# Oyster Harvests in Aransas Bay:
# A Regression Analysis

## Harvest vs Freshwater Inflows

F. Michael Speed
Michael Longnecker
Birgir Hrafnkelsson

*Department of Statistics*
*Texas A&M University*

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# 1. Summary Report

## 1.1 Description of the Problem[1]

Bimonthly freshwater inflows into Aransas Bay were recorded for the years 1962 to 1994. These variables, and various transformations of them, were used to construct a model for the annual harvest of oyster.

## 1.2 Constructing Models - General Discussion

Stability of coefficient estimates and accuracy of predicted values are primary goals in constructing models for prediction. To this end, the data must be examined from three points of view: individual observations (to detect outliers or influential points); variables, individually and in groups (to select an optimal set of predictors); and the interaction of these two, which produces the overall structure of the data set (to determine whether multicollinearity is present or not). The first two of these were examined by both graphic and quantitative means; the third by quantitative means only.

### 1.2.1 Detecting Influential Points and Outliers

The structures of individual variables were examined via box plots and histograms, as well as by all the usual numerical measures. For each pair of variables, 99 % prediction ellipses and 95% confidence regions were plotted in a further effort to look for unusual points. For example, suppose large values of Variable A are generally associated with large values for Variable B. If an observation consisted of a large value for Variable A but a small value for Variable B, that point would be considered unusual, even though it was well within the range of data for both variables and could not be considered an outlier.

In addition, a number of residual analysis techniques were employed. A large residual indicates a point not well-fit by the model. The deleted residual, however, is somewhat more useful in the search for influential points. The model is fitted without a given observation, and the predicted response and corresponding residual are calculated for that observation. The Studentized deleted residual is scaled to have a Student's $t$ distribution. Histograms and normal P-P plots of the residuals were also examined.

Other quantities, such as the Mahalanobis distance, Cook's distance, the leverage value, standarized values for the *Dffits* (to measure the influence of a given observation on the predicted response) and the *Dfbetas* (to measure the influence of a given observation on the calculated coefficients) were also used to build a general picture of the influence of individual points. Plots were made of the standardized *Dffits* value for each model against the standardized *Dfbeta* values for each predictor in the model. Points which were extreme indicated observations which had strong effects on both predicted values and coefficient estimates.

1 The following discussion, prepared by Jacqueline Kiffe, was taken from Seatrout Harvest in Galveston Bay: A Regression Analysis, by F. Michael Speed, Sr. and Jacqueline Kiffe.

### 1.2.2 Variable Selection

For each regression, residuals were plotted against each of the independent variables to look for nonlinear relationships between the response variable and individual predictors. Partial residual plots were employed to examine the overall relationship between the response and individual predictors. A partial residual is a corollary to the deleted residual. That is, the model is fitted without a given variable and the predicted response and corresponding residual are calculated for each observation. This seeks to answer the question, "What is the relationship of this predictor to the response variable, taking all other variables into account?" Thus, it examines the marginal relationship of a given predictor to the response.

Numerous measures have been developed over the years to assess the adequacy of a given model. We examined a number of these, including $R^2$ and mean squared error (*MSE*), and several others which directly incorporate penalties for having too many predictors in the model, such as adjusted $R^2$, *Cp*, *AIC*, and *SBC*. It is well-established that too many predictors in a model can lead to bad prediction, just as too few can, and these measures are used as part of the attempt to find an optimal model.

### 1.2.3 Multicollinearity

Multicollinearity arises when one or more variables are nearly closely approximated by linear combinations of the remaining variables, resulting in unstable coefficient estimates. The variance inflation factor (*VIF*) was calculated for each coefficient estimate to measure this instability, which is not usually considered profound for *VIF*'s less than 10. No problems were found with this data. Additionally, the condition index (a ratio of eigenvalues of the covariance matrix, with the largest eigenvalue always on top) was calculated. A ratio greater than 30 is considered cause for concern. Again, no evidence of multicollinearity was found.

### 1.2.4 Other Procedures

Several other miscellaneous diagnostics, including the Durbin-Watson test for serial autocorrelation were performed, and no general problems were detected. The Box-Cox procedure, used to find a transformation to normality, was also performed.

## 1.3 How the Final Model Was Chosen

### 1.3.1 Selecting the Data Set Used

First, the variables were explored thoroughly, individually and in pairs, in a first effort to detect outliers. The SAS® programming language allows a number of diagnostics to be calculated for a group of models on a given data set without actually performing a formal regression, thus allowing one to examine a large number of models quite efficiently. The Box-Cox procedure was performed to find if a transformation to normallity was suggested. The log transform was suggested for some variables, and the squared root for others. At this point, there were several data sets for which the diagnostic series was calculated:

1. Untransformed oyster data and untransformed inflow data
2. Untransformed oyster data and log of inflow data
3. Log of oyster data and log of inflow data
4. Log of oyster data and square root of inflow data
5. Square root of oyster data and log of inflow data
6. Various transformation suggested by Box-Cox

### 1.3.2 Selecting the Points to be Omitted

The full regression with all diagnostics was performed for these models, each one contained all variables in its corresponding data set. All diagnostics were generated, and influential points were determined for each model.

***Table 1.1*** *$R^2$ and Adjusted $R^2$ for full data sets.*

| Data Set | $R^2$ | Adj. $R^2$ |
|---|---|---|
| 1 | 0.0831 | -0.1461 |
| 2 | 0.2154 | 0.0193 |
| 3 | 0.3824 | 0.2280 |
| 4 | 0.2463 | 0.0579 |
| 5 | 0.2416 | 0.0520 |
| 6 | 0.3000 | 0.1250 |

Data sets 3, and 6 presented the highest $R^2$ values. These two models were considered final candidates. The observations flagged as potentially influential are given in the summary table below, for each model.

***Table 1.2*** *Summary of points flagged by Boxplots.*

| Year | Variable |
|---|---|
| None | None |

***Table 1.3*** *Summary of points flagged by 99% prediction ellipses.*

| Year | Variable |
|---|---|
| None | None |

***Table 1.4*** *Outliers of data set 3.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1962 | | | 1 | | | | 1 | 4 | 6 |
| 1989 | | | | | | | 1 | | |

***Table 1.5*** *Outliers of data set 6.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1962 | | | 1 | | | | 1 | 4 | 6 |
| 1985 | | | | | | | 1 | | |
| 1987 | | | | | | | 1 | | |

***A Key to Abbreviations:***

BOX Box plot
SRE Studentized residual
SDR Studentized deleted residual
LEV Leverage value
MAH Mahalanobis distance
COO Cook's distance
SDF Standardized Dffits value
SDB Standardized Dfbeta value

### 1.3.3 Selecting the Final Candidate Models

After the subset analysis led us to four models, Data Set 3 with 1962 omitted and Data Set 6 with 1962 omitted.

***Table 1.6*** *$R^2$ and Adjusted $R^2$ for data sets number 2, 3, 4 and 6.*

| Data set | Observations omitted | $R^2$ | Adj. $R^2$ |
|---|---|---|---|
| 3 | 1962 | 0.5268 | 0.4511 |
| 6 | 1962 | 0.5015 | 0.3976 |

### 1.3.4 Selecting the Final Models

It appears that Data set 3 with 1962 omitted is the best model. Regression was performed using this model, and the deleted residuals were calculated.

Ln(Oyster Harvest) = - 2.25585 + 0.71244*Ln(Jan.-Feb. Inflows)
- 0.31577*Ln(March-April Inflows)
+ 0.39876*Ln(Sept.-Oct. Inflows)
+ 0.74995*Ln(Nov.-Dec. Inflows)

## 1.4 Best Model: Logged Harvest and Logged Inflows

### 1.4.1 Summary Information

***Table 1.7*** *Descriptive statistics for dependent and independent variables.*

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| Ln(Oyster Harvest) | 3.268347 | 1.975355 | 30 |
| Ln(January-February Inflows) | 3.168343 | 1.238040 | 30 |
| Ln(March-April Inflows) | 3.048677 | 1.211017 | 30 |
| Ln(September-October Inflows) | 4.434336 | 1.442716 | 30 |
| Ln(November-December Inflows) | 3.282089 | 1.034712 | 30 |

***Table 1.8*** *Model summary for the final model.*

**Model Summary[a,b]**

| Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| Ln(November-December), Ln(September-October), Ln(March-April), Ln(January-February)[c,d] | .726 | .527 | .451 | 1.463453 | .901 |

a. Dependent Variable: Ln(Oyster Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Ln(November-December Inflows), Ln(September-October Inflows), Ln(March-April Inflows), Ln(January-February Inflows)

d. All requested variables entered.

***Table 1.9*** *Anova for the final model.*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 59.616 | 4 | 14.904 | 6.959 | .001[b] |
| | Residual | 53.542 | 25 | 2.142 | | |
| | Total | 113.159 | 29 | | | |

a. Dependent Variable: Ln(Oyster Harvest)

b. Independent Variables: (Constant), Ln(November-December Inflows), Ln(September-October Inflows), Ln(March-April Inflows), Ln(January-February Inflows)

***Table 1.10*** *Parameter estimates for the final model.*

**Coefficients**[a]

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | -2.256 | 1.192 | | -1.893 | .070 | -4.710 | .198 |
| Ln(January-February) | .712 | .306 | .447 | 2.328 | .028 | .082 | 1.343 |
| Ln(March-April) | -.316 | .312 | -.194 | -1.011 | .322 | -.959 | .327 |
| Ln(September-October) | .399 | .193 | .291 | 2.068 | .049 | .002 | .796 |
| Ln(November-December) | .750 | .310 | .393 | 2.421 | .023 | .112 | 1.388 |

a. Dependent Variable: Ln(Oyster Harvest)

***Table 1.11*** *Residuals statistics for the final model.*

**Residuals Statistics**[a]

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | .793875 | 5.634352 | 3.268347 | 1.433785 | 30 |
| Std. Predicted Value | -1.726 | 1.650 | .000 | 1.000 | 30 |
| Standard Error of Predicted Value | .370817 | .780469 | .588796 | .103063 | 30 |
| Adjusted Predicted Value | .621379 | 6.103640 | 3.310183 | 1.430660 | 30 |
| Residual | -2.275992 | 3.120659 | 1.2E-16 | 1.358782 | 30 |
| Std. Residual | -1.555 | 2.132 | .000 | .928 | 30 |
| Stud. Residual | -1.838 | 2.306 | -.013 | 1.026 | 30 |
| Deleted Residual | -3.180607 | 3.650951 | -4.2E-02 | 1.661112 | 30 |
| Stud. Deleted Residual | -1.937 | 2.547 | -.010 | 1.061 | 30 |
| Mahal. Distance | .895 | 7.281 | 3.867 | 1.654 | 30 |
| Cook's Distance | .000 | .269 | .046 | .062 | 30 |
| Centered Leverage Value | .031 | .251 | .133 | .057 | 30 |

a. Dependent Variable: Ln(Oyster Harvest)

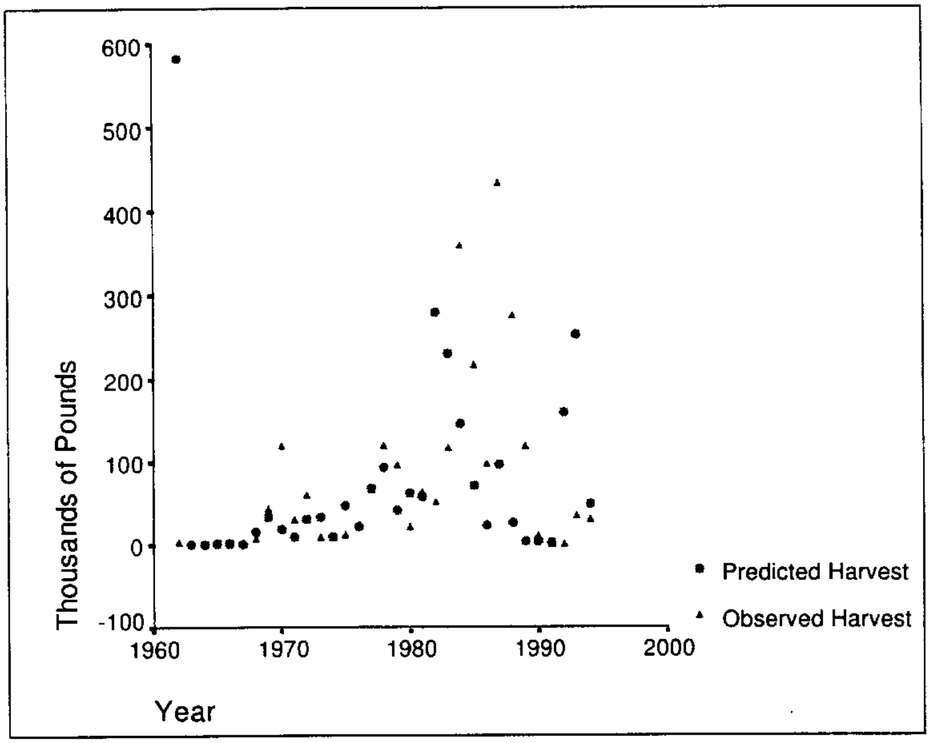


***Figure 1.1*** *Predicted and observed values for the harvest.*

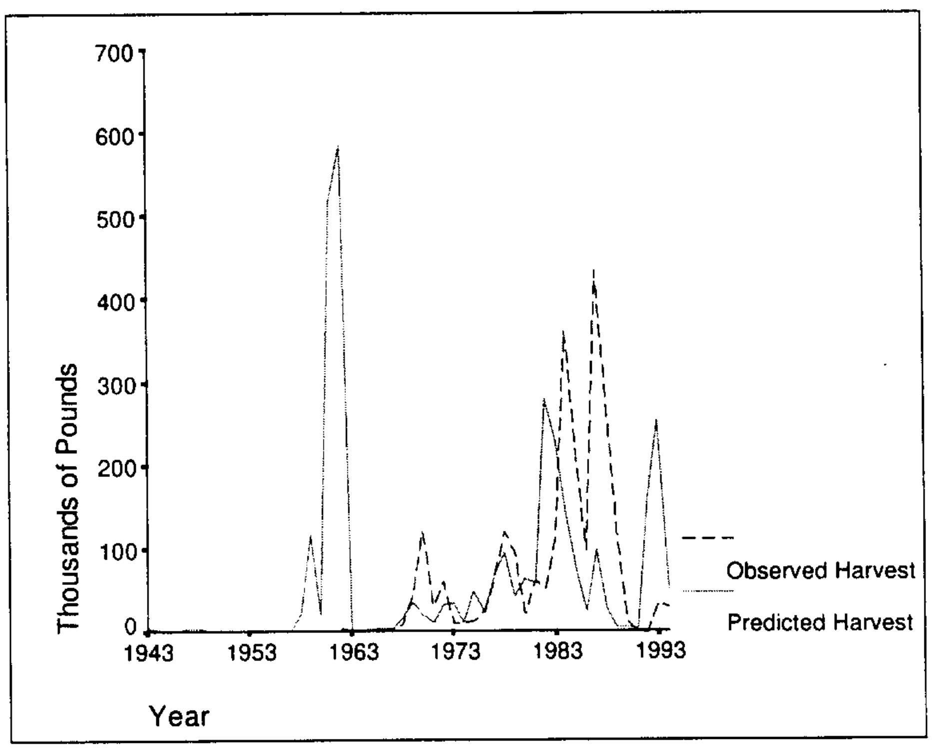


***Figure 1.2*** *Predicted and observed values for the harvest.*

***Table 1.12*** *Prediction Intervals for Oyster Harvest based on the final model.*

| YEAR | *OYSTER* | *PRE_1* | *LICI_1* | *UICI_1* |
|---|---|---|---|---|
| 1962 | 3.10 | 584.71 | 5.08 | 67355.51 |
| 1963 | .70 | 2.30 | .02 | 216.14 |
| 1964 | .30 | 2.43 | .03 | 207.20 |
| 1965 | .30 | 2.92 | .03 | 297.42 |
| 1966 | .90 | 4.07 | .05 | 353.97 |
| 1967 | 3.80 | 2.21 | .02 | 208.41 |
| 1968 | 8.30 | 16.77 | .18 | 1555.89 |
| 1969 | 43.90 | 34.74 | .35 | 3447.10 |
| 1970 | 120.20 | 19.61 | .27 | 1422.03 |
| 1971 | 30.00 | 11.07 | .16 | 769.02 |
| 1972 | 60.60 | 31.48 | .41 | 2396.29 |
| 1973 | 9.90 | 34.17 | .45 | 2586.46 |
| 1974 | 9.90 | 11.68 | .16 | 877.79 |
| 1975 | 12.40 | 48.04 | .54 | 4248.64 |
| 1976 | 24.20 | 22.64 | .26 | 1995.53 |
| 1977 | 65.60 | 69.45 | .91 | 5302.40 |
| 1978 | 120.00 | 94.51 | 1.25 | 7129.91 |
| 1979 | 96.00 | 42.76 | .64 | 2874.73 |
| 1980 | 21.60 | 63.56 | .78 | 5153.53 |
| 1981 | 62.40 | 58.46 | .73 | 4663.92 |
| 1982 | 51.50 | 279.88 | 3.53 | 22201.13 |
| 1983 | 117.10 | 231.56 | 2.90 | 18473.49 |
| 1984 | 360.00 | 146.85 | 1.99 | 10855.62 |
| 1985 | 216.80 | 72.68 | .94 | 5646.05 |
| 1986 | 97.10 | 24.24 | .27 | 2140.39 |
| 1987 | 433.20 | 97.15 | 1.05 | 8958.95 |
| 1988 | 276.40 | 27.84 | .35 | 2234.30 |
| 1989 | 118.60 | 5.23 | .07 | 411.82 |
| 1990 | 11.20 | 4.81 | .07 | 353.83 |
| 1993 | 34.60 | 253.54 | 2.79 | 23036.14 |
| 1994 | 29.60 | 49.96 | .67 | 3743.20 |

| | |
|---|---|
| *OYSTER* | Observed oyster harvest |
| *PRE_!* | Predicted oyster harvest |
| *LICI_1* | Lower limit for 99% prediction interval for the oyster harvest. |
| *UICI_1* | Upper limit for 99% prediction interval for the oyster harvest. |

# 2. EXPLORING THE DATA

## 2.1 Listing of data

***Table 2.1*** *The oyster data and the inflow data.*

| Year | *Oyster* | *JF_inflow* | *MA_inflow* | *MJ_inflow* | *JA_inflow* | *SO_inflow* | *ND_inflow* |
|---|---|---|---|---|---|---|---|
| 1962 | 3.10 | 101.62 | 8.13 | 22.26 | 13.73 | 286.38 | 146.58 |
| 1963 | .70 | 1.24 | 2.09 | 12.16 | 2.40 | 36.80 | 10.03 |
| 1964 | .30 | 3.06 | 3.19 | 6.75 | 39.26 | 11.26 | 10.30 |
| 1965 | .30 | 15.50 | 4.71 | 30.83 | 39.44 | 5.03 | 5.09 |
| 1966 | .90 | 22.85 | 53.73 | 171.90 | 12.23 | 7.49 | 12.36 |
| 1967 | 3.80 | 11.25 | 52.24 | 165.90 | 22.84 | 6.84 | 11.14 |
| 1968 | 8.30 | 9.83 | 4.45 | 308.94 | 48.16 | 735.03 | 5.56 |
| 1969 | 43.90 | 54.63 | 29.10 | 316.63 | 40.24 | 750.61 | 6.28 |
| 1970 | 120.20 | 55.55 | 54.13 | 105.72 | 16.43 | 21.54 | 24.73 |
| 1971 | 30.00 | 10.45 | 29.66 | 82.72 | 29.17 | 63.92 | 24.55 |
| 1972 | 60.60 | 13.22 | 21.79 | 186.87 | 46.60 | 595.65 | 21.22 |
| 1973 | 9.90 | 15.96 | 28.76 | 409.35 | 42.60 | 562.30 | 22.94 |
| 1974 | 9.90 | 8.32 | 12.59 | 271.14 | 16.99 | 304.44 | 9.96 |
| 1975 | 12.40 | 6.13 | 6.20 | 46.73 | 8.42 | 439.28 | 53.58 |
| 1976 | 24.20 | 4.45 | 13.50 | 35.02 | 127.65 | 178.24 | 59.71 |
| 1977 | 65.60 | 29.96 | 48.51 | 152.22 | 131.89 | 67.60 | 124.81 |
| 1978 | 120.00 | 41.79 | 39.51 | 158.18 | 12.04 | 63.88 | 129.69 |
| 1979 | 96.00 | 63.16 | 32.13 | 85.82 | 88.02 | 62.04 | 28.32 |
| 1980 | 21.60 | 111.42 | 31.82 | 59.09 | 214.91 | 212.52 | 14.50 |
| 1981 | 62.40 | 77.77 | 17.95 | 305.34 | 304.68 | 244.25 | 13.32 |
| 1982 | 51.50 | 101.88 | 29.18 | 338.25 | 179.88 | 187.08 | 117.59 |
| 1983 | 117.10 | 105.36 | 29.86 | 76.67 | 200.04 | 107.60 | 119.87 |
| 1984 | 360.00 | 78.59 | 19.09 | 37.88 | 196.61 | 283.59 | 42.69 |
| 1985 | 216.80 | 70.47 | 115.47 | 37.90 | 9.60 | 340.91 | 35.86 |
| 1986 | 97.10 | 16.42 | 113.88 | 50.42 | 14.71 | 107.66 | 60.71 |
| 1987 | 433.20 | 30.46 | 5.11 | 130.03 | 31.50 | 64.87 | 76.16 |
| 1988 | 276.40 | 25.69 | 5.44 | 120.87 | 27.08 | 26.54 | 27.93 |
| 1989 | 118.60 | 6.06 | 2.78 | 21.82 | 17.08 | 31.01 | 8.23 |
| 1990 | 11.20 | 12.34 | 30.45 | 16.36 | 193.50 | 22.82 | 12.06 |
| 1991 | . | 21.30 | 60.09 | 35.14 | 190.31 | 8.15 | 13.73 |
| 1992 | . | 164.68 | 236.13 | 298.03 | 35.59 | 80.72 | 133.00 |
| 1993 | 34.60 | 237.91 | 269.63 | 607.54 | 32.58 | 93.11 | 170.21 |
| 1994 | 29.60 | 90.63 | 88.99 | 382.20 | 15.88 | 27.78 | 58.23 |

| | |
|---|---|
| Oyster | Oyster harvest (thousands of pounds) |
| JF_inflow | Lagged January-February inflows (thousands of acre-feet) |
| MA_inflow | Lagged March-April inflows (thousands of acre-feet) |
| MJ_inflow | Lagged May-June inflows (thousands of acre-feet) |
| JA_inflow | Lagged July-August inflows (thousands of acre-feet) |
| SO_inflow | Lagged September-October inflows (thousands of acre-feet) |
| ND_inflow | Lagged November-December inflows (thousands of acre-feet) |

## 2.2 Examination of Individual Variables

***Table .2.2*** *Test of Normality for the oyster data and the inflow data.*

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Oyster Harvest | .232 | 31 | .000 | .719 | 31 | .010** |
| Ln(Oyster Harvest) | .120 | 31 | .200* | .923 | 31 | .039 |
| Square Root of Flounder Harvest | .110 | 31 | .200* | .914 | 31 | .020 |
| January-February Inflows | .204 | 31 | .002 | .784 | 31 | .010** |
| Ln(January-February Inflows) | .123 | 31 | .200* | .968 | 31 | .527 |
| Square Root of January-February Inflows | .162 | 31 | .038 | .927 | 31 | .047 |
| March-April Inflows | .261 | 31 | .000 | .639 | 31 | .010** |
| Ln(March-April Inflows) | .160 | 31 | .042 | .963 | 31 | .443 |
| Square Root of March-April Inflows | .171 | 31 | .021 | .878 | 31 | .010** |
| May-June Inflows | .161 | 31 | .040 | .852 | 31 | .010** |
| Ln(May-June Inflows) | .094 | 31 | .200* | .966 | 31 | .486 |
| Square Root of May-June Inflows | .107 | 31 | .200* | .947 | 31 | .203 |
| July-August Inflows | .318 | 31 | .000 | .752 | 31 | .010** |
| Ln(July-August Inflows) | .126 | 31 | .200* | .951 | 31 | .267 |
| Square Root of July-August Inflows | .236 | 31 | .000 | .860 | 31 | .010** |
| September-October Inflows | .231 | 31 | .000 | .794 | 31 | .010** |
| Ln(September-October Inflows) | .109 | 31 | .200* | .953 | 31 | .293 |
| Square Root of September-October Inflows | .164 | 31 | .034 | .913 | 31 | .019 |
| November-December Inflows | .234 | 31 | .000 | .796 | 31 | .010** |
| Ln(November-December Inflows) | .121 | 31 | .200* | .941 | 31 | .111 |
| Square Root of November-December Inflows | .173 | 31 | .019 | .884 | 31 | .010** |

**. This is an upper bound of the true significance.

*. This is a lower bound of the true significance.

a. *Lilliefors Significance Correction*

***Table .2.3*** *Percentiles of the oyster data and the inflow data.*

**Percentiles**

| | | Percentiles | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 10 | 25 | 50 | 75 | 90 | 95 |
| Weighted Average(Definition 1) | Oyster Harvest | .3000 | .7400 | 9.9000 | 34.6000 | 117.1000 | 264.4800 | 389.2800 |
| | Ln(Oyster Harvest) | -1.20397 | -.306412 | 2.292535 | 3.543854 | 4.763028 | 5.573274 | 5.960142 |
| | Square Root of Flounder Harvest | .547723 | .859065 | 3.146427 | 5.882176 | 10.8213 | 16.2451 | 19.7096 |
| | January-February Inflows | 2.3320 | 4.7720 | 10.4500 | 25.6900 | 77.7700 | 104.6640 | 162.0160 |
| | Ln(January-February Inflows) | .757094 | 1.554665 | 2.346602 | 3.246102 | 4.353756 | 4.650666 | 5.016741 |
| | Square Root of January-February Inflows | 1.494992 | 2.179943 | 3.232646 | 5.068530 | 8.818730 | 10.2303 | 12.5031 |
| | March-April Inflows | 2.5040 | 3.4420 | 6.2000 | 29.1000 | 48.5100 | 108.9020 | 177.1340 |
| | Ln(March-April Inflows) | .908336 | 1.226598 | 1.824549 | 3.370738 | 3.881770 | 4.685821 | 5.088227 |
| | Square Root of March-April Inflows | 1.578673 | 1.850746 | 2.489980 | 5.394442 | 6.964912 | 10.4239 | 13.0156 |
| | May-June Inflows | 9.9960 | 17.4520 | 37.8800 | 105.7200 | 271.1400 | 373.4100 | 488.6260 |
| | Ln(May-June Inflows) | 2.262708 | 2.852437 | 3.634423 | 4.660794 | 5.602635 | 5.921512 | 6.172510 |
| | Square Root of May-June Inflows | 3.131502 | 4.170037 | 6.154673 | 10.2820 | 16.4663 | 19.3183 | 21.9988 |
| | July-August Inflows | 6.0120 | 10.0880 | 15.8800 | 32.5800 | 127.6500 | 199.3540 | 250.8180 |
| | Ln(July-August Inflows) | 1.628553 | 2.307057 | 2.765060 | 3.483699 | 4.849292 | 5.295058 | 5.509836 |
| | Square Root of July-August Inflows | 2.360712 | 3.172683 | 3.984972 | 5.707889 | 11.2982 | 14.1192 | 15.7779 |
| | September-October Inflows | 6.1160 | 8.2440 | 27.7800 | 93.1100 | 286.3800 | 588.9800 | 741.2620 |
| | Ln(September-October Inflows) | 1.799841 | 2.095106 | 3.324316 | 4.533782 | 5.657320 | 6.378130 | 6.608301 |
| | Square Root of September-October Inflows | 2.466310 | 2.860548 | 5.270674 | 9.649352 | 16.9228 | 24.2673 | 27.2258 |
| | November-December Inflows | 5.3720 | 6.6700 | 11.1400 | 24.7300 | 60.7100 | 128.7140 | 156.0320 |
| | Ln(November-December Inflows) | 1.680270 | 1.891453 | 2.410542 | 3.208017 | 4.106108 | 4.857476 | 5.047356 |
| | Square Root of November-December Inflows | 2.317220 | 2.578554 | 3.337664 | 4.972927 | 7.791662 | 11.3449 | 12.4828 |
| Tukey's Hinges | Oyster Harvest | | | 9.9000 | 34.6000 | 107.1000 | | |
| | Ln(Oyster Harvest) | | | 2.292535 | 3.543854 | 4.669385 | | |
| | Square Root of Flounder Harvest | | | 3.146427 | 5.882176 | 10.3376 | | |
| | January-February Inflows | | | 10.8500 | 25.6900 | 74.1200 | | |
| | Ln(January-February Inflows) | | | 2.383485 | 3.246102 | 4.304471 | | |
| | Square Root of January-February Inflows | | | 3.293374 | 5.068530 | 8.606686 | | |
| | March-April Inflows | | | 7.1650 | 29.1000 | 44.0100 | | |
| | Ln(March-April Inflows) | | | 1.960055 | 3.370738 | 3.779162 | | |
| | Square Root of March-April Inflows | | | 2.670648 | 5.394442 | 6.625305 | | |
| | May-June Inflows | | | 37.8900 | 105.7200 | 229.0050 | | |
| | Ln(May-June Inflows) | | | 3.634687 | 4.660794 | 5.416524 | | |
| | Square Root of May-June Inflows | | | 6.155485 | 10.2820 | 15.0682 | | |
| | July-August Inflows | | | 16.1550 | 32.5800 | 107.8350 | | |
| | Ln(July-August Inflows) | | | 2.782085 | 3.483699 | 4.663428 | | |
| | Square Root of July-August Inflows | | | 4.019183 | 5.707889 | 10.3401 | | |
| | September-October Inflows | | | 29.3950 | 93.1100 | 284.9850 | | |
| | Ln(September-October Inflows) | | | 3.379313 | 4.533782 | 5.652425 | | |
| | Square Root of September-October Inflows | | | 5.419668 | 9.649352 | 16.8814 | | |
| | November-December Inflows | | | 11.6000 | 24.7300 | 60.2100 | | |
| | Ln(November-December Inflows) | | | 2.450218 | 3.208017 | 4.097804 | | |
| | Square Root of November-December Inflows | | | 3.405207 | 4.972927 | 7.759443 | | |

### 2.2.1 The oyster data

***Table .2.4*** *Descriptives for the oyster data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| Oyster Harvest | Mean | | 78.7161 | 19.2575 |
| | 95% Confidence Interval for Mean | Lower Bound | 39.3870 | |
| | | Upper Bound | 118.0453 | |
| | 5% Trimmed Mean | | 64.8220 | |
| | Median | | 34.6000 | |
| | Variance | | 11496.4 | |
| | Std. Deviation | | 107.2215 | |
| | Minimum | | .30 | |
| | Maximum | | 433.20 | |
| | Range | | 432.90 | |
| | Interquartile Range | | 107.2000 | |
| | Skewness | | 2.091 | .421 |
| | Kurtosis | | 4.166 | .821 |

***Table .2.5*** *Extreme Values for the oyster data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| Oyster Harvest | Highest | 1 | 26 | 1987 | 433.20 |
| | | 2 | 23 | 1984 | 360.00 |
| | | 3 | 27 | 1988 | 276.40 |
| | | 4 | 24 | 1985 | 216.80 |
| | | 5 | 9 | 1970 | 120.20 |
| | Lowest | 1 | 4 | 1965 | .30 |
| | | 2 | 3 | 1964 | .30 |
| | | 3 | 2 | 1963 | .70 |
| | | 4 | 5 | 1966 | .90 |
| | | 5 | 1 | 1962 | 3.10 |

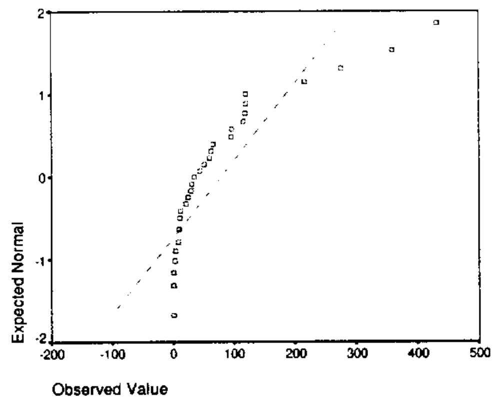


***Figure 2.1*** *Normal Q-Q Plot of Oyster Harvest.*

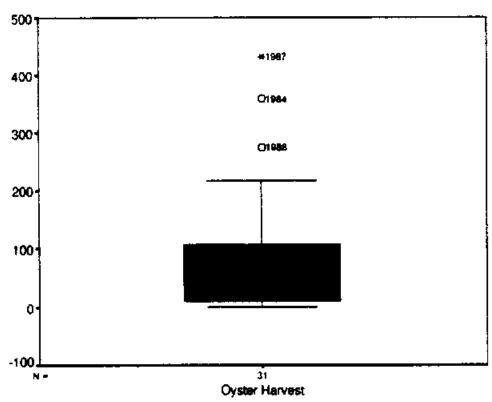


***Figure 2.2*** *BoxPlot of Oyster Harvest.*

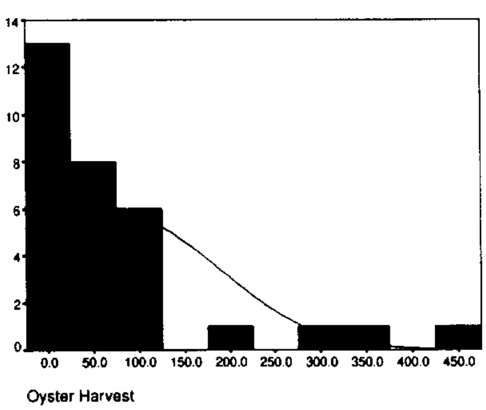


***Figure 2.3*** *Histogram of Oyster Harvest.*

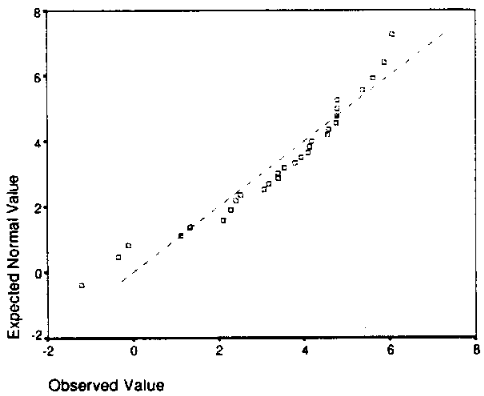


***Figure 2.4*** *Normal Q-Q Plot of Ln(Oyster Harvest).*

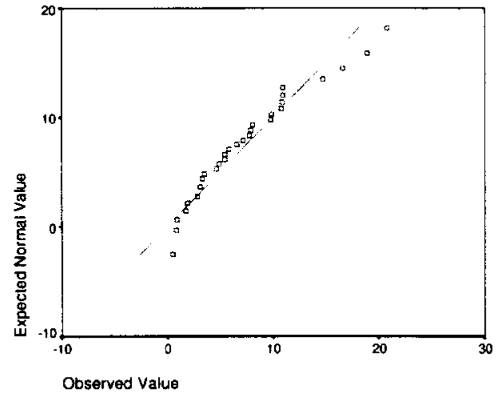


***Figure 2.5*** *Normal Q-Q Plot of Sqrt(Oyster Harvest).*

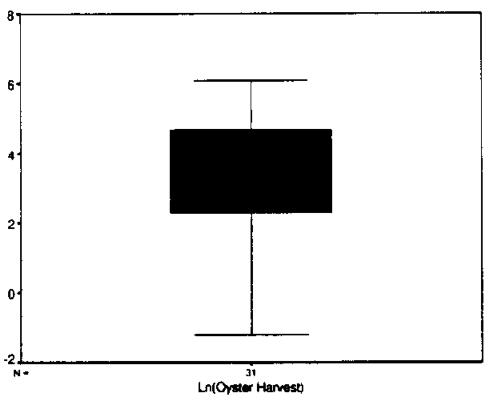


***Figure 2.6*** *BoxPlot of Ln(Oyster Harvest).*

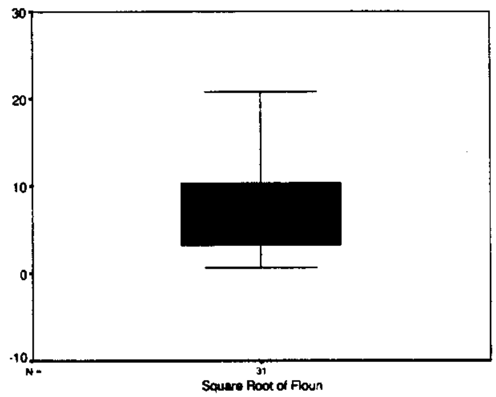


***Figure 2.7*** *BoxPlot of Sqrt(Oyster Harvest).*

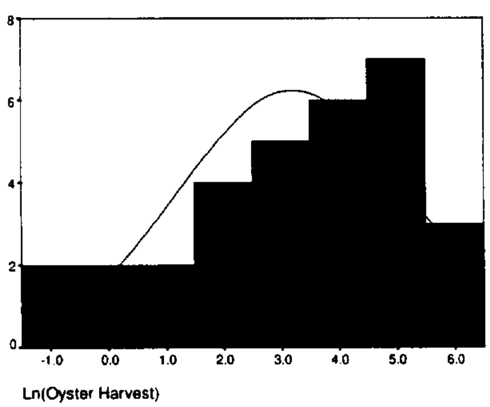


***Figure 2.8*** *Histogram of Ln(Oyster Harvest).*

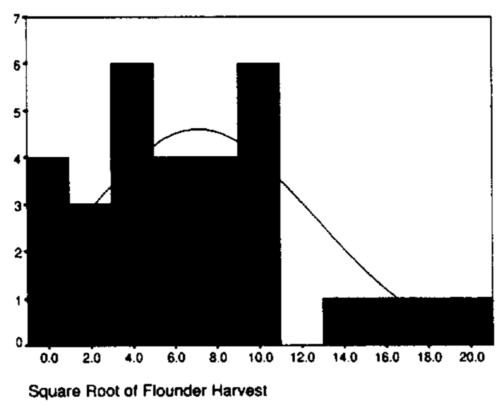


***Figure 2.9*** *Histogram of Sqrt(Oyster Harvest).*

### 2.2.2 The January-February Inflows data

***Table .2.6*** *Descriptives for the January-February Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| January-February Inflows | Mean | | 46.2571 | 9.0582 |
| | 95% Confidence Interval for Mean | Lower Bound | 27.7578 | |
| | | Upper Bound | 64.7564 | |
| | 5% Trimmed Mean | | 40.5683 | |
| | Median | | 25.6900 | |
| | Variance | | 2543.572 | |
| | Std. Deviation | | 50.4338 | |
| | Minimum | | 1.24 | |
| | Maximum | | 237.91 | |
| | Range | | 236.67 | |
| | Interquartile Range | | 67.3200 | |
| | Skewness | | 2.023 | .421 |
| | Kurtosis | | 5.696 | .821 |

***Table .2.7*** *Extreme Values for the January-February Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| January-February Inflows | Highest | 1 | 30 | 1993 | 237.91 |
| | | 2 | 19 | 1980 | 111.42 |
| | | 3 | 22 | 1983 | 105.36 |
| | | 4 | 21 | 1982 | 101.88 |
| | | 5 | 1 | 1962 | 101.62 |
| | Lowest | 1 | 2 | 1963 | 1.24 |
| | | 2 | 3 | 1964 | 3.06 |
| | | 3 | 15 | 1976 | 4.45 |
| | | 4 | 28 | 1989 | 6.06 |
| | | 5 | 14 | 1975 | 6.13 |

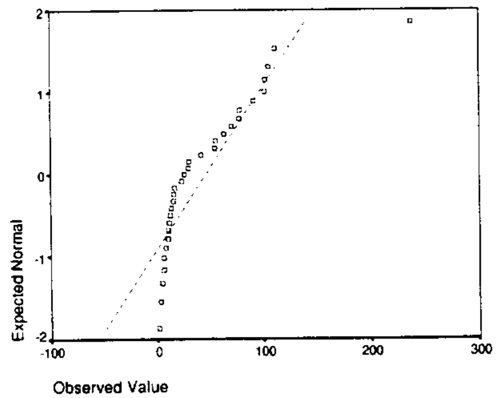


***Figure 2.10*** *Normal Q-Q Plot of January-February Inflows.*

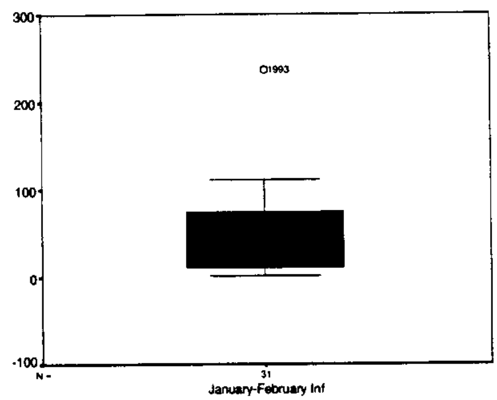


***Figure 2.11*** *BoxPlot of January-February Inflows.*

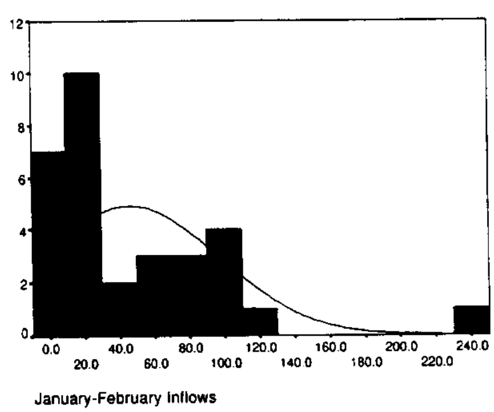


***Figure 2.12*** *Histogram of January-February Inflows.*

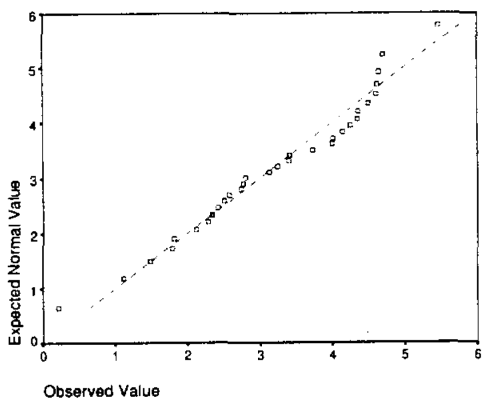


***Figure 2.13*** *Normal Q-Q Plot of Ln January-February Inflows).*

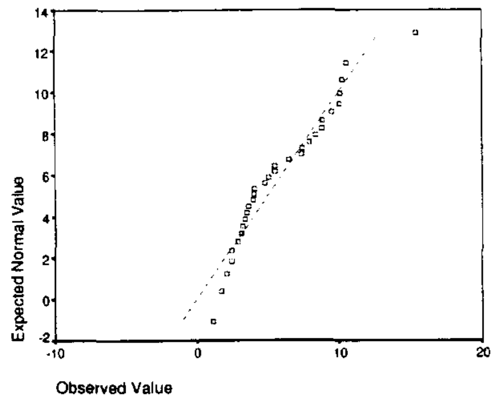


***Figure 2.14*** *Normal Q-Q Plot of Sqrt( January-February Inflows).*

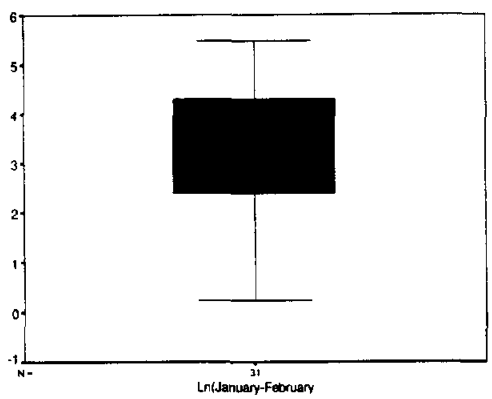


***Figure 2.15*** *BoxPlot of Ln(January-February Inflows).*

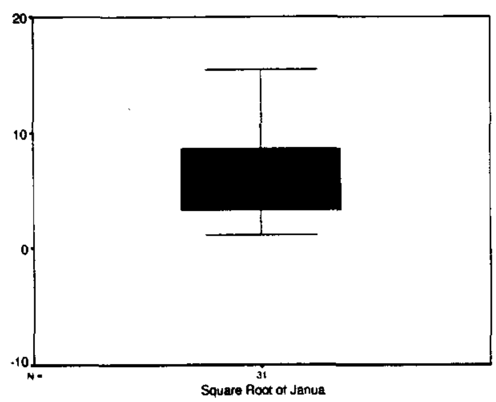


***Figure 2.16*** *BoxPlot of Square Root of January-February Inflows.*

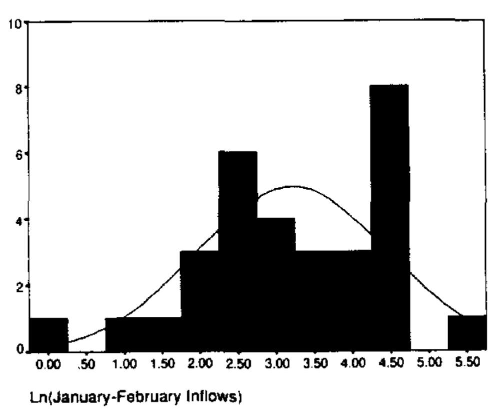


***Figure 2.17*** *Histogram of Ln(January-February Inflows).*

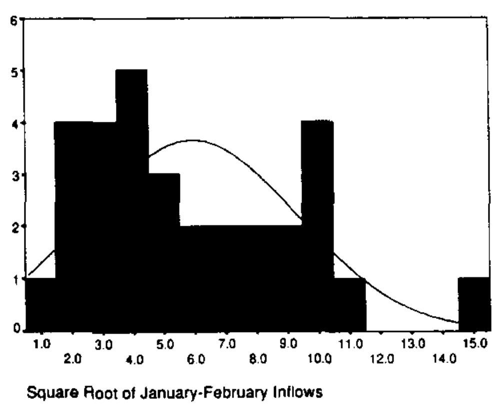


***Figure 2.18*** *Histogram of Sqrt(January-February Inflows).*

### 2.2.3 The March-April Inflows data

***Table .2.8*** *Descriptives for the March-April Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| March-April Inflows | Mean | | 38.8410 | 9.3676 |
| | 95% Confidence Interval for Mean | Lower Bound | 19.7097 | |
| | | Upper Bound | 57.9722 | |
| | 5% Trimmed Mean | | 31.0865 | |
| | Median | | 29.1000 | |
| | Variance | | 2720.335 | |
| | Std. Deviation | | 52.1568 | |
| | Minimum | | 2.09 | |
| | Maximum | | 269.63 | |
| | Range | | 267.54 | |
| | Interquartile Range | | 42.3100 | |
| | Skewness | | 3.234 | .421 |
| | Kurtosis | | 12.762 | .821 |

***Table .2.9*** *Extreme Values for the March-April Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| March-April Inflows | Highest | 1 | 30 | 1993 | 269.63 |
| | | 2 | 24 | 1985 | 115.47 |
| | | 3 | 25 | 1986 | 113.88 |
| | | 4 | 31 | 1994 | 88.99 |
| | | 5 | 9 | 1970 | 54.13 |
| | Lowest | 1 | 2 | 1963 | 2.09 |
| | | 2 | 28 | 1989 | 2.78 |
| | | 3 | 3 | 1964 | 3.19 |
| | | 4 | 7 | 1968 | 4.45 |
| | | 5 | 4 | 1965 | 4.71 |

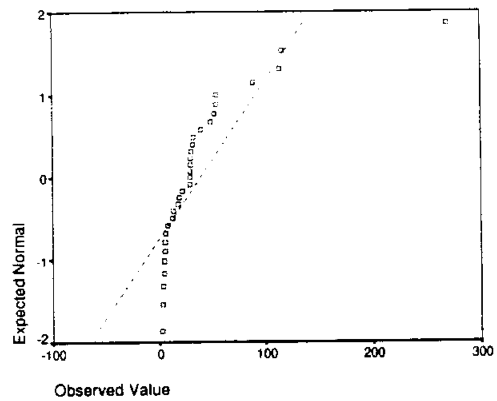


***Figure 2.19*** *Normal Q-Q Plot of March-April Inflows.*

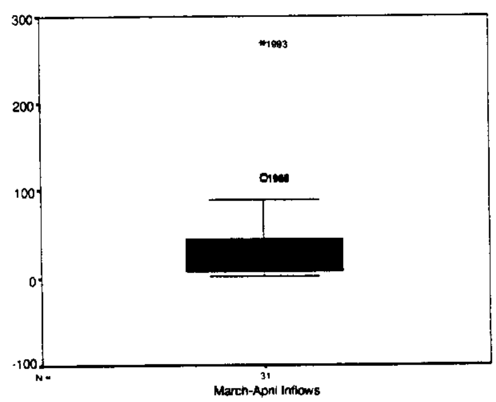


***Figure 2.20*** *BoxPlot of March-April Inflows.*

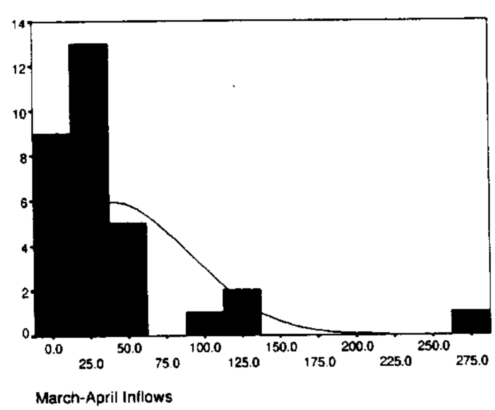


***Figure 2.21*** *Histogram of March-April Inflows.*

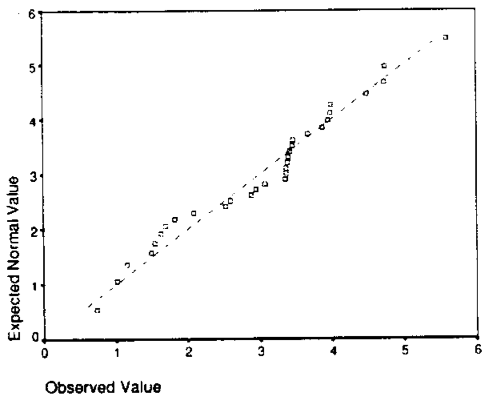


***Figure 2.22*** *Normal Q-Q Plot of Ln(March-April Inflows).*

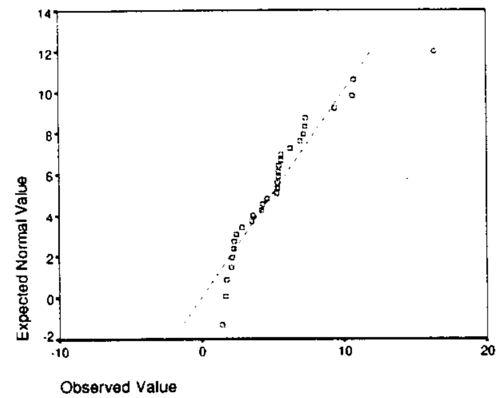


***Figure 2.23*** *Normal Q-Q Plot of Sqrt( March-April Inflows).*

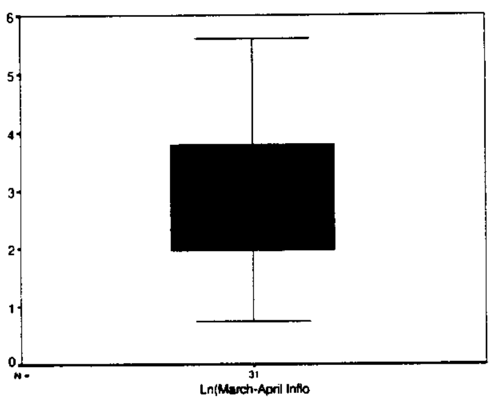


***Figure 2.24*** *BoxPlot of Ln(March-April) Inflows.*

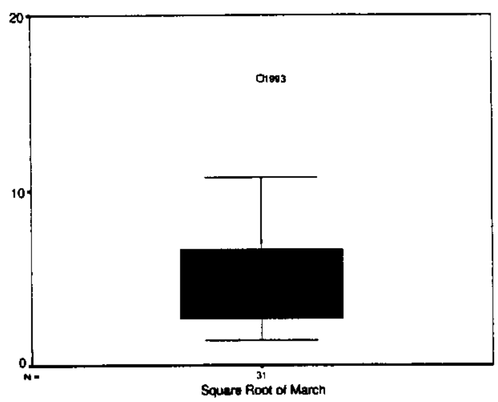


***Figure 2.25*** *BoxPlot of Square Root of March-April Inflows.*

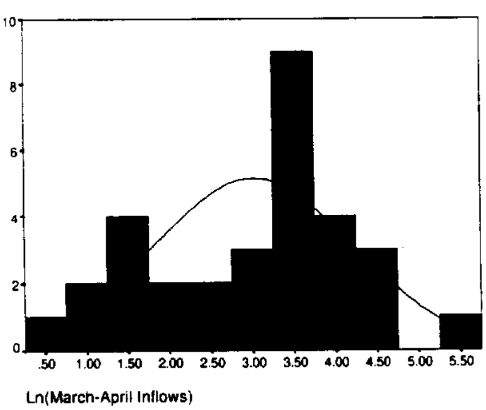


***Figure 2.26*** *Histogram of Ln(March-April Inflows).*

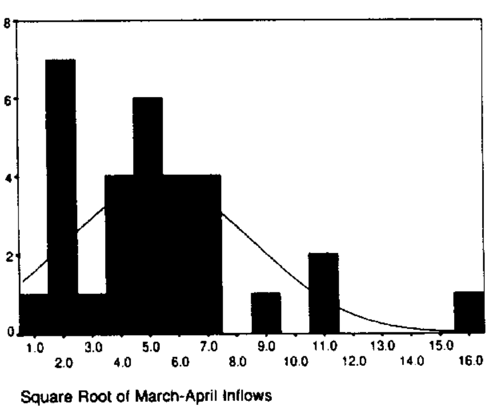


***Figure 2.27*** *Histogram of Sqrt(March-April Inflows).*

### 2.2.4 The May-June Inflows data

***Table .2.10*** *Descriptives for the May-June Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| May-June Inflows | Mean | | 153.3390 | 26.4041 |
| | 95% Confidence Interval for Mean | Lower Bound | 99.4146 | |
| | | Upper Bound | 207.2634 | |
| | 5% Trimmed Mean | | 140.0498 | |
| | Median | | 105.7200 | |
| | Variance | | 21612.5 | |
| | Std. Deviation | | 147.0119 | |
| | Minimum | | 6.75 | |
| | Maximum | | 607.54 | |
| | Range | | 600.79 | |
| | Interquartile Range | | 233.2600 | |
| | Skewness | | 1.324 | .421 |
| | Kurtosis | | 1.538 | .821 |

***Table .2.11*** *Extreme Values for the May-June Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| May-June Inflows | Highest | 1 | 30 | 1993 | 607.54 |
| | | 2 | 12 | 1973 | 409.35 |
| | | 3 | 31 | 1994 | 382.20 |
| | | 4 | 21 | 1982 | 338.25 |
| | | 5 | 8 | 1969 | 316.63 |
| | Lowest | 1 | 3 | 1964 | 6.75 |
| | | 2 | 2 | 1963 | 12.16 |
| | | 3 | 29 | 1990 | 16.36 |
| | | 4 | 28 | 1989 | 21.82 |
| | | 5 | 1 | 1962 | 22.26 |

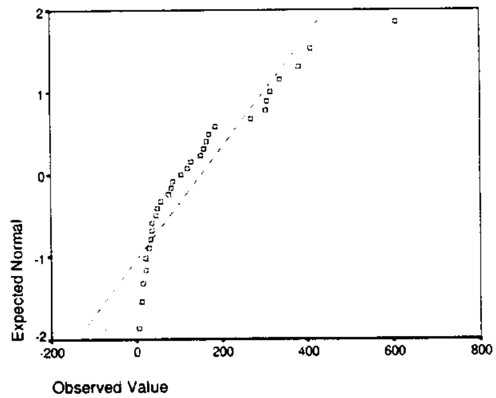


*Figure 2.28* Normal Q-Q Plot of May-June Inflows.

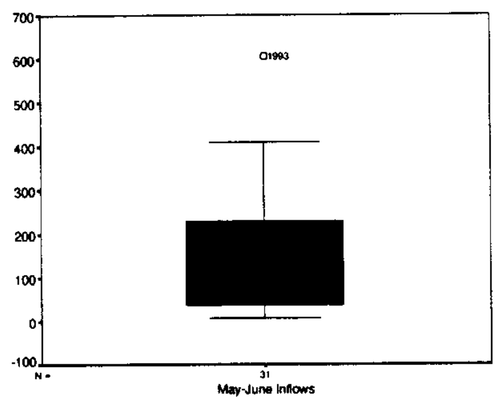


*Figure 2.29* BoxPlot of May-June Inflows.

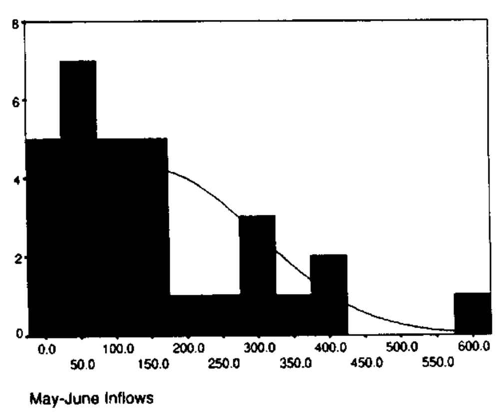


*Figure 2.30* Histogram of May-June Inflows.

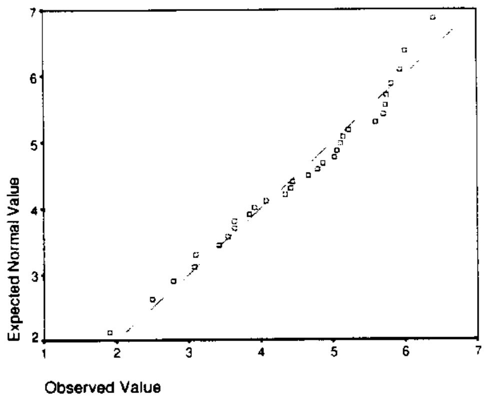


***Figure 2.31*** *Normal Q-Q Plot of Ln(May-June Inflows).*

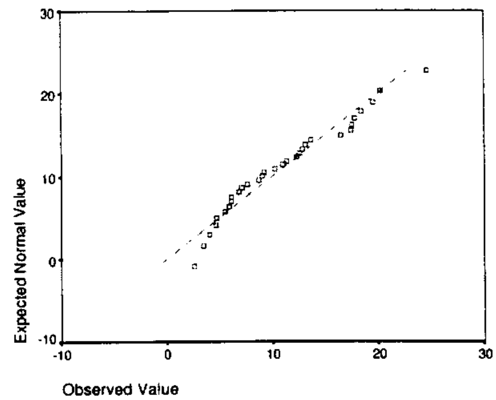


***Figure 2.32*** *Normal Q-Q Plot of Sqrt( May-June Inflows).*

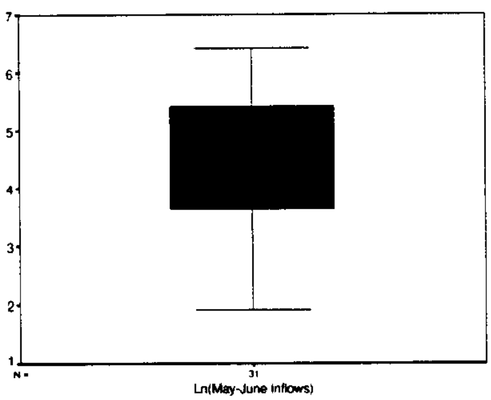


***Figure 2.33*** *BoxPlot of Ln(May-June) Inflows.*

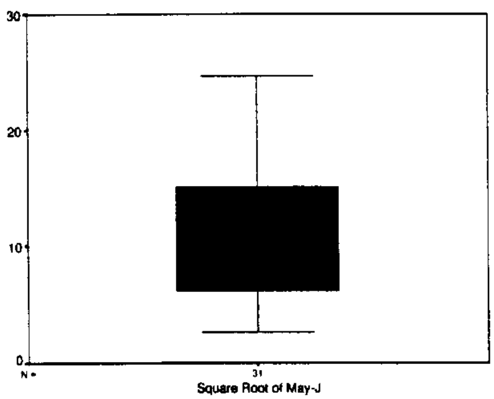


***Figure 2.34*** *BoxPlot of Square Root of May-June Inflows.*

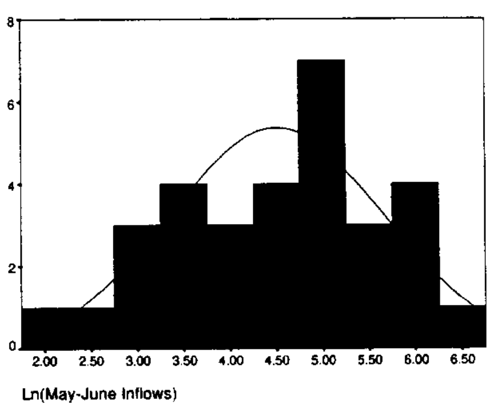


***Figure 2.35*** *Histogram of Ln(May-June Inflows).*

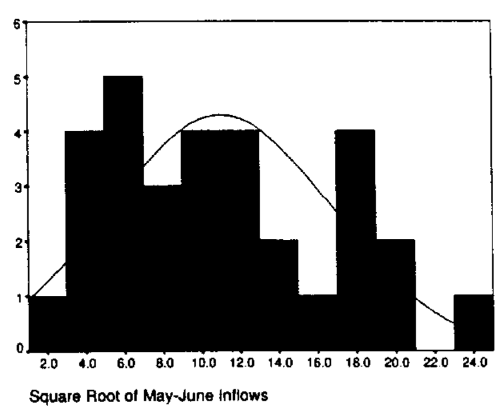


***Figure 2.36*** *Histogram of Sqrt(May-June Inflows).*

### 2.2.5 The July-August Inflows data

***Table .2.12*** *Descriptives for the July-August Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| July-August Inflows | Mean | | 70.1987 | 14.4174 |
| | 95% Confidence Interval for Mean | Lower Bound | 40.7544 | |
| | | Upper Bound | 99.6431 | |
| | 5% Trimmed Mean | | 62.5896 | |
| | Median | | 32.5800 | |
| | Variance | | 6443.744 | |
| | Std. Deviation | | 80.2729 | |
| | Minimum | | 2.40 | |
| | Maximum | | 304.68 | |
| | Range | | 302.28 | |
| | Interquartile Range | | 111.7700 | |
| | Skewness | | 1.456 | .421 |
| | Kurtosis | | 1.134 | .821 |

***Table .2.13*** *Extreme Values for the July-August Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| July-August Inflows | Highest | 1 | 20 | 1981 | 304.68 |
| | | 2 | 19 | 1980 | 214.91 |
| | | 3 | 22 | 1983 | 200.04 |
| | | 4 | 23 | 1984 | 196.61 |
| | | 5 | 29 | 1990 | 193.50 |
| | Lowest | 1 | 2 | 1963 | 2.40 |
| | | 2 | 14 | 1975 | 8.42 |
| | | 3 | 24 | 1985 | 9.60 |
| | | 4 | 17 | 1978 | 12.04 |
| | | 5 | 5 | 1966 | 12.23 |

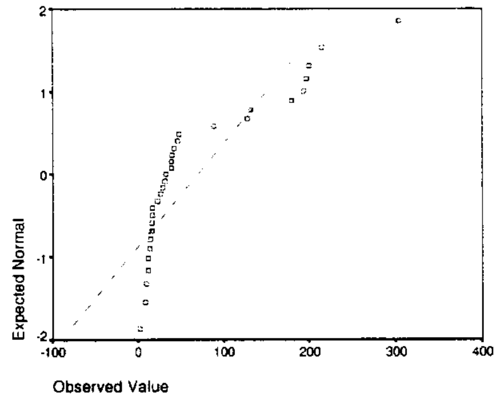


***Figure 2.37*** *Normal Q-Q Plot of July-August Inflows.*

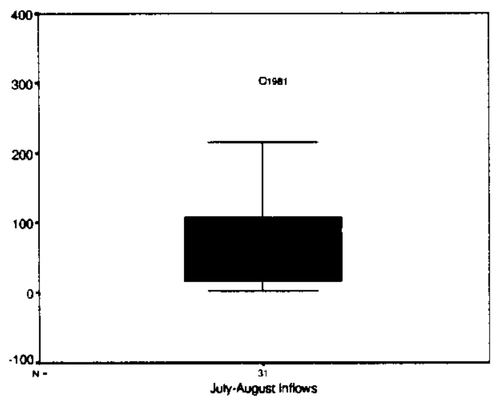


***Figure 2.38*** *BoxPlot of July-August Inflows.*

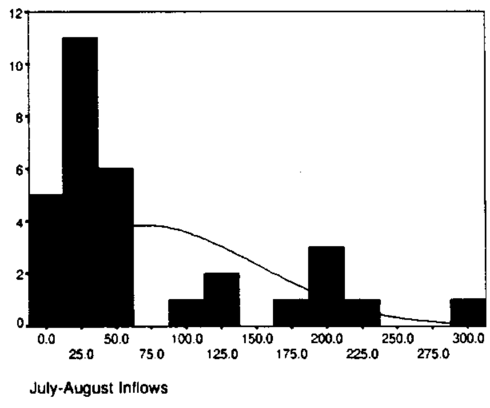


***Figure 2.39*** *Histogram of July-August Inflows.*

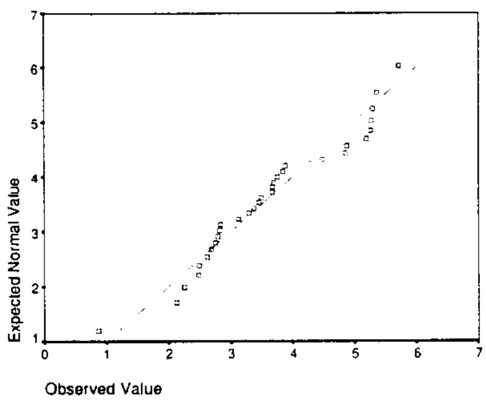


*Figure 2.40* Normal Q-Q Plot of Ln(July-August Inflows).

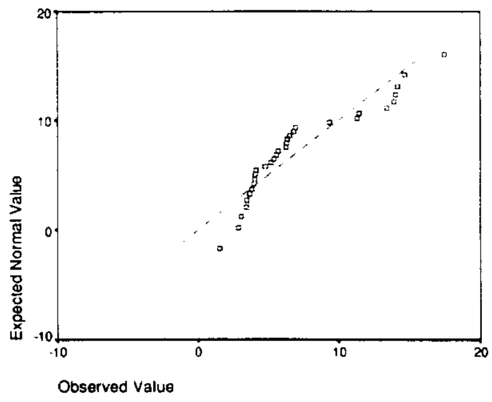


*Figure 2.41* Normal Q-Q Plot of Sqrt( July-August Inflows).

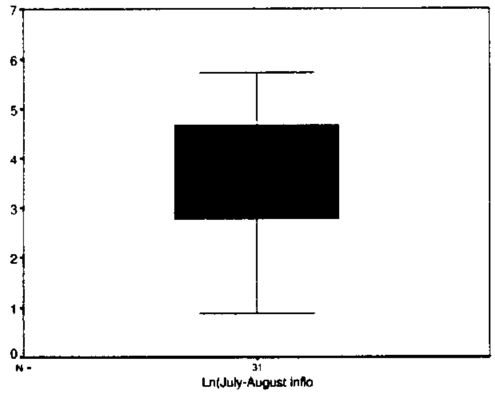


*Figure 2.42* BoxPlot of Ln(July-August) Inflows.

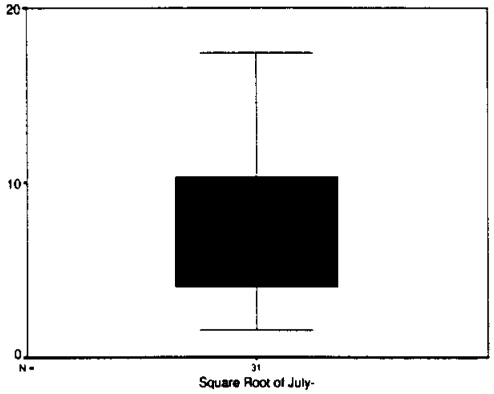


*Figure 2.43* BoxPlot of Square Root of July-August Inflows.

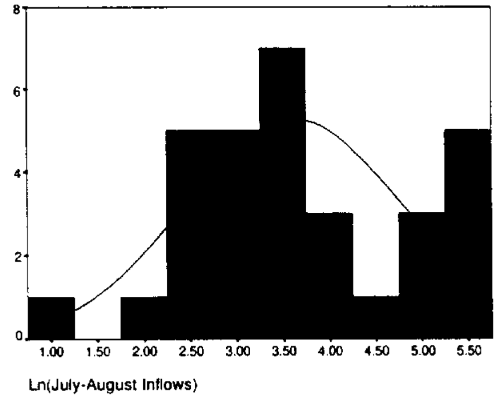


*Figure 2.44* Histogram of Ln(July-August Inflows).

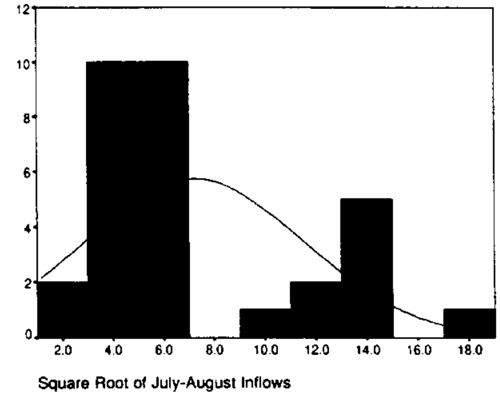


*Figure 2.45* Histogram of Sqrt(July-August Inflows).

## 2.2.6 The September-October Inflows data

***Table .2.14*** *Descriptives for the September-October Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| September-October Inflows | Mean | | 191.8732 | 39.1708 |
| | 95% Confidence Interval for Mean | Lower Bound | 111.8757 | |
| | | Upper Bound | 271.8708 | |
| | 5% Trimmed Mean | | 171.4839 | |
| | Median | | 93.1100 | |
| | Variance | | 47565.0 | |
| | Std. Deviation | | 218.0940 | |
| | Minimum | | 5.03 | |
| | Maximum | | 750.61 | |
| | Range | | 745.58 | |
| | Interquartile Range | | 258.6000 | |
| | Skewness | | 1.404 | .421 |
| | Kurtosis | | 1.084 | .821 |

***Table .2.15*** *Extreme Values for the September-October Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| September-October Inflows | Highest | 1 | 8 | 1969 | 750.61 |
| | | 2 | 7 | 1968 | 735.03 |
| | | 3 | 11 | 1972 | 595.65 |
| | | 4 | 12 | 1973 | 562.30 |
| | | 5 | 14 | 1975 | 439.28 |
| | Lowest | 1 | 4 | 1965 | 5.03 |
| | | 2 | 6 | 1967 | 6.84 |
| | | 3 | 5 | 1966 | 7.49 |
| | | 4 | 3 | 1964 | 11.26 |
| | | 5 | 9 | 1970 | 21.54 |

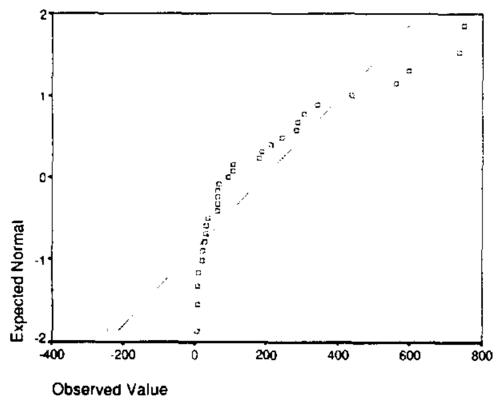


***Figure 2.46*** *Normal Q-Q Plot of September-October Inflows.*

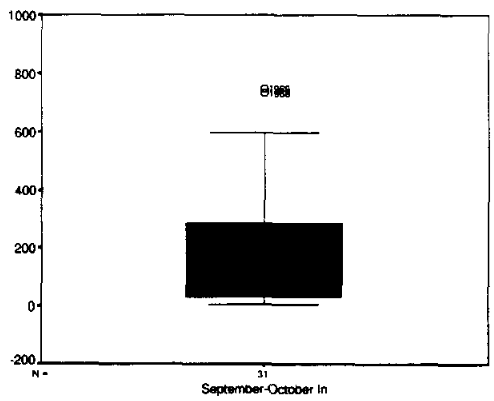


***Figure 2.47*** *BoxPlot of September-October Inflows.*

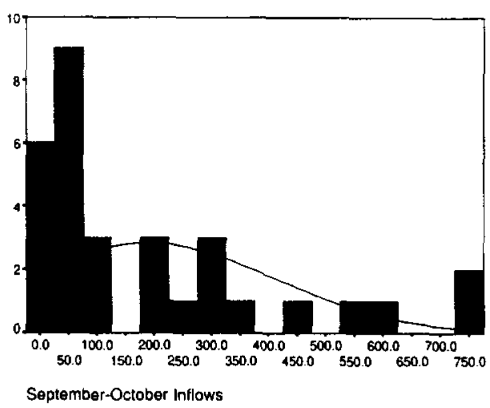


***Figure 2.48*** *Histogram of September-October Inflows.*

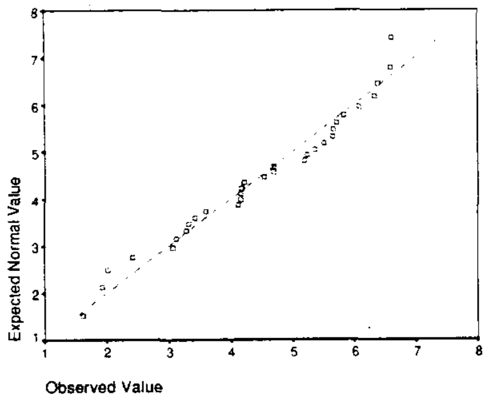


**Figure 2.49** *Normal Q-Q Plot of Ln(September-October Inflows).*

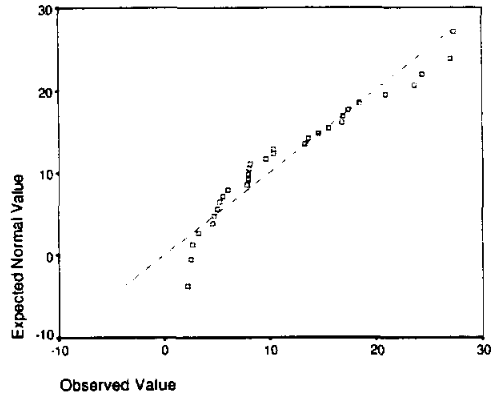


**Figure 2.50** *Normal Q-Q Plot of Sqrt( September-October Inflows).*

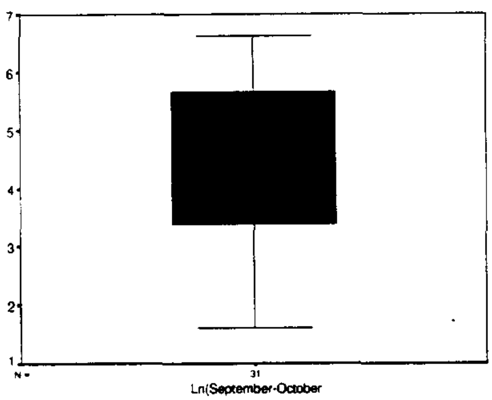


**Figure 2.51** *BoxPlot of Ln(September-October) Inflows.*

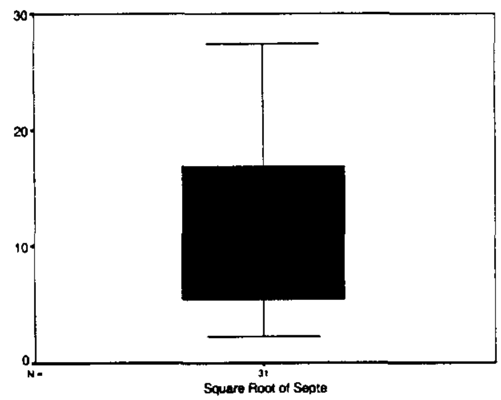


**Figure 2.52** *BoxPlot of Square Root of September-October Inflows.*

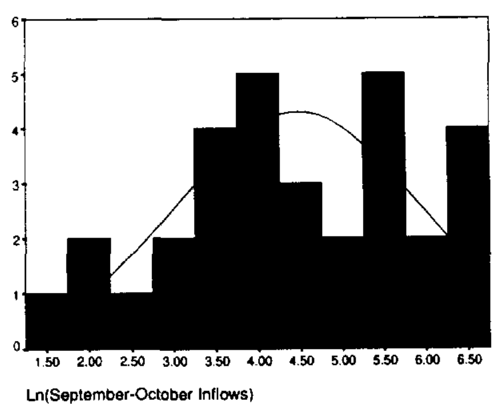


**Figure 2.53** *Histogram of Ln(September-October Inflows).*

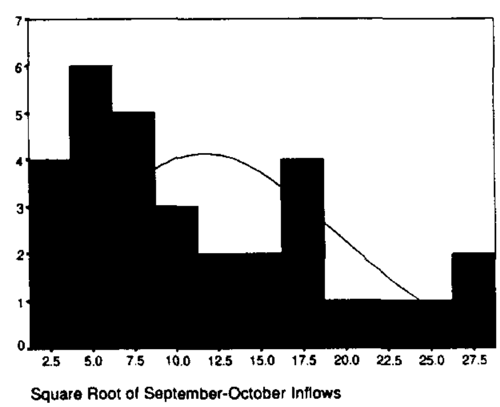


**Figure 2.54** *Histogram of Sqrt(September-October Inflows).*

## 2.2.7 The November-December Inflows data

***Table .2.16*** *Descriptives for the November-December Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| November-December Inflows | Mean | | 47.2326 | 8.6364 |
| | 95% Confidence Interval for Mean | Lower Bound | 29.5947 | |
| | | Upper Bound | 64.8704 | |
| | 5% Trimmed Mean | | 43.1983 | |
| | Median | | 24.7300 | |
| | Variance | | 2312.201 | |
| | Std. Deviation | | 48.0853 | |
| | Minimum | | 5.09 | |
| | Maximum | | 170.21 | |
| | Range | | 165.12 | |
| | Interquartile Range | | 49.5700 | |
| | Skewness | | 1.257 | .421 |
| | Kurtosis | | .388 | .821 |

***Table .2.17*** *Extreme Values for the November-December Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| November-December Inflows | Highest | 1 | 30 | 1993 | 170.21 |
| | | 2 | 1 | 1962 | 146.58 |
| | | 3 | 17 | 1978 | 129.69 |
| | | 4 | 16 | 1977 | 124.81 |
| | | 5 | 22 | 1983 | 119.87 |
| | Lowest | 1 | 4 | 1965 | 5.09 |
| | | 2 | 7 | 1968 | 5.56 |
| | | 3 | 8 | 1969 | 6.28 |
| | | 4 | 28 | 1989 | 8.23 |
| | | 5 | 13 | 1974 | 9.96 |

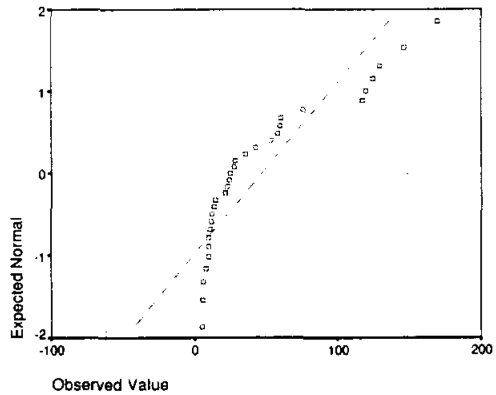


*Figure 2.55* Normal Q-Q Plot of November_December Inflows.

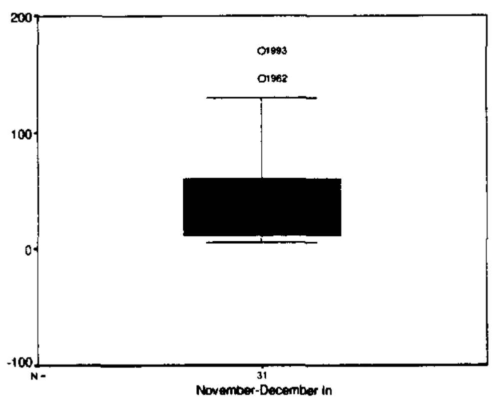


*Figure 2.56* BoxPlot of November_December Inflows.

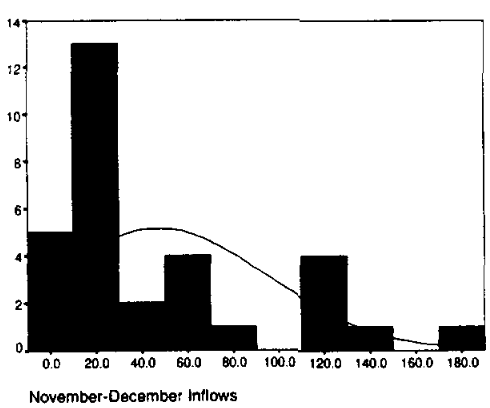


*Figure 2.57* Histogram of November_December Inflows.

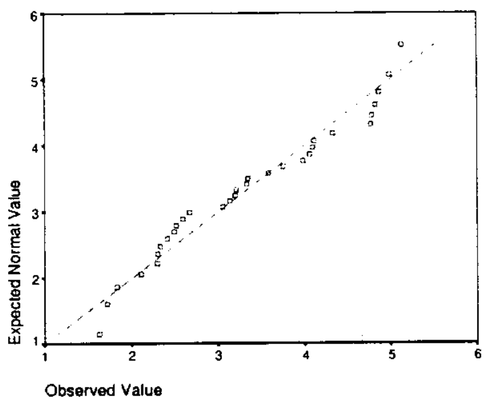


**Figure 2.58** *Normal Q-Q Plot of Ln(November_December Inflows).*

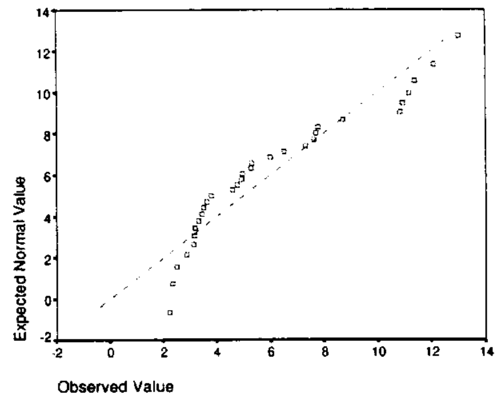


**Figure 2.59** *Normal Q-Q Plot of Sqrt( November_December Inflows).*

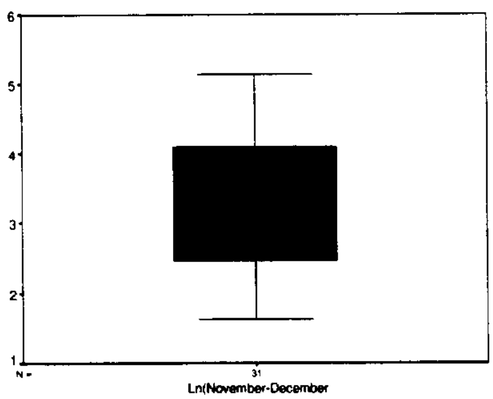


**Figure 2.60** *BoxPlot of Ln(November _December) Inflows.*

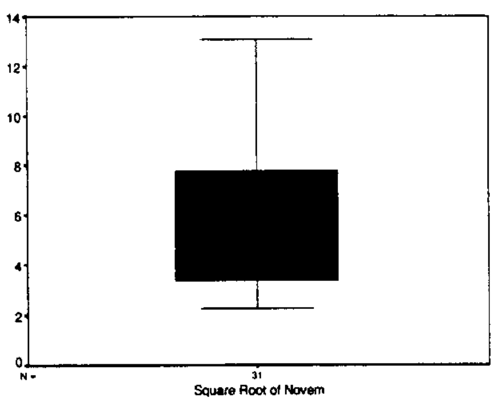


**Figure 2.61** *BoxPlot of Square Root of November_December Inflows.*

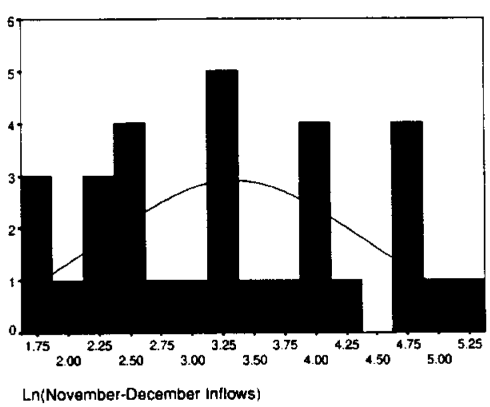


**Figure 2.62** *Histogram of Ln(November_ December Inflows).*

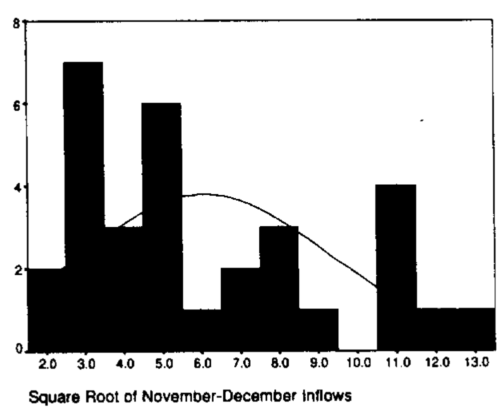


**Figure 2.63** *Histogram of Sqrt(November_ December Inflows).*

# 3. PREDICTION ELLIPSES AND CONFIDENCE REGIONS

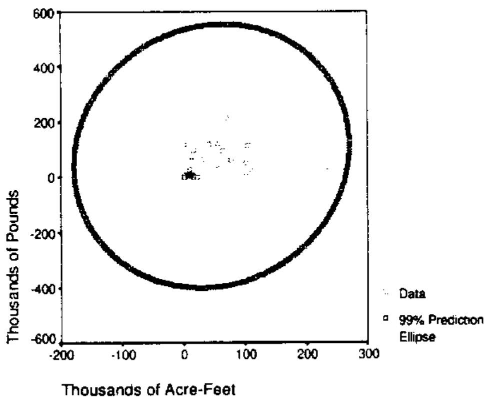


***Figure 3.1*** *Oyster Harvest vs. January-February Inflows, PE.*

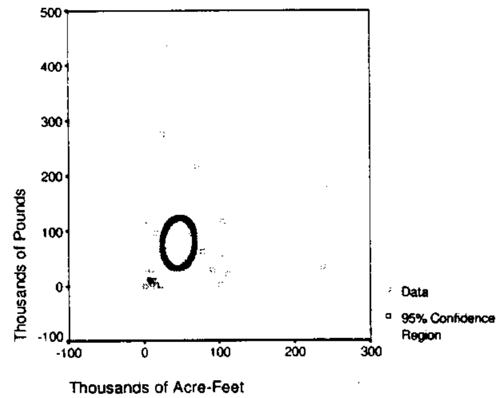


***Figure 3.2*** *Oyster Harvest vs. January-February Inflows, CR.*

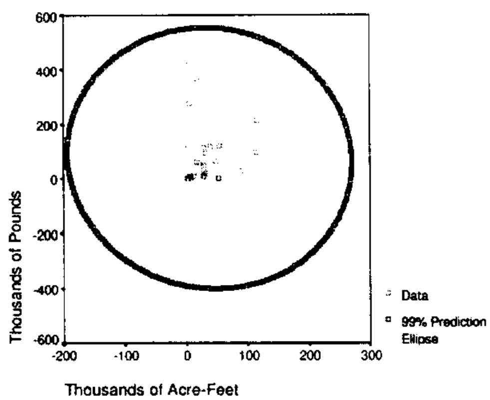


***Figure 3.3*** *Oyster Harvest vs. March-April Inflows, PE.*

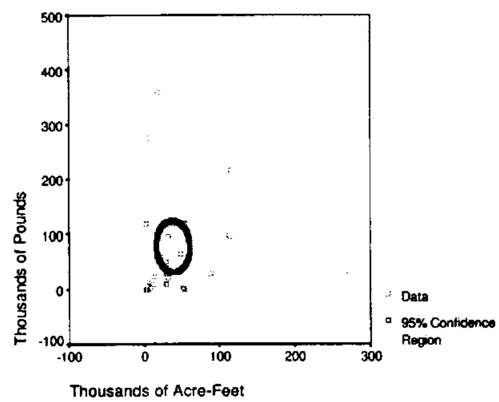


***Figure 3.4*** *Oyster Harvest vs. March-April Inflows, CR.*

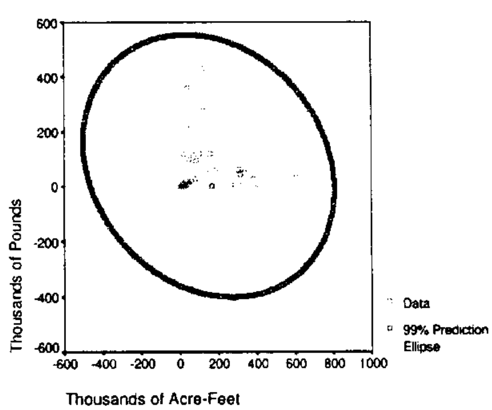


***Figure 3.5*** *Oyster Harvest vs. May-June Inflows, PE.*

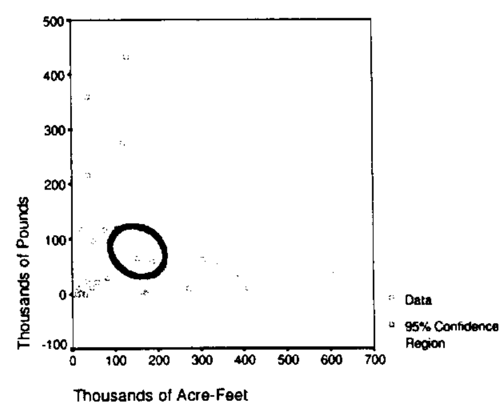


***Figure 3.6*** *Oyster Harvest vs. May-June Inflows, CR.*

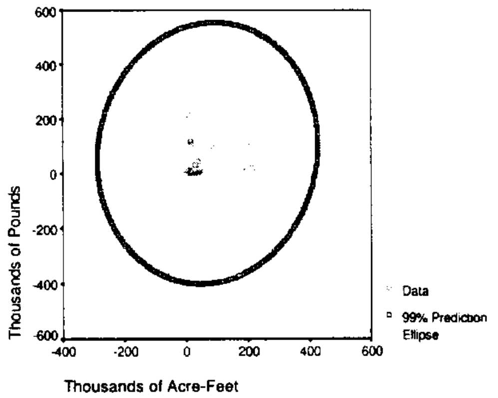


*Figure 3.7* Oyster Harvest vs. July-August Inflows, PE.

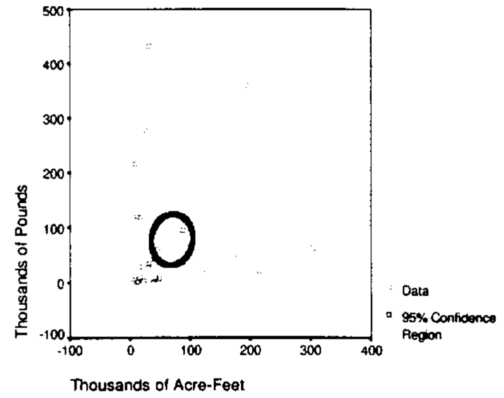


*Figure 3.8* Oyster Harvest vs..July-August Inflows, CR.

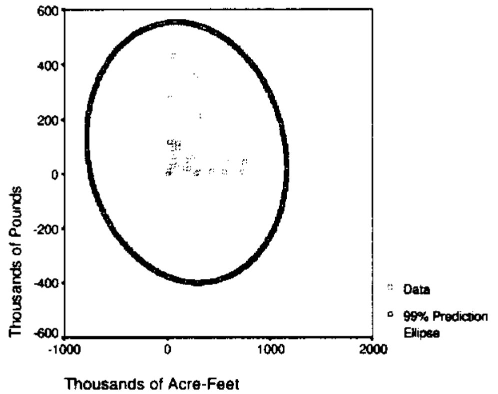


*Figure 3.9* Oyster Harvest vs. September-October Inflows, PE.

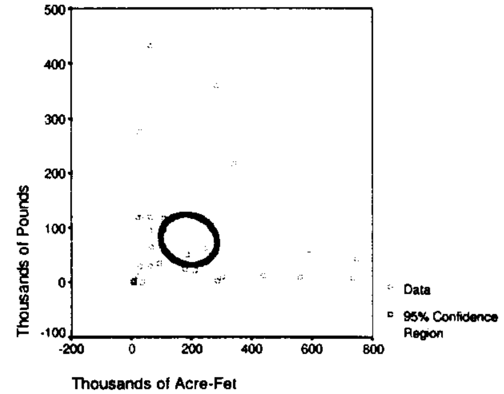


*Figure 3.10* Oyster Harvest vs. September-October Inflows, CR.

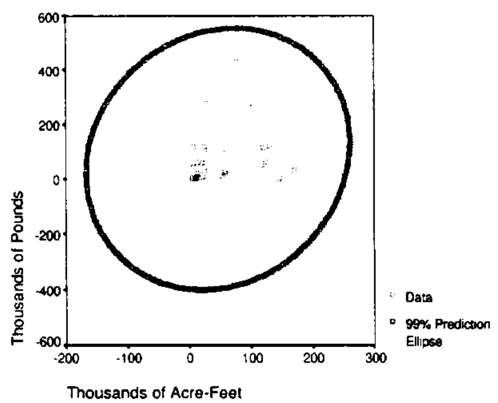


*Figure 3.11* Oyster Harvest vs. November-December Inflows, PE.

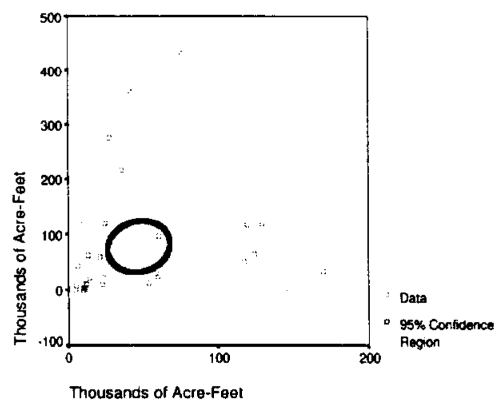


*Figure 3.12* Oyster Harvest vs. November-December Inflows, CR.

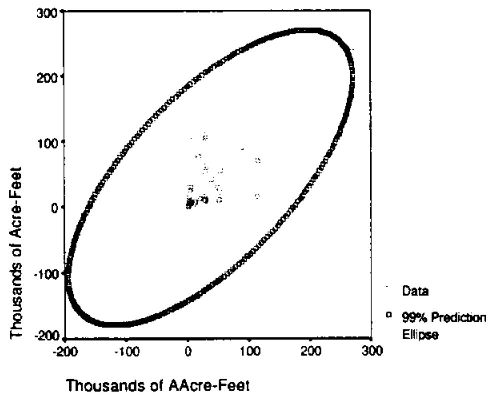


*Figure 3.13* January-February Inflows vs. March-April Inflows, PE.

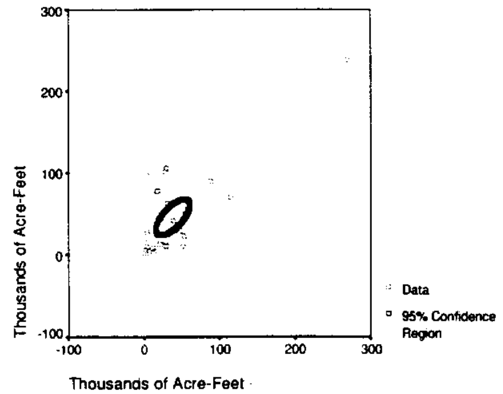


*Figure 3.14* January-February Inflows vs. March-April Inflows, CR.

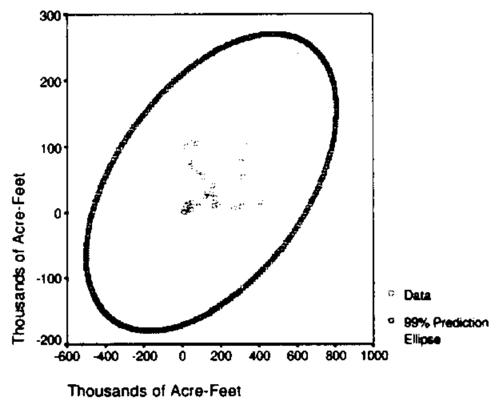


*Figure 3.15* January-February Inflows vs. May-June Inflows, PE.

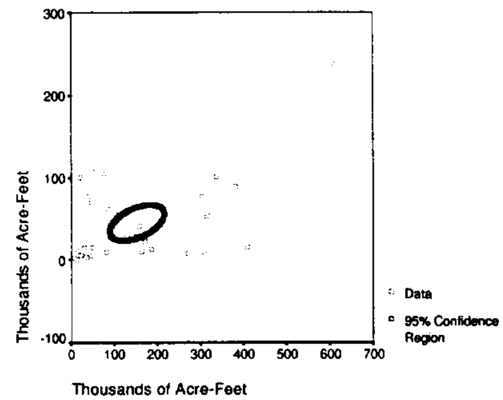


*Figure 3.16* January-February Inflows vs. May-June Inflows, CR.

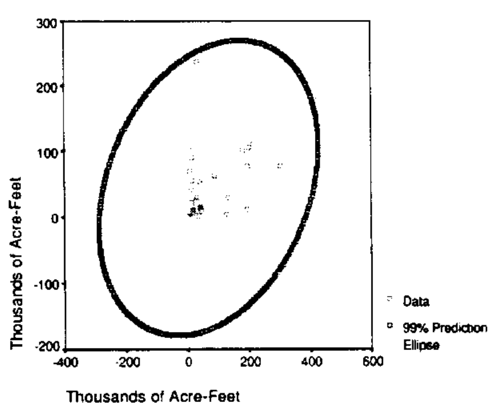


*Figure 3.17* January-February Inflows vs. July-August Inflows, PE.

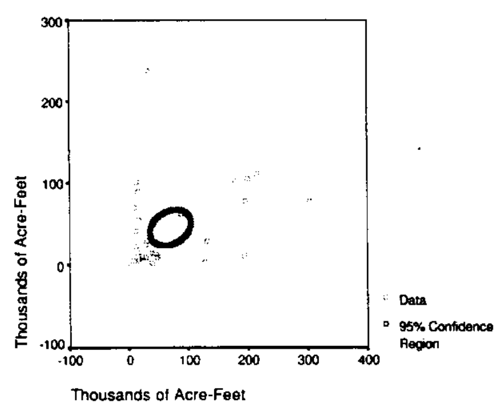


*Figure 3.18* January-February Inflows vs. July-August Inflows, CR.

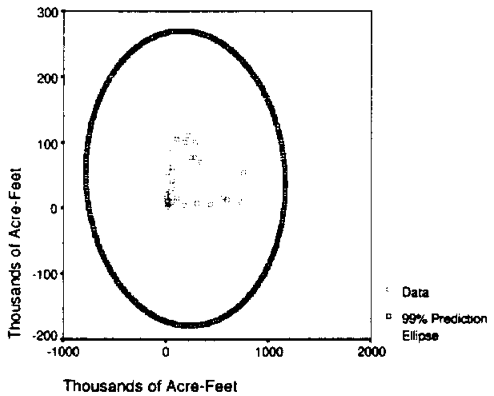


***Figure 3.19*** *January-February Inflows vs. September-October Inflows, PE.*

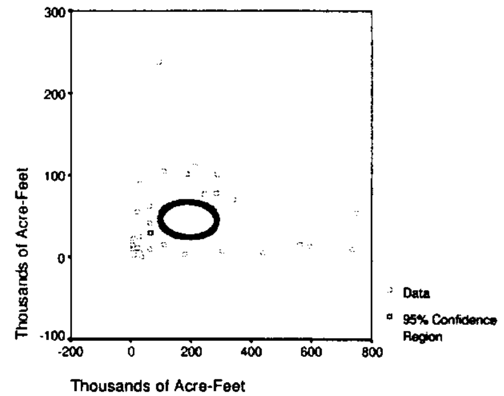


***Figure 3.20*** *January-February Inflows vs. September-October Inflows, CR.*

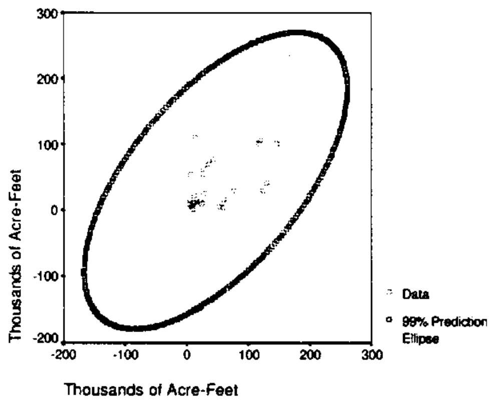


***Figure 3.21*** *January-February Inflows vs. November-December Inflows, PE.*

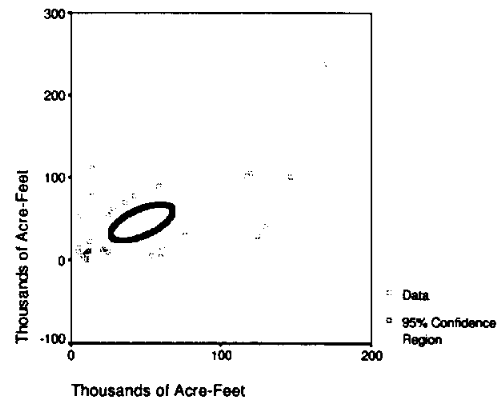


***Figure 3.22*** *January-February Inflows vs. November-December Inflows, CR.*

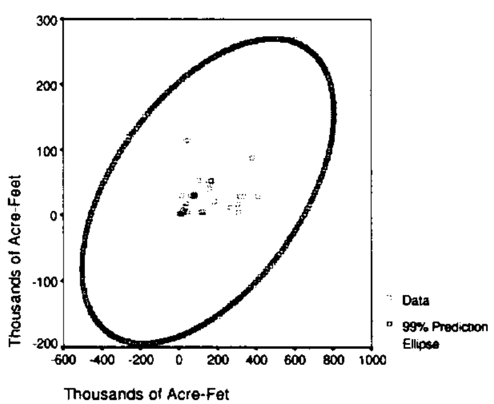


***Figure 3.23*** *March-April Inflows vs. May-June Inflows, PE.*

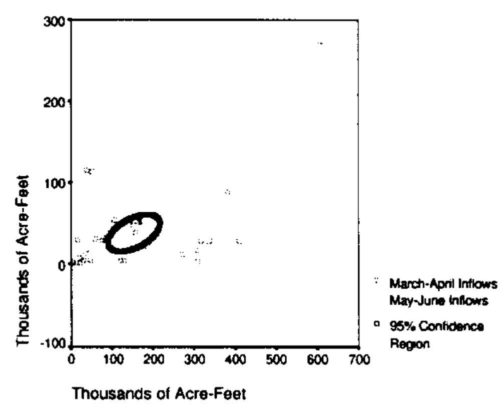


***Figure 3.24*** *March-April Inflows vs. May-June Inflows, CR.*

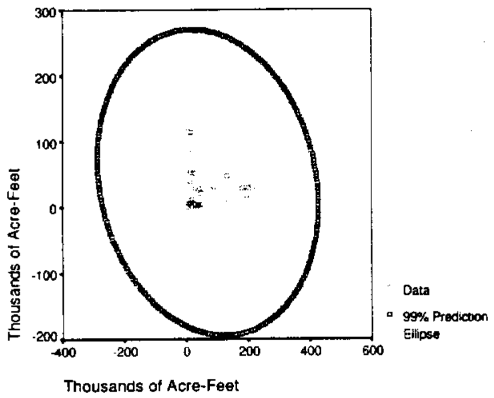


***Figure 3.25*** *March-April Inflows vs. July-August Inflows, PE.*

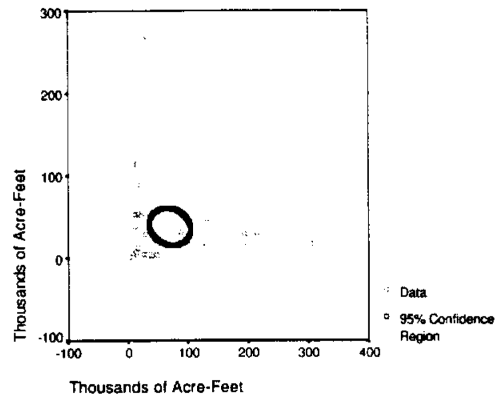


***Figure 3.26*** *March-April Inflows vs. July-August Inflows, CR.*

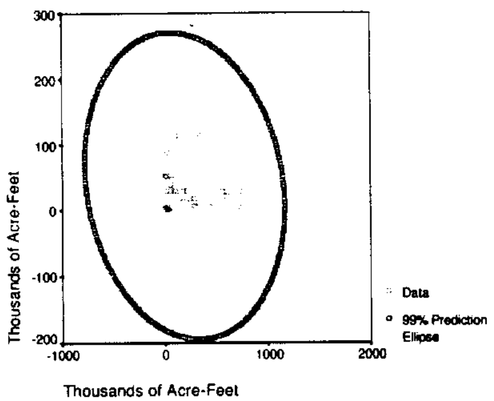


***Figure 3.27*** *March-April Inflows vs. September-October Inflows, PE.*

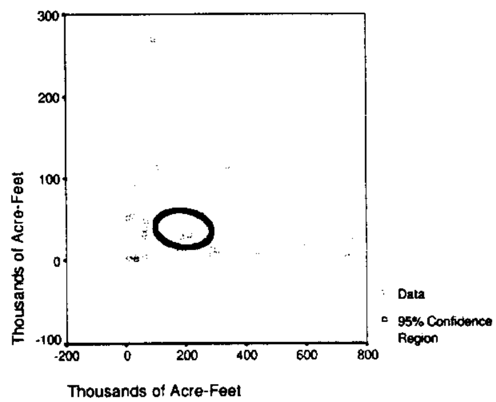


***Figure 3.28*** *March-April Inflows vs. September-October Inflows, CR.*

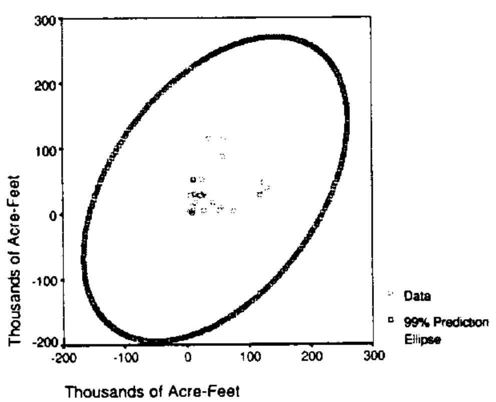


***Figure 3.29*** *March-April Inflows vs. November-December Inflows, PE.*

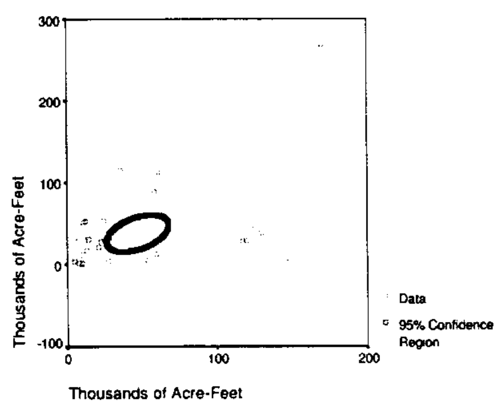


***Figure 3.30*** *March-April Inflows vs. November-December Inflows, CR.*

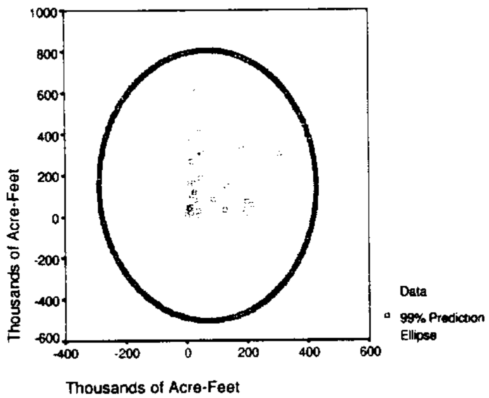


*Figure 3.31* May-June Inflows vs. July-August Inflows, PE.

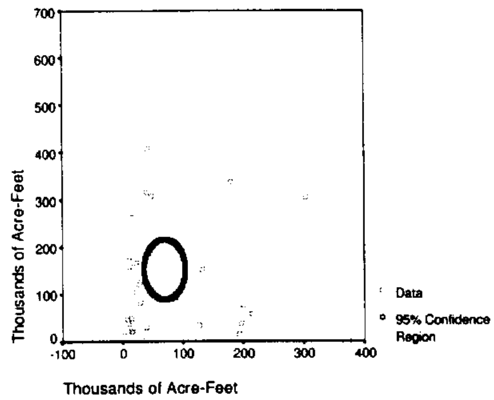


*Figure 3.32* May-June Inflows vs. July-August Inflows, CR.

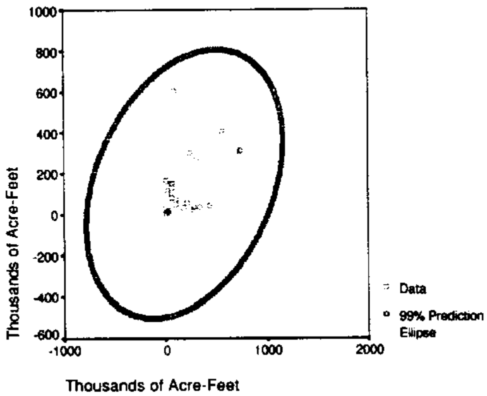


*Figure 3.33* May-June Inflows vs. September-October Inflows, PE.

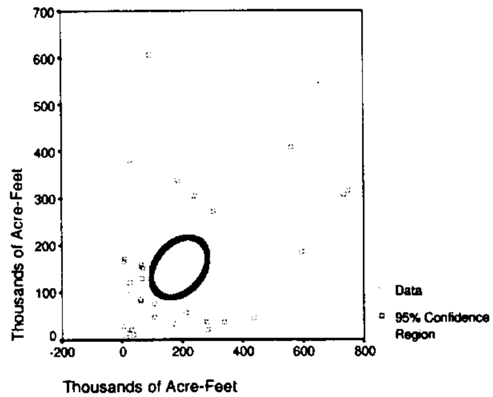


*Figure 3.34* May-June Inflows vs. September-October Inflows, CR.

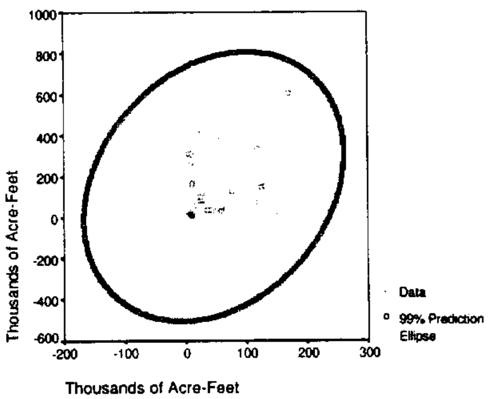


*Figure 3.35* May-June Inflows vs. November-December Inflows, PE.

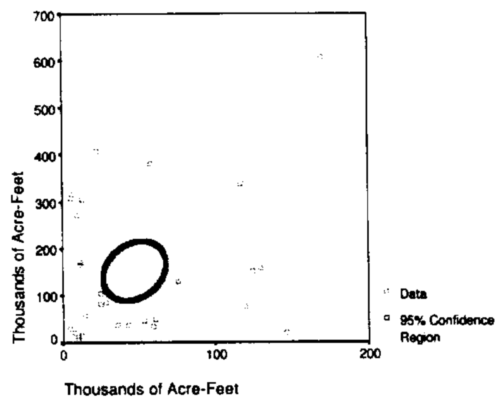


*Figure 3.36* May-June Inflows vs. November-December Inflows, CR.

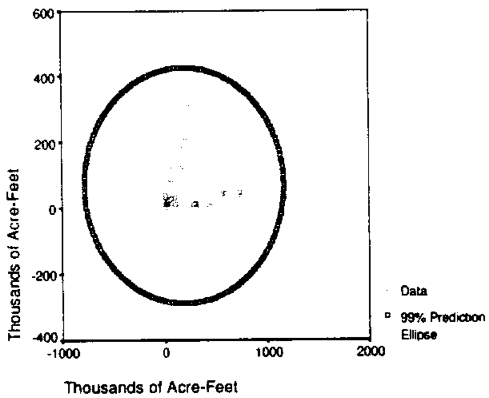


***Figure 3.37*** *July-August Inflows. vs. September-October Inflows, PE.*

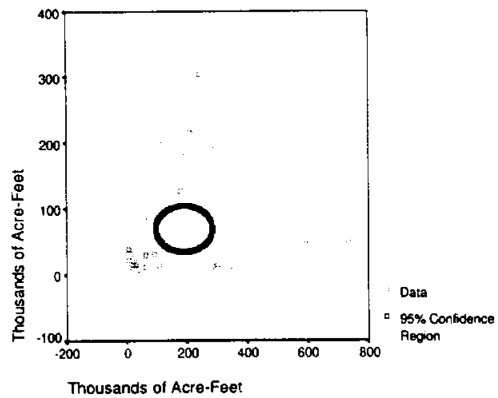


***Figure 3.38*** *July-August Inflows. vs. September-October Inflows, CR.*

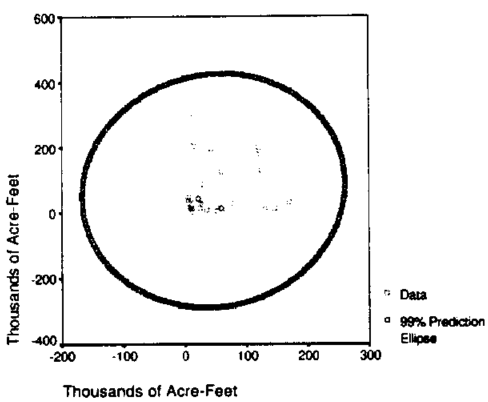


***Figure 3.39*** *July-August Inflows. vs. November-December Inflows, PE.*

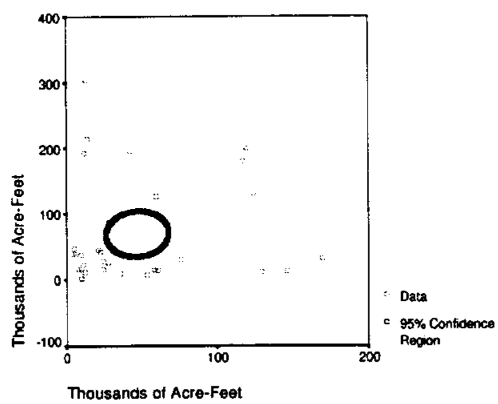


***Figure 3.40*** *July-August Inflows. vs. November-December Inflows, CR.*

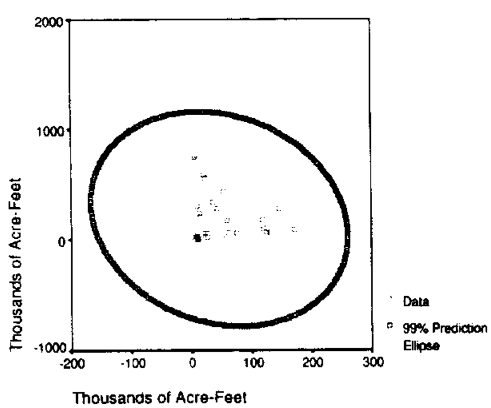


***Figure 3.41*** *September-October Inflows vs. November-December Inflows, PE.*

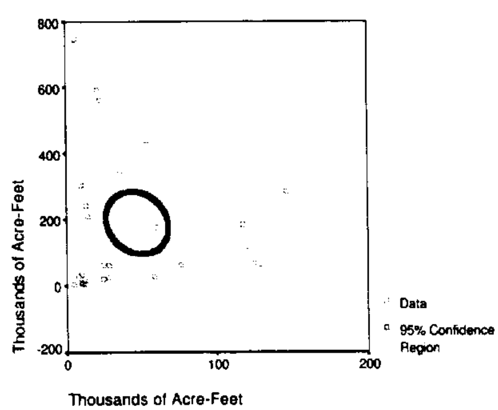


***Figure 3.42*** *September-October Inflows vs. November-December Inflows, CR.*

## 4. BOX-COX ANALYSIS

***Table .4.1*** *Mean Square Error from Box-Cox transformation of the oyster data and the inflow data for different lambda.*

| Lam | Oyster | JF_inflow | MA_inflo | MJ_inflow | JA_inflow | SO_inflow | ND_inflow |
|---|---|---|---|---|---|---|---|
| -2.0 | 418650562 | 817469 | 43482.7 | 2245914 | 668399 | 7995532 | 11603.8 |
| -1.9 | 192685382 | 498346 | 31289.8 | 1497208 | 426629 | 5109259 | 9283.8 |
| -1.8 | 89227666 | 305723 | 22675.2 | 1005244 | 273851 | 3286315 | 7472.3 |
| -1.7 | 41603119 | 188895 | 16558.3 | 680329 | 176913 | 2128983 | 6053.5 |
| -1.6 | 19548109 | 117663 | 12192.1 | 464551 | 115131 | 1390146 | 4938.8 |
| -1.5 | 9265725 | 73975 | 9058.0 | 320387 | 75564 | 915666 | 4060.4 |
| -1.4 | 4435816 | 47009 | 6795.1 | 223442 | 50089 | 609012 | 3366.0 |
| -1.3 | 2147876 | 30243 | 5151.3 | 157791 | 33592 | 409472 | 2815.7 |
| -1.2 | 1053728 | 19738 | 3949.7 | 112997 | 22841 | 278686 | 2378.4 |
| -1.1 | 524836 | 13099 | 3065.7 | 82190 | 15786 | 192301 | 2030.2 |
| -1.0 | 266055 | 8862 | 2411.2 | 60824 | 11124 | 134778 | 1752.8 |
| -0.9 | 137684 | 6131 | 1923.7 | 45878 | 8020 | 96150 | 1531.8 |
| -0.8 | 73007 | 4352 | 1558.6 | 35333 | 5938 | 69989 | 1356.2 |
| -0.7 | 39846 | 3180 | 1284.1 | 27833 | 4533 | 52122 | 1217.5 |
| -0.6 | 22510 | 2399 | 1077.2 | 22461 | 3581 | 39830 | 1109.1 |
| -0.5 | 13253 | 1875 | 921.5 | 18593 | 2935 | 31325 | 1026.1 |
| -0.4 | 8198 | 1521 | 805.3 | 15805 | 2502 | 25431 | 964.7 |
| -0.3 | 5376 | 1281 | 720.3 | 13806 | 2219 | 21367 | 922.2 |
| -0.2 | 3775 | 1122 | 660.8 | 12395 | 2046 | 18620 | 896.8 |
| -0.1 | 2862 | 1020 | 623.0 | 11436 | 1957 | 16851 | 887.4 |
| 0.0 | 2356 | 962 | 605.1 | 10838 | 1939 | 15842 | 893.7 |
| 0.1 | 2110 | 938 | 606.5 | 10542 | 1981 | 15464 | 915.8 |
| 0.2 | 2049 | 944 | 628.6 | 10513 | 2083 | 15652 | 954.9 |
| 0.3 | 2144 | 980 | 674.3 | 10736 | 2246 | 16392 | 1012.6 |
| 0.4 | 2394 | 1045 | 748.9 | 11213 | 2478 | 17720 | 1091.4 |
| 0.5 | 2827 | 1145 | 861.0 | 11959 | 2790 | 19720 | 1194.9 |
| 0.6 | 3499 | 1285 | 1023.1 | 13009 | 3199 | 22531 | 1327.9 |
| 0.7 | 4505 | 1476 | 1254.5 | 14413 | 3731 | 26361 | 1496.7 |
| 0.8 | 5996 | 1734 | 1583.2 | 16243 | 4416 | 31507 | 1709.4 |
| 0.9 | 8205 | 2079 | 2051.1 | 18599 | 5301 | 38383 | 1976.7 |
| 1.0 | 11496 | 2544 | 2720.3 | 21612 | 6444 | 47565 | 2312.2 |
| 1.1 | 16434 | 3170 | 3683.9 | 25461 | 7926 | 59853 | 2733.8 |
| 1.2 | 23900 | 4020 | 5081.2 | 30378 | 9856 | 76353 | 3264.4 |
| 1.3 | 35278 | 5181 | 7122.4 | 36676 | 12382 | 98605 | 3933.8 |
| 1.4 | 52749 | 6779 | 10125.8 | 44769 | 15704 | 128753 | 4780.8 |
| 1.5 | 79769 | 8992 | 14575.7 | 55209 | 20094 | 169793 | 5855.8 |
| 1.6 | 121838 | 12079 | 21211.5 | 68735 | 25928 | 225923 | 7224.6 |
| 1.7 | 187745 | 16411 | 31166.9 | 86338 | 33720 | 303042 | 8973.2 |
| 1.8 | 291595 | 22527 | 46186.4 | 109349 | 44178 | 409466 | 11214.5 |
| 1.9 | 456107 | 31209 | 68962.9 | 139564 | 58287 | 556942 | 14096.5 |
| 2.0 | 718011 | 43599 | 103666.5 | 179415 | 77409 | 762115 | 17814.5 |

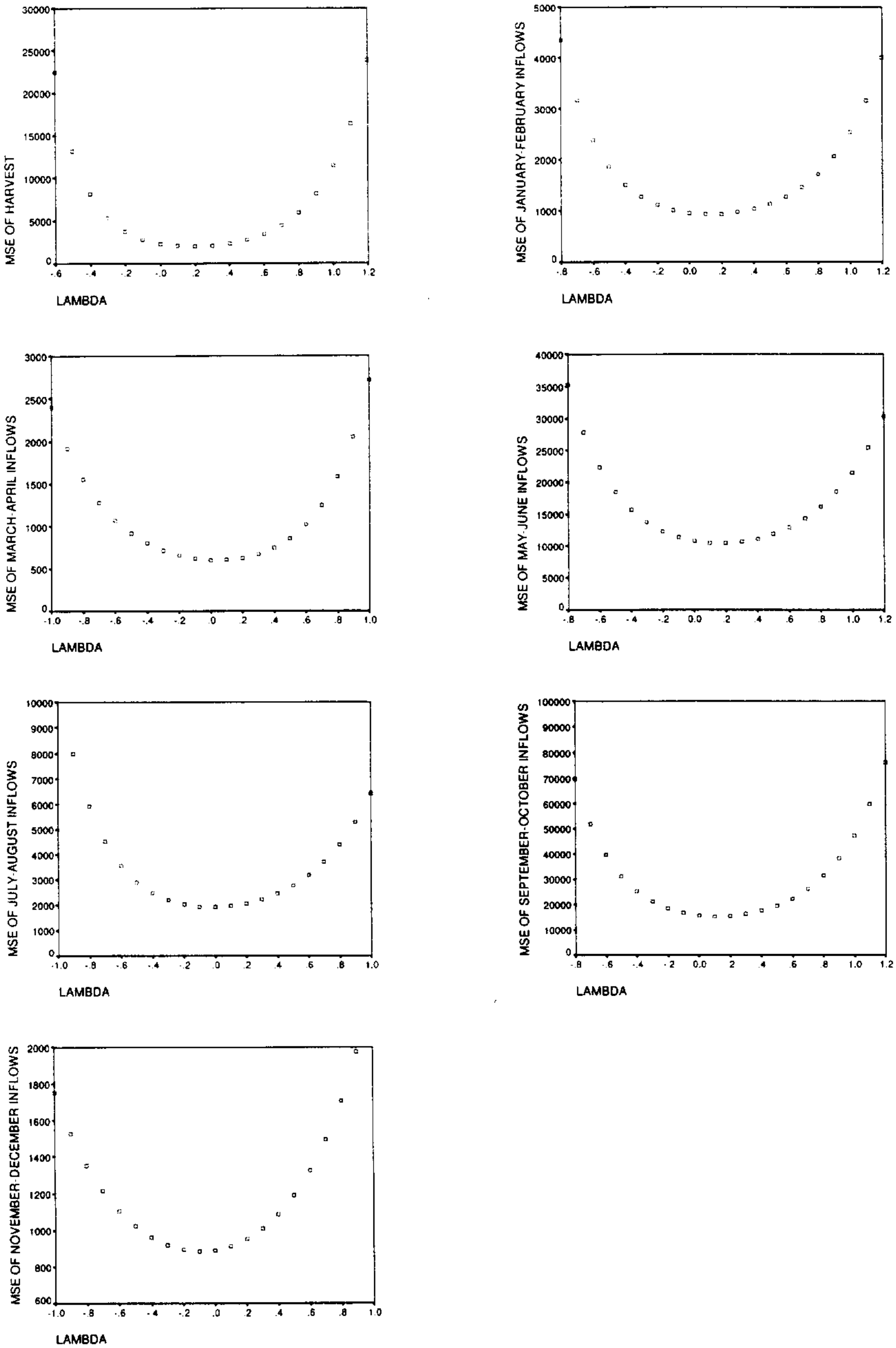


***Figure 4.1*** *Box-Cox Transformation - MSE of Oyster vs. Lambda and MSE of Inflow data vs. Lambda.*

# 5. Model Choice Diagnostics

## 5.1 Untransformed oyster data and untransformed inflow data

***Table 5.1*** *Regression Models for Dependent Variable: OYSTER on INFLOWS*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.0336 | 0.0002 | -1.702 | 291.8 | 11494 | 294.6 | QMJ_LAG |
| 1 | 0.0154 | -.0186 | -1.227 | 292.3 | 11710 | 295.2 | QND_LAG |
| 1 | 0.0128 | -.0213 | -1.158 | 292.4 | 11741 | 295.3 | QSO_LAG |
| 1 | 0.0067 | -.0275 | -1.000 | 292.6 | 11813 | 295.5 | QJF_LAG |
| 2 | 0.0730 | 0.0068 | -0.736 | 292.5 | 11418 | 296.8 | QJF_LAG QMJ_LAG |
| 2 | 0.0644 | -.0024 | -0.511 | 292.8 | 11524 | 297.1 | QMJ_LAG QND_LAG |
| 2 | 0.0378 | -.0309 | 0.186 | 293.6 | 11852 | 297.9 | QMA_LAG QMJ_LAG |
| 2 | 0.0376 | -.0312 | 0.193 | 293.6 | 11855 | 297.9 | QMJ_LAG QJA_LAG |
| 3 | 0.0783 | -.0241 | 1.127 | 294.3 | 11774 | 300.0 | QJF_LAG QMJ_LAG QND_LAG |
| 3 | 0.0764 | -.0262 | 1.176 | 294.4 | 11798 | 300.1 | QJF_LAG QMA_LAG QMJ_LAG |
| 3 | 0.0731 | -.0299 | 1.263 | 294.5 | 11840 | 300.2 | QJF_LAG QMJ_LAG QSO_LAG |
| 3 | 0.0731 | -.0299 | 1.264 | 294.5 | 11841 | 300.2 | QJF_LAG QMJ_LAG QJA_LAG |
| 4 | 0.0824 | -.0588 | 3.019 | 296.2 | 12172 | 303.3 | QJF_LAG QMA_LAG QMJ_LAG QND_LAG |
| 4 | 0.0784 | -.0634 | 3.124 | 296.3 | 12225 | 303.5 | QJF_LAG QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.0783 | -.0635 | 3.126 | 296.3 | 12226 | 303.5 | QJF_LAG QMJ_LAG QSO_LAG QND_LAG |
| 4 | 0.0775 | -.0644 | 3.147 | 296.3 | 12237 | 303.5 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG |
| 5 | 0.0829 | -.1006 | 5.007 | 298.1 | 12653 | 306.7 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.0826 | -.1008 | 5.013 | 298.2 | 12656 | 306.8 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 5 | 0.0784 | -.1059 | 5.124 | 298.3 | 12714 | 306.9 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.0782 | -.1061 | 5.128 | 298.3 | 12716 | 306.9 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 6 | 0.0831 | -.1461 | 7.000 | 300.1 | 13176 | 310.2 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 31

## 5.2 Untransformed oyster data and log of inflow data

***Table 5.2*** *Regression Models for Dependent Variable: Ln(OYSTER) on INFLOWS*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.0850 | 0.0535 | 0.989 | 290.1 | 10882 | 292.9 | LN_QND |
| 1 | 0.0791 | 0.0474 | 1.169 | 290.3 | 10952 | 293.1 | LN_QJF |
| 1 | 0.0071 | -.0271 | 3.370 | 292.6 | 11808 | 295.5 | LN_QJA |
| 1 | 0.0034 | -.0309 | 3.484 | 292.7 | 11852 | 295.6 | LN_QSO |
| 2 | 0.1599 | 0.0999 | 0.699 | 289.4 | 10348 | 293.7 | LN_QJF LN_QMA |
| 2 | 0.1211 | 0.0583 | 1.885 | 290.8 | 10826 | 295.1 | LN_QMA LN_QND |
| 2 | 0.1092 | 0.0456 | 2.247 | 291.2 | 10972 | 295.5 | LN_QJF LN_QND |
| 2 | 0.1083 | 0.0446 | 2.275 | 291.3 | 10983 | 295.6 | LN_QJF LN_QMJ |
| 3 | 0.2087 | 0.1208 | 1.205 | 289.6 | 10108 | 295.3 | LN_QJF LN_QMA LN_QND |
| 3 | 0.1690 | 0.0767 | 2.418 | 291.1 | 10615 | 296.8 | LN_QJF LN_QMA LN_QMJ |
| 3 | 0.1641 | 0.0712 | 2.570 | 291.3 | 10678 | 297.0 | LN_QJF LN_QMA LN_QJA |
| 3 | 0.1606 | 0.0673 | 2.676 | 291.4 | 10722 | 297.1 | LN_QJF LN_QMA LN_QSO |
| 4 | 0.2129 | 0.0918 | 3.076 | 291.4 | 10441 | 298.6 | LN_QJF LN_QMA LN_QMJ LN_QND |
| 4 | 0.2116 | 0.0903 | 3.117 | 291.5 | 10459 | 298.6 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.2102 | 0.0887 | 3.159 | 291.5 | 10476 | 298.7 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.1733 | 0.0461 | 4.288 | 292.9 | 10966 | 300.1 | LN_QJF LN_QMA LN_QMJ LN_QJA |
| 5 | 0.2145 | 0.0574 | 5.027 | 293.3 | 10836 | 301.9 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.2142 | 0.0570 | 5.038 | 293.4 | 10841 | 302.0 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.2126 | 0.0551 | 5.086 | 293.4 | 10863 | 302.0 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.1734 | 0.0080 | 6.286 | 294.9 | 11404 | 303.5 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 6 | 0.2154 | 0.0193 | 7.000 | 295.3 | 11275 | 305.3 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 31

## 5.3 Log of oyster data and log of inflow data

***Table 5.3*** *Regression Models for Dependent Variable: Ln(OYSTER) on Ln(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.2429 | 0.2168 | 2.420 | 36.70 | 3.070 | 39.57 | LN_QJF |
| 1 | 0.2167 | 0.1897 | 3.439 | 37.75 | 3.176 | 40.62 | LN_QND |
| 1 | 0.1406 | 0.1110 | 6.396 | 40.63 | 3.484 | 43.50 | LN_QSO |
| 1 | 0.1116 | 0.0810 | 7.522 | 41.66 | 3.602 | 44.52 | LN_QMA |
| 2 | 0.3207 | 0.2722 | 1.397 | 35.34 | 2.852 | 39.64 | LN_QJF LN_QSO |
| 2 | 0.3062 | 0.2567 | 1.960 | 35.99 | 2.913 | 40.29 | LN_QJF LN_QND |
| 2 | 0.3022 | 0.2524 | 2.116 | 36.17 | 2.930 | 40.47 | LN_QSO LN_QND |
| 2 | 0.2730 | 0.2210 | 3.253 | 37.44 | 3.053 | 41.75 | LN_QMJ LN_QND |
| 3 | 0.3713 | 0.3015 | 1.431 | 34.94 | 2.738 | 40.67 | LN_QJF LN_QSO LN_QND |
| 3 | 0.3341 | 0.2601 | 2.878 | 36.72 | 2.900 | 42.46 | LN_QJA LN_QSO LN_QND |
| 3 | 0.3287 | 0.2541 | 3.087 | 36.97 | 2.923 | 42.71 | LN_QMA LN_QSO LN_QND |
| 3 | 0.3279 | 0.2532 | 3.118 | 37.01 | 2.927 | 42.74 | LN_QMJ LN_QSO LN_QND |
| 4 | 0.3785 | 0.2829 | 3.151 | 36.58 | 2.810 | 43.75 | LN_QJF LN_QJA LN_QSO LN_QND |
| 4 | 0.3738 | 0.2775 | 3.333 | 36.81 | 2.832 | 43.98 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.3722 | 0.2756 | 3.398 | 36.90 | 2.839 | 44.07 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.3553 | 0.2561 | 4.054 | 37.72 | 2.916 | 44.89 | LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.3820 | 0.2584 | 5.016 | 38.41 | 2.907 | 47.01 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.3800 | 0.2560 | 5.093 | 38.51 | 2.916 | 47.11 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.3740 | 0.2488 | 5.326 | 38.81 | 2.944 | 47.41 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.3622 | 0.2346 | 5.787 | 39.39 | 3.000 | 47.99 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.3824 | 0.2280 | 7.000 | 40.39 | 3.026 | 50.42 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 31

## 5.4 Log of oyster data and square root of inflow data

***Table 5.4*** *Regression Models for Dependent Variable: Ln(OYSTER) on Sqrt(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.1495 | 0.1202 | 0.0809 | 40.31 | 3.448 | 43.17 | SQR_QJF |
| 1 | 0.1417 | 0.1121 | 0.331 | 40.59 | 3.480 | 43.46 | SQR_QND |
| 1 | 0.0673 | 0.0351 | 2.700 | 43.17 | 3.782 | 46.03 | SQR_QMA |
| 1 | 0.0589 | 0.0264 | 2.968 | 43.45 | 3.816 | 46.31 | SQR_QJA |
| 2 | 0.1874 | 0.1293 | 0.877 | 40.89 | 3.412 | 45.20 | SQR_QJA SQR_QND |
| 2 | 0.1857 | 0.1276 | 0.929 | 40.96 | 3.419 | 45.26 | SQR_QJF SQR_QND |
| 2 | 0.1835 | 0.1252 | 0.999 | 41.04 | 3.429 | 45.34 | SQR_QSO SQR_QND |
| 2 | 0.1758 | 0.1169 | 1.245 | 41.33 | 3.461 | 45.64 | SQR_QJF SQR_QSO |
| 3 | 0.2197 | 0.1330 | 1.846 | 41.64 | 3.398 | 47.37 | SQR_QJA SQR_QSO SQR_QND |
| 3 | 0.2183 | 0.1314 | 1.891 | 41.69 | 3.404 | 47.43 | SQR_QJF SQR_QSO SQR_QND |
| 3 | 0.2079 | 0.1199 | 2.222 | 42.10 | 3.449 | 47.84 | SQR_QJF SQR_QJA SQR_QND |
| 3 | 0.2062 | 0.1180 | 2.277 | 42.17 | 3.457 | 47.90 | SQR_QMA SQR_QJA SQR_QND |
| 4 | 0.2424 | 0.1258 | 3.125 | 42.72 | 3.426 | 49.89 | SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 4 | 0.2363 | 0.1188 | 3.318 | 42.97 | 3.454 | 50.14 | SQR_QJF SQR_QJA SQR_QSO SQR_QND |
| 4 | 0.2224 | 0.1028 | 3.760 | 43.53 | 3.516 | 50.70 | SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 4 | 0.2205 | 0.1006 | 3.821 | 43.60 | 3.525 | 50.77 | SQR_QJF SQR_QMA SQR_QSO SQR_QND |
| 5 | 0.2453 | 0.0944 | 5.031 | 44.60 | 3.549 | 53.20 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.2428 | 0.0913 | 5.112 | 44.71 | 3.561 | 53.31 | SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.2363 | 0.0836 | 5.318 | 44.97 | 3.592 | 53.57 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.2221 | 0.0665 | 5.770 | 45.54 | 3.659 | 54.14 | SQR_QJF SQR_QMA SQR_QMJ SQR_QSO SQR_QND |
| 6 | 0.2463 | 0.0579 | 7.000 | 46.56 | 3.692 | 56.60 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

N = 31

## 5.5 Square root of oyster data and log of inflow data

***Table 5.5*** *Regression Models for Dependent Variable: Sqrt(OYSTER) on Ln(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.1533 | 0.1241 | -0.206 | 102.0 | 25.24 | 104.9 | LN_QJF |
| 1 | 0.1437 | 0.1142 | 0.0985 | 102.4 | 25.53 | 105.2 | LN_QND |
| 1 | 0.0245 | -.0091 | 3.871 | 106.4 | 29.08 | 109.3 | LN_QJA |
| 1 | 0.0239 | -.0098 | 3.890 | 106.4 | 29.10 | 109.3 | LN_QSO |
| 2 | 0.1977 | 0.1404 | 0.390 | 102.3 | 24.77 | 106.7 | LN_QJF LN_QND |
| 2 | 0.1812 | 0.1227 | 0.913 | 103.0 | 25.29 | 107.3 | LN_QJF LN_QMA |
| 2 | 0.1654 | 0.1058 | 1.411 | 103.6 | 25.77 | 107.9 | LN_QJF LN_QMJ |
| 2 | 0.1597 | 0.0997 | 1.592 | 103.8 | 25.95 | 108.1 | LN_QJA LN_QND |
| 3 | 0.2387 | 0.1541 | 1.093 | 102.7 | 24.38 | 108.5 | LN_QJF LN_QMA LN_QND |
| 3 | 0.2060 | 0.1177 | 2.129 | 104.0 | 25.43 | 109.8 | LN_QJF LN_QMJ LN_QND |
| 3 | 0.2007 | 0.1118 | 2.296 | 104.2 | 25.60 | 110.0 | LN_QJF LN_QSO LN_QND |
| 3 | 0.1991 | 0.1101 | 2.345 | 104.3 | 25.65 | 110.0 | LN_QJF LN_QJA LN_QND |
| 4 | 0.2397 | 0.1227 | 3.061 | 104.7 | 25.28 | 111.9 | LN_QJF LN_QMA LN_QMJ LN_QND |
| 4 | 0.2397 | 0.1227 | 3.062 | 104.7 | 25.29 | 111.9 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.2389 | 0.1218 | 3.088 | 104.7 | 25.31 | 111.9 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.2124 | 0.0912 | 3.925 | 105.8 | 26.19 | 112.9 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 5 | 0.2416 | 0.0899 | 5.001 | 106.6 | 26.23 | 115.2 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.2399 | 0.0878 | 5.056 | 106.7 | 26.29 | 115.3 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.2397 | 0.0877 | 5.059 | 106.7 | 26.29 | 115.3 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.2128 | 0.0553 | 5.913 | 107.8 | 27.23 | 116.4 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.2416 | 0.0520 | 7.000 | 108.6 | 27.32 | 118.6 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 31

## 5.6 Various transformation suggested by Box-Cox

***Table 5.6*** *Regression Models for Dependent Variable: (OYSTER)$^{0.3}$ on variously transformed INFLOWS.*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.2061 | 0.1787 | 0.219 | -26.26 | 0.4027 | -23.40 | QR_QND |
| 1 | 0.1986 | 0.1710 | 0.476 | -25.97 | 0.4065 | -23.11 | QR_QJF |
| 1 | 0.0609 | 0.0285 | 5.197 | -21.06 | 0.4763 | -18.19 | LN_QMA |
| 1 | 0.0573 | 0.0248 | 5.320 | -20.94 | 0.4782 | -18.07 | QR_QSO |
| 2 | 0.2686 | 0.2163 | 0.076 | -26.81 | 0.3842 | -22.50 | QR_QJF QR_QND |
| 2 | 0.2428 | 0.1887 | 0.959 | -25.73 | 0.3978 | -21.43 | LN_QJA QR_QND |
| 2 | 0.2370 | 0.1825 | 1.159 | -25.50 | 0.4008 | -21.19 | QR_QSO QR_QND |
| 2 | 0.2235 | 0.1680 | 1.622 | -24.95 | 0.4079 | -20.65 | QR_QJF QR_QSO |
| 3 | 0.2891 | 0.2101 | 1.374 | -25.69 | 0.3873 | -19.95 | QR_QJF QR_QSO QR_QND |
| 3 | 0.2794 | 0.1993 | 1.707 | -25.27 | 0.3926 | -19.53 | QR_QJF LN_QJA QR_QND |
| 3 | 0.2743 | 0.1937 | 1.880 | -25.05 | 0.3954 | -19.31 | QR_QJF LN_QMA QR_QND |
| 3 | 0.2688 | 0.1875 | 2.069 | -24.81 | 0.3984 | -19.08 | QR_QJF QR_QMJ QR_QND |
| 4 | 0.2962 | 0.1880 | 3.128 | -24.00 | 0.3982 | -16.83 | QR_QJF LN_QJA QR_QSO QR_QND |
| 4 | 0.2927 | 0.1839 | 3.248 | -23.85 | 0.4001 | -16.68 | QR_QJF LN_QMA QR_QSO QR_QND |
| 4 | 0.2920 | 0.1830 | 3.274 | -23.81 | 0.4006 | -16.64 | QR_QJF QR_QMJ QR_QSO QR_QND |
| 4 | 0.2836 | 0.1734 | 3.562 | -23.45 | 0.4053 | -16.28 | QR_QJF LN_QMA LN_QJA QR_QND |
| 5 | 0.2990 | 0.1589 | 5.032 | -22.12 | 0.4124 | -13.52 | QR_QJF LN_QMA LN_QJA QR_QSO QR_QND |
| 5 | 0.2984 | 0.1581 | 5.053 | -22.10 | 0.4128 | -13.49 | QR_QJF QR_QMJ LN_QJA QR_QSO QR_QND |
| 5 | 0.2940 | 0.1528 | 5.206 | -21.90 | 0.4154 | -13.30 | QR_QJF LN_QMA QR_QMJ QR_QSO QR_QND |
| 5 | 0.2837 | 0.1405 | 5.558 | -21.45 | 0.4215 | -12.85 | QR_QJF LN_QMA QR_QMJ LN_QJA QR_QND |
| 6 | 0.3000 | 0.1250 | 7.000 | -20.17 | 0.4290 | -10.13 | QR_QJF LN_QMA QR_QMJ LN_QJA QR_QSO QR_QND |

N = 31

Dependent Variable: *(OYSTER)*$^{0.2}$

Independent Variables: *QR_QJF*=(January-February Inflows)$^{0.1}$

*QR_QMJ*=(May-June Inflows)$^{0.2}$

*QR_QND*=(September-October Inflows)$^{0.1}$

*QR_QND*=(November-December Inflows)$^{-0.1}$

# 6. REGRESSION FOR THE BEST MODELS

## 6.1 Regression - Log of oyster data on log of inflow data

### 6.1.1 ANOVA and Parameter Estimates

***Table 6.1*** *Model Summary for log of oyster data on log of inflow data.*

**Model Summary[a,b]**

| | Variables Entered | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| | Ln(November-December), Ln(July-August), Ln(May-June ), Ln(September-October), Ln(March-April), Ln(January-February)[c,d] | .382 | .228 | 1.739441 | .691 |

a. Dependent Variable: Ln(Oyster Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Ln(November-December Inflows), Ln(July-August Inflows), Ln(May-June Inflows), Ln(September-October Inflows), Ln(March-April Inflows), Ln(January-February Inflows)

d. All requested variables entered.

***Table 6.2*** *ANOVA table of log of oyster data on log of inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 44.962 | 6 | 7.494 | 2.477 | .052[b] |
| | Residual | 72.616 | 24 | 3.026 | | |
| | Total | 117.578 | 30 | | | |

a. Dependent Variable: Ln(Oyster Harvest)

b. Independent Variables: (Constant), Ln(November-December Inflows), Ln(July-August Inflows), Ln(May-June Inflows), Ln(September-October Inflows), Ln(March-April Inflows), Ln(January-February Inflows)

***Table 6.3*** *Table of coefficients for log of oyster data on log of inflow data.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | -2.358 | 1.803 | | -1.308 | .203 | -6.079 | 1.364 |
| Ln(January-February) | .346 | .390 | .218 | .887 | .384 | -.459 | 1.151 |
| Ln(March-April) | 4.5E-02 | .364 | .028 | .125 | .902 | -.706 | .797 |
| Ln(May-June) | .105 | .346 | .061 | .305 | .763 | -.608 | .819 |
| Ln(July-August) | .172 | .301 | .102 | .571 | .573 | -.450 | .794 |
| Ln(September-October) | .326 | .243 | .236 | 1.342 | .192 | -.175 | .827 |
| Ln(November-December) | .525 | .363 | .282 | 1.446 | .161 | -.224 | 1.273 |

a. Dependent Variable: Ln(Oyster Harvest)

### 6.1.2 Collinearity Diagnostic

***Table 6.4*** *Variance Inflation for log of oyster data on log of inflow data.*

**Coefficients[a]**

| | | Collinearity Statistics | |
|---|---|---|---|
| | t | Tolerance | VIF |
| (Constant) | -1.308 | | |
| Ln(January-February) | .887 | .428 | 2.339 |
| Ln(March-April) | .125 | .526 | 1.900 |
| Ln(May-June) | .305 | .636 | 1.573 |
| Ln(July-August) | .571 | .808 | 1.238 |
| Ln(September-October) | 1.342 | .829 | 1.206 |
| Ln(November-December) | 1.446 | .679 | 1.473 |

a. Dependent Variable: Ln(Oyster Harvest)

***Table 6.5*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(OYSTER) on . Ln(INFLOWS):*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *LN_QJF* | Var Prop *LN_QMA* | Var Prop *LN_QMJ* | Var Prop *LN_QJA* | Var Prop *LN_QSO* | Var Prop *LN_QND* |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.56198 | 1.00000 | 0.0493 | 0.0477 | 0.0456 | 0.0220 | 0.0208 | 0.0410 |
| 2 | 1.06417 | 1.55161 | 0.0025 | 0.0758 | 0.0047 | 0.2352 | 0.3351 | 0.0593 |
| 3 | 0.88836 | 1.69822 | 0.0216 | 0.0000 | 0.1250 | 0.4656 | 0.2506 | 0.0001 |
| 4 | 0.81819 | 1.76954 | 0.0000 | 0.0352 | 0.2346 | 0.0068 | 0.1176 | 0.4318 |
| 5 | 0.36575 | 2.64664 | 0.0008 | 0.6372 | 0.5162 | 0.0077 | 0.2713 | 0.2532 |
| 6 | 0.30154 | 2.91483 | 0.9258 | 0.2041 | 0.0740 | 0.2627 | 0.0045 | 0.2145 |

### 6.1.3 Residuals Diagnostics

***Table 6.6*** *Residuals Diagnostics for log of oyster data on log of inflow data.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | .549031 | 5.237872 | 3.199413 | 1.224232 | 31 |
| Std. Predicted Value | -2.165 | 1.665 | .000 | 1.000 | 31 |
| Standard Error of Predicted Value | .472762 | 1.134913 | .812834 | .152524 | 31 |
| Adjusted Predicted Value | .720260 | 7.127876 | 3.291824 | 1.366108 | 31 |
| Residual | -3.443763 | 3.425069 | -3.4E-16 | 1.555803 | 31 |
| Std. Residual | -1.980 | 1.969 | .000 | .894 | 31 |
| Stud. Residual | -2.612 | 2.143 | -.023 | 1.039 | 31 |
| Deleted Residual | -5.996474 | 4.055497 | -9.2E-02 | 2.120206 | 31 |
| Stud. Deleted Residual | -3.023 | 2.332 | -.027 | 1.100 | 31 |
| Mahal. Distance | 1.248 | 11.803 | 5.806 | 2.460 | 31 |
| Cook's Distance | .000 | .723 | .057 | .131 | 31 |
| Centered Leverage Value | .042 | .393 | .194 | .082 | 31 |

a. Dependent Variable: Ln(Oyster Harvest)

***Table 6.7*** *Case Values for Residuals Diagnostics for log of oyster data on log of inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 4.5752 | -3.4438 | -5.9965 | 7.1279 | 1.1238 | -1.9798 | -2.6125 | *-3.0232 |
| 1963 | .5490 | -.9057 | -1.3647 | 1.0080 | -2.1649 | -.5207 | -.6391 | -.6311 |
| 1964 | .9273 | -2.1313 | -2.8700 | 1.6660 | -1.8559 | -1.2253 | -1.4219 | -1.4545 |
| 1965 | 1.0350 | -2.2389 | -3.1338 | 1.9298 | -1.7680 | -1.2872 | -1.5228 | -1.5684 |
| 1966 | 1.8548 | -1.9601 | -2.5188 | 2.4134 | -1.0983 | -1.1269 | -1.2774 | -1.2953 |
| 1967 | 1.6278 | -.2928 | -.3875 | 1.7225 | -1.2837 | -.1684 | -.1937 | -.1897 |
| 1968 | 2.8235 | -.7073 | -1.0019 | 3.1182 | -.3070 | -.4066 | -.4839 | -.4761 |
| 1969 | 3.5448 | .2371 | .3320 | 3.4499 | .2822 | .1363 | .1613 | .1580 |
| 1970 | 2.8703 | 1.9188 | 2.2097 | 2.5794 | -.2688 | 1.1031 | 1.1838 | 1.1943 |
| 1971 | 2.6885 | .7127 | .7744 | 2.6268 | -.4174 | .4098 | .4271 | .4197 |
| 1972 | 3.5736 | .5307 | .6151 | 3.4892 | .3056 | .3051 | .3285 | .3223 |
| 1973 | 3.7407 | -1.4481 | -1.7471 | 4.0397 | .4421 | -.8325 | -.9145 | -.9112 |
| 1974 | 2.6385 | -.3460 | -.4194 | 2.7119 | -.4582 | -.1989 | -.2190 | -.2146 |
| 1975 | 3.1967 | -.6790 | -.8803 | 3.3980 | -.0022 | -.3903 | -.4445 | -.4369 |
| 1976 | 3.3211 | -.1347 | -.2016 | 3.3879 | .0994 | -.0775 | -.0947 | -.0928 |
| 1977 | 4.2703 | -.0867 | -.1098 | 4.2934 | .8748 | -.0499 | -.0561 | -.0549 |
| 1978 | 3.9702 | .8173 | .9659 | 3.8216 | .6296 | .4699 | .5108 | .5028 |
| 1979 | 3.5738 | .9906 | 1.0696 | 3.4948 | .3058 | .5695 | .5918 | .5836 |
| 1980 | 3.9343 | -.8616 | -1.1360 | 4.2087 | .6003 | -.4953 | -.5688 | -.5606 |
| 1981 | 4.0178 | .1157 | .1478 | 3.9858 | .6685 | .0665 | .0752 | .0736 |
| 1982 | 5.1090 | -1.1674 | -1.4464 | 5.3880 | 1.5598 | -.6711 | -.7471 | -.7400 |
| 1983 | 4.8132 | -.0502 | -.0606 | 4.8237 | 1.3182 | -.0289 | -.0317 | -.0310 |
| 1984 | 4.3886 | 1.4975 | 1.8404 | 4.0457 | .9713 | .8609 | .9544 | .9526 |
| 1985 | 3.8819 | 1.4971 | 2.5050 | 2.8740 | .5575 | .8607 | 1.1133 | 1.1192 |
| 1986 | 3.3809 | 1.1948 | 1.5838 | 2.9919 | .1483 | .6869 | .7908 | .7845 |
| 1987 | 3.6384 | 2.4328 | 3.1410 | 2.9302 | .3586 | 1.3986 | 1.5892 | 1.6447 |
| 1988 | 2.7310 | 2.8909 | 3.5191 | 2.1027 | -.3826 | 1.6620 | 1.8337 | 1.9358 |
| 1989 | 1.3507 | 3.4251 | 4.0555 | .7203 | -1.5101 | 1.9691 | 2.1426 | 2.3324 |
| 1990 | 2.1931 | .2228 | .3203 | 2.0956 | -.8220 | .1281 | .1536 | .1504 |
| 1993 | 5.2379 | -1.6940 | -2.2571 | 5.8010 | 1.6651 | -.9739 | -1.1242 | -1.1307 |
| 1994 | 3.7241 | -.3363 | -.4128 | 3.8006 | .4286 | -.1933 | -.2142 | -.2099 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that obs. |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.

[2]This is flagged if it exceeds $t_{n-p-2,a}=t_{23,0.01}=2.500$.

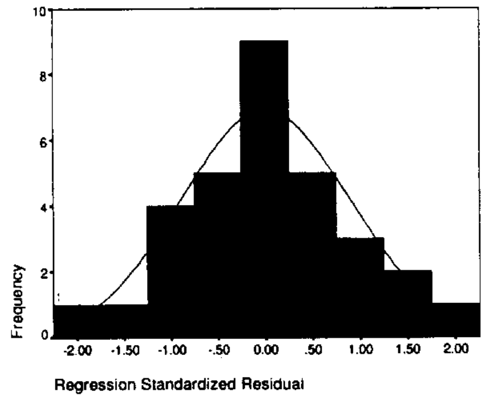


***Figure 6.1*** *Histogram of Standardized Residuals.*

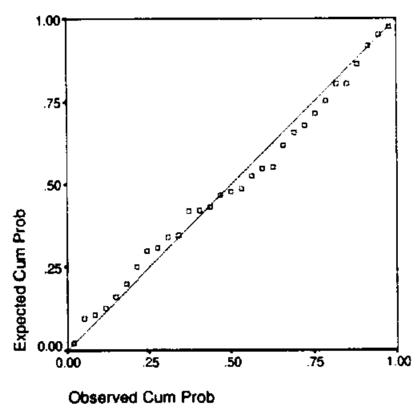


***Figure 6.2*** *Normal P-P Plot of Residuals.*

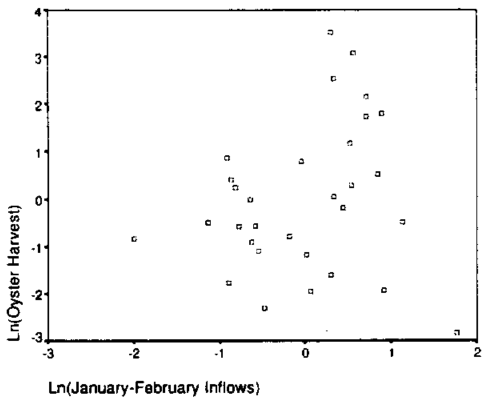


***Figure 6.3*** *Partial Residual Plot for Ln(January-February Inflows).*

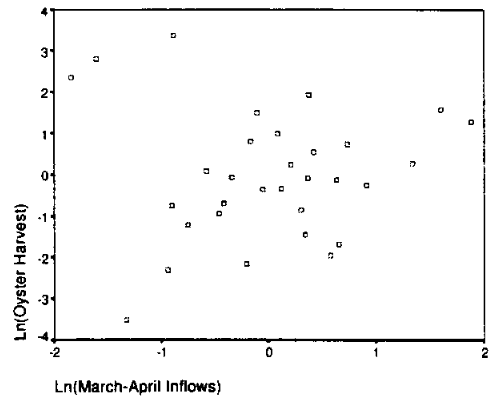


***Figure 6.4*** *Partial Residual Plot for Ln(March-April Inflows).*

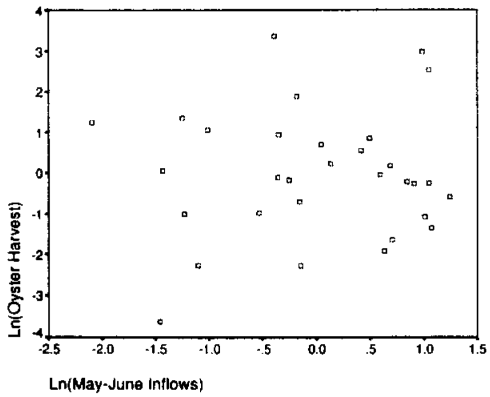


***Figure 6.5*** *Partial Residual Plot for Ln(May-June Inflows).*

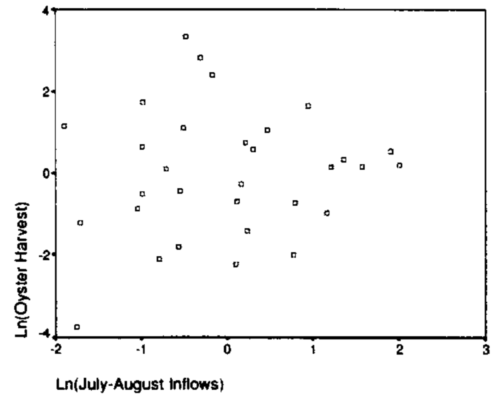


***Figure 6.6*** *Partial Residual Plot for Ln(July-August Inflows).*

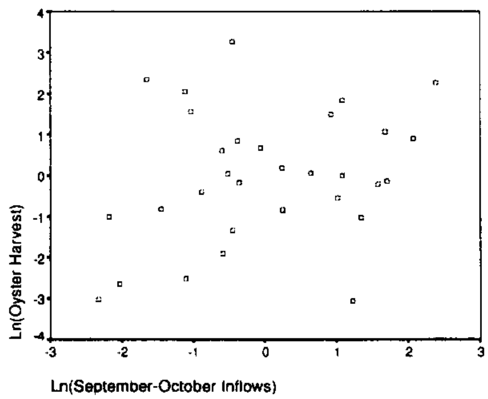


***Figure 6.7*** *Partial Residual Plot for Ln(September-October Inflows).*

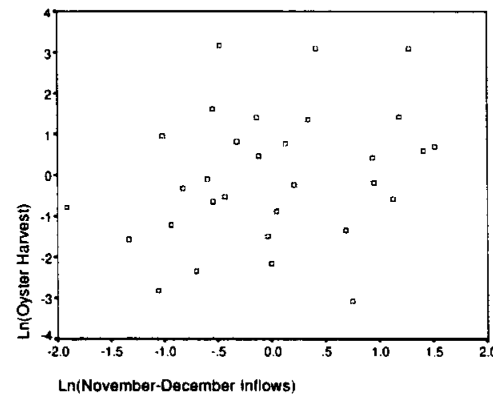


***Figure 6.8*** *Partial Residual Plot for Ln(November-December Inflows).*

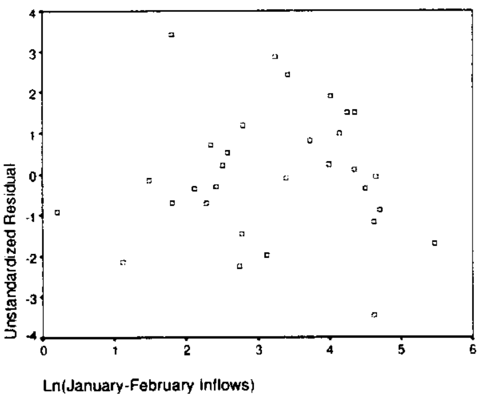


***Figure 6.9*** *Residuals Plot for Ln(January-February Inflows).*

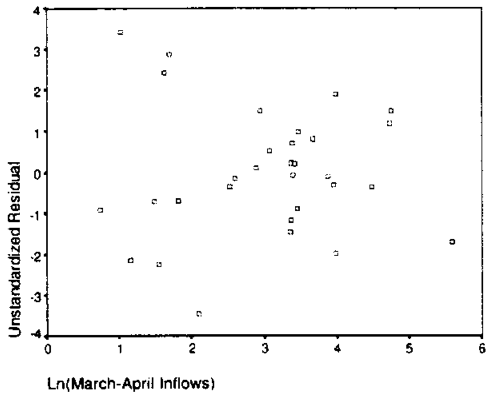


***Figure 6.10*** *Residuals Plot for Ln(March-April Inflows).*

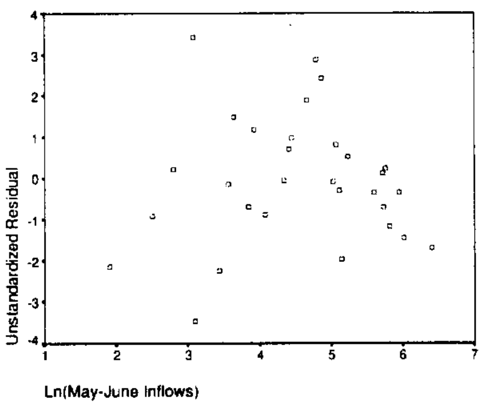


***Figure 6.11*** *Residuals Plot for Ln(May-June Inflows).*

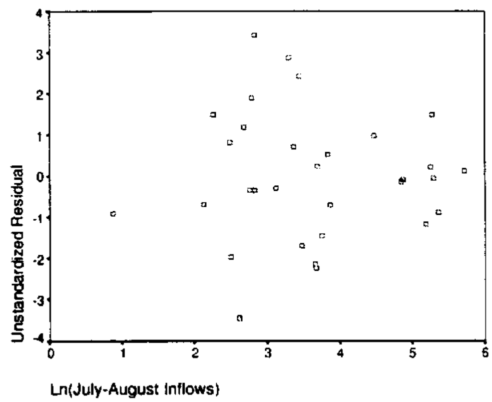


***Figure 6.12*** *Residuals Plot for Ln(July-August Inflows).*

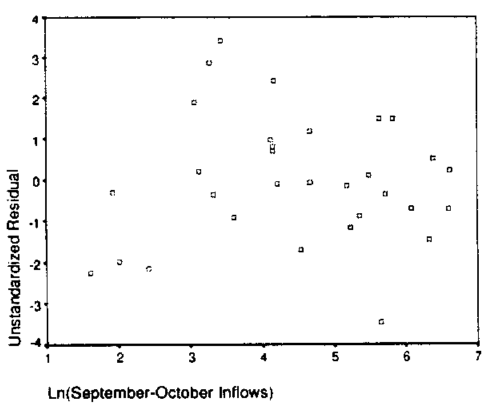


***Figure 6.13*** *Residuals Plot for Ln(September-October Inflows).*

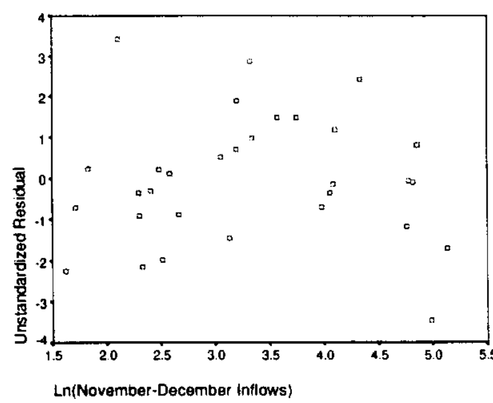


***Figure 6.14*** *Residuals Plot for Ln(November-December Inflows).*

### 6.1.4 Prediction Intervals for Oyster Harvest

***Table 6.8*** *Prediction Intervals for Oyster Harvest.*

| YEAR | *LICI_1* | *LN_FLOUN* | *UICI_1* |
|---|---|---|---|
| 1962 | -1.2339 | 1.1314 | 10.3842 |
| 1963 | -5.0750 | -.3567 | 6.1731 |
| 1964 | -4.5281 | -1.2040 | 6.3827 |
| 1965 | -4.4812 | -1.2040 | 6.5511 |
| 1966 | -3.5228 | -.1054 | 7.2324 |
| 1967 | -3.7989 | 1.3350 | 7.0546 |
| 1968 | -2.7109 | 2.1163 | 8.3579 |
| 1969 | -1.9721 | 3.7819 | 9.0617 |
| 1970 | -2.3051 | 4.7892 | 8.0457 |
| 1971 | -2.3666 | 3.4012 | 7.7435 |
| 1972 | -1.6144 | 4.1043 | 8.7616 |
| 1973 | -1.5243 | 2.2925 | 9.0057 |
| 1974 | -2.6352 | 2.2925 | 7.9122 |
| 1975 | -2.1961 | 2.5177 | 8.5894 |
| 1976 | -2.2929 | 3.1864 | 8.9351 |
| 1977 | -1.0817 | 4.1836 | 9.6223 |
| 1978 | -1.2558 | 4.7875 | 9.1961 |
| 1979 | -1.4678 | 4.5643 | 8.6154 |
| 1980 | -1.4867 | 3.0727 | 9.3552 |
| 1981 | -1.3488 | 4.1336 | 9.3844 |
| 1982 | -.2047 | 3.9416 | 10.4227 |
| 1983 | -.4542 | 4.7630 | 10.0807 |
| 1984 | -.9104 | 5.8861 | 9.6875 |
| 1985 | -1.8794 | 5.3790 | 9.6432 |
| 1986 | -2.0489 | 4.5757 | 8.8108 |
| 1987 | -1.7473 | 6.0712 | 9.0241 |
| 1988 | -2.5506 | 5.6218 | 8.0125 |
| 1989 | -3.8789 | 4.7758 | 6.5803 |
| 1990 | -3.3633 | 2.4159 | 7.7496 |
| 1993 | -.2004 | 3.5439 | 10.6761 |
| 1994 | -1.5728 | 3.3878 | 9.0210 |

| | |
|---|---|
| *LICI_1* | Lower limit for 99% prediction interval for the natural log of oyster harvest. |
| *LN_OYSTER* | Natural log of oyster harvest |
| *UICI_1* | Upper limit for 99% prediction interval for the natural log of oyster harvest. |

### 6.1.5 Outliers and Influential Point Detection

***Table 6.9*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1962 | 11.8033 | .7227 | .3934 | .1072 | .3459 |
| 1963 | 9.1221 | .0296 | .3041 | .2440 | .0000 |
| 1964 | 6.7540 | .1001 | .2251 | .4549 | .0022 |
| 1965 | 7.5988 | .1324 | .2533 | .3693 | .0052 |
| 1966 | 5.6857 | .0664 | .1895 | .5769 | .0006 |
| 1967 | 6.3588 | .0017 | .2120 | .4985 | .0000 |
| 1968 | 7.8544 | .0139 | .2618 | .3456 | .0000 |
| 1969 | 7.6093 | .0015 | .2536 | .3683 | .0000 |
| 1970 | 2.9811 | .0303 | .0994 | .8867 | .0000 |
| 1971 | 1.4206 | .0023 | .0474 | .9849 | .0000 |
| 1972 | 3.1467 | .0024 | .1049 | .8711 | .0000 |
| 1973 | 4.1663 | .0247 | .1389 | .7604 | .0000 |
| 1974 | 4.2823 | .0015 | .1427 | .7467 | .0000 |
| 1975 | 5.8925 | .0084 | .1964 | .5524 | .0000 |
| 1976 | 8.9790 | .0006 | .2993 | .2542 | .0000 |
| 1977 | 5.3376 | .0001 | .1779 | .6188 | .0000 |
| 1978 | 3.6474 | .0068 | .1216 | .8194 | .0000 |
| 1979 | 1.2483 | .0040 | .0416 | .9898 | .0000 |
| 1980 | 6.2786 | .0147 | .2093 | .5076 | .0000 |
| 1981 | 5.5357 | .0002 | .1845 | .5949 | .0000 |
| 1982 | 4.8193 | .0191 | .1606 | .6820 | .0000 |
| 1983 | 4.1995 | .0000 | .1400 | .7565 | .0000 |
| 1984 | 4.6210 | .0298 | .1540 | .7061 | .0000 |
| 1985 | 11.1027 | .1192 | .3701 | .1342 | .0038 |
| 1986 | 6.4010 | .0291 | .2134 | .4938 | .0000 |
| 1987 | 5.7960 | .1050 | .1932 | .5638 | .0025 |
| 1988 | 4.3879 | .1044 | .1463 | .7342 | .0025 |
| 1989 | 3.6958 | .1207 | .1232 | .8141 | .0039 |
| 1990 | 8.1640 | .0015 | .2721 | .3184 | .0000 |
| 1993 | 6.5167 | .0600 | .2172 | .4809 | .0004 |
| 1994 | 4.5935 | .0015 | .1531 | .7094 | .0000 |

*MAH_1* Mahalanobis distance
*COOK_1* Cook's distance
*LEV_1* Leverage value
*MAHA_PV* P-value associated with the Mahalanobis distance
*COOK_P* P-value associated with Cook's distance

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.
[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.
[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n-p-1$ denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.10*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1962 | *-2.6029 | -.5958 | *-1.5777 | *1.1050 |
| 1963 | -.4493 | -.3230 | .0936 | .0742 |
| 1964 | -.8563 | -.5605 | .1809 | .0728 |
| 1965 | -.9916 | -.6781 | -.3825 | .3657 |
| 1966 | -.6915 | -.2794 | -.0210 | -.1779 |
| 1967 | -.1079 | -.0255 | .0379 | -.0416 |
| 1968 | -.3073 | .0302 | .0227 | .1070 |
| 1969 | .1000 | .0030 | .0357 | .0082 |
| 1970 | .4650 | .2147 | .2057 | .1012 |
| 1971 | .1234 | .0114 | -.0844 | .0675 |
| 1972 | .1285 | -.0434 | -.0629 | .0303 |
| 1973 | -.4140 | .1898 | .2010 | -.0710 |
| 1974 | -.0988 | .0023 | .0309 | .0025 |
| 1975 | -.2379 | -.0198 | .0693 | .0431 |
| 1976 | -.0653 | .0180 | .0507 | -.0149 |
| 1977 | -.0283 | .0151 | .0157 | -.0047 |
| 1978 | .2144 | -.0217 | -.0049 | -.0186 |
| 1979 | .1648 | .0154 | .0716 | .0107 |
| 1980 | -.3163 | -.0284 | -.1637 | -.0410 |
| 1981 | .0387 | -.0120 | .0102 | -.0100 |
| 1982 | -.3618 | .2404 | -.0033 | .1293 |
| 1983 | -.0142 | .0049 | -.0026 | .0024 |
| 1984 | .4558 | -.0270 | .1702 | -.0236 |
| 1985 | .9183 | .2713 | .2907 | .4852 |
| 1986 | .4476 | .0301 | -.1850 | .3565 |
| 1987 | .8873 | -.0679 | .1428 | -.7194 |
| 1988 | .9024 | .1915 | .2719 | -.7159 |
| 1989 | *1.0007 | .8066 | .1745 | -.4685 |
| 1990 | .0995 | .0240 | -.0260 | .0506 |
| 1993 | -.6519 | .2732 | -.0887 | -.1786 |
| 1994 | -.1001 | .0032 | -.0233 | -.0057 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for log of January-February inflows |
| *SDFBET_2* | Standardized *dfbeta* for log of March-April inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

***Table 6.11*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1962 | *1.1540 | *1.2063 | -.6809 | -.6251 |
| 1963 | .0825 | .2295 | -.0271 | -.0078 |
| 1964 | .3696 | -.2273 | .2595 | .0000 |
| 1965 | .0529 | -.0337 | .6033 | .4092 |
| 1966 | -.1856 | .2007 | .4170 | .2144 |
| 1967 | -.0366 | -.0065 | .0664 | .0197 |
| 1968 | -.1405 | -.0119 | -.1246 | .1113 |
| 1969 | .0052 | -.0229 | .0540 | -.0746 |
| 1970 | -.0450 | -.2161 | -.1851 | -.1466 |
| 1971 | .0047 | .0166 | -.0035 | .0117 |
| 1972 | .0289 | .0188 | .0810 | -.0085 |
| 1973 | -.2140 | -.0410 | -.1866 | .0067 |
| 1974 | -.0493 | .0222 | -.0358 | .0269 |
| 1975 | .0151 | .0899 | -.1183 | -.0988 |
| 1976 | .0056 | -.0395 | -.0101 | -.0335 |
| 1977 | -.0073 | -.0169 | .0077 | -.0196 |
| 1978 | .0539 | -.0930 | -.0462 | .1357 |
| 1979 | -.0417 | .0497 | -.0324 | -.0409 |
| 1980 | .1572 | -.0884 | -.0911 | .1787 |
| 1981 | .0114 | .0196 | .0027 | -.0144 |
| 1982 | -.1656 | -.1660 | .0519 | -.1941 |
| 1983 | .0024 | -.0072 | .0017 | -.0067 |
| 1984 | -.2613 | .1735 | .1597 | -.0297 |
| 1985 | -.6025 | -.4759 | .4827 | -.3082 |
| 1986 | -.1814 | -.0785 | .1174 | .0639 |
| 1987 | .3904 | -.0545 | -.2895 | .4998 |
| 1988 | .4194 | -.1124 | -.4903 | .1840 |
| 1989 | -.1958 | -.2093 | -.1613 | -.2542 |
| 1990 | -.0513 | .0596 | -.0131 | -.0225 |
| 1993 | -.1835 | .1267 | .1069 | -.1880 |
| 1994 | -.0421 | .0397 | .0471 | -.0102 |

| | |
|---|---|
| *SDFBET_3* | Standardized *dfbeta* for log of May-June inflows |
| *SDFBET_4* | Standardized *dfbeta* for log of July-August inflows |
| *SDFBET_5* | Standardized *dfbeta* for log of September-October inflows |
| *SDFBET_6* | Standardized *dfbeta* for log of November-December inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p + 1) / n}$ for a large data set. The cutoff used here is 1.

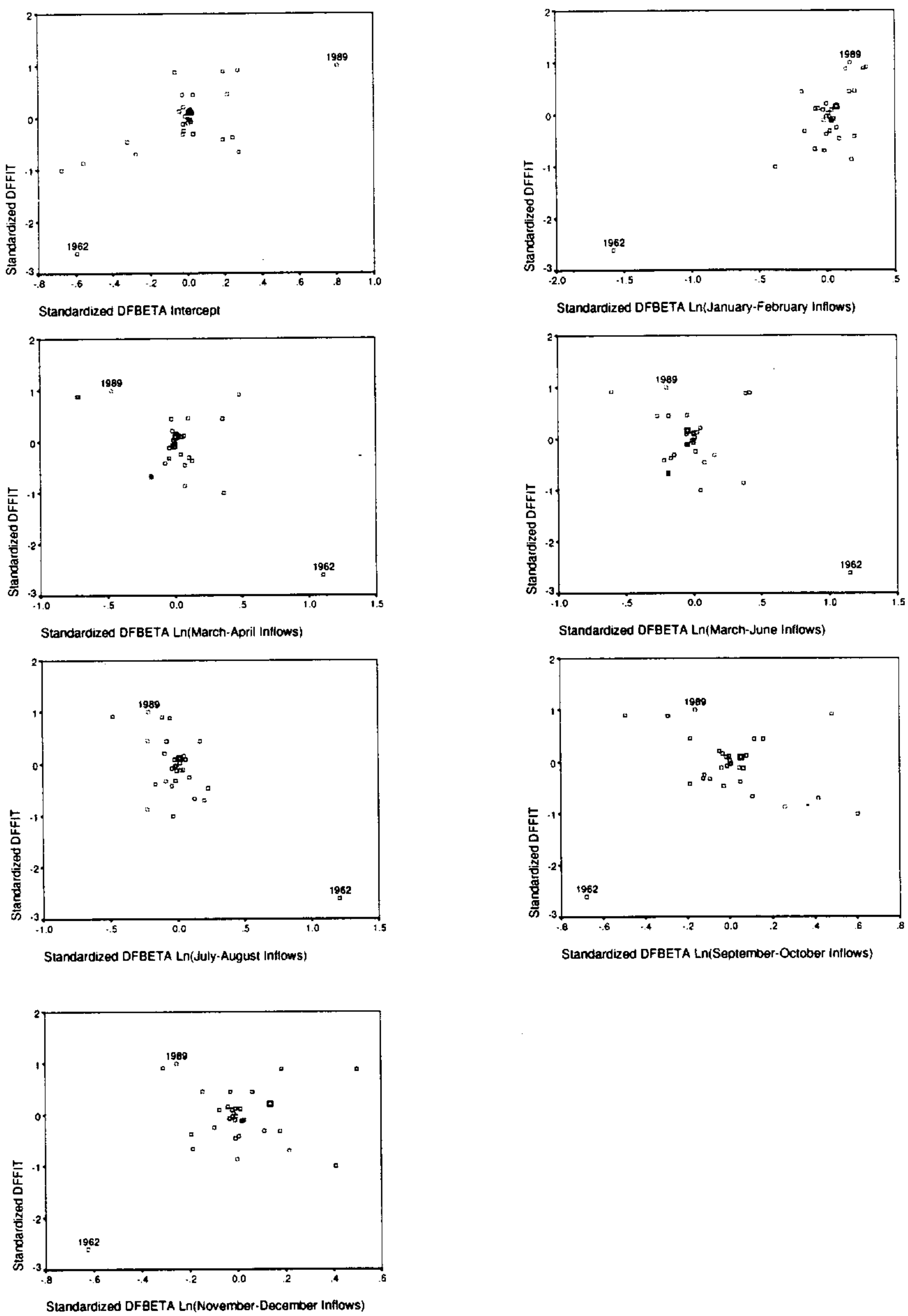


***Figure 6.15*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of log of inflow variables.*

## 6.2 Regression - Various transformation

### 6.2.1 ANOVA and Parameter Estimates

***Table 6.12*** *Model Summary for various transformation.*

**Model Summary[a,b]**

| Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| (November-December )^(-0.1), Ln(July-August), (May-June Inflows)^(0.2), (September-October)^(0.1), Ln(March-April Inflows), (January-February)^(0.1)[c,d] | .548 | .300 | .125 | .655018 | .682 |

a. Dependent Variable: (Oyster)^(0.2)

b. Method: Enter

c. Independent Variables: (Constant), (Novwember-December Inflows)^(-0.1), Ln(July-August Inflows), (May-June Inflows)^(0.2), (September-October Inflows)^(0.1), Ln(March-April Inflows), (January-February Inflows)^(0.1)

d. All requested variables entered.

***Table 6.13*** *ANOVA table of various transformations.*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 4.412 | 6 | .735 | 1.714 | .161[b] |
| | Residual | 10.297 | 24 | .429 | | |
| | Total | 14.710 | 30 | | | |

a. Dependent Variable: QR_OY2

b. Independent Variables: (Constant), (Novwember-December Inflows)^(-0.1), Ln(July-August Inflows), (May-June Inflows)^(0.2), (September-October Inflows)^(0.1), Ln(March-April Inflows), (January-February Inflows)^(0.1)

***Table 6.14*** *Table of coefficients for various transformations.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| (Constant) | 1.865 | 2.330 | | .800 | .431 | -2.944 | 6.675 |
| (January-February)^(0.1) | 1.146 | 1.058 | .277 | 1.083 | .290 | -1.038 | 3.329 |
| Ln(March-April) | -3.1E-02 | .136 | -.054 | -.231 | .820 | -.313 | .250 |
| (May-June)^(0.2) | -4.7E-02 | .265 | -.038 | -.178 | .860 | -.594 | .500 |
| Ln(July-August) | 5.1E-02 | .112 | .086 | .454 | .654 | -.181 | .283 |
| (September-October)^(0.1) | .440 | .589 | .139 | .747 | .463 | -.775 | 1.654 |
| (Novwember-December)^(-0.1) | -2.905 | 1.914 | -.315 | -1.518 | .142 | -6.856 | 1.045 |

a. Dependent Variable: (Oyster)^(0.2)

## 6.2.2 Collinearity Diagnostic

***Table 6.15*** *Collinearity Diagnostic for various transformations.*

**Coefficients[a]**

| | t | Collinearity Statistics | |
|---|---|---|---|
| | | Tolerance | VIF |
| (Constant) | .800 | | |
| (January-February)^(0.1) | 1.083 | .444 | 2.250 |
| Ln(March-April) | -.231 | .531 | 1.884 |
| (May-June)^(0.2) | -.178 | .652 | 1.535 |
| Ln(July-August) | .454 | .821 | 1.218 |
| (September-October)^(0.1) | .747 | .839 | 1.192 |
| (November-December)^(-0.1) | -1.518 | .679 | 1.473 |

a. Dependent Variable: (Oyster)^(0.2)

***Table 6.16*** *Collinearity Diagnostics(intercept adjusted) for various transformations.*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *QR_QJF* | Var Prop *QR_QMA* | Var Prop *QR_QMJ* | Var Prop *QR_QJA* | Var Prop *QR_QSO* | Var Prop *QR_QND* |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.50945 | 1.00000 | 0.0530 | 0.0508 | 0.0457 | 0.0229 | 0.0190 | 0.0427 |
| 2 | 1.09381 | 1.51467 | 0.0038 | 0.0604 | 0.0226 | 0.1673 | 0.3624 | 0.0824 |
| 3 | 0.91066 | 1.66001 | 0.0174 | 0.0066 | 0.1892 | 0.5071 | 0.1038 | 0.0102 |
| 4 | 0.80342 | 1.76734 | 0.0005 | 0.0425 | 0.1588 | 0.0473 | 0.2544 | 0.3794 |
| 5 | 0.36813 | 2.61091 | 0.0001 | 0.6135 | 0.5367 | 0.0127 | 0.2599 | 0.2794 |
| 6 | 0.31454 | 2.82457 | 0.9252 | 0.2261 | 0.0470 | 0.2426 | 0.0005 | 0.2059 |

### 6.2.3 Residuals Diagnostics

***Table 6.17*** *Residuals Diagnostics for various transformations.*

**Residuals Statistics**[a]

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 1.302810 | 2.673500 | 2.030184 | .383514 | 31 |
| Std. Predicted Value | -1.897 | 1.677 | .000 | 1.000 | 31 |
| Standard Error of Predicted Value | .180938 | .420542 | .306350 | 5.6E-02 | 31 |
| Adjusted Predicted Value | 1.327969 | 3.669001 | 2.062179 | .469633 | 31 |
| Residual | -1.419572 | 1.108392 | 2.9E-17 | .585866 | 31 |
| Std. Residual | -2.167 | 1.692 | .000 | .894 | 31 |
| Stud. Residual | -2.827 | 1.913 | -.021 | 1.044 | 31 |
| Deleted Residual | -2.415074 | 1.418259 | -3.2E-02 | .806821 | 31 |
| Stud. Deleted Residual | -3.388 | 2.034 | -.028 | 1.118 | 31 |
| Mahal. Distance | 1.321 | 11.398 | 5.806 | 2.392 | 31 |
| Cook's Distance | .000 | .801 | .059 | .145 | 31 |
| Centered Leverage Value | .044 | .380 | .194 | .080 | 31 |

a. Dependent Variable: (Oyster)^(0.2)

***Table 6.18*** *Case Values for Residuals Diagnostics for various transformations.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 2.6735 | -1.4196 | -2.4151 | 3.6690 | 1.6774 | -2.1672 | -2.8268 | *-3.3882 |
| 1963 | 1.3028 | -.3717 | -.5458 | 1.4769 | -1.8966 | -.5674 | -.6876 | -.6798 |
| 1964 | 1.4872 | -.7012 | -.9013 | 1.6873 | -1.4157 | -1.0706 | -1.2137 | -1.2264 |
| 1965 | 1.4650 | -.6790 | -.9370 | 1.7230 | -1.4738 | -1.0365 | -1.2177 | -1.2306 |
| 1966 | 1.5804 | -.6012 | -.7603 | 1.7394 | -1.1728 | -.9179 | -1.0322 | -1.0337 |
| 1967 | 1.4785 | -.1724 | -.2239 | 1.5299 | -1.4385 | -.2633 | -.3000 | -.2942 |
| 1968 | 1.7105 | -.1836 | -.2635 | 1.7904 | -.8334 | -.2803 | -.3358 | -.3295 |
| 1969 | 1.9423 | .1882 | .2688 | 1.8617 | -.2291 | .2874 | .3434 | .3370 |
| 1970 | 1.9643 | .6418 | .7376 | 1.8685 | -.1719 | .9798 | 1.0504 | 1.0527 |
| 1971 | 1.8220 | .1524 | .1663 | 1.8081 | -.5429 | .2326 | .2430 | .2382 |
| 1972 | 2.0055 | .2670 | .3120 | 1.9604 | -.0644 | .4076 | .4406 | .4331 |
| 1973 | 2.0094 | -.4277 | -.5281 | 2.1098 | -.0542 | -.6529 | -.7255 | -.7182 |
| 1974 | 1.6715 | -.0898 | -.1081 | 1.6898 | -.9353 | -.1370 | -.1504 | -.1473 |
| 1975 | 2.0448 | -.3903 | -.5150 | 2.1695 | .0382 | -.5958 | -.6844 | -.6766 |
| 1976 | 2.0730 | -.1817 | -.2682 | 2.1595 | .1115 | -.2773 | -.3370 | -.3307 |
| 1977 | 2.3500 | -.0412 | -.0519 | 2.3607 | .8339 | -.0629 | -.0706 | -.0691 |
| 1978 | 2.2907 | .3144 | .3687 | 2.2364 | .6794 | .4800 | .5198 | .5118 |
| 1979 | 2.1885 | .3030 | .3280 | 2.1634 | .4127 | .4626 | .4813 | .4735 |
| 1980 | 2.2869 | -.4381 | -.5860 | 2.4348 | .6695 | -.6689 | -.7735 | -.7669 |
| 1981 | 2.2081 | .0777 | .0995 | 2.1863 | .4638 | .1187 | .1342 | .1315 |
| 1982 | 2.6301 | -.4304 | -.5382 | 2.7378 | 1.5643 | -.6571 | -.7348 | -.7275 |
| 1983 | 2.6433 | -.0509 | -.0616 | 2.6540 | 1.5988 | -.0777 | -.0854 | -.0836 |
| 1984 | 2.4942 | .7512 | .9273 | 2.3180 | 1.2099 | 1.1468 | 1.2742 | 1.2918 |
| 1985 | 2.2433 | .6890 | 1.1545 | 1.7778 | .5558 | 1.0519 | 1.3616 | 1.3876 |
| 1986 | 2.0406 | .4565 | .6148 | 1.8823 | .0273 | .6969 | .8088 | .8028 |
| 1987 | 2.2608 | 1.1069 | 1.4183 | 1.9495 | .6013 | 1.6899 | 1.9129 | 2.0341 |
| 1988 | 1.9699 | 1.1084 | 1.3349 | 1.7434 | -.1572 | 1.6922 | 1.8570 | 1.9645 |
| 1989 | 1.5289 | 1.0702 | 1.2711 | 1.3280 | -1.3071 | 1.6338 | 1.7806 | 1.8711 |
| 1990 | 1.7530 | -.1318 | -.1870 | 1.8082 | -.7227 | -.2012 | -.2397 | -.2349 |
| 1993 | 2.6306 | -.5991 | -.8317 | 2.8632 | 1.5656 | -.9147 | -1.0777 | -1.0815 |
| 1994 | 2.1861 | -.2170 | -.2714 | 2.2404 | .4065 | -.3313 | -.3705 | -.3637 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that observation |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.

[2]This is flagged if it exceeds $t_{n-p-2,\alpha}=t_{23,0.01}=2.500$.

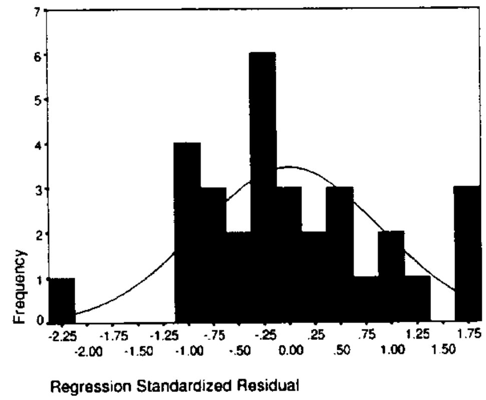


***Figure 6.16*** *Histogram of Standardized Residuals.*

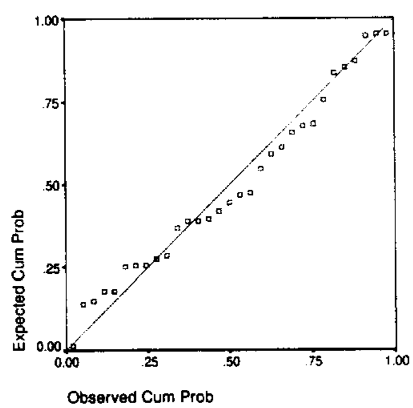


***Figure 6.17*** *Normal P-P Plot of Residuals.*

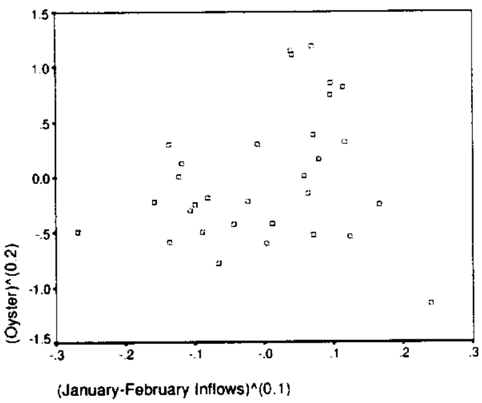


***Figure 6.18*** *Partial Residual Plot for (January-February)^(0.1).*

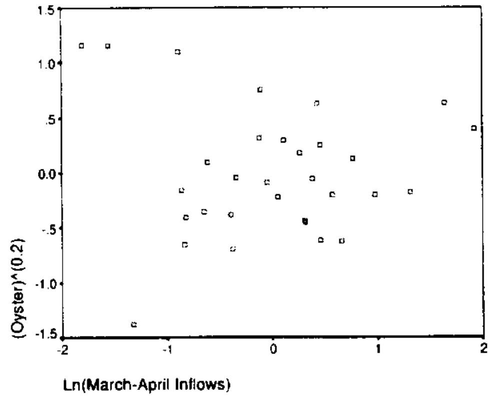


***Figure 6.19*** *Partial Residual Plot for Ln(March-April Inflows).*

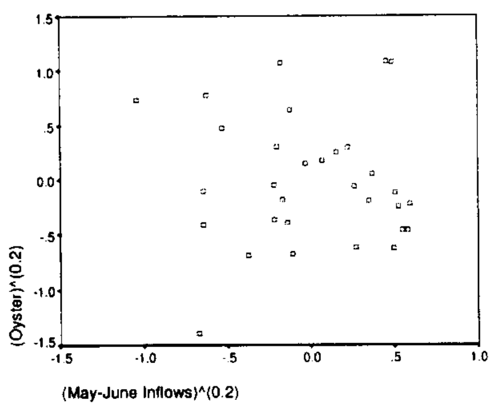


***Figure 6.20*** *Partial Residual Plot for (May-June Inflows)^(0.2).*

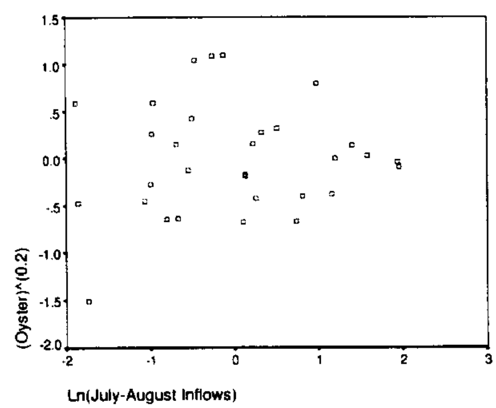


***Figure 6.21*** *Partial Residual Plot for Ln(July-August Inflows).*

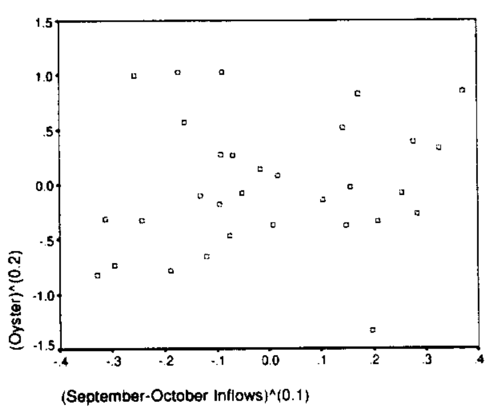


***Figure 6.22*** *Partial Residual Plot for (September-October)^(0.1).*

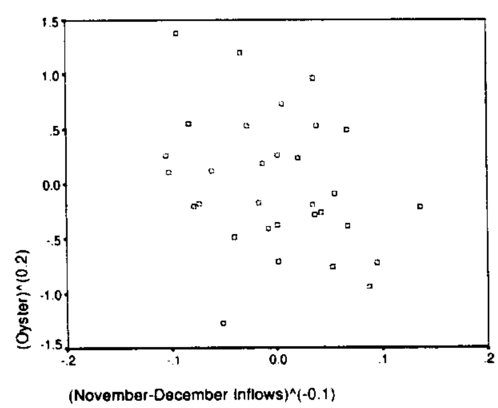


***Figure 6.23*** *Partial Residual Plot for (November-December Inflows)^(-0.1).*

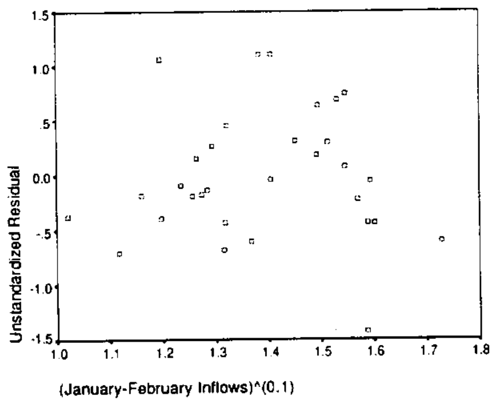


***Figure 6.24*** *Residuals Plot for (January-February)^(0.1).*

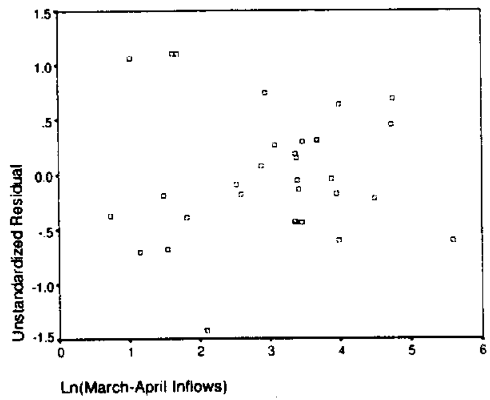


***Figure 6.25*** *Residuals Plot for Ln(March-April Inflows).*

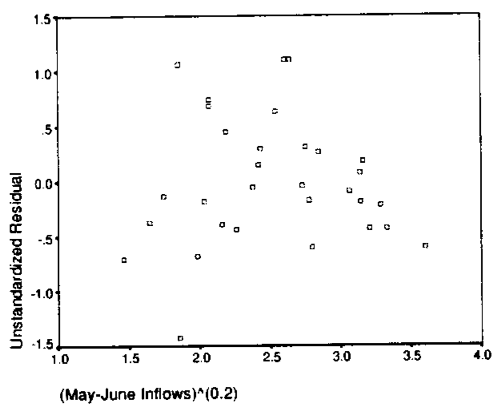


***Figure 6.26*** *Residuals Plot for Sqrt(May-June Inflows)^(0.2).*

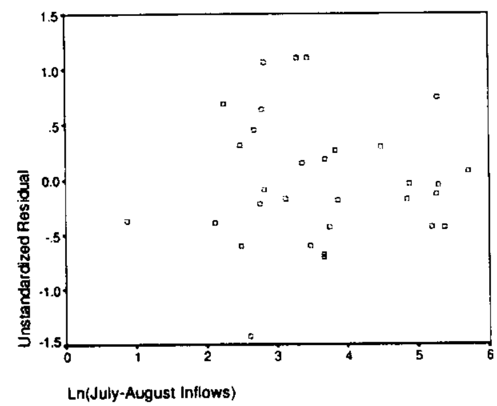


***Figure 6.27*** *Residuals Plot for Ln(July-August Inflows).*

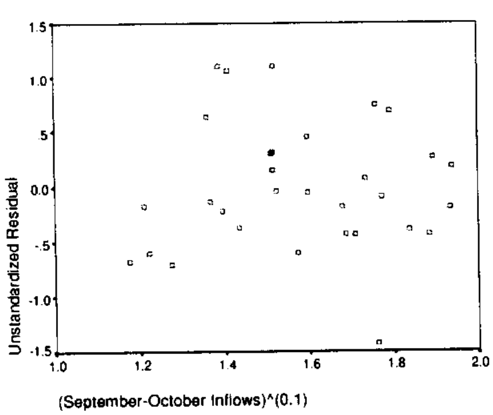


***Figure 6.28*** *Residuals Plot for (September-October Inflows)^(0.1).*

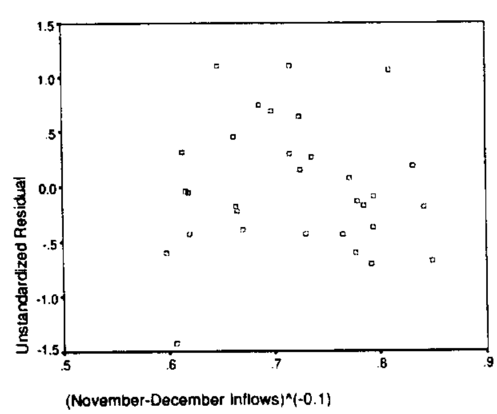


***Figure 6.29*** *Residuals Plot for(November-December Inflows)^(-0.1).*

### 6.2.4 Prediction Intervals for Oyster Harvest

***Table 6.19*** *Prediction Intervals for Oyster Harvest.*

| YEAR | *LICI_1* | *TR_OYST* | *UICI_1* |
|---|---|---|---|
| 1962 | .4964 | 1.2539 | 4.8506 |
| 1963 | -.8013 | .9311 | 3.4069 |
| 1964 | -.5380 | .7860 | 3.5125 |
| 1965 | -.6040 | .7860 | 3.5339 |
| 1966 | -.4342 | .9791 | 3.5950 |
| 1967 | -.5531 | 1.3060 | 3.5101 |
| 1968 | -.3808 | 1.5269 | 3.8019 |
| 1969 | -.1464 | 2.1306 | 4.0310 |
| 1970 | .0169 | 2.6060 | 3.9117 |
| 1971 | -.0851 | 1.9744 | 3.7291 |
| 1972 | .0457 | 2.2725 | 3.9653 |
| 1973 | .0108 | 1.5817 | 4.0080 |
| 1974 | -.3100 | 1.5817 | 3.6529 |
| 1975 | .0030 | 1.6546 | 4.0867 |
| 1976 | -.0341 | 1.8913 | 4.1801 |
| 1977 | .3382 | 2.3088 | 4.3617 |
| 1978 | .3284 | 2.6052 | 4.2531 |
| 1979 | .2878 | 2.4915 | 4.0891 |
| 1980 | .2368 | 1.8488 | 4.3371 |
| 1981 | .1856 | 2.2858 | 4.2306 |
| 1982 | .6231 | 2.1997 | 4.6372 |
| 1983 | .6587 | 2.5925 | 4.6280 |
| 1984 | .4957 | 3.2453 | 4.4927 |
| 1985 | .0731 | 2.9323 | 4.4136 |
| 1986 | -.0138 | 2.4971 | 4.0951 |
| 1987 | .2376 | 3.3677 | 4.2840 |
| 1988 | -.0115 | 3.0783 | 3.9513 |
| 1989 | -.4426 | 2.5991 | 3.5004 |
| 1990 | -.3319 | 1.6212 | 3.8379 |
| 1993 | .5581 | 2.0315 | 4.7031 |
| 1994 | .1790 | 1.9691 | 4.1932 |

*LICI*_1 Lower limit for 99% prediction interval for the log of (Oyster harvest)^(0.2).
*TR*_OYST (Oyster harvest)^(0.2)
*UICI*_1 Upper limit for 99% prediction interval for (Oyster harvest)^(0.2)

### 6.2.5 Outliers and Influential Point Detection

***Table 6.20*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1962 | 11.3984 | .8005 | .3799 | .1222 | .4052 |
| 1963 | 8.6025 | .0316 | .2868 | .2825 | .0000 |
| 1964 | 5.6918 | .0600 | .1897 | .5762 | .0004 |
| 1965 | 7.2932 | .0805 | .2431 | .3990 | .0011 |
| 1966 | 5.3083 | .0403 | .1769 | .6224 | .0001 |
| 1967 | 5.9228 | .0038 | .1974 | .5488 | .0000 |
| 1968 | 8.1248 | .0070 | .2708 | .3217 | .0000 |
| 1969 | 8.0274 | .0072 | .2676 | .3302 | .0000 |
| 1970 | 2.9291 | .0235 | .0976 | .8915 | .0000 |
| 1971 | 1.5407 | .0008 | .0514 | .9809 | .0000 |
| 1972 | 3.3626 | .0047 | .1121 | .8496 | .0000 |
| 1973 | 4.7354 | .0177 | .1578 | .6922 | .0000 |
| 1974 | 4.1245 | .0007 | .1375 | .7653 | .0000 |
| 1975 | 6.2971 | .0214 | .2099 | .5055 | .0000 |
| 1976 | 8.7163 | .0077 | .2905 | .2737 | .0000 |
| 1977 | 5.2060 | .0002 | .1735 | .6348 | .0000 |
| 1978 | 3.4505 | .0067 | .1150 | .8404 | .0000 |
| 1979 | 1.3214 | .0027 | .0440 | .9879 | .0000 |
| 1980 | 6.6005 | .0288 | .2200 | .4716 | .0000 |
| 1981 | 5.5939 | .0007 | .1865 | .5879 | .0000 |
| 1982 | 5.0368 | .0193 | .1679 | .6555 | .0000 |
| 1983 | 4.2375 | .0002 | .1412 | .7521 | .0000 |
| 1984 | 4.7313 | .0544 | .1577 | .6927 | .0003 |
| 1985 | 11.1294 | .1790 | .3710 | .1331 | .0128 |
| 1986 | 6.7568 | .0324 | .2252 | .4546 | .0001 |
| 1987 | 5.6176 | .1470 | .1873 | .5850 | .0071 |
| 1988 | 4.1228 | .1007 | .1374 | .7655 | .0022 |
| 1989 | 3.7741 | .0850 | .1258 | .8054 | .0013 |
| 1990 | 7.8842 | .0034 | .2628 | .3429 | .0000 |
| 1993 | 7.4227 | .0644 | .2474 | .3862 | .0005 |
| 1994 | 5.0397 | .0049 | .1680 | .6551 | .0000 |

*MAH_1* Mahalanobis distance

*COOK_1* Cook's distance

*LEV_1* Leverage value

*MAHA_PV* P-value associated with the Mahalanobis distance

*COOK_PV* P-value associated with Cook's distance

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.

[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n-p-1$ denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.21*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1962 | *-2.8373 | .1709 | *-1.7154 | *1.2186 |
| 1963 | -.4653 | -.1265 | .0587 | .1100 |
| 1964 | -.6551 | -.2449 | .1479 | .1084 |
| 1965 | -.7586 | .1598 | -.2883 | .2498 |
| 1966 | -.5316 | .0143 | -.0063 | -.1609 |
| 1967 | -.1606 | -.0286 | .0575 | -.0685 |
| 1968 | -.2173 | .0855 | .0153 | .0707 |
| 1969 | .2206 | -.1858 | .0756 | .0221 |
| 1970 | .4068 | -.0791 | .1733 | .1020 |
| 1971 | .0720 | .0322 | -.0493 | .0398 |
| 1972 | .1779 | -.0079 | -.0899 | .0448 |
| 1973 | -.3479 | .0007 | .1748 | -.0517 |
| 1974 | -.0666 | .0106 | .0213 | .0014 |
| 1975 | -.3825 | -.1457 | .1128 | .0632 |
| 1976 | -.2283 | -.1446 | .1738 | -.0482 |
| 1977 | -.0352 | -.0237 | .0198 | -.0063 |
| 1978 | .2127 | .1115 | -.0085 | -.0138 |
| 1979 | .1361 | -.0355 | .0570 | .0115 |
| 1980 | -.4454 | .3017 | -.2377 | -.0586 |
| 1981 | .0696 | -.0352 | .0190 | -.0189 |
| 1982 | -.3639 | -.0750 | -.0150 | .1389 |
| 1983 | -.0383 | -.0068 | -.0087 | .0065 |
| 1984 | .6256 | -.1654 | .2235 | -.0303 |
| 1985 | *1.1406 | -.4354 | .3332 | .6166 |
| 1986 | .4727 | .1386 | -.2053 | .3743 |
| 1987 | *1.0787 | .4754 | .1454 | -.8642 |
| 1988 | .8881 | .2147 | .2413 | -.6967 |
| 1989 | .8107 | .0084 | .1338 | -.3758 |
| 1990 | -.1520 | -.0107 | .0450 | -.0768 |
| 1993 | -.6739 | .0083 | -.1470 | -.1220 |
| 1994 | -.1820 | -.0104 | -.0416 | -.0049 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for (January-February inflows)^(0.1) |
| *SDFBET_2* | Standardized *dfbeta* for log of March-April inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

***Table 6.22*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1962 | *1.2016 | *1.3135 | -.7832 | .6654 |
| 1963 | .0722 | .2620 | -.0060 | -.0027 |
| 1964 | .2098 | -.1768 | .2354 | -.0056 |
| 1965 | .0645 | -.0276 | .4265 | -.3704 |
| 1966 | -.1261 | .1592 | .3073 | -.1804 |
| 1967 | -.0474 | -.0077 | .0937 | -.0356 |
| 1968 | -.0946 | -.0089 | -.0907 | -.0783 |
| 1969 | .0119 | -.0474 | .1189 | .1612 |
| 1970 | -.0554 | -.1855 | -.1625 | .1271 |
| 1971 | -.0028 | .0097 | -.0035 | -.0090 |
| 1972 | .0295 | .0261 | .1173 | .0019 |
| 1973 | -.1878 | -.0359 | -.1500 | .0185 |
| 1974 | -.0329 | .0149 | -.0229 | -.0165 |
| 1975 | .0431 | .1420 | -.1992 | .1666 |
| 1976 | .0275 | -.1355 | -.0378 | .1196 |
| 1977 | -.0082 | -.0210 | .0091 | .0237 |
| 1978 | .0503 | -.0932 | -.0452 | -.1332 |
| 1979 | -.0402 | .0430 | -.0301 | .0304 |
| 1980 | .2306 | -.1236 | -.1190 | -.2477 |
| 1981 | .0223 | .0358 | .0024 | .0242 |
| 1982 | -.1799 | -.1616 | .0549 | .1869 |
| 1983 | .0081 | -.0190 | .0041 | .0163 |
| 1984 | -.3612 | .2431 | .2224 | .0256 |
| 1985 | -.7565 | -.5805 | .6033 | .3560 |
| 1986 | -.2000 | -.0797 | .1205 | -.0736 |
| 1987 | .4600 | -.0476 | -.3566 | -.6340 |
| 1988 | .3981 | -.0931 | -.4957 | -.2104 |
| 1989 | -.1445 | -.1617 | -.1615 | .2136 |
| 1990 | .0729 | -.0932 | .0234 | -.0348 |
| 1993 | -.2561 | .1456 | .1363 | .1489 |
| 1994 | -.0868 | .0694 | .0883 | .0192 |

| | |
|---|---|
| *SDFBET_3* | Standardized *dfbeta* for (May-June inflows)^(0.2) |
| *SDFBET_4* | Standardized *dfbeta* for log of July-August inflows |
| *SDFBET_5* | Standardized *dfbeta* for (September-October inflows)^(0.1) |
| *SDFBET_6* | Standardized *dfbeta* for (November-December inflows)^(-0.1) |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

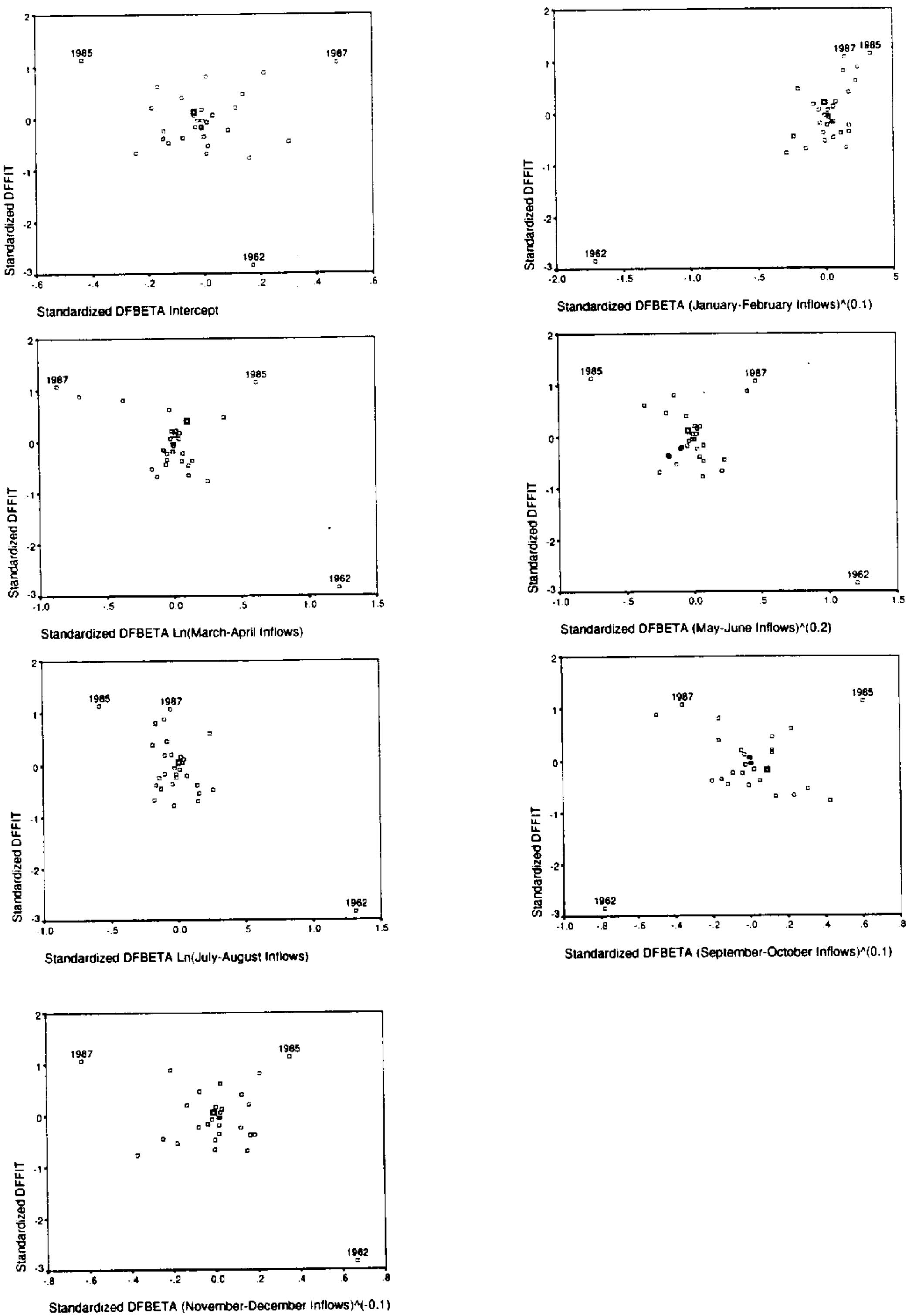


***Figure 6.30*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of various transforms of inflow variables.*

# 7. Examining Subsets of the Data

## 7.1 Log of oyster data and log of inflow data: 1962 Omitted

***Table** 7.1 Regression Models for Dependent Variable: Ln(OYSTER) on Ln(INFLOWS): 1962 Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.3093 | 0.2847 | 8.591 | 32.72 | 2.791 | 35.53 | LN_QJF |
| 1 | 0.3081 | 0.2834 | 8.653 | 32.78 | 2.796 | 35.58 | LN_QND |
| 1 | 0.1742 | 0.1447 | 15.36 | 38.09 | 3.337 | 40.89 | LN_QSO |
| 1 | 0.0997 | 0.0675 | 19.09 | 40.68 | 3.639 | 43.48 | LN_QMA |
| 2 | 0.4214 | 0.3785 | 4.980 | 29.42 | 2.425 | 33.62 | LN_QSO LN_QND |
| 2 | 0.4192 | 0.3761 | 5.091 | 29.53 | 2.434 | 33.73 | LN_QJF LN_QND |
| 2 | 0.4130 | 0.3695 | 5.400 | 29.85 | 2.460 | 34.05 | LN_QJF LN_QSO |
| 2 | 0.3372 | 0.2881 | 9.198 | 33.49 | 2.778 | 37.70 | LN_QJA LN_QND |
| 3 | 0.5075 | 0.4507 | 2.668 | 26.58 | 2.144 | 32.19 | LN_QJF LN_QSO LN_QND |
| 3 | 0.4459 | 0.3819 | 5.754 | 30.12 | 2.412 | 35.72 | LN_QJF LN_QMA LN_QND |
| 3 | 0.4318 | 0.3662 | 6.460 | 30.87 | 2.473 | 36.48 | LN_QJA LN_QSO LN_QND |
| 3 | 0.4308 | 0.3651 | 6.510 | 30.92 | 2.477 | 36.53 | LN_QJF LN_QMJ LN_QSO |
| 4 | 0.5268 | 0.4511 | 3.698 | 27.38 | 2.142 | 34.38 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.5223 | 0.4458 | 3.927 | 27.67 | 2.162 | 34.67 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.5078 | 0.4291 | 4.651 | 28.56 | 2.228 | 35.57 | LN_QJF LN_QJA LN_QSO LN_QND |
| 4 | 0.4459 | 0.3573 | 7.751 | 32.12 | 2.508 | 39.12 | LN_QJF LN_QMA LN_QMJ LN_QND |
| 5 | 0.5357 | 0.4389 | 5.257 | 28.81 | 2.189 | 37.22 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.5296 | 0.4316 | 5.560 | 29.20 | 2.218 | 37.61 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.5245 | 0.4255 | 5.814 | 29.52 | 2.242 | 37.93 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.4459 | 0.3305 | 9.750 | 34.11 | 2.612 | 42.52 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 6 | 0.5408 | 0.4210 | 7.000 | 30.48 | 2.259 | 40.29 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 30

***Table** 7.5 Parameter Estimates of Models for Dependent Variable: Ln(OYSTER) on Ln(INFLOWS): 1962 Omitted*

| OBS | _RMSE_ | INTERCEP | LN_QJF | LN_QMA | LN_QMJ | LN_QJA | LN_QSO | LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.67070 | 0.45672 | 0.88741 | . | . | . | . | . |
| 2 | 1.67219 | -0.20961 | . | . | . | . | . | 1.05968 |
| 3 | 1.82684 | 0.73423 | . | . | . | . | 0.57148 | . |
| 4 | 1.90753 | 1.69854 | . | 0.51492 | . | . | . | . |
| 5 | 1.55727 | -1.95129 | . | . | . | . | 0.46627 | 0.96038 |
| 6 | 1.56024 | -1.00059 | 0.60351 | . | . | . | . | 0.71808 |
| 7 | 1.56851 | -1.23099 | 0.79278 | . | . | . | 0.44822 | . |
| 8 | 1.66675 | -1.12082 | . | . | . | 0.28838 | . | 1.01584 |
| 9 | 1.46410 | -2.46183 | 0.53564 | . | . | . | 0.41501 | 0.66811 |
| 10 | 1.55299 | -0.82645 | 0.80732 | -0.36958 | . | . | . | 0.81157 |
| 11 | 1.57261 | -2.39540 | . | . | . | 0.17646 | 0.43589 | 0.94002 |
| 12 | 1.57400 | -0.60414 | 0.92464 | . | -0.28896 | . | 0.50914 | . |
| 13 | 1.46345 | -2.25585 | 0.71244 | -0.31577 | . | . | 0.39876 | 0.74995 |
| 14 | 1.47051 | -1.87101 | 0.65990 | . | -0.26371 | . | 0.47111 | 0.65793 |
| 15 | 1.49258 | -2.38886 | 0.55039 | . | . | -0.03458 | 0.41955 | 0.66405 |
| 16 | 1.58367 | -0.86807 | 0.80159 | -0.37237 | 0.01436 | . | . | 0.81247 |
| 17 | 1.47966 | -1.81934 | 0.78442 | -0.26889 | -0.20848 | . | 0.44553 | 0.72975 |
| 18 | 1.48927 | -2.02129 | 0.77220 | -0.34464 | . | -0.10223 | 0.41070 | 0.74543 |
| 19 | 1.49728 | -1.62109 | 0.71086 | . | -0.28813 | -0.09250 | 0.48845 | 0.64613 |
| 20 | 1.61629 | -0.83540 | 0.80861 | -0.37524 | 0.01296 | -0.01054 | . | 0.81211 |
| 21 | 1.50312 | -1.42943 | 0.87800 | -0.30207 | -0.23915 | -0.14195 | 0.46898 | 0.72051 |

***Table** 7.6 Criteria Statistics of Models for Dependent Variable: Ln(OYSTER) on Ln(INFLOWS): 1962 Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 2.79124 | 0.30934 | 0.28467 | 8.5915 | 32.7247 | 35.5271 |
| 2 | 2.79622 | 0.30810 | 0.28339 | 8.6532 | 32.7783 | 35.5807 |
| 3 | 3.33734 | 0.17421 | 0.14472 | 15.3593 | 38.0855 | 40.8879 |
| 4 | 3.63866 | 0.09965 | 0.06750 | 19.0935 | 40.6787 | 43.4811 |
| 5 | 2.42508 | 0.42137 | 0.37851 | 4.9805 | 29.4152 | 33.6188 |
| 6 | 2.43435 | 0.41916 | 0.37613 | 5.0912 | 29.5296 | 33.7332 |
| 7 | 2.46023 | 0.41298 | 0.36950 | 5.4004 | 29.8468 | 34.0504 |
| 8 | 2.77804 | 0.33715 | 0.28805 | 9.1984 | 33.4916 | 37.6952 |
| 9 | 2.14358 | 0.50748 | 0.45065 | 2.6676 | 26.5812 | 32.1860 |
| 10 | 2.41176 | 0.44586 | 0.38192 | 5.7538 | 30.1177 | 35.7225 |
| 11 | 2.47311 | 0.43176 | 0.36620 | 6.4598 | 30.8713 | 36.4761 |
| 12 | 2.47749 | 0.43076 | 0.36508 | 6.5101 | 30.9243 | 36.5291 |
| 13 | 2.14169 | 0.52684 | 0.45113 | 3.6980 | 27.3783 | 34.3843 |
| 14 | 2.16241 | 0.52226 | 0.44582 | 3.9272 | 27.6670 | 34.6730 |
| 15 | 2.22781 | 0.50781 | 0.42906 | 4.6509 | 28.5609 | 35.5669 |
| 16 | 2.50802 | 0.44591 | 0.35725 | 7.7515 | 32.1152 | 39.1212 |
| 17 | 2.18938 | 0.53565 | 0.43891 | 5.2566 | 28.8143 | 37.2214 |
| 18 | 2.21793 | 0.52960 | 0.43159 | 5.5599 | 29.2030 | 37.6102 |
| 19 | 2.24184 | 0.52452 | 0.42547 | 5.8139 | 29.5246 | 37.9318 |
| 20 | 2.61238 | 0.44594 | 0.33051 | 9.7500 | 34.1136 | 42.5208 |
| 21 | 2.25936 | 0.54078 | 0.42098 | 7.0000 | 30.4814 | 40.2897 |

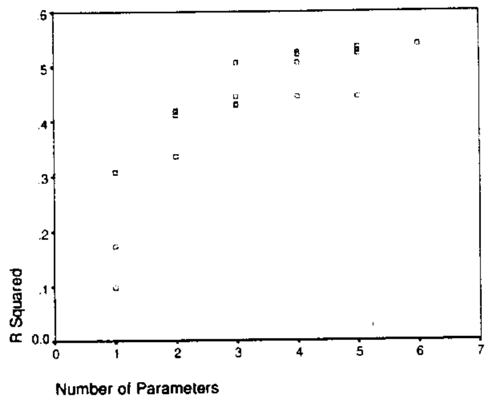


***Figure 7.7*** *The $R^2$ criteria vs. Number of parameters.*

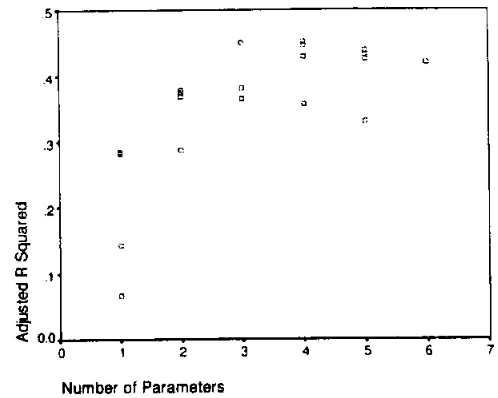


***Figure 7.8*** *The Adjusted $R^2$ criteria vs. Number of parameters.*

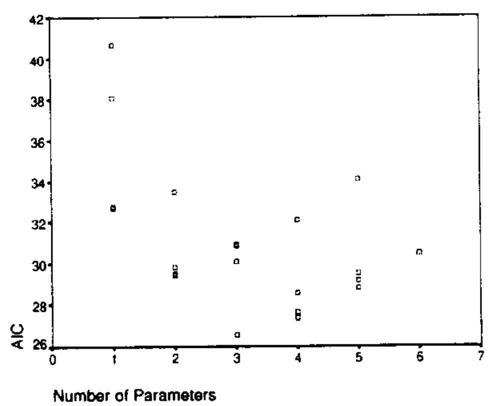


***Figure 7.9*** *The AIC criteria vs. Number of parameters..*

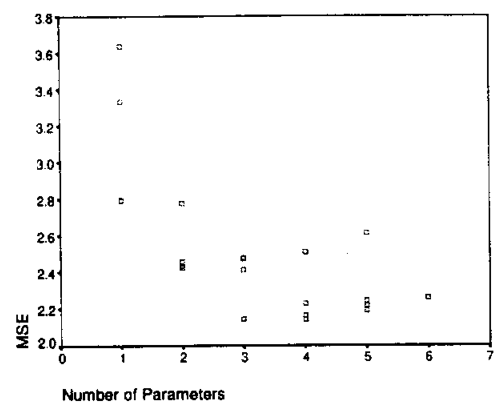


***Figure 7.10*** *MSE vs. Number of parameters.*

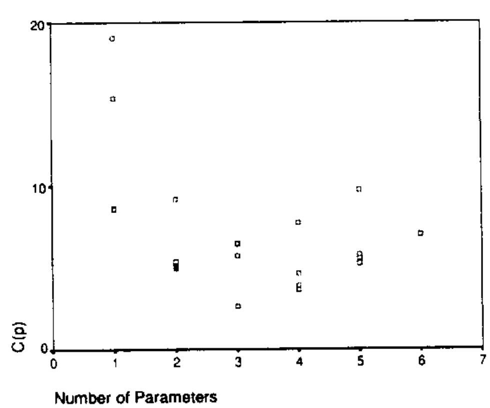


***Figure 7.11*** *The C(p) criteria vs. Number of parameters.*

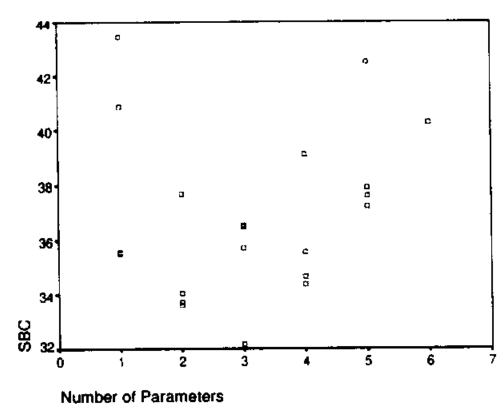


***Figure 7.12*** *The SBC criteria vs. Number of parameters.*

## 7.2 Various Transformation of data: 1962 Omitted

***Table** 7.7 Regression Models for Dependent Variable: Various Transformations 1962 Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.2950 | 0.2698 | 7.257 | -29.16 | 0.3547 | -26.36 | QR_QND |
| 1 | 0.2633 | 0.2370 | 8.750 | -27.85 | 0.3706 | -25.04 | QR_QJF |
| 1 | 0.0782 | 0.0453 | 17.48 | -21.12 | 0.4638 | -18.32 | QR_QSO |
| 1 | 0.0504 | 0.0165 | 18.79 | -20.23 | 0.4777 | -17.43 | LN_QMA |
| 2 | 0.3787 | 0.3326 | 5.309 | -30.95 | 0.3242 | -26.75 | QR_QJF QR_QND |
| 2 | 0.3445 | 0.2960 | 6.919 | -29.35 | 0.3420 | -25.15 | QR_QSO QR_QND |
| 2 | 0.3123 | 0.2614 | 8.439 | -27.91 | 0.3588 | -23.71 | LN_QJA QR_QND |
| 2 | 0.3029 | 0.2513 | 8.880 | -27.50 | 0.3637 | -23.30 | QR_QJF QR_QSO |
| 3 | 0.4407 | 0.3762 | 4.383 | -32.11 | 0.3030 | -26.50 | QR_QJF LN_QMA QR_QND |
| 3 | 0.4138 | 0.3461 | 5.653 | -30.70 | 0.3176 | -25.09 | QR_QJF QR_QSO QR_QND |
| 3 | 0.4027 | 0.3338 | 6.175 | -30.14 | 0.3236 | -24.53 | QR_QJF QR_QMJ QR_QND |
| 3 | 0.3789 | 0.3072 | 7.299 | -28.96 | 0.3365 | -23.36 | QR_QJF LN_QJA QR_QND |
| 4 | 0.4695 | 0.3847 | 5.021 | -31.70 | 0.2989 | -24.69 | QR_QJF LN_QMA QR_QSO QR_QND |
| 4 | 0.4657 | 0.3803 | 5.201 | -31.48 | 0.3010 | -24.48 | QR_QJF QR_QMJ QR_QSO QR_QND |
| 4 | 0.4526 | 0.3650 | 5.821 | -30.76 | 0.3084 | -23.75 | QR_QJF LN_QMA QR_QMJ QR_QND |
| 4 | 0.4426 | 0.3534 | 6.292 | -30.21 | 0.3141 | -23.21 | QR_QJF LN_QMA LN_QJA QR_QND |
| 5 | 0.5015 | 0.3976 | 5.514 | -31.56 | 0.2926 | -23.16 | QR_QJF LN_QMA QR_QMJ QR_QSO QR_QND |
| 5 | 0.4747 | 0.3653 | 6.778 | -29.99 | 0.3083 | -21.58 | QR_QJF LN_QMA LN_QJA QR_QSO QR_QND |
| 5 | 0.4704 | 0.3601 | 6.979 | -29.75 | 0.3108 | -21.34 | QR_QJF QR_QMJ LN_QJA QR_QSO QR_QND |
| 5 | 0.4557 | 0.3423 | 7.674 | -28.93 | 0.3195 | -20.52 | QR_QJF LN_QMA QR_QMJ LN_QJA QR_QND |
| 6 | 0.5124 | 0.3852 | 7.000 | -30.23 | 0.2986 | -20.42 | QR_QJF LN_QMA QR_QMJ LN_QJA QR_QSO QR_QND |

*N* = 30

***Table 7.8*** *Analysis of Variance for Dependent Variable: Various Transformations: 1962 Omitted*

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 6 | 7.21820 | 1.20303 | 4.028 | 0.0067 |
| Error | 23 | 6.86880 | 0.29864 | | |
| C Total | 29 | 14.08700 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 0.54648 | R-square | 0.5124 |
| Dep Mean | 2.05606 | Adj R-sq | 0.3852 |
| C.V. | 26.57914 | | |

***Table 7.9*** *Parameter Estimates for Dependent Variable: Various Transformations: 1962 Omitted*

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 1.533256 | 1.94676178 | 0.788 | 0.4390 | 0.00000000 |
| QR_QJF | 1 | 2.659696 | 0.98936443 | 2.688 | 0.0131 | 2.69436224 |
| LN_QMA | 1 | -0.170200 | 0.12098494 | -1.407 | 0.1729 | 2.08452974 |
| QR_QMJ | 1 | -0.312921 | 0.23466295 | -1.333 | 0.1954 | 1.64370892 |
| LN_QJA | 1 | -0.072185 | 0.10064813 | -0.717 | 0.4805 | 1.36502564 |
| QR_QSO | 1 | 0.824152 | 0.50403573 | 1.635 | 0.1156 | 1.22699762 |
| QR_QND | 1 | -3.967991 | 1.62725758 | -2.438 | 0.0229 | 1.41287742 |

***Table 7.10*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Various Transformations: 1962 Omitted*

| Number | Eigenvalue | Condition Index | Var Prop QR_QJF | Var Prop LN_QMA | Var Prop QR_QMJ | Var Prop LN_QJA | Var Prop QR_QSO | Var Prop QR_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.61809 | 1.00000 | 0.0419 | 0.0437 | 0.0425 | 0.0196 | 0.0164 | 0.0434 |
| 2 | 1.12307 | 1.52682 | 0.0021 | 0.0569 | 0.0171 | 0.1304 | 0.3713 | 0.0738 |
| 3 | 0.94043 | 1.66851 | 0.0134 | 0.0051 | 0.1653 | 0.4516 | 0.0963 | 0.0073 |
| 4 | 0.68714 | 1.95195 | 0.0270 | 0.0139 | 0.1449 | 0.0194 | 0.2330 | 0.5684 |
| 5 | 0.38273 | 2.61545 | 0.0029 | 0.5091 | 0.4934 | 0.0185 | 0.2536 | 0.2805 |
| 6 | 0.24853 | 3.24567 | 0.9126 | 0.3714 | 0.1368 | 0.3604 | 0.0294 | 0.0267 |

***Table** 7.11 Parameter Estimates of Models for Dependent Variable Various Transformations 1962 Omitted*

| OBS | _RMSE_ | INTERCEP | QR_QJF | LN_QMA | QR_QMJ | LN_QJA | QR_QSO | QR_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.59557 | 5.75275 | . | . | . | . | . | -5.10648 |
| 2 | 0.60880 | -0.88139 | 2.12419 | . | . | . | . | . |
| 3 | 0.68099 | 0.68061 | . | . | . | . | 0.87408 | . |
| 4 | 0.69119 | 1.66214 | . | 0.12921 | . | . | . | . |
| 5 | 0.56937 | 2.80181 | 1.36214 | . | . | . | . | -3.63216 |
| 6 | 0.58480 | 4.48788 | . | . | . | . | 0.69969 | -4.88016 |
| 7 | 0.59900 | 5.34732 | . | . | . | 0.078556 | . | -4.94346 |
| 8 | 0.60306 | -1.68618 | 1.98869 | . | . | . | 0.63051 | . |
| 9 | 0.55049 | 2.83435 | 2.15015 | -0.19766 | . | . | . | -4.34998 |
| 10 | 0.56359 | 1.97312 | 1.24918 | . | . | . | 0.59378 | -3.56236 |
| 11 | 0.56888 | 2.79220 | 1.75502 | . | -0.22666 | . | . | -3.57235 |
| 12 | 0.58012 | 2.81912 | 1.33179 | . | . | 0.009386 | . | -3.64553 |
| 13 | 0.54672 | 2.07943 | 2.00869 | -0.18793 | . | . | 0.53977 | -4.25120 |
| 14 | 0.54867 | 1.61305 | 1.81278 | . | -0.35230 | . | 0.84107 | -3.44033 |
| 15 | 0.55538 | 2.82465 | 2.36432 | -0.18067 | -0.16262 | . | . | -4.24538 |
| 16 | 0.56042 | 2.78125 | 2.27840 | -0.20587 | . | -0.029533 | . | -4.33775 |
| 17 | 0.54093 | 1.77059 | 2.32758 | -0.15454 | -0.28370 | . | 0.74851 | -4.03053 |
| 18 | 0.55527 | 1.94026 | 2.21134 | -0.20087 | . | -0.048882 | 0.57644 | -4.22424 |
| 19 | 0.55752 | 1.44944 | 1.99360 | . | -0.37567 | -0.046626 | 0.89600 | -3.36129 |
| 20 | 0.56522 | 2.75625 | 2.53993 | -0.19024 | -0.17151 | -0.037747 | . | -4.22403 |
| 21 | 0.54648 | 1.53326 | 2.65970 | -0.17020 | -0.31292 | -0.072185 | 0.82415 | -3.96799 |

***Table** 7.12 Criteria Statistics of Models for Dependent Variable: Various Transformations. 1962 Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 0.35471 | 0.29496 | 0.26978 | 7.2565 | -29.1636 | -26.3612 |
| 2 | 0.37063 | 0.26331 | 0.23700 | 8.7497 | -27.8459 | -25.0435 |
| 3 | 0.46375 | 0.07823 | 0.04531 | 17.4800 | -21.1220 | -18.3196 |
| 4 | 0.47775 | 0.05041 | 0.01649 | 18.7924 | -20.2300 | -17.4276 |
| 5 | 0.32418 | 0.37865 | 0.33263 | 5.3090 | -30.9542 | -26.7506 |
| 6 | 0.34200 | 0.34451 | 0.29596 | 6.9194 | -29.3496 | -25.1460 |
| 7 | 0.35881 | 0.31229 | 0.26135 | 8.4392 | -27.9101 | -23.7065 |
| 8 | 0.36368 | 0.30294 | 0.25131 | 8.8803 | -27.5049 | -23.3013 |
| 9 | 0.30304 | 0.44069 | 0.37615 | 4.3828 | -32.1097 | -26.5050 |
| 10 | 0.31763 | 0.41376 | 0.34612 | 5.6530 | -30.6990 | -25.0943 |
| 11 | 0.32363 | 0.40269 | 0.33377 | 6.1751 | -30.1379 | -24.5331 |
| 12 | 0.33654 | 0.37886 | 0.30719 | 7.2993 | -28.9642 | -23.3594 |
| 13 | 0.29890 | 0.46955 | 0.38468 | 5.0214 | -31.6991 | -24.6931 |
| 14 | 0.30104 | 0.46574 | 0.38026 | 5.2009 | -31.4847 | -24.4787 |
| 15 | 0.30845 | 0.45260 | 0.36502 | 5.8207 | -30.7558 | -23.7498 |
| 16 | 0.31407 | 0.44262 | 0.35344 | 6.2917 | -30.2135 | -23.2075 |
| 17 | 0.29260 | 0.50150 | 0.39764 | 5.5144 | -31.5627 | -23.1555 |
| 18 | 0.30833 | 0.47470 | 0.36527 | 6.7782 | -29.9922 | -21.5850 |
| 19 | 0.31083 | 0.47045 | 0.36012 | 6.9791 | -29.7499 | -21.3428 |
| 20 | 0.31947 | 0.45572 | 0.34233 | 7.6736 | -28.9272 | -20.5200 |
| 21 | 0.29864 | 0.51240 | 0.38520 | 7.0000 | -30.2263 | -20.4179 |

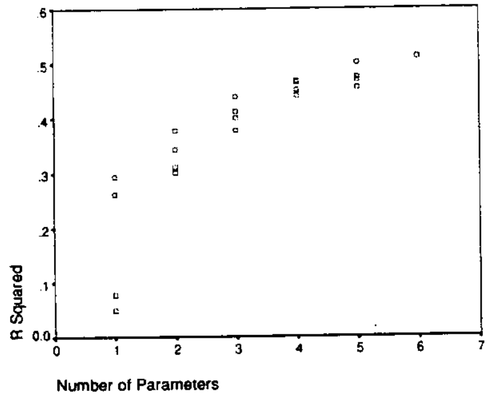


***Figure** 7.7 The $R^2$ criteria vs. Number of parameters.*

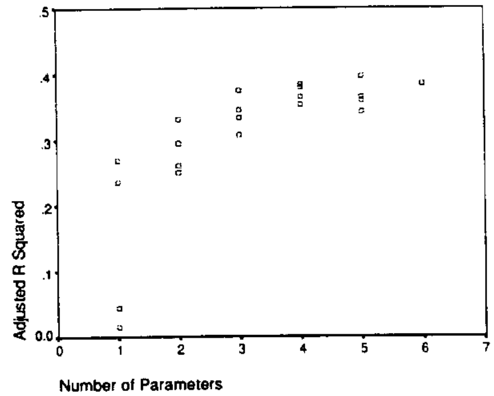


***Figure** 7.8 The Adjusted $R^2$ criteria vs. Number of parameters.*

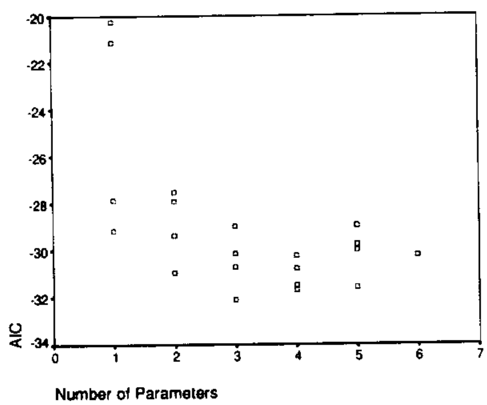


***Figure** 7.9 The AIC criteria vs. Number of parameters..*

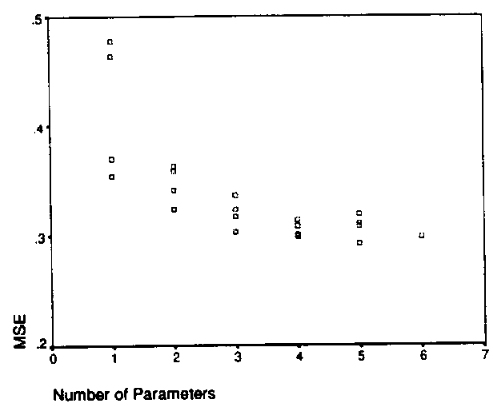


***Figure** 7.10 MSE vs. Number of parameters.*

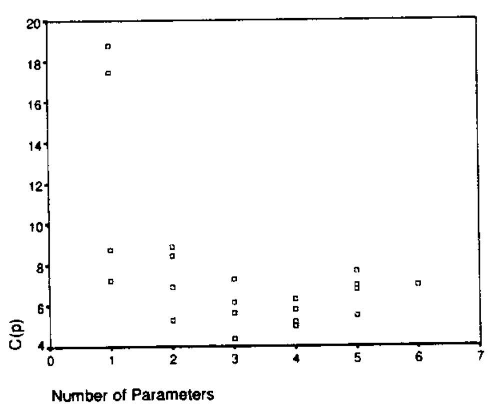


***Figure** 7.11 The C(p) criteria vs. Number of parameters.*

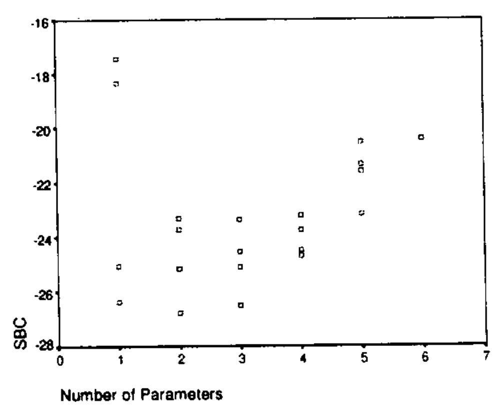


***Figure** 7.12 The SBC criteria vs. Number of parameters.*

# Drum Harvests in Corpus Christi Bay:
# A Regression Analysis

## Harvest vs Freshwater Inflows

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(2 of 15) 97-483-195

# Drum Harvest in Corpus Christi Bay:

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Department of Statistics

Texas A&M University

SPRING 1997

# Table of Contents

# 1. Summary Report

## 1.1 Description of the Problem[1]

Bimonthly freshwater inflows into Corpus Christi Bay were recorded for the years 1961 to 1993. These variables, and various transformations of them, were used to construct a model for the annual harvest of Drum.

## 1.2 Constructing Models - General Discussion

Stability of coefficient estimates and accuracy of predicted values are primary goals in constructing models for prediction. To this end, the data must be examined from three points of view: individual observations (to detect outliers or influential points); variables, individually and in groups (to select an optimal set of predictors); and the interaction of these two, which produces the overall structure of the data set (to determine whether multicollinearity is present or not). The first two of these were examined by both graphic and quantitative means; the third by quantitative means only.

### 1.2.1 Detecting Influential Points and Outliers

The structures of individual variables were examined via box plots and histograms, as well as by all the usual numerical measures. For each pair of variables, 99 % prediction ellipses and 95% confidence ellipses were plotted in a further effort to look for unusual points. For example, suppose large values of Variable A are generally associated with large values for Variable B. If an observation consisted of a large value for Variable A but a small value for Variable B, that point would be considered unusual, even though it was well within the range of data for both variables and could not be considered an outlier.

In addition, a number of residual analysis techniques were employed. A large *residual* indicates a point not well-fit by the model. The *deleted residual*, however, is somewhat more useful in the search for influential points. The model is fitted without a given observation, and the predicted response and corresponding residual are calculated for that observation. The *Studentized deleted residual* is scaled to have a Student's t distribution. Histograms and normal P-P plots of the residuals were also examined.

Other quantities, such as the Mahalanobis distance, Cook's distance, the leverage value, standarized values for the Dffits (to measure the influence of a given observation on the predicted response) and the Dfbetas (to measure the influence of a given observation on the calculated coefficients) were also used to build a general picture of the influence of individual points. Plots were made of the standardized Dffits value for each model against the Dfbeta values for each predictor in the model. Points which were extreme indicated observations which had strong effects on both predicted values and coefficient estimates.

### 1.2.2 Variable Selection

For each regression, residuals were plotted against each of the independent variables to look for nonlinear relationships between the response variable and individual predictors. Partial residual plots were employed to examine the overall relationship between the response and individual predictors. A partial

[1] The following discussion, prepared by Jacqueline Kiffe, was taken from Seatrout Harvests in Galveston Bay: A Regression Analysis, by F. Michael Speed, Sr. and Jacqueline Kiffe.

residual is a corollary to the deleted residual. That is, the model is fitted without a given variable and the predicted response and corresponding residual are calculated for each observation. This seeks to answer the question, "What is the relationship of this predictor to the response variable, taking all other variables into account?" Thus, it examines the marginal relationship of a given predictor to the response.

Numerous measures have been developed over the years to assess the adequacy of a given model. We examined a number of these, including $R^2$ and mean squared error (MSE), and several others which directly incorporate penalties for having too many predictors in the model, such as adjusted $R^2$, $C_p$, AIC, and SBC. It is well-established that too many predictors in a model can lead to bad prediction, just as too few can, and these measures are used as part of the attempt to find an optimal model.

### 1.2.3 Multicollinearity

Multicollinearity arises when one or more variables are nearly closely approximated by linear combinations of the remaining variables, resulting in unstable coefficient estimates. The variance inflation factor (VIF) was calculated for each coefficient estimate to measure this instability, which is not usually considered profound for VIF's less than 10. No problems were found with this data. Additionally, the condition index (a ratio of eigenvalues of the covariance matrix, with the largest eigenvalue always on top) was calculated. A ratio greater than 30 is considered cause for concern. Again, no evidence of multicollinearity was found.

### 1.2.4 Other Procedures

Several other miscellaneous diagnostics, including the Durbin-Watson test for serial autocorrelation were performed, and no general problems were detected. The Box-Cox procedure, used to find a transformation to normality, was also performed.

## 1.3 How the Final Model Was Chosen

### 1.3.1 Selecting the Data Set Used

First, the variables were explored thoroughly, individually and in pairs, in a first effort to detect outliers. The SAS programming language allows a number of diagnostics to be calculated for a group of models on a given data set without actually performing a formal regression, thus allowing one to examine a large number of models quite efficiently. The Box-Cox procedure was performed to find if a transformation to normality was suggested. The log transform was suggested for some variables, and the square root for others. At this point, there were several data sets for which the diagnostic series was calculated:

1. Untransformed data.
2. Harvest untransformed, and natural log of inflow variables.
3. All variables logged.
4. Harvest untransformed, and square root of inflows variables.
5. All variables square root.
6. Logged and square root variables.
7. Harvest untransformed, and logged and square root inflows.
8. Harvest and May-June Inflows untransformed, and logged and square root inflows.
9. Harvest and inflows variables transformed according to Box-Cox suggestion.

### 1.3.2 Selecting the Points to be Omitted

The full regression with all diagnostics was performed for these models, each one contained all variables in its corresponding data set. All diagnostics were generated, and influential points were determined for each model.

Table 1.1 R-Square and Adjusted R-Square values for the different suggested models.

| Data Set | $R^2$ | Adjusted $R^2$ |
|---|---|---|
| 1 | 0.6742 | 0.5990 |
| **2** | **0.6939** | **0.6232** |
| 3 | 0.6695 | 0.5933 |
| **4** | **0.6999** | **0.6306** |
| 5 | 0.6615 | 0.5833 |
| 6 | 0.6460 | 0.5643 |
| **7** | **0.7175** | **0.6523** |
| **8** | **0.7182** | **0.6532** |
| 9 | 0.5999 | 0.5075 |

Data set 8 presented the highest $R^2$ values. However , the models 2, 4, 7, and 8 were considered as final candidates. The observations flagged as potentially influential are given in the summary table below, for each model.

Table 1.2 Summary of points flagged by Boxplots.

| Year | Variable |
|---|---|
| 1964 | Ln (Jan-Feb), May-Jun Inflows. |
| 1967 | Sept-Oct, SQRT (Sept-Oct) Inflows. |
| 1968 | Jan-Feb, SQRT (Jan-Feb), Sept-Oct, SQRT (Sept-Oct) Inflows. |
| 1969 | Jan-Feb, SQRT (Jan-Feb), Sept-Oct, SQRT (Sept-Oct) Inflows. |
| 1970 | Jan-Feb, SQRT (Jan-Feb) Inflows. |
| 1971 | Jul-Aug, SQRT (Jul-Aug), Sept-Oct, SQRT (Sept-Oct) Inflows. |
| 1972 | Jul-Aug, SQRT (Jul-Aug), Sept-Oct, SQRT (Sept-Oct) Inflows. |
| 1973 | Jul-Aug, SQRT (Jul-Aug), Sept-Oct, SQRT (Sept-Oct) Inflows. |
| 1977 | Mar-Apr, Ln (Mar-Apr), SQRT (Mar-Apr) Inflows. |
| 1978 | Mar-Apr,Ln (Mar-Apr), SQRT (Mar-Apr) Inflows. |
| 1979 | Mar-Apr, Ln (Mar-Apr), SQRT (Mar-Apr) Inflows. |
| 1981 | May-Jun, Jul-Aug Inflows. |
| 1982 | Jul-Aug Inflows. |
| 1992 | Jan-Feb, Ln (Jan-Feb), SQRT (Jan-Feb), Mar-Apr, Ln (Mar-Apr), SQRT (Mar-Apr) Inflows. |
| 1993 | Jan-Feb, Ln (Jan-Feb), SQRT (Jan-Feb), Mar-Apr, Ln (Mar-Apr), SQRT (Mar-Apr) Inflows. |

Table 1.3 Summary of points flagged by 99% Prediction Ellipse.

| **Year** | **Variable** |
|---|---|
| 1973 | Jul-Aug vs. Sept-Oct Inflows. |
| 1979 | Harvest vs.Mar-Apr Inflows, Mar-Apr vs. Nov-Dec Inflows. |
| 1993 | Harvest vs. Jan-Feb Inflows. |

Table 1.4 Summary of points flagged by diagnostic measures.

| **YEAR** | **BOX** | **SRE** | **SDR** | **LEV** | **MAH** | **COO** | **SDF** | **SDB** | **TOTAL** |
|---|---|---|---|---|---|---|---|---|---|
| **DATA SET 2** | | | | | | | | | |
| 1964 | 1 | | | | | | | | 1 |
| 1973 | | | | | | | 1 | | 1 |
| 1977 | 1 | | | | | | | | 1 |
| 1978 | 1 | | | | | | | | 1 |
| 1979 | 1 | | | | | | | | 1 |
| 1981 | | | | | | | 1 | | 1 |
| 1992 | 2 | | | | | | | | 2 |
| **1993** | **2** | | | | | | **1** | | **3** |
| **Data Set 4** | | | | | | | | | |
| 1967 | 1 | | | | | | | | 1 |
| 1968 | 2 | | | | | | | | 2 |
| 1969 | 2 | | | | | | | | 2 |
| 1970 | 1 | | | | | | | | 1 |
| 1971 | 2 | | | | | | | | 2 |
| 1972 | 2 | | | | | | | | 2 |
| 1973 | 2 | | | | | | | | 2 |
| 1977 | 1 | | | | | | | | 1 |
| 1978 | 1 | | | | | | | | 1 |
| **1979** | **1** | | | | | | **1** | **1** | **3** |
| 1981 | | | | | | | 1 | | 1 |
| 1992 | 2 | | | | | | | | 2 |
| **1993** | **2** | | | | | | **1** | | **3** |
| **Data Set 7** | | | | | | | | | |
| 1964 | 1 | | | | | | | | 1 |
| 1977 | 1 | | | | | | | | 1 |
| 1978 | 1 | | | | | | | | 1 |
| **1979** | **1** | | | | | | **1** | **1** | **3** |
| 1981 | | | | | | | 1 | | 1 |
| 1992 | 2 | | | | | | | | 2 |
| 1993 | 2 | | | | | | | | 2 |

Table 1.4 Summary of points flagged by diagnostic measures (continued).

| **Data Set 8** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1964 | 1 | | | | | | | | 1 |
| 1977 | 1 | | | | | | | | 1 |
| 1978 | 1 | | | | | | | | 1 |
| **1979** | **1** | | | | | | **1** | **1** | **3** |
| **1981** | **1** | | | | | | **1** | **1** | **3** |
| 1992 | 2 | | | | | | | | 2 |
| **1993** | **2** | | | | | | **1** | | **3** |

Key to Abbreviations:

**BOX** Box plot
**SRE** Studentized residual
**SDR** Studentized deleted residual
**LEV** Leverage value
**MAH** Mahalanobis distance
**COO** Cook's distance
**SDF** Standardized Dffits value
**SDB** Standardized Dfbeta value

### 1.3.3 Selecting the Final Candidate Models

After the subset analysis led us to the models: Data Set 2 (harvest untransformed and logged inflows) 1993 omitted, Data Set 4 (harvest untransformed and square root inflows) 1979 and/or 1993 omitted; Data Set 7 (untransformed, logged and square root variables) 1979 omitted; and Data Set 8 (untransformed, logged and square root variables) 1979, 1981 and/or 1993 omitted.

Table 1.5 R-Square and Adjusted R-Square values for the different subsets.

| Data Set | Observations omitted | $R^2$ | Adjusted $R^2$ |
|---|---|---|---|
| 2 | 1993 | 0.6841 | 0.6083 |
| 4 | 1979 | 0.7441 | 0.6827 |
| | 1993 | 0.6928 | 0.6191 |
| | 1979 and 1993 | 0.7235 | 0.6544 |
| 7 | 1979 | 0.7486 | 0.6882 |
| 8 | 1979 | 0.7497 | 0.6896 |
| | 1981 | 0.7620 | 0.7049 |
| | 1993 | 0.7060 | 0.6354 |
| | **1979 and 1981** | **0.7988** | **0.7485** |
| | 1979 and 1993 | 0.7262 | 0.6577 |
| | 1981 and 1993 | 0.7522 | 0.6903 |
| | 1979, 1981 and 1993 | 0.7790 | 0.7213 |

### 1.3.4 Selecting the Final Model

It is clear that Data Set 8 with 1979 and 1981 omitted is the best model. Regression was performed using this model, and the deleted residuals were calculated.

| Best Candidate Model | $R^2$ | Adjusted $R^2$ | Prob>F |
|---|---|---|---|
| Drum Harvest = -82.94 - 47.71*Ln(January-February Inflows)<br>+ 44.50*SQRT(March-April Inflows)<br>+ 25.50*Ln(July-August Inflows)<br>+ 15.50*Ln(November-December Inflows) | 0.792 | 0.760 | $1.58*10^{-8}$ |

## 1.4 Best Model: Untransformed, Logged and Square Root Variables

### 1.4.1 Summary Information

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| Drum Harvest | 131.8968 | 115.7951 | 31 |
| Ln (January-February Inflows) | 3.3806 | .7289 | 31 |
| SQRT (March-April Inflows) | 4.9101 | 2.2403 | 31 |
| Ln (July-August Inflows) | 4.0518 | .9753 | 31 |
| Ln (November-December Inflows) | 3.5040 | .8800 | 31 |

**Model Summary[a,b]**

| Model | Variables | | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| | Entered | Removed | | | | | |
| 1 | Ln(Nov-Dec Inflows), Ln(Jan-Feb Inflows), SQRT(Mar-Apr Inflows), Ln(Jul-Aug Inflows)[c,d] | . | .890 | .792 | .760 | 56.7795 | 2.029 |

a. Dependent Variable: Drum Harvest

b. Method: Enter

c. Independent Variables: (Constant), Ln (November-December Inflows), Ln (January-February Inflows), SQRT (March-April Inflows), Ln (July-August Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 318433 | 4 | 79608.4 | 24.693 | .000[b] |
| | Residual | 83821.8 | 26 | 3223.917 | | |
| | Total | 402255 | 30 | | | |

a. Dependent Variable: Drum Harvest

b. Independent Variables: (Constant), Ln (November-December Inflows), Ln (January-February Inflows), SQRT (March-April Inflows), Ln (July-August Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. | 95% Confidence Interval for B Lower Bound | 95% Confidence Interval for B Upper Bound |
|---|---|---|---|---|---|---|---|---|
| 1 | (Constant) | -82.935 | 72.661 | | -1.141 | .264 | -232.292 | 66.422 |
| | Ln (Jan-Feb Inflows) | -47.707 | 16.416 | -.300 | -2.906 | .007 | -81.450 | -13.963 |
| | SQRT (Mar-Apr Inflows) | 44.495 | 5.333 | .861 | 8.344 | .000 | 33.533 | 55.456 |
| | Ln (Jul-Aug Inflows) | 25.500 | 12.479 | .215 | 2.043 | .051 | -.150 | 51.151 |
| | Ln (Nov-Dec Inflows) | 15.501 | 14.216 | .118 | 1.090 | .286 | -13.720 | 44.723 |

a. Dependent Variable: Drum Harvest

**Residuals Statistics[a]**

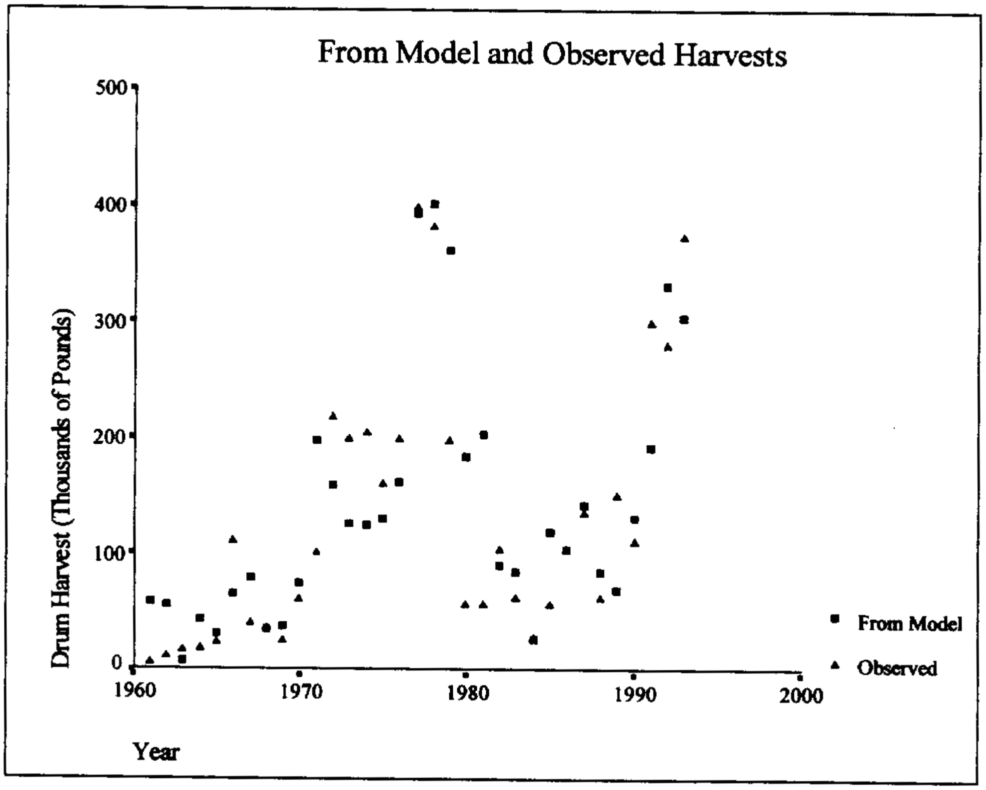
| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 9.3536 | 403.2188 | 131.8968 | 103.0264 | 31 |
| Std. Predicted Value | -1.189 | 2.634 | .000 | 1.000 | 31 |
| Standard Error of Predicted Value | 11.0939 | 34.8145 | 21.9802 | 6.1713 | 31 |
| Adjusted Predicted Value | 6.5503 | 411.3719 | 133.6044 | 104.6143 | 31 |
| Residual | -127.3999 | 107.3607 | 1.4E-15 | 52.8589 | 31 |
| Std. Residual | -2.244 | 1.891 | .000 | .931 | 31 |
| Stud. Residual | -2.639 | 2.008 | -.013 | 1.027 | 31 |
| Deleted Residual | -176.2474 | 121.0667 | -1.7076 | 64.7179 | 31 |
| Stud. Deleted Residual | -3.024 | 2.142 | -.020 | 1.082 | 31 |
| Mahal. Distance | .178 | 10.311 | 3.871 | 2.606 | 31 |
| Cook's Distance | .000 | .534 | .047 | .101 | 31 |
| Centered Leverage Value | .006 | .344 | .129 | .087 | 31 |

a. Dependent Variable: Drum Harvest

Table 1.6 Observed, predicted, lower and upper predicted intervals values for drum harvest.

| Year | Observed[a] | Predicted[a] | LICI | UICI |
|---|---|---|---|---|
| **1961** | 8.00 | 59.57374 | 0 | 228.52749 |
| **1962** | 13.70 | 57.81684 | 0 | 225.30213 |
| **1963** | 18.50 | 9.35360 | 0 | 184.66005 |
| **1964** | 19.80 | 44.77529 | 0 | 229.84617 |
| **1965** | 24.80 | 32.18796 | 0 | 201.09894 |
| **1966** | 112.70 | 66.87345 | 0 | 234.19441 |
| **1967** | 42.20 | 80.64787 | 0 | 246.62898 |
| **1968** | 38.20 | 36.15375 | 0 | 205.85810 |
| **1969** | 26.20 | 38.86576 | 0 | 210.49853 |
| **1970** | 63.10 | 76.36109 | 0 | 244.81862 |
| **1971** | 102.90 | 199.53884 | 29.33159 | 369.74609 |
| **1972** | 220.20 | 159.84969 | 0 | 328.92097 |
| **1973** | 201.10 | 126.86492 | 0 | 297.80525 |
| **1974** | 205.70 | 126.16231 | 0 | 286.91984 |
| **1975** | 161.80 | 132.14036 | 0 | 293.76667 |
| **1976** | 199.80 | 162.95816 | 0 | 333.46086 |
| **1977** | 400.80 | 394.76512 | 217.04956 | 572.48069 |
| **1978** | 383.30 | 403.21882 | 223.99158 | 582.44607 |
| **1979** | 198.60 | 363.11544 | 166.87015 | 559.36072 |
| **1980** | 58.10 | 185.49992 | 7.19747 | 363.80238 |
| **1981** | 58.30 | 204.83106 | 36.50593 | 373.15618 |
| **1982** | 105.90 | 91.08759 | 0 | 261.51246 |
| **1983** | 64.60 | 85.48259 | 0 | 247.84837 |
| **1984** | 29.30 | 27.98858 | 0 | 192.26900 |
| **1985** | 59.00 | 120.41725 | 0 | 285.84028 |
| **1986** | 105.50 | 105.12915 | 0 | 275.21906 |
| **1987** | 137.00 | 143.59592 | 0 | 306.46211 |
| **1988** | 63.80 | 85.40513 | 0 | 246.30929 |
| **1989** | 151.60 | 71.62687 | 0 | 235.80214 |
| **1990** | 112.80 | 133.46909 | 0 | 305.30653 |
| **1991** | 300.70 | 193.33933 | 26.87372 | 359.80494 |
| **1992** | 282.10 | 332.59721 | 150.65728 | 514.53714 |
| **1993** | 375.60 | 305.05381 | 125.79728 | 484.31034 |

[a] Drum harvest (thousands of pounds).
LICI Lower limit for 99% prediction interval for drum harvest.
UICI Upper limit for 99% prediction interval for drum harvest.



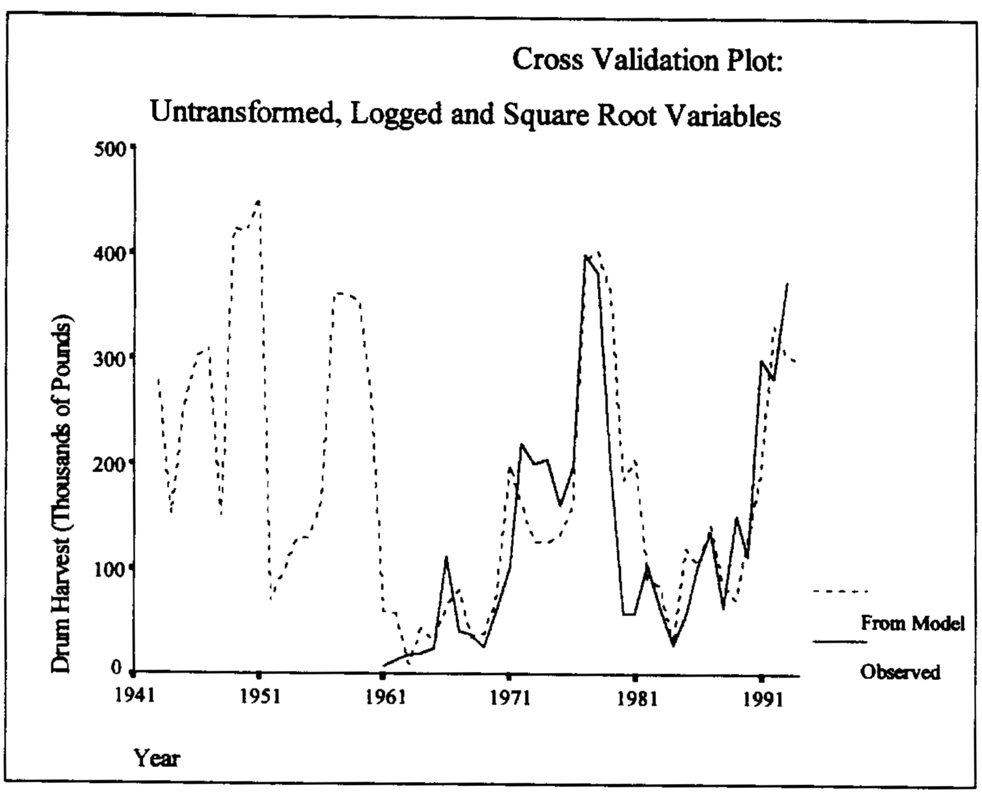




Fig. 1.1 Comparative plots of observed values vs. calculated from the regression model.

# 2. Exploring the Data

## 2.1 Listing of Data

Table 2.1. Drum harvest and water inflows data.

| Obs. | YEAR | DRUM | JF_LAG | MA_LAG | MJ_LAG | JA_LAG | SO_LAG | ND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | **1961** | 8.00 | 58.45 | 13.11 | 42.66 | 68.59 | 178.60 | 78.65 |
| 2 | **1962** | 13.70 | 49.25 | 12.81 | 38.52 | 52.35 | 88.84 | 72.87 |
| 3 | **1963** | 18.50 | 48.48 | 13.28 | 33.71 | 32.81 | 9.91 | 5.45 |
| 4 | **1964** | 19.80 | 5.49 | 6.64 | 7.72 | 10.11 | 68.57 | 9.75 |
| 5 | **1965** | 24.80 | 26.72 | 15.50 | 74.65 | 10.70 | 68.66 | 10.36 |
| 6 | **1966** | 112.70 | 27.01 | 20.93 | 166.41 | 12.65 | 69.73 | 12.21 |
| 7 | **1967** | 42.20 | 28.09 | 22.47 | 168.79 | 14.00 | 670.67 | 17.64 |
| 8 | **1968** | 38.20 | 89.91 | 21.03 | 219.30 | 27.86 | 675.78 | 18.02 |
| 9 | **1969** | 26.20 | 91.93 | 18.46 | 128.91 | 26.74 | 693.83 | 56.42 |
| 10 | **1970** | 63.10 | 95.26 | 25.37 | 211.69 | 38.31 | 34.80 | 46.74 |
| 11 | **1971** | 102.90 | 12.76 | 18.29 | 94.70 | 307.47 | 612.72 | 78.25 |
| 12 | **1972** | 220.20 | 21.69 | 17.45 | 147.81 | 310.47 | 605.99 | 40.51 |
| 13 | **1973** | 201.10 | 19.03 | 9.52 | 155.96 | 338.40 | 816.37 | 64.29 |
| 14 | **1974** | 205.70 | 23.79 | 19.07 | 158.31 | 73.99 | 289.82 | 37.63 |
| 15 | **1975** | 161.80 | 19.24 | 17.38 | 175.19 | 92.49 | 285.93 | 35.21 |
| 16 | **1976** | 199.80 | 17.23 | 16.72 | 105.85 | 126.23 | 158.61 | 138.05 |
| 17 | **1977** | 400.80 | 37.15 | 104.82 | 149.46 | 105.12 | 103.47 | 133.86 |
| 18 | **1978** | 383.30 | 30.44 | 104.63 | 105.60 | 101.84 | 134.64 | 135.35 |
| 19 | **1979** | 198.60 | 34.14 | 123.11 | 169.20 | 31.74 | 72.81 | 8.20 |
| 20 | **1980** | 58.10 | 13.59 | 24.89 | 171.41 | 202.89 | 89.12 | 9.85 |
| 21 | **1981** | 58.30 | 16.38 | 25.72 | 382.28 | 253.39 | 116.25 | 33.34 |
| 22 | **1982** | 105.90 | 31.23 | 10.21 | 331.11 | 249.34 | 93.12 | 35.41 |
| 23 | **1983** | 64.60 | 28.63 | 12.46 | 285.47 | 92.17 | 90.72 | 37.14 |
| 24 | **1984** | 29.30 | 34.54 | 12.84 | 49.24 | 22.02 | 30.08 | 14.66 |
| 25 | **1985** | 59.00 | 19.90 | 18.82 | 67.95 | 35.13 | 77.10 | 55.45 |
| 26 | **1986** | 105.50 | 20.90 | 17.17 | 68.31 | 25.67 | 66.52 | 70.43 |
| 27 | **1987** | 137.00 | 30.39 | 23.44 | 247.73 | 67.77 | 65.06 | 72.84 |
| 28 | **1988** | 63.80 | 28.55 | 15.19 | 193.85 | 54.64 | 24.36 | 30.15 |
| 29 | **1989** | 151.60 | 25.99 | 14.61 | 189.23 | 52.14 | 20.56 | 12.44 |
| 30 | **1990** | 112.80 | 10.17 | 17.54 | 21.55 | 66.60 | 24.99 | 8.76 |
| 31 | **1991** | 300.70 | 11.04 | 26.79 | 42.61 | 68.94 | 31.59 | 29.75 |
| 32 | **1992** | 282.10 | 112.42 | 114.69 | 207.59 | 75.05 | 37.19 | 32.98 |
| 33 | **1993** | 375.60 | 114.36 | 111.81 | 255.68 | 29.91 | 36.54 | 39.39 |

| | |
|---|---|
| **DRUM** | Drum harvest (thousands of pounds) |
| **JF_LAG** | Lagged January-February inflows (thousands of acre-feet) |
| **MA_LAG** | Lagged March-April inflows (thousands of acre-feet) |
| **MJ_LAG** | Lagged May-June inflows (thousands of acre-feet) |
| **JA_LAG** | Lagged July-August inflows (thousands of acre-feet) |
| **SO_LAG** | Lagged September-October inflows (thousands of acre-feet) |
| **ND_LAG** | Lagged November-December inflows (thousands of acre-feet) |

## 2.2 Test of Normality for Individual Variables

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Drum Harvest | .177 | 33 | .010 | .866 | 33 | .010** |
| Ln (Drum Harvest) | .117 | 33 | .200* | .958 | 33 | .349 |
| SQRT (Drum Harvest) | .141 | 33 | .092 | .946 | 33 | .167 |
| January-February Inflows | .266 | 33 | .000 | .773 | 33 | .010** |
| Ln (January-February Inflows) | .131 | 33 | .166 | .960 | 33 | .377 |
| SQRT (January-February Inflows) | .201 | 33 | .002 | .883 | 33 | .010** |
| March-April Inflows | .405 | 33 | .000 | .576 | 33 | .010** |
| Ln (March-April Inflows) | .250 | 33 | .000 | .803 | 33 | .010** |
| SQRT (March-April Inflows) | .336 | 33 | .000 | .673 | 33 | .010** |
| May-June Inflows | .091 | 33 | .200* | .956 | 33 | .315 |
| Ln (May-June Inflows) | .198 | 33 | .002 | .904 | 33 | .010** |
| SQRT (May-June Inflows) | .143 | 33 | .086 | .974 | 33 | .661 |
| July-August Inflows | .243 | 33 | .000 | .760 | 33 | .010** |
| Ln (July-August Inflows) | .080 | 33 | .200* | .958 | 33 | .349 |
| SQRT (July-August Inflows) | .165 | 33 | .023 | .882 | 33 | .010** |
| September-October Inflows | .296 | 33 | .000 | .689 | 33 | .010** |
| Ln (September-October Inflows) | .131 | 33 | .161 | .939 | 33 | .085 |
| SQRT (September-October Inflows) | .226 | 33 | .000 | .813 | 33 | .010** |
| November-December Inflows | .184 | 33 | .006 | .843 | 33 | .010** |
| Ln (November-December Inflows) | .136 | 33 | .129 | .950 | 33 | .223 |
| SQRT (November-December Inflows) | .109 | 33 | .200* | .931 | 33 | .052 |

**. This is an upper bound of the true significance.

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

## 2.3 Percentiles for Individual Variables

**Percentiles**

| | | Percentiles | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 10 | 25 | 50 | 75 | 90 | 95 |
| Weighted Average (Definition 1) | Drum Harvest | 11.9900 | 19.0200 | 40.2000 | 105.5000 | 200.4500 | 345.6400 | 388.5500 |
| | Ln (Drum Harvest) | 2.4560 | 2.9449 | 3.6926 | 4.6587 | 5.3006 | 5.8396 | 5.9622 |
| | SQRT (Drum Harvest) | 3.4395 | 4.3606 | 6.3384 | 10.2713 | 14.1580 | 18.5645 | 19.7106 |
| | January-February Inflows | 8.7660 | 11.7280 | 19.1350 | 28.0900 | 42.8150 | 93.9280 | 113.0020 |
| | Ln (January-February Inflows) | 2.1345 | 2.4594 | 2.9515 | 3.3354 | 3.7481 | 4.5424 | 4.7274 |
| | SQRT (January-February Inflows) | 2.9353 | 3.4224 | 4.3743 | 5.3000 | 6.5289 | 9.6913 | 10.6302 |
| | March-April Inflows | 8.6560 | 11.1100 | 13.9450 | 18.2900 | 25.1300 | 109.0140 | 117.2160 |
| | Ln (March-April Inflows) | 2.1453 | 2.4030 | 2.6340 | 2.9064 | 3.2240 | 4.6910 | 4.7635 |
| | SQRT (March-April Inflows) | 2.9329 | 3.3291 | 3.7332 | 4.2767 | 5.0129 | 10.4397 | 10.8252 |
| | May-June Inflows | 17.4010 | 35.6340 | 68.1300 | 155.9600 | 200.7200 | 273.5540 | 346.4610 |
| | Ln (May-June Inflows) | 2.7624 | 3.5711 | 4.2214 | 5.0496 | 5.3013 | 5.6101 | 5.8456 |
| | SQRT (May-June Inflows) | 4.0631 | 5.9662 | 8.2541 | 12.4884 | 14.1656 | 16.5335 | 18.6031 |
| | July-August Inflows | 10.5230 | 13.1900 | 28.8850 | 66.6000 | 103.4800 | 265.6380 | 318.8490 |
| | Ln (July-August Inflows) | 2.3532 | 2.5782 | 3.3627 | 4.1967 | 4.6393 | 5.6510 | 5.7639 |
| | SQRT (July-August Inflows) | 3.2436 | 3.6307 | 5.3736 | 8.1609 | 10.1722 | 16.6862 | 17.8528 |
| | September-October Inflows | 17.3650 | 24.6120 | 36.8650 | 88.8400 | 232.2650 | 673.7360 | 730.5920 |
| | Ln (September-October Inflows) | 2.8044 | 3.2032 | 3.6072 | 4.4868 | 5.4204 | 6.5128 | 6.5910 |
| | SQRT (September-October Inflows) | 4.1184 | 4.9610 | 6.0716 | 9.4255 | 15.1368 | 25.9564 | 27.0101 |
| | November-December Inflows | 7.3750 | 9.1560 | 13.5500 | 35.4100 | 67.3600 | 111.7760 | 136.1600 |
| | Ln (November-December Inflows) | 1.9816 | 2.2130 | 2.6030 | 3.5670 | 4.2090 | 4.6841 | 4.9138 |
| | SQRT (November-December Inflows) | 2.7049 | 3.0248 | 3.6779 | 5.9506 | 8.2052 | 10.4893 | 11.6686 |
| Tukey's Hinges | Drum Harvest | | | 42.2000 | 105.5000 | 199.6000 | | |
| | Ln (Drum Harvest) | | | 3.7424 | 4.6587 | 5.2973 | | |
| | SQRT (Drum Harvest) | | | 6.4962 | 10.2713 | 14.1351 | | |
| | January-February Inflows | | | 19.2400 | 28.0900 | 37.1500 | | |
| | Ln (January-February Inflows) | | | 2.9570 | 3.3354 | 3.6150 | | |
| | SQRT (January-February Inflows) | | | 4.3863 | 5.3000 | 6.0951 | | |
| | March-April Inflows | | | 14.6100 | 18.2900 | 24.8900 | | |
| | Ln (March-April Inflows) | | | 2.6817 | 2.9064 | 3.2145 | | |
| | SQRT (March-April Inflows) | | | 3.8223 | 4.2767 | 4.9890 | | |
| | May-June Inflows | | | 68.3100 | 155.9600 | 193.6500 | | |
| | Ln (May-June Inflows) | | | 4.2241 | 5.0496 | 5.2671 | | |
| | SQRT (May-June Inflows) | | | 8.2650 | 12.4884 | 13.9230 | | |
| | July-August Inflows | | | 29.9100 | 66.6000 | 101.8400 | | |
| | Ln (July-August Inflows) | | | 3.3982 | 4.1967 | 4.6234 | | |
| | SQRT (July-August Inflows) | | | 5.4690 | 8.1609 | 10.0916 | | |
| | September-October Inflows | | | 37.1900 | 88.8400 | 178.6000 | | |
| | Ln (September-October Inflows) | | | 3.6160 | 4.4868 | 5.1851 | | |
| | SQRT (September-October Inflows) | | | 6.0984 | 9.4255 | 13.3641 | | |
| | November-December Inflows | | | 14.6600 | 35.4100 | 64.2900 | | |
| | Ln (November-December Inflows) | | | 2.6851 | 3.5670 | 4.1634 | | |
| | SQRT (November-December Inflows) | | | 3.8288 | 5.9506 | 8.0181 | | |

## 2.4 Summary Information for Individual Variables

### 2.4.1 Summary Information for Drum Harvest

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| Drum Harvest | Mean | | 131.6879 | 19.7551 |
| | 95% Confidence Interval for Mean | Lower Bound | 91.4480 | |
| | | Upper Bound | 171.9277 | |
| | 5% Trimmed Mean | | 123.8670 | |
| | Median | | 105.5000 | |
| | Variance | | 12878.7 | |
| | Std. Deviation | | 113.4845 | |
| | Minimum | | 8.00 | |
| | Maximum | | 400.80 | |
| | Range | | 392.80 | |
| | Interquartile Range | | 160.2500 | |
| | Skewness | | 1.062 | .409 |
| | Kurtosis | | .262 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| Drum Harvest | Highest | 1 | 17 | 1977 | 400.80 |
| | | 2 | 18 | 1978 | 383.30 |
| | | 3 | 33 | 1993 | 375.60 |
| | | 4 | 31 | 1991 | 300.70 |
| | | 5 | 32 | 1992 | 282.10 |
| | Lowest | 1 | 1 | 1961 | 8.00 |
| | | 2 | 2 | 1962 | 13.70 |
| | | 3 | 3 | 1963 | 18.50 |
| | | 4 | 4 | 1964 | 19.80 |
| | | 5 | 5 | 1965 | 24.80 |

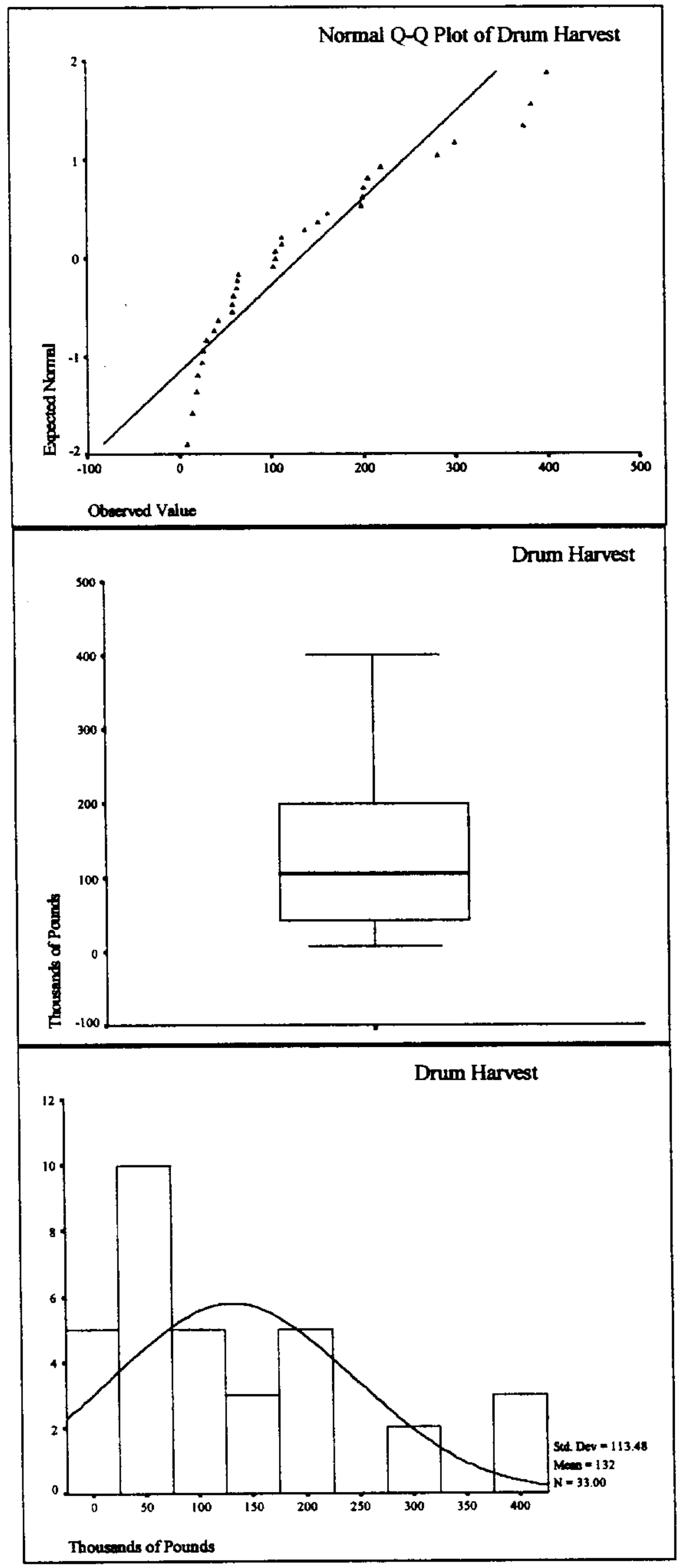



Fig. 2.1a. Exploratory Plots of Drum Harvest.

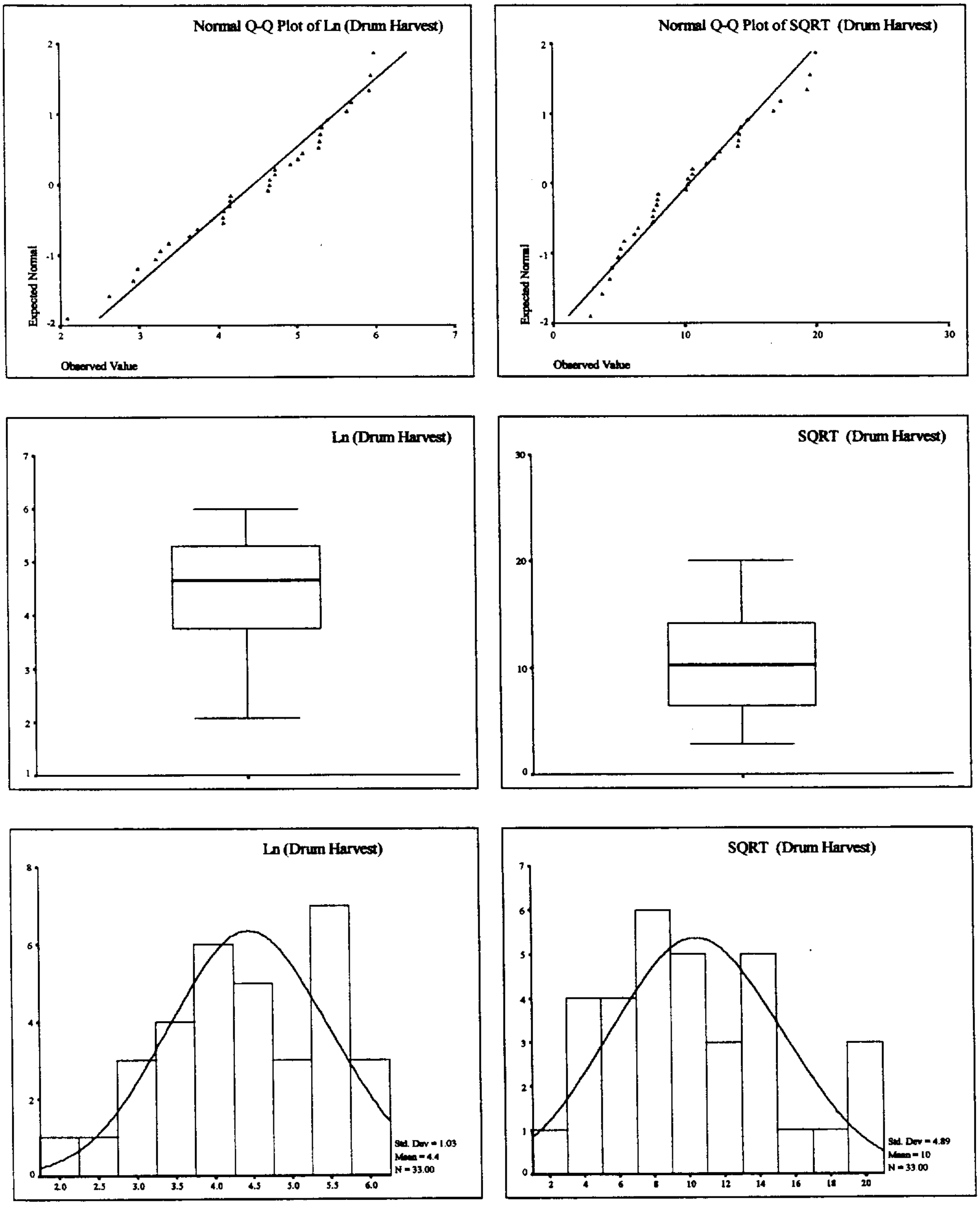



Fig. 2.1b. Exploratory Plots of Transformed Drum Harvest.

### 2.4.2 Summary Information for January-February Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| January-February Inflows | Mean | | 37.3985 | 5.1713 |
| | 95% Confidence Interval for Mean | Lower Bound | 26.8650 | |
| | | Upper Bound | 47.9320 | |
| | 5% Trimmed Mean | | 34.8356 | |
| | Median | | 28.0900 | |
| | Variance | | 882.482 | |
| | Std. Deviation | | 29.7066 | |
| | Minimum | | 5.49 | |
| | Maximum | | 114.36 | |
| | Range | | 108.87 | |
| | Interquartile Range | | 23.6800 | |
| | Skewness | | 1.572 | .409 |
| | Kurtosis | | 1.457 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| January-February Inflows | Highest | 1 | 33 | 1993 | 114.36 |
| | | 2 | 32 | 1992 | 112.42 |
| | | 3 | 10 | 1970 | 95.26 |
| | | 4 | 9 | 1969 | 91.93 |
| | | 5 | 8 | 1968 | 89.91 |
| | Lowest | 1 | 4 | 1964 | 5.49 |
| | | 2 | 30 | 1990 | 10.17 |
| | | 3 | 31 | 1991 | 11.04 |
| | | 4 | 11 | 1971 | 12.76 |
| | | 5 | 20 | 1980 | 13.59 |

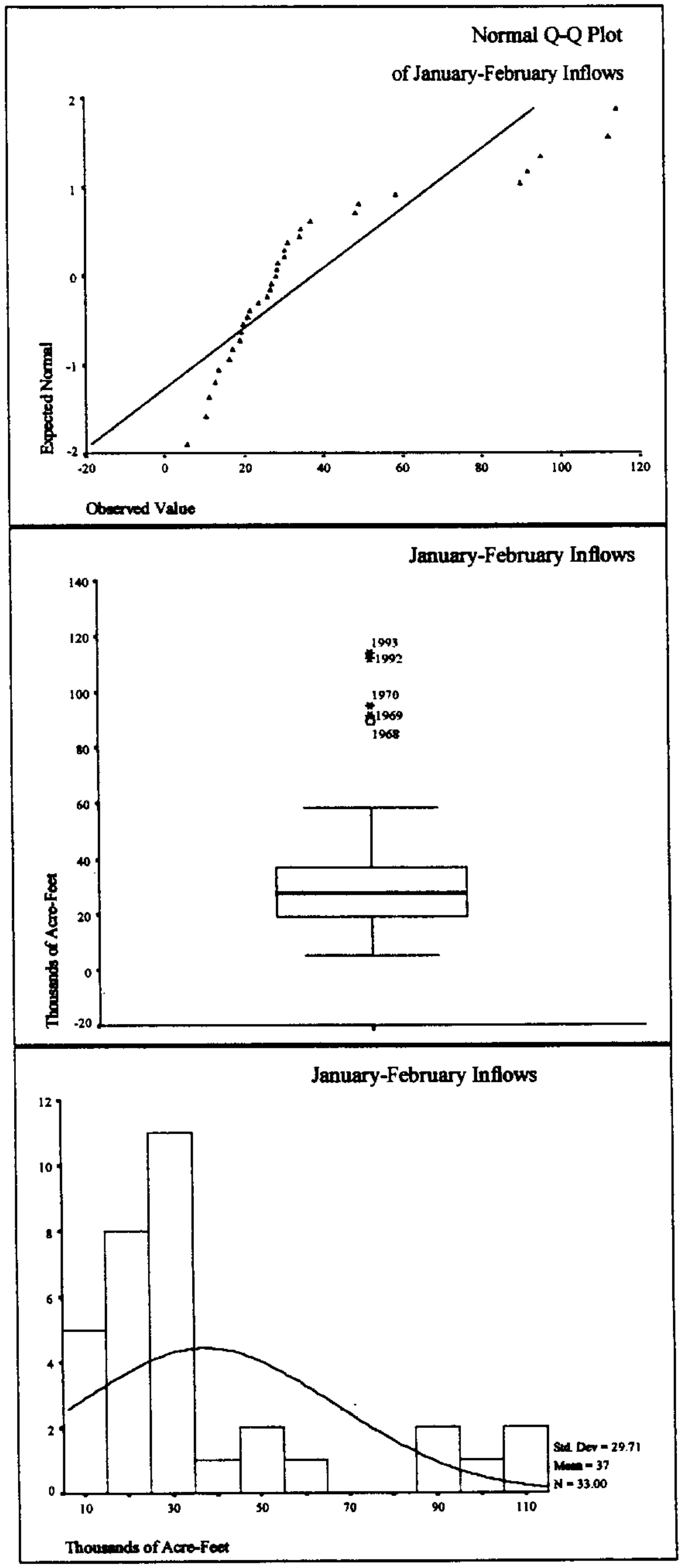



Fig. 2.2a. Exploratory Plots of January-February Inflows.

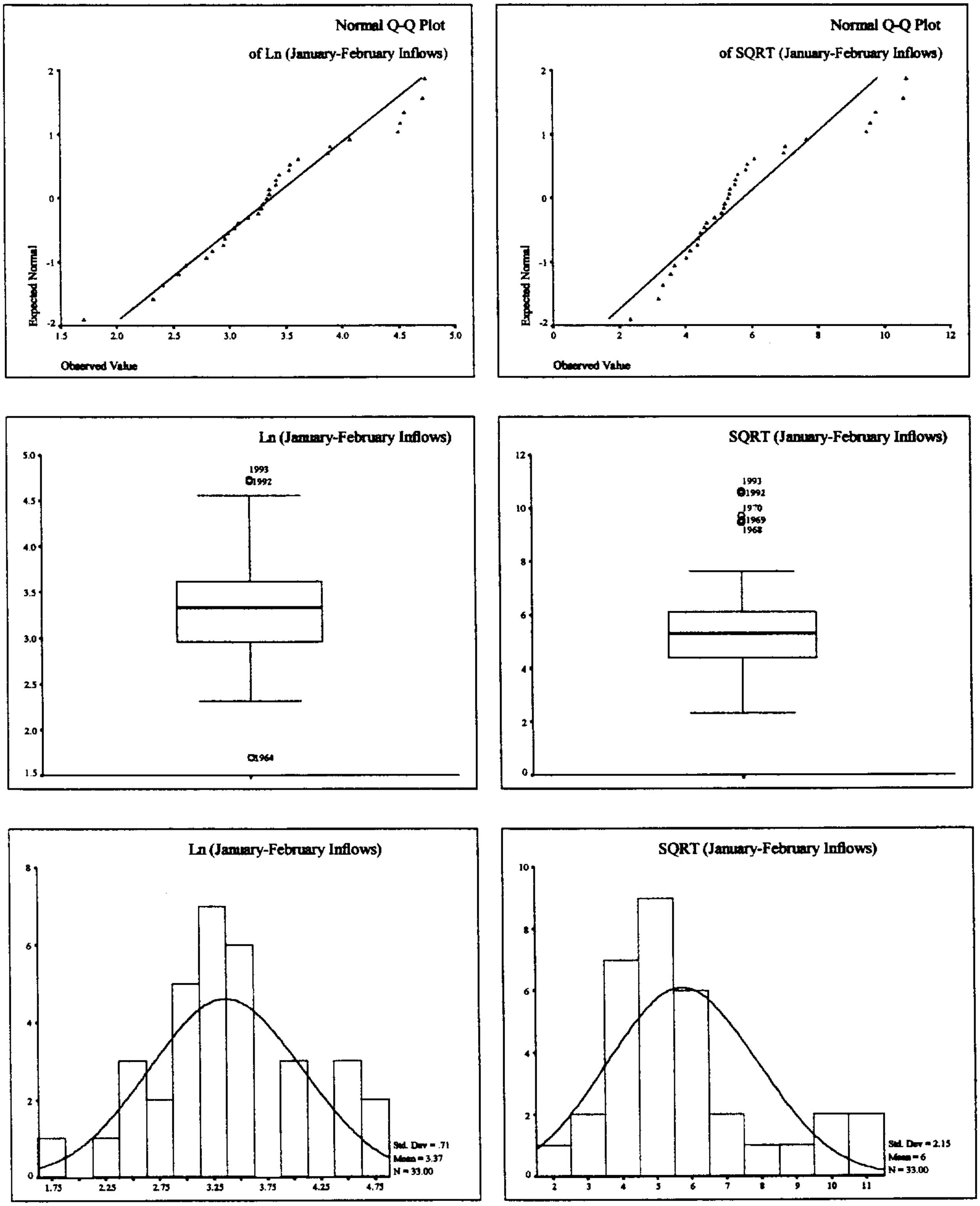



Fig. 2.2b. Exploratory Plots of Transformed January-February Inflows.

### 2.4.3 Summary Information for March-April Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| March-April Inflows | Mean | | 31.7203 | 6.0582 |
| | 95% Confidence Interval for Mean | Lower Bound | 19.3802 | |
| | | Upper Bound | 44.0604 | |
| | 5% Trimmed Mean | | 28.1577 | |
| | Median | | 18.2900 | |
| | Variance | | 1211.149 | |
| | Std. Deviation | | 34.8016 | |
| | Minimum | | 6.64 | |
| | Maximum | | 123.11 | |
| | Range | | 116.47 | |
| | Interquartile Range | | 11.1850 | |
| | Skewness | | 1.984 | .409 |
| | Kurtosis | | 2.279 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| March-April Inflows | Highest | 1 | 19 | 1979 | 123.11 |
| | | 2 | 32 | 1992 | 114.69 |
| | | 3 | 33 | 1993 | 111.81 |
| | | 4 | 17 | 1977 | 104.82 |
| | | 5 | 18 | 1978 | 104.63 |
| | Lowest | 1 | 4 | 1964 | 6.64 |
| | | 2 | 13 | 1973 | 9.52 |
| | | 3 | 22 | 1982 | 10.21 |
| | | 4 | 23 | 1983 | 12.46 |
| | | 5 | 2 | 1962 | 12.81 |

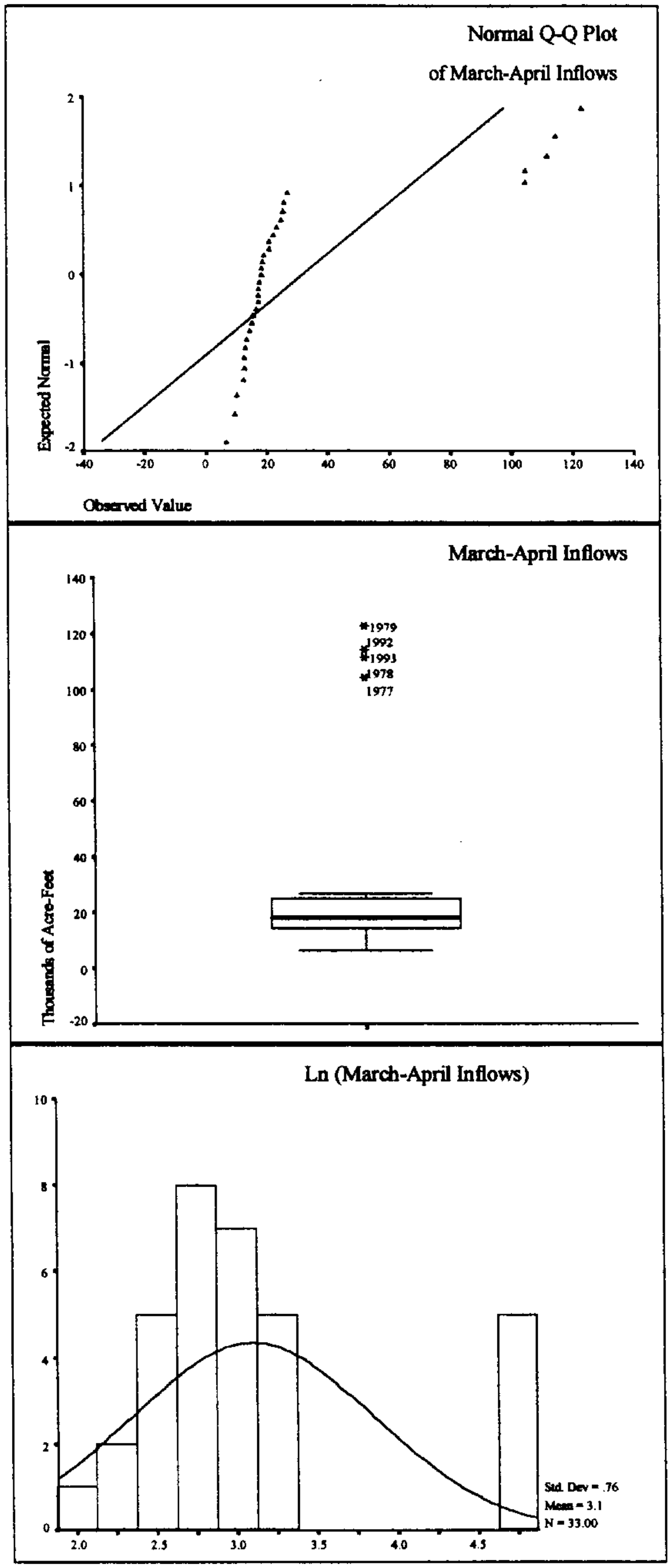



Fig. 2.3a. Exploratory Plots of March-April Inflows.

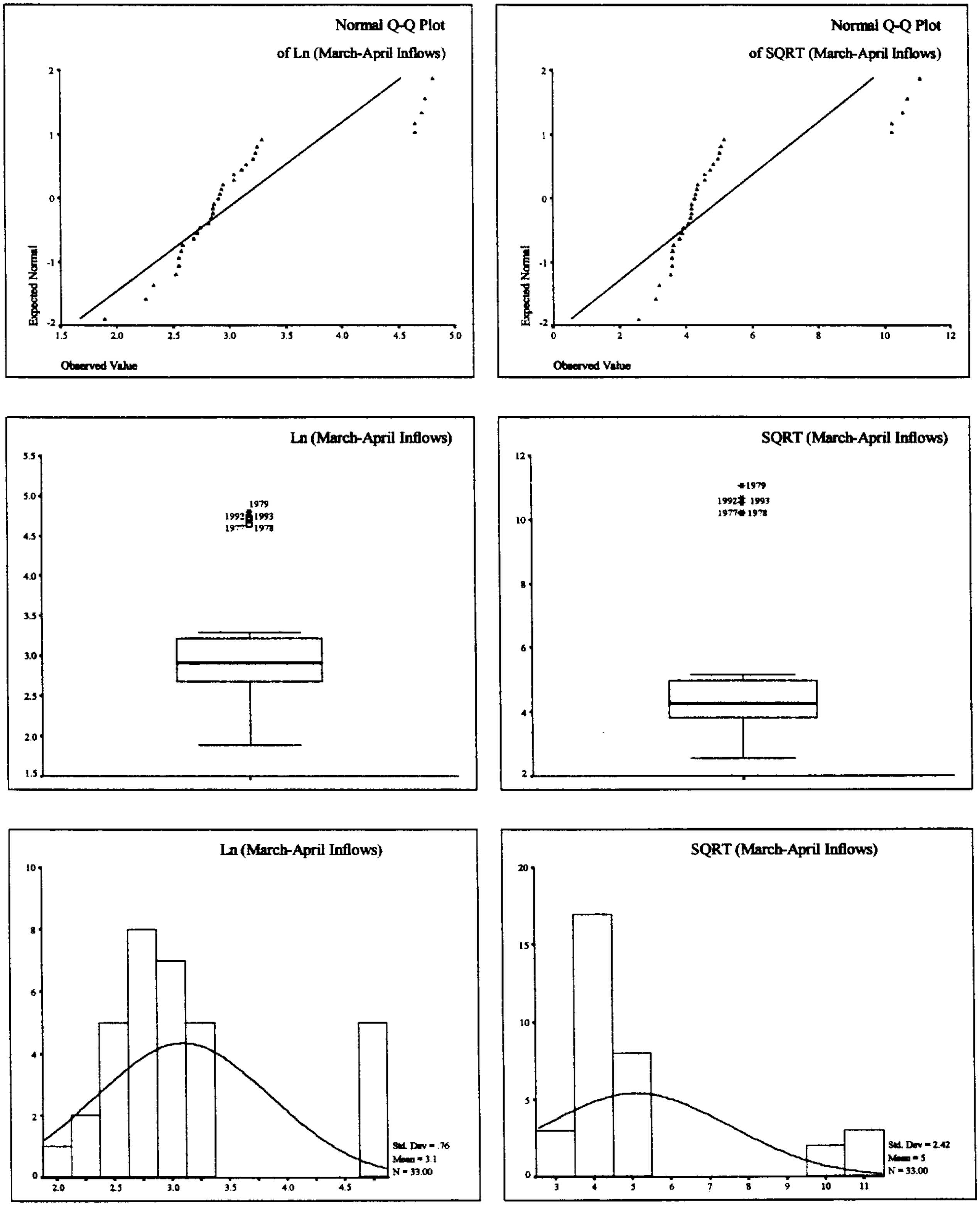



Fig. 2.3b. Exploratory Plots of Transformed March-April Inflows.

**2.4.4 Summary Information for May-June Inflows**

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| May-June Inflows | Mean | | 147.5288 | 15.8596 |
| | 95% Confidence Interval for Mean | Lower Bound | 115.2238 | |
| | | Upper Bound | 179.8338 | |
| | 5% Trimmed Mean | | 143.0714 | |
| | Median | | 155.9600 | |
| | Variance | | 8300.399 | |
| | Std. Deviation | | 91.1065 | |
| | Minimum | | 7.72 | |
| | Maximum | | 382.28 | |
| | Range | | 374.56 | |
| | Interquartile Range | | 132.5900 | |
| | Skewness | | .557 | .409 |
| | Kurtosis | | .110 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| May-June Inflows | Highest | 1 | 21 | 1981 | 382.28 |
| | | 2 | 22 | 1982 | 331.11 |
| | | 3 | 23 | 1983 | 285.47 |
| | | 4 | 33 | 1993 | 255.68 |
| | | 5 | 27 | 1987 | 247.73 |
| | Lowest | 1 | 4 | 1964 | 7.72 |
| | | 2 | 30 | 1990 | 21.55 |
| | | 3 | 3 | 1963 | 33.71 |
| | | 4 | 2 | 1962 | 38.52 |
| | | 5 | 31 | 1991 | 42.61 |

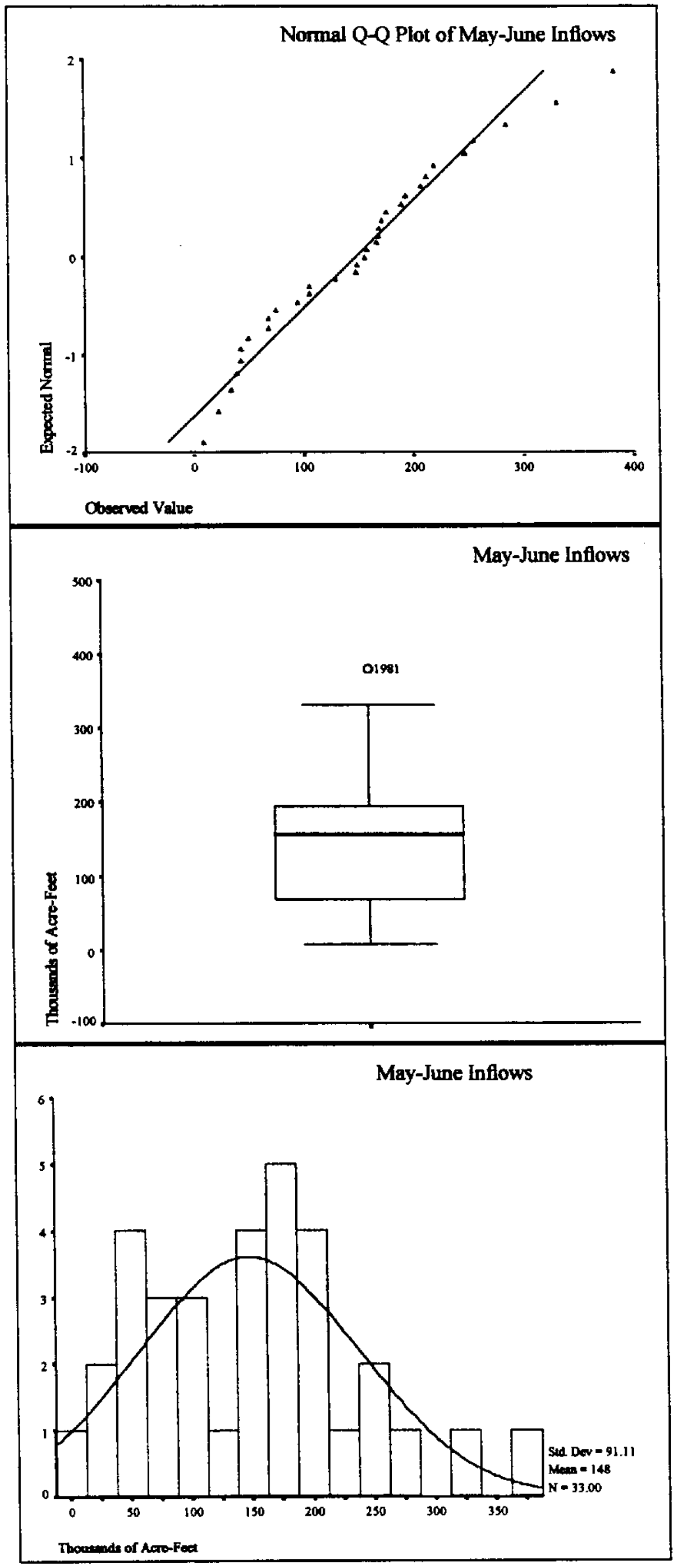



Fig. 2.4a. Exploratory Plots of May-June Inflows.

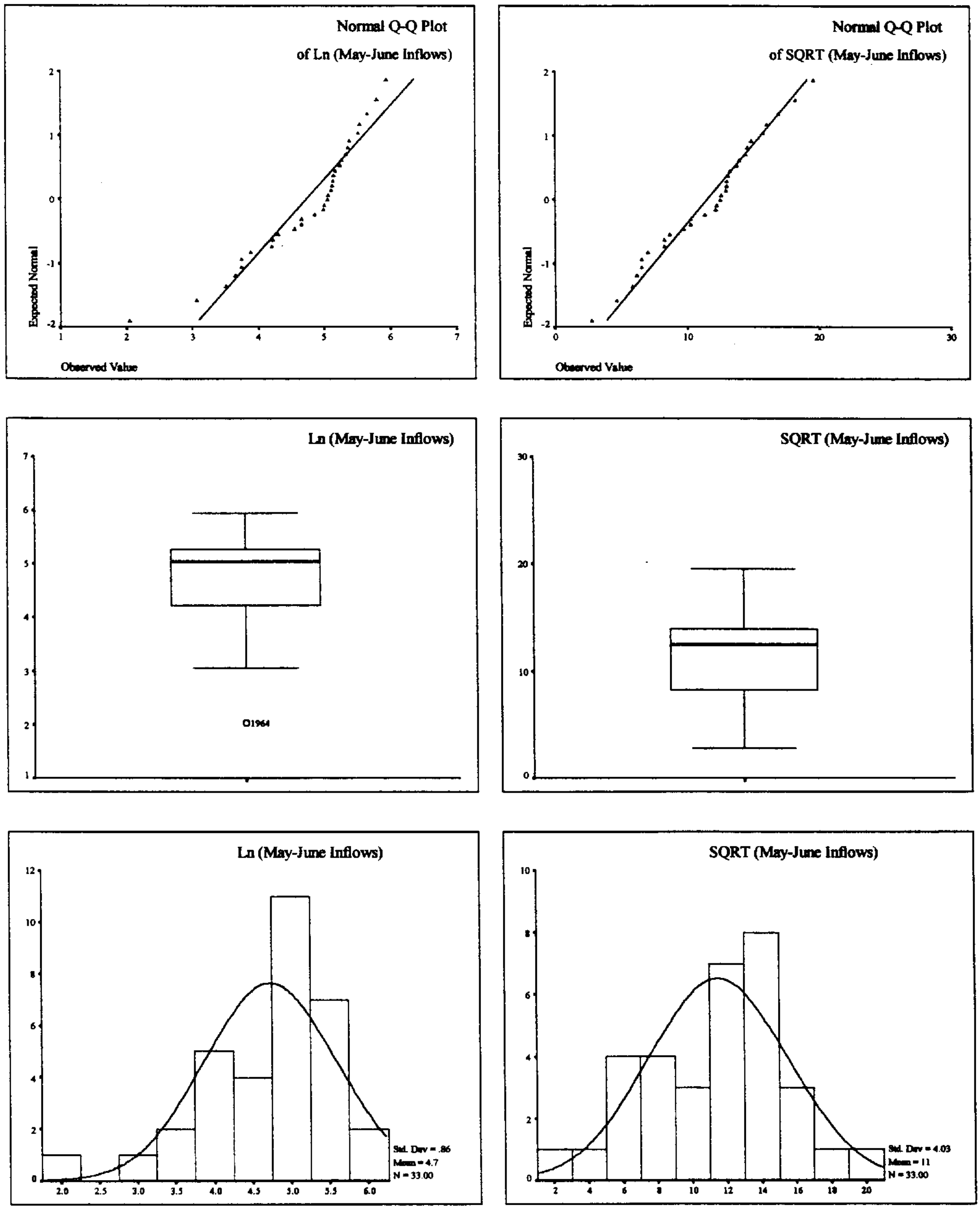



Fig. 2.4b. Exploratory Plots of Transformed May-June Inflows.

### 2.4.5 Summary Information for July-August Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| July-August Inflows | Mean | | 93.2585 | 16.4947 |
| | 95% Confidence Interval for Mean | Lower Bound | 59.6599 | |
| | | Upper Bound | 126.8570 | |
| | 5% Trimmed Mean | | 84.8572 | |
| | Median | | 66.6000 | |
| | Variance | | 8978.443 | |
| | Std. Deviation | | 94.7546 | |
| | Minimum | | 10.11 | |
| | Maximum | | 338.40 | |
| | Range | | 328.29 | |
| | Interquartile Range | | 74.5950 | |
| | Skewness | | 1.538 | .409 |
| | Kurtosis | | 1.221 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| July-August Inflows | Highest | 1 | 13 | 1973 | 338.40 |
| | | 2 | 12 | 1972 | 310.47 |
| | | 3 | 11 | 1971 | 307.47 |
| | | 4 | 21 | 1981 | 253.39 |
| | | 5 | 22 | 1982 | 249.34 |
| | Lowest | 1 | 4 | 1964 | 10.11 |
| | | 2 | 5 | 1965 | 10.70 |
| | | 3 | 6 | 1966 | 12.65 |
| | | 4 | 7 | 1967 | 14.00 |
| | | 5 | 24 | 1984 | 22.02 |

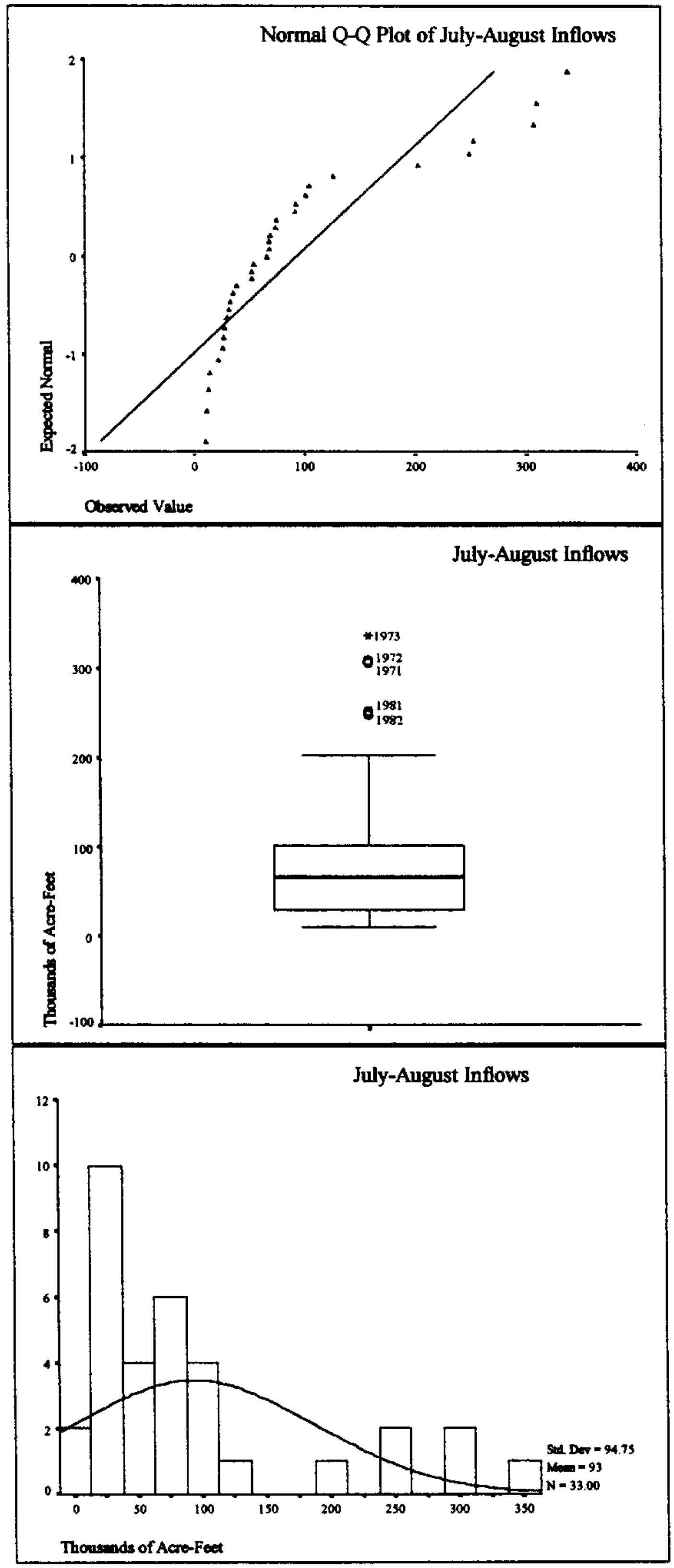



Fig. 2.5a. Exploratory Plots of July-August Inflows.

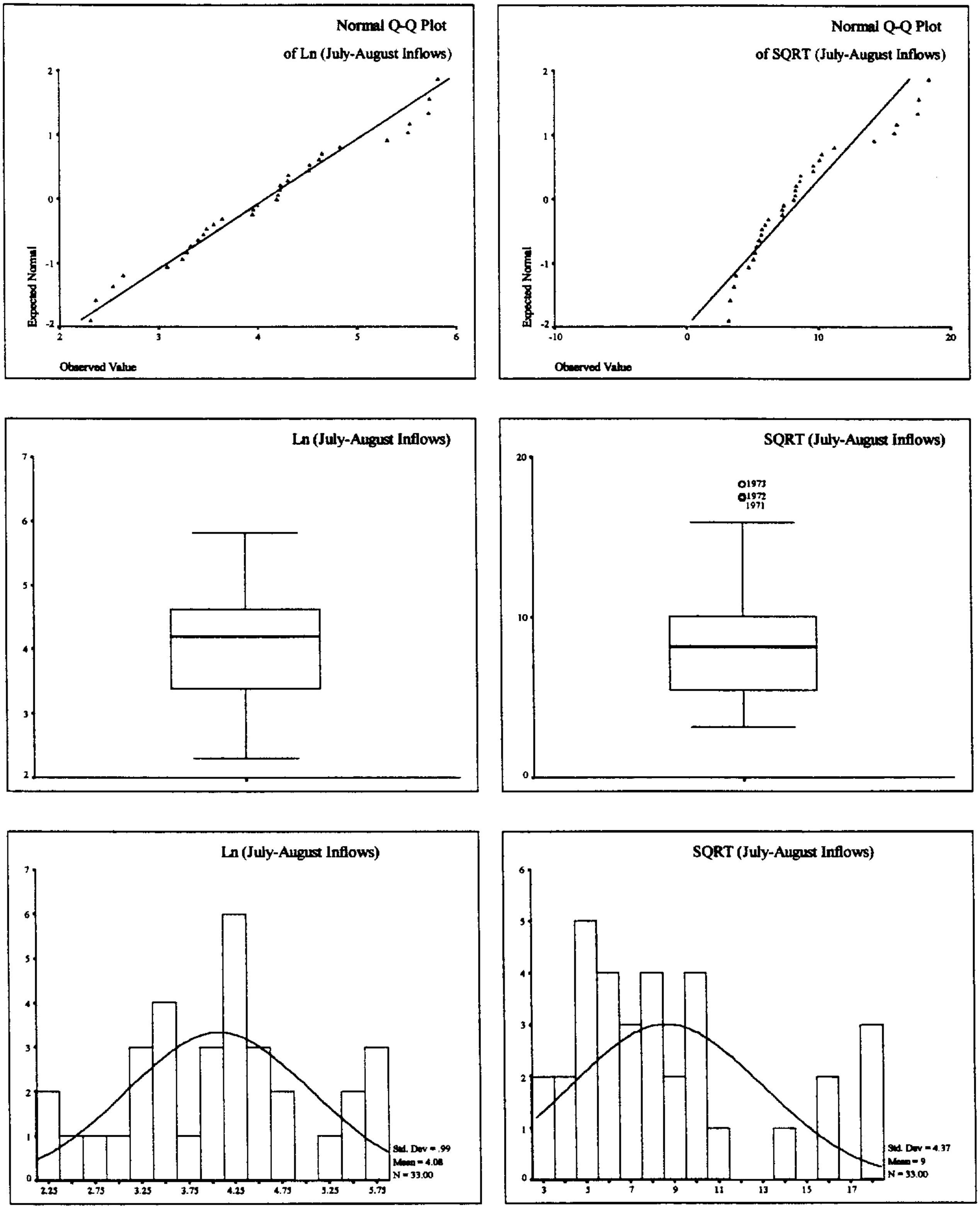



Fig. 2.5b. Exploratory Plots of Transformed July-August Inflows.

### 2.4.6 Summary Information for September-October Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| September-October Inflows | Mean | | 195.2409 | 42.1791 |
| | 95% Confidence Interval for Mean | Lower Bound | 109.3249 | |
| | | Upper Bound | 281.1569 | |
| | 5% Trimmed Mean | | 173.4787 | |
| | Median | | 88.8400 | |
| | Variance | | 58709.5 | |
| | Std. Deviation | | 242.3004 | |
| | Minimum | | 9.91 | |
| | Maximum | | 816.37 | |
| | Range | | 806.46 | |
| | Interquartile Range | | 195.4000 | |
| | Skewness | | 1.551 | .409 |
| | Kurtosis | | .892 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| September-October Inflows | Highest | 1 | 13 | 1973 | 816.37 |
| | | 2 | 9 | 1969 | 693.83 |
| | | 3 | 8 | 1968 | 675.78 |
| | | 4 | 7 | 1967 | 670.67 |
| | | 5 | 11 | 1971 | 612.72 |
| | Lowest | 1 | 3 | 1963 | 9.91 |
| | | 2 | 29 | 1989 | 20.56 |
| | | 3 | 28 | 1988 | 24.36 |
| | | 4 | 30 | 1990 | 24.99 |
| | | 5 | 24 | 1984 | 30.08 |

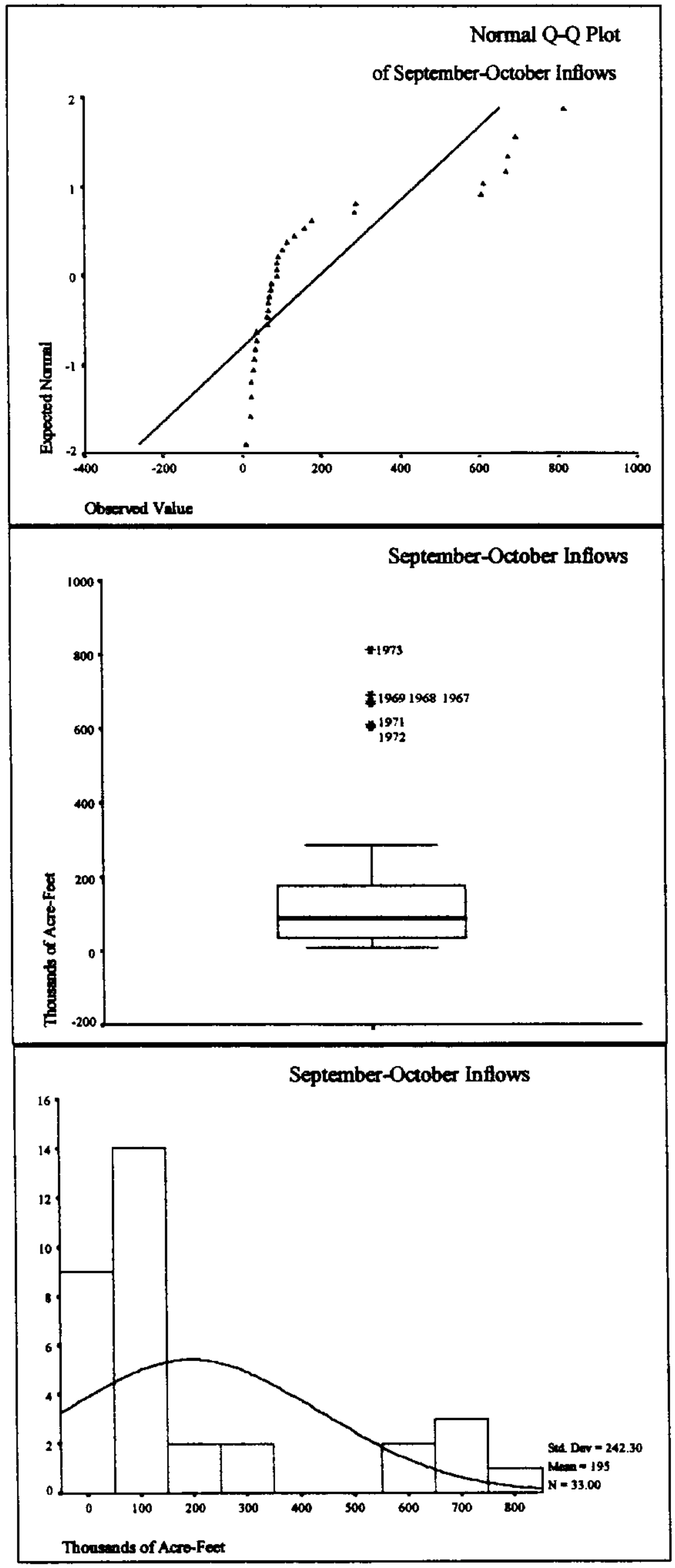



Fig. 2.6a. Exploratory Plots of September-October Inflows.

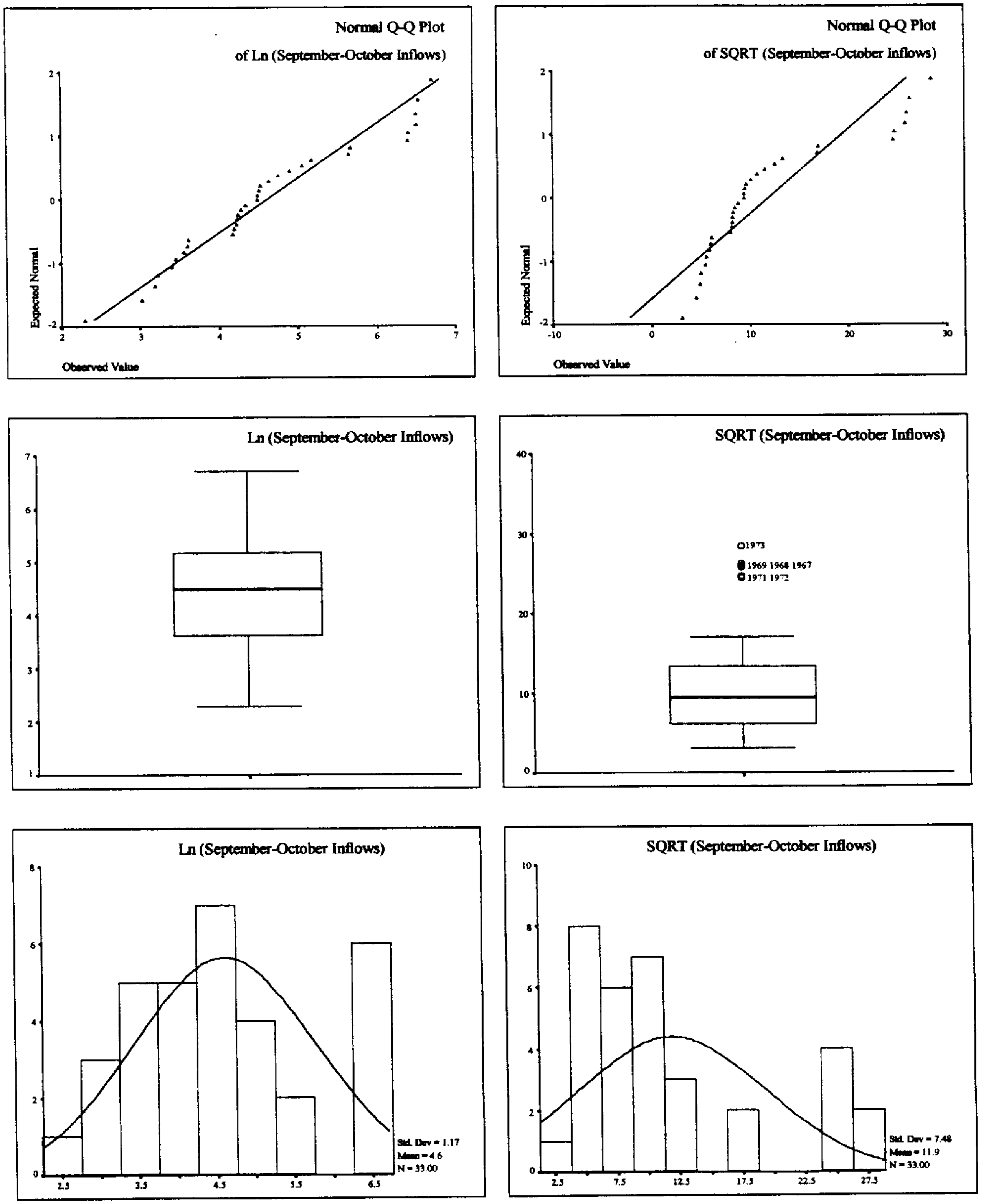



Fig. 2.6b. Exploratory Plots of Transformed September-October Inflows.

### 2.4.7 Summary Information for November-December Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| November-December Inflows | Mean | | 44.9106 | 6.4034 |
| | 95% Confidence Interval for Mean | Lower Bound | 31.8673 | |
| | | Upper Bound | 57.9539 | |
| | 5% Trimmed Mean | | 41.9274 | |
| | Median | | 35.4100 | |
| | Variance | | 1353.112 | |
| | Std. Deviation | | 36.7847 | |
| | Minimum | | 5.45 | |
| | Maximum | | 138.05 | |
| | Range | | 132.60 | |
| | Interquartile Range | | 53.8100 | |
| | Skewness | | 1.311 | .409 |
| | Kurtosis | | 1.306 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| November-December Inflows | Highest | 1 | 16 | 1976 | 138.05 |
| | | 2 | 18 | 1978 | 135.35 |
| | | 3 | 17 | 1977 | 133.86 |
| | | 4 | 1 | 1961 | 78.65 |
| | | 5 | 11 | 1971 | 78.25 |
| | Lowest | 1 | 3 | 1963 | 5.45 |
| | | 2 | 19 | 1979 | 8.20 |
| | | 3 | 30 | 1990 | 8.76 |
| | | 4 | 4 | 1964 | 9.75 |
| | | 5 | 20 | 1980 | 9.85 |

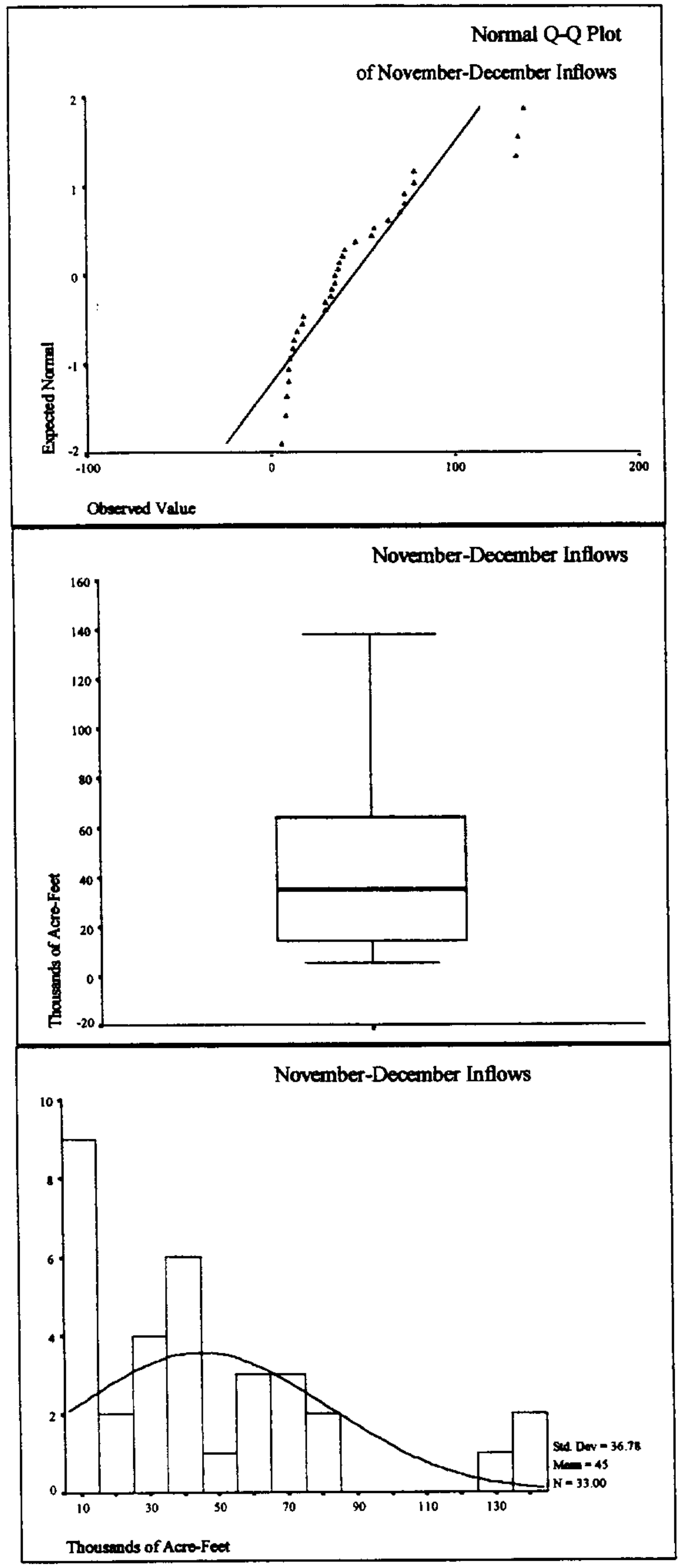



Fig. 2.7a. Exploratory Plots of November-December Inflows.

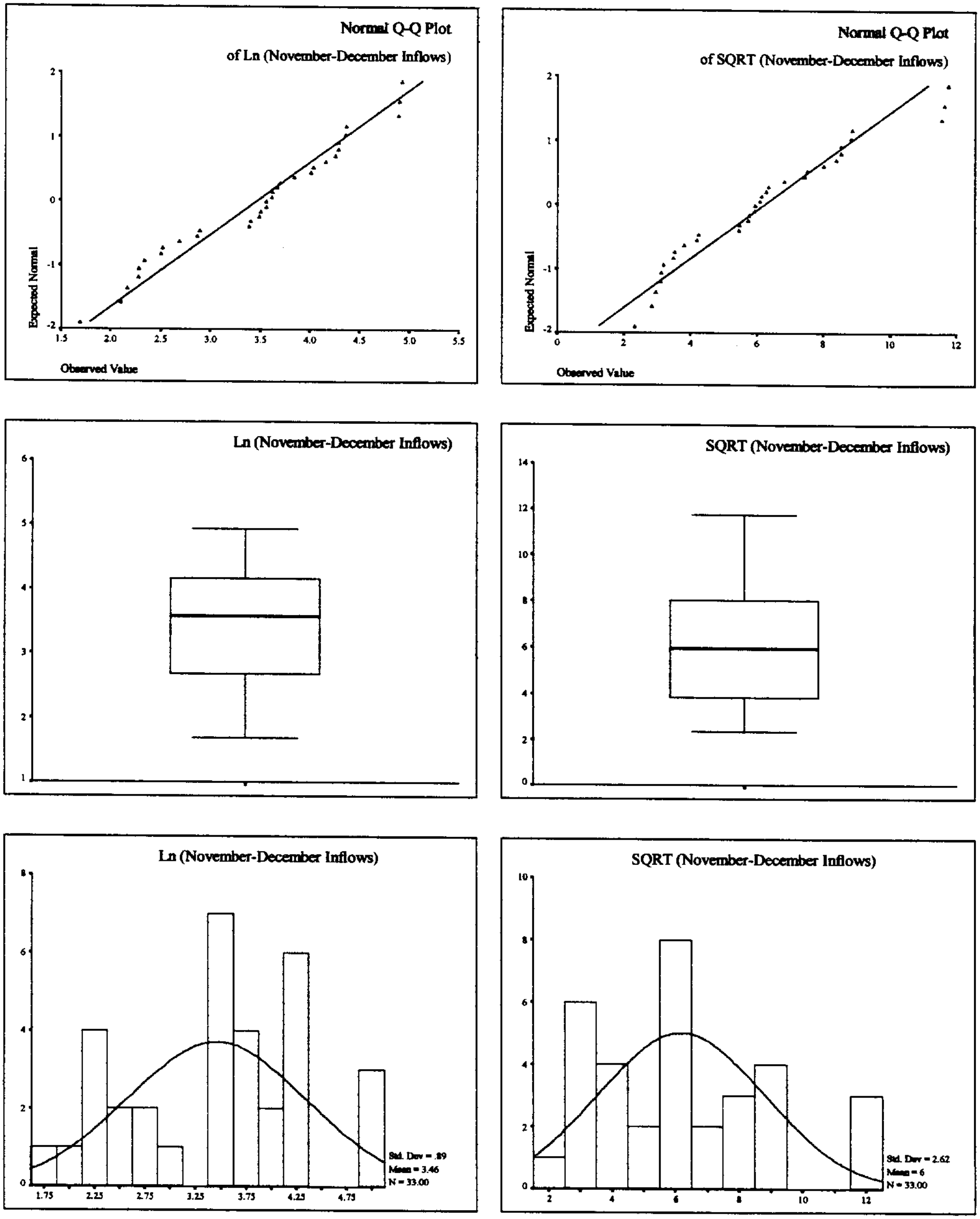



Fig. 2.7b. Exploratory Plots of Transformed November-December Inflows.

## 3. Prediction and Confidence Regions

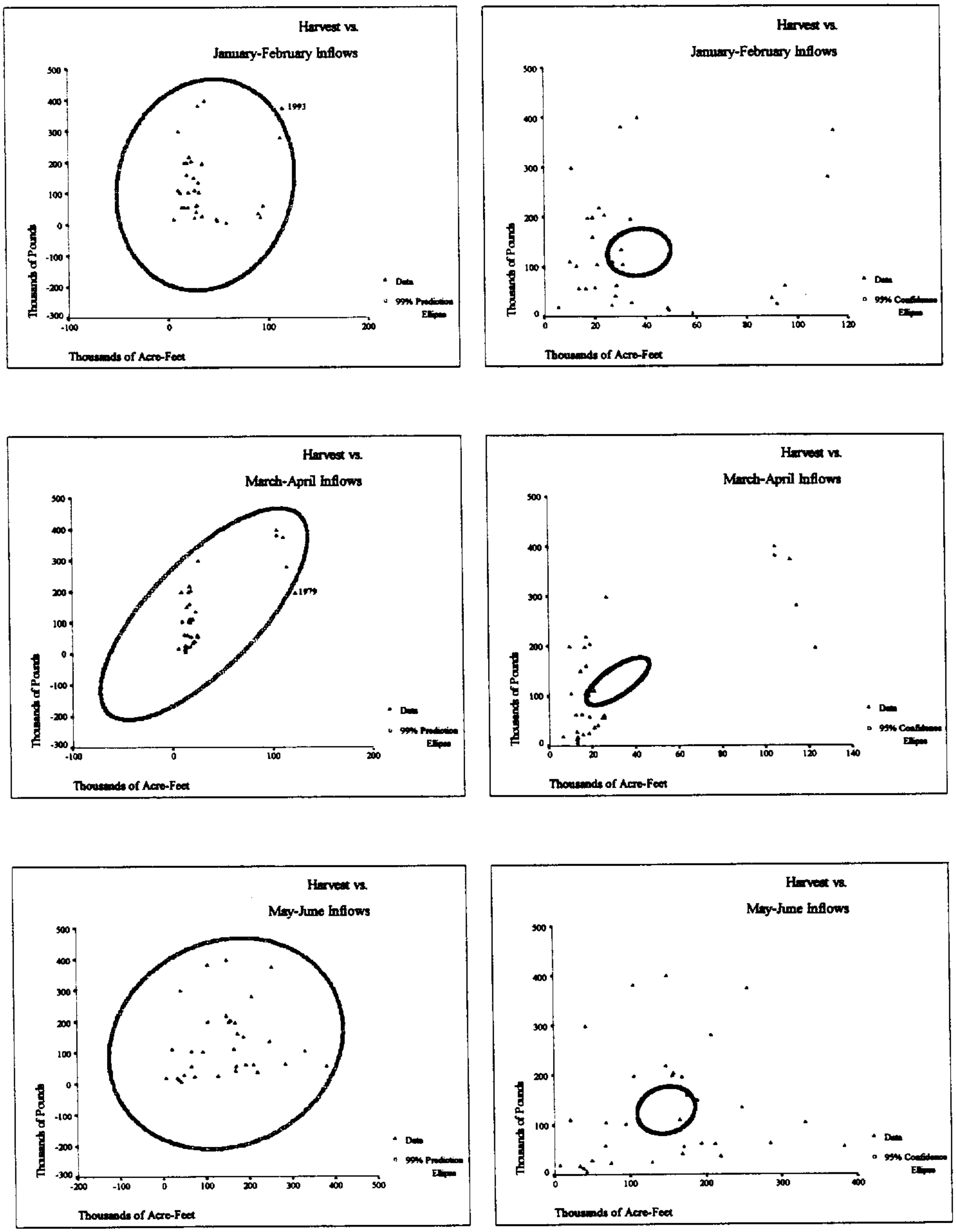



Fig. 3.1. Prediction and Confidence Ellipses.

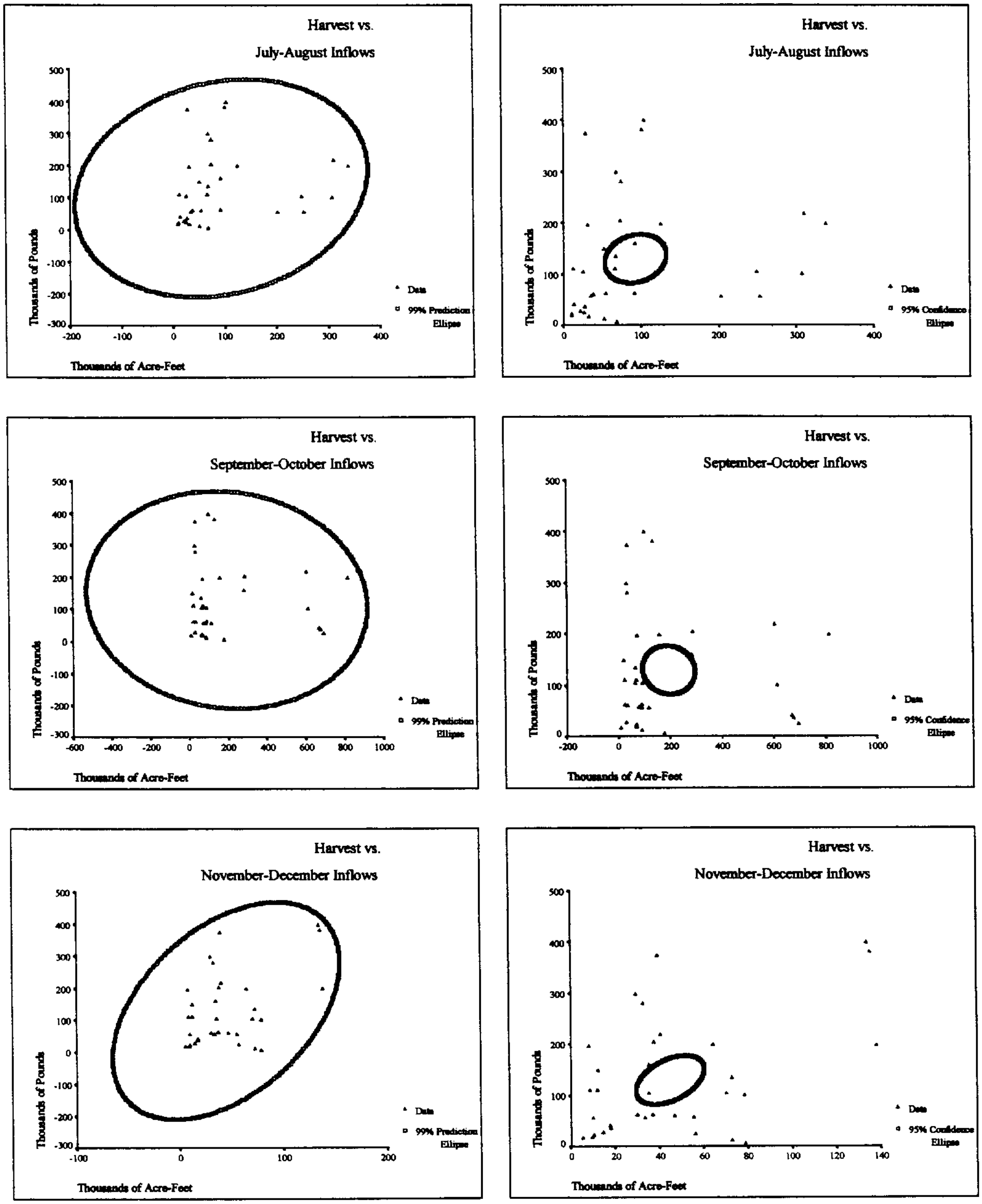



Fig. 3.2. Prediction and Confidence Ellipses.

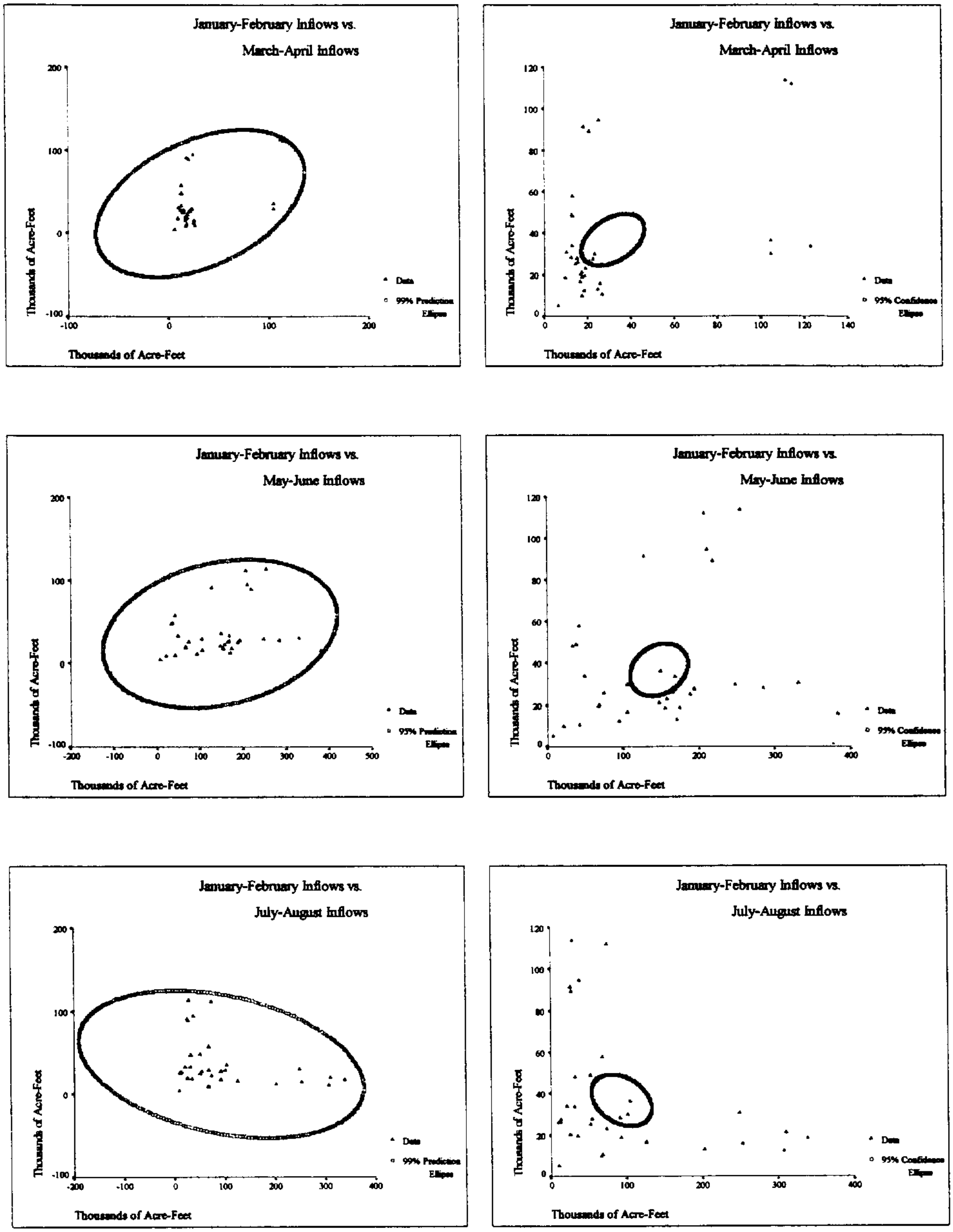



Fig. 3.3. Prediction and Confidence Ellipses.

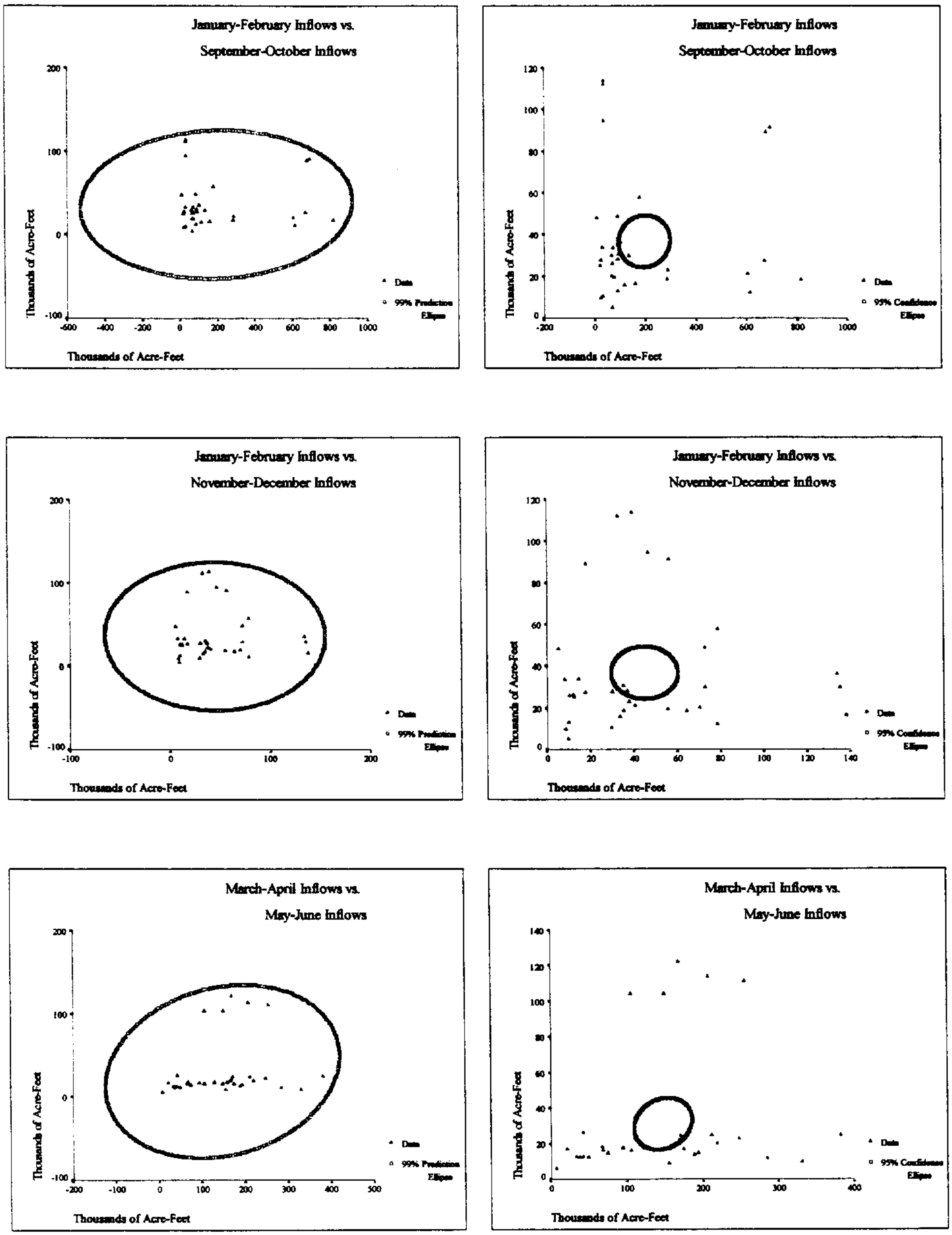



Fig. 3.4. Prediction and Confidence Ellipses.

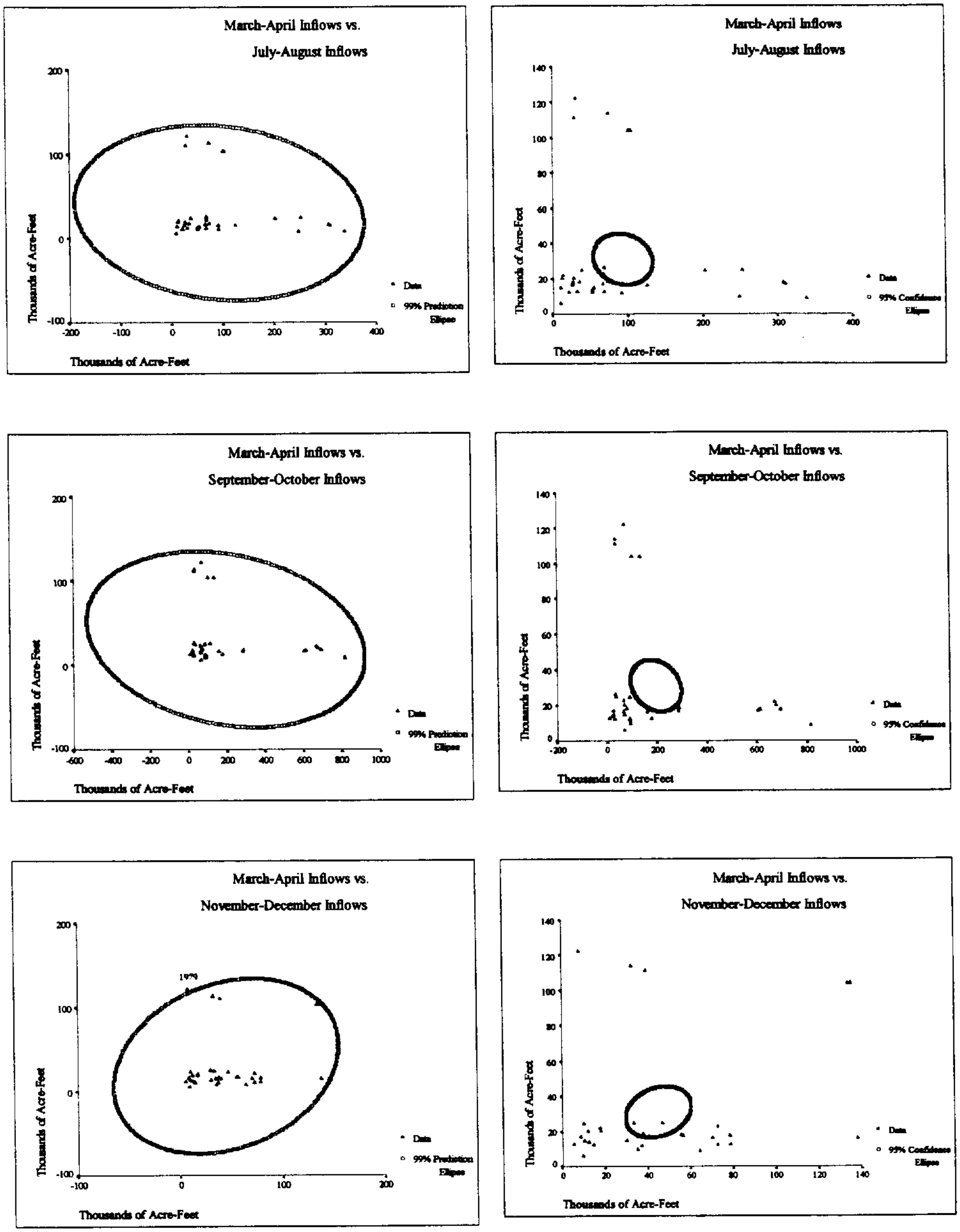



Fig. 3.5. Prediction and Confidence Ellipses.

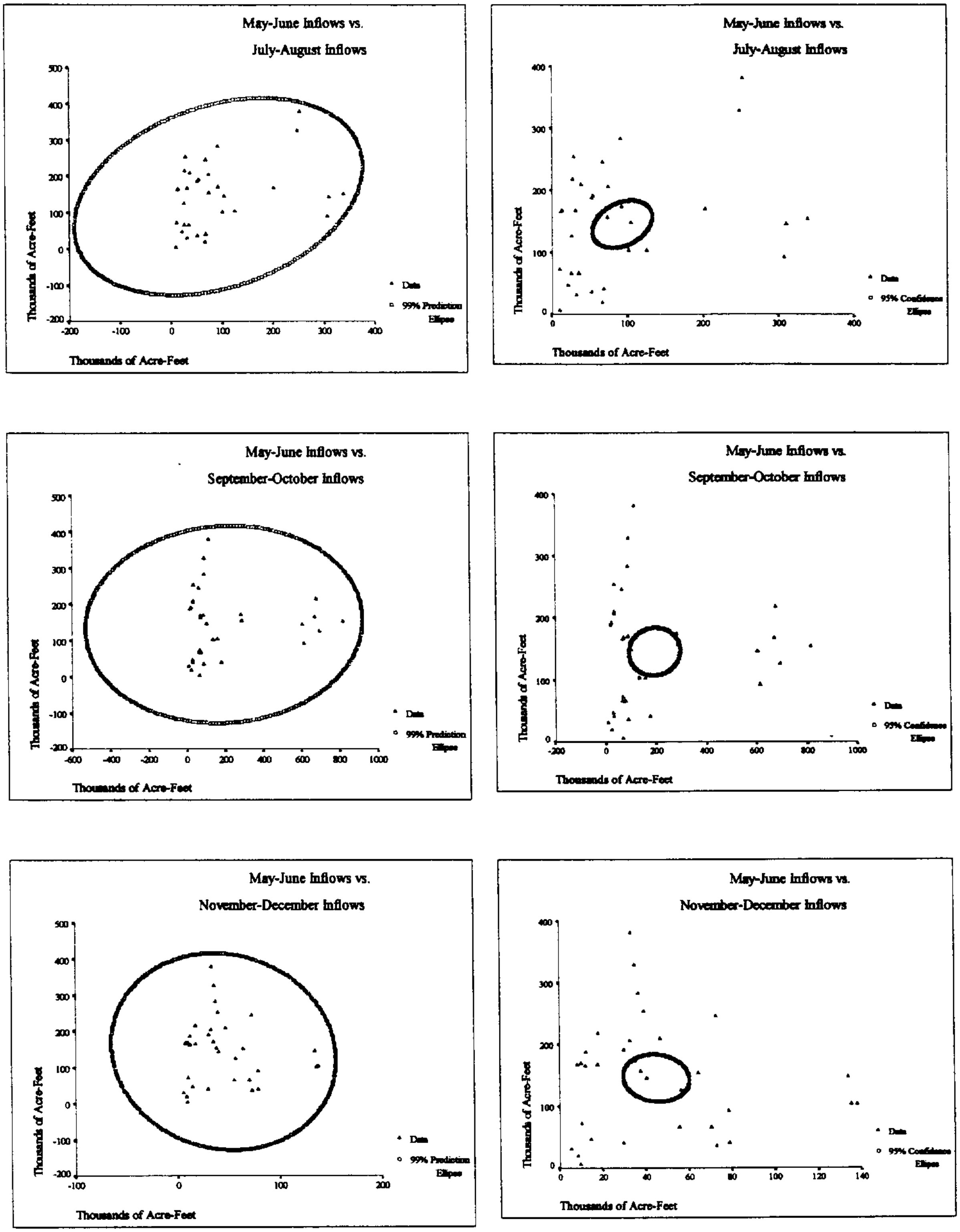



Fig. 3.6. Prediction and Confidence Ellipses.

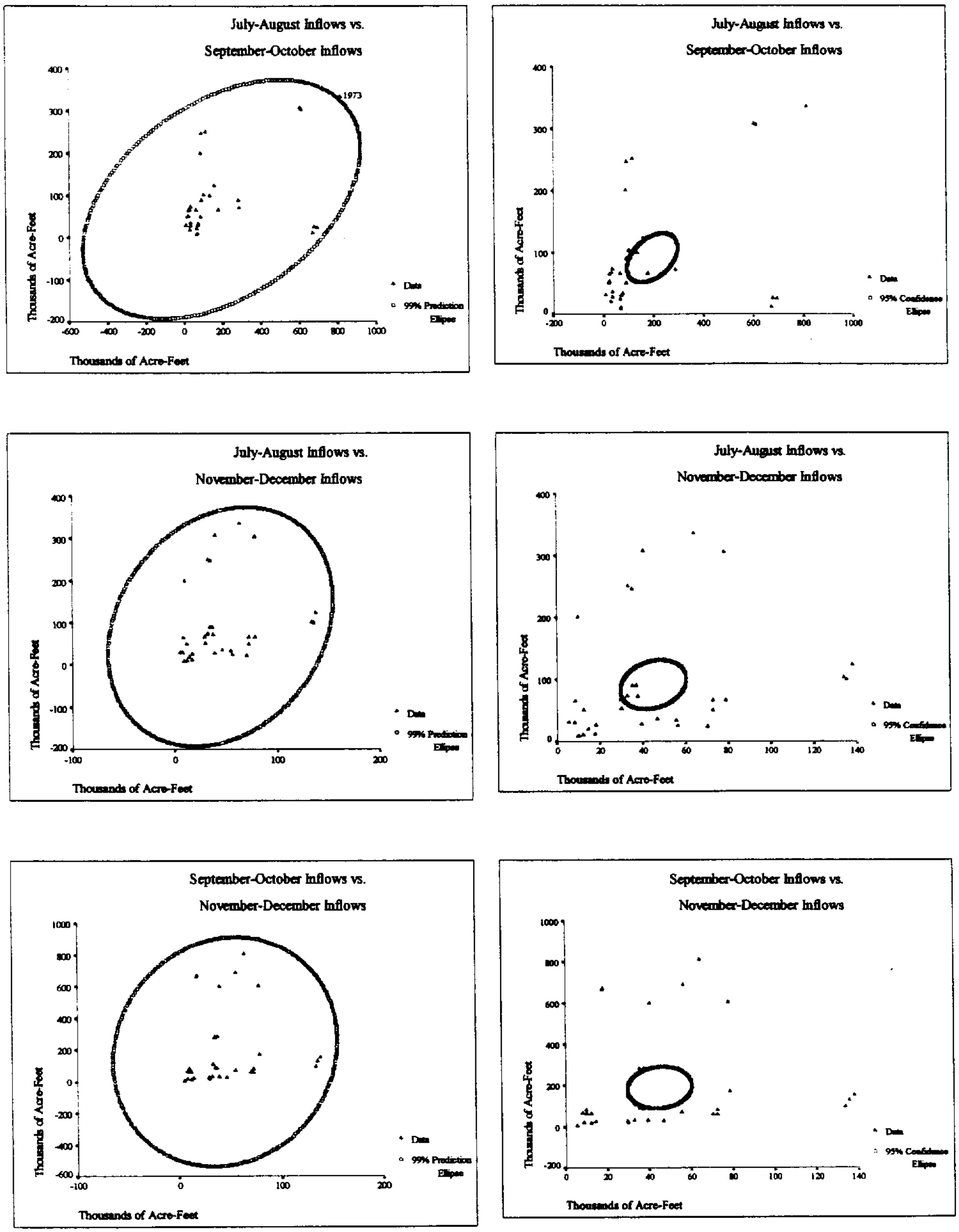



Fig. 3.7. Prediction and Confidence Ellipses.

## 4. Box-Cox Analysis

Table 4.1 Numerical Results.

| HARVEST | QJF_Lag | QMA_Lag | QMJ_Lag | QJA_Lag | QSO_Lag | QND_Lag | LAMBDA |
|---|---|---|---|---|---|---|---|
| 788518 | 5149 | 532 | 4434304 | 64632 | 821247 | 12106 | -2.0 |
| 551733 | 4120 | 469 | 2873672 | 50837 | 578271 | 9685 | -1.9 |
| 388912 | 3317 | 416 | 1873264 | 40196 | 410210 | 7801 | -1.8 |
| 276384 | 2689 | 372 | 1229209 | 31964 | 293417 | 6329 | -1.7 |
| 198192 | 2197 | 334 | 812620 | 25577 | 211837 | 5173 | -1.6 |
| 143542 | 1809 | 303 | 541771 | 20606 | 154541 | 4262 | -1.5 |
| 105106 | 1504 | 277 | 364682 | 16727 | 114066 | 3540 | -1.4 |
| 77895 | 1262 | 256 | 248179 | 13690 | 85298 | 2967 | -1.3 |
| 58496 | 1070 | 239 | 171014 | 11307 | 64721 | 2509 | -1.2 |
| 44565 | 918 | 225 | 119524 | 9432 | 49912 | 2142 | -1.1 |
| 34487 | 797 | 215 | 84887 | 7955 | 39190 | 1847 | -1.0 |
| 27142 | 701 | 208 | 61384 | 6791 | 31388 | 1609 | -0.9 |
| 21749 | 625 | 203 | 45284 | 5874 | 25692 | 1417 | -0.8 |
| 17766 | 565 | **201** | 34145 | 5155 | 21534 | 1262 | **-0.7** |
| 14807 | 519 | 203 | 26358 | 4595 | 18516 | 1137 | -0.6 |
| 12602 | 484 | 207 | 20857 | 4165 | 16358 | 1037 | -0.5 |
| 10960 | 458 | 214 | 16930 | 3843 | 14870 | 958 | -0.4 |
| 9744 | 440 | 224 | 14100 | 3614 | 13921 | 896 | -0.3 |
| 8857 | 430 | 239 | 12045 | 3466 | 13428 | 850 | -0.2 |
| 8230 | **426** | 257 | 10545 | 3392 | **13342** | 818 | **-0.1** |
| 7816 | 428 | 281 | 9449 | **3387** | 13648 | 798 | **0** |
| 7583 | 437 | 311 | 8654 | 3452 | 14356 | **790** | **0.1** |
| **7508** | 452 | 348 | 8089 | 3589 | 15502 | 793 | **0.2** |
| 7582 | 474 | 394 | 7705 | 3804 | 17152 | 808 | 0.3 |
| 7800 | 502 | 450 | 7466 | 4107 | 19409 | 835 | 0.4 |
| 8168 | 539 | 520 | 7351 | 4512 | 22416 | 876 | 0.5 |
| 8694 | 584 | 606 | **7344** | 5037 | 26371 | 931 | **0.6** |
| 9398 | 639 | 712 | 7438 | 5708 | 31544 | 1003 | 0.7 |
| 10305 | 706 | 844 | 7628 | 6558 | 38300 | 1095 | 0.8 |
| 11450 | 786 | 1008 | 7914 | 7630 | 47133 | 1210 | 0.9 |
| 12879 | 882 | 1211 | 8300 | 8978 | 58709 | 1353 | 1.0 |
| 14649 | 998 | 1465 | 8794 | 10676 | 73933 | 1529 | 1.1 |
| 16836 | 1136 | 1784 | 9406 | 12816 | 94031 | 1746 | 1.2 |
| 19535 | 1301 | 2184 | 10150 | 15516 | 120671 | 2012 | 1.3 |
| 22865 | 1499 | 2687 | 11043 | 18934 | 156131 | 2338 | 1.4 |
| 26980 | 1736 | 3324 | 12108 | 23271 | 203528 | 2740 | 1.5 |
| 32070 | 2021 | 4131 | 13373 | 28789 | 267140 | 3234 | 1.6 |
| 38381 | 2363 | 5158 | 14870 | 35830 | 352855 | 3843 | 1.7 |
| 46221 | 2776 | 6466 | 16640 | 44840 | 468796 | 4596 | 1.8 |
| 55985 | 3274 | 8138 | 18730 | 56404 | 626200 | 5527 | 1.9 |
| 68173 | 3877 | 10281 | 21201 | 71286 | 840653 | 6682 | 2.0 |

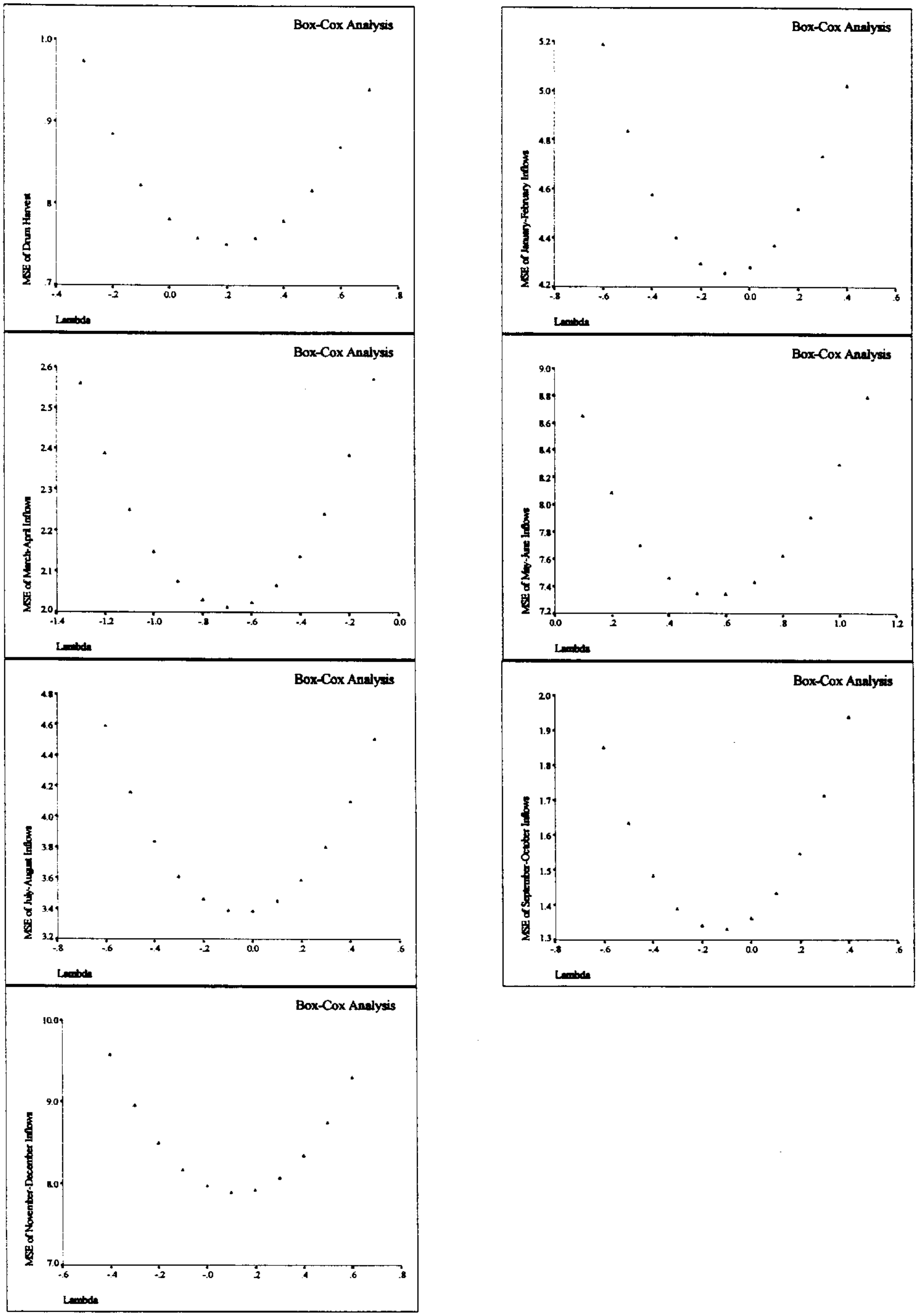



Fig 4.1. MSE of Harvest and Inflows Variables vs. Lambda obtained from Box-Cox Transformation

# 5. Model Choice Diagnostics

## 5.1 Untransformed Data

N = 33 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.536613 | 0.521665 | 7.9757 | 289.9 | 6160.4 | 292.9 | QMA_LAG |
| 1 | 0.201368 | 0.175605 | 34.7263 | 307.9 | 10617.2 | 310.8 | QND_LAG |
| 1 | 0.030268 | -.001014 | 48.3791 | 314.3 | 12891.8 | 317.3 | QJA_LAG |
| 1 | 0.019593 | -.012033 | 49.2309 | 314.6 | 13033.7 | 317.6 | QMJ_LAG |
| 2 | 0.614531 | 0.588834 | 3.7582 | 285.8 | 5295.3 | 290.3 | QMA_LAG QND_LAG |
| 2 | 0.607440 | 0.581270 | 4.3240 | 286.4 | 5392.7 | 290.9 | QMA_LAG QJA_LAG |
| 2 | 0.587200 | 0.559680 | 5.9391 | 288.1 | 5670.8 | 292.6 | QJF_LAG QMA_LAG |
| 2 | 0.543195 | 0.512741 | 9.4504 | 291.4 | 6275.3 | 295.9 | QMA_LAG QSO_LAG |
| 3 | 0.653612 | 0.617779 | 2.6398 | 284.3 | 4922.5 | 290.3 | QMA_LAG QJA_LAG QND_LAG |
| 3 | 0.651445 | 0.615388 | 2.8127 | 284.5 | 4953.3 | 290.5 | QJF_LAG QMA_LAG QND_LAG |
| 3 | 0.630794 | 0.592600 | 4.4606 | 286.4 | 5246.8 | 292.4 | QJF_LAG QMA_LAG QJA_LAG |
| 3 | 0.616372 | 0.576687 | 5.6113 | 287.7 | 5451.7 | 293.6 | QMA_LAG QMJ_LAG QND_LAG |
| 4 | 0.674106 | 0.627549 | 3.0045 | 284.3 | 4796.7 | 291.8 | QJF_LAG QMA_LAG QJA_LAG QND_LAG |
| 4 | 0.657238 | 0.608273 | 4.3504 | 285.9 | 5045.0 | 293.4 | QJF_LAG QMA_LAG QMJ_LAG QND_LAG |
| 4 | 0.656732 | 0.607693 | 4.3909 | 286.0 | 5052.4 | 293.5 | QJF_LAG QMA_LAG QSO_LAG QND_LAG |
| 4 | 0.655504 | 0.606291 | 4.4888 | 286.1 | 5070.5 | 293.6 | QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.674144 | 0.613800 | 5.0015 | 286.3 | 4973.8 | 295.3 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.674116 | 0.613767 | 5.0037 | 286.3 | 4974.2 | 295.3 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.661599 | 0.598933 | 6.0024 | 287.5 | 5165.2 | 296.5 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 5 | 0.657191 | 0.593708 | 6.3542 | 287.9 | 5232.5 | 296.9 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.674162 | 0.598969 | 7.0000 | 288.3 | 5164.8 | 298.7 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

## 5.5 Square Root All Variables

N = 33      Regression Models for Dependent Variable: SQRT (DRUM)

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.46136 | 0.44399 | 12.368 | 87.302 | 13.288 | 90.295 | SQRT_QMA |
| 1 | 0.14255 | 0.11489 | 36.853 | 102.6 | 21.152 | 105.6 | SQRT_QND |
| 1 | 0.09421 | 0.06499 | 40.565 | 104.5 | 22.345 | 107.4 | SQRT_QJA |
| 1 | 0.08107 | 0.05142 | 41.574 | 104.9 | 22.669 | 107.9 | SQRT_QMJ |
| 2 | 0.58647 | 0.55890 | 4.759 | 80.580 | 10.541 | 85.069 | SQRT_QMA SQRT_QJA |
| 2 | 0.55649 | 0.52692 | 7.062 | 82.890 | 11.306 | 87.379 | SQRT_QJF SQRT_QMA |
| 2 | 0.52082 | 0.48887 | 9.801 | 85.442 | 12.215 | 89.932 | SQRT_QMA SQRT_QND |
| 2 | 0.47413 | 0.43907 | 13.387 | 88.511 | 13.405 | 93.000 | SQRT_QMA SQRT_QMJ |
| 3 | 0.63010 | 0.59183 | 3.409 | 78.901 | 9.754 | 84.887 | SQRT_QJF SQRT_QMA SQRT_QJA |
| 3 | 0.61470 | 0.57484 | 4.591 | 80.246 | 10.160 | 86.232 | SQRT_QJF SQRT_QMA SQRT_QND |
| 3 | 0.60098 | 0.55970 | 5.645 | 81.401 | 10.522 | 87.387 | SQRT_QMA SQRT_QJA SQRT_QND |
| 3 | 0.58983 | 0.54740 | 6.501 | 82.310 | 10.816 | 88.296 | SQRT_QJF SQRT_QMA SQRT_QMJ |
| 4 | 0.65173 | 0.60197 | 3.747 | 78.912 | 9.512 | 86.395 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QND |
| 4 | 0.64772 | 0.59740 | 4.055 | 79.290 | 9.621 | 86.772 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QND |
| 4 | 0.63403 | 0.58175 | 5.107 | 80.548 | 9.995 | 88.030 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA |
| 4 | 0.63019 | 0.57736 | 5.401 | 80.892 | 10.100 | 88.375 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO |
| 5 | 0.66124 | 0.59850 | 5.017 | 79.999 | 9.595 | 88.978 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 5 | 0.65187 | 0.58741 | 5.736 | 80.898 | 9.860 | 89.877 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.64812 | 0.58295 | 6.025 | 81.252 | 9.967 | 90.232 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.63413 | 0.56638 | 7.099 | 82.539 | 10.363 | 91.518 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 6 | 0.66146 | 0.58333 | 7.000 | 81.977 | 9.957 | 92.453 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

## 5.6 Logged and Square Root Variables

N = 33 Regression Models for Dependent Variable: Ln (DRUM)

| Number In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.342359 | 0.321145 | 19.2968 | -8.5925 | 0.72682 | -5.5995 | SQRT_QMA |
| 1 | 0.162627 | 0.135615 | 32.4963 | -0.6193 | 0.92546 | 2.3737 | LN_QJA |
| 1 | 0.147175 | 0.119665 | 33.6310 | -0.0160 | 0.94254 | 2.9770 | SQRT_QMJ |
| 1 | 0.087263 | 0.057820 | 38.0310 | 2.2245 | 1.00876 | 5.2175 | LN_QND |
| 2 | 0.500583 | 0.467288 | 9.6770 | -15.6747 | 0.57035 | -11.1851 | SQRT_QMA LN_QJA |
| 2 | 0.463832 | 0.428087 | 12.3759 | -13.3315 | 0.61233 | -8.8419 | LN_QJF SQRT_QMA |
| 2 | 0.400228 | 0.360243 | 17.0469 | -9.6321 | 0.68496 | -5.1426 | SQRT_QMA SQRT_QMJ |
| 2 | 0.385295 | 0.344315 | 18.1436 | -8.8206 | 0.70202 | -4.3311 | SQRT_QMA LN_QND |
| 3 | 0.585192 | 0.542281 | 5.4633 | -19.8004 | 0.49006 | -13.8143 | LN_QJF SQRT_QMA SQRT_QMJ |
| 3 | 0.570311 | 0.525860 | 6.5562 | -18.6372 | 0.50764 | -12.6512 | LN_QJF SQRT_QMA LN_QJA |
| 3 | 0.524337 | 0.475131 | 9.9324 | -15.2829 | 0.56196 | -9.2968 | LN_QJF SQRT_QMA LN_QND |
| 3 | 0.511122 | 0.460548 | 10.9030 | -14.3785 | 0.57757 | -8.3925 | SQRT_QMA SQRT_QMJ LN_QJA |
| 4 | 0.631296 | 0.578624 | 4.0775 | -21.6884 | 0.45115 | -14.2059 | LN_QJF SQRT_QMA SQRT_QMJ LN_QND |
| 4 | 0.620605 | 0.566406 | 4.8626 | -20.7452 | 0.46423 | -13.2627 | LN_QJF SQRT_QMA SQRT_QMJ LN_QJA |
| 4 | 0.585608 | 0.526409 | 7.4327 | -17.8334 | 0.50706 | -10.3509 | LN_QJF SQRT_QMA SQRT_QMJ LN_QSO |
| 4 | 0.579780 | 0.519748 | 7.8608 | -17.3725 | 0.51419 | -9.8900 | LN_QJF SQRT_QMA LN_QJA LN_QND |
| 5 | 0.639641 | 0.572907 | 5.4646 | -20.4439 | 0.45727 | -11.4648 | LN_QJF SQRT_QMA SQRT_QMJ LN_QJA LN_QND |
| 5 | 0.637021 | 0.569803 | 5.6570 | -20.2049 | 0.46060 | -11.2259 | LN_QJF SQRT_QMA SQRT_QMJ LN_QSO LN_QND |
| 5 | 0.621306 | 0.551177 | 6.8111 | -18.8062 | 0.48054 | -9.8272 | LN_QJF SQRT_QMA SQRT_QMJ LN_QJA LN_QSO |
| 5 | 0.581010 | 0.503419 | 9.7704 | -15.4693 | 0.53167 | -6.4903 | LN_QJF SQRT_QMA LN_QJA LN_QSO LN_QND |
| 6 | 0.645967 | 0.564267 | 7.0000 | -19.0284 | 0.46652 | -8.5528 | LN_QJF SQRT_QMA SQRT_QMJ LN_QJA LN_QSO LN_QND |

## 5.7 Untransformed, Square Root and Logged Variables

N = 33 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.546830 | 0.532211 | 12.7049 | 289.2 | 6024.5 | 292.1 | SQRT_QMA |
| 1 | 0.150184 | 0.122770 | 49.2080 | 309.9 | 11297.6 | 312.9 | LN_QND |
| 1 | 0.099837 | 0.070799 | 53.8414 | 311.8 | 11966.9 | 314.8 | LN_QJA |
| 1 | 0.041431 | 0.010510 | 59.2164 | 313.9 | 12743.4 | 316.9 | SQRT_QMJ |
| 2 | 0.642319 | 0.618474 | 5.9171 | 283.3 | 4913.6 | 287.8 | SQRT_QMA LN_QJA |
| 2 | 0.623144 | 0.598020 | 7.6818 | 285.1 | 5177.0 | 289.6 | SQRT_QMA LN_QND |
| 2 | 0.605023 | 0.578691 | 9.3495 | 286.6 | 5425.9 | 291.1 | LN_QJF SQRT_QMA |
| 2 | 0.553590 | 0.523829 | 14.0828 | 290.7 | 6132.5 | 295.1 | SQRT_QMA LN_QSO |
| 3 | 0.697349 | 0.666041 | 2.8527 | 279.8 | 4301.0 | 285.8 | LN_QJF SQRT_QMA LN_QND |
| 3 | 0.672873 | 0.639033 | 5.1052 | 282.4 | 4648.8 | 288.4 | LN_QJF SQRT_QMA LN_QJA |
| 3 | 0.665609 | 0.631017 | 5.7738 | 283.1 | 4752.0 | 289.1 | SQRT_QMA LN_QJA LN_QND |
| 3 | 0.653801 | 0.617987 | 6.8605 | 284.3 | 4919.8 | 290.3 | SQRT_QMA SQRT_QMJ LN_QJA |
| 4 | 0.713422 | 0.672482 | 3.3736 | 280.0 | 4218.0 | 287.5 | LN_QJF SQRT_QMA LN_QJA LN_QND |
| 4 | 0.700223 | 0.657397 | 4.5883 | 281.5 | 4412.3 | 289.0 | LN_QJF SQRT_QMA SQRT_QMJ LN_QND |
| 4 | 0.699391 | 0.656447 | 4.6649 | 281.6 | 4424.5 | 289.1 | LN_QJF SQRT_QMA LN_QSO LN_QND |
| 4 | 0.675312 | 0.628928 | 6.8808 | 284.2 | 4778.9 | 291.6 | SQRT_QMA SQRT_QMJ LN_QJA LN_QND |
| 5 | 0.717466 | 0.665145 | 5.0014 | 281.6 | 4312.5 | 290.5 | LN_QJF SQRT_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.713477 | 0.660417 | 5.3686 | 282.0 | 4373.4 | 291.0 | LN_QJF SQRT_QMA SQRT_QMJ LN_QJA LN_QND |
| 5 | 0.703637 | 0.648755 | 6.2741 | 283.1 | 4523.6 | 292.1 | LN_QJF SQRT_QMA SQRT_QMJ LN_QSO LN_QND |
| 5 | 0.678044 | 0.618422 | 8.6294 | 285.9 | 4914.2 | 294.9 | SQRT_QMA SQRT_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.717481 | 0.652285 | 7.0000 | 283.6 | 4478.1 | 294.0 | LN_QJF SQRT_QMA SQRT_QMJ LN_QJA LN_QSO LN_QND |

## 5.8 Untransformed, Square Root and Logged Variables

N = 33 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.546830 | 0.532211 | 12.8108 | 289.2 | 6024.5 | 292.1 | SQRT_QMA |
| 1 | 0.150184 | 0.122770 | 49.4065 | 309.9 | 11297.6 | 312.9 | LN_QND |
| 1 | 0.099837 | 0.070799 | 54.0517 | 311.8 | 11966.9 | 314.8 | LN_QJA |
| 1 | 0.019593 | -.012033 | 61.4552 | 314.6 | 13033.7 | 317.6 | QMJ_LAG |
| 2 | 0.642319 | 0.618474 | 6.0007 | 283.3 | 4913.6 | 287.8 | SQRT_QMA LN_QJA |
| 2 | 0.623144 | 0.598020 | 7.7699 | 285.1 | 5177.0 | 289.6 | SQRT_QMA LN_QND |
| 2 | 0.605023 | 0.578691 | 9.4418 | 286.6 | 5425.9 | 291.1 | LN_QJF SQRT_QMA |
| 2 | 0.553590 | 0.523829 | 14.1871 | 290.7 | 6132.5 | 295.1 | SQRT_QMA LN_QSO |
| 3 | 0.697349 | 0.666041 | 2.9234 | 279.8 | 4301.0 | 285.8 | LN_QJF SQRT_QMA LN_QND |
| 3 | 0.672873 | 0.639033 | 5.1817 | 282.4 | 4648.8 | 288.4 | LN_QJF SQRT_QMA LN_QJA |
| 3 | 0.665609 | 0.631017 | 5.8519 | 283.1 | 4752.0 | 289.1 | SQRT_QMA LN_QJA LN_QND |
| 3 | 0.659250 | 0.624000 | 6.4386 | 283.7 | 4842.4 | 289.7 | SQRT_QMA QMJ_LAG LN_QJA |
| 4 | 0.713422 | 0.672482 | 3.4405 | 280.0 | 4218.0 | 287.5 | LN_QJF SQRT_QMA LN_QJA LN_QND |
| 4 | 0.699391 | 0.656447 | 4.7351 | 281.6 | 4424.5 | 289.1 | LN_QJF SQRT_QMA LN_QSO LN_QND |
| 4 | 0.698268 | 0.655164 | 4.8387 | 281.7 | 4441.1 | 289.2 | LN_QJF SQRT_QMA QMJ_LAG LN_QND |
| 4 | 0.678552 | 0.632630 | 6.6578 | 283.8 | 4731.3 | 291.3 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA |
| 5 | 0.717466 | 0.665145 | 5.0674 | 281.6 | 4312.5 | 290.5 | LN_QJF SQRT_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.714509 | 0.661640 | 5.3402 | 281.9 | 4357.6 | 290.9 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QND |
| 5 | 0.700794 | 0.645386 | 6.6056 | 283.5 | 4567.0 | 292.4 | LN_QJF SQRT_QMA QMJ_LAG LN_QSO LN_QND |
| 5 | 0.681827 | 0.622907 | 8.3555 | 285.5 | 4856.5 | 294.5 | SQRT_QMA QMJ_LAG LN_QJA LN_QSO LN_QND |
| 6 | 0.718197 | 0.653165 | 7.0000 | 283.5 | 4466.8 | 294.0 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QSO LN_QND |

## 5.9 Variables transformed according to the Box-Cox Analysis

N = 33    Regression Models for Dependent Variable: $(DRUM)^{0.2}$

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.358206 | 0.337503 | 12.7041 | -58.2361 | 0.161472 | -55.2431 | $QMA^{-0.7}$ |
| 1 | 0.158223 | 0.131069 | 25.6990 | -49.2849 | 0.211787 | -46.2919 | LN_QJA |
| 1 | 0.109261 | 0.080528 | 28.8806 | -47.4193 | 0.224105 | -44.4262 | $QMJ^{0.6}$ |
| 1 | 0.107242 | 0.078443 | 29.0118 | -47.3445 | 0.224613 | -44.3515 | $QND^{0.1}$ |
| 2 | 0.492819 | 0.459007 | 5.9569 | -64.0043 | 0.131858 | -59.5148 | $QMA^{-0.7}$ LN_QJA |
| 2 | 0.466600 | 0.431040 | 7.6606 | -62.3410 | 0.138674 | -57.8514 | $QJF^{-0.1}$ $QMA^{-0.7}$ |
| 2 | 0.404869 | 0.365194 | 11.6718 | -58.7272 | 0.154723 | -54.2376 | $QMA^{-0.7}$ $QND^{0.1}$ |
| 2 | 0.377702 | 0.336215 | 13.4372 | -57.2541 | 0.161786 | -52.7646 | $QMA^{-0.7}$ $QMJ^{0.6}$ |
| 3 | 0.554551 | 0.508470 | 3.9455 | -66.2872 | 0.119802 | -60.3012 | $QJF^{-0.1}$ $QMA^{-0.7}$ LN_QJA |
| 3 | 0.527363 | 0.478470 | 5.7121 | -64.3321 | 0.127114 | -58.3461 | $QJF^{-0.1}$ $QMA^{-0.7}$ $QND^{0.1}$ |
| 3 | 0.516992 | 0.467026 | 6.3860 | -63.6159 | 0.129903 | -57.6298 | $QJF^{-0.1}$ $QMA^{-0.7}$ $QMJ^{0.6}$ |
| 3 | 0.496264 | 0.444154 | 7.7330 | -62.2292 | 0.135478 | -56.2432 | $QMA^{-0.7}$ LN_QJA $QSO^{-0.1}$ |
| 4 | 0.573606 | 0.512692 | 4.7073 | -65.7299 | 0.118773 | -58.2474 | $QJF^{-0.1}$ $QMA^{-0.7}$ $QMJ^{0.6}$ $QND^{0.1}$ |
| 4 | 0.568403 | 0.506747 | 5.0453 | -65.3297 | 0.120222 | -57.8472 | $QJF^{-0.1}$ $QMA^{-0.7}$ LN_QJA $QND^{0.1}$ |
| 4 | 0.565610 | 0.503554 | 5.2269 | -65.1168 | 0.121000 | -57.6343 | $QJF^{-0.1}$ $QMA^{-0.7}$ $QMJ^{0.6}$ LN_QJA |
| 4 | 0.556363 | 0.492986 | 5.8277 | -64.4217 | 0.123576 | -56.9392 | $QJF^{-0.1}$ $QMA^{-0.7}$ LN_QJA $QSO^{-0.1}$ |
| 5 | 0.586452 | 0.509870 | 5.8725 | -64.7395 | 0.119461 | -55.7604 | $QJF^{-0.1}$ $QMA^{-0.7}$ $QMJ^{-0.6}$ LN_QJA $QND^{0.1}$ |
| 5 | 0.586400 | 0.509808 | 5.8759 | -64.7353 | 0.119476 | -55.7562 | $QJF^{-0.1}$ $QMA^{-0.7}$ $QMJ^{0.6}$ $QSO^{-0.1}$ $QND^{0.1}$ |
| 5 | 0.575968 | 0.497444 | 6.5538 | -63.9132 | 0.122489 | -54.9342 | $QJF^{-0.1}$ $QMA^{-0.7}$ LN_QJA $QSO^{-0.1}$ $QND^{0.1}$ |
| 5 | 0.568556 | 0.488659 | 7.0354 | -63.3414 | 0.124630 | -54.3624 | $QJF^{-0.1}$ $QMA^{-0.7}$ $QMJ^{0.6}$ LN_QJA $QSO^{-0.1}$ |
| 6 | 0.599880 | 0.507544 | 7.0000 | -63.8287 | 0.120028 | -53.3531 | $QJF^{-0.1}$ $QMA^{-0.7}$ $QMJ^{0.6}$ LN_QJA $QSO^{-0.1}$ $QND^{0.1}$ |

### 6.1.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | -6.6228 | 365.9526 | 131.6879 | 94.5311 | 33 |
| Std. Predicted Value | -1.463 | 2.478 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | 17.5761 | 46.2466 | 31.4796 | 6.2882 | 33 |
| Adjusted Predicted Value | -27.4475 | 359.5857 | 132.1959 | 96.9588 | 33 |
| Residual | -137.5622 | 113.1798 | -5.E-14 | 62.7902 | 33 |
| Std. Residual | -1.975 | 1.625 | .000 | .901 | 33 |
| Stud. Residual | -2.183 | 1.839 | -.003 | 1.008 | 33 |
| Deleted Residual | -168.1219 | 145.0074 | -.5080 | 78.8367 | 33 |
| Stud. Deleted Residual | -2.369 | 1.933 | -.004 | 1.039 | 33 |
| Mahal. Distance | 1.068 | 13.135 | 5.818 | 2.649 | 33 |
| Cook's Distance | .000 | .151 | .037 | .046 | 33 |
| Centered Leverage Value | .033 | .410 | .182 | .083 | 33 |

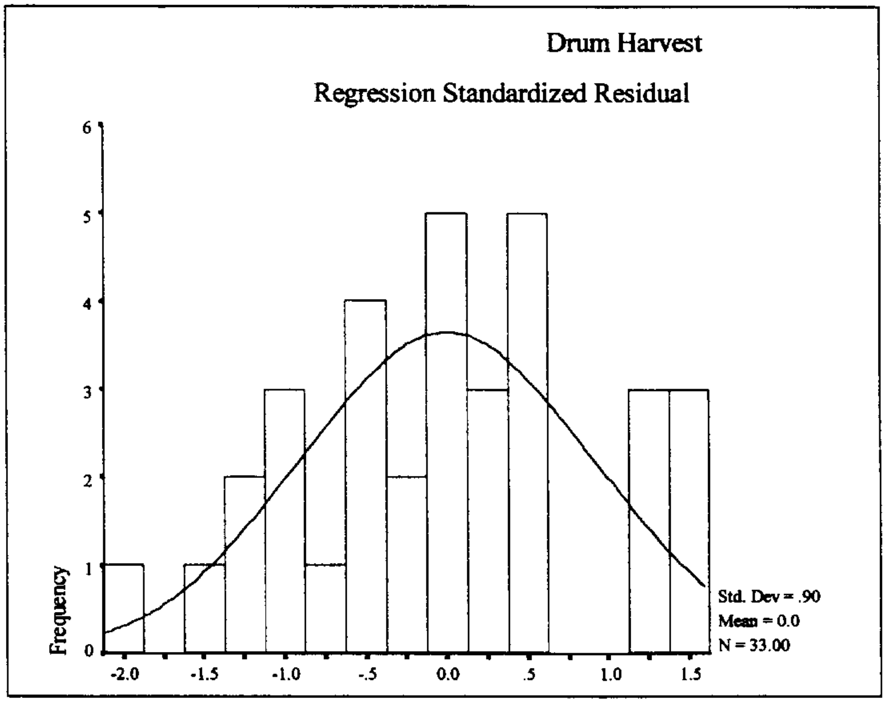
a. Dependent Variable: Drum Harvest

*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| 1961 | 73.67006 | -65.67006 | -87.69080 | 95.69080 | -.61374 | -.94273 | -1.08938 | -1.09347 |
| 1962 | 75.90806 | -62.20806 | -78.86932 | 92.56932 | -.59007 | -.89303 | -1.00553 | -1.00576 |
| 1963 | 4.64934 | 13.85066 | 22.40383 | -3.90383 | -1.34388 | .19883 | .25288 | .24828 |
| 1964 | -6.62285 | 26.42285 | 47.24755 | -27.44755 | -1.46312 | .37931 | .50722 | .49985 |
| 1965 | 28.18158 | -3.38158 | -3.97112 | 28.77112 | -1.09494 | -.04854 | -.05261 | -.05159 |
| 1966 | 69.18097 | 43.51903 | 53.74298 | 58.95702 | -.66123 | .62474 | .69426 | .68717 |
| 1967 | 71.60842 | -29.40842 | -42.16517 | 84.36517 | -.63555 | -.42217 | -.50551 | -.49815 |
| 1968 | 31.76956 | 6.43044 | 9.14664 | 29.05336 | -1.05699 | .09231 | .11010 | .10798 |
| 1969 | 53.60504 | -27.40504 | -37.04149 | 63.24149 | -.82600 | -.39341 | -.45738 | -.45032 |
| 1970 | 112.76298 | -49.66298 | -60.36926 | 123.46926 | -.20020 | -.71294 | -.78604 | -.78010 |
| 1971 | 187.56421 | -84.66421 | -105.78878 | 208.68878 | .59109 | -1.21540 | -1.35859 | -1.38217 |
| 1972 | 139.05923 | 81.14077 | 101.13430 | 119.06570 | .07798 | 1.16482 | 1.30043 | 1.31879 |
| 1973 | 87.92022 | 113.17978 | 145.00742 | 56.09258 | -.46300 | 1.62476 | 1.83907 | 1.93350 |
| 1974 | 122.16977 | 83.53023 | 89.20956 | 116.49044 | -.10069 | 1.19912 | 1.23922 | 1.25271 |
| 1975 | 121.47965 | 40.32035 | 43.73718 | 118.06282 | -.10799 | .57882 | .60285 | .59532 |
| 1976 | 178.04829 | 21.75171 | 25.88473 | 173.91527 | .49043 | .31226 | .34063 | .33477 |
| 1977 | 359.95663 | 40.84337 | 53.51727 | 347.28273 | 2.41475 | .58633 | .67116 | .66390 |
| 1978 | 365.95261 | 17.34739 | 23.71429 | 359.58571 | 2.47818 | .24903 | .29117 | .28598 |
| 1979 | 270.05340 | -71.45340 | -108.87151 | 307.47151 | 1.46370 | -1.02575 | -1.26616 | -1.28171 |
| 1980 | 159.08594 | -100.98594 | -132.31553 | 190.41553 | .28983 | -1.44971 | -1.65942 | -1.72087 |
| 1981 | 195.86218 | -137.56218 | -168.12188 | 226.42188 | .67887 | -1.97478 | -2.18314 | -2.36884 |
| 1982 | 67.19603 | 38.70397 | 49.49835 | 56.40165 | -.68223 | .55562 | .62834 | .62087 |
| 1983 | 77.13756 | -12.53756 | -14.45164 | 79.05164 | -.57706 | -.17998 | -.19323 | -.18962 |
| 1984 | 29.02252 | .27748 | .31379 | 28.98621 | -1.08605 | .00398 | .00424 | .00415 |
| 1985 | 139.04582 | -80.04582 | -89.37337 | 148.37337 | .07784 | -1.14910 | -1.21421 | -1.22589 |
| 1986 | 129.61235 | -24.11235 | -29.23892 | 134.73892 | -.02196 | -.34615 | -.38117 | -.37482 |
| 1987 | 167.73792 | -30.73792 | -35.84792 | 172.84792 | .38136 | -.44126 | -.47653 | -.46933 |
| 1988 | 95.15516 | -31.35516 | -37.42269 | 101.22269 | -.38646 | -.45012 | -.49175 | -.48446 |
| 1989 | 65.68960 | 85.91040 | 103.75109 | 47.84891 | -.69816 | 1.23329 | 1.35531 | 1.37858 |
| 1990 | 120.10435 | -7.30435 | -9.98830 | 122.78830 | -.12254 | -.10486 | -.12262 | -.12027 |
| 1991 | 203.51319 | 97.18681 | 115.53326 | 185.16674 | .75981 | 1.39517 | 1.52117 | 1.56279 |
| 1992 | 282.54196 | -.44196 | -.60563 | 282.70563 | 1.59581 | -.00634 | -.00743 | -.00728 |
| 1993 | 267.07823 | 108.52177 | 141.52737 | 234.07263 | 1.43223 | 1.55789 | 1.77909 | 1.86153 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.
[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



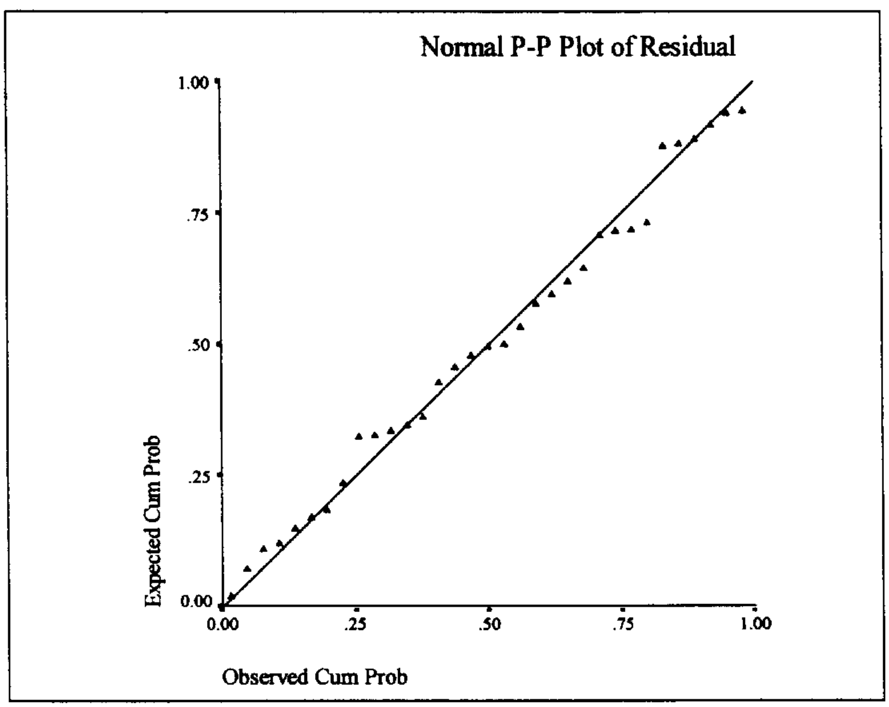




Fig. 6.1.1. Exploratory Plots of Drum Harvest Standardized Residual.

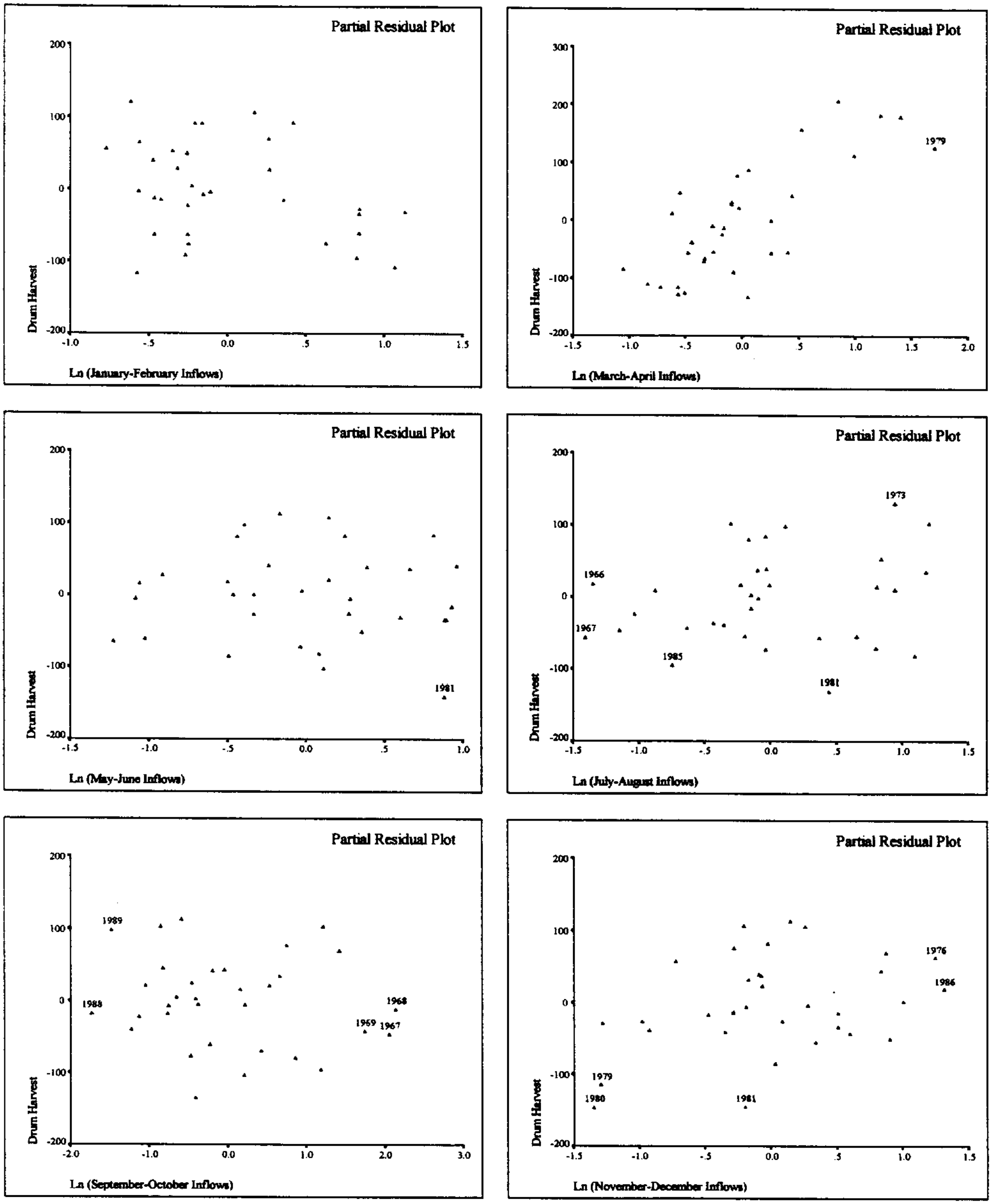



Fig. 6.1.2. Partial Residual Plots of Drum Harvest vs. Logged Inflows.

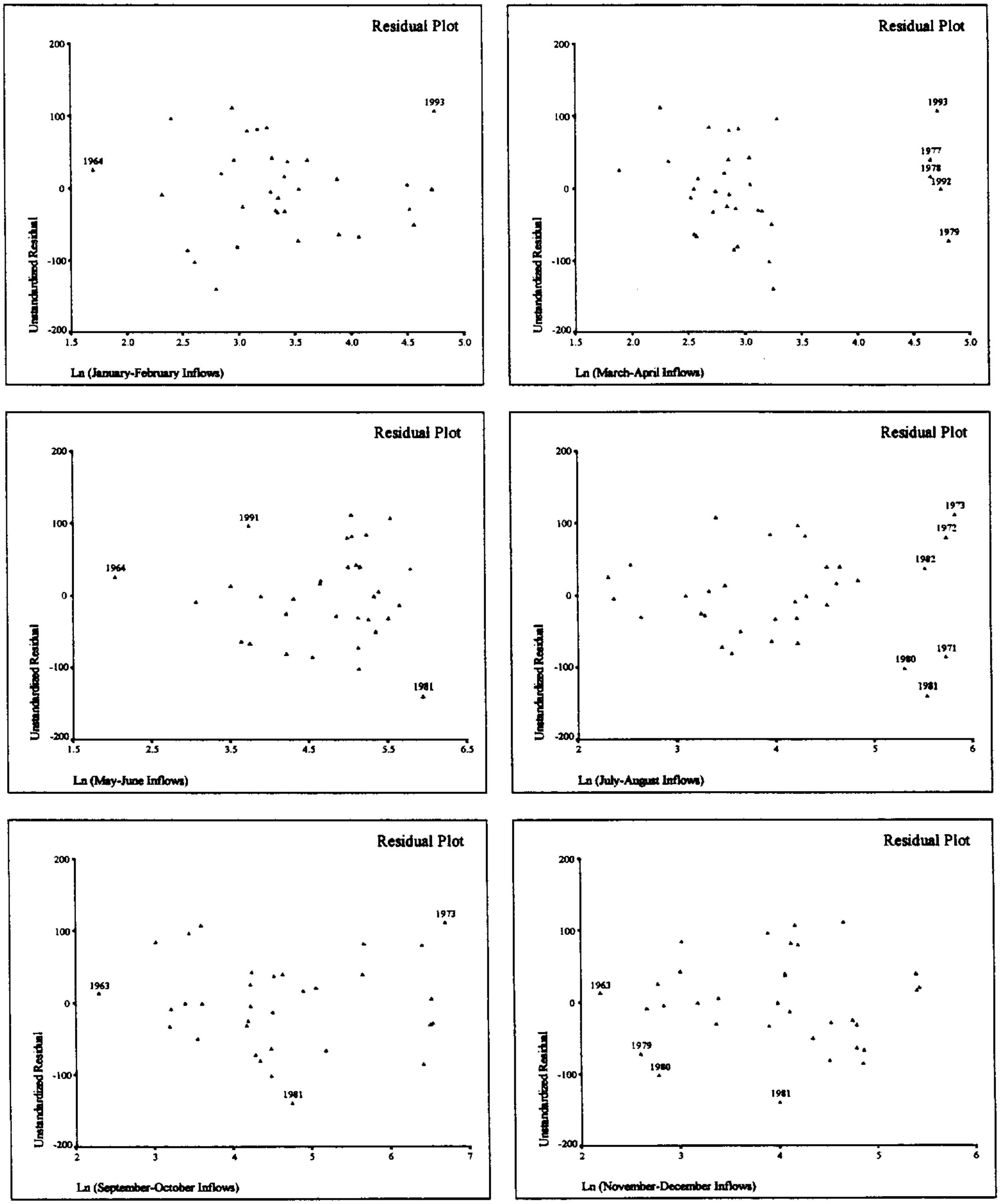



Fig. 6.1.3. Residual Plots of Drum Harvest vs. Logged Inflows.

### 6.1.4 Prediction Intervals for Drum Harvest

| YEAR | DRUM | LICI | UICI |
|---|---|---|---|
| 1961 | 8.00 | 0 | 290.17786 |
| 1962 | 13.70 | 0 | 288.93845 |
| 1963 | 18.50 | 0 | 232.18145 |
| 1964 | 19.80 | 0 | 225.71493 |
| 1965 | 24.80 | 0 | 235.61635 |
| 1966 | 112.70 | 0 | 280.35538 |
| 1967 | 42.20 | 0 | 292.52094 |
| 1968 | 38.20 | 0 | 252.20828 |
| 1969 | 26.20 | 0 | 270.89318 |
| 1970 | 63.10 | 0 | 322.79067 |
| 1971 | 102.90 | 0 | 399.57514 |
| 1972 | 220.20 | 0 | 350.89395 |
| 1973 | 201.10 | 0 | 301.67384 |
| 1974 | 205.70 | 0 | 321.80004 |
| 1975 | 161.80 | 0 | 322.46219 |
| 1976 | 199.80 | 0 | 386.49337 |
| 1977 | 400.80 | 144.68963 | 575.22364 |
| 1978 | 383.30 | 147.94742 | 583.95779 |
| 1979 | 198.60 | 45.67863 | 494.42818 |
| 1980 | 58.10 | 0 | 374.34950 |
| 1981 | 58.30 | 0 | 406.28415 |
| 1982 | 105.90 | 0 | 280.82568 |
| 1983 | 64.60 | 0 | 283.12152 |
| 1984 | 29.30 | 0 | 233.47874 |
| 1985 | 59.00 | 0 | 342.45986 |
| 1986 | 105.50 | 0 | 339.46043 |
| 1987 | 137.00 | 0 | 374.63835 |
| 1988 | 63.80 | 0 | 303.82164 |
| 1989 | 151.60 | 0 | 275.23599 |
| 1990 | 112.80 | 0 | 338.12898 |
| 1991 | 300.70 | 0 | 411.87987 |
| 1992 | 282.10 | 64.38533 | 500.69859 |
| 1993 | 375.60 | 52.12552 | 482.03094 |

**DRUM** Drum harvest
**LICI** Lower limit for 99% prediction interval for Drum harvest
**UICI** Upper limit for 99% prediction interval for Drum harvest

### 6.1.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| 1961 | 7.06608 | .05685 | .22082 | .4220 | .0003 |
| 1962 | 5.79035 | .03869 | .18095 | .5644 | .0001 |
| 1963 | 11.24703 | .00564 | .35147 | .1282 | .0000 |
| 1964 | 13.13454 | .02897 | .41045 | .0689 | .0000 |
| 1965 | 3.78089 | .00007 | .11815 | .8046 | .0000 |
| 1966 | 5.11791 | .01618 | .15993 | .6456 | .0000 |
| 1967 | 8.71166 | .01584 | .27224 | .2740 | .0000 |
| 1968 | 8.53306 | .00073 | .26666 | .2879 | .0000 |
| 1969 | 7.35519 | .01051 | .22985 | .3929 | .0000 |
| 1970 | 4.70539 | .01903 | .14704 | .6959 | .0000 |
| 1971 | 5.42027 | .06579 | .16938 | .6088 | .0006 |
| 1972 | 5.35648 | .05953 | .16739 | .6165 | .0004 |
| 1973 | 6.05397 | .13587 | .18919 | .5335 | .0055 |
| 1974 | 1.06751 | .01492 | .03336 | .9937 | .0000 |
| 1975 | 1.53020 | .00440 | .04782 | .9812 | .0000 |
| 1976 | 4.13975 | .00315 | .12937 | .7635 | .0000 |
| 1977 | 6.60851 | .01997 | .20652 | .4707 | .0000 |
| 1978 | 7.62178 | .00445 | .23818 | .3671 | .0000 |
| 1979 | 10.02840 | .11993 | .31339 | .1870 | .0038 |
| 1980 | 6.60724 | .12204 | .20648 | .4709 | .0040 |
| 1981 | 4.84698 | .15126 | .15147 | .6786 | .0076 |
| 1982 | 6.00872 | .01573 | .18777 | .5387 | .0000 |
| 1983 | 3.26862 | .00081 | .10214 | .8591 | .0000 |
| 1984 | 2.73306 | .00000 | .08541 | .9085 | .0000 |
| 1985 | 2.37002 | .02454 | .07406 | .9366 | .0000 |
| 1986 | 4.64098 | .00441 | .14503 | .7037 | .0000 |
| 1987 | 3.59180 | .00539 | .11224 | .8254 | .0000 |
| 1988 | 4.21862 | .00668 | .13183 | .7543 | .0000 |
| 1989 | 4.53292 | .05449 | .14165 | .7168 | .0003 |
| 1990 | 7.62902 | .00079 | .23841 | .3664 | .0000 |
| 1991 | 4.11184 | .06240 | .12849 | .7668 | .0005 |
| 1992 | 7.67819 | .00000 | .23994 | .3618 | .0000 |
| 1993 | 6.49302 | .13752 | .20291 | .4835 | .0057 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1961** | -.63320 | .07574 | -.43566 | .17341 | .42533 | -.19991 | -.09568 | -.10820 |
| **1962** | -.52050 | -.03718 | -.30203 | .17246 | .31798 | -.10130 | .04490 | -.17007 |
| **1963** | .19510 | .05771 | .11592 | -.03799 | -.09204 | .09043 | -.05790 | -.10171 |
| **1964** | .44375 | .37227 | -.16662 | -.00504 | -.16722 | -.14110 | .06225 | -.01127 |
| **1965** | -.02154 | -.01290 | .00405 | .00259 | -.00435 | .01392 | -.00217 | .00400 |
| **1966** | .33307 | .13661 | -.13793 | -.01923 | .20219 | -.24817 | -.00611 | -.01737 |
| **1967** | -.32809 | -.01604 | .08906 | -.04136 | -.09920 | .20284 | -.21559 | .05207 |
| **1968** | .07018 | -.02539 | .03524 | -.00561 | -.00089 | -.00459 | .04825 | -.03159 |
| **1969** | -.26703 | .08779 | -.14241 | .04719 | .04763 | .05460 | -.16047 | -.01103 |
| **1970** | -.36220 | .05043 | -.17539 | .13155 | -.08475 | .04069 | .18487 | -.11008 |
| **1971** | -.69041 | .14748 | .12117 | -.10687 | .20861 | -.29923 | -.32308 | -.01206 |
| **1972** | .65464 | -.26657 | .12730 | .02226 | -.17612 | .43061 | .36697 | -.26631 |
| **1973** | **1.02533** | -.31215 | .12204 | -.32734 | -.09968 | .50099 | .46873 | -.11237 |
| **1974** | .32665 | -.03754 | -.08529 | -.01431 | .08924 | -.05122 | .17183 | -.00879 |
| **1975** | .17330 | -.00919 | -.06973 | -.01499 | .06638 | -.01464 | .07216 | -.01151 |
| **1976** | .14592 | .01233 | -.05575 | -.02560 | .01520 | -.01977 | -.02943 | .11447 |
| **1977** | .36983 | -.12598 | -.06239 | .25237 | -.04859 | -.00504 | -.02637 | .16687 |
| **1978** | .17325 | -.04825 | -.03420 | .12690 | -.04581 | -.00047 | .00924 | .07013 |
| **1979** | -.92751 | .10567 | .12680 | -.73290 | .01363 | .01320 | -.24093 | .51224 |
| **1980** | -.95851 | .00877 | .17051 | -.21619 | -.06150 | -.52316 | -.07192 | .66508 |
| **1981** | **-1.11651** | .18723 | .48487 | -.03539 | -.63456 | -.28160 | .18692 | .12845 |
| **1982** | .32788 | -.05524 | .06083 | -.19976 | .12861 | .14303 | -.10130 | -.03012 |
| **1983** | -.07409 | -.00280 | .01014 | .04588 | -.05232 | .00709 | .02675 | -.01429 |
| **1984** | .00150 | .00090 | .00052 | -.00057 | -.00040 | -.00010 | -.00050 | -.00021 |
| **1985** | -.41847 | -.21101 | .19319 | .02681 | -.02910 | .23423 | .10646 | -.29392 |
| **1986** | -.17283 | -.08330 | .07549 | .02799 | -.03118 | .11462 | .05505 | -.13626 |
| **1987** | -.19136 | -.00930 | .06951 | .04676 | -.12508 | .07702 | .09997 | -.12820 |
| **1988** | -.21311 | -.06955 | .04242 | .10313 | -.12873 | .04522 | .16101 | -.06756 |
| **1989** | .62822 | .23207 | -.07819 | -.25493 | .34010 | -.01232 | -.39284 | -.10657 |
| **1990** | -.07291 | -.03859 | .00503 | -.01693 | .04193 | -.03218 | .00926 | .03260 |
| **1991** | .67900 | .36754 | -.33724 | .24325 | -.18460 | .04807 | -.25481 | .11233 |
| **1992** | -.00443 | .00217 | -.00232 | -.00229 | .00109 | -.00167 | .00061 | .00102 |
| **1993** | **1.02661** | -.36870 | .28999 | .49000 | .08735 | -.15138 | -.21976 | .07775 |

**SDFFITS** Standardized dffits value
**SDFB_0** Standardized dfbeta for the intercept term
**SDFB_1** Standardized dfbeta for the Logged January-February inflows
**SDFB_2** Standardized dfbeta for the Logged March-April inflows
**SDFB_3** Standardized dfbeta for the Logged May-June inflows
**SDFB_4** Standardized dfbeta for the Logged July-August inflows
**SDFB_5** Standardized dfbeta for the Logged September-October inflows
**SDFB_6** Standardized dfbeta for the Logged November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

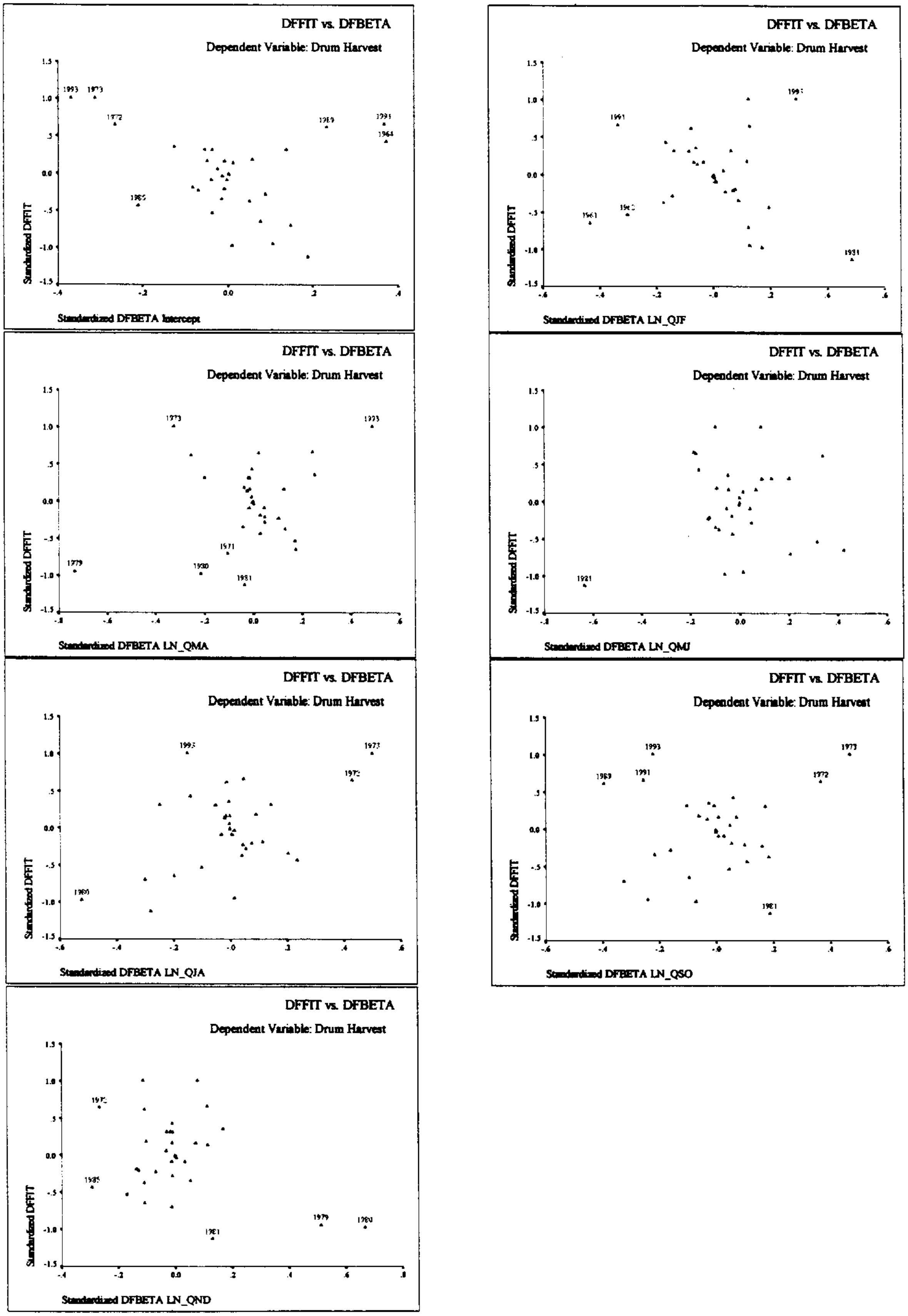



Fig. 6.1.4. Standardized DFFIT vs. Standardized DFBETA.

## 6.2 Model 4: Harvest Untransformed and Square Root Inflows

### 6.2.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | SQRT(Nov-Dec Inflows), SQRT(May-Jun Inflows), SQRT(Sept-Oct Inflows), SQRT(Jan-Feb Inflows), SQRT(Mar-Apr Inflows), SQRT(Jul-Aug Inflows)[c,d] | . | .837 | .700 | .631 | 68.9724 | 1.236 |

a. Dependent Variable: Drum Harvest

b. Method: Enter

c. Independent Variables: (Constant), SQRT (November-December Inflows), SQRT (May-June Inflows), SQRT (September-October Inflows), SQRT (January-February Inflows), SQRT (March-April Inflows), SQRT (July-August Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 288433 | 6 | 48072.1 | 10.105 | .000[b] |
| | Residual | 123687 | 26 | 4757.185 | | |
| | Total | 412120 | 32 | | | |

a. Dependent Variable: Drum Harvest

b. Independent Variables: (Constant), SQRT (November-December Inflows), SQRT (May-June Inflows), SQRT (September-October Inflows), SQRT (January-February Inflows), SQRT (March-April Inflows), SQRT (July-August Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. | 95% Confidence Interval for B Lower Bound | 95% Confidence Interval for B Upper Bound |
|---|---|---|---|---|---|---|---|---|
| 1 | (Constant) | -84.990 | 54.079 | | -1.572 | .128 | -196.151 | 26.171 |
| | SQRT (January-February Inflows) | -11.088 | 7.320 | -.211 | -1.515 | .142 | -26.135 | 3.959 |
| | SQRT (March-April Inflows) | 36.955 | 5.963 | .789 | 6.198 | .000 | 24.699 | 49.212 |
| | SQRT (May-June Inflows) | -6.1E-02 | 3.720 | -.002 | -.016 | .987 | -7.708 | 7.586 |
| | SQRT (July-August Inflows) | 4.191 | 3.880 | .161 | 1.080 | .290 | -3.784 | 12.167 |
| | SQRT (September-October Inflows) | -.321 | 1.857 | -.021 | -.173 | .864 | -4.138 | 3.496 |
| | SQRT (November-December Inflows) | 9.699 | 5.353 | .224 | 1.812 | .082 | -1.303 | 20.702 |

a. Dependent Variable: Drum Harvest

### 6.2.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | -84.989815 | 54.07904011 | -1.572 | 0.1281 | 0.00000000 |
| SQRT_QJF | 1 | -11.088182 | 7.32016201 | -1.515 | 0.1419 | 1.67357574 |
| SQRT_QMA | 1 | 36.955374 | 5.96254846 | 6.198 | 0.0001 | 1.40228493 |
| SQRT_QMJ | 1 | -0.061185 | 3.72035836 | -0.016 | 0.9870 | 1.51323832 |
| SQRT_QJA | 1 | 4.191421 | 3.87993379 | 1.080 | 0.2899 | 1.93361759 |
| SQRT_QSO | 1 | -0.320631 | 1.85696106 | -0.173 | 0.8643 | 1.29696335 |
| SQRT_QND | 1 | 9.699458 | 5.35270164 | 1.812 | 0.0815 | 1.32391707 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop SQRT_QJF | Var Prop SQRT_QMA | Var Prop SQRT_QMJ | Var Prop SQRT_QJA | Var Prop SQRT_QSO | Var Prop SQRT_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.79091 | 1.00000 | 0.0011 | 0.0074 | 0.0709 | 0.0988 | 0.0952 | 0.0939 |
| 2 | 1.68424 | 1.03118 | 0.1422 | 0.1544 | 0.0376 | 0.0262 | 0.0234 | 0.0011 |
| 3 | 0.93972 | 1.38051 | 0.0061 | 0.0541 | 0.2571 | 0.0019 | 0.0199 | 0.4226 |
| 4 | 0.84548 | 1.45541 | 0.1636 | 0.0770 | 0.0554 | 0.0871 | 0.4189 | 0.0043 |
| 5 | 0.45935 | 1.97453 | 0.1090 | 0.7016 | 0.1106 | 0.0020 | 0.3582 | 0.2832 |
| 6 | 0.28030 | 2.52769 | 0.5781 | 0.0055 | 0.4684 | 0.7840 | 0.0843 | 0.1951 |

### 6.2.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 17.7651 | 382.6385 | 131.6879 | 94.9396 | 33 |
| Std. Predicted Value | -1.200 | 2.643 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | 17.8861 | 42.6051 | 31.0766 | 6.6858 | 33 |
| Adjusted Predicted Value | 17.4995 | 382.3400 | 133.9176 | 98.1013 | 33 |
| Residual | -117.3248 | 145.7502 | 8.2E-14 | 62.1708 | 33 |
| Std. Residual | -1.701 | 2.113 | .000 | .901 | 33 |
| Stud. Residual | -2.019 | 2.259 | -.014 | 1.018 | 33 |
| Deleted Residual | -177.0894 | 166.5679 | -2.2297 | 79.8398 | 33 |
| Stud. Deleted Residual | -2.156 | 2.471 | -.012 | 1.059 | 33 |
| Mahal. Distance | 1.182 | 11.240 | 5.818 | 2.729 | 33 |
| Cook's Distance | .000 | .359 | .042 | .075 | 33 |
| Centered Leverage Value | .037 | .351 | .182 | .085 | 33 |

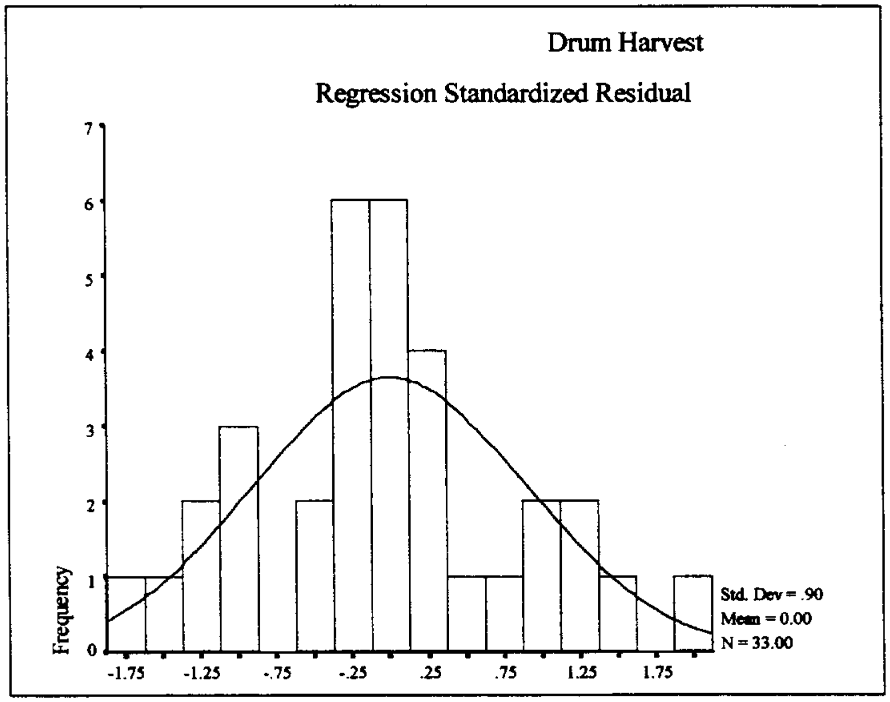
a. Dependent Variable: Drum Harvest

*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| 1961 | 80.09305 | -72.09305 | -91.34864 | 99.34864 | -.54345 | -1.04525 | -1.17658 | -1.18573 |
| 1962 | 79.18521 | -65.48521 | -80.38446 | 94.08446 | -.55301 | -.94944 | -1.05192 | -1.05417 |
| 1963 | 17.76513 | .73487 | 1.00054 | 17.49946 | -1.19995 | .01065 | .01243 | .01219 |
| 1964 | 25.04572 | -5.24572 | -7.07095 | 26.87095 | -1.12326 | -.07606 | -.08830 | -.08660 |
| 1965 | 44.93195 | -20.13195 | -22.51171 | 47.31171 | -.91380 | -.29188 | -.30865 | -.30322 |
| 1966 | 71.78543 | 40.91457 | 47.30678 | 65.39322 | -.63095 | .59320 | .63786 | .63043 |
| 1967 | 78.74285 | -36.54285 | -56.62971 | 98.82971 | -.55767 | -.52982 | -.65955 | -.65222 |
| 1968 | 33.39923 | 4.80077 | 6.99823 | 31.20177 | -1.03528 | .06960 | .08404 | .08242 |
| 1969 | 52.86530 | -26.66530 | -38.28927 | 64.48927 | -.83024 | -.38661 | -.46327 | -.45616 |
| 1970 | 82.40047 | -19.30047 | -24.71301 | 87.81301 | -.51914 | -.27983 | -.31664 | -.31110 |
| 1971 | 184.21251 | -81.31251 | -107.67554 | 210.57554 | .55324 | -1.17891 | -1.35663 | -1.38003 |
| 1972 | 144.69543 | 75.50457 | 99.30501 | 120.89499 | .13701 | 1.09471 | 1.25544 | 1.27016 |
| 1973 | 125.61368 | 75.48632 | 103.97568 | 97.12432 | -.06398 | 1.09444 | 1.28447 | 1.30150 |
| 1974 | 111.63370 | 94.06630 | 100.84821 | 104.85179 | -.21123 | 1.36383 | 1.41213 | 1.44108 |
| 1975 | 112.07082 | 49.72918 | 53.86605 | 107.93395 | -.20663 | .72100 | .75039 | .74392 |
| 1976 | 176.48253 | 23.31747 | 29.98978 | 169.81022 | .47182 | .33807 | .38340 | .37702 |
| 1977 | 376.96702 | 23.83298 | 33.11314 | 367.68686 | 2.58353 | .34554 | .40730 | .40067 |
| 1978 | 382.63847 | .66153 | .95999 | 382.34001 | 2.64327 | .00959 | .01155 | .01133 |
| 1979 | 308.11768 | -109.51768 | -177.08944 | 375.68944 | 1.85834 | -1.58785 | -2.01913 | -2.15617 |
| 1980 | 144.81985 | -86.71985 | -107.81384 | 165.91384 | .13832 | -1.25731 | -1.40191 | -1.42979 |
| 1981 | 175.62476 | -117.32476 | -155.71155 | 214.01155 | .46279 | -1.70104 | -1.95966 | -2.08146 |
| 1982 | 90.82417 | 15.07583 | 20.20860 | 85.69140 | -.43042 | .21858 | .25307 | .24846 |
| 1983 | 81.39154 | -16.79154 | -19.78159 | 84.38159 | -.52977 | -.24345 | -.26424 | -.25946 |
| 1984 | 36.88435 | -7.58435 | -8.56717 | 37.86717 | -.99857 | -.10996 | -.11687 | -.11463 |
| 1985 | 119.61620 | -60.61620 | -66.92425 | 125.92425 | -.12715 | -.87885 | -.92345 | -.92074 |
| 1986 | 116.96542 | -11.46542 | -13.39477 | 118.89477 | -.15507 | -.16623 | -.17968 | -.17630 |
| 1987 | 146.54015 | -9.54015 | -11.50704 | 148.50704 | .15644 | -.13832 | -.15191 | -.14903 |
| 1988 | 81.60165 | -17.80165 | -20.01138 | 83.81138 | -.52756 | -.25810 | -.27365 | -.26872 |
| 1989 | 61.91711 | 89.68289 | 101.85051 | 49.74949 | -.73490 | 1.30027 | 1.38567 | 1.41190 |
| 1990 | 95.44809 | 17.35191 | 22.04477 | 90.75523 | -.38171 | .25158 | .28356 | .27849 |
| 1991 | 154.94979 | 145.75021 | 166.56792 | 134.13208 | .24502 | 2.11317 | 2.25905 | 2.47091 |
| 1992 | 282.38805 | -.28805 | -.43418 | 282.53418 | 1.58733 | -.00418 | -.00513 | -.00503 |
| 1993 | 268.08265 | 107.51735 | 148.24209 | 227.35791 | 1.43665 | 1.55885 | 1.83042 | 1.92305 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.
[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



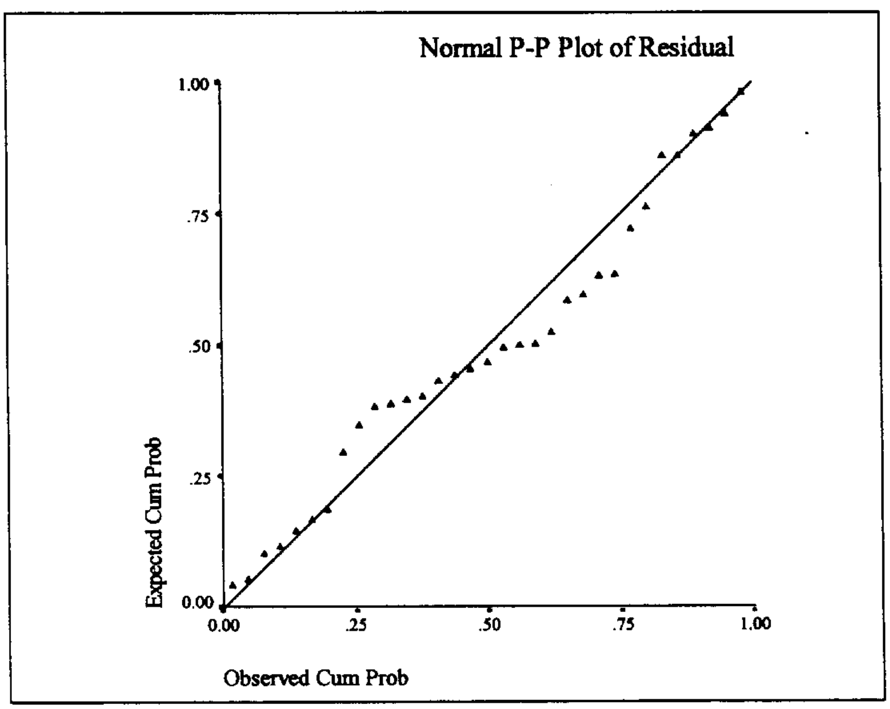




Fig. 6.2.1. Exploratory Plots of Drum Harvest Standardized Residual.

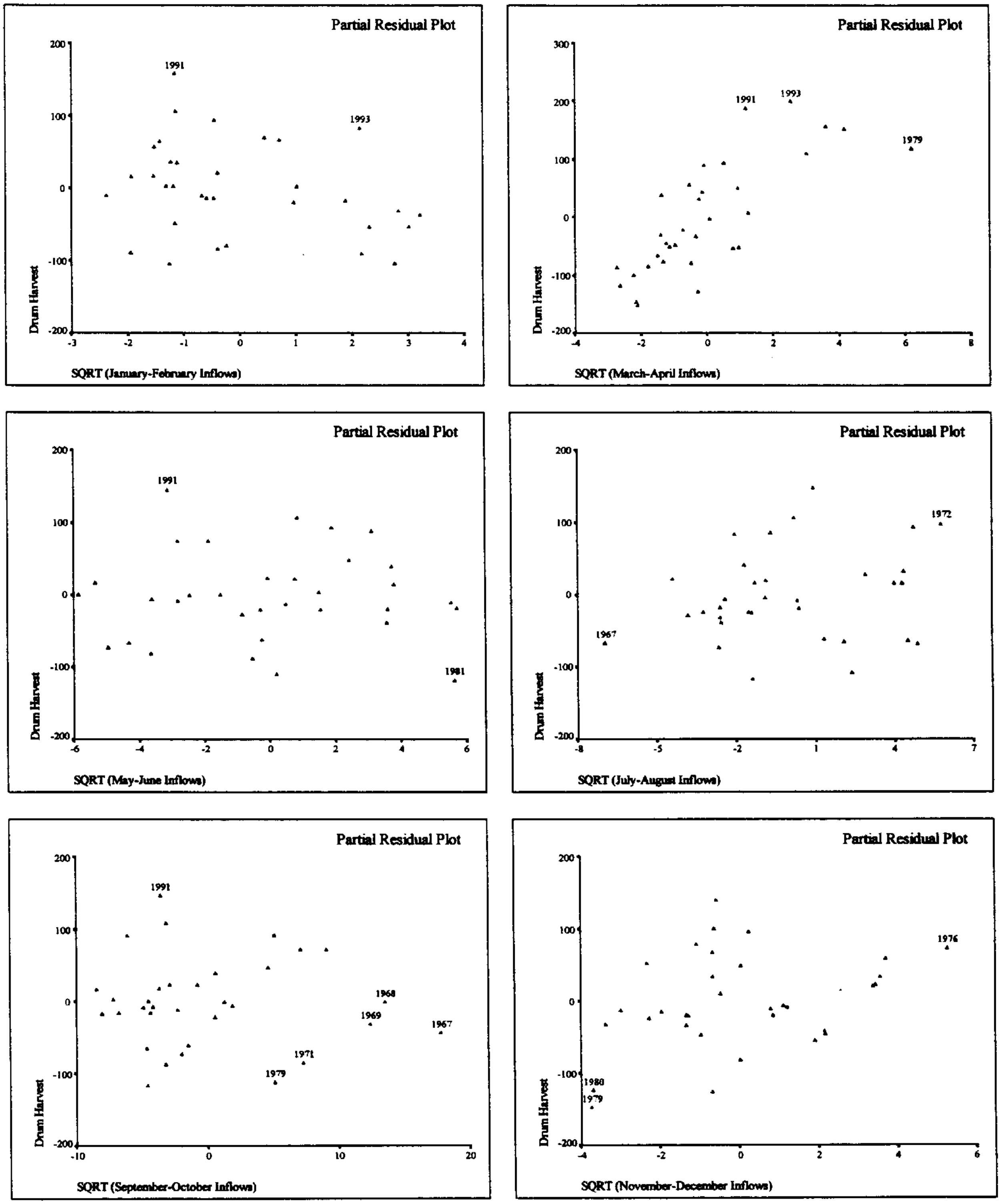



Fig. 6.2.2. Partial Residual Plots of Drum Harvest vs. Square Root Inflows.

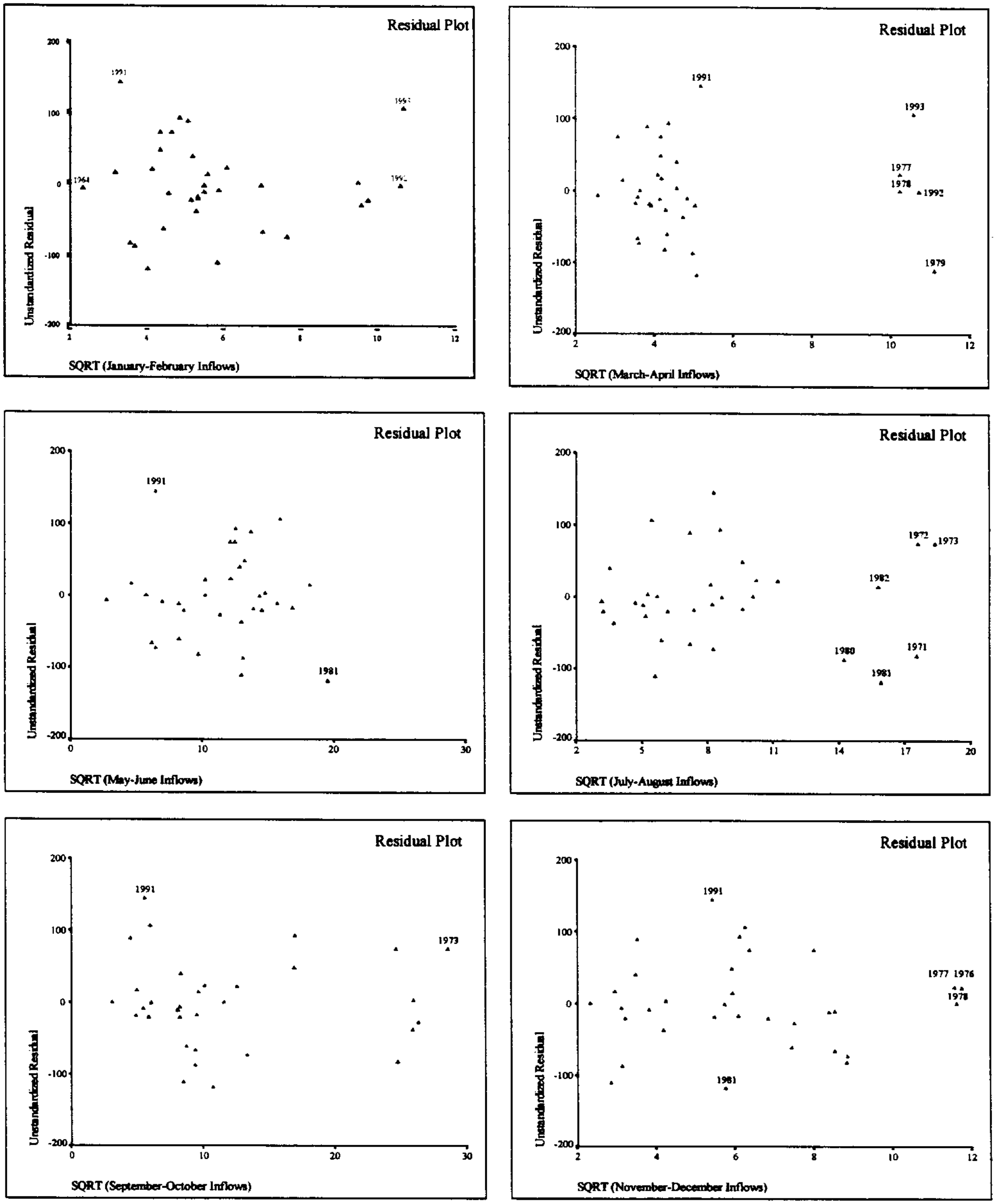



Fig. 6.2.3. Residual Plots of Drum Harvest vs. Square Root Inflows.

### 6.2.4 Prediction Intervals for Drum Harvest

| YEAR | DRUM | LICI | UICI |
|---|---|---|---|
| 1961 | 8.00 | 0 | 290.98198 |
| 1962 | 13.70 | 0 | 287.84667 |
| 1963 | 18.50 | 0 | 233.36817 |
| 1964 | 19.80 | 0 | 240.01777 |
| 1965 | 24.80 | 0 | 246.46210 |
| 1966 | 112.70 | 0 | 275.97820 |
| 1967 | 42.20 | 0 | 301.81296 |
| 1968 | 38.20 | 0 | 253.09269 |
| 1969 | 26.20 | 0 | 271.68594 |
| 1970 | 63.10 | 0 | 294.00435 |
| 1971 | 102.90 | 0 | 398.04581 |
| 1972 | 220.20 | 0 | 358.08443 |
| 1973 | 201.10 | 0 | 341.93719 |
| 1974 | 205.70 | 0 | 309.62758 |
| 1975 | 161.80 | 0 | 310.94865 |
| 1976 | 199.80 | 0 | 388.38741 |
| 1977 | 400.80 | 160.11303 | 593.82101 |
| 1978 | 383.30 | 163.20424 | 602.07271 |
| 1979 | 198.60 | 82.84674 | 533.38863 |
| 1980 | 58.10 | 0 | 354.38610 |
| 1981 | 58.30 | 0 | 389.60292 |
| 1982 | 105.90 | 0 | 305.44206 |
| 1983 | 64.60 | 0 | 287.02107 |
| 1984 | 29.30 | 0 | 239.23364 |
| 1985 | 59.00 | 0 | 320.09966 |
| 1986 | 105.50 | 0 | 321.95844 |
| 1987 | 137.00 | 0 | 353.92846 |
| 1988 | 63.80 | 0 | 283.56069 |
| 1989 | 151.60 | 0 | 264.69674 |
| 1990 | 112.80 | 0 | 306.51861 |
| 1991 | 300.70 | 0 | 358.22827 |
| 1992 | 282.10 | 60.81707 | 503.95903 |
| 1993 | 375.60 | 51.69823 | 484.46706 |

**DRUM** Drum harvest
**LICI** Lower limit for 99% prediction interval for Drum harvest
**UICI** Upper limit for 99% prediction interval for Drum harvest

### 6.2.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| 1961 | 5.77566 | .05282 | .18049 | .5662 | .0003 |
| 1962 | 4.96150 | .03597 | .15505 | .6647 | .0001 |
| 1963 | 7.52721 | .00001 | .23523 | .3761 | .0000 |
| 1964 | 7.29051 | .00039 | .22783 | .3993 | .0000 |
| 1965 | 2.41310 | .00161 | .07541 | .9335 | .0000 |
| 1966 | 3.35423 | .00908 | .10482 | .8504 | .0000 |
| 1967 | 10.38087 | .03416 | .32440 | .1680 | .0001 |
| 1968 | 9.07840 | .00046 | .28370 | .2471 | .0000 |
| 1969 | 8.74495 | .01337 | .27328 | .2715 | .0000 |
| 1970 | 6.03881 | .00402 | .18871 | .5352 | .0000 |
| 1971 | 6.86511 | .08524 | .21453 | .4431 | .0013 |
| 1972 | 6.69975 | .07098 | .20937 | .4608 | .0007 |
| 1973 | 7.79831 | .08895 | .24370 | .3507 | .0015 |
| 1974 | 1.18226 | .02054 | .03695 | .9913 | .0000 |
| 1975 | 1.48788 | .00669 | .04650 | .9827 | .0000 |
| 1976 | 6.14986 | .00601 | .19218 | .5224 | .0000 |
| 1977 | 7.99850 | .00923 | .24995 | .3327 | .0000 |
| 1978 | 8.97923 | .00001 | .28060 | .2542 | .0000 |
| 1979 | 11.24050 | .35934 | .35127 | .1285 | .0825 |
| 1980 | 5.29116 | .06829 | .16535 | .6245 | .0006 |
| 1981 | 6.91910 | .17950 | .21622 | .4374 | .0127 |
| 1982 | 7.15797 | .00311 | .22369 | .4126 | .0000 |
| 1983 | 3.86720 | .00178 | .12085 | .7949 | .0000 |
| 1984 | 2.70132 | .00025 | .08442 | .9112 | .0000 |
| 1985 | 2.04651 | .01268 | .06395 | .9572 | .0000 |
| 1986 | 3.63950 | .00078 | .11373 | .8202 | .0000 |
| 1987 | 4.50003 | .00068 | .14063 | .7207 | .0000 |
| 1988 | 2.56386 | .00133 | .08012 | .9222 | .0000 |
| 1989 | 2.85320 | .03722 | .08916 | .8982 | .0001 |
| 1990 | 5.84241 | .00311 | .18258 | .5583 | .0000 |
| 1991 | 3.02967 | .10413 | .09468 | .8822 | .0024 |
| 1992 | 9.80016 | .00000 | .30626 | .2002 | .0000 |
| 1993 | 7.82127 | .18129 | .24441 | .3486 | .0131 |

| | |
|---|---|
| **MAH** | Mahalonobis distance |
| **COO** | Cook's distance |
| **LEV** | Leverage value |
| **MAHA_PV** | P-value associated with the Mahalanobis distance |
| **COOK_PV** | P-value associated with Cook's distance |

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1961** | -.61280 | .02432 | -.39201 | .24303 | .35593 | -.15539 | .06971 | -.19832 |
| **1962** | -.50283 | -.05780 | -.26941 | .21643 | .27163 | -.08621 | .14572 | -.19667 |
| **1963** | .00733 | .00302 | .00427 | -.00150 | -.00448 | .00320 | -.00275 | -.00372 |
| **1964** | -.05108 | -.04823 | .02067 | -.00074 | .01957 | .01465 | -.00519 | .01027 |
| **1965** | -.10425 | -.08434 | .02006 | .00889 | .00511 | .04672 | -.00472 | .03313 |
| **1966** | .24918 | .13143 | -.10916 | -.01340 | .13539 | -.16664 | .01131 | -.03449 |
| **1967** | -.48356 | -.09334 | .20418 | -.08760 | -.15560 | .31765 | -.38934 | .06097 |
| **1968** | .05576 | -.01178 | .01993 | -.00609 | .00805 | -.01347 | .03623 | -.01503 |
| **1969** | -.30118 | .07527 | -.13401 | .06253 | .02532 | .07878 | -.18216 | -.03613 |
| **1970** | -.16474 | .04641 | -.11270 | .07981 | -.02962 | -.00750 | .07631 | -.03347 |
| **1971** | -.78579 | .10043 | .04059 | -.10681 | .31046 | -.40195 | -.31167 | -.00325 |
| **1972** | .71313 | -.13855 | .11106 | .06464 | -.22184 | .47299 | .27935 | -.26111 |
| **1973** | .79956 | -.19358 | .07275 | -.06811 | -.15370 | .40452 | .37513 | -.07850 |
| **1974** | .38694 | .08813 | -.18122 | -.00996 | .15281 | -.17204 | .20625 | .02903 |
| **1975** | .21456 | .04947 | -.11659 | -.00822 | .10082 | -.07283 | .09682 | .00274 |
| **1976** | .20168 | -.00335 | -.05054 | -.05177 | .01806 | -.03130 | -.03345 | .17484 |
| **1977** | .25002 | -.08018 | -.06149 | .14739 | -.00188 | -.02296 | -.00982 | .13557 |
| **1978** | .00761 | -.00169 | -.00223 | .00490 | -.00111 | -.00069 | .00047 | .00377 |
| **1979** | **-1.69365** | -.16053 | .56513 | **-1.46821** | -.02774 | .21157 | -.37651 | .79392 |
| **1980** | -.70517 | -.13961 | .06695 | -.13284 | .04532 | -.43599 | .13646 | .45699 |
| **1981** | **-1.19059** | .20236 | .32055 | .05589 | -.72773 | -.32081 | .29539 | .12723 |
| **1982** | .14497 | -.03212 | .03128 | -.06761 | .05876 | .07036 | -.06560 | -.01030 |
| **1983** | -.10949 | -.00176 | .01999 | .05398 | -.08651 | .02408 | .03268 | -.02444 |
| **1984** | -.04126 | -.02800 | -.01243 | .01188 | .01855 | -.00210 | .01362 | .01201 |
| **1985** | -.29702 | -.16811 | .11856 | .03864 | .01306 | .14381 | .03906 | -.16091 |
| **1986** | -.07232 | -.03229 | .02638 | .01588 | -.00497 | .04084 | .01162 | -.05005 |
| **1987** | -.06767 | .00364 | .02064 | .02117 | -.04869 | .02984 | .02150 | -.04366 |
| **1988** | -.09468 | -.02774 | .01416 | .04399 | -.05520 | .02274 | .05203 | -.01754 |
| **1989** | .52006 | .22729 | -.07250 | -.17676 | .25120 | -.05744 | -.24706 | -.12318 |
| **1990** | .14483 | .10463 | -.01285 | .02544 | -.09036 | .05098 | -.03098 | -.07264 |
| **1991** | .93383 | .64186 | -.32530 | .26841 | -.44480 | .13907 | -.25201 | -.11512 |
| **1992** | -.00358 | .00161 | -.00210 | -.00161 | .00082 | -.00149 | .00075 | .00109 |
| **1993** | **1.18353** | -.54192 | .51126 | .49272 | .10475 | .02482 | -.18798 | -.10845 |

**SDFFITS** Standardized dffits value
**SDFB_0** Standardized dfbeta for the intercept term
**SDFB_1** Standardized dfbeta for the Square Root January-February inflows
**SDFB_2** Standardized dfbeta for the Square Root March-April inflows
**SDFB_3** Standardized dfbeta for the Square Root May-June inflows
**SDFB_4** Standardized dfbeta for the Square Root July-August inflows
**SDFB_5** Standardized dfbeta for the Square Root September-October inflows
**SDFB_6** Standardized dfbeta for the Square Root November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

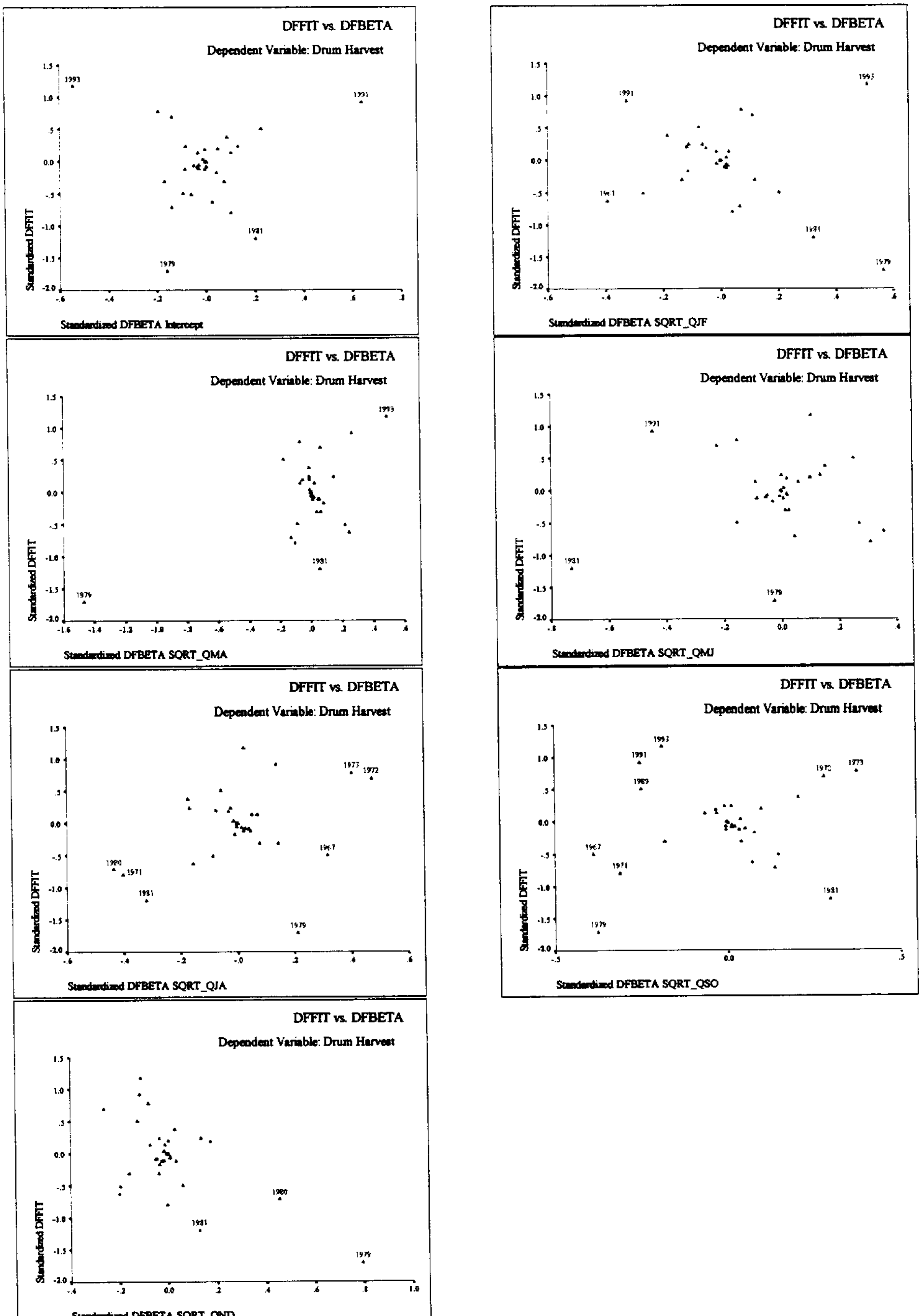



Fig. 6.2.4. Standardized DFFIT vs. Standardized DFBETA.

## 6.3 Model 7: Harvest Untransformed and Logged and Square Root Inflows

### 6.3.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | Ln(Nov-Dec Inflows), SQRT(May-Jun Inflows), SQRT(Mar-Apr Inflows), Ln(Jan-Feb Inflows), Ln(Sept-Oct Inflows), Ln(Jul-Aug Inflows)[c,d] | . | .847 | .717 | .652 | 66.9189 | 1.334 |

a. Dependent Variable: Drum Harvest

b. Method: Enter

c. Independent Variables: (Constant), Ln (November-December Inflows), SQRT (May-June Inflows), SQRT (March-April Inflows), Ln (January-February Inflows), Ln (September-October Inflows), Ln (July-August Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 295688 | 6 | 49281.4 | 11.005 | .000[b] |
| | Residual | 116432 | 26 | 4478.135 | | |
| | Total | 412120 | 32 | | | |

a. Dependent Variable: Drum Harvest

b. Independent Variables: (Constant), Ln (November-December Inflows), SQRT (May-June Inflows), SQRT (March-April Inflows), Ln (January-February Inflows), Ln (September-October Inflows), Ln (July-August Inflows)

**Coefficients**[a]

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| 1 | (Constant) | -80.700 | 91.854 | | -.879 | .388 | -269.507 | 108.108 |
| | Ln (January-February Inflows) | -40.238 | 21.121 | -.253 | -1.905 | .068 | -83.653 | 3.177 |
| | SQRT (March-April Inflows) | 36.880 | 5.535 | .787 | 6.663 | .000 | 25.502 | 48.257 |
| | SQRT (May-June Inflows) | .137 | 3.658 | .005 | .038 | .970 | -7.381 | 7.656 |
| | Ln (July-August Inflows) | 18.215 | 16.138 | .158 | 1.129 | .269 | -14.956 | 51.387 |
| | Ln (September-October Inflows) | -7.045 | 11.604 | -.072 | -.607 | .549 | -30.898 | 16.808 |
| | Ln (November-December Inflows) | 33.596 | 16.935 | .262 | 1.984 | .058 | -1.215 | 68.406 |

a. Dependent Variable: Drum Harvest

### 6.3.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | -80.699551 | 91.85356143 | -0.879 | 0.3877 | 0.00000000 |
| LN_QJF | 1 | -40.237967 | 21.12114359 | -1.905 | 0.0679 | 1.62367674 |
| SQRT_QMA | 1 | 36.879825 | 5.53506405 | 6.663 | 0.0001 | 1.28372076 |
| SQRT_QMJ | 1 | 0.137446 | 3.65750768 | 0.038 | 0.9703 | 1.55367834 |
| LN_QJA | 1 | 18.215305 | 16.13773409 | 1.129 | 0.2693 | 1.80645827 |
| LN_QSO | 1 | -7.044804 | 11.60427100 | -0.607 | 0.5491 | 1.30739894 |
| LN_QND | 1 | 33.595718 | 16.93515811 | 1.984 | 0.0579 | 1.60968650 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop SQRT_QMA | Var Prop SQRT_QMJ | Var Prop LN_QJA | Var Prop LN_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.99643 | 1.00000 | 0.0165 | 0.0237 | 0.0715 | 0.0637 | 0.0618 | 0.0849 |
| 2 | 1.59112 | 1.12015 | 0.1442 | 0.1479 | 0.0217 | 0.0437 | 0.0609 | 0.0076 |
| 3 | 0.84024 | 1.54144 | 0.0997 | 0.0121 | 0.1738 | 0.1565 | 0.2037 | 0.1203 |
| 4 | 0.78120 | 1.59863 | 0.0459 | 0.2435 | 0.2346 | 0.0339 | 0.1526 | 0.1664 |
| 5 | 0.51713 | 1.96485 | 0.1808 | 0.5718 | 0.0021 | 0.0270 | 0.4583 | 0.1583 |
| 6 | 0.27388 | 2.69990 | 0.5130 | 0.0010 | 0.4962 | 0.6752 | 0.0627 | 0.4624 |

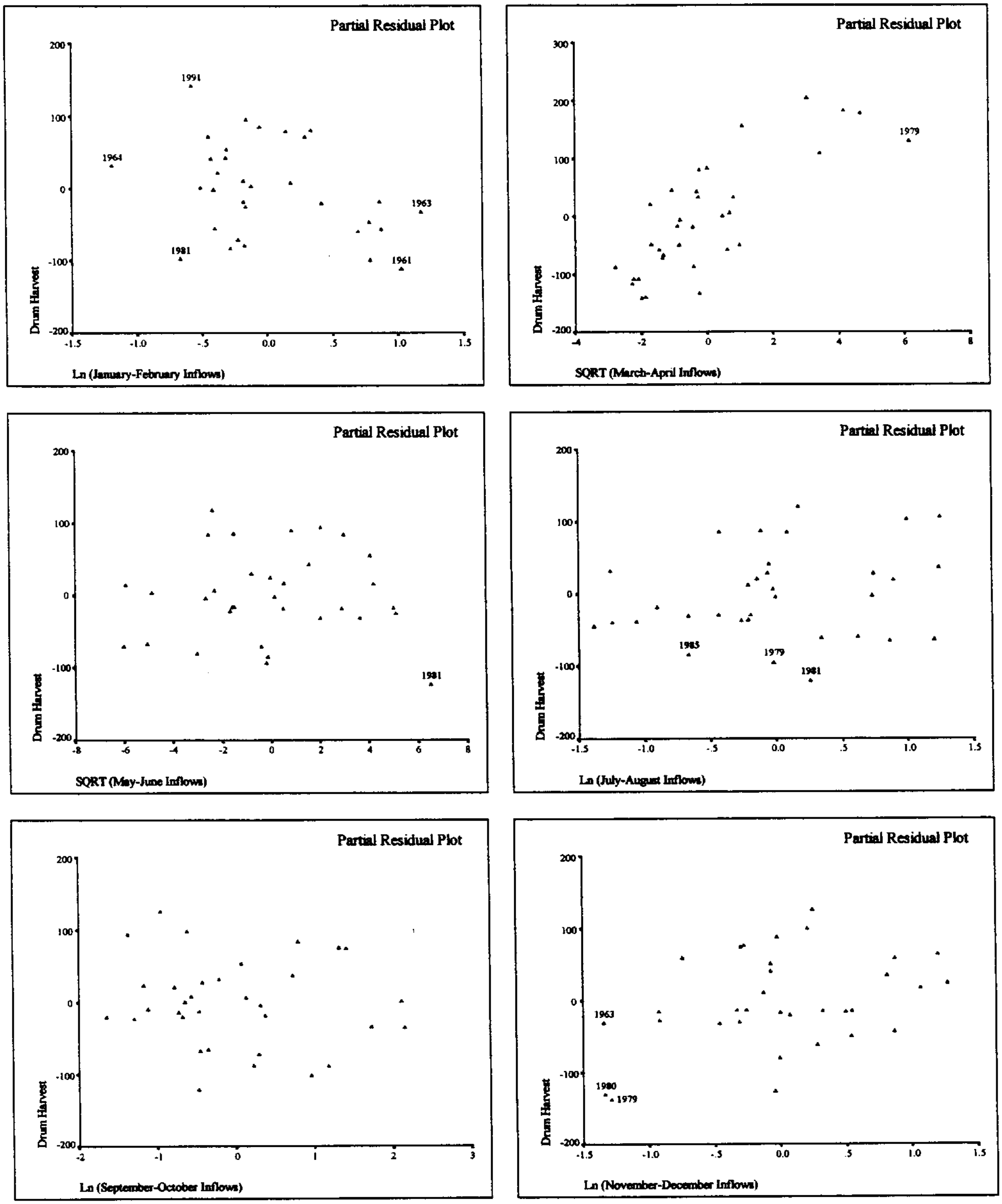



Fig. 6.3.2. Partial Residual Plots of Drum Harvest vs. Logged and Square Root Inflows.

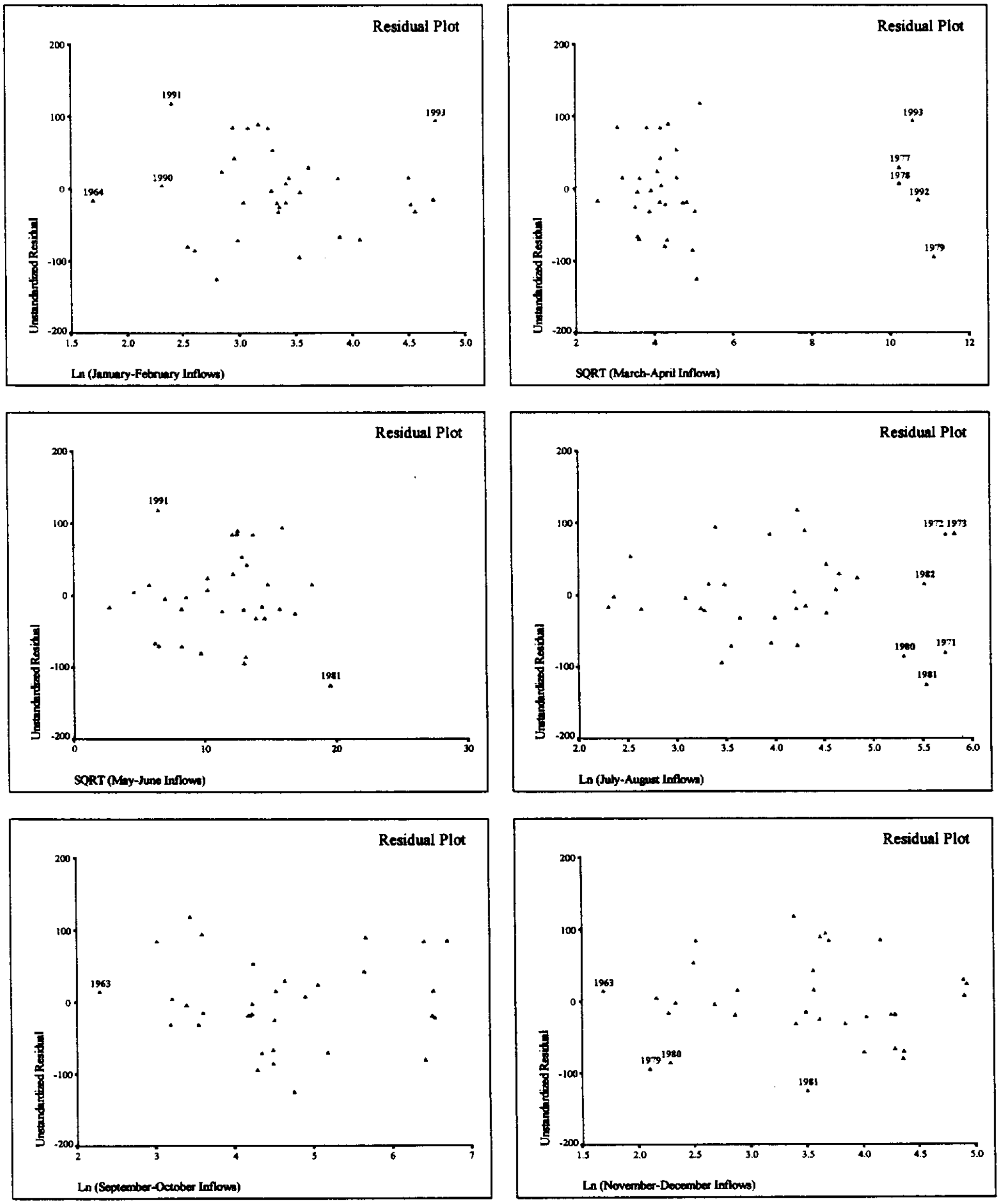



Fig. 6.3.3. Residual Plots of Drum Harvest vs. Logged and Square Root Inflows.

### 6.3.4 Prediction Intervals for Drum Harvest

| YEAR | DRUM | LICI | UICI |
|---|---|---|---|
| 1961 | 8.00 | 0 | 283.95255 |
| 1962 | 13.70 | 0 | 283.56066 |
| 1963 | 18.50 | 0 | 222.56341 |
| 1964 | 19.80 | 0 | 253.51829 |
| 1965 | 24.80 | 0 | 224.20328 |
| 1966 | 112.70 | 0 | 258.48759 |
| 1967 | 42.20 | 0 | 271.87440 |
| 1968 | 38.20 | 0 | 233.32922 |
| 1969 | 26.20 | 0 | 255.58874 |
| 1970 | 63.10 | 0 | 297.32621 |
| 1971 | 102.90 | 0 | 385.84093 |
| 1972 | 220.20 | 0 | 338.88128 |
| 1973 | 201.10 | 0 | 319.25076 |
| 1974 | 205.70 | 0 | 306.45592 |
| 1975 | 161.80 | 0 | 310.87121 |
| 1976 | 199.80 | 0 | 375.11890 |
| 1977 | 400.80 | 162.27825 | 577.17432 |
| 1978 | 383.30 | 164.99729 | 585.14487 |
| 1979 | 198.60 | 73.26182 | 510.12402 |
| 1980 | 58.10 | 0 | 348.11171 |
| 1981 | 58.30 | 0 | 389.07135 |
| 1982 | 105.90 | 0 | 294.55961 |
| 1983 | 64.60 | 0 | 287.22955 |
| 1984 | 29.30 | 0 | 229.60100 |
| 1985 | 59.00 | 0 | 324.71258 |
| 1986 | 105.50 | 0 | 324.73665 |
| 1987 | 137.00 | 0 | 354.39089 |
| 1988 | 63.80 | 0 | 293.76513 |
| 1989 | 151.60 | 0 | 265.80829 |
| 1990 | 112.80 | 0 | 315.55589 |
| 1991 | 300.70 | 0 | 380.98778 |
| 1992 | 282.10 | 86.79938 | 506.91167 |
| 1993 | 375.60 | 72.33091 | 489.12477 |

**DRUM** Drum harvest
**LICI** Lower limit for 99% prediction interval for Drum harvest
**UICI** Upper limit for 99% prediction interval for Drum harvest

### 6.3.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| 1961 | 6.60239 | .06198 | .20632 | .4714 | .0005 |
| 1962 | 5.41151 | .04352 | .16911 | .6099 | .0001 |
| 1963 | 11.76041 | .00872 | .36751 | .1087 | .0000 |
| 1964 | 11.19925 | .00735 | .34998 | .1302 | .0000 |
| 1965 | 3.60324 | .00000 | .11260 | .8242 | .0000 |
| 1966 | 4.39715 | .02349 | .13741 | .7331 | .0000 |
| 1967 | 8.44133 | .00620 | .26379 | .2953 | .0000 |
| 1968 | 8.64324 | .00560 | .27010 | .2793 | .0000 |
| 1969 | 7.43079 | .00644 | .23221 | .3854 | .0000 |
| 1970 | 5.18797 | .00915 | .16212 | .6370 | .0000 |
| 1971 | 5.67063 | .06513 | .17721 | .5787 | .0005 |
| 1972 | 5.51285 | .07383 | .17228 | .5976 | .0008 |
| 1973 | 5.64182 | .07763 | .17631 | .5821 | .0009 |
| 1974 | .99171 | .01830 | .03099 | .9950 | .0000 |
| 1975 | 1.40375 | .00526 | .04387 | .9855 | .0000 |
| 1976 | 4.10993 | .00442 | .12844 | .7670 | .0000 |
| 1977 | 6.85785 | .01320 | .21431 | .4438 | .0000 |
| 1978 | 7.87245 | .00114 | .24601 | .3440 | .0000 |
| 1979 | 11.18672 | .27312 | .34959 | .1307 | .0411 |
| 1980 | 6.31258 | .08583 | .19727 | .5038 | .0013 |
| 1981 | 6.84960 | .20770 | .21405 | .4447 | .0193 |
| 1982 | 5.91107 | .00296 | .18472 | .5502 | .0000 |
| 1983 | 3.43037 | .00348 | .10720 | .8425 | .0000 |
| 1984 | 3.00636 | .00005 | .09395 | .8844 | .0000 |
| 1985 | 2.40423 | .02072 | .07513 | .9341 | .0000 |
| 1986 | 4.53763 | .00257 | .14180 | .7162 | .0000 |
| 1987 | 4.16042 | .00212 | .13001 | .7611 | .0000 |
| 1988 | 3.62976 | .00605 | .11343 | .8213 | .0000 |
| 1989 | 3.79793 | .04754 | .11869 | .8027 | .0002 |
| 1990 | 6.98349 | .00035 | .21823 | .4306 | .0000 |
| 1991 | 3.96292 | .09811 | .12384 | .7840 | .0020 |
| 1992 | 7.86560 | .00366 | .24580 | .3446 | .0000 |
| 1993 | 7.22304 | .13281 | .22572 | .4060 | .0052 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

## 6.4 Model 8: Untransformed, Logged and Square Root Variables

### 6.4.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | Ln(Nov-Dec Inflows), May-June Inflows, SQRT(Mar-Apr Inflows), Ln(Jan-Feb Inflows), Ln(Sept-Oct Inflows), Ln(Jul-Aug Inflows)[c,d] | . | .847 | .718 | .653 | 66.8341 | 1.342 |

a. Dependent Variable: Drum Harvest

b. Method: Enter

c. Independent Variables: (Constant), Ln (November-December Inflows), May-June Inflows, SQRT (March-April Inflows), Ln (January-February Inflows), Ln (September-October Inflows), Ln (July-August Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 295983 | 6 | 49330.5 | 11.044 | .000[b] |
| | Residual | 116137 | 26 | 4466.797 | | |
| | Total | 412120 | 32 | | | |

a. Dependent Variable: Drum Harvest

b. Independent Variables: (Constant), Ln (November-December Inflows), May-June Inflows, SQRT (March-April Inflows), Ln (January-February Inflows), Ln (September-October Inflows), Ln (July-August Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| 1 | (Constant) | -88.630 | 93.934 | | -.944 | .354 | -281.715 | 104.454 |
| | Ln (January-February Inflows) | -37.863 | 20.670 | -.238 | -1.832 | .078 | -80.351 | 4.624 |
| | SQRT (March-April Inflows) | 37.053 | 5.490 | .791 | 6.749 | .000 | 25.767 | 48.338 |
| | May-June Inflows | -4.0E-02 | .155 | -.032 | -.260 | .797 | -.359 | .278 |
| | Ln (July-August Inflows) | 20.406 | 16.105 | .177 | 1.267 | .216 | -12.697 | 53.510 |
| | Ln (September-October Inflows) | -6.684 | 11.460 | -.069 | -.583 | .565 | -30.240 | 16.871 |
| | Ln (November-December Inflows) | 32.430 | 16.965 | .253 | 1.912 | .067 | -2.442 | 67.301 |

a. Dependent Variable: Drum Harvest

### 6.4.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | -88.630282 | 93.93420493 | -0.944 | 0.3541 | 0.00000000 |
| LN_QJF | 1 | -37.863153 | 20.66980031 | -1.832 | 0.0785 | 1.55897202 |
| SQRT_QMA | 1 | 37.052794 | 5.49040122 | 6.749 | 0.0001 | 1.26629378 |
| QMJ_LAG | 1 | -0.040215 | 0.15488196 | -0.260 | 0.7972 | 1.42644305 |
| LN_QJA | 1 | 20.406426 | 16.10464181 | 1.267 | 0.2163 | 1.80362403 |
| LN_QSO | 1 | -6.684197 | 11.45952938 | -0.583 | 0.5647 | 1.27822415 |
| LN_QND | 1 | 32.429581 | 16.96454624 | 1.912 | 0.0670 | 1.61937837 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop SQRT_QMA | Var Prop QMJ_LAG | Var Prop LN_QJA | Var Prop LN_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.92102 | 1.00000 | 0.0105 | 0.0172 | 0.0623 | 0.0796 | 0.0737 | 0.0961 |
| 2 | 1.57410 | 1.10471 | 0.1626 | 0.1679 | 0.0298 | 0.0308 | 0.0524 | 0.0025 |
| 3 | 0.92150 | 1.44383 | 0.0526 | 0.0043 | 0.3344 | 0.0827 | 0.1064 | 0.1455 |
| 4 | 0.77915 | 1.57020 | 0.1169 | 0.2628 | 0.1264 | 0.0865 | 0.2611 | 0.0608 |
| 5 | 0.51850 | 1.92483 | 0.1631 | 0.5460 | 0.0002 | 0.0157 | 0.4810 | 0.2097 |
| 6 | 0.28573 | 2.59291 | 0.4944 | 0.0018 | 0.4469 | 0.7047 | 0.0253 | 0.4853 |

### 6.4.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 8.9793 | 377.5374 | 131.6879 | 96.1741 | 33 |
| Std. Predicted Value | -1.276 | 2.556 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | 16.3008 | 41.8604 | 30.1521 | 6.2891 | 33 |
| Adjusted Predicted Value | 2.8333 | 375.3415 | 134.1879 | 99.3540 | 33 |
| Residual | -114.6242 | 116.8576 | 7.1E-14 | 60.2434 | 33 |
| Std. Residual | -1.715 | 1.748 | .000 | .901 | 33 |
| Stud. Residual | -2.083 | 1.902 | -.016 | 1.020 | 33 |
| Deleted Residual | -169.0850 | 138.3294 | -2.5001 | 77.6297 | 33 |
| Stud. Deleted Residual | -2.238 | 2.011 | -.017 | 1.052 | 33 |
| Mahal. Distance | .934 | 11.584 | 5.818 | 2.714 | 33 |
| Cook's Distance | .000 | .295 | .043 | .072 | 33 |
| Centered Leverage Value | .029 | .362 | .182 | .085 | 33 |

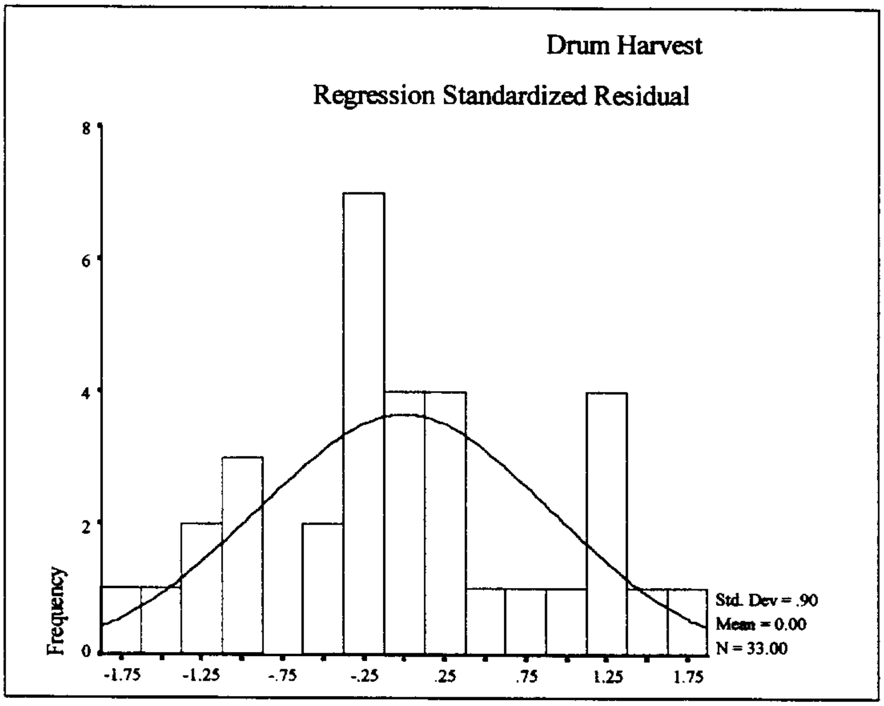
a. Dependent Variable: Drum Harvest

*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| 1961 | 82.95831 | -74.95831 | -94.89228 | 102.89228 | -.50668 | -1.12156 | -1.26191 | -1.27713 |
| 1962 | 84.74401 | -71.04401 | -86.61703 | 100.31703 | -.48811 | -1.06299 | -1.17373 | -1.18269 |
| 1963 | 8.97926 | 9.52074 | 15.66666 | 2.83334 | -1.27590 | .14245 | .18274 | .17930 |
| 1964 | 34.86118 | -15.06118 | -24.06994 | 43.86994 | -1.00679 | -.22535 | -.28488 | -.27979 |
| 1965 | 25.76706 | -.96706 | -1.12883 | 25.92883 | -1.10134 | -.01447 | -.01563 | -.01533 |
| 1966 | 53.94648 | 58.75352 | 69.06151 | 43.63849 | -.80834 | .87909 | .95310 | .95136 |
| 1967 | 57.36176 | -15.16176 | -21.37606 | 63.57606 | -.77283 | -.22686 | -.26936 | -.26450 |
| 1968 | 20.24236 | 17.95764 | 25.74766 | 12.45234 | -1.15879 | .26869 | .32173 | .31611 |
| 1969 | 48.31506 | -22.11506 | -29.93401 | 56.13401 | -.86689 | -.33089 | -.38497 | -.37858 |
| 1970 | 92.30734 | -29.20734 | -36.03061 | 99.13061 | -.40947 | -.43701 | -.48538 | -.47813 |
| 1971 | 185.00002 | -82.10002 | -104.22705 | 207.12705 | .55433 | -1.22842 | -1.38409 | -1.41015 |
| 1972 | 138.01648 | 82.18352 | 103.74869 | 116.45131 | .06580 | 1.22966 | 1.38161 | 1.40743 |
| 1973 | 116.92940 | 84.17060 | 106.53450 | 94.56550 | -.15346 | 1.25940 | 1.41686 | 1.44630 |
| 1974 | 114.39307 | 91.30693 | 97.08205 | 108.61795 | -.17983 | 1.36617 | 1.40872 | 1.43730 |
| 1975 | 116.90438 | 44.89562 | 48.28645 | 113.51355 | -.15372 | .67175 | .69665 | .68959 |
| 1976 | 175.50285 | 24.29715 | 28.91627 | 170.88373 | .45558 | .36354 | .39660 | .39008 |
| 1977 | 370.62303 | 30.17697 | 39.96696 | 360.83304 | 2.48440 | .45152 | .51963 | .51220 |
| 1978 | 377.53745 | 5.76255 | 7.95848 | 375.34152 | 2.55630 | .08622 | .10133 | .09938 |
| 1979 | 292.14192 | -93.54192 | -150.96106 | 349.56106 | 1.66837 | -1.39961 | -1.77802 | -1.86025 |
| 1980 | 143.11716 | -85.01716 | -110.54020 | 168.64020 | .11884 | -1.27206 | -1.45049 | -1.48362 |
| 1981 | 172.92416 | -114.62416 | -169.08498 | 227.38498 | .42877 | -1.71506 | -2.08302 | -2.23781 |
| 1982 | 84.13802 | 21.76198 | 28.67183 | 77.22817 | -.49441 | .32561 | .37375 | .36748 |
| 1983 | 83.07444 | -18.47444 | -21.64558 | 86.24558 | -.50547 | -.27642 | -.29921 | -.29390 |
| 1984 | 35.46587 | -6.16587 | -7.06031 | 36.36031 | -1.00050 | -.09226 | -.09872 | -.09682 |
| 1985 | 129.94605 | -70.94605 | -79.40962 | 138.40962 | -.01811 | -1.06152 | -1.12306 | -1.12897 |
| 1986 | 123.20675 | -17.70675 | -21.36751 | 126.86751 | -.08819 | -.26494 | -.29104 | -.28585 |
| 1987 | 148.72289 | -11.72289 | -13.92123 | 150.92123 | .17713 | -.17540 | -.19114 | -.18756 |
| 1988 | 91.84093 | -28.04093 | -32.06788 | 95.86788 | -.41432 | -.41956 | -.44868 | -.44168 |
| 1989 | 64.26895 | 87.33105 | 100.67465 | 50.92535 | -.70101 | 1.30668 | 1.40296 | 1.43095 |
| 1990 | 112.40787 | .39213 | .50947 | 112.29053 | -.20047 | .00587 | .00669 | .00656 |
| 1991 | 183.84242 | 116.85758 | 138.32942 | 162.37058 | .54229 | 1.74847 | 1.90234 | 2.01056 |
| 1992 | 298.35205 | -16.25205 | -22.39317 | 304.49317 | 1.73294 | -.24317 | -.28544 | -.28034 |
| 1993 | 277.86101 | 97.73899 | 133.07093 | 242.52907 | 1.51988 | 1.46241 | 1.70639 | 1.77563 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.
[2] This is flagged if it exceeds $t_{n-p-2,\alpha} = t_{25,0.01} = 2.485$



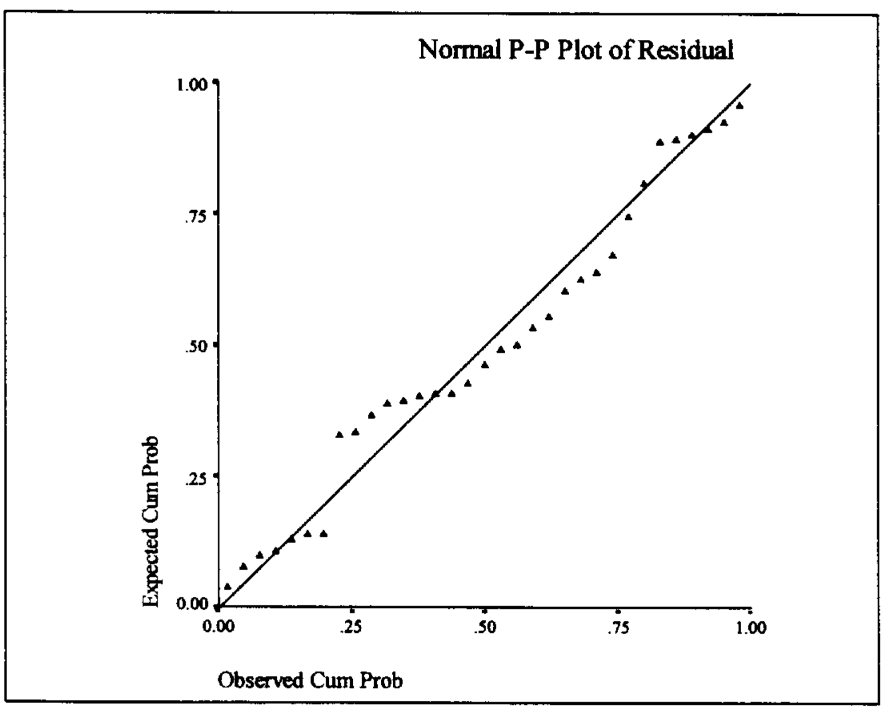




Fig. 6.4.1. Exploratory Plots of Drum Harvest Standardized Residual.

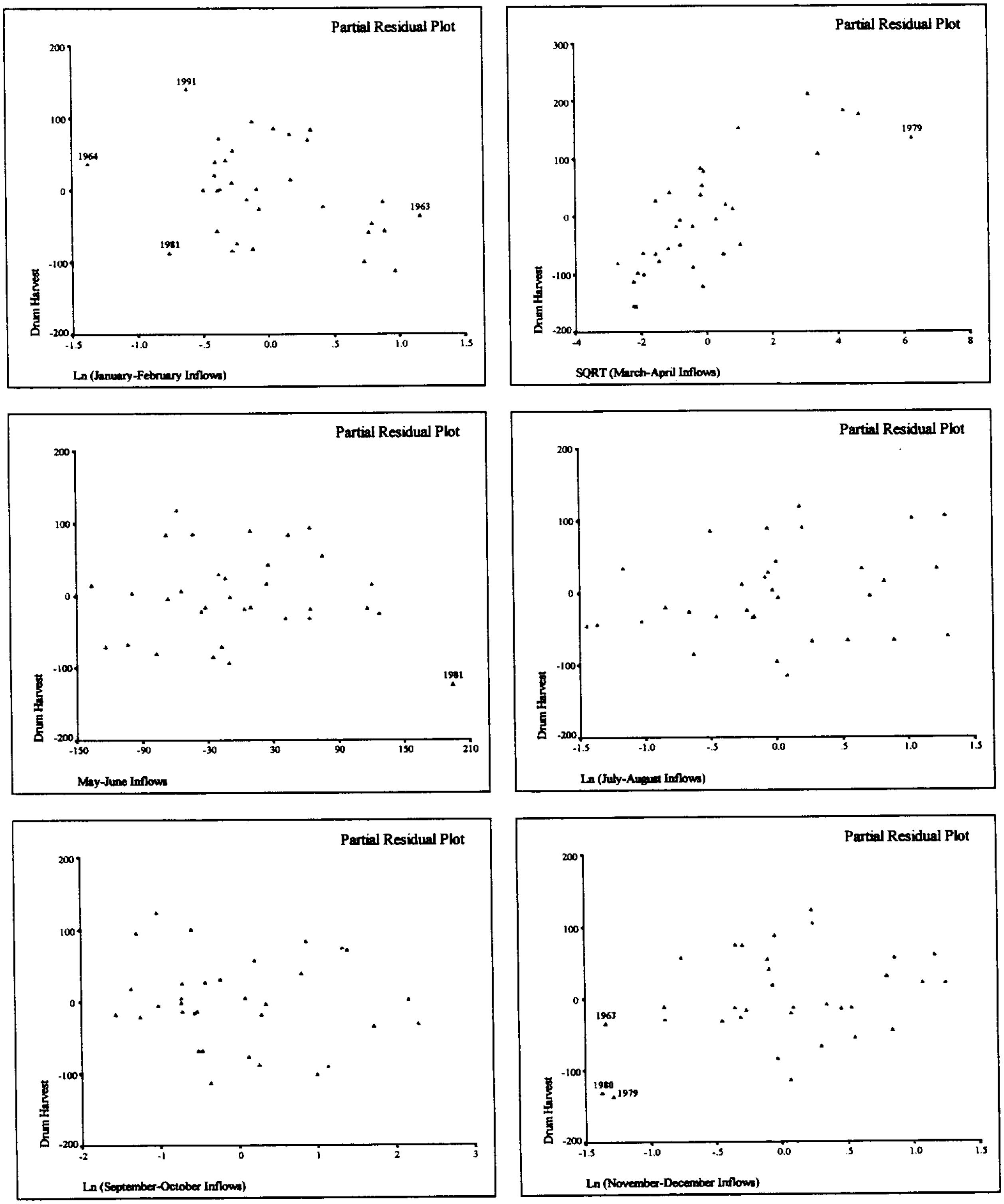



Fig. 6.4.2. Partial Residual Plots of Drum Harvest vs. Untransformed, Logged and Square Root Inflows.

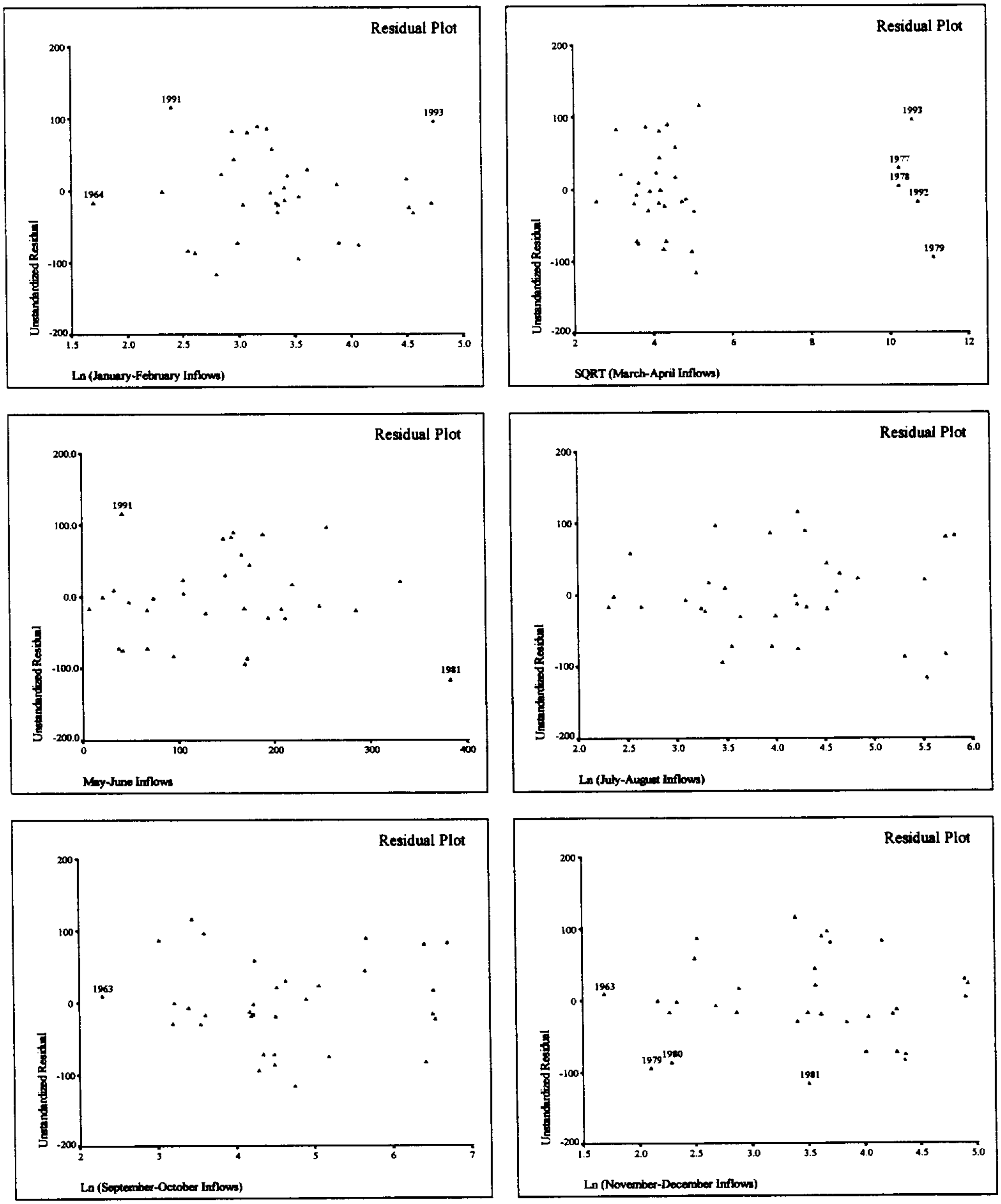



Fig. 6.4.3. Residual Plots of Drum Harvest vs. Untransformed, Logged and Square Root Inflows.

### 6.4.4 Prediction Intervals for Drum Harvest

| YEAR | DRUM | LICI | UICI |
|---|---|---|---|
| 1961 | 8.00 | 0 | 287.24834 |
| 1962 | 13.70 | 0 | 286.46202 |
| 1963 | 18.50 | 0 | 228.11202 |
| 1964 | 19.80 | 0 | 252.57135 |
| 1965 | 24.80 | 0 | 224.34125 |
| 1966 | 112.70 | 0 | 253.03711 |
| 1967 | 42.20 | 0 | 268.34933 |
| 1968 | 38.20 | 0 | 232.19540 |
| 1969 | 26.20 | 0 | 256.87700 |
| 1970 | 63.10 | 0 | 294.84290 |
| 1971 | 102.90 | 0 | 389.47795 |
| 1972 | 220.20 | 0 | 342.11989 |
| 1973 | 201.10 | 0 | 321.20695 |
| 1974 | 205.70 | 0 | 305.54991 |
| 1975 | 161.80 | 0 | 309.02732 |
| 1976 | 199.80 | 0 | 375.49941 |
| 1977 | 400.80 | 163.40939 | 577.83667 |
| 1978 | 383.30 | 167.76216 | 587.31275 |
| 1979 | 198.60 | 73.95044 | 510.33339 |
| 1980 | 58.10 | 0 | 349.15752 |
| 1981 | 58.30 | 0 | 386.46097 |
| 1982 | 105.90 | 0 | 291.02230 |
| 1983 | 64.60 | 0 | 281.92624 |
| 1984 | 29.30 | 0 | 232.59162 |
| 1985 | 59.00 | 0 | 325.30516 |
| 1986 | 105.50 | 0 | 324.19954 |
| 1987 | 137.00 | 0 | 348.56177 |
| 1988 | 63.80 | 0 | 288.86958 |
| 1989 | 151.60 | 0 | 261.90635 |
| 1990 | 112.80 | 0 | 318.40022 |
| 1991 | 300.70 | 0 | 383.44900 |
| 1992 | 282.10 | 88.71510 | 507.98899 |
| 1993 | 375.60 | 68.94334 | 486.77867 |

**DRUM** Drum harvest
**LICI** Lower limit for 99% prediction interval for Drum harvest
**UICI** Upper limit for 99% prediction interval for Drum harvest

### 6.4.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| 1961 | 5.75253 | .06050 | .17977 | .5689 | .0004 |
| 1962 | 4.78364 | .04314 | .14949 | .6863 | .0001 |
| 1963 | 11.58368 | .00308 | .36199 | .1151 | .0000 |
| 1964 | 11.00707 | .00693 | .34397 | .1383 | .0000 |
| 1965 | 3.61602 | .00001 | .11300 | .8228 | .0000 |
| 1966 | 3.80656 | .02277 | .11896 | .8018 | .0000 |
| 1967 | 8.33312 | .00425 | .26041 | .3041 | .0000 |
| 1968 | 8.71198 | .00641 | .27225 | .2740 | .0000 |
| 1969 | 7.38890 | .00749 | .23090 | .3895 | .0000 |
| 1970 | 5.09028 | .00786 | .15907 | .6489 | .0000 |
| 1971 | 5.82379 | .07376 | .18199 | .5605 | .0008 |
| 1972 | 5.68181 | .07156 | .17756 | .5774 | .0007 |
| 1973 | 5.74780 | .07620 | .17962 | .5695 | .0009 |
| 1974 | .93389 | .01793 | .02918 | .9958 | .0000 |
| 1975 | 1.27745 | .00524 | .03992 | .9890 | .0000 |
| 1976 | 4.14202 | .00427 | .12944 | .7633 | .0000 |
| 1977 | 6.86877 | .01251 | .21465 | .4427 | .0000 |
| 1978 | 7.85986 | .00056 | .24562 | .3451 | .0000 |
| 1979 | 11.20174 | .27722 | .35005 | .1301 | .0427 |
| 1980 | 6.41890 | .09023 | .20059 | .4918 | .0015 |
| 1981 | 9.33723 | .29451 | .29179 | .2293 | .0501 |
| 1982 | 6.74223 | .00634 | .21069 | .4562 | .0000 |
| 1983 | 3.71838 | .00220 | .11620 | .8116 | .0000 |
| 1984 | 3.08424 | .00020 | .09638 | .8771 | .0000 |
| 1985 | 2.44090 | .02149 | .07628 | .9315 | .0000 |
| 1986 | 4.51266 | .00250 | .14102 | .7192 | .0000 |
| 1987 | 4.08352 | .00098 | .12761 | .7701 | .0000 |
| 1988 | 3.04873 | .00413 | .09527 | .8805 | .0000 |
| 1989 | 3.27164 | .04296 | .10224 | .8588 | .0001 |
| 1990 | 6.40055 | .00000 | .20002 | .4938 | .0000 |
| 1991 | 3.99743 | .09499 | .12492 | .7801 | .0018 |
| 1992 | 7.80602 | .00440 | .24394 | .3500 | .0000 |
| 1993 | 7.52669 | .15037 | .23521 | .3762 | .0075 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1961** | -.65860 | .32579 | -.42742 | .25424 | .41072 | -.18579 | -.03037 | -.11003 |
| **1962** | -.55373 | .15222 | -.29335 | .23910 | .31116 | -.08422 | .11435 | -.18457 |
| **1963** | .14406 | .00416 | .08241 | -.03653 | -.07223 | .06746 | -.05345 | -.07827 |
| **1964** | -.21639 | -.18559 | .15041 | -.00886 | -.00812 | .12286 | -.01732 | -.00808 |
| **1965** | -.00627 | -.00368 | .00046 | .00054 | .00036 | .00337 | -.00099 | .00148 |
| **1966** | .39849 | .26831 | -.11989 | -.00901 | .18102 | -.28931 | .03675 | -.02709 |
| **1967** | -.16934 | -.03530 | .03781 | -.02111 | -.04668 | .10325 | -.12344 | .02456 |
| **1968** | .20820 | -.07283 | .10184 | -.02803 | .02101 | -.02389 | .14062 | -.08566 |
| **1969** | -.22510 | .10035 | -.12094 | .05190 | .03640 | .04823 | -.12998 | -.00838 |
| **1970** | -.23110 | .02994 | -.12561 | .09648 | -.05157 | .02338 | .11393 | -.07188 |
| **1971** | -.73208 | .23391 | .11983 | -.06911 | .28207 | -.33998 | -.31065 | .01182 |
| **1972** | .72096 | -.37749 | .14848 | -.00808 | -.24638 | .48966 | .37741 | -.30495 |
| **1973** | .74551 | -.35708 | .08110 | -.14704 | -.16225 | .40354 | .37075 | -.12028 |
| **1974** | .36147 | -.02330 | -.05598 | -.02035 | .03247 | -.02405 | .21887 | -.01807 |
| **1975** | .18951 | .00780 | -.06088 | -.00955 | .04239 | -.00011 | .09903 | -.01650 |
| **1976** | .17008 | .00484 | -.05366 | -.02741 | -.01348 | -.00874 | -.03029 | .12588 |
| **1977** | .29174 | -.05856 | -.05973 | .20304 | -.02690 | -.00831 | -.02322 | .12858 |
| **1978** | .06135 | -.01147 | -.01488 | .04462 | -.01447 | -.00080 | .00163 | .02379 |
| **1979** | **-1.45746** | -.11265 | .20504 | **-1.21108** | .05739 | .00050 | -.40266 | .77253 |
| **1980** | -.81290 | -.02169 | .06403 | -.14466 | .09838 | -.52800 | -.07512 | .58931 |
| **1981** | **-1.54251** | -.26958 | .63540 | .02406 | **-1.22617** | -.04965 | .16857 | -.04605 |
| **1982** | .20707 | -.02022 | .02186 | -.09401 | .11851 | .06563 | -.05149 | -.00740 |
| **1983** | -.12177 | -.02386 | .01613 | .05465 | -.09405 | .01705 | .03053 | -.02792 |
| **1984** | -.03688 | -.01153 | -.01348 | .01318 | .01589 | -.00027 | .01290 | .00708 |
| **1985** | -.38994 | -.17786 | .14657 | .03970 | .04731 | .18099 | .09468 | -.25532 |
| **1986** | -.12997 | -.06163 | .04825 | .02049 | -.00257 | .07751 | .03828 | -.09933 |
| **1987** | -.08122 | -.02197 | .02350 | .01924 | -.05511 | .03240 | .03541 | -.05558 |
| **1988** | -.16738 | -.07347 | .01094 | .07357 | -.06964 | .01928 | .12616 | -.05472 |
| **1989** | .55934 | .25959 | .02090 | -.19451 | .15975 | .07374 | -.33936 | -.13375 |
| **1990** | .00359 | .00149 | -.00065 | .00037 | -.00171 | .00147 | -.00093 | -.00168 |
| **1991** | .86183 | .43937 | -.41644 | .18141 | -.28973 | .09449 | -.38445 | .13238 |
| **1992** | -.17233 | .07308 | -.07998 | -.09179 | .02430 | -.05617 | .02910 | .03755 |
| **1993** | **1.06758** | -.12979 | .20805 | .52864 | .30847 | -.24907 | -.21033 | .12795 |

**SDFFITS** Standardized dffits value

**SDFB_0** Standardized dfbeta for the intercept term

**SDFB_1** Standardized dfbeta for the Logged January-February inflows

**SDFB_2** Standardized dfbeta for the Square Root March-April inflows

**SDFB_3** Standardized dfbeta for the May-June inflows

**SDFB_4** Standardized dfbeta for the Logged July-August inflows

**SDFB_5** Standardized dfbeta for the Logged September-October inflows

**SDFB_6** Standardized dfbeta for the Logged November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

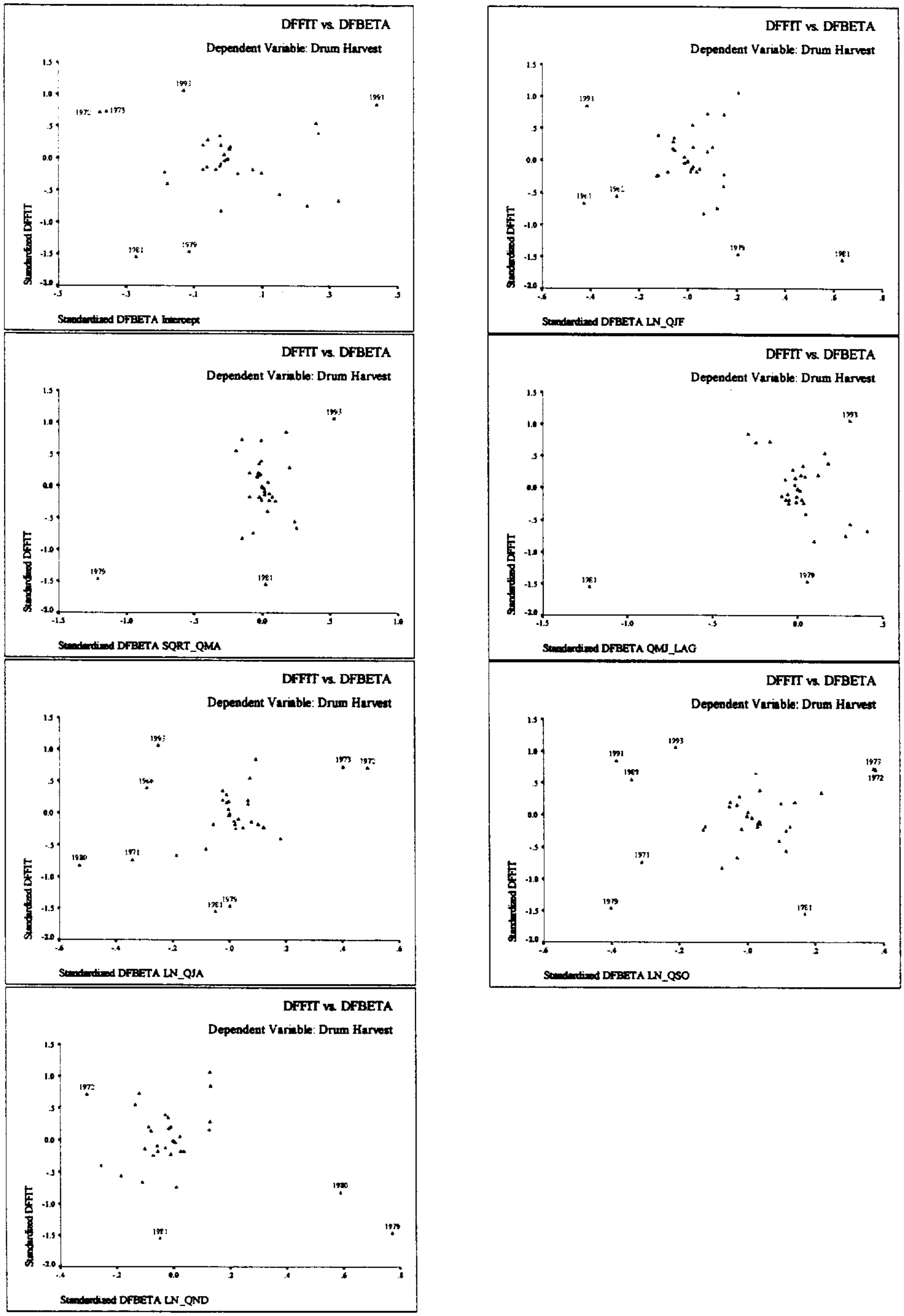



Fig. 6.4.4. Standardized DFFIT vs. Standardized DFBETA.

# 7. Examining Subsets of the Data

## 7.1 Model 2: Harvest Untransformed and Logged Inflows

### 7.1.1 Harvest Untransformed and Logged Inflows: 1993 Omitted

N = 32     Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.461826 | 0.443887 | 14.5915 | 281.8 | 6292.5 | 284.8 | LN_QMA |
| 1 | 0.161996 | 0.134062 | 38.3203 | 296.0 | 9798.2 | 298.9 | LN_QND |
| 1 | 0.157938 | 0.129869 | 38.6414 | 296.2 | 9845.6 | 299.1 | LN_QJA |
| 1 | 0.043474 | 0.011590 | 47.7002 | 300.2 | 11183.9 | 303.2 | LN_QMJ |
| 2 | 0.581364 | 0.552492 | 7.1312 | 275.8 | 5063.6 | 280.2 | LN_QMA LN_QJA |
| 2 | 0.551332 | 0.520389 | 9.5080 | 278.0 | 5426.8 | 282.4 | LN_QJF LN_QMA |
| 2 | 0.547480 | 0.516272 | 9.8128 | 278.3 | 5473.4 | 282.7 | LN_QMA LN_QND |
| 2 | 0.469440 | 0.432850 | 15.9889 | 283.4 | 6417.3 | 287.8 | LN_QMA LN_QSO |
| 3 | 0.658111 | 0.621480 | 3.0574 | 271.3 | 4283.0 | 277.2 | LN_QJF LN_QMA LN_QND |
| 3 | 0.634695 | 0.595555 | 4.9105 | 273.4 | 4576.3 | 279.3 | LN_QJF LN_QMA LN_QJA |
| 3 | 0.605574 | 0.563314 | 7.2152 | 275.9 | 4941.1 | 281.8 | LN_QMA LN_QMJ LN_QJA |
| 3 | 0.604566 | 0.562198 | 7.2950 | 276.0 | 4953.8 | 281.8 | LN_QMA LN_QJA LN_QND |
| 4 | 0.679809 | 0.632373 | 3.3402 | 271.2 | 4159.7 | 278.6 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.659765 | 0.609359 | 4.9265 | 273.2 | 4420.1 | 280.5 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.659440 | 0.608987 | 4.9522 | 273.2 | 4424.3 | 280.5 | LN_QJF LN_QMA LN_QMJ LN_QND |
| 4 | 0.638540 | 0.584991 | 6.6062 | 275.1 | 4695.9 | 282.4 | LN_QJF LN_QMA LN_QMJ LN_QJA |
| 5 | 0.683495 | 0.622629 | 5.0485 | 272.9 | 4270.0 | 281.6 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.681336 | 0.620054 | 5.2193 | 273.1 | 4299.1 | 281.9 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.662249 | 0.597296 | 6.7299 | 274.9 | 4556.6 | 283.7 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.639123 | 0.569724 | 8.5601 | 277.1 | 4868.6 | 285.8 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 6 | 0.684107 | 0.608293 | 7.0000 | 274.8 | 4432.2 | 285.1 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 7.2 Model 4: Harvest Untransformed and Square Root Inflows

### 7.2.1 Harvest Untransformed and Square Root Inflows: 1979 Omitted

N = 32 Regression Models for Dependent Variable: DRUM

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.60419 | 0.59100 | 10.664 | 276.8 | 5376 | 279.7 | SQRT_QMA |
| 1 | 0.21075 | 0.18444 | 49.096 | 298.9 | 10721 | 301.8 | SQRT_QND |
| 1 | 0.06752 | 0.03644 | 63.087 | 304.2 | 12666 | 307.2 | SQRT_QJA |
| 1 | 0.03917 | 0.00714 | 65.857 | 305.2 | 13051 | 308.1 | SQRT_QMJ |
| 2 | 0.69916 | 0.67842 | 3.387 | 270.0 | 4227 | 274.4 | SQRT_QJF SQRT_QMA |
| 2 | 0.67762 | 0.65539 | 5.491 | 272.2 | 4530 | 276.6 | SQRT_QMA SQRT_QJA |
| 2 | 0.64399 | 0.61944 | 8.776 | 275.4 | 5003 | 279.8 | SQRT_QMA SQRT_QND |
| 2 | 0.61108 | 0.58426 | 11.991 | 278.2 | 5465 | 282.6 | SQRT_QMA SQRT_QSO |
| 3 | 0.73012 | 0.70120 | 2.363 | 268.6 | 3928 | 274.4 | SQRT_QJF SQRT_QMA SQRT_QJA |
| 3 | 0.72842 | 0.69932 | 2.529 | 268.8 | 3952 | 274.6 | SQRT_QJF SQRT_QMA SQRT_QND |
| 3 | 0.71208 | 0.68124 | 4.124 | 270.6 | 4190 | 276.5 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 3 | 0.70328 | 0.67149 | 4.984 | 271.6 | 4318 | 277.5 | SQRT_QJF SQRT_QMA SQRT_QMJ |
| 4 | 0.74370 | 0.70573 | 3.036 | 268.9 | 3868 | 276.2 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QND |
| 4 | 0.73253 | 0.69290 | 4.127 | 270.3 | 4037 | 277.6 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QND |
| 4 | 0.73232 | 0.69266 | 4.148 | 270.3 | 4040 | 277.6 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.73187 | 0.69214 | 4.192 | 270.3 | 4047 | 277.7 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO |
| 5 | 0.74407 | 0.69485 | 5.000 | 270.9 | 4011 | 279.6 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.74370 | 0.69441 | 5.036 | 270.9 | 4017 | 279.7 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 5 | 0.73507 | 0.68412 | 5.879 | 272.0 | 4152 | 280.8 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.73233 | 0.68086 | 6.147 | 272.3 | 4195 | 281.1 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 6 | 0.74407 | 0.68265 | 7.000 | 272.9 | 4172 | 283.1 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

### 7.2.2 Harvest Untransformed and Square Root Inflows: 1993 Omitted

N = 32 Regression Models for Dependent Variable: DRUM

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.47794 | 0.46054 | 14.489 | 280.9 | 6104 | 283.8 | SQRT_QMA |
| 1 | 0.20533 | 0.17884 | 36.675 | 294.3 | 9291 | 297.2 | SQRT_QND |
| 1 | 0.10307 | 0.07317 | 44.997 | 298.2 | 10487 | 301.1 | SQRT_QJA |
| 1 | 0.01945 | -.01323 | 51.803 | 301.0 | 11465 | 304.0 | SQRT_QMJ |
| 2 | 0.58839 | 0.56000 | 7.500 | 275.3 | 4979 | 279.7 | SQRT_QMA SQRT_QJA |
| 2 | 0.57422 | 0.54486 | 8.652 | 276.3 | 5150 | 280.7 | SQRT_QJF SQRT_QMA |
| 2 | 0.57282 | 0.54336 | 8.766 | 276.5 | 5167 | 280.8 | SQRT_QMA SQRT_QND |
| 2 | 0.48734 | 0.45199 | 15.723 | 282.3 | 6201 | 286.7 | SQRT_QMA SQRT_QSO |
| 3 | 0.67256 | 0.63748 | 2.649 | 269.9 | 4102 | 275.8 | SQRT_QJF SQRT_QMA SQRT_QND |
| 3 | 0.63809 | 0.59931 | 5.455 | 273.1 | 4534 | 279.0 | SQRT_QJF SQRT_QMA SQRT_QJA |
| 3 | 0.62834 | 0.58852 | 6.248 | 274.0 | 4656 | 279.9 | SQRT_QMA SQRT_QJA SQRT_QND |
| 3 | 0.60695 | 0.56484 | 7.989 | 275.8 | 4924 | 281.6 | SQRT_QMA SQRT_QMJ SQRT_QJA |
| 4 | 0.69264 | 0.64710 | 3.015 | 269.9 | 3993 | 277.2 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QND |
| 4 | 0.67620 | 0.62823 | 4.353 | 271.6 | 4207 | 278.9 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QND |
| 4 | 0.67507 | 0.62693 | 4.445 | 271.7 | 4221 | 279.0 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.64213 | 0.58911 | 7.125 | 274.8 | 4649 | 282.1 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA |
| 5 | 0.69282 | 0.63375 | 5.000 | 271.9 | 4144 | 280.7 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 5 | 0.69264 | 0.63353 | 5.015 | 271.9 | 4147 | 280.7 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.67768 | 0.61570 | 6.232 | 273.4 | 4348 | 282.2 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.64323 | 0.57462 | 9.036 | 276.7 | 4813 | 285.5 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 6 | 0.69282 | 0.61910 | 7.000 | 273.9 | 4310 | 284.2 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

### 7.2.3 Harvest Untransformed and Square Root Inflows: 1979 and 1993 Omitted

N = 31 Regression Models for Dependent Variable: DRUM

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.53366 | 0.51758 | 13.484 | 269.2 | 5548 | 272.1 | SQRT_QMA |
| 1 | 0.24928 | 0.22339 | 38.173 | 284.0 | 8932 | 286.8 | SQRT_QND |
| 1 | 0.11778 | 0.08736 | 49.588 | 289.0 | 10496 | 291.8 | SQRT_QJA |
| 1 | 0.01722 | -.01667 | 58.318 | 292.3 | 11693 | 295.2 | SQRT_QMJ |
| 2 | 0.65971 | 0.63540 | 4.542 | 261.4 | 4193 | 265.7 | SQRT_QJF SQRT_QMA |
| 2 | 0.62525 | 0.59848 | 7.533 | 264.4 | 4618 | 268.7 | SQRT_QMA SQRT_QJA |
| 2 | 0.58569 | 0.55610 | 10.967 | 267.5 | 5105 | 271.8 | SQRT_QMA SQRT_QND |
| 2 | 0.54231 | 0.50962 | 14.733 | 270.6 | 5640 | 274.9 | SQRT_QMA SQRT_QSO |
| 3 | 0.70453 | 0.67171 | 2.650 | 259.0 | 3776 | 264.8 | SQRT_QJF SQRT_QMA SQRT_QND |
| 3 | 0.69953 | 0.66615 | 3.084 | 259.6 | 3840 | 265.3 | SQRT_QJF SQRT_QMA SQRT_QJA |
| 3 | 0.67850 | 0.64278 | 4.910 | 261.7 | 4108 | 267.4 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 3 | 0.66378 | 0.62642 | 6.188 | 263.0 | 4297 | 268.8 | SQRT_QJF SQRT_QMA SQRT_QMJ |
| 4 | 0.72261 | 0.67994 | 3.081 | 259.1 | 3681 | 266.3 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QND |
| 4 | 0.71029 | 0.66572 | 4.151 | 260.4 | 3845 | 267.6 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.70836 | 0.66349 | 4.318 | 260.6 | 3870 | 267.8 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QND |
| 4 | 0.70280 | 0.65707 | 4.801 | 261.2 | 3944 | 268.4 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO |
| 5 | 0.72347 | 0.66817 | 5.006 | 261.0 | 3816 | 269.6 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.72267 | 0.66720 | 5.076 | 261.1 | 3828 | 269.7 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 5 | 0.71252 | 0.65502 | 5.957 | 262.2 | 3968 | 270.8 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.70410 | 0.64492 | 6.688 | 263.1 | 4084 | 271.7 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 6 | 0.72354 | 0.65443 | 7.000 | 263.0 | 3974 | 273.0 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

## 7.3 Model 7: Harvest Untransformed, and Logged and Square Root Inflows

### 7.3.1 Harvest Untransformed, and Logged and Square Root Inflows: 1979 Omitted

N = 32 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.604190 | 0.590996 | 11.3567 | 276.8 | 5376.5 | 279.7 | SQRT_QMA |
| 1 | 0.189917 | 0.162915 | 52.5493 | 299.7 | 11003.7 | 302.7 | LN_QND |
| 1 | 0.110180 | 0.080520 | 60.4778 | 302.7 | 12086.8 | 305.7 | LN_QJA |
| 1 | 0.039168 | 0.007141 | 67.5388 | 305.2 | 13051.4 | 308.1 | SQRT_QMJ |
| 2 | 0.686978 | 0.665390 | 5.1249 | 271.3 | 4398.5 | 275.7 | LN_QJF SQRT_QMA |
| 2 | 0.682828 | 0.660954 | 5.5375 | 271.7 | 4456.8 | 276.1 | SQRT_QMA LN_QJA |
| 2 | 0.642642 | 0.617996 | 9.5334 | 275.5 | 5021.5 | 279.9 | SQRT_QMA LN_QND |
| 2 | 0.611503 | 0.584710 | 12.6296 | 278.2 | 5459.1 | 282.6 | SQRT_QMA LN_QSO |
| 3 | 0.732577 | 0.703925 | 2.5907 | 268.3 | 3892.0 | 274.1 | LN_QJF SQRT_QMA LN_QJA |
| 3 | 0.731072 | 0.702258 | 2.7404 | 268.4 | 3913.9 | 274.3 | LN_QJF SQRT_QMA LN_QND |
| 3 | 0.695604 | 0.662990 | 6.2671 | 272.4 | 4430.1 | 278.3 | LN_QJF SQRT_QMA LN_QSO |
| 3 | 0.694754 | 0.662049 | 6.3517 | 272.5 | 4442.5 | 278.4 | SQRT_QMA SQRT_QMJ LN_QJA |
| 4 | 0.748012 | 0.710680 | 3.0560 | 268.4 | 3803.2 | 275.7 | LN_QJF SQRT_QMA LN_QJA LN_QND |
| 4 | 0.734575 | 0.695253 | 4.3921 | 270.0 | 4006.0 | 277.3 | LN_QJF SQRT_QMA SQRT_QMJ LN_QND |
| 4 | 0.733163 | 0.693631 | 4.5325 | 270.2 | 4027.3 | 277.5 | LN_QJF SQRT_QMA LN_QJA LN_QSO |
| 4 | 0.733060 | 0.693514 | 4.5427 | 270.2 | 4028.8 | 277.5 | LN_QJF SQRT_QMA SQRT_QMJ LN_QJA |
| 5 | 0.748574 | 0.700222 | 5.0002 | 270.3 | 3940.7 | 279.1 | LN_QJF SQRT_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.748020 | 0.699562 | 5.0552 | 270.4 | 3949.3 | 279.2 | LN_QJF SQRT_QMA SQRT_QMJ LN_QJA LN_QND |
| 5 | 0.734923 | 0.683946 | 6.3575 | 272.0 | 4154.6 | 280.8 | LN_QJF SQRT_QMA SQRT_QMJ LN_QSO LN_QND |
| 5 | 0.733769 | 0.682570 | 6.4723 | 272.1 | 4172.7 | 280.9 | LN_QJF SQRT_QMA SQRT_QMJ LN_QJA LN_QSO |
| 6 | 0.748575 | 0.688234 | 7.0000 | 272.3 | 4098.2 | 282.5 | LN_QJF SQRT_QMA SQRT_QMJ LN_QJA LN_QSO LN_QND |

## 7.4 Model 8: Untransformed, Logged and Square Root Variables

### 7.4.1 Untransformed, Logged and Square Root Variables: 1979 Omitted

N = 32 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.604190 | 0.590996 | 11.5267 | 276.8 | 5376.5 | 279.7 | SQRT_QMA |
| 1 | 0.189917 | 0.162915 | 52.8972 | 299.7 | 11003.7 | 302.7 | LN_QND |
| 1 | 0.110180 | 0.080520 | 60.8599 | 302.7 | 12086.8 | 305.7 | LN_QJA |
| 1 | 0.018590 | -.014124 | 70.0064 | 305.9 | 13330.9 | 308.8 | QMJ_LAG |
| 2 | 0.686978 | 0.665390 | 5.2593 | 271.3 | 4398.5 | 275.7 | LN_QJF SQRT_QMA |
| 2 | 0.682828 | 0.660954 | 5.6737 | 271.7 | 4456.8 | 276.1 | SQRT_QMA LN_QJA |
| 2 | 0.642642 | 0.617996 | 9.6868 | 275.5 | 5021.5 | 279.9 | SQRT_QMA LN_QND |
| 2 | 0.611503 | 0.584710 | 12.7964 | 278.2 | 5459.1 | 282.6 | SQRT_QMA LN_QSO |
| 3 | 0.732577 | 0.703925 | 2.7056 | 268.3 | 3892.0 | 274.1 | LN_QJF SQRT_QMA LN_QJA |
| 3 | 0.731072 | 0.702258 | 2.8559 | 268.4 | 3913.9 | 274.3 | LN_QJF SQRT_QMA LN_QND |
| 3 | 0.700496 | 0.668407 | 5.9093 | 271.9 | 4358.9 | 277.7 | SQRT_QMA QMJ_LAG LN_QJA |
| 3 | 0.695604 | 0.662990 | 6.3979 | 272.4 | 4430.1 | 278.3 | LN_QJF SQRT_QMA LN_QSO |
| 4 | 0.748012 | 0.710680 | 3.1643 | 268.4 | 3803.2 | 275.7 | LN_QJF SQRT_QMA LN_QJA LN_QND |
| 4 | 0.736161 | 0.697074 | 4.3477 | 269.8 | 3982.0 | 277.2 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA |
| 4 | 0.733163 | 0.693631 | 4.6471 | 270.2 | 4027.3 | 277.5 | LN_QJF SQRT_QMA LN_QJA LN_QSO |
| 4 | 0.731973 | 0.692265 | 4.7660 | 270.3 | 4045.2 | 277.7 | LN_QJF SQRT_QMA QMJ_LAG LN_QND |
| 5 | 0.749244 | 0.701022 | 5.0412 | 270.2 | 3930.1 | 279.0 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QND |
| 5 | 0.748574 | 0.700222 | 5.1082 | 270.3 | 3940.7 | 279.1 | LN_QJF SQRT_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.736788 | 0.686170 | 6.2851 | 271.8 | 4125.4 | 280.5 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QSO |
| 5 | 0.732071 | 0.680546 | 6.7562 | 272.3 | 4199.3 | 281.1 | LN_QJF SQRT_QMA QMJ_LAG LN_QSO LN_QND |
| 6 | 0.749657 | 0.689574 | 7.0000 | 272.1 | 4080.6 | 282.4 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QSO LN_QND |

### 7.4.2 Untransformed, Logged and Square Root Variables: 1981 Omitted

N = 32 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.553904 | 0.539035 | 18.8622 | 280.6 | 6045.6 | 283.5 | SQRT_QMA |
| 1 | 0.153082 | 0.124852 | 60.9685 | 301.1 | 11477.6 | 304.0 | LN_QND |
| 1 | 0.131125 | 0.102162 | 63.2751 | 301.9 | 11775.2 | 304.8 | LN_QJA |
| 1 | 0.048371 | 0.016650 | 71.9684 | 304.8 | 12896.7 | 307.7 | QMJ_LAG |
| 2 | 0.679494 | 0.657390 | 7.6691 | 272.0 | 4493.3 | 276.4 | SQRT_QMA LN_QJA |
| 2 | 0.631885 | 0.606497 | 12.6704 | 276.4 | 5160.8 | 280.8 | SQRT_QMA LN_QND |
| 2 | 0.623608 | 0.597650 | 13.5399 | 277.1 | 5276.8 | 281.5 | LN_QJF SQRT_QMA |
| 2 | 0.561201 | 0.530939 | 20.0957 | 282.0 | 6151.7 | 286.4 | SQRT_QMA LN_QSO |
| 3 | 0.719818 | 0.689798 | 5.4331 | 269.7 | 4068.3 | 275.5 | LN_QJF SQRT_QMA LN_QND |
| 3 | 0.718563 | 0.688408 | 5.5649 | 269.8 | 4086.5 | 275.7 | LN_QJF SQRT_QMA LN_QJA |
| 3 | 0.695944 | 0.663366 | 7.9410 | 272.3 | 4415.0 | 278.2 | SQRT_QMA LN_QJA LN_QND |
| 3 | 0.681928 | 0.647849 | 9.4134 | 273.7 | 4618.5 | 279.6 | SQRT_QMA QMJ_LAG LN_QJA |
| 4 | 0.750801 | 0.713883 | 4.1783 | 267.9 | 3752.4 | 275.3 | LN_QJF SQRT_QMA LN_QJA LN_QND |
| 4 | 0.738680 | 0.699966 | 5.4516 | 269.4 | 3935.0 | 276.8 | LN_QJF SQRT_QMA QMJ_LAG LN_QND |
| 4 | 0.721644 | 0.680406 | 7.2413 | 271.5 | 4191.5 | 278.8 | LN_QJF SQRT_QMA LN_QSO LN_QND |
| 4 | 0.719980 | 0.678495 | 7.4160 | 271.7 | 4216.5 | 279.0 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA |
| 5 | 0.756032 | 0.709115 | 5.6288 | 269.2 | 3815.0 | 278.0 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QND |
| 5 | 0.755449 | 0.708420 | 5.6901 | 269.3 | 3824.1 | 278.1 | LN_QJF SQRT_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.743077 | 0.693668 | 6.9897 | 270.9 | 4017.5 | 279.7 | LN_QJF SQRT_QMA QMJ_LAG LN_QSO LN_QND |
| 5 | 0.720067 | 0.666233 | 9.4069 | 273.6 | 4377.4 | 282.4 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QSO |
| 6 | 0.762018 | 0.704902 | 7.0000 | 270.5 | 3870.2 | 280.7 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QSO LN_QND |

### 7.4.3 Untransformed, Logged and Square Root Variables: 1993 Omitted

N = 32 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.477937 | 0.460535 | 16.3910 | 280.9 | 6104.1 | 283.8 | SQRT_QMA |
| 1 | 0.161996 | 0.134062 | 43.2555 | 296.0 | 9798.2 | 298.9 | LN_QND |
| 1 | 0.157938 | 0.129869 | 43.6005 | 296.2 | 9845.6 | 299.1 | LN_QJA |
| 1 | 0.004924 | -.028245 | 56.6113 | 301.5 | 11634.7 | 304.4 | LN_QJF |
| 2 | 0.602304 | 0.574877 | 7.8161 | 274.2 | 4810.3 | 278.6 | SQRT_QMA LN_QJA |
| 2 | 0.568998 | 0.539273 | 10.6481 | 276.7 | 5213.2 | 281.1 | SQRT_QMA LN_QND |
| 2 | 0.562555 | 0.532386 | 11.1960 | 277.2 | 5291.1 | 281.6 | LN_QJF SQRT_QMA |
| 2 | 0.488168 | 0.452869 | 17.5211 | 282.2 | 6190.8 | 286.6 | SQRT_QMA LN_QSO |
| 3 | 0.676394 | 0.641722 | 3.5162 | 269.6 | 4053.9 | 275.4 | LN_QJF SQRT_QMA LN_QND |
| 3 | 0.651973 | 0.614685 | 5.5927 | 271.9 | 4359.9 | 277.8 | LN_QJF SQRT_QMA LN_QJA |
| 3 | 0.633466 | 0.594194 | 7.1664 | 273.6 | 4591.7 | 279.4 | SQRT_QMA QMJ_LAG LN_QJA |
| 3 | 0.627443 | 0.587527 | 7.6785 | 274.1 | 4667.2 | 279.9 | SQRT_QMA LN_QJA LN_QND |
| 4 | 0.699659 | 0.655164 | 3.5380 | 269.2 | 3901.8 | 276.5 | LN_QJF SQRT_QMA LN_QJA LN_QND |
| 4 | 0.677259 | 0.629445 | 5.4427 | 271.5 | 4192.9 | 278.8 | LN_QJF SQRT_QMA LN_QSO LN_QND |
| 4 | 0.676607 | 0.628697 | 5.4981 | 271.5 | 4201.3 | 278.9 | LN_QJF SQRT_QMA QMJ_LAG LN_QND |
| 4 | 0.664712 | 0.615039 | 6.5096 | 272.7 | 4355.9 | 280.0 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA |
| 5 | 0.704162 | 0.647270 | 5.1551 | 270.7 | 3991.2 | 279.5 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QND |
| 5 | 0.702164 | 0.644887 | 5.3250 | 270.9 | 4018.1 | 279.7 | LN_QJF SQRT_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.677644 | 0.615652 | 7.4100 | 273.4 | 4348.9 | 282.2 | LN_QJF SQRT_QMA QMJ_LAG LN_QSO LN_QND |
| 5 | 0.665456 | 0.601121 | 8.4463 | 274.6 | 4513.3 | 283.4 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QSO |
| 6 | 0.705986 | 0.635423 | 7.0000 | 272.5 | 4125.2 | 282.8 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QSO LN_QND |

### 7.4.4 Untransformed, Logged and Square Root Variables: 1979 and 1981 Omitted

N = 31 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.614490 | 0.601197 | 18.9845 | 268.0 | 5347.4 | 270.9 | SQRT_QMA |
| 1 | 0.192451 | 0.164605 | 69.3263 | 291.0 | 11201.4 | 293.8 | LN_QND |
| 1 | 0.142548 | 0.112981 | 75.2789 | 292.8 | 11893.6 | 295.7 | LN_QJA |
| 1 | 0.046173 | 0.013283 | 86.7746 | 296.1 | 13230.4 | 299.0 | QMJ_LAG |
| 2 | 0.721109 | 0.701188 | 8.2668 | 260.0 | 4006.6 | 264.3 | SQRT_QMA LN_QJA |
| 2 | 0.713187 | 0.692701 | 9.2117 | 260.9 | 4120.4 | 265.2 | LN_QJF SQRT_QMA |
| 2 | 0.653258 | 0.628490 | 16.3602 | 266.8 | 4981.4 | 271.1 | SQRT_QMA LN_QND |
| 2 | 0.622407 | 0.595436 | 20.0402 | 269.4 | 5424.6 | 273.7 | SQRT_QMA LN_QSO |
| 3 | 0.782091 | 0.757879 | 2.9927 | 254.4 | 3246.5 | 260.1 | LN_QJF SQRT_QMA LN_QJA |
| 3 | 0.758153 | 0.731281 | 5.8481 | 257.6 | 3603.1 | 263.3 | LN_QJF SQRT_QMA LN_QND |
| 3 | 0.736825 | 0.707583 | 8.3921 | 260.2 | 3920.9 | 265.9 | LN_QJF SQRT_QMA QMJ_LAG |
| 3 | 0.723932 | 0.693258 | 9.9300 | 261.7 | 4113.0 | 267.4 | SQRT_QMA LN_QJA LN_QND |
| 4 | 0.791620 | 0.759562 | 3.8560 | 255.0 | 3223.9 | 262.1 | LN_QJF SQRT_QMA LN_QJA LN_QND |
| 4 | 0.785655 | 0.752679 | 4.5676 | 255.9 | 3316.2 | 263.0 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA |
| 4 | 0.782241 | 0.748739 | 4.9749 | 256.3 | 3369.0 | 263.5 | LN_QJF SQRT_QMA LN_QJA LN_QSO |
| 4 | 0.779039 | 0.745045 | 5.3568 | 256.8 | 3418.6 | 264.0 | LN_QJF SQRT_QMA QMJ_LAG LN_QND |
| 5 | 0.797580 | 0.757097 | 5.1451 | 256.1 | 3257.0 | 264.7 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QND |
| 5 | 0.792273 | 0.750728 | 5.7781 | 256.9 | 3342.4 | 265.5 | LN_QJF SQRT_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.785745 | 0.742895 | 6.5568 | 257.8 | 3447.4 | 266.4 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QSO |
| 5 | 0.779608 | 0.735530 | 7.2888 | 258.7 | 3546.2 | 267.3 | LN_QJF SQRT_QMA QMJ_LAG LN_QSO LN_QND |
| 6 | 0.798797 | 0.748496 | 7.0000 | 257.9 | 3372.3 | 267.9 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QSO LN_QND |

| OBS | _MODEL_ | _TYPE_ | _DEPVAR_ | _RMSE_ | INTERCEP | LN_QJF | SQRT_QMA | QMJ_LAG | LN_QJA | LN_QSO |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MODEL1 | PARMS | DRUM | 73.126 | -67.042 | . | 40.5167 | . | . | . |
| 2 | MODEL1 | PARMS | DRUM | 105.837 | -70.368 | . | . | . | . | . |
| 3 | MODEL1 | PARMS | DRUM | 109.058 | -49.737 | . | . | . | 44.8281 | . |
| 4 | MODEL1 | PARMS | DRUM | 115.024 | 90.275 | . | . | 0.29889 | . | . |
| 5 | MODEL1 | PARMS | DRUM | 63.298 | -218.988 | . | 39.4003 | . | 38.8539 | . |
| 6 | MODEL1 | PARMS | DRUM | 64.191 | 81.858 | -55.2691 | 48.2444 | . | . | . |
| 7 | MODEL1 | PARMS | DRUM | 70.579 | -145.939 | . | 37.0576 | . | . | . |
| 8 | MODEL1 | PARMS | DRUM | 73.652 | -109.733 | . | 41.0958 | . | . | 8.63826 |
| 9 | MODEL1 | PARMS | DRUM | 56.978 | -72.285 | -44.5905 | 45.8302 | . | 32.0591 | . |
| 10 | MODEL1 | PARMS | DRUM | 60.026 | 1.569 | -57.0426 | 44.7628 | . | . | . |
| 11 | MODEL1 | PARMS | DRUM | 62.617 | 85.654 | -65.1455 | 47.6390 | 0.23385 | . | . |
| 12 | MODEL1 | PARMS | DRUM | 64.132 | -230.192 | . | 38.4436 | . | 35.5931 | . |
| 13 | MODEL1 | PARMS | DRUM | 56.780 | -82.935 | -47.7069 | 44.4948 | . | 25.5005 | . |
| 14 | MODEL1 | PARMS | DRUM | 57.587 | -56.520 | -49.7092 | 45.7986 | 0.09795 | 29.1109 | . |
| 15 | MODEL1 | PARMS | DRUM | 58.043 | -75.808 | -44.8325 | 45.9634 | . | 31.5356 | 1.25913 |
| 16 | MODEL1 | PARMS | DRUM | 58.469 | 7.561 | -66.2819 | 44.2980 | 0.22003 | . | . |
| 17 | MODEL1 | PARMS | DRUM | 57.070 | -63.690 | -54.8419 | 44.2733 | 0.12849 | 20.7488 | . |
| 18 | MODEL1 | PARMS | DRUM | 57.813 | -76.123 | -47.4866 | 44.0566 | . | 25.9958 | -2.82926 |
| 19 | MODEL1 | PARMS | DRUM | 58.715 | -59.377 | -49.8602 | 45.9025 | 0.09723 | 28.7251 | 0.97981 |
| 20 | MODEL1 | PARMS | DRUM | 59.550 | 15.648 | -66.4962 | 43.8796 | 0.22601 | . | -2.65235 |
| 21 | MODEL1 | PARMS | DRUM | 58.071 | -53.300 | -54.9208 | 43.6594 | 0.13536 | 21.1754 | -3.88807 |

| OBS | LN_QND | DRUM | _IN_ | _P_ | _EDF_ | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | . | -1 | 1 | 2 | 29 | 5347.36 | 0.61449 | 0.60120 | 18.9845 | 268.048 | 270.916 |
| 2 | 57.7238 | -1 | 1 | 2 | 29 | 11201.41 | 0.19245 | 0.16460 | 69.3263 | 290.970 | 293.838 |
| 3 | . | -1 | 1 | 2 | 29 | 11893.61 | 0.14255 | 0.11298 | 75.2789 | 292.829 | 295.697 |
| 4 | . | -1 | 1 | 2 | 29 | 13230.41 | 0.04617 | 0.01328 | 86.7746 | 296.131 | 298.999 |
| 5 | . | -1 | 2 | 3 | 28 | 4006.62 | 0.72111 | 0.70119 | 8.2668 | 260.012 | 264.314 |
| 6 | . | -1 | 2 | 3 | 28 | 4120.43 | 0.71319 | 0.69270 | 9.2117 | 260.880 | 265.182 |
| 7 | 27.3633 | -1 | 2 | 3 | 28 | 4981.39 | 0.65326 | 0.62849 | 16.3602 | 266.762 | 271.064 |
| 8 | . | -1 | 2 | 3 | 28 | 5424.60 | 0.62241 | 0.59544 | 20.0402 | 269.404 | 273.706 |
| 9 | . | -1 | 3 | 4 | 27 | 3246.49 | 0.78209 | 0.75788 | 2.9927 | 254.363 | 260.098 |
| 10 | 29.5031 | -1 | 3 | 4 | 27 | 3603.12 | 0.75815 | 0.73128 | 5.8481 | 257.594 | 263.329 |
| 11 | . | -1 | 3 | 4 | 27 | 3920.87 | 0.73682 | 0.70758 | 8.3921 | 260.214 | 265.949 |
| 12 | 8.3086 | -1 | 3 | 4 | 27 | 4112.95 | 0.72393 | 0.69326 | 9.9300 | 261.696 | 267.432 |
| 13 | 15.5013 | -1 | 4 | 5 | 26 | 3223.92 | 0.79162 | 0.75956 | 3.8560 | 254.976 | 262.146 |
| 14 | . | -1 | 4 | 5 | 26 | 3316.21 | 0.78565 | 0.75268 | 4.5676 | 255.851 | 263.021 |
| 15 | . | -1 | 4 | 5 | 26 | 3369.03 | 0.78224 | 0.74874 | 4.9749 | 256.341 | 263.511 |
| 16 | 28.6139 | -1 | 4 | 5 | 26 | 3418.57 | 0.77904 | 0.74504 | 5.3568 | 256.794 | 263.964 |
| 17 | 17.5911 | -1 | 5 | 6 | 25 | 3256.97 | 0.79758 | 0.75710 | 5.1451 | 256.077 | 264.681 |
| 18 | 17.1107 | -1 | 5 | 6 | 25 | 3342.37 | 0.79227 | 0.75073 | 5.7781 | 256.879 | 265.483 |
| 19 | . | -1 | 5 | 6 | 25 | 3447.40 | 0.78575 | 0.74289 | 6.5568 | 257.838 | 266.442 |
| 20 | 30.3535 | -1 | 5 | 6 | 25 | 3546.15 | 0.77961 | 0.73553 | 7.2888 | 258.714 | 267.318 |
| 21 | 19.9145 | -1 | 6 | 7 | 24 | 3372.30 | 0.79880 | 0.74850 | 7.0000 | 257.890 | 267.928 |

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | -53.299912 | 82.38766084 | -0.647 | 0.5238 | 0.00000000 |
| LN_QJF | 1 | -54.920812 | 18.80256745 | -2.921 | 0.0075 | 1.67114145 |
| SQRT_QMA | 1 | 43.659365 | 5.69334314 | 7.668 | 0.0001 | 1.44729798 |
| QMJ_LAG | 1 | 0.135364 | 0.15345404 | 0.882 | 0.3865 | 1.45182591 |
| LN_QJA | 1 | 21.175358 | 13.99660935 | 1.513 | 0.1434 | 1.65760533 |
| LN_QSO | 1 | -3.888068 | 10.20809028 | -0.381 | 0.7066 | 1.33962053 |
| LN_QND | 1 | 19.914510 | 15.96084655 | 1.248 | 0.2242 | 1.75508790 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop SQRT_QMA | Var Prop QMJ_LAG | Var Prop LN_QJA | Var Prop LN_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.03784 | 1.00000 | 0.0340 | 0.0509 | 0.0621 | 0.0490 | 0.0376 | 0.0790 |
| 2 | 1.56793 | 1.14005 | 0.1195 | 0.0825 | 0.0175 | 0.0763 | 0.1026 | 0.0167 |
| 3 | 0.88885 | 1.51416 | 0.0145 | 0.1859 | 0.3832 | 0.0001 | 0.0399 | 0.1264 |
| 4 | 0.79626 | 1.59977 | 0.1057 | 0.0282 | 0.0680 | 0.2446 | 0.3707 | 0.0215 |
| 5 | 0.41560 | 2.21434 | 0.2579 | 0.6440 | 0.0193 | 0.0333 | 0.3818 | 0.2555 |
| 6 | 0.29351 | 2.63496 | 0.4684 | 0.0085 | 0.4499 | 0.5967 | 0.0675 | 0.5010 |

Variable

| Variable | DF | Label |
|---|---|---|
| INTERCEP | 1 | Intercept |
| LN_QJF | 1 | Ln (January-February Inflows) |
| SQRT_QMA | 1 | SQRT (March-April Inflows) |
| QMJ_LAG | 1 | May-June Inflows |
| LN_QJA | 1 | Ln (July-August Inflows) |
| LN_QSO | 1 | Ln (September-October Inflows) |
| LN_QND | 1 | Ln (November-December Inflows) |

### 7.4.5 Untransformed, Logged and Square Root Variables: 1979 and 1993 Omitted

N = 31 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.533660 | 0.517579 | 13.8720 | 269.2 | 5548.4 | 272.1 | SQRT_QMA |
| 1 | 0.210409 | 0.183182 | 42.2029 | 285.5 | 9394.3 | 288.4 | LN_QND |
| 1 | 0.175432 | 0.146998 | 45.2685 | 286.9 | 9810.5 | 289.7 | LN_QJA |
| 1 | 0.006082 | -.028191 | 60.1110 | 292.7 | 11825.3 | 295.5 | LN_QJF |
| 2 | 0.639003 | 0.613218 | 6.6392 | 263.3 | 4448.4 | 267.6 | LN_QJF SQRT_QMA |
| 2 | 0.633579 | 0.607407 | 7.1146 | 263.7 | 4515.3 | 268.0 | SQRT_QMA LN_QJA |
| 2 | 0.581982 | 0.552124 | 11.6367 | 267.8 | 5151.1 | 272.1 | SQRT_QMA LN_QND |
| 2 | 0.543137 | 0.510504 | 15.0413 | 270.6 | 5629.7 | 274.9 | SQRT_QMA LN_QSO |
| 3 | 0.700336 | 0.667040 | 3.2638 | 259.5 | 3829.4 | 265.2 | LN_QJF SQRT_QMA LN_QJA |
| 3 | 0.698955 | 0.665506 | 3.3848 | 259.6 | 3847.0 | 265.4 | LN_QJF SQRT_QMA LN_QND |
| 3 | 0.661792 | 0.624213 | 6.6419 | 263.2 | 4322.0 | 269.0 | SQRT_QMA QMJ_LAG LN_QJA |
| 3 | 0.651749 | 0.613055 | 7.5221 | 264.1 | 4450.3 | 269.9 | LN_QJF SQRT_QMA LN_QSO |
| 4 | 0.722170 | 0.679427 | 3.3501 | 259.1 | 3686.9 | 266.3 | LN_QJF SQRT_QMA LN_QJA LN_QND |
| 4 | 0.708293 | 0.663415 | 4.5664 | 260.6 | 3871.1 | 267.8 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA |
| 4 | 0.701660 | 0.655762 | 5.1477 | 261.3 | 3959.1 | 268.5 | LN_QJF SQRT_QMA LN_QJA LN_QSO |
| 4 | 0.699320 | 0.653062 | 5.3528 | 261.6 | 3990.2 | 268.8 | LN_QJF SQRT_QMA QMJ_LAG LN_QND |
| 5 | 0.726008 | 0.671210 | 5.0138 | 260.7 | 3781.4 | 269.3 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QND |
| 5 | 0.722539 | 0.667047 | 5.3178 | 261.1 | 3829.3 | 269.7 | LN_QJF SQRT_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.709812 | 0.651774 | 6.4333 | 262.5 | 4005.0 | 271.1 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QSO |
| 5 | 0.699322 | 0.639186 | 7.3526 | 263.6 | 4149.8 | 272.2 | LN_QJF SQRT_QMA QMJ_LAG LN_QSO LN_QND |
| 6 | 0.726165 | 0.657706 | 7.0000 | 262.7 | 3936.8 | 272.7 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QSO LN_QND |

### 7.4.6 Untransformed, Logged and Square Root Variables: 1981 and 1993 Omitted

N = 31     Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.485960 | 0.468234 | 22.7928 | 272.3 | 6138.4 | 275.2 | SQRT_QMA |
| 1 | 0.198617 | 0.170983 | 50.6264 | 286.1 | 9569.7 | 289.0 | LN_QJA |
| 1 | 0.165069 | 0.136278 | 53.8761 | 287.4 | 9970.3 | 290.2 | LN_QND |
| 1 | 0.018423 | -.015424 | 68.0809 | 292.4 | 11721.5 | 295.2 | QMJ_LAG |
| 2 | 0.646835 | 0.621609 | 9.2095 | 262.7 | 4367.9 | 267.0 | SQRT_QMA LN_QJA |
| 2 | 0.585124 | 0.555490 | 15.1872 | 267.7 | 5131.2 | 272.0 | LN_QJF SQRT_QMA |
| 2 | 0.578857 | 0.548776 | 15.7942 | 268.1 | 5208.7 | 272.4 | SQRT_QMA LN_QND |
| 2 | 0.496805 | 0.460863 | 23.7422 | 273.7 | 6223.5 | 278.0 | SQRT_QMA LN_QSO |
| 3 | 0.708690 | 0.676322 | 5.2179 | 258.7 | 3736.4 | 264.5 | LN_QJF SQRT_QMA LN_QJA |
| 3 | 0.703598 | 0.670664 | 5.7111 | 259.3 | 3801.7 | 265.0 | LN_QJF SQRT_QMA LN_QND |
| 3 | 0.664220 | 0.626911 | 9.5255 | 263.1 | 4306.7 | 268.9 | SQRT_QMA LN_QJA LN_QND |
| 3 | 0.655080 | 0.616756 | 10.4108 | 264.0 | 4423.9 | 269.7 | SQRT_QMA QMJ_LAG LN_QJA |
| 4 | 0.746377 | 0.707358 | 3.5674 | 256.4 | 3378.1 | 263.6 | LN_QJF SQRT_QMA LN_QJA LN_QND |
| 4 | 0.720032 | 0.676960 | 6.1192 | 259.5 | 3729.0 | 266.7 | LN_QJF SQRT_QMA QMJ_LAG LN_QND |
| 4 | 0.708804 | 0.664005 | 7.2069 | 260.7 | 3878.5 | 267.9 | LN_QJF SQRT_QMA LN_QJA LN_QSO |
| 4 | 0.708757 | 0.663950 | 7.2114 | 260.7 | 3879.2 | 267.9 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA |
| 5 | 0.749339 | 0.699207 | 5.2804 | 258.1 | 3472.2 | 266.7 | LN_QJF SQRT_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.748467 | 0.698160 | 5.3649 | 258.2 | 3484.3 | 266.8 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QND |
| 5 | 0.722584 | 0.667101 | 7.8720 | 261.2 | 3842.8 | 269.8 | LN_QJF SQRT_QMA QMJ_LAG LN_QSO LN_QND |
| 5 | 0.708860 | 0.650632 | 9.2014 | 262.7 | 4032.9 | 271.3 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QSO |
| 6 | 0.752234 | 0.690292 | 7.0000 | 259.7 | 3575.1 | 269.7 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QSO LN_QND |

### 7.4.7 Untransformed, Logged and Square Root Variables: 1979, 1981 and 1993 Omitted

N = 30 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.545871 | 0.529652 | 21.2598 | 260.5 | 5528.8 | 263.3 | SQRT_QMA |
| 1 | 0.217653 | 0.189712 | 55.4165 | 276.8 | 9524.6 | 279.6 | LN_QJA |
| 1 | 0.213145 | 0.185043 | 55.8856 | 277.0 | 9579.5 | 279.8 | LN_QND |
| 1 | 0.016300 | -.018832 | 76.3707 | 283.7 | 11976.0 | 286.5 | QMJ_LAG |
| 2 | 0.679364 | 0.655613 | 9.3676 | 252.0 | 4048.1 | 256.2 | SQRT_QMA LN_QJA |
| 2 | 0.669887 | 0.645434 | 10.3539 | 252.9 | 4167.8 | 257.1 | LN_QJF SQRT_QMA |
| 2 | 0.594204 | 0.564145 | 18.2300 | 259.1 | 5123.3 | 263.3 | SQRT_QMA LN_QND |
| 2 | 0.555955 | 0.523063 | 22.2104 | 261.8 | 5606.2 | 266.0 | SQRT_QMA LN_QSO |
| 3 | 0.760540 | 0.732910 | 2.9198 | 245.3 | 3139.5 | 250.9 | LN_QJF SQRT_QMA LN_QJA |
| 3 | 0.730756 | 0.699689 | 6.0194 | 248.8 | 3530.0 | 254.4 | LN_QJF SQRT_QMA LN_QND |
| 3 | 0.694492 | 0.659242 | 9.7932 | 252.6 | 4005.5 | 258.2 | LN_QJF SQRT_QMA QMJ_LAG |
| 3 | 0.685840 | 0.649591 | 10.6936 | 253.4 | 4118.9 | 259.0 | SQRT_QMA QMJ_LAG LN_QJA |
| 4 | 0.774692 | 0.738643 | 3.4471 | 245.4 | 3072.2 | 252.4 | LN_QJF SQRT_QMA LN_QJA LN_QND |
| 4 | 0.762131 | 0.724071 | 4.7544 | 247.1 | 3243.4 | 254.1 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA |
| 4 | 0.761101 | 0.722877 | 4.8615 | 247.2 | 3257.5 | 254.2 | LN_QJF SQRT_QMA LN_QJA LN_QSO |
| 4 | 0.750742 | 0.710861 | 5.9395 | 248.5 | 3398.7 | 255.5 | LN_QJF SQRT_QMA QMJ_LAG LN_QND |
| 5 | 0.778155 | 0.731937 | 5.0868 | 247.0 | 3151.0 | 255.4 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QND |
| 5 | 0.775137 | 0.728290 | 5.4008 | 247.4 | 3193.8 | 255.8 | LN_QJF SQRT_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.762582 | 0.713120 | 6.7074 | 249.0 | 3372.2 | 257.4 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QSO |
| 5 | 0.751044 | 0.699178 | 7.9081 | 250.4 | 3536.1 | 258.8 | LN_QJF SQRT_QMA QMJ_LAG LN_QSO LN_QND |
| 6 | 0.778988 | 0.721333 | 7.0000 | 248.9 | 3275.6 | 258.7 | LN_QJF SQRT_QMA QMJ_LAG LN_QJA LN_QSO LN_QND |

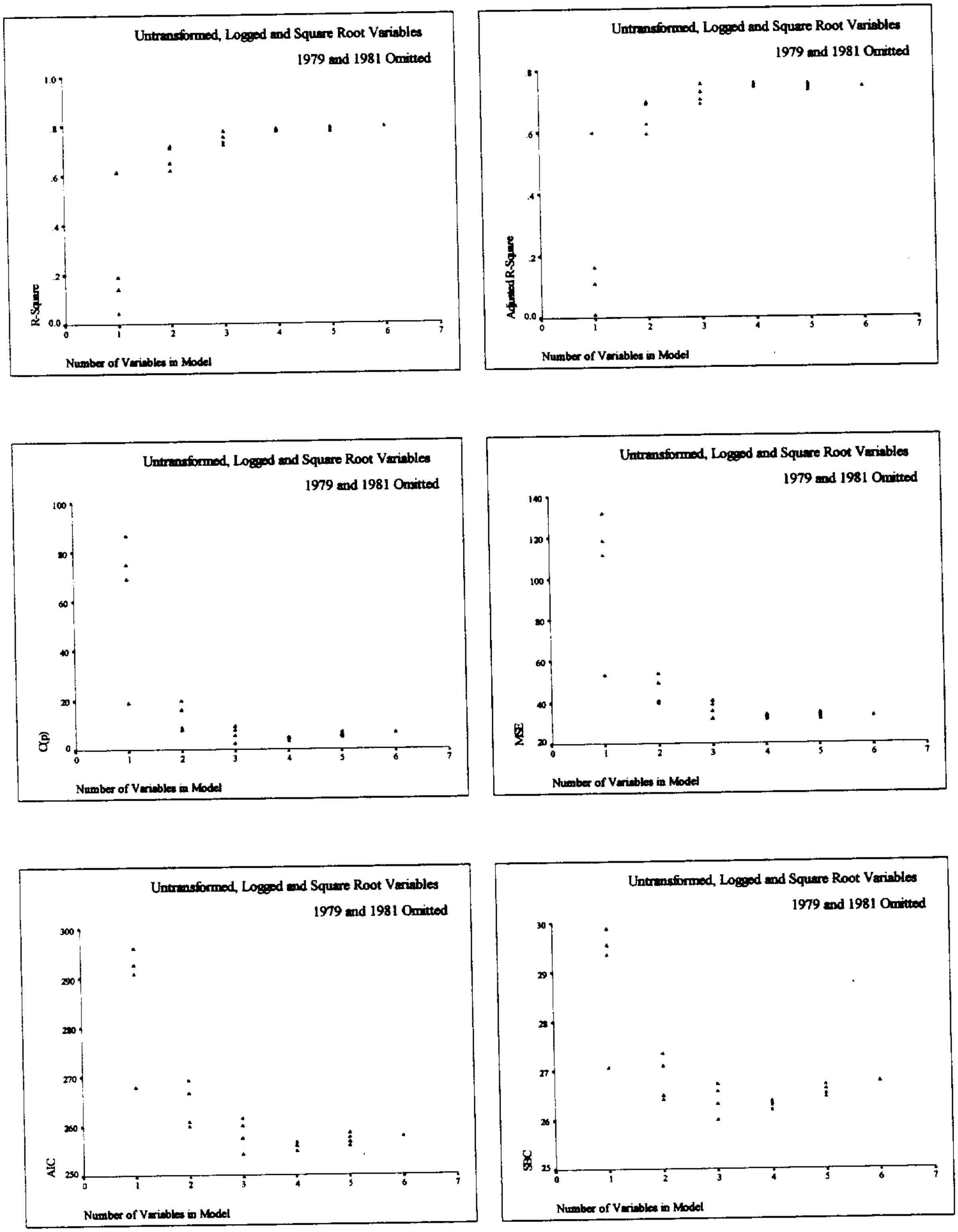



Fig. 7.1. Examining Subsets of Untransformed, Logged and Square Root Data: 1979 and 1981 Omitted.

# Drum Harvests in Aransas Bay:
# A Regression Analysis

## Harvest vs Freshwater Inflows

F. Michael Speed
Michael Longnecker
Rita Miranda-López

*Department of Statistics*
*Texas A&M University*

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Texas A&M University

SPRING 1997

# Table of Contents

## 1. Summary Report

### 1.1 Description of the Problem[1]

Bimonthly freshwater inflows into Aransas Bay were recorded for the years 1961 to 1993. These variables, and various transformations of them, were used to construct a model for the annual harvest of Drum.

### 1.2 Constructing Models - General Discussion

Stability of coefficient estimates and accuracy of predicted values are primary goals in constructing models for prediction. To this end, the data must be examined from three points of view: individual observations (to detect outliers or influential points); variables, individually and in groups (to select an optimal set of predictors); and the interaction of these two, which produces the overall structure of the data set (to determine whether multicollinearity is present or not). The first two of these were examined by both graphic and quantitative means; the third by quantitative means only.

#### 1.2.1 Detecting Influential Points and Outliers

The structures of individual variables were examined via box plots and histograms, as well as by all the usual numerical measures. For each pair of variables, 99 % prediction ellipses and 95% confidence ellipses were plotted in a further effort to look for unusual points. For example, suppose large values of Variable A are generally associated with large values for Variable B. If an observation consisted of a large value for Variable A but a small value for Variable B, that point would be considered unusual, even though it was well within the range of data for both variables and could not be considered an outlier.

In addition, a number of residual analysis techniques were employed. A large *residual* indicates a point not well-fit by the model. The *deleted residual*, however, is somewhat more useful in the search for influential points. The model is fitted without a given observation, and the predicted response and corresponding residual are calculated for that observation. The *Studentized deleted residual* is scaled to have a Student's t distribution. Histograms and normal P-P plots of the residuals were also examined.

Other quantities, such as the Mahalanobis distance, Cook's distance, the leverage value, standarized values for the Dffits (to measure the influence of a given observation on the predicted response) and the Dfbetas (to measure the influence of a given observation on the calculated coefficients) were also used to build a general picture of the influence of individual points. Plots were made of the standardized Dffits value for each model against the Dfbeta values for each predictor in the model. Points which were extreme indicated observations which had strong effects on both predicted values and coefficient estimates.

#### 1.2.2 Variable Selection

For each regression, residuals were plotted against each of the independent variables to look for nonlinear relationships between the response variable and individual predictors. Partial residual plots were employed to examine the overall relationship between the response and individual predictors. A partial

[1] The following discussion, prepared by Jacqueline Kiffe, was taken from Seatrout Harvests in Galveston Bay: A Regression Analysis, by F. Michael Speed, Sr. and Jacqueline Kiffe.

residual is a corollary to the deleted residual. That is, the model is fitted without a given variable and the predicted response and corresponding residual are calculated for each observation. This seeks to answer the question, "What is the relationship of this predictor to the response variable, taking all other variables into account?" Thus, it examines the marginal relationship of a given predictor to the response.

Numerous measures have been developed over the years to assess the adequacy of a given model. We examined a number of these, including $R^2$ and mean squared error (MSE), and several others which directly incorporate penalties for having too many predictors in the model, such as adjusted $R^2$, $C_p$, AIC, and SBC. It is well-established that too many predictors in a model can lead to bad prediction, just as too few can, and these measures are used as part of the attempt to find an optimal model.

#### 1.2.3 Multicollinearity

Multicollinearity arises when one or more variables are nearly closely approximated by linear combinations of the remaining variables, resulting in unstable coefficient estimates. The variance inflation factor (VIF) was calculated for each coefficient estimate to measure this instability, which is not usually considered profound for VIF's less than 10. No problems were found with this data. Additionally, the condition index (a ratio of eigenvalues of the covariance matrix, with the largest eigenvalue always on top) was calculated. A ratio greater than 30 is considered cause for concern. Again, no evidence of multicollinearity was found.

#### 1.2.4 Other Procedures

Several other miscellaneous diagnostics, including the Durbin-Watson test for serial autocorrelation were performed, and no general problems were detected. The Box-Cox procedure, used to find a transformation to normality, was also performed.

### 1.3 How the Final Model Was Chosen

#### 1.3.1 Selecting the Data Set Used

First, the variables were explored thoroughly, individually and in pairs, in a first effort to detect outliers. The SAS programming language allows a number of diagnostics to be calculated for a group of models on a given data set without actually performing a formal regression, thus allowing one to examine a large number of models quite efficiently. The Box-Cox procedure was performed to find if a transformation to normality was suggested. The log transform was suggested for some variables, and the square root for others. At this point, there were several data sets for which the diagnostic series was calculated:

1. Untransformed data.
2. Harvest untransformed, and natural log of inflow variables.
3. All variables logged.
4. Harvest untransformed, and square root of inflows variables.
5. All variables square root.
6. Harvest untransformed, and logged and square root inflows.
7. Logged and square root variables.
8. Harvest and inflows variables transformed according to Box-Cox suggestion.

**1.3.2 Selecting the Points to be Omitted**

The full regression with all diagnostics was performed for these models, each one contained all variables in its corresponding data set. All diagnostics were generated, and influential points were determined for each model.

Table 1.1 R-Square and Adjusted R-Square values for the different suggested models.

| Data Set | $R^2$ | Adjusted $R^2$ |
|---|---|---|
| **1** | **0.5055** | **0.3914** |
| **2** | **0.4666** | **0.3435** |
| 3 | 0.2736 | 0.1060 |
| **4** | **0.4995** | **0.3840** |
| 5 | 0.4369 | 0.3070 |
| **6** | **0.4692** | **0.3467** |
| 7 | 0.4159 | 0.2811 |
| 8 | 0.3569 | 0.2085 |

Data set 1 presented the highest $R^2$ values. However , the models 1, 2, 4, and 6 were considered as final candidates. The observations flagged as potentially influential are given in the summary table below, for each model.

Table 1.2 Summary of points flagged by 99% Prediction Ellipse.

| Year | Variable |
|---|---|
| 1962 | Harvest vs. Jan-Feb, Harvest vs. Mar-Apr, Harvest vs. May-Jun, Harvest vs. Jul-Aug, Harvest vs. Sept-Oct, Harvest vs. Nov-Dec, Jan-Feb vs. Mar-Apr Inflows. |
| 1992 | Harvest vs. Mar-Apr, Mar-Apr vs. May-Jun, Mar-Apr vs. Jul-Aug Mar-Apr vs. Sept-Oct, Mar-Apr vs. Nov-Dec Inflows. |
| 1993 | Harvest vs. Jan-Feb, Harvest vs. Mar-Apr, Jan-Feb vs. Mar-Apr, Jan-Feb vs. May-Jun, Jan-Feb vs. Jul-Aug, Jan-Feb vs. Sept-Oct, Jan-Feb vs. Nov-Dec, Mar-Apr vs. May-Jun, Mar-Apr vs. Jul-Aug Mar-Apr vs. Sept-Oct, Mar-Apr vs. Nov-Dec, May-Jun vs. Sept-Oct May-Jun vs. Nov-Dec Inflows. |

Table 1.3 Summary of points flagged by Boxplots.

| Year | Variable |
|---|---|
| 1962 | Harvest. |
| 1985 | Mar-Apr Inflows. |
| 1986 | Mar-Apr Inflows. |
| 1987 | Mar-Apr Inflows. |
| 1988 | Ln (Harvest). |
| 1992 | Mar-Apr, SQRT (Mar-Apr) Inflows. |
| 1993 | Jan-Feb, Mar-Apr, Ln (Mar-Apr), SQRT (Mar-Apr) Inflows. |

Table 1.4 Summary of points flagged by diagnostic measures.

| YEAR | BOX | SRE | SDR | LEV | MAH | COO | SDF | SDB | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| **DATA SET 1** | | | | | | | | | |
| **1962** | **1** | | | | | | **1** | **2** | **4** |
| **1964** | | | **1** | | | | **1** | **1** | **3** |
| 1985 | 1 | | | | | | | | 1 |
| 1986 | 1 | | | | | | | | 1 |
| 1987 | 1 | | | | | | | | 1 |
| 1992 | 1 | | | | | | | | 1 |
| **1993** | **2** | | | **1** | **1** | | | | **4** |
| **DATA SET 2** | | | | | | | | | |
| **1962** | **1** | | **1** | | | | **1** | | **3** |
| **1964** | | | | | | | **1** | **1** | **2** |
| 1986 | | | | | | | 1 | | 1 |
| **1988** | | | **1** | | | | **1** | | **2** |
| 1993 | 1 | | | | | | | | 1 |
| **Data Set 4** | | | | | | | | | |
| **1962** | **1** | | **1** | | | | **1** | | **3** |
| **1964** | | | **1** | | | | **1** | **1** | **3** |
| 1988 | | | 1 | | | | | | 1 |
| 1992 | 1 | | | | | | | | 1 |
| 1993 | 1 | | | | | | | | 1 |
| **Data Set 6** | | | | | | | | | |
| **1962** | **1** | | **1** | | | | **1** | | **3** |
| 1963 | | | | | | | 1 | | 1 |
| 1964 | | | | | | | 1 | | 1 |
| 1986 | | | | | | | 1 | | 1 |
| **1988** | | | **1** | | | | **1** | | **2** |
| 1993 | 1 | | | | | | | | 1 |

Key to Abbreviations:

**BOX** Box plot
**SRE** Studentized residual
**SDR** Studentized deleted residual
**LEV** Leverage value
**MAH** Mahalanobis distance
**COO** Cook's distance
**SDF** Standardized Dffits value
**SDB** Standardized Dfbeta value

### 1.3.3 Selecting the Final Candidate Models

After the subset analysis led us to the models: Data Set 1 (untransformed all variables) 1962, 1964 and/or 1993 omitted; Data Set 2 (harvest untransformed and logged inflows) 1962, 1964 and 1988 omitted, Data Set 4 (harvest untransformed and square root inflows) 1962 and/or 1964 omitted; Data Set 6 (untransformed, logged and square root variables) 1962 and/or 1988 omitted.

Table 1.5 R-Square and Adjusted R-Square values for the different subsets.

| Data Set | Observations omitted | $R^2$ | Adjusted $R^2$ |
|---|---|---|---|
| 1 | 1962 | 0.3969 | 0.2521 |
| | **1964** | **0.5809** | **0.4803** |
| | 1993 | 0.4998 | 0.3798 |
| | 1962 and 1964 | 0.4912 | 0.3641 |
| | 1962 and 1993 | 0.4912 | 0.3641 |
| | 1964 and 1993 | 0.5799 | 0.4749 |
| | 1962, 1964 and 1993 | 0.4762 | 0.3396 |
| 2 | 1962 | 0.3966 | 0.2517 |
| | 1964 | 0.4959 | 0.3750 |
| | 1988 | 0.5661 | 0.4619 |
| | 1962 and 1964 | 0.4219 | 0.2774 |
| | 1962 and 1988 | 0.5133 | 0.3916 |
| | 1964 and 1988 | 0.5843 | 0.4803 |
| | 1962, 1964 and 1988 | 0.5288 | 0.4059 |
| 4 | 1962 | 0.3942 | 0.2488 |
| | 1964 | 0.5640 | 0.4594 |
| | 1962 and 1964 | 0.4727 | 0.3408 |
| 6 | 1962 | 0.4112 | 0.2699 |
| | 1988 | 0.5731 | 0.4706 |
| | 1962 and 1988 | 0.5341 | 0.4176 |

### 1.3.4 Selecting the Final Model

Data Set 1 with 1964 omitted is selected as best model. Regression was performed using this model, and the deleted residuals were calculated.

| Best Candidate Model | $R^2$ | Adjusted $R^2$ | Prob>F |
|---|---|---|---|
| Drum Harvest = 64.894 + 0.541*(January-February Inflows) - 0.638*(March-April Inflows) - 0.687*(July-August Inflows) + 0.090*(September-October Inflows) + 0.914*(November-December Inflows) | 0.578 | 0.497 | $2.55 \times 10^{-4}$ |

## 1.4 Best Model: Untransformed Variables

### 1.4.1 Summary Information

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| Drum Harvest | 77.7406 | 61.9552 | 32 |
| January-February Inflows | 47.5103 | 40.2185 | 32 |
| March-April Inflows | 39.7263 | 44.2597 | 32 |
| July-August Inflows | 74.1784 | 70.3320 | 32 |
| September-October Inflows | 192.0331 | 167.9092 | 32 |
| November-December Inflows | 50.6116 | 40.1257 | 32 |

**Model Summary**[a,b]

| Model | Variables | | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| | Entered | Removed | | | | | |
| 1 | Nov-Dec Inflows, Sept-Oct Inflows, Jul-Aug Inflows, Mar-Apr Inflows, Jan-Feb Inflows[c,d] | . | .761 | .578 | .497 | 43.9241 | 1.716 |

a. Dependent Variable: Drum Harvest

b. Method: Enter

c. Independent Variables: (Constant), November-December Inflows, September-October Inflows, July-August Inflows, March-April Inflows, January-February Inflows

d. All requested variables entered.

**ANOVA**[a]

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 68829.3 | 5 | 13765.9 | 7.135 | .000[b] |
| | Residual | 50162.5 | 26 | 1929.325 | | |
| | Total | 118992 | 31 | | | |

a. Dependent Variable: Drum Harvest

b. Independent Variables: (Constant), November-December Inflows, September-October Inflows, July-August Inflows, March-April Inflows, January-February Inflows

**Coefficients [a]**

| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. | 95% Confidence Interval for B Lower Bound | 95% Confidence Interval for B Upper Bound |
|---|---|---|---|---|---|---|---|---|
| 1 | (Constant) | 64.894 | 18.619 | | 3.485 | .002 | 26.623 | 103.165 |
| | January-February Inflows | .541 | .267 | .351 | 2.030 | .053 | -.007 | 1.089 |
| | March-April Inflows | -.638 | .231 | -.456 | -2.760 | .010 | -1.113 | -.163 |
| | July-August Inflows | -.687 | .131 | -.780 | -5.256 | .000 | -.956 | -.419 |
| | September-October Inflows | 9.0E-02 | .048 | .243 | 1.851 | .075 | -.010 | .189 |
| | November-December Inflows | .914 | .248 | .592 | 3.689 | .001 | .405 | 1.422 |

a. Dependent Variable: Drum Harvest

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | -23.2093 | 200.1680 | 77.7406 | 47.1201 | 32 |
| Std. Predicted Value | -2.142 | 2.598 | .000 | 1.000 | 32 |
| Standard Error of Predicted Value | 11.7137 | 33.4026 | 18.4488 | 4.6988 | 32 |
| Adjusted Predicted Value | -36.5232 | 212.1954 | 76.8707 | 48.5333 | 32 |
| Residual | -75.9918 | 90.3299 | 1.5E-14 | 40.2262 | 32 |
| Std. Residual | -1.730 | 2.057 | .000 | .916 | 32 |
| Stud. Residual | -1.839 | 2.433 | .009 | 1.018 | 32 |
| Deleted Residual | -85.9081 | 126.4418 | .8699 | 49.9607 | 32 |
| Stud. Deleted Residual | -1.934 | 2.715 | .018 | 1.055 | 32 |
| Mahal. Distance | 1.236 | 16.959 | 4.844 | 3.190 | 32 |
| Cook's Distance | .000 | .394 | .042 | .075 | 32 |
| Centered Leverage Value | .040 | .547 | .156 | .103 | 32 |

a. Dependent Variable: Drum Harvest

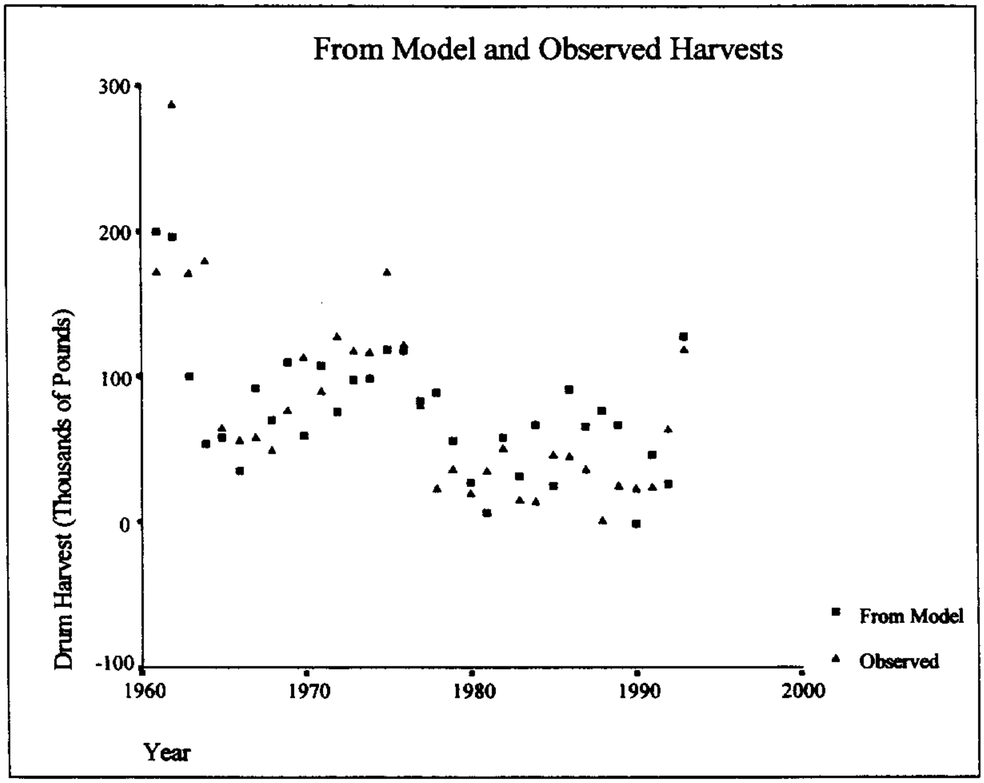
Table 1.6 Observed, predicted, lower and upper predicted intervals values for drum harvest.

| Year | Observed[a] | Predicted[a] | LICI | UICI |
|---|---|---|---|---|
| **1961** | 173.10 | 200.17 | 60.60 | 339.74 |
| **1962** | 286.90 | 196.57 | 58.18 | 334.96 |
| **1963** | 171.40 | 101.10 | 0 | 236.71 |
| **1964** | 180.70 | 54.48 | 0 | 185.28 |
| **1965** | 65.70 | 59.37 | 0 | 189.72 |
| **1966** | 57.40 | 36.05 | 0 | 166.55 |
| **1967** | 59.70 | 92.94 | 0 | 224.75 |
| **1968** | 50.70 | 70.86 | 0 | 203.62 |
| **1969** | 77.80 | 111.20 | 0 | 242.27 |
| **1970** | 114.00 | 60.40 | 0 | 188.03 |
| **1971** | 91.60 | 109.24 | 0 | 236.98 |
| **1972** | 129.00 | 76.92 | 0 | 205.74 |
| **1973** | 118.30 | 99.26 | 0 | 232.82 |
| **1974** | 118.00 | 99.34 | 0 | 225.66 |
| **1975** | 173.20 | 120.23 | 0 | 248.10 |
| **1976** | 123.40 | 118.49 | 0 | 255.90 |
| **1977** | 81.30 | 84.01 | 0 | 214.65 |
| **1978** | 24.10 | 89.45 | 0 | 218.55 |
| **1979** | 36.90 | 56.92 | 0 | 183.41 |
| **1980** | 20.60 | 27.82 | 0 | 160.36 |
| **1981** | 36.50 | 6.82 | 0 | 144.16 |
| **1982** | 51.90 | 58.85 | 0 | 194.24 |
| **1983** | 16.80 | 32.51 | 0 | 169.44 |
| **1984** | 15.70 | 67.61 | 0 | 202.97 |
| **1985** | 47.60 | 26.49 | 0 | 156.14 |
| **1986** | 46.40 | 92.02 | 0 | 219.81 |
| **1987** | 37.40 | 67.09 | 0 | 196.72 |
| **1988** | 2.10 | 78.09 | 0 | 207.00 |
| **1989** | 26.20 | 67.96 | 0 | 197.42 |
| **1990** | 24.00 | 0 | 0 | 111.60 |
| **1991** | 25.60 | 47.30 | 0 | 180.25 |
| **1992** | 64.90 | 26.82 | 0 | 169.60 |
| **1993** | 119.50 | 128.99 | 0 | 282.32 |

[a] Drum harvest (thousands of pounds).

LICI Lower limit for 99% prediction interval for drum harvest.

UICI Upper limit for 99% prediction interval for drum harvest.



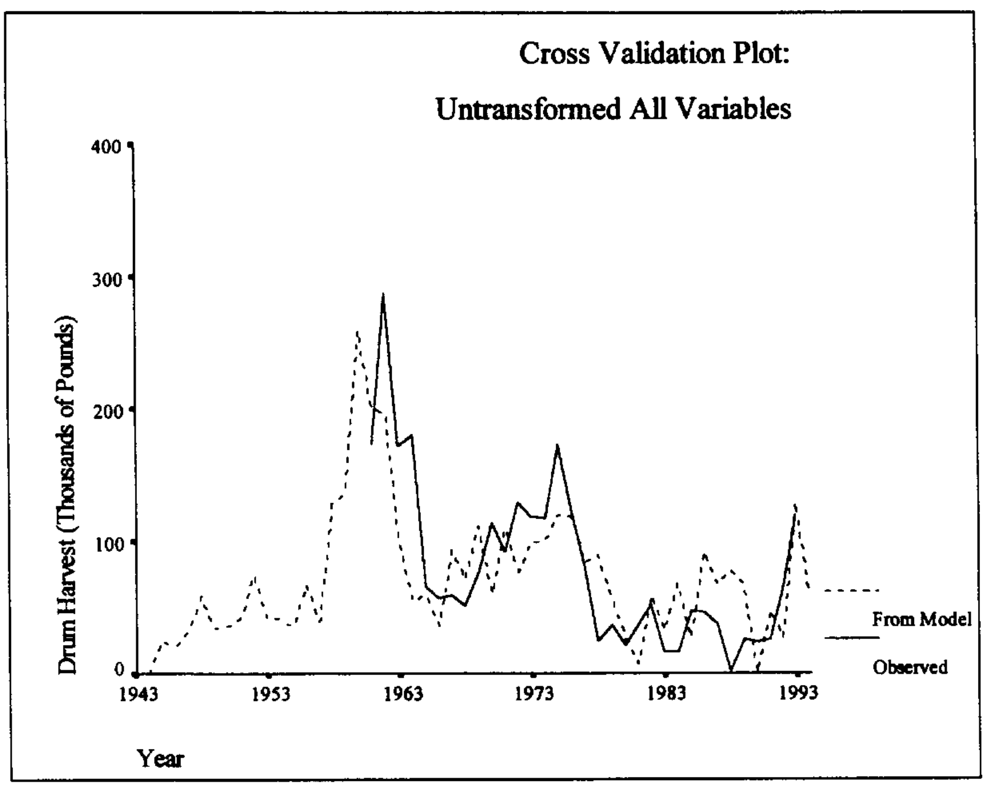




Fig. 1.1 Comparative plots of observed values vs. calculated from the regression model.

# 2. Exploring the Data

## 2.1 Listing of Data

Table 2.1. Drum harvest and water inflows data.

| Obs. | YEAR | DRUM | JF_LAG | MA_LAG | MJ_LAG | JA_LAG | SO_LAG | ND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | **1961** | 173.10 | 85.35 | 12.53 | 76.10 | 22.09 | 238.01 | 99.51 |
| 2 | **1962** | 286.90 | 71.46 | 11.40 | 58.42 | 16.61 | 197.47 | 102.87 |
| 3 | **1963** | 171.40 | 68.35 | 6.21 | 16.04 | 9.88 | 25.49 | 8.41 |
| 4 | **1964** | 180.70 | 2.27 | 2.73 | 11.40 | 27.05 | 9.91 | 8.54 |
| 5 | **1965** | 65.70 | 10.94 | 3.93 | 21.76 | 27.02 | 5.95 | 9.96 |
| 6 | **1966** | 57.40 | 16.67 | 37.16 | 117.89 | 33.60 | 6.96 | 9.10 |
| 7 | **1967** | 59.70 | 16.39 | 36.63 | 127.86 | 16.07 | 492.61 | 10.27 |
| 8 | **1968** | 50.70 | 12.89 | 36.99 | 303.30 | 39.42 | 502.38 | 5.04 |
| 9 | **1969** | 77.80 | 37.58 | 20.20 | 224.35 | 34.75 | 502.41 | 19.33 |
| 10 | **1970** | 114.00 | 42.43 | 38.25 | 263.17 | 35.14 | 54.97 | 17.70 |
| 11 | **1971** | 91.60 | 37.99 | 37.01 | 73.54 | 22.08 | 399.10 | 29.29 |
| 12 | **1972** | 129.00 | 14.82 | 33.38 | 176.66 | 39.38 | 415.48 | 16.51 |
| 13 | **1973** | 118.30 | 11.60 | 20.10 | 275.96 | 39.53 | 559.45 | 19.57 |
| 14 | **1974** | 118.00 | 13.40 | 22.00 | 302.27 | 31.27 | 311.23 | 38.09 |
| 15 | **1975** | 173.20 | 6.87 | 9.71 | 182.54 | 14.08 | 303.41 | 44.08 |
| 16 | **1976** | 123.40 | 5.73 | 11.83 | 52.72 | 87.96 | 153.34 | 114.66 |
| 17 | **1977** | 81.30 | 21.29 | 33.65 | 103.25 | 90.67 | 53.14 | 94.82 |
| 18 | **1978** | 24.10 | 29.50 | 34.03 | 127.02 | 90.38 | 75.87 | 93.72 |
| 19 | **1979** | 36.90 | 60.44 | 46.07 | 137.12 | 64.26 | 149.76 | 21.28 |
| 20 | **1980** | 20.60 | 83.81 | 22.90 | 64.94 | 145.73 | 196.12 | 16.15 |
| 21 | **1981** | 36.50 | 84.43 | 31.70 | 235.23 | 259.34 | 233.12 | 80.79 |
| 22 | **1982** | 51.90 | 109.62 | 20.93 | 233.23 | 206.96 | 126.17 | 86.40 |
| 23 | **1983** | 16.80 | 80.39 | 30.40 | 246.95 | 249.43 | 259.35 | 100.37 |
| 24 | **1984** | 15.70 | 110.17 | 21.69 | 54.92 | 134.92 | 228.72 | 31.91 |
| 25 | **1985** | 47.60 | 59.44 | 87.92 | 46.71 | 135.91 | 259.39 | 60.93 |
| 26 | **1986** | 46.40 | 50.87 | 77.70 | 37.42 | 11.36 | 82.91 | 54.22 |
| 27 | **1987** | 37.40 | 27.36 | 78.60 | 108.14 | 25.84 | 49.81 | 55.64 |
| 28 | **1988** | 2.10 | 21.02 | 4.35 | 92.74 | 23.02 | 31.80 | 19.23 |
| 29 | **1989** | 26.20 | 20.45 | 4.53 | 89.08 | 27.43 | 21.78 | 12.91 |
| 30 | **1990** | 24.00 | 8.94 | 21.24 | 16.96 | 131.02 | 19.54 | 9.76 |
| 31 | **1991** | 25.60 | 17.53 | 40.97 | 31.92 | 136.24 | 54.92 | 96.09 |
| 32 | **1992** | 64.90 | 114.69 | 176.81 | 201.10 | 143.36 | 66.40 | 115.20 |
| 33 | **1993** | 119.50 | 167.91 | 200.42 | 426.04 | 28.96 | 68.00 | 125.76 |

| | |
|---|---|
| **DRUM** | Drum harvest (thousands of pounds) |
| **JF_LAG** | Lagged January-February inflows (thousands of acre-feet) |
| **MA_LAG** | Lagged March-April inflows (thousands of acre-feet) |
| **MJ_LAG** | Lagged May-June inflows (thousands of acre-feet) |
| **JA_LAG** | Lagged July-August inflows (thousands of acre-feet) |
| **SO_LAG** | Lagged September-October inflows (thousands of acre-feet) |
| **ND_LAG** | Lagged November-December inflows (thousands of acre-feet) |

## 2.2 Test of Normality for Individual Variables

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Drum Harvest | .170 | 33 | .016 | .882 | 33 | .010** |
| Ln (Drum Harvest) | .096 | 33 | .200* | .930 | 33 | .048 |
| SQRT (Drum Harvest) | .101 | 33 | .200* | .973 | 33 | .621 |
| January-February Inflows | .185 | 33 | .005 | .869 | 33 | .010** |
| Ln (January-February Inflows) | .112 | 33 | .200* | .965 | 33 | .453 |
| SQRT (January-February Inflows) | .158 | 33 | .036 | .947 | 33 | .173 |
| March-April Inflows | .297 | 33 | .000 | .669 | 33 | .010** |
| Ln (March-April Inflows) | .157 | 33 | .039 | .956 | 33 | .320 |
| SQRT (March-April Inflows) | .200 | 33 | .002 | .873 | 33 | .010** |
| May-June Inflows | .143 | 33 | .085 | .914 | 33 | .017 |
| Ln (May-June Inflows) | .102 | 33 | .200* | .948 | 33 | .189 |
| SQRT (May-June Inflows) | .092 | 33 | .200* | .966 | 33 | .467 |
| July-August Inflows | .289 | 33 | .000 | .790 | 33 | .010** |
| Ln (July-August Inflows) | .185 | 33 | .006 | .931 | 33 | .051 |
| SQRT (July-August Inflows) | .252 | 33 | .000 | .872 | 33 | .010** |
| September-October Inflows | .185 | 33 | .005 | .873 | 33 | .010** |
| Ln (September-October Inflows) | .144 | 33 | .079 | .925 | 33 | .037 |
| SQRT (September-October Inflows) | .134 | 33 | .139 | .939 | 33 | .086 |
| November-December Inflows | .212 | 33 | .001 | .848 | 33 | .010** |
| Ln (November-December Inflows) | .154 | 33 | .046 | .908 | 33 | .012 |
| SQRT (November-December Inflows) | .182 | 33 | .007 | .885 | 33 | .010** |

**. This is an upper bound of the true significance.

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

## 2.3 Percentiles for Individual Variables

**Percentiles**

| | | Percentiles | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 10 | 25 | 50 | 75 | 90 | 95 |
| Weighted Average (Definition 1) | Drum Harvest | 11.6200 | 18.3200 | 31.3500 | 59.7000 | 118.9000 | 173.1600 | 212.5600 |
| | Ln (Drum Harvest) | 2.1501 | 2.9029 | 3.4315 | 4.0893 | 4.7783 | 5.1542 | 5.3355 |
| | SQRT (Drum Harvest) | 3.2084 | 4.2748 | 5.5801 | 7.7266 | 10.9041 | 13.1590 | 14.4912 |
| | January-February Inflows | 4.6920 | 7.6980 | 14.1100 | 29.5000 | 75.9250 | 109.9500 | 130.6560 |
| | Ln (January-February Inflows) | 1.4679 | 2.0325 | 2.6456 | 3.3844 | 4.3280 | 4.7000 | 4.8566 |
| | SQRT (January-February Inflows) | 2.1276 | 2.7686 | 3.7551 | 5.4314 | 8.7097 | 10.4857 | 11.3839 |
| | March-April Inflows | 3.5700 | 4.4220 | 12.1800 | 30.4000 | 37.7050 | 84.1920 | 183.8930 |
| | Ln (March-April Inflows) | 1.2593 | 1.4864 | 2.4994 | 3.4144 | 3.6297 | 4.4316 | 5.2127 |
| | SQRT (March-April Inflows) | 1.8834 | 2.1028 | 3.4896 | 5.5136 | 6.1403 | 9.1722 | 13.5550 |
| | May-June Inflows | 14.6480 | 18.8800 | 53.8200 | 108.1400 | 228.7900 | 291.7460 | 340.1220 |
| | Ln (May-June Inflows) | 2.6728 | 2.9305 | 3.9854 | 4.6834 | 5.4326 | 5.6749 | 5.8167 |
| | SQRT (May-June Inflows) | 3.8164 | 4.3369 | 7.3358 | 10.3990 | 15.1251 | 17.0764 | 18.3831 |
| | July-August Inflows | 10.9160 | 14.8760 | 24.4300 | 35.1400 | 132.9700 | 182.4680 | 252.4030 |
| | Ln (July-August Inflows) | 2.3882 | 2.6976 | 3.1941 | 3.5593 | 4.8900 | 5.1922 | 5.5309 |
| | SQRT (July-August Inflows) | 3.3023 | 3.8549 | 4.9406 | 5.9279 | 11.5310 | 13.4804 | 15.8866 |
| | September-October Inflows | 6.6570 | 13.7620 | 51.4750 | 149.7600 | 281.4000 | 498.4720 | 519.5220 |
| | Ln (September-October Inflows) | 1.8931 | 2.5651 | 3.9406 | 5.0090 | 5.6367 | 6.2115 | 6.2517 |
| | SQRT (September-October Inflows) | 2.5785 | 3.6570 | 7.1737 | 12.2376 | 16.7621 | 22.3262 | 22.7860 |
| | November-December Inflows | 7.3990 | 8.7640 | 14.5300 | 31.9100 | 94.2700 | 109.9440 | 118.3680 |
| | Ln (November-December Inflows) | 1.9758 | 2.1702 | 2.6700 | 3.4629 | 4.5461 | 4.6986 | 4.7730 |
| | SQRT (November-December Inflows) | 2.7035 | 2.9800 | 3.8059 | 5.6489 | 9.7092 | 10.4818 | 10.8775 |
| Tukey's Hinges | Drum Harvest | | | 36.5000 | 59.7000 | 118.3000 | | |
| | Ln (Drum Harvest) | | | 3.5973 | 4.0893 | 4.7732 | | |
| | SQRT (Drum Harvest) | | | 6.0415 | 7.7266 | 10.8766 | | |
| | January-February Inflows | | | 14.8200 | 29.5000 | 71.4600 | | |
| | Ln (January-February Inflows) | | | 2.6960 | 3.3844 | 4.2691 | | |
| | SQRT (January-February Inflows) | | | 3.8497 | 5.4314 | 8.4534 | | |
| | March-April Inflows | | | 12.5300 | 30.4000 | 37.1600 | | |
| | Ln (March-April Inflows) | | | 2.5281 | 3.4144 | 3.6152 | | |
| | SQRT (March-April Inflows) | | | 3.5398 | 5.5136 | 6.0959 | | |
| | May-June Inflows | | | 54.9200 | 108.1400 | 224.3500 | | |
| | Ln (May-June Inflows) | | | 4.0059 | 4.6834 | 5.4132 | | |
| | SQRT (May-June Inflows) | | | 7.4108 | 10.3990 | 14.9783 | | |
| | July-August Inflows | | | 25.8400 | 35.1400 | 131.0200 | | |
| | Ln (July-August Inflows) | | | 3.2519 | 3.5593 | 4.8753 | | |
| | SQRT (July-August Inflows) | | | 5.0833 | 5.9279 | 11.4464 | | |
| | September-October Inflows | | | 53.1400 | 149.7600 | 259.3900 | | |
| | Ln (September-October Inflows) | | | 3.9729 | 5.0090 | 5.5583 | | |
| | SQRT (September-October Inflows) | | | 7.2897 | 12.2376 | 16.1056 | | |
| | November-December Inflows | | | 16.1500 | 31.9100 | 93.7200 | | |
| | Ln (November-December Inflows) | | | 2.7819 | 3.4629 | 4.5403 | | |
| | SQRT (November-December Inflows) | | | 4.0187 | 5.6489 | 9.6809 | | |

## 2.4 Summary Information for Individual Variables

### 2.4.1 Summary Information for Drum Harvest

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| Drum Harvest | Mean | | 80.8606 | 11.0642 |
| | 95% Confidence Interval for Mean | Lower Bound | 58.3236 | |
| | | Upper Bound | 103.3976 | |
| | 5% Trimmed Mean | | 75.8162 | |
| | Median | | 59.7000 | |
| | Variance | | 4039.724 | |
| | Std. Deviation | | 63.5588 | |
| | Minimum | | 2.10 | |
| | Maximum | | 286.90 | |
| | Range | | 284.80 | |
| | Interquartile Range | | 87.5500 | |
| | Skewness | | 1.307 | .409 |
| | Kurtosis | | 1.944 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| Drum Harvest | Highest | 1 | 2 | 1962 | 286.90 |
| | | 2 | 4 | 1964 | 180.70 |
| | | 3 | 15 | 1975 | 173.20 |
| | | 4 | 1 | 1961 | 173.10 |
| | | 5 | 3 | 1963 | 171.40 |
| | Lowest | 1 | 28 | 1988 | 2.10 |
| | | 2 | 24 | 1984 | 15.70 |
| | | 3 | 23 | 1983 | 16.80 |
| | | 4 | 20 | 1980 | 20.60 |
| | | 5 | 30 | 1990 | 24.00 |

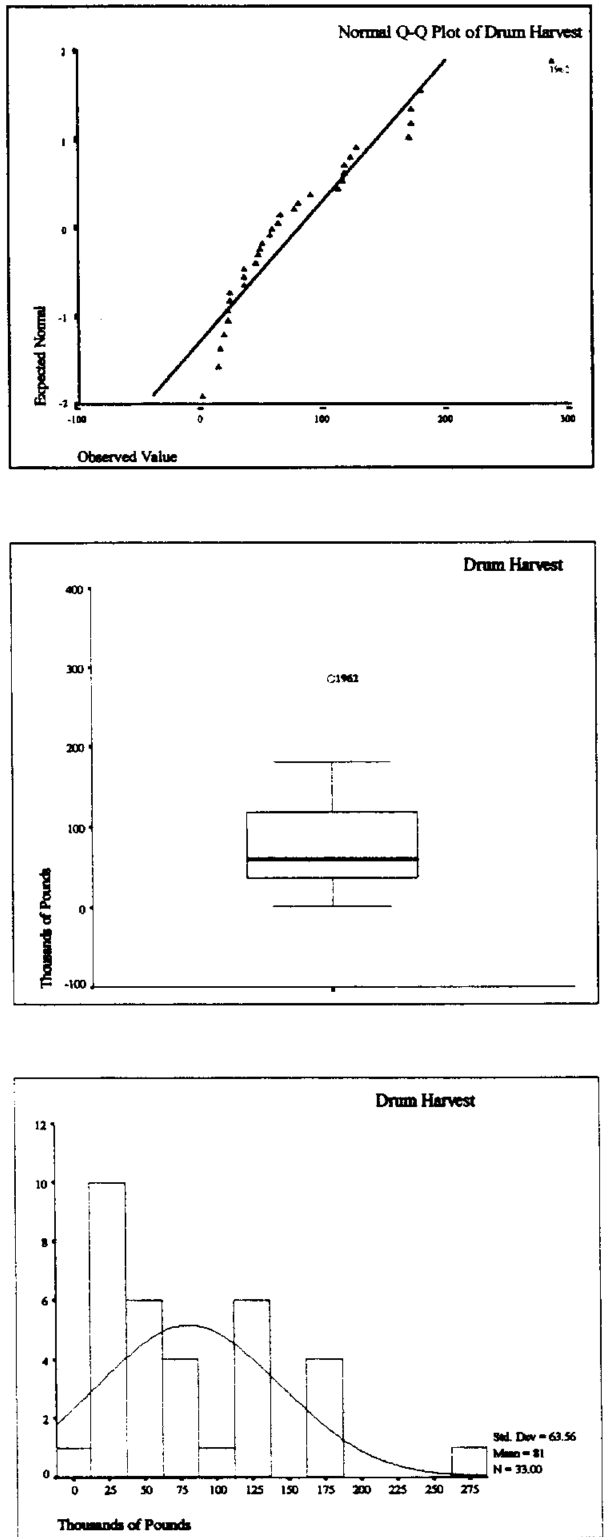



Fig. 2.1a. Exploratory Plots of Drum Harvest.

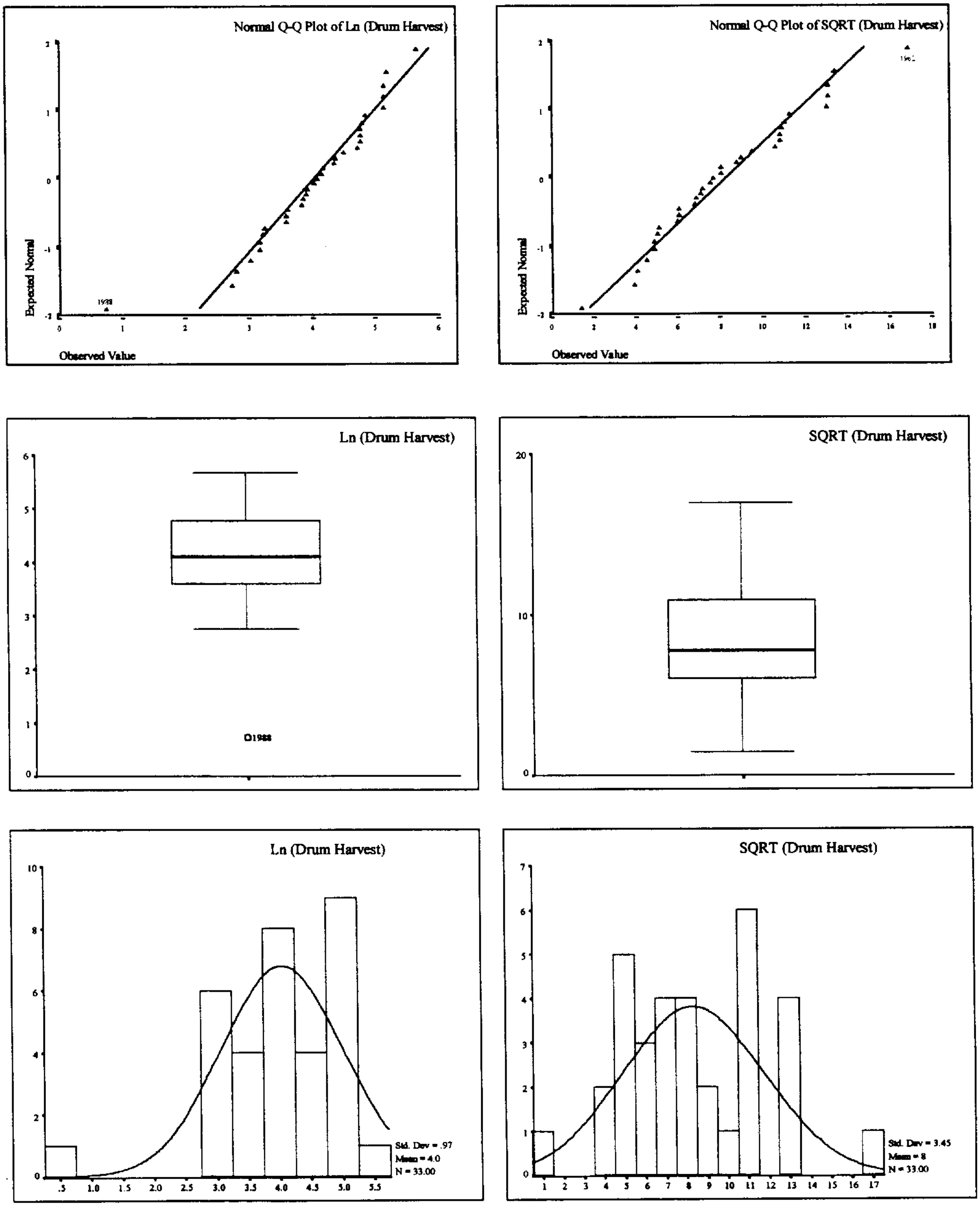



Fig. 2.1b. Exploratory Plots of Transformed Drum Harvest.

## 2.4.2 Summary Information for January-February Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| January-February Inflows | Mean | | 46.1394 | 7.0259 |
| | 95% Confidence Interval for Mean | Lower Bound | 31.8281 | |
| | | Upper Bound | 60.4507 | |
| | 5% Trimmed Mean | | 42.9006 | |
| | Median | | 29.5000 | |
| | Variance | | 1628.999 | |
| | Std. Deviation | | 40.3609 | |
| | Minimum | | 2.27 | |
| | Maximum | | 167.91 | |
| | Range | | 165.64 | |
| | Interquartile Range | | 61.8150 | |
| | Skewness | | 1.165 | .409 |
| | Kurtosis | | 1.019 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| January-February Inflows | Highest | 1 | 33 | 1993 | 167.91 |
| | | 2 | 32 | 1992 | 114.69 |
| | | 3 | 24 | 1984 | 110.17 |
| | | 4 | 22 | 1982 | 109.62 |
| | | 5 | 1 | 1961 | 85.35 |
| | Lowest | 1 | 4 | 1964 | 2.27 |
| | | 2 | 16 | 1976 | 5.73 |
| | | 3 | 15 | 1975 | 6.87 |
| | | 4 | 30 | 1990 | 8.94 |
| | | 5 | 5 | 1965 | 10.94 |

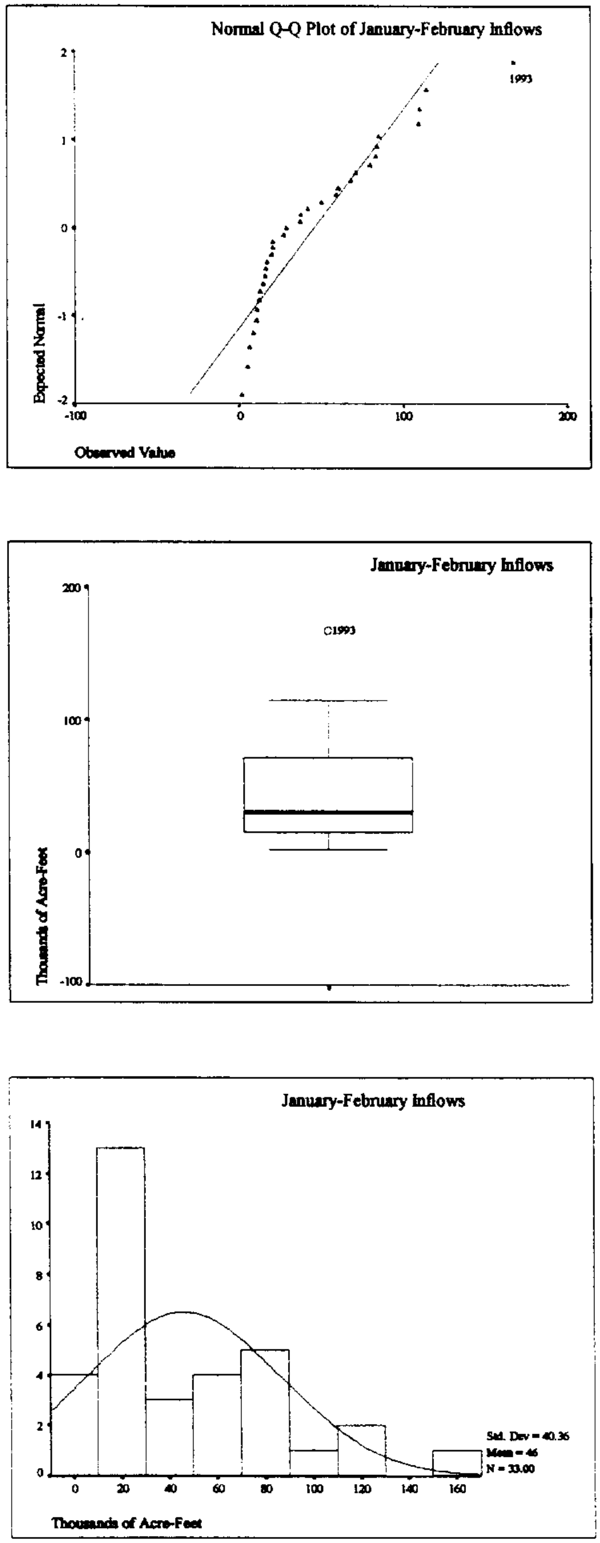



Fig. 2.2a. Exploratory Plots of January-February Inflows.

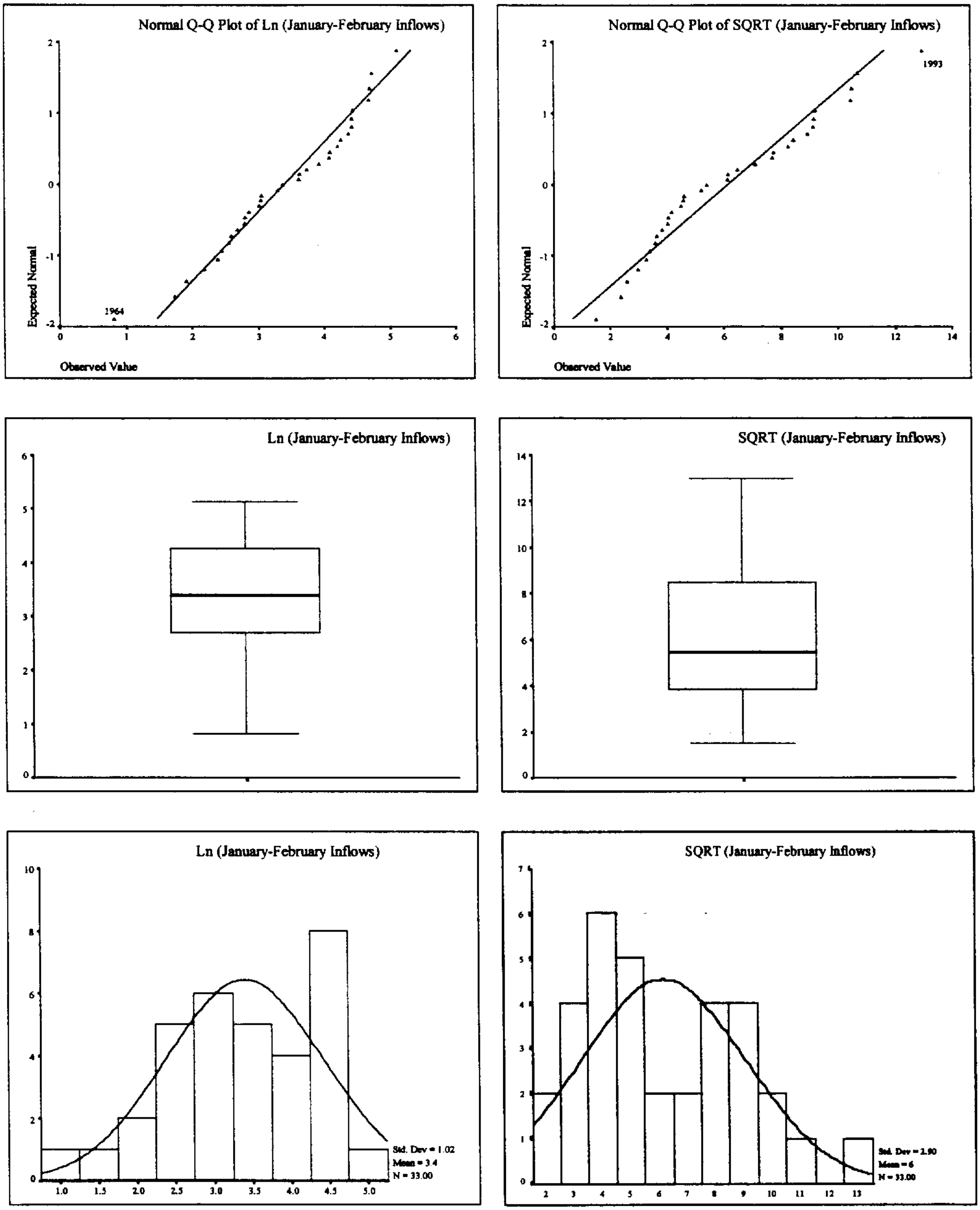



Fig. 2.2b. Exploratory Plots of Transformed January-February Inflows.

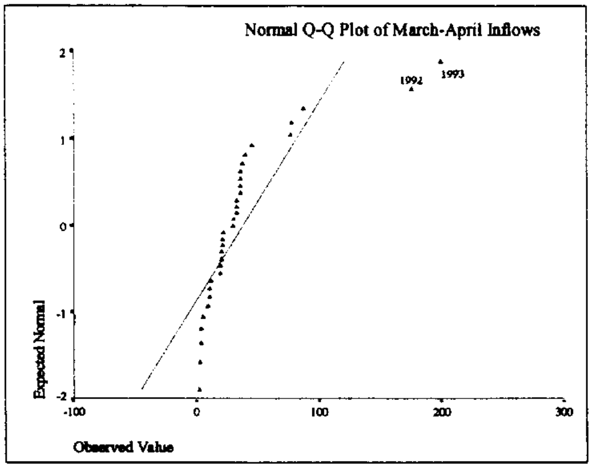
### 2.4.3 Summary Information for March-April Inflows

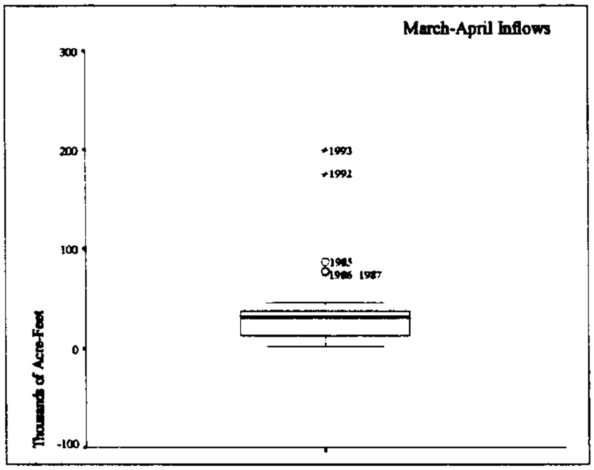
**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| March-April Inflows | Mean | | 38.6052 | 7.6657 |
| | 95% Confidence Interval for Mean | Lower Bound | 22.9906 | |
| | | Upper Bound | 54.2197 | |
| | 5% Trimmed Mean | | 32.0990 | |
| | Median | | 30.4000 | |
| | Variance | | 1939.183 | |
| | Std. Deviation | | 44.0362 | |
| | Minimum | | 2.73 | |
| | Maximum | | 200.42 | |
| | Range | | 197.69 | |
| | Interquartile Range | | 25.5250 | |
| | Skewness | | 2.649 | .409 |
| | Kurtosis | | 7.435 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| March-April Inflows | Highest | 1 | 33 | 1993 | 200.42 |
| | | 2 | 32 | 1992 | 176.81 |
| | | 3 | 25 | 1985 | 87.92 |
| | | 4 | 27 | 1987 | 78.60 |
| | | 5 | 26 | 1986 | 77.70 |
| | Lowest | 1 | 4 | 1964 | 2.73 |
| | | 2 | 5 | 1965 | 3.93 |
| | | 3 | 28 | 1988 | 4.35 |
| | | 4 | 29 | 1989 | 4.53 |
| | | 5 | 3 | 1963 | 6.21 |



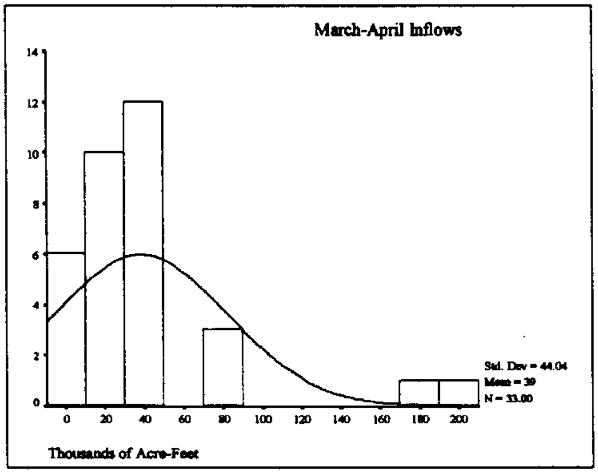




Fig. 2.3a. Exploratory Plots of March-April Inflows.

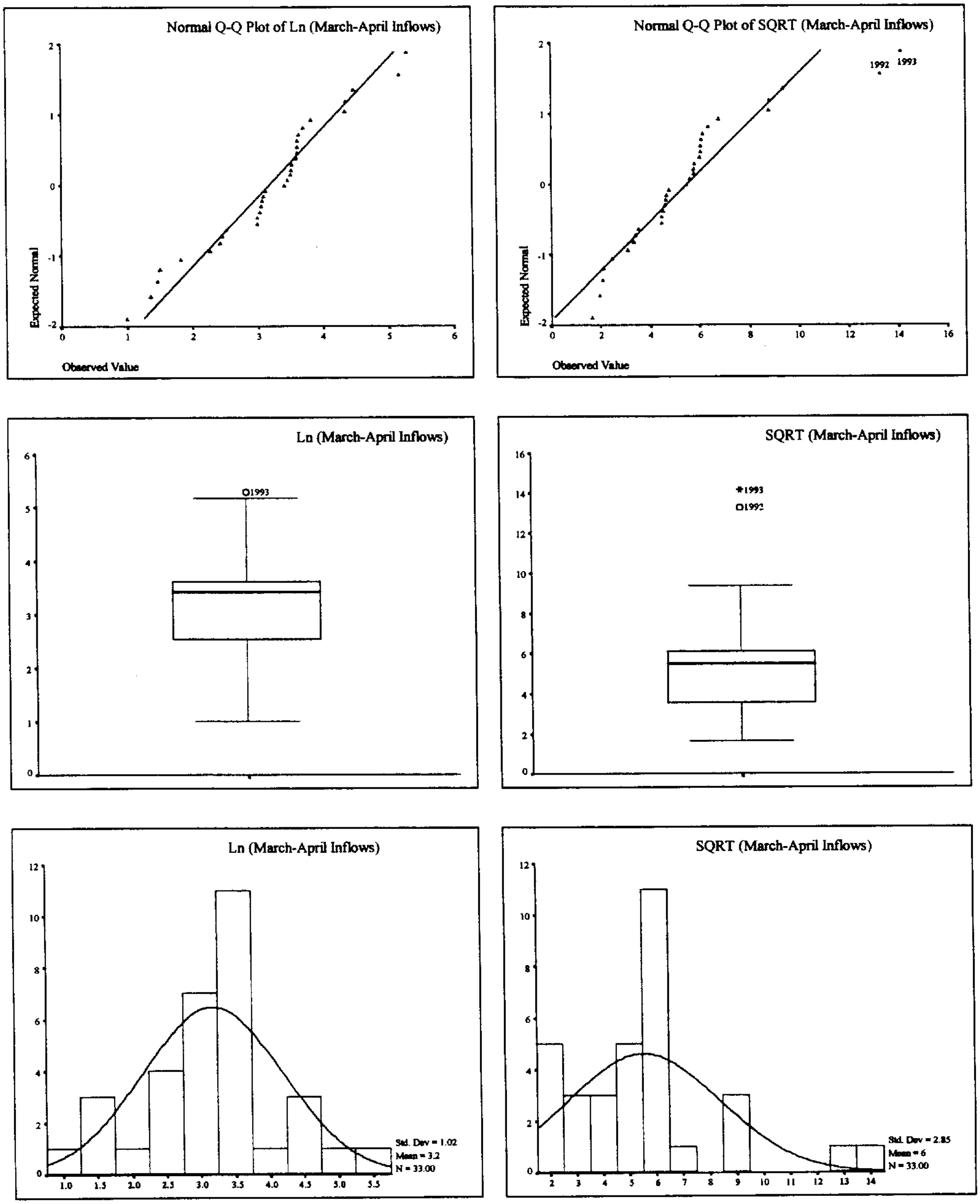



Fig. 2.3b. Exploratory Plots of Transformed March-April Inflows.

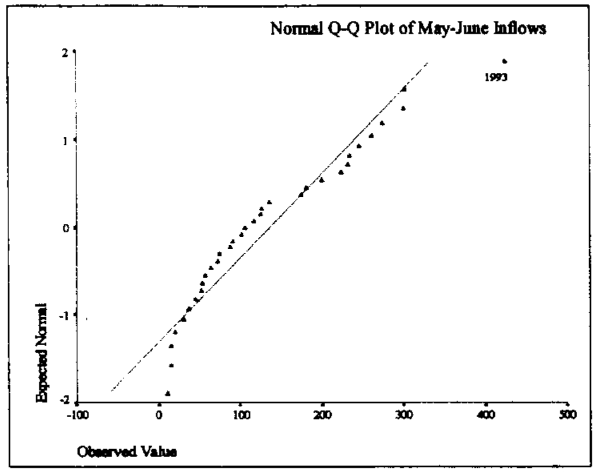
### 2.4.4 Summary Information for May-June Inflows

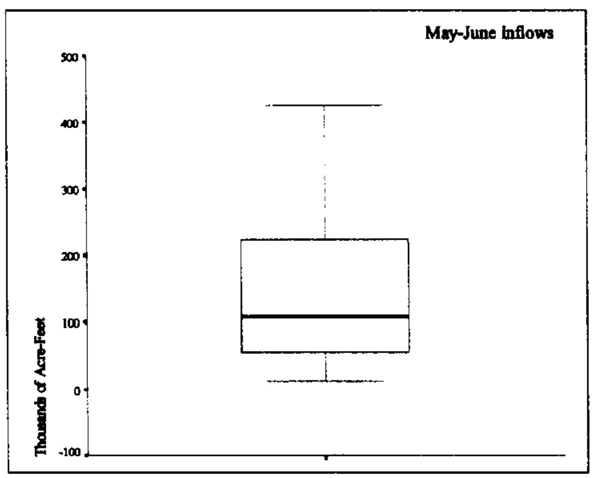
**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| May-June Inflows | Mean | | 137.4773 | 18.1285 |
| | 95% Confidence Interval for Mean | Lower Bound | 100.5508 | |
| | | Upper Bound | 174.4038 | |
| | 5% Trimmed Mean | | 131.0350 | |
| | Median | | 108.1400 | |
| | Variance | | 10845.2 | |
| | Std. Deviation | | 104.1401 | |
| | Minimum | | 11.40 | |
| | Maximum | | 426.04 | |
| | Range | | 414.64 | |
| | Interquartile Range | | 174.9700 | |
| | Skewness | | .856 | .409 |
| | Kurtosis | | .160 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| May-June Inflows | Highest | 1 | 33 | 1993 | 426.04 |
| | | 2 | 8 | 1968 | 303.30 |
| | | 3 | 14 | 1974 | 302.27 |
| | | 4 | 13 | 1973 | 275.96 |
| | | 5 | 10 | 1970 | 263.17 |
| | Lowest | 1 | 4 | 1964 | 11.40 |
| | | 2 | 3 | 1963 | 16.04 |
| | | 3 | 30 | 1990 | 16.96 |
| | | 4 | 5 | 1965 | 21.76 |
| | | 5 | 31 | 1991 | 31.92 |



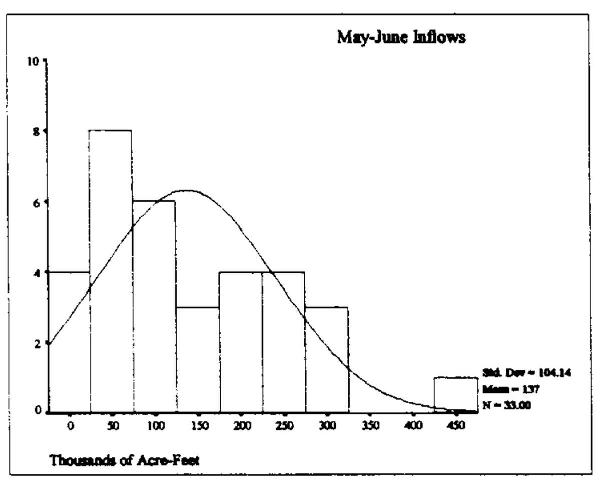




Fig. 2.4a. Exploratory Plots of May-June Inflows.

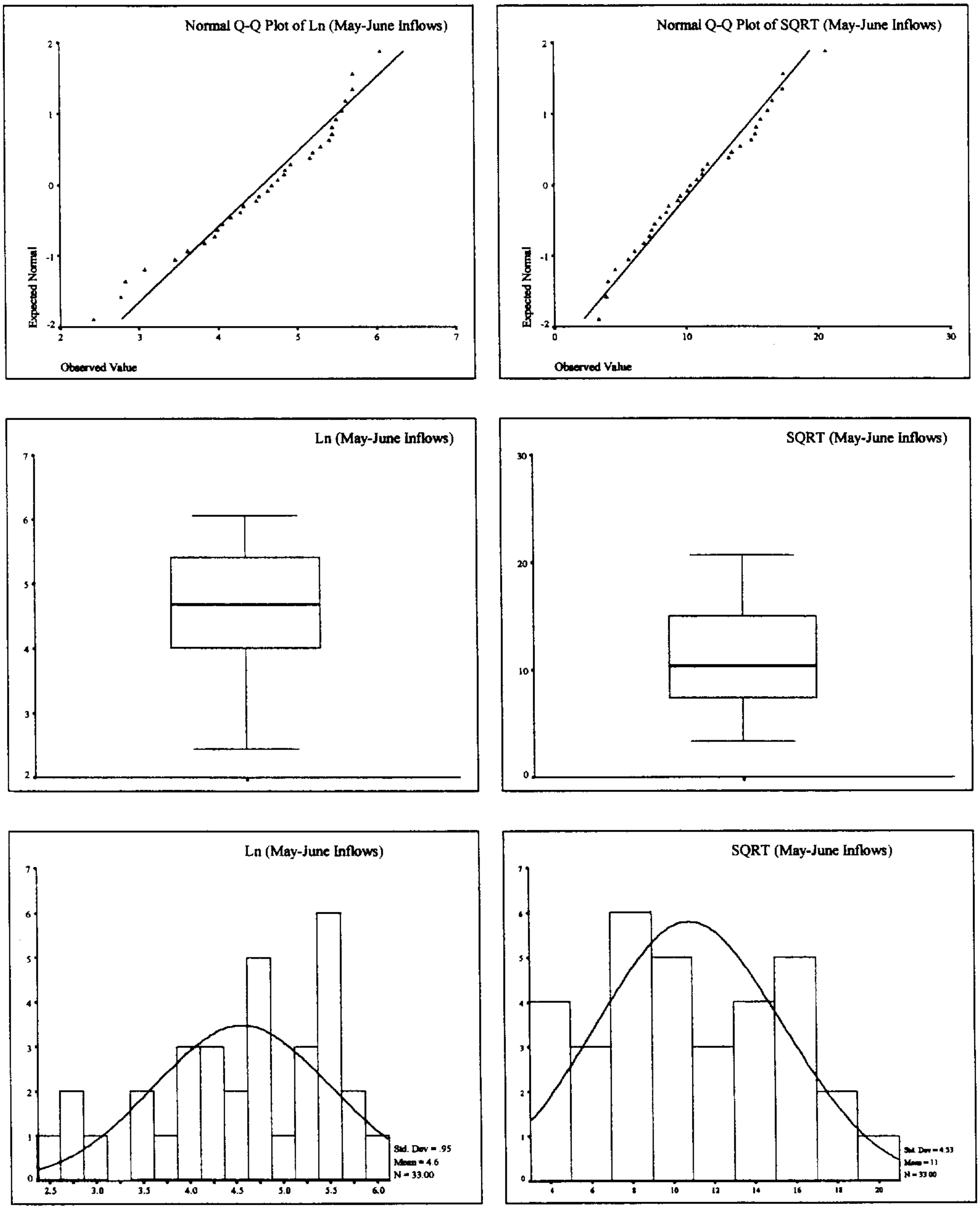



Fig. 2.4b. Exploratory Plots of Transformed May-June Inflows.

### 2.4.5 Summary Information for July-August Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| July-August Inflows | Mean | | 72.7503 | 12.1347 |
| | 95% Confidence Interval for Mean | Lower Bound | 48.0326 | |
| | | Upper Bound | 97.4680 | |
| | 5% Trimmed Mean | | 66.0615 | |
| | Median | | 35.1400 | |
| | Variance | | 4859.321 | |
| | Std. Deviation | | 69.7088 | |
| | Minimum | | 9.88 | |
| | Maximum | | 259.34 | |
| | Range | | 249.46 | |
| | Interquartile Range | | 108.5400 | |
| | Skewness | | 1.364 | .409 |
| | Kurtosis | | 1.070 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| July-August Inflows | Highest | 1 | 21 | 1981 | 259.34 |
| | | 2 | 23 | 1983 | 249.43 |
| | | 3 | 22 | 1982 | 206.96 |
| | | 4 | 20 | 1980 | 145.73 |
| | | 5 | 32 | 1992 | 143.36 |
| | Lowest | 1 | 3 | 1963 | 9.88 |
| | | 2 | 26 | 1986 | 11.36 |
| | | 3 | 15 | 1975 | 14.08 |
| | | 4 | 7 | 1967 | 16.07 |
| | | 5 | 2 | 1962 | 16.61 |

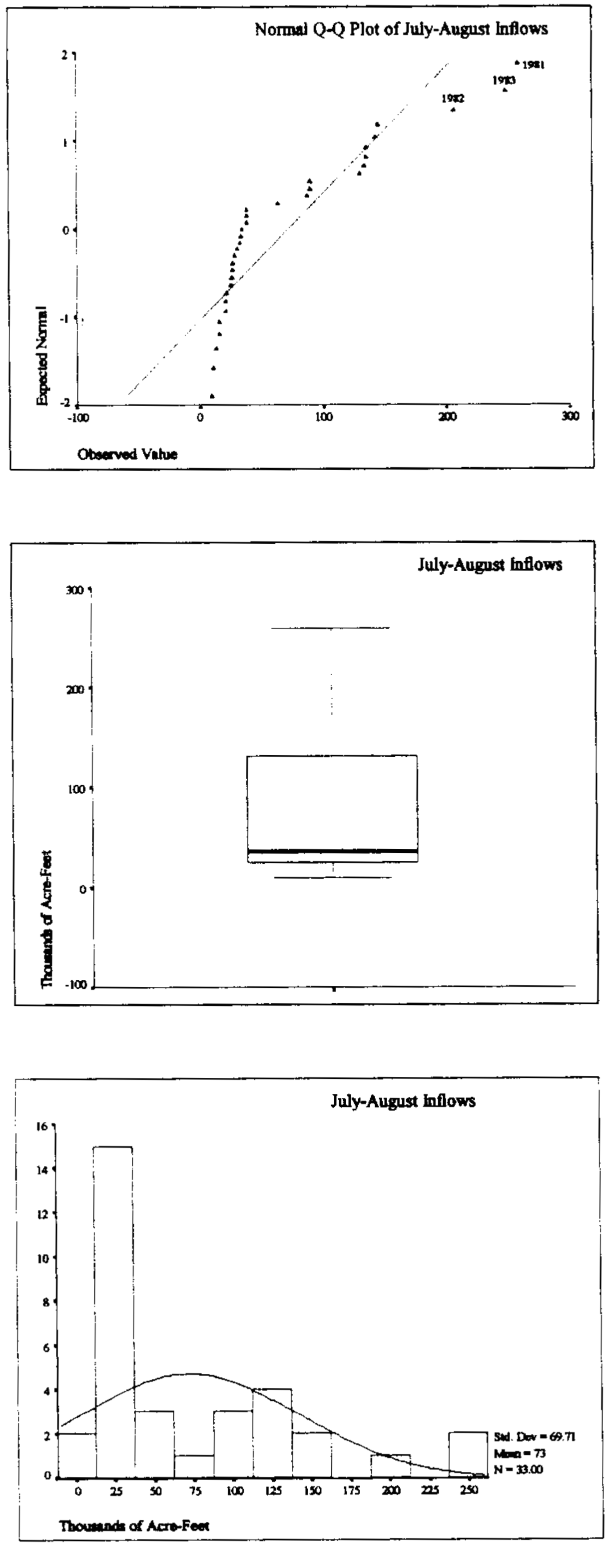



Fig. 2.5a. Exploratory Plots of July-August Inflows.

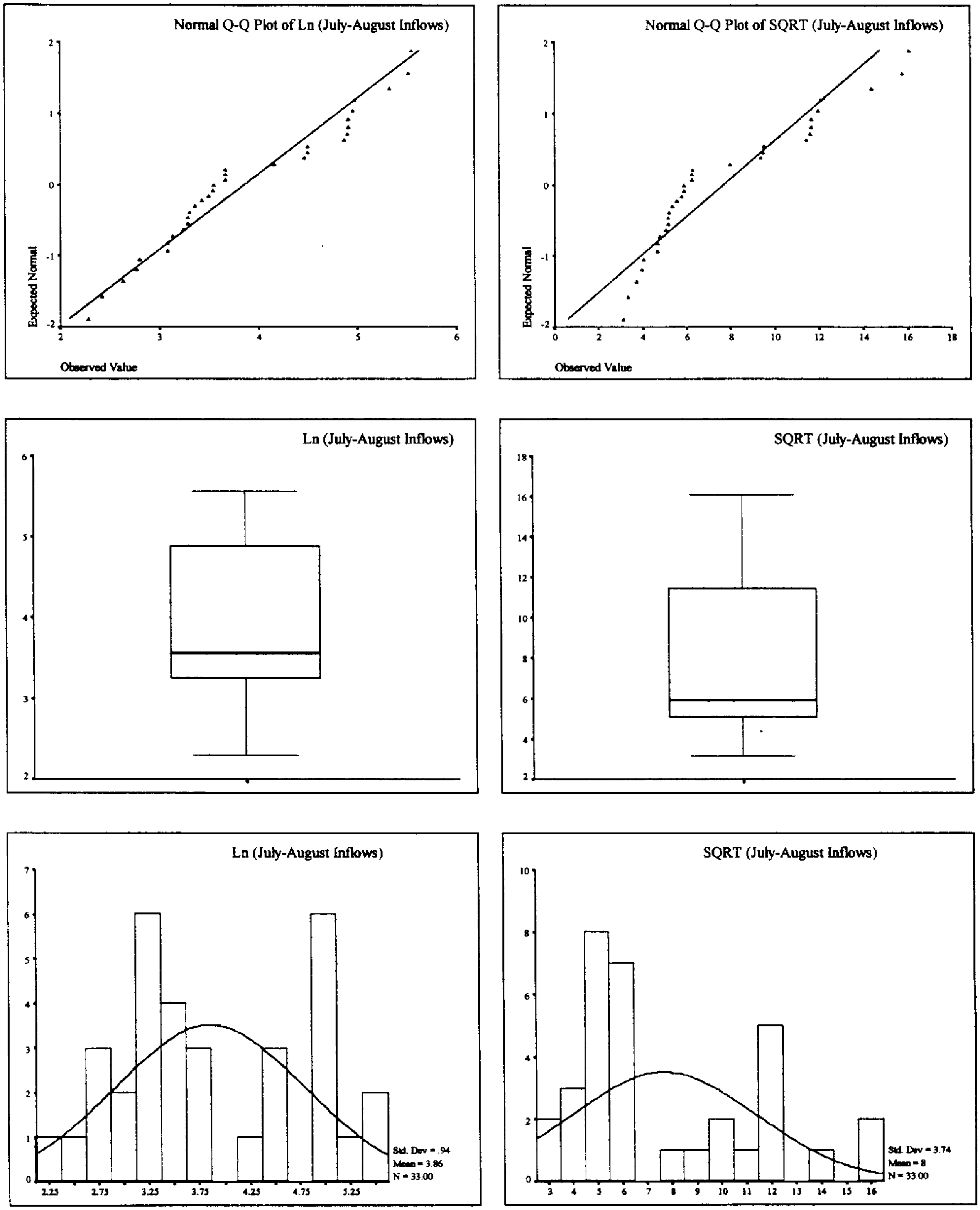



Fig. 2.5b. Exploratory Plots of Transformed July-August Inflows.

### 2.4.6 Summary Information for September-October Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| September-October Inflows | Mean | | 186.5142 | 29.2935 |
| | 95% Confidence Interval for Mean | Lower Bound | 126.8454 | |
| | | Upper Bound | 246.1831 | |
| | 5% Trimmed Mean | | 177.0532 | |
| | Median | | 149.7600 | |
| | Variance | | 28317.6 | |
| | Std. Deviation | | 168.2782 | |
| | Minimum | | 5.95 | |
| | Maximum | | 559.45 | |
| | Range | | 553.50 | |
| | Interquartile Range | | 229.9250 | |
| | Skewness | | .838 | .409 |
| | Kurtosis | | -.430 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| September-October Inflows | Highest | 1 | 13 | 1973 | 559.45 |
| | | 2 | 9 | 1969 | 502.41 |
| | | 3 | 8 | 1968 | 502.38 |
| | | 4 | 7 | 1967 | 492.61 |
| | | 5 | 12 | 1972 | 415.48 |
| | Lowest | 1 | 5 | 1965 | 5.95 |
| | | 2 | 6 | 1966 | 6.96 |
| | | 3 | 4 | 1964 | 9.91 |
| | | 4 | 30 | 1990 | 19.54 |
| | | 5 | 29 | 1989 | 21.78 |

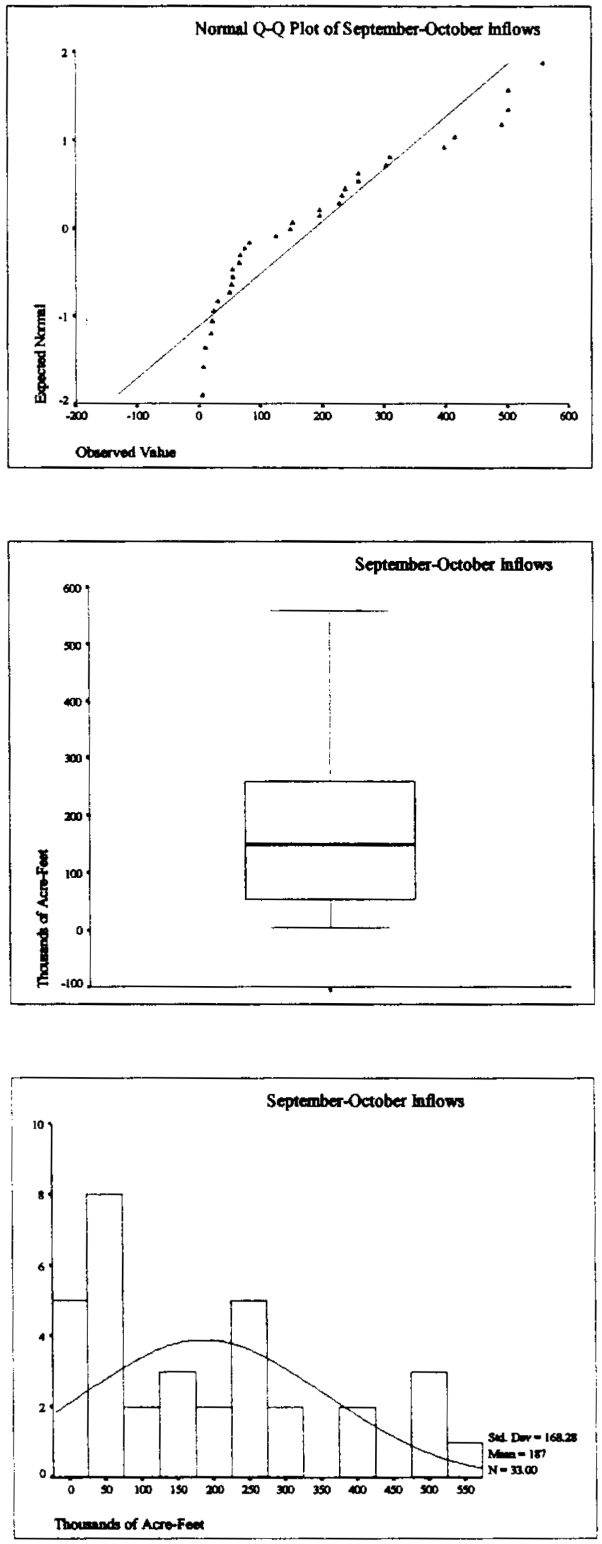



Fig. 2.6a. Exploratory Plots of September-October Inflows.

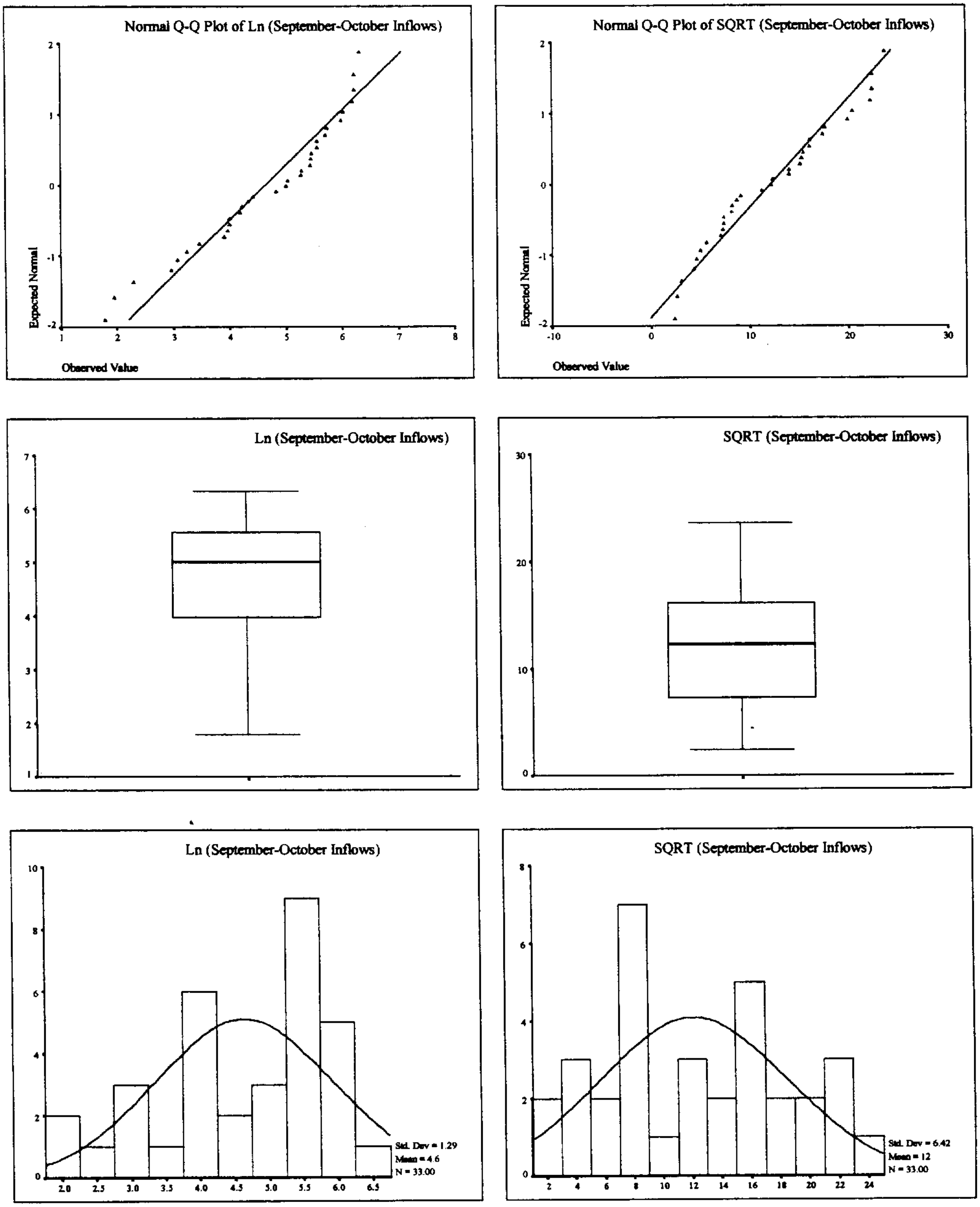



Fig. 2.6b. Exploratory Plots of Transformed September-October Inflows.

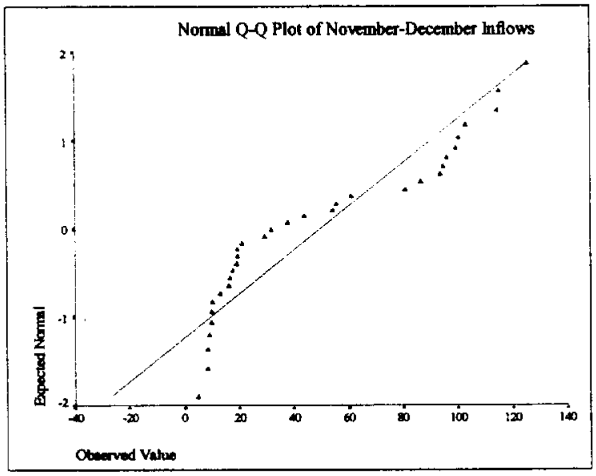
### 2.4.7 Summary Information for November-December Inflows

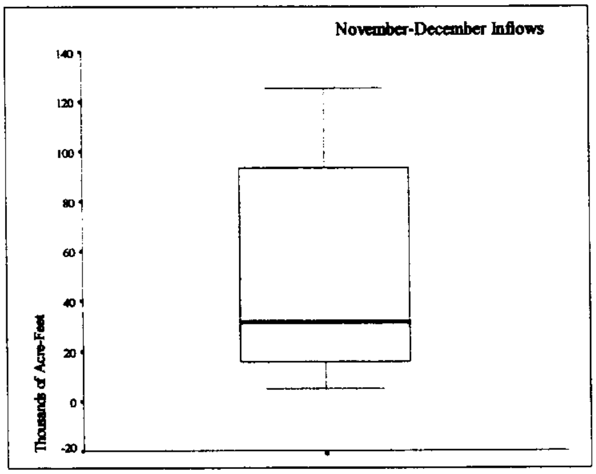
**Descriptives**

| | | | | Statistic | Std. Error |
|---|---|---|---|---|---|
| November-December Inflows | Mean | | | 49.3367 | 6.9922 |
| | 95% Confidence Interval for Mean | Lower Bound | | 35.0940 | |
| | | Upper Bound | | 63.5793 | |
| | 5% Trimmed Mean | | | 47.7092 | |
| | Median | | | 31.9100 | |
| | Variance | | | 1613.398 | |
| | Std. Deviation | | | 40.1671 | |
| | Minimum | | | 5.04 | |
| | Maximum | | | 125.76 | |
| | Range | | | 120.72 | |
| | Interquartile Range | | | 79.7400 | |
| | Skewness | | | .539 | .409 |
| | Kurtosis | | | -1.334 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| November-December Inflows | Highest | 1 | 33 | 1993 | 125.76 |
| | | 2 | 32 | 1992 | 115.20 |
| | | 3 | 16 | 1976 | 114.66 |
| | | 4 | 2 | 1962 | 102.87 |
| | | 5 | 23 | 1983 | 100.37 |
| | Lowest | 1 | 8 | 1968 | 5.04 |
| | | 2 | 3 | 1963 | 8.41 |
| | | 3 | 4 | 1964 | 8.54 |
| | | 4 | 6 | 1966 | 9.10 |
| | | 5 | 30 | 1990 | 9.76 |



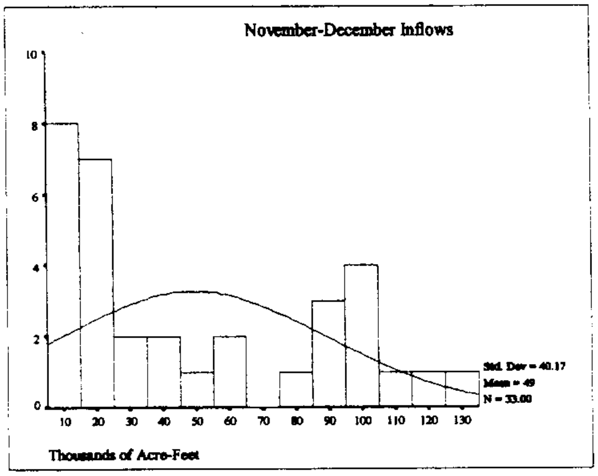




Fig. 2.7a. Exploratory Plots of November-December Inflows.

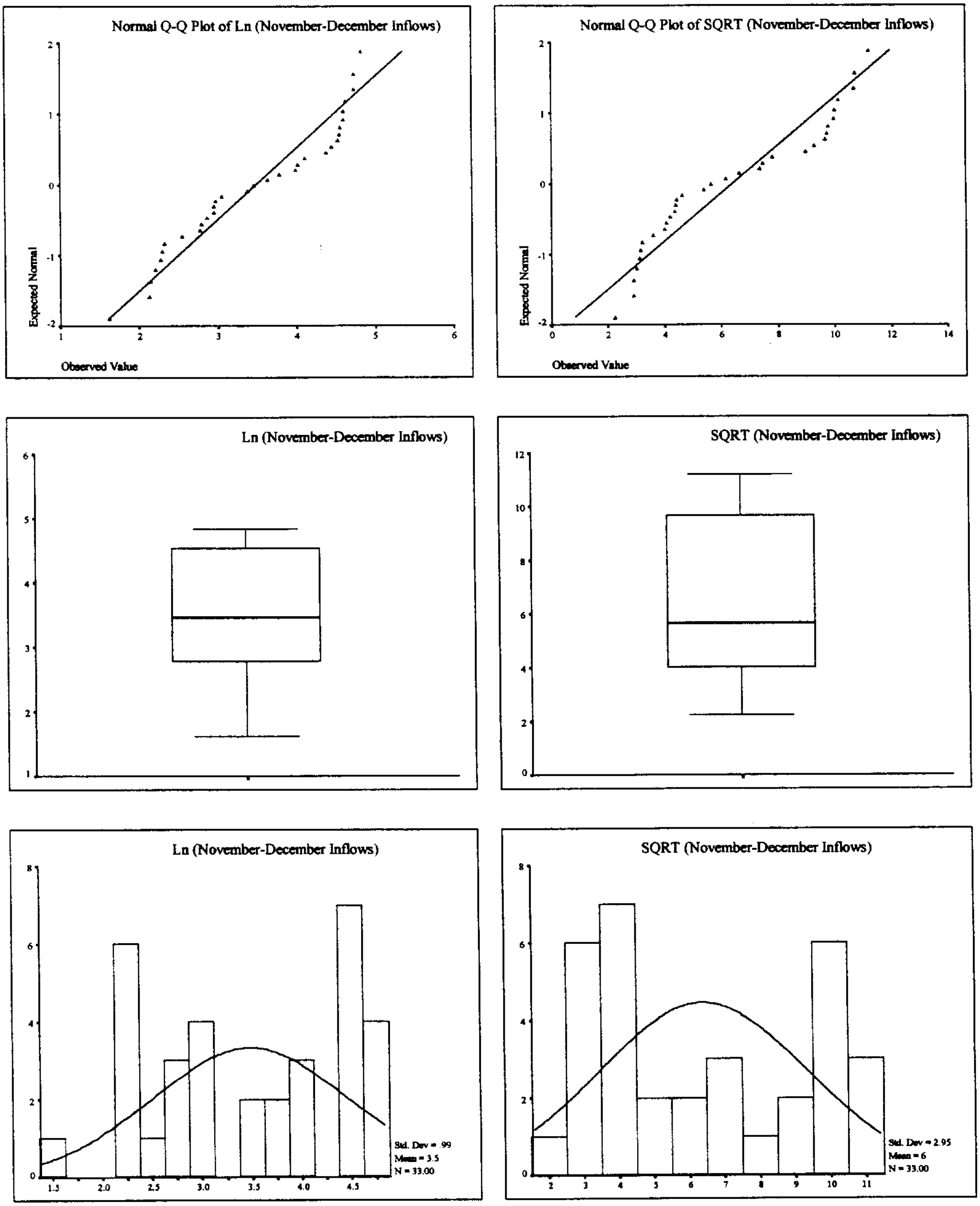



Fig. 2.7b. Exploratory Plots of Transformed November-December Inflows.

## 3. Prediction and Confidence Regions

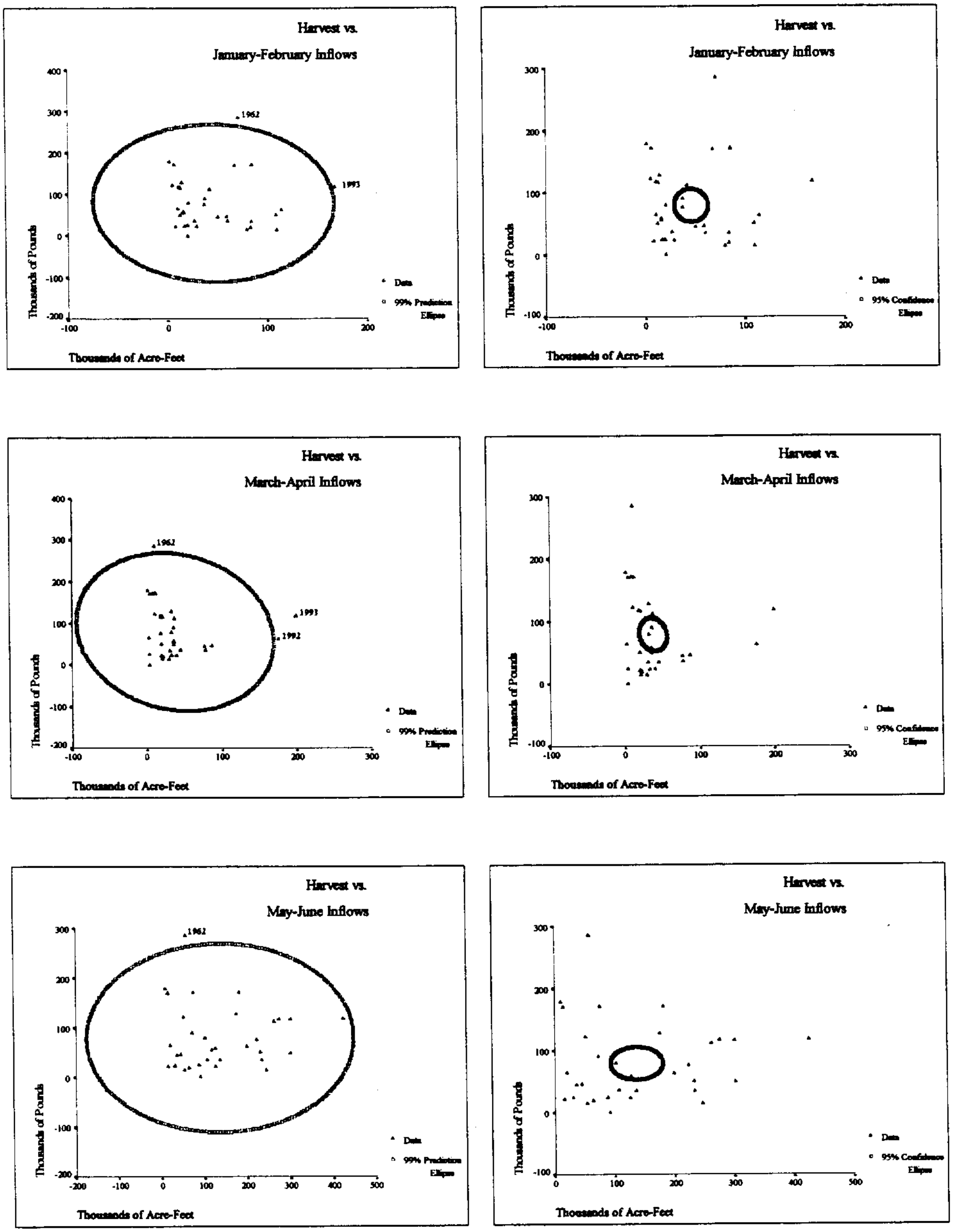



Fig. 3.1. Prediction and Confidence Ellipses.

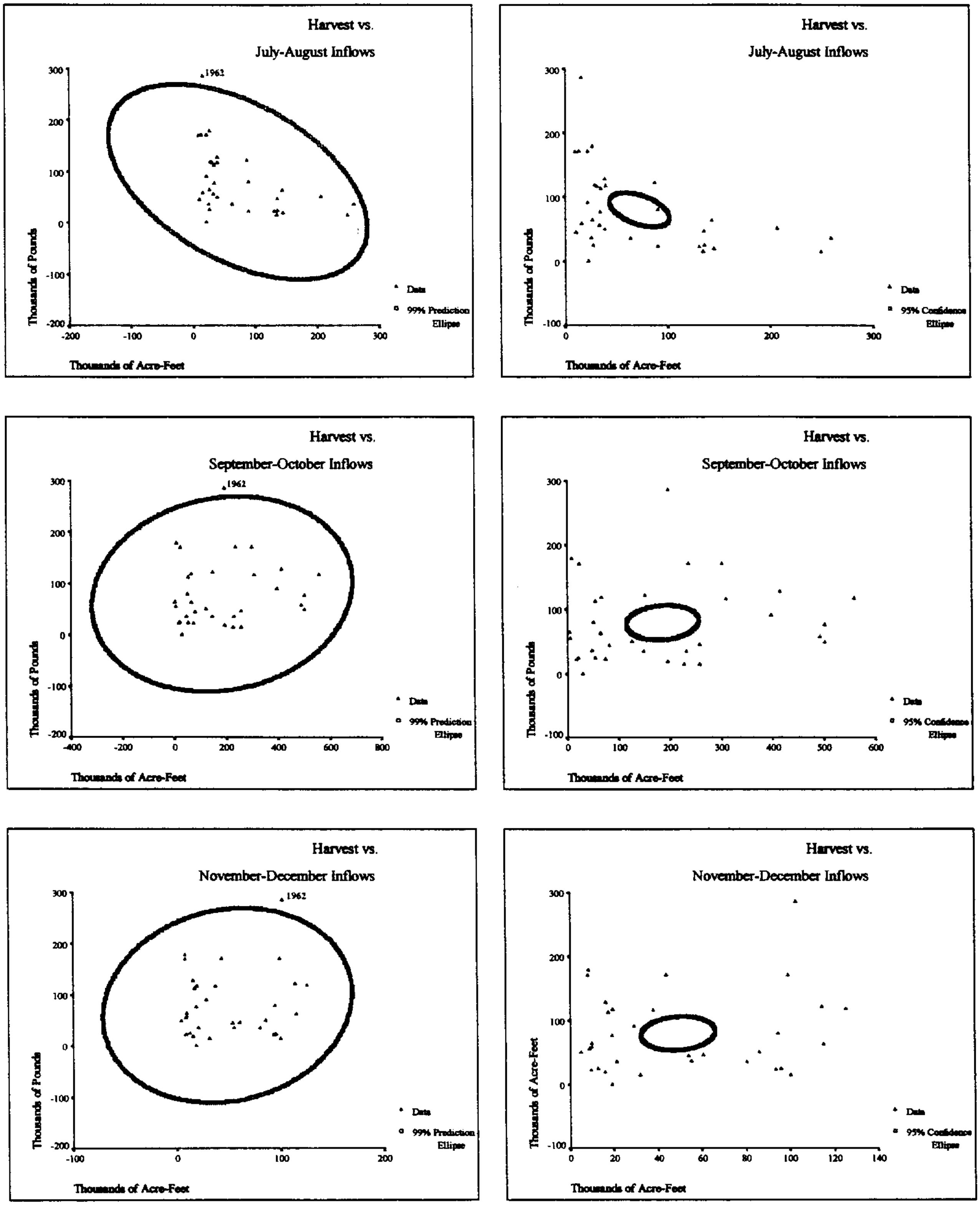



Fig. 3.2. Prediction and Confidence Ellipses.

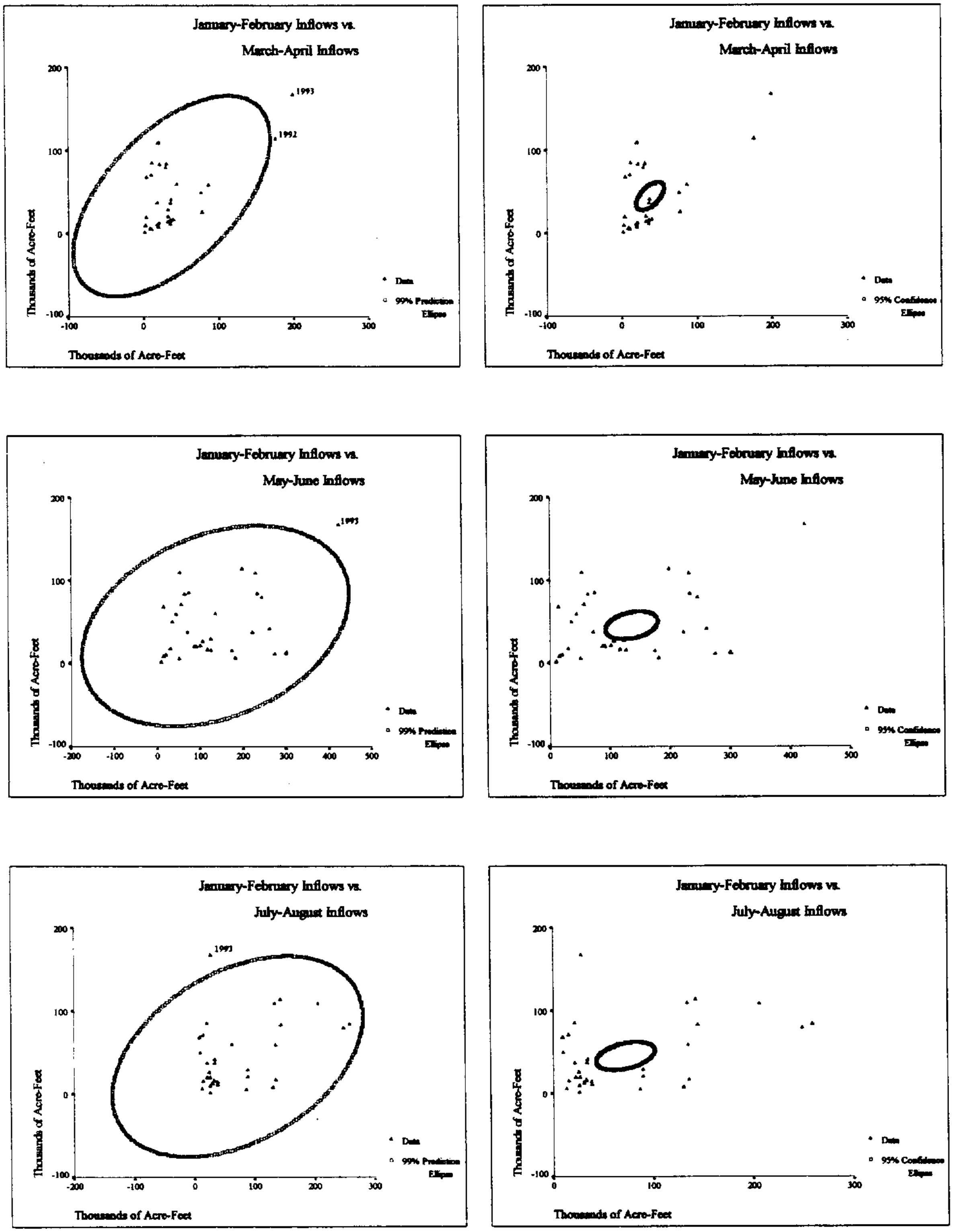



Fig. 3.3. Prediction and Confidence Ellipses.

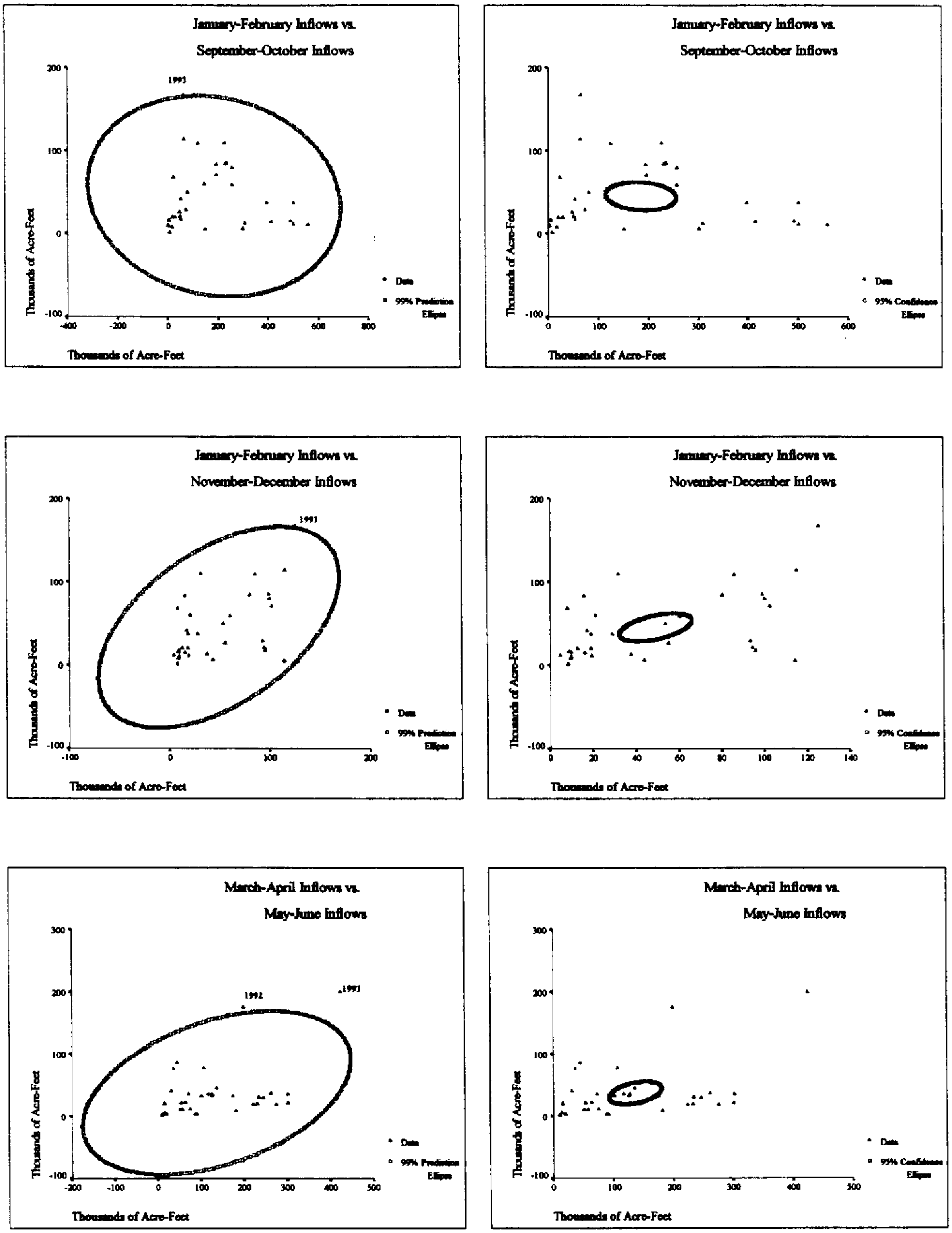



Fig. 3.4. Prediction and Confidence Ellipses.

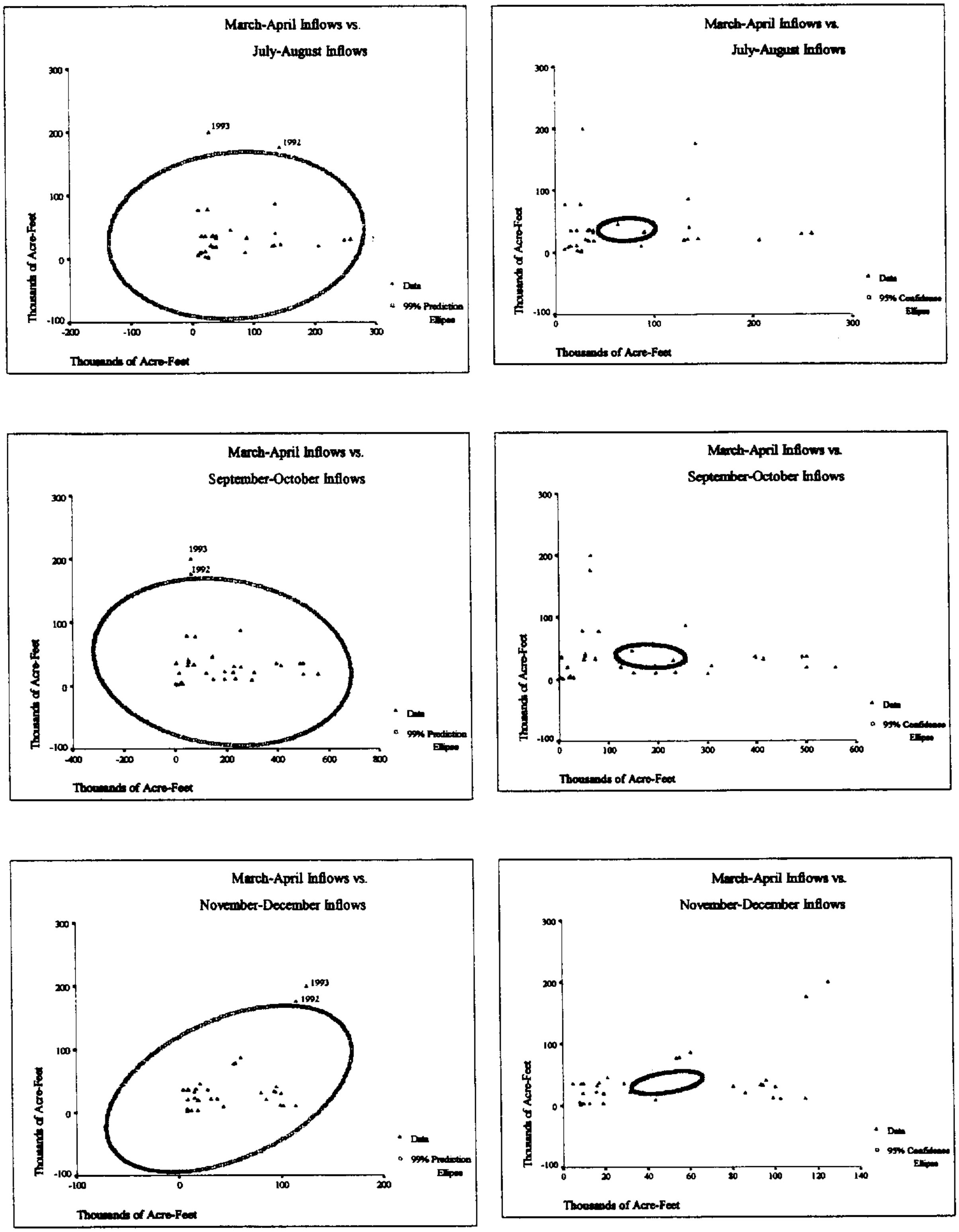



Fig. 3.5. Prediction and Confidence Ellipses.

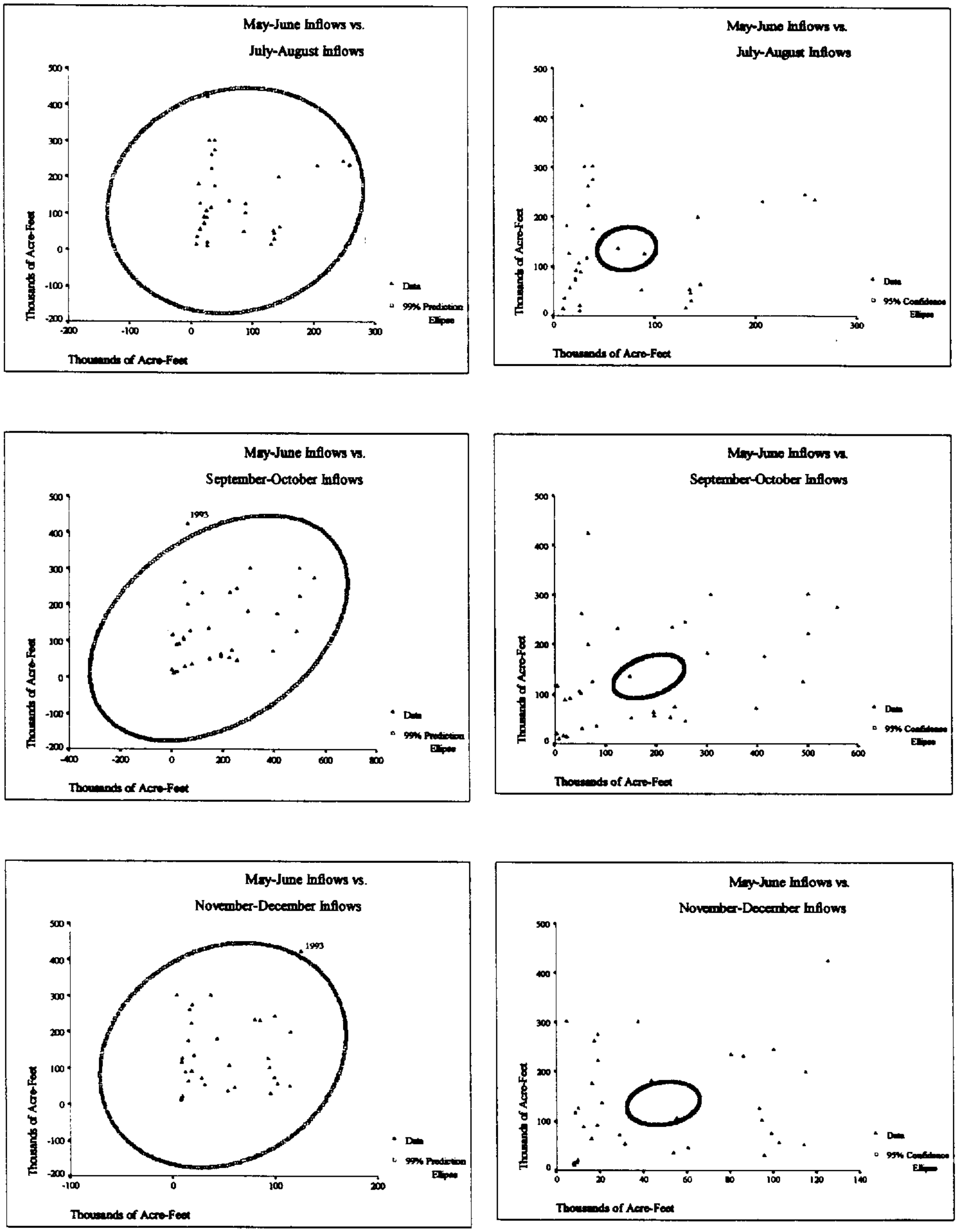



Fig. 3.6. Prediction and Confidence Ellipses.

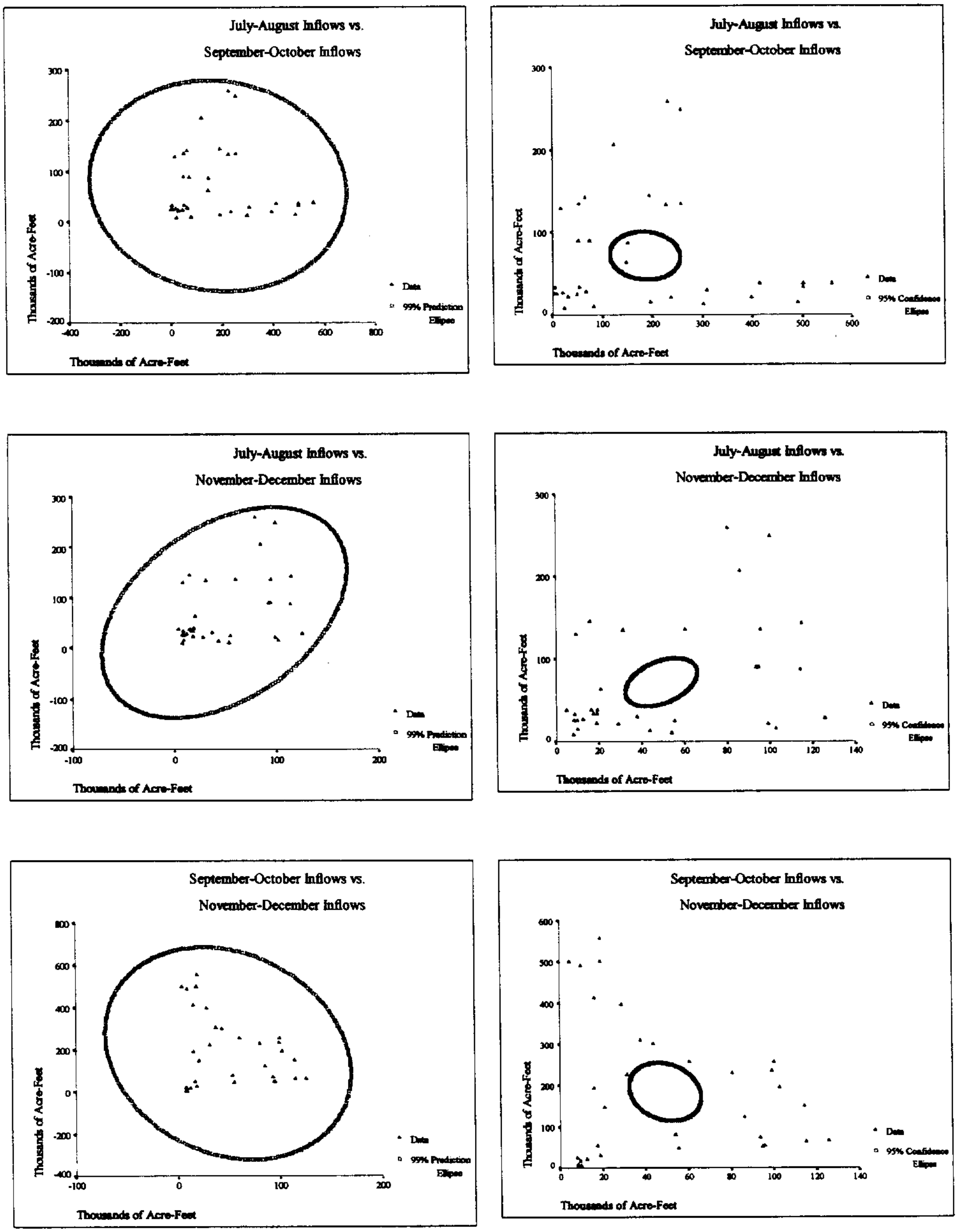



Fig. 3.7. Prediction and Confidence Ellipses.

## 4. Box-Cox Analysis

Table 4.1 Numerical Results.

| HARVEST | QJF_Lag | QMA_Lag | QMJ_Lag | QJA_Lag | QSO_Lag | QND_Lag | LAMBDA |
|---|---|---|---|---|---|---|---|
| 13302663 | 208041 | 36495 | 497725 | 15474 | 11675513 | 17811 | -2.0 |
| 7605387 | 137860 | 26783 | 367378 | 12740 | 7415600 | 13954 | -1.9 |
| 4370753 | 91936 | 19782 | 272875 | 10553 | 4738858 | 11016 | -1.8 |
| 2526284 | 61753 | 14712 | 204059 | 8799 | 3048850 | 8768 | -1.7 |
| 1469540 | 41821 | 11022 | 153718 | 7390 | 1976310 | 7041 | -1.6 |
| 860978 | 28588 | 8323 | 116715 | 6254 | 1291825 | 5706 | -1.5 |
| 508538 | 19752 | 6339 | 89383 | 5338 | 852346 | 4671 | -1.4 |
| 303167 | 13817 | 4872 | 69089 | 4597 | 568325 | 3864 | -1.3 |
| 182682 | 9802 | 3781 | 53944 | 3999 | 383472 | 3232 | -1.2 |
| 111471 | 7066 | 2967 | 42580 | 3514 | 262245 | 2735 | -1.1 |
| 69037 | 5188 | 2355 | 34009 | 3124 | 182094 | 2342 | -1.0 |
| 43523 | 3889 | 1893 | 27512 | 2809 | 128642 | 2032 | -0.9 |
| 28031 | 2982 | 1543 | 22563 | 2558 | 92672 | 1786 | -0.8 |
| 18524 | 2344 | 1277 | 18777 | 2360 | 68243 | 1590 | -0.7 |
| 12624 | 1892 | 1074 | 15873 | 2207 | 51499 | 1436 | -0.6 |
| 8918 | 1571 | 921 | 13640 | 2093 | 39927 | 1314 | -0.5 |
| 6564 | 1342 | 805 | 11924 | 2013 | 31874 | 1220 | -0.4 |
| 5053 | 1179 | 720 | 10612 | 1964 | 26251 | 1148 | -0.3 |
| 4076 | 1066 | 660 | 9616 | **1944** | 22331 | 1096 | **-0.2** |
| 3445 | 989 | 620 | 8876 | 1952 | 19632 | 1060 | -0.1 |
| 3042 | 941 | 600 | 8344 | 1988 | 17834 | 1040 | 0 |
| 2796 | 917 | **597** | 7987 | 2053 | 16722 | **1033** | **0.1** |
| 2662 | **913** | 612 | 7781 | 2149 | 16160 | 1039 | **0.2** |
| **2613** | 928 | 646 | **7710** | 2281 | **16064** | 1058 | **0.3** |
| 2632 | 960 | 702 | 7764 | 2452 | 16389 | 1090 | 0.4 |
| 2711 | 1011 | 785 | 7939 | 2669 | 17123 | 1135 | 0.5 |
| 2847 | 1081 | 901 | 8238 | 2941 | 18279 | 1195 | 0.6 |
| 3042 | 1174 | 1059 | 8664 | 3280 | 19897 | 1271 | 0.7 |
| 3299 | 1293 | 1271 | 9230 | 3699 | 22041 | 1364 | 0.8 |
| 3628 | 1442 | 1557 | 9949 | 4218 | 24806 | 1477 | 0.9 |
| 4040 | 1629 | 1939 | 10845 | 4859 | 28318 | 1613 | 1.0 |
| 4551 | 1861 | 2453 | 11945 | 5655 | 32745 | 1776 | 1.1 |
| 5183 | 2150 | 3144 | 13285 | 6644 | 38307 | 1970 | 1.2 |
| 5964 | 2509 | 4078 | 14909 | 7877 | 45287 | 2200 | 1.3 |
| 6927 | 2957 | 5345 | 16876 | 9419 | 54053 | 2473 | 1.4 |
| 8119 | 3517 | 7072 | 19256 | 11354 | 65075 | 2797 | 1.5 |
| 9597 | 4221 | 9435 | 22139 | 13793 | 78965 | 3182 | 1.6 |
| 11435 | 5107 | 12680 | 25634 | 16876 | 96508 | 3639 | 1.7 |
| 13729 | 6228 | 17155 | 29883 | 20789 | 118724 | 4183 | 1.8 |
| 16601 | 7651 | 23350 | 35058 | 25771 | 146930 | 4832 | 1.9 |
| 20209 | 9464 | 31955 | 41379 | 32136 | 182837 | 5607 | 2.0 |

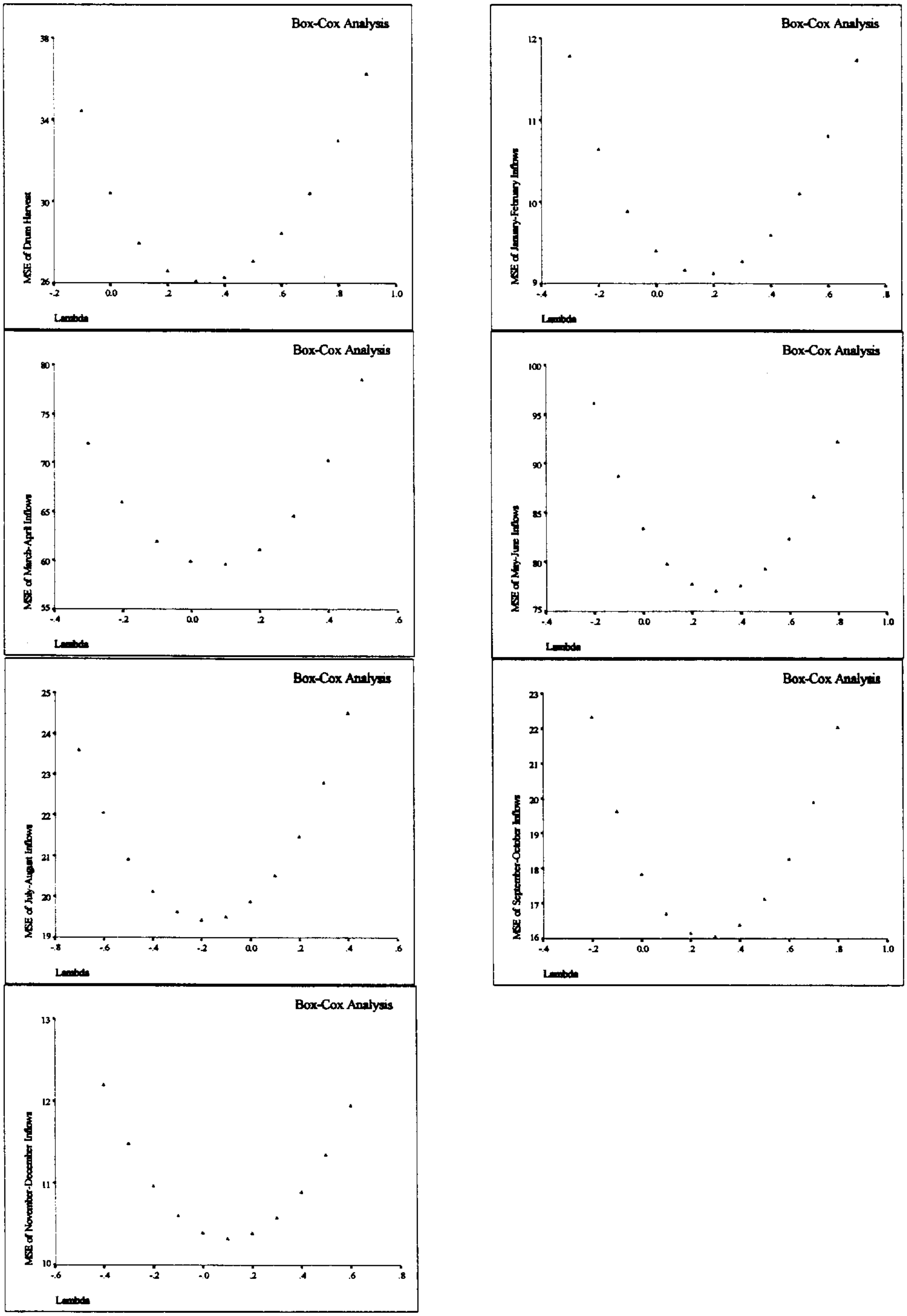



Fig 4.1. MSE of Harvest and Inflows Variables vs. Lambda obtained from Box-Cox Transformation

# 5. Model Choice Diagnostics

## 5.1 Untransformed Data

N = 33     Regression Models for Dependent Variable: DRUM

| Number In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.225039 | 0.200040 | 11.7468 | 268.6 | 3231.62 | 271.6 | QJA_LAG |
| 1 | 0.017563 | -.014128 | 22.6557 | 276.4 | 4096.80 | 279.4 | QND_LAG |
| 1 | 0.016230 | -.015504 | 22.7258 | 276.5 | 4102.36 | 279.5 | QSO_LAG |
| 1 | 0.015515 | -.016243 | 22.7634 | 276.5 | 4105.34 | 279.5 | QMA_LAG |
| 2 | 0.352819 | 0.309673 | 7.0282 | 264.7 | 2788.73 | 269.1 | QJA_LAG QND_LAG |
| 2 | 0.261123 | 0.211864 | 11.8495 | 269.0 | 3183.85 | 273.5 | QJF_LAG QJA_LAG |
| 2 | 0.234477 | 0.183442 | 13.2505 | 270.2 | 3298.67 | 274.7 | QJA_LAG QSO_LAG |
| 2 | 0.232268 | 0.181086 | 13.3667 | 270.3 | 3308.19 | 274.8 | QMA_LAG QJA_LAG |
| 3 | 0.433768 | 0.375192 | 4.7720 | 262.2 | 2524.05 | 268.2 | QMA_LAG QJA_LAG QND_LAG |
| 3 | 0.379987 | 0.315848 | 7.5997 | 265.2 | 2763.79 | 271.2 | QJA_LAG QSO_LAG QND_LAG |
| 3 | 0.355025 | 0.288304 | 8.9122 | 266.5 | 2875.06 | 272.5 | QJF_LAG QJA_LAG QND_LAG |
| 3 | 0.352828 | 0.285879 | 9.0277 | 266.7 | 2884.85 | 272.6 | QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.481323 | 0.407226 | 4.2716 | 261.4 | 2394.64 | 268.8 | QJF_LAG QMA_LAG QJA_LAG QND_LAG |
| 4 | 0.456520 | 0.378880 | 5.5757 | 262.9 | 2509.15 | 270.4 | QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.448467 | 0.369677 | 5.9991 | 263.4 | 2546.33 | 270.9 | QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.386132 | 0.298437 | 9.2766 | 266.9 | 2834.12 | 274.4 | QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.504654 | 0.412923 | 5.0449 | 261.8 | 2371.63 | 270.8 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.491814 | 0.397706 | 5.7200 | 262.7 | 2433.10 | 271.7 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.459279 | 0.359145 | 7.4307 | 264.7 | 2588.88 | 273.7 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.392601 | 0.280120 | 10.9365 | 268.6 | 2908.12 | 277.5 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.505507 | 0.391393 | 7.0000 | 263.8 | 2458.60 | 274.3 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

### 5.2 Logged Inflows

N = 33     Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.281133 | 0.257944 | 6.0410 | 266.1 | 2997.70 | 269.1 | LN_QJA |
| 1 | 0.081220 | 0.051582 | 15.7858 | 274.2 | 3831.35 | 277.2 | LN_QMA |
| 1 | 0.020920 | -.010663 | 18.7251 | 276.3 | 4082.80 | 279.3 | LN_QJF |
| 1 | 0.010513 | -.021406 | 19.2324 | 276.7 | 4126.20 | 279.7 | LN_QSO |
| 2 | 0.369616 | 0.327590 | 3.7280 | 263.8 | 2716.35 | 268.3 | LN_QJA LN_QND |
| 2 | 0.307825 | 0.261680 | 6.7400 | 266.9 | 2982.61 | 271.4 | LN_QJA LN_QSO |
| 2 | 0.298847 | 0.252104 | 7.1776 | 267.3 | 3021.29 | 271.8 | LN_QMA LN_QJA |
| 2 | 0.281471 | 0.233569 | 8.0246 | 268.1 | 3096.17 | 272.6 | LN_QMJ LN_QJA |
| 3 | 0.432769 | 0.374090 | 2.6496 | 262.3 | 2528.50 | 268.3 | LN_QMA LN_QJA LN_QND |
| 3 | 0.386815 | 0.323382 | 4.8896 | 264.9 | 2733.35 | 270.9 | LN_QJF LN_QJA LN_QND |
| 3 | 0.379592 | 0.315412 | 5.2417 | 265.3 | 2765.55 | 271.2 | LN_QJA LN_QSO LN_QND |
| 3 | 0.376539 | 0.312043 | 5.3905 | 265.4 | 2779.16 | 271.4 | LN_QMJ LN_QJA LN_QND |
| 4 | 0.459837 | 0.382671 | 3.3301 | 262.7 | 2493.84 | 270.2 | LN_QMA LN_QJA LN_QSO LN_QND |
| 4 | 0.434778 | 0.354032 | 4.5517 | 264.2 | 2609.53 | 271.7 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.433186 | 0.352212 | 4.6293 | 264.3 | 2616.88 | 271.8 | LN_QMA LN_QMJ LN_QJA LN_QND |
| 4 | 0.403718 | 0.318535 | 6.0656 | 266.0 | 2752.93 | 273.4 | LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.463781 | 0.364481 | 5.1379 | 264.4 | 2567.32 | 273.4 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.462984 | 0.363537 | 5.1768 | 264.5 | 2571.14 | 273.5 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.435342 | 0.330775 | 6.5242 | 266.2 | 2703.48 | 275.1 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.419278 | 0.311737 | 7.3072 | 267.1 | 2780.39 | 276.1 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.466610 | 0.343520 | 7.0000 | 266.3 | 2652.00 | 276.7 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 5.3 Logged All Variables

N = 33 Regression Models for Dependent Variable: LN (DRUM)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.165983 | 0.139079 | 0.8523 | -5.1887 | 0.805795 | -2.1957 | LN_QJA |
| 1 | 0.023525 | -.007975 | 5.9514 | 0.0152 | 0.943433 | 3.0083 | LN_QSO |
| 1 | 0.021597 | -.009964 | 6.0204 | 0.0803 | 0.945296 | 3.0733 | LN_QJF |
| 1 | 0.003434 | -.028713 | 6.6705 | 0.6873 | 0.962844 | 3.6803 | LN_QND |
| 2 | 0.216684 | 0.164463 | 1.0376 | -5.2584 | 0.782037 | -0.7689 | LN_QJA LN_QND |
| 2 | 0.206227 | 0.153309 | 1.4119 | -4.8208 | 0.792477 | -0.3312 | LN_QJA LN_QSO |
| 2 | 0.178734 | 0.123983 | 2.3959 | -3.6971 | 0.819925 | 0.7924 | LN_QMA LN_QJA |
| 2 | 0.171928 | 0.116723 | 2.6396 | -3.4248 | 0.826720 | 1.0648 | LN_QMJ LN_QJA |
| 3 | 0.240558 | 0.161995 | 2.1831 | -4.2798 | 0.784347 | 1.7062 | LN_QJA LN_QSO LN_QND |
| 3 | 0.236228 | 0.157217 | 2.3380 | -4.0922 | 0.788819 | 1.8938 | LN_QJF LN_QJA LN_QND |
| 3 | 0.218087 | 0.137199 | 2.9874 | -3.3175 | 0.807555 | 2.6685 | LN_QMA LN_QJA LN_QND |
| 3 | 0.217592 | 0.136653 | 3.0051 | -3.2967 | 0.808066 | 2.6894 | LN_QMJ LN_QJA LN_QND |
| 4 | 0.267502 | 0.162859 | 3.2186 | -3.4719 | 0.783538 | 4.0107 | LN_QJF LN_QJA LN_QSO LN_QND |
| 4 | 0.244910 | 0.137039 | 4.0273 | -2.4694 | 0.807705 | 5.0131 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.243690 | 0.135646 | 4.0709 | -2.4162 | 0.809009 | 5.0663 | LN_QMJ LN_QJA LN_QSO LN_QND |
| 4 | 0.240558 | 0.132067 | 4.1830 | -2.2798 | 0.812359 | 5.2027 | LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.270951 | 0.135942 | 5.0952 | -1.6276 | 0.808732 | 7.3514 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.268455 | 0.132984 | 5.1845 | -1.5149 | 0.811500 | 7.4642 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.245716 | 0.106034 | 5.9984 | -0.5047 | 0.836725 | 8.4743 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.244127 | 0.104151 | 6.0553 | -0.4353 | 0.838487 | 8.5438 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.273610 | 0.105982 | 7.0000 | 0.2518 | 0.836773 | 10.7273 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 5.4 Square Root Inflows

N = 33 Regression Models for Dependent Variable: DRUM

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.25926 | 0.23536 | 9.478 | 267.1 | 3088.9 | 270.1 | SQRT_QJA |
| 1 | 0.04845 | 0.01775 | 20.429 | 275.4 | 3968.0 | 278.4 | SQRT_QMA |
| 1 | 0.01641 | -.01532 | 22.094 | 276.5 | 4101.6 | 279.5 | SQRT_QSO |
| 1 | 0.01170 | -.02018 | 22.338 | 276.6 | 4121.3 | 279.6 | SQRT_QND |
| 2 | 0.37953 | 0.33817 | 5.231 | 263.3 | 2673.6 | 267.8 | SQRT_QJA SQRT_QND |
| 2 | 0.27844 | 0.23034 | 10.482 | 268.2 | 3109.2 | 272.7 | SQRT_QJA SQRT_QSO |
| 2 | 0.27681 | 0.22860 | 10.567 | 268.3 | 3116.3 | 272.8 | SQRT_QJF SQRT_QJA |
| 2 | 0.27565 | 0.22736 | 10.627 | 268.4 | 3121.2 | 272.9 | SQRT_QMA SQRT_QJA |
| 3 | 0.46308 | 0.40753 | 2.891 | 260.5 | 2393.4 | 266.5 | SQRT_QMA SQRT_QJA SQRT_QND |
| 3 | 0.40053 | 0.33852 | 6.140 | 264.1 | 2672.2 | 270.1 | SQRT_QJA SQRT_QSO SQRT_QND |
| 3 | 0.38096 | 0.31692 | 7.156 | 265.2 | 2759.4 | 271.2 | SQRT_QMJ SQRT_QJA SQRT_QND |
| 3 | 0.37954 | 0.31535 | 7.230 | 265.3 | 2765.8 | 271.2 | SQRT_QJF SQRT_QJA SQRT_QND |
| 4 | 0.48737 | 0.41414 | 3.629 | 261.0 | 2366.7 | 268.4 | SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.47594 | 0.40107 | 4.223 | 261.7 | 2419.5 | 269.2 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QND |
| 4 | 0.46808 | 0.39210 | 4.631 | 262.2 | 2455.8 | 269.7 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 4 | 0.41496 | 0.33138 | 7.390 | 265.3 | 2701.0 | 272.8 | SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.49933 | 0.40661 | 5.008 | 262.2 | 2397.1 | 271.2 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.48741 | 0.39249 | 5.627 | 263.0 | 2454.2 | 271.9 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.48005 | 0.38377 | 6.009 | 263.4 | 2489.4 | 272.4 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 5 | 0.41518 | 0.30688 | 9.379 | 267.3 | 2800.0 | 276.3 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.49948 | 0.38397 | 7.000 | 264.2 | 2488.6 | 274.7 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

### 5.5 Square Root All Variables

N = 33 Regression Models for Dependent Variable: SQRT (DRUM)

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.25729 | 0.23333 | 5.295 | 74.861 | 9.114 | 77.854 | SQRT_QJA |
| 1 | 0.02795 | -.00341 | 15.884 | 83.741 | 11.928 | 86.734 | SQRT_QSO |
| 1 | 0.01746 | -.01424 | 16.369 | 84.096 | 12.057 | 87.089 | SQRT_QMA |
| 1 | 0.00837 | -.02361 | 16.788 | 84.399 | 12.169 | 87.392 | SQRT_QND |
| 2 | 0.36467 | 0.32232 | 2.336 | 71.707 | 8.056 | 76.197 | SQRT_QJA SQRT_QND |
| 2 | 0.28882 | 0.24141 | 5.839 | 75.429 | 9.018 | 79.919 | SQRT_QJA SQRT_QSO |
| 2 | 0.26862 | 0.21986 | 6.771 | 76.353 | 9.274 | 80.843 | SQRT_QJF SQRT_QJA |
| 2 | 0.26478 | 0.21576 | 6.949 | 76.526 | 9.323 | 81.016 | SQRT_QMJ SQRT_QJA |
| 3 | 0.39841 | 0.33617 | 2.779 | 71.907 | 7.891 | 77.893 | SQRT_QMA SQRT_QJA SQRT_QND |
| 3 | 0.39839 | 0.33616 | 2.779 | 71.908 | 7.892 | 77.894 | SQRT_QJA SQRT_QSO SQRT_QND |
| 3 | 0.36589 | 0.30029 | 4.280 | 73.644 | 8.318 | 79.630 | SQRT_QMJ SQRT_QJA SQRT_QND |
| 3 | 0.36519 | 0.29953 | 4.312 | 73.680 | 8.327 | 79.666 | SQRT_QJF SQRT_QJA SQRT_QND |
| 4 | 0.43476 | 0.35401 | 3.100 | 71.850 | 7.679 | 79.333 | SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.41008 | 0.32581 | 4.240 | 73.260 | 8.015 | 80.743 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 4 | 0.40181 | 0.31635 | 4.622 | 73.720 | 8.127 | 81.203 | SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.40083 | 0.31524 | 4.667 | 73.774 | 8.140 | 81.256 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QND |
| 5 | 0.43672 | 0.33241 | 5.010 | 73.736 | 7.936 | 82.715 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.43504 | 0.33042 | 5.087 | 73.834 | 7.960 | 82.813 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.41193 | 0.30302 | 6.154 | 75.157 | 8.286 | 84.136 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 5 | 0.40217 | 0.29146 | 6.605 | 75.700 | 8.423 | 84.679 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.43693 | 0.30699 | 7.000 | 75.723 | 8.238 | 86.199 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

## 5.6 Harvest Untransformed, and Logged and Square Root Inflows

N = 33     Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.281133 | 0.257944 | 6.2097 | 266.1 | 2997.70 | 269.1 | LN_QJA |
| 1 | 0.081220 | 0.051582 | 16.0013 | 274.2 | 3831.35 | 277.2 | LN_QMA |
| 1 | 0.020920 | -.010663 | 18.9548 | 276.3 | 4082.80 | 279.3 | LN_QJF |
| 1 | 0.016407 | -.015322 | 19.1758 | 276.5 | 4101.62 | 279.5 | SQRT_QSO |
| 2 | 0.369616 | 0.327590 | 3.8759 | 263.8 | 2716.35 | 268.3 | LN_QJA LN_QND |
| 2 | 0.299856 | 0.253179 | 7.2927 | 267.3 | 3016.95 | 271.7 | LN_QJA SQRT_QSO |
| 2 | 0.298847 | 0.252104 | 7.3421 | 267.3 | 3021.29 | 271.8 | LN_QMA LN_QJA |
| 2 | 0.282051 | 0.234188 | 8.1647 | 268.1 | 3093.67 | 272.6 | SQRT_QMJ LN_QJA |
| 3 | 0.432769 | 0.374090 | 2.7826 | 262.3 | 2528.50 | 268.3 | LN_QMA LN_QJA LN_QND |
| 3 | 0.386815 | 0.323382 | 5.0335 | 264.9 | 2733.35 | 270.9 | LN_QJF LN_QJA LN_QND |
| 3 | 0.385957 | 0.322436 | 5.0755 | 264.9 | 2737.17 | 270.9 | LN_QJA SQRT_QSO LN_QND |
| 3 | 0.369868 | 0.304682 | 5.8635 | 265.8 | 2808.89 | 271.8 | SQRT_QMJ LN_QJA LN_QND |
| 4 | 0.466899 | 0.390742 | 3.1110 | 262.3 | 2461.24 | 269.7 | LN_QMA LN_QJA SQRT_QSO LN_QND |
| 4 | 0.441356 | 0.361549 | 4.3621 | 263.8 | 2579.16 | 271.3 | LN_QMA SQRT_QMJ LN_QJA LN_QND |
| 4 | 0.434778 | 0.354032 | 4.6843 | 264.2 | 2609.53 | 271.7 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.405681 | 0.320778 | 6.1094 | 265.8 | 2743.87 | 273.3 | LN_QJF LN_QJA SQRT_QSO LN_QND |
| 5 | 0.468825 | 0.370460 | 5.0166 | 264.1 | 2543.17 | 273.1 | LN_QJF LN_QMA LN_QJA SQRT_QSO LN_QND |
| 5 | 0.467151 | 0.368475 | 5.0986 | 264.2 | 2551.18 | 273.2 | LN_QMA SQRT_QMJ LN_QJA SQRT_QSO LN_QND |
| 5 | 0.443805 | 0.340806 | 6.2421 | 265.7 | 2662.96 | 274.6 | LN_QJF LN_QMA SQRT_QMJ LN_QJA LN_QND |
| 5 | 0.409466 | 0.300108 | 7.9240 | 267.6 | 2827.37 | 276.6 | LN_QJF SQRT_QMJ LN_QJA SQRT_QSO LN_QND |
| 6 | 0.469165 | 0.346664 | 7.0000 | 266.1 | 2639.30 | 276.6 | LN_QJF LN_QMA SQRT_QMJ LN_QJA SQRT_QSO LN_QND |

## 5.7 Logged and Square Root Variables

N = 33 Regression Models for Dependent Variable: SQRT (DRUM)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.268101 | 0.244491 | 3.5771 | 74.3770 | 8.9814 | 77.3700 | LN_QJA |
| 1 | 0.035324 | 0.004205 | 13.9380 | 83.4899 | 11.8379 | 86.4829 | LN_QMA |
| 1 | 0.028396 | -.002946 | 14.2464 | 83.7261 | 11.9229 | 86.7191 | LN_QJF |
| 1 | 0.027951 | -.003406 | 14.2662 | 83.7412 | 11.9284 | 86.7342 | SQRT_QSO |
| 2 | 0.342499 | 0.298665 | 2.2656 | 72.8395 | 8.3374 | 77.3290 | LN_QJA LN_QND |
| 2 | 0.298980 | 0.252246 | 4.2026 | 74.9544 | 8.8892 | 79.4440 | LN_QJA SQRT_QSO |
| 2 | 0.277653 | 0.229497 | 5.1519 | 75.9434 | 9.1597 | 80.4330 | SQRT_QMJ LN_QJA |
| 2 | 0.269348 | 0.220637 | 5.5216 | 76.3207 | 9.2650 | 80.8102 | LN_QMA LN_QJA |
| 3 | 0.370555 | 0.305441 | 3.0168 | 73.4004 | 8.2568 | 79.3864 | LN_QJA SQRT_QSO LN_QND |
| 3 | 0.365374 | 0.299723 | 3.2474 | 73.6709 | 8.3248 | 79.6570 | LN_QJF LN_QJA LN_QND |
| 3 | 0.361548 | 0.295501 | 3.4177 | 73.8693 | 8.3750 | 79.8553 | LN_QMA LN_QJA LN_QND |
| 3 | 0.345661 | 0.277971 | 4.1248 | 74.6804 | 8.5834 | 80.6664 | SQRT_QMJ LN_QJA LN_QND |
| 4 | 0.401940 | 0.316503 | 3.6198 | 73.7126 | 8.1253 | 81.1951 | LN_QMA LN_QJA SQRT_QSO LN_QND |
| 4 | 0.397247 | 0.311139 | 3.8287 | 73.9705 | 8.1891 | 81.4530 | LN_QJF LN_QJA SQRT_QSO LN_QND |
| 4 | 0.376386 | 0.287298 | 4.7572 | 75.0933 | 8.4725 | 82.5758 | LN_QMA SQRT_QMJ LN_QJA LN_QND |
| 4 | 0.373508 | 0.284009 | 4.8854 | 75.2453 | 8.5116 | 82.7278 | LN_QJF LN_QMA LN_QJA LN_QND |
| 5 | 0.413680 | 0.305102 | 5.0973 | 75.0583 | 8.2609 | 84.0374 | LN_QJF LN_QMA LN_QJA SQRT_QSO LN_QND |
| 5 | 0.403577 | 0.293129 | 5.5470 | 75.6221 | 8.4032 | 84.6011 | LN_QMA SQRT_QMJ LN_QJA SQRT_QSO LN_QND |
| 5 | 0.397263 | 0.285646 | 5.8280 | 75.9696 | 8.4922 | 84.9486 | LN_QJF SQRT_QMJ LN_QJA SQRT_QSO LN_QND |
| 5 | 0.389742 | 0.276731 | 6.1628 | 76.3789 | 8.5981 | 85.3579 | LN_QJF LN_QMA SQRT_QMJ LN_QJA LN_QND |
| 6 | 0.415866 | 0.281066 | 7.0000 | 76.9351 | 8.5466 | 87.4106 | LN_QJF LN_QMA SQRT_QMJ LN_QJA SQRT_QSO LN_QND |

## 5.8 Variables transformed according to the Box-Cox Analysis

N = 33 Regression Models for Dependent Variable: $(DRUM)^{0.3}$

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.237093 | 0.212483 | 1.8430 | -12.5568 | 0.644552 | -9.5638 | $(QJA)^{-0.2}$ |
| 1 | 0.028688 | -.002644 | 10.2685 | -4.5869 | 0.820625 | -1.5939 | $(QSO)^{0.3}$ |
| 1 | 0.017565 | -.014127 | 10.7182 | -4.2111 | 0.830023 | -1.2181 | $(QJF)^{0.2}$ |
| 1 | 0.014938 | -.016838 | 10.8244 | -4.1230 | 0.832242 | -1.1300 | $(QMA)^{0.1}$ |
| 2 | 0.301286 | 0.254705 | 1.2478 | -13.4573 | 0.609995 | -8.9678 | $(QJA)^{-0.2}$ $(QND)^{0.1}$ |
| 2 | 0.275650 | 0.227360 | 2.2842 | -12.2682 | 0.632376 | -7.7787 | $(QJA)^{-0.2}$ $(QSO)^{0.3}$ |
| 2 | 0.248371 | 0.198262 | 3.3871 | -11.0482 | 0.656191 | -6.5587 | $(QMJ)^{0.3}$ $(QJA)^{-0.2}$ |
| 2 | 0.237379 | 0.186538 | 3.8314 | -10.5692 | 0.665787 | -6.0796 | $(QMA)^{0.1}$ $(QJA)^{-0..2}$ |
| 3 | 0.331204 | 0.262019 | 2.0383 | -12.9015 | 0.604009 | -6.9154 | $(QJA)^{-0.2}$ $(QSO)^{0.3}$ $(QND)^{0.1}$ |
| 3 | 0.317966 | 0.247411 | 2.5735 | -12.2547 | 0.615964 | -6.2686 | $(QJF)^{0.2}$ $(QJA)^{-0.2}$ $(QND)^{0.1}$ |
| 3 | 0.307377 | 0.235727 | 3.0016 | -11.7463 | 0.625528 | -5.7602 | $(QMA)^{0.1}$ $(QJA)^{-0.2}$ $(QND)^{0.1}$ |
| 3 | 0.305441 | 0.233590 | 3.0798 | -11.6541 | 0.627277 | -5.6681 | $(QMJ)^{0.3}$ $(QJA)^{-0.2}$ $(QND)^{0.1}$ |
| 4 | 0.351797 | 0.259197 | 3.2057 | -11.9335 | 0.606318 | -4.4510 | $(QJF)^{0.2}$ $(QJA)^{-0.2}$ $(QSO)^{0.3}$ $(QND)^{0.1}$ |
| 4 | 0.343541 | 0.249761 | 3.5395 | -11.5159 | 0.614041 | -4.0333 | $(QMA)^{0.1}$ $(QJA)^{-0.2}$ $(QSO)^{0.3}$ $(QND)^{0.1}$ |
| 4 | 0.331679 | 0.236205 | 4.0191 | -10.9249 | 0.625136 | -3.4424 | $(QMJ)^{0.3}$ $(QJA)^{-0.2}$ $(QSO)^{0.3}$ $(QND)^{0.1}$ |
| 4 | 0.325864 | 0.229559 | 4.2542 | -10.6390 | 0.630575 | -3.1565 | $(QJF)^{0.2}$ $(QMJ)^{0.3}$ $(QJA)^{-0.2}$ $(QND)^{-0.1}$ |
| 5 | 0.356317 | 0.237117 | 5.0230 | -10.1645 | 0.624390 | -1.1854 | $(QJF)^{0.2}$ $(QMA)^{0.1}$ $(QJA)^{-0.2}$ $(QSO)^{0.3}$ $(QND)^{0.1}$ |
| 5 | 0.351798 | 0.231761 | 5.2057 | -9.9336 | 0.628774 | -0.9546 | $(QJF)^{0.2}$ $(QMJ)^{0.3}$ $(QJA)^{-0.2}$ $(QSO)^{0.3}$ $(QND)^{0.1}$ |
| 5 | 0.343875 | 0.222371 | 5.5260 | -9.5327 | 0.636459 | -0.5537 | $(QMA)^{0.1}$ $(QMJ)^{0.3}$ $(QJA)^{-0.2}$ $(QSO)^{0.3}$ $(QND)^{0.1}$ |
| 5 | 0.331129 | 0.207265 | 6.0413 | -8.8978 | 0.648823 | 0.0813 | $(QJF)^{0.2}$ $(QMA)^{0.1}$ $(QMJ)^{0.3}$ $(QJA)^{-0.2}$ $(QND)^{0.1}$ |
| 6 | 0.356886 | 0.208475 | 7.0000 | -8.1936 | 0.647832 | 2.2819 | $(QJF)^{0.2}$ $(QMA)^{0.1}$ $(QMJ)^{0.3}$ $(QJA)^{-0.2}$ $(QSO)^{0.3}$ $(QND)^{0.1}$ |

# 6. Regression for the Best Models

## 6.1 Model 1: Untransformed Variables

### 6.1.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | Nov-Dec Inflows, May-Jun Inflows, Jul-Aug Inflows, Sept-Oct Inflows, Jan-Feb Inflows, Mar-Apr Inflows[c,d] | . | .711 | .506 | .391 | 49.5843 | 1.489 |

a. Dependent Variable: Drum Harvest

b. Method: Enter

c. Independent Variables: (Constant), November-December Inflows, May-June Inflows, July-August Inflows, September-October Inflows, January-February Inflows, March-April Inflows

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 65347.5 | 6 | 10891.2 | 4.430 | .003[b] |
| | Residual | 63923.7 | 26 | 2458.602 | | |
| | Total | 129271 | 32 | | | |

a. Dependent Variable: Drum Harvest

b. Independent Variables: (Constant), November-December Inflows, May-June Inflows, July-August Inflows, September-October Inflows, January-February Inflows, March-April Inflows

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| 1 | (Constant) | 81.981 | 19.864 | | 4.127 | .000 | 41.149 | 122.813 |
| | January-February Inflows | .470 | .301 | .298 | 1.559 | .131 | -.150 | 1.090 |
| | March-April Inflows | -.682 | .280 | -.472 | -2.436 | .022 | -1.257 | -.107 |
| | May-June Inflows | 2.3E-02 | .108 | .037 | .212 | .834 | -.199 | .245 |
| | July-August Inflows | -.697 | .148 | -.765 | -4.718 | .000 | -1.001 | -.394 |
| | September-October Inflows | 5.2E-02 | .062 | .138 | .849 | .404 | -.074 | .179 |
| | November-December Inflows | .838 | .278 | .530 | 3.018 | .006 | .267 | 1.409 |

a. Dependent Variable: Drum Harvest

### 6.1.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 81.980580 | 19.86442999 | 4.127 | 0.0003 | 0.00000000 |
| QJF_LAG | 1 | 0.470053 | 0.30149813 | 1.559 | 0.1311 | 1.92731110 |
| QMA_LAG | 1 | -0.681747 | 0.27980688 | -2.436 | 0.0220 | 1.97604678 |
| QMJ_LAG | 1 | 0.022849 | 0.10786199 | 0.212 | 0.8339 | 1.64223279 |
| QJA_LAG | 1 | -0.697411 | 0.14781819 | -4.718 | 0.0001 | 1.38195204 |
| QSO_LAG | 1 | 0.052267 | 0.06159915 | 0.849 | 0.4039 | 1.39851439 |
| QND_LAG | 1 | 0.838282 | 0.27776659 | 3.018 | 0.0056 | 1.62017959 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop QJF_LAG | Var Prop QMA_LAG | Var Prop QMJ_LAG | Var Prop QJA_LAG | Var Prop QSO_LAG | Var Prop QND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.44570 | 1.00000 | 0.0616 | 0.0496 | 0.0255 | 0.0347 | 0.0020 | 0.0612 |
| 2 | 1.40207 | 1.32074 | 0.0006 | 0.0024 | 0.1712 | 0.0165 | 0.2681 | 0.0176 |
| 3 | 0.94595 | 1.60793 | 0.0004 | 0.1457 | 0.0019 | 0.4672 | 0.0790 | 0.0057 |
| 4 | 0.49237 | 2.22873 | 0.2218 | 0.0037 | 0.0074 | 0.0901 | 0.0665 | 0.8435 |
| 5 | 0.41133 | 2.43840 | 0.3791 | 0.0001 | 0.5580 | 0.0993 | 0.4592 | 0.0028 |
| 6 | 0.30259 | 2.84300 | 0.3366 | 0.7985 | 0.2359 | 0.2922 | 0.1253 | 0.0691 |

### 6.1.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics**[a]

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | -10.0818 | 195.7478 | 80.8606 | 45.1897 | 33 |
| Std. Predicted Value | -2.012 | 2.542 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | 13.2471 | 40.2517 | 22.2348 | 5.2898 | 33 |
| Adjusted Predicted Value | -19.4932 | 206.6294 | 79.4656 | 46.7607 | 33 |
| Residual | -90.6424 | 110.4412 | 1.5E-14 | 44.6947 | 33 |
| Std. Residual | -1.828 | 2.227 | .000 | .901 | 33 |
| Stud. Residual | -1.939 | 2.391 | .013 | 1.002 | 33 |
| Deleted Residual | -101.9872 | 133.1977 | 1.3950 | 55.5234 | 33 |
| Stud. Deleted Residual | -2.056 | 2.654 | .024 | 1.046 | 33 |
| Mahal. Distance | 1.314 | 20.118 | 5.818 | 3.514 | 33 |
| Cook's Distance | .000 | .313 | .035 | .059 | 33 |
| Centered Leverage Value | .041 | .629 | .182 | .110 | 33 |

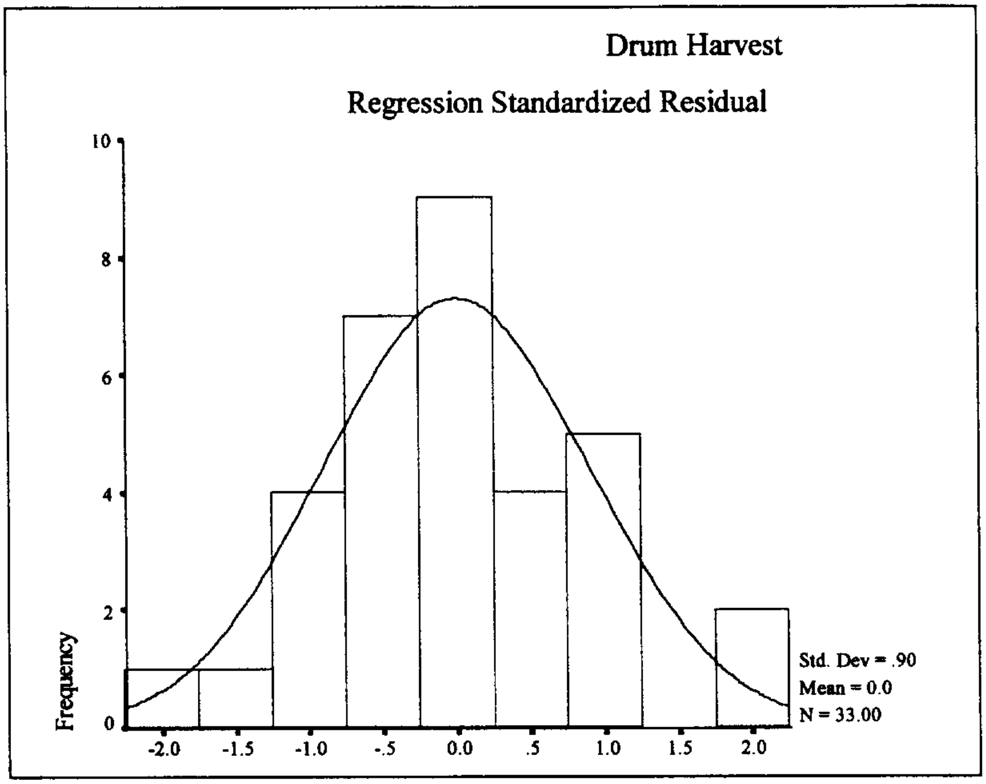
a. Dependent Variable: Drum Harvest

*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| **1961** | 195.74783 | -22.64783 | -33.52939 | 206.62939 | 2.54233 | -.45675 | -.55575 | -.54823 |
| **1962** | 194.10473 | 92.79527 | 133.19766 | 153.70234 | 2.50597 | 1.87147 | 2.24216 | 2.44799 |
| **1963** | 111.73336 | 59.66664 | 77.93368 | 93.46632 | .68318 | 1.20334 | 1.37526 | 1.40045 |
| **1964** | 70.25885 | 110.44115 | 127.23650 | 53.46350 | -.23461 | 2.22734 | 2.39071 | **2.65409** |
| **1965** | 74.75713 | -9.05713 | -10.33786 | 76.03786 | -.13506 | -.18266 | -.19515 | -.19150 |
| **1966** | 51.73552 | 5.66448 | 6.57034 | 50.82966 | -.64451 | .11424 | .12304 | .12068 |
| **1967** | 90.78292 | -31.08292 | -38.76102 | 98.46102 | .21957 | -.62687 | -.70003 | -.69299 |
| **1968** | 72.74291 | -22.04291 | -28.30593 | 79.00593 | -.17964 | -.44455 | -.50377 | -.49641 |
| **1969** | 109.22859 | -31.42859 | -37.16984 | 114.96984 | .62775 | -.63384 | -.68931 | -.68218 |
| **1970** | 75.06510 | 38.93490 | 49.90246 | 64.09754 | -.12825 | .78523 | .88897 | .88526 |
| **1971** | 106.30100 | -14.70100 | -17.50667 | 109.10667 | .56297 | -.29649 | -.32354 | -.31790 |
| **1972** | 78.31854 | 50.68146 | 57.21593 | 71.78407 | -.05625 | 1.02213 | 1.08602 | 1.08994 |
| **1973** | 98.11293 | 20.18707 | 25.72217 | 92.57783 | .38178 | .40713 | .45956 | .45248 |
| **1974** | 106.57675 | 11.42325 | 14.06252 | 103.93748 | .56907 | .23038 | .25561 | .25096 |
| **1975** | 125.75128 | 47.44872 | 53.33852 | 119.86148 | .99338 | .95693 | 1.01459 | 1.01518 |
| **1976** | 120.60130 | 2.79870 | 3.85833 | 119.54167 | .87942 | .05644 | .06627 | .06499 |
| **1977** | 90.43555 | -9.13555 | -10.67085 | 91.97085 | .21188 | -.18424 | -.19912 | -.19541 |
| **1978** | 95.04692 | -70.94692 | -80.71177 | 104.81177 | .31393 | -1.43083 | -1.52613 | -1.56839 |
| **1979** | 62.96615 | -26.06615 | -28.06967 | 64.96967 | -.39599 | -.52569 | -.54552 | -.53802 |
| **1980** | 29.40273 | -8.80273 | -11.08729 | 31.68729 | -1.13871 | -.17753 | -.19924 | -.19552 |
| **1981** | 4.47340 | 32.02660 | 44.79039 | -8.29039 | -1.69037 | .64590 | .76384 | .75756 |
| **1982** | 59.25392 | -7.35392 | -10.17677 | 62.07677 | -.47813 | -.14831 | -.17447 | -.17118 |
| **1983** | 28.42432 | -11.62432 | -16.15185 | 32.95185 | -1.16036 | -.23444 | -.27634 | -.27138 |
| **1984** | 64.84352 | -49.14352 | -68.19528 | 83.89528 | -.35444 | -.99111 | -1.16752 | -1.17610 |
| **1985** | 20.89760 | 26.70240 | 36.10926 | 11.49074 | -1.32692 | .53853 | .62624 | .61876 |
| **1986** | 95.63799 | -49.23799 | -57.56284 | 103.96284 | .32701 | -.99302 | -1.07369 | -1.07698 |
| **1987** | 74.95121 | -37.55121 | -42.89979 | 80.29979 | -.13077 | -.75732 | -.80946 | -.80394 |
| **1988** | 92.74240 | -90.64240 | -101.98716 | 104.08716 | .26293 | -1.82805 | -1.93907 | -2.05588 |
| **1989** | 83.37089 | -57.17089 | -64.87521 | 91.07521 | .05555 | -1.15300 | -1.22824 | -1.24093 |
| **1990** | -10.08176 | 34.08176 | 43.49320 | -19.49320 | -2.01246 | .68735 | .77648 | .77038 |
| **1991** | 51.42455 | -25.82455 | -32.50896 | 58.10896 | -.65139 | -.52082 | -.58435 | -.57680 |
| **1992** | 20.00612 | 44.89388 | 72.74678 | -7.84678 | -1.34664 | .90541 | 1.15254 | 1.16018 |
| **1993** | 122.78574 | -3.28574 | -9.63539 | 129.13539 | .92776 | -.06627 | -.11348 | -.11130 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.
[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



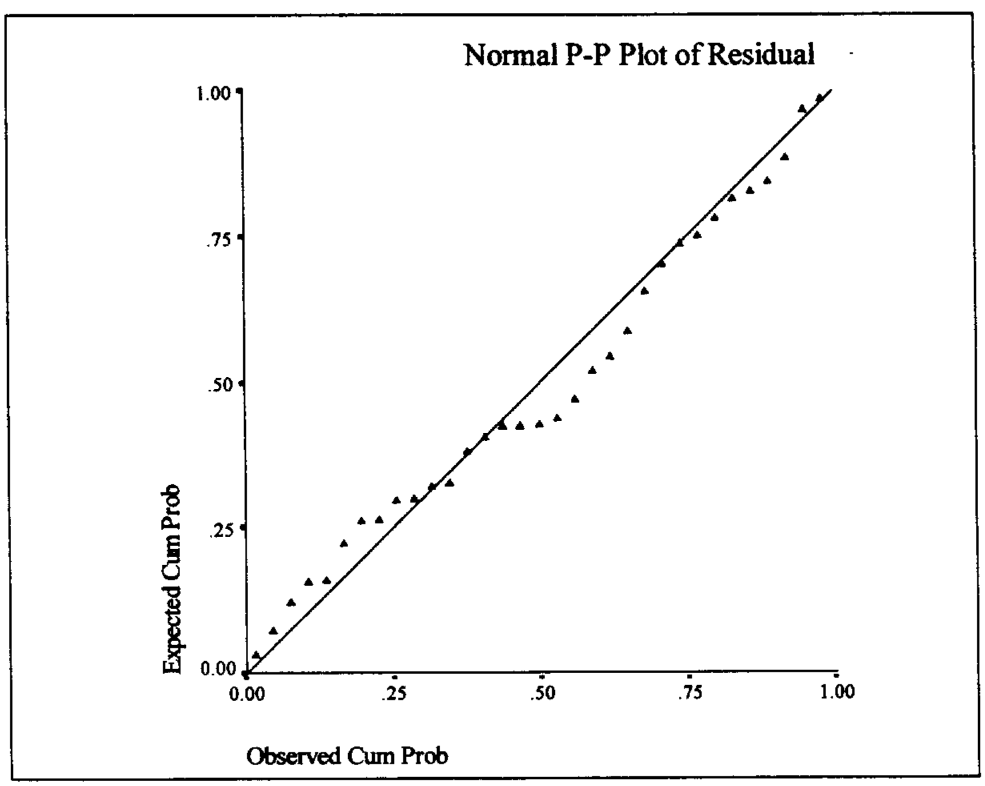




Fig. 6.1.1. Exploratory Plots of Drum Harvest Standardized Residual.

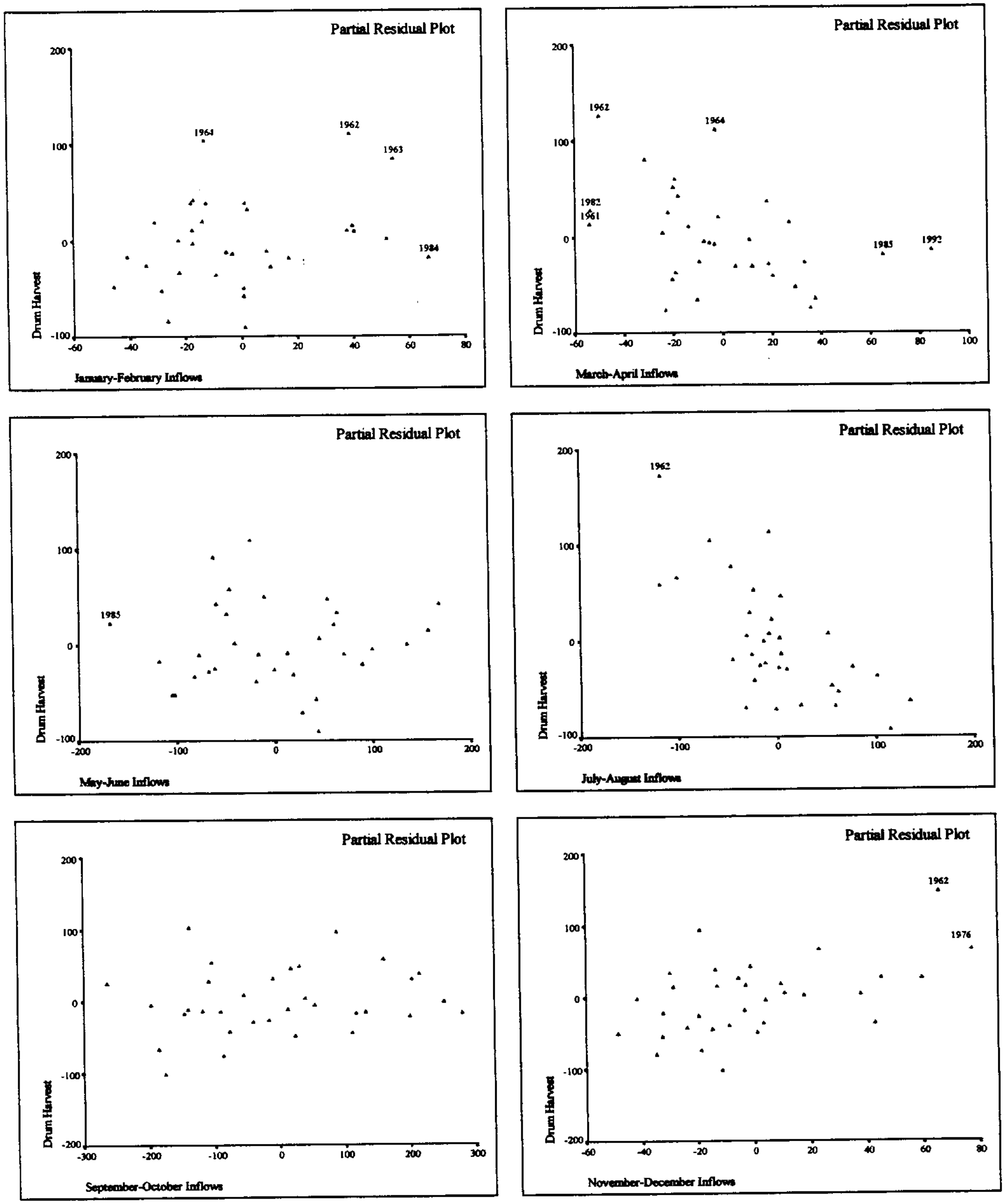



Fig. 6.1.2. Partial Residual Plots of Drum Harvest vs. Untransformed Inflows.

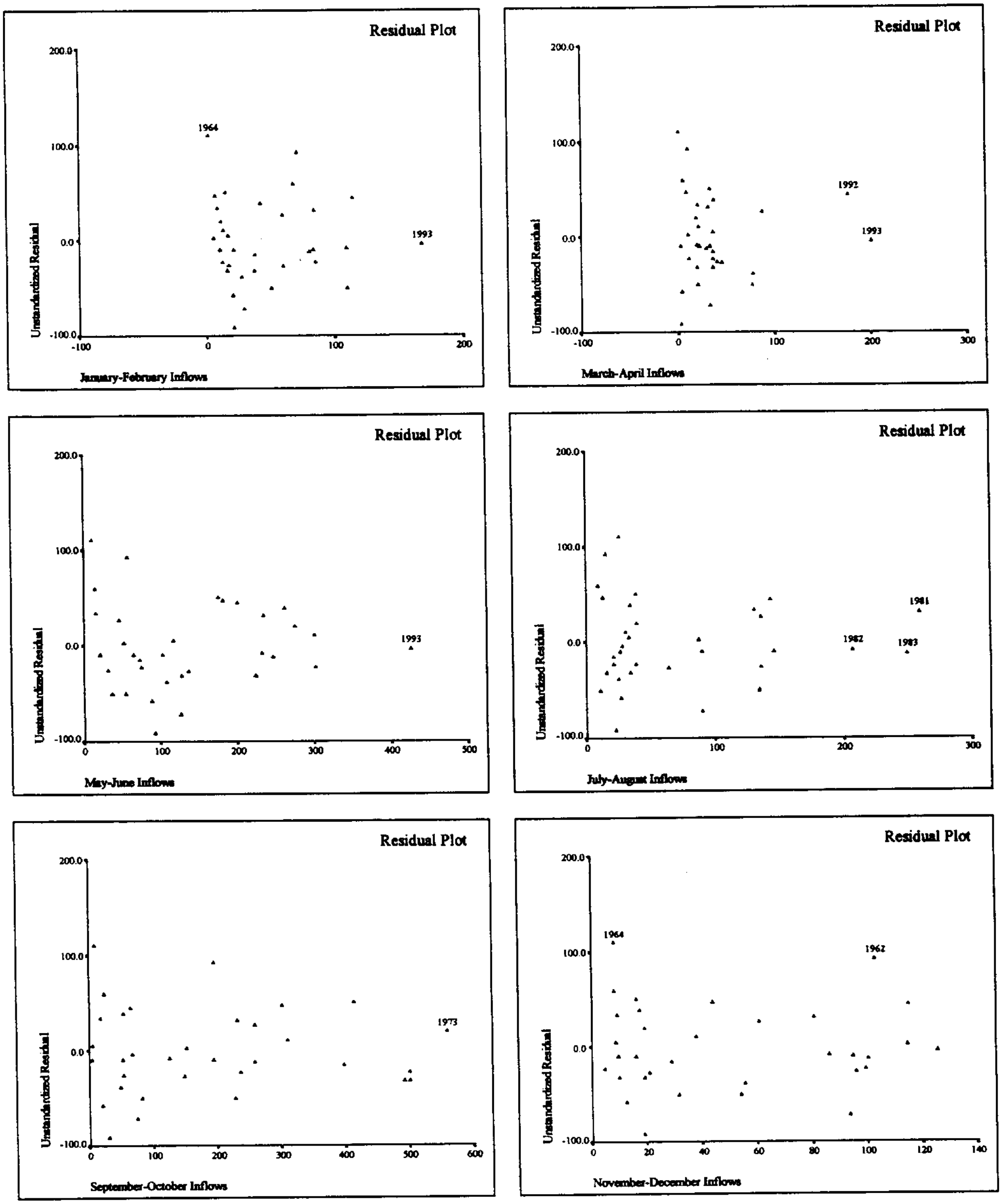



Fig. 6.1.3. Residual Plots of Drum Harvest vs. Untransformed Inflows.

### 6.1.4 Prediction Intervals for Drum Harvest

| YEAR | DRUM | LICI | UICI |
|---|---|---|---|
| 1961 | 173.10 | 37.17811 | 354.31755 |
| 1962 | 286.90 | 36.80981 | 351.39965 |
| 1963 | 171.40 | 0 | 264.81202 |
| 1964 | 180.70 | 0 | 216.85125 |
| 1965 | 65.70 | 0 | 220.82323 |
| 1966 | 57.40 | 0 | 198.70754 |
| 1967 | 59.70 | 0 | 241.59373 |
| 1968 | 50.70 | 0 | 225.00523 |
| 1969 | 77.80 | 0 | 257.26806 |
| 1970 | 114.00 | 0 | 227.23502 |
| 1971 | 91.60 | 0 | 254.71207 |
| 1972 | 129.00 | 0 | 223.75426 |
| 1973 | 118.30 | 0 | 249.99617 |
| 1974 | 118.00 | 0 | 256.73114 |
| 1975 | 173.20 | 0 | 270.93980 |
| 1976 | 123.40 | 0 | 276.15519 |
| 1977 | 81.30 | 0 | 237.79501 |
| 1978 | 24.10 | 0 | 240.92425 |
| 1979 | 36.90 | 0 | 205.57916 |
| 1980 | 20.60 | 0 | 180.71393 |
| 1981 | 36.50 | 0 | 160.65652 |
| 1982 | 51.90 | 0 | 214.97535 |
| 1983 | 16.80 | 0 | 184.32418 |
| 1984 | 15.70 | 0 | 220.68615 |
| 1985 | 47.60 | 0 | 175.58731 |
| 1986 | 46.40 | 0 | 243.04533 |
| 1987 | 37.40 | 0 | 221.06858 |
| 1988 | 2.10 | 0 | 237.98414 |
| 1989 | 26.20 | 0 | 229.10317 |
| 1990 | 24.00 | 0 | 141.87650 |
| 1991 | 25.60 | 0 | 202.70849 |
| 1992 | 64.90 | 0 | 182.03018 |
| 1993 | 119.50 | 0 | 300.24977 |

**DRUM** Drum harvest
**LICI** Lower limit for 99% prediction interval for Drum harvest
**UICI** Upper limit for 99% prediction interval for Drum harvest

### 6.1.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| **1961** | 9.41552 | .02120 | .29423 | .2242 | .0000 |
| **1962** | 8.73675 | .31269 | .27302 | .2721 | .0584 |
| **1963** | 6.53085 | .08272 | .20409 | .4793 | .0012 |
| **1964** | 3.25433 | .12417 | .10170 | .8605 | .0042 |
| **1965** | 2.99469 | .00077 | .09358 | .8855 | .0000 |
| **1966** | 3.44219 | .00035 | .10757 | .8413 | .0000 |
| **1967** | 5.36913 | .01729 | .16779 | .6150 | .0000 |
| **1968** | 6.11068 | .01030 | .19096 | .5269 | .0000 |
| **1969** | 3.97302 | .01240 | .12416 | .7829 | .0000 |
| **1970** | 6.06326 | .03180 | .18948 | .5324 | .0000 |
| **1971** | 4.15872 | .00285 | .12996 | .7613 | .0000 |
| **1972** | 2.68493 | .02172 | .08390 | .9125 | .0000 |
| **1973** | 5.91632 | .00827 | .18489 | .5496 | .0000 |
| **1974** | 5.03610 | .00216 | .15738 | .6556 | .0000 |
| **1975** | 2.56384 | .01825 | .08012 | .9222 | .0000 |
| **1976** | 7.81860 | .00024 | .24433 | .3489 | .0000 |
| **1977** | 3.63442 | .00095 | .11358 | .8208 | .0000 |
| **1978** | 2.90180 | .04579 | .09068 | .8939 | .0002 |
| **1979** | 1.31435 | .00327 | .04107 | .9881 | .0000 |
| **1980** | 5.62396 | .00147 | .17575 | .5843 | .0000 |
| **1981** | 8.14925 | .03322 | .25466 | .3196 | .0001 |
| **1982** | 7.90651 | .00167 | .24708 | .3409 | .0000 |
| **1983** | 8.00024 | .00425 | .25001 | .3326 | .0000 |
| **1984** | 7.97016 | .07549 | .24907 | .3352 | .0009 |
| **1985** | 7.36666 | .01974 | .23021 | .3917 | .0000 |
| **1986** | 3.65821 | .02784 | .11432 | .8182 | .0000 |
| **1987** | 3.01994 | .01333 | .09437 | .8832 | .0000 |
| **1988** | 2.58989 | .06723 | .08093 | .9202 | .0006 |
| **1989** | 2.83049 | .02904 | .08845 | .9002 | .0000 |
| **1990** | 5.95475 | .02378 | .18609 | .5450 | .0000 |
| **1991** | 5.61006 | .01263 | .17531 | .5859 | .0000 |
| **1992** | 11.28229 | .11773 | .35257 | .1268 | .0035 |
| **1993** | 20.11808 | .00355 | **.62869** | **.0053** | .0000 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1961** | -.38001 | .00504 | -.21145 | .20220 | .08839 | .23432 | -.09742 | -.22302 |
| **1962** | **1.61529** | .08549 | .69852 | -.82175 | -.39137 | **-1.01557** | .32422 | **1.08492** |
| **1963** | .77488 | .49382 | .53198 | -.28200 | -.15798 | -.31637 | -.20570 | -.26641 |
| **1964** | **1.03501** | **1.01855** | -.22293 | -.03588 | -.14731 | -.05485 | -.48637 | -.29929 |
| **1965** | -.07201 | -.07106 | .00666 | .00809 | .00713 | .00793 | .03711 | .02239 |
| **1966** | .04826 | .03871 | -.01364 | .00837 | .01311 | .00138 | -.03168 | -.02334 |
| **1967** | -.34443 | -.02324 | .04216 | -.12973 | .13805 | .02672 | -.26914 | .06359 |
| **1968** | -.26461 | .01922 | .07554 | -.03928 | -.10977 | -.01764 | -.09213 | .07460 |
| **1969** | -.29157 | .03174 | -.04759 | .03828 | -.03089 | .05502 | -.18474 | .03592 |
| **1970** | .46985 | .19036 | .00862 | -.10954 | .36787 | -.06657 | -.32768 | -.15956 |
| **1971** | -.13888 | -.01664 | -.01940 | -.03754 | .08835 | .03088 | -.10863 | .00661 |
| **1972** | .39137 | .04091 | -.11916 | .12020 | -.02346 | .01672 | .23073 | -.08729 |
| **1973** | .23693 | -.03862 | -.05423 | -.00374 | .06865 | -.00677 | .12958 | -.00761 |
| **1974** | .12063 | .00770 | -.03783 | -.03423 | .09545 | -.02236 | -.01907 | .01498 |
| **1975** | .35767 | .08560 | -.11648 | -.11431 | .12823 | -.14423 | .04233 | .14121 |
| **1976** | .03999 | .00302 | -.01884 | -.00578 | -.00676 | -.00171 | .00379 | .03314 |
| **1977** | -.08011 | -.01968 | .04351 | .00569 | -.00638 | -.00325 | .02355 | -.05358 |
| **1978** | -.58186 | -.11497 | .26664 | .09568 | -.10308 | .00292 | .17836 | -.40312 |
| **1979** | -.14916 | -.07615 | -.05789 | -.01756 | -.00037 | -.00389 | .02814 | .10162 |
| **1980** | -.09961 | -.01809 | -.05411 | .00353 | .03649 | -.04083 | -.01493 | .05939 |
| **1981** | .47824 | -.15779 | .01264 | -.08779 | .12580 | .36000 | -.01116 | -.02595 |
| **1982** | -.10606 | .02154 | -.04652 | .06073 | -.04372 | -.03351 | .02933 | -.00494 |
| **1983** | -.16936 | .06987 | .00592 | .04316 | -.04967 | -.10957 | -.00542 | -.03211 |
| **1984** | -.73228 | -.03913 | -.56659 | .14794 | .30803 | -.10080 | -.19137 | .26958 |
| **1985** | .36726 | -.01620 | -.06061 | .26544 | -.26170 | .16491 | .19157 | -.05217 |
| **1986** | -.44284 | -.20759 | -.00719 | -.23569 | .26305 | .15301 | -.03555 | -.00859 |
| **1987** | -.30341 | -.15472 | .14919 | -.18301 | .03459 | .04413 | .08107 | -.01717 |
| **1988** | -.72733 | -.63120 | -.01652 | .28235 | -.20944 | .20662 | .47312 | .13788 |
| **1989** | -.45554 | -.40269 | -.00786 | .15018 | -.12426 | .09074 | .30329 | .13735 |
| **1990** | .40483 | .23724 | -.16186 | .13543 | -.09130 | .26385 | -.11635 | -.20163 |
| **1991** | -.29346 | -.05475 | .17847 | -.07500 | .09456 | -.11410 | .01302 | -.13734 |
| **1992** | .91384 | -.19361 | -.10993 | .70744 | -.18999 | .23281 | .03290 | -.00816 |
| **1993** | -.15472 | .03768 | -.04617 | -.03608 | -.05619 | .05708 | .03306 | -.01191 |

**SDFFITS** Standardized dffits value
**SDFB_0** Standardized dfbeta for the intercept term
**SDFB_1** Standardized dfbeta for the untransformed January-February inflows
**SDFB_2** Standardized dfbeta for the untransformed March-April inflows
**SDFB_3** Standardized dfbeta for the untransformed May-June inflows
**SDFB_4** Standardized dfbeta for the untransformed July-August inflows
**SDFB_5** Standardized dfbeta for the untransformed September-October inflows
**SDFB_6** Standardized dfbeta for the untransformed November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

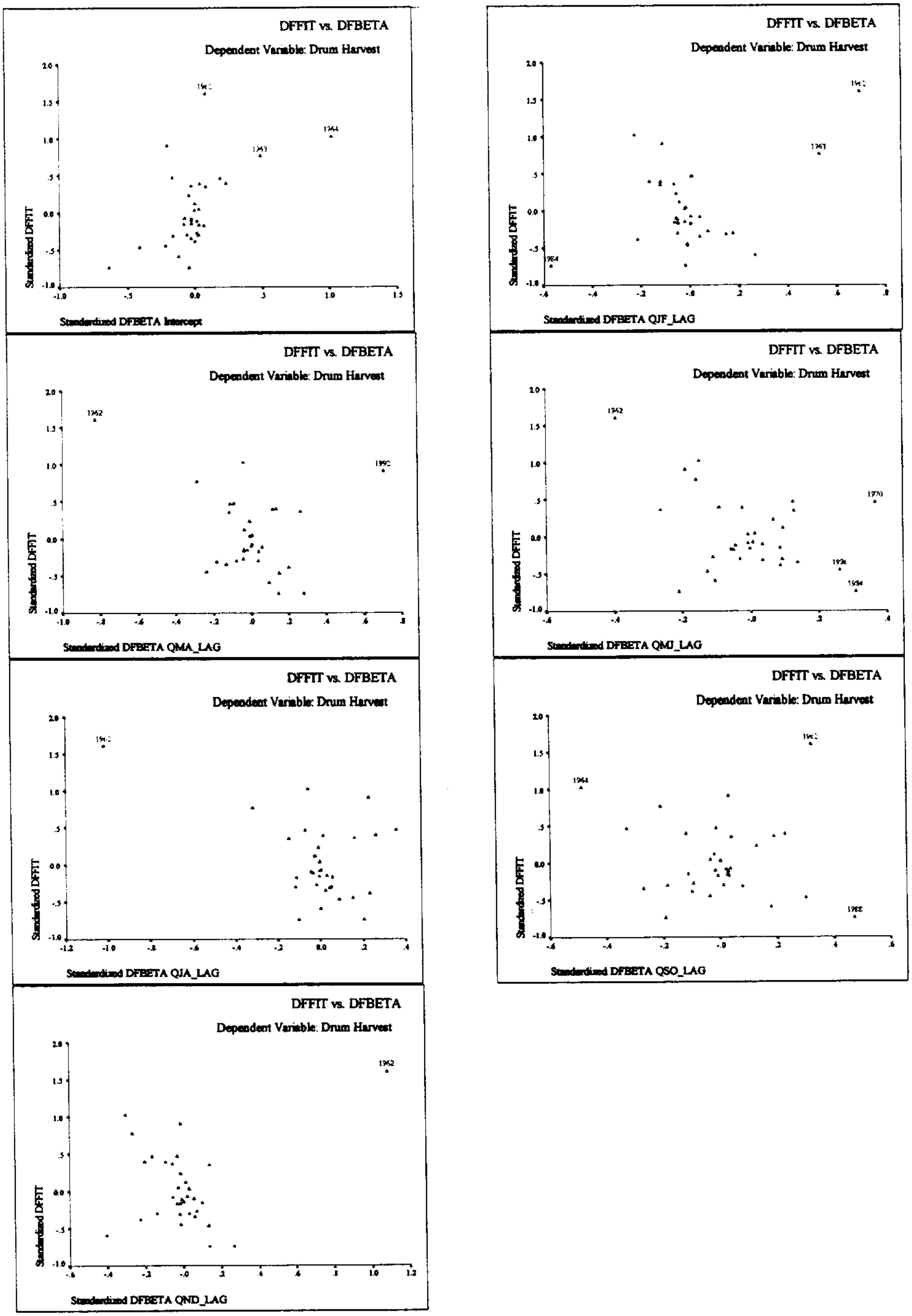



Fig. 6.1.4. Standardized DFFIT vs. Standardized DFBETA.

## 6.2 Model 2: Logged Inflows

### 6.2.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | Ln(Nov-Dec Inflows), Ln(Sept-Oct Inflows), Ln(Jul-Aug Inflows), Ln(Jan-Feb Inflows), Ln(May-Jun Inflows), Ln(Mar-Apr Inflows)[c,d] | . | .683 | .467 | .344 | 51.498 | 1.348 |

a. Dependent Variable: Drum Harvest

b. Method: Enter

c. Independent Variables: (Constant), Ln (November-December Inflows), Ln (September-October Inflows), Ln (July-August Inflows), Ln (January-February Inflows), Ln (May-June Inflows), Ln (March-April Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 60319.2 | 6 | 10053.2 | 3.791 | .008[b] |
| | Residual | 68951.9 | 26 | 2651.998 | | |
| | Total | 129271 | 32 | | | |

a. Dependent Variable: Drum Harvest

b. Independent Variables: (Constant), Ln (November-December Inflows), Ln (September-October Inflows), Ln (July-August Inflows), Ln (January-February Inflows), Ln (May-June Inflows), Ln (March-April Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. | 95% Confidence Interval for B Lower Bound | 95% Confidence Interval for B Upper Bound |
|---|---|---|---|---|---|---|---|---|
| 1 | (Constant) | 188.644 | 57.312 | | 3.292 | .003 | 70.839 | 306.450 |
| | Ln (January-February Inflows) | -4.012 | 10.804 | -.065 | -.371 | .713 | -26.220 | 18.196 |
| | Ln (March-April Inflows) | -17.443 | 11.484 | -.279 | -1.519 | .141 | -41.049 | 6.162 |
| | Ln (May-June Inflows) | -5.166 | 12.288 | -.077 | -.420 | .678 | -30.426 | 20.093 |
| | Ln (July-August Inflows) | -40.428 | 10.651 | -.595 | -3.796 | .001 | -62.321 | -18.536 |
| | Ln (September-October Inflows) | 10.472 | 8.482 | .212 | 1.235 | .228 | -6.964 | 27.908 |
| | Ln (November-December Inflows) | 26.557 | 11.109 | .413 | 2.391 | .024 | 3.722 | 49.392 |

a. Dependent Variable: Drum Harvest

## 6.2.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 188.644329 | 57.31151702 | 3.292 | 0.0029 | 0.00000000 |
| LN_QJF | 1 | -4.012142 | 10.80407333 | -0.371 | 0.7134 | 1.47207263 |
| LN_QMA | 1 | -17.443226 | 11.48381268 | -1.519 | 0.1408 | 1.64355554 |
| LN_QMJ | 1 | -5.166314 | 12.28847977 | -0.420 | 0.6776 | 1.63117428 |
| LN_QJA | 1 | -40.428332 | 10.65060770 | -3.796 | 0.0008 | 1.19843652 |
| LN_QSO | 1 | 10.472122 | 8.48236156 | 1.235 | 0.2280 | 1.43884310 |
| LN_QND | 1 | 26.556835 | 11.10905057 | 2.391 | 0.0244 | 1.45228025 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop LN_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop LN_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.66311 | 1.00000 | 0.0476 | 0.0514 | 0.0404 | 0.0302 | 0.0359 | 0.0463 |
| 2 | 1.11791 | 1.54345 | 0.0308 | 0.0003 | 0.1389 | 0.1993 | 0.1905 | 0.0752 |
| 3 | 0.72985 | 1.91019 | 0.2828 | 0.0499 | 0.0128 | 0.6087 | 0.0794 | 0.0050 |
| 4 | 0.59236 | 2.12033 | 0.0001 | 0.2966 | 0.0666 | 0.0734 | 0.1984 | 0.4947 |
| 5 | 0.49447 | 2.32072 | 0.5929 | 0.1835 | 0.0345 | 0.0866 | 0.1256 | 0.3492 |
| 6 | 0.40231 | 2.57285 | 0.0458 | 0.4183 | 0.7067 | 0.0018 | 0.3702 | 0.0296 |

### 6.2.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 6.4559 | 172.8488 | 80.8606 | 43.4163 | 33 |
| Std. Predicted Value | -1.714 | 2.119 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | 14.6741 | 31.3088 | 23.3331 | 4.3220 | 33 |
| Adjusted Predicted Value | -1.1842 | 169.8852 | 79.0979 | 45.4091 | 33 |
| Residual | -113.2230 | 114.0512 | 2.5E-14 | 46.4193 | 33 |
| Std. Residual | -2.199 | 2.215 | .000 | .901 | 33 |
| Stud. Residual | -2.428 | 2.559 | .015 | 1.030 | 33 |
| Deleted Residual | -138.0781 | 152.2357 | 1.7627 | 60.8191 | 33 |
| Stud. Deleted Residual | -2.707 | 2.901 | .015 | 1.093 | 33 |
| Mahal. Distance | 1.629 | 10.858 | 5.818 | 2.440 | 33 |
| Cook's Distance | .000 | .313 | .047 | .081 | 33 |
| Centered Leverage Value | .051 | .339 | .182 | .076 | 33 |

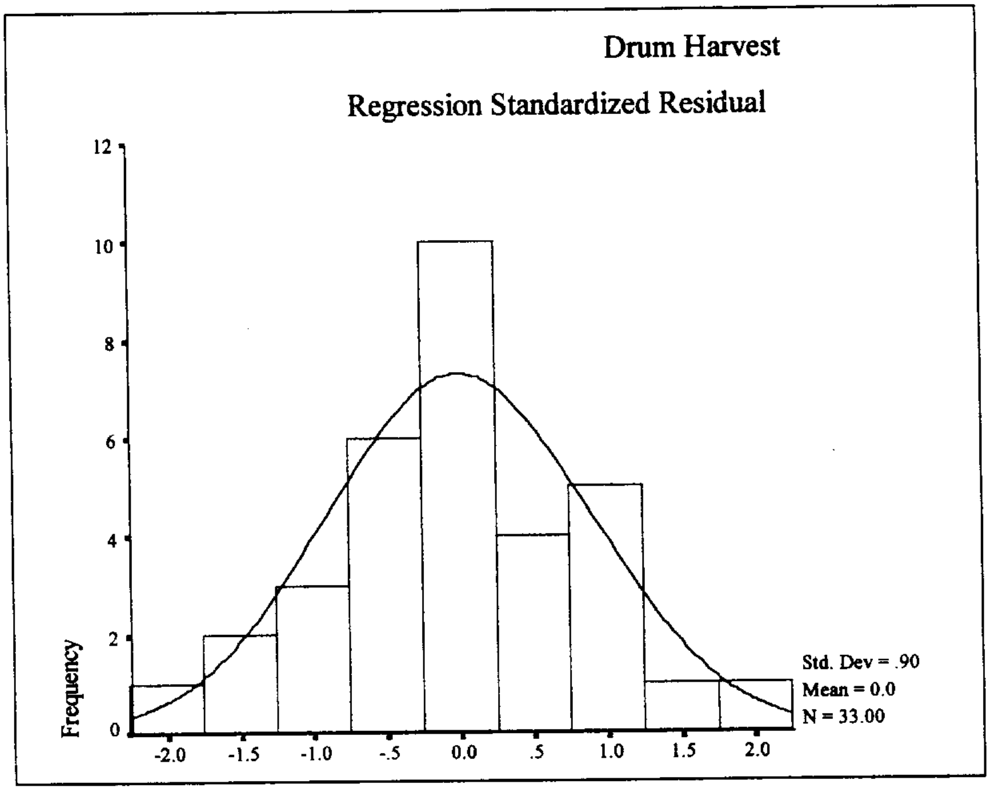
a. Dependent Variable: Drum Harvest

*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| **1961** | 158.66818 | 14.43182 | 18.47978 | 154.62022 | 1.79213 | .28024 | .31712 | .31156 |
| **1962** | 172.84876 | 114.05124 | 152.23566 | 134.66434 | 2.11875 | 2.21469 | 2.55871 | **2.90067** |
| **1963** | 123.36419 | 48.03581 | 76.20194 | 95.19806 | .97898 | .93278 | 1.17484 | 1.18388 |
| **1964** | 102.92054 | 77.77946 | 115.34737 | 65.35263 | .50810 | 1.51035 | 1.83929 | 1.93376 |
| **1965** | 85.70316 | -20.00316 | -25.92560 | 91.62560 | .11154 | -.38843 | -.44221 | -.43526 |
| **1966** | 26.52851 | 30.87149 | 45.13961 | 12.26039 | -1.25142 | .59947 | .72489 | .71811 |
| **1967** | 104.06495 | -44.36495 | -55.60213 | 115.30213 | .53446 | -.86150 | -.96445 | -.96310 |
| **1968** | 45.42039 | 5.27961 | 7.51177 | 43.18823 | -.81629 | .10252 | .12229 | .11995 |
| **1969** | 94.03505 | -16.23505 | -18.40916 | 96.20916 | .30344 | -.31526 | -.33570 | -.32990 |
| **1970** | 55.62511 | 58.37489 | 68.16426 | 45.83574 | -.58124 | 1.13355 | 1.22491 | 1.23736 |
| **1971** | 116.15245 | -24.55245 | -28.49859 | 120.09859 | .81287 | -.47677 | -.51366 | -.50626 |
| **1972** | 79.00766 | 49.99234 | 56.92624 | 72.07376 | -.04268 | .97077 | 1.03591 | 1.03743 |
| **1973** | 94.01151 | 24.28849 | 28.92054 | 89.37946 | .30290 | .47164 | .51466 | .50725 |
| **1974** | 112.40775 | 5.59225 | 6.49014 | 111.50986 | .72662 | .10859 | .11699 | .11474 |
| **1975** | 167.83061 | 5.36939 | 7.18055 | 166.01945 | 2.00316 | .10426 | .12057 | .11827 |
| **1976** | 115.70142 | 7.69858 | 11.09864 | 112.30136 | .80248 | .14949 | .17950 | .17612 |
| **1977** | 71.35819 | 9.94181 | 11.28804 | 70.01196 | -.21887 | .19305 | .20571 | .20188 |
| **1978** | 72.33199 | -48.23199 | -53.10762 | 77.20762 | -.19644 | -.93659 | -.98279 | -.98212 |
| **1979** | 45.31408 | -8.41408 | -9.15764 | 46.05764 | -.81874 | -.16339 | -.17045 | -.16724 |
| **1980** | 22.45218 | -1.85218 | -2.36529 | 22.96529 | -1.34531 | -.03597 | -.04064 | -.03986 |
| **1981** | 31.36320 | 5.13680 | 6.23209 | 30.26791 | -1.14006 | .09975 | .10987 | .10776 |
| **1982** | 42.07603 | 9.82397 | 12.50224 | 39.39776 | -.89332 | .19077 | .21520 | .21121 |
| **1983** | 40.49400 | -23.69400 | -28.91684 | 45.71684 | -.92976 | -.46010 | -.50829 | -.50091 |
| **1984** | 45.97916 | -30.27916 | -37.90595 | 53.60595 | -.80342 | -.58797 | -.65787 | -.65053 |
| **1985** | 43.07759 | 4.52241 | 5.77439 | 41.82561 | -.87025 | .08782 | .09923 | .09732 |
| **1986** | 132.29945 | -85.89945 | -123.48520 | 169.88520 | 1.18478 | -1.66803 | -1.99994 | -2.13193 |
| **1987** | 91.22983 | -53.82983 | -63.93804 | 101.33804 | .23883 | -1.04529 | -1.13921 | -1.14606 |
| **1988** | 115.32301 | -113.22301 | -138.07812 | 140.17812 | .79377 | -2.19861 | -2.42797 | **-2.70746** |
| **1989** | 93.30254 | -67.10254 | -83.15129 | 109.35129 | .28657 | -1.30302 | -1.45050 | -1.48363 |
| **1990** | 6.45594 | 17.54406 | 25.18422 | -1.18422 | -1.71375 | .34068 | .40817 | .40153 |
| **1991** | 59.00568 | -33.40568 | -42.64240 | 68.24240 | -.50338 | -.64868 | -.73290 | -.72621 |
| **1992** | 21.19989 | 43.70011 | 55.27751 | 9.62249 | -1.37415 | .84859 | .95440 | .95270 |
| **1993** | 80.84700 | 38.65300 | 59.39657 | 60.10343 | -.00031 | .75058 | .93043 | .92795 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.
[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



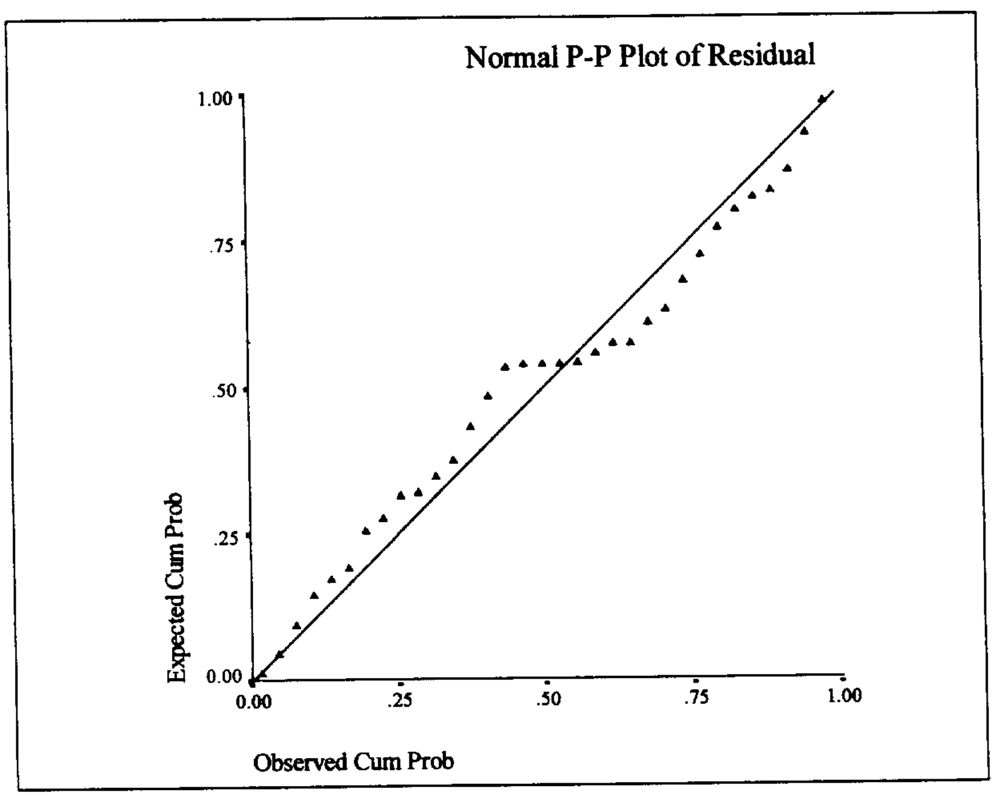




Fig. 6.2.1. Exploratory Plots of Drum Harvest Standardized Residual.

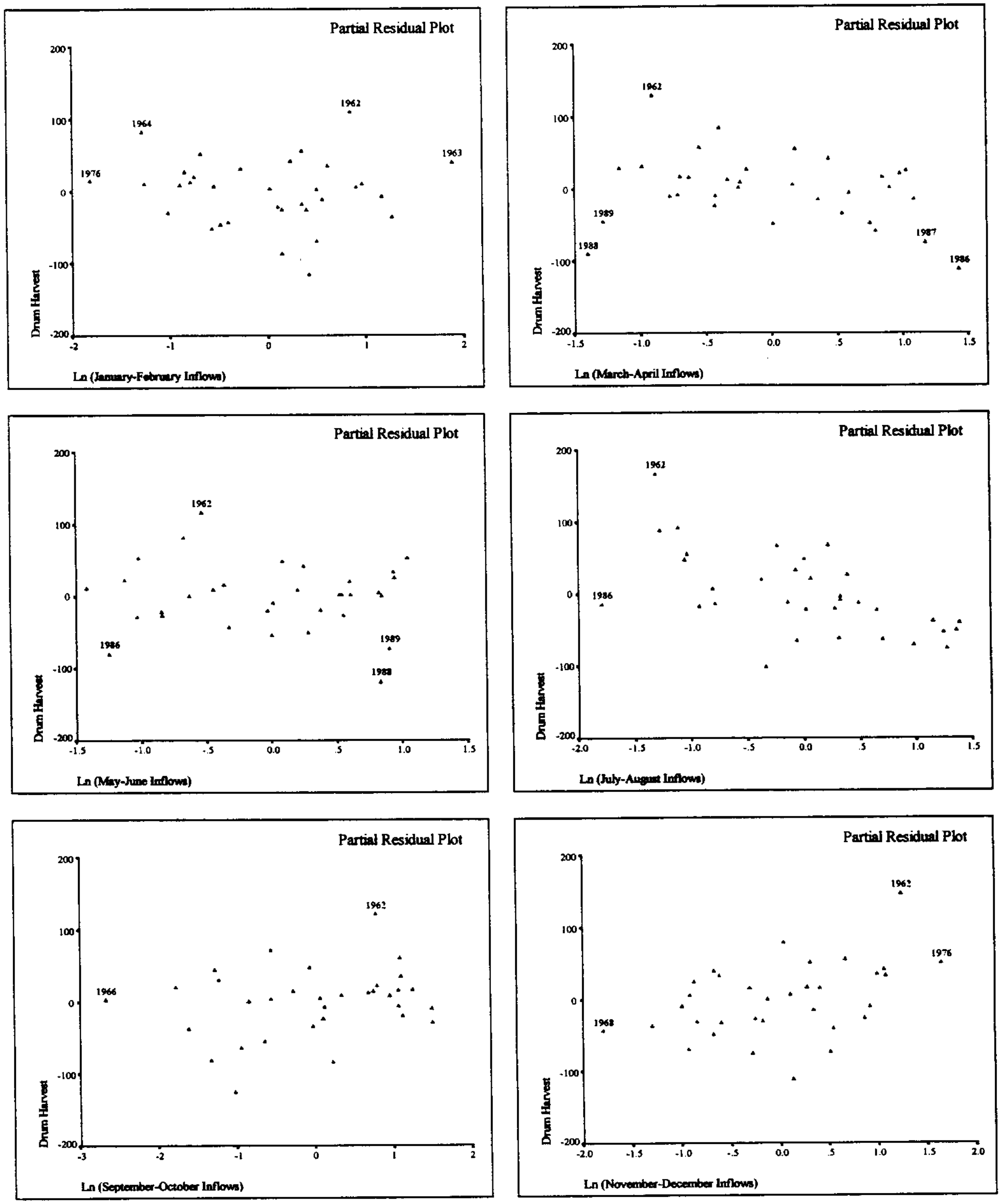



Fig. 6.2.2. Partial Residual Plots of Drum Harvest vs. Logged Inflows.

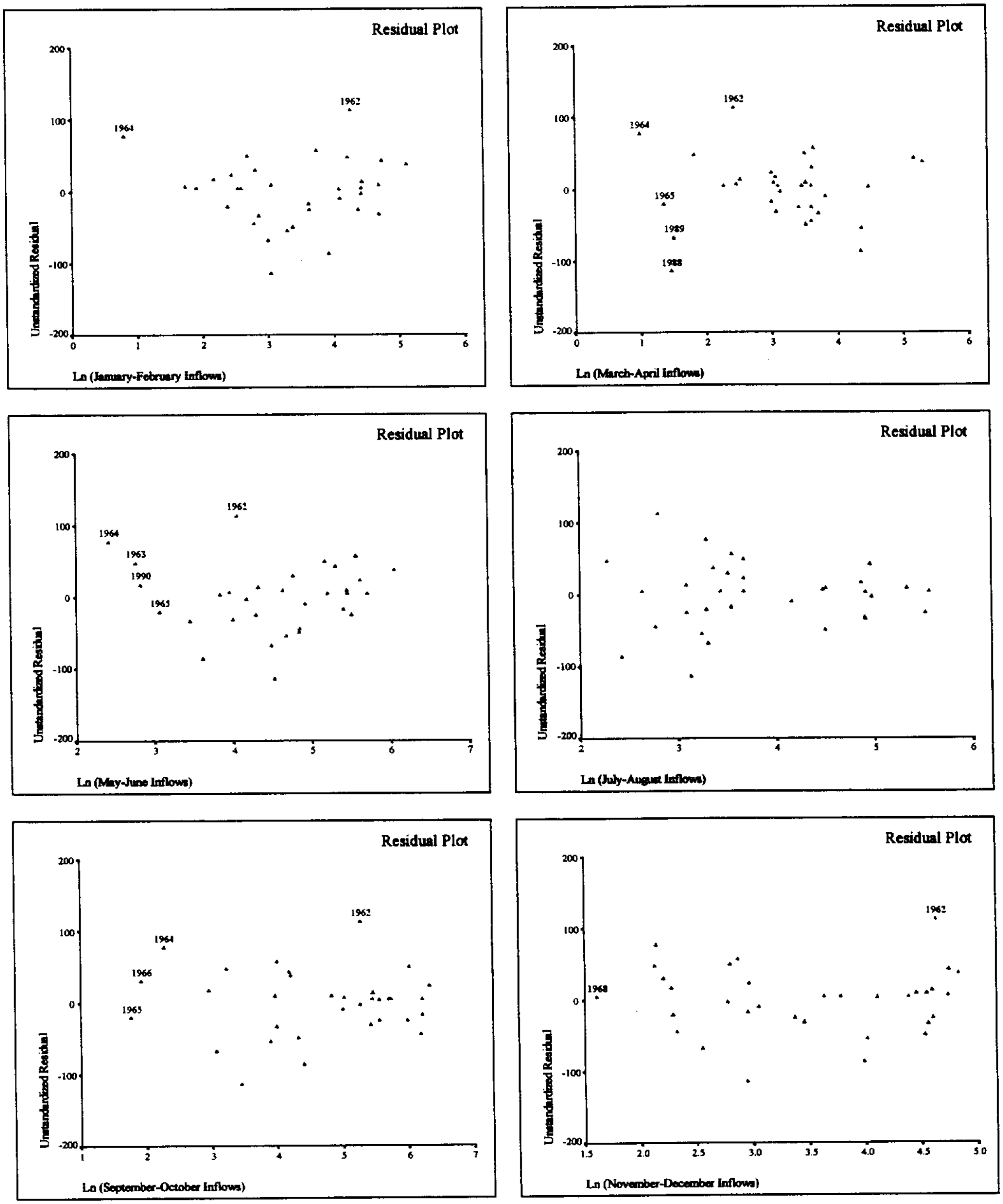



Fig. 6.2.3. Residual Plots of Drum Harvest vs. Logged Inflows.

### 6.2.4 Prediction Intervals for Drum Harvest

| YEAR | DRUM | LICI | UICI |
|---|---|---|---|
| 1961 | 173.10 | .67408 | 316.66228 |
| 1962 | 286.90 | 12.80871 | 332.88881 |
| 1963 | 171.40 | 0 | 290.83198 |
| 1964 | 180.70 | 0 | 267.68065 |
| 1965 | 65.70 | 0 | 244.30472 |
| 1966 | 57.40 | 0 | 190.69068 |
| 1967 | 59.70 | 0 | 260.95694 |
| 1968 | 50.70 | 0 | 208.39749 |
| 1969 | 77.80 | 0 | 245.34612 |
| 1970 | 114.00 | 0 | 208.65290 |
| 1971 | 91.60 | 0 | 268.83553 |
| 1972 | 129.00 | 0 | 230.56926 |
| 1973 | 118.30 | 0 | 248.14263 |
| 1974 | 118.00 | 0 | 265.08271 |
| 1975 | 173.20 | 7.70055 | 327.96068 |
| 1976 | 123.40 | 0 | 279.25507 |
| 1977 | 81.30 | 0 | 222.74790 |
| 1978 | 24.10 | 0 | 221.85339 |
| 1979 | 36.90 | 0 | 194.10710 |
| 1980 | 20.60 | 0 | 180.30901 |
| 1981 | 36.50 | 0 | 186.52615 |
| 1982 | 51.90 | 0 | 199.75717 |
| 1983 | 16.80 | 0 | 195.97767 |
| 1984 | 15.70 | 0 | 202.81261 |
| 1985 | 47.60 | 0 | 200.92703 |
| 1986 | 46.40 | 0 | 295.72940 |
| 1987 | 37.40 | 0 | 245.22332 |
| 1988 | 2.10 | 0 | 270.76663 |
| 1989 | 26.20 | 0 | 249.60000 |
| 1990 | 24.00 | 0 | 169.82303 |
| 1991 | 25.60 | 0 | 216.84165 |
| 1992 | 64.90 | 0 | 178.57024 |
| 1993 | 119.50 | 0 | 247.06378 |

**DRUM** Drum harvest
**LICI** Lower limit for 99% prediction interval for Drum harvest
**UICI** Upper limit for 99% prediction interval for Drum harvest

### 6.2.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| **1961** | 6.03983 | .00403 | .18874 | .5351 | .0000 |
| **1962** | 7.05668 | .31313 | .22052 | .4230 | .0586 |
| **1963** | 10.85830 | .11562 | .33932 | .1449 | .0034 |
| **1964** | 9.45250 | .23343 | .29539 | .2218 | .0268 |
| **1965** | 6.34038 | .00827 | .19814 | .5006 | .0000 |
| **1966** | 9.14514 | .03469 | .28579 | .2424 | .0001 |
| **1967** | 5.49750 | .03366 | .17180 | .5995 | .0001 |
| **1968** | 8.53929 | .00090 | .26685 | .2874 | .0000 |
| **1969** | 2.80948 | .00216 | .08780 | .9020 | .0000 |
| **1970** | 3.62596 | .03595 | .11331 | .8217 | .0001 |
| **1971** | 3.46128 | .00606 | .10816 | .8393 | .0000 |
| **1972** | 2.92806 | .02126 | .09150 | .8916 | .0000 |
| **1973** | 4.15557 | .00722 | .12986 | .7617 | .0000 |
| **1974** | 3.45740 | .00031 | .10804 | .8397 | .0000 |
| **1975** | 7.10172 | .00070 | .22193 | .4184 | .0000 |
| **1976** | 8.83349 | .00203 | .27605 | .2648 | .0000 |
| **1977** | 2.84668 | .00082 | .08896 | .8988 | .0000 |
| **1978** | 1.96812 | .01395 | .06150 | .9616 | .0000 |
| **1979** | 1.62855 | .00037 | .05089 | .9775 | .0000 |
| **1980** | 5.97207 | .00007 | .18663 | .5430 | .0000 |
| **1981** | 4.65431 | .00037 | .14545 | .7021 | .0000 |
| **1982** | 5.88545 | .00180 | .18392 | .5532 | .0000 |
| **1983** | 4.81001 | .00814 | .15031 | .6831 | .0000 |
| **1984** | 5.46880 | .01557 | .17090 | .6029 | .0000 |
| **1985** | 5.96843 | .00039 | .18651 | .5434 | .0000 |
| **1986** | 8.77029 | .25002 | .27407 | .2696 | .0324 |
| **1987** | 4.08930 | .03481 | .12779 | .7694 | .0001 |
| **1988** | 4.79054 | .18487 | .14970 | .6855 | .0138 |
| **1989** | 5.20652 | .07189 | .16270 | .6348 | .0007 |
| **1990** | 8.73818 | .01036 | .27307 | .2720 | .0000 |
| **1991** | 5.96178 | .02122 | .18631 | .5442 | .0000 |
| **1992** | 5.73243 | .03447 | .17914 | .5713 | .0001 |
| **1993** | 10.20593 | .06637 | .31894 | .1772 | .0006 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1961** | .16501 | .00882 | .07196 | -.07703 | -.02986 | -.07506 | .04656 | .08127 |
| **1962** | **1.67839** | .28676 | .60065 | -.67462 | -.42143 | -.90276 | .43791 | .90243 |
| **1963** | .90654 | .57103 | .59051 | -.18156 | -.35912 | -.34187 | -.01246 | -.27734 |
| **1964** | **1.34393** | **1.01907** | -.63031 | -.20730 | -.37392 | .10894 | -.21421 | .02477 |
| **1965** | -.23684 | -.16445 | -.01211 | .07804 | .00317 | -.00251 | .13091 | .02624 |
| **1966** | .48819 | .14283 | -.04869 | .16385 | .19625 | -.01224 | -.38078 | -.16922 |
| **1967** | -.48471 | -.13205 | .09038 | -.19058 | .08306 | .17393 | -.26889 | .21414 |
| **1968** | .07799 | -.00316 | -.01632 | .01888 | .01857 | .00968 | .02547 | -.05501 |
| **1969** | -.12073 | .02239 | -.02649 | .03334 | -.03179 | .01016 | -.06214 | .04487 |
| **1970** | .50671 | -.02601 | .10058 | .05504 | .33535 | -.06410 | -.27826 | -.19029 |
| **1971** | -.20296 | -.05477 | -.01748 | -.06539 | .10923 | .09061 | -.13474 | .01967 |
| **1972** | .38636 | -.00321 | -.15713 | .10737 | .02481 | .00272 | .19924 | -.14428 |
| **1973** | .22152 | -.03638 | -.09761 | -.02287 | .07968 | .00774 | .10049 | -.03559 |
| **1974** | .04598 | -.00789 | -.02304 | -.00650 | .02509 | -.00950 | .00718 | .01106 |
| **1975** | .06869 | .00841 | -.03605 | -.01897 | .02004 | -.02972 | .01559 | .03185 |
| **1976** | .11704 | .00484 | -.08014 | -.01573 | -.02240 | .02159 | .02612 | .07524 |
| **1977** | .07429 | -.00840 | -.03525 | .00797 | .01063 | .01465 | -.02962 | .04618 |
| **1978** | -.31226 | .08033 | .10311 | -.00253 | -.06993 | -.06653 | .10744 | -.19299 |
| **1979** | -.04972 | .00697 | -.02071 | -.01400 | -.00073 | -.01010 | -.00393 | .03130 |
| **1980** | -.02098 | .00252 | -.01111 | .00247 | .00670 | -.01162 | -.00717 | .01259 |
| **1981** | .04976 | -.03472 | .01258 | -.01831 | .01493 | .03352 | .00138 | .00282 |
| **1982** | .11028 | -.06560 | .04568 | -.06104 | .04672 | .05700 | -.02150 | .01448 |
| **1983** | -.23518 | .16747 | -.04690 | .09492 | -.07357 | -.14652 | -.01092 | -.04172 |
| **1984** | -.32649 | .04722 | -.19550 | .06968 | .14451 | -.14766 | -.13553 | .10572 |
| **1985** | .05121 | -.00271 | .00076 | .02668 | -.03698 | .01495 | .02277 | -.00286 |
| **1986** | **-1.41023** | -.65354 | -.08389 | -.81636 | .75858 | .94199 | -.10196 | -.28332 |
| **1987** | -.49663 | -.12179 | .14922 | -.32679 | -.00213 | .23885 | .19161 | -.14889 |
| **1988** | **-1.26853** | -.34856 | -.26986 | .92987 | -.59720 | .20613 | .50156 | -.08893 |
| **1989** | -.72556 | -.21053 | -.17541 | .47158 | -.35677 | .02123 | .35764 | .09770 |
| **1990** | .26498 | .11010 | -.07525 | .09701 | -.12887 | .13852 | -.02131 | -.10233 |
| **1991** | -.38186 | -.04716 | .17329 | -.13786 | .20037 | -.12009 | .00173 | -.16236 |
| **1992** | .49037 | -.19155 | .05446 | .24663 | .06586 | .08739 | -.21515 | .07264 |
| **1993** | .67979 | -.14441 | .14965 | .25227 | .25767 | -.30088 | -.33384 | .16551 |

**SDFFITS** Standardized dffits value
**SDFB_0** Standardized dfbeta for the intercept term
**SDFB_1** Standardized dfbeta for the logged January-February inflows
**SDFB_2** Standardized dfbeta for the logged March-April inflows
**SDFB_3** Standardized dfbeta for the logged May-June inflows
**SDFB_4** Standardized dfbeta for the logged July-August inflows
**SDFB_5** Standardized dfbeta for the logged September-October inflows
**SDFB_6** Standardized dfbeta for the logged November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

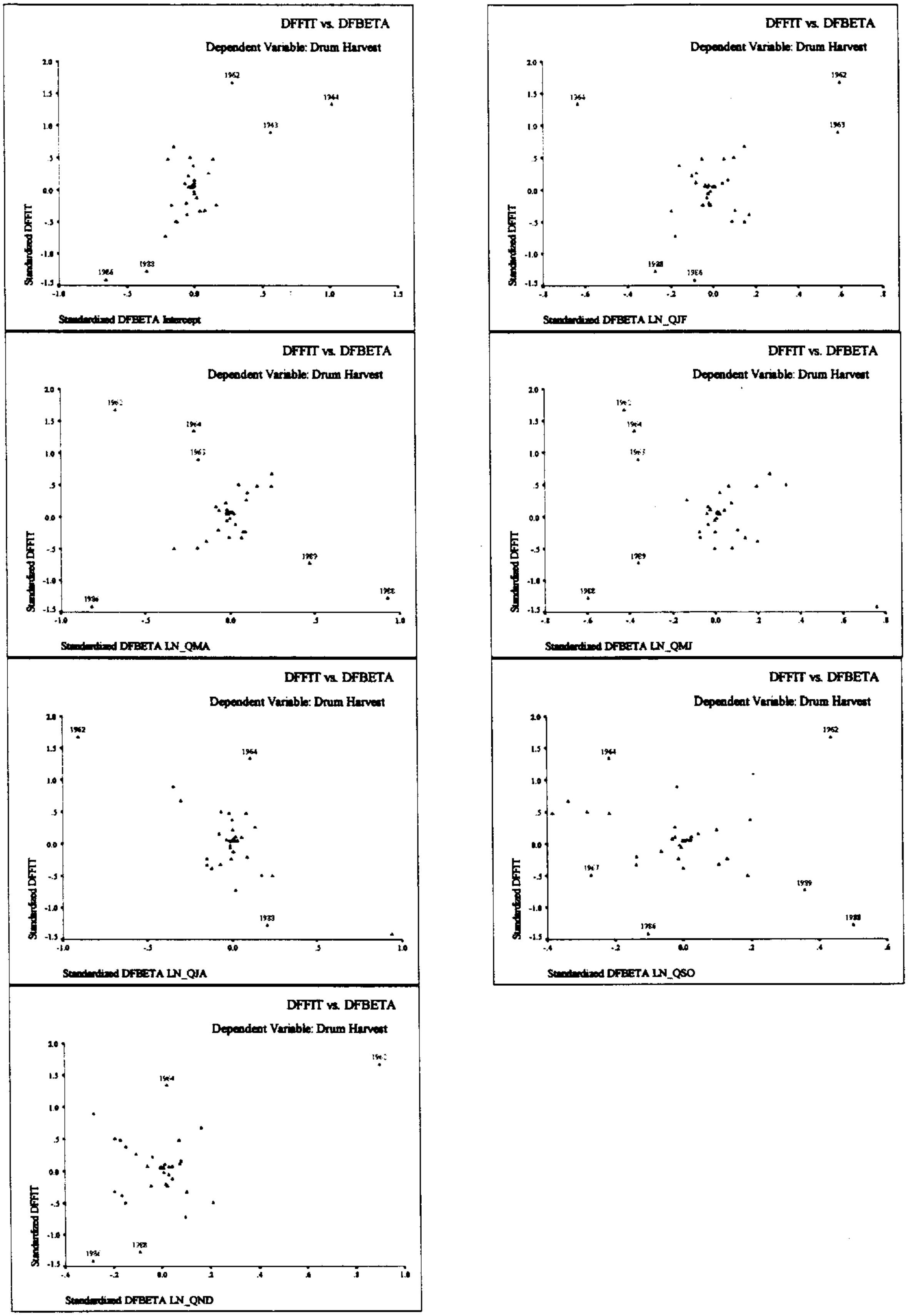



Fig. 6.2.4. Standardized DFFIT vs. Standardized DFBETA.

## 6.3 Model 4: Square Root Inflows

### 6.3.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | SQRT(Nov-Dec Inflows), SQRT(Sept-Oct Inflows), SQRT(Jul-Aug Inflows), SQRT(Mar-Apr Inflows), SQRT(May-Jun Inflows), SQRT(Jan-Feb Inflows)[c,d] | . | .707 | .499 | .384 | 49.8857 | 1.475 |

a. Dependent Variable: Drum Harvest

b. Method: Enter

c. Independent Variables: (Constant), SQRT (November-December Inflows), SQRT (September-October Inflows), SQRT (July-August Inflows), SQRT (March-April Inflows), SQRT (May-June Inflows), SQRT (January-February Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 64568.1 | 6 | 10761.4 | 4.324 | .004[b] |
| | Residual | 64703.0 | 26 | 2488.578 | | |
| | Total | 129271 | 32 | | | |

a. Dependent Variable: Drum Harvest

b. Independent Variables: (Constant), SQRT (November-December Inflows), SQRT (September-October Inflows), SQRT (July-August Inflows), SQRT (March-April Inflows), SQRT (May-June Inflows), SQRT (January-February Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. | 95% Confidence Interval for B Lower Bound | 95% Confidence Interval for B Upper Bound |
|---|---|---|---|---|---|---|---|---|
| 1 | (Constant) | 114.118 | 31.770 | | 3.592 | .001 | 48.815 | 179.422 |
| | SQRT (January-February Inflows) | 3.029 | 3.826 | .138 | .792 | .436 | -4.835 | 10.893 |
| | SQRT (March-April Inflows) | -8.240 | 3.938 | -.370 | -2.093 | .046 | -16.333 | -.146 |
| | SQRT (May-June Inflows) | -.216 | 2.440 | -.015 | -.088 | .930 | -5.231 | 4.799 |
| | SQRT (July-August Inflows) | -11.766 | 2.650 | -.693 | -4.440 | .000 | -17.213 | -6.319 |
| | SQRT (September-October Inflows) | 1.584 | 1.577 | .160 | 1.004 | .324 | -1.657 | 4.824 |
| | SQRT (November-December Inflows) | 10.540 | 3.690 | .489 | 2.856 | .008 | 2.954 | 18.125 |

a. Dependent Variable: Drum Harvest

### 6.3.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 114.118234 | 31.76961809 | 3.592 | 0.0013 | 0.00000000 |
| SQRT_QJF | 1 | 3.028943 | 3.82594711 | 0.792 | 0.4357 | 1.58517618 |
| SQRT_QMA | 1 | -8.239690 | 3.93750785 | -2.093 | 0.0463 | 1.62417881 |
| SQRT_QMJ | 1 | -0.215701 | 2.43974710 | -0.088 | 0.9302 | 1.57358890 |
| SQRT_QJA | 1 | -11.765892 | 2.64980808 | -4.440 | 0.0001 | 1.26432836 |
| SQRT_QSO | 1 | 1.583650 | 1.57655666 | 1.004 | 0.3244 | 1.31892067 |
| SQRT_QND | 1 | 10.539900 | 3.69029373 | 2.856 | 0.0083 | 1.52209099 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop SQRT_QJF | Var Prop SQRT_QMA | Var Prop SQRT_QMJ | Var Prop SQRT_QJA | Var Prop SQRT_QSO | Var Prop SQRT_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.39851 | 1.00000 | 0.0658 | 0.0596 | 0.0362 | 0.0439 | 0.0068 | 0.0620 |
| 2 | 1.35529 | 1.33031 | 0.0139 | 0.0000 | 0.1510 | 0.0427 | 0.2821 | 0.0342 |
| 3 | 0.84617 | 1.68362 | 0.0083 | 0.2200 | 0.0089 | 0.4999 | 0.1196 | 0.0049 |
| 4 | 0.51557 | 2.15689 | 0.0878 | 0.0276 | 0.0461 | 0.2342 | 0.0866 | 0.8363 |
| 5 | 0.50388 | 2.18177 | 0.7152 | 0.0706 | 0.1972 | 0.1287 | 0.1743 | 0.0219 |
| 6 | 0.38059 | 2.51039 | 0.1090 | 0.6222 | 0.5607 | 0.0506 | 0.3305 | 0.0406 |

### 6.3.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | -10.4367 | 191.4566 | 80.8606 | 44.9194 | 33 |
| Std. Predicted Value | -2.032 | 2.462 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | 13.9686 | 36.0159 | 22.6075 | 4.1601 | 33 |
| Adjusted Predicted Value | -22.9034 | 190.2347 | 78.7014 | 45.4580 | 33 |
| Residual | -105.3410 | 101.7682 | 2.8E-14 | 44.9663 | 33 |
| Std. Residual | -2.112 | 2.040 | .000 | .901 | 33 |
| Stud. Residual | -2.275 | 2.278 | .019 | 1.011 | 33 |
| Deleted Residual | -122.2748 | 135.2588 | 2.1592 | 56.7709 | 33 |
| Stud. Deleted Residual | -2.493 | 2.496 | .023 | 1.061 | 33 |
| Mahal. Distance | 1.539 | 15.710 | 5.818 | 2.600 | 33 |
| Cook's Distance | .000 | .309 | .038 | .063 | 33 |
| Centered Leverage Value | .048 | .491 | .182 | .081 | 33 |

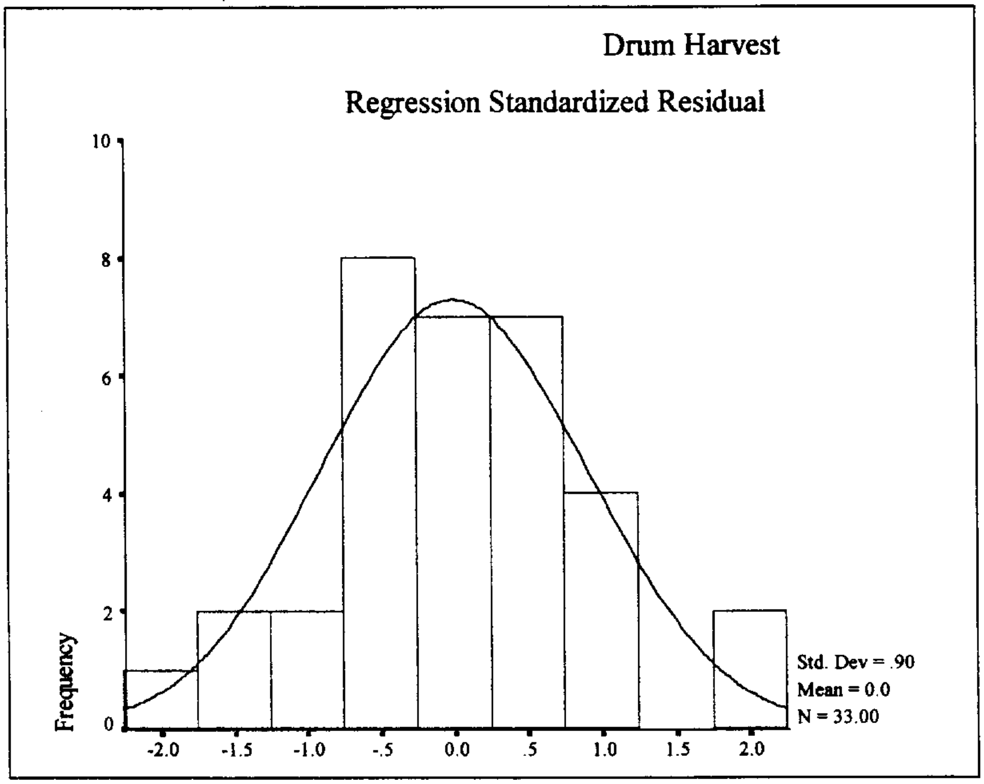
a. Dependent Variable: Drum Harvest

*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| **1961** | 185.32547 | -12.22547 | -17.13470 | 190.23470 | 2.32561 | -.24507 | -.29013 | -.28496 |
| **1962** | 191.45659 | 95.44341 | 135.25879 | 151.64121 | 2.46210 | 1.91324 | 2.27761 | **2.49625** |
| **1963** | 119.34074 | 52.05926 | 74.18396 | 97.21604 | .85665 | 1.04357 | 1.24574 | 1.25972 |
| **1964** | 78.93175 | 101.76825 | 126.04430 | 54.65570 | -.04294 | 2.04003 | 2.27035 | **2.48631** |
| **1965** | 82.76222 | -17.06222 | -20.38255 | 86.08255 | .04233 | -.34203 | -.37383 | -.36756 |
| **1966** | 41.68598 | 15.71402 | 19.37032 | 38.02968 | -.87211 | .31500 | .34973 | .34375 |
| **1967** | 95.83236 | -36.13236 | -44.82129 | 104.52129 | .33330 | -.72430 | -.80670 | -.80113 |
| **1968** | 56.40822 | -5.70822 | -7.46712 | 58.16712 | -.54436 | -.11443 | -.13087 | -.12837 |
| **1969** | 104.90022 | -27.10022 | -31.47250 | 109.27250 | .53517 | -.54325 | -.58543 | -.57788 |
| **1970** | 65.72661 | 48.27339 | 59.26516 | 54.73484 | -.33691 | .96768 | 1.07221 | 1.07543 |
| **1971** | 114.20320 | -22.60320 | -27.00401 | 118.60401 | .74228 | -.45310 | -.49525 | -.48794 |
| **1972** | 76.57779 | 52.42221 | 59.83543 | 69.16457 | -.09534 | 1.05085 | 1.12269 | 1.12859 |
| **1973** | 94.01862 | 24.28138 | 29.84511 | 88.45489 | .29292 | .48674 | .53963 | .53214 |
| **1974** | 110.00138 | 7.99862 | 9.53824 | 108.46176 | .64873 | .16034 | .17509 | .17179 |
| **1975** | 146.88028 | 26.31972 | 31.87351 | 141.32649 | 1.46974 | .52760 | .58060 | .57306 |
| **1976** | 113.58463 | 9.81537 | 13.85796 | 109.54204 | .72851 | .19676 | .23379 | .22949 |
| **1977** | 80.24649 | 1.05351 | 1.22029 | 80.07971 | -.01367 | .02112 | .02273 | .02229 |
| **1978** | 84.04566 | -59.94566 | -67.16406 | 91.26406 | .07091 | -1.20166 | -1.27195 | -1.28797 |
| **1979** | 52.89641 | -15.99641 | -17.35734 | 54.25734 | -.62254 | -.32066 | -.33402 | -.32824 |
| **1980** | 23.17749 | -2.57749 | -3.30552 | 23.90552 | -1.28415 | -.05167 | -.05851 | -.05738 |
| **1981** | 21.68724 | 14.81276 | 19.20122 | 17.29878 | -1.31732 | .29693 | .33807 | .33224 |
| **1982** | 51.33409 | .56591 | .76559 | 51.13441 | -.65732 | .01134 | .01319 | .01294 |
| **1983** | 37.73028 | -20.93028 | -27.25271 | 44.05271 | -.96017 | -.41957 | -.47876 | -.47154 |
| **1984** | 52.76006 | -37.06006 | -48.61002 | 64.31002 | -.62558 | -.74290 | -.85083 | -.84617 |
| **1985** | 29.34671 | 18.25329 | 24.91004 | 22.68996 | -1.14681 | .36590 | .42745 | .42063 |
| **1986** | 114.14444 | -67.74444 | -86.80297 | 133.20297 | .74097 | -1.35799 | -1.53719 | -1.58089 |
| **1987** | 84.65489 | -47.25489 | -55.19969 | 92.59969 | .08447 | -.94726 | -1.02380 | -1.02479 |
| **1988** | 107.44100 | -105.34100 | -122.27479 | 124.37479 | .59174 | -2.11165 | -2.27505 | **-2.49275** |
| **1989** | 91.88144 | -65.68144 | -77.28252 | 103.48252 | .24535 | -1.31664 | -1.42819 | -1.45885 |
| **1990** | -10.43674 | 34.43674 | 46.90344 | -22.90344 | -2.03247 | .69031 | .80563 | .80004 |
| **1991** | 50.56126 | -24.96126 | -32.15156 | 57.75156 | -.67453 | -.50037 | -.56788 | -.56034 |
| **1992** | 19.08832 | 45.81168 | 64.56044 | .33956 | -1.37518 | .91833 | 1.09017 | 1.09431 |
| **1993** | 100.20490 | 19.29510 | 40.30215 | 79.19785 | .43064 | .38679 | .55900 | .55147 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.
[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



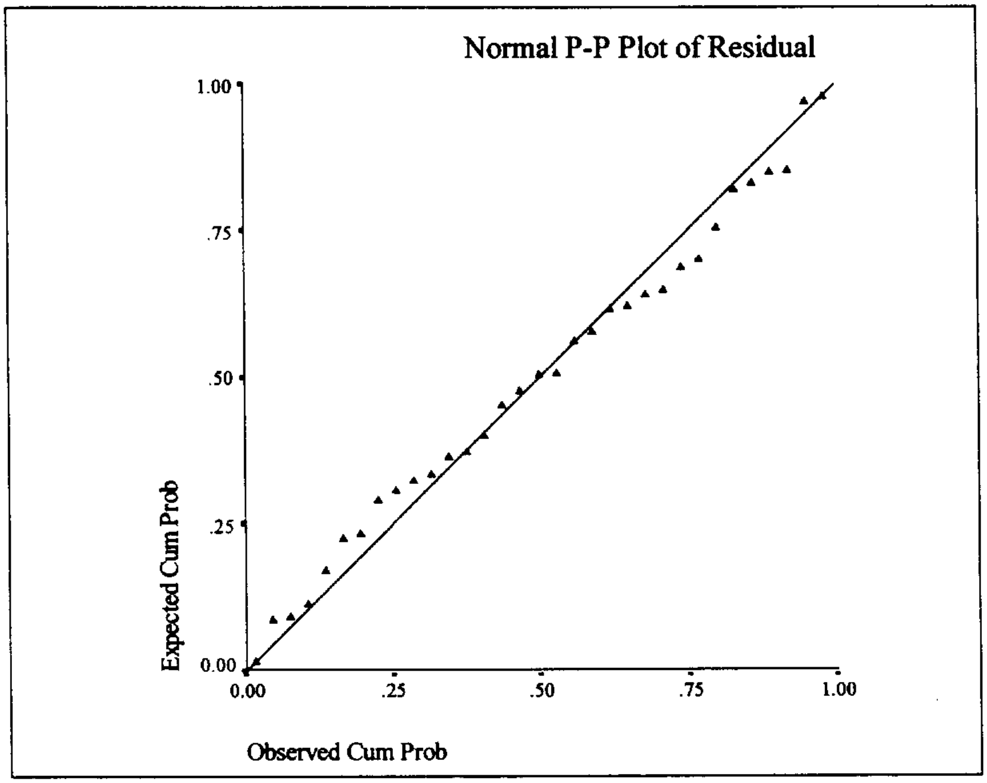




Fig. 6.3.1. Exploratory Plots of Drum Harvest Standardized Residual.

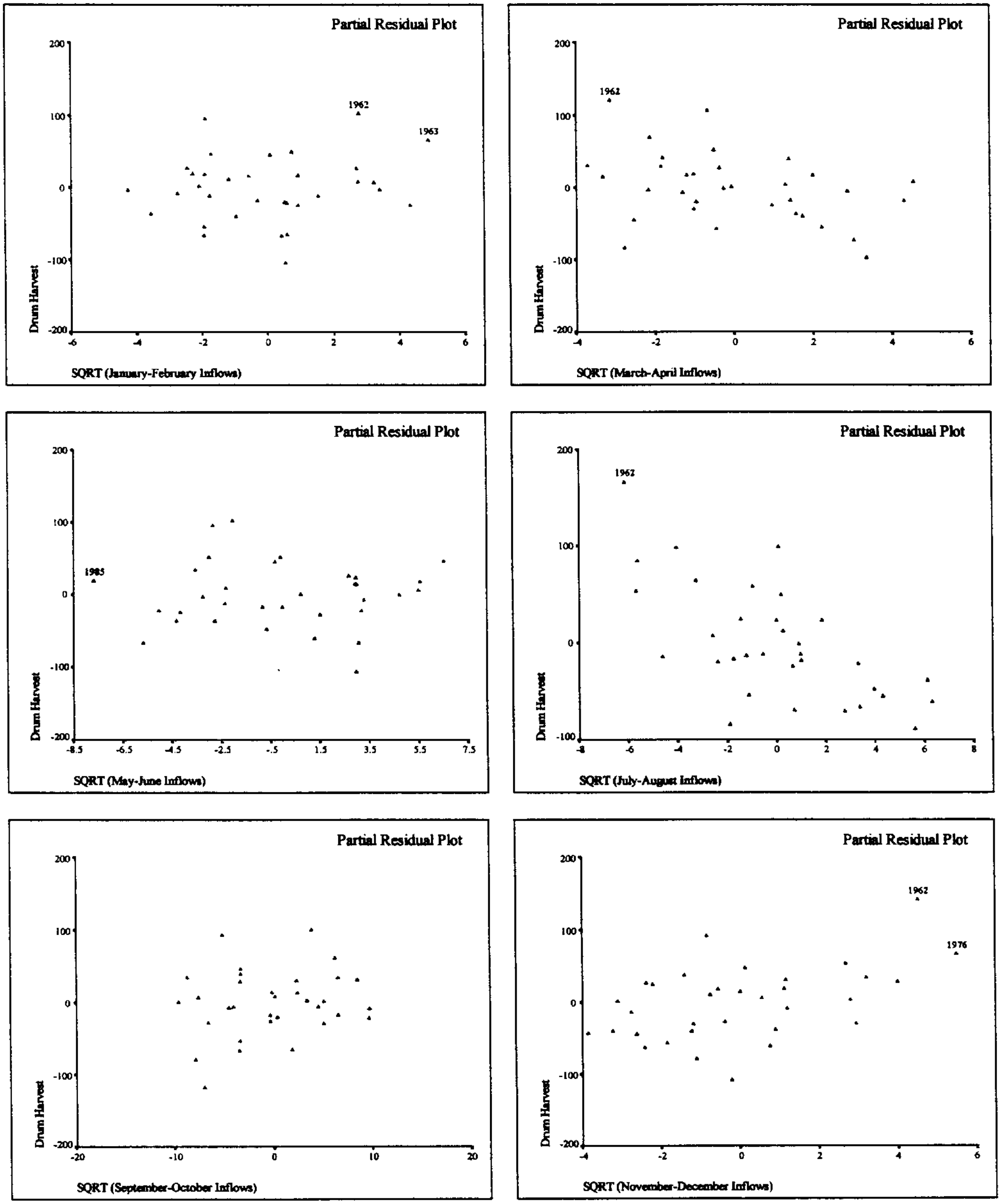



Fig. 6.3.2. Partial Residual Plots of Drum Harvest vs. Square root Inflows.

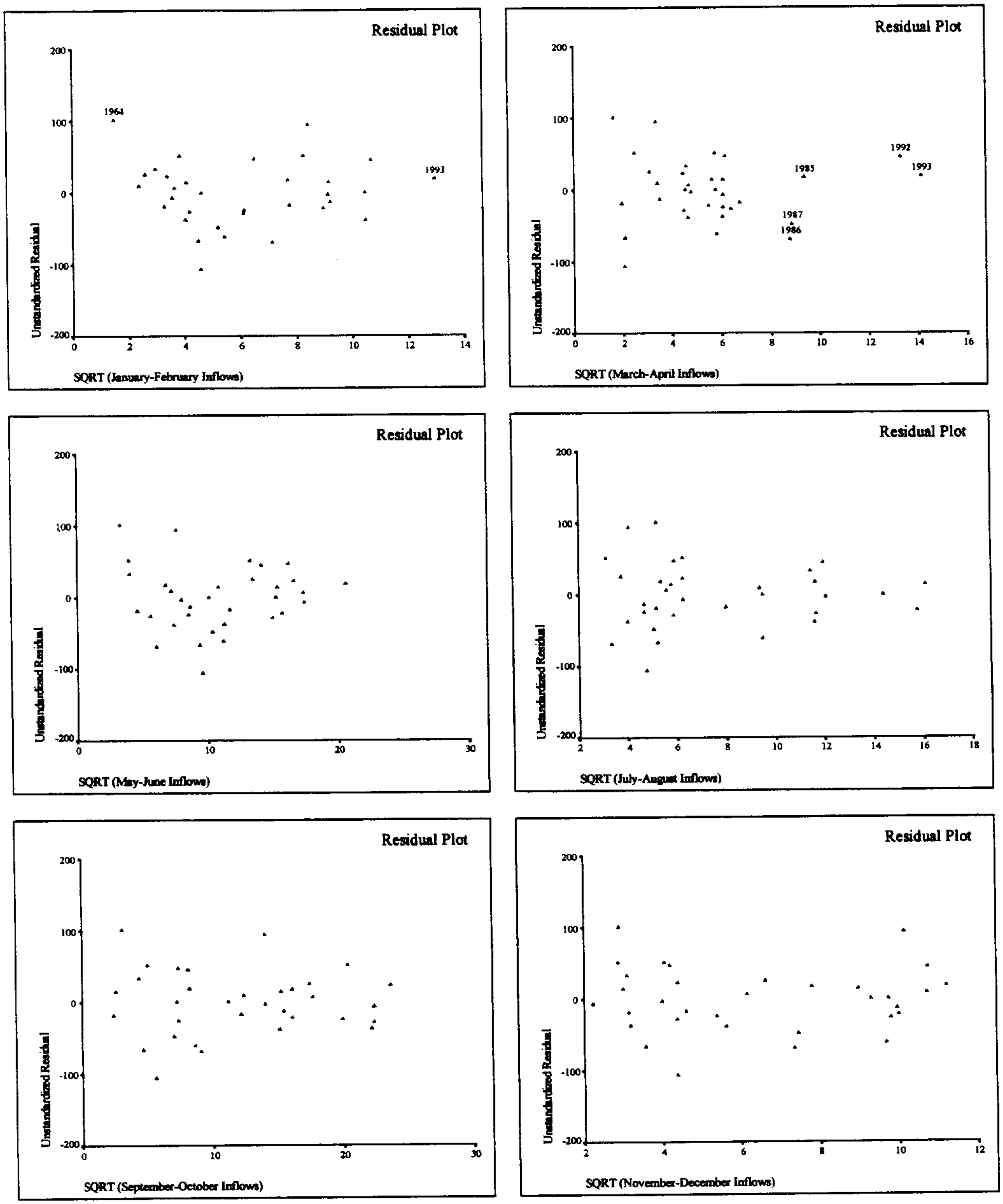



Fig. 6.3.3. Residual Plots of Drum Harvest vs. Square root Inflows.

### 6.3.4 Prediction Intervals for Drum Harvest

| YEAR | DRUM | LICI | UICI |
|---|---|---|---|
| 1961 | 173.10 | 28.09894 | 342.55201 |
| 1962 | 286.90 | 33.75070 | 349.16247 |
| 1963 | 171.40 | 0 | 277.28260 |
| 1964 | 180.70 | 0 | 230.31119 |
| 1965 | 65.70 | 0 | 232.24491 |
| 1966 | 57.40 | 0 | 192.82141 |
| 1967 | 59.70 | 0 | 247.29160 |
| 1968 | 50.70 | 0 | 210.48961 |
| 1969 | 77.80 | 0 | 252.83385 |
| 1970 | 114.00 | 0 | 216.65275 |
| 1971 | 91.60 | 0 | 263.69027 |
| 1972 | 129.00 | 0 | 223.53206 |
| 1973 | 118.30 | 0 | 245.00538 |
| 1974 | 118.00 | 0 | 259.38861 |
| 1975 | 173.20 | 0 | 297.09031 |
| 1976 | 123.40 | 0 | 271.12912 |
| 1977 | 81.30 | 0 | 228.03425 |
| 1978 | 24.10 | 0 | 229.92252 |
| 1979 | 36.90 | 0 | 196.84614 |
| 1980 | 20.60 | 0 | 176.30155 |
| 1981 | 36.50 | 0 | 175.33145 |
| 1982 | 51.90 | 0 | 206.98260 |
| 1983 | 16.80 | 0 | 191.58955 |
| 1984 | 15.70 | 0 | 206.96935 |
| 1985 | 47.60 | 0 | 185.39087 |
| 1986 | 46.40 | 0 | 267.22546 |
| 1987 | 37.40 | 0 | 232.91319 |
| 1988 | 2.10 | 0 | 255.34644 |
| 1989 | 26.20 | 0 | 240.53995 |
| 1990 | 24.00 | 0 | 145.51898 |
| 1991 | 25.60 | 0 | 203.89793 |
| 1992 | 64.90 | 0 | 176.55289 |
| 1993 | 119.50 | 0 | 271.17427 |

**DRUM** Drum harvest
**LICI** Lower limit for 99% prediction interval for Drum harvest
**UICI** Upper limit for 99% prediction interval for Drum harvest

### 6.3.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| 1961 | 8.19856 | .00483 | .25620 | .3154 | .0000 |
| 1962 | 8.44997 | .30915 | .26406 | .2946 | .0567 |
| 1963 | 8.57401 | .09422 | .26794 | .2847 | .0018 |
| 1964 | 5.19348 | .17565 | .16230 | .6364 | .0119 |
| 1965 | 4.24312 | .00388 | .13260 | .7514 | .0000 |
| 1966 | 5.07055 | .00407 | .15845 | .6514 | .0000 |
| 1967 | 5.23373 | .02236 | .16355 | .6315 | .0000 |
| 1968 | 6.56798 | .00075 | .20525 | .4752 | .0000 |
| 1969 | 3.47586 | .00790 | .10862 | .8378 | .0000 |
| 1970 | 4.96527 | .03740 | .15516 | .6642 | .0001 |
| 1971 | 4.24530 | .00682 | .13267 | .7511 | .0000 |
| 1972 | 2.99490 | .02546 | .09359 | .8855 | .0000 |
| 1973 | 4.99575 | .00953 | .15612 | .6605 | .0000 |
| 1974 | 4.19561 | .00084 | .13111 | .7570 | .0000 |
| 1975 | 4.60614 | .01016 | .14394 | .7079 | .0000 |
| 1976 | 8.36523 | .00322 | .26141 | .3015 | .0000 |
| 1977 | 3.40402 | .00001 | .10638 | .8453 | .0000 |
| 1978 | 2.46948 | .02783 | .07717 | .9294 | .0000 |
| 1979 | 1.53931 | .00136 | .04810 | .9809 | .0000 |
| 1980 | 6.07820 | .00014 | .18994 | .5306 | .0000 |
| 1981 | 6.34394 | .00484 | .19825 | .5002 | .0000 |
| 1982 | 7.37632 | .00001 | .23051 | .3908 | .0000 |
| 1983 | 6.45407 | .00989 | .20169 | .4878 | .0000 |
| 1984 | 6.63365 | .03223 | .20730 | .4680 | .0001 |
| 1985 | 7.58170 | .00952 | .23693 | .3709 | .0000 |
| 1986 | 6.05625 | .09497 | .18926 | .5332 | .0018 |
| 1987 | 3.63601 | .02518 | .11363 | .8206 | .0000 |
| 1988 | 3.46197 | .11886 | .10819 | .8392 | .0037 |
| 1989 | 3.83391 | .05147 | .11981 | .7987 | .0002 |
| 1990 | 7.53574 | .03357 | .23549 | .3753 | .0001 |
| 1991 | 6.18671 | .01327 | .19333 | .5181 | .0000 |
| 1992 | 8.32331 | .06948 | .26010 | .3050 | .0007 |
| 1993 | 15.70995 | .04860 | .49094 | .0279 | .0002 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1961** | -.18057 | -.00396 | -.08864 | .08774 | .03827 | .10141 | -.04877 | -.09989 |
| **1962** | **1.61228** | .16562 | .63503 | -.73306 | -.40726 | -.96267 | .37341 | .99660 |
| **1963** | .82123 | .49537 | .56543 | -.24970 | -.21701 | -.31894 | -.15337 | -.26182 |
| **1964** | **1.21434** | **1.12485** | -.39770 | -.14340 | -.26700 | .02043 | -.44178 | -.16828 |
| **1965** | -.16214 | -.14931 | .00880 | .04051 | .01570 | .01085 | .08353 | .03451 |
| **1966** | .16581 | .09332 | -.03439 | .03995 | .05511 | .00561 | -.11520 | -.07721 |
| **1967** | -.39286 | -.06000 | .06546 | -.15761 | .11938 | .08114 | -.27346 | .12114 |
| **1968** | -.07126 | .00339 | .01967 | -.01672 | -.02376 | -.00803 | -.02400 | .03481 |
| **1969** | -.23212 | .02299 | -.04559 | .04637 | -.04635 | .03946 | -.13070 | .05537 |
| **1970** | .51317 | .09926 | .06792 | -.04690 | .38074 | -.05942 | -.32704 | -.19275 |
| **1971** | -.21530 | -.02806 | -.02451 | -.06643 | .13054 | .07237 | -.16451 | .01371 |
| **1972** | .42441 | .02119 | -.15585 | .13396 | -.00311 | .01434 | .24060 | -.12287 |
| **1973** | .25473 | -.02653 | -.08535 | -.01607 | .08629 | .00091 | .12328 | -.02356 |
| **1974** | .07537 | -.00285 | -.02951 | -.01746 | .05055 | -.01409 | .00155 | .01573 |
| **1975** | .26324 | .05023 | -.10915 | -.08938 | .08304 | -.10853 | .04887 | .12558 |
| **1976** | .14728 | .01445 | -.08850 | -.02158 | -.03026 | .01341 | .02179 | .11108 |
| **1977** | .00887 | .00091 | -.00498 | -.00011 | .00088 | .00130 | -.00299 | .00571 |
| **1978** | -.44694 | -.00268 | .20068 | .04595 | -.08808 | -.05404 | .14461 | -.29817 |
| **1979** | -.09574 | -.01042 | -.04039 | -.02623 | -.00028 | -.01213 | .00226 | .06568 |
| **1980** | -.03050 | -.00030 | -.01620 | .00126 | .01026 | -.01498 | -.00711 | .01844 |
| **1981** | .18084 | -.09244 | .02716 | -.05479 | .05618 | .12697 | -.00128 | .00059 |
| **1982** | .00769 | -.00280 | .00319 | -.00438 | .00350 | .00318 | -.00210 | .00063 |
| **1983** | -.25917 | .14281 | -.02230 | .09179 | -.08477 | -.16103 | -.00841 | -.04840 |
| **1984** | -.47238 | .03067 | -.32215 | .07575 | .20339 | -.14270 | -.15878 | .17209 |
| **1985** | .25401 | -.03886 | -.02117 | .16744 | -.18337 | .08697 | .13257 | -.02663 |
| **1986** | -.83851 | -.26312 | -.06056 | -.47554 | .49454 | .43708 | -.11173 | -.10172 |
| **1987** | -.42020 | -.12095 | .16226 | -.26623 | .03338 | .13820 | .11669 | -.07522 |
| **1988** | -.99944 | -.67547 | -.11477 | .58536 | -.39080 | .26919 | .59213 | .03749 |
| **1989** | -.61311 | -.42683 | -.07395 | .31395 | -.23830 | .09154 | .39337 | .12679 |
| **1990** | .48137 | .22663 | -.17347 | .14762 | -.16000 | .30424 | -.09795 | -.21268 |
| **1991** | -.30074 | -.03547 | .17211 | -.08793 | .12859 | -.11462 | .00450 | -.13239 |
| **1992** | .70006 | -.26661 | .00922 | .46809 | -.01702 | .12986 | -.13318 | .01475 |
| **1993** | .57541 | -.17639 | .16643 | .18135 | .21723 | -.23732 | -.18992 | .06963 |

**SDFFITS** Standardized dffits value
**SDFB_0** Standardized dfbeta for the intercept term
**SDFB_1** Standardized dfbeta for the square root January-February inflows
**SDFB_2** Standardized dfbeta for the square root March-April inflows
**SDFB_3** Standardized dfbeta for the square root May-June inflows
**SDFB_4** Standardized dfbeta for the square root July-August inflows
**SDFB_5** Standardized dfbeta for the square root September-October inflows
**SDFB_6** Standardized dfbeta for the square root November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

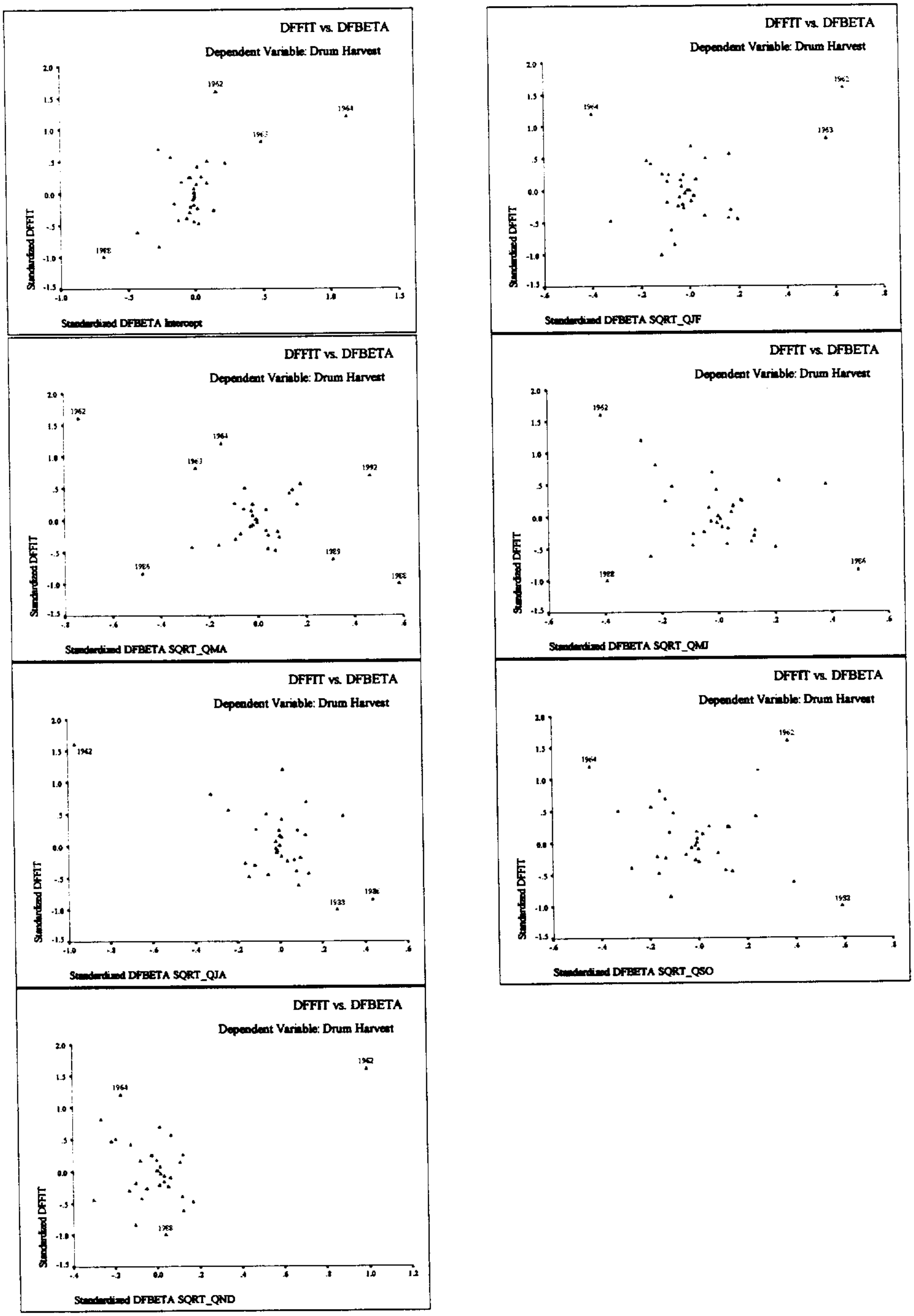



Fig. 6.3.4. Standardized DFFIT vs. Standardized DFBETA.

## 6.4 Model 6: Untransformed Harvest, and Logged and Square Root Inflows

### 6.4.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | Ln(Nov-Dec Inflows), SQRT(Sept-Oct Inflows), Ln(Jul-Aug Inflows), Ln(Jan-Feb Inflows), SQRT(May-Jun Inflows), Ln(Mar-Apr Inflows)[c,d] | . | .685 | .469 | .347 | 51.3741 | 1.353 |

a. Dependent Variable: Drum Harvest

b. Method: Enter

c. Independent Variables: (Constant), Ln (November-December Inflows), SQRT (September-October Inflows), Ln (July-August Inflows), Ln (January-February Inflows), SQRT (May-June Inflows), Ln (March-April Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 60649.5 | 6 | 10108.2 | 3.830 | .007[b] |
| | Residual | 68621.7 | 26 | 2639.295 | | |
| | Total | 129271 | 32 | | | |

a. Dependent Variable: Drum Harvest

b. Independent Variables: (Constant), Ln (November-December Inflows), SQRT (September-October Inflows), Ln (July-August Inflows), Ln (January-February Inflows), SQRT (May-June Inflows), Ln (March-April Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients B | Std. Error | Standardized Coefficients Beta | t | Sig. | 95% Confidence Interval for B Lower Bound | Upper Bound |
|---|---|---|---|---|---|---|---|---|
| 1 | (Constant) | 185.568 | 48.352 | | 3.838 | .001 | 86.178 | 284.957 |
| | Ln (January-February Inflows) | -3.379 | 10.759 | -.054 | -.314 | .756 | -25.495 | 18.737 |
| | Ln (March-April Inflows) | -19.612 | 11.469 | -.314 | -1.710 | .099 | -43.188 | 3.963 |
| | SQRT (May-June Inflows) | .318 | 2.468 | .023 | .129 | .898 | -4.754 | 5.391 |
| | Ln (July-August Inflows) | -40.232 | 10.628 | -.592 | -3.786 | .001 | -62.078 | -18.386 |
| | SQRT (September-October Inflows) | 1.781 | 1.598 | .180 | 1.114 | .275 | -1.504 | 5.066 |
| | Ln (November-December Inflows) | 28.582 | 11.026 | .444 | 2.592 | .015 | 5.917 | 51.247 |

a. Dependent Variable: Drum Harvest

### 6.4.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 185.567789 | 48.35226063 | 3.838 | 0.0007 | 0.00000000 |
| LN_QJF | 1 | -3.378968 | 10.75923702 | -0.314 | 0.7560 | 1.46690612 |
| LN_QMA | 1 | -19.612284 | 11.46933019 | -1.710 | 0.0992 | 1.64730294 |
| SQRT_QMJ | 1 | 0.318257 | 2.46767724 | 0.129 | 0.8984 | 1.51789511 |
| LN_QJA | 1 | -40.231961 | 10.62788369 | -3.786 | 0.0008 | 1.19907134 |
| SQRT_QSO | 1 | 1.780966 | 1.59800345 | 1.114 | 0.2753 | 1.27766890 |
| LN_QND | 1 | 28.581846 | 11.02629916 | 2.592 | 0.0154 | 1.43761059 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop LN_QMA | Var Prop SQRT_QMJ | Var Prop LN_QJA | Var Prop SQRT_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.43910 | 1.00000 | 0.0588 | 0.0648 | 0.0437 | 0.0401 | 0.0185 | 0.0549 |
| 2 | 1.29874 | 1.37042 | 0.0244 | 0.0001 | 0.1293 | 0.0804 | 0.2731 | 0.0643 |
| 3 | 0.75365 | 1.79899 | 0.1978 | 0.0379 | 0.0002 | 0.7418 | 0.0637 | 0.0022 |
| 4 | 0.56509 | 2.07756 | 0.0035 | 0.2244 | 0.1130 | 0.0553 | 0.3327 | 0.5090 |
| 5 | 0.51127 | 2.18418 | 0.5860 | 0.0354 | 0.1489 | 0.0743 | 0.1527 | 0.3673 |
| 6 | 0.43213 | 2.37578 | 0.1295 | 0.6375 | 0.5649 | 0.0081 | 0.1594 | 0.0023 |

### 6.4.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | -3.6107 | 171.6035 | 80.8606 | 43.5350 | 33 |
| Std. Predicted Value | -1.940 | 2.084 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | 14.6392 | 32.9520 | 23.3300 | 4.0061 | 33 |
| Adjusted Predicted Value | -14.4118 | 171.0954 | 78.9665 | 45.0579 | 33 |
| Residual | -115.7711 | 116.6458 | 1.6E-14 | 46.3080 | 33 |
| Std. Residual | -2.253 | 2.271 | .000 | .901 | 33 |
| Stud. Residual | -2.475 | 2.632 | .016 | 1.027 | 33 |
| Deleted Residual | -139.6298 | 156.7630 | 1.8941 | 60.3330 | 33 |
| Stud. Deleted Residual | -2.776 | 3.014 | .019 | 1.094 | 33 |
| Mahal. Distance | 1.629 | 12.195 | 5.818 | 2.294 | 33 |
| Cook's Distance | .000 | .340 | .045 | .079 | 33 |
| Centered Leverage Value | .051 | .381 | .182 | .072 | 33 |

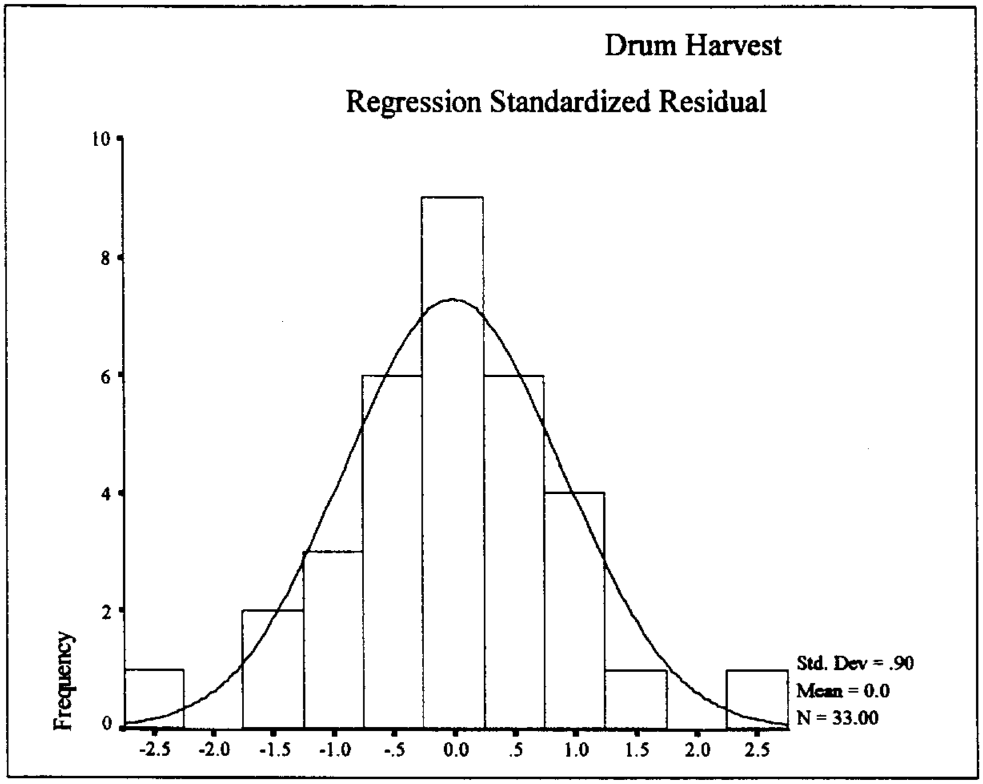
a. Dependent Variable: Drum Harvest

*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| 1961 | 158.17323 | 14.92677 | 19.38973 | 153.71027 | 1.77587 | .29055 | .33115 | .32541 |
| 1962 | 170.25418 | 116.64582 | 156.76302 | 130.13698 | 2.05337 | 2.27052 | 2.63216 | **3.01361** |
| 1963 | 114.45495 | 56.94505 | 86.43405 | 84.96595 | .77166 | 1.10844 | 1.36561 | 1.38986 |
| 1964 | 98.41101 | 82.28899 | 117.74812 | 62.95188 | .40313 | 1.60176 | 1.91604 | 2.02741 |
| 1965 | 89.54035 | -23.84035 | -29.18828 | 94.88828 | .19937 | -.46405 | -.51347 | -.50607 |
| 1966 | 35.03205 | 22.36795 | 28.81921 | 28.58079 | -1.05268 | .43539 | .49421 | .48690 |
| 1967 | 103.47490 | -43.77490 | -55.85992 | 115.55992 | .51945 | -.85208 | -.96254 | -.96113 |
| 1968 | 49.98269 | .71731 | 1.02509 | 49.67491 | -.70927 | .01396 | .01669 | .01637 |
| 1969 | 100.95162 | -23.15162 | -26.91094 | 104.71094 | .46149 | -.45065 | -.48586 | -.47860 |
| 1970 | 58.73380 | 55.26620 | 67.12473 | 46.87527 | -.50825 | 1.07576 | 1.18557 | 1.19531 |
| 1971 | 112.78539 | -21.18539 | -25.43034 | 117.03034 | .73331 | -.41238 | -.45180 | -.44478 |
| 1972 | 80.55135 | 48.44865 | 55.06056 | 73.93944 | -.00710 | .94306 | 1.00535 | 1.00557 |
| 1973 | 102.91351 | 15.38649 | 19.00952 | 99.29048 | .50656 | .29950 | .33290 | .32713 |
| 1974 | 118.66019 | -.66019 | -.78510 | 118.78510 | .86826 | -.01285 | -.01401 | -.01374 |
| 1975 | 171.60347 | 1.59653 | 2.10457 | 171.09543 | 2.08437 | .03108 | .03568 | .03499 |
| 1976 | 110.99936 | 12.40064 | 17.78612 | 105.61388 | .69229 | .24138 | .28908 | .28392 |
| 1977 | 71.26311 | 10.03689 | 11.38828 | 69.91172 | -.22045 | .19537 | .20811 | .20423 |
| 1978 | 72.61924 | -48.51924 | -53.38582 | 77.48582 | -.18930 | -.94443 | -.99066 | -.99030 |
| 1979 | 42.02529 | -5.12529 | -5.57824 | 42.47824 | -.89205 | -.09976 | -.10408 | -.10208 |
| 1980 | 15.78756 | 4.81244 | 6.13426 | 14.46574 | -1.49473 | .09367 | .10576 | .10373 |
| 1981 | 36.77852 | -.27852 | -.34069 | 36.84069 | -1.01257 | -.00542 | -.00600 | -.00588 |
| 1982 | 47.82545 | 4.07455 | 5.23534 | 46.66466 | -.75882 | .07931 | .08990 | .08817 |
| 1983 | 47.14466 | -30.34466 | -37.56530 | 54.36530 | -.77446 | -.59066 | -.65719 | -.64985 |
| 1984 | 40.28033 | -24.58033 | -30.94360 | 46.64360 | -.93213 | -.47846 | -.53683 | -.52935 |
| 1985 | 34.67491 | 12.92509 | 16.69803 | 30.90197 | -1.06089 | .25159 | .28596 | .28085 |
| 1986 | 121.44599 | -75.04599 | -107.15546 | 153.55546 | .93225 | -1.46078 | -1.74553 | -1.82170 |
| 1987 | 88.70654 | -51.30654 | -61.55868 | 98.95868 | .18022 | -.99869 | -1.09392 | -1.09825 |
| 1988 | 117.87108 | -115.77108 | -139.62979 | 141.72979 | .85013 | -2.25349 | -2.47483 | **-2.77561** |
| 1989 | 96.93555 | -70.73555 | -85.86169 | 112.06169 | .36924 | -1.37687 | -1.51696 | -1.55805 |
| 1990 | -3.61070 | 27.61070 | 38.41184 | -14.41184 | -1.94031 | .53744 | .63391 | .62646 |
| 1991 | 50.83752 | -25.23752 | -31.90625 | 57.50625 | -.68963 | -.49125 | -.55235 | -.54483 |
| 1992 | 22.97695 | 41.92305 | 52.49121 | 12.40879 | -1.32959 | .81604 | .91312 | .91010 |
| 1993 | 88.31591 | 31.18409 | 52.98102 | 66.51898 | .17125 | .60700 | .79119 | .78534 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.
[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



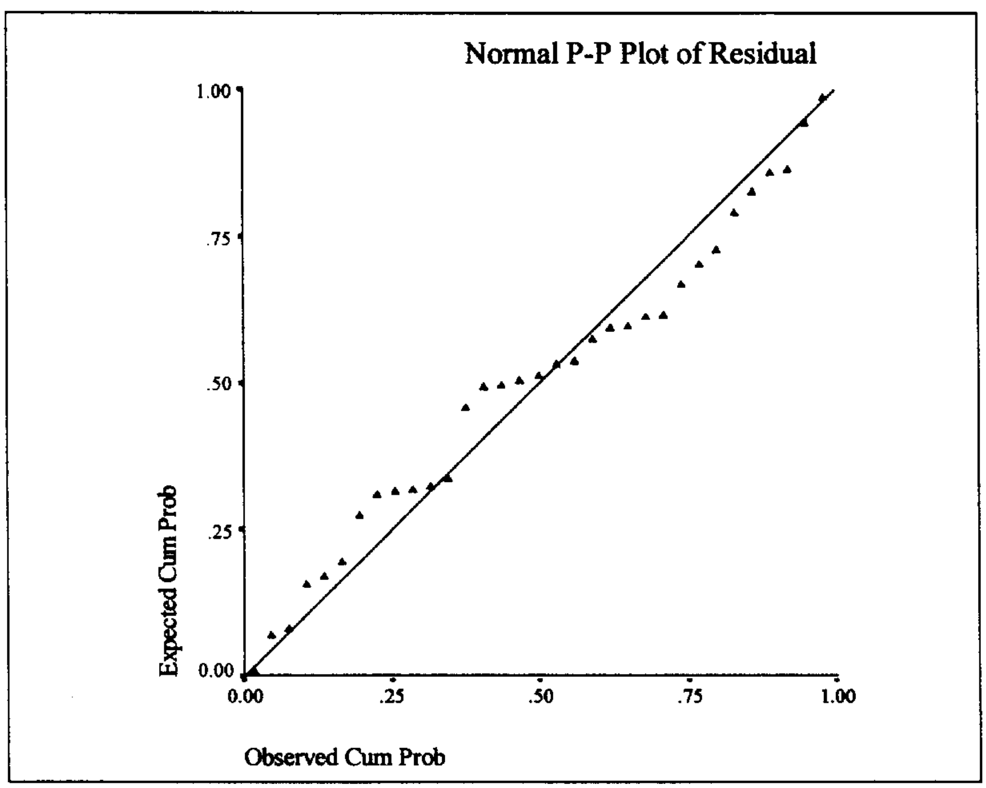




Fig. 6.4.1. Exploratory Plots of Drum Harvest Standardized Residual.

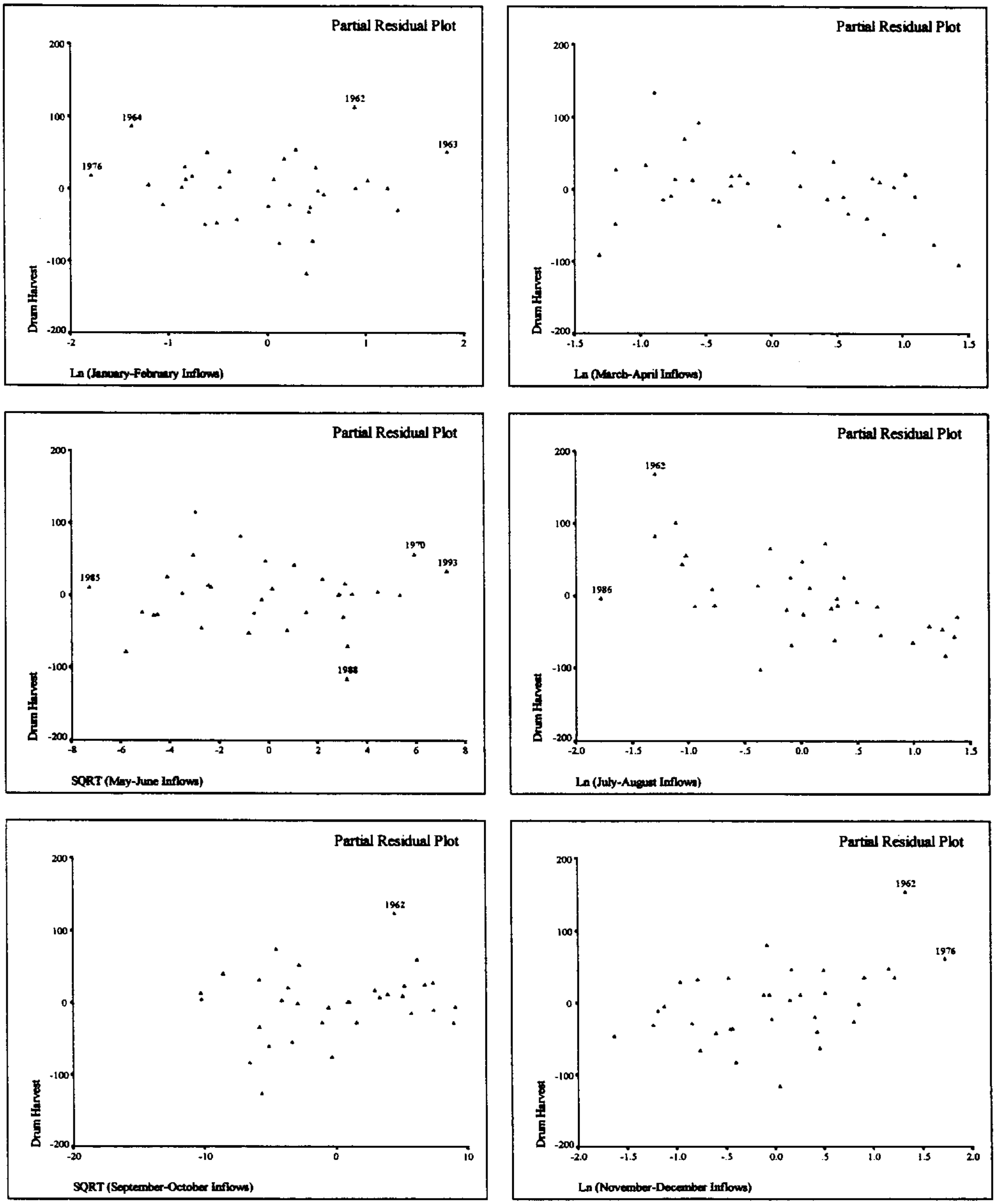



Fig. 6.4.2. Partial Residual Plots of Drum Harvest vs. Logged and square root Inflows.

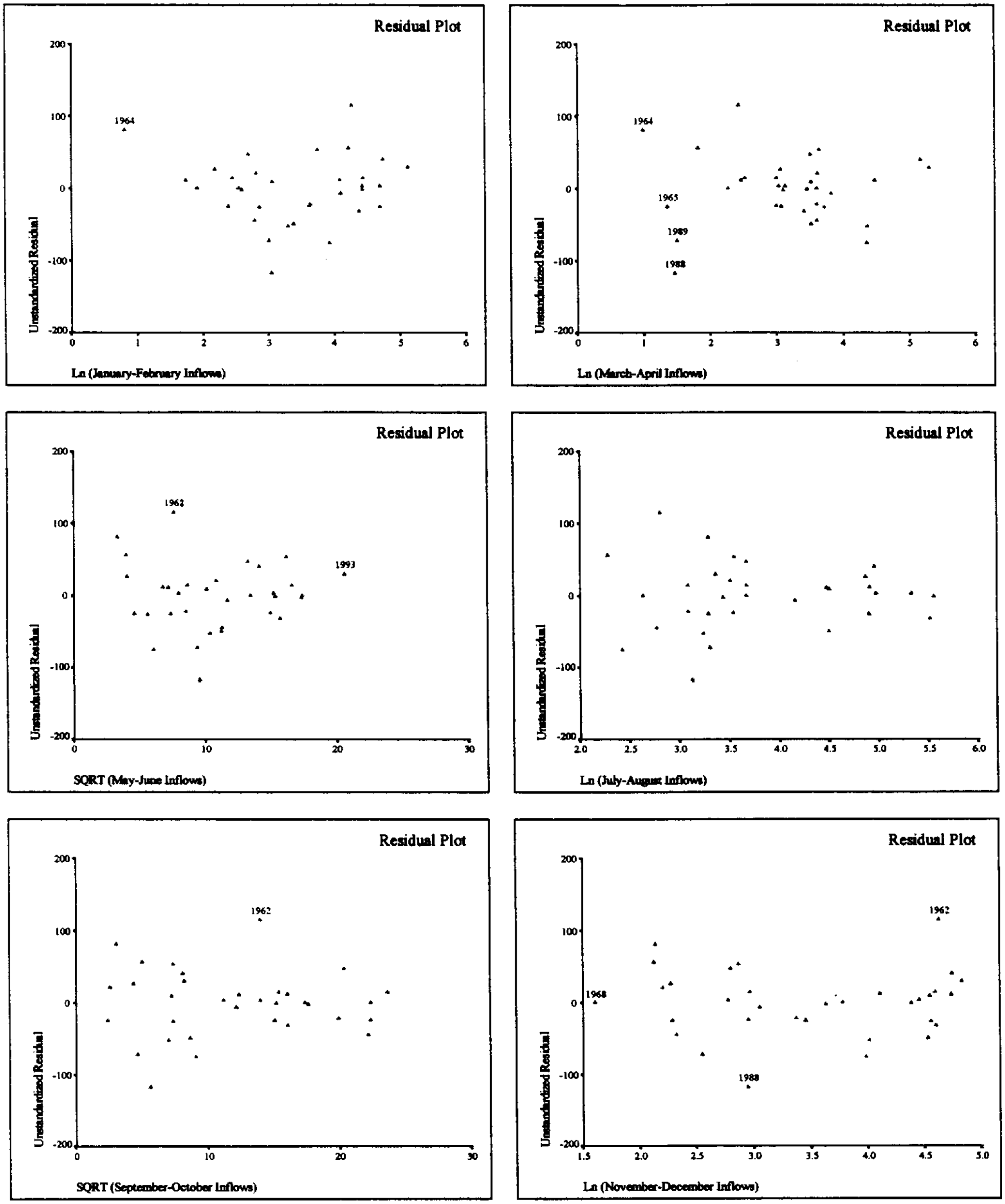



Fig. 6.4.3. Residual Plots of Drum Harvest vs. Logged and square root Inflows.

### 6.4.4 Prediction Intervals for Drum Harvest

| YEAR | DRUM | LICI | UICI |
|---|---|---|---|
| 1961 | 173.10 | 0 | 316.50599 |
| 1962 | 286.90 | 10.27365 | 330.23471 |
| 1963 | 171.40 | 0 | 279.77685 |
| 1964 | 180.70 | 0 | 261.24707 |
| 1965 | 65.70 | 0 | 244.82230 |
| 1966 | 57.40 | 0 | 192.95765 |
| 1967 | 59.70 | 0 | 260.91535 |
| 1968 | 50.70 | 0 | 212.76264 |
| 1969 | 77.80 | 0 | 253.35065 |
| 1970 | 114.00 | 0 | 213.58485 |
| 1971 | 91.60 | 0 | 266.99424 |
| 1972 | 129.00 | 0 | 231.63354 |
| 1973 | 118.30 | 0 | 258.67825 |
| 1974 | 118.00 | 0 | 272.35088 |
| 1975 | 173.20 | 12.54998 | 330.65695 |
| 1976 | 123.40 | 0 | 273.93845 |
| 1977 | 81.30 | 0 | 222.24954 |
| 1978 | 24.10 | 0 | 221.73785 |
| 1979 | 36.90 | 0 | 190.46174 |
| 1980 | 20.60 | 0 | 173.17213 |
| 1981 | 36.50 | 0 | 192.01170 |
| 1982 | 51.90 | 0 | 205.61343 |
| 1983 | 16.80 | 0 | 203.01566 |
| 1984 | 15.70 | 0 | 197.02647 |
| 1985 | 47.60 | 0 | 192.73587 |
| 1986 | 46.40 | 0 | 284.18874 |
| 1987 | 37.40 | 0 | 242.89015 |
| 1988 | 2.10 | 0 | 272.34049 |
| 1989 | 26.20 | 0 | 251.75400 |
| 1990 | 24.00 | 0 | 157.97212 |
| 1991 | 25.60 | 0 | 207.80254 |
| 1992 | 64.90 | 0 | 179.44274 |
| 1993 | 119.50 | 0 | 257.91149 |

**DRUM** Drum harvest
**LICI** Lower limit for 99% prediction interval for Drum harvest
**UICI** Upper limit for 99% prediction interval for Drum harvest

### 6.4.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| 1961 | 6.39580 | .00468 | .19987 | .4944 | .0000 |
| 1962 | 7.21942 | .34040 | .22561 | .4064 | .0723 |
| 1963 | 9.94785 | .13796 | .31087 | .1915 | .0058 |
| 1964 | 8.66691 | .22599 | .27084 | .2775 | .0245 |
| 1965 | 4.89339 | .00845 | .15292 | .6730 | .0000 |
| 1966 | 6.19360 | .01006 | .19355 | .5173 | .0000 |
| 1967 | 5.95335 | .03654 | .18604 | .5452 | .0001 |
| 1968 | 8.63822 | .00002 | .26994 | .2797 | .0000 |
| 1969 | 3.50054 | .00548 | .10939 | .8352 | .0000 |
| 1970 | 4.68355 | .04309 | .14636 | .6985 | .0001 |
| 1971 | 4.37189 | .00584 | .13662 | .7361 | .0000 |
| 1972 | 2.87300 | .01971 | .08978 | .8965 | .0000 |
| 1973 | 5.12921 | .00373 | .16029 | .6442 | .0000 |
| 1974 | 4.12137 | .00001 | .12879 | .7657 | .0000 |
| 1975 | 6.75500 | .00006 | .21109 | .4548 | .0000 |
| 1976 | 8.71962 | .00518 | .27249 | .2734 | .0000 |
| 1977 | 2.82758 | .00083 | .08836 | .9005 | .0000 |
| 1978 | 1.94738 | .01406 | .06086 | .9627 | .0000 |
| 1979 | 1.62864 | .00014 | .05090 | .9775 | .0000 |
| 1980 | 5.92572 | .00044 | .18518 | .5484 | .0000 |
| 1981 | 4.86962 | .00000 | .15218 | .6759 | .0000 |
| 1982 | 6.12538 | .00033 | .19142 | .5252 | .0000 |
| 1983 | 5.18121 | .01468 | .16191 | .6379 | .0000 |
| 1984 | 5.61080 | .01066 | .17534 | .5859 | .0000 |
| 1985 | 6.26076 | .00341 | .19565 | .5097 | .0000 |
| 1986 | 8.61920 | .18624 | .26935 | .2812 | .0141 |
| 1987 | 4.35967 | .03416 | .13624 | .7375 | .0001 |
| 1988 | 4.49818 | .18032 | .14057 | .7209 | .0129 |
| 1989 | 4.66770 | .07030 | .14587 | .7004 | .0007 |
| 1990 | 8.02848 | .02246 | .25089 | .3301 | .0000 |
| 1991 | 5.71863 | .01152 | .17871 | .5730 | .0000 |
| 1992 | 5.47292 | .03003 | .17103 | .6025 | .0000 |
| 1993 | 12.19543 | .06251 | .38111 | .0943 | .0005 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1961** | .17793 | .00253 | .07966 | -.07871 | -.04252 | -.07781 | .06072 | .09291 |
| **1962** | **1.76733** | .20571 | .65543 | -.68980 | -.48704 | -.93116 | .49309 | .99930 |
| **1963** | **1.00017** | .55425 | .65702 | -.24916 | -.24732 | -.39213 | -.14824 | -.35120 |
| **1964** | **1.33087** | .96783 | -.69378 | -.29644 | -.12624 | .11147 | -.33950 | -.03762 |
| **1965** | -.23969 | -.17581 | -.00235 | .09463 | .01439 | -.00279 | .10102 | .05301 |
| **1966** | .26149 | .12005 | -.04346 | .11556 | .05880 | -.00981 | -.17466 | -.13954 |
| **1967** | -.50500 | -.16826 | .06803 | -.20900 | .13961 | .17078 | -.30345 | .17442 |
| **1968** | .01072 | .00153 | -.00192 | .00242 | .00323 | .00133 | .00312 | -.00684 |
| **1969** | -.19286 | .00234 | -.04836 | .05053 | -.03821 | .01339 | -.11986 | .04684 |
| **1970** | .55369 | .10731 | .08293 | .05088 | .37654 | -.07124 | -.34906 | -.21923 |
| **1971** | -.19910 | -.02833 | -.02411 | -.06380 | .11923 | .07835 | -.13791 | .00214 |
| **1972** | .37148 | .04990 | -.13434 | .11387 | -.00422 | .00476 | .20695 | -.10586 |
| **1973** | .15874 | .00717 | -.05743 | -.01896 | .05471 | .00602 | .08413 | -.00847 |
| **1974** | -.00598 | -.00063 | .00269 | .00102 | -.00386 | .00117 | -.00050 | -.00166 |
| **1975** | .01974 | .00721 | -.01006 | -.00531 | .00562 | -.00874 | .00420 | .01050 |
| **1976** | .18711 | .00161 | -.12662 | -.02243 | -.03743 | .03511 | .03170 | .12619 |
| **1977** | .07494 | -.00898 | -.03736 | .01103 | .00171 | .01438 | -.02755 | .04253 |
| **1978** | -.31363 | .07257 | .10932 | -.01454 | -.03915 | -.06495 | .10734 | -.18102 |
| **1979** | -.03035 | .00259 | -.01295 | -.01016 | .00139 | -.00602 | .00178 | .01897 |
| **1980** | .05436 | -.01168 | .03007 | -.00463 | -.01952 | .03039 | .01443 | -.03094 |
| **1981** | -.00278 | .00185 | -.00072 | .00105 | -.00090 | -.00183 | -.00020 | -.00022 |
| **1982** | .04706 | -.02413 | .01889 | -.02628 | .02142 | .02365 | -.00898 | .00571 |
| **1983** | -.31700 | .21308 | -.06471 | .13229 | -.10713 | -.19160 | -.03632 | -.06378 |
| **1984** | -.26933 | .08403 | -.16611 | .05204 | .12705 | -.12246 | -.10639 | .07493 |
| **1985** | .15174 | -.05403 | .00487 | .07836 | -.11086 | .04509 | .06772 | -.00321 |
| **1986** | **-1.19160** | -.34759 | -.05788 | -.69499 | .60043 | .79863 | .01744 | -.21584 |
| **1987** | -.49093 | -.11468 | .15647 | -.33296 | .04501 | .23267 | .18925 | -.11243 |
| **1988** | **-1.26003** | -.68486 | -.25800 | .88728 | -.46905 | .22312 | .53018 | -.03741 |
| **1989** | -.72049 | -.40112 | -.16816 | .45356 | -.26767 | .02963 | .34903 | .14355 |
| **1990** | .39182 | .09009 | -.12710 | .13661 | -.14462 | .21280 | -.08339 | -.17682 |
| **1991** | -.28007 | .03722 | .13465 | -.10031 | .13625 | -.09044 | .01896 | -.11235 |
| **1992** | .45694 | -.22655 | .03747 | .23263 | .05282 | .08086 | -.18405 | .03916 |
| **1993** | .65658 | -.10656 | .10819 | .17759 | .35715 | -.27268 | -.32518 | .11024 |

**SDFFITS** Standardized dffits value
**SDFB_0** Standardized dfbeta for the intercept term
**SDFB_1** Standardized dfbeta for the logged January-February inflows
**SDFB_2** Standardized dfbeta for the logged March-April inflows
**SDFB_3** Standardized dfbeta for the square root May-June inflows
**SDFB_4** Standardized dfbeta for the logged July-August inflows
**SDFB_5** Standardized dfbeta for the square root September-October inflows
**SDFB_6** Standardized dfbeta for the logged November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

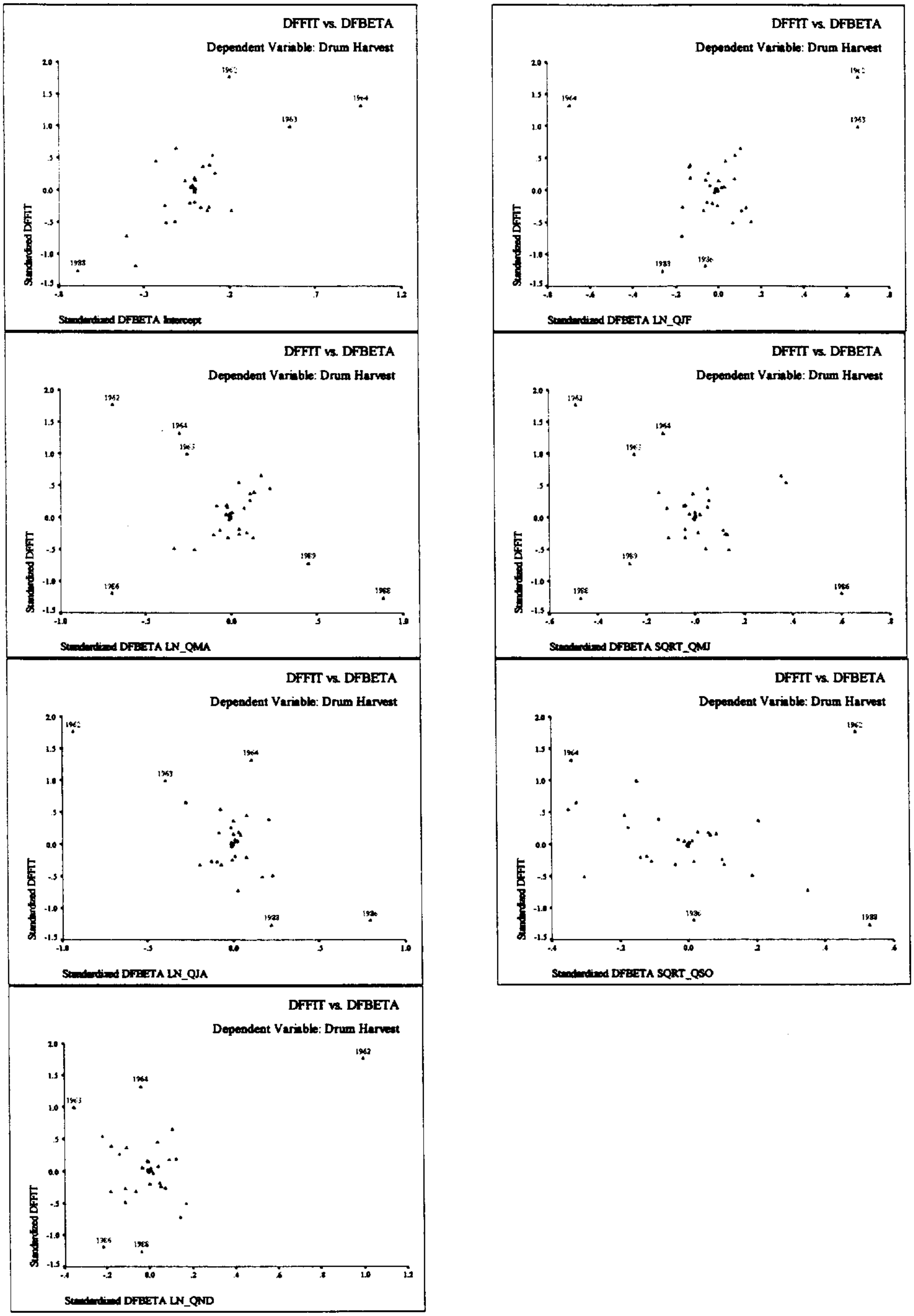



Fig. 6.4.4. Standardized DFFIT vs. Standardized DFBETA.

# 7. Examining Subsets of the Data

## 7.1 Model 1: Untransformed All Variables

### 7.1.1 Untransformed All Variables: 1962 Omitted

N = 32     Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.235196 | 0.209703 | 3.7011 | 247.9 | 2179.49 | 250.8 | QJA_LAG |
| 1 | 0.021994 | -.010607 | 12.5383 | 255.8 | 2787.07 | 258.7 | QSO_LAG |
| 1 | 0.011874 | -.021063 | 12.9578 | 256.1 | 2815.90 | 259.0 | QMJ_LAG |
| 1 | 0.009816 | -.023190 | 13.0431 | 256.2 | 2821.77 | 259.1 | QJF_LAG |
| 2 | 0.293983 | 0.245292 | 3.2644 | 247.4 | 2081.35 | 251.8 | QJA_LAG QND_LAG |
| 2 | 0.258030 | 0.206860 | 4.7546 | 248.9 | 2187.33 | 253.3 | QMJ_LAG QJA_LAG |
| 2 | 0.249098 | 0.197312 | 5.1249 | 249.3 | 2213.67 | 253.7 | QJA_LAG QSO_LAG |
| 2 | 0.248665 | 0.196849 | 5.1428 | 249.3 | 2214.94 | 253.7 | QJF_LAG QJA_LAG |
| 3 | 0.334165 | 0.262826 | 3.5988 | 247.5 | 2032.99 | 253.3 | QMA_LAG QJA_LAG QND_LAG |
| 3 | 0.322188 | 0.249565 | 4.0953 | 248.0 | 2069.56 | 253.9 | QJA_LAG QSO_LAG QND_LAG |
| 3 | 0.304600 | 0.230093 | 4.8243 | 248.9 | 2123.26 | 254.7 | QMJ_LAG QJA_LAG QND_LAG |
| 3 | 0.294688 | 0.219119 | 5.2352 | 249.3 | 2153.53 | 255.2 | QJF_LAG QJA_LAG QND_LAG |
| 4 | 0.368169 | 0.274565 | 4.1894 | 247.8 | 2000.62 | 255.1 | QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.360355 | 0.265592 | 4.5133 | 248.2 | 2025.36 | 255.5 | QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.360290 | 0.265518 | 4.5160 | 248.2 | 2025.57 | 255.5 | QJF_LAG QMA_LAG QJA_LAG QND_LAG |
| 4 | 0.323259 | 0.223001 | 6.0509 | 250.0 | 2142.82 | 257.3 | QJF_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.388266 | 0.270625 | 5.3564 | 248.8 | 2011.48 | 257.6 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.387743 | 0.270001 | 5.3780 | 248.8 | 2013.20 | 257.6 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.374391 | 0.254082 | 5.9315 | 249.5 | 2057.11 | 258.3 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.323583 | 0.193503 | 8.0375 | 252.0 | 2224.17 | 260.8 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.396863 | 0.252110 | 7.0000 | 250.3 | 2062.54 | 260.6 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

### 7.1.2 Untransformed All Variables: 1964 Omitted

N = 32 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.214439 | 0.188254 | 18.8580 | 259.4 | 3115.84 | 262.3 | QJA_LAG |
| 1 | 0.038021 | 0.005955 | 29.3812 | 265.8 | 3815.58 | 268.8 | QND_LAG |
| 1 | 0.036707 | 0.004597 | 29.4596 | 265.9 | 3820.80 | 268.8 | QSO_LAG |
| 1 | 0.007706 | -.025370 | 31.1895 | 266.8 | 3935.83 | 269.8 | QMA_LAG |
| 2 | 0.384423 | 0.341969 | 10.7187 | 253.5 | 2525.81 | 257.9 | QJA_LAG QND_LAG |
| 2 | 0.271957 | 0.221747 | 17.4272 | 258.9 | 2987.28 | 263.3 | QJF_LAG QJA_LAG |
| 2 | 0.237295 | 0.184695 | 19.4947 | 260.4 | 3129.50 | 264.8 | QJA_LAG QSO_LAG |
| 2 | 0.227031 | 0.173723 | 20.1069 | 260.8 | 3171.62 | 265.2 | QMJ_LAG QJA_LAG |
| 3 | 0.459583 | 0.401682 | 8.2354 | 251.4 | 2296.61 | 257.2 | QMA_LAG QJA_LAG QND_LAG |
| 3 | 0.445337 | 0.385909 | 9.0852 | 252.2 | 2357.16 | 258.1 | QJA_LAG QSO_LAG QND_LAG |
| 3 | 0.391296 | 0.326078 | 12.3087 | 255.2 | 2586.81 | 261.1 | QJF_LAG QJA_LAG QND_LAG |
| 3 | 0.388062 | 0.322497 | 12.5016 | 255.4 | 2600.56 | 261.2 | QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.522858 | 0.452170 | 6.4611 | 249.4 | 2102.81 | 256.7 | QJF_LAG QMA_LAG QJA_LAG QND_LAG |
| 4 | 0.511638 | 0.439288 | 7.1304 | 250.1 | 2152.26 | 257.5 | QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.490651 | 0.415192 | 8.3822 | 251.5 | 2244.75 | 258.8 | QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.454945 | 0.374196 | 10.5121 | 253.7 | 2402.11 | 261.0 | QJF_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.578438 | 0.497368 | 5.1458 | 247.4 | 1929.33 | 256.2 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.547791 | 0.460827 | 6.9739 | 249.7 | 2069.58 | 258.5 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.517339 | 0.424519 | 8.7903 | 251.8 | 2208.95 | 260.6 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.461478 | 0.357916 | 12.1224 | 255.3 | 2464.60 | 264.1 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.580883 | 0.480294 | 7.0000 | 249.2 | 1994.86 | 259.5 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

| OBS | _MODEL_ | _TYPE_ | _DEPVAR_ | _RMSE_ | INTERCEP | QJF_LAG | QMA_LAG | QMJ_LAG | QJA_LAG | QSO_LAG |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MODEL1 | PARMS | DRUM | 55.8197 | 108.000 | . | . | . | -0.40792 | . |
| 2 | MODEL1 | PARMS | DRUM | 61.7704 | 62.503 | . | . | . | . | . |
| 3 | MODEL1 | PARMS | DRUM | 61.8126 | 64.165 | . | . | . | . | 0.07069 |
| 4 | MODEL1 | PARMS | DRUM | 62.7362 | 82.622 | . | -0.12288 | . | . | . |
| 5 | MODEL1 | PARMS | DRUM | 50.2575 | 84.537 | . | . | . | -0.56471 | . |
| 6 | MODEL1 | PARMS | DRUM | 54.6560 | 95.519 | 0.40031 | . | . | -0.49606 | . |
| 7 | MODEL1 | PARMS | DRUM | 55.9420 | 96.367 | . | . | . | -0.39608 | 0.05600 |
| 8 | MODEL1 | PARMS | DRUM | 56.3171 | 99.042 | . | . | 0.06754 | -0.41592 | . |
| 9 | MODEL1 | PARMS | DRUM | 47.9230 | 92.353 | . | -0.43200 | . | -0.59953 | . |
| 10 | MODEL1 | PARMS | DRUM | 48.5505 | 61.949 | . | . | . | -0.56583 | 0.09367 |
| 11 | MODEL1 | PARMS | DRUM | 50.8607 | 81.878 | 0.15078 | . | . | -0.58426 | . |
| 12 | MODEL1 | PARMS | DRUM | 50.9957 | 80.122 | . | . | 0.03660 | -0.56610 | . |
| 13 | MODEL1 | PARMS | DRUM | 45.8564 | 87.151 | 0.52648 | -0.65774 | . | -0.68600 | . |
| 14 | MODEL1 | PARMS | DRUM | 46.3925 | 70.964 | . | -0.40674 | . | -0.59853 | 0.08680 |
| 15 | MODEL1 | PARMS | DRUM | 47.3788 | 80.470 | . | -0.54462 | 0.11541 | -0.61301 | . |
| 16 | MODEL1 | PARMS | DRUM | 49.0114 | 58.255 | 0.17860 | . | . | -0.58902 | 0.09593 |
| 17 | MODEL1 | PARMS | DRUM | 43.9241 | 64.894 | 0.54119 | -0.63793 | . | -0.68739 | 0.08974 |
| 18 | MODEL1 | PARMS | DRUM | 45.4927 | 76.721 | 0.50171 | -0.74829 | 0.10368 | -0.69404 | . |
| 19 | MODEL1 | PARMS | DRUM | 46.9995 | 69.053 | . | -0.46643 | 0.05645 | -0.60531 | 0.07097 |
| 20 | MODEL1 | PARMS | DRUM | 49.6448 | 60.543 | 0.22488 | . | -0.05664 | -0.59304 | 0.11139 |
| 21 | MODEL1 | PARMS | DRUM | 44.6639 | 63.755 | 0.53059 | -0.67270 | 0.03716 | -0.69011 | 0.07925 |

| OBS | QND_LAG | DRUM | _IN_ | _P_ | _EDF_ | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | . | -1 | 1 | 2 | 30 | 3115.84 | 0.21444 | 0.18825 | 18.8580 | 259.351 | 262.282 |
| 2 | 0.30107 | -1 | 1 | 2 | 30 | 3815.58 | 0.03802 | 0.00596 | 29.3812 | 265.834 | 268.765 |
| 3 | . | -1 | 1 | 2 | 30 | 3820.80 | 0.03671 | 0.00460 | 29.4596 | 265.878 | 268.809 |
| 4 | . | -1 | 1 | 2 | 30 | 3935.83 | 0.00771 | -0.02537 | 31.1895 | 266.827 | 269.758 |
| 5 | 0.69337 | -1 | 2 | 3 | 29 | 2525.81 | 0.38442 | 0.34197 | 10.7187 | 253.548 | 257.945 |
| 6 | . | -1 | 2 | 3 | 29 | 2987.28 | 0.27196 | 0.22175 | 17.4272 | 258.918 | 263.315 |
| 7 | . | -1 | 2 | 3 | 29 | 3129.50 | 0.23730 | 0.18469 | 19.4947 | 260.406 | 264.803 |
| 8 | . | -1 | 2 | 3 | 29 | 3171.62 | 0.22703 | 0.17372 | 20.1069 | 260.834 | 265.231 |
| 9 | 0.92906 | -1 | 3 | 4 | 28 | 2296.61 | 0.45958 | 0.40168 | 8.2354 | 251.381 | 257.244 |
| 10 | 0.78591 | -1 | 3 | 4 | 28 | 2357.16 | 0.44534 | 0.38591 | 9.0852 | 252.214 | 258.077 |
| 11 | 0.63304 | -1 | 3 | 4 | 28 | 2586.81 | 0.39130 | 0.32608 | 12.3087 | 255.189 | 261.052 |
| 12 | 0.68038 | -1 | 3 | 4 | 28 | 2600.56 | 0.38806 | 0.32250 | 12.5016 | 255.358 | 261.221 |
| 13 | 0.84155 | -1 | 4 | 5 | 27 | 2102.81 | 0.52286 | 0.45217 | 6.4611 | 249.396 | 256.725 |
| 14 | 1.00103 | -1 | 4 | 5 | 27 | 2152.26 | 0.51164 | 0.43929 | 7.1304 | 250.140 | 257.469 |
| 15 | 0.94953 | -1 | 4 | 5 | 27 | 2244.75 | 0.49065 | 0.41519 | 8.3822 | 251.486 | 258.815 |
| 16 | 0.71667 | -1 | 4 | 5 | 27 | 2402.11 | 0.45494 | 0.37420 | 10.5121 | 253.655 | 260.983 |
| 17 | 0.91350 | -1 | 5 | 6 | 26 | 1929.33 | 0.57844 | 0.49737 | 5.1458 | 247.433 | 256.228 |
| 18 | 0.86406 | -1 | 5 | 6 | 26 | 2069.58 | 0.54779 | 0.46083 | 6.9739 | 249.679 | 258.473 |
| 19 | 0.99792 | -1 | 5 | 6 | 26 | 2208.95 | 0.51734 | 0.42452 | 8.7903 | 251.764 | 260.559 |
| 20 | 0.73353 | -1 | 5 | 6 | 26 | 2464.60 | 0.46148 | 0.35792 | 12.1224 | 255.269 | 264.063 |
| 21 | 0.91317 | -1 | 6 | 7 | 25 | 1994.86 | 0.58088 | 0.48029 | 7.0000 | 249.247 | 259.507 |

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 63.755449 | 19.16559784 | 3.327 | 0.0027 | 0.00000000 |
| QJF_LAG | 1 | 0.530595 | 0.27253565 | 1.947 | 0.0629 | 1.86701192 |
| QMA_LAG | 1 | -0.672703 | 0.25206364 | -2.669 | 0.0132 | 1.93413533 |
| QMJ_LAG | 1 | 0.037162 | 0.09730798 | 0.382 | 0.7058 | 1.56948425 |
| QJA_LAG | 1 | -0.690108 | 0.13317807 | -5.182 | 0.0001 | 1.36339287 |
| QSO_LAG | 1 | 0.079254 | 0.05641042 | 1.405 | 0.1723 | 1.39417319 |
| QND_LAG | 1 | 0.913166 | 0.25178861 | 3.627 | 0.0013 | 1.58623539 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop QJF_LAG | Var Prop QMA_LAG | Var Prop QMJ_LAG | Var Prop QJA_LAG | Var Prop QSO_LAG | Var Prop QND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.39625 | 1.00000 | 0.0656 | 0.0520 | 0.0209 | 0.0355 | 0.0069 | 0.0652 |
| 2 | 1.40413 | 1.30636 | 0.0000 | 0.0069 | 0.2002 | 0.0155 | 0.2446 | 0.0142 |
| 3 | 0.95653 | 1.58277 | 0.0001 | 0.1384 | 0.0004 | 0.4727 | 0.0880 | 0.0061 |
| 4 | 0.50700 | 2.17402 | 0.2450 | 0.0025 | 0.0024 | 0.0771 | 0.0586 | 0.8319 |
| 5 | 0.42494 | 2.37466 | 0.3484 | 0.0006 | 0.5527 | 0.0988 | 0.4918 | 0.0087 |
| 6 | 0.31116 | 2.77509 | 0.3409 | 0.7995 | 0.2234 | 0.3004 | 0.1101 | 0.0740 |

| Variable | DF | Variable Label |
|---|---|---|
| INTERCEP | 1 | Intercept |
| QJF_LAG | 1 | January-February Inflows |
| QMA_LAG | 1 | March-April Inflows |
| QMJ_LAG | 1 | May-June Inflows |
| QJA_LAG | 1 | July-August Inflows |
| QSO_LAG | 1 | September-October Inflows |
| QND_LAG | 1 | November-December Inflows |

### 7.1.3 Untransformed All Variables: 1993 Omitted

N = 32 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.218871 | 0.192833 | 11.0404 | 261.4 | 3325.83 | 264.4 | QJA_LAG |
| 1 | 0.069216 | 0.038190 | 18.5201 | 267.0 | 3963.01 | 270.0 | QMA_LAG |
| 1 | 0.020504 | -.012146 | 20.9547 | 268.7 | 4170.42 | 271.6 | QSO_LAG |
| 1 | 0.010395 | -.022592 | 21.4599 | 269.0 | 4213.46 | 271.9 | QND_LAG |
| 2 | 0.356615 | 0.312243 | 6.1561 | 257.2 | 2833.81 | 261.6 | QJA_LAG QND_LAG |
| 2 | 0.259790 | 0.208741 | 10.9953 | 261.7 | 3260.28 | 266.1 | QJF_LAG QJA_LAG |
| 2 | 0.246993 | 0.195061 | 11.6349 | 262.3 | 3316.65 | 266.7 | QMA_LAG QJA_LAG |
| 2 | 0.230170 | 0.177079 | 12.4757 | 263.0 | 3390.74 | 267.4 | QJA_LAG QSO_LAG |
| 3 | 0.433067 | 0.372325 | 4.3350 | 255.2 | 2586.26 | 261.0 | QMA_LAG QJA_LAG QND_LAG |
| 3 | 0.381967 | 0.315749 | 6.8890 | 257.9 | 2819.37 | 263.8 | QJA_LAG QSO_LAG QND_LAG |
| 3 | 0.373931 | 0.306852 | 7.2906 | 258.4 | 2856.03 | 264.2 | QJF_LAG QJA_LAG QND_LAG |
| 3 | 0.361015 | 0.292552 | 7.9361 | 259.0 | 2914.95 | 264.9 | QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.475126 | 0.397367 | 4.2329 | 254.7 | 2483.07 | 262.0 | QJF_LAG QMA_LAG QJA_LAG QND_LAG |
| 4 | 0.457175 | 0.376757 | 5.1301 | 255.8 | 2567.99 | 263.1 | QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.443084 | 0.360578 | 5.8343 | 256.6 | 2634.65 | 263.9 | QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.399076 | 0.310050 | 8.0339 | 259.0 | 2842.85 | 266.4 | QJF_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.498683 | 0.402276 | 5.0555 | 255.2 | 2462.84 | 264.0 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.488051 | 0.389600 | 5.5869 | 255.9 | 2515.08 | 264.7 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.457431 | 0.353091 | 7.1173 | 257.8 | 2665.51 | 266.6 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.399494 | 0.284012 | 10.0130 | 261.0 | 2950.14 | 269.8 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.499794 | 0.379745 | 7.0000 | 257.2 | 2555.68 | 267.4 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

### 7.1.4 Untransformed All Variables: 1962 and 1964 Omitted

N = 31 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.226964 | 0.200307 | 9.4670 | 237.1 | 1968.12 | 239.9 | QJA_LAG |
| 1 | 0.056934 | 0.024414 | 17.4880 | 243.2 | 2401.01 | 246.1 | QSO_LAG |
| 1 | 0.044755 | 0.011816 | 18.0625 | 243.6 | 2432.02 | 246.5 | QMJ_LAG |
| 1 | 0.004032 | -.030312 | 19.9835 | 244.9 | 2535.70 | 247.8 | QND_LAG |
| 2 | 0.323619 | 0.275306 | 6.9074 | 234.9 | 1783.54 | 239.2 | QJA_LAG QND_LAG |
| 2 | 0.284854 | 0.233772 | 8.7361 | 236.6 | 1885.76 | 241.0 | QMJ_LAG QJA_LAG |
| 2 | 0.265831 | 0.213390 | 9.6335 | 237.5 | 1935.92 | 241.8 | QJA_LAG QSO_LAG |
| 2 | 0.259223 | 0.206310 | 9.9452 | 237.7 | 1953.35 | 242.0 | QJF_LAG QJA_LAG |
| 3 | 0.399333 | 0.332593 | 5.3357 | 233.2 | 1642.55 | 239.0 | QJA_LAG QSO_LAG QND_LAG |
| 3 | 0.358494 | 0.287216 | 7.2622 | 235.3 | 1754.23 | 241.0 | QMJ_LAG QJA_LAG QND_LAG |
| 3 | 0.357964 | 0.286626 | 7.2873 | 235.3 | 1755.68 | 241.0 | QMA_LAG QJA_LAG QND_LAG |
| 3 | 0.328738 | 0.254153 | 8.6660 | 236.7 | 1835.60 | 242.4 | QJF_LAG QJA_LAG QND_LAG |
| 4 | 0.428698 | 0.340805 | 5.9505 | 233.7 | 1622.34 | 240.9 | QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.428478 | 0.340552 | 5.9608 | 233.7 | 1622.97 | 240.9 | QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.407362 | 0.316187 | 6.9570 | 234.8 | 1682.93 | 242.0 | QJF_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.404600 | 0.313000 | 7.0873 | 235.0 | 1690.77 | 242.1 | QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.475288 | 0.370346 | 5.7526 | 233.1 | 1549.64 | 241.7 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.460229 | 0.352275 | 6.4630 | 233.9 | 1594.11 | 242.5 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.452799 | 0.343359 | 6.8135 | 234.4 | 1616.06 | 243.0 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.409467 | 0.291361 | 8.8576 | 236.7 | 1744.03 | 245.3 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.491242 | 0.364053 | 7.0000 | 234.1 | 1565.13 | 244.1 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

### 7.1.5 Untransformed All Variables: 1962 and 1993 Omitted

N = 31     Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.226964 | 0.200307 | 9.4670 | 237.1 | 1968.12 | 239.9 | QJA_LAG |
| 1 | 0.056934 | 0.024414 | 17.4880 | 243.2 | 2401.01 | 246.1 | QSO_LAG |
| 1 | 0.044755 | 0.011816 | 18.0625 | 243.6 | 2432.02 | 246.5 | QMJ_LAG |
| 1 | 0.004032 | -.030312 | 19.9835 | 244.9 | 2535.70 | 247.8 | QND_LAG |
| 2 | 0.323619 | 0.275306 | 6.9074 | 234.9 | 1783.54 | 239.2 | QJA_LAG QND_LAG |
| 2 | 0.284854 | 0.233772 | 8.7361 | 236.6 | 1885.76 | 241.0 | QMJ_LAG QJA_LAG |
| 2 | 0.265831 | 0.213390 | 9.6335 | 237.5 | 1935.92 | 241.8 | QJA_LAG QSO_LAG |
| 2 | 0.259223 | 0.206310 | 9.9452 | 237.7 | 1953.35 | 242.0 | QJF_LAG QJA_LAG |
| 3 | 0.399333 | 0.332593 | 5.3357 | 233.2 | 1642.55 | 239.0 | QJA_LAG QSO_LAG QND_LAG |
| 3 | 0.358494 | 0.287216 | 7.2622 | 235.3 | 1754.23 | 241.0 | QMJ_LAG QJA_LAG QND_LAG |
| 3 | 0.357964 | 0.286626 | 7.2873 | 235.3 | 1755.68 | 241.0 | QMA_LAG QJA_LAG QND_LAG |
| 3 | 0.328738 | 0.254153 | 8.6660 | 236.7 | 1835.60 | 242.4 | QJF_LAG QJA_LAG QND_LAG |
| 4 | 0.428698 | 0.340805 | 5.9505 | 233.7 | 1622.34 | 240.9 | QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.428478 | 0.340552 | 5.9608 | 233.7 | 1622.97 | 240.9 | QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.407362 | 0.316187 | 6.9570 | 234.8 | 1682.93 | 242.0 | QJF_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.404600 | 0.313000 | 7.0873 | 235.0 | 1690.77 | 242.1 | QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.475288 | 0.370346 | 5.7526 | 233.1 | 1549.64 | 241.7 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.460229 | 0.352275 | 6.4630 | 233.9 | 1594.11 | 242.5 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.452799 | 0.343359 | 6.8135 | 234.4 | 1616.06 | 243.0 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.409467 | 0.291361 | 8.8576 | 236.7 | 1744.03 | 245.3 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.491242 | 0.364053 | 7.0000 | 234.1 | 1565.13 | 244.1 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

### 7.1.6 Untransformed All Variables: 1964 and 1993 Omitted

N = 31 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.207227 | 0.179890 | 18.2933 | 252.2 | 3203.67 | 255.0 | QJA_LAG |
| 1 | 0.051855 | 0.019161 | 27.1701 | 257.7 | 3831.54 | 260.6 | QMA_LAG |
| 1 | 0.044815 | 0.011877 | 27.5723 | 257.9 | 3859.99 | 260.8 | QSO_LAG |
| 1 | 0.026896 | -.006659 | 28.5961 | 258.5 | 3932.40 | 261.4 | QND_LAG |
| 2 | 0.389013 | 0.345371 | 9.9073 | 246.1 | 2557.23 | 250.4 | QJA_LAG QND_LAG |
| 2 | 0.273529 | 0.221638 | 16.5053 | 251.5 | 3040.59 | 255.8 | QJF_LAG QJA_LAG |
| 2 | 0.234236 | 0.179539 | 18.7502 | 253.1 | 3205.04 | 257.4 | QJA_LAG QSO_LAG |
| 2 | 0.227193 | 0.171992 | 19.1526 | 253.4 | 3234.52 | 257.7 | QMA_LAG QJA_LAG |
| 3 | 0.454741 | 0.394156 | 8.1522 | 244.6 | 2366.66 | 250.3 | QMA_LAG QJA_LAG QND_LAG |
| 3 | 0.447523 | 0.386137 | 8.5645 | 245.0 | 2397.99 | 250.7 | QJA_LAG QSO_LAG QND_LAG |
| 3 | 0.423214 | 0.359126 | 9.9534 | 246.3 | 2503.50 | 252.0 | QJF_LAG QJA_LAG QND_LAG |
| 3 | 0.409308 | 0.343675 | 10.7479 | 247.0 | 2563.86 | 252.8 | QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.517632 | 0.443422 | 6.5590 | 242.8 | 2174.21 | 249.9 | QJF_LAG QMA_LAG QJA_LAG QND_LAG |
| 4 | 0.508280 | 0.432631 | 7.0933 | 243.4 | 2216.36 | 250.5 | QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.484591 | 0.405298 | 8.4467 | 244.8 | 2323.14 | 252.0 | QJF_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.482968 | 0.403425 | 8.5394 | 244.9 | 2330.45 | 252.1 | QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.573784 | 0.488541 | 5.3509 | 240.9 | 1997.96 | 249.5 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.554935 | 0.465921 | 6.4278 | 242.3 | 2086.32 | 250.9 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.511012 | 0.413214 | 8.9372 | 245.2 | 2292.21 | 253.8 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.485479 | 0.382575 | 10.3960 | 246.8 | 2411.90 | 255.4 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.579926 | 0.474907 | 7.0000 | 242.5 | 2051.22 | 252.5 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

### 7.1.7 Untransformed All Variables: 1962, 1964 and 1993 Omitted

N = 30 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.216421 | 0.188436 | 8.4090 | 229.9 | 1998.17 | 232.7 | QJA_LAG |
| 1 | 0.072872 | 0.039760 | 14.7126 | 235.0 | 2364.23 | 237.8 | QSO_LAG |
| 1 | 0.036570 | 0.002162 | 16.3067 | 236.1 | 2456.80 | 238.9 | QMA_LAG |
| 1 | 0.025551 | -.009251 | 16.7906 | 236.5 | 2484.90 | 239.3 | QJF_LAG |
| 2 | 0.301241 | 0.249481 | 6.6844 | 228.5 | 1847.87 | 232.7 | QJA_LAG QND_LAG |
| 2 | 0.265440 | 0.211028 | 8.2565 | 230.0 | 1942.55 | 234.2 | QJA_LAG QSO_LAG |
| 2 | 0.260503 | 0.205726 | 8.4733 | 230.2 | 1955.60 | 234.4 | QMJ_LAG QJA_LAG |
| 2 | 0.234026 | 0.177287 | 9.6360 | 231.2 | 2025.62 | 235.5 | QJF_LAG QJA_LAG |
| 3 | 0.379032 | 0.307382 | 5.2683 | 227.0 | 1705.31 | 232.6 | QJA_LAG QSO_LAG QND_LAG |
| 3 | 0.355617 | 0.281265 | 6.2965 | 228.1 | 1769.61 | 233.7 | QMJ_LAG QJA_LAG QND_LAG |
| 3 | 0.346189 | 0.270750 | 6.7106 | 228.5 | 1795.51 | 234.1 | QMA_LAG QJA_LAG QND_LAG |
| 3 | 0.313452 | 0.234235 | 8.1481 | 230.0 | 1885.41 | 235.6 | QJF_LAG QJA_LAG QND_LAG |
| 4 | 0.420545 | 0.327832 | 5.4454 | 226.9 | 1654.96 | 233.9 | QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.409046 | 0.314493 | 5.9504 | 227.5 | 1687.80 | 234.5 | QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.394260 | 0.297342 | 6.5996 | 228.2 | 1730.03 | 235.2 | QJF_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.388834 | 0.291048 | 6.8379 | 228.5 | 1745.53 | 235.5 | QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.457626 | 0.344632 | 5.8171 | 226.9 | 1613.60 | 235.3 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.449994 | 0.335409 | 6.1522 | 227.3 | 1636.31 | 235.7 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.435610 | 0.318029 | 6.7838 | 228.1 | 1679.10 | 236.5 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.404877 | 0.280893 | 8.1334 | 229.7 | 1770.53 | 238.1 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.476233 | 0.339598 | 7.0000 | 227.8 | 1625.99 | 237.7 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

## 7.2 Model 2: Harvest Untransformed and Logged Inflows

### 7.2.1 Harvest Untransformed and Logged Inflows: 1962 Omitted

N = 32 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.268340 | 0.243952 | 2.3121 | 246.5 | 2085.04 | 249.4 | LN_QJA |
| 1 | 0.084260 | 0.053736 | 9.9384 | 253.7 | 2609.62 | 256.6 | LN_QJF |
| 1 | 0.066625 | 0.035513 | 10.6691 | 254.3 | 2659.88 | 257.2 | LN_QMA |
| 1 | 0.003855 | -.029350 | 13.2696 | 256.4 | 2838.76 | 259.3 | LN_QSO |
| 2 | 0.304285 | 0.256305 | 2.8230 | 246.9 | 2050.97 | 251.3 | LN_QJA LN_QND |
| 2 | 0.287130 | 0.237966 | 3.5337 | 247.7 | 2101.55 | 252.1 | LN_QJF LN_QJA |
| 2 | 0.285984 | 0.236742 | 3.5812 | 247.7 | 2104.92 | 252.1 | LN_QJA LN_QSO |
| 2 | 0.282295 | 0.232798 | 3.7340 | 247.9 | 2115.80 | 252.3 | LN_QMA LN_QJA |
| 3 | 0.351886 | 0.282446 | 2.8509 | 246.6 | 1978.88 | 252.5 | LN_QJF LN_QJA LN_QND |
| 3 | 0.347774 | 0.277893 | 3.0213 | 246.8 | 1991.44 | 252.7 | LN_QMA LN_QJA LN_QND |
| 3 | 0.313851 | 0.240335 | 4.4267 | 248.4 | 2095.02 | 254.3 | LN_QJF LN_QJA LN_QSO |
| 3 | 0.313837 | 0.240320 | 4.4273 | 248.4 | 2095.06 | 254.3 | LN_QMA LN_QJA LN_QSO |
| 4 | 0.371998 | 0.278960 | 4.0177 | 247.6 | 1988.49 | 254.9 | LN_QMA LN_QJA LN_QSO LN_QND |
| 4 | 0.369930 | 0.276586 | 4.1034 | 247.7 | 1995.04 | 255.0 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.368693 | 0.275166 | 4.1546 | 247.8 | 1998.96 | 255.1 | LN_QJF LN_QJA LN_QSO LN_QND |
| 4 | 0.352304 | 0.256350 | 4.8336 | 248.6 | 2050.85 | 255.9 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 5 | 0.396490 | 0.280431 | 5.0030 | 248.3 | 1984.44 | 257.1 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.374738 | 0.254495 | 5.9042 | 249.5 | 2055.97 | 258.3 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.372405 | 0.251714 | 6.0008 | 249.6 | 2063.64 | 258.4 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.371445 | 0.250569 | 6.0406 | 249.6 | 2066.79 | 258.4 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.396562 | 0.251737 | 7.0000 | 250.3 | 2063.57 | 260.6 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

### 7.2.2 Harvest Untransformed and Logged Inflows: 1964 Omitted

N = 32     Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.274391 | 0.250204 | 7.9874 | 256.8 | 2878.05 | 259.7 | LN_QJA |
| 1 | 0.046210 | 0.014417 | 19.3043 | 265.6 | 3783.10 | 268.5 | LN_QSO |
| 1 | 0.039730 | 0.007721 | 19.6257 | 265.8 | 3808.81 | 268.7 | LN_QMA |
| 1 | 0.025682 | -.006795 | 20.3225 | 266.2 | 3864.53 | 269.2 | LN_QND |
| 2 | 0.412067 | 0.371520 | 3.1593 | 252.1 | 2412.39 | 256.5 | LN_QJA LN_QND |
| 2 | 0.341424 | 0.296005 | 6.6628 | 255.7 | 2702.24 | 260.1 | LN_QJA LN_QSO |
| 2 | 0.287197 | 0.238038 | 9.3523 | 258.2 | 2924.75 | 262.6 | LN_QJF LN_QJA |
| 2 | 0.280896 | 0.231303 | 9.6648 | 258.5 | 2950.60 | 262.9 | LN_QMJ LN_QJA |
| 3 | 0.452398 | 0.393726 | 3.1590 | 251.8 | 2327.15 | 257.7 | LN_QJA LN_QSO LN_QND |
| 3 | 0.441201 | 0.381329 | 3.7143 | 252.5 | 2374.73 | 258.3 | LN_QMA LN_QJA LN_QND |
| 3 | 0.412933 | 0.350033 | 5.1163 | 254.0 | 2494.86 | 259.9 | LN_QMJ LN_QJA LN_QND |
| 3 | 0.412270 | 0.349299 | 5.1492 | 254.1 | 2497.68 | 259.9 | LN_QJF LN_QJA LN_QND |
| 4 | 0.494781 | 0.419934 | 3.0570 | 251.2 | 2226.55 | 258.6 | LN_QMA LN_QJA LN_QSO LN_QND |
| 4 | 0.457119 | 0.376692 | 4.9248 | 253.5 | 2392.53 | 260.9 | LN_QMJ LN_QJA LN_QSO LN_QND |
| 4 | 0.452877 | 0.371821 | 5.1352 | 253.8 | 2411.23 | 261.1 | LN_QJF LN_QJA LN_QSO LN_QND |
| 4 | 0.449302 | 0.367717 | 5.3125 | 254.0 | 2426.98 | 261.3 | LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.495839 | 0.398885 | 5.0045 | 253.2 | 2307.35 | 262.0 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.494880 | 0.397742 | 5.0520 | 253.2 | 2311.73 | 262.0 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.457434 | 0.353094 | 6.9092 | 255.5 | 2483.11 | 264.3 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.450381 | 0.344685 | 7.2590 | 255.9 | 2515.39 | 264.7 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 6 | 0.495929 | 0.374952 | 7.0000 | 255.2 | 2399.21 | 265.4 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

### 7.2.3 Harvest Untransformed and Logged Inflows: 1988 Omitted

N = 32 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.338004 | 0.315938 | 10.1399 | 254.9 | 2711.40 | 257.8 | LN_QJA |
| 1 | 0.143680 | 0.115135 | 21.3356 | 263.1 | 3507.32 | 266.1 | LN_QMA |
| 1 | 0.026548 | -.005900 | 28.0839 | 267.2 | 3987.07 | 270.2 | LN_QJF |
| 1 | 0.009815 | -.023191 | 29.0480 | 267.8 | 4055.60 | 270.7 | LN_QMJ |
| 2 | 0.422421 | 0.382588 | 7.2763 | 252.5 | 2447.22 | 256.9 | LN_QJA LN_QND |
| 2 | 0.390982 | 0.348981 | 9.0876 | 254.2 | 2580.43 | 258.6 | LN_QMA LN_QJA |
| 2 | 0.352996 | 0.308376 | 11.2761 | 256.2 | 2741.38 | 260.6 | LN_QJA LN_QSO |
| 2 | 0.338226 | 0.292587 | 12.1271 | 256.9 | 2803.96 | 261.3 | LN_QMJ LN_QJA |
| 3 | 0.546601 | 0.498023 | 2.1219 | 246.8 | 1989.68 | 252.7 | LN_QMA LN_QJA LN_QND |
| 3 | 0.441132 | 0.381253 | 8.1983 | 253.5 | 2452.52 | 259.3 | LN_QJF LN_QJA LN_QND |
| 3 | 0.428575 | 0.367351 | 8.9218 | 254.2 | 2507.62 | 260.1 | LN_QMJ LN_QJA LN_QND |
| 3 | 0.427307 | 0.365947 | 8.9948 | 254.3 | 2513.18 | 260.1 | LN_QMA LN_QJA LN_QSO |
| 4 | 0.565458 | 0.501081 | 3.0355 | 247.4 | 1977.55 | 254.8 | LN_QMA LN_QJA LN_QSO LN_QND |
| 4 | 0.553062 | 0.486849 | 3.7496 | 248.3 | 2033.96 | 255.7 | LN_QMA LN_QMJ LN_QJA LN_QND |
| 4 | 0.546663 | 0.479502 | 4.1183 | 248.8 | 2063.09 | 256.1 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.447809 | 0.366003 | 9.8136 | 255.1 | 2512.96 | 262.4 | LN_QJF LN_QJA LN_QSO LN_QND |
| 5 | 0.565801 | 0.482301 | 5.0157 | 249.4 | 2051.99 | 258.2 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.565716 | 0.482200 | 5.0206 | 249.4 | 2052.39 | 258.2 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.553222 | 0.467303 | 5.7404 | 250.3 | 2111.44 | 259.1 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.459201 | 0.355201 | 11.1573 | 256.4 | 2555.78 | 265.2 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.566073 | 0.461931 | 7.0000 | 251.4 | 2132.73 | 261.6 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

### 7.2.4 Harvest Untransformed and Logged Inflows: 1962 and 1964 Omitted

N = 31 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.264524 | 0.239162 | 3.5345 | 235.5 | 1872.50 | 238.4 | LN_QJA |
| 1 | 0.043170 | 0.010175 | 12.7244 | 243.7 | 2436.05 | 246.5 | LN_QSO |
| 1 | 0.021919 | -.011808 | 13.6067 | 244.4 | 2490.16 | 247.2 | LN_QJF |
| 1 | 0.017538 | -.016340 | 13.7885 | 244.5 | 2501.31 | 247.4 | LN_QMA |
| 2 | 0.344187 | 0.297343 | 2.2272 | 234.0 | 1729.31 | 238.3 | LN_QJA LN_QND |
| 2 | 0.333015 | 0.285373 | 2.6910 | 234.5 | 1758.77 | 238.8 | LN_QJA LN_QSO |
| 2 | 0.292657 | 0.242132 | 4.3665 | 236.3 | 1865.19 | 240.6 | LN_QMJ LN_QJA |
| 2 | 0.264525 | 0.211991 | 5.5345 | 237.5 | 1939.37 | 241.8 | LN_QMA LN_QJA |
| 3 | 0.394612 | 0.327346 | 2.1337 | 233.5 | 1655.47 | 239.2 | LN_QJA LN_QSO LN_QND |
| 3 | 0.358420 | 0.287133 | 3.6362 | 235.3 | 1754.43 | 241.0 | LN_QMJ LN_QJA LN_QND |
| 3 | 0.354958 | 0.283286 | 3.7800 | 235.5 | 1763.90 | 241.2 | LN_QMA LN_QJA LN_QND |
| 3 | 0.351721 | 0.279690 | 3.9144 | 235.6 | 1772.75 | 241.3 | LN_QJF LN_QJA LN_QND |
| 4 | 0.415972 | 0.326121 | 3.2469 | 234.4 | 1658.48 | 241.5 | LN_QMA LN_QJA LN_QSO LN_QND |
| 4 | 0.403413 | 0.311630 | 3.7683 | 235.0 | 1694.14 | 242.2 | LN_QJF LN_QJA LN_QSO LN_QND |
| 4 | 0.394884 | 0.301789 | 4.1224 | 235.5 | 1718.36 | 242.6 | LN_QMJ LN_QJA LN_QSO LN_QND |
| 4 | 0.380060 | 0.284684 | 4.7378 | 236.2 | 1760.46 | 243.4 | LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.419053 | 0.302863 | 5.1190 | 236.2 | 1715.72 | 244.8 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.418761 | 0.302513 | 5.1311 | 236.2 | 1716.58 | 244.8 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.404028 | 0.284834 | 5.7428 | 237.0 | 1760.09 | 245.6 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.383516 | 0.260219 | 6.5944 | 238.0 | 1820.67 | 246.7 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 6 | 0.421919 | 0.277398 | 7.0000 | 238.1 | 1778.39 | 248.1 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

### 7.2.5 Harvest Untransformed and Logged Inflows: 1962 and 1988 Omitted

N = 31     Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.336824 | 0.313956 | 5.7014 | 234.8 | 1831.58 | 237.7 | LN_QJA |
| 1 | 0.133151 | 0.103260 | 15.7446 | 243.1 | 2394.09 | 246.0 | LN_QMA |
| 1 | 0.099615 | 0.068567 | 17.3983 | 244.3 | 2486.71 | 247.2 | LN_QJF |
| 1 | 0.005999 | -.028277 | 22.0145 | 247.4 | 2745.26 | 250.2 | LN_QND |
| 2 | 0.388847 | 0.345193 | 5.1362 | 234.3 | 1748.18 | 238.6 | LN_QMA LN_QJA |
| 2 | 0.371166 | 0.326249 | 6.0080 | 235.2 | 1798.76 | 239.5 | LN_QJA LN_QND |
| 2 | 0.358192 | 0.312349 | 6.6478 | 235.8 | 1835.87 | 240.1 | LN_QJF LN_QJA |
| 2 | 0.344596 | 0.297781 | 7.3182 | 236.5 | 1874.76 | 240.8 | LN_QJA LN_QSO |
| 3 | 0.479284 | 0.421426 | 2.6767 | 231.3 | 1544.66 | 237.1 | LN_QMA LN_QJA LN_QND |
| 3 | 0.422347 | 0.358164 | 5.4843 | 234.6 | 1713.56 | 240.3 | LN_QJF LN_QJA LN_QND |
| 3 | 0.413898 | 0.348775 | 5.9009 | 235.0 | 1738.62 | 240.7 | LN_QMA LN_QJA LN_QSO |
| 3 | 0.409486 | 0.343874 | 6.1184 | 235.2 | 1751.71 | 241.0 | LN_QMA LN_QMJ LN_QJA |
| 4 | 0.496293 | 0.418799 | 3.8380 | 232.3 | 1551.67 | 239.5 | LN_QMA LN_QJA LN_QSO LN_QND |
| 4 | 0.493953 | 0.416100 | 3.9534 | 232.5 | 1558.88 | 239.6 | LN_QMA LN_QMJ LN_QJA LN_QND |
| 4 | 0.489604 | 0.411081 | 4.1678 | 232.7 | 1572.28 | 239.9 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.429799 | 0.342075 | 7.1168 | 236.2 | 1756.51 | 243.3 | LN_QJF LN_QJA LN_QSO LN_QND |
| 5 | 0.508245 | 0.409894 | 5.2486 | 233.6 | 1575.45 | 242.2 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.506162 | 0.407395 | 5.3513 | 233.7 | 1582.12 | 242.3 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.500589 | 0.400706 | 5.6261 | 234.0 | 1599.98 | 242.6 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.430204 | 0.316245 | 9.0968 | 238.1 | 1825.47 | 246.7 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.513287 | 0.391609 | 7.0000 | 235.2 | 1624.27 | 245.3 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

### 7.2.6 Harvest Untransformed and Logged Inflows: 1964 and 1988 Omitted

N = 31 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.332011 | 0.308977 | 11.5621 | 245.8 | 2604.83 | 248.6 | LN_QJA |
| 1 | 0.090187 | 0.058814 | 25.5223 | 255.3 | 3547.82 | 258.2 | LN_QMA |
| 1 | 0.032862 | -.000488 | 28.8316 | 257.2 | 3771.36 | 260.1 | LN_QSO |
| 1 | 0.019800 | -.014000 | 29.5856 | 257.6 | 3822.30 | 260.5 | LN_QND |
| 2 | 0.463480 | 0.425157 | 5.9726 | 241.0 | 2166.88 | 245.3 | LN_QJA LN_QND |
| 2 | 0.378036 | 0.333610 | 10.9051 | 245.5 | 2511.97 | 249.8 | LN_QJA LN_QSO |
| 2 | 0.358542 | 0.312723 | 12.0305 | 246.5 | 2590.70 | 250.8 | LN_QMA LN_QJA |
| 2 | 0.341996 | 0.294996 | 12.9857 | 247.3 | 2657.53 | 251.6 | LN_QJF LN_QJA |
| 3 | 0.541164 | 0.490182 | 3.4880 | 238.1 | 1921.77 | 243.8 | LN_QMA LN_QJA LN_QND |
| 3 | 0.489066 | 0.432296 | 6.4955 | 241.4 | 2139.97 | 247.2 | LN_QJA LN_QSO LN_QND |
| 3 | 0.464427 | 0.404919 | 7.9179 | 242.9 | 2243.17 | 248.6 | LN_QMJ LN_QJA LN_QND |
| 3 | 0.464077 | 0.404530 | 7.9381 | 242.9 | 2244.64 | 248.7 | LN_QJF LN_QJA LN_QND |
| 4 | 0.578686 | 0.513868 | 3.3219 | 237.5 | 1832.49 | 244.6 | LN_QMA LN_QJA LN_QSO LN_QND |
| 4 | 0.559354 | 0.491563 | 4.4379 | 238.9 | 1916.57 | 246.0 | LN_QMA LN_QMJ LN_QJA LN_QND |
| 4 | 0.543765 | 0.473576 | 5.3378 | 239.9 | 1984.37 | 247.1 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.491364 | 0.413112 | 8.3629 | 243.3 | 2212.29 | 250.5 | LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.581560 | 0.497872 | 5.1560 | 239.3 | 1892.78 | 247.9 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.581248 | 0.497498 | 5.1740 | 239.3 | 1894.19 | 247.9 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.562261 | 0.474714 | 6.2701 | 240.6 | 1980.08 | 249.3 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.492076 | 0.390491 | 10.3218 | 245.3 | 2297.56 | 253.9 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.584262 | 0.480328 | 7.0000 | 241.1 | 1958.92 | 251.1 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

### 7.2.7 Harvest Untransformed and Logged Inflows: 1962, 1964 and 1988 Omitted

N = 30     Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.336736 | 0.313048 | 6.3778 | 223.9 | 1632.78 | 226.7 | LN_QJA |
| 1 | 0.060561 | 0.027010 | 19.8595 | 234.3 | 2312.64 | 237.1 | LN_QMA |
| 1 | 0.030877 | -.003735 | 21.3086 | 235.2 | 2385.72 | 238.1 | LN_QJF |
| 1 | 0.028551 | -.006143 | 21.4221 | 235.3 | 2391.44 | 238.1 | LN_QSO |
| 2 | 0.413584 | 0.370146 | 4.6264 | 222.2 | 1497.06 | 226.4 | LN_QJA LN_QND |
| 2 | 0.382437 | 0.336692 | 6.1469 | 223.7 | 1576.58 | 227.9 | LN_QJA LN_QSO |
| 2 | 0.365334 | 0.318322 | 6.9817 | 224.5 | 1620.24 | 228.8 | LN_QMJ LN_QJA |
| 2 | 0.351801 | 0.303786 | 7.6424 | 225.2 | 1654.79 | 229.4 | LN_QMA LN_QJA |
| 3 | 0.468036 | 0.406655 | 3.9683 | 221.3 | 1410.29 | 226.9 | LN_QMA LN_QJA LN_QND |
| 3 | 0.445338 | 0.381339 | 5.0763 | 222.5 | 1470.46 | 228.1 | LN_QJA LN_QSO LN_QND |
| 3 | 0.428398 | 0.362444 | 5.9032 | 223.4 | 1515.37 | 229.0 | LN_QMJ LN_QJA LN_QND |
| 3 | 0.423496 | 0.356977 | 6.1425 | 223.7 | 1528.36 | 229.3 | LN_QJF LN_QJA LN_QND |
| 4 | 0.512531 | 0.434537 | 3.7962 | 220.6 | 1344.02 | 227.6 | LN_QMA LN_QJA LN_QSO LN_QND |
| 4 | 0.511126 | 0.432907 | 3.8648 | 220.7 | 1347.89 | 227.7 | LN_QMA LN_QMJ LN_QJA LN_QND |
| 4 | 0.468919 | 0.383945 | 5.9252 | 223.2 | 1464.26 | 230.2 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.456227 | 0.369224 | 6.5447 | 223.9 | 1499.25 | 230.9 | LN_QJF LN_QJA LN_QSO LN_QND |
| 5 | 0.528134 | 0.429829 | 5.0345 | 221.7 | 1355.21 | 230.1 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.513241 | 0.411833 | 5.7615 | 222.6 | 1397.98 | 231.0 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.511925 | 0.410242 | 5.8258 | 222.7 | 1401.76 | 231.1 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.458956 | 0.346238 | 8.4115 | 225.8 | 1553.89 | 234.2 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.528841 | 0.405930 | 7.0000 | 223.6 | 1412.01 | 233.4 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 7.3 Model 4: Harvest Untransformed and Square Root Inflows

### 7.3.1 Harvest Untransformed and Square Root Inflows: 1962 Omitted

N = 32     Regression Models for Dependent Variable: DRUM

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.25978 | 0.23511 | 2.546 | 246.9 | 2109.4 | 249.8 | SQRT_QJA |
| 1 | 0.03247 | 0.00022 | 11.926 | 255.4 | 2757.2 | 258.4 | SQRT_QJF |
| 1 | 0.03058 | -.00174 | 12.004 | 255.5 | 2762.6 | 258.4 | SQRT_QMA |
| 1 | 0.01409 | -.01877 | 12.684 | 256.0 | 2809.6 | 259.0 | SQRT_QSO |
| 2 | 0.31487 | 0.26762 | 2.273 | 246.4 | 2019.8 | 250.8 | SQRT_QJA SQRT_QND |
| 2 | 0.27780 | 0.22800 | 3.802 | 248.1 | 2129.0 | 252.5 | SQRT_QJA SQRT_QSO |
| 2 | 0.26819 | 0.21772 | 4.199 | 248.5 | 2157.4 | 252.9 | SQRT_QMA SQRT_QJA |
| 2 | 0.26793 | 0.21744 | 4.210 | 248.5 | 2158.2 | 252.9 | SQRT_QMJ SQRT_QJA |
| 3 | 0.36556 | 0.29758 | 2.181 | 245.9 | 1937.1 | 251.8 | SQRT_QMA SQRT_QJA SQRT_QND |
| 3 | 0.33555 | 0.26436 | 3.419 | 247.4 | 2028.8 | 253.3 | SQRT_QJA SQRT_QSO SQRT_QND |
| 3 | 0.31825 | 0.24520 | 4.133 | 248.2 | 2081.6 | 254.1 | SQRT_QJF SQRT_QJA SQRT_QND |
| 3 | 0.31664 | 0.24343 | 4.199 | 248.3 | 2086.5 | 254.2 | SQRT_QMJ SQRT_QJA SQRT_QND |
| 4 | 0.39033 | 0.30001 | 3.158 | 246.7 | 1930.4 | 254.0 | SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.38069 | 0.28894 | 3.557 | 247.2 | 1961.0 | 254.5 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 4 | 0.36721 | 0.27346 | 4.113 | 247.9 | 2003.7 | 255.2 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QND |
| 4 | 0.33948 | 0.24163 | 5.257 | 249.2 | 2091.5 | 256.6 | SQRT_QJF SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.39294 | 0.27620 | 5.051 | 248.5 | 1996.1 | 257.3 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.39190 | 0.27496 | 5.094 | 248.6 | 1999.5 | 257.4 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.38163 | 0.26271 | 5.518 | 249.1 | 2033.3 | 257.9 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 5 | 0.33985 | 0.21290 | 7.242 | 251.2 | 2170.7 | 260.0 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.39417 | 0.24878 | 7.000 | 250.5 | 2071.7 | 260.7 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

### 7.3.2 Harvest Untransformed and Square Root Inflows: 1964 Omitted

N = 32 Regression Models for Dependent Variable: DRUM

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.24916 | 0.22414 | 15.056 | 257.9 | 2978.1 | 260.8 | SQRT_QJA |
| 1 | 0.04574 | 0.01393 | 26.722 | 265.6 | 3785.0 | 268.5 | SQRT_QSO |
| 1 | 0.03202 | -.00024 | 27.508 | 266.0 | 3839.4 | 269.0 | SQRT_QND |
| 1 | 0.02640 | -.00606 | 27.831 | 266.2 | 3861.7 | 269.1 | SQRT_QMA |
| 2 | 0.41710 | 0.37690 | 7.426 | 251.8 | 2391.7 | 256.2 | SQRT_QJA SQRT_QND |
| 2 | 0.29282 | 0.24405 | 14.553 | 258.0 | 2901.7 | 262.4 | SQRT_QJA SQRT_QSO |
| 2 | 0.29193 | 0.24310 | 14.604 | 258.0 | 2905.3 | 262.4 | SQRT_QJF SQRT_QJA |
| 2 | 0.25704 | 0.20580 | 16.605 | 259.6 | 3048.5 | 264.0 | SQRT_QMJ SQRT_QJA |
| 3 | 0.48094 | 0.42532 | 5.766 | 250.1 | 2205.9 | 256.0 | SQRT_QMA SQRT_QJA SQRT_QND |
| 3 | 0.47310 | 0.41665 | 6.215 | 250.6 | 2239.2 | 256.4 | SQRT_QJA SQRT_QSO SQRT_QND |
| 3 | 0.42113 | 0.35911 | 9.195 | 253.6 | 2460.0 | 259.4 | SQRT_QJF SQRT_QJA SQRT_QND |
| 3 | 0.41888 | 0.35662 | 9.324 | 253.7 | 2469.6 | 259.6 | SQRT_QMJ SQRT_QJA SQRT_QND |
| 4 | 0.53605 | 0.46732 | 4.605 | 248.5 | 2044.7 | 255.8 | SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.50716 | 0.43415 | 6.261 | 250.4 | 2172.0 | 257.8 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QND |
| 4 | 0.49862 | 0.42434 | 6.751 | 251.0 | 2209.6 | 258.3 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 4 | 0.47770 | 0.40032 | 7.951 | 252.3 | 2301.8 | 259.6 | SQRT_QJF SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.56354 | 0.47961 | 5.029 | 248.5 | 1997.5 | 257.3 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.53684 | 0.44777 | 6.560 | 250.4 | 2119.7 | 259.2 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.52385 | 0.43229 | 7.304 | 251.3 | 2179.1 | 260.1 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 5 | 0.48383 | 0.38456 | 9.600 | 253.9 | 2362.3 | 262.7 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.56404 | 0.45941 | 7.000 | 250.5 | 2075.0 | 260.8 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

### 7.3.3 Harvest Untransformed and Square Root Inflows: 1962 and 1964 Omitted

N = 31     Regression Models for Dependent Variable: DRUM

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.25208 | 0.22629 | 7.038 | 236.0 | 1904.2 | 238.9 | SQRT_QJA |
| 1 | 0.05480 | 0.02220 | 16.017 | 243.3 | 2406.4 | 246.2 | SQRT_QSO |
| 1 | 0.03093 | -.00249 | 17.103 | 244.1 | 2467.2 | 246.9 | SQRT_QMJ |
| 1 | 0.00832 | -.02587 | 18.132 | 244.8 | 2524.8 | 247.7 | SQRT_QMA |
| 2 | 0.35068 | 0.30430 | 4.551 | 233.7 | 1712.2 | 238.0 | SQRT_QJA SQRT_QND |
| 2 | 0.30657 | 0.25704 | 6.558 | 235.7 | 1828.5 | 240.0 | SQRT_QJA SQRT_QSO |
| 2 | 0.29344 | 0.24297 | 7.156 | 236.3 | 1863.1 | 240.6 | SQRT_QMJ SQRT_QJA |
| 2 | 0.26586 | 0.21342 | 8.411 | 237.5 | 1935.8 | 241.8 | SQRT_QJF SQRT_QJA |
| 3 | 0.41916 | 0.35462 | 3.434 | 232.2 | 1588.3 | 237.9 | SQRT_QJA SQRT_QSO SQRT_QND |
| 3 | 0.38212 | 0.31347 | 5.120 | 234.1 | 1689.6 | 239.9 | SQRT_QMA SQRT_QJA SQRT_QND |
| 3 | 0.37402 | 0.30447 | 5.489 | 234.5 | 1711.8 | 240.3 | SQRT_QMJ SQRT_QJA SQRT_QND |
| 3 | 0.35109 | 0.27899 | 6.532 | 235.6 | 1774.5 | 241.4 | SQRT_QJF SQRT_QJA SQRT_QND |
| 4 | 0.45187 | 0.36754 | 3.946 | 232.4 | 1556.5 | 239.6 | SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.42831 | 0.34036 | 5.018 | 233.7 | 1623.4 | 240.9 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 4 | 0.42062 | 0.33149 | 5.368 | 234.1 | 1645.3 | 241.3 | SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.41989 | 0.33064 | 5.401 | 234.2 | 1647.4 | 241.3 | SQRT_QJF SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.46361 | 0.35633 | 5.411 | 233.7 | 1584.1 | 242.3 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.46242 | 0.35491 | 5.465 | 233.8 | 1587.6 | 242.4 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.43622 | 0.32346 | 6.658 | 235.3 | 1665.0 | 243.9 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 5 | 0.42102 | 0.30523 | 7.350 | 236.1 | 1709.9 | 244.7 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.47265 | 0.34081 | 7.000 | 235.2 | 1622.3 | 245.2 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

## 7.4 Model 6: Harvest Untransformed, and Logged and Square Root Inflows

### 7.4.1 Harvest Untransformed, and Logged and Square Root Inflows: 1962 Omitted

N = 32 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.268340 | 0.243952 | 3.0669 | 246.5 | 2085.04 | 249.4 | LN_QJA |
| 1 | 0.084260 | 0.053736 | 10.8831 | 253.7 | 2609.62 | 256.6 | LN_QJF |
| 1 | 0.066625 | 0.035513 | 11.6319 | 254.3 | 2659.88 | 257.2 | LN_QMA |
| 1 | 0.014092 | -.018771 | 13.8625 | 256.0 | 2809.58 | 259.0 | SQRT_QSO |
| 2 | 0.304285 | 0.256305 | 3.5407 | 246.9 | 2050.97 | 251.3 | LN_QJA LN_QND |
| 2 | 0.287130 | 0.237966 | 4.2691 | 247.7 | 2101.55 | 252.1 | LN_QJF LN_QJA |
| 2 | 0.286112 | 0.236879 | 4.3123 | 247.7 | 2104.55 | 252.1 | LN_QJA SQRT_QSO |
| 2 | 0.282295 | 0.232798 | 4.4744 | 247.9 | 2115.80 | 252.3 | LN_QMA LN_QJA |
| 3 | 0.351886 | 0.282446 | 3.5195 | 246.6 | 1978.88 | 252.5 | LN_QJF LN_QJA LN_QND |
| 3 | 0.347774 | 0.277893 | 3.6941 | 246.8 | 1991.44 | 252.7 | LN_QMA LN_QJA LN_QND |
| 3 | 0.321423 | 0.248718 | 4.8130 | 248.1 | 2071.90 | 253.9 | LN_QJA SQRT_QSO LN_QND |
| 3 | 0.309374 | 0.235379 | 5.3246 | 248.6 | 2108.68 | 254.5 | LN_QMA SQRT_QMJ LN_QJA |
| 4 | 0.381182 | 0.289505 | 4.2756 | 247.1 | 1959.41 | 254.5 | LN_QMA LN_QJA SQRT_QSO LN_QND |
| 4 | 0.373012 | 0.280125 | 4.6224 | 247.6 | 1985.28 | 254.9 | LN_QJF LN_QJA SQRT_QSO LN_QND |
| 4 | 0.371600 | 0.278503 | 4.6824 | 247.6 | 1989.75 | 255.0 | LN_QMA SQRT_QMJ LN_QJA LN_QND |
| 4 | 0.369930 | 0.276586 | 4.7533 | 247.7 | 1995.04 | 255.0 | LN_QJF LN_QMA LN_QJA LN_QND |
| 5 | 0.401977 | 0.286972 | 5.3926 | 248.0 | 1966.40 | 256.8 | LN_QJF LN_QMA LN_QJA SQRT_QSO LN_QND |
| 5 | 0.397163 | 0.281233 | 5.5970 | 248.3 | 1982.23 | 257.1 | LN_QJF LN_QMA SQRT_QMJ LN_QJA LN_QND |
| 5 | 0.388056 | 0.270374 | 5.9837 | 248.8 | 2012.17 | 257.6 | LN_QMA SQRT_QMJ LN_QJA SQRT_QSO LN_QND |
| 5 | 0.375243 | 0.255097 | 6.5278 | 249.4 | 2054.31 | 258.2 | LN_QJF SQRT_QMJ LN_QJA SQRT_QSO LN_QND |
| 6 | 0.411223 | 0.269916 | 7.0000 | 249.5 | 2013.44 | 259.8 | LN_QJF LN_QMA SQRT_QMJ LN_QJA SQRT_QSO LN_QND |

## 7.4.2 Harvest Untransformed, and Logged and Square Root Inflows: 1988 Omitted

N = 32     Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.338004 | 0.315938 | 10.7664 | 254.9 | 2711.40 | 257.8 | LN_QJA |
| 1 | 0.143680 | 0.115135 | 22.1460 | 263.1 | 3507.32 | 266.1 | LN_QMA |
| 1 | 0.026548 | -.005900 | 29.0052 | 267.2 | 3987.07 | 270.2 | LN_QJF |
| 1 | 0.008403 | -.024650 | 30.0678 | 267.8 | 4061.38 | 270.8 | SQRT_QSO |
| 2 | 0.422421 | 0.382588 | 7.8230 | 252.5 | 2447.22 | 256.9 | LN_QJA LN_QND |
| 2 | 0.390982 | 0.348981 | 9.6640 | 254.2 | 2580.43 | 258.6 | LN_QMA LN_QJA |
| 2 | 0.345476 | 0.300337 | 12.3288 | 256.5 | 2773.24 | 260.9 | LN_QJA SQRT_QSO |
| 2 | 0.338474 | 0.292852 | 12.7389 | 256.9 | 2802.91 | 261.3 | SQRT_QMJ LN_QJA |
| 3 | 0.546601 | 0.498023 | 2.5510 | 246.8 | 1989.68 | 252.7 | LN_QMA LN_QJA LN_QND |
| 3 | 0.441132 | 0.381253 | 8.7273 | 253.5 | 2452.52 | 259.3 | LN_QJF LN_QJA LN_QND |
| 3 | 0.428828 | 0.367631 | 9.4478 | 254.2 | 2506.51 | 260.0 | LN_QJA SQRT_QSO LN_QND |
| 3 | 0.422957 | 0.361131 | 9.7916 | 254.5 | 2532.27 | 260.4 | SQRT_QMJ LN_QJA LN_QND |
| 4 | 0.566752 | 0.502567 | 3.3709 | 247.3 | 1971.66 | 254.7 | LN_QMA LN_QJA SQRT_QSO LN_QND |
| 4 | 0.564375 | 0.499838 | 3.5101 | 247.5 | 1982.48 | 254.8 | LN_QMA SQRT_QMJ LN_QJA LN_QND |
| 4 | 0.546663 | 0.479502 | 4.5473 | 248.8 | 2063.09 | 256.1 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.449197 | 0.367596 | 10.2550 | 255.0 | 2506.65 | 262.3 | LN_QJF LN_QJA SQRT_QSO LN_QND |
| 5 | 0.572936 | 0.490809 | 5.0088 | 248.9 | 2018.27 | 257.7 | LN_QMA SQRT_QMJ LN_QJA SQRT_QSO LN_QND |
| 5 | 0.566834 | 0.483533 | 5.3662 | 249.3 | 2047.11 | 258.1 | LN_QJF LN_QMA LN_QJA SQRT_QSO LN_QND |
| 5 | 0.564551 | 0.480811 | 5.4998 | 249.5 | 2057.90 | 258.3 | LN_QJF LN_QMA SQRT_QMJ LN_QJA LN_QND |
| 5 | 0.451178 | 0.345635 | 12.1390 | 256.9 | 2593.69 | 265.7 | LN_QJF SQRT_QMJ LN_QJA SQRT_QSO LN_QND |
| 6 | 0.573087 | 0.470627 | 7.0000 | 250.9 | 2098.26 | 261.1 | LN_QJF LN_QMA SQRT_QMJ LN_QJA SQRT_QSO LN_QND |

### 7.4.3 Harvest Untransformed, and Logged and Square Root Inflows: 1962 and 1988 Omitted

N = 31 Regression Models for Dependent Variable: DRUM

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.336824 | 0.313956 | 7.1613 | 234.8 | 1831.58 | 237.7 | LN_QJA |
| 1 | 0.133151 | 0.103260 | 17.6528 | 243.1 | 2394.09 | 246.0 | LN_QMA |
| 1 | 0.099615 | 0.068567 | 19.3803 | 244.3 | 2486.71 | 247.2 | LN_QJF |
| 1 | 0.005999 | -.028277 | 24.2026 | 247.4 | 2745.26 | 250.2 | LN_QND |
| 2 | 0.388847 | 0.345193 | 6.4815 | 234.3 | 1748.18 | 238.6 | LN_QMA LN_QJA |
| 2 | 0.371166 | 0.326249 | 7.3922 | 235.2 | 1798.76 | 239.5 | LN_QJA LN_QND |
| 2 | 0.358192 | 0.312349 | 8.0606 | 235.8 | 1835.87 | 240.1 | LN_QJF LN_QJA |
| 2 | 0.344954 | 0.298165 | 8.7425 | 236.5 | 1873.74 | 240.8 | SQRT_QMJ LN_QJA |
| 3 | 0.479284 | 0.421426 | 3.8229 | 231.3 | 1544.66 | 237.1 | LN_QMA LN_QJA LN_QND |
| 3 | 0.432006 | 0.368896 | 6.2583 | 234.0 | 1684.90 | 239.8 | LN_QMA SQRT_QMJ LN_QJA |
| 3 | 0.422347 | 0.358164 | 6.7558 | 234.6 | 1713.56 | 240.3 | LN_QJF LN_QJA LN_QND |
| 3 | 0.403093 | 0.336771 | 7.7476 | 235.6 | 1770.67 | 241.3 | LN_QMA LN_QJA SQRT_QSO |
| 4 | 0.518544 | 0.444474 | 3.8006 | 230.9 | 1483.13 | 238.1 | LN_QMA SQRT_QMJ LN_QJA LN_QND |
| 4 | 0.498907 | 0.421816 | 4.8121 | 232.1 | 1543.62 | 239.3 | LN_QMA LN_QJA SQRT_QSO LN_QND |
| 4 | 0.489604 | 0.411081 | 5.2913 | 232.7 | 1572.28 | 239.9 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.434827 | 0.347877 | 8.1130 | 235.9 | 1741.02 | 243.0 | LN_QJF LN_QMA SQRT_QMJ LN_QJA |
| 5 | 0.531389 | 0.437667 | 5.1389 | 232.1 | 1501.30 | 240.7 | LN_QJF LN_QMA SQRT_QMJ LN_QJA LN_QND |
| 5 | 0.521750 | 0.426100 | 5.6354 | 232.7 | 1532.18 | 241.3 | LN_QMA SQRT_QMJ LN_QJA SQRT_QSO LN_QND |
| 5 | 0.508923 | 0.410708 | 6.2961 | 233.5 | 1573.27 | 242.1 | LN_QJF LN_QMA LN_QJA SQRT_QSO LN_QND |
| 5 | 0.435512 | 0.322614 | 10.0777 | 237.8 | 1808.46 | 246.4 | LN_QJF LN_QMA SQRT_QMJ LN_QJA SQRT_QSO |
| 6 | 0.534086 | 0.417607 | 7.0000 | 233.9 | 1554.86 | 243.9 | LN_QJF LN_QMA SQRT_QMJ LN_QJA SQRT_QSO LN_QND |

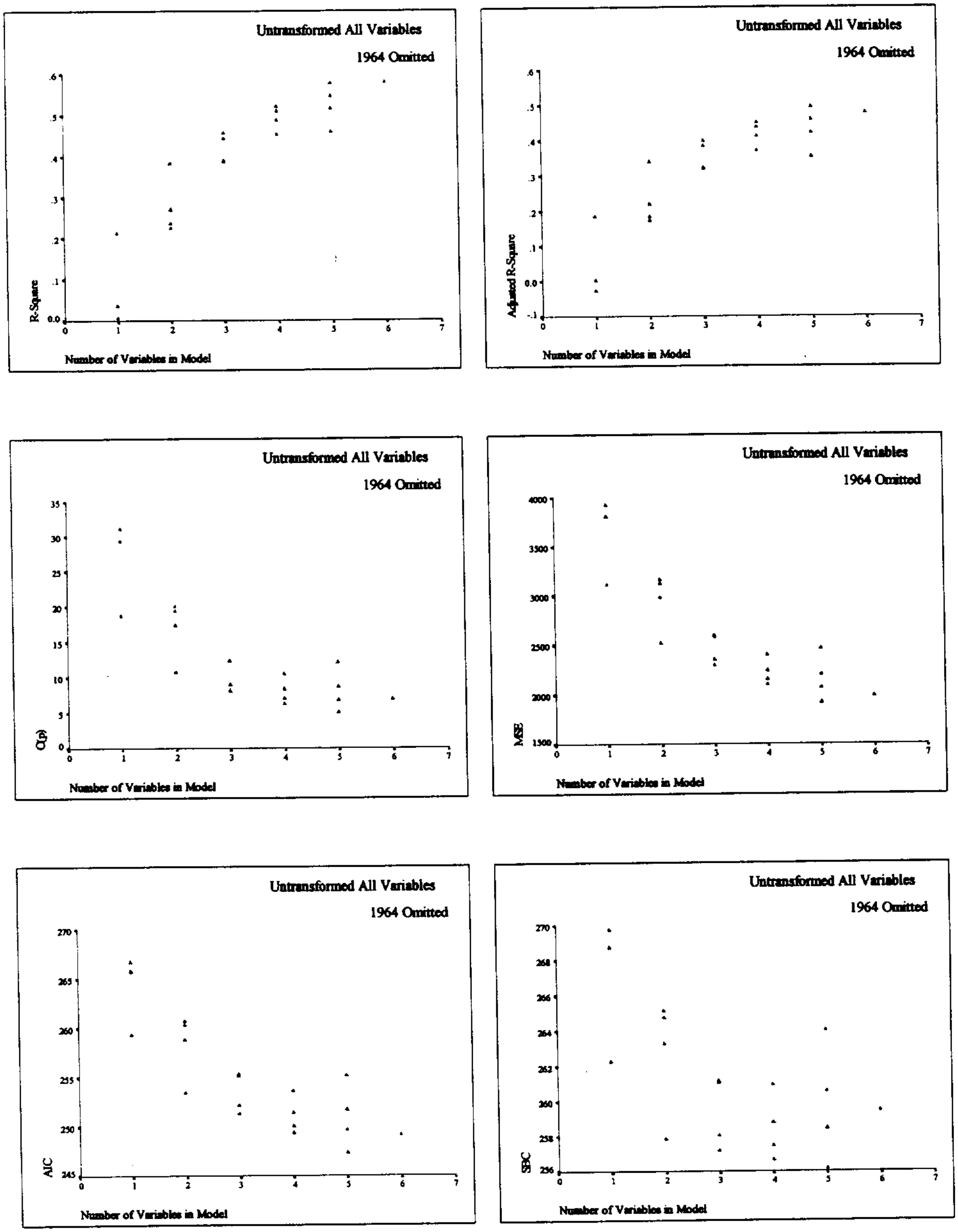



Fig. 7.1. Examining Subsets of Untransformed All Variables Data:
1964 Omitted.

# White Shrimp Harvests in Corpus Christi Bay: A Regression Analysis

## Harvest vs Freshwater Inflows

F. Michael Speed
Michael Longnecker
Rita Miranda-López

*Department of Statistics*
*Texas A&M University*

# White Shrimp Harvest in Corpus Christi Bay:

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Harvest vs. Freshwater Inflows

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Department of Statistics

Texas A&M University

WINTER 1997

## Table of Contents

# 1. Summary Report

## 1.1 Description of the Problem[1]

Bimonthly freshwater inflows into Corpus Christi Bay were recorded for the years 1962 to 1994. These variables, and various transformations of them, were used to construct a model for the annual harvest of white shrimp.

## 1.2 Constructing Models - General Discussion

Stability of coefficient estimates and accuracy of predicted values are primary goals in constructing models for prediction. To this end, the data must be examined from three points of view: individual observations (to detect outliers or influential points); variables, individually and in groups (to select an optimal set of predictors); and the interaction of these two, which produces the overall structure of the data set (to determine whether multicollinearity is present or not). The first two of these were examined by both graphic and quantitative means; the third by quantitative means only.

### 1.2.1 Detecting Influential Points and Outliers

The structures of individual variables were examined via box plots and histograms, as well as by all the usual numerical measures. For each pair of variables, 99 % prediction ellipses and 95% confidence ellipses were plotted in a further effort to look for unusual points. For example, suppose large values of Variable A are generally associated with large values for Variable B. If an observation consisted of a large value for Variable A but a small value for Variable B, that point would be considered unusual, even though it was well within the range of data for both variables and could not be considered an outlier.

In addition, a number of residual analysis techniques were employed. A large *residual* indicates a point not well-fit by the model. The *deleted residual*, however, is somewhat more useful in the search for influential points. The model is fitted without a given observation, and the predicted response and corresponding residual are calculated for that observation. The *Studentized deleted residual* is scaled to have a Student's t distribution. Histograms and normal P-P plots of the residuals were also examined.

Other quantities, such as the Mahalanobis distance, Cook's distance, the leverage value, standarized values for the Dffits (to measure the influence of a given observation on the predicted response) and the Dfbetas (to measure the influence of a given observation on the calculated coefficients) were also used to build a general picture of the influence of individual points. Plots were made of the standardized Dffits value for each model against the Dfbeta values for each predictor in the model. Points which were extreme indicated observations which had strong effects on both predicted values and coefficient estimates.

### 1.2.2 Variable Selection

For each regression, residuals were plotted against each of the independent variables to look for nonlinear relationships between the response variable and individual predictors. Partial residual plots were

[1] The following discussion, prepared by Jacqueline Kiffe, was taken from Seatrout Harvests in Galveston Bay: A Regression Analysis, by F. Michael Speed, Sr. and Jacqueline Kiffe.

employed to examine the overall relationship between the response and individual predictors. A partial residual is a corollary to the deleted residual. That is, the model is fitted without a given variable and the predicted response and corresponding residual are calculated for each observation. This seeks to answer the question, "What is the relationship of this predictor to the response variable, taking all other variables into account?" Thus, it examines the marginal relationship of a given predictor to the response.

Numerous measures have been developed over the years to assess the adequacy of a given model. We examined a number of these, including $R^2$ and mean squared error (MSE), and several others which directly incorporate penalties for having too many predictors in the model, such as adjusted $R^2$, $C_p$, AIC, and SBC. It is well-established that too many predictors in a model can lead to bad prediction, just as too few can, and these measures are used as part of the attempt to find an optimal model.

### 1.2.3 Multicollinearity

Multicollinearity arises when one or more variables are nearly closely approximated by linear combinations of the remaining variables, resulting in unstable coefficient estimates. The variance inflation factor (VIF) was calculated for each coefficient estimate to measure this instability, which is not usually considered profound for VIF's less than 10. No problems were found with this data. Additionally, the condition index (a ratio of eigenvalues of the covariance matrix, with the largest eigenvalue always on top) was calculated. A ratio greater than 30 is considered cause for concern. Again, no evidence of multicollinearity was found.

### 1.2.4 Other Procedures

Several other miscellaneous diagnostics, including the Durbin-Watson test for serial autocorrelation were performed, and no general problems were detected. The Box-Cox procedure, used to find a transformation to normality, was also performed.

## 1.3 How the Final Model Was Chosen

### 1.3.1 Selecting the Data Set Used

First, the variables were explored thoroughly, individually and in pairs, in a first effort to detect outliers. The SAS programming language allows a number of diagnostics to be calculated for a group of models on a given data set without actually performing a formal regression, thus allowing one to examine a large number of models quite efficiently. The Box-Cox procedure was performed to find if a transformation to normality was suggested. The log transform was suggested for some variables, and the square root for others. At this point, there were several data sets for which the diagnostic series was calculated:

1. Untransformed data.
2. Harvest untransformed, and natural log of inflow variables.
3. All variables logged.
4. Harvest untransformed, and square root of inflows variables.
5. All variables square root.
6. Logged and square root variables.
7. Harvest untransformed, and logged and square root inflows.
8. Harvest and inflows variables transformed according to Box-Cox suggestion.

### 1.3.2 Selecting the Points to be Omitted

The full regression with all diagnostics was performed for these models, each one contained all variables in its corresponding data set. All diagnostics were generated, and influential points were determined for each model.

Table 1.1 R-Square and Adjusted R-Square values for the different suggested models.

| Data Set | $R^2$ | Adjusted $R^2$ |
|---|---|---|
| 1 | 0.2142 | 0.0329 |
| **2** | **0.2446** | **0.0703** |
| **3** | **0.2812** | **0.1154** |
| 4 | 0.2287 | 0.0507 |
| **5** | **0.2300** | **0.0522** |
| **6** | **0.2790** | **0.1126** |
| 7 | 0.2420 | 0.0671 |
| **8** | **0.2481** | **0.0745** |

Data set 3 presented the highest $R^2$ values. However , the models 2, 3, 5, 6 and 8 were considered as final candidates. The observations flagged as potentially influential are given in the summary table below, for each model.

Table 1.2 Summary of points flagged by 99% Prediction Ellipse.

| Year | Variable |
|---|---|
| 1968 | Harvest vs. Jan-Feb, Harvest vs. Sept-Oct, Jan-Feb vs. Mar-Apr, Jan-Feb vs. May-Jun, Jan-Feb vs. Jul-Aug, Jan-Feb vs. Sept-Oct, Jan-Feb vs. Nov-Dec, Mar-Apr vs. Sept-Oct, May-Jun vs. Sept-Oct, Jul-Aug vs. Sept-Oct, Sept-Oct vs. Nov-Dec. |
| 1971 | Harvest vs. Jul-Aug, Jan-Feb vs. Jul-Aug, Mar-Apr vs. Jul-Aug, May-Jun vs. Jul-Aug, Jul-Aug vs. Sept-Oct, Jul-Aug vs. Nov-Dec. |
| 1972 | Harvest vs. Sept-Oct, Jan-Feb vs. Sept-Oct, Mar-Apr vs. Sept-Oct, May-Jun vs. Sept-Oct, Jul-Aug vs. Sept-Oct, Sept-Oct vs. Nov-Dec. |
| 1977 | Harvest vs. Mar-Apr, Harvest vs. Nov-Dec, Jan-Feb vs. Mar-Apr, Jan-Feb vs. Nov-Dec, Mar-Apr vs. May-Jun, Mar-Apr vs. Jul-Aug, Mar-Apr vs. Sept-Oct, Mar-Apr vs. Nov-Dec, May-Jun vs. Nov-Dec, Jul-Aug vs. Nov-Dec, Sept-Oct vs. Nov-Dec. |
| 1981 | Harvest vs. May-Jun, Jan-Feb vs. May-Jun, Mar-Apr vs. May-Jun, May-Jun vs. Jul-Aug, May-Jun vs. Sept-Oct, May-Jun vs. Nov-Dec. |
| 1984 | Harvest vs. May-Jun. |
| 1992 | Harvest vs. Jan-Feb, Harvest vs. Mar-Apr, Jan-Feb vs. Mar-Apr, Jan-Feb vs. May-Jun, Jan-Feb vs. Jul-Aug, Jan-Feb vs. Sept-Oct, Jan-Feb vs. Nov-Dec, Mar-Apr vs. May-Jun, Mar-Apr vs. Jul-Aug, Mar-Apr vs. Sept-Oct, Mar-Apr vs. Nov-Dec. |

Table 1.3 Summary of points flagged by Boxplots.

| Year | Variable |
|---|---|
| 1965 | Jan-Feb Inflows |
| 1968 | Jan-Feb, Ln (Jan-Feb), SQRT (Jan-Feb), Sept-Oct, SQRT (Sept-Oct) Inflows |
| 1970 | Nov-Dec, SQRT (Nov-Dec) Inflows |
| 1971 | Jul-Aug, SQRT (Jul-Aug) Inflows |
| 1972 | Sept-Oct, SQRT (Sept-Oct), Nov-Dec Inflows |
| 1974 | Sept-Oct, SQRT (Sept-Oct) Inflows |
| 1976 | Jul-Aug Inflows |
| 1977 | Jan-Feb, SQRT (Jan-Feb), Mar-Apr, Ln (Mar-Apr), SQRT (Mar-Apr), Nov-Dec, Ln (Nov-Dec), SQRT (Nov-Dec) Inflows |
| 1980 | Jul-Aug, SQRT (Jul-Aug) Inflows |
| 1981 | May-Jun, Jul-Aug Inflows |
| 1982 | Jan-Feb Inflows |
| 1984 | Harvest, SQRT (Harvest) |
| 1986 | Nov-Dec, SQRT (Nov-Dec) Inflows |
| 1987 | Jan-Feb, May-Jun Inflows |
| 1990 | Harvest, Jul-Aug Inflows |
| 1992 | Harvest, Jan-Feb, Ln (Jan-Feb), SQRT (Jan-Feb), Mar-Apr, SQRT (Mar-Apr) Inflows |

Table 1.4 Summary of points flagged by diagnostic measures.

| YEAR | BOX | SRE | SDR | LEV | MAH | COO | SDF | SDB | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| **DATA SET 2** | | | | | | | | | |
| 1968 | 1 | | | | | | | | 1 |
| 1971 | | | | | | | 1 | 1 | 2 |
| 1977 | 2 | | | | | | | | 2 |
| 1979 | | | | | | | 1 | | 1 |
| **1984** | **1** | **1** | **1** | | | | **1** | **1** | **5** |
| 1990 | | | | | | | 1 | | 1 |
| 1992 | 2 | | | | | | | | 2 |
| **Data Set 3** | | | | | | | | | |
| 1968 | 1 | | | | | | | | 1 |
| **1971** | | | | | | | **1** | **2** | **3** |
| 1977 | 2 | | | | | | | | 2 |
| 1984 | | | 1 | | | | 1 | | 2 |
| 1992 | 1 | | | | | | | | 1 |

Table 1.4 Summary of points flagged by diagnostic measures (continued).

| | BOX | SRE | SDR | LEV | MAH | COO | SDF | SDB | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| **Data Set 5** | | | | | | | | | |
| 1968 | 2 | | | 1 | | | | | 3 |
| 1970 | 1 | | | | | | | | 1 |
| 1971 | 1 | | | 1 | | | 1 | 1 | 4 |
| 1972 | 1 | | | | | | | | 1 |
| **1977** | **3** | | | **1** | **1** | | **1** | | **6** |
| 1980 | 1 | | | | | | | | 1 |
| 1984 | 1 | | 1 | | | | 1 | | 3 |
| 1986 | 1 | | | | | | | | 1 |
| 1992 | 2 | | | 1 | 1 | | | | 4 |
| **Data Set 6** | | | | | | | | | |
| 1968 | 2 | | | 1 | | | | | 3 |
| 1970 | 1 | | | | | | | | 1 |
| 1971 | | | | | | | 1 | 2 | 3 |
| 1972 | 1 | | | | | | | | 1 |
| 1974 | 1 | | | | | | | | 1 |
| **1977** | **3** | | | **1** | **1** | | | | **5** |
| 1984 | | | 1 | | | | 1 | | 2 |
| 1986 | 1 | | | | | | 1 | | 2 |
| **1992** | **2** | | | **1** | **1** | | | | **4** |
| **Data Set 8** | | | | | | | | | |
| **1971** | | | | | | | **1** | **2** | **3** |
| 1984 | | | 1 | | | | 1 | | 2 |
| 1990 | | | | | | | 1 | | 1 |

Key to Abbreviations:
**BOX** Box plot
**SRE** Studentized residual
**SDR** Studentized deleted residual
**LEV** Leverage value
**MAH** Mahalanobis distance
**COO** Cook's distance
**SDF** Standardized Dffits value
**SDB** Standardized Dfbeta value

### 1.3.3 Selecting the Final Candidate Models

After the subset analysis led us to the models: Data Set 2 (logged Inflows) 1984 omitted; Data Set 3 (all variables logged) 1971, 1977, and/or 1984 omitted; Data Set 5 (all variables square root) 1977 omitted;Data Set 6 (logged and square root variables) 1977 and/or 1992 omitted; and Data Set 8 (variables transformed according to the Box-Cox analysis) 1971 omitted.

Table 1.5 R-Square and Adjusted R-Square values for the different subsets.

| Data Set | Observations omitted | $R^2$ | Adjusted $R^2$ |
|---|---|---|---|
| **2** | **1984** | **0.3992** | **0.2550** |
| 3 | 1971 | 0.2909 | 0.1208 |
| | 1977 | 0.2840 | 0.1121 |
| | 1984 | 0.3843 | 0.2365 |
| | 1971 and 1977 | 0.2880 | 0.1100 |
| | **1971 and 1984** | **0.4214** | **0.2768** |
| 5 | 1977 | 0.2434 | 0.0618 |
| 6 | 1977 | 0.2834 | 0.1120 |
| | 1992 | 0.2224 | 0.0358 |
| | 1977 and 1992 | 0.2339 | 0.0423 |
| 8 | 1971 | 0.2578 | 0.0797 |

### 1.3.4 Selecting the Final Model

It is clear that Data Set 3 with 1971 and 1984 omitted is the best model, followed by Model 2 with 1984 omitted. Regression was performed for both models, and the deleted residuals were calculated.

| First Best Candidate Model | $R^2$ | Adjusted $R^2$ | Prob>F |
|---|---|---|---|
| Ln (White Shrimp Harvest) = 4.309 + 0.299*Ln(Mar-Apr Inflows) + 0.083*Ln (May-Jun Inflows) +0.192*Ln(Jul-Aug Inflows) - 0.044*Ln(Sept-Oct Inflows) | 0.421 | 0.331 | 0.005 |

| Second Best Candidate Model | $R^2$ | Adjusted $R^2$ | Prob>F |
|---|---|---|---|
| White Shrimp Harvest = - 175.725 + 159.846*Ln(Mar-Apr Inflows) + 50.271*Ln(May-Jun Inflows) + 44.432*Ln(Jul-Aug Inflows) - 42.909*Ln(Sept-Oct Inflows) | 0.391 | 0.301 | 0.008 |

## 1.4 First Best Model: Logged All Variables

### 1.4.1 Summary Information

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| Ln (White Shrimp Harvest) | 6.031264 | .655370 | 31 |
| Ln (March-April Inflows) | 2.899653 | 1.029147 | 31 |
| Ln (May-June Inflows) | 4.306057 | 1.506144 | 31 |
| Ln (July-August Inflows) | 3.500712 | 1.181042 | 31 |
| Ln (September-October Inflows) | 3.900671 | 1.521961 | 31 |

**Model Summary[a,b]**

| Model | Variables | | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| | Entered | Removed | | | | | |
| 1 | Ln(Sept-Oct Inflows), Ln(Jul-Aug Inflows), Ln(Mar-Apr Inflows), Ln(May-Jun Inflows)[c,d] | . | .648 | .421 | .331 | .535888 | 2.417 |

a. Dependent Variable: Ln (White Shrimp Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Ln (September-October Inflows), Ln (July-August Inflows), Ln (March-April Inflows), Ln (May-June Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 5.419 | 4 | 1.355 | 4.717 | .005[b] |
| | Residual | 7.467 | 26 | .287 | | |
| | Total | 12.885 | 30 | | | |

a. Dependent Variable: Ln (White Shrimp Harvest)

b. Independent Variables: (Constant), Ln (September-October Inflows), Ln (July-August Inflows), Ln (March-April Inflows), Ln (May-June Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. | 95% Confidence Interval for B Lower Bound | 95% Confidence Interval for B Upper Bound |
|---|---|---|---|---|---|---|---|---|
| 1 | (Constant) | 4.309 | .495 | | 8.699 | .000 | 3.291 | 5.327 |
| | Ln (March-April Inflows) | .299 | .125 | .469 | 2.398 | .024 | .043 | .555 |
| | Ln (May-June Inflows) | 8.3E-02 | .099 | .191 | .845 | .406 | -.119 | .286 |
| | Ln (July-August Inflows) | .192 | .110 | .345 | 1.749 | .092 | -.034 | .417 |
| | Ln (September-October Inflows) | -4.4E-02 | .071 | -.103 | -.629 | .535 | -.190 | .101 |

a. Dependent Variable: Ln (White Shrimp Harvest)

**Residuals Statistics[a]**

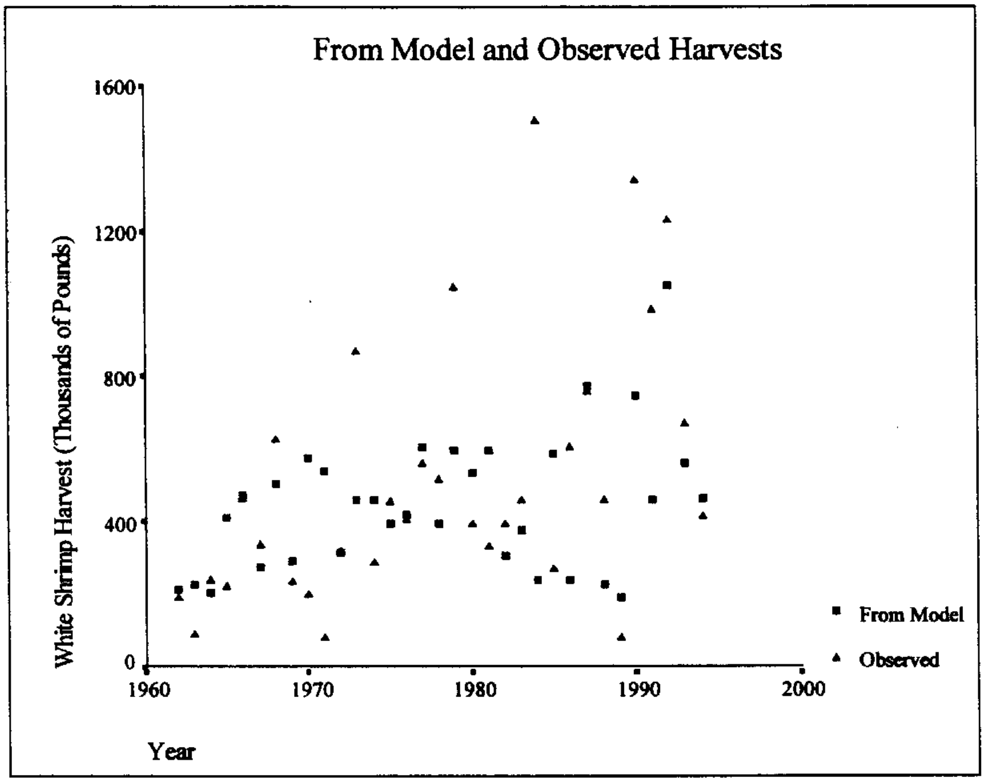
| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 5.273095 | 6.961130 | 6.031264 | .424998 | 31 |
| Std. Predicted Value | -1.784 | 2.188 | .000 | 1.000 | 31 |
| Standard Error of Predicted Value | .120721 | .364130 | .206833 | 6.0E-02 | 31 |
| Adjusted Predicted Value | 5.316638 | 6.896628 | 6.038573 | .427282 | 31 |
| Residual | -1.028817 | .913299 | 4.0E-16 | .498885 | 31 |
| Std. Residual | -1.920 | 1.704 | .000 | .931 | 31 |
| Stud. Residual | -1.977 | 1.816 | -.005 | 1.004 | 31 |
| Deleted Residual | -1.091500 | 1.036553 | -7.3E-03 | .584765 | 31 |
| Stud. Deleted Residual | -2.104 | 1.905 | -.011 | 1.032 | 31 |
| Mahal. Distance | .555 | 12.883 | 3.871 | 2.929 | 31 |
| Cook's Distance | .000 | .237 | .035 | .053 | 31 |
| Centered Leverage Value | .018 | .429 | .129 | .098 | 31 |

a. Dependent Variable: Ln (White Shrimp Harvest)

Table 1.6 Observed, predicted, lower and upper predicted intervals values for white shrimp harvest.

| Year | Observed[a] | Predicted[a] | LICI | UICI |
|---|---|---|---|---|
| **1962** | 196.70 | 216.19 | 44.55 | 1049.22 |
| **1963** | 95.80 | 229.87 | 46.88 | 1127.20 |
| **1964** | 242.90 | 209.39 | 42.21 | 1038.68 |
| **1965** | 226.70 | 415.08 | 85.28 | 2020.21 |
| **1966** | 469.90 | 477.39 | 90.26 | 2525.09 |
| **1967** | 343.70 | 279.32 | 58.87 | 1325.26 |
| **1968** | 633.70 | 508.46 | 97.28 | 2657.73 |
| **1969** | 238.50 | 297.63 | 63.09 | 1404.12 |
| **1970** | 206.80 | 578.58 | 125.13 | 2675.28 |
| **1971** | 84.10 | 544.57 | 76.71 | 3827.63 |
| **1972** | 324.80 | 319.93 | 59.59 | 1717.63 |
| **1973** | 873.00 | 462.13 | 94.61 | 2257.28 |
| **1974** | 292.00 | 463.34 | 76.57 | 2803.93 |
| **1975** | 461.10 | 398.58 | 82.26 | 1931.35 |
| **1976** | 410.30 | 425.37 | 85.87 | 2107.09 |
| **1977** | 568.00 | 607.83 | 107.17 | 3447.31 |
| **1978** | 521.70 | 398.09 | 83.47 | 1898.58 |
| **1979** | 1052.90 | 600.44 | 127.14 | 2835.63 |
| **1980** | 400.80 | 539.71 | 102.85 | 2832.03 |
| **1981** | 336.50 | 599.54 | 118.77 | 3026.35 |
| **1982** | 400.10 | 309.65 | 63.13 | 1518.75 |
| **1983** | 466.10 | 379.80 | 79.25 | 1820.24 |
| **1984** | 1511.10 | 242.26 | 51.42 | 1152.86 |
| **1985** | 274.70 | 592.36 | 127.22 | 2758.09 |
| **1986** | 611.10 | 245.17 | 50.75 | 1184.51 |
| **1987** | 764.30 | 776.44 | 157.84 | 3819.36 |
| **1988** | 463.40 | 229.10 | 47.92 | 1095.32 |
| **1989** | 88.10 | 195.02 | 39.26 | 968.72 |
| **1990** | 1344.90 | 749.61 | 136.07 | 4129.52 |
| **1991** | 990.20 | 462.54 | 100.19 | 2135.45 |
| **1992** | 1238.50 | 1054.82 | 194.82 | 5711.27 |
| **1993** | 675.50 | 566.95 | 121.88 | 2637.30 |
| **1994** | 421.50 | 468.16 | 101.74 | 2154.27 |

[a] White shrimp harvest (thousands of pounds).
LICI Lower limit for 99% prediction interval for white shrimp harvest.
UICI Upper limit for 99% prediction interval for white shrimp harvest.



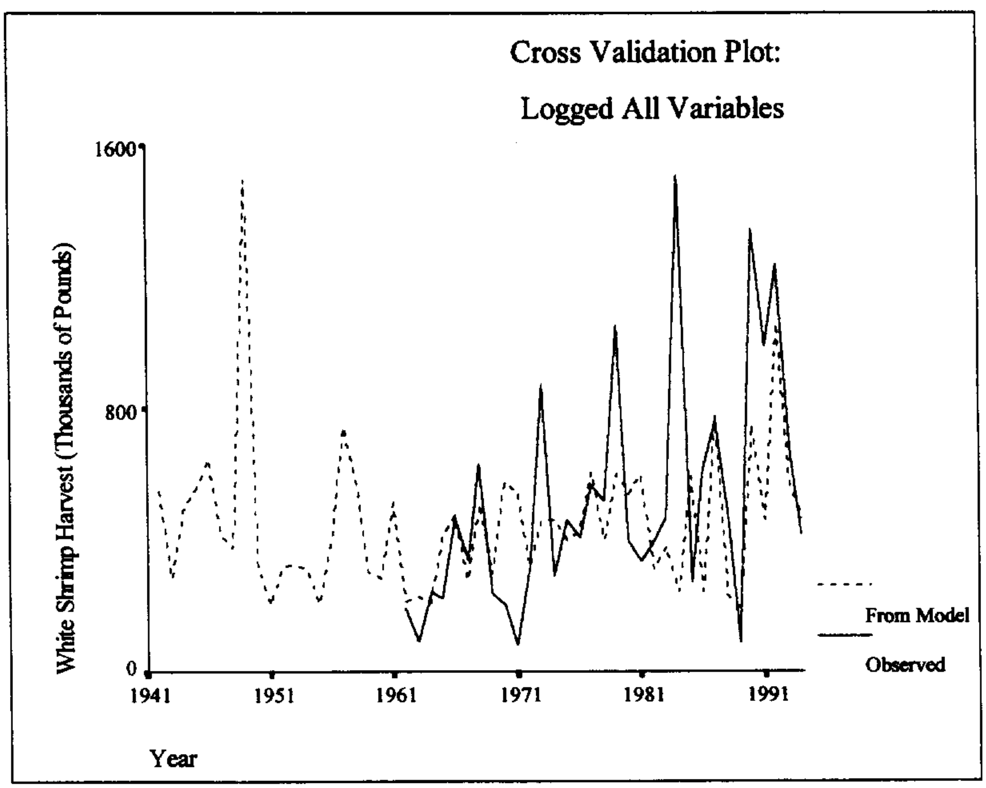




Fig. 1.1 Comparative plots of observed values vs. calculated from the regression model.

## 1.5 Second Best Model: Logged Inflows

### 1.5.1 Summary Information

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| White Shrimp Harvest | 491.1969 | 320.5747 | 32 |
| Ln (March-April Inflows) | 2.875059 | 1.021927 | 32 |
| Ln (May-June Inflows) | 4.242400 | 1.524784 | 32 |
| Ln (July-August Inflows) | 3.602463 | 1.296600 | 32 |
| Ln (September-October Inflows) | 3.868130 | 1.508486 | 32 |

**Model Summary**[a,b]

| Model | Variables | | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| | Entered | Removed | | | | | |
| 1 | Ln(Sept-Oct Inflows), Ln(Jul-Aug Inflows), Ln(Mar-Apr Inflows), Ln(May-Jun Inflows)[c,d] | . | .625 | .391 | .301 | 268.0604 | 1.693 |

a. Dependent Variable: White Shrimp Harvest

b. Method: Enter

c. Independent Variables: (Constant), Ln (September-October Inflows), Ln (July-August Inflows), Ln (March-April Inflows), Ln (May-June Inflows)

d. All requested variables entered.

**ANOVA**[a]

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 1245692 | 4 | 311423 | 4.334 | .008[b] |
| | Residual | 1940122 | 27 | 71856.4 | | |
| | Total | 3185813 | 31 | | | |

a. Dependent Variable: White Shrimp Harvest

b. Independent Variables: (Constant), Ln (September-October Inflows), Ln (July-August Inflows), Ln (March-April Inflows), Ln (May-June Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. | 95% Confidence Interval for B Lower Bound | 95% Confidence Interval for B Upper Bound |
|---|---|---|---|---|---|---|---|---|
| 1 | (Constant) | -175.725 | 239.281 | | -.734 | .469 | -666.690 | 315.240 |
| | Ln (Mar-Apr Inflows) | 159.846 | 59.727 | .510 | 2.676 | .012 | 37.297 | 282.395 |
| | Ln (May-Jun Inflows) | 50.271 | 42.898 | .239 | 1.172 | .251 | -37.749 | 138.291 |
| | Ln (Jul-Aug Inflows) | 44.432 | 43.690 | .180 | 1.017 | .318 | -45.214 | 134.077 |
| | Ln (Sept-Oct Inflows) | -42.909 | 35.276 | -.202 | -1.216 | .234 | -115.289 | 29.471 |

a. Dependent Variable: White Shrimp Harvest

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 153.4896 | 1010.840 | 491.1969 | 200.4585 | 32 |
| Std. Predicted Value | -1.685 | 2.592 | .000 | 1.000 | 32 |
| Standard Error of Predicted Value | 60.0552 | 173.5867 | 101.8580 | 29.6648 | 32 |
| Adjusted Predicted Value | 165.5857 | 922.4034 | 498.2933 | 206.4570 | 32 |
| Residual | -440.5810 | 606.8370 | -2.E-13 | 250.1691 | 32 |
| Std. Residual | -1.644 | 2.264 | .000 | .933 | 32 |
| Stud. Residual | -1.809 | 2.563 | -.011 | 1.027 | 32 |
| Deleted Residual | -636.2773 | 777.7081 | -7.0964 | 306.5470 | 32 |
| Stud. Deleted Residual | -1.893 | 2.891 | -.001 | 1.072 | 32 |
| Mahal. Distance | .587 | 12.031 | 3.875 | 2.917 | 32 |
| Cook's Distance | .000 | .473 | .049 | .103 | 32 |
| Centered Leverage Value | .019 | .388 | .125 | .094 | 32 |

a. Dependent Variable: White Shrimp Harvest

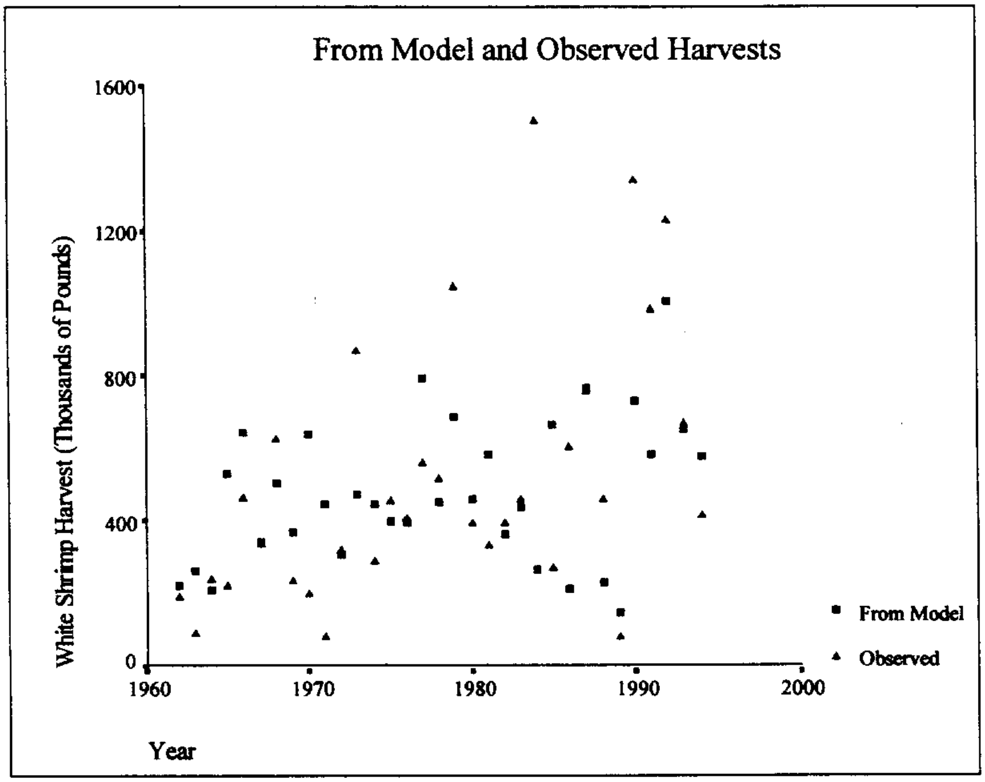
Table 1.7 Observed, predicted, lower and upper prediction intervals values for white shrimp harvest.

| Year | Observed[a] | Predicted[a] | LICI | UICI |
|---|---|---|---|---|
| **1962** | 196.70 | 226.71964 | .00000 | 1014.57995 |
| **1963** | 95.80 | 266.85778 | .00000 | 1059.89495 |
| **1964** | 242.90 | 213.06601 | .00000 | 1011.74764 |
| **1965** | 226.70 | 535.92403 | .00000 | 1316.69440 |
| **1966** | 469.90 | 651.37736 | .00000 | 1471.09189 |
| **1967** | 343.70 | 345.88716 | .00000 | 1122.15256 |
| **1968** | 633.70 | 511.14426 | .00000 | 1336.03157 |
| **1969** | 238.50 | 372.25019 | .00000 | 1145.00581 |
| **1970** | 206.80 | 647.38100 | .00000 | 1411.11777 |
| **1971** | 84.10 | 453.55985 | .00000 | 1338.39602 |
| **1972** | 324.80 | 311.88176 | .00000 | 1147.05379 |
| **1973** | 873.00 | 477.50320 | .00000 | 1268.54933 |
| **1974** | 292.00 | 451.30708 | .00000 | 1318.73270 |
| **1975** | 461.10 | 401.86179 | .00000 | 1188.88092 |
| **1976** | 410.30 | 398.78425 | .00000 | 1186.30894 |
| **1977** | 568.00 | 800.79284 | .00000 | 1661.54935 |
| **1978** | 521.70 | 456.67301 | .00000 | 1235.64117 |
| **1979** | 1052.90 | 695.84793 | .00000 | 1469.45968 |
| **1980** | 400.80 | 466.67661 | .00000 | 1275.22572 |
| **1981** | 336.50 | 587.30788 | .00000 | 1394.73293 |
| **1982** | 400.10 | 367.53605 | .00000 | 1153.28001 |
| **1983** | 466.10 | 444.52058 | .00000 | 1216.70290 |
| **1984** | 1511.10 | 272.05901 | .00000 | 1050.03696 |
| **1985** | 274.70 | 673.07827 | .00000 | 1439.82480 |
| **1986** | 611.10 | 219.03812 | .00000 | 1004.46491 |
| **1987** | 764.30 | 772.11753 | .00000 | 1566.08541 |
| **1988** | 463.40 | 236.32167 | .00000 | 1016.64500 |
| **1989** | 88.10 | 153.48962 | .00000 | 952.06969 |
| **1990** | 1344.90 | 738.06295 | .00000 | 1558.31609 |
| **1991** | 990.20 | 587.66033 | .00000 | 1350.62930 |
| **1992** | 1238.50 | 1010.83978 | .00000 | 1853.26777 |
| **1993** | 675.50 | 659.99597 | .00000 | 1426.72660 |
| **1994** | 421.50 | 582.83549 | .00000 | 1343.95671 |

[a] White shrimp harvest (thousands of pounds).

LICI Lower limit for 99% prediction interval for white shrimp harvest.

UICI Upper limit for 99% prediction interval for white shrimp harvest.



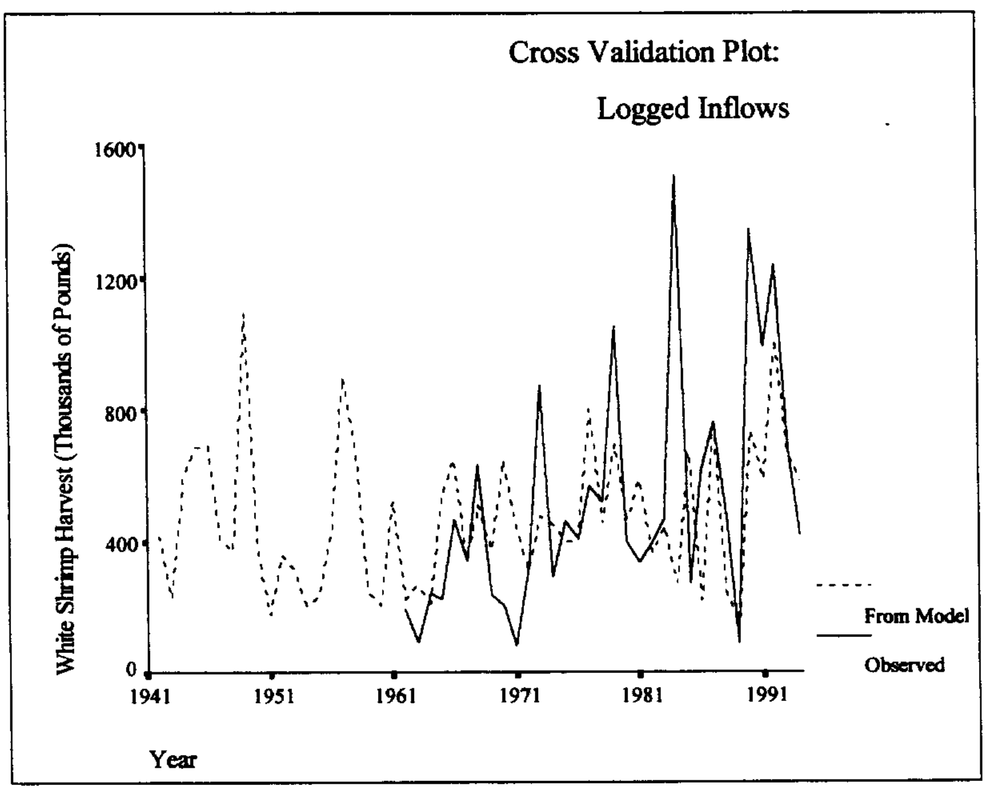




Fig. 1.2 Comparative plots of observed values vs. calculated from the regression model.

# 2. Exploring the Data

## 2.1 Listing of Data

Table 2.1. White shrimp harvest and water inflows data.

| Obs. | YEAR | WHITE SHRIMP | JF_LAG | MA_LAG | MJ_LAG | JA_LAG | SO_LAG | ND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | **1962** | 196.70 | 6.81 | 7.24 | 8.32 | 9.04 | 15.76 | 8.51 |
| 2 | **1963** | 95.80 | 6.06 | 7.11 | 8.59 | 10.46 | 6.98 | 4.16 |
| 3 | **1964** | 242.90 | 3.59 | 5.56 | 6.26 | 10.83 | 7.00 | 3.69 |
| 4 | **1965** | 226.70 | 70.52 | 33.82 | 209.10 | 10.81 | 191.73 | 21.41 |
| 5 | **1966** | 469.90 | 6.91 | 23.41 | 283.86 | 16.32 | 7.24 | 5.97 |
| 6 | **1967** | 343.70 | 6.85 | 10.18 | 13.39 | 14.88 | 10.21 | 9.24 |
| 7 | **1968** | 633.70 | 255.96 | 29.51 | 360.64 | 52.37 | 1994.55 | 37.71 |
| 8 | **1969** | 238.50 | 12.98 | 15.69 | 12.70 | 12.98 | 22.58 | 7.11 |
| 9 | **1970** | 206.80 | 16.83 | 30.92 | 261.71 | 49.57 | 64.36 | 124.43 |
| 10 | **1971** | 84.10 | 8.47 | 8.27 | 9.67 | 859.85 | 17.45 | 8.67 |
| 11 | **1972** | 324.80 | 39.77 | 13.17 | 172.06 | 21.99 | 1756.35 | 101.64 |
| 12 | **1973** | 873.00 | 8.85 | 7.13 | 286.16 | 133.35 | 44.15 | 11.21 |
| 13 | **1974** | 292.00 | 22.75 | 36.90 | 16.70 | 66.62 | 648.60 | 80.02 |
| 14 | **1975** | 461.10 | 26.13 | 8.11 | 222.72 | 77.49 | 176.70 | 21.67 |
| 15 | **1976** | 410.30 | 2.82 | 5.16 | 78.13 | 234.60 | 32.51 | 3.95 |
| 16 | **1977** | 568.00 | 82.51 | 301.21 | 147.52 | 3.28 | 266.62 | 388.53 |
| 17 | **1978** | 521.70 | 6.00 | 7.51 | 91.13 | 67.64 | 11.28 | 9.12 |
| 18 | **1979** | 1052.90 | 13.93 | 60.61 | 268.93 | 24.31 | 126.01 | 8.39 |
| 19 | **1980** | 400.80 | 20.84 | 6.54 | 154.18 | 516.71 | 81.14 | 7.09 |
| 20 | **1981** | 336.50 | 14.37 | 10.02 | 723.72 | 219.16 | 60.20 | 14.06 |
| 21 | **1982** | 400.10 | 58.47 | 14.06 | 115.43 | 12.14 | 207.42 | 78.86 |
| 22 | **1983** | 466.10 | 13.05 | 13.28 | 17.27 | 45.21 | 11.75 | 13.32 |
| 23 | **1984** | 1511.10 | 32.09 | 11.17 | 15.01 | 8.72 | 52.99 | 19.23 |
| 24 | **1985** | 274.70 | 14.57 | 32.01 | 171.56 | 51.48 | 25.51 | 11.43 |
| 25 | **1986** | 611.10 | 16.04 | 8.33 | 18.37 | 16.81 | 152.81 | 135.69 |
| 26 | **1987** | 764.30 | 60.56 | 29.97 | 553.27 | 135.02 | 21.24 | 64.18 |
| 27 | **1988** | 463.40 | 9.07 | 7.26 | 9.92 | 12.08 | 21.12 | 18.64 |
| 28 | **1989** | 88.10 | 8.36 | 6.59 | 4.50 | 9.32 | 30.73 | 7.62 |
| 29 | **1990** | 1344.90 | 13.08 | 38.77 | 50.24 | 178.40 | 9.84 | 11.07 |
| 30 | **1991** | 990.20 | 11.70 | 35.02 | 73.08 | 19.10 | 34.40 | 7.59 |
| 31 | **1992** | 1238.50 | 312.50 | 270.26 | 499.44 | 27.64 | 50.53 | 70.60 |
| 32 | **1993** | 675.50 | 18.90 | 30.16 | 194.51 | 42.98 | 26.64 | 20.77 |
| 33 | **1994** | 421.50 | 15.51 | 32.14 | 69.02 | 23.52 | 32.44 | 26.81 |

**WHITE SHRIMP** White Shrimp harvest (thousands of pounds)
**JF_LAG** Lagged January-February inflows (thousands of acre-feet)
**MA_LAG** Lagged March-April inflows (thousands of acre-feet)
**MJ_LAG** Lagged May-June inflows (thousands of acre-feet)
**JA_LAG** Lagged July-August inflows (thousands of acre-feet)
**SO_LAG** Lagged September-October inflows (thousands of acre-feet)
**ND_LAG** Lagged November-December inflows (thousands of acre-feet)

## 2.2 Test of Normality for Individual Variables

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| White Shrimp Harvest | .194 | 33 | .003 | .878 | 33 | .010** |
| Ln (White Shrimp Harvest) | .090 | 33 | .200* | .962 | 33 | .414 |
| SQRT (White Shrimp Harvest) | .132 | 33 | .151 | .957 | 33 | .333 |
| January-February Inflows | .321 | 33 | .000 | .488 | 33 | .010** |
| Ln (January-February Inflows) | .151 | 33 | .055 | .926 | 33 | .040 |
| SQRT (January-February Inflows) | .247 | 33 | .000 | .700 | 33 | .010** |
| March-April Inflows | .387 | 33 | .000 | .433 | 33 | .010** |
| Ln (March-April Inflows) | .132 | 33 | .152 | .863 | 33 | .010** |
| SQRT (March-April Inflows) | .254 | 33 | .000 | .640 | 33 | .010** |
| May-June Inflows | .196 | 33 | .002 | .810 | 33 | .010** |
| Ln (May-June Inflows) | .164 | 33 | .024 | .912 | 33 | .016 |
| SQRT (May-June Inflows) | .180 | 33 | .008 | .914 | 33 | .017 |
| July-August Inflows | .319 | 33 | .000 | .524 | 33 | .010** |
| Ln (July-August Inflows) | .127 | 33 | .197 | .947 | 33 | .178 |
| SQRT (July-August Inflows) | .211 | 33 | .001 | .753 | 33 | .010** |
| September-October Inflows | .362 | 33 | .000 | .428 | 33 | .010** |
| Ln (September-October Inflows) | .134 | 33 | .139 | .919 | 33 | .024 |
| SQRT (September-October Inflows) | .258 | 33 | .000 | .645 | 33 | .010** |
| November-December Inflows | .307 | 33 | .000 | .534 | 33 | .010** |
| Ln (November-December Inflows) | .148 | 33 | .063 | .919 | 33 | .025 |
| SQRT (November-December Inflows) | .256 | 33 | .000 | .756 | 33 | .010** |

**. This is an upper bound of the true significance.

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

## 2.3 Percentiles for Individual Variables

**Percentiles**

| | | Percentiles | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 10 | 25 | 50 | 75 | 90 | 95 |
| Weighted Average (Definition 1) | White Shrimp Harvest | 86.9000 | 136.1600 | 258.8000 | 421.5000 | 654.6000 | 1164.26 | 1394.76 |
| | Ln (White Shrimp Harvest) | 4.464533 | 4.850030 | 5.554165 | 6.043820 | 6.483514 | 7.056715 | 7.239030 |
| | SQRT (White Shrimp Harvest) | 9.321494 | 11.4826 | 16.0797 | 20.5306 | 25.5819 | 34.0948 | 37.3329 |
| | January-February Inflows | 3.3590 | 6.0240 | 8.4150 | 14.3700 | 29.1100 | 77.7140 | 272.9220 |
| | Ln (January-February Inflows) | 1.205728 | 1.795740 | 2.129994 | 2.665143 | 3.365814 | 4.350110 | 5.604896 |
| | SQRT (January-February Inflows) | 1.830096 | 2.454377 | 2.900846 | 3.790778 | 5.368277 | 8.809148 | 16.5024 |
| | March-April Inflows | 5.4400 | 6.5800 | 7.3850 | 13.2800 | 32.0750 | 51.8740 | 279.5450 |
| | Ln (March-April Inflows) | 1.693200 | 1.880964 | 1.999308 | 2.586259 | 3.468075 | 3.925735 | 5.631911 |
| | SQRT (March-April Inflows) | 2.332045 | 2.561245 | 2.717436 | 3.644173 | 5.663477 | 7.161766 | 16.7143 |
| | May-June Inflows | 5.7320 | 8.4280 | 14.2000 | 91.1300 | 242.2150 | 443.9200 | 604.4050 |
| | Ln (May-June Inflows) | 1.735149 | 2.131437 | 2.651612 | 4.512287 | 5.488576 | 6.083245 | 6.398414 |
| | SQRT (May-June Inflows) | 2.387796 | 2.903013 | 3.766755 | 9.546203 | 15.5506 | 21.0051 | 24.5358 |
| | July-August Inflows | 7.0660 | 9.1520 | 12.1100 | 24.3100 | 72.5850 | 228.4240 | 619.6520 |
| | Ln (July-August Inflows) | 1.872286 | 2.213661 | 2.494028 | 3.190888 | 4.282174 | 5.430650 | 6.400265 |
| | SQRT (July-August Inflows) | 2.610398 | 3.025143 | 3.479940 | 4.930517 | 8.513597 | 15.1116 | 24.7088 |
| | September-October Inflows | 6.9940 | 8.2800 | 16.6050 | 32.5100 | 139.4100 | 495.8060 | 1627.81 |
| | Ln (September-October Inflows) | 1.945052 | 2.102355 | 2.808407 | 3.481548 | 4.932776 | 6.119219 | 7.509147 |
| | SQRT (September-October Inflows) | 2.644617 | 2.869186 | 4.073603 | 5.701754 | 11.7935 | 21.8120 | 42.7343 |
| | November-December Inflows | 3.8720 | 4.8840 | 8.0050 | 13.3200 | 50.9450 | 115.3140 | 211.5420 |
| | Ln (November-December Inflows) | 1.353289 | 1.570008 | 2.078906 | 2.589267 | 3.895808 | 4.742821 | 5.225972 |
| | SQRT (November-December Inflows) | 1.967504 | 2.201106 | 2.826492 | 3.649858 | 7.078044 | 10.7256 | 14.0874 |
| Tukey's Hinges | White Shrimp Harvest | | | 274.7000 | 421.5000 | 633.7000 | | |
| | Ln (White Shrimp Harvest) | | | 5.615680 | 6.043820 | 6.451576 | | |
| | SQRT (White Shrimp Harvest) | | | 16.5741 | 20.5306 | 25.1734 | | |
| | January-February Inflows | | | 8.4700 | 14.3700 | 26.1300 | | |
| | Ln (January-February Inflows) | | | 2.136531 | 2.665143 | 3.263084 | | |
| | SQRT (January-February Inflows) | | | 2.910326 | 3.790778 | 5.111751 | | |
| | March-April Inflows | | | 7.5100 | 13.2800 | 32.0100 | | |
| | Ln (March-April Inflows) | | | 2.016235 | 2.586259 | 3.466048 | | |
| | SQRT (March-April Inflows) | | | 2.740436 | 3.644173 | 5.657738 | | |
| | May-June Inflows | | | 15.0100 | 91.1300 | 222.7200 | | |
| | Ln (May-June Inflows) | | | 2.708717 | 4.512287 | 5.405915 | | |
| | SQRT (May-June Inflows) | | | 3.874274 | 9.546203 | 14.9236 | | |
| | July-August Inflows | | | 12.1400 | 24.3100 | 67.6400 | | |
| | Ln (July-August Inflows) | | | 2.496506 | 3.190888 | 4.214200 | | |
| | SQRT (July-August Inflows) | | | 3.484250 | 4.930517 | 8.224354 | | |
| | September-October Inflows | | | 17.4500 | 32.5100 | 126.0100 | | |
| | Ln (September-October Inflows) | | | 2.859340 | 3.481548 | 4.836361 | | |
| | SQRT (September-October Inflows) | | | 4.177320 | 5.701754 | 11.2254 | | |
| | November-December Inflows | | | 8.3900 | 13.3200 | 37.7100 | | |
| | Ln (November-December Inflows) | | | 2.127041 | 2.589267 | 3.629925 | | |
| | SQRT (November-December Inflows) | | | 2.896550 | 3.649858 | 6.140847 | | |

## 2.4 Summary Information for Individual Variables

### 2.4.1 Summary Information for White Shrimp Harvest

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| White Shrimp Harvest | Mean | | 522.1030 | 63.0243 |
| | 95% Confidence Interval for Mean | Lower Bound | 393.7268 | |
| | | Upper Bound | 650.4793 | |
| | 5% Trimmed Mean | | 495.0421 | |
| | Median | | 421.5000 | |
| | Variance | | 131078 | |
| | Std. Deviation | | 362.0469 | |
| | Minimum | | 84.10 | |
| | Maximum | | 1511.10 | |
| | Range | | 1427.00 | |
| | Interquartile Range | | 395.8000 | |
| | Skewness | | 1.244 | .409 |
| | Kurtosis | | 1.048 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| White Shrimp Harvest | Highest | 1 | 23 | 1984 | 1511.10 |
| | | 2 | 29 | 1990 | 1344.90 |
| | | 3 | 31 | 1992 | 1238.50 |
| | | 4 | 18 | 1979 | 1052.90 |
| | | 5 | 30 | 1991 | 990.20 |
| | Lowest | 1 | 10 | 1971 | 84.10 |
| | | 2 | 28 | 1989 | 88.10 |
| | | 3 | 2 | 1963 | 95.80 |
| | | 4 | 1 | 1962 | 196.70 |
| | | 5 | 9 | 1970 | 206.80 |

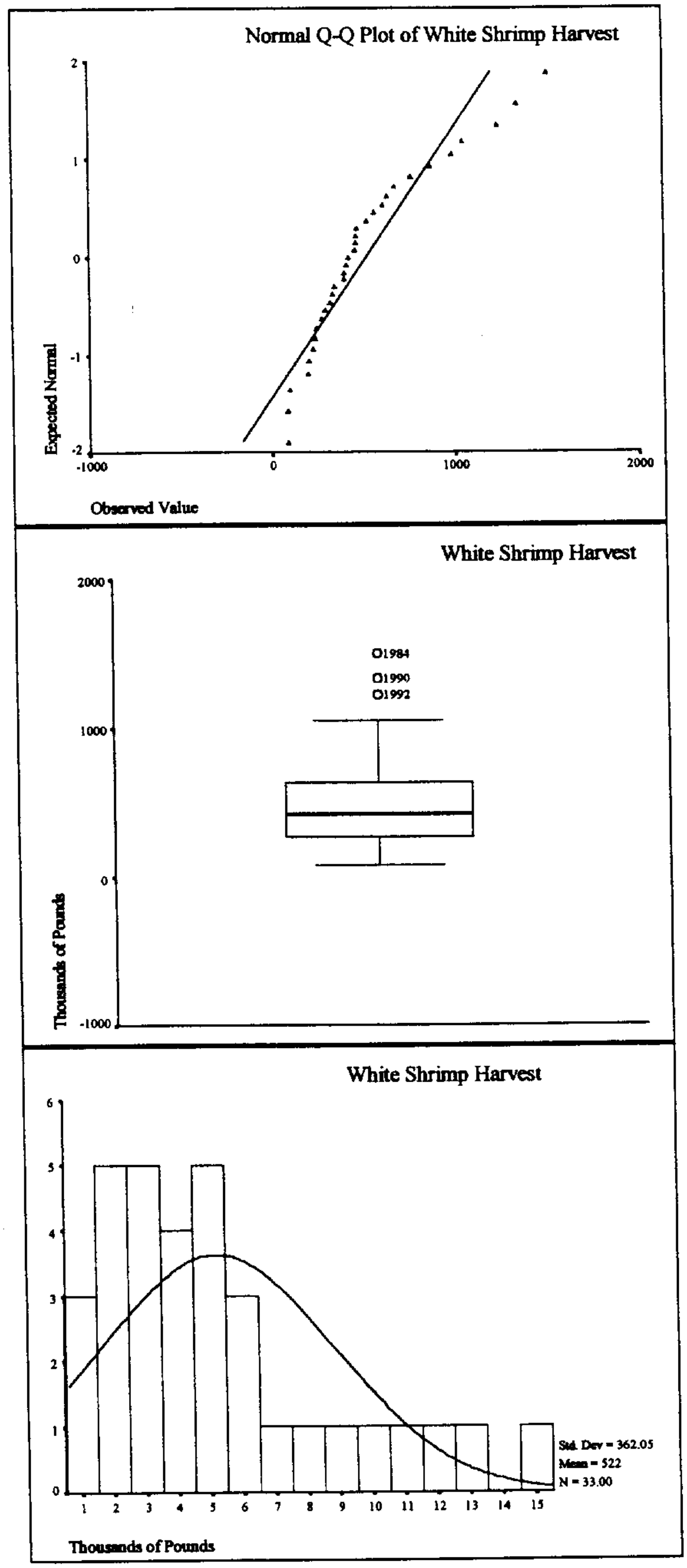



Fig. 2.1a. Exploratory Plots of White Shrimp Harvest.

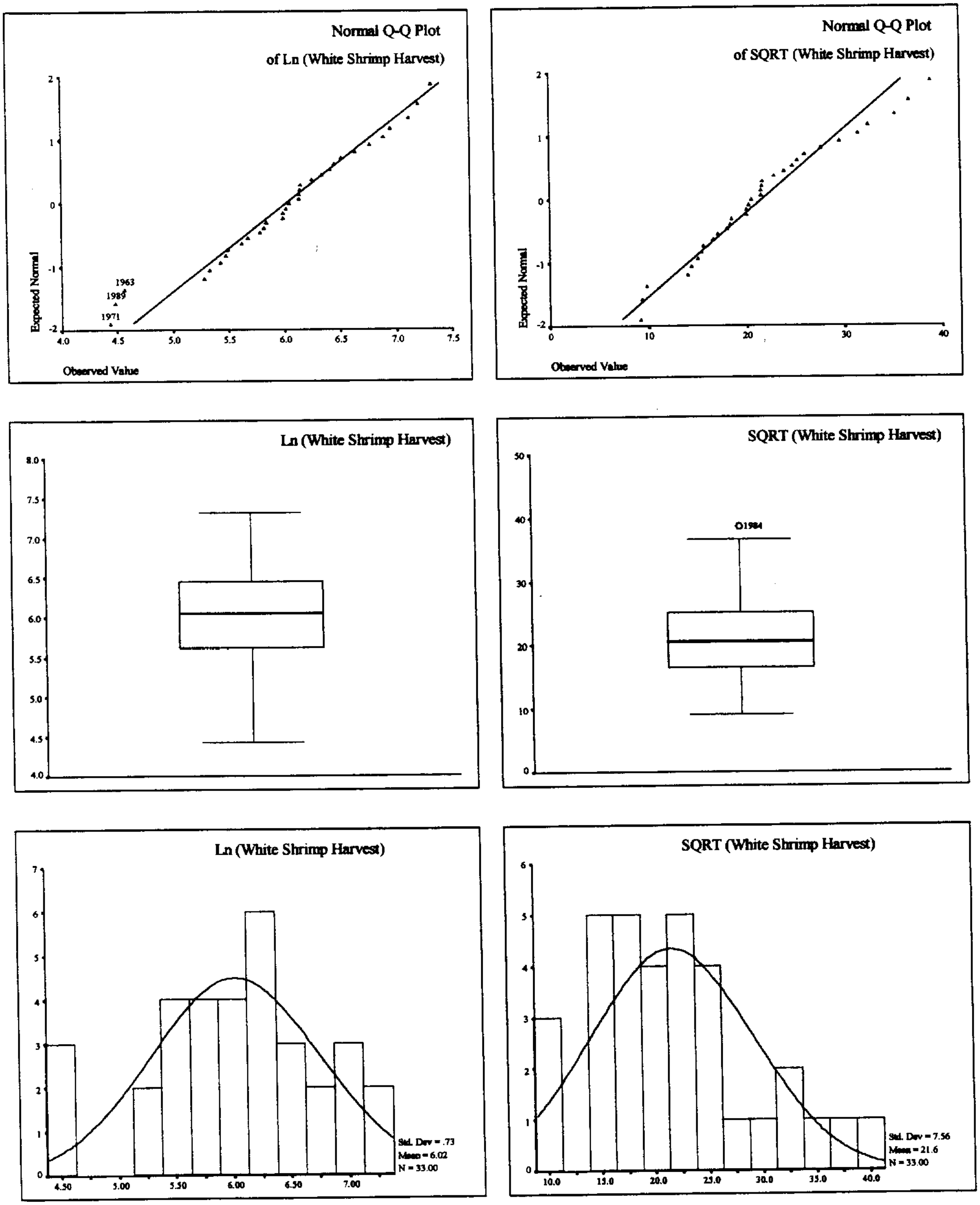



Fig. 2.1b. Exploratory Plots of Transformed White Shrimp Harvest.

### 2.4.2 Summary Information for January-February Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| January-February Inflows | Mean | | 36.8742 | 11.6916 |
| | 95% Confidence Interval for Mean | Lower Bound | 13.0591 | |
| | | Upper Bound | 60.6893 | |
| | 5% Trimmed Mean | | 24.6742 | |
| | Median | | 14.3700 | |
| | Variance | | 4510.917 | |
| | Std. Deviation | | 67.1634 | |
| | Minimum | | 2.82 | |
| | Maximum | | 312.50 | |
| | Range | | 309.68 | |
| | Interquartile Range | | 20.6950 | |
| | Skewness | | 3.423 | .409 |
| | Kurtosis | | 11.693 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| January-February Inflows | Highest | 1 | 31 | 1992 | 312.50 |
| | | 2 | 7 | 1968 | 255.96 |
| | | 3 | 16 | 1977 | 82.51 |
| | | 4 | 4 | 1965 | 70.52 |
| | | 5 | 26 | 1987 | 60.56 |
| | Lowest | 1 | 15 | 1976 | 2.82 |
| | | 2 | 3 | 1964 | 3.59 |
| | | 3 | 17 | 1978 | 6.00 |
| | | 4 | 2 | 1963 | 6.06 |
| | | 5 | 1 | 1962 | 6.81 |

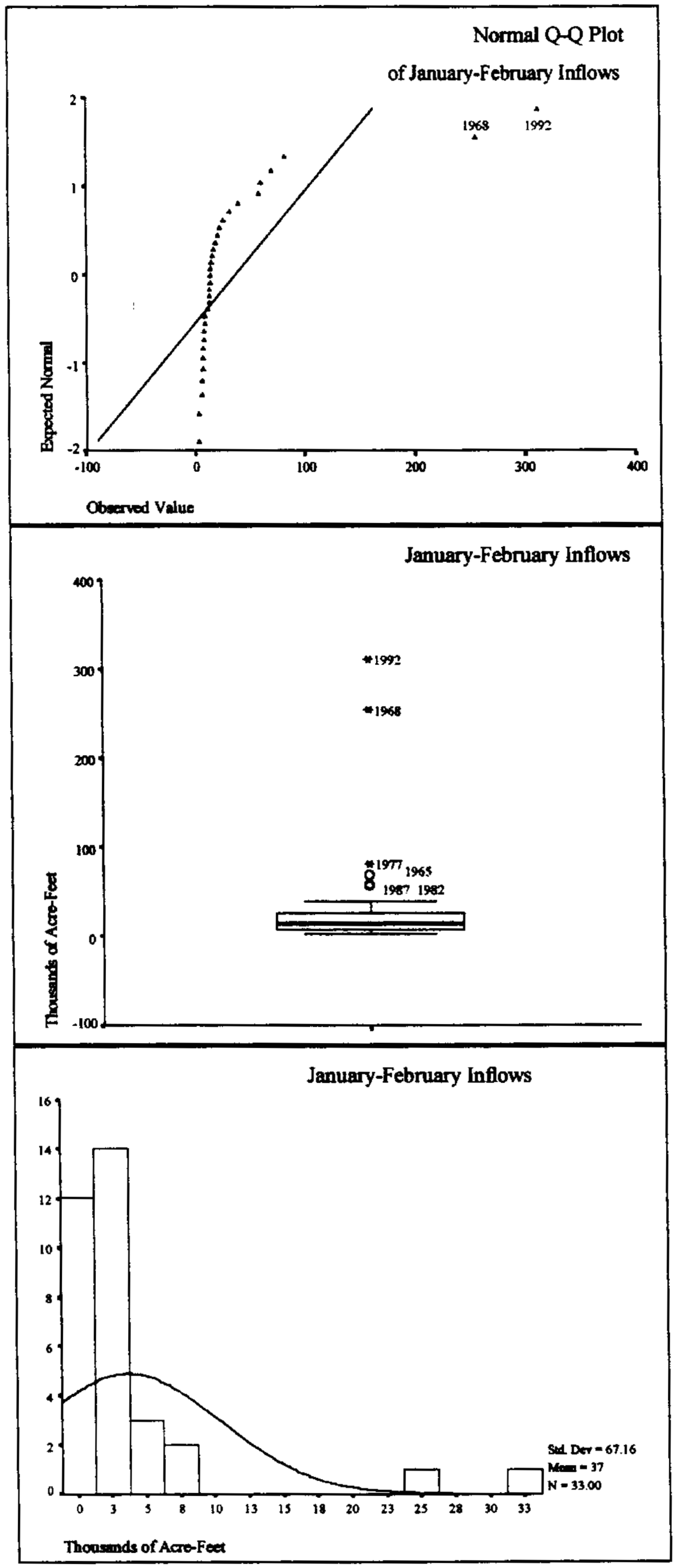



Fig. 2.2a. Exploratory Plots of January-February Inflows.

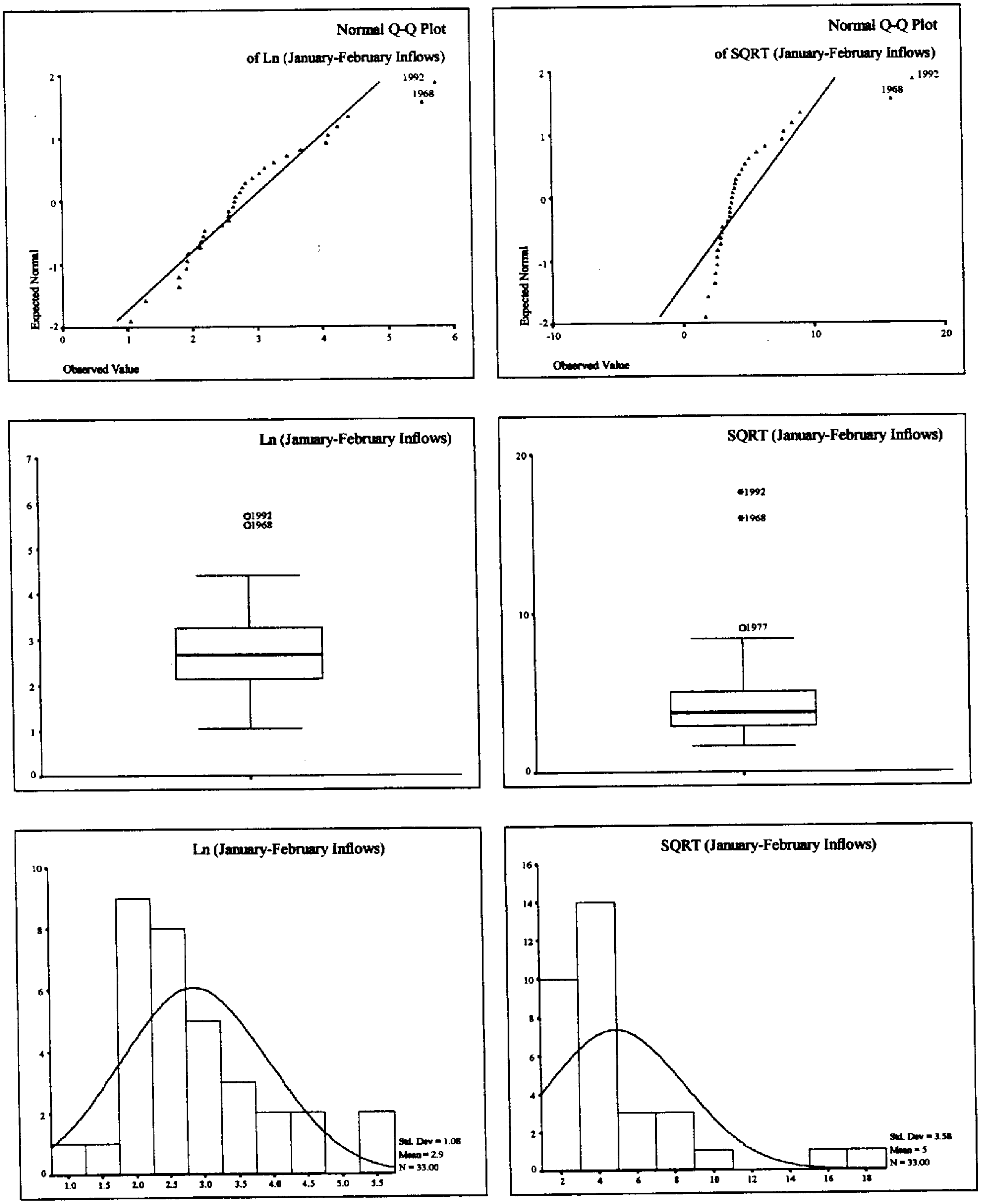



Fig. 2.2b. Exploratory Plots of Transformed January-February Inflows.

### 2.4.3 Summary Information for March-April Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| March-April Inflows | Mean | | 35.0633 | 11.5174 |
| | 95% Confidence Interval for Mean | Lower Bound | 11.6032 | |
| | | Upper Bound | 58.5234 | |
| | 5% Trimmed Mean | | 22.6073 | |
| | Median | | 13.2800 | |
| | Variance | | 4377.438 | |
| | Std. Deviation | | 66.1622 | |
| | Minimum | | 5.16 | |
| | Maximum | | 301.21 | |
| | Range | | 296.05 | |
| | Interquartile Range | | 24.6900 | |
| | Skewness | | 3.622 | .409 |
| | Kurtosis | | 12.609 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| March-April Inflows | Highest | 1 | 16 | 1977 | 301.21 |
| | | 2 | 31 | 1992 | 270.26 |
| | | 3 | 18 | 1979 | 60.61 |
| | | 4 | 29 | 1990 | 38.77 |
| | | 5 | 13 | 1974 | 36.90 |
| | Lowest | 1 | 15 | 1976 | 5.16 |
| | | 2 | 3 | 1964 | 5.56 |
| | | 3 | 19 | 1980 | 6.54 |
| | | 4 | 28 | 1989 | 6.59 |
| | | 5 | 2 | 1963 | 7.11 |

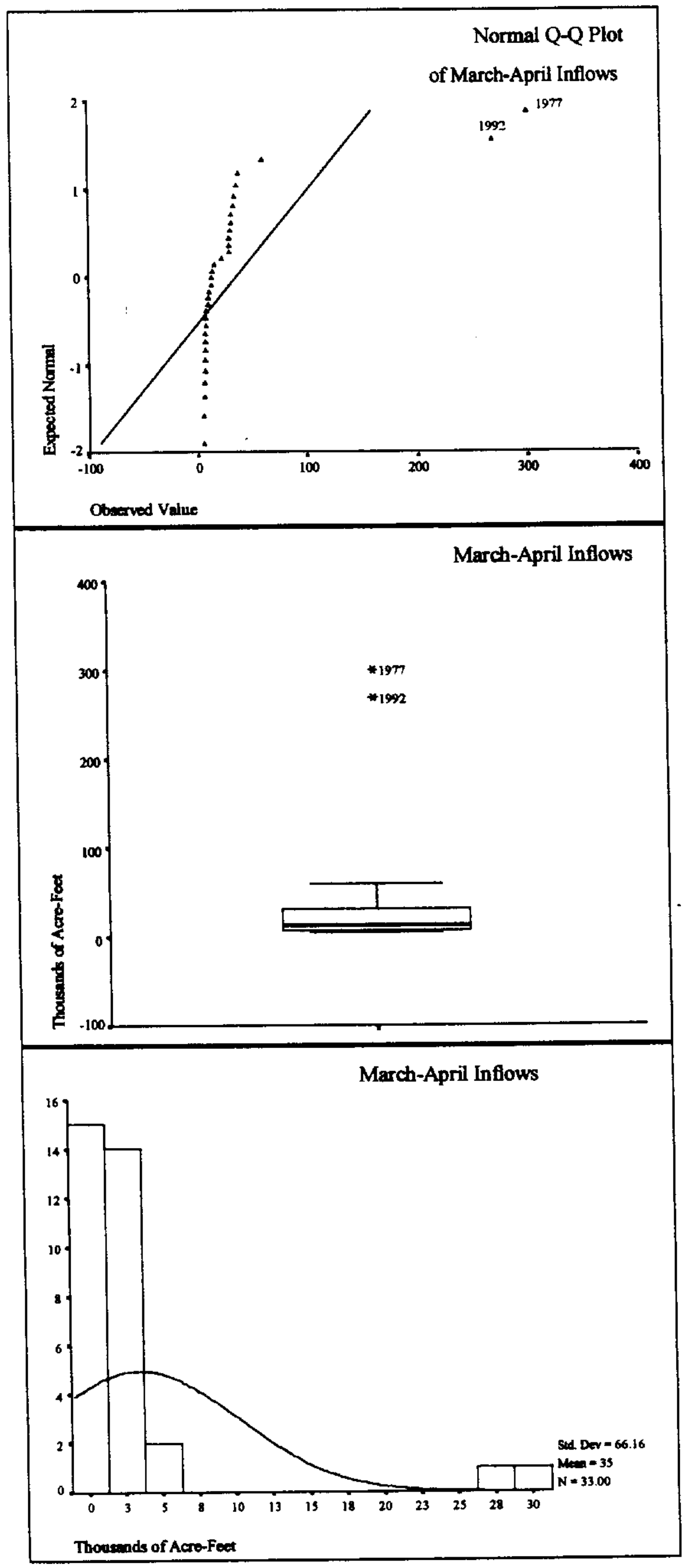



Fig. 2.3a. Exploratory Plots of March-April Inflows.

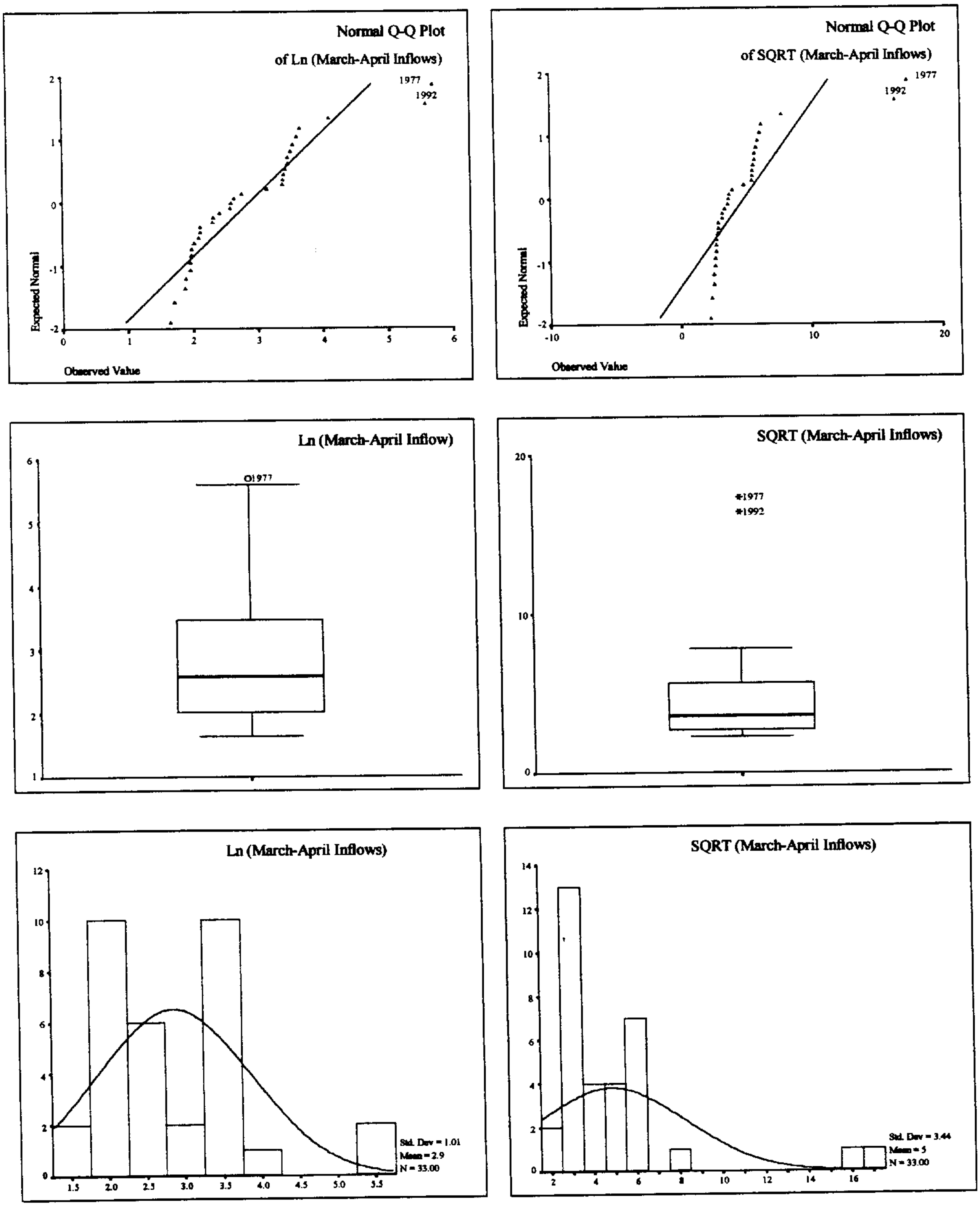



Fig. 2.3b. Exploratory Plots of Transformed March-April Inflows.

### 2.4.4 Summary Information for May-June Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| May-June Inflows | Mean | | 155.3670 | 30.6811 |
| | 95% Confidence Interval for Mean | Lower Bound | 92.8716 | |
| | | Upper Bound | 217.8623 | |
| | 5% Trimmed Mean | | 135.8652 | |
| | Median | | 91.1300 | |
| | Variance | | 31063.9 | |
| | Std. Deviation | | 176.2495 | |
| | Minimum | | 4.50 | |
| | Maximum | | 723.72 | |
| | Range | | 719.22 | |
| | Interquartile Range | | 228.0150 | |
| | Skewness | | 1.608 | .409 |
| | Kurtosis | | 2.616 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| May-June Inflows | Highest | 1 | 20 | 1981 | 723.72 |
| | | 2 | 26 | 1987 | 553.27 |
| | | 3 | 31 | 1992 | 499.44 |
| | | 4 | 7 | 1968 | 360.64 |
| | | 5 | 12 | 1973 | 286.16 |
| | Lowest | 1 | 28 | 1989 | 4.50 |
| | | 2 | 3 | 1964 | 6.26 |
| | | 3 | 1 | 1962 | 8.32 |
| | | 4 | 2 | 1963 | 8.59 |
| | | 5 | 10 | 1971 | 9.67 |

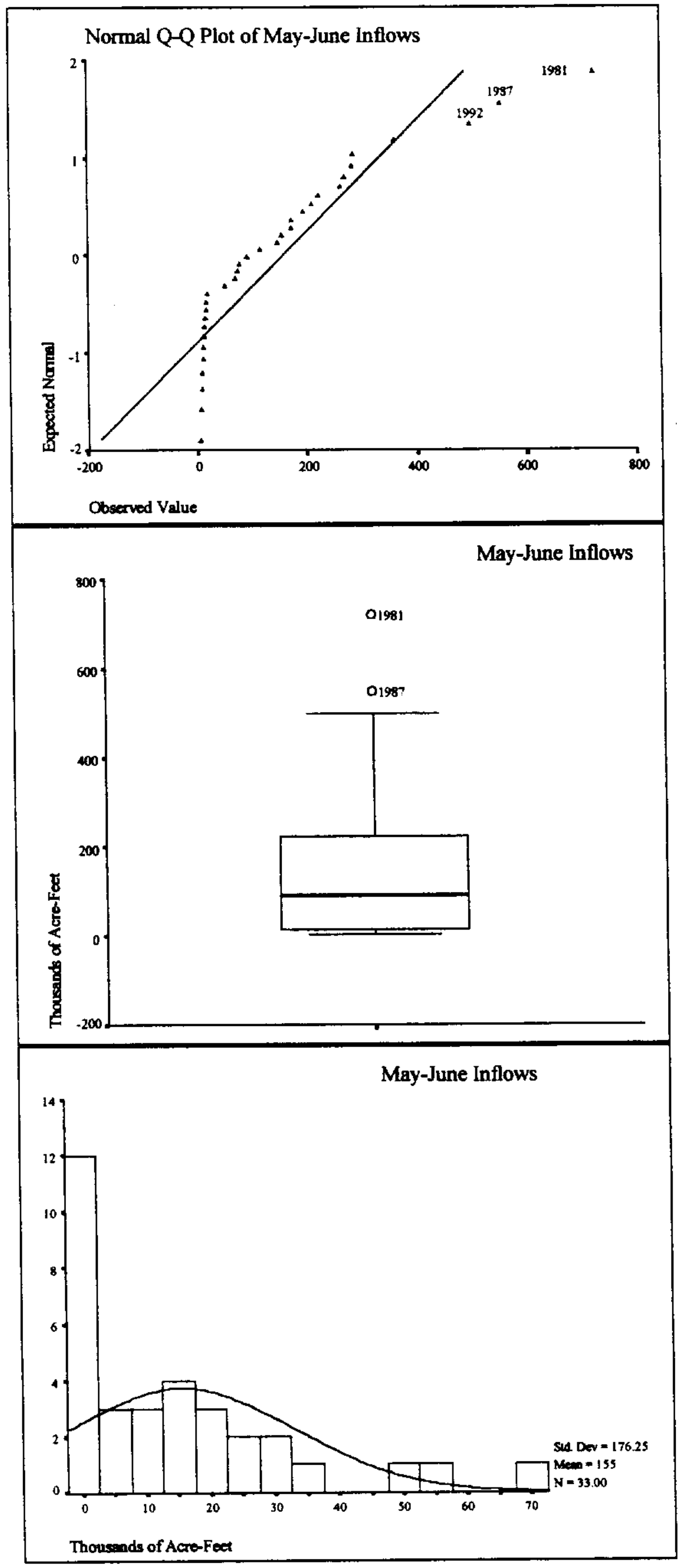



Fig. 2.4a. Exploratory Plots of May-June Inflows.

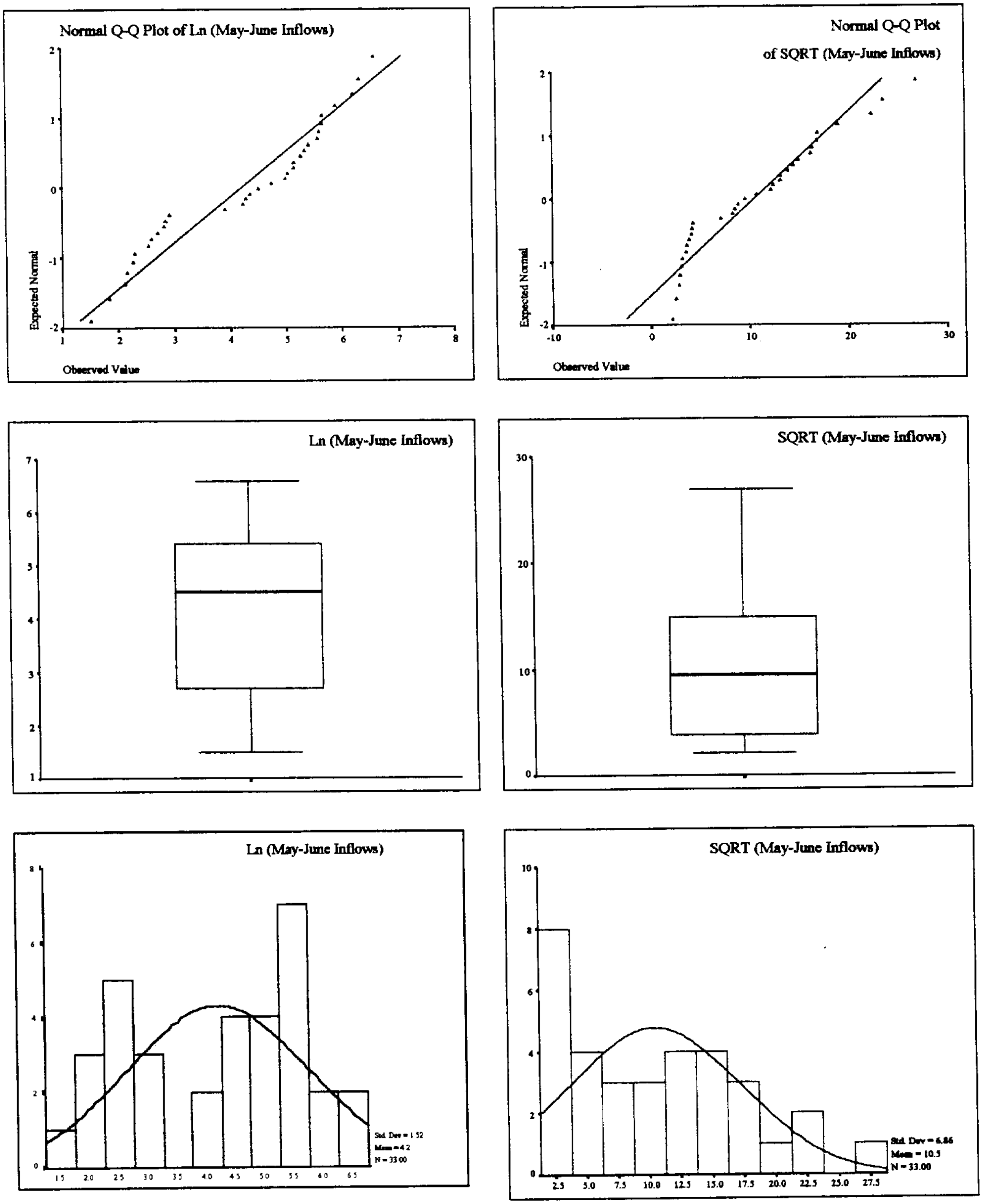



Fig. 2.4b. Exploratory Plots of Transformed May-June Inflows.

### 2.4.5 Summary Information for July-August Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| July-August Inflows | Mean | | 90.7479 | 29.7850 |
| | 95% Confidence Interval for Mean | Lower Bound | 30.0779 | |
| | | Upper Bound | 151.4179 | |
| | 5% Trimmed Mean | | 60.2701 | |
| | Median | | 24.3100 | |
| | Variance | | 29275.8 | |
| | Std. Deviation | | 171.1016 | |
| | Minimum | | 3.28 | |
| | Maximum | | 859.85 | |
| | Range | | 856.57 | |
| | Interquartile Range | | 60.4550 | |
| | Skewness | | 3.517 | .409 |
| | Kurtosis | | 13.598 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| July-August Inflows | Highest | 1 | 10 | 1971 | 859.85 |
| | | 2 | 19 | 1980 | 516.71 |
| | | 3 | 15 | 1976 | 234.60 |
| | | 4 | 20 | 1981 | 219.16 |
| | | 5 | 29 | 1990 | 178.40 |
| | Lowest | 1 | 16 | 1977 | 3.28 |
| | | 2 | 23 | 1984 | 8.72 |
| | | 3 | 1 | 1962 | 9.04 |
| | | 4 | 28 | 1989 | 9.32 |
| | | 5 | 2 | 1963 | 10.46 |

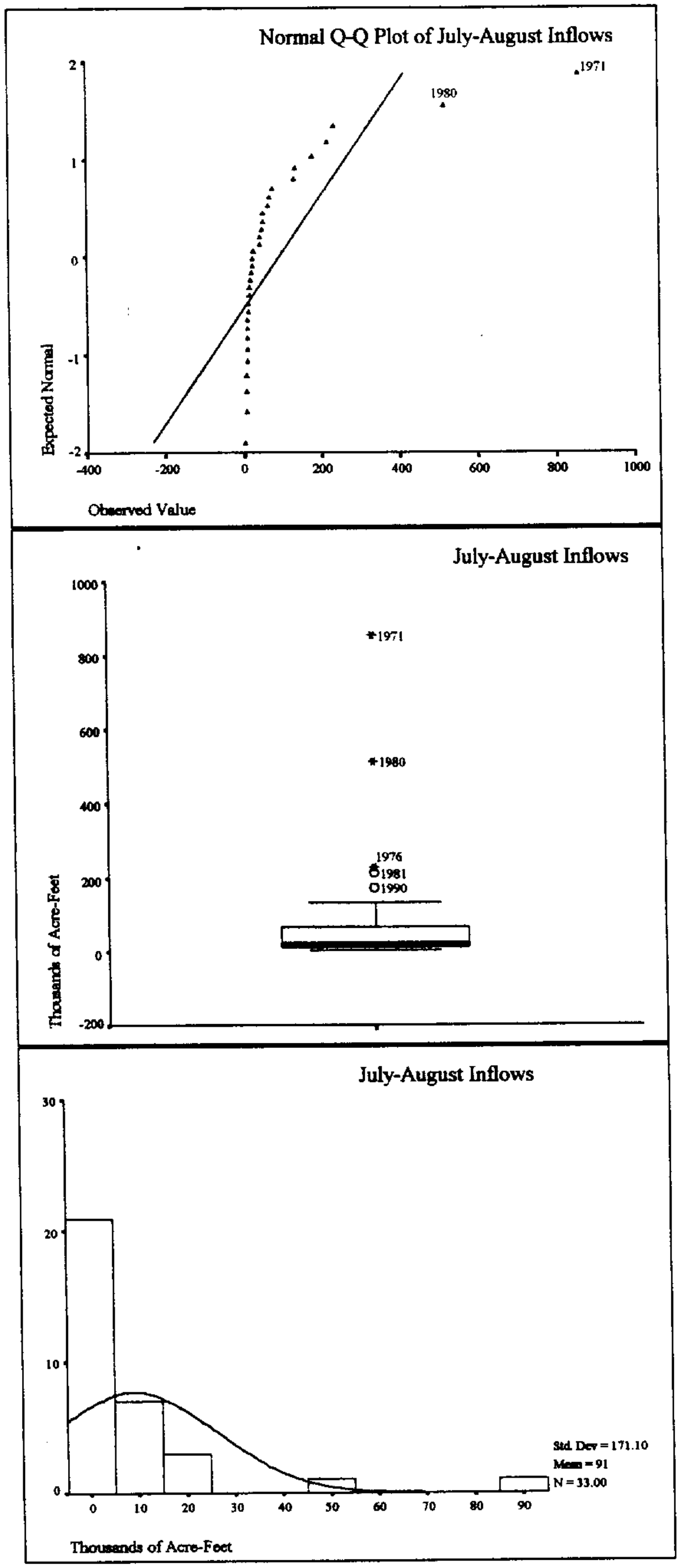



Fig. 2.5a. Exploratory Plots of July-August Inflows.

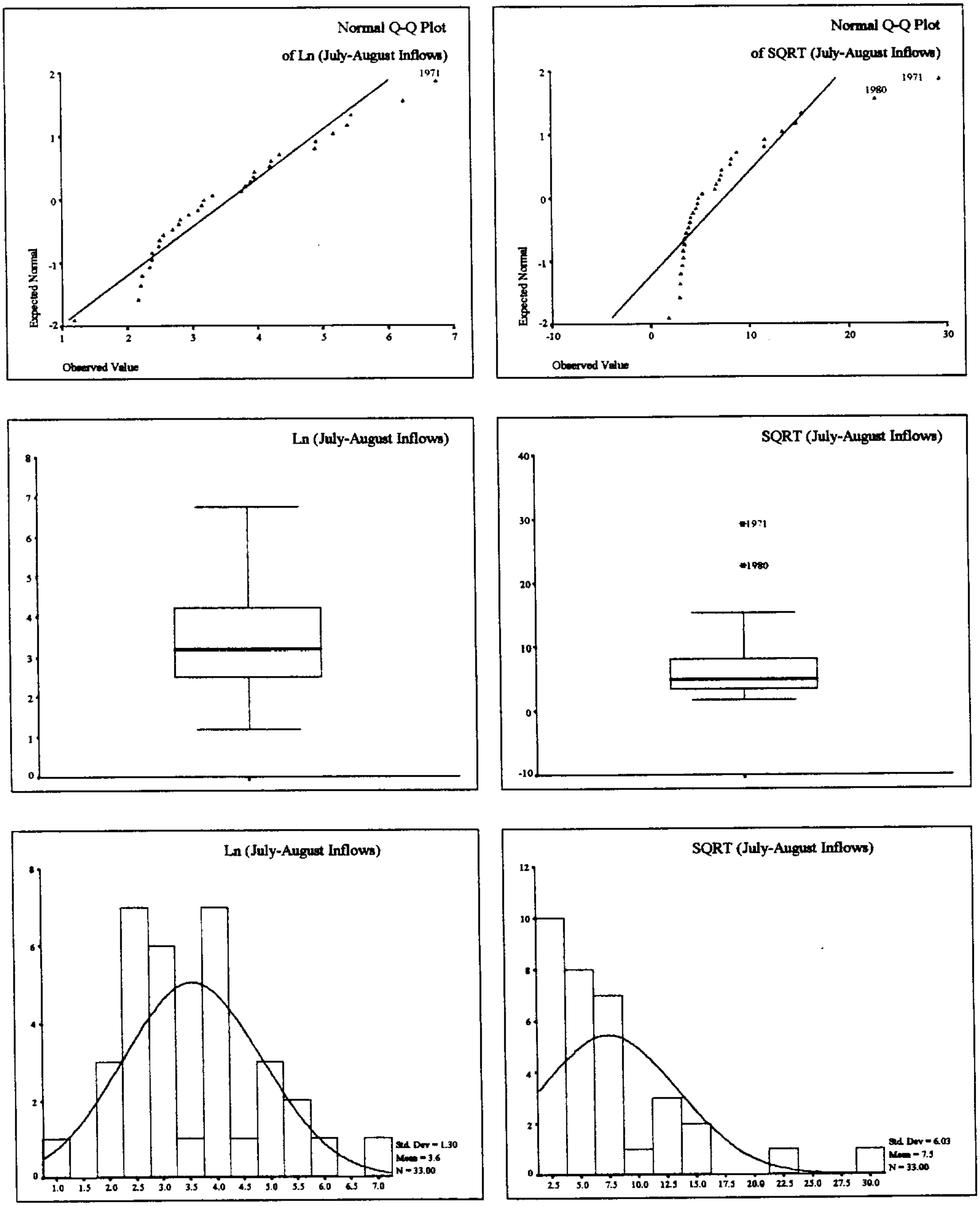



Fig. 2.5b. Exploratory Plots of Transformed July-August Inflows.

## 2.4.6 Summary Information for September-October Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| September-October Inflows | Mean | | 188.4497 | 78.8344 |
| | 95% Confidence Interval for Mean | Lower Bound | 27.8693 | |
| | | Upper Bound | 349.0301 | |
| | 5% Trimmed Mean | | 103.4051 | |
| | Median | | 32.5100 | |
| | Variance | | 205090 | |
| | Std. Deviation | | 452.8691 | |
| | Minimum | | 6.98 | |
| | Maximum | | 1994.55 | |
| | Range | | 1987.57 | |
| | Interquartile Range | | 122.8050 | |
| | Skewness | | 3.489 | .409 |
| | Kurtosis | | 11.706 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| September-October Inflows | Highest | 1 | 7 | 1968 | 1994.55 |
| | | 2 | 11 | 1972 | 1756.35 |
| | | 3 | 13 | 1974 | 648.60 |
| | | 4 | 16 | 1977 | 266.62 |
| | | 5 | 21 | 1982 | 207.42 |
| | Lowest | 1 | 2 | 1963 | 6.98 |
| | | 2 | 3 | 1964 | 7.00 |
| | | 3 | 5 | 1966 | 7.24 |
| | | 4 | 29 | 1990 | 9.84 |
| | | 5 | 6 | 1967 | 10.21 |

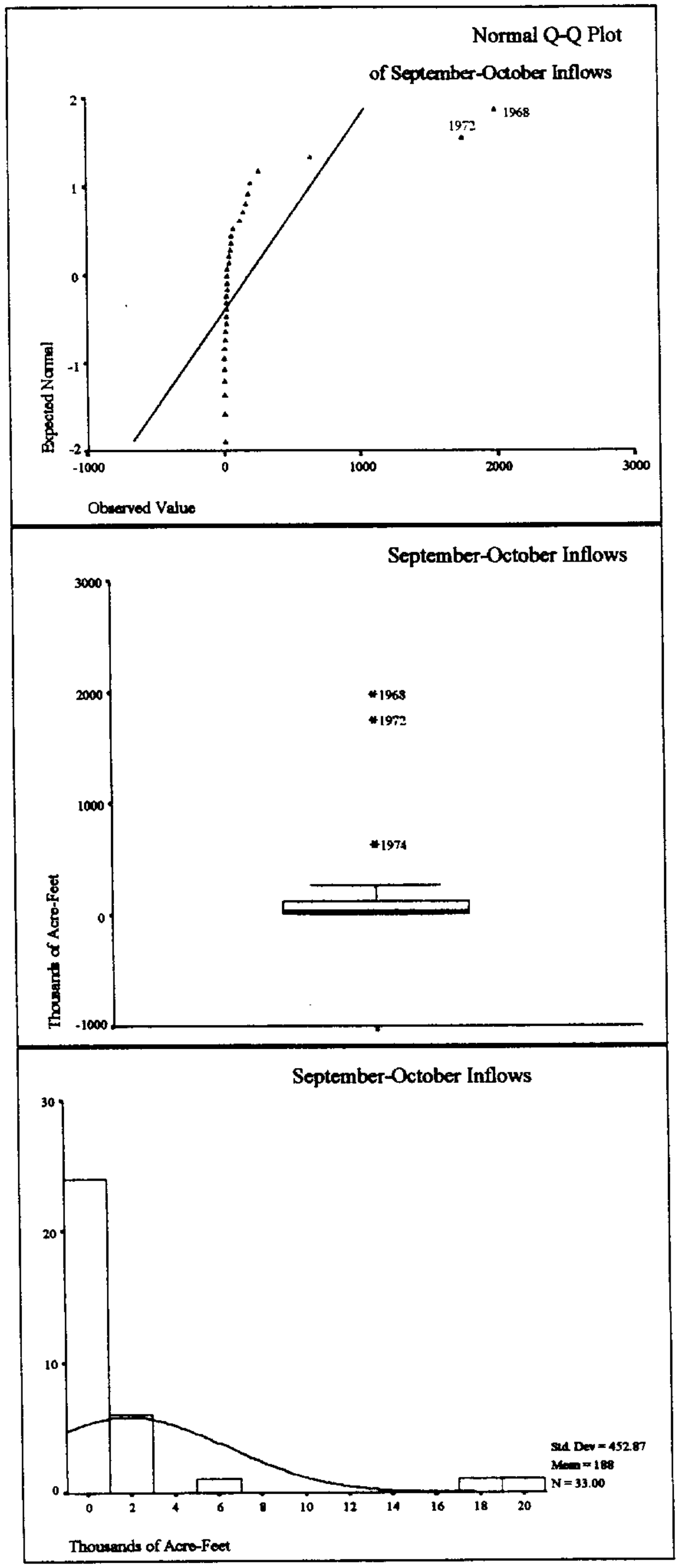



Fig. 2.6a. Exploratory Plots of September-October Inflows.

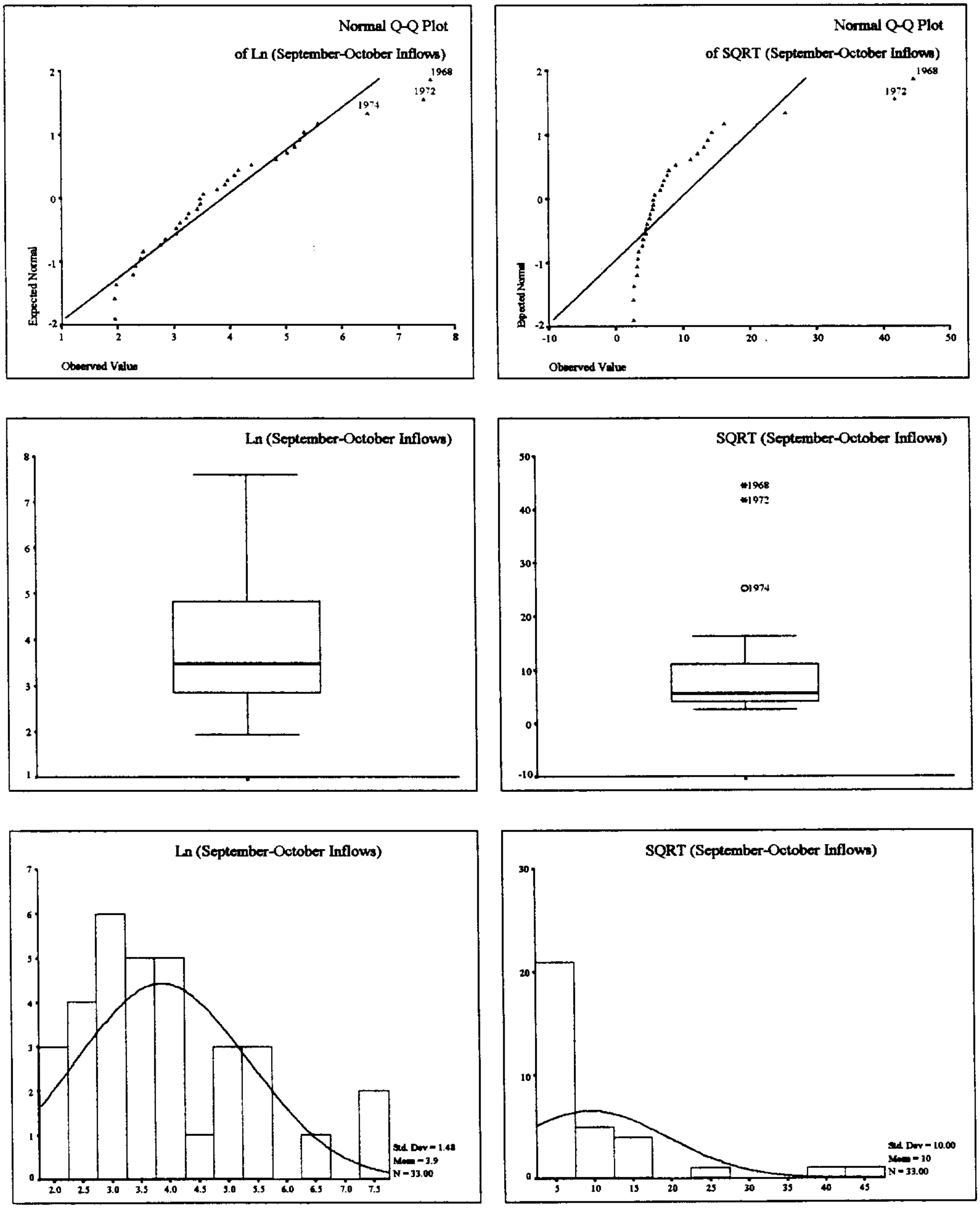



Fig. 2.6b. Exploratory Plots of Transformed September-October Inflows.

### 2.4.7 Summary Information for November-December Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| November-December Inflows | Mean | | 41.2845 | 12.5498 |
| | 95% Confidence Interval for Mean | Lower Bound | 15.7214 | |
| | | Upper Bound | 66.8476 | |
| | 5% Trimmed Mean | | 29.6096 | |
| | Median | | 13.3200 | |
| | Variance | | 5197.416 | |
| | Std. Deviation | | 72.0931 | |
| | Minimum | | 3.69 | |
| | Maximum | | 388.53 | |
| | Range | | 384.84 | |
| | Interquartile Range | | 42.9400 | |
| | Skewness | | 3.813 | .409 |
| | Kurtosis | | 17.224 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| November-December Inflows | Highest | 1 | 16 | 1977 | 388.53 |
| | | 2 | 25 | 1986 | 135.69 |
| | | 3 | 9 | 1970 | 124.43 |
| | | 4 | 11 | 1972 | 101.64 |
| | | 5 | 13 | 1974 | 80.02 |
| | Lowest | 1 | 3 | 1964 | 3.69 |
| | | 2 | 15 | 1976 | 3.95 |
| | | 3 | 2 | 1963 | 4.16 |
| | | 4 | 5 | 1966 | 5.97 |
| | | 5 | 19 | 1980 | 7.09 |

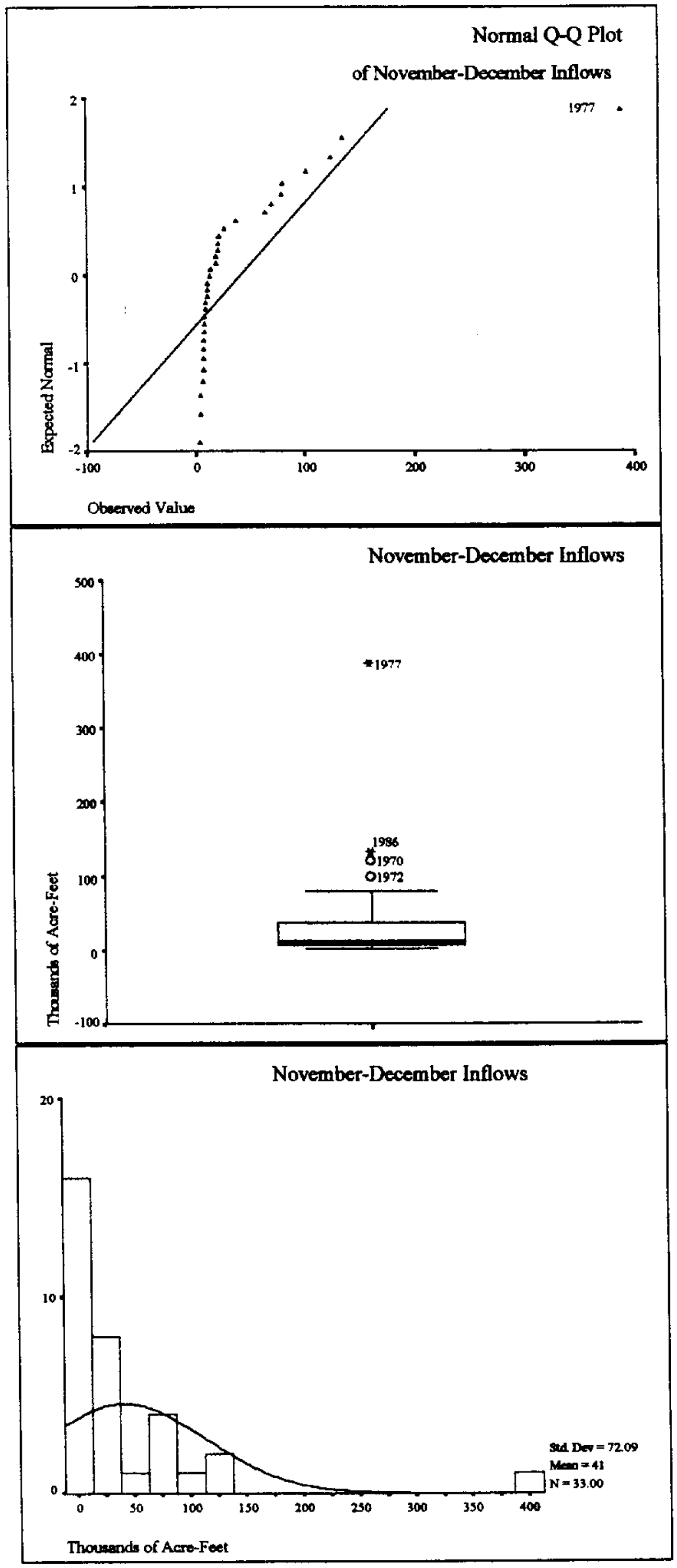



Fig. 2.7a. Exploratory Plots of November-December Inflows.

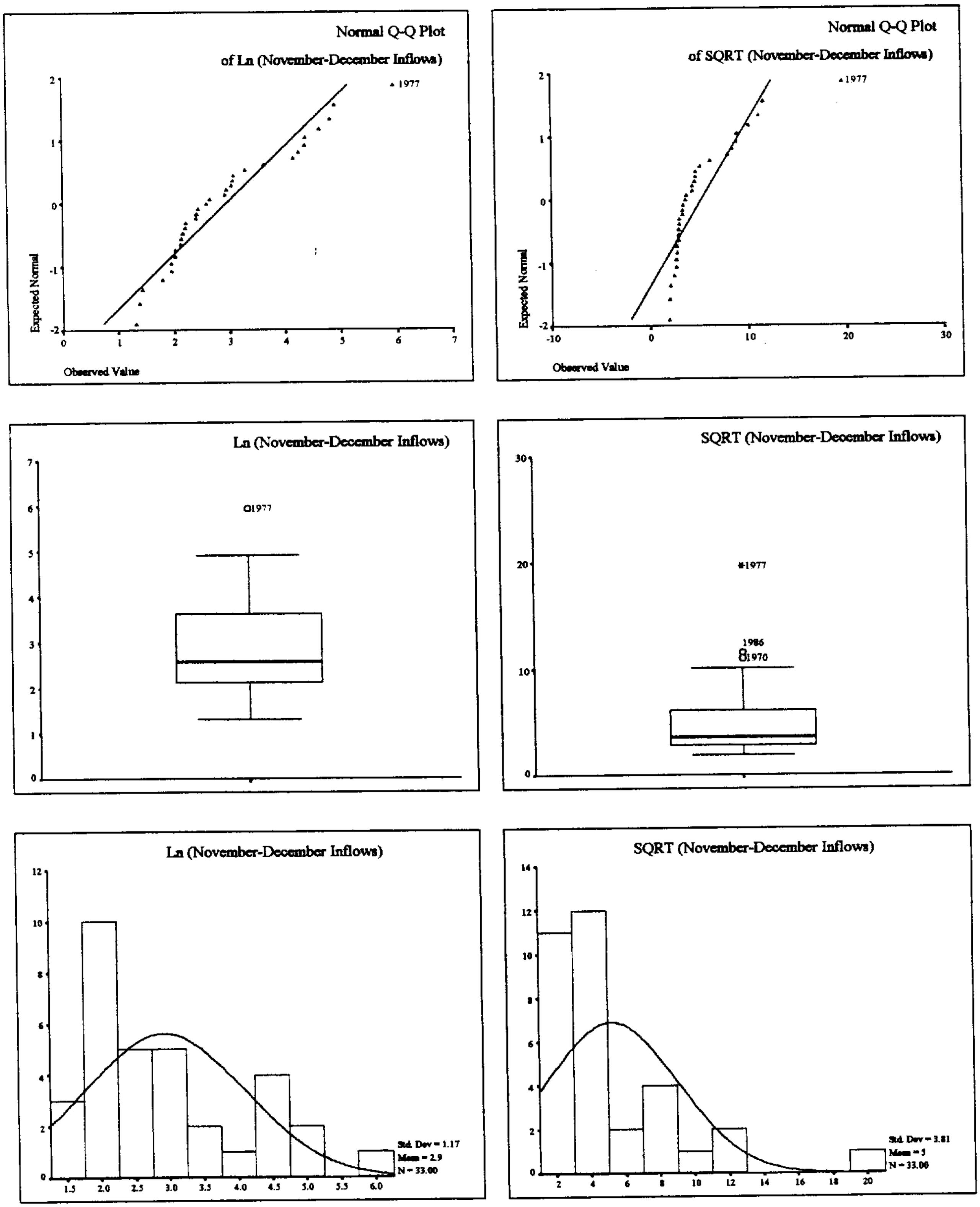



Fig. 2.7b. Exploratory Plots of Transformed November-December Inflows.

## 3. Prediction and Confidence Regions

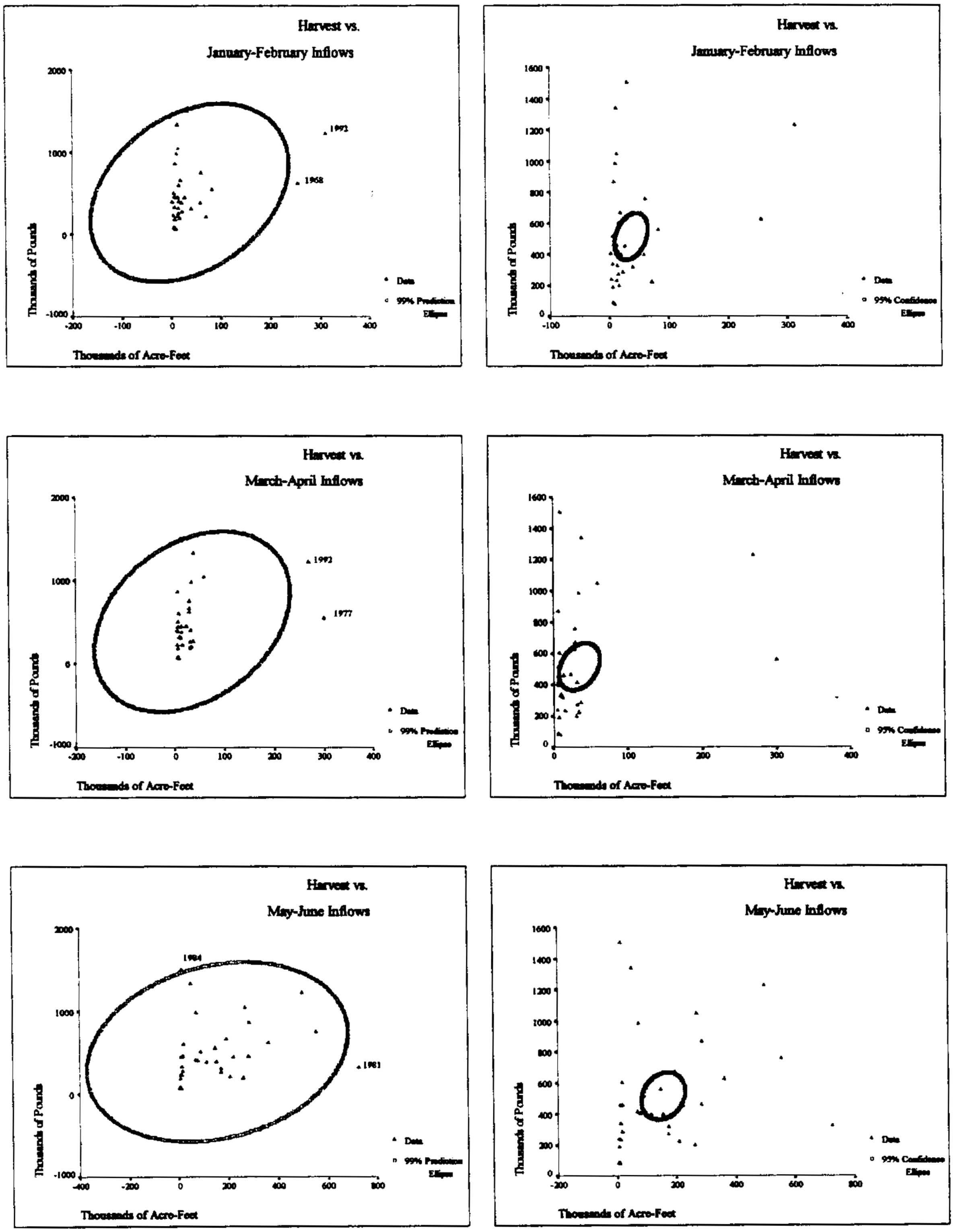



Fig. 3.1. Prediction and Confidence Ellipses.

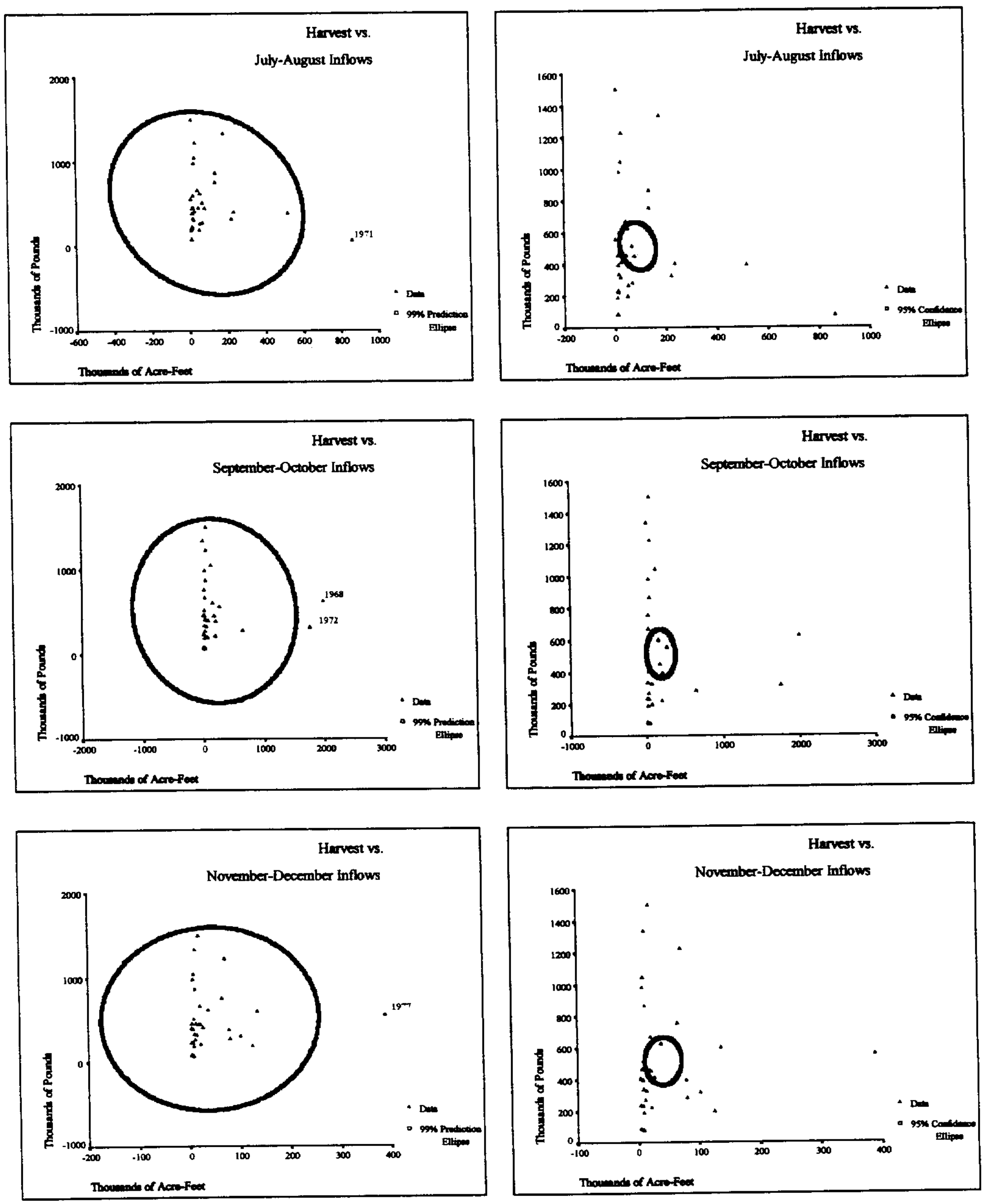



Fig. 3.2. Prediction and Confidence Ellipses.

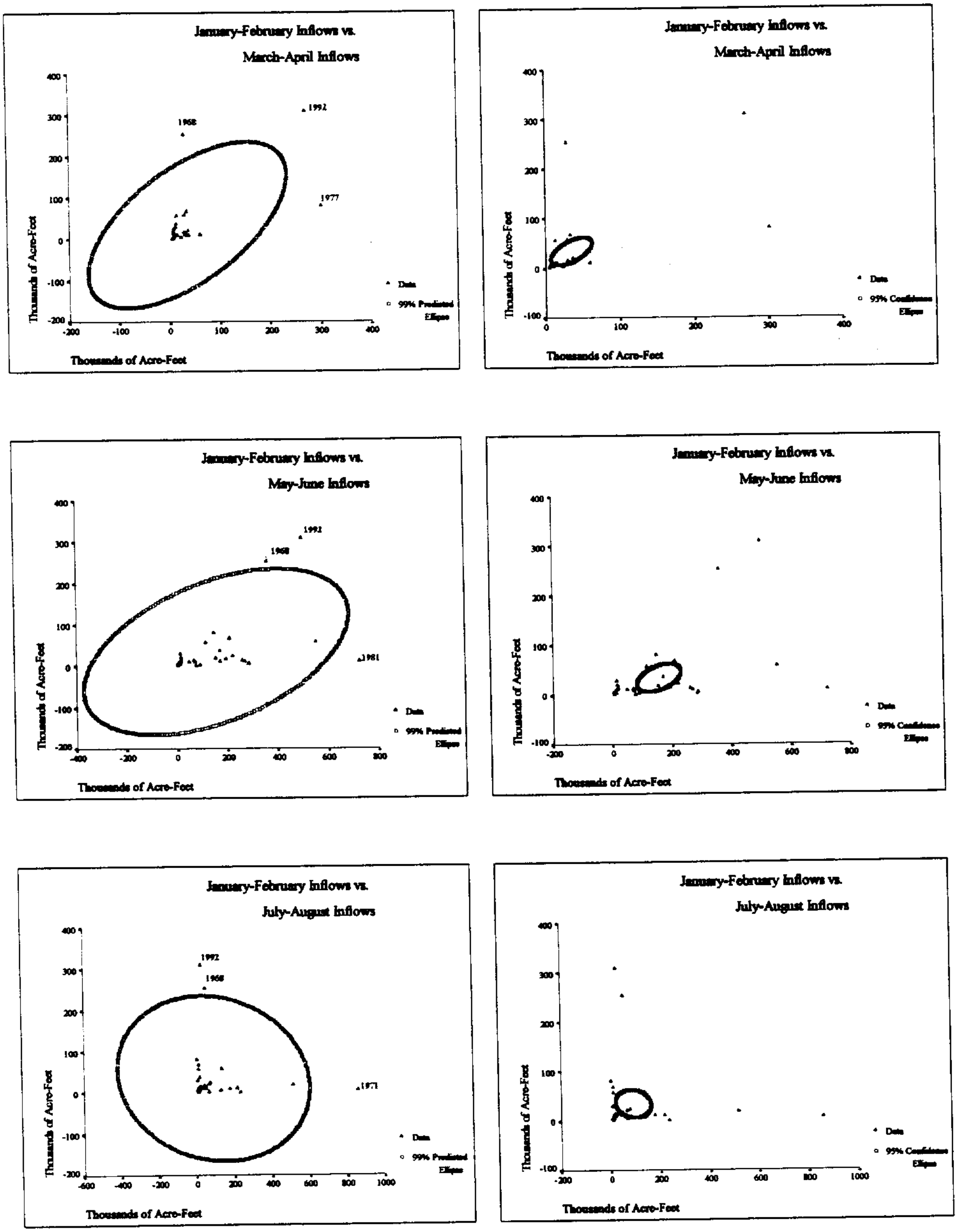



Fig. 3.3. Prediction and Confidence Ellipses.

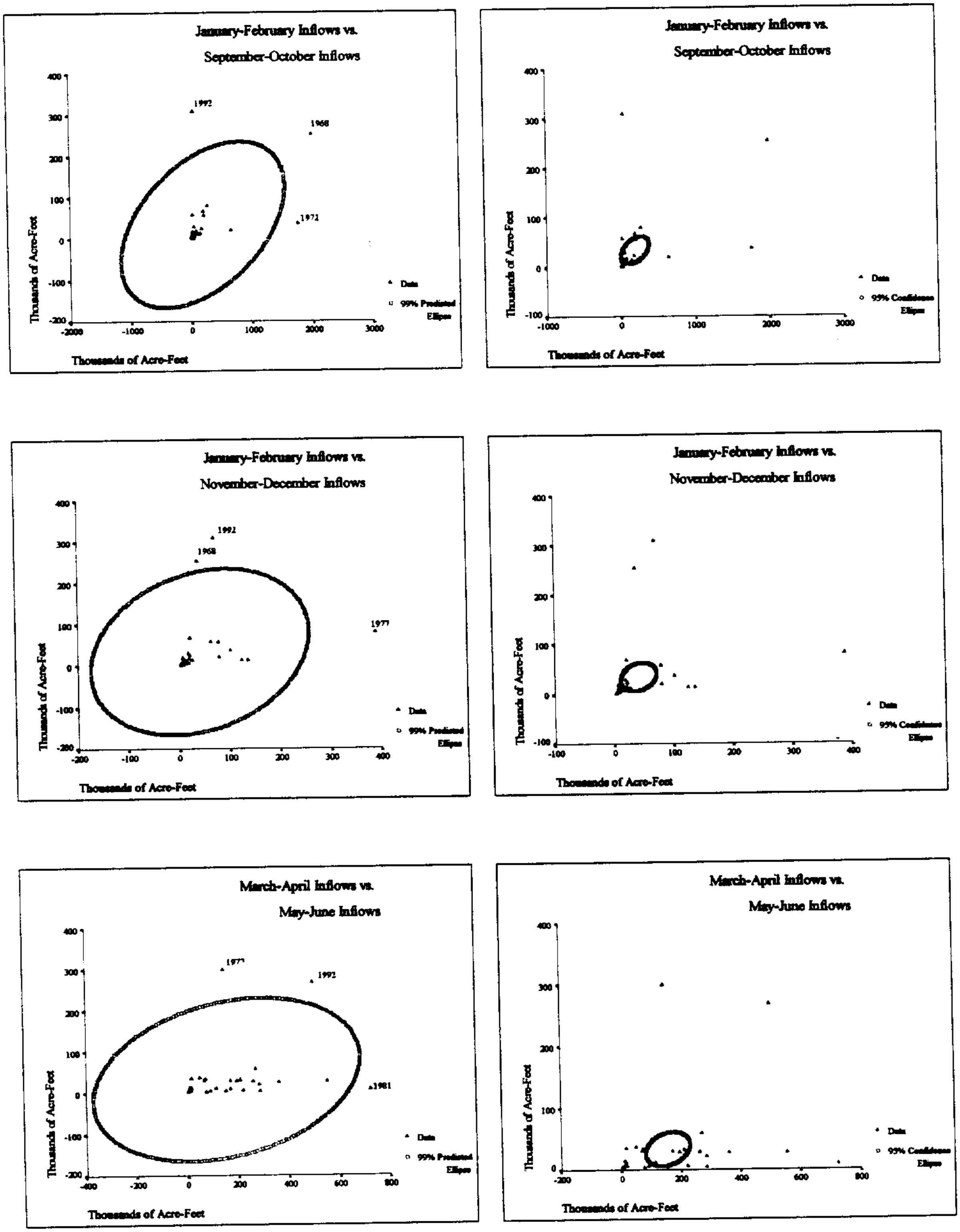



Fig. 3.4. Prediction and Confidence Ellipses.

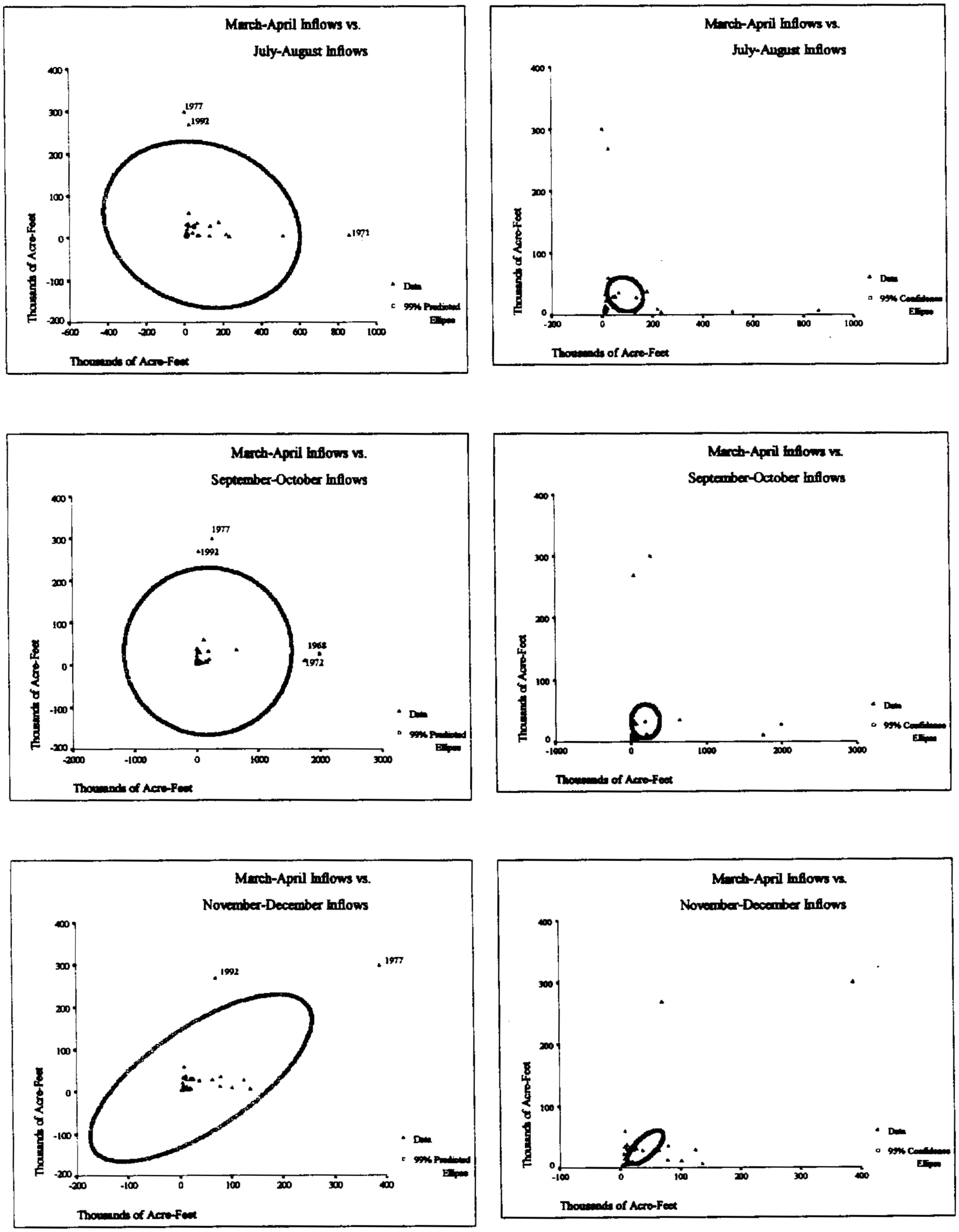



Fig. 3.5. Prediction and Confidence Ellipses.

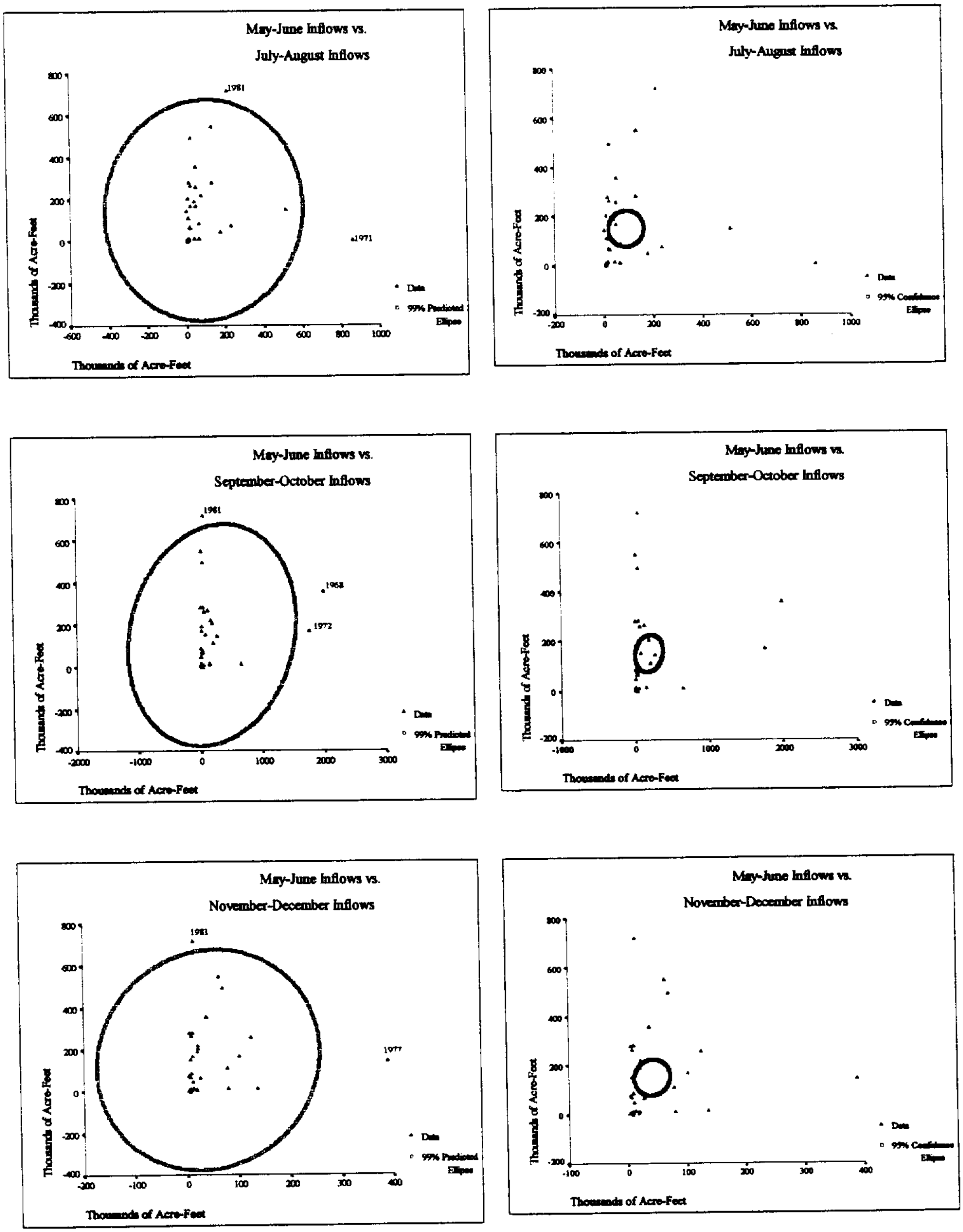



Fig. 3.6. Prediction and Confidence Ellipses.

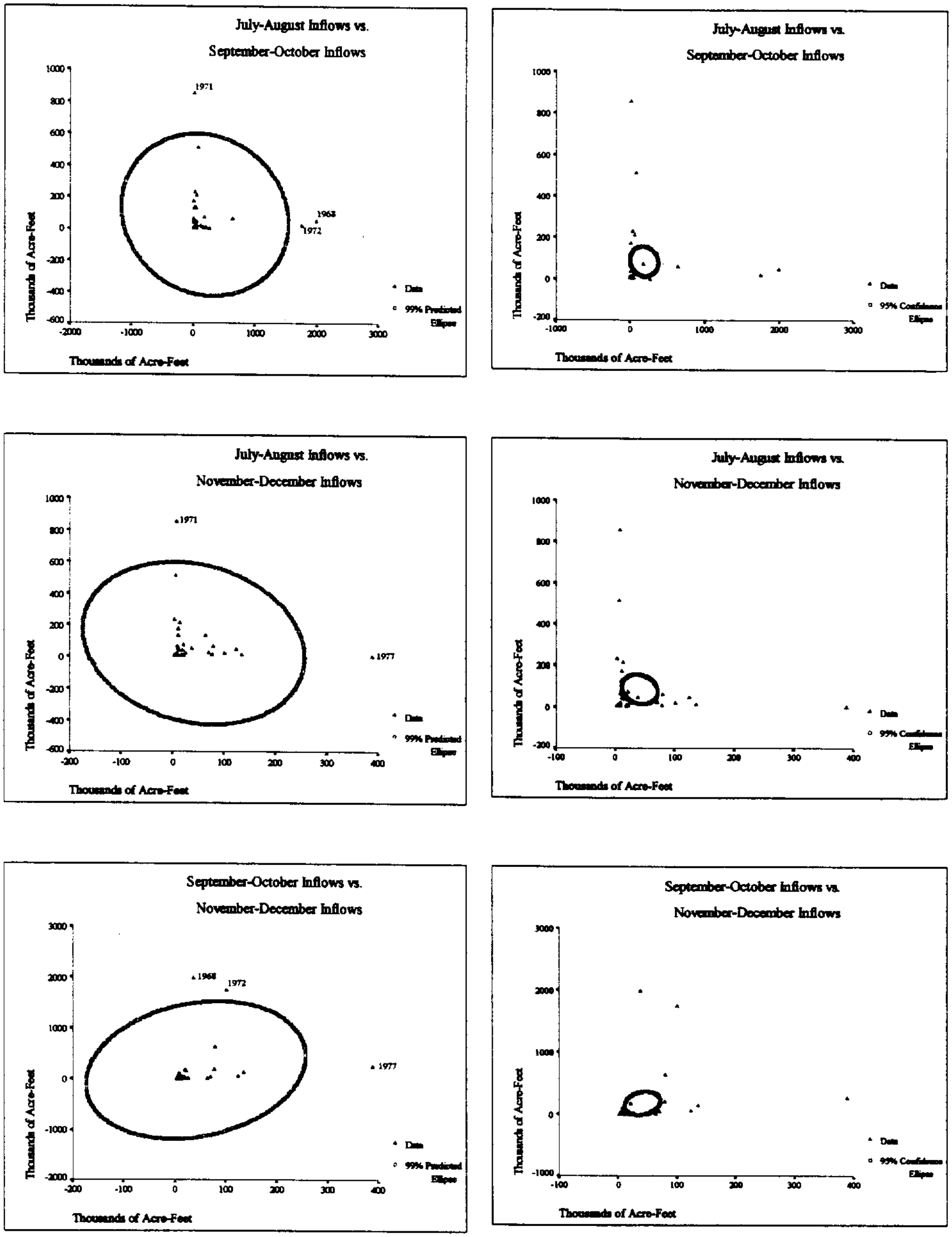



Fig. 3.7. Prediction and Confidence Ellipses.

## 4. Box-Cox Analysis

Table 4.1 Numerical Results.

| HARVEST | QJF_Lag | QMA_Lag | QMJ_Lag | QJA_Lag | QSO_Lag | QND_Lag | LAMBDA |
|---|---|---|---|---|---|---|---|
| 1561852 | 4469.46 | 749.47 | 2097535 | 121897.6 | 109391.4 | 3697.95 | -2.0 |
| 1259435 | 3485.17 | 663.98 | 1395118 | 84467.00 | 83003.75 | 2992.75 | -1.9 |
| 1020018 | 2735.08 | 590.99 | 935703.7 | 58964.78 | 63332.06 | 2436.51 | -1.8 |
| 830044 | 2161.60 | 528.61 | 633358.4 | 41512.60 | 48617.49 | 1996.73 | -1.7 |
| 678956 | 1721.67 | 475.28 | 433048.9 | 29511.53 | 37572.51 | 1648.21 | -1.6 |
| 558512 | 1383.08 | 429.70 | 299382.8 | 21215.40 | 29252.50 | 1371.42 | -1.5 |
| 462276 | 1121.66 | 390.79 | 209497.6 | 15447.69 | 22962.85 | 1151.22 | -1.4 |
| 385209 | 919.24 | 357.65 | 148554.4 | 11413.36 | 18191.65 | 975.82 | -1.3 |
| 323361 | 762.16 | 329.56 | 106872.8 | 8573.46 | 14560.81 | 836.06 | -1.2 |
| 273633 | 640.11 | 305.92 | 78103.29 | 6561.44 | 11790.59 | 724.82 | -1.1 |
| 233587 | 545.34 | 286.28 | 58057.46 | 5127.22 | 9673.72 | 636.60 | -1.0 |
| 201304 | 472.01 | 270.29 | 43955.55 | 4099.61 | 8056.64 | 567.13 | -0.9 |
| 175274 | 415.77 | 257.74 | 33941.13 | 3361.18 | 6825.91 | 513.16 | -0.8 |
| 154305 | 373.38 | 248.53 | 26766.39 | 2831.33 | 5898.37 | 472.26 | -0.7 |
| 137455 | 342.54 | 242.70 | 21587.35 | 2454.88 | 5214.26 | 442.67 | -0.6 |
| 123985 | 321.68 | **240.47** | 17829.79 | 2194.53 | 4732.61 | 423.24 | **-0.5** |
| 113312 | 309.89 | 242.27 | 15101.33 | 2025.80 | 4428.53 | 413.35 | -0.4 |
| 104979 | **306.89** | 248.80 | 13133.43 | 1933.90 | **4292.51** | **412.96** | **-0.3** |
| 98632 | 313.06 | 261.19 | 11743.12 | **1911.91** | 4331.79 | 422.64 | **-0.2** |
| 93998 | 329.53 | 281.13 | 10807.87 | 1960.15 | 4574.77 | 443.72 | -0.1 |
| 90873 | 358.41 | 311.10 | 10249.28 | 2086.58 | 5079.90 | 478.54 | 0 |
| 89109 | 403.15 | 354.85 | **10022.89** | 2308.56 | 5951.97 | 530.80 | **0.1** |
| **88607** | 469.08 | 417.89 | 10112.50 | 2656.25 | 7370.97 | 606.27 | **0.2** |
| 89309 | 564.32 | 508.47 | 10527.99 | 3178.56 | 9643.00 | 713.71 | 0.3 |
| 91198 | 701.16 | 638.94 | 11306.27 | 3953.11 | 13290.27 | 866.54 | 0.4 |
| 94292 | 898.19 | 827.97 | 12515.46 | 5102.56 | 19211.26 | 1085.37 | 0.5 |
| 98645 | 1183.69 | 1103.89 | 14262.79 | 6821.45 | 28968.06 | 1402.14 | 0.6 |
| 104348 | 1600.89 | 1509.97 | 16707.29 | 9420.63 | 45305.81 | 1866.78 | 0.7 |
| 111531 | 2216.32 | 2112.78 | 20079.03 | 13400.75 | 73099.19 | 2558.04 | 0.8 |
| 120367 | 3132.89 | 3015.24 | 24707.59 | 19575.13 | 121089.1 | 3601.23 | 0.9 |
| 131077 | 4510.92 | 4377.44 | 31063.89 | 29275.77 | 205090.5 | 5197.42 | 1.0 |
| 143939 | 6601.38 | 6449.63 | 39821.30 | 44701.31 | 353954.8 | 7671.60 | 1.1 |
| 159293 | 9799.47 | 9625.02 | 51945.31 | 69507.24 | 620714.3 | 11552.86 | 1.2 |
| 177558 | 14730.54 | 14524.32 | 68824.94 | 109812.5 | 1103523 | 17707.91 | 1.3 |
| 199245 | 22388.87 | 22131.62 | 92466.12 | 175923.8 | 1985195 | 27564.77 | 1.4 |
| 224974 | 34362.41 | 34013.61 | 125777.0 | 285302.8 | 3608197 | 43488.73 | 1.5 |
| 255497 | 53197.79 | 52674.11 | 172989.5 | 467691.1 | 6617478 | 69416.26 | 1.6 |
| 291729 | 82995.15 | 82129.26 | 240285.2 | 773998.8 | 12233556 | 111927.4 | 1.7 |
| 334776 | 130380.0 | 128842.9 | 336725.2 | 1291771 | 22776542 | 182065.2 | 1.8 |
| 385984 | 206095.9 | 203251.7 | 475636.6 | 2172194 | 42675073 | 298430.9 | 1.9 |
| 446987 | 327619.8 | 322258.5 | 676684.2 | 3677389 | 80414982 | 492463.0 | 2.0 |

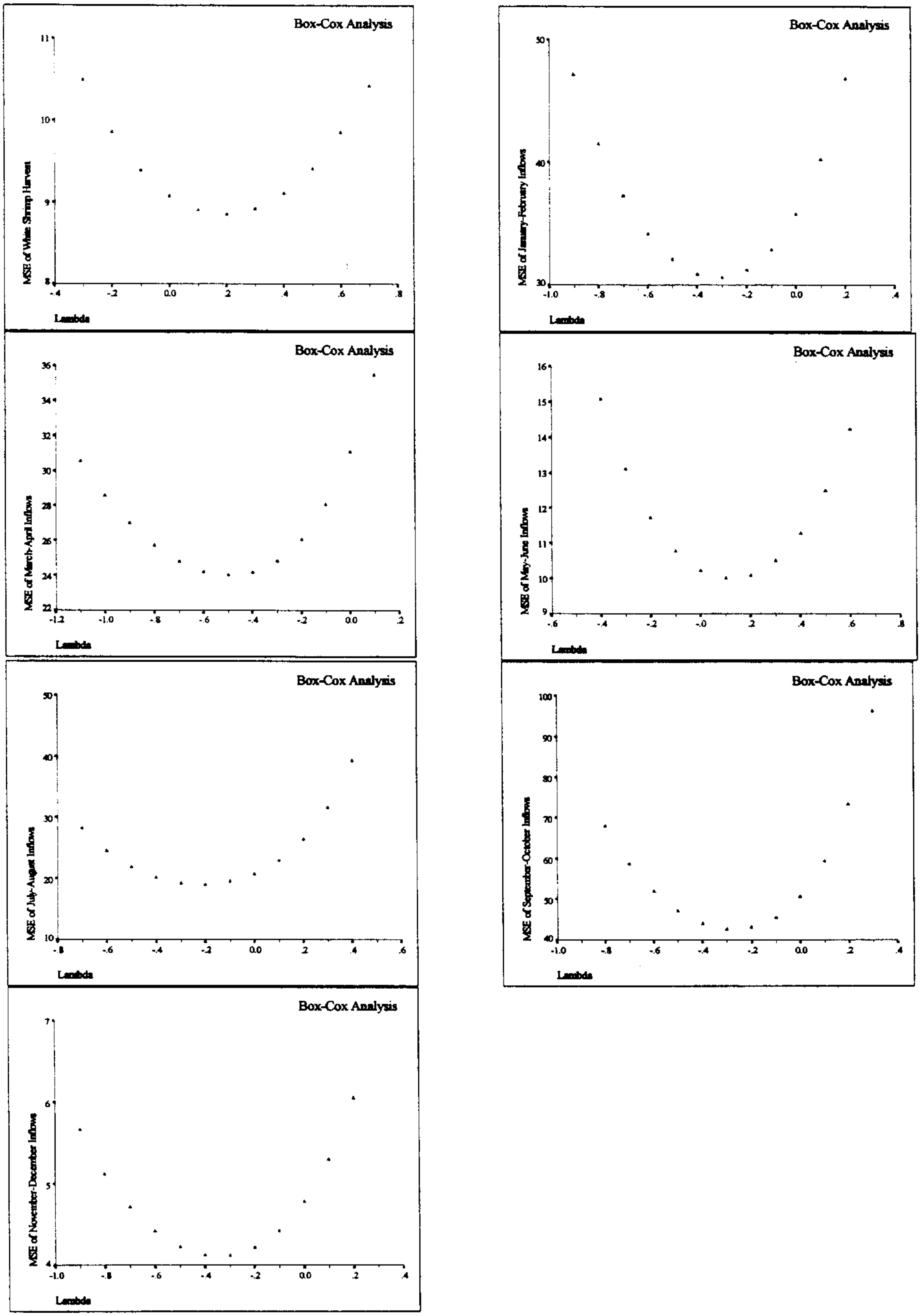



Fig 4.1. MSE of Harvest and Inflows Variables vs. Lambda obtained from Box-Cox Transformation

# 5. Model Choice Diagnostics

## 5.1 Untransformed Data

N = 33     Regression Models for Dependent Variable: WHITE SHRIMP

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.107735 | 0.078952 | 0.5237 | 388.1 | 120729 | 391.1 | QJF_LAG |
| 1 | 0.104565 | 0.075680 | 0.6286 | 388.2 | 121158 | 391.2 | QMA_LAG |
| 1 | 0.047758 | 0.017041 | 2.5082 | 390.2 | 128844 | 393.2 | QMJ_LAG |
| 1 | 0.022949 | -.008569 | 3.3291 | 391.1 | 132201 | 394.1 | QJA_LAG |
| 2 | 0.185369 | 0.131060 | -0.0451 | 387.1 | 113899 | 391.6 | QMA_LAG QND_LAG |
| 2 | 0.156215 | 0.099962 | 0.9196 | 388.2 | 117975 | 392.7 | QJF_LAG QSO_LAG |
| 2 | 0.132073 | 0.074211 | 1.7184 | 389.2 | 121350 | 393.7 | QJF_LAG QMA_LAG |
| 2 | 0.122876 | 0.064401 | 2.0227 | 389.5 | 122636 | 394.0 | QMA_LAG QMJ_LAG |
| 3 | 0.202148 | 0.119612 | 1.3997 | 388.4 | 115400 | 394.4 | QMA_LAG QJA_LAG QND_LAG |
| 3 | 0.193391 | 0.109949 | 1.6895 | 388.7 | 116666 | 394.7 | QMA_LAG QMJ_LAG QND_LAG |
| 3 | 0.191323 | 0.107667 | 1.7579 | 388.8 | 116965 | 394.8 | QJF_LAG QMA_LAG QND_LAG |
| 3 | 0.186446 | 0.102285 | 1.9193 | 389.0 | 117671 | 395.0 | QMA_LAG QSO_LAG QND_LAG |
| 4 | 0.211821 | 0.099224 | 3.0797 | 390.0 | 118072 | 397.5 | QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.206909 | 0.093610 | 3.2422 | 390.2 | 118808 | 397.7 | QJF_LAG QMA_LAG QJA_LAG QND_LAG |
| 4 | 0.202659 | 0.088753 | 3.3828 | 390.4 | 119444 | 397.9 | QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.195675 | 0.080771 | 3.6139 | 390.7 | 120491 | 398.1 | QJF_LAG QMA_LAG QMJ_LAG QND_LAG |
| 5 | 0.213049 | 0.067317 | 5.0390 | 391.9 | 122254 | 400.9 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.211822 | 0.065863 | 5.0796 | 392.0 | 122445 | 401.0 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.208545 | 0.061979 | 5.1881 | 392.1 | 122954 | 401.1 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.196516 | 0.047723 | 5.5860 | 392.6 | 124822 | 401.6 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 6 | 0.214228 | 0.032896 | 7.0000 | 393.9 | 126766 | 404.4 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

## 5.2 Logged Inflows

N = 33 Regression Models for Dependent Variable: WHITE SHRIMP

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.170935 | 0.144191 | -0.4642 | 385.7 | 112178 | 388.6 | LN_QMA |
| 1 | 0.113992 | 0.085411 | 1.4957 | 387.8 | 119882 | 390.8 | LN_QJF |
| 1 | 0.091242 | 0.061927 | 2.2788 | 388.7 | 122961 | 391.7 | LN_QMJ |
| 1 | 0.016228 | -.015507 | 4.8607 | 391.3 | 133111 | 394.3 | LN_QND |
| 2 | 0.185437 | 0.131133 | 1.0366 | 387.1 | 113889 | 391.6 | LN_QMA LN_QND |
| 2 | 0.185277 | 0.130962 | 1.0422 | 387.1 | 113912 | 391.6 | LN_QMA LN_QMJ |
| 2 | 0.183882 | 0.129474 | 1.0902 | 387.1 | 114107 | 391.6 | LN_QMA LN_QJA |
| 2 | 0.178578 | 0.123817 | 1.2727 | 387.3 | 114848 | 391.8 | LN_QMA LN_QSO |
| 3 | 0.217684 | 0.136755 | 1.9267 | 387.7 | 113152 | 393.7 | LN_QJF LN_QMA LN_QND |
| 3 | 0.215126 | 0.133932 | 2.0148 | 387.8 | 113522 | 393.8 | LN_QJF LN_QMA LN_QSO |
| 3 | 0.203296 | 0.120878 | 2.4219 | 388.3 | 115233 | 394.3 | LN_QMA LN_QMJ LN_QND |
| 3 | 0.203084 | 0.120645 | 2.4292 | 388.4 | 115264 | 394.3 | LN_QJF LN_QMJ LN_QSO |
| 4 | 0.232023 | 0.122312 | 3.4332 | 389.1 | 115046 | 396.6 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.229522 | 0.119454 | 3.5193 | 389.2 | 115420 | 396.7 | LN_QJF LN_QMA LN_QMJ LN_QSO |
| 4 | 0.227047 | 0.116625 | 3.6045 | 389.3 | 115791 | 396.8 | LN_QJF LN_QMA LN_QJA LN_QSO |
| 4 | 0.224486 | 0.113699 | 3.6926 | 389.5 | 116175 | 396.9 | LN_QJF LN_QMA LN_QJA LN_QND |
| 5 | 0.242532 | 0.102260 | 5.0715 | 390.7 | 117674 | 399.7 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.240152 | 0.099440 | 5.1534 | 390.8 | 118044 | 399.8 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.232704 | 0.090613 | 5.4097 | 391.1 | 119201 | 400.1 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.226659 | 0.083448 | 5.6178 | 391.4 | 120140 | 400.3 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 6 | 0.244609 | 0.070287 | 7.0000 | 392.6 | 121865 | 403.1 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 5.3 Logged All Variables

N = 33 Regression Models for Dependent Variable: Ln (WHITE SHRIMP)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.218510 | 0.193301 | -0.7311 | -25.8268 | 0.431140 | -22.8338 | LN_QMJ |
| 1 | 0.176076 | 0.149497 | 0.8038 | -24.0819 | 0.454550 | -21.0889 | LN_QMA |
| 1 | 0.132549 | 0.104567 | 2.3783 | -22.3831 | 0.478563 | -19.3900 | LN_QJF |
| 1 | 0.053775 | 0.023251 | 5.2278 | -19.5146 | 0.522023 | -16.5216 | LN_QND |
| 2 | 0.268770 | 0.220022 | -0.5492 | -26.0205 | 0.416859 | -21.5310 | LN_QMA LN_QMJ |
| 2 | 0.237779 | 0.186965 | 0.5718 | -24.6507 | 0.434526 | -20.1612 | LN_QJF LN_QMJ |
| 2 | 0.234038 | 0.182974 | 0.7072 | -24.4891 | 0.436659 | -19.9996 | LN_QMJ LN_QJA |
| 2 | 0.224382 | 0.172674 | 1.0564 | -24.0757 | 0.442164 | -19.5862 | LN_QMJ LN_QND |
| 3 | 0.273582 | 0.198436 | 1.2767 | -24.2384 | 0.428395 | -18.2523 | LN_QMA LN_QMJ LN_QSO |
| 3 | 0.269829 | 0.194294 | 1.4125 | -24.0683 | 0.430609 | -18.0823 | LN_QMA LN_QMJ LN_QND |
| 3 | 0.269600 | 0.194042 | 1.4208 | -24.0580 | 0.430744 | -18.0719 | LN_QMA LN_QMJ LN_QJA |
| 3 | 0.269158 | 0.193554 | 1.4368 | -24.0380 | 0.431005 | -18.0520 | LN_QJF LN_QMA LN_QMJ |
| 4 | 0.279984 | 0.177124 | 3.0452 | -22.5305 | 0.439785 | -15.0479 | LN_QJF LN_QMA LN_QMJ LN_QSO |
| 4 | 0.275076 | 0.171515 | 3.2227 | -22.3063 | 0.442783 | -14.8237 | LN_QMA LN_QMJ LN_QJA LN_QSO |
| 4 | 0.273751 | 0.170001 | 3.2706 | -22.2460 | 0.443592 | -14.7635 | LN_QMA LN_QMJ LN_QSO LN_QND |
| 4 | 0.271746 | 0.167709 | 3.3432 | -22.1550 | 0.444817 | -14.6725 | LN_QJF LN_QMA LN_QMJ LN_QND |
| 5 | 0.281132 | 0.148008 | 5.0036 | -20.5831 | 0.455347 | -11.6041 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.280029 | 0.146701 | 5.0435 | -20.5325 | 0.456045 | -11.5535 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.275154 | 0.140923 | 5.2199 | -20.3099 | 0.459133 | -11.3308 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.272813 | 0.138148 | 5.3046 | -20.2034 | 0.460616 | -11.2244 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 6 | 0.281232 | 0.115363 | 7.0000 | -18.5877 | 0.472794 | -8.1122 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 5.4 Square Root Inflows

N = 33 Regression Models for Dependent Variable: WHITE SHRIMP

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.14502 | 0.11744 | -0.180 | 386.7 | 115684 | 389.7 | SQRT_QMA |
| 1 | 0.11170 | 0.08305 | 0.943 | 387.9 | 120192 | 390.9 | SQRT_QJF |
| 1 | 0.06575 | 0.03562 | 2.492 | 389.6 | 126410 | 392.6 | SQRT_QMJ |
| 1 | 0.00496 | -.02713 | 4.541 | 391.7 | 134635 | 394.7 | SQRT_QJA |
| 2 | 0.19415 | 0.14043 | 0.164 | 386.7 | 112671 | 391.2 | SQRT_QMA SQRT_QND |
| 2 | 0.17570 | 0.12075 | 0.786 | 387.5 | 115250 | 392.0 | SQRT_QJF SQRT_QSO |
| 2 | 0.16024 | 0.10426 | 1.307 | 388.1 | 117412 | 392.6 | SQRT_QMA SQRT_QMJ |
| 2 | 0.15831 | 0.10219 | 1.372 | 388.2 | 117683 | 392.6 | SQRT_QJF SQRT_QMA |
| 3 | 0.21462 | 0.13337 | 1.474 | 387.9 | 113596 | 393.9 | SQRT_QJF SQRT_QMA SQRT_QND |
| 3 | 0.20855 | 0.12668 | 1.678 | 388.1 | 114473 | 394.1 | SQRT_QMA SQRT_QMJ SQRT_QND |
| 3 | 0.19544 | 0.11221 | 2.120 | 388.7 | 116369 | 394.7 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 3 | 0.19462 | 0.11131 | 2.148 | 388.7 | 116488 | 394.7 | SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.22185 | 0.11069 | 3.230 | 389.6 | 116569 | 397.0 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.21949 | 0.10798 | 3.310 | 389.7 | 116924 | 397.1 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QND |
| 4 | 0.21497 | 0.10282 | 3.462 | 389.9 | 117600 | 397.3 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QND |
| 4 | 0.21086 | 0.09812 | 3.601 | 390.0 | 118216 | 397.5 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 5 | 0.22679 | 0.08361 | 5.064 | 391.4 | 120119 | 400.3 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.22234 | 0.07833 | 5.214 | 391.5 | 120811 | 400.5 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.22108 | 0.07684 | 5.256 | 391.6 | 121006 | 400.6 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 5 | 0.21099 | 0.06488 | 5.596 | 392.0 | 122573 | 401.0 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.22868 | 0.05068 | 7.000 | 393.3 | 124435 | 403.7 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

### 5.5 Square Root All Variables

N = 33 Regression Models for Dependent Variable: SQRT (WHITE SHRIMP)

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.15000 | 0.12259 | -0.302 | 131.1 | 50.160 | 134.1 | SQRT_QMA |
| 1 | 0.12026 | 0.09188 | 0.702 | 132.3 | 51.915 | 135.3 | SQRT_QJF |
| 1 | 0.10540 | 0.07654 | 1.204 | 132.8 | 52.792 | 135.8 | SQRT_QMJ |
| 1 | 0.01222 | -.01965 | 4.350 | 136.1 | 58.291 | 139.1 | SQRT_QND |
| 2 | 0.18775 | 0.13360 | 0.424 | 131.6 | 49.530 | 136.1 | SQRT_QMA SQRT_QMJ |
| 2 | 0.17723 | 0.12238 | 0.779 | 132.1 | 50.172 | 136.6 | SQRT_QMA SQRT_QND |
| 2 | 0.16594 | 0.11033 | 1.160 | 132.5 | 50.860 | 137.0 | SQRT_QJF SQRT_QMA |
| 2 | 0.16259 | 0.10676 | 1.273 | 132.6 | 51.064 | 137.1 | SQRT_QJF SQRT_QSO |
| 3 | 0.21401 | 0.13270 | 1.537 | 132.6 | 49.581 | 138.5 | SQRT_QMA SQRT_QMJ SQRT_QND |
| 3 | 0.19891 | 0.11603 | 2.047 | 133.2 | 50.534 | 139.2 | SQRT_QJF SQRT_QMA SQRT_QND |
| 3 | 0.19443 | 0.11110 | 2.198 | 133.4 | 50.817 | 139.4 | SQRT_QMA SQRT_QMJ SQRT_QSO |
| 3 | 0.19126 | 0.10760 | 2.305 | 133.5 | 51.016 | 139.5 | SQRT_QMA SQRT_QMJ SQRT_QJA |
| 4 | 0.22050 | 0.10914 | 3.318 | 134.3 | 50.929 | 141.8 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 4 | 0.22021 | 0.10881 | 3.328 | 134.3 | 50.947 | 141.8 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QND |
| 4 | 0.21403 | 0.10174 | 3.536 | 134.6 | 51.351 | 142.0 | SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.21017 | 0.09733 | 3.667 | 134.7 | 51.603 | 142.2 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO |
| 5 | 0.22577 | 0.08240 | 5.140 | 136.1 | 52.457 | 145.0 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 5 | 0.22397 | 0.08026 | 5.201 | 136.1 | 52.579 | 145.1 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.22059 | 0.07626 | 5.315 | 136.3 | 52.808 | 145.3 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.21471 | 0.06929 | 5.513 | 136.5 | 53.207 | 145.5 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 6 | 0.22991 | 0.05220 | 7.000 | 137.9 | 54.184 | 148.4 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

## 5.6 Logged and Square Root Variables

N = 33 Regression Models for Dependent Variable: Ln (WHITE SHRIMP)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.218510 | 0.193301 | -0.8195 | -25.8268 | 0.431140 | -22.8338 | LN_QMJ |
| 1 | 0.139158 | 0.111389 | 2.0419 | -22.6355 | 0.474917 | -19.6424 | SQRT_QMA |
| 1 | 0.117452 | 0.088982 | 2.8247 | -21.8137 | 0.486893 | -18.8206 | SQRT_QJF |
| 1 | 0.025761 | -.005666 | 6.1310 | -18.5518 | 0.537477 | -15.5588 | SQRT_QND |
| 2 | 0.260525 | 0.211227 | -0.3345 | -25.6505 | 0.421559 | -21.1609 | SQRT_QMA LN_QMJ |
| 2 | 0.236596 | 0.185702 | 0.5283 | -24.5995 | 0.435201 | -20.1100 | SQRT_QJF LN_QMJ |
| 2 | 0.234038 | 0.182974 | 0.6206 | -24.4891 | 0.436659 | -19.9996 | LN_QMJ LN_QJA |
| 2 | 0.222952 | 0.171148 | 1.0204 | -24.0149 | 0.442979 | -19.5254 | LN_QMJ SQRT_QSO |
| 3 | 0.270522 | 0.195059 | 1.3050 | -24.0997 | 0.430200 | -18.1136 | SQRT_QMA LN_QMJ SQRT_QND |
| 3 | 0.265861 | 0.189915 | 1.4731 | -23.8894 | 0.432949 | -17.9034 | SQRT_QMA LN_QMJ SQRT_QSO |
| 3 | 0.262121 | 0.185788 | 1.6079 | -23.7217 | 0.435155 | -17.7357 | SQRT_QMA LN_QMJ LN_QJA |
| 3 | 0.261015 | 0.184568 | 1.6478 | -23.6723 | 0.435807 | -17.6863 | SQRT_QJF SQRT_QMA LN_QMJ |
| 4 | 0.274123 | 0.170426 | 3.1751 | -22.2629 | 0.443365 | -14.7804 | SQRT_QMA LN_QMJ LN_QJA SQRT_QND |
| 4 | 0.271758 | 0.167723 | 3.2604 | -22.1556 | 0.444810 | -14.6731 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO |
| 4 | 0.271690 | 0.167646 | 3.2628 | -22.1525 | 0.444851 | -14.6700 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QND |
| 4 | 0.271337 | 0.167242 | 3.2756 | -22.1365 | 0.445067 | -14.6540 | SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.275249 | 0.141036 | 5.1345 | -20.3142 | 0.459073 | -11.3351 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.275190 | 0.140966 | 5.1366 | -20.3115 | 0.459110 | -11.3324 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.275088 | 0.140846 | 5.1403 | -20.3069 | 0.459174 | -11.3278 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QND |
| 5 | 0.274508 | 0.140157 | 5.1612 | -20.2804 | 0.459542 | -11.3014 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 6 | 0.278979 | 0.112590 | 7.0000 | -18.4845 | 0.474276 | -8.0089 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |

## 5.7 Untransformed, Square Root and Logged Variables

N = 33 Regression Models for Dependent Variable: WHITE SHRIMP

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.145024 | 0.117444 | 0.3268 | 386.7 | 115684 | 389.7 | SQRT_QMA |
| 1 | 0.111702 | 0.083047 | 1.4697 | 387.9 | 120192 | 390.9 | SQRT_QJF |
| 1 | 0.091242 | 0.061927 | 2.1716 | 388.7 | 122961 | 391.7 | LN_QMJ |
| 1 | 0.003850 | -.028284 | 5.1692 | 391.7 | 134785 | 394.7 | SQRT_QND |
| 2 | 0.194149 | 0.140425 | 0.6417 | 386.7 | 112671 | 391.2 | SQRT_QMA SQRT_QND |
| 2 | 0.175703 | 0.120750 | 1.2744 | 387.5 | 115250 | 392.0 | SQRT_QJF SQRT_QSO |
| 2 | 0.172243 | 0.117060 | 1.3931 | 387.6 | 115734 | 392.1 | SQRT_QMA LN_QMJ |
| 2 | 0.159681 | 0.103660 | 1.8240 | 388.1 | 117490 | 392.6 | SQRT_QMA LN_QJA |
| 3 | 0.223509 | 0.143182 | 1.6346 | 387.5 | 112310 | 393.5 | SQRT_QMA LN_QMJ SQRT_QND |
| 3 | 0.214617 | 0.133370 | 1.9396 | 387.9 | 113596 | 393.9 | SQRT_QJF SQRT_QMA SQRT_QND |
| 3 | 0.204674 | 0.122399 | 2.2807 | 388.3 | 115034 | 394.3 | SQRT_QJF LN_QMJ SQRT_QSO |
| 3 | 0.201876 | 0.119312 | 2.3767 | 388.4 | 115439 | 394.4 | SQRT_QMA LN_QJA SQRT_QND |
| 4 | 0.232166 | 0.122476 | 3.3377 | 389.1 | 115024 | 396.6 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QND |
| 4 | 0.224191 | 0.113361 | 3.6112 | 389.5 | 116219 | 396.9 | SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.223556 | 0.112635 | 3.6330 | 389.5 | 116314 | 397.0 | SQRT_QMA LN_QMJ LN_QJA SQRT_QND |
| 4 | 0.221854 | 0.110690 | 3.6914 | 389.6 | 116569 | 397.0 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 5 | 0.241958 | 0.101580 | 5.0018 | 390.7 | 117763 | 399.7 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.232304 | 0.090138 | 5.3329 | 391.1 | 119263 | 400.1 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QND |
| 5 | 0.227228 | 0.084122 | 5.5071 | 391.3 | 120051 | 400.3 | SQRT_QJF SQRT_QMA LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.224217 | 0.080554 | 5.6103 | 391.5 | 120519 | 400.4 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 6 | 0.242011 | 0.067090 | 7.0000 | 392.7 | 122284 | 403.2 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |

## 5.8 Variables transformed according to the Box-Cox Analysis

N = 33 Regression Models for Dependent Variable: $(\text{WHTE SHRIMP})^{0.2}$

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.179073 | 0.152591 | -0.6147 | -51.7698 | 0.196425 | -48.7768 | $(\text{QMJ\_LAG})^{0.1}$ |
| 1 | 0.176374 | 0.149806 | -0.5214 | -51.6615 | 0.197071 | -48.6685 | $(\text{QMA\_LAG})^{-0.5}$ |
| 1 | 0.129171 | 0.101079 | 1.1108 | -49.8224 | 0.208365 | -46.8294 | $(\text{QJF\_LAG})^{-0.3}$ |
| 1 | 0.064336 | 0.034153 | 3.3526 | -47.4527 | 0.223878 | -44.4597 | $(\text{QND\_LAG})^{-0.3}$ |
| 2 | 0.238466 | 0.187697 | -0.6684 | -52.2481 | 0.188288 | -47.7586 | $(\text{QMA\_Lag})^{-0.5}$ $(\text{QMJ\_Lag})^{0.1}$ |
| 2 | 0.205624 | 0.152666 | 0.4672 | -50.8548 | 0.196408 | -46.3653 | $(\text{QJF\_Lag})^{-0.3}$ $(\text{QMJ\_Lag})^{0.1}$ |
| 2 | 0.195703 | 0.142083 | 0.8103 | -50.4452 | 0.198861 | -45.9557 | $(\text{QMA\_Lag})^{-0.3}$ $(\text{QJA\_Lag})^{-0.2}$ |
| 2 | 0.190159 | 0.136169 | 1.0020 | -50.2185 | 0.200232 | -45.7290 | $(\text{QMJ\_Lag})^{0.1}$ $(\text{QND\_Lag})^{-0.3}$ |
| 3 | 0.240682 | 0.162132 | 1.2550 | -50.3443 | 0.194214 | -44.3583 | $(\text{QMA\_Lag})^{-0.5}$ $(\text{QMJ\_Lag})^{0.1}$ $(\text{QSO\_Lag})^{-0.3}$ |
| 3 | 0.239585 | 0.160921 | 1.2930 | -50.2966 | 0.194494 | -44.3106 | $(\text{QJF\_Lag})^{-0.3}$ $(\text{QMA\_Lag})^{-0.5}$ $(\text{QMJ\_Lag})^{0.1}$ |
| 3 | 0.238774 | 0.160026 | 1.3210 | -50.2614 | 0.194702 | -44.2754 | $(\text{QMA\_Lag})^{-0.5}$ $(\text{QMJ\_Lag})^{0.1}$ $(\text{QJA\_Lag})^{-0.2}$ |
| 3 | 0.238496 | 0.159719 | 1.3306 | -50.2494 | 0.194773 | -44.2634 | $(\text{QMA\_Lag})^{-0.5}$ $(\text{QMJ\_Lag})^{0.1}$ $(\text{QND\_Lag})^{-0.3}$ |
| 4 | 0.247612 | 0.140129 | 3.0154 | -48.6469 | 0.199314 | -41.1643 | $(\text{QJF\_Lag})^{-0.3}$ $(\text{QMA\_Lag})^{-0.5}$ $(\text{QMJ\_Lag})^{0.1}$ $(\text{QSO\_Lag})^{-0.3}$ |
| 4 | 0.241693 | 0.133363 | 3.2201 | -48.3882 | 0.200882 | -40.9057 | $(\text{QMA\_Lag})^{-0.5}$ $(\text{QMJ\_Lag})^{0.1}$ $(\text{QSO\_Lag})^{-0.3}$ $(\text{QND\_Lag})^{-0.3}$ |
| 4 | 0.240978 | 0.132546 | 3.2448 | -48.3571 | 0.201071 | -40.8746 | $(\text{QJF\_Lag})^{-0.3}$ $(\text{QMA\_Lag})^{-0.5}$ $(\text{QMJ\_Lag})^{-0.1}$ $(\text{QND\_Lag})^{-0.3}$ |
| 4 | 0.240824 | 0.132370 | 3.2501 | -48.3505 | 0.201112 | -40.8679 | $(\text{QMA\_Lag})^{-0.5}$ $(\text{QMJ\_Lag})^{-0.1}$ $(\text{QJA\_Lag})^{-0.2}$ $(\text{QSO\_Lag})^{-0.3}$ |
| 5 | 0.248041 | 0.108789 | 5.0006 | -46.6656 | 0.206578 | -37.6866 | $(\text{QJF\_Lag})^{-0.3}$ $(\text{QMA\_Lag})^{-0.5}$ $(\text{QMJ\_Lag})^{0.1}$ $(\text{QJA\_Lag})^{-0.2}$ $(\text{QSO\_Lag})^{-0.3}$ |
| 5 | 0.247639 | 0.108313 | 5.0145 | -46.6480 | 0.206689 | -37.6690 | $(\text{QJF\_Lag})^{-0.3}$ $(\text{QMA\_Lag})^{-0.5}$ $(\text{QMJ\_Lag})^{0.1}$ $(\text{QSO\_Lag})^{-0.3}$ $(\text{QND\_Lag})^{-0.3}$ |
| 5 | 0.241916 | 0.101530 | 5.2124 | -46.3979 | 0.208261 | -37.4189 | $(\text{QMA\_Lag})^{-0.3}$ $(\text{QMJ\_Lag})^{0.1}$ $(\text{QJA\_Lag})^{-0.2}$ $(\text{QSO\_Lag})^{-0.3}$ $(\text{QND\_Lag})^{-0.3}$ |
| 5 | 0.241416 | 0.100937 | 5.2297 | -46.3762 | 0.208398 | -37.3971 | $(\text{QJF\_Lag})^{-0.3}$ $(\text{QMA\_Lag})^{-0.5}$ $(\text{QMJ\_Lag})^{0.1}$ $(\text{QJA\_Lag})^{-0.2}$ $(\text{QND\_Lag})^{-0.3}$ |
| 6 | 0.248057 | 0.074532 | 7.0000 | -44.6664 | 0.214519 | -34.1908 | $(\text{QJF\_Lag})^{-0.3}$ $(\text{QMA\_Lag})^{-0.5}$ $(\text{QMJ\_Lag})^{0.1}$ $(\text{QJA\_Lag})^{-0.2}$ $(\text{QSO\_Lag})^{-0.3}$ $(\text{QND\_Lag})^{-0.3}$ |

# 6. Regression for the Best Models

## 6.1 Model 2: Harvest Untransformed and Logged Inflows

### 6.1.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | Ln(Nov-Dec Inflows), Ln(Jul-Aug Inflows), Ln(May-Jun Inflows), Ln(Sept-Oct Inflows), Ln(Mar-Apr Inflows), Ln(Jan-Feb Inflows)[c,d] | . | .495 | .245 | .070 | 349.0914 | 2.067 |

a. Dependent Variable: White Shrimp Harvest

b. Method: Enter

c. Independent Variables: (Constant), Ln (November-December Inflows), Ln (July-August Inflows), Ln (May-June Inflows), Ln (September-October Inflows), Ln (March-April Inflows), Ln (January-February Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 1026009 | 6 | 171002 | 1.403 | .251[b] |
| | Residual | 3168485 | 26 | 121865 | | |
| | Total | 4194494 | 32 | | | |

a. Dependent Variable: White Shrimp Harvest

b. Independent Variables: (Constant), Ln (November-December Inflows), Ln (July-August Inflows), Ln (May-June Inflows), Ln (September-October Inflows), Ln (March-April Inflows), Ln (January-February Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. |
|---|---|---|---|---|---|---|
| 1 | (Constant) | 78.008 | 306.986 | | .254 | .801 |
| | Ln (January-February Inflows) | 117.998 | 105.344 | .353 | 1.120 | .273 |
| | Ln (March-April Inflows) | 108.888 | 95.102 | .303 | 1.145 | .263 |
| | Ln (May-June Inflows) | 22.256 | 56.828 | .094 | .392 | .699 |
| | Ln (July-August Inflows) | 15.135 | 56.612 | .054 | .267 | .791 |
| | Ln (September-October Inflows) | -50.447 | 64.181 | -.207 | -.786 | .439 |
| | Ln (November-December Inflows) | -53.637 | 83.794 | -.173 | -.640 | .528 |

a. Dependent Variable: White Shrimp Harvest

## 6.1.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 78.008295 | 306.98564362 | 0.254 | 0.8014 | 0.00000000 |
| LN_QJF | 1 | 117.998365 | 105.34429334 | 1.120 | 0.2729 | 3.40961792 |
| LN_QMA | 1 | 108.887727 | 95.10150747 | 1.145 | 0.2627 | 2.41803917 |
| LN_QMJ | 1 | 22.255675 | 56.82765575 | 0.392 | 0.6985 | 1.97038156 |
| LN_QJA | 1 | 15.134706 | 56.61181255 | 0.267 | 0.7913 | 1.42324529 |
| LN_QSO | 1 | -50.446862 | 64.18121550 | -0.786 | 0.4390 | 2.38475613 |
| LN_QND | 1 | -53.636863 | 83.79408839 | -0.640 | 0.5277 | 2.51688504 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop LN_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop LN_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 3.13466 | 1.00000 | 0.0249 | 0.0242 | 0.0218 | 0.0010 | 0.0248 | 0.0287 |
| 2 | 1.27425 | 1.56844 | 0.0001 | 0.0051 | 0.1069 | 0.3768 | 0.0002 | 0.0098 |
| 3 | 0.77079 | 2.01664 | 0.0000 | 0.2188 | 0.0638 | 0.0149 | 0.2301 | 0.0288 |
| 4 | 0.36156 | 2.94446 | 0.0000 | 0.0801 | 0.4330 | 0.5056 | 0.1018 | 0.3005 |
| 5 | 0.26664 | 3.42870 | 0.3745 | 0.0598 | 0.3401 | 0.0752 | 0.0486 | 0.5704 |
| 6 | 0.19210 | 4.03955 | 0.6005 | 0.6119 | 0.0344 | 0.0265 | 0.5944 | 0.0617 |

### 6.1.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 226.6966 | 1127.873 | 522.1030 | 179.0609 | 33 |
| Std. Predicted Value | -1.650 | 3.383 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | 87.1495 | 233.3955 | 155.0334 | 43.2604 | 33 |
| Adjusted Predicted Value | 73.1909 | 1038.451 | 525.0517 | 197.6689 | 33 |
| Residual | -462.3432 | 1026.833 | 2.1E-14 | 314.6667 | 33 |
| Std. Residual | -1.324 | 2.941 | .000 | .901 | 33 |
| Stud. Residual | -1.456 | 3.208 | -.003 | 1.012 | 33 |
| Deleted Residual | -643.2291 | 1221.587 | -2.9487 | 399.6363 | 33 |
| Stud. Deleted Residual | -1.490 | 4.048 | .030 | 1.115 | 33 |
| Mahal. Distance | 1.025 | 13.334 | 5.818 | 3.754 | 33 |
| Cook's Distance | .000 | .279 | .040 | .067 | 33 |
| Centered Leverage Value | .032 | .417 | .182 | .117 | 33 |

a. Dependent Variable: White Shrimp Harvest

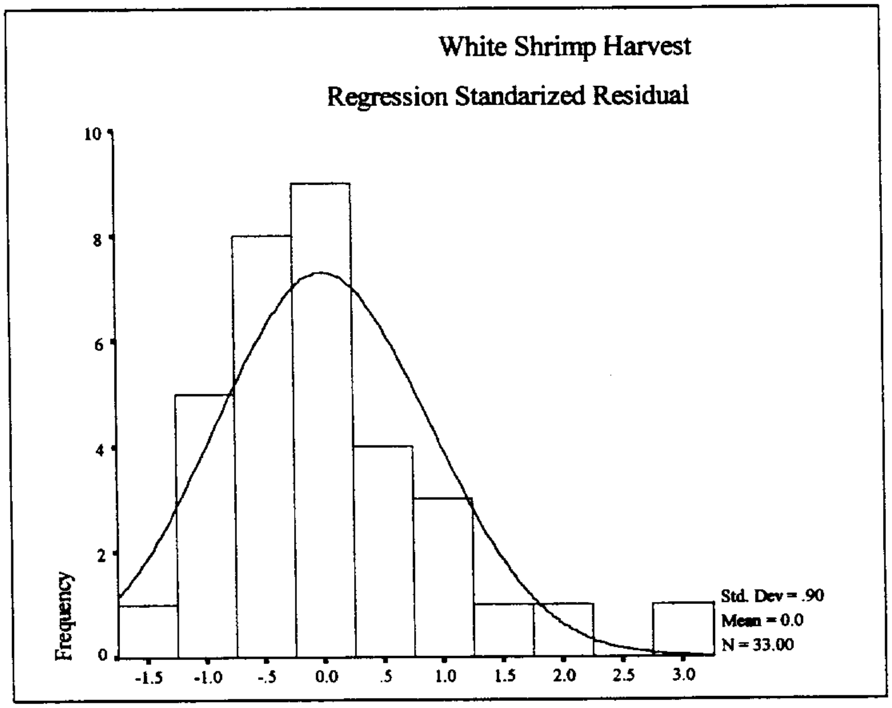
*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 346.45014 | -149.75014 | -169.49141 | 366.19141 | -.98097 | -.42897 | -.45637 | -.44931 |
| 1963 | 413.10238 | -317.30238 | -372.88583 | 468.68583 | -.60874 | -.90894 | -.98534 | -.98477 |
| 1964 | 324.31761 | -81.41761 | -96.70760 | 339.60760 | -1.10457 | -.23323 | -.25419 | -.24956 |
| 1965 | 689.04324 | -462.34324 | -558.61292 | 785.31292 | .93231 | -1.32442 | -1.45579 | -1.48952 |
| 1966 | 621.70794 | -151.80794 | -203.16288 | 673.06288 | .55626 | -.43487 | -.50307 | -.49572 |
| 1967 | 419.86838 | -76.16838 | -83.55929 | 427.25929 | -.57095 | -.21819 | -.22853 | -.22432 |
| 1968 | 713.81233 | -80.11233 | -138.83703 | 772.53703 | 1.07064 | -.22949 | -.30211 | -.29676 |
| 1969 | 513.16349 | -274.66349 | -309.17404 | 547.67404 | -.04992 | -.78680 | -.83476 | -.82975 |
| 1970 | 498.93779 | -292.13779 | -391.94391 | 598.74391 | -.12937 | -.83685 | -.96932 | -.96815 |
| 1971 | 452.82237 | -368.72237 | -643.22908 | 727.32908 | -.38691 | -1.05623 | -1.39506 | -1.42224 |
| 1972 | 329.89210 | -5.09210 | -7.09679 | 331.89679 | -1.07344 | -.01459 | -.01722 | -.01689 |
| 1973 | 428.42543 | 444.57457 | 520.07916 | 352.92084 | -.52316 | 1.27352 | 1.37742 | 1.40283 |
| 1974 | 404.11562 | -112.11562 | -195.45143 | 487.45143 | -.65892 | -.32116 | -.42405 | -.41726 |
| 1975 | 451.09196 | 10.00804 | 11.45815 | 449.64185 | -.39658 | .02867 | .03068 | .03008 |
| 1976 | 309.30645 | 100.99355 | 131.05798 | 279.24202 | -1.18840 | .28930 | .32956 | .32384 |
| 1977 | 747.76732 | -179.76732 | -314.09830 | 882.09830 | 1.26027 | -.51496 | -.68069 | -.67350 |
| 1978 | 432.38395 | 89.31605 | 100.51383 | 421.18617 | -.50105 | .25585 | .27142 | .26652 |
| 1979 | 650.48098 | 402.41902 | 612.02131 | 440.87869 | .71695 | 1.15276 | 1.42162 | 1.45157 |
| 1980 | 520.68835 | -119.88835 | -155.52550 | 556.32550 | -.00790 | -.34343 | -.39116 | -.38469 |
| 1981 | 523.05018 | -186.55018 | -228.83062 | 565.33062 | .00529 | -.53439 | -.59186 | -.58431 |
| 1982 | 485.99198 | -85.89198 | -104.76303 | 504.86303 | -.20167 | -.24604 | -.27173 | -.26683 |
| 1983 | 520.64812 | -54.54812 | -60.76285 | 526.86285 | -.00813 | -.15626 | -.16492 | -.16180 |
| 1984 | 484.26739 | 1026.83261 | 1221.58650 | 289.51350 | -.21130 | 2.94144 | **3.20828** | **4.04760** |
| 1985 | 651.61133 | -376.91133 | -410.66534 | 685.36534 | .72326 | -1.07969 | -1.12700 | -1.13314 |
| 1986 | 226.69661 | 384.40339 | 537.90913 | 73.19087 | -1.64975 | 1.10115 | 1.30259 | 1.32113 |
| 1987 | 769.89577 | -5.59577 | -8.24528 | 772.54528 | 1.38385 | -.01603 | -.01946 | -.01908 |
| 1988 | 332.04548 | 131.35452 | 148.90222 | 314.49778 | -1.06141 | .37628 | .40062 | .39406 |
| 1989 | 319.42687 | -231.32687 | -274.45468 | 362.55468 | -1.13188 | -.66265 | -.72179 | -.71497 |
| 1990 | 700.99457 | 643.90543 | 824.59565 | 520.30435 | .99905 | 1.84452 | 2.08734 | 2.24338 |
| 1991 | 608.38910 | 381.81090 | 443.51604 | 546.68396 | .48188 | 1.09373 | 1.17880 | 1.18809 |
| 1992 | 1127.87296 | 110.62704 | 200.04858 | 1038.45142 | 3.38304 | .31690 | .42615 | .41934 |
| 1993 | 641.67280 | 33.82720 | 36.29666 | 639.20334 | .66776 | .09690 | .10038 | .09845 |
| 1994 | 569.45899 | -147.95899 | -157.79322 | 579.29322 | .26447 | -.42384 | -.43770 | -.43079 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.

[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



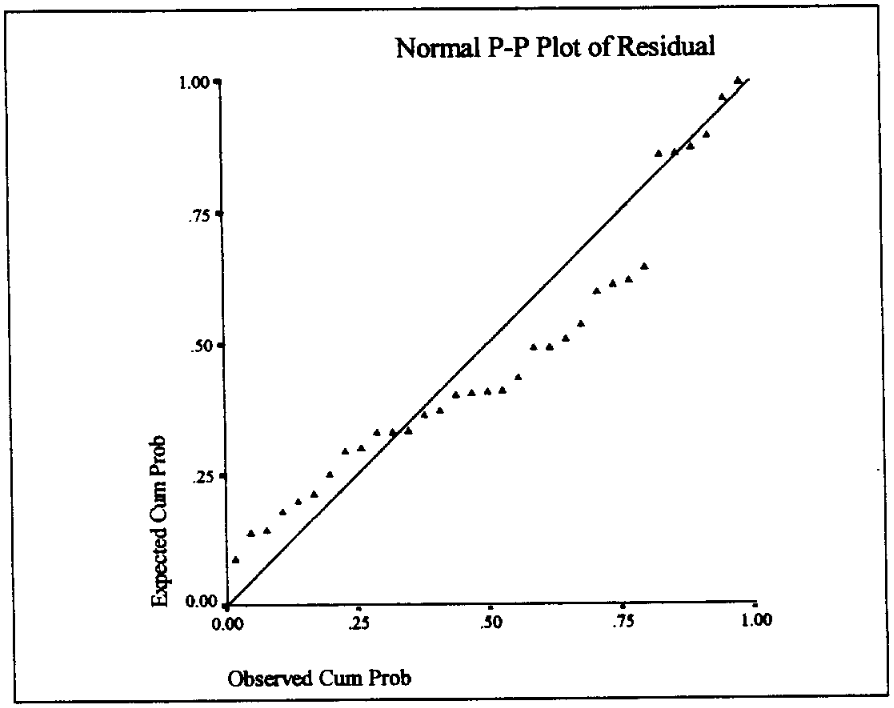




Fig. 6.1.1. Exploratory Plots of White Shrimp Harvest Standardized Residual.

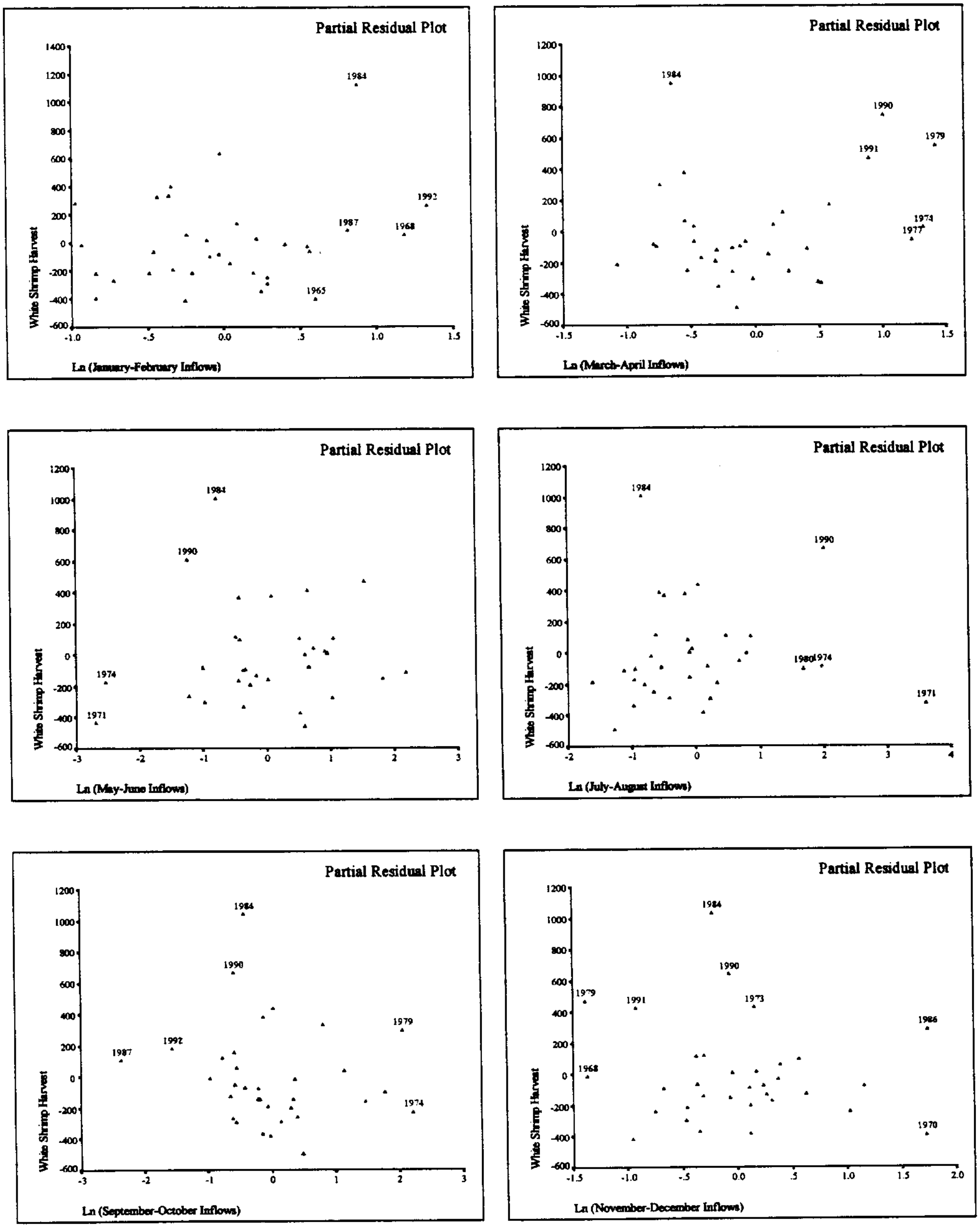



Fig. 6.1.2. Partial Residual Plots of White Shrimp Harvest vs. Logged Inflows.

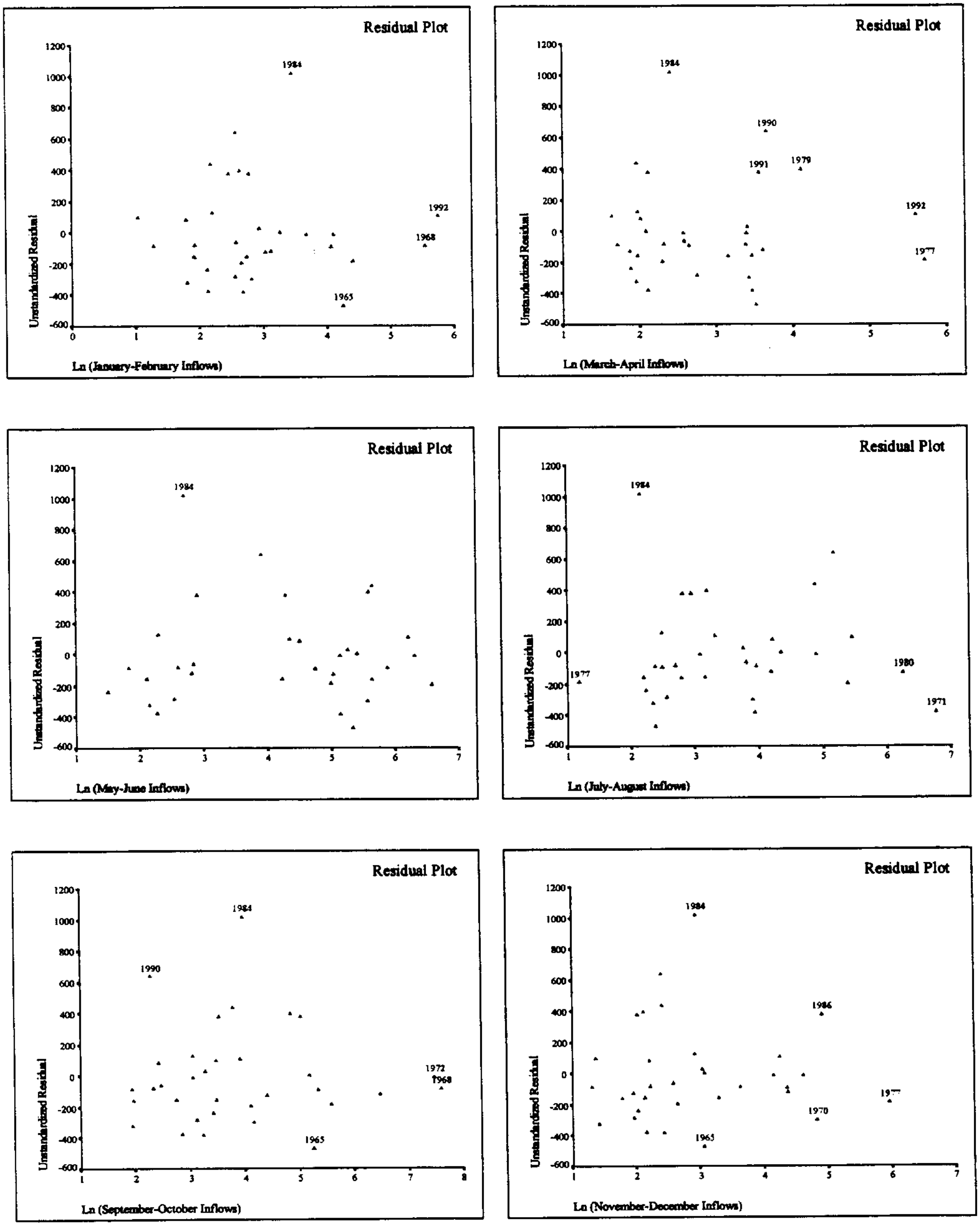



Fig. 6.1.3. Residual Plots of White Shrimp Harvest vs. Logged Inflows.

### 6.1.4 Prediction Intervals for White Shrimp Harvest

| YEAR | W_SH | LICI | UICI |
|---|---|---|---|
| **1962** | 196.70 | 0.00000 | 1371.41107 |
| **1963** | 95.80 | 0.00000 | 1452.91479 |
| **1964** | 242.90 | 0.00000 | 1368.21336 |
| **1965** | 226.70 | 0.00000 | 1739.33348 |
| **1966** | 469.90 | 0.00000 | 1707.43337 |
| **1967** | 343.70 | 0.00000 | 1431.88475 |
| **1968** | 633.70 | 0.00000 | 1870.94150 |
| **1969** | 238.50 | 0.00000 | 1535.89493 |
| **1970** | 206.80 | 0.00000 | 1585.47181 |
| **1971** | 84.10 | 0.00000 | 1611.49058 |
| **1972** | 324.80 | 0.00000 | 1428.41257 |
| **1973** | 873.00 | 0.00000 | 1466.47904 |
| **1974** | 292.00 | 0.00000 | 1562.62649 |
| **1975** | 461.10 | 0.00000 | 1480.67087 |
| **1976** | 410.30 | 0.00000 | 1384.85328 |
| **1977** | 568.00 | 0.00000 | 1906.80426 |
| **1978** | 521.70 | 0.00000 | 1455.01586 |
| **1979** | 1052.90 | 0.00000 | 1774.40324 |
| **1980** | 400.80 | 0.00000 | 1596.12247 |
| **1981** | 336.50 | 0.00000 | 1578.89390 |
| **1982** | 400.10 | 0.00000 | 1539.76765 |
| **1983** | 466.10 | 0.00000 | 1539.07240 |
| **1984** | 1511.10 | 0.00000 | 1528.75863 |
| **1985** | 274.70 | 0.00000 | 1660.71444 |
| **1986** | 611.10 | 0.00000 | 1326.45679 |
| **1987** | 764.30 | 0.00000 | 1884.93401 |
| **1988** | 463.40 | 0.00000 | 1357.63670 |
| **1989** | 88.10 | 0.00000 | 1362.88745 |
| **1990** | 1344.90 | 0.00000 | 1772.03869 |
| **1991** | 990.20 | 0.00000 | 1643.69622 |
| **1992** | 1238.50 | 0.00000 | 2294.72886 |
| **1993** | 675.50 | 0.00000 | 1644.15339 |
| **1994** | 421.50 | 0.00000 | 1569.25521 |

**W_SH** White shrimp harvest
**LICI** Lower limit for 99% prediction interval for white shrimp harvest
**UICI** Upper limit for 99% prediction interval for white shrimp harvest

### 6.1.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| 1962 | 2.75746 | .00392 | .08617 | .9065 | .0000 |
| 1963 | 3.80032 | .02430 | .11876 | .8025 | .0000 |
| 1964 | 4.08968 | .00173 | .12780 | .7694 | .0000 |
| 1965 | 4.54509 | .06304 | .14203 | .7153 | .0005 |
| 1966 | 7.11917 | .01223 | .22247 | .4166 | .0000 |
| 1967 | 1.86074 | .00072 | .05815 | .9671 | .0000 |
| 1968 | 12.56553 | .00956 | .39267 | .0834 | .0000 |
| 1969 | 2.60220 | .01251 | .08132 | .9192 | .0000 |
| 1970 | 7.17891 | .04586 | .22434 | .4105 | .0002 |
| 1971 | 12.68674 | .20699 | .39646 | .0801 | .0193 |
| 1972 | 8.06962 | .00002 | .25218 | .3265 | .0000 |
| 1973 | 3.67603 | .04603 | .11488 | .8162 | .0002 |
| 1974 | 12.67434 | .01909 | .39607 | .0805 | .0000 |
| 1975 | 3.08012 | .00002 | .09625 | .8775 | .0000 |
| 1976 | 6.37104 | .00462 | .19909 | .4972 | .0000 |
| 1977 | 12.71580 | .04946 | .39737 | .0793 | .0002 |
| 1978 | 2.59528 | .00132 | .08110 | .9198 | .0000 |
| 1979 | 9.98952 | .15038 | .31217 | .1892 | .0076 |
| 1980 | 6.36279 | .00650 | .19884 | .4981 | .0000 |
| 1981 | 4.94286 | .01134 | .15446 | .6669 | .0000 |
| 1982 | 4.79449 | .00232 | .14983 | .6850 | .0000 |
| 1983 | 2.30321 | .00044 | .07198 | .9412 | .0000 |
| 1984 | 4.13197 | .27889 | .12912 | .7645 | .0436 |
| 1985 | 1.66049 | .01625 | .05189 | .9762 | .0000 |
| 1986 | 8.16230 | .09680 | .25507 | .3185 | .0019 |
| 1987 | 9.31306 | .00003 | .29103 | .2310 | .0000 |
| 1988 | 2.80141 | .00306 | .08754 | .9027 | .0000 |
| 1989 | 4.05878 | .01388 | .12684 | .7730 | .0000 |
| 1990 | 6.04233 | .17466 | .18882 | .5348 | .0118 |
| 1991 | 3.48237 | .03208 | .10882 | .8371 | .0001 |
| 1992 | 13.33428 | .02097 | .41670 | .0644 | .0000 |
| 1993 | 1.20744 | .00011 | .03773 | .9908 | .0000 |
| 1994 | 1.02466 | .00182 | .03202 | .9944 | .0000 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1962** | -.16314 | -.14311 | -.00595 | .04023 | .03386 | .07457 | .01913 | .00764 |
| **1963** | -.41216 | -.36325 | -.09146 | .08250 | .06241 | .16818 | .11014 | .11901 |
| **1964** | -.10815 | -.09568 | .00718 | .01306 | .01634 | .04196 | .01026 | .02393 |
| **1965** | -.67969 | -.10477 | -.29542 | .06461 | -.15920 | .33964 | -.14694 | .37630 |
| **1966** | -.28832 | -.11781 | .08494 | -.01571 | -.20501 | .15021 | .06790 | .04282 |
| **1967** | -.06988 | -.05444 | .00192 | .00723 | .01240 | .02026 | .02473 | -.00612 |
| **1968** | -.25408 | .06761 | -.13923 | .03180 | .02330 | -.01186 | -.10578 | .12855 |
| **1969** | -.29412 | -.15408 | -.07566 | -.06223 | .13881 | .05816 | -.02390 | .15828 |
| **1970** | -.56588 | .12112 | .28385 | .00649 | -.18920 | -.04011 | .12474 | -.46518 |
| **1971** | **-1.22715** | .38021 | -.13989 | -.25295 | .82415 | **-1.09760** | .04899 | -.05348 |
| **1972** | -.01060 | .00110 | .00276 | .00257 | -.00199 | .00223 | -.00651 | -.00179 |
| **1973** | .57812 | .04934 | -.15653 | -.22719 | .38192 | .01346 | .00878 | .05686 |
| **1974** | -.35974 | .16919 | .13969 | -.19858 | .22673 | -.17671 | -.22415 | -.03513 |
| **1975** | .01145 | .00040 | .00206 | -.00696 | .00483 | -.00053 | .00218 | -.00039 |
| **1976** | .17669 | .00037 | -.10367 | .02220 | .03108 | .05217 | .07733 | -.03311 |
| **1977** | -.58220 | .15147 | .19418 | -.29770 | .03788 | .11549 | -.04922 | -.21807 |
| **1978** | .09437 | .03883 | -.02045 | -.03643 | .04884 | -.00560 | -.03992 | .02669 |
| **1979** | **1.04760** | -.15067 | -.52568 | .69277 | .19328 | -.16260 | .67504 | -.59407 |
| **1980** | -.20974 | .04905 | -.07464 | .05033 | .01105 | -.11927 | -.02780 | .07096 |
| **1981** | -.27817 | .03498 | .03996 | .09354 | -.19193 | -.03466 | .00775 | -.01734 |
| **1982** | -.12507 | -.03202 | -.04886 | .08646 | -.03211 | .05352 | .02258 | -.04406 |
| **1983** | -.05461 | -.01428 | -.02065 | .00328 | .02759 | -.01887 | .03036 | -.00980 |
| **1984** | **1.76275** | .96533 | **1.17374** | -.77445 | -.55449 | -.59413 | -.33878 | -.23113 |
| **1985** | -.33910 | .02961 | .08949 | -.16692 | -.10067 | -.02086 | .00443 | .09752 |
| **1986** | .83486 | .11634 | -.16999 | -.31425 | -.10970 | -.03915 | -.03520 | .65325 |
| **1987** | -.01313 | .00229 | -.00569 | .00485 | -.00364 | -.00300 | .01006 | -.00643 |
| **1988** | .14403 | .10267 | .01096 | -.06229 | -.03219 | -.04212 | -.04504 | .05669 |
| **1989** | -.30871 | -.21147 | -.04511 | .03693 | .15368 | .08321 | -.05702 | .08552 |
| **1990** | **1.18839** | -.41245 | -.01528 | .69828 | -.50730 | .83026 | -.27144 | -.04396 |
| **1991** | .47762 | .05672 | -.16815 | .31209 | .01766 | -.10019 | .19069 | -.28304 |
| **1992** | .37701 | -.11835 | .22618 | .08979 | -.03750 | .04352 | -.16092 | -.04147 |
| **1993** | .02660 | -.00069 | -.00336 | .00402 | .01223 | -.00098 | -.01030 | .00427 |
| **1994** | -.11106 | -.00424 | .04485 | -.04938 | -.00179 | .00648 | .01539 | -.03337 |

**DFFITS** Standardized dffits value
**SDFB_0** Standardized dfbeta for the intercept term
**SDFB_1** Standardized dfbeta for the Logged January-February inflows
**SDFB_2** Standardized dfbeta for the Logged March-April inflows
**SDFB_3** Standardized dfbeta for the Logged May-June inflows
**SDFB_4** Standardized dfbeta for the Logged July-August inflows
**SDFB_5** Standardized dfbeta for the Logged September-October inflows
**SDFB_6** Standardized dfbeta for the Logged November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

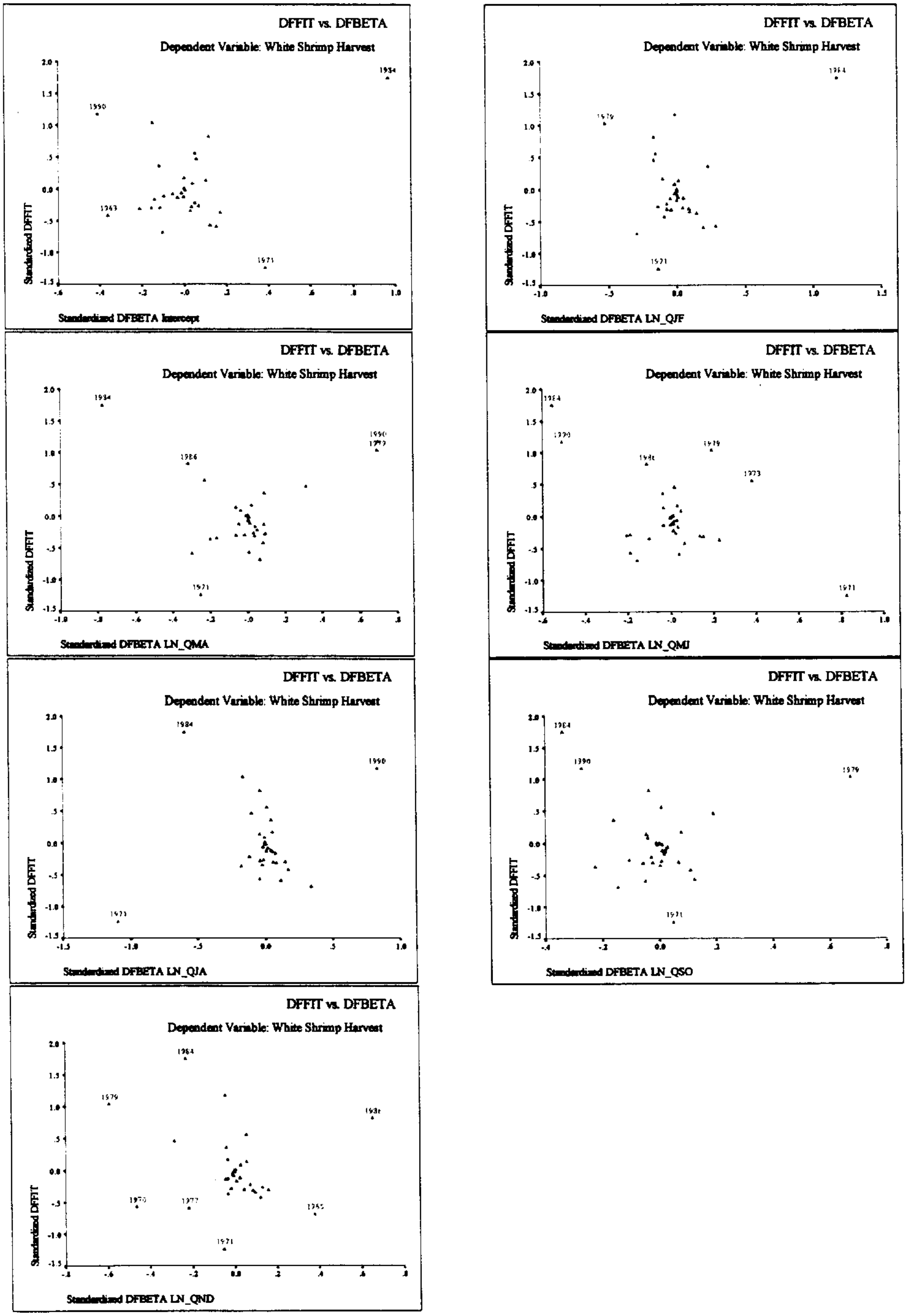



Fig. 6.1.4. Standardized DFFIT vs. Standardized DFBETA.

## 6.2 Model 3: Logged All Variables

### 6.2.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | Ln(Nov-Dec Inflows), Ln(Jul-Aug Inflows), Ln(May-Jun Inflows), Ln(Sept-Oct Inflows), Ln(Mar-Apr Inflows), Ln(Jan-Feb Inflows)[c,d] | . | .530 | .281 | .115 | .687600 | 1.964 |

a. Dependent Variable: Ln (White Shrimp Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Ln (November-December Inflows), Ln (July-August Inflows), Ln (May-June Inflows), Ln (September-October Inflows), Ln (March-April Inflows), Ln (January-February Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 4.810 | 6 | .802 | 1.696 | .162[b] |
| | Residual | 12.293 | 26 | .473 | | |
| | Total | 17.102 | 32 | | | |

a. Dependent Variable: Ln (White Shrimp Harvest)

b. Independent Variables: (Constant), Ln (November-December Inflows), Ln (July-August Inflows), Ln (May-June Inflows), Ln (September-October Inflows), Ln (March-April Inflows), Ln (January-February Inflows)

**Coefficients^a**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| 1 | (Constant) | 4.982 | .605 | | 8.240 | .000 | 3.739 | 6.225 |
| | Ln (January-February Inflows) | 9.7E-02 | .207 | .144 | .469 | .643 | -.329 | .524 |
| | Ln (March-April Inflows) | .135 | .187 | .186 | .721 | .477 | -.250 | .520 |
| | Ln (May-June Inflows) | .180 | .112 | .376 | 1.611 | .119 | -.050 | .410 |
| | Ln (July-August Inflows) | -2.3E-02 | .112 | -.041 | -.209 | .836 | -.252 | .206 |
| | Ln (September-October Inflows) | -7.0E-02 | .126 | -.142 | -.552 | .586 | -.330 | .190 |
| | Ln (November-December Inflows) | -1.0E-02 | .165 | -.016 | -.060 | .952 | -.349 | .329 |

a. Dependent Variable: Ln (White Shrimp Harvest)

## 6.2.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 4.982277 | 0.60466482 | 8.240 | 0.0001 | 0.00000000 |
| LN_QJF | 1 | 0.097295 | 0.20749501 | 0.469 | 0.6430 | 3.40961792 |
| LN_QMA | 1 | 0.135118 | 0.18731995 | 0.721 | 0.4771 | 2.41803917 |
| LN_QMJ | 1 | 0.180320 | 0.11193254 | 1.611 | 0.1193 | 1.97038156 |
| LN_QJA | 1 | -0.023268 | 0.11150740 | -0.209 | 0.8363 | 1.42324529 |
| LN_QSO | 1 | -0.069767 | 0.12641674 | -0.552 | 0.5857 | 2.38475613 |
| LN_QND | 1 | -0.009963 | 0.16504790 | -0.060 | 0.9523 | 2.51688504 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop LN_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop LN_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 3.13466 | 1.00000 | 0.0249 | 0.0242 | 0.0218 | 0.0010 | 0.0248 | 0.0287 |
| 2 | 1.27425 | 1.56844 | 0.0001 | 0.0051 | 0.1069 | 0.3768 | 0.0002 | 0.0098 |
| 3 | 0.77079 | 2.01664 | 0.0000 | 0.2188 | 0.0638 | 0.0149 | 0.2301 | 0.0288 |
| 4 | 0.36156 | 2.94446 | 0.0000 | 0.0801 | 0.4330 | 0.5056 | 0.1018 | 0.3005 |
| 5 | 0.26664 | 3.42870 | 0.3745 | 0.0598 | 0.3401 | 0.0752 | 0.0486 | 0.5704 |
| 6 | 0.19210 | 4.03955 | 0.6005 | 0.6119 | 0.0344 | 0.0265 | 0.5944 | 0.0617 |

### 6.2.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics**[a]

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 5.403727 | 7.024878 | 6.021872 | .387691 | 33 |
| Std. Predicted Value | -1.594 | 2.587 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | .171657 | .459715 | .305367 | 8.5E-02 | 33 |
| Adjusted Predicted Value | 5.271801 | 6.946650 | 6.034672 | .420743 | 33 |
| Residual | -1.074526 | 1.543165 | 4.0E-16 | .619794 | 33 |
| Std. Residual | -1.563 | 2.244 | .000 | .901 | 33 |
| Stud. Residual | -2.064 | 2.448 | -.008 | 1.020 | 33 |
| Deleted Residual | -1.874490 | 1.835849 | -1.3E-02 | .800640 | 33 |
| Stud. Deleted Residual | -2.213 | 2.736 | -.005 | 1.066 | 33 |
| Mahal. Distance | 1.025 | 13.334 | 5.818 | 3.754 | 33 |
| Cook's Distance | .000 | .453 | .044 | .086 | 33 |
| Centered Leverage Value | .032 | .417 | .182 | .117 | 33 |

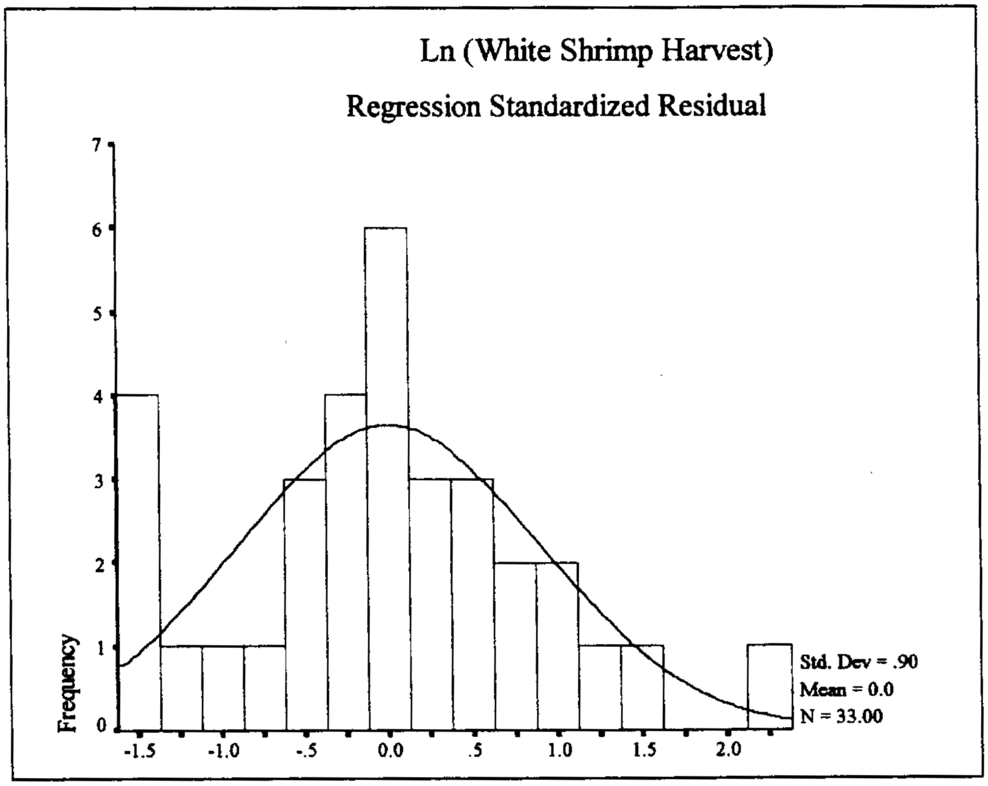
a. Dependent Variable: Ln (White Shrimp Harvest)

*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 5.55350 | -.27182 | -.30766 | 5.58934 | -1.20810 | -.39532 | -.42057 | -.41382 |
| 1963 | 5.60602 | -1.04375 | -1.22659 | 5.78886 | -1.07264 | -1.51797 | -1.64556 | -1.70482 |
| 1964 | 5.46498 | .02767 | .03286 | 5.45979 | -1.43643 | .04024 | .04386 | .04301 |
| 1965 | 6.38291 | -.95928 | -1.15903 | 6.58265 | .93125 | -1.39512 | -1.53350 | -1.57672 |
| 1966 | 6.39404 | -.24152 | -.32322 | 6.47574 | .95996 | -.35125 | -.40634 | -.39972 |
| 1967 | 5.70380 | .13597 | .14917 | 5.69060 | -.82043 | .19775 | .20712 | .20327 |
| 1968 | 6.38245 | .06913 | .11980 | 6.33178 | .93006 | .10053 | .13235 | .12982 |
| 1969 | 5.76531 | -.29094 | -.32750 | 5.80187 | -.66177 | -.42313 | -.44892 | -.44192 |
| 1970 | 6.29506 | -.96330 | -1.29241 | 6.62416 | .70464 | -1.40097 | -1.62273 | -1.67848 |
| 1971 | 5.50653 | -1.07453 | -1.87449 | 6.30650 | -1.32925 | -1.56272 | -2.06402 | -2.21338 |
| 1972 | 5.97803 | -.19482 | -.27151 | 6.05472 | -.11309 | -.28333 | -.33448 | -.32869 |
| 1973 | 6.07764 | .69429 | .81221 | 5.95973 | .14386 | 1.00973 | 1.09212 | 1.09635 |
| 1974 | 5.68840 | -.01165 | -.02030 | 5.69705 | -.86015 | -.01694 | -.02236 | -.02193 |
| 1975 | 6.06450 | .06912 | .07913 | 6.05448 | .10994 | .10052 | .10756 | .10549 |
| 1976 | 5.70719 | .30970 | .40189 | 5.61500 | -.81169 | .45041 | .51309 | .50569 |
| 1977 | 6.60662 | -.26450 | -.46215 | 6.80427 | 1.50829 | -.38467 | -.50847 | -.50110 |
| 1978 | 5.95356 | .30353 | .34158 | 5.91551 | -.17620 | .44143 | .46829 | .46114 |
| 1979 | 6.36908 | .59023 | .89765 | 6.06165 | .89557 | .85839 | 1.05859 | 1.06115 |
| 1980 | 5.96837 | .02509 | .03255 | 5.96092 | -.13799 | .03649 | .04156 | .04075 |
| 1981 | 6.30264 | -.48404 | -.59375 | 6.41235 | .72421 | -.70396 | -.77966 | -.77362 |
| 1982 | 6.11777 | -.12606 | -.15375 | 6.14546 | .24736 | -.18333 | -.20247 | -.19869 |
| 1983 | 5.80901 | .33539 | .37360 | 5.77080 | -.54906 | .48777 | .51481 | .50740 |
| 1984 | 5.77743 | 1.54317 | 1.83585 | 5.48474 | -.63051 | 2.24428 | 2.44787 | **2.73626** |
| 1985 | 6.29703 | -.68135 | -.74237 | 6.35805 | .70973 | -.99091 | -1.03433 | -1.03577 |
| 1986 | 5.59812 | .81714 | 1.14346 | 5.27180 | -1.09303 | 1.18840 | 1.40580 | 1.43408 |
| 1987 | 6.61104 | .02793 | .04115 | 6.59781 | 1.51967 | .04061 | .04930 | .04834 |
| 1988 | 5.57850 | .56010 | .63492 | 5.50367 | -1.14363 | .81457 | .86727 | .86300 |
| 1989 | 5.40373 | -.92525 | -1.09776 | 5.57623 | -1.59443 | -1.34563 | -1.46571 | -1.50058 |
| 1990 | 6.12883 | 1.07525 | 1.37698 | 5.82709 | .27588 | 1.56377 | 1.76963 | 1.85027 |
| 1991 | 6.14024 | .75767 | .88012 | 6.01779 | .30531 | 1.10191 | 1.18761 | 1.19748 |
| 1992 | 7.02488 | .09678 | .17501 | 6.94665 | 2.58712 | .14075 | .18927 | .18572 |
| 1993 | 6.33216 | .18329 | .19667 | 6.31878 | .80036 | .26656 | .27612 | .27116 |
| 1994 | 6.13244 | -.08862 | -.09451 | 6.13833 | .28519 | -.12888 | -.13309 | -.13055 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.
[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



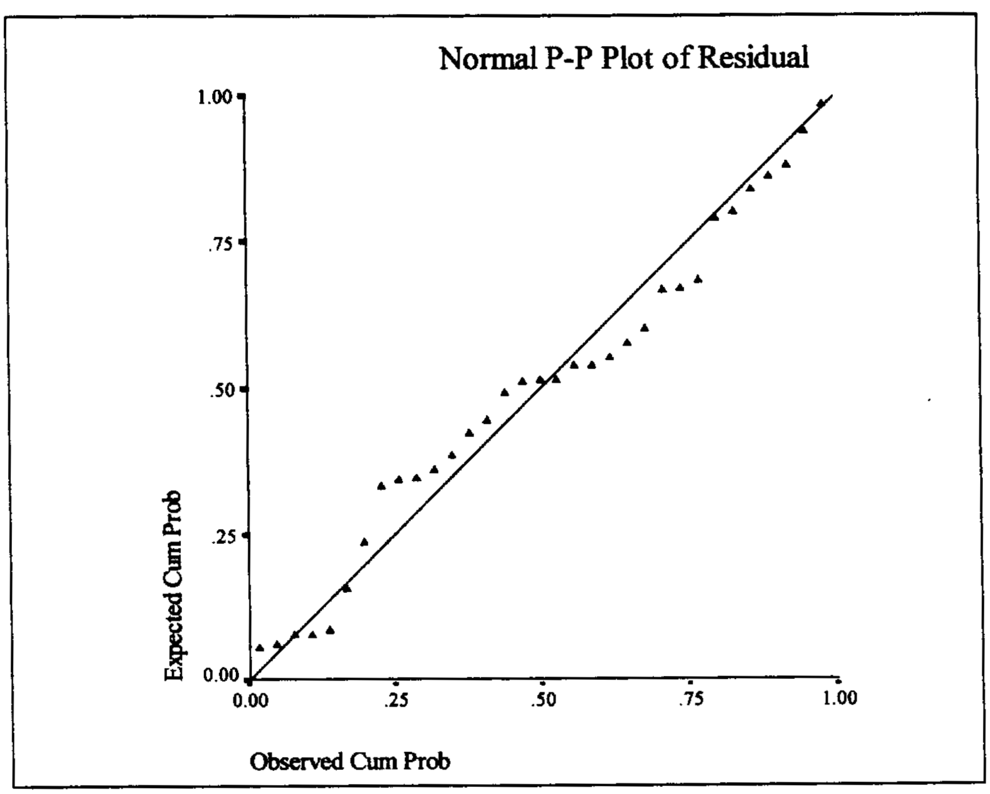




Fig. 6.2.1. Exploratory Plots of Ln (White Shrimp Harvest) Standardized Residual.

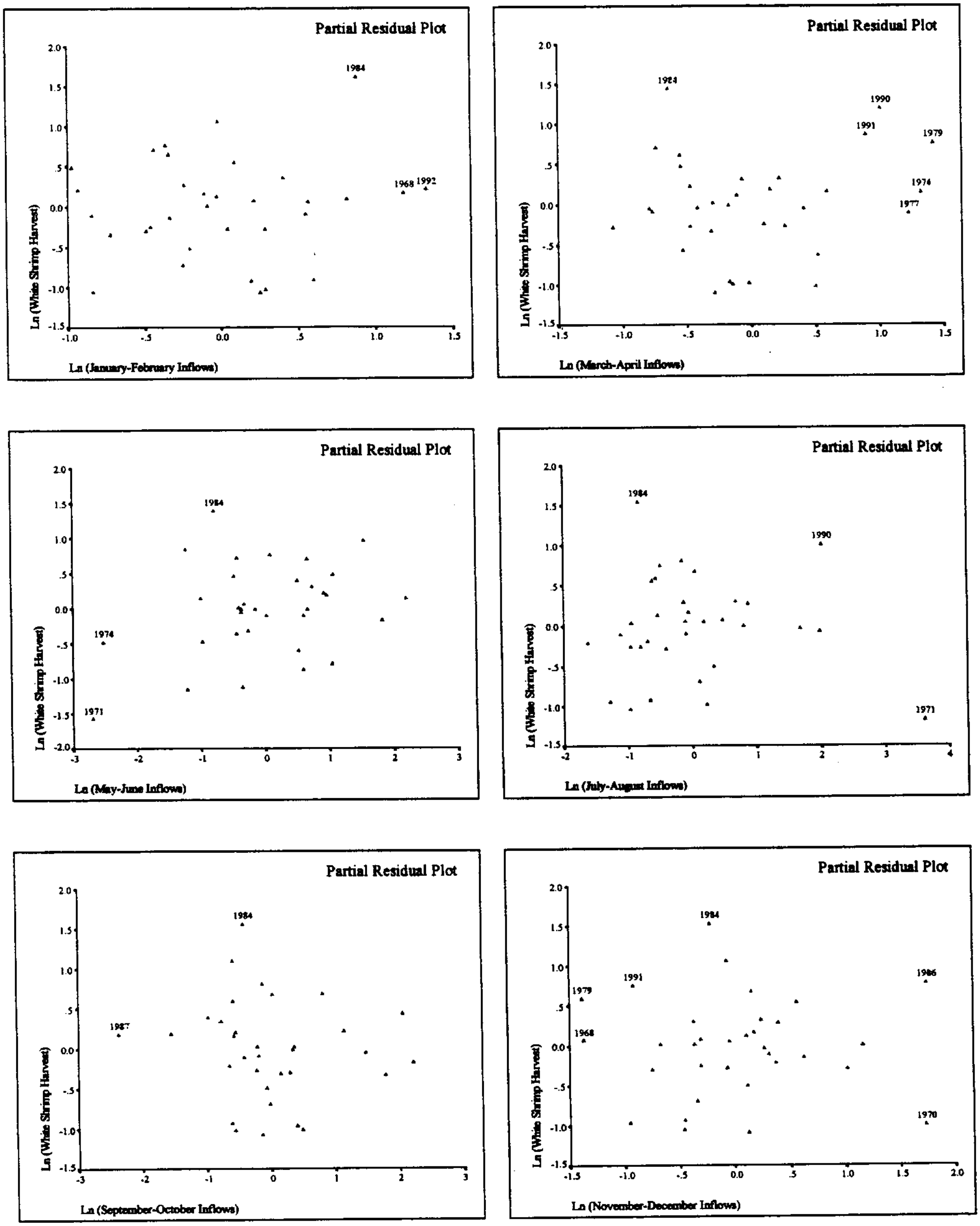



Fig. 6.2.2. Partial Residual Plots of Ln (White Shrimp Harvest) vs. Logged Inflows.

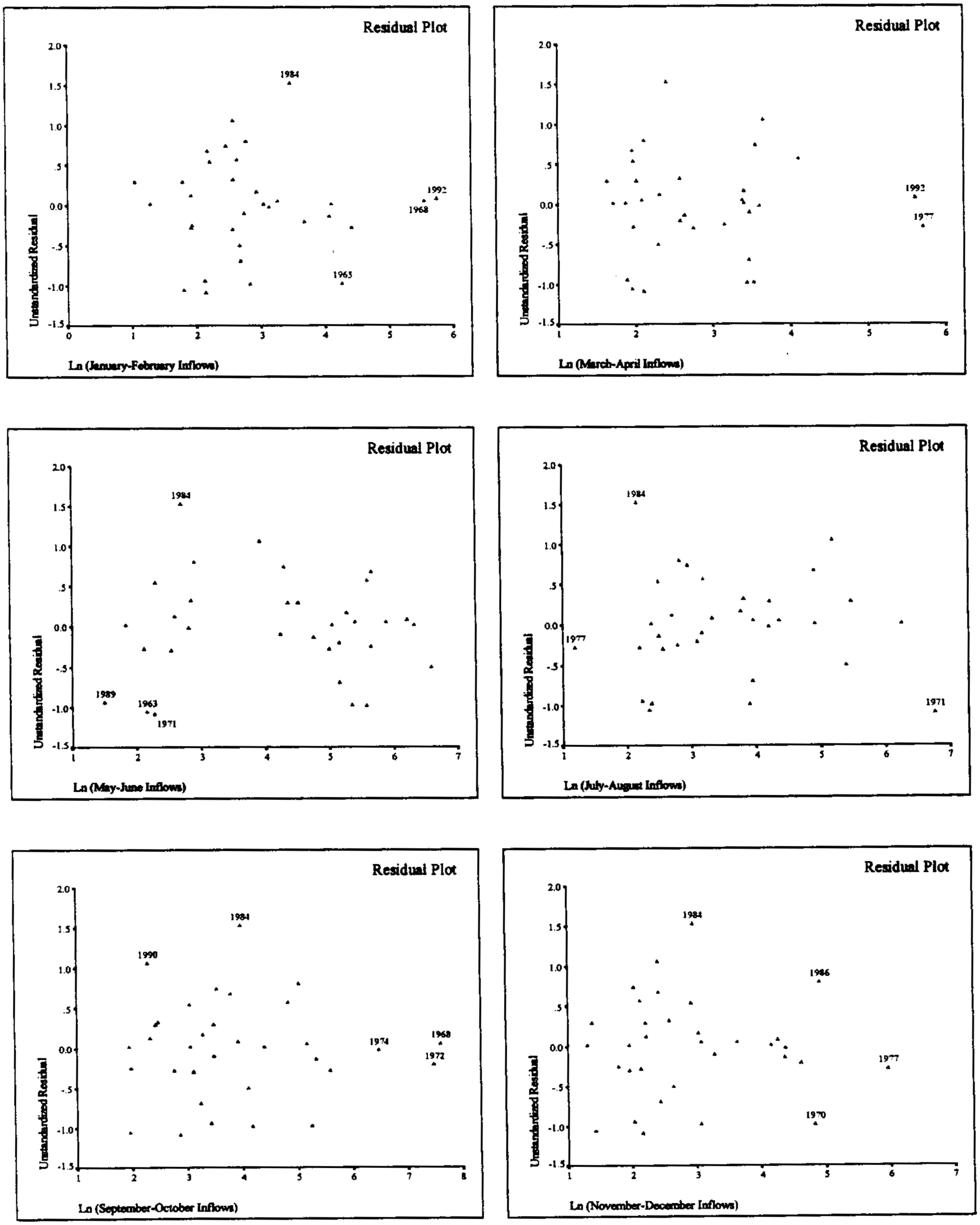



Fig. 6.2.3. Residual Plots of Ln (White Shrimp Harvest) vs. Logged Inflows.

### 6.2.4 Prediction Intervals for Ln (White Shrimp Harvest)

| YEAR | Ln_WSH | LICI | UICI |
|---|---|---|---|
| 1962 | 5.2817 | 3.53465 | 7.57235 |
| 1963 | 4.5623 | 3.55792 | 7.65412 |
| 1964 | 5.4926 | 3.40884 | 7.52113 |
| 1965 | 5.4236 | 4.31417 | 8.45165 |
| 1966 | 6.1525 | 4.25550 | 8.53258 |
| 1967 | 5.8398 | 3.71044 | 7.69715 |
| 1968 | 6.4516 | 4.10327 | 8.66163 |
| 1969 | 5.4744 | 3.75085 | 7.77977 |
| 1970 | 5.3318 | 4.15493 | 8.43519 |
| 1971 | 4.4320 | 3.22432 | 7.78874 |
| 1972 | 5.7832 | 3.81429 | 8.14176 |
| 1973 | 6.7719 | 4.03301 | 8.12228 |
| 1974 | 5.6768 | 3.40650 | 7.97030 |
| 1975 | 6.1336 | 4.03655 | 8.09244 |
| 1976 | 6.0169 | 3.58870 | 7.82568 |
| 1977 | 6.3421 | 4.32369 | 8.88956 |
| 1978 | 6.2571 | 3.93930 | 7.96782 |
| 1979 | 6.9593 | 4.15530 | 8.58285 |
| 1980 | 5.9935 | 3.85011 | 8.08664 |
| 1981 | 5.8186 | 4.22296 | 8.38232 |
| 1982 | 5.9917 | 4.04216 | 8.19338 |
| 1983 | 6.1444 | 3.80303 | 7.81498 |
| 1984 | 7.3206 | 3.72011 | 7.83475 |
| 1985 | 5.6157 | 4.30941 | 8.28464 |
| 1986 | 6.4153 | 3.43194 | 7.76430 |
| 1987 | 6.6390 | 4.41476 | 8.80731 |
| 1988 | 6.1386 | 3.55840 | 7.59859 |
| 1989 | 4.4785 | 3.34844 | 7.45901 |
| 1990 | 7.2041 | 4.01921 | 8.23845 |
| 1991 | 6.8979 | 4.10101 | 8.17946 |
| 1992 | 7.1217 | 4.72654 | 9.32322 |
| 1993 | 6.5155 | 4.35759 | 8.30673 |
| 1994 | 6.0438 | 4.16315 | 8.10172 |

**Ln_WSH** Ln (White Shrimp Harvest)
**LICI** Lower limit for 99% prediction interval for Ln (White Shrimp Harvest)
**UICI** Upper limit for 99% prediction interval for Ln (White Shrimp Harvest)

### 6.2.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| 1962 | 2.75746 | .00333 | .08617 | .9065 | .0000 |
| 1963 | 3.80032 | .06776 | .11876 | .8025 | .0006 |
| 1964 | 4.08968 | .00005 | .12780 | .7694 | .0000 |
| 1965 | 4.54509 | .06995 | .14203 | .7153 | .0007 |
| 1966 | 7.11917 | .00798 | .22247 | .4166 | .0000 |
| 1967 | 1.86074 | .00059 | .05815 | .9671 | .0000 |
| 1968 | 12.56553 | .00183 | .39267 | .0834 | .0000 |
| 1969 | 2.60220 | .00362 | .08132 | .9192 | .0000 |
| 1970 | 7.17891 | .12852 | .22434 | .4105 | .0047 |
| 1971 | 12.68674 | .45309 | .39646 | .0801 | .1414 |
| 1972 | 8.06962 | .00629 | .25218 | .3265 | .0000 |
| 1973 | 3.67603 | .02894 | .11488 | .8162 | .0000 |
| 1974 | 12.67434 | .00005 | .39607 | .0805 | .0000 |
| 1975 | 3.08012 | .00024 | .09625 | .8775 | .0000 |
| 1976 | 6.37104 | .01120 | .19909 | .4972 | .0000 |
| 1977 | 12.71580 | .02760 | .39737 | .0793 | .0000 |
| 1978 | 2.59528 | .00393 | .08110 | .9198 | .0000 |
| 1979 | 9.98952 | .08338 | .31217 | .1892 | .0012 |
| 1980 | 6.36279 | .00007 | .19884 | .4981 | .0000 |
| 1981 | 4.94286 | .01968 | .15446 | .6669 | .0000 |
| 1982 | 4.79449 | .00129 | .14983 | .6850 | .0000 |
| 1983 | 2.30321 | .00431 | .07198 | .9412 | .0000 |
| 1984 | 4.13197 | .16236 | .12912 | .7645 | .0095 |
| 1985 | 1.66049 | .01369 | .05189 | .9762 | .0000 |
| 1986 | 8.16230 | .11274 | .25507 | .3185 | .0031 |
| 1987 | 9.31306 | .00016 | .29103 | .2310 | .0000 |
| 1988 | 2.80141 | .01435 | .08754 | .9027 | .0000 |
| 1989 | 4.05878 | .05722 | .12684 | .7730 | .0004 |
| 1990 | 6.04233 | .12554 | .18882 | .5348 | .0044 |
| 1991 | 3.48237 | .03256 | .10882 | .8371 | .0001 |
| 1992 | 13.33428 | .00414 | .41670 | .0644 | .0000 |
| 1993 | 1.20744 | .00080 | .03773 | .9908 | .0000 |
| 1994 | 1.02466 | .00017 | .03202 | .9944 | .0000 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1962** | -.15025 | -.13181 | -.00548 | .03705 | .03118 | .06868 | .01762 | .00703 |
| **1963** | -.71354 | -.62885 | -.15833 | .14282 | .10804 | .29116 | .19068 | .20604 |
| **1964** | .01864 | .01649 | -.00124 | -.00225 | -.00282 | -.00723 | -.00177 | -.00412 |
| **1965** | -.71948 | -.11091 | -.31271 | .06839 | -.16852 | .35952 | -.15554 | .39833 |
| **1966** | -.23249 | -.09500 | .06849 | -.01266 | -.16531 | .12112 | .05475 | .03453 |
| **1967** | .06332 | .04933 | -.00174 | -.00655 | -.01124 | -.01836 | -.02241 | .00554 |
| **1968** | .11115 | -.02958 | .06091 | -.01391 | -.01019 | .00519 | .04628 | -.05623 |
| **1969** | -.15665 | -.08206 | -.04030 | -.03314 | .07393 | .03097 | -.01273 | .08430 |
| **1970** | -.98107 | .20999 | .49212 | .01125 | -.32801 | -.06954 | .21625 | -.80648 |
| **1971** | **-1.90978** | .59171 | -.21770 | -.39366 | **1.28260** | **-1.70817** | .07624 | -.08322 |
| **1972** | -.20624 | .02147 | .05370 | .05003 | -.03864 | .04342 | -.12672 | -.03484 |
| **1973** | .45182 | .03856 | -.12233 | -.17756 | .29848 | .01052 | .00686 | .04444 |
| **1974** | -.01890 | .00889 | .00734 | -.01044 | .01191 | -.00929 | -.01178 | -.00185 |
| **1975** | .04016 | .00140 | .00723 | -.02442 | .01695 | -.00185 | .00764 | -.00138 |
| **1976** | .27591 | .00058 | -.16188 | .03466 | .04853 | .08147 | .12075 | -.05170 |
| **1977** | -.43317 | .11270 | .14447 | -.22150 | .02819 | .08593 | -.03662 | -.16225 |
| **1978** | .16328 | .06718 | -.03538 | -.06303 | .08450 | -.00969 | -.06907 | .04618 |
| **1979** | .76584 | -.11015 | -.38429 | .50644 | .14129 | -.11887 | .49348 | -.43429 |
| **1980** | .02222 | -.00520 | .00791 | -.00533 | -.00117 | .01263 | .00294 | -.00752 |
| **1981** | -.36830 | .04631 | .05290 | .12384 | -.25412 | -.04589 | .01026 | -.02296 |
| **1982** | -.09313 | -.02384 | -.03638 | .06438 | -.02391 | .03985 | .01682 | -.03281 |
| **1983** | .17127 | .04478 | .06477 | -.01027 | -.08651 | .05917 | -.09520 | .03073 |
| **1984** | **1.19166** | .65258 | .79347 | -.52355 | -.37485 | -.40164 | -.22902 | -.15625 |
| **1985** | -.30996 | .02706 | .08180 | -.15258 | -.09202 | -.01907 | .00405 | .08914 |
| **1986** | .90624 | .12628 | -.18453 | -.34111 | -.11908 | -.04250 | -.03821 | .70910 |
| **1987** | .03327 | -.00580 | .01442 | -.01228 | .00922 | .00759 | -.02550 | .01630 |
| **1988** | .31543 | .22485 | .02399 | -.13641 | -.07050 | -.09224 | -.09864 | .12416 |
| **1989** | -.64792 | -.44383 | -.09467 | .07750 | .32253 | .17464 | -.11967 | .17948 |
| **1990** | .98015 | -.34018 | -.01260 | .57592 | -.41840 | .68477 | -.22387 | -.03626 |
| **1991** | .48140 | .05717 | -.16948 | .31456 | .01780 | -.10098 | .19219 | -.28528 |
| **1992** | .16698 | -.05241 | .10017 | .03977 | -.01661 | .01927 | -.07127 | -.01837 |
| **1993** | .07326 | -.00190 | -.00925 | .01108 | .03368 | -.00269 | -.02836 | .01175 |
| **1994** | -.03366 | -.00129 | .01359 | -.01497 | -.00054 | .00196 | .00466 | -.01011 |

**DFFITS** Standardized dffits value

**SDFB_0** Standardized dfbeta for the intercept term

**SDFB_1** Standardized dfbeta for the Logged January-February inflows

**SDFB_2** Standardized dfbeta for the Logged March-April inflows

**SDFB_3** Standardized dfbeta for the Logged May-June inflows

**SDFB_4** Standardized dfbeta for the Logged July-August inflows

**SDFB_5** Standardized dfbeta for the Logged September-October inflows

**SDFB_6** Standardized dfbeta for the Logged November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

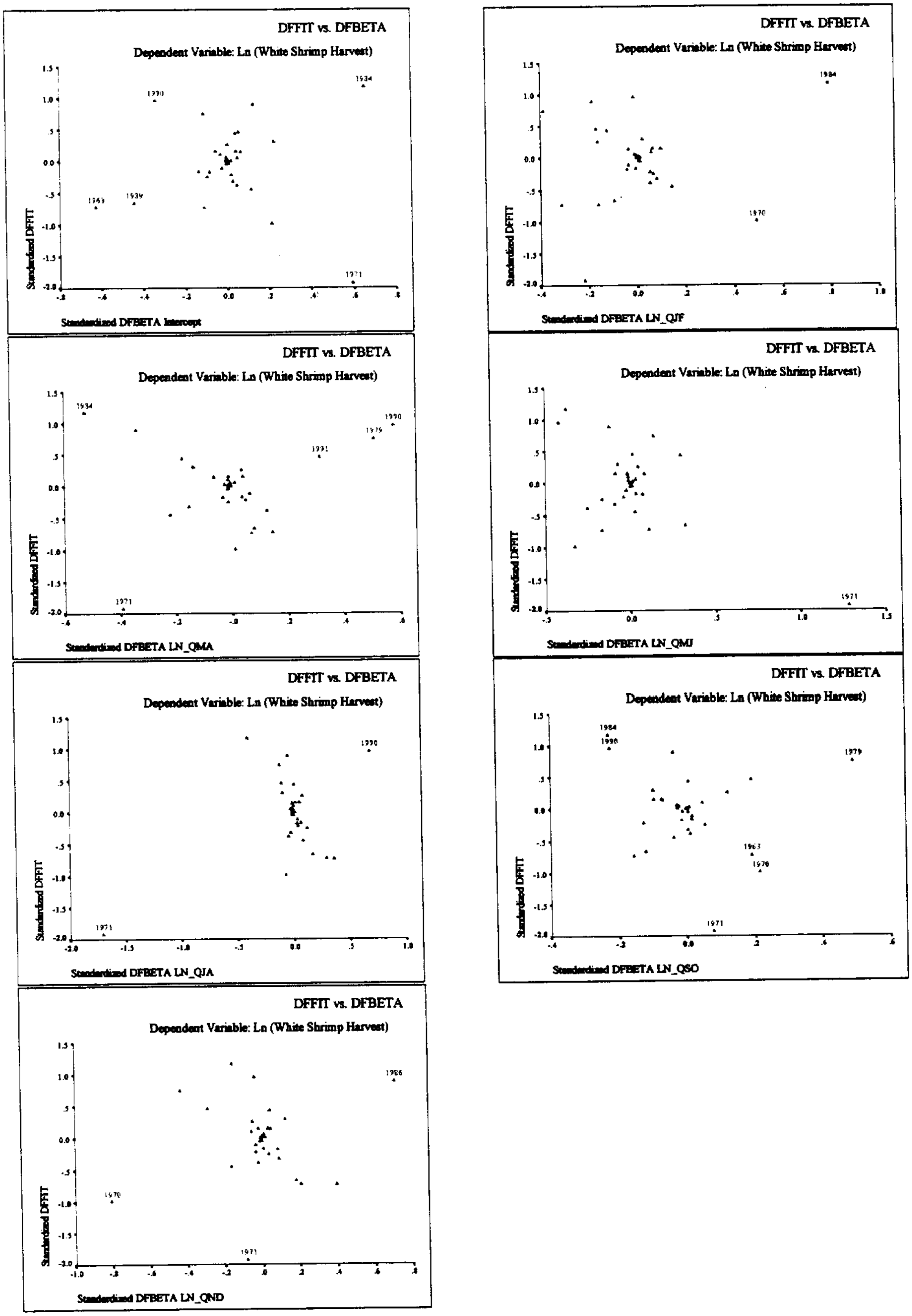



Fig. 6.2.4. Standardized DFFIT vs. Standardized DFBETA.

## 6.3 Model 5: Square Root All Variables

### 6.3.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | SQRT(Nov-Dec Inflows), SQRT(May-Jun Inflows), SQRT(Jul-Aug Inflows), SQRT(Sept-Oct Inflows), SQRT (Mar-Apr Inflows), SQRT (Jan-Feb Inflows)[c] | . | .479 | .230 | .052 | 7.360946 | 1.900 |

a. *Dependent Variable: SQRT (White Shrimp Harvest)*

b. Method: Enter

c. Independent Variables: (Constant), SQRT (November-December Inflows), SQRT (May-June Inflows), SQRT (July-August Inflows), SQRT (September-October Inflows), SQRT (March-April Inflows), SQRT (January-February Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 420.598 | 6 | 70.100 | 1.294 | .295[b] |
| | Residual | 1408.772 | 26 | 54.184 | | |
| | Total | 1829.369 | 32 | | | |

a. Dependent Variable: SQRT (White Shrimp Harvest)

b. Independent Variables: (Constant), SQRT (November-December Inflows), SQRT (May-June Inflows), SQRT (July-August Inflows), SQRT (September-October Inflows), SQRT (March-April Inflows), SQRT (January-February Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| 1 | (Constant) | 17.575 | 3.386 | | 5.190 | .000 | 10.615 | 24.535 |
| | SQRT (Jan-Feb Inflows) | .361 | .644 | .171 | .561 | .580 | -.962 | 1.684 |
| | SQRT (Mar-Apr Inflows) | .685 | .670 | .312 | 1.023 | .316 | -.692 | 2.062 |
| | SQRT (May-Jun Inflows) | .218 | .231 | .198 | .942 | .355 | -.257 | .693 |
| | SQRT (Jul-Aug Inflows) | -.104 | .233 | -.083 | -.448 | .658 | -.583 | .374 |
| | SQRT (Sept-Oct Inflows) | -7.1E-02 | .190 | -.094 | -.374 | .711 | -.461 | .319 |
| | SQRT (Nov-Dec Inflows) | -.365 | .510 | -.184 | -.716 | .480 | -1.413 | .683 |

a. Dependent Variable: SQRT (White Shrimp Harvest)

### 6.3.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 17.574689 | 3.38594658 | 5.190 | 0.0001 | 0.00000000 |
| SQRT_QJF | 1 | 0.361070 | 0.64367404 | 0.561 | 0.5796 | 3.13934695 |
| SQRT_QMA | 1 | 0.685012 | 0.66983235 | 1.023 | 0.3159 | 3.13781572 |
| SQRT_QMJ | 1 | 0.217641 | 0.23112237 | 0.942 | 0.3550 | 1.48623100 |
| SQRT_QJA | 1 | -0.104316 | 0.23286368 | -0.448 | 0.6579 | 1.16303742 |
| SQRT_QSO | 1 | -0.071014 | 0.18986981 | -0.374 | 0.7114 | 2.13030204 |
| SQRT_QND | 1 | -0.365318 | 0.50990390 | -0.716 | 0.4801 | 2.22536610 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop SQRT_QJF | Var Prop SQRT_QMA | Var Prop SQRT_QMJ | Var Prop SQRT_QJA | Var Prop SQRT_QSO | Var Prop SQRT_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.77081 | 1.00000 | 0.0316 | 0.0260 | 0.0294 | 0.0067 | 0.0237 | 0.0351 |
| 2 | 1.19503 | 1.52270 | 0.0045 | 0.0035 | 0.1751 | 0.4314 | 0.0009 | 0.0216 |
| 3 | 0.87633 | 1.77815 | 0.0003 | 0.1046 | 0.0354 | 0.0010 | 0.3553 | 0.0005 |
| 4 | 0.61040 | 2.13056 | 0.0268 | 0.0204 | 0.2285 | 0.4784 | 0.0006 | 0.2663 |
| 5 | 0.40054 | 2.63014 | 0.2815 | 0.0556 | 0.5262 | 0.0813 | 0.0003 | 0.2522 |
| 6 | 0.14688 | 4.34336 | 0.6554 | 0.7898 | 0.0054 | 0.0012 | 0.6192 | 0.4242 |

### 6.3.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics**[a]

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 16.36967 | 35.96000 | 21.6025 | 3.625421 | 33 |
| Std. Predicted Value | -1.443 | 3.960 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | 1.618292 | 6.086143 | 3.127458 | 1.328908 | 33 |
| Adjusted Predicted Value | 12.65128 | 37.51524 | 21.9989 | 4.495984 | 33 |
| Residual | -9.870127 | 18.54715 | -2.4E-15 | 6.635067 | 33 |
| Std. Residual | -1.341 | 2.520 | .000 | .901 | 33 |
| Stud. Residual | -1.596 | 2.693 | -.019 | 1.000 | 33 |
| Deleted Residual | -17.9915 | 21.18836 | -.396456 | 8.404749 | 33 |
| Stud. Deleted Residual | -1.648 | 3.110 | -.003 | 1.056 | 33 |
| Mahal. Distance | .577 | 20.906 | 5.818 | 6.005 | 33 |
| Cook's Distance | .000 | .490 | .042 | .092 | 33 |
| Centered Leverage Value | .018 | .653 | .182 | .188 | 33 |

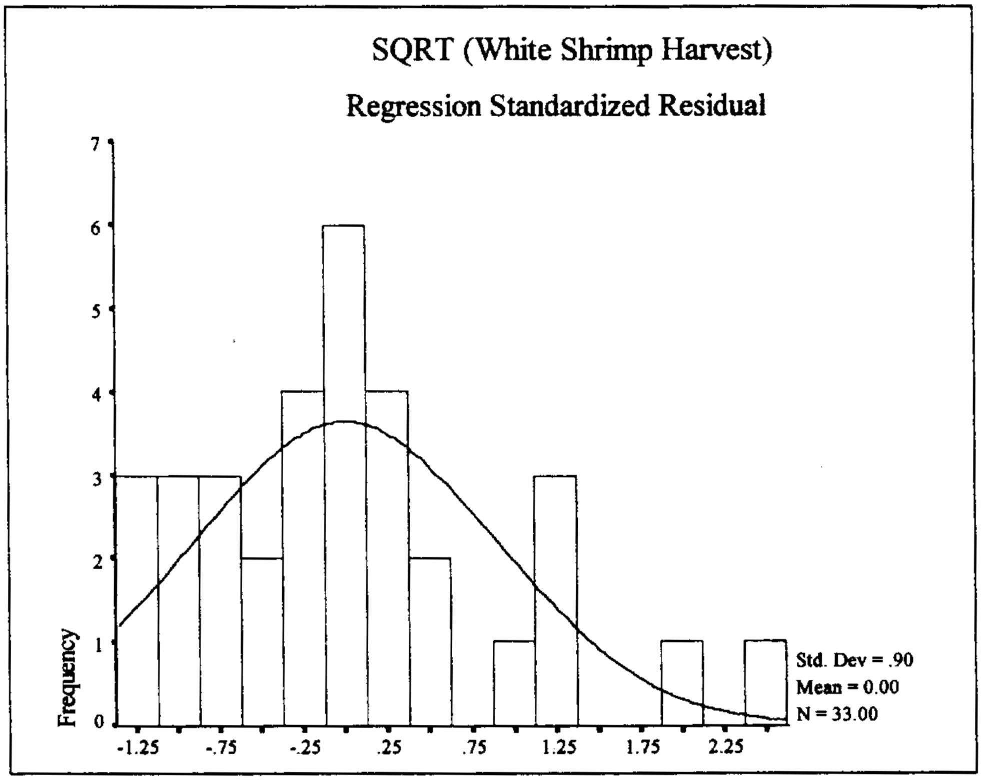
a. Dependent Variable: SQRT (White Shrimp Harvest)

*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 19.32663 | -5.30165 | -5.83508 | 19.86005 | -.62775 | -.72024 | -.75561 | -.74920 |
| 1963 | 19.65787 | -9.87013 | -10.95018 | 20.73793 | -.53638 | -1.34088 | -1.41234 | -1.44130 |
| 1964 | 19.18566 | -3.60041 | -4.00998 | 19.59523 | -.66663 | -.48912 | -.51620 | -.50878 |
| 1965 | 24.72102 | -9.66446 | -10.68426 | 25.74082 | .86018 | -1.31294 | -1.38047 | -1.40618 |
| 1966 | 23.99994 | -2.32277 | -2.80950 | 24.48667 | .66129 | -.31555 | -.34704 | -.34109 |
| 1967 | 19.76193 | -1.22279 | -1.32662 | 19.86577 | -.50768 | -.16612 | -.17303 | -.16976 |
| 1968 | 25.03590 | .13750 | .36510 | 24.80830 | .94704 | .01868 | .03044 | .02985 |
| 1969 | 20.67715 | -5.23370 | -5.73148 | 21.17492 | -.25524 | -.71101 | -.74405 | -.73750 |
| 1970 | 21.00669 | -6.62615 | -8.56865 | 22.94919 | -.16434 | -.90018 | -1.02365 | -1.02464 |
| 1971 | 16.84105 | -7.67045 | -17.99146 | 27.16206 | -1.31335 | -1.04205 | -1.59592 | -1.64771 |
| 1972 | 18.04420 | -.02199 | -.04033 | 18.06254 | -.98148 | -.00299 | -.00405 | -.00397 |
| 1973 | 21.26004 | 8.28653 | 9.31490 | 20.23167 | -.09446 | 1.12574 | 1.19355 | 1.20382 |
| 1974 | 18.41951 | -1.33151 | -1.75747 | 18.84547 | -.87796 | -.18089 | -.20782 | -.20395 |
| 1975 | 21.05636 | .41688 | .44931 | 21.02393 | -.15064 | .05663 | .05880 | .05766 |
| 1976 | 18.93211 | 1.32375 | 1.48351 | 18.77235 | -.73657 | .17983 | .19038 | .18681 |
| 1977 | 26.83724 | -3.00449 | -9.49656 | 33.32931 | 1.44390 | -.40817 | -.72566 | -.71889 |
| 1978 | 20.21434 | 2.62641 | 2.77634 | 20.06441 | -.38289 | .35680 | .36685 | .36066 |
| 1979 | 25.45476 | 6.99366 | 10.00334 | 22.44508 | 1.06257 | .95010 | 1.13630 | 1.14297 |
| 1980 | 19.69361 | .32638 | .42853 | 19.59146 | -.52653 | .04434 | .05081 | .04982 |
| 1981 | 23.50169 | -5.15775 | -7.63770 | 25.98164 | .52385 | -.70069 | -.85266 | -.84805 |
| 1982 | 20.61215 | -.60966 | -.75259 | 20.75509 | -.27316 | -.08282 | -.09202 | -.09025 |
| 1983 | 20.00170 | 1.58765 | 1.70448 | 19.88487 | -.44155 | .21569 | .22348 | .21935 |
| 1984 | 20.32572 | 18.54715 | 21.18836 | 17.68451 | -.35217 | 2.51967 | 2.69311 | **3.10997** |
| 1985 | 23.33701 | -6.76294 | -7.29806 | 23.87213 | .47843 | -.91876 | -.95442 | -.95272 |
| 1986 | 16.36966 | 8.35077 | 12.06916 | 12.65128 | -1.44337 | 1.13447 | 1.36385 | 1.38794 |
| 1987 | 24.78787 | 2.85811 | 4.04799 | 23.59799 | .87862 | .38828 | .46209 | .45499 |
| 1988 | 18.92717 | 2.59956 | 2.85858 | 18.66815 | -.73793 | .35316 | .37033 | .36410 |
| 1989 | 19.11829 | -9.73213 | -10.79253 | 20.17869 | -.68522 | -1.32213 | -1.39230 | -1.41919 |
| 1990 | 21.85692 | 14.81596 | 17.06639 | 19.60648 | .07018 | 2.01278 | 2.16024 | 2.33853 |
| 1991 | 22.84518 | 8.62227 | 9.66065 | 21.80679 | .34277 | 1.17135 | 1.23988 | 1.25342 |
| 1992 | 35.96000 | -.76767 | -2.32291 | 37.51523 | 3.96023 | -.10429 | -.18141 | -.17800 |
| 1993 | 23.22642 | 2.76396 | 2.93039 | 23.06000 | .44793 | .37549 | .38663 | .38022 |
| 1994 | 21.88636 | -1.35590 | -1.42476 | 21.95522 | .07830 | -.18420 | -.18882 | -.18528 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.
[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



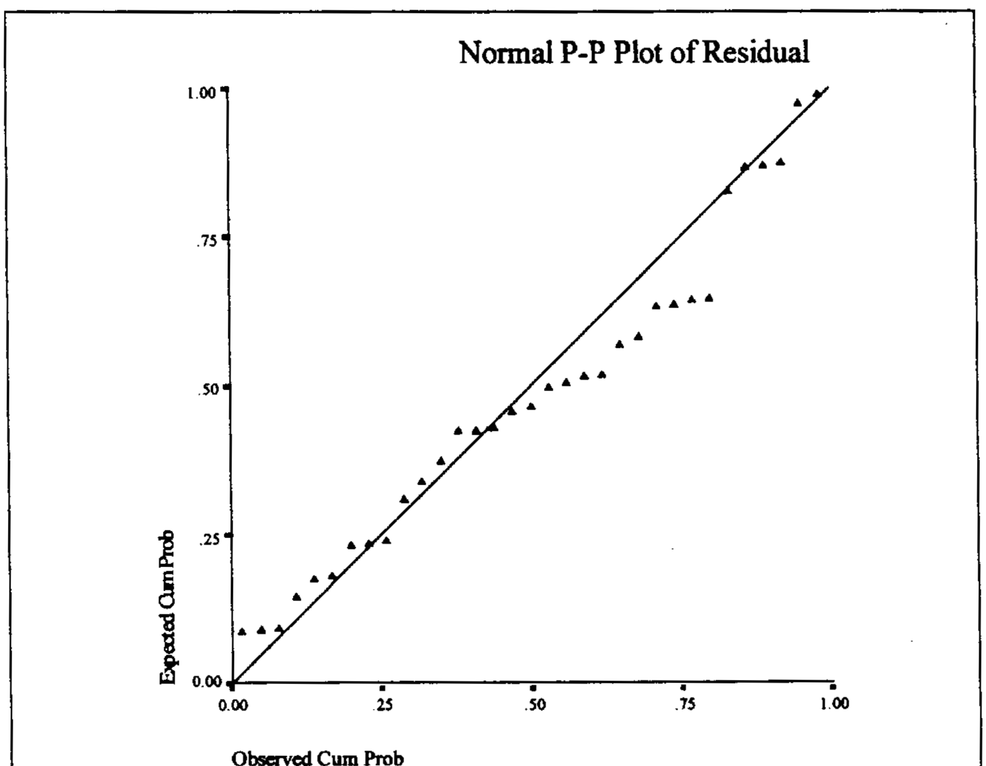




Fig. 6.3.1. Exploratory Plots of SQRT (White Shrimp Harvest) Standardized Residual.

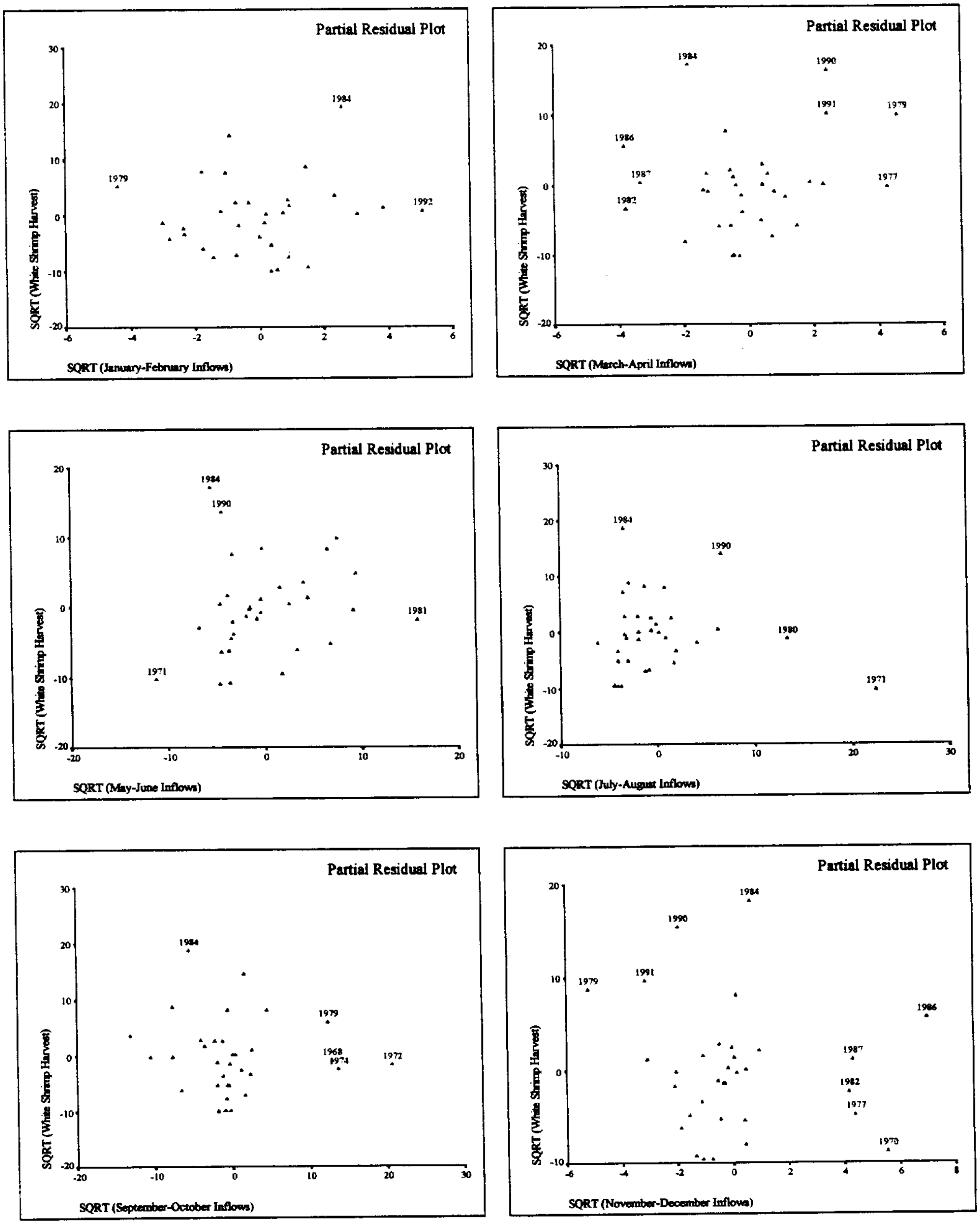



Fig. 6.3.2. Partial Residual Plots of SQRT (White Shrimp Harvest) vs. Square Root Inflows.

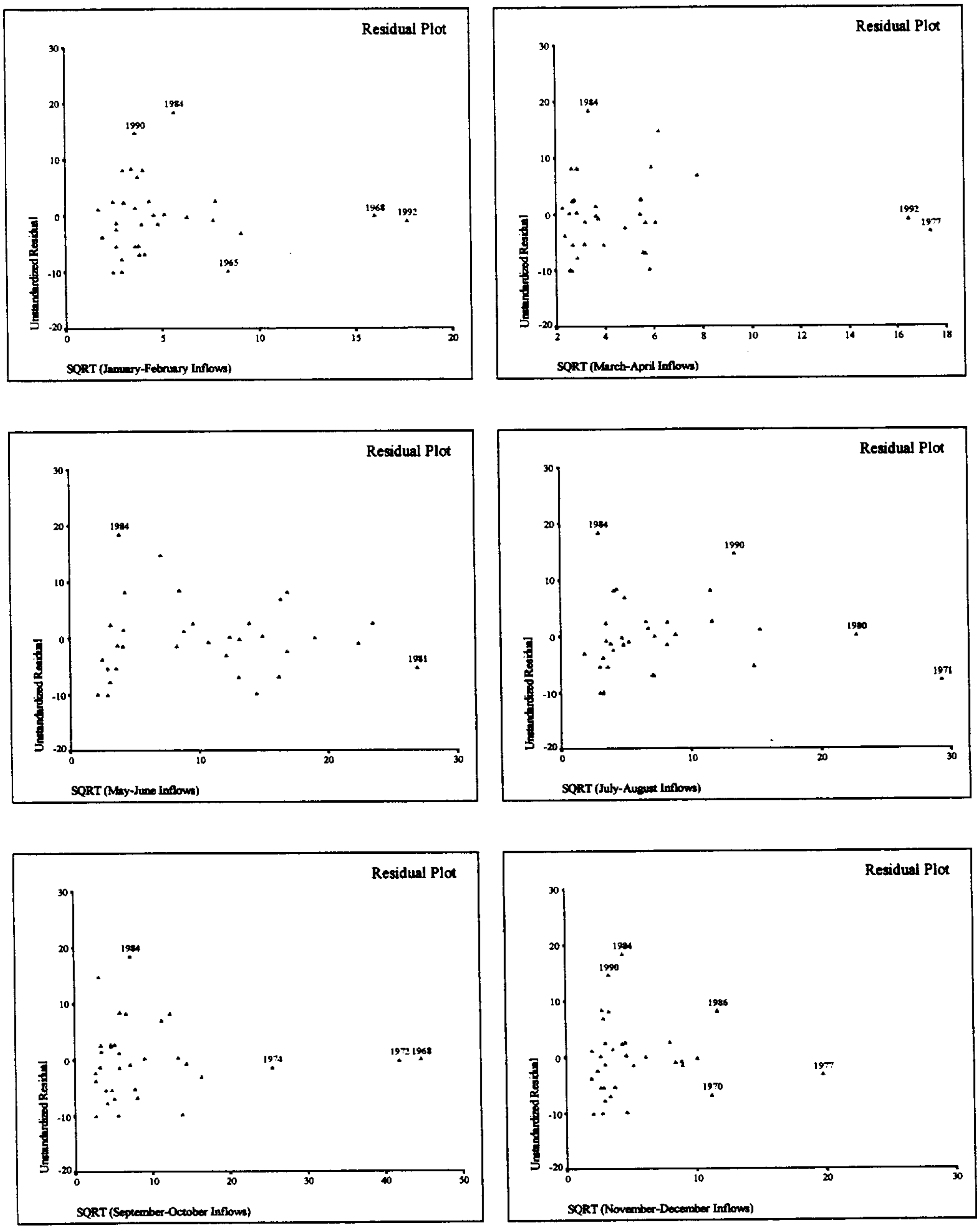



Fig. 6.3.3. Residual Plots of SQRT (White Shrimp Harvest) vs. Square Root Inflows.

### 6.3.4 Prediction Intervals for SQRT (White Shrimp Harvest)

| YEAR | SQRT_WSH | LICI | UICI |
|---|---|---|---|
| 1962 | 14.0250 | 0.00000 | 40.69507 |
| 1963 | 9.7877 | 0.00000 | 41.09685 |
| 1964 | 15.5852 | 0.00000 | 40.65880 |
| 1965 | 15.0566 | 0.00000 | 46.12889 |
| 1966 | 21.6772 | 0.00000 | 46.15495 |
| 1967 | 18.5391 | 0.00000 | 41.00128 |
| 1968 | 25.1734 | 0.00000 | 51.09681 |
| 1969 | 15.4434 | 0.00000 | 42.00083 |
| 1970 | 14.3805 | 0.00000 | 43.66077 |
| 1971 | 9.1706 | 0.00000 | 42.49967 |
| 1972 | 18.0222 | 0.00000 | 42.71373 |
| 1973 | 29.5466 | 0.00000 | 42.81352 |
| 1974 | 17.0880 | 0.00000 | 41.21785 |
| 1975 | 21.4732 | 0.00000 | 42.23575 |
| 1976 | 20.2559 | 0.00000 | 40.45927 |
| 1977 | 23.8328 | 0.00000 | 53.37719 |
| 1978 | 22.8408 | 0.00000 | 41.21331 |
| 1979 | 32.4484 | 0.00000 | 48.78365 |
| 1980 | 20.0200 | 0.00000 | 42.45537 |
| 1981 | 18.3439 | 0.00000 | 47.04329 |
| 1982 | 20.0025 | 0.00000 | 42.92408 |
| 1983 | 21.5893 | 0.00000 | 41.14501 |
| 1984 | 38.8729 | 0.00000 | 42.01710 |
| 1985 | 16.5741 | 0.00000 | 44.52760 |
| 1986 | 24.7204 | 0.00000 | 39.76323 |
| 1987 | 27.6460 | 0.00000 | 48.05460 |
| 1988 | 21.5267 | 0.00000 | 40.28773 |
| 1989 | 9.3862 | 0.00000 | 40.55355 |
| 1990 | 36.6729 | 0.00000 | 43.61770 |
| 1991 | 31.4674 | 0.00000 | 44.37035 |
| 1992 | 35.1923 | 0.00000 | 62.38856 |
| 1993 | 25.9904 | 0.00000 | 44.25320 |
| 1994 | 20.5305 | 0.00000 | 42.82880 |

**SQRT_WSH** SQRT (White Shrimp Harvest)
**LICI** Lower limit for 99% prediction interval for SQRT (White Shrimp Harvest)
**UICI** Upper limit for 99% prediction interval for SQRT (White Shrimp Harvest)

### 6.3.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| **1962** | 1.95565 | .00821 | .06111 | .9623 | .0000 |
| **1963** | 2.18657 | .03118 | .06833 | .9488 | .0000 |
| **1964** | 2.29871 | .00433 | .07183 | .9415 | .0000 |
| **1965** | 2.08466 | .02873 | .06515 | .9550 | .0000 |
| **1966** | 4.57414 | .00361 | .14294 | .7118 | .0000 |
| **1967** | 1.53492 | .00036 | .04797 | .9811 | .0000 |
| **1968** | 18.97891 | .00022 | **.59309** | .0083 | .0000 |
| **1969** | 1.80947 | .00752 | .05655 | .9696 | .0000 |
| **1970** | 6.28463 | .04388 | .19639 | .5069 | .0001 |
| **1971** | 17.38748 | .48958 | **.54336** | .0151 | .1670 |
| **1972** | 13.57999 | .00000 | .42437 | .0592 | .0000 |
| **1973** | 2.56312 | .02526 | .08010 | .9223 | .0000 |
| **1974** | 6.78618 | .00197 | .21207 | .4515 | .0000 |
| **1975** | 1.34038 | .00004 | .04189 | .9873 | .0000 |
| **1976** | 2.47638 | .00062 | .07739 | .9289 | .0000 |
| **1977** | 20.90626 | .16255 | **.65332** | **.0039** | .0096 |
| **1978** | .75834 | .00110 | .02370 | .9978 | .0000 |
| **1979** | 8.65807 | .07938 | .27056 | .2781 | .0010 |
| **1980** | 6.65869 | .00012 | .20808 | .4653 | .0000 |
| **1981** | 9.42067 | .04994 | .29440 | .2238 | .0002 |
| **1982** | 5.10787 | .00028 | .15962 | .6468 | .0000 |
| **1983** | 1.22360 | .00053 | .03824 | .9904 | .0000 |
| **1984** | 3.01924 | .14755 | .09435 | .8832 | .0071 |
| **1985** | 1.37666 | .01030 | .04302 | .9863 | .0000 |
| **1986** | 8.88918 | .11832 | .27779 | .2607 | .0036 |
| **1987** | 8.43654 | .01270 | .26364 | .2957 | .0000 |
| **1988** | 1.92988 | .00195 | .06031 | .9636 | .0000 |
| **1989** | 2.17439 | .03017 | .06795 | .9496 | .0000 |
| **1990** | 3.24993 | .10126 | .10156 | .8610 | .0022 |
| **1991** | 2.46985 | .02645 | .07718 | .9294 | .0000 |
| **1992** | 20.45496 | .00952 | **.63922** | **.0047** | .0000 |
| **1993** | .84772 | .00129 | .02649 | .9969 | .0000 |
| **1994** | .57697 | .00026 | .01803 | .9991 | .0000 |

| | |
|---|---|
| **MAH** | Mahalonobis distance |
| **COO** | Cook's distance |
| **LEV** | Leverage value |
| **MAHA_PV** | P-value associated with the Mahalanobis distance |
| **COOK_PV** | P-value associated with Cook's distance |

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| 1962 | -.23765 | -.22242 | -.02716 | .03900 | .09201 | .09998 | .04100 | .02506 |
| 1963 | -.47678 | -.44888 | -.04645 | .03862 | .17454 | .19355 | .07531 | .11588 |
| 1964 | -.17160 | -.16384 | -.00020 | .00923 | .05946 | .06892 | .01669 | .04201 |
| 1965 | -.45678 | -.13502 | -.19652 | .06233 | -.08168 | .20958 | .00974 | .13764 |
| 1966 | -.15614 | -.05632 | .07615 | -.03857 | -.10861 | .07313 | -.01038 | .05451 |
| 1967 | -.04947 | -.04496 | -.00263 | .00340 | .01854 | .01787 | .00919 | .00659 |
| 1968 | .03840 | -.00573 | .01636 | -.00556 | -.00243 | .00028 | .01617 | -.01039 |
| 1969 | -.22744 | -.18899 | -.02399 | -.02713 | .10937 | .07399 | .00954 | .08339 |
| 1970 | -.55478 | .06307 | .07288 | .20738 | -.24939 | .03039 | .19856 | -.44703 |
| 1971 | **-1.91131** | .48593 | -.20010 | -.16239 | .89133 | **-1.78419** | .05239 | -.07512 |
| 1972 | -.00362 | .00024 | .00141 | -.00021 | -.00043 | .00032 | -.00287 | -.00005 |
| 1973 | .42408 | .04048 | -.11833 | -.08161 | .30380 | .03294 | -.01815 | .01127 |
| 1974 | -.11536 | .00742 | .04829 | -.04915 | .04967 | -.03051 | -.08298 | .00458 |
| 1975 | .01608 | .00296 | .00110 | -.00761 | .00840 | -.00118 | .00056 | .00197 |
| 1976 | .06490 | .00869 | -.02084 | .01078 | -.00252 | .03917 | .01270 | -.01466 |
| 1977 | **-1.05674** | .39487 | .31079 | -.49704 | .13054 | -.07924 | -.07697 | -.38821 |
| 1978 | .08617 | .05529 | -.01108 | -.01860 | .01863 | -.00769 | -.02143 | -.00060 |
| 1979 | .74980 | .06661 | -.52451 | .56962 | .28076 | -.15240 | .43676 | -.49332 |
| 1980 | .02787 | -.00781 | .00374 | -.00193 | -.00269 | .02409 | .00002 | -.00067 |
| 1981 | -.58805 | .10911 | .15771 | .08620 | -.51196 | -.05503 | .01877 | -.03050 |
| 1982 | -.04370 | -.00876 | -.02676 | .03450 | .00117 | .01068 | .01981 | -.02897 |
| 1983 | .05950 | .04125 | .01840 | -.00941 | -.03292 | -.00047 | -.02101 | .00065 |
| 1984 | **1.17360** | .77396 | .75469 | -.56134 | -.57451 | -.35663 | -.47315 | .15561 |
| 1985 | -.26799 | -.07942 | .12437 | -.13391 | -.10373 | .04048 | -.04079 | .12886 |
| 1986 | .92616 | .16813 | .21426 | -.58149 | -.17433 | -.06731 | -.32865 | .80727 |
| 1987 | .29357 | -.06823 | .11147 | -.16358 | .16168 | .02439 | -.18435 | .16169 |
| 1988 | .11493 | .09577 | .02960 | -.04511 | -.04606 | -.04001 | -.03972 | .02498 |
| 1989 | -.46846 | -.42811 | -.07109 | .06699 | .22258 | .17753 | .03896 | .07777 |
| 1990 | .91140 | .00557 | -.19982 | .55387 | -.34692 | .53076 | .10654 | -.33806 |
| 1991 | .43498 | .21183 | -.20516 | .29237 | -.00921 | -.12003 | .15307 | -.28820 |
| 1992 | -.25336 | .07173 | -.13780 | -.05352 | .01885 | -.00861 | .08446 | .04381 |
| 1993 | .09330 | .02812 | -.02532 | .01571 | .04975 | -.02406 | -.01280 | -.01272 |
| 1994 | -.04176 | -.02333 | .01077 | -.01364 | .00460 | .01161 | .00189 | .00452 |

**DFFITS** Standardized dffits value
**SDFB_0** Standardized dfbeta for the intercept term
**SDFB_1** Standardized dfbeta for the Square Root January-February inflows
**SDFB_2** Standardized dfbeta for the Square Root March-April inflows
**SDFB_3** Standardized dfbeta for the Square Root May-June inflows
**SDFB_4** Standardized dfbeta for the Square Root July-August inflows
**SDFB_5** Standardized dfbeta for the Square Root September-October inflows
**SDFB_6** Standardized dfbeta for the Square Root November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

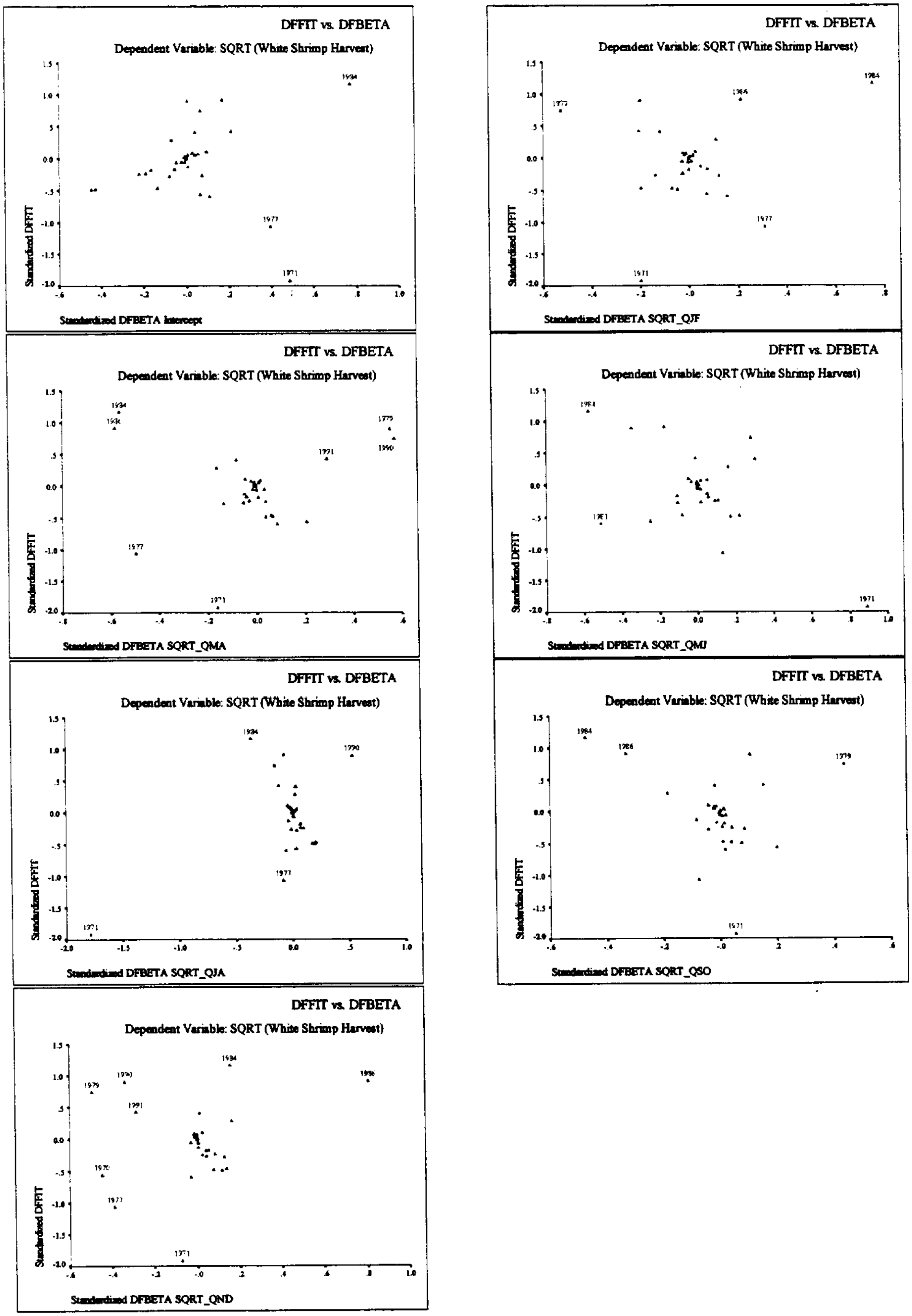



Fig. 6.3.4. Standardized DFFIT vs. Standardized DFBETA.

## 6.4 Model 6: Logged and Square Root and Square Root All Variables

### 6.4.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables | | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| | Entered | Removed | | | | | |
| 1 | SQRT(Nov-Dec Inflows), Ln(May-Jun Inflows), SQRT(Sept-Oct Inflows), Ln(Jul-Aug Inflows), SQRT(Jan-Feb Inflows), SQRT(Mar-Apr Inflows)[c,d] | . | .528 | .279 | .113 | .688677 | 1.935 |

a. Dependent Variable: Ln (White Shrimp Harvest)

b. Method: Enter

c. Independent Variables: (Constant), SQRT (November-December Inflows), Ln (May-June Inflows), SQRT (September-October Inflows), Ln (July-August Inflows), SQRT (January-February Inflows), SQRT (March-April Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 4.771 | 6 | .795 | 1.677 | .167[b] |
| | Residual | 12.331 | 26 | .474 | | |
| | Total | 17.102 | 32 | | | |

a. Dependent Variable: Ln (White Shrimp Harvest)

b. Independent Variables: (Constant), SQRT (November-December Inflows), Ln (May-June Inflows), SQRT (September-October Inflows), Ln (July-August Inflows), SQRT (January-February Inflows), SQRT (March-April Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| 1 | (Constant) | 5.188 | .476 | | 10.901 | .000 | 4.209 | 6.166 |
| | SQRT (Jan-Feb Inflows) | 2.2E-02 | .058 | .106 | .370 | .715 | -.098 | .142 |
| | SQRT (Mar-Apr Inflows) | 4.2E-02 | .064 | .198 | .654 | .519 | -.090 | .174 |
| | Ln (May-Jun Inflows) | .199 | .105 | .414 | 1.899 | .069 | -.016 | .414 |
| | Ln (Jul-Aug Inflows) | -4.1E-02 | .112 | -.073 | -.367 | .717 | -.271 | .189 |
| | SQRT (Sept-Oct Inflows) | -6.7E-03 | .018 | -.092 | -.375 | .711 | -.043 | .030 |
| | SQRT (Nov-Dec Inflows) | -1.9E-02 | .048 | -.100 | -.402 | .691 | -.118 | .079 |

a. Dependent Variable: Ln (White Shrimp Harvest)

### 6.4.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 5.187651 | 0.47587519 | 10.901 | 0.0001 | 0.00000000 |
| SQRT_QJF | 1 | 0.021571 | 0.05835372 | 0.370 | 0.7146 | 2.94768282 |
| SQRT_QMA | 1 | 0.041978 | 0.06415330 | 0.654 | 0.5186 | 3.28828633 |
| LN_QMJ | 1 | 0.198789 | 0.10468938 | 1.899 | 0.0687 | 1.71823913 |
| LN_QJA | 1 | -0.040972 | 0.11171979 | -0.367 | 0.7168 | 1.42420771 |
| SQRT_QSO | 1 | -0.006689 | 0.01785887 | -0.375 | 0.7110 | 2.15314751 |
| SQRT_QND | 1 | -0.019273 | 0.04799822 | -0.402 | 0.6913 | 2.25274215 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop SQRT_QJF | Var Prop SQRT_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop SQRT_QSO | Var Prop SQRT_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.77765 | 1.00000 | 0.0327 | 0.0250 | 0.0267 | 0.0033 | 0.0237 | 0.0355 |
| 2 | 1.34347 | 1.43789 | 0.0017 | 0.0062 | 0.1293 | 0.3136 | 0.0041 | 0.0184 |
| 3 | 0.86520 | 1.79177 | 0.0004 | 0.1003 | 0.0420 | 0.0014 | 0.3477 | 0.0009 |
| 4 | 0.49353 | 2.37236 | 0.2120 | 0.0001 | 0.0031 | 0.1524 | 0.0006 | 0.5226 |
| 5 | 0.37354 | 2.72690 | 0.1359 | 0.0540 | 0.7891 | 0.5186 | 0.0019 | 0.0002 |
| 6 | 0.14661 | 4.35269 | 0.6174 | 0.8144 | 0.0098 | 0.0108 | 0.6219 | 0.4225 |

### 6.4.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics**[a]

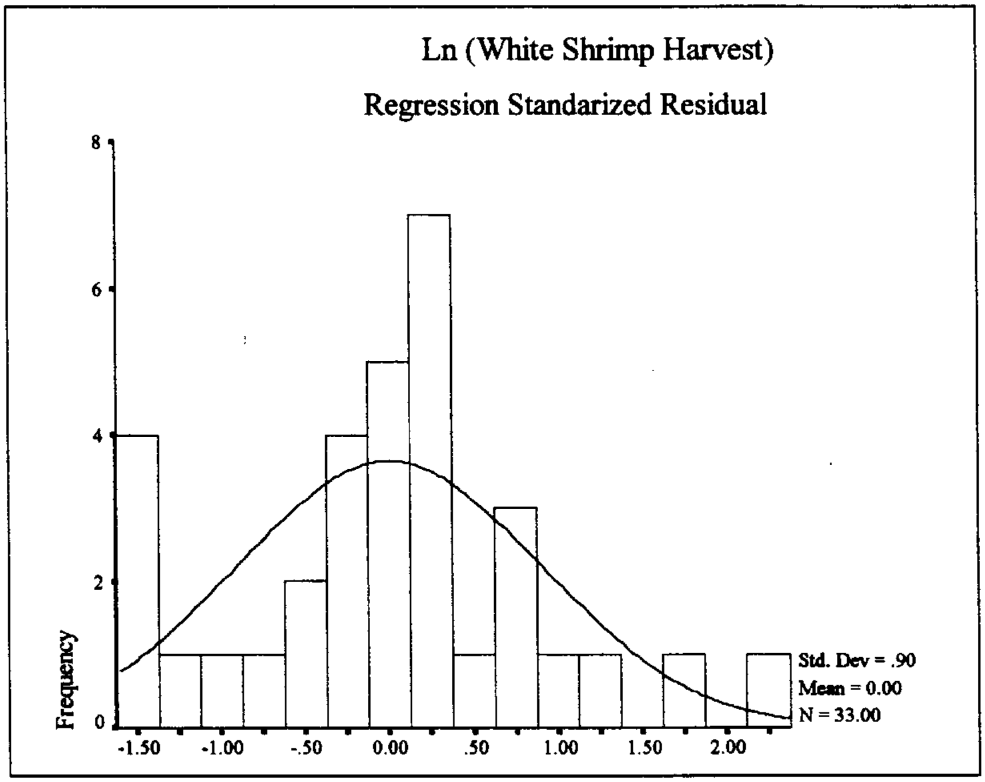
| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 5.460673 | 7.148766 | 6.021872 | .386135 | 33 |
| Std. Predicted Value | -1.453 | 2.918 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | .148550 | .568846 | .296163 | .115301 | 33 |
| Adjusted Predicted Value | 5.173621 | 7.206873 | 6.046880 | .435577 | 33 |
| Residual | -1.064771 | 1.553928 | -5.9E-16 | .620765 | 33 |
| Std. Residual | -1.546 | 2.256 | .000 | .901 | 33 |
| Stud. Residual | -1.976 | 2.418 | -.014 | 1.005 | 33 |
| Deleted Residual | -1.799644 | 1.784606 | -2.5E-02 | .784418 | 33 |
| Stud. Deleted Residual | -2.101 | 2.693 | -.010 | 1.050 | 33 |
| Mahal. Distance | .519 | 20.863 | 5.818 | 5.643 | 33 |
| Cook's Distance | .000 | .418 | .040 | .079 | 33 |
| Centered Leverage Value | .016 | .652 | .182 | .176 | 33 |

a. Dependent Variable: Ln (White Shrimp Harvest)

*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 5.60507 | -.32339 | -.36455 | 5.64623 | -1.07941 | -.46959 | -.49857 | -.49124 |
| 1963 | 5.62703 | -1.06477 | -1.20297 | 5.76523 | -1.02254 | -1.54611 | -1.64339 | -1.70231 |
| 1964 | 5.53979 | -.04714 | -.05398 | 5.54663 | -1.24848 | -.06845 | -.07325 | -.07183 |
| 1965 | 6.39568 | -.97205 | -1.13326 | 6.55689 | .96806 | -1.41147 | -1.52403 | -1.56602 |
| 1966 | 6.39082 | -.23830 | -.29947 | 6.45199 | .95548 | -.34602 | -.38790 | -.38148 |
| 1967 | 5.70322 | .13655 | .14805 | 5.69172 | -.82524 | .19828 | .20646 | .20262 |
| 1968 | 6.35196 | .09962 | .26527 | 6.18631 | .85484 | .14465 | .23605 | .23171 |
| 1969 | 5.74868 | -.27431 | -.30127 | 5.77564 | -.70750 | -.39832 | -.41743 | -.41071 |
| 1970 | 6.18769 | -.85594 | -1.10789 | 6.43964 | .42942 | -1.24287 | -1.41401 | -1.44315 |
| 1971 | 5.46067 | -1.02867 | -1.79964 | 6.23165 | -1.45337 | -1.49369 | -1.97567 | -2.10146 |
| 1972 | 5.89808 | -.11487 | -.21143 | 5.99464 | -.32059 | -.16680 | -.22630 | -.22212 |
| 1973 | 6.17892 | .59302 | .66900 | 6.10294 | .40672 | .86109 | .91460 | .91162 |
| 1974 | 5.59040 | .08636 | .12732 | 5.54943 | -1.11742 | .12540 | .15226 | .14937 |
| 1975 | 6.13522 | -.00161 | -.00175 | 6.13537 | .29355 | -.00234 | -.00244 | -.00239 |
| 1976 | 5.88556 | .13133 | .14931 | 5.86758 | -.35302 | .19070 | .20333 | .19954 |
| 1977 | 6.56709 | -.22497 | -.70806 | 7.05018 | 1.41199 | -.32667 | -.57954 | -.57199 |
| 1978 | 5.99919 | .25791 | .27618 | 5.98091 | -.05875 | .37450 | .38754 | .38111 |
| 1979 | 6.44543 | .51387 | .72805 | 6.23125 | 1.09692 | .74617 | .88816 | .88444 |
| 1980 | 6.02745 | -.03399 | -.04082 | 6.03429 | .01445 | -.04935 | -.05409 | -.05304 |
| 1981 | 6.36621 | -.54761 | -.66356 | 6.48216 | .89175 | -.79516 | -.87531 | -.87124 |
| 1982 | 6.08420 | -.09249 | -.11780 | 6.10952 | .16141 | -.13429 | -.15157 | -.14869 |
| 1983 | 5.73547 | .40893 | .44014 | 5.70426 | -.74172 | .59380 | .61604 | .60853 |
| 1984 | 5.76666 | 1.55393 | 1.78461 | 5.53599 | -.66093 | 2.25640 | 2.41808 | **2.69323** |
| 1985 | 6.26982 | -.65414 | -.71243 | 6.32810 | .64213 | -.94985 | -.99127 | -.99092 |
| 1986 | 5.55100 | .86427 | 1.24164 | 5.17362 | -1.21946 | 1.25497 | 1.50420 | 1.54369 |
| 1987 | 6.45463 | .18433 | .24944 | 6.38952 | 1.12074 | .26766 | .31136 | .30589 |
| 1988 | 5.60582 | .53277 | .59074 | 5.54785 | -1.07748 | .77362 | .81462 | .80919 |
| 1989 | 5.47504 | -.99656 | -1.16473 | 5.64320 | -1.41618 | -1.44707 | -1.56441 | -1.61176 |
| 1990 | 6.00815 | 1.19592 | 1.42630 | 5.77777 | -.03552 | 1.73655 | 1.89645 | 2.00334 |
| 1991 | 6.14978 | .74813 | .84227 | 6.05564 | .33125 | 1.08632 | 1.15265 | 1.16030 |
| 1992 | 7.14877 | -.02711 | -.08522 | 7.20687 | 2.91839 | -.03936 | -.06979 | -.06844 |
| 1993 | 6.28323 | .23222 | .24852 | 6.26693 | .67686 | .33720 | .34883 | .34286 |
| 1994 | 6.08506 | -.04124 | -.04325 | 6.08707 | .16364 | -.05988 | -.06133 | -.06014 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals
[1] Values greater than 3 are flagged.
[2] This is flagged if it exceeds $t_{n-p-2,\alpha} = t_{25,0.01} = 2.485$



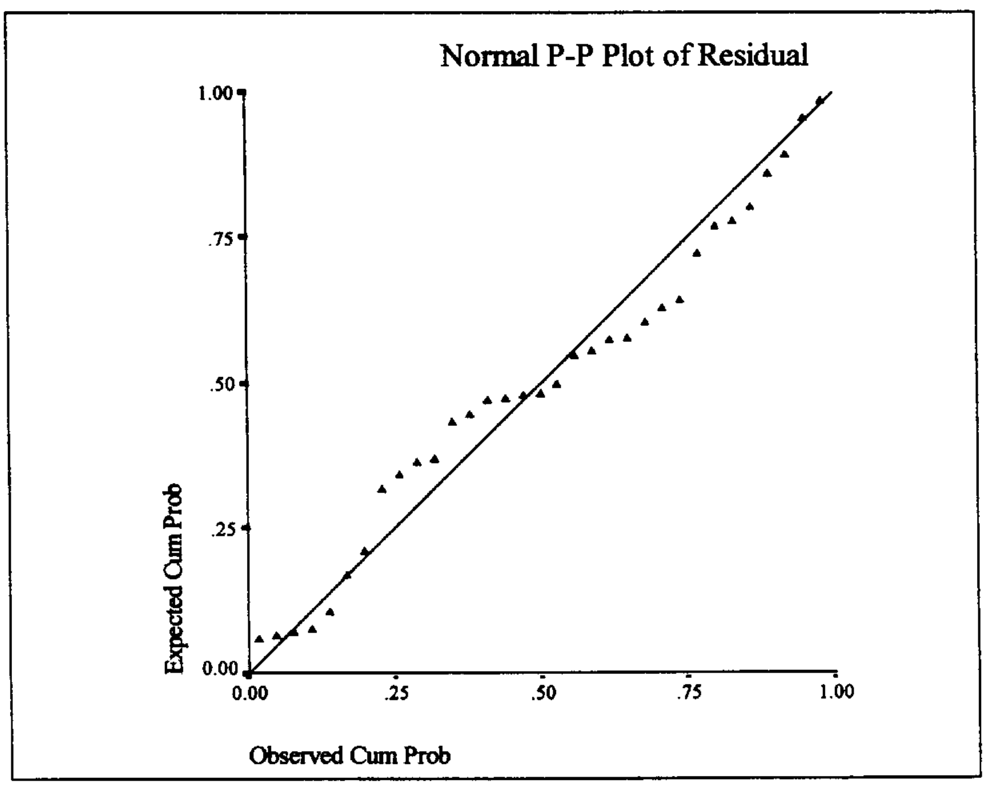




Fig. 6.4.1. Exploratory Plots of Ln (White Shrimp Harvest) Standardized Residual.

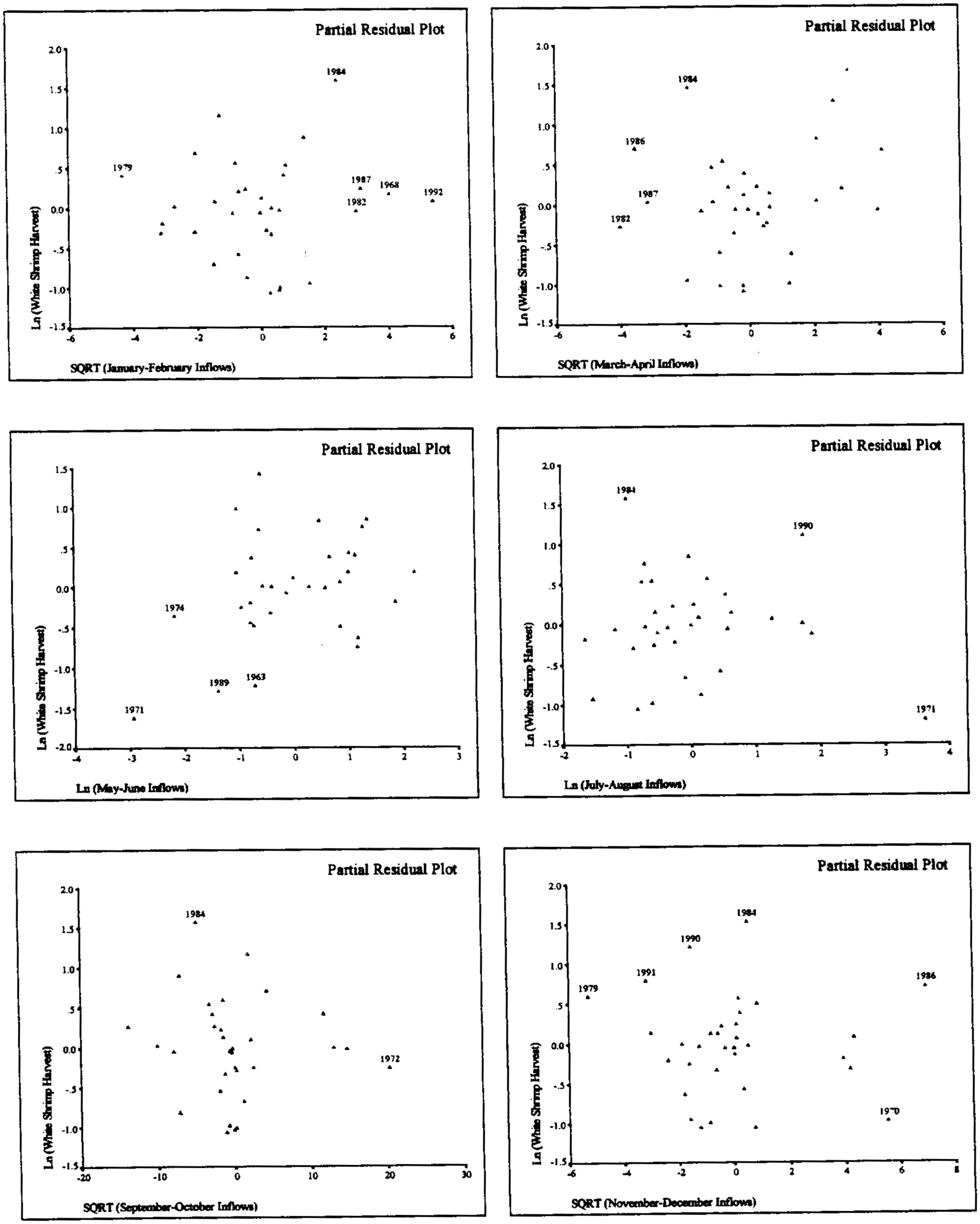



Fig. 6.4.2. Partial Residual Plots of Ln (White Shrimp Harvest) vs. Logged and Square Root Inflows.

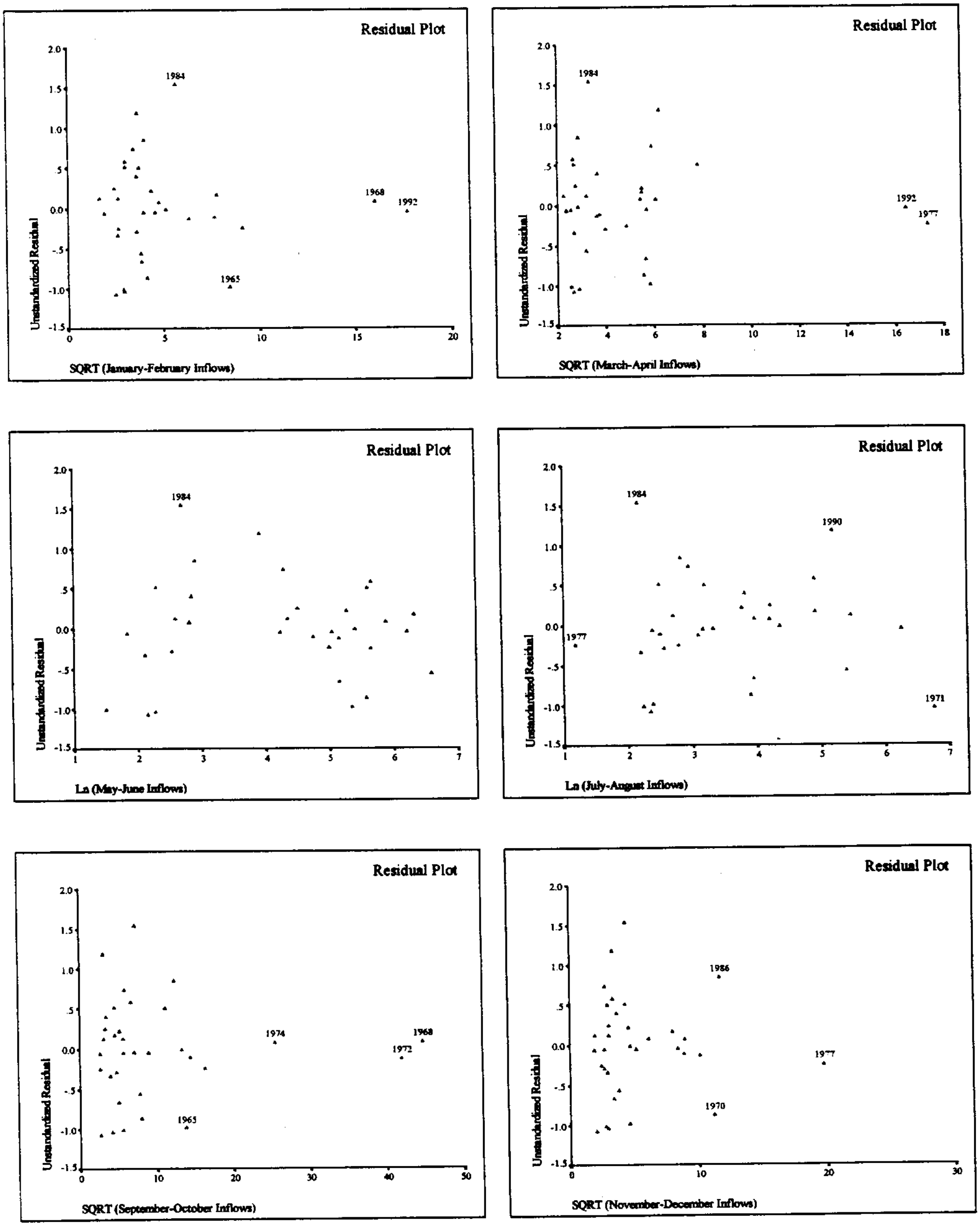



Fig. 6.4.3. Residual Plots of Ln (White Shrimp Harvest) vs. Logged and Square Root Inflows.

### 6.4.4 Prediction Intervals for Ln (White Shrimp Harvest)

| YEAR | Ln_WSH | LICI | UICI |
|---|---|---|---|
| 1962 | 5.2817 | 3.58631 | 7.62384 |
| 1963 | 4.5623 | 3.60647 | 7.64760 |
| 1964 | 5.4926 | 3.50859 | 7.57099 |
| 1965 | 5.4236 | 4.35045 | 8.44090 |
| 1966 | 6.1525 | 4.29080 | 8.49083 |
| 1967 | 5.8398 | 3.71664 | 7.68979 |
| 1968 | 6.4516 | 3.91295 | 8.79097 |
| 1969 | 5.4744 | 3.75125 | 7.74611 |
| 1970 | 5.3318 | 4.06759 | 8.30778 |
| 1971 | 4.4320 | 3.17357 | 7.74777 |
| 1972 | 5.7832 | 3.58843 | 8.20773 |
| 1973 | 6.7719 | 4.15953 | 8.19831 |
| 1974 | 5.6768 | 3.39034 | 7.79045 |
| 1975 | 6.1336 | 4.14403 | 8.12642 |
| 1976 | 6.0169 | 3.85999 | 7.91113 |
| 1977 | 6.3421 | 4.08506 | 9.04913 |
| 1978 | 6.2571 | 4.02326 | 7.97511 |
| 1979 | 6.9593 | 4.26844 | 8.62243 |
| 1980 | 5.9935 | 3.95981 | 8.09509 |
| 1981 | 5.8186 | 4.29210 | 8.44031 |
| 1982 | 5.9917 | 3.97492 | 8.19348 |
| 1983 | 6.1444 | 3.75515 | 7.71578 |
| 1984 | 7.3206 | 3.73311 | 7.80022 |
| 1985 | 5.6157 | 4.27945 | 8.26020 |
| 1986 | 6.4153 | 3.36582 | 7.73617 |
| 1987 | 6.6390 | 4.30570 | 8.60356 |
| 1988 | 6.1386 | 3.60048 | 7.61115 |
| 1989 | 4.4785 | 3.42791 | 7.52216 |
| 1990 | 7.2041 | 3.94575 | 8.07056 |
| 1991 | 6.8979 | 4.13203 | 8.16753 |
| 1992 | 7.1217 | 4.66702 | 9.63051 |
| 1993 | 6.5155 | 4.30784 | 8.25862 |
| 1994 | 6.0438 | 4.12741 | 8.04271 |

**Ln_WSH** Ln (White Shrimp Harvest)
**LICI** Lower limit for 99% prediction interval for Ln (White Shrimp Harvest)
**UICI** Upper limit for 99% prediction interval for Ln (White Shrimp Harvest)

## 6.4.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| **1962** | 2.64276 | .00452 | .08259 | .9160 | .0000 |
| **1963** | 2.70643 | .05007 | .08458 | .9108 | .0002 |
| **1964** | 3.08306 | .00011 | .09635 | .8772 | .0000 |
| **1965** | 3.58250 | .05503 | .11195 | .8264 | .0003 |
| **1966** | 5.56720 | .00552 | .17398 | .5911 | .0000 |
| **1967** | 1.51621 | .00051 | .04738 | .9817 | .0000 |
| **1968** | 19.01304 | .01324 | **.59416** | .0081 | .0000 |
| **1969** | 1.89422 | .00245 | .05919 | .9655 | .0000 |
| **1970** | 6.30760 | .08408 | .19711 | .5043 | .0012 |
| **1971** | 12.73928 | .41793 | .39810 | .0787 | .1181 |
| **1972** | 13.64497 | .00615 | .42641 | .0579 | .0000 |
| **1973** | 2.66472 | .01531 | .08327 | .9142 | .0000 |
| **1974** | 9.32605 | .00157 | .29144 | .2301 | .0000 |
| **1975** | 1.67684 | .00000 | .05240 | .9755 | .0000 |
| **1976** | 2.88326 | .00081 | .09010 | .8956 | .0000 |
| **1977** | 20.86309 | .10303 | **.65197** | **.0040** | .0024 |
| **1978** | 1.14750 | .00152 | .03586 | .9921 | .0000 |
| **1979** | 8.44422 | .04697 | .26388 | .2951 | .0002 |
| **1980** | 4.38821 | .00008 | .13713 | .7341 | .0000 |
| **1981** | 4.62201 | .02318 | .14444 | .7060 | .0000 |
| **1982** | 5.90797 | .00090 | .18462 | .5505 | .0000 |
| **1983** | 1.29929 | .00414 | .04060 | .9885 | .0000 |
| **1984** | 3.16661 | .12400 | .09896 | .8692 | .0042 |
| **1985** | 1.64816 | .01251 | .05151 | .9767 | .0000 |
| **1986** | 8.75613 | .14114 | .27363 | .2706 | .0063 |
| **1987** | 7.38316 | .00489 | .23072 | .3901 | .0000 |
| **1988** | 2.17050 | .01032 | .06783 | .9498 | .0000 |
| **1989** | 3.65055 | .05900 | .11408 | .8190 | .0004 |
| **1990** | 4.19909 | .09898 | .13122 | .7566 | .0021 |
| **1991** | 2.60689 | .02388 | .08147 | .9188 | .0000 |
| **1992** | 20.85040 | .00149 | **.65158** | **.0040** | .0000 |
| **1993** | 1.12889 | .00122 | .03528 | .9925 | .0000 |
| **1994** | .51921 | .00003 | .01623 | .9994 | .0000 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| 1962 | -.17524 | -.16470 | -.01470 | .02334 | .05773 | .07629 | .01764 | .02298 |
| 1963 | -.61328 | -.56755 | -.04265 | .03554 | .19842 | .24518 | .05694 | .15644 |
| 1964 | -.02735 | -.02497 | .00001 | .00019 | .01113 | .00886 | .00070 | .00673 |
| 1965 | -.63775 | -.22150 | -.22081 | .14432 | -.30112 | .42278 | .03219 | .18975 |
| 1966 | -.19328 | -.04896 | .07487 | -.02179 | -.14450 | .11400 | -.00016 | .07084 |
| 1967 | .05880 | .05063 | .00050 | -.00285 | -.01800 | -.01884 | -.00800 | -.00873 |
| 1968 | .29879 | -.02572 | .12947 | -.03910 | -.02253 | .00768 | .12732 | -.07958 |
| 1969 | -.12876 | -.10869 | -.00646 | -.01785 | .05128 | .03983 | -.00212 | .04855 |
| 1970 | -.78298 | .22615 | .06108 | .29779 | -.29482 | -.04125 | .30859 | -.63504 |
| 1971 | **-1.81930** | .45444 | -.13429 | -.31377 | **1.23931** | **-1.63023** | .01078 | -.14304 |
| 1972 | -.20365 | .00514 | .07836 | -.00745 | -.02692 | .02489 | -.15788 | -.00052 |
| 1973 | .32631 | -.08538 | -.06360 | -.07362 | .20123 | .04246 | -.03662 | .01234 |
| 1974 | .10288 | -.01152 | -.04124 | .04867 | -.06005 | .05102 | .06919 | .00112 |
| 1975 | -.00072 | .00011 | -.00008 | .00034 | -.00038 | .00000 | .00002 | -.00009 |
| 1976 | .07383 | -.01725 | -.02580 | .01242 | -.00002 | .04357 | .01159 | -.01227 |
| 1977 | -.83819 | .12521 | .26779 | -.37603 | .06458 | .04021 | -.06547 | -.29560 |
| 1978 | .10144 | .00993 | -.01544 | -.02318 | .04030 | .00375 | -.02688 | .00228 |
| 1979 | .57099 | .02390 | -.38493 | .40617 | .20348 | -.12951 | .31821 | -.38781 |
| 1980 | -.02379 | .01120 | -.00293 | .00224 | .00107 | -.01768 | .00096 | -.00001 |
| 1981 | -.40090 | .17437 | .05731 | .08347 | -.27225 | -.07104 | .04814 | -.02361 |
| 1982 | -.07780 | -.01708 | -.04256 | .06260 | -.02187 | .03188 | .03454 | -.04617 |
| 1983 | .16811 | .06563 | .03957 | -.00794 | -.09990 | .05637 | -.04760 | .01040 |
| 1984 | **1.03767** | .79726 | .59401 | -.49892 | -.26168 | -.45990 | -.36600 | .10072 |
| 1985 | -.29578 | .01182 | .12906 | -.12508 | -.13401 | .01480 | -.02947 | .12993 |
| 1986 | **1.02005** | .16593 | .21692 | -.60793 | -.17546 | -.00688 | -.34069 | .89612 |
| 1987 | .18180 | -.07224 | .09471 | -.10399 | .06171 | .03678 | -.12783 | .10772 |
| 1988 | .26692 | .22135 | .05888 | -.09112 | -.09834 | -.08282 | -.07343 | .04997 |
| 1989 | -.66209 | -.58693 | -.08744 | .03458 | .37035 | .17245 | -.00500 | .10777 |
| 1990 | .87928 | -.23123 | -.23596 | .53941 | -.34115 | .62085 | .10656 | -.23748 |
| 1991 | .41159 | .15187 | -.21319 | .24202 | .09170 | -.14066 | .13620 | -.27186 |
| 1992 | -.10021 | .02016 | -.05571 | -.02355 | .01458 | -.01136 | .03153 | .01600 |
| 1993 | .09083 | -.00369 | -.02089 | .00829 | .05552 | -.01556 | -.01664 | -.01103 |
| 1994 | -.01329 | -.00450 | .00462 | -.00366 | -.00282 | .00356 | .00077 | .00141 |

**DFFITS** Standardized dffits value
**SDFB_0** Standardized dfbeta for the intercept term
**SDFB_1** Standardized dfbeta for the Square Root January-February inflows
**SDFB_2** Standardized dfbeta for the Square Root March-April inflows
**SDFB_3** Standardized dfbeta for the Logged May-June inflows
**SDFB_4** Standardized dfbeta for the Logged July-August inflows
**SDFB_5** Standardized dfbeta for the Square Root September-October inflows
**SDFB_6** Standardized dfbeta for the Square Root November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

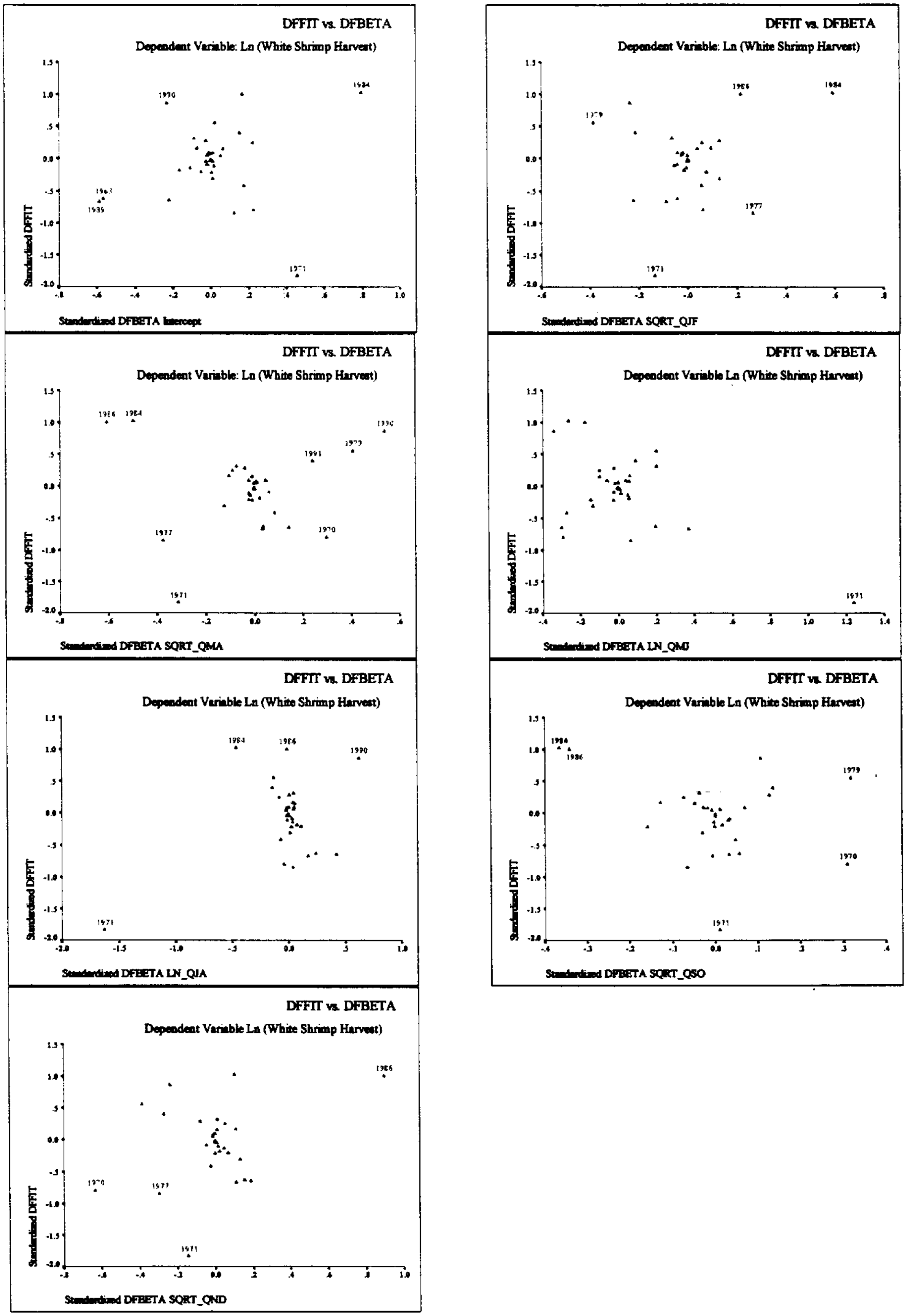



Fig. 6.4.4. Standardized DFFIT vs. Standardized DFBETA.

## 6.5 Model 8: Variables Transformed According to the Box-Cox Analysis

### 6.5.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | (Nov-Dec Inflows)^ -0.3, (Jul-Aug Inflows)^ -0.2, (May-Jun Inflows)^ 0.1, (Mar-Apr Inflows)^ -0.5, (Sept-Oct Inflows)^ -0.3, (Jan-Feb Inflows)^ -0.3[c,d] | . | .498 | .248 | .075 | .463162 | 1.944 |

a. Dependent Variable: (White Shrimp Harverst)^0.2

b. Method: Enter

c. Independent Variables: (Constant), (November-December Inflows)^ -0.3, (July-August Inflows)^ -0.2, (May-June Inflows)^ 0.1, (March-April Inflows)^ -0.5, (September-October Inflows)^ -0.3, (January-February Inflows)^ -0.3

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 1.840 | 6 | .307 | 1.430 | .241[b] |
| | Residual | 5.577 | 26 | .215 | | |
| | Total | 7.417 | 32 | | | |

a. Dependent Variable: (White Shrimp Harverst)^0.2

b. Independent Variables: (Constant), (November-December Inflows)^ -0.3, (July-August Inflows)^ -0.2, (May-June Inflows)^ 0.1, (March-April Inflows)^ -0.5, (September-October Inflows)^ -0.3, (January-February Inflows)^ -0.3

**Coefficients[a]**

| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. | 95% Confidence Interval for B Lower Bound | 95% Confidence Interval for B Upper Bound |
|---|---|---|---|---|---|---|---|---|
| 1 | (Constant) | 2.894 | 1.313 | | 2.204 | .037 | .194 | 5.593 |
| | (January-February Inflows)^ -0.3 | -.608 | 1.319 | -.161 | -.461 | .649 | -3.319 | 2.103 |
| | (March-April Inflows)^ -0.5 | -1.021 | 1.172 | -.225 | -.872 | .391 | -3.430 | 1.387 |
| | (May-June Inflows)^ 0.1 | .579 | .509 | .276 | 1.137 | .266 | -.468 | 1.626 |
| | (July-August Inflows)^ -0.2 | -9.5E-02 | .793 | -.024 | -.120 | .905 | -1.725 | 1.535 |
| | (September-October Inflows)^ -0.3 | .476 | .994 | .127 | .479 | .636 | -1.566 | 2.519 |
| | (November-December Inflows)^ -0.3 | 2.5E-02 | 1.054 | .007 | .024 | .981 | -2.142 | 2.192 |

a. Dependent Variable: (White Shrimp Harverst)^0.2

## 6.5.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 2.893541 | 1.31312613 | 2.204 | 0.0366 | 0.00000000 |
| $(QJF\_Lag)^{-0.3}$ | 1 | -0.607763 | 1.31885870 | -0.461 | 0.6488 | 4.20044409 |
| $(QMA\_Lag)^{-0.5}$ | 1 | -1.021347 | 1.17185988 | -0.872 | 0.3914 | 2.30573805 |
| $(QMJ\_Lag)^{0.1}$ | 1 | 0.578989 | 0.50943076 | 1.137 | 0.2661 | 2.03595063 |
| $(QJA\_Lag)^{-0.2}$ | 1 | -0.095351 | 0.79293594 | -0.120 | 0.9052 | 1.40023008 |
| $(QSO\_Lag)^{-0.3}$ | 1 | 0.476179 | 0.99365037 | 0.479 | 0.6358 | 2.42023465 |
| $(QND\_Lag)^{-0.3}$ | 1 | 0.025308 | 1.05419007 | 0.024 | 0.9810 | 3.03036042 |

Collinearity Diagnostics(intercept adjusted)

| # | Eigen value | Cond Index | Var Prop $(QJF\_Lag)^{-0.3}$ | Var Prop $(QMA\_Lag)^{-0.5}$ | Var Prop $(QMJ\_Lag)^{0.1}$ | Var Prop $(QJA\_Lag)^{-0.2}$ | Var Prop $(QSO\_Lag)^{-0.3}$ | Var Prop $(QND\_Lag)^{-0.3}$ |
|---|---|---|---|---|---|---|---|---|
| 1 | 3.226 | 1.000 | 0.0197 | 0.0235 | 0.0209 | 0.0001 | 0.0243 | 0.0236 |
| 2 | 1.269 | 1.594 | 0.0012 | 0.0043 | 0.0979 | 0.3926 | 0.0000 | 0.0079 |
| 3 | 0.746 | 2.079 | 0.0002 | 0.2608 | 0.0617 | 0.0197 | 0.2084 | 0.0264 |
| 4 | 0.358 | 2.999 | 0.0105 | 0.0805 | 0.5190 | 0.5140 | 0.1164 | 0.1657 |
| 5 | 0.226 | 3.780 | 0.0050 | 0.3691 | 0.2936 | 0.0736 | 0.4678 | 0.5688 |
| 6 | 0.174 | 4.302 | 0.9634 | 0.2618 | 0.0069 | 0.0000 | 0.1831 | 0.2076 |

### 6.5.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 2.965248 | 3.905459 | 3.368791 | .239788 | 33 |
| Std. Predicted Value | -1.683 | 2.238 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | .124190 | .305726 | .208372 | 4.6E-02 | 33 |
| Adjusted Predicted Value | 2.870553 | 3.817578 | 3.367968 | .267603 | 33 |
| Residual | -.708799 | 1.098060 | -8.7E-16 | .417488 | 33 |
| Std. Residual | -1.530 | 2.371 | .000 | .901 | 33 |
| Stud. Residual | -1.873 | 2.603 | .001 | 1.021 | 33 |
| Deleted Residual | -1.061270 | 1.323378 | 8.2E-04 | .538177 | 33 |
| Stud. Deleted Residual | -1.974 | 2.968 | .009 | 1.069 | 33 |
| Mahal. Distance | 1.331 | 12.973 | 5.818 | 2.959 | 33 |
| Cook's Distance | .000 | .249 | .043 | .063 | 33 |
| Centered Leverage Value | .042 | .405 | .182 | .092 | 33 |

a. Dependent Variable: (White Shrimp Harverst)^0.2

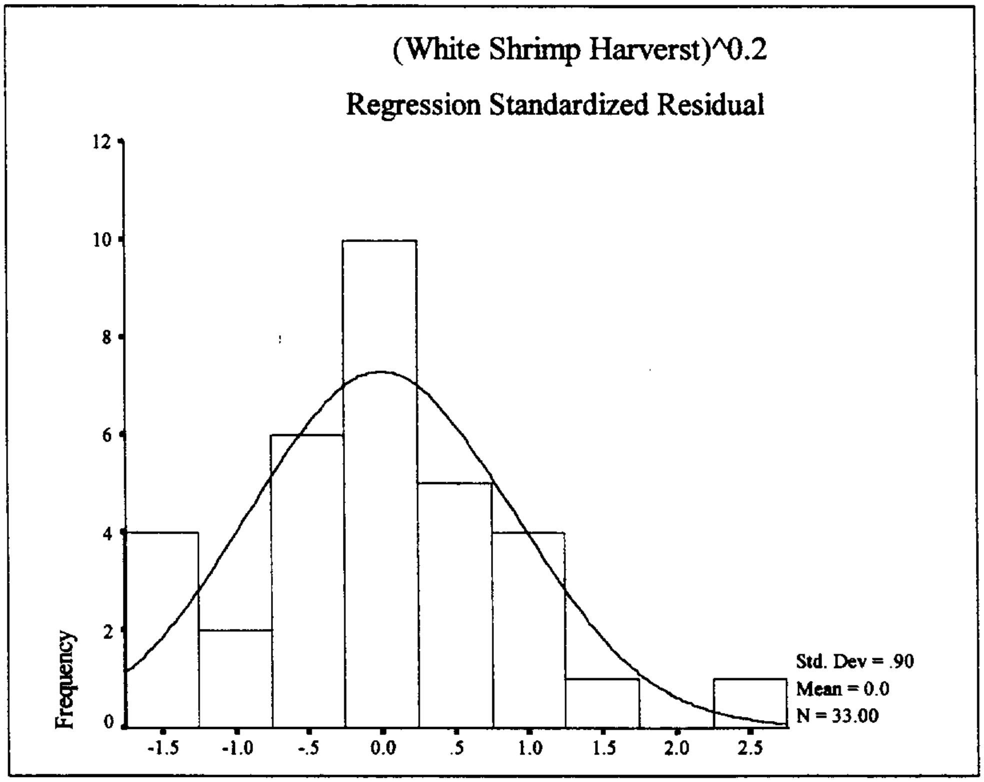
*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 3.04790 | -.17209 | -.19585 | 3.07166 | -1.33822 | -.37155 | -.39637 | -.38985 |
| 1963 | 3.09714 | -.60671 | -.75548 | 3.24590 | -1.13289 | -1.30994 | -1.46174 | -1.49615 |
| 1964 | 2.96525 | .03450 | .04325 | 2.95650 | -1.68291 | .07450 | .08341 | .08180 |
| 1965 | 3.58552 | -.62690 | -.76114 | 3.71977 | .90386 | -1.35352 | -1.49142 | -1.52933 |
| 1966 | 3.58386 | -.16091 | -.22969 | 3.65265 | .89693 | -.34742 | -.41508 | -.40838 |
| 1967 | 3.17731 | .03810 | .04238 | 3.17302 | -.79856 | .08226 | .08676 | .08509 |
| 1968 | 3.64764 | -.01371 | -.01848 | 3.65241 | 1.16291 | -.02960 | -.03437 | -.03370 |
| 1969 | 3.24442 | -.25561 | -.29912 | 3.28793 | -.51868 | -.55188 | -.59701 | -.58947 |
| 1970 | 3.55840 | -.65364 | -.87102 | 3.77578 | .79073 | -1.41125 | -1.62911 | -1.68583 |
| 1971 | 3.13518 | -.70880 | -1.06127 | 3.48765 | -.97423 | -1.53035 | -1.87259 | -1.97417 |
| 1972 | 3.38516 | -.20593 | -.24997 | 3.42921 | .06829 | -.44461 | -.48986 | -.48257 |
| 1973 | 3.34372 | .53067 | .63495 | 3.23944 | -.10457 | 1.14575 | 1.25328 | 1.26784 |
| 1974 | 3.28851 | -.17625 | -.31234 | 3.42461 | -.33478 | -.38054 | -.50658 | -.49921 |
| 1975 | 3.37163 | .03841 | .04516 | 3.36487 | .01185 | .08292 | .08992 | .08819 |
| 1976 | 3.04619 | .28516 | .46080 | 2.87055 | -1.34537 | .61569 | .78265 | .77666 |
| 1977 | 3.64515 | -.08990 | -.13597 | 3.69122 | 1.15250 | -.19410 | -.23871 | -.23433 |
| 1978 | 3.27712 | .21817 | .25373 | 3.24157 | -.38228 | .47105 | .50799 | .50061 |
| 1979 | 3.57423 | .44809 | .67334 | 3.34899 | .85676 | .96747 | 1.18596 | 1.19572 |
| 1980 | 3.32210 | -.00632 | -.00916 | 3.32494 | -.19472 | -.01365 | -.01643 | -.01611 |
| 1981 | 3.53444 | -.33262 | -.41502 | 3.61684 | .69080 | -.71814 | -.80218 | -.79652 |
| 1982 | 3.41777 | -.10316 | -.12072 | 3.43534 | .20428 | -.22272 | -.24094 | -.23652 |
| 1983 | 3.29642 | .12098 | .14095 | 3.27645 | -.30182 | .26121 | .28194 | .27689 |
| 1984 | 3.22567 | 1.09806 | 1.32338 | 3.00035 | -.59686 | 2.37079 | 2.60269 | **2.96789** |
| 1985 | 3.55850 | -.48402 | -.53173 | 3.60621 | .79116 | -1.04504 | -1.09533 | -1.09973 |
| 1986 | 3.10682 | .50081 | .68792 | 2.91971 | -1.09250 | 1.08129 | 1.26729 | 1.28293 |
| 1987 | 3.78026 | -.00755 | -.01086 | 3.78356 | 1.71596 | -.01631 | -.01956 | -.01918 |
| 1988 | 3.07244 | .34099 | .39523 | 3.01820 | -1.23587 | .73622 | .79262 | .78679 |
| 1989 | 2.97038 | -.52135 | -.62511 | 3.07414 | -1.66150 | -1.12562 | -1.23256 | -1.24556 |
| 1990 | 3.52338 | .70076 | .96357 | 3.26057 | .64469 | 1.51299 | 1.77416 | 1.85565 |
| 1991 | 3.44533 | .52791 | .63692 | 3.33632 | .31918 | 1.13980 | 1.25196 | 1.26641 |
| 1992 | 3.90546 | .24962 | .33750 | 3.81758 | 2.23809 | .53895 | .62668 | .61920 |
| 1993 | 3.57979 | .10086 | .10867 | 3.57198 | .87995 | .21777 | .22604 | .22187 |
| 1994 | 3.45699 | -.10765 | -.11769 | 3.46704 | .36783 | -.23242 | -.24303 | -.23858 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.

[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



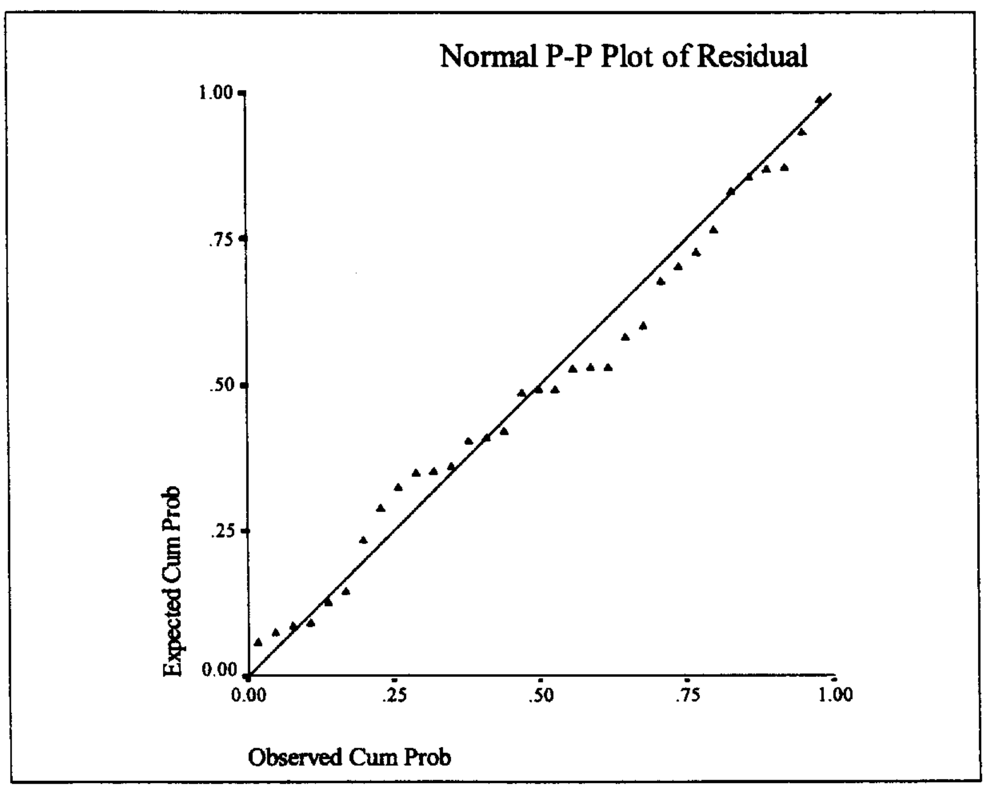




Fig. 6.5.1. Exploratory Plots of (White Shrimp Harvest) $^{0.2}$ Standardized Residual.

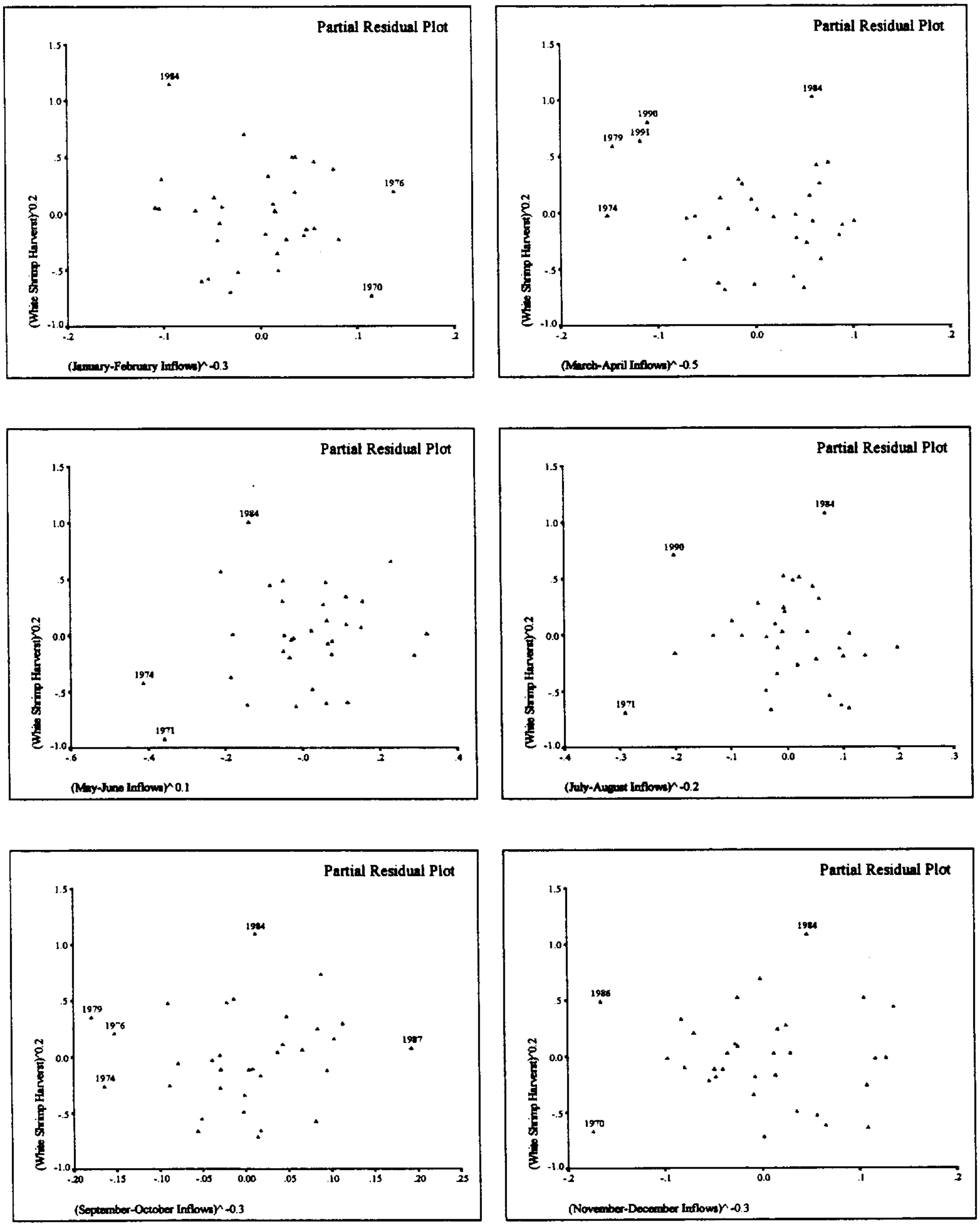



Fig. 6.5.2. Partial Residual Plots of (White Shrimp Harvest) $^{0.2}$ vs. Box-Cox Transformed Inflows.

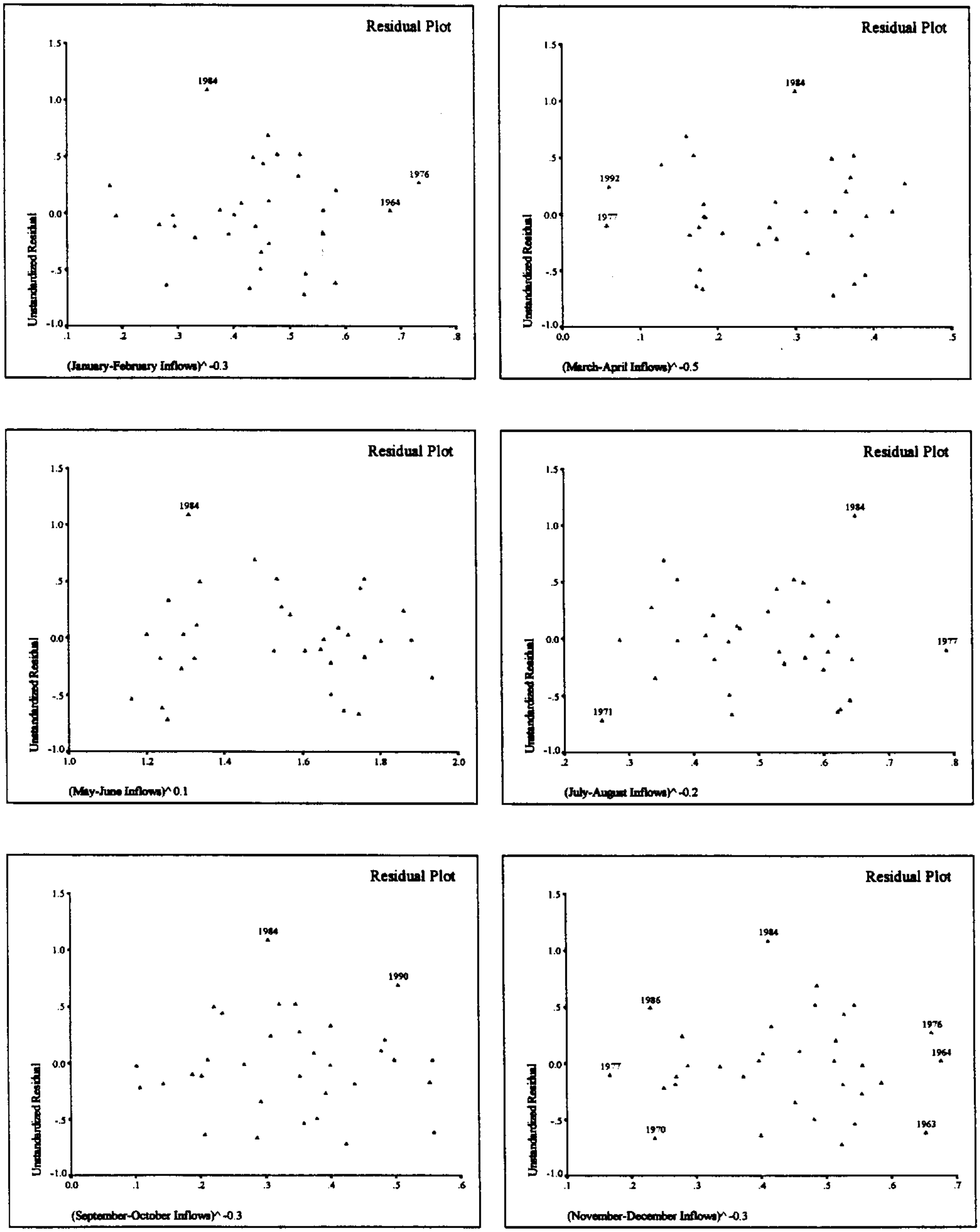



Fig. 6.5.3. Residual Plots of (White Shrimp Harvest) $^{0.2}$ vs. Box-Cox Transformed Inflows.

### 6.5.4 Prediction Intervals for (White Shrimp Harvest) $^{0.2}$

| YEAR | Box_WSH | LICI | UICI |
|---|---|---|---|
| 1962 | 2.8758 | 1.68506 | 4.41074 |
| 1963 | 2.4904 | 1.68912 | 4.50515 |
| 1964 | 2.9998 | 1.55407 | 4.37643 |
| 1965 | 2.9586 | 2.18964 | 4.98141 |
| 1966 | 3.4230 | 2.11677 | 5.05096 |
| 1967 | 3.2154 | 1.82685 | 4.52776 |
| 1968 | 3.6339 | 2.20411 | 5.09118 |
| 1969 | 2.9888 | 1.86699 | 4.62184 |
| 1970 | 2.9048 | 2.11974 | 4.99705 |
| 1971 | 2.4264 | 1.64976 | 4.62060 |
| 1972 | 3.1792 | 1.98938 | 4.78095 |
| 1973 | 3.8744 | 1.95505 | 4.73238 |
| 1974 | 3.1123 | 1.74642 | 4.83061 |
| 1975 | 3.4100 | 1.99170 | 4.75157 |
| 1976 | 3.3314 | 1.53368 | 4.55869 |
| 1977 | 3.5552 | 2.15600 | 5.13429 |
| 1978 | 3.4953 | 1.90291 | 4.65134 |
| 1979 | 4.0223 | 2.08748 | 5.06099 |
| 1980 | 3.3158 | 1.84900 | 4.79520 |
| 1981 | 3.2018 | 2.12546 | 4.94342 |
| 1982 | 3.3146 | 2.04033 | 4.79522 |
| 1983 | 3.4174 | 1.92129 | 4.67154 |
| 1984 | 4.3237 | 1.83342 | 4.61792 |
| 1985 | 3.0745 | 2.21501 | 4.90199 |
| 1986 | 3.6076 | 1.65531 | 4.55833 |
| 1987 | 3.7727 | 2.31038 | 5.25014 |
| 1988 | 3.4134 | 1.69997 | 4.44492 |
| 1989 | 2.4490 | 1.58067 | 4.36009 |
| 1990 | 4.2241 | 2.07144 | 4.97532 |
| 1991 | 3.9732 | 2.05255 | 4.83811 |
| 1992 | 4.1551 | 2.46059 | 5.35033 |
| 1993 | 3.6807 | 2.24734 | 4.91225 |
| 1994 | 3.3493 | 2.11620 | 4.79778 |

**Box_WSH** (White Shrimp Harvest) $^{0.2}$
**LICI** Lower limit for 99% prediction interval for (White Shrimp Harvest) $^{0.2}$
**UICI** Upper limit for 99% prediction interval for (White Shrimp Harvest) $^{0.2}$

### 6.5.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| **1962** | 2.91291 | .00310 | .09103 | .8929 | .0000 |
| **1963** | 5.33154 | .07484 | .16661 | .6196 | .0008 |
| **1964** | 5.50377 | .00025 | .17199 | .5987 | .0000 |
| **1965** | 4.67429 | .06805 | .14607 | .6996 | .0006 |
| **1966** | 8.61286 | .01052 | .26915 | .2817 | .0000 |
| **1967** | 2.26370 | .00012 | .07074 | .9438 | .0000 |
| **1968** | 7.28840 | .00006 | .22776 | .3995 | .0000 |
| **1969** | 3.68515 | .00867 | .11516 | .8152 | .0000 |
| **1970** | 7.01663 | .12609 | .21927 | .4272 | .0044 |
| **1971** | 9.65821 | .24911 | .30182 | .2088 | .0323 |
| **1972** | 4.66880 | .00733 | .14590 | .7003 | .0000 |
| **1973** | 4.28573 | .04409 | .13393 | .7463 | .0001 |
| **1974** | 12.97310 | .02831 | .40541 | .0728 | .0000 |
| **1975** | 3.81904 | .00020 | .11934 | .8004 | .0000 |
| **1976** | 11.22712 | .05390 | .35085 | .1290 | .0003 |
| **1977** | 9.87247 | .00417 | .30851 | .1959 | .0000 |
| **1978** | 3.51466 | .00601 | .10983 | .8337 | .0000 |
| **1979** | 9.73492 | .10100 | .30422 | .2041 | .0022 |
| **1980** | 8.95398 | .00002 | .27981 | .2560 | .0000 |
| **1981** | 5.38390 | .02277 | .16825 | .6132 | .0000 |
| **1982** | 3.68618 | .00141 | .11519 | .8151 | .0000 |
| **1983** | 3.56281 | .00187 | .11134 | .8285 | .0000 |
| **1984** | 4.47862 | .19857 | .13996 | .7233 | .0171 |
| **1985** | 1.90142 | .01689 | .05942 | .9651 | .0000 |
| **1986** | 7.73416 | .08572 | .24169 | .3566 | .0013 |
| **1987** | 8.77121 | .00002 | .27410 | .2695 | .0000 |
| **1988** | 3.42229 | .01428 | .10695 | .8434 | .0000 |
| **1989** | 4.34191 | .04319 | .13568 | .7397 | .0001 |
| **1990** | 7.75822 | .16864 | .24244 | .3544 | .0107 |
| **1991** | 4.50703 | .04624 | .14084 | .7199 | .0002 |
| **1992** | 7.36269 | .01975 | .23008 | .3921 | .0000 |
| **1993** | 1.33101 | .00057 | .04159 | .9876 | .0000 |
| **1994** | 1.76128 | .00079 | .05504 | .9719 | .0000 |

| | |
|---|---|
| **MAH** | Mahalonobis distance |
| **COO** | Cook's distance |
| **LEV** | Leverage value |
| **MAHA_PV** | P-value associated with the Mahalanobis distance |
| **COOK_PV** | P-value associated with Cook's distance |

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1962** | -.14487 | .02306 | -.00663 | -.04371 | .01543 | -.07172 | -.01561 | .00720 |
| **1963** | -.74085 | .14293 | .25758 | -.20374 | .03213 | -.27694 | -.29245 | -.24591 |
| **1964** | .04119 | -.01387 | .00412 | .00945 | .00242 | .01754 | .00739 | .00586 |
| **1965** | -.70771 | .10895 | .29625 | .00735 | -.11565 | -.32054 | .20245 | -.41463 |
| **1966** | -.26700 | .18422 | -.06296 | .03565 | -.17253 | -.11776 | -.09925 | -.01494 |
| **1967** | .02853 | -.00054 | .00378 | .00035 | -.00457 | .00563 | .01279 | -.00728 |
| **1968** | -.01988 | -.00478 | .01166 | -.00180 | .00128 | .00249 | .00661 | -.01032 |
| **1969** | -.24321 | -.08854 | .08166 | .07697 | .12980 | -.02000 | .04117 | -.15582 |
| **1970** | -.97221 | .08372 | -.63549 | .19262 | -.25015 | .09924 | -.07273 | .76969 |
| **1971** | **-1.39215** | **-1.08441** | .21700 | .19770 | .95106 | **1.20611** | -.07287 | -.00677 |
| **1972** | -.22318 | .01996 | -.04046 | -.07018 | -.04375 | -.04742 | .10122 | .06682 |
| **1973** | .56202 | -.27929 | .14299 | .26132 | .35272 | -.01242 | -.03966 | -.07933 |
| **1974** | -.43866 | -.33482 | -.15341 | .25652 | .30090 | .22834 | .23468 | .07263 |
| **1975** | .03700 | -.00593 | -.01076 | .02444 | .01190 | -.00146 | -.00607 | .00249 |
| **1976** | .60952 | -.13554 | .38616 | -.04224 | .12463 | -.08815 | -.32238 | .05573 |
| **1977** | -.16775 | .02845 | -.04586 | .04515 | -.02479 | -.09796 | .01787 | .05218 |
| **1978** | .20210 | -.08508 | .05462 | .07521 | .09308 | -.00447 | .09720 | -.08672 |
| **1979** | .84776 | -.10526 | .31547 | -.54478 | .10081 | .11500 | -.56335 | .45194 |
| **1980** | -.01080 | -.00191 | .00599 | -.00434 | .00047 | .00437 | .00161 | -.00561 |
| **1981** | -.39645 | .19846 | -.04398 | -.14896 | -.28248 | .02768 | .00264 | .01791 |
| **1982** | -.09760 | .01314 | .03069 | -.05514 | -.01875 | -.04091 | -.00451 | .02373 |
| **1983** | .11248 | .06239 | -.04070 | -.00317 | -.05908 | -.05059 | .06632 | -.01896 |
| **1984** | **1.34441** | .34427 | -.87067 | .48297 | -.49488 | .38359 | .08404 | .34331 |
| **1985** | -.34526 | -.00891 | -.05949 | .21464 | -.03288 | .07396 | .00681 | -.09208 |
| **1986** | .78418 | .14356 | .23882 | .23655 | -.13739 | .02980 | -.06853 | -.56644 |
| **1987** | -.01269 | .00058 | .00438 | -.00339 | -.00383 | .00314 | -.00950 | .00511 |
| **1988** | .31381 | .00368 | .01951 | .14087 | -.04796 | .08391 | .08726 | -.15956 |
| **1989** | -.55567 | -.07614 | .09125 | -.13134 | .21526 | -.17843 | .15117 | -.17312 |
| **1990** | **1.13641** | .64031 | -.10431 | -.60623 | -.50135 | -.75695 | .41451 | -.00969 |
| **1991** | .57547 | .03520 | .13188 | -.41595 | -.07609 | .05438 | -.26797 | .33280 |
| **1992** | .36740 | .02967 | -.20969 | -.02568 | .04353 | -.00784 | .17452 | .02559 |
| **1993** | .06175 | -.00446 | .00884 | -.02109 | .01625 | -.00848 | .02158 | -.01334 |
| **1994** | -.07288 | -.01763 | -.03391 | .04490 | .01333 | .00702 | -.00197 | .02804 |

**DFFITS** Standardized dffits value
**SDFB_0** Standardized dfbeta for the intercept term
**SDFB_1** Standardized dfbeta for the (January-February inflows) $^{-0.3}$
**SDFB_2** Standardized dfbeta for the (March-April inflows) $^{-0.5}$
**SDFB_3** Standardized dfbeta for the (May-June inflows) $^{0.1}$
**SDFB_4** Standardized dfbeta for the (July-August inflows) $^{-0.2}$
**SDFB_5** Standardized dfbeta for the (September-October inflows) $^{-0.3}$
**SDFB_6** Standardized dfbeta for the (November-December inflows) $^{-0.3}$

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

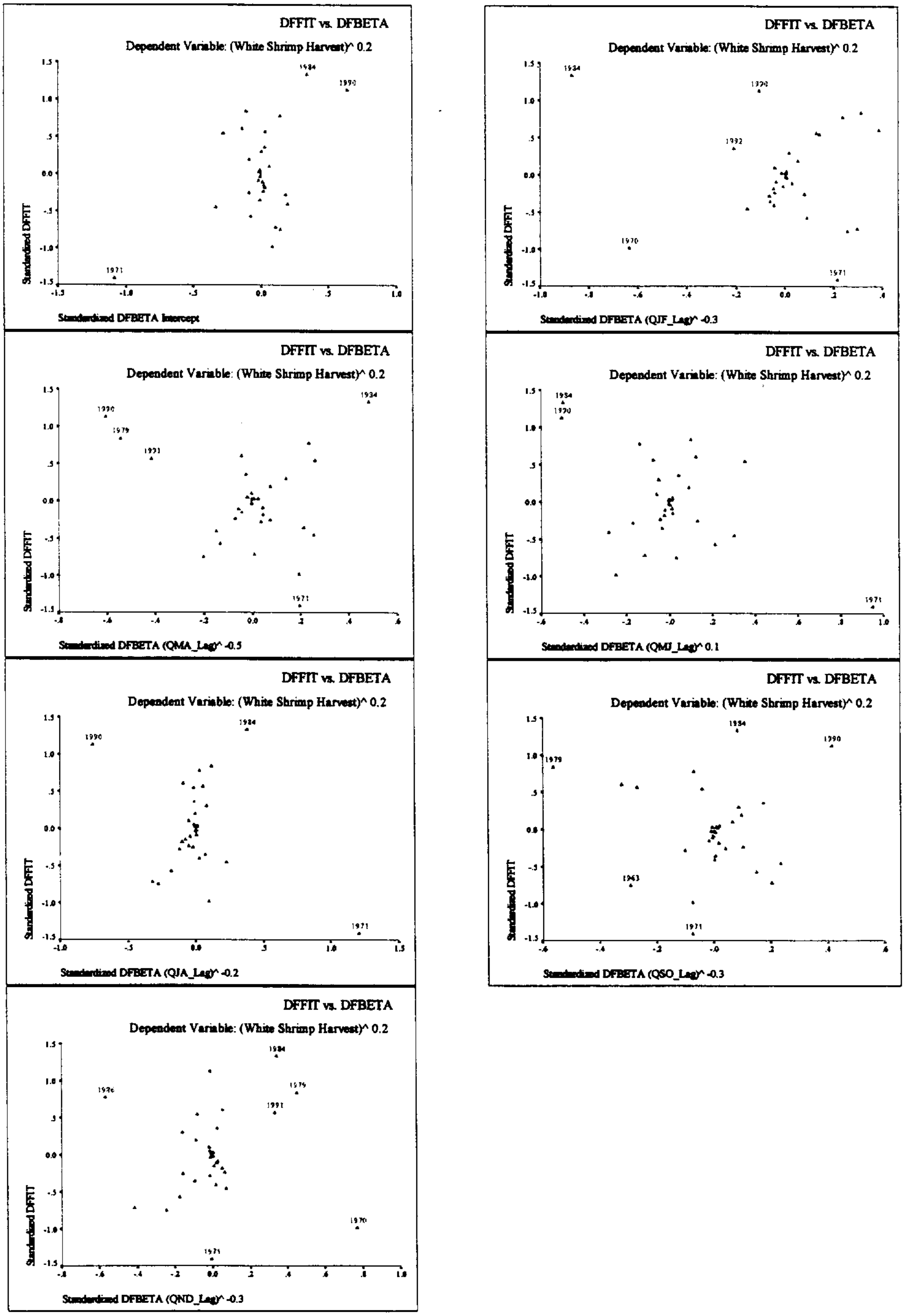



Fig. 6.5.4. Standardized DFFIT vs. Standardized DFBETA.

# 7. Examining Subsets of the Data

## 7.1 Model 2: Logged Inflows

### 7.1.1 Logged Inflows: 1984 Omitted

N = 32    Regression Models for Dependent Variable: WHITE

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.271324 | 0.247035 | 2.3197 | 362.1 | 77381 | 365.1 | LN_QMA |
| 1 | 0.204430 | 0.177911 | 5.1031 | 365.0 | 84485 | 367.9 | LN_QMJ |
| 1 | 0.110543 | 0.080895 | 9.0097 | 368.5 | 94455 | 371.5 | LN_QJF |
| 1 | 0.020696 | -.011947 | 12.7482 | 371.6 | 103996 | 374.5 | LN_QND |
| 2 | 0.342398 | 0.297047 | 1.3624 | 360.9 | 72241 | 365.3 | LN_QMA LN_QJA |
| 2 | 0.326360 | 0.279902 | 2.0297 | 361.6 | 74003 | 366.0 | LN_QMA LN_QMJ |
| 2 | 0.301338 | 0.253154 | 3.0709 | 362.8 | 76752 | 367.2 | LN_QMA LN_QND |
| 2 | 0.286309 | 0.237089 | 3.6962 | 363.5 | 78403 | 367.9 | LN_QMA LN_QSO |
| 3 | 0.367685 | 0.299937 | 2.3102 | 361.6 | 71944 | 367.5 | LN_QMA LN_QMJ LN_QSO |
| 3 | 0.367450 | 0.299677 | 2.3200 | 361.6 | 71971 | 367.5 | LN_QMA LN_QMJ LN_QND |
| 3 | 0.365393 | 0.297400 | 2.4056 | 361.7 | 72205 | 367.6 | LN_QMA LN_QJA LN_QND |
| 3 | 0.360038 | 0.291471 | 2.6284 | 362.0 | 72814 | 367.9 | LN_QMA LN_QJA LN_QSO |
| 4 | 0.391012 | 0.300792 | 3.3396 | 362.4 | 71856 | 369.7 | LN_QMA LN_QMJ LN_QJA LN_QSO |
| 4 | 0.388904 | 0.298371 | 3.4273 | 362.5 | 72105 | 369.8 | LN_QMA LN_QMJ LN_QJA LN_QND |
| 4 | 0.377420 | 0.285186 | 3.9051 | 363.1 | 73460 | 370.4 | LN_QMA LN_QMJ LN_QSO LN_QND |
| 4 | 0.368007 | 0.274378 | 4.2968 | 363.6 | 74571 | 370.9 | LN_QJF LN_QMA LN_QMJ LN_QJA |
| 5 | 0.397903 | 0.282115 | 5.0529 | 364.0 | 73776 | 372.8 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.391214 | 0.274140 | 5.3312 | 364.4 | 74595 | 373.2 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.389002 | 0.271502 | 5.4233 | 364.5 | 74866 | 373.3 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.378764 | 0.259296 | 5.8492 | 365.0 | 76121 | 373.8 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 6 | 0.399174 | 0.254975 | 7.0000 | 366.0 | 76565 | 376.2 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | -156.883885 | 250.15329935 | -0.627 | 0.5362 | 0.00000000 |
| LN_QJF | 1 | 19.991291 | 86.93992026 | 0.230 | 0.8200 | 3.65891814 |
| LN_QMA | 1 | 167.266709 | 76.74859172 | 2.179 | 0.0389 | 2.49065081 |
| LN_QMJ | 1 | 47.232038 | 45.46451922 | 1.039 | 0.3088 | 1.94578186 |
| LN_QJA | 1 | 41.794820 | 45.35356610 | 0.922 | 0.3656 | 1.40012690 |
| LN_QSO | 1 | -33.212418 | 51.05041532 | -0.651 | 0.5213 | 2.40111908 |
| LN_QND | 1 | -38.285420 | 66.52666416 | -0.575 | 0.5701 | 2.52504958 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop LN_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop LN_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 3.16011 | 1.00000 | 0.0231 | 0.0233 | 0.0224 | 0.0011 | 0.0241 | 0.0281 |
| 2 | 1.25979 | 1.58381 | 0.0000 | 0.0083 | 0.1011 | 0.3931 | 0.0007 | 0.0096 |
| 3 | 0.76677 | 2.03010 | 0.0000 | 0.2018 | 0.0760 | 0.0091 | 0.2308 | 0.0344 |
| 4 | 0.36852 | 2.92834 | 0.0012 | 0.0875 | 0.4537 | 0.5140 | 0.0990 | 0.2579 |
| 5 | 0.26243 | 3.47012 | 0.2726 | 0.0844 | 0.3385 | 0.0519 | 0.1012 | 0.6450 |
| 6 | 0.18238 | 4.16261 | 0.7031 | 0.5948 | 0.0084 | 0.0308 | 0.5441 | 0.0250 |

Variable

| Variable | DF | Label |
|---|---|---|
| INTERCEP | 1 | Intercept |
| LN_QJF | 1 | Ln (January-February Inflows) |
| LN_QMA | 1 | Ln (March-April Inflows) |
| LN_QMJ | 1 | Ln (May-June Inflows) |
| LN_QJA | 1 | Ln (July-August Inflows) |
| LN_QSO | 1 | Ln (September-October Inflows) |
| LN_QND | 1 | Ln (November-December Inflows) |

| OBS | _MODEL_ | _TYPE_ | _DEPVAR_ | _RMSE_ | INTERCEP | LN_QJF | LN_QMA | LN_QMJ | LN_QJA | LN_QSO |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MODEL1 | PARMS | WHITE | 278.174 | 21.410 | . | 163.401 | . | . | . |
| 2 | MODEL1 | PARMS | WHITE | 290.662 | 87.918 | . | . | 95.0591 | . | . |
| 3 | MODEL1 | PARMS | WHITE | 307.335 | 214.033 | 97.4775 | . | . | . | . |
| 4 | MODEL1 | PARMS | WHITE | 322.484 | 377.406 | . | . | . | . | . |
| 5 | MODEL1 | PARMS | WHITE | 268.777 | -281.845 | . | 183.854 | . | 67.8568 | . |
| 6 | MODEL1 | PARMS | WHITE | 272.035 | -102.882 | . | 124.146 | 55.9002 | . | . |
| 7 | MODEL1 | PARMS | WHITE | 277.042 | 82.140 | . | 199.494 | . | . | . |
| 8 | MODEL1 | PARMS | WHITE | 280.005 | 93.122 | . | 175.027 | . | . | -27.1809 |
| 9 | MODEL1 | PARMS | WHITE | 268.224 | -12.228 | . | 133.566 | 71.3451 | . | -47.3770 |
| 10 | MODEL1 | PARMS | WHITE | 268.274 | -44.229 | . | 162.603 | 61.7094 | . | . |
| 11 | MODEL1 | PARMS | WHITE | 268.710 | -214.139 | . | 214.587 | . | 64.6424 | . |
| 12 | MODEL1 | PARMS | WHITE | 269.841 | -209.824 | . | 196.872 | . | 69.1641 | -29.5124 |
| 13 | MODEL1 | PARMS | WHITE | 268.060 | -175.725 | . | 159.846 | 50.2709 | 44.4316 | -42.9092 |
| 14 | MODEL1 | PARMS | WHITE | 268.524 | -200.402 | . | 184.310 | 42.1248 | 42.8242 | . |
| 15 | MODEL1 | PARMS | WHITE | 271.035 | -10.290 | . | 153.726 | 69.0951 | . | -29.4854 |
| 16 | MODEL1 | PARMS | WHITE | 273.077 | -258.944 | -43.5007 | 178.247 | 44.1426 | 48.3242 | . |
| 17 | MODEL1 | PARMS | WHITE | 271.617 | -164.654 | . | 175.387 | 49.5828 | 41.8687 | -28.0295 |
| 18 | MODEL1 | PARMS | WHITE | 273.121 | -173.185 | 7.7303 | 156.054 | 49.3907 | 44.5106 | -45.5379 |
| 19 | MODEL1 | PARMS | WHITE | 273.617 | -200.691 | -4.9818 | 185.922 | 43.0543 | 42.7986 | . |
| 20 | MODEL1 | PARMS | WHITE | 275.900 | -2.579 | 20.5592 | 145.415 | 66.6421 | . | -34.8129 |
| 21 | MODEL1 | PARMS | WHITE | 276.703 | -156.884 | 19.9913 | 167.267 | 47.2320 | 41.7948 | -33.2124 |

| OBS | LN_QND | WHITE | _IN_ | _P_ | _EDF_ | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | . | -1 | 1 | 2 | 30 | 77380.82 | 0.27132 | 0.24704 | 2.3197 | 362.143 | 365.074 |
| 2 | . | -1 | 1 | 2 | 30 | 84484.53 | 0.20443 | 0.17791 | 5.1031 | 364.953 | 367.885 |
| 3 | . | -1 | 1 | 2 | 30 | 94454.77 | 0.11054 | 0.08089 | 9.0097 | 368.523 | 371.454 |
| 4 | 38.8509 | -1 | 1 | 2 | 30 | 103995.98 | 0.02070 | -0.01195 | 12.7482 | 371.602 | 374.534 |
| 5 | . | -1 | 2 | 3 | 29 | 72241.23 | 0.34240 | 0.29705 | 1.3624 | 360.858 | 365.256 |
| 6 | . | -1 | 2 | 3 | 29 | 74003.16 | 0.32636 | 0.27990 | 2.0297 | 361.630 | 366.027 |
| 7 | -56.1639 | -1 | 2 | 3 | 29 | 76751.99 | 0.30134 | 0.25315 | 3.0709 | 362.797 | 367.194 |
| 8 | . | -1 | 2 | 3 | 29 | 78402.93 | 0.28631 | 0.23709 | 3.6962 | 363.478 | 367.875 |
| 9 | . | -1 | 3 | 4 | 28 | 71944.16 | 0.36769 | 0.29994 | 2.3102 | 361.604 | 367.467 |
| 10 | -66.1893 | -1 | 3 | 4 | 28 | 71970.94 | 0.36745 | 0.29968 | 2.3200 | 361.616 | 367.479 |
| 11 | -49.3308 | -1 | 3 | 4 | 28 | 72204.92 | 0.36539 | 0.29740 | 2.4056 | 361.719 | 367.582 |
| 12 | . | -1 | 3 | 4 | 28 | 72814.24 | 0.36004 | 0.29147 | 2.6284 | 361.988 | 367.851 |
| 13 | . | -1 | 4 | 5 | 27 | 71856.36 | 0.39101 | 0.30079 | 3.3396 | 362.401 | 369.729 |
| 14 | -58.4807 | -1 | 4 | 5 | 27 | 72105.15 | 0.38890 | 0.29837 | 3.4273 | 362.511 | 369.840 |
| 15 | -40.8206 | -1 | 4 | 5 | 27 | 73460.10 | 0.37742 | 0.28519 | 3.9051 | 363.107 | 370.436 |
| 16 | . | -1 | 4 | 5 | 27 | 74570.86 | 0.36801 | 0.27438 | 4.2968 | 363.587 | 370.916 |
| 17 | -34.5367 | -1 | 5 | 6 | 26 | 73775.71 | 0.39790 | 0.28212 | 5.0529 | 364.037 | 372.831 |
| 18 | . | -1 | 5 | 6 | 26 | 74595.29 | 0.39121 | 0.27414 | 5.3312 | 364.390 | 373.185 |
| 19 | -56.4432 | -1 | 5 | 6 | 26 | 74866.41 | 0.38900 | 0.27150 | 5.4233 | 364.506 | 373.301 |
| 20 | -44.6644 | -1 | 5 | 6 | 26 | 76120.80 | 0.37876 | 0.25930 | 5.8492 | 365.038 | 373.832 |
| 21 | -38.2854 | -1 | 6 | 7 | 25 | 76564.81 | 0.39917 | 0.25498 | 7.0000 | 365.969 | 376.229 |

## 7.2 Model 3: Logged All Variables

### 7.2.1 Logged All Variables: 1971 Omitted

N = 32 Regression Models for Dependent Variable: LN_WSH

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.178537 | 0.151155 | 0.9628 | -27.6337 | 0.396923 | -24.7022 | LN_QMJ |
| 1 | 0.162334 | 0.134411 | 1.5341 | -27.0086 | 0.404752 | -24.0771 | LN_QMA |
| 1 | 0.120342 | 0.091020 | 3.0146 | -25.4434 | 0.425042 | -22.5119 | LN_QJF |
| 1 | 0.059751 | 0.028410 | 5.1509 | -23.3118 | 0.454319 | -20.3803 | LN_QJA |
| 2 | 0.265556 | 0.214905 | -0.1053 | -29.2168 | 0.367113 | -24.8196 | LN_QMA LN_QJA |
| 2 | 0.233432 | 0.180565 | 1.0273 | -27.8469 | 0.383171 | -23.4497 | LN_QMA LN_QMJ |
| 2 | 0.201156 | 0.146063 | 2.1653 | -26.5271 | 0.399304 | -22.1299 | LN_QJF LN_QMJ |
| 2 | 0.191099 | 0.135312 | 2.5199 | -26.1268 | 0.404331 | -21.7295 | LN_QJF LN_QJA |
| 3 | 0.273124 | 0.195244 | 1.6279 | -27.5482 | 0.376307 | -21.6853 | LN_QJF LN_QMA LN_QJA |
| 3 | 0.271863 | 0.193849 | 1.6723 | -27.4928 | 0.376959 | -21.6298 | LN_QMA LN_QMJ LN_QJA |
| 3 | 0.266543 | 0.187958 | 1.8599 | -27.2598 | 0.379714 | -21.3969 | LN_QMA LN_QJA LN_QSO |
| 3 | 0.265590 | 0.186904 | 1.8935 | -27.2183 | 0.380207 | -21.3553 | LN_QMA LN_QJA LN_QND |
| 4 | 0.286729 | 0.181059 | 3.1482 | -26.1528 | 0.382940 | -18.8242 | LN_QJF LN_QMA LN_QJA LN_QSO |
| 4 | 0.275820 | 0.168534 | 3.5328 | -25.6672 | 0.388796 | -18.3385 | LN_QJF LN_QMA LN_QMJ LN_QJA |
| 4 | 0.275574 | 0.168252 | 3.5415 | -25.6563 | 0.388929 | -18.3276 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.275307 | 0.167945 | 3.5509 | -25.6445 | 0.389072 | -18.3158 | LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.290922 | 0.154561 | 5.0003 | -24.3415 | 0.395330 | -15.5471 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.286729 | 0.149561 | 5.1482 | -24.1528 | 0.397668 | -15.3584 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.278289 | 0.139498 | 5.4458 | -23.7764 | 0.402374 | -14.9820 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.276348 | 0.137184 | 5.5142 | -23.6905 | 0.403456 | -14.8961 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.290932 | 0.120756 | 7.0000 | -22.3420 | 0.411138 | -12.0818 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

### 7.2.2 Logged All Variables: 1977 Omitted

N = 32     Regression Models for Dependent Variable: LN_WSH

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.214870 | 0.188699 | -0.5881 | -23.9881 | 0.444818 | -21.0566 | LN_QMJ |
| 1 | 0.195206 | 0.168379 | 0.0985 | -23.1965 | 0.455959 | -20.2650 | LN_QMA |
| 1 | 0.127396 | 0.098309 | 2.4660 | -20.6078 | 0.494377 | -17.6764 | LN_QJF |
| 1 | 0.048999 | 0.017299 | 5.2031 | -17.8548 | 0.538793 | -14.9233 | LN_QND |
| 2 | 0.273905 | 0.223829 | -0.6492 | -24.4895 | 0.425557 | -20.0923 | LN_QMA LN_QMJ |
| 2 | 0.233037 | 0.180143 | 0.7776 | -22.7372 | 0.449509 | -18.3400 | LN_QJF LN_QMJ |
| 2 | 0.229448 | 0.176306 | 0.9029 | -22.5878 | 0.451613 | -18.1906 | LN_QMJ LN_QJA |
| 2 | 0.219556 | 0.165733 | 1.2483 | -22.1797 | 0.457410 | -17.7825 | LN_QMJ LN_QND |
| 3 | 0.277079 | 0.199623 | 1.2399 | -22.6297 | 0.438829 | -16.7667 | LN_QMA LN_QMJ LN_QSO |
| 3 | 0.276267 | 0.198724 | 1.2683 | -22.5937 | 0.439322 | -16.7308 | LN_QMA LN_QMJ LN_QJA |
| 3 | 0.274099 | 0.196324 | 1.3440 | -22.4981 | 0.440637 | -16.6351 | LN_QJF LN_QMA LN_QMJ |
| 3 | 0.273925 | 0.196131 | 1.3501 | -22.4904 | 0.440743 | -16.6274 | LN_QMA LN_QMJ LN_QND |
| 4 | 0.281246 | 0.174764 | 3.0945 | -20.8147 | 0.452459 | -13.4860 | LN_QJF LN_QMA LN_QMJ LN_QSO |
| 4 | 0.280139 | 0.173493 | 3.1331 | -20.7654 | 0.453156 | -13.4367 | LN_QMA LN_QMJ LN_QJA LN_QSO |
| 4 | 0.278481 | 0.171589 | 3.1910 | -20.6918 | 0.454199 | -13.3631 | LN_QMA LN_QMJ LN_QSO LN_QND |
| 4 | 0.276376 | 0.169173 | 3.2645 | -20.5986 | 0.455524 | -13.2699 | LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.283678 | 0.145924 | 5.0096 | -18.9231 | 0.468271 | -10.1287 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.281586 | 0.143430 | 5.0826 | -18.8298 | 0.469638 | -10.0354 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.281284 | 0.143069 | 5.0931 | -18.8163 | 0.469836 | -10.0219 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.276621 | 0.137510 | 5.2559 | -18.6094 | 0.472884 | -9.8150 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 6 | 0.283952 | 0.112100 | 7.0000 | -16.9353 | 0.486816 | -6.6752 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

### 7.2.3 Logged All Variables: 1984 Omitted

N = 32 Regression Models for Dependent Variable: LN_WSH

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.314502 | 0.291652 | -0.1677 | -31.5643 | 0.351043 | -28.6328 | LN_QMJ |
| 1 | 0.221876 | 0.195938 | 3.5930 | -27.5086 | 0.398477 | -24.5771 | LN_QMA |
| 1 | 0.123949 | 0.094747 | 7.5690 | -23.7154 | 0.448626 | -20.7839 | LN_QJF |
| 1 | 0.059190 | 0.027830 | 10.1983 | -21.4332 | 0.481788 | -18.5018 | LN_QND |
| 2 | 0.369597 | 0.326121 | -0.4047 | -32.2454 | 0.333961 | -27.8482 | LN_QMA LN_QMJ |
| 2 | 0.320876 | 0.274040 | 1.5735 | -29.8632 | 0.359771 | -25.4660 | LN_QMJ LN_QSO |
| 2 | 0.319298 | 0.272353 | 1.6375 | -29.7890 | 0.360608 | -25.3918 | LN_QMJ LN_QJA |
| 2 | 0.317130 | 0.270035 | 1.7256 | -29.6872 | 0.361756 | -25.2900 | LN_QMJ LN_QND |
| 3 | 0.381941 | 0.315720 | 1.0941 | -30.8783 | 0.339116 | -25.0153 | LN_QMA LN_QMJ LN_QSO |
| 3 | 0.379510 | 0.313029 | 1.1929 | -30.7526 | 0.340449 | -24.8897 | LN_QJF LN_QMA LN_QMJ |
| 3 | 0.374106 | 0.307046 | 1.4123 | -30.4752 | 0.343414 | -24.6122 | LN_QMA LN_QMJ LN_QND |
| 3 | 0.371134 | 0.303756 | 1.5329 | -30.3236 | 0.345045 | -24.4606 | LN_QMA LN_QMJ LN_QJA |
| 4 | 0.383449 | 0.292109 | 3.0329 | -28.9565 | 0.350817 | -21.6278 | LN_QJF LN_QMA LN_QMJ LN_QSO |
| 4 | 0.382595 | 0.291127 | 3.0676 | -28.9121 | 0.351303 | -21.5835 | LN_QMA LN_QMJ LN_QJA LN_QSO |
| 4 | 0.381943 | 0.290379 | 3.0941 | -28.8784 | 0.351674 | -21.5497 | LN_QMA LN_QMJ LN_QSO LN_QND |
| 4 | 0.380418 | 0.288628 | 3.1560 | -28.7995 | 0.352542 | -21.4708 | LN_QJF LN_QMA LN_QMJ LN_QJA |
| 5 | 0.384066 | 0.265617 | 5.0079 | -26.9885 | 0.363946 | -18.1941 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.383576 | 0.265033 | 5.0278 | -26.9630 | 0.364235 | -18.1686 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.382612 | 0.263883 | 5.0669 | -26.9130 | 0.364805 | -18.1186 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.380580 | 0.261461 | 5.1494 | -26.8079 | 0.366006 | -18.0135 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 6 | 0.384260 | 0.236482 | 7.0000 | -24.9985 | 0.378385 | -14.7384 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

### 7.2.4 Logged All Variables: 1971 and 1977 Omitted

N = 31 Regression Models for Dependent Variable: LN_WSH

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.181556 | 0.153334 | 0.5870 | -25.9370 | 0.406968 | -23.0691 | LN_QMA |
| 1 | 0.175438 | 0.147004 | 0.7932 | -25.7062 | 0.410011 | -22.8382 | LN_QMJ |
| 1 | 0.116024 | 0.085542 | 2.7958 | -23.5493 | 0.439554 | -20.6813 | LN_QJF |
| 1 | 0.083286 | 0.051675 | 3.8993 | -22.4219 | 0.455833 | -19.5540 | LN_QJA |
| 2 | 0.265065 | 0.212570 | -0.2279 | -27.2734 | 0.378495 | -22.9714 | LN_QMA LN_QJA |
| 2 | 0.240422 | 0.186167 | 0.6028 | -26.2510 | 0.391186 | -21.9490 | LN_QMA LN_QMJ |
| 2 | 0.196975 | 0.139617 | 2.0672 | -24.5267 | 0.413562 | -20.2247 | LN_QJF LN_QMJ |
| 2 | 0.193294 | 0.135673 | 2.1913 | -24.3849 | 0.415458 | -20.0829 | LN_QJF LN_QJA |
| 3 | 0.271780 | 0.190866 | 1.5458 | -25.5579 | 0.388928 | -19.8219 | LN_QJF LN_QMA LN_QJA |
| 3 | 0.271485 | 0.190539 | 1.5558 | -25.5453 | 0.389085 | -19.8094 | LN_QMA LN_QMJ LN_QJA |
| 3 | 0.265713 | 0.184125 | 1.7503 | -25.3007 | 0.392168 | -19.5647 | LN_QMA LN_QJA LN_QSO |
| 3 | 0.265512 | 0.183902 | 1.7571 | -25.2922 | 0.392275 | -19.5563 | LN_QMA LN_QJA LN_QND |
| 4 | 0.283554 | 0.173331 | 3.1490 | -24.0632 | 0.397356 | -16.8933 | LN_QJF LN_QMA LN_QJA LN_QSO |
| 4 | 0.274742 | 0.163164 | 3.4460 | -23.6843 | 0.402243 | -16.5143 | LN_QJF LN_QMA LN_QMJ LN_QJA |
| 4 | 0.274265 | 0.162613 | 3.4621 | -23.6639 | 0.402508 | -16.4939 | LN_QMA LN_QMJ LN_QJA LN_QSO |
| 4 | 0.272924 | 0.161066 | 3.5072 | -23.6067 | 0.403251 | -16.4367 | LN_QJF LN_QMA LN_QJA LN_QND |
| 5 | 0.287843 | 0.145412 | 5.0044 | -22.2494 | 0.410776 | -13.6454 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.283613 | 0.140336 | 5.1470 | -22.0658 | 0.413216 | -13.4618 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.276399 | 0.131679 | 5.3901 | -21.7552 | 0.417377 | -13.1512 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.275835 | 0.131002 | 5.4091 | -21.7310 | 0.417703 | -13.1271 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 6 | 0.287973 | 0.109966 | 7.0000 | -20.2550 | 0.427814 | -10.2171 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

### 7.2.5 Logged All Variables: 1971 and 1984 Omitted

N = 31 Regression Models for Dependent Variable: LN_WSH

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.274163 | 0.249134 | 3.1089 | -33.1482 | 0.322504 | -30.2803 | LN_QMJ |
| 1 | 0.210597 | 0.183376 | 5.7457 | -30.5457 | 0.350748 | -27.6778 | LN_QMA |
| 1 | 0.113149 | 0.082568 | 9.7880 | -26.9373 | 0.394046 | -24.0694 | LN_QJA |
| 1 | 0.112250 | 0.081638 | 9.8253 | -26.9059 | 0.394445 | -24.0380 | LN_QJF |
| 2 | 0.401324 | 0.358561 | -0.1660 | -37.1190 | 0.275504 | -32.8170 | LN_QMA LN_QJA |
| 2 | 0.335462 | 0.287994 | 2.5661 | -33.8835 | 0.305813 | -29.5815 | LN_QMA LN_QMJ |
| 2 | 0.286165 | 0.235177 | 4.6110 | -31.6651 | 0.328499 | -27.3632 | LN_QMJ LN_QJA |
| 2 | 0.283596 | 0.232424 | 4.7176 | -31.5538 | 0.329681 | -27.2518 | LN_QMJ LN_QSO |
| 3 | 0.411731 | 0.346367 | 1.4024 | -35.6626 | 0.280742 | -29.9266 | LN_QMA LN_QMJ LN_QJA |
| 3 | 0.404639 | 0.338488 | 1.6965 | -35.2911 | 0.284126 | -29.5552 | LN_QMA LN_QJA LN_QSO |
| 3 | 0.401561 | 0.335067 | 1.8242 | -35.1313 | 0.285595 | -29.3953 | LN_QJF LN_QMA LN_QJA |
| 3 | 0.401486 | 0.334984 | 1.8273 | -35.1274 | 0.285631 | -29.3914 | LN_QMA LN_QJA LN_QND |
| 4 | 0.420534 | 0.331386 | 3.0372 | -34.1300 | 0.287176 | -26.9601 | LN_QMA LN_QMJ LN_QJA LN_QSO |
| 4 | 0.415048 | 0.325055 | 3.2648 | -33.8379 | 0.289896 | -26.6680 | LN_QJF LN_QMA LN_QMJ LN_QJA |
| 4 | 0.412857 | 0.322527 | 3.3557 | -33.7220 | 0.290981 | -26.5521 | LN_QMA LN_QMJ LN_QJA LN_QND |
| 4 | 0.405545 | 0.314091 | 3.6589 | -33.3384 | 0.294605 | -26.1684 | LN_QJF LN_QMA LN_QJA LN_QSO |
| 5 | 0.421384 | 0.305661 | 5.0019 | -32.1755 | 0.298226 | -23.5716 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.420535 | 0.304642 | 5.0372 | -32.1301 | 0.298663 | -23.5261 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.415063 | 0.298076 | 5.2641 | -31.8387 | 0.301483 | -23.2348 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.406093 | 0.287312 | 5.6362 | -31.3670 | 0.306106 | -22.7630 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 6 | 0.421430 | 0.276788 | 7.0000 | -30.1780 | 0.310627 | -20.1401 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 4.297023 | 0.52055924 | 8.255 | 0.0001 | 0.00000000 |
| LN_QJF | 1 | -0.007721 | 0.17590416 | -0.044 | 0.9654 | 3.64058711 |
| LN_QMA | 1 | 0.291304 | 0.15691864 | 1.856 | 0.0757 | 2.51875920 |
| LN_QMJ | 1 | 0.084234 | 0.10560646 | 0.798 | 0.4329 | 2.44341165 |
| LN_QJA | 1 | 0.193926 | 0.11492105 | 1.687 | 0.1045 | 1.77914868 |
| LN_QSO | 1 | -0.052876 | 0.10288740 | -0.514 | 0.6120 | 2.36817628 |
| LN_QND | 1 | 0.025847 | 0.13409248 | 0.193 | 0.8488 | 2.49324624 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop LN_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop LN_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 3.11530 | 1.00000 | 0.0239 | 0.0229 | 0.0186 | 0.0000 | 0.0250 | 0.0287 |
| 2 | 1.38156 | 1.50164 | 0.0003 | 0.0089 | 0.0795 | 0.2658 | 0.0000 | 0.0133 |
| 3 | 0.77413 | 2.00606 | 0.0001 | 0.2155 | 0.0431 | 0.0071 | 0.2371 | 0.0278 |
| 4 | 0.31037 | 3.16817 | 0.0460 | 0.0086 | 0.1104 | 0.2793 | 0.1907 | 0.7278 |
| 5 | 0.23357 | 3.65206 | 0.2741 | 0.1299 | 0.7280 | 0.4090 | 0.0061 | 0.1745 |
| 6 | 0.18506 | 4.10288 | 0.6555 | 0.6143 | 0.0204 | 0.0388 | 0.5411 | 0.0279 |

| Variable | DF | Variable Label |
|---|---|---|
| INTERCEP | 1 | Intercept |
| LN_QJF | 1 | Ln (January-February Inflows) |
| LN_QMA | 1 | Ln (March-April Inflows) |
| LN_QMJ | 1 | Ln (May-June Inflows) |
| LN_QJA | 1 | Ln (July-August Inflows) |
| LN_QSO | 1 | Ln (September-October Inflows) |
| LN_QND | 1 | Ln (November-December Inflows) |

| OBS | _MODEL_ | _TYPE_ | _DEPVAR_ | _RMSE_ | INTERCEP | LN_QJF | LN_QMA | LN_QMJ | LN_QJA | LN_QSO |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MODEL1 | PARMS | LN_WSH | 0.56789 | 5.05018 | . | . | 0.22784 | . | . |
| 2 | MODEL1 | PARMS | LN_WSH | 0.59224 | 5.18388 | . | 0.29224 | . | . | . |
| 3 | MODEL1 | PARMS | LN_WSH | 0.62773 | 5.37783 | . | . | . | 0.18666 | . |
| 4 | MODEL1 | PARMS | LN_WSH | 0.62805 | 5.46108 | 0.19894 | . | . | . | . |
| 5 | MODEL1 | PARMS | LN_WSH | 0.52488 | 4.15390 | . | 0.34887 | . | 0.24731 | . |
| 6 | MODEL1 | PARMS | LN_WSH | 0.55300 | 4.77400 | . | 0.17710 | 0.17272 | . | . |
| 7 | MODEL1 | PARMS | LN_WSH | 0.57315 | 4.91627 | . | . | 0.20340 | 0.06832 | . |
| 8 | MODEL1 | PARMS | LN_WSH | 0.57418 | 5.15217 | . | . | 0.24507 | . | -0.045165 |
| 9 | MODEL1 | PARMS | LN_WSH | 0.52985 | 4.19571 | . | 0.29554 | 0.06402 | 0.20080 | . |
| 10 | MODEL1 | PARMS | LN_WSH | 0.53303 | 4.21259 | . | 0.36014 | . | 0.25007 | -0.025902 |
| 11 | MODEL1 | PARMS | LN_WSH | 0.53441 | 4.15915 | -0.01235 | 0.35795 | . | 0.24840 | . |
| 12 | MODEL1 | PARMS | LN_WSH | 0.53444 | 4.16516 | . | 0.35404 | . | 0.24683 | . |
| 13 | MODEL1 | PARMS | LN_WSH | 0.53589 | 4.30885 | . | 0.29887 | 0.08322 | 0.19157 | -0.044397 |
| 14 | MODEL1 | PARMS | LN_WSH | 0.53842 | 4.22638 | -0.04984 | 0.32009 | 0.07855 | 0.19464 | . |
| 15 | MODEL1 | PARMS | LN_WSH | 0.53943 | 4.22880 | . | 0.30594 | 0.06827 | 0.19640 | . |
| 16 | MODEL1 | PARMS | LN_WSH | 0.54278 | 4.22587 | 0.03217 | 0.34166 | . | 0.24850 | -0.037796 |
| 17 | MODEL1 | PARMS | LN_WSH | 0.54610 | 4.29945 | . | 0.28831 | 0.08312 | 0.19419 | -0.054874 |
| 18 | MODEL1 | PARMS | LN_WSH | 0.54650 | 4.30896 | 0.00043 | 0.29867 | 0.08316 | 0.19159 | -0.044541 |
| 19 | MODEL1 | PARMS | LN_WSH | 0.54907 | 4.22968 | -0.04773 | 0.32049 | 0.07852 | 0.19429 | . |
| 20 | MODEL1 | PARMS | LN_WSH | 0.55327 | 4.21571 | 0.02613 | 0.33634 | . | 0.25090 | -0.044240 |
| 21 | MODEL1 | PARMS | LN_WSH | 0.55734 | 4.29702 | -0.00772 | 0.29130 | 0.08423 | 0.19393 | -0.052876 |

| OBS | LN_QND | LN_WSH | _IN_ | _P_ | _EDF_ | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | . | -1 | 1 | 2 | 29 | 0.32250 | 0.27416 | 0.24913 | 3.10890 | -33.1482 | -30.2803 |
| 2 | . | -1 | 1 | 2 | 29 | 0.35075 | 0.21060 | 0.18338 | 5.74571 | -30.5457 | -27.6778 |
| 3 | . | -1 | 1 | 2 | 29 | 0.39405 | 0.11315 | 0.08257 | 9.78800 | -26.9373 | -24.0694 |
| 4 | . | -1 | 1 | 2 | 29 | 0.39445 | 0.11225 | 0.08164 | 9.82529 | -26.9059 | -24.0380 |
| 5 | . | -1 | 2 | 3 | 28 | 0.27550 | 0.40132 | 0.35856 | -0.16596 | -37.1190 | -32.8170 |
| 6 | . | -1 | 2 | 3 | 28 | 0.30581 | 0.33546 | 0.28799 | 2.56613 | -33.8835 | -29.5815 |
| 7 | . | -1 | 2 | 3 | 28 | 0.32850 | 0.28616 | 0.23518 | 4.61103 | -31.6651 | -27.3632 |
| 8 | . | -1 | 2 | 3 | 28 | 0.32968 | 0.28360 | 0.23242 | 4.71760 | -31.5538 | -27.2518 |
| 9 | . | -1 | 3 | 4 | 27 | 0.28074 | 0.41173 | 0.34637 | 1.40236 | -35.6626 | -29.9266 |
| 10 | . | -1 | 3 | 4 | 27 | 0.28413 | 0.40464 | 0.33849 | 1.69652 | -35.2911 | -29.5552 |
| 11 | . | -1 | 3 | 4 | 27 | 0.28560 | 0.40156 | 0.33507 | 1.82422 | -35.1313 | -29.3953 |
| 12 | -0.008319 | -1 | 3 | 4 | 27 | 0.28563 | 0.40149 | 0.33498 | 1.82734 | -35.1274 | -29.3914 |
| 13 | . | -1 | 4 | 5 | 26 | 0.28718 | 0.42053 | 0.33139 | 3.03716 | -34.1300 | -26.9601 |
| 14 | . | -1 | 4 | 5 | 26 | 0.28990 | 0.41505 | 0.32505 | 3.26477 | -33.8379 | -26.6680 |
| 15 | -0.022399 | -1 | 4 | 5 | 26 | 0.29098 | 0.41286 | 0.32253 | 3.35566 | -33.7220 | -26.5521 |
| 16 | . | -1 | 4 | 5 | 26 | 0.29460 | 0.40555 | 0.31409 | 3.65894 | -33.3384 | -26.1684 |
| 17 | 0.024433 | -1 | 5 | 6 | 25 | 0.29823 | 0.42138 | 0.30566 | 5.00193 | -32.1755 | -23.5716 |
| 18 | . | -1 | 5 | 6 | 25 | 0.29866 | 0.42053 | 0.30464 | 5.03716 | -32.1301 | -23.5261 |
| 19 | -0.003115 | -1 | 5 | 6 | 25 | 0.30148 | 0.41506 | 0.29808 | 5.26411 | -31.8387 | -23.2348 |
| 20 | 0.020193 | -1 | 5 | 6 | 25 | 0.30611 | 0.40609 | 0.28731 | 5.63620 | -31.3670 | -22.7630 |
| 21 | 0.025847 | -1 | 6 | 7 | 24 | 0.31063 | 0.42143 | 0.27679 | 7.00000 | -30.1780 | -20.1401 |

## 7.3 Model 5: Square Root All Variables

### 7.3.1 Square Root All Variables: 1977 Omitted

N = 32     Regression Models for Dependent Variable: SQRT_WSH

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.21712 | 0.19102 | -2.132 | 125.5 | 47.606 | 128.5 | SQRT_QMA |
| 1 | 0.11817 | 0.08877 | 1.138 | 129.4 | 53.623 | 132.3 | SQRT_QJF |
| 1 | 0.10439 | 0.07454 | 1.593 | 129.9 | 54.460 | 132.8 | SQRT_QMJ |
| 1 | 0.01040 | -.02259 | 4.699 | 133.0 | 60.176 | 136.0 | SQRT_QND |
| 2 | 0.23274 | 0.17982 | -0.648 | 126.9 | 48.265 | 131.3 | SQRT_QMA SQRT_QMJ |
| 2 | 0.21932 | 0.16548 | -0.205 | 127.5 | 49.108 | 131.9 | SQRT_QMA SQRT_QND |
| 2 | 0.21807 | 0.16415 | -0.163 | 127.5 | 49.187 | 131.9 | SQRT_QJF SQRT_QMA |
| 2 | 0.21795 | 0.16402 | -0.160 | 127.5 | 49.194 | 131.9 | SQRT_QMA SQRT_QSO |
| 3 | 0.23696 | 0.15520 | 1.212 | 128.7 | 49.713 | 134.6 | SQRT_QMA SQRT_QMJ SQRT_QND |
| 3 | 0.23625 | 0.15442 | 1.236 | 128.8 | 49.759 | 134.6 | SQRT_QMA SQRT_QMJ SQRT_QSO |
| 3 | 0.23511 | 0.15316 | 1.274 | 128.8 | 49.834 | 134.7 | SQRT_QMA SQRT_QMJ SQRT_QJA |
| 3 | 0.23281 | 0.15062 | 1.349 | 128.9 | 49.983 | 134.8 | SQRT_QJF SQRT_QMA SQRT_QMJ |
| 4 | 0.24066 | 0.12817 | 3.090 | 130.6 | 51.304 | 137.9 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 4 | 0.23954 | 0.12688 | 3.127 | 130.6 | 51.380 | 137.9 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 4 | 0.23792 | 0.12502 | 3.181 | 130.7 | 51.490 | 138.0 | SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.23767 | 0.12473 | 3.189 | 130.7 | 51.507 | 138.0 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO |
| 5 | 0.24186 | 0.09606 | 5.051 | 132.5 | 53.193 | 141.3 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.24097 | 0.09500 | 5.080 | 132.6 | 53.256 | 141.4 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 5 | 0.24081 | 0.09481 | 5.085 | 132.6 | 53.267 | 141.4 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 5 | 0.23942 | 0.09315 | 5.131 | 132.6 | 53.365 | 141.4 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 6 | 0.24339 | 0.06180 | 7.000 | 134.5 | 55.210 | 144.7 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

## 7.4 Model 6: Logged and Square Root Variables

### 7.4.1 Logged and Square Root Variables: 1977 Omitted

N = 32 Regression Models for Dependent Variable: LN_WSH

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.214870 | 0.188699 | -0.5914 | -23.9881 | 0.444818 | -21.0566 | LN_QMJ |
| 1 | 0.181233 | 0.153940 | 0.5828 | -22.6457 | 0.463876 | -19.7142 | SQRT_QMA |
| 1 | 0.112019 | 0.082420 | 2.9990 | -20.0489 | 0.503089 | -17.1174 | SQRT_QJF |
| 1 | 0.021519 | -.011097 | 6.1584 | -16.9432 | 0.554362 | -14.0118 | SQRT_QND |
| 2 | 0.275394 | 0.225421 | -0.7043 | -24.5552 | 0.424684 | -20.1580 | SQRT_QMA LN_QMJ |
| 2 | 0.231947 | 0.178978 | 0.8124 | -22.6918 | 0.450148 | -18.2946 | SQRT_QJF LN_QMJ |
| 2 | 0.229448 | 0.176306 | 0.8997 | -22.5878 | 0.451613 | -18.1906 | LN_QMJ LN_QJA |
| 2 | 0.219863 | 0.166061 | 1.2343 | -22.1923 | 0.457230 | -17.7950 | LN_QMJ SQRT_QSO |
| 3 | 0.278859 | 0.201593 | 1.1748 | -22.7085 | 0.437749 | -16.8456 | SQRT_QMA LN_QMJ SQRT_QSO |
| 3 | 0.278857 | 0.201592 | 1.1748 | -22.7085 | 0.437750 | -16.8455 | SQRT_QMA LN_QMJ LN_QJA |
| 3 | 0.276735 | 0.199242 | 1.2489 | -22.6144 | 0.439038 | -16.7515 | SQRT_QMA LN_QMJ SQRT_QND |
| 3 | 0.275959 | 0.198383 | 1.2760 | -22.5801 | 0.439509 | -16.7172 | SQRT_QJF SQRT_QMA LN_QMJ |
| 4 | 0.283425 | 0.177265 | 3.0154 | -20.9118 | 0.451087 | -13.5831 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 4 | 0.280941 | 0.174414 | 3.1021 | -20.8011 | 0.452651 | -13.4724 | SQRT_QMA LN_QMJ LN_QJA SQRT_QND |
| 4 | 0.279833 | 0.173141 | 3.1407 | -20.7518 | 0.453348 | -13.4231 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA |
| 4 | 0.279170 | 0.172381 | 3.1639 | -20.7224 | 0.453765 | -13.3937 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO |
| 5 | 0.283643 | 0.145882 | 5.0077 | -18.9216 | 0.468294 | -10.1271 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.283635 | 0.145873 | 5.0080 | -18.9212 | 0.468299 | -10.1268 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 5 | 0.281248 | 0.143026 | 5.0914 | -18.8147 | 0.469860 | -10.0203 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QND |
| 5 | 0.279254 | 0.140649 | 5.1610 | -18.7261 | 0.471163 | -9.9317 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 6 | 0.283865 | 0.111992 | 7.0000 | -16.9315 | 0.486875 | -6.6713 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |

### 7.4.2 Logged and Square Root Variables: 1992 Omitted.

N = 32 Regression Models for Dependent Variable: LN_WSH

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.185929 | 0.158793 | -1.8274 | -25.0546 | 0.430238 | -22.1231 | LN_QMJ |
| 1 | 0.074821 | 0.043982 | 1.7448 | -20.9605 | 0.488959 | -18.0290 | SQRT_QMA |
| 1 | 0.052816 | 0.021244 | 2.4522 | -20.2083 | 0.500588 | -17.2769 | SQRT_QJF |
| 1 | 0.015879 | -.016925 | 3.6398 | -18.9841 | 0.520110 | -16.0527 | SQRT_QND |
| 2 | 0.205807 | 0.151035 | -0.4665 | -23.8456 | 0.434206 | -19.4484 | SQRT_QMA LN_QMJ |
| 2 | 0.198077 | 0.142772 | -0.2180 | -23.5357 | 0.438432 | -19.1385 | LN_QMJ LN_QJA |
| 2 | 0.188336 | 0.132359 | 0.0952 | -23.1493 | 0.443758 | -18.7521 | LN_QMJ SQRT_QSO |
| 2 | 0.187909 | 0.131903 | 0.1089 | -23.1325 | 0.443991 | -18.7353 | SQRT_QJF LN_QMJ |
| 3 | 0.213666 | 0.129416 | 1.2809 | -22.1639 | 0.445263 | -16.3009 | SQRT_QMA LN_QMJ SQRT_QND |
| 3 | 0.210282 | 0.125670 | 1.3896 | -22.0265 | 0.447179 | -16.1635 | SQRT_QMA LN_QMJ SQRT_QSO |
| 3 | 0.208576 | 0.123780 | 1.4445 | -21.9574 | 0.448145 | -16.0945 | SQRT_QMA LN_QMJ LN_QJA |
| 3 | 0.205813 | 0.120722 | 1.5333 | -21.8459 | 0.449710 | -15.9830 | SQRT_QJF SQRT_QMA LN_QMJ |
| 4 | 0.217953 | 0.102094 | 3.1430 | -20.3388 | 0.459237 | -13.0101 | SQRT_QMA LN_QMJ LN_QJA SQRT_QND |
| 4 | 0.214550 | 0.098187 | 3.2524 | -20.1999 | 0.461235 | -12.8712 | SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.214508 | 0.098139 | 3.2538 | -20.1982 | 0.461260 | -12.8695 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO |
| 4 | 0.214427 | 0.098046 | 3.2564 | -20.1949 | 0.461307 | -12.8662 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QND |
| 5 | 0.219130 | 0.068962 | 5.1052 | -18.3870 | 0.476182 | -9.5926 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.218730 | 0.068486 | 5.1181 | -18.3706 | 0.476426 | -9.5762 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.218320 | 0.067997 | 5.1312 | -18.3538 | 0.476676 | -9.5594 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QND |
| 5 | 0.217450 | 0.066959 | 5.1592 | -18.3182 | 0.477207 | -9.5238 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 6 | 0.222402 | 0.035778 | 7.0000 | -16.5214 | 0.493154 | -6.2612 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |

### 7.4.3 Logged and Square Root Variables: 1977 and 1992 Omitted.

N = 31 Regression Models for Dependent Variable: LN_WSH

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.181314 | 0.153083 | -1.3542 | -23.2420 | 0.443932 | -20.3740 | LN_QMJ |
| 1 | 0.135254 | 0.105435 | 0.0887 | -21.5452 | 0.468908 | -18.6773 | SQRT_QMA |
| 1 | 0.045559 | 0.012647 | 2.8984 | -18.4858 | 0.517545 | -15.6179 | SQRT_QJF |
| 1 | 0.007770 | -.026445 | 4.0822 | -17.2821 | 0.538037 | -14.4142 | SQRT_QND |
| 2 | 0.221287 | 0.165665 | -0.6063 | -22.7938 | 0.437337 | -18.4919 | SQRT_QMA LN_QMJ |
| 2 | 0.191468 | 0.133716 | 0.3278 | -21.6289 | 0.454084 | -17.3269 | LN_QMJ LN_QJA |
| 2 | 0.184206 | 0.125935 | 0.5552 | -21.3517 | 0.458163 | -17.0498 | LN_QMJ SQRT_QSO |
| 2 | 0.182415 | 0.124016 | 0.6113 | -21.2837 | 0.459169 | -16.9818 | SQRT_QJF LN_QMJ |
| 3 | 0.226306 | 0.140340 | 1.2364 | -20.9943 | 0.450612 | -15.2583 | SQRT_QMA LN_QMJ SQRT_QSO |
| 3 | 0.224167 | 0.137963 | 1.3035 | -20.9087 | 0.451858 | -15.1727 | SQRT_QMA LN_QMJ LN_QJA |
| 3 | 0.222768 | 0.136409 | 1.3473 | -20.8528 | 0.452673 | -15.1169 | SQRT_QMA LN_QMJ SQRT_QND |
| 3 | 0.221308 | 0.134787 | 1.3930 | -20.7947 | 0.453523 | -15.0587 | SQRT_QJF SQRT_QMA LN_QMJ |
| 4 | 0.230678 | 0.112321 | 3.0995 | -19.1699 | 0.465299 | -12.0000 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO |
| 4 | 0.230261 | 0.111840 | 3.1125 | -19.1531 | 0.465551 | -11.9832 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 4 | 0.226356 | 0.107334 | 3.2349 | -18.9963 | 0.467913 | -11.8263 | SQRT_QMA LN_QMJ LN_QJA SQRT_QND |
| 4 | 0.226320 | 0.107292 | 3.2360 | -18.9948 | 0.467935 | -11.8249 | SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.233778 | 0.080534 | 5.0024 | -17.2951 | 0.481961 | -8.6912 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 5 | 0.230688 | 0.076826 | 5.0992 | -17.1703 | 0.483905 | -8.5664 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.230359 | 0.076431 | 5.1095 | -17.1571 | 0.484112 | -8.5532 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.226360 | 0.071632 | 5.2347 | -16.9964 | 0.486627 | -8.3925 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QND |
| 6 | 0.233854 | 0.042317 | 7.0000 | -15.2982 | 0.501993 | -5.2603 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |

## 7.5 Model 8: Variables Transformed According to the Box-Cox Analysis

### 7.5.1 Variables Transformed According to the Box-Cox Analysis: 1971 Omitted

N = 32    Regression Models for Dependent Variable: $(WHITE\ SHRIMP)^{0.2}$

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.159999 | 0.131999 | 0.2954 | -52.5775 | 0.182044 | -49.6461 | $(QMA\_LAG)^{-0.5}$ |
| 1 | 0.142963 | 0.114395 | 0.8693 | -51.9350 | 0.185736 | -49.0035 | $(QMJ\_LAG)^{0.1}$ |
| 1 | 0.117160 | 0.087732 | 1.7384 | -50.9858 | 0.191328 | -48.0543 | $(QJF\_LAG)^{-0.3}$ |
| 1 | 0.052969 | 0.021402 | 3.9007 | -48.7398 | 0.205239 | -45.8083 | $(QND\_LAG)^{-0.3}$ |
| 2 | 0.236253 | 0.183580 | -0.2732 | -53.6228 | 0.171226 | -49.2256 | $(QMA\_LAG)^{-0.5}$ $(QJA\_LAG)^{-0.2}$ |
| 2 | 0.205557 | 0.150767 | 0.7608 | -52.3619 | 0.178107 | -47.9647 | $(QMA\_LAG)^{-0.5}$ $(QMJ\_LAG)^{0.1}$ |
| 2 | 0.178299 | 0.121630 | 1.6790 | -51.2824 | 0.184218 | -46.8852 | $(QJF\_LAG)^{-0.3}$ $(QJA\_LAG)^{-0.2}$ |
| 2 | 0.173073 | 0.116044 | 1.8550 | -51.0795 | 0.185390 | -46.6823 | $(QJF\_LAG)^{-0.3}$ $(QMJ\_LAG)^{0.1}$ |
| 3 | 0.245241 | 0.164374 | 1.4240 | -52.0017 | 0.175254 | -46.1387 | $(QJF\_LAG)^{-0.3}$ $(QMA\_LAG)^{-0.5}$ $(QJA\_LAG)^{-0.2}$ |
| 3 | 0.239606 | 0.158136 | 1.6138 | -51.7636 | 0.176562 | -45.9007 | $(QMA\_LAG)^{-0.5}$ $(QMJ\_LAG)^{0.1}$ $(QJA\_LAG)^{-0.2}$ |
| 3 | 0.237161 | 0.155429 | 1.6962 | -51.6609 | 0.177130 | -45.7980 | $(QMA\_LAG)^{0.5}$ $(QJA\_LAG)^{-0.2}$ $(QND\_LAG)^{-0.3}$ |
| 3 | 0.236426 | 0.154615 | 1.7210 | -51.6301 | 0.177301 | -45.7671 | $(QMA\_LAG)^{-0.5}$ $(QJA\_LAG)^{-0.2}$ $(QS0\_LAG)^{-0.3}$ |
| 4 | 0.256270 | 0.146088 | 3.0525 | -50.4727 | 0.179089 | -43.1440 | $(QJF\_LAG)^{-0.3}$ $(QMA\_LAG)^{-0.5}$ $(QJA\_LAG)^{-0.2}$ $(QS0\_LAG)^{-0.3}$ |
| 4 | 0.247337 | 0.135832 | 3.3534 | -50.0907 | 0.181240 | -42.7620 | $(QJF\_LAG)^{-0.3}$ $(QMA\_LAG)^{-0.5}$ $(QJA\_LAG)^{-0.2}$ $(QND\_LAG)^{-0.3}$ |
| 4 | 0.245939 | 0.134226 | 3.4005 | -50.0313 | 0.181576 | -42.7026 | $(QJF\_LAG)^{-0.3}$ $(QMA\_LAG)^{-0.5}$ $(QMJ\_LAG)^{0.1}$ $(QJA\_LAG)^{-0.2}$ |
| 4 | 0.240717 | 0.128231 | 3.5764 | -49.8104 | 0.182834 | -42.4817 | $(QMA\_LAG)^{-0.5}$ $(QMJ\_LAG)^{0.1}$ $(QJA\_LAG)^{0.2}$ $(QS0\_LAG)^{-0.3}$ |
| 5 | 0.257799 | 0.115068 | 5.0010 | -48.5386 | 0.185595 | -39.7441 | $(QJF\_LAG)^{-0.3}$ $(QMA\_LAG)^{-0.5}$ $(QMJ\_LAG)^{0.1}$ $(QJA\_LAG)^{-0.2}$ $(QS0\_LAG)^{-0.3}$ |
| 5 | 0.256358 | 0.113349 | 5.0496 | -48.4765 | 0.185955 | -39.6821 | $(QJF\_LAG)^{-0.3}$ $(QMA\_LAG)^{-0.5}$ $(QJA\_LAG)^{-0.2}$ $(QS0\_LAG)^{-0.3}$ $(QND\_LAG)^{-0.3}$ |
| 5 | 0.247922 | 0.103291 | 5.3337 | -48.1155 | 0.188064 | -39.3211 | $(QJF\_LAG)^{-0.3}$ $(QMA\_LAG)^{-0.5}$ $(QMJ\_LAG)^{0.1}$ $(QJA\_LAG)^{-0.2}$ $(QND\_LAG)^{-0.3}$ |
| 5 | 0.243340 | 0.097829 | 5.4881 | -47.9212 | 0.189210 | -39.1268 | $(QMA\_LAG)^{-0.5}$ $(QMJ\_LAG)^{0.1}$ $(QJA\_LAG)^{-0.2}$ $(QS0\_LAG)^{-0.3}$ $(QND\_LAG)^{-0.3}$ |
| 6 | 0.257829 | 0.079708 | 7.0000 | -46.5399 | 0.193010 | -36.2797 | $(QJF\_LAG)^{-0.3}$ $(QMA\_LAG)^{-0.5}$ $(QMJ\_LAG)^{0.1}$ $(QJA\_LAG)^{-0.2}$ $(QS0\_LAG)^{-0.3}$ $(QND\_LAG)^{-0.3}$ |

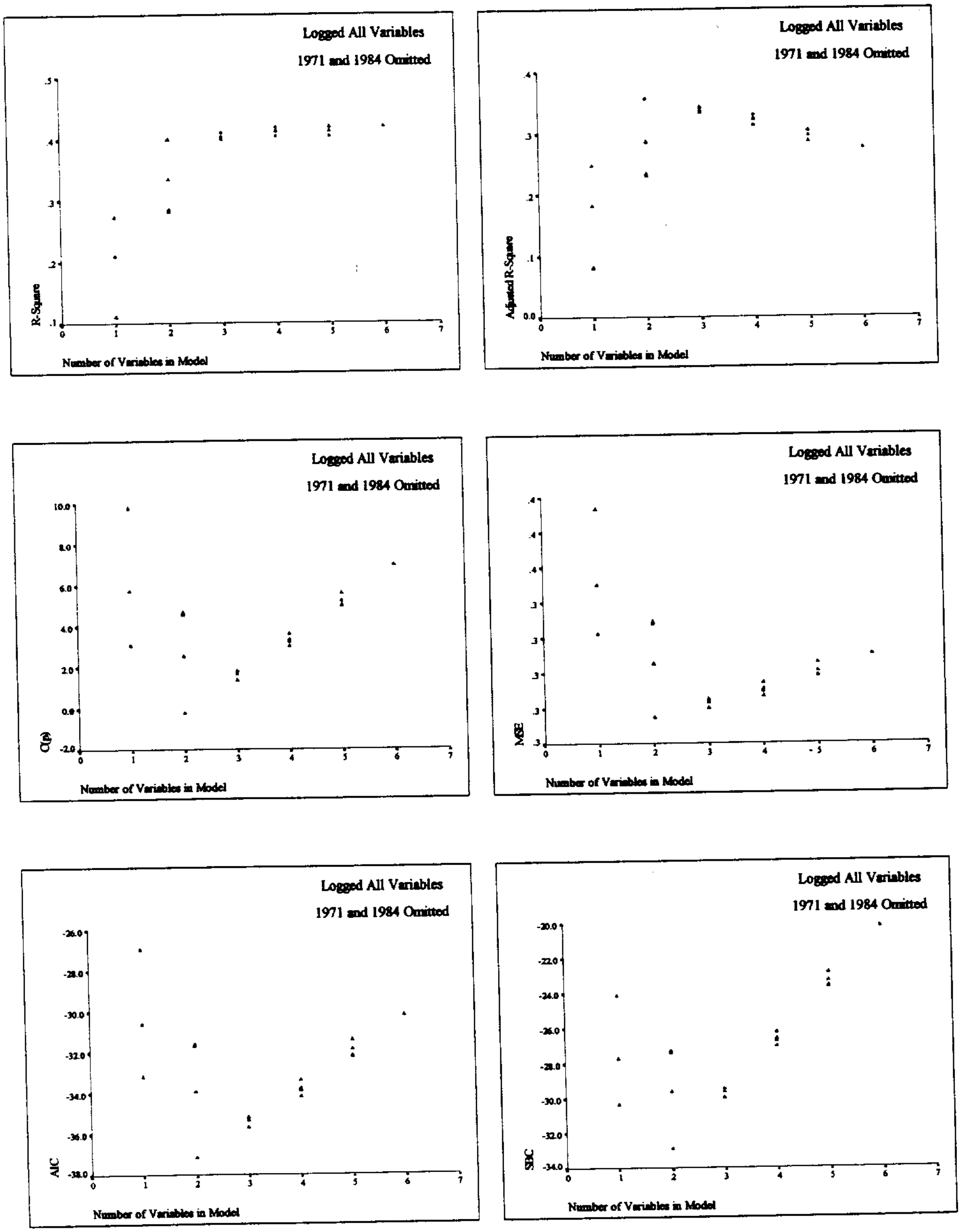



Fig. 7.1. Examining Subsets of Logged All Variables Data:
1971 and 1984 Omitted.

# White Shrimp Harvests in Aransas Bay:
# A Regression Analysis

## Harvest vs Freshwater Inflows

F. Michael Speed
Michael Longnecker
Rita Miranda-López

*Department of Statistics*
*Texas A&M University*

# White Shrimp Harvest in Aransas Bay:

# A Regression Analysis

Harvest vs. Freshwater Inflows



F. Michael Speed

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Department of Statistics

Texas A&M University

SPRING 1997

# Table of Contents

# 1. Summary Report

## 1.1 Description of the Problem[1]

Bimonthly freshwater inflows into Aransas Bay were recorded for the years 1962 to 1994. These variables, and various transformations of them, were used to construct a model for the annual harvest of white shrimp.

## 1.2 Constructing Models - General Discussion

Stability of coefficient estimates and accuracy of predicted values are primary goals in constructing models for prediction. To this end, the data must be examined from three points of view: individual observations (to detect outliers or influential points); variables, individually and in groups (to select an optimal set of predictors); and the interaction of these two, which produces the overall structure of the data set (to determine whether multicollinearity is present or not). The first two of these were examined by both graphic and quantitative means; the third by quantitative means only.

### 1.2.1 Detecting Influential Points and Outliers

The structures of individual variables were examined via box plots and histograms, as well as by all the usual numerical measures. For each pair of variables, 99 % prediction ellipses and 95% confidence ellipses were plotted in a further effort to look for unusual points. For example, suppose large values of Variable A are generally associated with large values for Variable B. If an observation consisted of a large value for Variable A but a small value for Variable B, that point would be considered unusual, even though it was well within the range of data for both variables and could not be considered an outlier.

In addition, a number of residual analysis techniques were employed. A large *residual* indicates a point not well-fit by the model. The *deleted residual*, however, is somewhat more useful in the search for influential points. The model is fitted without a given observation, and the predicted response and corresponding residual are calculated for that observation. The *Studentized deleted residual* is scaled to have a Student's t distribution. Histograms and normal P-P plots of the residuals were also examined.

Other quantities, such as the Mahalanobis distance, Cook's distance, the leverage value, standarized values for the Dffits (to measure the influence of a given observation on the predicted response) and the Dfbetas (to measure the influence of a given observation on the calculated coefficients) were also used to build a general picture of the influence of individual points. Plots were made of the standardized Dffits value for each model against the Dfbeta values for each predictor in the model. Points which were extreme indicated observations which had strong effects on both predicted values and coefficient estimates.

### 1.2.2 Variable Selection

For each regression, residuals were plotted against each of the independent variables to look for nonlinear relationships between the response variable and individual predictors. Partial residual plots were employed to examine the overall relationship between the response and individual predictors. A partial

[1] The following discussion, prepared by Jacqueline Kiffe, was taken from Seatrout Harvests in Galveston Bay: A Regression Analysis, by F. Michael Speed, Sr. and Jacqueline Kiffe.

residual is a corollary to the deleted residual. That is, the model is fitted without a given variable and the predicted response and corresponding residual are calculated for each observation. This seeks to answer the question, "What is the relationship of this predictor to the response variable, taking all other variables into account?" Thus, it examines the marginal relationship of a given predictor to the response.

Numerous measures have been developed over the years to assess the adequacy of a given model. We examined a number of these, including $R^2$ and mean squared error (MSE), and several others which directly incorporate penalties for having too many predictors in the model, such as adjusted $R^2$, $C_p$, AIC, and SBC. It is well-established that too many predictors in a model can lead to bad prediction, just as too few can, and these measures are used as part of the attempt to find an optimal model.

#### 1.2.3 Multicollinearity

Multicollinearity arises when one or more variables are nearly closely approximated by linear combinations of the remaining variables, resulting in unstable coefficient estimates. The variance inflation factor (VIF) was calculated for each coefficient estimate to measure this instability, which is not usually considered profound for VIF's less than 10. No problems were found with this data. Additionally, the condition index (a ratio of eigenvalues of the covariance matrix, with the largest eigenvalue always on top) was calculated. A ratio greater than 30 is considered cause for concern. Again, no evidence of multicollinearity was found.

#### 1.2.4 Other Procedures

Several other miscellaneous diagnostics, including the Durbin-Watson test for serial autocorrelation were performed, and no general problems were detected. The Box-Cox procedure, used to find a transformation to normality, was also performed.

### 1.3 How the Final Model Was Chosen

#### 1.3.1 Selecting the Data Set Used

First, the variables were explored thoroughly, individually and in pairs, in a first effort to detect outliers. The SAS programming language allows a number of diagnostics to be calculated for a group of models on a given data set without actually performing a formal regression, thus allowing one to examine a large number of models quite efficiently. The Box-Cox procedure was performed to find if a transformation to normality was suggested. The log transform was suggested for some variables, and the square root for others. At this point, there were several data sets for which the diagnostic series was calculated:

1. Untransformed data.
2. Harvest untransformed, and natural log of inflow variables.
3. All variables logged.
4. Harvest untransformed, and square root of inflows variables.
5. All variables square root.
6. Harvest and inflows variables transformed according to Box-Cox suggestion.

### 1.3.2 Selecting the Points to be Omitted

The full regression with all diagnostics was performed for these models, each one contained all variables in its corresponding data set. All diagnostics were generated, and influential points were determined for each model.

Table 1.1 R-Square and Adjusted R-Square values for the different suggested models.

| Data Set | $R^2$ | Adjusted $R^2$ |
|---|---|---|
| 1 | 0.4441 | 0.3158 |
| 2 | 0.4124 | 0.2768 |
| **3** | **0.4982** | **0.3824** |
| 4 | 0.4411 | 0.3122 |
| 5 | 0.4404 | 0.3112 |
| **6** | **0.4907** | **0.3732** |

Data set 3 presented the highest $R^2$ values. However , the models 3 and 6 were considered as final candidates. The observations flagged as potentially influential are given in the summary table below, for each model.

Table 1.2 Summary of points flagged by Boxplots.

| Year | Variable |
|---|---|
| 1968 | May-Jun, Sept-Oct, SQRT (Sept-Oct) Inflows. |
| 1972 | Sept-Oct, SQRT (Sept-Oct) Inflows. |
| 1974 | Sept-Oct Inflows. |
| 1975 | Nov-Dec Inflows. |
| 1976 | Jul-Aug, SQRT (Jul-Aug) Inflows. |
| 1977 | Nov-Dec, SQRT (Nov-Dec) Inflows. |
| 1979 | Jul-Aug Inflows. |
| 1980 | Jan-Feb, Jul-Aug, SQRT (Jul-Aug) Inflows. |
| 1981 | May-Jun, Jul-Aug, SQRT (Jul-Aug) Inflows. |
| 1982 | Jan-Feb, Nov-Dec, SQRT (Nov-Dec) Inflows. |
| 1983 | Jul-Aug Inflows. |
| 1984 | Jan-Feb, Sept-Oct Inflows. |
| 1985 | Mar-Apr Inflows. |
| 1986 | Nov-Dec Inflows. |
| 1990 | Jul-Aug, SQRT (Jul-Aug) Inflows. |
| 1992 | Harvest, Jan-Feb, SQRT (Jan-Feb), Mar-Apr, SQRT (Mar-Apr), May-Jun, Nov-Dec, SQRT (Nov-Dec) Inflows. |
| 1993 | Jan-Feb, May-Jun, SQRT (Jul-Aug) Inflows. |

Table 1.3 Summary of points flagged by 99% Prediction Ellipse.

| Year | Variable |
|---|---|
| 1968 | Harvest vs. Sept-Oct, Jan-Feb vs. Sept-Oct, Mar-Apr vs. Sept-Oct, May-Jun vs. Sept-Oct, Jul-Aug vs. Sept-Oct, Sept-Oct vs. Nov-Dec Inflows. |
| 1977 | Jan-Feb vs. Nov-Dec Inflows. |
| 1981 | May-Jun vs. Jul-Aug Inflows. |
| 1982 | Harvest vs. Nov-Dec, Mar-Apr vs. Nov-Dec Inflows. |
| 1985 | Jan-Feb vs. Mar-Apr, Mar-Apr vs. Nov-Dec Inflows. |
| 1992 | Harvest vs. Jan-Feb, Harvest vs. Mar-Apr, Harvest vs. Nov-Dec, Jan-Feb vs. Mar-Apr, Jan-Feb vs. Mar-Apr, Jan-Feb vs. May-Jun, Jan-Feb vs. Jul-Aug, Jan-Feb vs. Sept-Oct, Jan-Feb vs. Nov-Dec, Mar-Apr vs. May-Jun, Mar-Apr vs. Jul-Aug, Mar-Apr vs. Sept-Oct, Mar-Apr vs. Nov-Dec, May-Jun vs. Nov-Dec, Jul-Aug vs. Nov-Dec, Sept-Oct vs. Nov-Dec Inflows. |
| 1993 | May-Jun vs. Sept-Oct Inflows. |

Table 1.4 Summary of points flagged by diagnostic measures.

| YEAR | BOX | SRE | SDR | LEV | MAH | COO | SDF | SDB | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| **DATA SET 3** | | | | | | | | | |
| 1968 | | | | | | | 1 | | 1 |
| 1990 | | | | | | | 1 | | 1 |
| **1991** | | | **1** | | | | **1** | | **2** |
| **DATA SET 6** | | | | | | | | | |
| 1968 | | | | | | | 1 | | 1 |
| **1990** | | | | | | | **1** | **1** | **2** |
| **1991** | | | **1** | | | | **1** | | **2** |

Key to Abbreviations:

**BOX** Box plot
**SRE** Studentized residual
**SDR** Studentized deleted residual
**LEV** Leverage value
**MAH** Mahalanobis distance
**COO** Cook's distance
**SDF** Standardized Dffits value
**SDB** Standardized Dfbeta value

### 1.3.3 Selecting the Final Candidate Models

After the subset analysis led us to the models: Data Set 3 (all variables logged) 1968, 1990 and/or 1991 omitted; Data Set 6 (variables transformed according to Box-Cox analysis) 1968, 1990 and 1991 omitted.

Table 1.5 R-Square and Adjusted R-Square values for the different subsets.

| Data Set | Observations omitted | $R^2$ | Adjusted $R^2$ |
|---|---|---|---|
| 3 | 1968 | 0.5470 | 0.4383 |
| | 1990 | 0.5351 | 0.4235 |
| | 1991 | 0.5817 | 0.4813 |
| | 1968 and 1990 | 0.5592 | 0.4490 |
| | 1968 and 1991 | 0.6287 | 0.5359 |
| | **1990 and 1991** | **0.6481** | **0.5601** |
| | 1968, 1990 and 1991 | 0.6669 | 0.5800 |
| 6 | 1968 | 0.5421 | 0.4322 |
| | 1990 | 0.5308 | 0.4182 |
| | 1991 | 0.5848 | 0.4852 |
| | 1968 and 1990 | 0.5559 | 0.4449 |
| | 1968 and 1991 | 0.6348 | 0.5435 |
| | **1990 and 1991** | **0.6629** | **0.5786** |
| | 1968, 1990 and 1991 | 0.6821 | 0.5992 |

### 1.3.4 Selecting the Final Model

It is clear that Data Set 6 with 1990 and 1991 omitted is the best model, followed by Data Set 3 with 1990 and 1991 omitted. Regression was performed using both models, and the deleted residuals were calculated.

| First Best Candidate Model | $R^2$ | Adjusted $R^2$ | Prob>F |
|---|---|---|---|
| $(\text{White Shrimp Harvest})^{0.2} = 3.857 + 0.134 * \text{Ln (Jan-Feb Inflows)}$<br>$+ 1.221 * (\text{Mar-Apr Inflows})^{-0.1}$<br>$+ 0.111 * \text{Ln (May-Jun Inflows)}$<br>$- 2.492 * (\text{Nov-Dec Inflows})^{-0.1}$ | 0.651 | 0.598 | $1.07\text{x}10^{-0.5}$ |

| Second Best Candidate Model | $R^2$ | Adjusted $R^2$ | Prob>F |
|---|---|---|---|
| $\text{Ln (White Shrimp Harvest)} = 5.107 + 0.173 * \text{Ln (Jan-Feb Inflows)}$<br>$- 0.105 * \text{Ln (Mar-Apr Inflows)}$<br>$+ 0.139 * \text{Ln (May-Jun Inflows)}$<br>$+ 0.238 * \text{Ln (Nov-Dec Inflows)}$ | 0.636 | 0.580 | $1.81\text{x}10^{-5}$ |

## 1.4 First Best Model: Variables Transformed According to Box-Cox Analysis

### 1.4.1 Summary Information

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| (White Shrimp Harvest)^0.2 | 3.7989 | .4893 | 31 |
| Ln (January-February Inflows) | 2.8969 | 1.5269 | 31 |
| (March-April Inflows)^ -0.1 | .7749 | .1159 | 31 |
| Ln (May-June Inflows) | 4.2386 | 1.4537 | 31 |
| (November-December Inflows)^ -0.1 | .7465 | 9.884E-02 | 31 |

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | (Nov-Dec Inflows)^ -0.1, Ln(May-Jun Inflows), Ln(Jan-Feb Inflows), (Mar-Apr Inflows)^ -0.1[c,d] | . | .807 | .651 | .598 | .3104 | 2.084 |

a. Dependent Variable: (White Shrimp Harvest)^0.2

b. Method: Enter

c. Independent Variables: (Constant), (November-December Inflows)^ -0.1, Ln (May-June Inflows), Ln (January-February Inflows), (March-April Inflows)^ -0.1

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 4.679 | 4 | 1.170 | 12.143 | .000[b] |
| | Residual | 2.505 | 26 | 9.6E-02 | | |
| | Total | 7.183 | 30 | | | |

a. Dependent Variable: (White Shrimp Harvest)^0.2

b. Independent Variables: (Constant), (November-December Inflows)^ -0.1, Ln (May-June Inflows), Ln (January-February Inflows), (March-April Inflows)^ -0.1

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| 1 | (Constant) | 3.857 | .878 | | 4.395 | .000 | 2.053 | 5.661 |
| | Ln (January-February Inflows) | .134 | .050 | .418 | 2.698 | .012 | .032 | .236 |
| | (March-April Inflows)^ -0.1 | 1.221 | .763 | .289 | 1.600 | .122 | -.347 | 2.789 |
| | Ln (May-June Inflows) | .111 | .054 | .328 | 2.031 | .053 | -.001 | .222 |
| | (November-December Inflows)^ -0.1 | -2.492 | .672 | -.503 | -3.707 | .001 | -3.874 | -1.110 |

a. Dependent Variable: (White Shrimp Harvest)^0.2

**Residuals Statistics[a]**

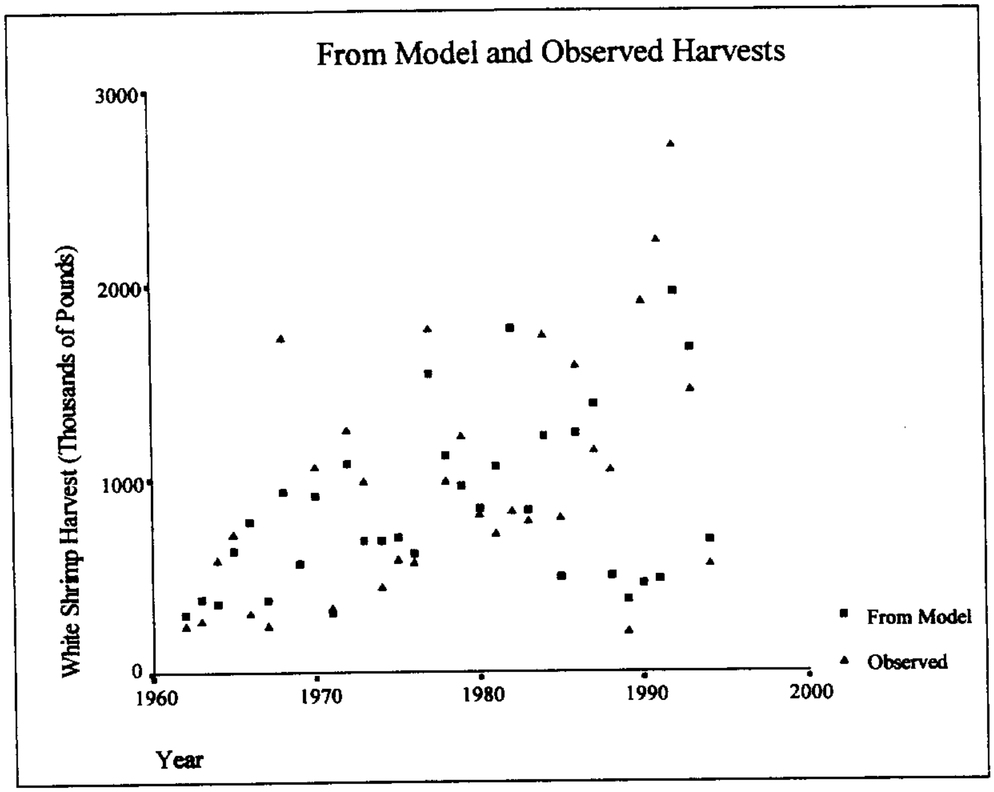
| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 3.1529 | 4.5555 | 3.7989 | .3949 | 31 |
| Std. Predicted Value | -1.636 | 1.916 | .000 | 1.000 | 31 |
| Standard Error of Predicted Value | 7.07E-02 | .1670 | .1219 | 2.65E-02 | 31 |
| Adjusted Predicted Value | 3.1480 | 4.5937 | 3.7925 | .3951 | 31 |
| Residual | -.6265 | .5461 | -1.E-17 | .2889 | 31 |
| Std. Residual | -2.018 | 1.760 | .000 | .931 | 31 |
| Stud. Residual | -2.193 | 1.916 | .009 | 1.022 | 31 |
| Deleted Residual | -.7477 | .6856 | 6.4E-03 | .3492 | 31 |
| Stud. Deleted Residual | -2.382 | 2.027 | .006 | 1.063 | 31 |
| Mahal. Distance | .587 | 7.715 | 3.871 | 2.060 | 31 |
| Cook's Distance | .000 | .242 | .043 | .061 | 31 |
| Centered Leverage Value | .020 | .257 | .129 | .069 | 31 |

a. Dependent Variable: (White Shrimp Harvest)^0.2

Table 1.6 Observed, predicted, lower and upper predicted intervals values for white shrimp harvest.

| Year | Observed[a] | Predicted[a] | LICI | UICI |
|---|---|---|---|---|
| **1962** | 249.90 | 311.57 | 52.75 | 1152.34 |
| **1963** | 279.30 | 392.81 | 72.53 | 1385.43 |
| **1964** | 592.30 | 364.66 | 70.79 | 1250.60 |
| **1965** | 723.10 | 641.81 | 152.97 | 1953.51 |
| **1966** | 320.80 | 790.09 | 199.74 | 2320.38 |
| **1967** | 252.40 | 380.28 | 72.86 | 1313.82 |
| **1968** | 1736.60 | 942.52 | 231.44 | 2817.64 |
| **1969** | 572.50 | 572.70 | 115.78 | 1919.51 |
| **1970** | 1068.40 | 921.58 | 250.41 | 2588.29 |
| **1971** | 343.80 | 313.47 | 56.40 | 1121.55 |
| **1972** | 1261.50 | 1084.25 | 308.23 | 2959.46 |
| **1973** | 997.60 | 684.10 | 159.07 | 2113.26 |
| **1974** | 448.20 | 684.25 | 173.85 | 2003.47 |
| **1975** | 589.20 | 702.58 | 154.05 | 2246.92 |
| **1976** | 576.60 | 619.82 | 146.11 | 1899.05 |
| **1977** | 1781.10 | 1544.80 | 471.20 | 4029.72 |
| **1978** | 993.40 | 1125.57 | 321.37 | 3063.80 |
| **1979** | 1227.40 | 967.05 | 262.98 | 2714.58 |
| **1980** | 824.60 | 853.66 | 200.08 | 2624.61 |
| **1981** | 726.70 | 1065.07 | 295.16 | 2954.49 |
| **1982** | 841.50 | 1776.09 | 549.99 | 4587.63 |
| **1983** | 792.90 | 845.54 | 227.80 | 2387.45 |
| **1984** | 1747.90 | 1228.42 | 323.32 | 3519.29 |
| **1985** | 806.50 | 498.25 | 94.57 | 1730.58 |
| **1986** | 1591.10 | 1242.20 | 333.42 | 3515.61 |
| **1987** | 1156.00 | 1386.02 | 408.93 | 3694.29 |
| **1988** | 1050.40 | 506.22 | 110.85 | 1620.19 |
| **1989** | 215.80 | 381.29 | 70.58 | 1342.89 |
| **1990** | 1917.70 | 468.85 | 81.22 | 1712.53 |
| **1991** | 2239.40 | 492.04 | 100.22 | 1642.17 |
| **1992** | 2726.90 | 1961.95 | 613.29 | 5036.57 |
| **1993** | 1469.70 | 1670.73 | 518.84 | 4307.48 |
| **1994** | 569.00 | 687.00 | 163.56 | 2092.52 |

[a] White Shrimp Harvest (Thousands of Pounds)
LICI Lower limit for 99% prediction interval for white shrimp harvest.
UICI Upper limit for 99% prediction interval for white shrimp harvest.



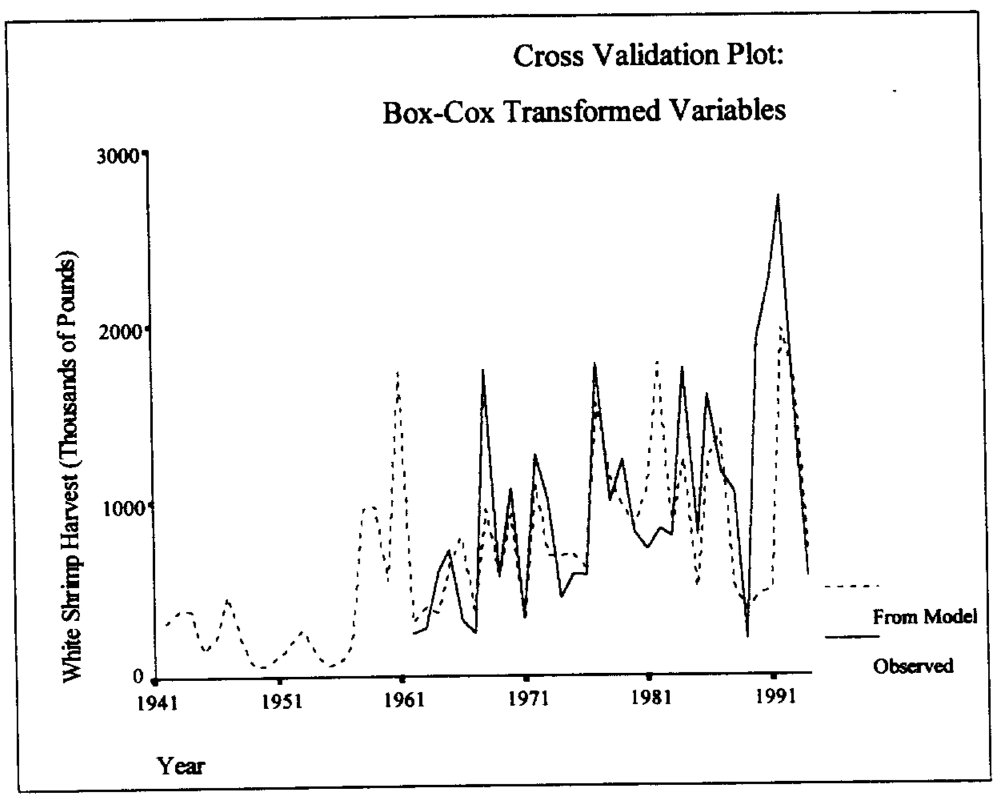




Fig. 1.1 Comparative plots of observed values vs. calculated from the regression model.

## 1.5 Second Best Model: Logged All Variables

### 1.5.1 Summary Information

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| Ln (White Shrimp Harvest) | 6.6325 | .6539 | 31 |
| Ln (January-February Inflows) | 2.8969 | 1.5269 | 31 |
| Ln (March-April Inflows) | 2.6636 | 1.5448 | 31 |
| Ln (May-June Inflows) | 4.2386 | 1.4537 | 31 |
| Ln (November-December Inflows) | 3.0094 | 1.3408 | 31 |

**Model Summary[a,b]**

| Model | Variables | | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| | Entered | Removed | | | | | |
| 1 | Ln(Nov-Dec Inflows), Ln(May-Jun Inflows), Ln(Jan-Feb Inflows), Ln(Marc-Apr Inflows)[c,d] | . | .798 | .636 | .580 | .4236 | 2.103 |

a. Dependent Variable: Ln (White Shrimp Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Ln (November-December Inflows), Ln (May-June Inflows), Ln (January-February Inflows), Ln (March-April Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 8.163 | 4 | 2.041 | 11.372 | .000[b] |
| | Residual | 4.666 | 26 | .179 | | |
| | Total | 12.829 | 30 | | | |

a. Dependent Variable: Ln (White Shrimp Harvest)

b. Independent Variables: (Constant), Ln (November-December Inflows), Ln (May-June Inflows), Ln (January-February Inflows), Ln (March-April Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| 1 | (Constant) | 5.107 | .271 | | 18.863 | .000 | 4.550 | 5.663 |
| | Ln (January-February Inflows) | .173 | .068 | .404 | 2.549 | .017 | .033 | .312 |
| | Ln (March-April Inflows) | -.105 | .076 | -.247 | -1.370 | .182 | -.262 | .052 |
| | Ln (May-June Inflows) | .139 | .073 | .308 | 1.889 | .070 | -.012 | .289 |
| | Ln (November-December Inflows) | .238 | .068 | .488 | 3.506 | .002 | .099 | .378 |

a. Dependent Variable: Ln (White Shrimp Harvest)

**Residuals Statistics[a]**

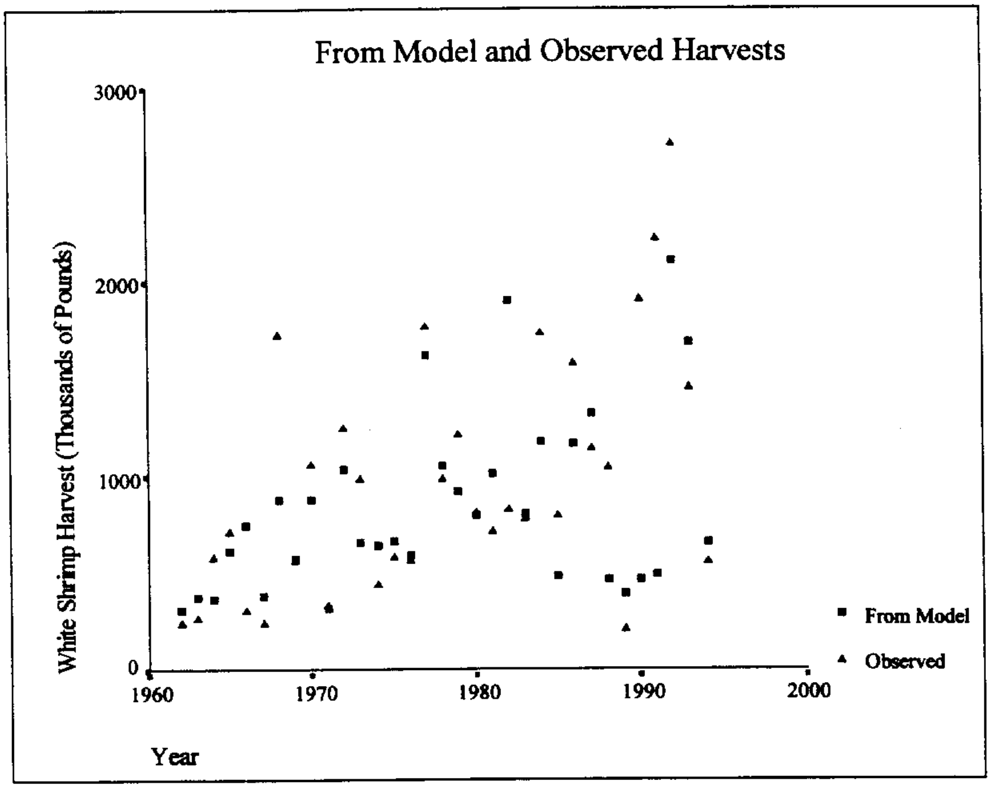
| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 5.7626 | 7.6586 | 6.6325 | .5216 | 31 |
| Std. Predicted Value | -1.668 | 1.967 | .000 | 1.000 | 31 |
| Standard Error of Predicted Value | 9.81E-02 | .2381 | .1661 | 3.74E-02 | 31 |
| Adjusted Predicted Value | 5.7921 | 7.7409 | 6.6235 | .5256 | 31 |
| Residual | -.8571 | .7866 | 2.4E-15 | .3944 | 31 |
| Std. Residual | -2.023 | 1.857 | .000 | .931 | 31 |
| Stud. Residual | -2.162 | 1.969 | .009 | 1.023 | 31 |
| Deleted Residual | -1.0057 | .8994 | 9.0E-03 | .4775 | 31 |
| Stud. Deleted Residual | -2.341 | 2.093 | .005 | 1.065 | 31 |
| Mahal. Distance | .642 | 8.507 | 3.871 | 2.137 | 31 |
| Cook's Distance | .000 | .224 | .044 | .064 | 31 |
| Centered Leverage Value | .021 | .284 | .129 | .071 | 31 |

a. Dependent Variable: Ln (White Shrimp Harvest)

Table 1.7 Observed, predicted, lower and upper predicted intervals values for white shrimp harvest.

| Year | Observed[a] | Predicted[a] | LICI | UICI |
|---|---|---|---|---|
| **1962** | 249.90 | 318.16 | 88.02 | 1150.03 |
| **1963** | 279.30 | 382.95 | 105.28 | 1393.03 |
| **1964** | 592.30 | 373.28 | 107.97 | 1290.57 |
| **1965** | 723.10 | 619.29 | 179.11 | 2141.25 |
| **1966** | 320.80 | 755.90 | 217.00 | 2633.09 |
| **1967** | 252.40 | 389.48 | 111.33 | 1362.65 |
| **1968** | 1736.60 | 883.54 | 237.12 | 3292.23 |
| **1969** | 572.50 | 580.46 | 154.32 | 2183.36 |
| **1970** | 1068.40 | 891.43 | 262.17 | 3031.04 |
| **1971** | 343.80 | 329.70 | 94.50 | 1150.29 |
| **1972** | 1261.50 | 1046.30 | 306.56 | 3571.00 |
| **1973** | 997.60 | 660.44 | 184.47 | 2364.51 |
| **1974** | 448.20 | 649.69 | 194.06 | 2175.02 |
| **1975** | 589.20 | 676.12 | 179.44 | 2547.63 |
| **1976** | 576.60 | 601.14 | 175.02 | 2064.76 |
| **1977** | 1781.10 | 1631.71 | 462.26 | 5759.72 |
| **1978** | 993.40 | 1057.19 | 308.29 | 3625.32 |
| **1979** | 1227.40 | 931.29 | 269.99 | 3212.36 |
| **1980** | 824.60 | 805.32 | 213.20 | 3041.94 |
| **1981** | 726.70 | 1018.54 | 292.65 | 3544.90 |
| **1982** | 841.50 | 1910.47 | 530.52 | 6879.84 |
| **1983** | 792.90 | 813.36 | 242.52 | 2727.82 |
| **1984** | 1747.90 | 1183.94 | 314.31 | 4459.69 |
| **1985** | 806.50 | 492.98 | 127.77 | 1902.16 |
| **1986** | 1591.10 | 1176.81 | 318.79 | 4344.23 |
| **1987** | 1156.00 | 1335.82 | 379.96 | 4696.29 |
| **1988** | 1050.40 | 478.33 | 138.35 | 1653.81 |
| **1989** | 215.80 | 400.81 | 112.59 | 1426.90 |
| **1990** | 1917.70 | 472.93 | 120.19 | 1860.95 |
| **1991** | 2239.40 | 500.66 | 139.16 | 1801.26 |
| **1992** | 2726.90 | 2118.86 | 574.24 | 7818.30 |
| **1993** | 1469.70 | 1696.91 | 483.31 | 5957.93 |
| **1994** | 569.00 | 667.35 | 190.78 | 2334.37 |

[a] White Shrimp Harvest (Thousands of Pounds)
LICI Lower limit for 99% prediction interval for white shrimp harvest.
UICI Upper limit for 99% prediction interval for white shrimp harvest.



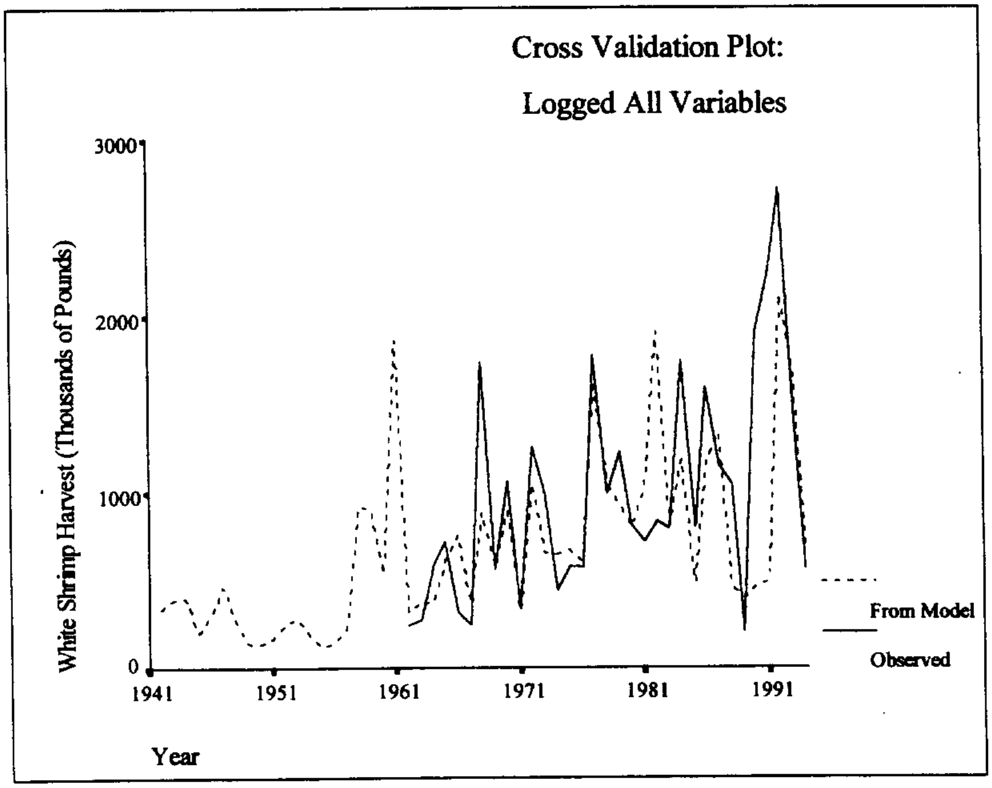




Fig. 1.2 Comparative plots of observed values vs. calculated from the regression model.

## 2. Exploring the Data

### 2.1 Listing of Data

Table 2.1. White shrimp harvest and water inflows data.

| Obs. | YEAR | WHITE SHRIMP | JF_LAG | MA_LAG | MJ_LAG | JA_LAG | SO_LAG | ND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | 1962 | 249.9 | .68 | 1.81 | 20.71 | 2.63 | 53.95 | 4.63 |
| 2 | 1963 | 279.3 | 1.80 | 2.37 | 3.62 | 2.17 | 19.66 | 15.44 |
| 3 | 1964 | 592.3 | 4.32 | 4.01 | 9.88 | 76.35 | 2.87 | 5.16 |
| 4 | 1965 | 723.1 | 26.69 | 5.40 | 51.79 | 2.54 | 7.20 | 5.01 |
| 5 | 1966 | 320.8 | 19.01 | 102.07 | 292.01 | 21.92 | 7.77 | 19.71 |
| 6 | 1967 | 252.4 | 3.48 | 2.42 | 39.80 | 23.76 | 5.91 | 2.57 |
| 7 | 1968 | 1736.6 | 16.18 | 6.49 | 578.09 | 72.56 | 1464.15 | 8.54 |
| 8 | 1969 | 572.5 | 93.08 | 51.71 | 55.18 | 7.92 | 37.07 | 4.01 |
| 9 | 1970 | 1068.4 | 18.02 | 56.55 | 156.25 | 24.95 | 6.01 | 45.45 |
| 10 | 1971 | 343.8 | 2.88 | 2.76 | 9.19 | 33.38 | 121.83 | 3.64 |
| 11 | 1972 | 1261.5 | 23.57 | 40.82 | 364.55 | 59.81 | 1069.46 | 38.79 |
| 12 | 1973 | 997.6 | 8.34 | 16.71 | 454.15 | 25.39 | 55.14 | 7.10 |
| 13 | 1974 | 448.2 | 8.29 | 8.48 | 88.13 | 8.60 | 553.75 | 12.82 |
| 14 | 1975 | 589.2 | 3.97 | 3.93 | 5.33 | 8.25 | 324.81 | 94.34 |
| 15 | 1976 | 576.6 | 4.93 | 23.07 | 64.70 | 247.05 | 31.67 | 25.08 |
| 16 | 1977 | 1781.1 | 54.98 | 73.95 | 239.73 | 16.72 | 103.54 | 224.55 |
| 17 | 1978 | 993.4 | 28.60 | 5.06 | 76.63 | 7.36 | 24.23 | 34.83 |
| 18 | 1979 | 1227.4 | 97.73 | 59.20 | 95.01 | 168.68 | 99.86 | 21.80 |
| 19 | 1980 | 824.6 | 125.10 | 4.44 | 23.18 | 261.14 | 325.18 | 7.20 |
| 20 | 1981 | 726.7 | 30.45 | 31.47 | 587.50 | 348.21 | 163.31 | 19.44 |
| 21 | 1982 | 841.5 | 173.32 | 26.89 | 89.01 | 11.54 | 210.86 | 215.74 |
| 22 | 1983 | 792.9 | 37.40 | 32.83 | 64.34 | 388.55 | 4.35 | 24.01 |
| 23 | 1984 | 1747.9 | 119.78 | 5.35 | 11.43 | 4.67 | 562.84 | 61.38 |
| 24 | 1985 | 806.5 | 21.15 | 225.58 | 64.37 | 14.53 | 118.99 | 10.35 |
| 25 | 1986 | 1591.1 | 11.69 | 2.17 | 36.46 | 14.89 | 96.34 | 111.07 |
| 26 | 1987 | 1156.0 | 49.23 | 8.05 | 223.59 | 48.12 | 33.40 | 41.25 |
| 27 | 1988 | 1050.4 | 2.15 | 2.83 | 18.16 | 6.05 | 19.69 | 14.61 |
| 28 | 1989 | 215.80 | 9.98 | 2.72 | 25.49 | 28.11 | 42.32 | 1.84 |
| 29 | 1990 | 1917.7 | 14.69 | 58.18 | 7.23 | 358.90 | 3.32 | 22.27 |
| 30 | 1991 | 2239.4 | 27.91 | 62.00 | 63.04 | 21.72 | 12.98 | 5.18 |
| 31 | 1992 | 2726.9 | 301.46 | 410.26 | 533.02 | 49.46 | 148.46 | 260.82 |
| 32 | 1993 | 1469.7 | 174.36 | 129.00 | 682.05 | 15.70 | 37.77 | 79.59 |
| 33 | 1994 | 569.0 | 6.90 | 48.98 | 82.35 | 16.06 | 17.79 | 36.87 |

| | |
|---|---|
| **WHITE SHRIMP** | White Shrimp harvest (thousands of pounds) |
| **JF_LAG** | Lagged January-February inflows (thousands of acre-feet) |
| **MA_LAG** | Lagged March-April inflows (thousands of acre-feet) |
| **MJ_LAG** | Lagged May-June inflows (thousands of acre-feet) |
| **JA_LAG** | Lagged July-August inflows (thousands of acre-feet) |
| **SO_LAG** | Lagged September-October inflows (thousands of acre-feet) |
| **ND_LAG** | Lagged November-December inflows (thousands of acre-feet) |

## 2.2 Test of Normality for Individual Variables

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| White Shrimp Harvest | .140 | 33 | .099 | .919 | 33 | .025 |
| Ln (White Shrimp Harvest) | .091 | 33 | .200* | .963 | 33 | .420 |
| SQRT (White Shrimp Harvest) | .085 | 33 | .200* | .966 | 33 | .471 |
| January-February Inflows | .290 | 33 | .000 | .684 | 33 | .010** |
| Ln (January-February Inflows) | .077 | 33 | .200* | .983 | 33 | .908 |
| SQRT (January-February Inflows) | .196 | 33 | .002 | .869 | 33 | .010** |
| March-April Inflows | .291 | 33 | .000 | .574 | 33 | .010** |
| Ln (March-April Inflows) | .150 | 33 | .058 | .925 | 33 | .037 |
| SQRT (March-April Inflows) | .193 | 33 | .003 | .816 | 33 | .010** |
| May-June Inflows | .316 | 33 | .000 | .730 | 33 | .010** |
| Ln (May-June Inflows) | .093 | 33 | .200* | .959 | 33 | .358 |
| SQRT (May-June Inflows) | .225 | 33 | .000 | .867 | 33 | .010** |
| July-August Inflows | .308 | 33 | .000 | .628 | 33 | .010** |
| Ln (July-August Inflows) | .115 | 33 | .200* | .948 | 33 | .187 |
| SQRT (July-August Inflows) | .237 | 33 | .000 | .782 | 33 | .010** |
| September-October Inflows | .303 | 33 | .000 | .577 | 33 | .010** |
| Ln (September-October Inflows) | .078 | 33 | .200* | .971 | 33 | .584 |
| SQRT (September-October Inflows) | .187 | 33 | .005 | .806 | 33 | .010** |
| November-December Inflows | .285 | 33 | .000 | .641 | 33 | .010** |
| Ln (November-December Inflows) | .085 | 33 | .200* | .968 | 33 | .500 |
| SQRT (November-December Inflows) | .185 | 33 | .006 | .829 | 33 | .010** |

*. This is a lower bound of the true significance.

**. This is an upper bound of the true significance.

a. Lilliefors Significance Correction

## 2.3 Percentiles for Individual Variables

**Percentiles**

| | | Percentiles | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 10 | 25 | 50 | 75 | 90 | 95 |
| Weighted Average (Definition 1) | White Shrimp Harvest | 239.6700 | 263.1600 | 570.7500 | 824.6000 | 1365.60 | 1863.06 | 2385.65 |
| | Ln (White Shrimp Harvest) | 5.4770 | 5.5715 | 6.3469 | 6.7149 | 7.2164 | 7.5293 | 7.7731 |
| | SQRT (White Shrimp Harvest) | 15.4728 | 16.2172 | 23.8903 | 28.7158 | 36.9271 | 43.1582 | 48.7915 |
| | January-February Inflows | 1.4640 | 2.4420 | 5.9150 | 19.0100 | 52.1050 | 154.0320 | 212.4900 |
| | Ln (January-February Inflows) | .2958 | .8824 | 1.7634 | 2.9450 | 3.9517 | 5.0247 | 5.3254 |
| | SQRT (January-February Inflows) | 1.1865 | 1.5586 | 2.4236 | 4.3600 | 7.2158 | 12.3730 | 14.4520 |
| | March-April Inflows | 2.0620 | 2.3900 | 3.9700 | 16.7100 | 57.3650 | 118.2280 | 260.9840 |
| | Ln (March-April Inflows) | .7203 | .8712 | 1.3787 | 2.8160 | 4.0493 | 4.7662 | 5.5961 |
| | SQRT (March-April Inflows) | 1.4348 | 1.5459 | 1.9925 | 4.0878 | 7.5738 | 10.8559 | 16.5900 |
| | May-June Inflows | 4.8170 | 8.0140 | 21.9450 | 64.3700 | 231.6800 | 560.0620 | 615.6650 |
| | Ln (May-June Inflows) | 1.5573 | 2.0742 | 3.0870 | 4.1646 | 5.4447 | 6.3273 | 6.4206 |
| | SQRT (May-June Inflows) | 2.1869 | 2.8259 | 4.6827 | 8.0231 | 15.2181 | 23.6610 | 24.8017 |
| | July-August Inflows | 2.4290 | 3.4460 | 8.4250 | 21.9200 | 66.1650 | 313.3820 | 367.7950 |
| | Ln (July-August Inflows) | .8849 | 1.1967 | 2.1310 | 3.0874 | 4.1678 | 5.7377 | 5.9069 |
| | SQRT (July-August Inflows) | 1.5575 | 1.8374 | 2.9024 | 4.6819 | 8.1260 | 17.6802 | 19.1748 |
| | September-October Inflows | 3.1850 | 4.9740 | 15.3850 | 42.3200 | 155.8850 | 559.2040 | 1187.87 |
| | Ln (September-October Inflows) | 1.1563 | 1.5928 | 2.7210 | 3.7453 | 5.0480 | 6.3266 | 7.0691 |
| | SQRT (September-October Inflows) | 1.7837 | 2.2238 | 3.9103 | 6.5054 | 12.4818 | 23.6473 | 34.3711 |
| | November-December Inflows | 2.3510 | 3.7880 | 6.1400 | 19.7100 | 43.3500 | 173.8720 | 235.4310 |
| | Ln (November-December Inflows) | .8437 | 1.3307 | 1.8024 | 2.9811 | 3.7681 | 5.1085 | 5.4590 |
| | SQRT (November-December Inflows) | 1.5291 | 1.9457 | 2.4703 | 4.4396 | 6.5821 | 13.0284 | 15.3345 |
| Tukey's Hinges | White Shrimp Harvest | | | 572.5000 | 824.6000 | 1261.50 | | |
| | Ln (White Shrimp Harvest) | | | 6.3500 | 6.7149 | 7.1401 | | |
| | SQRT (White Shrimp Harvest) | | | 23.9270 | 28.7158 | 35.5176 | | |
| | January-February Inflows | | | 6.9000 | 19.0100 | 49.2300 | | |
| | Ln (January-February Inflows) | | | 1.9315 | 2.9450 | 3.8965 | | |
| | SQRT (January-February Inflows) | | | 2.6268 | 4.3600 | 7.0164 | | |
| | March-April Inflows | | | 4.0100 | 16.7100 | 56.5500 | | |
| | Ln (March-April Inflows) | | | 1.3888 | 2.8160 | 4.0351 | | |
| | SQRT (March-April Inflows) | | | 2.0025 | 4.0878 | 7.5200 | | |
| | May-June Inflows | | | 23.1800 | 64.3700 | 223.5900 | | |
| | Ln (May-June Inflows) | | | 3.1433 | 4.1646 | 5.4098 | | |
| | SQRT (May-June Inflows) | | | 4.8146 | 8.0231 | 14.9529 | | |
| | July-August Inflows | | | 8.6000 | 21.9200 | 59.8100 | | |
| | Ln (July-August Inflows) | | | 2.1518 | 3.0874 | 4.0912 | | |
| | SQRT (July-August Inflows) | | | 2.9326 | 4.6819 | 7.7337 | | |
| | September-October Inflows | | | 17.7900 | 42.3200 | 148.4600 | | |
| | Ln (September-October Inflows) | | | 2.8788 | 3.7453 | 5.0003 | | |
| | SQRT (September-October Inflows) | | | 4.2178 | 6.5054 | 12.1844 | | |
| | November-December Inflows | | | 7.1000 | 19.7100 | 41.2500 | | |
| | Ln (November-December Inflows) | | | 1.9601 | 2.9811 | 3.7197 | | |
| | SQRT (November-December Inflows) | | | 2.6646 | 4.4396 | 6.4226 | | |

## 2.4 Summary Information for Individual Variables

### 2.4.1 Summary Information for White Shrimp Harvest

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| White Shrimp Harvest | Mean | | 990.6121 | 108.4236 |
| | 95% Confidence Interval for Mean | Lower Bound | 769.7604 | |
| | | Upper Bound | 1211.46 | |
| | 5% Trimmed Mean | | 947.1197 | |
| | Median | | 824.6000 | |
| | Variance | | 387938 | |
| | Std. Deviation | | 622.8463 | |
| | Minimum | | 215.80 | |
| | Maximum | | 2726.9 | |
| | Range | | 2511.1 | |
| | Interquartile Range | | 794.8500 | |
| | Skewness | | .952 | .409 |
| | Kurtosis | | .533 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| White Shrimp Harvest | Highest | 1 | 31 | 1992 | 2726.9 |
| | | 2 | 30 | 1991 | 2239.4 |
| | | 3 | 29 | 1990 | 1917.7 |
| | | 4 | 16 | 1977 | 1781.1 |
| | | 5 | 23 | 1984 | 1747.9 |
| | Lowest | 1 | 28 | 1989 | 215.80 |
| | | 2 | 1 | 1962 | 249.90 |
| | | 3 | 6 | 1967 | 252.40 |
| | | 4 | 2 | 1963 | 279.30 |
| | | 5 | 5 | 1966 | 320.80 |

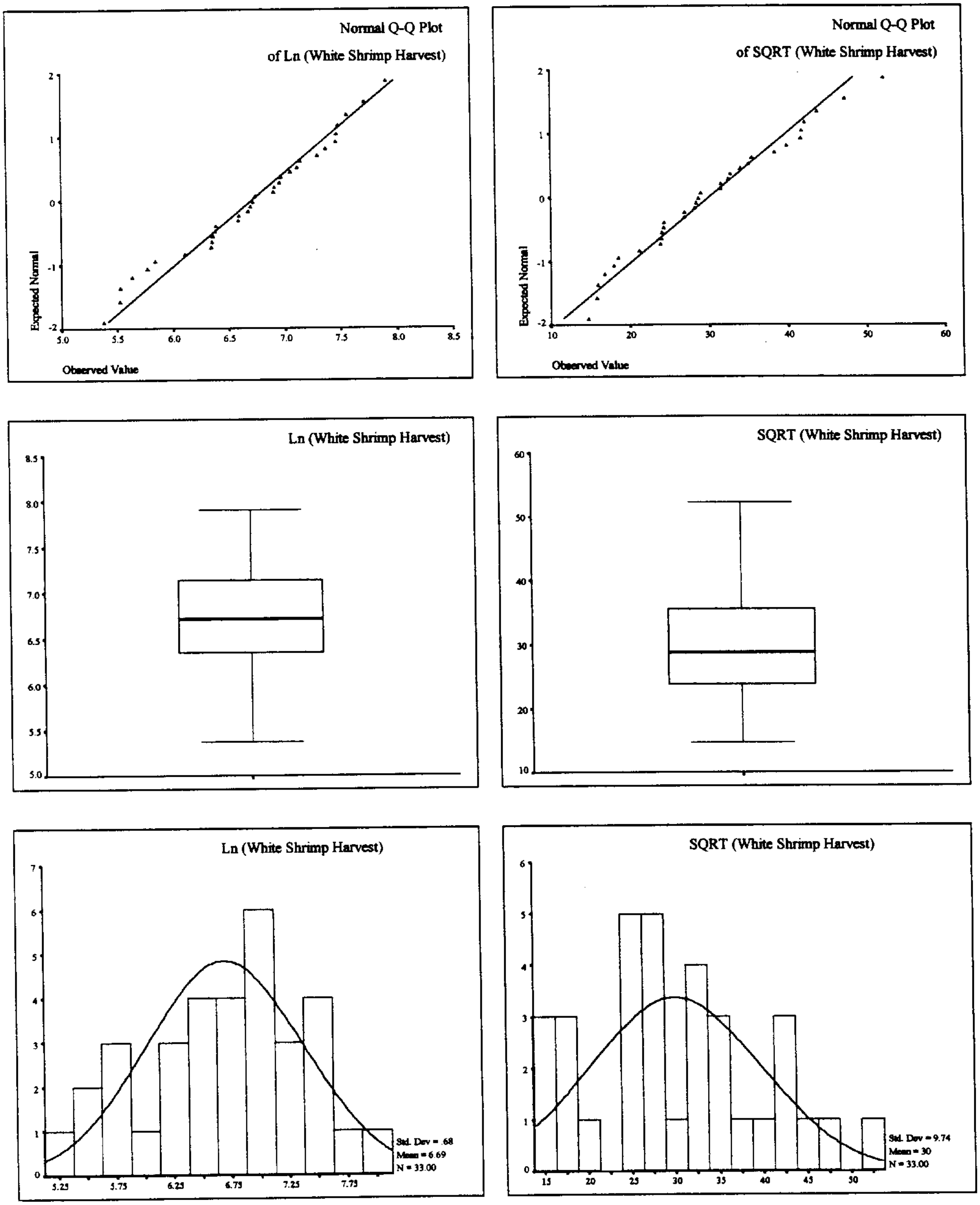



Fig. 2.1b. Exploratory Plots of Transformed White Shrimp Harvest.

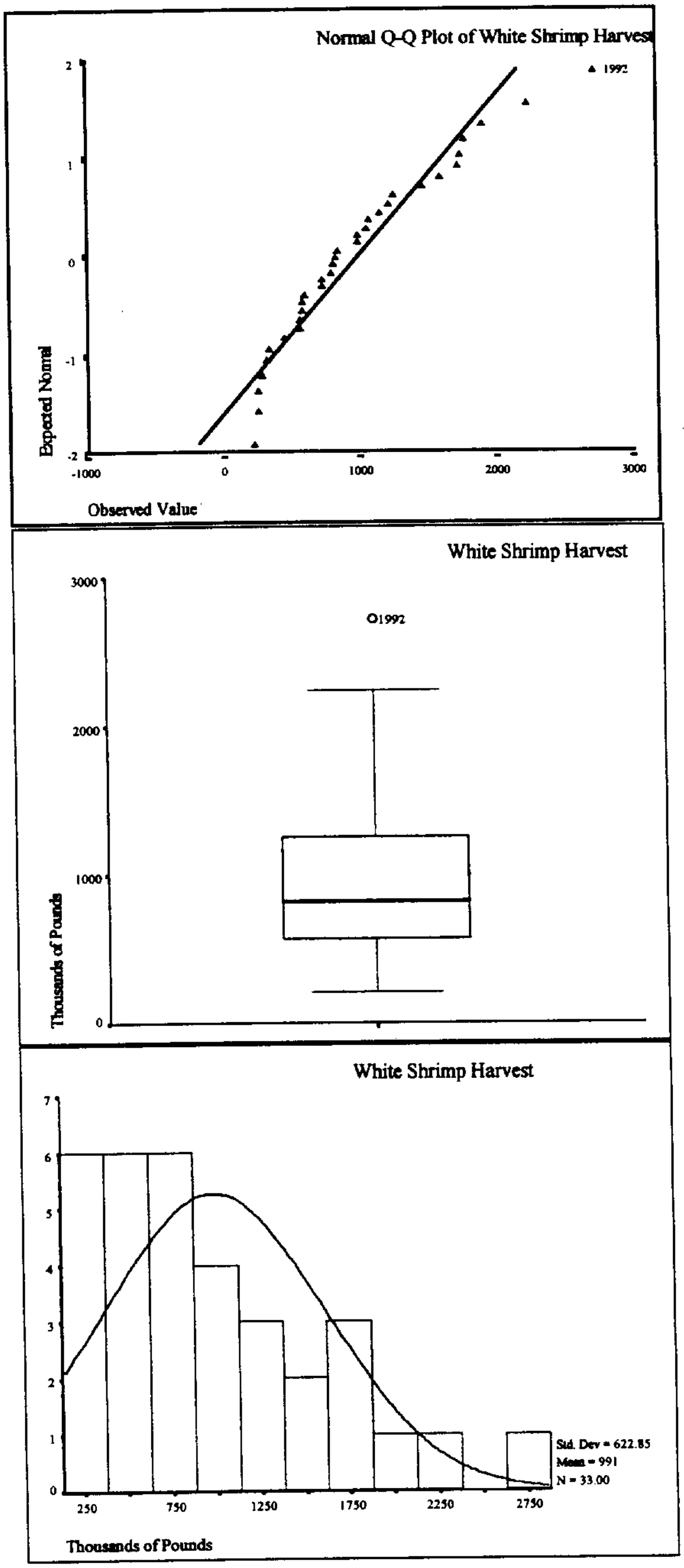



Fig. 2.1a. Exploratory Plots of White Shrimp Harvest.

### 2.4.2 Summary Information for January-February Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| January-February Inflows | Mean | | 46.1248 | 11.5995 |
| | 95% Confidence Interval for Mean | Lower Bound | 22.4975 | |
| | | Upper Bound | 69.7522 | |
| | 5% Trimmed Mean | | 37.2214 | |
| | Median | | 19.0100 | |
| | Variance | | 4440.060 | |
| | Std. Deviation | | 66.6338 | |
| | Minimum | | .68 | |
| | Maximum | | 301.5 | |
| | Range | | 300.8 | |
| | Interquartile Range | | 46.1900 | |
| | Skewness | | 2.350 | .409 |
| | Kurtosis | | 6.076 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| January-February Inflows | Highest | 1 | 31 | 1992 | 301.5 |
| | | 2 | 32 | 1993 | 174.4 |
| | | 3 | 21 | 1982 | 173.3 |
| | | 4 | 19 | 1980 | 125.1 |
| | | 5 | 23 | 1984 | 119.8 |
| | Lowest | 1 | 1 | 1962 | .68 |
| | | 2 | 2 | 1963 | 1.80 |
| | | 3 | 27 | 1988 | 2.15 |
| | | 4 | 10 | 1971 | 2.88 |
| | | 5 | 6 | 1967 | 3.48 |

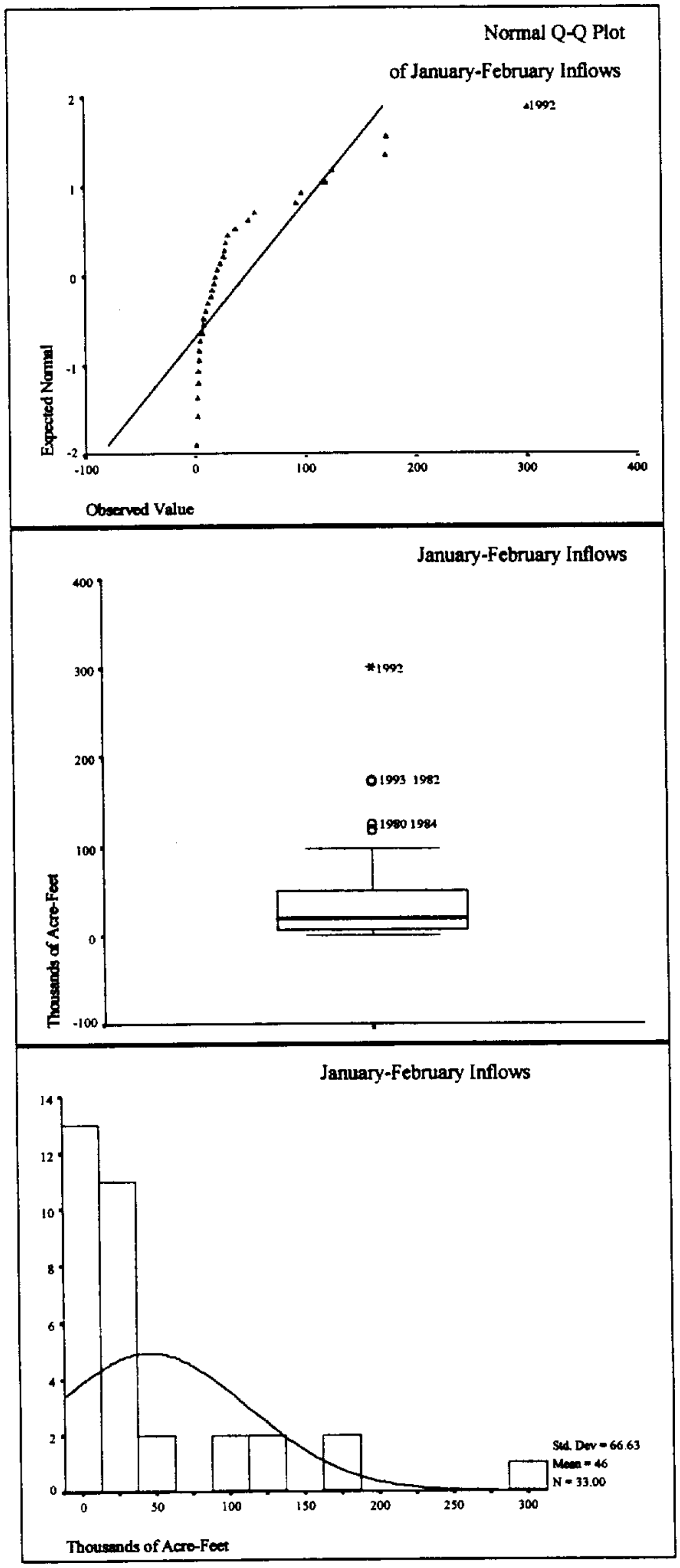



Fig. 2.2a. Exploratory Plots of January-February Inflows.

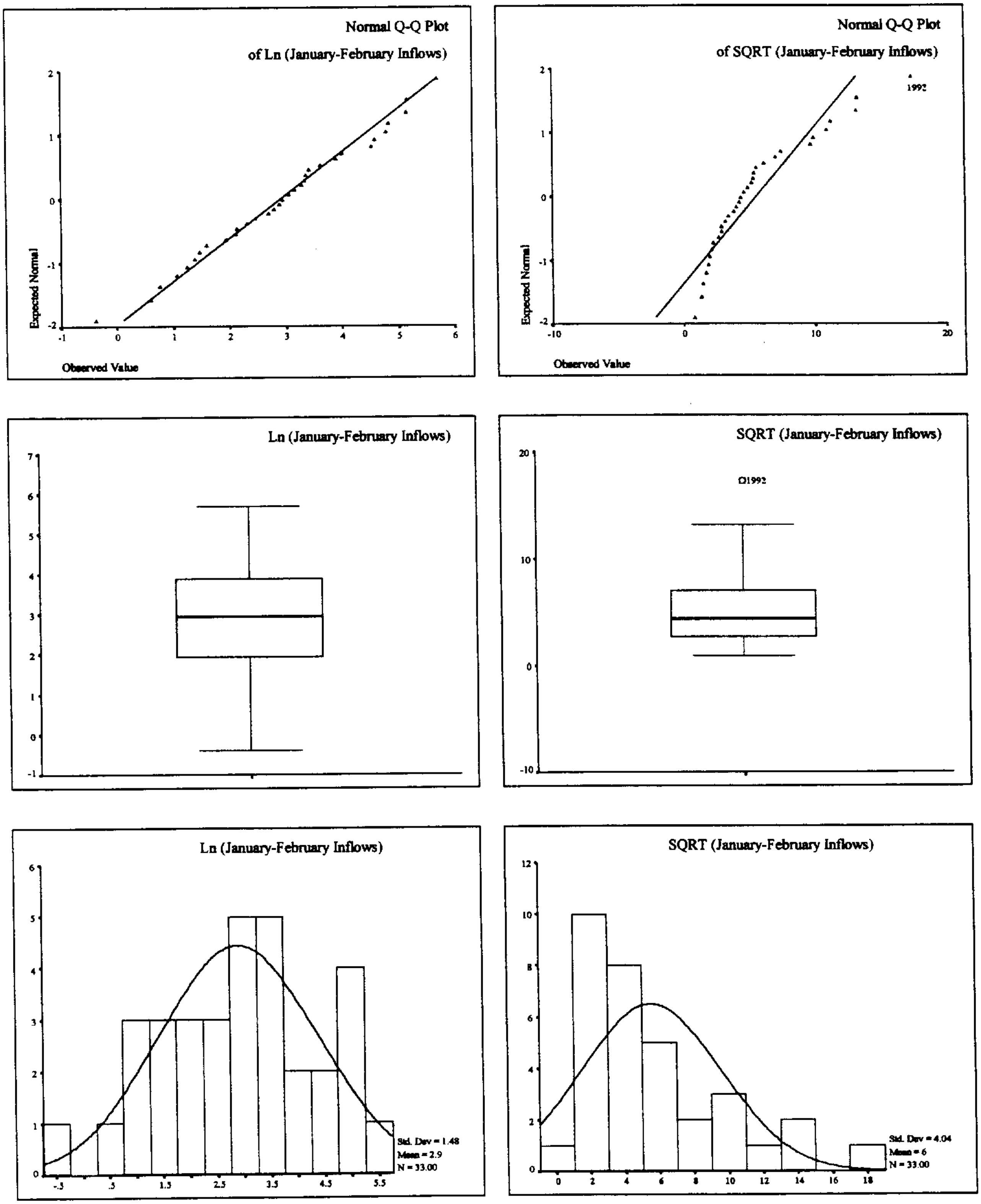



Fig. 2.2b. Exploratory Plots of Transformed January-February Inflows.

### 2.4.3 Summary Information for March-April Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| March-April Inflows | Mean | | 45.9867 | 13.9862 |
| | 95% Confidence Interval for Mean | Lower Bound | 17.4976 | |
| | | Upper Bound | 74.4757 | |
| | 5% Trimmed Mean | | 32.2375 | |
| | Median | | 16.7100 | |
| | Variance | | 6455.290 | |
| | Std. Deviation | | 80.3448 | |
| | Minimum | | 1.81 | |
| | Maximum | | 410.26 | |
| | Range | | 408.45 | |
| | Interquartile Range | | 53.3950 | |
| | Skewness | | 3.444 | .409 |
| | Kurtosis | | 13.667 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| March-April Inflows | Highest | 1 | 31 | 1992 | 410.26 |
| | | 2 | 24 | 1985 | 225.58 |
| | | 3 | 32 | 1993 | 129.00 |
| | | 4 | 5 | 1966 | 102.07 |
| | | 5 | 16 | 1977 | 73.95 |
| | Lowest | 1 | 1 | 1962 | 1.81 |
| | | 2 | 25 | 1986 | 2.17 |
| | | 3 | 2 | 1963 | 2.37 |
| | | 4 | 6 | 1967 | 2.42 |
| | | 5 | 28 | 1989 | 2.72 |

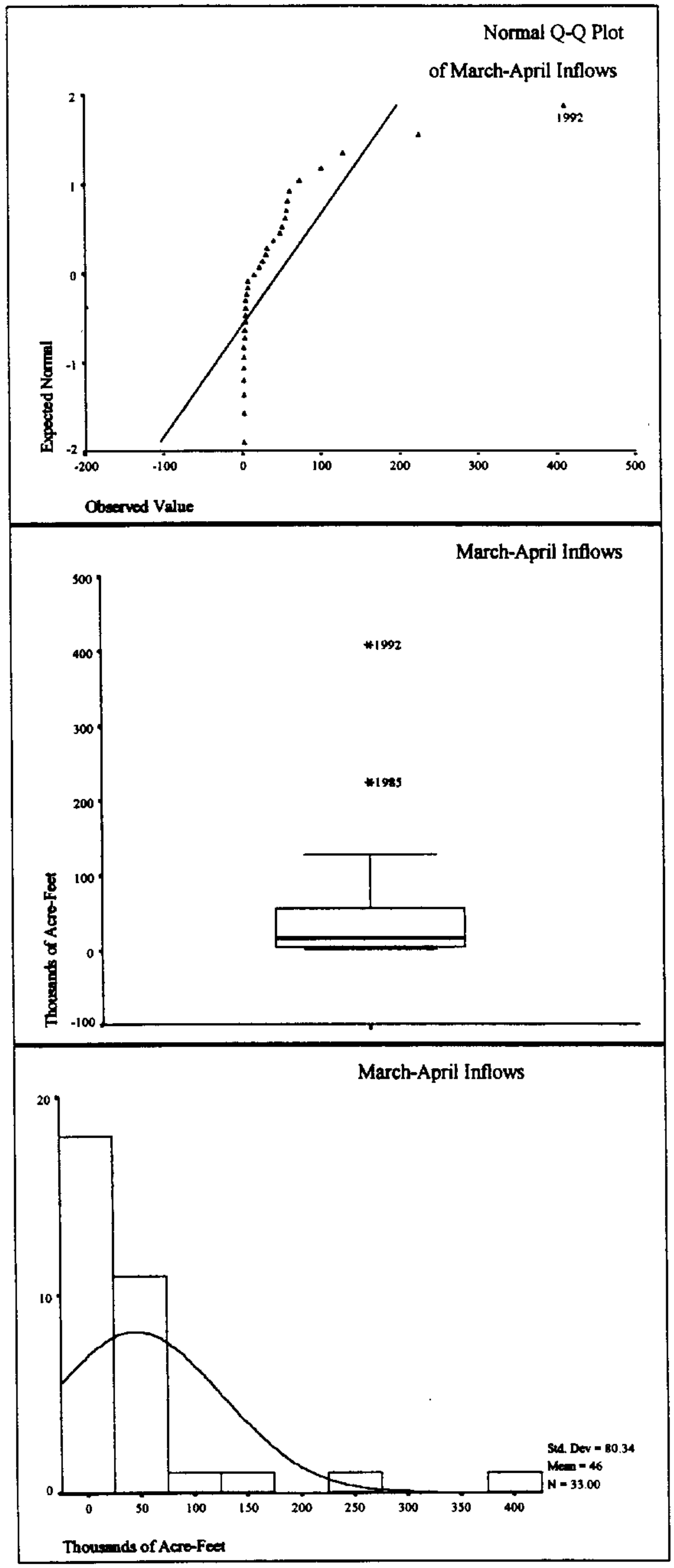



Fig. 2.3a. Exploratory Plots of March-April Inflows.

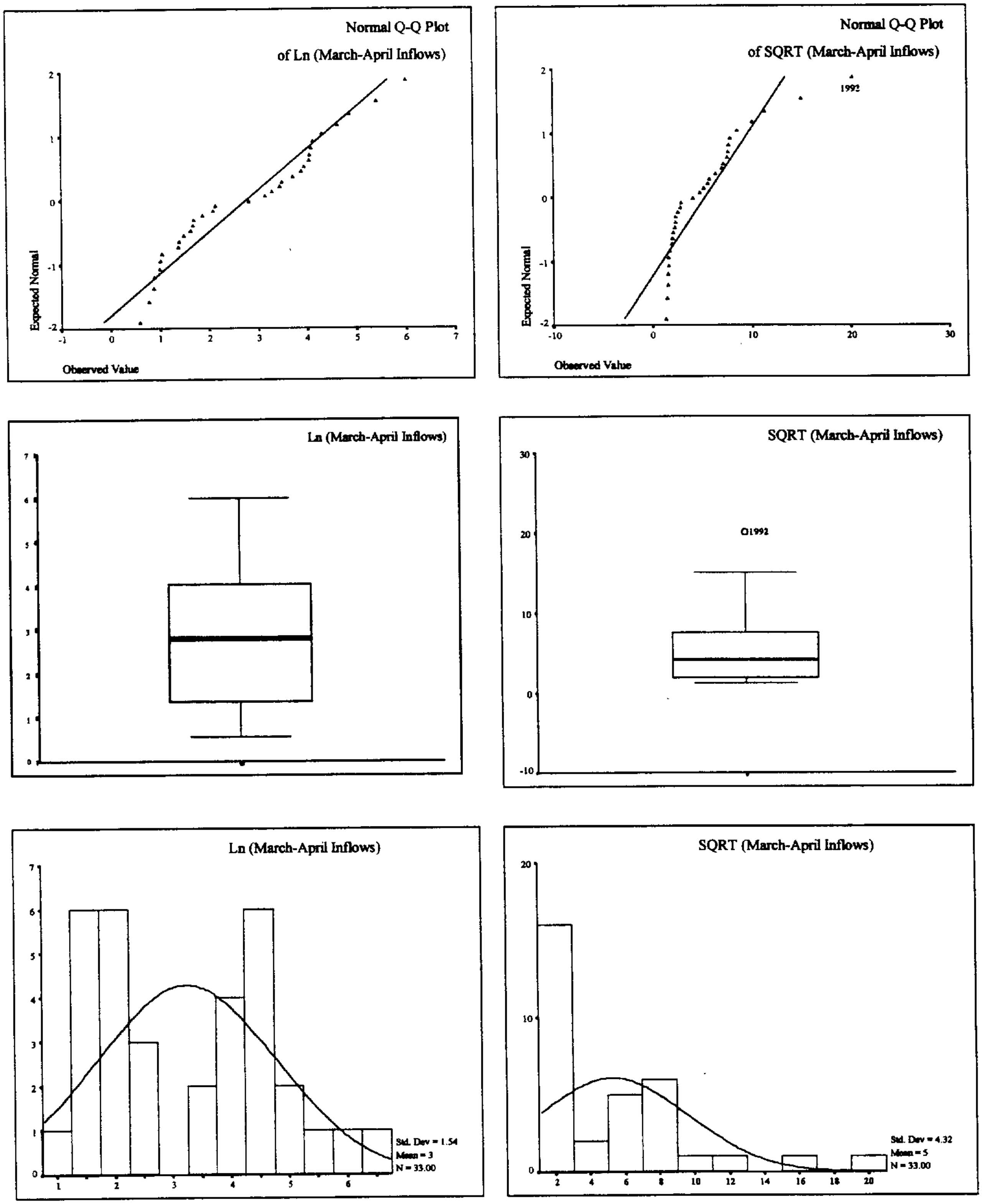



Fig. 2.3b. Exploratory Plots of Transformed March-April Inflows.

### 2.4.4 Summary Information for May-June Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| May-June Inflows | Mean | | 155.0294 | 34.4961 |
| | 95% Confidence Interval for Mean | Lower Bound | 84.7630 | |
| | | Upper Bound | 225.2957 | |
| | 5% Trimmed Mean | | 136.1940 | |
| | Median | | 64.3700 | |
| | Variance | | 39269.5 | |
| | Std. Deviation | | 198.1653 | |
| | Minimum | | 3.62 | |
| | Maximum | | 682.05 | |
| | Range | | 678.43 | |
| | Interquartile Range | | 209.7150 | |
| | Skewness | | 1.530 | .409 |
| | Kurtosis | | 1.097 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| May-June Inflows | Highest | 1 | 32 | 1993 | 682.05 |
| | | 2 | 20 | 1981 | 587.50 |
| | | 3 | 7 | 1968 | 578.09 |
| | | 4 | 31 | 1992 | 533.02 |
| | | 5 | 12 | 1973 | 454.15 |
| | Lowest | 1 | 2 | 1963 | 3.62 |
| | | 2 | 14 | 1975 | 5.33 |
| | | 3 | 29 | 1990 | 7.23 |
| | | 4 | 10 | 1971 | 9.19 |
| | | 5 | 3 | 1964 | 9.88 |

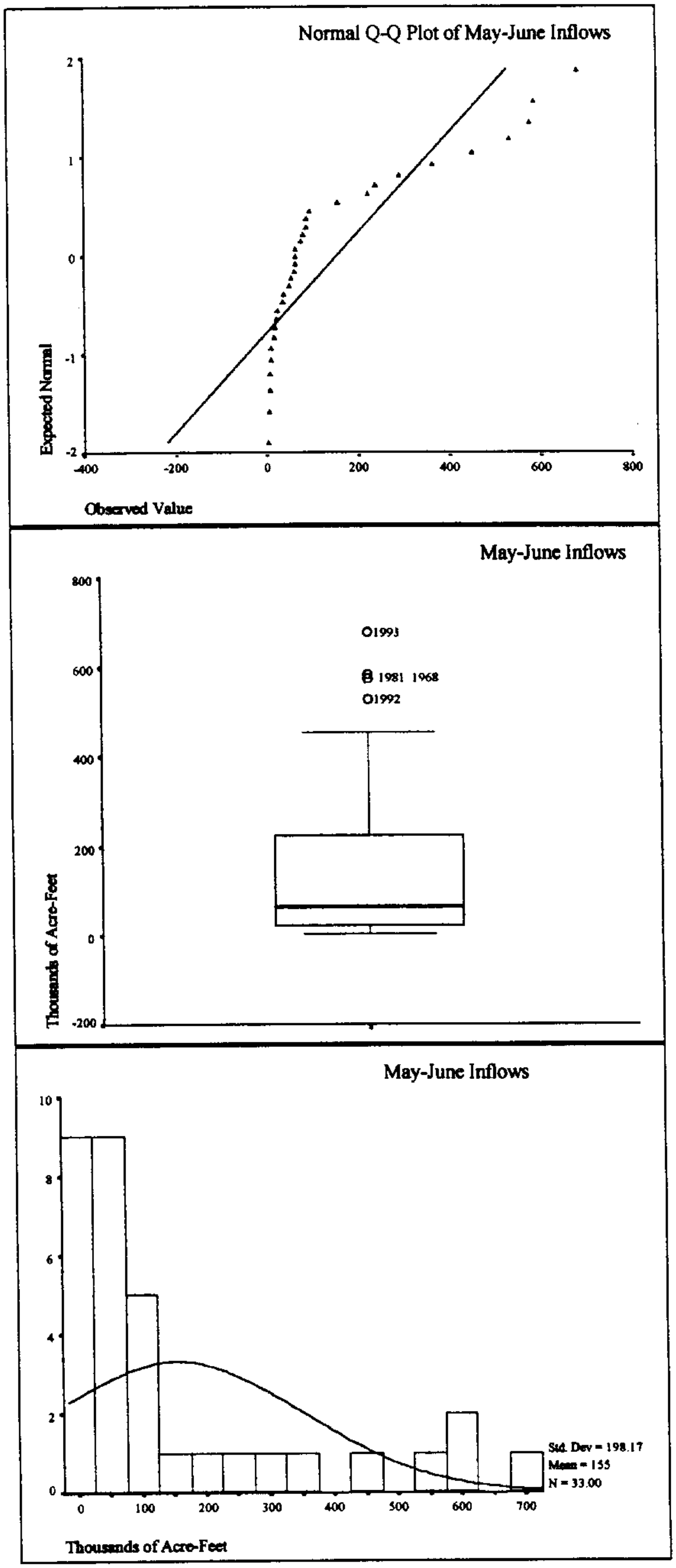



Fig. 2.4a. Exploratory Plots of May-June Inflows.

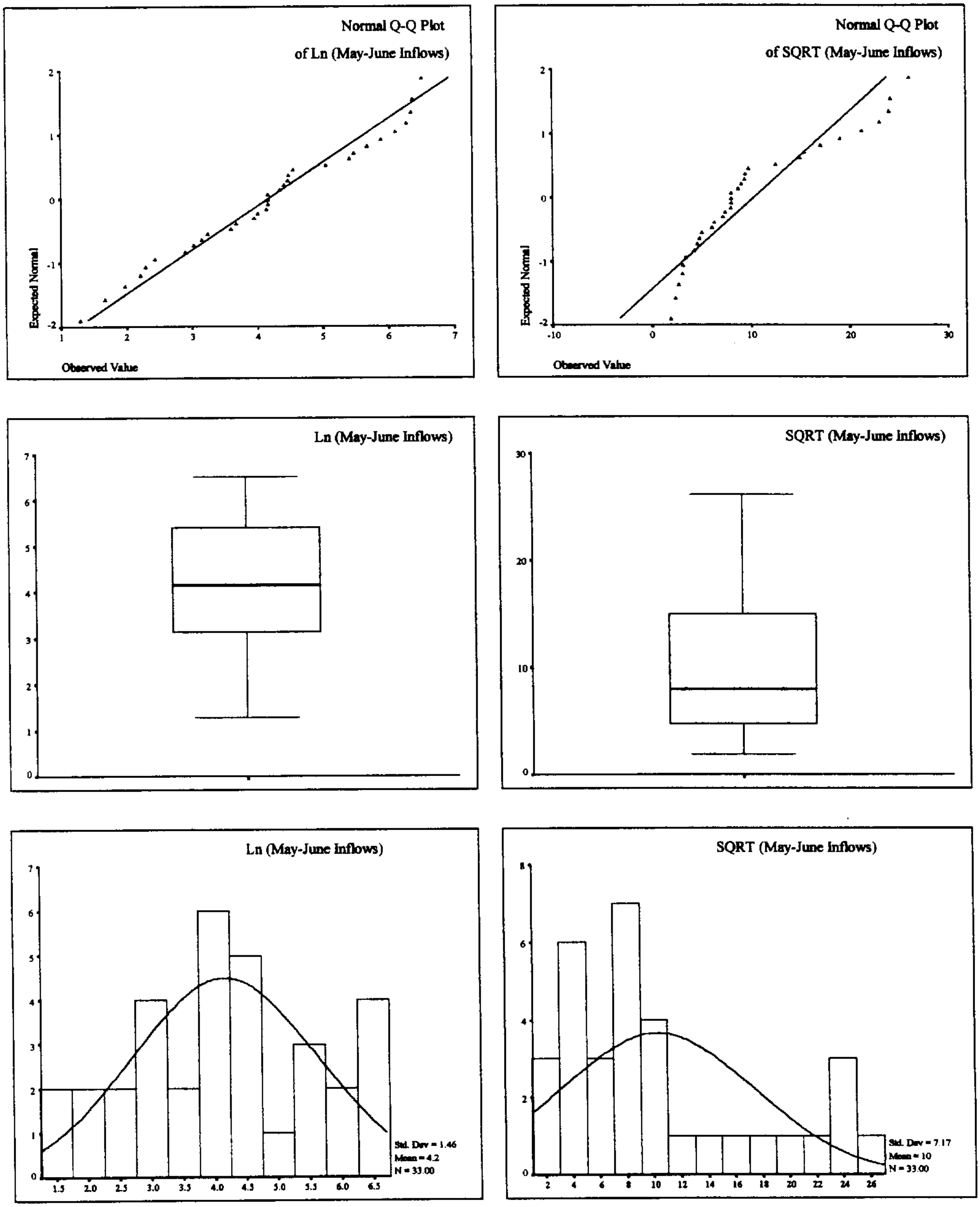



Fig. 2.4b. Exploratory Plots of Transformed May-June Inflows.

### 2.4.5 Summary Information for July-August Inflows

**Descriptives**

| | | | | Statistic | Std. Error |
|---|---|---|---|---|---|
| July-August Inflows | Mean | | | 72.6573 | 19.7117 |
| | 95% Confidence Interval for Mean | Lower Bound | | 32.5059 | |
| | | Upper Bound | | 112.8086 | |
| | 5% Trimmed Mean | | | 59.6644 | |
| | Median | | | 21.9200 | |
| | Variance | | | 12822.1 | |
| | Std. Deviation | | | 113.2349 | |
| | Minimum | | | 2.17 | |
| | Maximum | | | 388.55 | |
| | Range | | | 386.38 | |
| | Interquartile Range | | | 57.7600 | |
| | Skewness | | | 1.927 | .409 |
| | Kurtosis | | | 2.429 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| July-August Inflows | Highest | 1 | 22 | 1983 | 388.55 |
| | | 2 | 29 | 1990 | 358.90 |
| | | 3 | 20 | 1981 | 348.21 |
| | | 4 | 19 | 1980 | 261.14 |
| | | 5 | 15 | 1976 | 247.05 |
| | Lowest | 1 | 2 | 1963 | 2.17 |
| | | 2 | 4 | 1965 | 2.54 |
| | | 3 | 1 | 1962 | 2.63 |
| | | 4 | 23 | 1984 | 4.67 |
| | | 5 | 27 | 1988 | 6.05 |

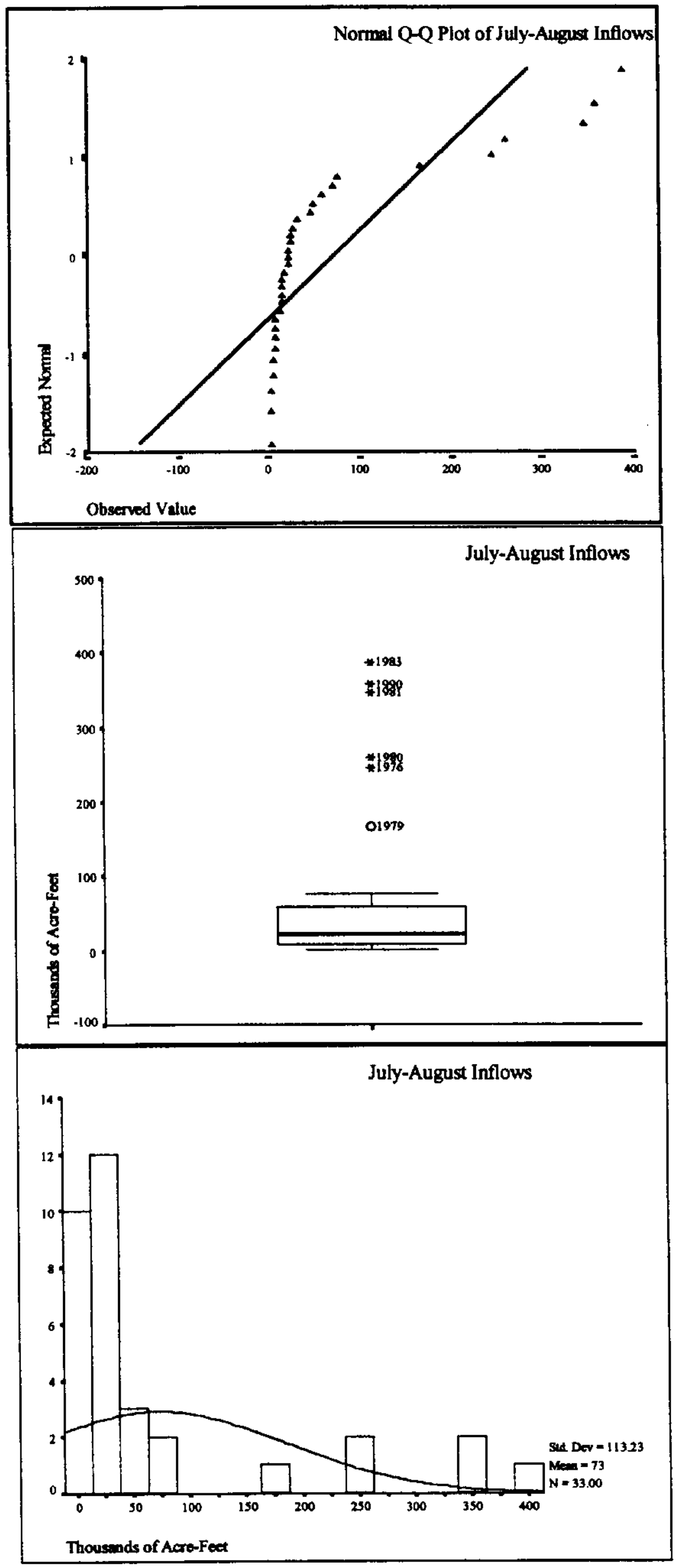



Fig. 2.5a. Exploratory Plots of July-August Inflows.

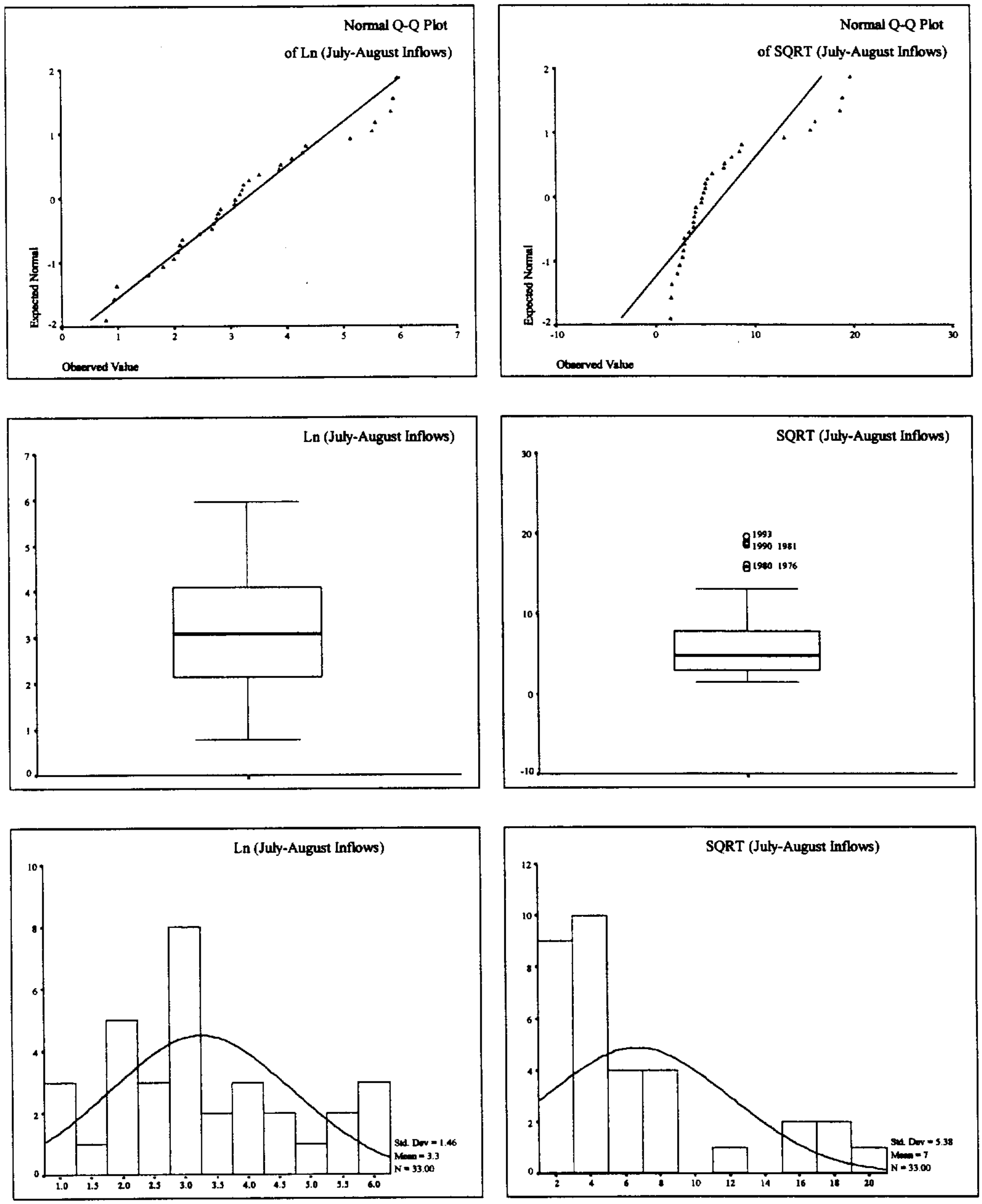



Fig. 2.5b. Exploratory Plots of Transformed July-August Inflows.

### 2.4.6 Summary Information for September-October Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| September-October Inflows | Mean | | 175.3479 | 55.6843 |
| | 95% Confidence Interval for Mean | Lower Bound | 61.9227 | |
| | | Upper Bound | 288.7731 | |
| | 5% Trimmed Mean | | 121.9580 | |
| | Median | | 42.3200 | |
| | Variance | | 102324 | |
| | Std. Deviation | | 319.8819 | |
| | Minimum | | 2.87 | |
| | Maximum | | 1464.2 | |
| | Range | | 1461.3 | |
| | Interquartile Range | | 140.5000 | |
| | Skewness | | 2.950 | .409 |
| | Kurtosis | | 9.132 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| September-October Inflows | Highest | 1 | 7 | 1968 | 1464.2 |
| | | 2 | 11 | 1972 | 1069.5 |
| | | 3 | 23 | 1984 | 562.84 |
| | | 4 | 13 | 1974 | 553.75 |
| | | 5 | 19 | 1980 | 325.18 |
| | Lowest | 1 | 3 | 1964 | 2.87 |
| | | 2 | 29 | 1990 | 3.32 |
| | | 3 | 22 | 1983 | 4.35 |
| | | 4 | 6 | 1967 | 5.91 |
| | | 5 | 9 | 1970 | 6.01 |

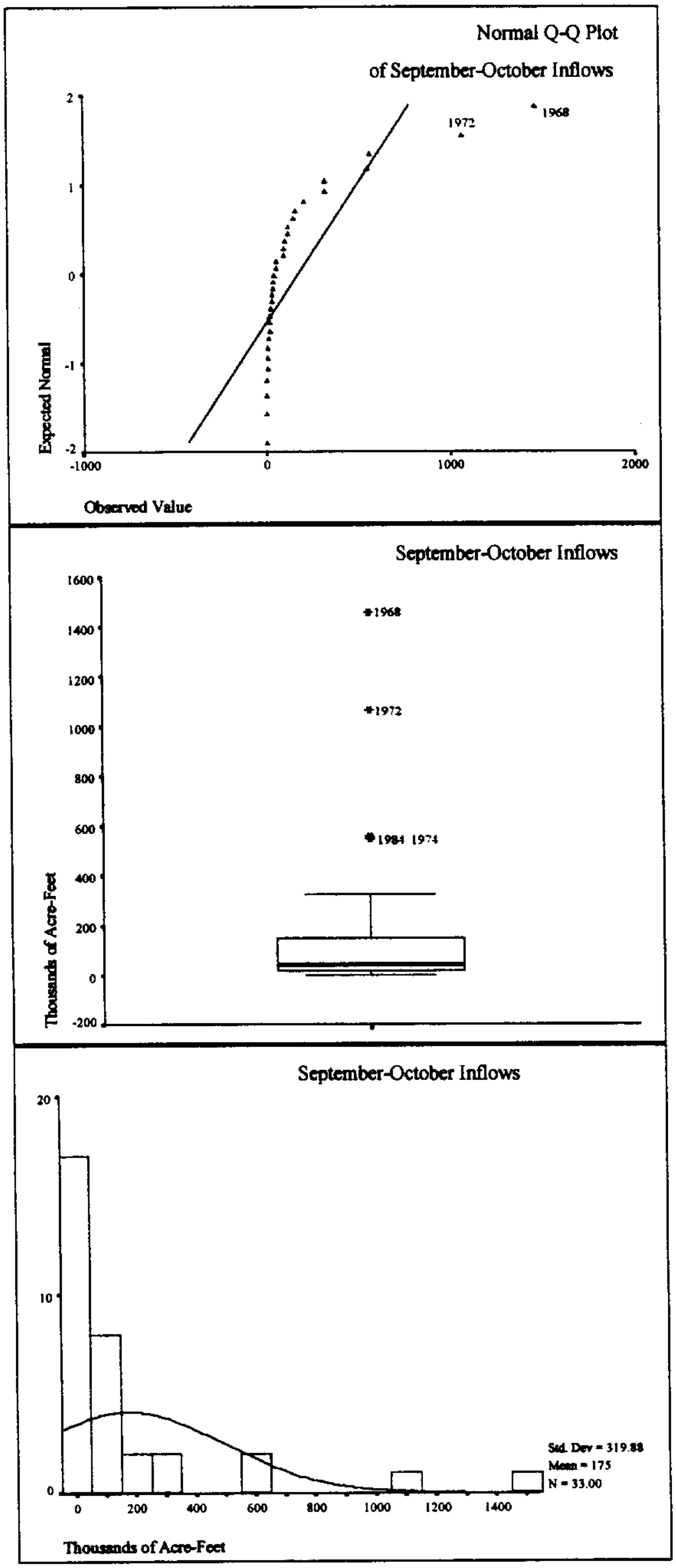



Fig. 2.6a. Exploratory Plots of September-October Inflows.

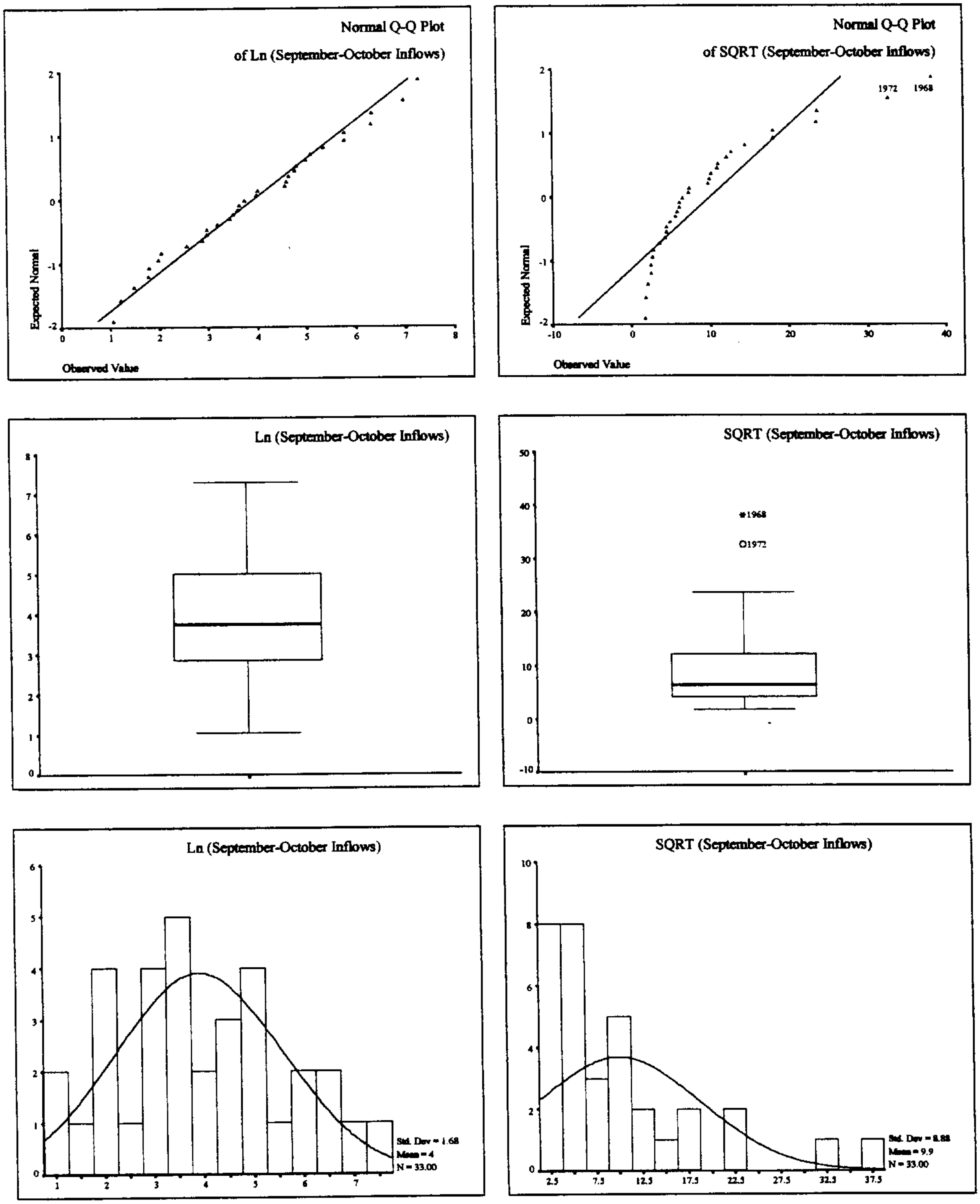



Fig. 2.6b. Exploratory Plots of Transformed September-October Inflows.

### 2.4.7 Summary Information for November-December Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| November-December Inflows | Mean | | 45.0027 | 11.5685 |
| | 95% Confidence Interval for Mean | Lower Bound | 21.4385 | |
| | | Upper Bound | 68.5670 | |
| | 5% Trimmed Mean | | 36.1886 | |
| | Median | | 19.7100 | |
| | Variance | | 4416.388 | |
| | Std. Deviation | | 66.4559 | |
| | Minimum | | 1.84 | |
| | Maximum | | 260.82 | |
| | Range | | 258.98 | |
| | Interquartile Range | | 37.2100 | |
| | Skewness | | 2.307 | .409 |
| | Kurtosis | | 4.659 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| November-December Inflows | Highest | 1 | 31 | 1992 | 260.82 |
| | | 2 | 16 | 1977 | 224.55 |
| | | 3 | 21 | 1982 | 215.74 |
| | | 4 | 25 | 1986 | 111.07 |
| | | 5 | 14 | 1975 | 94.34 |
| | Lowest | 1 | 28 | 1989 | 1.84 |
| | | 2 | 6 | 1967 | 2.57 |
| | | 3 | 10 | 1971 | 3.64 |
| | | 4 | 8 | 1969 | 4.01 |
| | | 5 | 1 | 1962 | 4.63 |

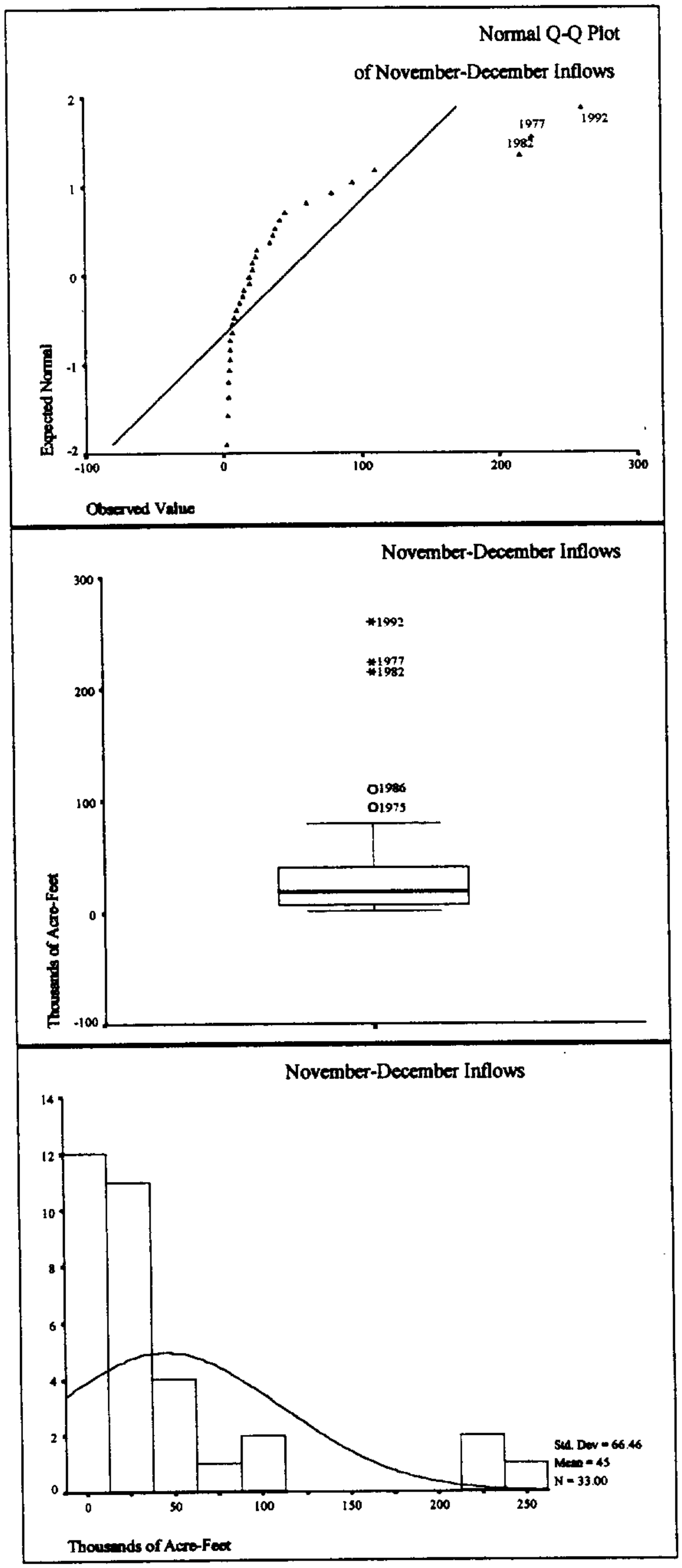



Fig. 2.7a. Exploratory Plots of November-December Inflows.

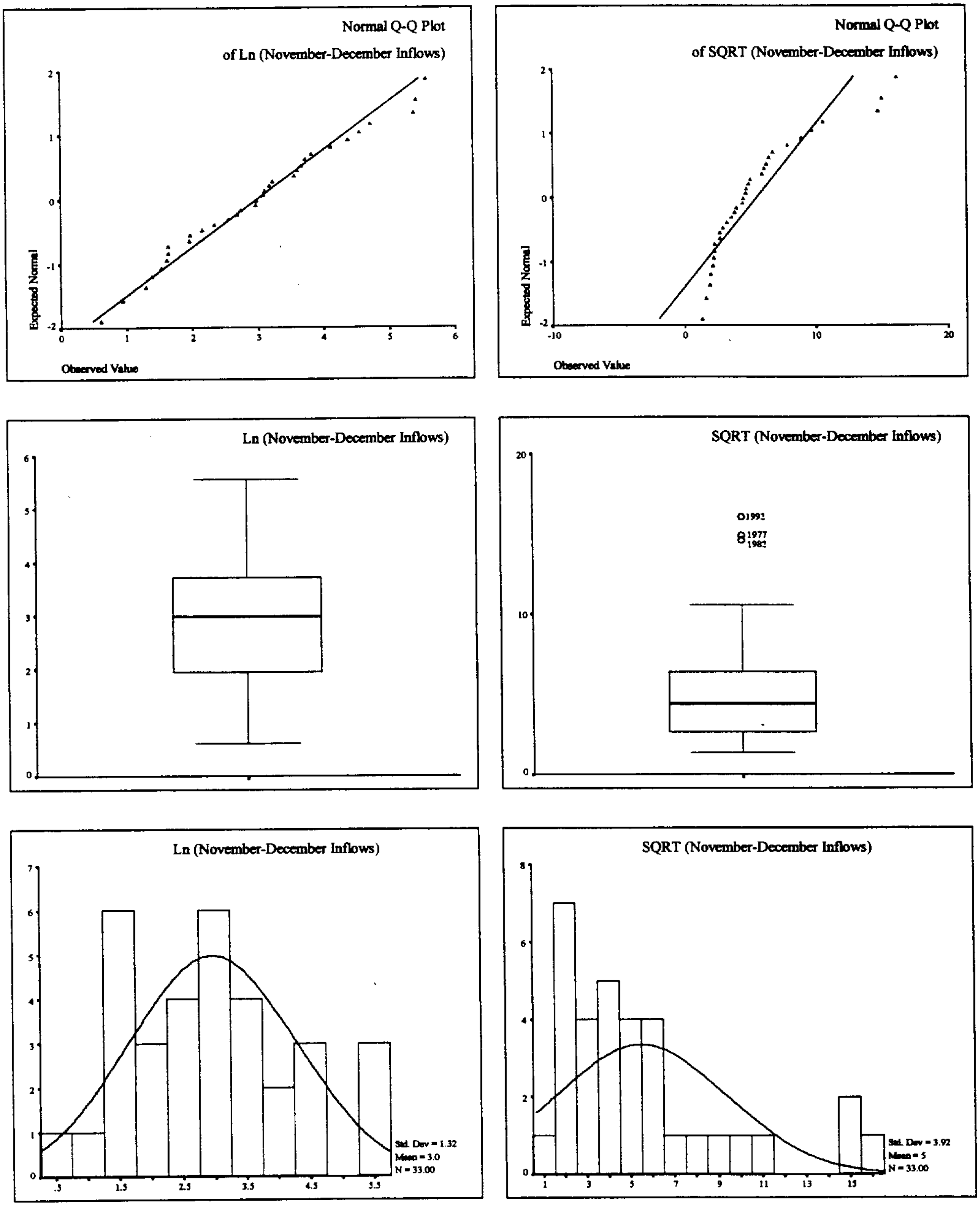



Fig. 2.7b. Exploratory Plots of Transformed November-December Inflows.

# 3. Prediction and Confidence Regions

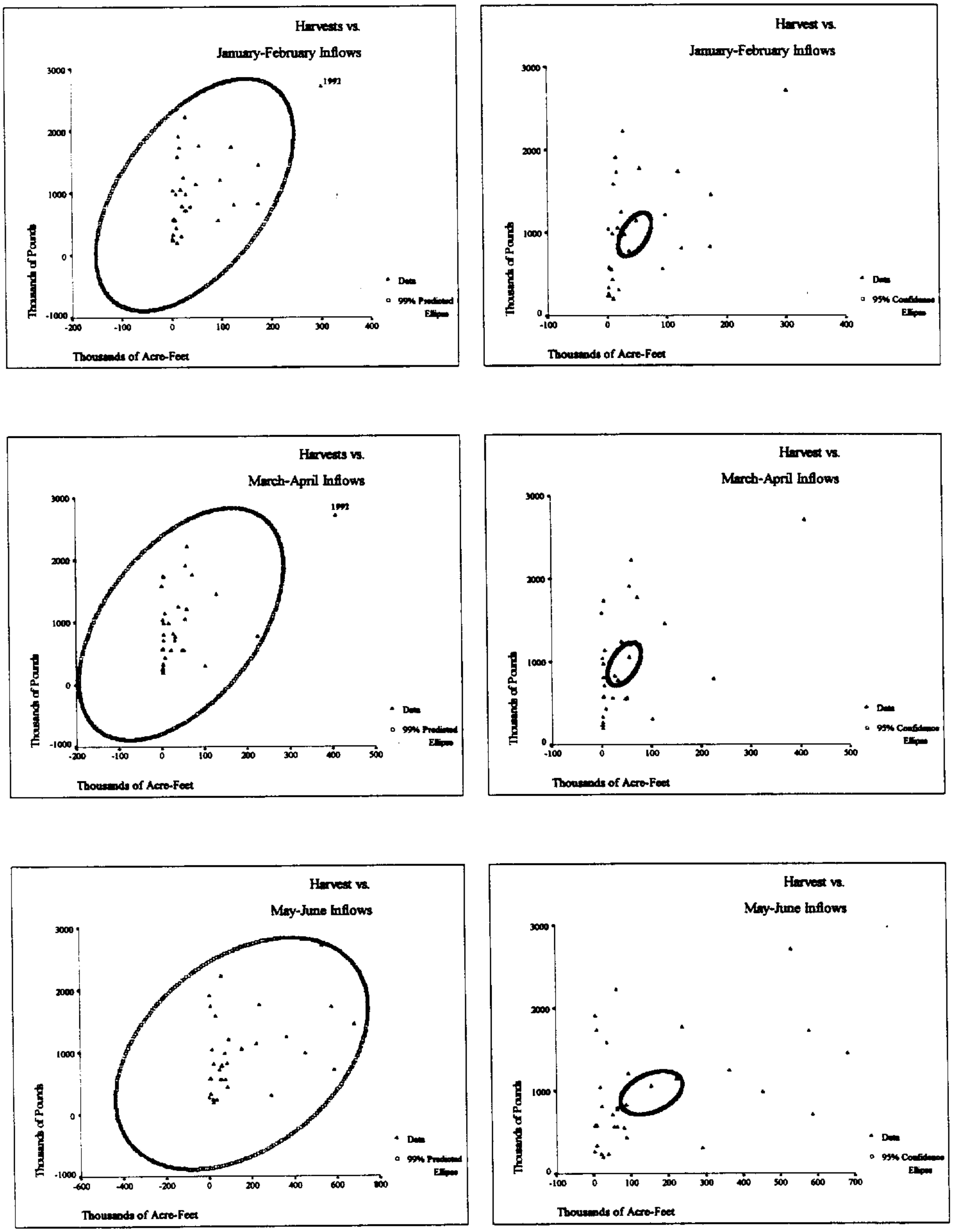



Fig. 3.1. Prediction and Confidence Ellipses.

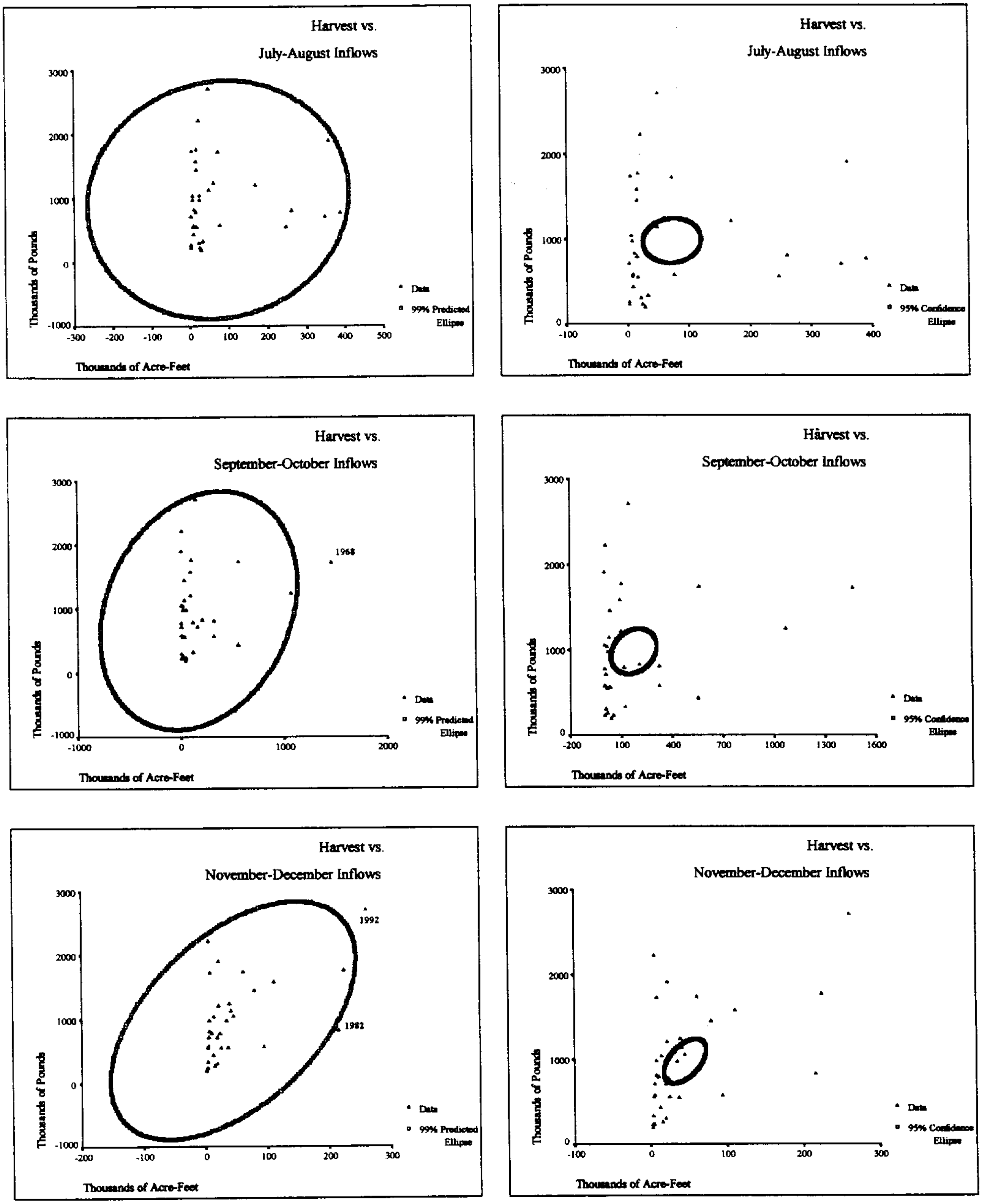



Fig. 3.2. Prediction and Confidence Ellipses.

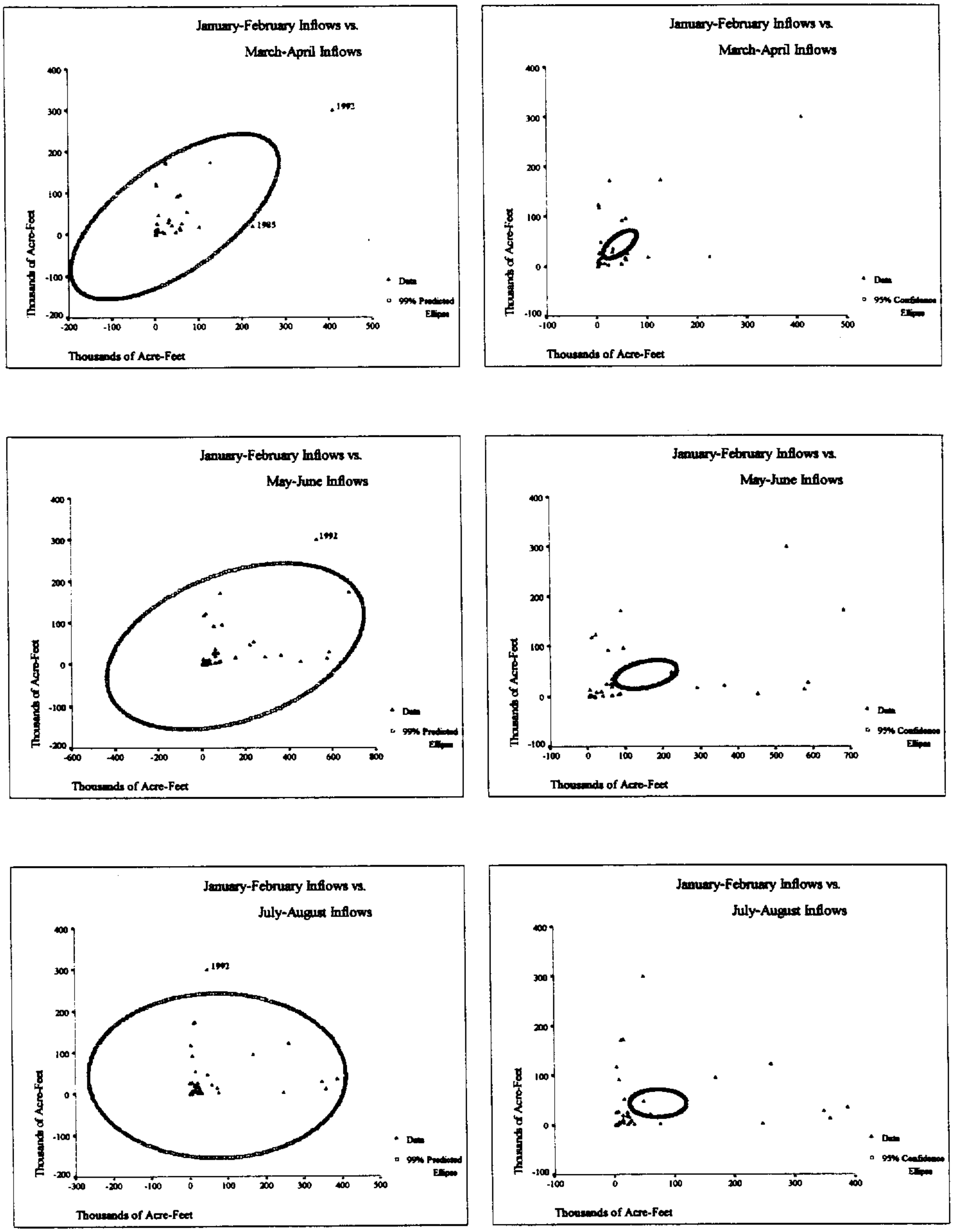



Fig. 3.3. Prediction and Confidence Ellipses.

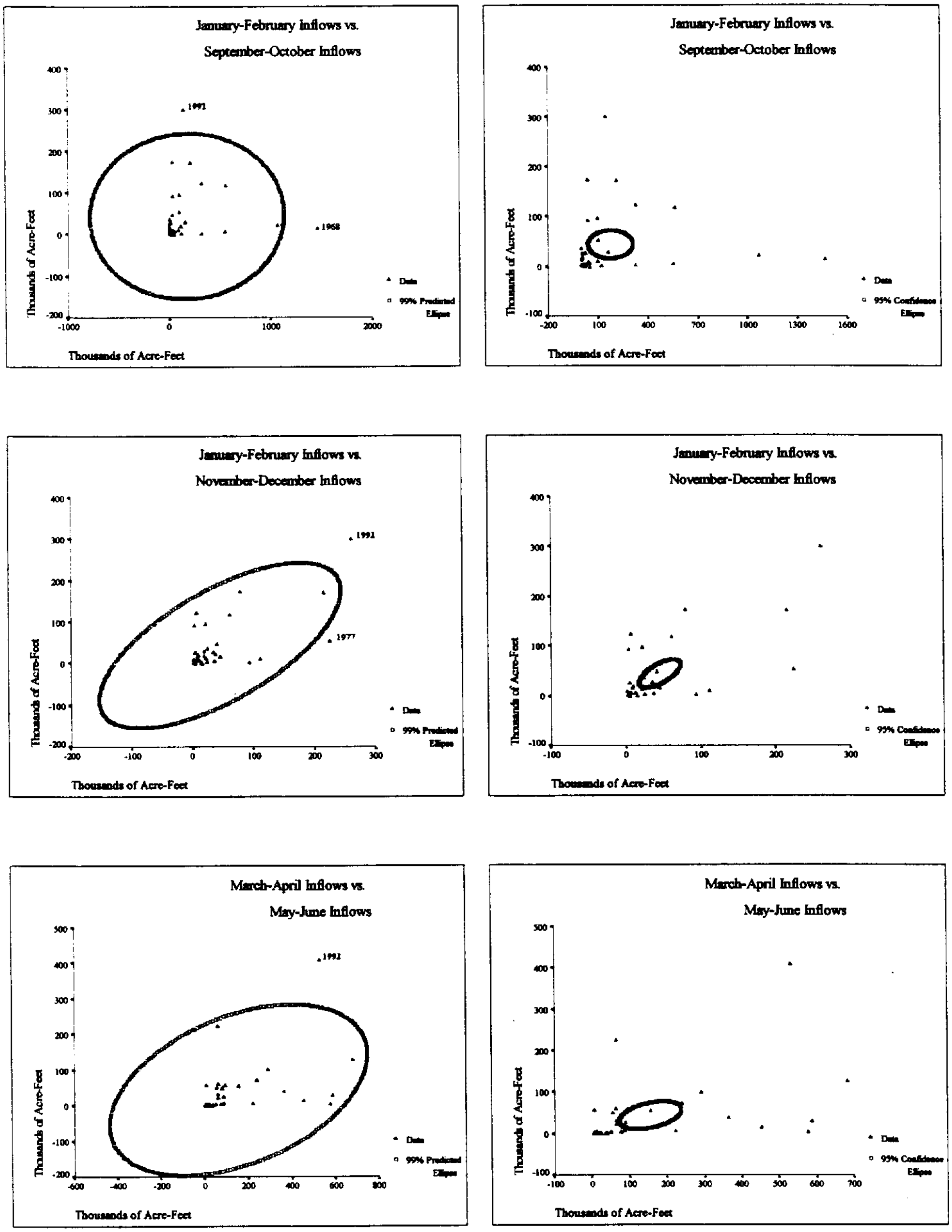



Fig. 3.4. Prediction and Confidence Ellipses.

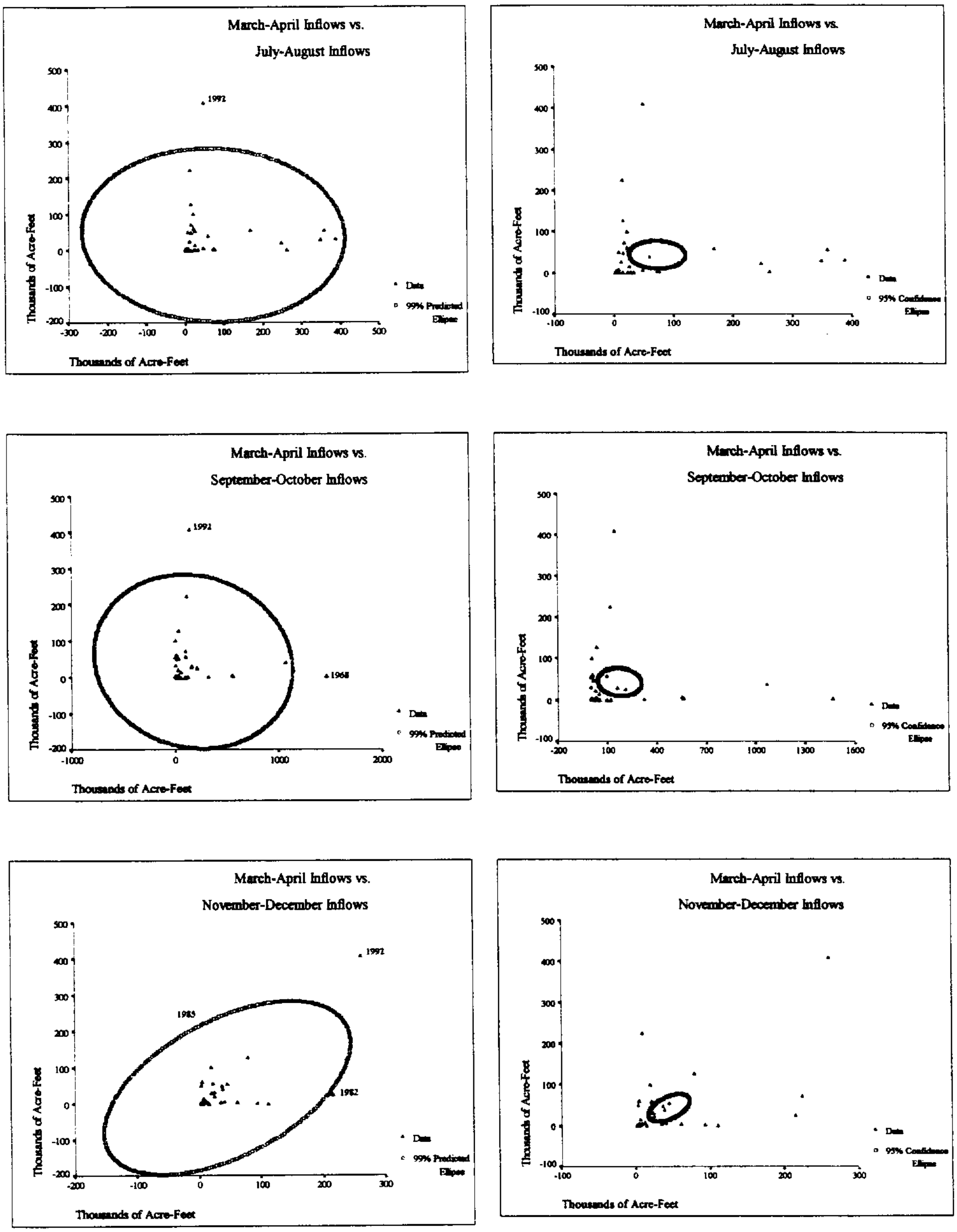



Fig. 3.5. Prediction and Confidence Ellipses.

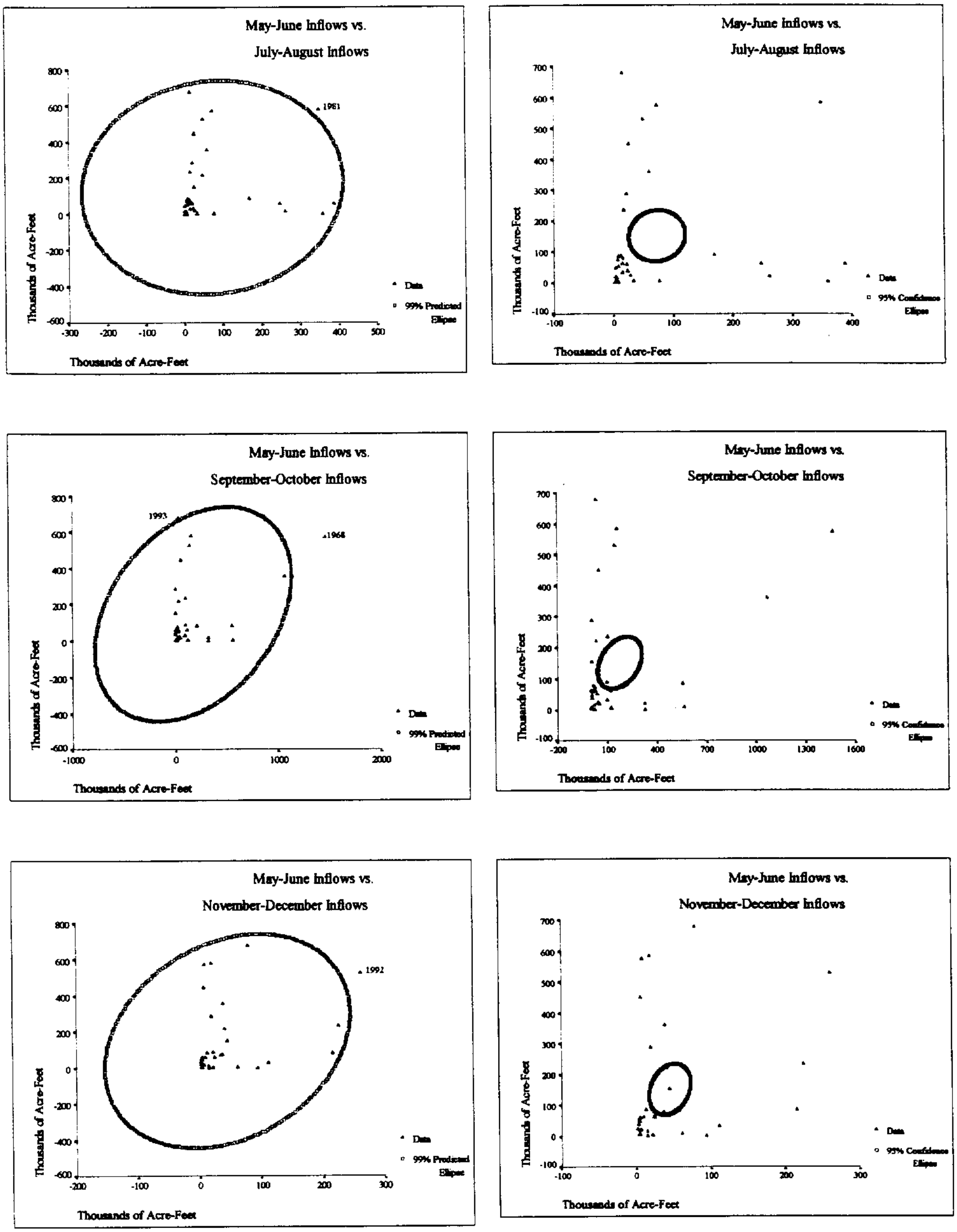



Fig. 3.6. Prediction and Confidence Ellipses.

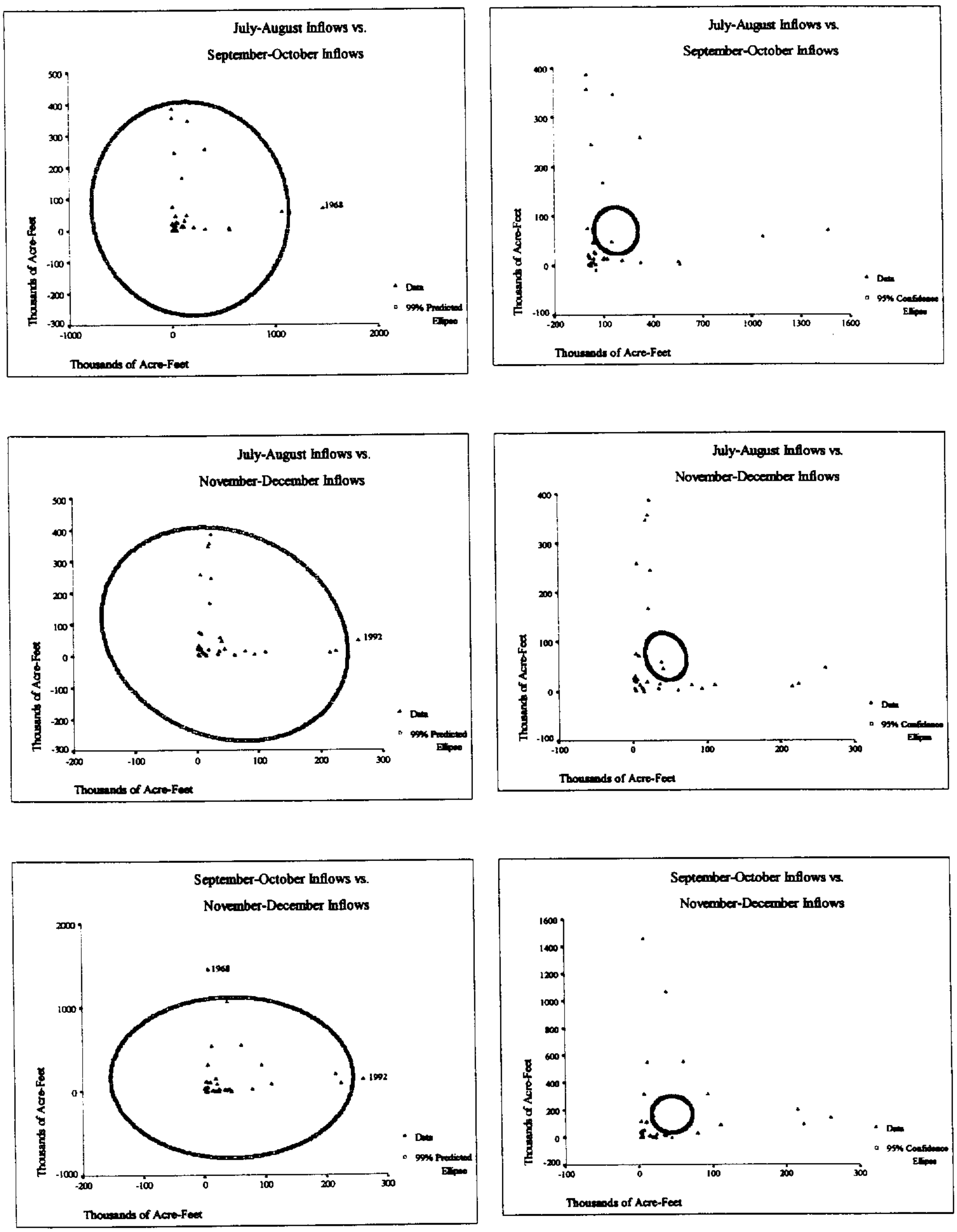



Fig. 3.7. Prediction and Confidence Ellipses.

## 4. Box-Cox Analysis

Table 4.1 Numerical Results.

| HARVEST | QJF_Lag | QMA_Lag | QMJ_Lag | QJA_Lag | QSO_Lag | QND_Lag | LAMBDA |
|---|---|---|---|---|---|---|---|
| 2015007 | 1309231 | 21493 | 3865802 | 192591 | 2940494 | 45695 | -2.0 |
| 1734030 | 753830 | 15955 | 2455214 | 131794 | 1879081 | 32247 | -1.9 |
| 1498295 | 436926 | 11921 | 1571034 | 90703 | 1209052 | 22929 | -1.8 |
| 1300174 | 255165 | 8971 | 1013589 | 62816 | 783815 | 16440 | -1.7 |
| 1133387 | 150312 | 6803 | 659923 | 43808 | 512369 | 11895 | -1.6 |
| 992762 | 89433 | 5203 | 434013 | 30791 | 338013 | 8694 | -1.5 |
| 874027 | 53829 | 4016 | 288646 | 21833 | 225267 | 6424 | -1.4 |
| 773657 | 32838 | 3131 | 194366 | 15635 | 151835 | 4805 | -1.3 |
| 688734 | 20348 | 2469 | 132701 | 11324 | 103641 | 3642 | -1.2 |
| 616845 | 12841 | 1971 | 92006 | 8308 | 71753 | 2801 | -1.1 |
| 555991 | 8277 | 1594 | 64897 | 6187 | 50477 | 2189 | -1.0 |
| 504517 | 5469 | 1309 | 46666 | 4687 | 36157 | 1741 | -0.9 |
| 461050 | 3717 | 1093 | 34287 | 3622 | 26439 | 1411 | -0.8 |
| 424455 | 2609 | 928 | 25809 | 2864 | 19793 | 1168 | -0.7 |
| 393794 | 1900 | 804 | 19959 | 2326 | 15222 | 989 | -0.6 |
| 368296 | 1440 | 712 | 15908 | 1948 | 12075 | 859 | -0.5 |
| 347326 | 1141 | 645 | 13109 | 1688 | 9924 | 766 | -0.4 |
| 330372 | 947 | 599 | 11203 | 1521 | 8492 | 704 | -0.3 |
| 317020 | 826 | 573 | 9955 | 1429 | 7603 | 667 | -0.2 |
| 306948 | 757 | **566** | 9216 | **1402** | 7157 | **654** | **-0.1** |
| 299907 | **730** | 577 | **8896** | 1440 | **7111** | 663 | **0** |
| 295723 | 738 | 612 | 8950 | 1544 | 7476 | 697 | 0.1 |
| **294284** | 782 | 674 | 9370 | 1728 | 8320 | 759 | **0.2** |
| 295536 | 866 | 776 | 10182 | 2011 | 9791 | 856 | 0.3 |
| 299487 | 997 | 932 | 11448 | 2424 | 12144 | 999 | 0.4 |
| 306201 | 1191 | 1169 | 13271 | 3016 | 15807 | 1201 | 0.5 |
| 315804 | 1470 | 1531 | 15806 | 3859 | 21485 | 1488 | 0.6 |
| 328483 | 1868 | 2085 | 19280 | 5058 | 30333 | 1891 | 0.7 |
| 344496 | 2437 | 2946 | 24013 | 6774 | 44267 | 2459 | 0.8 |
| 364174 | 3255 | 4300 | 30462 | 9243 | 66477 | 3266 | 0.9 |
| 387938 | 4440 | 6455 | 39269 | 12822 | 102324 | 4416 | 1.0 |
| 416303 | 6173 | 9930 | 51349 | 18047 | 160894 | 6069 | 1.1 |
| 449902 | 8730 | 15599 | 67997 | 25731 | 257694 | 8459 | 1.2 |
| 489500 | 12539 | 24945 | 91063 | 37112 | 419391 | 11938 | 1.3 |
| 536019 | 18266 | 40504 | 123193 | 54081 | 692146 | 17035 | 1.4 |
| 590569 | 26948 | 66638 | 168186 | 79544 | 1156358 | 24545 | 1.5 |
| 654481 | 40221 | 110887 | 231517 | 117981 | 1952868 | 35676 | 1.6 |
| 729353 | 60666 | 186352 | 321099 | 176328 | 3329690 | 52260 | 1.7 |
| 817100 | 92383 | 315899 | 448408 | 265364 | 5725718 | 77090 | 1.8 |
| 920021 | 141914 | 539616 | 630142 | 401895 | 9921147 | 114438 | 1.9 |
| 1040876 | 219738 | 928054 | 890660 | 612218 | 17308719 | 170852 | 2.0 |

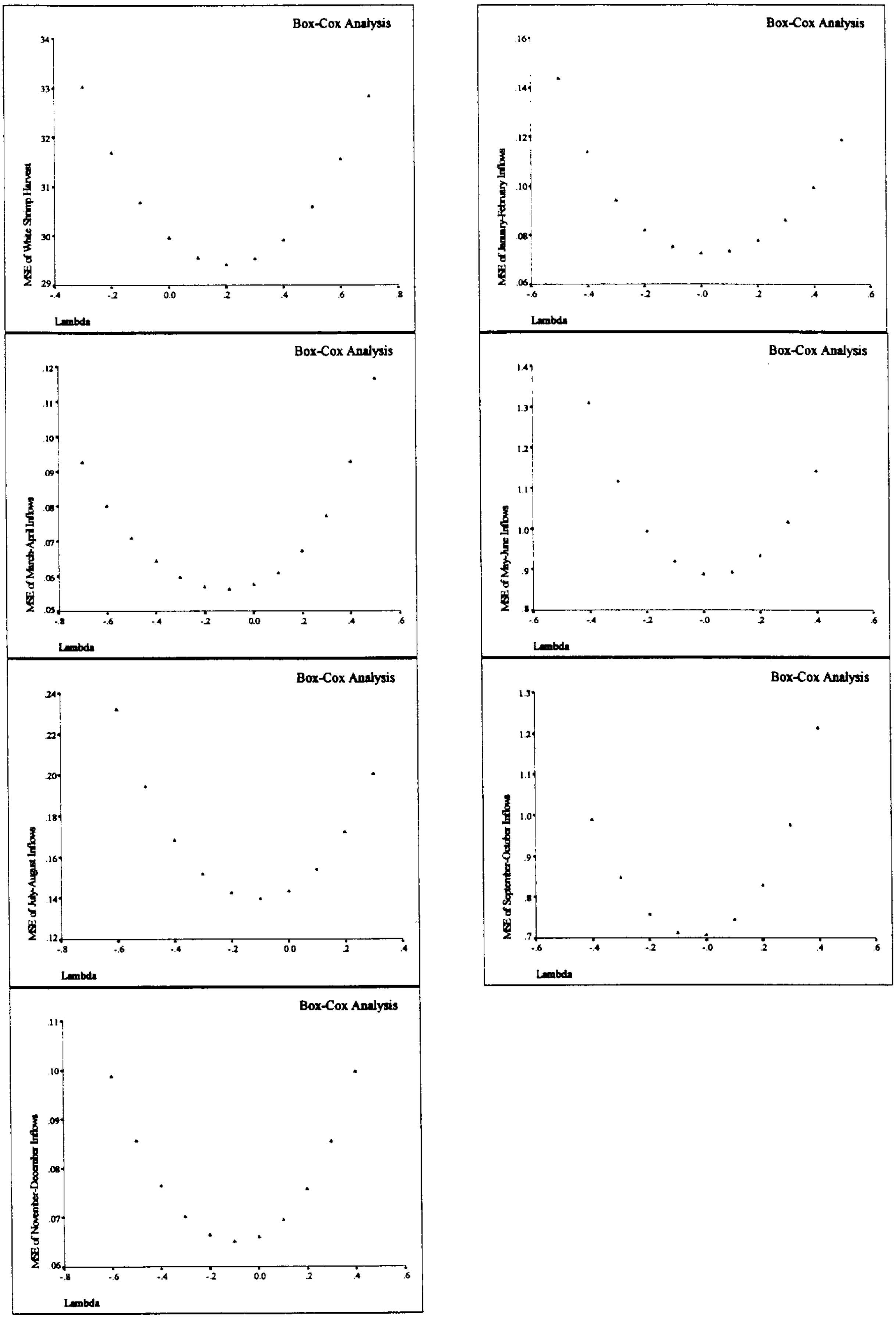



Fig 4.1. MSE of Harvest and Inflows Variables vs. Lambda obtained from Box-Cox Transformation

# 5. Model Choice Diagnostics

## 5.1 Untransformed Data

N = 33 Regression Models for Dependent Variable: WHITE SHRIMP

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.275105 | 0.251721 | 4.9029 | 417.0 | 290285 | 420.0 | QJF_LAG |
| 1 | 0.269759 | 0.246202 | 5.1529 | 417.3 | 292426 | 420.3 | QND_LAG |
| 1 | 0.253373 | 0.229289 | 5.9192 | 418.0 | 298988 | 421.0 | QMA_LAG |
| 1 | 0.153253 | 0.125938 | 10.6018 | 422.2 | 339081 | 425.2 | QMJ_LAG |
| 2 | 0.344542 | 0.300844 | 3.6553 | 415.7 | 271229 | 420.2 | QMA_LAG QND_LAG |
| 2 | 0.339050 | 0.294986 | 3.9122 | 416.0 | 273501 | 420.5 | QMJ_LAG QND_LAG |
| 2 | 0.332048 | 0.287517 | 4.2397 | 416.3 | 276399 | 420.8 | QMA_LAG QSO_LAG |
| 2 | 0.327010 | 0.282143 | 4.4753 | 416.6 | 278484 | 421.1 | QJF_LAG QND_LAG |
| 3 | 0.413417 | 0.352736 | 2.4341 | 414.0 | 251098 | 420.0 | QMA_LAG QSO_LAG QND_LAG |
| 3 | 0.384290 | 0.320596 | 3.7964 | 415.6 | 263567 | 421.6 | QJF_LAG QMA_LAG QSO_LAG |
| 3 | 0.377169 | 0.312738 | 4.1294 | 416.0 | 266615 | 422.0 | QMA_LAG QMJ_LAG QND_LAG |
| 3 | 0.376818 | 0.312351 | 4.1458 | 416.0 | 266765 | 422.0 | QJF_LAG QSO_LAG QND_LAG |
| 4 | 0.435822 | 0.355225 | 3.3862 | 414.8 | 250133 | 422.2 | QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.423100 | 0.340686 | 3.9812 | 415.5 | 255773 | 423.0 | QJF_LAG QMA_LAG QSO_LAG QND_LAG |
| 4 | 0.418944 | 0.335936 | 4.1756 | 415.7 | 257616 | 423.2 | QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 4 | 0.394032 | 0.307465 | 5.3407 | 417.1 | 268660 | 424.6 | QJF_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.441766 | 0.338389 | 5.1082 | 416.4 | 256664 | 425.4 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.438932 | 0.335030 | 5.2408 | 416.6 | 257967 | 425.6 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.427073 | 0.320976 | 5.7954 | 417.3 | 263419 | 426.2 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 5 | 0.407714 | 0.298031 | 6.7008 | 418.4 | 272320 | 427.3 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.444080 | 0.315791 | 7.0000 | 418.3 | 265430 | 428.7 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

## 5.2 Logged Inflows

N = 33    Regression Models for Dependent Variable: WHITE SHRIMP

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.311884 | 0.289687 | 1.4460 | 415.3 | 275557 | 418.3 | LN_QJF |
| 1 | 0.265151 | 0.241446 | 3.5137 | 417.5 | 294271 | 420.5 | LN_QND |
| 1 | 0.211358 | 0.185918 | 5.8938 | 419.8 | 315813 | 422.8 | LN_QMA |
| 1 | 0.115210 | 0.086668 | 10.1480 | 423.6 | 354316 | 426.6 | LN_QMJ |
| 2 | 0.394115 | 0.353722 | -0.1923 | 413.1 | 250715 | 417.6 | LN_QJF LN_QND |
| 2 | 0.339835 | 0.295824 | 2.2093 | 415.9 | 273176 | 420.4 | LN_QMA LN_QND |
| 2 | 0.337123 | 0.292931 | 2.3293 | 416.1 | 274298 | 420.6 | LN_QJF LN_QMA |
| 2 | 0.316916 | 0.271377 | 3.2234 | 417.1 | 282660 | 421.6 | LN_QJF LN_QMJ |
| 3 | 0.405832 | 0.344367 | 1.2892 | 414.5 | 254345 | 420.5 | LN_QJF LN_QMA LN_QND |
| 3 | 0.402748 | 0.340963 | 1.4257 | 414.6 | 255665 | 420.6 | LN_QJF LN_QJA LN_QND |
| 3 | 0.396505 | 0.334075 | 1.7019 | 415.0 | 258337 | 421.0 | LN_QJF LN_QMJ LN_QND |
| 3 | 0.394156 | 0.331483 | 1.8058 | 415.1 | 259343 | 421.1 | LN_QJF LN_QSO LN_QND |
| 4 | 0.410611 | 0.326412 | 3.0778 | 416.2 | 261310 | 423.7 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.407336 | 0.322670 | 3.2227 | 416.4 | 262762 | 423.9 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.405850 | 0.320971 | 3.2885 | 416.5 | 263421 | 424.0 | LN_QJF LN_QMA LN_QMJ LN_QND |
| 4 | 0.403936 | 0.318783 | 3.3731 | 416.6 | 264269 | 424.1 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 5 | 0.412229 | 0.303382 | 5.0062 | 418.1 | 270244 | 427.1 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.410611 | 0.301465 | 5.0778 | 418.2 | 270988 | 427.2 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.407377 | 0.297632 | 5.2209 | 418.4 | 272475 | 427.4 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.404040 | 0.293677 | 5.3685 | 418.6 | 274009 | 427.5 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.412369 | 0.276762 | 7.0000 | 420.1 | 280571 | 430.6 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 5.3 Logged All Variables

N = 33 Regression Models for Dependent Variable: LN (WWHITE SHRIMP)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.375044 | 0.354884 | 3.3807 | -38.1205 | 0.297049 | -35.1275 | LN_QJF |
| 1 | 0.322232 | 0.300369 | 6.1170 | -35.4434 | 0.322151 | -32.4504 | LN_QND |
| 1 | 0.220733 | 0.195595 | 11.3760 | -30.8383 | 0.370395 | -27.8453 | LN_QMA |
| 1 | 0.147436 | 0.119934 | 15.1737 | -27.8718 | 0.405234 | -24.8788 | LN_QMJ |
| 2 | 0.476067 | 0.441138 | 0.1465 | -41.9389 | 0.257333 | -37.4494 | LN_QJF LN_QND |
| 2 | 0.392345 | 0.351834 | 4.4843 | -37.0469 | 0.298454 | -32.5574 | LN_QJF LN_QMA |
| 2 | 0.390219 | 0.349567 | 4.5945 | -36.9317 | 0.299497 | -32.4422 | LN_QMA LN_QND |
| 2 | 0.383598 | 0.342504 | 4.9375 | -36.5753 | 0.302750 | -32.0857 | LN_QJF LN_QJA |
| 3 | 0.494608 | 0.442326 | 1.1858 | -41.1279 | 0.256786 | -35.1419 | LN_QJF LN_QJA LN_QND |
| 3 | 0.481641 | 0.428018 | 1.8576 | -40.2919 | 0.263374 | -34.3059 | LN_QJF LN_QMA LN_QND |
| 3 | 0.480550 | 0.426813 | 1.9142 | -40.2225 | 0.263929 | -34.2365 | LN_QJF LN_QMJ LN_QND |
| 3 | 0.476153 | 0.421962 | 2.1420 | -39.9444 | 0.266163 | -33.9583 | LN_QJF LN_QSO LN_QND |
| 4 | 0.496701 | 0.424801 | 3.0774 | -39.2648 | 0.264856 | -31.7823 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 4 | 0.496499 | 0.424570 | 3.0878 | -39.2516 | 0.264962 | -31.7691 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.495058 | 0.422923 | 3.1625 | -39.1573 | 0.265720 | -31.6748 | LN_QJF LN_QJA LN_QSO LN_QND |
| 4 | 0.483195 | 0.409366 | 3.7771 | -38.3910 | 0.271962 | -30.9085 | LN_QJF LN_QMA LN_QMJ LN_QND |
| 5 | 0.497677 | 0.404655 | 5.0267 | -37.3290 | 0.274132 | -28.3499 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.497466 | 0.404404 | 5.0377 | -37.3151 | 0.274247 | -28.3360 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.496938 | 0.403778 | 5.0651 | -37.2804 | 0.274536 | -28.3013 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.483683 | 0.388069 | 5.7518 | -36.4222 | 0.281769 | -27.4431 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 6 | 0.498194 | 0.382392 | 7.0000 | -35.3629 | 0.284383 | -24.8873 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 5.4 Square Root Inflows

N = 33     Regression Models for Dependent Variable: WHITE SHRIMP

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.29477 | 0.27202 | 3.809 | 416.1 | 282410 | 419.1 | SQRT_QJF |
| 1 | 0.28099 | 0.25780 | 4.450 | 416.8 | 287928 | 419.8 | SQRT_QND |
| 1 | 0.24906 | 0.22484 | 5.935 | 418.2 | 300714 | 421.2 | SQRT_QMA |
| 1 | 0.14758 | 0.12009 | 10.656 | 422.4 | 341352 | 425.4 | SQRT_QMJ |
| 2 | 0.36939 | 0.32735 | 2.338 | 414.4 | 260948 | 418.9 | SQRT_QMA SQRT_QND |
| 2 | 0.36486 | 0.32251 | 2.548 | 414.7 | 262823 | 419.2 | SQRT_QJF SQRT_QND |
| 2 | 0.34933 | 0.30595 | 3.271 | 415.5 | 269247 | 420.0 | SQRT_QJF SQRT_QMA |
| 2 | 0.33636 | 0.29212 | 3.874 | 416.1 | 274614 | 420.6 | SQRT_QMJ SQRT_QND |
| 3 | 0.40876 | 0.34759 | 2.506 | 414.3 | 253093 | 420.3 | SQRT_QMA SQRT_QSO SQRT_QND |
| 3 | 0.40199 | 0.34013 | 2.821 | 414.7 | 255989 | 420.7 | SQRT_QJF SQRT_QMA SQRT_QND |
| 3 | 0.39037 | 0.32731 | 3.361 | 415.3 | 260962 | 421.3 | SQRT_QJF SQRT_QMJ SQRT_QND |
| 3 | 0.38617 | 0.32267 | 3.557 | 415.5 | 262761 | 421.5 | SQRT_QMA SQRT_QJA SQRT_QND |
| 4 | 0.42984 | 0.34839 | 3.525 | 415.1 | 252783 | 422.6 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.42356 | 0.34121 | 3.817 | 415.5 | 255570 | 423.0 | SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.41278 | 0.32889 | 4.319 | 416.1 | 260347 | 423.6 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QND |
| 4 | 0.41150 | 0.32743 | 4.378 | 416.2 | 260914 | 423.6 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QND |
| 5 | 0.44022 | 0.33656 | 5.042 | 416.5 | 257375 | 425.5 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.43136 | 0.32606 | 5.454 | 417.0 | 261447 | 426.0 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.42483 | 0.31832 | 5.758 | 417.4 | 264449 | 426.4 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.42069 | 0.31341 | 5.951 | 417.6 | 266355 | 426.6 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 6 | 0.44113 | 0.31216 | 7.000 | 418.4 | 266839 | 428.9 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

## 5.5 Square Root All Variables

N = 33 Regression Models for Dependent Variable: SQRT (WWHITE SHRIMP)

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.29608 | 0.27338 | 3.704 | 141.6 | 68.922 | 144.6 | SQRT_QJF |
| 1 | 0.27891 | 0.25565 | 4.501 | 142.4 | 70.603 | 145.4 | SQRT_QND |
| 1 | 0.21727 | 0.19202 | 7.365 | 145.1 | 76.639 | 148.1 | SQRT_QMA |
| 1 | 0.15781 | 0.13064 | 10.128 | 147.5 | 82.461 | 150.5 | SQRT_QMJ |
| 2 | 0.36445 | 0.32208 | 2.527 | 140.3 | 64.303 | 144.7 | SQRT_QJF SQRT_QND |
| 2 | 0.34737 | 0.30386 | 3.321 | 141.1 | 66.031 | 145.6 | SQRT_QMA SQRT_QND |
| 2 | 0.34124 | 0.29732 | 3.606 | 141.4 | 66.651 | 145.9 | SQRT_QMJ SQRT_QND |
| 2 | 0.33548 | 0.29118 | 3.873 | 141.7 | 67.234 | 146.2 | SQRT_QJF SQRT_QMJ |
| 3 | 0.39468 | 0.33206 | 3.123 | 140.6 | 63.356 | 146.6 | SQRT_QJF SQRT_QMJ SQRT_QND |
| 3 | 0.39192 | 0.32902 | 3.251 | 140.8 | 63.644 | 146.8 | SQRT_QMA SQRT_QSO SQRT_QND |
| 3 | 0.38762 | 0.32427 | 3.451 | 141.0 | 64.094 | 147.0 | SQRT_QJF SQRT_QJA SQRT_QND |
| 3 | 0.38754 | 0.32419 | 3.454 | 141.0 | 64.103 | 147.0 | SQRT_QJF SQRT_QMA SQRT_QND |
| 4 | 0.41849 | 0.33541 | 4.017 | 141.3 | 63.038 | 148.8 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.41710 | 0.33383 | 4.081 | 141.4 | 63.188 | 148.9 | SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.41248 | 0.32855 | 4.296 | 141.7 | 63.689 | 149.1 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QND |
| 4 | 0.40681 | 0.32207 | 4.559 | 142.0 | 64.303 | 149.5 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QND |
| 5 | 0.43717 | 0.33294 | 5.149 | 142.2 | 63.272 | 151.2 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.42316 | 0.31634 | 5.800 | 143.1 | 64.847 | 152.0 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.42266 | 0.31574 | 5.823 | 143.1 | 64.904 | 152.1 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.42102 | 0.31381 | 5.899 | 143.2 | 65.087 | 152.2 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.44037 | 0.31123 | 7.000 | 144.1 | 65.332 | 154.5 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

## 5.6 Variables Transformed According to the Box-Cox Analysis

N = 33 Regression Models for Dependent Variable: $(\text{WWHITE SHRIMP})^{0.2}$

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.367269 | 0.346858 | 3.3036 | -56.2074 | 0.171710 | -53.2144 | LN_QJF |
| 1 | 0.318828 | 0.296854 | 5.7768 | -53.7730 | 0.184856 | -50.7800 | $(QND)^{-0.1}$ |
| 1 | 0.221833 | 0.196731 | 10.7287 | -49.3799 | 0.211179 | -46.3868 | $(QMA)^{-0.1}$ |
| 1 | 0.143113 | 0.115471 | 14.7478 | -46.1998 | 0.232542 | -43.2068 | LN_QMJ |
| 2 | 0.471762 | 0.436546 | -0.0312 | -60.1639 | 0.148131 | -55.6743 | LN_QJF $(QND)^{-0.1}$ |
| 2 | 0.387068 | 0.346206 | 4.2928 | -55.2565 | 0.171882 | -50.7670 | $(QMA)^{-0.1}$ $(QND)^{-0.1}$ |
| 2 | 0.384995 | 0.343994 | 4.3986 | -55.1451 | 0.172463 | -50.6556 | LN_QJF $(QMA)^{-0.1}$ |
| 2 | 0.375568 | 0.333939 | 4.8799 | -54.6431 | 0.175107 | -50.1536 | LN_QJF $(QJA)^{-0.1}$ |
| 3 | 0.487985 | 0.435018 | 1.1405 | -59.1933 | 0.148533 | -53.2072 | LN_QJF $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 3 | 0.476933 | 0.422823 | 1.7048 | -58.4885 | 0.151739 | -52.5025 | LN_QJF $(QMA)^{-0.1}$ $(QND)^{-0.1}$ |
| 3 | 0.475481 | 0.421220 | 1.7790 | -58.3970 | 0.152161 | -52.4110 | LN_QJF LN_QMJ $(QND)^{-0.1}$ |
| 3 | 0.471855 | 0.417220 | 1.9640 | -58.1697 | 0.153212 | -52.1837 | LN_QJF LN_QSO $(QND)^{-0.1}$ |
| 4 | 0.489459 | 0.416525 | 3.0653 | -57.2884 | 0.153395 | -49.8059 | LN_QJF $(QMA)^{-0.1}$ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.489388 | 0.416443 | 3.0689 | -57.2838 | 0.153417 | -49.8012 | LN_QJF LN_QMJ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.488388 | 0.415300 | 3.1200 | -57.2192 | 0.153717 | -49.7367 | LN_QJF $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 4 | 0.478054 | 0.403490 | 3.6476 | -56.5593 | 0.156822 | -49.0768 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QND)^{-0.1}$ |
| 5 | 0.490479 | 0.396124 | 5.0132 | -55.3544 | 0.158758 | -46.3753 | LN_QJF $(QMA)^{-0.1}$ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.490045 | 0.395609 | 5.0354 | -55.3263 | 0.158894 | -46.3472 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.489621 | 0.395107 | 5.0570 | -55.2989 | 0.159026 | -46.3198 | LN_QJF LN_QMJ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.478604 | 0.382049 | 5.6195 | -54.5941 | 0.162459 | -45.6151 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ LN_QSO $(QND)^{-0.1}$ |
| 6 | 0.490738 | 0.373216 | 7.0000 | -53.3711 | 0.164781 | -42.8956 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |

# 6. Regression for the Best Models

## 6.1 Model 3: Logged All Variables

### 6.1.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | Ln(Nov-Dec Inflows), Ln(Jul-Aug Inflows), Ln(Sept-Oct Inflows), Ln(May-Jun Inflows), Ln(Jan-Feb Inflows), Ln(Mar-Apr Inflows)[c,d] | . | .706 | .498 | .382 | .5333 | 1.961 |

a. Dependent Variable: Ln (White Shrimp Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Ln (November-December Inflows), Ln (July-August Inflows), Ln (September-October Inflows), Ln (May-June Inflows), Ln (January-February Inflows), Ln (March-April Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 7.341 | 6 | 1.223 | 4.302 | .004[b] |
| | Residual | 7.394 | 26 | .284 | | |
| | Total | 14.735 | 32 | | | |

a. Dependent Variable: Ln (White Shrimp Harvest)

b. Independent Variables: (Constant), Ln (November-December Inflows), Ln (July-August Inflows), Ln (September-October Inflows), Ln (May-June Inflows), Ln (January-February Inflows), Ln (March-April Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| 1 | (Constant) | 5.299 | .388 | | 13.661 | .000 | 4.502 | 6.096 |
| | Ln (January-February Inflows) | .163 | .088 | .356 | 1.851 | .076 | -.018 | .344 |
| | Ln (March-April Inflows) | 2.4E-02 | .093 | .054 | .255 | .801 | -.168 | .215 |
| | Ln (May-June Inflows) | 1.4E-02 | .085 | .030 | .164 | .871 | -.162 | .189 |
| | Ln (July-August Inflows) | 6.0E-02 | .070 | .130 | .867 | .394 | -.083 | .203 |
| | Ln (September-October Inflows) | 1.2E-02 | .064 | .031 | .194 | .848 | -.118 | .143 |
| | Ln (November-December Inflows) | .186 | .086 | .362 | 2.170 | .039 | .010 | .362 |

a. Dependent Variable: Ln (White Shrimp Harvest)

### 6.1.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 5.299046 | 0.38790510 | 13.661 | 0.0001 | 0.00000000 |
| LN_QJF | 1 | 0.163013 | 0.08805591 | 1.851 | 0.0755 | 1.91336830 |
| LN_QMA | 1 | 0.023748 | 0.09309403 | 0.255 | 0.8007 | 2.29912480 |
| LN_QMJ | 1 | 0.013963 | 0.08538427 | 0.164 | 0.8714 | 1.75209582 |
| LN_QJA | 1 | 0.060354 | 0.06960594 | 0.867 | 0.3938 | 1.16025507 |
| LN_QSO | 1 | 0.012334 | 0.06353177 | 0.194 | 0.8476 | 1.28539311 |
| LN_QND | 1 | 0.185993 | 0.08571306 | 2.170 | 0.0393 | 1.44041395 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop LN_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop LN_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.61865 | 1.00000 | 0.0527 | 0.0424 | 0.0498 | 0.0202 | 0.0107 | 0.0411 |
| 2 | 1.19442 | 1.48067 | 0.0013 | 0.0270 | 0.0015 | 0.2299 | 0.3003 | 0.0814 |
| 3 | 0.84306 | 1.76242 | 0.0011 | 0.0428 | 0.0115 | 0.3630 | 0.3506 | 0.1344 |
| 4 | 0.62875 | 2.04080 | 0.0105 | 0.0151 | 0.3911 | 0.3163 | 0.0008 | 0.3348 |
| 5 | 0.43312 | 2.45887 | 0.7412 | 0.0000 | 0.1911 | 0.0637 | 0.0002 | 0.3343 |
| 6 | 0.28200 | 3.04729 | 0.1931 | 0.8727 | 0.3550 | 0.0069 | 0.3374 | 0.0740 |

### 6.1.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 5.6852 | 7.7921 | 6.6934 | .4790 | 33 |
| Std. Predicted Value | -2.105 | 2.294 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | .1878 | .3284 | .2423 | 4.10E-02 | 33 |
| Adjusted Predicted Value | 5.7361 | 7.7575 | 6.6822 | .4954 | 33 |
| Residual | -.9635 | 1.1931 | 1.4E-15 | .4807 | 33 |
| Std. Residual | -1.807 | 2.237 | .000 | .901 | 33 |
| Stud. Residual | -1.964 | 2.431 | .009 | 1.014 | 33 |
| Deleted Residual | -1.1386 | 1.4090 | 1.1E-02 | .6124 | 33 |
| Stud. Deleted Residual | -2.087 | 2.712 | .020 | 1.059 | 33 |
| Mahal. Distance | 2.998 | 11.167 | 5.818 | 2.366 | 33 |
| Cook's Distance | .000 | .273 | .040 | .064 | 33 |
| Centered Leverage Value | .094 | .349 | .182 | .074 | 33 |

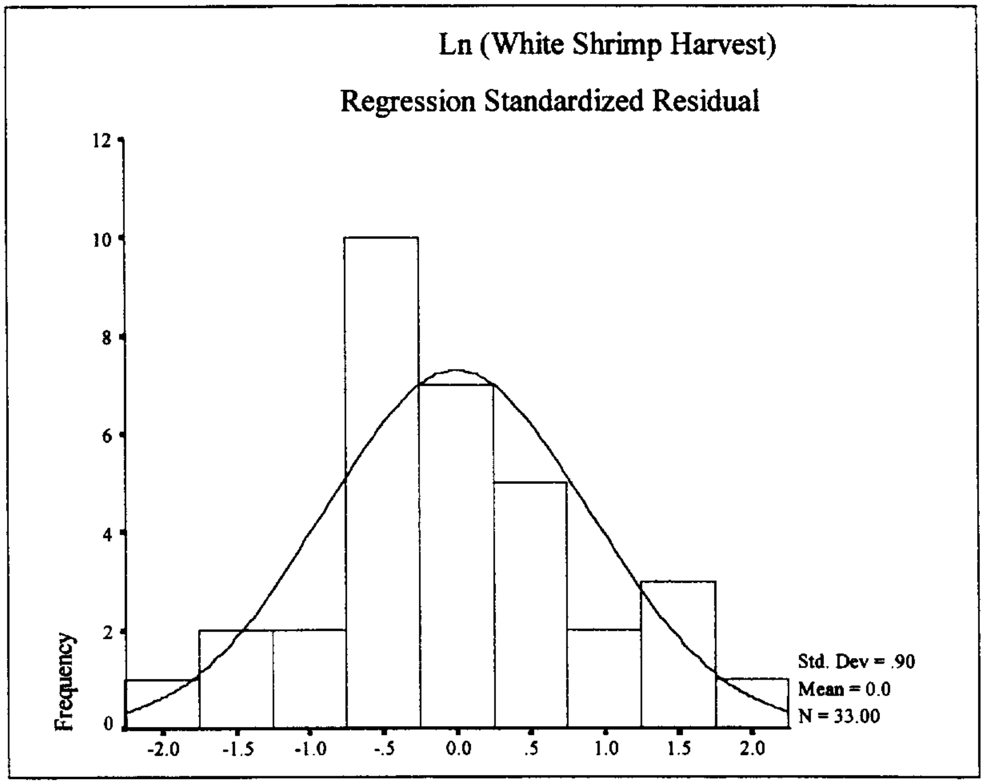
a. Dependent Variable: Ln (White Shrimp Harvest)

*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| **1962** | 5.68518 | -.16412 | -.21504 | 5.73611 | -2.10500 | -.30776 | -.35229 | -.34627 |
| **1963** | 6.02587 | -.39358 | -.50586 | 6.13815 | -1.39368 | -.73805 | -.83673 | -.83175 |
| **1964** | 6.18240 | .20161 | .24912 | 6.13489 | -1.06687 | .37806 | .42026 | .41350 |
| **1965** | 6.30992 | .27363 | .37795 | 6.20560 | -.80063 | .51311 | .60304 | .59551 |
| **1966** | 6.73432 | -.96351 | -1.13861 | 6.90942 | .08548 | -1.80677 | -1.96409 | -2.08699 |
| **1967** | 5.96343 | -.43242 | -.52530 | 6.05631 | -1.52405 | -.81087 | -.89372 | -.89014 |
| **1968** | 6.63345 | .82623 | 1.20278 | 6.25691 | -.12512 | 1.54935 | 1.86935 | 1.97023 |
| **1969** | 6.61552 | -.26551 | -.37518 | 6.72519 | -.16255 | -.49789 | -.59185 | -.58430 |
| **1970** | 6.86289 | .11103 | .12844 | 6.84548 | .35392 | .20820 | .22393 | .21979 |
| **1971** | 6.03782 | -.19776 | -.23831 | 6.07837 | -1.36874 | -.37084 | -.40709 | -.40046 |
| **1972** | 6.99795 | .14210 | .17640 | 6.96366 | .63591 | .26647 | .29689 | .29162 |
| **1973** | 6.40634 | .49901 | .59784 | 6.30752 | -.59930 | .93574 | 1.02422 | 1.02523 |
| **1974** | 6.43938 | -.33414 | -.38997 | 6.49521 | -.53032 | -.62658 | -.67691 | -.66969 |
| **1975** | 6.62405 | -.24529 | -.35332 | 6.73209 | -.14474 | -.45997 | -.55204 | -.54452 |
| **1976** | 6.66629 | -.30914 | -.38251 | 6.73966 | -.05656 | -.57971 | -.64484 | -.63743 |
| **1977** | 7.36515 | .11984 | .14132 | 7.34366 | 1.40258 | .22472 | .24403 | .23957 |
| **1978** | 6.76494 | .13620 | .16011 | 6.74103 | .14940 | .25540 | .27691 | .27193 |
| **1979** | 7.14600 | -.03335 | -.03817 | 7.15083 | .94502 | -.06253 | -.06690 | -.06561 |
| **1980** | 6.93993 | -.22503 | -.36252 | 7.07742 | .51477 | -.42198 | -.53559 | -.52811 |
| **1981** | 6.99484 | -.40633 | -.50919 | 7.09770 | .62942 | -.76195 | -.85295 | -.84834 |
| **1982** | 7.49341 | -.75822 | -.94060 | 7.67578 | 1.67036 | -1.42182 | -1.58361 | -1.63364 |
| **1983** | 6.99965 | -.32395 | -.41468 | 7.09038 | .63944 | -.60747 | -.68730 | -.68016 |
| **1984** | 7.08989 | .37628 | .55836 | 6.90781 | .82787 | .70560 | .85953 | .85507 |
| **1985** | 6.63847 | .05424 | .08262 | 6.61008 | -.11465 | .10170 | .12553 | .12313 |
| **1986** | 6.86386 | .50832 | .65211 | 6.72007 | .35594 | .95321 | 1.07964 | 1.08323 |
| **1987** | 7.02819 | .02453 | .02972 | 7.02300 | .69905 | .04599 | .05063 | .04965 |
| **1988** | 6.13319 | .82374 | .94032 | 6.01661 | -1.16961 | 1.54467 | 1.65037 | 1.71038 |
| **1989** | 6.10401 | -.72966 | -.86702 | 6.24137 | -1.23054 | -1.36825 | -1.49149 | -1.52942 |
| **1990** | 6.80826 | .75062 | 1.20206 | 6.35682 | .23985 | 1.40757 | 1.78124 | 1.86409 |
| **1991** | 6.52091 | 1.19305 | 1.40902 | 6.30494 | -.36010 | 2.23722 | 2.43129 | **2.71225** |
| **1992** | 7.79214 | .11878 | .15339 | 7.75753 | 2.29408 | .22273 | .25311 | .24850 |
| **1993** | 7.37196 | -.07914 | -.09686 | 7.38968 | 1.41678 | -.14841 | -.16418 | -.16108 |
| **1994** | 6.64193 | -.29805 | -.34096 | 6.68484 | -.10742 | -.55891 | -.59778 | -.59025 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.
[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



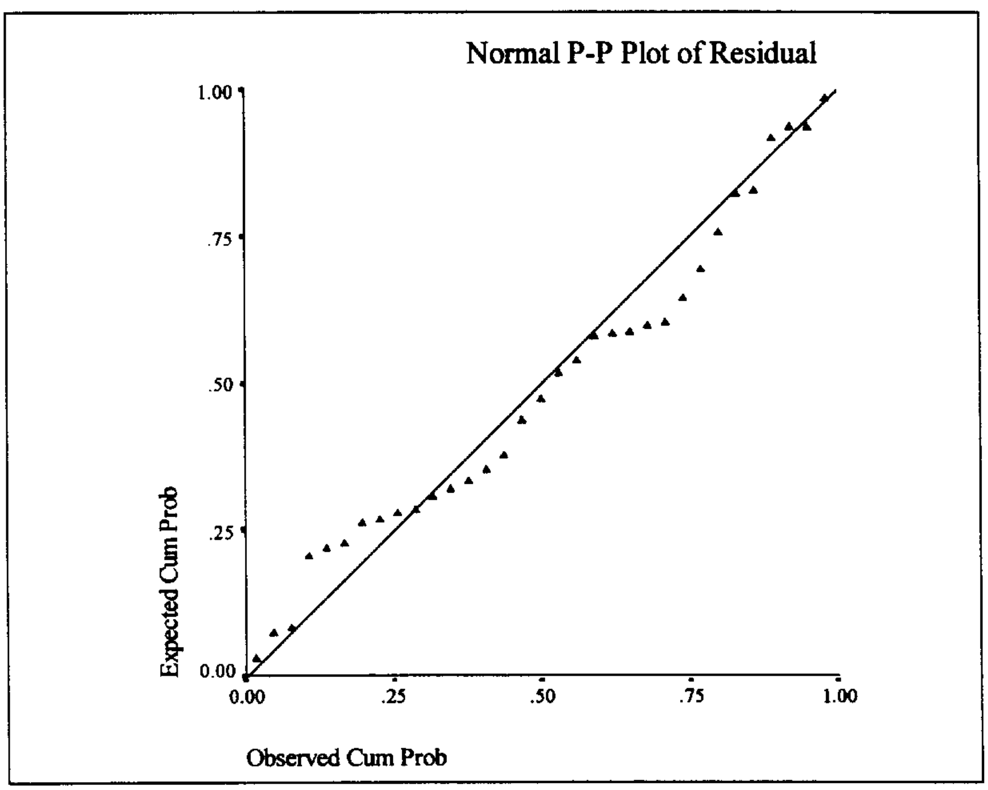




Fig. 6.1.1. Exploratory Plots of Ln (White Shrimp Harvest) Standardized Residual.

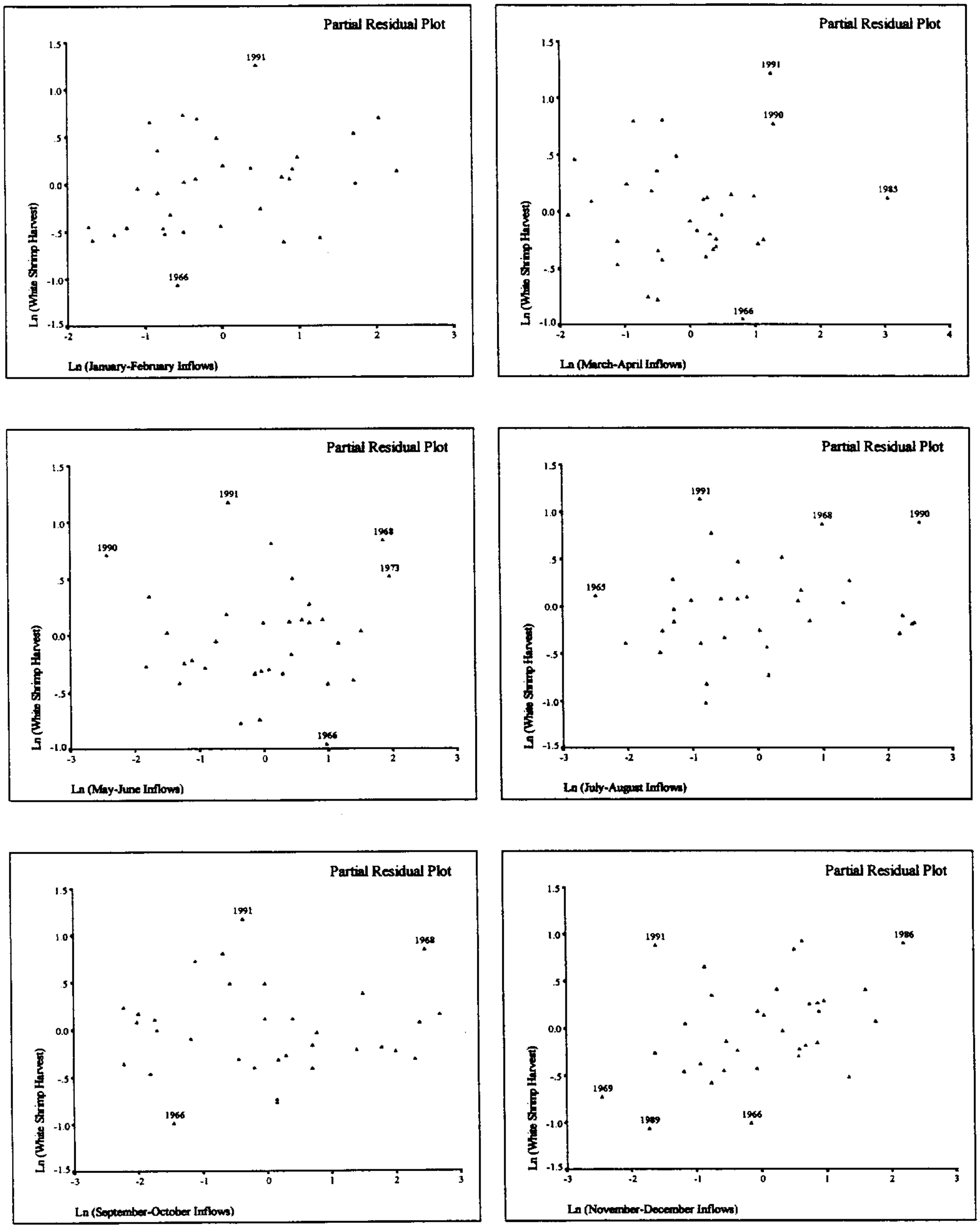



Fig. 6.1.2. Partial Residual Plots of Ln (White Shrimp Harvest) vs. Logged Inflows.

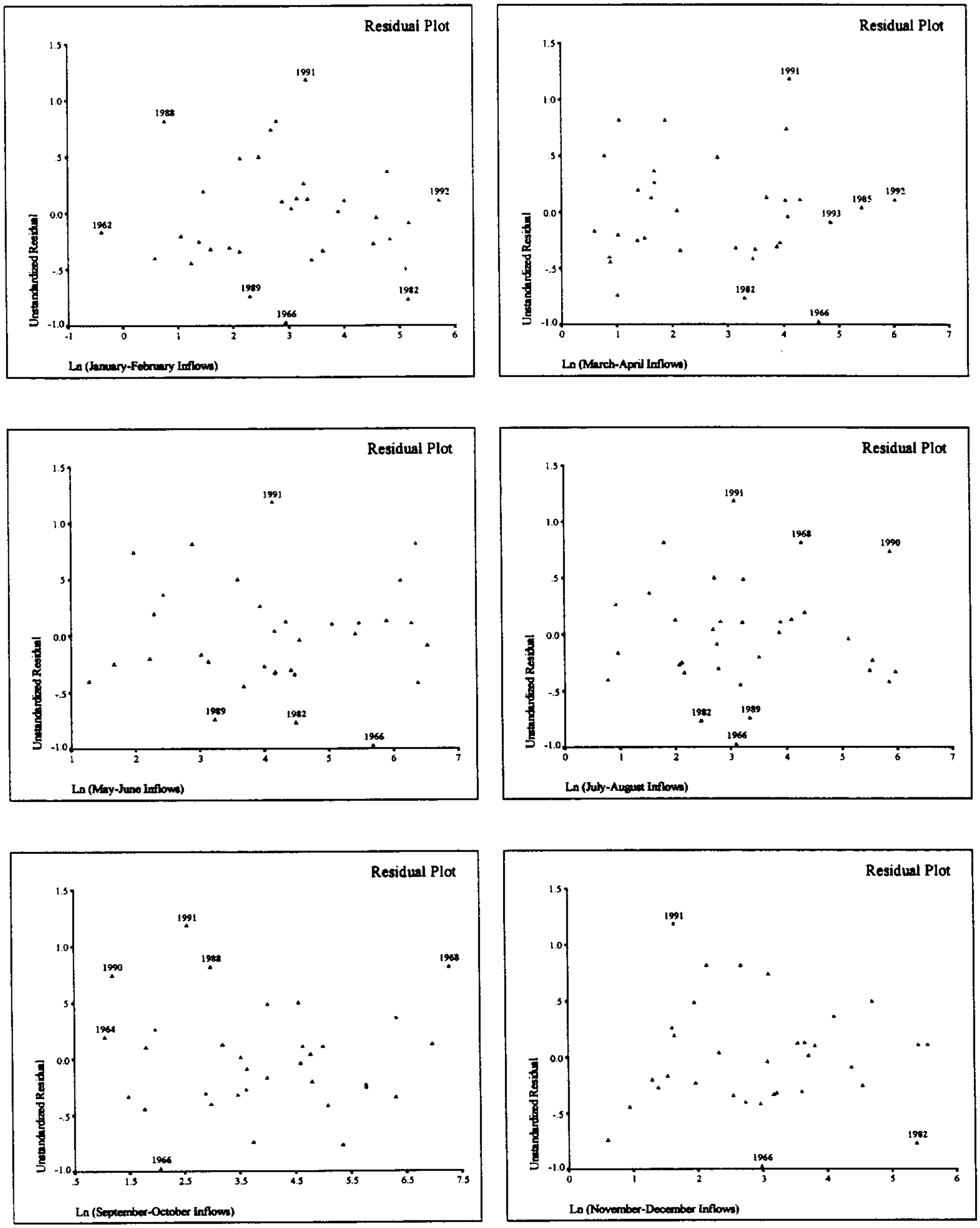



Fig. 6.1.3. Residual Plots of Ln (White Shrimp Harvest) vs. Logged Inflows.

### 6.1.4 Prediction Intervals for White Shrimp Harvest

| YEAR | Ln_WSH | LICI | UICI |
|---|---|---|---|
| 1962 | 5.52 | 4.03722 | 7.33314 |
| 1963 | 5.63 | 4.38783 | 7.66391 |
| 1964 | 6.38 | 4.56544 | 7.79936 |
| 1965 | 6.58 | 4.63604 | 7.98379 |
| 1966 | 5.77 | 5.14264 | 8.32601 |
| 1967 | 5.53 | 4.35593 | 7.57093 |
| 1968 | 7.46 | 4.93545 | 8.33146 |
| 1969 | 6.35 | 4.93100 | 8.30005 |
| 1970 | 6.97 | 5.28382 | 8.44196 |
| 1971 | 5.84 | 4.43487 | 7.64076 |
| 1972 | 7.14 | 5.37847 | 8.61744 |
| 1973 | 6.91 | 4.80673 | 8.00596 |
| 1974 | 6.11 | 4.85503 | 8.02373 |
| 1975 | 6.38 | 4.93078 | 8.31733 |
| 1976 | 6.36 | 5.04859 | 8.28399 |
| 1977 | 7.48 | 5.77466 | 8.95564 |
| 1978 | 6.90 | 5.17633 | 8.35355 |
| 1979 | 7.11 | 5.57332 | 8.71868 |
| 1980 | 6.71 | 5.19965 | 8.68021 |
| 1981 | 6.59 | 5.37024 | 8.61945 |
| 1982 | 6.74 | 5.87429 | 9.11253 |
| 1983 | 6.68 | 5.36372 | 8.63557 |
| 1984 | 7.47 | 5.38348 | 8.79631 |
| 1985 | 6.69 | 4.92087 | 8.35607 |
| 1986 | 7.37 | 5.22680 | 8.50092 |
| 1987 | 7.05 | 5.42207 | 8.63432 |
| 1988 | 6.96 | 4.56219 | 7.70419 |
| 1989 | 5.37 | 4.50912 | 7.69890 |
| 1990 | 7.56 | 5.07032 | 8.54620 |
| 1991 | 7.71 | 4.92957 | 8.11225 |
| 1992 | 7.91 | 6.15165 | 9.43264 |
| 1993 | 7.29 | 5.76028 | 8.98363 |
| 1994 | 6.34 | 5.06964 | 8.21423 |

| | |
|---|---|
| **Ln_WSH** | Ln (White shrimp harvest) |
| **LICI** | Lower limit for 99% prediction interval for white shrimp harvest |
| **UICI** | Upper limit for 99% prediction interval for white shrimp harvest |

### 6.1.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| 1962 | 6.60811 | .00550 | .20650 | .4708 | .0000 |
| 1963 | 6.13294 | .02853 | .19165 | .5243 | .0000 |
| 1964 | 5.13302 | .00595 | .16041 | .6437 | .0000 |
| 1965 | 7.86265 | .01981 | .24571 | .3449 | .0000 |
| 1966 | 3.95143 | .10015 | .12348 | .7854 | .0021 |
| 1967 | 4.68848 | .02451 | .14651 | .6979 | .0000 |
| 1968 | 9.04831 | .22751 | .28276 | .2492 | .0250 |
| 1969 | 8.38410 | .02067 | .26200 | .2999 | .0000 |
| 1970 | 3.36853 | .00112 | .10527 | .8489 | .0000 |
| 1971 | 4.47554 | .00485 | .13986 | .7237 | .0000 |
| 1972 | 5.25229 | .00304 | .16413 | .6292 | .0000 |
| 1973 | 4.32016 | .02968 | .13501 | .7423 | .0000 |
| 1974 | 3.61165 | .01094 | .11286 | .8233 | .0000 |
| 1975 | 8.81483 | .01917 | .27546 | .2662 | .0000 |
| 1976 | 5.16798 | .01410 | .16150 | .6395 | .0000 |
| 1977 | 3.89566 | .00153 | .12174 | .7917 | .0000 |
| 1978 | 3.80875 | .00192 | .11902 | .8015 | .0000 |
| 1979 | 3.07484 | .00009 | .09609 | .8780 | .0000 |
| 1980 | 11.16651 | .02504 | .34895 | .1315 | .0000 |
| 1981 | 5.49436 | .02631 | .17170 | .5999 | .0000 |
| 1982 | 5.23488 | .08617 | .16359 | .6313 | .0013 |
| 1983 | 6.03201 | .01890 | .18850 | .5360 | .0000 |
| 1984 | 9.46572 | .05107 | .29580 | .2209 | .0002 |
| 1985 | 10.02376 | .00118 | .31324 | .1872 | .0000 |
| 1986 | 6.08616 | .04710 | .19019 | .5297 | .0002 |
| 1987 | 4.62424 | .00008 | .14451 | .7057 | .0000 |
| 1988 | 2.99778 | .05507 | .09368 | .8852 | .0003 |
| 1989 | 4.10005 | .05983 | .12813 | .7682 | .0004 |
| 1990 | 11.04798 | .27260 | .34525 | .1365 | .0409 |
| 1991 | 3.93516 | .15287 | .12297 | .7872 | .0079 |
| 1992 | 6.25052 | .00267 | .19533 | .5108 | .0000 |
| 1993 | 4.88451 | .00086 | .15264 | .6741 | .0000 |
| 1994 | 3.05707 | .00735 | .09553 | .8797 | .0000 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1962** | -.19288 | -.09898 | .11287 | -.00757 | -.02750 | .07588 | -.03346 | .02343 |
| **1963** | -.44425 | -.33502 | .11583 | -.04155 | .19695 | .18503 | .02277 | -.08625 |
| **1964** | .20073 | .11174 | .00083 | -.04726 | -.04205 | .08462 | -.10944 | -.00407 |
| **1965** | .36769 | .24109 | .19717 | -.11859 | .08062 | -.22676 | -.18575 | -.13086 |
| **1966** | -.88969 | -.13547 | .21559 | -.31826 | -.35071 | .23671 | .39388 | .06046 |
| **1967** | -.41255 | -.22936 | .00228 | .19037 | -.15636 | -.01818 | .21242 | .12063 |
| **1968** | **1.33007** | -.59517 | -.19683 | -.35618 | .70911 | .30659 | .69578 | -.33021 |
| **1969** | -.37552 | -.17167 | -.19878 | -.13732 | .10099 | .18437 | -.02434 | .27353 |
| **1970** | .08704 | .01187 | -.01917 | .00888 | .02730 | -.00963 | -.05700 | .03335 |
| **1971** | -.18134 | -.06386 | .04885 | -.02315 | .07870 | -.04625 | -.09295 | .06561 |
| **1972** | .14327 | -.08474 | -.05834 | .03569 | .03093 | .02842 | .10397 | .00232 |
| **1973** | .45625 | -.03188 | -.15309 | -.03940 | .35206 | -.04371 | -.00402 | -.13597 |
| **1974** | -.27375 | .00484 | .09078 | -.04454 | -.03361 | .08215 | -.19753 | .06705 |
| **1975** | -.36138 | -.03646 | .13255 | -.04652 | .19161 | -.00243 | -.15549 | -.18596 |
| **1976** | -.31053 | .07275 | .19630 | -.04966 | .00541 | -.22323 | -.01447 | -.09759 |
| **1977** | .10144 | -.03535 | -.01469 | .01249 | .01661 | -.01909 | -.00108 | .06739 |
| **1978** | .11393 | .03189 | .04752 | -.07805 | .04334 | -.03899 | -.06130 | .03495 |
| **1979** | -.02496 | .00653 | -.00902 | -.00602 | .00839 | -.01207 | -.00646 | .00603 |
| **1980** | -.41280 | .03129 | -.25016 | .12975 | .13249 | -.19550 | -.11108 | .12799 |
| **1981** | -.42682 | .25990 | .07814 | .07070 | -.21221 | -.27169 | -.07988 | .01080 |
| **1982** | -.80120 | .13920 | -.37984 | .16009 | .10837 | .18644 | -.03216 | -.39318 |
| **1983** | -.35996 | .00738 | -.06300 | .06488 | .01696 | -.23872 | .20368 | -.07206 |
| **1984** | .59482 | .10247 | .34965 | -.08988 | -.29685 | -.17676 | .18394 | .04191 |
| **1985** | .08907 | .01380 | -.02077 | .08085 | -.03653 | -.02555 | .04293 | -.03995 |
| **1986** | .57612 | -.03682 | -.01327 | -.37842 | .08832 | .06082 | -.08437 | .43259 |
| **1987** | .02285 | -.00407 | .00827 | -.01793 | .01323 | .00442 | -.01110 | .00780 |
| **1988** | .64346 | .38619 | -.28180 | -.13146 | .03782 | -.16929 | -.14875 | .18602 |
| **1989** | -.66359 | -.32961 | -.21968 | .18811 | .01906 | -.03504 | -.03074 | .46233 |
| **1990** | **1.44562** | .28684 | -.12204 | .52888 | -.91475 | .77136 | -.30854 | .19600 |
| **1991** | **1.15398** | .57423 | .21642 | .64047 | -.25545 | -.33424 | -.12935 | -.76799 |
| **1992** | .13414 | -.06550 | .01765 | .04820 | -.00045 | -.00595 | .01364 | .04412 |
| **1993** | -.07622 | .01299 | -.02588 | -.00003 | -.03334 | .02981 | .02504 | -.00949 |
| **1994** | -.22394 | -.03855 | .14505 | -.11467 | -.00844 | .04177 | .03328 | -.06960 |

**DFFITS** Standardized dffits value
**SDFB_0** Standardized dfbeta for the intercept term
**SDFB_1** Standardized dfbeta for the Logged January-February inflows
**SDFB_2** Standardized dfbeta for the Logged March-April inflows
**SDFB_3** Standardized dfbeta for the Logged May-June inflows
**SDFB_4** Standardized dfbeta for the Logged July-August inflows
**SDFB_5** Standardized dfbeta for the Logged September-October inflows
**SDFB_6** Standardized dfbeta for the Logged November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

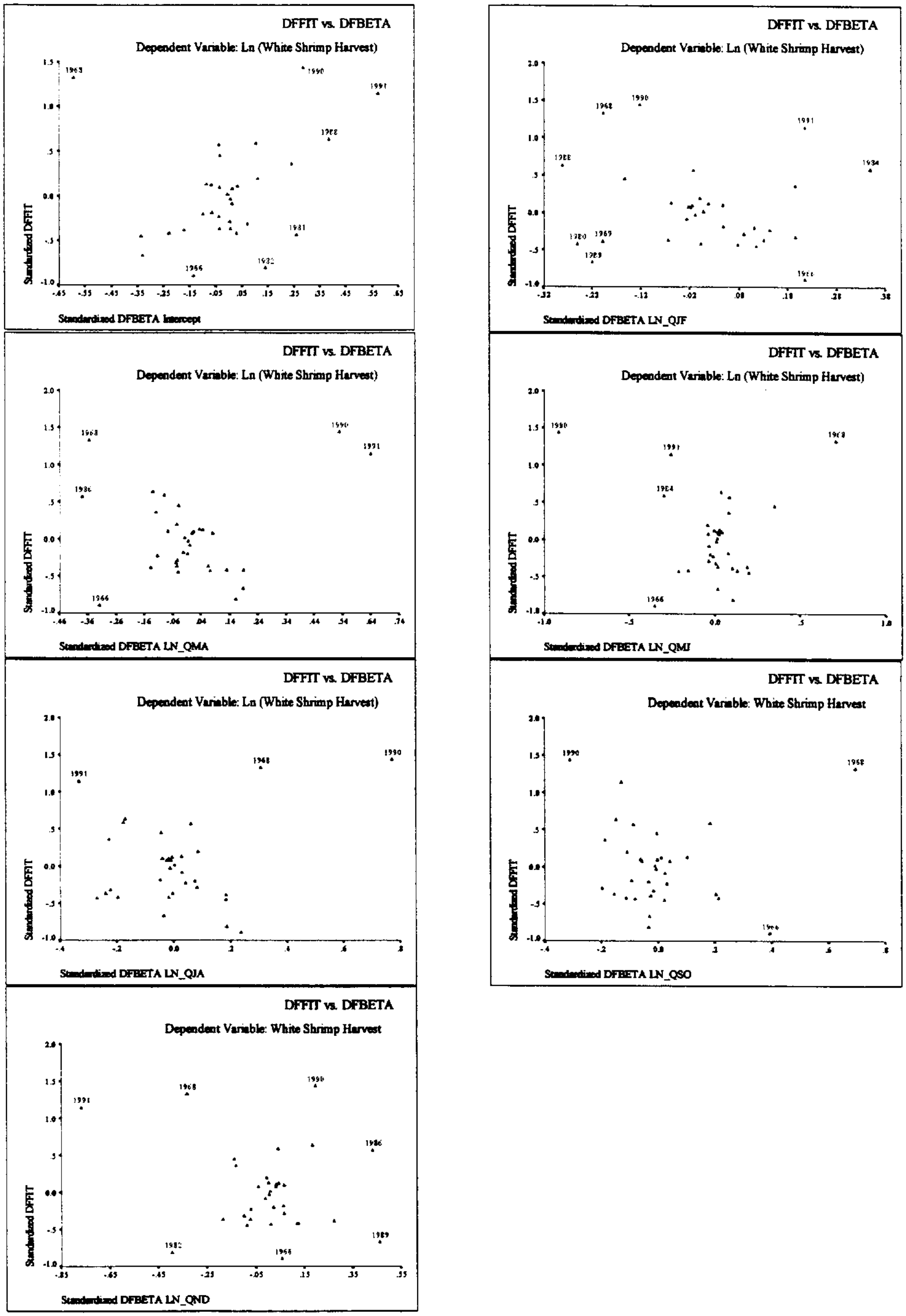



Fig. 6.1.4. Standardized DFFIT vs. Standardized DFBETA.

## 6.2 Model 6: Variables Transformed According to the Box-Cox Analysis

### 6.2.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | (QND)^ -0.1, (QJA)^ -0.1, Ln_QSO, Ln_QMJ, Ln_QJF, (QMA)^ -0.1[c,d] | . | .701 | .491 | .373 | .4059 | 1.818 |

a. Dependent Variable: (White Shrimp Harvest)^0.2

b. Method: Enter

c. Independent Variables: (Constant), (QND)^ -0.1, (QJA)^ -0.1, Ln_QSO, Ln_QMJ, Ln_QJF, (QMA)^ -0.1

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 4.128 | 6 | .688 | 4.176 | .005[b] |
| | Residual | 4.284 | 26 | .165 | | |
| | Total | 8.413 | 32 | | | |

a. Dependent Variable: (White Shrimp Harvest)^0.2

b. Independent Variables: (Constant), (QND)^ -0.1, (QJA)^ -0.1, Ln_QSO, Ln_QMJ, Ln_QJF, (QMA)^ -0.1

**Coefficients[a]**

| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. | 95% Confidence Interval for B Lower Bound | 95% Confidence Interval for B Upper Bound |
|---|---|---|---|---|---|---|---|---|
| 1 | (Constant) | 5.455 | 1.186 | | 4.599 | .000 | 3.016 | 7.893 |
| | Ln_QJF | .124 | .067 | .360 | 1.861 | .074 | -.013 | .262 |
| | (QMA)^ -0.1 | -.230 | .964 | -.052 | -.239 | .813 | -2.212 | 1.752 |
| | Ln_QMJ | 7.5E-03 | .066 | .021 | .115 | .909 | -.127 | .142 |
| | (QJA)^ -0.1 | -.592 | .752 | -.120 | -.787 | .438 | -2.138 | .954 |
| | Ln_QSO | 9.1E-03 | .048 | .030 | .188 | .852 | -.090 | .109 |
| | (QND)^ -0.1 | -1.904 | .879 | -.362 | -2.166 | .040 | -3.711 | -.097 |

a. Dependent Variable: (White Shrimp Harvest)^0.2

### 6.2.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 5.454520 | 1.18613557 | 4.599 | 0.0001 | 0.00000000 |
| BOX_QJF | 1 | 0.124475 | 0.06687096 | 1.861 | 0.0740 | 1.90437910 |
| BOX_QMA | 1 | -0.230194 | 0.96409023 | -0.239 | 0.8132 | 2.40497263 |
| BOX_QMJ | 1 | 0.007532 | 0.06554657 | 0.115 | 0.9094 | 1.78196298 |
| BOX_QJA | 1 | -0.592014 | 0.75217409 | -0.787 | 0.4384 | 1.18711798 |
| BOX_QSO | 1 | 0.009111 | 0.04843119 | 0.188 | 0.8522 | 1.28914286 |
| BOX_QND | 1 | -1.904270 | 0.87903516 | -2.166 | 0.0396 | 1.42266719 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop BOX_QJF | Var Prop BOX_QMA | Var Prop BOX_QMJ | Var Prop BOX_QJA | Var Prop BOX_QSO | Var Prop BOX_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.65183 | 1.00000 | 0.0509 | 0.0404 | 0.0483 | 0.0239 | 0.0099 | 0.0393 |
| 2 | 1.18231 | 1.49764 | 0.0023 | 0.0260 | 0.0012 | 0.2059 | 0.3199 | 0.0844 |
| 3 | 0.83521 | 1.78187 | 0.0025 | 0.0358 | 0.0159 | 0.3369 | 0.3366 | 0.1716 |
| 4 | 0.61485 | 2.07677 | 0.0034 | 0.0153 | 0.3749 | 0.3765 | 0.0000 | 0.3291 |
| 5 | 0.44543 | 2.43995 | 0.7362 | 0.0000 | 0.2090 | 0.0427 | 0.0001 | 0.2951 |
| 6 | 0.27037 | 3.13179 | 0.2047 | 0.8825 | 0.3507 | 0.0142 | 0.3336 | 0.0805 |

### 6.2.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 3.0776 | 4.6394 | 3.8477 | .3592 | 33 |
| Std. Predicted Value | -2.144 | 2.204 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | .1423 | .2485 | .1845 | 3.06E-02 | 33 |
| Adjusted Predicted Value | 3.0977 | 4.5833 | 3.8396 | .3711 | 33 |
| Residual | -.7181 | .9571 | -1.E-15 | .3659 | 33 |
| Std. Residual | -1.769 | 2.358 | .000 | .901 | 33 |
| Stud. Residual | -1.920 | 2.567 | .008 | 1.017 | 33 |
| Deleted Residual | -.8458 | 1.1343 | 8.1E-03 | .4688 | 33 |
| Stud. Deleted Residual | -2.032 | 2.913 | .022 | 1.067 | 33 |
| Mahal. Distance | 2.965 | 11.025 | 5.818 | 2.315 | 33 |
| Cook's Distance | .000 | .293 | .041 | .068 | 33 |
| Centered Leverage Value | .093 | .345 | .182 | .072 | 33 |

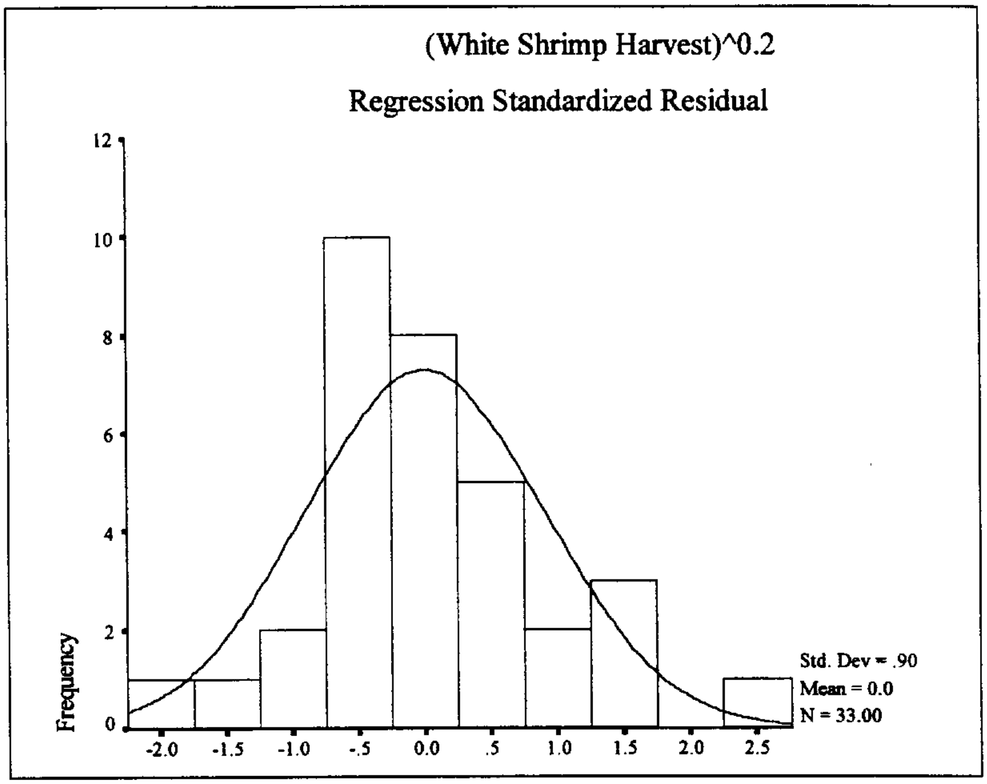
a. Dependent Variable: (White Shrimp Harvest)^0.2

*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 3.07760 | -.06075 | -.08081 | 3.09765 | -2.14412 | -.14967 | -.17261 | -.16935 |
| 1963 | 3.35715 | -.27244 | -.35615 | 3.44086 | -1.36584 | -.67115 | -.76737 | -.76113 |
| 1964 | 3.46334 | .12182 | .15213 | 3.43303 | -1.07021 | .30011 | .33536 | .32956 |
| 1965 | 3.55640 | .17473 | .24575 | 3.48538 | -.81112 | .43043 | .51047 | .50309 |
| 1966 | 3.88944 | -.71807 | -.84578 | 4.01715 | .11611 | -1.76895 | -1.91982 | -2.03207 |
| 1967 | 3.27894 | -.25608 | -.31717 | 3.34003 | -1.58359 | -.63084 | -.70207 | -.69505 |
| 1968 | 3.80202 | .64367 | .93331 | 3.51239 | -.12727 | 1.58567 | 1.90938 | 2.01921 |
| 1969 | 3.78810 | -.22724 | -.32451 | 3.88537 | -.16603 | -.55981 | -.66897 | -.66169 |
| 1970 | 3.98580 | .04830 | .05597 | 3.97813 | .38437 | .11899 | .12809 | .12564 |
| 1971 | 3.34836 | -.13276 | -.16163 | 3.37722 | -1.39032 | -.32705 | -.36086 | -.35474 |
| 1972 | 4.08288 | .08752 | .10904 | 4.06135 | .65465 | .21559 | .24065 | .23624 |
| 1973 | 3.63372 | .34544 | .41306 | 3.56610 | -.59584 | .85097 | .93054 | .92805 |
| 1974 | 3.67029 | -.27955 | -.32660 | 3.71734 | -.49405 | -.68865 | -.74436 | -.73781 |
| 1975 | 3.80277 | -.22137 | -.31805 | 3.89945 | -.12521 | -.54533 | -.65366 | -.64630 |
| 1976 | 3.82683 | -.26088 | -.32100 | 3.88694 | -.05821 | -.64268 | -.71289 | -.70598 |
| 1977 | 4.33230 | .13595 | .15771 | 4.31054 | 1.34906 | .33491 | .36071 | .35460 |
| 1978 | 3.91787 | .05793 | .06820 | 3.90760 | .19524 | .14272 | .15485 | .15192 |
| 1979 | 4.19436 | -.04676 | -.05331 | 4.20091 | .96501 | -.11518 | -.12299 | -.12064 |
| 1980 | 4.03121 | -.20077 | -.32115 | 4.15159 | .51079 | -.49459 | -.62553 | -.61805 |
| 1981 | 4.06609 | -.33125 | -.40618 | 4.14101 | .60789 | -.81603 | -.90362 | -.90032 |
| 1982 | 4.43699 | -.59097 | -.72195 | 4.56796 | 1.64050 | -1.45584 | -1.60910 | -1.66282 |
| 1983 | 4.07584 | -.27531 | -.34698 | 4.14751 | .63505 | -.67823 | -.76140 | -.75508 |
| 1984 | 4.16254 | .28893 | .42935 | 4.02212 | .87644 | .71176 | .86765 | .86339 |
| 1985 | 3.81496 | -.00148 | -.00217 | 3.81564 | -.09126 | -.00366 | -.00442 | -.00433 |
| 1986 | 3.97538 | .39319 | .51243 | 3.85614 | .35535 | .96862 | 1.10578 | 1.11074 |
| 1987 | 4.11075 | -.01256 | -.01525 | 4.11343 | .73223 | -.03094 | -.03409 | -.03343 |
| 1988 | 3.44051 | .57991 | .66440 | 3.35602 | -1.13377 | 1.42858 | 1.52912 | 1.57176 |
| 1989 | 3.37542 | -.44581 | -.54598 | 3.47559 | -1.31497 | -1.09823 | -1.21537 | -1.22714 |
| 1990 | 3.93656 | .59822 | .95317 | 3.58161 | .24727 | 1.47370 | 1.86021 | 1.95912 |
| 1991 | 3.72049 | .95714 | 1.13429 | 3.54334 | -.35427 | 2.35789 | 2.56683 | **2.91300** |
| 1992 | 4.63937 | .22620 | .28226 | 4.58331 | 2.20396 | .55724 | .62247 | .61498 |
| 1993 | 4.35882 | -.05905 | -.07230 | 4.37207 | 1.42289 | -.14546 | -.16096 | -.15791 |
| 1994 | 3.82233 | -.26583 | -.30637 | 3.86287 | -.07074 | -.65487 | -.70303 | -.69603 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.
[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



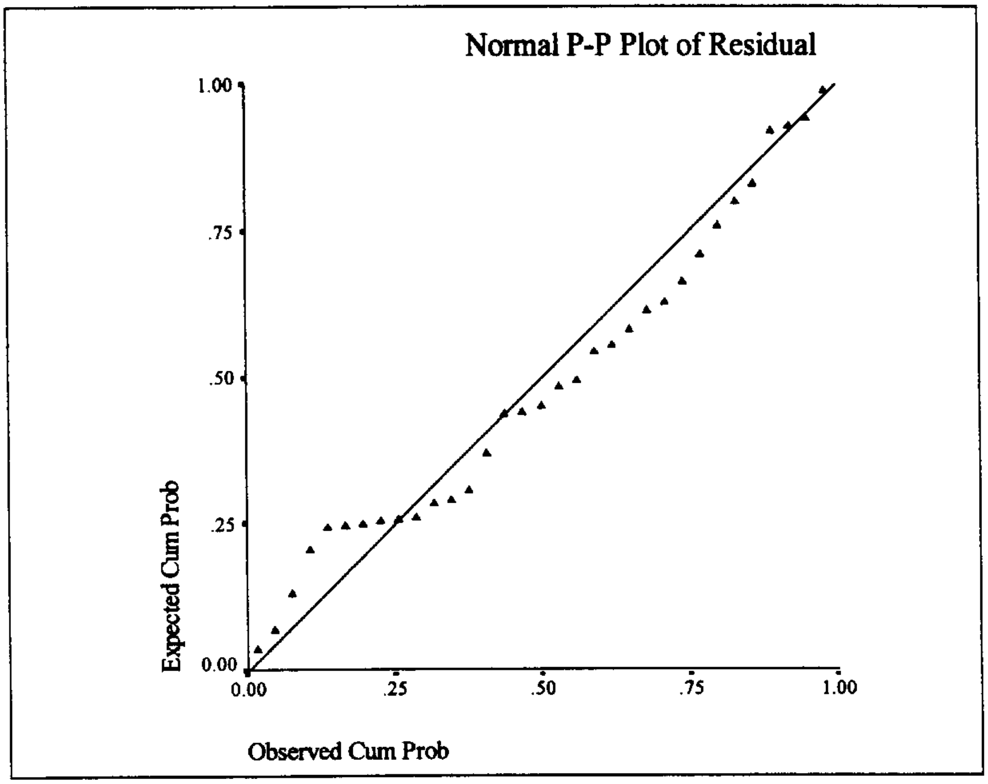




Fig. 6.2.1. Exploratory Plots of (White Shrimp Harvest)$^{0.2}$ Standardized Residual.

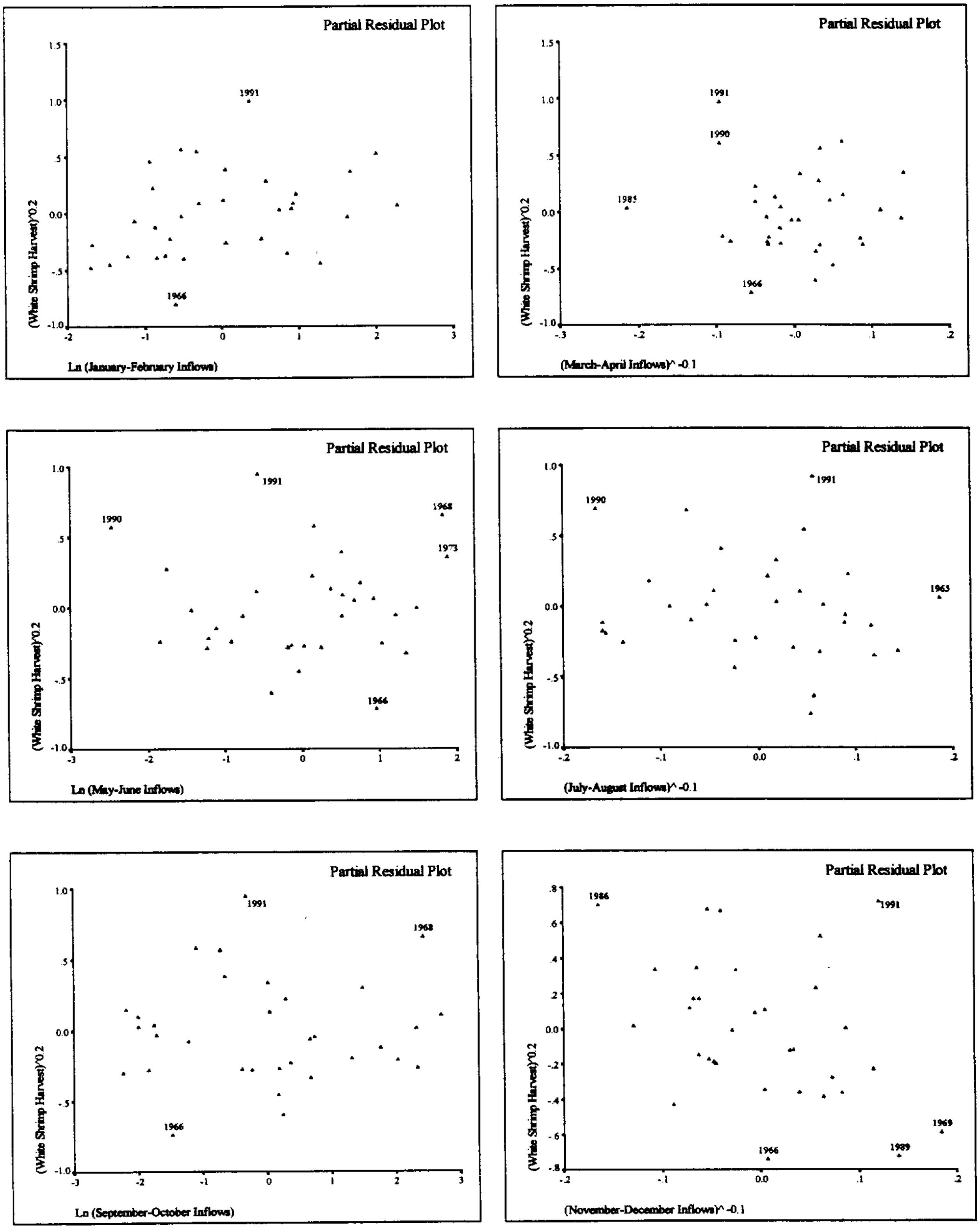



Fig. 6.2.2. Partial Residual Plots of (White Shrimp Harvest)$^{0.2}$ vs. Box-Cox Transformed Inflows.

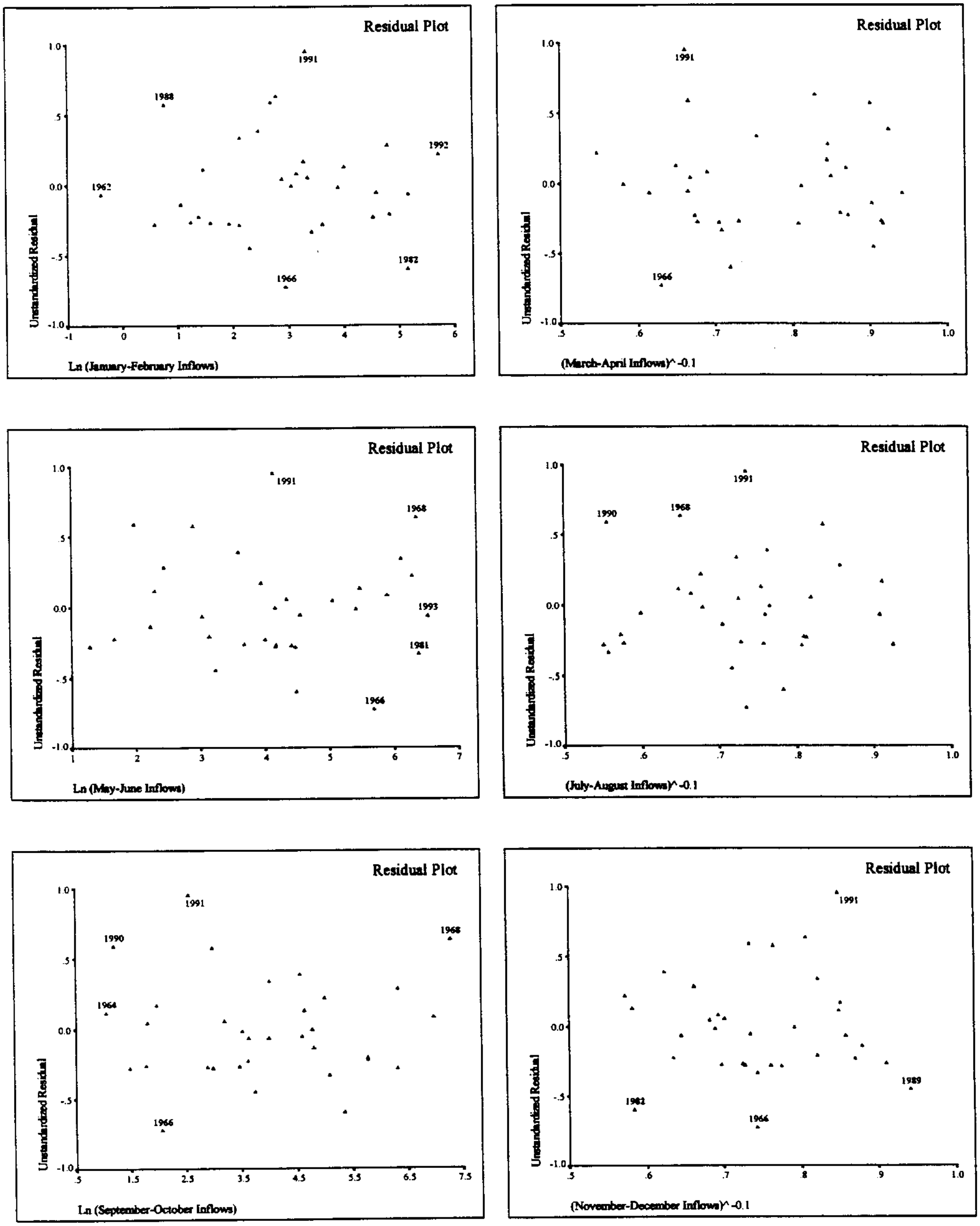



Fig. 6.2.3. Residual Plots of (White Shrimp Harvest)$^{0.2}$ vs. Box-Cox Transformed Inflows.

### 6.2.4 Prediction Intervals for White Shrimp Harvest

| YEAR | BOX_WSH | LICI | UICI |
|---|---|---|---|
| 1962 | 3.02 | 1.81743 | 4.33777 |
| 1963 | 3.08 | 2.10361 | 4.61069 |
| 1964 | 3.59 | 2.22812 | 4.69855 |
| 1965 | 3.73 | 2.27577 | 4.83703 |
| 1966 | 3.17 | 2.67931 | 5.09958 |
| 1967 | 3.02 | 2.04712 | 4.51075 |
| 1968 | 4.45 | 2.51084 | 5.09321 |
| 1969 | 3.56 | 2.50215 | 5.07405 |
| 1970 | 4.03 | 2.78299 | 5.18861 |
| 1971 | 3.22 | 2.12379 | 4.57292 |
| 1972 | 4.17 | 2.84858 | 5.31718 |
| 1973 | 3.98 | 2.41692 | 4.85052 |
| 1974 | 3.39 | 2.46379 | 4.87678 |
| 1975 | 3.58 | 2.51471 | 5.09082 |
| 1976 | 3.57 | 2.59778 | 5.05589 |
| 1977 | 4.47 | 3.12904 | 5.53557 |
| 1978 | 3.98 | 2.70796 | 5.12778 |
| 1979 | 4.15 | 2.99905 | 5.38967 |
| 1980 | 3.83 | 2.70862 | 5.35379 |
| 1981 | 3.73 | 2.83848 | 5.29369 |
| 1982 | 3.85 | 3.21096 | 5.66301 |
| 1983 | 3.80 | 2.83684 | 5.31484 |
| 1984 | 4.45 | 2.86314 | 5.46195 |
| 1985 | 3.81 | 2.52173 | 5.10819 |
| 1986 | 4.37 | 2.72303 | 5.22772 |
| 1987 | 4.10 | 2.88735 | 5.33414 |
| 1988 | 4.02 | 2.24296 | 4.63805 |
| 1989 | 2.93 | 2.14833 | 4.60251 |
| 1990 | 4.53 | 2.61515 | 5.25796 |
| 1991 | 4.68 | 2.50764 | 4.93335 |
| 1992 | 4.87 | 3.40445 | 5.87429 |
| 1993 | 4.30 | 3.13184 | 5.58581 |
| 1994 | 3.56 | 2.62206 | 5.02260 |

**BOX_WSH** (White shrimp harvest)$^{0.2}$
**LICI** Lower limit for 99% prediction interval for white shrimp harvest
**UICI** Upper limit for 99% prediction interval for white shrimp harvest

### 6.2.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| 1962 | 6.97100 | .00140 | .21784 | .4319 | .0000 |
| 1963 | 6.55180 | .02585 | .20474 | .4770 | .0000 |
| 1964 | 5.40464 | .00400 | .16889 | .6107 | .0000 |
| 1965 | 8.27832 | .01513 | .25870 | .3087 | .0000 |
| 1966 | 3.86203 | .09364 | .12069 | .7955 | .0017 |
| 1967 | 5.19356 | .01680 | .16230 | .6364 | .0000 |
| 1968 | 8.96086 | .23435 | .28003 | .2555 | .0271 |
| 1969 | 8.62169 | .02736 | .26943 | .2810 | .0000 |
| 1970 | 3.41736 | .00037 | .10679 | .8439 | .0000 |
| 1971 | 4.74552 | .00404 | .14830 | .6910 | .0000 |
| 1972 | 5.34793 | .00204 | .16712 | .6176 | .0000 |
| 1973 | 4.26888 | .02421 | .13340 | .7483 | .0000 |
| 1974 | 3.64088 | .01332 | .11378 | .8201 | .0000 |
| 1975 | 8.75803 | .02666 | .27369 | .2705 | .0000 |
| 1976 | 5.02285 | .01673 | .15696 | .6572 | .0000 |
| 1977 | 3.44518 | .00297 | .10766 | .8410 | .0000 |
| 1978 | 3.84851 | .00061 | .12027 | .7971 | .0000 |
| 1979 | 2.96521 | .00030 | .09266 | .8882 | .0000 |
| 1980 | 11.02527 | .03352 | .34454 | .1375 | .0001 |
| 1981 | 4.93314 | .02638 | .15416 | .6681 | .0000 |
| 1982 | 4.83576 | .08198 | .15112 | .6800 | .0011 |
| 1983 | 5.64002 | .02156 | .17625 | .5824 | .0000 |
| 1984 | 9.49642 | .05227 | .29676 | .2190 | .0003 |
| 1985 | 9.09423 | .00000 | .28419 | .2460 | .0000 |
| 1986 | 6.47642 | .05297 | .20239 | .4853 | .0003 |
| 1987 | 4.67362 | .00004 | .14605 | .6997 | .0000 |
| 1988 | 3.09976 | .04867 | .09687 | .8756 | .0002 |
| 1989 | 4.90133 | .04741 | .15317 | .6720 | .0002 |
| 1990 | 10.94669 | .29331 | .34208 | .1410 | .0495 |
| 1991 | 4.02798 | .17421 | .12587 | .7765 | .0116 |
| 1992 | 5.38613 | .01372 | .16832 | .6130 | .0000 |
| 1993 | 4.89479 | .00083 | .15296 | .6728 | .0000 |
| 1994 | 3.26420 | .01077 | .10201 | .8595 | .0000 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| 1962 | -.09729 | .02098 | .05386 | .00157 | -.01651 | -.04199 | -.01553 | -.01279 |
| 1963 | -.42191 | -.05214 | .10528 | .03534 | .17200 | -.19258 | .02428 | .08895 |
| 1964 | .16437 | .03336 | .00154 | .04001 | -.03482 | -.07579 | -.08794 | .00423 |
| 1965 | .32074 | -.22617 | .16428 | .08928 | .07301 | .20607 | -.15603 | .11265 |
| 1966 | -.85696 | -.10621 | .21885 | .29302 | -.34326 | -.21768 | .38682 | -.03160 |
| 1967 | -.33947 | .14119 | -.00644 | -.16171 | -.12895 | .03350 | .16911 | -.10810 |
| 1968 | **1.35448** | -.47139 | -.20939 | .36006 | .71520 | -.32645 | .70444 | .32375 |
| 1969 | -.43290 | .17004 | -.21263 | .17303 | .11663 | -.21044 | -.03476 | -.31599 |
| 1970 | .05008 | .01736 | -.01146 | -.00574 | .01486 | .00466 | -.03215 | -.01970 |
| 1971 | -.16542 | -.01313 | .04288 | .01671 | .06992 | .04967 | -.08245 | -.06173 |
| 1972 | .11717 | .02346 | -.04922 | -.03124 | .02256 | -.02217 | .08494 | -.00303 |
| 1973 | .41061 | -.13341 | -.14906 | .01764 | .30885 | .03496 | .00259 | .12538 |
| 1974 | -.30271 | .05772 | .11105 | .06345 | -.03183 | -.09323 | -.22168 | -.06826 |
| 1975 | -.42713 | -.21474 | .15553 | .05908 | .23010 | .00362 | -.18801 | .21567 |
| 1976 | -.33888 | -.25095 | .21806 | .06494 | .01724 | .23119 | -.01792 | .10549 |
| 1977 | .14186 | .04974 | -.01823 | -.02196 | .02304 | .03038 | .00196 | -.08782 |
| 1978 | .06396 | -.02711 | .02636 | .04337 | .02486 | .02054 | -.03457 | -.02211 |
| 1979 | -.04517 | -.01208 | -.01593 | .01094 | .01597 | .02153 | -.01143 | -.00953 |
| 1980 | -.47858 | .09447 | -.29321 | -.15843 | .15284 | .23089 | -.12248 | -.14060 |
| 1981 | -.42819 | -.03317 | .08099 | -.06669 | -.21543 | .25667 | -.08046 | -.00903 |
| 1982 | -.78281 | -.00707 | -.38680 | -.11888 | .12138 | -.19233 | -.05521 | .35186 |
| 1983 | -.38526 | -.15693 | -.07125 | -.06597 | .02506 | .24505 | .22622 | .08238 |
| 1984 | .60192 | -.11047 | .34638 | .07991 | -.29668 | .18108 | .18739 | -.05509 |
| 1985 | -.00293 | -.00076 | .00074 | .00266 | .00121 | -.00087 | -.00145 | -.00130 |
| 1986 | .61167 | .02770 | .01134 | .42490 | .10542 | -.08785 | -.09766 | -.44979 |
| 1987 | -.01547 | .00406 | -.00560 | -.01208 | -.00882 | .00361 | .00756 | .00571 |
| 1988 | .59995 | .02509 | -.25669 | .13569 | .04501 | .14955 | -.14366 | -.19254 |
| 1989 | -.58169 | .32214 | -.18846 | -.16229 | .00882 | .06101 | -.02750 | -.41406 |
| 1990 | **1.50908** | **1.14502** | -.13088 | -.56424 | -.98351 | -.75942 | -.32342 | -.20942 |
| 1991 | **1.25321** | -.07717 | .19121 | -.72372 | -.29136 | .33075 | -.11875 | .83520 |
| 1992 | .30616 | .08641 | .06504 | -.08031 | .01519 | .01325 | .02412 | -.09594 |
| 1993 | -.07480 | .01519 | -.02623 | -.00243 | -.03423 | -.02862 | .02528 | .01059 |
| 1994 | -.27179 | -.15610 | .17832 | .14507 | -.00309 | -.04974 | .03442 | .08428 |

**DFFITS** Standardized dffits value
**SDFB_0** Standardized dfbeta for the intercept term
**SDFB_1** Standardized dfbeta for the Logged January-February inflows
**SDFB_2** Standardized dfbeta for the (March-April inflows)$^{-0.1}$
**SDFB_3** Standardized dfbeta for the Logged May-June inflows
**SDFB_4** Standardized dfbeta for the (July-August inflows)$^{-0.1}$
**SDFB_5** Standardized dfbeta for the Logged September-October inflows
**SDFB_6** Standardized dfbeta for the (November-December inflows)$^{-0.1}$

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

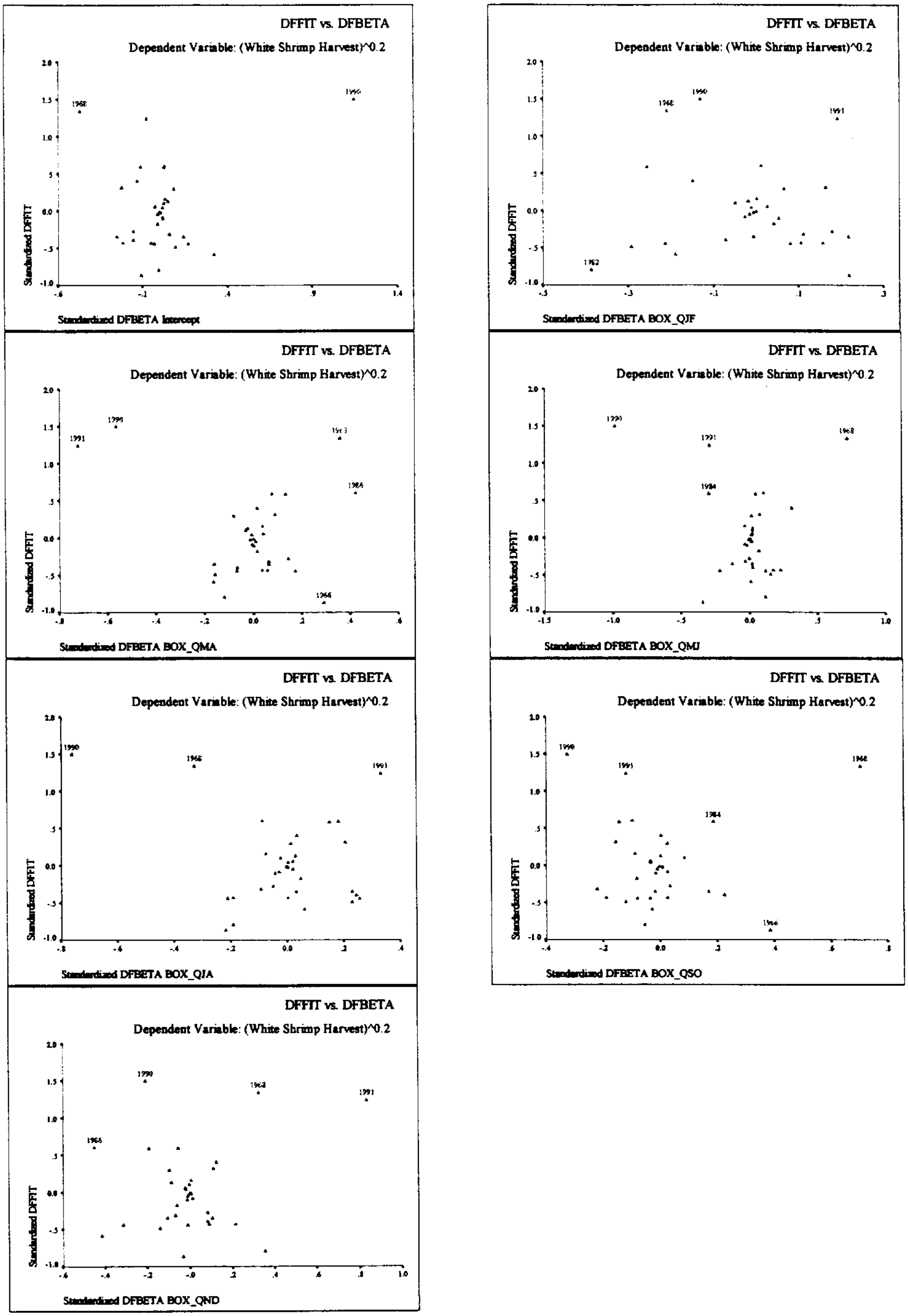



Fig. 6.2.4. Standardized DFFIT vs. Standardized DFBETA.

# 7. Examining Subsets of the Data

## 7.1 Model 3: Logged All Variables

### 7.1.1 Logged All Variables: 1968 Omitted

N = 32 Regression Models for Dependent Variable: LN (WHITE SHRIMP)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.394972 | 0.374805 | 5.3916 | -38.2394 | 0.284950 | -35.3079 | LN_QJF |
| 1 | 0.368199 | 0.347139 | 6.8692 | -36.8538 | 0.297559 | -33.9223 | LN_QND |
| 1 | 0.253775 | 0.228901 | 13.1843 | -31.5273 | 0.351450 | -28.5958 | LN_QMA |
| 1 | 0.121987 | 0.092720 | 20.4578 | -26.3230 | 0.413518 | -23.3915 | LN_QMJ |
| 2 | 0.519532 | 0.486397 | 0.5171 | -43.6158 | 0.234089 | -39.2186 | LN_QJF LN_QND |
| 2 | 0.448883 | 0.410875 | 4.4163 | -39.2259 | 0.268510 | -34.8286 | LN_QMA LN_QND |
| 2 | 0.420818 | 0.380875 | 5.9652 | -37.6364 | 0.282183 | -33.2392 | LN_QJF LN_QMA |
| 2 | 0.413885 | 0.373464 | 6.3478 | -37.2556 | 0.285561 | -32.8584 | LN_QJA LN_QND |
| 3 | 0.531407 | 0.481200 | 1.8618 | -42.4166 | 0.236457 | -36.5537 | LN_QJF LN_QJA LN_QND |
| 3 | 0.530164 | 0.479824 | 1.9304 | -42.3318 | 0.237084 | -36.4689 | LN_QJF LN_QSO LN_QND |
| 3 | 0.529900 | 0.479532 | 1.9449 | -42.3139 | 0.237218 | -36.4509 | LN_QJF LN_QMA LN_QND |
| 3 | 0.519847 | 0.468402 | 2.4998 | -41.6368 | 0.242291 | -35.7738 | LN_QJF LN_QMJ LN_QND |
| 4 | 0.539119 | 0.470841 | 3.4361 | -40.9477 | 0.241179 | -33.6190 | LN_QJF LN_QJA LN_QSO LN_QND |
| 4 | 0.537298 | 0.468750 | 3.5366 | -40.8215 | 0.242132 | -33.4928 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.536088 | 0.467361 | 3.6034 | -40.7379 | 0.242765 | -33.4093 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.535623 | 0.466826 | 3.6291 | -40.7058 | 0.243009 | -33.3771 | LN_QJF LN_QMA LN_QMJ LN_QND |
| 5 | 0.543135 | 0.455276 | 5.2145 | -39.2277 | 0.248273 | -30.4333 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.542400 | 0.454400 | 5.2551 | -39.1763 | 0.248672 | -30.3819 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.540497 | 0.452131 | 5.3601 | -39.0435 | 0.249706 | -30.2491 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.540166 | 0.451737 | 5.3783 | -39.0205 | 0.249886 | -30.2261 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.547021 | 0.438306 | 7.0000 | -37.5011 | 0.256007 | -27.2409 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 7.1.2 Logged All Variables: 1990 Omitted

N = 32 Regression Models for Dependent Variable: LN (WHITE SHRIMP)

| Number In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.403876 | 0.384005 | 4.0534 | -39.0941 | 0.277439 | -36.1626 | LN_QJF |
| 1 | 0.335249 | 0.313091 | 7.7434 | -35.6073 | 0.309379 | -32.6758 | LN_QND |
| 1 | 0.225820 | 0.200014 | 13.6274 | -30.7307 | 0.360308 | -27.7992 | LN_QMJ |
| 1 | 0.204203 | 0.177677 | 14.7897 | -29.8495 | 0.370368 | -26.9180 | LN_QMA |
| 2 | 0.505042 | 0.470907 | 0.6137 | -43.0454 | 0.238299 | -38.6481 | LN_QJF LN_QND |
| 2 | 0.434841 | 0.395865 | 4.3884 | -38.8010 | 0.272098 | -34.4038 | LN_QJF LN_QMJ |
| 2 | 0.432426 | 0.393283 | 4.5182 | -38.6646 | 0.273261 | -34.2674 | LN_QMJ LN_QND |
| 2 | 0.424816 | 0.385148 | 4.9275 | -38.2384 | 0.276925 | -33.8412 | LN_QJF LN_QSO |
| 3 | 0.526784 | 0.476082 | 1.4447 | -42.4828 | 0.235969 | -36.6198 | LN_QJF LN_QMJ LN_QND |
| 3 | 0.512521 | 0.460291 | 2.2116 | -41.5326 | 0.243081 | -35.6696 | LN_QJF LN_QSO LN_QND |
| 3 | 0.508605 | 0.455955 | 2.4221 | -41.2765 | 0.245034 | -35.4136 | LN_QJF LN_QJA LN_QND |
| 3 | 0.505786 | 0.452835 | 2.5737 | -41.0935 | 0.246439 | -35.2305 | LN_QJF LN_QMA LN_QND |
| 4 | 0.533625 | 0.464533 | 3.0768 | -40.9488 | 0.241171 | -33.6201 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.529957 | 0.460321 | 3.2741 | -40.6981 | 0.243068 | -33.3694 | LN_QJF LN_QMA LN_QMJ LN_QND |
| 4 | 0.527068 | 0.457005 | 3.4294 | -40.5020 | 0.244561 | -33.1734 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 4 | 0.515873 | 0.444151 | 4.0313 | -39.7534 | 0.250350 | -32.4247 | LN_QJF LN_QJA LN_QSO LN_QND |
| 5 | 0.534760 | 0.445291 | 5.0158 | -39.0267 | 0.249837 | -30.2323 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.533873 | 0.444233 | 5.0635 | -38.9658 | 0.250313 | -30.1714 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.530314 | 0.439989 | 5.2549 | -38.7224 | 0.252225 | -29.9280 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.517380 | 0.424568 | 5.9503 | -37.8531 | 0.259170 | -29.0587 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 6 | 0.535054 | 0.423467 | 7.0000 | -37.0470 | 0.259666 | -26.7868 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

### 7.1.3 Logged All Variables: 1991 Omitted

N = 32 Regression Models for Dependent Variable: LN (WHITE SHRIMP)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.423473 | 0.404255 | 6.4578 | -40.8579 | 0.262561 | -37.9265 | LN_QND |
| 1 | 0.387314 | 0.366891 | 8.6190 | -38.9114 | 0.279029 | -35.9799 | LN_QJF |
| 1 | 0.201307 | 0.174684 | 19.7362 | -30.4274 | 0.363739 | -27.4959 | LN_QMA |
| 1 | 0.159590 | 0.131576 | 22.2295 | -28.7982 | 0.382738 | -25.8667 | LN_QMJ |
| 2 | 0.546029 | 0.514720 | 1.1329 | -46.5056 | 0.213876 | -42.1084 | LN_QJF LN_QND |
| 2 | 0.490987 | 0.455883 | 4.4226 | -42.8435 | 0.239807 | -38.4463 | LN_QJA LN_QND |
| 2 | 0.470189 | 0.433651 | 5.6657 | -41.5620 | 0.249606 | -37.1648 | LN_QMJ LN_QND |
| 2 | 0.453800 | 0.416131 | 6.6452 | -40.5871 | 0.257327 | -36.1899 | LN_QMA LN_QND |
| 3 | 0.573327 | 0.527612 | 1.5013 | -46.4901 | 0.208194 | -40.6272 | LN_QJF LN_QJA LN_QND |
| 3 | 0.551597 | 0.503553 | 2.8001 | -44.9005 | 0.218798 | -39.0375 | LN_QJF LN_QMJ LN_QND |
| 3 | 0.548808 | 0.500466 | 2.9668 | -44.7021 | 0.220158 | -38.8391 | LN_QJF LN_QSO LN_QND |
| 3 | 0.546069 | 0.497434 | 3.1305 | -44.5084 | 0.221495 | -38.6455 | LN_QJF LN_QMA LN_QND |
| 4 | 0.578096 | 0.515592 | 3.2163 | -44.8498 | 0.213492 | -37.5211 | LN_QJF LN_QJA LN_QSO LN_QND |
| 4 | 0.575719 | 0.512862 | 3.3584 | -44.6700 | 0.214695 | -37.3413 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 4 | 0.574759 | 0.511760 | 3.4158 | -44.5976 | 0.215181 | -37.2689 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.553584 | 0.487449 | 4.6813 | -43.0426 | 0.225895 | -35.7140 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 5 | 0.579722 | 0.498899 | 5.1191 | -42.9733 | 0.220849 | -34.1789 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.579715 | 0.498891 | 5.1195 | -42.9728 | 0.220852 | -34.1784 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.578550 | 0.497502 | 5.1892 | -42.8842 | 0.221465 | -34.0898 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.553774 | 0.467962 | 6.6700 | -41.0563 | 0.234484 | -32.2619 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 6 | 0.581715 | 0.481327 | 7.0000 | -41.1254 | 0.228593 | -30.8653 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

### 7.1.4 Logged All Variables: 1968 and 1990 Omitted

N = 31 Regression Models for Dependent Variable: LN (WHITE SHRIMP)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.428116 | 0.408396 | 4.1386 | -39.5273 | 0.262524 | -36.6593 | LN_QJF |
| 1 | 0.386364 | 0.365204 | 6.4120 | -37.3428 | 0.281690 | -34.4748 | LN_QND |
| 1 | 0.237301 | 0.211001 | 14.5284 | -30.6015 | 0.350118 | -27.7335 | LN_QMA |
| 1 | 0.196589 | 0.168885 | 16.7451 | -28.9894 | 0.368806 | -26.1215 | LN_QMJ |
| 2 | 0.554577 | 0.522761 | -0.7470 | -45.2745 | 0.211774 | -40.9725 | LN_QJF LN_QND |
| 2 | 0.452948 | 0.413873 | 4.7866 | -38.9034 | 0.260093 | -34.6015 | LN_QMA LN_QND |
| 2 | 0.443303 | 0.403539 | 5.3117 | -38.3616 | 0.264679 | -34.0597 | LN_QMJ LN_QND |
| 2 | 0.440864 | 0.400926 | 5.4445 | -38.2261 | 0.265839 | -33.9241 | LN_QJF LN_QMA |
| 3 | 0.558515 | 0.509461 | 1.0385 | -43.5498 | 0.217676 | -37.8139 | LN_QJF LN_QMJ LN_QND |
| 3 | 0.557460 | 0.508289 | 1.0960 | -43.4758 | 0.218196 | -37.7399 | LN_QJF LN_QMA LN_QND |
| 3 | 0.555286 | 0.505873 | 1.2143 | -43.3239 | 0.219268 | -37.5880 | LN_QJF LN_QSO LN_QND |
| 3 | 0.555139 | 0.505710 | 1.2224 | -43.3136 | 0.219341 | -37.5777 | LN_QJF LN_QJA LN_QND |
| 4 | 0.558962 | 0.491110 | 3.0142 | -41.5812 | 0.225819 | -34.4113 | LN_QJF LN_QMA LN_QMJ LN_QND |
| 4 | 0.558852 | 0.490983 | 3.0202 | -41.5735 | 0.225876 | -34.4036 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.558567 | 0.490654 | 3.0357 | -41.5535 | 0.226022 | -34.3836 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 4 | 0.557693 | 0.489646 | 3.0833 | -41.4922 | 0.226469 | -34.3222 | LN_QJF LN_QMA LN_QSO LN_QND |
| 5 | 0.559184 | 0.471021 | 5.0021 | -39.5969 | 0.234734 | -30.9929 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.558999 | 0.470799 | 5.0122 | -39.5839 | 0.234832 | -30.9799 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.558903 | 0.470684 | 5.0174 | -39.5771 | 0.234883 | -30.9732 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.557874 | 0.469449 | 5.0734 | -39.5049 | 0.235431 | -30.9009 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 6 | 0.559223 | 0.449028 | 7.0000 | -37.5995 | 0.244493 | -27.5616 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

### 7.1.5 Logged All Variables: 1968 and 1991 Omitted

N = 31 Regression Models for Dependent Variable: LN (WHITE SHRIMP)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.488654 | 0.471021 | 6.0553 | -43.7204 | 0.229311 | -40.8524 | LN_QND |
| 1 | 0.410688 | 0.390367 | 11.0954 | -39.3212 | 0.264275 | -36.4532 | LN_QJF |
| 1 | 0.234813 | 0.208427 | 22.4645 | -31.2251 | 0.343145 | -28.3571 | LN_QMA |
| 1 | 0.131248 | 0.101291 | 29.1594 | -27.2900 | 0.389588 | -24.4221 | LN_QMJ |
| 2 | 0.606448 | 0.578337 | 0.4407 | -49.8372 | 0.182790 | -45.5352 | LN_QJF LN_QND |
| 2 | 0.541229 | 0.508459 | 4.6567 | -45.0837 | 0.213082 | -40.7818 | LN_QJA LN_QND |
| 2 | 0.526441 | 0.492615 | 5.6126 | -44.1003 | 0.219950 | -39.7983 | LN_QMA LN_QND |
| 2 | 0.505458 | 0.470133 | 6.9691 | -42.7562 | 0.229696 | -38.4543 | LN_QMJ LN_QND |
| 3 | 0.625115 | 0.583461 | 1.2340 | -49.3436 | 0.180569 | -43.6077 | LN_QJF LN_QJA LN_QND |
| 3 | 0.610972 | 0.567746 | 2.1482 | -48.1956 | 0.187381 | -42.4597 | LN_QJF LN_QSO LN_QND |
| 3 | 0.607457 | 0.563841 | 2.3754 | -47.9168 | 0.189074 | -42.1809 | LN_QJF LN_QMA LN_QND |
| 3 | 0.606859 | 0.563177 | 2.4141 | -47.8696 | 0.189362 | -42.1337 | LN_QJF LN_QMJ LN_QND |
| 4 | 0.627257 | 0.569912 | 3.0955 | -47.5212 | 0.186442 | -40.3513 | LN_QJF LN_QJA LN_QSO LN_QND |
| 4 | 0.626576 | 0.569126 | 3.1395 | -47.4647 | 0.186783 | -40.2947 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 4 | 0.625148 | 0.567478 | 3.2319 | -47.3463 | 0.187497 | -40.1764 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.611449 | 0.551671 | 4.1174 | -46.2336 | 0.194349 | -39.0637 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 5 | 0.628727 | 0.554473 | 5.0005 | -45.6438 | 0.193135 | -37.0398 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.627522 | 0.553026 | 5.0784 | -45.5433 | 0.193762 | -36.9394 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.626776 | 0.552131 | 5.1266 | -45.4813 | 0.194150 | -36.8773 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.612363 | 0.534836 | 6.0583 | -44.3067 | 0.201647 | -35.7028 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 6 | 0.628734 | 0.535918 | 7.0000 | -43.6444 | 0.201178 | -33.6065 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

### 7.1.6 Logged All Variables: 1990 and 1991 Omitted

N = 31 Regression Models for Dependent Variable: LN (WHITE SHRIMP)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.446755 | 0.427678 | 10.7315 | -41.7006 | 0.244749 | -38.8327 | LN_QND |
| 1 | 0.420843 | 0.400872 | 12.4987 | -40.2817 | 0.256212 | -37.4137 | LN_QJF |
| 1 | 0.249263 | 0.223376 | 24.2005 | -32.2378 | 0.332117 | -29.3698 | LN_QMJ |
| 1 | 0.182850 | 0.154672 | 28.7299 | -29.6100 | 0.361497 | -26.7420 | LN_QMA |
| 2 | 0.583791 | 0.554062 | 3.3856 | -48.5236 | 0.190702 | -44.2217 | LN_QJF LN_QND |
| 2 | 0.540533 | 0.507714 | 6.3358 | -45.4584 | 0.210522 | -41.1564 | LN_QMJ LN_QND |
| 2 | 0.486478 | 0.449798 | 10.0224 | -42.0104 | 0.235289 | -37.7084 | LN_QJA LN_QND |
| 2 | 0.486475 | 0.449794 | 10.0226 | -42.0102 | 0.235291 | -37.7082 | LN_QSO LN_QND |
| 3 | 0.610044 | 0.566715 | 3.5952 | -48.5434 | 0.185291 | -42.8074 | LN_QJF LN_QMJ LN_QND |
| 3 | 0.603729 | 0.559699 | 4.0258 | -48.0454 | 0.188291 | -42.3095 | LN_QJF LN_QSO LN_QND |
| 3 | 0.591119 | 0.545688 | 4.8858 | -47.0743 | 0.194283 | -41.3384 | LN_QJF LN_QJA LN_QND |
| 3 | 0.586402 | 0.540446 | 5.2075 | -46.7187 | 0.196524 | -40.9828 | LN_QJF LN_QMA LN_QND |
| 4 | 0.636310 | 0.580358 | 3.8038 | -48.7051 | 0.179457 | -41.5352 | LN_QJF LN_QMA LN_QMJ LN_QND |
| 4 | 0.628968 | 0.571887 | 4.3045 | -48.0856 | 0.183079 | -40.9156 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.611614 | 0.551862 | 5.4881 | -46.6685 | 0.191642 | -39.4985 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 4 | 0.610781 | 0.550901 | 5.5449 | -46.6021 | 0.192053 | -39.4321 | LN_QJF LN_QJA LN_QSO LN_QND |
| 5 | 0.645925 | 0.575110 | 5.1480 | -47.5357 | 0.181701 | -38.9318 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.638671 | 0.566405 | 5.6428 | -46.9070 | 0.185423 | -38.3031 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.630483 | 0.556580 | 6.2012 | -46.2124 | 0.189625 | -37.6085 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.612374 | 0.534849 | 7.4362 | -44.7292 | 0.198918 | -36.1253 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 6 | 0.648096 | 0.560120 | 7.0000 | -45.7263 | 0.188111 | -35.6884 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

| OBS | _MODEL_ | _TYPE_ | _DEPVAR_ | _RMSE_ | INTERCEP | LN_QJF | LN_QMA | LN_QMJ | LN_QJA | LN_QSO |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MODEL1 | PARMS | LN_WSH | 0.49472 | 5.65151 | . | . | . | . | . |
| 2 | MODEL1 | PARMS | LN_WSH | 0.50617 | 5.82770 | 0.27783 | . | . | . | . |
| 3 | MODEL1 | PARMS | LN_WSH | 0.57630 | 5.68055 | . | . | 0.22460 | . | . |
| 4 | MODEL1 | PARMS | LN_WSH | 0.60125 | 6.15039 | . | 0.18102 | . | . | . |
| 5 | MODEL1 | PARMS | LN_WSH | 0.43669 | 5.42852 | 0.18149 | . | . | . | . |
| 6 | MODEL1 | PARMS | LN_WSH | 0.45883 | 5.18440 | . | . | 0.14498 | . | . |
| 7 | MODEL1 | PARMS | LN_WSH | 0.48507 | 5.35962 | . | . | . | 0.091412 | . |
| 8 | MODEL1 | PARMS | LN_WSH | 0.48507 | 5.39680 | . | . | . | . | 0.082144 |
| 9 | MODEL1 | PARMS | LN_WSH | 0.43045 | 5.20122 | 0.14337 | . | 0.08508 | . | . |
| 10 | MODEL1 | PARMS | LN_WSH | 0.43393 | 5.25961 | 0.17013 | . | . | . | 0.058977 |
| 11 | MODEL1 | PARMS | LN_WSH | 0.44078 | 5.31360 | 0.16735 | . | . | 0.041431 | . |
| 12 | MODEL1 | PARMS | LN_WSH | 0.44331 | 5.44138 | 0.19578 | -0.02796 | . | . | . |
| 13 | MODEL1 | PARMS | LN_WSH | 0.42362 | 5.10662 | 0.17295 | -0.10470 | 0.13852 | . | . |
| 14 | MODEL1 | PARMS | LN_WSH | 0.42788 | 5.04099 | 0.13303 | . | 0.08345 | . | 0.057474 |
| 15 | MODEL1 | PARMS | LN_WSH | 0.43777 | 5.16269 | 0.13940 | . | 0.07867 | 0.020070 | . |
| 16 | MODEL1 | PARMS | LN_WSH | 0.43824 | 5.14802 | 0.15634 | . | . | 0.040646 | 0.058571 |
| 17 | MODEL1 | PARMS | LN_WSH | 0.42626 | 5.00391 | 0.16037 | -0.08725 | 0.12840 | . | 0.042492 |
| 18 | MODEL1 | PARMS | LN_WSH | 0.43061 | 5.05774 | 0.16855 | -0.10642 | 0.13152 | 0.024644 | . |
| 19 | MODEL1 | PARMS | LN_WSH | 0.43546 | 5.00337 | 0.12914 | . | 0.07715 | 0.019713 | 0.057391 |
| 20 | MODEL1 | PARMS | LN_WSH | 0.44600 | 5.15787 | 0.16734 | -0.02285 | . | 0.044760 | 0.054818 |
| 21 | MODEL1 | PARMS | LN_WSH | 0.43372 | 4.95803 | 0.15628 | -0.08908 | 0.12179 | 0.023637 | 0.042079 |

| OBS | LN_QND | LN_WSH | _IN_ | _P_ | _EDF_ | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.32599 | -1 | 1 | 2 | 29 | 0.24475 | 0.44675 | 0.42768 | 10.7315 | -41.7006 | -38.8327 |
| 2 | . | -1 | 1 | 2 | 29 | 0.25621 | 0.42084 | 0.40087 | 12.4987 | -40.2817 | -37.4137 |
| 3 | . | -1 | 1 | 2 | 29 | 0.33212 | 0.24926 | 0.22338 | 24.2005 | -32.2378 | -29.3698 |
| 4 | . | -1 | 1 | 2 | 29 | 0.36150 | 0.18285 | 0.15467 | 28.7299 | -29.6100 | -26.7420 |
| 5 | 0.22538 | -1 | 2 | 3 | 28 | 0.19070 | 0.58379 | 0.55406 | 3.3856 | -48.5236 | -44.2217 |
| 6 | 0.27701 | -1 | 2 | 3 | 28 | 0.21052 | 0.54053 | 0.50771 | 6.3358 | -45.4584 | -41.1564 |
| 7 | 0.32640 | -1 | 2 | 3 | 28 | 0.23529 | 0.48648 | 0.44980 | 10.0224 | -42.0104 | -37.7084 |
| 8 | 0.30020 | -1 | 2 | 3 | 28 | 0.23529 | 0.48647 | 0.44979 | 10.0226 | -42.0102 | -37.7082 |
| 9 | 0.21777 | -1 | 3 | 4 | 27 | 0.18529 | 0.61004 | 0.56672 | 3.5952 | -48.5434 | -42.8074 |
| 10 | 0.21316 | -1 | 3 | 4 | 27 | 0.18829 | 0.60373 | 0.55970 | 4.0258 | -48.0454 | -42.3095 |
| 11 | 0.23340 | -1 | 3 | 4 | 27 | 0.19428 | 0.59112 | 0.54569 | 4.8858 | -47.0743 | -41.3384 |
| 12 | 0.23210 | -1 | 3 | 4 | 27 | 0.19652 | 0.58640 | 0.54045 | 5.2075 | -46.7187 | -40.9828 |
| 13 | 0.23814 | -1 | 4 | 5 | 26 | 0.17946 | 0.63631 | 0.58036 | 3.8038 | -48.7051 | -41.5352 |
| 14 | 0.20601 | -1 | 4 | 5 | 26 | 0.18308 | 0.62897 | 0.57189 | 4.3045 | -48.0856 | -40.9156 |
| 15 | 0.22223 | -1 | 4 | 5 | 26 | 0.19164 | 0.61161 | 0.55186 | 5.4881 | -46.6685 | -39.4985 |
| 16 | 0.22112 | -1 | 4 | 5 | 26 | 0.19205 | 0.61078 | 0.55090 | 5.5449 | -46.6021 | -39.4321 |
| 17 | 0.22605 | -1 | 5 | 6 | 25 | 0.18170 | 0.64593 | 0.57511 | 5.1480 | -47.5357 | -38.9318 |
| 18 | 0.24396 | -1 | 5 | 6 | 25 | 0.18542 | 0.63867 | 0.56640 | 5.6428 | -46.9070 | -38.3031 |
| 19 | 0.21040 | -1 | 5 | 6 | 25 | 0.18962 | 0.63048 | 0.55658 | 6.2012 | -46.2124 | -37.6085 |
| 20 | 0.22818 | -1 | 5 | 6 | 25 | 0.19892 | 0.61237 | 0.53485 | 7.4362 | -44.7292 | -36.1253 |
| 21 | 0.23175 | -1 | 6 | 7 | 24 | 0.18811 | 0.64810 | 0.56012 | 7.0000 | -45.7263 | -35.6884 |

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 4.958035 | 0.32730614 | 15.148 | 0.0001 | 0.00000000 |
| LN_QJF | 1 | 0.156282 | 0.07196127 | 2.172 | 0.0400 | 1.92551780 |
| LN_QMA | 1 | -0.089077 | 0.08127599 | -1.096 | 0.2840 | 2.51398929 |
| LN_QMJ | 1 | 0.121791 | 0.07802918 | 1.561 | 0.1317 | 2.05187588 |
| LN_QJA | 1 | 0.023637 | 0.06143156 | 0.385 | 0.7038 | 1.22354124 |
| LN_QSO | 1 | 0.042079 | 0.05248403 | 0.802 | 0.4306 | 1.18371702 |
| LN_QND | 1 | 0.231747 | 0.07264198 | 3.190 | 0.0039 | 1.51296593 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop LN_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop LN_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.74743 | 1.00000 | 0.0468 | 0.0374 | 0.0418 | 0.0217 | 0.0115 | 0.0357 |
| 2 | 1.12241 | 1.56454 | 0.0048 | 0.0101 | 0.0220 | 0.2377 | 0.2692 | 0.1334 |
| 3 | 0.91198 | 1.73569 | 0.0004 | 0.0417 | 0.0001 | 0.2774 | 0.4582 | 0.0720 |
| 4 | 0.53228 | 2.27193 | 0.0360 | 0.0281 | 0.3182 | 0.3918 | 0.0895 | 0.3308 |
| 5 | 0.42452 | 2.54399 | 0.7822 | 0.0002 | 0.1031 | 0.0653 | 0.0037 | 0.3657 |
| 6 | 0.26138 | 3.24211 | 0.1299 | 0.8825 | 0.5148 | 0.0060 | 0.1679 | 0.0625 |

| Variable | DF | Variable Label |
|---|---|---|
| INTERCEP | 1 | Intercept |
| LN_QJF | 1 | Ln (January-February Inflows) |
| LN_QMA | 1 | Ln (March-April Inflows) |
| LN_QMJ | 1 | Ln (May-June Inflows) |
| LN_QJA | 1 | Ln (July-August Inflows) |
| LN_QSO | 1 | Ln (September-October Inflows) |
| LN_QND | 1 | Ln (November-December Inflows) |

### 7.1.7 Logged All Variables: 1968, 1990 and 1991 Omitted

N = 30     Regression Models for Dependent Variable: LN (WHITE SHRIMP)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.520852 | 0.503740 | 7.0832 | -45.2570 | 0.207441 | -42.4546 | LN_QND |
| 1 | 0.449913 | 0.430267 | 11.9813 | -41.1150 | 0.238154 | -38.3126 | LN_QJF |
| 1 | 0.216797 | 0.188826 | 28.0770 | -30.5155 | 0.339078 | -27.7131 | LN_QMJ |
| 1 | 0.216258 | 0.188267 | 28.1142 | -30.4949 | 0.339312 | -27.6925 | LN_QMA |
| 2 | 0.653761 | 0.628114 | -0.0936 | -53.0034 | 0.155452 | -48.7998 | LN_QJF LN_QND |
| 2 | 0.569526 | 0.537639 | 5.7225 | -46.4707 | 0.193271 | -42.2671 | LN_QMJ LN_QND |
| 2 | 0.546335 | 0.512730 | 7.3238 | -44.8965 | 0.203683 | -40.6929 | LN_QJA LN_QND |
| 2 | 0.545903 | 0.512266 | 7.3536 | -44.8679 | 0.203877 | -40.6643 | LN_QMA LN_QND |
| 3 | 0.658229 | 0.618794 | 1.5979 | -51.3930 | 0.159348 | -45.7882 | LN_QJF LN_QMJ LN_QND |
| 3 | 0.655970 | 0.616274 | 1.7539 | -51.1954 | 0.160401 | -45.5906 | LN_QJF LN_QJA LN_QND |
| 3 | 0.654506 | 0.614641 | 1.8550 | -51.0680 | 0.161084 | -45.4632 | LN_QJF LN_QMA LN_QND |
| 3 | 0.654189 | 0.614288 | 1.8769 | -51.0405 | 0.161231 | -45.4357 | LN_QJF LN_QSO LN_QND |
| 4 | 0.665237 | 0.611675 | 3.1141 | -50.0145 | 0.162324 | -43.0086 | LN_QJF LN_QMA LN_QMJ LN_QND |
| 4 | 0.659144 | 0.604607 | 3.5348 | -49.4734 | 0.165278 | -42.4674 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 4 | 0.659131 | 0.604593 | 3.5356 | -49.4724 | 0.165284 | -42.4664 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.657435 | 0.602625 | 3.6527 | -49.3234 | 0.166106 | -42.3174 | LN_QJF LN_QMA LN_QJA LN_QND |
| 5 | 0.666559 | 0.597092 | 5.0228 | -48.1333 | 0.168419 | -39.7261 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.665563 | 0.595888 | 5.0915 | -48.0438 | 0.168922 | -39.6366 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.660071 | 0.589252 | 5.4708 | -47.5551 | 0.171696 | -39.1479 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.657691 | 0.586376 | 5.6351 | -47.3458 | 0.172898 | -38.9386 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 6 | 0.666889 | 0.579990 | 7.0000 | -46.1629 | 0.175568 | -36.3546 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 7.2 Model 6: Variables Transformed According to the Box-Cox Analysis

### 7.2.1 Variables Transformed According to the Box-Cox Analysis: 1968 Omitted

N = 32 Regression Models for Dependent Variable: $(\text{WHITE SHRIMP})^{0.2}$

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.388051 | 0.367652 | 5.4089 | -55.9011 | 0.164085 | -52.9697 | LN_QJF |
| 1 | 0.364423 | 0.343237 | 6.6988 | -54.6889 | 0.170420 | -51.7574 | $(QND)^{-0.1}$ |
| 1 | 0.254383 | 0.229529 | 12.7064 | -49.5791 | 0.199926 | -46.6477 | $(QMA)^{-0.1}$ |
| 1 | 0.116858 | 0.087420 | 20.2144 | -44.1624 | 0.236801 | -41.2309 | LN_QMJ |
| 2 | 0.516140 | 0.482771 | 0.4159 | -61.4165 | 0.134213 | -57.0193 | LN_QJF $(QND)^{-0.1}$ |
| 2 | 0.444693 | 0.406395 | 4.3166 | -57.0092 | 0.154032 | -52.6120 | $(QMA)^{-0.1}$ $(QND)^{-0.1}$ |
| 2 | 0.414064 | 0.373655 | 5.9887 | -55.2912 | 0.162527 | -50.8940 | LN_QJF $(QMA)^{-0.1}$ |
| 2 | 0.405403 | 0.364396 | 6.4616 | -54.8216 | 0.164930 | -50.4244 | $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 3 | 0.526979 | 0.476299 | 1.8242 | -60.1415 | 0.135893 | -54.2785 | LN_QJF LN_QSO $(QND)^{-0.1}$ |
| 3 | 0.525588 | 0.474758 | 1.9001 | -60.0475 | 0.136292 | -54.1846 | LN_QJF $(QMA)^{-0.1}$ $(QND)^{-0.1}$ |
| 3 | 0.525429 | 0.474582 | 1.9088 | -60.0368 | 0.136338 | -54.1738 | LN_QJF $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 3 | 0.516817 | 0.465047 | 2.3790 | -59.4612 | 0.138812 | -53.5983 | LN_QJF LN_QMJ $(QND)^{-0.1}$ |
| 4 | 0.533681 | 0.464597 | 3.4583 | -58.5981 | 0.138929 | -51.2694 | LN_QJF $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 4 | 0.532607 | 0.463363 | 3.5170 | -58.5244 | 0.139249 | -51.1958 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QND)^{-0.1}$ |
| 4 | 0.532053 | 0.462728 | 3.5472 | -58.4866 | 0.139414 | -51.1579 | LN_QJF $(QMA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 4 | 0.530663 | 0.461131 | 3.6231 | -58.3916 | 0.139828 | -51.0629 | LN_QJF $(QMA)^{-0.1}$ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.537903 | 0.449039 | 5.2278 | -56.8892 | 0.142966 | -48.0947 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.537508 | 0.448567 | 5.2494 | -56.8618 | 0.143089 | -48.0673 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.536340 | 0.447174 | 5.3132 | -56.7810 | 0.143450 | -47.9866 | LN_QJF $(QMA)^{-0.1}$ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.535415 | 0.446071 | 5.3637 | -56.7173 | 0.143736 | -47.9229 | LN_QJF LN_QMJ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 6 | 0.542076 | 0.432174 | 7.0000 | -55.1794 | 0.147342 | -44.9193 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |

### 7.2.2 Variables Transformed According to the Box-Cox Analysis: 1990 Omitted

N = 32 Regression Models for Dependent Variable: $(\text{WHITE SHRIMP})^{0.2}$

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.397814 | 0.377741 | 4.0861 | -56.8510 | 0.159286 | -53.9195 | LN_QJF |
| 1 | 0.329499 | 0.307149 | 7.7261 | -53.4124 | 0.177356 | -50.4809 | $(QND)^{-0.1}$ |
| 1 | 0.224631 | 0.198785 | 13.3138 | -48.7623 | 0.205095 | -45.8308 | LN_QMJ |
| 1 | 0.203729 | 0.177187 | 14.4275 | -47.9111 | 0.210623 | -44.9796 | $(QMA)^{-0.1}$ |
| 2 | 0.500532 | 0.466086 | 0.6130 | -60.8358 | 0.136671 | -56.4386 | LN_QJF $(QND)^{-0.1}$ |
| 2 | 0.429266 | 0.389905 | 4.4103 | -56.5676 | 0.156172 | -52.1704 | LN_QJF LN_QMJ |
| 2 | 0.425407 | 0.385780 | 4.6159 | -56.3520 | 0.157228 | -51.9548 | LN_QMJ $(QND)^{-0.1}$ |
| 2 | 0.419934 | 0.379929 | 4.9075 | -56.0486 | 0.158726 | -51.6514 | LN_QJF LN_QSO |
| 3 | 0.521478 | 0.470208 | 1.4970 | -60.2067 | 0.135616 | -54.3437 | LN_QJF LN_QMJ $(QND)^{-0.1}$ |
| 3 | 0.508724 | 0.456088 | 2.1765 | -59.3650 | 0.139231 | -53.5020 | LN_QJF LN_QSO $(QND)^{-0.1}$ |
| 3 | 0.503338 | 0.450124 | 2.4635 | -59.0160 | 0.140757 | -53.1531 | LN_QJF $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 3 | 0.500990 | 0.447524 | 2.5886 | -58.8651 | 0.141423 | -53.0021 | LN_QJF $(QMA)^{-0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.529071 | 0.459304 | 3.0924 | -58.7185 | 0.138407 | -51.3899 | LN_QJF LN_QMJ LN_QSO $(QND)^{-0.1}$ |
| 4 | 0.525656 | 0.455383 | 3.2744 | -58.4873 | 0.139411 | -51.1586 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QND)^{-0.1}$ |
| 4 | 0.521528 | 0.450643 | 3.4943 | -58.2100 | 0.140624 | -50.8813 | LN_QJF LN_QMJ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.511339 | 0.438945 | 4.0372 | -57.5357 | 0.143619 | -50.2071 | LN_QJF $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.530726 | 0.440481 | 5.0042 | -56.8312 | 0.143226 | -48.0367 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.529106 | 0.438549 | 5.0905 | -56.7209 | 0.143720 | -47.9265 | LN_QJF LN_QMJ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.525785 | 0.434590 | 5.2675 | -56.4960 | 0.144733 | -47.7016 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.512446 | 0.418685 | 5.9782 | -55.6083 | 0.148805 | -46.8139 | LN_QJF $(QMA)^{-0.1}$ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 6 | 0.530805 | 0.418198 | 7.0000 | -54.8366 | 0.148929 | -44.5764 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |

### 7.2.3 Variables Transformed According to the Box-Cox Analysis: 1991 Omitted

N = 32 Regression Models for Dependent Variable: $(\text{WHITE SHRIMP})^{0.2}$

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.431002 | 0.412036 | 6.2636 | -59.6240 | 0.146064 | -56.6925 | $(QND)^{-0.1}$ |
| 1 | 0.382659 | 0.362081 | 9.1747 | -57.0146 | 0.158474 | -54.0831 | LN_QJF |
| 1 | 0.200539 | 0.173890 | 20.1416 | -48.7420 | 0.205225 | -45.8106 | $(QMA)^{-0.1}$ |
| 1 | 0.157721 | 0.129645 | 22.7199 | -47.0725 | 0.216216 | -44.1410 | LN_QMJ |
| 2 | 0.552353 | 0.521481 | 0.9562 | -65.2999 | 0.118875 | -60.9027 | LN_QJF $(QND^{-0.1})$ |
| 2 | 0.491434 | 0.456360 | 4.6246 | -61.2170 | 0.135053 | -56.8198 | $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 2 | 0.475504 | 0.439332 | 5.5838 | -60.2301 | 0.139283 | -55.8329 | LN_QMJ $(QND)^{-0.1}$ |
| 2 | 0.458648 | 0.421314 | 6.5988 | -59.2178 | 0.143759 | -54.8206 | $(QMA)^{-0.1}$ $(QND)^{-0.1}$ |
| 3 | 0.575340 | 0.529841 | 1.5720 | -64.9868 | 0.116798 | -59.1239 | LN_QJF $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 3 | 0.557197 | 0.509753 | 2.6645 | -63.6480 | 0.121789 | -57.7851 | LN_QJF LN_QMJ $(QND)^{-0.1}$ |
| 3 | 0.555735 | 0.508135 | 2.7525 | -63.5426 | 0.122191 | -57.6796 | LN_QJF LN_QSO $(QND)^{-0.1}$ |
| 3 | 0.552388 | 0.504430 | 2.9541 | -63.3024 | 0.123111 | -57.4395 | LN_QJF $(QMA)^{-0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.580506 | 0.518359 | 3.2609 | -63.3785 | 0.119651 | -56.0498 | LN_QJF $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 4 | 0.578131 | 0.515632 | 3.4039 | -63.1978 | 0.120328 | -55.8692 | LN_QJF $(QMA)^{-0.1}$ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.577069 | 0.514413 | 3.4678 | -63.1174 | 0.120631 | -55.7887 | LN_QJF LN_QMJ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.559764 | 0.494544 | 4.5099 | -61.8341 | 0.125567 | -54.5055 | LN_QJF LN_QMJ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.582949 | 0.502746 | 5.1138 | -61.5653 | 0.123529 | -52.7709 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.581786 | 0.501360 | 5.1838 | -61.4763 | 0.123874 | -52.6818 | LN_QJF $(QMA)^{-0.1}$ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.581556 | 0.501086 | 5.1977 | -61.4587 | 0.123942 | -52.6643 | LN_QJF LN_QMJ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.560358 | 0.475812 | 6.4741 | -59.8773 | 0.130220 | -51.0829 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ LN_QSO $(QND)^{-0.1}$ |
| 6 | 0.584838 | 0.485200 | 7.0000 | -59.7107 | 0.127888 | -49.4505 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |

### 7.2.4 Variables Transformed According to the Box-Cox Analysis: 1968 and 1990 Omitted

N = 31 Regression Models for Dependent Variable: $(\text{WHITE SHRIMP})^{0.2}$

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.423883 | 0.404016 | 4.1329 | -56.9629 | 0.149590 | -54.0950 | LN_QJF |
| 1 | 0.381031 | 0.359687 | 6.4486 | -54.7389 | 0.160717 | -51.8709 | $(QND)^{-0.1}$ |
| 1 | 0.236573 | 0.210248 | 14.2549 | -48.2362 | 0.198226 | -45.3683 | $(QMA)^{-0.1}$ |
| 1 | 0.194009 | 0.166216 | 16.5551 | -46.5543 | 0.209278 | -43.6864 | LN_QMJ |
| 2 | 0.552156 | 0.520167 | -0.7989 | -62.7708 | 0.120437 | -58.4688 | LN_QJF $(QND)^{-0.1}$ |
| 2 | 0.447084 | 0.407591 | 4.8791 | -56.2372 | 0.148693 | -51.9353 | $(QMA)^{-0.1}$ $(QND)^{-0.1}$ |
| 2 | 0.436480 | 0.396229 | 5.4521 | -55.6483 | 0.151545 | -51.3463 | LN_QMJ $(QND)^{-0.1}$ |
| 2 | 0.435976 | 0.395689 | 5.4794 | -55.6206 | 0.151681 | -51.3186 | LN_QJF LN_QMJ |
| 3 | 0.555428 | 0.506031 | 1.0243 | -60.9981 | 0.123985 | -55.2621 | LN_QJF LN_QMJ $(QND)^{-0.1}$ |
| 3 | 0.554245 | 0.504716 | 1.0882 | -60.9157 | 0.124315 | -55.1798 | LN_QJF $(QMA)^{-0.1}$ $(QND)^{-0.1}$ |
| 3 | 0.552760 | 0.503066 | 1.1685 | -60.8126 | 0.124729 | -55.0767 | LN_QJF LN_QSO $(QND)^{-0.1}$ |
| 3 | 0.552320 | 0.502578 | 1.1922 | -60.7822 | 0.124852 | -55.0462 | LN_QJF $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.555714 | 0.487362 | 3.0088 | -59.0180 | 0.128671 | -51.8481 | LN_QJF LN_QMJ LN_QSO $(QND)^{-0.1}$ |
| 4 | 0.555641 | 0.487278 | 3.0128 | -59.0130 | 0.128692 | -51.8430 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QND)^{-0.1}$ |
| 4 | 0.555443 | 0.487049 | 3.0235 | -58.9991 | 0.128749 | -51.8292 | LN_QJF LN_QMJ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.554460 | 0.485915 | 3.0766 | -58.9307 | 0.129034 | -51.7608 | LN_QJF $(QMA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.555852 | 0.467022 | 5.0014 | -57.0277 | 0.133776 | -48.4238 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.555730 | 0.466876 | 5.0080 | -57.0192 | 0.133813 | -48.4152 | LN_QJF LN_QMJ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.555668 | 0.466801 | 5.0113 | -57.0148 | 0.133832 | -48.4109 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.554464 | 0.465357 | 5.0764 | -56.9310 | 0.134194 | -48.3271 | LN_QJF $(QMA)^{-0.1}$ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 6 | 0.555877 | 0.444847 | 7.0000 | -55.0295 | 0.139342 | -44.9916 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |

### 7.2.5 Variables Transformed According to the Box-Cox Analysis: 1968 and 1991 Omitted

N = 31 Regression Models for Dependent Variable: $(\text{WHITE SHRIMP})^{0.2}$

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.498282 | 0.480982 | 5.9713 | -62.2077 | 0.126307 | -59.3397 | $(QND)^{-0.1}$ |
| 1 | 0.407551 | 0.387122 | 11.9339 | -57.0546 | 0.149148 | -54.1867 | LN_QJF |
| 1 | 0.234102 | 0.207691 | 23.3324 | -49.0943 | 0.192814 | -46.2263 | $(QMA)^{-0.1}$ |
| 1 | 0.127449 | 0.097361 | 30.3413 | -45.0528 | 0.219664 | -42.1848 | LN_QMJ |
| 2 | 0.616056 | 0.588631 | 0.2316 | -68.5014 | 0.100110 | -64.1995 | LN_QJF $(QND)^{-0.1}$ |
| 2 | 0.543030 | 0.510389 | 5.0306 | -63.1037 | 0.119150 | -58.8018 | $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 2 | 0.532606 | 0.499220 | 5.7157 | -62.4045 | 0.121868 | -58.1025 | $(QMA)^{-0.1}$ $(QND)^{-0.1}$ |
| 2 | 0.513093 | 0.478314 | 6.9980 | -61.1366 | 0.126956 | -56.8346 | LN_QMJ $(QND)^{-0.1}$ |
| 3 | 0.630092 | 0.588991 | 1.3092 | -67.6560 | 0.100022 | -61.9200 | LN_QJF $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 3 | 0.620296 | 0.578107 | 1.9530 | -66.8457 | 0.102671 | -61.1098 | LN_QJF LN_QSO $(QND)^{-0.1}$ |
| 3 | 0.616941 | 0.574379 | 2.1734 | -66.5730 | 0.103578 | -60.8371 | LN_QJF LN_QMJ $(QND)^{-0.1}$ |
| 3 | 0.616367 | 0.573741 | 2.2112 | -66.5266 | 0.103733 | -60.7906 | LN_QJF $(QMA)^{-0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.632486 | 0.575945 | 3.1519 | -65.8572 | 0.103197 | -58.6873 | LN_QJF LN_QMJ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.632338 | 0.575774 | 3.1616 | -65.8448 | 0.103238 | -58.6748 | LN_QJF $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 4 | 0.630483 | 0.573635 | 3.2835 | -65.6888 | 0.103759 | -58.5189 | LN_QJF $(QMA)^{-0.1}$ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.621274 | 0.563008 | 3.8887 | -64.9257 | 0.106345 | -57.7557 | LN_QJF LN_QMJ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.634727 | 0.561672 | 5.0046 | -64.0469 | 0.106670 | -55.4429 | LN_QJF LN_QMJ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.633313 | 0.559976 | 5.0975 | -63.9271 | 0.107083 | -55.3232 | LN_QJF $(QMA)^{-0.1}$ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.632502 | 0.559003 | 5.1508 | -63.8586 | 0.107320 | -55.2547 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.621650 | 0.545980 | 5.8640 | -62.9565 | 0.110489 | -54.3525 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ LN_QSO $(QND)^{-0.1}$ |
| 6 | 0.634797 | 0.543496 | 7.0000 | -62.0528 | 0.111094 | -52.0149 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |

### 7.2.6 Variables Transformed According to the Box-Cox Analysis: 1990 and 1991 Omitted

N = 31 Regression Models for Dependent Variable: $(\text{WHITE SHRIMP})^{0.2}$

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.453540 | 0.434697 | 11.8997 | -60.0619 | 0.135359 | -57.1939 | $(QND)^{-0.1}$ |
| 1 | 0.419023 | 0.398989 | 14.3568 | -58.1631 | 0.143909 | -55.2952 | LN_QJF |
| 1 | 0.251976 | 0.226182 | 26.2480 | -50.3287 | 0.185287 | -47.4607 | LN_QMJ |
| 1 | 0.180581 | 0.152325 | 31.3303 | -47.5027 | 0.202972 | -44.6347 | $(QMA)^{-0.1}$ |
| 2 | 0.591460 | 0.562278 | 4.0819 | -67.0789 | 0.104811 | -62.7769 | LN_QJF $(QND)^{-0.1}$ |
| 2 | 0.546246 | 0.513835 | 7.3004 | -63.8250 | 0.116410 | -59.5230 | LN_QMJ $(QND)^{-0.1}$ |
| 2 | 0.497546 | 0.461657 | 10.7671 | -60.6646 | 0.128904 | -56.3626 | LN_QSO $(QND)^{-0.1}$ |
| 2 | 0.488719 | 0.452199 | 11.3955 | -60.1247 | 0.131169 | -55.8227 | $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 3 | 0.617005 | 0.574450 | 4.2635 | -67.0805 | 0.101896 | -61.3446 | LN_QJF LN_QMJ $(QND)^{-0.1}$ |
| 3 | 0.614059 | 0.571177 | 4.4731 | -66.8430 | 0.102680 | -61.1070 | LN_QJF LN_QSO $(QND)^{-0.1}$ |
| 3 | 0.596925 | 0.552139 | 5.6928 | -65.4964 | 0.107238 | -59.7604 | LN_QJF $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 3 | 0.596036 | 0.551151 | 5.7561 | -65.4281 | 0.107475 | -59.6922 | LN_QJF $(QMA)^{-0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.651341 | 0.597701 | 3.8193 | -67.9922 | 0.096329 | -60.8223 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QND)^{-0.1}$ |
| 4 | 0.638626 | 0.583030 | 4.7244 | -66.8819 | 0.099842 | -59.7120 | LN_QJF LN_QMJ LN_QSO $(QND)^{-0.1}$ |
| 4 | 0.619226 | 0.560646 | 6.1054 | -65.2608 | 0.105202 | -58.0909 | LN_QJF $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 4 | 0.617590 | 0.558757 | 6.2219 | -65.1279 | 0.105654 | -57.9579 | LN_QJF LN_QMJ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.661519 | 0.593822 | 5.0948 | -66.9106 | 0.097257 | -58.3067 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.652907 | 0.583489 | 5.7078 | -66.1318 | 0.099732 | -57.5279 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.639159 | 0.566991 | 6.6864 | -64.9276 | 0.103682 | -56.3237 | LN_QJF LN_QMJ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.622359 | 0.546831 | 7.8823 | -63.5169 | 0.108509 | -54.9130 | LN_QJF $(QMA)^{-0.1}$ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 6 | 0.662850 | 0.578562 | 7.0000 | -65.0328 | 0.100911 | -54.9949 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |

| OBS | _MODEL_ | _TYPE_ | _DEPVAR_ | _RMSE_ | INTERCEP | BOX_QJF | BOX_QMA | BOX_QMJ | BOX_QJA | BOX_QSO |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MODEL1 | PARMS | BOX_WSH | 0.36791 | 6.28793 | . | . | . | . | . |
| 2 | MODEL1 | PARMS | BOX_WSH | 0.37935 | 3.19801 | 0.20744 | . | . | . | . |
| 3 | MODEL1 | PARMS | BOX_WSH | 0.43045 | 3.08273 | . | . | 0.16897 | . | . |
| 4 | MODEL1 | PARMS | BOX_WSH | 0.45052 | 5.18871 | . | -1.79355 | . | . | . |
| 5 | MODEL1 | PARMS | BOX_WSH | 0.32374 | 5.15229 | 0.13535 | . | . | . | . |
| 6 | MODEL1 | PARMS | BOX_WSH | 0.34119 | 5.45450 | . | . | 0.10805 | . | . |
| 7 | MODEL1 | PARMS | BOX_WSH | 0.35903 | 5.82331 | . | . | . | . | 0.064644 |
| 8 | MODEL1 | PARMS | BOX_WSH | 0.36217 | 6.93300 | . | . | . | -0.89651 | . |
| 9 | MODEL1 | PARMS | BOX_WSH | 0.31921 | 4.90116 | 0.10748 | . | 0.06288 | . | . |
| 10 | MODEL1 | PARMS | BOX_WSH | 0.32044 | 4.89188 | 0.12615 | . | . | . | 0.046975 |
| 11 | MODEL1 | PARMS | BOX_WSH | 0.32747 | 5.49565 | 0.12637 | . | . | -0.37248 | . |
| 12 | MODEL1 | PARMS | BOX_WSH | 0.32783 | 4.89145 | 0.14987 | 0.37304 | . | . | . |
| 13 | MODEL1 | PARMS | BOX_WSH | 0.31037 | 3.85729 | 0.13387 | 1.22071 | 0.11053 | . | . |
| 14 | MODEL1 | PARMS | BOX_WSH | 0.31598 | 4.65120 | 0.09901 | . | 0.06167 | . | 0.045957 |
| 15 | MODEL1 | PARMS | BOX_WSH | 0.32435 | 5.22746 | 0.11748 | . | . | -0.36220 | 0.046668 |
| 16 | MODEL1 | PARMS | BOX_WSH | 0.32504 | 5.03244 | 0.10580 | . | 0.05967 | -0.12854 | . |
| 17 | MODEL1 | PARMS | BOX_WSH | 0.31186 | 3.83807 | 0.12382 | 1.03495 | 0.10242 | . | 0.032739 |
| 18 | MODEL1 | PARMS | BOX_WSH | 0.31580 | 4.05451 | 0.13158 | 1.24228 | 0.10611 | -0.21115 | . |
| 19 | MODEL1 | PARMS | BOX_WSH | 0.32200 | 4.77685 | 0.09741 | . | 0.05862 | -0.12274 | 0.045903 |
| 20 | MODEL1 | PARMS | BOX_WSH | 0.32941 | 5.08839 | 0.12922 | 0.32621 | . | -0.43462 | 0.042652 |
| 21 | MODEL1 | PARMS | BOX_WSH | 0.31767 | 4.02017 | 0.12182 | 1.05691 | 0.09843 | -0.19474 | 0.032374 |

| OBS | BOX_QND | BOX_WSH | _IN_ | _P_ | _EDF_ | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | -3.33409 | -1 | 1 | 2 | 29 | 0.13536 | 0.45354 | 0.43470 | 11.8997 | -60.0619 | -57.1939 |
| 2 | . | -1 | 1 | 2 | 29 | 0.14391 | 0.41902 | 0.39899 | 14.3568 | -58.1631 | -55.2952 |
| 3 | . | -1 | 1 | 2 | 29 | 0.18529 | 0.25198 | 0.22618 | 26.2480 | -50.3287 | -47.4607 |
| 4 | . | -1 | 1 | 2 | 29 | 0.20297 | 0.18058 | 0.15233 | 31.3303 | -47.5027 | -44.6347 |
| 5 | -2.33809 | -1 | 2 | 3 | 28 | 0.10481 | 0.59146 | 0.56228 | 4.0819 | -67.0789 | -62.7769 |
| 6 | -2.83115 | -1 | 2 | 3 | 28 | 0.11641 | 0.54625 | 0.51384 | 7.3004 | -63.8250 | -59.5230 |
| 7 | -3.06205 | -1 | 2 | 3 | 28 | 0.12890 | 0.49755 | 0.46166 | 10.7671 | -60.6646 | -56.3626 |
| 8 | -3.31587 | -1 | 2 | 3 | 28 | 0.13117 | 0.48872 | 0.45220 | 11.3955 | -60.1247 | -55.8227 |
| 9 | -2.25053 | -1 | 3 | 4 | 27 | 0.10190 | 0.61701 | 0.57445 | 4.2635 | -67.0805 | -61.3446 |
| 10 | -2.20813 | -1 | 3 | 4 | 27 | 0.10268 | 0.61406 | 0.57118 | 4.4731 | -66.8430 | -61.1070 |
| 11 | -2.39660 | -1 | 3 | 4 | 27 | 0.10724 | 0.59693 | 0.55214 | 5.6928 | -65.4964 | -59.7604 |
| 12 | -2.43223 | -1 | 3 | 4 | 27 | 0.10747 | 0.59604 | 0.55115 | 5.7561 | -65.4281 | -59.6922 |
| 13 | -2.49224 | -1 | 4 | 5 | 26 | 0.09633 | 0.65134 | 0.59770 | 3.8193 | -67.9922 | -60.8223 |
| 14 | -2.12506 | -1 | 4 | 5 | 26 | 0.09984 | 0.63863 | 0.58303 | 4.7244 | -66.8819 | -59.7120 |
| 15 | -2.26587 | -1 | 4 | 5 | 26 | 0.10520 | 0.61923 | 0.56065 | 6.1054 | -65.2608 | -58.0909 |
| 16 | -2.27518 | -1 | 4 | 5 | 26 | 0.10565 | 0.61759 | 0.55876 | 6.2219 | -65.1279 | -57.9579 |
| 17 | -2.36607 | -1 | 5 | 6 | 25 | 0.09726 | 0.66152 | 0.59382 | 5.0948 | -66.9106 | -58.3067 |
| 18 | -2.53700 | -1 | 5 | 6 | 25 | 0.09973 | 0.65291 | 0.58349 | 5.7078 | -66.1318 | -57.5279 |
| 19 | -2.14874 | -1 | 5 | 6 | 25 | 0.10368 | 0.63916 | 0.56699 | 6.6864 | -64.9276 | -56.3237 |
| 20 | -2.37068 | -1 | 5 | 6 | 25 | 0.10851 | 0.62236 | 0.54683 | 7.8823 | -63.5169 | -54.9130 |
| 21 | -2.40876 | -1 | 6 | 7 | 24 | 0.10091 | 0.66285 | 0.57856 | 7.0000 | -65.0328 | -54.9949 |

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 4.020175 | 1.07584720 | 3.737 | 0.0010 | 0.00000000 |
| BOX_QJF | 1 | 0.121816 | 0.05253547 | 2.319 | 0.0292 | 1.91306200 |
| BOX_QMA | 1 | 1.056912 | 0.81387182 | 1.299 | 0.2064 | 2.64693294 |
| BOX_QMJ | 1 | 0.098433 | 0.05797850 | 1.698 | 0.1025 | 2.11176181 |
| BOX_QJA | 1 | -0.194737 | 0.63258487 | -0.308 | 0.7609 | 1.24724801 |
| BOX_QSO | 1 | 0.032374 | 0.03848167 | 0.841 | 0.4085 | 1.18624776 |
| BOX_QND | 1 | -2.408763 | 0.71741005 | -3.358 | 0.0026 | 1.49480441 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop BOX_QJF | Var Prop BOX_QMA | Var Prop BOX_QMJ | Var Prop BOX_QJA | Var Prop BOX_QSO | Var Prop BOX_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.78519 | 1.00000 | 0.0451 | 0.0353 | 0.0401 | 0.0243 | 0.0109 | 0.0344 |
| 2 | 1.11183 | 1.58273 | 0.0061 | 0.0108 | 0.0206 | 0.2072 | 0.3028 | 0.1324 |
| 3 | 0.89709 | 1.76201 | 0.0013 | 0.0351 | 0.0003 | 0.2851 | 0.4372 | 0.0965 |
| 4 | 0.51932 | 2.31585 | 0.0129 | 0.0262 | 0.2979 | 0.4483 | 0.0746 | 0.3711 |
| 5 | 0.43755 | 2.52297 | 0.7941 | 0.0007 | 0.1289 | 0.0332 | 0.0077 | 0.2955 |
| 6 | 0.24901 | 3.34438 | 0.1405 | 0.8918 | 0.5121 | 0.0017 | 0.1667 | 0.0702 |

| Variable | DF | Variable Label |
|---|---|---|
| INTERCEP | 1 | Intercept |
| BOX_QJF | 1 | Ln (January-February Inflows) |
| BOX_QMA | 1 | (March-April Inflows)^ -0.1 |
| BOX_QMJ | 1 | Ln (May-June Inflows) |
| BOX_QJA | 1 | (July-August Inflows)^ -0.1 |
| BOX_QSO | 1 | Ln (September-October Inflows) |
| BOX_QND | 1 | (November-December Inflows)^ -0.1 |

### 7.2.7 Variables Transformed According to the Box-Cox Analysis: 1968, 1990 and 1991 Omitted

N = 30 Regression Models for Dependent Variable: $(\text{WHITE SHRIMP})^{0.2}$

| Number In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.530858 | 0.514103 | 7.9406 | -63.4757 | 0.113019 | -60.6733 | $(QND)^{-0.1}$ |
| 1 | 0.451009 | 0.431402 | 13.7174 | -58.7604 | 0.132255 | -55.9580 | LN_QJF |
| 1 | 0.217562 | 0.189618 | 30.6064 | -48.1305 | 0.188494 | -45.3281 | LN_QMJ |
| 1 | 0.213951 | 0.185878 | 30.8676 | -47.9923 | 0.189364 | -45.1899 | $(QMA)^{-0.1}$ |
| 2 | 0.666383 | 0.641671 | 0.1359 | -71.7031 | 0.083347 | -67.4995 | LN_QJF $(QND)^{-0.1}$ |
| 2 | 0.577817 | 0.546544 | 6.5433 | -64.6397 | 0.105473 | -60.4361 | LN_QMJ $(QND)^{-0.1}$ |
| 2 | 0.552712 | 0.519580 | 8.3596 | -62.9068 | 0.111745 | -58.7032 | $(QMA)^{-0.1}$ $(QND)^{-0.1}$ |
| 2 | 0.551461 | 0.518235 | 8.4501 | -62.8230 | 0.112058 | -58.6194 | $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 3 | 0.670046 | 0.631975 | 1.8709 | -70.0343 | 0.085602 | -64.4295 | LN_QJF LN_QMJ $(QND)^{-0.1}$ |
| 3 | 0.668547 | 0.630302 | 1.9794 | -69.8983 | 0.085991 | -64.2935 | LN_QJF $(QMA)^{-0.1}$ $(QND)^{-0.1}$ |
| 3 | 0.667268 | 0.628876 | 2.0718 | -69.7828 | 0.086323 | -64.1780 | LN_QJF $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 3 | 0.667109 | 0.628699 | 2.0834 | -69.7685 | 0.086364 | -64.1637 | LN_QJF LN_QSO $(QND)^{-0.1}$ |
| 4 | 0.681124 | 0.630104 | 3.0695 | -69.0588 | 0.086037 | -62.0528 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QND)^{-0.1}$ |
| 4 | 0.671315 | 0.618726 | 3.7791 | -68.1499 | 0.088684 | -61.1439 | LN_QJF LN_QMJ LN_QSO $(QND)^{-0.1}$ |
| 4 | 0.670395 | 0.617659 | 3.8456 | -68.0661 | 0.088932 | -61.0601 | LN_QJF $(QMA)^{-0.1}$ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.670210 | 0.617443 | 3.8590 | -68.0492 | 0.088982 | -61.0432 | LN_QJF LN_QMJ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.681686 | 0.615370 | 5.0288 | -67.1117 | 0.089464 | -58.7045 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QJA)^{-0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.681525 | 0.615176 | 5.0404 | -67.0966 | 0.089510 | -58.6894 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.671490 | 0.603051 | 5.7664 | -66.1659 | 0.092330 | -57.7587 | LN_QJF LN_QMJ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.670717 | 0.602116 | 5.8224 | -66.0953 | 0.092547 | -57.6882 | LN_QJF $(QMA)^{-0.1}$ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 6 | 0.682084 | 0.599149 | 7.0000 | -65.1493 | 0.093237 | -55.3409 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |

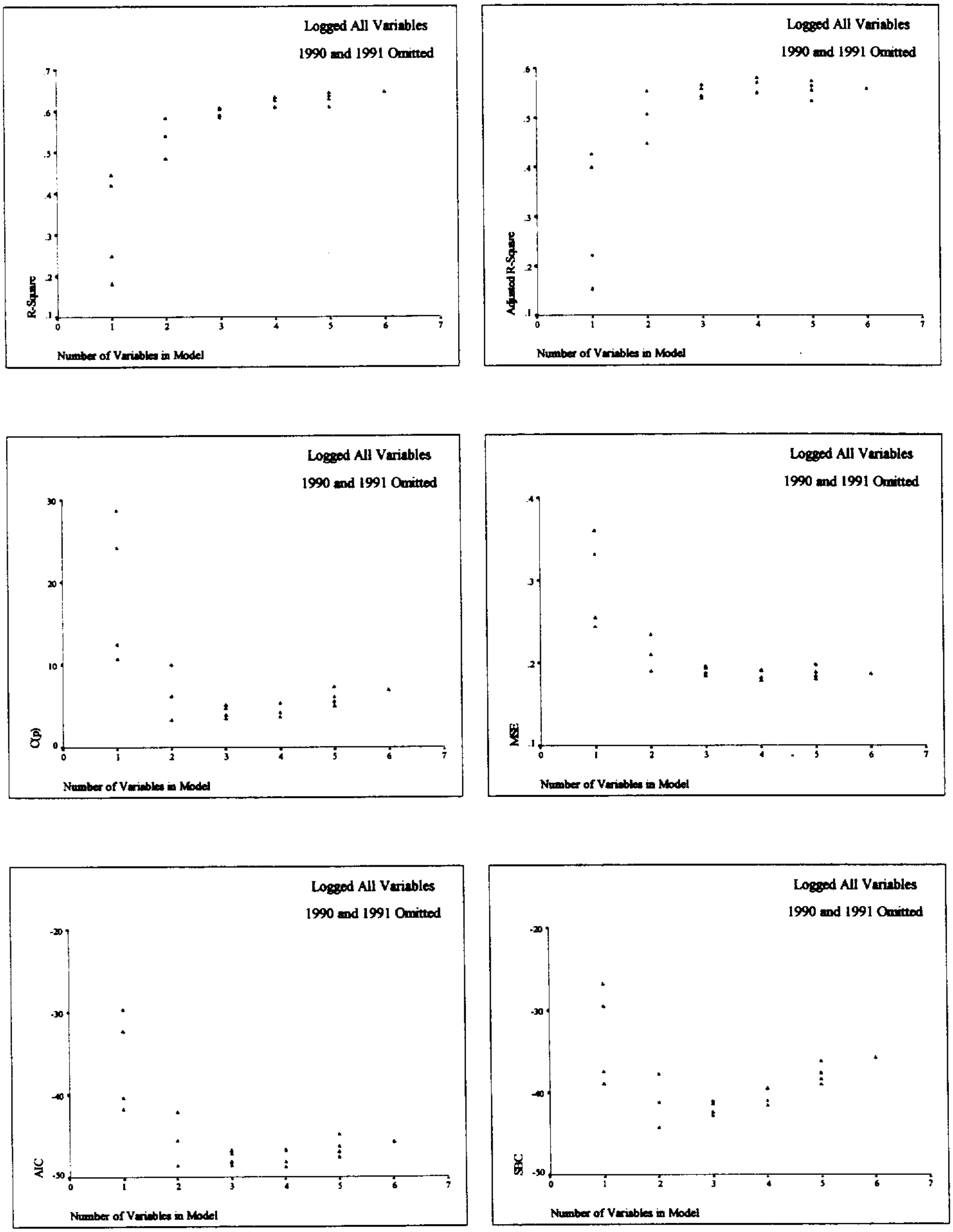



Fig. 7.1. Examining Subsets of Logged All Variables Data:
1990 and 1991 Omitted.

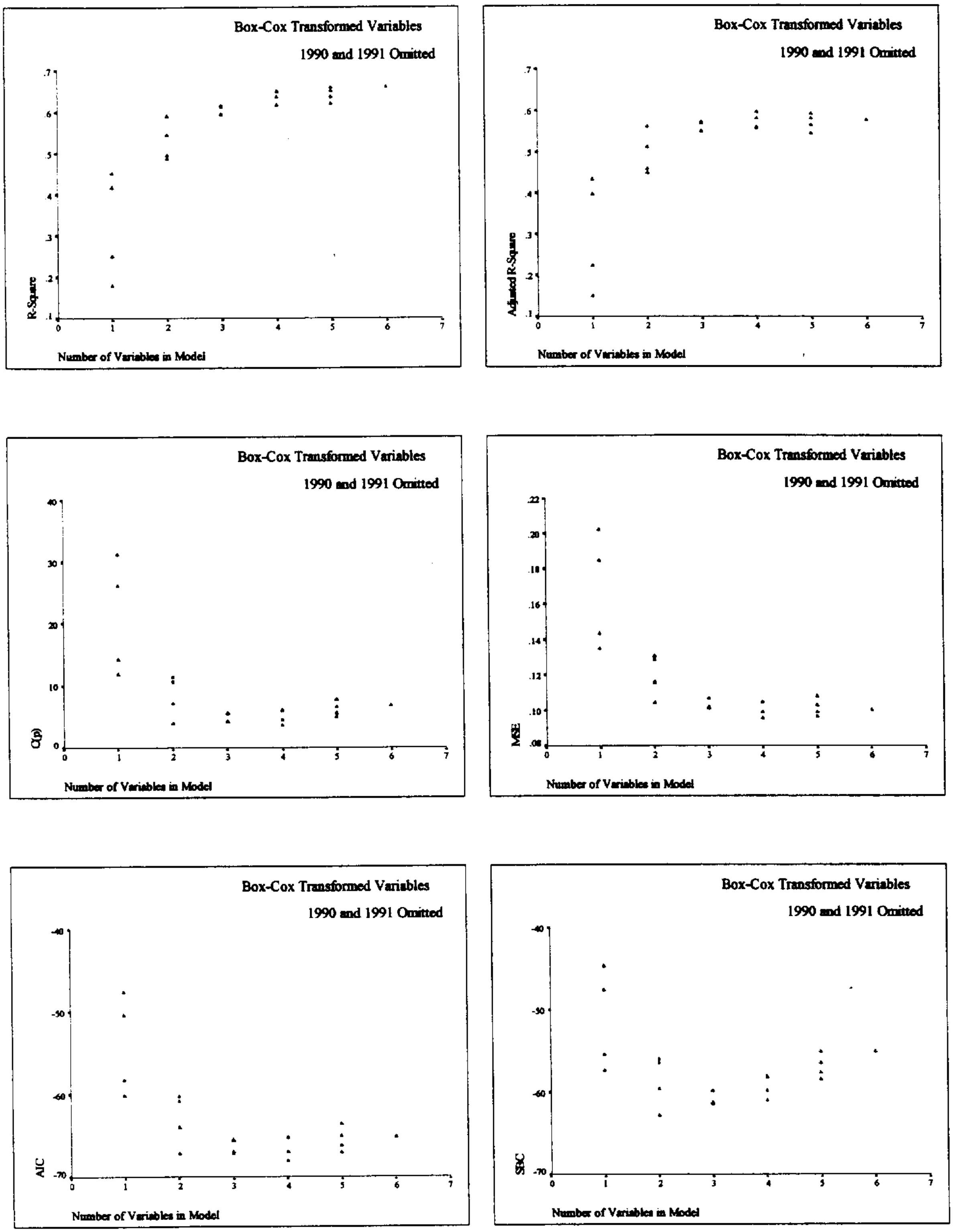



Fig. 7.2. Examining Subsets of Variables Transformed According to Box-Cox Analysis Data: 1990 and 1991 Omitted.

# Red Fish Harvests in Corpus Christi Bay: A Regression Analysis

## Harvest vs Freshwater Inflows

F. Michael Speed
Michael Longnecker
Birgir Hrafnkelsson

*Department of Statistics*
*Texas A&M University*

# RED FISH HARVESTS IN CORPUS CHRISTI BAY:

# A Regression Analysis
## Harvest vs. Freshwater Inflows

F. Michael Speed
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*Department of Statistics*
*Texas A&M University*
March 1997

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# 1. Summary Report

## 1.1 Description of the Problem[1]

Bimonthly freshwater inflows into Corpus Christi Bay were recorded for the years 1961 to 1980. These variables, and various transformations of them, were used to construct a model for the annual harvest of red fish.

## 1.2 Constructing Models - General Discussion

Stability of coefficient estimates and accuracy of predicted values are primary goals in constructing models for prediction. To this end, the data must be examined from three points of view: individual observations (to detect outliers or influential points); variables, individually and in groups (to select an optimal set of predictors); and the interaction of these two, which produces the overall structure of the data set (to determine whether multicollinearity is present or not). The first two of these were examined by both graphic and quantitative means; the third by quantitative means only.

### 1.2.1 Detecting Influential Points and Outliers

The structures of individual variables were examined via box plots and histograms, as well as by all the usual numerical measures. For each pair of variables, 99 % prediction ellipses and 95% confidence regions were plotted in a further effort to look for unusual points. For example, suppose large values of Variable A are generally associated with large values for Variable B. If an observation consisted of a large value for Variable A but a small value for Variable B, that point would be considered unusual, even though it was well within the range of data for both variables and could not be considered an outlier.

In addition, a number of residual analysis techniques were employed. A large residual indicates a point not well-fit by the model. The deleted residual, however, is somewhat more useful in the search for influential points. The model is fitted without a given observation, and the predicted response and corresponding residual are calculated for that observation. The Studentized deleted residual is scaled to have a Student's $t$ distribution. Histograms and normal P-P plots of the residuals were also examined.

Other quantities, such as the Mahalanobis distance, Cook's distance, the leverage value, standarized values for the *Dffits* (to measure the influence of a given observation on the predicted response) and the *Dfbetas* (to measure the influence of a given observation on the calculated coefficients) were also used to build a general picture of the influence of individual points. Plots were made of the standardized *Dffits* value for each model against the standardized *Dfbeta* values for each predictor in the model. Points which were extreme indicated observations which had strong effects on both predicted values and coefficient estimates.

1 The following discussion, prepared by Jacqueline Kiffe, was taken from Seatrout Harvest in Galveston Bay: A Regression Analysis, by F. Michael Speed, Sr. and Jacqueline Kiffe.

### 1.2.2 Variable Selection

For each regression, residuals were plotted against each of the independent variables to look for nonlinear relationships between the response variable and individual predictors. Partial residual plots were employed to examine the overall relationship between the response and individual predictors. A partial residual is a corollary to the deleted residual. That is, the model is fitted without a given variable and the predicted response and corresponding residual are calculated for each observation. This seeks to answer the question, "What is the relationship of this predictor to the response variable, taking all other variables into account?" Thus, it examines the marginal relationship of a given predictor to the response.

Numerous measures have been developed over the years to assess the adequacy of a given model. We examined a number of these, including $R^2$ and mean squared error (*MSE*), and several others which directly incorporate penalties for having too many predictors in the model, such as adjusted $R^2$, *Cp*, *AIC*, and *SBC*. It is well-established that too many predictors in a model can lead to bad prediction, just as too few can, and these measures are used as part of the attempt to find an optimal model.

### 1.2.3 Multicollinearity

Multicollinearity arises when one or more variables are nearly closely approximated by linear combinations of the remaining variables, resulting in unstable coefficient estimates. The variance inflation factor (*VIF*) was calculated for each coefficient estimate to measure this instability, which is not usually considered profound for *VIF*'s less than 10. No problems were found with this data. Additionally, the condition index (a ratio of eigenvalues of the covariance matrix, with the largest eigenvalue always on top) was calculated. A ratio greater than 30 is considered cause for concern. Again, no evidence of multicollinearity was found.

### 1.2.4 Other Procedures

Several other miscellaneous diagnostics, including the Durbin-Watson test for serial autocorrelation were performed, and no general problems were detected. The Box-Cox procedure, used to find a transformation to normality, was also performed.

## 1.3 How the Final Model Was Chosen

### 1.3.1 Selecting the Data Set Used

First, the variables were explored thoroughly, individually and in pairs, in a first effort to detect outliers. The SAS® programming language allows a number of diagnostics to be calculated for a group of models on a given data set without actually performing a formal regression, thus allowing one to examine a large number of models quite efficiently. The Box-Cox procedure was performed to find if a transformation to normality was suggested. The log transform was suggested for some variables, and the squared root for others. At this point, there were several data sets for which the diagnostic series was calculated:

1. Untransformed red fish data and untransformed inflow data
2. Untransformed red fish data and square root of inflow data
3. Log of red fish data and untransformed inflow data
4. Log of red fish data and log of inflow data
5. Log of red fish data and square root of inflow data
6. Square root of red fish data and untransformed inflow data
7. Square root of red·fish data and square root of inflow data
8. Various transformation suggested by Box-Cox

### 1.3.2 Selecting the Points to be Omitted

The full regression with all diagnostics was performed for these models, each one contained all variables in its corresponding data set. All diagnostics were generated, and influential points were determined for each model.

***Table 1.1*** *$R^2$ and Adjusted $R^2$ for full data sets.*

| Data Set | $R^2$ | Adj. $R^2$ |
|---|---|---|
| 1 | 0.9618 | 0.9442 |
| 2 | 0.9371 | 0.9080 |
| 3 | 0.9451 | 0.9198 |
| 4 | 0.9305 | 0.8984 |
| 5 | 0.9519 | 0.9298 |
| 6 | 0.9627 | 0.9455 |
| 7 | 0.9552 | 0.9346 |
| 8 | 0.9012 | 0.8556 |

Data sets 1,5, 6 and 7 presented the highest $R^2$ values. These four models were considered final candidates. The observations flagged as potentially influential are given in the summary table below, for each model.

***Table 1.2*** *Summary of points flagged by Boxplots.*

| Year | Variable |
|---|---|
| 1964 | Ln(March-April), Ln(May-June), Sqrt(May-June) |
| 1970 | January-February inflows. |
| 1971 | July-August inflows. |
| 1972 | July-August inflows. |
| 1973 | July-August inflows. |
| 1977 | March-April inflows. Ln(March-April), Sqrt(March-April) |
| 1978 | March-April inflows. Ln(March-April), Sqrt(March-April) |
| 1979 | March-April inflows. Ln(March-April), Sqrt(March-April) |

***Table 1.3*** *Summary of points flagged by 99% prediction ellipses.*

| Year | Variable |
|---|---|
| None | None |

***Table 1.4*** *Outliers of data set 1.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1961 | | | | 1 | | | | | 1 |
| 1966 | | | | | | | 1 | | 1 |
| 1968 | | | | | | | 1 | | 1 |
| 1969 | | | | | | | 1 | 4 | 5 |
| 1970 | 1 | | | | | | | | 1 |
| 1971 | 1 | | | | | | 1 | | 2 |
| 1972 | 1 | | | | | | | | 1 |
| 1973 | 1 | | | | | | 1 | | 2 |
| 1974 | | | | 1 | | | 1 | | 2 |
| 1977 | 1 | | | | | | | | 1 |
| 1978 | 1 | | | | | | | | 1 |
| 1979 | 1 | | | | | | | | 1 |

***Table 1.5*** *Outliers of data set 5.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1964 | 1 | | | 1 | | | | | 2 |
| 1966 | | | | | | | 1 | 1 | 2 |
| 1968 | | | | | | | 1 | | 1 |
| 1969 | | | | | | | 1 | 5 | 6 |
| 1977 | 1 | | | | | | | | 1 |
| 1978 | 1 | | | | | | | | 1 |
| 1979 | 1 | | | | | | | | 1 |

***Table 1.6*** *Outliers of data set 6.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1961 | | | | 1 | | | | | 1 |
| 1966 | | | | | | | 1 | | 1 |
| 1968 | | | | | | | 1 | | 1 |
| 1969 | | | 1 | | | | 1 | 5 | 7 |
| 1970 | 1 | | | | | | | | 1 |
| 1971 | 1 | | | | | | | | 1 |
| 1972 | 1 | | | | | | | | 1 |
| 1973 | 1 | | | | | | | | 1 |
| 1974 | | | | 1 | | | | | 1 |
| 1977 | 1 | | | | | | | | 1 |
| 1978 | 1 | | | | | | | | 1 |
| 1979 | 1 | | | | | | | | 1 |

***Table 1.7*** *Outliers of data set 7.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1964 | 1 | | | 1 | | | | | 1 |
| 1966 | | | | | | | 1 | 1 | 2 |
| 1968 | | | | | | | 1 | | 1 |
| 1969 | | | | | | | 1 | 3 | 4 |
| 1973 | | | | | | | 1 | | 1 |
| 1977 | 1 | | | | | | | | 1 |
| 1978 | 1 | | | | | | | | 1 |
| 1979 | 1 | | | | | | | | 1 |

***A Key to Abbreviations:***

BOX Box plot
SRE Studentized residual
SDR Studentized deleted residual
LEV Leverage value
MAH Mahalanobis distance
COO Cook's distance
SDF Standardized Dffits value
SDB Standardized Dfbeta value

### 1.3.3 Selecting the Final Candidate Models

After the subset analysis led us to four models, Data Set 1 with 1969 omitted; Data Set 5 with 1969 omitted, Data Set 6 with 1969 omitted and Data Set 7 with 1969 omitted.

***Table 1.8*** *$R^2$ and Adjusted $R^2$ for data sets number 1, 5, 6 and 7.*

| Data set | Observations omitted | $R^2$ | Adj. $R^2$ |
|---|---|---|---|
| 1 | 1969 | 0.9688 | 0.9532 |
| 5 | 1969 | 0.9652 | 0.9518 |
| 6 | 1969 | 0.9771 | 0.9657 |
| 7 | 1969 | 0.9646 | 0.9469 |

### 1.3.4 Selecting the Final Models

It appears that Data set 6 with 1969 omitted is the best model. Regression was performed using this model, and the deleted residuals were calculated.

Sqrt(Red fish Harvest) = 4.2151 - 0.08884*(Jan-Feb Inflows)
+ 0.048302*(March-April)
+ 0.026485*(May-Jun Inflows)
+ 0.008584*(Jul-Aug Inflows)
+ 0.003641*(Sep-Oct Inflows)
+ 0.011391*(Nov-Dec Inflows)

## 1.4 Best Model: Logged Harvest and Square Root of Inflow

### 1.4.1 Summary Information

***Table 1.9*** *Descriptive statistics for dependent and independent variables.*

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| Square Root of Red Harvest | 8.5905 | 3.6724 | 19 |
| January-February Inflows | 34.6168 | 24.4159 | 19 |
| March-April Inflows | 31.9484 | 35.6038 | 19 |
| May-June Inflows | 126.1547 | 62.5261 | 19 |
| July-August Inflows | 103.0537 | 107.6407 | 19 |
| SeptemberOctober Inflows | 275.7247 | 263.7114 | 19 |
| November-December Inflows | 59.4916 | 48.5328 | 19 |

***Table 1.10*** *Model summary for the final model.*

**Model Summary[a,b]**

| | Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|
| | January-February Inf., March-April Infl., May-June Infl., July-August Infl., SeptemberOctober Infl., November-December Infl.,[c,d] | .989 | .977 | .966 | .6801 | 2.607 |

a. Dependent Variable: Square Root of Red Harvest

b. Method: Enter

c. Independent Variables: (Constant), November-December Inflows, SeptemberOctober Inflows, July-August Inflows, May-June Inflows, January-February Inflows, March-April Inflows

d. All requested variables entered.

***Table 1.11*** *Anova for the final model.*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 237.206 | 6 | 39.534 | 85.464 | .000 |
| | Residual | 5.551 | 12 | .463 | | |
| | Total | 242.757 | 18 | | | |

a. Dependent Variable: Square Root of Red Harvest

***Table 1.12*** *Parameter estimates for the final model.*

**Coefficients**[a]

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | 4.215 | .521 | | 8.087 | .000 | 3.079 | 5.351 |
| January-February Infl. | -8.9E-02 | .010 | -.591 | -8.922 | .000 | -.111 | -.067 |
| March-April Infl. | 4.8E-02 | .010 | .468 | 4.705 | .001 | .026 | .071 |
| May-June Infl. | 2.6E-02 | .005 | .451 | 5.405 | .000 | .016 | .037 |
| July-August Infl. | 8.6E-03 | .002 | .252 | 4.234 | .001 | .004 | .013 |
| SeptemberOctober Infl. | 3.6E-03 | .001 | .261 | 3.601 | .004 | .001 | .006 |
| November-December Infl. | 1.1E-02 | .007 | .151 | 1.575 | .141 | -.004 | .027 |

a. Dependent Variable: Square Root of Red Harvest

***Table 1.13*** *Residuals statistics for the final model.*

**Residuals Statistics**[a]

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 2.8777 | 13.9144 | 8.5905 | 3.6302 | 19 |
| Std. Predicted Value | -1.574 | 1.467 | .000 | 1.000 | 19 |
| Standard Error of Predicted Value | .2250 | .5571 | .4050 | 8.23E-02 | 19 |
| Adjusted Predicted Value | 2.5304 | 13.9508 | 8.6771 | 3.5658 | 19 |
| Residual | -.8244 | 1.1833 | 4.2E-16 | .5553 | 19 |
| Std. Residual | -1.212 | 1.740 | .000 | .816 | 19 |
| Stud. Residual | -1.556 | 2.072 | -.045 | 1.027 | 19 |
| Deleted Residual | -1.8448 | 1.6784 | -9.E-02 | .9106 | 19 |
| Stud. Deleted Residual | -1.667 | 2.476 | -.020 | 1.115 | 19 |
| Mahal. Distance | 1.022 | 11.129 | 5.684 | 2.630 | 19 |
| Cook's Distance | .000 | .705 | .102 | .168 | 19 |
| Centered Leverage Value | .057 | .618 | .316 | .146 | 19 |

a. Dependent Variable: Square Root of Red Harvest

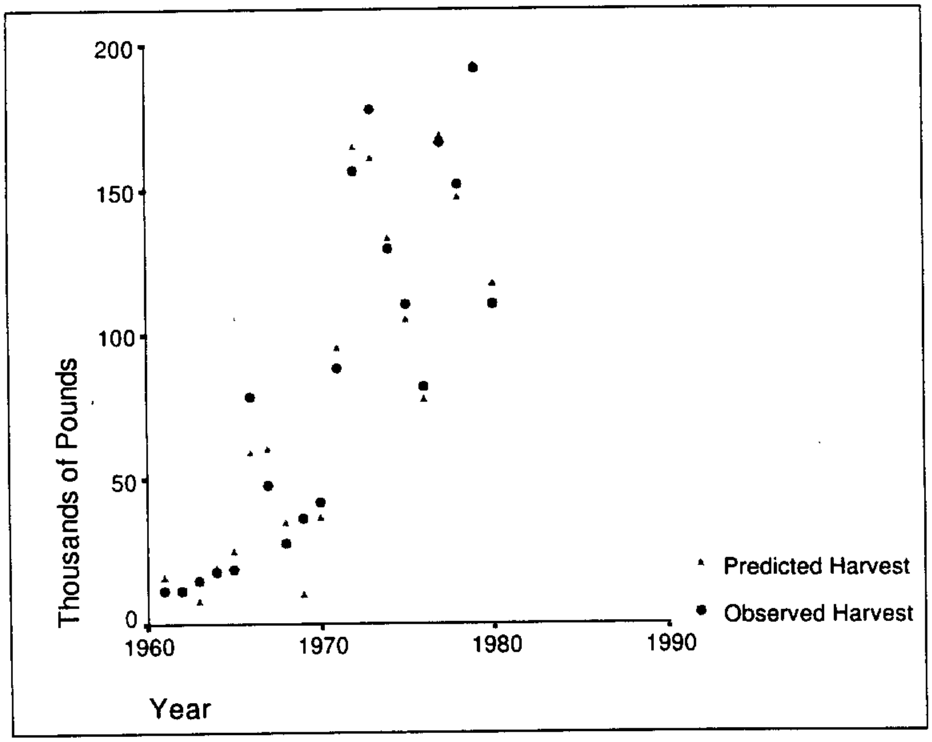


***Figure 1.1*** *Predicted and observed values for the harvest.*

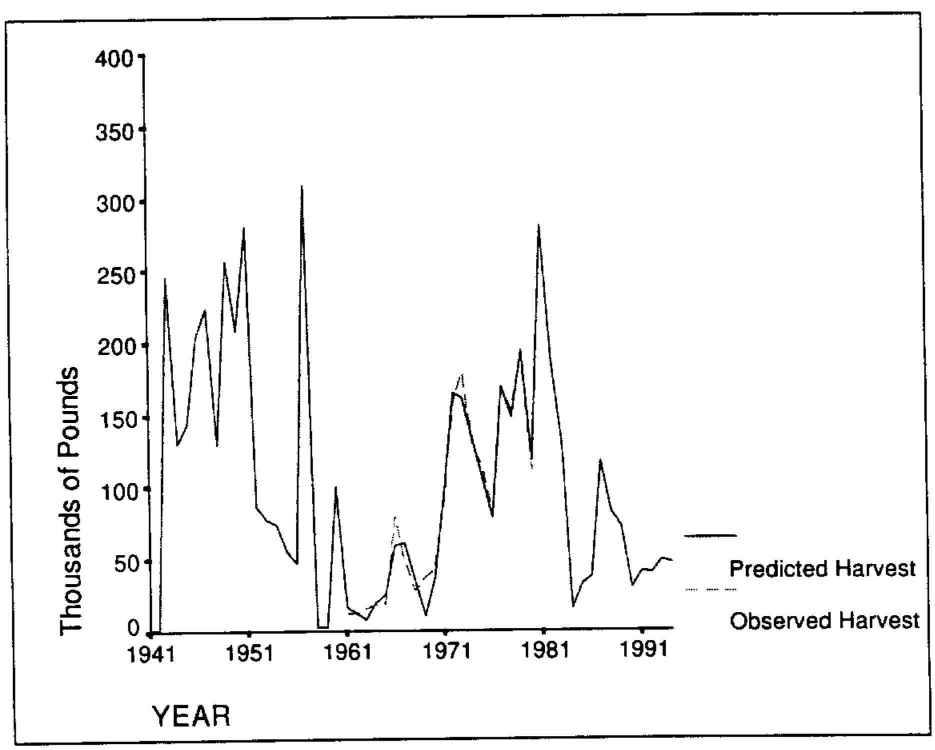


***Figure 1.2*** *Predicted and observed values for the harvest.*

***Table 1.14*** *Prediction Intervals for Red fish Fish Harvest based on the final model.*

| YEAR | *RED* | *PRE_1* | *LICI_1* | *UICI_1* |
|---|---|---|---|---|
| 1961 | 12.00 | 16.57 | 1.92 | 45.65 |
| 1962 | 12.10 | 12.07 | 1.39 | 33.31 |
| 1963 | 15.70 | 8.28 | 0.32 | 26.97 |
| 1964 | 18.30 | 19.69 | 3.50 | 49.05 |
| 1965 | 19.20 | 25.20 | 7.38 | 53.63 |
| 1966 | 79.10 | 59.45 | 28.58 | 101.50 |
| 1967 | 48.50 | 60.66 | 29.44 | 103.05 |
| 1968 | 28.50 | 35.21 | 11.32 | 72.30 |
| 1969 | 36.60 | 10.56 | 0.06 | 39.20 |
| 1970 | 42.40 | 36.99 | 12.84 | 73.65 |
| 1971 | 88.90 | 95.49 | 53.33 | 149.83 |
| 1972 | 156.70 | 164.70 | 109.05 | 231.79 |
| 1973 | 178.10 | 160.99 | 104.93 | 228.99 |
| 1974 | 129.90 | 133.54 | 79.06 | 202.20 |
| 1975 | 110.90 | 105.33 | 62.40 | 159.44 |
| 1976 | 82.30 | 77.82 | 44.00 | 121.21 |
| 1977 | 166.80 | 168.71 | 112.83 | 235.78 |
| 1978 | 152.20 | 147.31 | 94.62 | 211.63 |
| 1979 | 192.30 | 193.61 | 130.54 | 269.08 |
| 1980 | 111.00 | 117.72 | 72.03 | 174.59 |

| | |
|---|---|
| *RED* | Observed red fish fish harvest |
| *PRE_!* | Predicted trout harvest |
| *LICI_*1 | Lower limit for 99% prediction interval for the trout harvest. |
| *UICI_*1 | Upper limit for 99% prediction interval for the trout harvest. |

# 2. EXPLORING THE DATA

## 2.1 Listing of data

***Table 2.1*** *The red fish data and the inflow data.*

| Year | *Red* | *JF_inflow* | *MA_inflow* | *MJ_inflow* | *JA_inflow* | *SO_inflow* | *ND_inflow* |
|---|---|---|---|---|---|---|---|
| 1961 | 12.00 | 58.45 | 13.11 | 42.66 | 68.59 | 274.80 | 148.90 |
| 1962 | 12.10 | 49.25 | 12.81 | 38.52 | 52.35 | 178.60 | 78.65 |
| 1963 | 15.70 | 48.48 | 13.28 | 33.71 | 32.81 | 88.84 | 72.87 |
| 1964 | 18.30 | 5.49 | 6.64 | 7.72 | 10.11 | 9.91 | 5.45 |
| 1965 | 19.20 | 26.72 | 15.50 | 74.65 | 10.70 | 68.57 | 9.75 |
| 1966 | 79.10 | 27.01 | 20.93 | 166.41 | 12.65 | 68.66 | 10.36 |
| 1967 | 48.50 | 28.09 | 22.47 | 168.79 | 14.00 | 69.73 | 12.21 |
| 1968 | 28.50 | 89.91 | 21.03 | 219.30 | 27.86 | 670.67 | 17.64 |
| 1969 | 36.60 | 91.93 | 18.46 | 128.91 | 26.74 | 675.78 | 18.02 |
| 1970 | 42.40 | 95.26 | 25.37 | 211.69 | 38.31 | 693.83 | 56.42 |
| 1971 | 88.90 | 12.76 | 18.29 | 94.70 | 307.47 | 34.80 | 46.74 |
| 1972 | 156.70 | 21.69 | 17.45 | 147.81 | 310.47 | 612.72 | 78.25 |
| 1973 | 178.10 | 19.03 | 9.52 | 155.96 | 338.40 | 605.99 | 40.51 |
| 1974 | 129.90 | 23.79 | 19.07 | 158.31 | 73.99 | 816.37 | 64.29 |
| 1975 | 110.90 | 19.24 | 17.38 | 175.19 | 92.49 | 289.82 | 37.63 |
| 1976 | 82.30 | 17.23 | 16.72 | 105.85 | 126.23 | 285.93 | 35.21 |
| 1977 | 166.80 | 37.15 | 104.82 | 149.46 | 105.12 | 158.61 | 138.05 |
| 1978 | 152.20 | 30.44 | 104.63 | 105.60 | 101.84 | 103.47 | 133.86 |
| 1979 | 192.30 | 34.14 | 123.11 | 169.20 | 31.74 | 134.64 | 135.35 |
| 1980 | 111.00 | 13.59 | 24.89 | 171.41 | 202.89 | 72.81 | 8.20 |

| | |
|---|---|
| Red | Red fish harvest (thousands of pounds) |
| JF_inflow | Lagged January-February inflows (thousands of acre-feet) |
| MA_inflow | Lagged March-April inflows (thousands of acre-feet) |
| MJ_inflow | Lagged May-June inflows (thousands of acre-feet) |
| JA_inflow | Lagged July-August inflows (thousands of acre-feet) |
| SO_inflow | Lagged September-October inflows (thousands of acre-feet) |
| ND_inflow | Lagged November-December inflows (thousands of acre-feet) |

## 2.2 Examination of Individual Variables

***Table .2.2*** *Test of Normality for the red fish data and the inflow data.*

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Red Harvest | .167 | 20 | .145 | .901 | 20 | .045 |
| Ln(Red Harvest) | .173 | 20 | .118 | .899 | 20 | .042 |
| Square Root of Red Harvest | .120 | 20 | .200* | .915 | 20 | .084 |
| January-February Inflows | .205 | 20 | .027 | .834 | 20 | .010** |
| Ln(January-February Inflows) | .088 | 20 | .200* | .965 | 20 | .626 |
| Square Root of January-February Inflows | .151 | 20 | .200* | .925 | 20 | .156 |
| March-April Inflows | .417 | 20 | .000 | .579 | 20 | .010** |
| Ln(March-April Inflows) | .272 | 20 | .000 | .815 | 20 | .010** |
| Square Root of March-April Inflows | .355 | 20 | .000 | .681 | 20 | .010** |
| May-June Inflows | .188 | 20 | .062 | .931 | 20 | .213 |
| Ln(May-June Inflows) | .223 | 20 | .010 | .774 | 20 | .010** |
| Square Root of May-June Inflows | .214 | 20 | .017 | .885 | 20 | .021 |
| July-August Inflows | .228 | 20 | .008 | .772 | 20 | .010** |
| Ln(July-August Inflows) | .093 | 20 | .200* | .947 | 20 | .376 |
| Square Root of July-August Inflows | .149 | 20 | .200* | .886 | 20 | .023 |
| SeptemberOctober Inflows | .217 | 20 | .015 | .825 | 20 | .010** |
| Ln(September-October Inflows) | .154 | 20 | .200* | .929 | 20 | .191 |
| Square Root of Sepember-October Inflows | .177 | 20 | .101 | .901 | 20 | .044 |
| November-December Inflows | .144 | 20 | .200* | .866 | 20 | .010** |
| Ln(November-Desemb er Inflows) | .128 | 20 | .200* | .929 | 20 | .197 |
| Square Root of November-December Inflows | .142 | 20 | .200* | .924 | 20 | .144 |

*. This is a lower bound of the true significance.

**. This is an upper bound of the true significance.

a. *Lilliefors Significance Correction*

***Table .2.3*** *Percentiles of the red fish data and the inflow data.*

**Percentiles**

| | | Percentiles 5 | 10 | 25 | 50 | 75 | 90 | 95 |
|---|---|---|---|---|---|---|---|---|
| Weighted Average(Definition 1) | Red Harvest | 12.0050 | 12.4600 | 21.5250 | 80.7000 | 146.6250 | 176.9700 | 191.5900 |
| | Ln(Red Harvest) | 2.4853 | 2.5193 | 3.0537 | 4.3905 | 4.9856 | 5.1758 | 5.2552 |
| | Square Root of Red Harvest | 3.4648 | 3.5269 | 4.6210 | 8.9829 | 12.1020 | 13.3024 | 13.8411 |
| | January-February Inflows | 5.8535 | 12.8430 | 19.0825 | 27.5500 | 49.0575 | 91.7280 | 95.0935 |
| | Ln(January-February Inflows) | 1.7451 | 2.5526 | 2.9488 | 3.3158 | 3.8930 | 4.5188 | 4.5548 |
| | Square Root of January-February Inflows | 2.4045 | 3.5835 | 4.3683 | 5.2486 | 7.0041 | 9.5774 | 9.7515 |
| | March-April Inflows | 6.7840 | 9.8490 | 13.8350 | 18.3750 | 24.2850 | 104.8010 | 122.1955 |
| | Ln(March-April Inflows) | 1.9111 | 2.2831 | 2.6249 | 2.9110 | 3.1889 | 4.6521 | 4.8050 |
| | Square Root of March-April Inflows | 2.6023 | 3.1348 | 3.7174 | 4.2866 | 4.9268 | 10.2372 | 11.0526 |
| | May-June Inflows | 9.0195 | 34.1910 | 79.6625 | 148.6350 | 169.0975 | 208.0400 | 218.9195 |
| | Ln(May-June Inflows) | 2.1175 | 3.5311 | 4.3723 | 5.0015 | 5.1305 | 5.3362 | 5.3887 |
| | Square Root of May-June Inflows | 2.9299 | 5.8461 | 8.9129 | 12.1915 | 13.0037 | 14.4182 | 14.7958 |
| | July-August Inflows | 10.1395 | 10.8950 | 27.0200 | 60.4700 | 120.9525 | 310.1700 | 337.0035 |
| | Ln(July-August Inflows) | 2.3164 | 2.3870 | 3.2964 | 4.0930 | 4.7924 | 5.7371 | 5.8199 |
| | Square Root of July-August Inflows | 3.1842 | 3.2996 | 5.1979 | 7.7586 | 10.9896 | 17.6116 | 18.3569 |
| | SeptemberOctober Inflows | 11.1545 | 38.1770 | 70.5000 | 168.6050 | 611.0375 | 692.0250 | 810.2430 |
| | Ln(September-October Inflows) | 2.3563 | 3.6174 | 4.2554 | 5.1258 | 6.4151 | 6.5396 | 6.6967 |
| | Square Root of Sepember-October Inflows | 3.2856 | 6.1373 | 8.3961 | 12.9791 | 24.7191 | 26.3062 | 28.4606 |
| | November-December Inflows | 5.5875 | 8.3550 | 13.5675 | 43.6250 | 78.5500 | 137.7800 | 148.3575 |
| | Ln(November-Desember Inflows) | 1.7160 | 2.1214 | 2.5942 | 3.7731 | 4.3637 | 4.9256 | 4.9995 |
| | Square Root of November-December Inflows | 2.3610 | 2.8895 | 3.6707 | 6.6007 | 8.8628 | 11.7379 | 12.1798 |
| Tukey's Hinges | Red Harvest | | | 23.8500 | 80.7000 | 141.0500 | | |
| | Ln(Red Harvest) | | | 3.1524 | 4.3905 | 4.9460 | | |
| | Square Root of Red Harvest | | | 4.8602 | 8.9829 | 11.8672 | | |
| | January-February Inflows | | | 19.1350 | 27.5500 | 48.8650 | | |
| | Ln(January-February Inflows) | | | 2.9515 | 3.3158 | 3.8890 | | |
| | Square Root of January-February Inflows | | | 4.3743 | 5.2486 | 6.9903 | | |
| | March-April Inflows | | | 14.3900 | 18.3750 | 23.6800 | | |
| | Ln(March-April Inflows) | | | 2.6635 | 2.9110 | 3.1633 | | |
| | Square Root of March-April Inflows | | | 3.7906 | 4.2866 | 4.8646 | | |
| | May-June Inflows | | | 84.6750 | 148.6350 | 168.9950 | | |
| | Ln(May-June Inflows) | | | 4.4318 | 5.0015 | 5.1299 | | |
| | Square Root of May-June Inflows | | | 9.1857 | 12.1915 | 12.9998 | | |
| | July-August Inflows | | | 27.3000 | 60.4700 | 115.6750 | | |
| | Ln(July-August Inflows) | | | 3.3067 | 4.0930 | 4.7466 | | |
| | Square Root of July-August Inflows | | | 5.2247 | 7.7586 | 10.7440 | | |
| | SeptemberOctober Inflows | | | 71.2700 | 168.6050 | 609.3550 | | |
| | Ln(September-October Inflows) | | | 4.2662 | 5.1258 | 6.4124 | | |
| | Square Root of Sepember-October Inflows | | | 8.4417 | 12.9791 | 24.6850 | | |
| | November-December Inflows | | | 14.9250 | 43.6250 | 78.4500 | | |
| | Ln(November-Desember Inflows) | | | 2.6862 | 3.7731 | 4.3625 | | |
| | Square Root of November-December Inflows | | | 3.8471 | 6.6007 | 8.8572 | | |

### 2.2.1 The red fish data

***Table .2.4*** *Descriptives for the red fish data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| Red Harvest | Mean | | 84.0750 | 13.8448 |
| | 95% Confidence Interval for Mean | Lower Bound | 55.0974 | |
| | | Upper Bound | 113.0526 | |
| | 5% Trimmed Mean | | 82.0667 | |
| | Median | | 80.7000 | |
| | Variance | | 3833.586 | |
| | Std. Deviation | | 61.9160 | |
| | Minimum | | 12.00 | |
| | Maximum | | 192.30 | |
| | Range | | 180.30 | |
| | Interquartile Range | | 125.1000 | |
| | Skewness | | .364 | .512 |
| | Kurtosis | | -1.335 | .992 |

***Table .2.5*** *Extreme Values for the red fish data.*

**Extreme Values**

| | | | Case Number | YEAR | Value |
|---|---|---|---|---|---|
| RED | Highest | 1 | 19 | 1979 | 192.30 |
| | | 2 | 13 | 1973 | 178.10 |
| | | 3 | 17 | 1977 | 166.80 |
| | | 4 | 12 | 1972 | 156.70 |
| | | 5 | 18 | 1978 | 152.20 |
| | Lowest | 1 | 1 | 1961 | 12.00 |
| | | 2 | 2 | 1962 | 12.10 |
| | | 3 | 3 | 1963 | 15.70 |
| | | 4 | 4 | 1964 | 18.30 |
| | | 5 | 5 | 1965 | 19.20 |

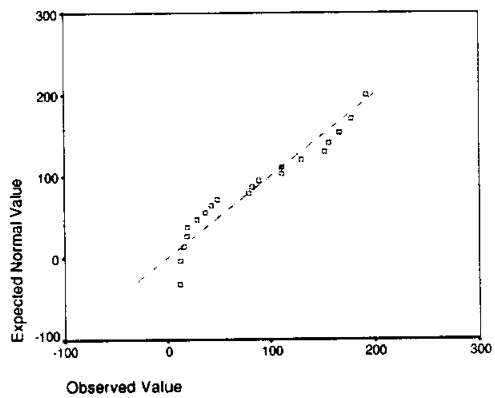


***Figure 2.1*** *Normal Q-Q Plot of Red fish Harvest.*

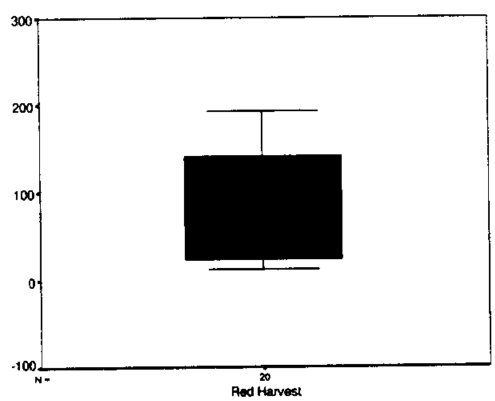


***Figure 2.2*** *BoxPlot of Red fish Harvest.*

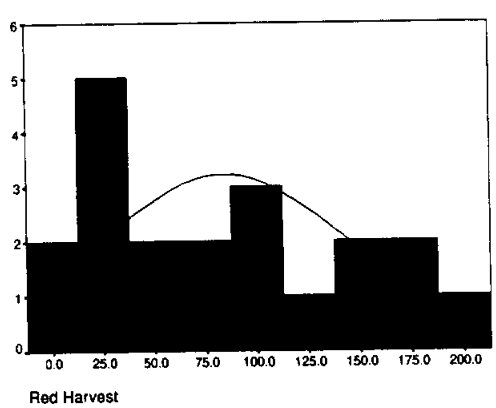


***Figure 2.3*** *Histogram of Red fish Harvest.*

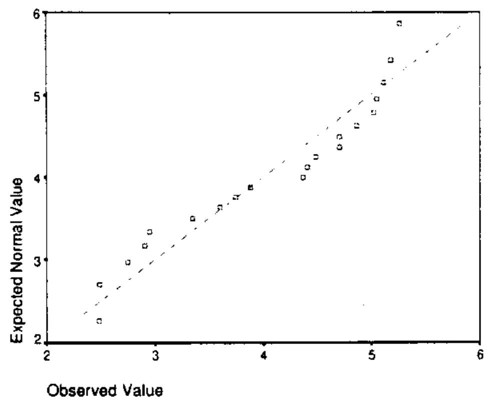


***Figure 2.4*** *Normal Q-Q Plot of Ln(Red fish Harvest).*

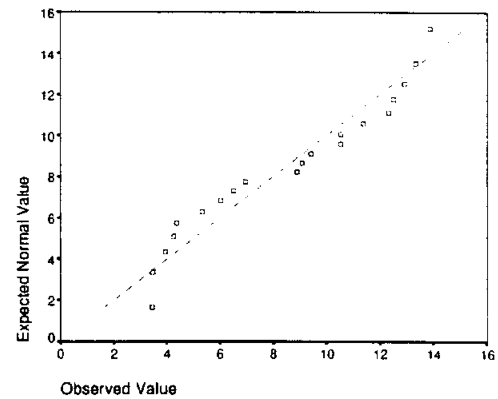


***Figure 2.5*** *Normal Q-Q Plot of Sqrt(RedHarvest).*

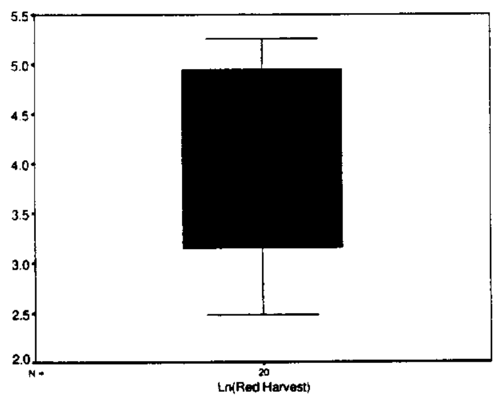


***Figure 2.6*** *BoxPlot of Ln(Red fish Harvest).*

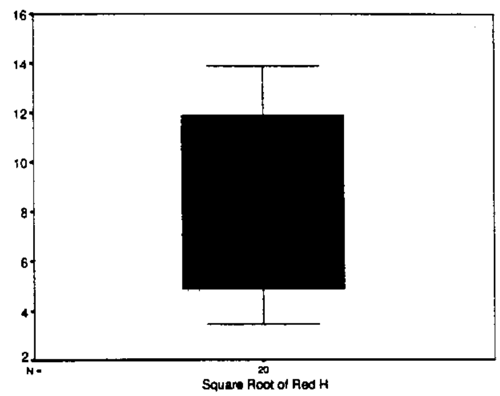


***Figure 2.7*** *BoxPlot of Sqrt(Red fish Harvest).*

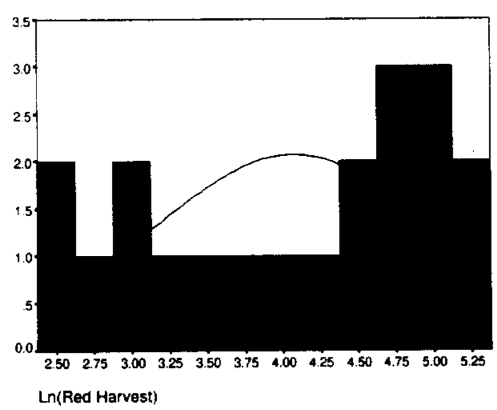


***Figure 2.8*** *Histogram of Ln(Red fish Harvest).*

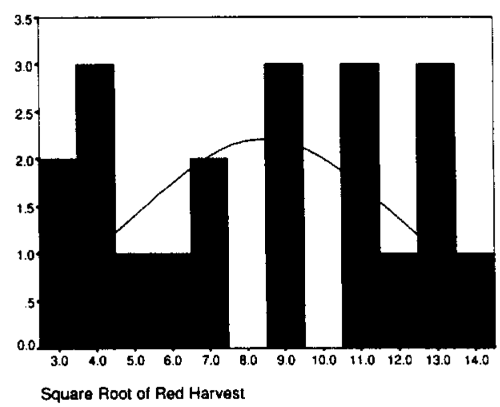


***Figure 2.9*** *Histogram of Sqrt(Red fish Harvest).*

### 2.2.2 The January-February Inflows data

***Table .2.6*** *Descriptives for the January-February Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| January-February Inflows | Mean | | 37.4825 | 6.0374 |
| | 95% Confidence Interval for Mean | Lower Bound | 24.8461 | |
| | | Upper Bound | 50.1189 | |
| | 5% Trimmed Mean | | 36.0500 | |
| | Median | | 27.5500 | |
| | Variance | | 728.999 | |
| | Std. Deviation | | 27.0000 | |
| | Minimum | | 5.49 | |
| | Maximum | | 95.26 | |
| | Range | | 89.77 | |
| | Interquartile Range | | 29.9750 | |
| | Skewness | | 1.243 | .512 |
| | Kurtosis | | .537 | .992 |

***Table .2.7*** *Extreme Values for the January-February Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| January-February Inflows | Highest | 1 | 10 | 1970 | 95.26 |
| | | 2 | 9 | 1969 | 91.93 |
| | | 3 | 8 | 1968 | 89.91 |
| | | 4 | 1 | 1961 | 58.45 |
| | | 5 | 2 | 1962 | 49.25 |
| | Lowest | 1 | 4 | 1964 | 5.49 |
| | | 2 | 11 | 1971 | 12.76 |
| | | 3 | 20 | 1980 | 13.59 |
| | | 4 | 16 | 1976 | 17.23 |
| | | 5 | 13 | 1973 | 19.03 |

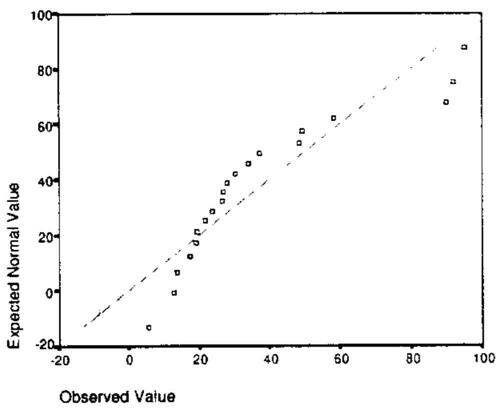


***Figure 2.10*** *Normal Q-Q Plot of January-February Inflows.*

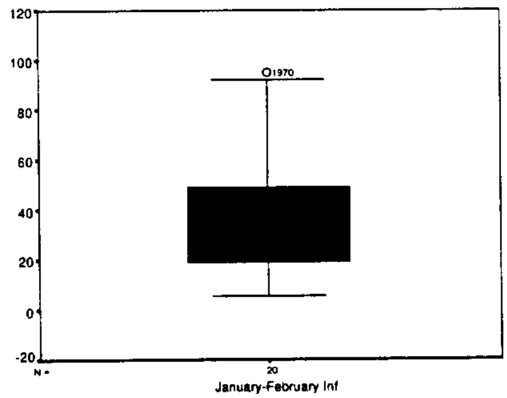


***Figure 2.11*** *BoxPlot of January-February Inflows.*

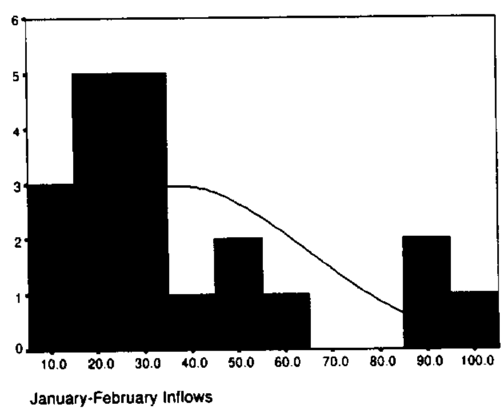


***Figure 2.12*** *Histogram of January-February Inflows.*

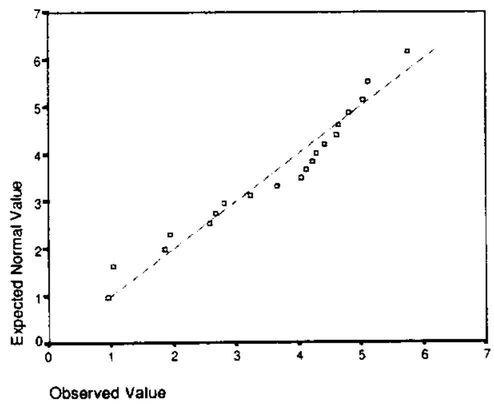


***Figure 2.13*** *Normal Q-Q Plot of Ln January-February Inflows).*

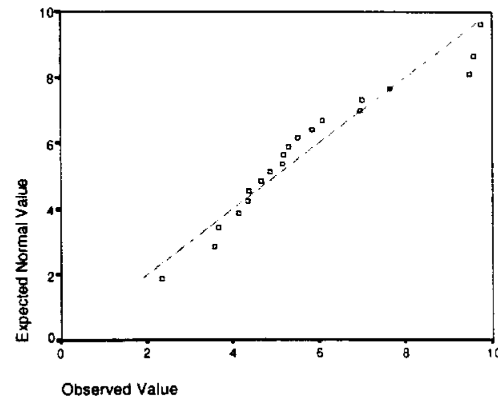


***Figure 2.14*** *Normal Q-Q Plot of Sqrt( January-February Inflows).*

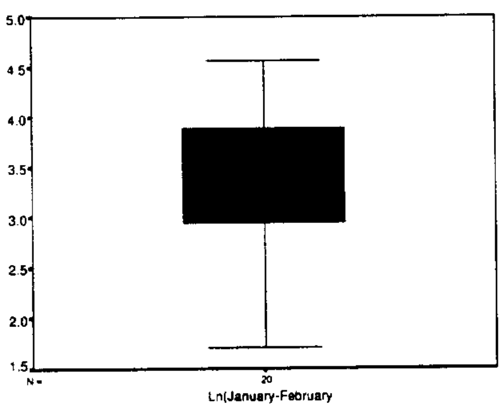


***Figure 2.15*** *BoxPlot of Ln(January-February Inflows).*

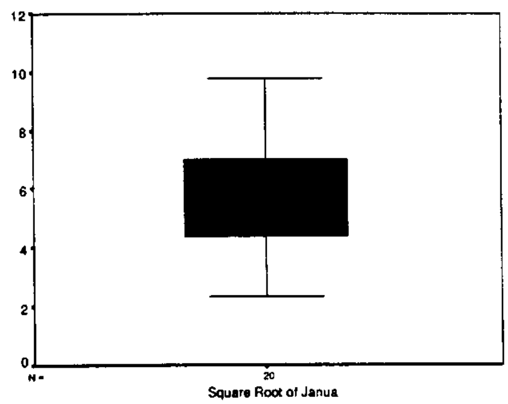


***Figure 2.16*** *BoxPlot of Square Root of January-February Inflows.*

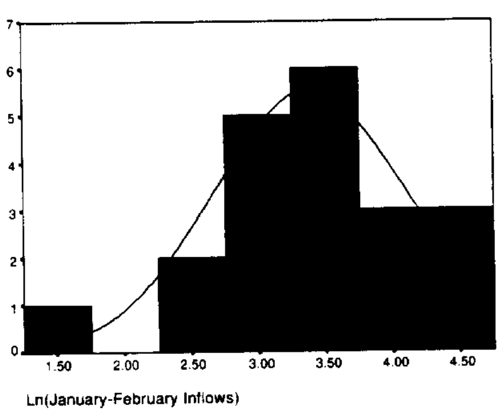


***Figure 2.17*** *Histogram of Ln(January-February Inflows).*

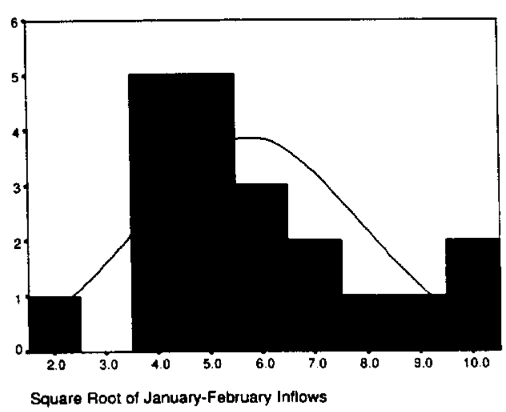


***Figure 2.18*** *Histogram of Sqrt(January-February Inflows).*

### 2.2.3 The March-April Inflows data

***Table .2.8*** *Descriptives for the March-April Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| March-April Inflows | Mean | | 31.2740 | 7.7782 |
| | 95% Confidence Interval for Mean | Lower Bound | 14.9940 | |
| | | Upper Bound | 47.5540 | |
| | 5% Trimmed Mean | | 27.5406 | |
| | Median | | 18.3750 | |
| | Variance | | 1210.01 | |
| | Std. Deviation | | 34.7852 | |
| | Minimum | | 6.64 | |
| | Maximum | | 123.11 | |
| | Range | | 116.47 | |
| | Interquartile Range | | 10.4500 | |
| | Skewness | | 2.087 | .512 |
| | Kurtosis | | 2.902 | .992 |

***Table .2.9*** *Extreme Values for the March-April Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| March-April Inflows | Highest | 1 | 19 | 1979 | 123.11 |
| | | 2 | 17 | 1977 | 104.82 |
| | | 3 | 18 | 1978 | 104.63 |
| | | 4 | 10 | 1970 | 25.37 |
| | | 5 | 20 | 1980 | 24.89 |
| | Lowest | 1 | 4 | 1964 | 6.64 |
| | | 2 | 13 | 1973 | 9.52 |
| | | 3 | 2 | 1962 | 12.81 |
| | | 4 | 1 | 1961 | 13.11 |
| | | 5 | 3 | 1963 | 13.28 |

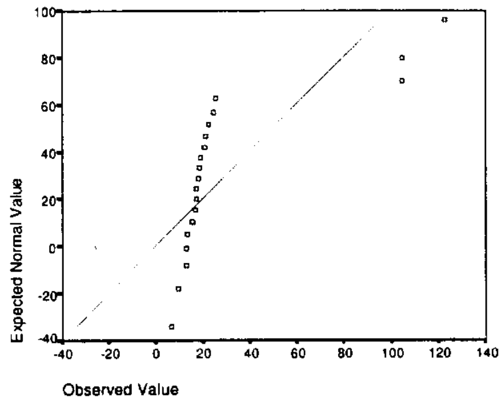


***Figure 2.19*** *Normal Q-Q Plot of March-April Inflows.*

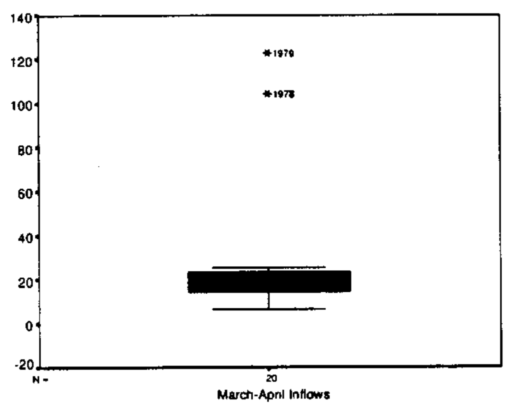


***Figure 2.20*** *BoxPlot of March-April Inflows.*

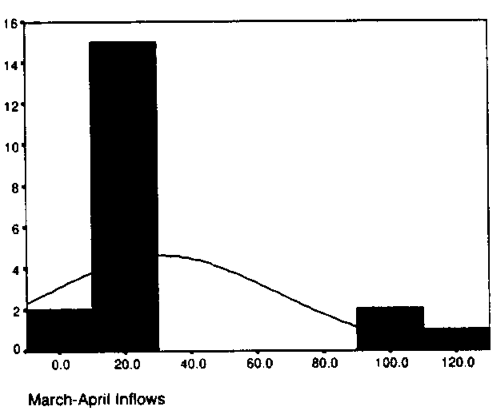


***Figure 2.21*** *Histogram of March-April Inflows.*

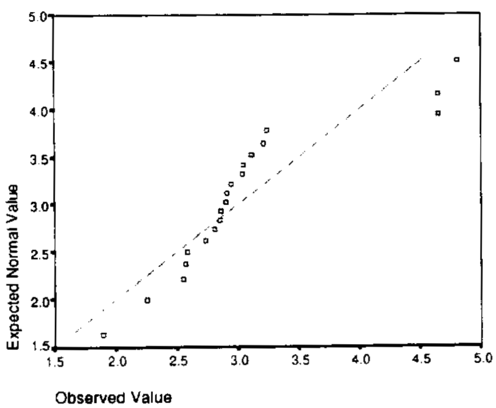


***Figure 2.22*** *Normal Q-Q Plot of Ln(March-April Inflows).*

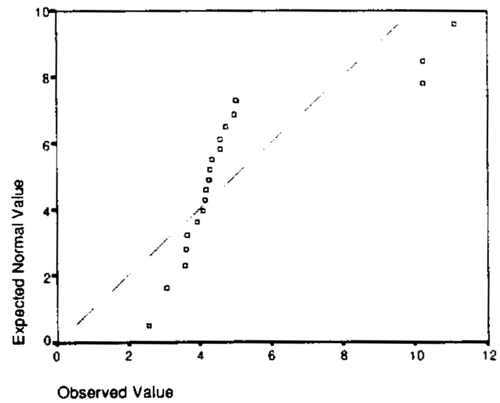


***Figure 2.23*** *Normal Q-Q Plot of Sqrt( March-April Inflows).*

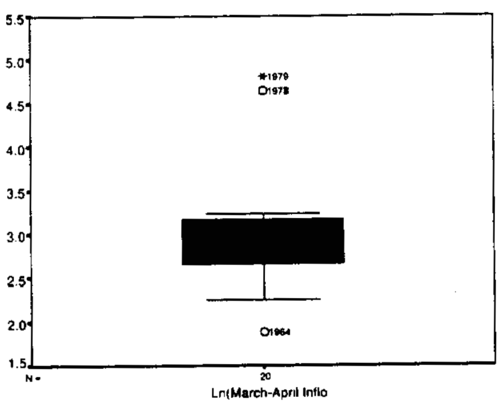


***Figure 2.24*** *BoxPlot of Ln(March-April) Inflows.*

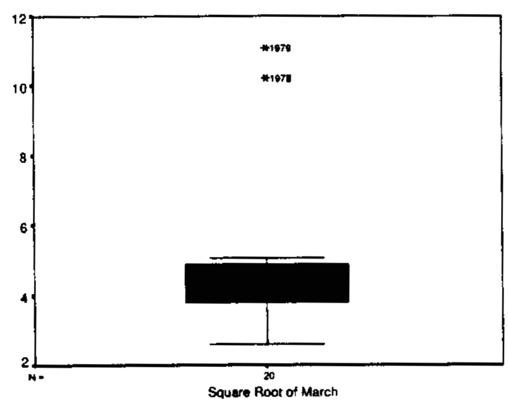


***Figure 2.25*** *BoxPlot of Square Root of March-April Inflows.*

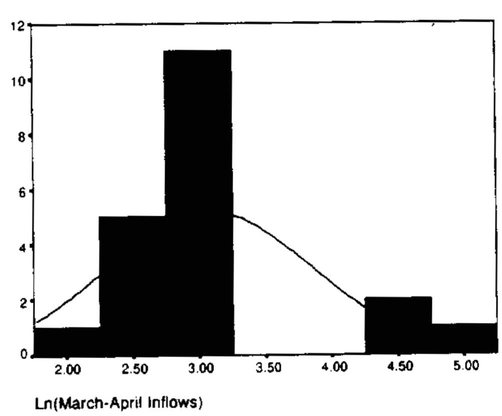


***Figure 2.26*** *Histogram of Ln(March-April Inflows).*

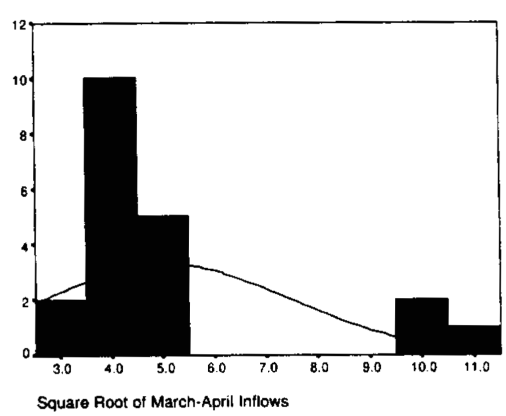


***Figure 2.27*** *Histogram of Sqrt(March-April Inflows).*

### 2.2.4 The May-June Inflows data

***Table .2.10*** *Descriptives for the May-June Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| May-June Inflows | Mean | | 126.293 | 13.6091 |
| | 95% Confidence Interval for Mean | Lower Bound | 97.8084 | |
| | | Upper Bound | 154.777 | |
| | 5% Trimmed Mean | | 127.713 | |
| | Median | | 148.635 | |
| | Variance | | 3704.13 | |
| | Std. Deviation | | 60.8616 | |
| | Minimum | | 7.72 | |
| | Maximum | | 219.30 | |
| | Range | | 211.58 | |
| | Interquartile Range | | 89.4350 | |
| | Skewness | | -.511 | .512 |
| | Kurtosis | | -.710 | .992 |

***Table .2.11*** *Extreme Values for the May-June Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| May-June Inflows | Highest | 1 | 8 | 1968 | 219.30 |
| | | 2 | 10 | 1970 | 211.69 |
| | | 3 | 15 | 1975 | 175.19 |
| | | 4 | 20 | 1980 | 171.41 |
| | | 5 | 19 | 1979 | 169.20 |
| | Lowest | 1 | 4 | 1964 | 7.72 |
| | | 2 | 3 | 1963 | 33.71 |
| | | 3 | 2 | 1962 | 38.52 |
| | | 4 | 1 | 1961 | 42.66 |
| | | 5 | 5 | 1965 | 74.65 |

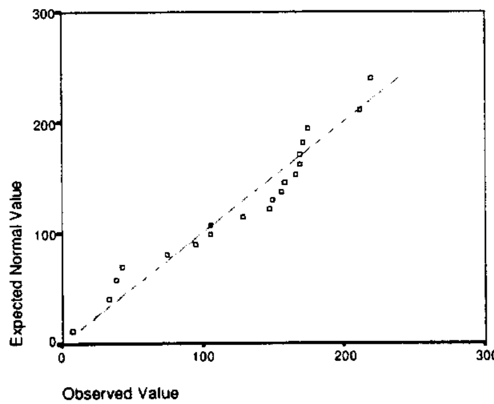


***Figure 2.28*** *Normal Q-Q Plot of May-June Inflows.*

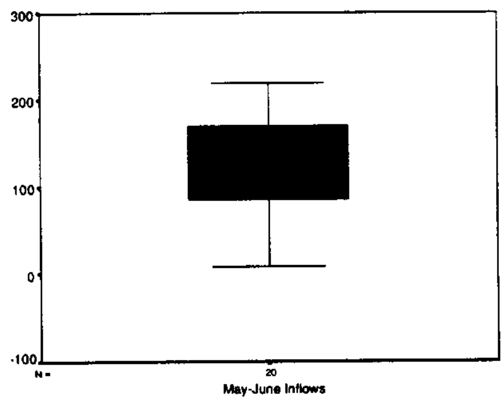


***Figure 2.29*** *BoxPlot of May-June Inflows.*

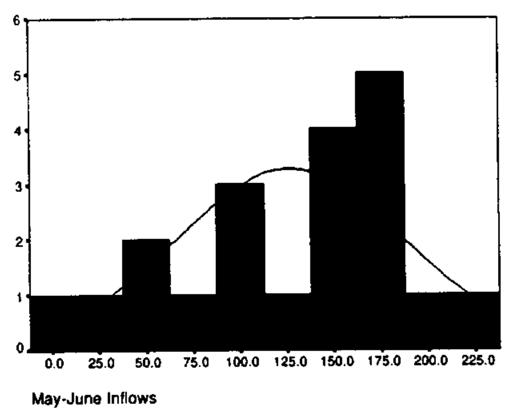


***Figure 2.30*** *Histogram of May-June Inflows.*

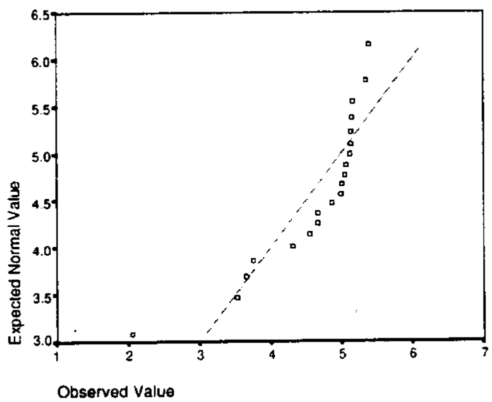


***Figure 2.31*** *Normal Q-Q Plot of Ln(May-June Inflows).*

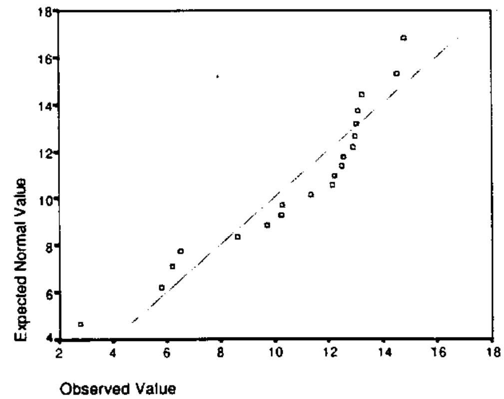


***Figure 2.32*** *Normal Q-Q Plot of Sqrt( May-June Inflows).*

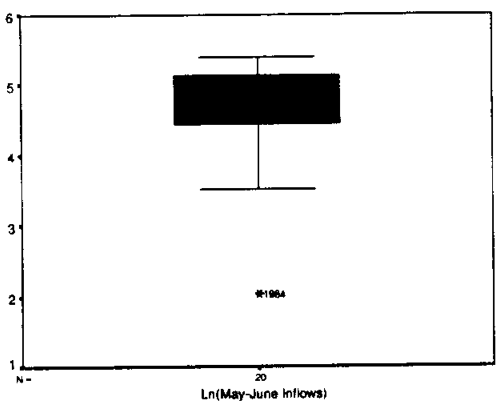


***Figure 2.33*** *BoxPlot of Ln(May-June) Inflows.*

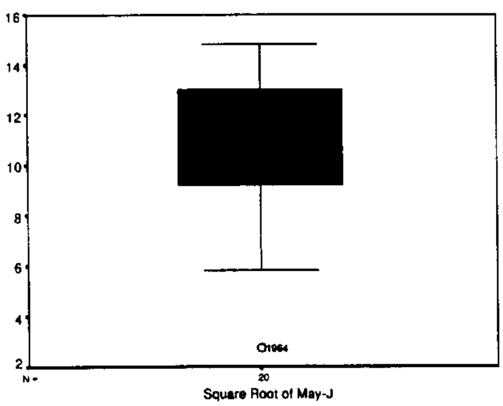


***Figure 2.34*** *BoxPlot of Square Root of May-June Inflows.*

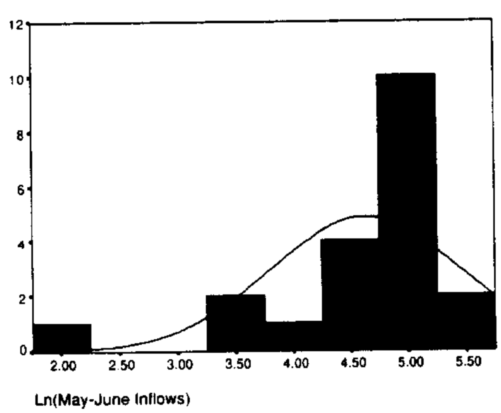


***Figure 2.35*** *Histogram of Ln(May-June Inflows).*

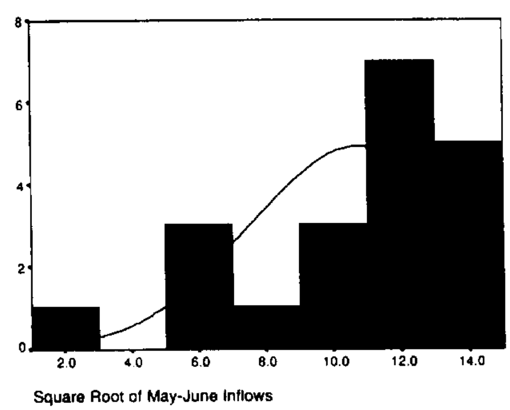


***Figure 2.36*** *Histogram of Sqrt(May-June Inflows).*

### 2.2.5 The July-August Inflows data

***Table .2.12*** *Descriptives for the July-August Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| July-August Inflows | Mean | | 99.2380 | 23.7359 |
| | 95% Confidence Interval for Mean | Lower Bound | 49.5581 | |
| | | Upper Bound | 148.918 | |
| | 5% Trimmed Mean | | 90.9028 | |
| | Median | | 60.4700 | |
| | Variance | | 11267.9 | |
| | Std. Deviation | | 106.150 | |
| | Minimum | | 10.11 | |
| | Maximum | | 338.40 | |
| | Range | | 328.29 | |
| | Interquartile Range | | 93.9325 | |
| | Skewness | | 1.412 | .512 |
| | Kurtosis | | .788 | .992 |

***Table .2.13*** *Extreme Values for the July-August Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| July-August Inflows | Highest | 1 | 13 | 1973 | 338.40 |
| | | 2 | 12 | 1972 | 310.47 |
| | | 3 | 11 | 1971 | 307.47 |
| | | 4 | 20 | 1980 | 202.89 |
| | | 5 | 16 | 1976 | 126.23 |
| | Lowest | 1 | 4 | 1964 | 10.11 |
| | | 2 | 5 | 1965 | 10.70 |
| | | 3 | 6 | 1966 | 12.65 |
| | | 4 | 7 | 1967 | 14.00 |
| | | 5 | 9 | 1969 | 26.74 |

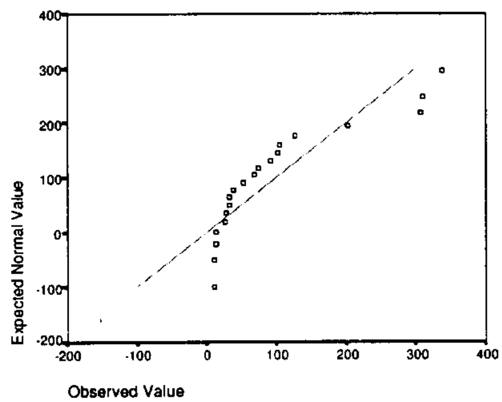


***Figure 2.37*** *Normal Q-Q Plot of July-August Inflows.*

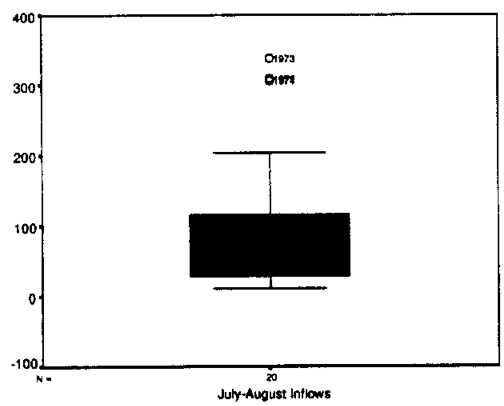


***Figure 2.38*** *BoxPlot of July-August Inflows.*

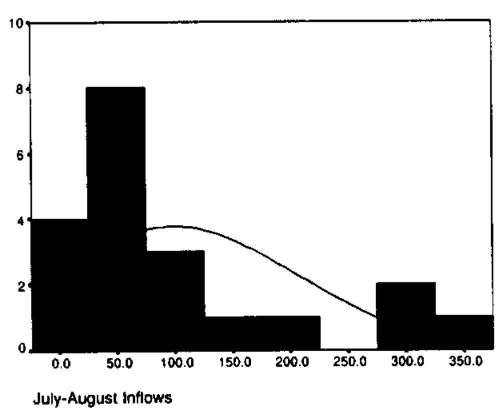


***Figure 2.39*** *Histogram of July-August Inflows.*

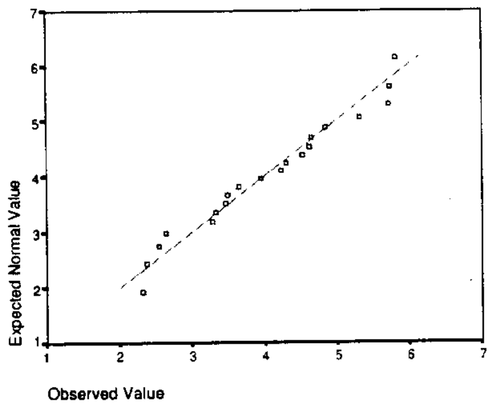


*Figure 2.40* Normal Q-Q Plot of Ln(July-August Inflows).

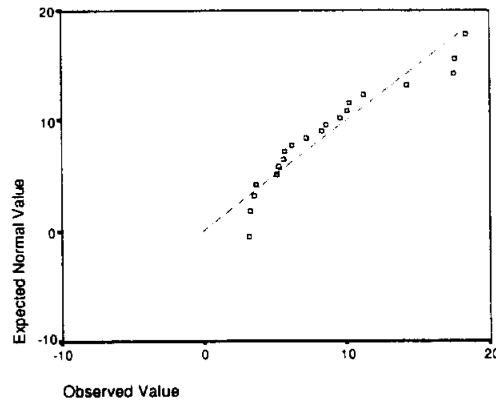


*Figure 2.41* Normal Q-Q Plot of Sqrt( July-August Inflows).

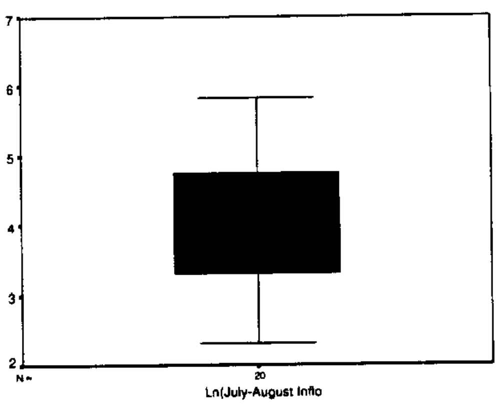


*Figure 2.42* BoxPlot of Ln(July-August) Inflows.

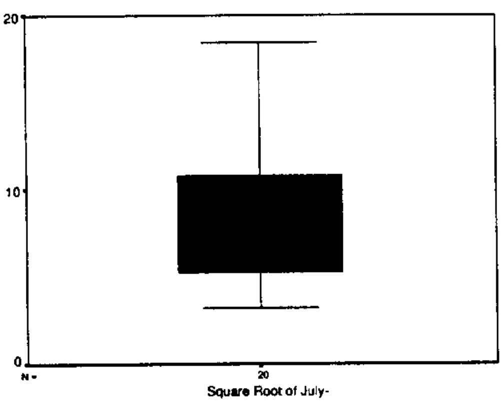


*Figure 2.43* BoxPlot of Square Root of July-August Inflows.

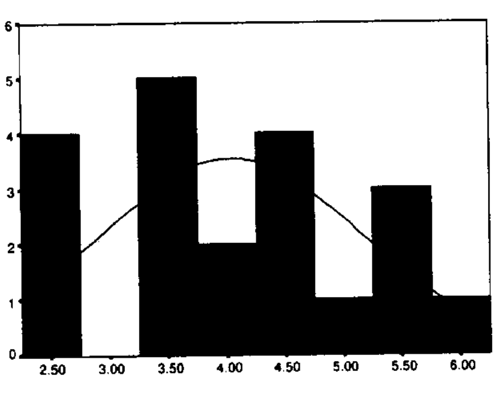


*Figure 2.44* Histogram of Ln(July-August Inflows).

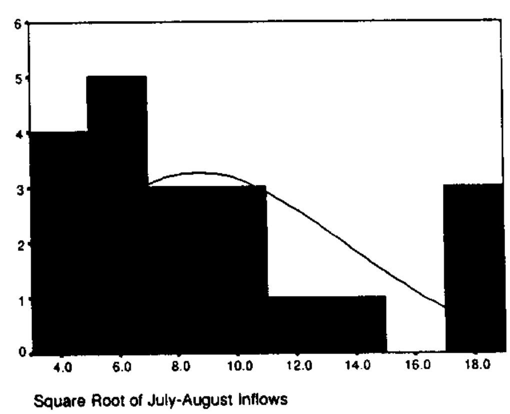


*Figure 2.45* Histogram of Sqrt(July-August Inflows).

### 2.2.6 The September-October Inflows data

***Table .2.14*** *Descriptives for the September-October Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| SeptemberOctober Inflows | Mean | | 295.728 | 60.7806 |
| | 95% Confidence Interval for Mean | Lower Bound | 168.512 | |
| | | Upper Bound | 422.943 | |
| | 5% Trimmed Mean | | 282.682 | |
| | Median | | 168.605 | |
| | Variance | | 73885.7 | |
| | Std. Deviation | | 271.819 | |
| | Minimum | | 9.91 | |
| | Maximum | | 816.37 | |
| | Range | | 806.46 | |
| | Interquartile Range | | 540.538 | |
| | Skewness | | .763 | .512 |
| | Kurtosis | | -1.095 | .992 |

***Table .2.15*** *Extreme Values for the September-October Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| SeptemberOctober Inflows | Highest | 1 | 14 | 1974 | 816.37 |
| | | 2 | 10 | 1970 | 693.83 |
| | | 3 | 9 | 1969 | 675.78 |
| | | 4 | 8 | 1968 | 670.67 |
| | | 5 | 12 | 1972 | 612.72 |
| | Lowest | 1 | 4 | 1964 | 9.91 |
| | | 2 | 11 | 1971 | 34.80 |
| | | 3 | 5 | 1965 | 68.57 |
| | | 4 | 6 | 1966 | 68.66 |
| | | 5 | 7 | 1967 | 69.73 |

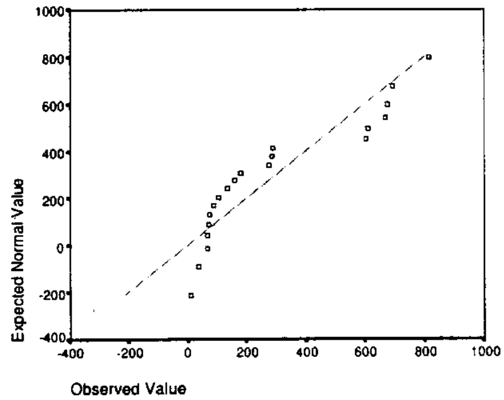


***Figure 2.46*** *Normal Q-Q Plot of September-October Inflows.*

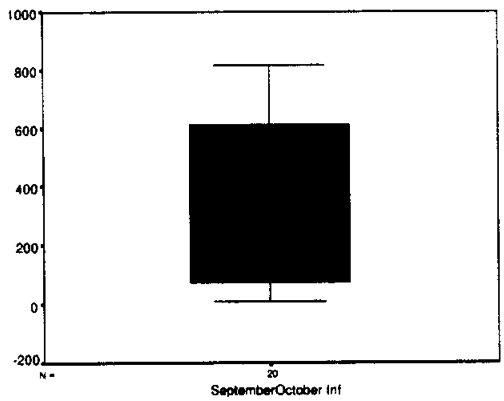


***Figure 2.47*** *BoxPlot of September-October Inflows.*

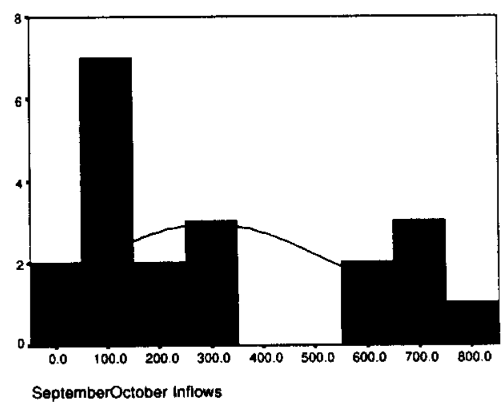


***Figure 2.48*** *Histogram of September-October Inflows.*

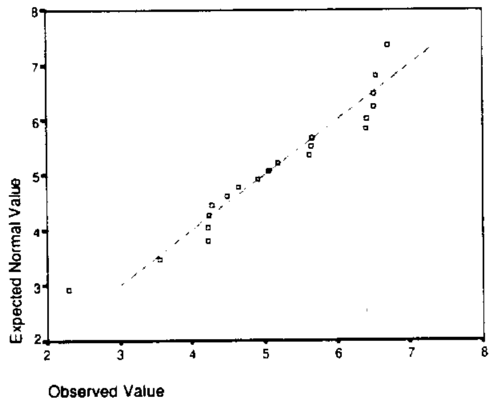


***Figure 2.49*** *Normal Q-Q Plot of Ln(September-October Inflows).*

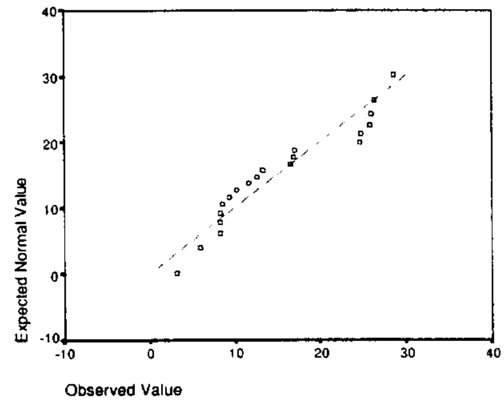


***Figure 2.50*** *Normal Q-Q Plot of Sqrt( September-October Inflows).*

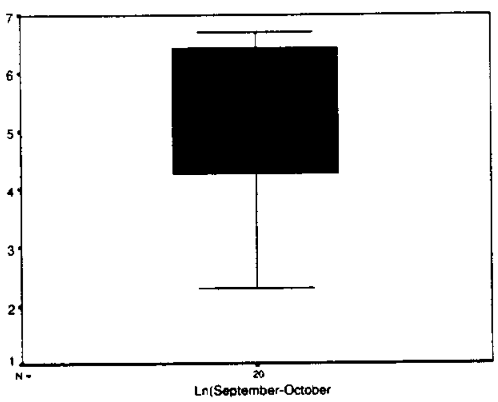


***Figure 2.51*** *BoxPlot of Ln(September-October) Inflows.*

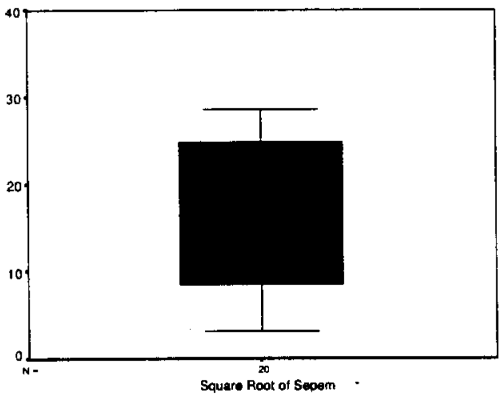


***Figure 2.52*** *BoxPlot of Square Root of September-October Inflows.*

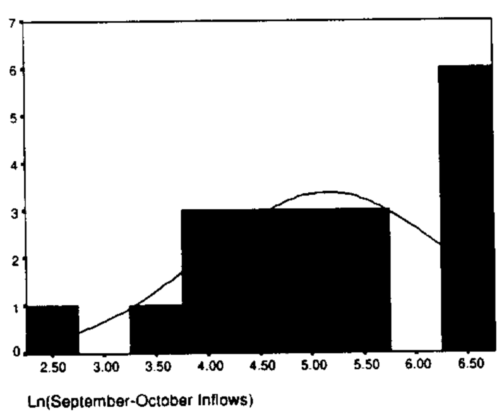


***Figure 2.53*** *Histogram of Ln(September-October Inflows).*

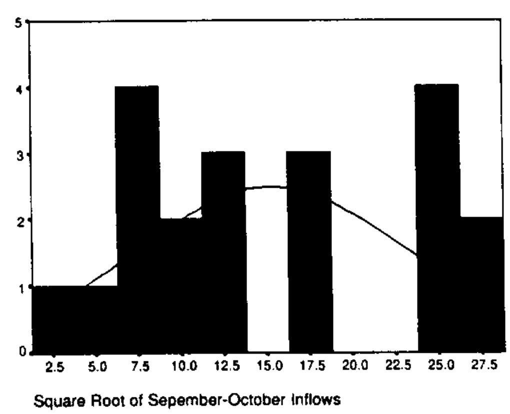


***Figure 2.54*** *Histogram of Sqrt(September-October Inflows).*

## 2.2.7 The November-December Inflows data

***Table .2.16*** *Descriptives for the November-December Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| November-December Inflows | Mean | | 57.4180 | 10.7644 |
| | 95% Confidence Interval for Mean | Lower Bound | 34.8878 | |
| | | Upper Bound | 79.9482 | |
| | 5% Trimmed Mean | | 55.2228 | |
| | Median | | 43.6250 | |
| | Variance | | 2317.46 | |
| | Std. Deviation | | 48.1400 | |
| | Minimum | | 5.45 | |
| | Maximum | | 148.90 | |
| | Range | | 143.45 | |
| | Interquartile Range | | 64.9825 | |
| | Skewness | | .796 | .512 |
| | Kurtosis | | -.626 | .992 |

***Table .2.17*** *Extreme Values for the November-December Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| November-December Inflows | Highest | 1 | 1 | 1961 | 148.90 |
| | | 2 | 17 | 1977 | 138.05 |
| | | 3 | 19 | 1979 | 135.35 |
| | | 4 | 18 | 1978 | 133.86 |
| | | 5 | 2 | 1962 | 78.65 |
| | Lowest | 1 | 4 | 1964 | 5.45 |
| | | 2 | 20 | 1980 | 8.20 |
| | | 3 | 5 | 1965 | 9.75 |
| | | 4 | 6 | 1966 | 10.36 |
| | | 5 | 7 | 1967 | 12.21 |

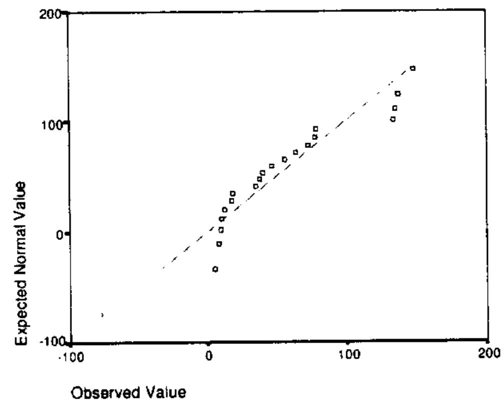


***Figure 2.55*** *Normal Q-Q Plot of November_December Inflows.*

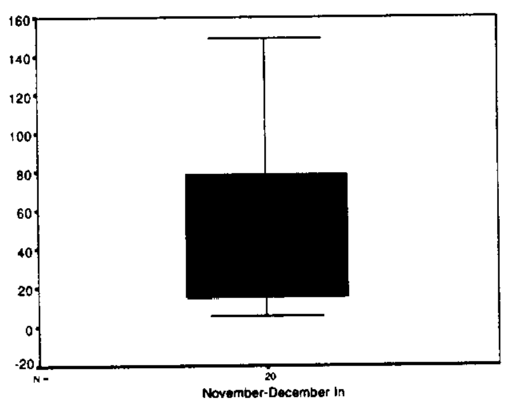


***Figure 2.56*** *BoxPlot of November_December Inflows.*

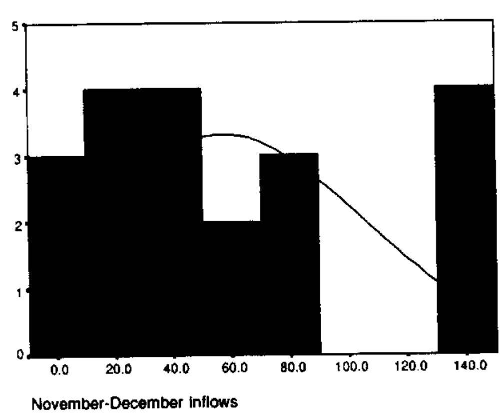


***Figure 2.57*** *Histogram of November_December Inflows.*

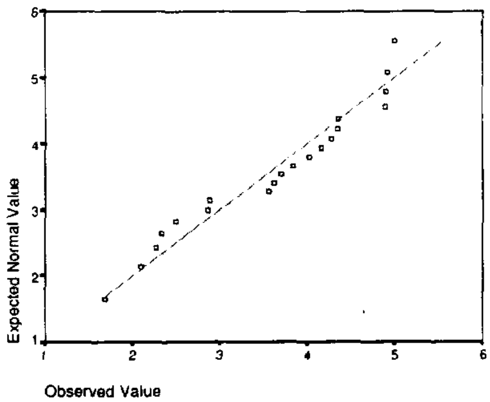


*Figure 2.58* Normal Q-Q Plot of Ln(November_December Inflows).

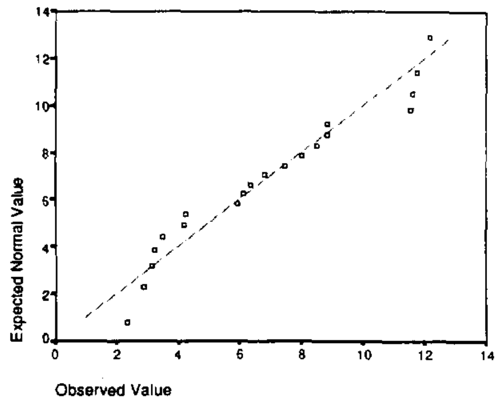


*Figure 2.59* Normal Q-Q Plot of Sqrt( November_December Inflows).

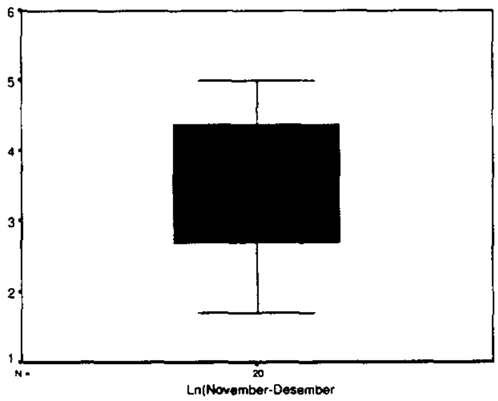


*Figure 2.60* BoxPlot of Ln(November _December) Inflows.

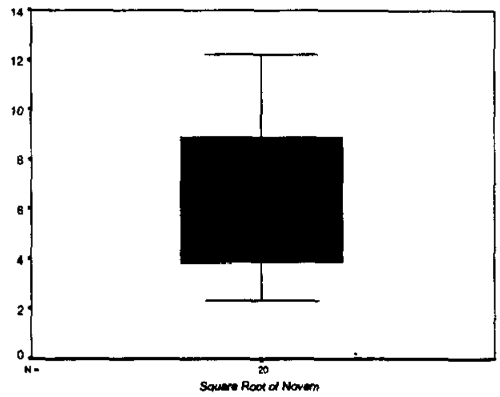


*Figure 2.61* BoxPlot of Square Root of November_December Inflows.

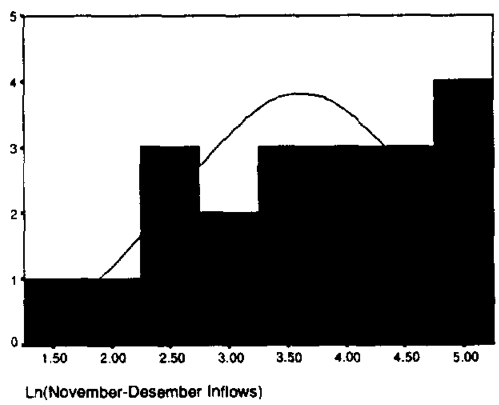


*Figure 2.62* Histogram of Ln(November_ December Inflows).

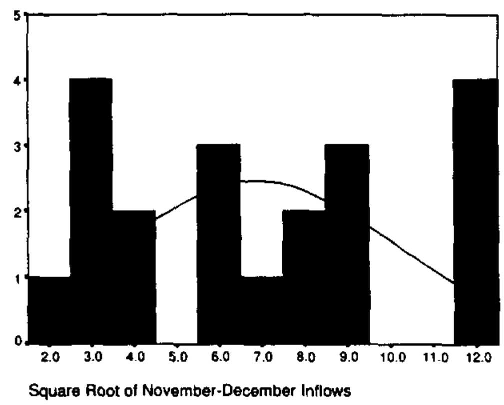


*Figure 2.63* Histogram of Sqrt(November_ December Inflows).

# 3. PREDICTION ELLIPSES AND CONFIDENCE REGIONS

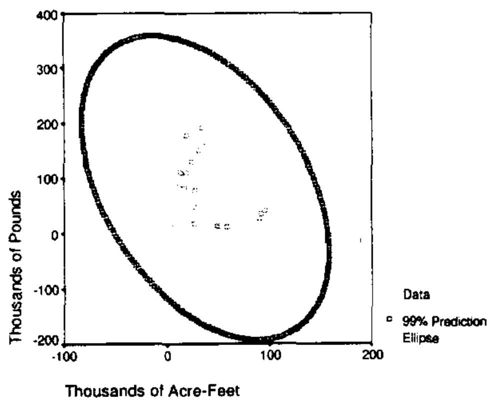


***Figure 3.1*** *Red fish Harvest vs. January-February Inflows, PE.*

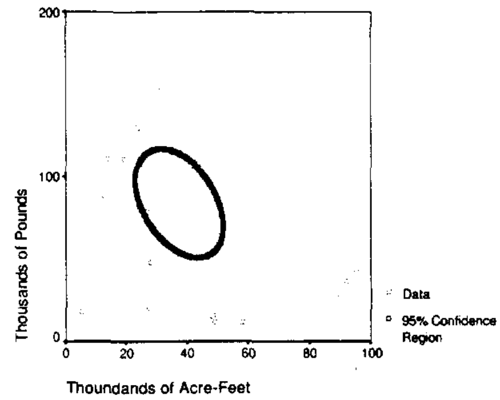


***Figure 3.2*** *Red fish Harvest vs. January-February Inflows, CR.*

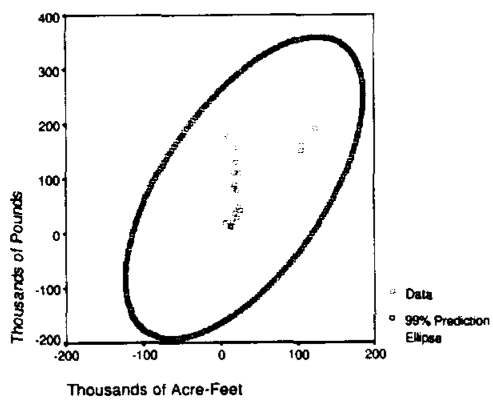


***Figure 3.3*** *Red fish Harvest vs. March-April Inflows, PE.*

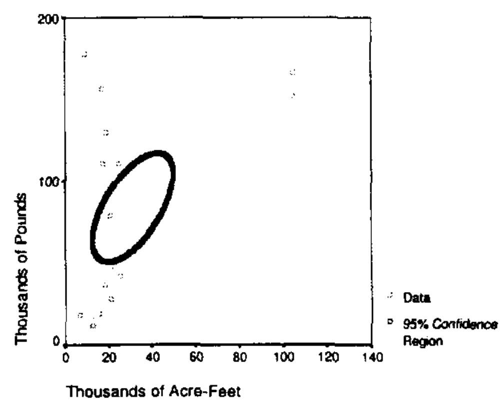


***Figure 3.4*** *Red fish Harvest vs. March-April Inflows, CR.*

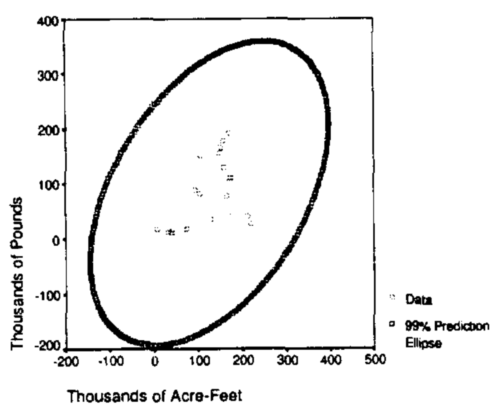


***Figure 3.5*** *Red fish Harvest vs. May-June Inflows, PE.*

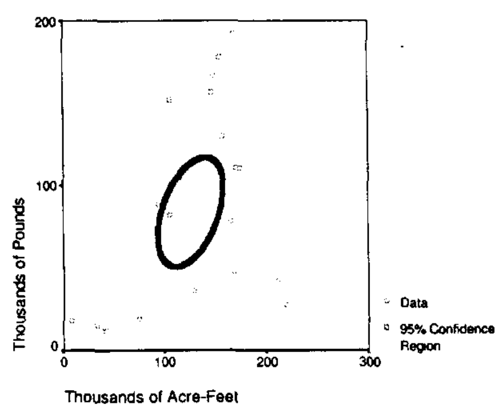


***Figure 3.6*** *Red fish Harvest vs. May-June Inflows, CR.*

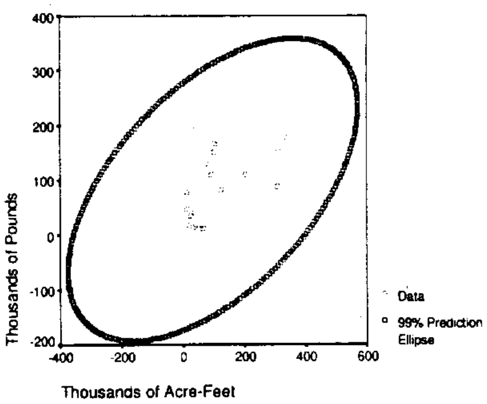


***Figure 3.7*** *Red fish Harvest vs. July-August Inflows, PE.*

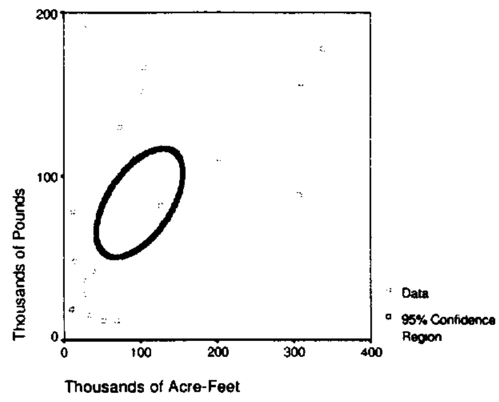


***Figure 3.8*** *Red fish Harvest vs. July-August Inflows, CR.*

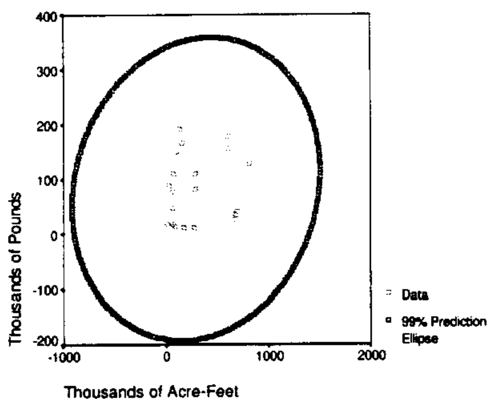


***Figure 3.9*** *Red fish Harvest vs. September-October Inflows, PE.*

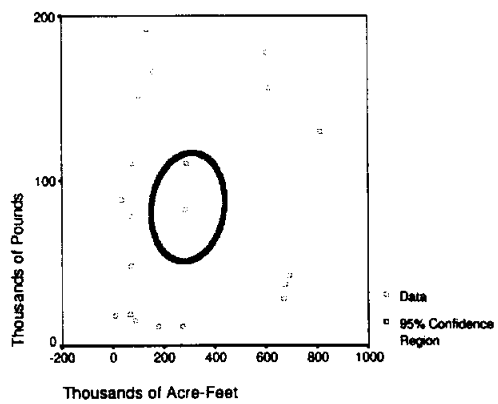


***Figure 3.10*** *Red fish Harvest vs. September-October Inflows, CR.*

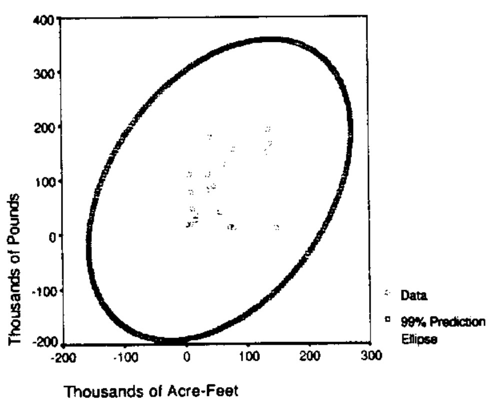


***Figure 3.11*** *Red fish Harvest vs. November-December Inflows, PE.*

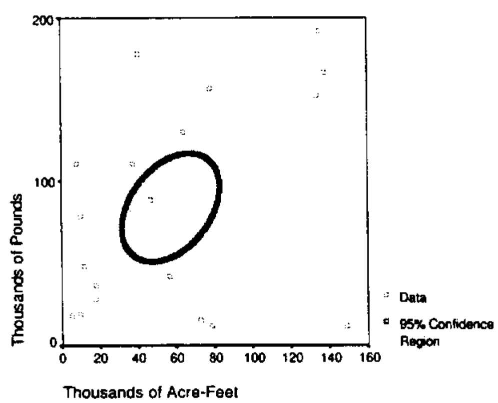


***Figure 3.12*** *Red fish Harvest vs. November-December Inflows, CR.*

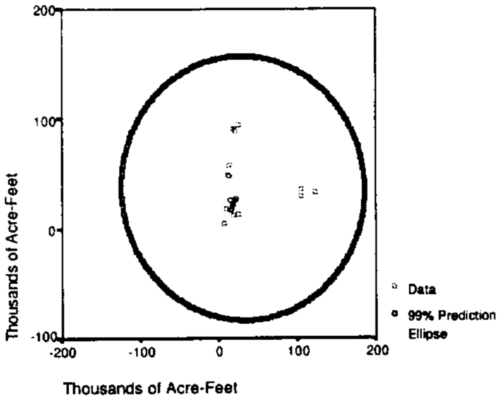


***Figure 3.13** January-February Inflows vs. March-April Inflows, PE.*

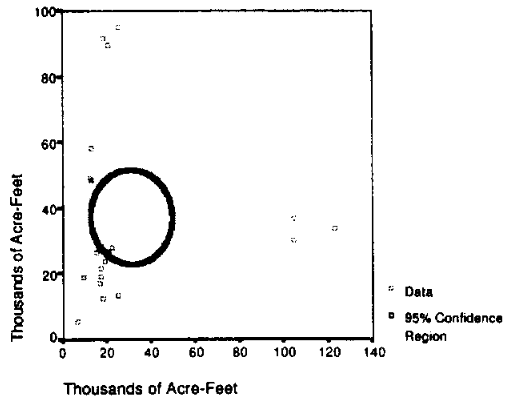


***Figure 3.14** January-February Inflows vs. March-April Inflows, CR.*

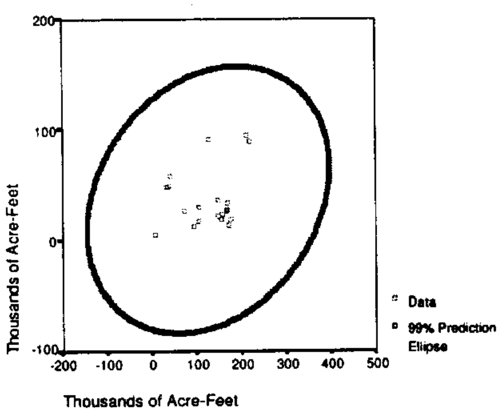


***Figure 3.15** January-February Inflows vs. May-June Inflows, PE.*

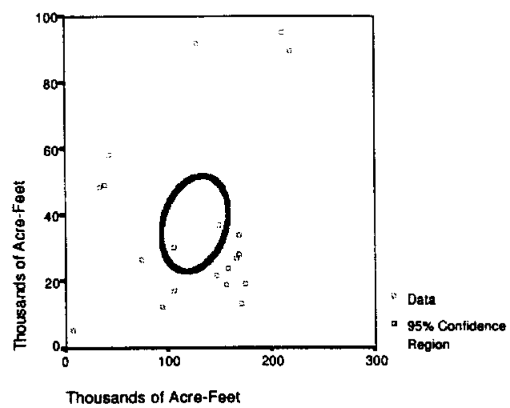


***Figure 3.16** January-February Inflows vs. May-June Inflows, CR.*

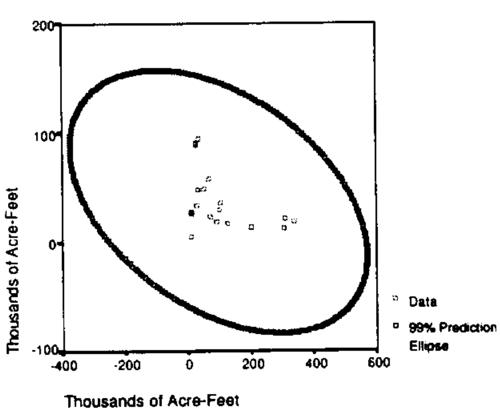


***Figure 3.17** January-February Inflows vs. July-August Inflows, PE.*

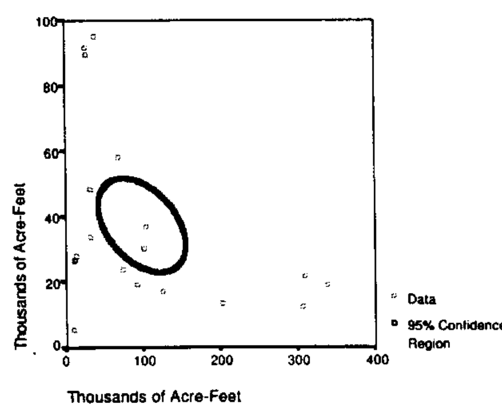


***Figure 3.18** January-February Inflows vs. July-August Inflows, CR.*

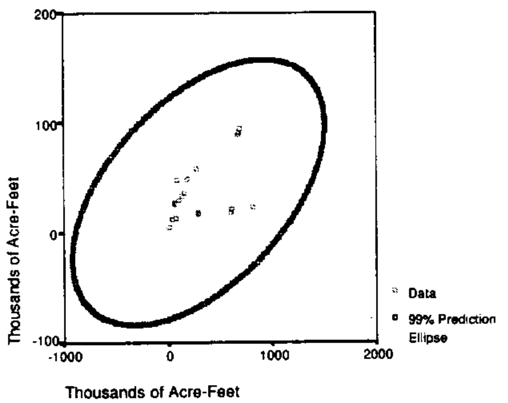


***Figure 3.19*** *January-February Inflows vs. September-October Inflows, PE.*

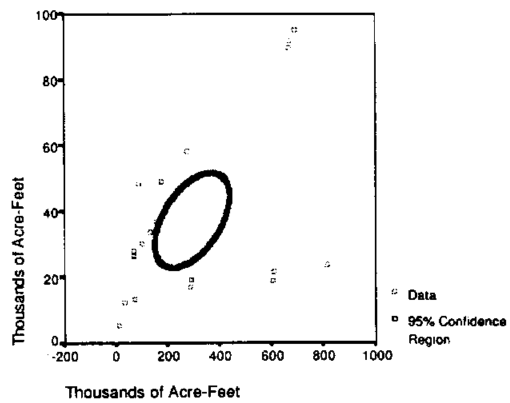


***Figure 3.20*** *January-February Inflows vs. September-October Inflows, CR.*

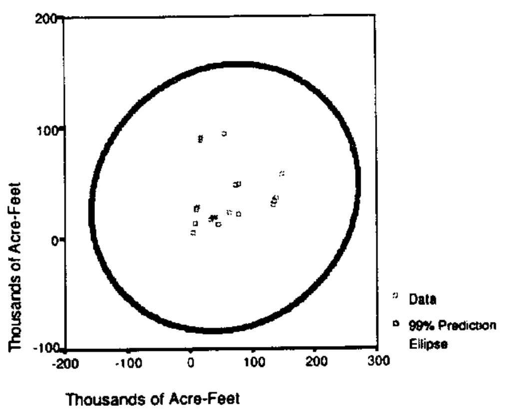


***Figure 3.21*** *January-February Inflows vs. November-December Inflows, PE.*

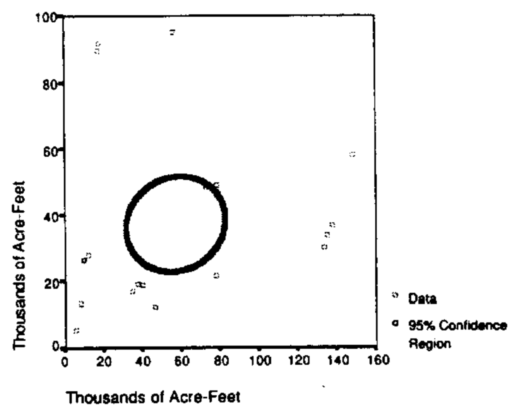


***Figure 3.22*** *January-February Inflows vs. November-December Inflows, CR.*

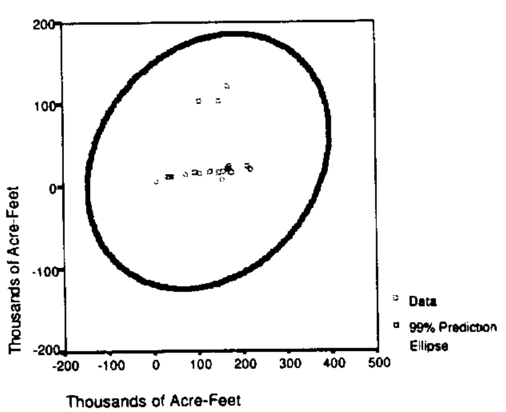


***Figure 3.23*** *March-April Inflows vs. May-June Inflows, PE.*

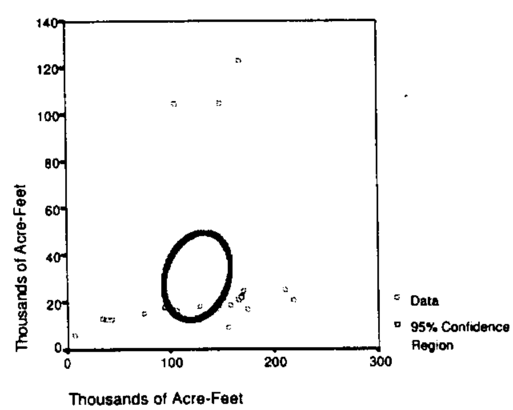


***Figure 3.24*** *March-April Inflows vs. May-June Inflows, CR.*

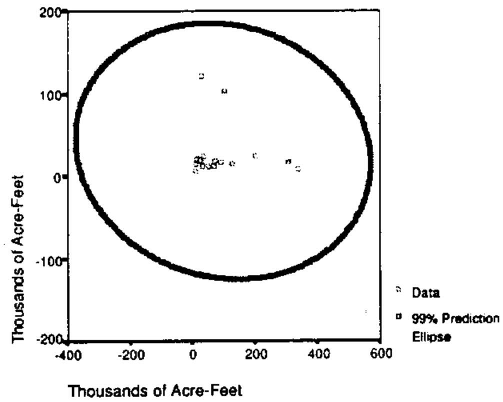


***Figure 3.25*** *March-April Inflows vs. July-August Inflows, PE.*

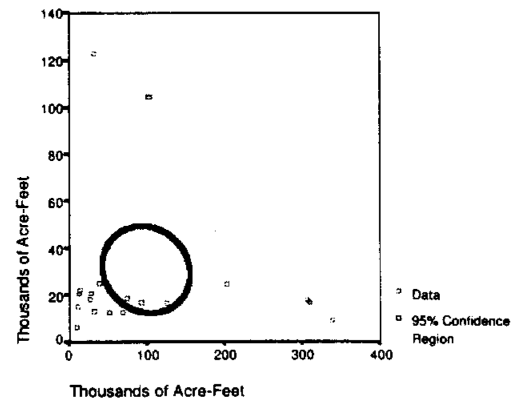


***Figure 3.26*** *March-April Inflows vs. July-August Inflows, CR.*

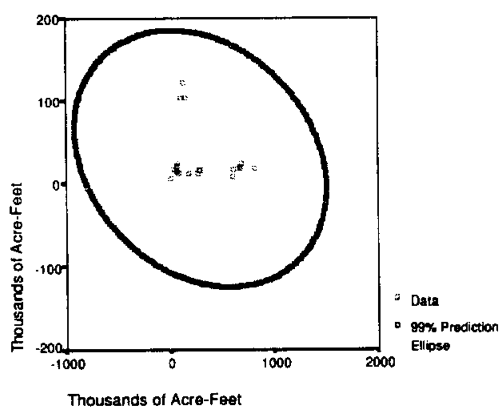


***Figure 3.27*** *March-April Inflows vs. September-October Inflows, PE.*

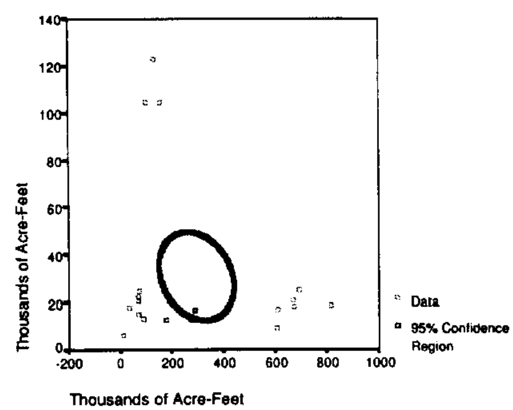


***Figure 3.28*** *March-April Inflows vs. September-October Inflows, CR.*

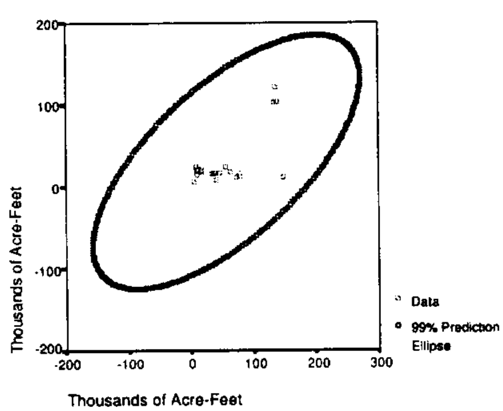


***Figure 3.29*** *March-April Inflows vs. November-December Inflows, PE.*

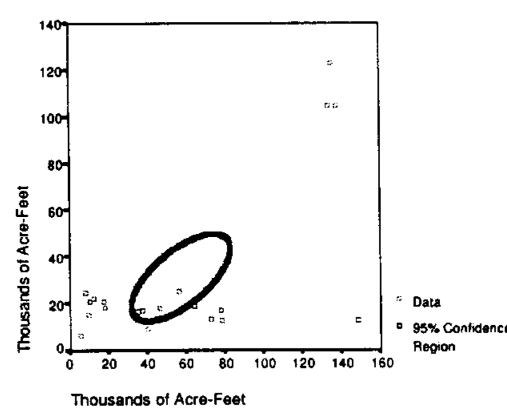


***Figure 3.30*** *March-April Inflows vs. November-December Inflows, CR.*

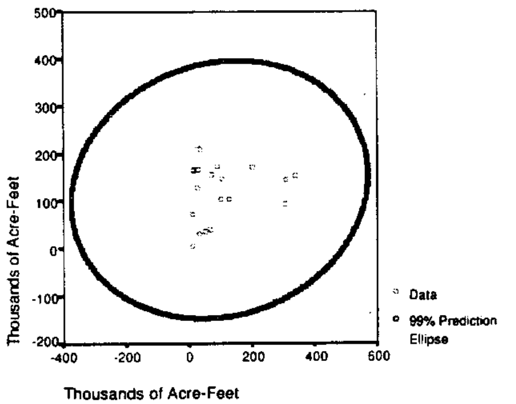


***Figure 3.31*** *May-June Inflows vs. July-August Inflows, PE.*

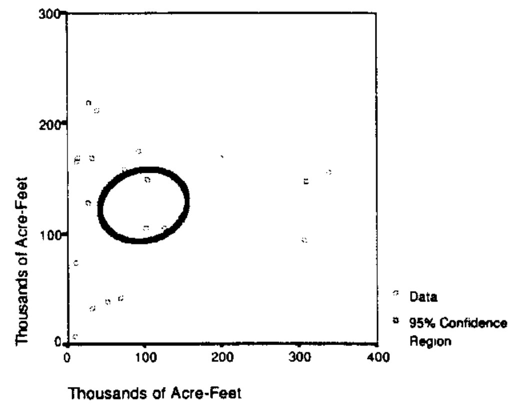


***Figure 3.32*** *May-June Inflows vs. July-August Inflows, CR.*

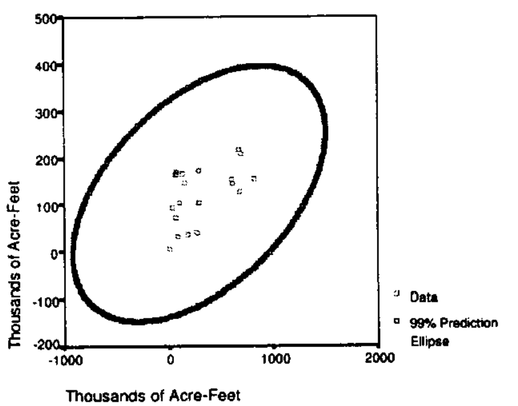


***Figure 3.33*** *May-June Inflows vs. September-October Inflows, PE.*

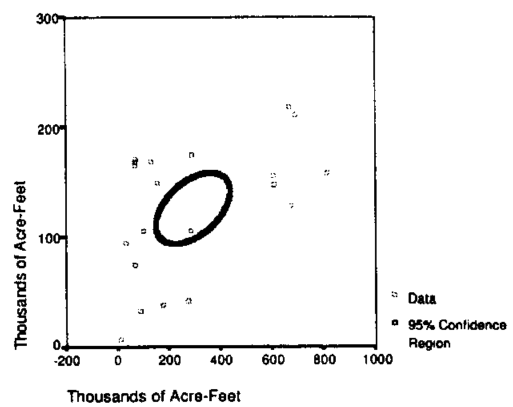


***Figure 3.34*** *May-June Inflows vs. September-October Inflows, CR.*

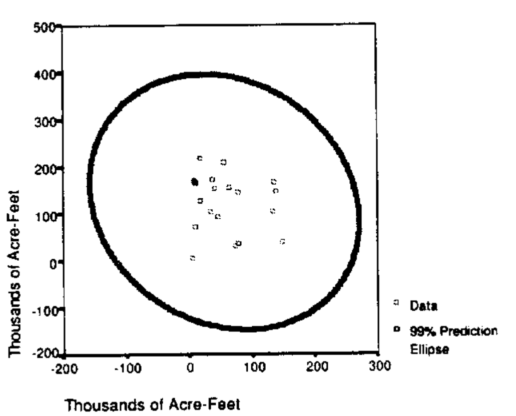


***Figure 3.35*** *May-June Inflows vs. November-December Inflows, PE.*

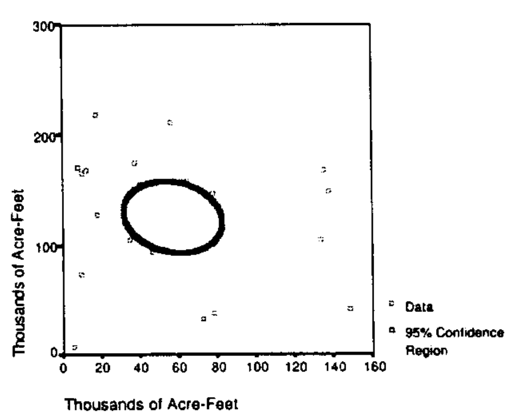


***Figure 3.36*** *May-June Inflows vs. November-December Inflows, CR.*

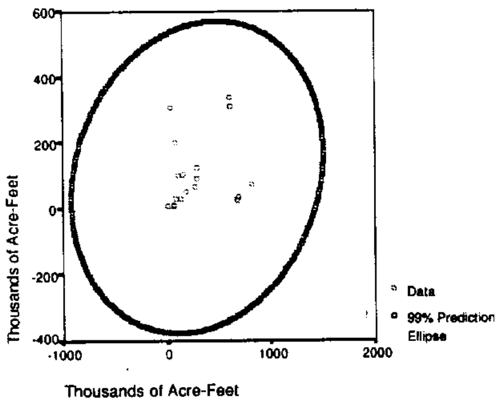


*Figure 3.37* *July-August Inflows. vs. September-October Inflows, PE.*

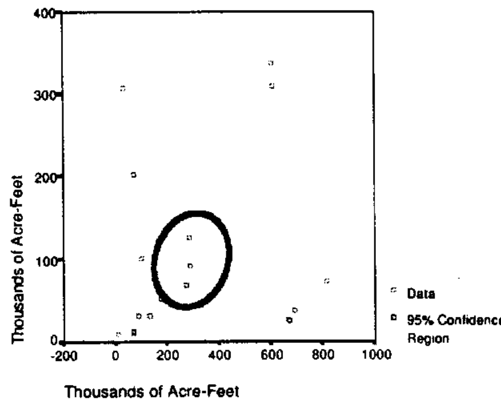


*Figure 3.38* *July-August Inflows. vs. September-October Inflows, CR.*

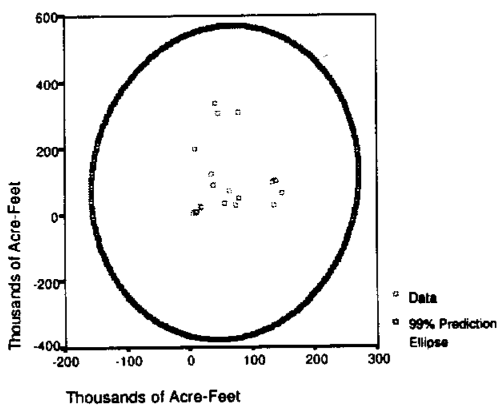


*Figure 3.39* *July-August Inflows. vs. November-December Inflows, PE.*

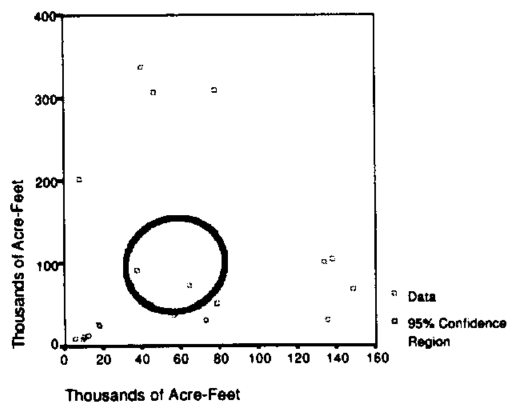


*Figure 3.40* *July-August Inflows. vs. November-December Inflows, CR.*

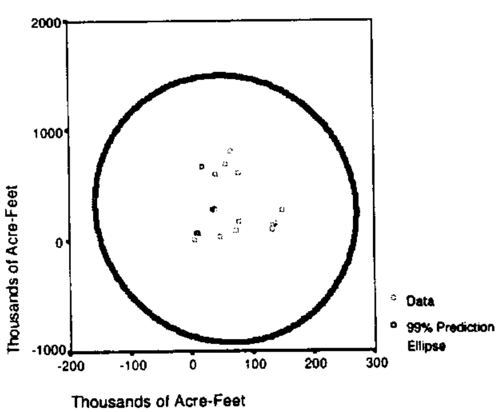


*Figure 3.41* *September-October Inflows vs. November-December Inflows, PE.*

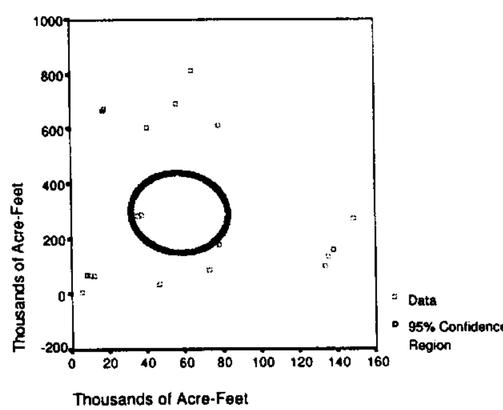


*Figure 3.42* *September-October Inflows vs. November-December Inflows, CR.*

## 4. Box-Cox Analysis

***Table .4.1*** *Mean Square Error from Box-Cox transformation of the red fish data and the inflow data for different lambda.*

| Lam. | Red | JF_inflow | MA_inflow | MJ_inflow | JA_inflow | SO_inflow | ND_inflow |
|---|---|---|---|---|---|---|---|
| -2.0 | 48759.99 | 8802.03 | 683.70 | 3973331 | 78647.81 | 35125032 | 44224.87 |
| -1.9 | 39604.59 | 6934.11 | 596.41 | 2618877 | 62167.31 | 21901470 | 33949.73 |
| -1.8 | 32330.74 | 5490.95 | 523.05 | 1734879 | 49380.12 | 13728189 | 26236.63 |
| -1.7 | 26535.40 | 4373.10 | 461.42 | 1155699 | 39431.52 | 8655697 | 20421.99 |
| -1.6 | 21904.69 | 3504.95 | 409.71 | 774646.5 | 31669.86 | 5493596 | 16018.95 |
| -1.5 | 18193.71 | 2828.90 | 366.42 | 522815.7 | 25597.49 | 3512848 | 12669.35 |
| -1.4 | 15211.06 | 2301.03 | 330.32 | 355572.9 | 20833.58 | 2265553 | 10108.99 |
| -1.3 | 12806.83 | 1887.78 | 300.42 | 243918.1 | 17086.22 | 1475597 | 8142.37 |
| -1.2 | 10863.39 | 1563.45 | 275.88 | 168947.8 | 14131.23 | 972149.1 | 6624.44 |
| -1.1 | 9288.26 | 1308.34 | 256.05 | 118296.1 | 11796.18 | 649106.6 | 5447.18 |
| -1.0 | 8008.60 | 1107.33 | 240.42 | 83844.21 | 9948.23 | 440292.3 | 4529.96 |
| -0.9 | 6966.92 | 948.78 | 228.59 | 60240.23 | 8484.94 | 304247.6 | 3812.35 |
| -0.8 | 6117.76 | 823.72 | 220.28 | 43941.45 | 7327.31 | 214874.8 | 3248.94 |
| -0.7 | 5425.17 | 725.25 | 215.31 | 32592.08 | 6414.44 | 155662.4 | 2805.50 |
| -0.6 | 4860.61 | 648.03 | 213.60 | 24618.09 | 5699.56 | 116107.4 | 2456.18 |
| -0.5 | 4401.48 | 587.97 | 215.18 | 18962.39 | 5146.93 | 89491.39 | 2181.42 |
| -0.4 | 4029.87 | 541.89 | 220.17 | 14911.17 | 4729.59 | 71492.48 | 1966.41 |
| -0.3 | 3731.59 | 507.39 | 228.82 | 11979.62 | 4427.67 | 59315.09 | 1799.96 |
| -0.2 | 3495.49 | 482.64 | 241.51 | 9836.45 | 4227.15 | 51142.47 | 1673.68 |
| -0.1 | 3312.81 | 466.25 | 258.75 | 8253.81 | 4118.98 | 45790.62 | 1581.33 |
| 0.0 | 3176.80 | 457.23 | 281.25 | 7073.92 | 4098.61 | 42488.60 | 1518.39 |
| 0.1 | 3082.36 | 454.89 | 309.95 | 6186.75 | 4165.65 | 40738.76 | 1481.74 |
| 0.2 | 3025.75 | 458.79 | 346.02 | 5515.00 | 4323.96 | 40227.58 | 1469.41 |
| 0.3 | 3004.43 | 468.72 | 391.00 | 5003.98 | 4581.89 | 40769.06 | 1480.40 |
| 0.4 | 3016.92 | 484.66 | 446.85 | 4614.70 | 4952.84 | 42269.01 | 1514.66 |
| 0.5 | 3062.66 | 506.78 | 516.06 | 4319.17 | 5456.18 | 44703.32 | 1572.97 |
| 0.6 | 3142.01 | 535.43 | 601.81 | 4097.16 | 6118.57 | 48105.47 | 1657.00 |
| 0.7 | 3256.20 | 571.14 | 708.15 | 3933.99 | 6975.76 | 52560.76 | 1769.30 |
| 0.8 | 3407.33 | 614.65 | 840.24 | 3818.94 | 8075.05 | 58205.40 | 1913.45 |
| 0.9 | 3598.45 | 666.88 | 1004.71 | 3744.21 | 9478.61 | 65229.86 | 2094.16 |
| 1.0 | 3833.59 | 729.00 | 1210.01 | 3704.13 | 11267.89 | 73885.72 | 2317.46 |
| 1.1 | 4117.89 | 802.45 | 1467.04 | 3694.63 | 13549.48 | 84496.52 | 2590.95 |
| 1.2 | 4457.75 | 888.98 | 1789.80 | 3712.84 | 16462.94 | 97472.61 | 2924.13 |
| 1.3 | 4861.00 | 990.69 | 2196.34 | 3756.86 | 20191.14 | 113330.9 | 3328.80 |
| 1.4 | 5337.12 | 1110.10 | 2710.01 | 3825.53 | 24974.09 | 132720.7 | 3819.55 |
| 1.5 | 5897.56 | 1250.26 | 3361.06 | 3918.30 | 31127.33 | 156456.1 | 4414.45 |
| 1.6 | 6556.05 | 1414.79 | 4188.73 | 4035.16 | 39066.46 | 185558.9 | 5135.76 |
| 1.7 | 7329.03 | 1608.02 | 5244.10 | 4176.54 | 49339.91 | 221311.7 | 6011.04 |
| 1.8 | 8236.21 | 1835.15 | 6593.74 | 4343.30 | 62672.75 | 265326.7 | 7074.30 |
| 1.9 | 9301.12 | 2102.39 | 8324.60 | 4536.69 | 80025.37 | 319633.5 | 8367.61 |
| 2.0 | 10551.92 | 2417.17 | 10550.47 | 4758.34 | 102672.2 | 386790.3 | 9943.03 |

# 5. Model Choice Diagnostics

## 5.1 Untransformed red fish data and untransformed inflow data

***Table 5.1*** *Regression Models for Dependent Variable: RED on INFLOWS*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.3771 | 0.3425 | 196.0 | 158.5 | 2520 | 160.5 | QMA_LAG |
| 1 | 0.3030 | 0.2643 | 221.3 | 160.8 | 2820 | 162.8 | QJA_LAG |
| 1 | 0.2078 | 0.1638 | 253.7 | 163.3 | 3205 | 165.3 | QMJ_LAG |
| 1 | 0.1786 | 0.1329 | 263.6 | 164.1 | 3324 | 166.1 | QJF_LAG |
| 2 | 0.7573 | 0.7287 | 68.63 | 141.7 | 1040 | 144.7 | QMA_LAG QJA_LAG |
| 2 | 0.5482 | 0.4951 | 139.8 | 154.1 | 1936 | 157.1 | QJF_LAG QMA_LAG |
| 2 | 0.5099 | 0.4522 | 152.9 | 155.7 | 2100 | 158.7 | QJF_LAG QMJ_LAG |
| 2 | 0.4858 | 0.4253 | 161.1 | 156.7 | 2203 | 159.7 | QMA_LAG QMJ_LAG |
| 3 | 0.8707 | 0.8465 | 32.02 | 131.1 | 589 | 135.1 | QJF_LAG QMA_LAG QSO_LAG |
| 3 | 0.8173 | 0.7830 | 50.20 | 138.0 | 832 | 142.0 | QMA_LAG QMJ_LAG QJA_LAG |
| 3 | 0.8107 | 0.7752 | 52.44 | 138.7 | 862 | 142.7 | QJF_LAG QMJ_LAG QND_LAG |
| 3 | 0.7913 | 0.7522 | 59.05 | 140.7 | 950 | 144.7 | QMA_LAG QJA_LAG QSO_LAG |
| 4 | 0.9341 | 0.9166 | 12.42 | 119.6 | 320 | 124.6 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG |
| 4 | 0.9019 | 0.8758 | 23.39 | 127.6 | 476 | 132.5 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG |
| 4 | 0.8903 | 0.8611 | 27.34 | 129.8 | 533 | 134.8 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG |
| 4 | 0.8711 | 0.8367 | 33.89 | 133.0 | 626 | 138.0 | QJF_LAG QMA_LAG QSO_LAG QND_LAG |
| 5 | 0.9610 | 0.9471 | 5.272 | 111.1 | 203 | 117.1 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.9412 | 0.9202 | 12.01 | 119.3 | 306 | 125.3 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.9144 | 0.8838 | 21.15 | 126.9 | 446 | 132.8 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 5 | 0.9034 | 0.8689 | 24.89 | 129.3 | 503 | 135.2 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 6 | 0.9618 | 0.9442 | 7.000 | 112.7 | 214 | 119.7 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 20

## 5.2 Untransformed red fish data and square root of inflow data

***Table 5.2*** *Regression Models for Dependent Variable: RED on Sqrt(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.3722 | 0.3373 | 113.7 | 158.7 | 2540 | 160.7 | SQR_QMA |
| 1 | 0.3433 | 0.3069 | 119.6 | 159.6 | 2657 | 161.6 | SQR_QJA |
| 1 | 0.2568 | 0.2155 | 137.5 | 162.1 | 3008 | 164.1 | SQR_QMJ |
| 1 | 0.1636 | 0.1171 | 156.8 | 164.4 | 3385 | 166.4 | SQR_QND |
| 2 | 0.7336 | 0.7023 | 41.03 | 143.5 | 1141 | 146.5 | SQR_QMA SQR_QJA |
| 2 | 0.5582 | 0.5063 | 77.26 | 153.7 | 1893 | 156.7 | SQR_QJF SQR_QMA |
| 2 | 0.5111 | 0.4536 | 86.99 | 155.7 | 2095 | 158.7 | SQR_QJF SQR_QMJ |
| 2 | 0.5022 | 0.4437 | 88.82 | 156.1 | 2133 | 159.0 | SQR_QMJ SQR_QJA |
| 3 | 0.8849 | 0.8633 | 11.78 | 128.8 | 524 | 132.7 | SQR_QJF SQR_QMA SQR_QSO |
| 3 | 0.8389 | 0.8087 | 21.28 | 135.5 | 733 | 139.5 | SQR_QJF SQR_QMJ SQR_QND |
| 3 | 0.7798 | 0.7385 | 33.48 | 141.7 | 1002 | 145.7 | SQR_QJF SQR_QMA SQR_QJA |
| 3 | 0.7725 | 0.7299 | 34.99 | 142.4 | 1036 | 146.4 | SQR_QMA SQR_QMJ SQR_QJA |
| 4 | 0.9231 | 0.9026 | 5.878 | 122.7 | 373 | 127.7 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO |
| 4 | 0.8991 | 0.8722 | 10.85 | 128.1 | 490 | 133.1 | SQR_QJF SQR_QMA SQR_QMJ SQR_QSO |
| 4 | 0.8857 | 0.8553 | 13.60 | 130.6 | 555 | 135.6 | SQR_QJF SQR_QMA SQR_QSO SQR_QND |
| 4 | 0.8604 | 0.8232 | 18.84 | 134.6 | 678 | 139.6 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA |
| 5 | 0.9355 | 0.9125 | 5.316 | 121.2 | 335 | 127.1 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO |
| 5 | 0.9259 | 0.8994 | 7.314 | 124.0 | 386 | 129.9 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.9179 | 0.8886 | 8.956 | 126.0 | 427 | 132.0 | SQR_QJF SQR_QMA SQR_QMJ SQR_QSO SQR_QND |
| 5 | 0.8838 | 0.8423 | 16.01 | 133.0 | 605 | 138.9 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QND |
| 6 | 0.9371 | 0.9080 | 7.000 | 122.7 | 353 | 129.7 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

N = 20

## 5.3 Log of red fish data and untransformed inflow data

***Table 5.3*** *Regression Models for Dependent Variable: Ln(RED) on INFLOWS*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.3629 | 0.3275 | 134.9 | -7.497 | 0.6253 | -5.506 | QMJ_LAG |
| 1 | 0.2903 | 0.2509 | 152.0 | -5.338 | 0.6966 | -3.347 | QJA_LAG |
| 1 | 0.2634 | 0.2225 | 158.4 | -4.594 | 0.7230 | -2.603 | QMA_LAG |
| 1 | 0.1677 | 0.1215 | 181.1 | -2.153 | 0.8169 | -0.161 | QJF_LAG |
| 2 | 0.6910 | 0.6546 | 59.17 | -19.97 | 0.3212 | -16.98 | QJF_LAG QMJ_LAG |
| 2 | 0.6167 | 0.5716 | 76.76 | -15.66 | 0.3983 | -12.67 | QMA_LAG QJA_LAG |
| 2 | 0.5865 | 0.5378 | 83.92 | -14.14 | 0.4298 | -11.15 | QMJ_LAG QJA_LAG |
| 2 | 0.5158 | 0.4588 | 100.7 | -10.98 | 0.5033 | -7.996 | QMA_LAG QMJ_LAG |
| 3 | 0.8213 | 0.7878 | 30.31 | -28.92 | 0.1973 | -24.94 | QJF_LAG QMJ_LAG QND_LAG |
| 3 | 0.8141 | 0.7792 | 32.02 | -28.13 | 0.2053 | -24.15 | QJF_LAG QMA_LAG QMJ_LAG |
| 3 | 0.7954 | 0.7570 | 36.45 | -26.21 | 0.2260 | -22.23 | QMA_LAG QMJ_LAG QJA_LAG |
| 3 | 0.7558 | 0.7100 | 45.83 | -22.67 | 0.2697 | -18.69 | QJF_LAG QMA_LAG QSO_LAG |
| 4 | 0.9066 | 0.8817 | 12.12 | -39.90 | 0.1100 | -34.92 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG |
| 4 | 0.8989 | 0.8720 | 13.93 | -38.32 | 0.1190 | -33.34 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG |
| 4 | 0.8527 | 0.8134 | 24.88 | -30.78 | 0.1735 | -25.80 | QJF_LAG QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.8394 | 0.7966 | 28.02 | -29.06 | 0.1891 | -24.08 | QJF_LAG QMJ_LAG QSO_LAG QND_LAG |
| 5 | 0.9419 | 0.9212 | 5.748 | -47.40 | 0.0733 | -41.43 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.9067 | 0.8734 | 14.10 | -37.91 | 0.1178 | -31.94 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.8993 | 0.8634 | 15.84 | -36.40 | 0.1270 | -30.42 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 5 | 0.8853 | 0.8444 | 19.15 | -33.79 | 0.1447 | -27.82 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.9451 | 0.9198 | 7.000 | -46.52 | 0.0746 | -39.55 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 20

## 5.4 Log of red fish data and log of inflow data

***Table 5.4*** *Regression Models for Dependent Variable: Ln(RED) on Ln(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.4199 | 0.3877 | 92.51 | -9.373 | 0.5693 | -7.381 | LN_QMJ |
| 1 | 0.3219 | 0.2842 | 110.8 | -6.249 | 0.6656 | -4.258 | LN_QJA |
| 1 | 0.3091 | 0.2707 | 113.2 | -5.875 | 0.6782 | -3.883 | LN_QMA |
| 1 | 0.0927 | 0.0423 | 153.7 | -0.426 | 0.8905 | 1.565 | LN_QJF |
| 2 | 0.7290 | 0.6971 | 36.69 | -22.59 | 0.2816 | -19.61 | LN_QJF LN_QMJ |
| 2 | 0.5788 | 0.5292 | 64.80 | -13.77 | 0.4378 | -10.78 | LN_QMA LN_QJA |
| 2 | 0.5712 | 0.5208 | 66.21 | -13.42 | 0.4456 | -10.43 | LN_QMJ LN_QJA |
| 2 | 0.5123 | 0.4549 | 77.24 | -10.84 | 0.5069 | -7.852 | LN_QJF LN_QMA |
| 3 | 0.8661 | 0.8410 | 13.04 | -34.70 | 0.1478 | -30.72 | LN_QJF LN_QMJ LN_QND |
| 3 | 0.8575 | 0.8307 | 14.66 | -33.44 | 0.1574 | -29.46 | LN_QJF LN_QMA LN_QSO |
| 3 | 0.8419 | 0.8123 | 17.58 | -31.37 | 0.1746 | -27.39 | LN_QJF LN_QMA LN_QMJ |
| 3 | 0.7707 | 0.7277 | 30.89 | -23.94 | 0.2532 | -19.95 | LN_QJF LN_QMJ LN_QJA |
| 4 | 0.9245 | 0.9044 | 4.114 | -44.17 | 0.0889 | -39.19 | LN_QJF LN_QMA LN_QMJ LN_QSO |
| 4 | 0.8989 | 0.8719 | 8.921 | -38.30 | 0.1191 | -33.32 | LN_QJF LN_QMA LN_QMJ LN_QND |
| 4 | 0.8883 | 0.8586 | 10.89 | -36.33 | 0.1315 | -31.35 | LN_QJF LN_QMA LN_QMJ LN_QJA |
| 4 | 0.8691 | 0.8342 | 14.49 | -33.15 | 0.1542 | -28.17 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 5 | 0.9295 | 0.9043 | 5.187 | -43.52 | 0.0890 | -37.55 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.9295 | 0.9043 | 5.195 | -43.51 | 0.0890 | -37.54 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.9013 | 0.8660 | 10.47 | -36.79 | 0.1246 | -30.81 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.8876 | 0.8475 | 13.02 | -34.20 | 0.1418 | -28.23 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 6 | 0.9305 | 0.8984 | 7.000 | -41.81 | 0.0944 | -34.84 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 20

## 5.5 Log of red fish data and square root of inflow data

*Table 5.5 Regression Models for Dependent Variable: Ln(RED) on Sqrt(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.4256 | 0.3937 | 139.4 | -9.569 | 0.5638 | -7.578 | SQR_QMJ |
| 1 | 0.3249 | 0.2874 | 166.6 | -6.338 | 0.6626 | -4.347 | SQR_QJA |
| 1 | 0.2876 | 0.2480 | 176.7 | -5.262 | 0.6993 | -3.270 | SQR_QMA |
| 1 | 0.1476 | 0.1003 | 214.5 | -1.675 | 0.8366 | 0.316 | SQR_QJF |
| 2 | 0.7253 | 0.6930 | 60.29 | -22.32 | 0.2854 | -19.34 | SQR_QJF SQR_QMJ |
| 2 | 0.6279 | 0.5842 | 86.63 | -16.25 | 0.3867 | -13.27 | SQR_QMA SQR_QJA |
| 2 | 0.6279 | 0.5841 | 86.64 | -16.25 | 0.3867 | -13.27 | SQR_QMJ SQR_QJA |
| 2 | 0.5414 | 0.4874 | 110.0 | -12.07 | 0.4766 | -9.084 | SQR_QMA SQR_QMJ |
| 3 | 0.8765 | 0.8534 | 21.39 | -36.32 | 0.1363 | -32.34 | SQR_QJF SQR_QMJ SQR_QND |
| 3 | 0.8467 | 0.8180 | 29.46 | -31.99 | 0.1693 | -28.01 | SQR_QJF SQR_QMA SQR_QMJ |
| 3 | 0.8148 | 0.7801 | 38.09 | -28.21 | 0.2045 | -24.22 | SQR_QJF SQR_QMA SQR_QSO |
| 3 | 0.7767 | 0.7349 | 48.39 | -24.47 | 0.2465 | -20.49 | SQR_QMA SQR_QMJ SQR_QJA |
| 4 | 0.9281 | 0.9090 | 9.439 | -45.14 | 0.0847 | -40.16 | SQR_QJF SQR_QMA SQR_QMJ SQR_QSO |
| 4 | 0.9156 | 0.8931 | 12.84 | -41.92 | 0.0994 | -36.94 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA |
| 4 | 0.8921 | 0.8633 | 19.19 | -37.01 | 0.1271 | -32.03 | SQR_QJF SQR_QMA SQR_QMJ SQR_QND |
| 4 | 0.8808 | 0.8490 | 22.24 | -35.02 | 0.1404 | -30.04 | SQR_QJF SQR_QMJ SQR_QJA SQR_QND |
| 5 | 0.9510 | 0.9335 | 5.243 | -50.81 | 0.0618 | -44.84 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO |
| 5 | 0.9315 | 0.9070 | 10.54 | -44.09 | 0.0865 | -38.11 | SQR_QJF SQR_QMA SQR_QMJ SQR_QSO SQR_QND |
| 5 | 0.9185 | 0.8893 | 14.06 | -40.61 | 0.1029 | -34.64 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QND |
| 5 | 0.9080 | 0.8752 | 16.88 | -38.20 | 0.1161 | -32.23 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 6 | 0.9519 | 0.9298 | 7.000 | -49.18 | 0.0653 | -42.21 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

N = 20

## 5.6 Square root of red fish data and untransformed inflow data

***Table 5.6*** *Regression Models for Dependent Variable: Sqrt(RED) on INFLOWS*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.3237 | 0.2861 | 219.8 | 46.60 | 9.35 | 48.59 | QMA_LAG |
| 1 | 0.3105 | 0.2722 | 224.3 | 46.99 | 9.53 | 48.98 | QJA_LAG |
| 1 | 0.2768 | 0.2366 | 236.1 | 47.94 | 10.00 | 49.94 | QMJ_LAG |
| 1 | 0.1848 | 0.1395 | 268.2 | 50.34 | 11.27 | 52.33 | QJF_LAG |
| 2 | 0.7065 | 0.6719 | 88.32 | 31.91 | 4.30 | 34.90 | QMA_LAG QJA_LAG |
| 2 | 0.6070 | 0.5607 | 123.0 | 37.75 | 5.75 | 40.74 | QJF_LAG QMJ_LAG |
| 2 | 0.5270 | 0.4713 | 150.9 | 41.45 | 6.93 | 44.44 | QMJ_LAG QJA_LAG |
| 2 | 0.5014 | 0.4427 | 159.8 | 42.51 | 7.30 | 45.49 | QJF_LAG QMA_LAG |
| 3 | 0.8344 | 0.8034 | 45.71 | 22.46 | 2.58 | 26.44 | QJF_LAG QMA_LAG QSO_LAG |
| 3 | 0.8269 | 0.7944 | 48.34 | 23.35 | 2.69 | 27.33 | QJF_LAG QMJ_LAG QND_LAG |
| 3 | 0.8138 | 0.7789 | 52.91 | 24.81 | 2.90 | 28.79 | QMA_LAG QMJ_LAG QJA_LAG |
| 3 | 0.7877 | 0.7479 | 62.00 | 27.43 | 3.30 | 31.41 | QJF_LAG QMA_LAG QMJ_LAG |
| 4 | 0.9093 | 0.8852 | 21.60 | 12.41 | 1.50 | 17.39 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG |
| 4 | 0.9090 | 0.8847 | 21.73 | 12.49 | 1.51 | 17.47 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG |
| 4 | 0.8947 | 0.8667 | 26.70 | 15.40 | 1.75 | 20.38 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG |
| 4 | 0.8629 | 0.8263 | 37.80 | 20.69 | 2.28 | 25.67 | QJF_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.9627 | 0.9494 | 5.001 | -3.352 | 0.66 | 2.622 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.9234 | 0.8960 | 18.70 | 11.04 | 1.36 | 17.02 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.9153 | 0.8851 | 21.52 | 13.05 | 1.51 | 19.02 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 5 | 0.9149 | 0.8845 | 21.66 | 13.14 | 1.51 | 19.12 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 6 | 0.9627 | 0.9455 | 7.000 | -1.353 | 0.71 | 5.617 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 20

## 5.7 Square root of red fish data and square root of inflow data

***Table 5.7*** *Regression Models for Dependent Variable: Sqrt(RED) on Sqrt(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.3517 | 0.3156 | 172.3 | 45.76 | 8.96 | 47.75 | SQR_QJA |
| 1 | 0.3345 | 0.2975 | 177.3 | 46.28 | 9.20 | 48.27 | SQR_QMJ |
| 1 | 0.3343 | 0.2973 | 177.4 | 46.29 | 9.20 | 48.28 | SQR_QMA |
| 1 | 0.1535 | 0.1065 | 229.9 | 51.09 | 11.70 | 53.08 | SQR_QJF |
| 2 | 0.7033 | 0.6684 | 72.18 | 32.13 | 4.34 | 35.11 | SQR_QMA SQR_QJA |
| 2 | 0.6238 | 0.5795 | 95.28 | 36.88 | 5.51 | 39.86 | SQR_QJF SQR_QMJ |
| 2 | 0.5728 | 0.5225 | 110.1 | 39.42 | 6.25 | 42.40 | SQR_QMJ SQR_QJA |
| 2 | 0.5322 | 0.4771 | 121.9 | 41.23 | 6.85 | 44.22 | SQR_QJF SQR_QMA |
| 3 | 0.8729 | 0.8491 | 24.92 | 17.17 | 1.98 | 21.16 | SQR_QJF SQR_QMA SQR_QSO |
| 3 | 0.8707 | 0.8464 | 25.56 | 17.52 | 2.01 | 21.50 | SQR_QJF SQR_QMJ SQR_QND |
| 3 | 0.7989 | 0.7612 | 46.41 | 26.35 | 3.13 | 30.33 | SQR_QJF SQR_QMA SQR_QMJ |
| 3 | 0.7845 | 0.7441 | 50.59 | 27.73 | 3.35 | 31.71 | SQR_QMA SQR_QMJ SQR_QJA |
| 4 | 0.9225 | 0.9018 | 12.52 | 9.284 | 1.29 | 14.26 | SQR_QJF SQR_QMA SQR_QMJ SQR_QSO |
| 4 | 0.9087 | 0.8843 | 16.53 | 12.56 | 1.52 | 17.54 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO |
| 4 | 0.8999 | 0.8732 | 19.07 | 14.39 | 1.66 | 19.37 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA |
| 4 | 0.8860 | 0.8557 | 23.10 | 16.99 | 1.89 | 21.97 | SQR_QJF SQR_QMA SQR_QMJ SQR_QND |
| 5 | 0.9550 | 0.9389 | 5.068 | 0.400 | 0.80 | 6.374 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO |
| 5 | 0.9349 | 0.9117 | 10.91 | 7.787 | 1.16 | 13.76 | SQR_QJF SQR_QMA SQR_QMJ SQR_QSO SQR_QND |
| 5 | 0.9292 | 0.9039 | 12.57 | 9.475 | 1.26 | 15.45 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.9130 | 0.8820 | 17.26 | 13.58 | 1.55 | 19.56 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QND |
| 6 | 0.9552 | 0.9346 | 7.000 | 2.296 | 0.86 | 9.266 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

N = 20

## 5.8 Various transformation suggested by Box-Cox

***Table 5.8*** *Regression Models for Dependent Variable:* $(RED)^{0.3}$ *on variously transformed INFLOWS.*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.3474 | 0.3112 | 69.88 | -7.473 | 0.6261 | -5.481 | LN_QJA |
| 1 | 0.2950 | 0.2558 | 76.78 | -5.927 | 0.6764 | -3.936 | QR_QMJ |
| 1 | 0.2945 | 0.2553 | 76.84 | -5.913 | 0.6768 | -3.922 | QR_QMA |
| 1 | 0.1069 | 0.0573 | 101.5 | -1.198 | 0.8568 | 0.794 | QR_QJF |
| 2 | 0.5783 | 0.5286 | 41.50 | -14.20 | 0.4284 | -11.22 | QR_QJF QR_QMA |
| 2 | 0.5726 | 0.5223 | 42.25 | -13.94 | 0.4342 | -10.95 | QR_QMA LN_QJA |
| 2 | 0.5645 | 0.5132 | 43.31 | -13.56 | 0.4424 | -10.57 | QR_QMJ LN_QJA |
| 2 | 0.5312 | 0.4761 | 47.69 | -12.09 | 0.4762 | -9.101 | QR_QJF QR_QMJ |
| 3 | 0.8673 | 0.8424 | 5.462 | -35.33 | 0.1432 | -31.35 | QR_QJF QR_QMA QR_QSO |
| 3 | 0.8360 | 0.8053 | 9.579 | -31.10 | 0.1770 | -27.11 | QR_QJF QR_QMJ QR_QND |
| 3 | 0.7302 | 0.6797 | 23.50 | -21.14 | 0.2912 | -17.16 | QR_QJF QR_QMA LN_QJA |
| 3 | 0.7185 | 0.6657 | 25.04 | -20.29 | 0.3038 | -16.30 | QR_QJF QR_QMA QR_QMJ |
| 4 | 0.8748 | 0.8414 | 6.481 | -34.49 | 0.1442 | -29.51 | QR_QJF QR_QMA LN_QJA QR_QSO |
| 4 | 0.8732 | 0.8394 | 6.688 | -34.24 | 0.1460 | -29.26 | QR_QJF QR_QMA QR_QMJ QR_QSO |
| 4 | 0.8701 | 0.8355 | 7.092 | -33.76 | 0.1495 | -28.78 | QR_QJF QR_QMA QR_QSO QR_QND |
| 4 | 0.8603 | 0.8231 | 8.381 | -32.30 | 0.1608 | -27.33 | QR_QJF QR_QMA QR_QMJ QR_QND |
| 5 | 0.8980 | 0.8616 | 5.418 | -36.60 | 0.1258 | -30.62 | QR_QJF QR_QMA QR_QMJ QR_QSO QR_QND |
| 5 | 0.8872 | 0.8469 | 6.846 | -34.58 | 0.1392 | -28.60 | QR_QJF QR_QMA QR_QMJ LN_QJA QR_QSO |
| 5 | 0.8757 | 0.8313 | 8.359 | -32.64 | 0.1533 | -26.66 | QR_QJF QR_QMA QR_QMJ LN_QJA QR_QND |
| 5 | 0.8749 | 0.8302 | 8.468 | -32.50 | 0.1544 | -26.53 | QR_QJF QR_QMA LN_QJA QR_QSO QR_QND |
| 6 | 0.9012 | 0.8556 | 7.000 | -35.23 | 0.1312 | -28.26 | QR_QJF QR_QMA QR_QMJ LN_QJA QR_QSO QR_QND |

N = 20

Dependent Variable: $(RED)^{0.3}$

Independent Variables:
QR_QJF=(January-February Inflows)$^{0.1}$
QR_QMA=(March-April Inflows)$^{-0.6}$
QR_QMJ=(May-June Inflows)$^{1.1}$
QR_QMJ=(September-October Inflows)$^{0.2}$
QR_QND=(November-December Inflows)$^{0.2}$

# 6. Regression for the Best Models

## 6.1 Regression - Red fish data on inflow data

### 6.1.1 ANOVA and Parameter Estimates

***Table 6.1*** *Model Summary for red fish data on inflow data.*

**Model Summary**[a,b]

| Model | Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|
| 1 | January-February Inflows, March-April Inflows, May-June Inflows, July-August Inflows, SeptemberOctober Inflows, November-December Inflows[c,d] | .981 | .962 | .944 | 14.6273 | 2.722 |

a. Dependent Variable: Red Harvest

b. Method: Enter

c. Independent Variables: (Constant), November-December Inflows, SeptemberOctober Inflows, July-August Inflows, May-June Inflows, January-February Inflows, March-April Inflows

d. All requested variables entered.

***Table 6.2*** *ANOVA table of red fish data on inflow data*

**ANOVA**[a]

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 70056.7 | 6 | 11676.1 | 54.572 | .000[b] |
| | Residual | 2781.435 | 13 | 213.957 | | |
| | Total | 72838.1 | 19 | | | |

a. Dependent Variable: Red Harvest

b. Independent Variables: (Constant), November-December Inflows, SeptemberOctober Inflows, July-August Inflows, May-June Inflows, January-February Inflows, March-April Inflows

*Table 6.3 Table of coefficients for red fish data on inflow data.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| (Constant) | 18.781 | 10.991 | | 1.709 | .111 | -4.963 | 42.526 |
| January-February Inflows | -1.271 | .186 | -.554 | -6.816 | .000 | -1.674 | -.868 |
| March-April Inflows | 1.140 | .192 | .640 | 5.952 | .000 | .726 | 1.554 |
| May-June Inflows | .238 | .090 | .234 | 2.648 | .020 | .044 | .432 |
| July-August Inflows | .170 | .042 | .292 | 4.019 | .001 | .079 | .262 |
| SeptemberOctober Inflows | 9.0E-02 | .020 | .393 | 4.459 | .001 | .046 | .133 |
| November-December Inflows | 6.7E-02 | .128 | .052 | .521 | .611 | -.210 | .344 |

a. Dependent Variable: Red Harvest

## 6.1.2 Collinearity Diagnostic

*Table 6.4 Variance Inflation for red fish data on inflow data.*

**Coefficients[a]**

| | t | Collinearity Statistics | |
|---|---|---|---|
| | | Tolerance | VIF |
| (Constant) | 1.709 | | |
| January-February Inflows | -6.816 | .444 | 2.251 |
| March-April Inflows | 5.952 | .254 | 3.941 |
| May-June Inflows | 2.648 | .377 | 2.653 |
| July-August Inflows | 4.019 | .557 | 1.796 |
| SeptemberOctober Inflows | 4.459 | .377 | 2.650 |
| November-December Inflows | .521 | .295 | 3.385 |

a. Dependent Variable: Red Harvest

*Table 6.5 Collinearity Diagnostics(intercept adjusted) for Dependent Variable: RED on INFLOWS.*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *QJF_LAG* | Var Prop *QMA_LAG* | Var Prop *QMJ_LAG* | Var Prop *QJA_LAG* | Var Prop *QSO_LAG* | Var Prop *QND_LAG* |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.86647 | 1.00000 | 0.0619 | 0.0077 | 0.0450 | 0.0010 | 0.0804 | 0.0094 |
| 2 | 1.68991 | 1.05094 | 0.0256 | 0.0657 | 0.0088 | 0.0116 | 0.0011 | 0.0674 |
| 3 | 1.29792 | 1.19919 | 0.0529 | 0.0044 | 0.0413 | 0.2647 | 0.0135 | 0.0038 |
| 4 | 0.80254 | 1.52503 | 0.0350 | 0.0335 | 0.1812 | 0.0675 | 0.0580 | 0.0826 |
| 5 | 0.23546 | 2.81549 | 0.7824 | 0.0001 | 0.0087 | 0.5234 | 0.5484 | 0.0205 |
| 6 | 0.10770 | 4.16295 | 0.0422 | 0.8885 | 0.7151 | 0.1318 | 0.2986 | 0.8163 |

### 6.1.3 Residuals Diagnostics

***Table 6.6*** *Residuals Diagnostics for red fish data on inflow data.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | -1.2531 | 182.4878 | 84.0750 | 60.7223 | 20 |
| Std. Predicted Value | -1.405 | 1.621 | .000 | 1.000 | 20 |
| Standard Error of Predicted Value | 4.8007 | 11.7417 | 8.4868 | 1.7347 | 20 |
| Adjusted Predicted Value | -6.3412 | 174.9467 | 84.5422 | 61.3492 | 20 |
| Residual | -18.1801 | 22.2060 | -2.E-14 | 12.0992 | 20 |
| Std. Residual | -1.243 | 1.518 | .000 | .827 | 20 |
| Stud. Residual | -1.541 | 1.804 | -.011 | 1.039 | 20 |
| Deleted Residual | -27.9472 | 34.9393 | -.4672 | 19.4800 | 20 |
| Stud. Deleted Residual | -1.638 | 2.002 | .015 | 1.096 | 20 |
| Mahal. Distance | 1.097 | 11.293 | 5.700 | 2.676 | 20 |
| Cook's Distance | .001 | .427 | .094 | .115 | 20 |
| Centered Leverage Value | .058 | .594 | .300 | .141 | 20 |

a. Dependent Variable: Red Harvest

***Table 6.7*** *Case Values for Residuals Diagnostics for red fish data on inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1961 | 15.85 | -3.8537 | -10.6469 | 22.65 | -1.1235 | -.2635 | -.4379 | -.4239 |
| 1962 | 10.13 | 1.9651 | 2.4812 | 9.62 | -1.2177 | .1343 | .1510 | .1452 |
| 1963 | -1.25 | 16.9531 | 22.0412 | -6.34 | -1.4052 | 1.1590 | 1.3215 | 1.3647 |
| 1964 | 24.18 | -5.8832 | -11.5182 | 29.82 | -.9863 | -.4022 | -.5628 | -.5474 |
| 1965 | 28.87 | -9.6667 | -12.1116 | 31.31 | -.9092 | -.6609 | -.7397 | -.7262 |
| 1966 | 56.89 | 22.2060 | 30.6592 | 48.44 | -.4476 | 1.5181 | 1.7838 | 1.9721 |
| 1967 | 58.29 | -9.7924 | -13.5010 | 62.00 | -.4246 | -.6695 | -.7861 | -.7739 |
| 1968 | 46.68 | -18.1801 | -27.9472 | 56.45 | -.6158 | -1.2429 | -1.5410 | -1.6377 |
| 1969 | 19.98 | 16.6234 | 34.9393 | 1.66 | -1.0556 | 1.1365 | 1.6476 | 1.7796 |
| 1970 | 49.47 | -7.0660 | -10.8784 | 53.28 | -.5700 | -.4831 | -.5994 | -.5840 |
| 1971 | 104.54 | -15.6421 | -26.5952 | 115.50 | .3371 | -1.0694 | -1.3944 | -1.4527 |
| 1972 | 159.28 | -2.5787 | -3.8150 | 160.51 | 1.2385 | -.1763 | -.2144 | -.2064 |
| 1973 | 157.19 | 20.9115 | 33.3075 | 144.79 | 1.2041 | 1.4296 | 1.8043 | 2.0022 |
| 1974 | 138.00 | -8.1003 | -22.7771 | 152.68 | .8881 | -.5538 | -.9286 | -.9233 |
| 1975 | 100.05 | 10.8498 | 14.2475 | 96.65 | .2631 | .7418 | .8500 | .8403 |
| 1976 | 90.59 | -8.2948 | -9.2962 | 91.60 | .1074 | -.5671 | -.6003 | -.5849 |
| 1977 | 167.94 | -1.1443 | -1.6278 | 168.43 | 1.3812 | -.0782 | -.0933 | -.0897 |
| 1978 | 160.04 | -7.8426 | -11.8650 | 164.07 | 1.2511 | -.5362 | -.6595 | -.6445 |
| 1979 | 182.49 | 9.8122 | 17.3533 | 174.95 | 1.6207 | .6708 | .8921 | .8846 |
| 1980 | 112.28 | -1.2762 | -1.7929 | 112.79 | .4644 | -.0872 | -.1034 | -.0994 |

*PRE_1* Predicted value of harvest
*RES_1* Ordinary residuals: observed harvest minus predicted harvest
*DRE_1* Deleted residuals: residuals obtained when the model is fitted without that observation
*ADJ_1* Adjusted predicted value: predicted value of harvest when the model is fitted without that observation
*ZPR_1* Z-score of the predicted value of harvest
*ZRE_1* Z-score of the residual
*SRE_1* Studentized residual
*SDR_1* Studentized deleted residuals

[1]Values greater than 3 are flagged.
[2]This is flagged if it exceeds $t_{n-p-2,\alpha}=t_{12,0.01}=2.681$.

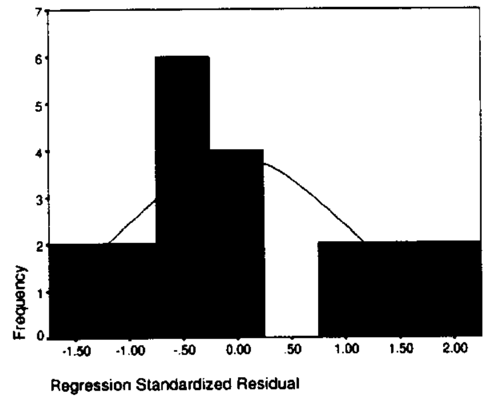


***Figure 6.1*** *Histogram of Standardized Residuals.*

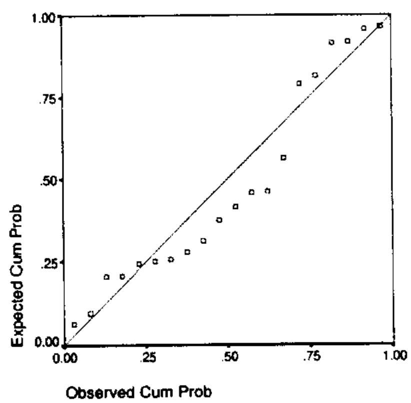


***Figure 6.2*** *Normal P-P Plot of Residuals.*

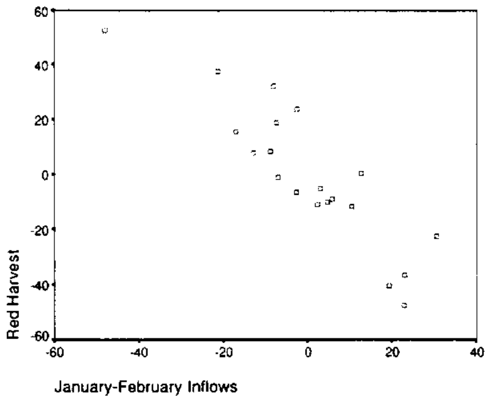


***Figure 6.3*** *Partial Residual Plot for January-February Inflows.*

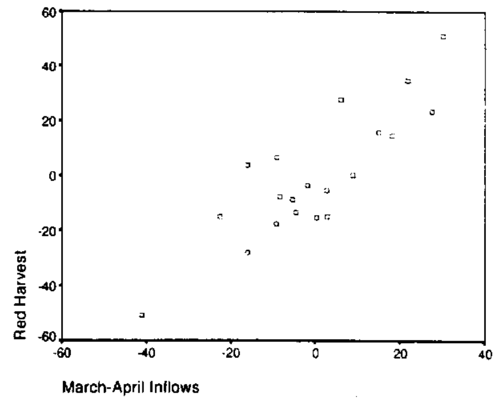


***Figure 6.4*** *Partial Residual Plot for March-April Inflows.*

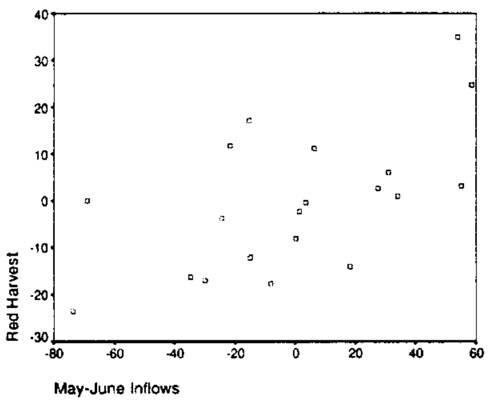


***Figure 6.5*** *Partial Residual Plot for May-June Inflows.*

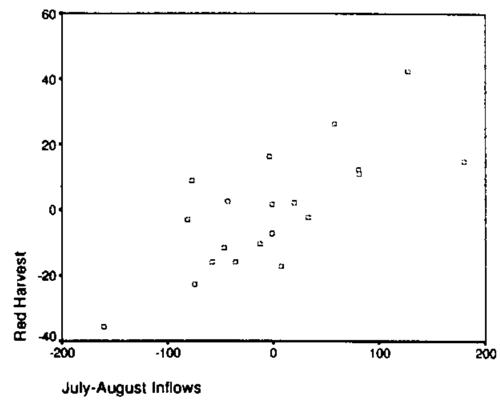


***Figure 6.6*** *Partial Residual Plot for July-August Inflows.*

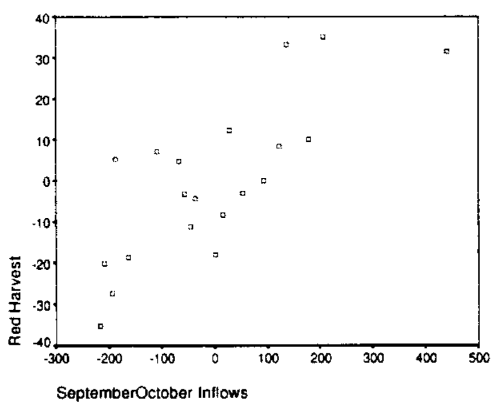


***Figure 6.7*** *Partial Residual Plot for September-October Inflows.*

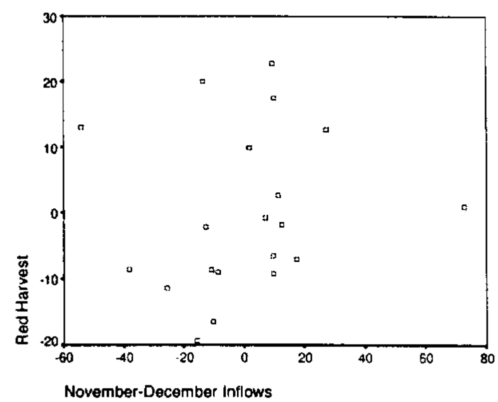


***Figure 6.8*** *Partial Residual Plot for November-December Inflows.*

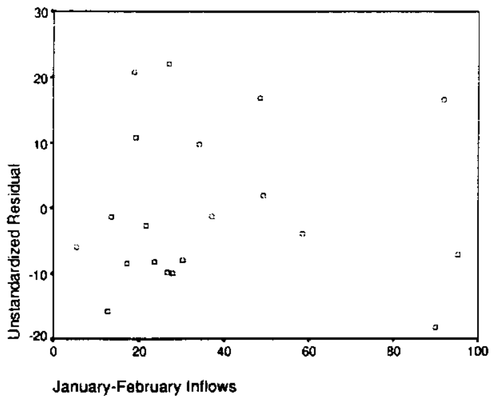


***Figure 6.9*** *Residuals Plot for January-February Inflows.*

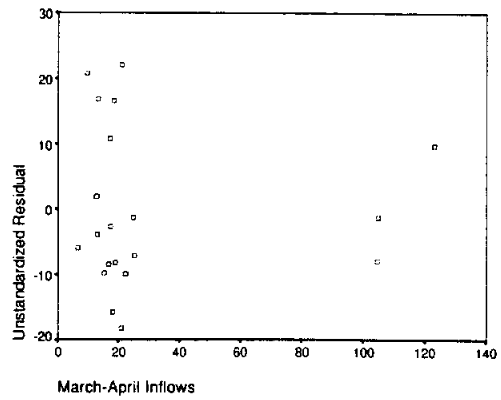


***Figure 6.10*** *Residuals Plot for March-April Inflows.*

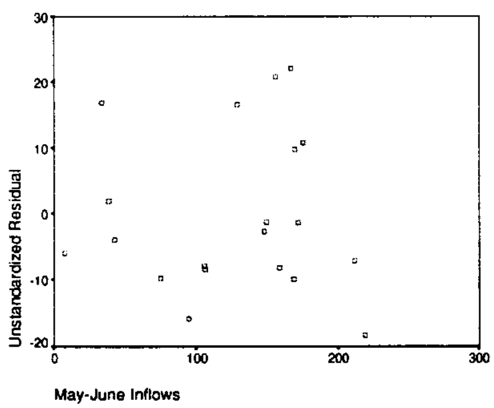


***Figure 6.11*** *Residuals Plot for May-June Inflows.*

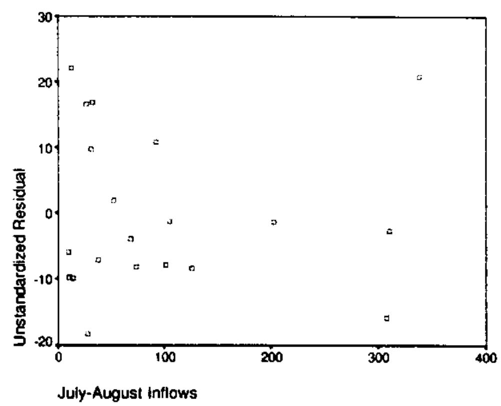


***Figure 6.12*** *Residuals Plot for July-August Inflows.*

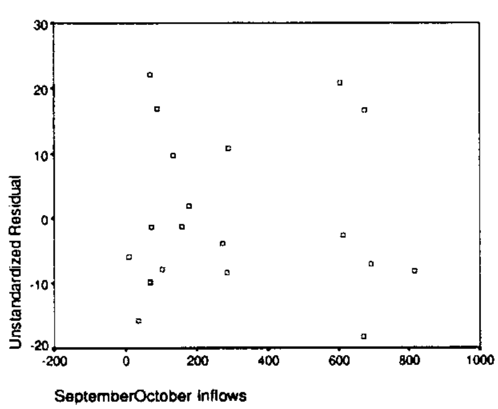


***Figure 6.13*** *Residuals Plot for September-October Inflows.*

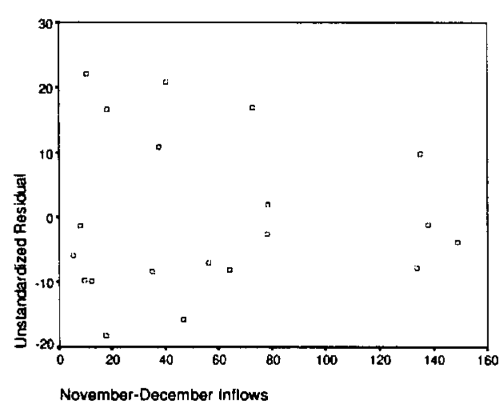


***Figure 6.14*** *Residuals Plot for November-December Inflows.*

### 6.1.4 Prediction Intervals for Red fish Harvest

***Table 6.8*** *Prediction Intervals for Red fish Harvest.*

| YEAR | *LICI_1* | *RED* | *UICI_1* |
|---|---|---|---|
| 1961 | 0.00 | 12.00 | 72.25 |
| 1962 | 0.00 | 12.10 | 58.56 |
| 1963 | 0.00 | 15.70 | 47.63 |
| 1964 | 0.00 | 18.30 | 77.95 |
| 1965 | 0.00 | 19.20 | 77.17 |
| 1966 | 7.13 | 79.10 | 106.66 |
| 1967 | 8.55 | 48.50 | 108.04 |
| 1968 | 0.00 | 28.50 | 97.86 |
| 1969 | 0.00 | 36.60 | 74.37 |
| 1970 | 0.00 | 42.40 | 100.67 |
| 1971 | 52.19 | 88.90 | 156.90 |
| 1972 | 108.58 | 156.70 | 209.98 |
| 1973 | 105.58 | 178.10 | 208.80 |
| 1974 | 81.50 | 129.90 | 194.50 |
| 1975 | 51.02 | 110.90 | 149.08 |
| 1976 | 44.22 | 82.30 | 136.97 |
| 1977 | 117.76 | 166.80 | 218.12 |
| 1978 | 109.06 | 152.20 | 211.03 |
| 1979 | 129.71 | 192.30 | 235.26 |
| 1980 | 62.27 | 111.00 | 162.29 |

*LICI_1* Lower limit for 99% prediction interval for the red fish harvest.
*RED* Red fish harvest
*UICI_1* Upper limit for 99% prediction interval for the red fish harvest.

### 6.1.5 Outliers and Influential Point Detection

***Table 6.9*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1961 | 11.1728 | .0483 | *.5880 | .1313 | .0003 |
| 1962 | 3.0023 | .0009 | .1580 | .8848 | .0000 |
| 1963 | 3.4360 | .0749 | .1808 | .8420 | .0011 |
| 1964 | 8.3452 | .0433 | .4392 | .3031 | .0002 |
| 1965 | 2.8853 | .0198 | .1519 | .8954 | .0000 |
| 1966 | 4.2885 | .1730 | .2257 | .7460 | .0135 |
| 1967 | 4.2691 | .0334 | .2247 | .7483 | .0001 |
| 1968 | 5.6902 | .1823 | .2995 | .5764 | .0156 |
| 1969 | 9.0102 | .4273 | .4742 | .2519 | .1317 |
| 1970 | 5.7087 | .0277 | .3005 | .5741 | .0000 |
| 1971 | 6.8751 | .1945 | .3618 | .4420 | .0187 |
| 1972 | 5.2070 | .0031 | .2741 | .6347 | .0000 |
| 1973 | 6.1212 | .2757 | .3222 | .5257 | .0474 |
| 1974 | 11.2930 | .2232 | *.5944 | .1263 | .0273 |
| 1975 | 3.5810 | .0323 | .1885 | .8266 | .0001 |
| 1976 | 1.0966 | .0062 | .0577 | .9931 | .0000 |
| 1977 | 4.6938 | .0005 | .2470 | .6973 | .0000 |
| 1978 | 5.4914 | .0319 | .2890 | .6002 | .0001 |
| 1979 | 7.3067 | .0874 | .3846 | .3977 | .0017 |
| 1980 | 4.5257 | .0006 | .2382 | .7176 | .0000 |

*MAH_1* Mahalanobis distance
*COOK_1* Cook's distance
*LEV_1* Leverage value
*MAHA_PV* P-value associated with the Mahalanobis distance
*COOK_P* P-value associated with Cook's distance

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.
[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p$+1 degrees of freedom. Small values indicate a problem.
[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p$+1 numerator degrees of freedom and $n$-$p$-1 denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.10*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1961 | -.5628 | .0775 | -.0427 | .3784 |
| 1962 | .0744 | .0277 | .0219 | -.0179 |
| 1963 | .7476 | .2905 | .2532 | -.1832 |
| 1964 | -.5357 | -.5326 | .1653 | -.1831 |
| 1965 | -.3652 | -.3181 | .0274 | -.0943 |
| 1966 | *1.2168 | .1671 | -.2350 | -.4865 |
| 1967 | -.4762 | -.0510 | .0809 | .1903 |
| 1968 | *-1.2004 | .3501 | -.5927 | -.0745 |
| 1969 | *1.8681 | .3574 | *1.0054 | *1.0210 |
| 1970 | -.4290 | .2132 | -.2127 | .0865 |
| 1971 | *-1.2156 | .0360 | -.4661 | -.0095 |
| 1972 | -.1429 | .0223 | .0281 | .0173 |
| 1973 | *1.5415 | -.0625 | -.0775 | .2002 |
| 1974 | *-1.2429 | -.3590 | .9448 | .0924 |
| 1975 | .4703 | .0058 | -.2598 | -.2841 |
| 1976 | -.2032 | -.1496 | .1019 | -.0216 |
| 1977 | -.0583 | .0134 | -.0040 | -.0210 |
| 1978 | -.4616 | -.0453 | -.0234 | -.2867 |
| 1979 | .7755 | -.0645 | -.1092 | .3367 |
| 1980 | -.0632 | .0031 | -.0088 | .0029 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for January-February inflows |
| *SDFBET_2* | Standardized *dfbeta* for March-April inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p + 1) / n}$ for a large data set. The cutoff used here is 1.

***Table 6.11*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1961 | -.1192 | .0938 | .1580 | -.4504 |
| 1962 | -.0242 | -.0003 | -.0127 | .0163 |
| 1963 | -.2040 | -.0140 | -.2304 | .1376 |
| 1964 | .3462 | .1275 | -.1882 | .2567 |
| 1965 | .1489 | .0830 | -.0179 | .1824 |
| 1966 | .7686 | -.5166 | -.5958 | .1914 |
| 1967 | -.3078 | .1948 | .2422 | -.0784 |
| 1968 | -.2289 | -.0453 | -.0049 | .2813 |
| 1969 | *-1.0923 | .4334 | .7355 | *-1.2204 |
| 1970 | -.1520 | .0017 | .0458 | -.0623 |
| 1971 | .0953 | -.9903 | .5634 | .1723 |
| 1972 | -.0021 | -.0592 | -.0424 | -.0277 |
| 1973 | -.2359 | .9338 | .4791 | -.3016 |
| 1974 | -.0028 | .7188 | -.9411 | -.2364 |
| 1975 | .3470 | -.2252 | -.0883 | .2299 |
| 1976 | .0569 | .0211 | -.0792 | .0469 |
| 1977 | -.0024 | -.0062 | .0052 | -.0067 |
| 1978 | .1684 | -.0760 | -.0586 | .0755 |
| 1979 | .0467 | -.1447 | .0445 | .0178 |
| 1980 | -.0226 | -.0277 | .0337 | .0130 |

| | |
|---|---|
| *SDFBET_3* | Standardized *dfbeta* for May-June inflows |
| *SDFBET_4* | Standardized *dfbeta* for July-August inflows |
| *SDFBET_5* | Standardized *dfbeta* for September-October inflows |
| *SDFBET_6* | Standardized *dfbeta* for November-December inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

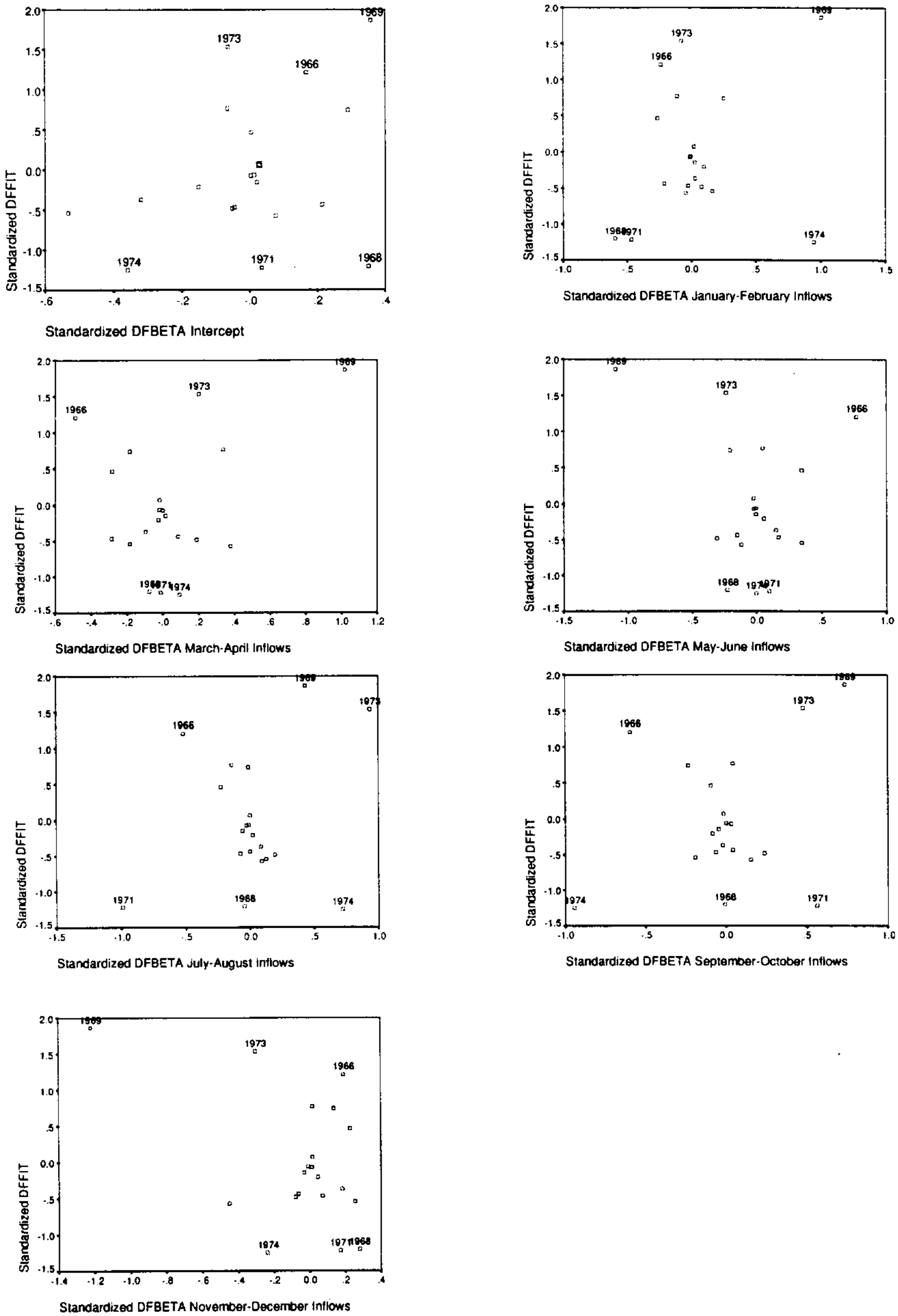


***Figure 6.15.*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of inflow variables.*

## 6.2 Regression - Log of red fish data on square root of inflow data

### 6.2.1 ANOVA and Parameter Estimates

***Table 6.12*** *Model Summary for log of red fish data on square root of inflow data.*

**Model Summary[a,b]**

| Model | Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|
| 1 | Sqrt( January-February), Sqrt(March-April) Sqrt(May-June), Sqrt(July-August), Sqrt(Sepember-October), Sqrt(November-December)[c,d] | .976 | .952 | .930 | .2556 | 2.624 |

a. Dependent Variable: Ln(Red Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of May-June Inflows, Square Root of July-August Inflows, Square Root of Sepember-October Inflows, Square Root of January-February Inflows, Square Root of March-April Inflows

d. All requested variables entered.

***Table 6.13*** *ANOVA table of log of red fish data on square root of inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 16.818 | 6 | 2.803 | 42.911 | .000[b] |
| | Residual | .849 | 13 | 6.5E-02 | | |
| | Total | 17.667 | 19 | | | |

a. Dependent Variable: Ln(Red Harvest)

b. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of May-June Inflows, Square Root of July-August Inflows, Square Root of Sepember-October Inflows, Square Root of January-February Inflows, Square Root of March-April Inflows

***Table 6.14*** *Table of coefficients for log of red fish data on square root of inflow data.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| (Constant) | 2.445 | .304 | | 8.035 | .000 | 1.788 | 3.102 |
| Sqrt(January-February) | -.279 | .045 | -.598 | -6.166 | .000 | -.377 | -.181 |
| Sqrt(March-April) | .217 | .050 | .548 | 4.346 | .001 | .109 | .325 |
| Sqrt(May-June) | .118 | .034 | .396 | 3.446 | .004 | .044 | .191 |
| Sqrt( July-August) | 4.3E-02 | .018 | .220 | 2.353 | .035 | .004 | .083 |
| Sqrt(Sepember-October) | 4.0E-02 | .013 | .332 | 3.009 | .010 | .011 | .069 |
| Sqrt(November-December) | -1.8E-02 | .036 | -.060 | -.493 | .630 | -.096 | .060 |

a. Dependent Variable: Ln(Red Harvest)

## 6.2.2 Collinearity Diagnostic

***Table 6.15*** *Collinearity Diagnostic for log of red fish data on square root of inflow data.*

**Coefficients[a]**

| | t | Collinearity Statistics | |
|---|---|---|---|
| | | Tolerance | VIF |
| (Constant) | 8.035 | | |
| Sqrt(January-February) | -6.166 | .393 | 2.547 |
| Sqrt(March-April) | 4.346 | .233 | 4.298 |
| Sqrt(May-June) | 3.446 | .280 | 3.574 |
| Sqrt(July-August) | 2.353 | .424 | 2.358 |
| Sqrt(Sepember-October) | 3.009 | .304 | 3.293 |
| Sqrt(November-December) | -.493 | .250 | 4.006 |

a. Dependent Variable: Ln(Red Harvest)

***Table 6.16*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(RED) on Sqrt(INFLOWS):*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *SQR_QJF* | Var Prop *SQR_QMA* | Var Prop *SQR_QMJ* | Var Prop *SQR_QJA* | Var Prop *SQR_QSO* | Var Prop *SQR_QND* |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.98368 | 1.00000 | 0.0421 | 0.0145 | 0.0332 | 0.0026 | 0.0411 | 0.0187 |
| 2 | 1.50719 | 1.14723 | 0.0355 | 0.0487 | 0.0031 | 0.0262 | 0.0310 | 0.0472 |
| 3 | 1.33244 | 1.22015 | 0.0551 | 0.0138 | 0.0179 | 0.1757 | 0.0160 | 0.0049 |
| 4 | 0.89306 | 1.49037 | 0.0202 | 0.0431 | 0.1311 | 0.0258 | 0.0262 | 0.0668 |
| 5 | 0.20068 | 3.14400 | 0.7977 | 0.0061 | 0.0065 | 0.4967 | 0.4872 | 0.0316 |
| 6 | 0.08296 | 4.89003 | 0.0494 | 0.8739 | 0.8082 | 0.2730 | 0.3986 | 0.8308 |

### 6.2.3 Residuals Diagnostics

***Table 6.17*** *Residuals Diagnostics for log of red fish data on square root of inflow data.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 2.4495 | 5.2554 | 4.0682 | .9408 | 20 |
| Std. Predicted Value | -1.720 | 1.262 | .000 | 1.000 | 20 |
| Standard Error of Predicted Value | 8.89E-02 | .2102 | .1488 | 2.78E-02 | 20 |
| Adjusted Predicted Value | 2.3326 | 5.2527 | 4.0566 | .9588 | 20 |
| Residual | -.3755 | .4371 | -1.E-15 | .2114 | 20 |
| Std. Residual | -1.469 | 1.710 | .000 | .827 | 20 |
| Stud. Residual | -1.808 | 2.104 | .018 | 1.031 | 20 |
| Deleted Residual | -.5687 | .7714 | 1.2E-02 | .3330 | 20 |
| Stud. Deleted Residual | -2.008 | 2.489 | .043 | 1.140 | 20 |
| Mahal. Distance | 1.347 | 11.906 | 5.700 | 2.447 | 20 |
| Cook's Distance | .000 | .669 | .086 | .160 | 20 |
| Centered Leverage Value | .071 | .627 | .300 | .129 | 20 |

a. Dependent Variable: Ln(Red Harvest)

***Table 6.18*** *Case Values for Residuals Diagnostics for log of red fish data on square root of inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1961 | 2.6700 | -.1851 | -.3487 | 2.8336 | -1.4861 | -.7243 | -.9940 | -.9935 |
| 1962 | 2.6836 | -.1904 | -.2467 | 2.7399 | -1.4717 | -.7449 | -.8479 | -.8381 |
| 1963 | 2.4495 | .3042 | .4210 | 2.3326 | -1.7205 | 1.1901 | 1.4002 | 1.4598 |
| 1964 | 2.8996 | .0073 | .0225 | 2.8845 | -1.2420 | .0284 | .0499 | .0480 |
| 1965 | 3.2911 | -.3362 | -.4130 | 3.3679 | -.8260 | -1.3152 | -1.4578 | -1.5313 |
| 1966 | 3.9336 | .4371 | .6434 | 3.7273 | -.1430 | 1.7101 | 2.0749 | 2.4376 |
| 1967 | 3.9573 | -.0758 | -.1104 | 3.9920 | -.1178 | -.2965 | -.3579 | -.3455 |
| 1968 | 3.7254 | -.3755 | -.5687 | 3.9186 | -.3643 | -1.4692 | -1.8080 | -2.0077 |
| 1969 | 3.2252 | .3748 | .7714 | 2.8286 | -.8960 | 1.4666 | 2.1040 | 2.4891 |
| 1970 | 3.7135 | .0336 | .0474 | 3.6997 | -.3770 | .1316 | .1563 | .1503 |
| 1971 | 4.3942 | .0933 | .1637 | 4.3238 | .3466 | .3650 | .4835 | .4688 |
| 1972 | 5.0759 | -.0215 | -.0300 | 5.0843 | 1.0711 | -.0843 | -.0994 | -.0956 |
| 1973 | 5.0320 | .1503 | .2238 | 4.9585 | 1.0245 | .5882 | .7177 | .7036 |
| 1974 | 4.8827 | -.0160 | -.0332 | 4.8999 | .8658 | -.0625 | -.0900 | -.0865 |
| 1975 | 4.6700 | .0386 | .0504 | 4.6583 | .6397 | .1510 | .1725 | .1659 |
| 1976 | 4.4407 | -.0303 | -.0345 | 4.4449 | .3960 | -.1187 | -.1266 | -.1217 |
| 1977 | 5.1441 | -.0273 | -.0393 | 5.1561 | 1.1436 | -.1067 | -.1281 | -.1231 |
| 1978 | 4.9736 | .0516 | .0815 | 4.9437 | .9623 | .2020 | .2539 | .2445 |
| 1979 | 5.2554 | .0036 | .0063 | 5.2527 | 1.2619 | .0142 | .0187 | .0180 |
| 1980 | 4.9459 | -.2364 | -.3755 | 5.0850 | .9329 | -.9248 | -1.1656 | -1.1835 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that observation |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.
[2]This is flagged if it exceeds $t_{n-p-2,\alpha}=t_{12,0.01}=2.681$.

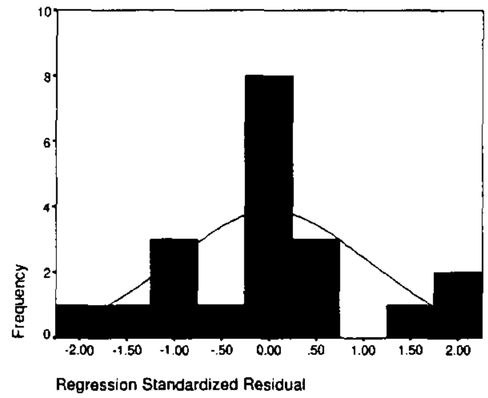


***Figure 6.16*** *Histogram of Standardized Residuals.*

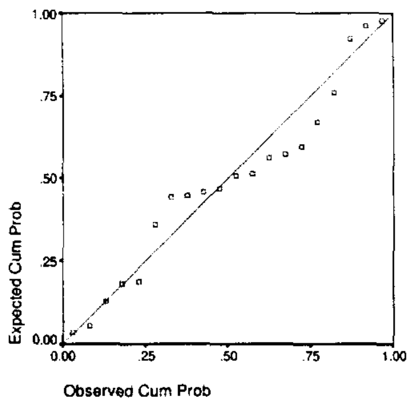


***Figure 6.17*** *Normal P-P Plot of Residuals.*

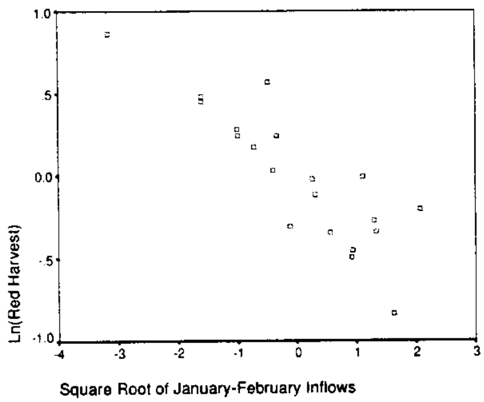


***Figure 6.18*** *Partial Residual Plot for Sqrt(January-February Inflows).*

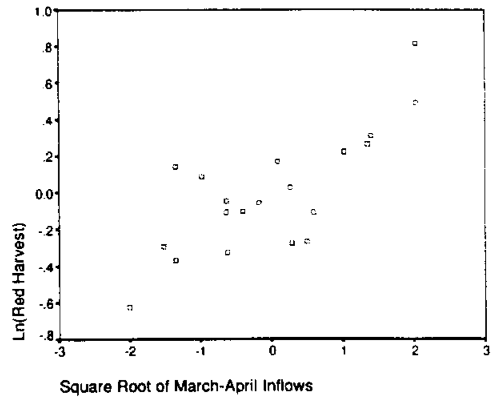


***Figure 6.19*** *Partial Residual Plot for Sqrt(March-April Inflows).*

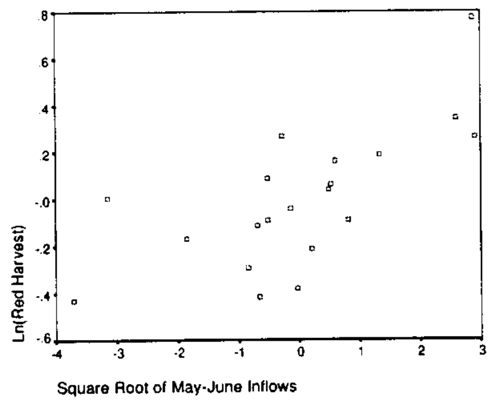


***Figure 6.20*** *Partial Residual Plot for Sqrt(May-June Inflows).*

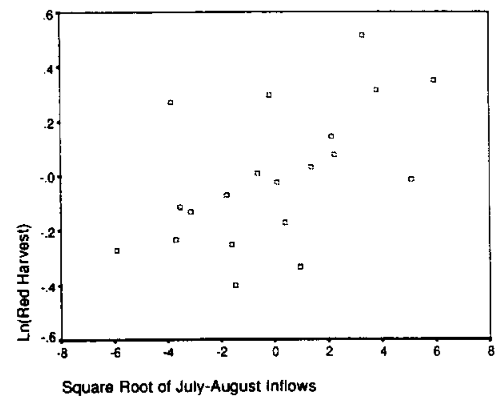


***Figure 6.21*** *Partial Residual Plot for Sqrt(July-August Inflows).*

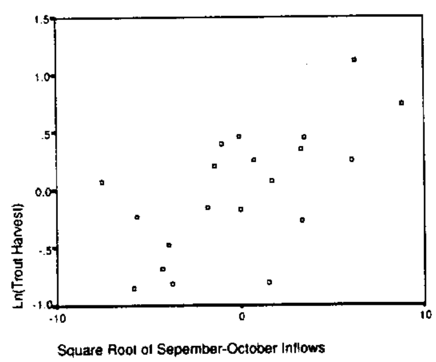


***Figure 6.22*** *Partial Residual Plot for Sqrt(September-October Inflows).*

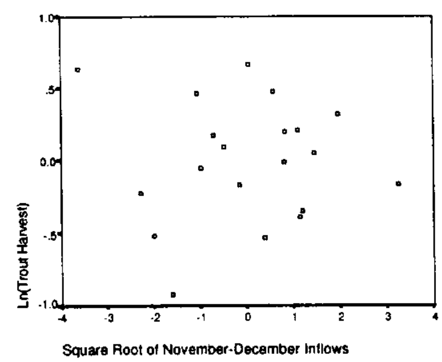


***Figure 6.23*** *Partial Residual Plot for Sqrt(November-December Inflows).*

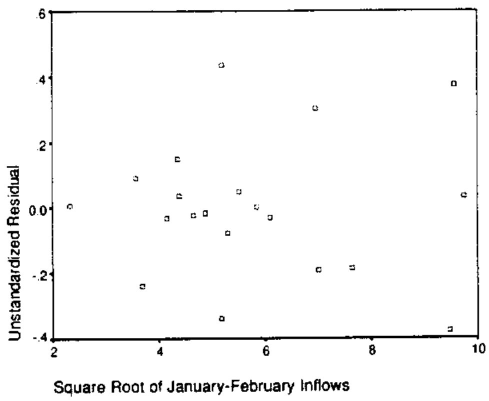


***Figure 6.24*** *Residuals Plot for Sqrt(January-February Inflows).*

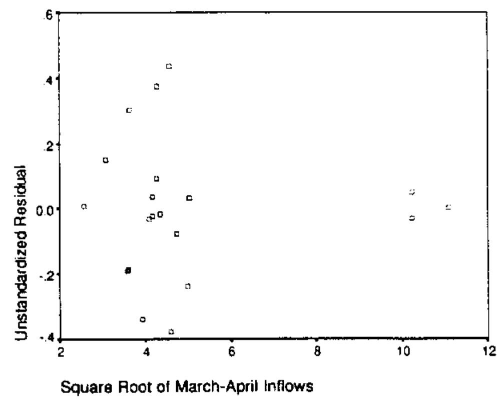


***Figure 6.25*** *Residuals Plot for Sqrt(March-April Inflows).*

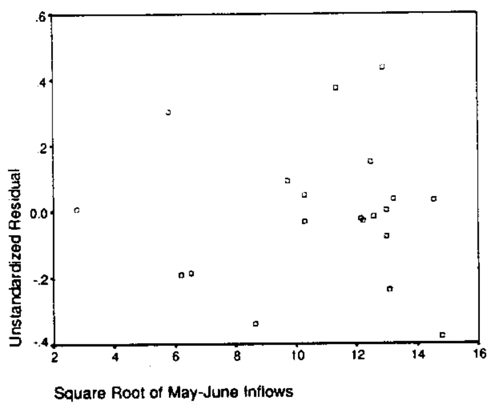


***Figure 6.26*** *Residuals Plot for Sqrt(May-June Inflows).*

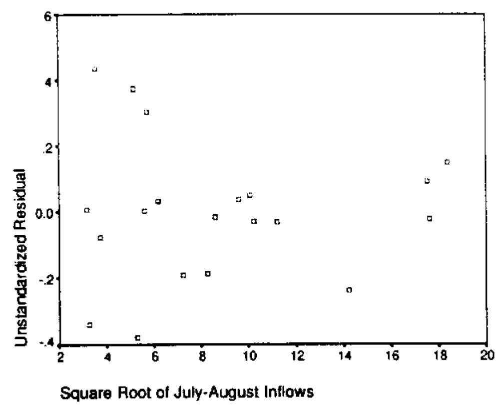


***Figure 6.27*** *Residuals Plot for Sqrt(July-August Inflows).*

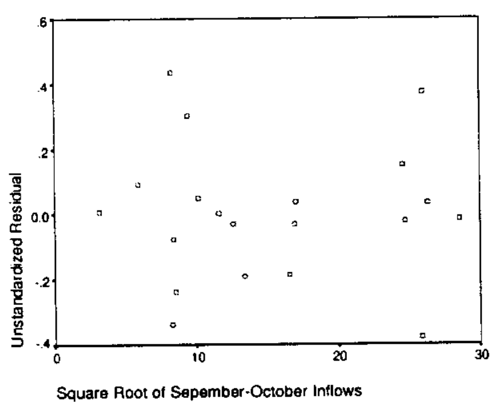


***Figure 6.28*** *Residuals Plot for Sqrt(September-October Inflows).*

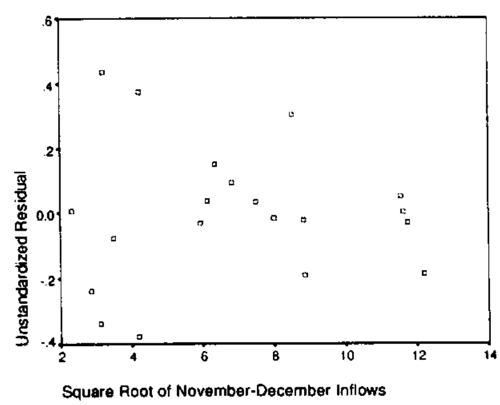


***Figure 6.29*** *Residuals Plot for Sqrt(November-December Inflows).*

### 6.2.4 Prediction Intervals for Red fish Harvest

***Table 6.19*** *Prediction Intervals for Red fish Harvest.*

| YEAR | *LICI_1* | *LN_RED* | *UICI_1* |
|---|---|---|---|
| 1961 | 1.7369 | 2.4849 | 3.6032 |
| 1962 | 1.8304 | 2.4932 | 3.5368 |
| 1963 | 1.5793 | 2.7537 | 3.3197 |
| 1964 | 1.9028 | 2.9069 | 3.8965 |
| 1965 | 2.4526 | 2.9549 | 4.1295 |
| 1966 | 3.0489 | 4.3707 | 4.8184 |
| 1967 | 3.0749 | 3.8816 | 4.8398 |
| 1968 | 2.8343 | 3.3499 | 4.6165 |
| 1969 | 2.2779 | 3.6000 | 4.1726 |
| 1970 | 2.8387 | 3.7471 | 4.5883 |
| 1971 | 3.4735 | 4.4875 | 5.3150 |
| 1972 | 4.2041 | 5.0543 | 5.9476 |
| 1973 | 4.1447 | 5.1823 | 5.9194 |
| 1974 | 3.9341 | 4.8668 | 5.8314 |
| 1975 | 3.8150 | 4.7086 | 5.5251 |
| 1976 | 3.6256 | 4.4104 | 5.2558 |
| 1977 | 4.2644 | 5.1168 | 6.0237 |
| 1978 | 4.0735 | 5.0252 | 5.8736 |
| 1979 | 4.3358 | 5.2591 | 6.1751 |
| 1980 | 4.0446 | 4.7095 | 5.8472 |

*LICI_1* Lower limit for 99% prediction interval for the natural log of red fish harvest.

*LN_RED* Natural log of red fish harvest

*UICI_1* Upper limit for 99% prediction interval for the natural log of red fish harvest.

### 6.2.5 Outliers and Influential Point Detection

***Table 6.20*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1961 | 7.9621 | .1247 | .4191 | .3360 | .0051 |
| 1962 | 3.3855 | .0304 | .1782 | .8472 | .0001 |
| 1963 | 4.3241 | .1076 | .2276 | .7418 | .0033 |
| 1964 | 11.9063 | .0007 | *.6266 | .1037 | .0000 |
| 1965 | 2.5837 | .0694 | .1360 | .9207 | .0008 |
| 1966 | 5.1440 | .2904 | .2707 | .6424 | .0540 |
| 1967 | 5.0106 | .0084 | .2637 | .6587 | .0000 |
| 1968 | 5.5041 | .2402 | .2897 | .5987 | .0332 |
| 1969 | 8.8183 | .6691 | .4641 | .2660 | .3050 |
| 1970 | 4.5796 | .0014 | .2410 | .7111 | .0000 |
| 1971 | 7.2245 | .0252 | .3802 | .4059 | .0000 |
| 1972 | 4.4121 | .0006 | .2322 | .7313 | .0000 |
| 1973 | 5.2894 | .0360 | .2784 | .6247 | .0001 |
| 1974 | 8.8997 | .0012 | .4684 | .2599 | .0000 |
| 1975 | 3.4867 | .0013 | .1835 | .8366 | .0000 |
| 1976 | 1.3469 | .0003 | .0709 | .9871 | .0000 |
| 1977 | 4.8555 | .0010 | .2556 | .6776 | .0000 |
| 1978 | 6.0160 | .0053 | .3166 | .5379 | .0000 |
| 1979 | 7.1613 | .0000 | .3769 | .4123 | .0000 |
| 1980 | 6.0896 | .1142 | .3205 | .5293 | .0039 |

*MAH_1* Mahalanobis distance

*COOK_1* Cook's distance

*LEV_1* Leverage value

*MAHA_PV* P-value associated with the Mahalanobis distance

*COOK_P* P-value associated with Cook's distance

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.

[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n-p-1$ denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.21*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1961 | -.9338 | .0406 | -.1344 | .5355 |
| 1962 | -.4557 | -.0848 | -.1577 | .1153 |
| 1963 | .9049 | .1588 | .3353 | -.3277 |
| 1964 | .0694 | .0655 | -.0240 | .0231 |
| 1965 | -.7320 | -.5049 | .0364 | -.0975 |
| 1966 | *1.6750 | .2421 | -.2524 | -.7760 |
| 1967 | -.2336 | -.0249 | .0294 | .1093 |
| 1968 | *-1.4400 | .4588 | -.7123 | -.2442 |
| 1969 | *2.5605 | -.0870 | *1.3077 | *1.4208 |
| 1970 | .0963 | -.0501 | .0422 | -.0222 |
| 1971 | .4073 | -.0752 | .1426 | -.0760 |
| 1972 | -.0599 | .0054 | .0143 | .0036 |
| 1973 | .4920 | -.0210 | -.0514 | .0165 |
| 1974 | -.0898 | -.0321 | .0697 | .0097 |
| 1975 | .0916 | .0128 | -.0536 | -.0562 |
| 1976 | -.0451 | -.0250 | .0227 | -.0071 |
| 1977 | -.0817 | .0261 | -.0079 | -.0393 |
| 1978 | .1860 | -.0179 | .0142 | .1220 |
| 1979 | .0155 | -.0015 | -.0042 | .0047 |
| 1980 | -.9079 | .0944 | -.2433 | -.1747 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for square root of January-February inflows |
| *SDFBET_2* | Standardized *dfbeta* for square root of March-April inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

***Table 6.22*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1961 | -.1489 | .1533 | .2781 | -.6296 |
| 1962 | .1071 | -.0284 | .0885 | -.1093 |
| 1963 | -.0620 | -.0195 | -.3806 | .2905 |
| 1964 | -.0417 | -.0108 | .0266 | -.0272 |
| 1965 | .1488 | .1763 | .0065 | .2521 |
| 1966 | *1.1362 | -.8116 | -.8659 | .4624 |
| 1967 | -.1621 | .1098 | .1267 | -.0680 |
| 1968 | .0096 | -.1704 | -.1931 | .5630 |
| 1969 | *-1.4981 | .8516 | *1.1640 | *-1.8169 |
| 1970 | .0318 | -.0077 | -.0096 | .0146 |
| 1971 | .0489 | .2664 | -.2426 | .0053 |
| 1972 | .0021 | -.0184 | -.0196 | -.0062 |
| 1973 | -.0594 | .2368 | .1561 | -.0856 |
| 1974 | -.0082 | .0530 | -.0572 | -.0257 |
| 1975 | .0658 | -.0480 | -.0141 | .0528 |
| 1976 | .0119 | -.0012 | -.0223 | .0086 |
| 1977 | .0103 | -.0148 | .0001 | .0030 |
| 1978 | -.0759 | .0479 | .0270 | -.0421 |
| 1979 | .0017 | -.0053 | .0009 | .0028 |
| 1980 | -.0415 | -.5484 | .2894 | .4209 |

| | |
|---|---|
| *SDFBET_3* | Standardized *dfbeta* for square root of May-June inflows |
| *SDFBET_4* | Standardized *dfbeta* for square root of July-August inflows |
| *SDFBET_5* | Standardized *dfbeta* for square root of September-October inflows |
| *SDFBET_6* | Standardized *dfbeta* for square root of November-December inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

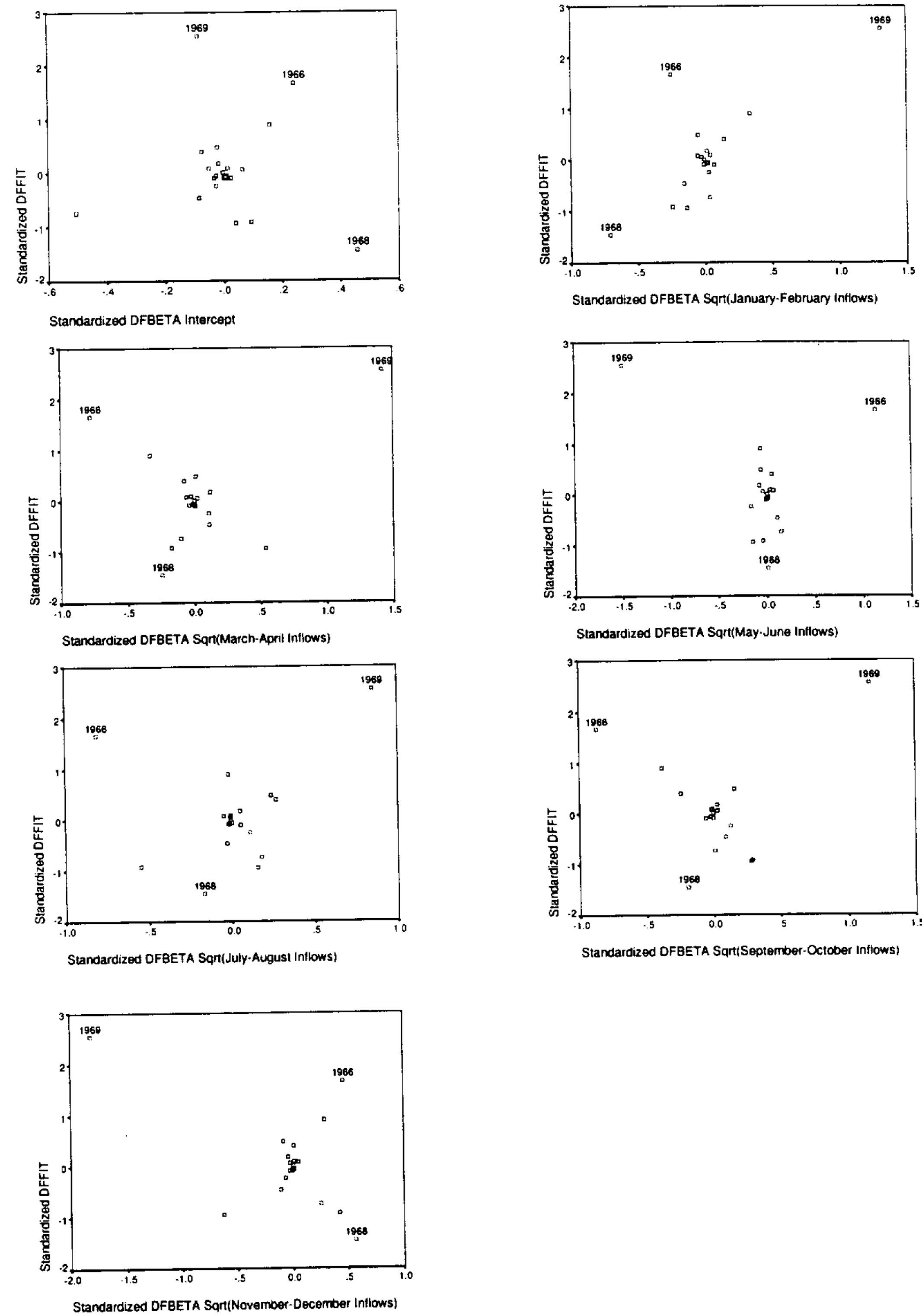


***Figure 6.30*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of square root of inflow variables.*

## 6.3 Regression - Square Root of red fish data on inflow data

### 6.3.1 ANOVA and Parameter Estimates

***Table 6.23*** *Model Summary for square root of red fish data on inflow data.*

**Model Summary[a,b]**

| Model | Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|
| 1 | January-February, March-April, May-June, July-August, September-October, November-December[c,d] | .981 | .963 | .945 | .8450 | 2.782 |

a. Dependent Variable: Square Root of Red Harvest

b. Method: Enter

c. Independent Variables: (Constant), November-December Inflows, SeptemberOctober Inflows, July-August Inflows, May-June Inflows, January-February Inflows, March-April Inflows

d. All requested variables entered.

***Table 6.24*** *ANOVA table of square root of red fish data on inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 239.607 | 6 | 39.935 | 55.931 | .000[b] |
| | Residual | 9.282 | 13 | .714 | | |
| | Total | 248.889 | 19 | | | |

a. Dependent Variable: Square Root of Red Harvest

b. Independent Variables: (Constant), November-December Inflows, SeptemberOctober Inflows, July-August Inflows, May-June Inflows, January-February Inflows, March-April Inflows

***Table 6.25*** *Table of coefficients for square root of red fish data on inflow data.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | 4.507 | .635 | | 7.098 | .000 | 3.135 | 5.878 |
| January-February | -7.5E-02 | .011 | -.559 | -6.957 | .000 | -.098 | -.052 |
| March-April | 6.3E-02 | .011 | .604 | 5.678 | .000 | .039 | .087 |
| May-June | 1.9E-02 | .005 | .323 | 3.702 | .003 | .008 | .030 |
| July-August | 9.9E-03 | .002 | .292 | 4.064 | .001 | .005 | .015 |
| September-October | 4.7E-03 | .001 | .356 | 4.081 | .001 | .002 | .007 |
| November-December | -2.2E-04 | .007 | -.003 | -.030 | .977 | -.016 | .016 |

a. Dependent Variable: Square Root of Red Harvest

## 6.3.2 Collinearity Diagnostic

***Table 6.26*** *Collinearity Diagnostic for square root of red fish data on inflow data.*

**Coefficients[a]**

| | | Collinearity Statistics | |
|---|---|---|---|
| | t | Tolerance | VIF |
| (Constant) | 7.098 | | |
| January-February | -6.957 | .444 | 2.251 |
| March-April | 5.678 | .254 | 3.941 |
| May-June | 3.702 | .377 | 2.653 |
| July-August | 4.064 | .557 | 1.796 |
| September-October | 4.081 | .377 | 2.650 |
| November-December | -.030 | .295 | 3.385 |

a. Dependent Variable: Square Root of Red Harvest

***Table 6.27*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Sqrt(RED) on INFLOWS.*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *QJF_LAG* | Var Prop *QMA_LAG* | Var Prop *QMJ_LAG* | Var Prop *QJA_LAG* | Var Prop *QSO_LAG* | Var Prop *QND_LAG* |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.86647 | 1.00000 | 0.0619 | 0.0077 | 0.0450 | 0.0010 | 0.0804 | 0.0094 |
| 2 | 1.68991 | 1.05094 | 0.0256 | 0.0657 | 0.0088 | 0.0116 | 0.0011 | 0.0674 |
| 3 | 1.29792 | 1.19919 | 0.0529 | 0.0044 | 0.0413 | 0.2647 | 0.0135 | 0.0038 |
| 4 | 0.80254 | 1.52503 | 0.0350 | 0.0335 | 0.1812 | 0.0675 | 0.0580 | 0.0826 |
| 5 | 0.23546 | 2.81549 | 0.7824 | 0.0001 | 0.0087 | 0.5234 | 0.5484 | 0.0205 |
| 6 | 0.10770 | 4.16295 | 0.0422 | 0.8885 | 0.7151 | 0.1318 | 0.2986 | 0.8163 |

### 6.3.3 Residuals Diagnostics

***Table 6.28*** *Residuals Diagnostics for square root of red fish data on inflow data.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 3.0866 | 13.8543 | 8.4635 | 3.5512 | 20 |
| Std. Predicted Value | -1.514 | 1.518 | .000 | 1.000 | 20 |
| Standard Error of Predicted Value | .2773 | .6783 | .4903 | .1002 | 20 |
| Adjusted Predicted Value | 2.8238 | 13.8443 | 8.4739 | 3.5960 | 20 |
| Residual | -1.4148 | 1.4515 | 6.7E-16 | .6989 | 20 |
| Std. Residual | -1.674 | 1.718 | .000 | .827 | 20 |
| Stud. Residual | -2.076 | 2.286 | -.004 | 1.036 | 20 |
| Deleted Residual | -2.1749 | 2.8003 | -1.E-02 | 1.1184 | 20 |
| Stud. Deleted Residual | -2.439 | 2.840 | .024 | 1.176 | 20 |
| Mahal. Distance | 1.097 | 11.293 | 5.700 | 2.676 | 20 |
| Cook's Distance | .000 | .822 | .092 | .191 | 20 |
| Centered Leverage Value | .058 | .594 | .300 | .141 | 20 |

a. Dependent Variable: Square Root of Red Harvest

***Table 6.29*** *Case Values for Residuals Diagnostics for square root of red fish data on inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1961 | 3.721 | -.2568 | -.7094 | 4.1735 | -1.3355 | -.3039 | -.5051 | -.4901 |
| 1962 | 3.710 | -.2316 | -.2925 | 3.7710 | -1.3385 | -.2741 | -.3080 | -.2970 |
| 1963 | 3.087 | .8757 | 1.1385 | 2.8238 | -1.5141 | 1.0364 | 1.1817 | 1.2017 |
| 1964 | 4.807 | -.5290 | -1.0357 | 5.3136 | -1.0297 | -.6261 | -.8760 | -.8676 |
| 1965 | 5.341 | -.9591 | -1.2017 | 5.5835 | -.8793 | -1.1351 | -1.2706 | -1.3044 |
| 1966 | 7.442 | 1.4515 | 2.0041 | 6.8897 | -.2876 | 1.7178 | 2.0185 | 2.3404 |
| 1967 | 7.522 | -.5577 | -.7689 | 7.7331 | -.2651 | -.6600 | -.7750 | -.7624 |
| 1968 | 6.753 | -1.4148 | -2.1749 | 7.5134 | -.4816 | -1.6743 | -2.0759 | -2.4394 |
| 1969 | 4.717 | 1.3323 | 2.8003 | 3.2495 | -1.0549 | 1.5767 | 2.2859 | *2.8400 |
| 1970 | 6.684 | -.1724 | -.2654 | 6.7770 | -.5011 | -.2040 | -.2532 | -.2438 |
| 1971 | 9.731 | -.3023 | -.5140 | 9.9427 | .3569 | -.3578 | -.4665 | -.4520 |
| 1972 | 12.790 | -.2723 | -.4028 | 12.9208 | 1.2184 | -.3222 | -.3919 | -.3788 |
| 1973 | 12.902 | .4431 | .7057 | 12.6397 | 1.2500 | .5244 | .6618 | .6468 |
| 1974 | 11.552 | -.1547 | -.4350 | 11.8324 | .8697 | -.1831 | -.3070 | -.2961 |
| 1975 | 9.806 | .7248 | .9517 | 9.5792 | .3781 | .8577 | .9829 | .9815 |
| 1976 | 8.901 | .1707 | .1913 | 8.8807 | .1233 | .2020 | .2138 | .2058 |
| 1977 | 12.944 | -.0286 | -.0407 | 12.9558 | 1.2616 | -.0338 | -.0403 | -.0388 |
| 1978 | 12.299 | .0377 | .0571 | 12.2798 | 1.0801 | .0447 | .0549 | .0528 |
| 1979 | 13.854 | .0129 | .0229 | 13.8443 | 1.5180 | .0153 | .0204 | .0196 |
| 1980 | 10.705 | -.1694 | -.2380 | 10.7737 | .6312 | -.2005 | -.2377 | -.2288 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that observation |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.
[2]This is flagged if it exceeds $t_{n-p-2,\alpha}=t_{12,0.01}=2.681$.

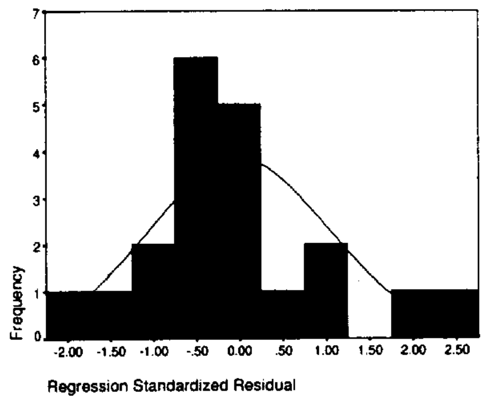


***Figure 6.31*** *Histogram of Standardized Residuals.*

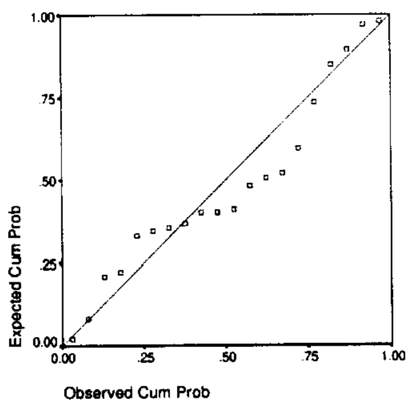


***Figure 6.32*** *Normal P-P Plot of Residuals.*

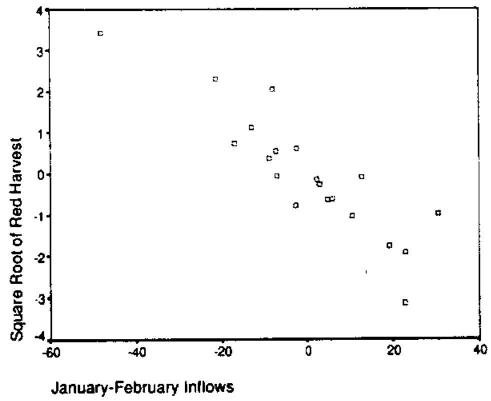


***Figure 6.33*** *Partial Residual Plot for January-February Inflows.*

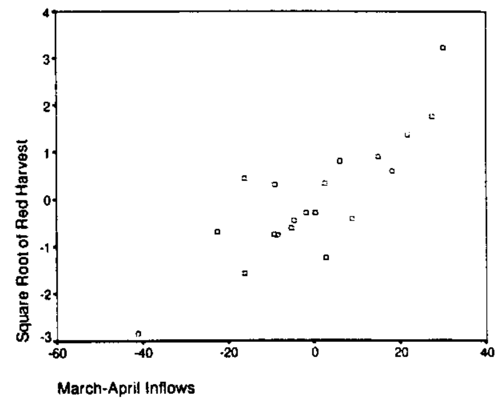


***Figure 6.34*** *Partial Residual Plot for March-April Inflows.*

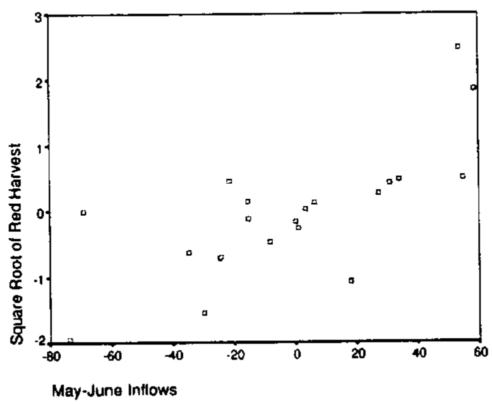


***Figure 6.35*** *Partial Residual Plot for May-June Inflows.*

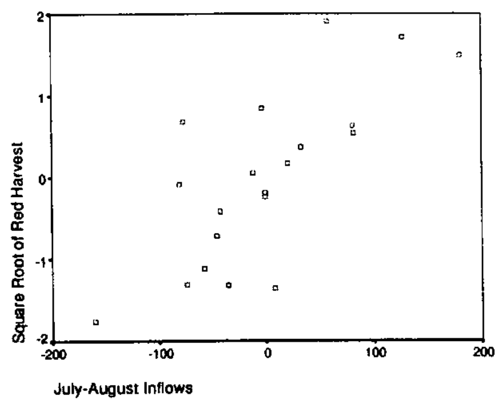


***Figure 6.36*** *Partial Residual Plot for July-August Inflows.*

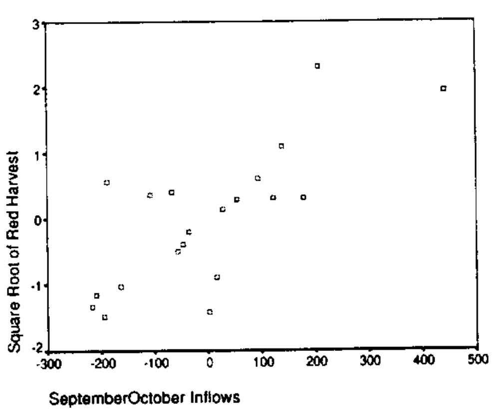


***Figure 6.37*** *Partial Residual Plot for September-October Inflows.*

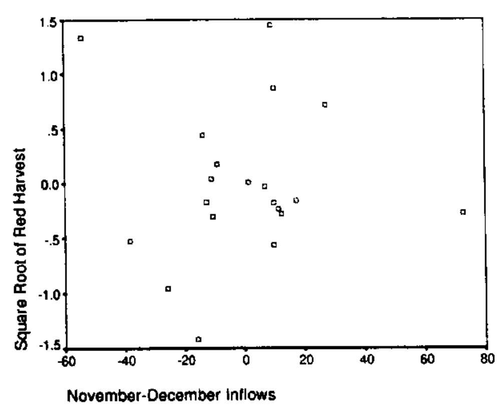


***Figure 6.38*** *Partial Residual Plot for November-December Inflows.*

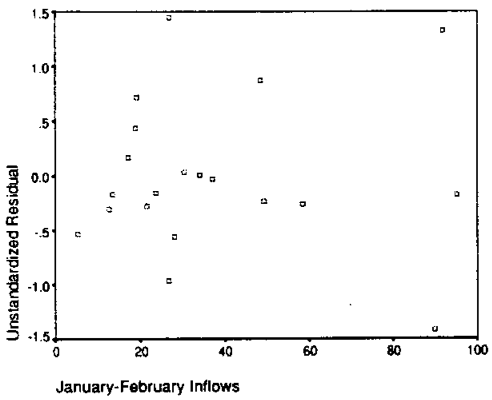


***Figure 6.39*** *Residuals Plot for January-February Inflows.*

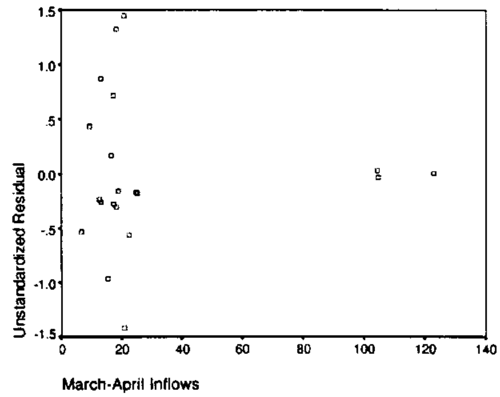


***Figure 6.40*** *Residuals Plot for March-April Inflows.*

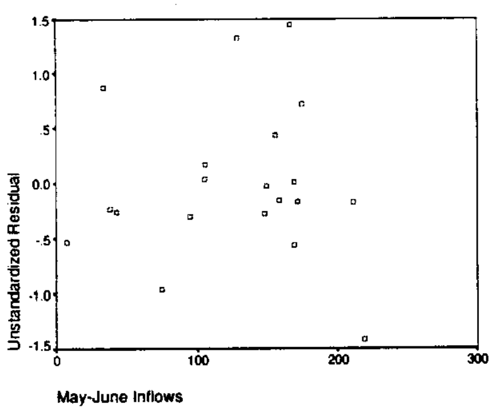


***Figure 6.41*** *Residuals Plot for May-June Inflows.*

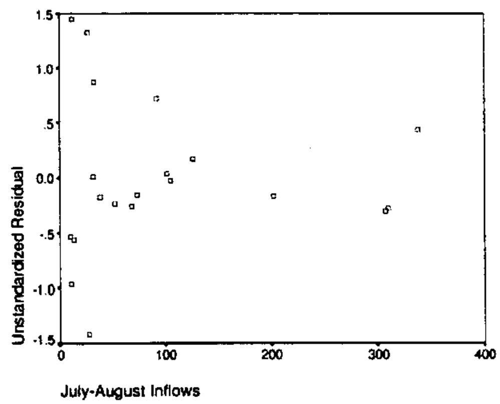


***Figure 6.42*** *Residuals Plot for July-August Inflows.*

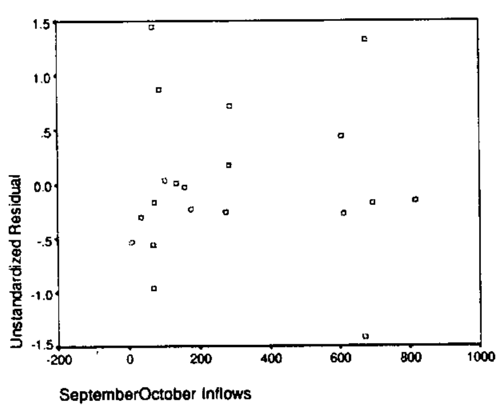


***Figure 6.43*** *Residuals Plot for September-October Inflows.*

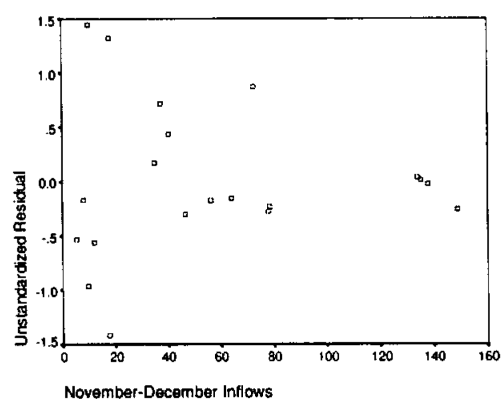


***Figure 6.44*** *Residuals Plot for November-December Inflows.*

### 6.3.4 Prediction Intervals for Red fish Harvest

***Table 6.30*** *Prediction Intervals for Red fish Harvest.*

| YEAR | *LICI_1* | *SQ_RED* | *UICI_1* |
|---|---|---|---|
| 1961 | 0.463 | 3.464 | 6.979 |
| 1962 | 0.913 | 3.479 | 6.508 |
| 1963 | 0.263 | 3.962 | 5.910 |
| 1964 | 1.701 | 4.278 | 7.913 |
| 1965 | 2.550 | 4.382 | 8.131 |
| 1966 | 4.567 | 8.894 | 10.317 |
| 1967 | 4.648 | 6.964 | 10.396 |
| 1968 | 3.796 | 5.339 | 9.710 |
| 1969 | 1.575 | 6.050 | 7.860 |
| 1970 | 3.726 | 6.512 | 9.642 |
| 1971 | 6.707 | 9.429 | 12.755 |
| 1972 | 9.861 | 12.518 | 15.719 |
| 1973 | 9.921 | 13.345 | 15.884 |
| 1974 | 8.288 | 11.397 | 14.816 |
| 1975 | 6.974 | 10.531 | 12.639 |
| 1976 | 6.222 | 9.072 | 11.580 |
| 1977 | 10.045 | 12.915 | 15.842 |
| 1978 | 9.354 | 12.337 | 15.245 |
| 1979 | 10.806 | 13.867 | 16.903 |
| 1980 | 7.816 | 10.536 | 13.594 |

*LICI_1* Lower limit for 99% prediction interval for the square root of red fish harvest.

*LN_RED* Square root of red fish harvest

*UICI_1* Upper limit for 99% prediction interval for the square root of red fish harvest.

### 6.3.5 Outliers and Influential Point Detection

***Table 6.31*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1961 | 11.1728 | .0642 | *.5880 | .1313 | .0006 |
| 1962 | 3.0023 | .0036 | .1580 | .8848 | .0000 |
| 1963 | 3.4360 | .0599 | .1808 | .8420 | .0005 |
| 1964 | 8.3452 | .1050 | .4392 | .3031 | .0030 |
| 1965 | 2.8853 | .0583 | .1519 | .8954 | .0005 |
| 1966 | 4.2885 | .2216 | .2257 | .7460 | .0268 |
| 1967 | 4.2691 | .0325 | .2247 | .7483 | .0001 |
| 1968 | 5.6902 | .3307 | .2995 | .5764 | .0740 |
| 1969 | 9.0102 | .8225 | .4742 | .2519 | .4141 |
| 1970 | 5.7087 | .0049 | .3005 | .5741 | .0000 |
| 1971 | 6.8751 | .0218 | .3618 | .4420 | .0000 |
| 1972 | 5.2070 | .0105 | .2741 | .6347 | .0000 |
| 1973 | 6.1212 | .0371 | .3222 | .5257 | .0001 |
| 1974 | 11.2930 | .0244 | *.5944 | .1263 | .0000 |
| 1975 | 3.5810 | .0432 | .1885 | .8266 | .0002 |
| 1976 | 1.0966 | .0008 | .0577 | .9931 | .0000 |
| 1977 | 4.6938 | .0001 | .2470 | .6973 | .0000 |
| 1978 | 5.4914 | .0002 | .2890 | .6002 | .0000 |
| 1979 | 7.3067 | .0000 | .3846 | .3977 | .0000 |
| 1980 | 4.5257 | .0033 | .2382 | .7176 | .0000 |

*MAH_1* Mahalanobis distance
*COOK_1* Cook's distance
*LEV_1* Leverage value
*MAHA_PV* P-value associated with the Mahalanobis distance
*COOK_PV* P-value associated with Cook's distance

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.

[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n-p-1$ denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.32*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1961 | -.6507 | .0896 | -.0493 | .4375 |
| 1962 | -.1522 | -.0567 | -.0447 | .0367 |
| 1963 | .6584 | .2558 | .2230 | -.1613 |
| 1964 | -.8491 | -.8442 | .2620 | -.2902 |
| 1965 | -.6560 | -.5713 | .0491 | -.1694 |
| 1966 | *1.4440 | .1983 | -.2788 | -.5773 |
| 1967 | -.4692 | -.0502 | .0797 | .1875 |
| 1968 | *-1.7880 | .5216 | -.8828 | -.1110 |
| 1969 | *2.9810 | .5703 | *1.6043 | *1.6293 |
| 1970 | -.1791 | .0890 | -.0888 | .0361 |
| 1971 | -.3783 | .0112 | -.1450 | -.0029 |
| 1972 | -.2623 | .0409 | .0516 | .0317 |
| 1973 | .4980 | -.0202 | -.0250 | .0647 |
| 1974 | -.3985 | -.1151 | .3030 | .0296 |
| 1975 | .5492 | .0068 | -.3034 | -.3318 |
| 1976 | .0715 | .0526 | -.0359 | .0076 |
| 1977 | -.0252 | .0058 | -.0017 | -.0091 |
| 1978 | .0378 | .0037 | .0019 | .0235 |
| 1979 | .0172 | -.0014 | -.0024 | .0075 |
| 1980 | -.1456 | .0072 | -.0202 | .0066 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for January-February inflows |
| *SDFBET_2* | Standardized *dfbeta* for March-April inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p + 1) / n}$ for a large data set. The cutoff used here is 1.

***Table 6.33*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1961 | -.1379 | .1085 | .1827 | -.5207 |
| 1962 | .0495 | .0006 | .0260 | -.0335 |
| 1963 | -.1796 | -.0123 | -.2029 | .1212 |
| 1964 | .5488 | .2021 | -.2984 | .4069 |
| 1965 | .2675 | .1491 | -.0322 | .3276 |
| 1966 | .9121 | -.6131 | -.7070 | .2272 |
| 1967 | -.3032 | .1919 | .2386 | -.0772 |
| 1968 | -.3410 | -.0675 | -.0073 | .4190 |
| 1969 | *-1.7430 | .6916 | *1.1737 | *-1.9475 |
| 1970 | -.0635 | .0007 | .0191 | -.0260 |
| 1971 | .0296 | -.3081 | .1753 | .0536 |
| 1972 | -.0038 | -.1086 | -.0778 | -.0509 |
| 1973 | -.0762 | .3017 | .1548 | -.0974 |
| 1974 | -.0009 | .2305 | -.3018 | -.0758 |
| 1975 | .4053 | -.2630 | -.1031 | .2686 |
| 1976 | -.0200 | -.0074 | .0279 | -.0165 |
| 1977 | -.0010 | -.0027 | .0023 | -.0029 |
| 1978 | -.0138 | .0062 | .0048 | -.0062 |
| 1979 | .0010 | -.0032 | .0010 | .0004 |
| 1980 | -.0520 | -.0637 | .0776 | .0299 |

| | |
|---|---|
| *SDFBET_3* | Standardized *dfbeta* for May-June inflows |
| *SDFBET_4* | Standardized *dfbeta* for July-August inflows |
| *SDFBET_5* | Standardized *dfbeta* for September-October inflows |
| *SDFBET_6* | Standardized *dfbeta* for November-December inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

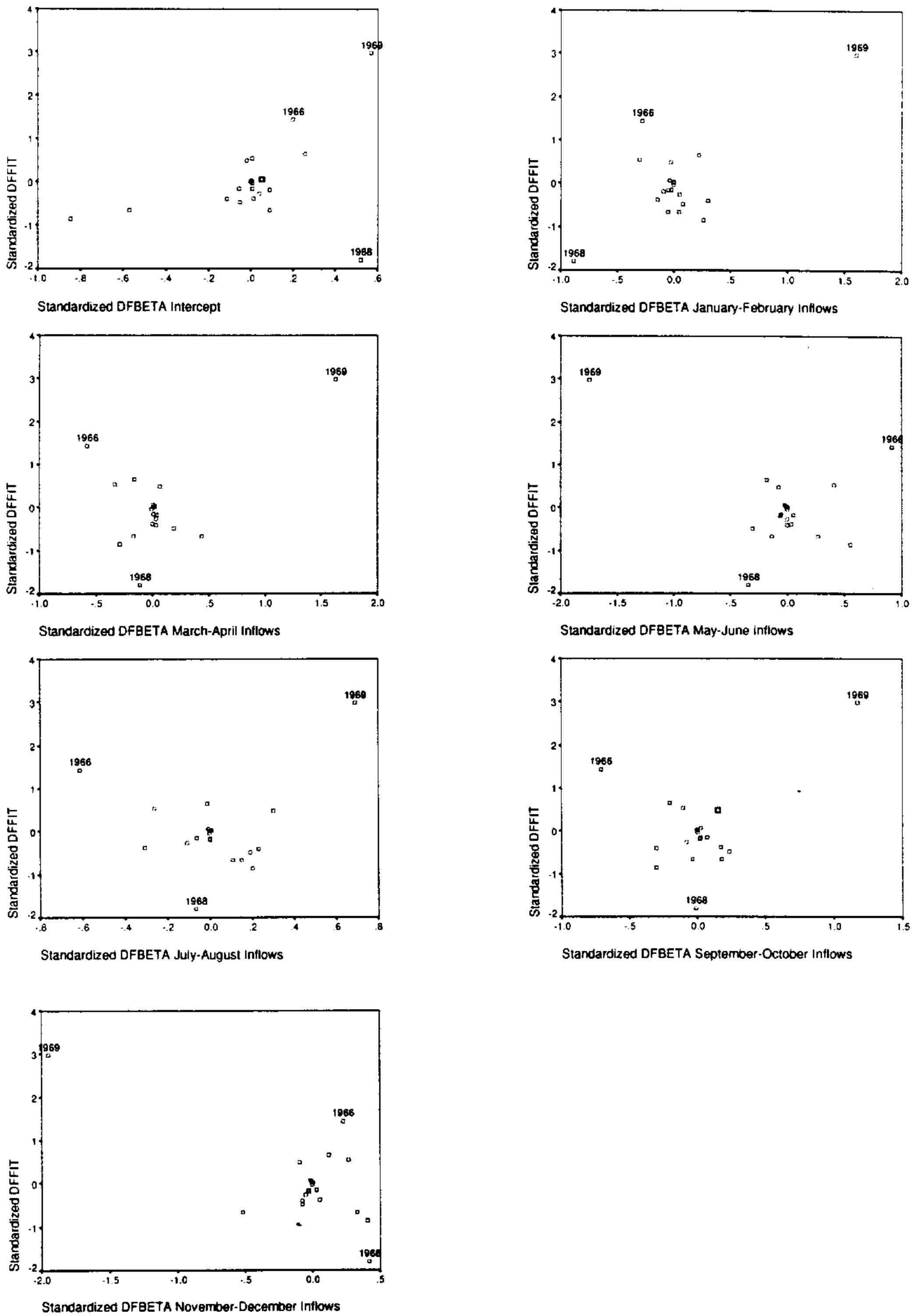


***Figure 6.45*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of inflow variables.*

## 6.4 Regression - Square Root of red fish data on square root of inflow data

### 6.4.1 ANOVA and Parameter Estimates

***Table 6.34*** *Model Summary for square root of red fish data on square root of inflow data.*

**Model Summary[a,b]**

| Model | Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|
| 1 | Sqrt(January-February), Sqrt(March-April), Sqrt(May-June), Sqrt(July-August), Sqrt(Sepember-October), Sqrt(November-December)[c,d] | .977 | .955 | .935 | .9257 | 2.670 |

a. Dependent Variable: Square Root of Red Harvest

b. Method: Enter

c. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of May-June Inflows, Square Root of July-August Inflows, Square Root of Sepember-October Inflows, Square Root of January-February Inflows, Square Root of March-April Inflows

d. All requested variables entered.

***Table 6.35*** *ANOVA table of square root of red fish data on square root of inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 237.750 | 6 | 39.625 | 46.242 | .000[b] |
| | Residual | 11.140 | 13 | .857 | | |
| | Total | 248.889 | 19 | | | |

a. Dependent Variable: Square Root of Red Harvest

b. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of May-June Inflows, Square Root of July-August Inflows, Square Root of Sepember-October Inflows, Square Root of January-February Inflows, Square Root of March-April Inflows

***Table 6.36*** *Table of coefficients for square root of red fish data on square root of inflow data.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| (Constant) | 2.590 | 1.102 | | 2.350 | .035 | .209 | 4.970 |
| Sqrt(January-February) | -1.100 | .164 | -.629 | -6.717 | .000 | -1.454 | -.746 |
| Sqrt(March-April) | .857 | .181 | .576 | 4.734 | .000 | .466 | 1.248 |
| Sqrt(May-June) | .340 | .124 | .305 | 2.752 | .016 | .073 | .607 |
| Sqrt(July-August) | .162 | .067 | .219 | 2.430 | .030 | .018 | .306 |
| Sqrt(Sepember-October) | .168 | .048 | .373 | 3.502 | .004 | .064 | .272 |
| Sqrt(November-December) | 3.4E-02 | .131 | .031 | .260 | .799 | -.249 | .317 |

a. Dependent Variable: Square Root of Red Harvest

### 6.4.2 Collinearity Diagnostic

***Table 6.37*** *Collinearity Diagnostic for square root of red fish data on square root of inflow data.*

**Coefficients[a]**

| | t | Collinearity Statistics | |
|---|---|---|---|
| | | Tolerance | VIF |
| (Constant) | 2.350 | | |
| Sqrt(January-February) | -6.717 | .393 | 2.547 |
| Sqrt(March-April) | 4.734 | .233 | 4.298 |
| Sqrt(May-June) | 2.752 | .280 | 3.574 |
| Sqrt(July-August) | 2.430 | .424 | 2.358 |
| Sqrt(Sepember-October) | 3.502 | .304 | 3.293 |
| Sqrt(November-December) | .260 | .250 | 4.006 |

a. Dependent Variable: Square Root of Red Harvest

***Table 6.38*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Sqrt(RED) on Sqrt(INFLOWS).*

| *Condition* | Var Prop | Var Prop | Var Prop | Var Prop | Var Prop | Var Prop | | |
|---|---|---|---|---|---|---|---|---|
| Number | *Eigenvalue* | *Index* | *SQR_QJF* | *SQR_QMA* | *SQR_QMJ* | *SQR_QJA* | *SQR_QSO* | *SQR_QND* |
| 1 | 1.98368 | 1.00000 | 0.0421 | 0.0145 | 0.0332 | 0.0026 | 0.0411 | 0.0187 |
| 2 | 1.50719 | 1.14723 | 0.0355 | 0.0487 | 0.0031 | 0.0262 | 0.0310 | 0.0472 |
| 3 | 1.33244 | 1.22015 | 0.0551 | 0.0138 | 0.0179 | 0.1757 | 0.0160 | 0.0049 |
| 4 | 0.89306 | 1.49037 | 0.0202 | 0.0431 | 0.1311 | 0.0258 | 0.0262 | 0.0668 |
| 5 | 0.20068 | 3.14400 | 0.7977 | 0.0061 | 0.0065 | 0.4967 | 0.4872 | 0.0316 |
| 6 | 0.08296 | 4.89003 | 0.0494 | 0.8739 | 0.8082 | 0.2730 | 0.3986 | 0.8308 |

### 6.4.3 Residuals Diagnostics

***Table 6.39*** *Residuals Diagnostics for square root of red fish data on square root of inflow data.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 2.8297 | 13.3543 | 8.4635 | 3.5374 | 20 |
| Std. Predicted Value | -1.593 | 1.383 | .000 | 1.000 | 20 |
| Standard Error of Predicted Value | .3219 | .7615 | .5388 | .1007 | 20 |
| Adjusted Predicted Value | 2.3945 | 13.0285 | 8.4333 | 3.5840 | 20 |
| Residual | -1.1384 | 1.6356 | 3.8E-16 | .7657 | 20 |
| Std. Residual | -1.230 | 1.767 | .000 | .827 | 20 |
| Stud. Residual | -1.513 | 2.144 | .014 | 1.022 | 20 |
| Deleted Residual | -1.7240 | 2.4079 | 3.0E-02 | 1.1827 | 20 |
| Stud. Deleted Residual | -1.602 | 2.562 | .055 | 1.108 | 20 |
| Mahal. Distance | 1.347 | 11.906 | 5.700 | 2.447 | 20 |
| Cook's Distance | .000 | .448 | .080 | .120 | 20 |
| Centered Leverage Value | .071 | .627 | .300 | .129 | 20 |

a. Dependent Variable: Square Root of Red Harvest

***Table 6.40*** *Case Values for Residuals Diagnostics for square root of red fish data on square root of inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1961 | 4.0466 | -.5825 | -1.0972 | 4.5613 | -1.2486 | -.6293 | -.8637 | -.8547 |
| 1962 | 3.7673 | -.2888 | -.3742 | 3.8527 | -1.3276 | -.3120 | -.3551 | -.3429 |
| 1963 | 2.8297 | 1.1326 | 1.5678 | 2.3945 | -1.5926 | 1.2236 | 1.4396 | 1.5085 |
| 1964 | 4.2887 | -.0108 | -.0334 | 4.3113 | -1.1802 | -.0117 | -.0205 | -.0197 |
| 1965 | 5.2433 | -.8615 | -1.0584 | 5.4402 | -.9103 | -.9307 | -1.0316 | -1.0343 |
| 1966 | 7.2582 | 1.6356 | 2.4079 | 6.4859 | -.3407 | 1.7669 | 2.1438 | 2.5618 |
| 1967 | 7.3681 | -.4039 | -.5886 | 7.5527 | -.3097 | -.4363 | -.5267 | -.5115 |
| 1968 | 6.4769 | -1.1384 | -1.7240 | 7.0626 | -.5616 | -1.2298 | -1.5134 | -1.6020 |
| 1969 | 4.9384 | 1.1114 | 2.2874 | 3.7624 | -.9965 | 1.2006 | 1.7224 | 1.8837 |
| 1970 | 6.8043 | -.2927 | -.4129 | 6.9244 | -.4690 | -.3162 | -.3756 | -.3628 |
| 1971 | 9.6962 | -.2675 | -.4696 | 9.8982 | .3485 | -.2890 | -.3829 | -.3700 |
| 1972 | 12.4965 | .0215 | .0299 | 12.4881 | 1.1401 | .0232 | .0274 | .0263 |
| 1973 | 12.0156 | 1.3299 | 1.9801 | 11.3653 | 1.0042 | 1.4366 | 1.7530 | 1.9273 |
| 1974 | 11.7163 | -.3190 | -.6623 | 12.0597 | .9196 | -.3446 | -.4965 | -.4816 |
| 1975 | 10.4665 | .0644 | .0841 | 10.4469 | .5662 | .0696 | .0795 | .0764 |
| 1976 | 9.8905 | -.8185 | -.9311 | 10.0030 | .4034 | -.8842 | -.9431 | -.9388 |
| 1977 | 12.9939 | -.0787 | -.1134 | 13.0285 | 1.2807 | -.0851 | -.1021 | -.0981 |
| 1978 | 12.5192 | -.1823 | -.2878 | 12.6247 | 1.1465 | -.1969 | -.2474 | -.2383 |
| 1979 | 13.3543 | .5130 | .8951 | 12.9721 | 1.3826 | .5541 | .7320 | .7182 |
| 1980 | 11.0992 | -.5635 | -.8952 | 11.4308 | .7451 | -.6087 | -.7673 | -.7544 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that observation |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.
[2]This is flagged if it exceeds $t_{n-p-2,\alpha}=t_{12,0.01}=2.681$.

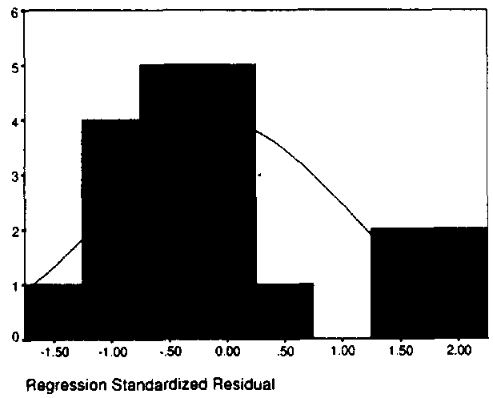


***Figure 6.46*** *Histogram of Standardized Residuals.*

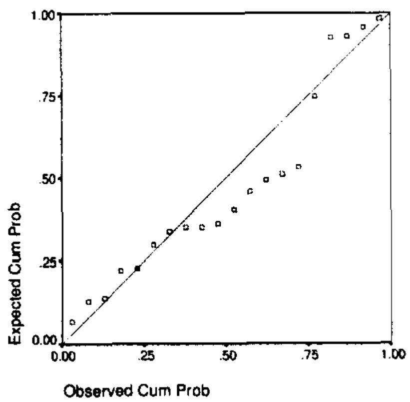


***Figure 6.47*** *Normal P-P Plot of Residuals.*

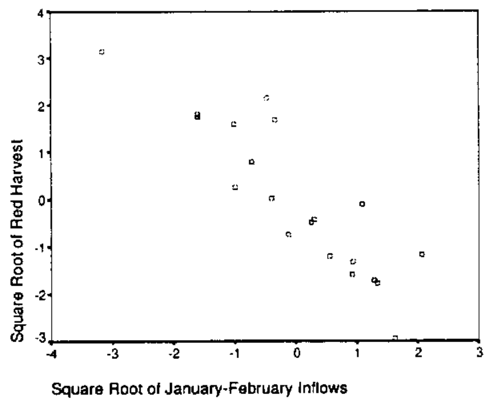


**Figure 6.48** *Partial Residual Plot for Sqrt(January-February Inflows).*

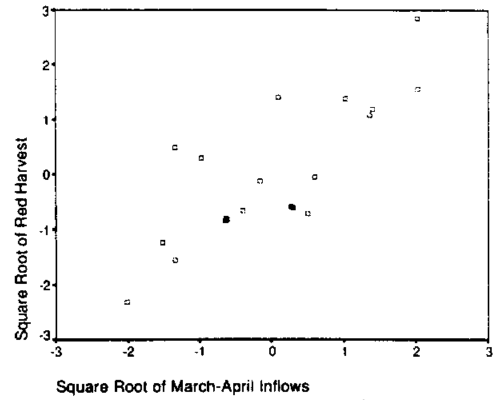


**Figure 6.49** *Partial Residual Plot for Sqrt(March-April Inflows).*

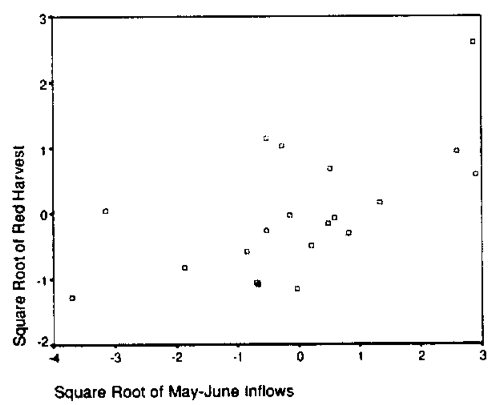


**Figure 6.50** *Partial Residual Plot for Sqrt(May-June Inflows).*

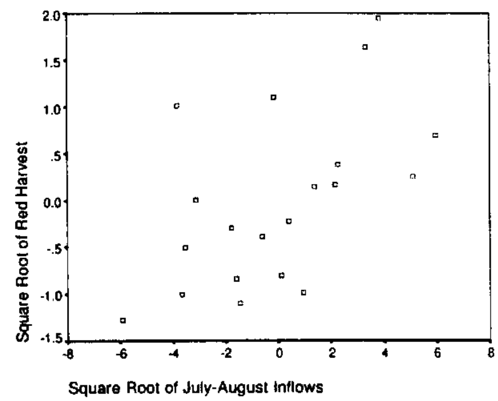


**Figure 6.51** *Partial Residual Plot for Sqrt(July-August Inflows).*

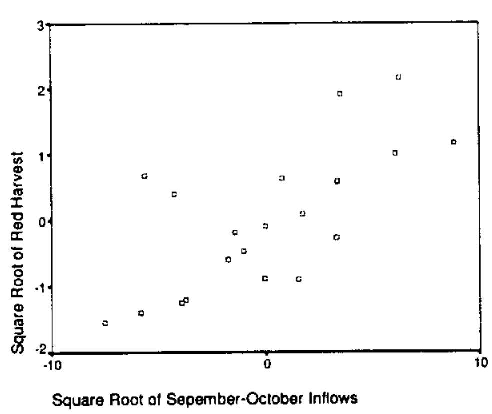


**Figure 6.52** *Partial Residual Plot for Sqrt(September-October Inflows).*

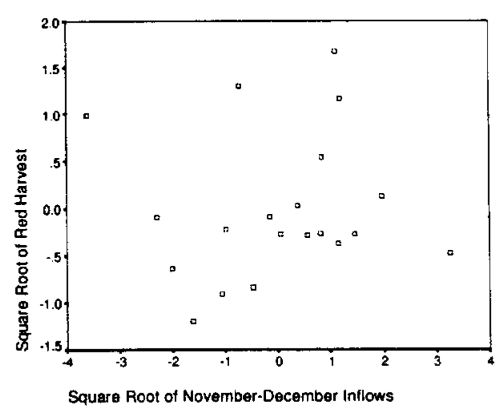


**Figure 6.53** *Partial Residual Plot for Sqrt(November-December Inflows).*

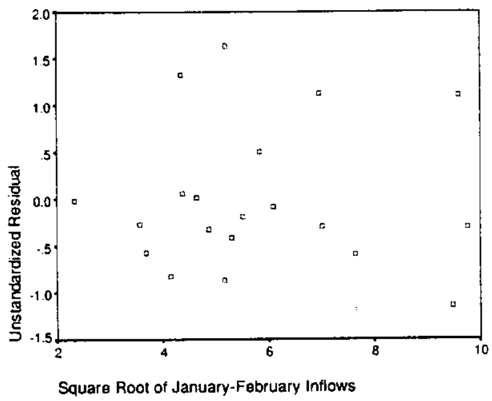


*Figure 6.54* Residuals Plot for Sqrt(January-February Inflows).

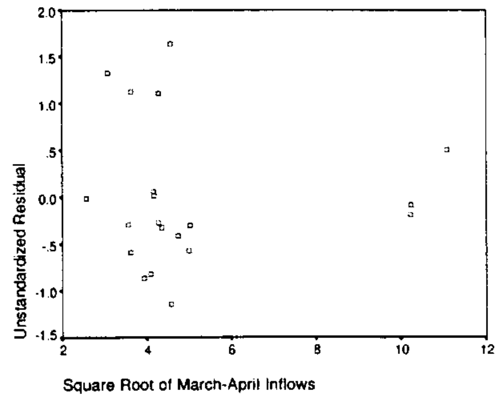


*Figure 6.55* Residuals Plot for Sqrt(March-April Inflows).

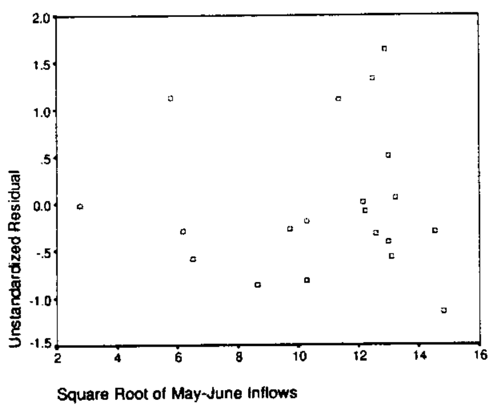


*Figure 6.56* Residuals Plot for Sqrt(May-June Inflows).

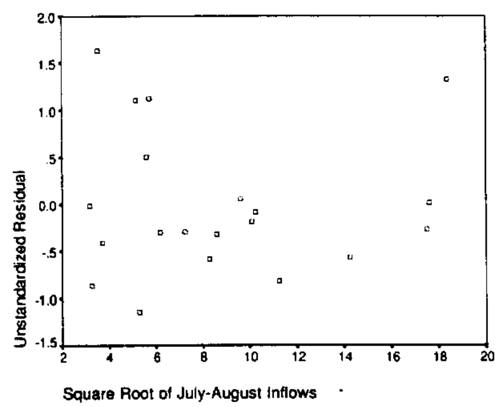


*Figure 6.57* Residuals Plot for Sqrt(July-August Inflows).

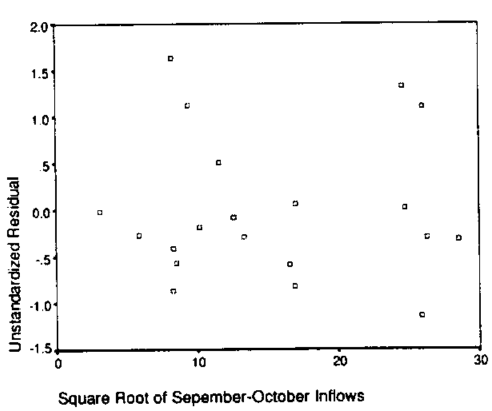


*Figure 6.58* Residuals Plot for Sqrt(September-October Inflows).

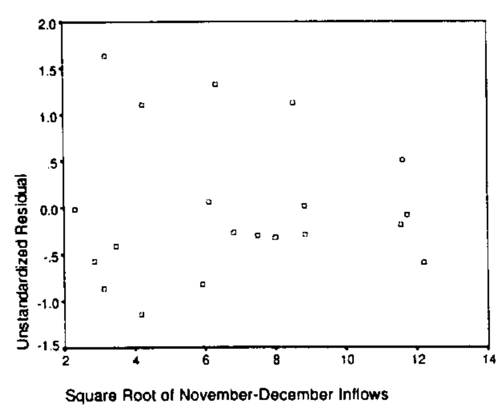


*Figure 6.59* Residuals Plot for Sqrt(November-December Inflows).

### 6.4.4 Prediction Intervals for Red fish Harvest

***Table 6.41*** *Prediction Intervals for Red fish Harvest.*

| YEAR | *LICI_1* | *SQ_RED* | *UICI_1* |
|---|---|---|---|
| 1961 | 0.667 | 3.464 | 7.426 |
| 1962 | 0.677 | 3.479 | 6.858 |
| 1963 | 0.000 | 3.962 | 5.981 |
| 1964 | 0.678 | 4.278 | 7.899 |
| 1965 | 2.207 | 4.382 | 8.280 |
| 1966 | 4.054 | 8.894 | 10.463 |
| 1967 | 4.172 | 6.964 | 10.564 |
| 1968 | 3.249 | 5.339 | 9.704 |
| 1969 | 1.507 | 6.050 | 8.370 |
| 1970 | 3.636 | 6.512 | 9.973 |
| 1971 | 6.361 | 9.429 | 13.031 |
| 1972 | 9.339 | 12.518 | 15.654 |
| 1973 | 8.802 | 13.345 | 15.229 |
| 1974 | 8.280 | 11.397 | 15.152 |
| 1975 | 7.370 | 10.531 | 13.563 |
| 1976 | 6.938 | 9.072 | 12.843 |
| 1977 | 9.808 | 12.915 | 16.180 |
| 1978 | 9.259 | 12.337 | 15.779 |
| 1979 | 10.023 | 13.867 | 16.685 |
| 1980 | 7.835 | 10.536 | 14.364 |

*LICI_1* Lower limit for 99% prediction interval for the square root of red fish harvest.

*LN_RED* Square root of red fish harvest

*UICI_1* Upper limit for 99% prediction interval for the square root of red fish harvest.

### 6.4.5 Outliers and Influential Point Detection

***Table 6.42*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1961 | 7.9621 | .0941 | .4191 | .3360 | .0022 |
| 1962 | 3.3855 | .0053 | .1782 | .8472 | .0000 |
| 1963 | 4.3241 | .1138 | .2276 | .7418 | .0039 |
| 1964 | 11.9063 | .0001 | *.6266 | .1037 | .0000 |
| 1965 | 2.5837 | .0347 | .1360 | .9207 | .0001 |
| 1966 | 5.1440 | .3100 | .2707 | .6424 | .0634 |
| 1967 | 5.0106 | .0181 | .2637 | .6587 | .0000 |
| 1968 | 5.5041 | .1683 | .2897 | .5987 | .0125 |
| 1969 | 8.8183 | .4485 | .4641 | .2660 | .1457 |
| 1970 | 4.5796 | .0083 | .2410 | .7111 | .0000 |
| 1971 | 7.2245 | .0158 | .3802 | .4059 | .0000 |
| 1972 | 4.4121 | .0000 | .2322 | .7313 | .0000 |
| 1973 | 5.2894 | .2146 | .2784 | .6247 | .0246 |
| 1974 | 8.8997 | .0379 | .4684 | .2599 | .0001 |
| 1975 | 3.4867 | .0003 | .1835 | .8366 | .0000 |
| 1976 | 1.3469 | .0175 | .0709 | .9871 | .0000 |
| 1977 | 4.8555 | .0007 | .2556 | .6776 | .0000 |
| 1978 | 6.0160 | .0051 | .3166 | .5379 | .0000 |
| 1979 | 7.1613 | .0570 | .3769 | .4123 | .0004 |
| 1980 | 6.0896 | .0495 | .3205 | .5293 | .0003 |

| | |
|---|---|
| *MAH_1* | Mahalanobis distance |
| *COOK_1* | Cook's distance |
| *LEV_1* | Leverage value |
| *MAHA_PV* | P-value associated with the Mahalanobis distance |
| *COOK_PV* | P-value associated with Cook's distance |

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.
[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p$+1 degrees of freedom. Small values indicate a problem.
[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p$+1 numerator degrees of freedom and $n$-$p$-1 denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.43*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1961 | -.8033 | .0349 | -.1156 | .4607 |
| 1962 | -.1864 | -.0347 | -.0645 | .0472 |
| 1963 | .9351 | .1641 | .3464 | -.3386 |
| 1964 | -.0286 | -.0269 | .0099 | -.0095 |
| 1965 | -.4944 | -.3410 | .0246 | -.0658 |
| 1966 | *1.7603 | .2544 | -.2652 | -.8155 |
| 1967 | -.3459 | -.0368 | .0435 | .1619 |
| 1968 | *-1.1490 | .3660 | -.5684 | -.1948 |
| 1969 | *1.9377 | -.0658 | .9896 | *1.0752 |
| 1970 | -.2325 | .1210 | -.1019 | .0537 |
| 1971 | -.3215 | .0594 | -.1125 | .0600 |
| 1972 | .0165 | -.0015 | -.0039 | -.0010 |
| 1973 | *1.3477 | -.0574 | -.1408 | .0451 |
| 1974 | -.4997 | -.1786 | .3878 | .0538 |
| 1975 | .0422 | .0059 | -.0247 | -.0259 |
| 1976 | -.3481 | -.1931 | .1754 | -.0545 |
| 1977 | -.0651 | .0208 | -.0063 | -.0313 |
| 1978 | -.1813 | .0175 | -.0138 | -.1189 |
| 1979 | .6199 | -.0583 | -.1684 | .1897 |
| 1980 | -.5788 | .0602 | -.1551 | -.1114 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for square root of January-February inflows |
| *SDFBET_2* | Standardized *dfbeta* for square root of March-April inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

***Table 6.44*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1961 | -.1281 | .1318 | .2392 | -.5416 |
| 1962 | .0438 | -.0116 | .0362 | -.0447 |
| 1963 | -.0641 | -.0202 | -.3933 | .3002 |
| 1964 | .0171 | .0044 | -.0109 | .0112 |
| 1965 | .1005 | .1191 | .0044 | .1703 |
| 1966 | *1.1941 | -.8530 | -.9100 | .4860 |
| 1967 | -.2399 | .1626 | .1876 | -.1007 |
| 1968 | .0076 | -.1359 | -.1541 | .4492 |
| 1969 | *-1.1337 | .6444 | .8809 | *-1.3750 |
| 1970 | -.0767 | .0186 | .0232 | -.0352 |
| 1971 | -.0386 | -.2102 | .1915 | -.0042 |
| 1972 | -.0006 | .0051 | .0054 | .0017 |
| 1973 | -.1627 | .6486 | .4277 | -.2346 |
| 1974 | -.0456 | .2947 | -.3182 | -.1428 |
| 1975 | .0303 | -.0221 | -.0065 | .0243 |
| 1976 | .0921 | -.0093 | -.1717 | .0661 |
| 1977 | .0082 | -.0118 | .0001 | .0024 |
| 1978 | .0740 | -.0467 | -.0263 | .0410 |
| 1979 | .0662 | -.2129 | .0378 | .1128 |
| 1980 | -.0265 | -.3496 | .1845 | .2683 |

*SDFBET_3* Standardized *dfbeta* for square root of May-June inflows
*SDFBET_4* Standardized *dfbeta* for square root of July-August inflows
*SDFBET_5* Standardized *dfbeta* for square root of September-October inflows
*SDFBET_6* Standardized *dfbeta* for square root of November-December inflows

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

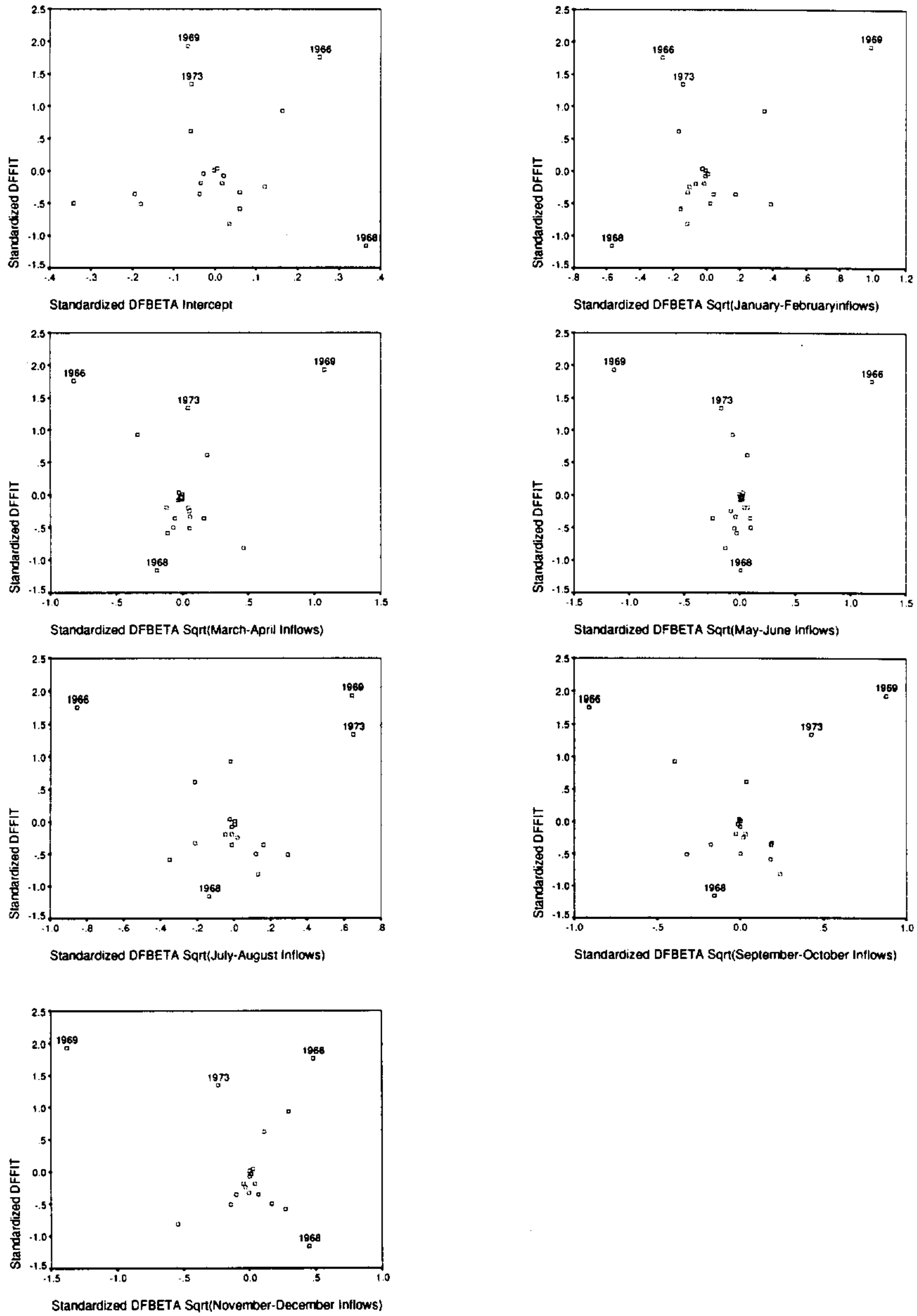


***Figure 6.60*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of square root of inflow variables.*

# 7. EXAMINING SUBSETS OF THE DATA

## 7.1 Untransformed red fish data and untransformed inflow data: 1969 Omitted

***Table** 7.1 Regression Models for Dependent Variable: RED on INFLOWS: 1969 Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.3730 | 0.3362 | 225.9 | 151.3 | 2599 | 153.2 | QMA_LAG |
| 1 | 0.2885 | 0.2467 | 258.4 | 153.7 | 2949 | 155.6 | QJA_LAG |
| 1 | 0.2166 | 0.1705 | 286.0 | 155.5 | 3247 | 157.4 | QMJ_LAG |
| 1 | 0.1515 | 0.1015 | 311.1 | 157.0 | 3517 | 158.9 | QJF_LAG |
| 2 | 0.7496 | 0.7183 | 83.21 | 135.8 | 1103 | 138.7 | QMA_LAG QJA_LAG |
| 2 | 0.5393 | 0.4817 | 164.0 | 147.4 | 2029 | 150.3 | QJF_LAG QMA_LAG |
| 2 | 0.5025 | 0.4404 | 178.1 | 148.9 | 2191 | 151.7 | QJF_LAG QMJ_LAG |
| 2 | 0.4881 | 0.4241 | 183.7 | 149.4 | 2255 | 152.3 | QMA_LAG QMJ_LAG |
| 3 | 0.8820 | 0.8584 | 34.33 | 123.5 | 554 | 127.3 | QJF_LAG QMJ_LAG QND_LAG |
| 3 | 0.8670 | 0.8404 | 40.10 | 125.8 | 625 | 129.6 | QJF_LAG QMA_LAG QSO_LAG |
| 3 | 0.8125 | 0.7750 | 61.05 | 132.3 | 881 | 136.1 | QMA_LAG QMJ_LAG QJA_LAG |
| 3 | 0.7932 | 0.7519 | 68.45 | 134.2 | 971 | 138.0 | QMA_LAG QJA_LAG QSO_LAG |
| 4 | 0.9327 | 0.9134 | 16.87 | 114.9 | 339 | 119.6 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG |
| 4 | 0.9068 | 0.8801 | 26.83 | 121.1 | 469 | 125.8 | QJF_LAG QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.9021 | 0.8742 | 28.60 | 122.0 | 493 | 126.7 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG |
| 4 | 0.8986 | 0.8696 | 29.97 | 122.7 | 510 | 127.4 | QJF_LAG QMJ_LAG QSO_LAG QND_LAG |
| 5 | 0.9631 | 0.9490 | 7.164 | 105.4 | 200 | 111.1 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.9392 | 0.9159 | 16.35 | 114.9 | 329 | 120.6 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.9317 | 0.9055 | 19.23 | 117.1 | 370 | 122.8 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.9313 | 0.9048 | 19.42 | 117.3 | 373 | 122.9 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 6 | 0.9688 | 0.9532 | 7.000 | 104.3 | 183 | 110.9 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 19

***Table** 7.2 Analysis of Variance for Dependent Variable: RED on INFLOWS: 1969 Omitted*

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 6 | 68265.01133 | 11377.50189 | 62.041 | 0.0001 |
| Error | 12 | 2200.62551 | 183.38546 | | |
| C Total | 18 | 70465.63684 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 13.54199 | R-square | 0.9688 |
| Dep Mean | 86.57368 | Adj R-sq | 0.9532 |
| C.V. | 15.64215 | | |

***Table** 7.3 Parameter Estimates for Dependent Variable: RED on INFLOWS: 1969 Omitted*

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 15.144550 | 10.37858461 | 1.459 | 0.1702 | 0.00000000 |
| QJF_LAG | 1 | -1.444397 | 0.19826107 | -7.285 | 0.0001 | 2.29999436 |
| QMA_LAG | 1 | 0.958832 | 0.20440570 | 4.691 | 0.0005 | 5.19860981 |
| QMJ_LAG | 1 | 0.328671 | 0.09755805 | 3.369 | 0.0056 | 3.65222037 |
| QJA_LAG | 1 | 0.153294 | 0.04037306 | 3.797 | 0.0025 | 1.85371831 |
| QSO_LAG | 1 | 0.075935 | 0.02013225 | 3.772 | 0.0027 | 2.76662458 |
| QND_LAG | 1 | 0.211767 | 0.14397178 | 1.471 | 0.1671 | 4.79218105 |

***Table** 7.4 Collinearity Diagnostics(intercept adjusted) for Dependent Variable: RED on INFLOWS: 1969 Omitted*

| Number | Eigenvalue | Condition Index | Var Prop QJF_LAG | Var Prop QMA_LAG | Var Prop QMJ_LAG | Var Prop QJA_LAG | Var Prop QSO_LAG | Var Prop QND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.82678 | 1.00000 | 0.0749 | 0.0057 | 0.0407 | 0.0016 | 0.0577 | 0.0072 |
| 2 | 1.73803 | 1.02521 | 0.0002 | 0.0424 | 0.0086 | 0.0188 | 0.0303 | 0.0426 |
| 3 | 1.27508 | 1.19694 | 0.0709 | 0.0107 | 0.0103 | 0.2523 | 0.0055 | 0.0094 |
| 4 | 0.81881 | 1.49366 | 0.0368 | 0.0341 | 0.1344 | 0.0469 | 0.0471 | 0.0525 |
| 5 | 0.26835 | 2.60911 | 0.6017 | 0.0028 | 0.0130 | 0.4819 | 0.4873 | 0.0082 |
| 6 | 0.07295 | 5.00425 | 0.2156 | 0.9044 | 0.7930 | 0.1985 | 0.3722 | 0.8800 |

***Table** 7.5 Parameter Estimates of Models for Dependent Variable: RED on INFLOWS: 1969 Omitted*

| OBS | _RMSE_ | INTERCEP | QJF_LAG | QMA_LAG | QMJ_LAG | QJA_LAG | QSO_LAG | QND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | 50.978 | 52.283 | . | 1.07332 | . | . | . | . |
| 2 | 54.306 | 54.398 | . | . | . | 0.31222 | . | . |
| 3 | 56.985 | 27.822 | . | . | 0.46571 | . | . | . |
| 4 | 59.307 | 121.097 | - 0.99728 | . | . | . | . | . |
| 5 | 33.207 | 11.161 | . | 1.20173 | . | 0.35922 | . | . |
| 6 | 45.043 | 87.782 | -1.04544 | 1.09495 | . | . | . | . |
| 7 | 46.806 | 58.153 | -1.42324 | . | 0.61582 | . | . | . |
| 8 | 47.483 | 12.692 | . | 0.93868 | 0.34792 | . | . | . |
| 9 | 23.542 | 5.677 | -1.89525 | . | 0.76677 | . | . | 0.83663 |
| 10 | 24.996 | 61.925 | -1.77681 | 1.35610 | . | . | 0.15534 | . |
| 11 | 29.679 | -15.916 | . | 1.09318 | 0.26014 | 0.33717 | . | . |
| 12 | 31.166 | -2.814 | . | 1.27465 | . | 0.33356 | 0.05183 | . |
| 13 | 18.409 | 36.060 | -1.28639 | 1.35415 | . | 0.18434 | 0.11890 | . |
| 14 | 21.664 | -4.306 | -1.65761 | . | 0.71522 | 0.10498 | . | 0.79364 |
| 15 | 22.194 | 45.796 | -1.78353 | 1.21280 | 0.23724 | . | 0.12274 | . |
| 16 | 22.592 | 8.549 | -2.02150 | . | 0.69777 | . | 0.03796 | 0.83218 |
| 17 | 14.135 | 21.925 | -1.30979 | 1.22060 | 0.22120 | 0.17790 | 0.08978 | . |
| 18 | 18.149 | 35.998 | -1.19822 | 1.49500 | . | 0.19970 | 0.11869 | -0.15150 |
| 19 | 19.235 | -0.593 | -1.31498 | 0.52184 | 0.56061 | 0.17066 | . | 0.46568 |
| 20 | 19.304 | 24.932 | -1.92651 | 0.67331 | 0.45505 | . | 0.08465 | 0.43824 |
| 21 | 13.542 | 15.145 | -1.44440 | 0.95883 | 0.32867 | 0.15329 | 0.07594 | 0.21177 |

***Table** 7.6 Criteria Statistics of Models for Dependent Variable: RED on INFLOWS: 1969 Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 2598.79 | 0.37304 | 0.33616 | 225.910 | 151.280 | 153.169 |
| 2 | 2949.10 | 0.28852 | 0.24667 | 258.385 | 153.683 | 155.571 |
| 3 | 3247.25 | 0.21659 | 0.17051 | 286.023 | 155.512 | 157.401 |
| 4 | 3517.26 | 0.15145 | 0.10154 | 311.053 | 157.030 | 158.919 |
| 5 | 1102.71 | 0.74962 | 0.71832 | 83.209 | 135.840 | 138.673 |
| 6 | 2028.89 | 0.53932 | 0.48173 | 164.016 | 147.424 | 150.258 |
| 7 | 2190.83 | 0.50255 | 0.44037 | 178.146 | 148.884 | 151.717 |
| 8 | 2254.66 | 0.48806 | 0.42406 | 183.714 | 149.429 | 152.262 |
| 9 | 554.23 | 0.88202 | 0.85842 | 34.333 | 123.543 | 127.320 |
| 10 | 624.79 | 0.86700 | 0.84040 | 40.105 | 125.820 | 129.597 |
| 11 | 880.83 | 0.81250 | 0.77500 | 61.047 | 132.345 | 136.123 |
| 12 | 971.33 | 0.79323 | 0.75188 | 68.450 | 134.203 | 137.981 |
| 13 | 338.89 | 0.93267 | 0.91343 | 16.872 | 114.886 | 119.608 |
| 14 | 469.32 | 0.90676 | 0.88011 | 26.829 | 121.072 | 125.795 |
| 15 | 492.55 | 0.90214 | 0.87418 | 28.602 | 121.990 | 126.712 |
| 16 | 510.41 | 0.89859 | 0.86962 | 29.965 | 122.667 | 127.389 |
| 17 | 199.80 | 0.96314 | 0.94896 | 7.164 | 105.439 | 111.105 |
| 18 | 329.39 | 0.93923 | 0.91586 | 16.350 | 114.937 | 120.604 |
| 19 | 369.97 | 0.93175 | 0.90549 | 19.227 | 117.145 | 122.811 |
| 20 | 372.65 | 0.93125 | 0.90481 | 19.417 | 117.282 | 122.948 |
| 21 | 183.39 | 0.96877 | 0.95316 | 7.000 | 104.289 | 110.900 |

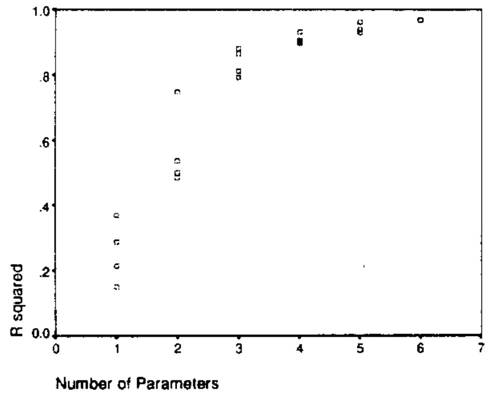


***Figure 7.1*** *The $R^2$ criteria vs. Number of parameters.*

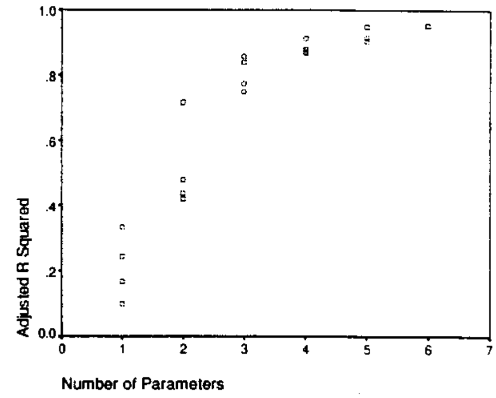


***Figure 7.2*** *The Adjusted $R^2$ criteria vs. Number of parameters.*

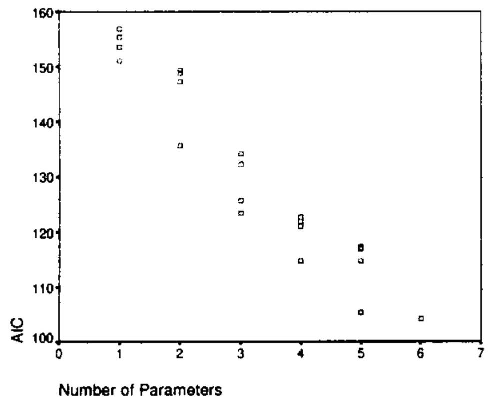


***Figure 7.3*** *The AIC criteria vs. Number of parameters..*

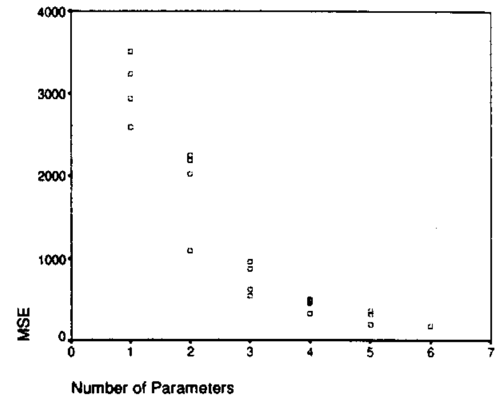


***Figure 7.4*** *MSE vs. Number of parameters.*

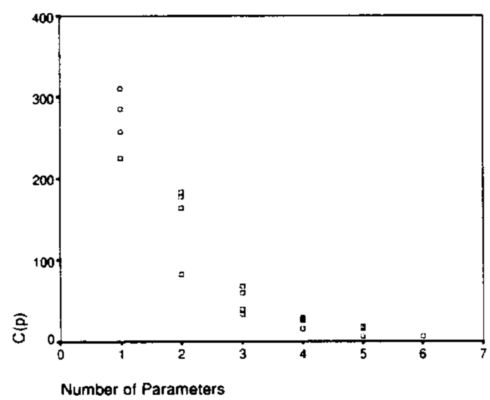


***Figure 7.5*** *The C(p) criteria vs. Number of parameters.*

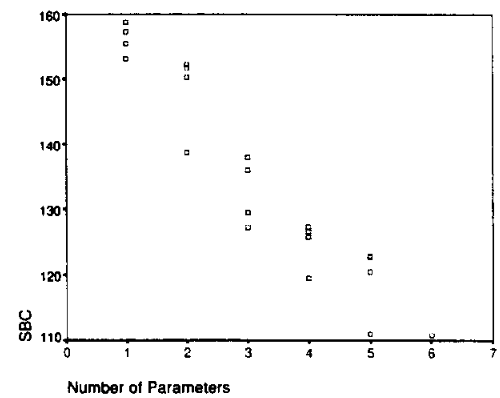


***Figure 7.6*** *The SBC criteria vs. Number of parameters.*

## 7.2 Log of red fish data and square root inflow data: 1969 Omitted

*Table 7.7 Regression Models for Dependent Variable: Ln(RED) on Sqrt(INFLOWS): 1969 Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.4383 | 0.4052 | 194.9 | -8.589 | 0.5762 | -6.700 | SQR_QMJ |
| 1 | 0.3163 | 0.2760 | 240.5 | -4.855 | 0.7013 | -2.966 | SQR_QJA |
| 1 | 0.2838 | 0.2416 | 252.6 | -3.973 | 0.7346 | -2.084 | SQR_QMA |
| 1 | 0.1398 | 0.0892 | 306.4 | -0.492 | 0.8823 | 1.397 | SQR_QJF |
| 2 | 0.7335 | 0.7002 | 86.57 | -20.76 | 0.2904 | -17.92 | SQR_QJF SQR_QMJ |
| 2 | 0.6266 | 0.5800 | 126.5 | -14.35 | 0.4069 | -11.52 | SQR_QMJ SQR_QJA |
| 2 | 0.6238 | 0.5767 | 127.6 | -14.21 | 0.4100 | -11.37 | SQR_QMA SQR_QJA |
| 2 | 0.5476 | 0.4911 | 156.0 | -10.70 | 0.4930 | -7.869 | SQR_QMA SQR_QMJ |
| 3 | 0.9396 | 0.9275 | 11.56 | -46.96 | 0.0702 | -43.19 | SQR_QJF SQR_QMJ SQR_QND |
| 3 | 0.8667 | 0.8400 | 38.81 | -31.92 | 0.1550 | -28.14 | SQR_QJF SQR_QMA SQR_QMJ |
| 3 | 0.8189 | 0.7826 | 56.68 | -26.09 | 0.2106 | -22.32 | SQR_QJF SQR_QMA SQR_QSO |
| 3 | 0.7842 | 0.7411 | 69.61 | -22.77 | 0.2508 | -18.99 | SQR_QJF SQR_QMJ SQR_QJA |
| 4 | 0.9473 | 0.9323 | 10.67 | -47.57 | 0.0656 | -42.84 | SQR_QJF SQR_QMA SQR_QMJ SQR_QND |
| 4 | 0.9400 | 0.9228 | 13.42 | -45.08 | 0.0747 | -40.36 | SQR_QJF SQR_QMA SQR_QMJ SQR_QSO |
| 4 | 0.9399 | 0.9228 | 13.44 | -45.06 | 0.0748 | -40.34 | SQR_QJF SQR_QMJ SQR_QJA SQR_QND |
| 4 | 0.9397 | 0.9224 | 13.54 | -44.99 | 0.0751 | -40.26 | SQR_QJF SQR_QMJ SQR_QSO SQR_QND |
| 5 | 0.9652 | 0.9518 | 5.993 | -53.45 | 0.0466 | -47.78 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO |
| 5 | 0.9589 | 0.9431 | 8.342 | -50.29 | 0.0551 | -44.62 | SQR_QJF SQR_QMA SQR_QMJ SQR_QSO SQR_QND |
| 5 | 0.9553 | 0.9381 | 9.712 | -48.67 | 0.0600 | -43.00 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QND |
| 5 | 0.9399 | 0.9168 | 15.44 | -43.06 | 0.0806 | -37.40 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 6 | 0.9679 | 0.9518 | 7.000 | -52.96 | 0.0467 | -46.35 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

N = 19

***Table 7.8*** *Analysis of Variance for Dependent Variable: Ln(RED) on Sqrt(INFLOWS): 1969 Omitted*

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 6 | 16.87667 | 2.81278 | 60.271 | 0.0001 |
| Error | 12 | 0.56003 | 0.04667 | | |
| C Total | 18 | 17.43670 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 0.21603 | R-square | 0.9679 |
| Dep Mean | 4.09281 | Adj R-sq | 0.9518 |
| C.V. | 5.27828 | | |

***Table 7.9*** *Parameter Estimates for Dependent Variable: Ln(RED) on Sqrt(INFLOWS): 1969 Omitted*

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 2.467265 | 0.25734300 | 9.587 | 0.0001 | 0.00000000 |
| SQR_QJF | 1 | -0.328893 | 0.04318503 | -7.616 | 0.0001 | 2.64007754 |
| SQR_QMA | 1 | 0.157247 | 0.04865970 | 3.232 | 0.0072 | 5.66666585 |
| SQR_QMJ | 1 | 0.160787 | 0.03365786 | 4.777 | 0.0005 | 4.86004312 |
| SQR_QJA | 1 | 0.030016 | 0.01641871 | 1.828 | 0.0925 | 2.55616956 |
| SQR_QSO | 1 | 0.026868 | 0.01237808 | 2.171 | 0.0507 | 3.61861438 |
| SQR_QND | 1 | 0.037675 | 0.03780569 | 0.997 | 0.3387 | 5.91636935 |

***Table 7.10*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(RED) on Sqrt(INFLOWS): 1969 Omitted*

| Number | Eigenvalue | Condition Index | Var Prop SQR_QJF | Var Prop SQR_QMA | Var Prop SQR_QMJ | Var Prop SQR_QJA | Var Prop SQR_QSO | Var Prop SQR_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.07329 | 1.00000 | 0.0361 | 0.0119 | 0.0201 | 0.0039 | 0.0315 | 0.0166 |
| 2 | 1.42511 | 1.20616 | 0.0078 | 0.0328 | 0.0168 | 0.0570 | 0.0432 | 0.0188 |
| 3 | 1.30572 | 1.26010 | 0.0945 | 0.0146 | 0.0001 | 0.1279 | 0.0084 | 0.0129 |
| 4 | 0.91579 | 1.50464 | 0.0170 | 0.0361 | 0.0978 | 0.0218 | 0.0199 | 0.0405 |
| 5 | 0.22374 | 3.04410 | 0.6349 | 0.0115 | 0.0108 | 0.4206 | 0.4175 | 0.0152 |
| 6 | 0.05635 | 6.06580 | 0.2097 | 0.8931 | 0.8545 | 0.3688 | 0.4796 | 0.8960 |

***Table 7.11*** *Parameter Estimates of Models for Dependent Variable: Ln(RED) on Sqrt(INFLOWS): 1969 Omitted*

| OBS | _RMSE_ | INTERCEP | SQR_QJF | SQR_QMA | SQR_QMJ | SQR_QJA | SQR_QSO | SQR_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.75905 | 1.99210 | . | . | 0.19537 | . | . | . |
| 2 | 0.83744 | 3.09584 | . | . | . | 0.11163 | . | . |
| 3 | 0.85710 | 3.01813 | . | 0.21048 | . | . | . | . |
| 4 | 0.93933 | 5.16455 | -0.19206 | . | . | . | . | . |
| 5 | 0.53892 | 3.18021 | -0.28706 | . | 0.23385 | . | . | . |
| 6 | 0.63789 | 1.49873 | . | . | 0.16809 | 0.08808 | . | . |
| 7 | 0.64032 | 1.93880 | . | 0.21927 | . | 0.11583 | . | . |
| 8 | 0.70215 | 1.65606 | . | 0.13860 | 0.16081 | . | . | . |
| 9 | 0.26494 | 2.45362 | -0.38035 | . | 0.25411 | . | . | 0.14656 |
| 10 | 0.39367 | 2.85804 | -0.29901 | 0.15327 | 0.19723 | . | . | . |
| 11 | 0.45887 | 3.61408 | -0.39592 | 0.28564 | . | . | 0.083336 | . |
| 12 | 0.50080 | 2.66756 | -0.23149 | . | 0.21078 | 0.05046 | . | . |
| 13 | 0.25609 | 2.47352 | -0.36839 | 0.04903 | 0.23897 | . | . | 0.12176 |
| 14 | 0.27339 | 2.93821 | -0.37211 | 0.20776 | 0.13616 | . | 0.047862 | . |
| 15 | 0.27352 | 2.42283 | -0.37351 | . | 0.25165 | 0.00449 | . | 0.14358 |
| 16 | 0.27409 | 2.46137 | -0.38198 | . | 0.25271 | . | 0.001335 | 0.14610 |
| 17 | 0.21597 | 2.49269 | -0.30721 | 0.19929 | 0.13400 | 0.03998 | 0.033820 | . |
| 18 | 0.23469 | 2.64920 | -0.38376 | 0.11427 | 0.19175 | . | 0.025729 | 0.07978 |
| 19 | 0.24494 | 2.29514 | -0.31616 | 0.08672 | 0.21183 | 0.02822 | . | 0.08392 |
| 20 | 0.28385 | 2.42448 | -0.37387 | . | 0.25153 | 0.00438 | 0.000161 | 0.14359 |
| 21 | 0.21603 | 2.46726 | -0.32889 | 0.15725 | 0.16079 | 0.03002 | 0.026868 | 0.03767 |

***Table 7.12*** *Criteria Statistics of Models for Dependent Variable: Ln(RED) on Sqrt(INFLOWS): 1969 Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 0.57616 | 0.43827 | 0.40523 | 194.876 | -8.5893 | -6.7004 |
| 2 | 0.70131 | 0.31626 | 0.27604 | 240.463 | -4.8547 | -2.9658 |
| 3 | 0.73462 | 0.28378 | 0.24165 | 252.598 | -3.9729 | -2.0840 |
| 4 | 0.88234 | 0.13976 | 0.08916 | 306.407 | -0.4917 | 1.3972 |
| 5 | 0.29044 | 0.73349 | 0.70018 | 86.573 | -20.7562 | -17.9229 |
| 6 | 0.40690 | 0.62662 | 0.57995 | 126.503 | -14.3496 | -11.5163 |
| 7 | 0.41001 | 0.62377 | 0.57675 | 127.567 | -14.2051 | -11.3718 |
| 8 | 0.49302 | 0.54760 | 0.49105 | 156.027 | -10.7020 | -7.8687 |
| 9 | 0.07019 | 0.93961 | 0.92754 | 11.561 | -46.9646 | -43.1869 |
| 10 | 0.15497 | 0.86668 | 0.84002 | 38.810 | -31.9171 | -28.1393 |
| 11 | 0.21056 | 0.81887 | 0.78264 | 56.676 | -26.0933 | -22.3155 |
| 12 | 0.25080 | 0.78425 | 0.74110 | 69.611 | -22.7702 | -18.9924 |
| 13 | 0.06558 | 0.94734 | 0.93230 | 10.674 | -47.5666 | -42.8444 |
| 14 | 0.07474 | 0.93999 | 0.92284 | 13.422 | -45.0823 | -40.3601 |
| 15 | 0.07481 | 0.93993 | 0.92277 | 13.443 | -45.0643 | -40.3421 |
| 16 | 0.07512 | 0.93968 | 0.92245 | 13.536 | -44.9861 | -40.2639 |
| 17 | 0.04664 | 0.96522 | 0.95185 | 5.993 | -53.4492 | -47.7826 |
| 18 | 0.05508 | 0.95894 | 0.94314 | 8.342 | -50.2916 | -44.6250 |
| 19 | 0.05999 | 0.95527 | 0.93807 | 9.712 | -48.6671 | -43.0004 |
| 20 | 0.08057 | 0.93993 | 0.91683 | 15.443 | -43.0646 | -37.3980 |
| 21 | 0.04667 | 0.96788 | 0.95182 | 7.000 | -52.9599 | -46.3488 |

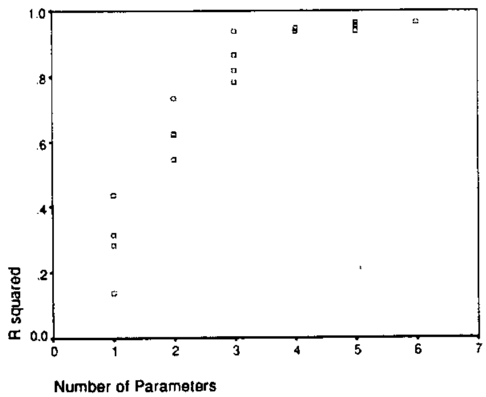


***Figure** 7.7 The $R^2$ criteria vs. Number of parameters.*

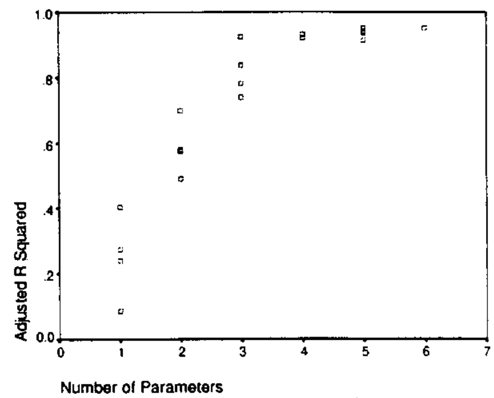


***Figure** 7.8 The Adjusted $R^2$ criteria vs. Number of parameters.*

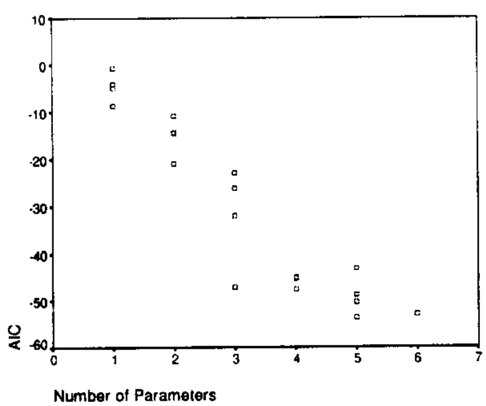


***Figure** 7.9 The AIC criteria vs. Number of parameters..*

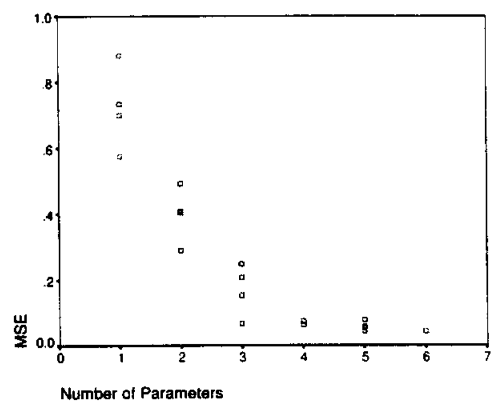


***Figure** 7.10 MSE vs. Number of parameters.*

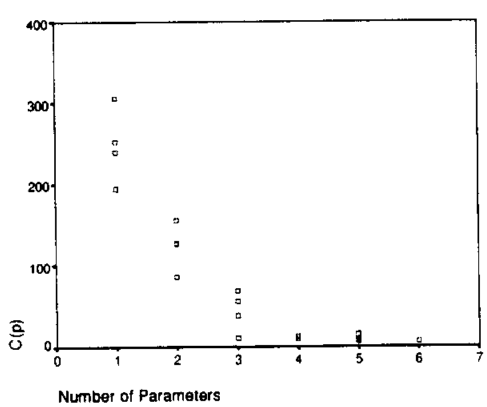


***Figure** 7.11 The C(p) criteria vs. Number of parameters.*

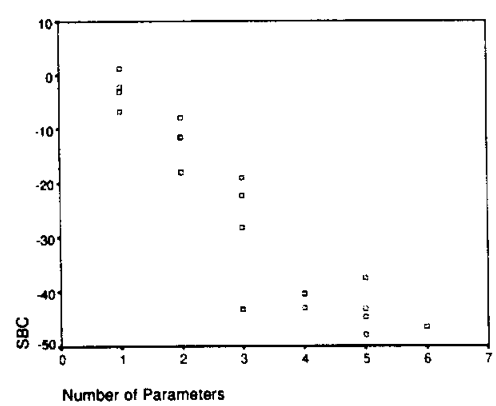


***Figure** 7.12 The SBC criteria vs. Number of parameters.*

## 7.3 Square root of red fish data and untransformed inflow data: 1969 Omitted

***Table 7.13*** *Regression Models for Dependent Variable: Sqrt(RED) on INFLOWS: 1969 Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.3186 | 0.2785 | 342.6 | 45.12 | 9.73 | 47.01 | QMA_LAG |
| 1 | 0.2979 | 0.2566 | 353.5 | 45.69 | 10.03 | 47.57 | QJA_LAG |
| 1 | 0.2855 | 0.2435 | 359.9 | 46.02 | 10.20 | 47.91 | QMJ_LAG |
| 1 | 0.1671 | 0.1181 | 422.1 | 48.93 | 11.89 | 50.82 | QJF_LAG |
| 2 | 0.6991 | 0.6615 | 144.9 | 31.59 | 4.57 | 34.42 | QMA_LAG QJA_LAG |
| 2 | 0.6155 | 0.5675 | 188.8 | 36.24 | 5.83 | 39.08 | QJF_LAG QMJ_LAG |
| 2 | 0.5219 | 0.4621 | 237.9 | 40.38 | 7.25 | 43.22 | QMJ_LAG QJA_LAG |
| 2 | 0.5001 | 0.4376 | 249.4 | 41.23 | 7.59 | 44.07 | QJF_LAG QMA_LAG |
| 3 | 0.9092 | 0.8911 | 36.63 | 10.81 | 1.47 | 14.59 | QJF_LAG QMJ_LAG QND_LAG |
| 3 | 0.8329 | 0.7995 | 76.67 | 22.41 | 2.70 | 26.18 | QJF_LAG QMA_LAG QSO_LAG |
| 3 | 0.8095 | 0.7714 | 88.96 | 24.90 | 3.08 | 28.68 | QMA_LAG QMJ_LAG QJA_LAG |
| 3 | 0.8093 | 0.7712 | 89.07 | 24.92 | 3.09 | 28.70 | QJF_LAG QMA_LAG QMJ_LAG |
| 4 | 0.9325 | 0.9132 | 26.42 | 7.188 | 1.17 | 11.91 | QJF_LAG QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.9265 | 0.9055 | 29.56 | 8.803 | 1.27 | 13.52 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG |
| 4 | 0.9211 | 0.8986 | 32.38 | 10.14 | 1.37 | 14.86 | QJF_LAG QMJ_LAG QSO_LAG QND_LAG |
| 4 | 0.9175 | 0.8939 | 34.30 | 11.00 | 1.43 | 15.73 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG |
| 5 | 0.9724 | 0.9618 | 7.482 | -7.807 | 0.52 | -2.140 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.9524 | 0.9341 | 17.97 | 2.543 | 0.89 | 8.210 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.9430 | 0.9211 | 22.92 | 5.982 | 1.06 | 11.65 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 5 | 0.9350 | 0.9099 | 27.14 | 8.485 | 1.21 | 14.15 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.9771 | 0.9657 | 7.000 | -9.379 | 0.46 | -2.768 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 19

***Table 7.14*** *Analysis of Variance for Dependent Variable: Sqrt(RED) on INFLOWS: 1969 Omitted*

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 6 | 237.20582 | 39.53430 | 85.464 | 0.0001 |
| Error | 12 | 5.55101 | 0.46258 | | |
| C Total | 18 | 242.75683 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 0.68014 | R-square | 0.9771 |
| Dep Mean | 8.59052 | Adj R-sq | 0.9657 |
| C.V. | 7.91728 | | |

***Table 7.15*** *Parameter Estimates for Dependent Variable: Sqrt(RED) on INFLOWS: 1969 Omitted*

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 4.215141 | 0.52125589 | 8.087 | 0.0001 | 0.00000000 |
| QJF_LAG | 1 | -0.088840 | 0.00995750 | -8.922 | 0.0001 | 2.29999436 |
| QMA_LAG | 1 | 0.048302 | 0.01026611 | 4.705 | 0.0005 | 5.19860981 |
| QMJ_LAG | 1 | 0.026485 | 0.00489977 | 5.405 | 0.0002 | 3.65222037 |
| QJA_LAG | 1 | 0.008584 | 0.00202770 | 4.234 | 0.0012 | 1.85371831 |
| QSO_LAG | 1 | 0.003641 | 0.00101113 | 3.601 | 0.0036 | 2.76662458 |
| QND_LAG | 1 | 0.011391 | 0.00723086 | 1.575 | 0.1411 | 4.79218105 |

***Table 7.16*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Sqrt(RED) on INFLOWS: 1969 Omitted*

| Number | Eigenvalue | Condition Index | Var Prop QJF_LAG | Var Prop QMA_LAG | Var Prop QMJ_LAG | Var Prop QJA_LAG | Var Prop QSO_LAG | Var Prop QND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.82678 | 1.00000 | 0.0749 | 0.0057 | 0.0407 | 0.0016 | 0.0577 | 0.0072 |
| 2 | 1.73803 | 1.02521 | 0.0002 | 0.0424 | 0.0086 | 0.0188 | 0.0303 | 0.0426 |
| 3 | 1.27508 | 1.19694 | 0.0709 | 0.0107 | 0.0103 | 0.2523 | 0.0055 | 0.0094 |
| 4 | 0.81881 | 1.49366 | 0.0368 | 0.0341 | 0.1344 | 0.0469 | 0.0471 | 0.0525 |
| 5 | 0.26835 | 2.60911 | 0.6017 | 0.0028 | 0.0130 | 0.4819 | 0.4873 | 0.0082 |
| 6 | 0.07295 | 5.00425 | 0.2156 | 0.9044 | 0.7930 | 0.1985 | 0.3722 | 0.8800 |

***Table 7.17*** *Parameter Estimates of Models for Dependent Variable: Sqrt(RED) on INFLOWS: 1969 Omitted*

| OBS | _RMSE_ | INTERCEP | QJF_LAG | QMA_LAG | QMJ_LAG | QJA_LAG | QSO_LAG | QND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | 3.13475 | 4.50121 | . | . | . | 0.028698 | . | . |
| 1 | 3.11938 | 6.7305 | . | 0.058219 | . | . | . | . |
| 2 | 3.16643 | 6.6716 | . | . | . | 0.018620 | . | . |
| 3 | 3.19416 | 4.6313 | . | . | 0.031384 | . | . | . |
| 4 | 3.44869 | 10.7190 | -0.06149 | . | . | . | . | . |
| 5 | 2.13677 | 4.3044 | . | 0.065795 | . | 0.021193 | . | . |
| 6 | 2.41519 | 6.5438 | -0.08974 | . | 0.040849 | . | . | . |
| 7 | 2.69328 | 3.3374 | . | . | 0.027995 | 0.016704 | . | . |
| 8 | 2.75411 | 8.9073 | -0.06411 | 0.059545 | . | . | . | . |
| 9 | 1.21197 | 3.8341 | -0.11412 | . | 0.048644 | . | . | 0.043201 |
| 10 | 1.64425 | 7.3777 | -0.10737 | 0.074994 | . | . | .0091895 | . |
| 11 | 1.75574 | 2.1981 | . | 0.057350 | 0.020236 | 0.019478 | . | . |
| 12 | 1.75671 | 5.7473 | -0.08759 | 0.046572 | 0.034779 | . | . | . |
| 13 | 1.08187 | 3.2659 | -0.10059 | . | 0.045709 | 0.005975 | . | 0.040754 |
| 14 | 1.12883 | 4.0174 | -0.06010 | 0.053281 | 0.028324 | 0.013372 | . | . |
| 15 | 1.16931 | 3.9770 | -0.12040 | . | 0.045211 | . | .0018889 | 0.042979 |
| 16 | 1.19618 | 5.9093 | -0.10798 | 0.061948 | 0.021597 | . | .0062218 | . |
| 17 | 0.71785 | 4.5799 | -0.08160 | 0.062383 | 0.020704 | 0.009908 | .0043862 | . |
| 18 | 0.94260 | 3.4605 | -0.08263 | 0.027346 | 0.037608 | 0.009417 | . | 0.023568 |
| 19 | 1.03187 | 4.7633 | -0.11584 | 0.032313 | 0.033562 | . | .0041296 | 0.024074 |
| 20 | 1.10213 | 3.4230 | -0.10577 | . | 0.044434 | 0.005075 | .0009449 | 0.041012 |
| 21 | 0.68014 | 4.2151 | -0.08884 | 0.048302 | 0.026485 | 0.008584 | .0036414 | 0.011391 |

***Table 7.18*** *Criteria Statistics of Models for Dependent Variable: Sqrt(RED) on INFLOWS: 1969 Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 9.7306 | 0.31858 | 0.27850 | 342.599 | 45.1169 | 47.0057 |
| 2 | 10.0263 | 0.29787 | 0.25657 | 353.466 | 45.6857 | 47.5745 |
| 3 | 10.2026 | 0.28552 | 0.24349 | 359.947 | 46.0170 | 47.9058 |
| 4 | 11.8934 | 0.16712 | 0.11812 | 422.085 | 48.9305 | 50.8193 |
| 5 | 4.5658 | 0.69907 | 0.66145 | 144.923 | 31.5881 | 34.4214 |
| 6 | 5.8331 | 0.61554 | 0.56748 | 188.759 | 36.2424 | 39.0757 |
| 7 | 7.2537 | 0.52191 | 0.46215 | 237.895 | 40.3837 | 43.2170 |
| 8 | 7.5851 | 0.50007 | 0.43758 | 249.356 | 41.2324 | 44.0657 |
| 9 | 1.4689 | 0.90924 | 0.89109 | 36.630 | 10.8139 | 14.5917 |
| 10 | 2.7036 | 0.83295 | 0.79954 | 76.667 | 22.4054 | 26.1832 |
| 11 | 3.0826 | 0.80952 | 0.77143 | 88.959 | 24.8985 | 28.6762 |
| 12 | 3.0860 | 0.80931 | 0.77118 | 89.069 | 24.9194 | 28.6972 |
| 13 | 1.1704 | 0.93250 | 0.91321 | 26.423 | 7.1881 | 11.9103 |
| 14 | 1.2742 | 0.92651 | 0.90552 | 29.565 | 8.8025 | 13.5247 |
| 15 | 1.3673 | 0.92115 | 0.89862 | 32.380 | 10.1413 | 14.8635 |
| 16 | 1.4309 | 0.91748 | 0.89390 | 34.304 | 11.0049 | 15.7270 |
| 17 | 0.5153 | 0.97240 | 0.96179 | 7.482 | -7.8069 | -2.1403 |
| 18 | 0.8885 | 0.95242 | 0.93412 | 17.969 | 2.5434 | 8.2101 |
| 19 | 1.0648 | 0.94298 | 0.92105 | 22.923 | 5.9819 | 11.6485 |
| 20 | 1.2147 | 0.93495 | 0.90993 | 27.137 | 8.4850 | 14.1517 |
| 21 | 0.4626 | 0.97713 | 0.96570 | 7.000 | -9.3787 | -2.7677 |

## 7.4 Square root of red fish data and square root of inflow data: 1969 Omitted

***Table 7.19*** *Regression Models for Dependent Variable: Sqrt(RED) on Sqrt(INFLOWS): 1969 Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.3513 | 0.3131 | 204.8 | 44.18 | 9.26 | 46.07 | SQR_QMJ |
| 1 | 0.3385 | 0.2996 | 209.1 | 44.55 | 9.45 | 46.44 | SQR_QJA |
| 1 | 0.3309 | 0.2915 | 211.7 | 44.77 | 9.56 | 46.66 | SQR_QMA |
| 1 | 0.1323 | 0.0813 | 279.0 | 49.71 | 12.39 | 51.60 | SQR_QJF |
| 2 | 0.6959 | 0.6578 | 90.05 | 31.79 | 4.61 | 34.62 | SQR_QMA SQR_QJA |
| 2 | 0.6178 | 0.5701 | 116.5 | 36.13 | 5.80 | 38.96 | SQR_QJF SQR_QMJ |
| 2 | 0.5709 | 0.5172 | 132.4 | 38.33 | 6.51 | 41.16 | SQR_QMJ SQR_QJA |
| 2 | 0.5291 | 0.4702 | 146.6 | 40.10 | 7.15 | 42.93 | SQR_QJF SQR_QMA |
| 3 | 0.9262 | 0.9114 | 14.01 | 6.889 | 1.19 | 10.67 | SQR_QJF SQR_QMJ SQR_QND |
| 3 | 0.8714 | 0.8457 | 32.57 | 17.43 | 2.08 | 21.21 | SQR_QJF SQR_QMA SQR_QSO |
| 3 | 0.8054 | 0.7664 | 54.95 | 25.31 | 3.15 | 29.09 | SQR_QJF SQR_QMA SQR_QMJ |
| 3 | 0.7808 | 0.7369 | 63.28 | 27.57 | 3.55 | 31.35 | SQR_QMA SQR_QMJ SQR_QJA |
| 4 | 0.9342 | 0.9155 | 13.28 | 6.690 | 1.14 | 11.41 | SQR_QJF SQR_QMA SQR_QMJ SQR_QND |
| 4 | 0.9270 | 0.9061 | 15.73 | 8.675 | 1.27 | 13.40 | SQR_QJF SQR_QMJ SQR_QSO SQR_QND |
| 4 | 0.9267 | 0.9057 | 15.84 | 8.760 | 1.27 | 13.48 | SQR_QJF SQR_QMJ SQR_QJA SQR_QND |
| 4 | 0.9245 | 0.9030 | 16.57 | 9.311 | 1.31 | 14.03 | SQR_QJF SQR_QMA SQR_QMJ SQR_QSO |
| 5 | 0.9593 | 0.9436 | 6.797 | -0.415 | 0.76 | 5.251 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO |
| 5 | 0.9539 | 0.9361 | 8.630 | 1.955 | 0.86 | 7.621 | SQR_QJF SQR_QMA SQR_QMJ SQR_QSO SQR_QND |
| 5 | 0.9435 | 0.9218 | 12.14 | 5.800 | 1.05 | 11.47 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QND |
| 5 | 0.9274 | 0.8995 | 17.60 | 10.57 | 1.36 | 16.24 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 6 | 0.9646 | 0.9469 | 7.000 | -1.066 | 0.72 | 5.545 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

*N* = 19

**Table 7.20** *Analysis of Variance for Dependent Variable: Sqrt(RED) on Sqrt(INFLOWS): 1969 Omitted*

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 6 | 234.15932 | 39.02655 | 54.471 | 0.0001 |
| Error | 12 | 8.59751 | 0.71646 | | |
| C Total | 18 | 242.75683 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 0.84644 | R-square | 0.9646 |
| Dep Mean | 8.59052 | Adj R-sq | 0.9469 |
| C.V. | 9.85318 | | |

**Table 7.21** *Parameter Estimates for Dependent Variable: Sqrt(RED) on Sqrt(INFLOWS): 1969 Omitted*

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 2.655958 | 1.00830870 | 2.634 | 0.0218 | 0.00000000 |
| SQR_QJF | 1 | -1.248523 | 0.16920547 | -7.379 | 0.0001 | 2.64007754 |
| SQR_QMA | 1 | 0.679140 | 0.19065605 | 3.562 | 0.0039 | 5.66666585 |
| SQR_QMJ | 1 | 0.468112 | 0.13187656 | 3.550 | 0.0040 | 4.86004312 |
| SQR_QJA | 1 | 0.122561 | 0.06433097 | 1.905 | 0.0810 | 2.55616956 |
| SQR_QSO | 1 | 0.129553 | 0.04849918 | 2.671 | 0.0204 | 3.61861438 |
| SQR_QND | 1 | 0.198561 | 0.14812842 | 1.340 | 0.2049 | 5.91636935 |

**Table 7.22** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Sqrt(RED) on Sqrt(INFLOWS): 1969 Omitted*

| Number | Eigenvalue | Condition Index | Var Prop QJF_LAG | Var Prop QMA_LAG | Var Prop QMJ_LAG | Var Prop QJA_LAG | Var Prop QSO_LAG | Var Prop QND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.07329 | 1.00000 | 0.0361 | 0.0119 | 0.0201 | 0.0039 | 0.0315 | 0.0166 |
| 2 | 1.42511 | 1.20616 | 0.0078 | 0.0328 | 0.0168 | 0.0570 | 0.0432 | 0.0188 |
| 3 | 1.30572 | 1.26010 | 0.0945 | 0.0146 | 0.0001 | 0.1279 | 0.0084 | 0.0129 |
| 4 | 0.91579 | 1.50464 | 0.0170 | 0.0361 | 0.0978 | 0.0218 | 0.0199 | 0.0405 |
| 5 | 0.22374 | 3.04410 | 0.6349 | 0.0115 | 0.0108 | 0.4206 | 0.4175 | 0.0152 |
| 6 | 0.05635 | 6.06580 | 0.2097 | 0.8931 | 0.8545 | 0.3688 | 0.4796 | 0.8960 |

***Table** 7.23 Parameter Estimates of Models for Dependent Variable: Sqrt(RED) on Sqrt(INFLOWS): 1969 Omitted*

| OBS | _RMSE_ | INTERCEP | QJF_LAG | QMA_LAG | QMJ_LAG | QJA_LAG | QSO_LAG | QND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | 3.04368 | 1.5734 | . | . | 0.65260 | . | . | . |
| 2 | 3.07347 | 4.7420 | . | . | . | 0.43091 | . | . |
| 3 | 3.09117 | 4.2608 | . | 0.84800 | . | . | . | . |
| 4 | 3.52001 | 12.4814 | -0.69726 | . | . | . | . | . |
| 5 | 2.14814 | 0.0880 | . | 0.88197 | . | 0.44780 | . | . |
| 6 | 2.40797 | 5.7860 | -1.01783 | . | 0.78905 | . | . | . |
| 7 | 2.55164 | -0.4144 | . | . | 0.54271 | 0.35488 | . | . |
| 8 | 2.67303 | 8.6116 | -0.86126 | 0.93715 | . | . | . | . |
| 9 | 1.09305 | 2.4701 | -1.44356 | . | 0.88151 | . | . | 0.66886 |
| 10 | 1.44254 | 6.4107 | -1.47726 | 1.13022 | . | . | 0.31532 | . |
| 11 | 1.77479 | 4.3596 | -1.07072 | 0.67860 | 0.62692 | . | . | . |
| 12 | 1.88360 | -2.3922 | . | 0.72148 | 0.35017 | 0.39567 | . | . |
| 13 | 1.06777 | 2.5460 | -1.39794 | 0.18697 | 0.82376 | . | . | 0.57429 |
| 14 | 1.12505 | 2.5709 | -1.46470 | . | 0.86322 | . | 0.01738 | 0.66279 |
| 15 | 1.12756 | 2.3253 | -1.41138 | . | 0.86991 | 0.02111 | . | 0.65482 |
| 16 | 1.14403 | 4.7409 | -1.41843 | 0.93783 | 0.33638 | . | 0.22768 | . |
| 17 | 0.87199 | 2.7900 | -1.13426 | 0.90071 | 0.32692 | 0.17509 | 0.16619 | . |
| 18 | 0.92811 | 3.3988 | -1.47256 | 0.50366 | 0.59452 | . | 0.12490 | 0.37047 |
| 19 | 1.02694 | 1.8260 | -1.18713 | 0.33910 | 0.71421 | 0.11391 | . | 0.42157 |
| 20 | 1.16437 | 3.7375 | -1.03031 | 1.24378 | . | 0.23745 | 0.24982 | -0.22140 |
| 21 | 0.84644 | 2.6560 | -1.24852 | 0.67914 | 0.46811 | 0.12256 | 0.12955 | 0.19856 |

***Table** 7.24 Criteria Statistics of Models for Dependent Variable: Ln(RED) on Sqrt(INFLOWS): 1969 Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 9.2640 | 0.35125 | 0.31309 | 204.814 | 44.1833 | 46.0721 |
| 2 | 9.4462 | 0.33849 | 0.29958 | 209.138 | 44.5534 | 46.4423 |
| 3 | 9.5553 | 0.33085 | 0.29149 | 211.727 | 44.7716 | 46.6604 |
| 4 | 12.3904 | 0.13231 | 0.08127 | 278.998 | 49.7083 | 51.5972 |
| 5 | 4.6145 | 0.69586 | 0.65784 | 90.051 | 31.7897 | 34.6230 |
| 6 | 5.7983 | 0.61784 | 0.57007 | 116.488 | 36.1286 | 38.9619 |
| 7 | 6.5109 | 0.57087 | 0.51723 | 132.401 | 38.3308 | 41.1642 |
| 8 | 7.1451 | 0.52907 | 0.47020 | 146.565 | 40.0970 | 42.9303 |
| 9 | 1.1948 | 0.92618 | 0.91141 | 14.014 | 6.8894 | 10.6672 |
| 10 | 2.0809 | 0.87142 | 0.84570 | 32.567 | 17.4319 | 21.2097 |
| 11 | 3.1499 | 0.80537 | 0.76644 | 54.946 | 25.3084 | 29.0862 |
| 12 | 3.5480 | 0.78077 | 0.73692 | 63.281 | 27.5697 | 31.3475 |
| 13 | 1.1401 | 0.93425 | 0.91546 | 13.279 | 6.6896 | 11.4118 |
| 14 | 1.2657 | 0.92700 | 0.90615 | 15.733 | 8.6750 | 13.3972 |
| 15 | 1.2714 | 0.92668 | 0.90573 | 15.844 | 8.7598 | 13.4820 |
| 16 | 1.3088 | 0.92452 | 0.90295 | 16.575 | 9.3111 | 14.0333 |
| 17 | 0.7604 | 0.95928 | 0.94362 | 6.797 | -0.4152 | 5.2514 |
| 18 | 0.8614 | 0.95387 | 0.93613 | 8.630 | 1.9546 | 7.6213 |
| 19 | 1.0546 | 0.94352 | 0.92180 | 12.136 | 5.7998 | 11.4665 |
| 20 | 1.3558 | 0.92740 | 0.89947 | 17.600 | 10.5725 | 16.2391 |
| 21 | 0.7165 | 0.96458 | 0.94688 | 7.000 | -1.0664 | 5.5447 |

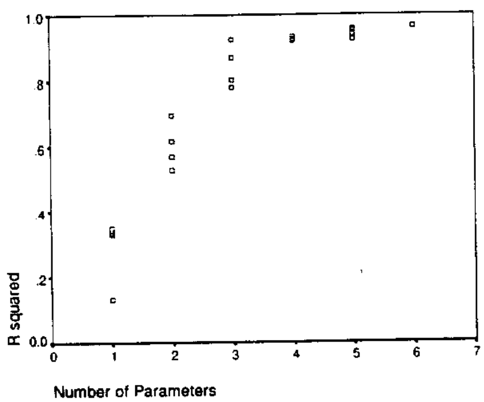


***Figure 7.19*** *The $R^2$ criteria vs. Number of parameters.*

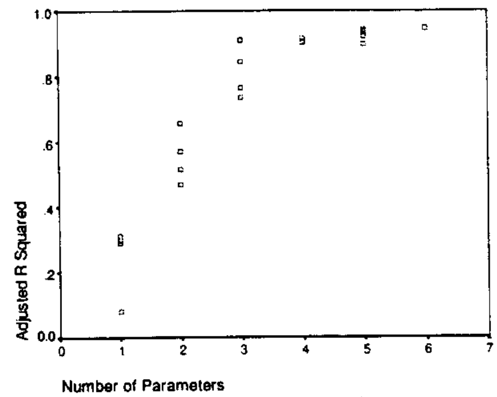


***Figure 7.20*** *The Adjusted $R^2$ criteria vs. Number of parameters.*

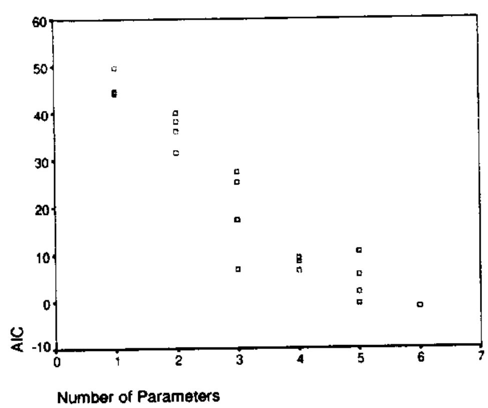


***Figure 7.21*** *The AIC criteria vs. Number of parameters..*

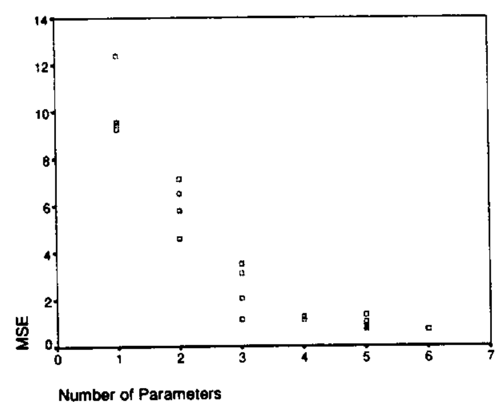


***Figure 7.22*** *MSE vs. Number of parameters.*

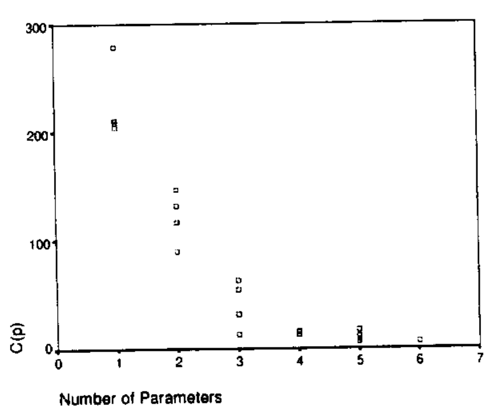


***Figure 7.23*** *The C(p) criteria vs. Number of parameters.*

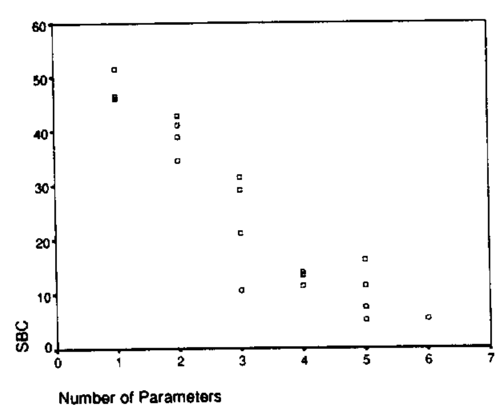


***Figure 7.24*** *The SBC criteria vs. Number of parameters.*

# Red Fish Harvests in Aransas Bay: A Regression Analysis

## Harvest vs Freshwater Inflows

F. Michael Speed
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*Department of Statistics*
*Texas A&M University*

# RED FISH HARVESTS IN ARANSAS BAY:

# A Regression Analysis

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*Texas A&M University*
May 1997

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# 1. SUMMARY REPORT

## 1.1 Description of the Problem[1]

Bimonthly freshwater inflows into Aransas Bay were recorded for the years 1961 to 1980. These variables, and various transformations of them, were used to construct a model for the annual harvest of red fish.

## 1.2 Constructing Models - General Discussion

Stability of coefficient estimates and accuracy of predicted values are primary goals in constructing models for prediction. To this end, the data must be examined from three points of view: individual observations (to detect outliers or influential points); variables, individually and in groups (to select an optimal set of predictors); and the interaction of these two, which produces the overall structure of the data set (to determine whether multicollinearity is present or not). The first two of these were examined by both graphic and quantitative means; the third by quantitative means only.

### 1.2.1 Detecting Influential Points and Outliers

The structures of individual variables were examined via box plots and histograms, as well as by all the usual numerical measures. For each pair of variables, 99 % prediction ellipses and 95% confidence regions were plotted in a further effort to look for unusual points. For example, suppose large values of Variable A are generally associated with large values for Variable B. If an observation consisted of a large value for Variable A but a small value for Variable B, that point would be considered unusual, even though it was well within the range of data for both variables and could not be considered an outlier.

In addition, a number of residual analysis techniques were employed. A large residual indicates a point not well-fit by the model. The deleted residual, however, is somewhat more useful in the search for influential points. The model is fitted without a given observation, and the predicted response and corresponding residual are calculated for that observation. The Studentized deleted residual is scaled to have a Student's $t$ distribution. Histograms and normal P-P plots of the residuals were also examined.

Other quantities, such as the Mahalanobis distance, Cook's distance, the leverage value, standarized values for the *Dffits* (to measure the influence of a given observation on the predicted response) and the *Dfbetas* (to measure the influence of a given observation on the calculated coefficients) were also used to build a general picture of the influence of individual points. Plots were made of the standardized *Dffits* value for each model against the standardized *Dfbeta* values for each predictor in the model. Points which were extreme indicated observations which had strong effects on both predicted values and coefficient estimates.

1 The following discussion, prepared by Jacqueline Kiffe, was taken from Seatrout Harvest in Galveston Bay: A Regression Analysis, by F. Michael Speed, Sr. and Jacqueline Kiffe.

### 1.2.2 Variable Selection

For each regression, residuals were plotted against each of the independent variables to look for nonlinear relationships between the response variable and individual predictors. Partial residual plots were employed to examine the overall relationship between the response and individual predictors. A partial residual is a corollary to the deleted residual. That is, the model is fitted without a given variable and the predicted response and corresponding residual are calculated for each observation. This seeks to answer the question, "What is the relationship of this predictor to the response variable, taking all other variables into account?" Thus, it examines the marginal relationship of a given predictor to the response.

Numerous measures have been developed over the years to assess the adequacy of a given model. We examined a number of these, including $R^2$ and mean squared error (*MSE*), and several others which directly incorporate penalties for having too many predictors in the model, such as adjusted $R^2$, *Cp*, *AIC*, and *SBC*. It is well-established that too many predictors in a model can lead to bad prediction, just as too few can, and these measures are used as part of the attempt to find an optimal model.

### 1.2.3 Multicollinearity

Multicollinearity arises when one or more variables are nearly closely approximated by linear combinations of the remaining variables, resulting in unstable coefficient estimates. The variance inflation factor (*VIF*) was calculated for each coefficient estimate to measure this instability, which is not usually considered profound for *VIF*'s less than 10. No problems were found with this data. Additionally, the condition index (a ratio of eigenvalues of the covariance matrix, with the largest eigenvalue always on top) was calculated. A ratio greater than 30 is considered cause for concern. Again, no evidence of multicollinearity was found.

### 1.2.4 Other Procedures

Several other miscellaneous diagnostics, including the Durbin-Watson test for serial autocorrelation were performed, and no general problems were detected. The Box-Cox procedure, used to find a transformation to normality, was also performed.

## 1.3 How the Final Model Was Chosen

### 1.3.1 Selecting the Data Set Used

First, the variables were explored thoroughly, individually and in pairs, in a first effort to detect outliers. The SAS® programming language allows a number of diagnostics to be calculated for a group of models on a given data set without actually performing a formal regression, thus allowing one to examine a large number of models quite efficiently. The Box-Cox procedure was performed to find if a transformation to normallity was suggested. The log transform was suggested for some variables, and the squared root for others. At this point, there were several data sets for which the diagnostic series was calculated:

1. Untransformed red fish data and untransformed inflow data
2. Untransformed red fish data and log of inflow data
3. Log of red fish data and untransformed inflow data
4. Log of red fish data and log of inflow data
5. Log of red fish data and square root of inflow data
6. Square root of red fish data and log of inflow data
7. Various transformation suggested by Box-Cox

### 1.3.2 Selecting the Points to be Omitted

The full regression with all diagnostics was performed for these models, each one contained all variables in its corresponding data set. All diagnostics were generated, and influential points were determined for each model.

***Table 1.1*** *$R^2$ and Adjusted $R^2$ for full data sets.*

| Data Set | $R^2$ | Adj. $R^2$ |
|---|---|---|
| 1 | 0.4195 | 0.1516 |
| 2 | 0.6449 | 0.4810 |
| 3 | 0.6201 | 0.4448 |
| 4 | 0.7176 | 0.5872 |
| 5 | 0.6823 | 0.5356 |
| 6 | 0.6986 | 0.5595 |
| 7 | 0.6790 | 0.5308 |

Data sets 4, 5, and 6 presented the highest $R^2$ values. These three models were considered final candidates. The observations flagged as potentially influential are given in the summary table below, for each model.

***Table 1.2*** *Summary of points flagged by Boxplots.*

| Year | Variable |
|---|---|
| 1980 | Sqrt(July-August) |

***Table 1.3*** *Summary of points flagged by 99% prediction ellipses.*

| Year | Variable |
|---|---|
| None | None |

***Table 1.4*** *Outliers of data set 4.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1963 | | | | 1 | | | 1 | | 2 |
| 1964 | | | | 1 | | | | | 1 |
| 1965 | | | | | | | 1 | 2 | 3 |
| 1966 | | | | | | | 1 | | 1 |
| 1971 | | | 1 | | | | 1 | 5 | 7 |
| 1980 | | | | 1 | | | 1 | | 1 |

***Table 1.5*** *Outliers of data set 5.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1963 | | | | | | | 1 | | 1 |
| 1966 | | | | | | | 1 | | 1 |
| 1971 | | | 1 | | | | 1 | 4 | 6 |
| 1975 | | | | | | | 1 | | 1 |
| 1980 | 1 | | | 1 | | | | | 2 |

***Table 1.6*** *Outliers of data set 6.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1963 | | | | 1 | | | 1 | | 2 |
| 1964 | | | | 1 | | | | | 1 |
| 1965 | | | | | | | 1 | | 1 |
| 1971 | | | 1 | | | | 1 | 6 | 8 |
| 1975 | | | | | | | 1 | | 1 |
| 1980 | | | | 1 | | | | | 1 |

***A Key to Abbreviations:***

BOX Box plot
SRE Studentized residual
SDR Studentized deleted residual
LEV Leverage value
MAH Mahalanobis distance
COO Cook's distance
SDF Standardized Dffits value
SDB Standardized Dfbeta value

### 1.3.3 Selecting the Final Candidate Models

After the subset analysis led us to four models, Data Set 4 with 1971 omitted; Data Set 5 with 1971 omitted and Data Set 6 with 1971 omitted.

***Table 1.7*** *$R^2$ and Adjusted $R^2$ for data sets number 4, 5 and 6.*

| Data set | Observations omitted | $R^2$ | Adj. $R^2$ |
|---|---|---|---|
| 4 | 1971 | 0.8411 | 0.7616 |
| 5 | 1971 | 0.8098 | 0.7366 |
| 6 | 1971 | 0.8443 | 0.7844 |

### 1.3.4 Selecting the Final Models

It appears that Data set 6 with 1971 omitted is the best model. Regression was performed using this model, and the deleted residuals were calculated.

Sqrt(Red Fish Harvest) = 0.7237 - 1.43727*Ln(Jan.-Feb. Inflows)
- 3.42192*Ln( March-April Inflows)
+ 5.22836*Ln(May-June Inflows)
- 1.08327*Ln(Jul-Aug Inflows)
+ 1.57990*Ln(Nov.-Dec. Inflows)

## 1.4 Best Model: Square Root of Harvest and Logged Inflows

### 1.4.1 Summary Information

***Table 1.8*** *Descriptive statistics for dependent and independent variables.*

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| Sqrt(Red Harvest) | 11.8076 | 3.925777 | 19 |
| Ln(January-February) | 3.056934 | 1.004890 | 19 |
| Ln(March-April) | 2.893973 | .823433 | 19 |
| Ln(May-June) | 4.592815 | .981871 | 19 |
| Ln(July-August) | 3.575460 | .708844 | 19 |
| Ln(November-December) | 3.317189 | 1.053418 | 19 |

***Table 1.9*** *Model summary for the final model.*

**Model Summary[a,b]**

| | Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|
| | Ln(November-December), Ln(March-April), Ln(July-August), Ln(January-February), Ln(May-June)[c,d] | .919 | .844 | .784 | 1.822657 | 2.126 |

a. Dependent Variable: Square Root of Red Harvest

b. Method: Enter

c. Independent Variables: (Constant), Ln(November-December Inflows), Ln(March-April Inflows), Ln(July-August Inflows), Ln(January-February Inflows), Ln(May-June Inflows)

d. All requested variables entered.

***Table 1.10*** *Anova for the final model.*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 234.224 | 5 | 46.845 | 14.101 | .000[b] |
| | Residual | 43.187 | 13 | 3.322 | | |
| | Total | 277.411 | 18 | | | |

a. Dependent Variable: Square Root of Red Harvest

b. Independent Variables: (Constant), Ln(November-December Inflows), Ln(March-April Inflows), Ln(July-August Inflows), Ln(January-February Inflows), Ln(May-June Inflows)

***Table 1.11*** *Parameter estimates for the final model.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| (Constant) | .724 | 3.663 | | .198 | .846 | -7.190 | 8.638 |
| Ln(January-February) | -1.437 | .545 | -.368 | -2.639 | .020 | -2.614 | -.261 |
| Ln(March-April) | -3.422 | 1.118 | -.718 | -3.061 | .009 | -5.837 | -1.007 |
| Ln(May-June) | 5.228 | .815 | 1.308 | 6.418 | .000 | 3.468 | 6.988 |
| Ln(July-August) | -1.083 | .723 | -.196 | -1.499 | .158 | -2.644 | .478 |
| Ln(November-December) | 1.580 | .477 | .424 | 3.315 | .006 | .550 | 2.610 |

a. Dependent Variable: Square Root of Red Harvest

***Table 1.12*** *Residuals statistics for the final model.*

**Residuals Statistics**[a]

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 4.898922 | 20.28498 | 11.8076 | 3.607276 | 19 |
| Std. Predicted Value | -1.915 | 2.350 | .000 | 1.000 | 19 |
| Standard Error of Predicted Value | .646483 | 1.366512 | 1.001093 | .222475 | 19 |
| Adjusted Predicted Value | 4.373954 | 18.90722 | 11.7593 | 3.580542 | 19 |
| Residual | -2.787144 | 2.913218 | 4.7E-17 | 1.548961 | 19 |
| Std. Residual | -1.529 | 1.598 | .000 | .850 | 19 |
| Stud. Residual | -1.731 | 1.802 | .010 | .981 | 19 |
| Deleted Residual | -3.570117 | 3.702942 | 4.8E-02 | 2.085278 | 19 |
| Stud. Deleted Residual | -1.895 | 1.999 | .012 | 1.022 | 19 |
| Mahal. Distance | 1.317 | 9.171 | 4.737 | 2.480 | 19 |
| Cook's Distance | .000 | .214 | .055 | .056 | 19 |
| Centered Leverage Value | .073 | .509 | .263 | .138 | 19 |

a. Dependent Variable: Square Root of Red Harvest

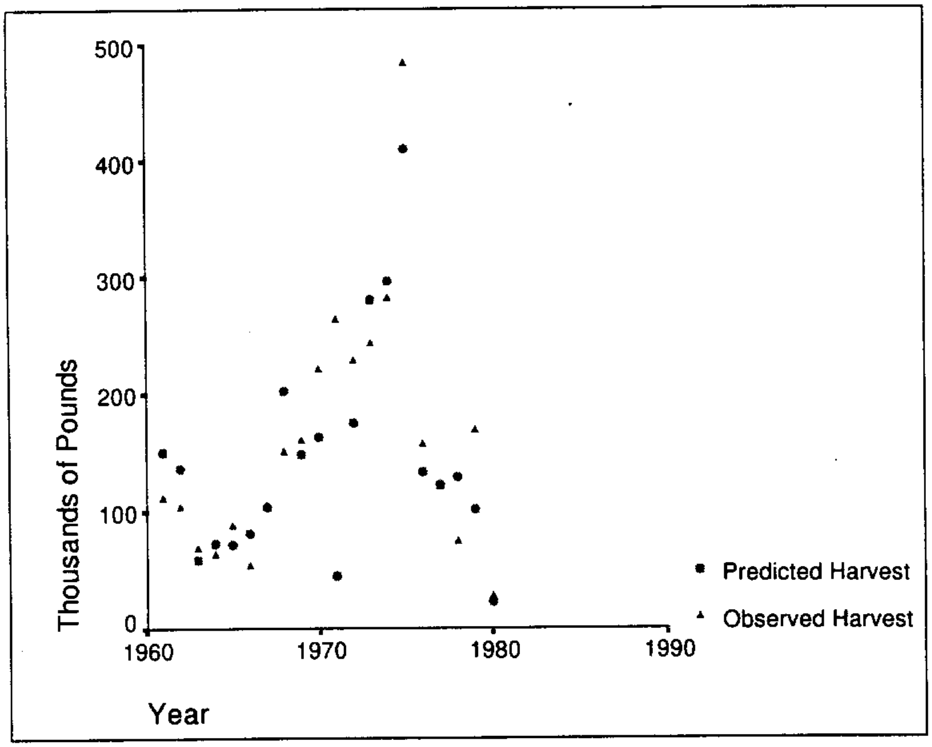


*Figure 1.1* *Predicted and observed values for the harvest.*

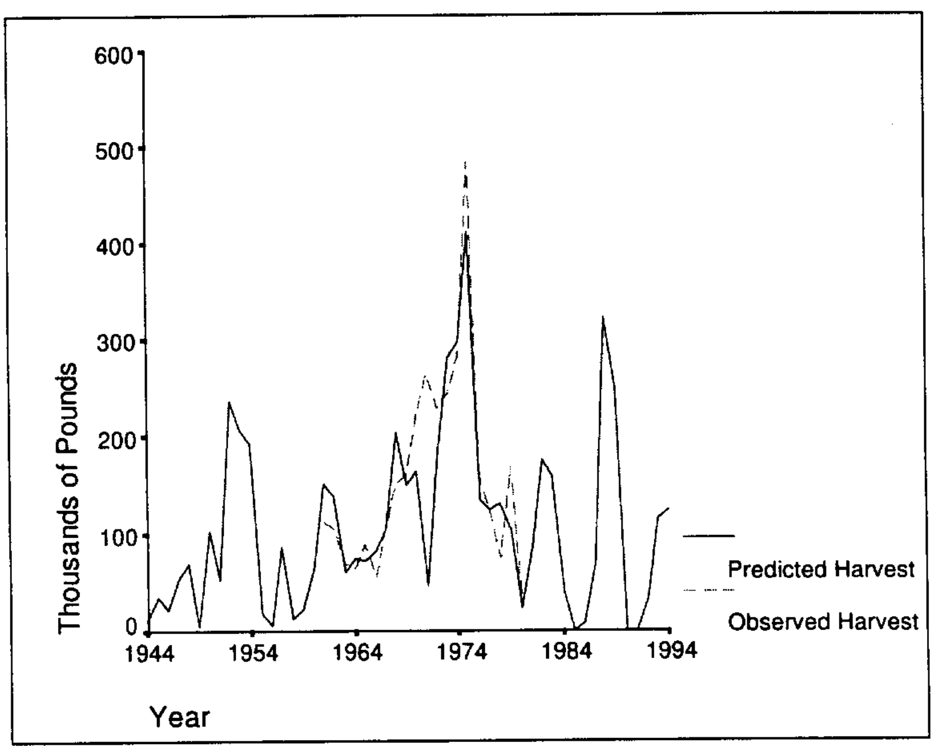


*Figure 1.2* *Predicted and observed values for the harvest.*

*Table 1.14 Prediction Intervals for Red Fish Harvest based on the final model.*

| YEAR | RED | PRE_1 | LICI_1 | UICI_1 |
|---|---|---|---|---|
| 1961 | 112.30 | 151.13 | 37.30 | 341.49 |
| 1962 | 104.40 | 138.09 | 31.30 | 320.70 |
| 1963 | 69.30 | 60.08 | 1.04 | 209.70 |
| 1964 | 64.30 | 74.38 | 3.11 | 239.84 |
| 1965 | 88.70 | 72.64 | 4.75 | 221.00 |
| 1966 | 55.30 | 82.28 | 7.98 | 234.64 |
| 1967 | 105.60 | 104.56 | 12.58 | 285.74 |
| 1968 | 151.40 | 203.70 | 69.43 | 408.54 |
| 1969 | 160.70 | 149.82 | 32.78 | 351.74 |
| 1970 | 222.20 | 164.53 | 48.26 | 349.97 |
| 1971 | 264.10 | 46.20 | 0.02 | 181.03 |
| 1972 | 229.00 | 175.67 | 55.19 | 364.03 |
| 1973 | 244.00 | 281.04 | 115.29 | 519.43 |
| 1974 | 282.00 | 297.44 | 126.42 | 540.54 |
| 1975 | 484.30 | 411.48 | 187.31 | 722.73 |
| 1976 | 158.50 | 135.08 | 27.96 | 322.48 |
| 1977 | 121.60 | 124.34 | 24.17 | 302.24 |
| 1978 | 74.70 | 130.65 | 28.81 | 305.99 |
| 1979 | 169.70 | 102.29 | 16.53 | 261.18 |
| 1980 | 28.40 | 24.00 | 0.00 | 137.67 |

*RED* Observed red fish harvest
*PRE_!* Predicted red fish harvest
*LICI_1* Lower limit for 99% prediction interval for the red fish harvest.
*UICI_1* Upper limit for 99% prediction interval for the red fish harvest.

# 2. EXPLORING THE DATA

## 2.1 Listing of data

***Table 2.1*** *The red fish data and the inflow data.*

| Year | *Red Fish* | *JF_inflow* | *MA_inflow* | *MJ_inflow* | *JA_inflow* | *SO_inflow* | *ND_inflow* |
|---|---|---|---|---|---|---|---|
| 1961 | 112.30 | 85.35 | 12.53 | 76.10 | 22.09 | 261.57 | 102.55 |
| 1962 | 104.40 | 71.46 | 11.40 | 58.42 | 16.61 | 238.01 | 99.51 |
| 1963 | 69.30 | 68.35 | 6.21 | 16.04 | 9.88 | 197.47 | 102.87 |
| 1964 | 64.30 | 2.27 | 2.73 | 11.40 | 27.05 | 25.49 | 8.41 |
| 1965 | 88.70 | 10.94 | 3.93 | 21.76 | 27.02 | 9.91 | 8.54 |
| 1966 | 55.30 | 16.67 | 37.16 | 117.89 | 33.60 | 5.95 | 9.96 |
| 1967 | 105.60 | 16.39 | 36.63 | 127.86 | 16.07 | 6.96 | 9.10 |
| 1968 | 151.40 | 12.89 | 36.99 | 303.30 | 39.42 | 492.61 | 10.27 |
| 1969 | 160.70 | 37.58 | 20.20 | 224.35 | 34.75 | 502.38 | 5.04 |
| 1970 | 222.20 | 42.43 | 38.25 | 263.17 | 35.14 | 502.41 | 19.33 |
| 1971 | 264.10 | 37.99 | 37.01 | 73.54 | 22.08 | 54.97 | 17.70 |
| 1972 | 229.00 | 14.82 | 33.38 | 176.66 | 39.38 | 399.10 | 29.29 |
| 1973 | 244.00 | 11.60 | 20.10 | 275.96 | 39.53 | 415.48 | 16.51 |
| 1974 | 282.00 | 13.40 | 22.00 | 302.27 | 31.27 | 559.45 | 19.57 |
| 1975 | 484.30 | 6.87 | 9.71 | 182.54 | 14.08 | 311.23 | 38.09 |
| 1976 | 158.50 | 5.73 | 11.83 | 52.72 | 87.96 | 303.41 | 44.08 |
| 1977 | 121.60 | 21.29 | 33.65 | 103.25 | 90.67 | 153.34 | 114.66 |
| 1978 | 74.70 | 29.50 | 34.03 | 127.02 | 90.38 | 53.14 | 94.82 |
| 1979 | 169.70 | 60.44 | 46.07 | 137.12 | 64.26 | 75.87 | 93.72 |
| 1980 | 28.40 | 83.81 | 22.90 | 64.94 | 145.73 | 149.76 | 21.28 |

| | |
|---|---|
| Red Fish | Red fish harvest (thousands of pounds) |
| JF_inflow | Lagged January-February inflows (thousands of acre-feet) |
| MA_inflow | Lagged March-April inflows (thousands of acre-feet) |
| MJ_inflow | Lagged May-June inflows (thousands of acre-feet) |
| JA_inflow | Lagged July-August inflows (thousands of acre-feet) |
| SO_inflow | Lagged September-October inflows (thousands of acre-feet) |
| ND_inflow | Lagged November-December inflows (thousands of acre-feet) |

## 2.2 Examination of Individual Variables

***Table .2.2*** *Test of Normality for the red fish data and the inflow data.*

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Red Harvest | .162 | 20 | .180 | .875 | 20 | .014 |
| Ln(Red Harvest) | .088 | 20 | .200* | .987 | 20 | .984 |
| Square Root of Red Harvest | .100 | 20 | .200* | .967 | 20 | .658 |
| January-February Inflows | .220 | 20 | .013 | .857 | 20 | .010** |
| Ln(January-February Inflows) | .109 | 20 | .200* | .953 | 20 | .434 |
| Square Root of January-February Inflows | .183 | 20 | .079 | .929 | 20 | .197 |
| March-April Inflows | .209 | 20 | .022 | .914 | 20 | .080 |
| Ln(March-April Inflows) | .210 | 20 | .021 | .865 | 20 | .010** |
| Square Root of March-April Inflows | .217 | 20 | .015 | .909 | 20 | .063 |
| May-June Inflows | .145 | 20 | .200* | .918 | 20 | .092 |
| Ln(May-June Inflows) | .129 | 20 | .200* | .911 | 20 | .070 |
| Square Root of May-June Inflows | .091 | 20 | .200* | .955 | 20 | .455 |
| July-August Inflows | .306 | 20 | .000 | .800 | 20 | .010** |
| Ln(July-August Inflows) | .179 | 20 | .094 | .965 | 20 | .623 |
| Square Root of July-August Inflows | .246 | 20 | .002 | .901 | 20 | .044 |
| September-October Inflows | .149 | 20 | .200* | .907 | 20 | .056 |
| Ln(September-October Inflows) | .201 | 20 | .033 | .852 | 20 | .010** |
| Square Root of September-October Inflows | .109 | 20 | .200* | .922 | 20 | .123 |
| November-December Inflows | .257 | 20 | .001 | .778 | 20 | .010** |
| Ln(November-December Inflows) | .187 | 20 | .066 | .902 | 20 | .046 |
| Square Root of November-December Inflows | .214 | 20 | .017 | .843 | 20 | .010** |

*. This is a lower bound of the true significance.

**. This is an upper bound of the true significance.

a. Lilliefors Significance Correction

***Table .2.3*** *Percentiles of the red fish data and the inflow data.*

**Percentiles**

| | | Percentiles | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 10 | 25 | 50 | 75 | 90 | 95 |
| Weighted Average(Definition 1) | Red Harvest | 29.7450 | 56.2000 | 78.2000 | 136.5000 | 227.3000 | 280.2100 | 474.1850 |
| | Ln(Red Harvest) | 3.379708 | 4.027852 | 4.356425 | 4.910331 | 5.426186 | 5.635349 | 6.155665 |
| | Square Root of Red Harvest | 5.434527 | 7.494630 | 8.836704 | 11.6659 | 15.0762 | 16.7387 | 21.7461 |
| | January-February Inflows | 2.4430 | 5.8440 | 11.9225 | 18.9800 | 55.9375 | 82.5750 | 85.2730 |
| | Ln(January-February Inflows) | .866077 | 1.763860 | 2.477367 | 2.935924 | 4.013202 | 4.412611 | 4.445850 |
| | Square Root of January-February Inflows | 1.551006 | 2.416475 | 3.451974 | 4.348500 | 7.459195 | 9.084642 | 9.234320 |
| | March-April Inflows | 2.7900 | 4.1580 | 11.5075 | 22.4500 | 36.9000 | 38.1410 | 45.6790 |
| | Ln(March-April Inflows) | 1.022519 | 1.414392 | 2.442870 | 3.111090 | 3.608203 | 3.641252 | 3.820861 |
| | Square Root of March-April Inflows | 1.668779 | 2.033379 | 3.392161 | 4.737905 | 6.074523 | 6.175783 | 6.757347 |
| | May-June Inflows | 11.6320 | 16.6120 | 60.0500 | 122.4550 | 213.8975 | 299.6390 | 303.2485 |
| | Ln(May-June Inflows) | 2.450687 | 2.805584 | 4.094110 | 4.807048 | 5.361648 | 5.702214 | 5.714552 |
| | Square Root of May-June Inflows | 3.407819 | 4.070973 | 7.747107 | 11.0640 | 14.6114 | 17.3085 | 17.4140 |
| | July-August Inflows | 10.0900 | 14.2790 | 22.0825 | 34.1750 | 58.0775 | 90.6410 | 142.9770 |
| | Ln(July-August Inflows) | 2.308225 | 2.657975 | 3.094785 | 3.531353 | 4.041468 | 4.506906 | 4.958029 |
| | Square Root of July-August Inflows | 3.173701 | 3.777973 | 4.699202 | 5.845732 | 7.583997 | 9.520556 | 11.9444 |
| | September-October Inflows | 6.0005 | 7.2550 | 53.5975 | 217.7400 | 411.3850 | 502.4070 | 556.5980 |
| | Ln(September-October Inflows) | 1.791231 | 1.975516 | 3.981394 | 5.378950 | 6.019379 | 6.219411 | 6.321577 |
| | Square Root of September-October Inflows | 2.449208 | 2.689165 | 7.320833 | 14.7400 | 20.2819 | 22.4144 | 23.5908 |
| | November-December Inflows | 5.2085 | 8.4230 | 10.0375 | 20.4250 | 94.5450 | 102.8380 | 114.0705 |
| | Ln(November-December Inflows) | 1.643007 | 2.130955 | 2.306240 | 3.015883 | 4.549063 | 4.633154 | 4.736546 |
| | Square Root of November-December Inflows | 2.277745 | 2.902233 | 3.168131 | 4.518412 | 9.723394 | 10.1409 | 10.6797 |
| Tukey's Hinges | Red Harvest | | | 81.7000 | 136.5000 | 225.6000 | | |
| | Ln(Red Harvest) | | | 4.399370 | 4.910331 | 5.418650 | | |
| | Square Root of Red Harvest | | | 9.030492 | 11.6659 | 15.0196 | | |
| | January-February Inflows | | | 12.2450 | 18.9800 | 51.4350 | | |
| | Ln(January-February Inflows) | | | 2.503728 | 2.935924 | 3.924753 | | |
| | Square Root of January-February Inflows | | | 3.498071 | 4.348500 | 7.144074 | | |
| | March-April Inflows | | | 11.6150 | 22.4500 | 36.8100 | | |
| | Ln(March-April Inflows) | | | 2.452126 | 3.111090 | 3.605758 | | |
| | Square Root of March-April Inflows | | | 3.407933 | 4.737905 | 6.067106 | | |
| | May-June Inflows | | | 61.6800 | 122.4550 | 203.4450 | | |
| | Ln(May-June Inflows) | | | 4.120561 | 4.807048 | 5.310088 | | |
| | Square Root of May-June Inflows | | | 7.850917 | 11.0640 | 14.2445 | | |
| | July-August Inflows | | | 22.0850 | 34.1750 | 51.8950 | | |
| | Ln(July-August Inflows) | | | 3.094899 | 3.531353 | 3.919999 | | |
| | Square Root of July-August Inflows | | | 4.699468 | 5.845732 | 7.151761 | | |
| | September-October Inflows | | | 54.0550 | 217.7400 | 407.2900 | | |
| | Ln(September-October Inflows) | | | 3.989859 | 5.378950 | 6.009323 | | |
| | Square Root of September-October Inflows | | | 7.351947 | 14.7400 | 20.1804 | | |
| | November-December Inflows | | | 10.1150 | 20.4250 | 94.2700 | | |
| | Ln(November-December Inflows) | | | 2.313902 | 3.015883 | 4.546146 | | |
| | Square Root of November-December Inflows | | | 3.180315 | 4.518412 | 9.709233 | | |

### 2.2.1 The red fish data

***Table .2.4*** *Descriptives for the red fish data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| Red Harvest | Mean | | 159.5250 | 23.7625 |
| | 95% Confidence Interval for Mean | Lower Bound | 109.7895 | |
| | | Upper Bound | 209.2605 | |
| | 5% Trimmed Mean | | 148.7667 | |
| | Median | | 136.5000 | |
| | Variance | | 11293.1 | |
| | Std. Deviation | | 106.2691 | |
| | Minimum | | 28.40 | |
| | Maximum | | 484.30 | |
| | Range | | 455.90 | |
| | Interquartile Range | | 149.1000 | |
| | Skewness | | 1.559 | .512 |
| | Kurtosis | | 3.385 | .992 |

***Table .2.5*** *Extreme Values for the red fish data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| Red Harvest | Highest | 1 | 15 | 1975 | 484.30 |
| | | 2 | 14 | 1974 | 282.00 |
| | | 3 | 11 | 1971 | 264.10 |
| | | 4 | 13 | 1973 | 244.00 |
| | | 5 | 12 | 1972 | 229.00 |
| | Lowest | 1 | 20 | 1980 | 28.40 |
| | | 2 | 6 | 1966 | 55.30 |
| | | 3 | 4 | 1964 | 64.30 |
| | | 4 | 3 | 1963 | 69.30 |
| | | 5 | 18 | 1978 | 74.70 |

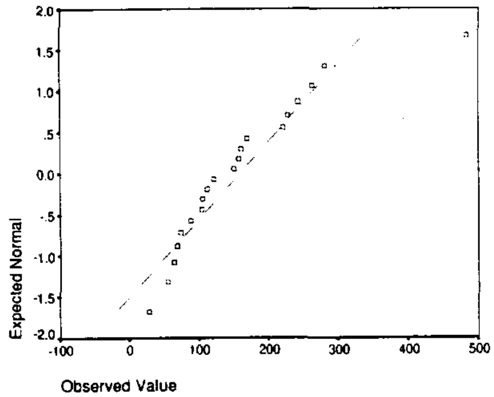


***Figure 2.1*** *Normal Q-Q Plot of Red Fish Harvest.*

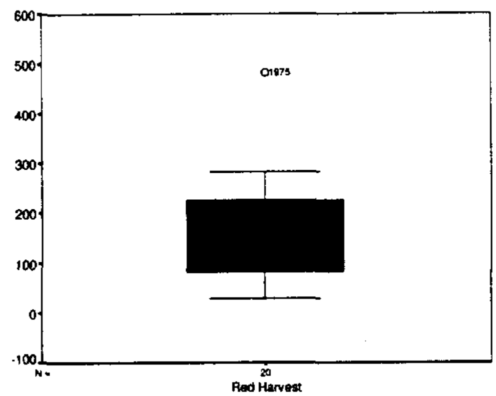


***Figure 2.2*** *BoxPlot of Red Fish Harvest.*

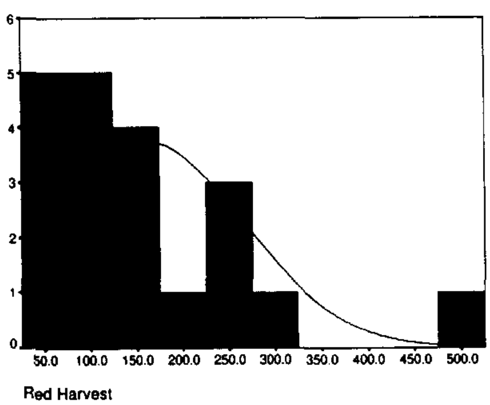


***Figure 2.3*** *Histogram of Red Fish Harvest.*

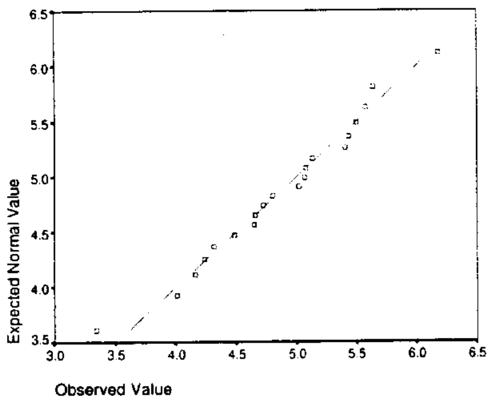


***Figure 2.4*** *Normal Q-Q Plot of Ln(Red Fish Harvest).*

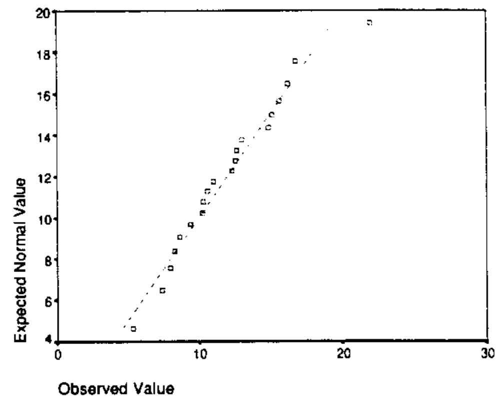


***Figure 2.5*** *Normal Q-Q Plot of Sqrt(Red Fish Harvest).*

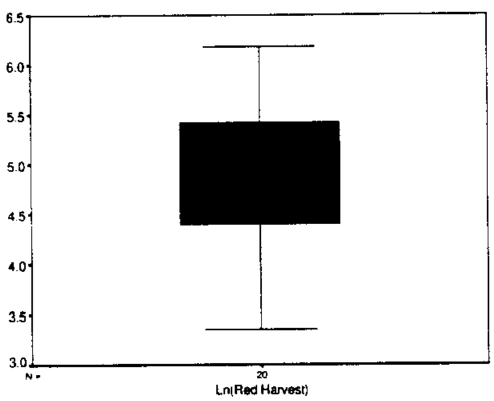


***Figure 2.6*** *BoxPlot of Ln(Red Fish Harvest).*

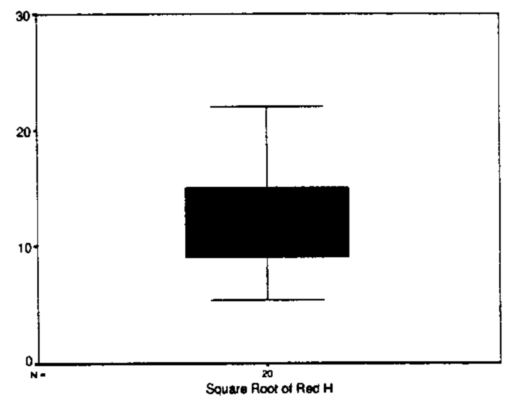


***Figure 2.7*** *BoxPlot of Sqrt(Red Fish Harvest).*

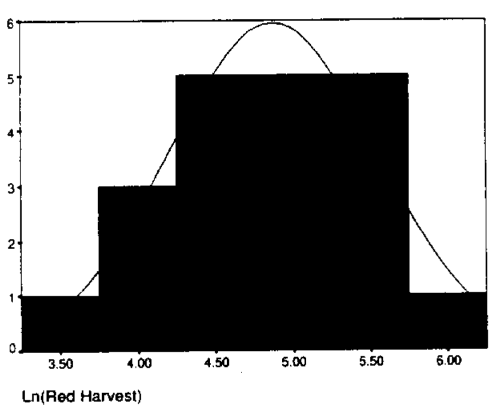


***Figure 2.8*** *Histogram of Ln(Red Fish Harvest).*

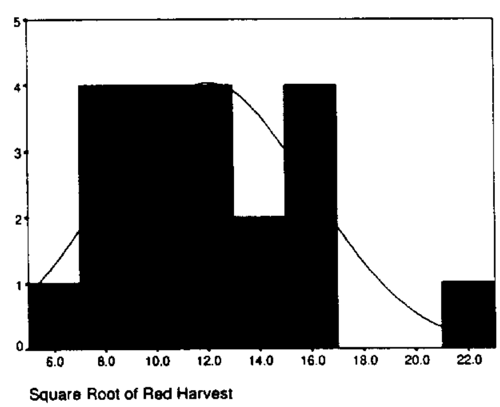


***Figure 2.9*** *Histogram of Sqrt(Red Fish Harvest).*

### 2.2.2 The January-February Inflows data

***Table .2.6*** *Descriptives for the January-February Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| January-February Inflows | Mean | | 32.4890 | 6.0827 |
| | 95% Confidence Interval for Mean | Lower Bound | 19.7577 | |
| | | Upper Bound | 45.2203 | |
| | 5% Trimmed Mean | | 31.2311 | |
| | Median | | 18.9800 | |
| | Variance | | 739.994 | |
| | Std. Deviation | | 27.2028 | |
| | Minimum | | 2.27 | |
| | Maximum | | 85.35 | |
| | Range | | 83.08 | |
| | Interquartile Range | | 44.0150 | |
| | Skewness | | .869 | .512 |
| | Kurtosis | | -.632 | .992 |

***Table .2.7*** *Extreme Values for the January-February Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| January-February Inflows | Highest | 1 | 1 | 1961 | 85.35 |
| | | 2 | 20 | 1980 | 83.81 |
| | | 3 | 2 | 1962 | 71.46 |
| | | 4 | 3 | 1963 | 68.35 |
| | | 5 | 19 | 1979 | 60.44 |
| | Lowest | 1 | 4 | 1964 | 2.27 |
| | | 2 | 16 | 1976 | 5.73 |
| | | 3 | 15 | 1975 | 6.87 |
| | | 4 | 5 | 1965 | 10.94 |
| | | 5 | 13 | 1973 | 11.60 |

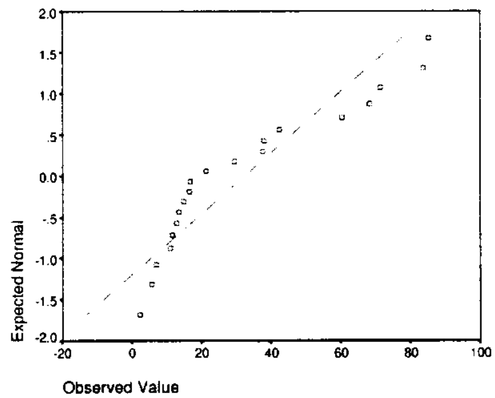


***Figure 2.10*** *Normal Q-Q Plot of January-February Inflows.*

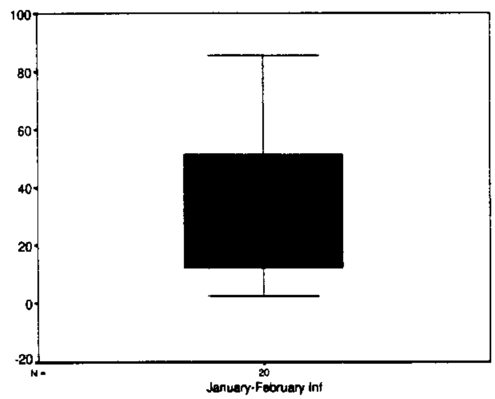


***Figure 2.11*** *BoxPlot of January-February Inflows.*

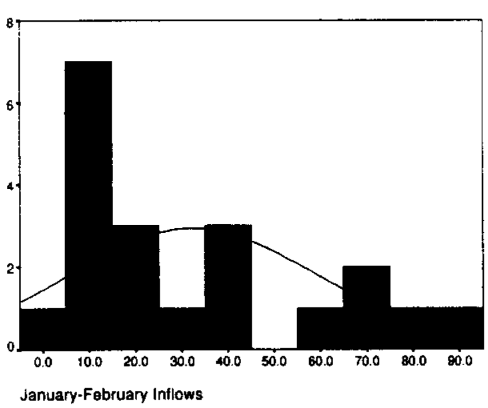


***Figure 2.12*** *Histogram of January-February Inflows.*

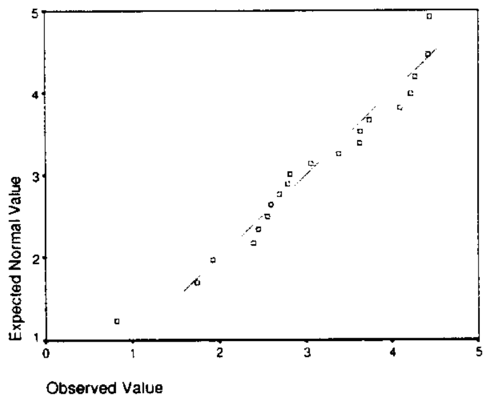


***Figure 2.13*** *Normal Q-Q Plot of Ln January-February Inflows).*

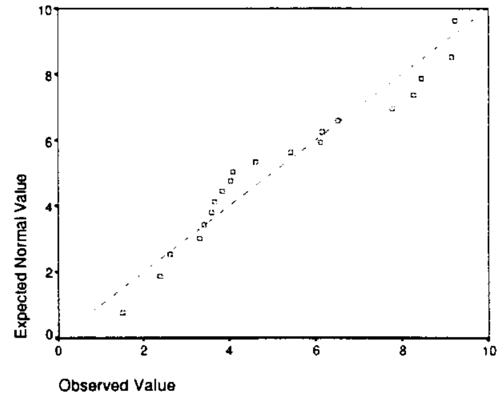


***Figure 2.14*** *Normal Q-Q Plot of Sqrt( January-February Inflows).*

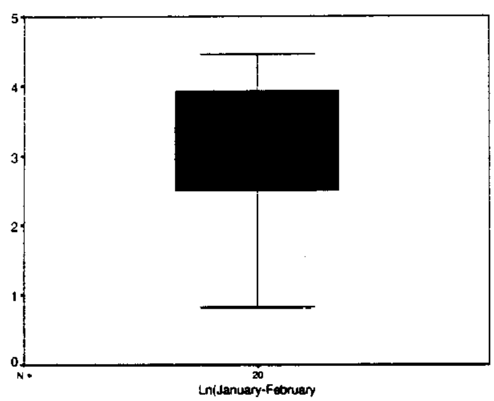


***Figure 2.15*** *BoxPlot of Ln(January-February Inflows).*

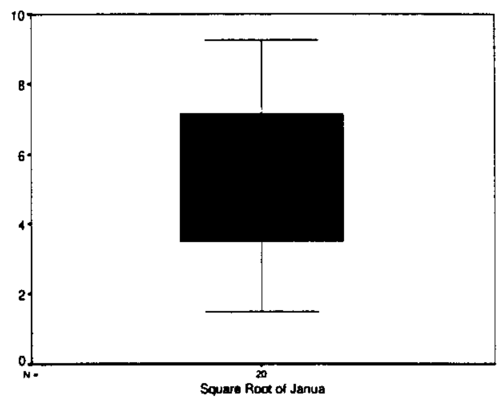


***Figure 2.16*** *BoxPlot of Square Root of January-February Inflows.*

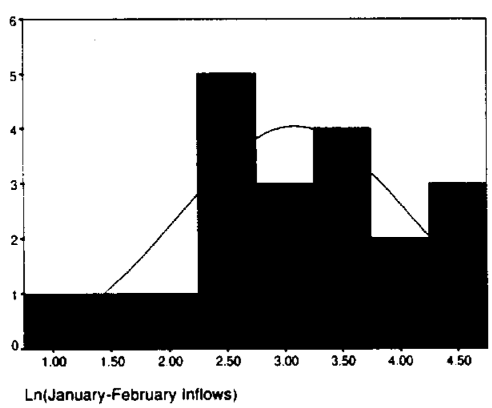


***Figure 2.17*** *Histogram of Ln(January-February Inflows).*

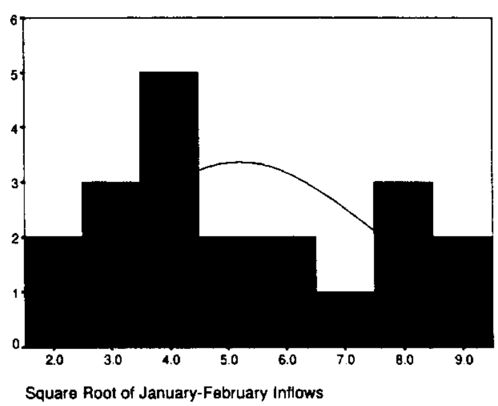


***Figure 2.18*** *Histogram of Sqrt(January-February Inflows).*

### 2.2.3 The March-April Inflows data

***Table .2.8*** *Descriptives for the March-April Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| March-April Inflows | Mean | | 23.8355 | 3.0311 |
| | 95% Confidence Interval for Mean | Lower Bound | 17.4914 | |
| | | Upper Bound | 30.1796 | |
| | 5% Trimmed Mean | | 23.7728 | |
| | Median | | 22.4500 | |
| | Variance | | 183.748 | |
| | Std. Deviation | | 13.5554 | |
| | Minimum | | 2.73 | |
| | Maximum | | 46.07 | |
| | Range | | 43.34 | |
| | Interquartile Range | | 25.3925 | |
| | Skewness | | -.115 | .512 |
| | Kurtosis | | -1.426 | .992 |

***Table .2.9*** *Extreme Values for the March-April Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| March-April Inflows | Highest | 1 | 19 | 1979 | 46.07 |
| | | 2 | 10 | 1970 | 38.25 |
| | | 3 | 6 | 1966 | 37.16 |
| | | 4 | 11 | 1971 | 37.01 |
| | | 5 | 8 | 1968 | 36.99 |
| | Lowest | 1 | 4 | 1964 | 2.73 |
| | | 2 | 5 | 1965 | 3.93 |
| | | 3 | 3 | 1963 | 6.21 |
| | | 4 | 15 | 1975 | 9.71 |
| | | 5 | 2 | 1962 | 11.40 |

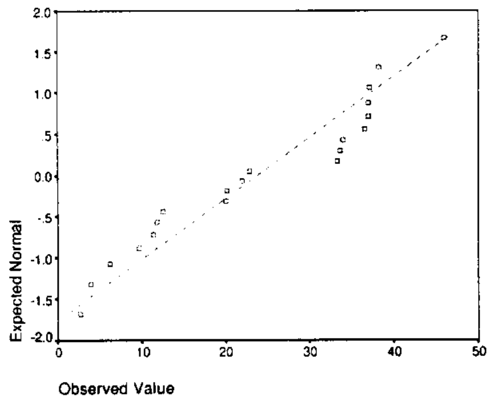


***Figure 2.19*** *Normal Q-Q Plot of March-April Inflows.*

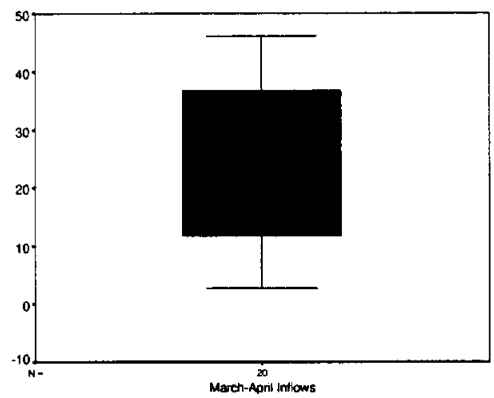


***Figure 2.20*** *BoxPlot of March-April Inflows.*

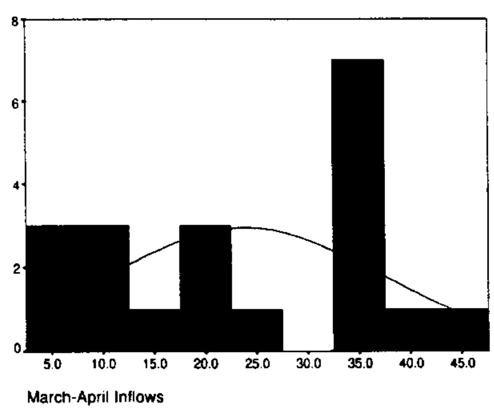


***Figure 2.21*** *Histogram of March-April Inflows.*

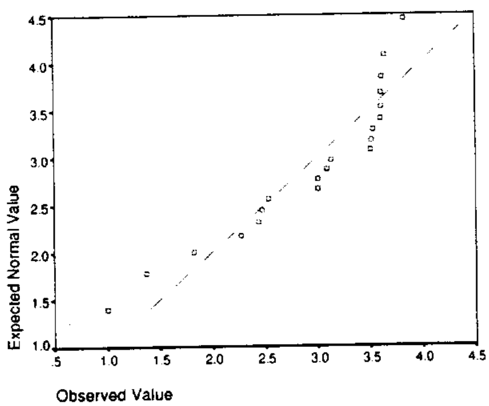


***Figure 2.22*** *Normal Q-Q Plot of Ln(March-April Inflows).*

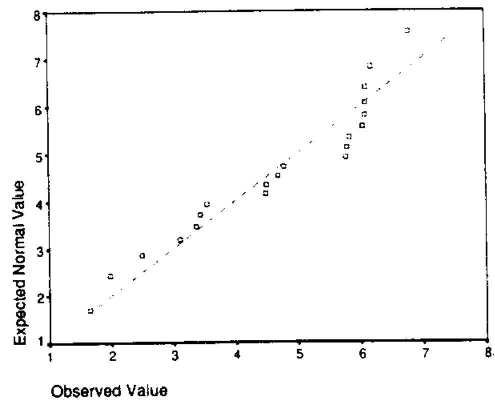


***Figure 2.23*** *Normal Q-Q Plot of Sqrt( March-April Inflows).*

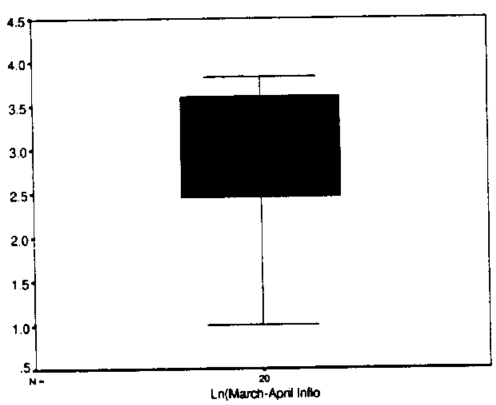


***Figure 2.24*** *BoxPlot of Ln(March-April) Inflows.*

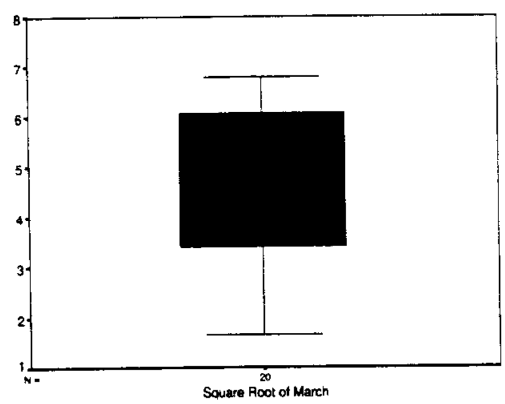


***Figure 2.25*** *BoxPlot of Square Root of March-April Inflows.*

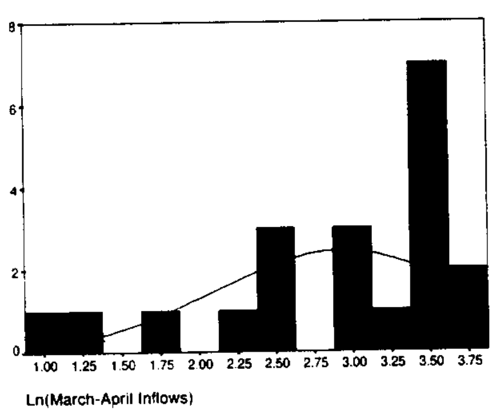


***Figure 2.26*** *Histogram of Ln(March-April Inflows).*

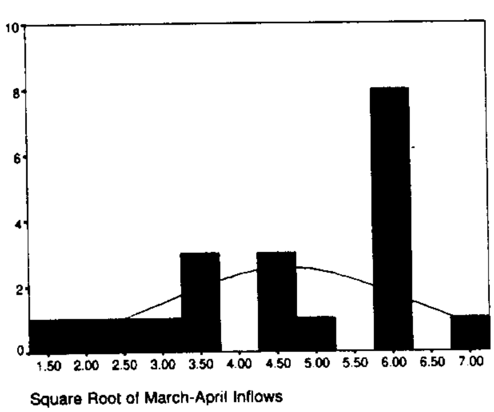


***Figure 2.27*** *Histogram of Sqrt(March-April Inflows).*

### 2.2.4 The May-June Inflows data

***Table .2.10*** *Descriptives for the May-June Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| May-June Inflows | Mean | | 135.8155 | 21.3386 |
| | 95% Confidence Interval for Mean | Lower Bound | 91.1532 | |
| | | Upper Bound | 180.4778 | |
| | 5% Trimmed Mean | | 133.4228 | |
| | Median | | 122.4550 | |
| | Variance | | 9106.752 | |
| | Std. Deviation | | 95.4293 | |
| | Minimum | | 11.40 | |
| | Maximum | | 303.30 | |
| | Range | | 291.90 | |
| | Interquartile Range | | 153.8475 | |
| | Skewness | | .537 | .512 |
| | Kurtosis | | -.904 | .992 |

***Table .2.11*** *Extreme Values for the May-June Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| May-June Inflows | Highest | 1 | 8 | 1968 | 303.30 |
| | | 2 | 14 | 1974 | 302.27 |
| | | 3 | 13 | 1973 | 275.96 |
| | | 4 | 10 | 1970 | 263.17 |
| | | 5 | 9 | 1969 | 224.35 |
| | Lowest | 1 | 4 | 1964 | 11.40 |
| | | 2 | 3 | 1963 | 16.04 |
| | | 3 | 5 | 1965 | 21.76 |
| | | 4 | 16 | 1976 | 52.72 |
| | | 5 | 2 | 1962 | 58.42 |

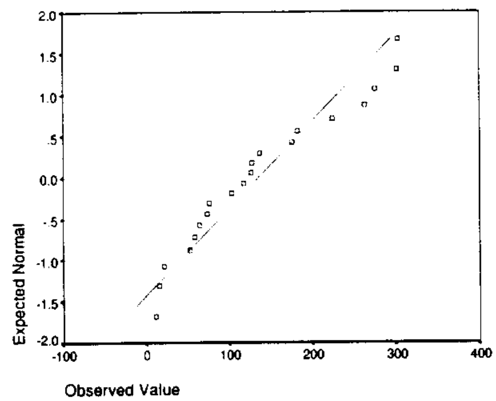


***Figure 2.28*** *Normal Q-Q Plot of May-June Inflows.*

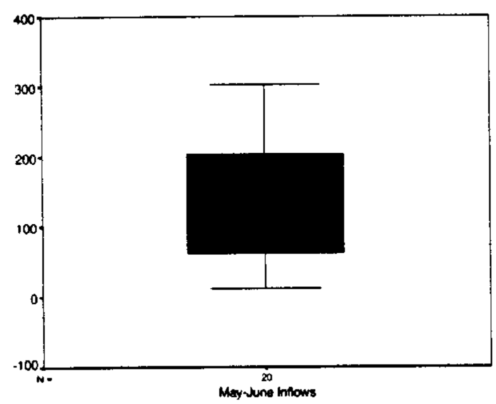


***Figure 2.29*** *BoxPlot of May-June Inflows.*

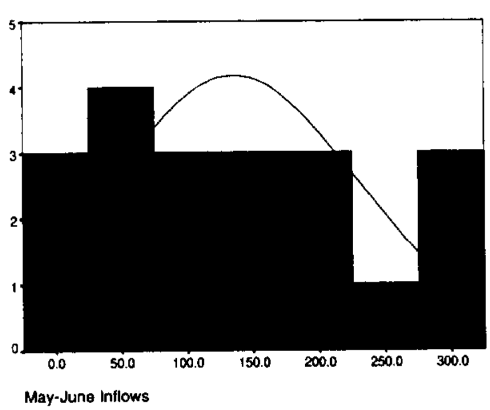


***Figure 2.30*** *Histogram of May-June Inflows.*

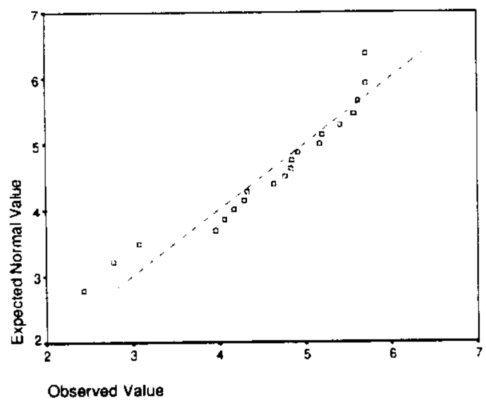


***Figure 2.31*** *Normal Q-Q Plot of Ln(May-June Inflows).*

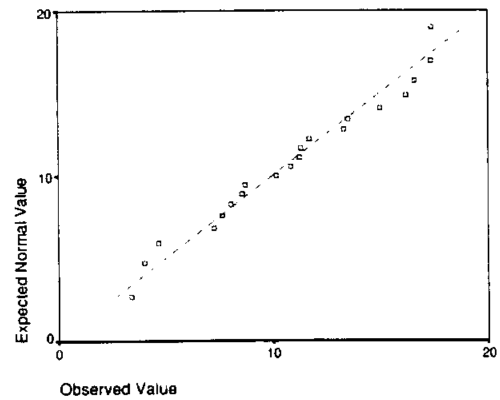


***Figure 2.32*** *Normal Q-Q Plot of Sqrt( May-June Inflows).*

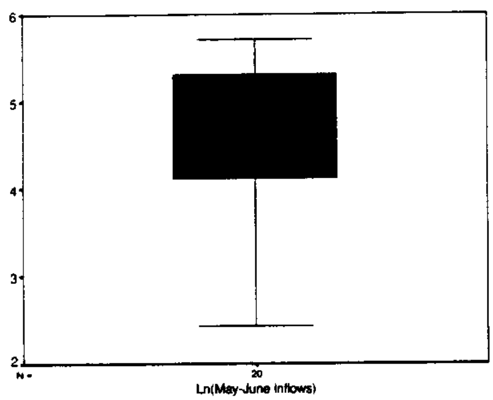


***Figure 2.33*** *BoxPlot of Ln(May-June) Inflows.*

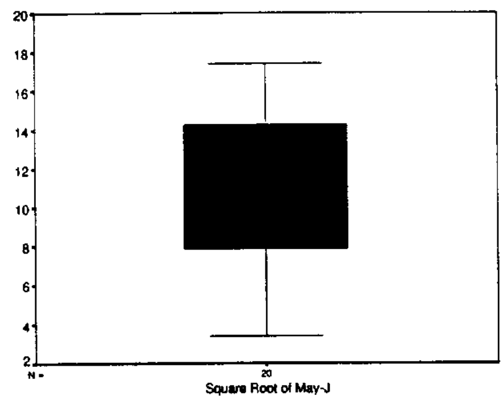


***Figure 2.34*** *BoxPlot of Square Root of May-June Inflows.*

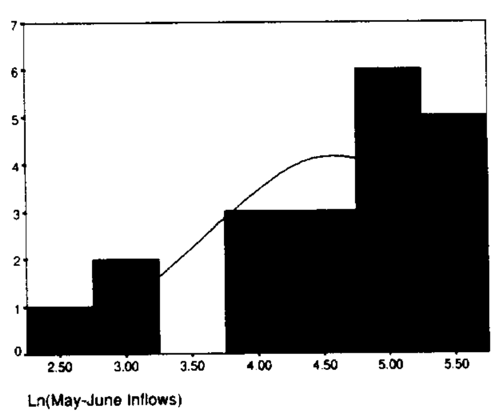


***Figure 2.35*** *Histogram of Ln(May-June Inflows).*

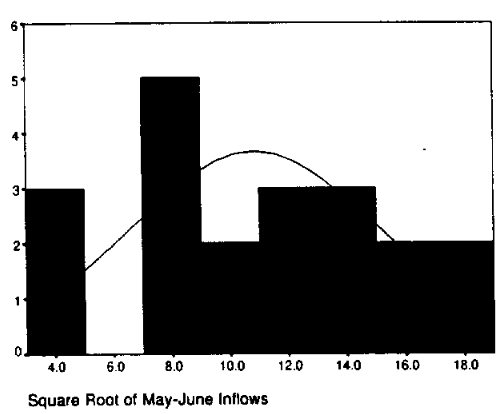


***Figure 2.36*** *Histogram of Sqrt(May-June Inflows).*

### 2.2.5 The July-August Inflows data

***Table .2.12*** *Descriptives for the July-August Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| July-August Inflows | Mean | | 44.3485 | 7.7189 |
| | 95% Confidence Interval for Mean | Lower Bound | 28.1926 | |
| | | Upper Bound | 60.5044 | |
| | 5% Trimmed Mean | | 40.6311 | |
| | Median | | 34.1750 | |
| | Variance | | 1191.638 | |
| | Std. Deviation | | 34.5201 | |
| | Minimum | | 9.88 | |
| | Maximum | | 145.73 | |
| | Range | | 135.85 | |
| | Interquartile Range | | 35.9950 | |
| | Skewness | | 1.676 | .512 |
| | Kurtosis | | 2.704 | .992 |

***Table .2.13*** *Extreme Values for the July-August Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| July-August Inflows | Highest | 1 | 20 | 1980 | 145.73 |
| | | 2 | 17 | 1977 | 90.67 |
| | | 3 | 18 | 1978 | 90.38 |
| | | 4 | 16 | 1976 | 87.96 |
| | | 5 | 19 | 1979 | 64.26 |
| | Lowest | 1 | 3 | 1963 | 9.88 |
| | | 2 | 15 | 1975 | 14.08 |
| | | 3 | 7 | 1967 | 16.07 |
| | | 4 | 2 | 1962 | 16.61 |
| | | 5 | 11 | 1971 | 22.08 |

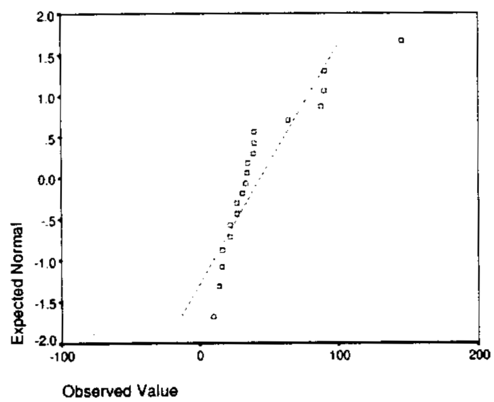


***Figure 2.37*** *Normal Q-Q Plot of July-August Inflows.*

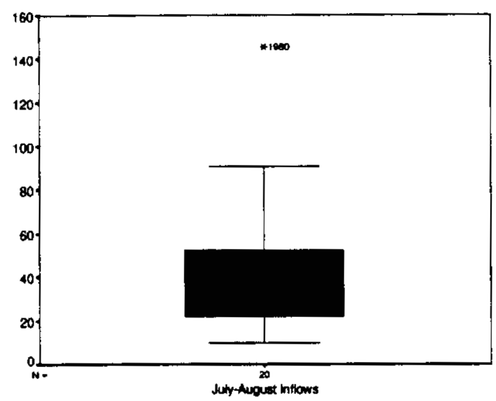


***Figure 2.38*** *BoxPlot of July-August Inflows.*

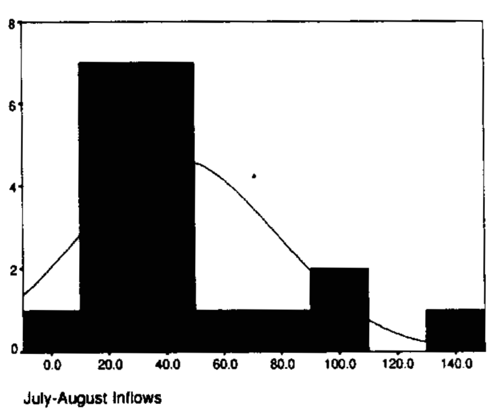


***Figure 2.39*** *Histogram of July-August Inflows.*

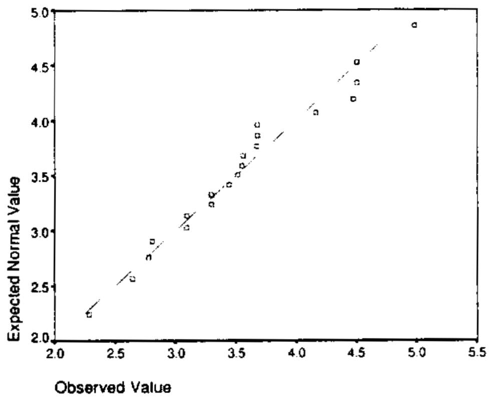


*Figure 2.40* Normal Q-Q Plot of Ln(July-August Inflows).

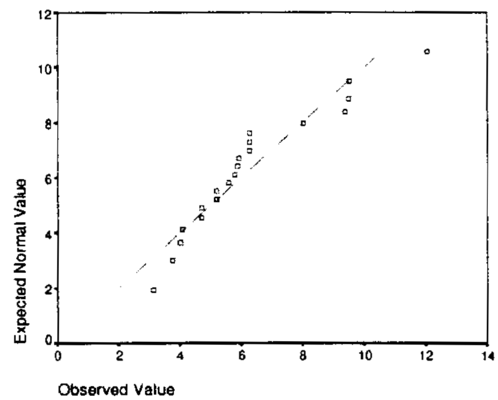


*Figure 2.41* Normal Q-Q Plot of Sqrt( July-August Inflows).

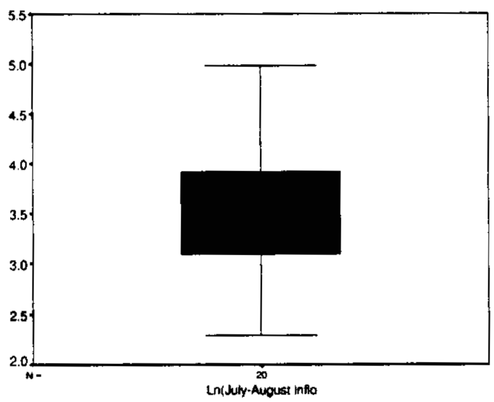


*Figure 2.42* BoxPlot of Ln(July-August) Inflows.

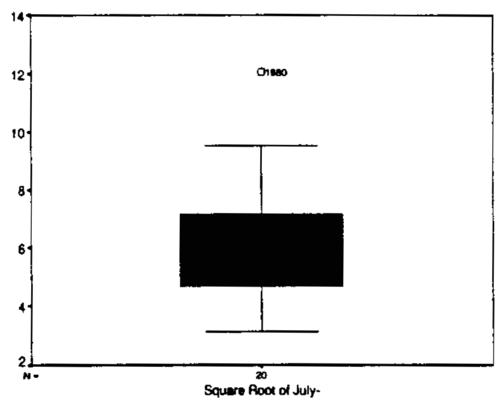


*Figure 2.43* BoxPlot of Square Root of July-August Inflows.

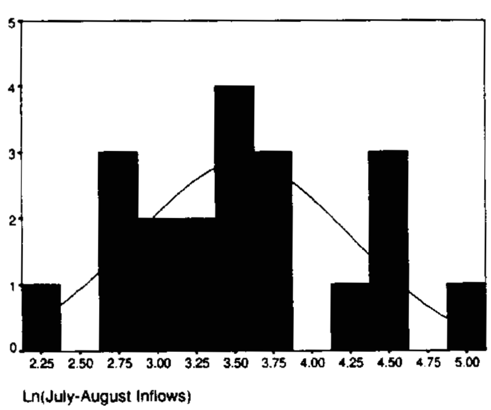


*Figure 2.44* Histogram of Ln(July-August Inflows).

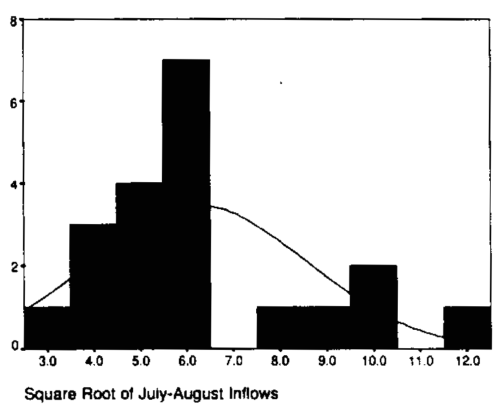


*Figure 2.45* Histogram of Sqrt(July-August Inflows).

### 2.2.6 The September-October Inflows data

***Table .2.14*** *Descriptives for the September-October Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| September-October Inflows | Mean | | 235.9255 | 42.6274 |
| | 95% Confidence Interval for Mean | Lower Bound | 146.7053 | |
| | | Upper Bound | 325.1457 | |
| | 5% Trimmed Mean | | 230.7283 | |
| | Median | | 217.7400 | |
| | Variance | | 36341.9 | |
| | Std. Deviation | | 190.6356 | |
| | Minimum | | 5.95 | |
| | Maximum | | 559.45 | |
| | Range | | 553.50 | |
| | Interquartile Range | | 357.7875 | |
| | Skewness | | .313 | .512 |
| | Kurtosis | | -1.338 | .992 |

***Table .2.15*** *Extreme Values for the September-October Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| September-October Inflows | Highest | 1 | 14 | 1974 | 559.45 |
| | | 2 | 10 | 1970 | 502.41 |
| | | 3 | 9 | 1969 | 502.38 |
| | | 4 | 8 | 1968 | 492.61 |
| | | 5 | 13 | 1973 | 415.48 |
| | Lowest | 1 | 6 | 1966 | 5.95 |
| | | 2 | 7 | 1967 | 6.96 |
| | | 3 | 5 | 1965 | 9.91 |
| | | 4 | 4 | 1964 | 25.49 |
| | | 5 | 18 | 1978 | 53.14 |

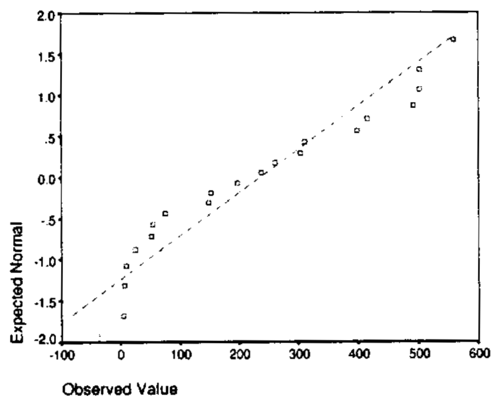


*Figure 2.46* *Normal Q-Q Plot of September-October Inflows.*

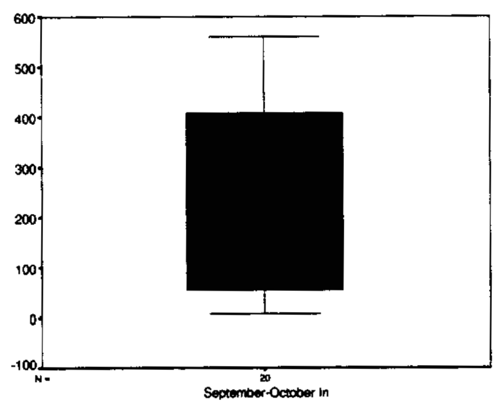


*Figure 2.47* *BoxPlot of September-October Inflows.*

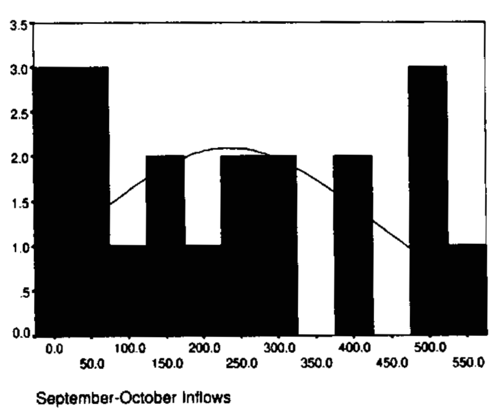


*Figure 2.48* *Histogram of September-October Inflows.*

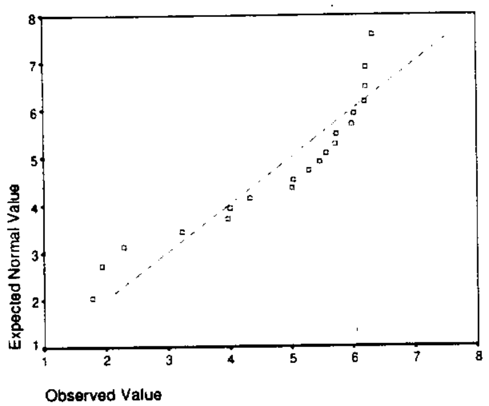


**Figure 2.49** *Normal Q-Q Plot of Ln(September-October Inflows).*

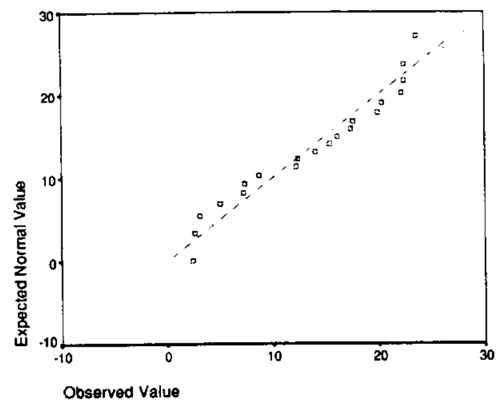


**Figure 2.50** *Normal Q-Q Plot of Sqrt( September-October Inflows).*

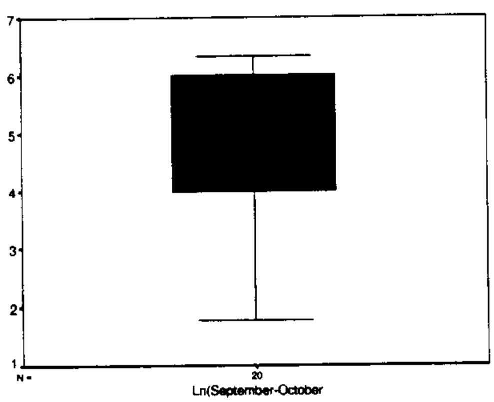


**Figure 2.51** *BoxPlot of Ln(September-October) Inflows.*

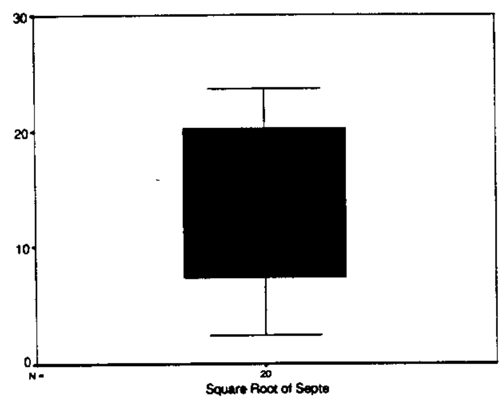


**Figure 2.52** *BoxPlot of Square Root of September-October Inflows.*

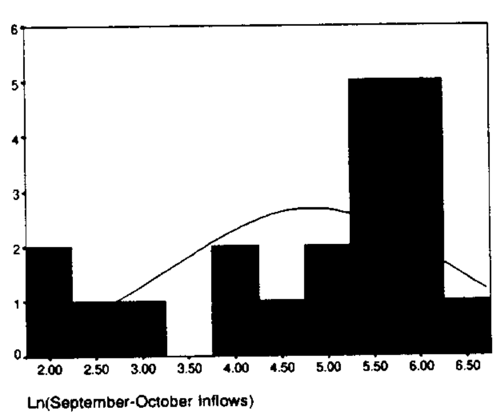


**Figure 2.53** *Histogram of Ln(September-October Inflows).*

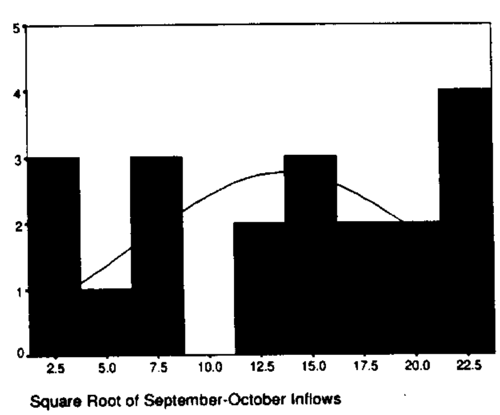


**Figure 2.54** *Histogram of Sqrt(September-October Inflows).*

### 2.2.7 The November-December Inflows data

***Table .2.16*** *Descriptives for the November-December Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| November-December Inflows | Mean | | 43.2650 | 9.0305 |
| | 95% Confidence Interval for Mean | Lower Bound | 24.3640 | |
| | | Upper Bound | 62.1660 | |
| | 5% Trimmed Mean | | 41.4222 | |
| | Median | | 20.4250 | |
| | Variance | | 1630.981 | |
| | Std. Deviation | | 40.3854 | |
| | Minimum | | 5.04 | |
| | Maximum | | 114.66 | |
| | Range | | 109.62 | |
| | Interquartile Range | | 84.5075 | |
| | Skewness | | .798 | .512 |
| | Kurtosis | | -1.225 | .992 |

***Table .2.17*** *Extreme Values for the November-December Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| November-December Inflows | Highest | 1 | 17 | 1977 | 114.66 |
| | | 2 | 3 | 1963 | 102.87 |
| | | 3 | 1 | 1961 | 102.55 |
| | | 4 | 2 | 1962 | 99.51 |
| | | 5 | 18 | 1978 | 94.82 |
| | Lowest | 1 | 9 | 1969 | 5.04 |
| | | 2 | 4 | 1964 | 8.41 |
| | | 3 | 5 | 1965 | 8.54 |
| | | 4 | 7 | 1967 | 9.10 |
| | | 5 | 6 | 1966 | 9.96 |

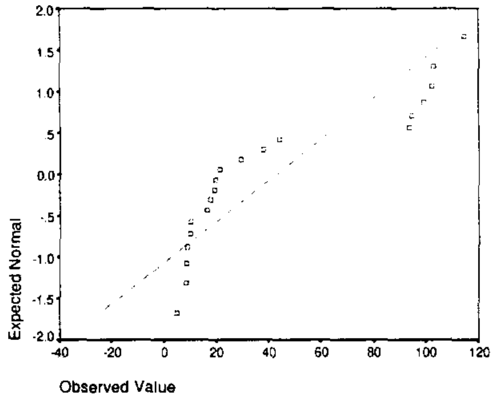


***Figure 2.55*** *Normal Q-Q Plot of November_December Inflows.*

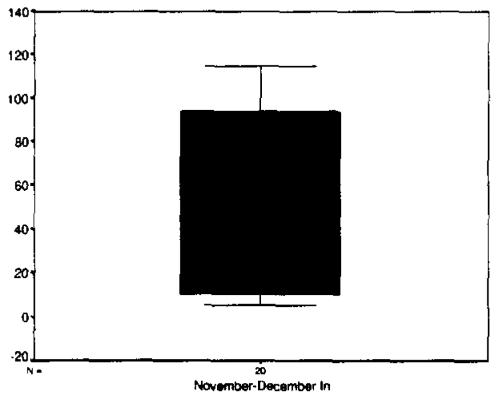


***Figure 2.56*** *BoxPlot of November_December Inflows.*

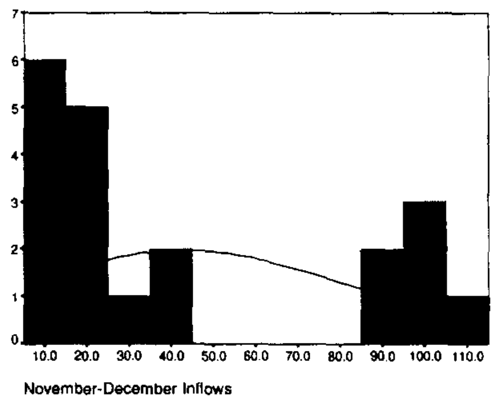


***Figure 2.57*** *Histogram of November_December Inflows.*

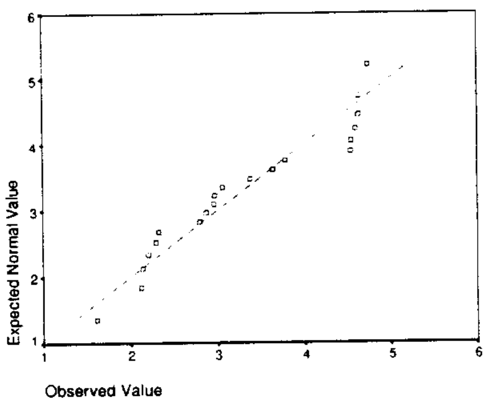


**Figure 2.58** *Normal Q-Q Plot of Ln(November_December Inflows).*

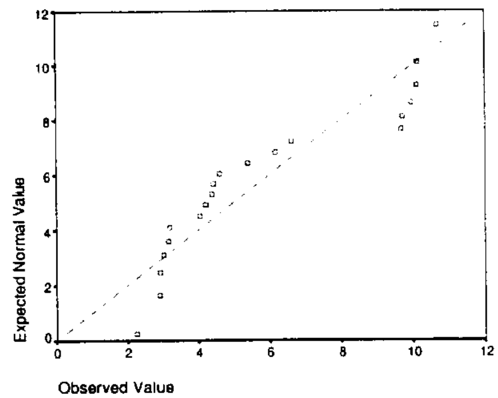


**Figure 2.59** *Normal Q-Q Plot of Sqrt( November_December Inflows).*

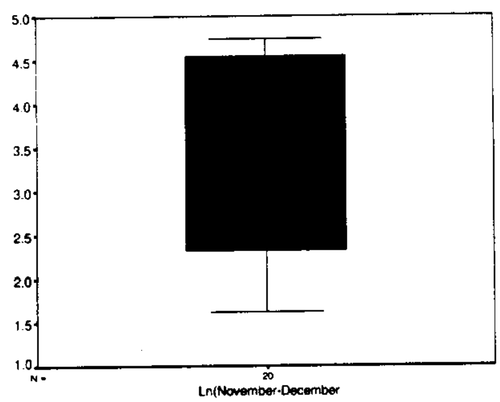


**Figure 2.60** *BoxPlot of Ln(November _December) Inflows.*

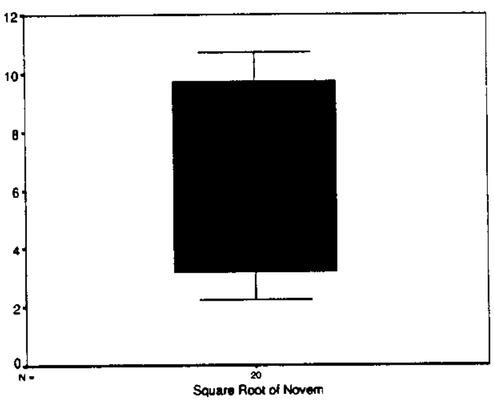


**Figure 2.61** *BoxPlot of Square Root of November_December Inflows.*

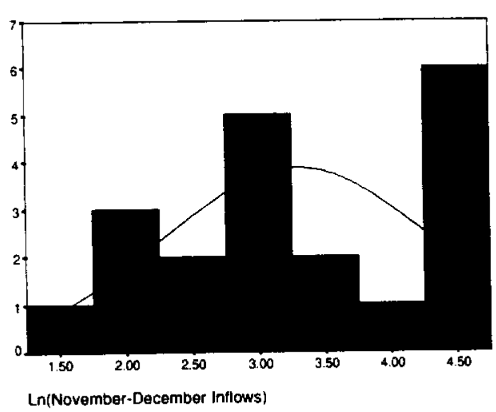


**Figure 2.62** *Histogram of Ln(November_ December Inflows).*

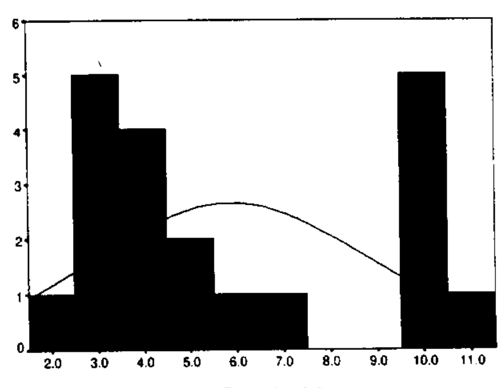


**Figure 2.63** *Histogram of Sqrt(November_ December Inflows).*

# 3. PREDICTION ELLIPSES AND CONFIDENCE REGIONS

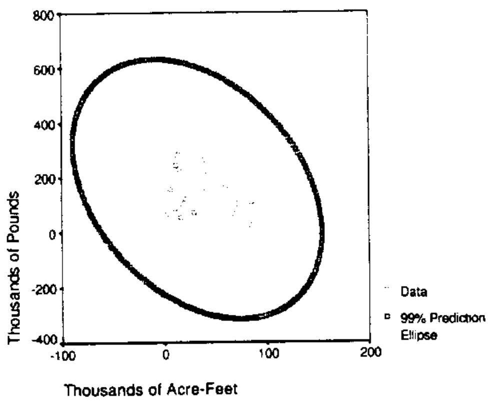


***Figure 3.1*** *Red Fish Harvest vs. January-February Inflows, PE.*

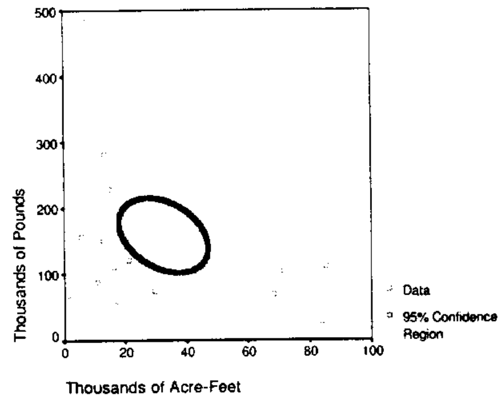


***Figure 3.2*** *Red Fish Harvest vs. January-February Inflows, CR.*

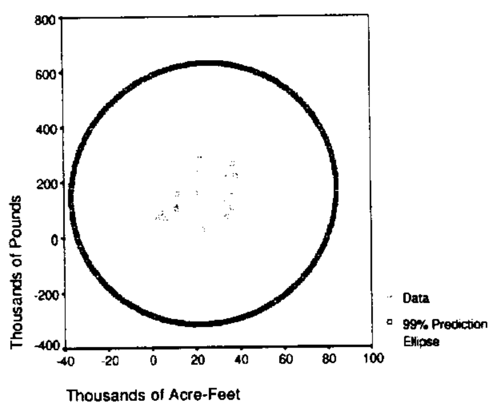


***Figure 3.3*** *Red Fish Harvest vs. March-April Inflows, PE.*

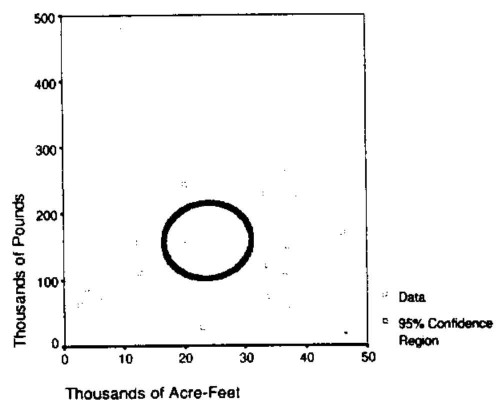


***Figure 3.4*** *Red Fish Harvest vs. March-April Inflows, CR.*

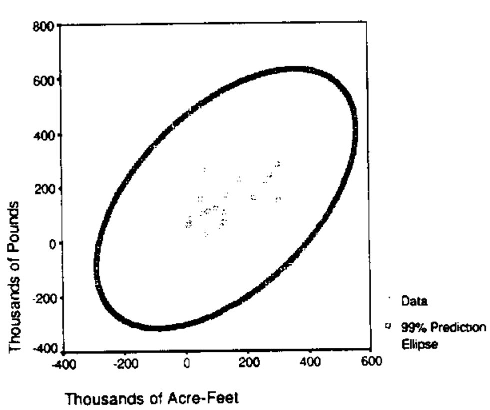


***Figure 3.5*** *Red Fish Harvest vs. May-June Inflows, PE.*

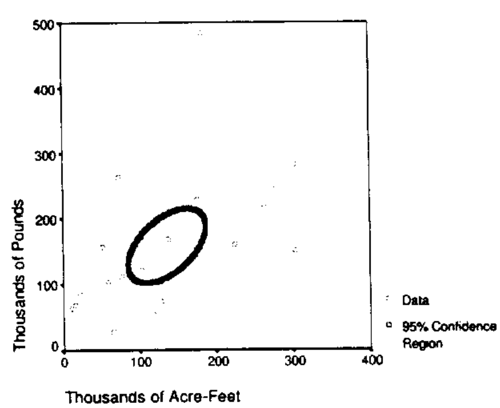


***Figure 3.6*** *Red Fish Harvest vs. May-June Inflows, CR.*

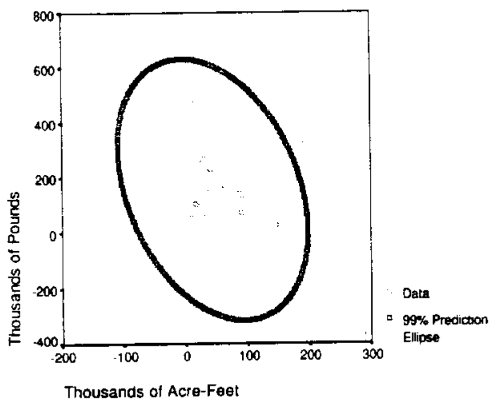


*Figure 3.7 Red Fish Harvest vs. July-August Inflows, PE.*

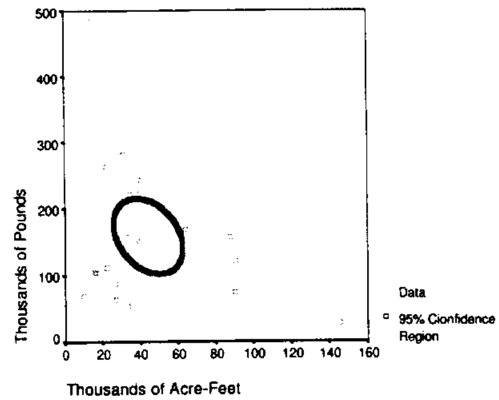


*Figure 3.8 Red Fish Harvest vs. July-August Inflows, CR.*

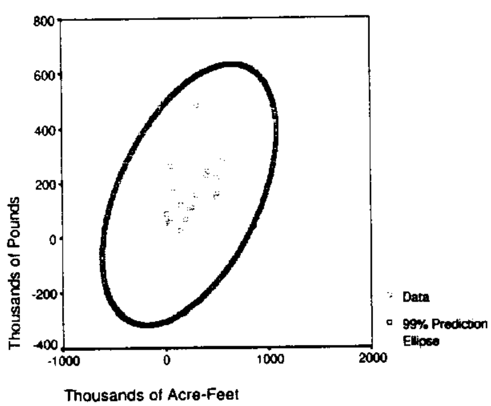


*Figure 3.9 Red Fish Harvest vs. September-October Inflows, PE.*

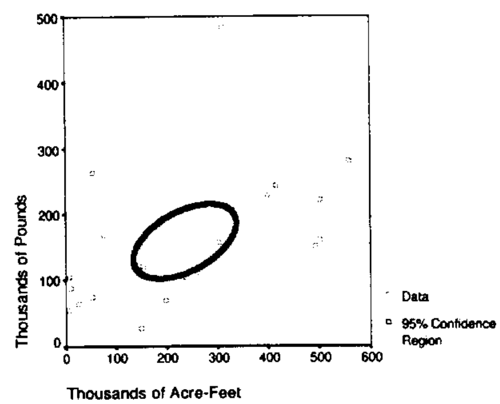


*Figure 3.10 Red Fish Harvest vs. September-October Inflows, CR.*

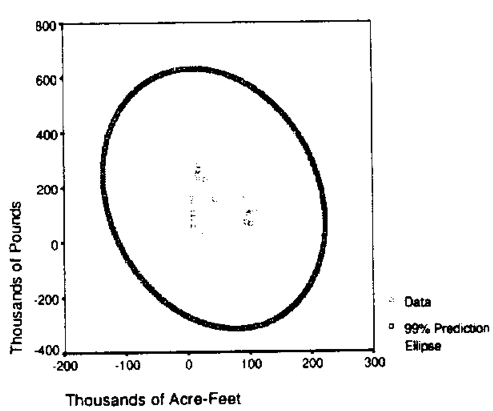


*Figure 3.11 Red Fish Harvest vs. November-December Inflows, PE.*

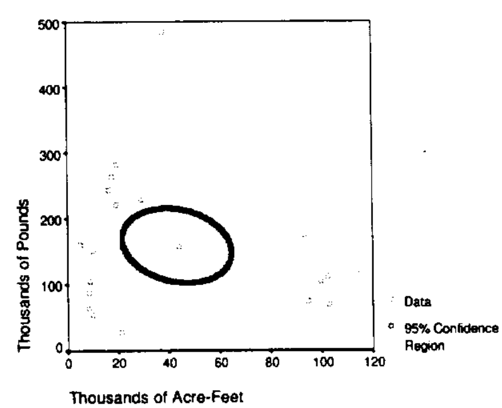


*Figure 3.12 Red Fish Harvest vs. November-December Inflows, CR.*

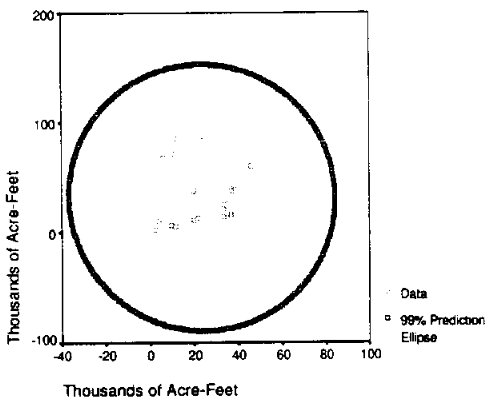


***Figure 3.13*** *January-February Inflows vs. March-April Inflows, PE.*

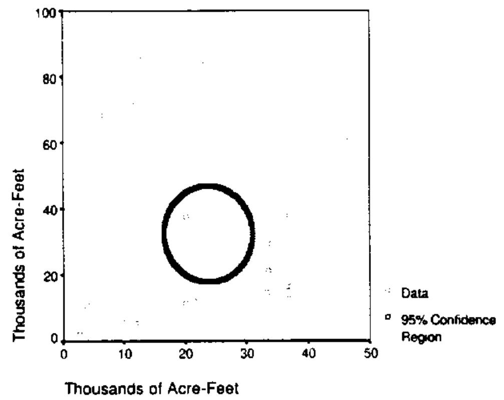


***Figure 3.14*** *January-February Inflows vs. March-April Inflows, CR.*

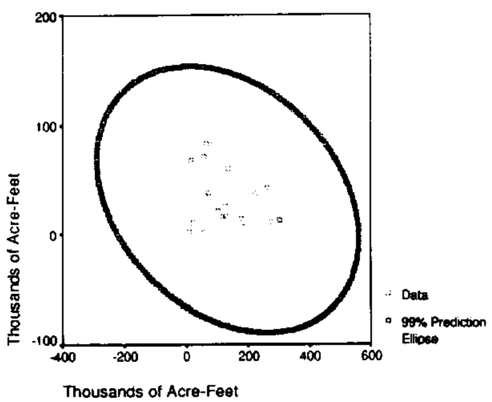


***Figure 3.15*** *January-February Inflows vs. May-June Inflows, PE.*

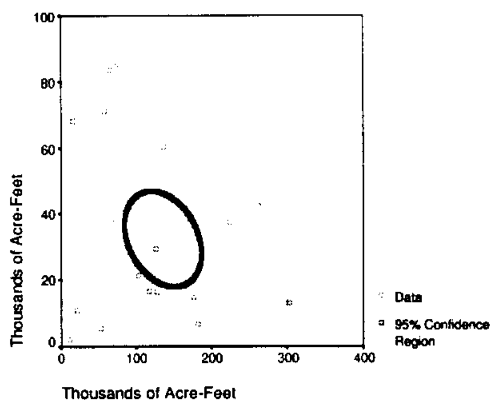


***Figure 3.16*** *January-February Inflows vs. May-June Inflows, CR.*

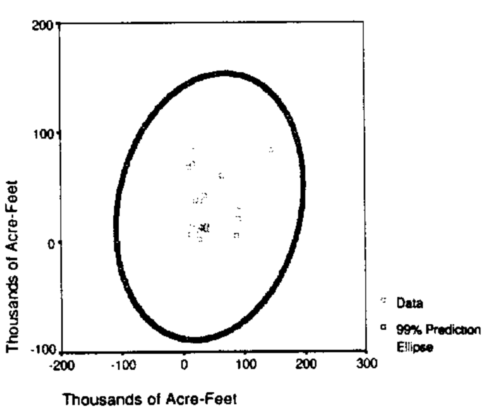


***Figure 3.17*** *January-February Inflows vs. July-August Inflows, PE.*

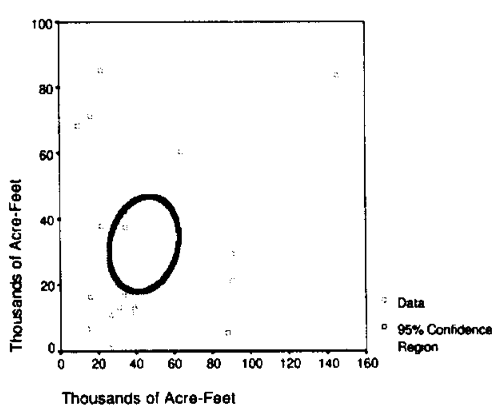


***Figure 3.18*** *January-February Inflows vs. July-August Inflows, CR.*

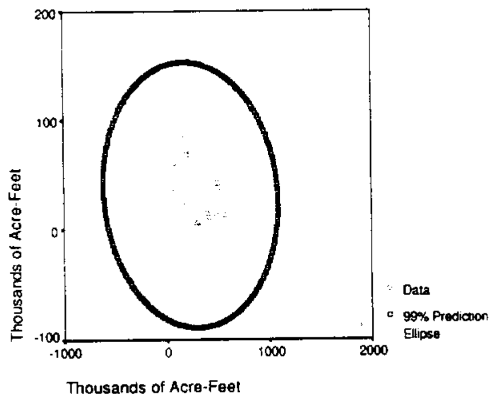


***Figure 3.19*** *January-February Inflows vs. September-October Inflows, PE.*

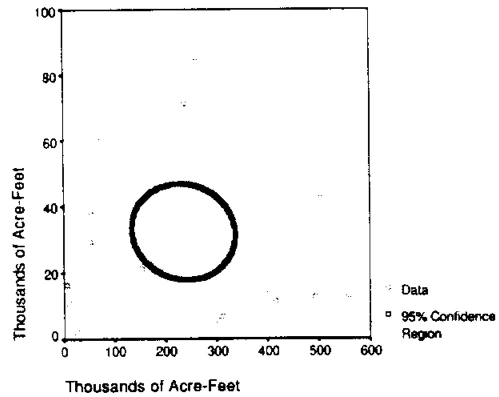


***Figure 3.20*** *January-February Inflows vs. September-October Inflows, CR.*

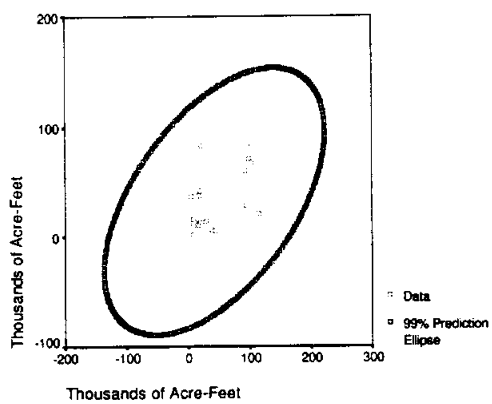


***Figure 3.21*** *January-February Inflows vs. November-December Inflows, PE.*

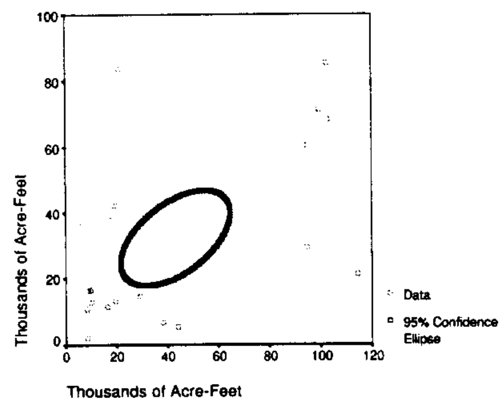


***Figure 3.22*** *January-February Inflows vs. November-December Inflows, CR.*

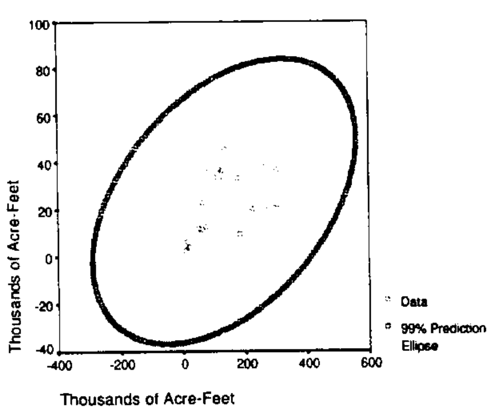


***Figure 3.23*** *March-April Inflows vs. May-June Inflows, PE.*

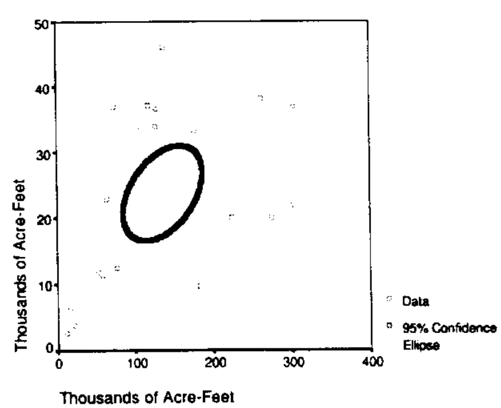


***Figure 3.24*** *March-April Inflows vs. May-June Inflows, CR.*

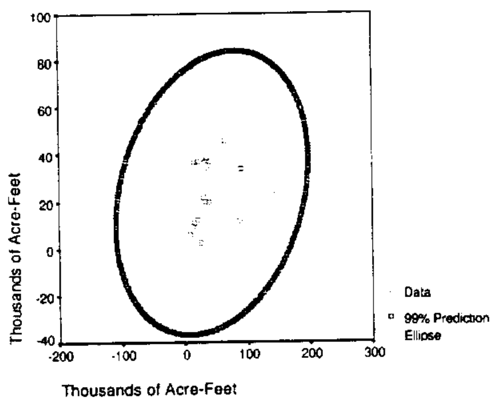


***Figure 3.25*** *March-April Inflows vs. July-August Inflows, PE.*

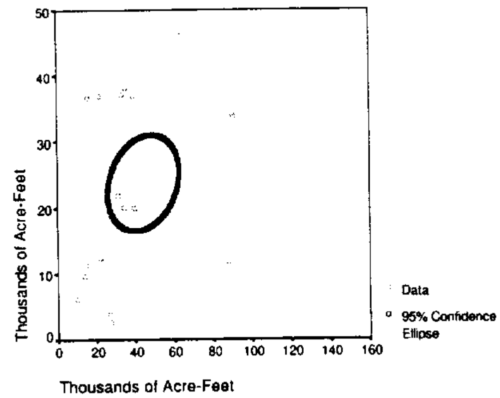


***Figure 3.26*** *March-April Inflows vs. July-August Inflows, CR.*

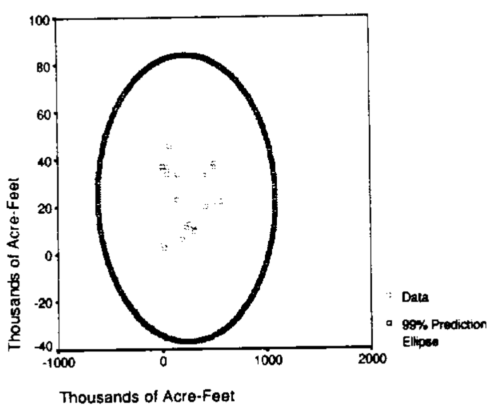


***Figure 3.27*** *March-April Inflows vs. September-October Inflows, PE.*

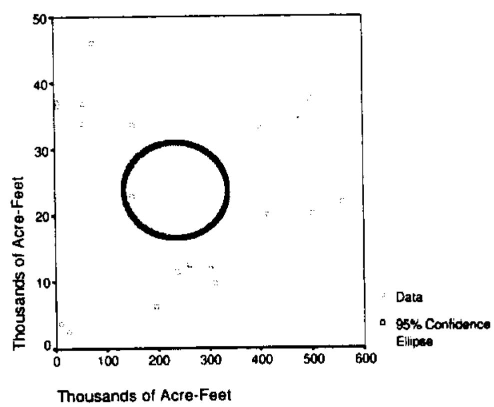


***Figure 3.28*** *March-April Inflows vs. September-October Inflows, CR.*

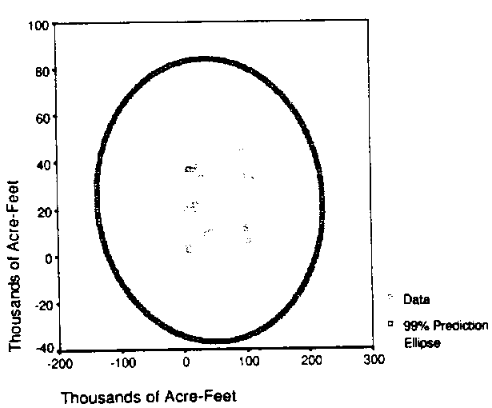


***Figure 3.29*** *March-April Inflows vs. November-December Inflows, PE.*

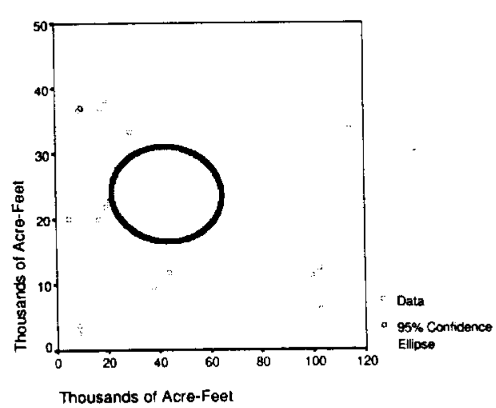


***Figure 3.30*** *March-April Inflows vs. November-December Inflows, CR.*

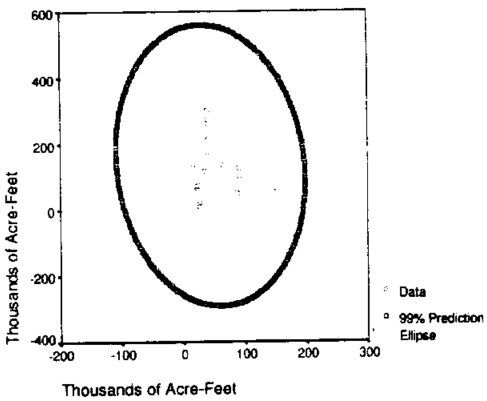


**Figure 3.31** *May-June Inflows vs. July-August Inflows, PE.*

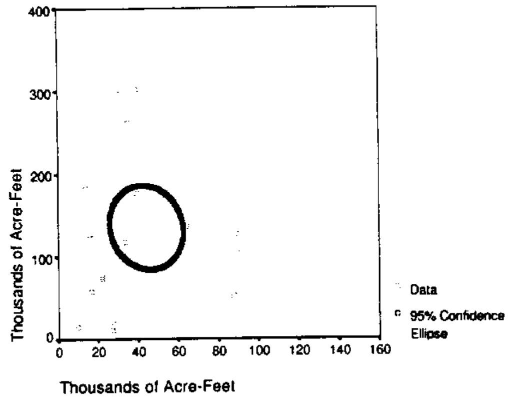


**Figure 3.32** *May-June Inflows vs. July-August Inflows, CR.*

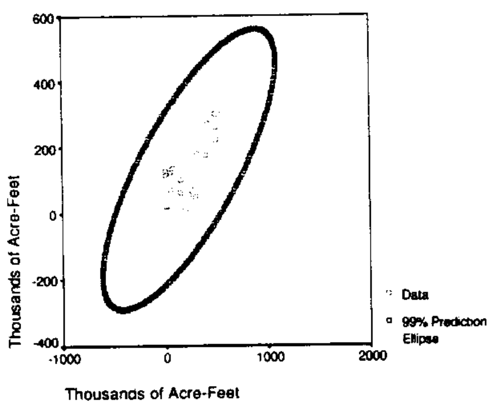


**Figure 3.33** *May-June Inflows vs. September-October Inflows, PE.*

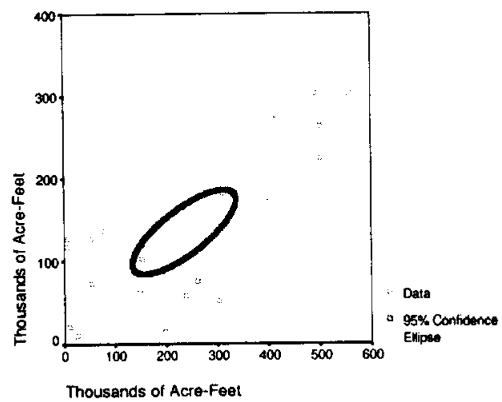


**Figure 3.34** *May-June Inflows vs. September-October Inflows, CR.*

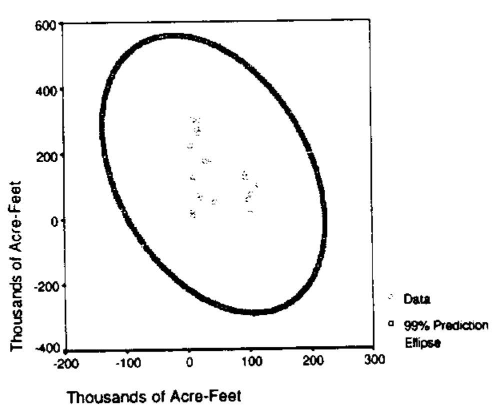


**Figure 3.35** *May-June Inflows vs. November-December Inflows, PE.*

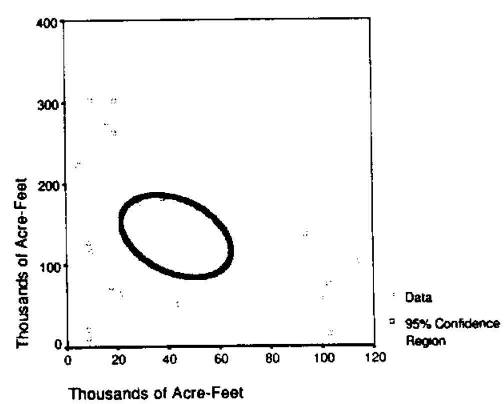


**Figure 3.36** *May-June Inflows vs. November-December Inflows, CR.*

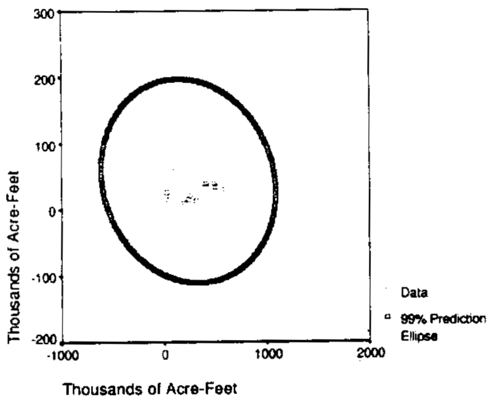


*Figure 3.37* July-August Inflows. vs. September-October Inflows, PE.

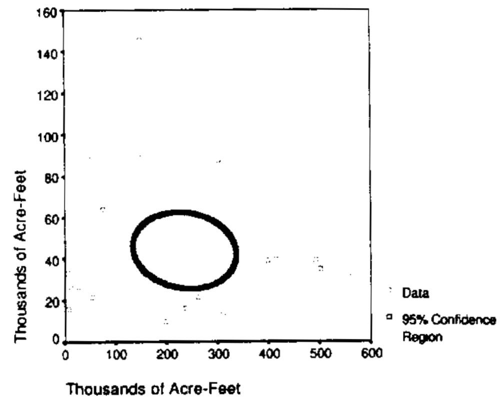


*Figure 3.38* July-August Inflows. vs. September-October Inflows, CR.

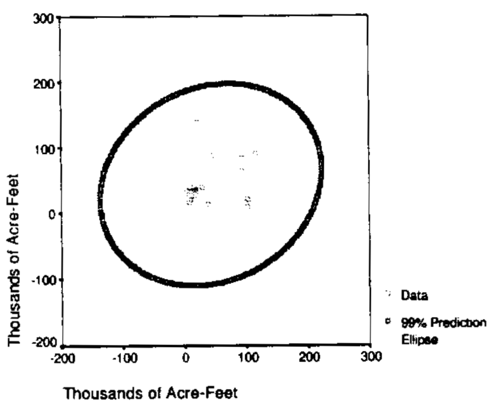


*Figure 3.39* July-August Inflows. vs. November-December Inflows, PE.

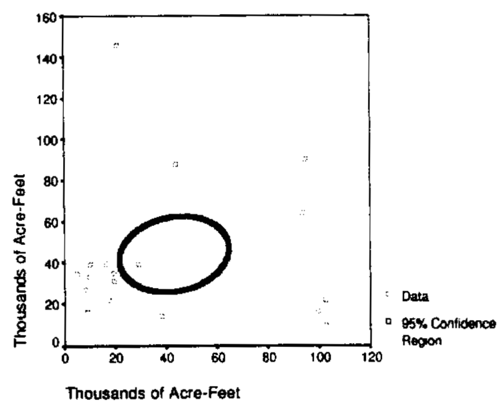


*Figure 3.40* July-August Inflows. vs. November-December Inflows, CR.

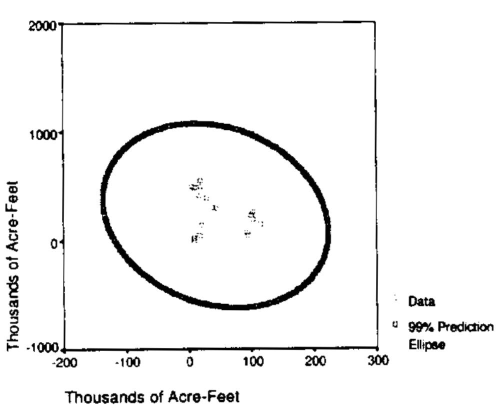


*Figure 3.41* September-October Inflows vs. November-December Inflows, PE.

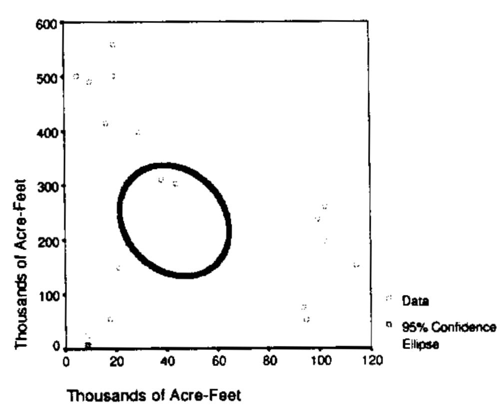


*Figure 3.42* September-October Inflows vs. November-December Inflows, CR.

## 4. Box-Cox Analysis

***Table .4.1*** *Mean Square Error from Box-Cox transformation of the red fish data and the inflow data for different lambda.*

| Lam. | Red Fish | JF_inflow | MA_inflo | MJ_inflow | JA_inflow | SO_inflow | ND_inflow |
|---|---|---|---|---|---|---|---|
| -2.0 | 91546.5 | 50708.9 | 11029.2 | 752149 | 2628.4 | 53961199 | 8343.5 |
| -1.9 | 74701.0 | 35668.4 | 8383.1 | 549366 | 2277.7 | 33067621 | 6719.1 |
| -1.8 | 61282.7 | 25230.2 | 6406.9 | 403544 | 1983.7 | 20385066 | 5447.7 |
| -1.7 | 50568.2 | 17958.9 | 4925.6 | 298249 | 1736.8 | 12649071 | 4449.2 |
| -1.6 | 41991.3 | 12873.4 | 3811.1 | 221888 | 1529.3 | 7905462 | 3662.3 |
| -1.5 | 35108.2 | 9301.4 | 2969.2 | 166258 | 1354.6 | 4980172 | 3040.0 |
| -1.4 | 29570.6 | 6780.9 | 2330.5 | 125539 | 1207.6 | 3165084 | 2546.5 |
| -1.3 | 25104.9 | 4993.8 | 1843.8 | 95586 | 1083.9 | 2031339 | 2153.8 |
| -1.2 | 21495.3 | 3720.1 | 1471.4 | 73441 | 980.0 | 1318060 | 1840.6 |
| -1.1 | 18572.2 | 2807.5 | 1185.1 | 56982 | 892.8 | 865806 | 1590.4 |
| -1.0 | 16201.3 | 2150.0 | 963.9 | 44685 | 819.9 | 576637 | 1390.4 |
| -0.9 | 14276.8 | 1673.8 | 792.3 | 35448 | 759.4 | 390069 | 1230.6 |
| -0.8 | 12714.8 | 1327.0 | 658.5 | 28475 | 709.7 | 268535 | 1103.5 |
| -0.7 | 11449.0 | 1073.3 | 553.6 | 23185 | 669.5 | 188557 | 1002.9 |
| -0.6 | 10427.0 | 887.2 | 471.1 | 19155 | 637.7 | 135368 | 924.5 |
| -0.5 | 9607.5 | 750.4 | 406.0 | 16074 | 613.6 | 99615 | 864.5 |
| -0.4 | 8958.0 | 650.1 | 354.4 | 13713 | 596.5 | 75334 | 820.5 |
| -0.3 | 8453.2 | 577.1 | 313.4 | 11904 | 586.0 | 58690 | 790.4 |
| <u>-0.2</u> | 8073.5 | 525.1 | 280.7 | 10522 | <u>581.9</u> | 47200 | 772.9 |
| <u>-0.1</u> | 7804.2 | 489.2 | 254.8 | 9474 | 584.1 | 39246 | <u>767.0</u> |
| 0.0 | 7634.7 | 466.4 | 234.2 | 8693 | 592.6 | 33763 | 772.3 |
| <u>0.1</u> | <u>7557.8</u> | 454.3 | 218.0 | 8126 | 607.8 | 30053 | 788.7 |
| <u>0.2</u> | 7569.3 | <u>451.6</u> | 205.4 | 7736 | 630.0 | 27653 | 816.6 |
| 0.3 | 7668.0 | 457.2 | 195.7 | 7497 | 659.8 | 26261 | 856.6 |
| <u>0.4</u> | 7855.3 | 470.7 | 188.6 | <u>7390</u> | 698.1 | <u>25685</u> | 909.7 |
| 0.5 | 8135.6 | 492.2 | 183.6 | 7401 | 746.0 | 25810 | 977.6 |
| 0.6 | 8515.7 | 521.8 | 180.5 | 7522 | 804.8 | 26577 | 1062.3 |
| <u>0.7</u> | 9005.9 | 560.3 | <u>179.1</u> | 7752 | 876.4 | 27973 | 1166.3 |
| 0.8 | 9619.8 | 608.5 | 179.3 | 8089 | 962.8 | 30020 | 1292.8 |
| 0.9 | 10374.8 | 667.9 | 180.8 | 8538 | 1066.7 | 32779 | 1446.1 |
| 1.0 | 11293.1 | 740.0 | 183.7 | 9107 | 1191.6 | 36342 | 1631.0 |
| 1.1 | 12402.5 | 827.1 | 188.0 | 9805 | 1341.6 | 40841 | 1853.8 |
| 1.2 | 13737.3 | 931.9 | 193.6 | 10648 | 1521.7 | 46450 | 2122.3 |
| 1.3 | 15339.7 | 1057.8 | 200.6 | 11654 | 1738.3 | 53395 | 2445.9 |
| 1.4 | 17261.8 | 1209.0 | 208.9 | 12844 | 1999.2 | 61965 | 2836.2 |
| 1.5 | 19567.6 | 1390.4 | 218.8 | 14247 | 2314.2 | 72525 | 3307.8 |
| 1.6 | 22335.6 | 1608.5 | 230.2 | 15896 | 2695.3 | 85533 | 3878.3 |
| 1.7 | 25662.3 | 1871.0 | 243.3 | 17831 | 3157.7 | 101571 | 4569.9 |
| 1.8 | 29666.4 | 2187.3 | 258.2 | 20099 | 3720.0 | 121369 | 5409.8 |
| 1.9 | 34493.7 | 2569.3 | 275.2 | 22757 | 4405.7 | 145847 | 6431.8 |
| 2.0 | 40323.9 | 3031.3 | 294.4 | 25875 | 5244.0 | 176165 | 7677.8 |

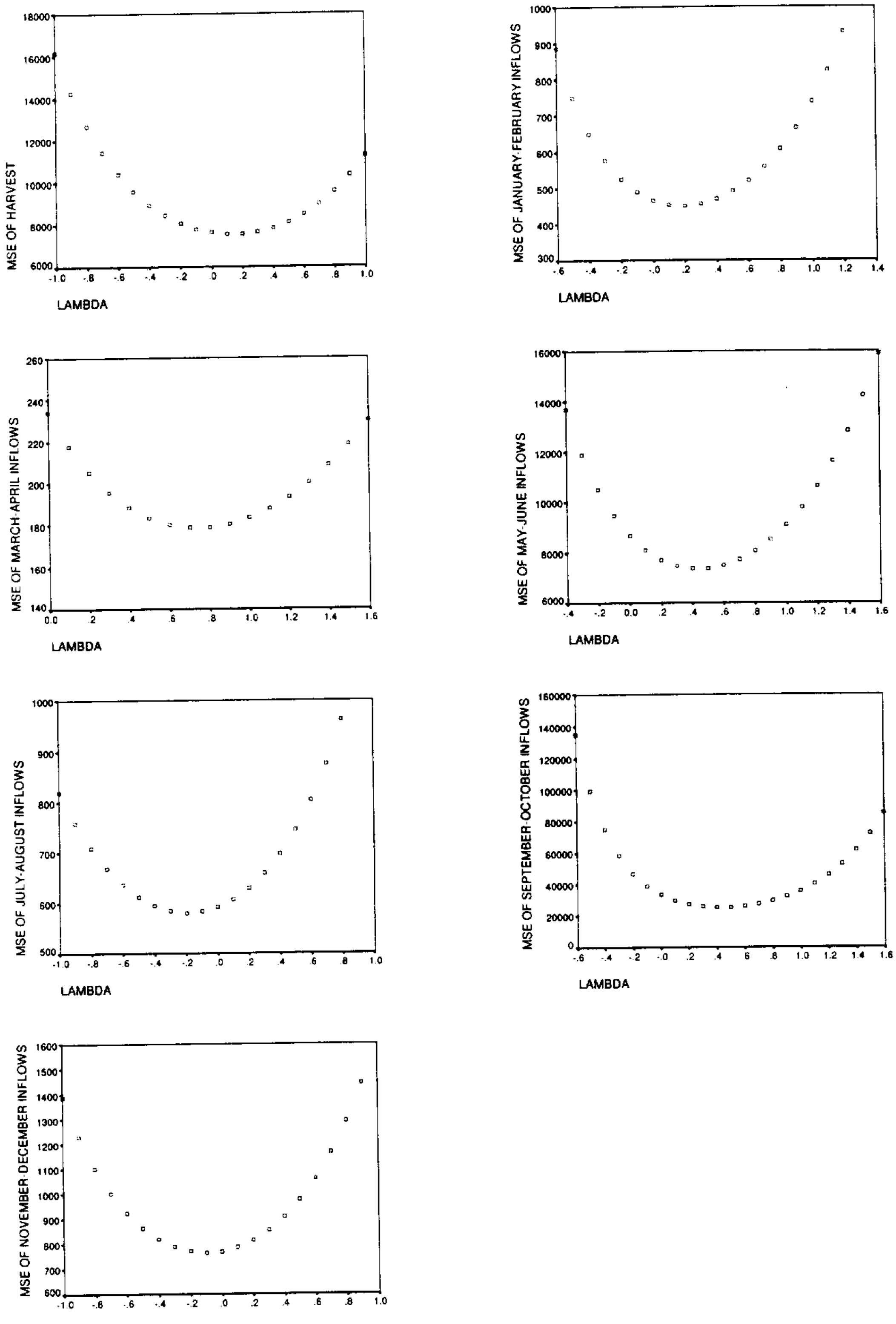


***Figure 4.1*** *Box-Cox Transformation - MSE of Red Fish vs. Lambda and MSE of Inflow data vs. Lambda.*

# 5. MODEL CHOICE DIAGNOSTICS

## 5.1 Untransformed red fish data and untransformed inflow data

*Table 5.1 Regression Models for Dependent Variable: RED FISH on INFLOWS*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.2799 | 0.2399 | 0.127 | 183.0 | 8584 | 185.0 | QMJ_LAG |
| 1 | 0.2420 | 0.1998 | 0.977 | 184.1 | 9036 | 186.1 | QSO_LAG |
| 1 | 0.1195 | 0.0706 | 3.719 | 187.1 | 10496 | 189.1 | QJF_LAG |
| 1 | 0.1056 | 0.0559 | 4.030 | 187.4 | 10662 | 189.4 | QJA_LAG |
| 2 | 0.3537 | 0.2777 | 0.474 | 182.9 | 8157 | 185.9 | QMJ_LAG QJA_LAG |
| 2 | 0.3379 | 0.2600 | 0.829 | 183.4 | 8357 | 186.4 | QJF_LAG QSO_LAG |
| 2 | 0.3276 | 0.2485 | 1.057 | 183.7 | 8486 | 186.7 | QMA_LAG QMJ_LAG |
| 2 | 0.3185 | 0.2383 | 1.263 | 183.9 | 8602 | 186.9 | QJF_LAG QMJ_LAG |
| 3 | 0.3875 | 0.2726 | 1.717 | 183.8 | 8214 | 187.8 | QJF_LAG QJA_LAG QSO_LAG |
| 3 | 0.3789 | 0.2624 | 1.911 | 184.1 | 8330 | 188.1 | QJF_LAG QMJ_LAG QJA_LAG |
| 3 | 0.3731 | 0.2556 | 2.039 | 184.3 | 8407 | 188.3 | QMA_LAG QMJ_LAG QJA_LAG |
| 3 | 0.3674 | 0.2487 | 2.168 | 184.5 | 8484 | 188.4 | QMJ_LAG QJA_LAG QSO_LAG |
| 4 | 0.4062 | 0.2478 | 3.298 | 185.2 | 8494 | 190.2 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 4 | 0.3966 | 0.2357 | 3.513 | 185.5 | 8631 | 190.5 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG |
| 4 | 0.3948 | 0.2334 | 3.554 | 185.6 | 8657 | 190.5 | QJF_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.3942 | 0.2326 | 3.568 | 185.6 | 8666 | 190.6 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG |
| 5 | 0.4187 | 0.2111 | 5.019 | 186.8 | 8910 | 192.7 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.4101 | 0.1994 | 5.211 | 187.1 | 9041 | 193.0 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.4064 | 0.1944 | 5.293 | 187.2 | 9097 | 193.2 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.4050 | 0.1924 | 5.326 | 187.2 | 9120 | 193.2 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.4195 | 0.1516 | 7.000 | 188.7 | 9581 | 195.7 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 20

## 5.2 Untransformed red fish data and log of inflow data

*Table 5.2 Regression Models for Dependent Variable: RED FISH on Ln(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.2714 | 0.2309 | 10.67 | 183.3 | 8685 | 185.3 | LN_QMJ |
| 1 | 0.2124 | 0.1686 | 12.84 | 184.8 | 9389 | 186.8 | LN_QSO |
| 1 | 0.0697 | 0.0181 | 18.06 | 188.2 | 11089 | 190.2 | LN_QJA |
| 1 | 0.0695 | 0.0178 | 18.07 | 188.2 | 11093 | 190.2 | LN_QJF |
| 2 | 0.4514 | 0.3869 | 6.084 | 179.6 | 6924 | 182.6 | LN_QMA LN_QMJ |
| 2 | 0.4158 | 0.3471 | 7.387 | 180.9 | 7373 | 183.8 | LN_QMJ LN_QJA |
| 2 | 0.3693 | 0.2951 | 9.091 | 182.4 | 7961 | 185.4 | LN_QJF LN_QMJ |
| 2 | 0.3375 | 0.2595 | 10.26 | 183.4 | 8362 | 186.4 | LN_QJF LN_QSO |
| 3 | 0.5132 | 0.4220 | 5.820 | 179.2 | 6528 | 183.2 | LN_QJF LN_QMJ LN_QJA |
| 3 | 0.5086 | 0.4165 | 5.989 | 179.4 | 6590 | 183.4 | LN_QMA LN_QMJ LN_QJA |
| 3 | 0.4833 | 0.3864 | 6.918 | 180.4 | 6930 | 184.4 | LN_QMJ LN_QJA LN_QSO |
| 3 | 0.4734 | 0.3747 | 7.278 | 180.8 | 7062 | 184.8 | LN_QMA LN_QMJ LN_QND |
| 4 | 0.6114 | 0.5078 | 4.227 | 176.7 | 5559 | 181.7 | LN_QJF LN_QMJ LN_QJA LN_QSO |
| 4 | 0.5905 | 0.4812 | 4.994 | 177.8 | 5858 | 182.7 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 4 | 0.5749 | 0.4615 | 5.565 | 178.5 | 6081 | 183.5 | LN_QJF LN_QMA LN_QJA LN_QSO |
| 4 | 0.5434 | 0.4216 | 6.718 | 179.9 | 6532 | 184.9 | LN_QJF LN_QMA LN_QMJ LN_QJA |
| 5 | 0.6444 | 0.5175 | 5.017 | 176.9 | 5449 | 182.9 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.6165 | 0.4795 | 6.042 | 178.4 | 5878 | 184.4 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.6117 | 0.4730 | 6.216 | 178.7 | 5951 | 184.7 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.5856 | 0.4376 | 7.173 | 180.0 | 6352 | 186.0 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 6 | 0.6449 | 0.4810 | 7.000 | 178.9 | 5861 | 185.9 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 20

## 5.3 Log of red fish data and untransformed inflow data

***Table 5.3*** *Regression Models for Dependent Variable: Ln(RED) on INFLOWS*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.3498 | 0.3136 | 6.251 | -21.67 | 0.3078 | -19.68 | QMJ_LAG |
| 1 | 0.3202 | 0.2824 | 7.263 | -20.78 | 0.3218 | -18.79 | QSO_LAG |
| 1 | 0.1741 | 0.1282 | 12.26 | -16.89 | 0.3909 | -14.90 | QJA_LAG |
| 1 | 0.1417 | 0.0940 | 13.37 | -16.12 | 0.4063 | -14.13 | QJF_LAG |
| 2 | 0.4779 | 0.4165 | 3.866 | -24.06 | 0.2617 | -21.08 | QMJ_LAG QJA_LAG |
| 2 | 0.4456 | 0.3804 | 4.970 | -22.86 | 0.2778 | -19.88 | QJA_LAG QSO_LAG |
| 2 | 0.4324 | 0.3656 | 5.423 | -22.39 | 0.2845 | -19.41 | QJF_LAG QSO_LAG |
| 2 | 0.3935 | 0.3221 | 6.755 | -21.07 | 0.3040 | -18.08 | QJF_LAG QMJ_LAG |
| 3 | 0.5249 | 0.4358 | 4.259 | -23.95 | 0.2530 | -19.97 | QJF_LAG QJA_LAG QSO_LAG |
| 3 | 0.5031 | 0.4100 | 5.003 | -23.05 | 0.2646 | -19.07 | QJF_LAG QMJ_LAG QJA_LAG |
| 3 | 0.5016 | 0.4082 | 5.054 | -22.99 | 0.2654 | -19.01 | QMA_LAG QJA_LAG QSO_LAG |
| 3 | 0.5012 | 0.4077 | 5.068 | -22.98 | 0.2656 | -18.99 | QMJ_LAG QJA_LAG QSO_LAG |
| 4 | 0.5744 | 0.4609 | 4.563 | -24.15 | 0.2417 | -19.17 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG |
| 4 | 0.5648 | 0.4488 | 4.891 | -23.71 | 0.2472 | -18.73 | QJF_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.5588 | 0.4412 | 5.097 | -23.43 | 0.2506 | -18.45 | QJF_LAG QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.5442 | 0.4226 | 5.599 | -22.78 | 0.2589 | -17.80 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.6201 | 0.4844 | 5.001 | -24.42 | 0.2312 | -18.45 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.5964 | 0.4522 | 5.813 | -23.21 | 0.2457 | -17.24 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.5770 | 0.4259 | 6.476 | -22.27 | 0.2575 | -16.30 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.5593 | 0.4018 | 7.082 | -21.45 | 0.2682 | -15.48 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 6 | 0.6201 | 0.4448 | 7.000 | -22.42 | 0.2490 | -15.45 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 20

## 5.4 Log of red fish data and log of inflow data

***Table 5.4*** *Regression Models for Dependent Variable: Ln(RED) on Ln(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.3262 | 0.2887 | 15.02 | -20.96 | 0.3190 | -18.97 | LN_QMJ |
| 1 | 0.2490 | 0.2072 | 18.57 | -18.79 | 0.3555 | -16.80 | LN_QSO |
| 1 | 0.0706 | 0.0189 | 26.78 | -14.53 | 0.4400 | -12.54 | LN_QJA |
| 1 | 0.0559 | 0.0034 | 27.46 | -14.22 | 0.4469 | -12.22 | LN_QJF |
| 2 | 0.4800 | 0.4188 | 9.937 | -24.14 | 0.2606 | -21.16 | LN_QMJ LN_QJA |
| 2 | 0.4500 | 0.3853 | 11.32 | -23.02 | 0.2757 | -20.04 | LN_QMA LN_QMJ |
| 2 | 0.4104 | 0.3410 | 13.14 | -21.63 | 0.2955 | -18.64 | LN_QJF LN_QMJ |
| 2 | 0.4007 | 0.3302 | 13.59 | -21.30 | 0.3004 | -18.32 | LN_QMJ LN_QSO |
| 3 | 0.5638 | 0.4820 | 8.080 | -25.66 | 0.2323 | -21.67 | LN_QJF LN_QMJ LN_QJA |
| 3 | 0.5570 | 0.4739 | 8.392 | -25.35 | 0.2359 | -21.37 | LN_QMJ LN_QJA LN_QSO |
| 3 | 0.5292 | 0.4409 | 9.672 | -24.13 | 0.2507 | -20.15 | LN_QMA LN_QMJ LN_QJA |
| 3 | 0.5149 | 0.4239 | 10.33 | -23.53 | 0.2584 | -19.55 | LN_QJF LN_QMJ LN_QSO |
| 4 | 0.6757 | 0.5892 | 4.930 | -29.58 | 0.1842 | -24.61 | LN_QJF LN_QMA LN_QJA LN_QSO |
| 4 | 0.6711 | 0.5834 | 5.138 | -29.31 | 0.1868 | -24.33 | LN_QJF LN_QMJ LN_QJA LN_QSO |
| 4 | 0.6510 | 0.5579 | 6.065 | -28.12 | 0.1982 | -23.14 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 4 | 0.5721 | 0.4580 | 9.697 | -24.04 | 0.2431 | -19.06 | LN_QJF LN_QMA LN_QMJ LN_QJA |
| 5 | 0.7092 | 0.6054 | 5.385 | -29.77 | 0.1770 | -23.79 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.6904 | 0.5798 | 6.253 | -28.51 | 0.1885 | -22.54 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.6882 | 0.5769 | 6.352 | -28.37 | 0.1898 | -22.40 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.6571 | 0.5346 | 7.784 | -26.47 | 0.2087 | -20.50 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 6 | 0.7176 | 0.5872 | 7.000 | -28.35 | 0.1851 | -21.38 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 20

## 5.5 Log of red fish data and square root of inflow data

***Table 5.5*** *Regression Models for Dependent Variable: Ln(RED) on Sqrt(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.3568 | 0.3210 | 10.32 | -21.89 | 0.3045 | -19.90 | SQR_QMJ |
| 1 | 0.3007 | 0.2618 | 12.61 | -20.22 | 0.3310 | -18.23 | SQR_QSO |
| 1 | 0.1210 | 0.0722 | 19.96 | -15.64 | 0.4161 | -13.65 | SQR_QJA |
| 1 | 0.1062 | 0.0565 | 20.57 | -15.31 | 0.4231 | -13.32 | SQR_QJF |
| 2 | 0.4956 | 0.4363 | 6.636 | -24.75 | 0.2528 | -21.77 | SQR_QMJ SQR_QJA |
| 2 | 0.4280 | 0.3607 | 9.403 | -22.24 | 0.2867 | -19.25 | SQR_QJF SQR_QSO |
| 2 | 0.4200 | 0.3518 | 9.729 | -21.96 | 0.2907 | -18.97 | SQR_QJA SQR_QSO |
| 2 | 0.4135 | 0.3445 | 9.998 | -21.74 | 0.2940 | -18.75 | SQR_QMA SQR_QMJ |
| 3 | 0.5379 | 0.4513 | 6.906 | -24.51 | 0.2461 | -20.52 | SQR_QMJ SQR_QJA SQR_QSO |
| 3 | 0.5350 | 0.4478 | 7.025 | -24.38 | 0.2476 | -20.40 | SQR_QJF SQR_QMJ SQR_QJA |
| 3 | 0.5281 | 0.4397 | 7.306 | -24.09 | 0.2513 | -20.10 | SQR_QJF SQR_QJA SQR_QSO |
| 3 | 0.5200 | 0.4300 | 7.639 | -23.75 | 0.2556 | -19.76 | SQR_QMJ SQR_QJA SQR_QND |
| 4 | 0.6333 | 0.5355 | 5.004 | -27.13 | 0.2083 | -22.15 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO |
| 4 | 0.6196 | 0.5181 | 5.566 | -26.39 | 0.2161 | -21.42 | SQR_QJF SQR_QMJ SQR_QJA SQR_QND |
| 4 | 0.5992 | 0.4924 | 6.398 | -25.35 | 0.2277 | -20.37 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO |
| 4 | 0.5536 | 0.4346 | 8.264 | -23.20 | 0.2536 | -18.22 | SQR_QJF SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.6796 | 0.5651 | 5.111 | -27.83 | 0.1950 | -21.85 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.6606 | 0.5394 | 5.886 | -26.68 | 0.2065 | -20.70 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.6335 | 0.5026 | 6.997 | -25.14 | 0.2231 | -19.16 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO |
| 5 | 0.6211 | 0.4858 | 7.502 | -24.48 | 0.2306 | -18.50 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QND |
| 6 | 0.6823 | 0.5356 | 7.000 | -26.00 | 0.2082 | -19.03 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

N = 20

## 5.6 Square root of red fish data and log of inflow data

***Table 5.6*** *Regression Models for Dependent Variable: Sqrt(RED) on Ln(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.3201 | 0.2823 | 13.32 | 50.19 | 11.19 | 52.18 | LN_QMJ |
| 1 | 0.2491 | 0.2073 | 16.39 | 52.18 | 12.36 | 54.17 | LN_QSO |
| 1 | 0.0651 | 0.0132 | 24.32 | 56.56 | 15.38 | 58.55 | LN_QJA |
| 1 | 0.0613 | 0.0091 | 24.49 | 56.64 | 15.45 | 58.63 | LN_QJF |
| 2 | 0.4711 | 0.4089 | 8.809 | 47.16 | 9.21 | 50.15 | LN_QMA LN_QMJ |
| 2 | 0.4648 | 0.4019 | 9.081 | 47.40 | 9.32 | 50.39 | LN_QMJ LN_QJA |
| 2 | 0.4107 | 0.3413 | 11.42 | 49.33 | 10.27 | 52.32 | LN_QJF LN_QMJ |
| 2 | 0.3961 | 0.3251 | 12.04 | 49.82 | 10.52 | 52.80 | LN_QMJ LN_QSO |
| 3 | 0.5550 | 0.4715 | 7.193 | 45.71 | 8.24 | 49.69 | LN_QJF LN_QMJ LN_QJA |
| 3 | 0.5433 | 0.4577 | 7.696 | 46.23 | 8.45 | 50.21 | LN_QMJ LN_QJA LN_QSO |
| 3 | 0.5356 | 0.4486 | 8.027 | 46.56 | 8.60 | 50.55 | LN_QMA LN_QMJ LN_QJA |
| 3 | 0.5181 | 0.4277 | 8.784 | 47.30 | 8.92 | 51.29 | LN_QJF LN_QMJ LN_QSO |
| 4 | 0.6652 | 0.5760 | 4.438 | 42.02 | 6.61 | 47.00 | LN_QJF LN_QMJ LN_QJA LN_QSO |
| 4 | 0.6476 | 0.5537 | 5.197 | 43.04 | 6.96 | 48.02 | LN_QJF LN_QMA LN_QJA LN_QSO |
| 4 | 0.6337 | 0.5360 | 5.798 | 43.82 | 7.23 | 48.80 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 4 | 0.5735 | 0.4597 | 8.396 | 46.86 | 8.42 | 51.84 | LN_QJF LN_QMA LN_QMJ LN_QJA |
| 5 | 0.6969 | 0.5886 | 5.074 | 42.03 | 6.41 | 48.01 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.6713 | 0.5540 | 6.175 | 43.65 | 6.95 | 49.62 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.6578 | 0.5355 | 6.760 | 44.46 | 7.24 | 50.43 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.6490 | 0.5236 | 7.140 | 44.97 | 7.43 | 50.94 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 6 | 0.6986 | 0.5595 | 7.000 | 43.92 | 6.87 | 50.89 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 20

## 5.7 Various transformation suggested by Box-Cox

***Table 5.7*** *Regression Models for Dependent Variable: Sqrt(RED) on variously transformed INFLOWS.*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.3568 | 0.3210 | 10.05 | -94.71 | 0.0080 | -92.72 | QR_QMJ |
| 1 | 0.2955 | 0.2564 | 12.53 | -92.89 | 0.0087 | -90.90 | QR_QSO |
| 1 | 0.0777 | 0.0264 | 21.35 | -87.50 | 0.0114 | -85.51 | QR_QJF |
| 1 | 0.0522 | -.0004 | 22.38 | -86.96 | 0.0118 | -84.97 | QR_QJA |
| 2 | 0.4761 | 0.4145 | 7.215 | -96.82 | 0.0069 | -93.83 | QR_QMJ QR_QJA |
| 2 | 0.4231 | 0.3552 | 9.362 | -94.89 | 0.0076 | -91.90 | QR_QMA QR_QMJ |
| 2 | 0.4153 | 0.3465 | 9.679 | -94.62 | 0.0077 | -91.63 | QR_QJF QR_QMJ |
| 2 | 0.4108 | 0.3415 | 9.859 | -94.47 | 0.0077 | -91.48 | QR_QMJ QR_QSO |
| 3 | 0.5358 | 0.4488 | 6.797 | -97.24 | 0.0065 | -93.25 | QR_QJF QR_QMJ QR_QJA |
| 3 | 0.5190 | 0.4288 | 7.480 | -96.52 | 0.0067 | -92.54 | QR_QMJ QR_QJA QR_QSO |
| 3 | 0.5046 | 0.4117 | 8.063 | -95.93 | 0.0069 | -91.95 | QR_QMJ QR_QJA QR_QND |
| 3 | 0.4956 | 0.4010 | 8.428 | -95.57 | 0.0070 | -91.59 | QR_QMA QR_QMJ QR_QJA |
| 4 | 0.6359 | 0.5388 | 4.744 | -100.1 | 0.0054 | -95.12 | QR_QJF QR_QMJ QR_QJA QR_QND |
| 4 | 0.6230 | 0.5225 | 5.266 | -99.40 | 0.0056 | -94.42 | QR_QJF QR_QMA QR_QJA QR_QSO |
| 4 | 0.5985 | 0.4914 | 6.261 | -98.14 | 0.0060 | -93.16 | QR_QJF QR_QMJ QR_QJA QR_QSO |
| 4 | 0.5390 | 0.4161 | 8.669 | -95.37 | 0.0069 | -90.39 | QR_QJF QR_QMA QR_QMJ QR_QJA |
| 5 | 0.6650 | 0.5454 | 5.566 | -99.76 | 0.0053 | -93.78 | QR_QJF QR_QMJ QR_QJA QR_QSO QR_QND |
| 5 | 0.6609 | 0.5398 | 5.733 | -99.51 | 0.0054 | -93.54 | QR_QJF QR_QMA QR_QJA QR_QSO QR_QND |
| 5 | 0.6375 | 0.5080 | 6.681 | -98.18 | 0.0058 | -92.20 | QR_QJF QR_QMA QR_QMJ QR_QJA QR_QND |
| 5 | 0.6265 | 0.4931 | 7.126 | -97.58 | 0.0060 | -91.61 | QR_QJF QR_QMA QR_QMJ QR_QJA QR_QSO |
| 6 | 0.6790 | 0.5308 | 7.000 | -98.61 | 0.0055 | -91.64 | QR_QJF QR_QMA QR_QMJ QR_QJA QR_QSO QR_QND |

N = 20

Dependent Variable: $(RED)^{0.1}$

Independent Variables:
- *QR_QJF*=(January-February Inflows)$^{0.2}$
- *QR_QMA*=(March-April Inflows)$^{0.7}$
- *QR_QMJ*=(May-June Inflows)$^{0.4}$
- *QR_QMJ*=(July-August Inflows)$^{-0.2}$
- *QR_QND*=(September-October Inflows)$^{0.4}$
- *QR_QND*=(November-December Inflows)$^{-0.1}$

# 6. Regression for the Best Models

## 6.1 Regression - Log of red fish data on log of inflow data

### 6.1.1 ANOVA and Parameter Estimates

***Table 6.1*** *Model Summary for log of red fish data on log of inflow data.*

**Model Summary[a,b]**

| | Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|
| | Ln(November-December), Ln(March-April), Ln(September-October), Ln(July-August), Ln(January-February), Ln(May-June)[c,d] | .847 | .718 | .587 | .430239 | 2.086 |

a. Dependent Variable: Ln(Red Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Ln(November-December Inflows), Ln(March-April Inflows), Ln(September-October Inflows), Ln(July-August Inflows), Ln(January-February Inflows), Ln(May-June Inflows)

d. All requested variables entered.

***Table 6.2*** *ANOVA table of log of red fish data on log of inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 6.114 | 6 | 1.019 | 5.505 | .005[b] |
| | Residual | 2.406 | 13 | .185 | | |
| | Total | 8.520 | 19 | | | |

a. Dependent Variable: Ln(Red Harvest)

b. Independent Variables: (Constant), Ln(November-December Inflows), Ln(March-April Inflows), Ln(September-October Inflows), Ln(July-August Inflows), Ln(January-February Inflows), Ln(May-June Inflows)

***Table 6.3*** *Table of coefficients for log of red fish data on log of inflow data.*

**Coefficients**[a]

| | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| (Constant) | 4.483 | .847 | | 5.292 | .000 | 2.653 | 6.313 |
| Ln(January-February) | -.347 | .136 | -.511 | -2.557 | .024 | -.640 | -.054 |
| Ln(March-April) | .184 | .296 | .224 | .621 | .546 | -.456 | .823 |
| Ln(May-June) | .284 | .254 | .406 | 1.119 | .283 | -.264 | .832 |
| Ln(July-August) | -.468 | .167 | -.488 | -2.797 | .015 | -.829 | -.106 |
| Ln(September-October) | .170 | .102 | .378 | 1.669 | .119 | -.050 | .391 |
| Ln(November-December) | .140 | .120 | .215 | 1.163 | .266 | -.120 | .400 |

a. Dependent Variable: Ln(Red Harvest)

### 6.1.2 Collinearity Diagnostic

***Table 6.4*** *Variance Inflation for log of red fish data on log of inflow data.*

**Coefficients**[a]

| | t | Collinearity Statistics | |
|---|---|---|---|
| | | Tolerance | VIF |
| (Constant) | 5.292 | | |
| Ln(January-February) | -2.557 | .543 | 1.842 |
| Ln(March-April) | .621 | .167 | 6.006 |
| Ln(May-June) | 1.119 | .165 | 6.067 |
| Ln(July-August) | -2.797 | .714 | 1.400 |
| Ln(September-October) | 1.669 | .424 | 2.358 |
| Ln(November-December) | 1.163 | .633 | 1.579 |

a. Dependent Variable: Ln(Red Harvest)

***Table 6.5*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(RED) on Ln(INFLOWS):*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *LN_QJF* | Var Prop *LN_QMA* | Var Prop *LN_QMJ* | Var Prop *LN_QJA* | Var Prop *LN_QSO* | Var Prop *LN_QND* |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.24535 | 1.00000 | 0.0274 | 0.0241 | 0.0212 | 0.0327 | 0.0247 | 0.0110 |
| 2 | 1.43658 | 1.25019 | 0.1023 | 0.0059 | 0.0160 | 0.0111 | 0.0095 | 0.2134 |
| 3 | 0.97499 | 1.51755 | 0.0190 | 0.0119 | 0.0139 | 0.2247 | 0.2166 | 0.0058 |
| 4 | 0.86292 | 1.61308 | 0.1375 | 0.0169 | 0.0042 | 0.3880 | 0.0761 | 0.0354 |
| 5 | 0.40587 | 2.35205 | 0.4349 | 0.0235 | 0.0207 | 0.1365 | 0.0844 | 0.6372 |
| 6 | 0.07428 | 5.49791 | 0.2789 | 0.9177 | 0.9240 | 0.2070 | 0.5886 | 0.0972 |

### 6.1.3 Residuals Diagnostics

***Table 6.6*** *Residuals Diagnostics for log of red fish data on log of inflow data.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 3.657249 | 5.961111 | 4.871218 | .567267 | 20 |
| Std. Predicted Value | -2.140 | 1.921 | .000 | 1.000 | 20 |
| Standard Error of Predicted Value | .178181 | .326076 | .250219 | 4.8E-02 | 20 |
| Adjusted Predicted Value | 3.390635 | 5.779921 | 4.885558 | .593180 | 20 |
| Residual | -.525708 | .834603 | -5.8E-16 | .355881 | 20 |
| Std. Residual | -1.222 | 1.940 | .000 | .827 | 20 |
| Stud. Residual | -1.428 | 2.476 | -.011 | 1.065 | 20 |
| Deleted Residual | -.847800 | 1.360220 | -1.4E-02 | .599327 | 20 |
| Stud. Deleted Residual | -1.495 | 3.274 | .034 | 1.202 | 20 |
| Mahal. Distance | 2.309 | 9.964 | 5.700 | 2.483 | 20 |
| Cook's Distance | .000 | .552 | .110 | .157 | 20 |
| Centered Leverage Value | .122 | .524 | .300 | .131 | 20 |

a. Dependent Variable: Ln(Red Harvest)

***Table 6.7*** *Case Values for Residuals Diagnostics for log of red fish data on log of inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1961 | 4.7830 | -.0619 | -.0865 | 4.8076 | -.1555 | -.1438 | -.1700 | -.1635 |
| 1962 | 4.8653 | -.2171 | -.2920 | 4.9402 | -.0104 | -.5046 | -.5852 | -.5698 |
| 1963 | 4.6179 | -.3794 | -.8478 | 5.0862 | -.4466 | -.8819 | -1.3183 | -1.3608 |
| 1964 | 4.3814 | -.2178 | -.5119 | 4.6754 | -.8635 | -.5063 | -.7761 | -.7636 |
| 1965 | 3.9277 | .5575 | 1.0946 | 3.3906 | -1.6632 | 1.2958 | 1.8157 | 2.0193 |
| 1966 | 4.5068 | -.4940 | -.7647 | 4.7774 | -.6425 | -1.1481 | -1.4285 | -1.4948 |
| 1967 | 4.8922 | -.2325 | -.4090 | 5.0687 | .0370 | -.5405 | -.7168 | -.7027 |
| 1968 | 5.5456 | -.5257 | -.6926 | 5.7126 | 1.1889 | -1.2219 | -1.4025 | -1.4627 |
| 1969 | 4.9401 | .1394 | .2428 | 4.8367 | .1215 | .3240 | .4276 | .4138 |
| 1970 | 5.2435 | .1600 | .1932 | 5.2104 | .6563 | .3720 | .4087 | .3952 |
| 1971 | 4.7417 | .8346 | 1.3602 | 4.2161 | -.2283 | 1.9399 | 2.4765 | *3.2737 |
| 1972 | 5.4361 | -.0024 | -.0030 | 5.4367 | .9958 | -.0055 | -.0062 | -.0059 |
| 1973 | 5.4795 | .0176 | .0219 | 5.4753 | 1.0724 | .0410 | .0457 | .0439 |
| 1974 | 5.6561 | -.0142 | -.0175 | 5.6594 | 1.3836 | -.0329 | -.0366 | -.0351 |
| 1975 | 5.9611 | .2216 | .4028 | 5.7799 | 1.9213 | .5150 | .6944 | .6799 |
| 1976 | 4.8665 | .1993 | .3294 | 4.7364 | -.0083 | .4632 | .5955 | .5801 |
| 1977 | 4.7971 | .0036 | .0051 | 4.7957 | -.1306 | .0084 | .0100 | .0096 |
| 1978 | 4.5392 | -.2257 | -.3360 | 4.6495 | -.5853 | -.5246 | -.6401 | -.6249 |
| 1979 | 4.5862 | .5479 | .7171 | 4.4170 | -.5025 | 1.2734 | 1.4568 | 1.5301 |
| 1980 | 3.6572 | -.3109 | -.6930 | 4.0394 | -2.1400 | -.7225 | -1.0788 | -1.0862 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that observation |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.
[2]This is flagged if it exceeds $t_{n-p-2,\alpha}=t_{12,0.01}=2.681$.

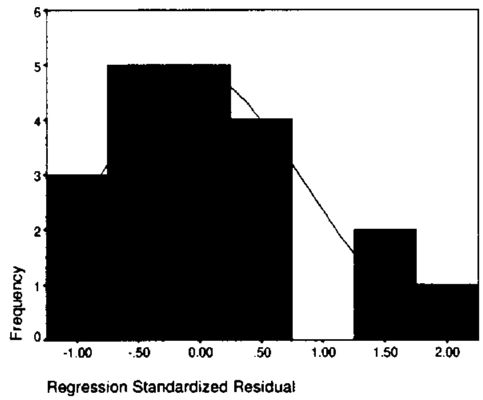


***Figure 6.1*** *Histogram of Standardized Residuals.*

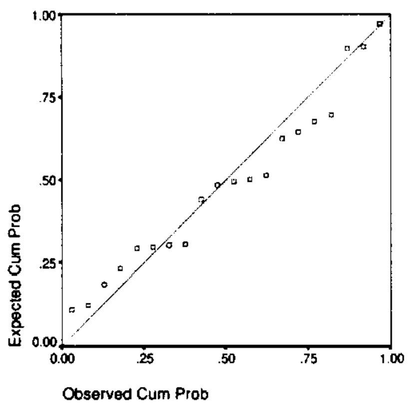


***Figure 6.2*** *Normal P-P Plot of Residuals.*

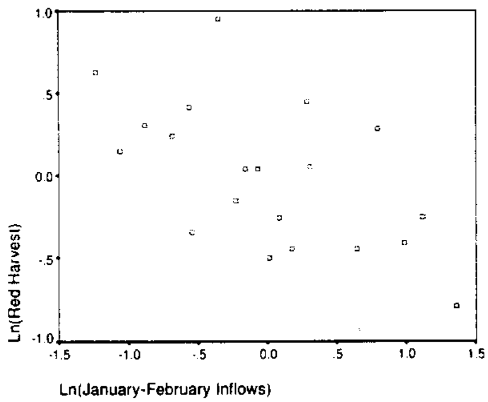


***Figure 6.3*** *Partial Residual Plot for Ln(January-February Inflows).*

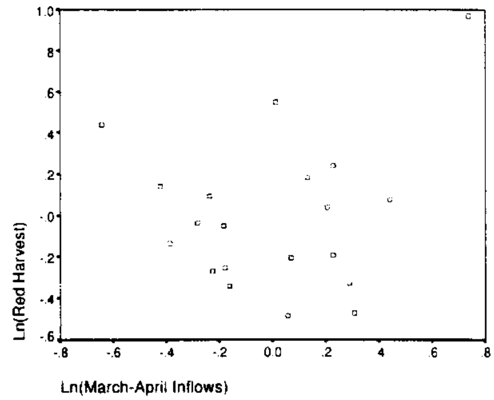


***Figure 6.4*** *Partial Residual Plot for Ln(March-April Inflows).*

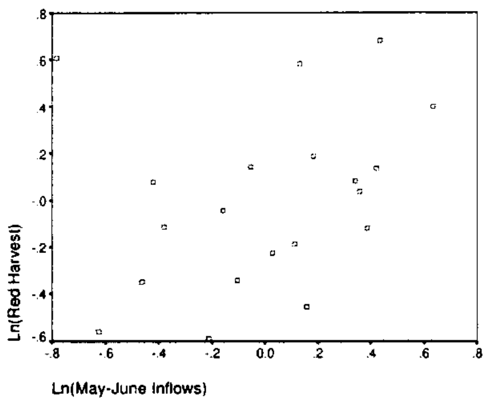


***Figure 6.5*** *Partial Residual Plot for Ln(May-June Inflows).*

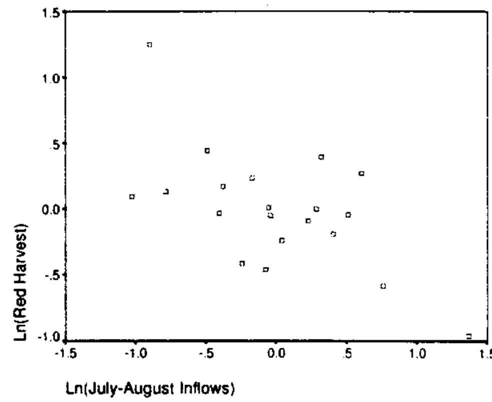


***Figure 6.6*** *Partial Residual Plot for Ln(July-August Inflows).*

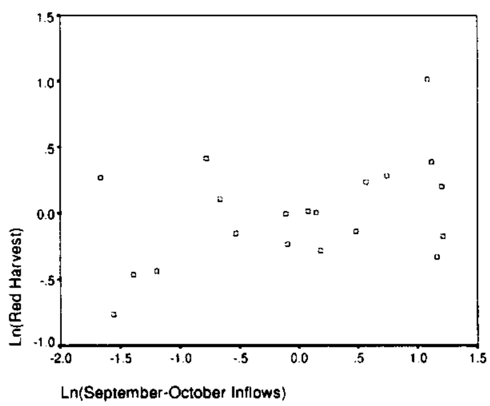


***Figure 6.7*** *Partial Residual Plot for Ln(September-October Inflows).*

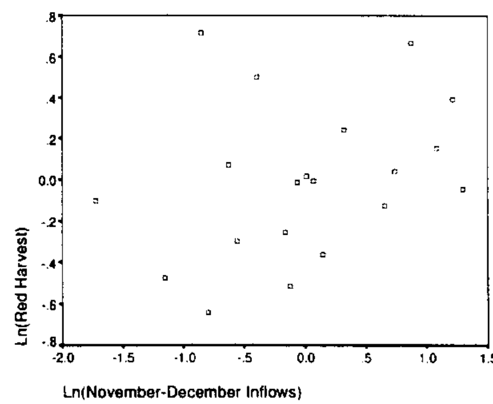


***Figure 6.8*** *Partial Residual Plot for Ln(November-December Inflows).*

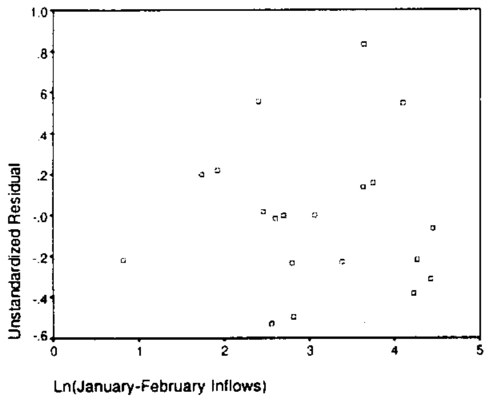


***Figure 6.9*** *Residuals Plot for Ln(January-February Inflows).*

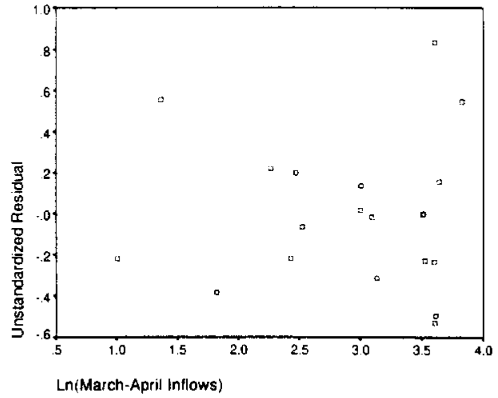


***Figure 6.10*** *Residuals Plot for Ln(March-April Inflows).*

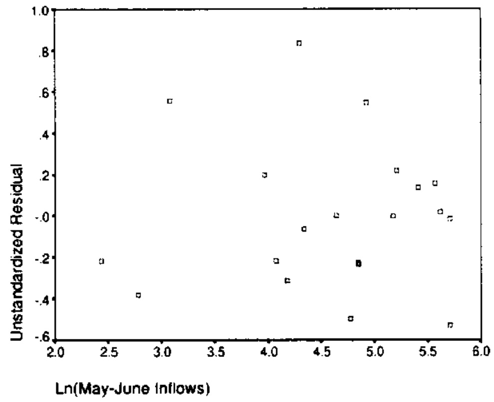


***Figure 6.11*** *Residuals Plot for Ln(May-June Inflows).*

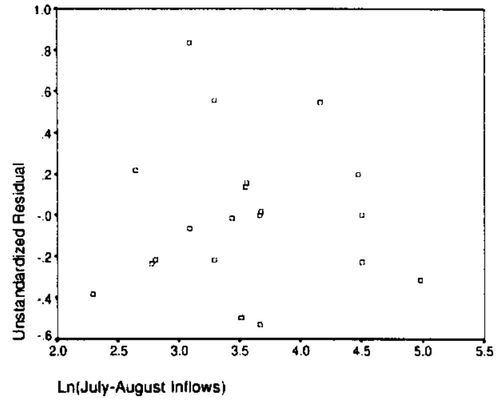


***Figure 6.12*** *Residuals Plot for Ln(July-August Inflows).*

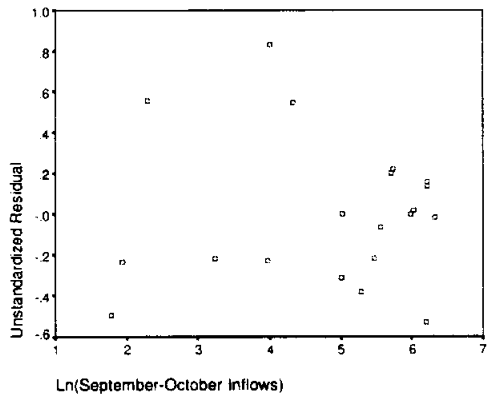


***Figure 6.13*** *Residuals Plot for Ln(September-October Inflows).*

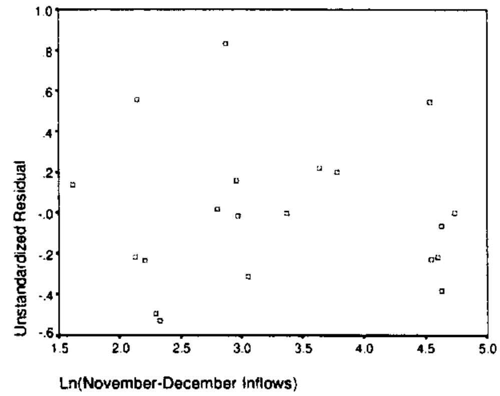


***Figure 6.14*** *Residuals Plot for Ln(November-December Inflows).*

### 6.1.4 Prediction Intervals for Red fish Harvest

***Table 6.8*** *Prediction Intervals for Red fish Harvest.*

| YEAR | *LICI_1* | *LN_RED* | *UICI_1* |
|---|---|---|---|
| 1961 | 3.3142 | 4.7212 | 6.2518 |
| 1962 | 3.4126 | 4.6482 | 6.3180 |
| 1963 | 3.0031 | 4.2384 | 6.2327 |
| 1964 | 2.7552 | 4.1636 | 6.0076 |
| 1965 | 2.3454 | 4.4853 | 5.5101 |
| 1966 | 2.9987 | 4.0128 | 6.0148 |
| 1967 | 3.3416 | 4.6597 | 6.4428 |
| 1968 | 4.1019 | 5.0199 | 6.9894 |
| 1969 | 3.3926 | 5.0795 | 6.4877 |
| 1970 | 3.8408 | 5.4036 | 6.6463 |
| 1971 | 3.2157 | 5.5763 | 6.2677 |
| 1972 | 4.0178 | 5.4337 | 6.8544 |
| 1973 | 4.0635 | 5.4972 | 6.8955 |
| 1974 | 4.2421 | 5.6419 | 7.0700 |
| 1975 | 4.4006 | 6.1827 | 7.5216 |
| 1976 | 3.3357 | 5.0658 | 6.3972 |
| 1977 | 3.3257 | 4.8007 | 6.2685 |
| 1978 | 3.0455 | 4.3135 | 6.0328 |
| 1979 | 3.1454 | 5.1340 | 6.0270 |
| 1980 | 2.0430 | 3.3464 | 5.2715 |

*LICI_1* Lower limit for 99% prediction interval for the natural log of red fish harvest.
*LN_RED* Natural log of red fish harvest.
*UICI_1* Upper limit for 99% prediction interval for the natural log of red fish harvest.

### 6.1.5 Outliers and Influential Point Detection

***Table 6.9*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1961 | 4.4548 | .0016 | .2345 | .7262 | .0000 |
| 1962 | 3.9221 | .0169 | .2064 | .7887 | .0000 |
| 1963 | 9.5463 | .3064 | *.5024 | .2158 | .0616 |
| 1964 | 9.9637 | .1161 | *.5244 | .1906 | .0041 |
| 1965 | 8.3728 | .4537 | .4407 | .3009 | .1493 |
| 1966 | 5.7757 | .1597 | .3040 | .5662 | .0107 |
| 1967 | 7.2474 | .0557 | .3814 | .4036 | .0004 |
| 1968 | 3.6293 | .0892 | .1910 | .8214 | .0018 |
| 1969 | 7.1420 | .0194 | .3759 | .4143 | .0000 |
| 1970 | 2.3088 | .0049 | .1215 | .9408 | .0000 |
| 1971 | 6.3920 | .5518 | .3364 | .4948 | .2186 |
| 1972 | 2.8055 | .0000 | .1477 | .9024 | .0000 |
| 1973 | 2.7314 | .0001 | .1438 | .9087 | .0000 |
| 1974 | 2.6666 | .0000 | .1403 | .9140 | .0000 |
| 1975 | 7.5971 | .0563 | .3998 | .3695 | .0004 |
| 1976 | 6.5561 | .0331 | .3451 | .4765 | .0001 |
| 1977 | 4.5407 | .0000 | .2390 | .7158 | .0000 |
| 1978 | 5.2875 | .0286 | .2783 | .6249 | .0000 |
| 1979 | 3.5331 | .0936 | .1860 | .8317 | .0021 |
| 1980 | 9.5273 | .2044 | *.5014 | .2170 | .0215 |

| | |
|---|---|
| *MAH_1* | Mahalanobis distance |
| *COOK_1* | Cook's distance |
| *LEV_1* | Leverage value |
| *MAHA_PV* | P-value associated with the Mahalanobis distance |
| *COOK_P* | P-value associated with Cook's distance |

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.

[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n$-$p$-1 denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.10*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1961 | -.1031 | .0312 | -.0603 | .0514 |
| 1962 | -.3346 | .0030 | -.1339 | .0812 |
| 1963 | *-1.5118 | -.7942 | -.1134 | -.4057 |
| 1964 | -.8871 | -.5953 | .3910 | -.0577 |
| 1965 | *1.9819 | .3276 | .7115 | *-1.2485 |
| 1966 | *-1.1065 | -.2003 | -.0062 | -.0718 |
| 1967 | -.6121 | -.2586 | .0681 | -.1468 |
| 1968 | -.8243 | -.1220 | .2888 | -.3569 |
| 1969 | .3564 | -.0334 | .1931 | -.0890 |
| 1970 | .1798 | -.0204 | .0420 | .0398 |
| 1971 | *2.5980 | *1.6632 | -.4622 | *2.1308 |
| 1972 | -.0029 | -.0007 | .0018 | -.0020 |
| 1973 | .0215 | -.0076 | -.0010 | -.0095 |
| 1974 | -.0170 | .0044 | .0020 | .0049 |
| 1975 | .6148 | -.0365 | -.1622 | -.2657 |
| 1976 | .4688 | .0436 | -.2896 | .1170 |
| 1977 | .0061 | -.0017 | -.0025 | .0016 |
| 1978 | -.4369 | .2501 | -.0198 | .1188 |
| 1979 | .8503 | -.3998 | .1564 | .0140 |
| 1980 | *-1.2044 | .3837 | -.6964 | .1806 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for log of January-February inflows |
| *SDFBET_2* | Standardized *dfbeta* for log of March-April inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

***Table 6.11*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1961 | -.0410 | .0029 | .0242 | -.0400 |
| 1962 | -.0443 | .1036 | .0146 | -.1216 |
| 1963 | .7479 | .8102 | -.5859 | -.0848 |
| 1964 | .3190 | -.0193 | -.1342 | .1821 |
| 1965 | .7257 | .6688 | *-1.1174 | -.3098 |
| 1966 | -.1720 | .0537 | .6865 | .0622 |
| 1967 | -.0156 | .2854 | .2641 | .0416 |
| 1968 | .2078 | .1574 | -.4618 | .3730 |
| 1969 | .0589 | .0610 | .0733 | -.2634 |
| 1970 | -.0138 | -.0283 | .0766 | -.0764 |
| 1971 | *-1.9296 | *-1.4568 | *1.0771 | -.9973 |
| 1972 | .0015 | .0010 | -.0019 | .0001 |
| 1973 | .0122 | .0044 | -.0013 | .0002 |
| 1974 | -.0079 | .0008 | -.0013 | -.0008 |
| 1975 | .3435 | -.1734 | -.1438 | .3116 |
| 1976 | -.1843 | .1489 | .1984 | .0683 |
| 1977 | -.0011 | .0018 | .0002 | .0034 |
| 1978 | -.1743 | -.2259 | .2517 | -.2773 |
| 1979 | .1354 | .2199 | -.3239 | .4287 |
| 1980 | .1009 | -.8654 | -.0709 | .5219 |

*SDFBET_3* Standardized *dfbeta* for log of May-June inflows
*SDFBET_4* Standardized *dfbeta* for log of July-August inflows
*SDFBET_5* Standardized *dfbeta* for log of September-October inflows
*SDFBET_6* Standardized *dfbeta* for log of November-December inflows

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p + 1) / n}$ for a large data set. The cutoff used here is 1.

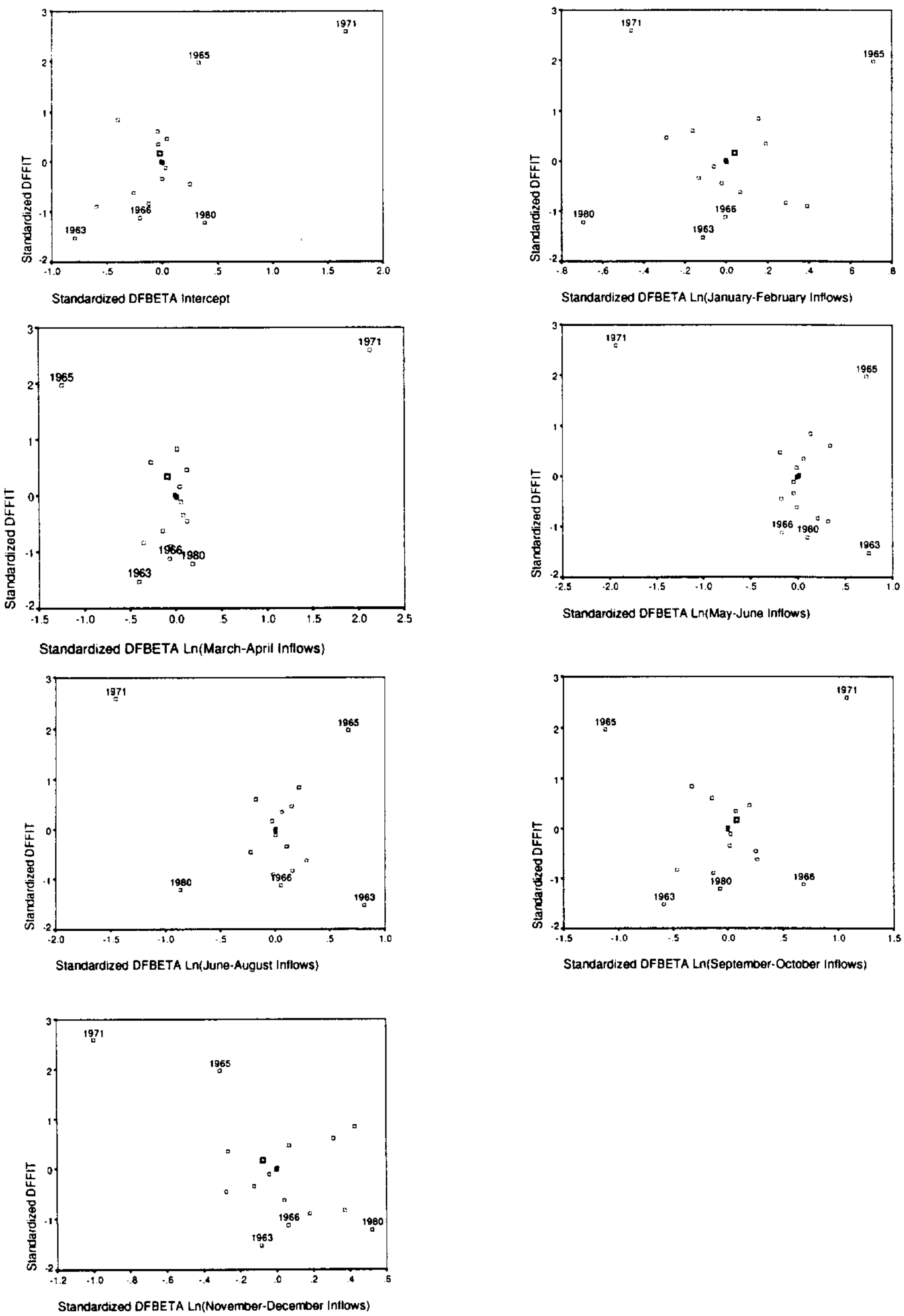


***Figure 6.15*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of log of inflow variables.*

## 6.2 Regression - Log of red fish data on square root of inflow data

### 6.2.1 ANOVA and Parameter Estimates

***Table 6.12*** *Model Summary for log of red fish data on square root of inflow data.*

**Model Summary[a,b]**

| Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| Sqrt(November-December), Sqrt(September-October), Sqrt(March-April), Sqrt(July-August), Sqrt( January-February), Sqrt(May-June)[c,d] | .826 | .682 | .536 | .456338 | 1.919 |

a. Dependent Variable: Ln(Red Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of September-October Inflows, Square Root of March-April Inflows, Square Root of July-August Inflows, Square Root of January-February Inflows, Square Root of May-June Inflows

d. All requested variables entered.

***Table 6.13*** *ANOVA table of log of red fish data on square root of inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 5.813 | 6 | .969 | 4.653 | .010[b] |
| | Residual | 2.707 | 13 | .208 | | |
| | Total | 8.520 | 19 | | | |

a. Dependent Variable: Ln(Red Harvest)

b. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of September-October Inflows, Square Root of March-April Inflows, Square Root of July-August Inflows, Square Root of January-February Inflows, Square Root of May-June Inflows

***Table 6.14*** *Table of coefficients for log of red fish data on square root of inflow data.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | 4.621 | .486 | | 9.513 | .000 | 3.571 | 5.670 |
| Sqrt(January-February) | -.135 | .058 | -.477 | -2.332 | .036 | -.260 | -.010 |
| Sqrt(March-April) | .127 | .135 | .296 | .941 | .364 | -.164 | .418 |
| Sqrt(May-June) | 2.1E-02 | .062 | .135 | .333 | .744 | -.114 | .156 |
| Sqrt(July-August) | -.131 | .051 | -.451 | -2.544 | .024 | -.241 | -.020 |
| Sqrt(September-October) | 4.4E-02 | .028 | .471 | 1.582 | .138 | -.016 | .103 |
| Sqrt(November-December) | 6.1E-02 | .043 | .275 | 1.413 | .181 | -.032 | .155 |

a. Dependent Variable: Ln(Red Harvest)

### 6.2.2 Collinearity Diagnostic

***Table 6.15*** *Collinearity Diagnostic for log of red fish data on square root of inflow data.*

**Coefficients[a]**

| | | Collinearity Statistics | |
|---|---|---|---|
| | t | Tolerance | VIF |
| (Constant) | 9.513 | | |
| Sqrt(January-February) | -2.332 | .583 | 1.714 |
| Sqrt(March-April) | .941 | .246 | 4.057 |
| Sqrt(May-June) | .333 | .148 | 6.772 |
| Sqrt(July-August) | -2.544 | .778 | 1.285 |
| Sqrt(September-October) | 1.582 | .275 | 3.635 |
| Sqrt(November-December) | 1.413 | .645 | 1.551 |

a. Dependent Variable: Ln(Red Harvest)

***Table 6.16*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(RED) on Sqrt(INFLOWS).*

| Condition | Var Prop | Var Prop | Var Prop | Var Prop | Var Prop | Var Prop | | |
|---|---|---|---|---|---|---|---|---|
| Number | Eigenvalue | Index | SQR_QJF | SQR_QMA | SQR_QMJ | SQR_QJA | SQR_QSO | SQR_QND |
| 1 | 1.96860 | 1.00000 | 0.0052 | 0.0285 | 0.0354 | 0.0081 | 0.0287 | 0.0188 |
| 1 | 1.96860 | 1.00000 | 0.0052 | 0.0285 | 0.0354 | 0.0081 | 0.0287 | 0.0188 |
| 2 | 1.63314 | 1.09791 | 0.1383 | 0.0151 | 0.0000 | 0.0717 | 0.0008 | 0.1410 |
| 3 | 1.13754 | 1.31551 | 0.0325 | 0.0363 | 0.0020 | 0.2104 | 0.0932 | 0.0343 |
| 4 | 0.74148 | 1.62941 | 0.0937 | 0.0744 | 0.0024 | 0.4848 | 0.0628 | 0.0119 |
| 5 | 0.44471 | 2.10396 | 0.5038 | 0.0170 | 0.0063 | 0.0790 | 0.0108 | 0.7302 |
| 6 | 0.07452 | 5.13961 | 0.2265 | 0.8288 | 0.9539 | 0.1459 | 0.8037 | 0.0638 |

### 6.2.3 Residuals Diagnostics

***Table 6.17*** *Residuals Diagnostics for log of red fish data on square root of inflow data.*

**Residuals Statistics**[a]

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 3.402244 | 5.658507 | 4.871218 | .553136 | 20 |
| Std. Predicted Value | -2.656 | 1.423 | .000 | 1.000 | 20 |
| Standard Error of Predicted Value | .216319 | .396765 | .266678 | 4.3E-02 | 20 |
| Adjusted Predicted Value | 3.575256 | 5.789975 | 4.869288 | .564826 | 20 |
| Residual | -.599181 | .868675 | -1.5E-15 | .377469 | 20 |
| Std. Residual | -1.313 | 1.904 | .000 | .827 | 20 |
| Stud. Residual | -1.550 | 2.427 | .003 | 1.024 | 20 |
| Deleted Residual | -.860218 | 1.412402 | 1.9E-03 | .582806 | 20 |
| Stud. Deleted Residual | -1.649 | 3.154 | .037 | 1.149 | 20 |
| Mahal. Distance | 3.319 | 13.413 | 5.700 | 2.338 | 20 |
| Cook's Distance | .000 | .527 | .079 | .123 | 20 |
| Centered Leverage Value | .175 | .706 | .300 | .123 | 20 |

a. Dependent Variable: Ln(Red Harvest)

***Table 6.18*** *Case Values for Residuals Diagnostics for log of red fish data on square root of inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1961 | 4.7191 | .0021 | .0030 | 4.7182 | -.2750 | .0045 | .0054 | .0052 |
| 1962 | 4.8214 | -.1732 | -.2372 | 4.8855 | -.0900 | -.3796 | -.4442 | -.4301 |
| 1963 | 4.7305 | -.4921 | -.8602 | 5.0987 | -.2543 | -1.0784 | -1.4257 | -1.4914 |
| 1964 | 4.4166 | -.2530 | -.4408 | 4.6044 | -.8219 | -.5544 | -.7318 | -.7181 |
| 1965 | 4.1611 | .3242 | .5207 | 3.9645 | -1.2838 | .7104 | .9003 | .8933 |
| 1966 | 4.6120 | -.5992 | -.8346 | 4.8474 | -.4687 | -1.3130 | -1.5497 | -1.6490 |
| 1967 | 4.8540 | -.1944 | -.2995 | 4.9591 | -.0311 | -.4259 | -.5287 | -.5135 |
| 1968 | 5.6169 | -.5970 | -.7700 | 5.7900 | 1.3482 | -1.3083 | -1.4858 | -1.5667 |
| 1969 | 5.0236 | .0560 | .0787 | 5.0008 | .2754 | .1227 | .1455 | .1399 |
| 1970 | 5.3394 | .0642 | .0833 | 5.3203 | .8464 | .1406 | .1602 | .1540 |
| 1971 | 4.7077 | .8687 | 1.4124 | 4.1639 | -.2957 | 1.9036 | 2.4273 | *3.1538 |
| 1972 | 5.4962 | -.0625 | -.0869 | 5.5206 | 1.1299 | -.1369 | -.1614 | -.1552 |
| 1973 | 5.3947 | .1025 | .1362 | 5.3610 | .9463 | .2246 | .2589 | .2494 |
| 1974 | 5.6585 | -.0166 | -.0216 | 5.6635 | 1.4233 | -.0364 | -.0415 | -.0399 |
| 1975 | 5.6028 | .5799 | .8768 | 5.3059 | 1.3227 | 1.2707 | 1.5625 | 1.6657 |
| 1976 | 4.8287 | .2371 | .4862 | 4.5795 | -.0769 | .5195 | .7440 | .7305 |
| 1977 | 4.8992 | -.0985 | -.1582 | 4.9589 | .0506 | -.2158 | -.2735 | -.2635 |
| 1978 | 4.5361 | -.2226 | -.3687 | 4.6822 | -.6058 | -.4879 | -.6279 | -.6126 |
| 1979 | 4.6036 | .5304 | .7481 | 4.3860 | -.4838 | 1.1623 | 1.3804 | 1.4356 |
| 1980 | 3.4022 | -.0559 | -.2289 | 3.5753 | -2.6557 | -.1224 | -.2478 | -.2386 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that observation |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.
[2]This is flagged if it exceeds $t_{n-p-2,\alpha}=t_{12,0.01}=2.681$.

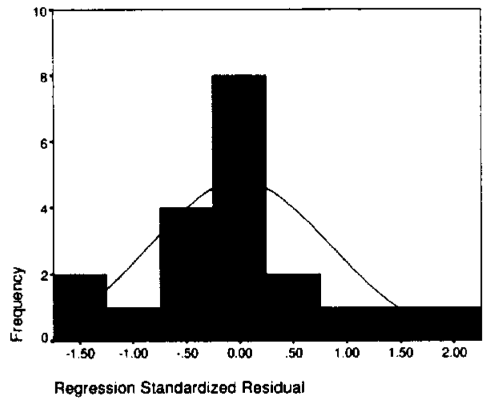


***Figure 6.16*** *Histogram of Standardized Residuals.*

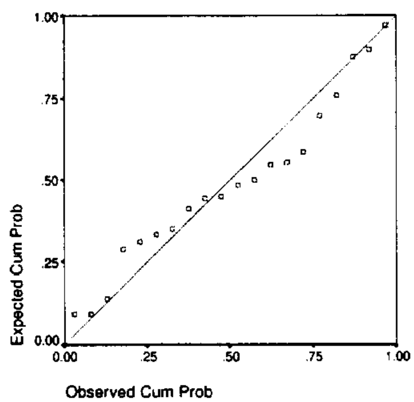


***Figure 6.17*** *Normal P-P Plot of Residuals.*

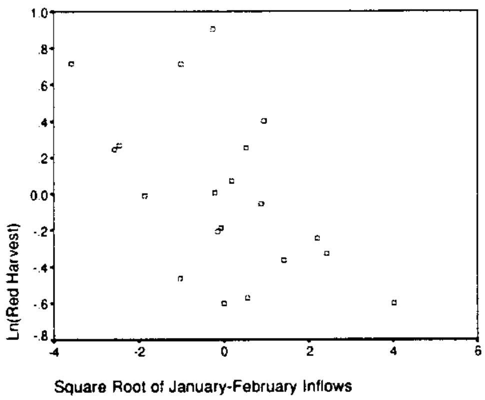


***Figure 6.18*** *Partial Residual Plot for Sqrt(January-February Inflows).*

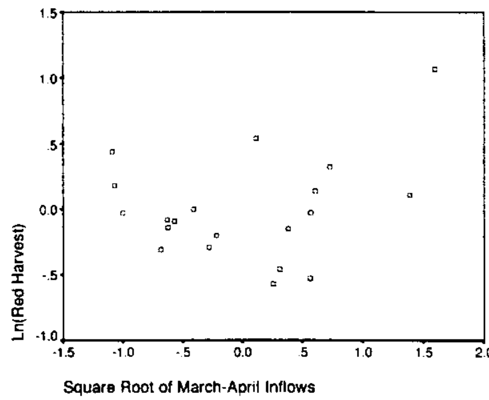


***Figure 6.19*** *Partial Residual Plot for Sqrt(March-April Inflows).*

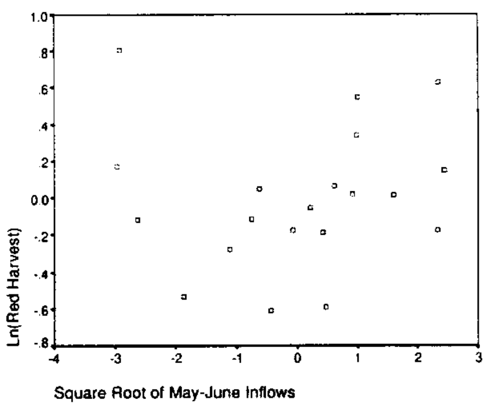


***Figure 6.20*** *Partial Residual Plot for Sqrt(May-June Inflows).*

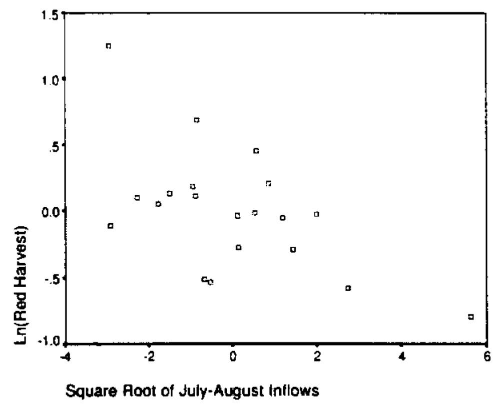


***Figure 6.21*** *Partial Residual Plot for Sqrt(July-August Inflows).*

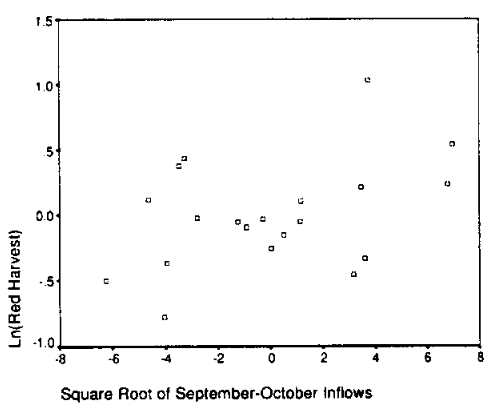


***Figure 6.22*** *Partial Residual Plot for Sqrt(September-October Inflows).*

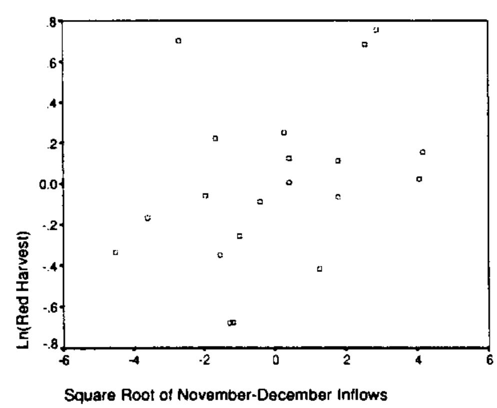


***Figure 6.23*** *Partial Residual Plot for Sqrt(November-December Inflows).*

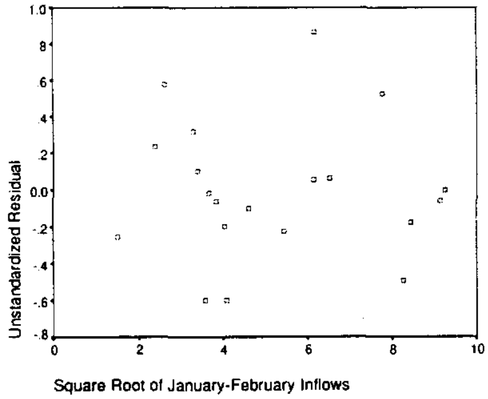


***Figure 6.24*** *Residuals Plot for Sqrt(January-February Inflows).*

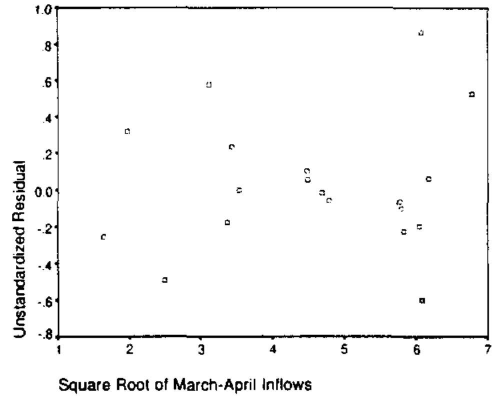


***Figure 6.25*** *Residuals Plot for Sqrt(March-April Inflows).*

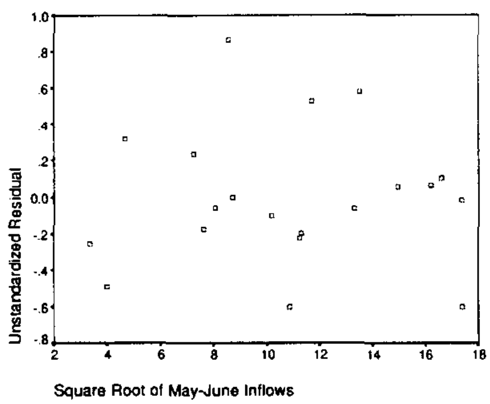


***Figure 6.26*** *Residuals Plot for Sqrt(May-June Inflows).*

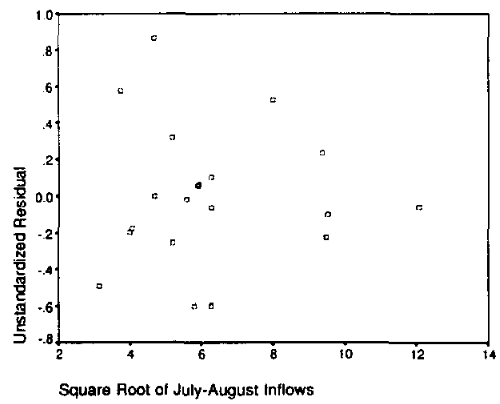


***Figure 6.27*** *Residuals Plot for Sqrt(July-August Inflows).*

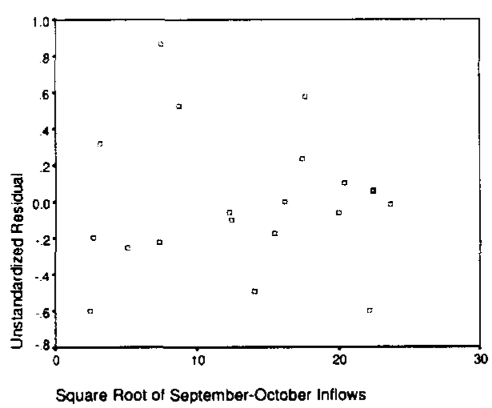


***Figure 6.28*** *Residuals Plot for Sqrt(September-October Inflows).*

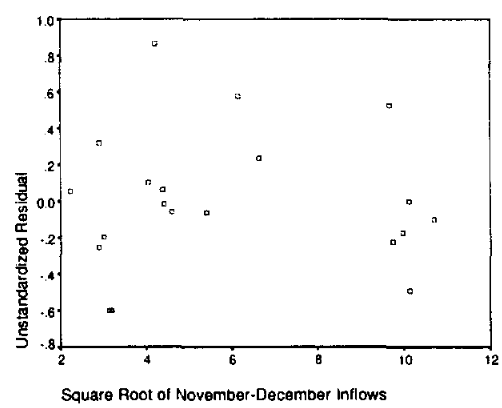


***Figure 6.29*** *Residuals Plot for Sqrt(November-December Inflows).*

### 6.2.4 Prediction Intervals for Red fish Harvest

***Table 6.19*** *Prediction Intervals for Red fish Harvest.*

| YEAR | *LICI_1* | *LN_RED* | *UICI_1* |
|---|---|---|---|
| 1961 | 3.1484 | 4.7212 | 6.2898 |
| 1962 | 3.2724 | 4.6482 | 6.3705 |
| 1963 | 3.0879 | 4.2384 | 6.3732 |
| 1964 | 2.7751 | 4.1636 | 6.0581 |
| 1965 | 2.5478 | 4.4853 | 5.7744 |
| 1966 | 3.0555 | 4.0128 | 6.1684 |
| 1967 | 3.2563 | 4.6597 | 6.4518 |
| 1968 | 4.0957 | 5.0199 | 7.1382 |
| 1969 | 3.4631 | 5.0795 | 6.5840 |
| 1970 | 3.8154 | 5.4036 | 6.8635 |
| 1971 | 3.0899 | 5.5763 | 6.3254 |
| 1972 | 3.9404 | 5.4337 | 7.0519 |
| 1973 | 3.8595 | 5.4972 | 6.9299 |
| 1974 | 4.1324 | 5.6419 | 7.1846 |
| 1975 | 4.0124 | 6.1827 | 7.1933 |
| 1976 | 3.1382 | 5.0658 | 6.5192 |
| 1977 | 3.2859 | 4.8007 | 6.5125 |
| 1978 | 2.9118 | 4.3135 | 6.1604 |
| 1979 | 3.0418 | 5.1340 | 6.1655 |
| 1980 | 1.5807 | 3.3464 | 5.2238 |

*LICI_1* Lower limit for 99% prediction interval for the natural log of red fish harvest.
*LN_RED* Natural log of red fish harvest
*UICI_1* Upper limit for 99% prediction interval for the natural log of red fish harvest.

### 6.2.5 Outliers and Influential Point Detection

***Table 6.20*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1961 | 4.8562 | .0000 | .2556 | .6775 | .0000 |
| 1962 | 4.1783 | .0104 | .2199 | .7590 | .0000 |
| 1963 | 7.1808 | .2172 | .3779 | .4103 | .0254 |
| 1964 | 7.1443 | .0568 | .3760 | .4140 | .0004 |
| 1965 | 6.2220 | .0702 | .3275 | .5141 | .0009 |
| 1966 | 4.4101 | .1348 | .2321 | .7315 | .0065 |
| 1967 | 5.7183 | .0216 | .3010 | .5730 | .0000 |
| 1968 | 3.3194 | .0914 | .1747 | .8540 | .0020 |
| 1969 | 4.5354 | .0012 | .2387 | .7164 | .0000 |
| 1970 | 3.4054 | .0011 | .1792 | .8451 | .0000 |
| 1971 | 6.3644 | .5268 | .3350 | .4979 | .2006 |
| 1972 | 4.3870 | .0015 | .2309 | .7343 | .0000 |
| 1973 | 3.7488 | .0031 | .1973 | .8082 | .0000 |
| 1974 | 3.4696 | .0001 | .1826 | .8384 | .0000 |
| 1975 | 5.4839 | .1786 | .2886 | .6011 | .0147 |
| 1976 | 8.7860 | .0831 | .4624 | .2684 | .0015 |
| 1977 | 6.2203 | .0065 | .3274 | .5143 | .0000 |
| 1978 | 6.5784 | .0370 | .3462 | .4741 | .0001 |
| 1979 | 4.5784 | .1117 | .2410 | .7113 | .0037 |
| 1980 | 13.4131 | .0272 | *.7060 | .0627 | .0000 |

| | |
|---|---|
| *MAH_1* | Mahalanobis distance |
| *COOK_1* | Cook's distance |
| *LEV_1* | Leverage value |
| *MAHA_PV* | P-value associated with the Mahalanobis distance |
| *COOK_PV* | P-value associated with Cook's distance |

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.

[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n-p-1$ denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.21*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1961 | .0035 | -.0003 | .0019 | -.0011 |
| 1962 | -.2615 | -.0242 | -.0895 | .0313 |
| 1963 | *-1.2899 | -.4467 | -.1379 | -.1808 |
| 1964 | -.6186 | -.5441 | .2222 | .0772 |
| 1965 | .6956 | .5186 | .0753 | -.3573 |
| 1966 | *-1.0337 | -.3044 | -.0005 | -.1492 |
| 1967 | -.3776 | -.1453 | .0056 | -.0719 |
| 1968 | -.8435 | .0944 | .2294 | -.2964 |
| 1969 | .0891 | -.0009 | .0464 | -.0200 |
| 1970 | .0840 | -.0226 | .0193 | .0314 |
| 1971 | *2.4951 | .7962 | -.1353 | *1.8949 |
| 1972 | -.0970 | -.0049 | .0570 | -.0750 |
| 1973 | .1429 | -.0113 | .0072 | -.0843 |
| 1974 | -.0220 | .0022 | .0012 | .0076 |
| 1975 | *1.1919 | .3314 | -.2622 | -.6546 |
| 1976 | .7489 | .1309 | -.4729 | .2254 |
| 1977 | -.2051 | .0640 | .1091 | -.0560 |
| 1978 | -.4963 | .1925 | .0138 | .1572 |
| 1979 | .9196 | -.4659 | .2029 | .0600 |
| 1980 | -.4199 | .1100 | -.2467 | .0885 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for square root of January-February inflows |
| *SDFBET_2* | Standardized *dfbeta* for square root of March-April inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

***Table 6.22*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1961 | .0008 | -.0006 | -.0005 | .0011 |
| 1962 | .0052 | .1002 | -.0158 | -.0866 |
| 1963 | .5040 | .6475 | -.4318 | -.2374 |
| 1964 | .1443 | -.0152 | -.0018 | .1382 |
| 1965 | .1533 | .1109 | -.3177 | -.1776 |
| 1966 | -.1266 | .1486 | .4763 | .2159 |
| 1967 | -.0376 | .1629 | .1516 | .0591 |
| 1968 | .1059 | .1041 | -.3448 | .2134 |
| 1969 | .0140 | .0099 | .0118 | -.0566 |
| 1970 | -.0149 | -.0187 | .0370 | -.0323 |
| 1971 | *-1.6111 | *-1.3352 | .9169 | *-1.0272 |
| 1972 | .0659 | .0309 | -.0756 | .0069 |
| 1973 | .0965 | .0385 | -.0483 | .0115 |
| 1974 | -.0100 | -.0007 | .0008 | -.0019 |
| 1975 | .6559 | -.1935 | -.4033 | .5619 |
| 1976 | -.4253 | .2358 | .4428 | .0289 |
| 1977 | .0345 | -.0543 | -.0233 | -.1321 |
| 1978 | -.2514 | -.2424 | .2975 | -.3048 |
| 1979 | .2358 | .1132 | -.3589 | .4148 |
| 1980 | -.0144 | -.3060 | .0266 | .2068 |

*SDFBET_3* Standardized *dfbeta* for square root of May-June inflows
*SDFBET_4* Standardized *dfbeta* for square root of July-August inflows
*SDFBET_5* Standardized *dfbeta* for square root of September-October inflows
*SDFBET_6* Standardized *dfbeta* for square root of November-December inflows

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

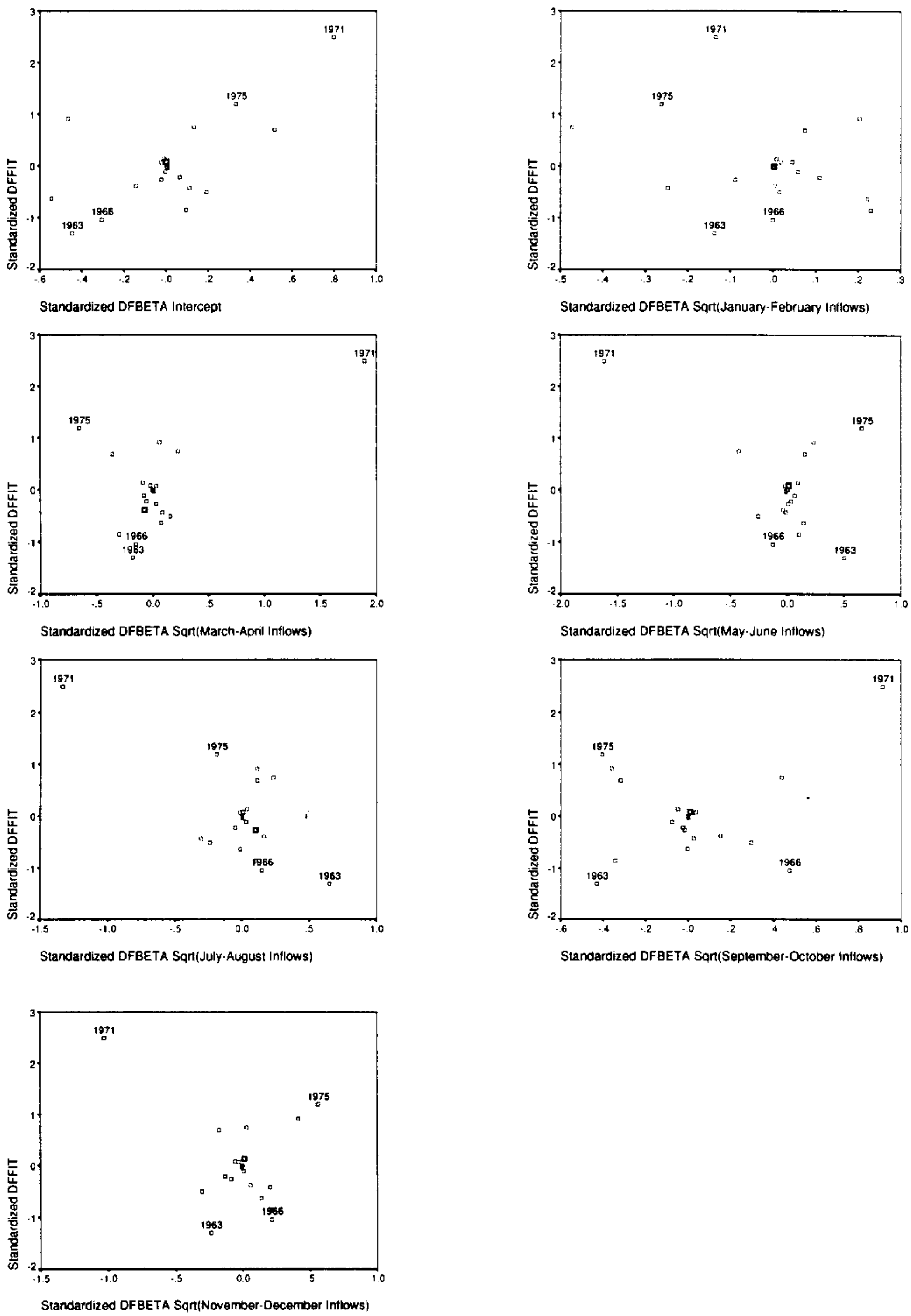


***Figure 6.30*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of square root of inflow variables.*

## 6.3 Regression - Square root of red fish data on log of inflow data

### 6.3.1 ANOVA and Parameter Estimates

***Table 6.23*** *Model Summary for square root of red fish data on log of inflow data.*

**Model Summary[a,b]**

| Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| Ln(November-December), Ln(March-April), Ln(September-October), Ln(July-August), Ln(January-February), Ln(May-June)[c,d] | .836 | .699 | .559 | 2.620522 | 1.723 |

a. Dependent Variable: Square Root of Red Harvest

b. Method: Enter

c. Independent Variables: (Constant), Ln(November-December Inflows), Ln(March-April Inflows), Ln(September-October Inflows), Ln(July-August Inflows), Ln(January-February Inflows), Ln(May-June Inflows)

d. All requested variables entered.

***Table 6.24*** *ANOVA table of square root of red fish data on log of inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 206.896 | 6 | 34.483 | 5.021 | .007[b] |
| | Residual | 89.273 | 13 | 6.867 | | |
| | Total | 296.169 | 19 | | | |

a. Dependent Variable: Square Root of Red Harvest

b. Independent Variables: (Constant), Ln(November-December Inflows), Ln(March-April Inflows), Ln(September-October Inflows), Ln(July-August Inflows), Ln(January-February Inflows), Ln(May-June Inflows)

***Table 6.25*** *Table of coefficients for square root of red fish data on log of inflow data.*

**Coefficients**[a]

| | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| (Constant) | 9.018 | 5.160 | | 1.748 | .104 | -2.129 | 20.166 |
| Ln(January-February) | -1.910 | .827 | -.477 | -2.309 | .038 | -3.696 | -.123 |
| Ln(March-April) | .490 | 1.803 | .101 | .272 | .790 | -3.404 | 4.384 |
| Ln(May-June) | 2.051 | 1.546 | .498 | 1.327 | .207 | -1.289 | 5.390 |
| Ln(July-August) | -2.512 | 1.019 | -.444 | -2.466 | .028 | -4.713 | -.311 |
| Ln(September-October) | .910 | .622 | .342 | 1.463 | .167 | -.434 | 2.253 |
| Ln(November-December) | .795 | .733 | .207 | 1.084 | .298 | -.790 | 2.379 |

a. Dependent Variable: Square Root of Red Harvest

### 6.3.2 Collinearity Diagnostic

***Table 6.26*** *Variance Inflation for square root of red fish data on log of inflow data.*

**Coefficients**[a]

| | t | Collinearity Statistics | |
|---|---|---|---|
| | | Tolerance | VIF |
| (Constant) | 1.748 | | |
| Ln(January-February) | -2.309 | .543 | 1.842 |
| Ln(March-April) | .272 | .167 | 6.006 |
| Ln(May-June) | 1.327 | .165 | 6.067 |
| Ln(July-August) | -2.466 | .714 | 1.400 |
| Ln(September-October) | 1.463 | .424 | 2.358 |
| Ln(November-December) | 1.084 | .633 | 1.579 |

a. Dependent Variable: Square Root of Red Harvest

***Table 6.27*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Sqrt(RED) on Ln(INFLOWS):*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *LN_QJF* | Var Prop *LN_QMA* | Var Prop *LN_QMJ* | Var Prop *LN_QJA* | Var Prop *LN_QSO* | Var Prop *LN_QND* |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.24535 | 1.00000 | 0.0274 | 0.0241 | 0.0212 | 0.0327 | 0.0247 | 0.0110 |
| 2 | 1.43658 | 1.25019 | 0.1023 | 0.0059 | 0.0160 | 0.0111 | 0.0095 | 0.2134 |
| 3 | 0.97499 | 1.51755 | 0.0190 | 0.0119 | 0.0139 | 0.2247 | 0.2166 | 0.0058 |
| 4 | 0.86292 | 1.61308 | 0.1375 | 0.0169 | 0.0042 | 0.3880 | 0.0761 | 0.0354 |
| 5 | 0.40587 | 2.35205 | 0.4349 | 0.0235 | 0.0207 | 0.1365 | 0.0844 | 0.6372 |
| 6 | 0.07428 | 5.49791 | 0.2789 | 0.9177 | 0.9240 | 0.2070 | 0.5886 | 0.0972 |

### 6.3.3 Residuals Diagnostics

***Table 6.28*** *Residuals Diagnostics for square root of red fish data on log of inflow data.*

**Residuals Statistics**[a]

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 5.126221 | 18.60142 | 12.0298 | 3.299887 | 20 |
| Std. Predicted Value | -2.092 | 1.991 | .000 | 1.000 | 20 |
| Standard Error of Predicted Value | 1.085275 | 1.986085 | 1.524051 | .291576 | 20 |
| Adjusted Predicted Value | 4.564575 | 17.02309 | 12.0059 | 3.487503 | 20 |
| Residual | -3.581364 | 5.440958 | -1.5E-15 | 2.167617 | 20 |
| Std. Residual | -1.367 | 2.076 | .000 | .827 | 20 |
| Stud. Residual | -1.569 | 2.651 | .005 | 1.054 | 20 |
| Deleted Residual | -4.718616 | 8.867565 | 2.4E-02 | 3.561517 | 20 |
| Stud. Deleted Residual | -1.674 | 3.757 | .068 | 1.240 | 20 |
| Mahal. Distance | 2.309 | 9.964 | 5.700 | 2.483 | 20 |
| Cook's Distance | .000 | .632 | .100 | .159 | 20 |
| Centered Leverage Value | .122 | .524 | .300 | .131 | 20 |

a. Dependent Variable: Square Root of Red Harvest

***Table 6.29*** *Case Values for Residuals Diagnostics for square root of red fish data on log of inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1961 | 11.6184 | -1.0212 | -1.4272 | 12.0244 | -.1247 | -.3897 | -.4607 | -.4463 |
| 1962 | 11.9756 | -1.7580 | -2.3642 | 12.5819 | -.0164 | -.6709 | -.7780 | -.7655 |
| 1963 | 10.2739 | -1.9492 | -4.3552 | 12.6799 | -.5321 | -.7438 | -1.1119 | -1.1230 |
| 1964 | 9.2894 | -1.2706 | -2.9856 | 11.0043 | -.8305 | -.4849 | -.7432 | -.7298 |
| 1965 | 6.9460 | 2.4720 | 4.8535 | 4.5646 | -1.5406 | .9433 | 1.3218 | 1.3650 |
| 1966 | 9.8182 | -2.3818 | -3.6869 | 11.1233 | -.6702 | -.9089 | -1.1308 | -1.1442 |
| 1967 | 11.9339 | -1.6578 | -2.9157 | 13.1919 | -.0291 | -.6326 | -.8390 | -.8288 |
| 1968 | 15.8858 | -3.5814 | -4.7186 | 17.0231 | 1.1685 | -1.3667 | -1.5687 | -1.6739 |
| 1969 | 12.6968 | -.0200 | -.0348 | 12.7116 | .2021 | -.0076 | -.0101 | -.0097 |
| 1970 | 14.1455 | .7609 | .9184 | 13.9880 | .6411 | .2903 | .3190 | .3077 |
| 1971 | 10.8102 | 5.4410 | 8.8676 | 7.3836 | -.3696 | 2.0763 | 2.6506 | *3.7567 |
| 1972 | 15.1047 | .0281 | .0350 | 15.0978 | .9318 | .0107 | .0120 | .0115 |
| 1973 | 15.8100 | -.1895 | -.2351 | 15.8556 | 1.1456 | -.0723 | -.0805 | -.0774 |
| 1974 | 16.7603 | .0326 | .0402 | 16.7526 | 1.4335 | .0124 | .0138 | .0133 |
| 1975 | 18.6014 | 3.4054 | 6.1899 | 15.8169 | 1.9915 | 1.2995 | 1.7520 | 1.9259 |
| 1976 | 11.9876 | .6020 | .9952 | 11.5945 | -.0128 | .2297 | .2954 | .2848 |
| 1977 | 11.4347 | -.4074 | -.5730 | 11.6003 | -.1804 | -.1555 | -.1844 | -.1774 |
| 1978 | 10.1352 | -1.4923 | -2.2216 | 10.8645 | -.5742 | -.5695 | -.6948 | -.6803 |
| 1979 | 10.2425 | 2.7844 | 3.6442 | 9.3827 | -.5416 | 1.0625 | 1.2156 | 1.2405 |
| 1980 | 5.1262 | .2029 | .4524 | 4.8767 | -2.0921 | .0774 | .1156 | .1112 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that observation |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.
[2]This is flagged if it exceeds $t_{n-p-2,\alpha}=t_{12,0.01}=2.681$.

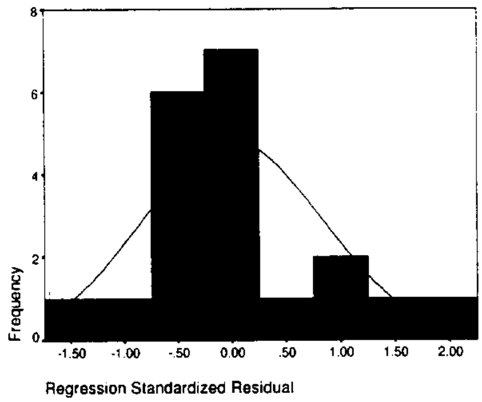


***Figure 6.31*** *Histogram of Standardized Residuals.*

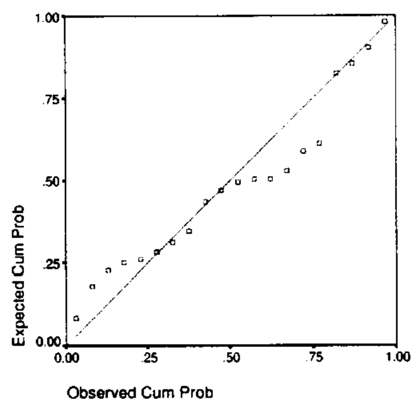


***Figure 6.32*** *Normal P-P Plot of Residuals.*

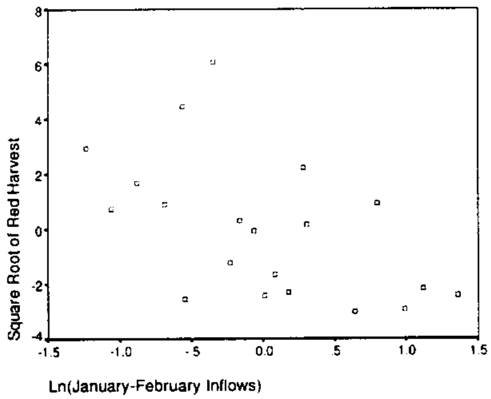


***Figure 6.33*** *Partial Residual Plot for Ln(January-February Inflows).*

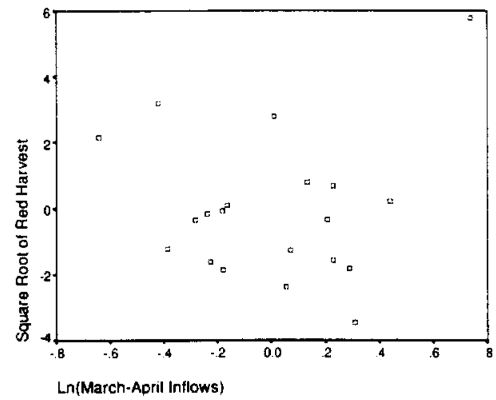


***Figure 6.34*** *Partial Residual Plot for Ln(March-April Inflows).*

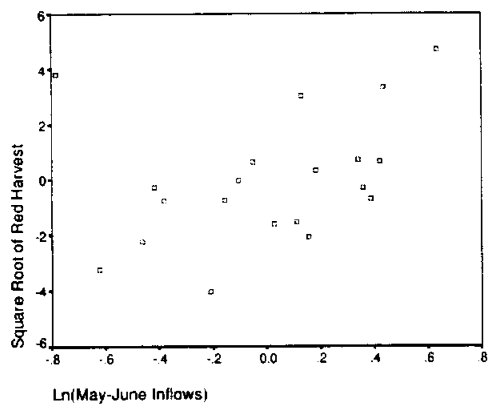


***Figure 6.35*** *Partial Residual Plot for Ln(May-June Inflows).*

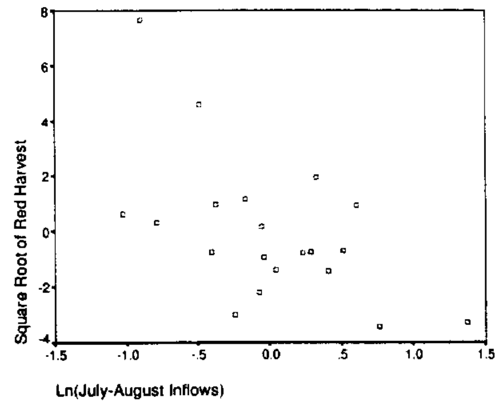


***Figure 6.36*** *Partial Residual Plot for Ln(July-August Inflows).*

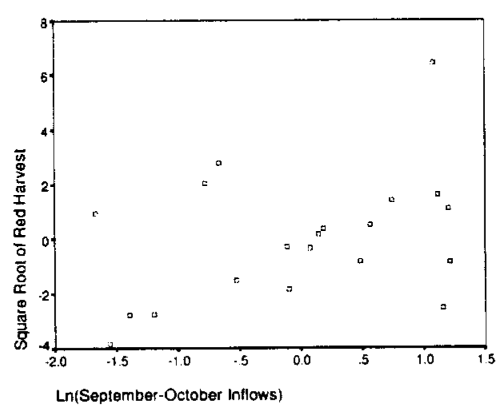


***Figure 6.37*** *Partial Residual Plot for Ln(September-October Inflows).*

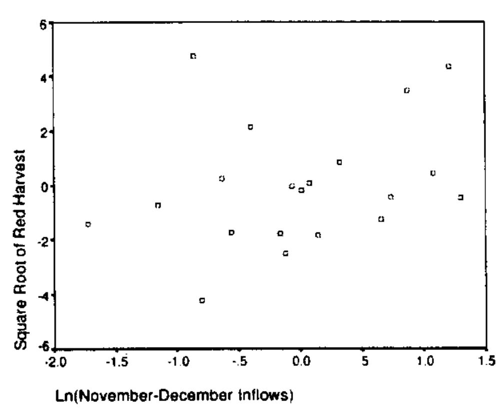


***Figure 6.38*** *Partial Residual Plot for Ln(November-December Inflows).*

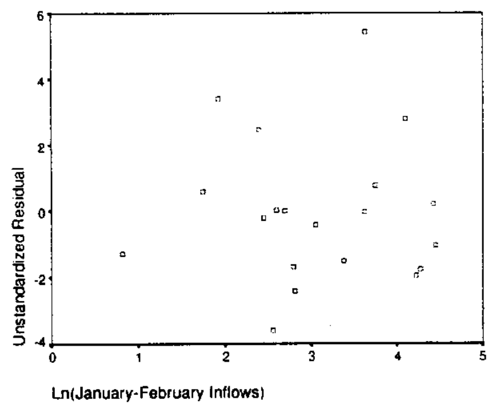


*Figure 6.39* *Residuals Plot for Ln(January-February Inflows).*

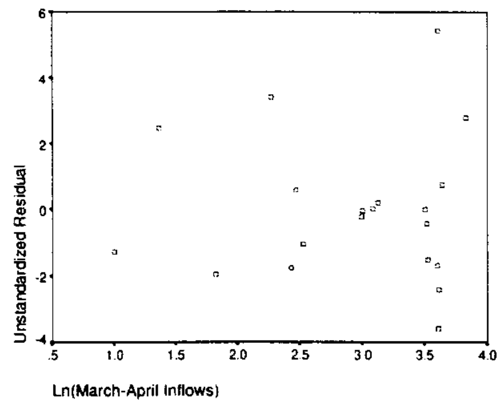


*Figure 6.40* *Residuals Plot for Ln(March-April Inflows).*

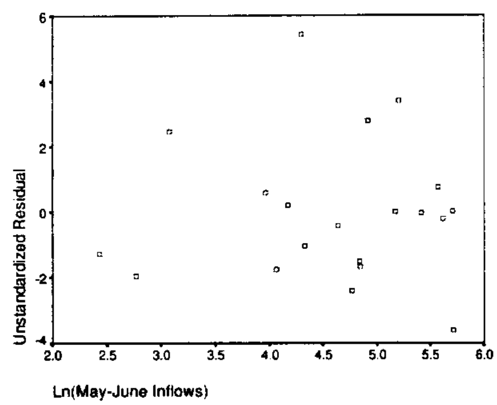


*Figure 6.41* *Residuals Plot for Ln(May-June Inflows).*

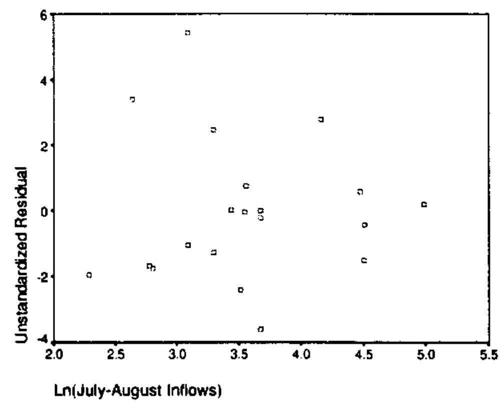


*Figure 6.42* *Residuals Plot for Ln(July-August Inflows).*

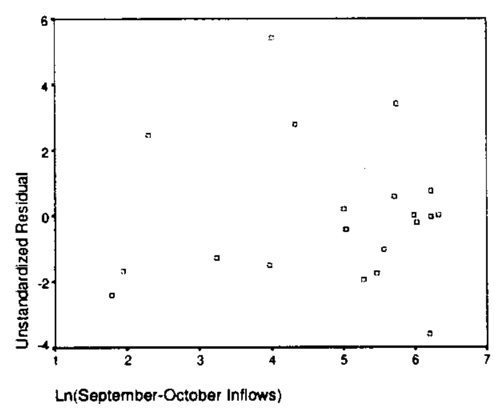


*Figure 6.43* *Residuals Plot for Ln(September-October Inflows).*

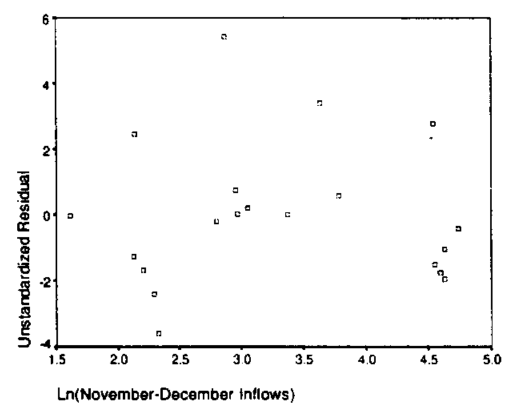


*Figure 6.44* *Residuals Plot for Ln(November-December Inflows).*

### 6.3.4 Prediction Intervals for Red fish Harvest

***Table 6.30*** *Prediction Intervals for Red fish Harvest.*

| YEAR | *LICI_1* | *SQ_RED* | *UICI_1* |
|---|---|---|---|
| 1961 | 2.6721 | 10.5972 | 20.5647 |
| 1962 | 3.1275 | 10.2176 | 20.8237 |
| 1963 | 0.4386 | 8.3247 | 20.1092 |
| 1964 | 0.0000 | 8.0187 | 19.1941 |
| 1965 | 0.0000 | 9.4181 | 16.5837 |
| 1966 | 0.6330 | 7.4364 | 19.0034 |
| 1967 | 2.4896 | 10.2762 | 21.3782 |
| 1968 | 7.0922 | 12.3045 | 24.6795 |
| 1969 | 3.2708 | 12.6768 | 22.1227 |
| 1970 | 5.6016 | 14.9064 | 22.6894 |
| 1971 | 1.5156 | 16.2512 | 20.1048 |
| 1972 | 6.4660 | 15.1327 | 23.7434 |
| 1973 | 7.1854 | 15.6205 | 24.4346 |
| 1974 | 8.1480 | 16.7929 | 25.3726 |
| 1975 | 9.0966 | 22.0068 | 28.1062 |
| 1976 | 2.6641 | 12.5897 | 21.3111 |
| 1977 | 2.4726 | 11.0272 | 20.3967 |
| 1978 | 1.0375 | 8.6429 | 19.2328 |
| 1979 | 1.4668 | 13.0269 | 19.0182 |
| 1980 | 0.0000 | 5.3292 | 14.9584 |

*LICI_1* Lower limit for 99% prediction interval for the square root of red fish harvest.

*SQ_RED* Square root of red fish harvest.

*UICI_1* Upper limit for 99% prediction interval for the square root of red fish harvest.

### 6.3.5 Outliers and Influential Point Detection

***Table 6.31*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1961 | 4.4548 | .0121 | .2345 | .7262 | .0000 |
| 1962 | 3.9221 | .0298 | .2064 | .7887 | .0001 |
| 1963 | 9.5463 | .2180 | *.5024 | .2158 | .0256 |
| 1964 | 9.9637 | .1065 | *.5244 | .1906 | .0032 |
| 1965 | 8.3728 | .2405 | .4407 | .3009 | .0333 |
| 1966 | 5.7757 | .1001 | .3040 | .5662 | .0026 |
| 1967 | 7.2474 | .0763 | .3814 | .4036 | .0011 |
| 1968 | 3.6293 | .1116 | .1910 | .8214 | .0037 |
| 1969 | 7.1420 | .0000 | .3759 | .4143 | .0000 |
| 1970 | 2.3088 | .0030 | .1215 | .9408 | .0000 |
| 1971 | 6.3920 | .6321 | .3364 | .4948 | .2777 |
| 1972 | 2.8055 | .0000 | .1477 | .9024 | .0000 |
| 1973 | 2.7314 | .0002 | .1438 | .9087 | .0000 |
| 1974 | 2.6666 | .0000 | .1403 | .9140 | .0000 |
| 1975 | 7.5971 | .3586 | .3998 | .3695 | .0894 |
| 1976 | 6.5561 | .0081 | .3451 | .4765 | .0000 |
| 1977 | 4.5407 | .0020 | .2390 | .7158 | .0000 |
| 1978 | 5.2875 | .0337 | .2783 | .6249 | .0001 |
| 1979 | 3.5331 | .0652 | .1860 | .8317 | .0007 |
| 1980 | 9.5273 | .0023 | *.5014 | .2170 | .0000 |

| | |
|---|---|
| *MAH_1* | Mahalanobis distance |
| *COOK_1* | Cook's distance |
| *LEV_1* | Leverage value |
| *MAHA_PV* | P-value associated with the Mahalanobis distance |
| *COOK_P* | P-value associated with Cook's distance |

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.

[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n-p-1$ denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.32*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1961 | -.2814 | .0850 | -.1646 | .1402 |
| 1962 | -.4495 | .0040 | -.1800 | .1091 |
| 1963 | *-1.2476 | -.6554 | -.0936 | -.3348 |
| 1964 | -.8478 | -.5689 | .3737 | -.0552 |
| 1965 | *1.3397 | .2214 | .4810 | -.8440 |
| 1966 | -.8470 | -.1534 | -.0048 | -.0549 |
| 1967 | -.7220 | -.3050 | .0803 | -.1731 |
| 1968 | -.9433 | -.1397 | .3305 | -.4084 |
| 1969 | -.0083 | .0008 | -.0045 | .0021 |
| 1970 | .1400 | -.0159 | .0327 | .0310 |
| 1971 | *2.9813 | *1.9085 | -.5303 | *2.4451 |
| 1972 | .0057 | .0013 | -.0036 | .0039 |
| 1973 | -.0379 | .0135 | .0018 | .0167 |
| 1974 | .0064 | -.0017 | -.0007 | -.0019 |
| 1975 | *1.7415 | -.1035 | -.4594 | -.7528 |
| 1976 | .2301 | .0214 | -.1422 | .0574 |
| 1977 | -.1131 | .0315 | .0455 | -.0301 |
| 1978 | -.4756 | .2723 | -.0216 | .1293 |
| 1979 | .6894 | -.3241 | .1268 | .0114 |
| 1980 | .1232 | -.0393 | .0713 | -.0185 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for log of January-February inflows |
| *SDFBET_2* | Standardized *dfbeta* for log of March-April inflows |

*Items are flagged if $|sdffits|$ or $|sdfbeta|$ exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

***Table 6.33*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1961 | -.1118 | .0079 | .0660 | -.1092 |
| 1962 | -.0595 | .1391 | .0196 | -.1634 |
| 1963 | .6172 | .6686 | -.4835 | -.0700 |
| 1964 | .3049 | -.0185 | -.1282 | .1740 |
| 1965 | .4906 | .4521 | -.7553 | -.2094 |
| 1966 | -.1316 | .0411 | .5255 | .0476 |
| 1967 | -.0184 | .3366 | .3115 | .0491 |
| 1968 | .2379 | .1801 | -.5285 | .4268 |
| 1969 | -.0014 | -.0014 | -.0017 | .0062 |
| 1970 | -.0107 | -.0221 | .0596 | -.0595 |
| 1971 | *-2.2142 | *-1.6718 | *1.2361 | *-1.1445 |
| 1972 | -.0029 | -.0019 | .0037 | -.0002 |
| 1973 | -.0215 | -.0077 | .0023 | -.0004 |
| 1974 | .0030 | -.0003 | .0005 | .0003 |
| 1975 | .9732 | -.4911 | -.4074 | .8827 |
| 1976 | -.0905 | .0731 | .0974 | .0335 |
| 1977 | .0197 | -.0334 | -.0038 | -.0638 |
| 1978 | -.1898 | -.2459 | .2740 | -.3019 |
| 1979 | .1098 | .1783 | -.2626 | .3476 |
| 1980 | -.0103 | .0886 | .0073 | -.0534 |

*SDFBET_3* Standardized *dfbeta* for log of May-June inflows
*SDFBET_4* Standardized *dfbeta* for log of July-August inflows
*SDFBET_5* Standardized *dfbeta* for log of September-October inflows
*SDFBET_6* Standardized *dfbeta* for log of November-December inflows

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

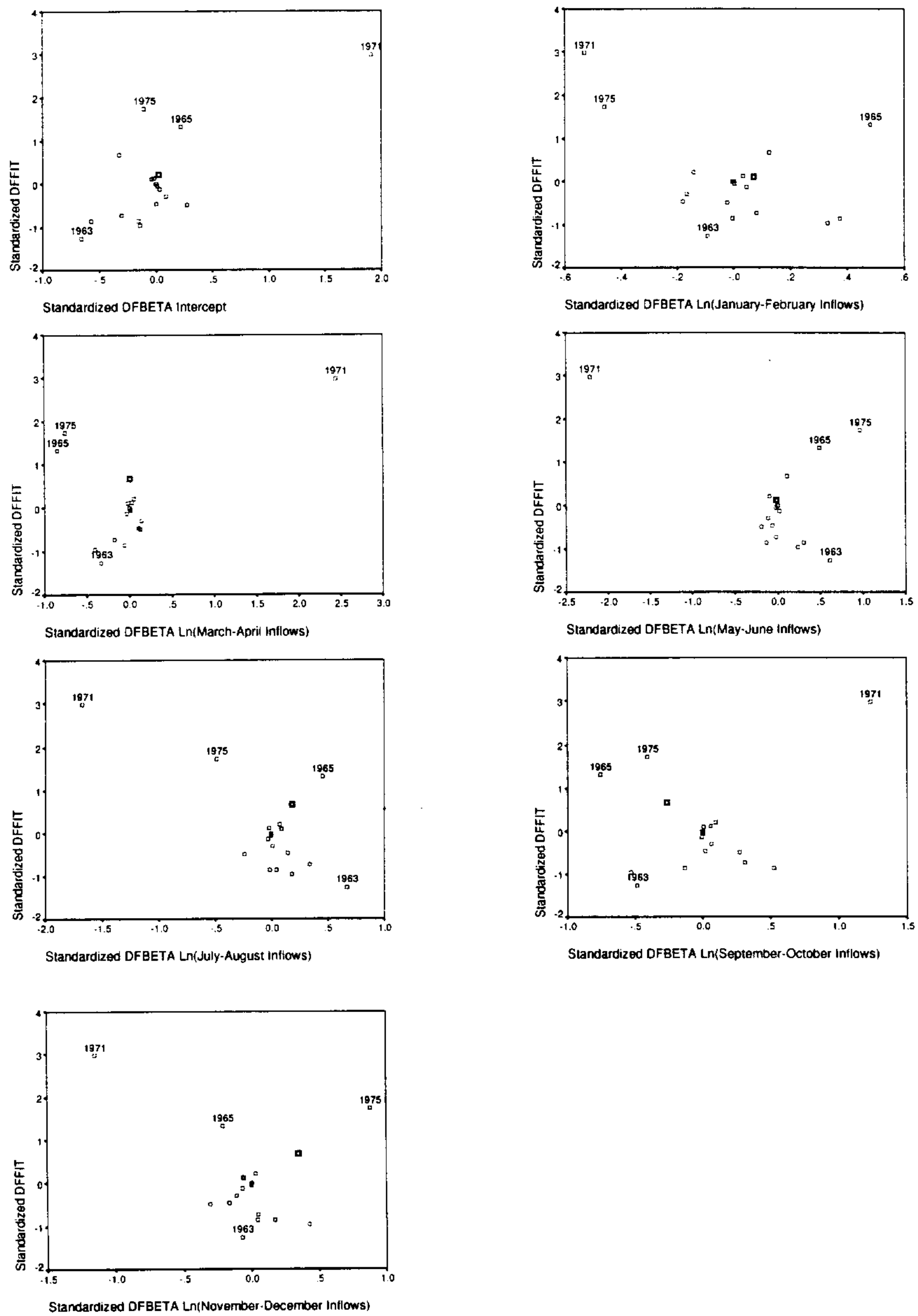


***Figure 6.45*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of log of inflow variables.*

# 7. EXAMINING SUBSETS OF THE DATA

## 7.1 Log of red fish data and log of inflow data: 1971 Omitted

***Table 7.1*** *Regression Models for Dependent Variable: Ln(RED) on Ln(INFLOWS): 1971 Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.3703 | 0.3333 | 32.54 | -21.23 | 0.2962 | -19.34 | LN_QMJ |
| 1 | 0.3053 | 0.2645 | 37.45 | -19.36 | 0.3268 | -17.47 | LN_QSO |
| 1 | 0.0784 | 0.0242 | 54.57 | -13.99 | 0.4335 | -12.11 | LN_QJF |
| 1 | 0.0565 | 0.0010 | 56.23 | -13.55 | 0.4439 | -11.66 | LN_QJA |
| 2 | 0.6393 | 0.5942 | 14.23 | -29.81 | 0.1803 | -26.98 | LN_QMA LN_QMJ |
| 2 | 0.5043 | 0.4424 | 24.42 | -23.78 | 0.2477 | -20.94 | LN_QMJ LN_QJA |
| 2 | 0.4888 | 0.4249 | 25.60 | -23.19 | 0.2555 | -20.36 | LN_QJF LN_QMJ |
| 2 | 0.4704 | 0.4042 | 26.99 | -22.52 | 0.2647 | -19.68 | LN_QMJ LN_QSO |
| 3 | 0.7128 | 0.6553 | 10.68 | -32.15 | 0.1531 | -28.37 | LN_QMA LN_QMJ LN_QND |
| 3 | 0.6586 | 0.5904 | 14.77 | -28.86 | 0.1820 | -25.09 | LN_QMA LN_QMJ LN_QJA |
| 3 | 0.6557 | 0.5868 | 14.99 | -28.70 | 0.1836 | -24.92 | LN_QJF LN_QMA LN_QMJ |
| 3 | 0.6546 | 0.5855 | 15.08 | -28.64 | 0.1842 | -24.86 | LN_QMA LN_QMJ LN_QSO |
| 4 | 0.7839 | 0.7222 | 7.314 | -35.55 | 0.1234 | -30.83 | LN_QJF LN_QMA LN_QMJ LN_QND |
| 4 | 0.7619 | 0.6938 | 8.978 | -33.71 | 0.1360 | -28.98 | LN_QJF LN_QMJ LN_QJA LN_QSO |
| 4 | 0.7480 | 0.6760 | 10.02 | -32.63 | 0.1439 | -27.91 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 4 | 0.7304 | 0.6534 | 11.35 | -31.35 | 0.1540 | -26.63 | LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.8258 | 0.7588 | 6.149 | -37.65 | 0.1071 | -31.98 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.8251 | 0.7578 | 6.206 | -37.57 | 0.1076 | -31.90 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.7855 | 0.7031 | 9.190 | -33.70 | 0.1319 | -28.03 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.7632 | 0.6721 | 10.88 | -31.81 | 0.1457 | -26.15 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 6 | 0.8411 | 0.7616 | 7.000 | -37.39 | 0.1059 | -30.78 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 19

**Table 7.2** *Analysis of Variance for Dependent Variable: Ln(RED) on Ln(INFLOWS): 1971 Omitted*

| Source | *DF* | Sum of Squares | Mean Square | *F* Value | Prob>*F* |
|---|---|---|---|---|---|
| Model | 6 | 6.72594 | 1.12099 | 10.583 | 0.0003 |
| Error | 12 | 1.27112 | 0.10593 | | |
| C Total | 18 | 7.99706 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 0.32546 | R-square | 0.8411 |
| Dep Mean | 4.83411 | Adj R-sq | 0.7616 |
| C.V. | 6.73267 | | |

**Table 7.3** *Parameter Estimates for Dependent Variable: Ln(RED) on Ln(INFLOWS): 1971 Omitted*

| Variable | *DF* | *Parameter Estimate* | *Standard Error* | *T* for H0: *Parameter=0* | Prob > \|*T*\| | *Variance Inflation* |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 3.417370 | 0.71880742 | 4.754 | 0.0005 | 0.00000000 |
| LN_QJF | 1 | -0.299674 | 0.10372297 | -2.889 | 0.0136 | 1.84608706 |
| LN_QMA | 1 | -0.293387 | 0.26711806 | -1.098 | 0.2936 | 8.22108140 |
| LN_QMJ | 1 | 0.654522 | 0.22284332 | 2.937 | 0.0124 | 8.13529810 |
| LN_QJA | 1 | -0.283506 | 0.13849992 | -2.047 | 0.0632 | 1.63781782 |
| LN_QSO | 1 | 0.087178 | 0.08131495 | 1.072 | 0.3048 | 2.57024647 |
| LN_QND | 1 | 0.230812 | 0.09521420 | 2.424 | 0.0321 | 1.70950518 |

**Table 7.4** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(RED) on Ln(INFLOWS): 1971 Omitted*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *LN_QJF* | Var Prop *LN_QMA* | Var Prop *LN_QMJ* | Var Prop *LN_QJA* | Var Prop *LN_QSO* | Var Prop *LN_QND* |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.29355 | 1.00000 | 0.0265 | 0.0176 | 0.0152 | 0.0280 | 0.0217 | 0.0097 |
| 2 | 1.45515 | 1.25545 | 0.1036 | 0.0042 | 0.0114 | 0.0104 | 0.0089 | 0.1922 |
| 3 | 0.98936 | 1.52257 | 0.0079 | 0.0054 | 0.0116 | 0.2533 | 0.1652 | 0.0101 |
| 4 | 0.79599 | 1.69746 | 0.1559 | 0.0141 | 0.0034 | 0.2746 | 0.1286 | 0.0263 |
| 5 | 0.41131 | 2.36141 | 0.4479 | 0.0171 | 0.0134 | 0.1070 | 0.0665 | 0.5900 |
| 6 | 0.05465 | 6.47830 | 0.2583 | 0.9416 | 0.9449 | 0.3266 | 0.6092 | 0.1717 |

***Table 7.5*** *Parameter Estimates of Models for Dependent Variable: Ln(RED) on Ln(INFLOWS): 1971 Omitted*

| OBS | _RMSE_ | INTERCEP | LN_QJF | LN_QMA | LN_QMJ | LN_QJA | LN_QSO | LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.54424 | 2.93673 | . | . | 0.41312 | . | . | . |
| 2 | 0.57166 | 3.65034 | . | . | . | . | 0.24351 | . |
| 3 | 0.65842 | 5.40200 | -0.18577 | . | . | . | . | . |
| 4 | 0.66622 | 5.63299 | . | . | . | -0.22343 | . | . |
| 5 | 0.42462 | 2.81976 | . | -0.69232 | 0.87482 | . | . | . |
| 6 | 0.49773 | 3.96078 | . | . | 0.46359 | -0.35124 | . | . |
| 7 | 0.50549 | 3.52785 | -0.22948 | . | 0.43715 | . | . | . |
| 8 | 0.51451 | 2.66700 | . | . | 0.30741 | . | 0.15536 | . |
| 9 | 0.39131 | 2.08034 | . | -0.80516 | 0.97596 | . | . | 0.18132 |
| 10 | 0.42661 | 3.27719 | . | -0.59370 | 0.83078 | -0.15118 | . | . |
| 11 | 0.42845 | 3.07939 | -0.09526 | -0.60803 | 0.82858 | . | . | . |
| 12 | 0.42914 | 2.71700 | . | -0.62232 | 0.78323 | . | 0.06600 | . |
| 13 | 0.35134 | 2.33914 | -0.21842 | -0.66324 | 0.91596 | . | . | 0.26384 |
| 14 | 0.36882 | 4.29645 | -0.26978 | . | 0.36124 | -0.34102 | 0.18978 | . |
| 15 | 0.37938 | 3.93453 | -0.36050 | . | 0.54470 | -0.38767 | . | 0.26709 |
| 16 | 0.39242 | 2.52544 | . | -0.70974 | 0.93275 | -0.14426 | . | 0.17921 |
| 17 | 0.32733 | 3.09791 | -0.26104 | -0.48371 | 0.83550 | -0.22956 | . | 0.27659 |
| 18 | 0.32804 | 3.91819 | -0.35966 | . | 0.43282 | -0.37378 | 0.14653 | 0.19643 |
| 19 | 0.36321 | 2.38237 | -0.22719 | -0.61787 | 0.86632 | . | 0.02670 | 0.24891 |
| 20 | 0.38166 | 4.17720 | -0.24901 | -0.08050 | 0.41863 | -0.31467 | 0.17557 | . |
| 21 | 0.32546 | 3.41737 | -0.29967 | -0.29339 | 0.65452 | -0.28351 | 0.08718 | 0.23081 |

***Table 7.6*** *Criteria Statistics of Models for Dependent Variable: Ln(RED) on Ln(INFLOWS): 1971 Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 0.29620 | 0.37034 | 0.33330 | 32.5366 | -21.2309 | -19.3420 |
| 2 | 0.32679 | 0.30532 | 0.26445 | 37.4457 | -19.3636 | -17.4748 |
| 3 | 0.43352 | 0.07844 | 0.02423 | 54.5740 | -13.9940 | -12.1051 |
| 4 | 0.44386 | 0.05646 | 0.00096 | 56.2334 | -13.5462 | -11.6573 |
| 5 | 0.18030 | 0.63927 | 0.59417 | 14.2340 | -29.8146 | -26.9813 |
| 6 | 0.24774 | 0.50434 | 0.44238 | 24.4203 | -23.7774 | -20.9440 |
| 7 | 0.25552 | 0.48878 | 0.42487 | 25.5952 | -23.1900 | -20.3567 |
| 8 | 0.26472 | 0.47037 | 0.40416 | 26.9851 | -22.5178 | -19.6845 |
| 9 | 0.15312 | 0.71279 | 0.65535 | 10.6833 | -32.1451 | -28.3674 |
| 10 | 0.18200 | 0.65863 | 0.59036 | 14.7719 | -28.8630 | -25.0853 |
| 11 | 0.18357 | 0.65569 | 0.58683 | 14.9941 | -28.6999 | -24.9221 |
| 12 | 0.18416 | 0.65457 | 0.58548 | 15.0787 | -28.6381 | -24.8604 |
| 13 | 0.12344 | 0.78390 | 0.72216 | 7.3143 | -35.5506 | -30.8284 |
| 14 | 0.13603 | 0.76186 | 0.69383 | 8.9782 | -33.7053 | -28.9831 |
| 15 | 0.14393 | 0.74803 | 0.67604 | 10.0228 | -32.6323 | -27.9101 |
| 16 | 0.15399 | 0.73041 | 0.65339 | 11.3526 | -31.3484 | -26.6262 |
| 17 | 0.10714 | 0.82583 | 0.75884 | 6.1494 | -37.6483 | -31.9816 |
| 18 | 0.10761 | 0.82507 | 0.75779 | 6.2064 | -37.5662 | -31.8995 |
| 19 | 0.13192 | 0.78555 | 0.70307 | 9.1901 | -33.6958 | -28.0292 |
| 20 | 0.14566 | 0.76321 | 0.67214 | 10.8764 | -31.8133 | -26.1466 |
| 21 | 0.10593 | 0.84105 | 0.76158 | 7.0000 | -37.3862 | -30.7751 |

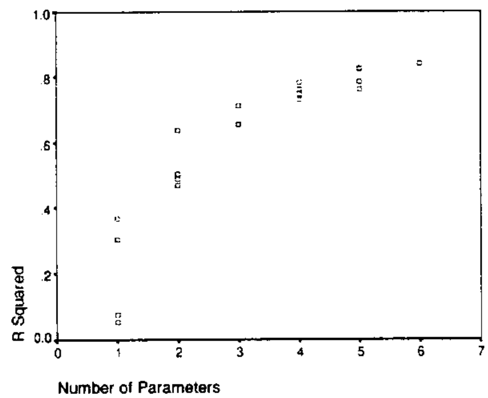


***Figure 7.1*** *The $R^2$ criteria vs. Number of parameters.*

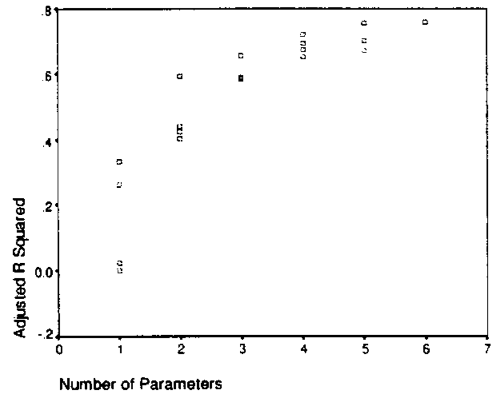


***Figure 7.2*** *The Adjusted $R^2$ criteria vs. Number of parameters.*

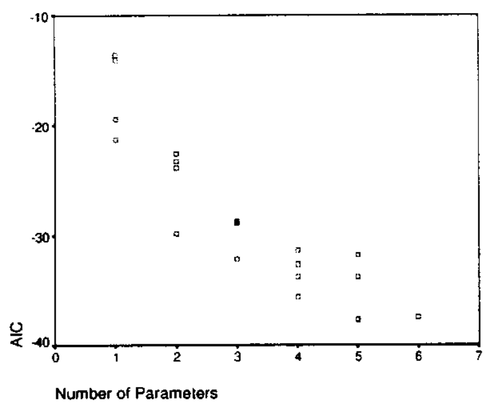


***Figure 7.4*** *The AIC criteria vs. Number of parameters..*

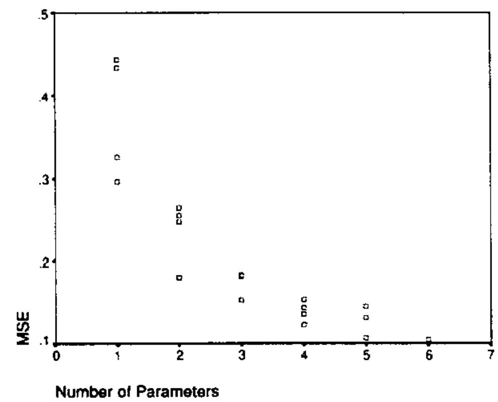


***Figure 7.3*** *MSE vs. Number of parameters.*

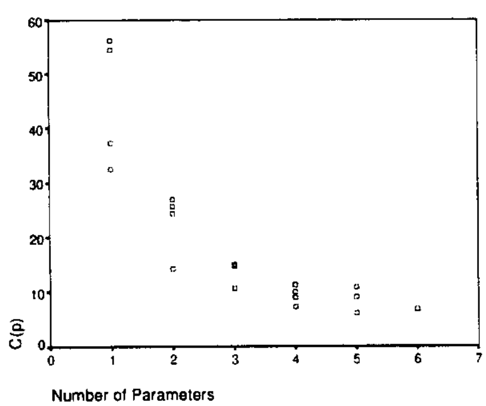


***Figure 7.5*** *The C(p) criteria vs. Number of parameters.*

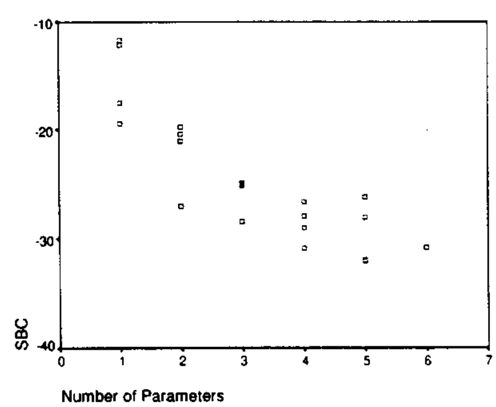


***Figure 7.6*** *The SBC criteria vs. Number of parameters.*

## 7.2 Log of red fish data and square root of inflow data: 1971 Omitted

***Table** 7.7 Regression Models for Dependent Variable: Ln(RED) on Sqrt(INFLOWS): 1971 Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.4263 | 0.3926 | 22.19 | -23.00 | 0.2699 | -21.11 | SQR_QMJ |
| 1 | 0.3984 | 0.3631 | 24.00 | -22.10 | 0.2830 | -20.21 | SQR_QSO |
| 1 | 0.1312 | 0.0801 | 41.32 | -15.11 | 0.4087 | -13.23 | SQR_QJF |
| 1 | 0.1039 | 0.0512 | 43.09 | -14.53 | 0.4215 | -12.64 | SQR_QJA |
| 2 | 0.5833 | 0.5312 | 14.02 | -27.07 | 0.2083 | -24.24 | SQR_QMA SQR_QMJ |
| 2 | 0.5680 | 0.5140 | 15.01 | -26.39 | 0.2159 | -23.56 | SQR_QJF SQR_QSO |
| 2 | 0.5397 | 0.4821 | 16.84 | -25.18 | 0.2301 | -22.35 | SQR_QMJ SQR_QJA |
| 2 | 0.5079 | 0.4464 | 18.90 | -23.91 | 0.2460 | -21.08 | SQR_QMJ SQR_QSO |
| 3 | 0.6570 | 0.5884 | 11.24 | -28.77 | 0.1829 | -25.00 | SQR_QMA SQR_QMJ SQR_QND |
| 3 | 0.6341 | 0.5609 | 12.72 | -27.54 | 0.1951 | -23.77 | SQR_QJF SQR_QJA SQR_QSO |
| 3 | 0.6221 | 0.5465 | 13.50 | -26.93 | 0.2015 | -23.15 | SQR_QJF SQR_QMJ SQR_QSO |
| 3 | 0.6167 | 0.5400 | 13.85 | -26.66 | 0.2044 | -22.88 | SQR_QJF SQR_QSO SQR_QND |
| 4 | 0.7600 | 0.6915 | 6.557 | -33.56 | 0.1371 | -28.84 | SQR_QJF SQR_QMA SQR_QMJ SQR_QND |
| 4 | 0.7351 | 0.6594 | 8.174 | -31.68 | 0.1513 | -26.96 | SQR_QJF SQR_QMJ SQR_QJA SQR_QND |
| 4 | 0.7099 | 0.6270 | 9.807 | -29.96 | 0.1657 | -25.23 | SQR_QJF SQR_QMJ SQR_QSO SQR_QND |
| 4 | 0.6998 | 0.6140 | 10.46 | -29.30 | 0.1715 | -24.58 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO |
| 5 | 0.8098 | 0.7366 | 5.332 | -35.97 | 0.1170 | -30.31 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.7965 | 0.7182 | 6.194 | -34.69 | 0.1252 | -29.02 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QND |
| 5 | 0.7641 | 0.6734 | 8.293 | -31.89 | 0.1451 | -26.22 | SQR_QJF SQR_QMA SQR_QMJ SQR_QSO SQR_QND |
| 5 | 0.7638 | 0.6730 | 8.312 | -31.86 | 0.1453 | -26.19 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 6 | 0.8149 | 0.7223 | 7.000 | -34.49 | 0.1234 | -27.88 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

N = 19

***Table** 7.8 Analysis of Variance for Dependent Variable: Ln(RED) on Sqrt(INFLOWS): 1971 Omitted*

| Source | *DF* | Sum of Squares | Mean Square | *F* Value | Prob>*F* |
|---|---|---|---|---|---|
| Model | 6 | 6.51680 | 1.08613 | 8.805 | 0.0008 |
| Error | 12 | 1.48026 | 0.12336 | | |
| C Total | 18 | 7.99706 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 0.35122 | R-square | 0.8149 |
| Dep Mean | 4.83411 | Adj R-sq | 0.7223 |
| C.V. | 7.26545 | | |

***Table** 7.9 Parameter Estimates for Dependent Variable: Ln(RED) on Sqrt(INFLOWS): 1971 Omitted*

| Variable | *DF* | *Parameter Estimate* | *Standard Error* | *T* for H0: Parameter=0 | Prob > \|*T*\| | *Variance Inflation* |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 4.323113 | 0.38556560 | 11.212 | 0.0001 | 0.00000000 |
| SQR_QJF | 1 | -0.128778 | 0.04453164 | -2.892 | 0.0135 | 1.70171962 |
| SQR_QMA | 1 | -0.069660 | 0.12092136 | -0.576 | 0.5752 | 5.26097401 |
| SQR_QMJ | 1 | 0.098283 | 0.05400228 | 1.820 | 0.0938 | 8.41000049 |
| SQR_QJA | 1 | -0.077832 | 0.04289251 | -1.815 | 0.0946 | 1.47731803 |
| SQR_QSO | 1 | 0.024218 | 0.02215937 | 1.093 | 0.2959 | 3.77953691 |
| SQR_QND | 1 | 0.095474 | 0.03506688 | 2.723 | 0.0185 | 1.68634850 |

***Table** 7.10 Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(RED) on Sqrt(INFLOWS): 1971 Omitted*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *SQR_QJF* | Var Prop *SQR_QMA* | Var Prop *SQR_QMJ* | Var Prop *SQR_QJA* | Var Prop *SQR_QSO* | Var Prop *SQR_QND* |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.02114 | 1.00000 | 0.0035 | 0.0241 | 0.0271 | 0.0072 | 0.0259 | 0.0155 |
| 2 | 1.66340 | 1.10230 | 0.1357 | 0.0114 | 0.0001 | 0.0621 | 0.0003 | 0.1282 |
| 3 | 1.15683 | 1.32180 | 0.0452 | 0.0204 | 0.0017 | 0.2087 | 0.0821 | 0.0284 |
| 4 | 0.65484 | 1.75684 | 0.0544 | 0.0663 | 0.0040 | 0.4415 | 0.1053 | 0.0011 |
| 5 | 0.44346 | 2.13487 | 0.5770 | 0.0064 | 0.0029 | 0.0299 | 0.0012 | 0.6915 |
| 6 | 0.06034 | 5.78768 | 0.1842 | 0.8714 | 0.9643 | 0.2505 | 0.7853 | 0.1353 |

***Table** 7.11 Parameter Estimates of Models for Dependent Variable: Ln(RED) on Sqrt(INFLOWS): 1971 Omitted*

| OBS | _RMSE_ | INTERCEP | SQR_QJF | SQR_QMA | SQR_QMJ | SQR_QJA | SQR_QSO | SQR_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.51949 | 3.76006 | . | . | 0.09790 | . | . | . |
| 2 | 0.53196 | 4.02417 | . | . | . | . | 0.057930 | . |
| 3 | 0.63929 | 5.34785 | -0.09956 | . | . | . | . | . |
| 4 | 0.64925 | 5.41565 | . | . | . | -0.09160 | . | . |
| 5 | 0.45638 | 4.21265 | . | -0.22090 | 0.14848 | . | . | . |
| 6 | 0.46467 | 4.56935 | -0.11352 | . | . | . | 0.060835 | . |
| 7 | 0.47966 | 4.35552 | . | . | 0.09900 | -0.09570 | . | . |
| 8 | 0.49596 | 3.66700 | . | . | 0.06357 | . | 0.033592 | . |
| 9 | 0.42762 | 3.77687 | . | -0.26322 | 0.17093 | . | . | 0.06403 |
| 10 | 0.44169 | 5.01282 | -0.10609 | . | . | -0.07349 | 0.059742 | . |
| 11 | 0.44888 | 4.22741 | -0.09641 | . | 0.04624 | . | 0.042695 | . |
| 12 | 0.45206 | 4.41288 | -0.15229 | . | . | . | 0.062019 | 0.05689 |
| 13 | 0.37024 | 4.01212 | -0.10656 | -0.22560 | 0.16161 | . | . | 0.10507 |
| 14 | 0.38900 | 4.33530 | -0.12752 | . | 0.10846 | -0.09993 | . | 0.10063 |
| 15 | 0.40707 | 3.88340 | -0.14433 | . | 0.06318 | . | 0.037703 | 0.07952 |
| 16 | 0.41411 | 4.67376 | -0.08649 | . | 0.05119 | -0.08003 | 0.039563 | . |
| 17 | 0.34208 | 4.34928 | -0.13908 | . | 0.07098 | -0.09135 | 0.033495 | 0.08961 |
| 18 | 0.35384 | 4.28227 | -0.11063 | -0.16570 | 0.14871 | -0.06212 | . | 0.10732 |
| 19 | 0.38093 | 3.99993 | -0.11415 | -0.18973 | 0.14069 | . | 0.010740 | 0.09957 |
| 20 | 0.38118 | 4.56333 | -0.16036 | 0.12349 | . | -0.11161 | 0.058679 | 0.07082 |
| 21 | 0.35122 | 4.32311 | -0.12878 | -0.06966 | 0.09828 | -0.07783 | 0.024218 | 0.09547 |

***Table** 7.12 Criteria Statistics of Models for Dependent Variable: Ln(RED) on Sqrt(INFLOWS): 1971 Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 0.26987 | 0.42631 | 0.39256 | 22.1920 | -22.9996 | -21.1107 |
| 2 | 0.28298 | 0.39844 | 0.36305 | 23.9990 | -22.0982 | -20.2094 |
| 3 | 0.40870 | 0.13120 | 0.08009 | 41.3240 | -15.1141 | -13.2252 |
| 4 | 0.42153 | 0.10393 | 0.05122 | 43.0921 | -14.5269 | -12.6380 |
| 5 | 0.20828 | 0.58329 | 0.53120 | 14.0153 | -27.0737 | -24.2404 |
| 6 | 0.21592 | 0.56801 | 0.51401 | 15.0057 | -26.3897 | -23.5564 |
| 7 | 0.23007 | 0.53969 | 0.48215 | 16.8420 | -25.1830 | -22.3497 |
| 8 | 0.24597 | 0.50787 | 0.44636 | 18.9044 | -23.9133 | -21.0799 |
| 9 | 0.18286 | 0.65701 | 0.58841 | 11.2358 | -28.7731 | -24.9953 |
| 10 | 0.19509 | 0.63408 | 0.56089 | 12.7227 | -27.5432 | -23.7655 |
| 11 | 0.20150 | 0.62205 | 0.54646 | 13.5021 | -26.9290 | -23.1512 |
| 12 | 0.20435 | 0.61669 | 0.54003 | 13.8495 | -26.6615 | -22.8837 |
| 13 | 0.13708 | 0.76003 | 0.69146 | 6.5573 | -33.5593 | -28.8371 |
| 14 | 0.15132 | 0.73510 | 0.65941 | 8.1736 | -31.6813 | -26.9591 |
| 15 | 0.16571 | 0.70991 | 0.62702 | 9.8066 | -29.9554 | -25.2332 |
| 16 | 0.17149 | 0.69978 | 0.61401 | 10.4630 | -29.3037 | -24.5815 |
| 17 | 0.11702 | 0.80978 | 0.73662 | 5.3319 | -35.9739 | -30.3072 |
| 18 | 0.12520 | 0.79647 | 0.71820 | 6.1944 | -34.6893 | -29.0227 |
| 19 | 0.14511 | 0.76411 | 0.67338 | 8.2927 | -31.8853 | -26.2186 |
| 20 | 0.14530 | 0.76381 | 0.67296 | 8.3123 | -31.8609 | -26.1942 |
| 21 | 0.12336 | 0.81490 | 0.72235 | 7.0000 | -34.4922 | -27.8811 |

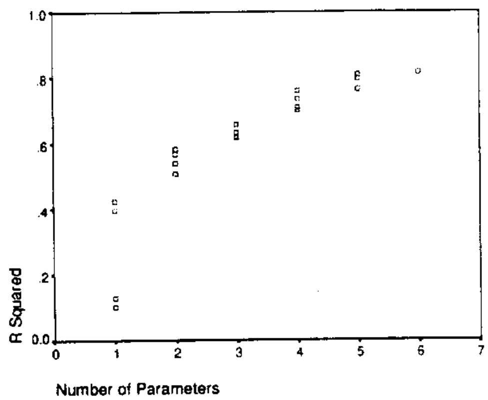


***Figure 7.7*** *The $R^2$ criteria vs. Number of parameters.*

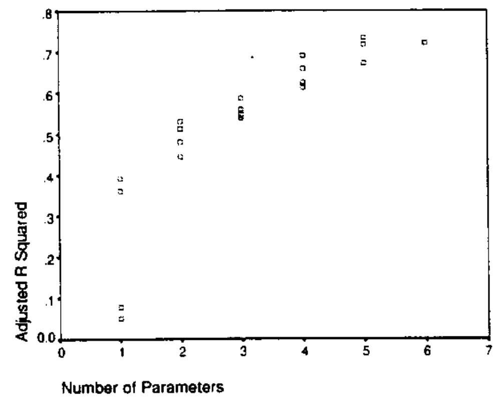


***Figure 7.8*** *The Adjusted $R^2$ criteria vs. Number of parameters.*

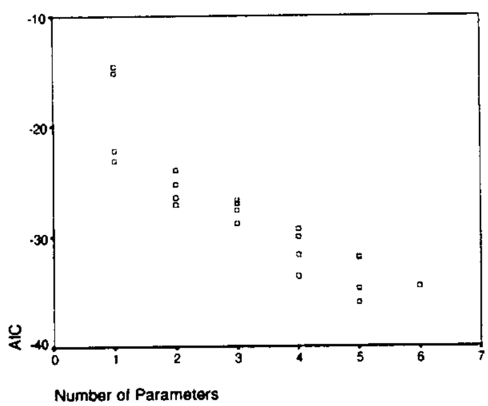


***Figure 7.9*** *The AIC criteria vs. Number of parameters..*

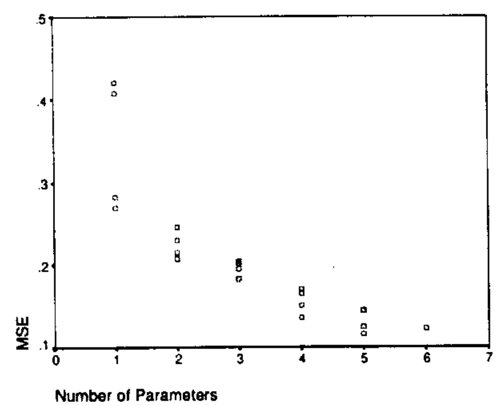


***Figure 7.10*** *MSE vs. Number of parameters.*

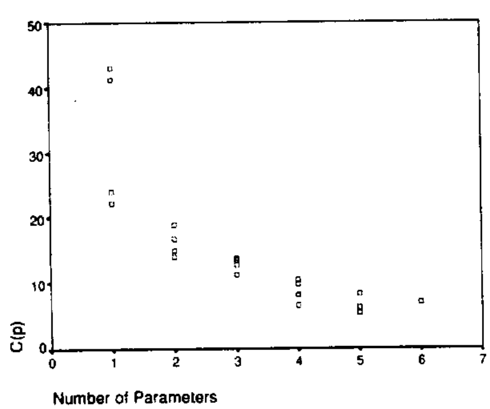


***Figure 7.11*** *The C(p) criteria vs. Number of parameters.*

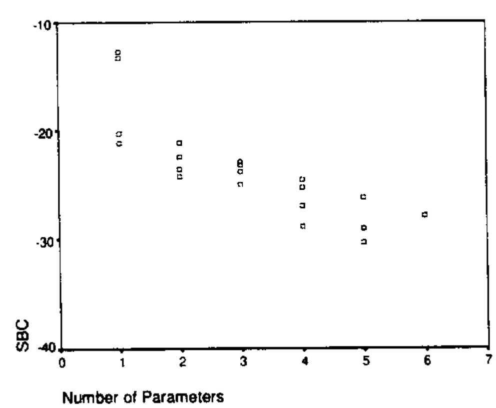


***Figure 7.12*** *The SBC criteria vs. Number of parameters.*

## 7.3 Square root of red fish data and log of inflow data: 1971 Omitted

***Table** 7.13 Regression Models for Dependent Variable: Sqrt(RED) on Ln(INFLOWS): 1971 Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.3647 | 0.3273 | 36.55 | 46.32 | 10.37 | 48.21 | LN_QMJ |
| 1 | 0.3066 | 0.2658 | 41.26 | 47.98 | 11.31 | 49.87 | LN_QSO |
| 1 | 0.0856 | 0.0318 | 59.20 | 53.24 | 14.92 | 55.13 | LN_QJF |
| 1 | 0.0513 | -.0046 | 61.99 | 53.94 | 15.48 | 55.83 | LN_QJA |
| 2 | 0.6803 | 0.6403 | 12.94 | 35.27 | 5.54 | 38.11 | LN_QMA LN_QMJ |
| 2 | 0.4916 | 0.4280 | 28.25 | 44.09 | 8.81 | 46.92 | LN_QJF LN_QMJ |
| 2 | 0.4898 | 0.4260 | 28.40 | 44.15 | 8.85 | 46.99 | LN_QMJ LN_QJA |
| 2 | 0.4777 | 0.4124 | 29.38 | 44.60 | 9.06 | 47.43 | LN_QJF LN_QSO |
| 3 | 0.7517 | 0.7021 | 9.145 | 32.47 | 4.59 | 36.25 | LN_QMA LN_QMJ LN_QND |
| 3 | 0.6948 | 0.6337 | 13.77 | 36.39 | 5.64 | 40.17 | LN_QJF LN_QMA LN_QMJ |
| 3 | 0.6922 | 0.6307 | 13.97 | 36.55 | 5.69 | 40.33 | LN_QMA LN_QMJ LN_QSO |
| 3 | 0.6907 | 0.6289 | 14.09 | 36.64 | 5.72 | 40.42 | LN_QMA LN_QMJ LN_QJA |
| 4 | 0.8174 | 0.7652 | 5.816 | 28.63 | 3.62 | 33.35 | LN_QJF LN_QMA LN_QMJ LN_QND |
| 4 | 0.7609 | 0.6926 | 10.40 | 33.75 | 4.74 | 38.47 | LN_QMA LN_QMJ LN_QJA LN_QND |
| 4 | 0.7603 | 0.6918 | 10.45 | 33.80 | 4.75 | 38.52 | LN_QJF LN_QMJ LN_QJA LN_QSO |
| 4 | 0.7536 | 0.6832 | 10.99 | 34.32 | 4.88 | 39.04 | LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.8443 | 0.7844 | 5.632 | 27.60 | 3.32 | 33.27 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.8179 | 0.7479 | 7.775 | 30.58 | 3.89 | 36.24 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.8154 | 0.7444 | 7.980 | 30.84 | 3.94 | 36.51 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.7711 | 0.6830 | 11.57 | 34.93 | 4.88 | 40.59 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 6 | 0.8521 | 0.7782 | 7.000 | 28.62 | 3.42 | 35.24 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 19

***Table 7.14*** *Analysis of Variance for Dependent Variable: Sqrt(RED) on Ln(INFLOWS): 1971 Omitted*

| Source | *DF* | *Sum of Squares* | *Mean Square* | *F* Value | Prob>*F* |
|---|---|---|---|---|---|
| Model | 6 | 236.38630 | 39.39772 | 11.524 | 0.0002 |
| Error | 12 | 41.02470 | 3.41872 | | |
| C Total | 18 | 277.41100 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 1.84898 | R-square | 0.8521 |
| Dep Mean | 11.80764 | Adj R-sq | 0.7782 |
| C.V. | 15.65917 | | |

***Table 7.15*** *Parameter Estimates for Dependent Variable: Sqrt(RED) on Ln(INFLOWS): 1971 Omitted*

| Variable | *DF* | *Parameter Estimate* | *Standard Error* | *T* for H0: *Parameter=0* | Prob > \|*T*\| | *Variance Inflation* |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 2.069976 | 4.08358067 | 0.507 | 0.6214 | 0.00000000 |
| LN_QJF | 1 | -1.600090 | 0.58925533 | -2.715 | 0.0188 | 1.84608706 |
| LN_QMA | 1 | -2.619838 | 1.51751096 | -1.726 | 0.1099 | 8.22108140 |
| LN_QMJ | 1 | 4.465660 | 1.26598399 | 3.527 | 0.0042 | 8.13529810 |
| LN_QJA | 1 | -1.310625 | 0.78682491 | -1.666 | 0.1216 | 1.63781782 |
| LN_QSO | 1 | 0.367390 | 0.46195428 | 0.795 | 0.4419 | 2.57024647 |
| LN_QND | 1 | 1.387002 | 0.54091658 | 2.564 | 0.0248 | 1.70950518 |

***Table 7.16*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Sqrt(RED) on Ln(INFLOWS): 1971 Omitted*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *LN_QJF* | Var Prop *LN_QMA* | Var Prop *LN_QMJ* | Var Prop *LN_QJA* | Var Prop *LN_QSO* | Var Prop *LN_QND* |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.29355 | 1.00000 | 0.0265 | 0.0176 | 0.0152 | 0.0280 | 0.0217 | 0.0097 |
| 2 | 1.45515 | 1.25545 | 0.1036 | 0.0042 | 0.0114 | 0.0104 | 0.0089 | 0.1922 |
| 3 | 0.98936 | 1.52257 | 0.0079 | 0.0054 | 0.0116 | 0.2533 | 0.1652 | 0.0101 |
| 4 | 0.79599 | 1.69746 | 0.1559 | 0.0141 | 0.0034 | 0.2746 | 0.1286 | 0.0263 |
| 5 | 0.41131 | 2.36141 | 0.4479 | 0.0171 | 0.0134 | 0.1070 | 0.0665 | 0.5900 |
| 6 | 0.05465 | 6.47830 | 0.2583 | 0.9416 | 0.9449 | 0.3266 | 0.6092 | 0.1717 |

***Table 7.17*** *Parameter Estimates of Models for Dependent Variable: Sqrt(RED) on Ln(INFLOWS): 1971 Omitted*

| OBS | _RMSE_ | INTERCEP | LN_QJF | LN_QMA | LN_QMJ | LN_QJA | LN_QSO | LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 3.21974 | 0.7177 | . | . | 2.41463 | . | . | . |
| 2 | 3.36373 | 4.8206 | . | . | . | . | 1.43729 | . |
| 3 | 3.86288 | 15.3012 | -1.14284 | . | . | . | . | . |
| 4 | 3.93471 | 16.2905 | . | . | . | -1.25379 | . | . |
| 5 | 2.35437 | -0.0286 | . | -4.41715 | 5.36040 | . | . | . |
| 6 | 2.96897 | 4.3212 | -1.39889 | . | 2.56112 | . | . | . |
| 7 | 2.97423 | 6.5448 | . | . | 2.70181 | -1.99865 | . | . |
| 8 | 3.00925 | 8.7829 | -1.65028 | . | . | . | 1.65998 | . |
| 9 | 2.14272 | -4.3216 | . | -5.07229 | 5.94758 | . | . | 1.05276 |
| 10 | 2.37589 | 1.4070 | -0.52673 | -3.95106 | 5.10473 | . | . | . |
| 11 | 2.38571 | -0.5634 | . | -4.05285 | 4.88374 | . | 0.34348 | . |
| 12 | 2.39152 | 1.9500 | . | -3.99057 | 5.16988 | -0.65392 | . | . |
| 13 | 1.90212 | -2.8569 | -1.23617 | -4.26909 | 5.60805 | . | . | 1.51977 |
| 14 | 2.17647 | -2.4283 | . | -4.66641 | 5.76379 | -0.61364 | . | 1.04378 |
| 15 | 2.17935 | 8.6218 | -1.64159 | . | 2.09239 | -1.93661 | 1.13518 | . |
| 16 | 2.20947 | -4.5221 | . | -5.31443 | 6.23584 | . | -0.16295 | 1.16412 |
| 17 | 1.82266 | 0.7237 | -1.43727 | -3.42192 | 5.22836 | -1.08327 | . | 1.57990 |
| 18 | 1.97114 | -2.7147 | -1.26500 | -4.11988 | 5.44480 | . | 0.08781 | 1.47065 |
| 19 | 1.98483 | 6.5421 | -2.13573 | . | 2.48595 | -2.11673 | 0.89742 | 1.07999 |
| 20 | 2.21016 | 6.6360 | -1.29562 | -1.34056 | 3.04815 | -1.49792 | 0.89855 | . |
| 21 | 1.84898 | 2.0700 | -1.60009 | -2.61984 | 4.46566 | -1.31062 | 0.36739 | 1.38700 |

***Table 7.18*** *Criteria Statistics of Models for Dependent Variable: Sqrt(RED) on Ln(INFLOWS): 1971 Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 10.3667 | 0.36472 | 0.32735 | 36.5496 | 46.3201 | 48.2090 |
| 2 | 11.3147 | 0.30662 | 0.26584 | 41.2637 | 47.9827 | 49.8716 |
| 3 | 14.9218 | 0.08558 | 0.03179 | 59.2004 | 53.2404 | 55.1293 |
| 4 | 15.4820 | 0.05125 | -0.00456 | 61.9859 | 53.9406 | 55.8294 |
| 5 | 5.5430 | 0.68030 | 0.64034 | 12.9420 | 35.2732 | 38.1065 |
| 6 | 8.8148 | 0.49160 | 0.42805 | 28.2542 | 44.0870 | 46.9204 |
| 7 | 8.8461 | 0.48979 | 0.42602 | 28.4005 | 44.1543 | 46.9876 |
| 8 | 9.0556 | 0.47771 | 0.41242 | 29.3812 | 44.5992 | 47.4325 |
| 9 | 4.5913 | 0.75174 | 0.70209 | 9.1446 | 32.4675 | 36.2453 |
| 10 | 5.6449 | 0.69477 | 0.63373 | 13.7674 | 36.3928 | 40.1706 |
| 11 | 5.6916 | 0.69225 | 0.63070 | 13.9725 | 36.5495 | 40.3272 |
| 12 | 5.7194 | 0.69074 | 0.62889 | 14.0944 | 36.6420 | 40.4197 |
| 13 | 3.6180 | 0.81741 | 0.76524 | 5.8162 | 28.6305 | 33.3527 |
| 14 | 4.7370 | 0.76094 | 0.69263 | 10.3986 | 33.7506 | 38.4728 |
| 15 | 4.7496 | 0.76031 | 0.69182 | 10.4499 | 33.8008 | 38.5230 |
| 16 | 4.8818 | 0.75363 | 0.68324 | 10.9913 | 34.3223 | 39.0445 |
| 17 | 3.3221 | 0.84432 | 0.78444 | 5.6325 | 27.6009 | 33.2676 |
| 18 | 3.8854 | 0.81792 | 0.74789 | 7.7746 | 30.5770 | 36.2437 |
| 19 | 3.9395 | 0.81539 | 0.74438 | 7.9805 | 30.8399 | 36.5066 |
| 20 | 4.8848 | 0.77109 | 0.68304 | 11.5750 | 34.9262 | 40.5929 |
| 21 | 3.4187 | 0.85212 | 0.77817 | 7.0000 | 28.6250 | 35.2360 |

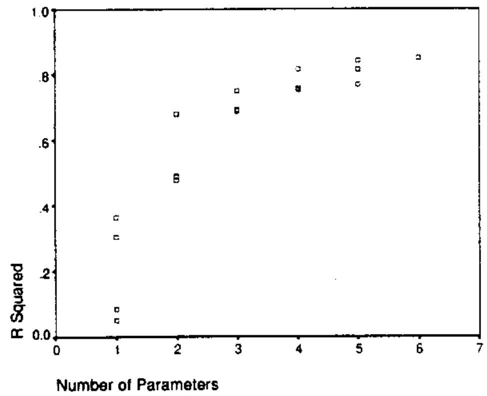


***Figure 7.13*** *The $R^2$ criteria vs. Number of parameters.*

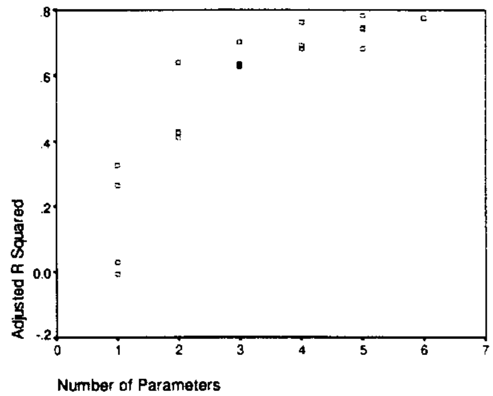


***Figure 7.14*** *The Adjusted $R^2$ criteria vs. Number of parameters.*

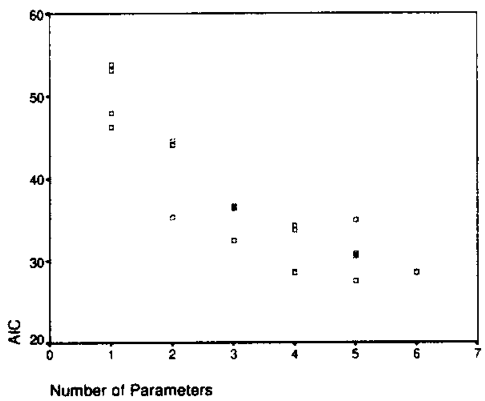


***Figure 7.15*** *The AIC criteria vs. Number of parameters..*

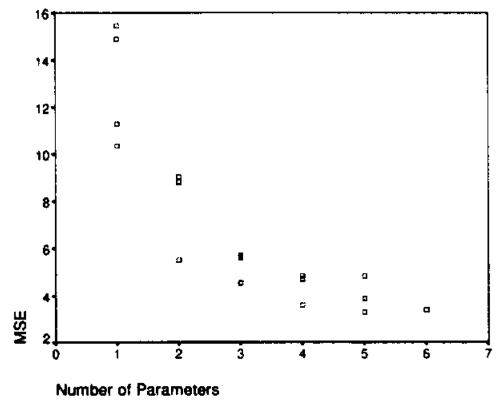


***Figure 7.16*** *MSE vs. Number of parameters.*

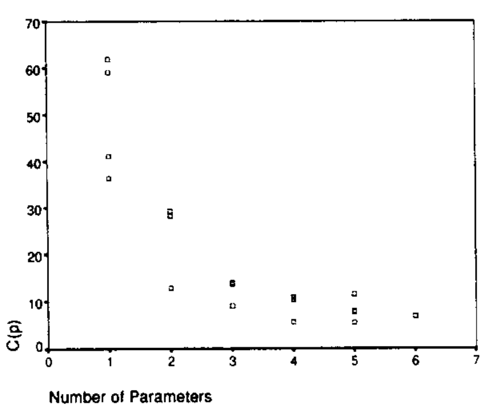


***Figure 7.17*** *The C(p) criteria vs. Number of parameters.*

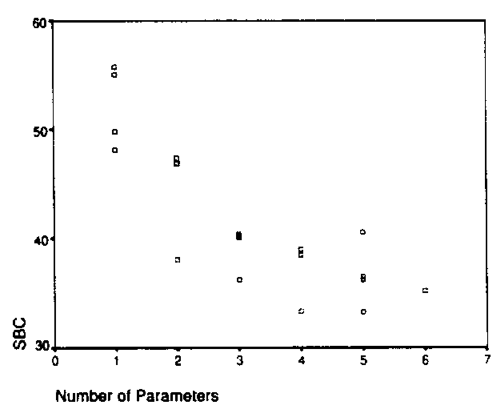


***Figure 7.18*** *The SBC criteria vs. Number of parameters.*

# Brown Shrimp Harvests in Corpus Christi Bay: A Regression Analysis

## Harvest vs Freshwater Inflows

F. Michael Speed
Michael Longnecker
Rita Miranda-López

*Department of Statistics*
*Texas A&M University*



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# Brown Shrimp Harvest in Corpus Christi Bay:

# A Regression Analysis

Harvest vs. Freshwater Inflows



F. Michael Speed

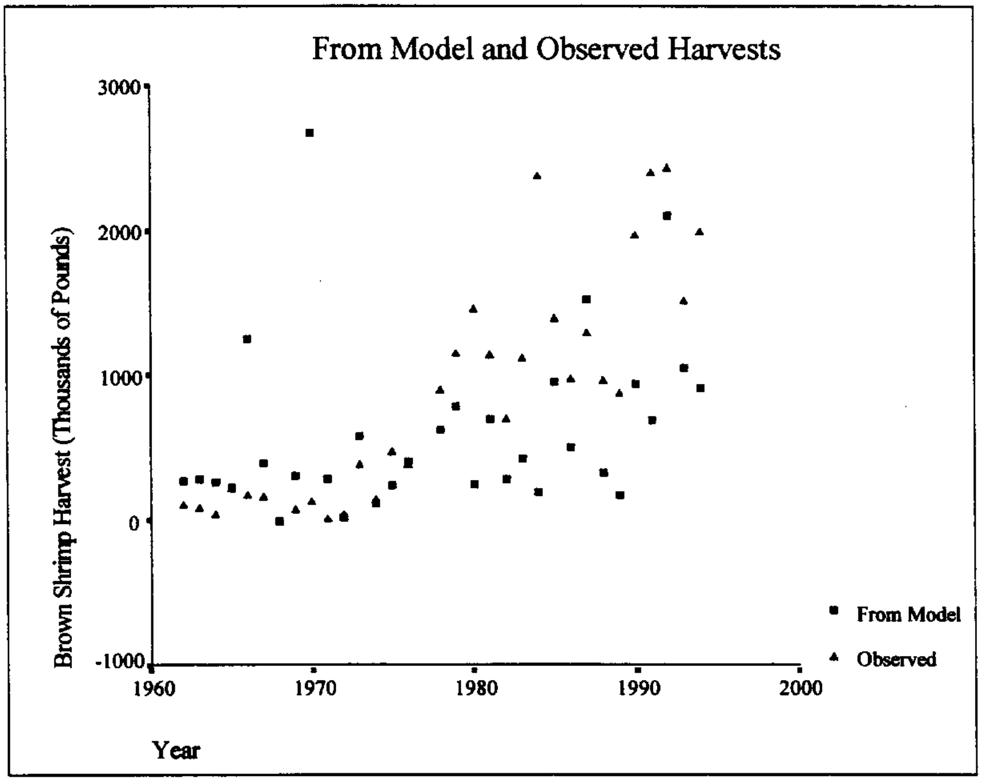
Michael T. Longnecker

Rita Miranda-López

Department of Statistics

Texas A&M University

WINTER 1997



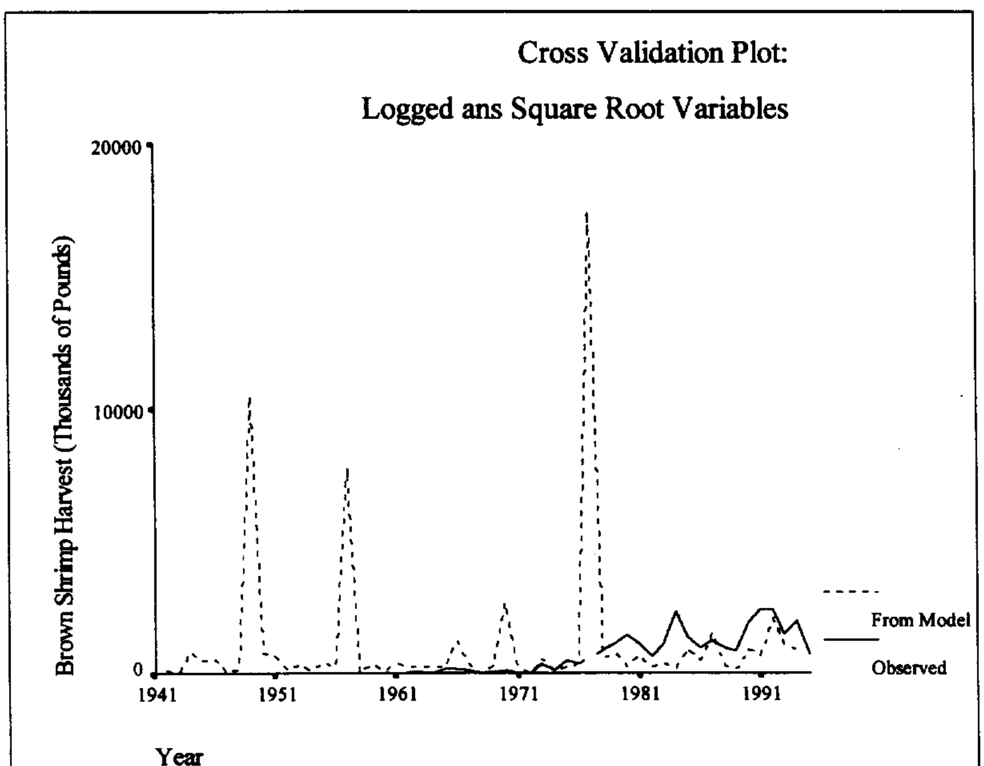




Fig. 1.1 Comparative plots of observed values vs. calculated from the regression model.

# Table of Contents

# 1. Summary Report

## 1.1 Description of the Problem[1]

Bimonthly freshwater inflows into Corpus Christi Bay were recorded for the years 1962 to 1994. These variables, and various transformations of them, were used to construct a model for the annual harvest of brown shrimp.

## 1.2 Constructing Models - General Discussion

Stability of coefficient estimates and accuracy of predicted values are primary goals in constructing models for prediction. To this end, the data must be examined from three points of view: individual observations (to detect outliers or influential points); variables, individually and in groups (to select an optimal set of predictors); and the interaction of these two, which produces the overall structure of the data set (to determine whether multicollinearity is present or not). The first two of these were examined by both graphic and quantitative means; the third by quantitative means only.

### 1.2.1 Detecting Influential Points and Outliers

The structures of individual variables were examined via box plots and histograms, as well as by all the usual numerical measures. For each pair of variables, 99 % prediction ellipses and 95% confidence ellipses were plotted in a further effort to look for unusual points. For example, suppose large values of Variable A are generally associated with large values for Variable B. If an observation consisted of a large value for Variable A but a small value for Variable B, that point would be considered unusual, even though it was well within the range of data for both variables and could not be considered an outlier.

In addition, a number of residual analysis techniques were employed. A large *residual* indicates a point not well-fit by the model. The *deleted residual*, however, is somewhat more useful in the search for influential points. The model is fitted without a given observation, and the predicted response and corresponding residual are calculated for that observation. The *Studentized deleted residual* is scaled to have a Student's t distribution. Histograms and normal P-P plots of the residuals were also examined.

Other quantities, such as the Mahalanobis distance, Cook's distance, the leverage value, standarized values for the Dffits (to measure the influence of a given observation on the predicted response) and the Dfbetas (to measure the influence of a given observation on the calculated coefficients) were also used to build a general picture of the influence of individual points. Plots were made of the standardized Dffits value for each model against the Dfbeta values for each predictor in the model. Points which were extreme indicated observations which had strong effects on both predicted values and coefficient estimates.

### 1.2.2 Variable Selection

For each regression, residuals were plotted against each of the independent variables to look for nonlinear relationships between the response variable and individual predictors. Partial residual plots were employed to examine the overall relationship between the response and individual predictors. A partial

[1] The following discussion, prepared by Jacqueline Kiffe, was taken from Seatrout Harvests in Galveston Bay: A Regression Analysis, by F. Michael Speed, Sr. and Jacqueline Kiffe.

residual is a corollary to the deleted residual. That is, the model is fitted without a given variable and the predicted response and corresponding residual are calculated for each observation. This seeks to answer the question, "What is the relationship of this predictor to the response variable, taking all other variables into account?" Thus, it examines the marginal relationship of a given predictor to the response.

Numerous measures have been developed over the years to assess the adequacy of a given model. We examined a number of these, including $R^2$ and mean squared error (MSE), and several others which directly incorporate penalties for having too many predictors in the model, such as adjusted $R^2$, $C_p$, AIC, and SBC. It is well-established that too many predictors in a model can lead to bad prediction, just as too few can, and these measures are used as part of the attempt to find an optimal model.

#### 1.2.3 Multicollinearity

Multicollinearity arises when one or more variables are nearly closely approximated by linear combinations of the remaining variables, resulting in unstable coefficient estimates. The variance inflation factor (VIF) was calculated for each coefficient estimate to measure this instability, which is not usually considered profound for VIF's less than 10. No problems were found with this data. Additionally, the condition index (a ratio of eigenvalues of the covariance matrix, with the largest eigenvalue always on top) was calculated. A ratio greater than 30 is considered cause for concern. Again, no evidence of multicollinearity was found.

#### 1.2.4 Other Procedures

Several other miscellaneous diagnostics, including the Durbin-Watson test for serial autocorrelation were performed, and no general problems were detected. The Box-Cox procedure, used to find a transformation to normality, was also performed.

### 1.3 How the Final Model Was Chosen

#### 1.3.1 Selecting the Data Set Used

First, the variables were explored thoroughly, individually and in pairs, in a first effort to detect outliers. The SAS programming language allows a number of diagnostics to be calculated for a group of models on a given data set without actually performing a formal regression, thus allowing one to examine a large number of models quite efficiently. The Box-Cox procedure was performed to find if a transformation to normality was suggested. The log transform was suggested for some variables, and the square root for others. At this point, there were several data sets for which the diagnostic series was calculated:

1. Untransformed data.
2. Harvest untransformed, and natural log of inflow variables.
3. All variables logged.
4. Harvest untransformed, and square root of inflows variables.
5. All variables square root.
6. Logged and square root variables.
7. Harvest untransformed, and logged and square root inflows.
8. Harvest and inflows variables transformed according to Box-Cox suggestion.

### 1.3.2 Selecting the Points to be Omitted

The full regression with all diagnostics was performed for these models, each one contained all variables in its corresponding data set. All diagnostics were generated, and influential points were determined for each model.

Table 1.1 R-Square and Adjusted R-Square values for the different suggested models.

| Data Set | $R^2$ | Adjusted $R^2$ |
|---|---|---|
| 1 | 0.2703 | 0.1019 |
| 2 | 0.2693 | 0.1007 |
| 3 | 0.2517 | 0.0791 |
| **4** | **0.2809** | **0.1145** |
| **5** | **0.2880** | **0.1237** |
| **6** | **0.4660** | **0.3428** |
| **7** | **0.2952** | **0.1326** |

Data set 6 presented the highest $R^2$ values. However , the models 4, 5, 6, and 7 were considered as final candidates. The observations flagged as potentially influential are given in the summary table below, for each model.

Table 1.2 Summary of points flagged by 99% Prediction Ellipse.

| Year | Variable |
|---|---|
| 1968 | Harvest vs. Jan-Feb, Harvest vs. Sept-Oct, Jan-Feb vs. Mar-Apr, Jan-Feb vs. May-Jun, Jan-Feb vs. Jul-Aug, Jan-Feb vs. Sept-Oct, Jan-Feb vs. Nov-Dec, Mar-Apr vs. Sept-Oct, May-Jun vs. Sept-Oct, Jul-Aug vs. Sept-Oct, Sept-Oct vs. Nov-Dec. |
| 1971 | Harvest vs. Jul-Aug, Jan-Feb vs. Jul-Aug, Mar-Apr vs. Jul-Aug, May-Jun vs. Jul-Aug, Jul-Aug vs. Sept-Oct, Jul-Aug vs. Nov-Dec. |
| 1972 | Harvest vs. Sept-Oct, Jan-Feb vs. Sept-Oct, Mar-Apr vs. Sept-Oct, May-Jun vs. Sept-Oct, Jul-Aug vs. Sept-Oct, Sept-Oct vs. Nov-Dec. |
| 1977 | Harvest vs. Mar-Apr, Harvest vs. Nov-Dec, Jan-Feb vs. Mar-Apr, Jan-Feb vs. Nov-Dec, Mar-Apr vs. May-Jun, Mar-Apr vs. Jul-Aug, Mar-Apr vs. Sept-Oct, Mar-Apr vs. Nov-Dec, May-Jun vs. Nov-Dec, Jul-Aug vs. Nov-Dec, Sept-Oct vs. Nov-Dec. |
| 1981 | Harvest vs. May-Jun, Jan-Feb vs. May-Jun, Mar-Apr vs. May-Jun, May-Jun vs. Jul-Aug, May-Jun vs. Sept-Oct, May-Jun vs. Nov-Dec. |
| 1992 | Harvest vs. Jan-Feb, Harvest vs Mar-Apr, Jan-Feb vs. Mar-Apr, Jan-Feb vs. May-Jun, Jan-Feb vs. Jul-Aug, Jan-Feb vs. Sept-Oct, Jan-Feb vs. Nov-Dec, Mar-Apr vs. May-Jun, Mar-Apr vs. Jul-Aug, Mar-Apr vs. Sept-Oct, Mar-Apr vs. Nov-Dec. |

Table 1.3 Summary of points flagged by Boxplots.

| Year | Variable |
|---|---|
| 1965 | Jan-Feb Inflows |
| 1968 | Ln(harvest), Jan-Feb, Ln (Jan-Feb), SQRT (Jan-Feb), Sept-Oct, SQRT (Sept-Oct) Inflows |
| 1970 | Nov-Dec, SQRT (Nov-Dec) Inflows |
| 1971 | Jul-Aug, SQRT (Jul-Aug) Inflows |
| 1972 | Sept-Oct, SQRT (Sept-Oct), Nov-Dec Inflows |
| 1974 | Sept-Oct, SQRT (Sept-Oct) Inflows |
| 1976 | Jul-Aug Inflows |
| 1977 | Jan-Feb, SQRT (Jan-Feb), Mar-Apr, Ln (Mar-Apr), SQRT (Mar-Apr), Nov-Dec, Ln (Nov-Dec), SQRT (Nov-Dec) Inflows |
| 1980 | Jul-Aug, SQRT (Jul-Aug) Inflows |
| 1981 | May-Jun, Jul-Aug Inflows |
| 1982 | Jan-Feb Inflows |
| 1986 | Nov-Dec, SQRT (Nov-Dec) Inflows |
| 1987 | Jan-Feb, May-Jun Inflows |
| 1990 | Jul-Aug Inflows |
| 1992 | Jan-Feb, Ln (Jan-Feb), SQRT (Jan-Feb), Mar-Apr, SQRT (Mar-Apr) Inflows |

Table 1.4 Summary of points flagged by diagnostic measures.

| YEAR | BOX | SRE | SDR | LEV | MAH | COO | SDF | SDB | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| **DATA SET 4** | | | | | | | | | |
| 1968 | 2 | | | 1 | | | 1 | | 4 |
| 1970 | 1 | | | | | | | | 1 |
| 1971 | 1 | | | 1 | | | 1 | 1 | 4 |
| 1972 | 1 | | | | | | | | 1 |
| 1974 | 1 | | | | | | | | 1 |
| **1977** | **3** | | | **1** | **1** | | **1** | | **6** |
| 1980 | 1 | | | | | | | | 1 |
| 1986 | 1 | | | | | | | | 1 |
| 1992 | 1 | | | 1 | 1 | | | | 3 |
| **Data Set 5** | | | | | | | | | |
| **1968** | **2** | | | **1** | | | **1** | | **4** |
| 1970 | 1 | | | | | | | | 1 |
| **1971** | **1** | | | **1** | | | **1** | **2** | **5** |
| 1972 | 1 | | | | | | | | 1 |
| 1974 | 1 | | | | | | | | 1 |
| **1977** | **3** | | | **1** | | | **1** | | **5** |
| 1980 | 1 | | | | | | | | 1 |
| 1986 | 1 | | | | | | | | 1 |
| **1992** | **2** | | | **1** | **1** | | | | **4** |

Table 1.4 Summary of points flagged by diagnostic measures (continued).

| | BOX | SRE | SDR | LEV | MAH | COO | SDF | SDB | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| **Data Set 6** | | | | | | | | | |
| **1968** | **3** | | **1** | **1** | **1** | **1** | **1** | **2** | **10** |
| 1970 | 1 | | | | | | | | 1 |
| 1971 | | | | | | | 1 | 2 | 3 |
| 1972 | 1 | | | | | | | | 1 |
| 1974 | 1 | | | | | | | | 1 |
| **1977** | **3** | | | **1** | **1** | | **1** | | **6** |
| 1992 | 1 | | | 1 | 1 | | 1 | | 4 |
| **Data Set 7** | | | | | | | | | |
| **1968** | **2** | | | **1** | **1** | | **1** | | **5** |
| 1970 | 1 | | | | | | | | 1 |
| 1971 | | | | | | | 1 | 1 | 2 |
| 1972 | 1 | | | | | | | | 1 |
| 1974 | 1 | | | | | | | | 1 |
| **1977** | **3** | | | **1** | **1** | | **1** | | **6** |
| 1984 | | | 1 | | | | 1 | | 2 |
| 1986 | 1 | | | | | | | | 1 |
| **1992** | **2** | | | **1** | **1** | | | | **4** |

Key to Abbreviations:
**BOX** Box plot
**SRE** Studentized residual
**SDR** Studentized deleted residual
**LEV** Leverage value
**MAH** Mahalanobis distance
**COO** Cook's distance
**SDF** Standardized Dffits value
**SDB** Standardized Dfbeta value

### 1.3.3 Selecting the Final Candidate Models

After the subset analysis led us to the models: Data Set 4 (harvest untransformed and square root inflows) 1977 omitted; Data Set 5 (all variables square root) 1968, 1971, 1977 and/or 1992 omitted; Data Set 6 (logged and square root variables) 1968 and/or 1977 omitted; and Data Set 7 (harvest untransformed, and logged and square root inflows) 1968, 1977 and/or 1992 omitted.

Table 1.5 R-Square and Adjusted R-Square values for the different subsets.

| Data Set | Observations omitted | $R^2$ | Adjusted $R^2$ |
|---|---|---|---|
| 4 | 1977 | 0.3273 | 0.1658 |
| 5 | 1968 | 0.2469 | 0.0662 |
| | 1971 | 0.3610 | 0.2076 |
| | 1977 | 0.3172 | 0.1534 |
| | 1992 | 0.2191 | 0.0316 |
| | 1968 and 1971 | 0.3185 | 0.1481 |
| | 1968 and 1977 | 0.2604 | 0.0755 |
| | 1968 and 1992 | 0.1860 | - 0.0175 |
| | 1971 and 1977 | 0.3976 | 0.2469 |
| | 1971 and 1992 | 0.2979 | 0.1224 |
| | 1977 and 1992 | 0.2657 | 0.0822 |
| **6** | 1968 | 0.2731 | 0.0986 |
| | **1977** | **0.4983** | **0.3780** |
| | 1968 and 1977 | 0.2742 | 0.0927 |
| 7 | 1968 | 0.2879 | 0.1171 |
| | 1977 | 0.3344 | 0.1747 |
| | 1992 | 0.1837 | - 0.0123 |
| | 1968 and 1977 | 0.1942 | - 0.0073 |
| | 1968 and 1992 | 0.1795 | - 0.0256 |
| | 1977 and 1992 | 0.2435 | 0.0543 |

### 1.3.4 Selecting the Final Model

It is clear that Data Set 6 with 1977 omitted is the best model. Regression was performed using both models, and the deleted residuals were calculated.

| Best Candidate Model | $R^2$ | Adjusted $R^2$ | Prob>F |
|---|---|---|---|
| Ln (Brown Shrimp Harvest) = 4.897 - 0.162*(Jan-Feb Inflows)$^{0.5}$ + 0.196*(Mar-Apr Inflows)$^{0.5}$ + 0.284*Ln (May-Jun Inflows) - 0.107*(Sept-Oct Inflows)$^{0.5}$ + 0.166*(Nov-Dec Inflows)$^{0.5}$ | 0.4921 | 0.3944 | 0.002 |

## 1.4 Best Model: Logged and Square Root Variables

### 1.4.1 Summary Information

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| Ln (Brown Shrimp Harvest) | 5.961313 | 1.771708 | 32 |
| SQRT (January-February Inflows) | 4.813593 | 3.559986 | 32 |
| SQRT (March-April Inflows) | 4.465370 | 2.650715 | 32 |
| Ln (May-June Inflows) | 4.170986 | 1.541868 | 32 |
| SQRT (September-October Inflows) | 9.350173 | 10.08767 | 32 |
| SQRT (November-December Inflows) | 4.765457 | 2.823595 | 32 |

**Model Summary** [a,b]

| Model | Variables | | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| | Entered | Removed | | | | | |
| 1 | SQRT(November-December Inflows), Ln(May-June Inflows), SQRT(March-April Inflows), SQRT(September-October Inflows), SQRT(January-February Inflows) [c,d] | . | .702 | .492 | .394 | 1.378689 | .823 |

a. Dependent Variable: Ln (Brown Shrimp Harvest)

b. Method: Enter

c. Independent Variables: (Constant), SQRT (November-December Inflows), Ln (May-June Inflows), SQRT (March-April Inflows), SQRT (September-October Inflows), SQRT (January-February Inflows)

d. All requested variables entered.

**ANOVA** [a]

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 47.887 | 5 | 9.577 | 5.039 | .002 [b] |
| | Residual | 49.420 | 26 | 1.901 | | |
| | Total | 97.307 | 31 | | | |

a. Dependent Variable: Ln (Brown Shrimp Harvest)

b. Independent Variables: (Constant), SQRT (November-December Inflows), Ln (May-June Inflows), SQRT (March-April Inflows), SQRT (September-October Inflows), SQRT (January-February Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. | 95% Confidence Interval for B Lower Bound | 95% Confidence Interval for B Upper Bound |
|---|---|---|---|---|---|---|---|---|
| 1 | (Constant) | 4.897 | .775 | | 6.322 | .000 | 3.305 | 6.490 |
| | SQRT (January-February Inflows) | -.162 | .129 | -.326 | -1.260 | .219 | -.427 | .103 |
| | SQRT (March-April Inflows) | .196 | .152 | .293 | 1.287 | .210 | -.117 | .509 |
| | Ln (May-June Inflows) | .284 | .187 | .247 | 1.515 | .142 | -.101 | .669 |
| | SQRT (September-October Inflows) | -.107 | .036 | -.612 | -2.989 | .006 | -.181 | -.034 |
| | SQRT (November-December Inflows) | .166 | .108 | .265 | 1.544 | .135 | -.055 | .388 |

a. Dependent Variable: Ln (Brown Shrimp Harvest)

**Residuals Statistics[a]**

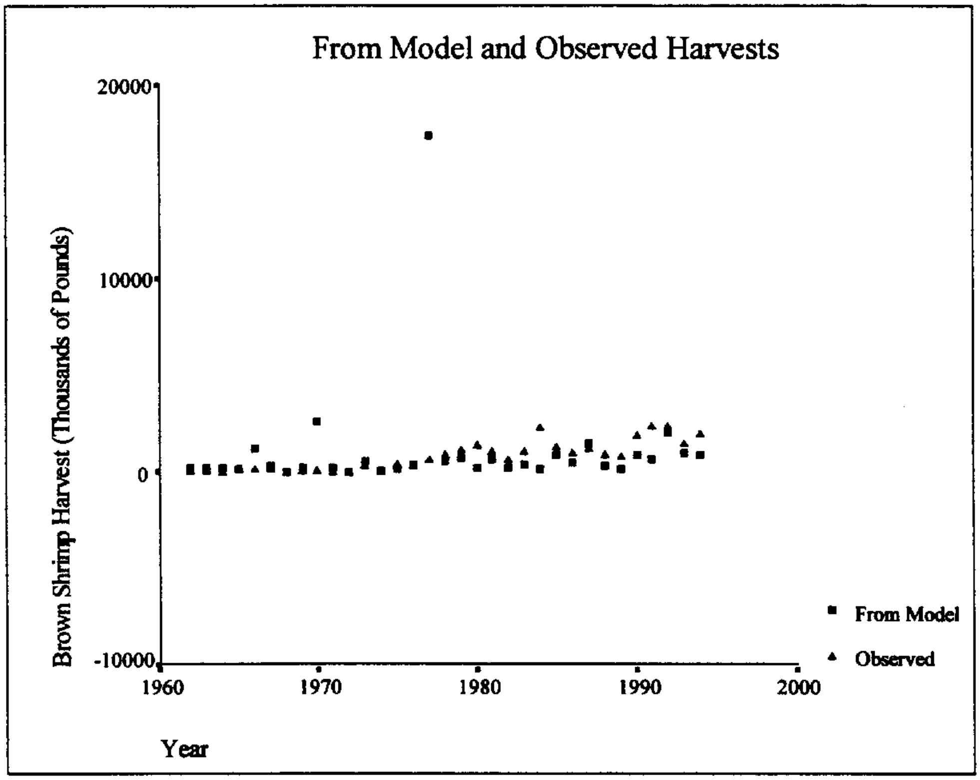
| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 1.255185 | 7.892989 | 5.961313 | 1.242876 | 32 |
| Std. Predicted Value | -3.786 | 1.554 | .000 | 1.000 | 32 |
| Standard Error of Predicted Value | .337955 | 1.223998 | .551526 | .232166 | 32 |
| Adjusted Predicted Value | 2.538358 | 9.316341 | 6.053767 | 1.102016 | 32 |
| Residual | -2.959235 | 2.432866 | -2.2E-16 | 1.262619 | 32 |
| Std. Residual | -2.146 | 1.765 | .000 | .916 | 32 |
| Stud. Residual | -2.612 | 1.870 | -.024 | 1.055 | 32 |
| Deleted Residual | -5.578587 | 2.731533 | -9.2E-02 | 1.792585 | 32 |
| Stud. Deleted Residual | -2.982 | 1.971 | -.047 | 1.117 | 32 |
| Mahal. Distance | .894 | 23.465 | 4.844 | 5.554 | 32 |
| Cook's Distance | .000 | 1.865 | .094 | .337 | 32 |
| Centered Leverage Value | .029 | .757 | .156 | .179 | 32 |

a. Dependent Variable: Ln (Brown Shrimp Harvest)

Table 1.6 Observed, predicted, lower and upper prediction intervals values for brown shrimp harvest.

| Year | Observed[a] | Predicted[a] | LICI | UICI |
|---|---|---|---|---|
| 1962 | 115.49 | 287.17 | 5.23 | 15773.04 |
| 1963 | 95.39 | 294.46 | 5.27 | 16441.86 |
| 1964 | 52.40 | 272.29 | 4.74 | 15652.19 |
| 1965 | 226.78 | 237.42 | 4.41 | 12790.78 |
| 1966 | 187.28 | 1258.62 | 21.32 | 74316.55 |
| 1967 | 171.48 | 401.56 | 7.63 | 21130.36 |
| 1968 | .60 | 3.51 | .02 | 505.55 |
| 1969 | 88.79 | 311.61 | 5.80 | 16738.66 |
| 1970 | 138.89 | 2678.02 | 32.57 | 220172.2 |
| 1971 | 19.30 | 290.72 | 5.36 | 15767.83 |
| 1972 | 51.80 | 24.96 | .24 | 2644.71 |
| 1973 | 396.15 | 592.83 | 10.19 | 34474.11 |
| 1974 | 150.09 | 129.23 | 1.47 | 11382.89 |
| 1975 | 482.74 | 245.78 | 4.46 | 13557.66 |
| 1976 | 397.15 | 413.16 | 7.55 | 22595.71 |
| 1977 | 738.60 | 17348.30 | 19.72 | 15263882.88 |
| 1978 | 909.98 | 637.68 | 12.04 | 33763.67 |
| 1979 | 1166.54 | 794.89 | 9.92 | 63673.60 |
| 1980 | 1468.79 | 260.11 | 4.59 | 14741.16 |
| 1981 | 1149.54 | 706.07 | 10.94 | 45571.46 |
| 1982 | 708.11 | 289.03 | 4.51 | 18513.68 |
| 1983 | 1135.24 | 433.22 | 8.34 | 22501.13 |
| 1984 | 2392.93 | 210.07 | 3.72 | 11877.14 |
| 1985 | 1403.90 | 957.77 | 17.75 | 51672.82 |
| 1986 | 993.86 | 516.44 | 5.91 | 45112.56 |
| 1987 | 1309.61 | 1533.04 | 21.13 | 111234.6 |
| 1988 | 981.77 | 333.98 | 6.13 | 18187.33 |
| 1989 | 894.98 | 185.02 | 3.11 | 11000.89 |
| 1990 | 1976.50 | 950.30 | 17.32 | 52138.79 |
| 1991 | 2414.93 | 696.51 | 12.43 | 39039.58 |
| 1992 | 2440.92 | 2084.59 | 12.42 | 349806.7 |
| 1993 | 1525.88 | 1059.41 | 20.26 | 55389.30 |
| 1994 | 2007.60 | 914.51 | 17.71 | 47226.86 |

[a] Brown shrimp harvest (thousands of pounds).
LICI Lower limit for 99% prediction interval for brown shrimp harvest.
UICI Upper limit for 99% prediction interval for brown shrimp harvest.



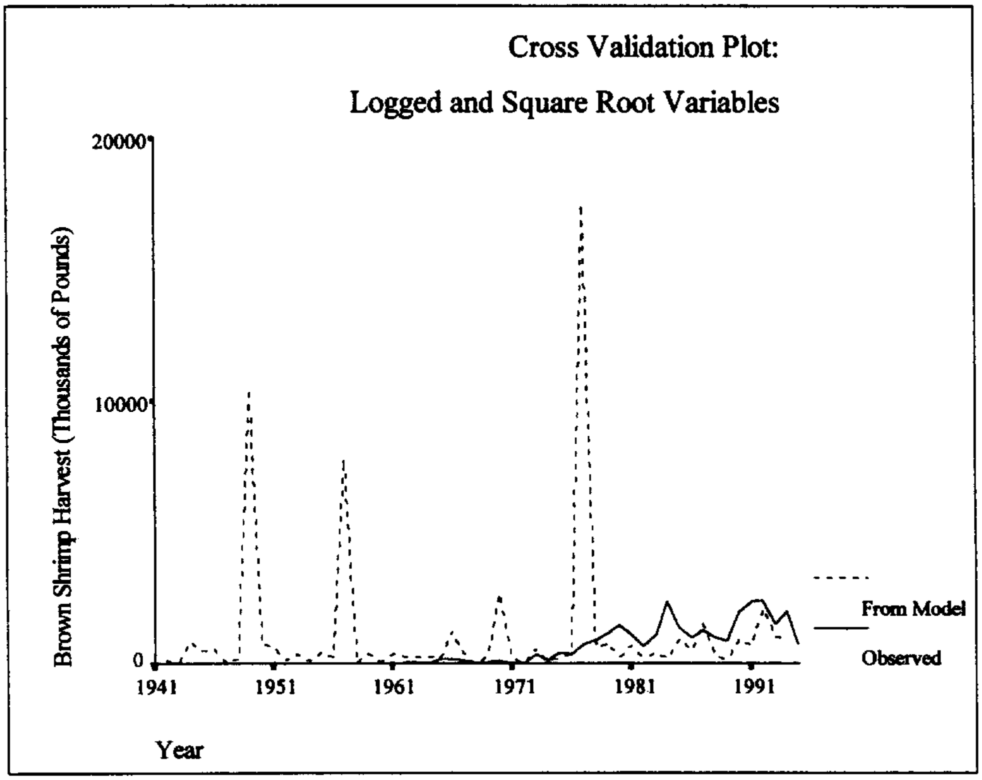




Fig. 1.1 Comparative plots of observed values vs. calculated from the regression model.

## 2. Exploring the Data

### 2.1 Listing of Data

Table 2.1. Brown shrimp harvest and water inflows data.

| Obs. | YEAR | BROWN SHRIMP | JF_LAG | MA_LAG | MJ_LAG | JA_LAG | SO_LAG | ND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | **1962** | 115.50 | 6.81 | 7.24 | 8.32 | 9.04 | 15.76 | 8.51 |
| 2 | **1963** | 95.40 | 6.06 | 7.11 | 8.59 | 10.46 | 6.98 | 4.16 |
| 3 | **1964** | 52.40 | 3.59 | 5.56 | 6.26 | 10.83 | 7.00 | 3.69 |
| 4 | **1965** | 226.80 | 70.52 | 33.82 | 209.10 | 10.81 | 191.73 | 21.41 |
| 5 | **1966** | 187.30 | 6.91 | 23.41 | 283.86 | 16.32 | 7.24 | 5.97 |
| 6 | **1967** | 171.50 | 6.85 | 10.18 | 13.39 | 14.88 | 10.21 | 9.24 |
| 7 | **1968** | .60 | 255.96 | 29.51 | 360.64 | 52.37 | 1994.55 | 37.71 |
| 8 | **1969** | 88.80 | 12.98 | 15.69 | 12.70 | 12.98 | 22.58 | 7.11 |
| 9 | **1970** | 138.90 | 16.83 | 30.92 | 261.71 | 49.57 | 64.36 | 124.43 |
| 10 | **1971** | 19.30 | 8.47 | 8.27 | 9.67 | 859.85 | 17.45 | 8.67 |
| 11 | **1972** | 51.80 | 39.77 | 13.17 | 172.06 | 21.99 | 1756.35 | 101.64 |
| 12 | **1973** | 396.20 | 8.85 | 7.13 | 286.16 | 133.35 | 44.15 | 11.21 |
| 13 | **1974** | 150.10 | 22.75 | 36.90 | 16.70 | 66.62 | 648.60 | 80.02 |
| 14 | **1975** | 482.80 | 26.13 | 8.11 | 222.72 | 77.49 | 176.70 | 21.67 |
| 15 | **1976** | 397.20 | 2.82 | 5.16 | 78.13 | 234.60 | 32.51 | 3.95 |
| 16 | **1977** | 738.60 | 82.51 | 301.21 | 147.52 | 3.28 | 266.62 | 388.53 |
| 17 | **1978** | 910.10 | 6.00 | 7.51 | 91.13 | 67.64 | 11.28 | 9.12 |
| 18 | **1979** | 1166.70 | 13.93 | 60.61 | 268.93 | 24.31 | 126.01 | 8.39 |
| 19 | **1980** | 1469.00 | 20.84 | 6.54 | 154.18 | 516.71 | 81.14 | 7.09 |
| 20 | **1981** | 1149.70 | 14.37 | 10.02 | 723.72 | 219.16 | 60.20 | 14.06 |
| 21 | **1982** | 708.20 | 58.47 | 14.06 | 115.43 | 12.14 | 207.42 | 78.86 |
| 22 | **1983** | 1135.40 | 13.05 | 13.28 | 17.27 | 45.21 | 11.75 | 13.32 |
| 23 | **1984** | 2393.30 | 32.09 | 11.17 | 15.01 | 8.72 | 52.99 | 19.23 |
| 24 | **1985** | 1404.10 | 14.57 | 32.01 | 171.56 | 51.48 | 25.51 | 11.43 |
| 25 | **1986** | 994.00 | 16.04 | 8.33 | 18.37 | 16.81 | 152.81 | 135.69 |
| 26 | **1987** | 1309.80 | 60.56 | 29.97 | 553.27 | 135.02 | 21.24 | 64.18 |
| 27 | **1988** | 981.90 | 9.07 | 7.26 | 9.92 | 12.08 | 21.12 | 18.64 |
| 28 | **1989** | 895.10 | 8.36 | 6.59 | 4.50 | 9.32 | 30.73 | 7.62 |
| 29 | **1990** | 1976.80 | 13.08 | 38.77 | 50.24 | 178.40 | 9.84 | 11.07 |
| 30 | **1991** | 2415.30 | 11.70 | 35.02 | 73.08 | 19.10 | 34.40 | 7.59 |
| 31 | **1992** | 2441.30 | 312.50 | 270.26 | 499.44 | 27.64 | 50.53 | 70.60 |
| 32 | **1993** | 1526.10 | 18.90 | 30.16 | 194.51 | 42.98 | 26.64 | 20.77 |
| 33 | **1994** | 2007.90 | 15.51 | 32.14 | 69.02 | 23.52 | 32.44 | 26.81 |

**BROWN SHRIMP** Brown Shrimp harvest (thousands of pounds)
**JF_LAG** Lagged January-February inflows (thousands of acre-feet)
**MA_LAG** Lagged March-April inflows (thousands of acre-feet)
**MJ_LAG** Lagged May-June inflows (thousands of acre-feet)
**JA_LAG** Lagged July-August inflows (thousands of acre-feet)
**SO_LAG** Lagged September-October inflows (thousands of acre-feet)
**ND_LAG** Lagged November-December inflows (thousands of acre-feet)

**2.2 Test of Normality for Individual Variables**

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Brown Shrimp Harvest | .157 | 33 | .039 | .882 | 33 | .010** |
| Ln (Brown Shrimp Harvest) | .176 | 33 | .011 | .840 | 33 | .010** |
| SQRT (Brown Shrimp Harvest) | .131 | 33 | .165 | .941 | 33 | .097 |
| January-February Inflows | .321 | 33 | .000 | .488 | 33 | .010** |
| Ln (January-February Inflows) | .151 | 33 | .055 | .926 | 33 | .040 |
| SQRT (January-February Inflows) | .247 | 33 | .000 | .700 | 33 | .010** |
| March-April Inflows | .387 | 33 | .000 | .433 | 33 | .010** |
| Ln (March-April Inflows) | .132 | 33 | .152 | .863 | 33 | .010** |
| SQRT (March-April Inflows) | .254 | 33 | .000 | .640 | 33 | .010** |
| May-June Inflows | .196 | 33 | .002 | .810 | 33 | .010** |
| Ln (May-June Inflows) | .164 | 33 | .024 | .912 | 33 | .016 |
| SQRT (May-June Inflows) | .180 | 33 | .008 | .914 | 33 | .017 |
| July-August Inflows | .319 | 33 | .000 | .524 | 33 | .010** |
| Ln (July-August Inflows) | .127 | 33 | .197 | .947 | 33 | .178 |
| SQRT (July-August Inflows) | .211 | 33 | .001 | .753 | 33 | .010** |
| September-October Inflows | .362 | 33 | .000 | .428 | 33 | .010** |
| Ln (September-October Inflows) | .134 | 33 | .139 | .919 | 33 | .024 |
| SQRT (September-October Inflows) | .258 | 33 | .000 | .645 | 33 | .010** |
| November-December Inflows | .307 | 33 | .000 | .534 | 33 | .010** |
| Ln (November-December Inflows) | .148 | 33 | .063 | .919 | 33 | .025 |
| SQRT (November-December Inflows) | .256 | 33 | .000 | .756 | 33 | .010** |

**. This is an upper bound of the true significance.

a. Lilliefors Significance Correction

## 2.3 Percentiles for Individual Variables

**Percentiles**

| | | Percentiles | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 10 | 25 | 50 | 75 | 90 | 95 |
| Weighted Average (Definition 1) | Brown Shrimp Harvest | 13.6900 | 52.0400 | 144.5000 | 738.6000 | 1356.95 | 2239.14 | 2423.10 |
| | Ln (Brown Shrimp Harvest) | 1.918826 | 3.951997 | 4.972528 | 6.604757 | 7.212391 | 7.710195 | 7.792791 |
| | SQRT (Brown Shrimp Harvest) | 3.307603 | 7.213847 | 12.0186 | 27.1772 | 36.8312 | 47.2767 | 49.2248 |
| | January-February Inflows | 3.3580 | 6.0240 | 8.4150 | 14.3700 | 29.1100 | 77.7140 | 272.9220 |
| | Ln (January-February Inflows) | 1.205728 | 1.795740 | 2.129994 | 2.665143 | 3.365814 | 4.350110 | 5.604896 |
| | SQRT (January-February Inflows) | 1.830096 | 2.454377 | 2.900846 | 3.790776 | 5.388277 | 8.809148 | 16.5024 |
| | March-April Inflows | 5.4400 | 6.5600 | 7.3850 | 13.2800 | 32.0750 | 51.8740 | 279.5450 |
| | Ln (March-April Inflows) | 1.693200 | 1.880864 | 1.999308 | 2.586259 | 3.468075 | 3.925735 | 5.631911 |
| | SQRT (March-April Inflows) | 2.332045 | 2.561245 | 2.717438 | 3.644173 | 5.663477 | 7.161768 | 16.7143 |
| | May-June Inflows | 5.7320 | 8.4280 | 14.2000 | 91.1300 | 242.2150 | 443.9200 | 604.4050 |
| | Ln (May-June Inflows) | 1.735149 | 2.131437 | 2.651612 | 4.512287 | 5.486576 | 6.083245 | 6.398414 |
| | SQRT (May-June Inflows) | 2.387796 | 2.903013 | 3.766755 | 9.546203 | 15.5508 | 21.0051 | 24.5358 |
| | July-August Inflows | 7.0880 | 9.1520 | 12.1100 | 24.3100 | 72.5650 | 228.4240 | 619.6520 |
| | Ln (July-August Inflows) | 1.872286 | 2.213861 | 2.494028 | 3.190888 | 4.282174 | 5.430650 | 6.400265 |
| | SQRT (July-August Inflows) | 2.610398 | 3.025143 | 3.479940 | 4.930517 | 8.513597 | 15.1116 | 24.7068 |
| | September-October Inflows | 6.9940 | 8.2800 | 16.6050 | 32.5100 | 139.4100 | 495.6080 | 1827.81 |
| | Ln (September-October Inflows) | 1.945052 | 2.102355 | 2.808407 | 3.481548 | 4.932778 | 6.119219 | 7.509147 |
| | SQRT (September-October Inflows) | 2.644617 | 2.869186 | 4.073603 | 5.701754 | 11.7935 | 21.8120 | 42.7343 |
| | November-December Inflows | 3.8720 | 4.8840 | 8.0050 | 13.3200 | 50.9450 | 115.3140 | 211.5420 |
| | Ln (November-December Inflows) | 1.353289 | 1.570006 | 2.078906 | 2.589267 | 3.895808 | 4.742821 | 5.225972 |
| | SQRT (November-December Inflows) | 1.967504 | 2.201106 | 2.828492 | 3.649658 | 7.076044 | 10.7256 | 14.0674 |
| Tukey's Hinges | Brown Shrimp Harvest | | | 150.1000 | 738.6000 | 1309.80 | | |
| | Ln (Brown Shrimp Harvest) | | | 5.011302 | 6.604757 | 7.177630 | | |
| | SQRT (Brown Shrimp Harvest) | | | 12.2515 | 27.1772 | 36.1912 | | |
| | January-February Inflows | | | 8.4700 | 14.3700 | 26.1300 | | |
| | Ln (January-February Inflows) | | | 2.136531 | 2.665143 | 3.263084 | | |
| | SQRT (January-February Inflows) | | | 2.910326 | 3.790776 | 5.111751 | | |
| | March-April Inflows | | | 7.5100 | 13.2800 | 32.0100 | | |
| | Ln (March-April Inflows) | | | 2.016235 | 2.586259 | 3.466048 | | |
| | SQRT (March-April Inflows) | | | 2.740438 | 3.644173 | 5.657738 | | |
| | May-June Inflows | | | 15.0100 | 91.1300 | 222.7200 | | |
| | Ln (May-June Inflows) | | | 2.708717 | 4.512287 | 5.405915 | | |
| | SQRT (May-June Inflows) | | | 3.874274 | 9.546203 | 14.9236 | | |
| | July-August Inflows | | | 12.1400 | 24.3100 | 67.6400 | | |
| | Ln (July-August Inflows) | | | 2.496506 | 3.190888 | 4.214200 | | |
| | SQRT (July-August Inflows) | | | 3.484250 | 4.930517 | 8.224354 | | |
| | September-October Inflows | | | 17.4500 | 32.5100 | 126.0100 | | |
| | Ln (September-October Inflows) | | | 2.859340 | 3.481548 | 4.836361 | | |
| | SQRT (September-October Inflows) | | | 4.177320 | 5.701754 | 11.2254 | | |
| | November-December Inflows | | | 8.3900 | 13.3200 | 37.7100 | | |
| | Ln (November-December Inflows) | | | 2.127041 | 2.589267 | 3.629925 | | |
| | SQRT (November-December Inflows) | | | 2.896550 | 3.649658 | 6.140647 | | |

## 2.4 Summary Information for Individual Variables

### 2.4.1 Summary Information for Brown Shrimp Harvest

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| Brown Shrimp Harvest | Mean | | 854.4818 | 133.7219 |
| | 95% Confidence Interval for Mean | Lower Bound | 582.0993 | |
| | | Upper Bound | 1126.86 | |
| | 5% Trimmed Mean | | 813.9229 | |
| | Median | | 738.6000 | |
| | Variance | | 590091 | |
| | Std. Deviation | | 768.1737 | |
| | Minimum | | .60 | |
| | Maximum | | 2441.30 | |
| | Range | | 2440.70 | |
| | Interquartile Range | | 1212.45 | |
| | Skewness | | .728 | .409 |
| | Kurtosis | | -.515 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| Brown Shrimp Harvest | Highest | 1 | 31 | 1992 | 2441.30 |
| | | 2 | 30 | 1991 | 2415.30 |
| | | 3 | 23 | 1984 | 2393.30 |
| | | 4 | 33 | 1994 | 2007.90 |
| | | 5 | 29 | 1990 | 1976.80 |
| | Lowest | 1 | 7 | 1968 | .60 |
| | | 2 | 10 | 1971 | 19.30 |
| | | 3 | 11 | 1972 | 51.80 |
| | | 4 | 3 | 1964 | 52.40 |
| | | 5 | 8 | 1969 | 88.80 |

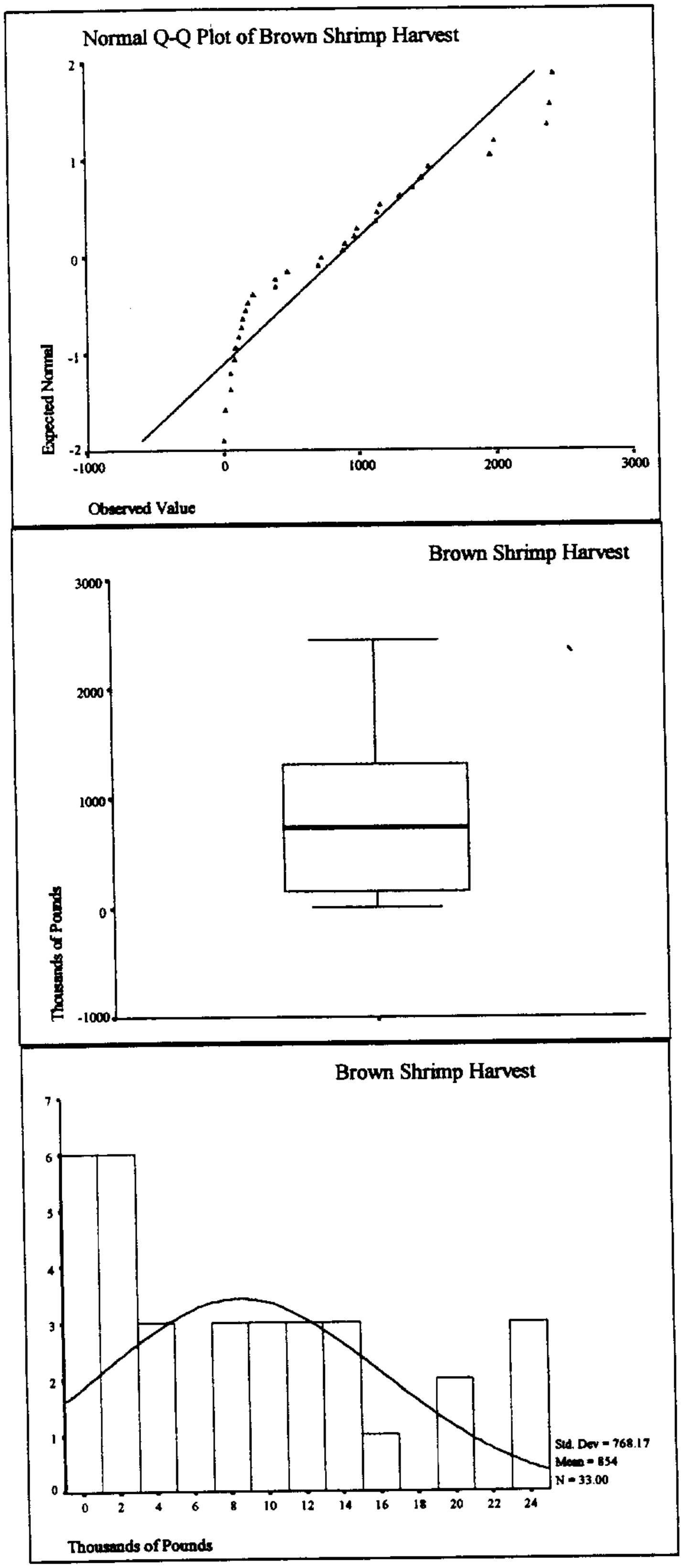



Fig. 2.1a. Exploratory Plots of Brown Shrimp Harvest.

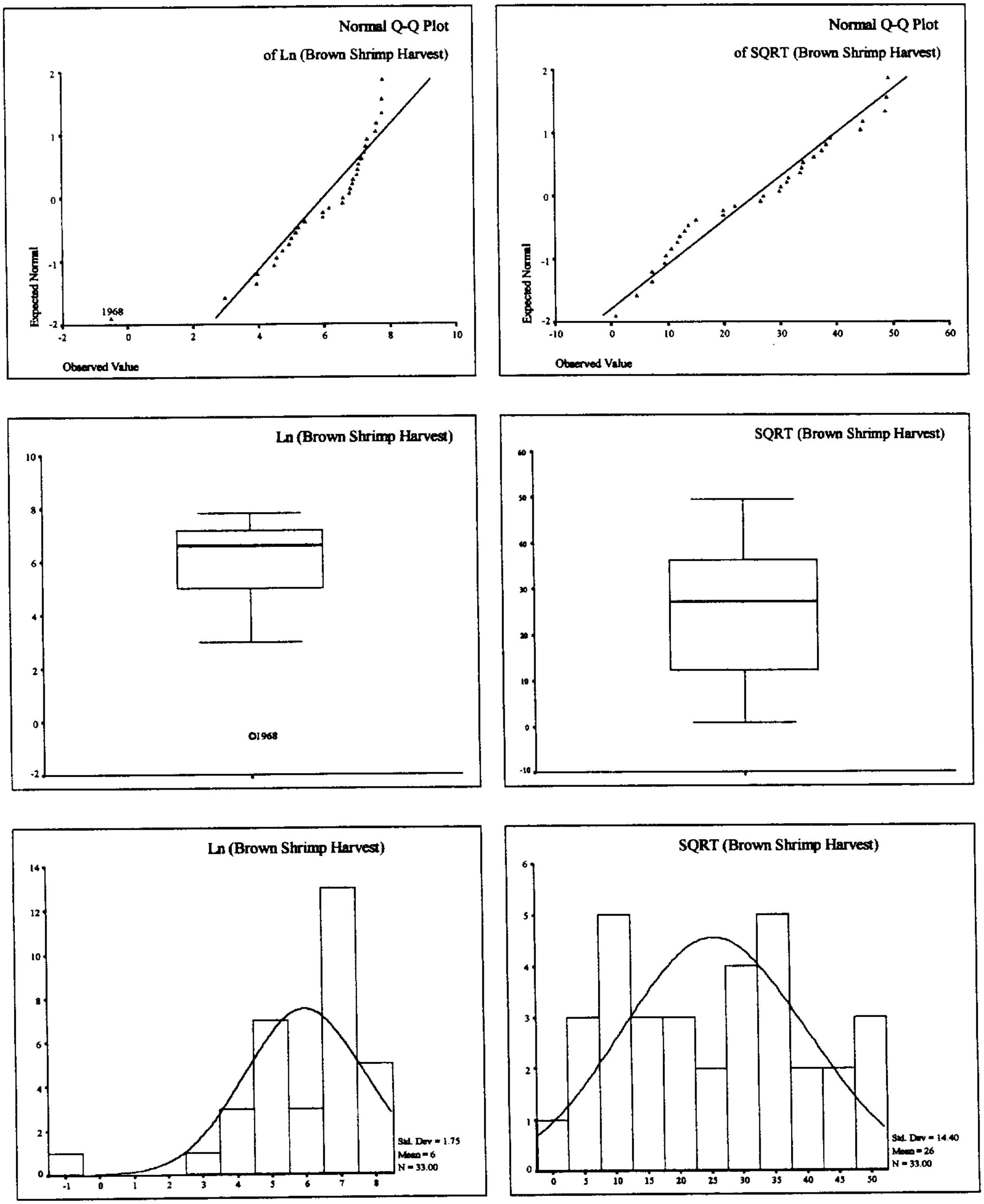



Fig. 2.1b. Exploratory Plots of Transformed Brown Shrimp Harvest.

### 2.4.2 Summary Information for January-February Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| January-February Inflows | Mean | | 36.8742 | 11.6916 |
| | 95% Confidence Interval for Mean | Lower Bound | 13.0591 | |
| | | Upper Bound | 60.6893 | |
| | 5% Trimmed Mean | | 24.6742 | |
| | Median | | 14.3700 | |
| | Variance | | 4510.917 | |
| | Std. Deviation | | 67.1634 | |
| | Minimum | | 2.82 | |
| | Maximum | | 312.50 | |
| | Range | | 309.68 | |
| | Interquartile Range | | 20.6950 | |
| | Skewness | | 3.423 | .409 |
| | Kurtosis | | 11.693 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| January-February Inflows | Highest | 1 | 31 | 1992 | 312.50 |
| | | 2 | 7 | 1968 | 255.96 |
| | | 3 | 16 | 1977 | 82.51 |
| | | 4 | 4 | 1965 | 70.52 |
| | | 5 | 26 | 1987 | 60.56 |
| | Lowest | 1 | 15 | 1976 | 2.82 |
| | | 2 | 3 | 1964 | 3.59 |
| | | 3 | 17 | 1978 | 6.00 |
| | | 4 | 2 | 1963 | 6.06 |
| | | 5 | 1 | 1962 | 6.81 |

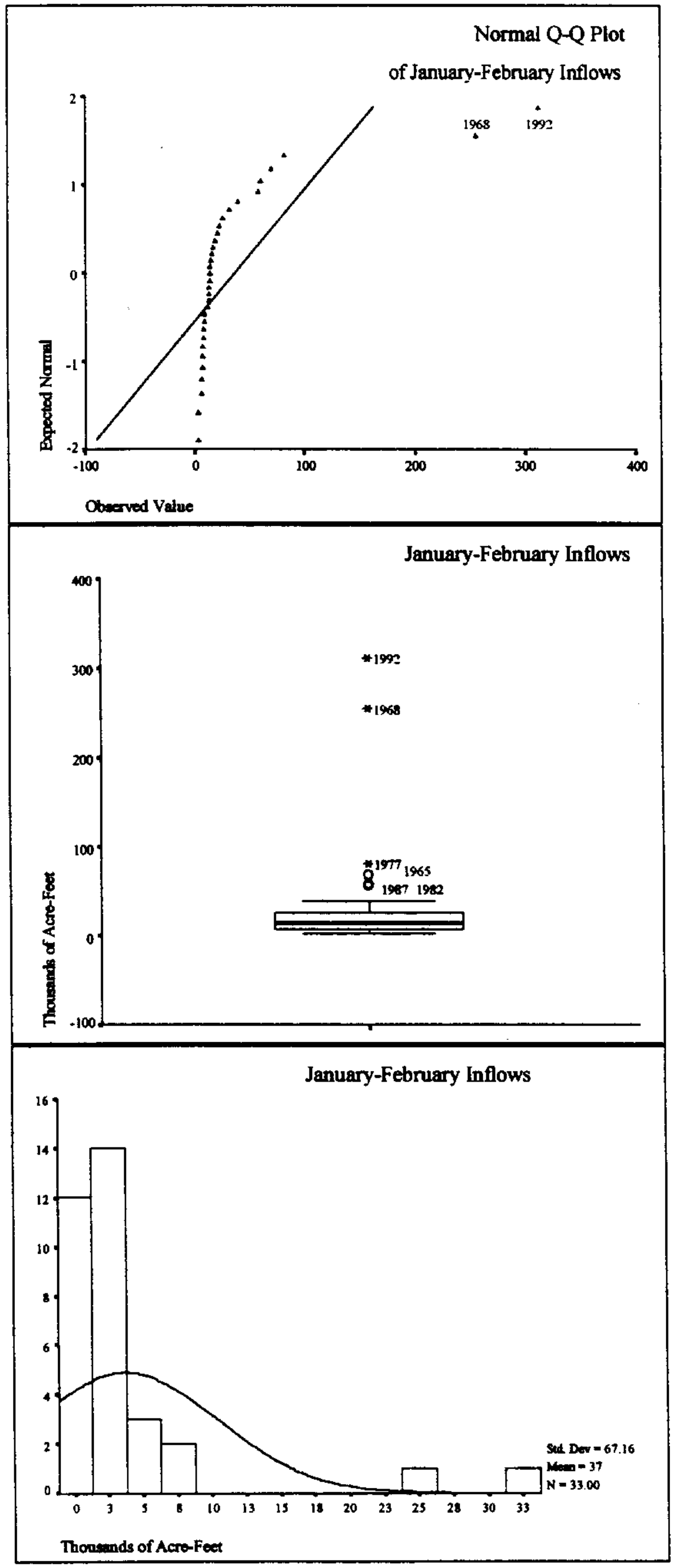



Fig. 2.2a. Exploratory Plots of January-February Inflows.

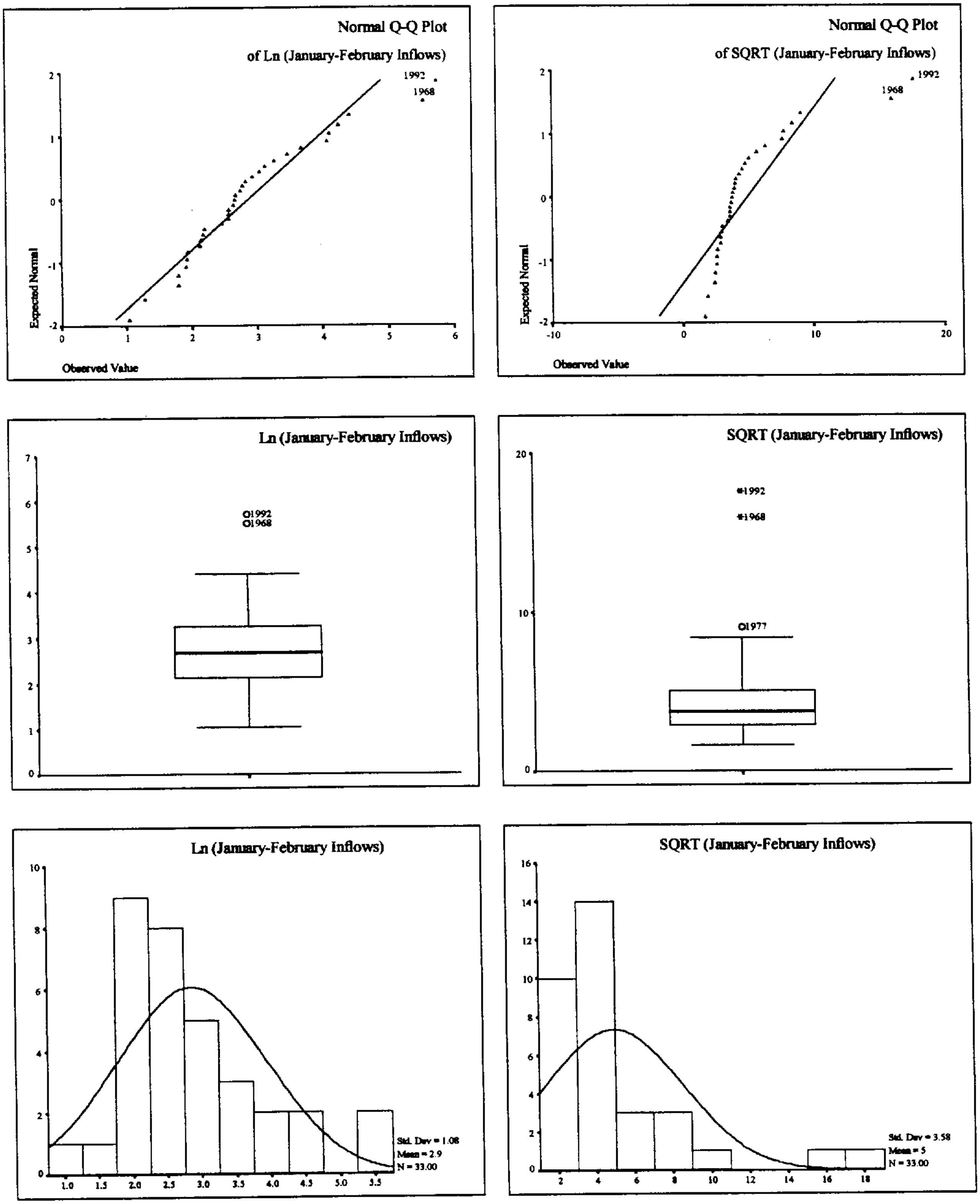



Fig. 2.2b. Exploratory Plots of Transformed January-February Inflows.

### 2.4.3 Summary Information for March-April Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| March-April Inflows | Mean | | 35.0633 | 11.5174 |
| | 95% Confidence Interval for Mean | Lower Bound | 11.6032 | |
| | | Upper Bound | 58.5234 | |
| | 5% Trimmed Mean | | 22.6073 | |
| | Median | | 13.2800 | |
| | Variance | | 4377.438 | |
| | Std. Deviation | | 66.1622 | |
| | Minimum | | 5.16 | |
| | Maximum | | 301.21 | |
| | Range | | 296.05 | |
| | Interquartile Range | | 24.6900 | |
| | Skewness | | 3.622 | .409 |
| | Kurtosis | | 12.609 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| March-April Inflows | Highest | 1 | 16 | 1977 | 301.21 |
| | | 2 | 31 | 1992 | 270.26 |
| | | 3 | 18 | 1979 | 60.61 |
| | | 4 | 29 | 1990 | 38.77 |
| | | 5 | 13 | 1974 | 36.90 |
| | Lowest | 1 | 15 | 1976 | 5.16 |
| | | 2 | 3 | 1964 | 5.56 |
| | | 3 | 19 | 1980 | 6.54 |
| | | 4 | 28 | 1989 | 6.59 |
| | | 5 | 2 | 1963 | 7.11 |

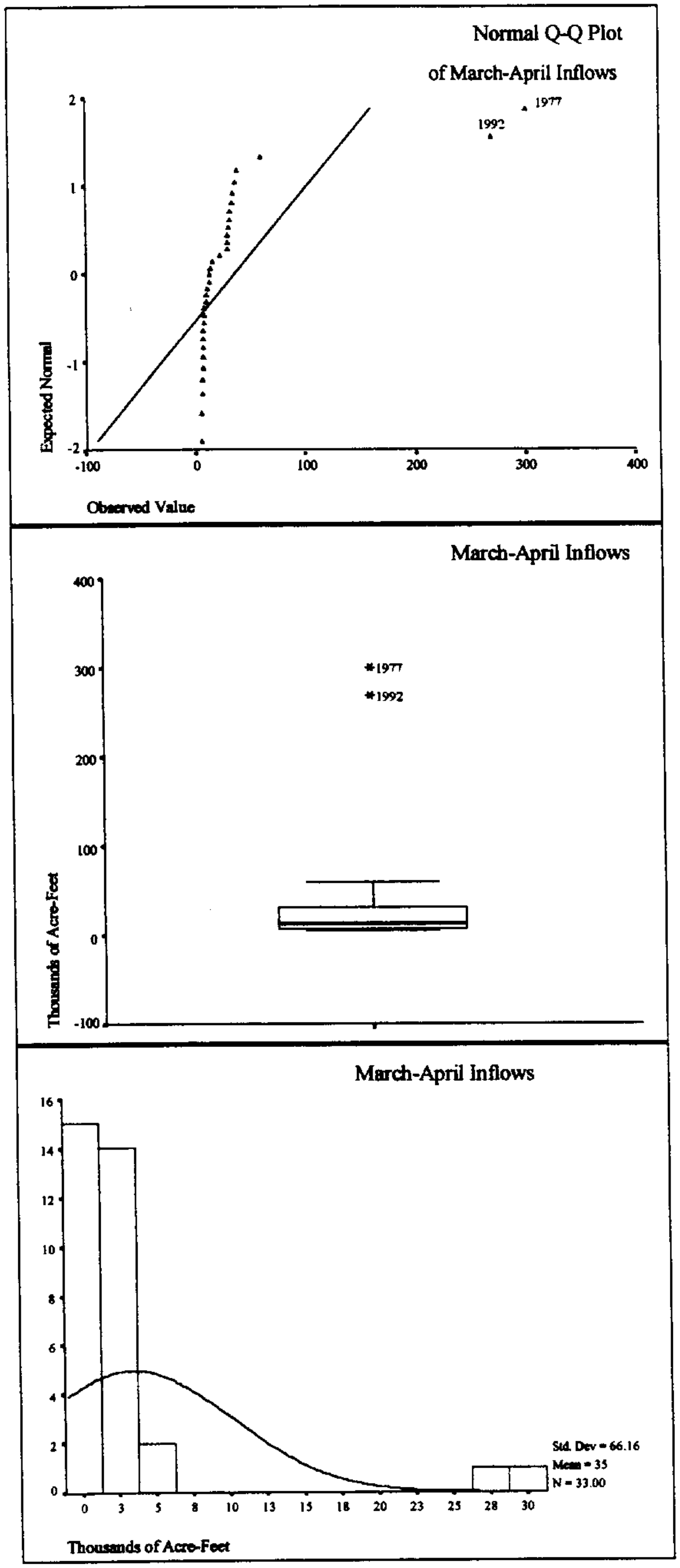



Fig. 2.3a. Exploratory Plots of March-April Inflows.

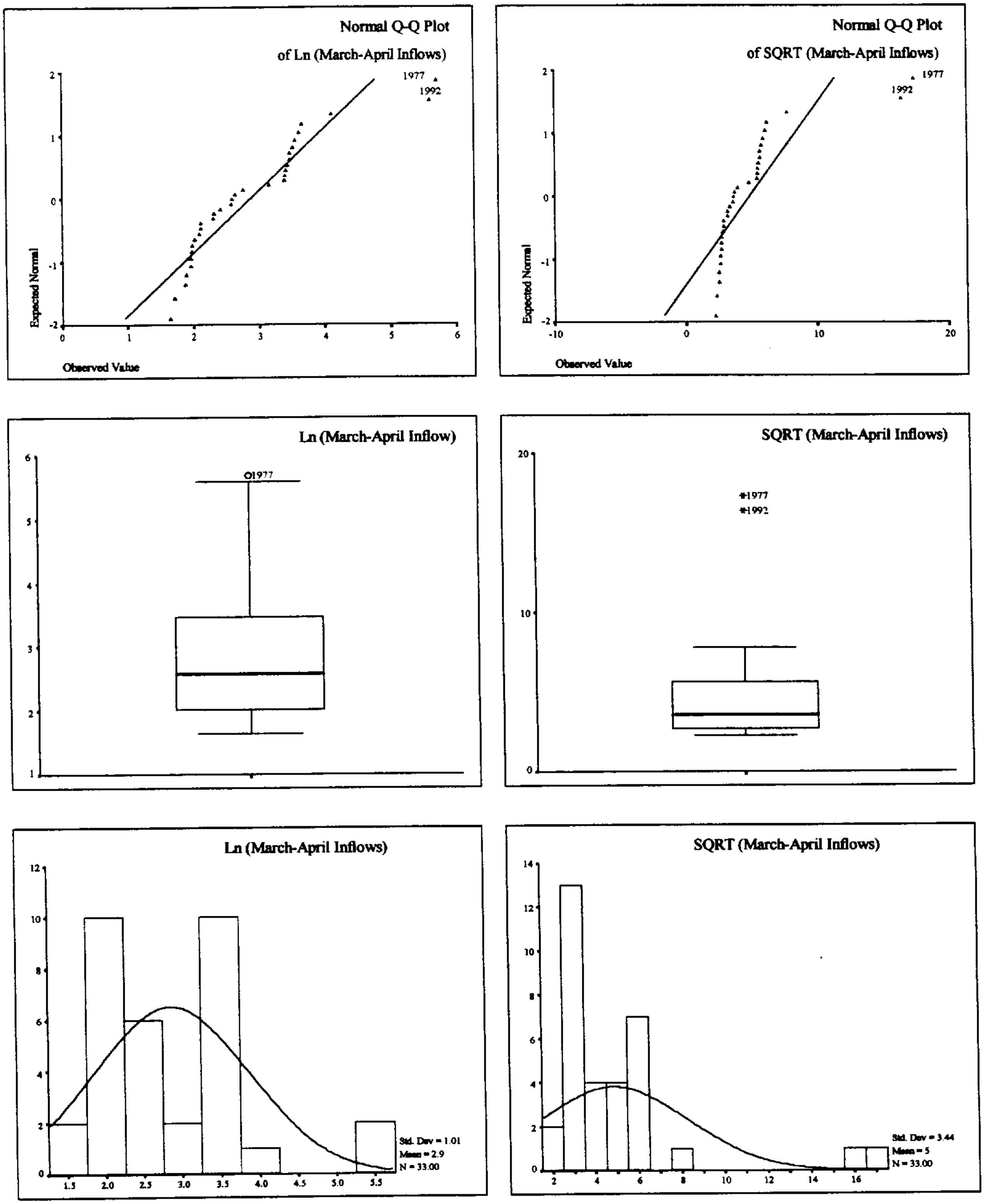



Fig. 2.3b. Exploratory Plots of Transformed March-April Inflows.

### 2.4.4 Summary Information for May-June Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| May-June Inflows | Mean | | 155.3670 | 30.6811 |
| | 95% Confidence Interval for Mean | Lower Bound | 92.8716 | |
| | | Upper Bound | 217.8623 | |
| | 5% Trimmed Mean | | 135.8652 | |
| | Median | | 91.1300 | |
| | Variance | | 31063.9 | |
| | Std. Deviation | | 176.2495 | |
| | Minimum | | 4.50 | |
| | Maximum | | 723.72 | |
| | Range | | 719.22 | |
| | Interquartile Range | | 228.0150 | |
| | Skewness | | 1.608 | .409 |
| | Kurtosis | | 2.616 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| May-June Inflows | Highest | 1 | 20 | 1981 | 723.72 |
| | | 2 | 26 | 1987 | 553.27 |
| | | 3 | 31 | 1992 | 499.44 |
| | | 4 | 7 | 1968 | 360.64 |
| | | 5 | 12 | 1973 | 286.16 |
| | Lowest | 1 | 28 | 1989 | 4.50 |
| | | 2 | 3 | 1964 | 6.26 |
| | | 3 | 1 | 1962 | 8.32 |
| | | 4 | 2 | 1963 | 8.59 |
| | | 5 | 10 | 1971 | 9.67 |

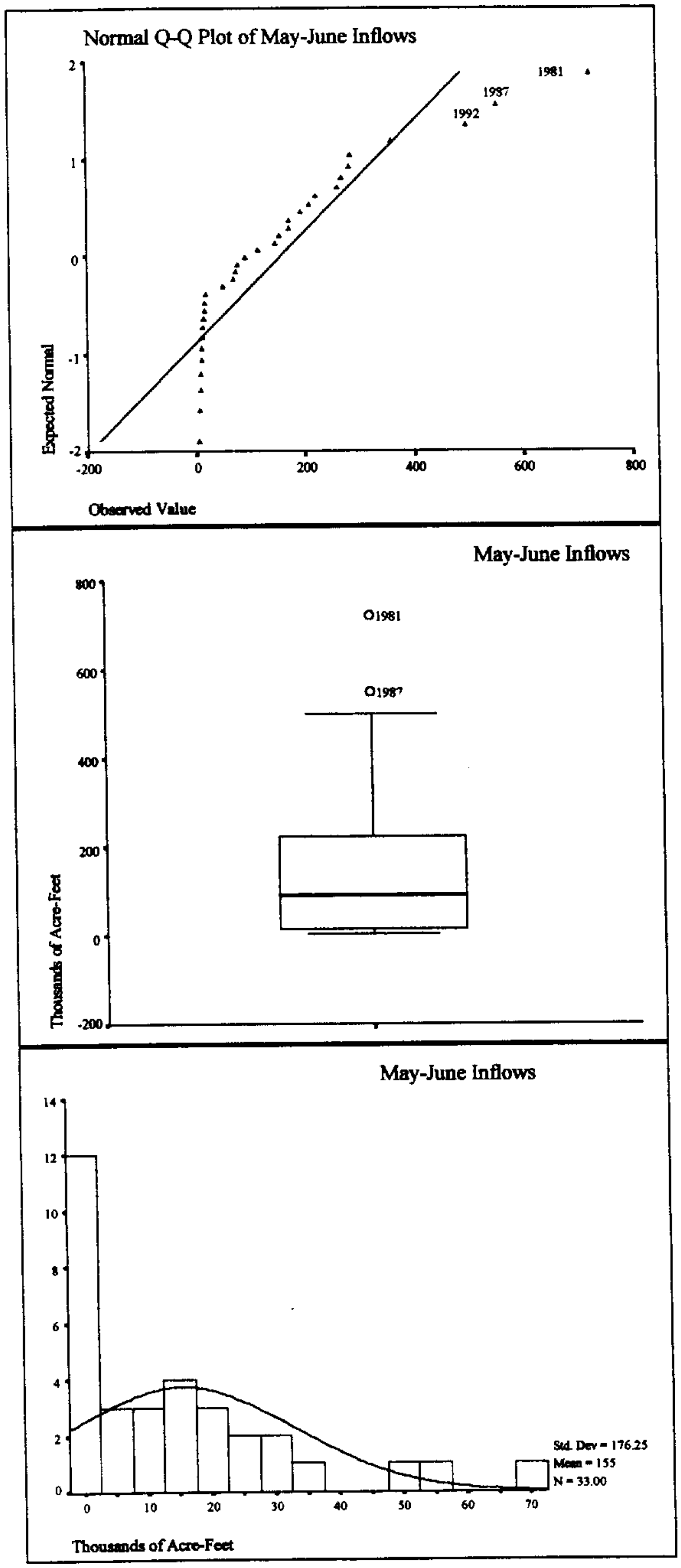



Fig. 2.4a. Exploratory Plots of May-June Inflows.

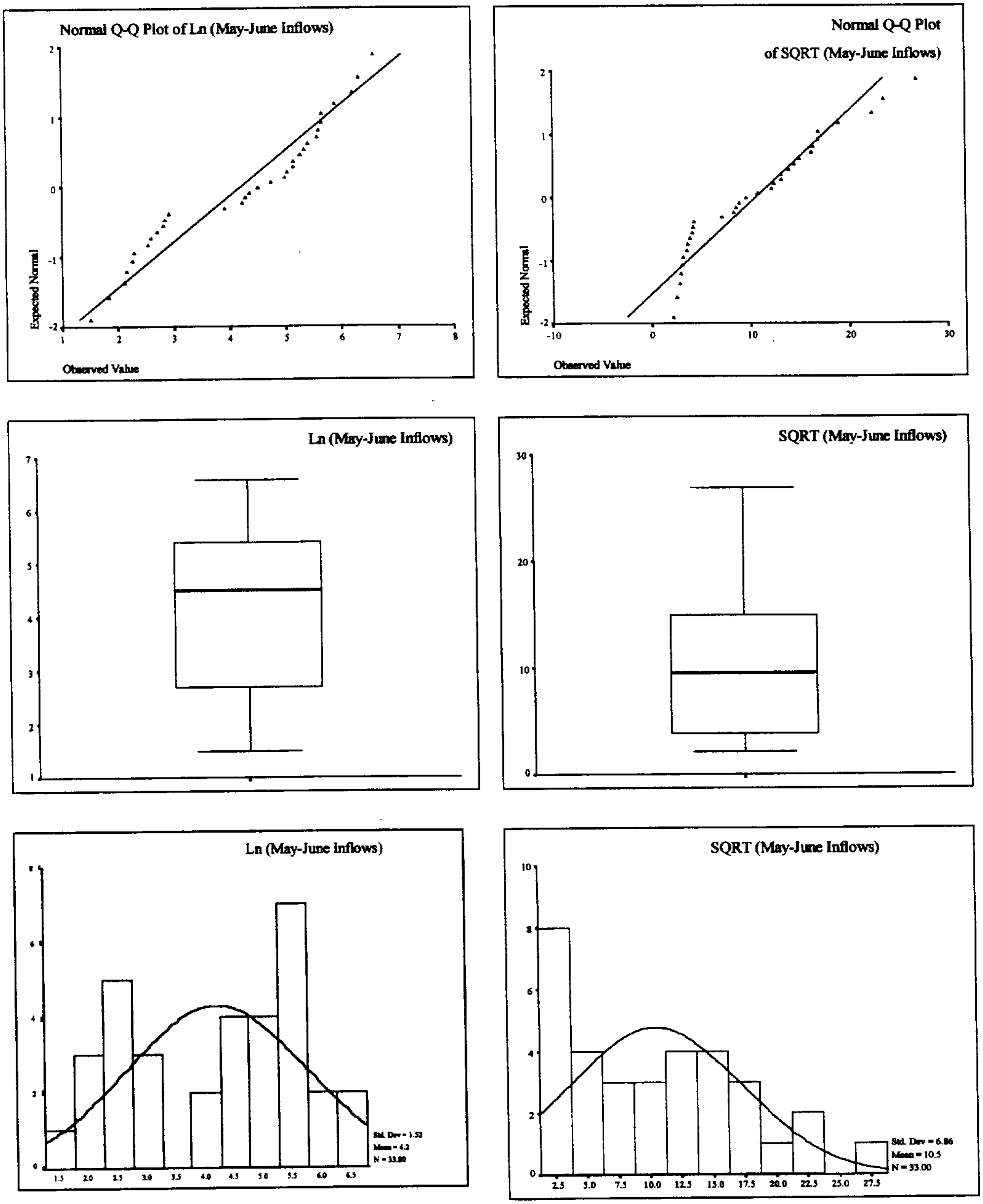



Fig. 2.4b. Exploratory Plots of Transformed May-June Inflows.

### 2.4.5 Summary Information for July-August Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| July-August Inflows | Mean | | 90.7479 | 29.7850 |
| | 95% Confidence Interval for Mean | Lower Bound | 30.0779 | |
| | | Upper Bound | 151.4179 | |
| | 5% Trimmed Mean | | 60.2701 | |
| | Median | | 24.3100 | |
| | Variance | | 29275.8 | |
| | Std. Deviation | | 171.1016 | |
| | Minimum | | 3.28 | |
| | Maximum | | 859.85 | |
| | Range | | 856.57 | |
| | Interquartile Range | | 60.4550 | |
| | Skewness | | 3.517 | .409 |
| | Kurtosis | | 13.598 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| July-August Inflows | Highest | 1 | 10 | 1971 | 859.85 |
| | | 2 | 19 | 1980 | 516.71 |
| | | 3 | 15 | 1976 | 234.60 |
| | | 4 | 20 | 1981 | 219.16 |
| | | 5 | 29 | 1990 | 178.40 |
| | Lowest | 1 | 16 | 1977 | 3.28 |
| | | 2 | 23 | 1984 | 8.72 |
| | | 3 | 1 | 1962 | 9.04 |
| | | 4 | 28 | 1989 | 9.32 |
| | | 5 | 2 | 1963 | 10.46 |

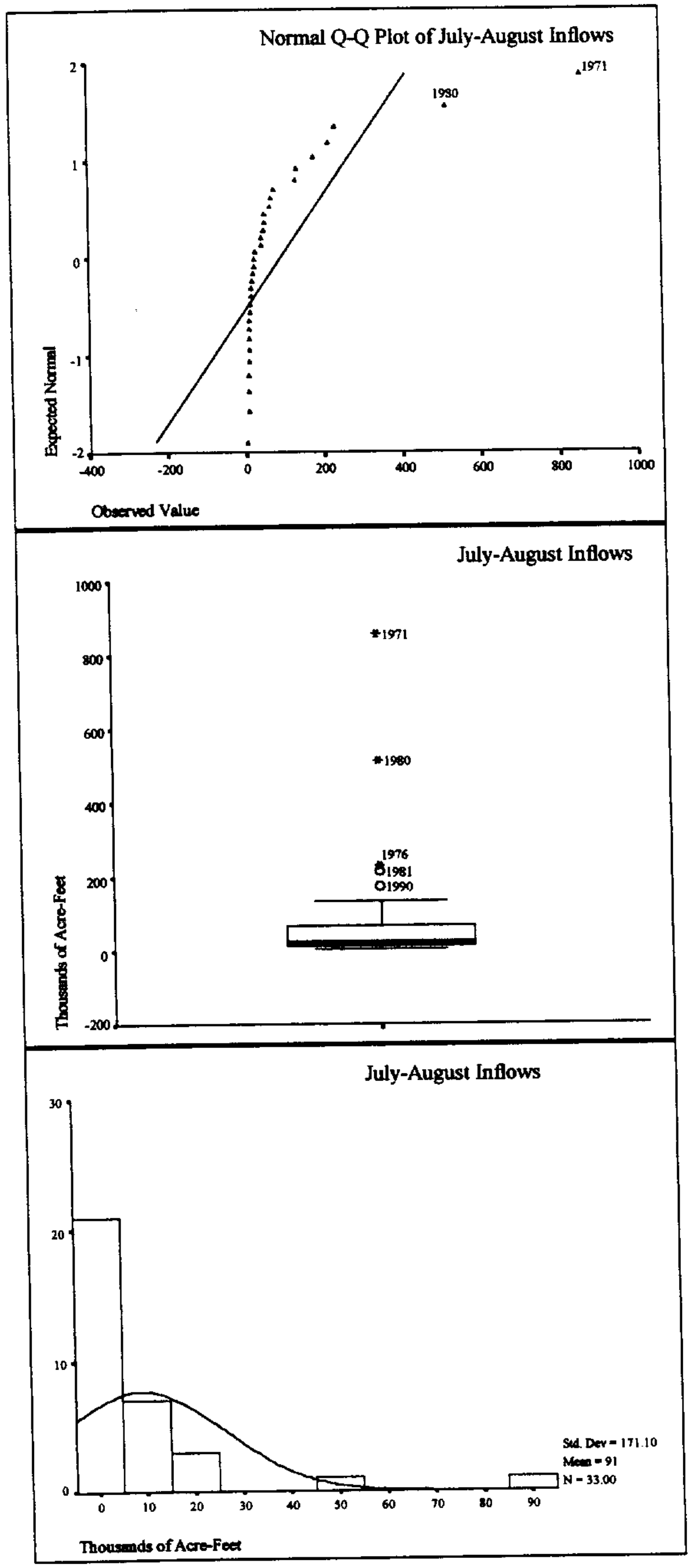



Fig. 2.5a. Exploratory Plots of July-August Inflows.

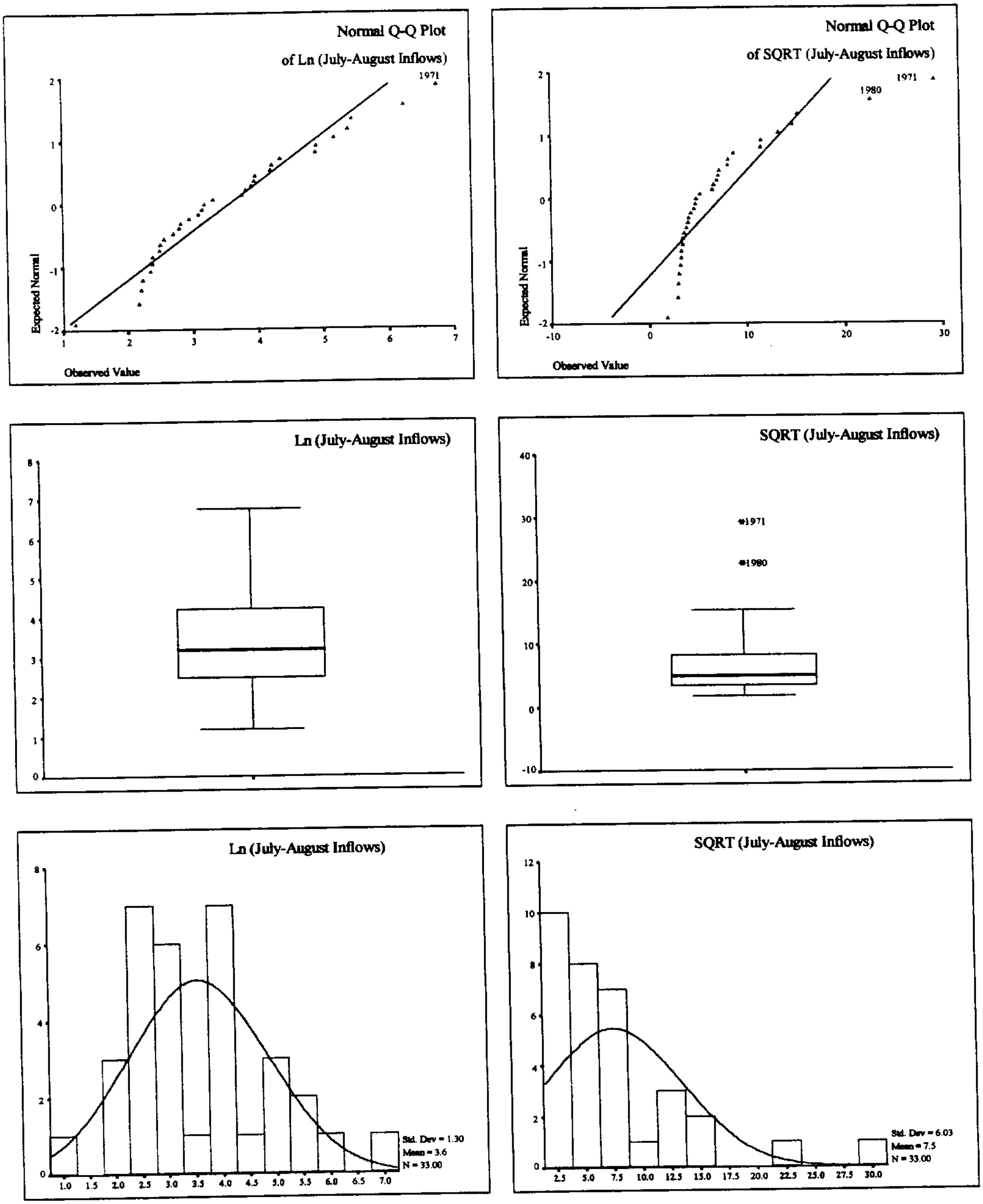



Fig. 2.5b. Exploratory Plots of Transformed July-August Inflows.

### 2.4.6 Summary Information for September-October Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| September-October Inflows | Mean | | 188.4497 | 78.8344 |
| | 95% Confidence Interval for Mean | Lower Bound | 27.8693 | |
| | | Upper Bound | 349.0301 | |
| | 5% Trimmed Mean | | 103.4051 | |
| | Median | | 32.5100 | |
| | Variance | | 205090 | |
| | Std. Deviation | | 452.8691 | |
| | Minimum | | 6.98 | |
| | Maximum | | 1994.55 | |
| | Range | | 1987.57 | |
| | Interquartile Range | | 122.8050 | |
| | Skewness | | 3.489 | .409 |
| | Kurtosis | | 11.706 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| September-October Inflows | Highest | 1 | 7 | 1968 | 1994.55 |
| | | 2 | 11 | 1972 | 1756.35 |
| | | 3 | 13 | 1974 | 648.60 |
| | | 4 | 16 | 1977 | 266.62 |
| | | 5 | 21 | 1982 | 207.42 |
| | Lowest | 1 | 2 | 1963 | 6.98 |
| | | 2 | 3 | 1964 | 7.00 |
| | | 3 | 5 | 1966 | 7.24 |
| | | 4 | 29 | 1990 | 9.84 |
| | | 5 | 6 | 1967 | 10.21 |

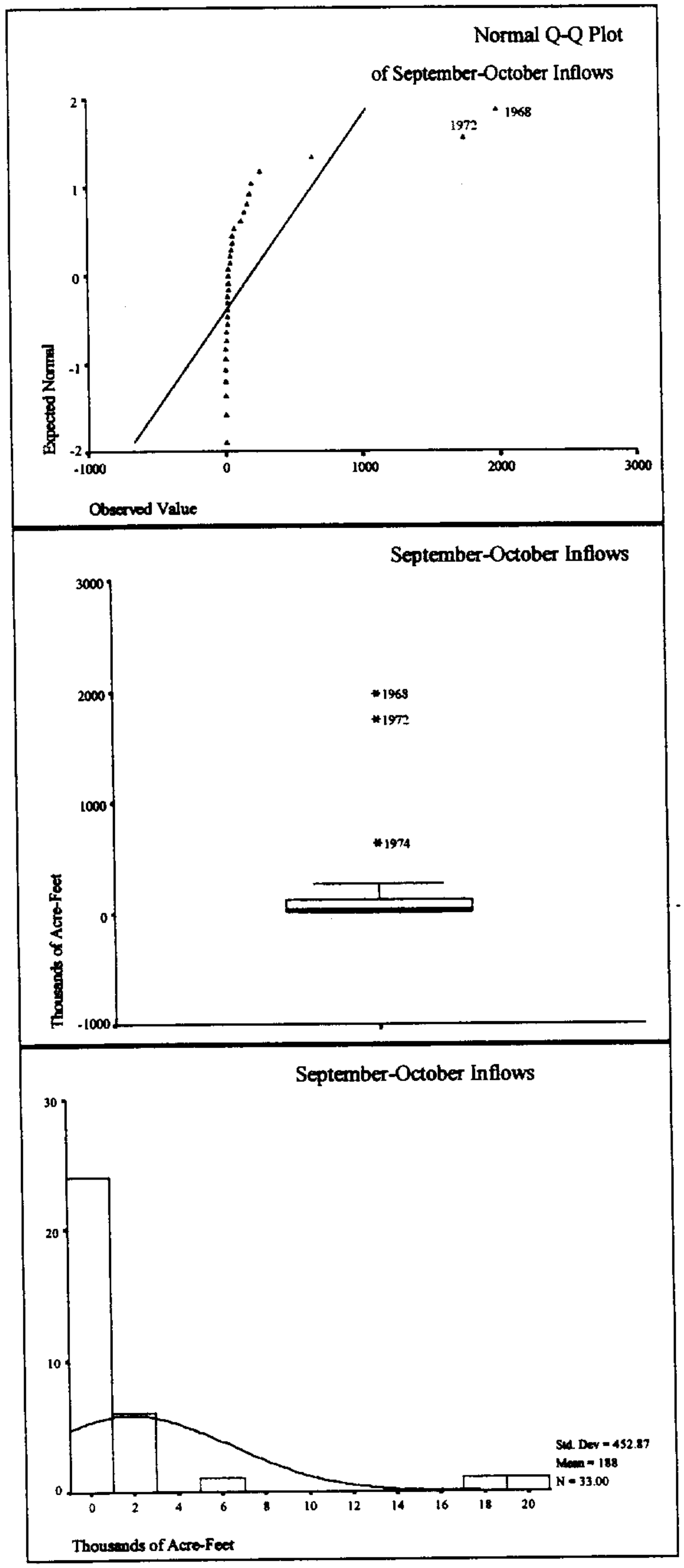



Fig. 2.6a. Exploratory Plots of September-October Inflows.

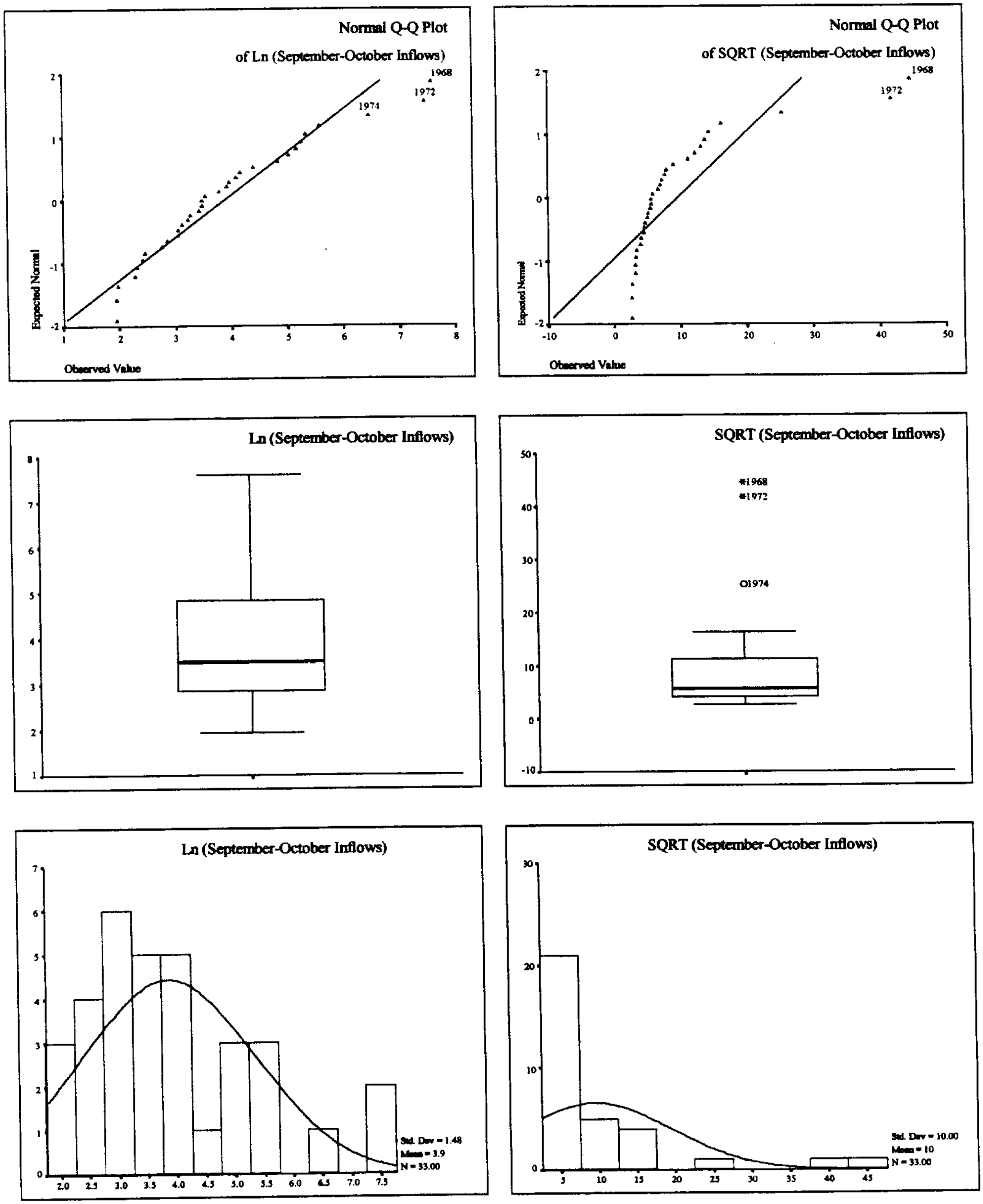



Fig. 2.6b. Exploratory Plots of Transformed September-October Inflows.

### 2.4.7 Summary Information for November-December Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| November-December Inflows | Mean | | 41.2845 | 12.5498 |
| | 95% Confidence Interval for Mean | Lower Bound | 15.7214 | |
| | | Upper Bound | 66.8476 | |
| | 5% Trimmed Mean | | 29.6096 | |
| | Median | | 13.3200 | |
| | Variance | | 5197.416 | |
| | Std. Deviation | | 72.0931 | |
| | Minimum | | 3.69 | |
| | Maximum | | 388.53 | |
| | Range | | 384.84 | |
| | Interquartile Range | | 42.9400 | |
| | Skewness | | 3.813 | .409 |
| | Kurtosis | | 17.224 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| November-December Inflows | Highest | 1 | 16 | 1977 | 388.53 |
| | | 2 | 25 | 1986 | 135.69 |
| | | 3 | 9 | 1970 | 124.43 |
| | | 4 | 11 | 1972 | 101.64 |
| | | 5 | 13 | 1974 | 80.02 |
| | Lowest | 1 | 3 | 1964 | 3.69 |
| | | 2 | 15 | 1976 | 3.95 |
| | | 3 | 2 | 1963 | 4.16 |
| | | 4 | 5 | 1966 | 5.97 |
| | | 5 | 19 | 1980 | 7.09 |

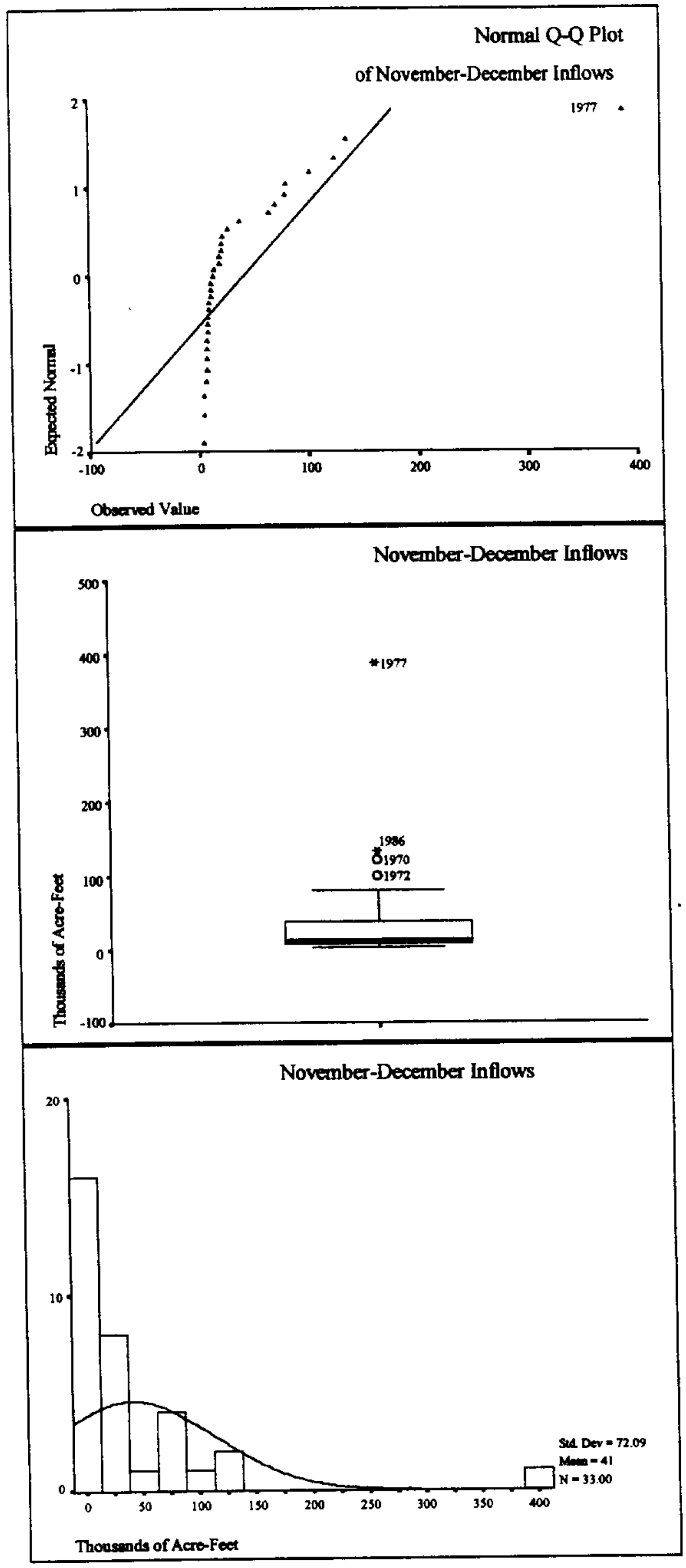



Fig. 2.7a. Exploratory Plots of November-December Inflows.

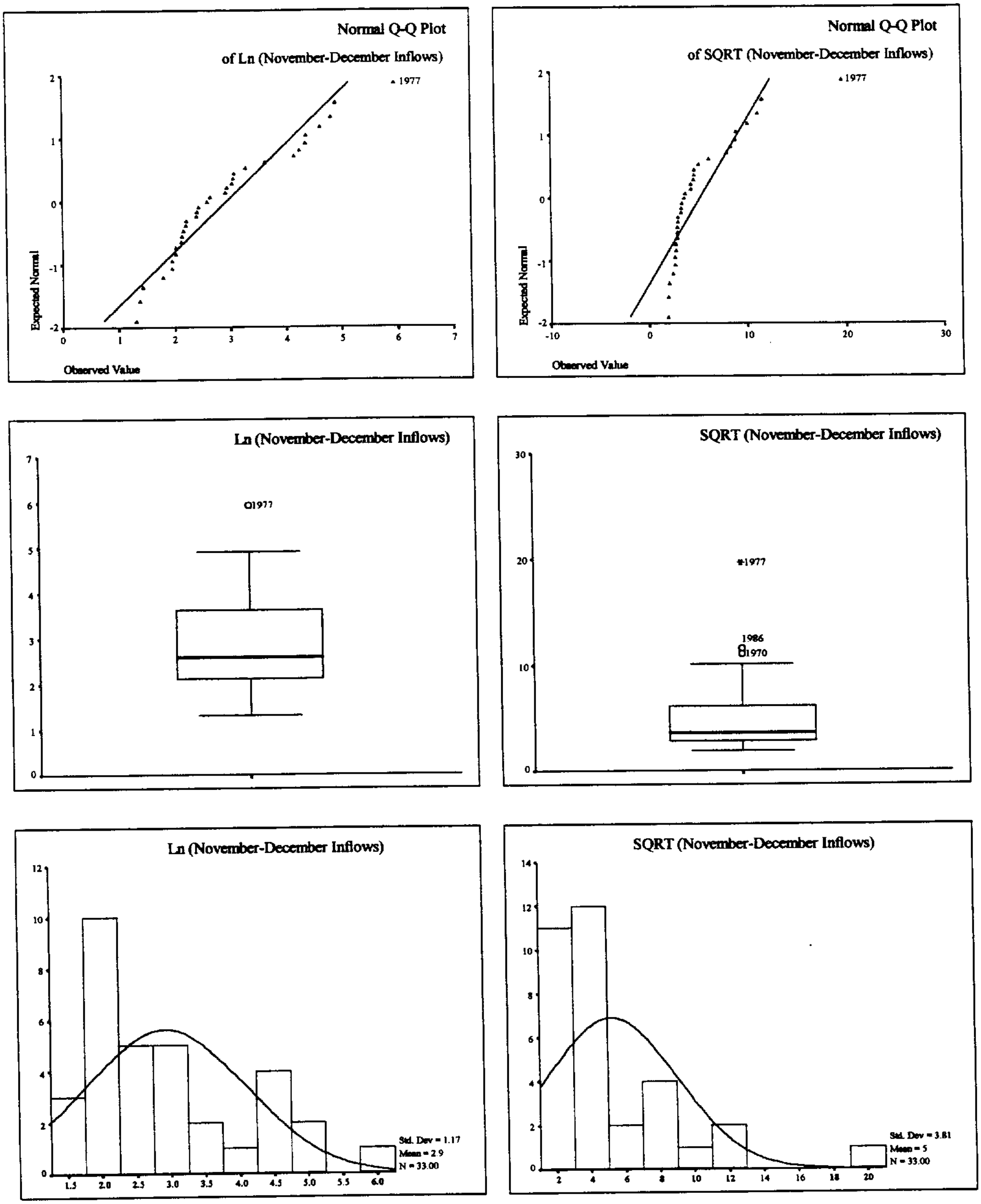



Fig. 2.7b. Exploratory Plots of Transformed November-December Inflows.

## 3. Prediction and Confidence Regions

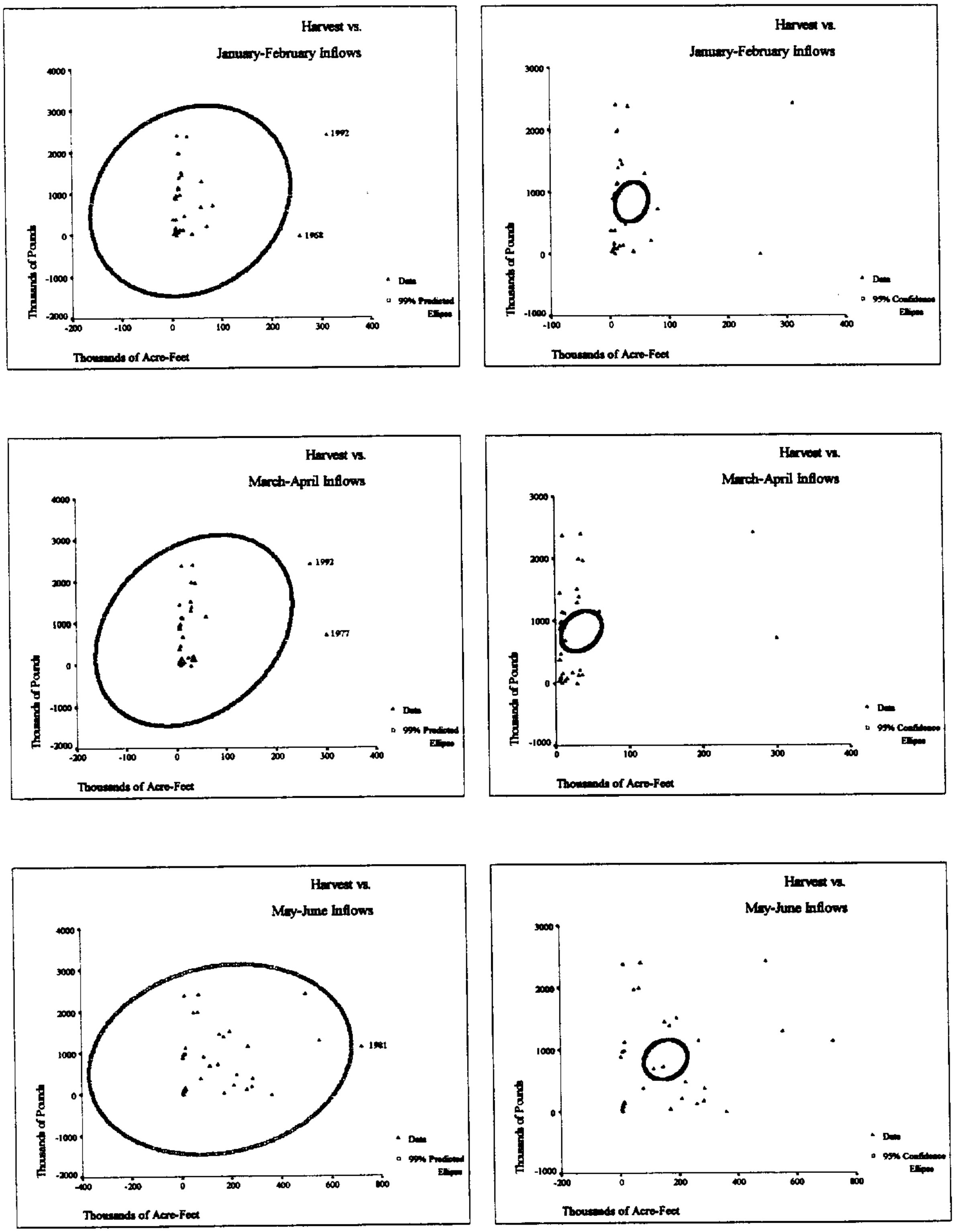



Fig. 3.1. Prediction and Confidence Ellipses.

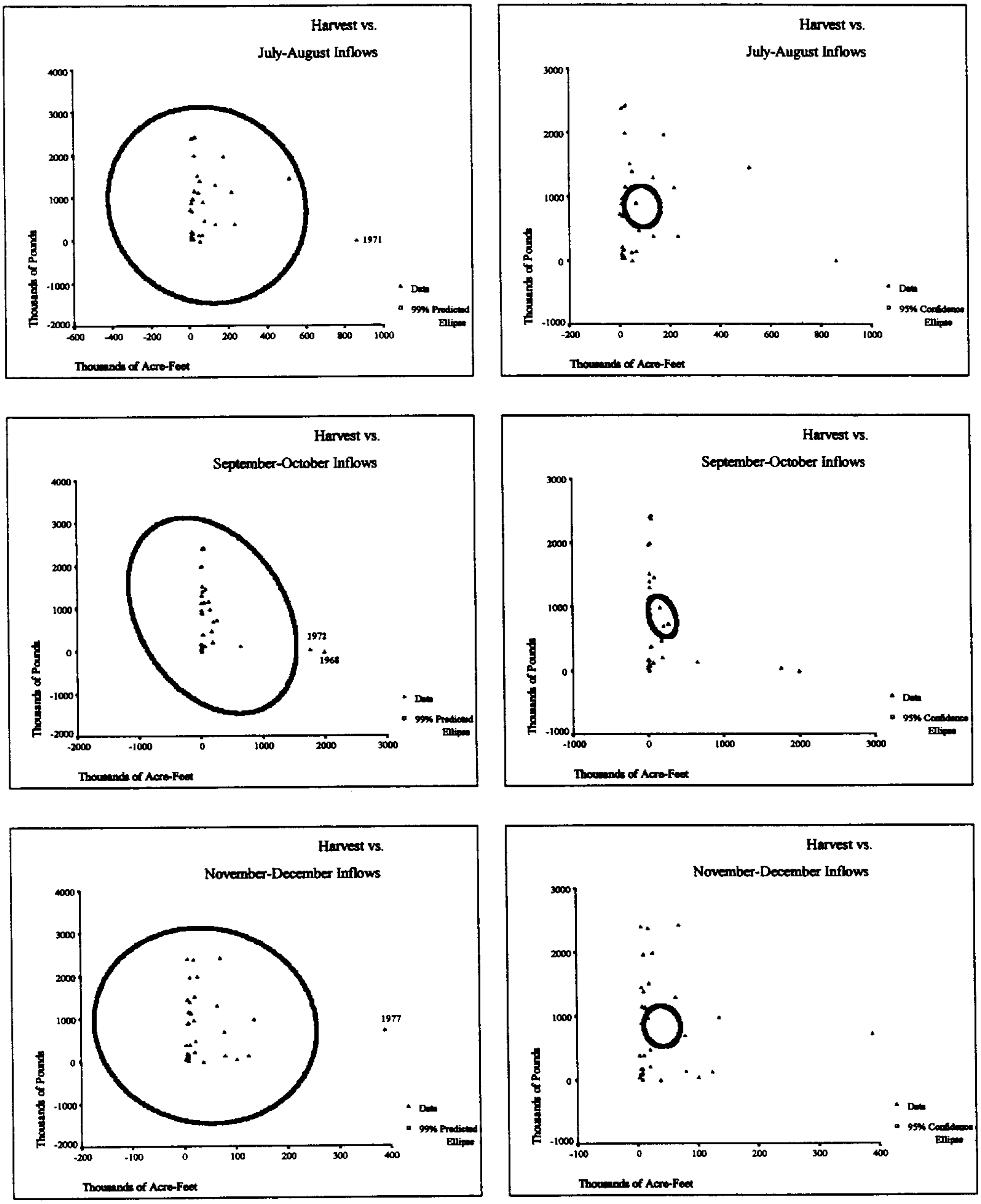



Fig. 3.2. Prediction and Confidence Ellipses.

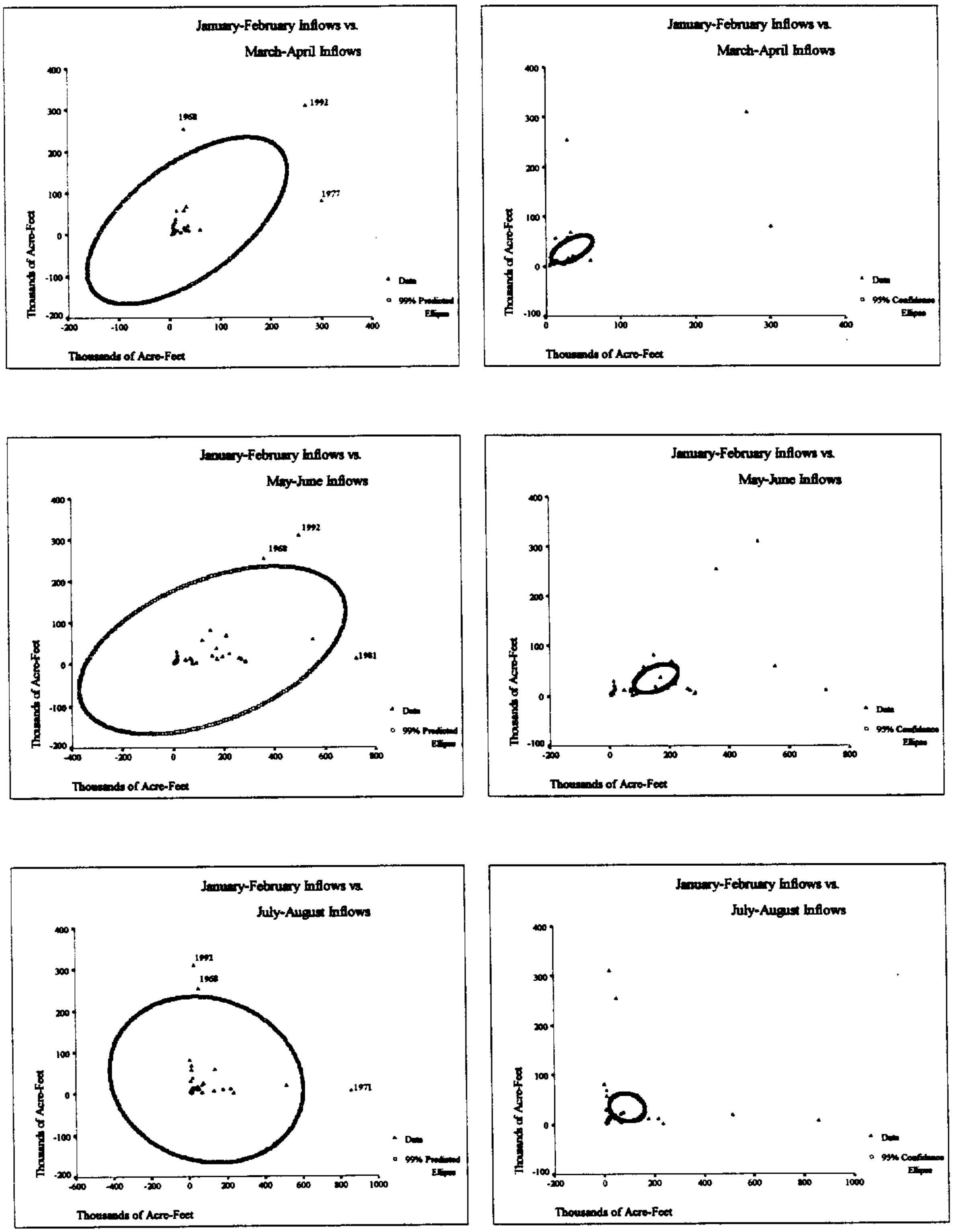



Fig. 3.3. Prediction and Confidence Ellipses.

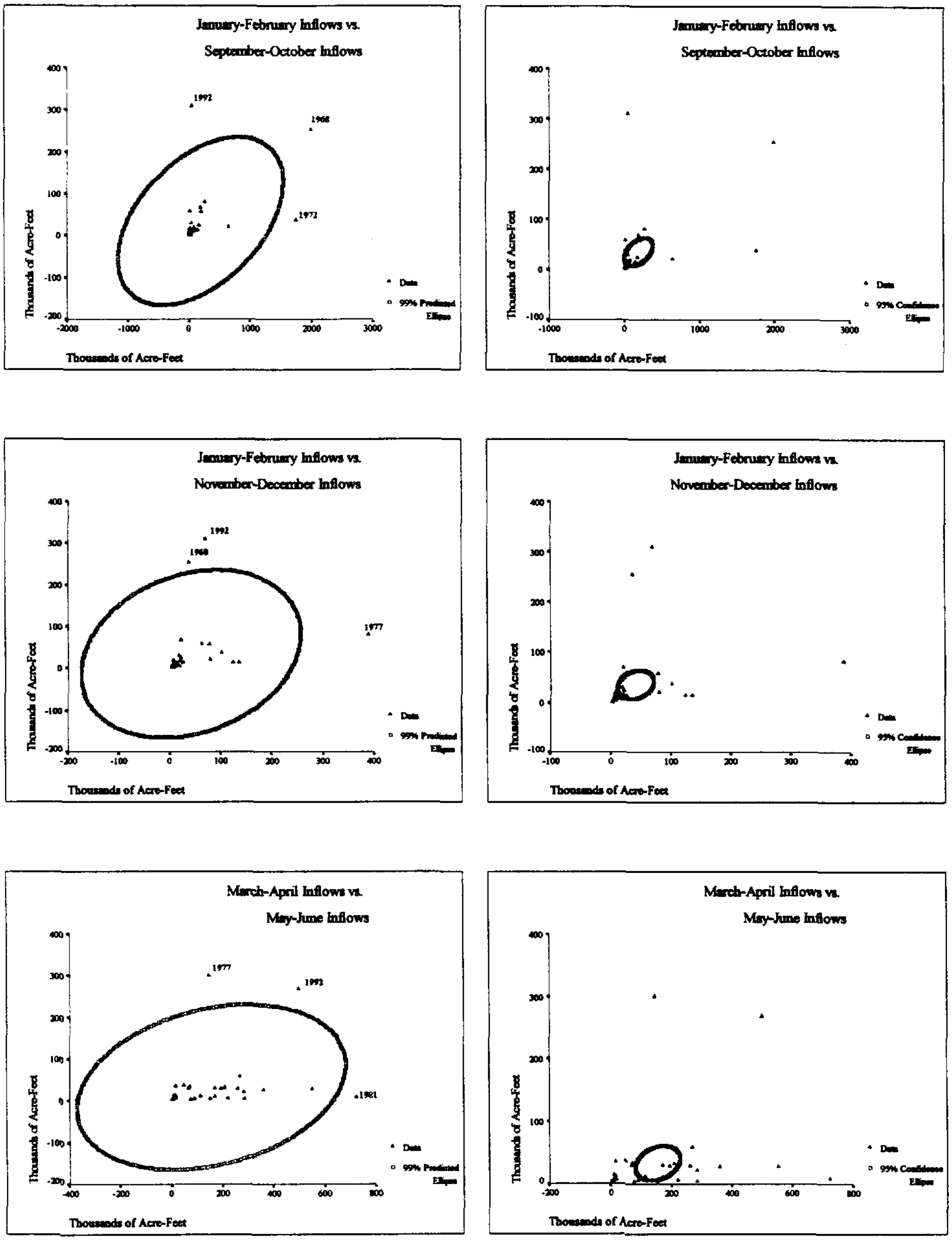



Fig. 3.4. Prediction and Confidence Ellipses.

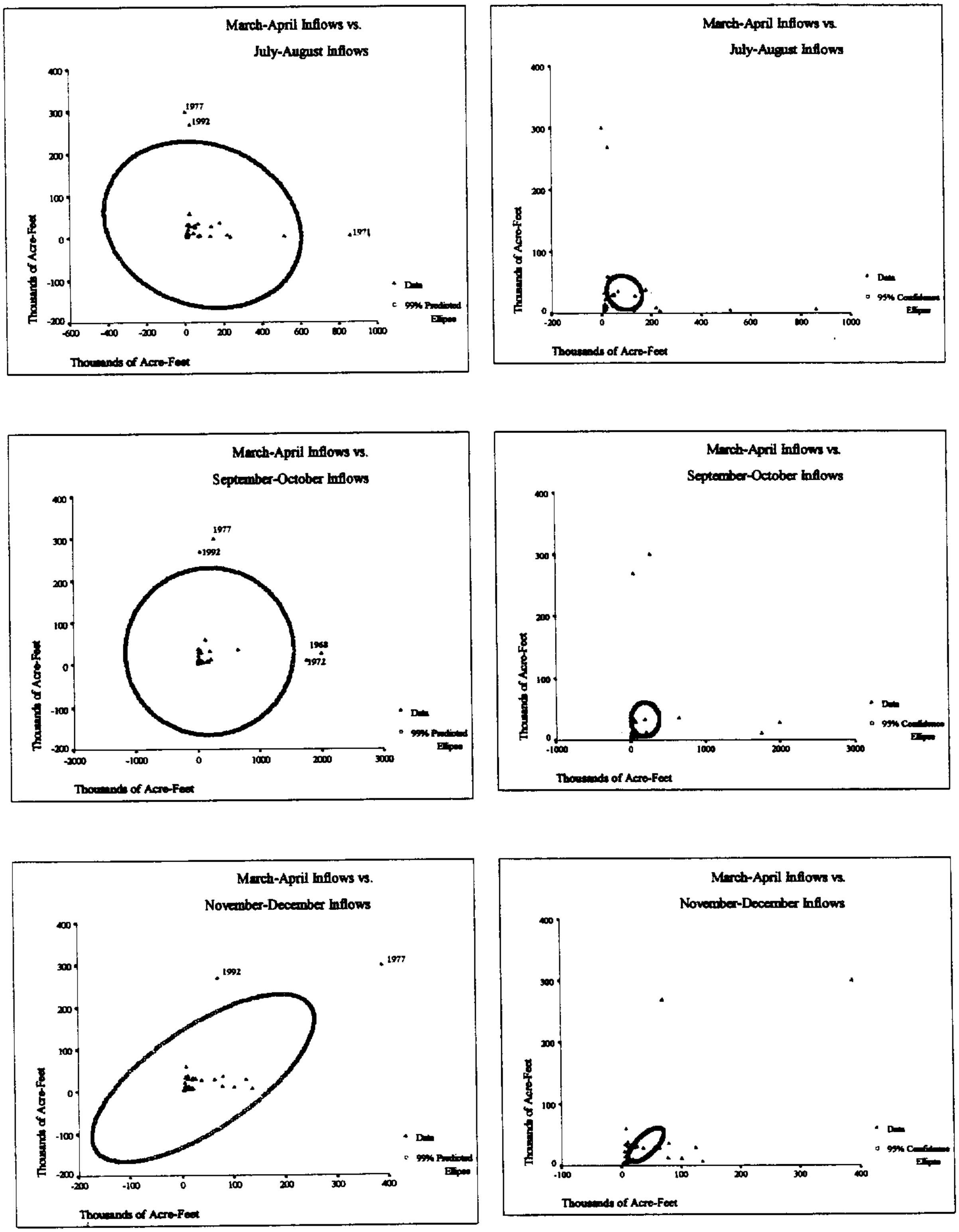



Fig. 3.5. Prediction and Confidence Ellipses.

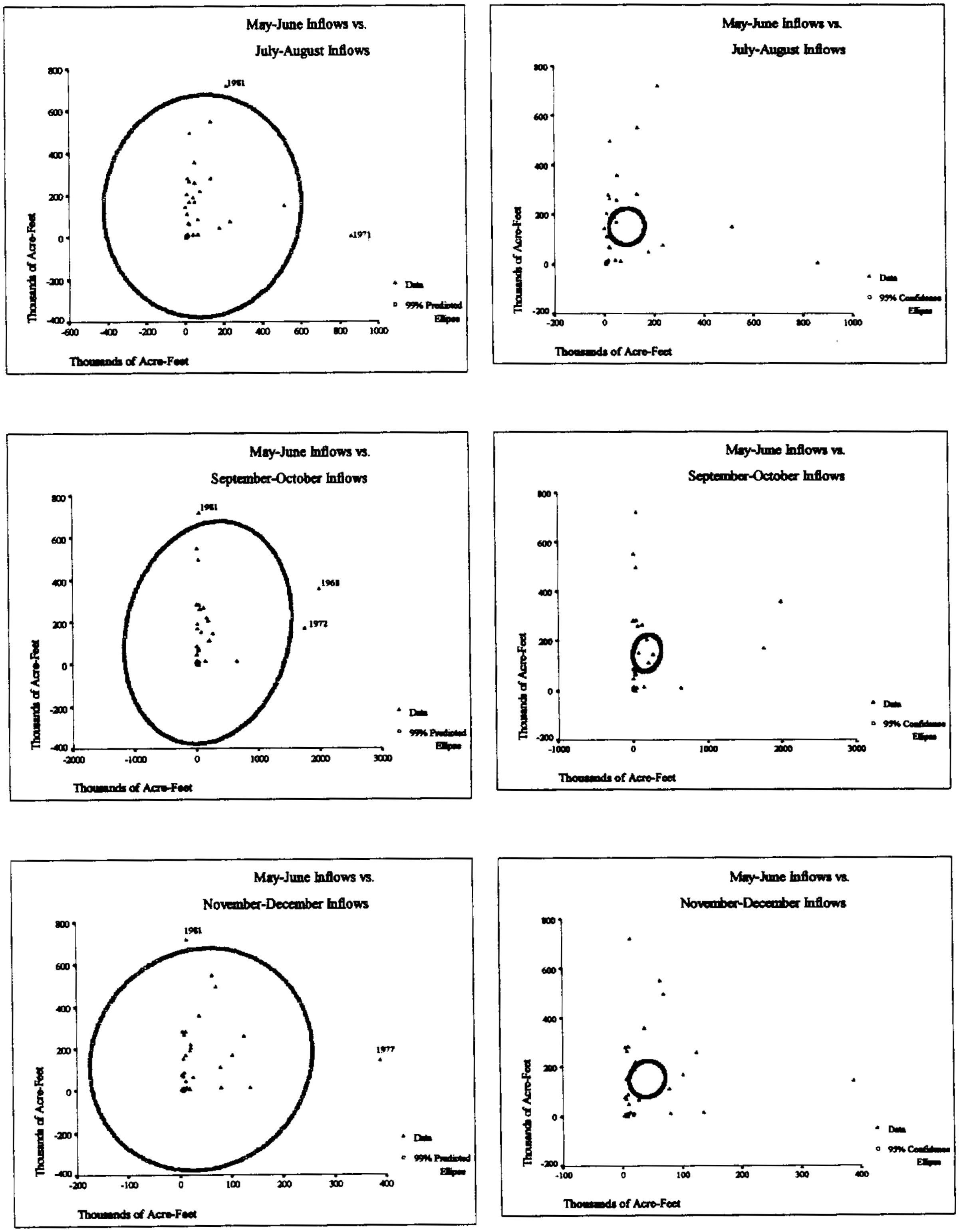



Fig. 3.6. Prediction and Confidence Ellipses.

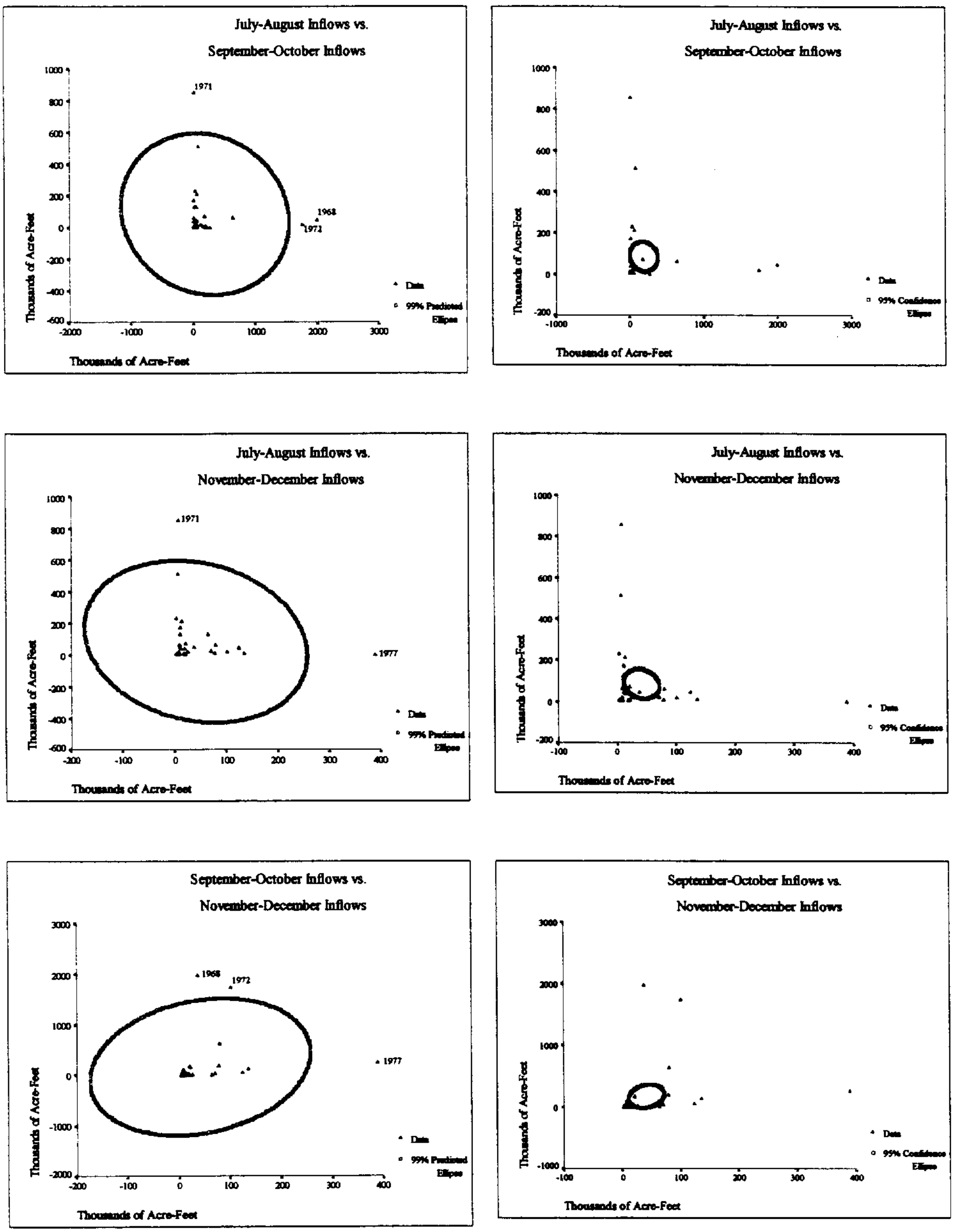



Fig. 3.7. Prediction and Confidence Ellipses.

# 4. Box-Cox Analysis

Table 4.1 Numerical Results.

| HARVEST | QJF_Lag | QMA_Lag | QMJ_Lag | QJA_Lag | QSO_Lag | QND_Lag | LAMBDA |
|---|---|---|---|---|---|---|---|
| 2.25E+14 | 4469.46 | 749.47 | 2097535 | 121897.6 | 109391.4 | 3697.95 | -2.0 |
| 6.79E+13 | 3485.17 | 663.98 | 1395118 | 84467.00 | 83003.75 | 2992.75 | -1.9 |
| 2.07E+13 | 2735.08 | 590.99 | 935703.7 | 58964.78 | 63332.06 | 2436.51 | -1.8 |
| 6.32E+12 | 2161.60 | 528.61 | 633358.4 | 41512.60 | 48617.49 | 1996.73 | -1.7 |
| 1.95E+12 | 1721.67 | 475.28 | 433048.9 | 29511.53 | 37572.51 | 1648.21 | -1.6 |
| 6.05E+11 | 1383.08 | 429.70 | 299382.8 | 21215.40 | 29252.50 | 1371.42 | -1.5 |
| 1.90E+11 | 1121.66 | 390.79 | 209497.6 | 15447.69 | 22962.85 | 1151.22 | -1.4 |
| 6.00E+10 | 919.24 | 357.65 | 148554.4 | 11413.36 | 18191.65 | 975.82 | -1.3 |
| 1.92E+10 | 762.16 | 329.56 | 106872.8 | 8573.46 | 14560.81 | 836.06 | -1.2 |
| 6.23E+09 | 640.11 | 305.92 | 78103.29 | 6561.44 | 11790.59 | 724.82 | -1.1 |
| 2.05E+09 | 545.34 | 286.28 | 58057.46 | 5127.22 | 9673.72 | 636.60 | -1.0 |
| 6.90E+08 | 472.01 | 270.29 | 43955.55 | 4099.61 | 8056.64 | 567.13 | -0.9 |
| 2.37E+08 | 415.77 | 257.74 | 33941.13 | 3361.18 | 6825.91 | 513.16 | -0.8 |
| 84076859 | 373.38 | 248.53 | 26766.39 | 2831.33 | 5898.37 | 472.26 | -0.7 |
| 30909479 | 342.54 | 242.70 | 21587.35 | 2454.88 | 5214.26 | 442.67 | -0.6 |
| 11944528 | 321.68 | **240.47** | 17829.79 | 2194.53 | 4732.61 | 423.24 | **-0.5** |
| 4942163 | 309.89 | 242.27 | 15101.33 | 2025.80 | 4428.53 | 413.35 | -0.4 |
| 2246365 | **306.89** | 248.80 | 13133.43 | 1933.90 | **4292.51** | **412.96** | **-0.3** |
| 1155753 | 313.06 | 261.19 | 11743.12 | **1911.91** | 4331.79 | 422.64 | **-0.2** |
| 689218 | 329.53 | 281.13 | 10807.87 | 1960.15 | 4574.77 | 443.72 | -0.1 |
| 478246 | 358.41 | 311.10 | 10249.28 | 2086.58 | 5079.90 | 478.54 | 0 |
| 379002 | 403.15 | 354.85 | **10022.89** | 2308.56 | 5951.97 | 530.80 | **0.1** |
| 332951 | 469.08 | 417.89 | 10112.50 | 2656.25 | 7370.97 | 606.27 | 0.2 |
| 315292 | 564.32 | 508.47 | 10527.99 | 3178.56 | 9643.00 | 713.71 | 0.3 |
| **315251** | 701.16 | 638.94 | 11306.27 | 3953.11 | 13290.27 | 866.54 | **0.4** |
| 328288 | 898.19 | 827.97 | 12515.46 | 5102.56 | 19211.26 | 1085.37 | 0.5 |
| 352916 | 1183.69 | 1103.89 | 14262.79 | 6821.45 | 28968.06 | 1402.14 | 0.6 |
| 389383 | 1600.89 | 1509.97 | 16707.29 | 9420.63 | 45305.81 | 1866.78 | 0.7 |
| 439165 | 2216.32 | 2112.78 | 20079.03 | 13400.75 | 73099.19 | 2558.04 | 0.8 |
| 504824 | 3132.89 | 3015.24 | 24707.59 | 19575.13 | 121089.1 | 3601.23 | 0.9 |
| 590091 | 4510.92 | 4377.44 | 31063.89 | 29275.77 | 205090.5 | 5197.42 | 1.0 |
| 700090 | 6601.38 | 6449.63 | 39821.30 | 44701.31 | 353954.8 | 7671.60 | 1.1 |
| 841705 | 9799.47 | 9625.02 | 51945.31 | 69507.24 | 620714.3 | 11552.86 | 1.2 |
| 1024113 | 14730.54 | 14524.32 | 68824.94 | 109812.5 | 1103523 | 17707.91 | 1.3 |
| 1259503 | 22388.87 | 22131.62 | 92466.12 | 175923.8 | 1985195 | 27564.77 | 1.4 |
| 1564072 | 34362.41 | 34013.61 | 125777.0 | 285302.8 | 3608197 | 43488.73 | 1.5 |
| 1959361 | 53197.79 | 52674.11 | 172989.5 | 467691.1 | 6617478 | 69416.26 | 1.6 |
| 2474059 | 82995.15 | 82129.26 | 240285.2 | 773998.8 | 12233556 | 111927.4 | 1.7 |
| 3146454 | 130380.0 | 128842.9 | 336725.2 | 1291771 | 22776542 | 182065.2 | 1.8 |
| 4027735 | 206095.9 | 203251.7 | 475636.6 | 2172194 | 42675073 | 298430.9 | 1.9 |
| 5186479 | 327619.8 | 322258.5 | 676684.2 | 3677389 | 80414982 | 492463.0 | 2.0 |

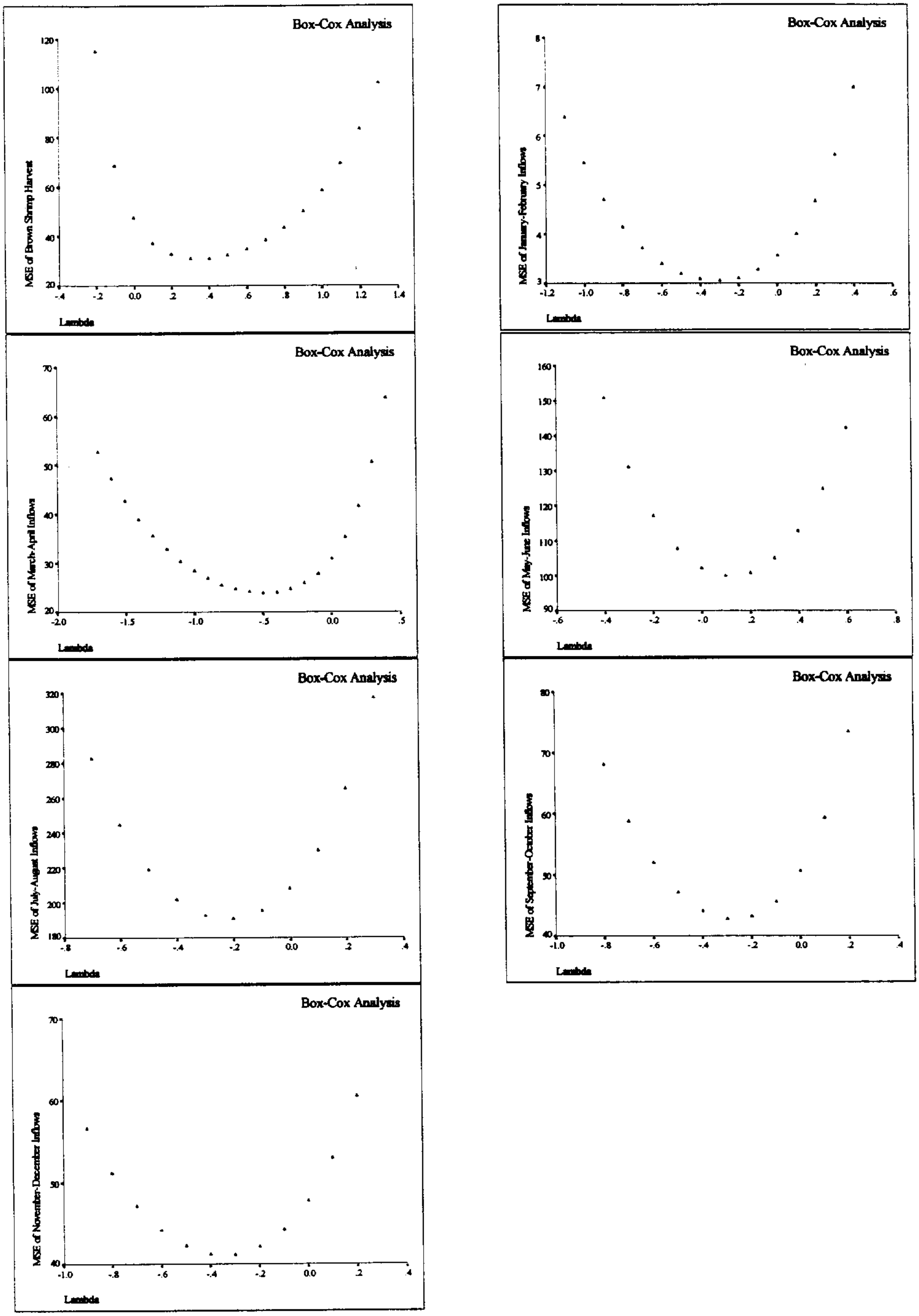



Fig 4.1. MSE of Harvest and Inflows Variables vs. Lambda obtained from Box-Cox Transformation

# 5. Model Choice Diagnostics

## 5.1 Untransformed Data

N = 33     Regression Models for Dependent Variable: BROWN SHRIMP

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.100140 | 0.071112 | 3.0618 | 438.0 | 548128 | 441.0 | QSO_LAG |
| 1 | 0.079223 | 0.049520 | 3.8070 | 438.8 | 560869 | 441.8 | QMA_LAG |
| 1 | 0.028496 | -.002843 | 5.6144 | 440.5 | 591768 | 443.5 | QJF_LAG |
| 1 | 0.022844 | -.008677 | 5.8158 | 440.7 | 595211 | 443.7 | QMJ_LAG |
| 2 | 0.225814 | 0.174202 | 0.5840 | 435.0 | 487296 | 439.5 | QJF_LAG QSO_LAG |
| 2 | 0.204459 | 0.151423 | 1.3449 | 435.9 | 500737 | 440.4 | QMA_LAG QND_LAG |
| 2 | 0.181665 | 0.127109 | 2.1571 | 436.9 | 515085 | 441.4 | QMA_LAG QSO_LAG |
| 2 | 0.140913 | 0.083641 | 3.6090 | 438.5 | 540735 | 443.0 | QMJ_LAG QSO_LAG |
| 3 | 0.257345 | 0.180518 | 1.4606 | 435.7 | 483569 | 441.7 | QMA_LAG QSO_LAG QND_LAG |
| 3 | 0.230921 | 0.151361 | 2.4021 | 436.8 | 500774 | 442.8 | QJF_LAG QJA_LAG QSO_LAG |
| 3 | 0.229582 | 0.149883 | 2.4498 | 436.9 | 501646 | 442.9 | QJF_LAG QMA_LAG QSO_LAG |
| 3 | 0.228133 | 0.148285 | 2.5014 | 436.9 | 502589 | 442.9 | QJF_LAG QSO_LAG QND_LAG |
| 4 | 0.262903 | 0.157604 | 3.2626 | 437.4 | 497090 | 444.9 | QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.262183 | 0.156780 | 3.2882 | 437.5 | 497576 | 444.9 | QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 4 | 0.261214 | 0.155673 | 3.3227 | 437.5 | 498230 | 445.0 | QJF_LAG QMA_LAG QSO_LAG QND_LAG |
| 4 | 0.234404 | 0.125034 | 4.2780 | 438.7 | 516310 | 446.2 | QJF_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.268709 | 0.133285 | 5.0557 | 439.2 | 511441 | 448.1 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.266690 | 0.130892 | 5.1276 | 439.3 | 512853 | 448.2 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.263994 | 0.127697 | 5.2237 | 439.4 | 514738 | 448.4 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 5 | 0.237198 | 0.095938 | 6.1784 | 440.6 | 533479 | 449.5 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.270272 | 0.101874 | 7.0000 | 441.1 | 529976 | 451.6 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

## 5.2 Logged Inflows

N = 33    Regression Models for Dependent Variable: BROWN SHRIMP

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.132976 | 0.105008 | 1.8521 | 436.8 | 528127 | 439.8 | LN_QMA |
| 1 | 0.053807 | 0.023285 | 4.6692 | 439.7 | 576351 | 442.7 | LN_QJF |
| 1 | 0.039507 | 0.008523 | 5.1781 | 440.2 | 585062 | 443.2 | LN_QMJ |
| 1 | 0.022461 | -.009072 | 5.7846 | 440.7 | 595444 | 443.7 | LN_QSO |
| 2 | 0.218055 | 0.165926 | 0.8246 | 435.4 | 492180 | 439.9 | LN_QJF LN_QSO |
| 2 | 0.203795 | 0.150715 | 1.3321 | 436.0 | 501155 | 440.5 | LN_QMA LN_QSO |
| 2 | 0.162394 | 0.106554 | 2.8053 | 437.6 | 527214 | 442.1 | LN_QMA LN_QND |
| 2 | 0.149878 | 0.093203 | 3.2507 | 438.1 | 535093 | 442.6 | LN_QMA LN_QJA |
| 3 | 0.250922 | 0.173432 | 1.6551 | 436.0 | 487750 | 441.9 | LN_QJF LN_QMA LN_QSO |
| 3 | 0.230881 | 0.151317 | 2.3683 | 436.8 | 500800 | 442.8 | LN_QJF LN_QMJ LN_QSO |
| 3 | 0.226708 | 0.146712 | 2.5168 | 437.0 | 503517 | 443.0 | LN_QJF LN_QJA LN_QSO |
| 3 | 0.222841 | 0.142445 | 2.6543 | 437.2 | 506035 | 443.2 | LN_QMA LN_QJA LN_QSO |
| 4 | 0.267762 | 0.163156 | 3.0559 | 437.2 | 493814 | 444.7 | LN_QJF LN_QMA LN_QJA LN_QSO |
| 4 | 0.256449 | 0.150228 | 3.4584 | 437.7 | 501443 | 445.2 | LN_QJF LN_QMA LN_QMJ LN_QSO |
| 4 | 0.254348 | 0.147826 | 3.5332 | 437.8 | 502860 | 445.3 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.233201 | 0.123658 | 4.2857 | 438.7 | 517121 | 446.2 | LN_QJF LN_QMJ LN_QJA LN_QSO |
| 5 | 0.269277 | 0.133958 | 5.0020 | 439.1 | 511044 | 448.1 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.267869 | 0.132290 | 5.0521 | 439.2 | 512028 | 448.2 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.258795 | 0.121535 | 5.3750 | 439.6 | 518374 | 448.6 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.233380 | 0.091414 | 6.2793 | 440.7 | 536148 | 449.7 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.269332 | 0.100717 | 7.0000 | 441.1 | 530659 | 451.6 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 5.3 Logged All Variables

N = 33     Regression Models for Dependent Variable: Ln (BROWN SHRIMP)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.089821 | 0.060460 | 2.6256 | 36.7152 | 2.86879 | 39.7083 | LN_QSO |
| 1 | 0.033702 | 0.002531 | 4.5755 | 38.6897 | 3.04567 | 41.6827 | LN_QMA |
| 1 | 0.016854 | -.014860 | 5.1609 | 39.2601 | 3.09878 | 42.2531 | LN_QMJ |
| 1 | 0.006164 | -.025895 | 5.5324 | 39.6170 | 3.13247 | 42.6100 | LN_QJF |
| 2 | 0.180686 | 0.126065 | 1.4683 | 35.2445 | 2.66848 | 39.7340 | LN_QSO LN_QND |
| 2 | 0.169228 | 0.113843 | 1.8665 | 35.7028 | 2.70579 | 40.1923 | LN_QMA LN_QSO |
| 2 | 0.160345 | 0.104368 | 2.1751 | 36.0538 | 2.73472 | 40.5433 | LN_QMJ LN_QSO |
| 2 | 0.115512 | 0.056547 | 3.7329 | 37.7704 | 2.88074 | 42.2599 | LN_QJF LN_QSO |
| 3 | 0.232793 | 0.153426 | 1.6578 | 35.0761 | 2.58493 | 41.0621 | LN_QMJ LN_QSO LN_QND |
| 3 | 0.203548 | 0.121157 | 2.6739 | 36.3106 | 2.68346 | 42.2966 | LN_QMA LN_QSO LN_QND |
| 3 | 0.196059 | 0.112893 | 2.9342 | 36.6194 | 2.70869 | 42.6054 | LN_QMA LN_QMJ LN_QSO |
| 3 | 0.182136 | 0.097529 | 3.4180 | 37.1861 | 2.75561 | 43.1721 | LN_QJA LN_QSO LN_QND |
| 4 | 0.237871 | 0.128996 | 3.4813 | 36.8569 | 2.65953 | 44.3394 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.236914 | 0.127902 | 3.5146 | 36.8983 | 2.66287 | 44.3808 | LN_QMA LN_QMJ LN_QSO LN_QND |
| 4 | 0.236194 | 0.127079 | 3.5396 | 36.9294 | 2.66538 | 44.4120 | LN_QMJ LN_QJA LN_QSO LN_QND |
| 4 | 0.208991 | 0.095989 | 4.4848 | 38.0843 | 2.76031 | 45.5668 | LN_QJF LN_QMA LN_QSO LN_QND |
| 5 | 0.249883 | 0.110972 | 5.0640 | 38.3326 | 2.71456 | 47.3117 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.243176 | 0.103024 | 5.2970 | 38.6264 | 2.73883 | 47.6054 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.238426 | 0.097394 | 5.4621 | 38.8328 | 2.75602 | 47.8119 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.212872 | 0.067108 | 6.3500 | 39.9220 | 2.84850 | 48.9010 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 6 | 0.251724 | 0.079045 | 7.0000 | 40.2515 | 2.81205 | 50.7271 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 5.4 Square Root Inflows

N = 33 Regression Models for Dependent Variable: BROWN SHRIMP

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.11083 | 0.08215 | 3.149 | 437.6 | 541615 | 440.6 | SQRT_QMA |
| 1 | 0.08532 | 0.05581 | 4.072 | 438.5 | 557158 | 441.5 | SQRT_QSO |
| 1 | 0.03315 | 0.00196 | 5.958 | 440.4 | 588933 | 443.4 | SQRT_QJF |
| 1 | 0.02567 | -.00576 | 6.229 | 440.6 | 593491 | 443.6 | SQRT_QMJ |
| 2 | 0.25004 | 0.20004 | 0.116 | 434.0 | 472049 | 438.5 | SQRT_QJF SQRT_QSO |
| 2 | 0.22806 | 0.17660 | 0.911 | 434.9 | 485883 | 439.4 | SQRT_QMA SQRT_QSO |
| 2 | 0.19460 | 0.14090 | 2.121 | 436.3 | 506946 | 440.8 | SQRT_QMA SQRT_QND |
| 2 | 0.14243 | 0.08526 | 4.007 | 438.4 | 539780 | 442.9 | SQRT_QMJ SQRT_QSO |
| 3 | 0.26868 | 0.19303 | 1.442 | 435.2 | 476186 | 441.1 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 3 | 0.25314 | 0.17588 | 2.004 | 435.9 | 486304 | 441.8 | SQRT_QJF SQRT_QMJ SQRT_QSO |
| 3 | 0.25004 | 0.17246 | 2.116 | 436.0 | 488322 | 442.0 | SQRT_QJF SQRT_QSO SQRT_QND |
| 3 | 0.25004 | 0.17246 | 2.116 | 436.0 | 488324 | 442.0 | SQRT_QJF SQRT_QJA SQRT_QSO |
| 4 | 0.27903 | 0.17604 | 3.068 | 436.7 | 486212 | 444.2 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.27109 | 0.16696 | 3.355 | 437.1 | 491569 | 444.5 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO |
| 4 | 0.26941 | 0.16504 | 3.416 | 437.1 | 492703 | 444.6 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO |
| 4 | 0.25810 | 0.15212 | 3.824 | 437.6 | 500327 | 445.1 | SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.28088 | 0.14770 | 5.001 | 438.6 | 502932 | 447.6 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.27934 | 0.14588 | 5.057 | 438.7 | 504008 | 447.7 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.27127 | 0.13632 | 5.348 | 439.0 | 509647 | 448.0 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 5 | 0.25810 | 0.12072 | 5.824 | 439.6 | 518857 | 448.6 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.28091 | 0.11496 | 7.000 | 440.6 | 522253 | 451.1 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

## 5.5 Square Root All Variables

N = 33 Regression Models for Dependent Variable: SQRT (BROWN SHRIMP)

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.13026 | 0.10220 | 2.762 | 174.4 | 186.18 | 177.4 | SQRT_QSO |
| 1 | 0.08983 | 0.06047 | 4.238 | 175.9 | 194.84 | 178.9 | SQRT_QMA |
| 1 | 0.03083 | -.00044 | 6.393 | 178.0 | 207.47 | 181.0 | SQRT_QMJ |
| 1 | 0.00759 | -.02442 | 7.241 | 178.8 | 212.44 | 181.8 | SQRT_QJF |
| 2 | 0.25562 | 0.20600 | 0.184 | 171.3 | 164.66 | 175.8 | SQRT_QMA SQRT_QSO |
| 2 | 0.24405 | 0.19365 | 0.606 | 171.8 | 167.22 | 176.3 | SQRT_QJF SQRT_QSO |
| 2 | 0.20436 | 0.15132 | 2.056 | 173.5 | 176.00 | 178.0 | SQRT_QMJ SQRT_QSO |
| 2 | 0.16647 | 0.11090 | 3.439 | 175.0 | 184.38 | 179.5 | SQRT_QSO SQRT_QND |
| 3 | 0.28044 | 0.20600 | 1.277 | 172.2 | 164.66 | 178.1 | SQRT_QMA SQRT_QMJ SQRT_QSO |
| 3 | 0.27246 | 0.19719 | 1.569 | 172.5 | 166.48 | 178.5 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 3 | 0.26083 | 0.18437 | 1.993 | 173.1 | 169.14 | 179.0 | SQRT_QJF SQRT_QMJ SQRT_QSO |
| 3 | 0.25740 | 0.18058 | 2.119 | 173.2 | 169.93 | 179.2 | SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.28719 | 0.18536 | 3.031 | 173.9 | 168.94 | 181.3 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO |
| 4 | 0.28134 | 0.17867 | 3.244 | 174.1 | 170.33 | 181.6 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 4 | 0.28091 | 0.17818 | 3.260 | 174.1 | 170.43 | 181.6 | SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.27262 | 0.16871 | 3.563 | 174.5 | 172.39 | 182.0 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 5 | 0.28797 | 0.15612 | 5.002 | 175.8 | 175.00 | 184.8 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 5 | 0.28722 | 0.15523 | 5.030 | 175.9 | 175.19 | 184.8 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.28191 | 0.14893 | 5.224 | 176.1 | 176.49 | 185.1 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.27266 | 0.13797 | 5.561 | 176.5 | 178.77 | 185.5 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.28803 | 0.12373 | 7.000 | 177.8 | 181.72 | 188.3 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

## 5.6 Logged and Square Root Variables

N = 33 Regression Models for Dependent Variable: Ln (BROWN SHRIMP)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.296506 | 0.273812 | 5.2518 | 28.2150 | 2.21734 | 31.2081 | SQRT_QSO |
| 1 | 0.040403 | 0.009448 | 17.7210 | 38.4600 | 3.02455 | 41.4530 | SQRT_QMA |
| 1 | 0.037029 | 0.005966 | 17.8853 | 38.5758 | 3.03519 | 41.5688 | SQRT_QJF |
| 1 | 0.016854 | -.014860 | 18.8676 | 39.2601 | 3.09878 | 42.2531 | LN_QMJ |
| 2 | 0.385772 | 0.344824 | 2.9056 | 25.7372 | 2.00052 | 30.2267 | LN_QMJ SQRT_QSO |
| 2 | 0.383299 | 0.342186 | 3.0260 | 25.8697 | 2.00857 | 30.3593 | SQRT_QSO SQRT_QND |
| 2 | 0.375174 | 0.333519 | 3.4216 | 26.3017 | 2.03503 | 30.7912 | SQRT_QMA SQRT_QSO |
| 2 | 0.311668 | 0.265779 | 6.5136 | 29.4960 | 2.24187 | 33.9856 | SQRT_QJF SQRT_QSO |
| 3 | 0.448504 | 0.391453 | 1.8513 | 24.1820 | 1.85814 | 30.1680 | LN_QMJ SQRT_QSO SQRT_QND |
| 3 | 0.418863 | 0.358746 | 3.2945 | 25.9096 | 1.95801 | 31.8956 | SQRT_QMA LN_QMJ SQRT_QSO |
| 3 | 0.410564 | 0.349588 | 3.6985 | 26.3776 | 1.98597 | 32.3636 | LN_QMJ LN_QJA SQRT_QSO |
| 3 | 0.398227 | 0.335974 | 4.2992 | 27.0611 | 2.02754 | 33.0472 | SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.453515 | 0.375446 | 3.6073 | 25.8808 | 1.90701 | 33.3633 | LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 4 | 0.452859 | 0.374696 | 3.6393 | 25.9204 | 1.90931 | 33.4029 | SQRT_QJF LN_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.449592 | 0.370963 | 3.7983 | 26.1168 | 1.92070 | 33.5994 | SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.439717 | 0.359677 | 4.2791 | 26.7037 | 1.95516 | 34.1862 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO |
| 5 | 0.461649 | 0.361955 | 5.2113 | 27.3859 | 1.94821 | 36.3650 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.460004 | 0.360004 | 5.2914 | 27.4866 | 1.95416 | 36.4657 | SQRT_QJF LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.453701 | 0.352535 | 5.5983 | 27.8696 | 1.97697 | 36.8486 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.447021 | 0.344618 | 5.9235 | 28.2706 | 2.00115 | 37.2497 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 6 | 0.465989 | 0.342756 | 7.0000 | 29.1188 | 2.00683 | 39.5944 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |

### 5.7 Untransformed, Square Root and Logged Variables

N = 33 Regression Models for Dependent Variable: BROWN SHRIMP

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.110833 | 0.082150 | 3.8016 | 437.6 | 541615 | 440.6 | SQRT_QMA |
| 1 | 0.085316 | 0.055810 | 4.7430 | 438.5 | 557158 | 441.5 | SQRT_QSO |
| 1 | 0.039507 | 0.008523 | 6.4329 | 440.2 | 585062 | 443.2 | LN_QMJ |
| 1 | 0.033151 | 0.001962 | 6.6674 | 440.4 | 588933 | 443.4 | SQRT_QJF |
| 2 | 0.250038 | 0.200041 | 0.6663 | 434.0 | 472049 | 438.5 | SQRT_QJF SQRT_QSO |
| 2 | 0.228059 | 0.176596 | 1.4772 | 434.9 | 485883 | 439.4 | SQRT_QMA SQRT_QSO |
| 2 | 0.194596 | 0.140903 | 2.7116 | 436.3 | 506946 | 440.8 | SQRT_QMA SQRT_QND |
| 2 | 0.172381 | 0.117207 | 3.5311 | 437.2 | 520928 | 441.7 | LN_QMJ SQRT_QSO |
| 3 | 0.270577 | 0.195120 | 1.9086 | 435.1 | 474952 | 441.1 | SQRT_QJF LN_QMJ SQRT_QSO |
| 3 | 0.268683 | 0.193030 | 1.9785 | 435.2 | 476186 | 441.1 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 3 | 0.255534 | 0.178520 | 2.4636 | 435.8 | 484748 | 441.7 | SQRT_QMA LN_QMJ SQRT_QSO |
| 3 | 0.255063 | 0.178000 | 2.4810 | 435.8 | 485054 | 441.8 | SQRT_QJF LN_QJA SQRT_QSO |
| 4 | 0.284248 | 0.181998 | 3.4043 | 436.5 | 482696 | 443.9 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO |
| 4 | 0.280805 | 0.178063 | 3.5313 | 436.6 | 485018 | 444.1 | SQRT_QJF SQRT_QMA LN_QJA SQRT_QSO |
| 4 | 0.279034 | 0.176038 | 3.5967 | 436.7 | 486212 | 444.2 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.271938 | 0.167929 | 3.8584 | 437.0 | 490997 | 444.5 | SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.293152 | 0.162254 | 5.0758 | 438.0 | 494346 | 447.0 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.288259 | 0.156455 | 5.2563 | 438.3 | 497768 | 447.2 | SQRT_QJF SQRT_QMA LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.287588 | 0.155660 | 5.2811 | 438.3 | 498238 | 447.3 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 5 | 0.273786 | 0.139302 | 5.7903 | 438.9 | 507890 | 447.9 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 6 | 0.295208 | 0.132564 | 7.0000 | 439.9 | 511866 | 450.4 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |

## 5.8 Variables transformed according to the Box-Cox Analysis

N = 33 Regression Models for Dependent Variable: (BROWN SHRIMP)$^{0.4}$

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.079484 | 0.049790 | -1.4389 | 120.8 | 36.6164 | 123.7 | (QMA_LAG)$^{-0.5}$ |
| 1 | 0.043333 | 0.012473 | -0.3566 | 122.0 | 38.0544 | 125.0 | (QMJ_LAG)$^{0.1}$ |
| 1 | 0.037407 | 0.006356 | -0.1791 | 122.2 | 38.2901 | 125.2 | (QJF_LAG)$^{-0.3}$ |
| 1 | 0.014886 | -.016892 | 0.4952 | 123.0 | 39.1859 | 126.0 | (QND_LAG)$^{-0.3}$ |
| 2 | 0.096921 | 0.036716 | 0.0390 | 122.1 | 37.1202 | 126.6 | (QMA_LAG)$^{-0.5}$ (QSO_LAG)$^{-0.3}$ |
| 2 | 0.092038 | 0.031507 | 0.1852 | 122.3 | 37.3209 | 126.8 | (QJF_LAG)$^{-0.3}$ (QSO_LAG)$^{-0.3}$ |
| 2 | 0.089873 | 0.029198 | 0.2500 | 122.4 | 37.4099 | 126.9 | (QMA_LAG)$^{-0.5}$ (QJA_LAG)$^{-0.2}$ |
| 2 | 0.085910 | 0.024971 | 0.3687 | 122.5 | 37.5728 | 127.0 | (QMA_LAG)$^{-0.5}$ (QMJ_LAG)$^{0.1}$ |
| 3 | 0.113991 | 0.022334 | 1.5279 | 123.5 | 37.6744 | 129.5 | (QJF_LAG)$^{-0.3}$ (QMA_LAG)$^{-0.5}$ (QSO_LAG)$^{-0.3}$ |
| 3 | 0.113819 | 0.022145 | 1.5330 | 123.5 | 37.6817 | 129.5 | (QJF_LAG)$^{-0.3}$ (QMJ_LAG)$^{0.1}$ (QSO_LAG)$^{-0.3}$ |
| 3 | 0.113322 | 0.021597 | 1.5479 | 123.5 | 37.7028 | 129.5 | (QMA_LAG)$^{-0.5}$ (QMJ_LAG)$^{0.1}$ (QSO_LAG)$^{-0.3}$ |
| 3 | 0.108902 | 0.016719 | 1.6803 | 123.7 | 37.8907 | 129.7 | (QMA_LAG)$^{-0.5}$ (QJA_LAG)$^{-0.2}$ (QSO_LAG)$^{-0.3}$ |
| 4 | 0.126787 | 0.002042 | 3.1448 | 125.0 | 38.4563 | 132.5 | (QJF_LAG)$^{-0.3}$ (QMA_LAG)$^{-0.5}$ (QJA_LAG)$^{-0.2}$ (QSO_LAG)$^{-0.3}$ |
| 4 | 0.126760 | 0.002011 | 3.1456 | 125.0 | 38.4575 | 132.5 | (QJF_LAG)$^{-0.3}$ (QMA_LAG)$^{-0.5}$ (QMJ_LAG)$^{0.1}$ (QSO_LAG)$^{-0.3}$ |
| 4 | 0.118508 | -.007419 | 3.3926 | 125.3 | 38.8209 | 132.8 | (QMA_LAG)$^{-0.5}$ (QMJ_LAG)$^{0.1}$ (QSO_LAG)$^{-0.3}$ (QND_LAG)$^{-0.3}$ |
| 4 | 0.116007 | -.010278 | 3.4675 | 125.4 | 38.9311 | 132.9 | (QMA_LAG)$^{-0.5}$ (QMJ_LAG)$^{0.1}$ (QJA_LAG)$^{-0.2}$ (QSO_LAG)$^{-0.3}$ |
| 5 | 0.130887 | -.030059 | 5.0220 | 126.9 | 39.6934 | 135.8 | (QJF_LAG)$^{-0.3}$ (QMA_LAG)$^{-0.5}$ (QMJ_LAG)$^{-0.1}$ (QJA_LAG)$^{-0.2}$ (QSO_LAG)$^{-0.3}$ |
| 5 | 0.127320 | -.034288 | 5.1288 | 127.0 | 39.8563 | 136.0 | (QJF_LAG)$^{-0.3}$ (QMA_LAG)$^{-0.5}$ (QMJ_LAG)$^{-0.1}$ (QSO_LAG)$^{-0.3}$ (QND_LAG)$^{-0.3}$ |
| 5 | 0.127189 | -.034442 | 5.1327 | 127.0 | 39.8622 | 136.0 | (QJF_LAG)$^{-0.3}$ (QMA_LAG)$^{-0.5}$ (QJA_LAG)$^{-0.2}$ (QSO_LAG)$^{-0.3}$ (QND_LAG)$^{-0.3}$ |
| 5 | 0.121962 | -.040638 | 5.2892 | 127.2 | 40.1010 | 136.2 | (QMA_LAG)$^{-0.5}$ (QMJ_LAG)$^{0.1}$ (QJA_LAG)$^{-0.2}$ (QSO_LAG)$^{-0.3}$ (QND_LAG)$^{-0.3}$ |
| 6 | 0.131622 | -.068773 | 7.0000 | 128.8 | 41.1852 | 139.3 | (QJF_LAG)$^{-0.3}$ (QMA_LAG)$^{-0.5}$ (QMJ_LAG)$^{-0.1}$ (QJA_LAG)$^{-0.2}$ (QSO_LAG)$^{-0.3}$ (QND_LAG)$^{-0.3}$ |

# 6. Regression for the Best Models

## 6.1 Model 4: Harvest Untransformed and Square Root Inflows

### 6.1.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | SQRT(Nov-Dec Inflows), SQRT(May-Jun Inflows), SQRT(Jul-Aug Inflows), SQRT(Sep-Oct Inflows), SQRT(Mar-Apr Inflows), SQRT(Jan-Feb Inflows)[c,d] | . | .530 | .281 | .115 | 722.6705 | .743 |

a. Dependent Variable: Brown Shrimp Harvest

b. Method: Enter

c. Independent Variables: (Constant), SQRT (November-December Inflows), SQRT (May-June Inflows), SQRT (July-August Inflows), SQRT (September-October Inflows), SQRT (March-April Inflows), SQRT (January-February Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 5304338 | 6 | 884056 | 1.693 | .163[b] |
| | Residual | 1.4E+07 | 26 | 522253 | | |
| | Total | 1.9E+07 | 32 | | | |

a. Dependent Variable: Brown Shrimp Harvest

b. Independent Variables: (Constant), SQRT (November-December Inflows), SQRT (May-June Inflows), SQRT (July-August Inflows), SQRT (September-October Inflows), SQRT (March-April Inflows), SQRT (January-February Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 655.458 | 332.420 | | 1.972 | .059 |
| | SQRT (January-February Inflows) | 57.379 | 63.194 | .268 | .908 | .372 |
| | SQRT (March-April Inflows) | 65.537 | 65.762 | .294 | .997 | .328 |
| | SQRT (May-June Inflows) | 5.406 | 22.691 | .048 | .238 | .814 |
| | SQRT (July-August Inflows) | .774 | 22.862 | .006 | .034 | .973 |
| | SQRT (September-October Inflows) | -32.532 | 18.641 | -.424 | -1.745 | .093 |
| | SQRT (November-December Inflows) | -29.544 | 50.060 | -.146 | -.590 | .560 |

a. Dependent Variable: Brown Shrimp Harvest

### 6.1.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 655.458424 | 332.41975891 | 1.972 | 0.0594 | 0.00000000 |
| SQRT_QJF | 1 | 57.379352 | 63.19354523 | 0.908 | 0.3722 | 3.13934695 |
| SQRT_QMA | 1 | 65.537080 | 65.76167156 | 0.997 | 0.3282 | 3.13781572 |
| SQRT_QMJ | 1 | 5.405730 | 22.69074276 | 0.238 | 0.8136 | 1.48623100 |
| SQRT_QJA | 1 | 0.773758 | 22.86169818 | 0.034 | 0.9733 | 1.16303742 |
| SQRT_QSO | 1 | -32.531936 | 18.64071835 | -1.745 | 0.0928 | 2.13030204 |
| SQRT_QND | 1 | -29.543788 | 50.06048579 | -0.590 | 0.5602 | 2.22536610 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop SQRT_QJF | Var Prop SQRT_QMA | Var Prop SQRT_QMJ | Var Prop SQRT_QJA | Var Prop SQRT_QSO | Var Prop SQRT_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.77081 | 1.00000 | 0.0316 | 0.0260 | 0.0294 | 0.0067 | 0.0237 | 0.0351 |
| 2 | 1.19503 | 1.52270 | 0.0045 | 0.0035 | 0.1751 | 0.4314 | 0.0009 | 0.0216 |
| 3 | 0.87633 | 1.77815 | 0.0003 | 0.1046 | 0.0354 | 0.0010 | 0.3553 | 0.0005 |
| 4 | 0.61040 | 2.13056 | 0.0268 | 0.0204 | 0.2285 | 0.4784 | 0.0006 | 0.2663 |
| 5 | 0.40054 | 2.63014 | 0.2815 | 0.0556 | 0.5262 | 0.0813 | 0.0003 | 0.2522 |
| 6 | 0.14688 | 4.34336 | 0.6554 | 0.7898 | 0.0054 | 0.0012 | 0.6192 | 0.4242 |

### 6.1.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | -331.5399 | 2392.581 | 854.4818 | 407.1370 | 33 |
| Std. Predicted Value | -2.913 | 3.778 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | 158.8780 | 597.5151 | 307.0423 | 130.4673 | 33 |
| Adjusted Predicted Value | -651.1605 | 2410.673 | 915.1550 | 542.3209 | 33 |
| Residual | -870.5665 | 1536.905 | -7.E-15 | 651.4064 | 33 |
| Std. Residual | -1.205 | 2.127 | .000 | .901 | 33 |
| Stud. Residual | -1.713 | 2.273 | -.030 | 1.016 | 33 |
| Deleted Residual | -1895.75 | 1755.769 | -60.6732 | 869.6266 | 33 |
| Stud. Deleted Residual | -1.783 | 2.490 | -.022 | 1.048 | 33 |
| Mahal. Distance | .577 | 20.906 | 5.818 | 6.005 | 33 |
| Cook's Distance | .000 | .564 | .059 | .131 | 33 |
| Centered Leverage Value | .018 | .653 | .182 | .188 | 33 |

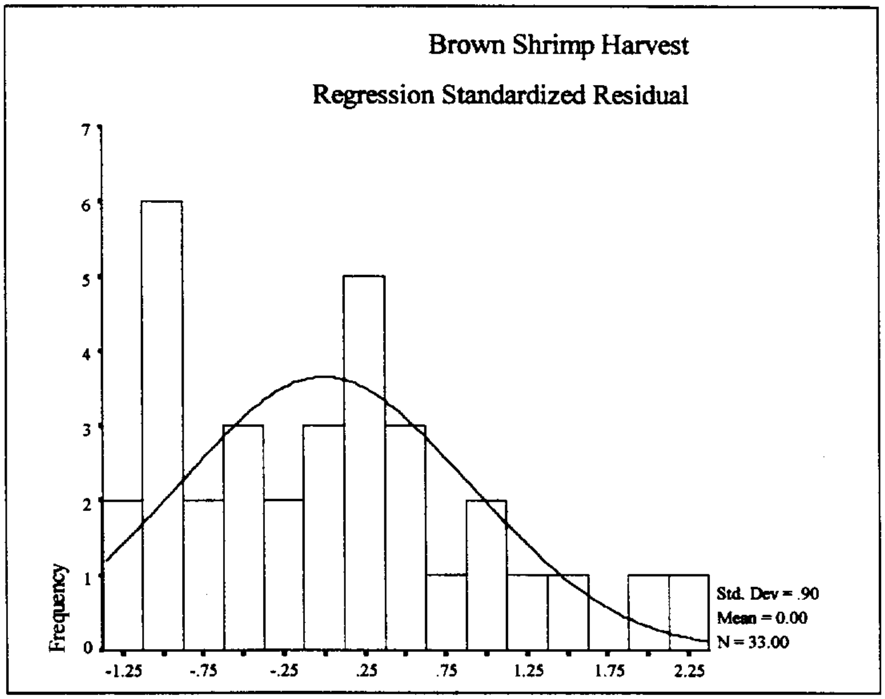
a. Dependent Variable: Brown Shrimp Harvest

*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 784.12367 | -668.62367 | -735.89719 | 851.39719 | -.17281 | -.92521 | -.97064 | -.96952 |
| 1963 | 843.60132 | -748.20132 | -830.07444 | 925.47444 | -.02672 | -1.03533 | -1.09050 | -1.09465 |
| 1964 | 791.95925 | -739.55925 | -823.68900 | 876.08900 | -.15357 | -1.02337 | -1.08001 | -1.08362 |
| 1965 | 1011.99088 | -785.19088 | -868.04447 | 1094.84447 | .38687 | -1.08651 | -1.14240 | -1.14944 |
| 1966 | 1057.86647 | -870.56647 | -1052.99205 | 1240.29205 | .49955 | -1.20465 | -1.32487 | -1.34535 |
| 1967 | 843.74855 | -672.24855 | -729.33281 | 900.83281 | -.02636 | -.93023 | -.96892 | -.96774 |
| 1968 | 403.41853 | -402.81853 | -1069.60211 | 1070.20211 | -1.10789 | -.55740 | -.90829 | -.90513 |
| 1969 | 910.46797 | -821.66797 | -899.81598 | 988.61598 | .13751 | -1.13699 | -1.18983 | -1.19985 |
| 1970 | 757.63417 | -618.73417 | -800.11957 | 939.01957 | -.23787 | -.85618 | -.97362 | -.97261 |
| 1971 | 827.53151 | -808.23151 | -1895.75159 | 1915.05159 | -.06619 | -1.11840 | -1.71285 | -1.78320 |
| 1972 | -331.539 | 383.33995 | 702.96044 | -651.16044 | -2.91308 | .53045 | .71832 | .71146 |
| 1973 | 786.45686 | -390.25686 | -438.68824 | 834.88824 | -.16708 | -.54002 | -.57255 | -.56500 |
| 1974 | 262.86235 | -112.76235 | -148.83589 | 298.93589 | -1.45312 | -.15604 | -.17927 | -.17589 |
| 1975 | 652.91789 | -170.11789 | -183.35419 | 666.15419 | -.49508 | -.23540 | -.24439 | -.23992 |
| 1976 | 716.11342 | -318.91342 | -357.40205 | 754.60205 | -.33986 | -.44130 | -.46717 | -.46003 |
| 1977 | 1267.60415 | -529.00415 | -1672.07257 | 2410.67257 | 1.01470 | -.73201 | -1.30142 | -1.31986 |
| 1978 | 835.09561 | 75.00439 | 79.28591 | 830.81409 | -.04762 | .10379 | .10671 | .10466 |
| 1979 | 1021.54139 | 145.15861 | 207.62685 | 959.07315 | .41033 | .20086 | .24023 | .23582 |
| 1980 | 798.00507 | 670.99493 | 881.01847 | 587.98153 | -.13872 | .92849 | 1.06393 | 1.06675 |
| 1981 | 874.11408 | 275.58592 | 408.09346 | 741.60654 | .04822 | .38134 | .46405 | .45694 |
| 1982 | 669.84417 | 38.35583 | 47.34843 | 660.85157 | -.45350 | .05308 | .05897 | .05783 |
| 1983 | 909.89733 | 225.50267 | 242.09606 | 893.30394 | .13611 | .31204 | .32332 | .31768 |
| 1984 | 856.39521 | 1536.90479 | 1755.76860 | 637.53140 | .00470 | 2.12670 | 2.27309 | 2.49006 |
| 1985 | 1057.43440 | 346.66560 | 374.09562 | 1030.00438 | .49849 | .47970 | .49832 | .49099 |
| 1986 | 354.46364 | 639.53636 | 924.30556 | 69.69444 | -1.22813 | .88496 | 1.06390 | 1.06672 |
| 1987 | 1210.29902 | 99.50098 | 140.92520 | 1168.87480 | .87395 | .13769 | .16386 | .16076 |
| 1988 | 747.50751 | 234.39249 | 257.74744 | 724.15256 | -.26275 | .32434 | .34012 | .33426 |
| 1989 | 741.53949 | 153.56051 | 170.29215 | 724.80785 | -.27741 | .21249 | .22377 | .21963 |
| 1990 | 1119.35360 | 857.44640 | 987.68605 | 989.11395 | .65057 | 1.18650 | 1.27342 | 1.28956 |
| 1991 | 1016.95511 | 1398.34489 | 1566.74829 | 848.55171 | .39906 | 1.93497 | 2.04817 | 2.19310 |
| 1992 | 2392.58051 | 48.71949 | 147.42068 | 2293.87932 | 3.77784 | .06742 | .11727 | .11502 |
| 1993 | 1042.73882 | 483.36118 | 512.46628 | 1013.63372 | .46239 | .66885 | .68870 | .68157 |
| 1994 | 963.37800 | 1044.52200 | 1097.57127 | 910.32873 | .26747 | 1.44536 | 1.48161 | 1.51835 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.
[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



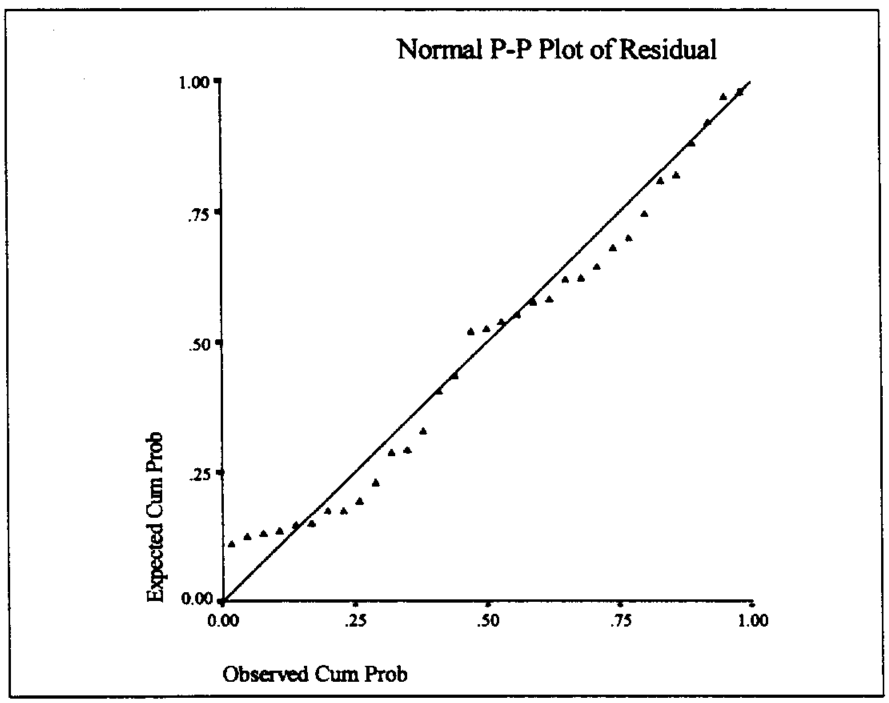




Fig. 6.1.1. Exploratory Plots of Brown Shrimp Harvest Standardized Residual.

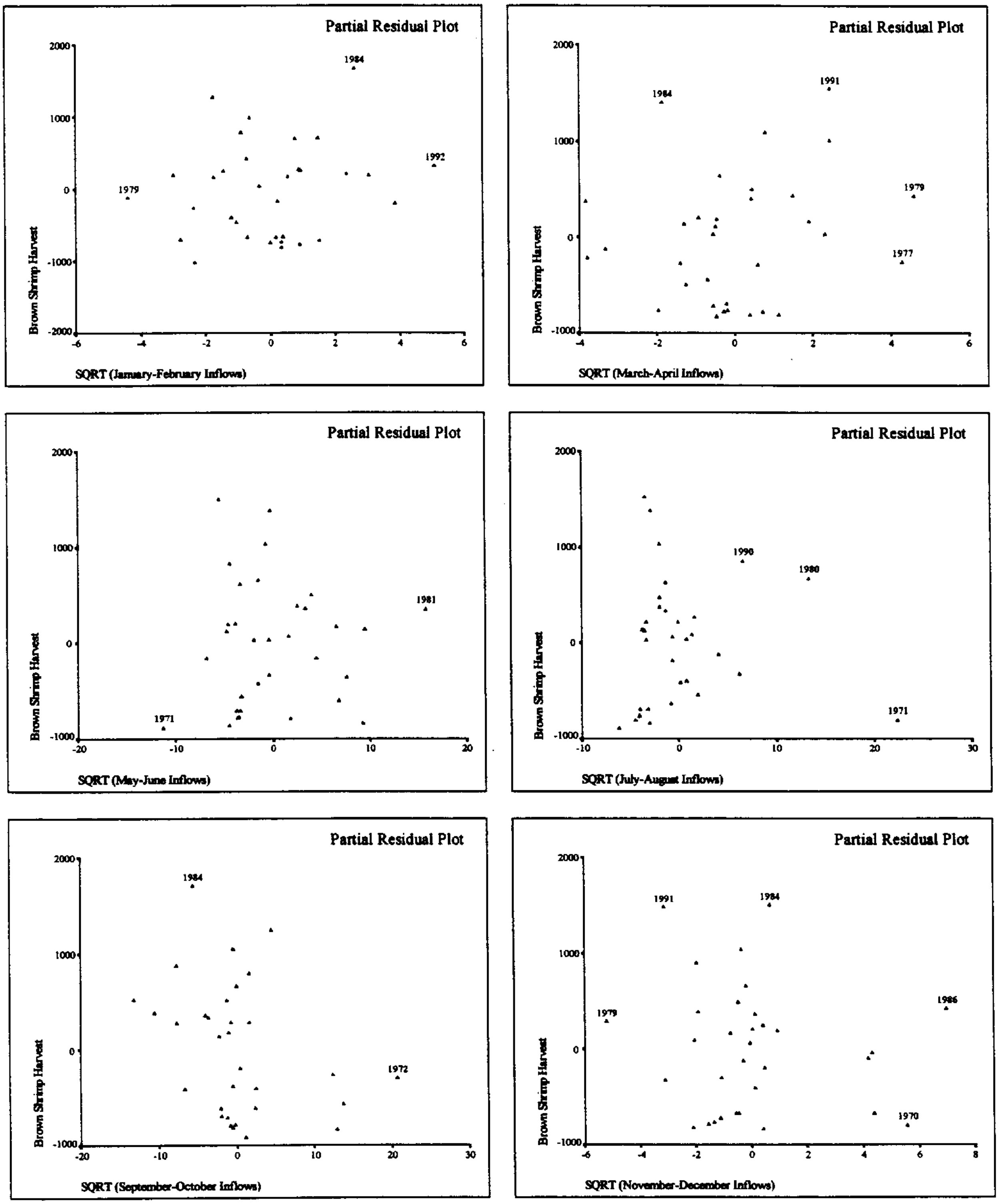



Fig. 6.1.2. Partial Residual Plots of Brown Shrimp Harvest vs. Square Root Inflows.

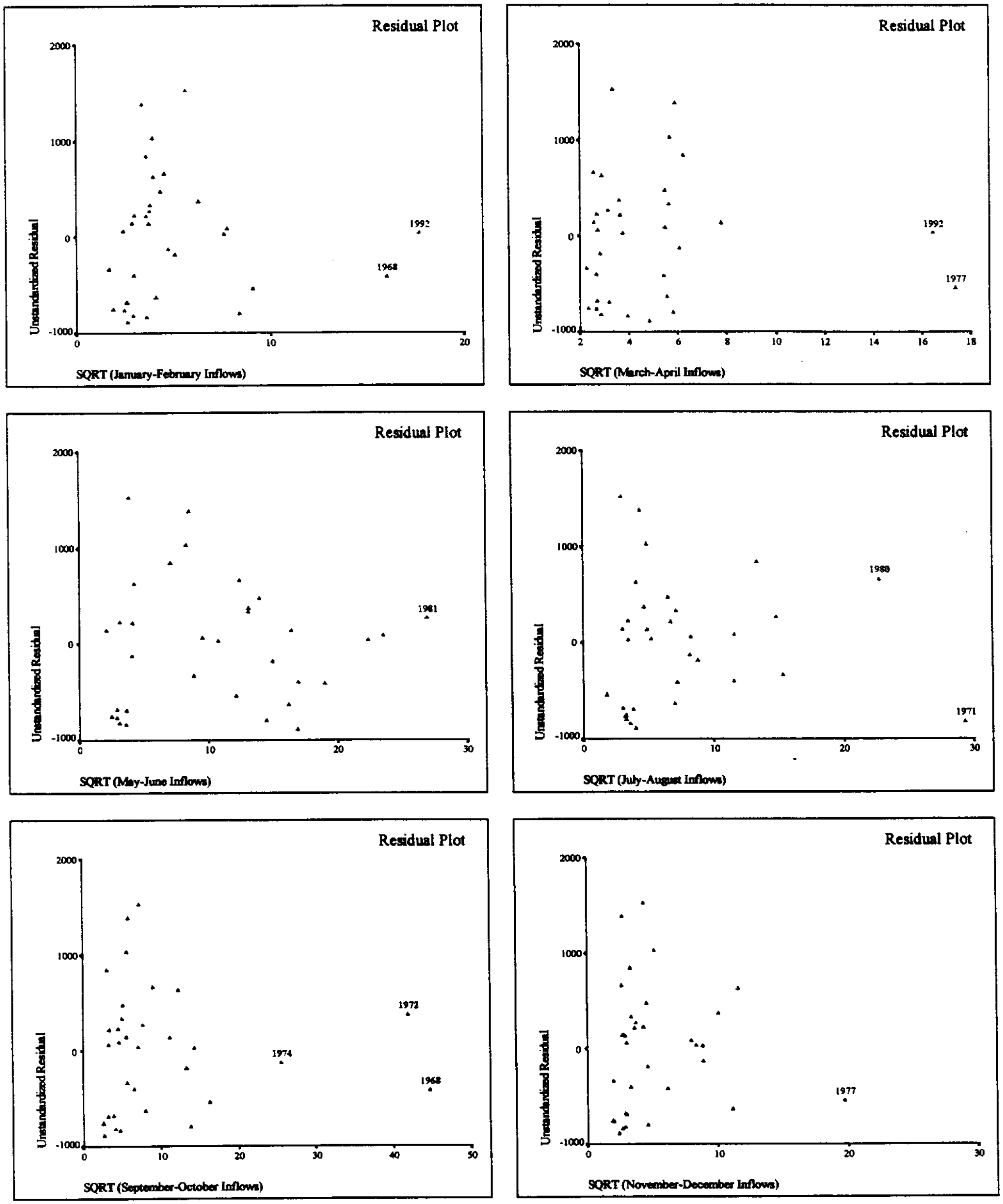



Fig. 6.1.3. Residual Plots of Brown Shrimp Harvest vs. Square Root Inflows.

### 6.1.4 Prediction Intervals for Brown Shrimp Harvest

| YEAR | B_SH | LICI | UICI |
|---|---|---|---|
| 1962 | 115.50 | 0.00000 | 2881.99881 |
| 1963 | 95.40 | 0.00000 | 2948.40062 |
| 1964 | 52.40 | 0.00000 | 2900.11270 |
| 1965 | 226.80 | 0.00000 | 3113.73709 |
| 1966 | 187.30 | 0.00000 | 3232.96348 |
| 1967 | 171.50 | 0.00000 | 2928.94928 |
| 1968 | .60 | 0.00000 | 2961.98234 |
| 1969 | 88.80 | 0.00000 | 3003.94819 |
| 1970 | 138.90 | 0.00000 | 2981.72789 |
| 1971 | 19.30 | 0.00000 | 3346.59995 |
| 1972 | 51.80 | 0.00000 | 2090.42404 |
| 1973 | 396.20 | 0.00000 | 2902.49793 |
| 1974 | 150.10 | 0.00000 | 2501.11946 |
| 1975 | 482.80 | 0.00000 | 2732.23208 |
| 1976 | 397.20 | 0.00000 | 2829.57034 |
| 1977 | 738.60 | 0.00000 | 3873.19843 |
| 1978 | 910.10 | 0.00000 | 2896.69748 |
| 1979 | 1166.70 | 0.00000 | 3311.88618 |
| 1980 | 1469.00 | 0.00000 | 3032.67050 |
| 1981 | 1149.70 | 0.00000 | 3185.34257 |
| 1982 | 708.20 | 0.00000 | 2860.34724 |
| 1983 | 1135.40 | 0.00000 | 2985.66994 |
| 1984 | 2393.30 | 0.00000 | 2985.97428 |
| 1985 | 1404.10 | 0.00000 | 3137.84765 |
| 1986 | 994.00 | 0.00000 | 2651.15732 |
| 1987 | 1309.80 | 0.00000 | 3494.54120 |
| 1988 | 981.90 | 0.00000 | 2844.60862 |
| 1989 | 895.10 | 0.00000 | 2845.97390 |
| 1990 | 1976.80 | 0.00000 | 3255.74731 |
| 1991 | 2415.30 | 0.00000 | 3130.21732 |
| 1992 | 2441.30 | 0.00000 | 4987.23883 |
| 1993 | 1526.10 | 0.00000 | 3107.07053 |
| 1994 | 2007.90 | 0.00000 | 3019.42943 |

**B_SH** Brown shrimp harvest
**LICI** Lower limit for 99% prediction interval for brown shrimp harvest
**UICI** Upper limit for 99% prediction interval for brown shrimp harvest

### 6.1.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| **1962** | 1.95565 | .01354 | .06111 | .9623 | .0000 |
| **1963** | 2.18657 | .01859 | .06833 | .9488 | .0000 |
| **1964** | 2.29871 | .01896 | .07183 | .9415 | .0000 |
| **1965** | 2.08466 | .01967 | .06515 | .9550 | .0000 |
| **1966** | 4.57414 | .05255 | .14294 | .7118 | .0003 |
| **1967** | 1.53492 | .01139 | .04797 | .9811 | .0000 |
| **1968** | 18.97891 | .19509 | **.59309** | .0083 | .0163 |
| **1969** | 1.80947 | .01924 | .05655 | .9696 | .0000 |
| **1970** | 6.28463 | .03970 | .19639 | .5069 | .0001 |
| **1971** | 17.38748 | .56395 | **.54336** | .0151 | .2222 |
| **1972** | 13.57999 | .06146 | .42437 | .0592 | .0004 |
| **1973** | 2.56312 | .00581 | .08010 | .9223 | .0000 |
| **1974** | 6.78618 | .00147 | .21207 | .4515 | .0000 |
| **1975** | 1.34038 | .00066 | .04189 | .9873 | .0000 |
| **1976** | 2.47638 | .00376 | .07739 | .9289 | .0000 |
| **1977** | 20.90626 | .52282 | **.65332** | **.0039** | .1912 |
| **1978** | .75834 | .00009 | .02370 | .9978 | .0000 |
| **1979** | 8.65807 | .00355 | .27056 | .2781 | .0000 |
| **1980** | 6.65869 | .05061 | .20808 | .4653 | .0002 |
| **1981** | 9.42067 | .01479 | .29440 | .2238 | .0000 |
| **1982** | 5.10787 | .00012 | .15962 | .6468 | .0000 |
| **1983** | 1.22360 | .00110 | .03824 | .9904 | .0000 |
| **1984** | 3.01924 | .10511 | .09435 | .8832 | .0025 |
| **1985** | 1.37666 | .00281 | .04302 | .9863 | .0000 |
| **1986** | 8.88918 | .07200 | .27779 | .2607 | .0007 |
| **1987** | 8.43654 | .00160 | .26364 | .2957 | .0000 |
| **1988** | 1.92988 | .00165 | .06031 | .9636 | .0000 |
| **1989** | 2.17439 | .00078 | .06795 | .9496 | .0000 |
| **1990** | 3.24993 | .03519 | .10156 | .8610 | .0001 |
| **1991** | 2.46985 | .07217 | .07718 | .9294 | .0008 |
| **1992** | 20.45496 | .00398 | **.63922** | **.0047** | .0000 |
| **1993** | .84772 | .00408 | .02649 | .9969 | .0000 |
| **1994** | .57697 | .01593 | .01803 | .9991 | .0000 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1962** | -.30753 | -.28783 | -.03514 | .05047 | .11907 | .12938 | .05306 | .03243 |
| **1963** | -.36211 | -.34092 | -.03528 | .02933 | .13256 | .14700 | .05720 | .08801 |
| **1964** | -.36548 | -.34895 | -.00043 | .01966 | .12664 | .14678 | .03555 | .08948 |
| **1965** | -.37338 | -.11037 | -.16064 | .05095 | -.06677 | .17131 | .00796 | .11251 |
| **1966** | -.61585 | -.22214 | .30036 | -.15213 | -.42840 | .28843 | -.04095 | .21500 |
| **1967** | -.28200 | -.25628 | -.01499 | .01937 | .10569 | .10189 | .05237 | .03755 |
| **1968** | **-1.16452** | .17391 | -.49615 | .16869 | .07359 | -.00855 | -.49023 | .31522 |
| **1969** | -.37003 | -.30747 | -.03903 | -.04414 | .17794 | .12037 | .01552 | .13567 |
| **1970** | -.52661 | .05987 | .06918 | .19685 | -.23672 | .02884 | .18848 | -.42433 |
| **1971** | **-2.06848** | .52589 | -.21656 | -.17574 | .96462 | **-1.93091** | .05669 | -.08130 |
| **1972** | .64965 | -.04295 | -.25318 | .03764 | .07780 | -.05800 | .51398 | .00852 |
| **1973** | -.19904 | -.01900 | .05554 | .03830 | -.14259 | -.01546 | .00852 | -.00529 |
| **1974** | -.09949 | .00640 | .04165 | -.04239 | .04284 | -.02631 | -.07156 | .00395 |
| **1975** | -.06692 | -.01233 | -.00460 | .03165 | -.03494 | .00489 | -.00235 | -.00819 |
| **1976** | -.15982 | -.02140 | .05132 | -.02655 | .00622 | -.09647 | -.03128 | .03610 |
| **1977** | **-1.94014** | .72498 | .57060 | -.91255 | .23968 | -.14547 | -.14131 | -.71275 |
| **1978** | .02501 | .01605 | -.00322 | -.00540 | .00541 | -.00223 | -.00622 | -.00017 |
| **1979** | .15470 | .01374 | -.10822 | .11753 | .05793 | -.03144 | .09011 | -.10179 |
| **1980** | .59681 | -.16718 | .08009 | -.04139 | -.05764 | .51585 | .00042 | -.01424 |
| **1981** | .31685 | -.05879 | -.08498 | -.04644 | .27585 | .02965 | -.01011 | .01644 |
| **1982** | .02800 | .00562 | .01715 | -.02210 | -.00075 | -.00684 | -.01270 | .01856 |
| **1983** | .08617 | .05975 | .02665 | -.01363 | -.04767 | -.00069 | -.03043 | .00094 |
| **1984** | .93967 | .61969 | .60426 | -.44945 | -.46000 | -.28554 | -.37884 | .12459 |
| **1985** | .13811 | .04093 | -.06410 | .06901 | .05346 | -.02086 | .02102 | -.06641 |
| **1986** | .71181 | .12922 | .16467 | -.44691 | -.13398 | -.05173 | -.25259 | .62044 |
| **1987** | .10373 | -.02411 | .03939 | -.05780 | .05712 | .00862 | -.06513 | .05713 |
| **1988** | .10551 | .08792 | .02717 | -.04141 | -.04228 | -.03673 | -.03647 | .02293 |
| **1989** | .07250 | .06625 | .01100 | -.01037 | -.03445 | -.02747 | -.00603 | -.01204 |
| **1990** | .50258 | .00307 | -.11019 | .30543 | -.19131 | .29268 | .05875 | -.18642 |
| **1991** | .76107 | .37064 | -.35896 | .51155 | -.01611 | -.21002 | .26782 | -.50425 |
| **1992** | .16372 | -.04635 | .08905 | .03459 | -.01218 | .00556 | -.05457 | -.02831 |
| **1993** | .16725 | .05040 | -.04538 | .02816 | .08919 | -.04313 | -.02294 | -.02281 |
| **1994** | .34218 | .19121 | -.08825 | .11175 | -.03766 | -.09510 | -.01551 | -.03706 |

**SDFFITS** Standardized dffits value
**SDFB_0** Standardized dfbeta for the intercept term
**SDFB_1** Standardized dfbeta for the Square root January-February inflows
**SDFB_2** Standardized dfbeta for the Square root March-April inflows
**SDFB_3** Standardized dfbeta for the Square root May-June inflows
**SDFB_4** Standardized dfbeta for the Square root July-August inflows
**SDFB_5** Standardized dfbeta for the Square root September-October inflows
**SDFB_6** Standardized dfbeta for the Square root November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

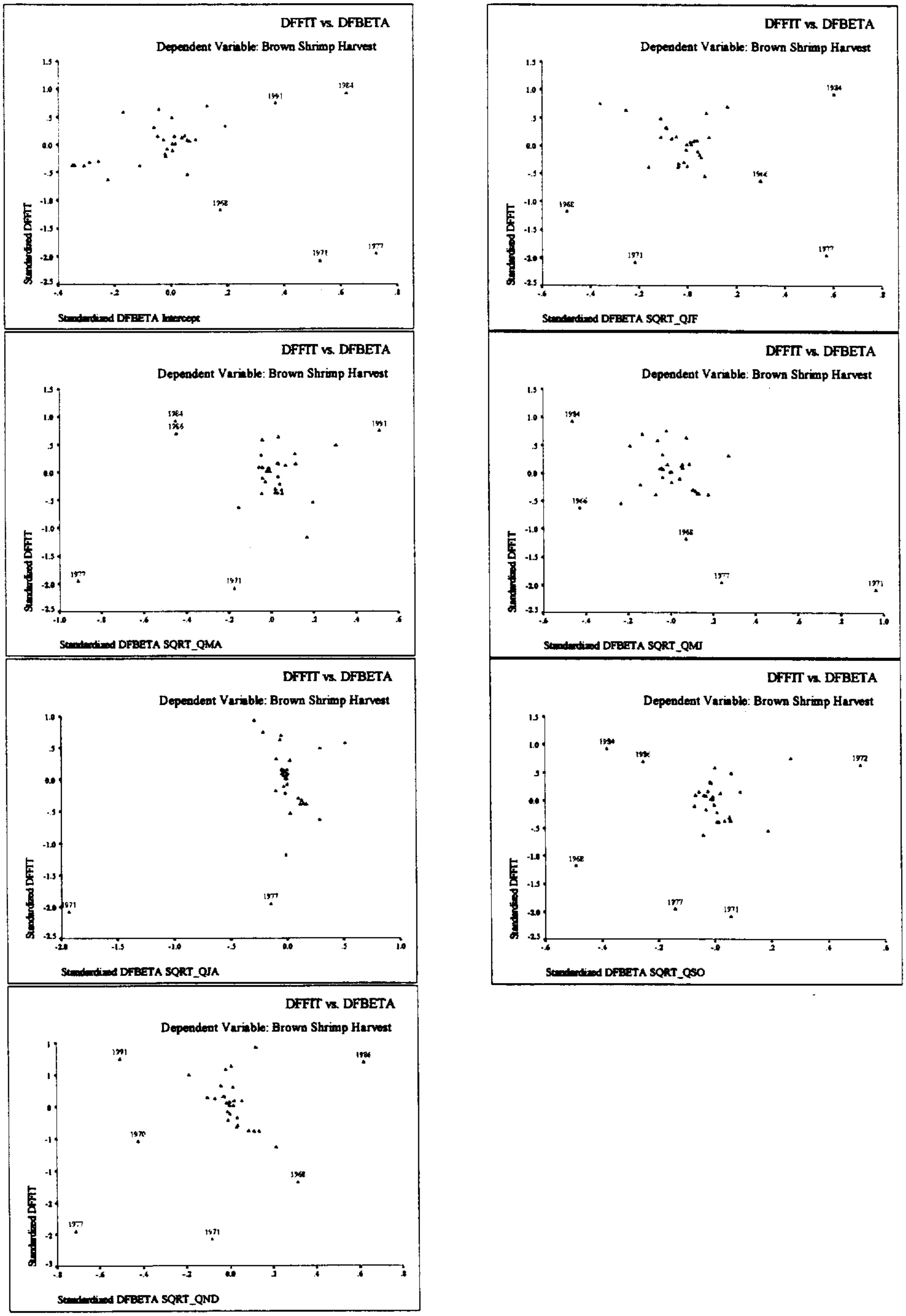



Fig. 6.1.4. Standardized DFFIT vs. Standardized DFBETA.

## 6.2 Model 5: Square Root Variables

### 6.2.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | SQRT(Nov-Dec Inflows), SQRT(May-Jun Inflows), SQRT(Jul-Aug Inflows), SQRT(Sept-Oct Inflows), SQRT(Mar-Apr Inflows), SQRT(Jan-Feb Inflows)[c,d] | . | .537 | .288 | .124 | 13.4803 | .564 |

a. Dependent Variable: SQRT (Brown Shrimp Harvest)

b. Method: Enter

c. Independent Variables: (Constant), SQRT (November-December Inflows), SQRT (May-June Inflows), SQRT (July-August Inflows), SQRT (September-October Inflows), SQRT (March-April Inflows), SQRT (January-February Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 1911.399 | 6 | 318.566 | 1.753 | .148[b] |
| | Residual | 4724.674 | 26 | 181.718 | | |
| | Total | 6636.073 | 32 | | | |

a. Dependent Variable: SQRT (Brown Shrimp Harvest)

b. Independent Variables: (Constant), SQRT (November-December Inflows), SQRT (May-June Inflows), SQRT (July-August Inflows), SQRT (September-October Inflows), SQRT (March-April Inflows), SQRT (January-February Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 22.609 | 6.201 | | 3.646 | .001 |
| | SQRT (January-February Inflows) | .558 | 1.179 | .139 | .473 | .640 |
| | SQRT (March-April Inflows) | .941 | 1.227 | .225 | .767 | .450 |
| | SQRT (May-June Inflows) | .317 | .423 | .151 | .749 | .460 |
| | SQRT (July-August Inflows) | -7.3E-02 | .426 | -.031 | -.172 | .865 |
| | SQRT (September-October Inflows) | -.724 | .348 | -.503 | -2.081 | .047 |
| | SQRT (November-December Inflows) | -4.3E-02 | .934 | -.011 | -.047 | .963 |

a. Dependent Variable: SQRT (Brown Shrimp Harvest)

### 6.2.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 22.608622 | 6.20077185 | 3.646 | 0.0012 | 0.00000000 |
| SQRT_QJF | 1 | 0.557543 | 1.17877697 | 0.473 | 0.6402 | 3.13934695 |
| SQRT_QMA | 1 | 0.940539 | 1.22668136 | 0.767 | 0.4501 | 3.13781572 |
| SQRT_QMJ | 1 | 0.317083 | 0.42326040 | 0.749 | 0.4605 | 1.48623100 |
| SQRT_QJA | 1 | -0.073293 | 0.42644930 | -0.172 | 0.8649 | 1.16303742 |
| SQRT_QSO | 1 | -0.723547 | 0.34771351 | -2.081 | 0.0474 | 2.13030204 |
| SQRT_QND | 1 | -0.043434 | 0.93380024 | -0.047 | 0.9633 | 2.22536610 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop SQRT_QJF | Var Prop SQRT_QMA | Var Prop SQRT_QMJ | Var Prop SQRT_QJA | Var Prop SQRT_QSO | Var Prop SQRT_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.77081 | 1.00000 | 0.0316 | 0.0260 | 0.0294 | 0.0067 | 0.0237 | 0.0351 |
| 2 | 1.19503 | 1.52270 | 0.0045 | 0.0035 | 0.1751 | 0.4314 | 0.0009 | 0.0216 |
| 3 | 0.87633 | 1.77815 | 0.0003 | 0.1046 | 0.0354 | 0.0010 | 0.3553 | 0.0005 |
| 4 | 0.61040 | 2.13056 | 0.0268 | 0.0204 | 0.2285 | 0.4784 | 0.0006 | 0.2663 |
| 5 | 0.40054 | 2.63014 | 0.2815 | 0.0556 | 0.5262 | 0.0813 | 0.0003 | 0.2522 |
| 6 | 0.14688 | 4.34336 | 0.6554 | 0.7898 | 0.0054 | 0.0012 | 0.6192 | 0.4242 |

### 6.2.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 2.592587 | 49.11939 | 25.5615 | 7.728597 | 33 |
| Std. Predicted Value | -2.972 | 3.048 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | 2.963620 | 11.14571 | 5.727394 | 2.433665 | 33 |
| Adjusted Predicted Value | -1.246656 | 52.04380 | 26.8276 | 9.791685 | 33 |
| Residual | -18.2293 | 24.45638 | -7.5E-16 | 12.15097 | 33 |
| Std. Residual | -1.352 | 1.814 | .000 | .901 | 33 |
| Stud. Residual | -2.071 | 1.939 | -.034 | 1.025 | 33 |
| Deleted Residual | -42.7578 | 27.93911 | -1.26610 | 16.50285 | 33 |
| Stud. Deleted Residual | -2.222 | 2.056 | -.037 | 1.050 | 33 |
| Mahal. Distance | .577 | 20.906 | 5.818 | 6.005 | 33 |
| Cook's Distance | .000 | .824 | .063 | .155 | 33 |
| Centered Leverage Value | .018 | .653 | .182 | .188 | 33 |

a. Dependent Variable: SQRT (Brown Shrimp Harvest)

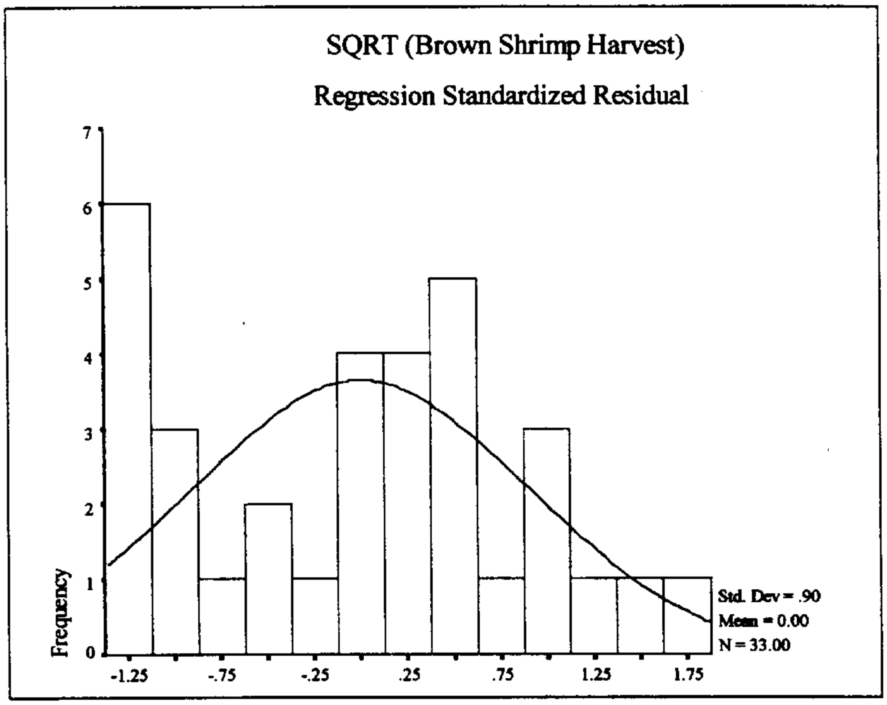
*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| **1962** | 24.28945 | -13.54236 | -14.90492 | 25.65201 | -.16459 | -1.00460 | -1.05393 | -1.05628 |
| **1963** | 25.18114 | -15.41385 | -17.10054 | 26.86783 | -.04921 | -1.14344 | -1.20437 | -1.21537 |
| **1964** | 24.43715 | -17.19837 | -19.15480 | 26.39358 | -.14547 | -1.27582 | -1.34643 | -1.36887 |
| **1965** | 26.88481 | -11.82493 | -13.07270 | 28.13258 | .17123 | -.87720 | -.92232 | -.91958 |
| **1966** | 31.61810 | -17.93234 | -21.69003 | 35.37579 | .78366 | -1.33026 | -1.46302 | -1.49757 |
| **1967** | 25.50232 | -12.40652 | -13.46002 | 26.55582 | -.00765 | -.92034 | -.95862 | -.95707 |
| **1968** | 9.54848 | -8.77388 | -23.29724 | 24.07184 | -2.07191 | -.65087 | -1.06059 | -1.06325 |
| **1969** | 25.65479 | -16.23142 | -17.77517 | 27.19855 | .01208 | -1.20409 | -1.26004 | -1.27512 |
| **1970** | 28.45028 | -16.66469 | -21.55004 | 33.33563 | .37378 | -1.23623 | -1.40580 | -1.43408 |
| **1971** | 22.62247 | -18.22930 | -42.75782 | 47.15100 | -.38028 | -1.35229 | -2.07106 | -2.22242 |
| **1972** | 2.59259 | 4.60463 | 8.44388 | -1.24666 | -2.97193 | .34158 | .46256 | .45546 |
| **1973** | 26.34311 | -6.43834 | -7.23734 | 27.14212 | .10114 | -.47761 | -.50638 | -.49901 |
| **1974** | 12.86327 | -.61174 | -.80744 | 13.05897 | -1.64301 | -.04538 | -.05214 | -.05113 |
| **1975** | 22.40382 | -.43111 | -.46465 | 22.43736 | -.40857 | -.03198 | -.03320 | -.03256 |
| **1976** | 23.14971 | -3.21983 | -3.60842 | 23.53830 | -.31206 | -.23885 | -.25286 | -.24825 |
| **1977** | 35.04440 | -7.86721 | -24.86661 | 52.04380 | 1.22699 | -.58361 | -1.03757 | -1.03917 |
| **1978** | 26.41470 | 3.75316 | 3.96741 | 26.20046 | .11040 | .27842 | .28625 | .28114 |
| **1979** | 28.60243 | 5.55456 | 7.94494 | 26.21205 | .39347 | .41205 | .49280 | .48550 |
| **1980** | 23.19708 | 15.13045 | 19.86633 | 18.46120 | -.30593 | 1.12241 | 1.28613 | 1.30330 |
| **1981** | 29.36773 | 4.53949 | 6.72217 | 27.18505 | .49249 | .33675 | .40979 | .40313 |
| **1982** | 22.74364 | 3.86839 | 4.77534 | 21.83669 | -.36460 | .28697 | .31884 | .31326 |
| **1983** | 26.23640 | 7.45929 | 8.00818 | 25.68752 | .08733 | .55335 | .57335 | .56580 |
| **1984** | 24.46498 | 24.45638 | 27.93911 | 20.98226 | -.14187 | 1.81423 | 1.93911 | 2.05593 |
| **1985** | 29.88414 | 7.58719 | 8.18752 | 29.28380 | .55931 | .56284 | .58468 | .57713 |
| **1986** | 19.16449 | 12.36327 | 17.86832 | 13.65944 | -.82770 | .91714 | 1.10258 | 1.10737 |
| **1987** | 35.02051 | 1.17065 | 1.65801 | 34.53315 | 1.22390 | .08684 | .10335 | .10136 |
| **1988** | 24.05322 | 7.28206 | 8.00765 | 23.32763 | -.19515 | .54020 | .56647 | .55893 |
| **1989** | 22.95317 | 6.96506 | 7.72395 | 22.19427 | -.33749 | .51668 | .54411 | .53660 |
| **1990** | 29.33571 | 15.12550 | 17.42295 | 27.03826 | .48835 | 1.12205 | 1.20425 | 1.21524 |
| **1991** | 28.10856 | 21.03714 | 23.57066 | 25.57504 | .32957 | 1.56059 | 1.65189 | 1.71214 |
| **1992** | 49.11939 | .29012 | .87788 | 48.53163 | 3.04815 | .02152 | .03744 | .03671 |
| **1993** | 30.20705 | 8.85828 | 9.39168 | 29.67365 | .60109 | .65713 | .67662 | .66940 |
| **1994** | 28.06938 | 16.74022 | 17.59043 | 27.21917 | .32450 | 1.24183 | 1.27297 | 1.28907 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.

[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



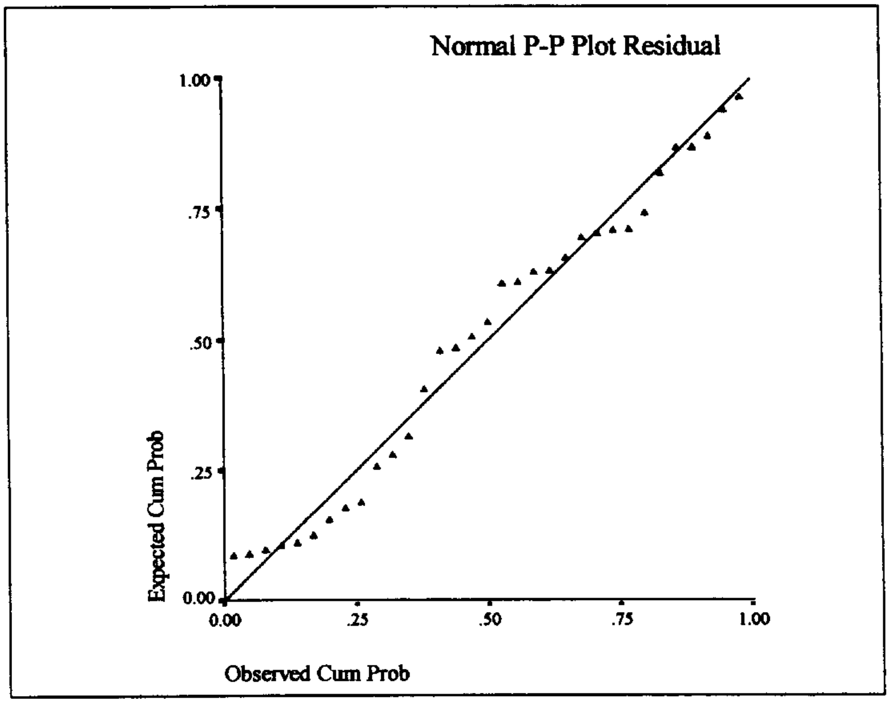




Fig. 6.2.1. Exploratory Plots of SQRT (Brown Shrimp Harvest) Standardized Residual.

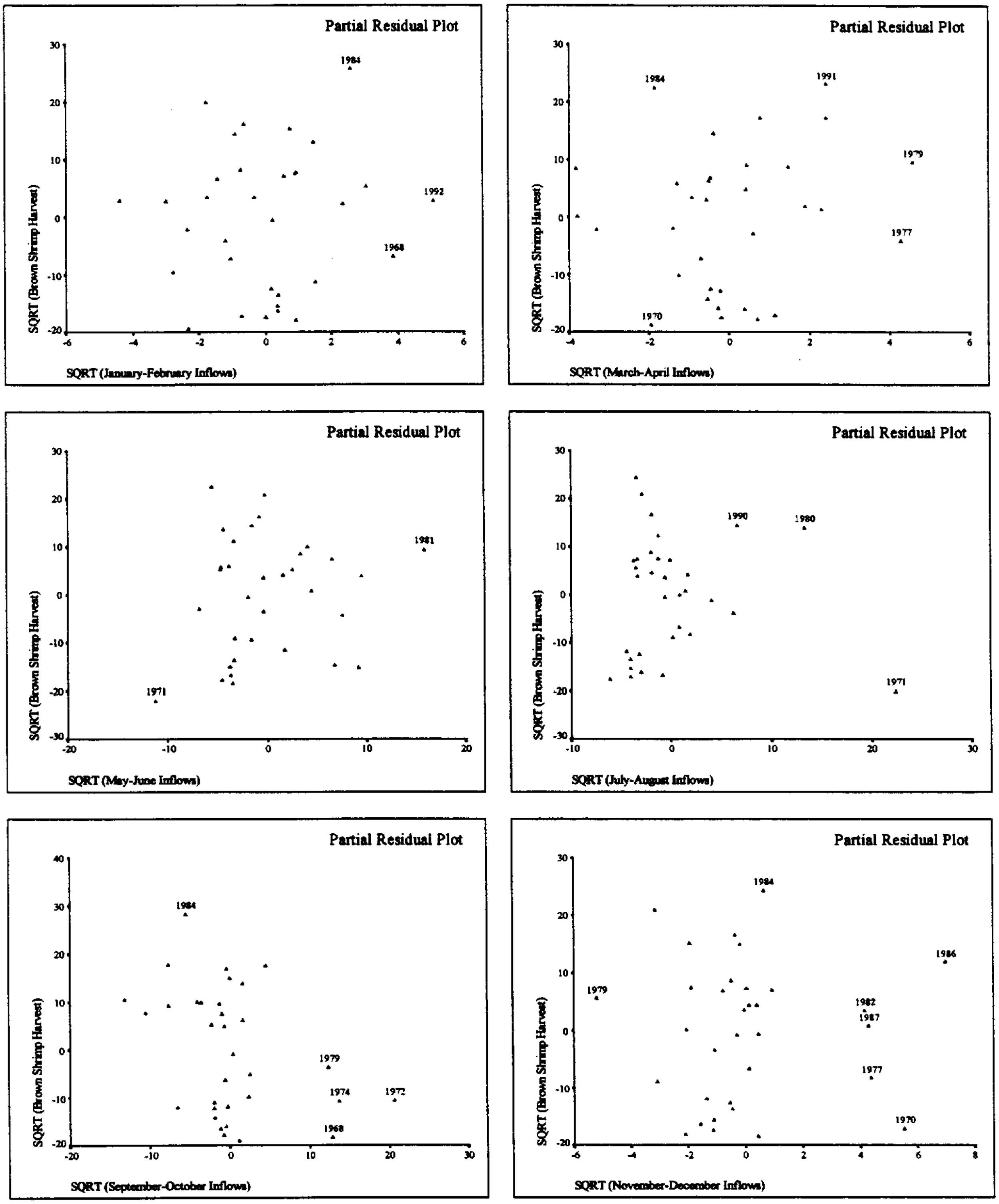



Fig. 6.2.2. Partial Residual Plots of SQRT (Brown Shrimp Harvest) vs. Square Root Inflows.

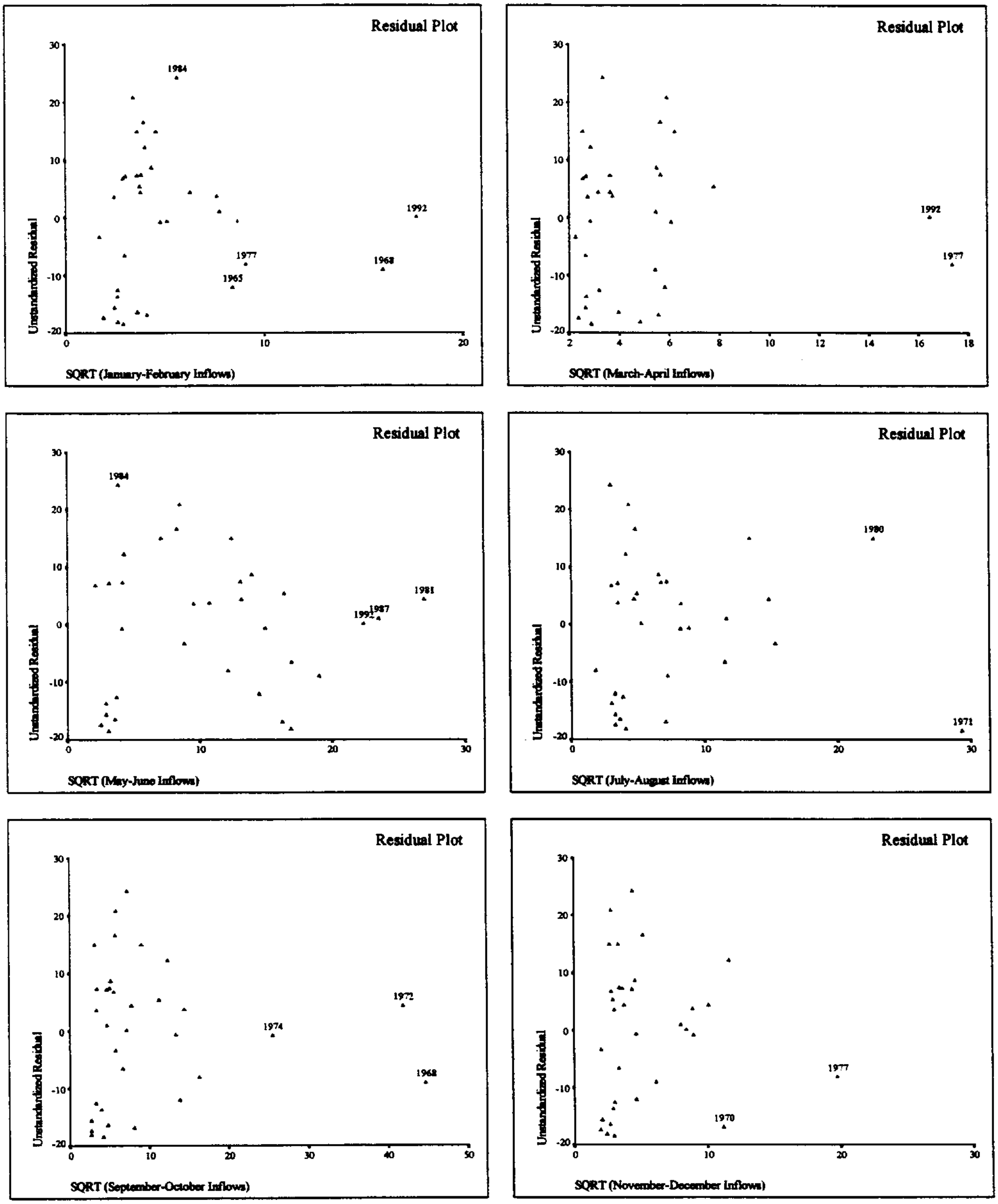



Fig. 6.2.3. Residual Plots of SQRT (Brown Shrimp Harvest) vs. Square Root Inflows.

### 6.2.4 Prediction Intervals for Brown Shrimp Harvest

| YEAR | SQRT (BSH) | LICI | UICI |
|---|---|---|---|
| 1962 | 10.7471 | -14.84314 | 63.42204 |
| 1963 | 9.7673 | -14.08060 | 64.44289 |
| 1964 | 7.2388 | -14.88716 | 63.76147 |
| 1965 | 15.0599 | -12.31999 | 66.08960 |
| 1966 | 13.6858 | -8.95494 | 72.19114 |
| 1967 | 13.0958 | -13.39385 | 64.39848 |
| 1968 | .7746 | -38.17754 | 57.27449 |
| 1969 | 9.4234 | -13.39581 | 64.70540 |
| 1970 | 11.7856 | -13.03672 | 69.93728 |
| 1971 | 4.3932 | -24.36682 | 69.61176 |
| 1972 | 7.1972 | -42.58537 | 47.77055 |
| 1973 | 19.9048 | -13.12833 | 65.81455 |
| 1974 | 12.2515 | -28.88792 | 54.61446 |
| 1975 | 21.9727 | -16.38255 | 61.19018 |
| 1976 | 19.9299 | -16.27353 | 62.57295 |
| 1977 | 27.1772 | -13.55889 | 83.64770 |
| 1978 | 30.1679 | -12.04126 | 64.87067 |
| 1979 | 34.1570 | -14.12038 | 71.32524 |
| 1980 | 38.3275 | -18.48711 | 64.88128 |
| 1981 | 33.9072 | -13.74463 | 72.48010 |
| 1982 | 26.6120 | -18.11678 | 63.60406 |
| 1983 | 33.6957 | -12.48390 | 64.95670 |
| 1984 | 48.9214 | -15.25899 | 64.18896 |
| 1985 | 37.4713 | -8.92273 | 68.69100 |
| 1986 | 31.5278 | -23.67674 | 62.00573 |
| 1987 | 36.1912 | -7.58846 | 77.62949 |
| 1988 | 31.3353 | -15.06493 | 63.17137 |
| 1989 | 29.9182 | -16.30177 | 62.20811 |
| 1990 | 44.4612 | -10.51538 | 69.18681 |
| 1991 | 49.1457 | -11.31105 | 67.52817 |
| 1992 | 49.4095 | .72009 | 97.51869 |
| 1993 | 39.0653 | -8.29984 | 68.71393 |
| 1994 | 44.8096 | -10.28306 | 66.42181 |

**SQRT (BSH)** Square root brown shrimp harvest
**LICI** Lower limit for 99% prediction interval for brown shrimp harvest
**UICI** Upper limit for 99% prediction interval for brown shrimp harvest

### 6.2.5 Outlier and Influential Point Detection

*Calculated Quantities*

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| 1962 | 1.95565 | .01597 | .06111 | .9623 | .0000 |
| 1963 | 2.18657 | .02267 | .06833 | .9488 | .0000 |
| 1964 | 2.29871 | .02946 | .07183 | .9415 | .0000 |
| 1965 | 2.08466 | .01282 | .06515 | .9550 | .0000 |
| 1966 | 4.57414 | .06407 | .14294 | .7118 | .0005 |
| 1967 | 1.53492 | .01115 | .04797 | .9811 | .0000 |
| 1968 | 18.97891 | .26600 | **.59309** | .0083 | .0385 |
| 1969 | 1.80947 | .02157 | .05655 | .9696 | .0000 |
| 1970 | 6.28463 | .08277 | .19639 | .5069 | .0012 |
| 1971 | 17.38748 | .82450 | **.54336** | .0151 | .4235 |
| 1972 | 13.57999 | .02549 | .42437 | .0592 | .0000 |
| 1973 | 2.56312 | .00455 | .08010 | .9223 | .0000 |
| 1974 | 6.78618 | .00012 | .21207 | .4515 | .0000 |
| 1975 | 1.34038 | .00001 | .04189 | .9873 | .0000 |
| 1976 | 2.47638 | .00110 | .07739 | .9289 | .0000 |
| 1977 | 20.90626 | .33232 | **.65332** | .0039 | .0684 |
| 1978 | .75834 | .00067 | .02370 | .9978 | .0000 |
| 1979 | 8.65807 | .01493 | .27056 | .2781 | .0000 |
| 1980 | 6.65869 | .07396 | .20808 | .4653 | .0008 |
| 1981 | 9.42067 | .01153 | .29440 | .2238 | .0000 |
| 1982 | 5.10787 | .00340 | .15962 | .6468 | .0000 |
| 1983 | 1.22360 | .00346 | .03824 | .9904 | .0000 |
| 1984 | 3.01924 | .07650 | .09435 | .8832 | .0009 |
| 1985 | 1.37666 | .00386 | .04302 | .9863 | .0000 |
| 1986 | 8.88918 | .07733 | .27779 | .2607 | .0009 |
| 1987 | 8.43654 | .00064 | .26364 | .2957 | .0000 |
| 1988 | 1.92988 | .00457 | .06031 | .9636 | .0000 |
| 1989 | 2.17439 | .00461 | .06795 | .9496 | .0000 |
| 1990 | 3.24993 | .03147 | .10156 | .8610 | .0000 |
| 1991 | 2.46985 | .04695 | .07718 | .9294 | .0002 |
| 1992 | 20.45496 | .00041 | **.63922** | **.0047** | .0000 |
| 1993 | .84772 | .00394 | .02649 | .9969 | .0000 |
| 1994 | .57697 | .01176 | .01803 | .9991 | .0000 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with $p + 1$ degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with $p + 1$ numerator degree of freedom and $n - p - 1$ denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1962** | -.33505 | -.31358 | -.03829 | .05499 | .12972 | .14096 | .05780 | .03533 |
| **1963** | -.40204 | -.37852 | -.03917 | .03257 | .14718 | .16321 | .06351 | .09772 |
| **1964** | -.46169 | -.44081 | -.00054 | .02483 | .15998 | .18542 | .04490 | .11303 |
| **1965** | -.29872 | -.08830 | -.12851 | .04076 | -.05342 | .13706 | .00637 | .09001 |
| **1966** | -.68554 | -.24727 | .33434 | -.16934 | -.47687 | .32106 | -.04558 | .23933 |
| **1967** | -.27889 | -.25346 | -.01483 | .01916 | .10453 | .10076 | .05179 | .03713 |
| **1968** | **-1.36796** | .20429 | -.58282 | .19815 | .08644 | -.01005 | -.57588 | .37029 |
| **1969** | -.39324 | -.32676 | -.04148 | -.04691 | .18910 | .12792 | .01649 | .14418 |
| **1970** | -.77647 | .08828 | .10200 | .29025 | -.34904 | .04253 | .27791 | -.62566 |
| **1971** | **-2.57797** | .65542 | -.26990 | -.21903 | **1.20222** | **-2.40651** | .07066 | -.10132 |
| **1972** | .41588 | -.02750 | -.16208 | .02410 | .04980 | -.03713 | .32903 | .00545 |
| **1973** | -.17579 | -.01678 | .04905 | .03383 | -.12593 | -.01366 | .00752 | -.00467 |
| **1974** | -.02892 | .00186 | .01211 | -.01232 | .01245 | -.00765 | -.02080 | .00115 |
| **1975** | -.00908 | -.00167 | -.00062 | .00430 | -.00474 | .00066 | -.00032 | -.00111 |
| **1976** | -.08624 | -.01155 | .02769 | -.01433 | .00335 | -.05206 | -.01688 | .01948 |
| **1977** | **-1.52754** | .57080 | .44925 | -.71848 | .18871 | -.11454 | -.11126 | -.56117 |
| **1978** | .06717 | .04310 | -.00864 | -.01450 | .01453 | -.00599 | -.01671 | -.00047 |
| **1979** | .31849 | .02829 | -.22280 | .24196 | .11926 | -.06473 | .18552 | -.20955 |
| **1980** | .72915 | -.20425 | .09786 | -.05056 | -.07042 | .63024 | .00051 | -.01740 |
| **1981** | .27954 | -.05187 | -.07497 | -.04098 | .24337 | .02616 | -.00892 | .01450 |
| **1982** | .15168 | .03042 | .09290 | -.11974 | -.00406 | -.03708 | -.06877 | .10055 |
| **1983** | .15348 | .10641 | .04746 | -.02428 | -.08491 | -.00122 | -.05419 | .00167 |
| **1984** | .77584 | .51165 | .49891 | -.37109 | -.37980 | -.23576 | -.31279 | .10287 |
| **1985** | .16234 | .04811 | -.07534 | .08112 | .06284 | -.02452 | .02471 | -.07806 |
| **1986** | .73893 | .13414 | .17095 | -.46394 | -.13909 | -.05371 | -.26221 | .64408 |
| **1987** | .06540 | -.01520 | .02483 | -.03644 | .03602 | .00543 | -.04107 | .03602 |
| **1988** | .17643 | .14702 | .04543 | -.06924 | -.07070 | -.06142 | -.06098 | .03835 |
| **1989** | .17713 | .16187 | .02688 | -.02533 | -.08416 | -.06712 | -.01473 | -.02940 |
| **1990** | .47362 | .00289 | -.10384 | .28783 | -.18028 | .27582 | .05537 | -.17567 |
| **1991** | .59417 | .28936 | -.28024 | .39936 | -.01258 | -.16396 | .20908 | -.39367 |
| **1992** | .05225 | -.01479 | .02842 | .01104 | -.00389 | .00178 | -.01742 | -.00904 |
| **1993** | .16426 | .04950 | -.04457 | .02765 | .08760 | -.04236 | -.02253 | -.02240 |
| **1994** | .29051 | .16234 | -.07492 | .09487 | -.03197 | -.08074 | -.01317 | -.03146 |

**SDFFITS** Standardized dffits value
**SDFB_0** Standardized dfbeta for the intercept term
**SDFB_1** Standardized dfbeta for the Square root January-February inflows
**SDFB_2** Standardized dfbeta for the Square root March-April inflows
**SDFB_3** Standardized dfbeta for the Square root May-June inflows
**SDFB_4** Standardized dfbeta for the Square root July-August inflows
**SDFB_5** Standardized dfbeta for the Square root September-October inflows
**SDFB_6** Standardized dfbeta for the Square root November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

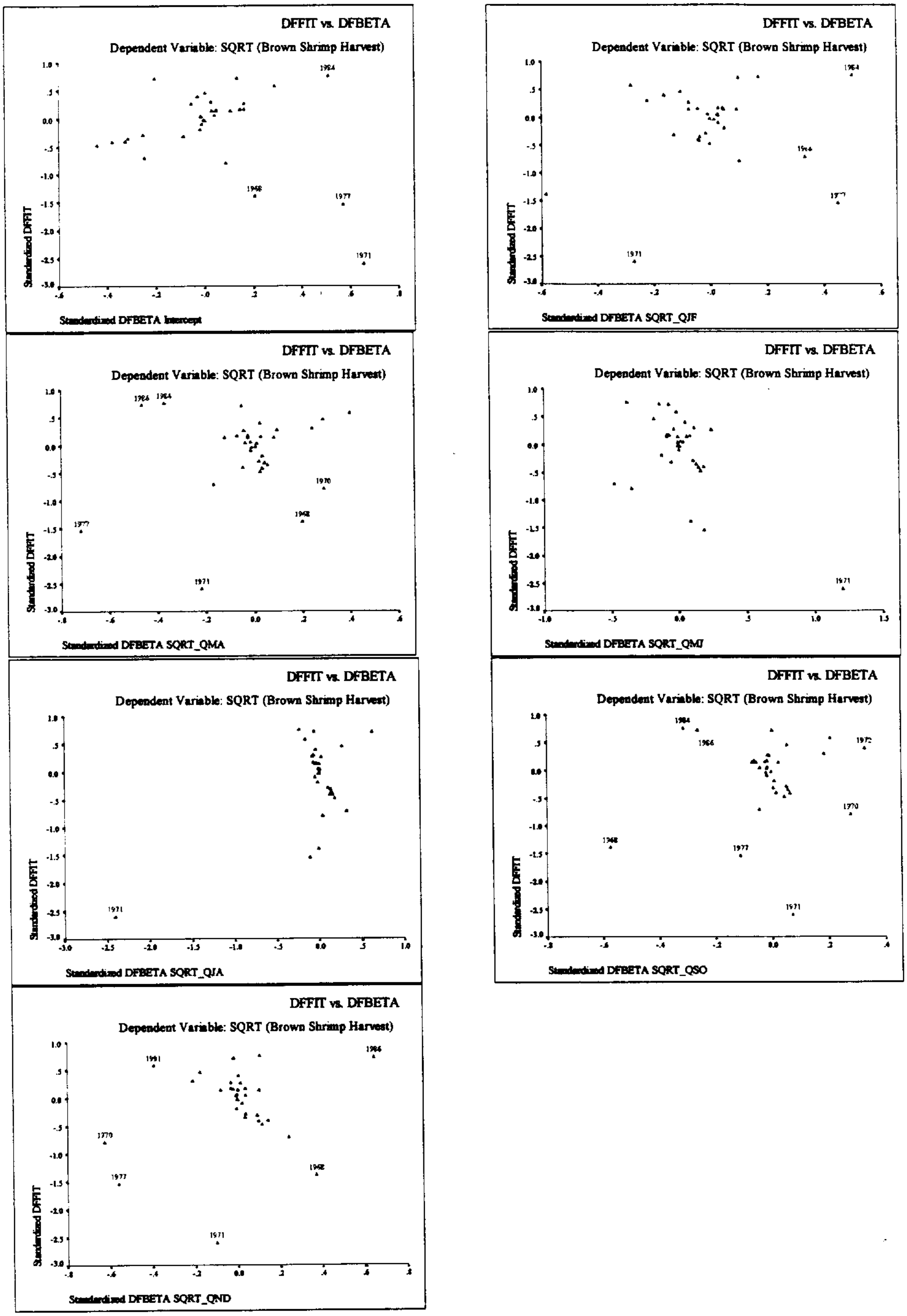



Fig. 6.2.4. Standardized DFFIT vs. Standardized DFBETA.

## 6.3 Model 6: Logged and Square Root Variables

### 6.3.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | SQRT(Nov-Dec Inflows), Ln(May-Jun Inflows), SQRT(Sept-Oct Inflows), Ln(Jul-Aug Inflows), SQRT(Jan-Feb Inflows), SQRT(Mar-Apr Inflows)[c,d] | . | .683 | .466 | .343 | 1.416627 | .790 |

a. Dependent Variable: Ln (Brown Shrimp Harvest)

b. Method: Enter

c. Independent Variables: (Constant), SQRT (November-December Inflows), Ln (May-June Inflows), SQRT (September-October Inflows), Ln (July-August Inflows), SQRT (January-February Inflows), SQRT (March-April Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 45.531 | 6 | 7.589 | 3.781 | .008[b] |
| | Residual | 52.178 | 26 | 2.007 | | |
| | Total | 97.709 | 32 | | | |

a. Dependent Variable: Ln (Brown Shrimp Harvest)

b. Independent Variables: (Constant), SQRT (November-December Inflows), Ln (May-June Inflows), SQRT (September-October Inflows), Ln (July-August Inflows), SQRT (January-February Inflows), SQRT (March-April Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. | 95% Confidence Interval for B Lower Bound | 95% Confidence Interval for B Upper Bound |
|---|---|---|---|---|---|---|---|---|
| 1 | (Constant) | 5.509 | .979 | | 5.628 | .000 | 3.497 | 7.521 |
| | SQRT (January-February Inflows) | -9.3E-02 | .120 | -.190 | -.773 | .446 | -.340 | .154 |
| | SQRT (March-April Inflows) | 7.1E-02 | .132 | .140 | .540 | .594 | -.200 | .342 |
| | Ln (May-June Inflows) | .370 | .215 | .323 | 1.718 | .098 | -.073 | .813 |
| | Ln (July-August Inflows) | -.106 | .230 | -.079 | -.460 | .650 | -.578 | .367 |
| | SQRT (September-October Inflows) | -.114 | .037 | -.651 | -3.095 | .005 | -.189 | -.038 |
| | SQRT (November-December Inflows) | 9.5E-02 | .099 | .207 | .961 | .345 | -.108 | .298 |

a. Dependent Variable: Ln (Brown Shrimp Harvest)

## 6.3.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 5.509112 | 0.97888805 | 5.628 | 0.0001 | 0.00000000 |
| SQRT_QJF | 1 | -0.092846 | 0.12003516 | -0.773 | 0.4462 | 2.94768282 |
| SQRT_QMA | 1 | 0.071239 | 0.13196507 | 0.540 | 0.5939 | 3.28828633 |
| LN_QMJ | 1 | 0.370010 | 0.21534887 | 1.718 | 0.0977 | 1.71823913 |
| LN_QJA | 1 | -0.105638 | 0.22981061 | -0.460 | 0.6496 | 1.42420771 |
| SQRT_QSO | 1 | -0.113684 | 0.03673618 | -3.095 | 0.0047 | 2.15314751 |
| SQRT_QND | 1 | 0.094882 | 0.09873363 | 0.961 | 0.3454 | 2.25274215 |

| Number | Eigenvalue | Condition Index | Var Prop SQRT_QJF | Var Prop SQRT_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop SQRT_QSO | Var Prop SQRT_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.77765 | 1.00000 | 0.0327 | 0.0250 | 0.0267 | 0.0033 | 0.0237 | 0.0355 |
| 2 | 1.34347 | 1.43789 | 0.0017 | 0.0062 | 0.1293 | 0.3136 | 0.0041 | 0.0184 |
| 3 | 0.86520 | 1.79177 | 0.0004 | 0.1003 | 0.0420 | 0.0014 | 0.3477 | 0.0009 |
| 4 | 0.49353 | 2.37236 | 0.2120 | 0.0001 | 0.0031 | 0.1524 | 0.0006 | 0.5226 |
| 5 | 0.37354 | 2.72690 | 0.1359 | 0.0540 | 0.7891 | 0.5186 | 0.0019 | 0.0002 |
| 6 | 0.14661 | 4.35269 | 0.6174 | 0.8144 | 0.0098 | 0.0108 | 0.6219 | 0.4225 |

## 6.3.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 1.676601 | 7.638411 | 5.980812 | 1.192834 | 33 |
| Std. Predicted Value | -3.608 | 1.390 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | .305572 | 1.170132 | .609215 | .237176 | 33 |
| Adjusted Predicted Value | 2.116358 | 9.858050 | 6.107009 | 1.282253 | 33 |
| Residual | -2.413937 | 2.197174 | -1.3E-16 | 1.276930 | 33 |
| Std. Residual | -1.704 | 1.551 | .000 | .901 | 33 |
| Stud. Residual | -2.520 | 1.662 | -.033 | 1.092 | 33 |
| Deleted Residual | -5.824762 | 2.589583 | -.126197 | 1.998267 | 33 |
| Stud. Deleted Residual | -2.842 | 1.724 | -.055 | 1.142 | 33 |
| Mahal. Distance | .519 | 20.863 | 5.818 | 5.643 | 33 |
| Cook's Distance | .000 | 1.508 | .111 | .285 | 33 |
| Centered Leverage Value | .016 | .652 | .182 | .176 | 33 |

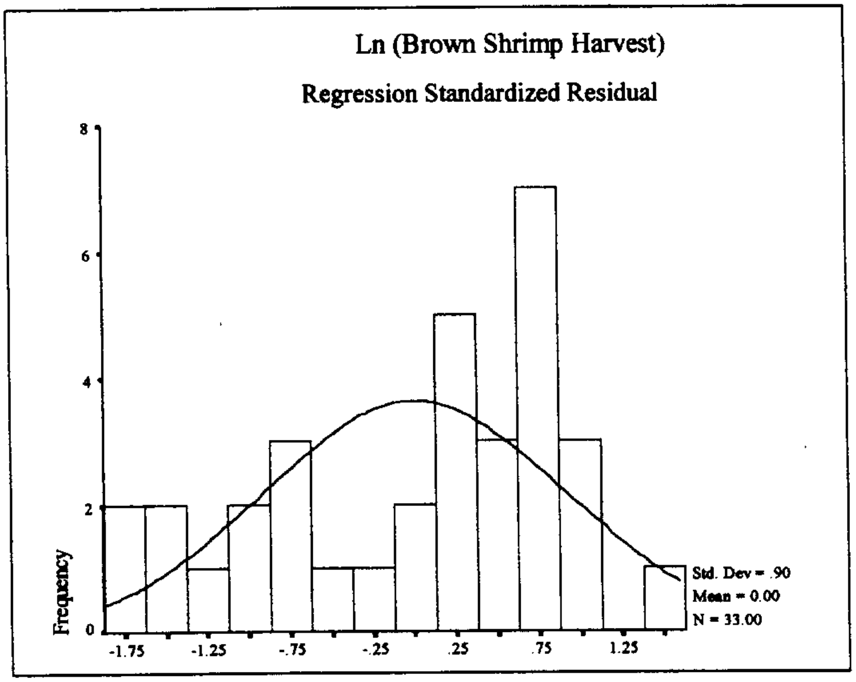
a. Dependent Variable: Ln (Brown Shrimp Harvest)

*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 5.83533 | -1.08606 | -1.22427 | 5.97354 | -.12196 | -.76665 | -.81397 | -.80853 |
| 1963 | 5.91143 | -1.35335 | -1.52900 | 6.08708 | -.05816 | -.95534 | -1.01544 | -1.01607 |
| 1964 | 5.80966 | -1.85075 | -2.11914 | 6.07804 | -.14349 | -1.30645 | -1.39797 | -1.42544 |
| 1965 | 5.73403 | -.30996 | -.36137 | 5.78544 | -.20689 | -.21880 | -.23625 | -.23191 |
| 1966 | 7.33068 | -2.09797 | -2.63656 | 7.86927 | 1.13165 | -1.48096 | -1.66021 | -1.72179 |
| 1967 | 6.09334 | -.94875 | -1.02867 | 6.17325 | .09433 | -.66973 | -.69736 | -.69031 |
| 1968 | 1.67660 | -2.18743 | -5.82476 | 5.31394 | -3.60839 | -1.54411 | -2.51971 | **-2.84202** |
| 1969 | 5.83921 | -1.35282 | -1.48579 | 5.97218 | -.11871 | -.95496 | -1.00079 | -1.00082 |
| 1970 | 7.31830 | -2.38455 | -3.08645 | 8.02021 | 1.12127 | -1.68326 | -1.91504 | -2.02618 |
| 1971 | 5.37404 | -2.41394 | -4.22316 | 7.18327 | -.50868 | -1.70400 | -2.25386 | -2.46385 |
| 1972 | 2.95261 | .99478 | 1.83103 | 2.11636 | -2.53867 | .70222 | .95270 | .95095 |
| 1973 | 6.56152 | -.57960 | -.65387 | 6.63579 | .48683 | -.40914 | -.43457 | -.42768 |
| 1974 | 4.05066 | .96064 | 1.41633 | 3.59497 | -1.61812 | .67812 | .82339 | .81814 |
| 1975 | 5.70859 | .47102 | .51348 | 5.66612 | -.22822 | .33249 | .34716 | .34121 |
| 1976 | 6.09148 | -.10704 | -.12169 | 6.10613 | .09278 | -.07556 | -.08056 | -.07901 |
| 1977 | 7.63841 | -1.03365 | -3.25329 | 9.85805 | 1.38963 | -.72966 | -1.29448 | -1.31233 |
| 1978 | 6.60605 | .20751 | .22221 | 6.59134 | .52416 | .14648 | .15158 | .14870 |
| 1979 | 6.34880 | .61313 | .86869 | 6.19325 | .39233 | .43281 | .51517 | .50777 |
| 1980 | 5.70023 | 1.59211 | 1.91229 | 5.38005 | -.23522 | 1.12387 | 1.23171 | 1.24465 |
| 1981 | 6.72330 | .32396 | .39255 | 6.65471 | .62246 | .22868 | .25173 | .24714 |
| 1982 | 5.76491 | .79782 | 1.01623 | 5.54649 | -.18100 | .56318 | .63561 | .62817 |
| 1983 | 6.04144 | .99330 | 1.06911 | 5.96563 | .05083 | .70117 | .72744 | .72068 |
| 1984 | 5.58325 | 2.19717 | 2.52334 | 5.25709 | -.33329 | 1.55099 | 1.66213 | 1.72402 |
| 1985 | 6.79169 | .45546 | .49604 | 6.75111 | .67979 | .32151 | .33553 | .32973 |
| 1986 | 5.82169 | 1.08005 | 1.55165 | 5.35009 | -.13340 | .76241 | .91383 | .91083 |
| 1987 | 7.23150 | -.05387 | -.07289 | 7.25052 | 1.04850 | -.03802 | -.04423 | -.04338 |
| 1988 | 5.89444 | .99505 | 1.10332 | 5.78617 | -.07241 | .70241 | .73964 | .73302 |
| 1989 | 5.37597 | 1.42096 | 1.66075 | 5.13619 | -.50706 | 1.00306 | 1.08439 | 1.08823 |
| 1990 | 6.37760 | 1.11164 | 1.32578 | 6.26345 | .41648 | .78471 | .85696 | .85245 |
| 1991 | 6.38405 | 1.30553 | 1.46981 | 6.31977 | .42189 | .92158 | .97784 | .97698 |
| 1992 | 6.97648 | .82380 | 2.58958 | 5.21070 | .83471 | .58152 | 1.03103 | 1.03233 |
| 1993 | 6.89521 | .43526 | .46581 | 6.86466 | .76657 | .30725 | .31785 | .31229 |
| 1994 | 6.62429 | .98055 | 1.02840 | 6.57644 | .53946 | .69217 | .70886 | .70191 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.
[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



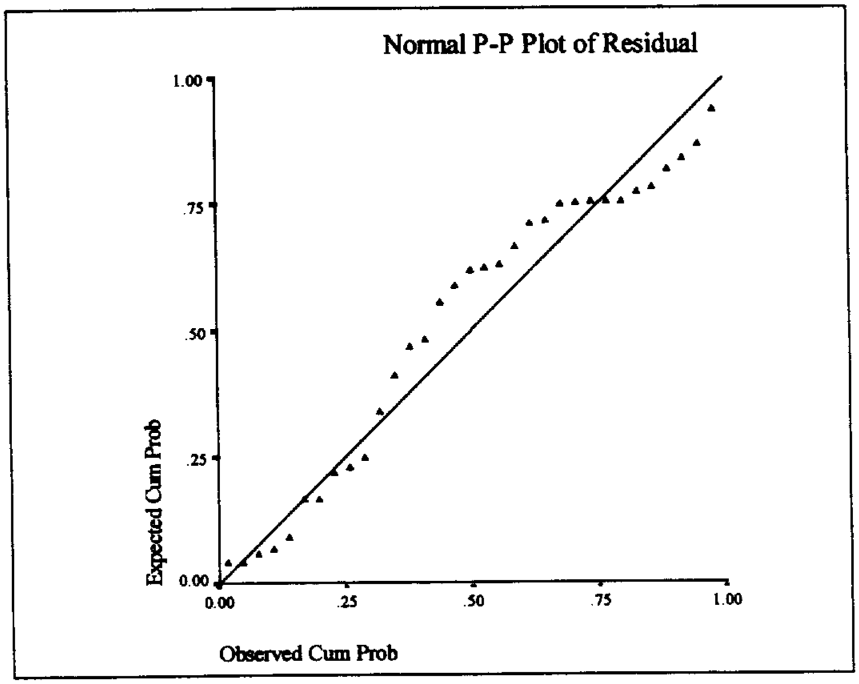




Fig. 6.3.1. Exploratory Plots of Ln (Brown Shrimp Harvest) Standardized Residual.

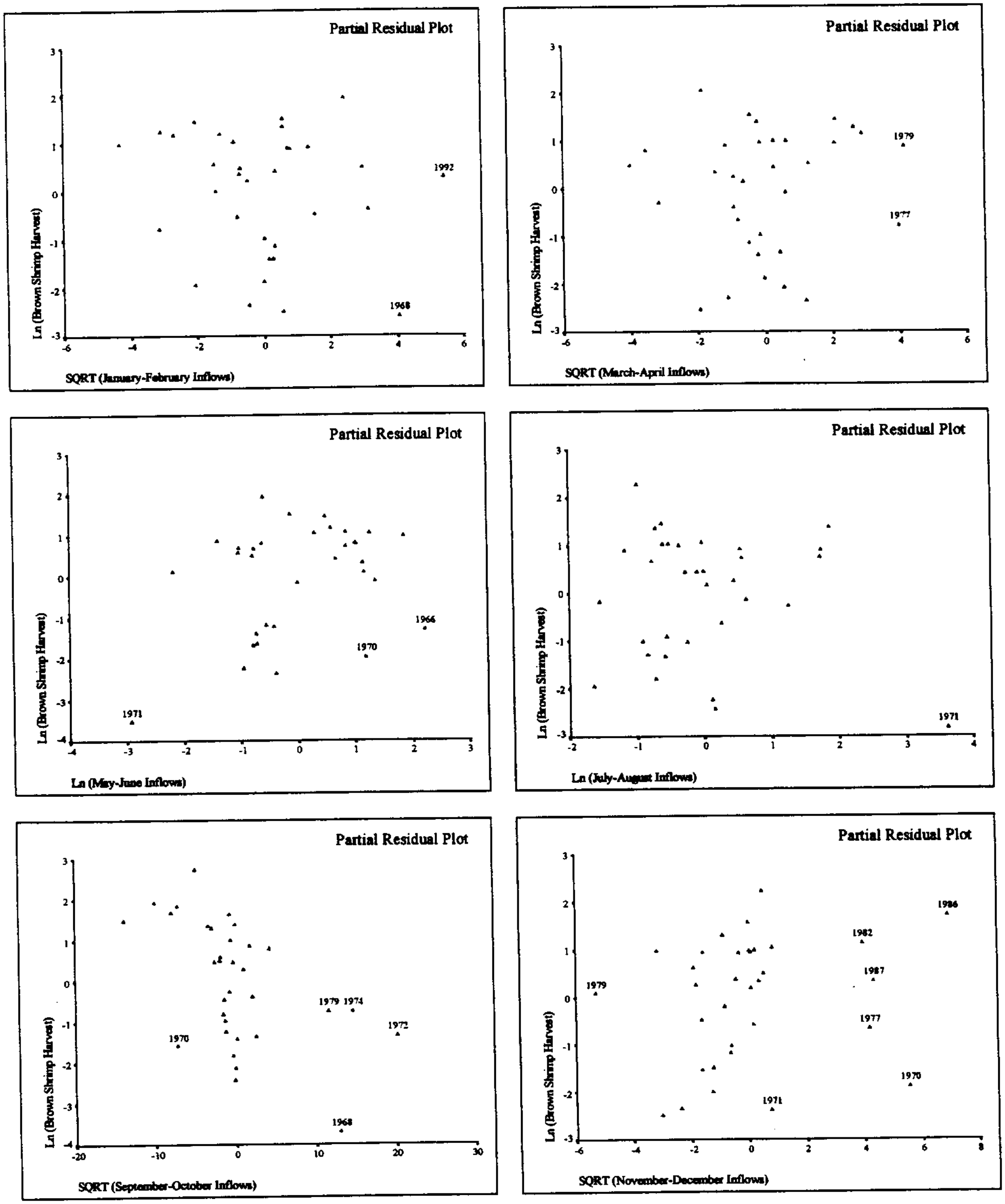



Fig. 6.3.2. Partial Residual Plots of Ln (Brown Shrimp Harvest) vs. Logged and Square Root Inflows.

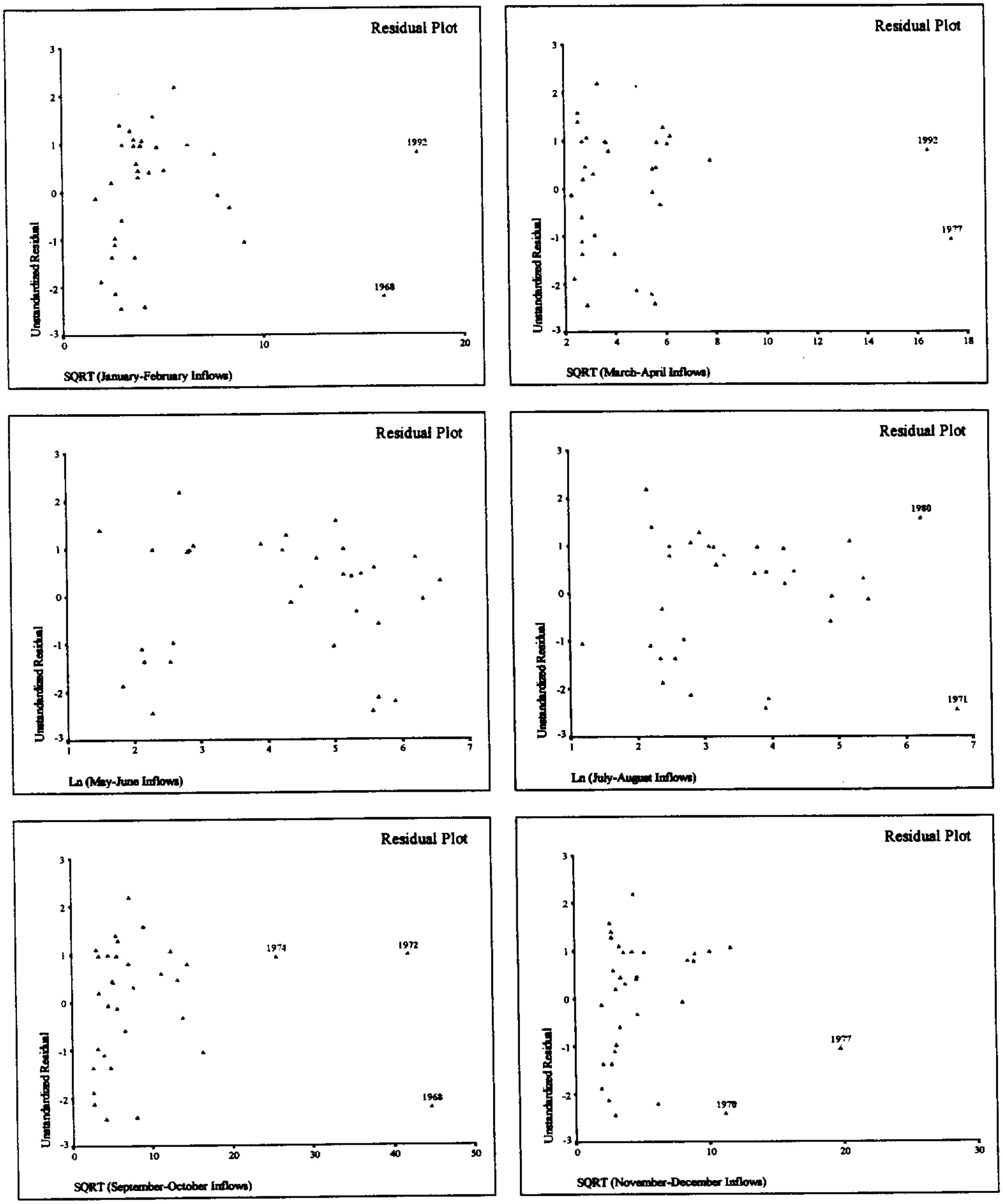



Fig. 6.3.3. Residual Plots of Ln (Brown Shrimp Harvest) vs. Logged and Square Root Inflows.

### 6.3.4 Prediction Intervals for Brown Shrimp Harvest

| YEAR | Ln (B_SH) | LICI | UICI |
|---|---|---|---|
| 1962 | 4.7493 | 1.68268 | 9.98798 |
| 1963 | 4.5581 | 1.75507 | 10.06779 |
| 1964 | 3.9589 | 1.63142 | 9.98790 |
| 1965 | 5.4241 | 1.52695 | 9.94111 |
| 1966 | 5.2327 | 3.01089 | 11.65047 |
| 1967 | 5.1446 | 2.00690 | 10.17978 |
| 1968 | -.5108 | -3.34051 | 6.69371 |
| 1969 | 4.4864 | 1.73043 | 9.94798 |
| 1970 | 4.9338 | 2.95721 | 11.67939 |
| 1971 | 2.9601 | .66942 | 10.07867 |
| 1972 | 3.9474 | -1.79840 | 7.70361 |
| 1973 | 5.9819 | 2.40759 | 10.71545 |
| 1974 | 5.0113 | -.47490 | 8.57623 |
| 1975 | 6.1796 | 1.61264 | 9.80453 |
| 1976 | 5.9844 | 1.92483 | 10.25813 |
| 1977 | 6.6048 | 2.53280 | 12.74402 |
| 1978 | 6.8136 | 2.54151 | 10.67058 |
| 1979 | 7.0619 | 1.97066 | 10.92694 |
| 1980 | 7.2923 | 1.44703 | 9.95343 |
| 1981 | 7.0473 | 2.45681 | 10.98979 |
| 1982 | 6.5627 | 1.42606 | 10.10376 |
| 1983 | 7.0347 | 1.96787 | 10.11501 |
| 1984 | 7.7804 | 1.40017 | 9.76633 |
| 1985 | 7.2472 | 2.69744 | 10.88594 |
| 1986 | 6.9017 | 1.32672 | 10.31666 |
| 1987 | 7.1776 | 2.81110 | 11.65189 |
| 1988 | 6.8895 | 1.76942 | 10.01946 |
| 1989 | 6.7969 | 1.16498 | 9.58697 |
| 1990 | 7.5892 | 2.23518 | 10.72002 |
| 1991 | 7.7896 | 2.33349 | 10.63461 |
| 1992 | 7.8003 | 1.87147 | 12.08149 |
| 1993 | 7.3305 | 2.83178 | 10.95863 |
| 1994 | 7.6048 | 2.59736 | 10.65123 |

**Ln (B_SH)** Logged brown shrimp harvest
**LICI** Lower limit for 99% prediction interval for brown shrimp harvest
**UICI** Upper limit for 99% prediction interval for brown shrimp harvest

### 6.3.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| **1962** | 2.64276 | .01204 | .08259 | .9160 | .0000 |
| **1963** | 2.70643 | .01912 | .08458 | .9108 | .0000 |
| **1964** | 3.08306 | .04049 | .09635 | .8772 | .0001 |
| **1965** | 3.58250 | .00132 | .11195 | .8264 | .0000 |
| **1966** | 5.56720 | .10109 | .17398 | .5911 | .0022 |
| **1967** | 1.51621 | .00585 | .04738 | .9817 | .0000 |
| **1968** | 19.01304 | 1.50818 | **.59416** | .0081 | **.7917** |
| **1969** | 1.89422 | .01406 | .05919 | .9655 | .0000 |
| **1970** | 6.30760 | .15422 | .19711 | .5043 | .0081 |
| **1971** | 12.73928 | .54390 | .39810 | .0787 | .2067 |
| **1972** | 13.64497 | .10900 | .42641 | .0579 | .0028 |
| **1973** | 2.66472 | .00346 | .08327 | .9142 | .0000 |
| **1974** | 9.32605 | .04594 | .29144 | .2301 | .0002 |
| **1975** | 1.67684 | .00155 | .05240 | .9755 | .0000 |
| **1976** | 2.88326 | .00013 | .09010 | .8956 | .0000 |
| **1977** | 20.86309 | .51404 | **.65197** | **.0040** | .1844 |
| **1978** | 1.14750 | .00023 | .03586 | .9921 | .0000 |
| **1979** | 8.44422 | .01580 | .26388 | .2951 | .0000 |
| **1980** | 4.38821 | .04359 | .13713 | .7341 | .0001 |
| **1981** | 4.62201 | .00192 | .14444 | .7060 | .0000 |
| **1982** | 5.90797 | .01580 | .18462 | .5505 | .0000 |
| **1983** | 1.29929 | .00577 | .04060 | .9885 | .0000 |
| **1984** | 3.16661 | .05859 | .09896 | .8692 | .0004 |
| **1985** | 1.64816 | .00143 | .05151 | .9767 | .0000 |
| **1986** | 8.75613 | .05209 | .27363 | .2706 | .0003 |
| **1987** | 7.38316 | .00010 | .23072 | .3901 | .0000 |
| **1988** | 2.17050 | .00850 | .06783 | .9498 | .0000 |
| **1989** | 3.65055 | .02835 | .11408 | .8190 | .0000 |
| **1990** | 4.19909 | .02021 | .13122 | .7566 | .0000 |
| **1991** | 2.60689 | .01719 | .08147 | .9188 | .0000 |
| **1992** | 20.85040 | .32550 | **.65158** | .0040 | .0646 |
| **1993** | 1.12889 | .00101 | .03528 | .9925 | .0000 |
| **1994** | .51921 | .00350 | .01623 | .9994 | .0000 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1962** | -.28843 | -.27108 | -.02419 | .03841 | .09502 | .12557 | .02904 | .03783 |
| **1963** | -.36605 | -.33876 | -.02546 | .02121 | .11843 | .14634 | .03399 | .09338 |
| **1964** | -.54282 | -.49550 | .00016 | .00379 | .22087 | .17580 | .01393 | .13349 |
| **1965** | -.09445 | -.03280 | -.03270 | .02137 | -.04459 | .06261 | .00477 | .02810 |
| **1966** | -.87239 | -.22099 | .33793 | -.09836 | -.65218 | .51452 | -.00073 | .31973 |
| **1967** | -.20034 | -.17251 | -.00172 | .00970 | .06134 | .06417 | .02726 | .02975 |
| **1968** | **-3.66482** | .31545 | **-1.58797** | .47954 | .27631 | -.09415 | **-1.56164** | .97606 |
| **1969** | -.31378 | -.26486 | -.01574 | -.04349 | .12497 | .09707 | -.00517 | .11830 |
| **1970** | **-1.09930** | .31751 | .08576 | .41809 | -.41393 | -.05791 | .43326 | -.89159 |
| **1971** | **-2.13303** | .53280 | -.15745 | -.36788 | **1.45303** | **-1.91136** | .01264 | -.16771 |
| **1972** | .87189 | -.02202 | -.33549 | .03188 | .11526 | -.10656 | .67594 | .00221 |
| **1973** | -.15309 | .04006 | .02984 | .03454 | -.09441 | -.01992 | .01718 | -.00579 |
| **1974** | .56349 | -.06309 | -.22587 | .26656 | -.32893 | .27945 | .37895 | .00612 |
| **1975** | .10245 | -.01566 | .01071 | -.04883 | .05487 | .00019 | -.00237 | .01293 |
| **1976** | -.02923 | .00683 | .01021 | -.00492 | .00001 | -.01725 | -.00459 | .00486 |
| **1977** | **-1.92308** | .28728 | .61439 | -.86274 | .14817 | .09226 | -.15020 | -.67819 |
| **1978** | .03958 | .00388 | -.00602 | -.00904 | .01573 | .00146 | -.01049 | .00089 |
| **1979** | .32782 | .01372 | -.22099 | .23319 | .11682 | -.07435 | .18269 | -.22265 |
| **1980** | .55816 | -.26286 | .06881 | -.05265 | -.02517 | .41486 | -.02264 | .00032 |
| **1981** | .11372 | -.04946 | -.01626 | -.02368 | .07723 | .02015 | -.01366 | .00670 |
| **1982** | .32868 | .07216 | .17982 | -.26447 | .09241 | -.13468 | -.14593 | .19505 |
| **1983** | .19909 | .07772 | .04686 | -.00940 | -.11831 | .06675 | -.05638 | .01231 |
| **1984** | .66425 | .51035 | .38024 | -.31938 | -.16751 | -.29440 | -.23429 | .06447 |
| **1985** | .09842 | -.00393 | -.04295 | .04162 | .04459 | -.00493 | .00981 | -.04324 |
| **1986** | .60186 | .09790 | .12799 | -.35870 | -.10353 | -.00406 | -.20102 | .52874 |
| **1987** | -.02578 | .01024 | -.01343 | .01475 | -.00875 | -.00522 | .01813 | -.01528 |
| **1988** | .24180 | .20051 | .05334 | -.08254 | -.08908 | -.07502 | -.06652 | .04527 |
| **1989** | .44703 | .39628 | .05904 | -.02335 | -.25005 | -.11644 | .00338 | -.07277 |
| **1990** | .37415 | -.09839 | -.10040 | .22953 | -.14516 | .26418 | .04534 | -.10105 |
| **1991** | .34656 | .12787 | -.17951 | .20378 | .07721 | -.11844 | .11468 | -.22891 |
| **1992** | **1.51139** | -.30408 | .84026 | .35524 | -.21991 | .17134 | -.47550 | -.24138 |
| **1993** | .08273 | -.00336 | -.01903 | .00755 | .05057 | -.01418 | -.01516 | -.01004 |
| **1994** | .15506 | .05246 | -.05388 | .04271 | .03286 | -.04157 | -.00896 | -.01640 |

**SDFFITS** Standardized dffits value
**SDFB_0** Standardized dfbeta for the intercept term
**SDFB_1** Standardized dfbeta for the Square root January-February inflows
**SDFB_2** Standardized dfbeta for the Square root March-April inflows
**SDFB_3** Standardized dfbeta for the logged May-June inflows
**SDFB_4** Standardized dfbeta for the logged July-August inflows
**SDFB_5** Standardized dfbeta for the Square root September-October inflows
**SDFB_6** Standardized dfbeta for the Square root November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

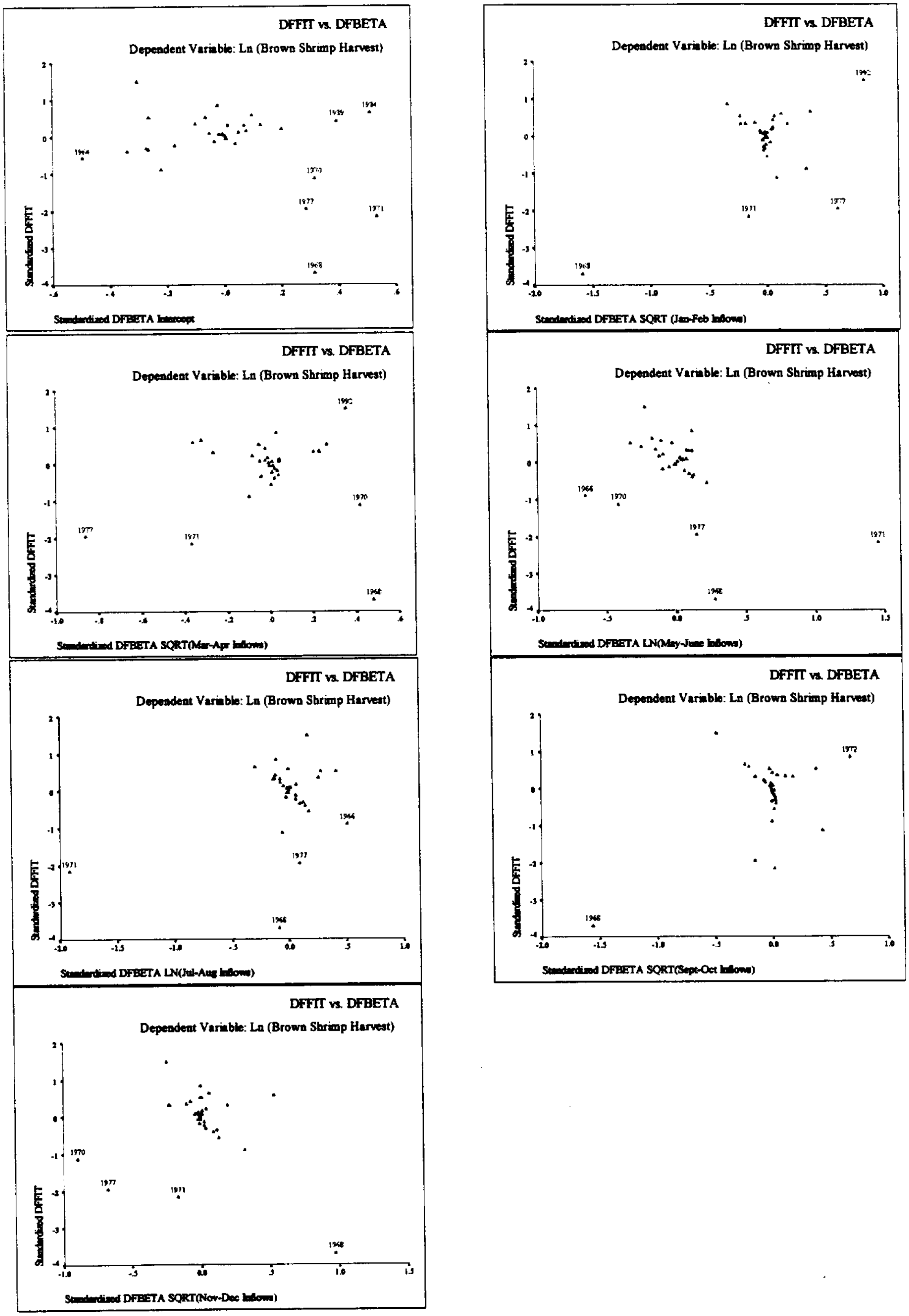



Fig. 6.3.4. Standardized DFFIT vs. Standardized DFBETA.

## 6.4 Model 7: Harvest Untransformed and Logged and Square Root Inflows

### 6.4.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | SQRT (Nov-Dec Inflows), Ln (May-Jun Inflows), SQRT (Sept-Oct Inflows), Ln (Jul-Aug Inflows), SQRT (Jan-Feb Inflows), SQRT (Mar-Apr Inflows)[c,d] | . | .543 | .295 | .133 | 715.4483 | .804 |

a. Dependent Variable: Brown Shrimp Harvest

b. Method: Enter

c. Independent Variables: (Constant), SQRT (November-December Inflows), Ln (May-June Inflows), SQRT (September-October Inflows), Ln (July-August Inflows), SQRT (January-February Inflows), SQRT (March-April Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 5574384 | 6 | 929064 | 1.815 | .135[b] |
| | Residual | 1.3E+07 | 26 | 511866 | | |
| | Total | 1.9E+07 | 32 | | | |

a. Dependent Variable: Brown Shrimp Harvest

b. Independent Variables: (Constant), SQRT (November-December Inflows), Ln (May-June Inflows), SQRT (September-October Inflows), Ln (July-August Inflows), SQRT (January-February Inflows), SQRT (March-April Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| 1 | (Constant) | 395.444 | 494.374 | | .800 | .431 | -620.757 | 1411.645 |
| | SQRT (January-February Inflows) | 53.891 | 60.622 | .251 | .889 | .382 | -70.719 | 178.502 |
| | SQRT (March-April Inflows) | 63.330 | 66.647 | .284 | .950 | .351 | -73.665 | 200.325 |
| | Ln (May-June Inflows) | 55.065 | 108.759 | .109 | .506 | .617 | -168.492 | 278.623 |
| | Ln (July-August Inflows) | 31.963 | 116.063 | .054 | .275 | .785 | -206.607 | 270.534 |
| | SQRT (September-October Inflows) | -33.647 | 18.553 | -.438 | -1.814 | .081 | -71.783 | 4.490 |
| | SQRT (November-December Inflows) | -26.438 | 49.864 | -.131 | -.530 | .600 | -128.935 | 76.059 |

a. Dependent Variable: Brown Shrimp Harvest

### 6.4.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 395.444267 | 494.37433037 | 0.800 | 0.4310 | 0.00000000 |
| SQRT_QJF | 1 | 53.891379 | 60.62215425 | 0.889 | 0.3822 | 2.94768282 |
| SQRT_QMA | 1 | 63.330220 | 66.64719364 | 0.950 | 0.3507 | 3.28828633 |
| LN_QMJ | 1 | 55.065473 | 108.75907151 | 0.506 | 0.6169 | 1.71823913 |
| LN_QJA | 1 | 31.963337 | 116.06277867 | 0.275 | 0.7852 | 1.42420771 |
| SQRT_QSO | 1 | -33.646974 | 18.55311654 | -1.814 | 0.0813 | 2.15314751 |
| SQRT_QND | 1 | -26.437863 | 49.86410125 | -0.530 | 0.6005 | 2.25274215 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop SQRT_QJF | Var Prop SQRT_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop SQRT_QSO | Var Prop SQRT_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.77765 | 1.00000 | 0.0327 | 0.0250 | 0.0267 | 0.0033 | 0.0237 | 0.0355 |
| 2 | 1.34347 | 1.43789 | 0.0017 | 0.0062 | 0.1293 | 0.3136 | 0.0041 | 0.0184 |
| 3 | 0.86520 | 1.79177 | 0.0004 | 0.1003 | 0.0420 | 0.0014 | 0.3477 | 0.0009 |
| 4 | 0.49353 | 2.37236 | 0.2120 | 0.0001 | 0.0031 | 0.1524 | 0.0006 | 0.5226 |
| 5 | 0.37354 | 2.72690 | 0.1359 | 0.0540 | 0.7891 | 0.5186 | 0.0019 | 0.0002 |
| 6 | 0.14661 | 4.35269 | 0.6174 | 0.8144 | 0.0098 | 0.0108 | 0.6219 | 0.4225 |

### 6.4.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | -329.2586 | 2376.166 | 854.4818 | 417.3721 | 33 |
| Std. Predicted Value | -2.836 | 3.646 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | 154.3251 | 590.9597 | 307.6761 | 119.7828 | 33 |
| Adjusted Predicted Value | -649.5886 | 2274.280 | 905.4400 | 517.0982 | 33 |
| Residual | -901.3826 | 1623.401 | -3.E-14 | 644.8964 | 33 |
| Std. Residual | -1.260 | 2.269 | .000 | .901 | 33 |
| Stud. Residual | -1.549 | 2.432 | -.026 | 1.007 | 33 |
| Deleted Residual | -1535.68 | 1864.391 | -50.9582 | 833.6316 | 33 |
| Stud. Deleted Residual | -1.594 | 2.713 | -.015 | 1.044 | 33 |
| Mahal. Distance | .519 | 20.863 | 5.818 | 5.643 | 33 |
| Cook's Distance | .000 | .449 | .048 | .092 | 33 |
| Centered Leverage Value | .016 | .652 | .182 | .176 | 33 |

a. Dependent Variable: Brown Shrimp Harvest

*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 682.82184 | -567.32184 | -639.51631 | 755.01631 | -.41129 | -.79296 | -.84190 | -.83704 |
| 1963 | 747.61884 | -652.21884 | -736.86964 | 832.26964 | -.25604 | -.91162 | -.96898 | -.96780 |
| 1964 | 684.22421 | -631.82421 | -723.44783 | 775.84783 | -.40793 | -.88312 | -.94498 | -.94297 |
| 1965 | 998.36382 | -771.56382 | -899.52693 | 1126.42693 | .34473 | -1.07843 | -1.16443 | -1.17281 |
| 1966 | 1088.6825 | -901.38258 | -1132.78586 | 1320.08586 | .56113 | -1.25988 | -1.41238 | -1.44134 |
| 1967 | 779.84639 | -608.34639 | -659.58612 | 831.08612 | -.17882 | -.85030 | -.88539 | -.88158 |
| 1968 | 387.37120 | -386.77120 | -1029.90866 | 1030.50866 | -1.11917 | -.54060 | -.88216 | -.87827 |
| 1969 | 831.96679 | -743.16679 | -816.21609 | 905.01609 | -.05394 | -1.03874 | -1.08860 | -1.09265 |
| 1970 | 835.16919 | -696.26919 | -901.22070 | 1040.12070 | -.04627 | -.97319 | -1.10720 | -1.11224 |
| 1971 | 856.92189 | -837.62189 | -1465.41273 | 1484.71273 | .00585 | -1.17077 | -1.54855 | -1.59375 |
| 1972 | -329.25863 | 381.05863 | 701.38863 | -649.58863 | -2.83618 | .53262 | .72260 | .71579 |
| 1973 | 880.66034 | -484.46034 | -546.53313 | 942.73313 | .06272 | -.67714 | -.71922 | -.71237 |
| 1974 | 233.03200 | -82.93200 | -122.27206 | 272.37206 | -1.48896 | -.11592 | -.14075 | -.13807 |
| 1975 | 717.66497 | -234.86497 | -256.04064 | 738.84064 | -.32781 | -.32828 | -.34276 | -.33686 |
| 1976 | 799.85895 | -402.65895 | -457.77764 | 854.97764 | -.13087 | -.56281 | -.60009 | -.59256 |
| 1977 | 1226.5248 | -487.92481 | -1535.68007 | 2274.28007 | .89139 | -.68198 | -1.20990 | -1.22128 |
| 1978 | 891.32793 | 18.77207 | 20.10206 | 889.99794 | .08828 | .02624 | .02715 | .02662 |
| 1979 | 1045.3963 | 121.30367 | 171.86321 | 994.83679 | .45742 | .16955 | .20181 | .19805 |
| 1980 | 907.05632 | 561.94368 | 674.95449 | 794.04551 | .12597 | .78544 | .86081 | .85638 |
| 1981 | 974.85632 | 174.84368 | 211.86518 | 937.83482 | .28841 | .24438 | .26901 | .26416 |
| 1982 | 666.91659 | 41.28341 | 52.58545 | 655.61455 | -.44940 | .05770 | .06512 | .06386 |
| 1983 | 887.78923 | 247.61077 | 266.50770 | 868.89230 | .07980 | .34609 | .35906 | .35296 |
| 1984 | 769.89900 | 1623.4010 | 1864.39134 | 528.90866 | -.20266 | 2.26907 | 2.43166 | 2.71279 |
| 1985 | 1109.4148 | 294.68515 | 320.94072 | 1083.15928 | .61081 | .41189 | .42985 | .42300 |
| 1986 | 320.64511 | 673.35489 | 967.36956 | 26.63044 | -1.27904 | .94116 | 1.12808 | 1.13428 |
| 1987 | 1299.2393 | 10.56072 | 14.29108 | 1295.50892 | 1.06561 | .01476 | .01717 | .01684 |
| 1988 | 665.60152 | 316.29848 | 350.71446 | 631.18554 | -.45255 | .44210 | .46553 | .45840 |
| 1989 | 608.50827 | 286.59173 | 334.95315 | 560.14685 | -.58934 | .40058 | .43306 | .42619 |
| 1990 | 1172.5489 | 804.25102 | 959.18251 | 1017.61749 | .76207 | 1.12412 | 1.22763 | 1.24027 |
| 1991 | 1014.9724 | 1400.3276 | 1576.53414 | 838.76586 | .38453 | 1.95727 | 2.07677 | 2.22976 |
| 1992 | 2376.1655 | 65.13442 | 204.74673 | 2236.55327 | 3.64587 | .09104 | .16141 | .15836 |
| 1993 | 1093.8037 | 432.29623 | 462.63637 | 1063.46363 | .57340 | .60423 | .62508 | .61759 |
| 1994 | 972.28933 | 1035.6107 | 1086.14722 | 921.75278 | .28226 | 1.44750 | 1.48240 | 1.51923 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.

[2] This is flagged if it exceeds $t_{n-p-2,\alpha} = t_{25,0.01} = 2.485$

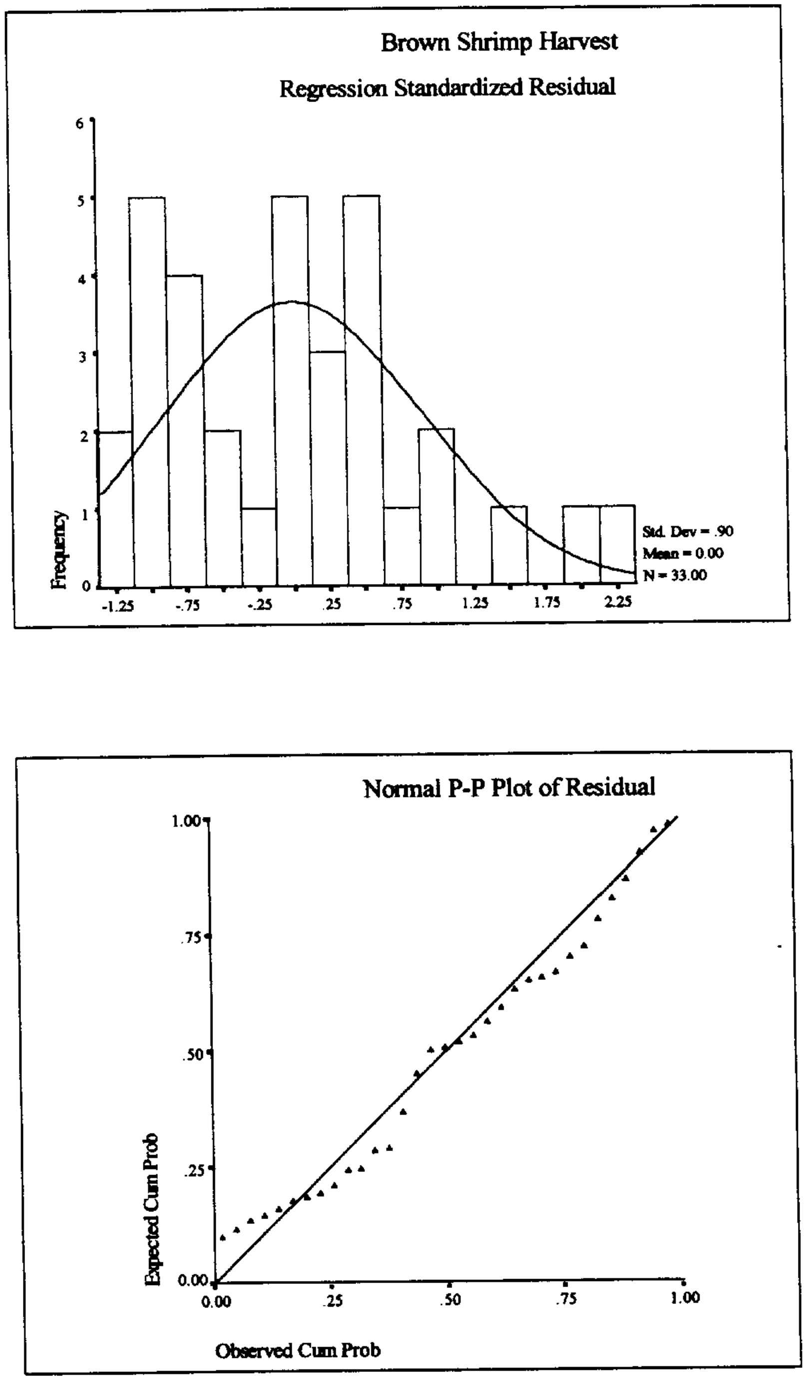



Fig. 6.4.1. Exploratory Plots of Brown Shrimp Harvest Standardized Residual.

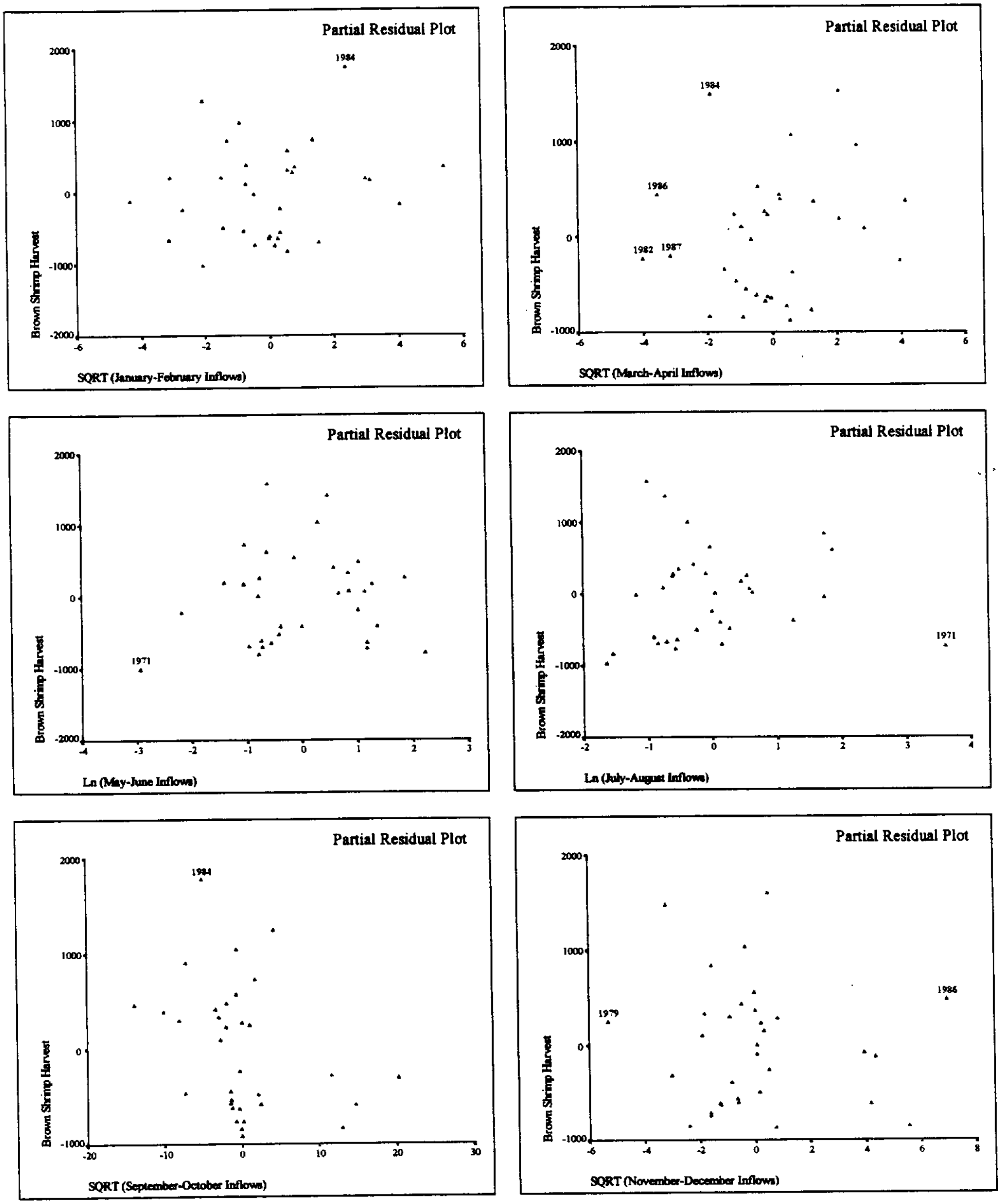



Fig. 6.4.2. Partial Residual Plots of Brown Shrimp Harvest vs. Logged and Square Root Inflows.

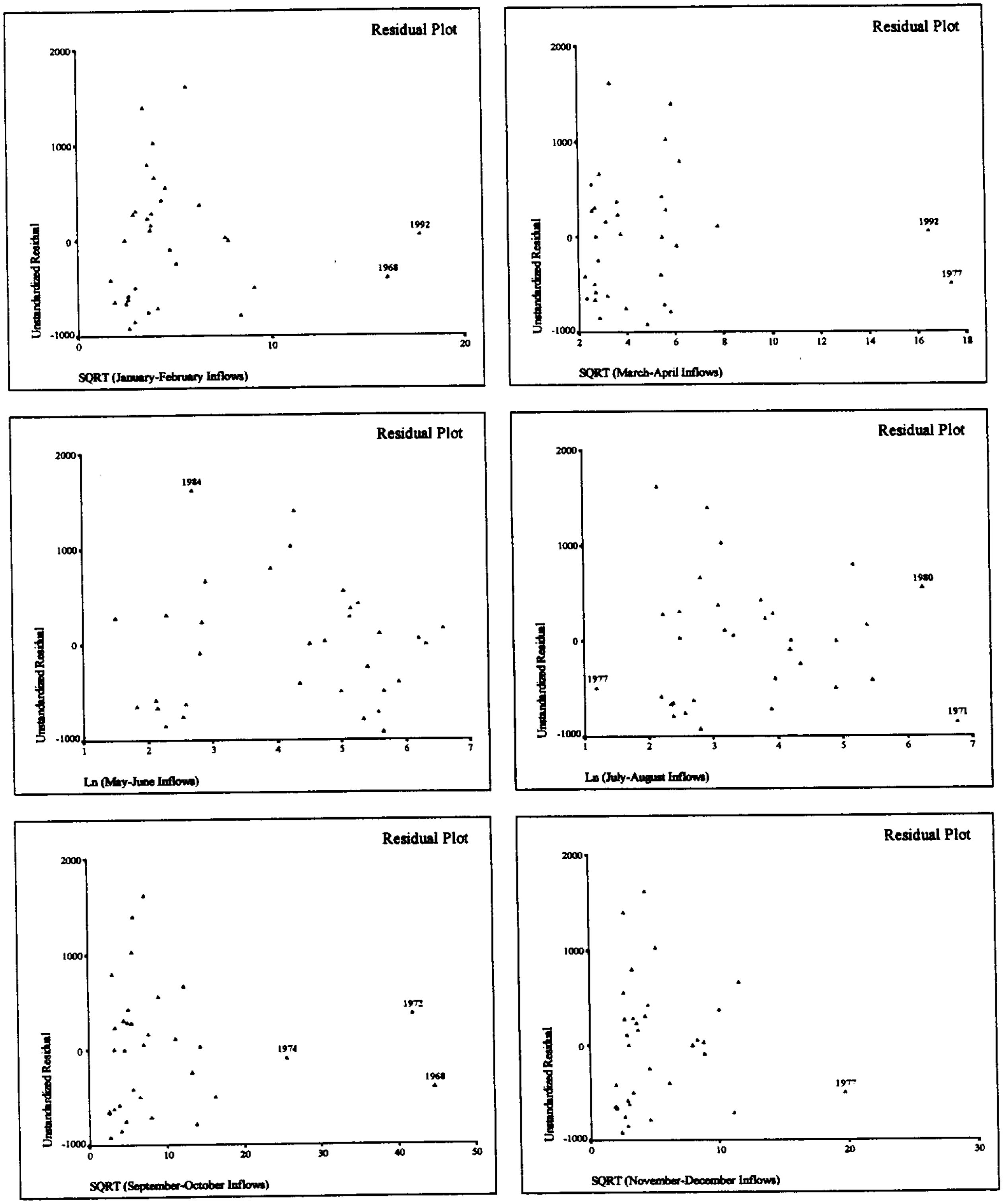



Fig. 6.4.3. Residual Plots of Brown Shrimp Harvest vs. Logged and Square Root Inflows.

### 6.4.4 Prediction Intervals for Brown Shrimp Harvest

| YEAR | B_SH | LICI | UICI |
|---|---|---|---|
| 1962 | 115.50 | -1414.41833 | 2780.06200 |
| 1963 | 95.40 | -1351.49534 | 2846.73301 |
| 1964 | 52.40 | -1425.94091 | 2794.38932 |
| 1965 | 226.80 | -1126.46707 | 3123.09471 |
| 1966 | 187.30 | -1092.97000 | 3270.33516 |
| 1967 | 171.50 | -1283.95575 | 2843.64853 |
| 1968 | .60 | -2146.45492 | 2921.19731 |
| 1969 | 88.80 | -1243.11550 | 2907.04909 |
| 1970 | 138.90 | -1367.34137 | 3037.67975 |
| 1971 | 19.30 | -1519.08644 | 3232.93022 |
| 1972 | 51.80 | -2728.69094 | 2070.17367 |
| 1973 | 396.20 | -1217.22643 | 2978.54711 |
| 1974 | 150.10 | -2052.54345 | 2518.60745 |
| 1975 | 482.80 | -1350.93802 | 2786.26796 |
| 1976 | 397.20 | -1304.45101 | 2904.16892 |
| 1977 | 738.60 | -1351.99594 | 3805.04555 |
| 1978 | 910.10 | -1161.41165 | 2944.06752 |
| 1979 | 1166.70 | -1216.22737 | 3307.02003 |
| 1980 | 1469.00 | -1240.96460 | 3055.07724 |
| 1981 | 1149.70 | -1179.87558 | 3129.58822 |
| 1982 | 708.20 | -1524.36062 | 2858.19380 |
| 1983 | 1135.40 | -1169.51177 | 2945.09023 |
| 1984 | 2393.30 | -1342.70981 | 2882.50781 |
| 1985 | 1404.10 | -958.33183 | 3177.16154 |
| 1986 | 994.00 | -1949.47950 | 2590.76972 |
| 1987 | 1309.80 | -933.22416 | 3531.70271 |
| 1988 | 981.90 | -1417.68640 | 2748.88944 |
| 1989 | 895.10 | -1518.19958 | 2735.21612 |
| 1990 | 1976.80 | -970.02781 | 3315.12577 |
| 1991 | 2415.30 | -1081.21135 | 3111.15615 |
| 1992 | 2441.30 | -202.05140 | 4954.38257 |
| 1993 | 1526.10 | -958.37616 | 3145.98371 |
| 1994 | 2007.90 | -1061.46124 | 3006.03990 |

**B_SH** Brown shrimp harvest
**LICI** Lower limit for 99% prediction interval for brown shrimp harvest
**UICI** Upper limit for 99% prediction interval for brown shrimp harvest

### 6.4.5 Outlier and Influential Point Detection

*Calculated Quantities*

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| **1962** | 2.64276 | .01289 | .08259 | .9160 | .0000 |
| **1963** | 2.70643 | .01741 | .08458 | .9108 | .0000 |
| **1964** | 3.08306 | .01850 | .09635 | .8772 | .0000 |
| **1965** | 3.58250 | .03213 | .11195 | .8264 | .0000 |
| **1966** | 5.56720 | .07316 | .17398 | .5911 | .0007 |
| **1967** | 1.51621 | .00943 | .04738 | .9817 | .0000 |
| **1968** | 19.01304 | .18486 | **.59416** | .0081 | .0133 |
| **1969** | 1.89422 | .01664 | .05919 | .9655 | .0000 |
| **1970** | 6.40760 | .05155 | .19711 | .5043 | .0002 |
| **1971** | 12.73928 | .25676 | .39810 | .0787 | .0338 |
| **1972** | 13.64497 | .06270 | .42641 | .0579 | .0004 |
| **1973** | 2.66472 | .00947 | .08327 | .9142 | .0000 |
| **1974** | 9.32605 | .00134 | .29144 | .2301 | .0000 |
| **1975** | 1.67684 | .00151 | .05240 | .9755 | .0000 |
| **1976** | 2.88326 | .00704 | .09010 | .8956 | .0000 |
| **1977** | 20.86309 | .44906 | **.65197** | **.0040** | .1364 |
| **1978** | 1.14750 | .00001 | .03586 | .9921 | .0000 |
| **1979** | 8.44422 | .00243 | .26388 | .2951 | .0000 |
| **1980** | 4.38821 | .02129 | .13713 | .7341 | .0000 |
| **1981** | 4.62201 | .00219 | .14444 | .7060 | .0000 |
| **1982** | 5.90797 | .00017 | .18462 | .5505 | .0000 |
| **1983** | 1.29929 | .00141 | .04060 | .9885 | .0000 |
| **1984** | 3.16661 | .12540 | .09896 | .8692 | .0041 |
| **1985** | 1.64816 | .00235 | .05151 | .9767 | .0000 |
| **1986** | 8.75613 | .07938 | .27363 | .2706 | .0010 |
| **1987** | 7.38316 | .00001 | .23072 | .3901 | .0000 |
| **1988** | 2.17050 | .00337 | .06783 | .9498 | .0000 |
| **1989** | 3.65055 | .00452 | .11408 | .8190 | .0000 |
| **1990** | 4.19909 | .04147 | .13122 | .7566 | .0001 |
| **1991** | 2.60689 | .07753 | .08147 | .9188 | .0009 |
| **1992** | 20.85040 | .00798 | **.65158** | **.0040** | .0000 |
| **1993** | 1.12889 | .00392 | .03528 | .9925 | .0000 |
| **1994** | .51921 | .01532 | .01623 | .9994 | .0000 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| 1962 | -.29860 | -.28064 | -.02504 | .03976 | .09837 | .13000 | .03006 | .03916 |
| 1963 | -.34866 | -.32266 | -.02425 | .02020 | .11281 | .13939 | .03237 | .08894 |
| 1964 | -.35909 | -.32779 | .00011 | .00251 | .14611 | .11630 | .00921 | .08831 |
| 1965 | -.47762 | -.16589 | -.16536 | .10808 | -.22552 | .31663 | .02411 | .14211 |
| 1966 | -.73029 | -.18500 | .28289 | -.08234 | -.54595 | .43072 | -.00061 | .26765 |
| 1967 | -.25585 | -.22031 | -.00220 | .01239 | .07833 | .08195 | .03481 | .03799 |
| 1968 | **-1.13254** | .09748 | -.49073 | .14819 | .08539 | -.02910 | -.48260 | .30163 |
| 1969 | -.34257 | -.28916 | -.01718 | -.04748 | .13643 | .10598 | -.00564 | .12915 |
| 1970 | -.60344 | .17429 | .04707 | .22951 | -.22722 | -.03179 | .23783 | -.48942 |
| 1971 | **-1.37976** | .34465 | -.10184 | -.23797 | .93990 | **-1.23638** | .00818 | -.10849 |
| 1972 | .65628 | -.01657 | -.25253 | .02400 | .08676 | -.08021 | .50879 | .00166 |
| 1973 | -.25499 | .06672 | .04970 | .05753 | -.15725 | -.03318 | .02862 | -.00964 |
| 1974 | -.09509 | .01065 | .03812 | -.04498 | .05551 | -.04716 | -.06395 | -.00103 |
| 1975 | -.10115 | .01546 | -.01057 | .04821 | -.05417 | -.00019 | .00233 | -.01277 |
| 1976 | -.21924 | .05122 | .07661 | -.03688 | .00007 | -.12940 | -.03443 | .03645 |
| 1977 | **-1.78965** | .26735 | .57176 | -.80288 | .13789 | .08586 | -.13978 | -.63114 |
| 1978 | .00709 | .00069 | -.00108 | -.00162 | .00282 | .00026 | -.00188 | .00016 |
| 1979 | .12786 | .00535 | -.08620 | .09095 | .04557 | -.02900 | .07126 | -.08684 |
| 1980 | .38404 | -.18086 | .04735 | -.03622 | -.01732 | .28545 | -.01558 | .00022 |
| 1981 | .12155 | -.05287 | -.01738 | -.02531 | .08254 | .02154 | -.01460 | .00716 |
| 1982 | .03342 | .00734 | .01828 | -.02689 | .00940 | -.01369 | -.01484 | .01983 |
| 1983 | .09751 | .03807 | .02295 | -.00460 | -.05794 | .03269 | -.02761 | .00603 |
| 1984 | **1.04521** | .80305 | .59832 | -.50255 | -.26358 | -.46324 | -.36866 | .10145 |
| 1985 | .12626 | -.00505 | -.05510 | .05339 | .05720 | -.00632 | .01258 | -.05547 |
| 1986 | .74952 | .12192 | .15939 | -.44670 | -.12892 | -.00505 | -.25033 | .65846 |
| 1987 | .01001 | -.00398 | .00521 | -.00572 | .00340 | .00202 | -.00704 | .00593 |
| 1988 | .15121 | .12539 | .03335 | -.05162 | -.05571 | -.04692 | -.04160 | .02831 |
| 1989 | .17507 | .15520 | .02312 | -.00914 | -.09793 | -.04560 | .00132 | -.02850 |
| 1990 | .54437 | -.14315 | -.14608 | .33395 | -.21120 | .38437 | .06597 | -.14702 |
| 1991 | .79096 | .29185 | -.40969 | .46510 | .17623 | -.27031 | .26173 | -.52244 |
| 1992 | .23184 | -.04665 | .12889 | .05449 | -.03373 | .02628 | -.07294 | -.03703 |
| 1993 | .16361 | -.00664 | -.03762 | .01494 | .10002 | -.02804 | -.02998 | -.01986 |
| 1994 | .33560 | .11355 | -.11661 | .09245 | .07111 | -.08997 | -.01938 | -.03549 |

**SDFFITS** Standardized dffits value

**SDFB_0** Standardized dfbeta for the intercept term

**SDFB_1** Standardized dfbeta for the Square root January-February inflows

**SDFB_2** Standardized dfbeta for the Square root March-April inflows

**SDFB_3** Standardized dfbeta for the logged May-June inflows

**SDFB_4** Standardized dfbeta for the logged July-August inflows

**SDFB_5** Standardized dfbeta for the Square root September-October inflows

**SDFB_6** Standardized dfbeta for the Square root November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

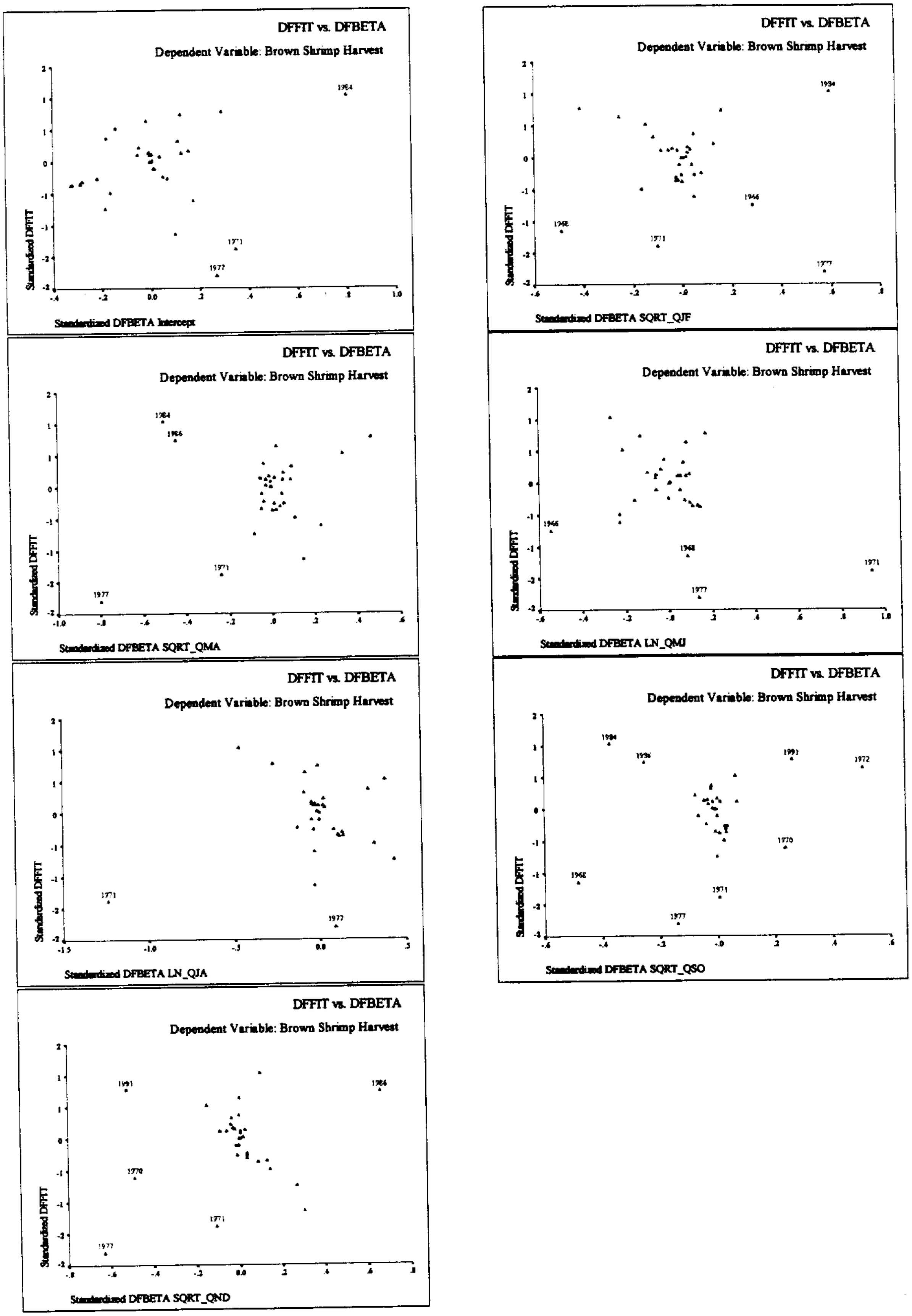



Fig. 6.4.4. Standardized DFFIT vs. Standardized DFBETA.

# 7. Examining Subsets of the Data

## 7.1 Model 4: Harvest Untransformed and Square Root Inflows

### 7.1.1 Harvest Untransformed and Square Root Inflows: 1977 Omitted

N = 32 Regression Models for Dependent Variable: BROWN

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.21397 | 0.18777 | 1.210 | 421.5 | 494388 | 424.4 | SQRT_QMA |
| 1 | 0.08472 | 0.05421 | 6.013 | 426.4 | 575685 | 429.3 | SQRT_QSO |
| 1 | 0.03684 | 0.00474 | 7.792 | 428.0 | 605797 | 430.9 | SQRT_QJF |
| 1 | 0.02612 | -.00634 | 8.191 | 428.3 | 612541 | 431.3 | SQRT_QMJ |
| 2 | 0.32291 | 0.27621 | -0.838 | 418.7 | 440557 | 423.1 | SQRT_QMA SQRT_QSO |
| 2 | 0.25326 | 0.20176 | 1.750 | 421.8 | 485874 | 426.2 | SQRT_QJF SQRT_QSO |
| 2 | 0.24478 | 0.19269 | 2.065 | 422.2 | 491391 | 426.6 | SQRT_QJF SQRT_QMA |
| 2 | 0.23850 | 0.18598 | 2.298 | 422.5 | 495476 | 426.9 | SQRT_QMA SQRT_QND |
| 3 | 0.32614 | 0.25394 | 1.042 | 420.6 | 454113 | 426.4 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 3 | 0.32399 | 0.25156 | 1.121 | 420.7 | 455558 | 426.5 | SQRT_QMA SQRT_QJA SQRT_QSO |
| 3 | 0.32339 | 0.25089 | 1.144 | 420.7 | 455966 | 426.6 | SQRT_QMA SQRT_QMJ SQRT_QSO |
| 3 | 0.32313 | 0.25061 | 1.153 | 420.7 | 456140 | 426.6 | SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.32698 | 0.22728 | 3.010 | 422.5 | 470340 | 429.9 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO |
| 4 | 0.32631 | 0.22650 | 3.035 | 422.6 | 470811 | 429.9 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.32623 | 0.22641 | 3.038 | 422.6 | 470868 | 429.9 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO |
| 4 | 0.32434 | 0.22424 | 3.108 | 422.6 | 472188 | 430.0 | SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.32726 | 0.19788 | 5.000 | 424.5 | 488232 | 433.3 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.32698 | 0.19756 | 5.010 | 424.5 | 488429 | 433.3 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 5 | 0.32640 | 0.19686 | 5.032 | 424.5 | 488856 | 433.3 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.32448 | 0.19457 | 5.103 | 424.6 | 490251 | 433.4 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.32726 | 0.16580 | 7.000 | 426.5 | 507761 | 436.8 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

## 7.2 Model 5: Square Root Variables

### 7.2.1 Square Root Variables: 1968 Omitted

N = 32    Regression Models for Dependent Variable: SQRT_BSH

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.10649 | 0.07670 | 1.663 | 167.9 | 178.78 | 170.8 | SQRT_QJF |
| 1 | 0.10566 | 0.07585 | 1.690 | 167.9 | 178.94 | 170.9 | SQRT_QMA |
| 1 | 0.06949 | 0.03848 | 2.891 | 169.2 | 186.18 | 172.1 | SQRT_QMJ |
| 1 | 0.05067 | 0.01903 | 3.515 | 169.8 | 189.94 | 172.8 | SQRT_QSO |
| 2 | 0.22126 | 0.16755 | -0.148 | 165.5 | 161.19 | 169.9 | SQRT_QJF SQRT_QSO |
| 2 | 0.18384 | 0.12755 | 1.095 | 167.0 | 168.93 | 171.4 | SQRT_QMA SQRT_QSO |
| 2 | 0.15878 | 0.10076 | 1.927 | 168.0 | 174.12 | 172.4 | SQRT_QMA SQRT_QND |
| 2 | 0.14078 | 0.08152 | 2.524 | 168.6 | 177.84 | 173.0 | SQRT_QJF SQRT_QND |
| 3 | 0.23546 | 0.15354 | 1.381 | 166.9 | 163.90 | 172.8 | SQRT_QJF SQRT_QMJ SQRT_QSO |
| 3 | 0.22790 | 0.14517 | 1.632 | 167.2 | 165.52 | 173.1 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 3 | 0.22188 | 0.13851 | 1.832 | 167.5 | 166.81 | 173.3 | SQRT_QJF SQRT_QSO SQRT_QND |
| 3 | 0.22127 | 0.13784 | 1.852 | 167.5 | 166.94 | 173.4 | SQRT_QJF SQRT_QJA SQRT_QSO |
| 4 | 0.24172 | 0.12939 | 3.173 | 168.6 | 168.58 | 176.0 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO |
| 4 | 0.23690 | 0.12384 | 3.333 | 168.8 | 169.65 | 176.2 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO |
| 4 | 0.23576 | 0.12254 | 3.371 | 168.9 | 169.90 | 176.2 | SQRT_QJF SQRT_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.23370 | 0.12017 | 3.439 | 169.0 | 170.36 | 176.3 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 5 | 0.24614 | 0.10117 | 5.026 | 170.5 | 174.04 | 179.2 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.24226 | 0.09655 | 5.155 | 170.6 | 174.93 | 179.4 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 5 | 0.23746 | 0.09082 | 5.315 | 170.8 | 176.04 | 179.6 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.23372 | 0.08636 | 5.439 | 171.0 | 176.91 | 179.8 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.24693 | 0.06620 | 7.000 | 172.4 | 180.81 | 182.7 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

## 7.2.2 Square Root Variables: 1971 Omitted

N = 32 Regression Models for Dependent Variable: SQRT_BSH

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.16200 | 0.13407 | 4.785 | 166.7 | 172.46 | 169.7 | SQRT_QSO |
| 1 | 0.08065 | 0.05000 | 7.968 | 169.7 | 189.20 | 172.6 | SQRT_QMA |
| 1 | 0.04103 | 0.00906 | 9.518 | 171.1 | 197.36 | 174.0 | SQRT_QJA |
| 1 | 0.01737 | -.01538 | 10.443 | 171.8 | 202.22 | 174.8 | SQRT_QMJ |
| 2 | 0.27771 | 0.22790 | 2.258 | 164.0 | 153.77 | 168.4 | SQRT_QMA SQRT_QSO |
| 2 | 0.27217 | 0.22198 | 2.475 | 164.2 | 154.95 | 168.6 | SQRT_QJF SQRT_QSO |
| 2 | 0.21551 | 0.16141 | 4.692 | 166.6 | 167.01 | 171.0 | SQRT_QMJ SQRT_QSO |
| 2 | 0.19659 | 0.14118 | 5.432 | 167.4 | 171.04 | 171.8 | SQRT_QJA SQRT_QSO |
| 3 | 0.34524 | 0.27509 | 1.616 | 162.8 | 144.37 | 168.7 | SQRT_QMA SQRT_QJA SQRT_QSO |
| 3 | 0.31632 | 0.24307 | 2.748 | 164.2 | 150.75 | 170.1 | SQRT_QJF SQRT_QJA SQRT_QSO |
| 3 | 0.29616 | 0.22075 | 3.536 | 165.2 | 155.20 | 171.0 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 3 | 0.29259 | 0.21680 | 3.676 | 165.3 | 155.98 | 171.2 | SQRT_QMA SQRT_QMJ SQRT_QSO |
| 4 | 0.35778 | 0.26263 | 3.126 | 164.2 | 146.85 | 171.6 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO |
| 4 | 0.34550 | 0.24853 | 3.606 | 164.8 | 149.66 | 172.2 | SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.34547 | 0.24850 | 3.607 | 164.8 | 149.67 | 172.2 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 4 | 0.33245 | 0.23356 | 4.117 | 165.5 | 152.65 | 172.8 | SQRT_QJF SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.36092 | 0.23802 | 5.003 | 166.1 | 151.76 | 174.9 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 5 | 0.35785 | 0.23436 | 5.123 | 166.2 | 152.48 | 175.0 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.34577 | 0.21995 | 5.596 | 166.8 | 155.35 | 175.6 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.33352 | 0.20535 | 6.075 | 167.4 | 158.26 | 176.2 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.36099 | 0.20763 | 7.000 | 168.1 | 157.81 | 178.3 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

### 7.2.3 Square Root Variables: 1977 Omitted

N = 32 Regression Models for Dependent Variable: SQRT_BSH

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.14293 | 0.11437 | 3.382 | 169.8 | 189.51 | 172.7 | SQRT_QMA |
| 1 | 0.13406 | 0.10520 | 3.707 | 170.1 | 191.47 | 173.0 | SQRT_QSO |
| 1 | 0.03059 | -.00172 | 7.496 | 173.7 | 214.35 | 176.6 | SQRT_QMJ |
| 1 | 0.00720 | -.02590 | 8.352 | 174.5 | 219.52 | 177.4 | SQRT_QJF |
| 2 | 0.30169 | 0.25354 | -0.431 | 165.2 | 159.73 | 169.6 | SQRT_QMA SQRT_QSO |
| 2 | 0.24379 | 0.19164 | 1.689 | 167.8 | 172.97 | 172.1 | SQRT_QJF SQRT_QSO |
| 2 | 0.20770 | 0.15306 | 3.011 | 169.2 | 181.23 | 173.6 | SQRT_QMJ SQRT_QSO |
| 2 | 0.20196 | 0.14692 | 3.221 | 169.5 | 182.54 | 173.9 | SQRT_QJF SQRT_QMA |
| 3 | 0.31125 | 0.23746 | 1.219 | 166.8 | 163.17 | 172.6 | SQRT_QMA SQRT_QMJ SQRT_QSO |
| 3 | 0.30795 | 0.23381 | 1.340 | 166.9 | 163.95 | 172.8 | SQRT_QMA SQRT_QSO SQRT_QND |
| 3 | 0.30244 | 0.22770 | 1.542 | 167.2 | 165.26 | 173.0 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 3 | 0.30182 | 0.22701 | 1.564 | 167.2 | 165.40 | 173.1 | SQRT_QMA SQRT_QJA SQRT_QSO |
| 4 | 0.31713 | 0.21597 | 3.004 | 168.5 | 167.77 | 175.8 | SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.31160 | 0.20962 | 3.206 | 168.7 | 169.13 | 176.1 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 4 | 0.31128 | 0.20925 | 3.218 | 168.8 | 169.20 | 176.1 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO |
| 4 | 0.30857 | 0.20613 | 3.317 | 168.9 | 169.87 | 176.2 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 5 | 0.31722 | 0.18592 | 5.001 | 170.5 | 174.20 | 179.3 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.31715 | 0.18583 | 5.003 | 170.5 | 174.22 | 179.3 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.31164 | 0.17926 | 5.205 | 170.7 | 175.62 | 179.5 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 5 | 0.30890 | 0.17599 | 5.305 | 170.9 | 176.32 | 179.7 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.31723 | 0.15337 | 7.000 | 172.5 | 181.16 | 182.7 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

### 7.2.4 Square Root Variables: 1992 Omitted

N = 32     Regression Models for Dependent Variable: SQRT_BSH

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.13297 | 0.10407 | -0.244 | 167.2 | 174.84 | 170.1 | SQRT_QSO |
| 1 | 0.02491 | -.00759 | 3.215 | 170.9 | 196.63 | 173.9 | SQRT_QMA |
| 1 | 0.01948 | -.01320 | 3.389 | 171.1 | 197.72 | 174.0 | SQRT_QJF |
| 1 | 0.00841 | -.02464 | 3.743 | 171.5 | 199.96 | 174.4 | SQRT_QMJ |
| 2 | 0.19052 | 0.13469 | -0.0866 | 167.0 | 168.86 | 171.4 | SQRT_QMA SQRT_QSO |
| 2 | 0.17236 | 0.11528 | 0.495 | 167.7 | 172.65 | 172.1 | SQRT_QMJ SQRT_QSO |
| 2 | 0.17145 | 0.11431 | 0.524 | 167.7 | 172.84 | 172.1 | SQRT_QJF SQRT_QSO |
| 2 | 0.15417 | 0.09584 | 1.077 | 168.4 | 176.44 | 172.8 | SQRT_QSO SQRT_QND |
| 3 | 0.21418 | 0.12998 | 1.156 | 168.0 | 169.78 | 173.9 | SQRT_QMA SQRT_QMJ SQRT_QSO |
| 3 | 0.20193 | 0.11643 | 1.548 | 168.5 | 172.43 | 174.4 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 3 | 0.19084 | 0.10414 | 1.903 | 169.0 | 174.82 | 174.8 | SQRT_QMA SQRT_QSO SQRT_QND |
| 3 | 0.19065 | 0.10394 | 1.909 | 169.0 | 174.86 | 174.8 | SQRT_QMA SQRT_QJA SQRT_QSO |
| 4 | 0.21813 | 0.10229 | 3.030 | 169.9 | 175.19 | 177.2 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO |
| 4 | 0.21530 | 0.09905 | 3.120 | 170.0 | 175.82 | 177.3 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 4 | 0.21420 | 0.09778 | 3.155 | 170.0 | 176.07 | 177.4 | SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.20215 | 0.08395 | 3.541 | 170.5 | 178.76 | 177.8 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 5 | 0.21901 | 0.06882 | 5.001 | 171.8 | 181.72 | 180.6 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 5 | 0.21814 | 0.06779 | 5.029 | 171.9 | 181.92 | 180.7 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.21535 | 0.06445 | 5.119 | 172.0 | 182.57 | 180.8 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.20333 | 0.05012 | 5.503 | 172.5 | 185.37 | 181.3 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.21905 | 0.03162 | 7.000 | 173.8 | 188.98 | 184.1 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

### 7.2.5 Square Root Variables: 1968 and 1971 Omitted

N = 31    Regression Models for Dependent Variable: SQRT_BSH

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.09723 | 0.06610 | 4.790 | 161.4 | 171.39 | 164.3 | SQRT_QJF |
| 1 | 0.09626 | 0.06509 | 4.824 | 161.4 | 171.57 | 164.3 | SQRT_QMA |
| 1 | 0.07083 | 0.03879 | 5.720 | 162.3 | 176.40 | 165.2 | SQRT_QSO |
| 1 | 0.04932 | 0.01654 | 6.477 | 163.0 | 180.48 | 165.9 | SQRT_QMJ |
| 2 | 0.23713 | 0.18264 | 1.864 | 158.2 | 150.00 | 162.5 | SQRT_QJF SQRT_QSO |
| 2 | 0.19590 | 0.13846 | 3.316 | 159.8 | 158.11 | 164.1 | SQRT_QMA SQRT_QSO |
| 2 | 0.18093 | 0.12243 | 3.843 | 160.4 | 161.05 | 164.7 | SQRT_QMA SQRT_QJA |
| 2 | 0.16338 | 0.10362 | 4.461 | 161.0 | 164.50 | 165.3 | SQRT_QJF SQRT_QJA |
| 3 | 0.29629 | 0.21810 | 1.780 | 157.7 | 143.49 | 163.4 | SQRT_QJF SQRT_QJA SQRT_QSO |
| 3 | 0.27363 | 0.19293 | 2.578 | 158.7 | 148.11 | 164.4 | SQRT_QMA SQRT_QJA SQRT_QSO |
| 3 | 0.24314 | 0.15904 | 3.652 | 159.9 | 154.33 | 165.7 | SQRT_QJF SQRT_QMJ SQRT_QSO |
| 3 | 0.24219 | 0.15799 | 3.686 | 160.0 | 154.52 | 165.7 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 4 | 0.31075 | 0.20471 | 3.271 | 159.0 | 145.95 | 166.2 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO |
| 4 | 0.29914 | 0.19132 | 3.680 | 159.5 | 148.41 | 166.7 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO |
| 4 | 0.29646 | 0.18822 | 3.774 | 159.7 | 148.97 | 166.8 | SQRT_QJF SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.27674 | 0.16547 | 4.469 | 160.5 | 153.15 | 167.7 | SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.31560 | 0.17872 | 5.100 | 160.8 | 150.72 | 169.4 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 5 | 0.31337 | 0.17605 | 5.179 | 160.9 | 151.21 | 169.5 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.29937 | 0.15924 | 5.672 | 161.5 | 154.29 | 170.1 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.27678 | 0.13214 | 6.467 | 162.5 | 159.27 | 171.1 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.31845 | 0.14807 | 7.000 | 162.7 | 156.34 | 172.7 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

### 7.2.6 Square Root Variables: 1968 and 1977 Omitted

N = 31 Regression Models for Dependent Variable: SQRT_BSH

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.17639 | 0.14799 | -0.274 | 161.2 | 170.45 | 164.1 | SQRT_QMA |
| 1 | 0.11280 | 0.08221 | 1.789 | 163.5 | 183.61 | 166.4 | SQRT_QJF |
| 1 | 0.06939 | 0.03730 | 3.198 | 165.0 | 192.60 | 167.9 | SQRT_QMJ |
| 1 | 0.05335 | 0.02071 | 3.718 | 165.5 | 195.92 | 168.4 | SQRT_QSO |
| 2 | 0.24032 | 0.18606 | -0.349 | 160.7 | 162.84 | 165.0 | SQRT_QMA SQRT_QSO |
| 2 | 0.22304 | 0.16754 | 0.212 | 161.4 | 166.54 | 165.7 | SQRT_QJF SQRT_QSO |
| 2 | 0.19049 | 0.13267 | 1.268 | 162.7 | 173.52 | 167.0 | SQRT_QMA SQRT_QND |
| 2 | 0.18319 | 0.12485 | 1.505 | 163.0 | 175.08 | 167.3 | SQRT_QMA SQRT_QMJ |
| 3 | 0.25329 | 0.17032 | 1.230 | 162.2 | 165.98 | 167.9 | SQRT_QMA SQRT_QMJ SQRT_QSO |
| 3 | 0.25102 | 0.16780 | 1.304 | 162.3 | 166.49 | 168.0 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 3 | 0.24227 | 0.15808 | 1.588 | 162.6 | 168.43 | 168.4 | SQRT_QMA SQRT_QSO SQRT_QND |
| 3 | 0.24063 | 0.15625 | 1.641 | 162.7 | 168.80 | 168.4 | SQRT_QMA SQRT_QJA SQRT_QSO |
| 4 | 0.26002 | 0.14617 | 3.012 | 163.9 | 170.82 | 171.1 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO |
| 4 | 0.25462 | 0.13995 | 3.187 | 164.1 | 172.06 | 171.3 | SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.25358 | 0.13874 | 3.221 | 164.2 | 172.30 | 171.3 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 4 | 0.25120 | 0.13600 | 3.298 | 164.3 | 172.85 | 171.4 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 5 | 0.26027 | 0.11233 | 5.004 | 165.9 | 177.59 | 174.5 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 5 | 0.26018 | 0.11221 | 5.007 | 165.9 | 177.61 | 174.5 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.25478 | 0.10573 | 5.182 | 166.1 | 178.91 | 174.7 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.25139 | 0.10167 | 5.292 | 166.3 | 179.72 | 174.9 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.26039 | 0.07549 | 7.000 | 167.9 | 184.96 | 177.9 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

### 7.2.7 Square Root Variables: 1968 and 1992 Omitted

N = 31 Regression Models for Dependent Variable: SQRT_BSH

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.05123 | 0.01851 | 0.973 | 162.6 | 178.40 | 165.5 | SQRT_QSO |
| 1 | 0.03494 | 0.00166 | 1.453 | 163.2 | 181.46 | 166.0 | SQRT_QMA |
| 1 | 0.03353 | 0.00021 | 1.495 | 163.2 | 181.73 | 166.1 | SQRT_QMJ |
| 1 | 0.02244 | -.01127 | 1.822 | 163.6 | 183.81 | 166.4 | SQRT_QJF |
| 2 | 0.15184 | 0.09126 | 0.00663 | 161.2 | 165.18 | 165.5 | SQRT_QJF SQRT_QSO |
| 2 | 0.11030 | 0.04674 | 1.232 | 162.6 | 173.27 | 166.9 | SQRT_QMA SQRT_QSO |
| 2 | 0.10023 | 0.03596 | 1.528 | 163.0 | 175.23 | 167.3 | SQRT_QMJ SQRT_QSO |
| 2 | 0.07720 | 0.01128 | 2.207 | 163.8 | 179.71 | 168.1 | SQRT_QMA SQRT_QND |
| 3 | 0.16505 | 0.07227 | 1.617 | 162.7 | 168.63 | 168.4 | SQRT_QJF SQRT_QMJ SQRT_QSO |
| 3 | 0.15863 | 0.06515 | 1.806 | 162.9 | 169.92 | 168.6 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 3 | 0.15666 | 0.06295 | 1.865 | 163.0 | 170.32 | 168.7 | SQRT_QJF SQRT_QSO SQRT_QND |
| 3 | 0.15184 | 0.05760 | 2.007 | 163.2 | 171.29 | 168.9 | SQRT_QJF SQRT_QJA SQRT_QSO |
| 4 | 0.17657 | 0.04989 | 3.277 | 164.2 | 172.70 | 171.4 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.17154 | 0.04409 | 3.426 | 164.4 | 173.75 | 171.6 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO |
| 4 | 0.16820 | 0.04023 | 3.524 | 164.6 | 174.45 | 171.7 | SQRT_QJF SQRT_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.16609 | 0.03779 | 3.587 | 164.6 | 174.89 | 171.8 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO |
| 5 | 0.18552 | 0.02262 | 5.014 | 165.9 | 177.65 | 174.5 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.17661 | 0.01194 | 5.276 | 166.2 | 179.59 | 174.8 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.17184 | 0.00621 | 5.417 | 166.4 | 180.64 | 175.0 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 5 | 0.16980 | 0.00376 | 5.477 | 166.5 | 181.08 | 175.1 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.18598 | -.01752 | 7.000 | 167.9 | 184.95 | 177.9 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

### 7.2.8 Square Root Variables: 1971 and 1977 Omitted

N = 31 Regression Models for Dependent Variable: SQRT_BSH

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.16556 | 0.13679 | 6.242 | 162.5 | 177.62 | 165.4 | SQRT_QSO |
| 1 | 0.13265 | 0.10274 | 7.553 | 163.7 | 184.63 | 166.6 | SQRT_QMA |
| 1 | 0.04367 | 0.01069 | 11.098 | 166.7 | 203.57 | 169.6 | SQRT_QJA |
| 1 | 0.01728 | -.01661 | 12.149 | 167.6 | 209.19 | 170.4 | SQRT_QMJ |
| 2 | 0.32136 | 0.27288 | 2.035 | 158.1 | 149.62 | 162.4 | SQRT_QMA SQRT_QSO |
| 2 | 0.27208 | 0.22009 | 3.998 | 160.3 | 160.48 | 164.6 | SQRT_QJF SQRT_QSO |
| 2 | 0.21877 | 0.16296 | 6.122 | 162.5 | 172.24 | 166.8 | SQRT_QMJ SQRT_QSO |
| 2 | 0.20609 | 0.14938 | 6.627 | 163.0 | 175.03 | 167.3 | SQRT_QJA SQRT_QSO |
| 3 | 0.38071 | 0.31191 | 1.671 | 157.3 | 141.59 | 163.0 | SQRT_QMA SQRT_QJA SQRT_QSO |
| 3 | 0.32601 | 0.25112 | 3.850 | 159.9 | 154.10 | 165.6 | SQRT_QMA SQRT_QSO SQRT_QND |
| 3 | 0.32535 | 0.25039 | 3.876 | 159.9 | 154.24 | 165.6 | SQRT_QMA SQRT_QMJ SQRT_QSO |
| 3 | 0.32276 | 0.24751 | 3.979 | 160.0 | 154.84 | 165.8 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 4 | 0.38934 | 0.29539 | 3.327 | 158.8 | 144.99 | 166.0 | SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.38620 | 0.29177 | 3.452 | 159.0 | 145.73 | 166.2 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 4 | 0.38122 | 0.28602 | 3.650 | 159.2 | 146.91 | 166.4 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO |
| 4 | 0.33605 | 0.23390 | 5.450 | 161.4 | 157.64 | 168.6 | SQRT_QJF SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.39605 | 0.27526 | 5.060 | 160.5 | 149.13 | 169.1 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.38969 | 0.26763 | 5.313 | 160.8 | 150.70 | 169.4 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.38787 | 0.26544 | 5.386 | 160.9 | 151.15 | 169.5 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 5 | 0.33739 | 0.20487 | 7.396 | 163.4 | 163.61 | 172.0 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.39755 | 0.24694 | 7.000 | 162.4 | 154.96 | 172.4 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

### 7.2.9 Square Root Variables: 1971 and 1992 Omitted

N = 31 Regression Models for Dependent Variable: SQRT_BSH

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.16606 | 0.13730 | 1.508 | 159.6 | 161.58 | 162.4 | SQRT_QSO |
| 1 | 0.05354 | 0.02090 | 5.354 | 163.5 | 183.39 | 166.4 | SQRT_QJA |
| 1 | 0.03073 | -.00269 | 6.134 | 164.2 | 187.80 | 167.1 | SQRT_QJF |
| 1 | 0.01827 | -.01558 | 6.560 | 164.6 | 190.22 | 167.5 | SQRT_QMA |
| 2 | 0.21538 | 0.15934 | 1.822 | 159.7 | 157.46 | 164.0 | SQRT_QMA SQRT_QSO |
| 2 | 0.21161 | 0.15530 | 1.950 | 159.8 | 158.21 | 164.1 | SQRT_QJA SQRT_QSO |
| 2 | 0.20136 | 0.14431 | 2.301 | 160.2 | 160.27 | 164.5 | SQRT_QJF SQRT_QSO |
| 2 | 0.18966 | 0.13178 | 2.701 | 160.7 | 162.62 | 165.0 | SQRT_QMJ SQRT_QSO |
| 3 | 0.28589 | 0.20654 | 1.411 | 158.8 | 148.62 | 164.5 | SQRT_QMA SQRT_QJA SQRT_QSO |
| 3 | 0.24999 | 0.16666 | 2.639 | 160.3 | 156.09 | 166.0 | SQRT_QJF SQRT_QJA SQRT_QSO |
| 3 | 0.24435 | 0.16039 | 2.831 | 160.5 | 157.26 | 166.2 | SQRT_QJA SQRT_QSO SQRT_QND |
| 3 | 0.22839 | 0.14266 | 3.377 | 161.2 | 160.58 | 166.9 | SQRT_QMA SQRT_QMJ SQRT_QSO |
| 4 | 0.29435 | 0.18579 | 3.122 | 160.4 | 152.50 | 167.6 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO |
| 4 | 0.28657 | 0.17681 | 3.388 | 160.7 | 154.18 | 167.9 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 4 | 0.28593 | 0.17608 | 3.410 | 160.8 | 154.32 | 167.9 | SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.26865 | 0.15613 | 4.001 | 161.5 | 158.06 | 168.7 | SQRT_QJF SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.29788 | 0.15745 | 5.002 | 162.2 | 157.81 | 170.8 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 5 | 0.29443 | 0.15332 | 5.119 | 162.4 | 158.58 | 171.0 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.28660 | 0.14392 | 5.387 | 162.7 | 160.34 | 171.3 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.26962 | 0.12355 | 5.967 | 163.5 | 164.16 | 172.1 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.29792 | 0.12240 | 7.000 | 164.2 | 164.37 | 174.3 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

### 7.2.10 Square Root Variables: 1977 and 1992 Omitted

N = 31 Regression Models for Dependent Variable: SQRT_BSH

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.13781 | 0.10808 | 1.181 | 162.9 | 179.69 | 165.7 | SQRT_QSO |
| 1 | 0.05996 | 0.02754 | 3.726 | 165.5 | 195.91 | 168.4 | SQRT_QMA |
| 1 | 0.02425 | -.00940 | 4.893 | 166.7 | 203.35 | 169.6 | SQRT_QJF |
| 1 | 0.00813 | -.02607 | 5.420 | 167.2 | 206.71 | 170.1 | SQRT_QMJ |
| 2 | 0.24501 | 0.19109 | -0.323 | 160.7 | 162.96 | 165.0 | SQRT_QMA SQRT_QSO |
| 2 | 0.17653 | 0.11771 | 1.916 | 163.4 | 177.75 | 167.7 | SQRT_QMJ SQRT_QSO |
| 2 | 0.17089 | 0.11166 | 2.100 | 163.6 | 178.96 | 167.9 | SQRT_QJF SQRT_QSO |
| 2 | 0.15541 | 0.09508 | 2.606 | 164.2 | 182.31 | 168.5 | SQRT_QSO SQRT_QND |
| 3 | 0.25382 | 0.17092 | 1.389 | 162.4 | 167.03 | 168.1 | SQRT_QMA SQRT_QMJ SQRT_QSO |
| 3 | 0.25308 | 0.17009 | 1.413 | 162.4 | 167.19 | 168.1 | SQRT_QMA SQRT_QSO SQRT_QND |
| 3 | 0.25307 | 0.17008 | 1.414 | 162.4 | 167.20 | 168.1 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 3 | 0.24544 | 0.16160 | 1.663 | 162.7 | 168.90 | 168.5 | SQRT_QMA SQRT_QJA SQRT_QSO |
| 4 | 0.26139 | 0.14776 | 3.142 | 164.1 | 171.69 | 171.2 | SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.26112 | 0.14745 | 3.151 | 164.1 | 171.76 | 171.2 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.25802 | 0.14387 | 3.252 | 164.2 | 172.48 | 171.4 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO |
| 4 | 0.25406 | 0.13929 | 3.382 | 164.4 | 173.40 | 171.5 | SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.26568 | 0.11882 | 5.002 | 165.9 | 177.52 | 174.5 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.26191 | 0.11429 | 5.125 | 166.0 | 178.44 | 174.6 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.26140 | 0.11368 | 5.141 | 166.1 | 178.56 | 174.7 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.25804 | 0.10965 | 5.251 | 166.2 | 179.37 | 174.8 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 6 | 0.26573 | 0.08216 | 7.000 | 167.9 | 184.91 | 177.9 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

## 7.3 Model 6: Logged and Square Root Variables

### 7.3.1 Logged and Square Root Variables: 1968 Omitted

N = 32    Regression Models for Dependent Variable: LN_BSH

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.129443 | 0.100425 | 1.9395 | 16.4562 | 1.57427 | 19.3877 | LN_QMJ |
| 1 | 0.088090 | 0.057693 | 3.3617 | 17.9413 | 1.64906 | 20.8727 | SQRT_QMA |
| 1 | 0.081519 | 0.050903 | 3.5877 | 18.1710 | 1.66094 | 21.1025 | SQRT_QJF |
| 1 | 0.046229 | 0.014437 | 4.8014 | 19.3775 | 1.72476 | 22.3090 | SQRT_QSO |
| 2 | 0.218383 | 0.164479 | 0.8808 | 15.0076 | 1.46218 | 19.4048 | LN_QMJ SQRT_QSO |
| 2 | 0.180958 | 0.124473 | 2.1678 | 16.5042 | 1.53219 | 20.9015 | SQRT_QJF SQRT_QSO |
| 2 | 0.158257 | 0.100206 | 2.9486 | 17.3791 | 1.57466 | 21.7763 | SQRT_QMA SQRT_QSO |
| 2 | 0.157543 | 0.099443 | 2.9731 | 17.4063 | 1.57599 | 21.8035 | SQRT_QMA LN_QMJ |
| 3 | 0.263685 | 0.184795 | 1.3228 | 15.0970 | 1.42663 | 20.9599 | SQRT_QJF LN_QMJ SQRT_QSO |
| 3 | 0.255403 | 0.175625 | 1.6076 | 15.4549 | 1.44267 | 21.3178 | SQRT_QMA LN_QMJ SQRT_QSO |
| 3 | 0.241689 | 0.160442 | 2.0792 | 16.0389 | 1.46924 | 21.9019 | LN_QMJ LN_QJA SQRT_QSO |
| 3 | 0.238339 | 0.156733 | 2.1944 | 16.1800 | 1.47573 | 22.0429 | LN_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.271622 | 0.163714 | 3.0498 | 16.7502 | 1.46352 | 24.0789 | SQRT_QJF LN_QMJ LN_QJA SQRT_QSO |
| 4 | 0.267158 | 0.158589 | 3.2033 | 16.9457 | 1.47249 | 24.2744 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO |
| 4 | 0.266434 | 0.157757 | 3.2283 | 16.9773 | 1.47394 | 24.3060 | SQRT_QJF LN_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.261480 | 0.152070 | 3.3986 | 17.1927 | 1.48389 | 24.5213 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 5 | 0.272768 | 0.132916 | 5.0104 | 18.6998 | 1.51741 | 27.4942 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 5 | 0.272597 | 0.132712 | 5.0163 | 18.7073 | 1.51777 | 27.5017 | SQRT_QJF LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.267841 | 0.127041 | 5.1799 | 18.9159 | 1.52770 | 27.7103 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.261725 | 0.119749 | 5.3902 | 19.1821 | 1.54046 | 27.9765 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 6 | 0.273070 | 0.098607 | 7.0000 | 20.6865 | 1.57745 | 30.9466 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |

## 7.3.2 Logged and Square Root Variables: 1977 Omitted

N = 32 Regression Models for Dependent Variable: LN_BSH

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.310888 | 0.287917 | 6.3419 | 27.6732 | 2.23519 | 30.6047 | SQRT_QSO |
| 1 | 0.044413 | 0.012560 | 19.6217 | 38.1347 | 3.09952 | 41.0662 | SQRT_QJF |
| 1 | 0.044278 | 0.012420 | 19.6284 | 38.1392 | 3.09996 | 41.0707 | SQRT_QMA |
| 1 | 0.015526 | -.017289 | 21.0612 | 39.0877 | 3.19322 | 42.0192 | LN_QMJ |
| 2 | 0.396024 | 0.354371 | 4.0991 | 25.4534 | 2.02660 | 29.8506 | LN_QMJ SQRT_QSO |
| 2 | 0.393103 | 0.351248 | 4.2447 | 25.6078 | 2.03640 | 30.0050 | SQRT_QSO SQRT_QND |
| 2 | 0.376911 | 0.333939 | 5.0516 | 26.4504 | 2.09073 | 30.8476 | SQRT_QMA SQRT_QSO |
| 2 | 0.321404 | 0.274604 | 7.8178 | 29.1811 | 2.27698 | 33.5783 | SQRT_QJF SQRT_QSO |
| 3 | 0.454850 | 0.396441 | 3.1675 | 24.1742 | 1.89454 | 30.0372 | LN_QMJ SQRT_QSO SQRT_QND |
| 3 | 0.423646 | 0.361894 | 4.7226 | 25.9554 | 2.00298 | 31.8183 | SQRT_QMA SQRT_QSO SQRT_QND |
| 3 | 0.416634 | 0.354130 | 5.0720 | 26.3424 | 2.02735 | 32.2053 | SQRT_QMA LN_QMJ SQRT_QSO |
| 3 | 0.411612 | 0.348570 | 5.3223 | 26.6167 | 2.04480 | 32.4796 | LN_QMJ LN_QJA SQRT_QSO |
| 4 | 0.462537 | 0.382913 | 4.7844 | 25.7198 | 1.93700 | 33.0485 | LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 4 | 0.461110 | 0.381274 | 4.8556 | 25.8047 | 1.94215 | 33.1333 | SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.459784 | 0.379753 | 4.9216 | 25.8833 | 1.94692 | 33.2119 | SQRT_QJF LN_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.447270 | 0.365385 | 5.5453 | 26.6161 | 1.99202 | 33.9448 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 5 | 0.492121 | 0.394452 | 5.3101 | 25.9081 | 1.90078 | 34.7025 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.470489 | 0.368659 | 6.3882 | 27.2428 | 1.98175 | 36.0373 | SQRT_QJF LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.466152 | 0.363489 | 6.6043 | 27.5039 | 1.99798 | 36.2983 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.455101 | 0.350313 | 7.1550 | 28.1595 | 2.03933 | 36.9539 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 6 | 0.498344 | 0.377947 | 7.0000 | 27.5135 | 1.95259 | 37.7737 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |

| OBS | _MODEL_ | _TYPE_ | _DEPVAR_ | _RMSE_ | INTERCEP | SQRT_QJF | SQRT_QMA | LN_QMJ | LN_QJA | SQRT_QSO |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MODEL1 | PARMS | LN_BSH | 1.49506 | 6.87695 | . | . | . | . | -0.09793 |
| 2 | MODEL1 | PARMS | LN_BSH | 1.76055 | 6.46617 | -0.10488 | . | . | . | . |
| 3 | MODEL1 | PARMS | LN_BSH | 1.76067 | 5.33329 | . | 0.14064 | . | . | . |
| 4 | MODEL1 | PARMS | LN_BSH | 1.78696 | 5.36411 | . | . | 0.14318 | . | . |
| 5 | MODEL1 | PARMS | LN_BSH | 1.42359 | 5.55991 | . | . | 0.34914 | . | -0.11282 |
| 6 | MODEL1 | PARMS | LN_BSH | 1.42702 | 6.15946 | . | . | . | . | -0.12790 |
| 7 | MODEL1 | PARMS | LN_BSH | 1.44594 | 6.14215 | . | 0.17232 | . | . | -0.10164 |
| 8 | MODEL1 | PARMS | LN_BSH | 1.50897 | 6.69272 | 0.06034 | . | . | . | -0.10929 |
| 9 | MODEL1 | PARMS | LN_BSH | 1.37642 | 5.12512 | . | . | 0.30135 | . | -0.13647 |
| 10 | MODEL1 | PARMS | LN_BSH | 1.41527 | 5.77910 | . | 0.12364 | . | . | -0.12443 |
| 11 | MODEL1 | PARMS | LN_BSH | 1.42385 | 5.41921 | . | 0.10712 | 0.26535 | . | -0.11155 |
| 12 | MODEL1 | PARMS | LN_BSH | 1.42997 | 6.02307 | . | . | 0.41152 | -0.19200 | -0.11558 |
| 13 | MODEL1 | PARMS | LN_BSH | 1.39176 | 5.47962 | . | . | 0.34847 | -0.13654 | -0.13707 |
| 14 | MODEL1 | PARMS | LN_BSH | 1.39361 | 5.08553 | . | 0.06147 | 0.25779 | . | -0.13351 |
| 15 | MODEL1 | PARMS | LN_BSH | 1.39532 | 5.09616 | -0.04622 | . | 0.33584 | . | -0.13091 |
| 16 | MODEL1 | PARMS | LN_BSH | 1.41139 | 5.67649 | -0.14085 | 0.24559 | . | . | -0.10106 |
| 17 | MODEL1 | PARMS | LN_BSH | 1.37869 | 4.89730 | -0.16236 | 0.19578 | 0.28378 | . | -0.10749 |
| 18 | MODEL1 | PARMS | LN_BSH | 1.40774 | 5.51423 | -0.05983 | . | 0.40271 | -0.16431 | -0.12999 |
| 19 | MODEL1 | PARMS | LN_BSH | 1.41350 | 5.38961 | . | 0.04807 | 0.30656 | -0.11380 | -0.13465 |
| 20 | MODEL1 | PARMS | LN_BSH | 1.42805 | 5.64378 | -0.16093 | 0.22102 | 0.35790 | -0.15614 | -0.08773 |
| 21 | MODEL1 | PARMS | LN_BSH | 1.39735 | 5.23172 | -0.16559 | 0.18354 | 0.33854 | -0.12655 | -0.10824 |

| OBS | SQRT_QND | LN_BSH | _IN_ | _P_ | _EDF_ | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | . | -1 | 1 | 2 | 30 | 2.23519 | 0.31089 | 0.28792 | 6.3419 | 27.6732 | 30.6047 |
| 2 | . | -1 | 1 | 2 | 30 | 3.09952 | 0.04441 | 0.01256 | 19.6217 | 38.1347 | 41.0662 |
| 3 | . | -1 | 1 | 2 | 30 | 3.09996 | 0.04428 | 0.01242 | 19.6284 | 38.1392 | 41.0707 |
| 4 | . | -1 | 1 | 2 | 30 | 3.19322 | 0.01553 | -0.01729 | 21.0612 | 39.0877 | 42.0192 |
| 5 | . | -1 | 2 | 3 | 29 | 2.02660 | 0.39602 | 0.35437 | 4.0991 | 25.4534 | 29.8506 |
| 6 | 0.20937 | -1 | 2 | 3 | 29 | 2.03640 | 0.39310 | 0.35125 | 4.2447 | 25.6078 | 30.0050 |
| 7 | . | -1 | 2 | 3 | 29 | 2.09073 | 0.37691 | 0.33394 | 5.0516 | 26.4504 | 30.8476 |
| 8 | . | -1 | 2 | 3 | 29 | 2.27698 | 0.32140 | 0.27460 | 7.8178 | 29.1811 | 33.5783 |
| 9 | 0.17949 | -1 | 3 | 4 | 28 | 1.89454 | 0.45485 | 0.39644 | 3.1675 | 24.1742 | 30.0372 |
| 10 | 0.16652 | -1 | 3 | 4 | 28 | 2.00298 | 0.42365 | 0.36189 | 4.7226 | 25.9554 | 31.8183 |
| 11 | . | -1 | 3 | 4 | 28 | 2.02735 | 0.41663 | 0.35413 | 5.0720 | 26.3424 | 32.2053 |
| 12 | . | -1 | 3 | 4 | 28 | 2.04480 | 0.41161 | 0.34857 | 5.3223 | 26.6167 | 32.4796 |
| 13 | 0.16912 | -1 | 4 | 5 | 27 | 1.93700 | 0.46254 | 0.38291 | 4.7844 | 25.7198 | 33.0485 |
| 14 | 0.16250 | -1 | 4 | 5 | 27 | 1.94215 | 0.46111 | 0.38127 | 4.8556 | 25.8047 | 33.1333 |
| 15 | 0.19115 | -1 | 4 | 5 | 27 | 1.94692 | 0.45978 | 0.37975 | 4.9216 | 25.8833 | 33.2119 |
| 16 | 0.17020 | -1 | 4 | 5 | 27 | 1.99202 | 0.44727 | 0.36538 | 5.5453 | 26.6161 | 33.9448 |
| 17 | 0.16635 | -1 | 5 | 6 | 26 | 1.90078 | 0.49212 | 0.39445 | 5.3101 | 25.9081 | 34.7025 |
| 18 | 0.18210 | -1 | 5 | 6 | 26 | 1.98175 | 0.47049 | 0.36866 | 6.3882 | 27.2428 | 36.0373 |
| 19 | 0.15756 | -1 | 5 | 6 | 26 | 1.99798 | 0.46615 | 0.36349 | 6.6043 | 27.5039 | 36.2983 |
| 20 | . | -1 | 5 | 6 | 26 | 2.03933 | 0.45510 | 0.35031 | 7.1550 | 28.1595 | 36.9539 |
| 21 | 0.16093 | -1 | 6 | 7 | 25 | 1.95259 | 0.49834 | 0.37795 | 7.0000 | 27.5135 | 37.7737 |

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 5.231720 | 0.98843461 | 5.293 | 0.0001 | 0.00000000 |
| SQRT_QJF | 1 | -0.165591 | 0.13073536 | -1.267 | 0.2170 | 3.43900351 |
| SQRT_QMA | 1 | 0.183541 | 0.15577909 | 1.178 | 0.2498 | 2.70703874 |
| LN_QMJ | 1 | 0.338537 | 0.21376845 | 1.584 | 0.1258 | 1.72477161 |
| LN_QJA | 1 | -0.126553 | 0.22724335 | -0.557 | 0.5825 | 1.27791728 |
| SQRT_QSO | 1 | -0.108241 | 0.03647292 | -2.968 | 0.0065 | 2.14918232 |
| SQRT_QND | 1 | 0.160932 | 0.10962642 | 1.468 | 0.1546 | 1.52119677 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop SQRT_QJF | Var Prop SQRT_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop SQRT_QSO | Var Prop SQRT_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.66301 | 1.00000 | 0.0323 | 0.0263 | 0.0382 | 0.0007 | 0.0275 | 0.0443 |
| 2 | 1.25332 | 1.45766 | 0.0019 | 0.0001 | 0.1092 | 0.3952 | 0.0175 | 0.0394 |
| 3 | 1.00386 | 1.62874 | 0.0083 | 0.1520 | 0.0008 | 0.0673 | 0.1742 | 0.0619 |
| 4 | 0.51693 | 2.26972 | 0.0660 | 0.0056 | 0.0010 | 0.0238 | 0.1954 | 0.8154 |
| 5 | 0.40236 | 2.57262 | 0.0688 | 0.0531 | 0.8407 | 0.5091 | 0.0015 | 0.0005 |
| 6 | 0.16052 | 4.07307 | 0.8225 | 0.7629 | 0.0101 | 0.0039 | 0.5839 | 0.0385 |

Variable

| Variable | DF | Label |
|---|---|---|
| INTERCEP | 1 | Intercept |
| SQRT_QJF | 1 | SQRT (January-February Inflows) |
| SQRT_QMA | 1 | SQRT (March-April Inflows) |
| LN_QMJ | 1 | Ln (May-June Inflows) |
| LN_QJA | 1 | Ln (July-August Inflows) |
| SQRT_QSO | 1 | SQRT (September-October Inflows) |
| SQRT_QND | 1 | SQRT (November-December Inflows) |

### 7.3.3 Logged and Square Root Variables: 1968 and 1977 Omitted

N = 31 Regression Models for Dependent Variable: LN_BSH

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.126955 | 0.096850 | 1.8682 | 17.0348 | 1.62770 | 19.9028 | LN_QMJ |
| 1 | 0.117360 | 0.086925 | 2.1855 | 17.3737 | 1.64559 | 20.2417 | SQRT_QMA |
| 1 | 0.078803 | 0.047038 | 3.4604 | 18.6991 | 1.71748 | 21.5671 | SQRT_QJF |
| 1 | 0.052798 | 0.020136 | 4.3203 | 19.5621 | 1.76596 | 22.4301 | SQRT_QSO |
| 2 | 0.220863 | 0.165210 | 0.7630 | 15.5071 | 1.50450 | 19.8090 | LN_QMJ SQRT_QSO |
| 2 | 0.178704 | 0.120040 | 2.1571 | 17.1406 | 1.58591 | 21.4426 | SQRT_QMA SQRT_QSO |
| 2 | 0.178407 | 0.119722 | 2.1669 | 17.1519 | 1.58648 | 21.4538 | SQRT_QJF SQRT_QSO |
| 2 | 0.169882 | 0.110588 | 2.4488 | 17.4719 | 1.60295 | 21.7738 | SQRT_QMA LN_QMJ |
| 3 | 0.261801 | 0.179779 | 1.4094 | 15.8339 | 1.47825 | 21.5698 | SQRT_QJF LN_QMJ SQRT_QSO |
| 3 | 0.258861 | 0.176512 | 1.5066 | 15.9571 | 1.48413 | 21.6930 | SQRT_QMA LN_QMJ SQRT_QSO |
| 3 | 0.239437 | 0.154930 | 2.1489 | 16.7591 | 1.52303 | 22.4950 | LN_QMJ LN_QJA SQRT_QSO |
| 3 | 0.237534 | 0.152815 | 2.2118 | 16.8366 | 1.52684 | 22.5725 | LN_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.269168 | 0.156732 | 3.1658 | 17.5229 | 1.51978 | 24.6929 | SQRT_QJF LN_QMJ LN_QJA SQRT_QSO |
| 4 | 0.266455 | 0.153602 | 3.2555 | 17.6378 | 1.52542 | 24.8077 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 4 | 0.265505 | 0.152506 | 3.2869 | 17.6779 | 1.52740 | 24.8479 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO |
| 4 | 0.264301 | 0.151116 | 3.3267 | 17.7287 | 1.52990 | 24.8987 | SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.271887 | 0.126265 | 5.0759 | 19.4074 | 1.57469 | 28.0113 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 5 | 0.271271 | 0.125526 | 5.0962 | 19.4336 | 1.57602 | 28.0375 | SQRT_QJF LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.271028 | 0.125233 | 5.1043 | 19.4440 | 1.57655 | 28.0479 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.268165 | 0.121798 | 5.1989 | 19.5655 | 1.58274 | 28.1694 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 6 | 0.274181 | 0.092727 | 7.0000 | 21.3096 | 1.63514 | 31.3475 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |

## 7.4 Model 7: Harvest Untransformed, and Logged and Square Root Inflows

### 7.4.1 Harvest Untransformed, and Logged and Square Root Inflows: 1968 Omitted

N = 32 Regression Models for Dependent Variable: BROWN

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.128706 | 0.099662 | 2.5911 | 423.5 | 526582 | 426.4 | SQRT_QJF |
| 1 | 0.119736 | 0.090393 | 2.9060 | 423.8 | 532003 | 426.8 | SQRT_QMA |
| 1 | 0.061703 | 0.030426 | 4.9435 | 425.9 | 567076 | 428.8 | LN_QMJ |
| 1 | 0.047802 | 0.016062 | 5.4316 | 426.3 | 575477 | 429.3 | SQRT_QSO |
| 2 | 0.245813 | 0.193800 | 0.4794 | 420.9 | 471523 | 425.3 | SQRT_QJF SQRT_QSO |
| 2 | 0.203095 | 0.148136 | 1.9792 | 422.7 | 498231 | 427.0 | SQRT_QMA SQRT_QND |
| 2 | 0.196127 | 0.140687 | 2.2239 | 422.9 | 502587 | 427.3 | SQRT_QMA SQRT_QSO |
| 2 | 0.188670 | 0.132716 | 2.4857 | 423.2 | 507249 | 427.6 | SQRT_QJF SQRT_QND |
| 3 | 0.261948 | 0.182871 | 1.9129 | 422.2 | 477915 | 428.1 | SQRT_QJF LN_QMJ SQRT_QSO |
| 3 | 0.255188 | 0.175387 | 2.1503 | 422.5 | 482292 | 428.4 | SQRT_QJF LN_QJA SQRT_QSO |
| 3 | 0.254128 | 0.174213 | 2.1875 | 422.5 | 482979 | 428.4 | SQRT_QJF SQRT_QSO SQRT_QND |
| 3 | 0.251523 | 0.171329 | 2.2789 | 422.6 | 484666 | 428.5 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 4 | 0.273832 | 0.166252 | 3.4957 | 423.7 | 487635 | 431.0 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.269734 | 0.161547 | 3.6395 | 423.9 | 490387 | 431.2 | SQRT_QJF LN_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.265894 | 0.157138 | 3.7744 | 424.0 | 492966 | 431.4 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO |
| 4 | 0.265081 | 0.156205 | 3.8029 | 424.1 | 493512 | 431.4 | SQRT_QJF SQRT_QMA LN_QJA SQRT_QSO |
| 5 | 0.285333 | 0.147897 | 5.0919 | 425.2 | 498370 | 434.0 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.283004 | 0.145120 | 5.1737 | 425.3 | 499995 | 434.1 | SQRT_QJF SQRT_QMA LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.270420 | 0.130116 | 5.6155 | 425.8 | 508770 | 434.6 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 5 | 0.270321 | 0.129998 | 5.6189 | 425.8 | 508839 | 434.6 | SQRT_QJF LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 6 | 0.287950 | 0.117058 | 7.0000 | 427.0 | 516407 | 437.3 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |

### 7.4.2 Harvest Untransformed, and Logged and Square Root Inflows: 1977 Omitted.

N = 32 Regression Models for Dependent Variable: BROWN

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.213971 | 0.187770 | 1.5234 | 421.5 | 494388 | 424.4 | SQRT_QMA |
| 1 | 0.084716 | 0.054207 | 6.3782 | 426.4 | 575685 | 429.3 | SQRT_QSO |
| 1 | 0.040916 | 0.008946 | 8.0233 | 427.9 | 603234 | 430.8 | LN_QMJ |
| 1 | 0.036841 | 0.004736 | 8.1764 | 428.0 | 605797 | 430.9 | SQRT_QJF |
| 2 | 0.322905 | 0.276209 | -0.5682 | 418.7 | 440557 | 423.1 | SQRT_QMA SQRT_QSO |
| 2 | 0.253257 | 0.201757 | 2.0478 | 421.8 | 485874 | 426.2 | SQRT_QJF SQRT_QSO |
| 2 | 0.244777 | 0.192693 | 2.3663 | 422.2 | 491391 | 426.6 | SQRT_QJF SQRT_QMA |
| 2 | 0.238500 | 0.185983 | 2.6021 | 422.5 | 495476 | 426.9 | SQRT_QMA SQRT_QND |
| 3 | 0.331079 | 0.259409 | 1.1248 | 420.3 | 450783 | 426.2 | SQRT_QMA LN_QMJ SQRT_QSO |
| 3 | 0.327265 | 0.255186 | 1.2680 | 420.5 | 453353 | 426.4 | SQRT_QMA LN_QJA SQRT_QSO |
| 3 | 0.326136 | 0.253937 | 1.3104 | 420.6 | 454113 | 426.4 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 3 | 0.323128 | 0.250606 | 1.4234 | 420.7 | 456140 | 426.6 | SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.333298 | 0.234527 | 3.0414 | 422.2 | 465927 | 429.5 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO |
| 4 | 0.331859 | 0.232875 | 3.0955 | 422.3 | 466933 | 429.6 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 4 | 0.331235 | 0.232159 | 3.1189 | 422.3 | 467369 | 429.6 | SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.330427 | 0.231232 | 3.1492 | 422.4 | 467934 | 429.7 | SQRT_QJF SQRT_QMA LN_QJA SQRT_QSO |
| 5 | 0.334208 | 0.206171 | 5.0073 | 424.2 | 483188 | 433.0 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 5 | 0.333423 | 0.205235 | 5.0367 | 424.2 | 483757 | 433.0 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.332086 | 0.203641 | 5.0869 | 424.3 | 484727 | 433.1 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.330740 | 0.202036 | 5.1375 | 424.3 | 485704 | 433.1 | SQRT_QJF SQRT_QMA LN_QJA SQRT_QSO SQRT_QND |
| 6 | 0.334401 | 0.174657 | 7.0000 | 426.2 | 502369 | 436.4 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |

### 7.4.3 Harvest Untransformed, and Logged and Square Root Inflows: 1992 Omitted.

N = 32     Regression Models for Dependent Variable: BROWN

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.088341 | 0.057952 | -0.0811 | 421.5 | 494916 | 424.5 | SQRT_QSO |
| 1 | 0.021631 | -.010982 | 1.9619 | 423.8 | 531132 | 426.7 | SQRT_QMA |
| 1 | 0.015045 | -.017786 | 2.1635 | 424.0 | 534707 | 426.9 | LN_QMJ |
| 1 | 0.006944 | -.026158 | 2.4116 | 424.3 | 539105 | 427.2 | SQRT_QND |
| 2 | 0.138805 | 0.079413 | 0.3735 | 421.7 | 483642 | 426.1 | LN_QMJ SQRT_QSO |
| 2 | 0.134887 | 0.075225 | 0.4935 | 421.8 | 485842 | 426.2 | SQRT_QJF SQRT_QSO |
| 2 | 0.134302 | 0.074599 | 0.5114 | 421.9 | 486171 | 426.3 | SQRT_QMA SQRT_QSO |
| 2 | 0.092227 | 0.029622 | 1.7999 | 423.4 | 509800 | 427.8 | SQRT_QSO SQRT_QND |
| 3 | 0.163699 | 0.074095 | 1.6111 | 422.8 | 486435 | 428.6 | SQRT_QMA LN_QMJ SQRT_QSO |
| 3 | 0.161122 | 0.071242 | 1.6900 | 422.9 | 487934 | 428.7 | SQRT_QJF LN_QMJ SQRT_QSO |
| 3 | 0.153866 | 0.063209 | 1.9122 | 423.1 | 492155 | 429.0 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 3 | 0.148243 | 0.056984 | 2.0844 | 423.3 | 495425 | 429.2 | SQRT_QMA LN_QJA SQRT_QSO |
| 4 | 0.173757 | 0.051351 | 3.3031 | 424.4 | 498385 | 431.7 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO |
| 4 | 0.171803 | 0.049107 | 3.3629 | 424.5 | 499563 | 431.8 | SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.167035 | 0.043633 | 3.5090 | 424.6 | 502439 | 432.0 | SQRT_QJF SQRT_QMA LN_QJA SQRT_QSO |
| 4 | 0.165285 | 0.041624 | 3.5625 | 424.7 | 503495 | 432.0 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 5 | 0.181764 | 0.024411 | 5.0579 | 426.1 | 512538 | 434.9 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.176428 | 0.018048 | 5.2213 | 426.3 | 515880 | 435.1 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 5 | 0.174865 | 0.016185 | 5.2692 | 426.3 | 516859 | 435.1 | SQRT_QJF SQRT_QMA LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.172804 | 0.013728 | 5.3323 | 426.4 | 518150 | 435.2 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 6 | 0.183655 | -.012268 | 7.0000 | 428.0 | 531808 | 438.2 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |

### 7.4.4 Harvest Untransformed, and Logged and Square Root Inflows: 1968 and 1977 Omitted.

N = 31 Regression Models for Dependent Variable: BROWN

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.102083 | 0.071120 | -0.2573 | 408.0 | 487875 | 410.8 | SQRT_QSO |
| 1 | 0.020510 | -.013266 | 2.1722 | 410.7 | 532198 | 413.5 | SQRT_QMA |
| 1 | 0.011428 | -.022661 | 2.4427 | 410.9 | 537132 | 413.8 | SQRT_QND |
| 1 | 0.008288 | -.025909 | 2.5363 | 411.0 | 538838 | 413.9 | LN_QMJ |
| 2 | 0.150733 | 0.090071 | 0.2938 | 408.2 | 477922 | 412.5 | SQRT_QJF SQRT_QSO |
| 2 | 0.148064 | 0.087211 | 0.3733 | 408.3 | 479424 | 412.6 | SQRT_QMA SQRT_QSO |
| 2 | 0.139911 | 0.078476 | 0.6161 | 408.6 | 484012 | 412.9 | LN_QMJ SQRT_QSO |
| 2 | 0.104140 | 0.040150 | 1.6815 | 409.9 | 504142 | 414.2 | SQRT_QSO SQRT_QND |
| 3 | 0.169122 | 0.076802 | 1.7461 | 409.6 | 484891 | 415.3 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 3 | 0.167601 | 0.075113 | 1.7914 | 409.6 | 485778 | 415.4 | SQRT_QMA LN_QMJ SQRT_QSO |
| 3 | 0.166893 | 0.074325 | 1.8125 | 409.6 | 486192 | 415.4 | SQRT_QJF LN_QMJ SQRT_QSO |
| 3 | 0.164916 | 0.072129 | 1.8714 | 409.7 | 487345 | 415.5 | SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.184923 | 0.059527 | 3.2755 | 411.0 | 493965 | 418.1 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.180579 | 0.054514 | 3.4049 | 411.1 | 496598 | 418.3 | SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.180396 | 0.054303 | 3.4103 | 411.1 | 496709 | 418.3 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO |
| 4 | 0.176395 | 0.049687 | 3.5295 | 411.3 | 499133 | 418.5 | SQRT_QJF SQRT_QMA LN_QJA SQRT_QSO |
| 5 | 0.193424 | 0.032108 | 5.0223 | 412.6 | 508366 | 421.2 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.189499 | 0.027399 | 5.1392 | 412.8 | 510839 | 421.4 | SQRT_QJF SQRT_QMA LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.181922 | 0.018306 | 5.3649 | 413.1 | 515615 | 421.7 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 5 | 0.180794 | 0.016952 | 5.3985 | 413.1 | 516326 | 421.7 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 6 | 0.194174 | -.007283 | 7.0000 | 414.6 | 529055 | 424.6 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |

### 7.4.5 Harvest Untransformed, and Logged and Square Root Inflows: 1968 and 1992 Omitted.

N = 31 Regression Models for Dependent Variable: BROWN

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.049773 | 0.017007 | 0.7954 | 409.4 | 511762 | 412.3 | SQRT_QSO |
| 1 | 0.030013 | -.003435 | 1.3734 | 410.1 | 522404 | 413.0 | LN_QMJ |
| 1 | 0.026635 | -.006929 | 1.4723 | 410.2 | 524223 | 413.1 | SQRT_QMA |
| 1 | 0.013116 | -.020914 | 1.8677 | 410.6 | 531504 | 413.5 | SQRT_QJF |
| 2 | 0.124654 | 0.062129 | 0.6051 | 408.9 | 488271 | 413.2 | SQRT_QJF SQRT_QSO |
| 2 | 0.102683 | 0.038589 | 1.2478 | 409.7 | 500526 | 414.0 | LN_QMJ SQRT_QSO |
| 2 | 0.097290 | 0.032810 | 1.4055 | 409.9 | 503534 | 414.2 | SQRT_QMA SQRT_QSO |
| 2 | 0.088517 | 0.023412 | 1.6621 | 410.2 | 508427 | 414.5 | SQRT_QMA SQRT_QND |
| 3 | 0.143353 | 0.048170 | 2.0581 | 410.2 | 495537 | 416.0 | SQRT_QJF LN_QMJ SQRT_QSO |
| 3 | 0.137308 | 0.041454 | 2.2349 | 410.5 | 499034 | 416.2 | SQRT_QJF SQRT_QSO SQRT_QND |
| 3 | 0.136119 | 0.040132 | 2.2697 | 410.5 | 499722 | 416.2 | SQRT_QJF LN_QJA SQRT_QSO |
| 3 | 0.131221 | 0.034690 | 2.4130 | 410.7 | 502556 | 416.4 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 4 | 0.165079 | 0.036629 | 3.4226 | 411.4 | 501546 | 418.6 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.153126 | 0.022838 | 3.7722 | 411.9 | 508726 | 419.0 | SQRT_QJF LN_QMJ SQRT_QSO SQRT_QND |
| 4 | 0.147959 | 0.016875 | 3.9234 | 412.1 | 511830 | 419.2 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO |
| 4 | 0.147587 | 0.016446 | 3.9343 | 412.1 | 512053 | 419.2 | SQRT_QJF SQRT_QMA LN_QJA SQRT_QSO |
| 5 | 0.177274 | 0.012729 | 5.0659 | 413.0 | 513989 | 421.6 | SQRT_QJF SQRT_QMA LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.174470 | 0.009364 | 5.1479 | 413.1 | 515741 | 421.7 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.154102 | -.015078 | 5.7437 | 413.8 | 528466 | 422.4 | SQRT_QJF LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.153085 | -.016298 | 5.7734 | 413.9 | 529101 | 422.5 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 6 | 0.179526 | -.025593 | 7.0000 | 414.9 | 533940 | 424.9 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |

### 7.4.6 Harvest Untransformed, and Logged and Square Root Inflows: 1977 and 1992 Omitted.

N = 31 Regression Models for Dependent Variable: BROWN

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.089499 | 0.058102 | 1.8842 | 409.4 | 511190 | 412.3 | SQRT_QMA |
| 1 | 0.088455 | 0.057023 | 1.9173 | 409.4 | 511776 | 412.3 | SQRT_QSO |
| 1 | 0.015651 | -.018292 | 4.2269 | 411.8 | 552651 | 414.7 | LN_QMJ |
| 1 | 0.009985 | -.024153 | 4.4066 | 412.0 | 555832 | 414.9 | SQRT_QND |
| 2 | 0.223525 | 0.168063 | -0.3676 | 406.5 | 451512 | 410.8 | SQRT_QMA SQRT_QSO |
| 2 | 0.138575 | 0.077045 | 2.3273 | 409.7 | 500909 | 414.0 | LN_QMJ SQRT_QSO |
| 2 | 0.137174 | 0.075543 | 2.3718 | 409.7 | 501724 | 414.0 | SQRT_QJF SQRT_QSO |
| 2 | 0.125224 | 0.062740 | 2.7508 | 410.2 | 508673 | 414.5 | SQRT_QJF SQRT_QMA |
| 3 | 0.237473 | 0.152748 | 1.1899 | 407.9 | 459823 | 413.6 | SQRT_QJF SQRT_QMA SQRT_QSO |
| 3 | 0.230042 | 0.144491 | 1.4257 | 408.2 | 464304 | 414.0 | SQRT_QMA LN_QMJ SQRT_QSO |
| 3 | 0.228535 | 0.142817 | 1.4735 | 408.3 | 465213 | 414.0 | SQRT_QMA LN_QJA SQRT_QSO |
| 3 | 0.224003 | 0.137781 | 1.6172 | 408.5 | 467946 | 414.2 | SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.242281 | 0.125709 | 3.0374 | 409.7 | 474498 | 416.9 | SQRT_QJF SQRT_QMA LN_QJA SQRT_QSO |
| 4 | 0.240398 | 0.123537 | 3.0971 | 409.8 | 475677 | 417.0 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO |
| 4 | 0.237944 | 0.120704 | 3.1750 | 409.9 | 477214 | 417.1 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.231456 | 0.113219 | 3.3808 | 410.2 | 481277 | 417.3 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 5 | 0.242981 | 0.091577 | 5.0152 | 411.7 | 493022 | 420.3 | SQRT_QJF SQRT_QMA LN_QJA SQRT_QSO SQRT_QND |
| 5 | 0.242859 | 0.091431 | 5.0191 | 411.7 | 493102 | 420.3 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO |
| 5 | 0.240777 | 0.088933 | 5.0851 | 411.8 | 494457 | 420.4 | SQRT_QJF SQRT_QMA LN_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.231957 | 0.078349 | 5.3649 | 412.1 | 500201 | 420.7 | SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |
| 6 | 0.243460 | 0.054325 | 7.0000 | 413.7 | 513240 | 423.7 | SQRT_QJF SQRT_QMA LN_QMJ LN_QJA SQRT_QSO SQRT_QND |

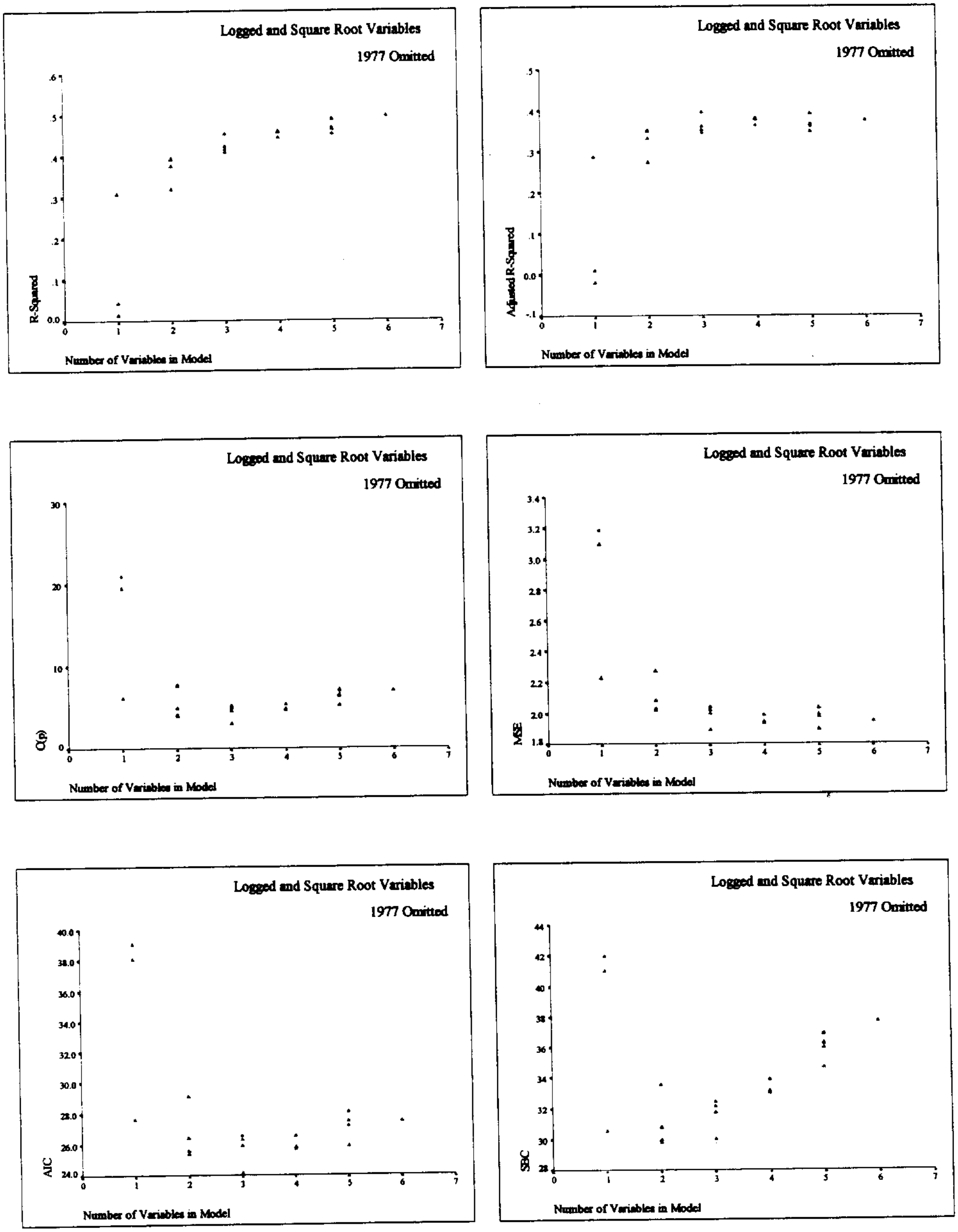



Fig. 7.1. Examining Subsets of Logged and Square Root Data:
1977 Omitted.

# Brown Shrimp Harvests in Aransas Bay: A Regression Analysis

## Harvest vs Freshwater Inflows

F. Michael Speed
Michael Longnecker
Rita Miranda-López

*Department of Statistics*
*Texas A&M University*

# Brown Shrimp Harvest in Aransas Bay:

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Harvest vs. Freshwater Inflows

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SPRING 1997

# Table of Contents

# 1. Summary Report

## 1.1 Description of the Problem[1]

Bimonthly freshwater inflows into Aransas Bay were recorded for the years 1962 to 1994. These variables, and various transformations of them, were used to construct a model for the annual harvest of brown shrimp.

## 1.2 Constructing Models - General Discussion

Stability of coefficient estimates and accuracy of predicted values are primary goals in constructing models for prediction. To this end, the data must be examined from three points of view: individual observations (to detect outliers or influential points); variables, individually and in groups (to select an optimal set of predictors); and the interaction of these two, which produces the overall structure of the data set (to determine whether multicollinearity is present or not). The first two of these were examined by both graphic and quantitative means; the third by quantitative means only.

### 1.2.1 Detecting Influential Points and Outliers

The structures of individual variables were examined via box plots and histograms, as well as by all the usual numerical measures. For each pair of variables, 99 % prediction ellipses and 95% confidence ellipses were plotted in a further effort to look for unusual points. For example, suppose large values of Variable A are generally associated with large values for Variable B. If an observation consisted of a large value for Variable A but a small value for Variable B, that point would be considered unusual, even though it was well within the range of data for both variables and could not be considered an outlier.

In addition, a number of residual analysis techniques were employed. A large *residual* indicates a point not well-fit by the model. The *deleted residual*, however, is somewhat more useful in the search for influential points. The model is fitted without a given observation, and the predicted response and corresponding residual are calculated for that observation. The *Studentized deleted residual* is scaled to have a Student's t distribution. Histograms and normal P-P plots of the residuals were also examined.

Other quantities, such as the Mahalanobis distance, Cook's distance, the leverage value, standarized values for the Dffits (to measure the influence of a given observation on the predicted response) and the Dfbetas (to measure the influence of a given observation on the calculated coefficients) were also used to build a general picture of the influence of individual points. Plots were made of the standardized Dffits value for each model against the Dfbeta values for each predictor in the model. Points which were extreme indicated observations which had strong effects on both predicted values and coefficient estimates.

### 1.2.2 Variable Selection

For each regression, residuals were plotted against each of the independent variables to look for nonlinear relationships between the response variable and individual predictors. Partial residual plots were employed to examine the overall relationship between the response and individual predictors. A partial

[1] The following discussion, prepared by Jacqueline Kiffe, was taken from Seatrout Harvests in Galveston Bay: A Regression Analysis, by F. Michael Speed, Sr. and Jacqueline Kiffe.

residual is a corollary to the deleted residual. That is, the model is fitted without a given variable and the predicted response and corresponding residual are calculated for each observation. This seeks to answer the question, "What is the relationship of this predictor to the response variable, taking all other variables into account?" Thus, it examines the marginal relationship of a given predictor to the response.

Numerous measures have been developed over the years to assess the adequacy of a given model. We examined a number of these, including $R^2$ and mean squared error (MSE), and several others which directly incorporate penalties for having too many predictors in the model, such as adjusted $R^2$, $C_p$, AIC, and SBC. It is well-established that too many predictors in a model can lead to bad prediction, just as too few can, and these measures are used as part of the attempt to find an optimal model.

#### 1.2.3 Multicollinearity

Multicollinearity arises when one or more variables are nearly closely approximated by linear combinations of the remaining variables, resulting in unstable coefficient estimates. The variance inflation factor (VIF) was calculated for each coefficient estimate to measure this instability, which is not usually considered profound for VIF's less than 10. No problems were found with this data. Additionally, the condition index (a ratio of eigenvalues of the covariance matrix, with the largest eigenvalue always on top) was calculated. A ratio greater than 30 is considered cause for concern. Again, no evidence of multicollinearity was found.

#### 1.2.4 Other Procedures

Several other miscellaneous diagnostics, including the Durbin-Watson test for serial autocorrelation were performed, and no general problems were detected. The Box-Cox procedure, used to find a transformation to normality, was also performed.

### 1.3 How the Final Model Was Chosen

#### 1.3.1 Selecting the Data Set Used

First, the variables were explored thoroughly, individually and in pairs, in a first effort to detect outliers. The SAS programming language allows a number of diagnostics to be calculated for a group of models on a given data set without actually performing a formal regression, thus allowing one to examine a large number of models quite efficiently. The Box-Cox procedure was performed to find if a transformation to normality was suggested. The log transform was suggested for some variables, and the square root for others. At this point, there were several data sets for which the diagnostic series was calculated:

1. Untransformed data.
2. Harvest untransformed, and natural log of inflow variables.
3. All variables logged.
4. Harvest untransformed, and square root of inflows variables.
5. All variables square root.
6. Harvest and inflows variables transformed according to Box-Cox suggestion.

### 1.3.2 Selecting the Points to be Omitted

The full regression with all diagnostics was performed for these models, each one contained all variables in its corresponding data set. All diagnostics were generated, and influential points were determined for each model.

Table 1.1 R-Square and Adjusted R-Square values for the different suggested models.

| Data Set | $R^2$ | Adjusted $R^2$ |
|---|---|---|
| 1 | 0.1636 | - 0.0295 |
| 2 | 0.2342 | 0.0575 |
| **3** | **0.3542** | **0.2051** |
| 4 | 0.2048 | 0.0212 |
| **5** | **0.2849** | **0.1198** |
| **6** | **0.3393** | **0.1868** |

Data set 3 presented the highest $R^2$ values. However , the models 3, 5 and 6 were considered as final candidates. The observations flagged as potentially influential are given in the summary table below, for each model.

Table 1.2 Summary of points flagged by Boxplots.

| Year | Variable |
|---|---|
| 1968 | May-Jun, Sept-Oct, SQRT (Sept-Oct) Inflows. |
| 1972 | Sept-Oct, SQRT (Sept-Oct) Inflows. |
| 1974 | Sept-Oct Inflows. |
| 1975 | Nov-Dec Inflows. |
| 1976 | Jul-Aug, SQRT (Jul-Aug) Inflows. |
| 1977 | Nov-Dec, SQRT (Nov-Dec) Inflows. |
| 1979 | Jul-Aug Inflows. |
| 1980 | Jan-Feb, Jul-Aug, SQRT (Jul-Aug) Inflows. |
| 1981 | May-Jun, Jul-Aug, SQRT (Jul-Aug) Inflows. |
| 1982 | Jan-Feb, Nov-Dec, SQRT (Nov-Dec) Inflows. |
| 1983 | Jul-Aug Inflows. |
| 1984 | Jan-Feb, Sept-Oct Inflows. |
| 1985 | Mar-Apr Inflows. |
| 1986 | Nov-Dec Inflows. |
| 1990 | Jul-Aug, SQRT (Jul-Aug) Inflows. |
| 1992 | Jan-Feb, SQRT (Jan-Feb), Mar-Apr, SQRT (Mar-Apr), May-Jun, Nov-Dec, SQRT (Nov-Dec) Inflows. |
| 1993 | Jan-Feb, May-Jun, SQRT (Jul-Aug) Inflows. |

Table 1.3 Summary of points flagged by 99% Prediction Ellipse.

| Year | Variable |
|---|---|
| 1968 | Harvest vs. Sept-Oct, Jan-Feb vs. Sept-Oct, Mar-Apr vs. Sept-Oct, May-Jun vs. Sept-Oct, Jul-Aug vs. Sept-Oct, Sept-Oct vs. Nov-Dec Inflows. |
| 1977 | Jan-Feb vs. Nov-Dec Inflows. |
| 1981 | May-Jun vs. Jul-Aug Inflows. |
| 1982 | Mar-Apr vs. Nov-Dec Inflows. |
| 1985 | Jan-Feb vs. Mar-Apr, Mar-Apr vs. Nov-Dec Inflows. |
| 1992 | Harvest vs. Jan-Feb, Harvest vs. Mar-Apr, Harvest vs. Nov-Dec, Jan-Feb vs. Mar-Apr, Jan-Feb vs. Mar-Apr, Jan-Feb vs. May-Jun, Jan-Feb vs. Jul-Aug, Jan-Feb vs. Sept-Oct, Jan-Feb vs. Nov-Dec, Mar-Apr vs. May-Jun, Mar-Apr vs. Jul-Aug, Mar-Apr vs. Sept-Oct, Mar-Apr vs. Nov-Dec, May-Jun vs. Nov-Dec, Jul-Aug vs. Nov-Dec, Sept-Oct vs. Nov-Dec Inflows. |
| 1993 | May-Jun vs. Sept-Oct Inflows. |

Table 1.4 Summary of points flagged by diagnostic measures.

| YEAR | BOX | SRE | SDR | LEV | MAH | COO | SDF | SDB | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| **DATA SET 3** | | | | | | | | | |
| **1965** | | | | | | | **1** | | **1** |
| **1968** | | | | | | | **1** | | **1** |
| **DATA SET 5** | | | | | | | | | |
| 1968 | 1 | | | | | | | | 1 |
| 1972 | 1 | | | | | | | | 1 |
| 1976 | 1 | | | | | | | | 1 |
| 1977 | 1 | | | | | | | | 1 |
| 1980 | 1 | | | | | | | | 1 |
| 1981 | 1 | | | | | | | | 1 |
| 1982 | 1 | | | | | | | | 1 |
| 1984 | | | | | | | 1 | | 1 |
| **1985** | | | | | | | **1** | **1** | **2** |
| 1990 | 1 | | | | | | | | 1 |
| **1992** | **3** | | | | | | **1** | | **4** |
| 1993 | 1 | | | | | | | | |
| **DATA SET 6** | | | | | | | | | |
| **1965** | | | | | | | **1** | | **1** |

Key to Abbreviations:

**BOX** Box plot
**SDR** Studentized deleted residual
**MAH** Mahalanobis distance
**SDF** Standardized Dffits value
**SRE** Studentized residual
**LEV** Leverage value
**COO** Cook's distance
**SDB** Standardized Dfbeta value

### 1.3.3 Selecting the Final Candidate Models

After the subset analysis led us to the models: Data Set 3 (all variables logged) 1965 and/or 1968 omitted; Data Set 5 (all variables square root) 1985 and/or 1992 omitted; Data Set 6 (variables transformed according to Box-Cox analysis) 1965 omitted.

Table 1.5 R-Square and Adjusted R-Square values for the different subsets.

| Data Set | Observations omitted | $R^2$ | Adjusted $R^2$ |
|---|---|---|---|
| 3 | **1965** | **0.3773** | **0.2279** |
| | 1968 | 0.3090 | 0.1432 |
| | 1965 and 1968 | 0.3027 | 0.1284 |
| 5 | 1985 | 0.2993 | 0.1311 |
| | 1992 | 0.3210 | 0.1581 |
| | 1985 and 1992 | 0.3148 | 0.1435 |
| 6 | 1965 | 0.3497 | 0.1936 |

### 1.3.4 Selecting the Final Model

It is clear that Data Set 3 with 1965 omitted is the best model. Regression was performed using this model, and the deleted residuals were calculated.

| Best Candidate Model | $R^2$ | Adjusted $R^2$ | Prob>F |
|---|---|---|---|
| Ln (Brown Shrimp Harvest) = 6.598 + 0.472*Ln (Jan-Feb Inflows) - 0.242*Ln (May-Jun Inflows) - 0.321*Ln (Sept-Oct Inflows) + 0.286*Ln (Nov-Dec Inflows) | 0.367 | 0.273 | 0.012 |

## 1.4 Best Model: Logged All Variables

### 1.4.1 Summary Information

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| Ln (Brown Shrimp Harvest) | 6.5378 | 1.4604 | 32 |
| Ln (January-February Inflows) | 2.8917 | 1.5030 | 32 |
| Ln (May-June Inflows) | 4.1742 | 1.4843 | 32 |
| Ln (September-October Inflows) | 3.9752 | 1.6722 | 32 |
| Ln (November-December Inflows) | 3.0134 | 1.3180 | 32 |

**Model Summary[a,b]**

| Model | Variables | | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| | Entered | Removed | | | | | |
| 1 | Ln(November-December Inflows), Ln(September-October Inflows), Ln(May-June Inflows), Ln(January-February Inflows)[c,d] | . | .606 | .367 | .273 | 1.2450 | .793 |

a. Dependent Variable: Ln (Brown Shrimp Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Ln (November-December Inflows), Ln (September-October Inflows), Ln (May-June Inflows), Ln (January-February Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 24.268 | 4 | 6.067 | 3.914 | .012[b] |
| | Residual | 41.850 | 27 | 1.550 | | |
| | Total | 66.118 | 31 | | | |

a. Dependent Variable: Ln (Brown Shrimp Harvest)

b. Independent Variables: (Constant), Ln (November-December Inflows), Ln (September-October Inflows), Ln (May-June Inflows), Ln (January-February Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| 1 | (Constant) | 6.598 | .826 | | 7.992 | .000 | 4.904 | 8.292 |
| | Ln (January-February Inflows) | .472 | .190 | .485 | 2.488 | .019 | .083 | .861 |
| | Ln (May-June Inflows) | -.242 | .175 | -.246 | -1.381 | .179 | -.602 | .118 |
| | Ln (September-October Inflows) | -.321 | .140 | -.368 | -2.286 | .030 | -.609 | -.033 |
| | Ln (November-December Inflows) | .286 | .196 | .259 | 1.462 | .155 | -.115 | .688 |

a. Dependent Variable: Ln (Brown Shrimp Harvest)

**Residuals Statistics[a]**

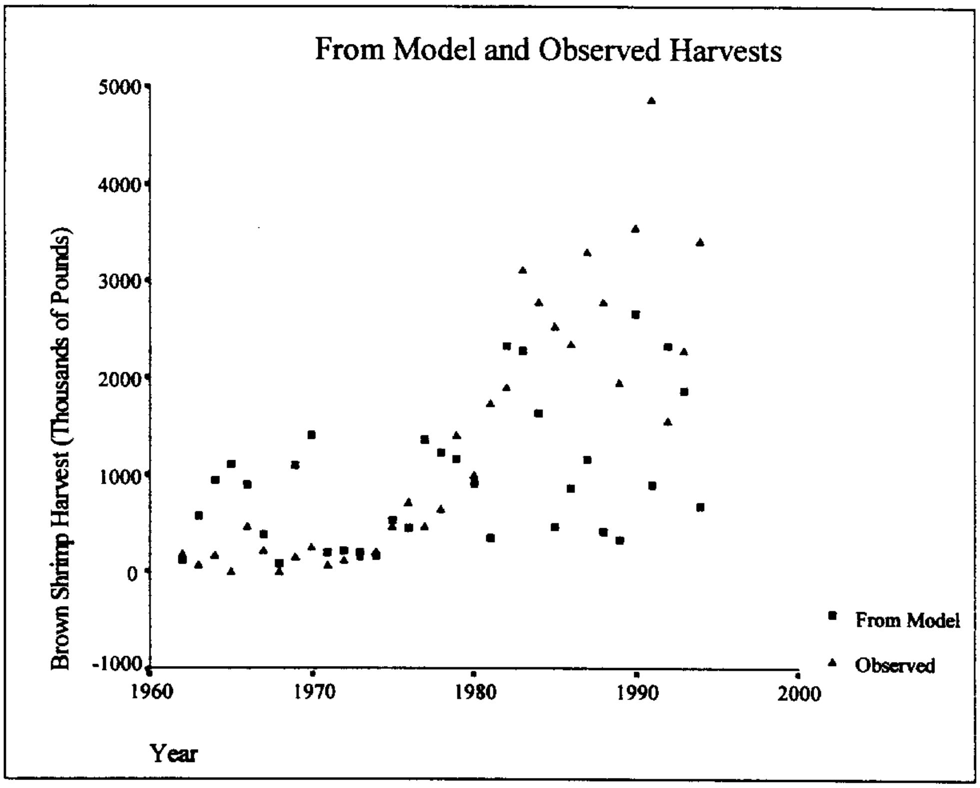
| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 4.6447 | 7.8900 | 6.5378 | .8848 | 32 |
| Std. Predicted Value | -2.140 | 1.528 | .000 | 1.000 | 32 |
| Standard Error of Predicted Value | .2762 | .6919 | .4815 | .1035 | 32 |
| Adjusted Predicted Value | 4.7319 | 7.8551 | 6.5781 | .8808 | 32 |
| Residual | -2.1031 | 1.8654 | -1.E-16 | 1.1619 | 32 |
| Std. Residual | -1.689 | 1.498 | .000 | .933 | 32 |
| Stud. Residual | -1.991 | 1.586 | -.015 | 1.017 | 32 |
| Deleted Residual | -2.9207 | 2.0905 | -4.E-02 | 1.3825 | 32 |
| Stud. Deleted Residual | -2.115 | 1.635 | -.020 | 1.044 | 32 |
| Mahal. Distance | .557 | 8.606 | 3.875 | 2.034 | 32 |
| Cook's Distance | .000 | .308 | .039 | .064 | 32 |
| Centered Leverage Value | .018 | .278 | .125 | .066 | 32 |

a. Dependent Variable: Ln (Brown Shrimp Harvest)

Table 1.6 Observed, predicted, lower and upper predicted intervals values for brown shrimp harvest.

| Year | Observed[a] | Predicted[a] | LICI | UICI |
|---|---|---|---|---|
| **1962** | 195.70 | 126.58 | 2.89 | 5539.34 |
| **1963** | 76.90 | 596.69 | 14.00 | 25432.48 |
| **1964** | 182.20 | 958.24 | 23.26 | 39480.96 |
| **1965** | 22.65 | 1117.53 | 28.26 | 44190.31 |
| **1966** | 482.90 | 904.97 | 23.05 | 35529.16 |
| **1967** | 235.70 | 401.07 | 9.94 | 16183.54 |
| **1968** | 12.70 | 104.03 | 2.10 | 5152.38 |
| **1969** | 162.50 | 1099.49 | 24.54 | 49261.42 |
| **1970** | 258.60 | 1416.44 | 35.89 | 55896.09 |
| **1971** | 78.90 | 218.72 | 5.37 | 8904.83 |
| **1972** | 137.50 | 237.01 | 5.65 | 9949.58 |
| **1973** | 172.20 | 219.36 | 5.31 | 9056.54 |
| **1974** | 210.90 | 183.72 | 4.70 | 7178.35 |
| **1975** | 486.70 | 538.36 | 10.40 | 27858.45 |
| **1976** | 732.60 | 470.69 | 13.11 | 16894.98 |
| **1977** | 474.00 | 1368.92 | 34.06 | 55018.28 |
| **1978** | 659.80 | 1239.33 | 36.20 | 42431.64 |
| **1979** | 1427.60 | 1165.33 | 31.97 | 42479.75 |
| **1980** | 1010.90 | 918.15 | 18.58 | 45364.55 |
| **1981** | 1744.40 | 357.42 | 9.29 | 13749.99 |
| **1982** | 1916.50 | 2352.61 | 56.17 | 98541.53 |
| **1983** | 3122.30 | 2289.54 | 58.43 | 89713.25 |
| **1984** | 2789.60 | 1653.64 | 33.19 | 82399.30 |
| **1985** | 2551.70 | 475.14 | 13.74 | 16432.02 |
| **1986** | 2365.10 | 870.64 | 22.34 | 33933.57 |
| **1987** | 3308.90 | 1169.73 | 33.10 | 41337.32 |
| **1988** | 2789.90 | 431.96 | 11.45 | 16297.35 |
| **1989** | 1967.10 | 354.60 | 8.70 | 14451.20 |
| **1990** | 3558.10 | 2670.35 | 61.33 | 116268.2 |
| **1991** | 4883.30 | 909.30 | 23.89 | 34610.27 |
| **1992** | 1572.50 | 2340.04 | 53.77 | 101829.9 |
| **1993** | 2293.10 | 1881.07 | 46.07 | 76801.83 |
| **1994** | 3415.20 | 699.17 | 19.03 | 25687.99 |

[a] Brown shrimp harvest (thousands of pounds).
LICI Lower limit for 99% prediction interval for brown shrimp harvest.
UICI Upper limit for 99% prediction interval for brown shrimp harvest.



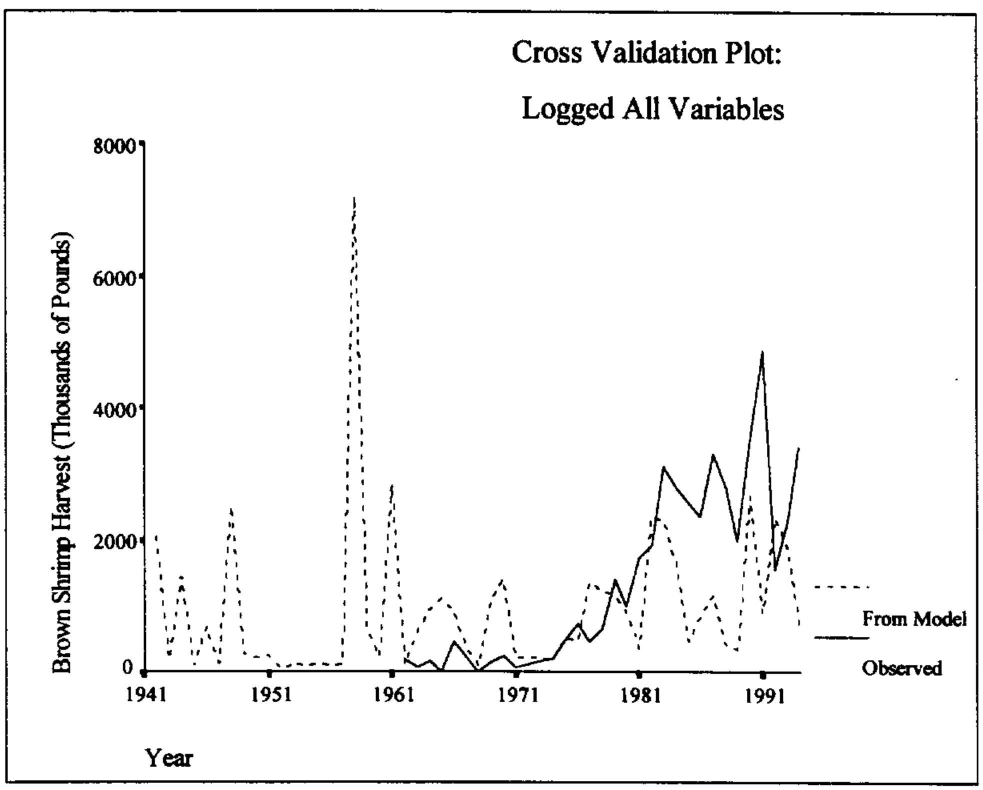




Fig. 1.1 Comparative plots of observed values vs. calculated from the regression model.

## 2.2 Test of Normality for Individual Variables

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Brown Shrimp Harvest | .200 | 33 | .002 | .865 | 33 | .010** |
| Ln (Brown Shrimp Harvest) | .158 | 33 | .037 | .917 | 33 | .020 |
| SQRT (Brown Shrimp Harvest) | .155 | 33 | .042 | .921 | 33 | .028 |
| January-February Inflows | .290 | 33 | .000 | .684 | 33 | .010** |
| Ln (January-February Inflows) | .077 | 33 | .200* | .983 | 33 | .908 |
| SQRT (January-February Inflows) | .196 | 33 | .002 | .869 | 33 | .010** |
| March-April Inflows | .291 | 33 | .000 | .574 | 33 | .010** |
| Ln (March-April Inflows) | .150 | 33 | .058 | .925 | 33 | .037 |
| SQRT (March-April Inflows) | .193 | 33 | .003 | .816 | 33 | .010** |
| May-June Inflows | .316 | 33 | .000 | .730 | 33 | .010** |
| Ln (May-June Inflows) | .093 | 33 | .200* | .959 | 33 | .358 |
| SQRT (May-June Inflows) | .225 | 33 | .000 | .867 | 33 | .010** |
| July-August Inflows | .308 | 33 | .000 | .628 | 33 | .010** |
| Ln (July-August Inflows) | .115 | 33 | .200* | .948 | 33 | .187 |
| SQRT (July-August Inflows) | .237 | 33 | .000 | .782 | 33 | .010** |
| September-October Inflows | .303 | 33 | .000 | .577 | 33 | .010** |
| Ln (September-October Inflows) | .078 | 33 | .200* | .971 | 33 | .584 |
| SQRT (September-October Inflows) | .187 | 33 | .005 | .806 | 33 | .010** |
| November-December Inflows | .285 | 33 | .000 | .641 | 33 | .010** |
| Ln (November-December Inflows) | .085 | 33 | .200* | .968 | 33 | .500 |
| SQRT (November-December Inflows) | .185 | 33 | .006 | .829 | 33 | .010** |

**. This is an upper bound of the true significance.

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

## 2.3 Percentiles for Individual Variables

**Percentiles**

| | | Percentiles | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 10 | 25 | 50 | 75 | 90 | 95 |
| Weighted Average (Definition 1) | Brown Shrimp Harvest | 19.6300 | 77.7000 | 188.9500 | 732.6000 | 2458.40 | 3372.68 | 3955.66 |
| | Ln (Brown Shrimp Harvest) | 2.9450 | 4.3528 | 5.2408 | 6.5966 | 7.8065 | 8.1233 | 8.2720 |
| | SQRT (Brown Shrimp Harvest) | 4.3969 | 8.8146 | 13.7437 | 27.0666 | 49.5733 | 58.0730 | 62.7191 |
| | January-February Inflows | 1.4640 | 2.4420 | 5.9150 | 19.0100 | 52.1050 | 154.0320 | 212.4900 |
| | Ln (January-February Inflows) | .2958 | .8824 | 1.7634 | 2.9450 | 3.9517 | 5.0247 | 5.3254 |
| | SQRT (January-February Inflows) | 1.1865 | 1.5586 | 2.4236 | 4.3600 | 7.2156 | 12.3730 | 14.4520 |
| | March-April Inflows | 2.0620 | 2.3900 | 3.9700 | 16.7100 | 57.3650 | 118.2280 | 280.9840 |
| | Ln (March-April Inflows) | .7203 | .8712 | 1.3787 | 2.8160 | 4.0493 | 4.7662 | 5.5981 |
| | SQRT (March-April Inflows) | 1.4348 | 1.5459 | 1.9925 | 4.0678 | 7.5738 | 10.8559 | 16.5900 |
| | May-June Inflows | 4.8170 | 8.0140 | 21.9450 | 64.3700 | 231.6800 | 560.0620 | 615.8650 |
| | Ln (May-June Inflows) | 1.5573 | 2.0742 | 3.0870 | 4.1646 | 5.4447 | 6.3273 | 6.4206 |
| | SQRT (May-June Inflows) | 2.1869 | 2.8259 | 4.6827 | 8.0231 | 15.2181 | 23.6610 | 24.8017 |
| | July-August Inflows | 2.4290 | 3.4460 | 8.4250 | 21.9200 | 66.1650 | 313.3820 | 367.7950 |
| | Ln (July-August Inflows) | .8849 | 1.1967 | 2.1310 | 3.0874 | 4.1876 | 5.7377 | 5.9069 |
| | SQRT (July-August Inflows) | 1.5575 | 1.8374 | 2.9024 | 4.6819 | 8.1260 | 17.6602 | 19.1748 |
| | September-October Inflows | 3.1850 | 4.9740 | 15.3850 | 42.3200 | 155.8650 | 559.2040 | 1187.87 |
| | Ln (September-October Inflows) | 1.1563 | 1.5928 | 2.7210 | 3.7453 | 5.0460 | 6.3265 | 7.0691 |
| | SQRT (September-October Inflows) | 1.7837 | 2.2238 | 3.9103 | 6.5054 | 12.4818 | 23.6473 | 34.3711 |
| | November-December Inflows | 2.3510 | 3.7660 | 6.1400 | 19.7100 | 43.3600 | 173.8720 | 235.4310 |
| | Ln (November-December Inflows) | .8437 | 1.3307 | 1.8024 | 2.9811 | 3.7681 | 5.1085 | 5.4590 |
| | SQRT (November-December Inflows) | 1.5291 | 1.9457 | 2.4703 | 4.4396 | 6.5821 | 13.0284 | 15.3345 |
| Tukey's Hinges | Brown Shrimp Harvest | | | 195.7000 | 732.6000 | 2365.10 | | |
| | Ln (Brown Shrimp Harvest) | | | 5.2766 | 6.5966 | 7.7686 | | |
| | SQRT (Brown Shrimp Harvest) | | | 13.9893 | 27.0666 | 48.6323 | | |
| | January-February Inflows | | | 6.9000 | 19.0100 | 49.2300 | | |
| | Ln (January-February Inflows) | | | 1.9315 | 2.9450 | 3.8965 | | |
| | SQRT (January-February Inflows) | | | 2.6268 | 4.3600 | 7.0164 | | |
| | March-April Inflows | | | 4.0100 | 16.7100 | 56.5600 | | |
| | Ln (March-April Inflows) | | | 1.3888 | 2.8160 | 4.0351 | | |
| | SQRT (March-April Inflows) | | | 2.0025 | 4.0678 | 7.5200 | | |
| | May-June Inflows | | | 23.1800 | 64.3700 | 223.5900 | | |
| | Ln (May-June Inflows) | | | 3.1433 | 4.1646 | 5.4098 | | |
| | SQRT (May-June Inflows) | | | 4.8146 | 8.0231 | 14.9529 | | |
| | July-August Inflows | | | 8.6000 | 21.9200 | 59.8100 | | |
| | Ln (July-August Inflows) | | | 2.1518 | 3.0874 | 4.0912 | | |
| | SQRT (July-August Inflows) | | | 2.9326 | 4.6819 | 7.7337 | | |
| | September-October Inflows | | | 17.7900 | 42.3200 | 148.4600 | | |
| | Ln (September-October Inflows) | | | 2.8786 | 3.7453 | 5.0003 | | |
| | SQRT (September-October Inflows) | | | 4.2178 | 6.5054 | 12.1844 | | |
| | November-December Inflows | | | 7.1000 | 19.7100 | 41.2500 | | |
| | Ln (November-December Inflows) | | | 1.9601 | 2.9811 | 3.7197 | | |
| | SQRT (November-December Inflows) | | | 2.6646 | 4.4396 | 6.4226 | | |

## 2.4 Summary Information for Individual Variables

### 2.4.1 Summary Information for Brown Shrimp Harvest

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| Brown Shrimp Harvest | Mean | | 1372.68 | 233.8066 |
| | 95% Confidence Interval for Mean | Lower Bound | 896.4363 | |
| | | Upper Bound | 1848.93 | |
| | 5% Trimmed Mean | | 1281.99 | |
| | Median | | 732.6000 | |
| | Variance | | 1803963 | |
| | Std. Deviation | | 1343.12 | |
| | Minimum | | 12.70 | |
| | Maximum | | 4883.3 | |
| | Range | | 4870.6 | |
| | Interquartile Range | | 2269.45 | |
| | Skewness | | .812 | .409 |
| | Kurtosis | | -.318 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| Brown Shrimp Harvest | Highest | 1 | 30 | 1991 | 4883.3 |
| | | 2 | 29 | 1990 | 3558.1 |
| | | 3 | 33 | 1994 | 3415.2 |
| | | 4 | 26 | 1987 | 3308.9 |
| | | 5 | 22 | 1983 | 3122.3 |
| | Lowest | 1 | 7 | 1968 | 12.70 |
| | | 2 | 4 | 1965 | 22.60 |
| | | 3 | 2 | 1963 | 76.90 |
| | | 4 | 10 | 1971 | 78.90 |
| | | 5 | 11 | 1972 | 137.50 |

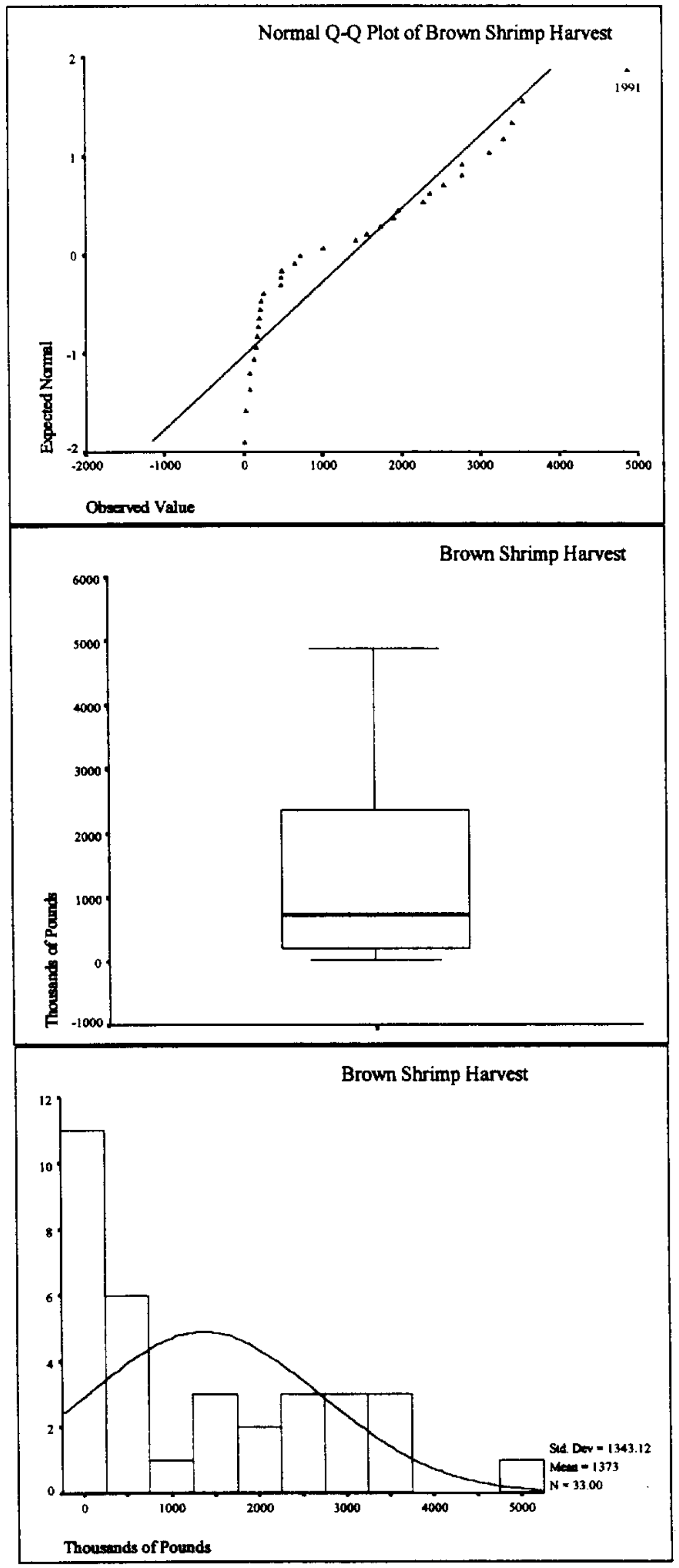



Fig. 2.1a. Exploratory Plots of Brown Shrimp Harvest.

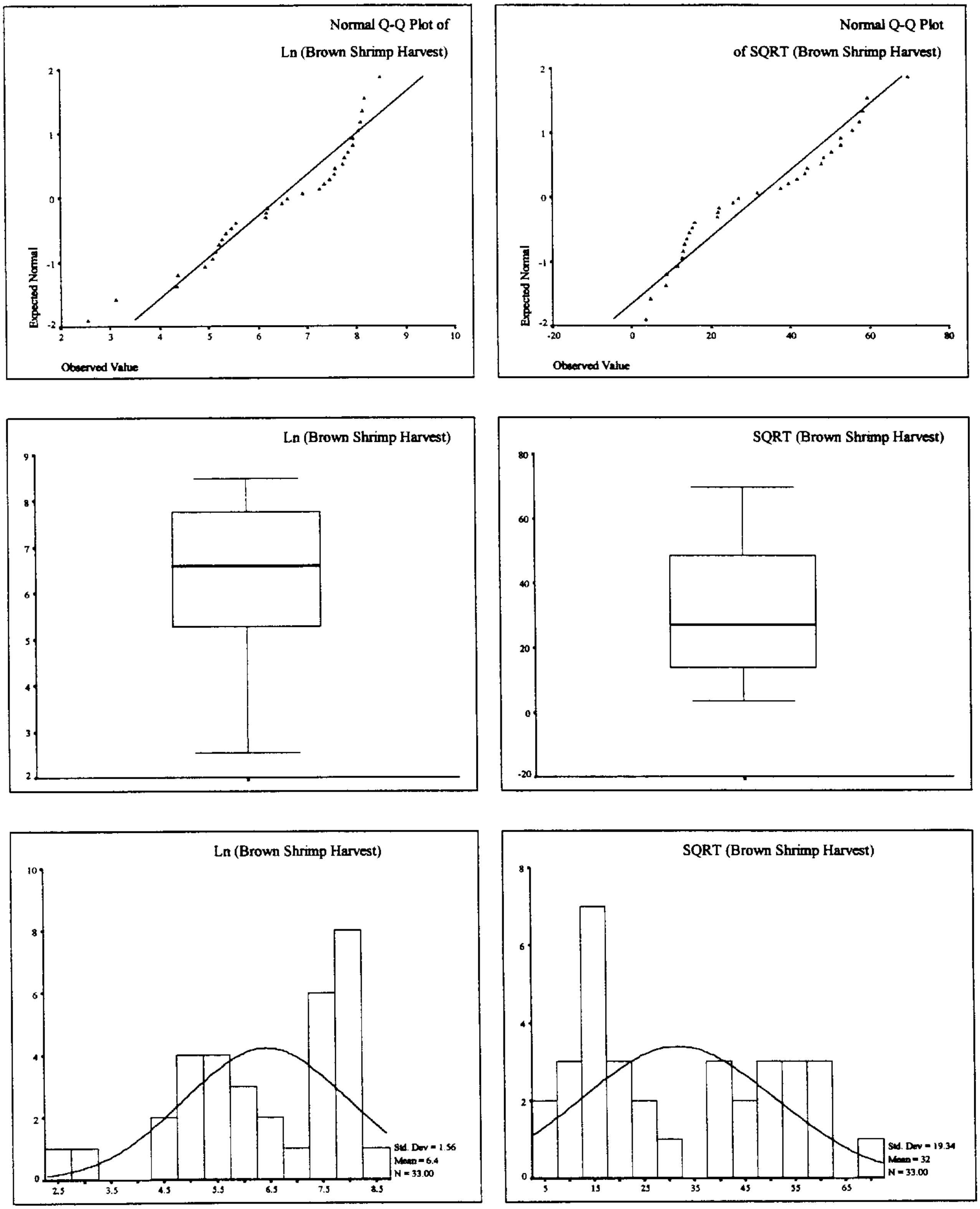



Fig. 2.1b. Exploratory Plots of Transformed Brown Shrimp Harvest.

### 2.4.2 Summary Information for January-February Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| January-February Inflows | Mean | | 46.1248 | 11.5995 |
| | 95% Confidence Interval for Mean | Lower Bound | 22.4975 | |
| | | Upper Bound | 69.7522 | |
| | 5% Trimmed Mean | | 37.2214 | |
| | Median | | 19.0100 | |
| | Variance | | 4440.060 | |
| | Std. Deviation | | 66.6338 | |
| | Minimum | | .68 | |
| | Maximum | | 301.5 | |
| | Range | | 300.8 | |
| | Interquartile Range | | 46.1900 | |
| | Skewness | | 2.350 | .409 |
| | Kurtosis | | 6.076 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| January-February Inflows | Highest | 1 | 31 | 1992 | 301.5 |
| | | 2 | 32 | 1993 | 174.4 |
| | | 3 | 21 | 1982 | 173.3 |
| | | 4 | 19 | 1980 | 125.1 |
| | | 5 | 23 | 1984 | 119.8 |
| | Lowest | 1 | 1 | 1962 | .68 |
| | | 2 | 2 | 1963 | 1.80 |
| | | 3 | 27 | 1988 | 2.15 |
| | | 4 | 10 | 1971 | 2.88 |
| | | 5 | 6 | 1967 | 3.48 |

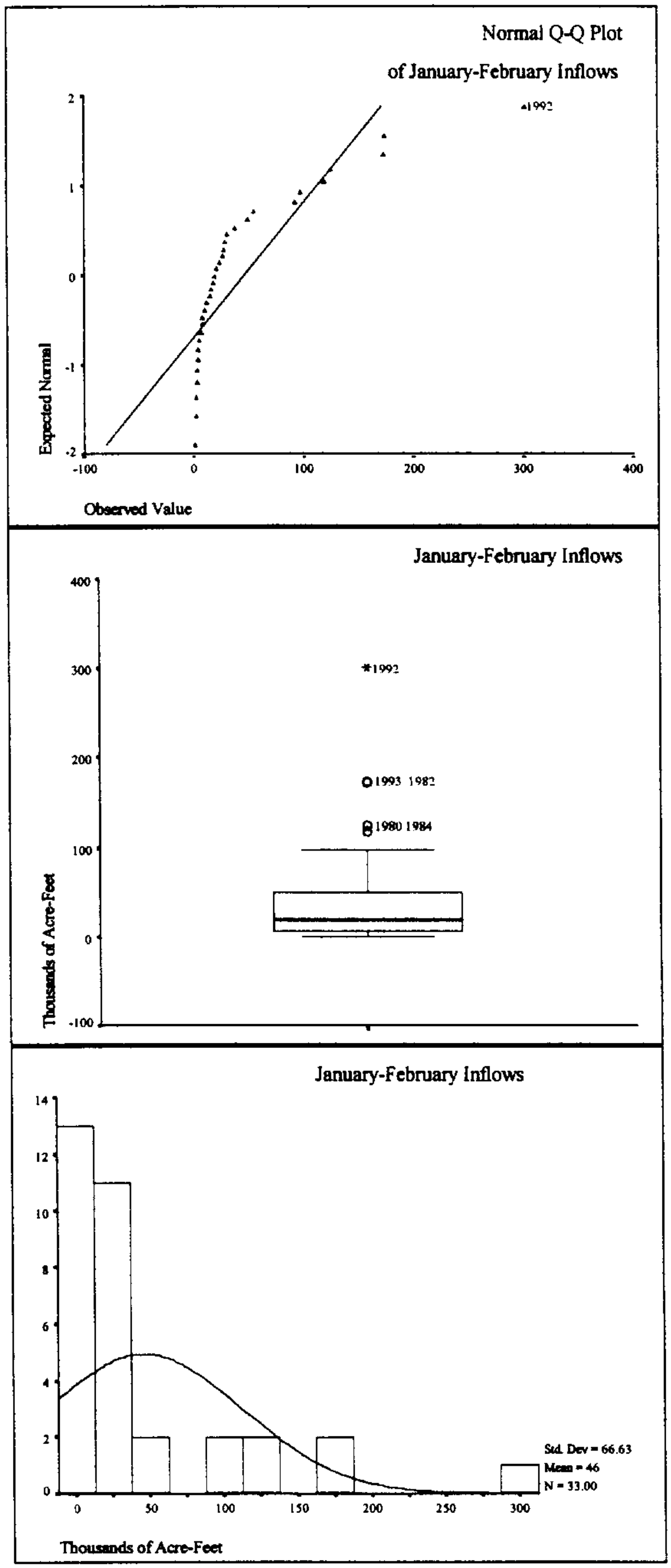



Fig. 2.2a. Exploratory Plots of January-February Inflows.

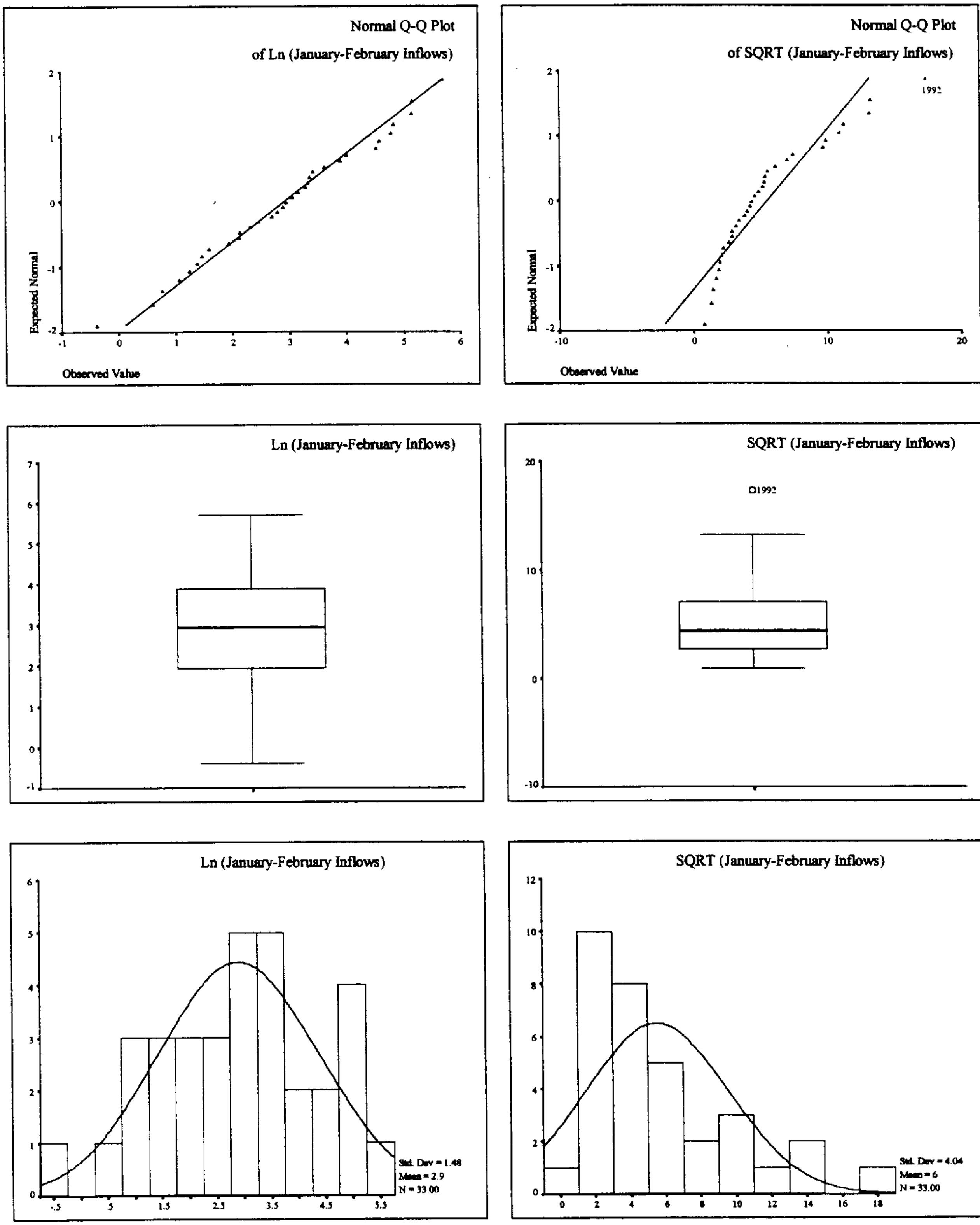



Fig. 2.2b. Exploratory Plots of Transformed January-February Inflows.

### 2.4.3 Summary Information for March-April Inflows

**Descriptives**

| | | | | Statistic | Std. Error |
|---|---|---|---|---|---|
| March-April Inflows | Mean | | | 45.9867 | 13.9862 |
| | 95% Confidence Interval for Mean | Lower Bound | | 17.4976 | |
| | | Upper Bound | | 74.4757 | |
| | 5% Trimmed Mean | | | 32.2375 | |
| | Median | | | 16.7100 | |
| | Variance | | | 6455.290 | |
| | Std. Deviation | | | 80.3448 | |
| | Minimum | | | 1.81 | |
| | Maximum | | | 410.26 | |
| | Range | | | 408.45 | |
| | Interquartile Range | | | 53.3950 | |
| | Skewness | | | 3.444 | .409 |
| | Kurtosis | | | 13.667 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| March-April Inflows | Highest | 1 | 31 | 1992 | 410.26 |
| | | 2 | 24 | 1985 | 225.58 |
| | | 3 | 32 | 1993 | 129.00 |
| | | 4 | 5 | 1966 | 102.07 |
| | | 5 | 16 | 1977 | 73.95 |
| | Lowest | 1 | 1 | 1962 | 1.81 |
| | | 2 | 25 | 1986 | 2.17 |
| | | 3 | 2 | 1963 | 2.37 |
| | | 4 | 6 | 1967 | 2.42 |
| | | 5 | 28 | 1989 | 2.72 |

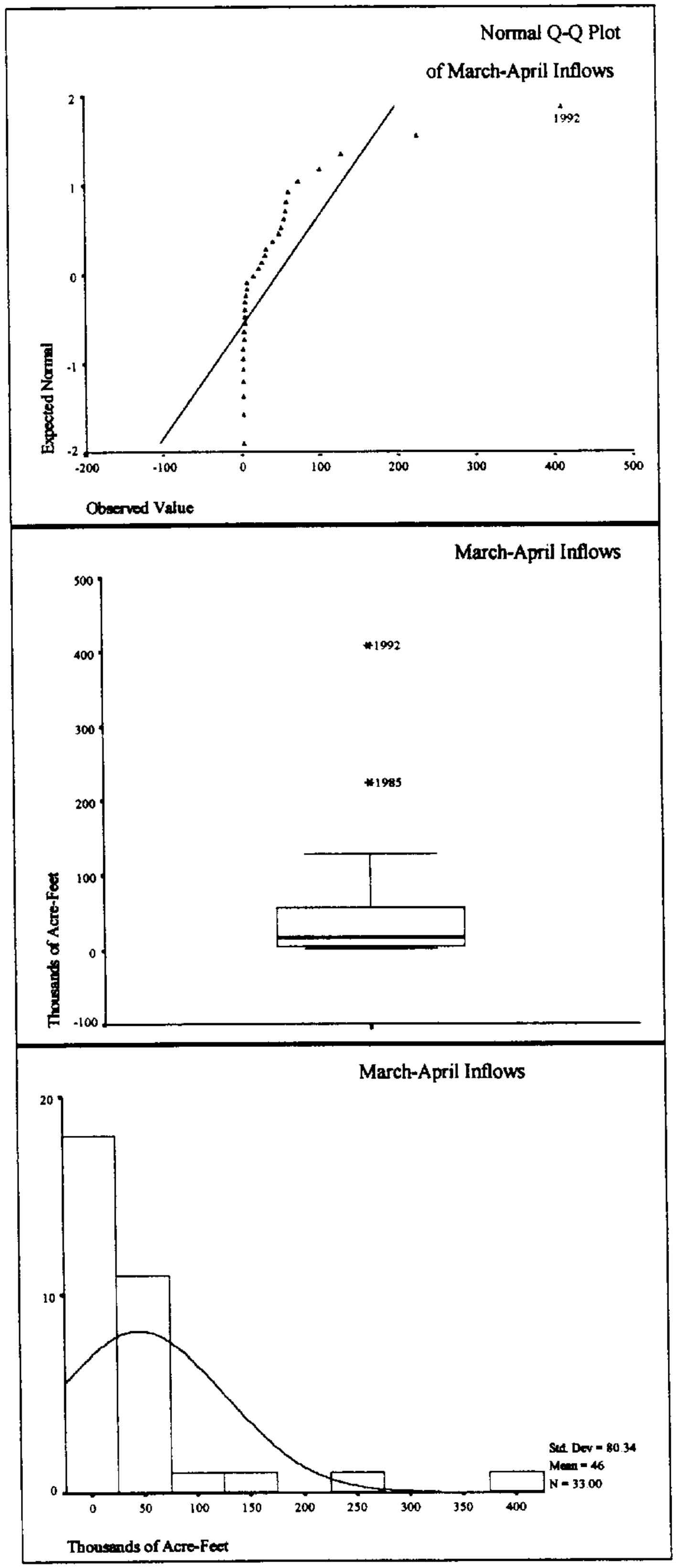



Fig. 2.3a. Exploratory Plots of March-April Inflows.

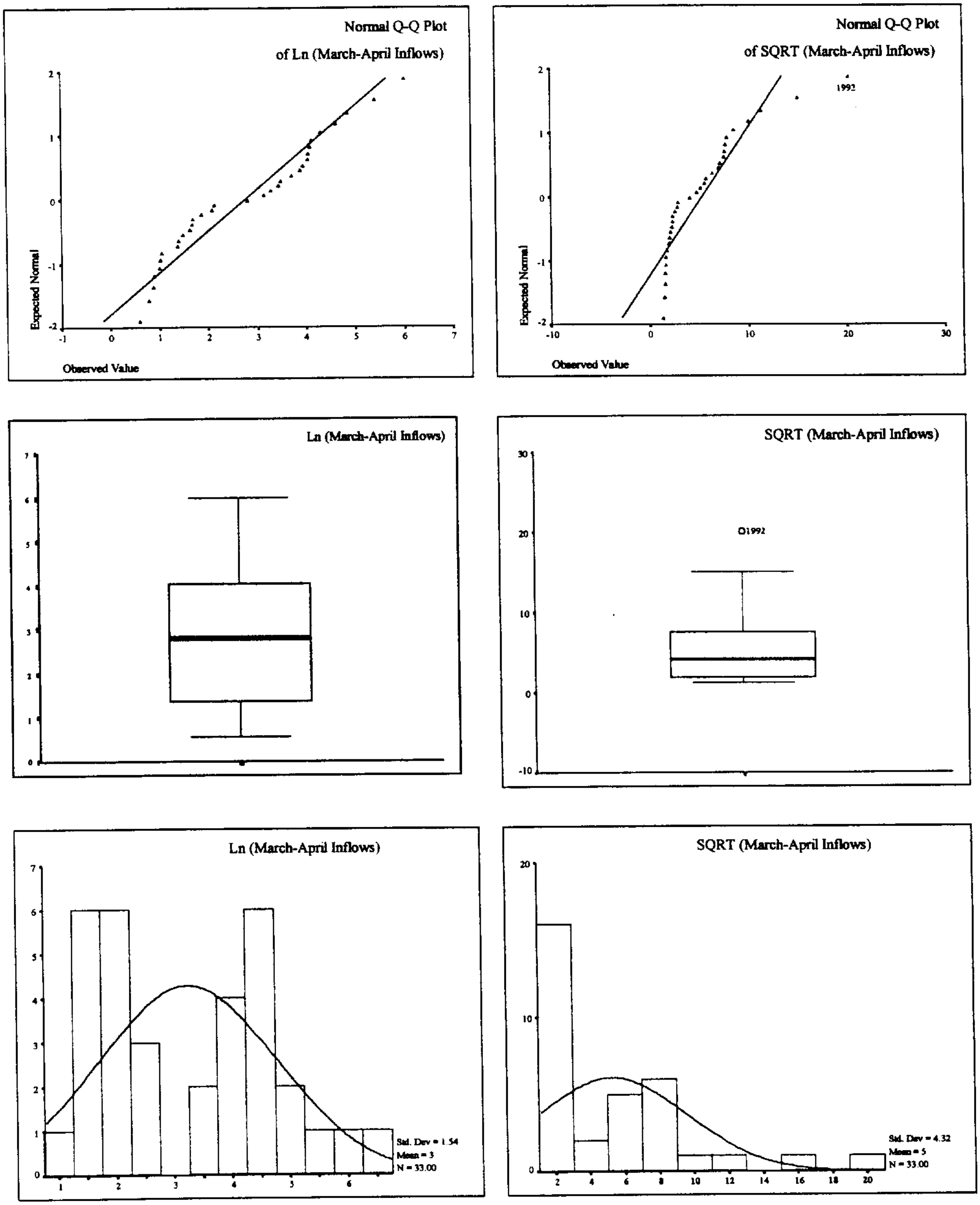



Fig. 2.3b. Exploratory Plots of Transformed March-April Inflows.

### 2.4.4 Summary Information for May-June Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| May-June Inflows | Mean | | 155.0294 | 34.4961 |
| | 95% Confidence Interval for Mean | Lower Bound | 84.7630 | |
| | | Upper Bound | 225.2957 | |
| | 5% Trimmed Mean | | 136.1940 | |
| | Median | | 64.3700 | |
| | Variance | | 39269.5 | |
| | Std. Deviation | | 198.1653 | |
| | Minimum | | 3.62 | |
| | Maximum | | 682.05 | |
| | Range | | 678.43 | |
| | Interquartile Range | | 209.7150 | |
| | Skewness | | 1.530 | .409 |
| | Kurtosis | | 1.097 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| May-June Inflows | Highest | 1 | 32 | 1993 | 682.05 |
| | | 2 | 20 | 1981 | 587.50 |
| | | 3 | 7 | 1968 | 578.09 |
| | | 4 | 31 | 1992 | 533.02 |
| | | 5 | 12 | 1973 | 454.15 |
| | Lowest | 1 | 2 | 1963 | 3.62 |
| | | 2 | 14 | 1975 | 5.33 |
| | | 3 | 29 | 1990 | 7.23 |
| | | 4 | 10 | 1971 | 9.19 |
| | | 5 | 3 | 1964 | 9.88 |

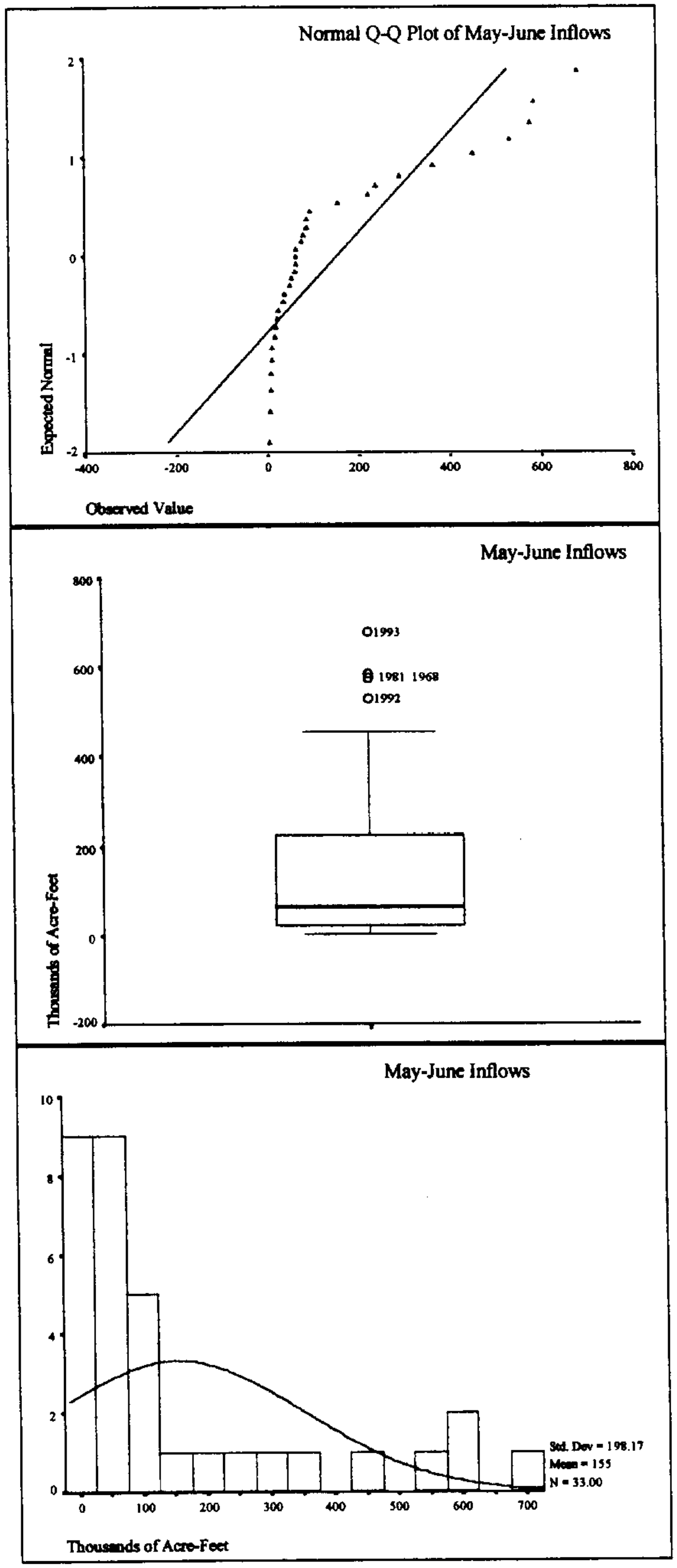



Fig. 2.4a. Exploratory Plots of May-June Inflows.

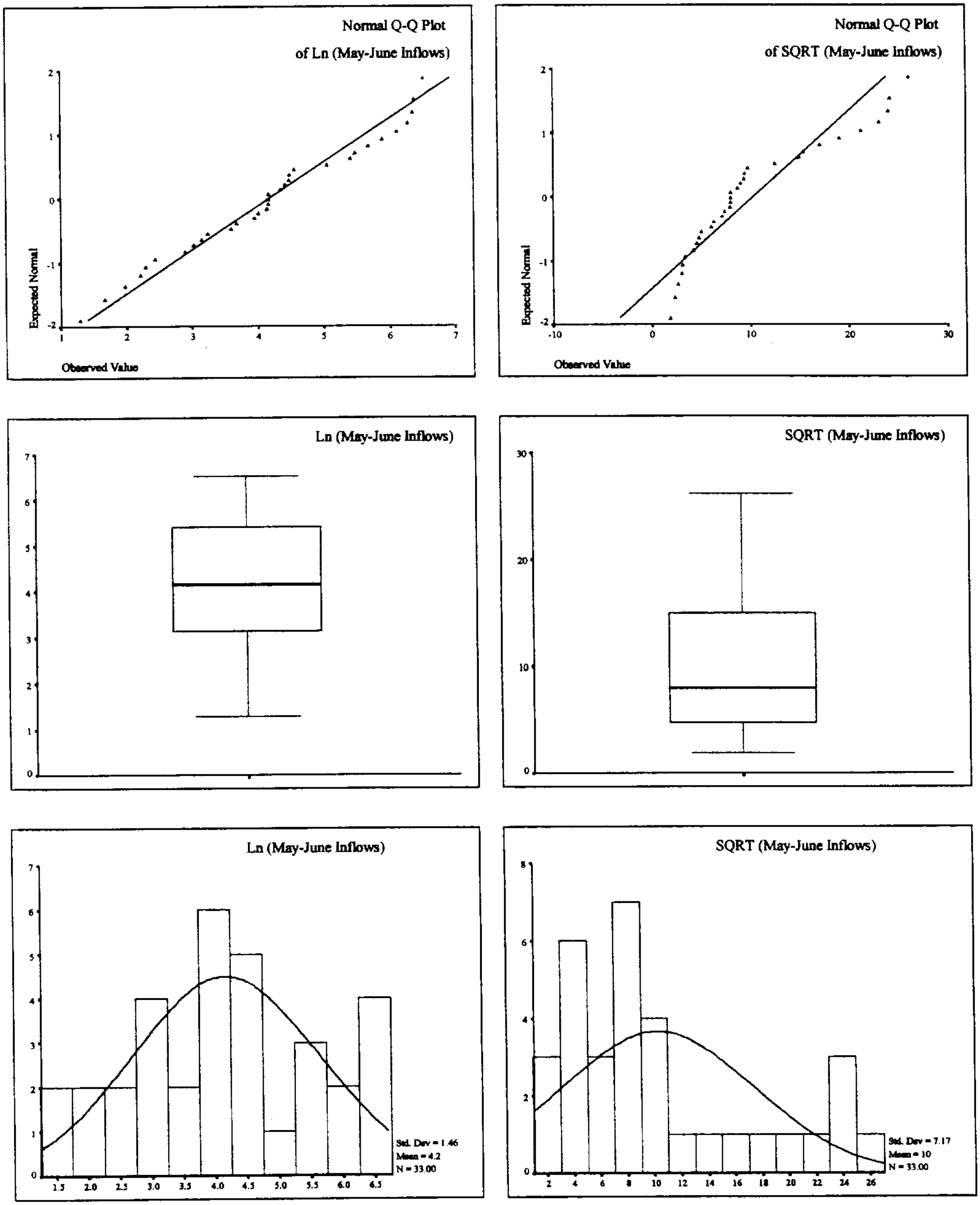



Fig. 2.4b. Exploratory Plots of Transformed May-June Inflows.

### 2.4.5 Summary Information for July-August Inflows

**Descriptives**

| | | | | Statistic | Std. Error |
|---|---|---|---|---|---|
| July-August Inflows | Mean | | | 72.6573 | 19.7117 |
| | 95% Confidence Interval for Mean | Lower Bound | | 32.5059 | |
| | | Upper Bound | | 112.8086 | |
| | 5% Trimmed Mean | | | 59.6644 | |
| | Median | | | 21.9200 | |
| | Variance | | | 12822.1 | |
| | Std. Deviation | | | 113.2349 | |
| | Minimum | | | 2.17 | |
| | Maximum | | | 388.55 | |
| | Range | | | 386.38 | |
| | Interquartile Range | | | 57.7600 | |
| | Skewness | | | 1.927 | .409 |
| | Kurtosis | | | 2.429 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| July-August Inflows | Highest | 1 | 22 | 1983 | 388.55 |
| | | 2 | 29 | 1990 | 358.90 |
| | | 3 | 20 | 1981 | 348.21 |
| | | 4 | 19 | 1980 | 261.14 |
| | | 5 | 15 | 1976 | 247.05 |
| | Lowest | 1 | 2 | 1963 | 2.17 |
| | | 2 | 4 | 1965 | 2.54 |
| | | 3 | 1 | 1962 | 2.63 |
| | | 4 | 23 | 1984 | 4.67 |
| | | 5 | 27 | 1988 | 6.05 |

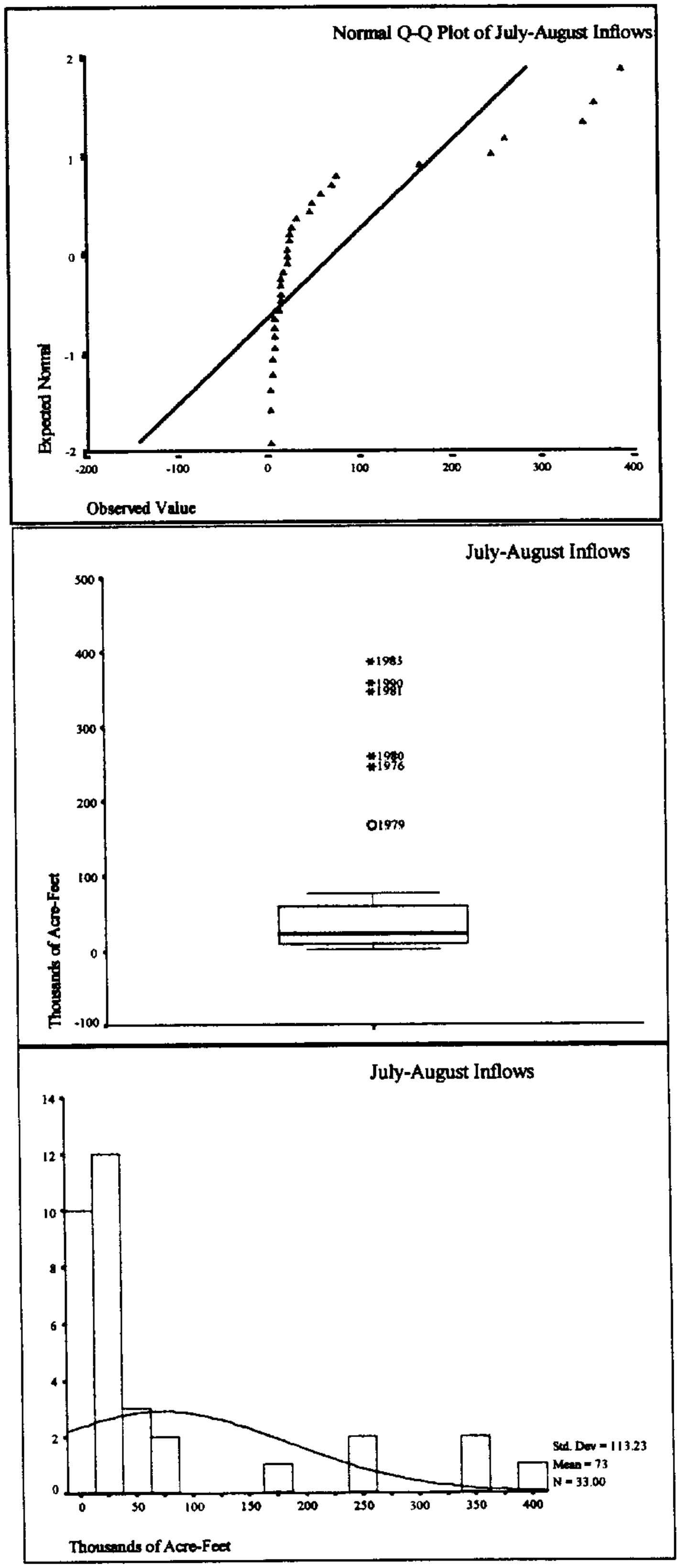



Fig. 2.5a. Exploratory Plots of July-August Inflows.

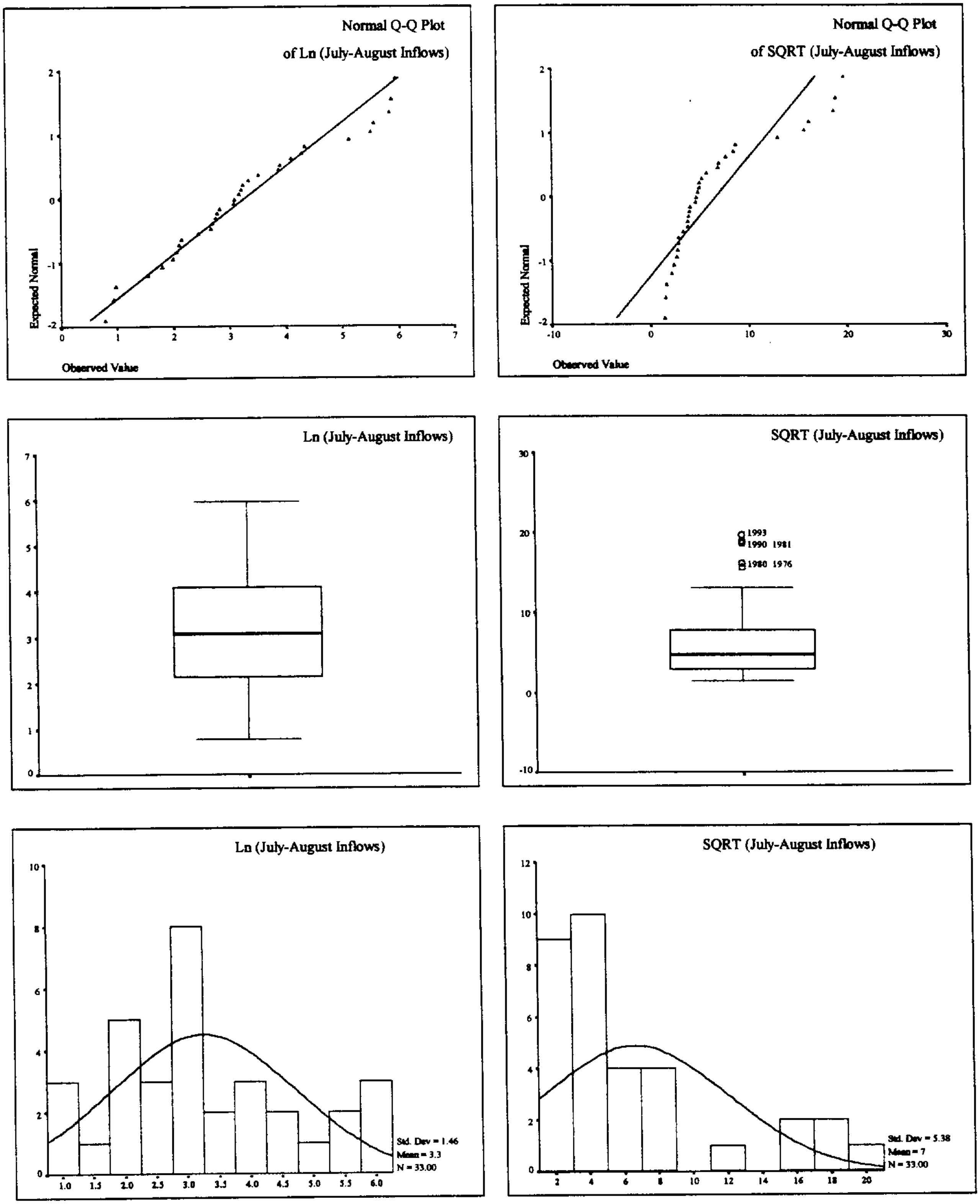



Fig. 2.5b. Exploratory Plots of Transformed July-August Inflows.

### 2.4.6 Summary Information for September-October Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| September-October Inflows | Mean | | 175.3479 | 55.6843 |
| | 95% Confidence Interval for Mean | Lower Bound | 61.9227 | |
| | | Upper Bound | 288.7731 | |
| | 5% Trimmed Mean | | 121.9580 | |
| | Median | | 42.3200 | |
| | Variance | | 102324 | |
| | Std. Deviation | | 319.8819 | |
| | Minimum | | 2.87 | |
| | Maximum | | 1464.2 | |
| | Range | | 1461.3 | |
| | Interquartile Range | | 140.5000 | |
| | Skewness | | 2.950 | .409 |
| | Kurtosis | | 9.132 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| September-October Inflows | Highest | 1 | 7 | 1968 | 1464.2 |
| | | 2 | 11 | 1972 | 1069.5 |
| | | 3 | 23 | 1984 | 562.84 |
| | | 4 | 13 | 1974 | 553.75 |
| | | 5 | 19 | 1980 | 325.18 |
| | Lowest | 1 | 3 | 1964 | 2.87 |
| | | 2 | 29 | 1990 | 3.32 |
| | | 3 | 22 | 1983 | 4.35 |
| | | 4 | 6 | 1967 | 5.91 |
| | | 5 | 9 | 1970 | 6.01 |

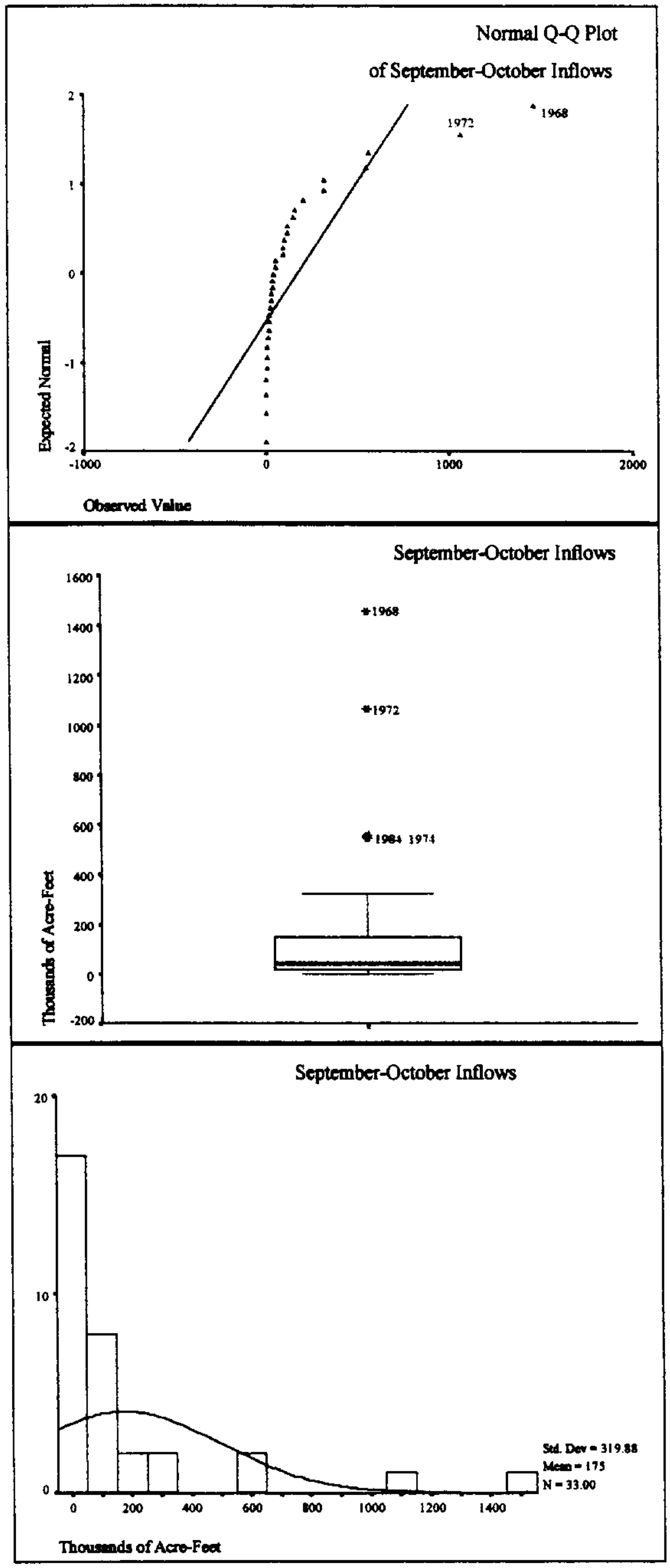



Fig. 2.6a. Exploratory Plots of September-October Inflows.

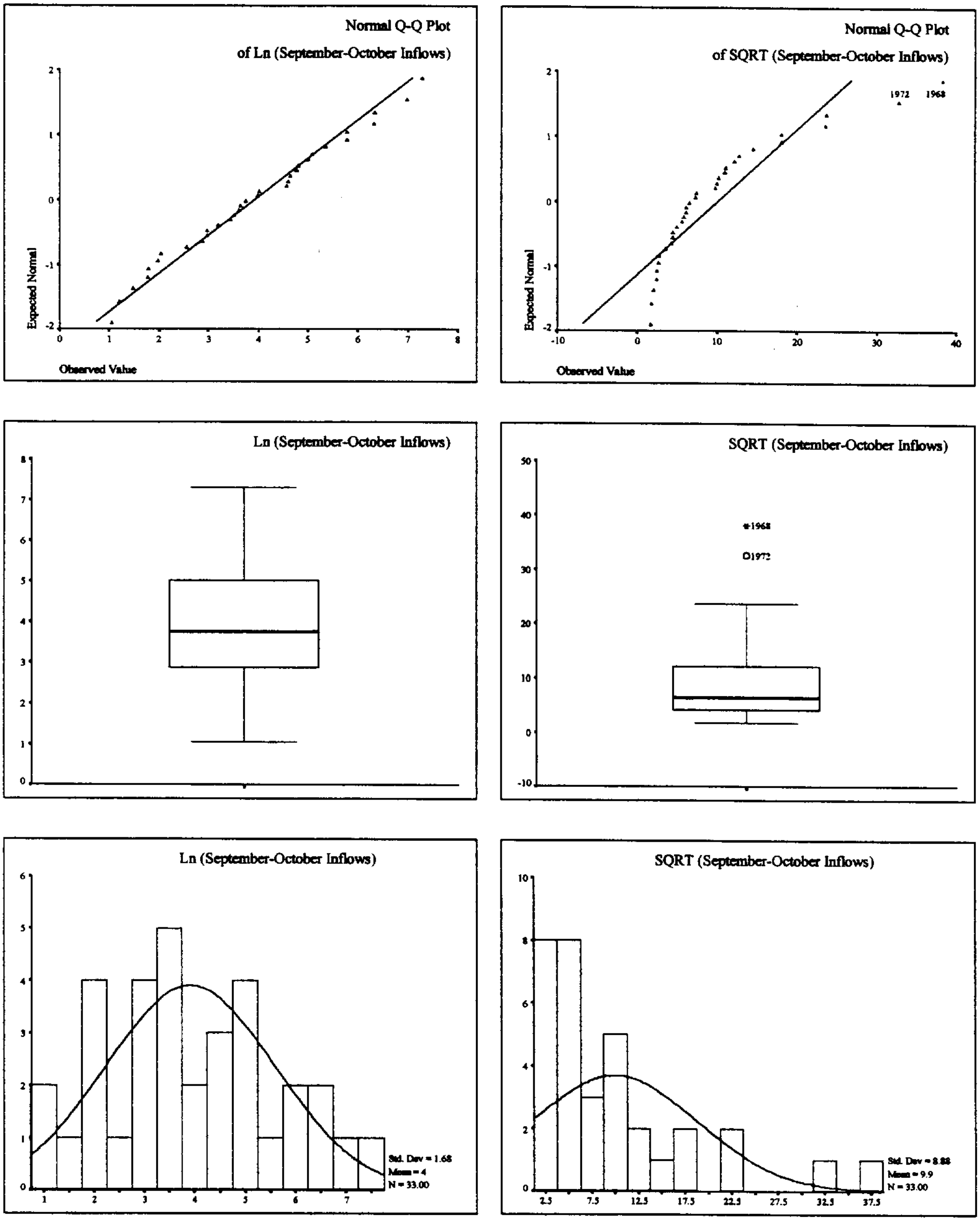



Fig. 2.6b. Exploratory Plots of Transformed September-October Inflows.

### 2.4.7 Summary Information for November-December Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| November-December Inflows | Mean | | 45.0027 | 11.5685 |
| | 95% Confidence Interval for Mean | Lower Bound | 21.4385 | |
| | | Upper Bound | 68.5670 | |
| | 5% Trimmed Mean | | 36.1886 | |
| | Median | | 19.7100 | |
| | Variance | | 4416.388 | |
| | Std. Deviation | | 66.4559 | |
| | Minimum | | 1.84 | |
| | Maximum | | 260.82 | |
| | Range | | 258.98 | |
| | Interquartile Range | | 37.2100 | |
| | Skewness | | 2.307 | .409 |
| | Kurtosis | | 4.659 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| November-December Inflows | Highest | 1 | 31 | 1992 | 260.82 |
| | | 2 | 16 | 1977 | 224.55 |
| | | 3 | 21 | 1982 | 215.74 |
| | | 4 | 25 | 1986 | 111.07 |
| | | 5 | 14 | 1975 | 94.34 |
| | Lowest | 1 | 28 | 1989 | 1.84 |
| | | 2 | 6 | 1967 | 2.57 |
| | | 3 | 10 | 1971 | 3.64 |
| | | 4 | 8 | 1969 | 4.01 |
| | | 5 | 1 | 1962 | 4.63 |

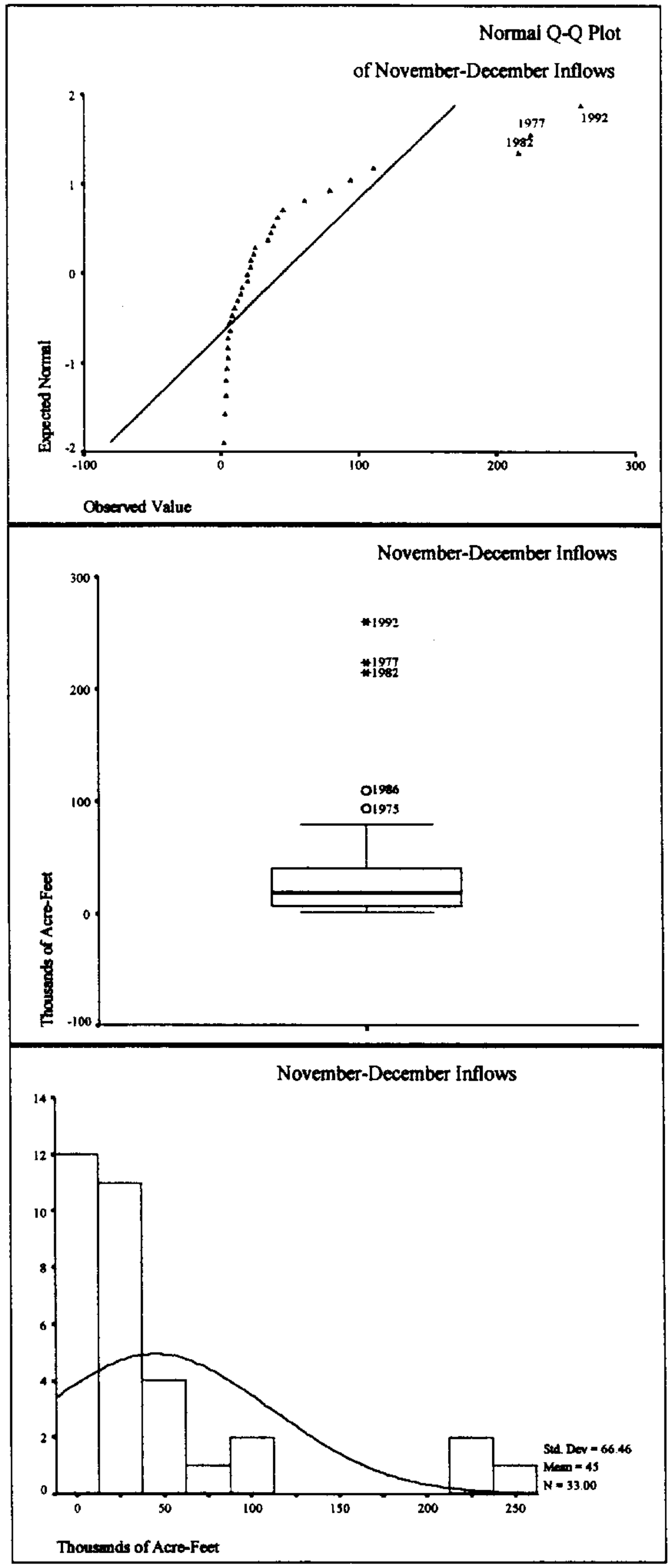



Fig. 2.7a. Exploratory Plots of November-December Inflows.

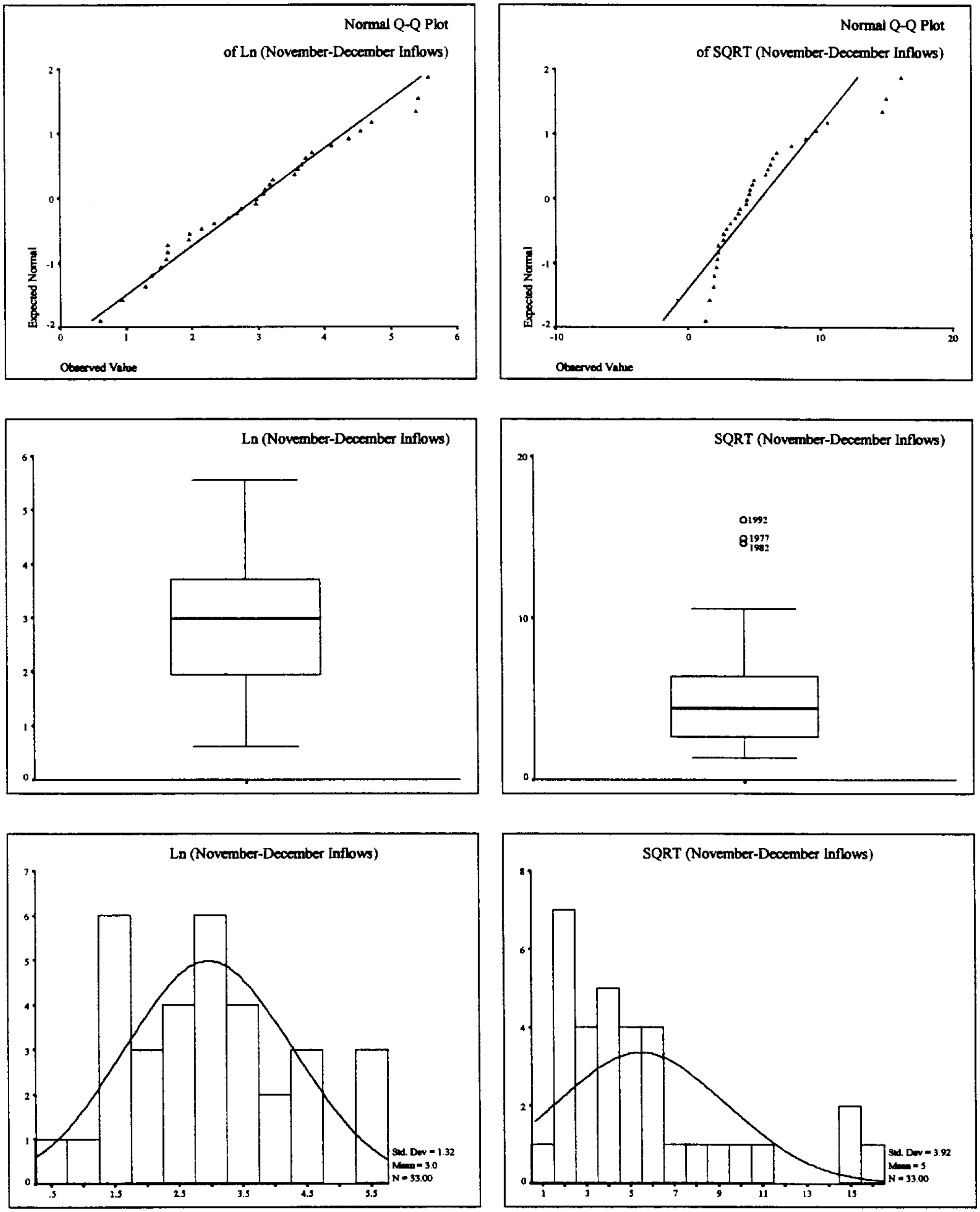



Fig. 2.7b. Exploratory Plots of Transformed November-December Inflows.

## 3. Prediction and Confidence Regions

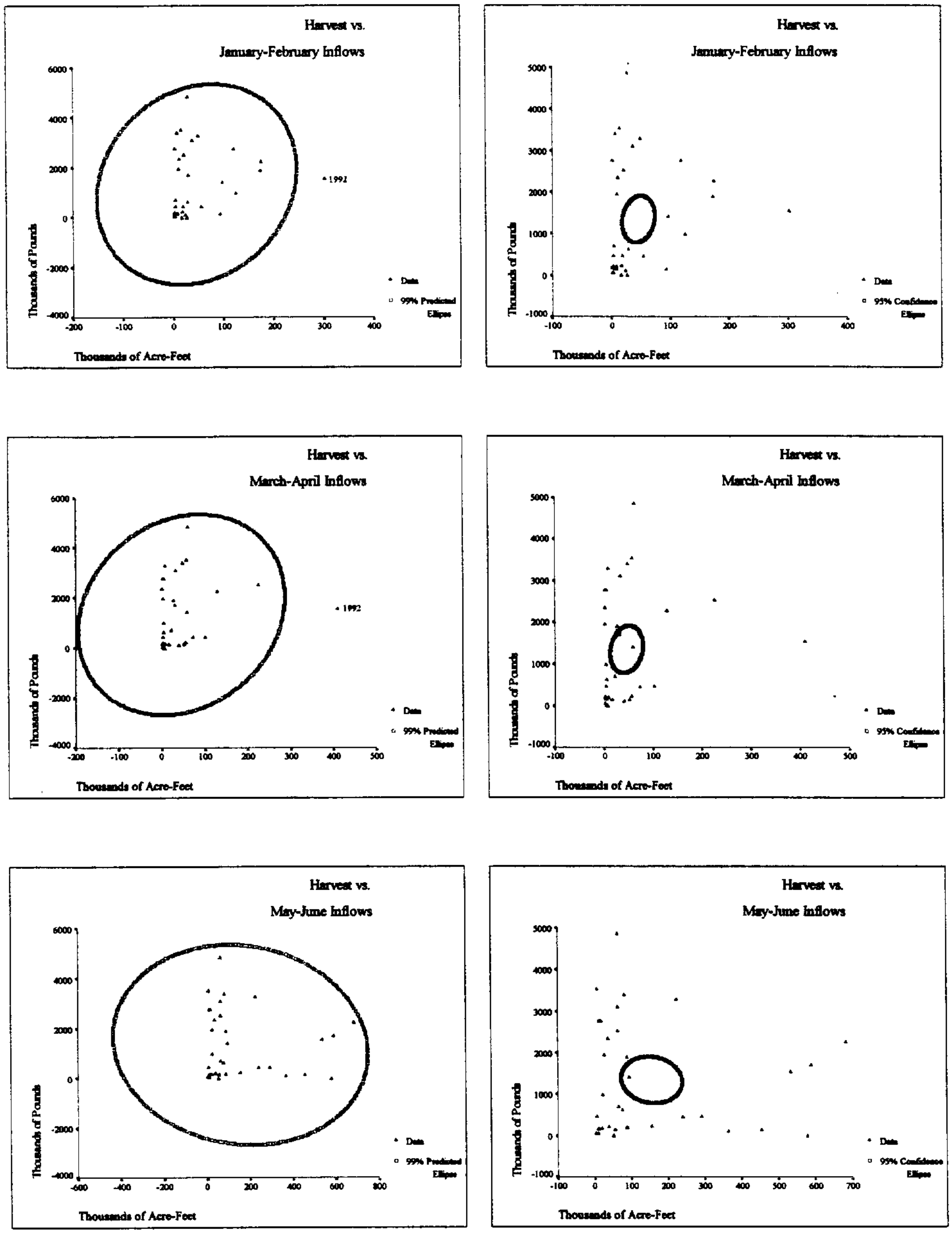



Fig. 3.1. Prediction and Confidence Ellipses.

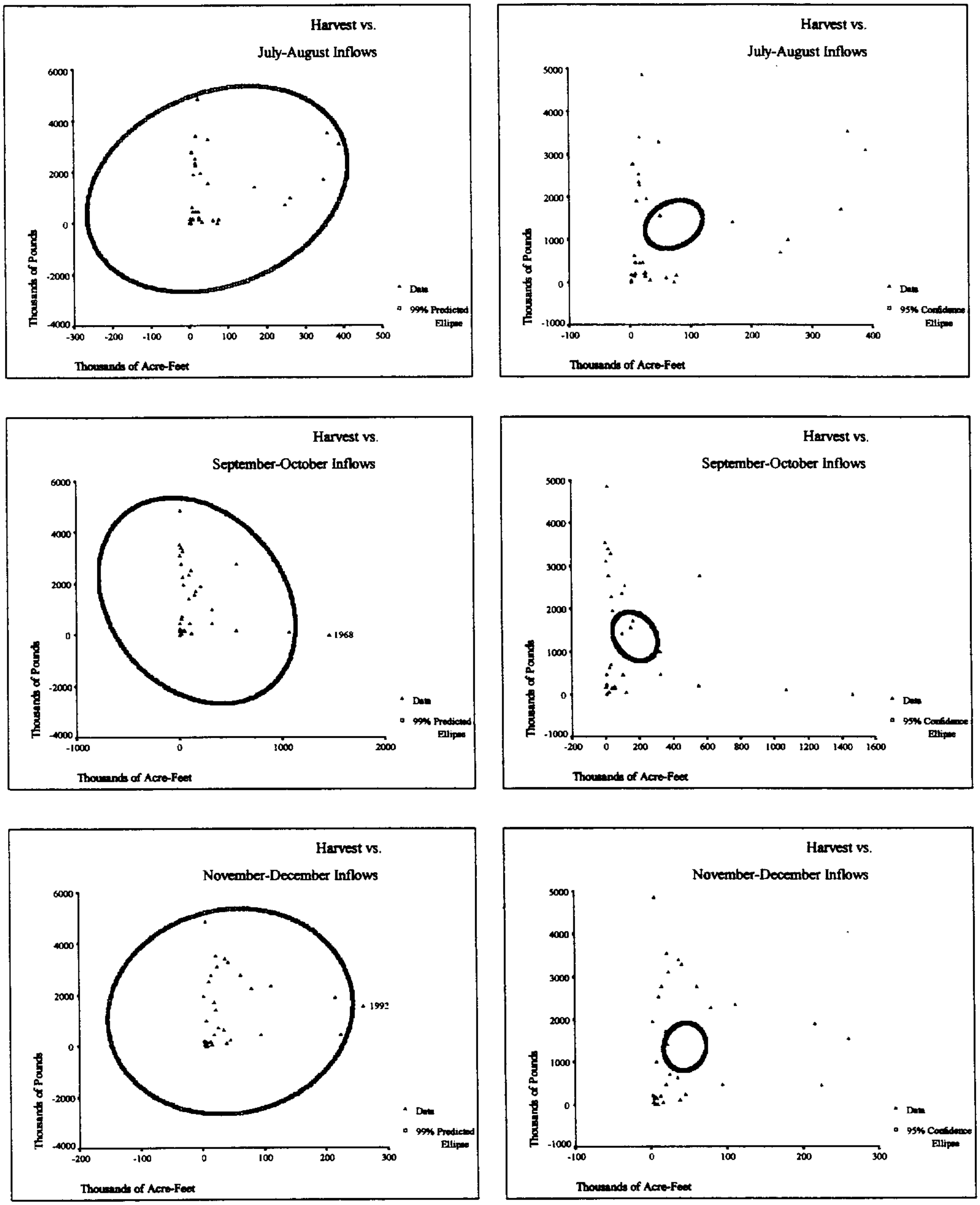



Fig. 3.2. Prediction and Confidence Ellipses.

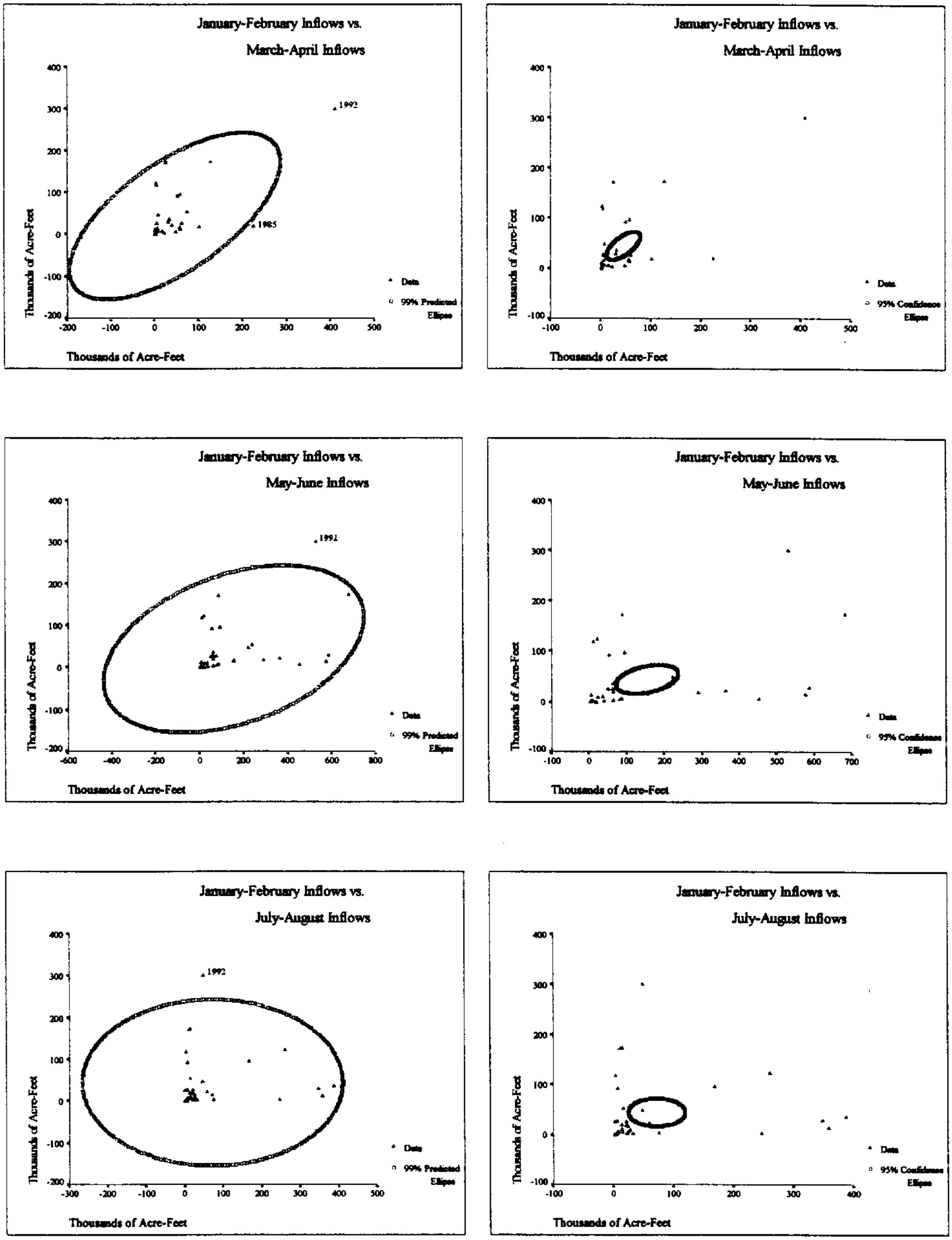



Fig. 3.3. Prediction and Confidence Ellipses.

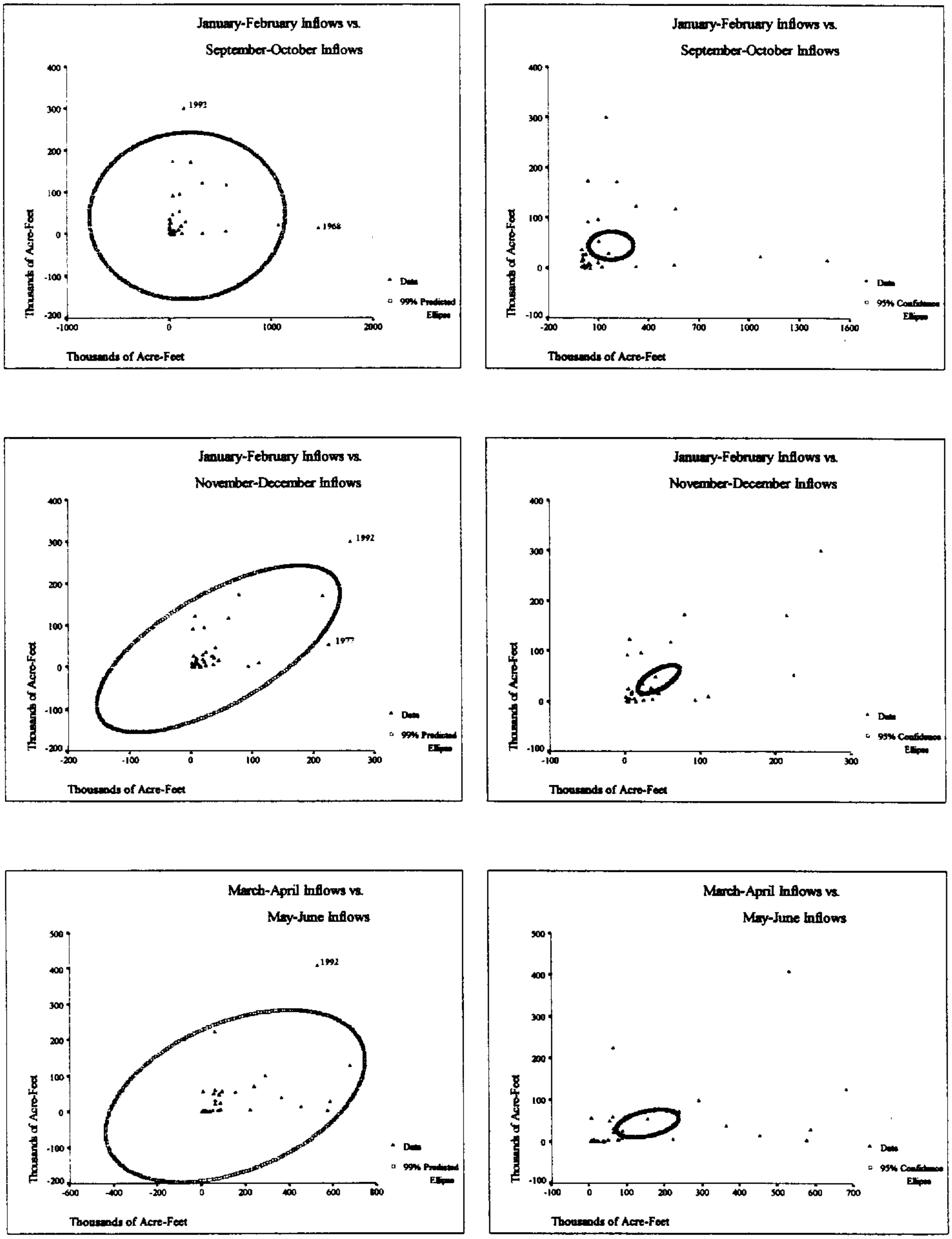



Fig. 3.4. Prediction and Confidence Ellipses.

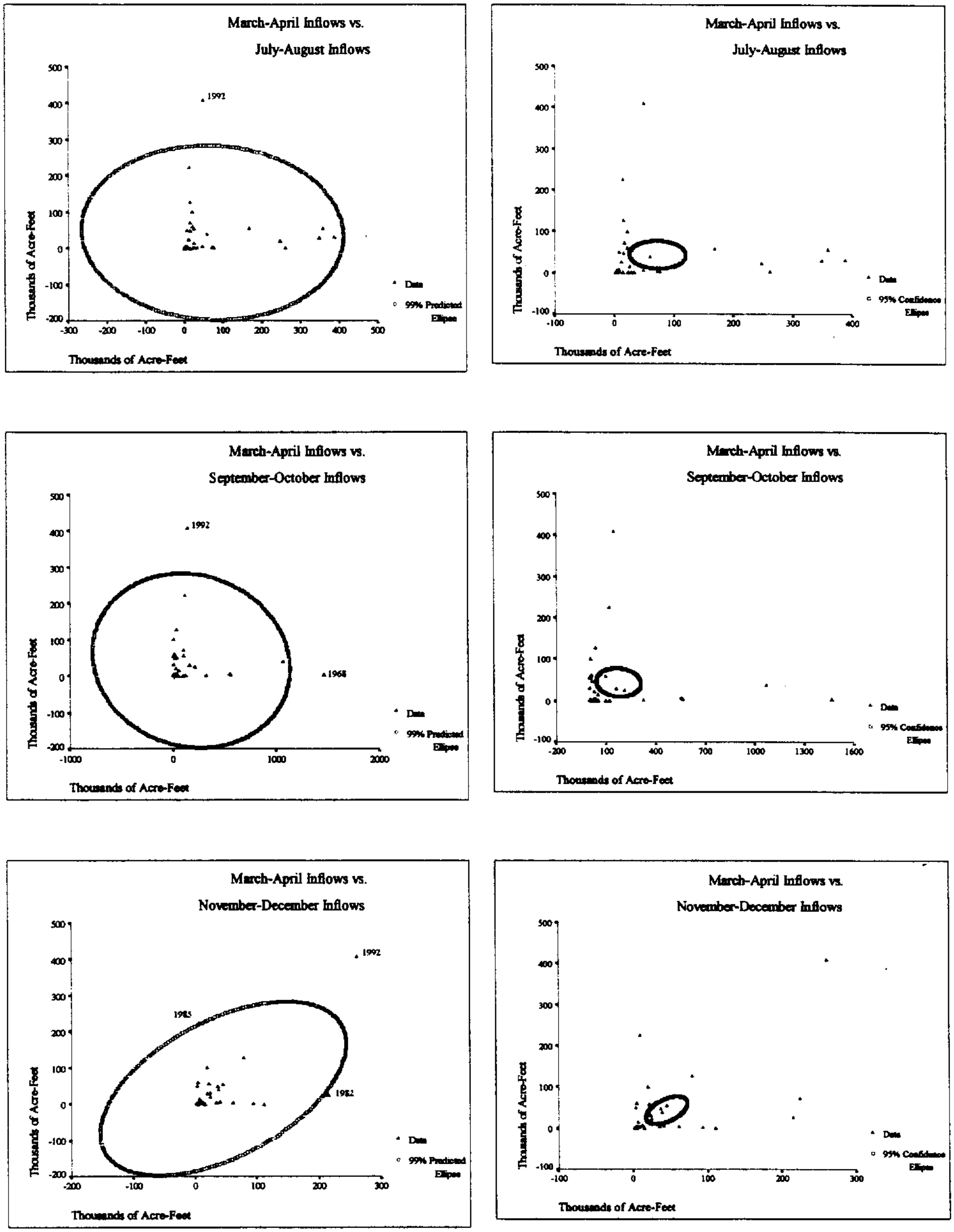



Fig. 3.5. Prediction and Confidence Ellipses.

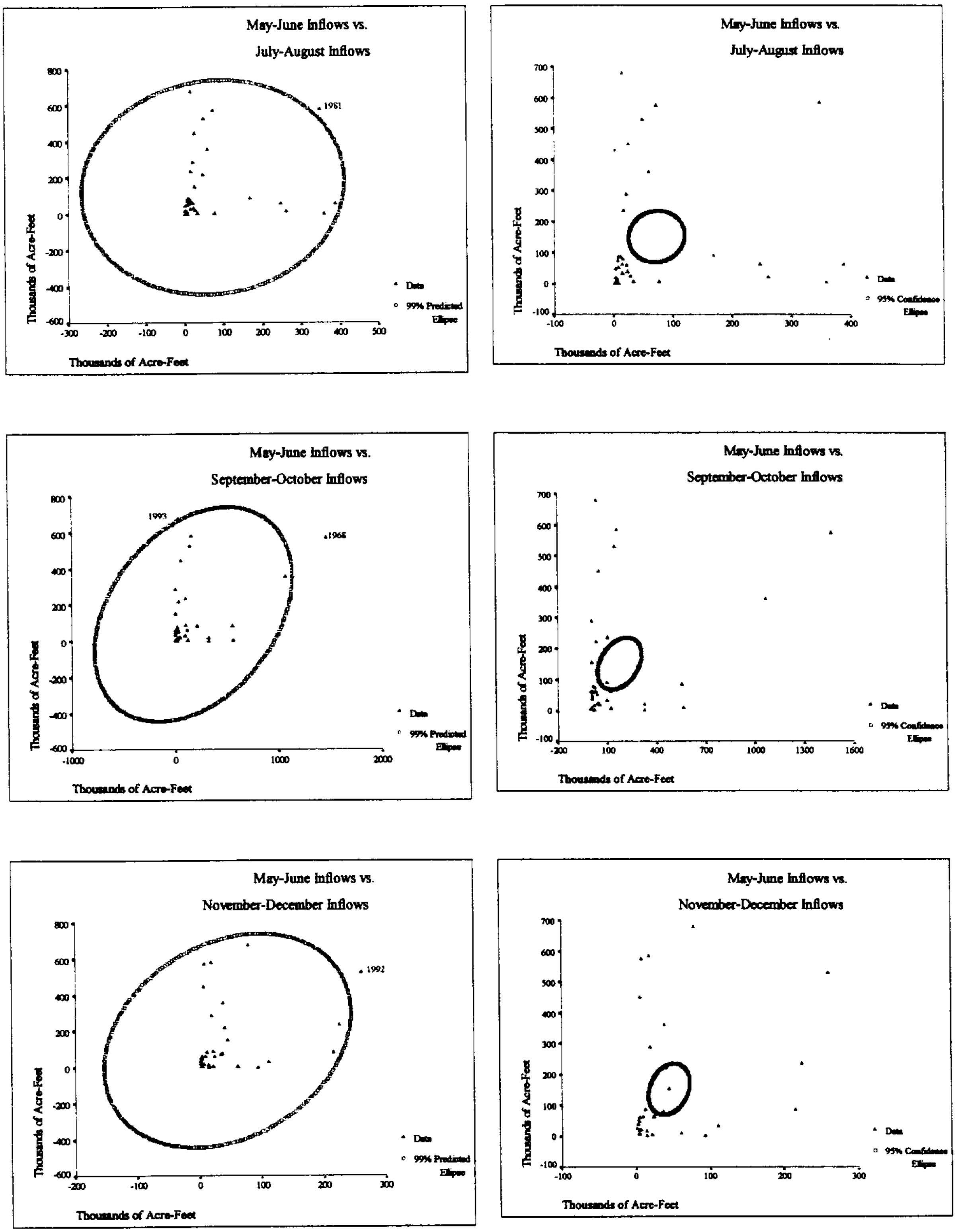



Fig. 3.6. Prediction and Confidence Ellipses.

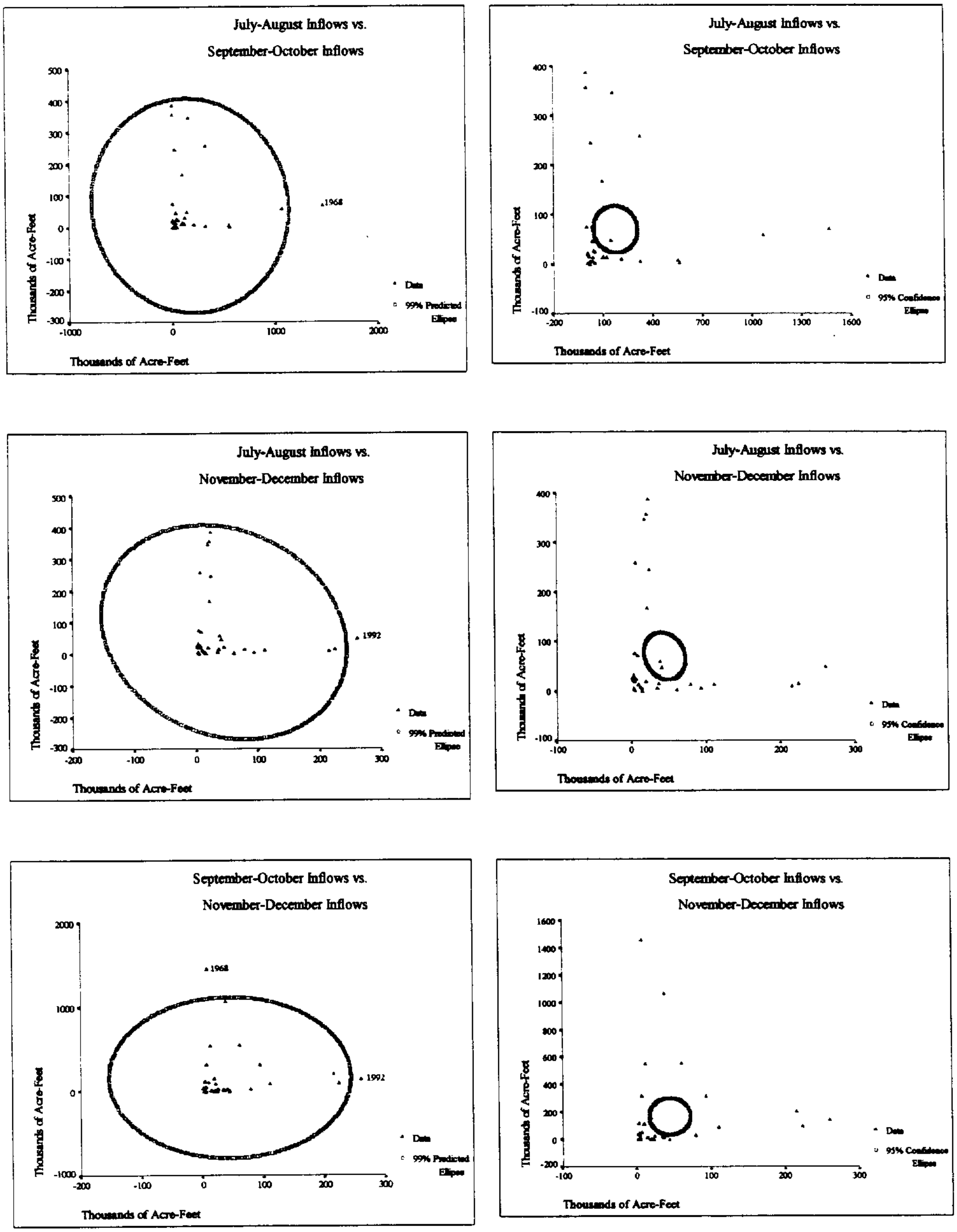



Fig. 3.7. Prediction and Confidence Ellipses.

## 4. Box-Cox Analysis

Table 4.1 Numerical Results.

| HARVEST | QJF_Lag | QMA_Lag | QMJ_Lag | QJA_Lag | QSO_Lag | QND_Lag | LAMBDA |
|---|---|---|---|---|---|---|---|
| 1.82E+10 | 1309231 | 21493 | 3865802 | 192591 | 2940494 | 45695 | -2.0 |
| 9.36E+09 | 753830 | 15955 | 2455214 | 131794 | 1879081 | 32247 | -1.9 |
| 4.83E+09 | 436926 | 11921 | 1571034 | 90703 | 1209052 | 22929 | -1.8 |
| 2.51E+09 | 255165 | 8971 | 1013589 | 62816 | 783815 | 16440 | -1.7 |
| 1.32E+09 | 150312 | 6803 | 659923 | 43808 | 512369 | 11895 | -1.6 |
| 6.98E+08 | 89433 | 5203 | 434013 | 30791 | 338013 | 8694 | -1.5 |
| 3.73E+08 | 53829 | 4016 | 288646 | 21833 | 225267 | 6424 | -1.4 |
| 2.02E+08 | 32838 | 3131 | 194366 | 15635 | 151835 | 4805 | -1.3 |
| 1.11E+08 | 20348 | 2469 | 132701 | 11324 | 103641 | 3642 | -1.2 |
| 61617538 | 12841 | 1971 | 92006 | 8308 | 71753 | 2801 | -1.1 |
| 34950982 | 8277 | 1594 | 64897 | 6187 | 50477 | 2189 | -1.0 |
| 20265086 | 5469 | 1309 | 46666 | 4687 | 36157 | 1741 | -0.9 |
| 12063064 | 3717 | 1093 | 34287 | 3622 | 26439 | 1411 | -0.8 |
| 7410829 | 2609 | 928 | 25809 | 2864 | 19793 | 1168 | -0.7 |
| 4727246 | 1900 | 804 | 19959 | 2326 | 15222 | 989 | -0.6 |
| 3151410 | 1440 | 712 | 15908 | 1948 | 12075 | 859 | -0.5 |
| 2209300 | 1141 | 645 | 13109 | 1688 | 9924 | 766 | -0.4 |
| 1636796 | 947 | 599 | 11203 | 1521 | 8492 | 704 | -0.3 |
| 1284903 | 826 | 573 | 9955 | 1429 | 7603 | 667 | -0.2 |
| 1068557 | 757 | **566** | 9216 | **1402** | 7157 | **654** | **-0.1** |
| 938714 | **730** | 577 | **8896** | 1440 | **7111** | 663 | **0** |
| 866976 | 738 | 612 | 8950 | 1544 | 7476 | 697 | 0.1 |
| **837075** | 782 | 674 | 9370 | 1728 | 8320 | 759 | **0.2** |
| 840119 | 866 | 776 | 10182 | 2011 | 9791 | 856 | 0.3 |
| 871954 | 997 | 932 | 11448 | 2424 | 12144 | 999 | 0.4 |
| 931753 | 1191 | 1169 | 13271 | 3016 | 15807 | 1201 | 0.5 |
| 1021329 | 1470 | 1531 | 15806 | 3859 | 21485 | 1488 | 0.6 |
| 1144929 | 1868 | 2085 | 19280 | 5058 | 30333 | 1891 | 0.7 |
| 1309374 | 2437 | 2946 | 24013 | 6774 | 44267 | 2459 | 0.8 |
| 1524507 | 3255 | 4300 | 30462 | 9243 | 66477 | 3266 | 0.9 |
| 1803963 | 4440 | 6455 | 39269 | 12822 | 102324 | 4416 | 1.0 |
| 2166312 | 6173 | 9930 | 51349 | 18047 | 160894 | 6069 | 1.1 |
| 2636692 | 8730 | 15599 | 67997 | 25731 | 257694 | 8459 | 1.2 |
| 3249091 | 12539 | 24945 | 91063 | 37112 | 419391 | 11938 | 1.3 |
| 4049524 | 18266 | 40504 | 123193 | 54081 | 692146 | 17035 | 1.4 |
| 5100438 | 26948 | 66638 | 168186 | 79544 | 1156358 | 24545 | 1.5 |
| 6486840 | 40221 | 110887 | 231517 | 117981 | 1952868 | 35676 | 1.6 |
| 8324825 | 60666 | 186352 | 321099 | 176328 | 3329690 | 52260 | 1.7 |
| 10773479 | 92383 | 315899 | 448408 | 265364 | 5725718 | 77090 | 1.8 |
| 14051514 | 141914 | 539616 | 630142 | 401895 | 9921147 | 114438 | 1.9 |
| 18460609 | 219738 | 928054 | 890660 | 612218 | 17308719 | 170852 | 2.0 |

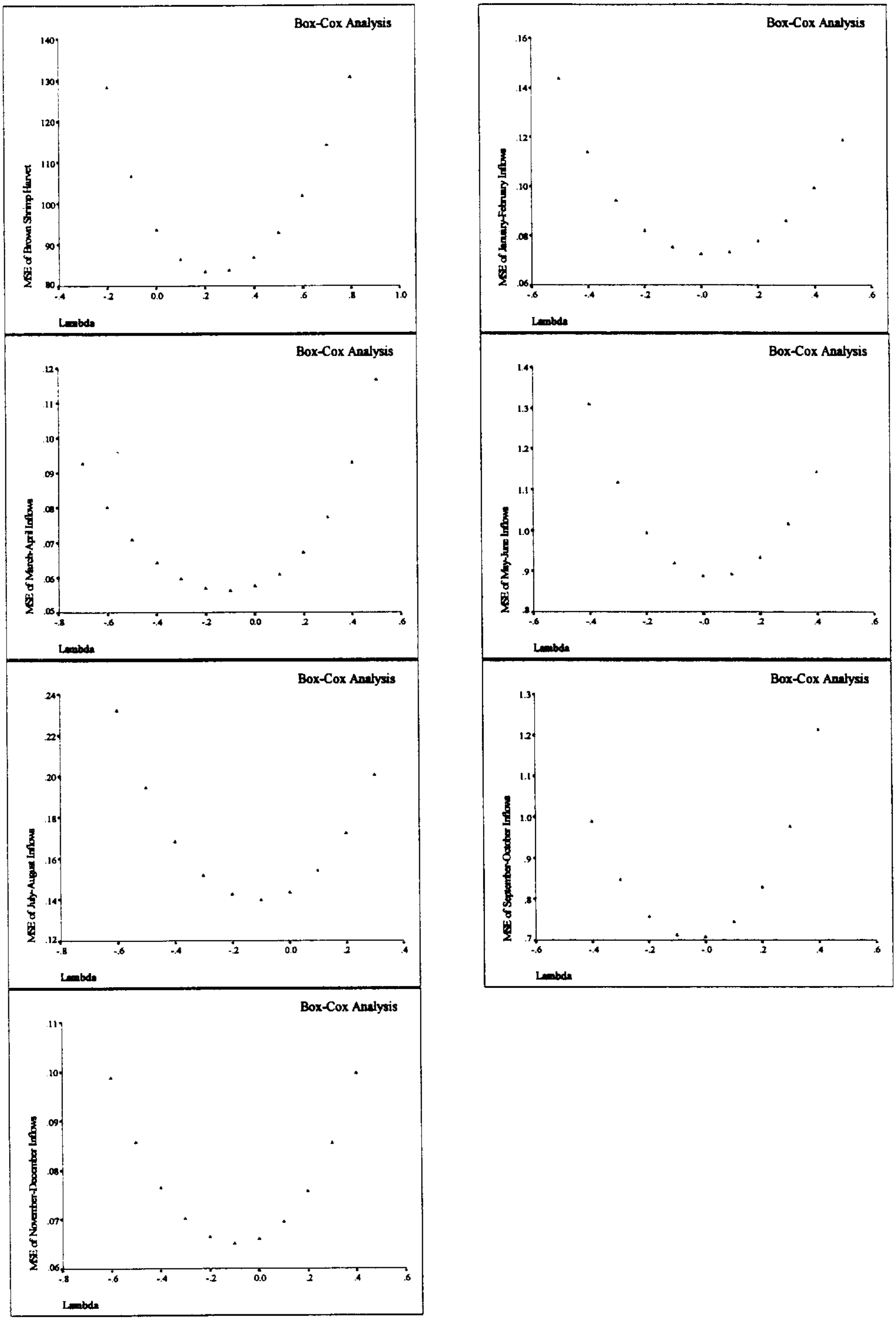



Fig 4.1. MSE of Harvest and Inflows Variables vs. Lambda obtained from Box-Cox Transformation

# 5. Model Choice Diagnostics

## 5.1 Untransformed Data

N = 33 Regression Models for Dependent Variable: BROWN SHRIMP

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.060780 | 0.030483 | 0.1950 | 476.3 | 1748973 | 479.3 | QSO_LAG |
| 1 | 0.058683 | 0.028318 | 0.2602 | 476.4 | 1752879 | 479.4 | QJA_LAG |
| 1 | 0.031247 | -.000003 | 1.1130 | 477.3 | 1803969 | 480.3 | QMA_LAG |
| 1 | 0.025543 | -.005892 | 1.2903 | 477.5 | 1814591 | 480.5 | QJF_LAG |
| 2 | 0.114975 | 0.055973 | 0.5104 | 476.3 | 1702989 | 480.8 | QJA_LAG QSO_LAG |
| 2 | 0.093296 | 0.032849 | 1.1843 | 477.1 | 1744704 | 481.6 | QMA_LAG QJA_LAG |
| 2 | 0.088268 | 0.027486 | 1.3405 | 477.3 | 1754379 | 481.8 | QJF_LAG QSO_LAG |
| 2 | 0.084566 | 0.023537 | 1.4556 | 477.5 | 1761503 | 481.9 | QMA_LAG QSO_LAG |
| 3 | 0.142241 | 0.053507 | 1.6628 | 477.3 | 1707438 | 483.3 | QJF_LAG QJA_LAG QSO_LAG |
| 3 | 0.141892 | 0.053122 | 1.6737 | 477.3 | 1708132 | 483.3 | QMA_LAG QJA_LAG QSO_LAG |
| 3 | 0.133899 | 0.044303 | 1.9221 | 477.6 | 1724043 | 483.6 | QMA_LAG QMJ_LAG QJA_LAG |
| 3 | 0.128624 | 0.038482 | 2.0861 | 477.8 | 1734543 | 483.8 | QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.155396 | 0.034739 | 3.2539 | 478.8 | 1741296 | 486.3 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 4 | 0.151221 | 0.029967 | 3.3837 | 479.0 | 1749904 | 486.4 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 4 | 0.147652 | 0.025888 | 3.4946 | 479.1 | 1757262 | 486.6 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG |
| 4 | 0.143222 | 0.020825 | 3.6324 | 479.3 | 1766396 | 486.7 | QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.163552 | 0.008654 | 5.0004 | 480.5 | 1788351 | 489.5 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.157287 | 0.001229 | 5.1952 | 480.7 | 1801747 | 489.7 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.151345 | -.005813 | 5.3798 | 481.0 | 1814449 | 489.9 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.147663 | -.010177 | 5.4943 | 481.1 | 1822322 | 490.1 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.163565 | -.029459 | 7.0000 | 482.5 | 1857105 | 492.9 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

## 5.2 Logged Inflows

N = 33 Regression Models for Dependent Variable: BROWN SHRIMP

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.081280 | 0.051644 | 2.1913 | 475.6 | 1710799 | 478.6 | LN_QMA |
| 1 | 0.076469 | 0.046677 | 2.3547 | 475.7 | 1719759 | 478.7 | LN_QJF |
| 1 | 0.042425 | 0.011536 | 3.5105 | 476.9 | 1783153 | 479.9 | LN_QND |
| 1 | 0.041395 | 0.010472 | 3.5455 | 477.0 | 1785072 | 480.0 | LN_QJA |
| 2 | 0.146374 | 0.089465 | 1.9814 | 475.1 | 1642571 | 479.6 | LN_QJF LN_QSO |
| 2 | 0.140359 | 0.083050 | 2.1856 | 475.4 | 1654144 | 479.9 | LN_QMA LN_QMJ |
| 2 | 0.112816 | 0.053670 | 3.1207 | 476.4 | 1707144 | 480.9 | LN_QJF LN_QMJ |
| 2 | 0.112187 | 0.053000 | 3.1420 | 476.4 | 1708354 | 480.9 | LN_QMA LN_QSO |
| 3 | 0.177606 | 0.092531 | 2.9210 | 475.9 | 1637041 | 481.9 | LN_QJF LN_QMA LN_QMJ |
| 3 | 0.171608 | 0.085913 | 3.1246 | 476.2 | 1648980 | 482.1 | LN_QJF LN_QMJ LN_QSO |
| 3 | 0.164142 | 0.077674 | 3.3781 | 476.4 | 1663843 | 482.4 | LN_QJF LN_QSO LN_QND |
| 3 | 0.160517 | 0.073674 | 3.5012 | 476.6 | 1671058 | 482.6 | LN_QMA LN_QMJ LN_QJA |
| 4 | 0.205786 | 0.092327 | 3.9642 | 476.8 | 1637408 | 484.2 | LN_QJF LN_QMA LN_QMJ LN_QSO |
| 4 | 0.194159 | 0.079039 | 4.3590 | 477.2 | 1661380 | 484.7 | LN_QJF LN_QMA LN_QMJ LN_QJA |
| 4 | 0.191960 | 0.076526 | 4.4337 | 477.3 | 1665913 | 484.8 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.190696 | 0.075082 | 4.4766 | 477.4 | 1668519 | 484.9 | LN_QJF LN_QMJ LN_QJA LN_QSO |
| 5 | 0.219129 | 0.074523 | 5.5113 | 478.2 | 1669526 | 487.2 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.216890 | 0.071870 | 5.5873 | 478.3 | 1674312 | 487.3 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.216182 | 0.071030 | 5.6113 | 478.3 | 1675827 | 487.3 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.201296 | 0.053388 | 6.1167 | 478.9 | 1707654 | 487.9 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 6 | 0.234188 | 0.057462 | 7.0000 | 479.6 | 1700304 | 490.0 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 5.3 Logged All Variables

N = 33 Regression Models for Dependent Variable: LN (BROWN SHRIMP)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.142077 | 0.114402 | 5.5379 | 27.0999 | 2.14367 | 30.0929 | LN_QND |
| 1 | 0.118155 | 0.089708 | 6.5010 | 28.0075 | 2.20344 | 31.0005 | LN_QJF |
| 1 | 0.115608 | 0.087079 | 6.6035 | 28.1026 | 2.20980 | 31.0957 | LN_QMA |
| 1 | 0.068855 | 0.038818 | 8.4856 | 29.8026 | 2.32662 | 32.7956 | LN_QJA |
| 2 | 0.210140 | 0.157483 | 4.7978 | 26.3721 | 2.03938 | 30.8617 | LN_QJA LN_QND |
| 2 | 0.200266 | 0.146950 | 5.1953 | 26.7821 | 2.06488 | 31.2717 | LN_QSO LN_QND |
| 2 | 0.183635 | 0.129211 | 5.8649 | 27.4613 | 2.10782 | 31.9509 | LN_QMA LN_QND |
| 2 | 0.177886 | 0.123079 | 6.0963 | 27.6929 | 2.12266 | 32.1824 | LN_QJF LN_QND |
| 3 | 0.263360 | 0.187155 | 4.6554 | 26.0702 | 1.96756 | 32.0562 | LN_QJA LN_QSO LN_QND |
| 3 | 0.255473 | 0.178453 | 4.9728 | 26.4216 | 1.98862 | 32.4077 | LN_QMA LN_QMJ LN_QND |
| 3 | 0.251733 | 0.174326 | 5.1234 | 26.5870 | 1.99861 | 32.5730 | LN_QJF LN_QSO LN_QND |
| 3 | 0.246204 | 0.168225 | 5.3460 | 26.8299 | 2.01338 | 32.8160 | LN_QMJ LN_QJA LN_QND |
| 4 | 0.308738 | 0.209986 | 4.8285 | 25.9720 | 1.91230 | 33.4546 | LN_QMA LN_QMJ LN_QJA LN_QND |
| 4 | 0.289622 | 0.188139 | 5.5981 | 26.8722 | 1.96518 | 34.3548 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 4 | 0.289060 | 0.187497 | 5.6207 | 26.8983 | 1.96673 | 34.3809 | LN_QJF LN_QJA LN_QSO LN_QND |
| 4 | 0.286860 | 0.184983 | 5.7093 | 27.0003 | 1.97282 | 34.4828 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 5 | 0.339206 | 0.216836 | 5.6020 | 26.4845 | 1.89571 | 35.4636 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.327001 | 0.202371 | 6.0933 | 27.0885 | 1.93073 | 36.0675 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.325767 | 0.200909 | 6.1430 | 27.1489 | 1.93427 | 36.1280 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.311871 | 0.184440 | 6.7024 | 27.8221 | 1.97413 | 36.8012 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 6 | 0.354159 | 0.205118 | 7.0000 | 27.7292 | 1.92408 | 38.2047 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 5.4 Square Root Inflows

N = 33    Regression Models for Dependent Variable: BROWN SHRIMP

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.06161 | 0.03134 | 1.680 | 476.3 | 1747428 | 479.3 | SQRT_QMA |
| 1 | 0.05481 | 0.02432 | 1.902 | 476.5 | 1760089 | 479.5 | SQRT_QSO |
| 1 | 0.04658 | 0.01582 | 2.171 | 476.8 | 1775417 | 479.8 | SQRT_QJF |
| 1 | 0.04531 | 0.01451 | 2.213 | 476.8 | 1777788 | 479.8 | SQRT_QJA |
| 2 | 0.12213 | 0.06361 | 1.701 | 476.1 | 1689212 | 480.6 | SQRT_QJF SQRT_QSO |
| 2 | 0.11685 | 0.05798 | 1.874 | 476.3 | 1699375 | 480.8 | SQRT_QMA SQRT_QMJ |
| 2 | 0.10790 | 0.04842 | 2.166 | 476.6 | 1716610 | 481.1 | SQRT_QMA SQRT_QSO |
| 2 | 0.09949 | 0.03946 | 2.441 | 476.9 | 1732779 | 481.4 | SQRT_QJA SQRT_QSO |
| 3 | 0.16052 | 0.07367 | 2.446 | 476.6 | 1671058 | 482.6 | SQRT_QMA SQRT_QMJ SQRT_QJA |
| 3 | 0.15679 | 0.06957 | 2.568 | 476.7 | 1678467 | 482.7 | SQRT_QJF SQRT_QJA SQRT_QSO |
| 3 | 0.14376 | 0.05519 | 2.994 | 477.2 | 1704409 | 483.2 | SQRT_QMA SQRT_QJA SQRT_QSO |
| 3 | 0.14097 | 0.05210 | 3.085 | 477.4 | 1709975 | 483.3 | SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.17655 | 0.05891 | 3.922 | 478.0 | 1697686 | 485.4 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 4 | 0.17555 | 0.05777 | 3.955 | 478.0 | 1699749 | 485.5 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA |
| 4 | 0.17406 | 0.05607 | 4.003 | 478.1 | 1702808 | 485.5 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO |
| 4 | 0.17084 | 0.05238 | 4.109 | 478.2 | 1709464 | 485.7 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 5 | 0.20037 | 0.05229 | 5.143 | 479.0 | 1709629 | 488.0 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 5 | 0.19251 | 0.04298 | 5.400 | 479.3 | 1726434 | 488.3 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.18267 | 0.03131 | 5.722 | 479.7 | 1747487 | 488.7 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.17820 | 0.02602 | 5.868 | 479.9 | 1757029 | 488.9 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 6 | 0.20475 | 0.02123 | 7.000 | 480.8 | 1765671 | 491.3 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

## 5.5 Square Root All Variables

N = 33     Regression Models for Dependent Variable: SQRT (BROWN SHRIMP)

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.08661 | 0.05715 | 4.207 | 195.5 | 352.68 | 198.5 | SQRT_QJF |
| 1 | 0.08583 | 0.05634 | 4.236 | 195.5 | 352.98 | 198.5 | SQRT_QMA |
| 1 | 0.06285 | 0.03262 | 5.071 | 196.3 | 361.85 | 199.3 | SQRT_QJA |
| 1 | 0.05802 | 0.02763 | 5.246 | 196.5 | 363.72 | 199.5 | SQRT_QSO |
| 2 | 0.17381 | 0.11873 | 3.037 | 194.2 | 329.64 | 198.7 | SQRT_QJF SQRT_QSO |
| 2 | 0.14120 | 0.08395 | 4.222 | 195.5 | 342.65 | 200.0 | SQRT_QMA SQRT_QMJ |
| 2 | 0.13628 | 0.07869 | 4.401 | 195.7 | 344.62 | 200.1 | SQRT_QJF SQRT_QJA |
| 2 | 0.13537 | 0.07773 | 4.434 | 195.7 | 344.98 | 200.2 | SQRT_QMA SQRT_QJA |
| 3 | 0.22045 | 0.13981 | 3.341 | 194.3 | 321.76 | 200.3 | SQRT_QJF SQRT_QJA SQRT_QSO |
| 3 | 0.21401 | 0.13270 | 3.575 | 194.5 | 324.42 | 200.5 | SQRT_QJA SQRT_QSO SQRT_QND |
| 3 | 0.20008 | 0.11733 | 4.082 | 195.1 | 330.17 | 201.1 | SQRT_QMA SQRT_QMJ SQRT_QJA |
| 3 | 0.18749 | 0.10344 | 4.539 | 195.6 | 335.36 | 201.6 | SQRT_QJF SQRT_QMJ SQRT_QSO |
| 4 | 0.24267 | 0.13448 | 4.534 | 195.3 | 323.75 | 202.8 | SQRT_QJF SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.23976 | 0.13115 | 4.639 | 195.4 | 324.99 | 202.9 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO |
| 4 | 0.23794 | 0.12907 | 4.705 | 195.5 | 325.77 | 203.0 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 4 | 0.23493 | 0.12563 | 4.815 | 195.7 | 327.06 | 203.1 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA |
| 5 | 0.26693 | 0.13117 | 5.651 | 196.2 | 324.99 | 205.2 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.26565 | 0.12966 | 5.698 | 196.3 | 325.55 | 205.3 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.26533 | 0.12928 | 5.709 | 196.3 | 325.69 | 205.3 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 5 | 0.25011 | 0.11124 | 6.263 | 197.0 | 332.44 | 206.0 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 6 | 0.28485 | 0.11981 | 7.000 | 197.4 | 329.24 | 207.9 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

### 5.6 Variables Transformed According to the Box-Cox Analysis

N = 33 Regression Models for Dependent Variable: $(\text{BROWN SHRIMP})^{0.2}$

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.126934 | 0.098770 | 5.3565 | 2.6032 | 1.02040 | 5.5962 | $(\text{QND\_LAG})^{-0.1}$ |
| 1 | 0.125489 | 0.097278 | 5.4134 | 2.6578 | 1.02209 | 5.6508 | LN_QJF |
| 1 | 0.109231 | 0.080496 | 6.0532 | 3.2656 | 1.04109 | 6.2587 | $(\text{QMA\_LAG})^{-0.1}$ |
| 1 | 0.071558 | 0.041608 | 7.5357 | 4.6326 | 1.08512 | 7.6256 | $(\text{QJA\_LAG})^{-0.1}$ |
| 2 | 0.193421 | 0.139649 | 4.7401 | 1.9893 | 0.97411 | 6.4788 | $(\text{QJA\_LAG})^{-0.1}$ $(\text{QND\_LAG})^{-0.1}$ |
| 2 | 0.180484 | 0.125849 | 5.2493 | 2.5144 | 0.98974 | 7.0039 | LN_QSO $(\text{QND\_LAG})^{-0.1}$ |
| 2 | 0.177209 | 0.122356 | 5.3781 | 2.6460 | 0.99369 | 7.1355 | LN_QJF LN_QSO |
| 2 | 0.173204 | 0.118085 | 5.5357 | 2.8062 | 0.99853 | 7.2958 | LN_QJF $(\text{QND\_LAG})^{-0.1}$ |
| 3 | 0.244506 | 0.166351 | 4.7299 | 1.8301 | 0.94388 | 7.8161 | LN_QJF LN_QSO $(\text{QND\_LAG})^{-0.1}$ |
| 3 | 0.243072 | 0.164770 | 4.7863 | 1.8927 | 0.94567 | 7.8787 | $(\text{QJA\_LAG})^{-0.1}$ LN_QSO $(\text{QND\_LAG})^{-0.1}$ |
| 3 | 0.232464 | 0.153064 | 5.2037 | 2.3519 | 0.95893 | 8.3380 | $(\text{QMA\_LAG})^{-0.1}$ LN_QMJ $(\text{QND\_LAG})^{-0.1}$ |
| 3 | 0.229633 | 0.149940 | 5.3152 | 2.4734 | 0.96246 | 8.4595 | LN_QJF $(\text{QMA\_LAG})^{-0.1}$ LN_QMJ |
| 4 | 0.283242 | 0.180849 | 5.2055 | 2.0932 | 0.92747 | 9.5757 | $(\text{QMA\_LAG})^{-0.1}$ LN_QMJ $(\text{QJA\_LAG})^{-0.1}$ $(\text{QND\_LAG})^{-0.1}$ |
| 4 | 0.282001 | 0.179429 | 5.2544 | 2.1503 | 0.92907 | 9.6328 | LN_QJF LN_QMJ $(\text{QJA\_LAG})^{-0.1}$ $(\text{QND\_LAG})^{-0.1}$ |
| 4 | 0.278987 | 0.175985 | 5.3730 | 2.2885 | 0.93297 | 9.7711 | LN_QJF LN_QMJ LN_QSO $(\text{QND\_LAG})^{-0.1}$ |
| 4 | 0.278374 | 0.175285 | 5.3971 | 2.3165 | 0.93377 | 9.7991 | LN_QJF $(\text{QJA\_LAG})^{-0.1}$ LN_QSO $(\text{QND\_LAG})^{-0.1}$ |
| 5 | 0.330073 | 0.206013 | 5.3627 | 1.8634 | 0.89898 | 10.8424 | LN_QJF LN_QMJ $(\text{QJA\_LAG})^{-0.1}$ LN_QSO $(\text{QND\_LAG})^{-0.1}$ |
| 5 | 0.310470 | 0.182780 | 6.1341 | 2.8151 | 0.92528 | 11.7942 | LN_QJF $(\text{QMA\_LAG})^{-0.1}$ LN_QMJ $(\text{QJA\_LAG})^{-0.1}$ $(\text{QND\_LAG})^{-0.1}$ |
| 5 | 0.299302 | 0.169543 | 6.5736 | 3.3454 | 0.94027 | 12.3244 | $(\text{QMA\_LAG})^{-0.1}$ LN_QMJ $(\text{QJA\_LAG})^{-0.1}$ LN_QSO $(\text{QND\_LAG})^{-0.1}$ |
| 5 | 0.298025 | 0.168030 | 6.6238 | 3.4055 | 0.94198 | 12.3845 | LN_QJF $(\text{QMA\_LAG})^{-0.1}$ LN_QMJ LN_QSO $(\text{QND\_LAG})^{-0.1}$ |
| 6 | 0.339290 | 0.186818 | 7.0000 | 3.4062 | 0.92071 | 13.8818 | LN_QJF $(\text{QMA\_LAG})^{-0.1}$ LN_QMJ $(\text{QJA\_LAG})^{-0.1}$ LN_QSO $(\text{QND\_LAG})^{-0.1}$ |

# 6. Regression for the Best Models

## 6.1 Model 3: Logged All Variables

### 6.1.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | Ln(Nov-Dec Inflows), Ln(Jul-Aug Inflows), Ln(Sept-Oct Inflows), Ln(May-Jun Inflows), Ln(Jan-Feb Inflows), Ln(Mar-Apr Inflows)[c,d] | . | .595 | .354 | .205 | 1.3871 | .970 |

a. Dependent Variable: Ln (Brown Shrimp Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Ln (November-December Inflows), Ln (July-August Inflows), Ln (September-October Inflows), Ln (May-June Inflows), Ln (January-February Inflows), Ln (March-April Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 27.433 | 6 | 4.572 | 2.376 | .058[b] |
| | Residual | 50.026 | 26 | 1.924 | | |
| | Total | 77.459 | 32 | | | |

a. Dependent Variable: Ln (Brown Shrimp Harvest)

b. Independent Variables: (Constant), Ln (November-December Inflows), Ln (July-August Inflows), Ln (September-October Inflows), Ln (May-June Inflows), Ln (January-February Inflows), Ln (March-April Inflows)

**Coefficients**[a]

| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. | 95% Confidence Interval for B Lower Bound | 95% Confidence Interval for B Upper Bound |
|---|---|---|---|---|---|---|---|---|
| 1 | (Constant) | 5.425 | 1.009 | | 5.377 | .000 | 3.351 | 7.499 |
| | Ln (January-February Inflows) | .245 | .229 | .233 | 1.069 | .295 | -.226 | .716 |
| | Ln (March-April Inflows) | .188 | .242 | .185 | .776 | .445 | -.310 | .686 |
| | Ln (May-June Inflows) | -.359 | .222 | -.338 | -1.618 | .118 | -.816 | .097 |
| | Ln (July-August Inflows) | .236 | .181 | .222 | 1.305 | .203 | -.136 | .608 |
| | Ln (September-October Inflows) | -.173 | .165 | -.187 | -1.046 | .305 | -.512 | .167 |
| | Ln (November-December Inflows) | .399 | .223 | .339 | 1.790 | .085 | -.059 | .857 |

a. Dependent Variable: Ln (Brown Shrimp Harvest)

## 6.1.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 5.425121 | 1.00898609 | 5.377 | 0.0001 | 0.00000000 |
| LN_QJF | 1 | 0.244870 | 0.22904362 | 1.069 | 0.2949 | 1.91336830 |
| LN_QMA | 1 | 0.187875 | 0.24214834 | 0.776 | 0.4448 | 2.29912480 |
| LN_QMJ | 1 | -0.359357 | 0.22209438 | -1.618 | 0.1177 | 1.75209582 |
| LN_QJA | 1 | 0.236231 | 0.18105312 | 1.305 | 0.2034 | 1.16025507 |
| LN_QSO | 1 | -0.172792 | 0.16525348 | -1.046 | 0.3054 | 1.28539311 |
| LN_QND | 1 | 0.399035 | 0.22294959 | 1.790 | 0.0851 | 1.44041395 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop LN_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop LN_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.61865 | 1.00000 | 0.0527 | 0.0424 | 0.0498 | 0.0202 | 0.0107 | 0.0411 |
| 2 | 1.19442 | 1.48067 | 0.0013 | 0.0270 | 0.0015 | 0.2299 | 0.3003 | 0.0814 |
| 3 | 0.84306 | 1.76242 | 0.0011 | 0.0428 | 0.0115 | 0.3630 | 0.3506 | 0.1344 |
| 4 | 0.62875 | 2.04080 | 0.0105 | 0.0151 | 0.3911 | 0.3163 | 0.0008 | 0.3348 |
| 5 | 0.43312 | 2.45887 | 0.7412 | 0.0000 | 0.1911 | 0.0637 | 0.0002 | 0.3343 |
| 6 | 0.28200 | 3.04729 | 0.1931 | 0.8727 | 0.3550 | 0.0069 | 0.3374 | 0.0740 |

### 6.1.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 4.5039 | 8.5564 | 6.4341 | .9259 | 33 |
| Std. Predicted Value | -2.085 | 2.292 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | .4884 | .8542 | .6302 | .1066 | 33 |
| Adjusted Predicted Value | 4.2642 | 8.7846 | 6.4648 | .9620 | 33 |
| Residual | -2.5319 | 2.1873 | 1.8E-15 | 1.2503 | 33 |
| Std. Residual | -1.825 | 1.577 | .000 | .901 | 33 |
| Stud. Residual | -2.145 | 1.719 | -.010 | 1.018 | 33 |
| Deleted Residual | -3.4971 | 2.5991 | -3.E-02 | 1.6027 | 33 |
| Stud. Deleted Residual | -2.319 | 1.790 | -.013 | 1.049 | 33 |
| Mahal. Distance | 2.998 | 11.167 | 5.818 | 2.366 | 33 |
| Cook's Distance | .000 | .251 | .041 | .061 | 33 |
| Centered Leverage Value | .094 | .349 | .182 | .074 | 33 |

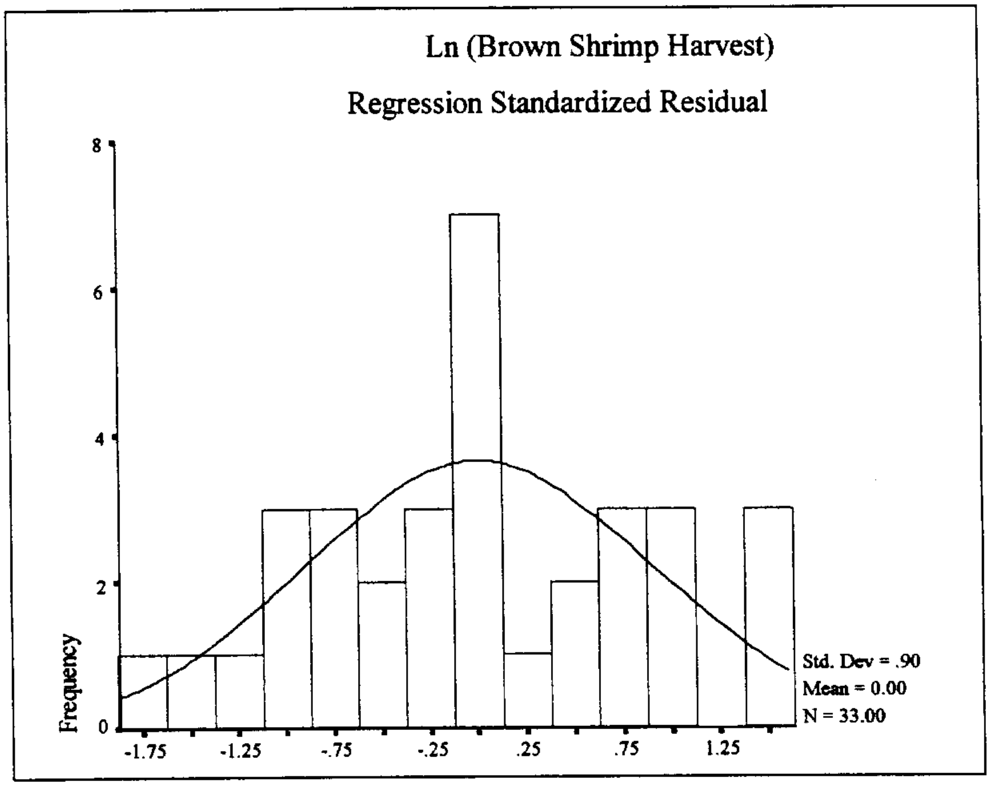
a. Dependent Variable: Ln (Brown Shrimp Harvest)

*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 4.50395 | .77263 | 1.01237 | 4.26421 | -2.0847 | .55701 | .63759 | .63016 |
| 1963 | 6.02934 | -1.6868 | -2.1681 | 6.51056 | -.43718 | -1.2161 | -1.3787 | -1.4042 |
| 1964 | 6.71799 | -1.5129 | -1.8694 | 7.07450 | .30658 | -1.0907 | -1.2124 | -1.2239 |
| 1965 | 5.64984 | -2.5319 | -3.4971 | 6.61509 | -.84706 | -1.8253 | -2.1452 | -2.3187 |
| 1966 | 6.53995 | -.36014 | -.42559 | 6.60540 | .11429 | -.25963 | -.28224 | -.27718 |
| 1967 | 5.39074 | .07182 | .08725 | 5.37531 | -1.1269 | .05178 | .05707 | .05596 |
| 1968 | 4.78120 | -2.2396 | -3.2603 | 5.80187 | -1.7852 | -1.6146 | -1.9481 | -2.0670 |
| 1969 | 6.25405 | -1.1634 | -1.6439 | 6.73457 | -.19449 | -.83870 | -.99697 | -.99685 |
| 1970 | 7.04898 | -1.4937 | -1.7280 | 7.28324 | .66406 | -1.0768 | -1.1582 | -1.1662 |
| 1971 | 5.59216 | -1.2240 | -1.4750 | 5.84315 | -.90936 | -.88239 | -.96865 | -.96746 |
| 1972 | 5.99702 | -1.0734 | -1.3325 | 6.25611 | -.47209 | -.77384 | -.86218 | -.85779 |
| 1973 | 5.12819 | .02047 | .02452 | 5.12413 | -1.4105 | .01476 | .01615 | .01584 |
| 1974 | 5.16994 | .18145 | .21177 | 5.13962 | -1.3654 | .13081 | .14132 | .13863 |
| 1975 | 6.73211 | -.54446 | -.78427 | 6.97192 | .32184 | -.39252 | -.47109 | -.46393 |
| 1976 | 6.89718 | -.30058 | -.37192 | 6.96852 | .50012 | -.21670 | -.24104 | -.23663 |
| 1977 | 7.26974 | -1.1085 | -1.3073 | 7.46850 | .90250 | -.79917 | -.86786 | -.86361 |
| 1978 | 6.32914 | .16279 | .19137 | 6.30057 | -.11339 | .11736 | .12725 | .12481 |
| 1979 | 7.32305 | -.05930 | -.06788 | 7.33163 | .96008 | -.04275 | -.04574 | -.04485 |
| 1980 | 6.86099 | .05761 | .09280 | 6.82579 | .46103 | .04153 | .05271 | .05169 |
| 1981 | 6.30458 | 1.15958 | 1.45311 | 6.01105 | -.13991 | .83597 | .93581 | .93350 |
| 1982 | 7.49041 | .06785 | .08416 | 7.47409 | 1.14083 | .04891 | .05448 | .05342 |
| 1983 | 7.89426 | .15206 | .19465 | 7.85167 | 1.57701 | .10963 | .12403 | .12166 |
| 1984 | 6.94923 | .98443 | 1.46081 | 6.47285 | .55633 | .70970 | .86452 | .86019 |
| 1985 | 6.43278 | 1.41174 | 2.15055 | 5.69397 | -.00146 | 1.01775 | 1.25615 | 1.27092 |
| 1986 | 6.60863 | 1.15995 | 1.48806 | 6.28052 | .18846 | .83623 | .94715 | .94521 |
| 1987 | 6.62015 | 1.48422 | 1.79864 | 6.30573 | .20092 | 1.07001 | 1.17790 | 1.18714 |
| 1988 | 5.74653 | 2.18723 | 2.49679 | 5.43697 | -.74264 | 1.57682 | 1.68472 | 1.75030 |
| 1989 | 5.39702 | 2.18730 | 2.59907 | 4.98525 | -1.1201 | 1.57687 | 1.71890 | 1.79031 |
| 1990 | 8.55639 | -.37941 | -.60758 | 8.78457 | 2.29213 | -.27352 | -.34613 | -.34020 |
| 1991 | 6.46715 | 2.02642 | 2.39325 | 6.10032 | .03567 | 1.46089 | 1.58762 | 1.63823 |
| 1992 | 7.97488 | -.61446 | -.79349 | 8.15392 | 1.66408 | -.44298 | -.50339 | -.49604 |
| 1993 | 7.02665 | .71101 | .87020 | 6.86746 | .63995 | .51258 | .56707 | .55953 |
| 1994 | 6.64200 | 1.49399 | 1.70905 | 6.42694 | .22451 | 1.07705 | 1.15197 | 1.15958 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.
[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



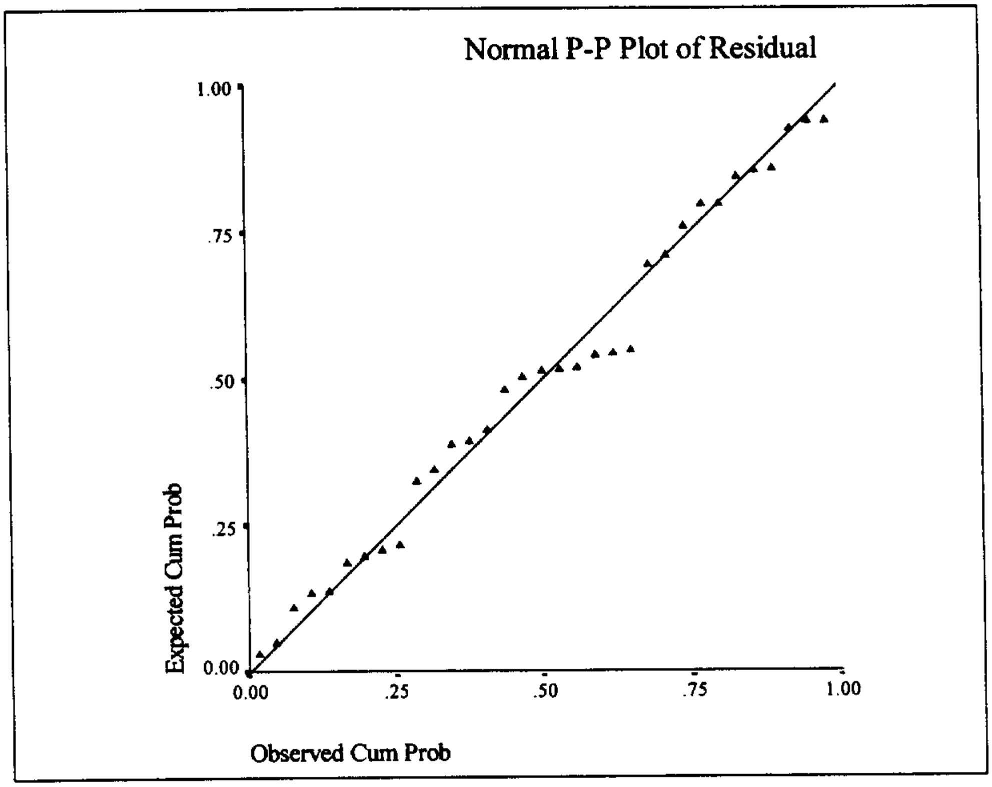




Fig. 6.1.1. Exploratory Plots of Ln (Brown Shrimp Harvest) Standardized Residual.

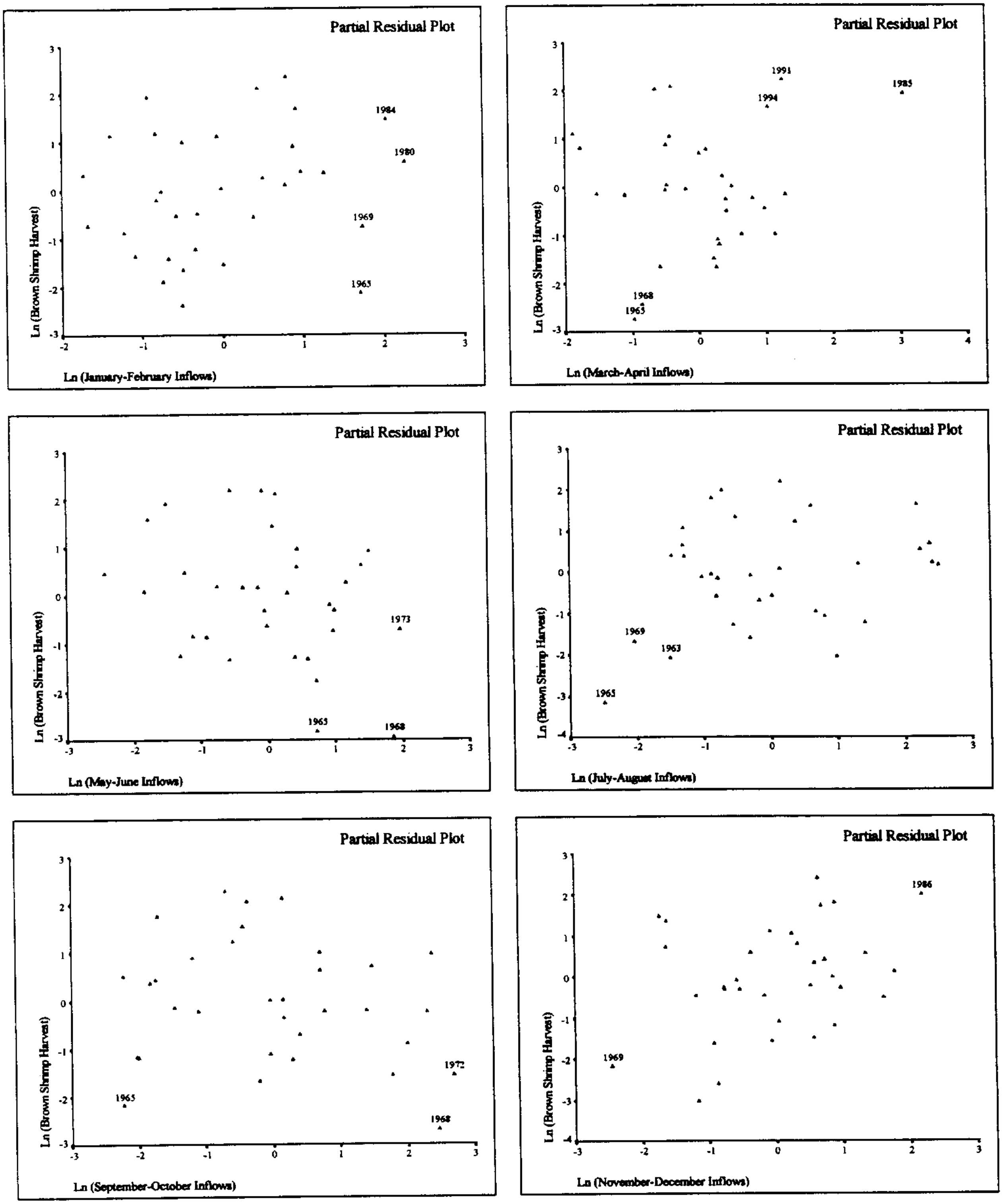



Fig. 6.1.2. Partial Residual Plots of Ln (Brown Shrimp Harvest) vs. Logged Inflows.

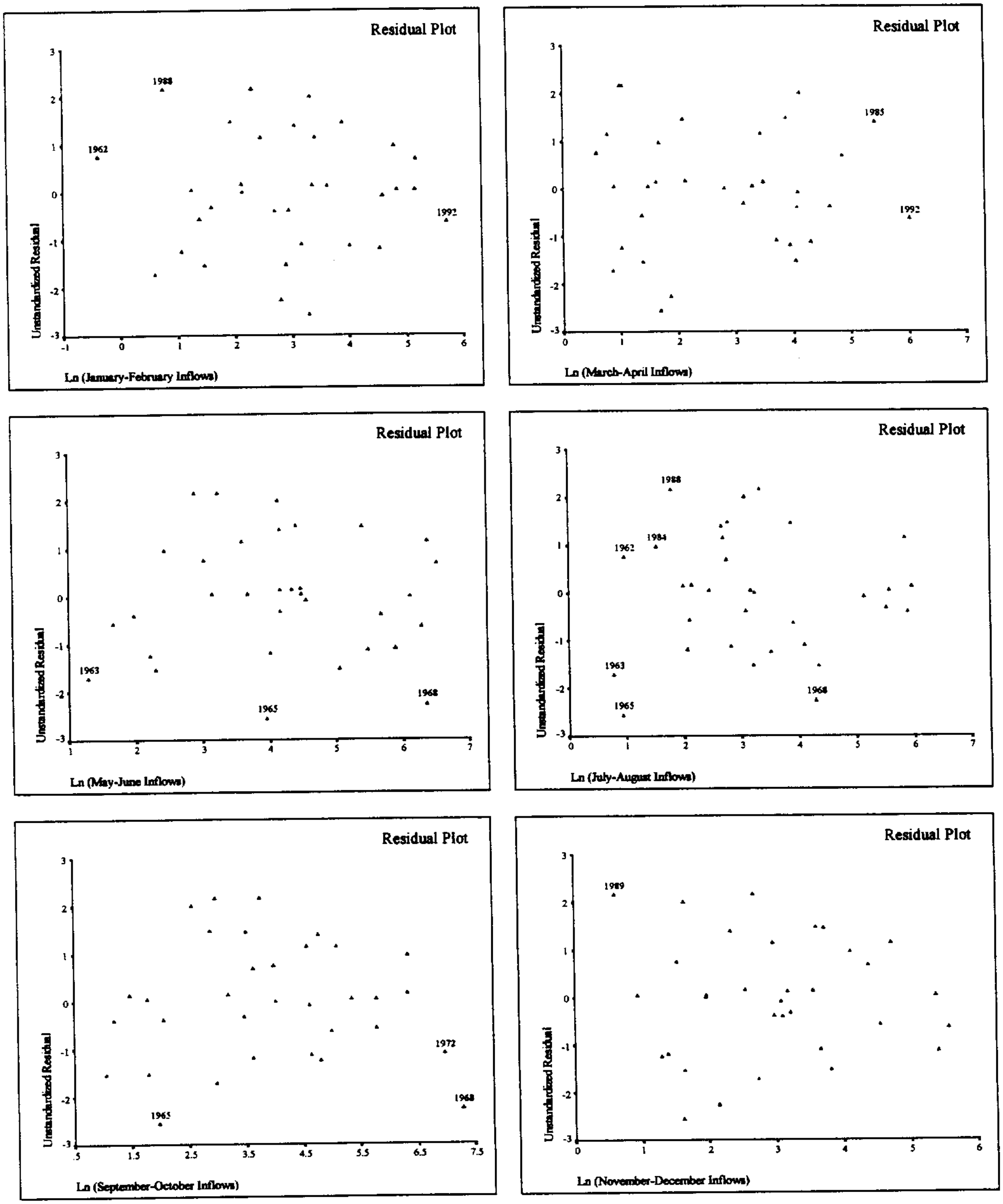



Fig. 6.1.3. Residual Plots of Ln (Brown Shrimp Harvest) vs. Logged Inflows.

### 6.1.4 Prediction Intervals for Brown Shrimp Harvest

| YEAR | Ln (BSH) | LICI | UICI |
|---|---|---|---|
| 1962 | 5.28 | 0.21742 | 8.7904 |
| 1963 | 4.34 | 1.76862 | 10.2901 |
| 1964 | 5.21 | 2.51210 | 10.9239 |
| 1965 | 3.12 | 1.29590 | 10.0038 |
| 1966 | 6.18 | 2.39978 | 10.6801 |
| 1967 | 5.46 | 1.20945 | 9.5720 |
| 1968 | 2.54 | 0.36450 | 9.1979 |
| 1969 | 5.09 | 1.87239 | 10.6357 |
| 1970 | 5.56 | 2.94162 | 11.1563 |
| 1971 | 4.37 | 1.42271 | 9.76161 |
| 1972 | 4.92 | 1.78455 | 10.2095 |
| 1973 | 5.15 | 0.96740 | 9.2889 |
| 1974 | 5.35 | 1.04886 | 9.2910 |
| 1975 | 6.19 | 2.32770 | 11.1365 |
| 1976 | 6.60 | 2.68936 | 11.1050 |
| 1977 | 6.16 | 3.13270 | 11.4068 |
| 1978 | 6.49 | 2.19698 | 10.4613 |
| 1979 | 7.26 | 3.23233 | 11.4138 |
| 1980 | 6.92 | 2.33433 | 11.3877 |
| 1981 | 7.46 | 2.07879 | 10.5304 |
| 1982 | 7.56 | 3.27890 | 11.7019 |
| 1983 | 8.05 | 3.63904 | 12.1495 |
| 1984 | 7.93 | 2.51064 | 11.3878 |
| 1985 | 7.84 | 1.96510 | 10.9005 |
| 1986 | 7.77 | 2.35045 | 10.8668 |
| 1987 | 8.10 | 2.44244 | 10.7979 |
| 1988 | 7.93 | 1.66018 | 9.8328 |
| 1989 | 7.58 | 1.24853 | 9.5455 |
| 1990 | 8.18 | 4.03581 | 13.0770 |
| 1991 | 8.49 | 2.32790 | 10.6064 |
| 1992 | 7.36 | 3.70775 | 12.2420 |
| 1993 | 7.74 | 2.83450 | 11.2188 |
| 1994 | 8.14 | 2.55229 | 10.7317 |

**Ln (BSH)** Ln (Brown shrimp harvest)
**LICI** Lower limit for 99% prediction interval for brown shrimp harvest
**UICI** Upper limit for 99% prediction interval for brown shrimp harvest

### 6.1.5 Outlier and Influential Point Detection

*Calculated Quantities*

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| 1962 | 6.60811 | .01802 | .20650 | .4708 | .0000 |
| 1963 | 6.13294 | .07746 | .19165 | .5243 | .0009 |
| 1964 | 5.13302 | .04948 | .16041 | .6437 | .0002 |
| 1965 | 7.86265 | .25063 | .24571 | .3449 | .0326 |
| 1966 | 3.95143 | .00207 | .12348 | .7854 | .0000 |
| 1967 | 4.68848 | .00010 | .14651 | .6979 | .0000 |
| 1968 | 9.04831 | .24707 | .28276 | .2492 | .0314 |
| 1969 | 8.38410 | .05865 | .26200 | .2999 | .0004 |
| 1970 | 3.36853 | .03005 | .10527 | .8489 | .0000 |
| 1971 | 4.47554 | .02749 | .13986 | .7237 | .0000 |
| 1972 | 5.25229 | .02563 | .16413 | .6292 | .0000 |
| 1973 | 4.32016 | .00001 | .13501 | .7423 | .0000 |
| 1974 | 3.61165 | .00048 | .11286 | .8233 | .0000 |
| 1975 | 8.81483 | .01396 | .27546 | .2662 | .0000 |
| 1976 | 5.16798 | .00197 | .16150 | .6395 | .0000 |
| 1977 | 3.89566 | .01929 | .12174 | .7917 | .0000 |
| 1978 | 3.80875 | .00041 | .11902 | .8015 | .0000 |
| 1979 | 3.07484 | .00004 | .09609 | .8780 | .0000 |
| 1980 | 11.1665 | .00024 | .34895 | .1315 | .0000 |
| 1981 | 5.49436 | .03167 | .17170 | .5999 | .0000 |
| 1982 | 5.23488 | .00010 | .16359 | .6313 | .0000 |
| 1983 | 6.03201 | .00062 | .18850 | .5360 | .0000 |
| 1984 | 9.46572 | .05167 | .29580 | .2209 | .0002 |
| 1985 | 10.0238 | .11797 | .31324 | .1872 | .0036 |
| 1986 | 6.08616 | .03625 | .19019 | .5297 | .0001 |
| 1987 | 4.62424 | .04199 | .14451 | .7057 | .0001 |
| 1988 | 2.99778 | .05739 | .09368 | .8852 | .0004 |
| 1989 | 4.10005 | .07946 | .12813 | .7682 | .0010 |
| 1990 | 11.0480 | .01029 | .34525 | .1365 | .0000 |
| 1991 | 3.93516 | .06518 | .12297 | .7872 | .0005 |
| 1992 | 6.25052 | .01055 | .19533 | .5108 | .0000 |
| 1993 | 4.88451 | .01029 | .15264 | .6741 | .0000 |
| 1994 | 3.05707 | .02729 | .09553 | .8797 | .0000 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with $p + 1$ degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with $p + 1$ numerator degree of freedom and $n - p - 1$ denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1962** | .35102 | .18012 | -.20540 | .01378 | .05005 | -.13809 | .06089 | -.04263 |
| **1963** | -.75000 | -.56559 | .19555 | -.07014 | .33249 | .31237 | .03843 | -.14562 |
| **1964** | -.59415 | -.33074 | -.00245 | .13989 | .12448 | -.25046 | .32394 | .01205 |
| **1965** | **-1.4317** | -.93875 | -.76772 | .46177 | -.31393 | .88294 | .72324 | .50951 |
| **1966** | -.11816 | -.01799 | .02863 | -.04227 | -.04658 | .03144 | .05231 | .00803 |
| **1967** | .02594 | .01442 | -.00014 | -.01197 | .00983 | .00114 | -.01336 | -.00758 |
| **1968** | **-1.3954** | .62441 | .20650 | .37368 | -.74395 | -.32165 | -.72996 | .34643 |
| **1969** | -.64066 | -.29288 | -.33913 | -.23427 | .17230 | .31454 | -.04152 | .46666 |
| **1970** | -.46184 | -.06298 | .10172 | -.04712 | -.14485 | .05109 | .30246 | -.17693 |
| **1971** | -.43809 | -.15427 | .11801 | -.05592 | .19012 | -.11172 | -.22456 | .15851 |
| **1972** | -.42143 | .24925 | .17159 | -.10498 | -.09097 | -.08361 | -.30582 | -.00682 |
| **1973** | .00705 | -.00049 | -.00237 | -.00061 | .00544 | -.00068 | -.00006 | -.00210 |
| **1974** | .05667 | -.00100 | -.01879 | .00922 | .00696 | -.01701 | .04089 | -.01388 |
| **1975** | -.30789 | -.03106 | .11293 | -.03964 | .16325 | -.00207 | -.13248 | -.15844 |
| **1976** | -.11527 | .02701 | .07287 | -.01844 | .00201 | -.08287 | -.00537 | -.03623 |
| **1977** | -.36569 | .12743 | .05297 | -.04501 | -.05989 | .06881 | .00388 | -.24294 |
| **1978** | .05229 | .01464 | .02181 | -.03582 | .01989 | -.01790 | -.02814 | .01604 |
| **1979** | -.01706 | .00446 | -.00616 | -.00411 | .00574 | -.00825 | -.00442 | .00412 |
| **1980** | .04040 | -.00306 | .02449 | -.01270 | -.01297 | .01913 | .01087 | -.01253 |
| **1981** | .46967 | -.28599 | -.08598 | -.07779 | .23351 | .29896 | .08790 | -.01188 |
| **1982** | .02620 | -.00455 | .01242 | -.00524 | -.00354 | -.00610 | .00105 | .01286 |
| **1983** | .06439 | -.00132 | .01127 | -.01161 | -.00303 | .04270 | -.03643 | .01289 |
| **1984** | .59838 | .10308 | .35174 | -.09042 | -.29863 | -.17782 | .18504 | .04216 |
| **1985** | .91941 | .14245 | -.21438 | .83455 | -.37705 | -.26370 | .44314 | -.41239 |
| **1986** | .50271 | -.03213 | -.01158 | -.33020 | .07706 | .05307 | -.07362 | .37747 |
| **1987** | .54640 | -.09730 | .19764 | -.42858 | .31641 | .10565 | -.26531 | .18655 |
| **1988** | .65847 | .39520 | -.28837 | -.13452 | .03870 | -.17324 | -.15223 | .19036 |
| **1989** | .77679 | .38584 | .25715 | -.22020 | -.02232 | .04102 | .03598 | -.54119 |
| **1990** | -.26383 | -.05235 | .02227 | -.09652 | .16694 | -.14077 | .05631 | -.03577 |
| **1991** | .69701 | .34684 | .13072 | .38685 | -.15429 | -.20188 | -.07813 | -.46387 |
| **1992** | -.26776 | .13075 | -.03523 | -.09621 | .00090 | .01187 | -.02723 | -.08807 |
| **1993** | .26476 | -.04511 | .08991 | .00011 | .11582 | -.10356 | -.08698 | .03297 |
| **1994** | .43995 | .07573 | -.28496 | .22528 | .01657 | -.08205 | -.06539 | .13674 |

**SDFFITS** Standardized dffits value
**SDFB_0** Standardized dfbeta for the intercept term
**SDFB_1** Standardized dfbeta for the Logged January-February inflows
**SDFB_2** Standardized dfbeta for the Logged March-April inflows
**SDFB_3** Standardized dfbeta for the Logged May-June inflows
**SDFB_4** Standardized dfbeta for the Logged July-August inflows
**SDFB_5** Standardized dfbeta for the Logged September-October inflows
**SDFB_6** Standardized dfbeta for the Logged November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

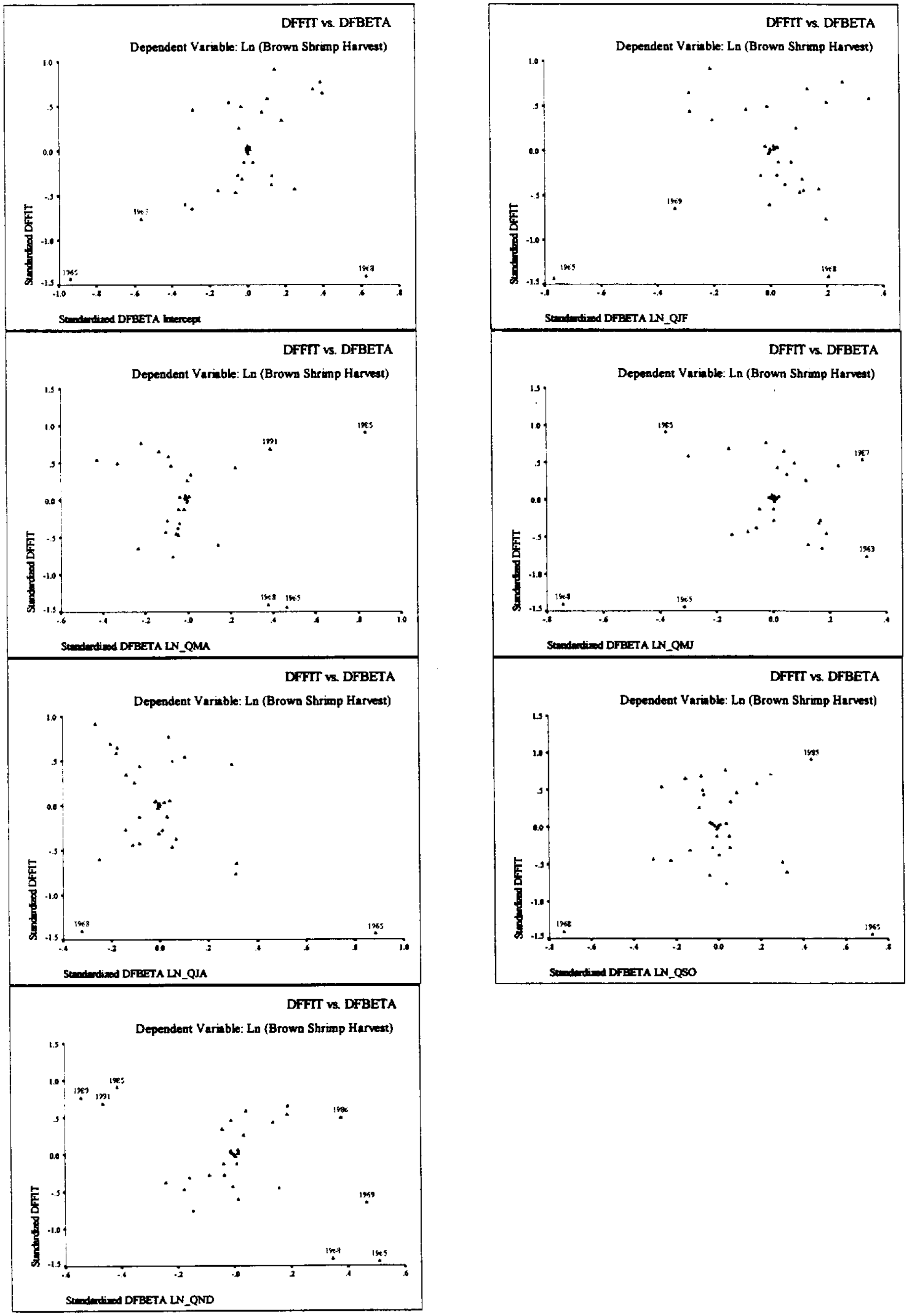



Fig. 6.1.4. Standardized DFFIT vs. Standardized DFBETA.

## 6.2 Model 5: Square Root All Variables

### 6.2.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | SQRT(Nov-Dec Inflows), SQRT(Jul-Aug Inflows), SQRT(Sept-Oct Inflows), SQRT(May-Jun Inflows), SQRT(Jan-Feb Inflows), SQRT(Mar-Apr Inflows)[c,d] | . | .534 | .285 | .120 | 18.1449 | .791 |

a. Dependent Variable: SQRT (Brown Shrimp Harvest)

b. Method: Enter

c. Independent Variables: (Constant), SQRT (November-December Inflows), SQRT (July-August Inflows), SQRT (September-October Inflows), SQRT (May-June Inflows), SQRT (January-February Inflows), SQRT (March-April Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 3409.538 | 6 | 568.256 | 1.726 | .155[b] |
| | Residual | 8560.190 | 26 | 329.238 | | |
| | Total | 11969.7 | 32 | | | |

a. Dependent Variable: SQRT (Brown Shrimp Harvest)

b. Independent Variables: (Constant), SQRT (November-December Inflows), SQRT (July-August Inflows), SQRT (September-October Inflows), SQRT (May-June Inflows), SQRT (January-February Inflows), SQRT (March-April Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. | 95% Confidence Interval for B Lower Bound | 95% Confidence Interval for B Upper Bound |
|---|---|---|---|---|---|---|---|---|
| 1 | (Constant) | 22.574 | 8.008 | | 2.819 | .009 | 6.112 | 39.035 |
| | SQRT (January-February Inflows) | .925 | 1.108 | .193 | .835 | .411 | -1.352 | 3.202 |
| | SQRT (March-April Inflows) | .842 | 1.043 | .188 | .807 | .427 | -1.302 | 2.987 |
| | SQRT (May-June Inflows) | -.676 | .565 | -.251 | -1.196 | .242 | -1.838 | .486 |
| | SQRT (July-August Inflows) | .943 | .618 | .263 | 1.527 | .139 | -.327 | 2.212 |
| | SQRT (September-October Inflows) | -.456 | .406 | -.209 | -1.124 | .271 | -1.291 | .378 |
| | SQRT (November-December Inflows) | .884 | 1.049 | .179 | .842 | .407 | -1.273 | 3.040 |

a. Dependent Variable: SQRT (Brown Shrimp Harvest)

### 6.2.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 22.573767 | 8.00831668 | 2.819 | 0.0091 | 0.00000000 |
| SQRT_QJF | 1 | 0.925188 | 1.10759515 | 0.835 | 0.4112 | 1.94666125 |
| SQRT_QMA | 1 | 0.842045 | 1.04328661 | 0.807 | 0.4269 | 1.97602924 |
| SQRT_QMJ | 1 | -0.675978 | 0.56509231 | -1.196 | 0.2424 | 1.59545075 |
| SQRT_QJA | 1 | 0.942880 | 0.61764637 | 1.527 | 0.1389 | 1.07507529 |
| SQRT_QSO | 1 | -0.456224 | 0.40598393 | -1.124 | 0.2714 | 1.26295953 |
| SQRT_QND | 1 | 0.883579 | 1.04905631 | 0.842 | 0.4073 | 1.64682610 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop SQRT_QJF | Var Prop SQRT_QMA | Var Prop SQRT_QMJ | Var Prop SQRT_QJA | Var Prop SQRT_QSO | Var Prop SQRT_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.45241 | 1.00000 | 0.0592 | 0.0517 | 0.0534 | 0.0019 | 0.0103 | 0.0548 |
| 2 | 1.09621 | 1.49572 | 0.0009 | 0.0537 | 0.0017 | 0.3004 | 0.3550 | 0.0184 |
| 3 | 1.07154 | 1.51284 | 0.0036 | 0.0139 | 0.0595 | 0.3929 | 0.2188 | 0.0638 |
| 4 | 0.67722 | 1.90297 | 0.1034 | 0.0699 | 0.3899 | 0.1993 | 0.0220 | 0.1658 |
| 5 | 0.39272 | 2.49893 | 0.4282 | 0.0843 | 0.1522 | 0.0923 | 0.0722 | 0.6757 |
| 6 | 0.30990 | 2.81309 | 0.4046 | 0.7265 | 0.3433 | 0.0133 | 0.3217 | 0.0215 |

### 6.2.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 5.3442 | 55.4285 | 31.7800 | 10.3222 | 33 |
| Std. Predicted Value | -2.561 | 2.291 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | 5.1548 | 12.5402 | 8.0347 | 2.3340 | 33 |
| Adjusted Predicted Value | 6.9229 | 69.8517 | 31.7348 | 11.9203 | 33 |
| Residual | -21.9478 | 36.3943 | 1.1E-14 | 16.3556 | 33 |
| Std. Residual | -1.210 | 2.006 | .000 | .901 | 33 |
| Stud. Residual | -1.348 | 2.129 | .001 | .999 | 33 |
| Deleted Residual | -30.1970 | 41.0160 | 4.5E-02 | 20.3425 | 33 |
| Stud. Deleted Residual | -1.371 | 2.298 | .011 | 1.020 | 33 |
| Mahal. Distance | 1.613 | 14.315 | 5.818 | 3.903 | 33 |
| Cook's Distance | .000 | .189 | .036 | .047 | 33 |
| Centered Leverage Value | .050 | .447 | .182 | .122 | 33 |

a. Dependent Variable: SQRT (Brown Shrimp Harvest)

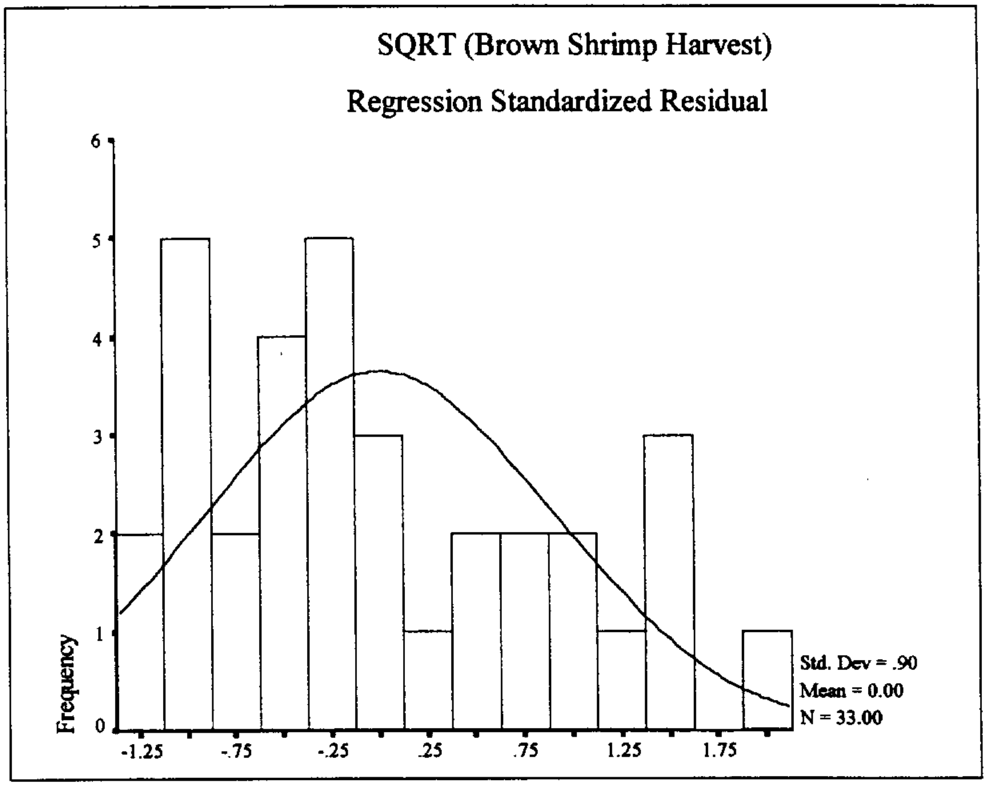
*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 21.47263 | -7.48335 | -8.32717 | 22.31645 | -.99856 | -.41242 | -.43505 | -.42817 |
| 1963 | 26.66320 | -17.89393 | -20.08103 | 28.85030 | -.49570 | -.98617 | -1.04470 | -1.04661 |
| 1964 | 33.53112 | -20.03297 | -22.09314 | 35.59129 | .16965 | -1.10405 | -1.15943 | -1.16750 |
| 1965 | 26.70179 | -21.94785 | -25.49804 | 30.25198 | -.49197 | -1.20959 | -1.30375 | -1.32239 |
| 1966 | 30.62894 | -8.65396 | -10.20381 | 32.17879 | -.11151 | -.47694 | -.51789 | -.51047 |
| 1967 | 26.24842 | -10.89589 | -12.02650 | 27.37903 | -.53589 | -.60049 | -.63088 | -.62342 |
| 1968 | 5.34425 | -1.78054 | -3.35919 | 6.92290 | -2.56105 | -.09813 | -.13478 | -.13221 |
| 1969 | 34.17866 | -21.43111 | -27.92009 | 40.66764 | .23238 | -1.18111 | -1.34811 | -1.37071 |
| 1970 | 33.93165 | -17.85060 | -19.52854 | 35.60958 | .20845 | -.98378 | -1.02898 | -1.03019 |
| 1971 | 25.59119 | -16.70862 | -18.28020 | 27.16277 | -.59956 | -.92084 | -.96318 | -.96179 |
| 1972 | 17.41405 | -5.68801 | -7.94358 | 19.66962 | -1.39175 | -.31348 | -.37045 | -.36422 |
| 1973 | 17.99974 | -4.87724 | -6.27177 | 19.39427 | -1.33501 | -.26879 | -.30481 | -.29942 |
| 1974 | 16.53666 | -2.01426 | -2.37320 | 16.89559 | -1.47675 | -.11101 | -.12050 | -.11819 |
| 1975 | 27.59388 | -5.53260 | -7.40923 | 29.47051 | -.40554 | -.30491 | -.35286 | -.34683 |
| 1976 | 39.91268 | -12.84609 | -15.58576 | 42.65235 | .78789 | -.70797 | -.77982 | -.77378 |
| 1977 | 38.66226 | -16.89072 | -22.85635 | 44.62789 | .66675 | -.93088 | -1.08286 | -1.08662 |
| 1978 | 29.02516 | -3.33859 | -3.68232 | 29.36889 | -.26688 | -.18400 | -.19324 | -.18962 |
| 1979 | 43.42215 | -5.63855 | -6.52019 | 44.30378 | 1.12788 | -.31075 | -.33416 | -.32838 |
| 1980 | 40.82227 | -9.02762 | -14.68371 | 46.47836 | .87601 | -.49753 | -.63453 | -.62708 |
| 1981 | 31.67825 | 10.08777 | 15.00981 | 26.75621 | -.00985 | .55596 | .67816 | .67095 |
| 1982 | 42.29918 | 1.47867 | 2.13715 | 41.64070 | 1.01909 | .08149 | .09797 | .09609 |
| 1983 | 49.59809 | 6.27946 | 8.34065 | 47.53689 | 1.72619 | .34607 | .39885 | .39230 |
| 1984 | 30.49812 | 22.31854 | 32.10695 | 20.70972 | -.12418 | 1.23002 | 1.47529 | 1.51128 |
| 1985 | 35.51221 | 15.00214 | 28.40233 | 22.11202 | .36158 | .82680 | 1.13762 | 1.14438 |
| 1986 | 31.36815 | 17.26415 | 21.44612 | 27.18618 | -.03990 | .95146 | 1.06045 | 1.06311 |
| 1987 | 30.92538 | 26.59766 | 30.87313 | 26.64991 | -.08279 | 1.46585 | 1.57927 | 1.62869 |
| 1988 | 26.13831 | 26.68119 | 29.31189 | 23.50762 | -.54655 | 1.47045 | 1.54124 | 1.58547 |
| 1989 | 26.70210 | 17.64990 | 19.19943 | 25.15258 | -.49194 | .97272 | 1.01452 | 1.01511 |
| 1990 | 51.92590 | 7.72391 | 11.25398 | 48.39583 | 1.95171 | .42568 | .51383 | .50643 |
| 1991 | 33.48627 | 36.39435 | 41.01601 | 28.86461 | .16530 | 2.00576 | 2.12931 | 2.29791 |
| 1992 | 55.42848 | -15.77372 | -30.19697 | 69.85173 | 2.29103 | -.86932 | -1.20280 | -1.21369 |
| 1993 | 35.51521 | 12.37112 | 18.04230 | 29.84403 | .36186 | .68180 | .82337 | .81812 |
| 1994 | 31.98232 | 26.45739 | 29.19145 | 29.24826 | .01960 | 1.45812 | 1.53160 | 1.57457 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.

[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



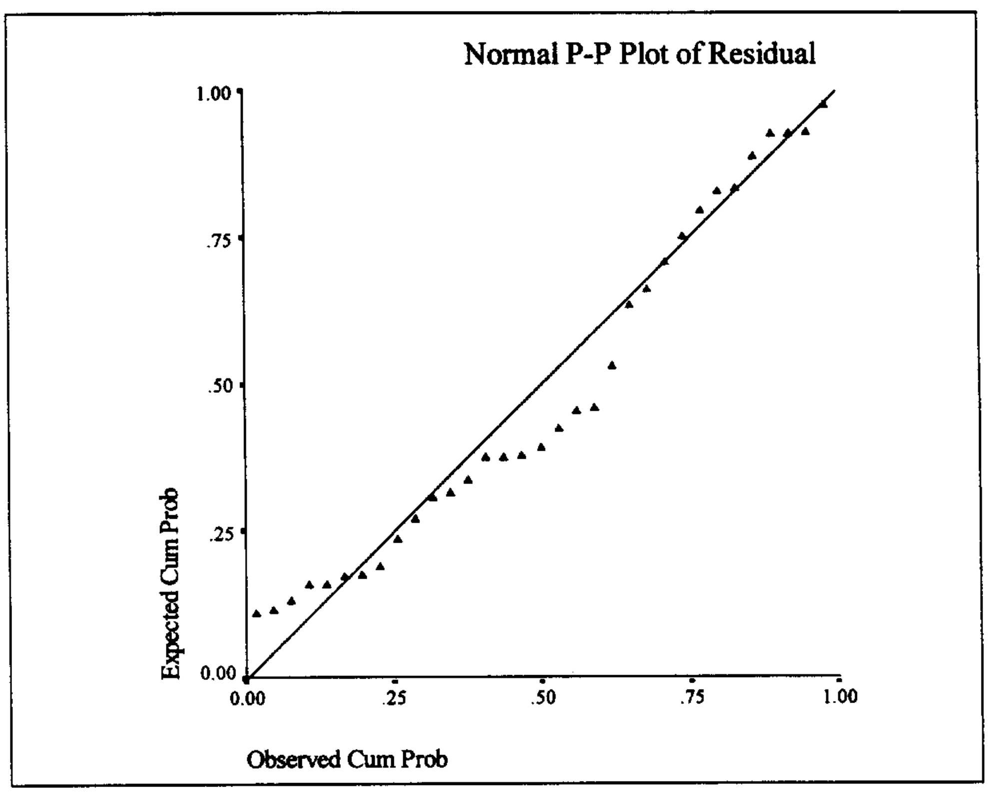




Fig. 6.2.1. Exploratory Plots of SQRT (Brown Shrimp Harvest) Standardized Residual.

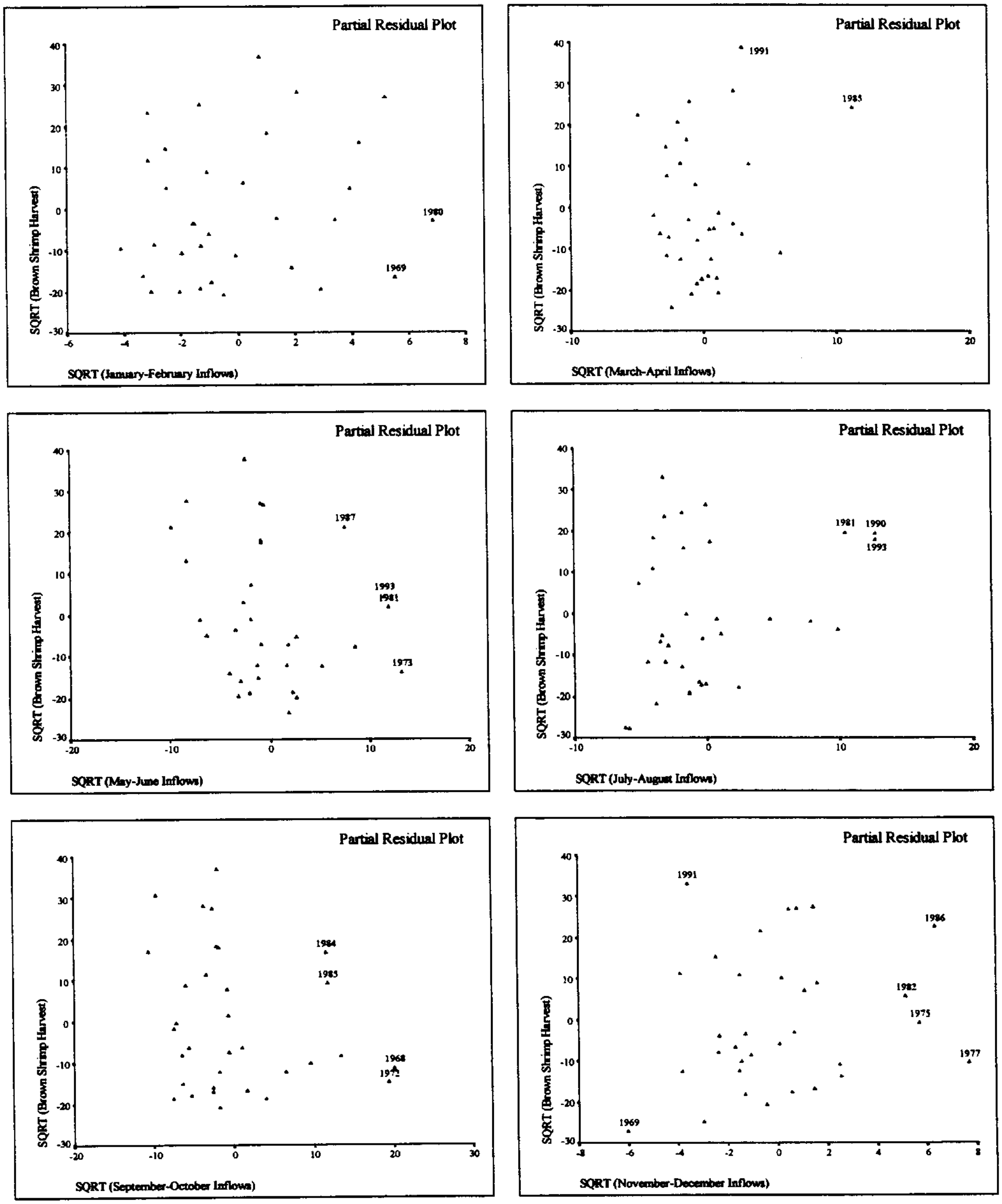



Fig. 6.2.2. Partial Residual Plots of SQRT (Brown Shrimp Harvest) vs. Square Root Inflows.

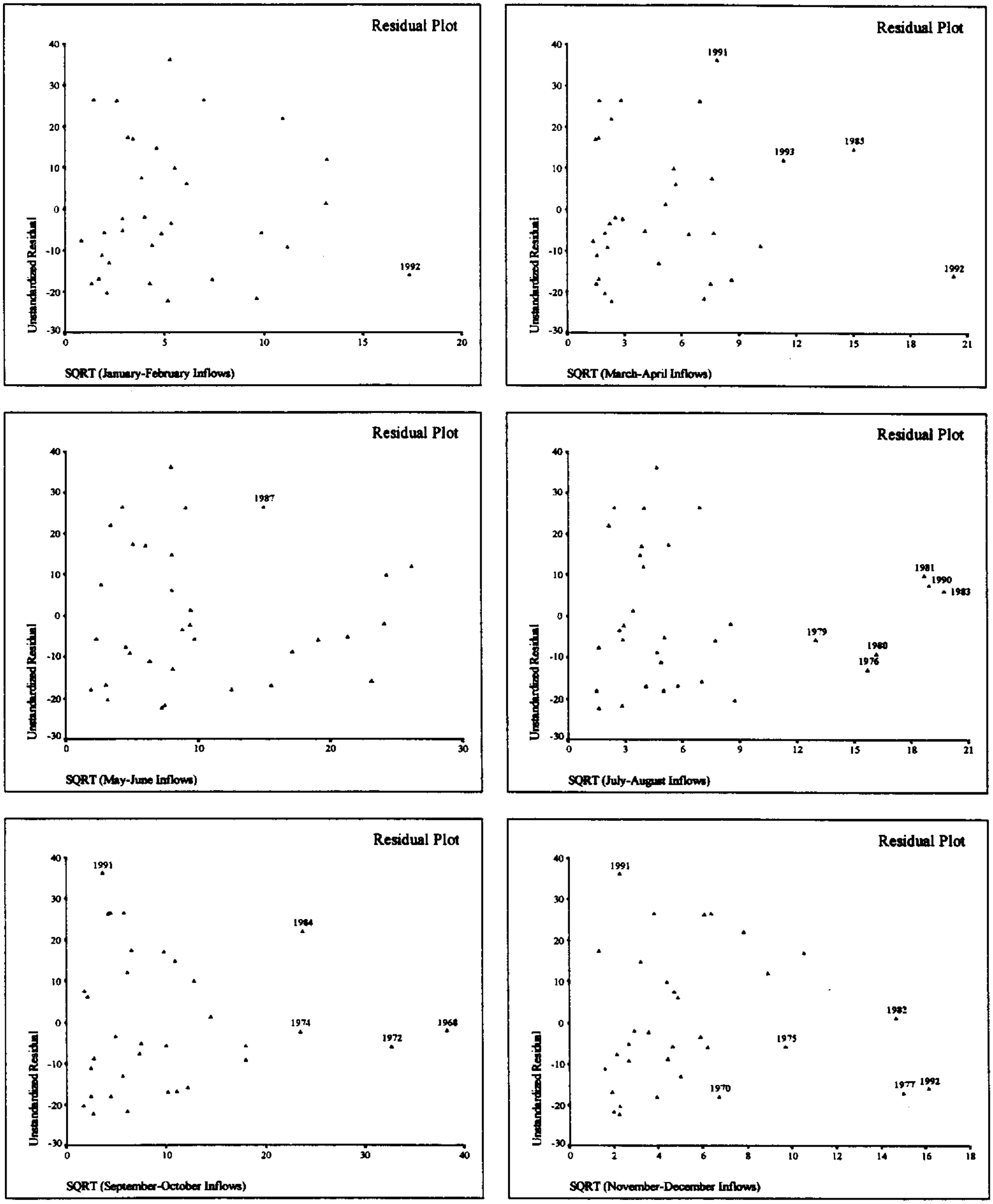



Fig. 6.2.3. Residual Plots of SQRT (Brown Shrimp Harvest) vs. Square Root Inflows.

### 6.2.4 Prediction Intervals for Brown Shrimp Harvest

| YEAR | SQRT (BSH) | LICI | UICI |
|---|---|---|---|
| 1962 | 13.99 | 0 | 74.38515 |
| 1963 | 8.77 | 0 | 79.75749 |
| 1964 | 13.50 | 0 | 86.24907 |
| 1965 | 4.75 | 0 | 80.51705 |
| 1966 | 21.97 | 0 | 84.74229 |
| 1967 | 15.35 | 0 | 78.98471 |
| 1968 | 3.56 | 0 | 66.47364 |
| 1969 | 12.75 | 0 | 90.15146 |
| 1970 | 16.08 | 0 | 86.47264 |
| 1971 | 8.88 | 0 | 78.13338 |
| 1972 | 11.73 | 0 | 74.54519 |
| 1973 | 13.12 | 0 | 73.74356 |
| 1974 | 14.52 | 0 | 70.63487 |
| 1975 | 22.06 | 0 | 84.03862 |
| 1976 | 27.07 | 0 | 94.58431 |
| 1977 | 21.77 | 0 | 95.28064 |
| 1978 | 25.69 | 0 | 81.74546 |
| 1979 | 37.78 | 0 | 97.14243 |
| 1980 | 31.79 | 0 | 100.16321 |
| 1981 | 41.77 | 0 | 89.77945 |
| 1982 | 43.78 | 0 | 99.96539 |
| 1983 | 55.88 | 0 | 105.90403 |
| 1984 | 52.82 | 0 | 88.09281 |
| 1985 | 50.51 | 0 | 96.68007 |
| 1986 | 48.63 | 0 | 86.48478 |
| 1987 | 57.52 | 0 | 84.72295 |
| 1988 | 52.82 | 0 | 78.77179 |
| 1989 | 44.35 | 0 | 79.11678 |
| 1990 | 59.65 | 0 | 109.71456 |
| 1991 | 69.88 | 0 | 86.67064 |
| 1992 | 39.65 | 0 | 116.71756 |
| 1993 | 47.89 | 0 | 93.31824 |
| 1994 | 58.44 | 0 | 84.71017 |

**SQRT (BSH)** Square root brown shrimp harvest
**LICI** Lower limit for 99% prediction interval for brown shrimp harvest
**UICI** Upper limit for 99% prediction interval for brown shrimp harvest

### 6.2.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| 1962 | 2.27298 | .00305 | .07103 | .9432 | .0000 |
| 1963 | 2.51554 | .01906 | .07861 | .9259 | .0000 |
| 1964 | 2.01428 | .01975 | .06295 | .9590 | .0000 |
| 1965 | 3.48579 | .03928 | .10893 | .8367 | .0001 |
| 1966 | 3.89076 | .00686 | .12159 | .7923 | .0000 |
| 1967 | 2.03861 | .00590 | .06371 | .9577 | .0000 |
| 1968 | 14.06867 | .00230 | .43965 | .0500 | .0000 |
| 1969 | 6.46750 | .07861 | .20211 | .4863 | .0010 |
| 1970 | 1.77981 | .01422 | .05562 | .9710 | .0000 |
| 1971 | 1.78140 | .01247 | .05567 | .9709 | .0000 |
| 1972 | 8.11669 | .00777 | .25365 | .3224 | .0000 |
| 1973 | 6.14549 | .00379 | .19205 | .5229 | .0000 |
| 1974 | 3.87015 | .00037 | .12094 | .7946 | .0000 |
| 1975 | 7.13534 | .00603 | .22298 | .4149 | .0000 |
| 1976 | 4.65527 | .01853 | .14548 | .7019 | .0000 |
| 1977 | 7.38247 | .05916 | .23070 | .3902 | .0004 |
| 1978 | 2.01738 | .00055 | .06304 | .9589 | .0000 |
| 1979 | 3.35723 | .00249 | .10491 | .8501 | .0000 |
| 1980 | 11.35654 | .03604 | .35489 | .1238 | .0001 |
| 1981 | 9.52379 | .03206 | .29762 | .2172 | .0000 |
| 1982 | 8.88988 | .00061 | .27781 | .2607 | .0000 |
| 1983 | 6.93836 | .00746 | .21682 | .4353 | .0000 |
| 1984 | 8.78611 | .13637 | .27457 | .2684 | .0056 |
| 1985 | 14.12787 | .16514 | .44150 | .0490 | .0099 |
| 1986 | 5.27027 | .03892 | .16470 | .6270 | .0001 |
| 1987 | 3.46183 | .05727 | .10818 | .8393 | .0003 |
| 1988 | 1.90225 | .03346 | .05945 | .9651 | .0001 |
| 1989 | 1.61292 | .01291 | .05040 | .9781 | .0000 |
| 1990 | 9.06784 | .01724 | .28337 | .2478 | .0000 |
| 1991 | 2.63605 | .08225 | .08238 | .9165 | .0011 |
| 1992 | 14.31476 | .18898 | .44734 | .0459 | .0148 |
| 1993 | 9.08876 | .04440 | .28402 | .2463 | .0001 |
| 1994 | 2.02741 | .03463 | .06336 | .9583 | .0001 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with $p + 1$ degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with $p + 1$ numerator degree of freedom and $n - p - 1$ denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1962** | -.14378 | -.13200 | .03539 | .01092 | .01207 | .06828 | .00597 | .02735 |
| **1963** | -.36590 | -.32281 | .08948 | .03219 | .10333 | .14641 | .06498 | -.03685 |
| **1964** | -.37440 | -.25876 | .03732 | .06391 | .07993 | -.09987 | .14460 | .03184 |
| **1965** | -.53185 | -.42716 | -.25221 | .19758 | -.08289 | .28483 | .24312 | .24528 |
| **1966** | -.21603 | -.05819 | .06654 | -.09296 | -.08962 | .05890 | .06958 | .04576 |
| **1967** | -.20082 | -.17795 | .00385 | .06385 | -.03366 | .04200 | .09425 | .05759 |
| **1968** | -.12449 | .02696 | .01754 | .01172 | -.04834 | -.00447 | -.08167 | .02452 |
| **1969** | -.75424 | -.34442 | -.52458 | -.10135 | .15504 | .33019 | .06231 | .54632 |
| **1970** | -.31585 | -.10601 | .13370 | -.06246 | -.08885 | .04903 | .15474 | -.09151 |
| **1971** | -.29497 | -.20787 | .05679 | -.02016 | .12746 | .01532 | -.08952 | .07578 |
| **1972** | -.22936 | .07152 | .07724 | -.05570 | -.02500 | -.01505 | -.18665 | -.00225 |
| **1973** | -.16011 | -.04305 | .02113 | .05048 | -.13920 | .03347 | .05703 | .03297 |
| **1974** | -.04989 | -.01253 | .01180 | -.00846 | .00761 | .01475 | -.03833 | .00944 |
| **1975** | -.20200 | -.02411 | .10046 | -.00981 | .08682 | .00414 | -.08589 | -.13201 |
| **1976** | -.35734 | .02238 | .17301 | -.02812 | .03351 | -.28533 | .03418 | -.12233 |
| **1977** | -.64577 | .15138 | .23577 | .01281 | -.08746 | .00374 | .07316 | -.55956 |
| **1978** | -.06084 | -.03779 | -.01648 | .03745 | -.01629 | .02359 | .03187 | -.00770 |
| **1979** | -.12985 | .01418 | -.07324 | -.01626 | .03737 | -.05729 | -.00781 | .04856 |
| **1980** | -.49636 | .03837 | -.33387 | .12778 | .15739 | -.21192 | -.11635 | .17655 |
| **1981** | .46867 | -.16000 | -.05312 | -.12731 | .30231 | .29144 | -.06205 | .00930 |
| **1982** | .06412 | -.00982 | .02773 | -.02491 | -.00954 | -.00598 | -.00176 | .03431 |
| **1983** | .22476 | -.03457 | .00524 | -.01529 | -.02535 | .19542 | -.06089 | .02867 |
| **1984** | **1.00085** | .09620 | .57596 | -.19488 | -.46623 | -.24683 | .46871 | -.06680 |
| **1985** | **1.08155** | .14592 | -.30139 | **1.01515** | -.48256 | -.21723 | .41403 | -.35399 |
| **1986** | .52323 | .08223 | -.18201 | -.19136 | -.03283 | .01089 | -.04754 | .43350 |
| **1987** | .65299 | .12253 | .22416 | -.49171 | .41319 | -.00023 | -.37870 | .08009 |
| **1988** | .49784 | .44012 | -.13510 | -.09289 | -.04398 | -.17905 | -.13722 | .04716 |
| **1989** | .30078 | .25981 | .06614 | -.07439 | -.02971 | -.06210 | -.05015 | -.14971 |
| **1990** | .34236 | -.02803 | -.09269 | .12189 | -.15816 | .26451 | -.01136 | .05673 |
| **1991** | .81887 | .48296 | .11463 | .41478 | -.18077 | -.27298 | -.11045 | -.50253 |
| **1992** | **-1.16058** | .55917 | -.19119 | -.56082 | .06289 | .03700 | -.05967 | -.24731 |
| **1993** | .55392 | -.04877 | .25755 | -.09585 | .35299 | -.17163 | -.23531 | -.08630 |
| **1994** | .50617 | .22548 | -.31772 | .21923 | -.02928 | -.10347 | -.09417 | .14069 |

**SDFFITS** Standardized dffits value
**SDFB_0** Standardized dfbeta for the intercept term
**SDFB_1** Standardized dfbeta for the Square root January-February inflows
**SDFB_2** Standardized dfbeta for the Square root March-April inflows
**SDFB_3** Standardized dfbeta for the Square root May-June inflows
**SDFB_4** Standardized dfbeta for the Square root July-August inflows
**SDFB_5** Standardized dfbeta for the Square root September-October inflows
**SDFB_6** Standardized dfbeta for the Square root November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

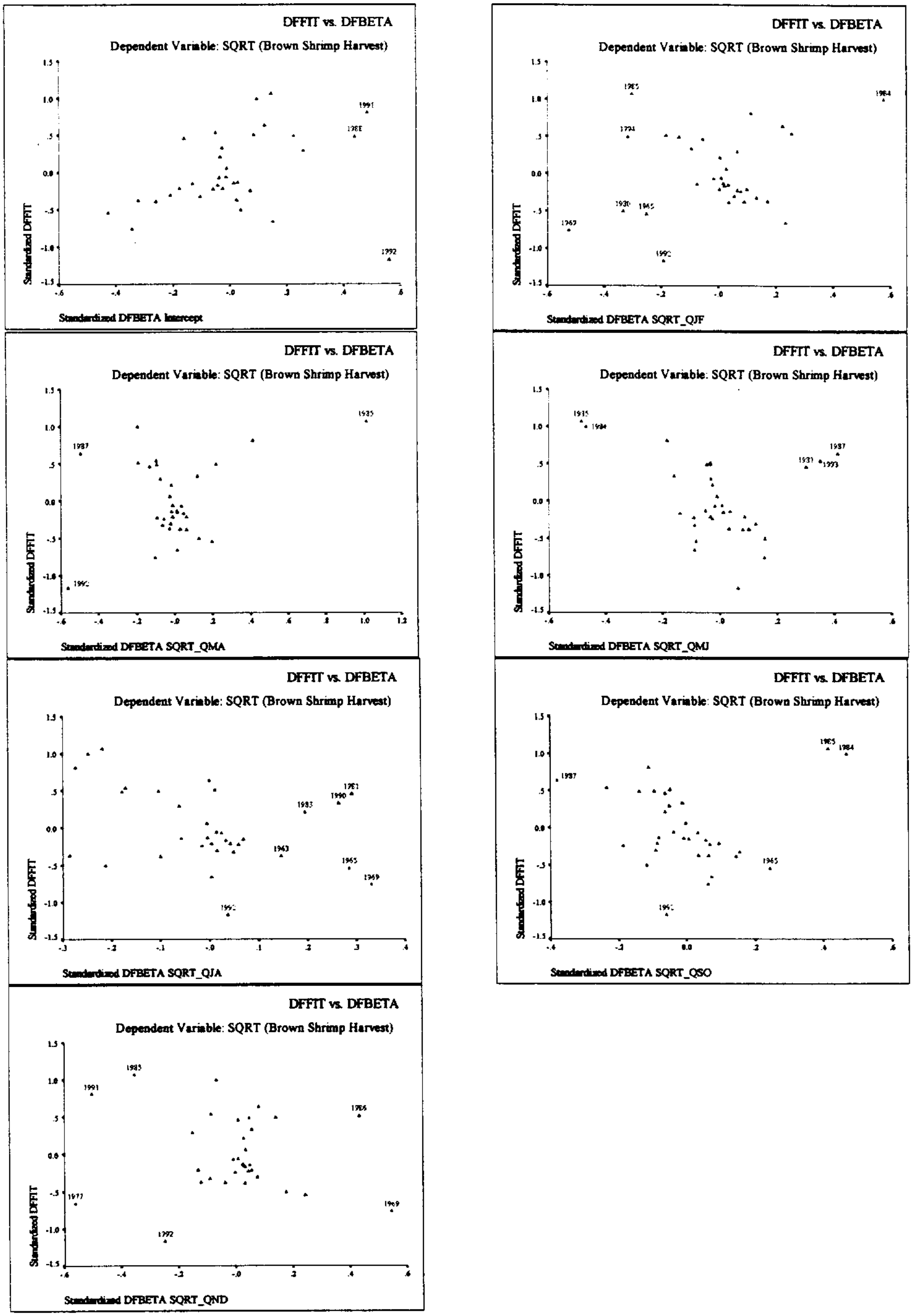



Fig. 6.2.4. Standardized DFFIT vs. Standardized DFBETA.

## 6.3 Model 6: Variables Transformed According to the Box-Cox Analysis

### 6.3.1 ANOVA and Parameter Estimates

**Model Summary**[a,b]

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | (Nov-Dec Inflows)^ -0.1, (Jul-Aug Inflows)^ -0.1, Ln(Sept-Oct Inflows), Ln(Ma-Jun Inflows), Ln(Jan-Feb Inflows), (Mar-Apr Inflows)^ -0.1[c,d] | . | .582 | .339 | .187 | .9595 | .773 |

a. Dependent Variable: (Brown Shrimp Harvest)^0.2

b. Method: Enter

c. Independent Variables: (Constant), (November-December Inflows)^-0.1, (July-August Inflows)^-0.1, Ln (September-October Inflows), Ln (May-June Inflows), Ln (January-February Inflows), (March-April Inflows)^-0.1

d. All requested variables entered.

**ANOVA**[a]

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 12.293 | 6 | 2.049 | 2.225 | .073[b] |
| | Residual | 23.938 | 26 | .921 | | |
| | Total | 36.231 | 32 | | | |

a. Dependent Variable: (Brown Shrimp Harvest)^0.2

b. Independent Variables: (Constant), (November-December Inflows)^-0.1, (July-August Inflows)^-0.1, Ln (September-October Inflows), Ln (May-June Inflows), Ln (January-February Inflows), (March-April Inflows)^-0.1

**Coefficients[a]**

| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. | 95% Confidence Interval for B Lower Bound | 95% Confidence Interval for B Upper Bound |
|---|---|---|---|---|---|---|---|---|
| 1 | (Constant) | 9.911 | 2.804 | | 3.535 | .002 | 4.148 | 15.674 |
| | Ln (January-February Inflows) | .198 | .158 | .276 | 1.254 | .221 | -.127 | .523 |
| | (March-April Inflows)^ -0.1 | -1.372 | 2.279 | -.149 | -.602 | .552 | -6.057 | 3.312 |
| | Ln (May-June Inflows) | -.239 | .155 | -.329 | -1.544 | .135 | -.558 | .079 |
| | (July-August Inflows)^ -0.1 | -2.266 | 1.778 | -.221 | -1.274 | .214 | -5.920 | 1.389 |
| | Ln (September-October Inflows) | -.122 | .114 | -.193 | -1.065 | .297 | -.357 | .113 |
| | (November-December Inflows)^ -0.1 | -3.368 | 2.078 | -.308 | -1.621 | .117 | -7.639 | .904 |

a. Dependent Variable: (Brown Shrimp Harvest)^0.2

## 6.3.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 9.910780 | 2.80376732 | 3.535 | 0.0016 | 0.00000000 |
| LN_QJF | 1 | 0.198286 | 0.15806846 | 1.254 | 0.2208 | 1.90437910 |
| $(QMA)^{-0.1}$ | 1 | -1.372433 | 2.27890029 | -0.602 | 0.5522 | 2.40497263 |
| LN_QMJ | 1 | -0.239253 | 0.15493788 | -1.544 | 0.1346 | 1.78196298 |
| $(QJA)^{-0.1}$ | 1 | -2.265667 | 1.77797648 | -1.274 | 0.2138 | 1.18711798 |
| LN_QSO | 1 | -0.121914 | 0.11448083 | -1.065 | 0.2967 | 1.28914286 |
| $(QND)^{-0.1}$ | 1 | -3.367543 | 2.07784854 | -1.621 | 0.1172 | 1.42266719 |

Collinearity Diagnostics(intercept adjusted)

| # | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop $(QMA)^{-0.1}$ | Var Prop LN_QMJ | Var Prop $(QJA)^{-0.1}$ | Var Prop LN_QSO | Var Prop $(QND)^{-0.1}$ |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.65183 | 1.00000 | 0.0509 | 0.0404 | 0.0483 | 0.0239 | 0.0099 | 0.0393 |
| 2 | 1.18231 | 1.49764 | 0.0023 | 0.0260 | 0.0012 | 0.2059 | 0.3199 | 0.0844 |
| 3 | 0.83521 | 1.78187 | 0.0025 | 0.0358 | 0.0159 | 0.3369 | 0.3366 | 0.1716 |
| 4 | 0.61485 | 2.07677 | 0.0034 | 0.0153 | 0.3749 | 0.3765 | 0.0000 | 0.3291 |
| 5 | 0.44543 | 2.43995 | 0.7362 | 0.0000 | 0.2090 | 0.0427 | 0.0001 | 0.2951 |
| 6 | 0.27037 | 3.13179 | 0.2047 | 0.8825 | 0.3507 | 0.0142 | 0.3336 | 0.0805 |

### 6.3.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 2.3838 | 5.1827 | 3.7827 | .6198 | 33 |
| Std. Predicted Value | -2.257 | 2.259 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | .3365 | .5875 | .4361 | 7.24E-02 | 33 |
| Adjusted Predicted Value | 2.2223 | 5.2131 | 3.7998 | .6448 | 33 |
| Residual | -1.4215 | 1.6305 | -8.E-16 | .8649 | 33 |
| Std. Residual | -1.481 | 1.699 | .000 | .901 | 33 |
| Stud. Residual | -1.757 | 1.850 | -.008 | 1.013 | 33 |
| Deleted Residual | -1.9993 | 1.9323 | -2.E-02 | 1.0963 | 33 |
| Stud. Deleted Residual | -1.835 | 1.947 | -.003 | 1.035 | 33 |
| Mahal. Distance | 2.965 | 11.025 | 5.818 | 2.315 | 33 |
| Cook's Distance | .000 | .179 | .039 | .043 | 33 |
| Centered Leverage Value | .093 | .345 | .182 | .072 | 33 |

a. Dependent Variable: (Brown Shrimp Harvest)^0.2

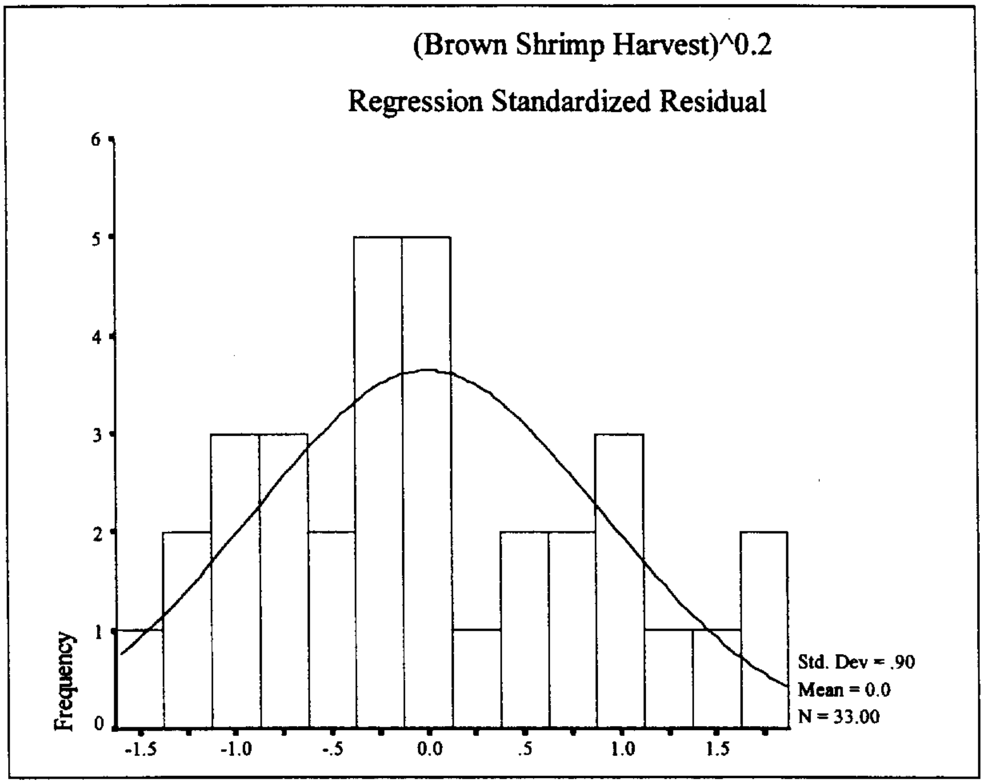
*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 2.38376 | .48912 | .65056 | 2.22233 | -2.25712 | .50975 | .58788 | .58034 |
| 1963 | 3.43944 | -1.05610 | -1.38061 | 3.76394 | -.55388 | -1.10064 | -1.25842 | -1.27337 |
| 1964 | 4.00335 | -1.17125 | -1.46259 | 4.29470 | .35596 | -1.22064 | -1.36403 | -1.38813 |
| 1965 | 3.28715 | -1.42153 | -1.99934 | 3.86496 | -.79959 | -1.48148 | -1.75696 | -1.83522 |
| 1966 | 3.85911 | -.41743 | -.49166 | 3.93335 | .12324 | -.43503 | -.47213 | -.46496 |
| 1967 | 3.08902 | -.10727 | -.13286 | 3.11461 | -1.11924 | -.11179 | -.12441 | -.12203 |
| 1968 | 2.72059 | -1.05810 | -1.53421 | 3.19670 | -1.71367 | -1.10272 | -1.32783 | -1.34858 |
| 1969 | 3.71169 | -.94366 | -1.34757 | 4.11559 | -.11462 | -.98345 | -1.17523 | -1.18429 |
| 1970 | 4.19861 | -1.16104 | -1.34550 | 4.38307 | .67099 | -1.21000 | -1.30258 | -1.32112 |
| 1971 | 3.20967 | -.81407 | -.99107 | 3.38668 | -.92458 | -.84840 | -.93610 | -.93379 |
| 1972 | 3.48786 | -.81078 | -1.01023 | 3.68730 | -.47575 | -.84498 | -.94319 | -.94112 |
| 1973 | 2.93534 | -.13502 | -.16145 | 2.96177 | -1.36720 | -.14072 | -.15387 | -.15095 |
| 1974 | 2.94388 | -.02769 | -.03235 | 2.94854 | -1.35342 | -.02886 | -.03119 | -.03059 |
| 1975 | 3.91004 | -.46295 | -.66515 | 4.11224 | .20541 | -.48248 | -.57832 | -.57077 |
| 1976 | 4.05962 | -.31874 | -.39219 | 4.13306 | .44674 | -.33219 | -.36847 | -.36227 |
| 1977 | 4.26698 | -.83808 | -.97221 | 4.40111 | .78130 | -.87342 | -.94072 | -.93856 |
| 1978 | 3.76515 | -.10176 | -.11980 | 3.78319 | -.02837 | -.10606 | -.11507 | -.11287 |
| 1979 | 4.42489 | -.15003 | -.17107 | 4.44592 | 1.03607 | -.15636 | -.16696 | -.16381 |
| 1980 | 4.16575 | -.17604 | -.28159 | 4.27130 | .61797 | -.18346 | -.23203 | -.22776 |
| 1981 | 3.70462 | .74506 | .91359 | 3.53610 | -.12602 | .77648 | .85983 | .85538 |
| 1982 | 4.47754 | .05668 | .06924 | 4.46497 | 1.12101 | .05907 | .06528 | .06402 |
| 1983 | 4.78669 | .21245 | .26775 | 4.73138 | 1.61981 | .22141 | .24856 | .24402 |
| 1984 | 4.17109 | .71665 | 1.06496 | 3.82278 | .62660 | .74687 | .91046 | .90736 |
| 1985 | 3.73912 | 1.06226 | 1.54961 | 3.25177 | -.07036 | 1.10706 | 1.33710 | 1.35869 |
| 1986 | 3.87887 | .85014 | 1.10795 | 3.62106 | .15511 | .88599 | 1.01145 | 1.01192 |
| 1987 | 3.98774 | 1.06977 | 1.29882 | 3.75869 | .33077 | 1.11488 | 1.22845 | 1.24116 |
| 1988 | 3.30090 | 1.58694 | 1.81816 | 3.06969 | -.77739 | 1.65387 | 1.77025 | 1.85101 |
| 1989 | 3.10253 | 1.45538 | 1.78239 | 2.77551 | -1.09745 | 1.51675 | 1.67853 | 1.74308 |
| 1990 | 5.18271 | -.05121 | -.08160 | 5.21309 | 2.25875 | -.05337 | -.06737 | -.06607 |
| 1991 | 3.83643 | 1.63049 | 1.93227 | 3.53465 | .08664 | 1.69925 | 1.84983 | 1.94652 |
| 1992 | 4.71466 | -.35635 | -.44467 | 4.80298 | 1.50359 | -.37137 | -.41485 | -.40815 |
| 1993 | 4.19195 | .50790 | .62187 | 4.07799 | .66025 | .52932 | .58571 | .57816 |
| 1994 | 3.89334 | 1.19625 | 1.37866 | 3.71093 | .17847 | 1.24670 | 1.33838 | 1.36008 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.

[2] This is flagged if it exceeds $t_{n-p-2,\alpha} = t_{25,0.01} = 2.485$



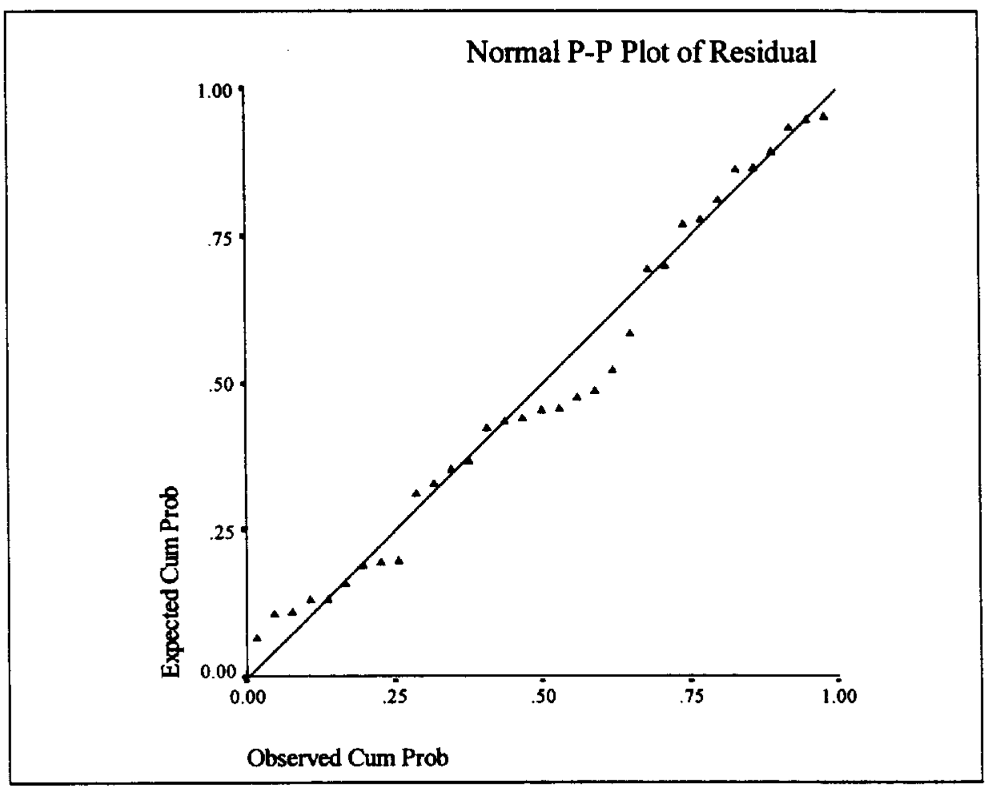




Fig. 6.3.1. Exploratory Plots of (Brown Shrimp Harvest)$^{0.2}$ Standardized Residual.

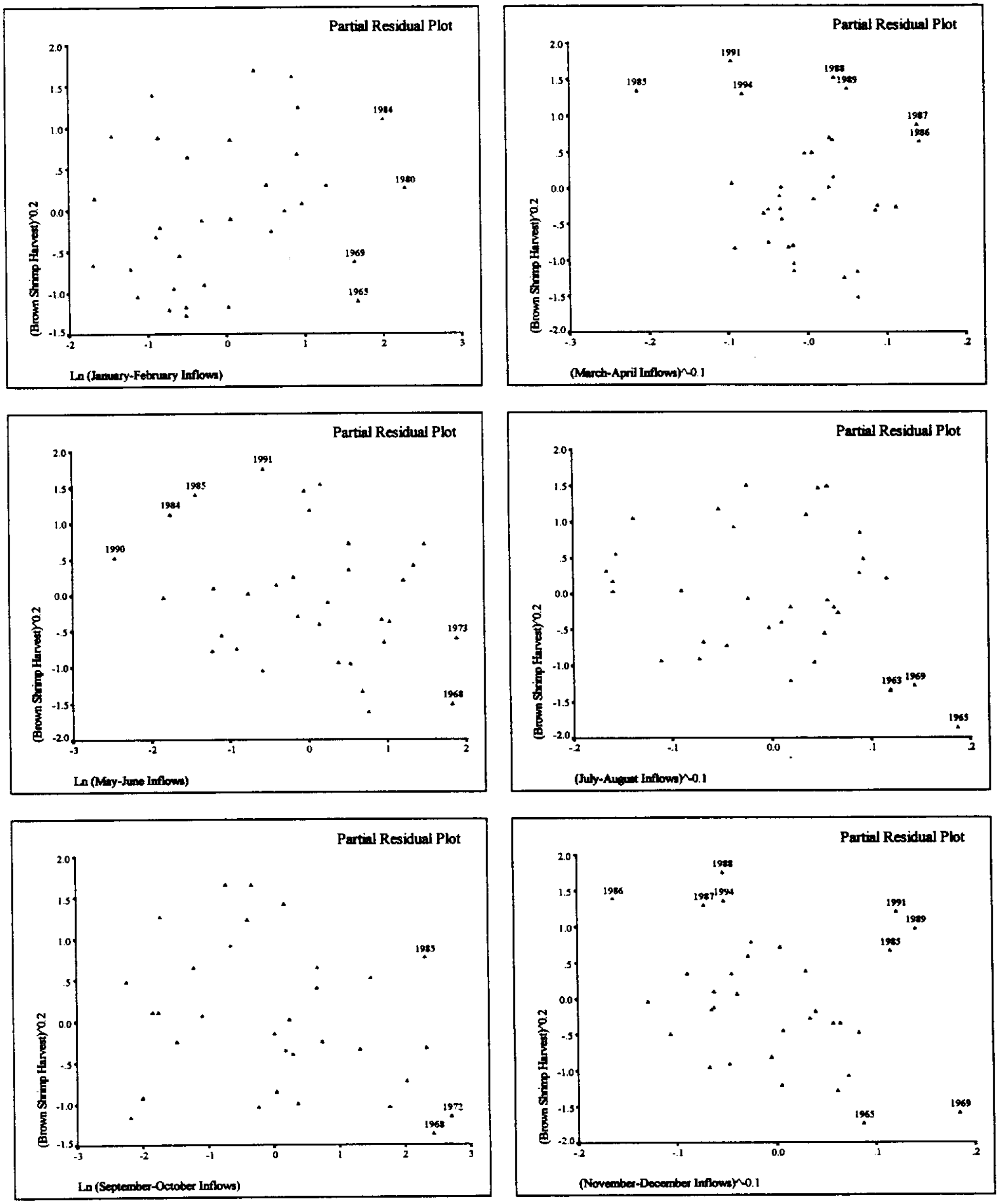



Fig. 6.3.2. Partial Residual Plots of (Brown Shrimp Harvest)$^{0.2}$ vs. Box-Cox Transformed Inflows.

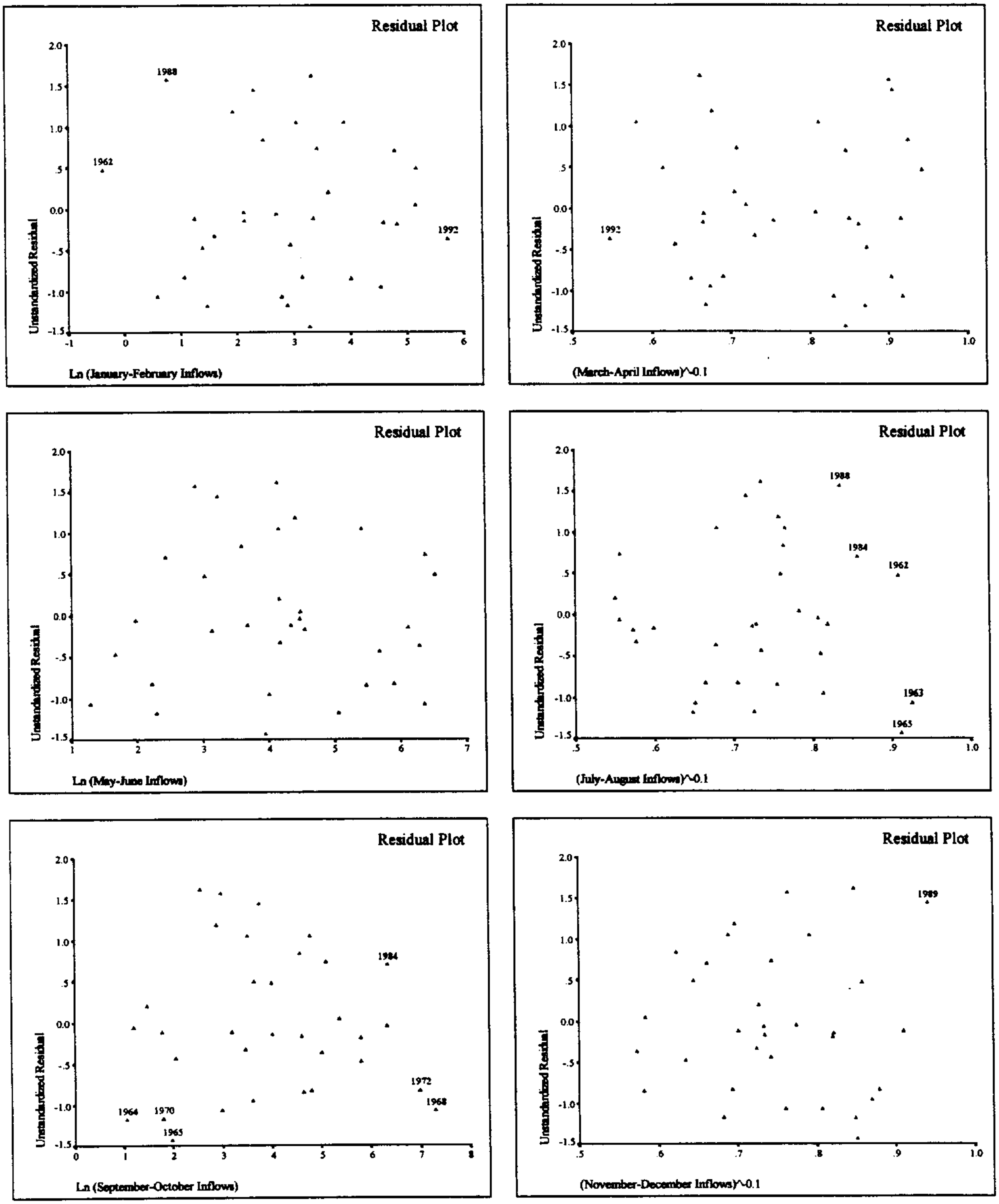



Fig. 6.3.3. Residual Plots of (Brown Shrimp Harvest)$^{0.2}$ vs. Box-Cox Transformed Inflows.

### 6.3.4 Prediction Intervals for Brown Shrimp Harvest

| YEAR | BOX_BSH | LICI | UICI |
|---|---|---|---|
| 1962 | 2.87 | -.59501 | 5.36254 |
| 1963 | 2.38 | 0.47633 | 6.40254 |
| 1964 | 2.83 | 1.08357 | 6.92314 |
| 1965 | 1.87 | 0.26001 | 6.31428 |
| 1966 | 3.44 | 0.99862 | 6.71961 |
| 1967 | 2.98 | 0.17728 | 6.00076 |
| 1968 | 1.66 | -0.33148 | 5.77267 |
| 1969 | 2.77 | 0.67198 | 6.75139 |
| 1970 | 3.04 | 1.35543 | 7.04178 |
| 1971 | 2.40 | 0.31507 | 6.10427 |
| 1972 | 2.68 | 0.57023 | 6.40548 |
| 1973 | 2.80 | 0.05909 | 5.81158 |
| 1974 | 2.92 | 0.09198 | 5.79577 |
| 1975 | 3.45 | 0.86536 | 6.95473 |
| 1976 | 3.74 | 1.15440 | 6.96484 |
| 1977 | 3.43 | 1.42272 | 7.11124 |
| 1978 | 3.66 | 0.90518 | 6.62512 |
| 1979 | 4.27 | 1.59943 | 7.25034 |
| 1980 | 3.99 | 1.03944 | 7.29206 |
| 1981 | 4.45 | 0.80283 | 6.60641 |
| 1982 | 4.53 | 1.57948 | 7.37559 |
| 1983 | 5.00 | 1.85797 | 7.71541 |
| 1984 | 4.89 | 1.09959 | 7.24260 |
| 1985 | 4.80 | 0.68219 | 6.79604 |
| 1986 | 4.73 | 0.91859 | 6.83914 |
| 1987 | 5.06 | 1.09590 | 6.87958 |
| 1988 | 4.89 | 0.47017 | 6.13164 |
| 1989 | 4.56 | 0.20196 | 6.00310 |
| 1990 | 5.13 | 2.05919 | 8.30622 |
| 1991 | 5.47 | 0.96950 | 6.70336 |
| 1992 | 4.36 | 1.79558 | 7.63373 |
| 1993 | 4.70 | 1.29163 | 7.09227 |
| 1994 | 5.09 | 1.05616 | 6.73053 |

**BOX_BSH** (Brown shrimp harvest)$^{0.2}$
**LICI** Lower limit for 99% prediction interval for brown shrimp harvest
**UICI** Upper limit for 99% prediction interval for brown shrimp harvest

### 6.3.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| 1962 | 6.97100 | .01630 | .21784 | .4319 | .0000 |
| 1963 | 6.55180 | .06951 | .20474 | .4770 | .0007 |
| 1964 | 5.40464 | .06612 | .16889 | .6107 | .0006 |
| 1965 | 8.27832 | .17925 | .25870 | .3087 | .0127 |
| 1966 | 3.86203 | .00566 | .12069 | .7955 | .0000 |
| 1967 | 5.19356 | .00053 | .16230 | .6364 | .0000 |
| 1968 | 8.96086 | .11334 | .28003 | .2555 | .0032 |
| 1969 | 8.62169 | .08445 | .26943 | .2810 | .0012 |
| 1970 | 3.41736 | .03851 | .10679 | .8439 | .0001 |
| 1971 | 4.74552 | .02722 | .14830 | .6910 | .0000 |
| 1972 | 5.34793 | .03126 | .16712 | .6176 | .0000 |
| 1973 | 4.26888 | .00066 | .13340 | .7483 | .0000 |
| 1974 | 3.64088 | .00002 | .11378 | .8201 | .0000 |
| 1975 | 8.75803 | .02087 | .27369 | .2705 | .0000 |
| 1976 | 5.02285 | .00447 | .15696 | .6572 | .0000 |
| 1977 | 3.44518 | .02023 | .10766 | .8410 | .0000 |
| 1978 | 3.84851 | .00034 | .12027 | .7971 | .0000 |
| 1979 | 2.96521 | .00056 | .09266 | .8882 | .0000 |
| 1980 | 11.02527 | .00461 | .34454 | .1375 | .0000 |
| 1981 | 4.93314 | .02389 | .15416 | .6681 | .0000 |
| 1982 | 4.83576 | .00013 | .15112 | .6800 | .0000 |
| 1983 | 5.64002 | .00230 | .17625 | .5824 | .0000 |
| 1984 | 9.49642 | .05756 | .29676 | .2190 | .0004 |
| 1985 | 9.09423 | .11718 | .28419 | .2460 | .0035 |
| 1986 | 6.47642 | .04432 | .20239 | .4853 | .0001 |
| 1987 | 4.67362 | .04616 | .14605 | .6997 | .0002 |
| 1988 | 3.09976 | .06523 | .09687 | .8756 | .0005 |
| 1989 | 4.90133 | .09044 | .15317 | .6720 | .0015 |
| 1990 | 10.94669 | .00038 | .34208 | .1410 | .0000 |
| 1991 | 4.02798 | .09048 | .12587 | .7765 | .0015 |
| 1992 | 5.38613 | .00609 | .16832 | .6130 | .0000 |
| 1993 | 4.89479 | .01100 | .15296 | .6728 | .0000 |
| 1994 | 3.26420 | .03902 | .10201 | .8595 | .0001 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1962** | .33340 | -.07191 | -.18457 | -.00537 | .05656 | .14389 | .05321 | .04384 |
| **1963** | -.70586 | -.08723 | .17614 | .05913 | .28776 | -.32218 | .04062 | .14881 |
| **1964** | -.69233 | -.14052 | -.00651 | -.16854 | .14666 | .31924 | .37041 | -.01781 |
| **1965** | **-1.17005** | .82504 | -.59929 | -.32568 | -.26634 | -.75173 | .56920 | -.41094 |
| **1966** | -.19608 | -.02430 | .05008 | .06705 | -.07854 | -.04981 | .08851 | -.00723 |
| **1967** | -.05960 | .02479 | -.00113 | -.02839 | -.02264 | .00588 | .02969 | -.01898 |
| **1968** | -.90462 | .31483 | .13984 | -.24048 | -.47766 | .21803 | -.47048 | -.21622 |
| **1969** | -.77480 | .30433 | -.38056 | .30969 | .20875 | -.37665 | -.06222 | -.56554 |
| **1970** | -.52659 | -.18252 | .12055 | .06034 | -.15629 | -.04902 | .33804 | .20712 |
| **1971** | -.43543 | -.03458 | .11288 | .04400 | .18404 | .13074 | -.21702 | -.16248 |
| **1972** | -.46677 | -.09346 | .19607 | .12447 | -.08989 | .08833 | -.33837 | .01205 |
| **1973** | -.06679 | .02170 | .02424 | -.00287 | -.05024 | -.00569 | -.00042 | -.02039 |
| **1974** | -.01255 | .00239 | .00460 | .00263 | -.00132 | -.00387 | -.00919 | -.00283 |
| **1975** | -.37721 | -.18964 | .13736 | .05217 | .20321 | .00319 | -.16604 | .19046 |
| **1976** | -.17389 | -.12877 | .11190 | .03332 | .00885 | .11863 | -.00919 | .05413 |
| **1977** | -.37548 | -.13166 | .04825 | .05813 | -.06099 | -.08042 | -.00519 | .23244 |
| **1978** | -.04752 | .02014 | -.01958 | -.03222 | -.01847 | -.01526 | .02568 | .01642 |
| **1979** | -.06134 | -.01640 | -.02162 | .01486 | .02169 | .02924 | -.01552 | -.01294 |
| **1980** | -.17636 | .03482 | -.10805 | -.05839 | .05633 | .08509 | -.04514 | -.05182 |
| **1981** | .40681 | .03152 | -.07695 | .06336 | .20468 | -.24386 | .07644 | .00858 |
| **1982** | .03014 | .00027 | .01489 | .00458 | -.00467 | .00740 | .00213 | -.01355 |
| **1983** | .12451 | .05072 | .02303 | .02132 | -.00810 | -.07919 | -.07311 | -.02662 |
| **1984** | .63257 | -.11609 | .36402 | .08398 | -.31179 | .19031 | .19693 | -.05790 |
| **1985** | .92029 | .23795 | -.23364 | -.83417 | -.37959 | .27325 | .45361 | .40824 |
| **1986** | .55725 | .02524 | .01033 | .38710 | .09604 | -.08003 | -.08897 | -.40977 |
| **1987** | .57431 | -.15056 | .20800 | .44832 | .32740 | -.13398 | -.28073 | -.21213 |
| **1988** | .70654 | .02955 | -.30229 | .15979 | .05301 | .17612 | -.16918 | -.22675 |
| **1989** | .82626 | -.45759 | .26770 | .23052 | -.01253 | -.08666 | .03906 | .58815 |
| **1990** | -.05089 | -.03861 | .00441 | .01903 | .03317 | .02561 | .01091 | .00706 |
| **1991** | .83742 | -.05157 | .12777 | -.48360 | -.19469 | .22102 | -.07935 | .55809 |
| **1992** | -.20319 | -.05735 | -.04316 | .05330 | -.01008 | -.00879 | -.01601 | .06368 |
| **1993** | .27387 | -.05563 | .09604 | .00889 | .12533 | .10477 | -.09256 | -.03877 |
| **1994** | .53110 | .30502 | -.34844 | -.28348 | .00603 | .09719 | -.06725 | -.16469 |

**SDFFITS** Standardized dffits value

**SDFB_0** Standardized dfbeta for the intercept term

**SDFB_1** Standardized dfbeta for the Logged January-February inflows

**SDFB_2** Standardized dfbeta for the $(\text{March-April inflows})^{-0.1}$

**SDFB_3** Standardized dfbeta for the Logged May-June inflows

**SDFB_4** Standardized dfbeta for the $(\text{July-August inflows})^{-0.1}$

**SDFB_5** Standardized dfbeta for the Logged September-October inflows

**SDFB_6** Standardized dfbeta for the $(\text{November-December inflows})^{-0.1}$

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

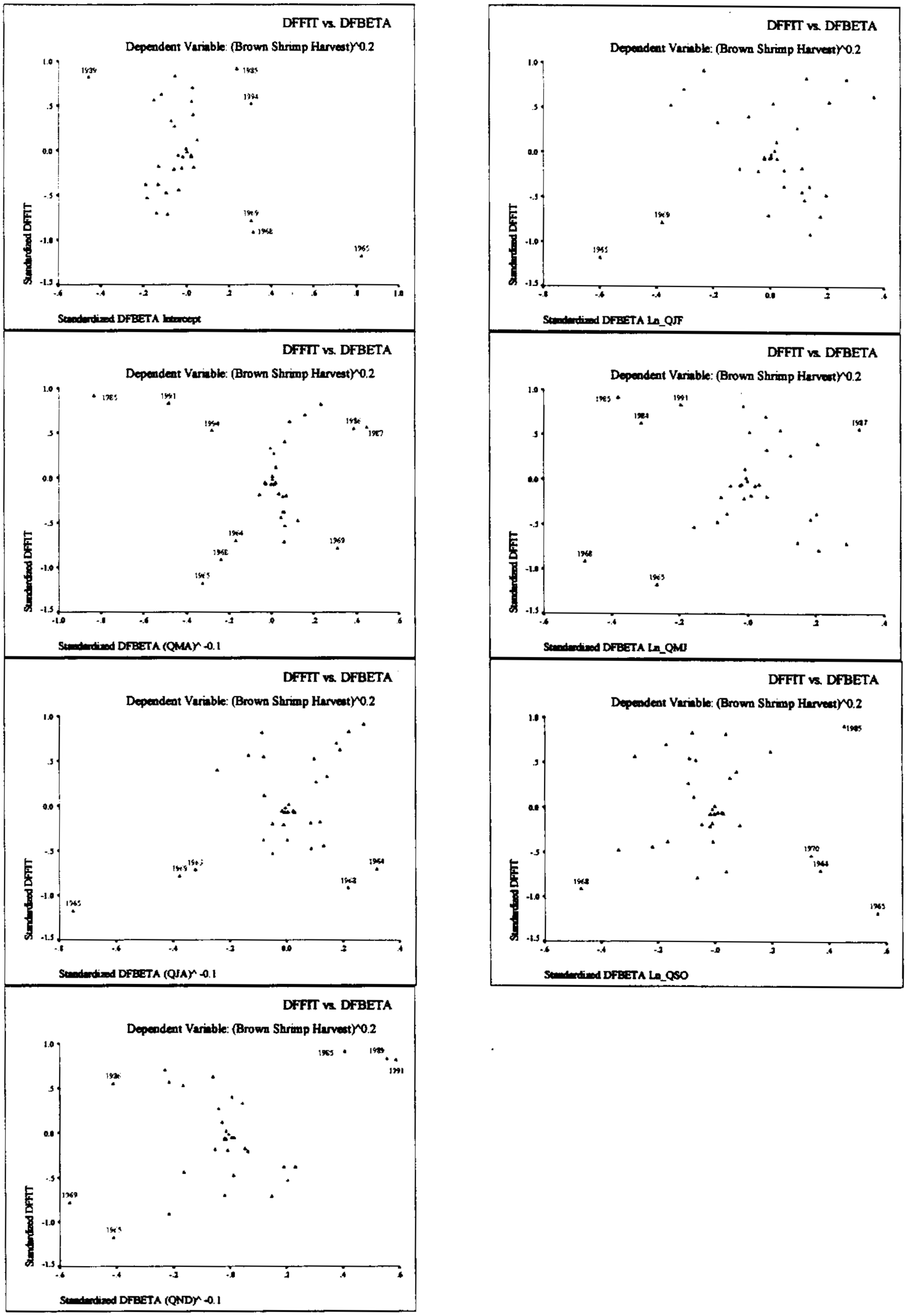



Fig. 6.3.4. Standardized DFFIT vs. Standardized DFBETA.

# 7. Examining Subsets of the Data

## 7.1 Model 3: Logged All Variables

### 7.1.1 Logged All Variables: 1965 Omitted

N = 32 Regression Models for Dependent Variable: LN (BROWN SHRIMP)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.153334 | 0.125112 | 5.9918 | 21.8962 | 1.86600 | 24.8277 | LN_QJF |
| 1 | 0.113719 | 0.084176 | 7.5822 | 23.3595 | 1.95331 | 26.2910 | LN_QND |
| 1 | 0.101747 | 0.071805 | 8.0629 | 23.7889 | 1.97969 | 26.7203 | LN_QMA |
| 1 | 0.055980 | 0.024513 | 9.9003 | 25.3791 | 2.08056 | 28.3106 | LN_QSO |
| 2 | 0.276894 | 0.227024 | 3.0311 | 18.8482 | 1.64863 | 23.2454 | LN_QJF LN_QSO |
| 2 | 0.218289 | 0.164378 | 5.3840 | 21.3419 | 1.78225 | 25.7391 | LN_QSO LN_QND |
| 2 | 0.210534 | 0.156088 | 5.6953 | 21.6578 | 1.79993 | 26.0550 | LN_QJF LN_QMJ |
| 2 | 0.181618 | 0.125177 | 6.8562 | 22.8090 | 1.86586 | 27.2062 | LN_QJF LN_QND |
| 3 | 0.322322 | 0.249714 | 3.2073 | 18.7719 | 1.60024 | 24.6349 | LN_QJF LN_QSO LN_QND |
| 3 | 0.316908 | 0.243720 | 3.4246 | 19.0266 | 1.61302 | 24.8895 | LN_QJF LN_QMJ LN_QSO |
| 3 | 0.276900 | 0.199425 | 5.0309 | 20.8479 | 1.70750 | 26.7109 | LN_QJF LN_QMA LN_QSO |
| 3 | 0.276894 | 0.199418 | 5.0311 | 20.8482 | 1.70751 | 26.7111 | LN_QJF LN_QJA LN_QSO |
| 4 | 0.367048 | 0.273277 | 3.4116 | 18.5870 | 1.54998 | 25.9157 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.328227 | 0.228705 | 4.9702 | 20.4919 | 1.64505 | 27.8206 | LN_QJF LN_QMA LN_QMJ LN_QSO |
| 4 | 0.324294 | 0.224189 | 5.1281 | 20.6787 | 1.65468 | 28.0074 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.324247 | 0.224135 | 5.1300 | 20.6809 | 1.65480 | 28.0096 | LN_QJF LN_QJA LN_QSO LN_QND |
| 5 | 0.373898 | 0.253494 | 5.1366 | 20.2388 | 1.59218 | 29.0332 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.371251 | 0.250338 | 5.2429 | 20.3739 | 1.59891 | 29.1683 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.329047 | 0.200018 | 6.9373 | 22.4528 | 1.70623 | 31.2472 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.326933 | 0.197497 | 7.0222 | 22.5534 | 1.71161 | 31.3479 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 6 | 0.377301 | 0.227853 | 7.0000 | 22.0644 | 1.64687 | 32.3246 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

| OBS | _MODEL_ | _TYPE_ | _DEPVAR_ | _RMSE_ | INTERCEP | LN_QJF | LN_QMA | LN_QMJ | LN_QJA | LN_QSO |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MODEL1 | PARMS | LN_BSH | 1.36601 | 5.43748 | 0.38050 | . | . | . | . |
| 2 | MODEL1 | PARMS | LN_BSH | 1.39761 | 5.41177 | . | . | . | . | . |
| 3 | MODEL1 | PARMS | LN_BSH | 1.40701 | 5.70003 | . | 0.30095 | . | . | . |
| 4 | MODEL1 | PARMS | LN_BSH | 1.44241 | 7.35919 | . | . | . | . | -0.20664 |
| 5 | MODEL1 | PARMS | LN_BSH | 1.28399 | 6.43383 | 0.47325 | . | . | . | -0.31812 |
| 6 | MODEL1 | PARMS | LN_BSH | 1.33501 | 6.30904 | . | . | . | . | -0.29030 |
| 7 | MODEL1 | PARMS | LN_BSH | 1.34161 | 6.18384 | 0.51452 | . | -0.27165 | . | . |
| 8 | MODEL1 | PARMS | LN_BSH | 1.36596 | 5.05767 | 0.28967 | . | . | . | . |
| 9 | MODEL1 | PARMS | LN_BSH | 1.26501 | 6.02383 | 0.36425 | . | . | . | -0.34208 |
| 10 | MODEL1 | PARMS | LN_BSH | 1.27005 | 6.99655 | 0.57998 | . | -0.22873 | . | -0.29714 |
| 11 | MODEL1 | PARMS | LN_BSH | 1.30671 | 6.43924 | 0.47545 | -0.00319 | . | . | -0.31885 |
| 12 | MODEL1 | PARMS | LN_BSH | 1.30672 | 6.43570 | 0.47344 | . | . | -0.000608 | -0.31822 |
| 13 | MODEL1 | PARMS | LN_BSH | 1.24498 | 6.59825 | 0.47157 | . | -0.24215 | . | -0.32112 |
| 14 | MODEL1 | PARMS | LN_BSH | 1.28259 | 6.90453 | 0.50700 | 0.15066 | -0.29520 | . | -0.25659 |
| 15 | MODEL1 | PARMS | LN_BSH | 1.28634 | 6.10248 | 0.39862 | -0.05623 | . | . | -0.35592 |
| 16 | MODEL1 | PARMS | LN_BSH | 1.28639 | 5.85576 | 0.34445 | . | . | 0.048872 | -0.33521 |
| 17 | MODEL1 | PARMS | LN_BSH | 1.26182 | 6.31665 | 0.44121 | . | -0.25926 | 0.093688 | -0.30647 |
| 18 | MODEL1 | PARMS | LN_BSH | 1.26448 | 6.56355 | 0.43237 | 0.09352 | -0.28266 | . | -0.29460 |
| 19 | MODEL1 | PARMS | LN_BSH | 1.30623 | 6.82119 | 0.50043 | 0.14919 | -0.29997 | 0.031685 | -0.25137 |
| 20 | MODEL1 | PARMS | LN_BSH | 1.30829 | 5.91754 | 0.38139 | -0.06644 | . | 0.057926 | -0.35029 |
| 21 | MODEL1 | PARMS | LN_BSH | 1.28330 | 6.30142 | 0.40755 | 0.08443 | -0.29485 | 0.088335 | -0.28337 |

| OBS | LN_QND | LN_BSH | _IN_ | _P_ | _EDF_ | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | . | -1 | 1 | 2 | 30 | 1.86600 | 0.15333 | 0.12511 | 5.99177 | 21.8962 | 24.8277 |
| 2 | 0.37366 | -1 | 1 | 2 | 30 | 1.95331 | 0.11372 | 0.08418 | 7.58223 | 23.3595 | 26.2910 |
| 3 | . | -1 | 1 | 2 | 30 | 1.97969 | 0.10175 | 0.07181 | 8.06288 | 23.7889 | 26.7203 |
| 4 | . | -1 | 1 | 2 | 30 | 2.08056 | 0.05598 | 0.02451 | 9.90031 | 25.3791 | 28.3106 |
| 5 | . | -1 | 2 | 3 | 29 | 1.64863 | 0.27689 | 0.22702 | 3.03113 | 18.8482 | 23.2454 |
| 6 | 0.45885 | -1 | 2 | 3 | 29 | 1.78225 | 0.21829 | 0.16438 | 5.38398 | 21.3419 | 25.7391 |
| 7 | . | -1 | 2 | 3 | 29 | 1.79993 | 0.21053 | 0.15609 | 5.69530 | 21.6578 | 26.0550 |
| 8 | 0.21320 | -1 | 2 | 3 | 29 | 1.86586 | 0.18162 | 0.12518 | 6.85625 | 22.8090 | 27.2062 |
| 9 | 0.27227 | -1 | 3 | 4 | 28 | 1.60024 | 0.32232 | 0.24971 | 3.20728 | 18.7719 | 24.6349 |
| 10 | . | -1 | 3 | 4 | 28 | 1.61302 | 0.31691 | 0.24372 | 3.42463 | 19.0266 | 24.8895 |
| 11 | . | -1 | 3 | 4 | 28 | 1.70750 | 0.27690 | 0.19943 | 5.03086 | 20.8479 | 26.7109 |
| 12 | . | -1 | 3 | 4 | 28 | 1.70751 | 0.27689 | 0.19942 | 5.03112 | 20.8482 | 26.7111 |
| 13 | 0.28644 | -1 | 4 | 5 | 27 | 1.54998 | 0.36705 | 0.27328 | 3.41163 | 18.5870 | 25.9157 |
| 14 | . | -1 | 4 | 5 | 27 | 1.64505 | 0.32823 | 0.22870 | 4.97021 | 20.4919 | 27.8206 |
| 15 | 0.28340 | -1 | 4 | 5 | 27 | 1.65468 | 0.32429 | 0.22419 | 5.12811 | 20.6787 | 28.0074 |
| 16 | 0.28396 | -1 | 4 | 5 | 27 | 1.65480 | 0.32425 | 0.22414 | 5.13000 | 20.6809 | 28.0096 |
| 17 | 0.30984 | -1 | 5 | 6 | 26 | 1.59218 | 0.37390 | 0.25349 | 5.13661 | 20.2388 | 29.0332 |
| 18 | 0.27031 | -1 | 5 | 6 | 26 | 1.59891 | 0.37125 | 0.25034 | 5.24289 | 20.3739 | 29.1683 |
| 19 | . | -1 | 5 | 6 | 26 | 1.70623 | 0.32905 | 0.20002 | 6.93726 | 22.4528 | 31.2472 |
| 20 | 0.29926 | -1 | 5 | 6 | 26 | 1.71161 | 0.32693 | 0.19750 | 7.02215 | 22.5534 | 31.3479 |
| 21 | 0.29394 | -1 | 6 | 7 | 25 | 1.64687 | 0.37730 | 0.22785 | 7.00000 | 22.0644 | 32.3246 |

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 6.301419 | 1.00707545 | 6.257 | 0.0001 | 0.00000000 |
| LN_QJF | 1 | 0.407552 | 0.22321520 | 1.826 | 0.0798 | 2.11859709 |
| LN_QMA | 1 | 0.084428 | 0.22842558 | 0.370 | 0.7148 | 2.35332048 |
| LN_QMJ | 1 | -0.294854 | 0.20734787 | -1.422 | 0.1674 | 1.78290772 |
| LN_QJA | 1 | 0.088335 | 0.17923645 | 0.493 | 0.6264 | 1.21963086 |
| LN_QSO | 1 | -0.283365 | 0.16015066 | -1.769 | 0.0890 | 1.34997127 |
| LN_QND | 1 | 0.293940 | 0.21118551 | 1.392 | 0.1762 | 1.45835119 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop LN_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop LN_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.60718 | 1.00000 | 0.0501 | 0.0417 | 0.0499 | 0.0172 | 0.0084 | 0.0397 |
| 2 | 1.26137 | 1.43768 | 0.0012 | 0.0210 | 0.0009 | 0.2334 | 0.2536 | 0.0769 |
| 3 | 0.85430 | 1.74695 | 0.0002 | 0.0432 | 0.0229 | 0.2518 | 0.3466 | 0.1732 |
| 4 | 0.61213 | 2.06379 | 0.0474 | 0.0373 | 0.3891 | 0.3214 | 0.0007 | 0.2460 |
| 5 | 0.40352 | 2.54187 | 0.5282 | 0.0414 | 0.2207 | 0.1592 | 0.0020 | 0.4603 |
| 6 | 0.26150 | 3.15752 | 0.3729 | 0.8153 | 0.3164 | 0.0169 | 0.3887 | 0.0039 |

Variable

| Variable | DF | Label |
|---|---|---|
| INTERCEP | 1 | Intercept |
| LN_QJF | 1 | Ln (January-February Inflows) |
| LN_QMA | 1 | Ln (March-April Inflows) |
| LN_QMJ | 1 | Ln (May-June Inflows) |
| LN_QJA | 1 | Ln (July-August Inflows) |
| LN_QSO | 1 | Ln (September-October Inflows) |
| LN_QND | 1 | Ln (November-December Inflows) |

### 7.1.3 Logged All Variables: 1965 and 1968 Omitted

N = 31 Regression Models for Dependent Variable: LN (BROWN SHRIMP)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.197524 | 0.169853 | 0.6191 | 11.7695 | 1.37344 | 14.6374 | LN_QJF |
| 1 | 0.103843 | 0.072941 | 3.8434 | 15.1923 | 1.53378 | 18.0603 | LN_QND |
| 1 | 0.094800 | 0.063586 | 4.1546 | 15.5035 | 1.54925 | 18.3715 | LN_QMA |
| 1 | 0.073959 | 0.042026 | 4.8719 | 16.2092 | 1.58492 | 19.0772 | LN_QJA |
| 2 | 0.239611 | 0.185297 | 1.1706 | 12.0994 | 1.34789 | 16.4014 | LN_QJF LN_QSO |
| 2 | 0.220972 | 0.165327 | 1.8121 | 12.8502 | 1.38093 | 17.1521 | LN_QJF LN_QJA |
| 2 | 0.212117 | 0.155840 | 2.1169 | 13.2005 | 1.39662 | 17.5025 | LN_QJF LN_QND |
| 2 | 0.207516 | 0.150910 | 2.2752 | 13.3810 | 1.40478 | 17.6830 | LN_QJF LN_QMJ |
| 3 | 0.265944 | 0.184382 | 2.2643 | 13.0069 | 1.34940 | 18.7428 | LN_QJF LN_QSO LN_QND |
| 3 | 0.250200 | 0.166889 | 2.8062 | 13.6647 | 1.37834 | 19.4007 | LN_QJF LN_QJA LN_QSO |
| 3 | 0.249844 | 0.166493 | 2.8184 | 13.6794 | 1.37900 | 19.4154 | LN_QJF LN_QMJ LN_QSO |
| 3 | 0.245379 | 0.161533 | 2.9721 | 13.8634 | 1.38721 | 19.5993 | LN_QJF LN_QJA LN_QND |
| 4 | 0.283394 | 0.173147 | 3.6637 | 14.2610 | 1.36799 | 21.4310 | LN_QJF LN_QJA LN_QSO LN_QND |
| 4 | 0.280588 | 0.169910 | 3.7603 | 14.3822 | 1.37335 | 21.5521 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.267645 | 0.154976 | 4.2057 | 14.9349 | 1.39805 | 22.1049 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.264736 | 0.151619 | 4.3059 | 15.0578 | 1.40361 | 22.2277 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 5 | 0.302641 | 0.163169 | 5.0013 | 15.4170 | 1.38450 | 24.0210 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.287264 | 0.144717 | 5.5305 | 16.0931 | 1.41503 | 24.6971 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.281061 | 0.137273 | 5.7440 | 16.3618 | 1.42734 | 24.9657 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.269069 | 0.122883 | 6.1567 | 16.8746 | 1.45115 | 25.4785 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 6 | 0.302678 | 0.128348 | 7.0000 | 17.4154 | 1.44211 | 27.4533 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 7.2 Model 5: Square Root All Variables

### 7.2.1 Square Root All Variables: 1985 Omitted

N = 32 Regression Models for Dependent Variable: SQRT (BROWN SHRIMP)

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.09376 | 0.06355 | 4.331 | 189.4 | 350.65 | 192.4 | SQRT_QJF |
| 1 | 0.07435 | 0.04349 | 5.024 | 190.1 | 358.16 | 193.1 | SQRT_QJA |
| 1 | 0.06700 | 0.03590 | 5.286 | 190.4 | 361.00 | 193.3 | SQRT_QND |
| 1 | 0.06155 | 0.03027 | 5.481 | 190.6 | 363.11 | 193.5 | SQRT_QSO |
| 2 | 0.18679 | 0.13071 | 3.012 | 188.0 | 325.50 | 192.4 | SQRT_QJF SQRT_QSO |
| 2 | 0.16186 | 0.10406 | 3.902 | 188.9 | 335.48 | 193.3 | SQRT_QJA SQRT_QND |
| 2 | 0.15364 | 0.09527 | 4.195 | 189.3 | 338.77 | 193.7 | SQRT_QJF SQRT_QJA |
| 2 | 0.15217 | 0.09370 | 4.248 | 189.3 | 339.36 | 193.7 | SQRT_QSO SQRT_QND |
| 3 | 0.24987 | 0.16950 | 2.762 | 187.4 | 310.98 | 193.3 | SQRT_QJA SQRT_QSO SQRT_QND |
| 3 | 0.24358 | 0.16254 | 2.986 | 187.7 | 313.58 | 193.5 | SQRT_QJF SQRT_QJA SQRT_QSO |
| 3 | 0.20167 | 0.11613 | 4.482 | 189.4 | 330.96 | 195.3 | SQRT_QJF SQRT_QSO SQRT_QND |
| 3 | 0.19860 | 0.11273 | 4.591 | 189.5 | 332.23 | 195.4 | SQRT_QJF SQRT_QMJ SQRT_QSO |
| 4 | 0.27584 | 0.16855 | 3.835 | 188.3 | 311.33 | 195.6 | SQRT_QJF SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.26137 | 0.15194 | 4.352 | 188.9 | 317.55 | 196.2 | SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.26093 | 0.15144 | 4.367 | 188.9 | 317.74 | 196.3 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO |
| 4 | 0.25006 | 0.13896 | 4.755 | 189.4 | 322.41 | 196.7 | SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.29861 | 0.16372 | 5.023 | 189.2 | 313.14 | 198.0 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.28689 | 0.14976 | 5.441 | 189.8 | 318.37 | 198.6 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.26509 | 0.12376 | 6.219 | 190.7 | 328.10 | 199.5 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.26234 | 0.12048 | 6.317 | 190.9 | 329.33 | 199.7 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 6 | 0.29926 | 0.13108 | 7.000 | 191.2 | 325.36 | 201.5 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

### 7.2.2 Square Root All Variables: 1992 Omitted

N = 32 Regression Models for Dependent Variable: SQRT (BROWN SHRIMP)

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.10045 | 0.07046 | 5.121 | 190.0 | 357.00 | 193.0 | SQRT_QMA |
| 1 | 0.09105 | 0.06076 | 5.467 | 190.4 | 360.72 | 193.3 | SQRT_QJF |
| 1 | 0.06276 | 0.03151 | 6.509 | 191.3 | 371.95 | 194.3 | SQRT_QJA |
| 1 | 0.06007 | 0.02874 | 6.608 | 191.4 | 373.02 | 194.4 | SQRT_QSO |
| 2 | 0.18203 | 0.12562 | 4.117 | 189.0 | 335.81 | 193.4 | SQRT_QJF SQRT_QSO |
| 2 | 0.15514 | 0.09688 | 5.107 | 190.0 | 346.85 | 194.4 | SQRT_QMA SQRT_QMJ |
| 2 | 0.14652 | 0.08766 | 5.425 | 190.3 | 350.39 | 194.7 | SQRT_QMA SQRT_QJA |
| 2 | 0.14187 | 0.08269 | 5.596 | 190.5 | 352.30 | 194.9 | SQRT_QMA SQRT_QSO |
| 3 | 0.22671 | 0.14386 | 4.472 | 189.2 | 328.81 | 195.0 | SQRT_QJF SQRT_QJA SQRT_QSO |
| 3 | 0.21624 | 0.13227 | 4.858 | 189.6 | 333.26 | 195.5 | SQRT_QJA SQRT_QSO SQRT_QND |
| 3 | 0.21418 | 0.12999 | 4.933 | 189.7 | 334.13 | 195.6 | SQRT_QJF SQRT_QMA SQRT_QMJ |
| 3 | 0.21030 | 0.12569 | 5.077 | 189.9 | 335.79 | 195.7 | SQRT_QMA SQRT_QMJ SQRT_QJA |
| 4 | 0.26913 | 0.16085 | 4.910 | 189.4 | 322.28 | 196.7 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 4 | 0.26296 | 0.15377 | 5.137 | 189.6 | 325.00 | 197.0 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA |
| 4 | 0.26021 | 0.15061 | 5.239 | 189.8 | 326.22 | 197.1 | SQRT_QJF SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.25238 | 0.14162 | 5.527 | 190.1 | 329.67 | 197.4 | SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.29267 | 0.15665 | 6.043 | 190.3 | 323.89 | 199.1 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.28975 | 0.15316 | 6.151 | 190.5 | 325.24 | 199.3 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 5 | 0.28962 | 0.15301 | 6.156 | 190.5 | 325.29 | 199.3 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 5 | 0.27868 | 0.13997 | 6.559 | 191.0 | 330.30 | 199.8 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.32101 | 0.15806 | 7.000 | 191.0 | 323.35 | 201.3 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

### 7.2.3 Square Root All Variables: 1985 and 1992 Omitted

N = 31 Regression Models for Dependent Variable: SQRT (BROWN SHRIMP)

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.09717 | 0.06604 | 4.621 | 184.3 | 359.08 | 187.2 | SQRT_QJF |
| 1 | 0.07444 | 0.04252 | 5.417 | 185.1 | 368.12 | 188.0 | SQRT_QJA |
| 1 | 0.07148 | 0.03946 | 5.520 | 185.2 | 369.29 | 188.1 | SQRT_QMA |
| 1 | 0.06392 | 0.03164 | 5.785 | 185.4 | 372.30 | 188.3 | SQRT_QSO |
| 2 | 0.19419 | 0.13663 | 3.223 | 182.8 | 331.93 | 187.1 | SQRT_QJF SQRT_QSO |
| 2 | 0.16272 | 0.10291 | 4.325 | 184.0 | 344.90 | 188.3 | SQRT_QJA SQRT_QND |
| 2 | 0.15531 | 0.09497 | 4.585 | 184.3 | 347.95 | 188.6 | SQRT_QJF SQRT_QJA |
| 2 | 0.15077 | 0.09011 | 4.743 | 184.4 | 349.82 | 188.7 | SQRT_QSO SQRT_QND |
| 3 | 0.25310 | 0.17011 | 3.159 | 182.4 | 319.06 | 188.2 | SQRT_QJA SQRT_QSO SQRT_QND |
| 3 | 0.24885 | 0.16539 | 3.308 | 182.6 | 320.88 | 188.4 | SQRT_QJF SQRT_QJA SQRT_QSO |
| 3 | 0.21928 | 0.13254 | 4.344 | 183.8 | 333.51 | 189.6 | SQRT_QJF SQRT_QSO SQRT_QND |
| 3 | 0.20262 | 0.11403 | 4.927 | 184.5 | 340.62 | 190.2 | SQRT_QJF SQRT_QMJ SQRT_QSO |
| 4 | 0.29485 | 0.18637 | 3.697 | 182.7 | 312.81 | 189.8 | SQRT_QJF SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.26249 | 0.14902 | 4.831 | 184.1 | 327.17 | 191.2 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO |
| 4 | 0.26124 | 0.14758 | 4.874 | 184.1 | 327.72 | 191.3 | SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 4 | 0.25554 | 0.14100 | 5.074 | 184.3 | 330.25 | 191.5 | SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.31174 | 0.17409 | 5.105 | 183.9 | 317.53 | 192.5 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.29568 | 0.15482 | 5.668 | 184.6 | 324.94 | 193.2 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.27723 | 0.13268 | 6.314 | 185.4 | 333.45 | 194.0 | SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.27286 | 0.12743 | 6.467 | 185.6 | 335.47 | 194.2 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 6 | 0.31476 | 0.14345 | 7.000 | 185.8 | 329.31 | 195.8 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

## 7.3 Model 6: Variables Transformed According to the Box-Cox Analysis

### 7.3.1 Variables Transformed According to the Box-Cox Analysis: 1965 Omitted

N = 32 Regression Models for Dependent Variable: $(BROWN\ SHRIMP)^{0.2}$

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.152534 | 0.124285 | 4.5801 | -0.8580 | 0.91643 | 2.0735 | LN_QJF |
| 1 | 0.101078 | 0.071114 | 6.5583 | 1.0282 | 0.97207 | 3.9597 | $(QND)^{-0.1}$ |
| 1 | 0.096557 | 0.066442 | 6.7321 | 1.1888 | 0.97696 | 4.1203 | $(QMA)^{-0.1}$ |
| 1 | 0.046688 | 0.014911 | 8.6493 | 2.9081 | 1.03088 | 5.8396 | LN_QSO |
| 2 | 0.261408 | 0.210471 | 2.3945 | -3.2582 | 0.82623 | 1.1390 | LN_QJF LN_QSO |
| 2 | 0.204205 | 0.149323 | 4.5937 | -0.8711 | 0.89022 | 3.5261 | LN_QJF LN_QMJ |
| 2 | 0.188091 | 0.132098 | 5.2131 | -0.2296 | 0.90825 | 4.1676 | LN_QSO $(QND)^{-0.1}$ |
| 2 | 0.175173 | 0.118288 | 5.7098 | 0.2755 | 0.92270 | 4.6727 | LN_QJF $(QND)^{-0.1}$ |
| 3 | 0.297755 | 0.222515 | 2.9972 | -2.8730 | 0.81363 | 2.9899 | LN_QJF LN_QSO $(QND)^{-0.1}$ |
| 3 | 0.297737 | 0.222495 | 2.9979 | -2.8722 | 0.81365 | 2.9908 | LN_QJF LN_QMJ LN_QSO |
| 3 | 0.261512 | 0.182388 | 4.3905 | -1.2627 | 0.85562 | 4.6003 | LN_QJF $(QJA)^{-0.1}$ LN_QSO |
| 3 | 0.261490 | 0.182364 | 4.3914 | -1.2617 | 0.85565 | 4.6012 | LN_QJF $(QMA)^{-0.1}$ LN_QSO |
| 4 | 0.338858 | 0.240911 | 3.4170 | -2.8030 | 0.79438 | 4.5256 | LN_QJF LN_QMJ LN_QSO $(QND)^{-0.1}$ |
| 4 | 0.307206 | 0.204570 | 4.6339 | -1.3066 | 0.83241 | 6.0221 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ LN_QSO |
| 4 | 0.300141 | 0.196458 | 4.9055 | -0.9819 | 0.84090 | 6.3468 | LN_QJF $(QMA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 4 | 0.300095 | 0.196406 | 4.9072 | -0.9798 | 0.84095 | 6.3489 | LN_QJF LN_QMJ $(QJA)^{-0.1}$ LN_QSO |
| 5 | 0.347385 | 0.221882 | 5.0892 | -1.2184 | 0.81429 | 7.5760 | LN_QJF LN_QMJ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.342230 | 0.215736 | 5.2874 | -0.9667 | 0.82072 | 7.8278 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ LN_QSO $(QND)^{-0.1}$ |
| 5 | 0.309000 | 0.176115 | 6.5649 | 0.6104 | 0.86219 | 9.4049 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QJA)^{-0.1}$ LN_QSO |
| 5 | 0.303508 | 0.169568 | 6.7760 | 0.8637 | 0.86904 | 9.6582 | LN_QJF $(QMA)^{-0.1}$ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |
| 6 | 0.349706 | 0.193635 | 7.0000 | 0.6676 | 0.84385 | 10.9277 | LN_QJF $(QMA)^{-0.1}$ LN_QMJ $(QJA)^{-0.1}$ LN_QSO $(QND)^{-0.1}$ |

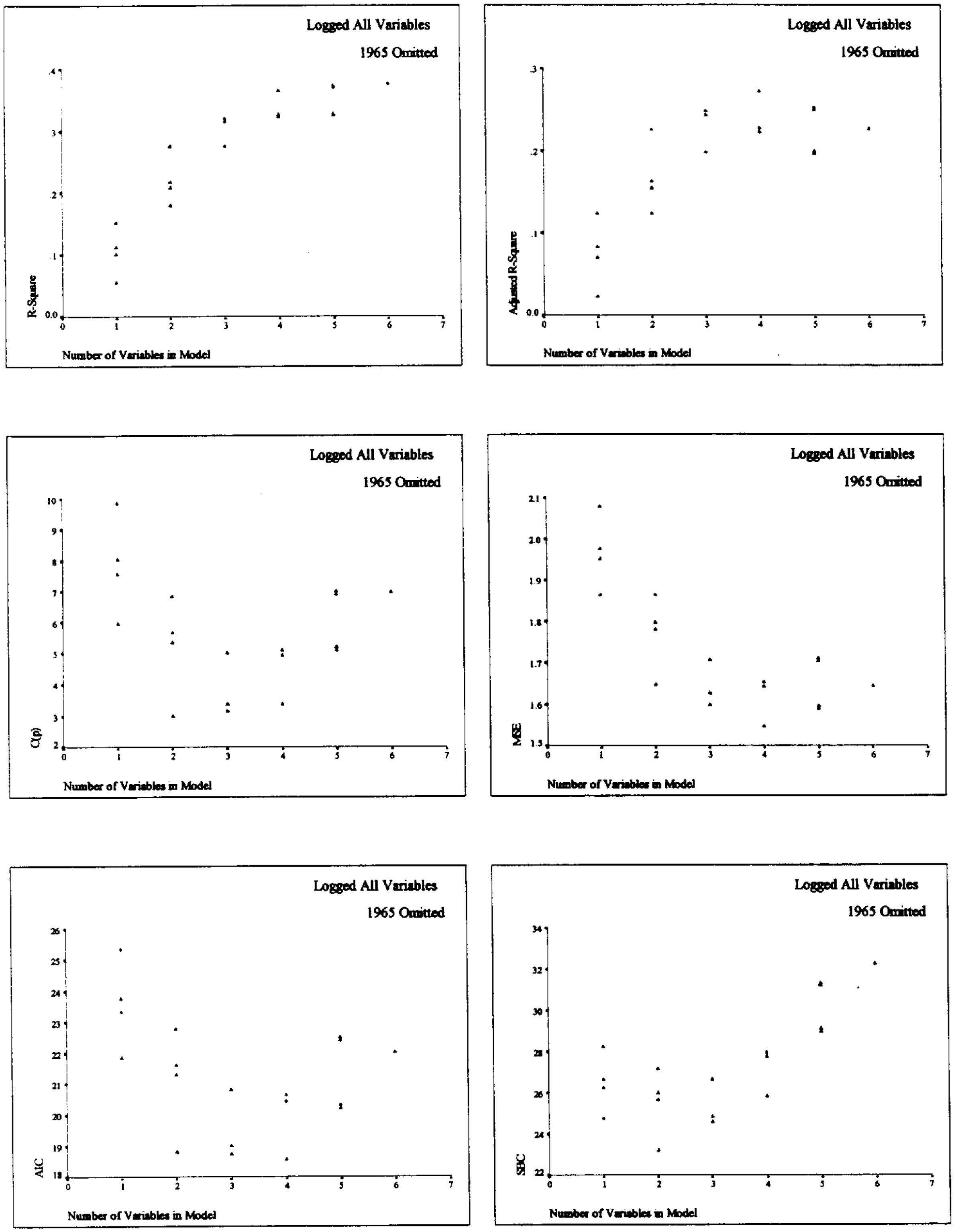



Fig. 7.1. Examining Subsets of Logged Data:
1965 Omitted.

# Crab Harvests in Corpus Christi Bay: A Regression Analysis

## Harvest vs Freshwater Inflows

F. Michael Speed
Michael Longnecker
Birgir Hrafnkelsson

*Department of Statistics*
*Texas A&M University*

# CRAB HARVESTS IN CORPUS CHRISTI BAY:

# A Regression Analysis
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F. Michael Speed
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*Department of Statistics*
*Texas A&M University*
May 1997

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# 1. SUMMARY REPORT

## 1.1 Description of the Problem[1]

Bimonthly freshwater inflows into Corpus Christi Bay were recorded for the years 1962 to 1994. These variables, and various transformations of them, were used to construct a model for the annual harvest of crab.

## 1.2 Constructing Models - General Discussion

Stability of coefficient estimates and accuracy of predicted values are primary goals in constructing models for prediction. To this end, the data must be examined from three points of view: individual observations (to detect outliers or influential points); variables, individually and in groups (to select an optimal set of predictors); and the interaction of these two, which produces the overall structure of the data set (to determine whether multicollinearity is present or not). The first two of these were examined by both graphic and quantitative means; the third by quantitative means only.

### 1.2.1 Detecting Influential Points and Outliers

The structures of individual variables were examined via box plots and histograms, as well as by all the usual numerical measures. For each pair of variables, 99 % prediction ellipses and 95% confidence regions were plotted in a further effort to look for unusual points. For example, suppose large values of Variable A are generally associated with large values for Variable B. If an observation consisted of a large value for Variable A but a small value for Variable B, that point would be considered unusual, even though it was well within the range of data for both variables and could not be considered an outlier.

In addition, a number of residual analysis techniques were employed. A large residual indicates a point not well-fit by the model. The deleted residual, however, is somewhat more useful in the search for influential points. The model is fitted without a given observation, and the predicted response and corresponding residual are calculated for that observation. The Studentized deleted residual is scaled to have a Student's $t$ distribution. Histograms and normal P-P plots of the residuals were also examined.

Other quantities, such as the Mahalanobis distance, Cook's distance, the leverage value, standarized values for the *Dffits* (to measure the influence of a given observation on the predicted response) and the *Dfbetas* (to measure the influence of a given observation on the calculated coefficients) were also used to build a general picture of the influence of individual points. Plots were made of the standardized *Dffits* value for each model against the standardized *Dfbeta* values for each predictor in the model. Points which were extreme indicated observations which had strong effects on both predicted values and coefficient estimates.

1 The following discussion, prepared by Jacqueline Kiffe, was taken from Seatrout Harvest in Galveston Bay: A Regression Analysis, by F. Michael Speed, Sr. and Jacqueline Kiffe.

### 1.2.2 Variable Selection

For each regression, residuals were plotted against each of the independent variables to look for nonlinear relationships between the response variable and individual predictors. Partial residual plots were employed to examine the overall relationship between the response and individual predictors. A partial residual is a corollary to the deleted residual. That is, the model is fitted without a given variable and the predicted response and corresponding residual are calculated for each observation. This seeks to answer the question, "What is the relationship of this predictor to the response variable, taking all other variables into account?" Thus, it examines the marginal relationship of a given predictor to the response.

Numerous measures have been developed over the years to assess the adequacy of a given model. We examined a number of these, including $R^2$ and mean squared error (*MSE*), and several others which directly incorporate penalties for having too many predictors in the model, such as adjusted $R^2$, *Cp*, *AIC*, and *SBC*. It is well-established that too many predictors in a model can lead to bad prediction, just as too few can, and these measures are used as part of the attempt to find an optimal model.

### 1.2.3 Multicollinearity

Multicollinearity arises when one or more variables are nearly closely approximated by linear combinations of the remaining variables, resulting in unstable coefficient estimates. The variance inflation factor (*VIF*) was calculated for each coefficient estimate to measure this instability, which is not usually considered profound for *VIF*'s less than 10. No problems were found with this data. Additionally, the condition index (a ratio of eigenvalues of the covariance matrix, with the largest eigenvalue always on top) was calculated. A ratio greater than 30 is considered cause for concern. Again, no evidence of multicollinearity was found.

### 1.2.4 Other Procedures

Several other miscellaneous diagnostics, including the Durbin-Watson test for serial autocorrelation were performed, and no general problems were detected. The Box-Cox procedure, used to find a transformation to normality, was also performed.

## 1.3 How the Final Model Was Chosen

### 1.3.1 Selecting the Data Set Used

First, the variables were explored thoroughly, individually and in pairs, in a first effort to detect outliers. The SAS® programming language allows a number of diagnostics to be calculated for a group of models on a given data set without actually performing a formal regression, thus allowing one to examine a large number of models quite efficiently. The Box-Cox procedure was performed to find if a transformation to normallity was suggested. The log transform was suggested for some variables, and the squared root for others. At this point, there were several data sets for which the diagnostic series was calculated:

1. Untransformed crab data and untransformed inflow data
2. Log of crab data and untransformed inflow data
3. Log of crab data and log of inflow data
4. Log of crab data and square root of inflow data
5. Square root of crab data and log of inflow data
6. Various transformation suggested by Box-Cox

### 1.3.2 Selecting the Points to be Omitted

The full regression with all diagnostics was performed for these models, each one contained all variables in its corresponding data set. All diagnostics were generated, and influential points were determined for each model.

***Table 1.1*** *$R^2$ and Adjusted $R^2$ for full data sets.*

| Data Set | $R^2$ | Adj. $R^2$ |
|---|---|---|
| 1 | 0.1596 | -0.0805 |
| 2 | 0.3323 | 0.1415 |
| 3 | 0.2765 | 0.0698 |
| 4 | 0.2669 | 0.0574 |
| 5 | 0.2322 | 0.0128 |
| 6 | 0.2735 | 0.0659 |

Data sets 2, 3, 4 and 6 presented the highest $R^2$ values. These four models were considered final candidates. The observations flagged as potentially influential are given in the summary table below, for each model.

***Table 1.2*** *Summary of points flagged by Boxplots.*

| Year | Variable |
|---|---|
| 1963 | Ln(May-June) |
| 1969 | Jan-Feb Inflows, Sqrt(Jan-Feb) |
| 1971 | July-Aug Inflows, Sqrt(July-Aug), Sept-Oct Inflows, Sqrt(Sept-Oct) |
| 1972 | July-Aug Inflows, Sqrt(July-Aug), Sept-Oct Inflows, Sqrt(Sept-Oct) |
| 1973 | Sept-Oct Inflows, |
| 1974 | Sept-Oct Inflows, Sqrt(Sept-Oct) |
| 1976 | Nov-Dec Inflows, Sqrt(Nov-Dec) |
| 1977 | March-April Inflows, Ln(Mar-Apr), Sqrt(Mar-Apr), Nov-Dec Inflows Sqrt(Nov-Dec) |
| 1978 | Ln(Crab), March-April Inflows, Ln(Mar-Apr), Sqrt(Mar-Apr), |
| 1980 | July-Aug Inflows, |
| 1981 | Ln(Crab), May-June Inflows, July-Aug Inflows, Sqrt(July-Aug), Crab^0.1 |
| 1984 | Ln(May-June) |
| 1986 | Crab, Sqrt(Crab) |
| 1989 | Crab, Sqrt(Crab), Ln(May-June) |
| 1990 | Crab, |
| 1992 | Jan-Feb Inflows, Sqrt(Jan-Feb), March-April Inflows, Ln(Mar-Apr), Sqrt(Mar-Apr), |
| 1993 | Crab, Sqrt(Crab), Jan-Feb Inflows, Sqrt((Jan-Feb), March-April Inflows, Ln(Mar-Apr), Sqrt(Mar-Apr), |

***Table 1.3*** *Summary of points flagged by 99% prediction ellipses.*

| Year | Variable |
|---|---|
| None | None |

***Table 1.4*** *Outliers of data set 2.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1969 | 1 | | | | | | 1 | 2 | 4 |
| 1971 | 2 | | | | | | | | 2 |
| 1972 | 2 | | | | | | | | 2 |
| 1973 | 1 | | | | | | | | 1 |
| 1974 | 1 | | | | | | | | 1 |
| 1976 | 1 | | | | | | | | 1 |
| 1977 | 2 | | | 1 | 1 | | | | 4 |
| 1978 | 2 | | | | | | 1 | 2 | 5 |
| 1980 | 1 | | | | | | | | 1 |
| 1981 | 3 | | | | | | 1 | | 4 |
| 1992 | 2 | | | | | | | | 2 |
| 1993 | 2 | | | | | | 1 | | 3 |

***Table 1.5*** *Outliers of data set 3.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1963 | 1 | | | | | | 1 | | 2 |
| 1977 | 1 | | | | | | 1 | | 2 |
| 1978 | 2 | | | | | | 1 | 1 | 4 |
| 1981 | 1 | | | | | | 1 | | 2 |
| 1984 | 1 | | | | | | | | 1 |
| 1989 | 1 | | | | | | | | 1 |
| 1990 | | | | | | | 1 | | 1 |
| 1992 | 1 | | | | | | | | 1 |
| 1993 | 1 | | | | | | 1 | | 2 |

***Table 1.6*** *Outliers of data set 4.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1969 | 1 | | | | | | | | 1 |
| 1971 | 2 | | | | | | | | 2 |
| 1972 | 2 | | | | | | | | 2 |
| 1974 | 1 | | | | | | | | 1 |
| 1976 | 1 | | | | | | | | 1 |
| 1977 | 2 | | | 1 | | | | | 3 |
| 1978 | 2 | | | | | | 1 | 1 | 4 |
| 1981 | 2 | | | | | | 1 | | 3 |
| 1992 | 2 | | | | | | 1 | | 3 |
| 1993 | 2 | | | | | | 1 | | 3 |

***Table 1.7*** *Outliers of data set 6.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1963 | | | | | | | 1 | | 1 |
| 1977 | | | | | | | 1 | | 1 |
| 1978 | | | | | | | 1 | | 1 |
| 1981 | 1 | | | | | | 1 | | 2 |
| 1989 | | | | | | | 1 | | 1 |
| 1990 | | | | | | | 1 | | 1 |
| 1993 | | | | | | | 1 | | 1 |

***A Key to Abbreviations:***

BOX Box plot
SRE Studentized residual
SDR Studentized deleted residual
LEV Leverage value
MAH Mahalanobis distance
COO Cook's distance
SDF Standardized Dffits value
SDB Standardized Dfbeta value

### 1.3.3 Selecting the Final Candidate Models

After the subset analysis led us to four models, Data Set 2 with 1978 omitted; Data Set 3 with 1978 omitted, Data Set 4 with 1978 omitted and Data Set 6 with none omitted.

***Table 1.8*** *$R^2$ and Adjusted $R^2$ for data sets number 2, 3, 4 and 6.*

| Data set | Observations omitted | $R^2$ | Adj. $R^2$ |
|---|---|---|---|
| 2 | 1978 | 0.3662 | 0.2836 |
| 3 | 1978 | 0.3244 | 0.2015 |
| 4 | 1978 | 0.2810 | 0.2211 |
| 6 | None | 0.2555 | 0.1625 |

### 1.3.4 Selecting the Final Models

It appears that Data set 2 with 1978 omitted is the best model. Regression was performed using this model, and the deleted residuals were calculated.

$$\begin{aligned}\text{Ln(Crab Harvest)} = \; & 5.11848 + 0.0067075*(\text{March-April}) \\ & - 0.0072524*(\text{Jul-Aug Inflows}) \\ & + 0.0023169*(\text{Sep-Oct Inflows})\end{aligned}$$

# 1.4 Best Model: Logged Harvest and Square Root of Inflow

## 1.4.1 Summary Information

***Table 1.9*** *Descriptive statistics for dependent and independent variables.*

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| Ln(Crab Harvest) | 4.91409 | 1.15117 | 27 |
| March-April Inflows | 33.5011 | 43.4990 | 27 |
| July-August Inflows | 106.7481 | 126.6195 | 27 |
| September-October Inflows | 148.9370 | 234.1876 | 27 |

***Table 1.10*** *Model summary for the final model.*

**Model Summary[a,b]**

| Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| September-October Inflows, March-April Inflows, July-August Inflows[c,d] | .605 | .366 | .284 | .97438 | 1.254 |

a. Dependent Variable: Ln(Crab Harvest)

b. Method: Enter

c. Independent Variables: (Constant), September-October Inflows, March-April Inflows, July-August Inflows

d. All requested variables entered.

***Table 1.11*** *Anova for the final model.*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 12.619 | 3 | 4.206 | 4.430 | .013[b] |
| | Residual | 21.837 | 23 | .949 | | |
| | Total | 34.455 | 26 | | | |

a. Dependent Variable: Ln(Crab Harvest)

b. Independent Variables: (Constant), September-October Inflows, March-April Inflows, July-August Inflows

***Table 1.12** Parameter estimates for the final model.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | 5.118 | .302 | | 16.948 | .000 | 4.494 | 5.743 |
| March-April Inflows | 6.7E-03 | .004 | .253 | 1.508 | .145 | -.002 | .016 |
| July-August Inflows | -7.3E-03 | .002 | -.798 | -3.037 | .006 | -.012 | -.002 |
| September-October Inflows | 2.3E-03 | .001 | .471 | 1.795 | .086 | .000 | .005 |

a. Dependent Variable: Ln(Crab Harvest)

***Table 1.13** Residuals statistics for the final model.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 2.81561 | 6.06224 | 4.91409 | .69666 | 27 |
| Std. Predicted Value | -3.012 | 1.648 | .000 | 1.000 | 27 |
| Standard Error of Predicted Value | .20286 | .66930 | .34112 | .15883 | 27 |
| Adjusted Predicted Value | 3.50741 | 6.10300 | 4.93046 | .66490 | 27 |
| Residual | -1.70980 | 1.85939 | -1.8E-15 | .91644 | 27 |
| Std. Residual | -1.755 | 1.908 | .000 | .941 | 27 |
| Stud. Residual | -1.902 | 1.970 | -.007 | 1.014 | 27 |
| Deleted Residual | -2.00824 | 1.98132 | -1.6E-02 | 1.07908 | 27 |
| Stud. Deleted Residual | -2.026 | 2.113 | -.003 | 1.048 | 27 |
| Mahal. Distance | .164 | 11.305 | 2.889 | 3.674 | 27 |
| Cook's Distance | .000 | .267 | .048 | .071 | 27 |
| Centered Leverage Value | .006 | .435 | .111 | .141 | 27 |

a. Dependent Variable: Ln(Crab Harvest)

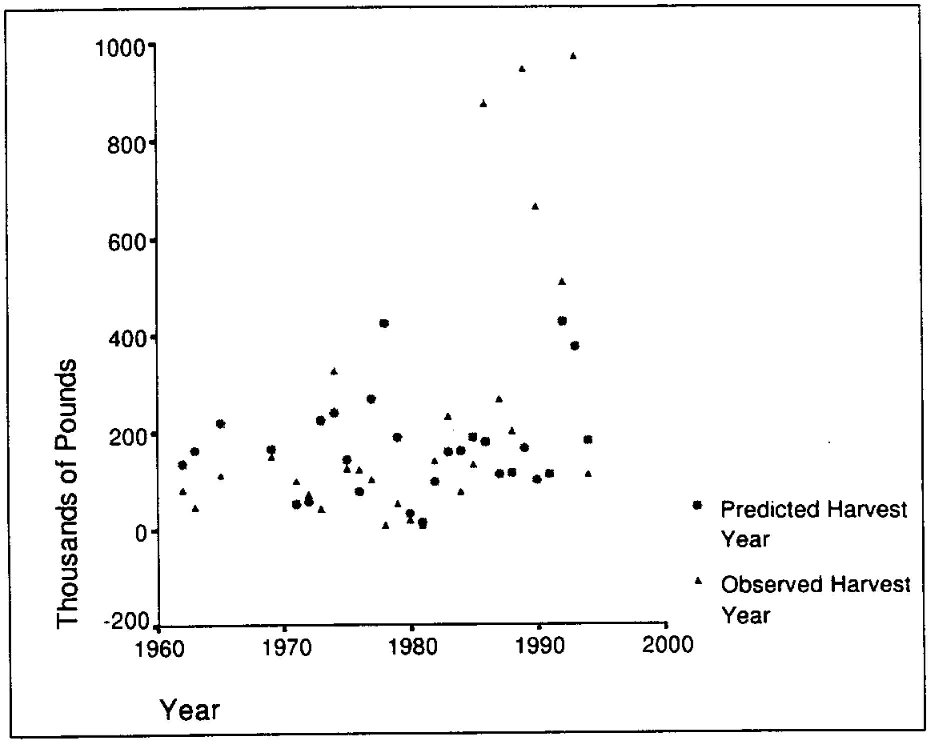


***Figure 1.1*** *Predicted and observed values for the harvest.*

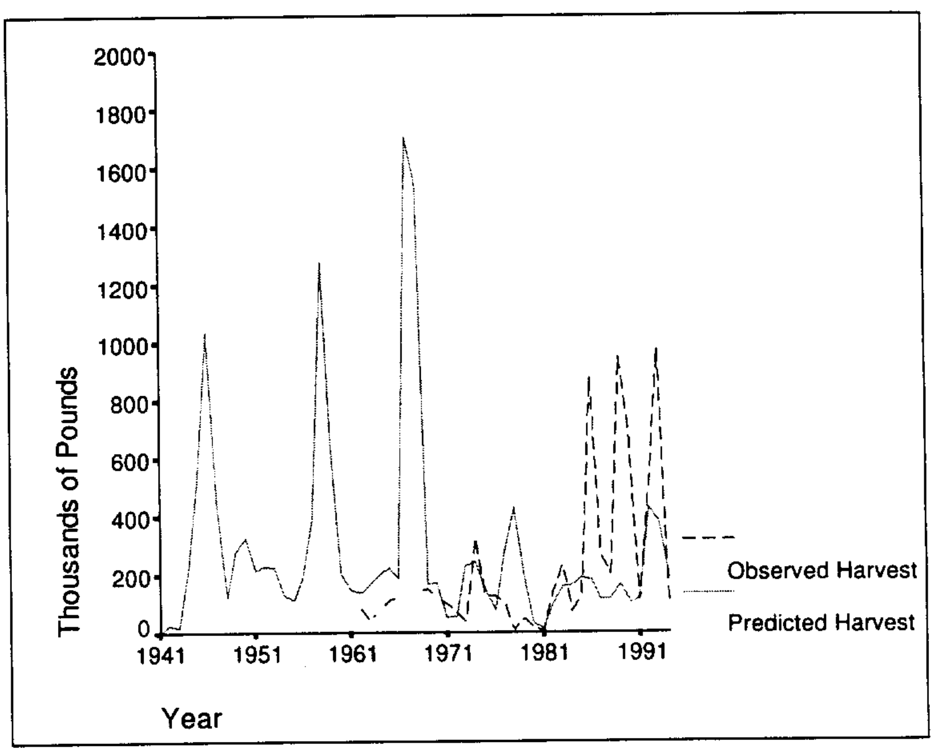


***Figure 1.2*** *Predicted and observed values for the harvest.*

***Table 1.14*** *Prediction Intervals for Red fish Fish Harvest based on the final model.*

| YEAR | *RED* | *PRE_1* | *LICI_1* | *UICI_1* |
|---|---|---|---|---|
| 1962 | 83.20 | 139.1660 | 8.3290 | 2325.261 |
| 1963 | 45.30 | 166.0229 | 9.6715 | 2849.991 |
| 1964 | . | 203.1615 | 11.6434 | 3544.892 |
| 1965 | 113.70 | 221.9810 | 12.9509 | 3804.807 |
| 1966 | . | 187.2169 | 11.2015 | 3129.072 |
| 1967 | . | 1703.423 | 18.2213 | 159245.1 |
| 1968 | . | 1547.628 | 17.6161 | 135964.1 |
| 1969 | 152.20 | 169.6572 | 10.2218 | 2815.901 |
| 1970 | . | 171.1883 | 10.3124 | 2841.780 |
| 1971 | 100.50 | 54.9871 | 2.0893 | 1447.201 |
| 1972 | 70.70 | 59.0555 | 2.2286 | 1564.902 |
| 1973 | 41.10 | 227.1941 | 12.1118 | 4261.737 |
| 1974 | 326.20 | 243.9652 | 12.6698 | 4697.713 |
| 1975 | 125.80 | 146.8312 | 8.9820 | 2400.296 |
| 1976 | 123.80 | 79.6634 | 4.7358 | 1340.060 |
| 1977 | 102.80 | 271.8577 | 11.4793 | 6438.265 |
| 1978 | 9.30 | 426.5552 | 18.0259 | 10093.80 |
| 1979 | 50.50 | 191.2410 | 11.6102 | 3150.083 |
| 1980 | 17.40 | 34.6588 | 1.5832 | 758.7139 |
| 1981 | 7.70 | 16.7034 | .6047 | 461.3639 |
| 1982 | 141.60 | 100.9287 | 6.1043 | 1668.762 |
| 1983 | 231.80 | 160.3319 | 9.5459 | 2692.908 |
| 1984 | 76.10 | 163.3556 | 9.6992 | 2751.251 |
| 1985 | 132.80 | 190.8669 | 11.4149 | 3191.466 |
| 1986 | 877.20 | 182.6948 | 10.9530 | 3047.337 |
| 1987 | 267.60 | 115.0541 | 6.9046 | 1917.186 |
| 1988 | 202.80 | 117.9214 | 7.0909 | 1961.016 |
| 1989 | 948.50 | 169.7541 | 9.8925 | 2912.955 |
| 1990 | 665.50 | 103.6636 | 6.1893 | 1736.233 |
| 1991 | 112.20 | 115.3757 | 6.9669 | 1910.682 |
| 1992 | 508.40 | 429.3359 | 18.3263 | 10058.20 |
| 1993 | 973.60 | 379.3195 | 16.4724 | 8734.832 |
| 1994 | 112.50 | 183.8341 | 11.1314 | 3035.995 |

| | |
|---|---|
| *RED* | Observed red fish fish harvest |
| *PRE_!* | Predicted trout harvest |
| *LICI_*1 | Lower limit for 99% prediction interval for the trout harvest. |
| *UICI_*1 | Upper limit for 99% prediction interval for the trout harvest. |

# 2. Exploring the Data

## 2.1 Listing of data

***Table 2.1*** *The crab data and the inflow data.*

| Year | *Crab* | *JF_inflow* | *MA_inflow* | *MJ_inflow* | *JA_inflow* | *SO_inflow* | *ND_inflow* |
|---|---|---|---|---|---|---|---|
| 1962 | 83.20 | 69.68 | 16.37 | 46.26 | 43.98 | 11.37 | 6.34 |
| 1963 | 45.30 | 6.44 | 7.18 | 8.46 | 9.75 | 6.99 | 3.93 |
| 1964 | . | 4.82 | 6.34 | 7.42 | 10.65 | 99.37 | 12.55 |
| 1965 | 113.70 | 37.06 | 19.69 | 107.68 | 10.82 | 99.49 | 13.69 |
| 1966 | . | 38.71 | 28.61 | 246.48 | 13.56 | 8.73 | 7.61 |
| 1967 | . | 6.88 | 16.79 | 148.63 | 15.60 | 1002.38 | 23.48 |
| 1968 | . | 131.41 | 19.85 | 187.02 | 33.63 | 1008.56 | 22.41 |
| 1969 | 152.20 | 134.47 | 22.60 | 186.67 | 32.68 | 43.47 | 65.77 |
| 1970 | . | 14.90 | 23.31 | 137.21 | 31.28 | 40.91 | 66.55 |
| 1971 | 100.50 | 12.65 | 19.60 | 135.69 | 454.71 | 886.90 | 55.16 |
| 1972 | 70.70 | 24.12 | 10.72 | 90.87 | 440.92 | 900.25 | 56.42 |
| 1973 | 41.10 | 24.31 | 10.15 | 229.11 | 77.67 | 346.38 | 45.61 |
| 1974 | 326.20 | 15.80 | 22.01 | 151.43 | 99.99 | 412.65 | 50.84 |
| 1975 | 125.80 | 24.44 | 22.51 | 119.71 | 72.05 | 104.60 | 12.81 |
| 1976 | 123.80 | 14.47 | 6.63 | 150.42 | 156.04 | 149.56 | 196.24 |
| 1977 | 102.80 | 42.66 | 153.18 | 112.83 | 118.94 | 138.95 | 198.82 |
| 1978 | 9.30 | 44.25 | 154.36 | 119.33 | 35.46 | 68.65 | 8.75 |
| 1979 | 50.50 | 9.96 | 34.06 | 180.03 | 45.97 | 103.58 | 7.74 |
| 1980 | 17.40 | 17.39 | 33.57 | 211.56 | 270.51 | 70.67 | 10.58 |
| 1981 | 7.70 | 17.60 | 8.28 | 438.95 | 367.94 | 133.81 | 46.46 |
| 1982 | 141.60 | 36.42 | 12.04 | 419.57 | 115.65 | 109.59 | 46.09 |
| 1983 | 231.80 | 35.76 | 13.67 | 66.35 | 28.67 | 32.37 | 16.28 |
| 1984 | 76.10 | 22.57 | 12.23 | 16.14 | 26.96 | 39.25 | 15.33 |
| 1985 | 132.80 | 23.33 | 21.59 | 93.29 | 30.10 | 89.16 | 73.56 |
| 1986 | 877.20 | 15.30 | 20.17 | 94.96 | 34.14 | 87.03 | 99.94 |
| 1987 | 267.60 | 38.30 | 19.15 | 285.82 | 75.92 | 21.18 | 41.41 |
| 1988 | 202.80 | 34.81 | 18.62 | 281.60 | 73.55 | 25.92 | 13.13 |
| 1989 | 948.50 | 8.71 | 6.93 | 7.21 | 10.70 | 20.28 | 9.34 |
| 1990 | 665.50 | 10.72 | 22.68 | 27.37 | 93.86 | 22.12 | 9.33 |
| 1991 | 112.20 | 12.39 | 36.90 | 61.66 | 98.75 | 42.46 | 39.09 |
| 1992 | 508.40 | 162.10 | 152.64 | 286.26 | 23.37 | 38.59 | 45.68 |
| 1993 | 973.60 | 165.70 | 150.21 | 346.97 | 35.31 | 29.54 | 23.79 |
| 1994 | 112.50 | 17.21 | 31.15 | 131.76 | 33.25 | 55.14 | 30.55 |

| | |
|---|---|
| Crab | Crab harvest (thousands of pounds) |
| JF_inflow | Lagged January-February inflows (thousands of acre-feet) |
| MA_inflow | Lagged March-April inflows (thousands of acre-feet) |
| MJ_inflow | Lagged May-June inflows (thousands of acre-feet) |
| JA_inflow | Lagged July-August inflows (thousands of acre-feet) |
| SO_inflow | Lagged September-October inflows (thousands of acre-feet) |
| ND_inflow | Lagged November-December inflows (thousands of acre-feet) |

## 2.2 Examination of Individual Variables

***Table .2.2*** *Test of Normality for the crab data and the inflow data.*

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Crab Harvest | .295 | 28 | .000 | .703 | 28 | .010** |
| Ln(Crab Harvest) | .112 | 28 | .200* | .949 | 28 | .276 |
| Square Root of Crab Harvest | .223 | 28 | .001 | .864 | 28 | .010** |
| January-February Inflows | .305 | 28 | .000 | .641 | 28 | .010** |
| Ln(January-February Inflows) | .122 | 28 | .200* | .953 | 28 | .327 |
| Square Root of January-February Inflows | .207 | 28 | .003 | .794 | 28 | .010** |
| March-April Inflows | .365 | 28 | .000 | .573 | 28 | .010** |
| Ln(March-April Inflows) | .217 | 28 | .002 | .863 | 28 | .010** |
| Square Root of March-April Inflows | .293 | 28 | .000 | .705 | 28 | .010** |
| May-June Inflows | .163 | 28 | .054 | .914 | 28 | .032 |
| Ln(May-June Inflows) | .188 | 28 | .012 | .893 | 28 | .010** |
| Square Root of May-June Inflows | .087 | 28 | .200* | .974 | 28 | .691 |
| July-August Inflows | .274 | 28 | .000 | .687 | 28 | .010** |
| Ln(July-August Inflows) | .122 | 28 | .200* | .953 | 28 | .327 |
| Square Root of July-August Inflows | .168 | 28 | .041 | .842 | 28 | .010** |
| September_october Inflows | .351 | 28 | .000 | .565 | 28 | .010** |
| Ln(September-October Inflows) | .115 | 28 | .200* | .964 | 28 | .479 |
| Square Root of September-October Inflows | .230 | 28 | .001 | .773 | 28 | .010** |
| November-December Inflows | .225 | 28 | .001 | .706 | 28 | .010** |
| Ln(November-December Inflows) | .139 | 28 | .176 | .958 | 28 | .399 |
| Square Root of November-December Inflows | .154 | 28 | .086 | .877 | 28 | .010** |

**. This is an upper bound of the true significance.

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

***Table .2.3*** *Percentiles of the crab data and the inflow data.*

**Percentiles**

| | | Percentiles 5 | 10 | 25 | 50 | 75 | 90 | 95 |
|---|---|---|---|---|---|---|---|---|
| Weighted Average(Definition 1) | Crab Harvest | 8.4200 | 16.5900 | 72.0500 | 118.7500 | 258.6500 | 884.3300 | 962.3050 |
| | Ln(Crab Harvest) | 2.12618 | 2.79382 | 4.27685 | 4.77612 | 5.55359 | 6.78455 | 6.86925 |
| | Square Root of Crab Harvest | 2.89850 | 4.05916 | 8.48713 | 10.89478 | 16.07511 | 29.73558 | 31.02039 |
| | January-February Inflows | 7.4615 | 9.8350 | 14.6775 | 23.7250 | 37.9900 | 137.2330 | 164.0800 |
| | Ln(January-February Inflows) | 2.31911 | 2.38028 | 3.42508 | 4.05267 | 4.71419 | 5.92601 | 6.10580 |
| | Square Root of January-February Inflows | 2.72382 | 3.13548 | 3.83084 | 4.87066 | 6.16345 | 11.70969 | 12.80918 |
| | March-April Inflows | 6.7650 | 7.1550 | 12.0875 | 19.9300 | 32.9650 | 152.6940 | 153.8290 |
| | Ln(March-April Inflows) | 1.91152 | 1.96776 | 2.49215 | 2.99215 | 3.49493 | 5.02844 | 5.03583 |
| | Square Root of March-April Inflows | 2.60080 | 2.67485 | 3.47669 | 4.46422 | 5.74078 | 12.35694 | 12.40276 |
| | May-June Inflows | 7.7725 | 15.3720 | 72.4800 | 125.7350 | 224.7225 | 354.2300 | 430.2290 |
| | Ln(May-June Inflows) | 2.04742 | 2.71671 | 4.27357 | 4.83303 | 5.41428 | 5.86824 | 6.06407 |
| | Square Root of May-June Inflows | 2.78570 | 3.90658 | 8.49231 | 11.20994 | 14.98856 | 18.81276 | 20.74066 |
| | July-August Inflows | 10.1775 | 10.8080 | 30.7450 | 59.0100 | 111.7350 | 375.2380 | 448.5045 |
| | Ln(July-August Inflows) | 2.31911 | 2.38028 | 3.42508 | 4.05267 | 4.71419 | 5.92601 | 6.10580 |
| | Square Root of July-August Inflows | 3.18936 | 3.28755 | 5.54392 | 7.63417 | 10.56543 | 19.36340 | 21.17730 |
| | September_october Inflows | 8.9610 | 19.3890 | 30.2475 | 69.6600 | 127.7550 | 460.0750 | 894.2425 |
| | Ln(September-October Inflows) | 2.16340 | 2.95177 | 3.40862 | 4.24352 | 4.84650 | 6.09911 | 6.79595 |
| | Square Root of September-October Inflows | 2.97150 | 4.39019 | 5.49867 | 8.34604 | 11.29285 | 21.26050 | 29.90368 |
| | November-December Inflows | 5.0145 | 7.6000 | 11.1375 | 34.8200 | 54.0800 | 109.5700 | 197.6590 |
| | Ln(November-December Inflows) | 1.58385 | 2.02645 | 2.40678 | 3.54262 | 3.98985 | 4.67205 | 5.28652 |
| | Square Root of November-December Inflows | 2.22340 | 2.75567 | 3.33429 | 5.88970 | 7.35279 | 10.39816 | 14.05905 |
| Tukey's Hinges | Crab Harvest | | | 73.4000 | 118.7500 | 249.7000 | | |
| | Ln(Crab Harvest) | | | 4.29525 | 4.77612 | 5.51768 | | |
| | Square Root of Crab Harvest | | | 8.56593 | 10.89478 | 15.79173 | | |
| | January-February Inflows | | | 14.8850 | 23.7250 | 37.6800 | | |
| | Ln(January-February Inflows) | | | 3.44564 | 4.05267 | 4.67782 | | |
| | Square Root of January-February Inflows | | | 3.85773 | 4.87066 | 6.13820 | | |
| | March-April Inflows | | | 12.1350 | 19.9300 | 32.3600 | | |
| | Ln(March-April Inflows) | | | 2.49606 | 2.99215 | 3.47622 | | |
| | Square Root of March-April Inflows | | | 3.48351 | 4.46422 | 5.68759 | | |
| | May-June Inflows | | | 78.6100 | 125.7350 | 220.3350 | | |
| | Ln(May-June Inflows) | | | 4.35219 | 4.83303 | 5.39436 | | |
| | Square Root of May-June Inflows | | | 8.83906 | 11.20994 | 14.84074 | | |
| | July-August Inflows | | | 31.3900 | 59.0100 | 107.8200 | | |
| | Ln(July-August Inflows) | | | 3.44564 | 4.05267 | 4.67782 | | |
| | Square Root of July-August Inflows | | | 5.60149 | 7.63417 | 10.37678 | | |
| | September_october Inflows | | | 30.9550 | 69.6600 | 121.7000 | | |
| | Ln(September-October Inflows) | | | 3.43149 | 4.24352 | 4.79658 | | |
| | Square Root of September-October Inflows | | | 5.56227 | 8.34604 | 11.01808 | | |
| | November-December Inflows | | | 11.6950 | 34.8200 | 53.0000 | | |
| | Ln(November-December Inflows) | | | 2.45460 | 3.54262 | 3.96946 | | |
| | Square Root of November-December Inflows | | | 3.41590 | 5.88970 | 7.27860 | | |

### 2.2.1 The crab data

***Table .2.4*** *Descriptives for the crab data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| Crab Harvest | Mean | | 236.4571 | 53.9575 |
| | 95% Confidence Interval for Mean | Lower Bound | 125.7455 | |
| | | Upper Bound | 347.1688 | |
| | 5% Trimmed Mean | | 208.5865 | |
| | Median | | 118.7500 | |
| | Variance | | 81519.5 | |
| | Std. Deviation | | 285.5162 | |
| | Minimum | | 7.70 | |
| | Maximum | | 973.60 | |
| | Range | | 965.90 | |
| | Interquartile Range | | 186.6000 | |
| | Skewness | | 1.784 | .441 |
| | Kurtosis | | 2.037 | .858 |

***Table .2.5*** *Extreme Values for the crab data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| Crab Harvest | Highest | 1 | 27 | 1993 | 973.60 |
| | | 2 | 23 | 1989 | 948.50 |
| | | 3 | 20 | 1986 | 877.20 |
| | | 4 | 24 | 1990 | 665.50 |
| | | 5 | 26 | 1992 | 508.40 |
| | Lowest | 1 | 15 | 1981 | 7.70 |
| | | 2 | 12 | 1978 | 9.30 |
| | | 3 | 14 | 1980 | 17.40 |
| | | 4 | 7 | 1973 | 41.10 |
| | | 5 | 2 | 1963 | 45.30 |

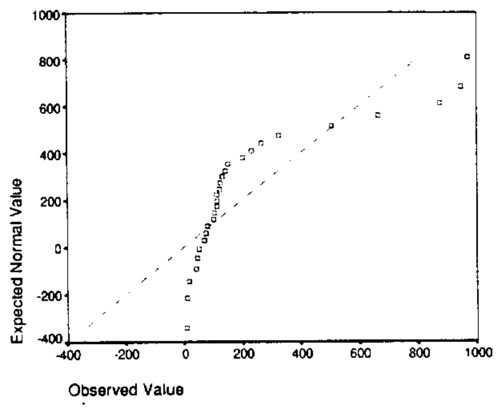


***Figure 2.1*** *Normal Q-Q Plot of Crab Harvest.*

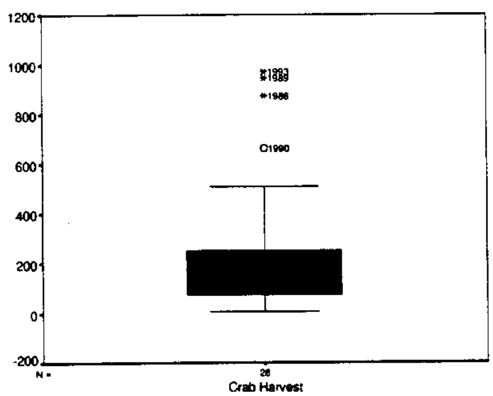


***Figure 2.2*** *BoxPlot of Crab Harvest.*

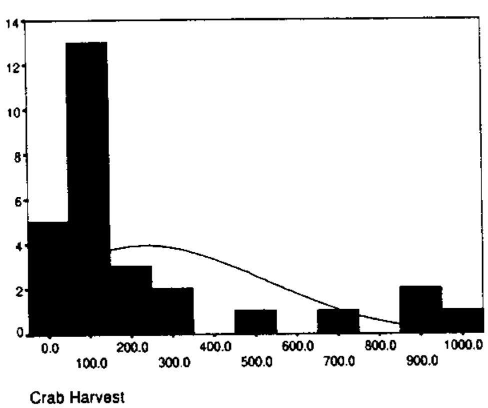


***Figure 2.3*** *Histogram of Crab Harvest.*

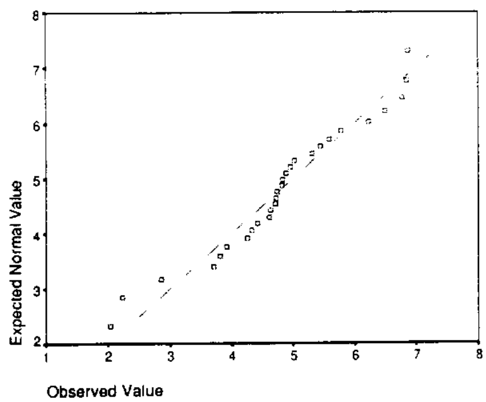


***Figure 2.4*** *Normal Q-Q Plot of Ln(Crab Harvest).*

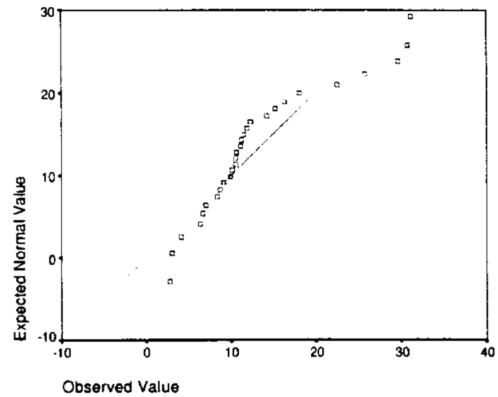


***Figure 2.5*** *Normal Q-Q Plot of Sqrt(Crab Harvest).*

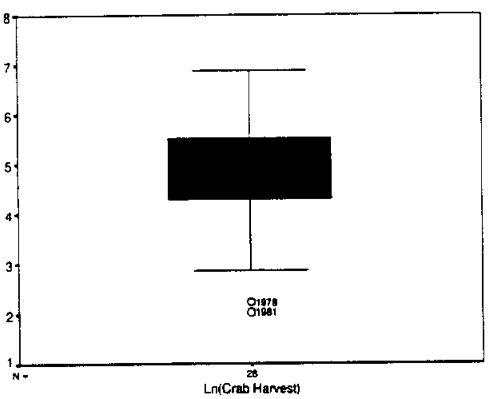


***Figure 2.6*** *BoxPlot of Ln(Crab Harvest).*

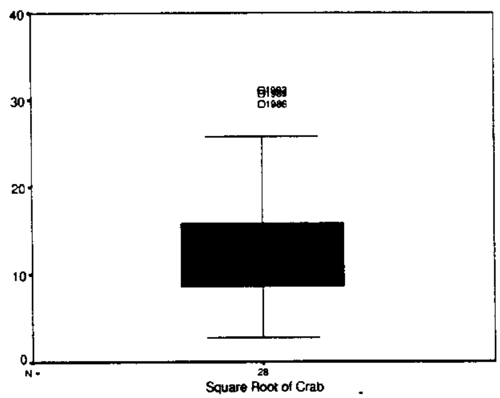


***Figure 2.7*** *BoxPlot of Sqrt(Crab Harvest).*

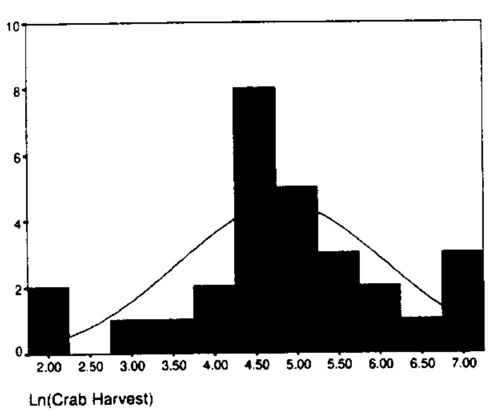


***Figure 2.8*** *Histogram of Ln(Crab Harvest).*

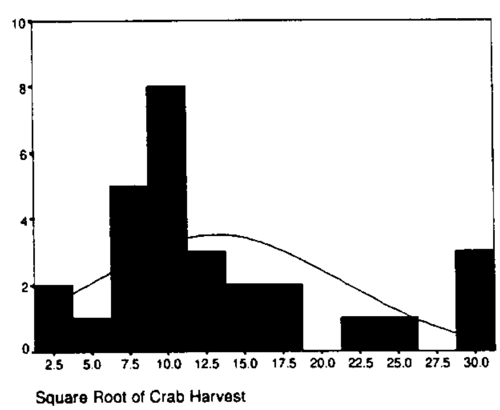


***Figure 2.9*** *Histogram of Sqrt(Crab Harvest).*

### 2.2.2 The January-February Inflows data

***Table .2.6*** *Descriptives for the January-February Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| January-February Inflows | Mean | | 38.5221 | 8.1832 |
| | 95% Confidence Interval for Mean | Lower Bound | 21.7317 | |
| | | Upper Bound | 55.3126 | |
| | 5% Trimmed Mean | | 33.2602 | |
| | Median | | 23.7250 | |
| | Variance | | 1875.002 | |
| | Std. Deviation | | 43.3013 | |
| | Minimum | | 6.44 | |
| | Maximum | | 165.70 | |
| | Range | | 159.26 | |
| | Interquartile Range | | 23.3125 | |
| | Skewness | | 2.277 | .441 |
| | Kurtosis | | 4.351 | .858 |

***Table .2.7*** *Extreme Values for the January-February Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| January-February Inflows | Highest | 1 | 27 | 1993 | 165.70 |
| | | 2 | 26 | 1992 | 162.10 |
| | | 3 | 4 | 1969 | 134.47 |
| | | 4 | 1 | 1962 | 69.68 |
| | | 5 | 12 | 1978 | 44.25 |
| | Lowest | 1 | 2 | 1963 | 6.44 |
| | | 2 | 23 | 1989 | 8.71 |
| | | 3 | 13 | 1979 | 9.96 |
| | | 4 | 24 | 1990 | 10.72 |
| | | 5 | 25 | 1991 | 12.39 |

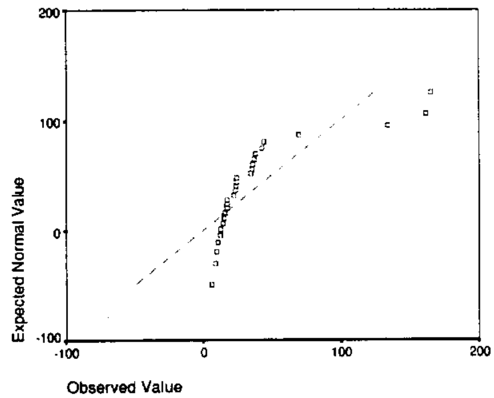


***Figure 2.10*** *Normal Q-Q Plot of January-February Inflows.*

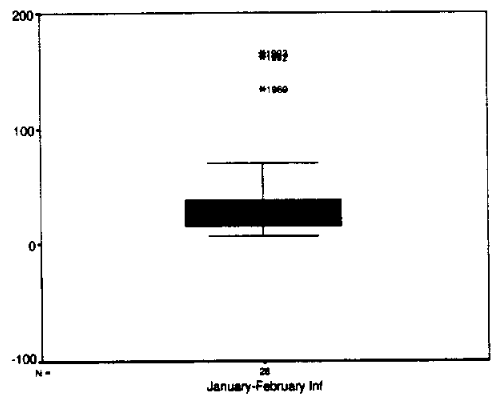


***Figure 2.11*** *BoxPlot of January-February Inflows.*

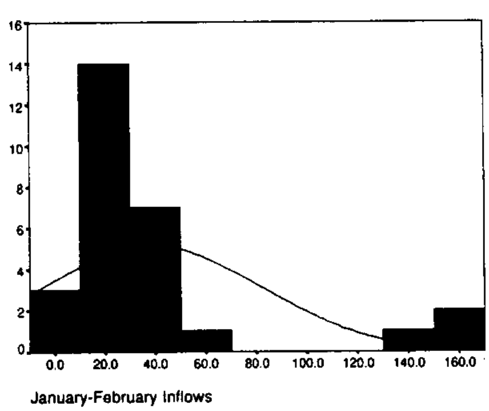


***Figure 2.12*** *Histogram of January-February Inflows.*

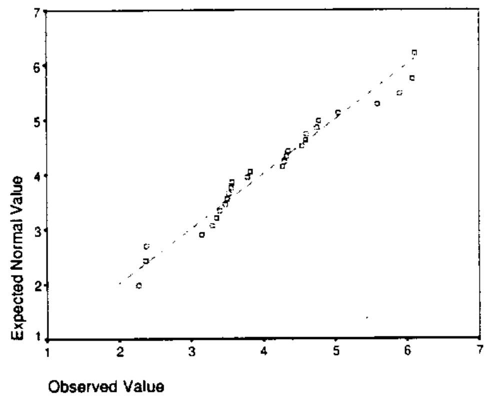


***Figure 2.13*** *Normal Q-Q Plot of Ln January-February Inflows).*

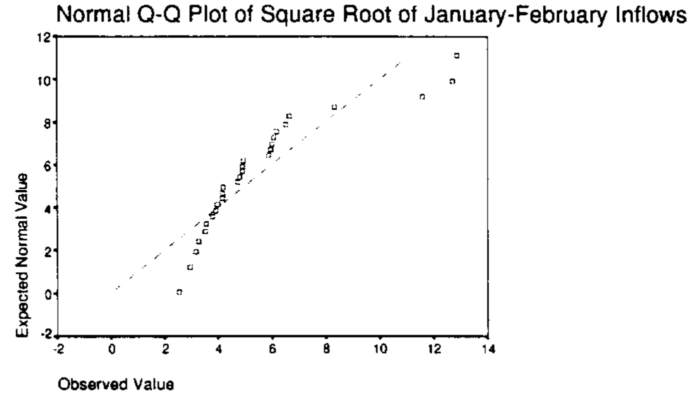


***Figure 2.14*** *Normal Q-Q Plot of Sqrt( January-February Inflows).*

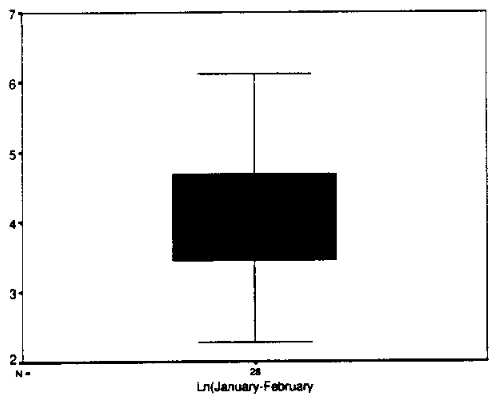


***Figure 2.15*** *BoxPlot of Ln(January-February Inflows).*

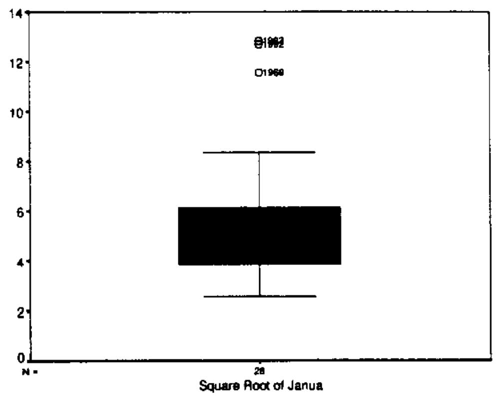


***Figure 2.16*** *BoxPlot of Square Root of January-February Inflows.*

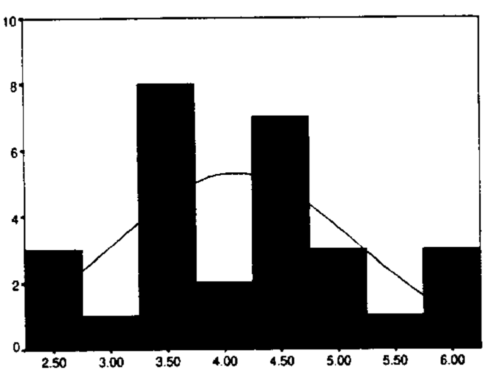


***Figure 2.17*** *Histogram of Ln(January-February Inflows).*

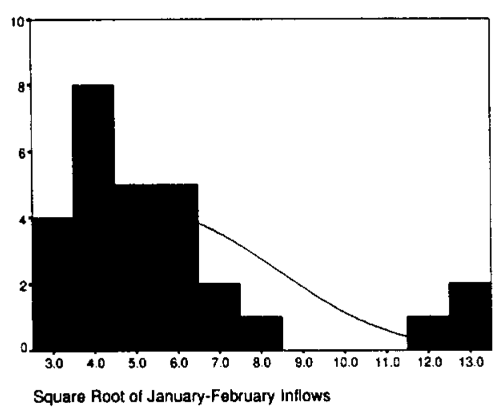


***Figure 2.18*** *Histogram of Sqrt(January-February Inflows).*

### 2.2.3 The March-April Inflows data

***Table .2.8*** *Descriptives for the March-April Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| March-April Inflows | Mean | | 37.8175 | 9.1491 |
| | 95% Confidence Interval for Mean | Lower Bound | 19.0451 | |
| | | Upper Bound | 56.5899 | |
| | 5% Trimmed Mean | | 33.0895 | |
| | Median | | 19.9300 | |
| | Variance | | 2343.758 | |
| | Std. Deviation | | 48.4124 | |
| | Minimum | | 6.63 | |
| | Maximum | | 154.36 | |
| | Range | | 147.73 | |
| | Interquartile Range | | 20.8775 | |
| | Skewness | | 2.035 | .441 |
| | Kurtosis | | 2.547 | .858 |

***Table .2.9*** *Extreme Values for the March-April Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| March-April Inflows | Highest | 1 | 12 | 1978 | 154.36 |
| | | 2 | 11 | 1977 | 153.18 |
| | | 3 | 26 | 1992 | 152.64 |
| | | 4 | 27 | 1993 | 150.21 |
| | | 5 | 25 | 1991 | 36.90 |
| | Lowest | 1 | 10 | 1976 | 6.63 |
| | | 2 | 23 | 1989 | 6.93 |
| | | 3 | 2 | 1963 | 7.18 |
| | | 4 | 15 | 1981 | 8.28 |
| | | 5 | 7 | 1973 | 10.15 |

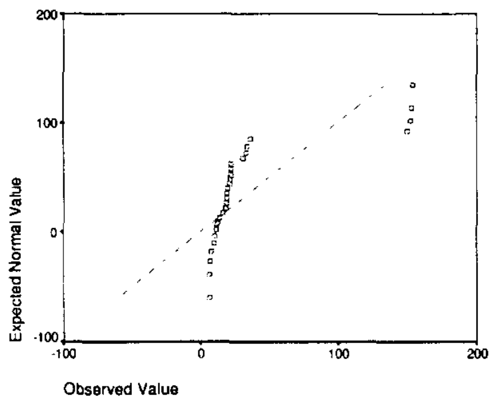


***Figure 2.19*** *Normal Q-Q Plot of March-April Inflows.*

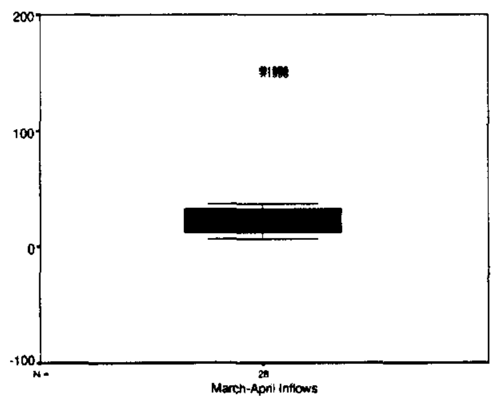


***Figure 2.20*** *BoxPlot of March-April Inflows.*

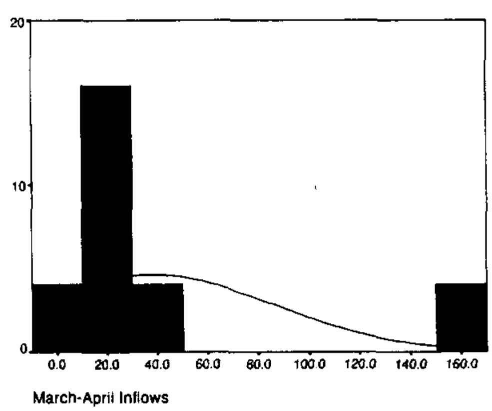


***Figure 2.21*** *Histogram of March-April Inflows.*

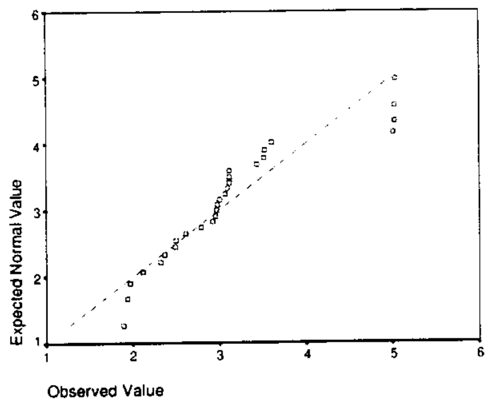


***Figure 2.22*** *Normal Q-Q Plot of Ln(March-April Inflows).*

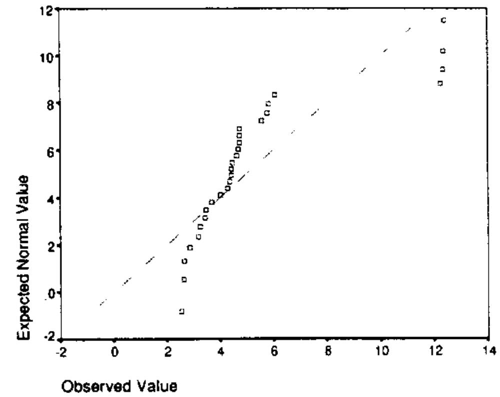


***Figure 2.23*** *Normal Q-Q Plot of Sqrt( March-April Inflows).*

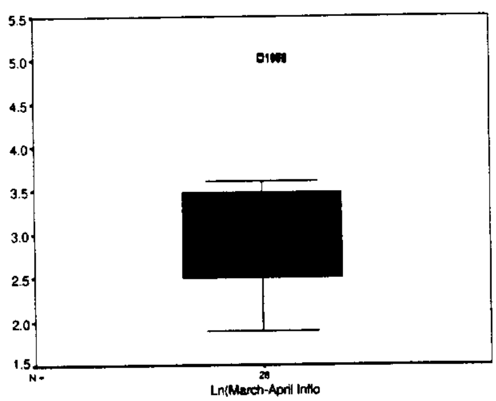


***Figure 2.24*** *BoxPlot of Ln(March-April) Inflows.*

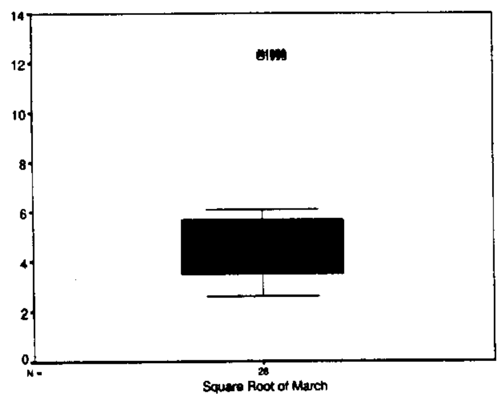


***Figure 2.25*** *BoxPlot of Square Root of March-April Inflows.*

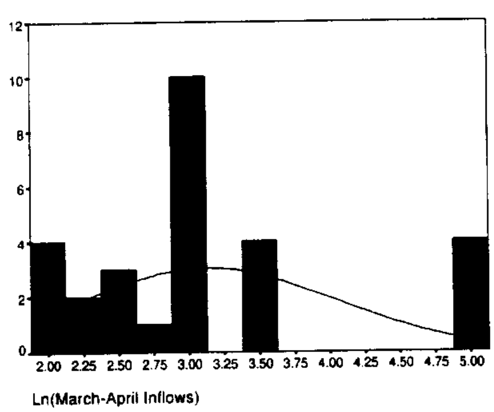


***Figure 2.26*** *Histogram of Ln(March-April Inflows).*

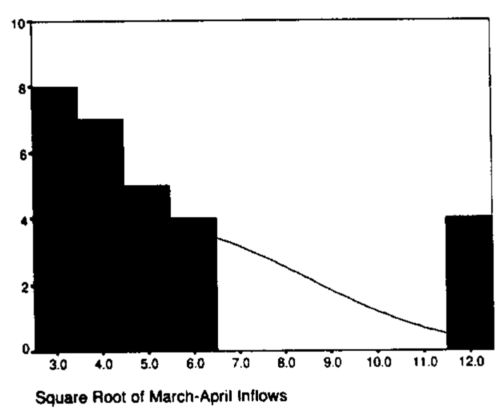


***Figure 2.27*** *Histogram of Sqrt(March-April Inflows).*

### 2.2.4 The May-June Inflows data

***Table .2.10*** *Descriptives for the May-June Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| May-June Inflows | Mean | | 157.4271 | 22.2508 |
| | 95% Confidence Interval for Mean | Lower Bound | 111.7723 | |
| | | Upper Bound | 203.0820 | |
| | 5% Trimmed Mean | | 150.4202 | |
| | Median | | 125.7350 | |
| | Variance | | 13862.8 | |
| | Std. Deviation | | 117.7402 | |
| | Minimum | | 7.21 | |
| | Maximum | | 438.95 | |
| | Range | | 431.74 | |
| | Interquartile Range | | 152.2425 | |
| | Skewness | | .928 | .441 |
| | Kurtosis | | .289 | .858 |

***Table .2.11*** *Extreme Values for the May-June Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| May-June Inflows | Highest | 1 | 15 | 1981 | 438.95 |
| | | 2 | 16 | 1982 | 419.57 |
| | | 3 | 27 | 1993 | 346.97 |
| | | 4 | 26 | 1992 | 286.26 |
| | | 5 | 21 | 1987 | 285.82 |
| | Lowest | 1 | 23 | 1989 | 7.21 |
| | | 2 | 2 | 1963 | 8.46 |
| | | 3 | 18 | 1984 | 16.14 |
| | | 4 | 24 | 1990 | 27.37 |
| | | 5 | 1 | 1962 | 46.26 |

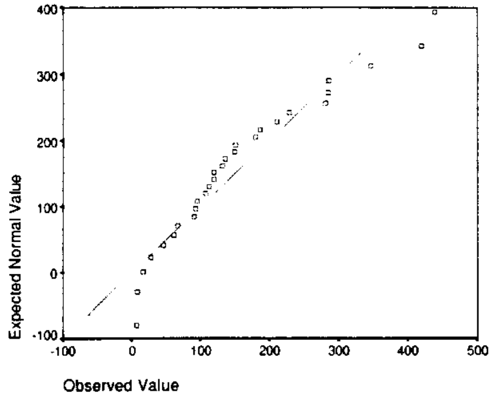


*Figure 2.28* Normal Q-Q Plot of May-June Inflows.

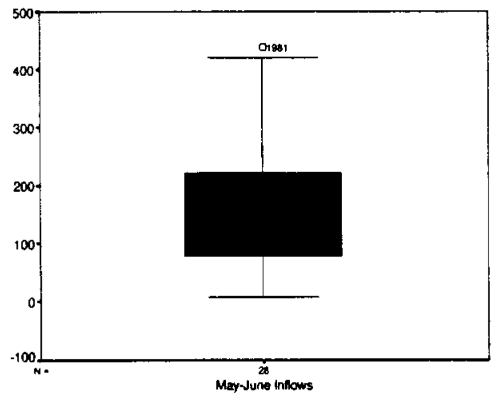


*Figure 2.29* BoxPlot of May-June Inflows.

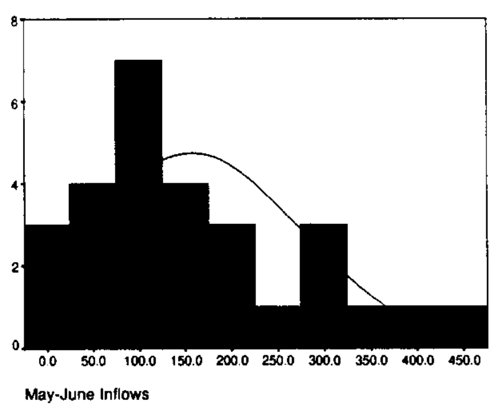


*Figure 2.30* Histogram of May-June Inflows.

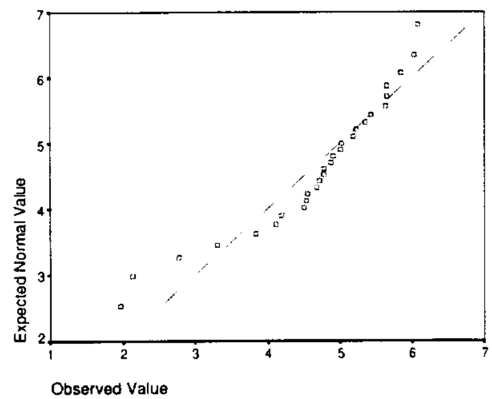


***Figure 2.31*** *Normal Q-Q Plot of Ln(May-June Inflows).*

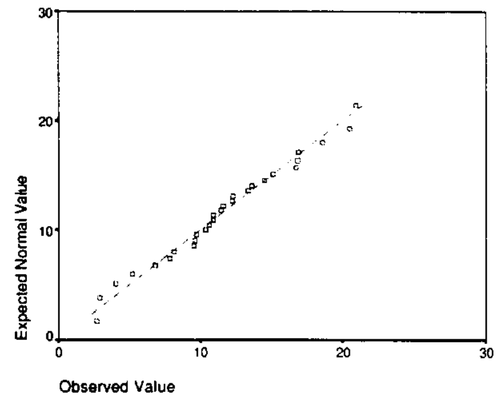


***Figure 2.32*** *Normal Q-Q Plot of Sqrt( May-June Inflows).*

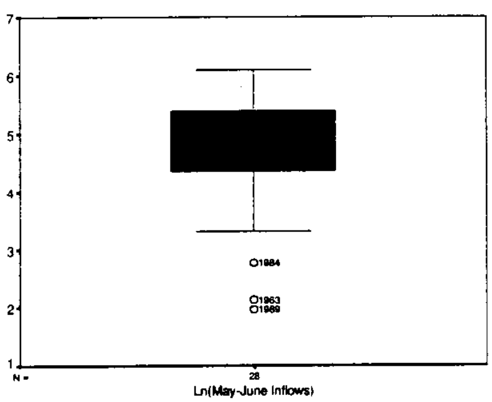


***Figure 2.33*** *BoxPlot of Ln(May-June) Inflows.*

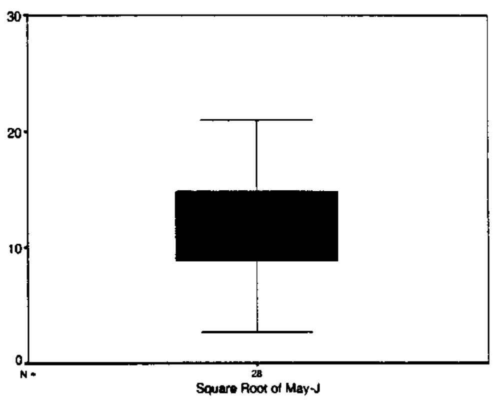


***Figure 2.34*** *BoxPlot of Square Root of May-June Inflows.*

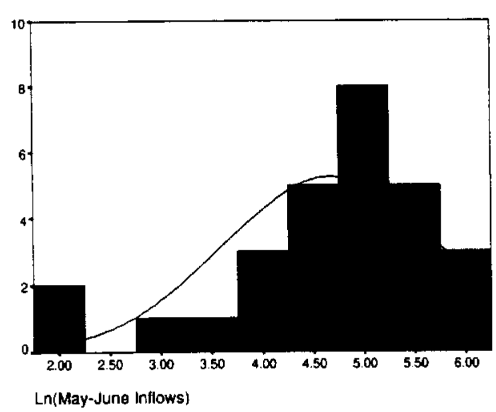


***Figure 2.35*** *Histogram of Ln(May-June Inflows).*

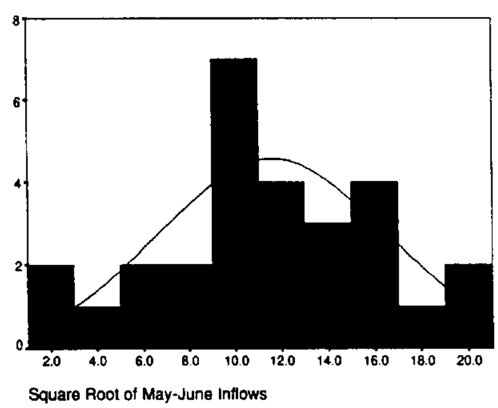


***Figure 2.36*** *Histogram of Sqrt(May-June Inflows).*

### 2.2.5 The July-August Inflows data

***Table .2.12*** *Descriptives for the July-August Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| July-August Inflows | Mean | | 104.2021 | 23.6192 |
| | 95% Confidence Interval for Mean | Lower Bound | 55.7396 | |
| | | Upper Bound | 152.6647 | |
| | 5% Trimmed Mean | | 90.1806 | |
| | Median | | 59.0100 | |
| | Variance | | 15620.2 | |
| | Std. Deviation | | 124.9809 | |
| | Minimum | | 9.75 | |
| | Maximum | | 454.71 | |
| | Range | | 444.96 | |
| | Interquartile Range | | 80.9900 | |
| | Skewness | | 1.998 | .441 |
| | Kurtosis | | 3.098 | .858 |

***Table .2.13*** *Extreme Values for the July-August Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| July-August Inflows | Highest | 1 | 5 | 1971 | 454.71 |
| | | 2 | 6 | 1972 | 440.92 |
| | | 3 | 15 | 1981 | 367.94 |
| | | 4 | 14 | 1980 | 270.51 |
| | | 5 | 10 | 1976 | 156.04 |
| | Lowest | 1 | 2 | 1963 | 9.75 |
| | | 2 | 23 | 1989 | 10.70 |
| | | 3 | 3 | 1965 | 10.82 |
| | | 4 | 26 | 1992 | 23.37 |
| | | 5 | 18 | 1984 | 26.96 |

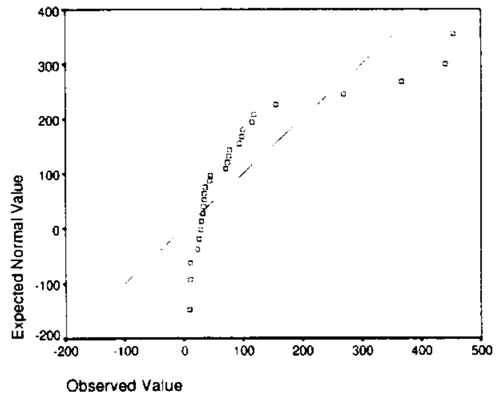


***Figure 2.37*** *Normal Q-Q Plot of July-August Inflows.*

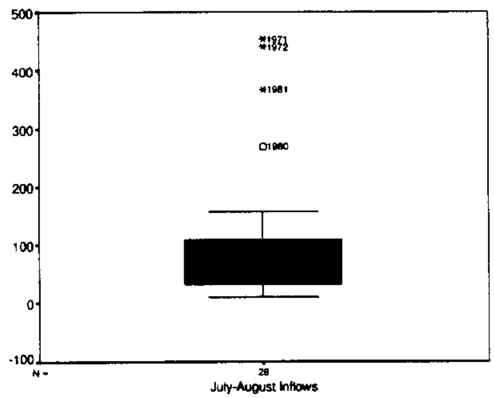


***Figure 2.38*** *BoxPlot of July-August Inflows.*

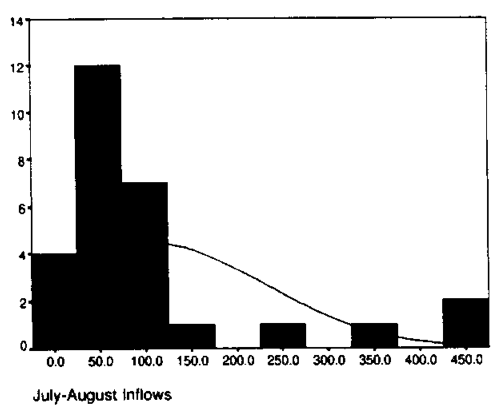


***Figure 2.39*** *Histogram of July-August Inflows.*

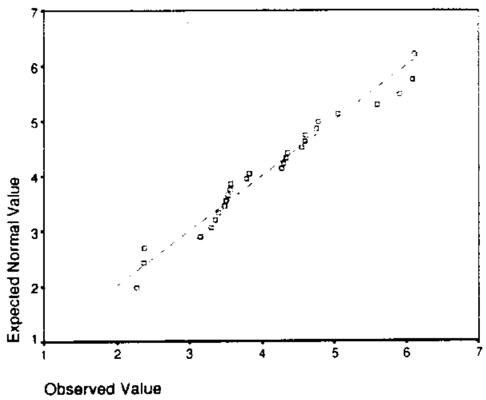


***Figure 2.40*** *Normal Q-Q Plot of Ln(July-August Inflows).*

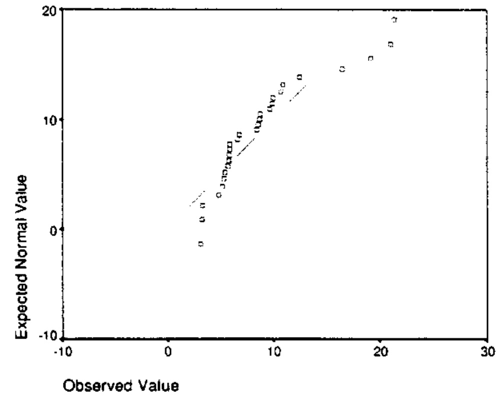


***Figure 2.41*** *Normal Q-Q Plot of Sqrt( July-August Inflows).*

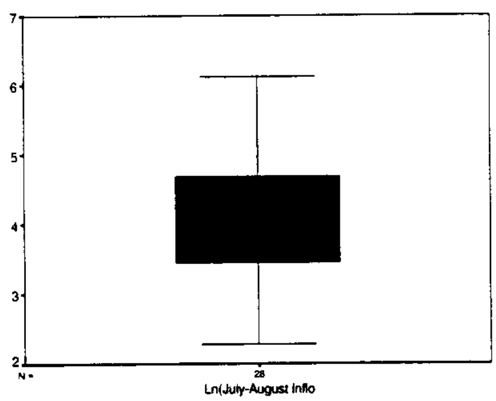


***Figure 2.42*** *BoxPlot of Ln(July-August) Inflows.*

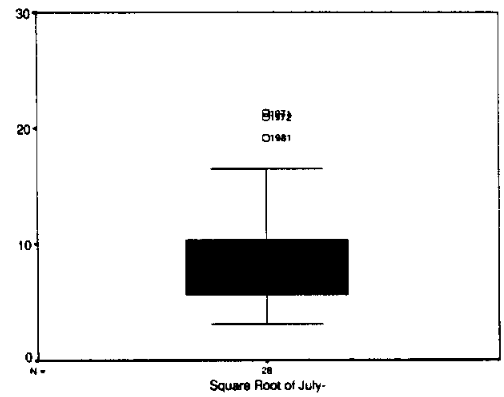


***Figure 2.43*** *BoxPlot of Square Root of July-August Inflows.*

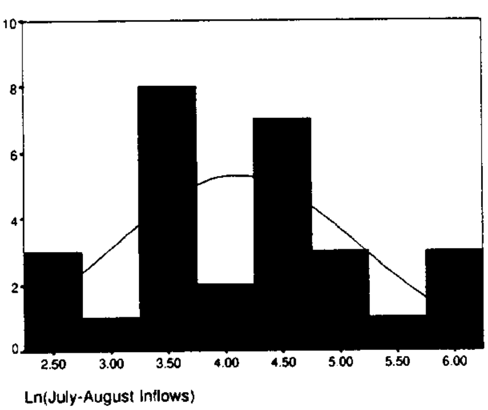


***Figure 2.44*** *Histogram of Ln(July-August Inflows).*

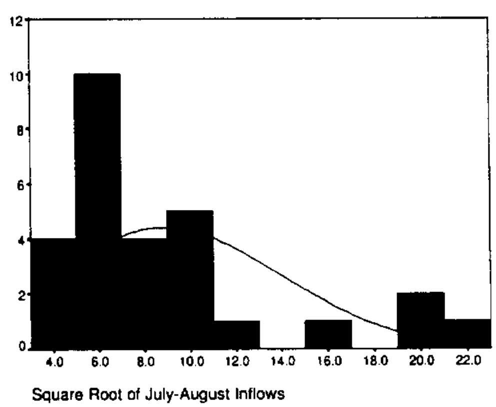


***Figure 2.45*** *Histogram of Sqrt(July-August Inflows).*

## 2.2.6 The September-October Inflows data

***Table .2.14*** *Descriptives for the September-October Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| September_october Inflows | Mean | | 146.0696 | 43.5245 |
| | 95% Confidence Interval for Mean | Lower Bound | 56.7647 | |
| | | Upper Bound | 235.3746 | |
| | 5% Trimmed Mean | | 112.0398 | |
| | Median | | 69.6600 | |
| | Variance | | 53042.8 | |
| | Std. Deviation | | 230.3102 | |
| | Minimum | | 6.99 | |
| | Maximum | | 900.25 | |
| | Range | | 893.26 | |
| | Interquartile Range | | 97.5075 | |
| | Skewness | | 2.742 | .441 |
| | Kurtosis | | 7.062 | .858 |

***Table .2.15*** *Extreme Values for the September-October Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| September_october Inflows | Highest | 1 | 6 | 1972 | 900.25 |
| | | 2 | 5 | 1971 | 886.90 |
| | | 3 | 8 | 1974 | 412.65 |
| | | 4 | 7 | 1973 | 346.38 |
| | | 5 | 10 | 1976 | 149.56 |
| | Lowest | 1 | 2 | 1963 | 6.99 |
| | | 2 | 1 | 1962 | 11.37 |
| | | 3 | 23 | 1989 | 20.28 |
| | | 4 | 21 | 1987 | 21.18 |
| | | 5 | 24 | 1990 | 22.12 |

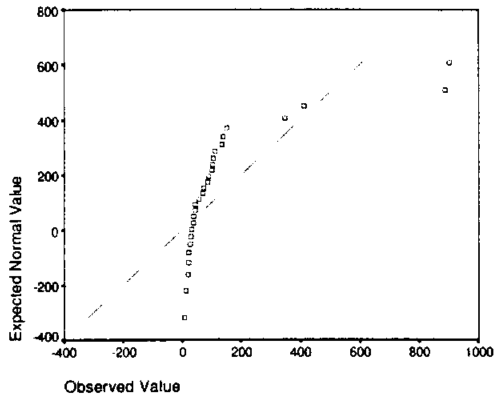


***Figure 2.46*** *Normal Q-Q Plot of September-October Inflows.*

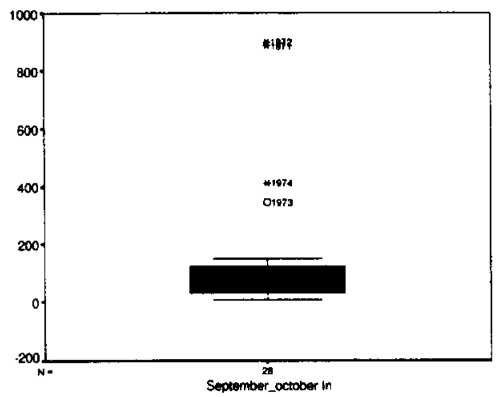


***Figure 2.47*** *BoxPlot of September-October Inflows.*

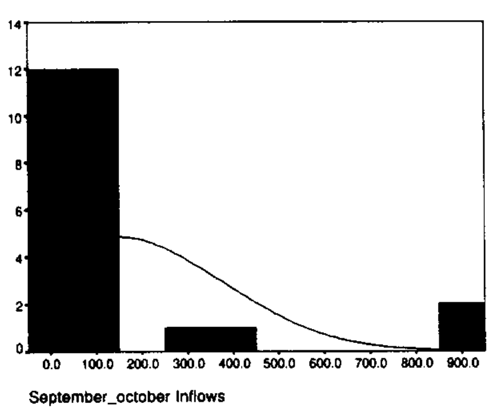


***Figure 2.48*** *Histogram of September-October Inflows.*

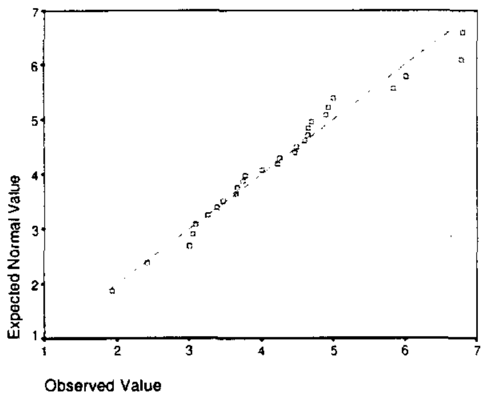


***Figure 2.49*** *Normal Q-Q Plot of Ln(September-October Inflows).*

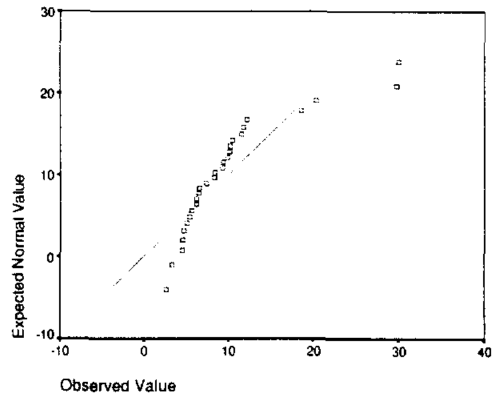


***Figure 2.50*** *Normal Q-Q Plot of Sqrt( September-October Inflows).*

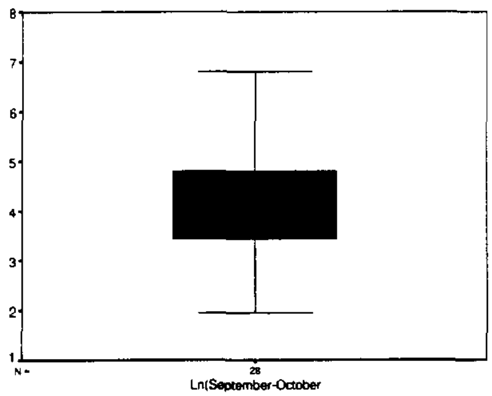


***Figure 2.51*** *BoxPlot of Ln(September-October) Inflows.*

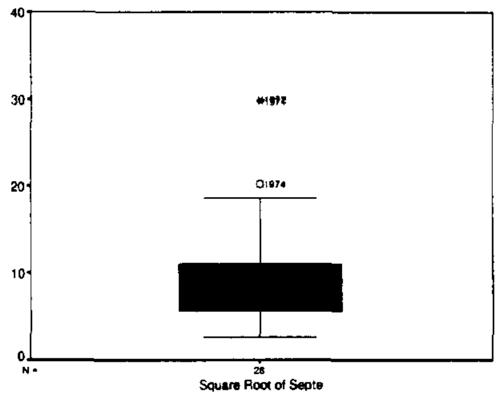


***Figure 2.52*** *BoxPlot of Square Root of September-October Inflows.*

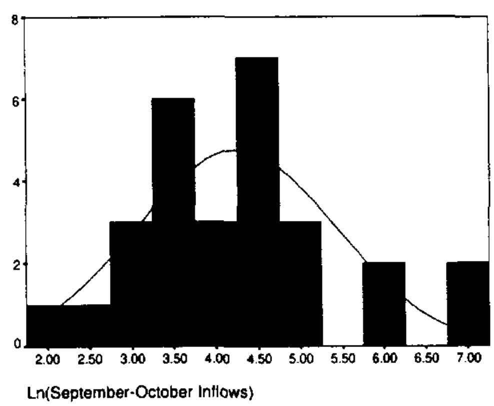


***Figure 2.53*** *Histogram of Ln(September-October Inflows).*

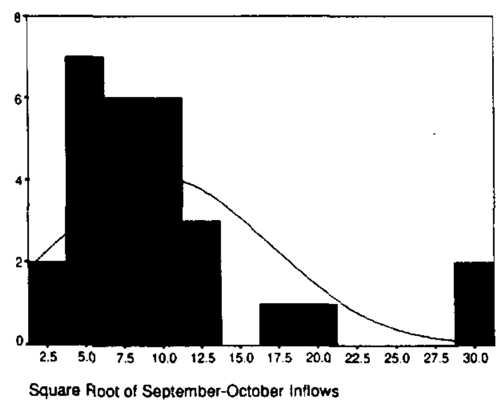


***Figure 2.54*** *Histogram of Sqrt(September-October Inflows).*

### 2.2.7 The November-December Inflows data

***Table .2.16*** *Descriptives for the November-December Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| November-December Inflows | Mean | | 44.3814 | 9.3518 |
| | 95% Confidence Interval for Mean | Lower Bound | 25.1931 | |
| | | Upper Bound | 63.5698 | |
| | 5% Trimmed Mean | | 38.0515 | |
| | Median | | 34.8200 | |
| | Variance | | 2448.780 | |
| | Std. Deviation | | 49.4851 | |
| | Minimum | | 3.93 | |
| | Maximum | | 198.82 | |
| | Range | | 194.89 | |
| | Interquartile Range | | 42.9425 | |
| | Skewness | | 2.273 | .441 |
| | Kurtosis | | 5.339 | .858 |

***Table .2.17*** *Extreme Values for the November-December Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| November-December Inflows | Highest | 1 | 11 | 1977 | 198.82 |
| | | 2 | 10 | 1976 | 196.24 |
| | | 3 | 20 | 1986 | 99.94 |
| | | 4 | 19 | 1985 | 73.56 |
| | | 5 | 4 | 1969 | 65.77 |
| | Lowest | 1 | 2 | 1963 | 3.93 |
| | | 2 | 1 | 1962 | 6.34 |
| | | 3 | 13 | 1979 | 7.74 |
| | | 4 | 12 | 1978 | 8.75 |
| | | 5 | 24 | 1990 | 9.33 |

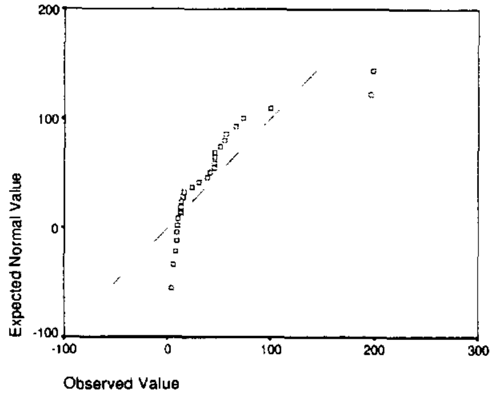


***Figure 2.55*** *Normal Q-Q Plot of November_December Inflows.*

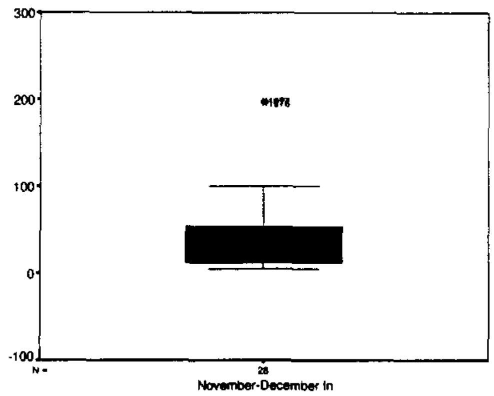


***Figure 2.56*** *BoxPlot of November_December Inflows.*

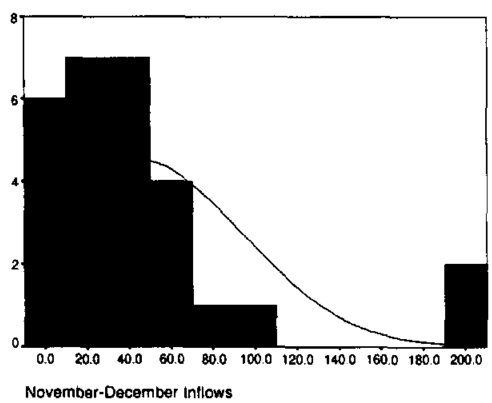


***Figure 2.57*** *Histogram of November_December Inflows.*

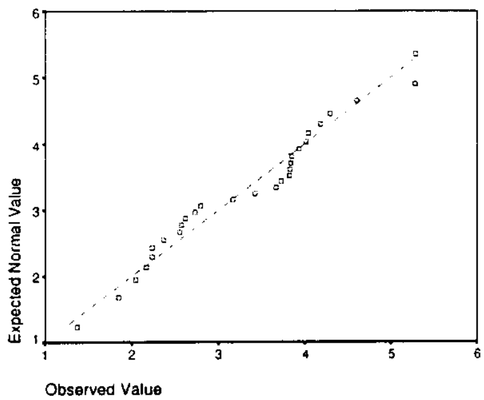


*Figure 2.58* *Normal Q-Q Plot of Ln(November_December Inflows).*

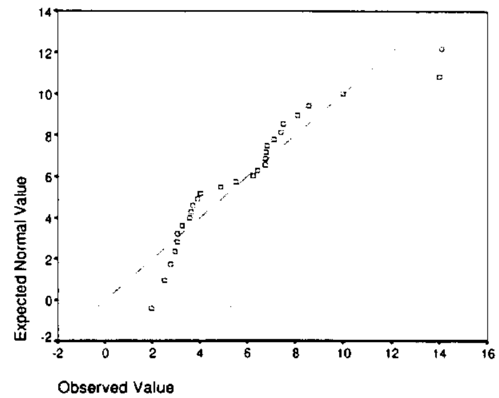


*Figure 2.59* *Normal Q-Q Plot of Sqrt( November_December Inflows).*

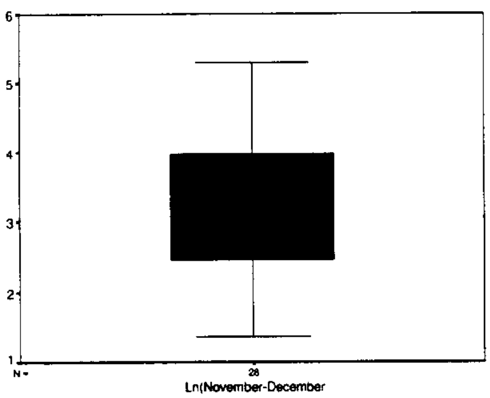


*Figure 2.60* *BoxPlot of Ln(November _December) Inflows.*

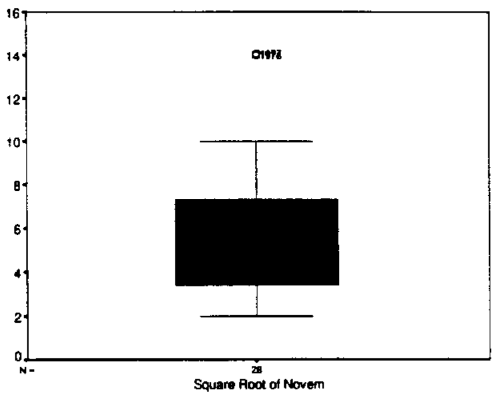


*Figure 2.61* *BoxPlot of Square Root of November_December Inflows.*

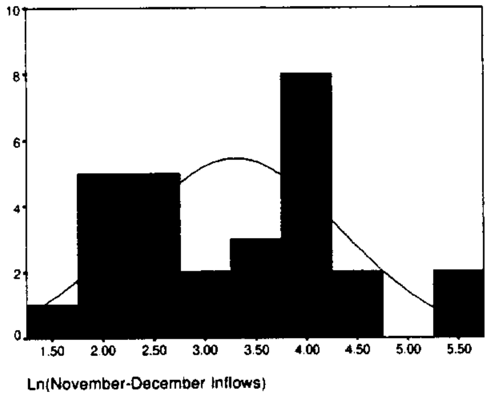


*Figure 2.62* *Histogram of Ln(November_ December Inflows).*

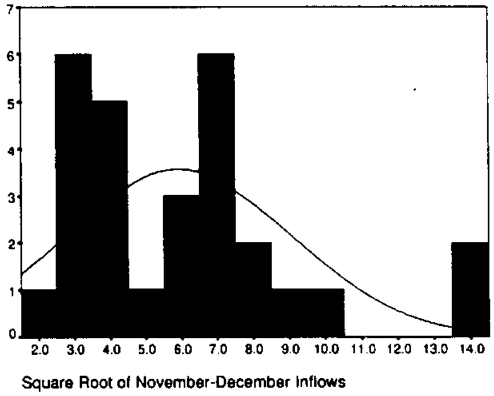


*Figure 2.63* *Histogram of Sqrt(November_ December Inflows).*

## 3. PREDICTION ELLIPSES AND CONFIDENCE REGIONS

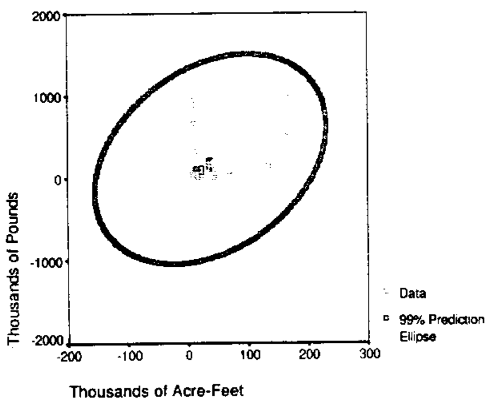


***Figure 3.1*** *Crab Harvest vs. January-February Inflows, PE.*

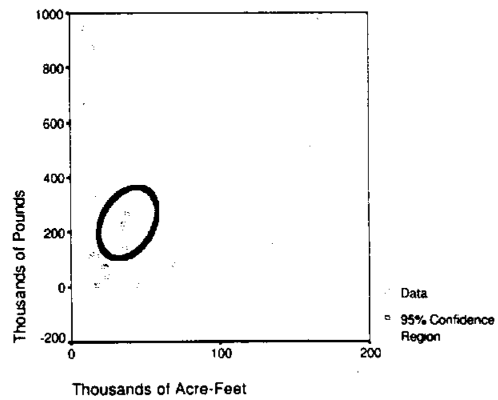


***Figure 3.2*** *Crab Harvest vs. January-February Inflows, CR.*

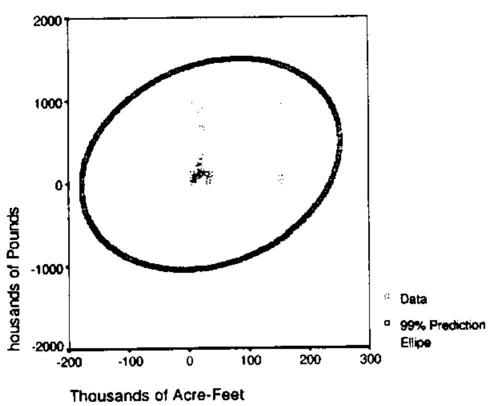


***Figure 3.3*** *Crab Harvest vs. March-April Inflows, PE.*

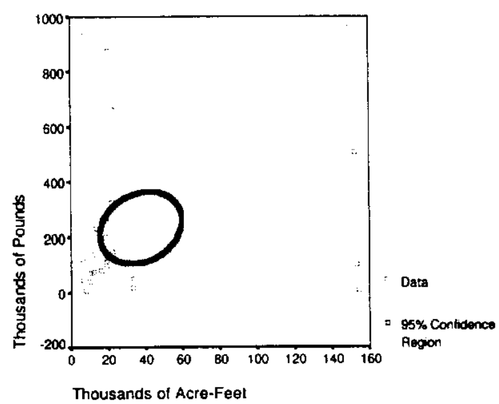


***Figure 3.4*** *Crab Harvest vs. March-April Inflows, CR.*

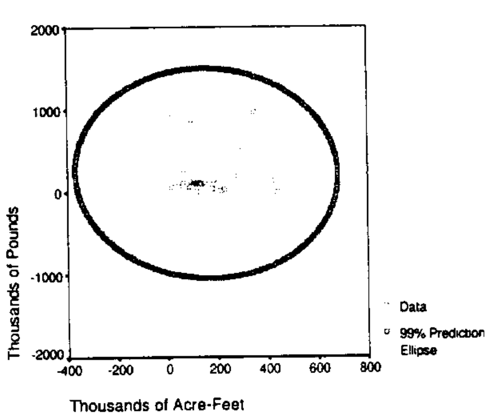


***Figure 3.5*** *Crab Harvest vs. May-June Inflows, PE.*

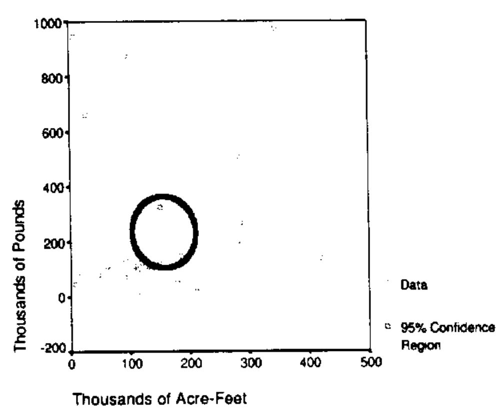


***Figure 3.6*** *Crab Harvest vs. May-June Inflows, CR.*

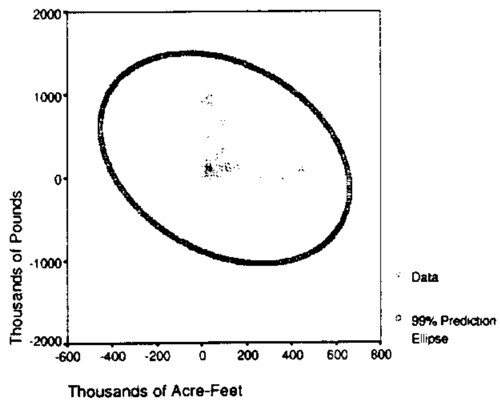


***Figure 3.7*** *Crab Harvest vs. July-August Inflows, PE.*

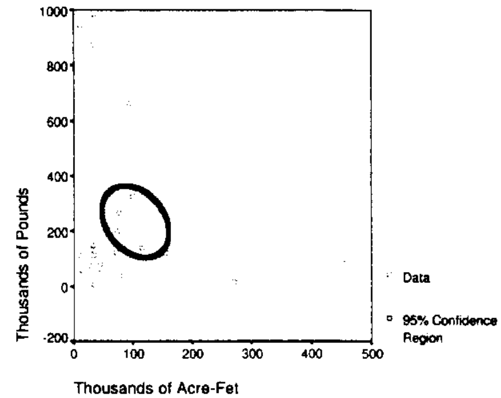


***Figure 3.8*** *Crab Harvest vs. July-August Inflows, CR.*

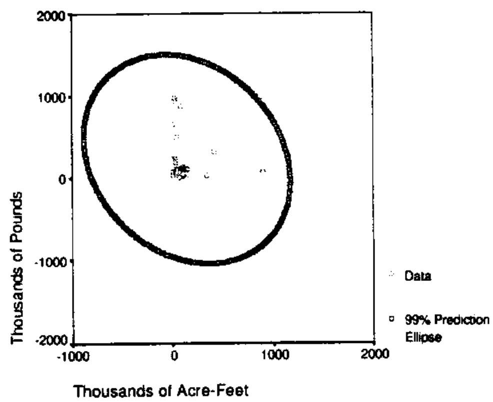


***Figure 3.9*** *Crab Harvest vs. September-October Inflows, PE.*

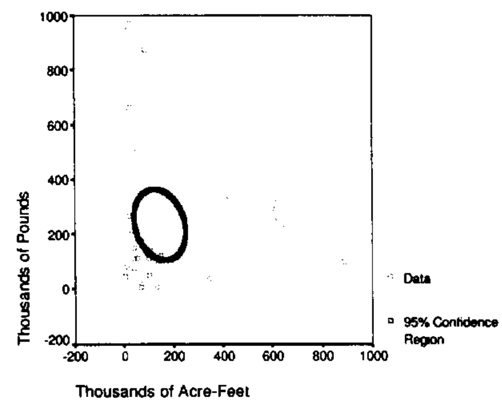


***Figure 3.10*** *Crab Harvest vs. September-October Inflows, CR.*

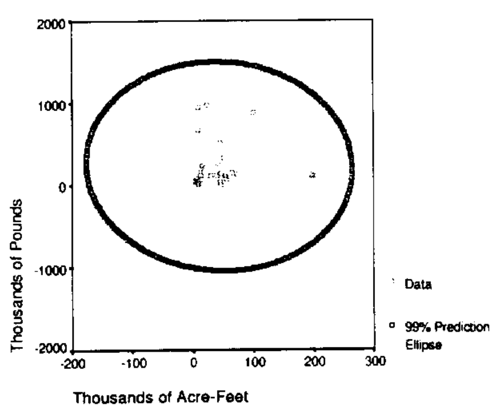


***Figure 3.11*** *Crab Harvest vs. November-December Inflows, PE.*

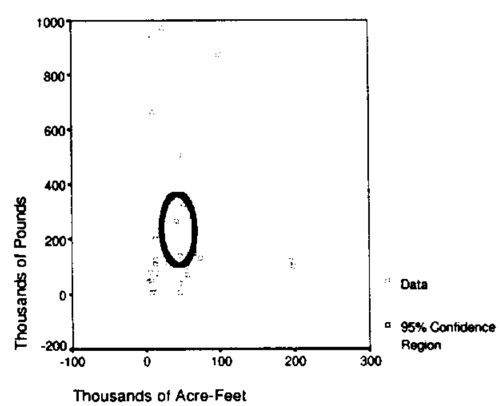


***Figure 3.12*** *Crab Harvest vs. November-December Inflows, CR.*

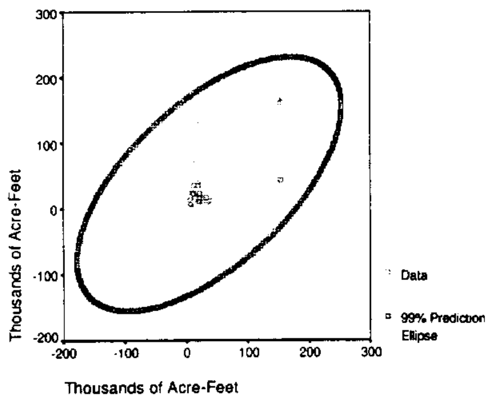


***Figure 3.13*** *January-February Inflows vs. March-April Inflows, PE.*

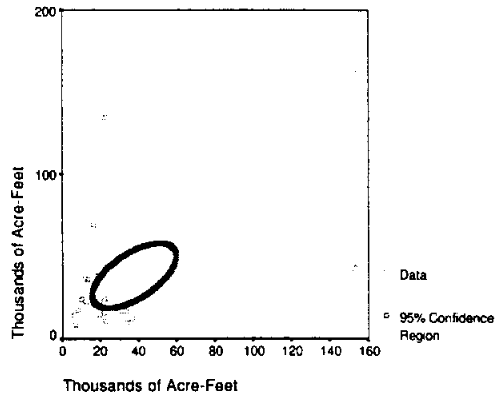


***Figure 3.14*** *January-February Inflows vs. March-April Inflows, CR.*

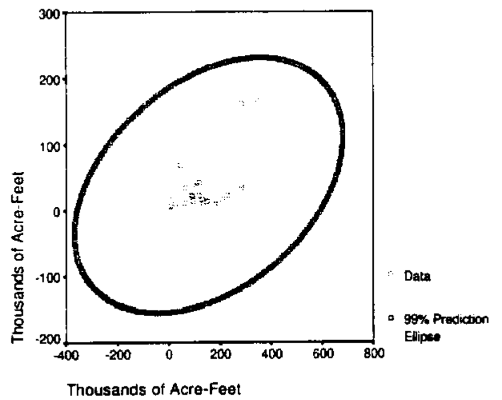


***Figure 3.15*** *January-February Inflows vs. May-June Inflows, PE.*

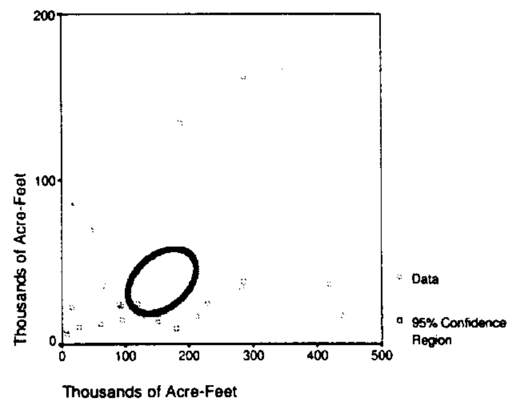


***Figure 3.16*** *January-February Inflows vs. May-June Inflows, CR.*

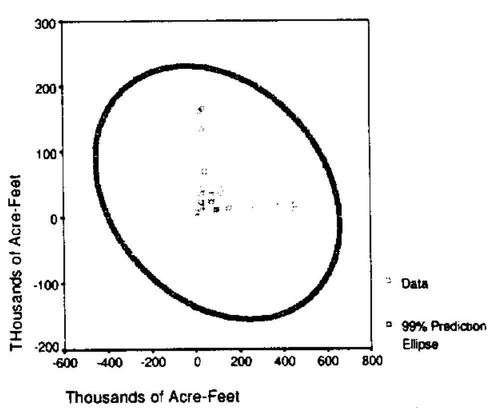


***Figure 3.17*** *January-February Inflows vs. July-August Inflows, PE.*

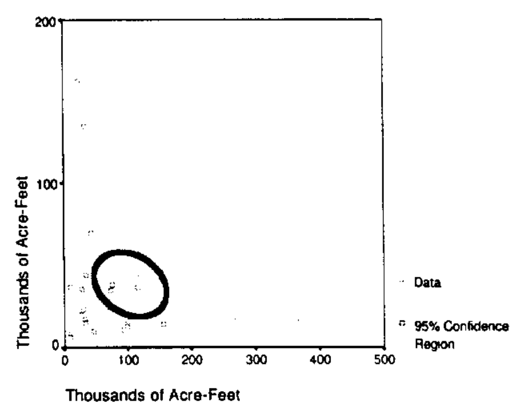


***Figure 3.18*** *January-February Inflows vs. July-August Inflows, CR.*

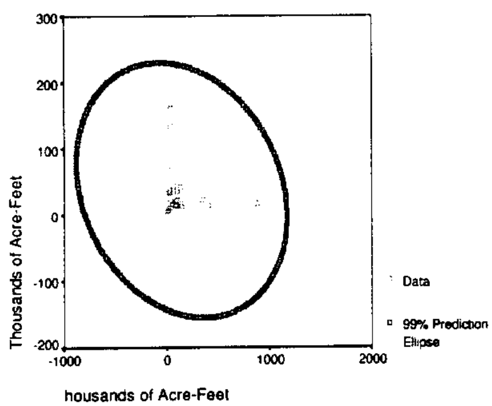


**Figure 3.19** *January-February Inflows vs. September-October Inflows, PE.*

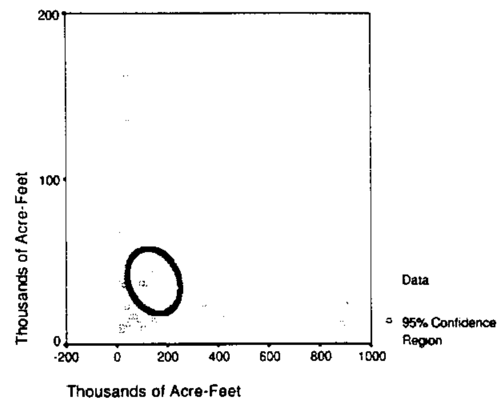


**Figure 3.20** *January-February Inflows vs. September-October Inflows, CR.*

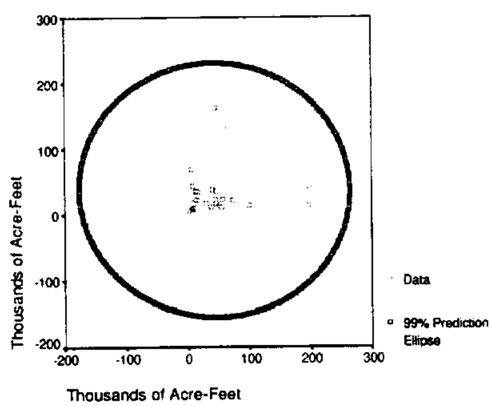


**Figure 3.21** *January-February Inflows vs. November-December Inflows, PE.*

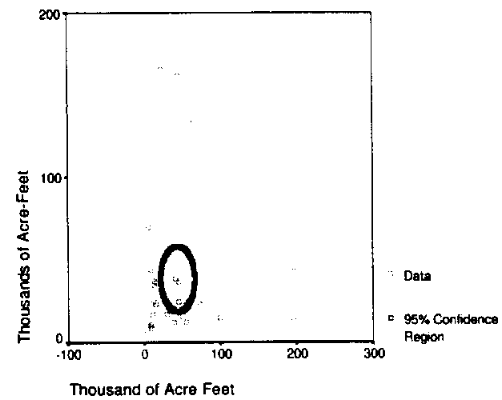


**Figure 3.22** *January-February Inflows vs. November-December Inflows, CR.*

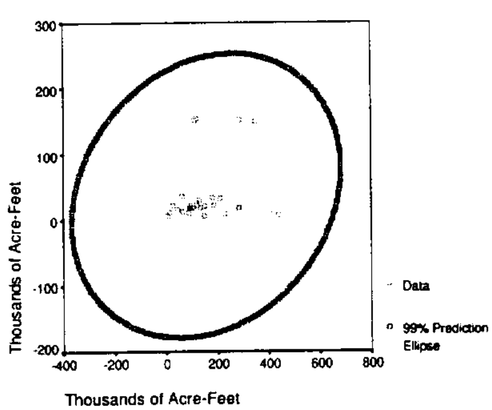


**Figure 3.23** *March-April Inflows vs. May-June Inflows, PE.*

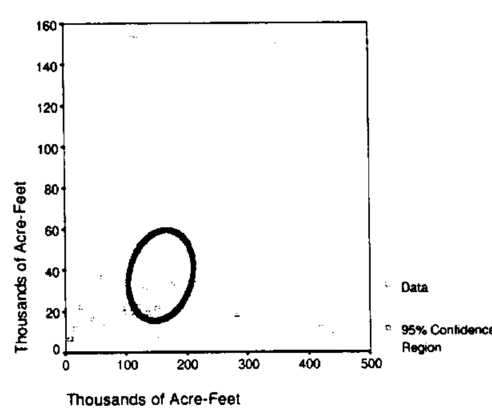


**Figure 3.24** *March-April Inflows vs. May-June Inflows, CR.*

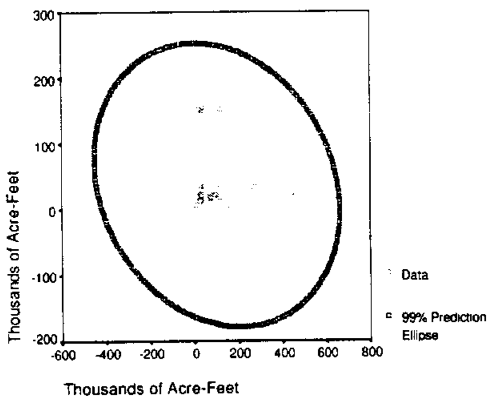


***Figure 3.25*** *March-April Inflows vs. July-August Inflows, PE.*

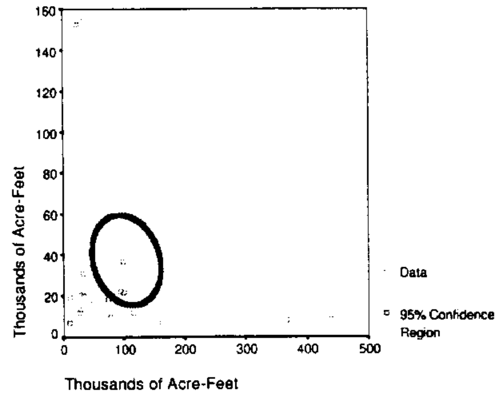


***Figure 3.26*** *March-April Inflows vs. July-August Inflows, CR.*

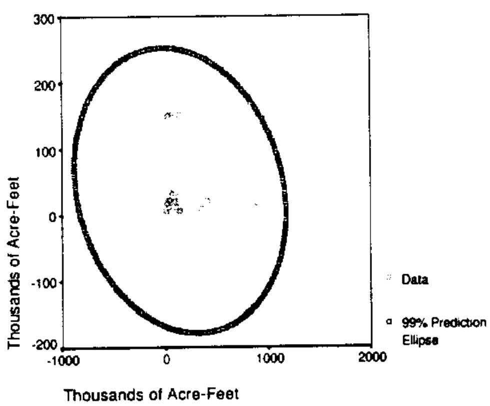


***Figure 3.27*** *March-April Inflows vs. September-October Inflows, PE.*

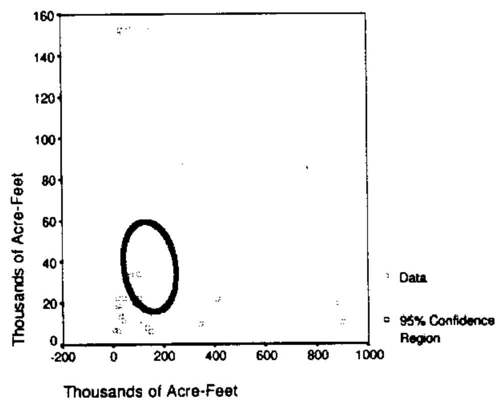


***Figure 3.28*** *March-April Inflows vs. September-October Inflows, CR.*

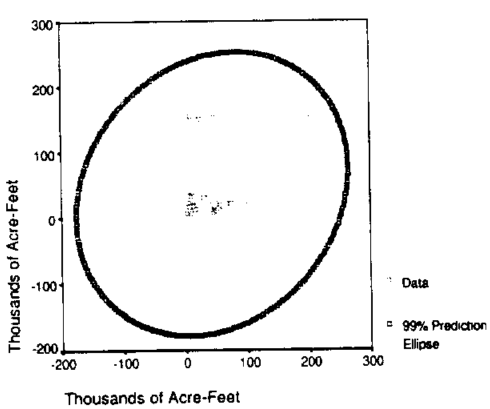


***Figure 3.29*** *March-April Inflows vs. November-December Inflows, PE.*

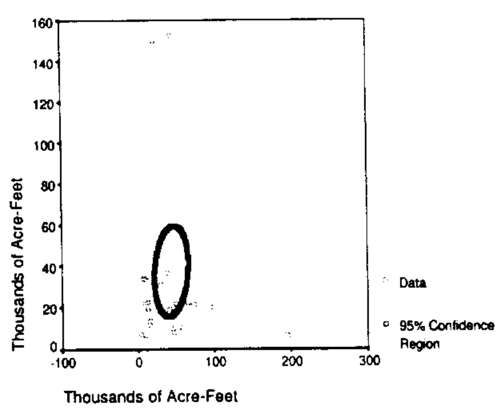


***Figure 3.30*** *March-April Inflows vs. November-December Inflows, CR.*

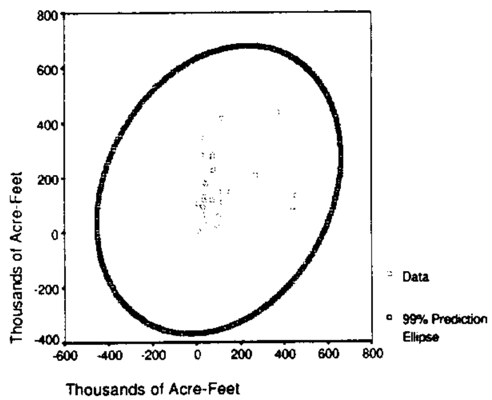


***Figure 3.31*** *May-June Inflows vs. July-August Inflows, PE.*

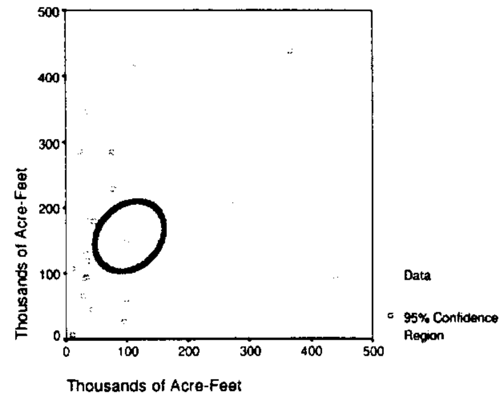


***Figure 3.32*** *May-June Inflows vs. July-August Inflows, CR.*

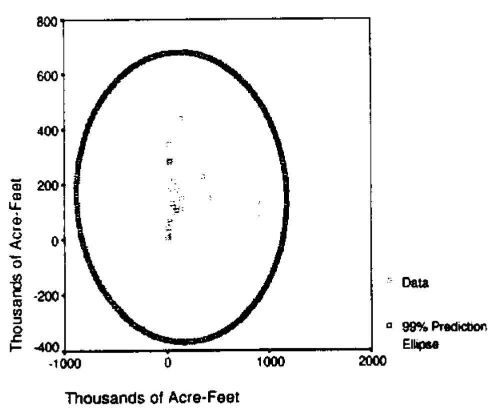


***Figure 3.33*** *May-June Inflows vs. September-October Inflows, PE.*

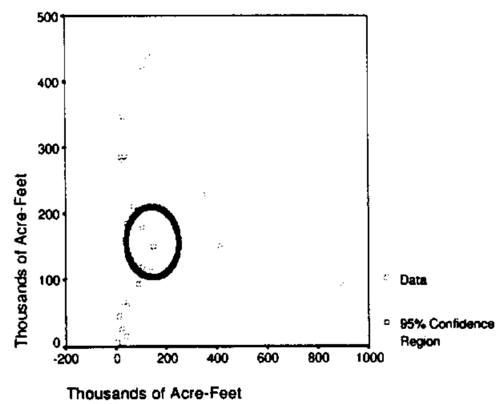


***Figure 3.34*** *May-June Inflows vs. September-October Inflows, CR.*

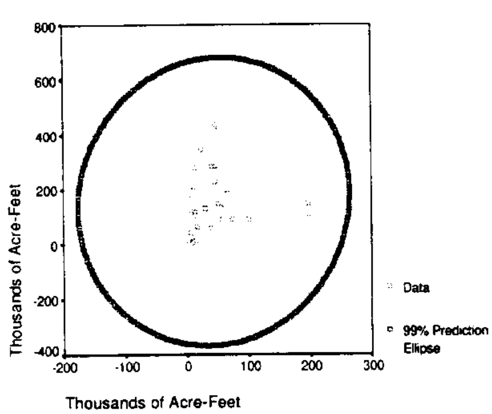


***Figure 3.35*** *May-June Inflows vs. November-December Inflows, PE.*

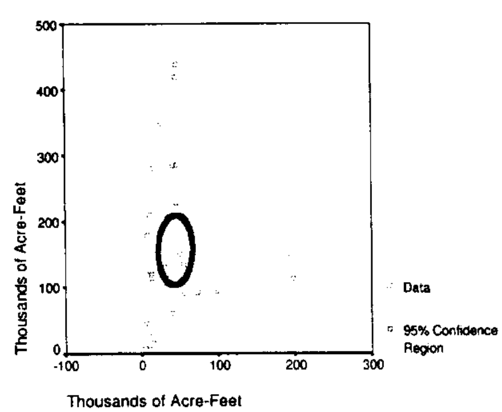


***Figure 3.36*** *May-June Inflows vs. November-December Inflows, CR.*

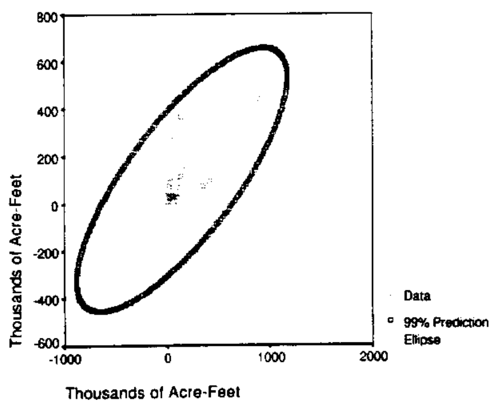


***Figure 3.37*** *July-August Inflows. vs. September-October Inflows, PE.*

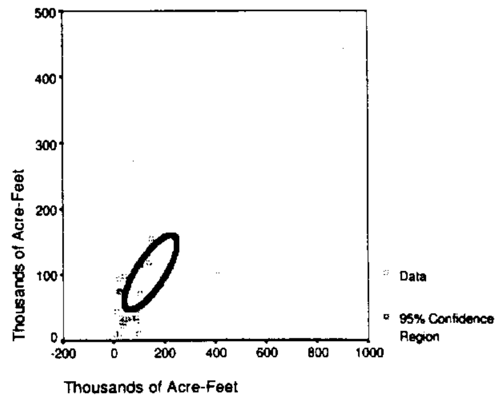


***Figure 3.38*** *July-August Inflows. vs. September-October Inflows, CR.*

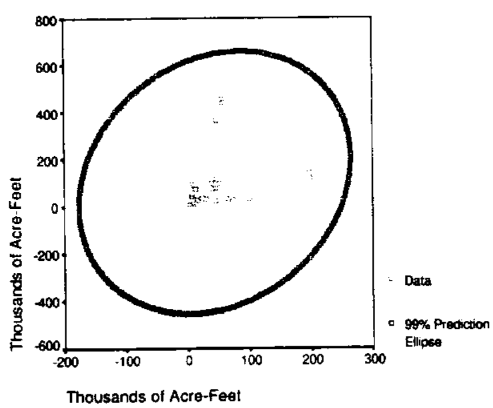


***Figure 3.39*** *July-August Inflows. vs. November-December Inflows, PE.*

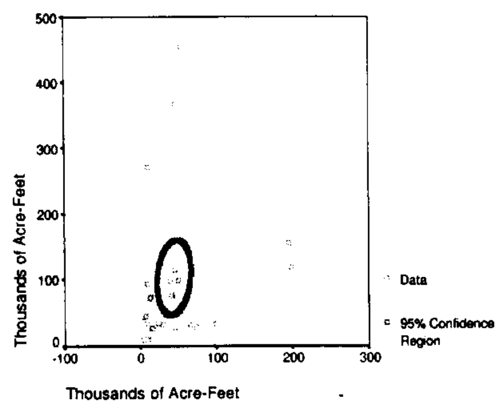


***Figure 3.40*** *July-August Inflows. vs. November-December Inflows, CR.*

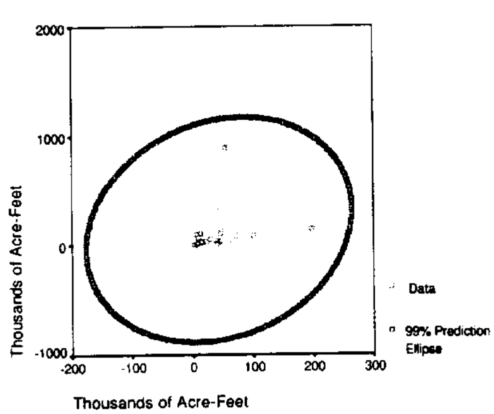


***Figure 3.41*** *September-October Inflows vs. November-December Inflows, PE.*

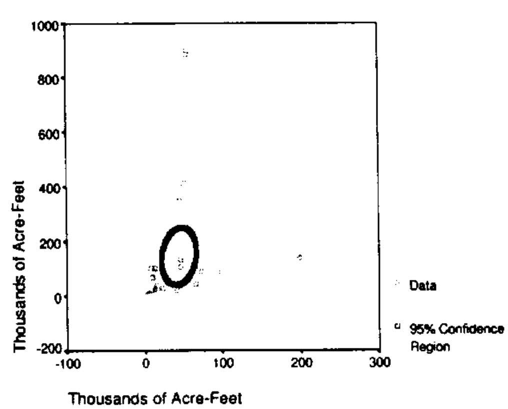


***Figure 3.42*** *September-October Inflows vs. November-December Inflows, CR.*

## 4. BOX-COX ANALYSIS

***Table .4.1*** *Mean Square Error from Box-Cox transformation of the crab data and the inflow data for different lambda.*

| Lam. | Crab | JF_inflow | MA_inflow | MJ_inflow | JA_inflow | SO_inflow | ND_inflow |
|---|---|---|---|---|---|---|---|
| -2.0 | 12881033 | 2049.2 | 1493.5 | 7353497 | 96171.0 | 462301.6 | 16809.9 |
| -1.9 | 8286247 | 1746.2 | 1293.2 | 4802808 | 74275.4 | 326276.6 | 12876.0 |
| -1.8 | 5360772 | 1496.6 | 1124.7 | 3154840 | 57643.9 | 231788.5 | 9936.9 |
| -1.7 | 3489751 | 1290.6 | 982.8 | 2085348 | 44977.4 | 165866.9 | 7731.7 |
| -1.6 | 2287330 | 1120.3 | 863.3 | 1387928 | 35304.3 | 119660.8 | 6069.5 |
| -1.5 | 1510571 | 979.3 | 762.6 | 930775.6 | 27896.5 | 87112.7 | 4810.7 |
| -1.4 | 1005987 | 862.6 | 678.0 | 629440.2 | 22207.8 | 64064.9 | 3852.7 |
| -1.3 | 676248.3 | 765.9 | 607.1 | 429616.2 | 17827.2 | 47654.4 | 3120.1 |
| -1.2 | 459391.5 | 686.1 | 547.9 | 296249.9 | 14445.3 | 35903.4 | 2557.1 |
| -1.1 | 315805.2 | 620.3 | 498.8 | 206622.1 | 11828.8 | 27440.9 | 2122.3 |
| -1.0 | 220055.2 | 566.5 | 458.6 | 145943.9 | 9801.4 | 21313.4 | 1785.3 |
| -0.9 | 155734.0 | 522.9 | 426.3 | 104544.1 | 8229.8 | 16855.3 | 1523.2 |
| -0.8 | 112205.9 | 488.3 | 401.1 | 76067.1 | 7013.2 | 13601.1 | 1318.9 |
| -0.7 | 82541.5 | 461.7 | 382.5 | 56314.6 | 6075.6 | 11224.3 | 1159.9 |
| -0.6 | 62203.7 | 442.3 | 370.2 | 42498.0 | 5359.8 | 9496.3 | 1036.7 |
| -0.5 | 48207.1 | 429.8 | 364.2 | 32754.6 | 4823.2 | 8257.5 | 942.3 |
| -0.4 | 38579.9 | 423.8 | 364.5 | 25832.6 | 4434.6 | 7398.6 | 871.7 |
| -0.3 | 32016.4 | 424.5 | 371.5 | 20885.9 | 4171.9 | 6847.3 | 821.2 |
| -0.2 | 27654.1 | 432.2 | 386.0 | 17339.1 | 4020.7 | 6559.6 | 788.4 |
| -0.1 | 24928.6 | 447.4 | 408.9 | 14799.1 | 3972.9 | 6515.7 | 772.0 |
| 0.0 | 23481.2 | 471.2 | 441.7 | 12995.8 | 4026.7 | 6717.7 | 771.6 |
| 0.1 | 23099.6 | 504.7 | 486.4 | 11743.9 | 4186.1 | 7190.2 | 787.5 |
| 0.2 | 23682.1 | 550.0 | 545.6 | 10915.9 | 4461.4 | 7984.4 | 821.3 |
| 0.3 | 25217.2 | 609.4 | 623.0 | 10425.5 | 4870.3 | 9185.0 | 875.5 |
| 0.4 | 27776.0 | 686.2 | 723.3 | 10215.8 | 5439.3 | 10922.0 | 954.1 |
| 0.5 | 31513.5 | 784.7 | 852.6 | 10251.0 | 6205.9 | 13389.6 | 1062.5 |
| 0.6 | 36679.9 | 910.5 | 1019.4 | 10512.0 | 7221.7 | 16874.1 | 1208.5 |
| 0.7 | 43641.9 | 1071.1 | 1234.7 | 10993.0 | 8557.4 | 21797.0 | 1402.9 |
| 0.8 | 52915.5 | 1276.2 | 1513.1 | 11699.5 | 10308.5 | 28779.4 | 1660.0 |
| 0.9 | 65214.6 | 1538.6 | 1874.1 | 12647.3 | 12604.4 | 38739.9 | 1999.7 |
| 1.0 | 81519.5 | 1875.0 | 2343.8 | 13862.8 | 15620.2 | 53042.8 | 2448.8 |
| 1.1 | 103173.4 | 2307.7 | 2957.0 | 15383.3 | 19593.1 | 73723.0 | 3043.8 |
| 1.2 | 132017.7 | 2866.1 | 3760.5 | 17258.5 | 24845.4 | 103830.1 | 3834.7 |
| 1.3 | 170580.6 | 3589.2 | 4817.2 | 19552.4 | 31815.8 | 147953.6 | 4889.6 |
| 1.4 | 222341.0 | 4528.8 | 6212.2 | 22345.8 | 41103.5 | 213029.7 | 6302.0 |
| 1.5 | 292098.1 | 5753.9 | 8060.1 | 25740.0 | 53528.4 | 309582.0 | 8200.2 |
| 1.6 | 386489.7 | 7356.6 | 10516.5 | 29861.4 | 70216.1 | 453636.4 | 10761.0 |
| 1.7 | 514720.0 | 9460.5 | 13792.6 | 34867.3 | 92714.9 | 669682.3 | 14228.4 |
| 1.8 | 689584.2 | 12231.0 | 18176.1 | 40953.2 | 123161.0 | 995264.2 | 18939.7 |
| 1.9 | 928913.2 | 15890.7 | 24059.2 | 48362.0 | 164507.8 | 1488117 | 25362.8 |
| 2.0 | 1257613 | 20739.1 | 31977.9 | 57396.1 | 220848.7 | 2237277 | 34147.3 |

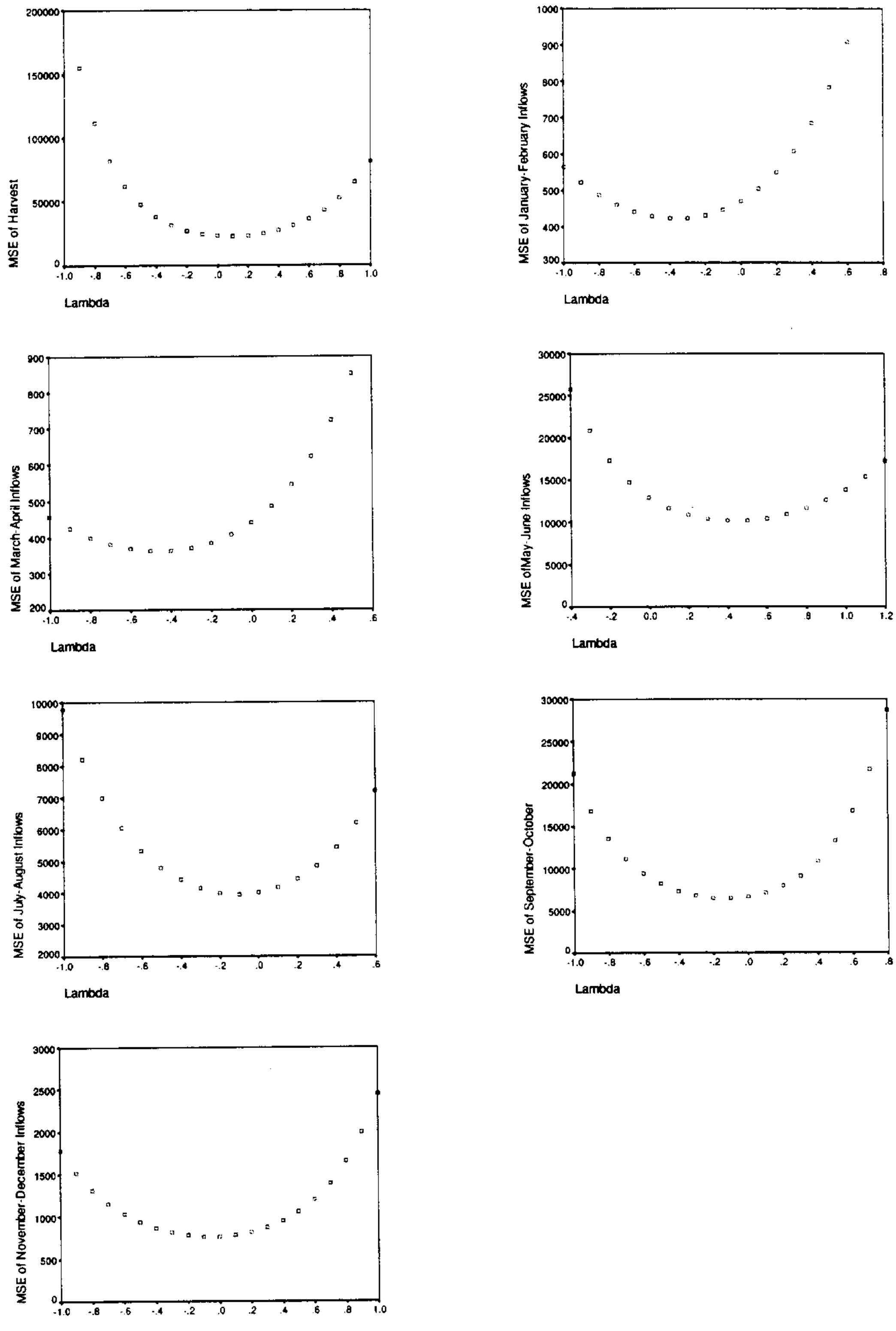


***Figure 4.1*** *Box-Cox Transformation - MSE of Crab vs. Lambda and MSE of Inflow data vs. Lambda.*

# 5. MODEL CHOICE DIAGNOSTICS

## 5.1 Untransformed crab data and untransformed inflow data

***Table 5.1*** *Regression Models for Dependent Variable: CRAB on INFLOWS*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.1026 | 0.0681 | -1.575 | 316.6 | 75972 | 319.3 | QJF_LAG |
| 1 | 0.0895 | 0.0544 | -1.247 | 317.0 | 77082 | 319.7 | QJA_LAG |
| 1 | 0.0447 | 0.0080 | -0.130 | 318.3 | 80868 | 321.0 | QMA_LAG |
| 1 | 0.0443 | 0.0076 | -0.119 | 318.4 | 80903 | 321.0 | QSO_LAG |
| 2 | 0.1531 | 0.0854 | -0.839 | 317.0 | 74558 | 321.0 | QJF_LAG QJA_LAG |
| 2 | 0.1271 | 0.0573 | -0.188 | 317.8 | 76850 | 321.8 | QJF_LAG QMJ_LAG |
| 2 | 0.1240 | 0.0539 | -0.109 | 317.9 | 77128 | 321.9 | QJF_LAG QSO_LAG |
| 2 | 0.1149 | 0.0441 | 0.117 | 318.2 | 77926 | 322.2 | QMA_LAG QJA_LAG |
| 3 | 0.1594 | 0.0543 | 1.005 | 318.8 | 77092 | 324.1 | QJF_LAG QMJ_LAG QJA_LAG |
| 3 | 0.1547 | 0.0490 | 1.123 | 318.9 | 77523 | 324.2 | QJF_LAG QJA_LAG QSO_LAG |
| 3 | 0.1533 | 0.0474 | 1.158 | 319.0 | 77652 | 324.3 | QJF_LAG QMA_LAG QJA_LAG |
| 3 | 0.1532 | 0.0474 | 1.159 | 319.0 | 77658 | 324.3 | QJF_LAG QJA_LAG QND_LAG |
| 4 | 0.1595 | 0.0133 | 3.002 | 320.8 | 80433 | 327.4 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 4 | 0.1594 | 0.0133 | 3.004 | 320.8 | 80438 | 327.4 | QJF_LAG QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.1594 | 0.0133 | 3.004 | 320.8 | 80438 | 327.4 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG |
| 4 | 0.1548 | 0.0079 | 3.119 | 320.9 | 80879 | 327.6 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG |
| 5 | 0.1596 | -.0314 | 5.001 | 322.8 | 84082 | 330.7 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.1596 | -.0315 | 5.001 | 322.8 | 84084 | 330.7 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.1595 | -.0315 | 5.003 | 322.8 | 84091 | 330.8 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.1549 | -.0372 | 5.119 | 322.9 | 84554 | 330.9 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.1596 | -.0805 | 7.000 | 324.8 | 88083 | 334.1 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 28

## 5.2 Log of crab data and untransformed inflow data

***Table 5.2*** *Regression Models for Dependent Variable: Ln(CRAB) on INFLOWS*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.1467 | 0.1139 | 2.834 | 10.51 | 1.359 | 13.17 | QJA_LAG |
| 1 | 0.0955 | 0.0608 | 4.444 | 12.14 | 1.440 | 14.80 | QJF_LAG |
| 1 | 0.0197 | -.0181 | 6.831 | 14.40 | 1.561 | 17.06 | QSO_LAG |
| 1 | 0.0162 | -.0217 | 6.941 | 14.50 | 1.567 | 17.16 | QMJ_LAG |
| 2 | 0.2082 | 0.1449 | 2.901 | 10.41 | 1.311 | 14.41 | QJA_LAG QSO_LAG |
| 2 | 0.1946 | 0.1301 | 3.330 | 10.89 | 1.334 | 14.89 | QJF_LAG QJA_LAG |
| 2 | 0.1712 | 0.1049 | 4.064 | 11.69 | 1.372 | 15.69 | QJA_LAG QND_LAG |
| 2 | 0.1658 | 0.0991 | 4.234 | 11.88 | 1.381 | 15.87 | QJF_LAG QMJ_LAG |
| 3 | 0.2585 | 0.1658 | 3.321 | 10.58 | 1.279 | 15.91 | QJF_LAG QJA_LAG QSO_LAG |
| 3 | 0.2291 | 0.1328 | 4.243 | 11.66 | 1.330 | 16.99 | QJF_LAG QMA_LAG QJA_LAG |
| 3 | 0.2288 | 0.1324 | 4.254 | 11.68 | 1.330 | 17.01 | QJA_LAG QSO_LAG QND_LAG |
| 3 | 0.2201 | 0.1227 | 4.526 | 11.99 | 1.345 | 17.32 | QJF_LAG QMJ_LAG QJA_LAG |
| 4 | 0.2910 | 0.1676 | 4.299 | 11.32 | 1.276 | 17.99 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG |
| 4 | 0.2765 | 0.1507 | 4.753 | 11.89 | 1.302 | 18.55 | QJF_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.2686 | 0.1414 | 5.003 | 12.19 | 1.317 | 18.86 | QJF_LAG QMA_LAG QJA_LAG QND_LAG |
| 4 | 0.2636 | 0.1355 | 5.159 | 12.38 | 1.326 | 19.05 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.3247 | 0.1712 | 5.239 | 11.96 | 1.271 | 19.95 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.2977 | 0.1381 | 6.086 | 13.06 | 1.322 | 21.05 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.2971 | 0.1374 | 6.105 | 13.08 | 1.323 | 21.07 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.2819 | 0.1186 | 6.585 | 13.68 | 1.351 | 21.67 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.3323 | 0.1415 | 7.000 | 13.64 | 1.316 | 22.97 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 28

## 5.3 Log of crab data and log of inflow data

***Table 5.3*** *Regression Models for Dependent Variable: Ln(CRAB) on Ln(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.1146 | 0.0806 | 1.700 | 11.54 | 1.410 | 14.21 | LN_QJA |
| 1 | 0.0578 | 0.0216 | 3.349 | 13.28 | 1.500 | 15.95 | LN_QSO |
| 1 | 0.0305 | -.0068 | 4.143 | 14.09 | 1.544 | 16.75 | LN_QJF |
| 1 | 0.0249 | -.0126 | 4.303 | 14.24 | 1.553 | 16.91 | LN_QMJ |
| 2 | 0.2239 | 0.1618 | 0.527 | 9.853 | 1.285 | 13.85 | LN_QJA LN_QND |
| 2 | 0.1826 | 0.1172 | 1.727 | 11.31 | 1.354 | 15.30 | LN_QSO LN_QND |
| 2 | 0.1303 | 0.0608 | 3.244 | 13.04 | 1.440 | 17.04 | LN_QJF LN_QJA |
| 2 | 0.1176 | 0.0470 | 3.613 | 13.45 | 1.461 | 17.44 | LN_QMA LN_QJA |
| 3 | 0.2587 | 0.1661 | 1.517 | 10.57 | 1.279 | 15.90 | LN_QJA LN_QSO LN_QND |
| 3 | 0.2355 | 0.1400 | 2.191 | 11.43 | 1.319 | 16.76 | LN_QMJ LN_QJA LN_QND |
| 3 | 0.2255 | 0.1287 | 2.481 | 11.80 | 1.336 | 17.12 | LN_QJF LN_QJA LN_QND |
| 3 | 0.2242 | 0.1272 | 2.520 | 11.84 | 1.338 | 17.17 | LN_QMA LN_QJA LN_QND |
| 4 | 0.2689 | 0.1417 | 3.222 | 12.18 | 1.316 | 18.84 | LN_QMJ LN_QJA LN_QSO LN_QND |
| 4 | 0.2588 | 0.1299 | 3.516 | 12.57 | 1.334 | 19.23 | LN_QMA LN_QJA LN_QSO LN_QND |
| 4 | 0.2587 | 0.1298 | 3.517 | 12.57 | 1.334 | 19.23 | LN_QJF LN_QJA LN_QSO LN_QND |
| 4 | 0.2528 | 0.1229 | 3.688 | 12.79 | 1.345 | 19.45 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 5 | 0.2761 | 0.1116 | 5.013 | 13.91 | 1.362 | 21.90 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.2717 | 0.1062 | 5.141 | 14.07 | 1.371 | 22.07 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.2588 | 0.0903 | 5.516 | 14.57 | 1.395 | 22.56 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.2531 | 0.0833 | 5.682 | 14.78 | 1.406 | 22.78 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 6 | 0.2765 | 0.0698 | 7.000 | 15.89 | 1.426 | 25.21 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 28

## 5.4 Log of crab data and square root of inflow data

***Table 5.4*** *Regression Models for Dependent Variable: Ln(CRAB) on Sqrt(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.1442 | 0.1113 | 0.514 | 10.59 | 1.363 | 13.26 | SQR_QJA |
| 1 | 0.0638 | 0.0278 | 2.817 | 13.11 | 1.491 | 15.77 | SQR_QJF |
| 1 | 0.0391 | 0.0021 | 3.524 | 13.83 | 1.530 | 16.50 | SQR_QSO |
| 1 | 0.0202 | -.0175 | 4.065 | 14.38 | 1.560 | 17.04 | SQR_QMJ |
| 2 | 0.2078 | 0.1444 | 0.692 | 10.43 | 1.312 | 14.43 | SQR_QJA SQR_QND |
| 2 | 0.1695 | 0.1030 | 1.789 | 11.75 | 1.375 | 15.75 | SQR_QJF SQR_QJA |
| 2 | 0.1561 | 0.0886 | 2.171 | 12.20 | 1.397 | 16.19 | SQR_QJA SQR_QSO |
| 2 | 0.1445 | 0.0761 | 2.505 | 12.58 | 1.417 | 16.58 | SQR_QMJ SQR_QJA |
| 3 | 0.2224 | 0.1252 | 2.275 | 11.91 | 1.341 | 17.24 | SQR_QJF SQR_QJA SQR_QND |
| 3 | 0.2112 | 0.1126 | 2.594 | 12.31 | 1.361 | 17.64 | SQR_QMJ SQR_QJA SQR_QND |
| 3 | 0.2107 | 0.1121 | 2.608 | 12.33 | 1.362 | 17.65 | SQR_QJA SQR_QSO SQR_QND |
| 3 | 0.2100 | 0.1113 | 2.628 | 12.35 | 1.363 | 17.68 | SQR_QMA SQR_QJA SQR_QND |
| 4 | 0.2443 | 0.1129 | 3.647 | 13.11 | 1.360 | 19.77 | SQR_QJF SQR_QMJ SQR_QJA SQR_QND |
| 4 | 0.2424 | 0.1106 | 3.701 | 13.18 | 1.364 | 19.84 | SQR_QJF SQR_QMA SQR_QJA SQR_QND |
| 4 | 0.2270 | 0.0926 | 4.142 | 13.74 | 1.391 | 20.40 | SQR_QJF SQR_QJA SQR_QSO SQR_QND |
| 4 | 0.2132 | 0.0764 | 4.537 | 14.24 | 1.416 | 20.90 | SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.2649 | 0.0978 | 5.057 | 14.34 | 1.383 | 22.33 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QND |
| 5 | 0.2466 | 0.0754 | 5.580 | 15.02 | 1.418 | 23.02 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.2466 | 0.0754 | 5.581 | 15.02 | 1.418 | 23.02 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.2141 | 0.0355 | 6.511 | 16.21 | 1.479 | 24.20 | SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 6 | 0.2669 | 0.0574 | 7.000 | 16.26 | 1.445 | 25.59 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

N = 28

## 5.5 Square root of crab data and log of inflow data

***Table 5.5*** *Regression Models for Dependent Variable: Sqrt(CRAB) on Ln(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.1128 | 0.0786 | 0.267 | 115.9 | 58.66 | 118.6 | LN_QJA |
| 1 | 0.0783 | 0.0428 | 1.211 | 117.0 | 60.94 | 119.7 | LN_QSO |
| 1 | 0.0246 | -.0129 | 2.679 | 118.6 | 64.49 | 121.3 | LN_QJF |
| 1 | 0.0242 | -.0134 | 2.690 | 118.6 | 64.52 | 121.3 | LN_QMJ |
| 2 | 0.1706 | 0.1043 | 0.685 | 116.0 | 57.03 | 120.0 | LN_QJA LN_QND |
| 2 | 0.1582 | 0.0909 | 1.024 | 116.5 | 57.88 | 120.5 | LN_QSO LN_QND |
| 2 | 0.1274 | 0.0576 | 1.867 | 117.5 | 60.00 | 121.5 | LN_QMA LN_QJA |
| 2 | 0.1244 | 0.0543 | 1.949 | 117.6 | 60.21 | 121.6 | LN_QJF LN_QJA |
| 3 | 0.2122 | 0.1137 | 1.548 | 116.6 | 56.43 | 121.9 | LN_QJA LN_QSO LN_QND |
| 3 | 0.1793 | 0.0768 | 2.446 | 117.7 | 58.78 | 123.1 | LN_QMA LN_QJA LN_QND |
| 3 | 0.1764 | 0.0735 | 2.525 | 117.8 | 58.99 | 123.2 | LN_QMJ LN_QJA LN_QND |
| 3 | 0.1754 | 0.0723 | 2.553 | 117.9 | 59.06 | 123.2 | LN_QMJ LN_QSO LN_QND |
| 4 | 0.2191 | 0.0833 | 3.359 | 118.4 | 58.36 | 125.0 | LN_QMA LN_QJA LN_QSO LN_QND |
| 4 | 0.2169 | 0.0807 | 3.419 | 118.4 | 58.53 | 125.1 | LN_QMJ LN_QJA LN_QSO LN_QND |
| 4 | 0.2122 | 0.0752 | 3.547 | 118.6 | 58.88 | 125.3 | LN_QJF LN_QJA LN_QSO LN_QND |
| 4 | 0.2014 | 0.0626 | 3.841 | 119.0 | 59.68 | 125.6 | LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.2320 | 0.0574 | 5.007 | 119.9 | 60.01 | 127.9 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.2212 | 0.0441 | 5.302 | 120.3 | 60.86 | 128.3 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.2209 | 0.0438 | 5.310 | 120.3 | 60.88 | 128.3 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.2057 | 0.0252 | 5.725 | 120.8 | 62.06 | 128.8 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 6 | 0.2322 | 0.0128 | 7.000 | 121.9 | 62.85 | 131.2 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 28

## 5.6 Various transformation suggested by Box-Cox

***Table 5.6*** *Regression Models for Dependent Variable: $(CRAB)^{0.3}$ on variously transformed INFLOWS.*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.1075 | 0.0732 | 1.798 | -90.65 | 0.0366 | -87.99 | QR_QJA |
| 1 | 0.0628 | 0.0268 | 3.091 | -89.29 | 0.0385 | -86.62 | QR_QSO |
| 1 | 0.0201 | -.0176 | 4.325 | -88.04 | 0.0402 | -85.37 | LN_QND |
| 1 | 0.0180 | -.0198 | 4.386 | -87.98 | 0.0403 | -85.31 | QR_QMJ |
| 2 | 0.2068 | 0.1433 | 0.929 | -91.96 | 0.0339 | -87.96 | QR_QJA LN_QND |
| 2 | 0.1879 | 0.1229 | 1.475 | -91.30 | 0.0347 | -87.30 | QR_QSO LN_QND |
| 2 | 0.1184 | 0.0479 | 3.483 | -89.00 | 0.0376 | -85.00 | QR_QMA QR_QJA |
| 2 | 0.1160 | 0.0453 | 3.552 | -88.92 | 0.0377 | -84.93 | QR_QJF QR_QJA |
| 3 | 0.2555 | 0.1625 | 1.520 | -91.73 | 0.0331 | -86.40 | QR_QJA QR_QSO LN_QND |
| 3 | 0.2142 | 0.1160 | 2.715 | -90.22 | 0.0350 | -84.89 | QR_QMA QR_QJA LN_QND |
| 3 | 0.2110 | 0.1124 | 2.807 | -90.11 | 0.0351 | -84.78 | QR_QMJ QR_QJA LN_QND |
| 3 | 0.2076 | 0.1085 | 2.906 | -89.98 | 0.0353 | -84.66 | QR_QMJ QR_QSO LN_QND |
| 4 | 0.2628 | 0.1346 | 3.309 | -90.01 | 0.0342 | -83.35 | QR_QMA QR_QJA QR_QSO LN_QND |
| 4 | 0.2600 | 0.1313 | 3.391 | -89.90 | 0.0344 | -83.24 | QR_QMJ QR_QJA QR_QSO LN_QND |
| 4 | 0.2561 | 0.1267 | 3.505 | -89.75 | 0.0345 | -83.09 | QR_QJF QR_QJA QR_QSO LN_QND |
| 4 | 0.2269 | 0.0924 | 4.349 | -88.67 | 0.0359 | -82.01 | QR_QMA QR_QMJ QR_QSO LN_QND |
| 5 | 0.2723 | 0.1069 | 5.034 | -88.37 | 0.0353 | -80.38 | QR_QMA QR_QMJ QR_QJA QR_QSO LN_QND |
| 5 | 0.2689 | 0.1027 | 5.134 | -88.24 | 0.0355 | -80.24 | QR_QJF QR_QMA QR_QJA QR_QSO LN_QND |
| 5 | 0.2603 | 0.0921 | 5.383 | -87.91 | 0.0359 | -79.92 | QR_QJF QR_QMJ QR_QJA QR_QSO LN_QND |
| 5 | 0.2271 | 0.0515 | 6.340 | -86.68 | 0.0375 | -78.69 | QR_QJF QR_QMA QR_QMJ QR_QSO LN_QND |
| 6 | 0.2735 | 0.0659 | 7.000 | -86.42 | 0.0369 | -77.09 | QR_QJF QR_QMA QR_QMJ QR_QJA |

N = 28

Dependent Variable: $(CRAB)^{0.1}$

Independent Variables:
*QR_QJF*=$(\text{January-February Inflows})^{-0.4}$
*QR_QMA*=$(\text{March-April Inflows})^{-0.5}$
*QR_QMJ*=$(\text{May-June Inflows})^{0.4}$
*QR_QMJ*=$(\text{July-August Inflows})^{-0.1}$
*QR_QND*=$(\text{September-October Inflows})^{-0.1}$

# 6. Regression for the Best Models

## 6.1 Regression - Log of crab data on inflow data

### 6.1.1 ANOVA and Parameter Estimates

***Table 6.1*** *Model Summary for log of crabdata on inflow data.*

**Model Summary[a,b]**

| Model | Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|
| 1 | November-December Inflows, January-February Inflows, September-October Inflows, May-June Inflows, March-April Inflows, July-August Inflows[c,d] | .576 | .332 | .141 | 1.14738 | 1.200 |

a. Dependent Variable: Ln(Crab Harvest)

b. Method: Enter

c. Independent Variables: (Constant), November-December Inflows, January-February Inflows, September-October Inflows, May-June Inflows, March-April Inflows, July-August Inflows

d. All requested variables entered.

***Table 6.2*** *ANOVA table of log of crab data on inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 13.756 | 6 | 2.293 | 1.742 | .161[b] |
| | Residual | 27.646 | 21 | 1.316 | | |
| | Total | 41.402 | 27 | | | |

a. Dependent Variable: Ln(Crab Harvest)

b. Independent Variables: (Constant), November-December Inflows, January-February Inflows, September-October Inflows, May-June Inflows, March-April Inflows, July-August Inflows

***Table 6.3*** *Table of coefficients for log of crabdata on inflow data.*

**Coefficients**[a]

| | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| (Constant) | 4.916 | .448 | | 10.982 | .000 | 3.985 | 5.847 |
| January-February | 1.3E-02 | .007 | .452 | 1.759 | .093 | -.002 | .028 |
| March-April | -7.5E-03 | .006 | -.294 | -1.259 | .222 | -.020 | .005 |
| May-June | -1.2E-03 | .002 | -.109 | -.489 | .630 | -.006 | .004 |
| July-August | -5.8E-03 | .003 | -.581 | -1.756 | .094 | -.013 | .001 |
| September-October | 1.7E-03 | .002 | .320 | 1.051 | .305 | -.002 | .005 |
| November-December | 4.9E-03 | .005 | .195 | 1.042 | .309 | -.005 | .015 |

a. Dependent Variable: Ln(Crab Harvest)

## 6.1.2 Collinearity Diagnostic

***Table 6.4*** *Variance Inflation for log of crabdata on inflow data.*

**Coefficients**[a]

| | t | Collinearity Statistics | |
|---|---|---|---|
| | | Tolerance | VIF |
| (Constant) | 10.982 | | |
| January-February | 1.759 | .481 | 2.078 |
| March-April | -1.259 | .584 | 1.711 |
| May-June | -.489 | .634 | 1.577 |
| July-August | -1.756 | .291 | 3.438 |
| September-October | 1.051 | .343 | 2.919 |
| November-December | 1.042 | .903 | 1.107 |

a. Dependent Variable: Ln(Crab Harvest)

***Table 6.5*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: LN(CRAB) on INFLOWS.*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *QJF_LAG* | Var Prop *QMA_LAG* | Var Prop *QMJ_LAG* | Var Prop *QJA_LAG* | Var Prop *QSO_LAG* | Var Prop *QND_LAG* |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.14142 | 1.00000 | 0.0539 | 0.0501 | 0.0055 | 0.0371 | 0.0440 | 0.0041 |
| 2 | 1.66142 | 1.13530 | 0.0446 | 0.0580 | 0.0989 | 0.0310 | 0.0245 | 0.0686 |
| 3 | 0.98439 | 1.47492 | 0.0068 | 0.0430 | 0.1771 | 0.0088 | 0.0000 | 0.5588 |
| 4 | 0.71436 | 1.73138 | 0.0472 | 0.1416 | 0.2954 | 0.0030 | 0.0935 | 0.2806 |
| 5 | 0.34286 | 2.49914 | 0.6370 | 0.6793 | 0.0372 | 0.0325 | 0.0563 | 0.0869 |
| 6 | 0.15554 | 3.71042 | 0.2105 | 0.0279 | 0.3860 | 0.8877 | 0.7817 | 0.0011 |

### 6.1.3 Residuals Diagnostics

***Table 6.6*** *Residuals Diagnostics for log of crabdata on inflow data.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 2.91694 | 6.47902 | 4.81823 | .71378 | 28 |
| Std. Predicted Value | -2.664 | 2.327 | .000 | 1.000 | 28 |
| Standard Error of Predicted Value | .27451 | .89405 | .54218 | .19097 | 28 |
| Adjusted Predicted Value | 3.43511 | 7.66659 | 4.90398 | .81936 | 28 |
| Residual | -1.91865 | 2.10375 | 3.2E-16 | 1.01189 | 28 |
| Std. Residual | -1.672 | 1.834 | .000 | .882 | 28 |
| Stud. Residual | -2.229 | 1.989 | -.030 | 1.041 | 28 |
| Deleted Residual | -3.40984 | 2.47599 | -8.6E-02 | 1.43942 | 28 |
| Stud. Deleted Residual | -2.490 | 2.155 | -.033 | 1.091 | 28 |
| Mahal. Distance | .581 | 15.429 | 5.786 | 4.522 | 28 |
| Cook's Distance | .000 | .552 | .068 | .125 | 28 |
| Centered Leverage Value | .022 | .571 | .214 | .167 | 28 |

a. Dependent Variable: Ln(Crab Harvest)

***Table 6.7** Case Values for Residuals Diagnostics for log of crab data on inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 5.4387 | -1.0174 | -1.2875 | 5.7088 | .8693 | -.8868 | -.9975 | -.9974 |
| 1963 | 4.9111 | -1.0978 | -1.2665 | 5.0798 | .1302 | -.9568 | -1.0277 | -1.0291 |
| 1965 | 5.2997 | -.5662 | -.6192 | 5.3527 | .6746 | -.4934 | -.5160 | -.5068 |
| 1969 | 6.4790 | -1.4538 | -2.6414 | 7.6666 | 2.3267 | -1.2671 | -1.7079 | -1.7962 |
| 1971 | 3.9572 | .6529 | 1.1750 | 3.4351 | -1.2062 | .5690 | .7634 | .7556 |
| 1972 | 4.3324 | -.0739 | -.1431 | 4.4016 | -.6807 | -.0644 | -.0897 | -.0875 |
| 1973 | 5.2633 | -1.5473 | -2.0705 | 5.7865 | .6236 | -1.3486 | -1.5600 | -1.6191 |
| 1974 | 5.1649 | .6226 | .7908 | 4.9967 | .4857 | .5426 | .6115 | .6022 |
| 1975 | 4.7537 | .0810 | .0859 | 4.7488 | -.0904 | .0706 | .0727 | .0710 |
| 1976 | 5.2002 | -.3815 | -.7167 | 5.5354 | .5351 | -.3325 | -.4557 | -.4470 |
| 1977 | 4.7150 | -.0822 | -.2093 | 4.8421 | -.1446 | -.0717 | -.1143 | -.1116 |
| 1978 | 4.1487 | -1.9187 | -3.4098 | 5.6399 | -.9380 | -1.6722 | -2.2292 | -2.4900 |
| 1979 | 4.5337 | -.6118 | -.7064 | 4.6284 | -.3986 | -.5332 | -.5729 | -.5636 |
| 1980 | 3.2625 | -.4060 | -.5959 | 3.4523 | -2.1796 | -.3538 | -.4287 | -.4202 |
| 1981 | 2.9169 | -.8757 | -1.8660 | 3.9073 | -2.6637 | -.7632 | -1.1141 | -1.1209 |
| 1982 | 4.5625 | .3905 | .5638 | 4.3892 | -.3583 | .3404 | .4090 | .4007 |
| 1983 | 5.1701 | .2758 | .3021 | 5.1438 | .4930 | .2403 | .2516 | .2459 |
| 1984 | 5.0852 | -.7532 | -.8472 | 5.1792 | .3741 | -.6564 | -.6962 | -.6874 |
| 1985 | 5.2886 | -.3998 | -.4378 | 5.3267 | .6590 | -.3484 | -.3646 | -.3570 |
| 1986 | 5.2957 | 1.4810 | 1.7085 | 5.0682 | .6689 | 1.2908 | 1.3864 | 1.4195 |
| 1987 | 4.7409 | .8486 | .9585 | 4.6310 | -.1084 | .7396 | .7860 | .7786 |
| 1988 | 4.5880 | .7242 | .8264 | 4.4859 | -.3225 | .6312 | .6742 | .6652 |
| 1989 | 4.9877 | 1.8672 | 2.1371 | 4.7178 | .2374 | 1.6274 | 1.7410 | 1.8368 |
| 1990 | 4.3968 | 2.1037 | 2.4760 | 4.0246 | -.5904 | 1.8335 | 1.9891 | 2.1548 |
| 1991 | 4.4246 | .2957 | .3300 | 4.3903 | -.5515 | .2577 | .2723 | .2662 |
| 1992 | 5.6917 | .5396 | .8467 | 5.3846 | 1.2237 | .4703 | .5891 | .5797 |
| 1993 | 5.4952 | 1.3858 | 2.3051 | 4.5759 | .9485 | 1.2078 | 1.5577 | 1.6164 |
| 1994 | 4.8063 | -.0833 | -.0896 | 4.8126 | -.0167 | -.0726 | -.0753 | -.0735 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that observation |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.
[2]This is flagged if it exceeds $t_{n-p-2,\alpha}=t_{12,0.01}=2.681$.

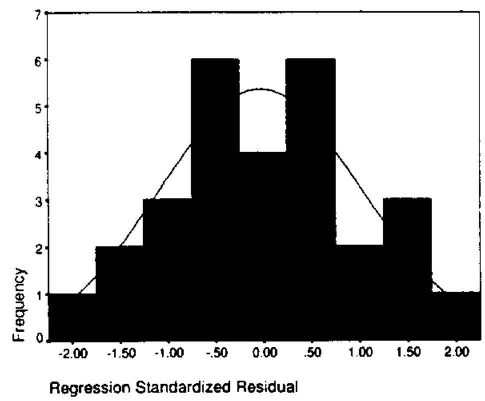


***Figure 6.1*** *Histogram of Standardized Residuals.*

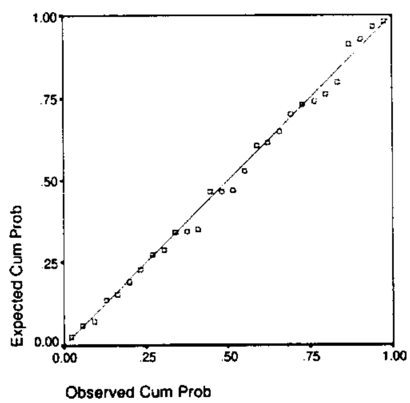


***Figure 6.2*** *Normal P-P Plot of Residuals.*

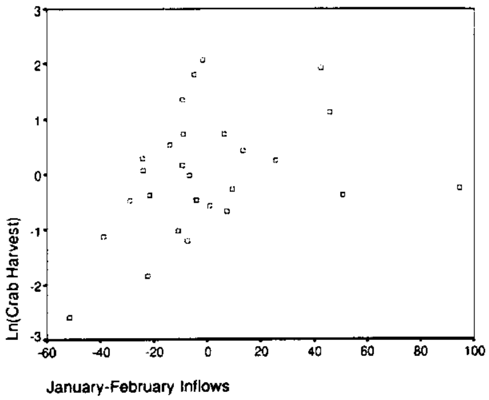


***Figure 6.3*** *Partial Residual Plot for January-February Inflows.*

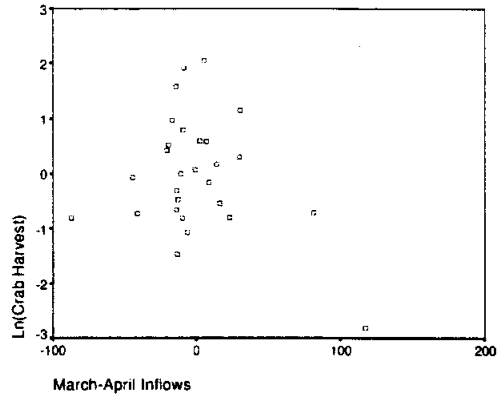


***Figure 6.4*** *Partial Residual Plot for March-April Inflows.*

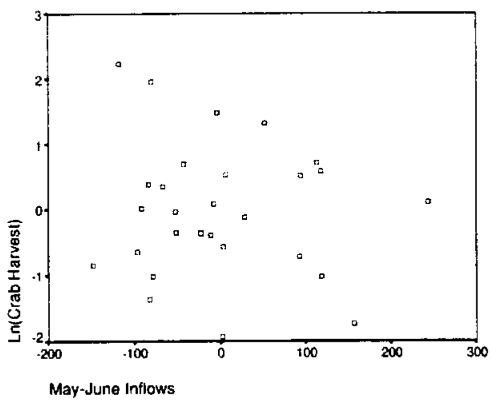


***Figure 6.5*** *Partial Residual Plot for May-June Inflows.*

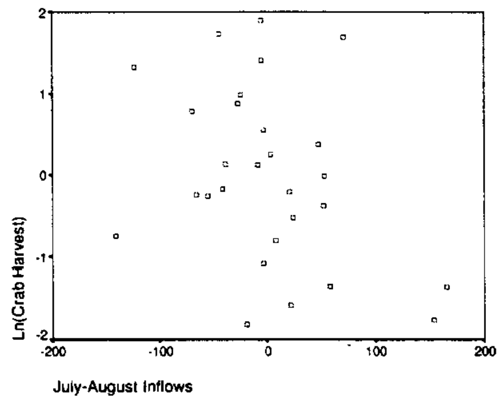


***Figure 6.6*** *Partial Residual Plot for July-August Inflows.*

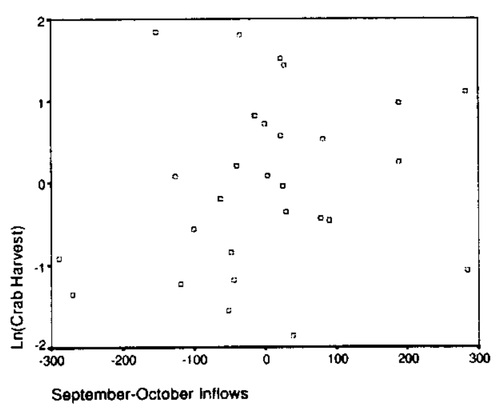


***Figure 6.7*** *Partial Residual Plot for September-October Inflows.*

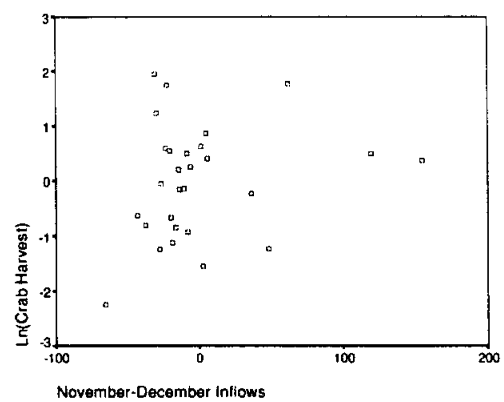


***Figure 6.8*** *Partial Residual Plot for November-December Inflows.*

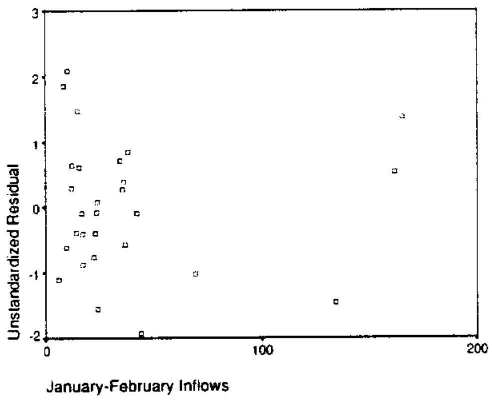


***Figure 6.9*** *Residuals Plot for January-February Inflows.*

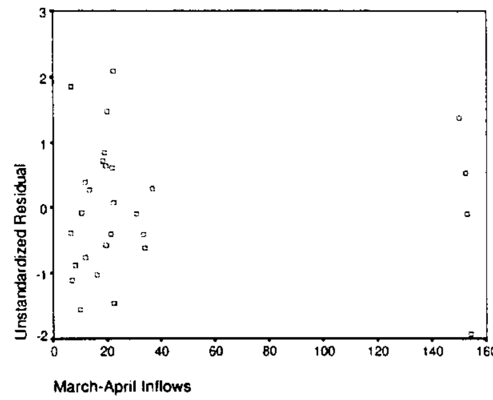


***Figure 6.10*** *Residuals Plot for March-April Inflows.*

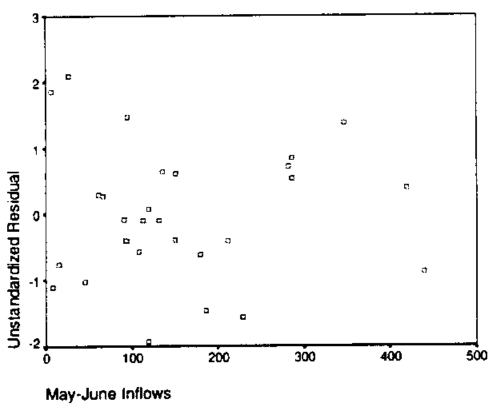


***Figure 6.11*** *Residuals Plot for May-June Inflows.*

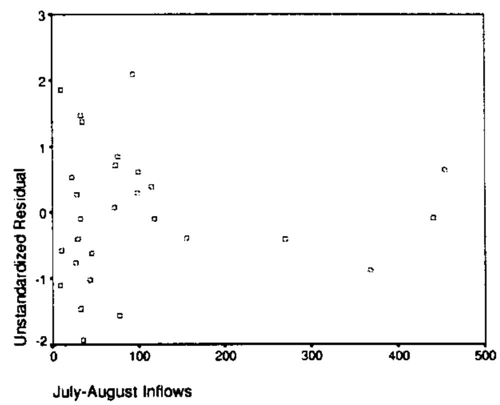


***Figure 6.12*** *Residuals Plot for July-August Inflows.*

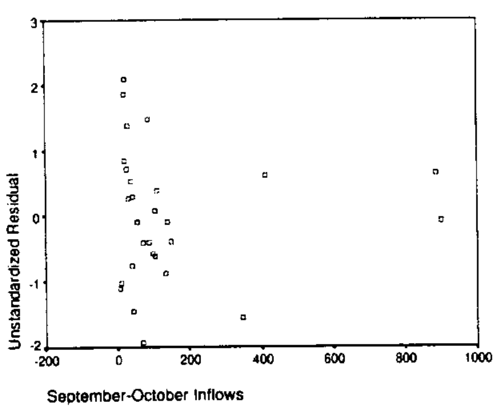


***Figure 6.13*** *Residuals Plot for September-October Inflows.*

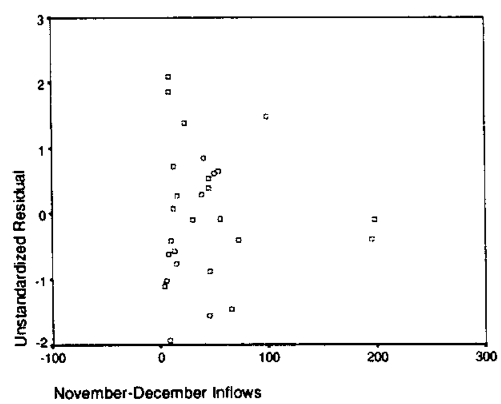


***Figure 6.14*** *Residuals Plot for November-December Inflows.*

### 6.1.4 Prediction Intervals for Crab Harvest

***Table 6.8*** *Prediction Intervals for Crab Harvest.*

| YEAR | *LICI_1* | *LN_CRAB* | *UICI_1* |
|---|---|---|---|
| 1962 | 1.8655 | 4.4212 | 9.0119 |
| 1963 | 1.4529 | 3.8133 | 8.3694 |
| 1965 | 1.9149 | 4.7336 | 8.6846 |
| 1969 | 2.5677 | 5.0252 | 10.3904 |
| 1971 | .0530 | 4.6102 | 7.8615 |
| 1972 | .3756 | 4.2584 | 8.2892 |
| 1973 | 1.6274 | 3.7160 | 8.8993 |
| 1974 | 1.5874 | 5.7875 | 8.7425 |
| 1975 | 1.4134 | 4.8347 | 8.0940 |
| 1976 | 1.2645 | 4.8187 | 9.1358 |
| 1977 | .5966 | 4.6328 | 8.8334 |
| 1978 | .2539 | 2.2300 | 8.0434 |
| 1979 | 1.0743 | 3.9220 | 7.9932 |
| 1980 | -.4681 | 2.8565 | 6.9930 |
| 1981 | -1.1023 | 2.0412 | 6.9362 |
| 1982 | .8480 | 4.9530 | 8.2769 |
| 1983 | 1.7829 | 5.4459 | 8.5573 |
| 1984 | 1.6611 | 4.3320 | 8.5093 |
| 1985 | 1.9019 | 4.8888 | 8.6754 |
| 1986 | 1.8375 | 6.7767 | 8.7538 |
| 1987 | 1.3111 | 5.5895 | 8.1706 |
| 1988 | 1.1444 | 5.3122 | 8.0316 |
| 1989 | 1.5400 | 6.8549 | 8.4354 |
| 1990 | .9125 | 6.5005 | 7.8811 |
| 1991 | 1.0115 | 4.7203 | 7.8376 |
| 1992 | 1.8994 | 6.2313 | 9.4841 |
| 1993 | 1.6530 | 6.8810 | 9.3375 |
| 1994 | 1.4456 | 4.7230 | 8.1670 |

*LICI_1* Lower limit for 99% prediction interval for the log of crab harvest.

*LN_CRAB* Log of crab harvest

*UICI_1* Upper limit for 99% prediction interval for the log of crab harvest.

### 6.1.5 Outliers and Influential Point Detection

***Table 6.9*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1962 | 4.6997 | .0377 | .1741 | .6966 | .0001 |
| 1963 | 2.6322 | .0232 | .0975 | .9168 | .0000 |
| 1965 | 1.3476 | .0036 | .0499 | .9871 | .0000 |
| 1969 | 11.1749 | .3404 | .4139 | .1312 | .0740 |
| 1971 | 11.0333 | .0666 | .4086 | .1372 | .0006 |
| 1972 | 12.0898 | .0011 | .4478 | .0976 | .0000 |
| 1973 | 5.8578 | .1175 | .2170 | .5564 | .0037 |
| 1974 | 4.7796 | .0144 | .1770 | .6868 | .0000 |
| 1975 | .5812 | .0000 | .0215 | .9991 | .0000 |
| 1976 | 11.6629 | .0261 | .4320 | .1122 | .0000 |
| 1977 | 15.4292 | .0029 | *.5715 | *.0309 | .0000 |
| 1978 | 10.8433 | .5518 | .4016 | .1456 | .2143 |
| 1979 | 2.6533 | .0073 | .0983 | .9151 | .0000 |
| 1980 | 7.6403 | .0123 | .2830 | .3654 | .0000 |
| 1981 | 13.3648 | .2005 | .4950 | .0637 | .0182 |
| 1982 | 7.3337 | .0106 | .2716 | .3950 | .0000 |
| 1983 | 1.3885 | .0009 | .0514 | .9859 | .0000 |
| 1984 | 2.0308 | .0086 | .0752 | .9581 | .0000 |
| 1985 | 1.3807 | .0018 | .0511 | .9862 | .0000 |
| 1986 | 2.6304 | .0422 | .0974 | .9170 | .0001 |
| 1987 | 2.1295 | .0114 | .0789 | .9523 | .0000 |
| 1988 | 2.3739 | .0092 | .0879 | .9363 | .0000 |
| 1989 | 2.4457 | .0626 | .0906 | .9311 | .0005 |
| 1990 | 3.0949 | .1000 | .1146 | .8761 | .0022 |
| 1991 | 1.8379 | .0012 | .0681 | .9683 | .0000 |
| 1992 | 8.8297 | .0282 | .3270 | .2651 | .0000 |
| 1993 | 9.8040 | .2300 | .3631 | .2000 | .0267 |
| 1994 | .9302 | .0001 | .0345 | .9959 | .0000 |

*MAH_1* Mahalanobis distance

*COOK_1* Cook's distance

*LEV_1* Leverage value

*MAHA_PV* P-value associated with the Mahalanobis distance

*COOK_P* P-value associated with Cook's distance

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.

[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n$-$p$-1 denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.10*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1962 | -.5139 | -.2743 | -.3651 | .2365 |
| 1963 | -.4034 | -.4018 | .0532 | .0341 |
| 1965 | -.1551 | -.1127 | -.0029 | .0351 |
| 1969 | *-1.6234 | .0558 | *-1.4674 | *1.0941 |
| 1971 | .6757 | -.0885 | .0388 | .0387 |
| 1972 | -.0847 | .0074 | -.0200 | .0067 |
| 1973 | -.9414 | -.0619 | .2688 | .1254 |
| 1974 | .3130 | .0499 | -.1066 | .0103 |
| 1975 | .0175 | .0147 | -.0032 | -.0003 |
| 1976 | -.4190 | .0384 | -.0358 | .1399 |
| 1977 | -.1388 | .0249 | .0333 | -.0755 |
| 1978 | *-2.1952 | -.4164 | *1.0949 | *-2.0286 |
| 1979 | -.2217 | -.1066 | .1509 | -.0737 |
| 1980 | -.2874 | -.0472 | .0137 | -.0433 |
| 1981 | *-1.1920 | .2529 | .1150 | .0828 |
| 1982 | .2669 | -.0473 | -.0743 | -.0469 |
| 1983 | .0760 | .0658 | .0217 | -.0275 |
| 1984 | -.2428 | -.2272 | -.0334 | .0520 |
| 1985 | -.1101 | -.0599 | .0106 | .0260 |
| 1986 | .5563 | .2058 | -.0927 | -.1130 |
| 1987 | .2801 | .0281 | -.0481 | -.0713 |
| 1988 | .2499 | .0547 | -.0650 | -.0342 |
| 1989 | .6983 | .6926 | -.0620 | -.0883 |
| 1990 | .9064 | .7139 | -.0289 | .0711 |
| 1991 | .0906 | .0634 | -.0172 | .0210 |
| 1992 | .4374 | -.1297 | .2134 | .1138 |
| 1993 | *1.3166 | -.4234 | .5664 | .3330 |
| 1994 | -.0202 | -.0146 | .0106 | -.0036 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for January-February inflows |
| *SDFBET_2* | Standardized *dfbeta* for March-April inflows |

*Items are flagged if $|sdffits|$ or $|sdfbeta|$ exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

***Table 6.11*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1962 | .3414 | -.1851 | .1908 | .0853 |
| 1963 | .1773 | .0108 | .0696 | .1235 |
| 1965 | -.0041 | .0833 | -.0588 | .0423 |
| 1969 | .4098 | -.1490 | .1810 | -.4792 |
| 1971 | -.0873 | .1364 | .2720 | -.0857 |
| 1972 | .0227 | -.0181 | -.0328 | .0068 |
| 1973 | -.6029 | .7528 | -.7622 | -.0216 |
| 1974 | .1310 | -.2387 | .2736 | .0037 |
| 1975 | -.0011 | -.0018 | .0003 | -.0079 |
| 1976 | .0278 | -.0412 | .0876 | -.3885 |
| 1977 | .0190 | -.0105 | .0160 | -.0871 |
| 1978 | -.0162 | .1819 | -.1808 | .8885 |
| 1979 | -.1150 | .1131 | -.0771 | .0924 |
| 1980 | .0532 | -.2406 | .2095 | .0885 |
| 1981 | -.3992 | -.7178 | .6313 | .0501 |
| 1982 | .2406 | -.0955 | .0558 | .0123 |
| 1983 | -.0352 | .0024 | -.0149 | -.0147 |
| 1984 | .1436 | -.0167 | .0500 | .0484 |
| 1985 | .0082 | .0439 | -.0151 | -.0565 |
| 1986 | -.0093 | -.1944 | .0463 | .3879 |
| 1987 | .1923 | -.0581 | -.0174 | .0178 |
| 1988 | .1722 | -.0550 | -.0006 | -.0681 |
| 1989 | -.3229 | -.0350 | -.1002 | -.1749 |
| 1990 | -.5635 | .4676 | -.5102 | -.2894 |
| 1991 | -.0478 | .0424 | -.0505 | -.0066 |
| 1992 | .0096 | -.0066 | .0222 | -.0235 |
| 1993 | .2238 | -.0301 | .0802 | -.2517 |
| 1994 | -.0045 | .0084 | -.0027 | .0031 |

*SDFBET_3* Standardized *dfbeta* for May-June inflows
*SDFBET_4* Standardized *dfbeta* for July-August inflows
*SDFBET_5* Standardized *dfbeta* for September-October inflows
*SDFBET_6* Standardized *dfbeta* for November-December inflows

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p + 1) / n}$ for a large data set. The cutoff used here is 1.

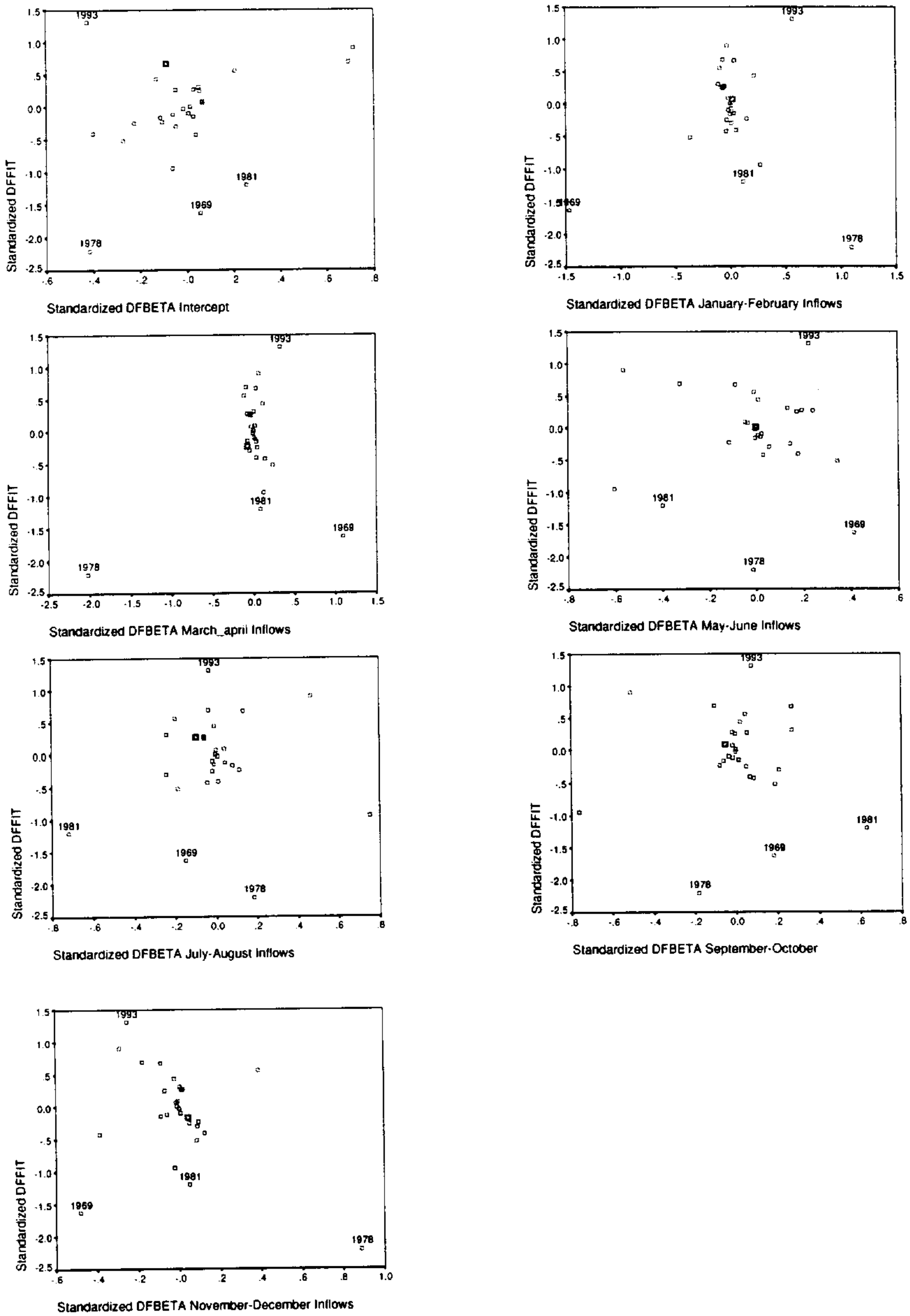


*Figure 6.15. Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of inflow variables.*

## 6.2 Regression - Log of trout data on log of inflow data

### 6.2.1 ANOVA and Parameter Estimates

***Table 6.12*** *Model Summary for log of trout data on log of inflow data.*

**Model Summary[a,b]**

| | Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|
| | Ln(November-December), Ln(March-April), Ln(July-August), Ln(January-February), Ln(September-October), Ln(May-June)[c,d] | .526 | .277 | .070 | 1.19429 | 1.489 |

a. Dependent Variable: Ln(Crab Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Ln(November-December Inflows), Ln(March-April Inflows), Ln(July-August Inflows), Ln(January-February Inflows), Ln(September-October Inflows), Ln(May-June Inflows)

d. All requested variables entered.

***Table 6.13*** *ANOVA table of log of trout data on log of inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 11.449 | 6 | 1.908 | 1.338 | .285[b] |
| | Residual | 29.953 | 21 | 1.426 | | |
| | Total | 41.402 | 27 | | | |

a. Dependent Variable: Ln(Crab Harvest)

b. Independent Variables: (Constant), Ln(November-December Inflows), Ln(March-April Inflows), Ln(July-August Inflows), Ln(January-February Inflows), Ln(September-October Inflows), Ln(May-June Inflows)

***Table 6.14*** *Table of coefficients for log of trout data on log of inflow data.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | 5.794 | 1.489 | | 3.893 | .001 | 2.699 | 8.890 |
| Ln(January-February) | .153 | .408 | .103 | .375 | .711 | -.696 | 1.002 |
| Ln(March-April) | 3.5E-02 | .302 | .026 | .115 | .910 | -.593 | .662 |
| Ln(May-June) | -.239 | .333 | -.205 | -.718 | .480 | -.931 | .453 |
| Ln(July-August) | -.328 | .318 | -.279 | -1.033 | .313 | -.990 | .333 |
| Ln(September-October) | -.242 | .293 | -.229 | -.826 | .418 | -.850 | .367 |
| Ln(November-December) | .577 | .290 | .477 | 1.988 | .060 | -.027 | 1.181 |

a. Dependent Variable: Ln(Crab Harvest)

### 6.2.2 Collinearity Diagnostic

***Table 6.15*** *Variance Inflation for log of trout data on log of inflow data.*

**Coefficients[a]**

| | | Collinearity Statistics | |
|---|---|---|---|
| | t | Tolerance | VIF |
| (Constant) | 3.893 | | |
| Ln(January-February) | .375 | .453 | 2.206 |
| Ln(March-April) | .115 | .684 | 1.463 |
| Ln(May-June) | -.718 | .422 | 2.369 |
| Ln(July-August) | -1.033 | .472 | 2.117 |
| Ln(September-October) | -.826 | .446 | 2.241 |
| Ln(November-December) | 1.988 | .599 | 1.670 |

a. Dependent Variable: Ln(Crab Harvest)

***Table 6.16*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(TROUT) on Ln(INFLOWS):*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *LN_QJF* | Var Prop *LN_QMA* | Var Prop *LN_QMJ* | Var Prop *LN_QJA* | Var Prop *LN_QSO* | Var Prop *LN_QND* |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.53959 | 1.00000 | 0.0057 | 0.0068 | 0.0426 | 0.0403 | 0.0415 | 0.0549 |
| 2 | 1.80802 | 1.18517 | 0.1019 | 0.1262 | 0.0136 | 0.0258 | 0.0244 | 0.0013 |
| 3 | 0.59436 | 2.06708 | 0.0344 | 0.1378 | 0.0305 | 0.1859 | 0.0006 | 0.5617 |
| 4 | 0.51654 | 2.21733 | 0.1033 | 0.6439 | 0.1836 | 0.0196 | 0.0925 | 0.0494 |
| 5 | 0.30408 | 2.88993 | 0.0208 | 0.0526 | 0.0449 | 0.4481 | 0.7341 | 0.2789 |
| 6 | 0.23741 | 3.27062 | 0.7339 | 0.0327 | 0.6847 | 0.2803 | 0.1070 | 0.0538 |

### 6.2.3 Residuals Diagnostics

***Table 6.17*** *Residuals Diagnostics for log of trout data on log of inflow data.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 3.56747 | 5.76325 | 4.81823 | .65120 | 28 |
| Std. Predicted Value | -1.921 | 1.451 | .000 | 1.000 | 28 |
| Standard Error of Predicted Value | .36246 | .80213 | .58684 | .11247 | 28 |
| Adjusted Predicted Value | 3.45587 | 6.59079 | 4.86222 | .78315 | 28 |
| Residual | -2.23476 | 1.97635 | 1.6E-16 | 1.05326 | 28 |
| Std. Residual | -1.871 | 1.655 | .000 | .882 | 28 |
| Stud. Residual | -2.231 | 1.909 | -.016 | 1.032 | 28 |
| Deleted Residual | -3.17643 | 2.63053 | -4.4E-02 | 1.44936 | 28 |
| Stud. Deleted Residual | -2.492 | 2.049 | -.021 | 1.079 | 28 |
| Mahal. Distance | 1.523 | 11.215 | 5.786 | 2.465 | 28 |
| Cook's Distance | .001 | .300 | .056 | .077 | 28 |
| Centered Leverage Value | .056 | .415 | .214 | .091 | 28 |

a. Dependent Variable: Ln(Crab Harvest)

***Table 6.18*** *Case Values for Residuals Diagnostics for log of trout data on log of inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 4.8608 | -.4395 | -.6823 | 5.1035 | .0653 | -.3680 | -.4585 | -.4497 |
| 1963 | 5.2099 | -1.3966 | -2.1621 | 5.9754 | .6015 | -1.1694 | -1.4550 | -1.4974 |
| 1965 | 4.9496 | -.2161 | -.3161 | 5.0497 | .2018 | -.1809 | -.2188 | -.2138 |
| 1969 | 5.7632 | -.7381 | -1.0118 | 6.0370 | 1.4512 | -.6180 | -.7236 | -.7151 |
| 1971 | 3.7778 | .8323 | 1.1543 | 3.4559 | -1.5977 | .6969 | .8207 | .8141 |
| 1972 | 3.9711 | .2874 | .5059 | 3.7525 | -1.3009 | .2406 | .3193 | .3123 |
| 1973 | 4.4277 | -.7117 | -.8830 | 4.5990 | -.5997 | -.5959 | -.6638 | -.6547 |
| 1974 | 4.4249 | 1.3626 | 1.5965 | 4.1910 | -.6041 | 1.1410 | 1.2350 | 1.2515 |
| 1975 | 4.1920 | .6427 | .7079 | 4.1268 | -.9616 | .5381 | .5648 | .5554 |
| 1976 | 5.2503 | -.4316 | -.6064 | 5.4250 | .6634 | -.3614 | -.4283 | -.4199 |
| 1977 | 5.7075 | -1.0747 | -1.9580 | 6.5908 | 1.3656 | -.8999 | -1.2147 | -1.2293 |
| 1978 | 4.4648 | -2.2348 | -3.1764 | 5.4064 | -.5428 | -1.8712 | -2.2309 | -2.4924 |
| 1979 | 3.8305 | .0914 | .1393 | 3.7826 | -1.5167 | .0766 | .0945 | .0922 |
| 1980 | 3.5675 | -.7110 | -.9610 | 3.8175 | -1.9207 | -.5953 | -.6921 | -.6833 |
| 1981 | 3.9454 | -1.9042 | -2.5852 | 4.6265 | -1.3403 | -1.5944 | -1.8578 | -1.9833 |
| 1982 | 4.5042 | .4488 | .5332 | 4.4198 | -.4822 | .3758 | .4096 | .4013 |
| 1983 | 5.0985 | .3474 | .3835 | 5.0623 | .4303 | .2909 | .3056 | .2989 |
| 1984 | 5.3009 | -.9688 | -1.2179 | 5.5499 | .7411 | -.8112 | -.9095 | -.9056 |
| 1985 | 5.5773 | -.6885 | -.7991 | 5.6879 | 1.1657 | -.5765 | -.6211 | -.6118 |
| 1986 | 5.6476 | 1.1292 | 1.4390 | 5.3377 | 1.2736 | .9455 | 1.0673 | 1.0711 |
| 1987 | 5.0932 | .4963 | .6394 | 4.9501 | .4223 | .4155 | .4717 | .4628 |
| 1988 | 4.3797 | .9325 | 1.1466 | 4.1656 | -.6734 | .7808 | .8658 | .8604 |
| 1989 | 5.5050 | 1.3499 | 1.9374 | 4.9175 | 1.0546 | 1.1303 | 1.3541 | 1.3832 |
| 1990 | 4.5242 | 1.9763 | 2.6305 | 3.8700 | -.4515 | 1.6548 | 1.9092 | 2.0495 |
| 1991 | 5.0220 | -.3017 | -.3815 | 5.1018 | .3128 | -.2526 | -.2841 | -.2777 |
| 1992 | 5.6842 | .5471 | .7538 | 5.4774 | 1.3298 | .4581 | .5377 | .5284 |
| 1993 | 5.1935 | 1.6875 | 2.3036 | 4.5774 | .5762 | 1.4130 | 1.6509 | 1.7271 |
| 1994 | 5.0371 | -.3141 | -.3619 | 5.0849 | .3361 | -.2630 | -.2823 | -.2760 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that observation |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.
[2]This is flagged if it exceeds $t_{n-p-2,\alpha}=t_{12,0.01}=2.681$.

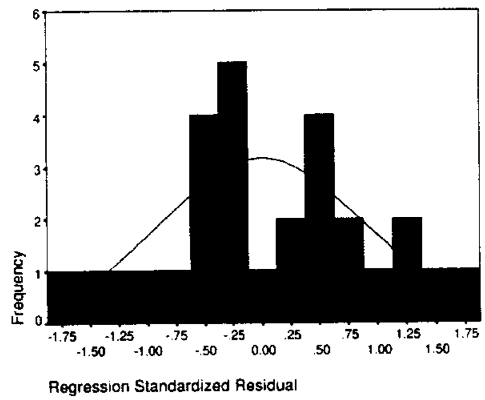


*Figure 6.16* *Histogram of Standardized Residuals.*

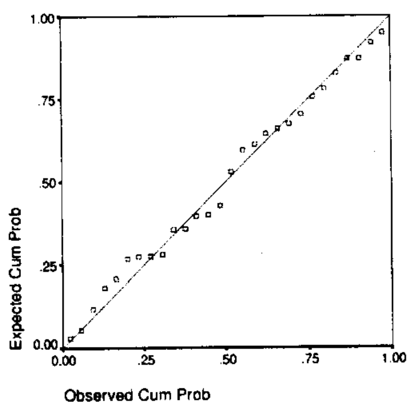


*Figure 6.17* *Normal P-P Plot of Residuals.*

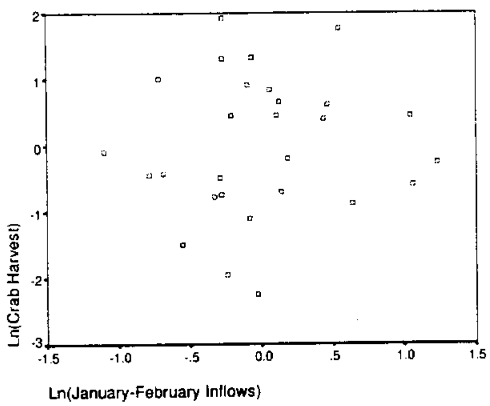


*Figure 6.18* *Partial Residual Plot for Ln(January-February Inflows).*

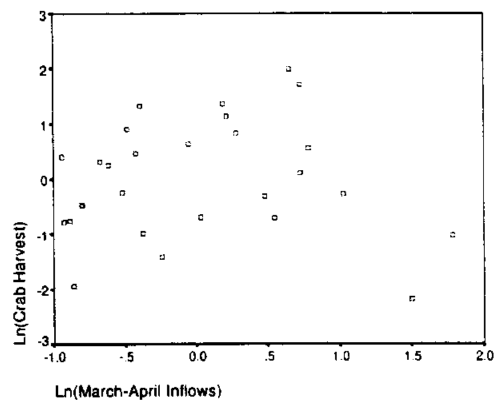


*Figure 6.19* *Partial Residual Plot for Ln(March-April Inflows).*

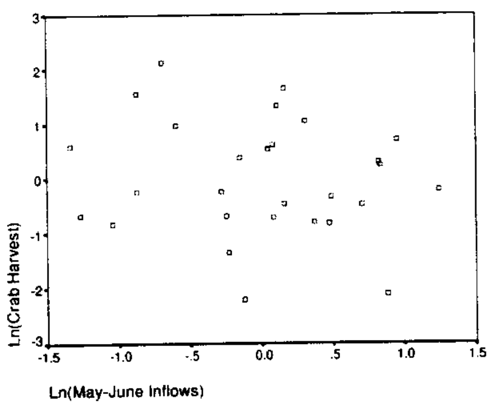


*Figure 6.20* *Partial Residual Plot for Ln(May-June Inflows).*

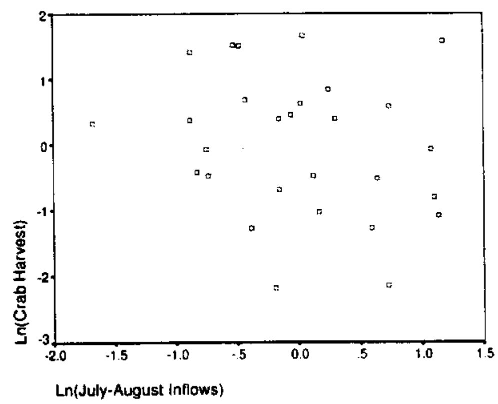


*Figure 6.21* *Partial Residual Plot for Ln(July-August Inflows).*

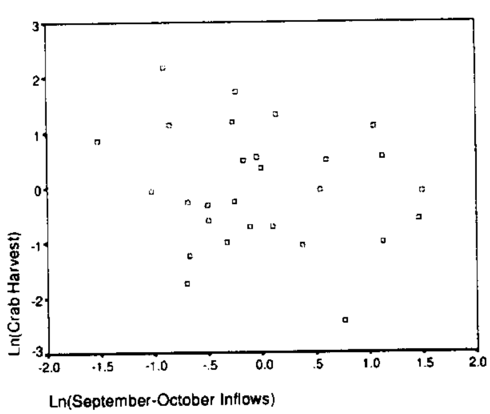


*Figure 6.22* *Partial Residual Plot for Ln(September-October Inflows).*

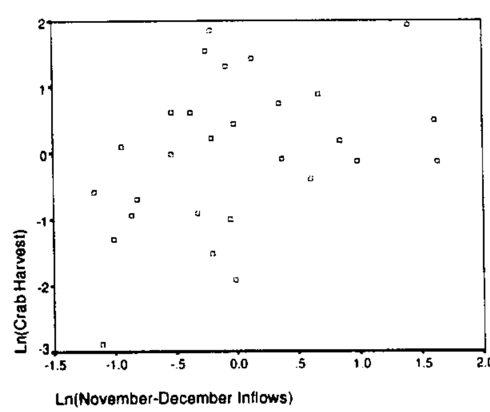


*Figure 6.23* *Partial Residual Plot for Ln(November-December Inflows).*

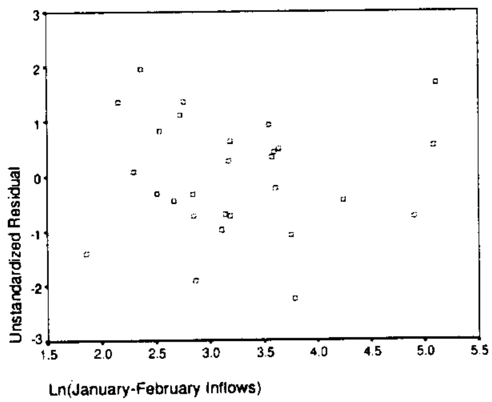


***Figure 6.24*** *Residuals Plot for Ln(January-February Inflows).*

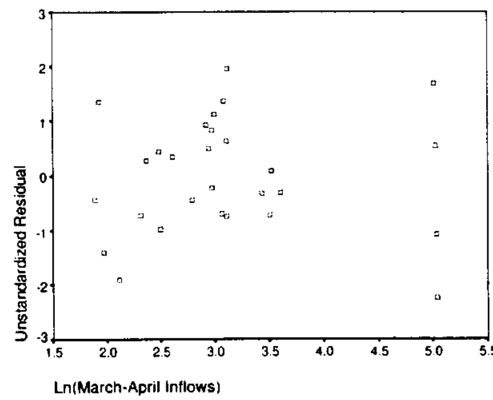


***Figure 6.25*** *Residuals Plot for Ln(March-April Inflows).*

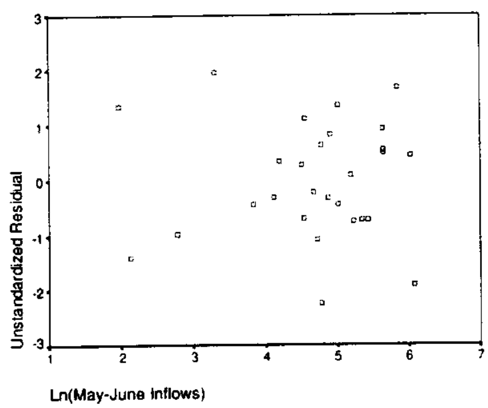


***Figure 6.26*** *Residuals Plot for Ln(May-June Inflows).*

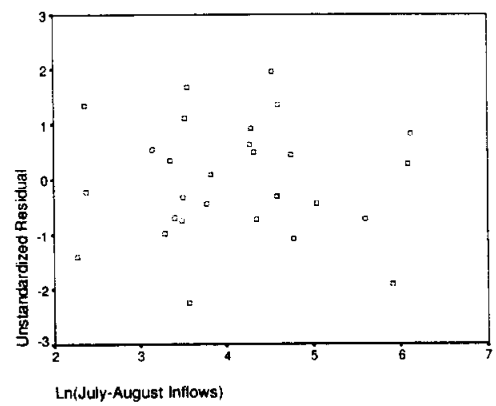


***Figure 6.27*** *Residuals Plot for Ln(July-August Inflows).*

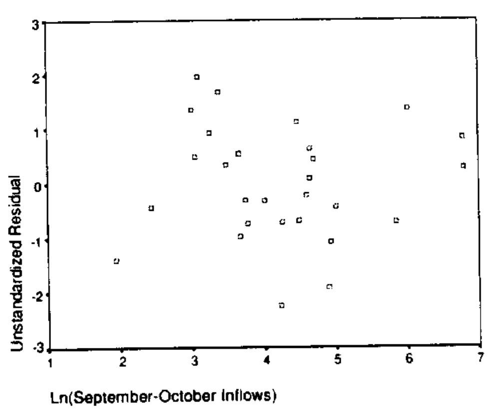


***Figure 6.28*** *Residuals Plot for Ln(September-October Inflows).*

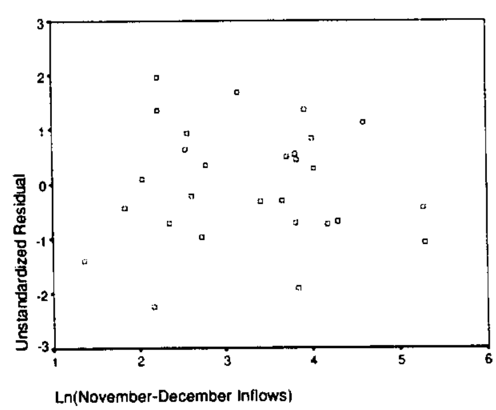


***Figure 6.29*** *Residuals Plot for Ln(November-December Inflows).*

### 6.2.4 Prediction Intervals for Trout Harvest

***Table 6.19*** *Prediction Intervals for Trout Harvest.*

| YEAR | *LICI_1* | *LN_TROUT* | *UICI_1* |
|---|---|---|---|
| 1962 | .9235 | 4.421 | 8.7981 |
| 1963 | 1.2752 | 3.813 | 9.1447 |
| 1965 | 1.0698 | 4.734 | 8.8294 |
| 1969 | 1.9517 | 5.025 | 9.5748 |
| 1971 | -.0462 | 4.610 | 7.6018 |
| 1972 | -.0754 | 4.258 | 8.0175 |
| 1973 | .7328 | 3.716 | 8.1227 |
| 1974 | .8042 | 5.788 | 8.0455 |
| 1975 | .6583 | 4.835 | 7.7258 |
| 1976 | 1.4123 | 4.819 | 9.0882 |
| 1977 | 1.6342 | 4.633 | 9.7809 |
| 1978 | .6146 | 2.230 | 8.3150 |
| 1979 | -.0893 | 3.922 | 7.7504 |
| 1980 | -.2285 | 2.856 | 7.3634 |
| 1981 | .1446 | 2.041 | 7.7463 |
| 1982 | .8649 | 4.953 | 8.1436 |
| 1983 | 1.5614 | 5.446 | 8.6356 |
| 1984 | 1.5897 | 4.332 | 9.0120 |
| 1985 | 1.9695 | 4.889 | 9.1852 |
| 1986 | 1.9198 | 6.777 | 9.3753 |
| 1987 | 1.3523 | 5.589 | 8.8341 |
| 1988 | .6960 | 5.312 | 8.0634 |
| 1989 | 1.6448 | 6.855 | 9.3653 |
| 1990 | .7456 | 6.501 | 8.3028 |
| 1991 | 1.3035 | 4.720 | 8.7404 |
| 1992 | 1.8671 | 6.231 | 9.5014 |
| 1993 | 1.3866 | 6.881 | 9.0003 |
| 1994 | 1.4393 | 4.723 | 8.6349 |

*LICI_1* Lower limit for 99% prediction interval for the natural log of trout harvest.

*LN_TROUT* Natural log of trout harvest

*UICI_1* Upper limit for 99% prediction interval for the natural log of trout harvest.

### 6.2.5 Outliers and Influential Point Detection

***Table 6.20*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1962 | 8.6421 | .0166 | .3201 | .2794 | .0000 |
| 1963 | 8.5948 | .1658 | .3183 | .2831 | .0105 |
| 1965 | 7.5809 | .0032 | .2808 | .3710 | .0000 |
| 1969 | 6.3415 | .0277 | .2349 | .5005 | .0000 |
| 1971 | 6.5661 | .0372 | .2432 | .4754 | .0001 |
| 1972 | 10.6997 | .0111 | .3963 | .1523 | .0000 |
| 1973 | 4.2739 | .0152 | .1583 | .7477 | .0000 |
| 1974 | 2.9907 | .0374 | .1108 | .8859 | .0001 |
| 1975 | 1.5226 | .0046 | .0564 | .9815 | .0000 |
| 1976 | 6.8182 | .0106 | .2525 | .4481 | .0000 |
| 1977 | 11.2154 | .1732 | .4154 | .1295 | .0119 |
| 1978 | 7.0400 | .2996 | .2607 | .4247 | .0538 |
| 1979 | 8.3180 | .0007 | .3081 | .3054 | .0000 |
| 1980 | 6.0606 | .0241 | .2245 | .5327 | .0000 |
| 1981 | 6.1484 | .1763 | .2277 | .5225 | .0126 |
| 1982 | 3.3115 | .0045 | .1226 | .8548 | .0000 |
| 1983 | 1.5786 | .0014 | .0585 | .9795 | .0000 |
| 1984 | 4.5576 | .0304 | .1688 | .7138 | .0000 |
| 1985 | 2.7722 | .0089 | .1027 | .9052 | .0000 |
| 1986 | 4.8494 | .0447 | .1796 | .6783 | .0002 |
| 1987 | 5.0809 | .0092 | .1882 | .6501 | .0000 |
| 1988 | 4.0779 | .0246 | .1510 | .7708 | .0000 |
| 1989 | 7.2232 | .1140 | .2675 | .4060 | .0034 |
| 1990 | 5.7503 | .1724 | .2130 | .5692 | .0118 |
| 1991 | 4.6856 | .0031 | .1735 | .6983 | .0000 |
| 1992 | 6.4421 | .0156 | .2386 | .4892 | .0000 |
| 1993 | 6.2566 | .1421 | .2317 | .5101 | .0066 |
| 1994 | 2.6010 | .0017 | .0963 | .9193 | .0000 |

*MAH_1* Mahalanobis distance

*COOK_1* Cook's distance

*LEV_1* Leverage value

*MAHA_PV* P-value associated with the Mahalanobis distance

*COOK_P* P-value associated with Cook's distance

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.

[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n-p-1$ denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.21*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1962 | -.3342 | -.0085 | -.2357 | .1126 |
| 1963 | *-1.1086 | *-1.0450 | .3511 | .1122 |
| 1965 | -.1455 | -.0343 | -.0159 | .0337 |
| 1969 | -.4356 | .0940 | -.3032 | .1956 |
| 1971 | .5063 | -.1979 | .0199 | .0692 |
| 1972 | .2724 | -.1153 | .1480 | -.0640 |
| 1973 | -.3212 | .0140 | -.0343 | .1633 |
| 1974 | .5185 | -.0594 | -.1247 | .0650 |
| 1975 | .1769 | -.0025 | .0241 | -.0074 |
| 1976 | -.2672 | -.0294 | .0497 | .1005 |
| 1977 | *-1.1145 | .4269 | .0465 | -.7481 |
| 1978 | *-1.6179 | .3168 | .0303 | *-1.1264 |
| 1979 | .0668 | .0186 | -.0428 | .0209 |
| 1980 | -.4052 | .0565 | .0897 | -.1103 |
| 1981 | *-1.1861 | .0946 | .1892 | .5004 |
| 1982 | .1741 | -.0193 | .0154 | -.1036 |
| 1983 | .0964 | .0370 | .0465 | -.0535 |
| 1984 | -.4592 | -.1546 | -.2209 | .0948 |
| 1985 | -.2452 | -.0679 | .0636 | -.0050 |
| 1986 | .5611 | .1948 | -.2943 | .0659 |
| 1987 | .2486 | .0293 | -.0382 | -.0557 |
| 1988 | .4123 | .0557 | -.0320 | -.1163 |
| 1989 | .9125 | .7306 | -.0398 | -.1642 |
| 1990 | *1.1791 | .3573 | -.2209 | .3891 |
| 1991 | -.1429 | -.0255 | .0729 | -.0811 |
| 1992 | .3249 | -.1226 | .0980 | .1231 |
| 1993 | *1.0435 | -.4493 | .3734 | .3710 |
| 1994 | -.1077 | -.0456 | .0794 | -.0360 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for log of January-February inflows |
| *SDFBET_2* | Standardized *dfbeta* for log of March-April inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p + 1) / n}$ for a large data set. The cutoff used here is 1.

***Table 6.22*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1962 | .1362 | -.1646 | .0698 | .1169 |
| 1963 | .1192 | .1904 | .3082 | .0908 |
| 1965 | -.0351 | .1153 | -.0930 | .0513 |
| 1969 | .0574 | .0339 | .0223 | -.1231 |
| 1971 | -.1587 | .1883 | .2646 | -.0870 |
| 1972 | -.1540 | .1189 | .1521 | -.0538 |
| 1973 | -.0957 | .1420 | -.2016 | .0562 |
| 1974 | .0406 | -.1705 | .3496 | -.0252 |
| 1975 | .0126 | .0027 | .0866 | -.1326 |
| 1976 | -.0220 | -.0165 | .0840 | -.1951 |
| 1977 | .4801 | -.2625 | .1334 | -.6596 |
| 1978 | .1016 | .1477 | -.5593 | .8010 |
| 1979 | .0394 | -.0267 | .0153 | -.0322 |
| 1980 | -.0819 | -.2396 | .0973 | .1937 |
| 1981 | -.5670 | -.4464 | .3982 | .0060 |
| 1982 | .1014 | -.0062 | -.0186 | -.0017 |
| 1983 | -.0135 | -.0129 | -.0007 | -.0150 |
| 1984 | .3574 | -.0463 | -.0931 | .0119 |
| 1985 | -.0157 | .1446 | -.0154 | -.1582 |
| 1986 | .1032 | -.2823 | -.0789 | .4135 |
| 1987 | .1202 | .0425 | -.1958 | .0866 |
| 1988 | .2529 | .0630 | -.1995 | -.1225 |
| 1989 | -.4025 | -.2325 | .0553 | .0533 |
| 1990 | -.4542 | .7400 | -.5244 | -.1162 |
| 1991 | .0244 | -.0531 | .0782 | -.0643 |
| 1992 | .0074 | -.0703 | -.0068 | .0533 |
| 1993 | .0895 | .0222 | -.1159 | -.1207 |
| 1994 | -.0581 | .0589 | .0187 | -.0273 |

*SDFBET_3* Standardized *dfbeta* for log of May-June inflows
*SDFBET_4* Standardized *dfbeta* for log of July-August inflows
*SDFBET_5* Standardized *dfbeta* for log of September-October inflows
*SDFBET_6* Standardized *dfbeta* for log of November-December inflows

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

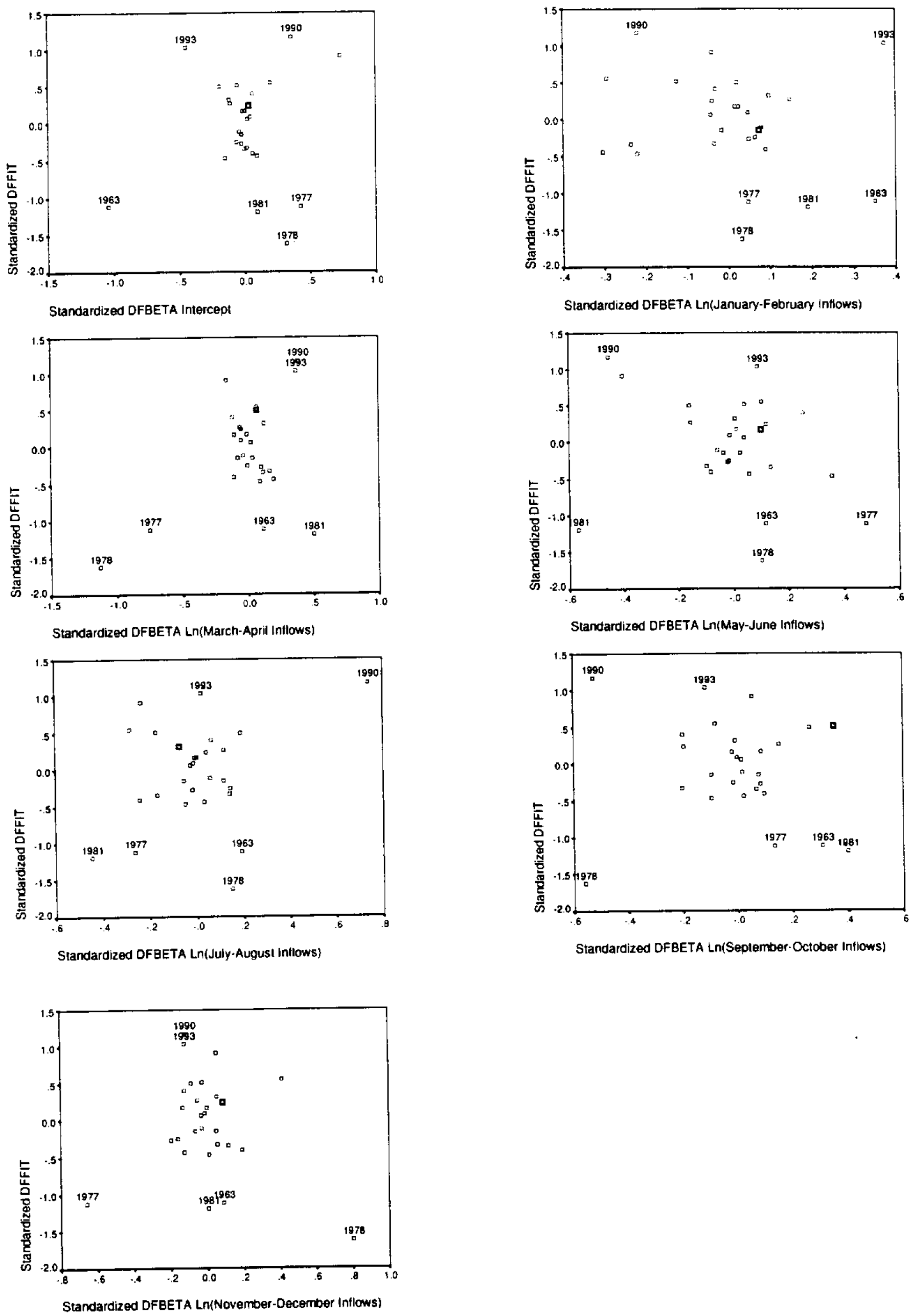


***Figure 6.30*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of log of inflow variables.*

## 6.3 Regression - Log of crab data on square root of inflow data

### 6.3.1 ANOVA and Parameter Estimates

***Table 6.23*** *Model Summary for log of crab data on square root of inflow data.*

**Model Summary[a,b]**

| Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| Sqrt(November-December), Sqrt(January-February), Sqrt(July-August), Sqrt(March-April), Sqrt(May-June), Sqrt(September-October)[c,d] | .517 | .267 | .057 | 1.20225 | 1.257 |

a. Dependent Variable: Ln(Crab Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of January-February Inflows, Square Root of July-August Inflows, Square Root of March-April Inflows, Square Root of May-June Inflows, Square Root of September-October Inflows

d. All requested variables entered.

***Table 6.24*** *ANOVA table of log of crab data on square root of inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 11.049 | 6 | 1.841 | 1.274 | .311[b] |
| | Residual | 30.354 | 21 | 1.445 | | |
| | Total | 41.402 | 27 | | | |

a. Dependent Variable: Ln(Crab Harvest)

b. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of January-February Inflows, Square Root of July-August Inflows, Square Root of March-April Inflows, Square Root of May-June Inflows, Square Root of September-October Inflows

***Table 6.25*** *Table of coefficients for log of crab data on square root of inflow data.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| (Constant) | 5.029 | .815 | | 6.169 | .000 | 3.334 | 6.725 |
| Sqrt( January-February) | .150 | .122 | .333 | 1.229 | .233 | -.104 | .404 |
| Sqrt(March-April) | -7.2E-02 | .095 | -.179 | -.762 | .454 | -.270 | .125 |
| Sqrt(May-June ) | -4.6E-02 | .061 | -.184 | -.761 | .455 | -.173 | .080 |
| Sqrt(July-August) | -9.6E-02 | .074 | -.394 | -1.299 | .208 | -.251 | .058 |
| Sqrt(September-October) | 1.2E-02 | .050 | .067 | .239 | .813 | -.092 | .116 |
| Sqrt(November-December) | .104 | .082 | .263 | 1.263 | .220 | -.067 | .276 |

a. Dependent Variable: Ln(Crab Harvest)

### 6.3.2 Collinearity Diagnostic

***Table 6.26*** *Collinearity Diagnostic for log of crab data on square root of inflow data.*

**Coefficients[a]**

| | t | Collinearity Statistics | |
|---|---|---|---|
| | | Tolerance | VIF |
| (Constant) | 6.169 | | |
| Sqrt(January-February) | 1.229 | .475 | 2.105 |
| Sqrt(March-April) | -.762 | .635 | 1.574 |
| Sqrt(May-June) | -.761 | .600 | 1.666 |
| Sqrt(July-August) | -1.299 | .378 | 2.642 |
| Sqrt(September-October) | .239 | .442 | 2.263 |
| Sqrt(November-December) | 1.263 | .806 | 1.241 |

a. Dependent Variable: Ln(Crab Harvest)

***Table 6.27*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Sqrt(CRAB) on Sqrt(INFLOWS).*

| Condition | Var Prop | Var Prop | Var Prop | Var Prop | Var Prop | Var Prop | | |
|---|---|---|---|---|---|---|---|---|
| Number | Eigenvalue | Index | SQR_QJF | SQR_QMA | SQR_QMJ | SQR_QJA | SQR_QSO | SQR_QND |
| 1 | 2.17615 | 1.00000 | 0.0203 | 0.0182 | 0.0065 | 0.0624 | 0.0702 | 0.0433 |
| 2 | 1.90766 | 1.06806 | 0.0791 | 0.0907 | 0.0914 | 0.0024 | 0.0014 | 0.0429 |
| 3 | 0.76020 | 1.69192 | 0.0034 | 0.0542 | 0.2487 | 0.0332 | 0.0014 | 0.5781 |
| 4 | 0.59096 | 1.91896 | 0.0003 | 0.3883 | 0.1830 | 0.0325 | 0.1341 | 0.3109 |
| 5 | 0.34946 | 2.49543 | 0.6271 | 0.4120 | 0.0989 | 0.0471 | 0.2631 | 0.0068 |
| 6 | 0.21557 | 3.17727 | 0.2699 | 0.0367 | 0.3714 | 0.8224 | 0.5298 | 0.0180 |

### 6.3.3 Residuals Diagnostics

***Table 6.28*** *Residuals Diagnostics for log of crab data on square root of inflow data.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 3.41522 | 6.16391 | 4.81823 | .63969 | 28 |
| Std. Predicted Value | -2.193 | 2.104 | .000 | 1.000 | 28 |
| Standard Error of Predicted Value | .29994 | .89405 | .58285 | .14979 | 28 |
| Adjusted Predicted Value | 3.25211 | 6.88460 | 4.88383 | .77480 | 28 |
| Residual | -2.22486 | 2.12620 | -6.7E-16 | 1.06029 | 28 |
| Std. Residual | -1.851 | 1.769 | .000 | .882 | 28 |
| Stud. Residual | -2.306 | 1.985 | -.022 | 1.040 | 28 |
| Deleted Residual | -3.45519 | 2.67843 | -6.6E-02 | 1.48776 | 28 |
| Stud. Deleted Residual | -2.604 | 2.149 | -.024 | 1.089 | 28 |
| Mahal. Distance | .716 | 13.967 | 5.786 | 3.357 | 28 |
| Cook's Distance | .000 | .420 | .062 | .093 | 28 |
| Centered Leverage Value | .027 | .517 | .214 | .124 | 28 |

a. Dependent Variable: Ln(Crab Harvest)

***Table 6.29*** *Case Values for Residuals Diagnostics for log of crab data on square root of inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 5.3373 | -.9161 | -1.2999 | 5.7211 | .8115 | -.7620 | -.9077 | -.9037 |
| 1963 | 5.0186 | -1.2053 | -1.5268 | 5.3401 | .3132 | -1.0025 | -1.1283 | -1.1361 |
| 1965 | 5.3279 | -.5943 | -.7084 | 5.4420 | .7967 | -.4944 | -.5397 | -.5304 |
| 1969 | 6.1639 | -1.1387 | -1.8594 | 6.8846 | 2.1036 | -.9471 | -1.2103 | -1.2246 |
| 1971 | 3.7784 | .8318 | 1.3580 | 3.2521 | -1.6255 | .6918 | .8840 | .8792 |
| 1972 | 4.2064 | .0520 | .1005 | 4.1579 | -.9564 | .0433 | .0602 | .0587 |
| 1973 | 4.9131 | -1.1971 | -1.5804 | 5.2964 | .1483 | -.9957 | -1.1441 | -1.1530 |
| 1974 | 4.7377 | 1.0498 | 1.3120 | 4.4755 | -.1259 | .8732 | .9762 | .9750 |
| 1975 | 4.5974 | .2373 | .2531 | 4.5816 | -.3453 | .1974 | .2038 | .1991 |
| 1976 | 5.2462 | -.4276 | -.6914 | 5.5101 | .6691 | -.3556 | -.4522 | -.4435 |
| 1977 | 5.1797 | -.5469 | -1.2234 | 5.8562 | .5650 | -.4549 | -.6804 | -.6714 |
| 1978 | 4.4549 | -2.2249 | -3.4552 | 5.6852 | -.5680 | -1.8506 | -2.3062 | -2.6044 |
| 1979 | 4.2158 | -.2938 | -.3841 | 4.3061 | -.9417 | -.2444 | -.2794 | -.2732 |
| 1980 | 3.4152 | -.5588 | -.8026 | 3.6590 | -2.1932 | -.4648 | -.5570 | -.5476 |
| 1981 | 3.4779 | -1.4366 | -2.3492 | 4.3905 | -2.0953 | -1.1950 | -1.5281 | -1.5818 |
| 1982 | 4.5287 | .4243 | .5427 | 4.4103 | -.4527 | .3530 | .3992 | .3910 |
| 1983 | 5.2535 | .1924 | .2123 | 5.2336 | .6805 | .1600 | .1681 | .1641 |
| 1984 | 5.2855 | -.9534 | -1.1134 | 5.4455 | .7304 | -.7930 | -.8570 | -.8514 |
| 1985 | 5.4472 | -.5583 | -.6345 | 5.5233 | .9832 | -.4644 | -.4951 | -.4860 |
| 1986 | 5.4287 | 1.3480 | 1.6532 | 5.1236 | .9543 | 1.1212 | 1.2417 | 1.2589 |
| 1987 | 4.7418 | .8477 | .9906 | 4.5989 | -.1196 | .7051 | .7622 | .7544 |
| 1988 | 4.4350 | .8773 | 1.0313 | 4.2809 | -.5991 | .7297 | .7912 | .7839 |
| 1989 | 5.2143 | 1.6406 | 2.0248 | 4.8301 | .6192 | 1.3646 | 1.5160 | 1.5677 |
| 1990 | 4.3743 | 2.1262 | 2.6784 | 3.8221 | -.6939 | 1.7685 | 1.9849 | 2.1492 |
| 1991 | 4.5252 | .1951 | .2278 | 4.4925 | -.4581 | .1623 | .1753 | .1712 |
| 1992 | 5.5726 | .6586 | .9678 | 5.2634 | 1.1793 | .5478 | .6641 | .6550 |
| 1993 | 5.2095 | 1.6715 | 2.5510 | 4.3300 | .6117 | 1.3903 | 1.7176 | 1.8080 |
| 1994 | 4.8238 | -.1009 | -.1116 | 4.8346 | .0088 | -.0839 | -.0883 | -.0862 |

*PRE_1* Predicted value of harvest
*RES_1* Ordinary residuals: observed harvest minus predicted harvest
*DRE_1* Deleted residuals: residuals obtained when the model is fitted without that observation
*ADJ_1* Adjusted predicted value: predicted value of harvest when the model is fitted without that observation
*ZPR_1* Z-score of the predicted value of harvest
*ZRE_1* Z-score of the residual
*SRE_1* Studentized residual
*SDR_1* Studentized deleted residuals

[1]Values greater than 3 are flagged.
[2]This is flagged if it exceeds $t_{n-p-2,\alpha}=t_{12,0.01}=2.681$.

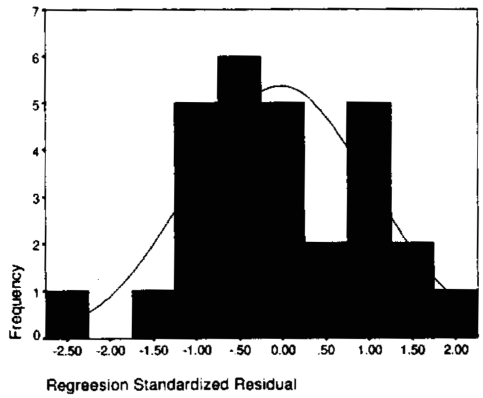


***Figure 6.31*** *Histogram of Standardized Residuals.*

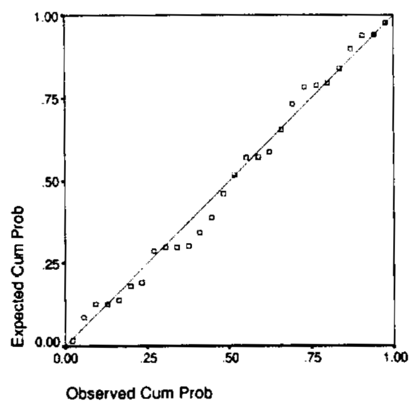


***Figure 6.32*** *Normal P-P Plot of Residuals.*

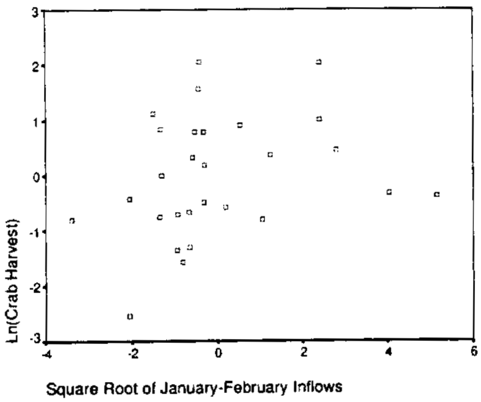


***Figure 6.33*** *Partial Residual Plot for Sqrt(January-February Inflows).*

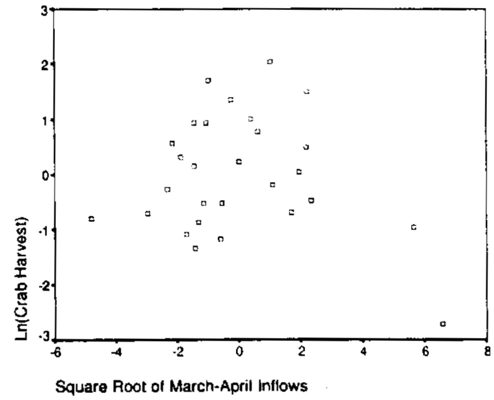


***Figure 6.34*** *Partial Residual Plot for Sqrt(March-April Inflows).*

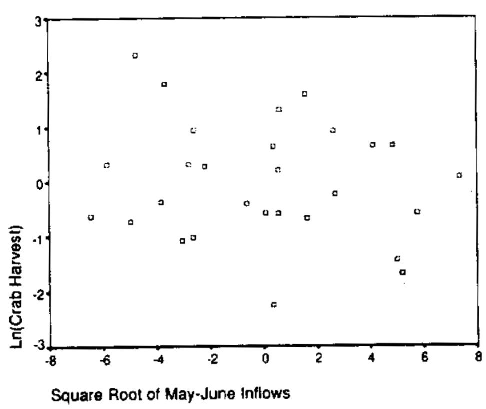


***Figure 6.35*** *Partial Residual Plot for Sqrt(May-June Inflows).*

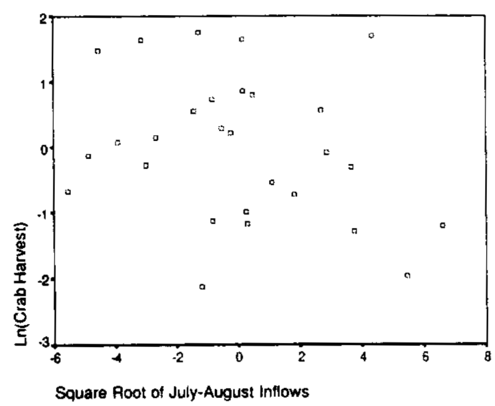


***Figure 6.36*** *Partial Residual Plot for Sqrt(July-August Inflows).*

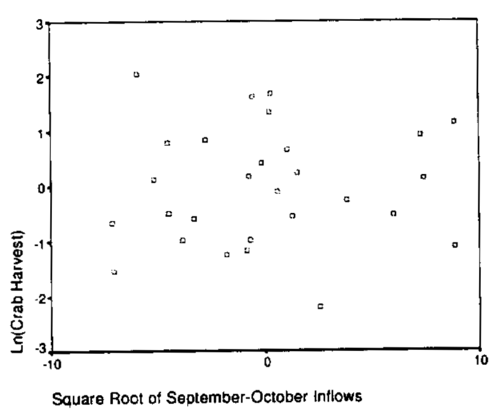


***Figure 6.37*** *Partial Residual Plot for Sqrt(September-October Inflows).*

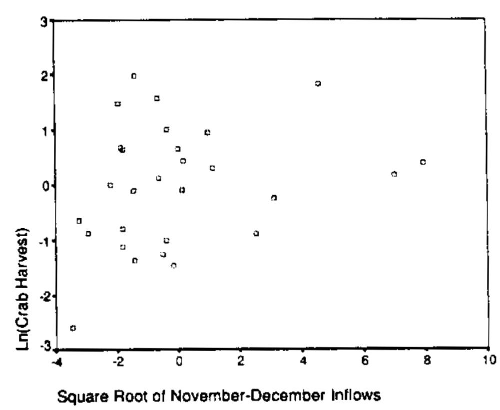


***Figure 6.38*** *Partial Residual Plot for Sqrt(November-December Inflows).*

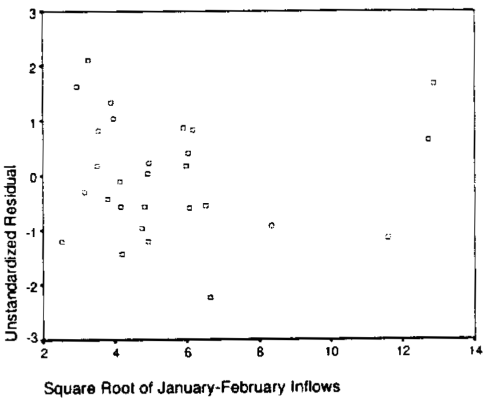


***Figure 6.39*** *Residuals Plot for Sqrt(January-February Inflows).*

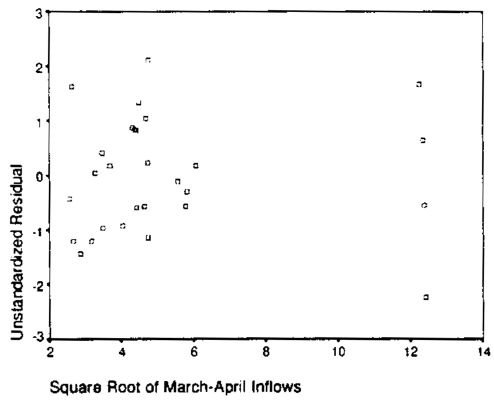


***Figure 6.40*** *Residuals Plot for Sqrt(March-April Inflows).*

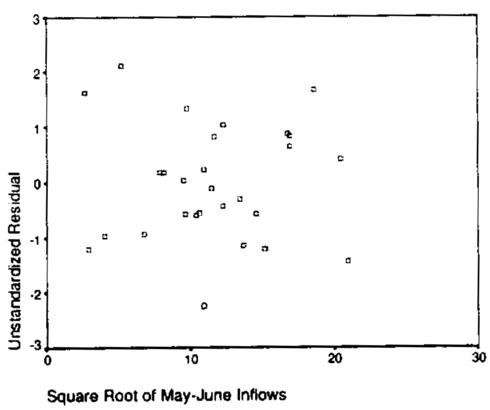


***Figure 6.41*** *Residuals Plot for Sqrt(May-June Inflows).*

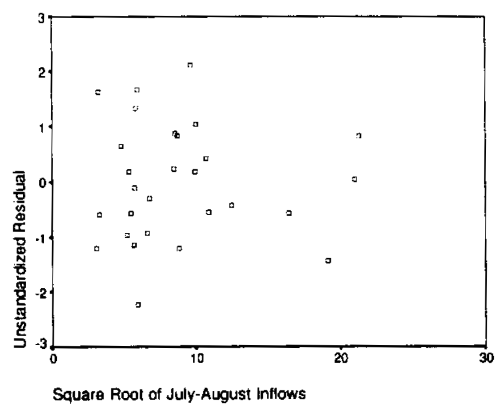


***Figure 6.42*** *Residuals Plot for Sqrt(July-August Inflows).*

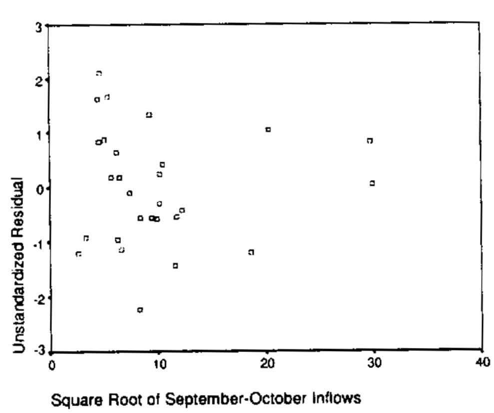


***Figure 6.43*** *Residuals Plot for Sqrt(September-October Inflows).*

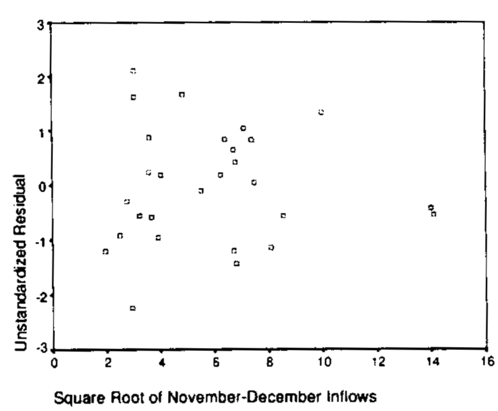


***Figure 6.44*** *Residuals Plot for Sqrt(November-December Inflows).*

### 6.3.4 Prediction Intervals for Crab Harvest

***Table 6.30*** *Prediction Intervals for Crab Harvest.*

| YEAR | *LICI_1* | *SQ_CRAB* | *UICI_1* |
|---|---|---|---|
| 1962 | 1.4632 | 4.4212 | 9.2114 |
| 1963 | 1.2733 | 3.8133 | 8.7639 |
| 1965 | 1.6601 | 4.7336 | 8.9957 |
| 1969 | 2.1541 | 5.0252 | 10.1737 |
| 1971 | -.2313 | 4.6102 | 7.7881 |
| 1972 | .0622 | 4.2584 | 8.3506 |
| 1973 | 1.1187 | 3.7160 | 8.7075 |
| 1974 | 1.0090 | 5.7875 | 8.4664 |
| 1975 | 1.0890 | 4.8347 | 8.1057 |
| 1976 | 1.2451 | 4.8187 | 9.2473 |
| 1977 | .9376 | 4.6328 | 9.4217 |
| 1978 | .4909 | 2.2300 | 8.4189 |
| 1979 | .4329 | 3.9220 | 7.9987 |
| 1980 | -.4716 | 2.8565 | 7.3020 |
| 1981 | -.5332 | 2.0412 | 7.4889 |
| 1982 | .7717 | 4.9530 | 8.2856 |
| 1983 | 1.6936 | 5.4459 | 8.8134 |
| 1984 | 1.6452 | 4.3320 | 8.9258 |
| 1985 | 1.8447 | 4.8888 | 9.0496 |
| 1986 | 1.7238 | 6.7767 | 9.1336 |
| 1987 | 1.1005 | 5.5895 | 8.3830 |
| 1988 | .7856 | 5.3122 | 8.0844 |
| 1989 | 1.5014 | 6.8549 | 8.9272 |
| 1990 | .6359 | 6.5005 | 8.1128 |
| 1991 | .8851 | 4.7203 | 8.1653 |
| 1992 | 1.6625 | 6.2313 | 9.4827 |
| 1993 | 1.2621 | 6.8810 | 9.1570 |
| 1994 | 1.2603 | 4.7230 | 8.3874 |

*LICI_1* Lower limit for 99% prediction interval for the log of crab harvest.

*LN_CRAB* Log of crab harvest

*UICI_1* Upper limit for 99% prediction interval for the log of crab harvest.

### 6.3.5 Outliers and Influential Point Detection

***Table 6.31*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1962 | 7.0079 | .0493 | .2596 | .4281 | .0002 |
| 1963 | 4.7212 | .0485 | .1749 | .6939 | .0002 |
| 1965 | 3.3832 | .0080 | .1253 | .8474 | .0000 |
| 1969 | 9.5008 | .1324 | .3519 | .2187 | .0054 |
| 1971 | 9.4988 | .0706 | .3518 | .2188 | .0007 |
| 1972 | 12.0546 | .0005 | .4465 | .0988 | .0000 |
| 1973 | 5.5838 | .0599 | .2068 | .5891 | .0004 |
| 1974 | 4.4319 | .0340 | .1641 | .7289 | .0001 |
| 1975 | .7163 | .0004 | .0265 | .9982 | .0000 |
| 1976 | 9.3389 | .0180 | .3459 | .2292 | .0000 |
| 1977 | 13.9670 | .0818 | *.5173 | .0518 | .0012 |
| 1978 | 8.6500 | .4202 | .3204 | .2788 | .1212 |
| 1979 | 5.3807 | .0034 | .1993 | .6136 | .0000 |
| 1980 | 7.2378 | .0193 | .2681 | .4045 | .0000 |
| 1981 | 9.5244 | .2119 | .3528 | .2172 | .0213 |
| 1982 | 4.9246 | .0063 | .1824 | .6692 | .0000 |
| 1983 | 1.5653 | .0004 | .0580 | .9800 | .0000 |
| 1984 | 2.9149 | .0176 | .1080 | .8928 | .0000 |
| 1985 | 2.2755 | .0048 | .0843 | .9430 | .0000 |
| 1986 | 4.0194 | .0499 | .1489 | .7775 | .0002 |
| 1987 | 2.9301 | .0140 | .1085 | .8914 | .0000 |
| 1988 | 3.0688 | .0157 | .1137 | .8786 | .0000 |
| 1989 | 4.1588 | .0769 | .1540 | .7613 | .0010 |
| 1990 | 4.6026 | .1462 | .1705 | .7083 | .0072 |
| 1991 | 2.9111 | .0007 | .1078 | .8931 | .0000 |
| 1992 | 7.6610 | .0296 | .2837 | .3634 | .0000 |
| 1993 | 8.3447 | .2218 | .3091 | .3032 | .0241 |
| 1994 | 1.6261 | .0001 | .0602 | .9776 | .0000 |

| | |
|---|---|
| *MAH_1* | Mahalanobis distance |
| *COOK_1* | Cook's distance |
| *LEV_1* | Leverage value |
| *MAHA_PV* | P-value associated with the Mahalanobis distance |
| *COOK_PV* | P-value associated with Cook's distance |

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.

[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n-p-1$ denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.32*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1962 | -.5849 | -.1338 | -.4414 | .2514 |
| 1963 | -.5868 | -.5636 | .1212 | .0583 |
| 1965 | -.2324 | -.1068 | -.0110 | .0517 |
| 1969 | -.9743 | .2044 | -.8205 | .5933 |
| 1971 | .6994 | -.1792 | .0609 | .0567 |
| 1972 | .0567 | -.0139 | .0231 | -.0092 |
| 1973 | -.6524 | -.0514 | .0866 | .1772 |
| 1974 | .4873 | .0443 | -.1462 | .0350 |
| 1975 | .0513 | .0268 | -.0060 | .0002 |
| 1976 | -.3484 | .0246 | .0180 | .1031 |
| 1977 | -.7468 | .2366 | .1376 | -.4487 |
| 1978 | *-1.9367 | -.0737 | .6756 | *-1.6864 |
| 1979 | -.1514 | -.0621 | .1073 | -.0579 |
| 1980 | -.3617 | .0029 | .0611 | -.0888 |
| 1981 | *-1.2607 | .2492 | .1656 | .2265 |
| 1982 | .2065 | -.0213 | -.0261 | -.0751 |
| 1983 | .0528 | .0328 | .0219 | -.0256 |
| 1984 | -.3487 | -.2473 | -.0975 | .0948 |
| 1985 | -.1795 | -.0624 | .0348 | .0225 |
| 1986 | .5989 | .1758 | -.2118 | -.0259 |
| 1987 | .3097 | .0159 | -.0257 | -.0930 |
| 1988 | .3285 | .0639 | -.0458 | -.0703 |
| 1989 | .7586 | .7029 | -.0767 | -.1340 |
| 1990 | *1.0953 | .5724 | -.1017 | .2014 |
| 1991 | .0701 | .0243 | -.0244 | .0286 |
| 1992 | .4488 | -.2091 | .1932 | .1383 |
| 1993 | *1.3115 | -.5945 | .5430 | .3910 |
| 1994 | -.0281 | -.0151 | .0189 | -.0080 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for square root of January-February inflows |
| *SDFBET_2* | Standardized *dfbeta* for square root of March-April inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p + 1) / n}$ for a large data set. The cutoff used here is 1.

***Table 6.33*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1962 | .3516 | -.2498 | .1744 | .1327 |
| 1963 | .1973 | .0649 | .0975 | .1246 |
| 1965 | -.0476 | .1739 | -.1454 | .0720 |
| 1969 | .2095 | -.0306 | .0574 | -.2733 |
| 1971 | -.1485 | .1872 | .3427 | -.1368 |
| 1972 | -.0242 | .0184 | .0252 | -.0080 |
| 1973 | -.3374 | .4519 | -.4907 | .0451 |
| 1974 | .1454 | -.3033 | .4034 | -.0252 |
| 1975 | .0059 | -.0066 | .0126 | -.0310 |
| 1976 | .0183 | -.0386 | .1071 | -.3084 |
| 1977 | .1952 | -.1126 | .1404 | -.4833 |
| 1978 | -.0572 | .2386 | -.3435 | .7682 |
| 1979 | -.0915 | .0750 | -.0498 | .0692 |
| 1980 | -.0183 | -.2675 | .1959 | .1322 |
| 1981 | -.5350 | -.6819 | .6003 | .0199 |
| 1982 | .1654 | -.0388 | -.0038 | .0059 |
| 1983 | -.0190 | -.0023 | -.0057 | -.0071 |
| 1984 | .2325 | -.0151 | .0280 | .0240 |
| 1985 | -.0024 | .0953 | -.0269 | -.1117 |
| 1986 | .0432 | -.2674 | .0116 | .4406 |
| 1987 | .1711 | .0246 | -.1550 | .0561 |
| 1988 | .2093 | .0085 | -.0992 | -.1079 |
| 1989 | -.3261 | -.1346 | -.0427 | -.0747 |
| 1990 | -.5837 | .6492 | -.6013 | -.2270 |
| 1991 | -.0261 | .0330 | -.0403 | .0144 |
| 1992 | .0153 | -.0395 | .0341 | .0007 |
| 1993 | .1788 | .0235 | .0246 | -.2949 |
| 1994 | -.0123 | .0148 | -.0021 | -.0009 |

| | |
|---|---|
| *SDFBET_3* | Standardized *dfbeta* for square root of May-June inflows |
| *SDFBET_4* | Standardized *dfbeta* for square root of July-August inflows |
| *SDFBET_5* | Standardized *dfbeta* for square root of September-October inflows |
| *SDFBET_6* | Standardized *dfbeta* for square root of November-December inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p + 1) / n}$ for a large data set. The cutoff used here is 1.

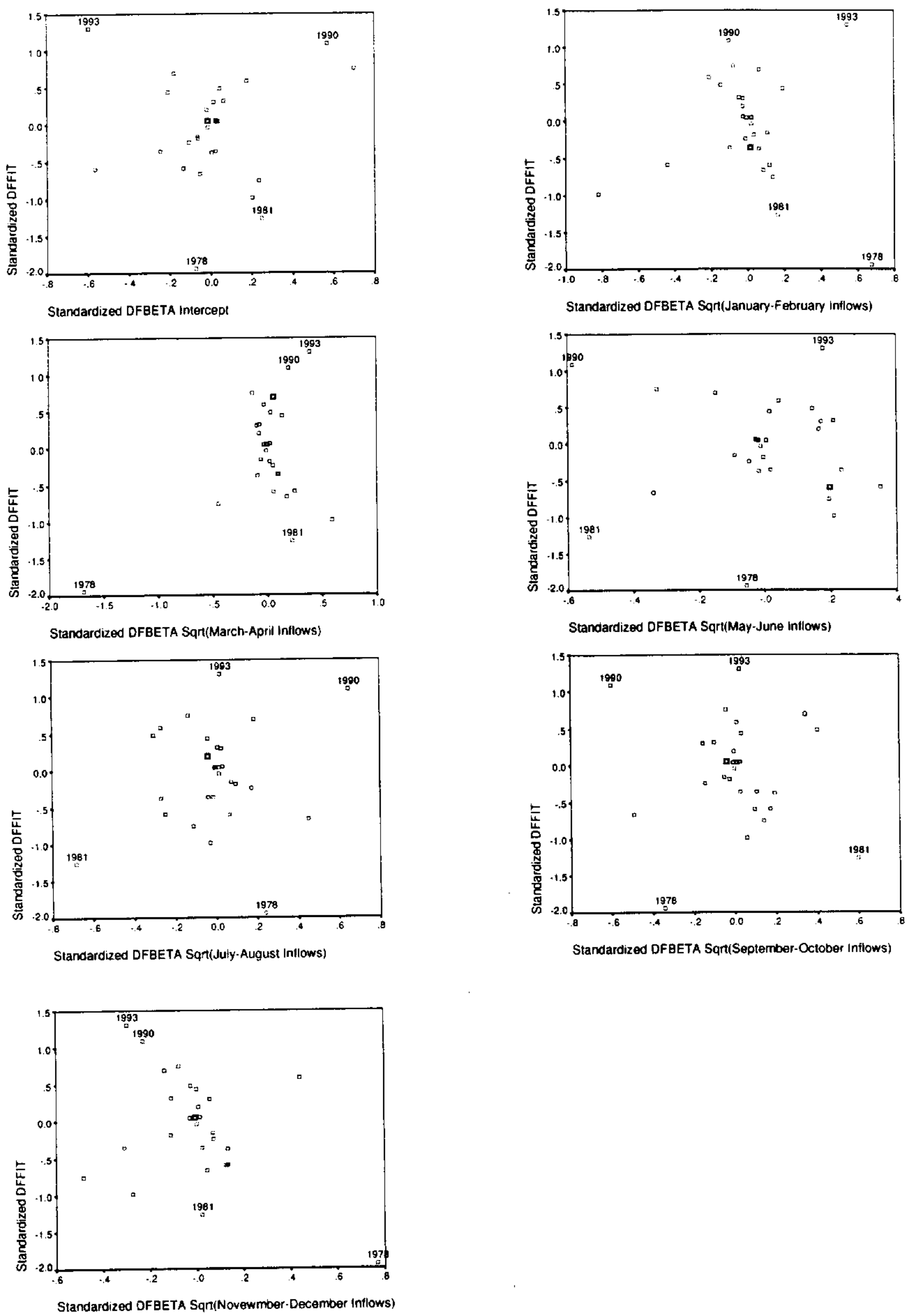


***Figure 6.45*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of square root of inflow variables.*

## 6.4 Regression - Various transformation

### 6.4.1 ANOVA and Parameter Estimates

***Table 6.34*** *Model Summary for various transformation.*

**Model Summary[a,b]**

| Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| Ln(November-December ), (March-April)^(-0.5), (July-August)^(-0.1), (January-February)^(-0.4), (May-June)^(0.4), (September-Octtober)^(-0.1)[c,d] | .523 | .274 | .066 | .192181 | 1.453 |

a. Dependent Variable: Crab^(0.1)

b. Method: Enter

c. Independent Variables: (Constant), Ln(November-December Inflows), (March-April)^(-0.5), (July-August)^(-0.1), (January-February)^(-0.4), (May-June)^(0.4), (September-Octtober)^(-0.1)

d. All requested variables entered.

***Table 6.35*** *ANOVA table of various transformations.*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | .292 | 6 | 4.9E-02 | 1.318 | .293[b] |
| | Residual | .776 | 21 | 3.7E-02 | | |
| | Total | 1.068 | 27 | | | |

a. Dependent Variable: Crab^(0.1)

b. Independent Variables: (Constant), Ln(November-December Inflows), (March-April)^(-0.5), (July-August)^(-0.1), (January-February)^(-0.4), (May-June)^(0.4), (September-Octtober)^(-0.1)

***Table 6.36*** *Table of coefficients for various transformations.*

**Coefficients**[a]

| | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| (Constant) | .263 | .764 | | .344 | .734 | -1.327 | 1.852 |
| (January-February)^(-0.4) | .111 | .601 | .048 | .185 | .855 | -1.138 | 1.361 |
| (March-April)^(-0.5) | -.305 | .492 | -.134 | -.619 | .543 | -1.329 | .719 |
| (May-June)^(0.4) | -7.7E-03 | .021 | -.094 | -.367 | .718 | -.051 | .036 |
| (July-August)^(-0.1) | .863 | .746 | .301 | 1.158 | .260 | -.688 | 2.415 |
| (September-Octtober)^(-0.1) | .853 | .708 | .325 | 1.204 | .242 | -.620 | 2.325 |
| Ln(November-December) | 9.8E-02 | .047 | .502 | 2.063 | .052 | -.001 | .196 |

a. Dependent Variable: Crab^(0.1)

### 6.4.2 Collinearity Diagnostic

***Table 6.37*** *Collinearity Diagnostic for various transformations.*

**Coefficients**[a]

| | t | Collinearity Statistics | |
|---|---|---|---|
| | | Tolerance | VIF |
| (Constant) | .344 | | |
| (January-February)^(-0.4) | .185 | .510 | 1.962 |
| (March-April)^(-0.5) | -.619 | .735 | 1.360 |
| (May-June)^(0.4) | -.367 | .522 | 1.915 |
| (July-August)^(-0.1) | 1.158 | .511 | 1.955 |
| (September-Octtober)^(-0.1) | 1.204 | .475 | 2.105 |
| Ln(November-December) | 2.063 | .584 | 1.712 |

a. Dependent Variable: Crab^(0.1)

***Table 6.38*** *Collinearity Diagnostics(intercept adjusted) for various transformations.*

| Condition Number | Var Prop Eigenvalue | Var Prop Index | Var Prop QR_QJF | Var Prop QR_QMA | Var Prop QR_QMJ | Var Prop QR_QJA | QR_QSO | QR_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.52849 | 1.00000 | 0.0143 | 0.0102 | 0.0478 | 0.0426 | 0.0422 | 0.0525 |
| 2 | 1.64038 | 1.24153 | 0.1175 | 0.1461 | 0.0164 | 0.0334 | 0.0341 | 0.0070 |
| 3 | 0.63026 | 2.00296 | 0.1031 | 0.4983 | 0.0140 | 0.1223 | 0.0279 | 0.2230 |
| 4 | 0.60915 | 2.03736 | 0.0009 | 0.1758 | 0.3170 | 0.0999 | 0.0631 | 0.2718 |
| 5 | 0.31024 | 2.85486 | 0.0042 | 0.0316 | 0.0779 | 0.4673 | 0.7676 | 0.2883 |
| 6 | 0.28148 | 2.99712 | 0.7599 | 0.1380 | 0.5269 | 0.2345 | 0.0651 | 0.1574 |

### 6.4.3 Residuals Diagnostics

***Table 6.39*** *Residuals Diagnostics for various transformations.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 1.449349 | 1.786350 | 1.630886 | .103995 | 28 |
| Std. Predicted Value | -1.746 | 1.495 | .000 | 1.000 | 28 |
| Standard Error of Predicted Value | 6.3E-02 | .126831 | 9.4E-02 | 1.8E-02 | 28 |
| Adjusted Predicted Value | 1.396950 | 1.900417 | 1.638539 | .126178 | 28 |
| Residual | -.335464 | .310857 | -4.0E-17 | .169488 | 28 |
| Std. Residual | -1.746 | 1.618 | .000 | .882 | 28 |
| Stud. Residual | -2.002 | 1.900 | -.016 | 1.036 | 28 |
| Deleted Residual | -.441274 | .428942 | -7.7E-03 | .235214 | 28 |
| Stud. Deleted Residual | -2.172 | 2.038 | -.016 | 1.077 | 28 |
| Mahal. Distance | 1.893 | 10.795 | 5.786 | 2.513 | 28 |
| Cook's Distance | .003 | .311 | .059 | .083 | 28 |
| Centered Leverage Value | .070 | .400 | .214 | .093 | 28 |

a. Dependent Variable: Crab^(0.1)

***Table 6.40*** *Case Values for Residuals Diagnostics for various transformations.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 1.6125 | -.0565 | -.0964 | 1.6524 | -.1764 | -.2941 | -.3841 | -.3762 |
| 1963 | 1.7069 | -.2427 | -.4300 | 1.8942 | .7312 | -1.2629 | -1.6809 | -1.7633 |
| 1965 | 1.6445 | -.0392 | -.0587 | 1.6641 | .1313 | -.2038 | -.2495 | -.2438 |
| 1969 | 1.7547 | -.1018 | -.1269 | 1.7798 | 1.1907 | -.5299 | -.5915 | -.5821 |
| 1971 | 1.4717 | .1140 | .1527 | 1.4330 | -1.5311 | .5933 | .6865 | .6776 |
| 1972 | 1.4493 | .0815 | .1339 | 1.3970 | -1.7456 | .4243 | .5438 | .5344 |
| 1973 | 1.5374 | -.0874 | -.1089 | 1.5589 | -.8988 | -.4546 | -.5075 | -.4983 |
| 1974 | 1.5727 | .2112 | .2463 | 1.5375 | -.5600 | 1.0987 | 1.1866 | 1.1989 |
| 1975 | 1.5249 | .0968 | .1083 | 1.5134 | -1.0193 | .5037 | .5327 | .5234 |
| 1976 | 1.6787 | -.0596 | -.0890 | 1.7081 | .4600 | -.3103 | -.3791 | -.3713 |
| 1977 | 1.7846 | -.1954 | -.3111 | 1.9004 | 1.4784 | -1.0165 | -1.2829 | -1.3041 |
| 1978 | 1.5853 | -.3355 | -.4413 | 1.6911 | -.4385 | -1.7456 | -2.0020 | -2.1720 |
| 1979 | 1.5183 | -.0381 | -.0589 | 1.5392 | -1.0827 | -.1980 | -.2464 | -.2409 |
| 1980 | 1.4607 | -.1301 | -.1731 | 1.5037 | -1.6363 | -.6770 | -.7808 | -.7733 |
| 1981 | 1.4801 | -.2537 | -.3826 | 1.6091 | -1.4495 | -1.3201 | -1.6212 | -1.6915 |
| 1982 | 1.5593 | .0817 | .1024 | 1.5386 | -.6882 | .4250 | .4760 | .4670 |
| 1983 | 1.6576 | .0663 | .0754 | 1.6485 | .2572 | .3448 | .3679 | .3601 |
| 1984 | 1.6625 | -.1203 | -.1483 | 1.6905 | .3038 | -.6259 | -.6950 | -.6862 |
| 1985 | 1.7596 | -.1291 | -.1493 | 1.7798 | 1.2378 | -.6718 | -.7225 | -.7140 |
| 1986 | 1.7864 | .1829 | .2306 | 1.7387 | 1.4949 | .9519 | 1.0687 | 1.0725 |
| 1987 | 1.6971 | .0518 | .0660 | 1.6829 | .6362 | .2695 | .3041 | .2974 |
| 1988 | 1.5746 | .1264 | .1524 | 1.5486 | -.5410 | .6577 | .7222 | .7137 |
| 1989 | 1.7072 | .2775 | .3960 | 1.5887 | .7339 | 1.4441 | 1.7250 | 1.8171 |
| 1990 | 1.6048 | .3109 | .4289 | 1.4867 | -.2510 | 1.6175 | 1.9001 | 2.0377 |
| 1991 | 1.7027 | -.0994 | -.1308 | 1.7340 | .6904 | -.5174 | -.5934 | -.5840 |
| 1992 | 1.7736 | .0911 | .1208 | 1.7440 | 1.3727 | .4741 | .5458 | .5365 |
| 1993 | 1.6943 | .2956 | .3885 | 1.6014 | .6098 | 1.5383 | 1.7634 | 1.8645 |
| 1994 | 1.7026 | -.0990 | -.1111 | 1.7148 | .6900 | -.5150 | -.5456 | -.5363 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that observation |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.
[2]This is flagged if it exceeds $t_{n-p-2,\alpha}=t_{12,0.01}=2.681$.

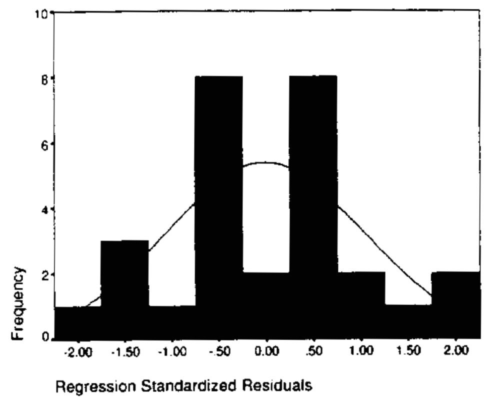


***Figure 6.46*** *Histogram of Standardized Residuals.*

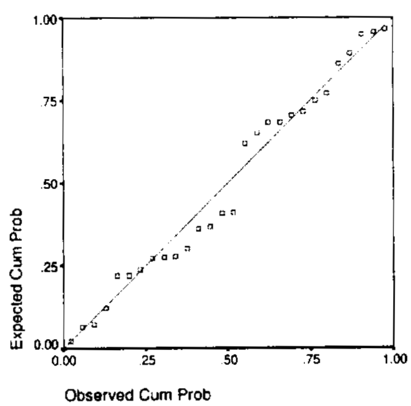


***Figure 6.47*** *Normal P-P Plot of Residuals.*

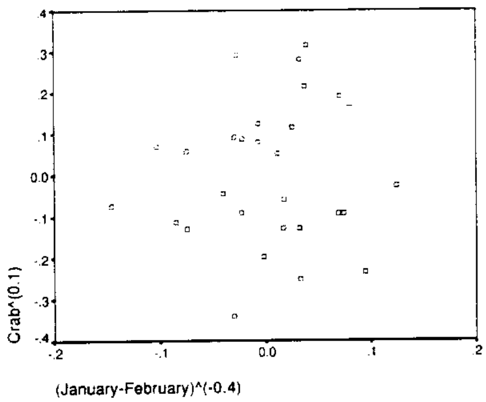


***Figure 6.48*** *Partial Residual Plot for (January-February)^(-0.4).*

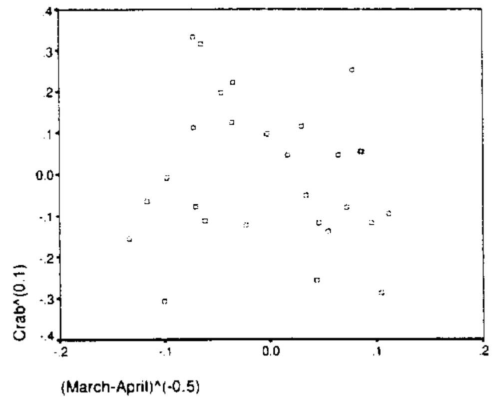


***Figure 6.49*** *Partial Residual Plot for (March-April Inflows)^(-0.5).*

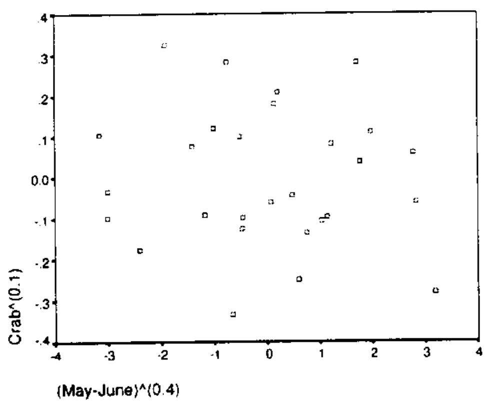


***Figure 6.50*** *Partial Residual Plot for (May-June Inflows)^(0.4).*

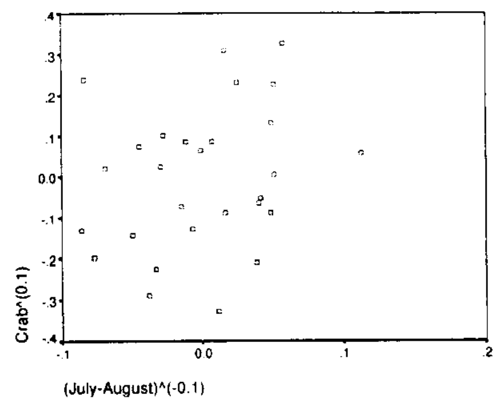


***Figure 6.51*** *Partial Residual Plot for (July-August Inflows)^(-0.1).*

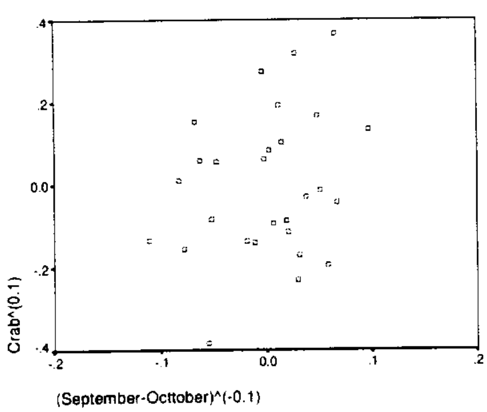


***Figure 6.52*** *Partial Residual Plot for (September-October)^(-0.1).*

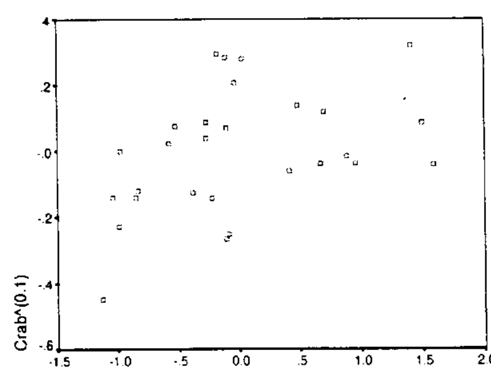


***Figure 6.53*** *Partial Residual Plot for Ln(November-December Inflows).*

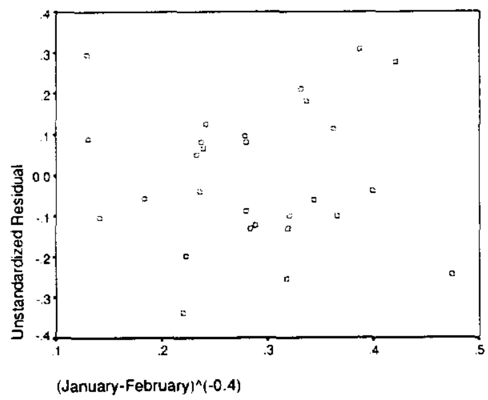


***Figure 6.54*** *Residuals Plot for (January-February)^(-0.4).*

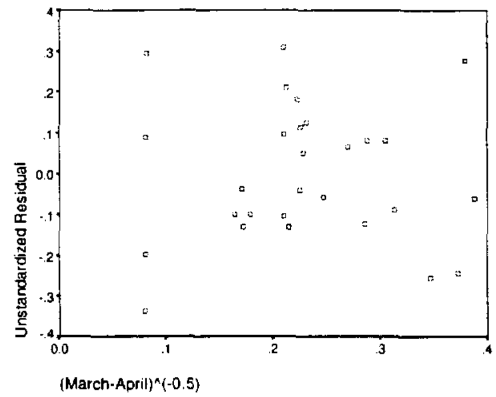


***Figure 6.55*** *Residuals Plot for (March-April Inflows)^(-0.5).*

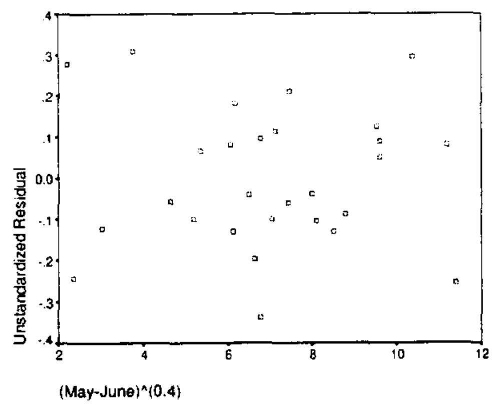


***Figure 6.56*** *Residuals Plot for Sqrt(May-June Inflows)^(0.4).*

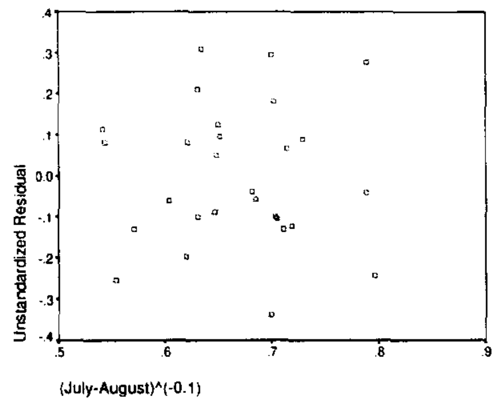


***Figure 6.57*** *Residuals Plot for (July-August Inflows)^(-0.1).*

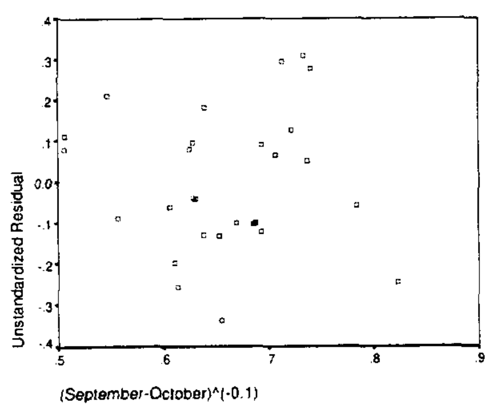


***Figure 6.58*** *Residuals Plot for (September-October Inflows)^(-0.1).*

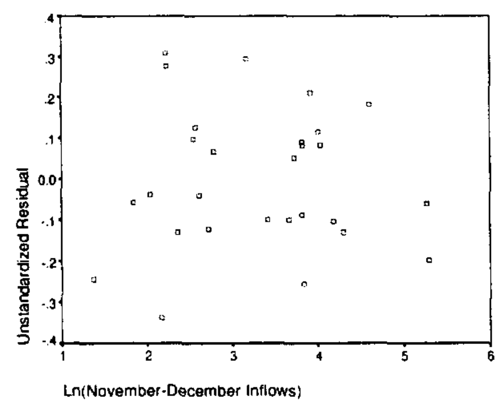


***Figure 6.59*** *Residuals Plot for Ln(November-December Inflows).*

### 6.4.4 Prediction Intervals for Crab Harvest

***Table 6.41*** *Prediction Intervals for Crab Harvest.*

| YEAR | *LICI_1* | *TR_CRAB* | *UICI_1* |
|---|---|---|---|
| 1962 | .9656 | 1.5560 | 2.2595 |
| 1963 | 1.0550 | 1.4642 | 2.3589 |
| 1965 | 1.0164 | 1.6054 | 2.2727 |
| 1969 | 1.1593 | 1.6529 | 2.3501 |
| 1971 | .8626 | 1.5857 | 2.0808 |
| 1972 | .8075 | 1.5309 | 2.0912 |
| 1973 | .9420 | 1.4501 | 2.1329 |
| 1974 | .9910 | 1.7838 | 2.1543 |
| 1975 | .9527 | 1.6217 | 2.0971 |
| 1976 | 1.0511 | 1.6191 | 2.3063 |
| 1977 | 1.1473 | 1.5893 | 2.4220 |
| 1978 | .9794 | 1.2498 | 2.1912 |
| 1979 | .8850 | 1.4802 | 2.1515 |
| 1980 | .8528 | 1.3306 | 2.0687 |
| 1981 | .8510 | 1.2264 | 2.1093 |
| 1982 | .9626 | 1.6410 | 2.1560 |
| 1983 | 1.0814 | 1.7239 | 2.2339 |
| 1984 | 1.0691 | 1.5422 | 2.2558 |
| 1985 | 1.1798 | 1.6305 | 2.3394 |
| 1986 | 1.1887 | 1.9693 | 2.3840 |
| 1987 | 1.0973 | 1.7488 | 2.2968 |
| 1988 | .9859 | 1.7010 | 2.1634 |
| 1989 | 1.0870 | 1.9847 | 2.3274 |
| 1990 | .9903 | 1.9156 | 2.2193 |
| 1991 | 1.0968 | 1.6032 | 2.3085 |
| 1992 | 1.1663 | 1.8647 | 2.3809 |
| 1993 | 1.0886 | 1.9899 | 2.3000 |
| 1994 | 1.1296 | 1.6037 | 2.2757 |

*LICI_1* Lower limit for 99% prediction interval for the log of (Crab harvest)^(0.1).
*TR_CRAB* (Crab harvest)^(0.1)
*UICI_1* Upper limit for 99% prediction interval for (Crab harvest)^(0.1)

### 6.4.5 Outliers and Influential Point Detection

***Table 6.42*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1962 | 10.2038 | .0149 | .3779 | .1773 | .0000 |
| 1963 | 10.7952 | .3114 | .3998 | .1478 | .0594 |
| 1965 | 8.0179 | .0044 | .2970 | .3310 | .0000 |
| 1969 | 4.3646 | .0123 | .1617 | .7370 | .0000 |
| 1971 | 5.8681 | .0228 | .2173 | .5552 | .0000 |
| 1972 | 9.5989 | .0271 | .3555 | .2125 | .0000 |
| 1973 | 4.3694 | .0091 | .1618 | .7364 | .0000 |
| 1974 | 2.8861 | .0335 | .1069 | .8953 | .0001 |
| 1975 | 1.8930 | .0048 | .0701 | .9655 | .0000 |
| 1976 | 7.9548 | .0101 | .2946 | .3366 | .0000 |
| 1977 | 9.0828 | .1393 | .3364 | .2468 | .0062 |
| 1978 | 5.5099 | .1806 | .2041 | .5980 | .0135 |
| 1979 | 8.6026 | .0048 | .3186 | .2825 | .0000 |
| 1980 | 5.7402 | .0288 | .2126 | .5704 | .0000 |
| 1981 | 8.1323 | .1908 | .3012 | .3211 | .0158 |
| 1982 | 4.5073 | .0082 | .1669 | .7198 | .0000 |
| 1983 | 2.3158 | .0027 | .0858 | .9403 | .0000 |
| 1984 | 4.1410 | .0161 | .1534 | .7634 | .0000 |
| 1985 | 2.6894 | .0117 | .0996 | .9122 | .0000 |
| 1986 | 4.6123 | .0425 | .1708 | .7072 | .0001 |
| 1987 | 4.8390 | .0036 | .1792 | .6796 | .0000 |
| 1988 | 3.6468 | .0153 | .1351 | .8194 | .0000 |
| 1989 | 7.1126 | .1814 | .2634 | .4172 | .0137 |
| 1990 | 6.4686 | .1959 | .2396 | .4862 | .0170 |
| 1991 | 5.5084 | .0159 | .2040 | .5982 | .0000 |
| 1992 | 5.6672 | .0139 | .2099 | .5791 | .0000 |
| 1993 | 5.4893 | .1395 | .2033 | .6005 | .0063 |
| 1994 | 1.9824 | .0052 | .0734 | .9608 | .0000 |

| | |
|---|---|
| *MAH_1* | Mahalanobis distance |
| *COOK_1* | Cook's distance |
| *LEV_1* | Leverage value |
| *MAHA_PV* | P-value associated with the Mahalanobis distance |
| *COOK_PV* | P-value associated with Cook's distance |

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.
[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.
[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n-p-1$ denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.43*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1962 | -.3160 | -.1427 | .2237 | -.0912 |
| 1963 | *-1.5489 | .7328 | -.6912 | -.2669 |
| 1965 | -.1722 | -.0056 | .0378 | -.0263 |
| 1969 | -.2886 | .0376 | .1732 | -.0774 |
| 1971 | .3944 | .2282 | .0615 | -.0718 |
| 1972 | .4284 | .3443 | -.2200 | .1505 |
| 1973 | -.2472 | -.0298 | .0405 | -.1367 |
| 1974 | .4890 | .1029 | .1509 | -.1143 |
| 1975 | .1801 | .1247 | -.0517 | -.0037 |
| 1976 | -.2608 | .0768 | -.0244 | -.1305 |
| 1977 | *-1.0039 | -.0723 | .0113 | .5620 |
| 1978 | *-1.2198 | -.5787 | .2364 | .6387 |
| 1979 | -.1784 | .0182 | -.1162 | .0752 |
| 1980 | -.4445 | -.1720 | -.0880 | .1407 |
| 1981 | *-1.2057 | .1789 | -.2103 | -.5591 |
| 1982 | .2354 | -.0499 | -.0127 | .1168 |
| 1983 | .1339 | .0331 | -.0900 | .0643 |
| 1984 | -.3314 | -.1315 | .1768 | -.1069 |
| 1985 | -.2825 | .0999 | -.0392 | .0437 |
| 1986 | .5472 | -.3039 | .2643 | -.1418 |
| 1987 | .1556 | -.0746 | .0114 | .0147 |
| 1988 | .3239 | -.0409 | -.0171 | .0609 |
| 1989 | *1.1871 | -.3628 | .2199 | .4371 |
| 1990 | *1.2559 | .2931 | .2897 | -.4456 |
| 1991 | -.3280 | .0310 | -.1562 | .1992 |
| 1992 | .3061 | -.0955 | -.0427 | -.1143 |
| 1993 | *1.0449 | -.1743 | -.1854 | -.3558 |
| 1994 | -.1877 | .0977 | -.1222 | .1019 |

*SDFFITS* Standardized *dffits* value

*SDFBET_0* Standardized *dfbeta* for the intercept term

*SDFBET_1* Standardized *dfbeta* for (January-February inflows)^(-0.4)

*SDFBET_2* Standardized *dfbeta* for (March-April inflows)^(-0.5)

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

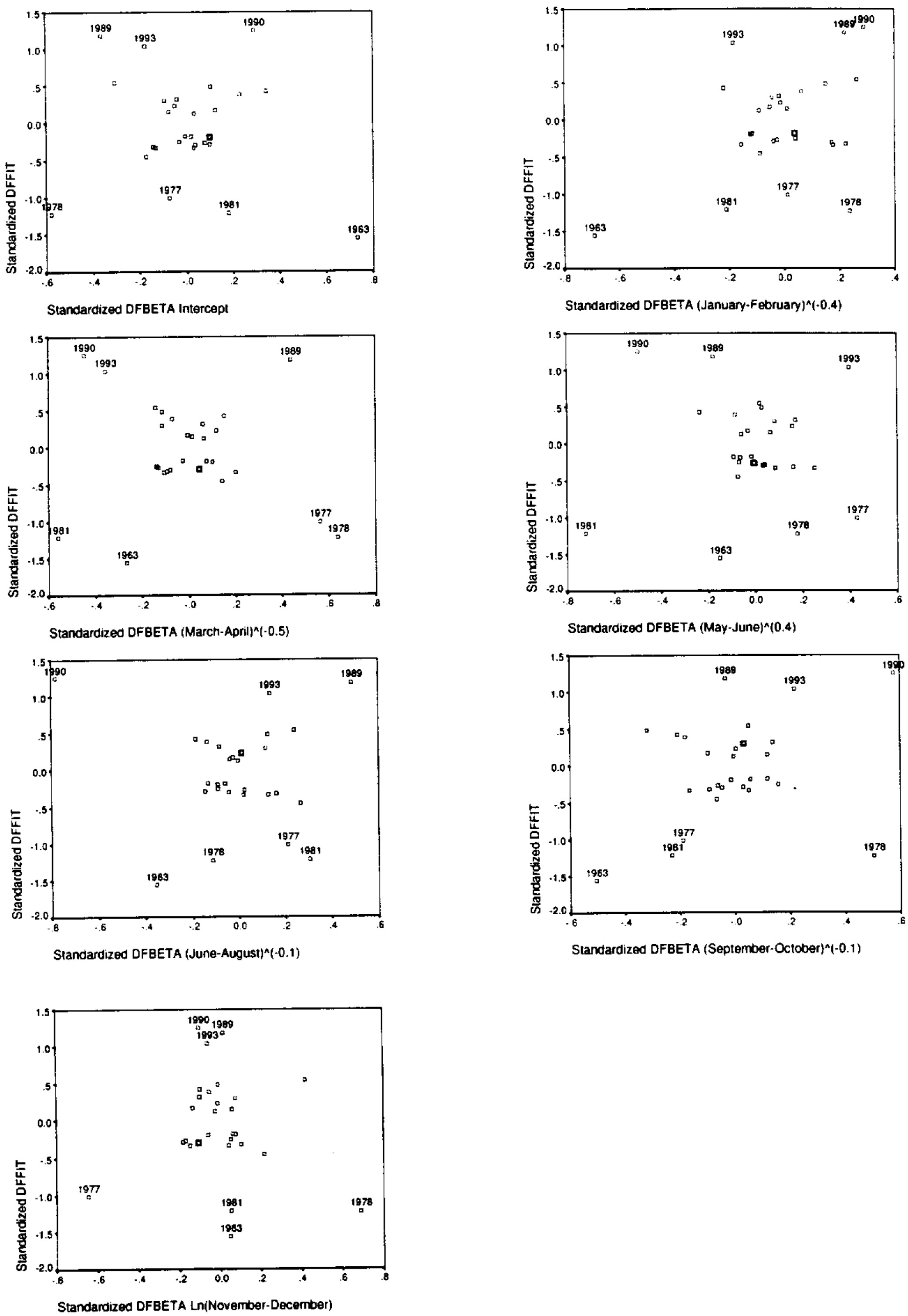


***Figure 6.60*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of various transforms of inflow variables.*

# 7. EXAMINING SUBSETS OF THE DATA

## 7.1 Log of crab data and untransformed inflow data: 1978 Omitted

***Table** 7.1 Regression Models for Dependent Variable: CRAB on INFLOWS: 1978 Omitted*

| In | *Rsq* | *Adj Rsq* | *C(p)* | *AIC* | *MSE* | *SBC* | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.2219 | 0.1908 | 2.408 | 3.809 | 1.072 | 6.401 | QJA_LAG |
| 1 | 0.1229 | 0.0878 | 5.640 | 7.042 | 1.209 | 9.634 | QJF_LAG |
| 1 | 0.0924 | 0.0561 | 6.637 | 7.966 | 1.251 | 10.56 | QMA_LAG |
| 1 | 0.0337 | -.0049 | 8.552 | 9.657 | 1.332 | 12.25 | QSO_LAG |
| 2 | 0.3036 | 0.2456 | 1.739 | 2.813 | 1.000 | 6.701 | QJA_LAG QSO_LAG |
| 2 | 0.2790 | 0.2189 | 2.544 | 3.752 | 1.035 | 7.640 | QJF_LAG QJA_LAG |
| 2 | 0.2774 | 0.2172 | 2.595 | 3.810 | 1.037 | 7.698 | QMA_LAG QJA_LAG |
| 2 | 0.2342 | 0.1704 | 4.006 | 5.379 | 1.099 | 9.266 | QJA_LAG QND_LAG |
| 3 | 0.3662 | 0.2836 | 1.694 | 2.269 | 0.949 | 7.453 | QMA_LAG QJA_LAG QSO_LAG |
| 3 | 0.3638 | 0.2808 | 1.775 | 2.374 | 0.953 | 7.558 | QJF_LAG QJA_LAG QSO_LAG |
| 3 | 0.3179 | 0.2289 | 3.273 | 4.254 | 1.022 | 9.437 | QJF_LAG QMJ_LAG QJA_LAG |
| 3 | 0.3126 | 0.2229 | 3.447 | 4.464 | 1.030 | 9.647 | QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.3771 | 0.2638 | 3.341 | 3.804 | 0.976 | 10.28 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG |
| 4 | 0.3731 | 0.2592 | 3.469 | 3.974 | 0.982 | 10.45 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 4 | 0.3709 | 0.2565 | 3.542 | 4.070 | 0.985 | 10.55 | QJF_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.3679 | 0.2530 | 3.640 | 4.198 | 0.990 | 10.68 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.3854 | 0.2391 | 5.067 | 5.438 | 1.008 | 13.21 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.3804 | 0.2328 | 5.233 | 5.660 | 1.017 | 13.43 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.3789 | 0.2310 | 5.281 | 5.724 | 1.019 | 13.50 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.3681 | 0.2176 | 5.634 | 6.190 | 1.037 | 13.97 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.3875 | 0.2038 | 7.000 | 7.348 | 1.055 | 16.42 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 27

***Table 7.2*** *Analysis of Variance for Dependent Variable: Ln(CRAB) on INFLOWS: 1978 Omitted*

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 6 | 13.35147 | 2.22524 | 2.109 | 0.0976 |
| Error | 20 | 21.10373 | 1.05519 | | |
| C Total | 26 | 34.45520 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 1.02722 | R-square | 0.3875 |
| Dep Mean | 4.91409 | Adj R-sq | 0.2038 |
| C.V. | 20.90363 | | |

***Table 7.3*** *Parameter Estimates for Dependent Variable: Ln(CRAB) on INFLOWS: 1978 Omitted*

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 5.083245 | 0.40636185 | 12.509 | 0.0001 | 0.00000000 |
| QJF_LAG | 1 | 0.005725 | 0.00718955 | 0.796 | 0.4352 | 2.47826694 |
| QMA_LAG | 1 | 0.003324 | 0.00688937 | 0.482 | 0.6347 | 2.21289839 |
| QMJ_LAG | 1 | -0.001117 | 0.00210852 | -0.530 | 0.6020 | 1.57068115 |
| QJA_LAG | 1 | -0.006287 | 0.00294077 | -2.138 | 0.0450 | 3.41638489 |
| QSO_LAG | 1 | 0.001987 | 0.00147036 | 1.351 | 0.1916 | 2.92160712 |
| QND_LAG | 1 | 0.001157 | 0.00446294 | 0.259 | 0.7981 | 1.22318121 |

***Table 7.4*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(CRAB) on INFLOWS: 1978 Omitted*

| Number | Eigenvalue | Condition Index | Var Prop QJF_LAG | Var Prop QMA_LAG | Var Prop QMJ_LAG | Var Prop QJA_LAG | Var Prop QSO_LAG | Var Prop QND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.15555 | 1.00000 | 0.0540 | 0.0478 | 0.0122 | 0.0291 | 0.0361 | 0.0002 |
| 2 | 1.73859 | 1.11348 | 0.0205 | 0.0389 | 0.0726 | 0.0403 | 0.0350 | 0.0691 |
| 3 | 1.00945 | 1.46129 | 0.0091 | 0.0254 | 0.1883 | 0.0100 | 0.0001 | 0.4755 |
| 4 | 0.67526 | 1.78667 | 0.0777 | 0.0696 | 0.3515 | 0.0010 | 0.0985 | 0.2378 |
| 5 | 0.26976 | 2.82680 | 0.5296 | 0.7149 | 0.0000 | 0.0848 | 0.0958 | 0.1987 |
| 6 | 0.15139 | 3.77334 | 0.3090 | 0.1033 | 0.3755 | 0.8349 | 0.7346 | 0.0187 |

***Table** 7.5 Parameter Estimates of Models for Dependent Variable: Ln(CRAB) on INFLOWS: 1978 Omitted*

| OBS | _RMSE_ | INTERCEP | QJF_LAG | QMA_LAG | QMJ_LAG | QJA_LAG | QSO_LAG | QND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.03556 | 5.37125 | . | . | . | -.0042827 | . | . |
| 2 | 1.09946 | 4.56358 | .0091493 | . | . | . | . | . |
| 3 | 1.11843 | 4.64462 | . | .0080437 | . | . | . | . |
| 4 | 1.15400 | 5.04855 | . | . | . | . | -.0009028 | . |
| 5 | 0.99988 | 5.37989 | . | . | . | . | -.0009028 | . |
| 6 | 1.01741 | 5.06351 | .0064458 | . | . | -.0074604 | 0.0022195 | . |
| 7 | 1.01851 | 5.12507 | . | .0063077 | . | -.0039560 | . | . |
| 8 | 1.04853 | 5.27165 | . | . | . | -.0044614 | . | .0025970 |
| 9 | 0.97438 | 5.11848 | . | .0067075 | . | -.0072524 | 0.0023169 | . |
| 10 | 0.97628 | 5.06407 | .0066184 | . | . | -.0069354 | 0.0022614 | . |
| 11 | 1.01085 | 5.22794 | .0092758 | . | -.0022067 | -.0029855 | . | . |
| 12 | 1.01480 | 5.29462 | . | . | . | -.0075525 | 0.0021772 | .0022192 |
| 13 | 0.98773 | 5.03619 | .0037927 | .0041752 | . | -.0070301 | 0.0023041 | . |
| 14 | 0.99084 | 5.15079 | .0080895 | . | -.0011648 | -.0061267 | 0.0019634 | . |
| 15 | 0.99261 | 4.99241 | .0065233 | . | . | -.0070252 | 0.0022230 | .0019829 |
| 16 | 0.99496 | 5.16566 | . | .0070525 | -.0004500 | -.0069743 | 0.0022032 | . |
| 17 | 1.00415 | 5.11932 | .0052897 | .0040212 | -.0011028 | -.0062609 | 0.0020204 | . |
| 18 | 1.00828 | 5.07909 | .0080022 | . | -.0011715 | -.0062126 | 0.0019229 | .0019979 |
| 19 | 1.00948 | 5.00105 | .0041852 | .0035179 | . | -.0070647 | 0.0022762 | .0010938 |
| 20 | 1.01823 | 5.15652 | . | .0069256 | -.0004390 | -.0069984 | 0.0021980 | .0003278 |
| 21 | 1.02722 | 5.08325 | .0057248 | .0033237 | -.0011174 | -.0062874 | 0.0019871 | .0011572 |

***Table** 7.6 Criteria Statistics of Models for Dependent Variable: Ln(CRAB) on INFLOWS: 1978 Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 1.07239 | 0.22189 | 0.19077 | 2.40761 | 3.80910 | 6.4008 |
| 2 | 1.20881 | 0.12291 | 0.08783 | 5.63967 | 7.04219 | 9.6339 |
| 3 | 1.25089 | 0.09238 | 0.05608 | 6.63659 | 7.96605 | 10.5577 |
| 4 | 1.33172 | 0.03373 | -0.00492 | 8.55178 | 9.65679 | 12.2485 |
| 5 | 0.99976 | 0.30361 | 0.24558 | 1.73931 | 2.81335 | 6.7009 |
| 6 | 1.03513 | 0.27898 | 0.21889 | 2.54373 | 3.75199 | 7.6395 |
| 7 | 1.03737 | 0.27741 | 0.21720 | 2.59475 | 3.81044 | 7.6980 |
| 8 | 1.09942 | 0.23419 | 0.17037 | 4.00606 | 5.37897 | 9.2665 |
| 9 | 0.94942 | 0.36623 | 0.28357 | 1.69450 | 2.26921 | 7.4526 |
| 10 | 0.95312 | 0.36376 | 0.28077 | 1.77525 | 2.37437 | 7.5577 |
| 11 | 1.02182 | 0.31790 | 0.22893 | 3.27269 | 4.25354 | 9.4369 |
| 12 | 1.02982 | 0.31256 | 0.22290 | 3.44706 | 4.46410 | 9.6474 |
| 13 | 0.97561 | 0.37706 | 0.26380 | 3.34096 | 3.80397 | 10.2832 |
| 14 | 0.98176 | 0.37313 | 0.25916 | 3.46919 | 3.97365 | 10.4528 |
| 15 | 0.98527 | 0.37089 | 0.25651 | 3.54232 | 4.06994 | 10.5491 |
| 16 | 0.98994 | 0.36791 | 0.25299 | 3.63974 | 4.19767 | 10.6769 |
| 17 | 1.00832 | 0.38544 | 0.23912 | 5.06723 | 5.43816 | 13.2132 |
| 18 | 1.01663 | 0.38037 | 0.23284 | 5.23274 | 5.65994 | 13.4350 |
| 19 | 1.01905 | 0.37890 | 0.23102 | 5.28085 | 5.72406 | 13.4991 |
| 20 | 1.03680 | 0.36809 | 0.21763 | 5.63403 | 6.19020 | 13.9652 |
| 21 | 1.05519 | 0.38750 | 0.20375 | 7.00000 | 7.34755 | 16.4184 |

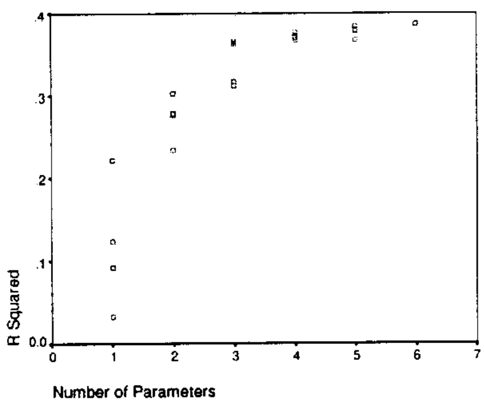


***Figure 7.1*** *The $R^2$ criteria vs. Number of parameters.*

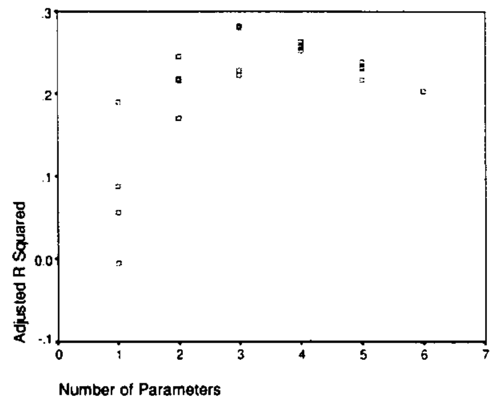


***Figure 7.2*** *The Adjusted $R^2$ criteria vs. Number of parameters.*

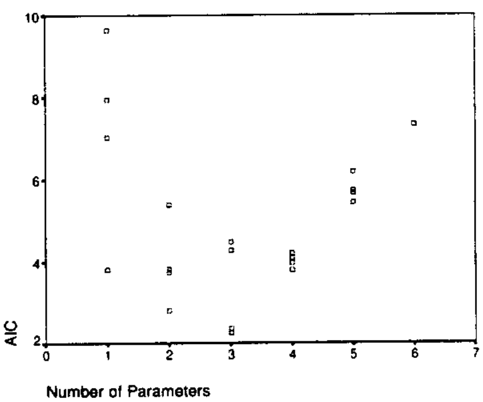


***Figure 7.3*** *The AIC criteria vs. Number of parameters..*

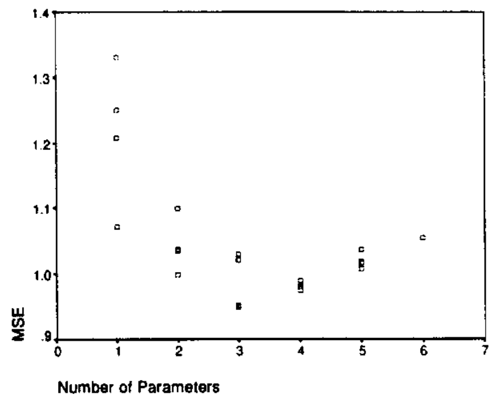


***Figure 7.4*** *MSE vs. Number of parameters.*

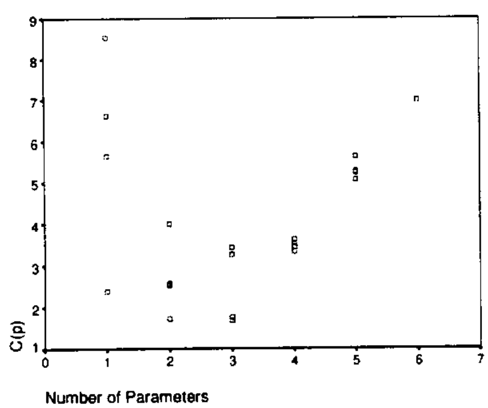


***Figure 7.5*** *The C(p) criteria vs. Number of parameters.*

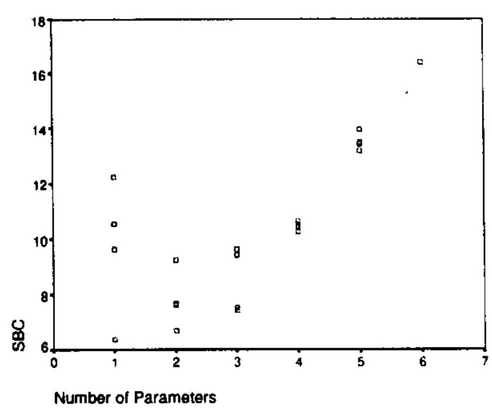


***Figure 7.6*** *The SBC criteria vs. Number of parameters.*

## 7.2 Log of crab data and square root inflow data: 1978 Omitted

***Table** 7.7 Regression Models for Dependent Variable: Ln(CRAB) on Ln(INFLOWS): 1978 Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.1744 | 0.1414 | 1.893 | 5.408 | 1.138 | 8.000 | LN_QJA |
| 1 | 0.0880 | 0.0516 | 4.497 | 8.095 | 1.257 | 10.69 | LN_QMA |
| 1 | 0.0701 | 0.0329 | 5.040 | 8.622 | 1.282 | 11.21 | LN_QSO |
| 1 | 0.0622 | 0.0247 | 5.277 | 8.849 | 1.292 | 11.44 | LN_QJF |
| 2 | 0.2527 | 0.1905 | 1.532 | 4.717 | 1.073 | 8.605 | LN_QMA LN_QJA |
| 2 | 0.2489 | 0.1863 | 1.649 | 4.857 | 1.078 | 8.744 | LN_QJA LN_QND |
| 2 | 0.2118 | 0.1461 | 2.766 | 6.157 | 1.132 | 10.04 | LN_QJF LN_QJA |
| 2 | 0.1760 | 0.1073 | 3.846 | 7.357 | 1.183 | 11.24 | LN_QMJ LN_QJA |
| 3 | 0.2999 | 0.2086 | 2.110 | 4.957 | 1.049 | 10.14 | LN_QMA LN_QJA LN_QND |
| 3 | 0.2656 | 0.1698 | 3.145 | 6.250 | 1.100 | 11.43 | LN_QJA LN_QSO LN_QND |
| 3 | 0.2630 | 0.1669 | 3.221 | 6.343 | 1.104 | 11.53 | LN_QJF LN_QJA LN_QND |
| 3 | 0.2608 | 0.1644 | 3.288 | 6.423 | 1.107 | 11.61 | LN_QMA LN_QMJ LN_QJA |
| 4 | 0.3244 | 0.2015 | 3.372 | 5.997 | 1.058 | 12.48 | LN_QMA LN_QMJ LN_QJA LN_QND |
| 4 | 0.3093 | 0.1838 | 3.825 | 6.591 | 1.082 | 13.07 | LN_QMA LN_QJA LN_QSO LN_QND |
| 4 | 0.2999 | 0.1726 | 4.110 | 6.957 | 1.096 | 13.44 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.2876 | 0.1581 | 4.480 | 7.426 | 1.116 | 13.91 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 5 | 0.3325 | 0.1736 | 5.126 | 7.668 | 1.095 | 15.44 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.3317 | 0.1726 | 5.151 | 7.702 | 1.097 | 15.48 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.3096 | 0.1453 | 5.816 | 8.579 | 1.133 | 16.35 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.2934 | 0.1251 | 6.307 | 9.208 | 1.159 | 16.98 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.3367 | 0.1377 | 7.000 | 9.499 | 1.143 | 18.57 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 27

**Table 7.8** *Analysis of Variance for Dependent Variable: Ln(CRAB) on Ln(INFLOWS): 1978 Omitted*

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 6 | 11.60108 | 1.93351 | 1.692 | 0.1748 |
| Error | 20 | 22.85412 | 1.14271 | | |
| C Total | 26 | 34.45520 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 1.06897 | R-square | 0.3367 |
| Dep Mean | 4.91409 | Adj R-sq | 0.1377 |
| C.V. | 21.75325 | | |

**Table 7.9** *Parameter Estimates for Dependent Variable: Ln(CRAB) on Ln(INFLOWS): 1978 Omitted*

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 5.372368 | 1.34308719 | 4.000 | 0.0007 | 0.00000000 |
| LN_QJF | 1 | 0.142023 | 0.36550575 | 0.389 | 0.7017 | 2.17231297 |
| LN_QMA | 1 | 0.338679 | 0.29627665 | 1.143 | 0.2665 | 1.46992970 |
| LN_QMJ | 1 | -0.269186 | 0.29792911 | -0.904 | 0.3770 | 2.37197326 |
| LN_QJA | 1 | -0.370488 | 0.28504649 | -1.300 | 0.2085 | 2.10337012 |
| LN_QSO | 1 | -0.095112 | 0.26838892 | -0.354 | 0.7268 | 2.35376214 |
| LN_QND | 1 | 0.369111 | 0.27298898 | 1.352 | 0.1914 | 1.75615569 |

**Table 7.10** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(CRAB) on Ln(INFLOWS): 1978 Omitted*

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop LN_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop LN_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.59083 | 1.00000 | 0.0081 | 0.0125 | 0.0424 | 0.0360 | 0.0351 | 0.0519 |
| 2 | 1.78834 | 1.20363 | 0.1000 | 0.1171 | 0.0090 | 0.0330 | 0.0329 | 0.0009 |
| 3 | 0.58056 | 2.11250 | 0.0000 | 0.0002 | 0.1214 | 0.2069 | 0.0166 | 0.5466 |
| 4 | 0.50784 | 2.25869 | 0.1749 | 0.8570 | 0.0937 | 0.0216 | 0.0188 | 0.0101 |
| 5 | 0.29319 | 2.97265 | 0.0031 | 0.0002 | 0.0385 | 0.4452 | 0.7656 | 0.3268 |
| 6 | 0.23923 | 3.29085 | 0.7138 | 0.0131 | 0.6950 | 0.2573 | 0.1310 | 0.0638 |

***Table** 7.11 Parameter Estimates of Models for Dependent Variable: Ln(CRAB) on Ln(INFLOWS): 1978 Omitted*

| OBS | _RMSE_ | INTERCEP | LN_QJF | LN_QMA | LN_QMJ | LN_QJA | LN_QSO | LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.06668 | 6.77088 | . | . | . | -0.45074 | . | . |
| 2 | 1.12110 | 3.69716 | . | 0.39817 | . | . | . | . |
| 3 | 1.13210 | 5.99338 | . | . | . | . | -0.25427 | . |
| 4 | 1.13687 | 3.81480 | 0.33962 | . | . | . | . | . |
| 5 | 1.03576 | 5.57121 | . | 0.37581 | . | -0.43833 | . | . |
| 6 | 1.03845 | 6.18920 | . | . | . | -0.58470 | . | 0.33904 |
| 7 | 1.06375 | 5.79004 | 0.26582 | . | . | -0.42150 | . | . |
| 8 | 1.08764 | 6.64277 | . | . | 0.04789 | -0.47393 | . | . |
| 9 | 1.02410 | 5.30414 | . | 0.31086 | . | -0.54974 | . | 0.27652 |
| 10 | 1.04892 | 6.28046 | . | . | . | -0.48483 | -0.18150 | 0.41912 |
| 11 | 1.05072 | 5.63500 | 0.17112 | . | . | -0.54810 | . | 0.29403 |
| 12 | 1.05229 | 5.70908 | . | 0.43365 | -0.12056 | -0.37803 | . | . |
| 13 | 1.02867 | 5.49796 | . | 0.40197 | -0.21803 | -0.46384 | . | 0.33400 |
| 14 | 1.04004 | 5.42993 | . | 0.29103 | . | -0.47608 | -0.13790 | 0.34135 |
| 15 | 1.04712 | 5.30024 | 0.00215 | 0.30978 | . | -0.54940 | . | 0.27617 |
| 16 | 1.05626 | 5.61807 | 0.33673 | . | -0.24986 | -0.42597 | . | 0.33733 |
| 17 | 1.04648 | 5.24332 | 0.17543 | 0.34428 | -0.28983 | -0.40789 | . | 0.32441 |
| 18 | 1.04714 | 5.60130 | . | 0.38069 | -0.20909 | -0.40220 | -0.12201 | 0.38900 |
| 19 | 1.06429 | 5.48754 | -0.02942 | 0.30507 | . | -0.47825 | -0.14253 | 0.34831 |
| 20 | 1.07675 | 5.76219 | 0.29450 | . | -0.22642 | -0.38179 | -0.11148 | 0.38947 |
| 21 | 1.06897 | 5.37237 | 0.14202 | 0.33868 | -0.26919 | -0.37049 | -0.09511 | 0.36911 |

***Table** 7.12 Criteria Statistics of Models for Dependent Variable: Ln(CRAB) on Ln(INFLOWS): 1978 Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 1.13781 | 0.17443 | 0.14140 | 1.89296 | 5.40798 | 7.9997 |
| 2 | 1.25686 | 0.08805 | 0.05157 | 4.49739 | 8.09464 | 10.6863 |
| 3 | 1.28164 | 0.07006 | 0.03287 | 5.03968 | 8.62194 | 11.2136 |
| 4 | 1.29248 | 0.06220 | 0.02469 | 5.27681 | 8.84931 | 11.4410 |
| 5 | 1.07281 | 0.25273 | 0.19046 | 1.53195 | 4.71741 | 8.6049 |
| 6 | 1.07837 | 0.24886 | 0.18626 | 1.64873 | 4.85698 | 8.7445 |
| 7 | 1.13157 | 0.21180 | 0.14611 | 2.76615 | 6.15726 | 10.0448 |
| 8 | 1.18297 | 0.17600 | 0.10733 | 3.84561 | 7.35656 | 11.2441 |
| 9 | 1.04879 | 0.29990 | 0.20858 | 2.10962 | 4.95686 | 10.1402 |
| 10 | 1.10024 | 0.26555 | 0.16976 | 3.14521 | 6.24995 | 11.4333 |
| 11 | 1.10402 | 0.26303 | 0.16690 | 3.22130 | 6.34256 | 11.5259 |
| 12 | 1.10732 | 0.26083 | 0.16441 | 3.28776 | 6.42319 | 11.6065 |
| 13 | 1.05816 | 0.32435 | 0.20151 | 3.37236 | 5.99702 | 12.4762 |
| 14 | 1.08169 | 0.30933 | 0.18376 | 3.82522 | 6.59063 | 13.0698 |
| 15 | 1.09646 | 0.29990 | 0.17261 | 4.10957 | 6.95680 | 13.4360 |
| 16 | 1.11568 | 0.28762 | 0.15810 | 4.47975 | 7.42616 | 13.9053 |
| 17 | 1.09513 | 0.33254 | 0.17362 | 5.12559 | 7.66796 | 15.4430 |
| 18 | 1.09651 | 0.33169 | 0.17257 | 5.15098 | 7.70201 | 15.4770 |
| 19 | 1.13271 | 0.30963 | 0.14525 | 5.81635 | 8.57913 | 16.3541 |
| 20 | 1.15940 | 0.29336 | 0.12512 | 6.30672 | 9.20779 | 16.9828 |
| 21 | 1.14271 | 0.33670 | 0.13771 | 7.00000 | 9.49895 | 18.5698 |

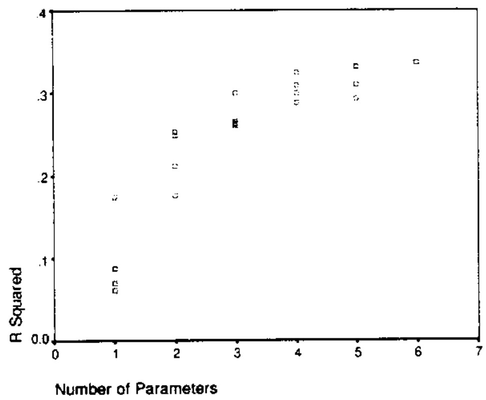


***Figure 7.7*** *The $R^2$ criteria vs. Number of parameters.*

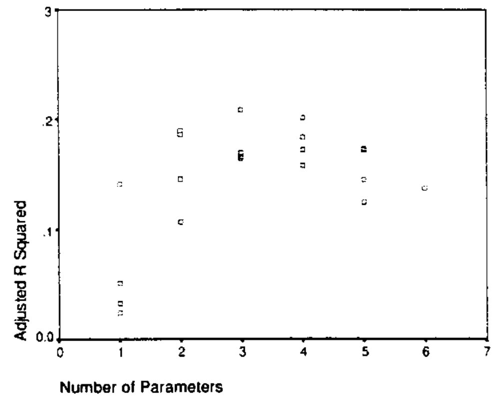


***Figure 7.8*** *The Adjusted $R^2$ criteria vs. Number of parameters.*

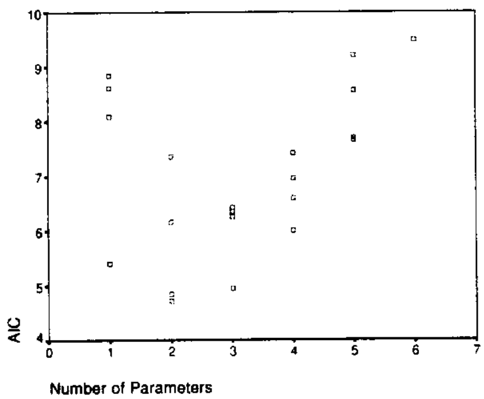


***Figure 7.9*** *The AIC criteria vs. Number of parameters..*

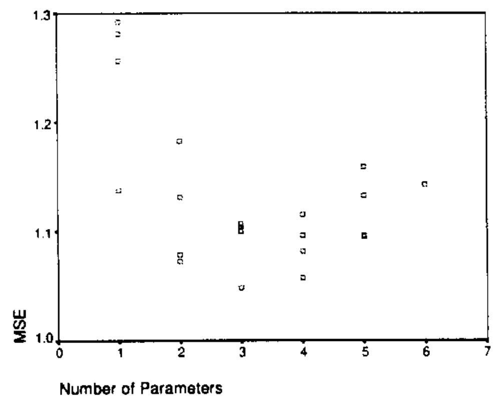


***Figure 7.10*** *MSE vs. Number of parameters.*

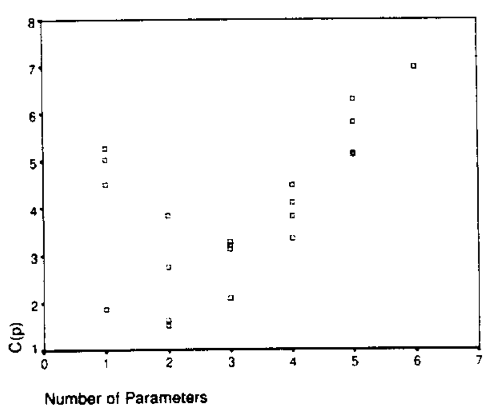


***Figure 7.11*** *The C(p) criteria vs. Number of parameters.*

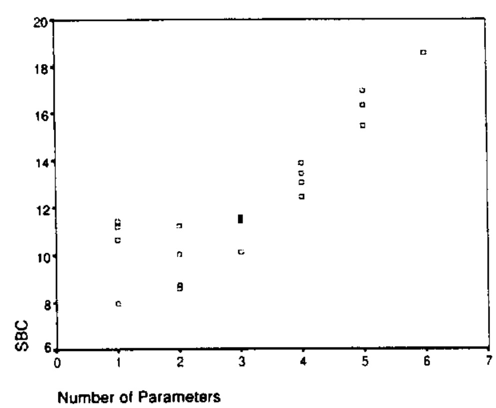


***Figure 7.12*** *The SBC criteria vs. Number of parameters.*

## 7.3 Log of crab data and square root inflow data: 1978 Omitted

***Table 7.13*** *Regression Models for Dependent Variable: Ln(CRAB) on Sqrt(INFLOWS): 1978 Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.2215 | 0.1903 | 0.669 | 3.824 | 1.073 | 6.416 | SQR_QJA |
| 1 | 0.0972 | 0.0611 | 4.446 | 7.822 | 1.244 | 10.41 | SQR_QJF |
| 1 | 0.0924 | 0.0561 | 4.593 | 7.966 | 1.251 | 10.56 | SQR_QMA |
| 1 | 0.0570 | 0.0192 | 5.671 | 9.000 | 1.300 | 11.59 | SQR_QSO |
| 2 | 0.2810 | 0.2211 | 0.859 | 3.675 | 1.032 | 7.563 | SQR_QMA SQR_QJA |
| 2 | 0.2615 | 0.1999 | 1.453 | 4.400 | 1.060 | 8.287 | SQR_QJA SQR_QND |
| 2 | 0.2609 | 0.1993 | 1.470 | 4.420 | 1.061 | 8.308 | SQR_QJF SQR_QJA |
| 2 | 0.2425 | 0.1793 | 2.031 | 5.086 | 1.088 | 8.973 | SQR_QJA SQR_QSO |
| 3 | 0.3071 | 0.2167 | 2.067 | 4.680 | 1.038 | 9.863 | SQR_QMA SQR_QJA SQR_QSO |
| 3 | 0.2999 | 0.2086 | 2.285 | 4.957 | 1.049 | 10.14 | SQR_QMA SQR_QJA SQR_QND |
| 3 | 0.2924 | 0.2001 | 2.512 | 5.244 | 1.060 | 10.43 | SQR_QMA SQR_QMJ SQR_QJA |
| 3 | 0.2895 | 0.1968 | 2.601 | 5.355 | 1.064 | 10.54 | SQR_QJF SQR_QJA SQR_QND |
| 4 | 0.3167 | 0.1924 | 3.774 | 6.302 | 1.070 | 12.78 | SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 4 | 0.3165 | 0.1922 | 3.781 | 6.310 | 1.071 | 12.79 | SQR_QJF SQR_QMJ SQR_QJA SQR_QND |
| 4 | 0.3148 | 0.1902 | 3.832 | 6.376 | 1.073 | 12.86 | SQR_QMA SQR_QMJ SQR_QJA SQR_QSO |
| 4 | 0.3135 | 0.1887 | 3.871 | 6.427 | 1.075 | 12.91 | SQR_QMA SQR_QMJ SQR_QJA SQR_QND |
| 5 | 0.3300 | 0.1704 | 5.370 | 7.771 | 1.099 | 15.55 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QND |
| 5 | 0.3290 | 0.1693 | 5.399 | 7.810 | 1.101 | 15.58 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO |
| 5 | 0.3265 | 0.1661 | 5.476 | 7.911 | 1.105 | 15.69 | SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.3264 | 0.1660 | 5.480 | 7.917 | 1.105 | 15.69 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 6 | 0.3422 | 0.1448 | 7.000 | 9.276 | 1.133 | 18.35 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

N = 27

***Table 7.14*** *Analysis of Variance for Dependent Variable: Ln(CRAB) on Sqrt(INFLOWS): 1978 Omitted*

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 6 | 11.78893 | 1.96482 | 1.734 | 0.1649 |
| Error | 20 | 22.66628 | 1.13331 | | |
| C Total | 26 | 34.45520 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 1.06457 | R-square | 0.3422 |
| Dep Mean | 4.91409 | Adj R-sq | 0.1448 |
| C.V. | 21.66367 | | |

***Table 7.15*** *Parameter Estimates for Dependent Variable: Ln(CRAB) on Sqrt(INFLOWS): 1978 Omitted*

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 5.082618 | 0.72219784 | 7.038 | 0.0001 | 0.00000000 |
| SQR_QJF | 1 | 0.077065 | 0.11170928 | 0.690 | 0.4982 | 2.23357128 |
| SQR_QMA | 1 | 0.069437 | 0.10017965 | 0.693 | 0.4962 | 1.77722439 |
| SQR_QMJ | 1 | -0.043402 | 0.05408552 | -0.802 | 0.4317 | 1.66524749 |
| SQR_QJA | 1 | -0.111997 | 0.06594704 | -1.698 | 0.1050 | 2.62985736 |
| SQR_QSO | 1 | 0.027290 | 0.04485694 | 0.608 | 0.5498 | 2.29702998 |
| SQR_QND | 1 | 0.048068 | 0.07609140 | 0.632 | 0.5347 | 1.30321329 |

***Table 7.16*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(CRAB) on Sqrt(INFLOWS): 1978 Omitted*

| Number | Eigenvalue | Condition Index | Var Prop SQR_QJF | Var Prop SQR_QMA | Var Prop SQR_QMJ | Var Prop SQR_QJA | Var Prop SQR_QSO | Var Prop SQR_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.13583 | 1.00000 | 0.0150 | 0.0085 | 0.0097 | 0.0666 | 0.0745 | 0.0438 |
| 2 | 2.00396 | 1.03238 | 0.0729 | 0.0890 | 0.0754 | 0.0006 | 0.0001 | 0.0387 |
| 3 | 0.78667 | 1.64773 | 0.0077 | 0.0492 | 0.2635 | 0.0303 | 0.0013 | 0.4951 |
| 4 | 0.52615 | 2.01479 | 0.0184 | 0.2853 | 0.2556 | 0.0378 | 0.1490 | 0.3721 |
| 5 | 0.34029 | 2.50528 | 0.5278 | 0.4482 | 0.0374 | 0.1048 | 0.2706 | 0.0029 |
| 6 | 0.20710 | 3.21136 | 0.3582 | 0.1197 | 0.3584 | 0.7599 | 0.5045 | 0.0473 |

***Table** 7.17 Parameter Estimates of Models for Dependent Variable: Ln(CRAB) on Sqrt(INFLOWS): 1978 Omitted*

| OBS | _RMSE_ | INTERCEP | SQR_QJF | SQR_QMA | SQR_QMJ | SQR_QJA | SQR_QSO | SQR_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.03586 | 5.86589 | . | . | . | -0.10552 | . | . |
| 2 | 1.11544 | 4.20094 | 0.12851 | . | . | . | . | . |
| 3 | 1.11842 | 4.27103 | . | 0.12595 | . | . | . | . |
| 4 | 1.14005 | 5.30554 | . | .4 | . | . | -0.038947 | . |
| 5 | 1.01597 | 5.27939 | . | 0.10201 | . | -0.09824 | . | . |
| 6 | 1.02969 | 5.53023 | . | . | . | -0.11981 | . | 0.077165 |
| 7 | 1.03008 | 5.29049 | 0.08464 | . | . | -0.09380 | . | . |
| 8 | 1.04285 | 5.82771 | . | . | . | -0.13930 | 0.034120 | . |
| 9 | 1.01886 | 5.21124 | . | 0.10646 | . | -0.13561 | 0.038063 | . |
| 10 | 1.02410 | 5.13523 | . | 0.08533 | . | -0.10966 | . | 0.055196 |
| 11 | 1.02957 | 5.42694 | . | 0.11876 | -0.027891 | -0.08816 | . | . |
| 12 | 1.03169 | 5.08615 | 0.07236 | . | . | -0.10776 | . | 0.066164 |
| 13 | 1.03449 | 5.11585 | . | 0.09335 | . | -0.13782 | 0.031698 | 0.040889 |
| 14 | 1.03466 | 5.17467 | 0.11827 | . | -0.048481 | -0.08695 | . | 0.071511 |
| 15 | 1.03592 | 5.33832 | . | 0.12008 | -0.023174 | -0.12478 | 0.035558 | . |
| 16 | 1.03689 | 5.28831 | . | 0.10268 | -0.030566 | -0.09929 | . | 0.058498 |
| 17 | 1.04848 | 5.11613 | 0.07901 | 0.06396 | -0.048036 | -0.08600 | . | 0.060899 |
| 18 | 1.04923 | 5.18476 | 0.07336 | 0.08472 | -0.039348 | -0.11158 | 0.035144 | . |
| 19 | 1.05120 | 5.24935 | . | 0.10735 | -0.026225 | -0.12580 | 0.028174 | 0.045312 |
| 20 | 1.05132 | 5.14909 | 0.11954 | . | -0.044355 | -0.11036 | 0.024496 | 0.060809 |
| 21 | 1.06457 | 5.08262 | 0.07706 | 0.06944 | -0.043402 | -0.11200 | 0.027290 | 0.048068 |

***Table** 7.18 Criteria Statistics of Models for Dependent Variable: Ln(CRAB) on Sqrt(INFLOWS): 1978 Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 1.07300 | 0.22146 | 0.19031 | 0.66945 | 3.82434 | 6.4160 |
| 2 | 1.24421 | 0.09722 | 0.06111 | 4.44638 | 7.82167 | 10.4133 |
| 3 | 1.25086 | 0.09240 | 0.05609 | 4.59305 | 7.96557 | 10.5572 |
| 4 | 1.29971 | 0.05696 | 0.01924 | 5.67053 | 8.99983 | 11.5915 |
| 5 | 1.03219 | 0.28102 | 0.22110 | 0.85862 | 3.67542 | 7.5629 |
| 6 | 1.06025 | 0.26147 | 0.19993 | 1.45281 | 4.39957 | 8.2871 |
| 7 | 1.06107 | 0.26090 | 0.19931 | 1.47018 | 4.42045 | 8.3080 |
| 8 | 1.08754 | 0.24247 | 0.17934 | 2.03070 | 5.08570 | 8.9732 |
| 9 | 1.03807 | 0.30705 | 0.21667 | 2.06714 | 4.67964 | 9.8630 |
| 10 | 1.04879 | 0.29990 | 0.20858 | 2.28457 | 4.95687 | 10.1402 |
| 11 | 1.06001 | 0.29241 | 0.20011 | 2.51234 | 5.24427 | 10.4276 |
| 12 | 1.06438 | 0.28949 | 0.19682 | 2.60094 | 5.35524 | 10.5386 |
| 13 | 1.07017 | 0.31669 | 0.19245 | 3.77426 | 6.30164 | 12.7808 |
| 14 | 1.07052 | 0.31646 | 0.19218 | 3.78107 | 6.31049 | 12.7897 |
| 15 | 1.07312 | 0.31480 | 0.19022 | 3.83152 | 6.37596 | 12.8551 |
| 16 | 1.07514 | 0.31351 | 0.18870 | 3.87074 | 6.42674 | 12.9059 |
| 17 | 1.09932 | 0.32998 | 0.17045 | 5.37012 | 7.77120 | 15.5462 |
| 18 | 1.10088 | 0.32903 | 0.16927 | 5.39906 | 7.80954 | 15.5846 |
| 19 | 1.10503 | 0.32650 | 0.16614 | 5.47592 | 7.91108 | 15.6861 |
| 20 | 1.10527 | 0.32635 | 0.16596 | 5.48042 | 7.91701 | 15.6920 |
| 21 | 1.13331 | 0.34215 | 0.14480 | 7.00000 | 9.27611 | 18.3470 |

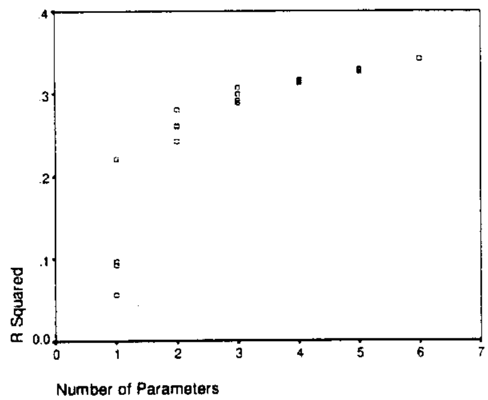


***Figure 7.13*** *The $R^2$ criteria vs. Number of parameters.*

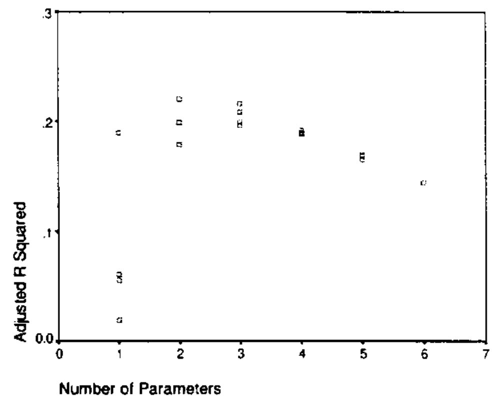


***Figure 7.14*** *The Adjusted $R^2$ criteria vs. Number of parameters.*

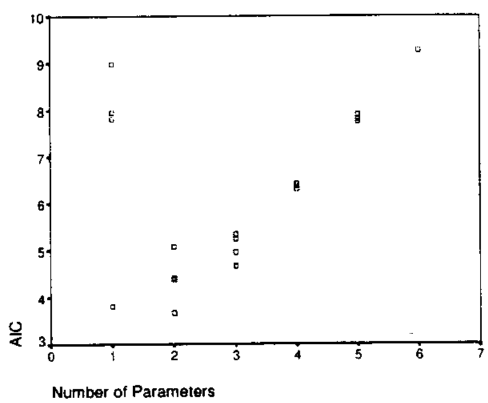


***Figure 7.15*** *The AIC criteria vs. Number of parameters..*

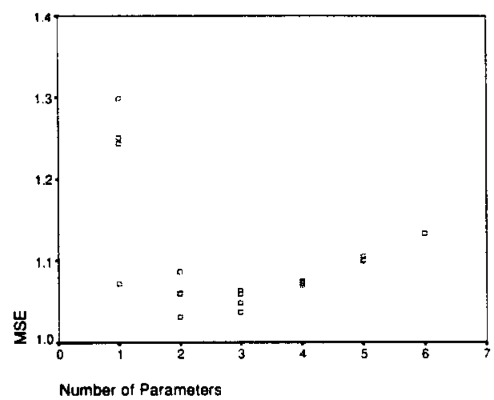


***Figure 7.16*** *MSE vs. Number of parameters.*

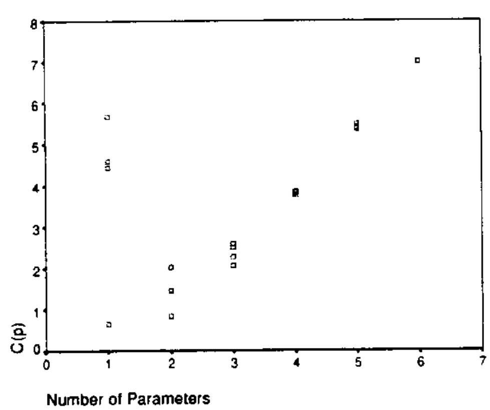


***Figure 7.17*** *The C(p) criteria vs. Number of parameters.*

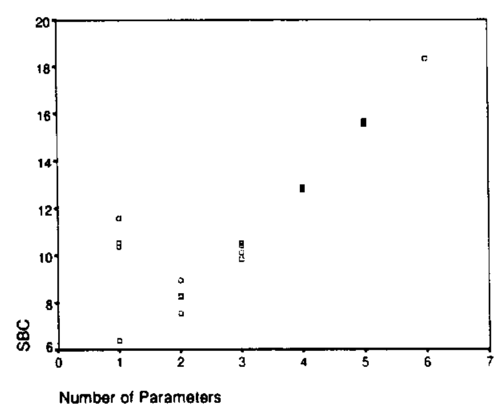


***Figure 7.18*** *The SBC criteria vs. Number of parameters.*

## 7.4 Various Transformation of data: None Omitted

***Table 7.19*** *Regression Models for Dependent Variable: Various Transformations None Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.1075 | 0.0732 | 1.798 | -90.65 | 0.0366 | -87.99 | QR_QJA |
| 1 | 0.0628 | 0.0268 | 3.091 | -89.29 | 0.0385 | -86.62 | QR_QSO |
| 1 | 0.0201 | -.0176 | 4.325 | -88.04 | 0.0402 | -85.37 | LN_QND |
| 1 | 0.0180 | -.0198 | 4.386 | -87.98 | 0.0403 | -85.31 | QR_QMJ |
| 2 | 0.2068 | 0.1433 | 0.929 | -91.96 | 0.0339 | -87.96 | QR_QJA LN_QND |
| 2 | 0.1879 | 0.1229 | 1.475 | -91.30 | 0.0347 | -87.30 | QR_QSO LN_QND |
| 2 | 0.1184 | 0.0479 | 3.483 | -89.00 | 0.0376 | -85.00 | QR_QMA QR_QJA |
| 2 | 0.1160 | 0.0453 | 3.552 | -88.92 | 0.0377 | -84.93 | QR_QJF QR_QJA |
| 3 | 0.2555 | 0.1625 | 1.520 | -91.73 | 0.0331 | -86.40 | QR_QJA QR_QSO LN_QND |
| 3 | 0.2142 | 0.1160 | 2.715 | -90.22 | 0.0350 | -84.89 | QR_QMA QR_QJA LN_QND |
| 3 | 0.2110 | 0.1124 | 2.807 | -90.11 | 0.0351 | -84.78 | QR_QMJ QR_QJA LN_QND |
| 3 | 0.2076 | 0.1085 | 2.906 | -89.98 | 0.0353 | -84.66 | QR_QMJ QR_QSO LN_QND |
| 4 | 0.2628 | 0.1346 | 3.309 | -90.01 | 0.0342 | -83.35 | QR_QMA QR_QJA QR_QSO LN_QND |
| 4 | 0.2600 | 0.1313 | 3.391 | -89.90 | 0.0344 | -83.24 | QR_QMJ QR_QJA QR_QSO LN_QND |
| 4 | 0.2561 | 0.1267 | 3.505 | -89.75 | 0.0345 | -83.09 | QR_QJF QR_QJA QR_QSO LN_QND |
| 4 | 0.2269 | 0.0924 | 4.349 | -88.67 | 0.0359 | -82.01 | QR_QMA QR_QMJ QR_QSO LN_QND |
| 5 | 0.2723 | 0.1069 | 5.034 | -88.37 | 0.0353 | -80.38 | QR_QMA QR_QMJ QR_QJA QR_QSO LN_QND |
| 5 | 0.2689 | 0.1027 | 5.134 | -88.24 | 0.0355 | -80.24 | QR_QJF QR_QMA QR_QJA QR_QSO LN_QND |
| 5 | 0.2603 | 0.0921 | 5.383 | -87.91 | 0.0359 | -79.92 | QR_QJF QR_QMJ QR_QJA QR_QSO LN_QND |
| 5 | 0.2271 | 0.0515 | 6.340 | -86.68 | 0.0375 | -78.69 | QR_QJF QR_QMA QR_QMJ QR_QSO LN_QND |
| 6 | 0.2735 | 0.0659 | 7.000 | -86.42 | 0.0369 | -77.09 | QR_QJF QR_QMA QR_QMJ QR_QJA QR_QSO LN_QND |

*N* = 28

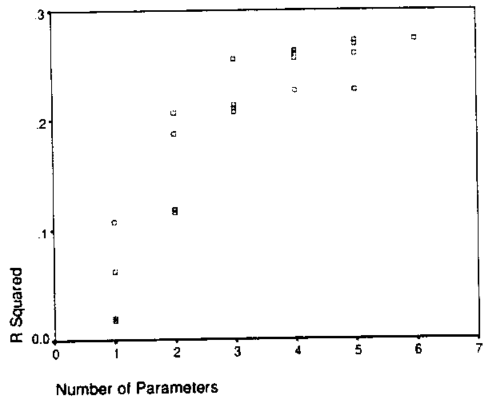


*Figure 7.19* The $R^2$ criteria vs. Number of parameters.

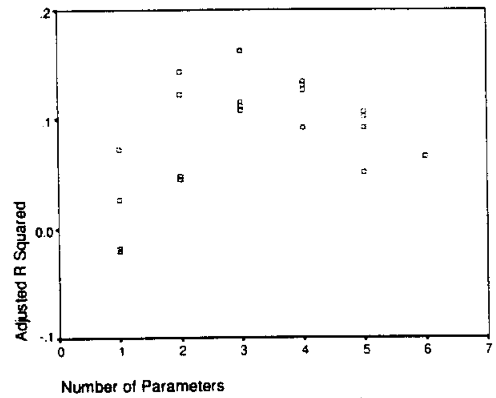


*Figure 7.20* The Adjusted $R^2$ criteria vs. Number of parameters.

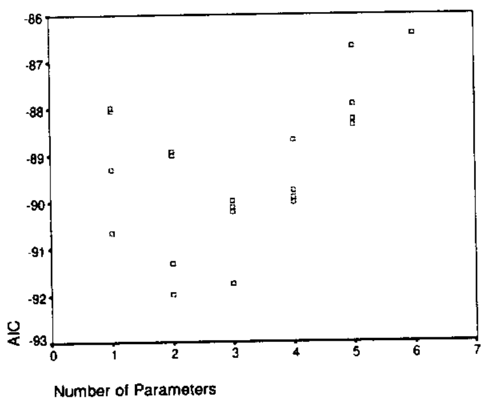


*Figure 7.21* The AIC criteria vs. Number of parameters..

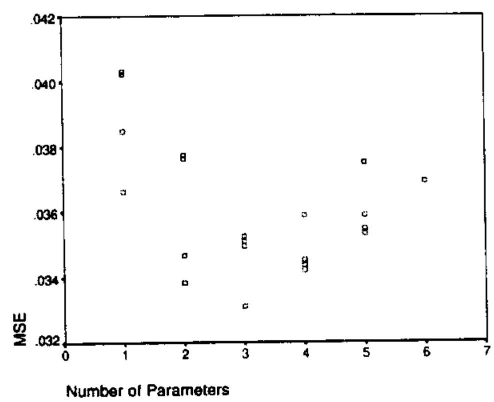


*Figure 7.22* MSE vs. Number of parameters.

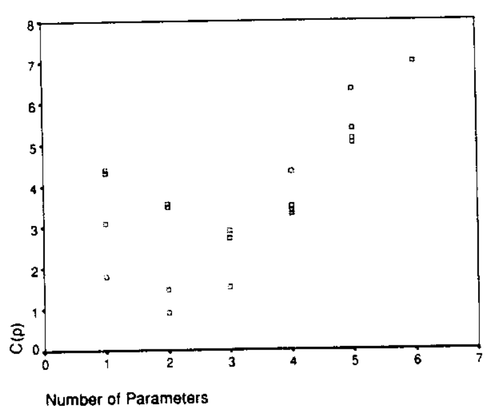


*Figure 7.23* The C(p) criteria vs. Number of parameters.

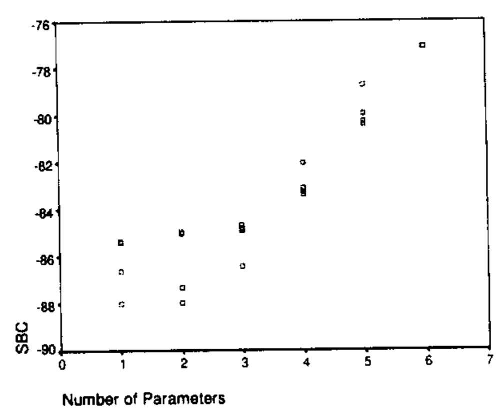


*Figure 7.24* The SBC criteria vs. Number of parameters.

***Table** 7.20 Analysis of Variance for Dependent Variable: Various Transformations: None Omitted*

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 6 | 0.29201 | 0.04867 | 1.318 | 0.2928 |
| Error | 21 | 0.77561 | 0.03693 | | |
| C Total | 27 | 1.06761 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 0.19218 | R-square | 0.2735 |
| Dep Mean | 1.63089 | Adj R-sq | 0.0659 |
| C.V. | 11.78386 | | |

***Table** 7.21 Parameter Estimates for Dependent Variable: Various Transformations: None Omitted*

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 0.262692 | 0.76424651 | 0.344 | 0.7345 | 0.00000000 |
| QR_QJF | 1 | 0.111276 | 0.60080218 | 0.185 | 0.8548 | 1.96164678 |
| QR_QMA | 1 | -0.304684 | 0.49242800 | -0.619 | 0.5427 | 1.36034040 |
| QR_QMJ | 1 | -0.007668 | 0.02091655 | -0.367 | 0.7176 | 1.91515644 |
| QR_QJA | 1 | 0.863460 | 0.74584782 | 1.158 | 0.2600 | 1.95538690 |
| QR_QSO | 1 | 0.852605 | 0.70821980 | 1.204 | 0.2420 | 2.10467957 |
| LN_QND | 1 | 0.097603 | 0.04730534 | 2.063 | 0.0517 | 1.71214022 |

***Table** 7.22 Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Various Transformations: None Omitted*

| Number | Eigenvalue | Condition Index | Var Prop QR_QJF | Var Prop QR_QMA | Var Prop QR_QMJ | Var Prop QR_QJA | Var Prop QR_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.52849 | 1.00000 | 0.0143 | 0.0102 | 0.0478 | 0.0426 | 0.0422 | 0.0525 |
| 2 | 1.64038 | 1.24153 | 0.1175 | 0.1461 | 0.0164 | 0.0334 | 0.0341 | 0.0070 |
| 3 | 0.63026 | 2.00296 | 0.1031 | 0.4983 | 0.0140 | 0.1223 | 0.0279 | 0.2230 |
| 4 | 0.60915 | 2.03736 | 0.0009 | 0.1758 | 0.3170 | 0.0999 | 0.0631 | 0.2718 |
| 5 | 0.31024 | 2.85486 | 0.0042 | 0.0316 | 0.0779 | 0.4673 | 0.7676 | 0.2883 |
| 6 | 0.28148 | 2.99712 | 0.7599 | 0.1380 | 0.5269 | 0.2345 | 0.0651 | 0.1574 |

***Table** 7.23 Parameter Estimates of Models for Dependent Variable Various Transformations None Omitted*

| OBS | _RMSE_ | INTERCEP | QR_QJF | QR_QMA | QR_QMJ | QR_QJA | QR_QSO | LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.19143 | 1.00352 | . | . | . | 0.94032 | . | . |
| 2 | 0.19617 | 1.19779 | . | . | . | . | 0.65774 | . |
| 3 | 0.20059 | 1.53987 | . | . | . | . | . | 0.027568 |
| 4 | 0.20081 | 1.70710 | . | . | -0.010900 | . | . | . |
| 5 | 0.18405 | 0.48929 | . | . | . | 1.37481 | . | 0.067953 |
| 6 | 0.18623 | 0.48152 | . | . | . | . | 1.32176 | 0.084520 |
| 7 | 0.19403 | 1.06058 | . | -0.23720 | . | 0.93613 | . | . |
| 8 | 0.19429 | 1.07210 | -0.21298 | . | . | 0.92873 | . | . |
| 9 | 0.18198 | 0.14358 | . | . | . | 0.96070 | 0.82696 | 0.091421 |
| 10 | 0.18697 | 0.54466 | . | -0.19556 | . | 1.36432 | . | 0.066854 |
| 11 | 0.18734 | 0.56877 | . | . | -0.006061 | 1.30210 | . | 0.071410 |
| 12 | 0.18775 | 0.59033 | . | . | -0.012527 | . | 1.24760 | 0.092885 |
| 13 | 0.18498 | 0.19892 | . | -0.19424 | . | 0.95071 | 0.82612 | 0.090305 |
| 14 | 0.18534 | 0.22450 | . | . | -0.006240 | 0.88475 | 0.82914 | 0.095042 |
| 15 | 0.18583 | 0.10976 | 0.05607 | . | . | 0.96662 | 0.83921 | 0.093176 |
| 16 | 0.18944 | 0.70976 | . | -0.32897 | -0.016172 | . | 1.21588 | 0.093550 |
| 17 | 0.18792 | 0.34319 | . | -0.26531 | -0.009564 | 0.83065 | 0.82914 | 0.095447 |
| 18 | 0.18836 | 0.09675 | 0.21910 | -0.29952 | . | 0.96843 | 0.87350 | 0.096558 |
| 19 | 0.18947 | 0.26791 | -0.04923 | . | -0.007298 | 0.86668 | 0.81876 | 0.094115 |
| 20 | 0.19366 | 0.74175 | -0.05392 | -0.30867 | -0.016965 | . | 1.19711 | 0.092542 |
| 21 | 0.19218 | 0.26269 | 0.11128 | -0.30468 | -0.007668 | 0.86346 | 0.85260 | 0.097603 |

***Table** 7.24 Criteria Statistics of Models for Dependent Variable: Various Transformations. None Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 0.036647 | 0.10752 | 0.07320 | 1.79818 | -90.6549 | -87.9905 |
| 2 | 0.038483 | 0.06280 | 0.02675 | 3.09087 | -89.2859 | -86.6215 |
| 3 | 0.040236 | 0.02012 | -0.01757 | 4.32475 | -88.0388 | -85.3744 |
| 4 | 0.040323 | 0.01799 | -0.01978 | 4.38617 | -87.9782 | -85.3138 |
| 5 | 0.033874 | 0.20679 | 0.14333 | 0.92880 | -91.9564 | -87.9598 |
| 6 | 0.034681 | 0.18787 | 0.12290 | 1.47548 | -91.2966 | -87.3000 |
| 7 | 0.037647 | 0.11844 | 0.04791 | 3.48260 | -88.9995 | -85.0029 |
| 8 | 0.037749 | 0.11603 | 0.04532 | 3.55213 | -88.9232 | -84.9266 |
| 9 | 0.033117 | 0.25552 | 0.16246 | 1.52018 | -91.7317 | -86.4029 |
| 10 | 0.034956 | 0.21418 | 0.11595 | 2.71504 | -90.2187 | -84.8898 |
| 11 | 0.035098 | 0.21100 | 0.11237 | 2.80702 | -90.1055 | -84.7767 |
| 12 | 0.035250 | 0.20757 | 0.10852 | 2.90604 | -89.9842 | -84.6554 |
| 13 | 0.034219 | 0.26281 | 0.13461 | 3.30931 | -90.0074 | -83.3464 |
| 14 | 0.034350 | 0.25998 | 0.13128 | 3.39109 | -89.9001 | -83.2391 |
| 15 | 0.034532 | 0.25605 | 0.12667 | 3.50467 | -89.7519 | -83.0908 |
| 16 | 0.035888 | 0.22685 | 0.09239 | 4.34878 | -88.6738 | -82.0128 |
| 17 | 0.035312 | 0.27233 | 0.10695 | 5.03430 | -88.3711 | -80.3779 |
| 18 | 0.035480 | 0.26886 | 0.10270 | 5.13439 | -88.2382 | -80.2450 |
| 19 | 0.035898 | 0.26027 | 0.09215 | 5.38284 | -87.9109 | -79.9177 |
| 20 | 0.037505 | 0.22715 | 0.05150 | 6.34025 | -86.6845 | -78.6913 |
| 21 | 0.036934 | 0.27351 | 0.06594 | 7.00000 | -86.4168 | -77.0914 |

# Crab Harvests in Aransas Bay:
# A Regression Analysis

## Harvest vs Freshwater Inflows

F. Michael Speed
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Rita Miranda-López

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97-483-195 (11 of 15)

# Crab Harvest in Aransas Bay:

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Department of Statistics

Texas A&M University

SPRING 1997

# Table of Contents

# 1. Summary Report

## 1.1 Description of the Problem[1]

Bimonthly freshwater inflows into Aransas Bay were recorded for the years 1962 to 1994. These variables, and various transformations of them, were used to construct a model for the annual harvest of Crab.

## 1.2 Constructing Models - General Discussion

Stability of coefficient estimates and accuracy of predicted values are primary goals in constructing models for prediction. To this end, the data must be examined from three points of view: individual observations (to detect outliers or influential points); variables, individually and in groups (to select an optimal set of predictors); and the interaction of these two, which produces the overall structure of the data set (to determine whether multicollinearity is present or not). The first two of these were examined by both graphic and quantitative means; the third by quantitative means only.

### 1.2.1 Detecting Influential Points and Outliers

The structures of individual variables were examined via box plots and histograms, as well as by all the usual numerical measures. For each pair of variables, 99 % prediction ellipses and 95% confidence ellipses were plotted in a further effort to look for unusual points. For example, suppose large values of Variable A are generally associated with large values for Variable B. If an observation consisted of a large value for Variable A but a small value for Variable B, that point would be considered unusual, even though it was well within the range of data for both variables and could not be considered an outlier.

In addition, a number of residual analysis techniques were employed. A large *residual* indicates a point not well-fit by the model. The *deleted residual*, however, is somewhat more useful in the search for influential points. The model is fitted without a given observation, and
the predicted response and corresponding residual are calculated for that observation. The *Studentized deleted residual* is scaled to have a Student's t distribution. Histograms and normal P-P plots of the residuals were also examined.

Other quantities, such as the Mahalanobis distance, Cook's distance, the leverage value, standarized values for the Dffits (to measure the influence of a given observation on the predicted response) and the Dfbetas (to measure the influence of a given observation on the calculated coefficients) were also used to build a general picture of the influence of individual points. Plots were made of the standardized Dffits value for each model against the Dfbeta values for each predictor in the model. Points which were extreme indicated observations which had strong effects on both predicted values and coefficient estimates.

### 1.2.2 Variable Selection

For each regression, residuals were plotted against each of the independent variables to look for nonlinear relationships between the response variable and individual predictors. Partial residual plots were employed to examine the overall relationship between the response and individual predictors. A partial

[1] The following discussion, prepared by Jacqueline Kiffe, was taken from Seatrout Harvests in Galveston Bay: A Regression Analysis, by F. Michael Speed, Sr. and Jacqueline Kiffe.

residual is a corollary to the deleted residual. That is, the model is fitted without a given variable and the predicted response and corresponding residual are calculated for each observation. This seeks to answer the question, "What is the relationship of this predictor to the response variable, taking all other variables into account?" Thus, it examines the marginal relationship of a given predictor to the response.

Numerous measures have been developed over the years to assess the adequacy of a given model. We examined a number of these, including $R^2$ and mean squared error (MSE), and several others which directly incorporate penalties for having too many predictors in the model, such as adjusted $R^2$, $C_p$, AIC, and SBC. It is well-established that too many predictors in a model can lead to bad prediction, just as too few can, and these measures are used as part of the attempt to find an optimal model.

#### 1.2.3 Multicollinearity

Multicollinearity arises when one or more variables are nearly closely approximated by linear combinations of the remaining variables, resulting in unstable coefficient estimates. The variance inflation factor (VIF) was calculated for each coefficient estimate to measure this instability, which is not usually considered profound for VIF's less than 10. No problems were found with this data. Additionally, the condition index (a ratio of eigenvalues of the covariance matrix, with the largest eigenvalue always on top) was calculated. A ratio greater than 30 is considered cause for concern. Again, no evidence of multicollinearity was found.

#### 1.2.4 Other Procedures

Several other miscellaneous diagnostics, including the Durbin-Watson test for serial autocorrelation were performed, and no general problems were detected. The Box-Cox procedure, used to find a transformation to normality, was also performed.

### 1.3 How the Final Model Was Chosen

#### 1.3.1 Selecting the Data Set Used

First, the variables were explored thoroughly, individually and in pairs, in a first effort to detect outliers. The SAS programming language allows a number of diagnostics to be calculated for a group of models on a given data set without actually performing a formal regression, thus allowing one to examine a large number of models quite efficiently. The Box-Cox procedure was performed to find if a transformation to normality was suggested. The log transform was suggested for some variables, and the square root for others. At this point, there were several data sets for which the diagnostic series was calculated:

1. Untransformed data.
2. Harvest untransformed, and natural log of inflow variables.
3. All variables logged.
4. Harvest untransformed, and square root of inflows variables.
5. All variables square root.
6. Square Root Harvest and logged inflows.
7. Harvest and inflows variables transformed according to Box-Cox suggestion.

**1.3.2 Selecting the Points to be Omitted**

The full regression with all diagnostics was performed for these models, each one contained all variables in its corresponding data set. All diagnostics were generated, and influential points were determined for each model.

Table 1.1 R-Square and Adjusted R-Square values for the different suggested models.

| **Data Set** | **$R^2$** | **Adjusted $R^2$** |
|---|---|---|
| 1 | 0.4217 | 0.2882 |
| 2 | 0.5426 | 0.4371 |
| **3** | **0.5468** | **0.4422** |
| 4 | 0.4859 | 0.3672 |
| 5 | 0.4824 | 0.3629 |
| **6** | **0.5689** | **0.4694** |
| **7** | **0.5584** | **0.4565** |

Data set 6 presented the highest $R^2$ values. However , the models 3, 6, and 7 were considered as final candidates. The observations flagged as potentially influential are given in the summary table below, for each model.

Table 1.2 Summary of points flagged by 99% Prediction Ellipse.

| **Year** | **Variable** |
|---|---|
| 1981 | May-Jun vs. Jul-Aug Inflows. |
| 1992 | Harvest vs. Mar-Apr, Jan-Feb vs. Mar-Apr, Jan-Feb vs. Nov-Dec Mar-Apr vs. May-Jun, Mar-Apr vs. Jul-Aug, Mar-Apr vs. Sept-Oct Mar-Apr vs. Nov-Dec Inflows. |
| 1993 | Harvest vs. Jan-Feb, Harvest vs. Mar-Apr, Harvest vs. May-Jun, Jan-Feb vs. Mar-Apr, Jan-Feb vs. May-Jun, Jan-Feb vs. Jul-Aug, Jan-Feb vs. Sept-Oct, Jan-Feb vs. Nov-Dec, Mar-Apr vs. May-Jun Mar-Apr vs. Jul-Aug, Mar-Apr vs. Sept-Oct, Mar-Apr vs. Nov-Dec May-Jun vs. Jul-Aug, May-Jun vs. Sept-Oct, May-Jun vs. Nov-Dec Inflows. |

Table 1.3 Summary of points flagged by Boxplots.

| **Year** | **Variable** |
|---|---|
| 1965 | Ln (Harvest). |
| 1966 | Ln (Harvest). |
| 1967 | Sept-Oct Inflows. |
| 1968 | Sept-Oct Inflows. |
| 1971 | Sept-Oct Inflows. |
| 1981 | Jul-Aug Inflows. |
| 1991 | Nov-Dec Inflows. |
| 1992 | Mar-Apr, SQRT (Mar-Apr), Nov-Dec Inflows. |
| 1993 | Jan-Feb, Mar-Apr, SQRT (Mar-Apr) Inflows. |

Table 1.4 Summary of points flagged by diagnostic measures.

| YEAR | BOX | SRE | SDR | LEV | MAH | COO | SDF | SDB | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| **DATA SET 3** | | | | | | | | | |
| **1965** | 1 | | 1 | | | | 1 | | 3 |
| **1966** | 1 | | 1 | | | | 1 | 1 | 4 |
| 1990 | | | | | | | 1 | | 1 |
| **DATA SET 6** | | | | | | | | | |
| **1968** | | | | | | | 1 | | 1 |
| **1988** | | | 1 | | | | 1 | | 2 |
| **Data Set 7** | | | | | | | | | |
| **1968** | | | | | | | 1 | | 1 |
| **1988** | | | 1 | | | | 1 | | 2 |

Key to Abbreviations:

**BOX** Box plot
**SRE** Studentized residual
**SDR** Studentized deleted residual
**LEV** Leverage value
**MAH** Mahalanobis distance
**COO** Cook's distance
**SDF** Standardized Dffits value
**SDB** Standardized Dfbeta value

### 1.3.3 Selecting the Final Candidate Models

After the subset analysis led us to the models: Data Set 3 (logged all variables) 1965 and/or 1966 omitted; Data Set 6 (square root harvest and logged inflows) 1968 and 1988 omitted, Data Set 7 (variables transformed according to Box-Cox analysis) 1968 and/or 1988 omitted.

Table 1.5 R-Square and Adjusted R-Square values for the different subsets.

| Data Set | Observations omitted | $R^2$ | Adjusted $R^2$ |
|---|---|---|---|
| 3 | 1965 | 0.5813 | 0.4808 |
| | 1966 | 0.5038 | 0.3847 |
| | 1965 and 1966 | 0.5744 | 0.4680 |
| **6** | 1968 | 0.5925 | 0.4948 |
| | 1988 | 0.6481 | 0.5637 |
| | **1968 and 1988** | **0.6604** | **0.5755** |
| 7 | 1968 | 0.5769 | 0.4754 |
| | 1988 | 0.6450 | 0.5598 |
| | 1968 and 1988 | 0.6525 | 0.5669 |

### 1.3.4 Selecting the Final Model

Data Set 6 with 1968 and 1988 omitted is selected as best model. Regression was performed using this model, and the deleted residuals were calculated.

| Best Candidate Model | $R^2$ | Adjusted $R^2$ | Prob>F |
|---|---|---|---|
| SQRT (Crab Harvest) = - 2.913 + 7.416*Ln(January-February Inflows) - 3.252*Ln(March-April Inflows) - 3.027*Ln(May-June Inflows) + 4.379*Ln(September-October Inflows) + 4.653*Ln(November-December Inflows) | 0.650 | 0.58 | $4.28 \times 10^{-5}$ |

## 1.4 Best Model: Square Root Harvest and Logged Inflows

### 1.4.1 Summary Information

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| SQRT (Crab Harvest) | 32.3096 | 13.6036 | 31 |
| Ln (January-February Inflows) | 3.3001 | 1.2780 | 31 |
| Ln (March-April Inflows) | 3.2235 | 1.2270 | 31 |
| Ln (May-June Inflows) | 4.4623 | 1.1623 | 31 |
| Ln (September-October Inflows) | 4.3142 | 1.4097 | 31 |
| Ln (November-December Inflows) | 3.4049 | 1.0033 | 31 |

**Model Summary[a,b]**

| Model | Variables | | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| | Entered | Removed | | | | | |
| 1 | Ln(Nov-Dec Inflows), Ln(Sept-Oct Inflows), Ln(Jan-Feb Inflows), Ln(May-Jun Inflows), Ln(Mar-Apr Inflows)[c,d] | . | .806 | .650 | .580 | 8.8180 | 1.442 |

a. Dependent Variable: SQRT (Crab Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Ln (November-December Inflows), Ln (September-October Inflows), Ln (January-February Inflows), Ln (May-June Inflows), Ln (March-April Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 3607.805 | 5 | 721.561 | 9.280 | .000[b] |
| | Residual | 1943.918 | 25 | 77.757 | | |
| | Total | 5551.724 | 30 | | | |

a. Dependent Variable: SQRT (Crab Harvest)

b. Independent Variables: (Constant), Ln (November-December Inflows), Ln (September-October Inflows), Ln (January-February Inflows), Ln (May-June Inflows), Ln (March-April Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| 1 | (Constant) | -2.913 | 7.654 | | -.381 | .707 | -18.677 | 12.851 |
| | Ln (January-February Inflows) | 7.416 | 1.709 | .697 | 4.340 | .000 | 3.897 | 10.935 |
| | Ln (March-April Inflows) | -3.252 | 1.888 | -.293 | -1.722 | .097 | -7.141 | .638 |
| | Ln (May-June Inflows) | -3.027 | 1.849 | -.259 | -1.637 | .114 | -6.834 | .781 |
| | Ln (September-October Inflows) | 4.379 | 1.260 | .454 | 3.476 | .002 | 1.784 | 6.974 |
| | Ln (November-December Inflows) | 4.653 | 1.815 | .343 | 2.563 | .017 | .914 | 8.392 |

a. Dependent Variable: SQRT (Crab Harvest)

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 10.1792 | 51.0571 | 32.3096 | 10.9663 | 31 |
| Std. Predicted Value | -2.018 | 1.710 | .000 | 1.000 | 31 |
| Standard Error of Predicted Value | 1.9433 | 5.3667 | 3.8134 | .7242 | 31 |
| Adjusted Predicted Value | 9.8279 | 52.3464 | 32.4594 | 11.1022 | 31 |
| Residual | -16.2222 | 14.1680 | 4.9E-15 | 8.0497 | 31 |
| Std. Residual | -1.840 | 1.607 | .000 | .913 | 31 |
| Stud. Residual | -2.014 | 1.647 | -.007 | 1.010 | 31 |
| Deleted Residual | -19.4410 | 14.9815 | -.1498 | 9.8963 | 31 |
| Stud. Deleted Residual | -2.156 | 1.709 | -.011 | 1.035 | 31 |
| Mahal. Distance | .489 | 10.144 | 4.839 | 2.040 | 31 |
| Cook's Distance | .000 | .247 | .039 | .052 | 31 |
| Centered Leverage Value | .016 | .338 | .161 | .068 | 31 |

a. Dependent Variable: SQRT (Crab Harvest)

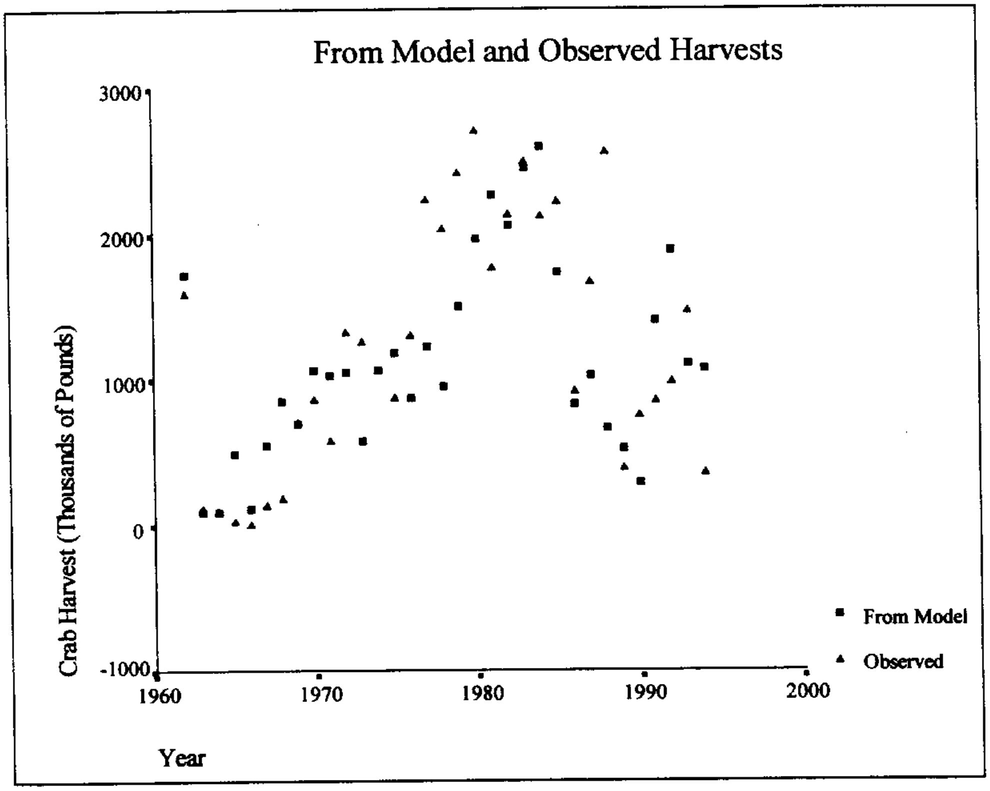
Table 1.6 Observed, predicted, lower and upper predicted intervals values for crab harvest.

| Year | Observed[a] | Predicted[a] | LICI | UICI |
|---|---|---|---|---|
| **1962** | 1605.40 | 1736.43 | 186.66 | 4855.09 |
| **1963** | 125.20 | 103.62 | 302.40 | 1424.91 |
| **1964** | 112.30 | 109.74 | 297.22 | 1458.61 |
| **1965** | 39.60 | 506.93 | 16.17 | 2406.05 |
| **1966** | 19.30 | 129.87 | 266.96 | 1531.23 |
| **1967** | 155.60 | 556.48 | 26.87 | 2741.96 |
| **1968** | 197.50 | 862.84 | .00 | 3458.28 |
| **1969** | 724.20 | 715.00 | .08 | 2830.18 |
| **1970** | 878.10 | 1082.07 | 57.64 | 3386.98 |
| **1971** | 591.80 | 1043.32 | 33.24 | 3461.63 |
| **1972** | 1338.90 | 1068.67 | 40.40 | 3483.93 |
| **1973** | 1272.80 | 587.71 | 9.57 | 2660.33 |
| **1974** | 1079.90 | 1074.48 | 31.37 | 3594.95 |
| **1975** | 892.40 | 1203.56 | 65.44 | 3757.11 |
| **1976** | 1318.80 | 890.70 | 5.94 | 3277.70 |
| **1977** | 2244.60 | 1246.85 | 86.23 | 3762.07 |
| **1978** | 2051.20 | 968.59 | 35.44 | 3168.73 |
| **1979** | 2436.30 | 1519.87 | 170.41 | 4214.20 |
| **1980** | 2716.10 | 1986.53 | 311.15 | 5112.47 |
| **1981** | 1777.30 | 2281.08 | 431.15 | 5588.63 |
| **1982** | 2150.40 | 2073.95 | 356.68 | 5212.17 |
| **1983** | 2509.00 | 2464.86 | 547.23 | 5761.08 |
| **1984** | 2129.70 | 2606.82 | 578.00 | 6095.32 |
| **1985** | 2231.50 | 1746.92 | 220.64 | 4724.98 |
| **1986** | 936.00 | 841.64 | 3.63 | 3149.18 |
| **1987** | 1683.60 | 1039.25 | 28.21 | 3500.26 |
| **1988** | 2571.90 | 675.39 | .80 | 2795.13 |
| **1989** | 405.10 | 532.48 | 10.34 | 2437.12 |
| **1990** | 766.10 | 307.38 | 90.81 | 1988.62 |
| **1991** | 868.20 | 1418.54 | 113.97 | 4179.77 |
| **1992** | 997.60 | 1908.31 | 284.62 | 4969.92 |
| **1993** | 1487.40 | 1124.80 | 35.07 | 3739.86 |
| **1994** | 368.50 | 1092.52 | 51.15 | 3475.62 |

[a] Crab harvest (thousands of pounds).

LICI Lower limit for 99% prediction interval for crab harvest.

UICI Upper limit for 99% prediction interval for crab harvest.



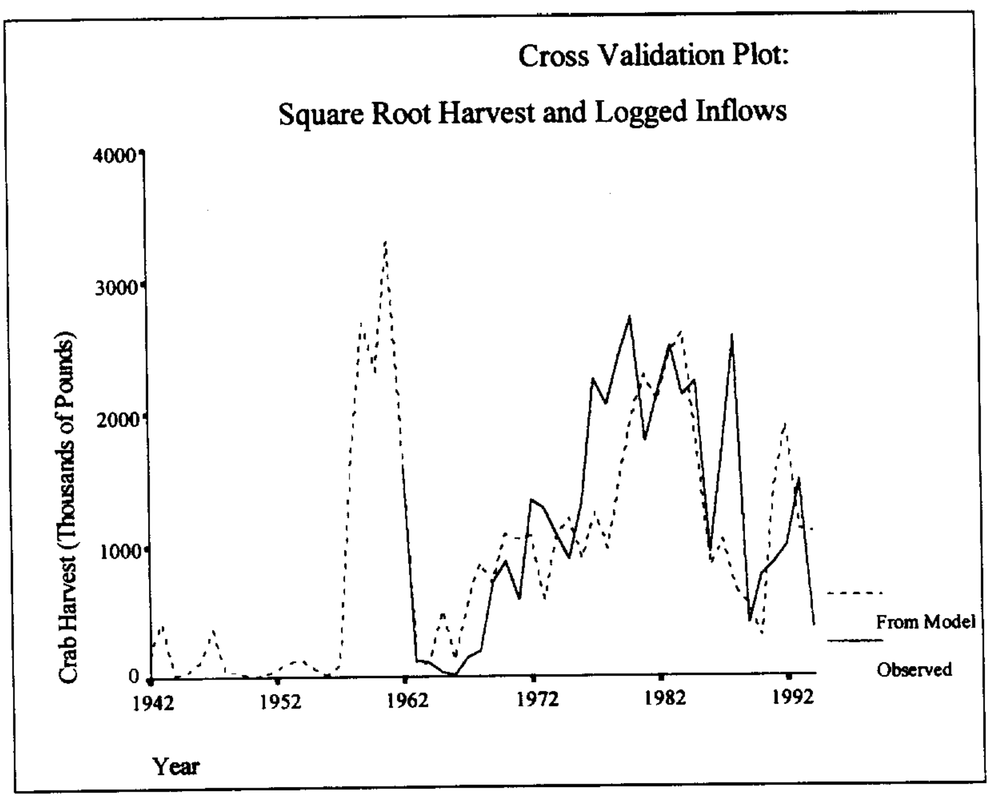




Fig. 1.1 Comparative plots of observed values vs. calculated from the regression model.

# 2. Exploring the Data

## 2.1 Listing of Data

Table 2.1. Crab harvest and water inflows data.

| Obs. | YEAR | CRAB | JF_LAG | MA_LAG | MJ_LAG | JA_LAG | SO_LAG | ND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | **1962** | 1605.40 | 101.6 | 8.13 | 22.26 | 13.73 | 36.80 | 10.03 |
| 2 | **1963** | 125.20 | 1.24 | 2.09 | 12.16 | 2.40 | 11.26 | 10.30 |
| 3 | **1964** | 112.30 | 3.06 | 3.19 | 6.75 | 39.26 | 5.03 | 5.09 |
| 4 | **1965** | 39.60 | 15.50 | 4.71 | 30.83 | 39.44 | 7.49 | 12.36 |
| 5 | **1966** | 19.30 | 22.85 | 53.73 | 171.90 | 12.23 | 6.84 | 11.14 |
| 6 | **1967** | 155.60 | 11.25 | 52.24 | 165.90 | 22.84 | 735.03 | 5.56 |
| 7 | **1968** | 197.50 | 9.83 | 4.45 | 308.94 | 48.16 | 750.61 | 6.28 |
| 8 | **1969** | 724.20 | 54.63 | 29.10 | 316.63 | 40.24 | 21.54 | 24.73 |
| 9 | **1970** | 878.10 | 55.55 | 54.13 | 105.72 | 16.43 | 63.92 | 24.55 |
| 10 | **1971** | 591.80 | 10.45 | 29.66 | 82.72 | 29.17 | 595.65 | 21.22 |
| 11 | **1972** | 1338.90 | 13.22 | 21.79 | 186.87 | 46.60 | 562.30 | 22.94 |
| 12 | **1973** | 1272.80 | 15.96 | 28.76 | 409.35 | 42.60 | 304.44 | 9.96 |
| 13 | **1974** | 1079.90 | 8.32 | 12.59 | 271.14 | 16.99 | 439.28 | 53.58 |
| 14 | **1975** | 892.40 | 6.13 | 6.20 | 46.73 | 8.42 | 178.24 | 59.71 |
| 15 | **1976** | 1318.80 | 4.45 | 13.50 | 35.02 | 127.65 | 67.60 | 124.81 |
| 16 | **1977** | 2244.60 | 29.96 | 48.51 | 152.22 | 131.89 | 63.88 | 129.69 |
| 17 | **1978** | 2051.20 | 41.79 | 39.51 | 158.18 | 12.04 | 62.04 | 28.32 |
| 18 | **1979** | 2436.30 | 63.16 | 32.13 | 85.82 | 88.02 | 212.52 | 14.50 |
| 19 | **1980** | 2716.10 | 111.4 | 31.82 | 59.09 | 214.91 | 244.25 | 13.32 |
| 20 | **1981** | 1777.30 | 77.77 | 17.95 | 305.34 | 304.68 | 187.08 | 117.59 |
| 21 | **1982** | 2150.40 | 101.9 | 29.18 | 338.25 | 179.88 | 107.60 | 119.87 |
| 22 | **1983** | 2509.00 | 105.4 | 29.86 | 76.67 | 200.04 | 283.59 | 42.69 |
| 23 | **1984** | 2129.70 | 78.59 | 19.09 | 37.88 | 196.61 | 340.91 | 35.86 |
| 24 | **1985** | 2231.50 | 70.47 | 115.47 | 37.90 | 9.60 | 107.66 | 60.71 |
| 25 | **1986** | 936.00 | 16.42 | 113.88 | 50.42 | 14.71 | 64.87 | 76.16 |
| 26 | **1987** | 1683.60 | 30.46 | 5.11 | 130.03 | 31.50 | 26.54 | 27.93 |
| 27 | **1988** | 2571.90 | 25.69 | 5.44 | 120.87 | 27.08 | 31.01 | 8.23 |
| 28 | **1989** | 405.10 | 6.06 | 2.78 | 21.82 | 17.08 | 22.82 | 12.06 |
| 29 | **1990** | 766.10 | 12.34 | 30.45 | 16.36 | 193.50 | 8.15 | 13.73 |
| 30 | **1991** | 868.20 | 21.30 | 60.09 | 35.14 | 190.31 | 80.72 | 133.00 |
| 31 | **1992** | 997.60 | 164.7 | 236.13 | 298.03 | 35.59 | 93.11 | 170.21 |
| 32 | **1993** | 1487.40 | 237.9 | 269.63 | 607.54 | 32.58 | 27.78 | 58.23 |
| 33 | **1994** | 368.50 | 90.63 | 88.99 | 382.20 | 15.88 | 72.01 | 33.98 |

**CRAB** Crab harvest (thousands of pounds)
**JF_LAG** Lagged January-February inflows (thousands of acre-feet)
**MA_LAG** Lagged March-April inflows (thousands of acre-feet)
**MJ_LAG** Lagged May-June inflows (thousands of acre-feet)
**JA_LAG** Lagged July-August inflows (thousands of acre-feet)
**SO_LAG** Lagged September-October inflows (thousands of acre-feet)
**ND_LAG** Lagged November-December inflows (thousands of acre-feet)

## 2.2 Test of Normality for Individual Variables

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Crab Harvest | .108 | 33 | .200* | .934 | 33 | .064 |
| Ln (Crab Harvest) | .201 | 33 | .002 | .834 | 33 | .010** |
| SQRT (Crab Harvest) | .097 | 33 | .200* | .937 | 33 | .079 |
| January-February Inflows | .213 | 33 | .001 | .801 | 33 | .010** |
| Ln (January-February Inflows) | .115 | 33 | .200* | .972 | 33 | .598 |
| SQRT (January-February Inflows) | .144 | 33 | .078 | .931 | 33 | .050 |
| March-April Inflows | .262 | 33 | .000 | .655 | 33 | .010** |
| Ln (March-April Inflows) | .150 | 33 | .057 | .963 | 33 | .417 |
| SQRT (March-April Inflows) | .173 | 33 | .013 | .870 | 33 | .010** |
| May-June Inflows | .165 | 33 | .023 | .855 | 33 | .010** |
| Ln (May-June Inflows) | .102 | 33 | .200* | .961 | 33 | .396 |
| SQRT (May-June Inflows) | .117 | 33 | .200* | .942 | 33 | .100 |
| July-August Inflows | .317 | 33 | .000 | .761 | 33 | .010** |
| Ln (July-August Inflows) | .129 | 33 | .182 | .947 | 33 | .177 |
| SQRT (July-August Inflows) | .238 | 33 | .000 | .862 | 33 | .010** |
| September-October Inflows | .262 | 33 | .000 | .758 | 33 | .010** |
| Ln (September-October Inflows) | .103 | 33 | .200* | .956 | 33 | .321 |
| SQRT (September-October Inflows) | .176 | 33 | .011 | .895 | 33 | .010** |
| November-December Inflows | .220 | 33 | .000 | .789 | 33 | .010** |
| Ln (November-December Inflows) | .128 | 33 | .189 | .944 | 33 | .128 |
| SQRT (November-December Inflows) | .159 | 33 | .034 | .883 | 33 | .010** |

*. This is a lower bound of the true significance.

**. This is an upper bound of the true significance.

a. Lilliefors Significance Correction

## 2.3 Percentiles for Individual Variables

**Percentiles**

| | | Percentiles | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 10 | 25 | 50 | 75 | 90 | 95 |
| Weighted Average (Definition 1) | Crab Harvest | 33.5100 | 117.4600 | 498.4500 | 1079.90 | 2090.45 | 2479.92 | 2615.16 |
| | Ln (Crab Harvest) | 3.4632 | 4.7647 | 6.1937 | 6.9846 | 7.6450 | 7.8159 | 7.8688 |
| | SQRT (Crab Harvest) | 5.7230 | 10.8340 | 22.2270 | 32.8618 | 45.7194 | 49.7975 | 51.1346 |
| | January-February Inflows | 2.5140 | 5.0940 | 10.8500 | 25.6900 | 78.1800 | 108.9960 | 186.6490 |
| | Ln (January-February Inflows) | .8474 | 1.6164 | 2.3835 | 3.2461 | 4.3590 | 4.6909 | 5.2144 |
| | SQRT (January-February Inflows) | 1.5586 | 2.2504 | 3.2934 | 5.0685 | 8.8419 | 10.4391 | 13.6102 |
| | March-April Inflows | 2.5730 | 3.6940 | 7.1650 | 29.1800 | 52.9850 | 114.8340 | 246.1800 |
| | Ln (March-April Inflows) | .9369 | 1.2932 | 1.9601 | 3.3735 | 3.9699 | 4.7435 | 5.5042 |
| | SQRT (March-April Inflows) | 1.6008 | 1.9154 | 2.6708 | 5.4019 | 7.2789 | 10.7160 | 15.6827 |
| | May-June Inflows | 10.5370 | 18.5440 | 36.5100 | 105.7200 | 284.5850 | 364.6200 | 468.8070 |
| | Ln (May-June Inflows) | 2.3216 | 2.9100 | 3.5969 | 4.6608 | 5.6499 | 5.8971 | 6.1330 |
| | SQRT (May-June Inflows) | 3.2204 | 4.2953 | 6.0413 | 10.2820 | 16.8649 | 19.0866 | 21.5572 |
| | July-August Inflows | 6.6140 | 10.5760 | 16.1550 | 35.5900 | 129.7700 | 198.6680 | 241.8410 |
| | Ln (July-August Inflows) | 1.7541 | 2.3524 | 2.7821 | 3.5721 | 4.8656 | 5.2916 | 5.4749 |
| | SQRT (July-August Inflows) | 2.4960 | 3.2470 | 4.0192 | 5.9657 | 11.3913 | 14.0948 | 15.4984 |
| | September-October Inflows | 6.2970 | 7.7540 | 27.1600 | 72.0100 | 263.9200 | 582.3100 | 739.7040 |
| | Ln (September-October Inflows) | 1.8306 | 2.0473 | 3.3015 | 4.2768 | 5.5729 | 6.3666 | 6.6062 |
| | SQRT (September-October Inflows) | 2.5036 | 2.7840 | 5.2112 | 8.4859 | 16.2343 | 24.1287 | 27.1972 |
| | November-December Inflows | 5.4190 | 7.0600 | 11.6000 | 24.7300 | 60.2100 | 127.7380 | 144.1630 |
| | Ln (November-December Inflows) | 1.6891 | 1.9455 | 2.4502 | 3.2080 | 4.0978 | 4.8498 | 4.9644 |
| | SQRT (November-December Inflows) | 2.3274 | 2.6511 | 3.4052 | 4.9729 | 7.7594 | 11.3016 | 11.9867 |
| Tukey's Hinges | Crab Harvest | | | 591.8000 | 1079.90 | 2051.20 | | |
| | Ln (Crab Harvest) | | | 6.3832 | 6.9846 | 7.6262 | | |
| | SQRT (Crab Harvest) | | | 24.3269 | 32.8618 | 45.2902 | | |
| | January-February Inflows | | | 11.2500 | 25.6900 | 77.7700 | | |
| | Ln (January-February Inflows) | | | 2.4204 | 3.2461 | 4.3538 | | |
| | SQRT (January-February Inflows) | | | 3.3541 | 5.0685 | 8.8187 | | |
| | March-April Inflows | | | 8.1300 | 29.1800 | 52.2400 | | |
| | Ln (March-April Inflows) | | | 2.0956 | 3.3735 | 3.9558 | | |
| | SQRT (March-April Inflows) | | | 2.8513 | 5.4019 | 7.2277 | | |
| | May-June Inflows | | | 37.8800 | 105.7200 | 271.1400 | | |
| | Ln (May-June Inflows) | | | 3.6344 | 4.6608 | 5.6026 | | |
| | SQRT (May-June Inflows) | | | 6.1547 | 10.2820 | 16.4663 | | |
| | July-August Inflows | | | 16.4300 | 35.5900 | 127.6500 | | |
| | Ln (July-August Inflows) | | | 2.7991 | 3.5721 | 4.8493 | | |
| | SQRT (July-August Inflows) | | | 4.0534 | 5.9657 | 11.2982 | | |
| | September-October Inflows | | | 27.7800 | 72.0100 | 244.2500 | | |
| | Ln (September-October Inflows) | | | 3.3243 | 4.2768 | 5.4982 | | |
| | SQRT (September-October Inflows) | | | 5.2707 | 8.4859 | 15.6285 | | |
| | November-December Inflows | | | 12.0600 | 24.7300 | 59.7100 | | |
| | Ln (November-December Inflows) | | | 2.4899 | 3.2080 | 4.0895 | | |
| | SQRT (November-December Inflows) | | | 3.4728 | 4.9729 | 7.7272 | | |

## 2.4 Summary Information for Individual Variables

### 2.4.1 Summary Information for Crab Harvest

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| Crab Harvest | Mean | | 1232.80 | 146.3026 |
| | 95% Confidence Interval for Mean | Lower Bound | 934.7884 | |
| | | Upper Bound | 1530.81 | |
| | 5% Trimmed Mean | | 1220.52 | |
| | Median | | 1079.90 | |
| | Variance | | 706347 | |
| | Std. Deviation | | 840.4443 | |
| | Minimum | | 19.30 | |
| | Maximum | | 2716.10 | |
| | Range | | 2696.80 | |
| | Interquartile Range | | 1592.00 | |
| | Skewness | | .190 | .409 |
| | Kurtosis | | -1.191 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| Crab Harvest | Highest | 1 | 19 | 1980 | 2716.10 |
| | | 2 | 27 | 1988 | 2571.90 |
| | | 3 | 22 | 1983 | 2509.00 |
| | | 4 | 18 | 1979 | 2436.30 |
| | | 5 | 16 | 1977 | 2244.60 |
| | Lowest | 1 | 5 | 1966 | 19.30 |
| | | 2 | 4 | 1965 | 39.60 |
| | | 3 | 3 | 1964 | 112.30 |
| | | 4 | 2 | 1963 | 125.20 |
| | | 5 | 6 | 1967 | 155.60 |

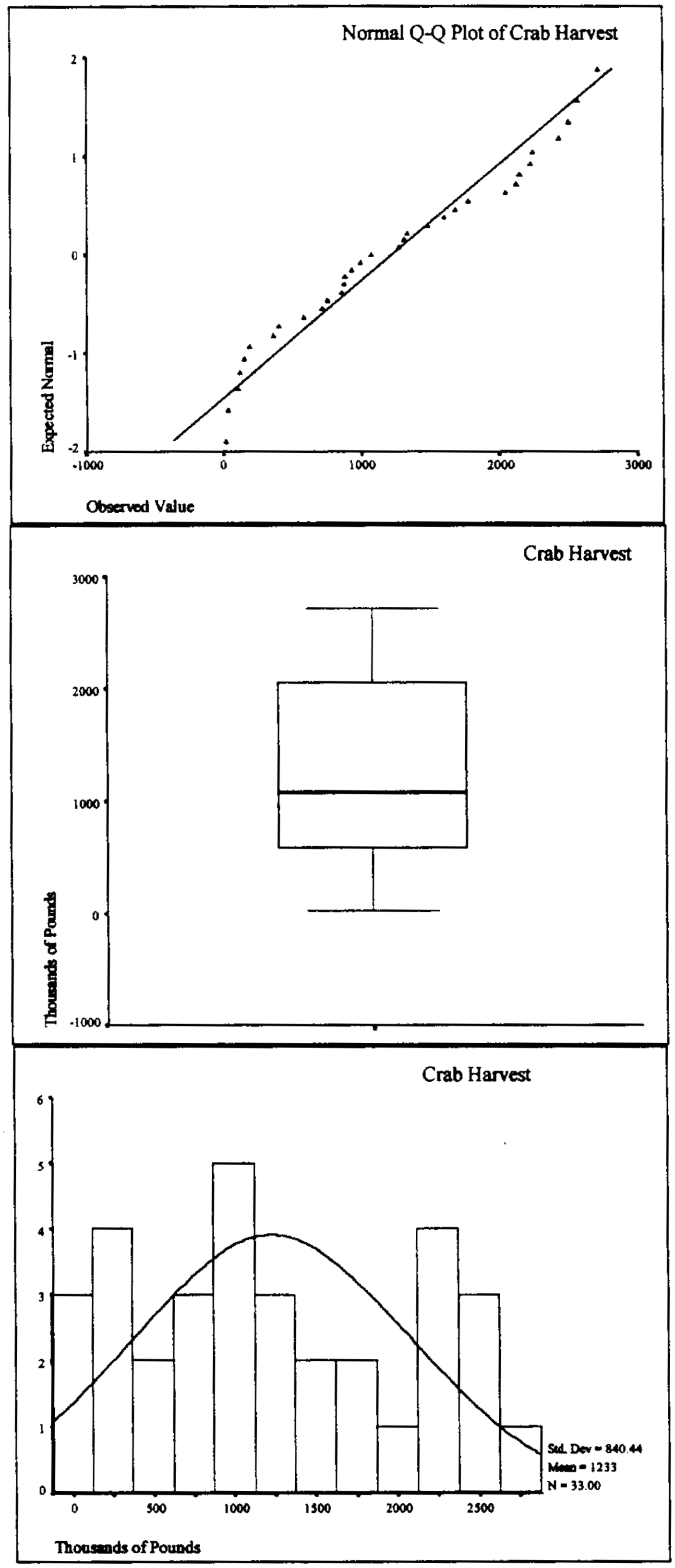



Fig. 2.1a. Exploratory Plots of Crab Harvest.

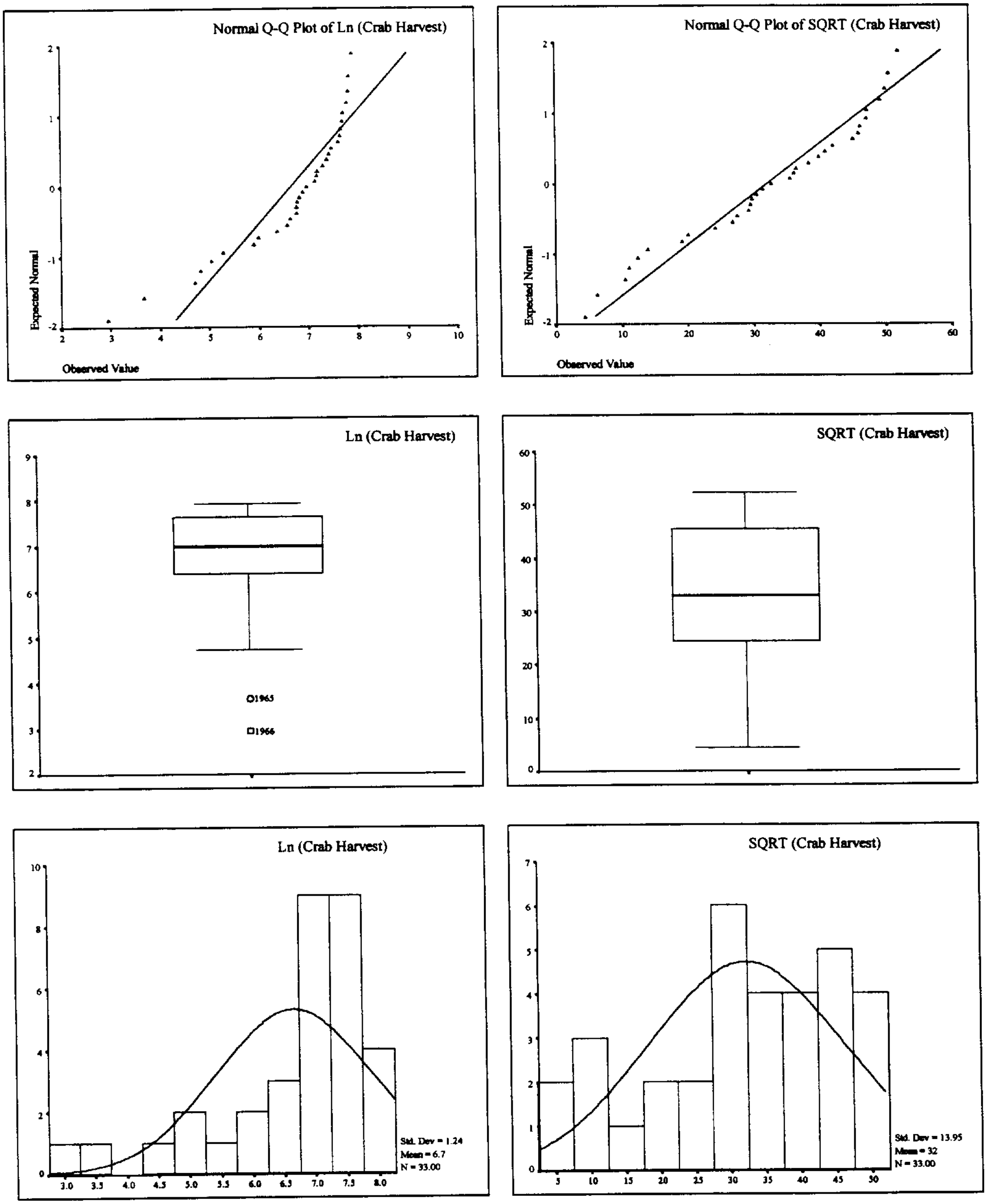



Fig. 2.1b. Exploratory Plots of Transformed Crab Harvest.

## 2.4.2 Summary Information for January-February Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| January-February Inflows | Mean | | 49.0894 | 9.2671 |
| | 95% Confidence Interval for Mean | Lower Bound | 30.2128 | |
| | | Upper Bound | 67.9660 | |
| | 5% Trimmed Mean | | 42.8205 | |
| | Median | | 25.6900 | |
| | Variance | | 2834.040 | |
| | Std. Deviation | | 53.2357 | |
| | Minimum | | 1.24 | |
| | Maximum | | 237.91 | |
| | Range | | 236.67 | |
| | Interquartile Range | | 67.3300 | |
| | Skewness | | 1.798 | .409 |
| | Kurtosis | | 3.895 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| January-February Inflows | Highest | 1 | 32 | 1993 | 237.91 |
| | | 2 | 31 | 1992 | 164.68 |
| | | 3 | 19 | 1980 | 111.42 |
| | | 4 | 22 | 1983 | 105.36 |
| | | 5 | 21 | 1982 | 101.88 |
| | Lowest | 1 | 2 | 1963 | 1.24 |
| | | 2 | 3 | 1964 | 3.06 |
| | | 3 | 15 | 1976 | 4.45 |
| | | 4 | 28 | 1989 | 6.06 |
| | | 5 | 14 | 1975 | 6.13 |

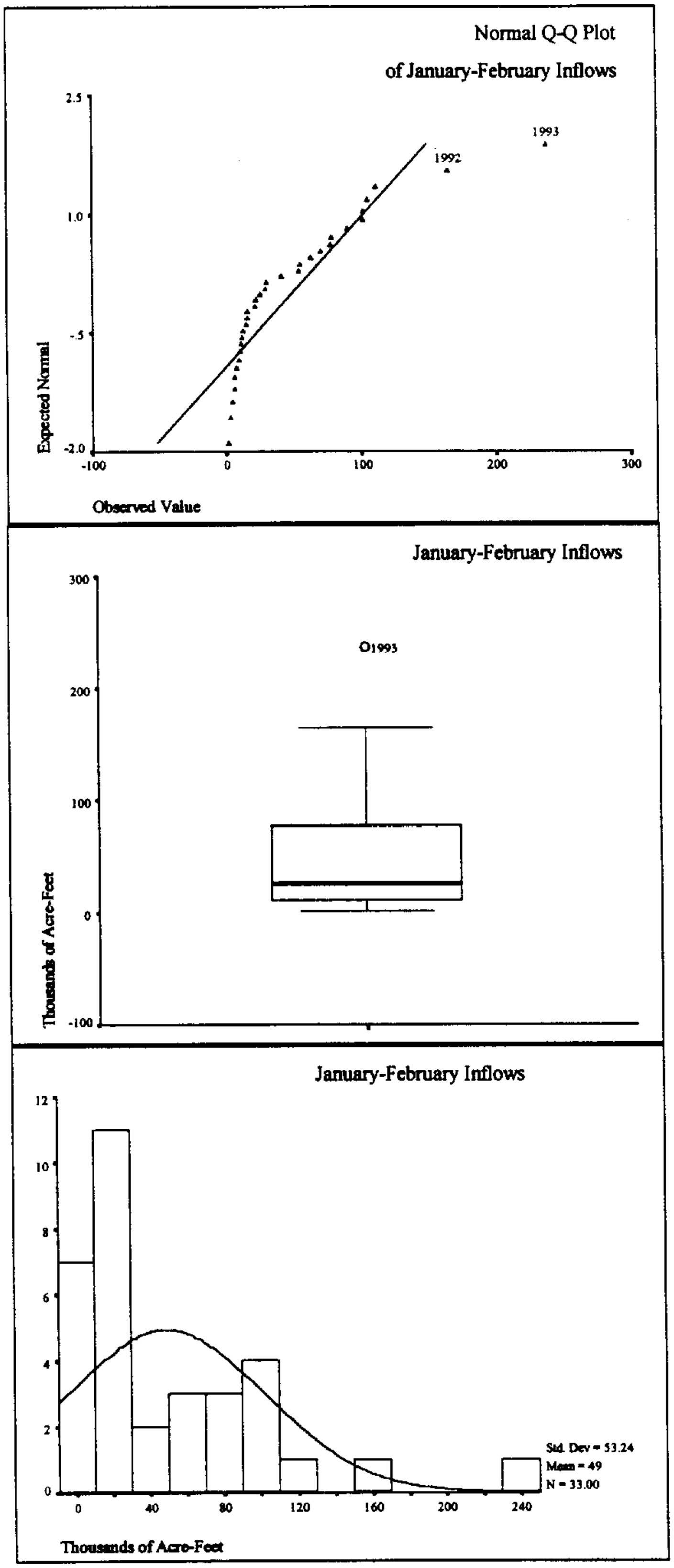



Fig. 2.2a. Exploratory Plots of January-February Inflows.

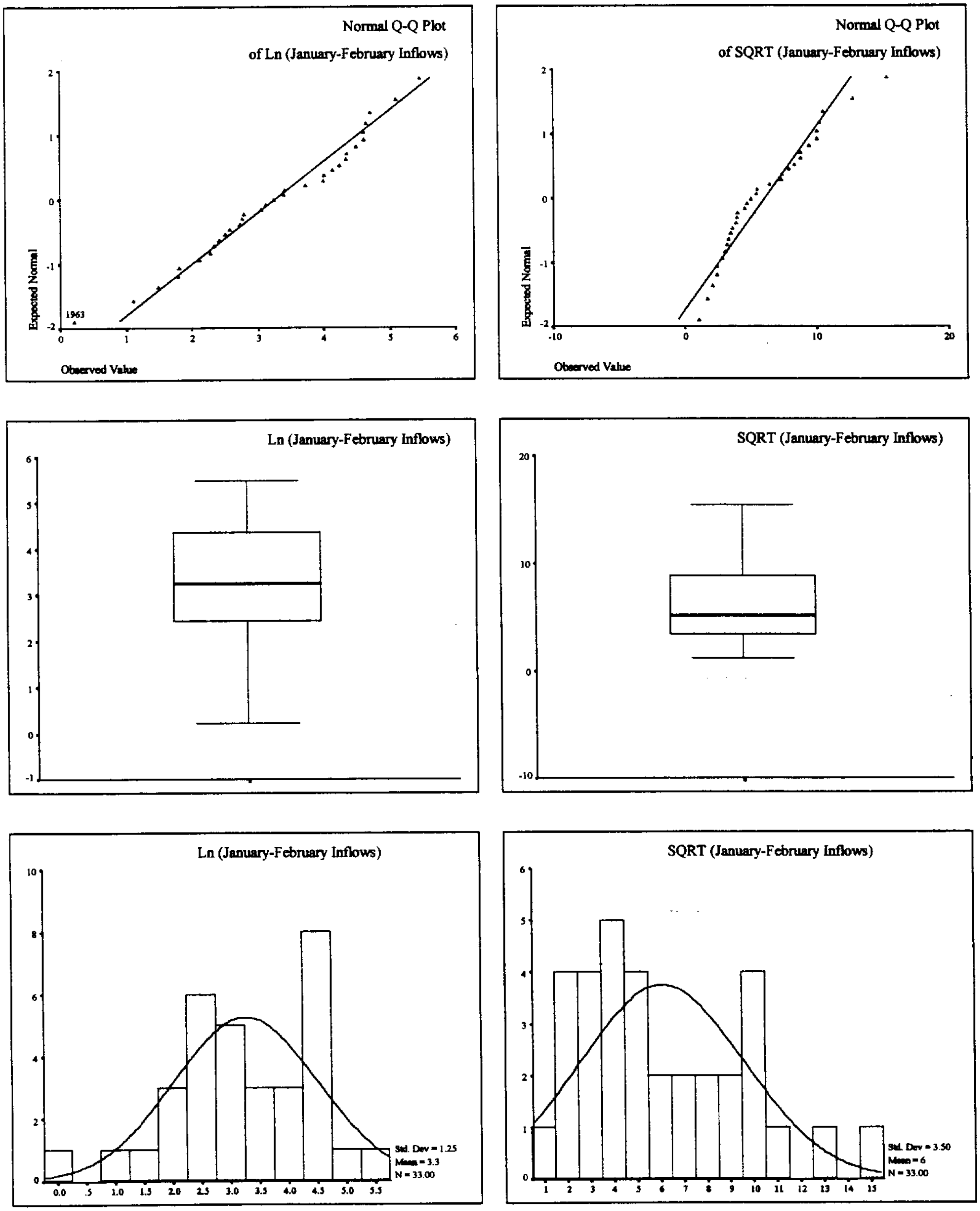



Fig. 2.2b. Exploratory Plots of Transformed January-February Inflows.

### 2.4.3 Summary Information for March-April Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| March-April Inflows | Mean | | 45.4633 | 10.6395 |
| | 95% Confidence Interval for Mean | Lower Bound | 23.7915 | |
| | | Upper Bound | 67.1352 | |
| | 5% Trimmed Mean | | 36.1373 | |
| | Median | | 29.1800 | |
| | Variance | | 3735.540 | |
| | Std. Deviation | | 61.1191 | |
| | Minimum | | 2.09 | |
| | Maximum | | 269.63 | |
| | Range | | 267.54 | |
| | Interquartile Range | | 45.8200 | |
| | Skewness | | 2.649 | .409 |
| | Kurtosis | | 7.303 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| March-April Inflows | Highest | 1 | 32 | 1993 | 269.63 |
| | | 2 | 31 | 1992 | 236.13 |
| | | 3 | 24 | 1985 | 115.47 |
| | | 4 | 25 | 1986 | 113.88 |
| | | 5 | 33 | 1994 | 88.99 |
| | Lowest | 1 | 2 | 1963 | 2.09 |
| | | 2 | 28 | 1989 | 2.78 |
| | | 3 | 3 | 1964 | 3.19 |
| | | 4 | 7 | 1968 | 4.45 |
| | | 5 | 4 | 1965 | 4.71 |

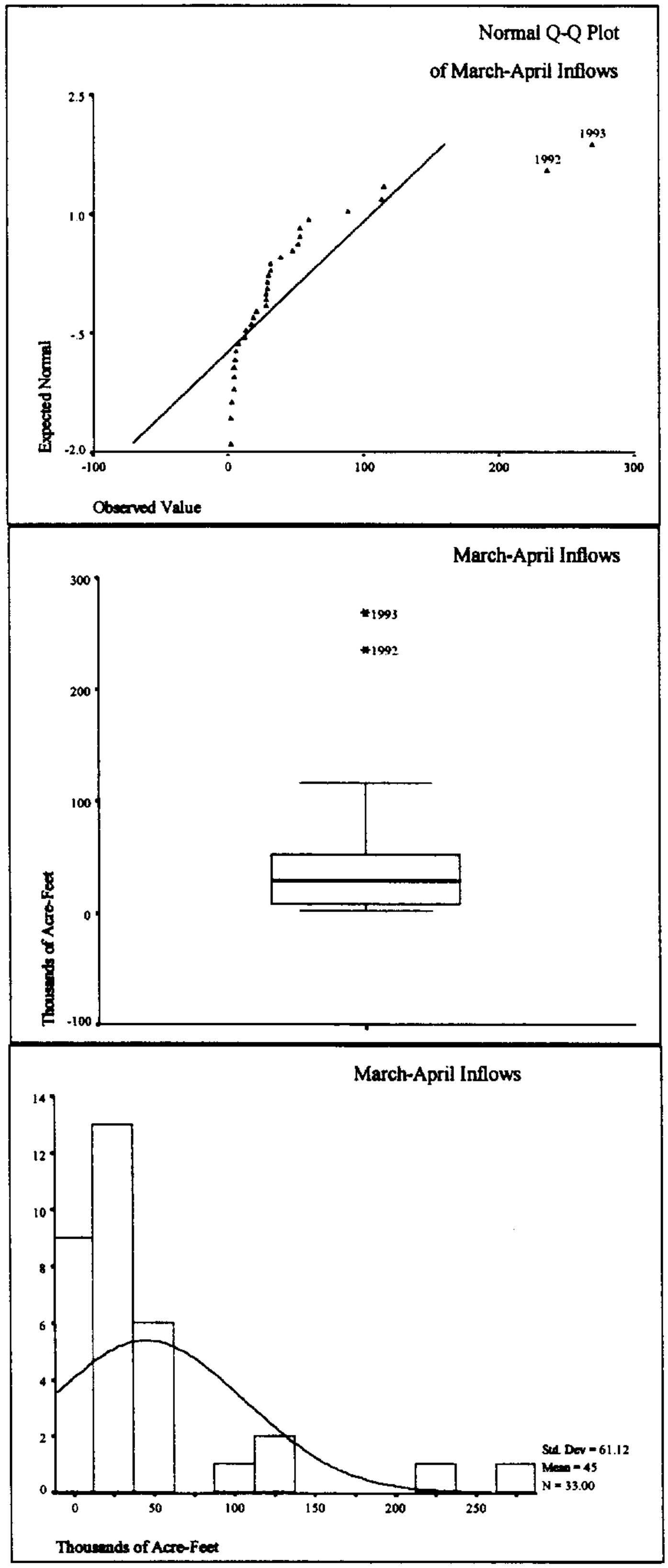



Fig. 2.3a. Exploratory Plots of March-April Inflows.

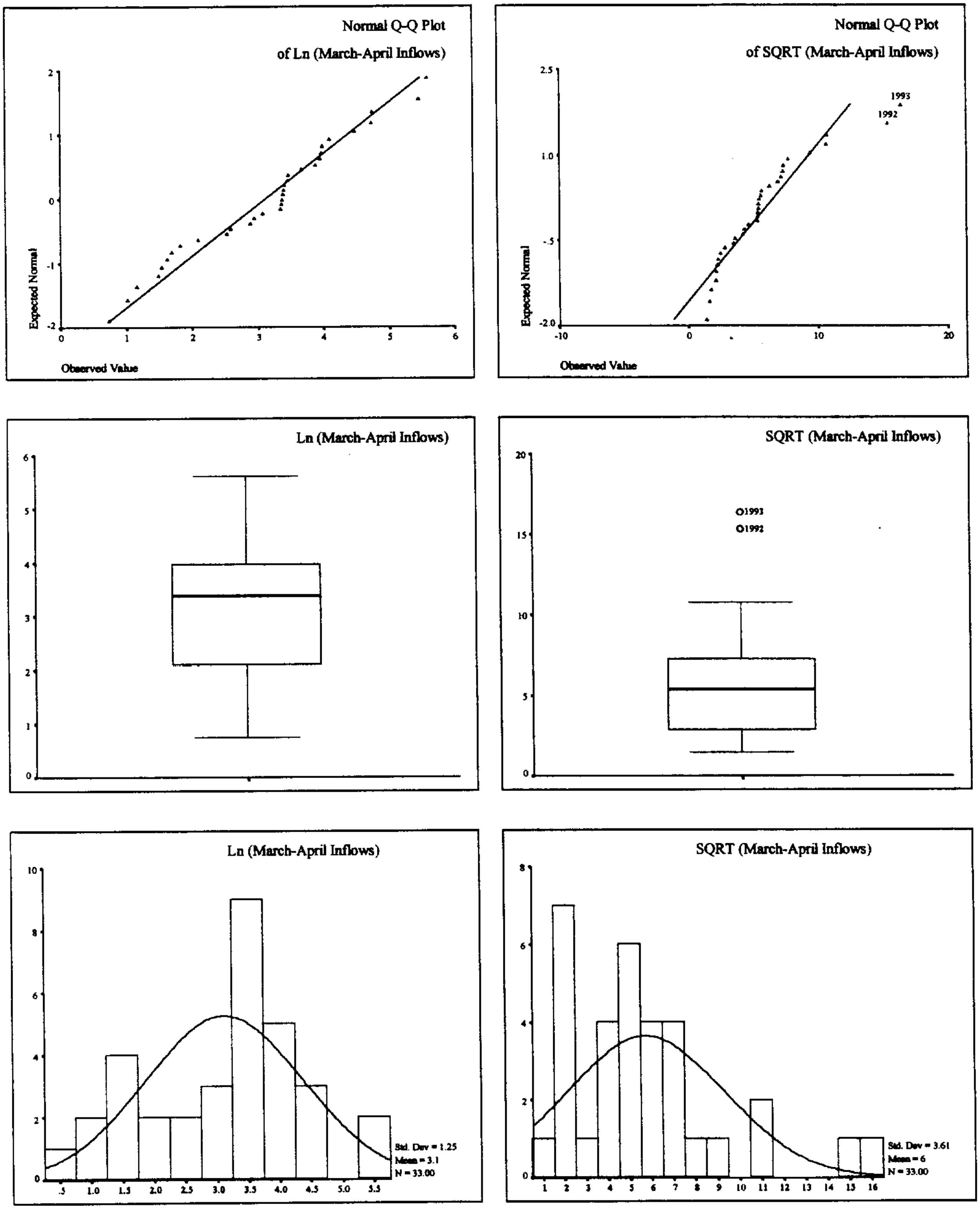



Fig. 2.3b. Exploratory Plots of Transformed March-April Inflows.

### 2.4.4 Summary Information for May-June Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| May-June Inflows | Mean | | 154.1418 | 25.4367 |
| | 95% Confidence Interval for Mean | Lower Bound | 102.3289 | |
| | | Upper Bound | 205.9547 | |
| | 5% Trimmed Mean | | 141.3606 | |
| | Median | | 105.7200 | |
| | Variance | | 21351.9 | |
| | Std. Deviation | | 146.1228 | |
| | Minimum | | 6.75 | |
| | Maximum | | 607.54 | |
| | Range | | 600.79 | |
| | Interquartile Range | | 248.0750 | |
| | Skewness | | 1.256 | .409 |
| | Kurtosis | | 1.331 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| May-June Inflows | Highest | 1 | 32 | 1993 | 607.54 |
| | | 2 | 12 | 1973 | 409.35 |
| | | 3 | 33 | 1994 | 382.20 |
| | | 4 | 21 | 1982 | 338.25 |
| | | 5 | 8 | 1969 | 316.63 |
| | Lowest | 1 | 3 | 1964 | 6.75 |
| | | 2 | 2 | 1963 | 12.16 |
| | | 3 | 29 | 1990 | 16.36 |
| | | 4 | 28 | 1989 | 21.82 |
| | | 5 | 1 | 1962 | 22.26 |

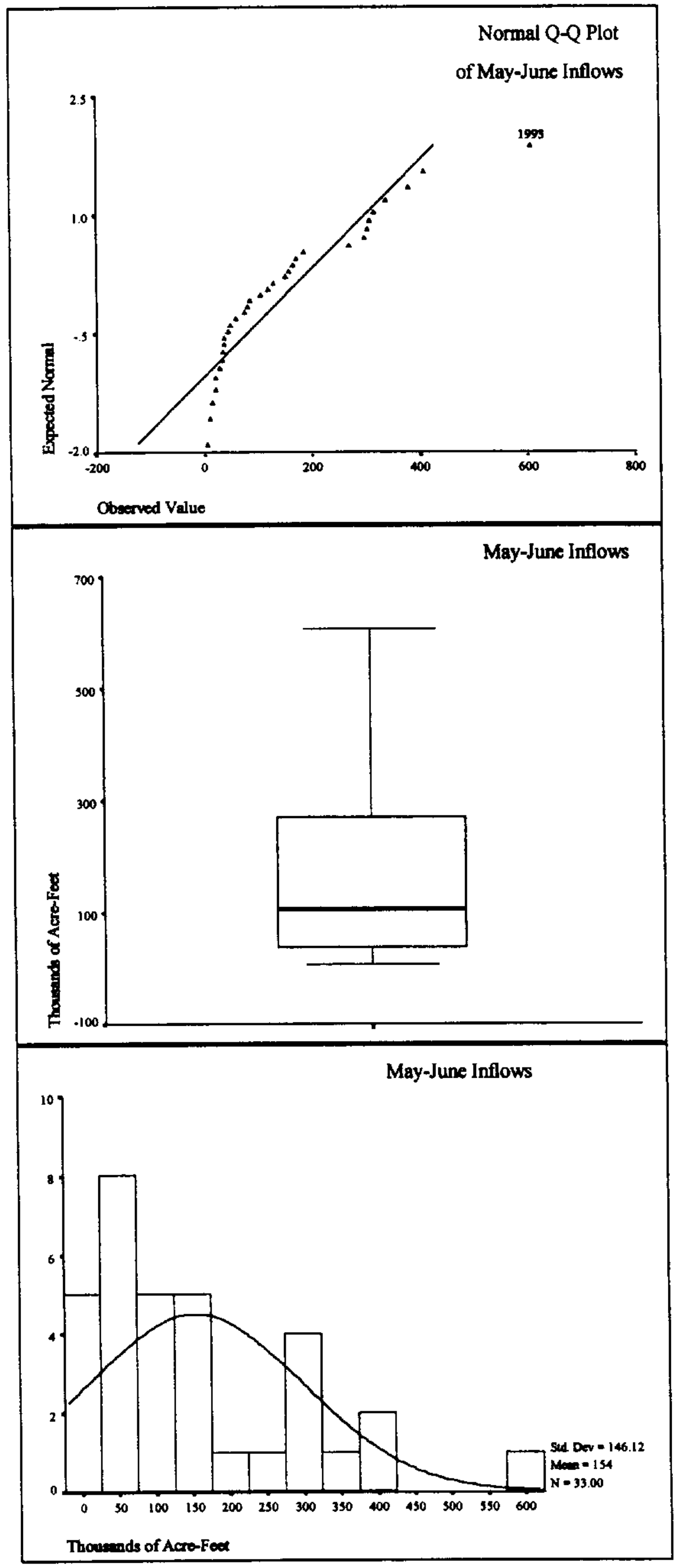



Fig. 2.4a. Exploratory Plots of May-June Inflows.

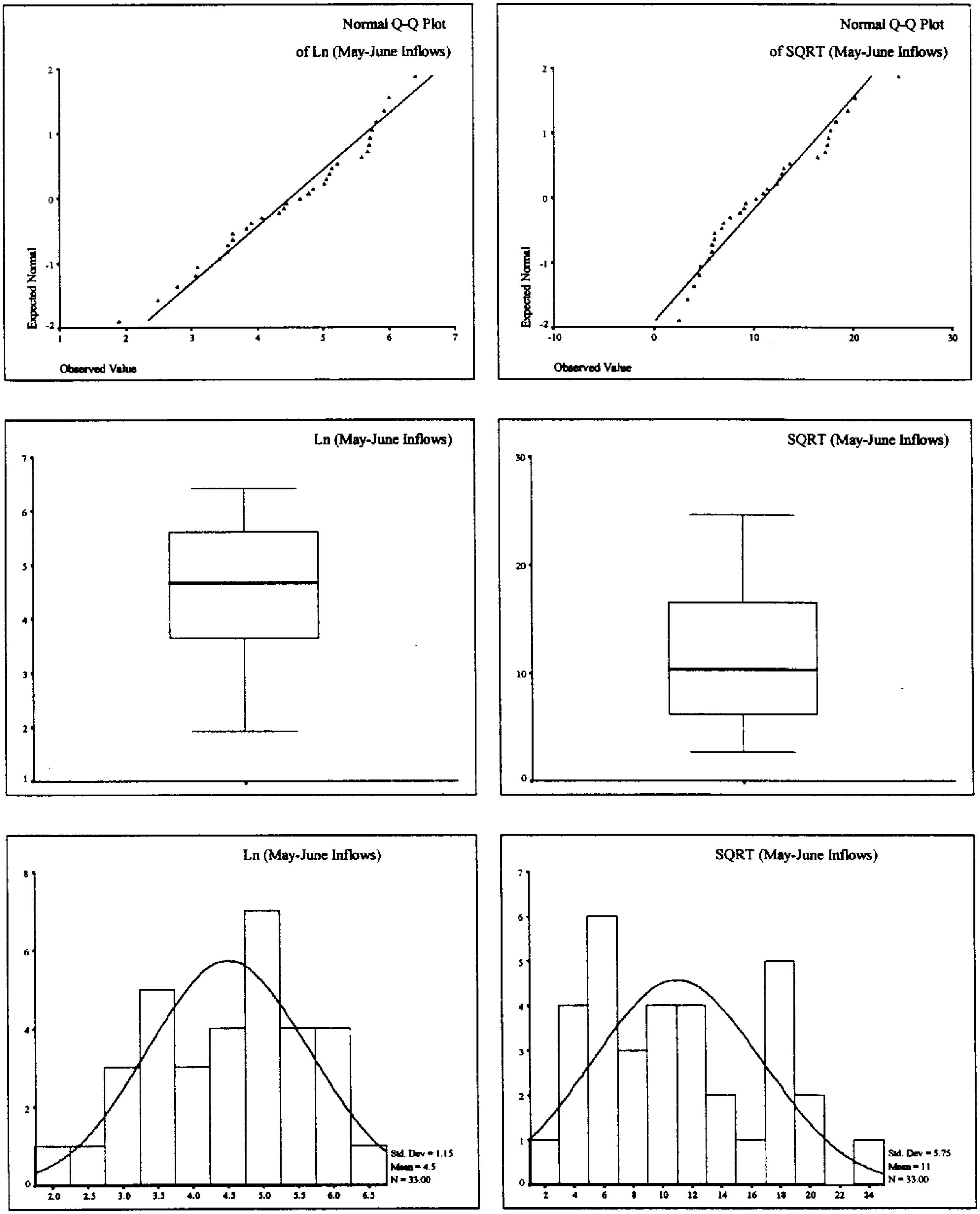



Fig. 2.4b. Exploratory Plots of Transformed May-June Inflows.

### 2.4.5 Summary Information for July-August Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| July-August Inflows | Mean | | 72.7897 | 14.0587 |
| | 95% Confidence Interval for Mean | Lower Bound | 44.1531 | |
| | | Upper Bound | 101.4263 | |
| | 5% Trimmed Mean | | 65.6504 | |
| | Median | | 35.5900 | |
| | Variance | | 6522.352 | |
| | Std. Deviation | | 80.7611 | |
| | Minimum | | 2.40 | |
| | Maximum | | 304.68 | |
| | Range | | 302.28 | |
| | Interquartile Range | | 113.6150 | |
| | Skewness | | 1.339 | .409 |
| | Kurtosis | | .709 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| July-August Inflows | Highest | 1 | 20 | 1981 | 304.68 |
| | | 2 | 19 | 1980 | 214.91 |
| | | 3 | 22 | 1983 | 200.04 |
| | | 4 | 23 | 1984 | 196.61 |
| | | 5 | 29 | 1990 | 193.50 |
| | Lowest | 1 | 2 | 1963 | 2.40 |
| | | 2 | 14 | 1975 | 8.42 |
| | | 3 | 24 | 1985 | 9.60 |
| | | 4 | 17 | 1978 | 12.04 |
| | | 5 | 5 | 1966 | 12.23 |

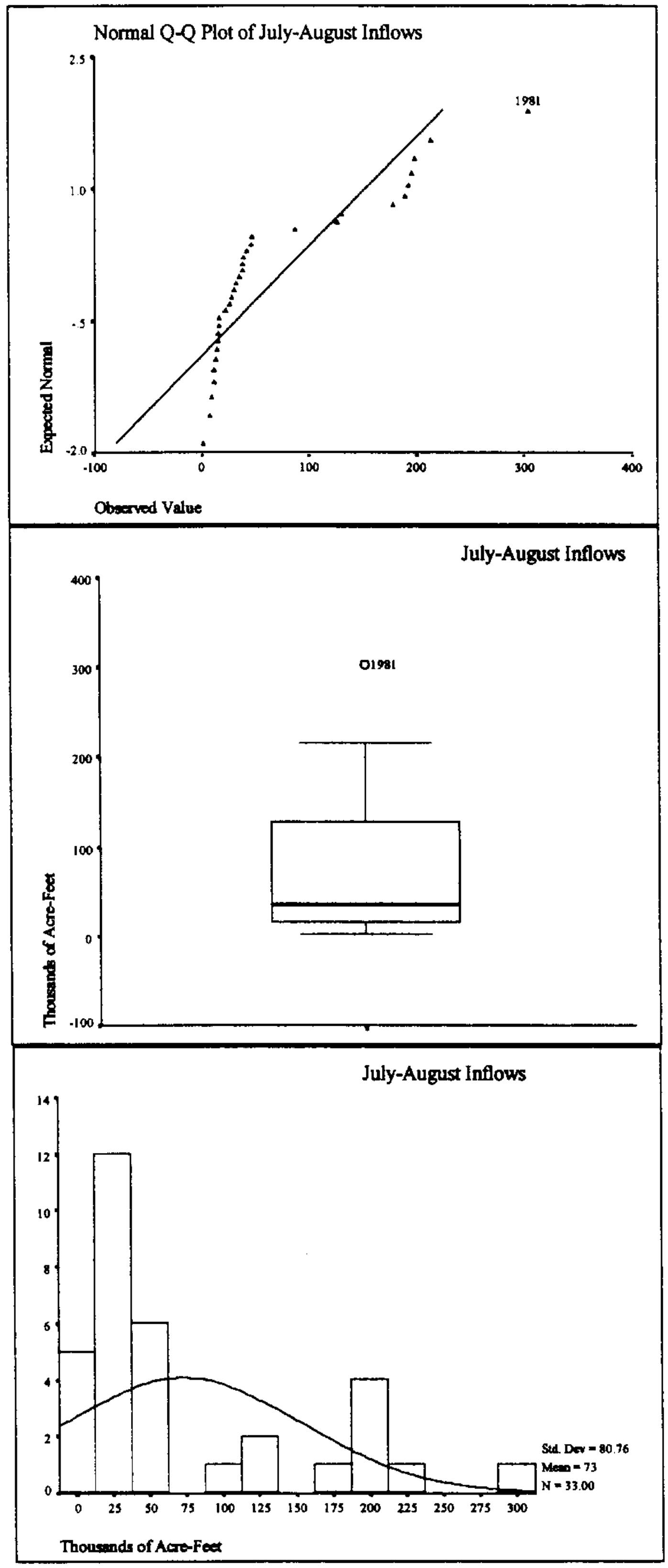



Fig. 2.5a. Exploratory Plots of July-August Inflows.

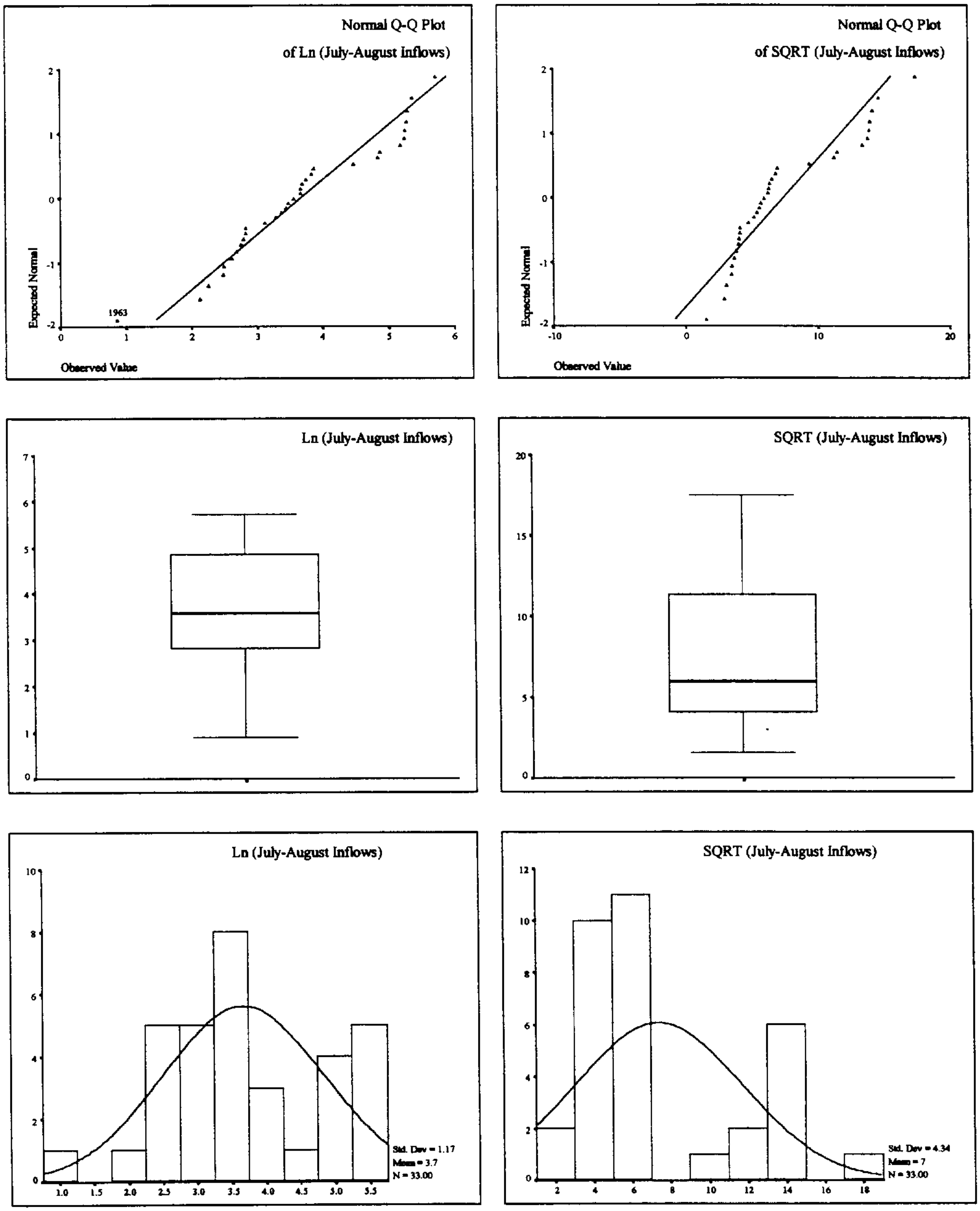



Fig. 2.5b. Exploratory Plots of Transformed July-August Inflows.

### 2.4.6 Summary Information for September-October Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| September-October Inflows | Mean | | 176.4415 | 37.3182 |
| | 95% Confidence Interval for Mean | Lower Bound | 100.4268 | |
| | | Upper Bound | 252.4562 | |
| | 5% Trimmed Mean | | 154.3675 | |
| | Median | | 72.0100 | |
| | Variance | | 45957.4 | |
| | Std. Deviation | | 214.3768 | |
| | Minimum | | 5.03 | |
| | Maximum | | 750.61 | |
| | Range | | 745.58 | |
| | Interquartile Range | | 236.7600 | |
| | Skewness | | 1.577 | .409 |
| | Kurtosis | | 1.572 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| September-October Inflows | Highest | 1 | 7 | 1968 | 750.61 |
| | | 2 | 6 | 1967 | 735.03 |
| | | 3 | 10 | 1971 | 595.65 |
| | | 4 | 11 | 1972 | 562.30 |
| | | 5 | 13 | 1974 | 439.28 |
| | Lowest | 1 | 3 | 1964 | 5.03 |
| | | 2 | 5 | 1966 | 6.84 |
| | | 3 | 4 | 1965 | 7.49 |
| | | 4 | 29 | 1990 | 8.15 |
| | | 5 | 2 | 1963 | 11.26 |

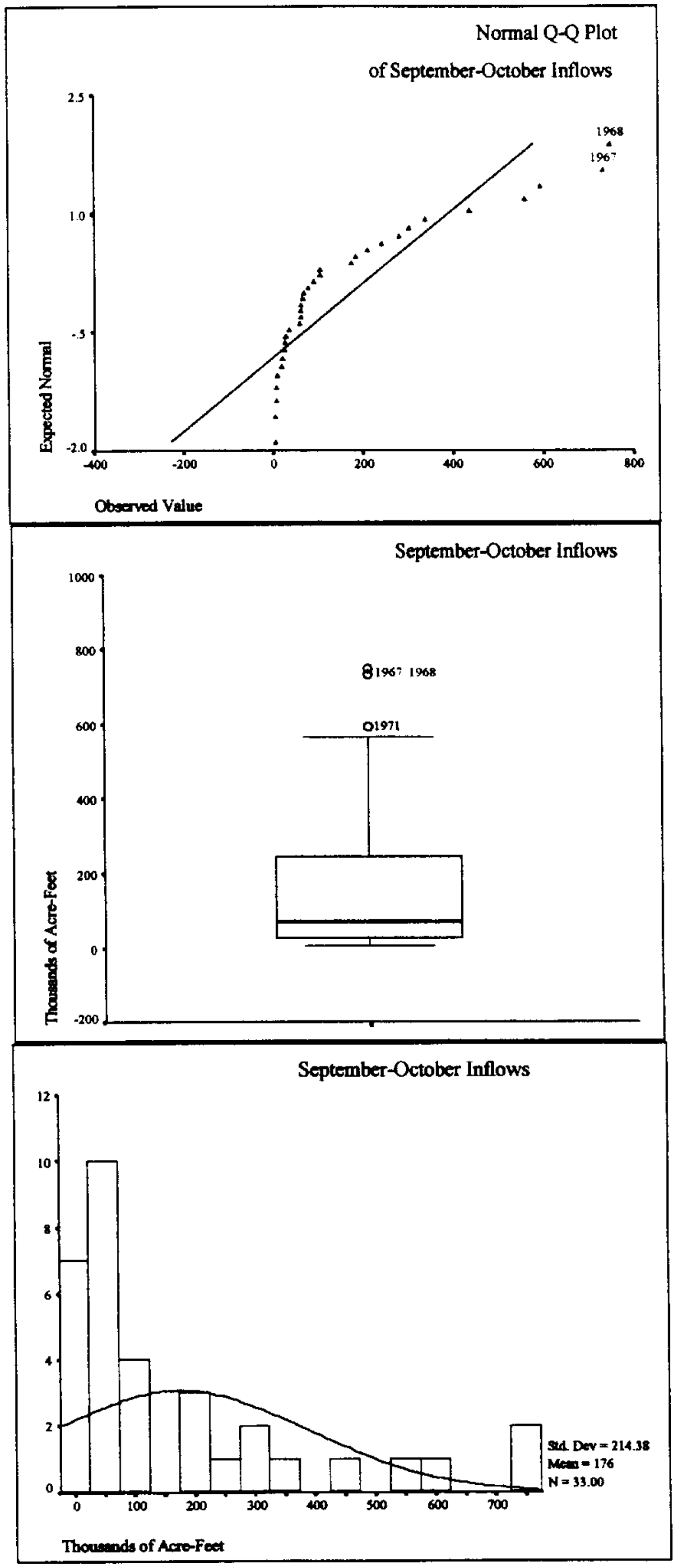



Fig. 2.6a. Exploratory Plots of September-October Inflows.

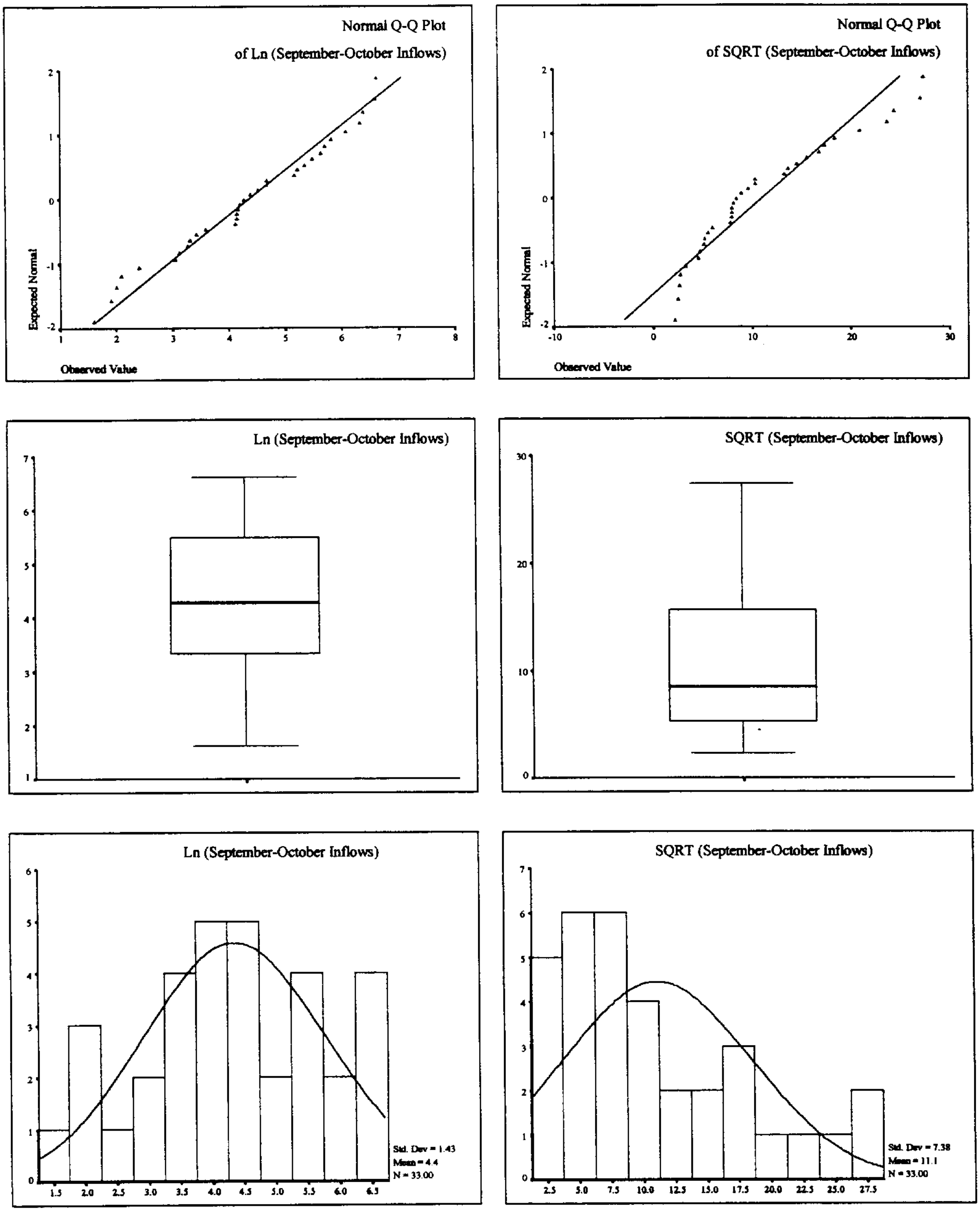



Fig. 2.6b. Exploratory Plots of Transformed September-October Inflows.

### 2.4.7 Summary Information for November-December Inflows

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| November-December Inflows | Mean | | 45.4042 | 8.0269 |
| | 95% Confidence Interval for Mean | Lower Bound | 29.0539 | |
| | | Upper Bound | 61.7546 | |
| | 5% Trimmed Mean | | 41.5143 | |
| | Median | | 24.7300 | |
| | Variance | | 2126.247 | |
| | Std. Deviation | | 46.1112 | |
| | Minimum | | 5.09 | |
| | Maximum | | 170.21 | |
| | Range | | 165.12 | |
| | Interquartile Range | | 48.6100 | |
| | Skewness | | 1.326 | .409 |
| | Kurtosis | | .639 | .798 |

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| November-December Inflows | Highest | 1 | 31 | 1992 | 170.21 |
| | | 2 | 30 | 1991 | 133.00 |
| | | 3 | 16 | 1977 | 129.69 |
| | | 4 | 15 | 1976 | 124.81 |
| | | 5 | 21 | 1982 | 119.87 |
| | Lowest | 1 | 3 | 1964 | 5.09 |
| | | 2 | 6 | 1967 | 5.56 |
| | | 3 | 7 | 1968 | 6.28 |
| | | 4 | 27 | 1988 | 8.23 |
| | | 5 | 12 | 1973 | 9.96 |

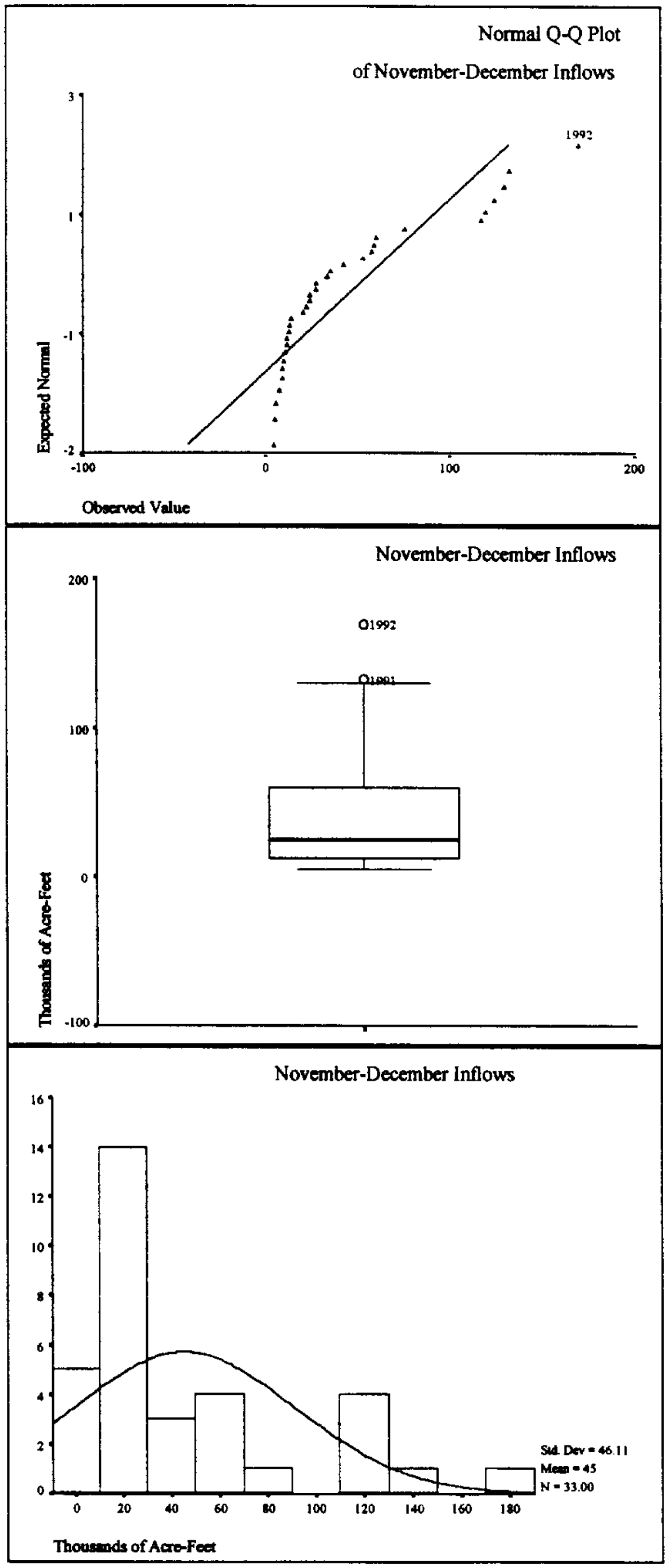



Fig. 2.7a. Exploratory Plots of November-December Inflows.

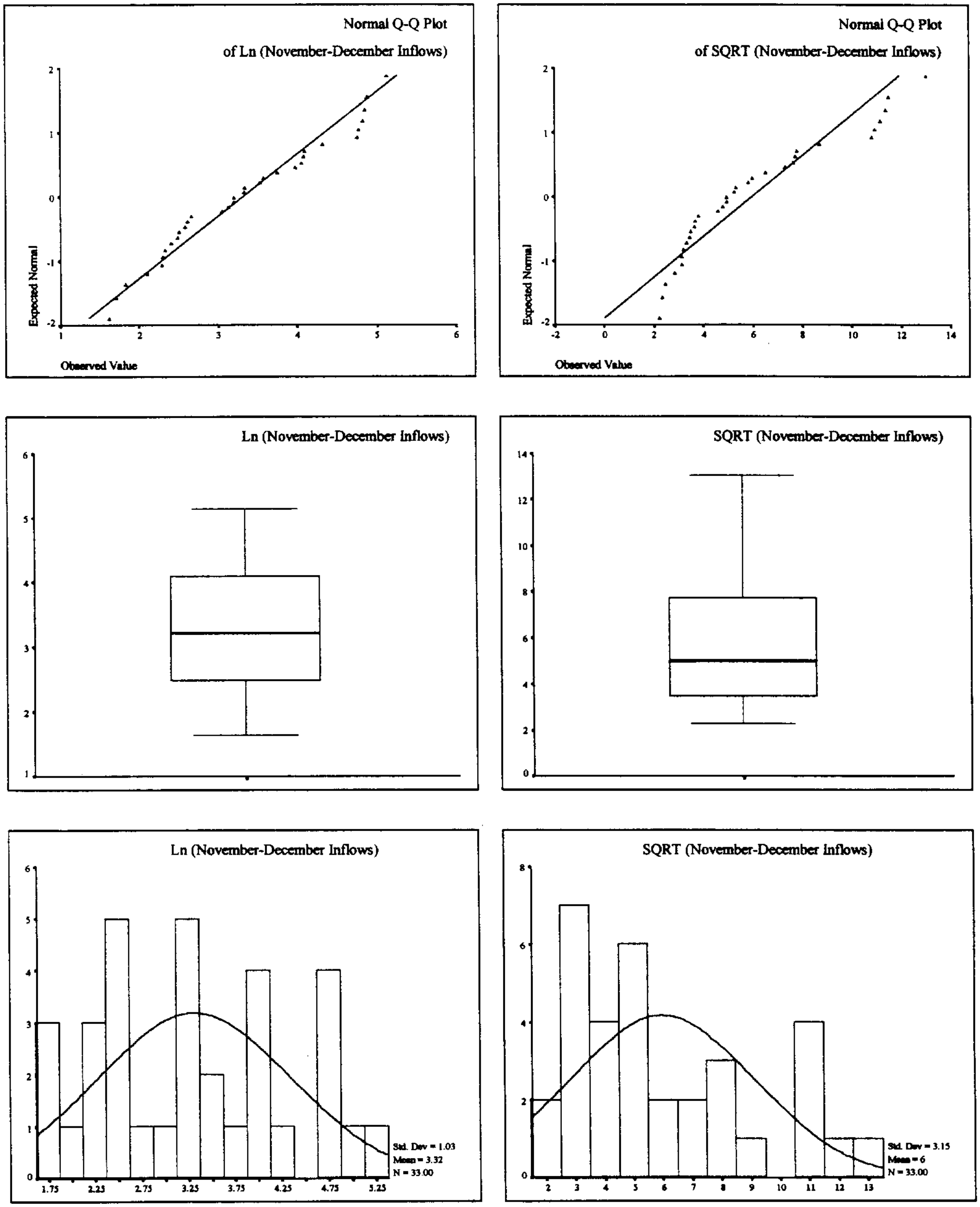



Fig. 2.7b. Exploratory Plots of Transformed November-December Inflows.

# 3. Prediction and Confidence Regions

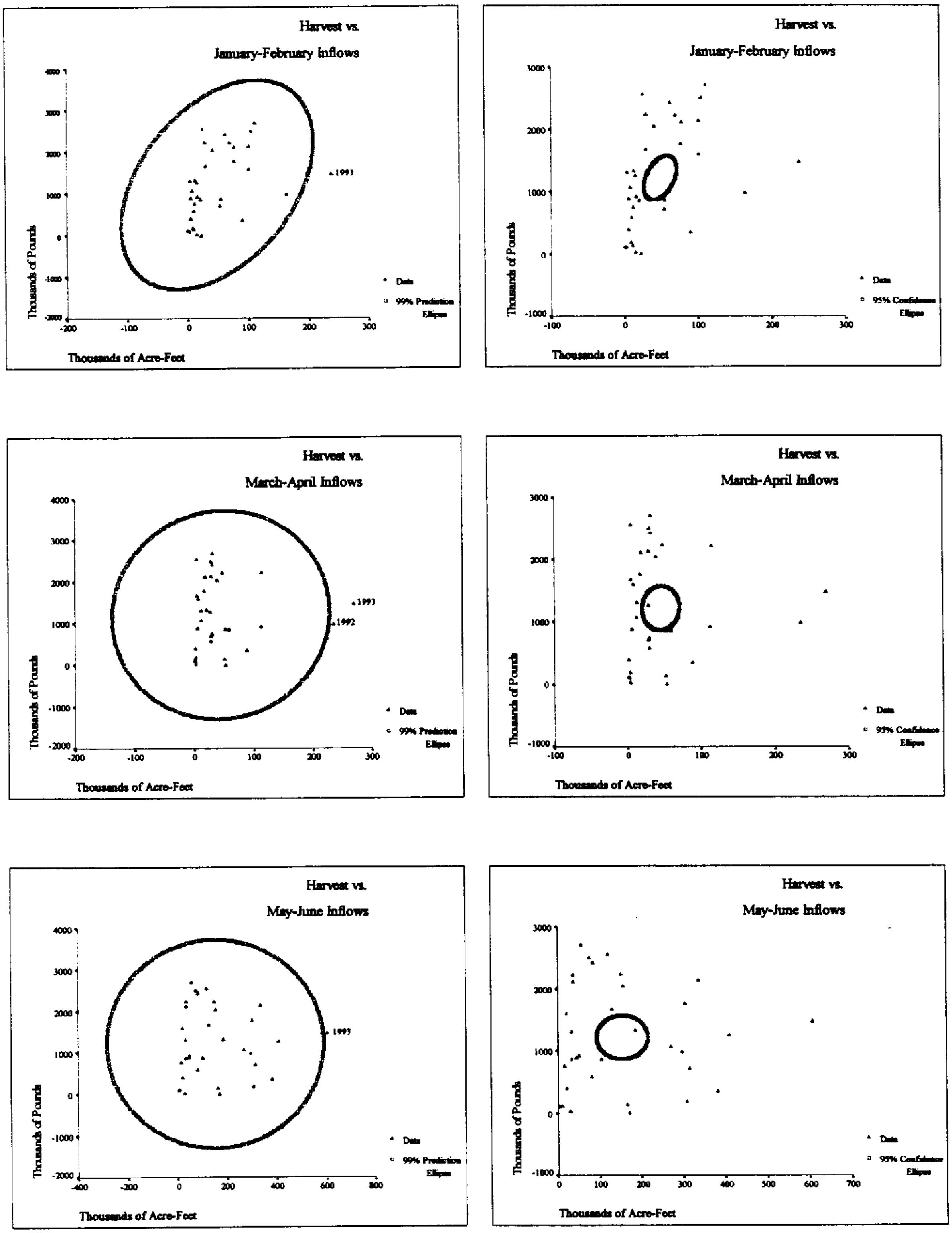



Fig. 3.1. Prediction and Confidence Ellipses.

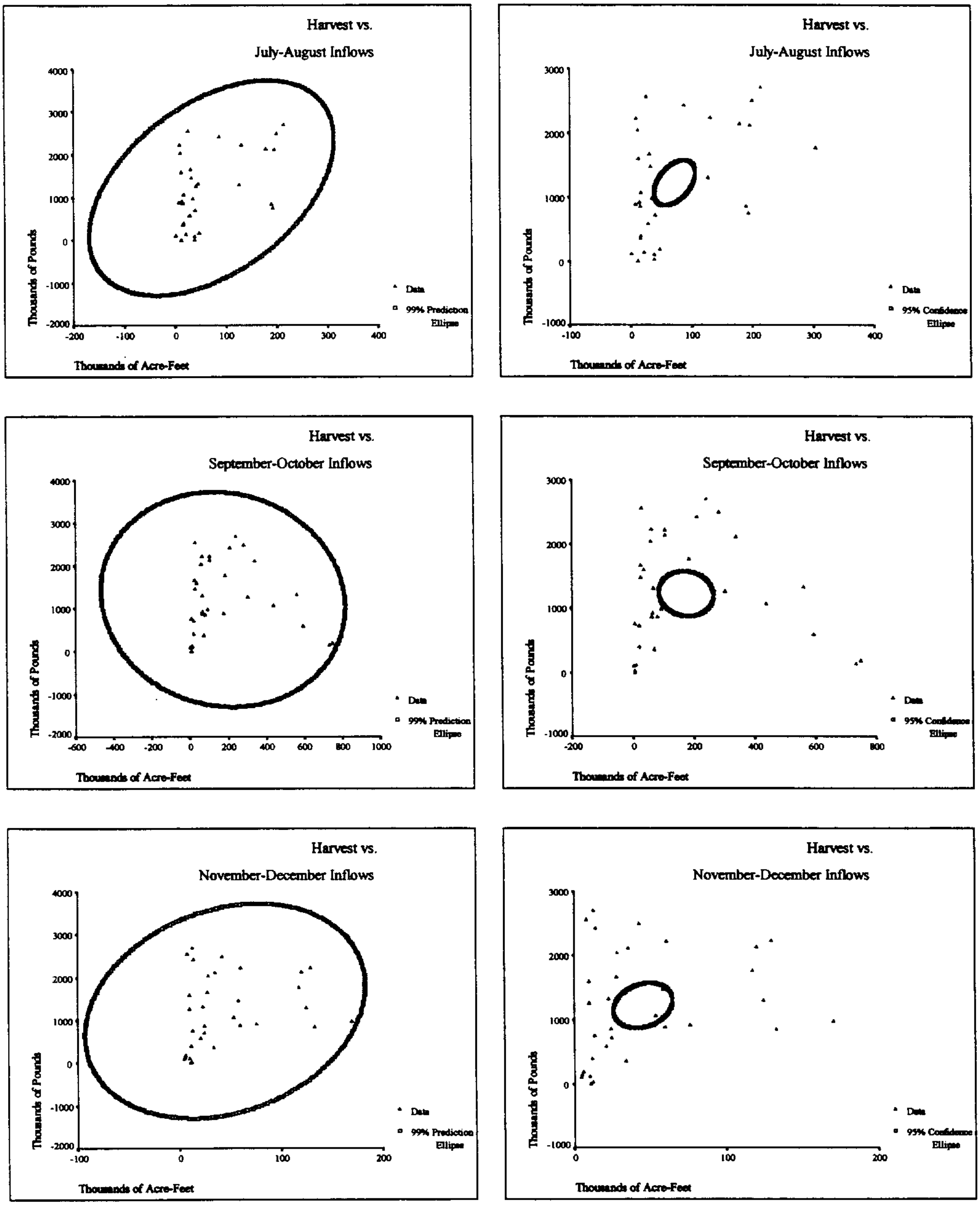



Fig. 3.2. Prediction and Confidence Ellipses.

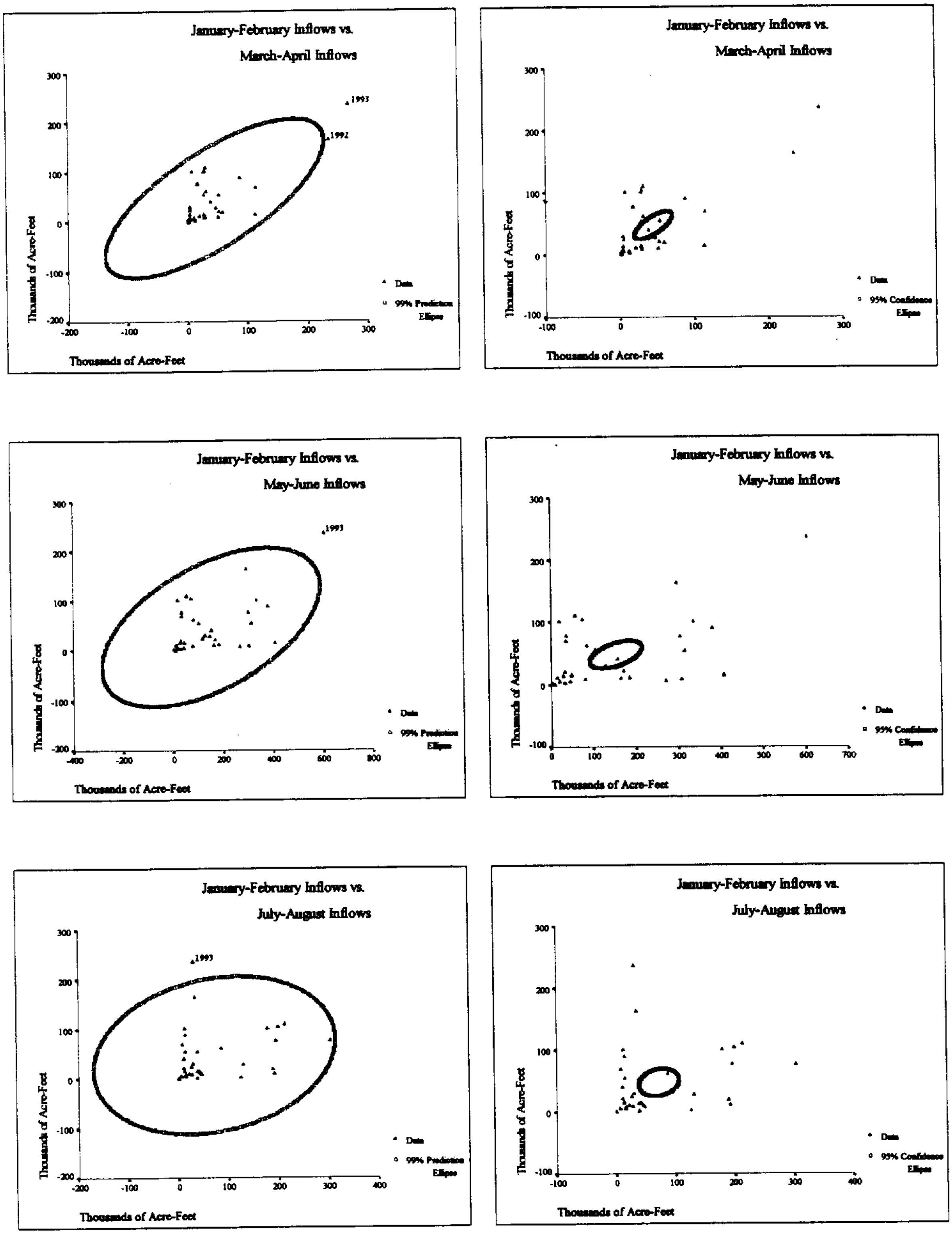



Fig. 3.3. Prediction and Confidence Ellipses.

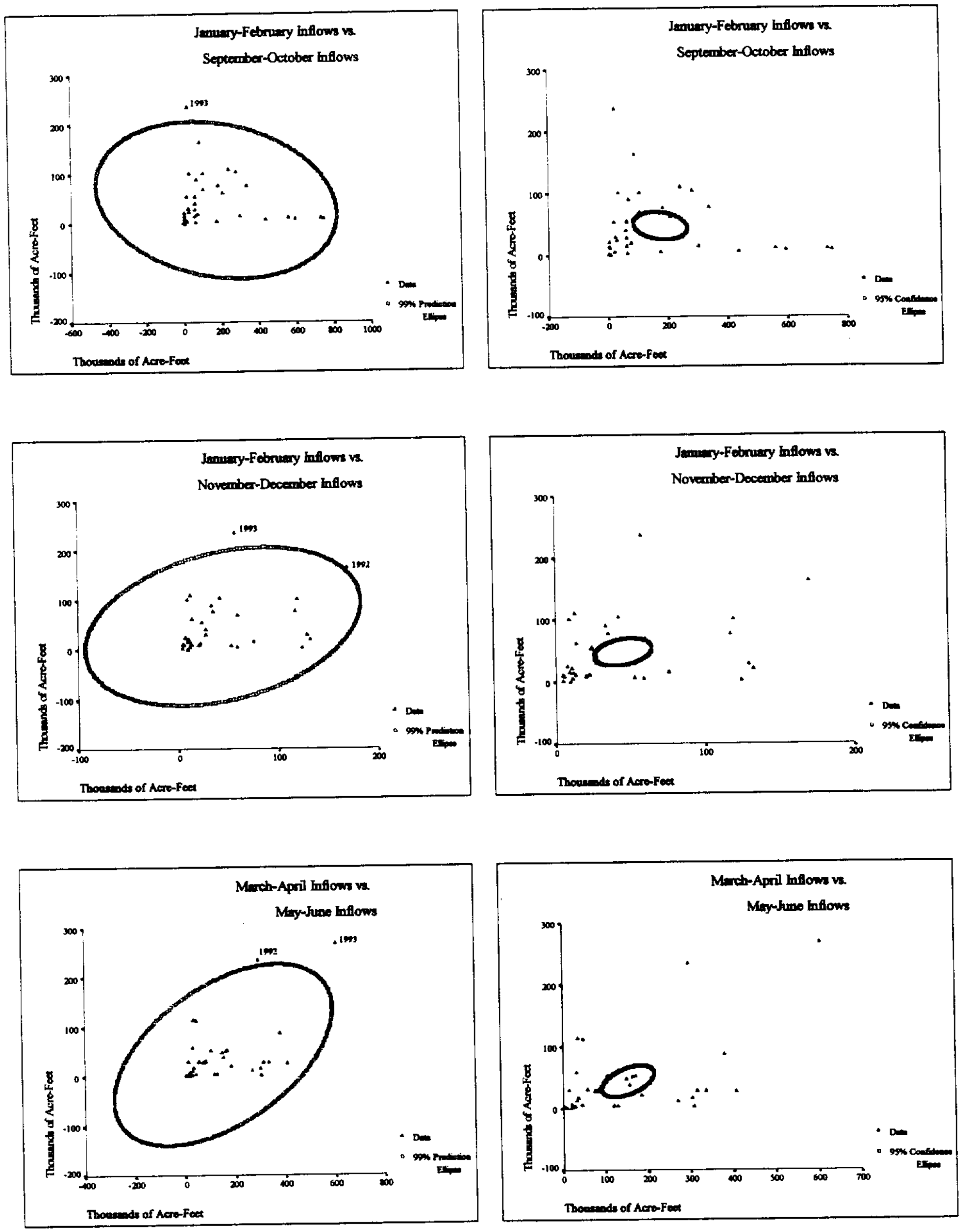



Fig. 3.4. Prediction and Confidence Ellipses.

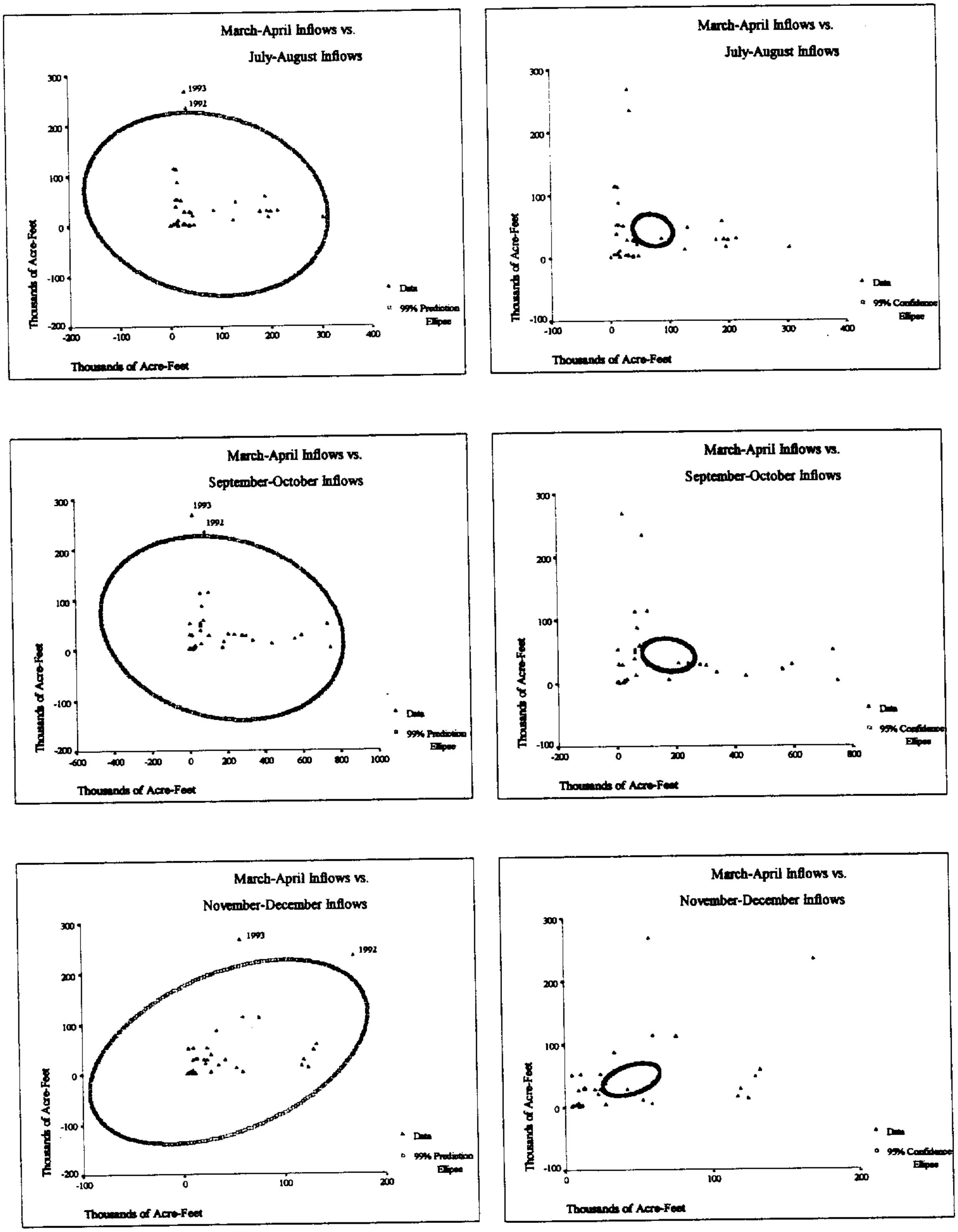



Fig. 3.5. Prediction and Confidence Ellipses.

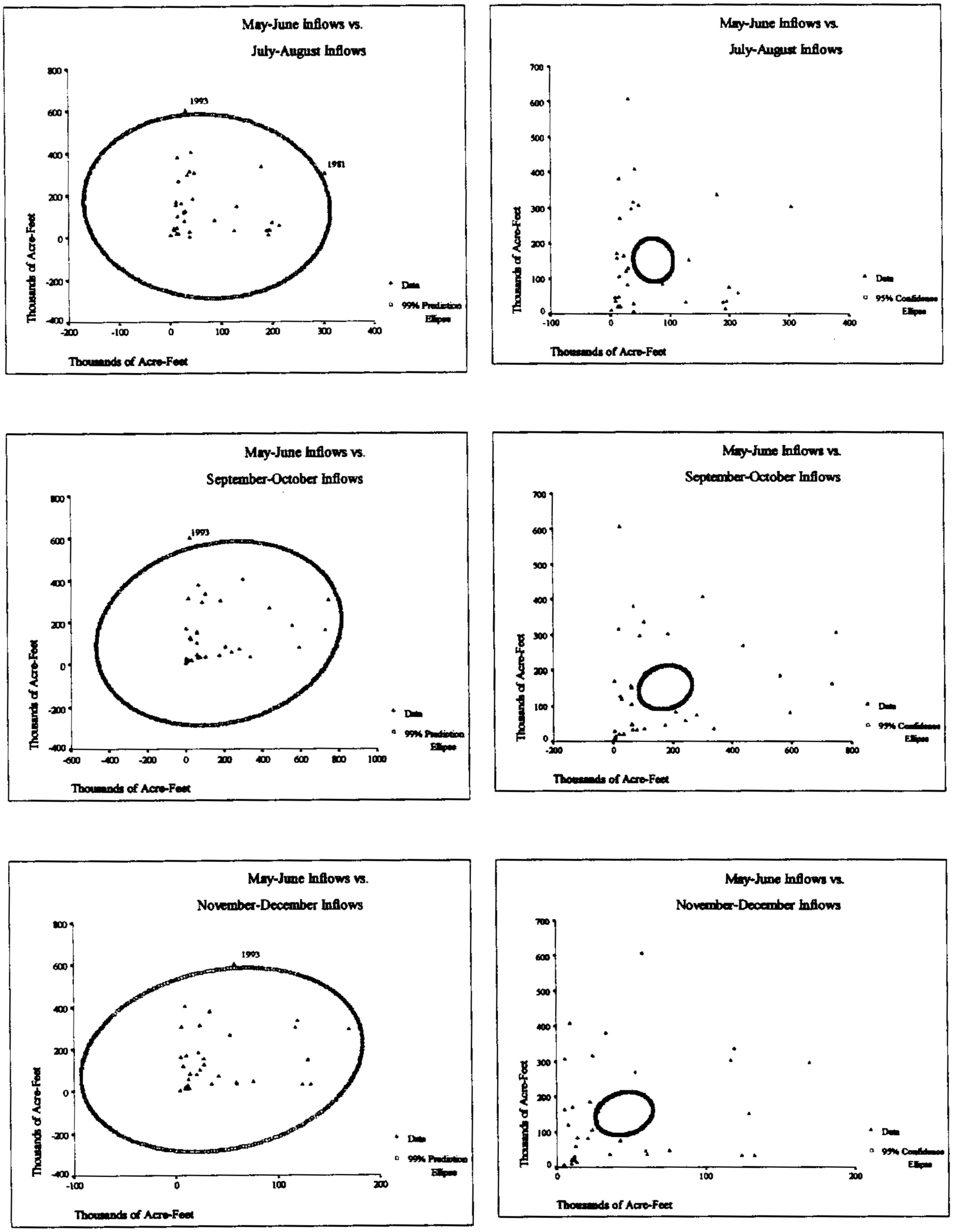



Fig. 3.6. Prediction and Confidence Ellipses.

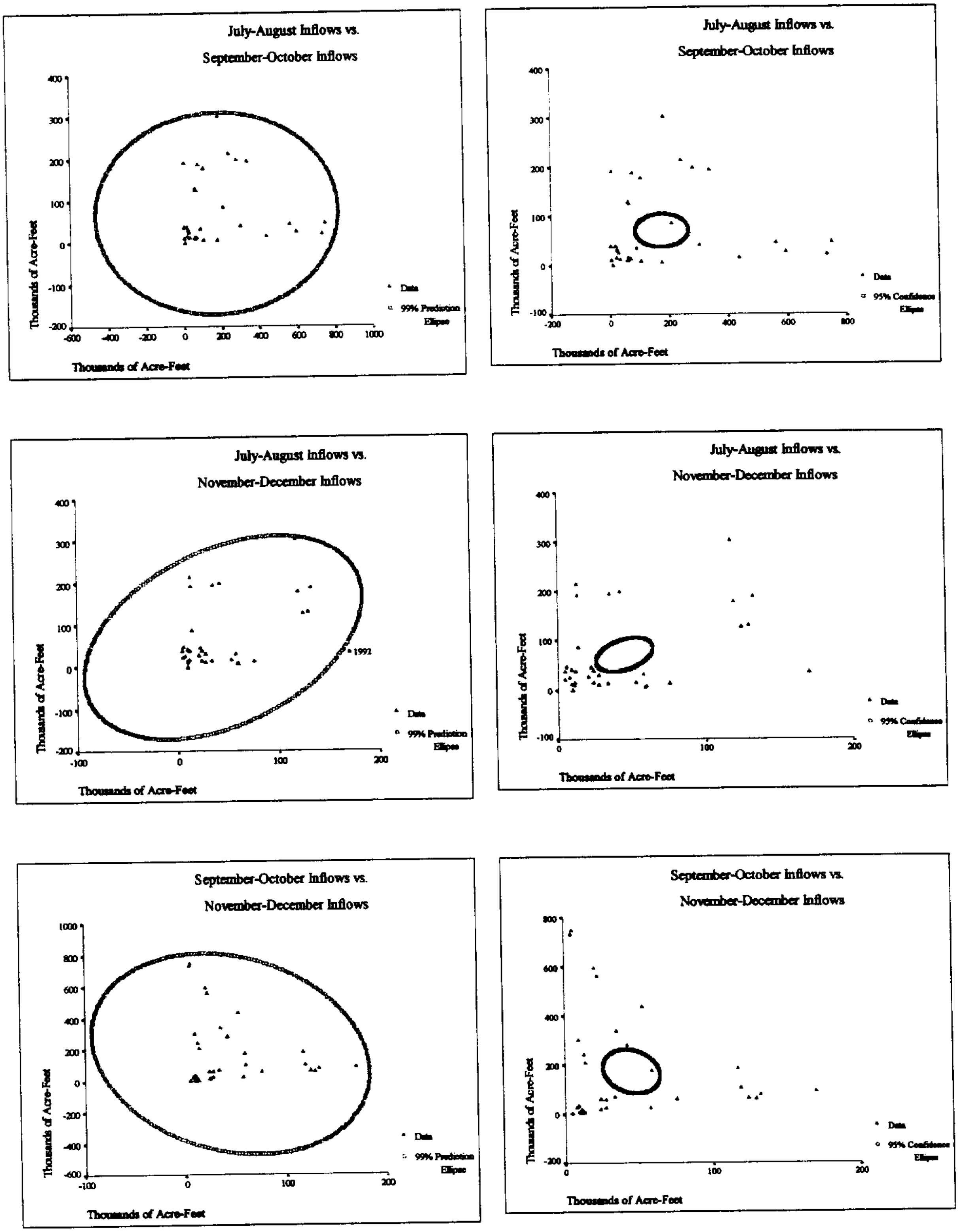



Fig. 3.7. Prediction and Confidence Ellipses.

## 4. Box-Cox Analysis

Table 4.1 Numerical Results.

| HARVEST | QJF_Lag | QMA_Lag | QMJ_Lag | QJA_Lag | QSO_Lag | QND_Lag | LAMBDA |
|---|---|---|---|---|---|---|---|
| 1.34E+10 | 1054158 | 78386 | 2212213 | 836818 | 3990474 | 9796 | -2.0 |
| 7.10E+09 | 636109 | 55267 | 1472829 | 529247 | 2623139 | 7869 | -1.9 |
| 3.80E+09 | 386295 | 39247 | 987656 | 336641 | 1735864 | 6359 | -1.8 |
| 2.05E+09 | 236282 | 28089 | 667661 | 215525 | 1157060 | 5172 | -1.7 |
| 1.11E+09 | 145714 | 20273 | 455433 | 139018 | 777366 | 4236 | -1.6 |
| 6.09E+08 | 90709 | 14767 | 313828 | 90447 | 526804 | 3497 | -1.5 |
| 3.37E+08 | 57081 | 10864 | 218724 | 59443 | 360415 | 2911 | -1.4 |
| 1.89E+08 | 36372 | 8080 | 154399 | 39534 | 249186 | 2445 | -1.3 |
| 1.07E+08 | 23516 | 6080 | 110562 | 26666 | 174309 | 2073 | -1.2 |
| 62001710 | 15463 | 4633 | 80446 | 18289 | 123535 | 1777 | -1.1 |
| 36451445 | 10370 | 3580 | 59581 | 12795 | 88845 | 1540 | -1.0 |
| 21884275 | 7115 | 2808 | 45001 | 9163 | 64962 | 1351 | -0.9 |
| 13459162 | 5011 | 2238 | 34723 | 6743 | 48396 | 1201 | -0.8 |
| 8508632 | 3635 | 1816 | 27419 | 5119 | 36827 | 1082 | -0.7 |
| 5548896 | 2726 | 1503 | 22192 | 4023 | 28703 | 990 | -0.6 |
| 3746009 | 2119 | 1270 | 18432 | 3283 | 22983 | 919 | -0.5 |
| 2625935 | 1712 | 1098 | 15724 | 2787 | 18963 | 867 | -0.4 |
| 1915893 | 1438 | 974 | 13783 | 2462 | 16171 | 831 | -0.3 |
| 1456819 | 1257 | 889 | 12416 | 2260 | 14290 | 811 | -0.2 |
| 1154647 | 1142 | 836 | 11490 | 2154 | 13110 | **804** | **-0.1** |
| 952917 | 1077 | **812** | 10915 | **2123** | 12501 | 812 | **0** |
| 817228 | **1051** | 816 | 10634 | 2158 | **12388** | 834 | **0.1** |
| 726314 | 1060 | 850 | **10612** | 2256 | 12746 | 871 | **0.2** |
| 666853 | 1101 | 917 | 10836 | 2418 | 13591 | 925 | 0.3 |
| 630427 | 1177 | 1026 | 11305 | 2648 | 14979 | 999 | 0.4 |
| 611705 | 1290 | 1186 | 12035 | 2959 | 17018 | 1095 | 0.5 |
| **607354** | 1448 | 1416 | 13057 | 3365 | 19869 | 1218 | **0.6** |
| 615377 | 1663 | 1741 | 14419 | 3889 | 23773 | 1374 | 0.7 |
| 634710 | 1949 | 2196 | 16188 | 4561 | 29068 | 1570 | 0.8 |
| 664977 | 2329 | 2835 | 18458 | 5421 | 36238 | 1817 | 0.9 |
| 706347 | 2834 | 3736 | 21352 | 6522 | 45957 | 2126 | 1.0 |
| 759451 | 3508 | 5010 | 25035 | 7937 | 59181 | 2515 | 1.1 |
| 825355 | 4410 | 6824 | 29725 | 9761 | 77253 | 3004 | 1.2 |
| 905550 | 5626 | 9422 | 35711 | 12123 | 102077 | 3620 | 1.3 |
| 1001986 | 7274 | 13164 | 43379 | 15197 | 136356 | 4401 | 1.4 |
| 1117113 | 9523 | 18586 | 53238 | 19216 | 183937 | 5392 | 1.5 |
| 1253956 | 12609 | 26484 | 65972 | 24496 | 250322 | 6653 | 1.6 |
| 1416206 | 16870 | 38047 | 82492 | 31470 | 343394 | 8266 | 1.7 |
| 1608340 | 22786 | 55059 | 104023 | 40726 | 474492 | 10334 | 1.8 |
| 1835772 | 31043 | 80200 | 132214 | 53069 | 659971 | 12995 | 1.9 |
| 2105034 | 42628 | 117509 | 169292 | 69607 | 923480 | 16430 | 2.0 |

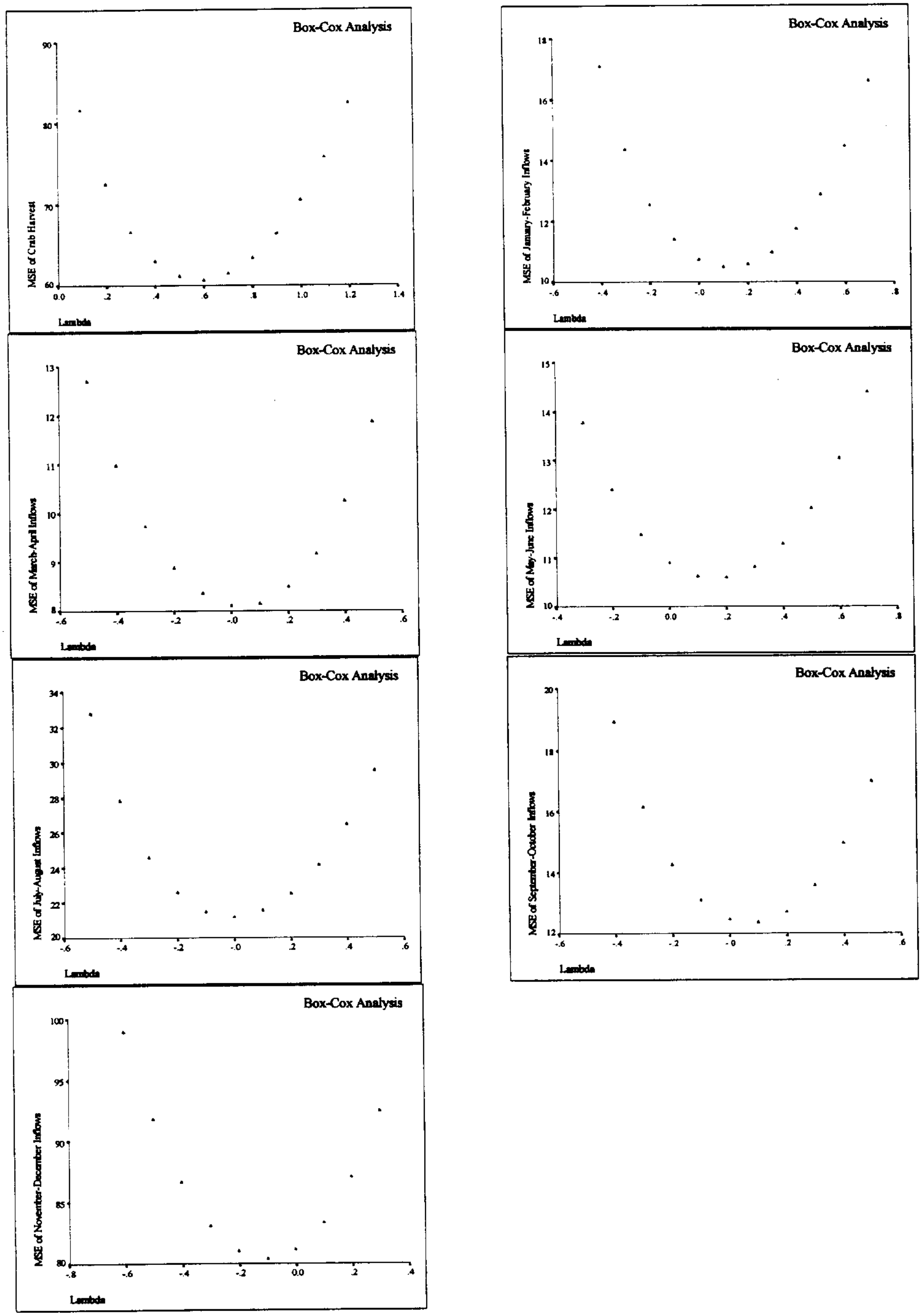



Fig 4.1. MSE of Harvest and Inflows Variables vs. Lambda obtained from Box-Cox Transformation

# 5. Model Choice Diagnostics

## 5.1 Untransformed Data

N = 33 Regression Models for Dependent Variable: CRAB

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.206885 | 0.181300 | 6.6547 | 439.8 | 578286 | 442.8 | QJA_LAG |
| 1 | 0.172478 | 0.145784 | 8.2014 | 441.2 | 603373 | 444.2 | QJF_LAG |
| 1 | 0.054867 | 0.024379 | 13.4887 | 445.6 | 689127 | 448.6 | QND_LAG |
| 1 | 0.005872 | -.026197 | 15.6912 | 447.2 | 724851 | 450.2 | QSO_LAG |
| 2 | 0.321712 | 0.276493 | 3.4926 | 436.6 | 511047 | 441.1 | QJF_LAG QMA_LAG |
| 2 | 0.316732 | 0.271180 | 3.7165 | 436.9 | 514799 | 441.3 | QJF_LAG QJA_LAG |
| 2 | 0.234796 | 0.183782 | 7.3999 | 440.6 | 576533 | 445.1 | QJF_LAG QMJ_LAG |
| 2 | 0.218111 | 0.165985 | 8.1500 | 441.3 | 589104 | 445.8 | QMA_LAG QJA_LAG |
| 3 | 0.383616 | 0.319852 | 2.7097 | 435.5 | 480420 | 441.4 | QJF_LAG QMA_LAG QND_LAG |
| 3 | 0.376795 | 0.312326 | 3.0163 | 435.8 | 485736 | 441.8 | QJF_LAG QMA_LAG QJA_LAG |
| 3 | 0.350641 | 0.283466 | 4.1921 | 437.2 | 506122 | 443.2 | QJF_LAG QMA_LAG QMJ_LAG |
| 3 | 0.349260 | 0.281942 | 4.2542 | 437.2 | 507198 | 443.2 | QJF_LAG QMJ_LAG QJA_LAG |
| 4 | 0.409260 | 0.324868 | 3.5569 | 436.1 | 476877 | 443.5 | QJF_LAG QMA_LAG QMJ_LAG QND_LAG |
| 4 | 0.397857 | 0.311836 | 4.0695 | 436.7 | 486082 | 444.2 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG |
| 4 | 0.395815 | 0.309503 | 4.1613 | 436.8 | 487730 | 444.3 | QJF_LAG QMA_LAG QJA_LAG QND_LAG |
| 4 | 0.384211 | 0.296242 | 4.6829 | 437.4 | 497097 | 444.9 | QJF_LAG QMA_LAG QSO_LAG QND_LAG |
| 5 | 0.418082 | 0.310319 | 5.1603 | 437.6 | 487154 | 446.5 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.415437 | 0.307185 | 5.2791 | 437.7 | 489368 | 446.7 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 5 | 0.398432 | 0.287030 | 6.0436 | 438.7 | 503604 | 447.6 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.395847 | 0.283967 | 6.1598 | 438.8 | 505768 | 447.8 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.421647 | 0.288181 | 7.0000 | 439.4 | 502791 | 449.8 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

## 5.2 Logged Inflows

N = 33     Regression Models for Dependent Variable: CRAB

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.338899 | 0.317573 | 8.5804 | 433.8 | 482030 | 436.8 | LN_QJF |
| 1 | 0.196338 | 0.170414 | 16.6843 | 440.2 | 585976 | 443.2 | LN_QJA |
| 1 | 0.115870 | 0.087349 | 21.2586 | 443.4 | 644648 | 446.4 | LN_QND |
| 1 | 0.093564 | 0.064324 | 22.5265 | 444.2 | 660912 | 447.2 | LN_QSO |
| 2 | 0.405076 | 0.365414 | 6.8186 | 432.3 | 448238 | 436.8 | LN_QJF LN_QJA |
| 2 | 0.385171 | 0.344182 | 7.9501 | 433.4 | 463235 | 437.9 | LN_QJF LN_QSO |
| 2 | 0.381697 | 0.340477 | 8.1475 | 433.6 | 465852 | 438.0 | LN_QJF LN_QMA |
| 2 | 0.359770 | 0.317088 | 9.3940 | 434.7 | 482373 | 439.2 | LN_QJF LN_QMJ |
| 3 | 0.449044 | 0.392048 | 6.3192 | 431.8 | 429425 | 437.7 | LN_QJF LN_QMJ LN_QSO |
| 3 | 0.442747 | 0.385100 | 6.6771 | 432.1 | 434332 | 438.1 | LN_QJF LN_QMA LN_QSO |
| 3 | 0.438350 | 0.380248 | 6.9271 | 432.4 | 437760 | 438.4 | LN_QJF LN_QMA LN_QJA |
| 3 | 0.436919 | 0.378669 | 7.0085 | 432.5 | 438875 | 438.5 | LN_QJF LN_QMA LN_QND |
| 4 | 0.489627 | 0.416717 | 6.0122 | 431.2 | 412000 | 438.7 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.485965 | 0.412531 | 6.2204 | 431.5 | 414957 | 438.9 | LN_QJF LN_QMA LN_QMJ LN_QSO |
| 4 | 0.479296 | 0.404910 | 6.5995 | 431.9 | 420340 | 439.4 | LN_QJF LN_QMJ LN_QJA LN_QSO |
| 4 | 0.478382 | 0.403866 | 6.6515 | 431.9 | 421078 | 439.4 | LN_QJF LN_QMA LN_QJA LN_QSO |
| 5 | 0.531605 | 0.444865 | 5.6260 | 430.4 | 392118 | 439.4 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.510368 | 0.419695 | 6.8332 | 431.9 | 409896 | 440.8 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.508699 | 0.417717 | 6.9281 | 432.0 | 411293 | 440.9 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.488769 | 0.394096 | 8.0611 | 433.3 | 427978 | 442.3 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.542617 | 0.437068 | 7.0000 | 431.6 | 397625 | 442.1 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 5.3 Logged All Variables

N = 33 Regression Models for Dependent Variable: Ln (CRAB)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.253957 | 0.229891 | 13.8014 | 7.5935 | 1.18698 | 10.5865 | LN_QJF |
| 1 | 0.234240 | 0.209539 | 14.9326 | 8.4543 | 1.21835 | 11.4473 | LN_QND |
| 1 | 0.181562 | 0.155161 | 17.9548 | 10.6498 | 1.30217 | 13.6428 | LN_QSO |
| 1 | 0.156096 | 0.128873 | 19.4158 | 11.6610 | 1.34268 | 14.6540 | LN_QJA |
| 2 | 0.376210 | 0.334624 | 8.7876 | 3.6875 | 1.02556 | 8.1771 | LN_QJF LN_QSO |
| 2 | 0.359392 | 0.316684 | 9.7525 | 4.5655 | 1.05321 | 9.0550 | LN_QJF LN_QND |
| 2 | 0.355332 | 0.312354 | 9.9854 | 4.7739 | 1.05988 | 9.2635 | LN_QSO LN_QND |
| 2 | 0.309167 | 0.263111 | 12.6340 | 7.0563 | 1.13578 | 11.5458 | LN_QJF LN_QJA |
| 3 | 0.456564 | 0.400347 | 6.1776 | 1.1367 | 0.92426 | 7.1228 | LN_QJF LN_QSO LN_QND |
| 3 | 0.419246 | 0.359168 | 8.3186 | 3.3285 | 0.98773 | 9.3145 | LN_QJF LN_QMJ LN_QSO |
| 3 | 0.404549 | 0.342950 | 9.1618 | 4.1532 | 1.01272 | 10.1393 | LN_QJF LN_QJA LN_QSO |
| 3 | 0.400157 | 0.338105 | 9.4137 | 4.3957 | 1.02019 | 10.3817 | LN_QJF LN_QMA LN_QND |
| 4 | 0.512121 | 0.442424 | 4.9902 | -0.4221 | 0.85940 | 7.0604 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.507344 | 0.436965 | 5.2643 | -0.1006 | 0.86782 | 7.3820 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.470265 | 0.394589 | 7.3916 | 2.2941 | 0.93313 | 9.7766 | LN_QJF LN_QJA LN_QSO LN_QND |
| 4 | 0.436533 | 0.356038 | 9.3268 | 4.3313 | 0.99255 | 11.8138 | LN_QJF LN_QMJ LN_QJA LN_QSO |
| 5 | 0.545442 | 0.461264 | 5.0786 | -0.7566 | 0.83036 | 8.2225 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.516660 | 0.427152 | 6.7299 | 1.2695 | 0.88294 | 10.2485 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.512592 | 0.422332 | 6.9632 | 1.5460 | 0.89037 | 10.5251 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.440600 | 0.337008 | 11.0935 | 6.0922 | 1.02188 | 15.0712 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 6 | 0.546812 | 0.442230 | 7.0000 | 1.1438 | 0.85970 | 11.6194 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 5.4 Square Root Inflows

N = 33    Regression Models for Dependent Variable: CRAB

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.27151 | 0.24801 | 7.839 | 437.0 | 531167 | 440.0 | SQRT_QJF |
| 1 | 0.21323 | 0.18785 | 10.786 | 439.5 | 573661 | 442.5 | SQRT_QJA |
| 1 | 0.08235 | 0.05275 | 17.405 | 444.6 | 669090 | 447.6 | SQRT_QND |
| 1 | 0.00992 | -.02202 | 21.067 | 447.1 | 721897 | 450.1 | SQRT_QMA |
| 2 | 0.38420 | 0.34315 | 4.140 | 433.4 | 463966 | 437.9 | SQRT_QJF SQRT_QJA |
| 2 | 0.36145 | 0.31888 | 5.291 | 434.6 | 481108 | 439.1 | SQRT_QJF SQRT_QMA |
| 2 | 0.30833 | 0.26222 | 7.977 | 437.3 | 521129 | 441.7 | SQRT_QJF SQRT_QMJ |
| 2 | 0.28976 | 0.24241 | 8.916 | 438.1 | 535119 | 442.6 | SQRT_QJF SQRT_QSO |
| 3 | 0.42855 | 0.36943 | 3.898 | 433.0 | 445402 | 438.9 | SQRT_QJF SQRT_QMA SQRT_QJA |
| 3 | 0.42118 | 0.36130 | 4.270 | 433.4 | 451141 | 439.4 | SQRT_QJF SQRT_QMA SQRT_QND |
| 3 | 0.40411 | 0.34246 | 5.134 | 434.3 | 464448 | 440.3 | SQRT_QJF SQRT_QMJ SQRT_QJA |
| 3 | 0.39021 | 0.32712 | 5.837 | 435.1 | 475283 | 441.1 | SQRT_QJF SQRT_QJA SQRT_QSO |
| 4 | 0.44751 | 0.36858 | 4.939 | 433.8 | 446003 | 441.3 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QND |
| 4 | 0.44211 | 0.36241 | 5.212 | 434.2 | 450359 | 441.6 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.43880 | 0.35863 | 5.380 | 434.4 | 453033 | 441.8 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA |
| 4 | 0.43659 | 0.35611 | 5.491 | 434.5 | 454812 | 442.0 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QND |
| 5 | 0.47642 | 0.37946 | 5.477 | 434.1 | 438313 | 443.0 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.45966 | 0.35959 | 6.325 | 435.1 | 452348 | 444.1 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.45911 | 0.35894 | 6.353 | 435.1 | 452809 | 444.1 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 5 | 0.45711 | 0.35658 | 6.453 | 435.3 | 454480 | 444.2 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO |
| 6 | 0.48585 | 0.36720 | 7.000 | 435.5 | 446974 | 445.9 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

## 5.5 Square Root All Variables

N = 33 Regression Models for Dependent Variable: SQRT (CRAB)

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.26901 | 0.24543 | 7.718 | 166.6 | 146.76 | 169.6 | SQRT_QJF |
| 1 | 0.19935 | 0.17352 | 11.218 | 169.6 | 160.74 | 172.6 | SQRT_QJA |
| 1 | 0.13771 | 0.10990 | 14.314 | 172.0 | 173.12 | 175.0 | SQRT_QND |
| 1 | 0.02225 | -.00929 | 20.113 | 176.2 | 196.30 | 179.2 | SQRT_QMA |
| 2 | 0.37173 | 0.32985 | 4.558 | 163.6 | 130.34 | 168.1 | SQRT_QJF SQRT_QJA |
| 2 | 0.32365 | 0.27856 | 6.974 | 166.0 | 140.31 | 170.5 | SQRT_QJF SQRT_QMA |
| 2 | 0.31453 | 0.26883 | 7.432 | 166.4 | 142.21 | 170.9 | SQRT_QJF SQRT_QND |
| 2 | 0.29528 | 0.24830 | 8.399 | 167.4 | 146.20 | 171.8 | SQRT_QJF SQRT_QSO |
| 3 | 0.42322 | 0.36356 | 3.972 | 162.7 | 123.78 | 168.7 | SQRT_QJF SQRT_QMA SQRT_QND |
| 3 | 0.39306 | 0.33028 | 5.487 | 164.4 | 130.26 | 170.4 | SQRT_QJF SQRT_QMA SQRT_QJA |
| 3 | 0.38521 | 0.32161 | 5.882 | 164.9 | 131.94 | 170.8 | SQRT_QJF SQRT_QJA SQRT_QND |
| 3 | 0.38331 | 0.31952 | 5.977 | 165.0 | 132.35 | 170.9 | SQRT_QJF SQRT_QJA SQRT_QSO |
| 4 | 0.45382 | 0.37579 | 4.435 | 162.9 | 121.40 | 170.4 | SQRT_QJF SQRT_QMA SQRT_QSO SQRT_QND |
| 4 | 0.43981 | 0.35978 | 5.139 | 163.8 | 124.52 | 171.3 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QND |
| 4 | 0.43098 | 0.34970 | 5.582 | 164.3 | 126.48 | 171.8 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QND |
| 4 | 0.40635 | 0.32154 | 6.820 | 165.7 | 131.95 | 173.2 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO |
| 5 | 0.47875 | 0.38223 | 5.183 | 163.4 | 120.15 | 172.4 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QSO SQRT_QND |
| 5 | 0.46208 | 0.36247 | 6.020 | 164.4 | 123.99 | 173.4 | SQRT_QJF SQRT_QMA SQRT_QJA SQRT_QSO SQRT_QND |
| 5 | 0.44543 | 0.34273 | 6.857 | 165.5 | 127.83 | 174.4 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QND |
| 5 | 0.42875 | 0.32296 | 7.694 | 166.4 | 131.68 | 175.4 | SQRT_QJF SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |
| 6 | 0.48239 | 0.36294 | 7.000 | 165.2 | 123.90 | 175.7 | SQRT_QJF SQRT_QMA SQRT_QMJ SQRT_QJA SQRT_QSO SQRT_QND |

## 5.6 Square Root Harvest and Logged Inflows

N = 33 Regression Models for Dependent Variable: SQRT (CRAB)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.334112 | 0.312631 | 11.1590 | 163.5 | 133.687 | 166.5 | LN_QJF |
| 1 | 0.190545 | 0.164433 | 19.8173 | 169.9 | 162.511 | 172.9 | LN_QJA |
| 1 | 0.188347 | 0.162164 | 19.9499 | 170.0 | 162.952 | 173.0 | LN_QND |
| 1 | 0.128423 | 0.100308 | 23.5638 | 172.4 | 174.982 | 175.4 | LN_QSO |
| 2 | 0.406447 | 0.366876 | 8.7965 | 161.7 | 123.137 | 166.2 | LN_QJF LN_QSO |
| 2 | 0.397491 | 0.357324 | 9.3367 | 162.2 | 124.995 | 166.7 | LN_QJF LN_QJA |
| 2 | 0.392988 | 0.352520 | 9.6082 | 162.4 | 125.929 | 166.9 | LN_QJF LN_QND |
| 2 | 0.353802 | 0.310722 | 11.9715 | 164.5 | 134.059 | 169.0 | LN_QJF LN_QMA |
| 3 | 0.458091 | 0.402032 | 7.6819 | 160.7 | 116.300 | 166.7 | LN_QJF LN_QMJ LN_QSO |
| 3 | 0.454935 | 0.398549 | 7.8723 | 160.9 | 116.977 | 166.9 | LN_QJF LN_QMA LN_QND |
| 3 | 0.450912 | 0.394109 | 8.1149 | 161.1 | 117.841 | 167.1 | LN_QJF LN_QSO LN_QND |
| 3 | 0.447239 | 0.390057 | 8.3364 | 161.3 | 118.629 | 167.3 | LN_QJF LN_QJA LN_QSO |
| 4 | 0.526811 | 0.459212 | 5.5375 | 158.2 | 105.179 | 165.7 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.508850 | 0.438686 | 6.6207 | 159.4 | 109.171 | 166.9 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.484308 | 0.410637 | 8.1008 | 161.1 | 114.626 | 168.5 | LN_QJF LN_QMJ LN_QJA LN_QSO |
| 4 | 0.480701 | 0.406515 | 8.3184 | 161.3 | 115.428 | 168.8 | LN_QJF LN_QMA LN_QJA LN_QND |
| 5 | 0.562994 | 0.482067 | 5.3553 | 157.6 | 100.733 | 166.6 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.538441 | 0.452967 | 6.8361 | 159.4 | 106.393 | 168.4 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.522877 | 0.434521 | 7.7747 | 160.5 | 109.981 | 169.5 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.499125 | 0.406371 | 9.2072 | 162.1 | 115.456 | 171.1 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 6 | 0.568886 | 0.469398 | 7.0000 | 159.1 | 103.198 | 169.6 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 5.7 Variables transformed according to the Box-Cox Analysis

N = 33 Regression Models for Dependent Variable: $(CRAB)^{0.6}$

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.332100 | 0.310555 | 10.3260 | 219.4 | 727.41 | 222.4 | $(QJF)^{0.1}$ |
| 1 | 0.193418 | 0.167399 | 18.4916 | 225.6 | 878.45 | 228.6 | LN_QJA |
| 1 | 0.182393 | 0.156018 | 19.1408 | 226.1 | 890.46 | 229.1 | $(QND)^{-0.1}$ |
| 1 | 0.089940 | 0.060583 | 24.5844 | 229.6 | 991.15 | 232.6 | $(QSO)^{0.1}$ |
| 2 | 0.401509 | 0.361609 | 8.2392 | 217.8 | 673.54 | 222.3 | $(QJF)^{0.1}$ LN_QJA |
| 2 | 0.389537 | 0.348839 | 8.9441 | 218.4 | 687.02 | 222.9 | $(QJF)^{0.1}$ $(QSO)^{-0.1}$ |
| 2 | 0.384517 | 0.343484 | 9.2397 | 218.7 | 692.67 | 223.2 | $(QJF)^{0.1}$ $(QND)^{-0.1}$ |
| 2 | 0.353200 | 0.310080 | 11.0836 | 220.3 | 727.91 | 224.8 | $(QJF)^{0.1}$ LN_QMA |
| 3 | 0.445637 | 0.388290 | 7.6409 | 217.2 | 645.39 | 223.2 | $(QJF)^{0.1}$ LN_QMA $(QND)^{-0.1}$ |
| 3 | 0.445570 | 0.388215 | 7.6449 | 217.2 | 645.47 | 223.2 | $(QJF)^{0.1}$ $(QMJ)^{-0.2}$ $(QSO)^{0.1}$ |
| 3 | 0.436678 | 0.378403 | 8.1685 | 217.8 | 655.83 | 223.8 | $(QJF)^{0.1}$ LN_QJA $(QSO)^{0.1}$ |
| 3 | 0.433988 | 0.375435 | 8.3268 | 217.9 | 658.96 | 223.9 | $(QJF)^{0.1}$ LN_QJA $(QND)^{-0.1}$ |
| 4 | 0.509498 | 0.439426 | 5.8808 | 215.2 | 591.44 | 222.7 | $(QJF)^{0.1}$ LN_QMA $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.494705 | 0.422520 | 6.7518 | 216.2 | 609.28 | 223.7 | $(QJF)^{0.1}$ $(QMJ)^{0.2}$ $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.479090 | 0.404675 | 7.6712 | 217.2 | 628.11 | 224.7 | $(QJF)^{0.1}$ LN_QMA LN_QJA $(QND)^{-0.1}$ |
| 4 | 0.477489 | 0.402844 | 7.7655 | 217.3 | 630.04 | 224.8 | $(QJF)^{0.1}$ $(QMJ)^{0.2}$ LN_QJA $(QSO)^{0.1}$ |
| 5 | 0.548512 | 0.464904 | 5.5836 | 214.5 | 564.56 | 223.4 | $(QJF)^{0.1}$ LN_QMA $(QMJ)^{0.2}$ $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.526077 | 0.438313 | 6.9046 | 216.1 | 592.62 | 225.0 | $(QJF)^{0.1}$ LN_QMA LN_QJA $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.513655 | 0.423591 | 7.6360 | 216.9 | 608.15 | 225.9 | $(QJF)^{0.1}$ $(QMJ)^{0.2}$ LN_QJA $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.492509 | 0.398529 | 8.8811 | 218.3 | 634.59 | 227.3 | $(QJF)^{0.1}$ LN_QMA $(QMJ)^{0.2}$ LN_QJA $(QSO)^{0.1}$ |
| 6 | 0.558424 | 0.456522 | 7.0000 | 215.7 | 573.40 | 226.2 | $(QJF)^{0.1}$ LN_QMA $(QMJ)^{0.2}$ LN_QJA $(QSO)^{0.1}$ $(QND)^{-0.1}$ |

# 6. Regression for the Best Models

## 6.1 Model 3: Logged All Variables

### 6.1.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | Ln(Nov-Dec Inflows), Ln(Sept-Oct Inflows), Ln(Jul-Aug Inflows), Ln(Jan-Feb Inflows), Ln(May-Jun Inflows), Ln(Mar-Apr Inflows)[c,d] | . | .739 | .547 | .442 | .9272 | 1.101 |

a. Dependent Variable: Ln (Crab Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Ln (November-December Inflows), Ln (September-October Inflows), Ln (July-August Inflows), Ln (January-February Inflows), Ln (May-June Inflows), Ln (March-April Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 26.970 | 6 | 4.495 | 5.229 | .001[b] |
| | Residual | 22.352 | 26 | .860 | | |
| | Total | 49.322 | 32 | | | |

a. Dependent Variable: Ln (Crab Harvest)

b. Independent Variables: (Constant), Ln (November-December Inflows), Ln (September-October Inflows), Ln (July-August Inflows), Ln (January-February Inflows), Ln (May-June Inflows), Ln (March-April Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| 1 | (Constant) | 3.493 | .857 | | 4.076 | .000 | 1.731 | 5.254 |
| | Ln (January-February Inflows) | .562 | .191 | .566 | 2.948 | .007 | .170 | .954 |
| | Ln (March-April Inflows) | -.267 | .191 | -.270 | -1.401 | .173 | -.660 | .125 |
| | Ln (May-June Inflows) | -.244 | .186 | -.226 | -1.315 | .200 | -.627 | .138 |
| | Ln (July-August Inflows) | 4.5E-02 | .161 | .043 | .280 | .781 | -.286 | .377 |
| | Ln (September-October Inflows) | .356 | .132 | .411 | 2.706 | .012 | .086 | .626 |
| | Ln (November-December Inflows) | .470 | .190 | .391 | 2.468 | .020 | .079 | .861 |

a. Dependent Variable: Ln (Crab Harvest)

### 6.1.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 3.492666 | 0.85693838 | 4.076 | 0.0004 | 0.00000000 |
| LN_QJF | 1 | 0.562214 | 0.19067828 | 2.948 | 0.0067 | 2.11430662 |
| LN_QMA | 1 | -0.267488 | 0.19090701 | -1.401 | 0.1730 | 2.12729055 |
| LN_QMJ | 1 | -0.244494 | 0.18589280 | -1.315 | 0.1999 | 1.69528623 |
| LN_QJA | 1 | 0.045209 | 0.16127435 | 0.280 | 0.7814 | 1.32666629 |
| LN_QSO | 1 | 0.355975 | 0.13154391 | 2.706 | 0.0119 | 1.32141172 |
| LN_QND | 1 | 0.469852 | 0.19033953 | 2.468 | 0.0205 | 1.43661057 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop LN_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop LN_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.68076 | 1.00000 | 0.0418 | 0.0421 | 0.0420 | 0.0229 | 0.0255 | 0.0416 |
| 2 | 0.99090 | 1.64481 | 0.0196 | 0.0109 | 0.1250 | 0.0647 | 0.3752 | 0.1050 |
| 3 | 0.97445 | 1.65863 | 0.0142 | 0.0652 | 0.0376 | 0.4709 | 0.1237 | 0.0039 |
| 4 | 0.67233 | 1.99682 | 0.1842 | 0.0035 | 0.0188 | 0.1140 | 0.0650 | 0.5717 |
| 5 | 0.41057 | 2.55527 | 0.0228 | 0.3052 | 0.6704 | 0.0278 | 0.2940 | 0.1227 |
| 6 | 0.27099 | 3.14521 | 0.7174 | 0.5731 | 0.1061 | 0.2996 | 0.1165 | 0.1551 |

### 6.1.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 4.8029 | 8.2654 | 6.6673 | .9180 | 33 |
| Std. Predicted Value | -2.031 | 1.741 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | .2677 | .5644 | .4196 | 8.08E-02 | 33 |
| Adjusted Predicted Value | 4.7889 | 8.4317 | 6.6805 | .9424 | 33 |
| Residual | -2.1663 | 1.7981 | -6.E-16 | .8358 | 33 |
| Std. Residual | -2.336 | 1.939 | .000 | .901 | 33 |
| Stud. Residual | -2.542 | 2.098 | -.007 | 1.013 | 33 |
| Deleted Residual | -2.5879 | 2.1050 | -1.E-02 | 1.0611 | 33 |
| Stud. Deleted Residual | -2.876 | 2.257 | -.019 | 1.073 | 33 |
| Mahal. Distance | 1.698 | 10.889 | 5.818 | 2.538 | 33 |
| Cook's Distance | .000 | .297 | .039 | .066 | 33 |
| Centered Leverage Value | .053 | .340 | .182 | .079 | 33 |

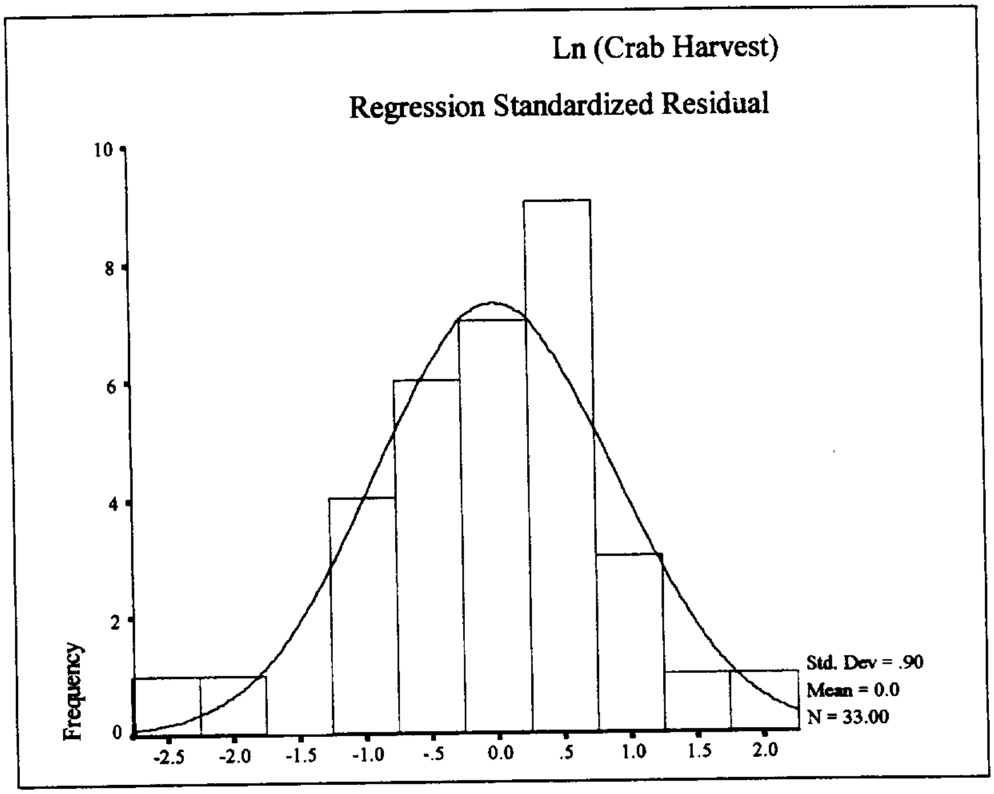
a. Dependent Variable: Ln (Crab Harvest)

*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 7.25682 | .12431 | .19749 | 7.18364 | .64212 | .13407 | .16899 | .16579 |
| 1963 | 4.80289 | .02702 | .04099 | 4.78892 | -2.03087 | .02914 | .03589 | .03520 |
| 1964 | 4.84985 | -.12867 | -.18352 | 4.90470 | -1.97972 | -.13878 | -.16574 | -.16260 |
| 1965 | 5.84518 | -2.16635 | -2.56526 | 6.24409 | -.89553 | -2.33644 | -2.54247 | **-2.87614** |
| 1966 | 4.85802 | -1.89791 | -2.58793 | 5.54804 | -1.97082 | -2.04692 | -2.39024 | **-2.65341** |
| 1967 | 5.84251 | -.79522 | -1.19007 | 6.23736 | -.89845 | -.85765 | -1.04919 | -1.05132 |
| 1968 | 6.37185 | -1.08611 | -1.53923 | 6.82497 | -.32185 | -1.17138 | -1.39449 | -1.42160 |
| 1969 | 6.19964 | .38543 | .45163 | 6.13344 | -.50944 | .41569 | .44998 | .44297 |
| 1970 | 6.65448 | .12328 | .13451 | 6.64325 | -.01399 | .13296 | .13889 | .13624 |
| 1971 | 6.68810 | -.30493 | -.35975 | 6.74291 | .02263 | -.32887 | -.35721 | -.35114 |
| 1972 | 6.74081 | .45879 | .52117 | 6.67843 | .08005 | .49482 | .52738 | .51993 |
| 1973 | 5.96628 | 1.18270 | 1.47224 | 5.67674 | -.76363 | 1.27556 | 1.42315 | 1.45327 |
| 1974 | 6.80126 | .18336 | .23232 | 6.75231 | .14589 | .19776 | .22260 | .21848 |
| 1975 | 6.94695 | -.15303 | -.20614 | 7.00005 | .30458 | -.16505 | -.19156 | -.18797 |
| 1976 | 6.75346 | .43102 | .59966 | 6.58482 | .09383 | .46486 | .54831 | .54080 |
| 1977 | 7.12353 | .59275 | .69573 | 7.02055 | .49693 | .63929 | .69260 | .68551 |
| 1978 | 6.52259 | 1.10359 | 1.20394 | 6.42224 | -.15765 | 1.19023 | 1.24317 | 1.25696 |
| 1979 | 7.17331 | .62493 | .70450 | 7.09374 | .55116 | .67399 | .71562 | .70874 |
| 1980 | 7.63629 | .27066 | .35133 | 7.55562 | 1.05546 | .29191 | .33258 | .32682 |
| 1981 | 8.12990 | -.64705 | -.84801 | 8.33086 | 1.59314 | -.69785 | -.79891 | -.79319 |
| 1982 | 7.91503 | -.24162 | -.29773 | 7.97114 | 1.35909 | -.26059 | -.28927 | -.28411 |
| 1983 | 8.15533 | -.32769 | -.38702 | 8.21466 | 1.62084 | -.35342 | -.38408 | -.37770 |
| 1984 | 8.26541 | -.60167 | -.76793 | 8.43167 | 1.74075 | -.64891 | -.73311 | -.72642 |
| 1985 | 7.42308 | .28735 | .40644 | 7.30399 | .82323 | .30991 | .36858 | .36237 |
| 1986 | 6.48352 | .35809 | .45322 | 6.38840 | -.20021 | .38621 | .43449 | .42761 |
| 1987 | 6.67452 | .75417 | .91304 | 6.51565 | .00784 | .81339 | .89497 | .89142 |
| 1988 | 6.05434 | 1.79806 | 2.10495 | 5.74745 | -.66770 | 1.93924 | 2.09821 | 2.25745 |
| 1989 | 5.88993 | .11420 | .13225 | 5.87189 | -.84679 | .12317 | .13254 | .13001 |
| 1990 | 5.52404 | 1.11728 | 1.74901 | 4.89231 | -1.24534 | 1.20500 | 1.50765 | 1.54757 |
| 1991 | 7.34460 | -.57818 | -.74264 | 7.50906 | .73774 | -.62357 | -.70671 | -.69974 |
| 1992 | 7.69667 | -.79132 | -.97978 | 7.88513 | 1.12124 | -.85345 | -.94966 | -.94780 |
| 1993 | 6.75537 | .54941 | .74043 | 6.56436 | .09591 | .59255 | .68789 | .68075 |
| 1994 | 6.67611 | -.76667 | -.88319 | 6.79263 | .00957 | -.82686 | -.88747 | -.88373 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.
[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



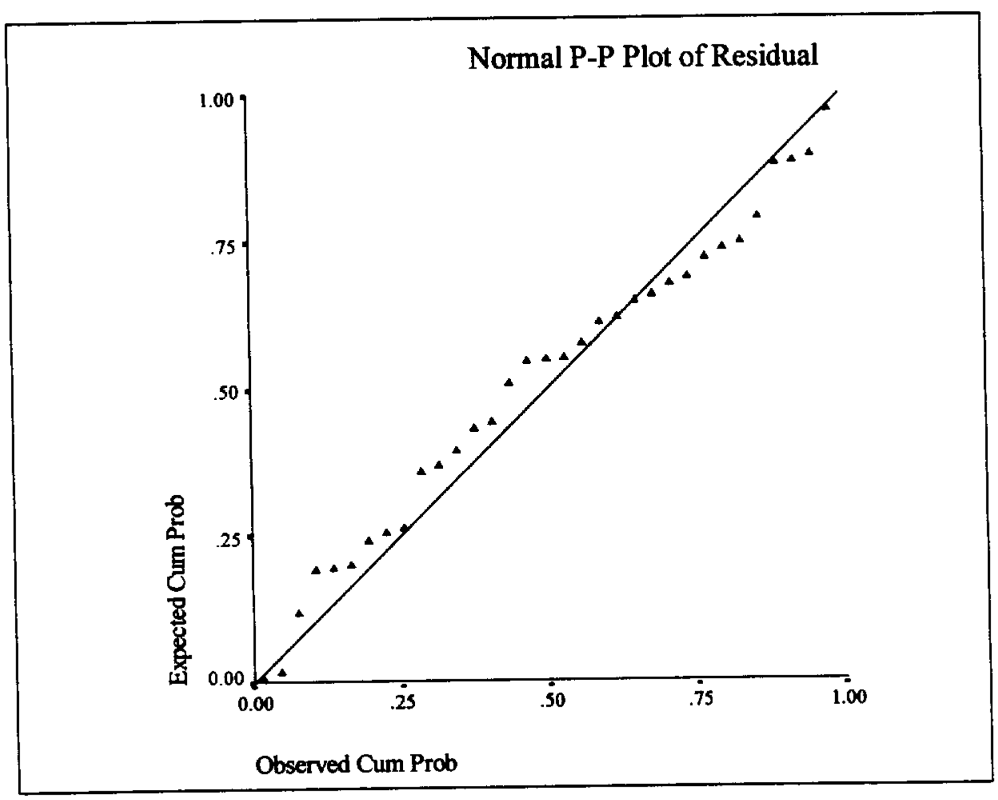




Fig. 6.1.1. Exploratory Plots of Ln (Crab Harvest Standardized Residual).

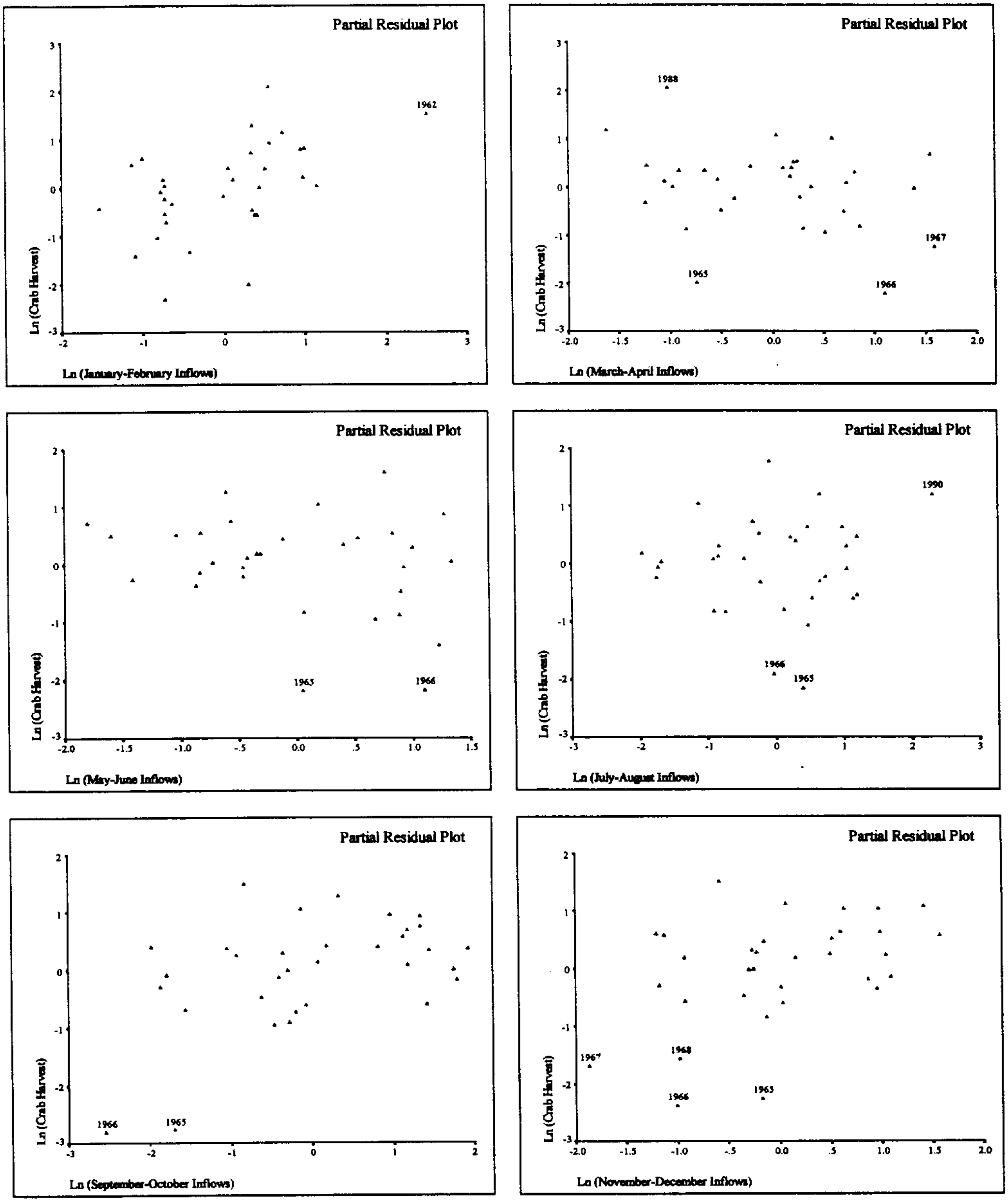



Fig. 6.1.2. Partial Residual Plots of Ln (Crab Harvest) vs. Logged Inflows.

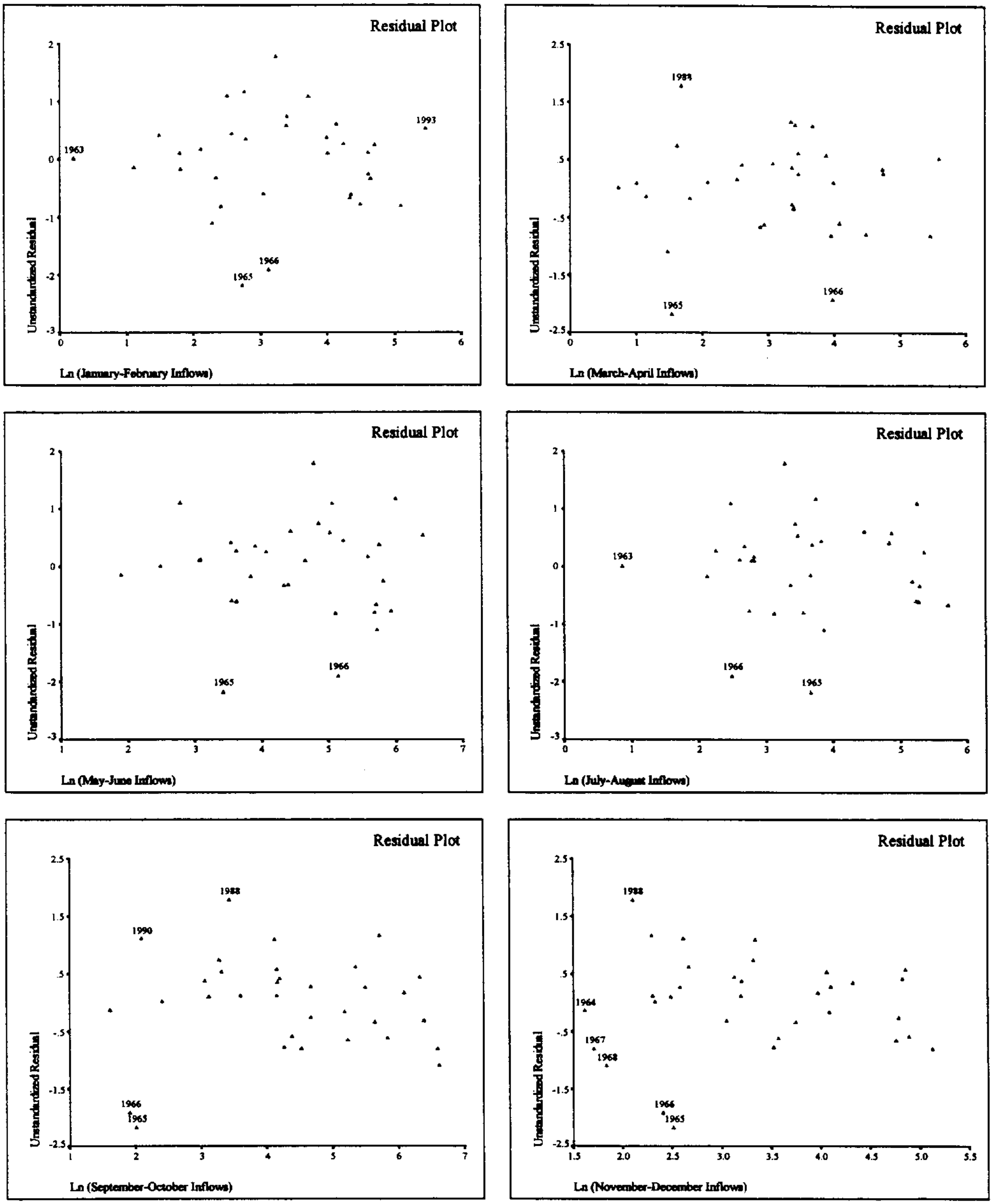



Fig. 6.1.3. Residual Plots of Ln (Crab Harvest) vs. Logged Inflows.

### 6.1.4 Prediction Intervals for Crab Harvest

| YEAR | Ln(CRAB) | LICI | UICI |
|---|---|---|---|
| 1962 | 7.38 | 4.24056 | 10.27308 |
| 1963 | 4.83 | 1.81966 | 7.78612 |
| 1964 | 4.72 | 1.91354 | 7.78616 |
| 1965 | 3.68 | 3.07566 | 8.61469 |
| 1966 | 2.96 | 1.95838 | 7.75765 |
| 1967 | 5.05 | 2.86922 | 8.81579 |
| 1968 | 5.29 | 3.44062 | 9.30307 |
| 1969 | 6.59 | 3.44084 | 8.95843 |
| 1970 | 6.78 | 3.97269 | 9.33626 |
| 1971 | 6.38 | 3.92235 | 9.45385 |
| 1972 | 7.20 | 4.01455 | 9.46707 |
| 1973 | 7.15 | 3.14787 | 8.78469 |
| 1974 | 6.98 | 3.96635 | 9.63617 |
| 1975 | 6.79 | 4.05763 | 9.83626 |
| 1976 | 7.18 | 3.83716 | 9.66976 |
| 1977 | 7.72 | 4.36301 | 9.88405 |
| 1978 | 7.63 | 3.84094 | 9.20425 |
| 1979 | 7.80 | 4.45527 | 9.89135 |
| 1980 | 7.91 | 4.77936 | 10.49322 |
| 1981 | 7.48 | 5.26441 | 10.99540 |
| 1982 | 7.67 | 5.10629 | 10.72377 |
| 1983 | 7.83 | 5.38845 | 10.92221 |
| 1984 | 7.66 | 5.42374 | 11.10708 |
| 1985 | 7.71 | 4.49341 | 10.35276 |
| 1986 | 6.84 | 3.64959 | 9.31745 |
| 1987 | 7.43 | 3.88293 | 9.46610 |
| 1988 | 7.85 | 3.29649 | 8.81219 |
| 1989 | 6.00 | 3.14337 | 8.63649 |
| 1990 | 6.64 | 2.51811 | 8.52996 |
| 1991 | 6.77 | 4.49714 | 10.19205 |
| 1992 | 6.91 | 4.88336 | 10.50999 |
| 1993 | 7.30 | 3.86566 | 9.64508 |
| 1994 | 5.91 | 3.93499 | 9.41723 |

**Ln(CRAB)** Logged crab harvest
**LICI** Lower limit for 99% prediction interval for Crab harvest
**UICI** Upper limit for 99% prediction interval for Crab harvest

### 6.1.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| 1962 | 10.88853 | .00240 | .34027 | .1436 | .0000 |
| 1963 | 9.93328 | .00010 | .31041 | .1924 | .0000 |
| 1964 | 8.59441 | .00167 | .26858 | .2831 | .0000 |
| 1965 | 4.00646 | .17004 | .12520 | .7790 | .0108 |
| 1966 | 7.56250 | .29674 | .23633 | .3727 | .0511 |
| 1967 | 9.64764 | .07808 | .30149 | .2094 | .0010 |
| 1968 | 8.45061 | .11590 | .26408 | .2945 | .0034 |
| 1969 | 3.72068 | .00497 | .11627 | .8113 | .0000 |
| 1970 | 1.70098 | .00025 | .05316 | .9745 | .0000 |
| 1971 | 3.90603 | .00328 | .12206 | .7905 | .0000 |
| 1972 | 2.86039 | .00540 | .08939 | .8976 | .0000 |
| 1973 | 5.32364 | .07083 | .16636 | .6205 | .0007 |
| 1974 | 5.77318 | .00189 | .18041 | .5665 | .0000 |
| 1975 | 7.27454 | .00182 | .22733 | .4009 | .0000 |
| 1976 | 8.02973 | .01680 | .25093 | .3300 | .0000 |
| 1977 | 3.76673 | .01191 | .11771 | .8062 | .0000 |
| 1978 | 1.69763 | .02008 | .05305 | .9747 | .0000 |
| 1979 | 2.64477 | .00932 | .08265 | .9158 | .0000 |
| 1980 | 6.37747 | .00471 | .19930 | .4964 | .0000 |
| 1981 | 6.61373 | .02832 | .20668 | .4702 | .0000 |
| 1982 | 5.06121 | .00278 | .15816 | .6525 | .0000 |
| 1983 | 3.93609 | .00382 | .12300 | .7871 | .0000 |
| 1984 | 5.95831 | .02122 | .18620 | .5446 | .0000 |
| 1985 | 8.40671 | .00804 | .26271 | .2981 | .0000 |
| 1986 | 5.74651 | .00716 | .17958 | .5696 | .0000 |
| 1987 | 4.59818 | .02410 | .14369 | .7089 | .0000 |
| 1988 | 3.69572 | .10734 | .11549 | .8141 | .0027 |
| 1989 | 3.39593 | .00040 | .10612 | .8461 | .0000 |
| 1990 | 10.58851 | .18360 | .33089 | .1576 | .0136 |
| 1991 | 6.11687 | .02030 | .19115 | .5262 | .0000 |
| 1992 | 5.18535 | .03068 | .16204 | .6374 | .0000 |
| 1993 | 7.28556 | .02350 | .22767 | .3998 | .0000 |
| 1994 | 3.25213 | .01710 | .10163 | .8607 | .0000 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with $p + 1$ degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with $p + 1$ numerator degree of freedom and $n - p - 1$ denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1962** | .12721 | .06525 | .10779 | -.05256 | -.06689 | -.06055 | .02439 | -.01246 |
| **1963** | .02530 | .01975 | -.00568 | -.00475 | -.00369 | -.01295 | -.00249 | .00452 |
| **1964** | -.10616 | -.07796 | .02890 | -.01115 | .02796 | -.03553 | .04283 | .03648 |
| **1965** | **-1.23419** | -.68854 | -.19318 | .47094 | -.03410 | -.21673 | .75035 | .10831 |
| **1966** | **-1.59992** | -.49949 | .46132 | -.70555 | -.68504 | .01056 | **1.11840** | .63578 |
| **1967** | -.74082 | -.06312 | .28700 | -.42143 | -.01737 | -.03034 | -.32803 | .49256 |
| **1968** | -.91823 | .12616 | .14381 | .29009 | -.41961 | -.14136 | -.34222 | .33794 |
| **1969** | .18358 | -.01786 | .00565 | -.02045 | .12898 | .02566 | -.12656 | -.02114 |
| **1970** | .04111 | .01384 | .01492 | .01142 | -.00880 | -.02218 | .00173 | -.00703 |
| **1971** | -.14887 | -.00791 | .05551 | -.05501 | .03486 | .01392 | -.10476 | .02668 |
| **1972** | .19171 | -.04727 | -.08247 | .02223 | .04602 | .02300 | .10587 | -.02960 |
| **1973** | .71906 | -.13791 | -.33165 | .19791 | .41620 | .18670 | .07711 | -.39815 |
| **1974** | .11289 | -.02587 | -.03660 | -.03321 | .04574 | -.03537 | .03942 | .05018 |
| **1975** | -.11073 | -.02349 | .00030 | .04722 | .02004 | .06615 | -.04501 | -.07053 |
| **1976** | .33828 | -.03755 | -.20108 | .01490 | -.01409 | .13345 | -.03180 | .18605 |
| **1977** | .28572 | -.12712 | -.11330 | .03246 | .07958 | .12818 | -.09781 | .14954 |
| **1978** | .37904 | .09028 | .09450 | .01383 | .05248 | -.25429 | -.02253 | .01888 |
| **1979** | .25291 | .00819 | .08861 | .03851 | -.08442 | .06332 | .10365 | -.14278 |
| **1980** | .17842 | -.00184 | .07696 | .01390 | -.07667 | .06848 | .06269 | -.08933 |
| **1981** | -.44205 | .27438 | -.06554 | .23223 | -.16206 | -.18167 | .02473 | -.20427 |
| **1982** | -.13691 | .08244 | -.02883 | .06305 | -.05723 | -.04078 | .02779 | -.06799 |
| **1983** | -.16072 | .03932 | -.08262 | .03063 | .06807 | -.04733 | -.06924 | -.00219 |
| **1984** | -.38185 | .02438 | -.19432 | .08428 | .23229 | -.07842 | -.20480 | -.00647 |
| **1985** | .23328 | .07135 | .08434 | .06494 | -.15512 | -.14623 | .08219 | .04631 |
| **1986** | .22039 | .04671 | -.07600 | .13841 | -.07906 | -.06834 | .01281 | .05970 |
| **1987** | .40913 | .03320 | .14562 | -.32588 | .16338 | -.05517 | -.14466 | .12884 |
| **1988** | .93262 | .28313 | .28317 | -.51004 | .37937 | -.02769 | -.28750 | -.28991 |
| **1989** | .05168 | .03759 | .00327 | -.02621 | -.00944 | -.01085 | -.00580 | .00473 |
| **1990** | **1.16369** | .33757 | -.44759 | .61827 | -.23400 | .78163 | -.53986 | -.44669 |
| **1991** | -.37320 | .05608 | .13187 | -.14041 | .13793 | -.16672 | .00716 | -.14212 |
| **1992** | -.46253 | .15812 | -.08980 | -.11287 | -.01473 | .13283 | .04087 | -.20837 |
| **1993** | .40139 | -.09046 | .05527 | .13244 | .15967 | -.03105 | -.19958 | -.02345 |
| **1994** | -.34452 | .03024 | -.07428 | -.06031 | -.12982 | .14876 | .06182 | .02377 |

**SDFFITS** Standardized dffits value

**SDFB_0** Standardized dfbeta for the intercept term

**SDFB_1** Standardized dfbeta for the logged January-February inflows

**SDFB_2** Standardized dfbeta for the logged March-April inflows

**SDFB_3** Standardized dfbeta for the logged May-June inflows

**SDFB_4** Standardized dfbeta for the logged July-August inflows

**SDFB_5** Standardized dfbeta for the logged September-October inflows

**SDFB_6** Standardized dfbeta for the logged November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

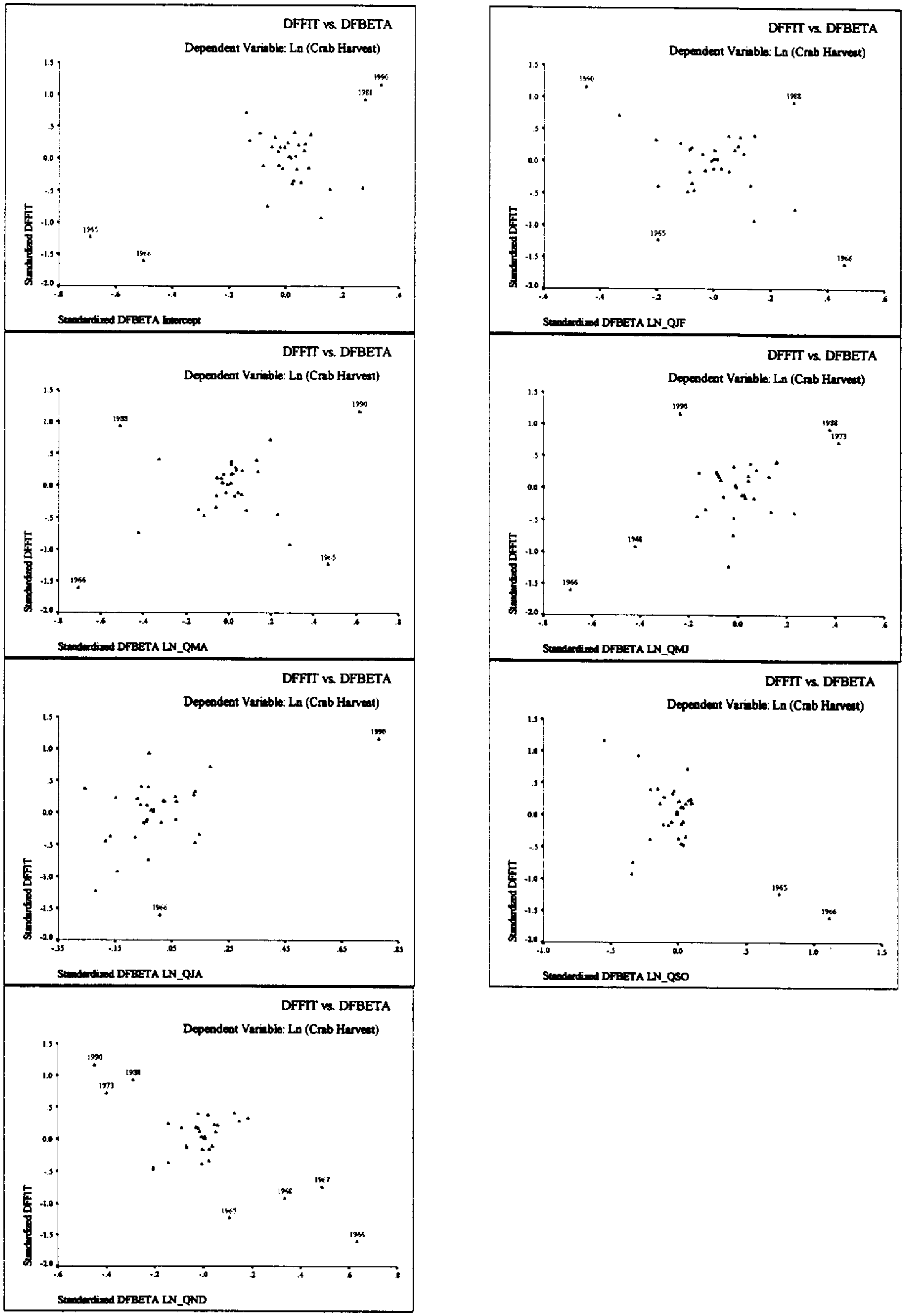



Fig. 6.1.4. Standardized DFFIT vs. Standardized DFBETA.

## 6.2 Model 6: Square Root Harvest and Logged Inflows

### 6.2.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | Ln(Nov-Dec Inflows), Ln(Sept-Oct Inflows), Ln(Jul-Aug Inflows), Ln(Jan-Feb Inflows), Ln(May-Jun Inflows), Ln(Mar-Apr Inflows)[c,d] | . | .754 | .569 | .469 | 10.1586 | 1.222 |

a. Dependent Variable: SQRT (Crab Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Ln (November-December Inflows), Ln (September-October Inflows), Ln (July-August Inflows), Ln (January-February Inflows), Ln (May-June Inflows), Ln (March-April Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 3540.592 | 6 | 590.099 | 5.718 | .001[b] |
| | Residual | 2683.135 | 26 | 103.198 | | |
| | Total | 6223.728 | 32 | | | |

a. Dependent Variable: SQRT (Crab Harvest)

b. Independent Variables: (Constant), Ln (November-December Inflows), Ln (September-October Inflows), Ln (July-August Inflows), Ln (January-February Inflows), Ln (May-June Inflows), Ln (March-April Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| 1 | (Constant) | -1.782 | 9.389 | | -.190 | .851 | -21.081 | 17.516 |
| | Ln (January-February Inflows) | 7.711 | 2.089 | .691 | 3.691 | .001 | 3.416 | 12.005 |
| | Ln (March-April Inflows) | -3.484 | 2.092 | -.313 | -1.666 | .108 | -7.784 | .815 |
| | Ln (May-June Inflows) | -2.760 | 2.037 | -.227 | -1.355 | .187 | -6.946 | 1.427 |
| | Ln (July-August Inflows) | 1.053 | 1.767 | .088 | .596 | .556 | -2.579 | 4.685 |
| | Ln (September-October Inflows) | 3.253 | 1.441 | .334 | 2.257 | .033 | .290 | 6.215 |
| | Ln (November-December Inflows) | 4.277 | 2.085 | .317 | 2.051 | .050 | -.009 | 8.564 |

a. Dependent Variable: SQRT (Crab Harvest)

### 6.2.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | -1.782466 | 9.38880357 | -0.190 | 0.8509 | 0.00000000 |
| LN_QJF | 1 | 7.710727 | 2.08911277 | 3.691 | 0.0010 | 2.11430662 |
| LN_QMA | 1 | -3.484129 | 2.09161873 | -1.666 | 0.1078 | 2.12729055 |
| LN_QMJ | 1 | -2.759788 | 2.03668204 | -1.355 | 0.1871 | 1.69528623 |
| LN_QJA | 1 | 1.053265 | 1.76695690 | 0.596 | 0.5563 | 1.32666629 |
| LN_QSO | 1 | 3.252965 | 1.44122369 | 2.257 | 0.0326 | 1.32141172 |
| LN_QND | 1 | 4.277463 | 2.08540132 | 2.051 | 0.0505 | 1.43661057 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop LN_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop LN_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.68076 | 1.00000 | 0.0418 | 0.0421 | 0.0420 | 0.0229 | 0.0255 | 0.0416 |
| 2 | 0.99090 | 1.64481 | 0.0196 | 0.0109 | 0.1250 | 0.0647 | 0.3752 | 0.1050 |
| 3 | 0.97445 | 1.65863 | 0.0142 | 0.0652 | 0.0376 | 0.4709 | 0.1237 | 0.0039 |
| 4 | 0.67233 | 1.99682 | 0.1842 | 0.0035 | 0.0188 | 0.1140 | 0.0650 | 0.5717 |
| 5 | 0.41057 | 2.55527 | 0.0228 | 0.3052 | 0.6704 | 0.0278 | 0.2940 | 0.1227 |
| 6 | 0.27099 | 3.14521 | 0.7174 | 0.5731 | 0.1061 | 0.2996 | 0.1165 | 0.1551 |

### 6.2.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 9.1875 | 51.4078 | 32.3141 | 10.5187 | 33 |
| Std. Predicted Value | -2.199 | 1.815 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | 2.9329 | 6.1840 | 4.5967 | .8855 | 33 |
| Adjusted Predicted Value | 8.1529 | 52.8610 | 32.4855 | 10.7384 | 33 |
| Residual | -19.3735 | 22.9381 | -1.E-15 | 9.1569 | 33 |
| Std. Residual | -1.907 | 2.258 | .000 | .901 | 33 |
| Stud. Residual | -2.075 | 2.443 | -.008 | 1.000 | 33 |
| Deleted Residual | -22.9409 | 26.8532 | -.1714 | 11.3187 | 33 |
| Stud. Deleted Residual | -2.228 | 2.729 | -.005 | 1.040 | 33 |
| Mahal. Distance | 1.698 | 10.889 | 5.818 | 2.538 | 33 |
| Cook's Distance | .000 | .166 | .033 | .041 | 33 |
| Centered Leverage Value | .053 | .340 | .182 | .079 | 33 |

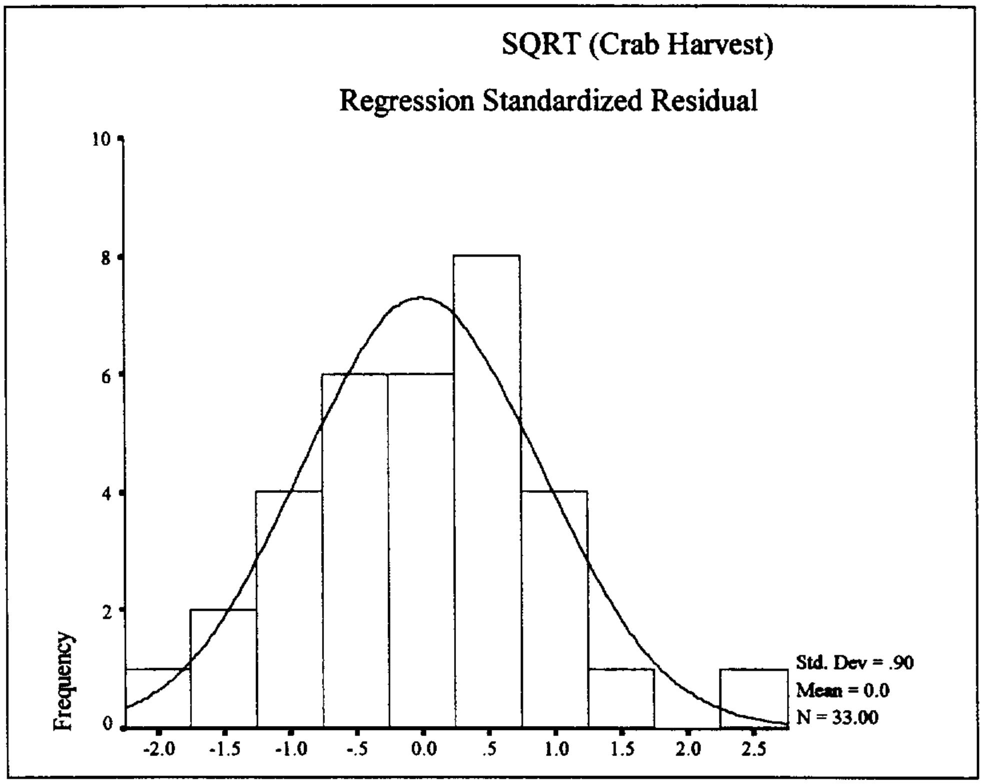
a. Dependent Variable: SQRT (Crab Harvest)

*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 42.33611 | -2.26867 | -3.60432 | 43.67177 | .95278 | -.22332 | -.28149 | -.27645 |
| 1963 | 9.18748 | 2.00180 | 3.03634 | 8.15294 | -2.19861 | .19705 | .24269 | .23825 |
| 1964 | 13.61096 | -3.01379 | -4.29852 | 14.89569 | -1.77808 | -.29667 | -.35431 | -.34827 |
| 1965 | 25.66631 | -19.37345 | -22.94087 | 29.23373 | -.63199 | -1.90710 | -2.07527 | -2.22783 |
| 1966 | 13.46199 | -9.06881 | -12.36596 | 16.75914 | -1.79224 | -.89272 | -1.04245 | -1.04426 |
| 1967 | 21.09415 | -8.62017 | -12.90043 | 25.37440 | -1.06666 | -.84856 | -1.03807 | -1.03968 |
| 1968 | 28.29389 | -14.24042 | -20.18156 | 34.23503 | -.38219 | -1.40181 | -1.66880 | -1.73176 |
| 1969 | 29.03088 | -2.11992 | -2.48401 | 29.39498 | -.31213 | -.20868 | -.22589 | -.22172 |
| 1970 | 32.58816 | -2.95540 | -3.22452 | 32.85727 | .02606 | -.29093 | -.30388 | -.29851 |
| 1971 | 29.72085 | -5.39391 | -6.36349 | 30.69043 | -.24653 | -.53097 | -.57672 | -.56917 |
| 1972 | 30.99845 | 5.59253 | 6.35291 | 30.23807 | -.12507 | .55052 | .58675 | .57921 |
| 1973 | 23.66060 | 12.01572 | 14.95733 | 20.71899 | -.82267 | 1.18281 | 1.31968 | 1.33969 |
| 1974 | 30.07449 | 2.78734 | 3.53148 | 29.33035 | -.21291 | .27438 | .30884 | .30340 |
| 1975 | 31.82925 | -1.95618 | -2.63506 | 32.50813 | -.04609 | -.19256 | -.22349 | -.21936 |
| 1976 | 30.30795 | 6.00733 | 8.35782 | 27.95747 | -.19072 | .59135 | .69751 | .69046 |
| 1977 | 36.51461 | 10.86260 | 12.74972 | 34.62749 | .39934 | 1.06930 | 1.15846 | 1.16647 |
| 1978 | 30.56490 | 14.72528 | 16.06430 | 29.22587 | -.16629 | 1.44954 | 1.51401 | 1.55472 |
| 1979 | 39.39459 | 9.96430 | 11.23310 | 38.12579 | .67314 | .98087 | 1.04145 | 1.04322 |
| 1980 | 45.86497 | 6.25124 | 8.11427 | 44.00195 | 1.28827 | .61536 | .70109 | .69407 |
| 1981 | 49.37094 | -7.21290 | -9.45312 | 51.61116 | 1.62157 | -.71003 | -.81285 | -.80739 |
| 1982 | 47.20557 | -.83317 | -1.02666 | 47.39906 | 1.41571 | -.08202 | -.09104 | -.08929 |
| 1983 | 50.32870 | -.23878 | -.28202 | 50.37194 | 1.71263 | -.02351 | -.02555 | -.02505 |
| 1984 | 51.40780 | -5.25913 | -6.71236 | 52.86103 | 1.81521 | -.51770 | -.58487 | -.57732 |
| 1985 | 39.61677 | 7.62198 | 10.78093 | 36.45782 | .69426 | .75030 | .89233 | .88872 |
| 1986 | 27.41661 | 3.17751 | 4.02156 | 26.57256 | -.46559 | .31279 | .35189 | .34588 |
| 1987 | 33.98503 | 7.04666 | 8.53103 | 32.50067 | .15886 | .69366 | .76323 | .75694 |
| 1988 | 27.77577 | 22.93814 | 26.85318 | 23.86073 | -.43145 | 2.25800 | 2.44311 | **2.72935** |
| 1989 | 23.85332 | -3.72622 | -4.31489 | 24.44198 | -.80435 | -.36680 | -.39472 | -.38822 |
| 1990 | 21.55384 | 6.12468 | 9.58769 | 18.09082 | -1.02296 | .60290 | .75433 | .74792 |
| 1991 | 38.43915 | -8.97392 | -11.52653 | 40.99176 | .58230 | -.88338 | -1.00117 | -1.00121 |
| 1992 | 43.29549 | -11.71068 | -14.49961 | 46.08442 | 1.04399 | -1.15278 | -1.28273 | -1.29961 |
| 1993 | 35.08879 | 3.47804 | 4.68724 | 33.87959 | .26379 | .34237 | .39746 | .39093 |
| 1994 | 32.82598 | -13.62963 | -15.70111 | 34.89746 | .04867 | -1.34168 | -1.44003 | -1.47199 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.
[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



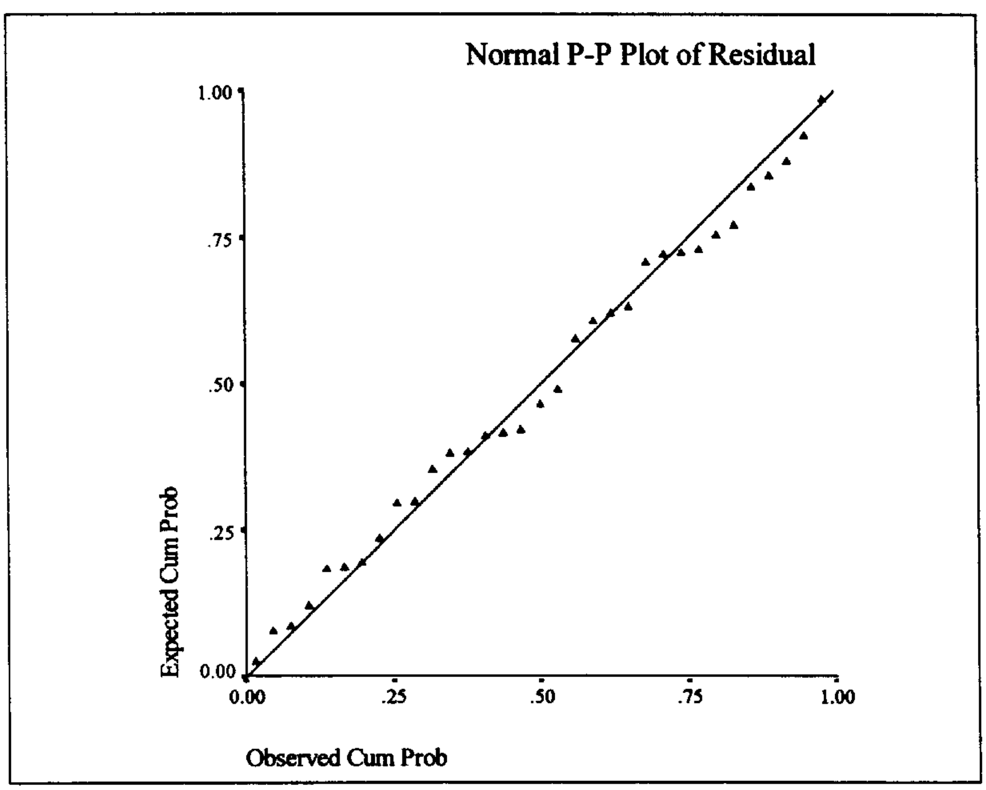




Fig. 6.2.1. Exploratory Plots of SQRT (Crab Harvest Standardized Residual).

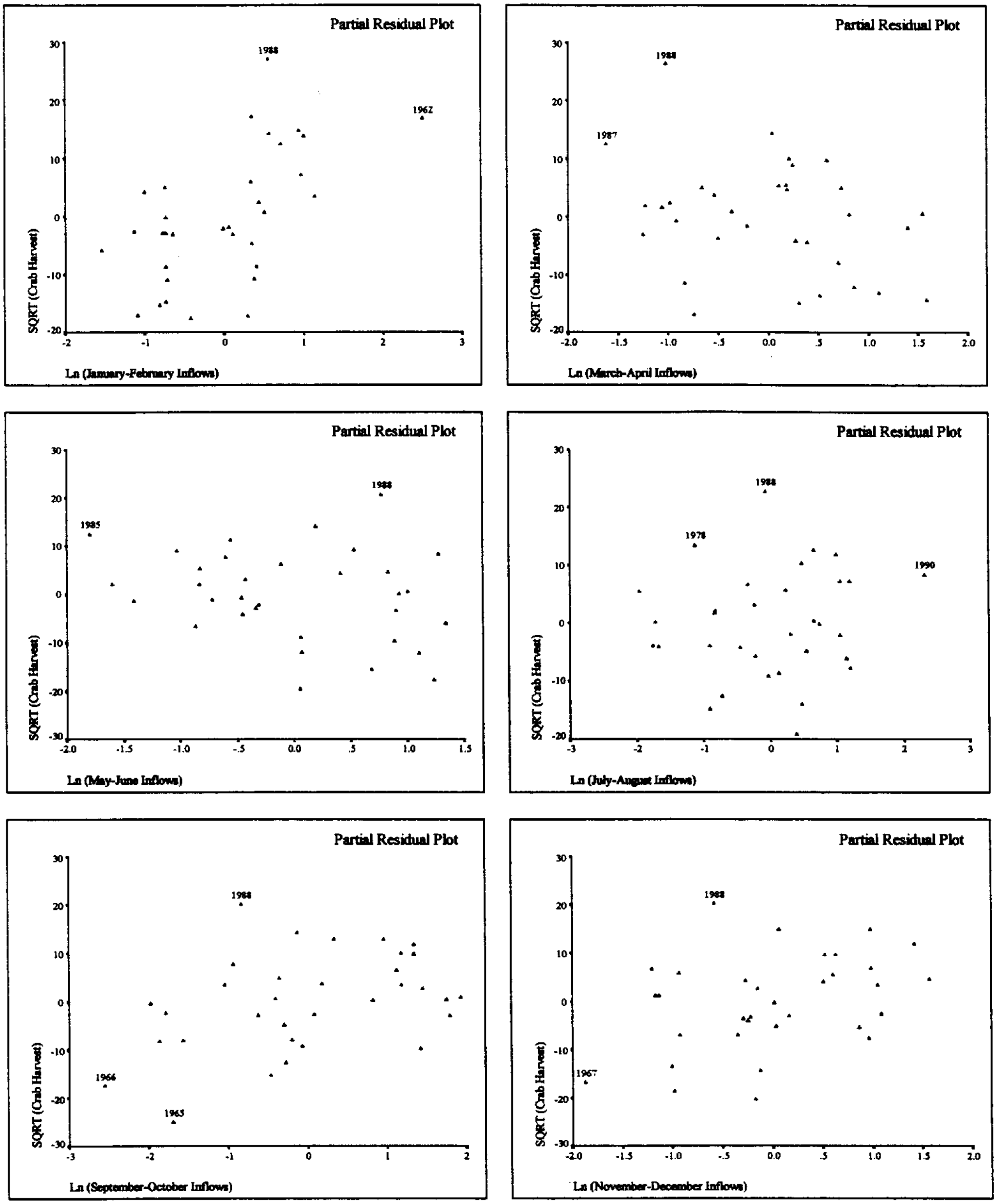



Fig. 6.2.2. Partial Residual Plots of SQRT (Crab Harvest) vs. Logged Inflows.

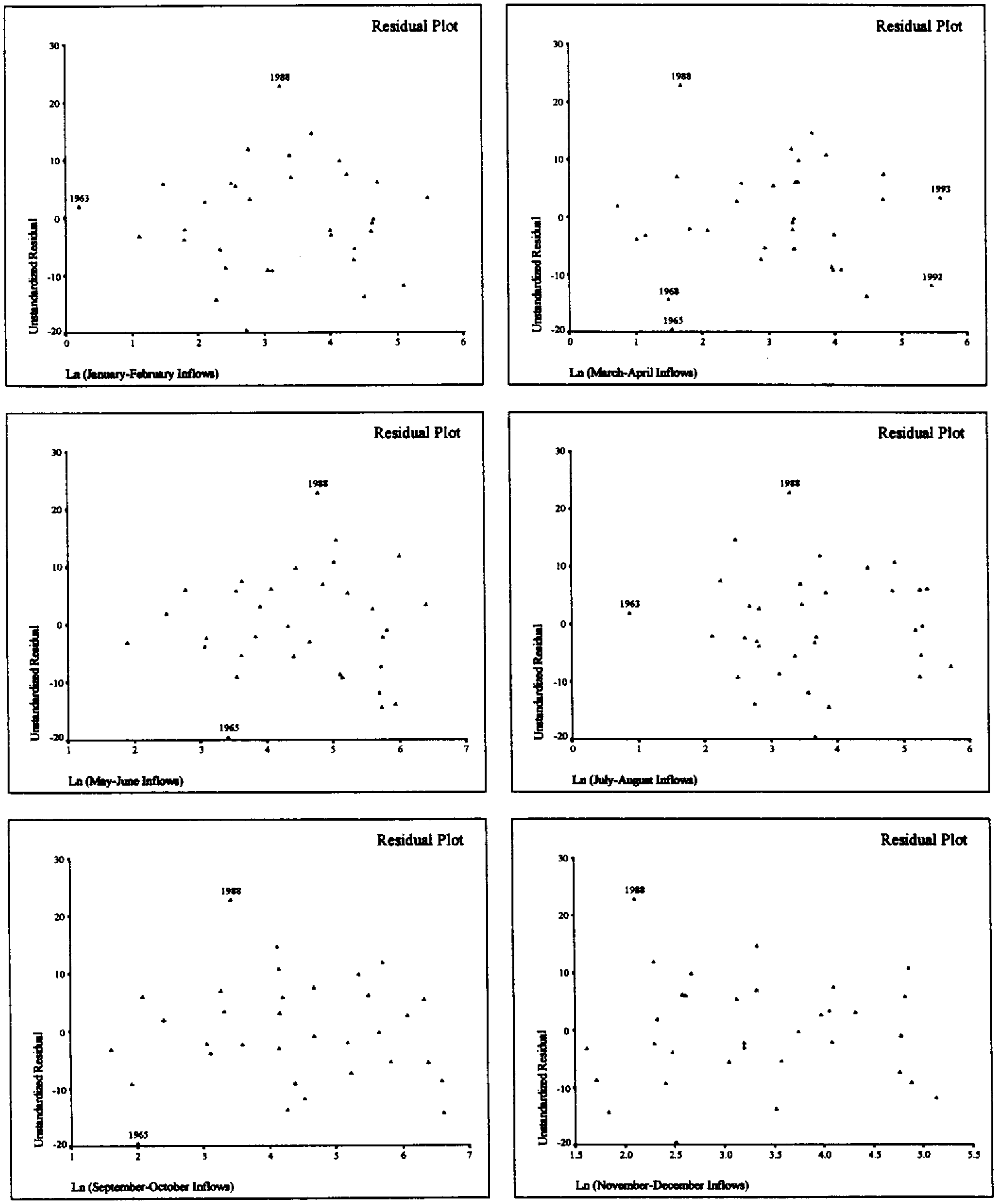



Fig. 6.2.3. Residual Plots of SQRT (Crab Harvest) vs. Logged Inflows.

### 6.2.4 Prediction Intervals for Crab Harvest

| YEAR | SQRT_CRAB | LICI | UICI |
|---|---|---|---|
| 1962 | 40.07 | 9.28934 | 75.38289 |
| 1963 | 11.19 | 0 | 41.87238 |
| 1964 | 10.60 | 0 | 45.78182 |
| 1965 | 6.29 | 0 | 56.00972 |
| 1966 | 4.39 | 0 | 45.23099 |
| 1967 | 12.47 | 0 | 53.67007 |
| 1968 | 14.05 | 0 | 60.40906 |
| 1969 | 26.91 | 0 | 59.25681 |
| 1970 | 29.63 | 3.20593 | 61.97038 |
| 1971 | 24.33 | 0 | 60.02302 |
| 1972 | 36.59 | 1.12898 | 60.86792 |
| 1973 | 35.68 | 0 | 54.53974 |
| 1974 | 32.86 | 0 | 61.13435 |
| 1975 | 29.87 | .17330 | 63.48520 |
| 1976 | 36.32 | 0 | 62.25954 |
| 1977 | 47.38 | 6.26972 | 66.75950 |
| 1978 | 45.29 | 1.18409 | 59.94570 |
| 1979 | 49.36 | 9.61514 | 69.17405 |
| 1980 | 52.12 | 14.56382 | 77.16612 |
| 1981 | 42.16 | 17.97595 | 80.76592 |
| 1982 | 46.37 | 16.43243 | 77.97872 |
| 1983 | 50.09 | 20.01418 | 80.64323 |
| 1984 | 46.15 | 20.27382 | 82.54178 |
| 1985 | 47.24 | 7.51863 | 71.71492 |
| 1986 | 30.59 | 0 | 58.46578 |
| 1987 | 41.03 | 3.39979 | 64.57027 |
| 1988 | 50.71 | 0 | 57.99141 |
| 1989 | 20.13 | 0 | 53.94519 |
| 1990 | 27.68 | 0 | 54.48738 |
| 1991 | 29.47 | 7.24183 | 69.63648 |
| 1992 | 31.58 | 12.47215 | 74.11882 |
| 1993 | 38.57 | 3.42850 | 66.74907 |
| 1994 | 19.20 | 2.79367 | 62.85829 |

**SQRT(CRAB)** Square root crab harvest
**LICI** Lower limit for 99% prediction interval for Crab harvest
**UICI** Upper limit for 99% prediction interval for Crab harvest

### 6.2.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| 1962 | 10.88853 | .00666 | .34027 | .1436 | .0000 |
| 1963 | 9.93328 | .00435 | .31041 | .1924 | .0000 |
| 1964 | 8.59441 | .00764 | .26858 | .2831 | .0000 |
| 1965 | 4.00646 | .11329 | .12520 | .7790 | .0031 |
| 1966 | 7.56250 | .05644 | .23633 | .3727 | .0003 |
| 1967 | 9.64764 | .07644 | .30149 | .2094 | .0009 |
| 1968 | 8.45061 | .16598 | .26408 | .2945 | .0101 |
| 1969 | 3.72068 | .00125 | .11627 | .8113 | .0000 |
| 1970 | 1.70098 | .00120 | .05316 | .9745 | .0000 |
| 1971 | 3.90603 | .00854 | .12206 | .7905 | .0000 |
| 1972 | 2.86039 | .00669 | .08939 | .8976 | .0000 |
| 1973 | 5.32364 | .06091 | .16636 | .6205 | .0004 |
| 1974 | 5.77318 | .00364 | .18041 | .5665 | .0000 |
| 1975 | 7.27454 | .00248 | .22733 | .4009 | .0000 |
| 1976 | 8.02973 | .02719 | .25093 | .3300 | .0000 |
| 1977 | 3.76673 | .03331 | .11771 | .8062 | .0001 |
| 1978 | 1.69763 | .02978 | .05305 | .9747 | .0000 |
| 1979 | 2.64477 | .01973 | .08265 | .9158 | .0000 |
| 1980 | 6.37747 | .02093 | .19930 | .4964 | .0000 |
| 1981 | 6.61373 | .02932 | .20668 | .4702 | .0000 |
| 1982 | 5.06121 | .00027 | .15816 | .6525 | .0000 |
| 1983 | 3.93609 | .00002 | .12300 | .7871 | .0000 |
| 1984 | 5.95831 | .01350 | .18620 | .5446 | .0000 |
| 1985 | 8.40671 | .04714 | .26271 | .2981 | .0002 |
| 1986 | 5.74651 | .00470 | .17958 | .5696 | .0000 |
| 1987 | 4.59818 | .01753 | .14369 | .7089 | .0000 |
| 1988 | 3.69572 | .14553 | .11549 | .8141 | .0068 |
| 1989 | 3.39593 | .00352 | .10612 | .8461 | .0000 |
| 1990 | 10.58851 | .04596 | .33089 | .1576 | .0002 |
| 1991 | 6.11687 | .04073 | .19115 | .5262 | .0001 |
| 1992 | 5.18535 | .05598 | .16204 | .6374 | .0003 |
| 1993 | 7.28556 | .00785 | .22767 | .3998 | .0000 |
| 1994 | 3.25213 | .04502 | .10163 | .8607 | .0002 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds (2p+1)/n or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with p + 1 degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with p + 1 numerator degree of freedom and n - p - 1 denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1962** | -.21211 | -.10879 | -.17974 | .08764 | .11154 | .10095 | -.04066 | .02078 |
| **1963** | .17127 | .13369 | -.03842 | -.03214 | -.02498 | -.08764 | -.01686 | .03058 |
| **1964** | -.22739 | -.16698 | .06189 | -.02387 | .05989 | -.07609 | .09173 | .07814 |
| **1965** | -.95599 | -.53334 | -.14963 | .36478 | -.02641 | -.16788 | .58121 | .08389 |
| **1966** | -.62966 | -.19657 | .18155 | -.27767 | -.26960 | .00416 | .44015 | .25021 |
| **1967** | -.73262 | -.06242 | .28383 | -.41676 | -.01718 | -.03000 | -.32440 | .48711 |
| **1968** | **-1.11857** | .15369 | .17519 | .35338 | -.51116 | -.17221 | -.41689 | .41167 |
| **1969** | -.09189 | .00894 | -.00283 | .01024 | -.06456 | -.01284 | .06335 | .01058 |
| **1970** | -.09008 | -.03033 | -.03269 | -.02502 | .01929 | .04861 | -.00379 | .01541 |
| **1971** | -.24132 | -.01281 | .08998 | -.08916 | .05650 | .02257 | -.16981 | .04325 |
| **1972** | .21357 | -.05266 | -.09187 | .02476 | .05126 | .02562 | .11794 | -.03297 |
| **1973** | .66286 | -.12714 | -.30573 | .18244 | .38367 | .17211 | .07109 | -.36703 |
| **1974** | .15677 | -.03592 | -.05082 | -.04612 | .06352 | -.04911 | .05474 | .06968 |
| **1975** | -.12923 | -.02741 | .00035 | .05511 | .02339 | .07720 | -.05253 | -.08231 |
| **1976** | .43189 | -.04795 | -.25672 | .01902 | -.01799 | .17038 | -.04060 | .23753 |
| **1977** | .48619 | -.21631 | -.19280 | .05523 | .13541 | .21812 | -.16644 | .25446 |
| **1978** | .46883 | .11167 | .11689 | .01710 | .06492 | -.31453 | -.02787 | .02335 |
| **1979** | .37226 | .01206 | .13042 | .05668 | -.12427 | .09321 | .15256 | -.21017 |
| **1980** | .37890 | -.00390 | .16344 | .02952 | -.16281 | .14544 | .13314 | -.18971 |
| **1981** | -.44996 | .27929 | -.06671 | .23638 | -.16496 | -.18493 | .02518 | -.20792 |
| **1982** | -.04303 | .02591 | -.00906 | .01981 | -.01799 | -.01282 | .00873 | -.02137 |
| **1983** | -.01066 | .00261 | -.00548 | .00203 | .00451 | -.00314 | -.00459 | -.00014 |
| **1984** | -.30348 | .01938 | -.15444 | .06698 | .18461 | -.06233 | -.16277 | -.00514 |
| **1985** | .57214 | .17500 | .20686 | .15928 | -.38043 | -.35865 | .20157 | .11359 |
| **1986** | .17827 | .03778 | -.06147 | .11196 | -.06395 | -.05528 | .01036 | .04829 |
| **1987** | .34741 | .02819 | .12365 | -.27671 | .13873 | -.04684 | -.12284 | .10940 |
| **1988** | **1.12758** | .34232 | .34236 | -.61666 | .45867 | -.03348 | -.34760 | -.35051 |
| **1989** | -.15430 | -.11225 | -.00976 | .07826 | .02820 | .03239 | .01733 | -.01412 |
| **1990** | .56239 | .16314 | -.21631 | .29880 | -.11309 | .37775 | -.26091 | -.21588 |
| **1991** | -.53398 | .08024 | .18869 | -.20090 | .19736 | -.23855 | .01024 | -.20335 |
| **1992** | -.63422 | .21681 | -.12313 | -.15477 | -.02020 | .18214 | .05604 | -.28572 |
| **1993** | .23050 | -.05195 | .03174 | .07605 | .09169 | -.01783 | -.11461 | -.01347 |
| **1994** | -.57386 | .05036 | -.12373 | -.10046 | -.21623 | .24779 | .10298 | .03959 |

**SDFFITS** Standardized dffits value
**SDFB_0** Standardized dfbeta for the intercept term
**SDFB_1** Standardized dfbeta for the logged January-February inflows
**SDFB_2** Standardized dfbeta for the logged March-April inflows
**SDFB_3** Standardized dfbeta for the logged May-June inflows
**SDFB_4** Standardized dfbeta for the logged July-August inflows
**SDFB_5** Standardized dfbeta for the logged September-October inflows
**SDFB_6** Standardized dfbeta for the logged November-December inflows

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

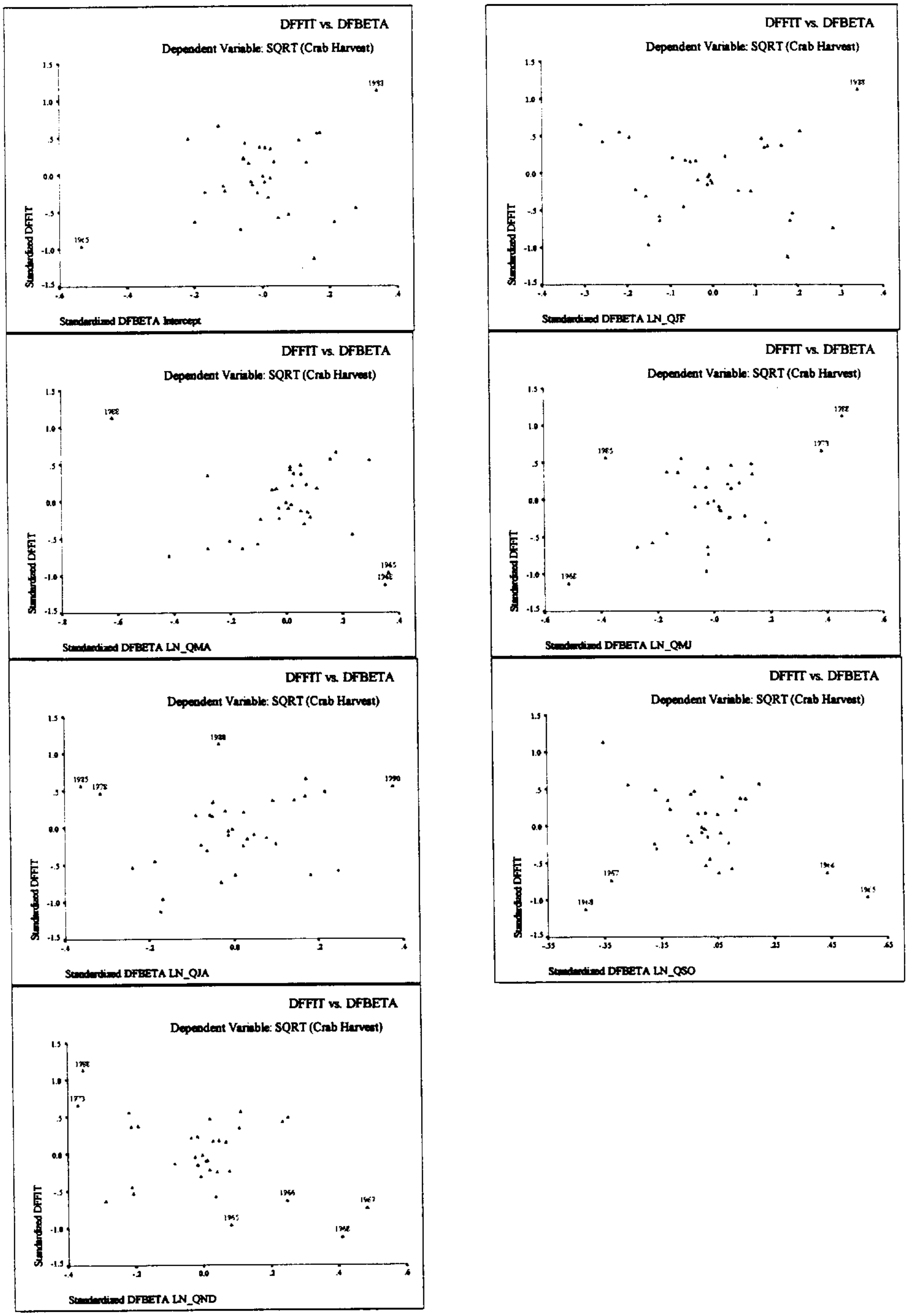



Fig. 6.2.4. Standardized DFFIT vs. Standardized DFBETA.

## 6.3 Model 7: Variables Transformed According Box-Cox Analysis

### 6.3.1 ANOVA and Parameter Estimates

**Model Summary[a,b]**

| Model | Variables Entered | Variables Removed | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|---|
| 1 | (Nov-Dec Inflows)^-0.1, (Sept-Oct Inflows)^0.1, Ln(Jul-Aug Inflows), (May-Jun Inflows)^0.2, (Jan-Feb Inflows)^0.1, Ln(Mar-Apr Inflows)[c,d] | . | .747 | .558 | .457 | 23.9459 | 1.197 |

a. Dependent Variable: (Crab Harvest)^0.6

b. Method: Enter

c. Independent Variables: (Constant), (November-December Inflows)^-0.1, (September-October Inflows)^0.1, Ln (July-August Inflows), (May-June Inflows)^0.2, (January-February Inflows)^0.1, Ln (March-April Inflows)

d. All requested variables entered.

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 18853.6 | 6 | 3142.260 | 5.480 | .001[b] |
| | Residual | 14908.5 | 26 | 573.404 | | |
| | Total | 33762.1 | 32 | | | |

a. Dependent Variable: (Crab Harvest)^0.6

b. Independent Variables: (Constant), (November-December Inflows)^-0.1, (September-October Inflows)^0.1, Ln (July-August Inflows), (May-June Inflows)^0.2, (January-February Inflows)^0.1, Ln (March-April Inflows)

**Coefficients[a]**

| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. | 95% Confidence Interval for B Lower Bound | 95% Confidence Interval for B Upper Bound |
|---|---|---|---|---|---|---|---|---|
| 1 | (Constant) | -41.561 | 75.779 | | -.548 | .588 | -197.327 | 114.205 |
| | (January-February Inflows)^0.1 | 131.003 | 35.329 | .691 | 3.708 | .001 | 58.383 | 203.623 |
| | Ln (March-April Inflows) | -7.950 | 4.897 | -.306 | -1.624 | .117 | -18.015 | 2.115 |
| | (May-June Inflows)^0.2 | -13.121 | 9.507 | -.225 | -1.380 | .179 | -32.664 | 6.422 |
| | Ln (July-August Inflows) | 3.152 | 4.126 | .114 | .764 | .452 | -5.329 | 11.632 |
| | (September-October Inflows)^0.1 | 44.180 | 21.544 | .300 | 2.051 | .051 | -.105 | 88.465 |
| | (November-December Inflows)^-0.1 | -135.399 | 68.729 | -.307 | -1.970 | .060 | -276.673 | 5.875 |

a. Dependent Variable: (Crab Harvest)^0.6

### 6.3.2 Collinearity Diagnostics

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | -41.560946 | 75.77901138 | -0.548 | 0.5881 | 0.00000000 |
| $QJF^{0.1}$ | 1 | 131.002861 | 35.32924155 | 3.708 | 0.0010 | 2.04220523 |
| Ln_QMA | 1 | -7.950043 | 4.89658942 | -1.624 | 0.1165 | 2.09825174 |
| $QMJ^{0.2}$ | 1 | -13.121042 | 9.50739912 | -1.380 | 0.1793 | 1.57110633 |
| Ln_QJA | 1 | 3.151814 | 4.12570089 | 0.764 | 0.4518 | 1.30170839 |
| $QSO^{0.1}$ | 1 | 44.179798 | 21.54440213 | 2.051 | 0.0505 | 1.25895293 |
| $QND^{-0.1}$ | 1 | -135.399166 | 68.72877516 | -1.970 | 0.0596 | 1.43258808 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop $QJF^{0.1}$ | Var Prop Ln_QMA | Var Prop $QMJ^{0.2}$ | Var Prop Ln_QJA | Var Prop $QSO^{0.1}$ | Var Prop $QND^{-0.1}$ |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.60308 | 1.00000 | 0.0460 | 0.0463 | 0.0446 | 0.0244 | 0.0210 | 0.0452 |
| 2 | 1.03031 | 1.58949 | 0.0311 | 0.0352 | 0.0335 | 0.0361 | 0.5235 | 0.0520 |
| 3 | 0.98356 | 1.62684 | 0.0003 | 0.0209 | 0.1575 | 0.4939 | 0.0026 | 0.0548 |
| 4 | 0.66258 | 1.98209 | 0.1824 | 0.0073 | 0.0307 | 0.1308 | 0.0837 | 0.5567 |
| 5 | 0.43812 | 2.43752 | 0.0497 | 0.2758 | 0.6646 | 0.0404 | 0.2434 | 0.1391 |
| 6 | 0.28236 | 3.03629 | 0.6905 | 0.6144 | 0.0691 | 0.2745 | 0.1258 | 0.1521 |

### 6.3.3 Residuals Diagnostics

***Summary Information***

**Residuals Statistics**[a]

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 16.6134 | 111.6783 | 66.3292 | 24.2729 | 33 |
| Std. Predicted Value | -2.048 | 1.868 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | 6.7894 | 14.3116 | 10.8378 | 2.0743 | 33 |
| Adjusted Predicted Value | 15.8820 | 115.1053 | 66.7996 | 24.6608 | 33 |
| Residual | -43.6122 | 56.2156 | 1.7E-14 | 21.5845 | 33 |
| Std. Residual | -1.821 | 2.348 | .000 | .901 | 33 |
| Stud. Residual | -1.971 | 2.527 | -.009 | .995 | 33 |
| Deleted Residual | -51.0712 | 65.1360 | -.4704 | 26.4296 | 33 |
| Stud. Deleted Residual | -2.095 | 2.853 | -.003 | 1.037 | 33 |
| Mahal. Distance | 1.603 | 10.461 | 5.818 | 2.503 | 33 |
| Cook's Distance | .000 | .156 | .032 | .039 | 33 |
| Centered Leverage Value | .050 | .327 | .182 | .078 | 33 |

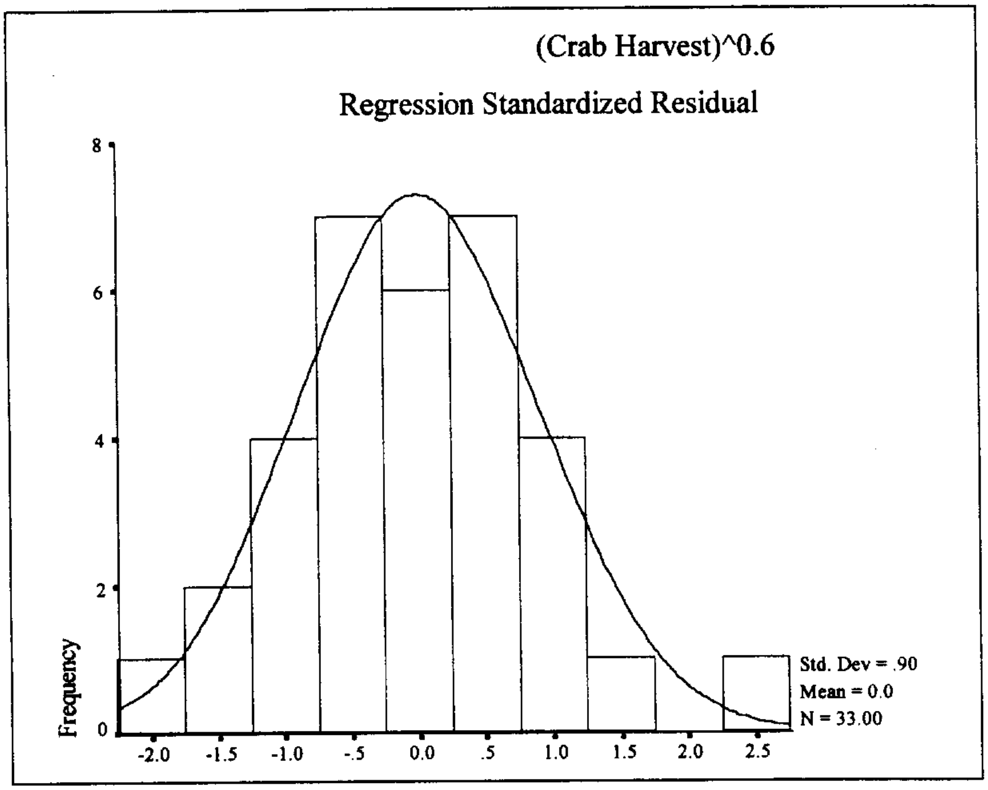
a. Dependent Variable: (Crab Harvest)^0.6

*Case Values for Residuals Diagnostics*

| YEAR | PRE | RES | DRE | ADJ | ZPR | ZRE | SRE [1] | SDR [2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 89.43033 | -5.60989 | -8.72729 | 92.54774 | .95172 | -.23427 | -.29220 | -.28700 |
| 1963 | 16.61345 | 1.52343 | 2.25491 | 15.88198 | -2.04820 | .06362 | .07740 | .07591 |
| 1964 | 24.92668 | -7.93533 | -11.01631 | 28.00766 | -1.70571 | -.33139 | -.39045 | -.38400 |
| 1965 | 52.70330 | -43.61218 | -51.07120 | 60.16232 | -.56136 | -1.82128 | -1.97089 | -2.09547 |
| 1966 | 24.20809 | -18.30153 | -24.21432 | 30.12088 | -1.73531 | -.76429 | -.87912 | -.87516 |
| 1967 | 38.68156 | -18.01797 | -27.50571 | 48.16930 | -1.13903 | -.75245 | -.92968 | -.92717 |
| 1968 | 55.10756 | -31.26569 | -45.16738 | 69.00925 | -.46231 | -1.30568 | -1.56934 | -1.61737 |
| 1969 | 59.04253 | -7.05309 | -8.23304 | 60.22247 | -.30020 | -.29454 | -.31823 | -.31266 |
| 1970 | 66.61642 | -8.25493 | -9.00667 | 67.36816 | .01183 | -.34473 | -.36009 | -.35398 |
| 1971 | 59.98334 | -13.92535 | -16.56968 | 62.62767 | -.26144 | -.58153 | -.63435 | -.62690 |
| 1972 | 62.52860 | 12.64215 | 14.41142 | 60.75933 | -.15658 | .52795 | .56368 | .55614 |
| 1973 | 43.35729 | 29.56430 | 37.32420 | 35.59738 | -.94640 | 1.23463 | 1.38723 | 1.41361 |
| 1974 | 59.16958 | 6.90434 | 8.88415 | 57.18978 | -.29496 | .28833 | .32707 | .32138 |
| 1975 | 63.62279 | -4.69288 | -6.34666 | 65.27657 | -.11150 | -.19598 | -.22791 | -.22371 |
| 1976 | 62.18051 | 12.31110 | 16.96071 | 57.53090 | -.17092 | .51412 | .60345 | .59592 |
| 1977 | 74.88047 | 27.60997 | 32.35211 | 70.13834 | .35230 | 1.15302 | 1.24811 | 1.26227 |
| 1978 | 61.04387 | 36.05291 | 39.20456 | 57.89222 | -.21775 | 1.50560 | 1.57003 | 1.61816 |
| 1979 | 83.17615 | 24.47990 | 27.57529 | 80.08076 | .69406 | 1.02230 | 1.08501 | 1.08888 |
| 1980 | 100.12225 | 14.79030 | 19.38424 | 95.52831 | 1.39221 | .61766 | .70710 | .70014 |
| 1981 | 105.26499 | -16.16935 | -21.26936 | 110.36500 | 1.60408 | -.67525 | -.77445 | -.76832 |
| 1982 | 100.58097 | -.69338 | -.85883 | 100.74642 | 1.41111 | -.02896 | -.03223 | -.03160 |
| 1983 | 110.28719 | -.71498 | -.85444 | 110.42664 | 1.81099 | -.02986 | -.03264 | -.03201 |
| 1984 | 111.67828 | -12.36872 | -15.79571 | 115.10527 | 1.86830 | -.51653 | -.58372 | -.57617 |
| 1985 | 81.88833 | 20.24280 | 28.30555 | 73.82558 | .64101 | .84536 | .99963 | .99962 |
| 1986 | 53.10072 | 7.54016 | 9.67620 | 50.96468 | -.54499 | .31488 | .35671 | .35064 |
| 1987 | 70.23207 | 16.01480 | 19.08246 | 67.16442 | .16079 | .66879 | .73004 | .72332 |
| 1988 | 54.99658 | 56.21563 | 65.13600 | 46.07621 | -.46688 | 2.34761 | 2.52702 | **2.85295** |
| 1989 | 46.66032 | -9.97119 | -11.56164 | 48.25076 | -.81032 | -.41641 | -.44839 | -.44139 |
| 1990 | 43.65383 | 10.12004 | 15.71342 | 38.06045 | -.93419 | .42262 | .52662 | .51917 |
| 1991 | 79.06558 | -21.09978 | -27.22817 | 85.19397 | .52472 | -.88115 | -1.00096 | -1.00100 |
| 1992 | 92.01343 | -29.00859 | -35.71548 | 98.72031 | 1.05814 | -1.21142 | -1.34419 | -1.36642 |
| 1993 | 75.48954 | 4.57803 | 6.39232 | 73.67525 | .37739 | .19118 | .22591 | .22174 |
| 1994 | 66.55772 | -31.89501 | -37.03725 | 71.69996 | .00941 | -1.33196 | -1.43533 | -1.46676 |

**PRE** Predicted value of harvest
**RES** Ordinary residual of harvest; observed minus predicted
**DRE** Deleted residual; residual obtained when the model is fitted without that observation
**ADJ** Adjusted predicted value; predicted value of harvest when the model is fitted without that observation.
**ZPR** Z-score of the predicted value of harvest
**ZRE** Z-score of the residual
**SRE** Studentized residual
**SDR** Studentized deleted residuals

[1] Values greater than 3 are flagged.
[2] This is flagged if it exceeds $t_{n-p-2,a} = t_{25,0.01} = 2.485$



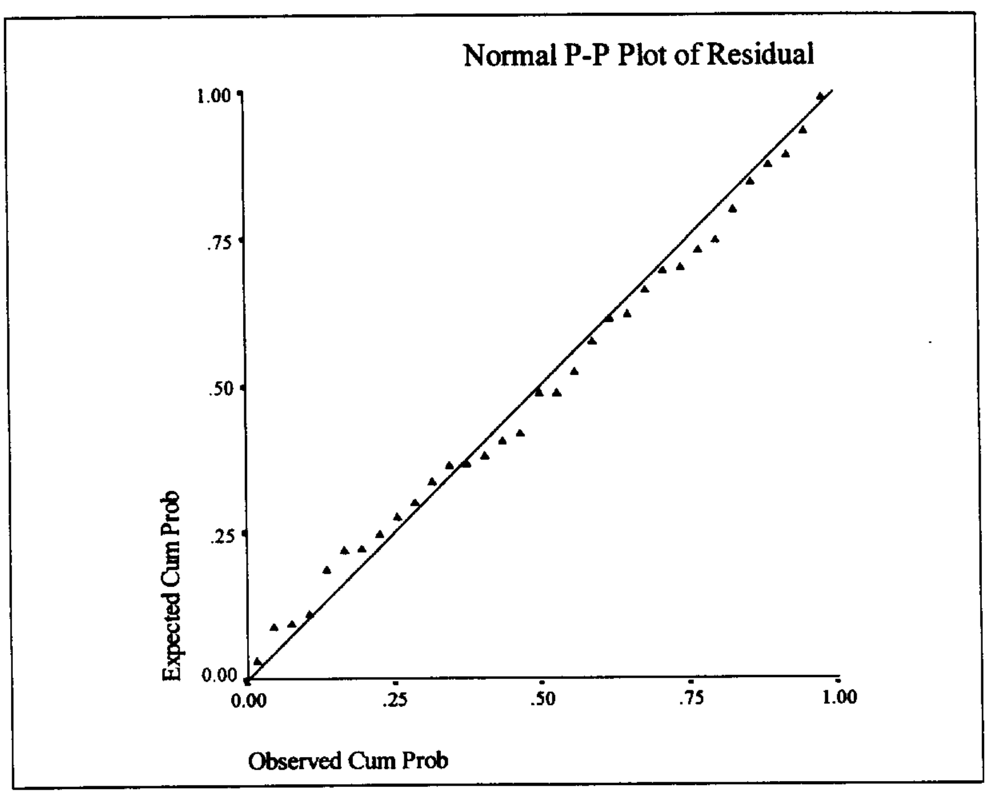




Fig. 6.3.1. Exploratory Plots of (Crab Harvest Standardized Residual) $^{0.6}$.

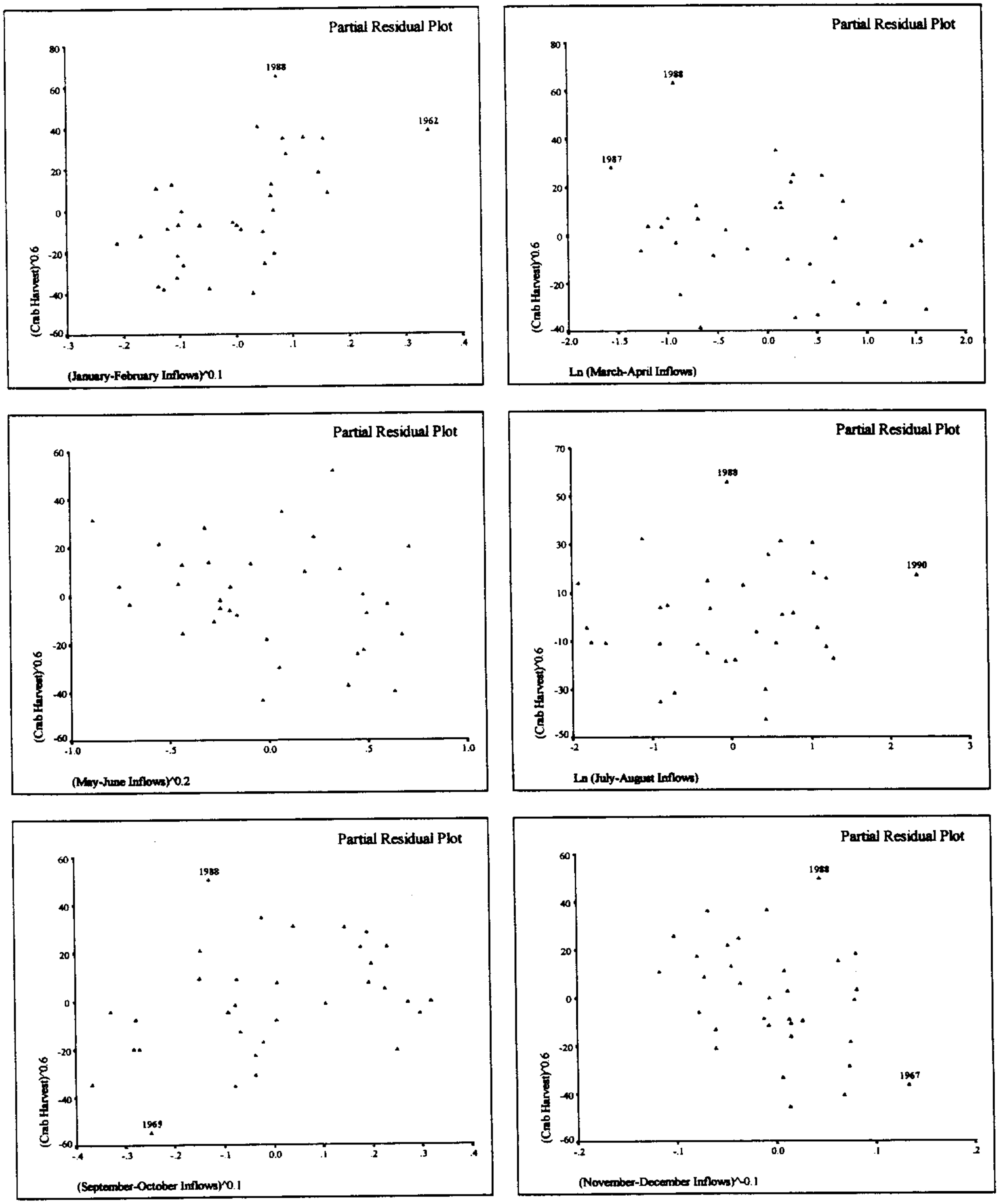



Fig. 6.3.2. Partial Residual Plots of (Crab Harvest)$^{0.6}$ vs. Box-Cox Transformed Inflows.

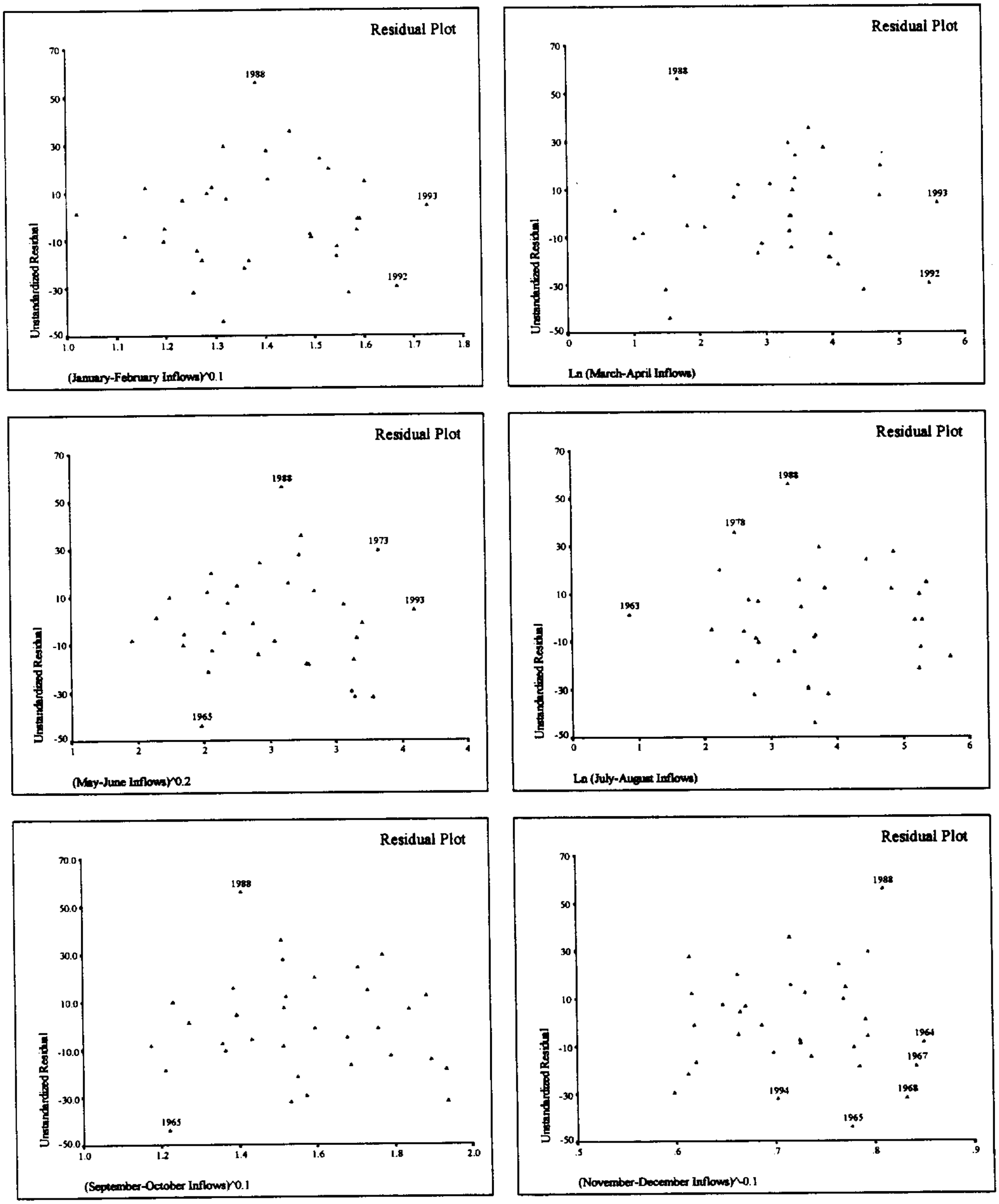



Fig. 6.3.3. Residual Plots of (Crab Harvest)$^{0.6}$ vs. Box-Cox Transformed Inflows.

### 6.3.4 Prediction Intervals for Crab Harvest

| YEAR | Box(CRAB) | LICI | UICI |
|---|---|---|---|
| 1962 | 83.82 | 11.91341 | 166.94726 |
| 1963 | 18.14 | 0 | 93.18767 |
| 1964 | 16.99 | 0 | 100.19704 |
| 1965 | 9.09 | 0 | 123.93550 |
| 1966 | 5.91 | 0 | 98.42739 |
| 1967 | 20.66 | 0 | 115.84744 |
| 1968 | 23.84 | 0 | 131.20007 |
| 1969 | 51.99 | 0 | 130.18973 |
| 1970 | 58.36 | 0 | 135.87631 |
| 1971 | 46.06 | 0 | 131.63500 |
| 1972 | 75.17 | 0 | 133.03352 |
| 1973 | 72.92 | 0 | 116.48648 |
| 1974 | 66.07 | 0 | 132.74968 |
| 1975 | 58.93 | 0 | 138.32932 |
| 1976 | 74.49 | 0 | 137.28795 |
| 1977 | 102.49 | 3.63188 | 146.12907 |
| 1978 | 97.10 | 0 | 130.20539 |
| 1979 | 107.66 | 13.00220 | 153.35011 |
| 1980 | 114.91 | 26.11777 | 174.12672 |
| 1981 | 89.10 | 31.17715 | 179.35283 |
| 1982 | 99.89 | 27.91512 | 173.24682 |
| 1983 | 109.57 | 38.52363 | 182.05074 |
| 1984 | 99.31 | 38.27559 | 185.08097 |
| 1985 | 102.13 | 6.46599 | 157.31066 |
| 1986 | 60.64 | 0 | 126.61778 |
| 1987 | 86.25 | 0 | 141.91984 |
| 1988 | 111.21 | 0 | 125.94536 |
| 1989 | 36.69 | 0 | 117.62821 |
| 1990 | 53.77 | 0 | 121.13535 |
| 1991 | 57.97 | 5.41848 | 152.71269 |
| 1992 | 63.00 | 19.49581 | 164.53104 |
| 1993 | 80.07 | .09726 | 150.88183 |
| 1994 | 34.66 | 0 | 137.56544 |

**Box(CRAB)** $(\text{Crab harvest})^{0.6}$
**LICI** Lower limit for 99% prediction interval for Crab harvest
**UICI** Upper limit for 99% prediction interval for Crab harvest

### 6.3.5 Outlier and Influential Point Detection

***Calculated Quantities***

| YEAR | MAH | COO | LEV [1] | MAHA_PV [2] | COOK_PV [3] |
|---|---|---|---|---|---|
| 1962 | 10.46076 | .00678 | .32690 | .1639 | .0000 |
| 1963 | 9.41085 | .00041 | .29409 | .2245 | .0000 |
| 1964 | 7.97987 | .00846 | .24937 | .3344 | .0000 |
| 1965 | 3.70395 | .09491 | .11575 | .8132 | .0018 |
| 1966 | 6.84424 | .03567 | .21388 | .4453 | .0001 |
| 1967 | 10.06829 | .06502 | .31463 | .1847 | .0005 |
| 1968 | 8.87931 | .15643 | .27748 | .2614 | .0085 |
| 1969 | 3.61648 | .00242 | .11301 | .8227 | .0000 |
| 1970 | 1.70119 | .00169 | .05316 | .9745 | .0000 |
| 1971 | 4.13713 | .01092 | .12929 | .7639 | .0000 |
| 1972 | 2.95889 | .00635 | .09247 | .8888 | .0000 |
| 1973 | 5.68328 | .07216 | .17760 | .5772 | .0007 |
| 1974 | 6.16140 | .00438 | .19254 | .5210 | .0000 |
| 1975 | 7.36868 | .00261 | .23027 | .3915 | .0000 |
| 1976 | 7.80279 | .01965 | .24384 | .3503 | .0000 |
| 1977 | 3.72083 | .03822 | .11628 | .8113 | .0001 |
| 1978 | 1.60278 | .03078 | .05009 | .9785 | .0000 |
| 1979 | 2.62237 | .02127 | .08195 | .9176 | .0000 |
| 1980 | 6.61409 | .02219 | .20669 | .4701 | .0000 |
| 1981 | 6.70332 | .02703 | .20948 | .4604 | .0000 |
| 1982 | 5.19503 | .00004 | .16234 | .6362 | .0000 |
| 1983 | 4.25312 | .00003 | .13291 | .7502 | .0000 |
| 1984 | 5.97294 | .01349 | .18665 | .5429 | .0000 |
| 1985 | 8.14540 | .05686 | .25454 | .3199 | .0003 |
| 1986 | 6.09438 | .00515 | .19045 | .5288 | .0000 |
| 1987 | 4.17455 | .01458 | .13045 | .7595 | .0000 |
| 1988 | 3.41270 | .14476 | .10665 | .8444 | .0067 |
| 1989 | 3.43230 | .00458 | .10726 | .8423 | .0000 |
| 1990 | 10.42109 | .02190 | .32566 | .1659 | .0000 |
| 1991 | 6.23271 | .04157 | .19477 | .5129 | .0001 |
| 1992 | 5.03947 | .05968 | .15748 | .6551 | .0004 |
| 1993 | 8.11264 | .00289 | .25352 | .3228 | .0000 |
| 1994 | 3.47317 | .04745 | .10854 | .8381 | .0002 |

**MAH** Mahalonobis distance
**COO** Cook's distance
**LEV** Leverage value
**MAHA_PV** P-value associated with the Mahalanobis distance
**COOK_PV** P-value associated with Cook's distance

[1] This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2] MAHA_PV = 1 - F(MAH), where F is the CDF of a Chi-Square variable with $p + 1$ degrees of freedom. Small values indicate a problem.

[3] COOK_PV = F(COO), where F is the CDF of an F-ratio random variable with $p + 1$ numerator degree of freedom and $n - p - 1$ denominator degree of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

| YEAR | SDFFIT | SDFB_0 | SDFB_1 | SDFB_2 | SDFB_3 | SDFB_4 | SDFB_5 | SDFB_6 |
|---|---|---|---|---|---|---|---|---|
| **1962** | -.21395 | .07738 | -.18047 | .08724 | .10649 | .09725 | -.03439 | -.02878 |
| **1963** | .05260 | .02592 | -.00868 | -.01289 | -.00685 | -.02894 | -.00620 | -.00928 |
| **1964** | -.23927 | -.02639 | .06862 | -.01958 | .04321 | -.08493 | .10982 | -.09805 |
| **1965** | -.86660 | -.15376 | -.10326 | .31092 | .02386 | -.16651 | .50627 | -.09552 |
| **1966** | -.49744 | -.01258 | .15438 | -.24568 | -.17960 | .01140 | .33091 | -.21435 |
| **1967** | -.67280 | .33830 | .23202 | -.37602 | .00301 | -.00909 | -.30570 | -.44004 |
| **1968** | **-1.07847** | .45382 | .13362 | .34475 | -.49372 | -.14279 | -.43825 | -.38129 |
| **1969** | -.12788 | -.00160 | -.00118 | .01314 | -.09056 | -.01859 | .08557 | -.01388 |
| **1970** | -.10682 | .01870 | -.03656 | -.03304 | .02829 | .05689 | -.00258 | -.01676 |
| **1971** | -.27318 | .02871 | .09285 | -.09422 | .07417 | .03529 | -.19611 | -.03092 |
| **1972** | .20805 | -.02650 | -.08401 | .01944 | .04409 | .01666 | .12368 | .01645 |
| **1973** | .72423 | -.25798 | -.32666 | .18412 | .44983 | .17625 | .06208 | .37196 |
| **1974** | .17209 | .06281 | -.05391 | -.05219 | .06994 | -.05579 | .06552 | -.08220 |
| **1975** | -.13280 | -.07209 | .00189 | .05616 | .02477 | .07880 | -.05300 | .08705 |
| **1976** | .36622 | .27694 | -.21684 | .01349 | -.02304 | .14549 | -.04504 | -.20413 |
| **1977** | .52313 | .30718 | -.22628 | .07840 | .12698 | .24508 | -.17870 | -.26368 |
| **1978** | .47843 | .02691 | .10150 | .03521 | .05151 | -.32165 | -.03116 | -.03384 |
| **1979** | .38720 | -.27505 | .14572 | .06044 | -.14436 | .09538 | .15203 | .21129 |
| **1980** | .39020 | -.27226 | .18484 | .02381 | -.17452 | .14430 | .12940 | .18922 |
| **1981** | -.43150 | -.05603 | -.06314 | .22695 | -.16951 | -.18232 | .01456 | .19355 |
| **1982** | -.01544 | -.00245 | -.00328 | .00712 | -.00696 | -.00481 | .00284 | .00721 |
| **1983** | -.01414 | .00524 | -.00765 | .00289 | .00625 | -.00390 | -.00614 | .00053 |
| **1984** | -.30328 | .09932 | -.15610 | .07146 | .18056 | -.06342 | -.15992 | .01239 |
| **1985** | .63087 | .03500 | .21141 | .18708 | -.41377 | -.39043 | .20380 | -.12284 |
| **1986** | .18663 | .08963 | -.07087 | .11901 | -.06820 | -.05477 | .00354 | -.04998 |
| **1987** | .31657 | .07683 | .10592 | -.25125 | .11454 | -.03953 | -.10430 | -.10643 |
| **1988** | **1.13647** | -.30367 | .33433 | -.58186 | .40648 | -.01276 | -.35065 | .40076 |
| **1989** | -.17628 | -.05673 | -.00627 | .08809 | .02902 | .03396 | .02793 | .01542 |
| **1990** | .38597 | .02759 | -.15985 | .20616 | -.07570 | .26183 | -.19088 | .14897 |
| **1991** | -.53947 | -.26150 | .21355 | -.21348 | .19442 | -.25184 | .03646 | .19440 |
| **1992** | -.65703 | -.10180 | -.15153 | -.15918 | -.03378 | .18635 | .04866 | .25978 |
| **1993** | .13959 | -.01622 | .02497 | .03713 | .06274 | -.01180 | -.06506 | .00967 |
| **1994** | -.58894 | .08499 | -.11838 | -.09335 | -.25300 | .24501 | .10986 | -.03322 |

**SDFFITS** Standardized dffits value
**SDFB_0** Standardized dfbeta for the intercept term
**SDFB_1** Standardized dfbeta for the $(\text{January-February inflows})^{0.1}$
**SDFB_2** Standardized dfbeta for the logged March-April inflows
**SDFB_3** Standardized dfbeta for the $(\text{May-June inflows})^{0.2}$
**SDFB_4** Standardized dfbeta for the logged July-August inflows
**SDFB_5** Standardized dfbeta for the $(\text{September-October inflows})^{0.1}$
**SDFB_6** Standardized dfbeta for the $(\text{November-December inflows})^{-0.1}$

Items in **bold** are flagged if |sdffits| or |sdfbeta| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

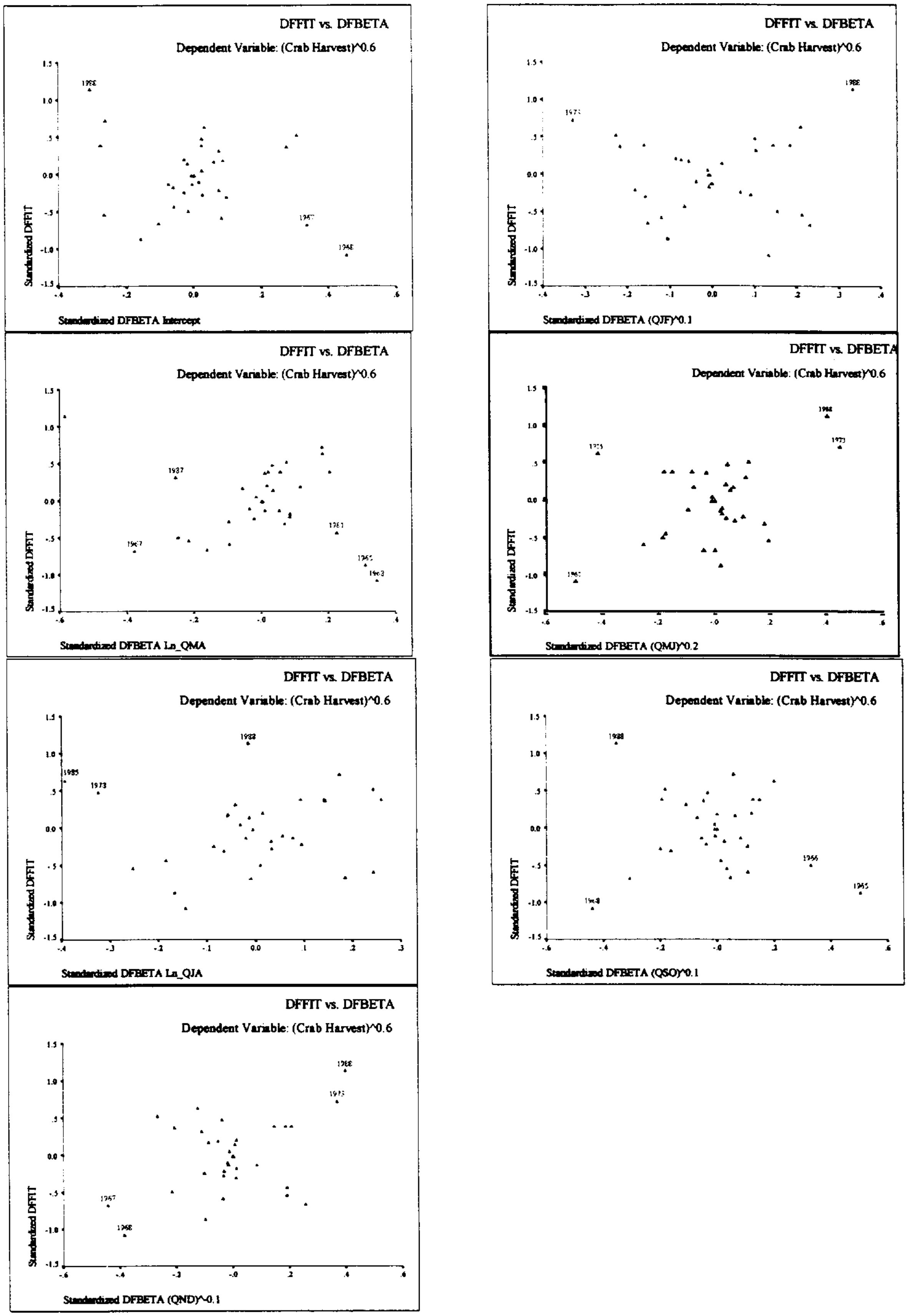



Fig. 6.3.4. Standardized DFFIT vs. Standardized DFBETA.

# 7. Examining Subsets of the Data

## 7.1 Model 3: Logged All Variables

### 7.1.1 Logged All Variables: 1965 Omitted

N = 32 Regression Models for Dependent Variable: LN (CRAB)

| Number In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.274632 | 0.250453 | 15.3105 | 0.9557 | 0.96987 | 3.8871 | LN_QJF |
| 1 | 0.225015 | 0.199182 | 18.2730 | 3.0729 | 1.03621 | 6.0044 | LN_QND |
| 1 | 0.192068 | 0.165137 | 20.2402 | 4.4052 | 1.08026 | 7.3367 | LN_QJA |
| 1 | 0.120438 | 0.091119 | 24.5171 | 7.1235 | 1.17603 | 10.0550 | LN_QSO |
| 2 | 0.370308 | 0.326881 | 11.5978 | -1.5707 | 0.87097 | 2.8265 | LN_QJF LN_QND |
| 2 | 0.349596 | 0.304740 | 12.8345 | -0.5351 | 0.89962 | 3.8621 | LN_QJF LN_QSO |
| 2 | 0.349212 | 0.304330 | 12.8574 | -0.5162 | 0.90015 | 3.8810 | LN_QJF LN_QJA |
| 2 | 0.318927 | 0.271956 | 14.6657 | 0.9393 | 0.94204 | 5.3366 | LN_QJA LN_QND |
| 3 | 0.466705 | 0.409566 | 7.8421 | -4.8877 | 0.76398 | 0.9753 | LN_QJF LN_QMA LN_QND |
| 3 | 0.430701 | 0.369705 | 9.9918 | -2.7971 | 0.81556 | 3.0658 | LN_QJF LN_QSO LN_QND |
| 3 | 0.415279 | 0.352630 | 10.9127 | -1.9418 | 0.83766 | 3.9212 | LN_QJF LN_QJA LN_QND |
| 3 | 0.409390 | 0.346110 | 11.2643 | -1.6211 | 0.84609 | 4.2419 | LN_QJF LN_QMJ LN_QSO |
| 4 | 0.535445 | 0.466622 | 5.7378 | -7.3035 | 0.69016 | 0.0252 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.499098 | 0.424891 | 7.9080 | -4.8930 | 0.74415 | 2.4357 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.491266 | 0.415898 | 8.3756 | -4.3965 | 0.75579 | 2.9322 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.474900 | 0.397107 | 9.3528 | -3.3832 | 0.78011 | 3.9455 | LN_QJF LN_QMA LN_QMJ LN_QND |
| 5 | 0.576552 | 0.495119 | 5.2834 | -8.2683 | 0.65328 | 0.5261 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.545907 | 0.458582 | 7.1131 | -6.0324 | 0.70056 | 2.7620 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.512352 | 0.418573 | 9.1166 | -3.7511 | 0.75233 | 5.0433 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.497556 | 0.400932 | 10.0001 | -2.7946 | 0.77516 | 5.9998 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 6 | 0.581298 | 0.480809 | 7.0000 | -6.6290 | 0.67180 | 3.6312 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 7.1.2 Logged All Variables: 1966 Omitted

N = 32 Regression Models for Dependent Variable: LN (CRAB)

| Number In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.341546 | 0.319597 | 5.1758 | -6.3678 | 0.77147 | -3.4363 | LN_QJF |
| 1 | 0.229523 | 0.203840 | 10.8200 | -1.3401 | 0.90272 | 1.5914 | LN_QND |
| 1 | 0.160726 | 0.132751 | 14.2862 | 1.3968 | 0.98333 | 4.3282 | LN_QMA |
| 1 | 0.129616 | 0.100603 | 15.8537 | 2.5615 | 1.01978 | 5.4930 | LN_QJA |
| 2 | 0.424356 | 0.384657 | 3.0034 | -8.6688 | 0.69770 | -4.2716 | LN_QJF LN_QND |
| 2 | 0.396654 | 0.355044 | 4.3992 | -7.1647 | 0.73128 | -2.7675 | LN_QJF LN_QSO |
| 2 | 0.369316 | 0.325821 | 5.7766 | -5.7467 | 0.76442 | -1.3495 | LN_QJF LN_QJA |
| 2 | 0.342571 | 0.297231 | 7.1241 | -4.4176 | 0.79683 | -0.0204 | LN_QJF LN_QMA |
| 3 | 0.469518 | 0.412681 | 2.7280 | -9.2833 | 0.66593 | -3.4203 | LN_QJF LN_QSO LN_QND |
| 3 | 0.437749 | 0.377508 | 4.3286 | -7.4221 | 0.70581 | -1.5591 | LN_QJF LN_QJA LN_QND |
| 3 | 0.433486 | 0.372788 | 4.5434 | -7.1803 | 0.71116 | -1.3174 | LN_QJF LN_QMA LN_QND |
| 3 | 0.424632 | 0.362985 | 4.9895 | -6.6841 | 0.72228 | -0.8211 | LN_QJF LN_QMJ LN_QND |
| 4 | 0.488992 | 0.413287 | 3.7468 | -8.4801 | 0.66524 | -1.1514 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.486340 | 0.410243 | 3.8804 | -8.3145 | 0.66869 | -0.9858 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.476981 | 0.399497 | 4.3519 | -7.7366 | 0.68088 | -0.4080 | LN_QJF LN_QJA LN_QSO LN_QND |
| 4 | 0.443817 | 0.361419 | 6.0229 | -5.7693 | 0.72405 | 1.5594 | LN_QJF LN_QMA LN_QJA LN_QND |
| 5 | 0.502020 | 0.406255 | 5.0904 | -7.3065 | 0.67322 | 1.4879 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.492637 | 0.395068 | 5.5631 | -6.7092 | 0.68590 | 2.0852 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.490425 | 0.392430 | 5.6746 | -6.5700 | 0.68889 | 2.2245 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.443886 | 0.336941 | 8.0194 | -3.7733 | 0.75181 | 5.0211 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 6 | 0.503814 | 0.384729 | 7.0000 | -5.4220 | 0.69762 | 4.8382 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

### 7.1.3 Logged All Variables: 1965 and 1966 Omitted

N = 31    Regression Models for Dependent Variable: LN (CRAB)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.414872 | 0.394695 | 5.9966 | -19.0333 | 0.508485 | -16.1654 | LN_QJF |
| 1 | 0.229297 | 0.202722 | 16.4615 | -10.4937 | 0.669752 | -7.6257 | LN_QND |
| 1 | 0.177921 | 0.149574 | 19.3587 | -8.4932 | 0.714399 | -5.6252 | LN_QJA |
| 1 | 0.116653 | 0.086193 | 22.8138 | -6.2648 | 0.767642 | -3.3969 | LN_QMA |
| 2 | 0.486768 | 0.450109 | 3.9422 | -21.0975 | 0.461935 | -16.7956 | LN_QJF LN_QND |
| 2 | 0.458966 | 0.420321 | 5.5100 | -19.4621 | 0.486958 | -15.1602 | LN_QJF LN_QJA |
| 2 | 0.425409 | 0.384367 | 7.4024 | -17.5967 | 0.517161 | -13.2947 | LN_QJF LN_QSO |
| 2 | 0.424260 | 0.383136 | 7.4672 | -17.5347 | 0.518195 | -13.2328 | LN_QJF LN_QMA |
| 3 | 0.536030 | 0.484477 | 3.1643 | -22.2256 | 0.433064 | -16.4897 | LN_QJF LN_QMA LN_QND |
| 3 | 0.513142 | 0.459047 | 4.4549 | -20.7330 | 0.454426 | -14.9970 | LN_QJF LN_QJA LN_QND |
| 3 | 0.495431 | 0.439367 | 5.4537 | -19.6252 | 0.470958 | -13.8893 | LN_QJF LN_QMJ LN_QND |
| 3 | 0.495126 | 0.439029 | 5.4709 | -19.6065 | 0.471243 | -13.8705 | LN_QJF LN_QSO LN_QND |
| 4 | 0.552803 | 0.484004 | 4.2184 | -21.3671 | 0.433461 | -14.1972 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.551617 | 0.482635 | 4.2853 | -21.2850 | 0.434612 | -14.1150 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.539174 | 0.468278 | 4.9869 | -20.4365 | 0.446672 | -13.2665 | LN_QJF LN_QMA LN_QMJ LN_QND |
| 4 | 0.519400 | 0.445462 | 6.1020 | -19.1340 | 0.465839 | -11.9641 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 5 | 0.566549 | 0.479859 | 5.4432 | -20.3350 | 0.436943 | -11.7310 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.563195 | 0.475834 | 5.6323 | -20.0960 | 0.440324 | -11.4921 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.555107 | 0.466129 | 6.0884 | -19.5272 | 0.448478 | -10.9233 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.532937 | 0.439524 | 7.3387 | -18.0197 | 0.470827 | -9.4158 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.574408 | 0.468010 | 7.0000 | -18.9022 | 0.446897 | -8.8643 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

## 7.2 Model 6: Square Root Harvest and Logged Inflows

### 7.2.1 Square Root Harvest and Logged Inflows: 1968 Omitted

N = 32 Regression Models for Dependent Variable: SQRT (CRAB)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.320619 | 0.297973 | 13.6851 | 158.5 | 133.155 | 161.4 | LN_QJF |
| 1 | 0.208665 | 0.182287 | 20.5542 | 163.3 | 155.098 | 166.3 | LN_QJA |
| 1 | 0.207962 | 0.181561 | 20.5974 | 163.4 | 155.236 | 166.3 | LN_QSO |
| 1 | 0.158110 | 0.130047 | 23.6562 | 165.3 | 165.006 | 168.3 | LN_QND |
| 2 | 0.439003 | 0.400314 | 8.4213 | 154.3 | 113.744 | 158.7 | LN_QJF LN_QSO |
| 2 | 0.395553 | 0.353867 | 11.0873 | 156.7 | 122.554 | 161.1 | LN_QJF LN_QJA |
| 2 | 0.368795 | 0.325263 | 12.7291 | 158.1 | 127.979 | 162.5 | LN_QJF LN_QND |
| 2 | 0.352188 | 0.307511 | 13.7481 | 158.9 | 131.346 | 163.3 | LN_QJF LN_QMA |
| 3 | 0.505647 | 0.452680 | 6.3322 | 152.3 | 103.812 | 158.2 | LN_QJF LN_QMA LN_QSO |
| 3 | 0.484937 | 0.429752 | 7.6029 | 153.6 | 108.161 | 159.5 | LN_QJF LN_QJA LN_QSO |
| 3 | 0.473268 | 0.416833 | 8.3189 | 154.3 | 110.611 | 160.2 | LN_QJF LN_QMJ LN_QSO |
| 3 | 0.461673 | 0.403996 | 9.0303 | 155.0 | 113.046 | 160.9 | LN_QJF LN_QSO LN_QND |
| 4 | 0.565298 | 0.500898 | 4.6722 | 150.2 | 94.666 | 157.5 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.538975 | 0.470675 | 6.2873 | 152.1 | 100.399 | 159.4 | LN_QJF LN_QMA LN_QJA LN_QSO |
| 4 | 0.520040 | 0.448935 | 7.4491 | 153.3 | 104.522 | 160.7 | LN_QJF LN_QMA LN_QMJ LN_QSO |
| 4 | 0.506105 | 0.432935 | 8.3041 | 154.3 | 107.557 | 161.6 | LN_QJF LN_QMJ LN_QJA LN_QSO |
| 5 | 0.582459 | 0.502163 | 5.6192 | 150.9 | 94.426 | 159.7 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.580542 | 0.499877 | 5.7368 | 151.0 | 94.860 | 159.8 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.547080 | 0.459980 | 7.7900 | 153.5 | 102.427 | 162.3 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.524729 | 0.433330 | 9.1614 | 155.0 | 107.482 | 163.8 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.592551 | 0.494763 | 7.0000 | 152.1 | 95.830 | 162.4 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

### 7.2.2 Square Root Harvest and Logged Inflows: 1988 Omitted

N = 32 Regression Models for Dependent Variable: SQRT (CRAB)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.354872 | 0.333368 | 17.8331 | 156.8 | 126.331 | 159.7 | LN_QJF |
| 1 | 0.259531 | 0.234848 | 24.6067 | 161.2 | 145.002 | 164.1 | LN_QND |
| 1 | 0.215330 | 0.189175 | 27.7469 | 163.0 | 153.657 | 166.0 | LN_QJA |
| 1 | 0.159785 | 0.131778 | 31.6931 | 165.2 | 164.534 | 168.2 | LN_QSO |
| 2 | 0.452742 | 0.415000 | 12.8799 | 153.5 | 110.862 | 157.9 | LN_QJF LN_QND |
| 2 | 0.449480 | 0.411513 | 13.1117 | 153.7 | 111.522 | 158.1 | LN_QJF LN_QSO |
| 2 | 0.430140 | 0.390839 | 14.4857 | 154.8 | 115.440 | 159.2 | LN_QJF LN_QJA |
| 2 | 0.368207 | 0.324635 | 18.8857 | 158.1 | 127.986 | 162.5 | LN_QJF LN_QMJ |
| 3 | 0.529649 | 0.479255 | 9.4161 | 150.7 | 98.685 | 156.5 | LN_QJF LN_QSO LN_QND |
| 3 | 0.520382 | 0.468994 | 10.0745 | 151.3 | 100.629 | 157.2 | LN_QJF LN_QMJ LN_QSO |
| 3 | 0.499468 | 0.445839 | 11.5603 | 152.7 | 105.017 | 158.5 | LN_QJF LN_QJA LN_QND |
| 3 | 0.497252 | 0.443386 | 11.7177 | 152.8 | 105.482 | 158.7 | LN_QJF LN_QJA LN_QSO |
| 4 | 0.615019 | 0.557985 | 5.3510 | 146.3 | 83.765 | 153.6 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.579795 | 0.517543 | 7.8535 | 149.1 | 91.429 | 156.4 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.558274 | 0.492833 | 9.3824 | 150.7 | 96.112 | 158.0 | LN_QJF LN_QJA LN_QSO LN_QND |
| 4 | 0.549961 | 0.483288 | 9.9730 | 151.3 | 97.920 | 158.6 | LN_QJF LN_QMJ LN_QJA LN_QSO |
| 5 | 0.641227 | 0.572232 | 5.4890 | 146.0 | 81.065 | 154.8 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.627381 | 0.555723 | 6.4728 | 147.2 | 84.194 | 156.0 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.594848 | 0.516934 | 8.7840 | 149.9 | 91.544 | 158.7 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.551454 | 0.465195 | 11.8669 | 153.1 | 101.349 | 161.9 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 6 | 0.648110 | 0.563657 | 7.0000 | 147.4 | 82.690 | 157.6 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

### 7.2.3 Square Root Harvest and Logged Inflows: 1968 and 1988 Omitted

N = 31 Regression Models for Dependent Variable: SQRT (CRAB)

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.341743 | 0.319044 | 19.5203 | 151.9 | 126.016 | 154.7 | LN_QJF |
| 1 | 0.249524 | 0.223646 | 26.0376 | 155.9 | 143.670 | 158.8 | LN_QSO |
| 1 | 0.234835 | 0.208450 | 27.0758 | 156.5 | 146.482 | 159.4 | LN_QJA |
| 1 | 0.227142 | 0.200491 | 27.6194 | 156.8 | 147.955 | 159.7 | LN_QND |
| 2 | 0.489470 | 0.453004 | 11.0801 | 146.0 | 101.226 | 150.3 | LN_QJF LN_QSO |
| 2 | 0.429616 | 0.388874 | 15.3102 | 149.4 | 113.093 | 153.7 | LN_QJF LN_QJA |
| 2 | 0.427662 | 0.386780 | 15.4483 | 149.5 | 113.481 | 153.8 | LN_QJF LN_QND |
| 2 | 0.391289 | 0.347810 | 18.0188 | 151.4 | 120.693 | 155.7 | LN_QJA LN_QSO |
| 3 | 0.543132 | 0.492369 | 9.2878 | 144.5 | 93.941 | 150.3 | LN_QJF LN_QJA LN_QSO |
| 3 | 0.539728 | 0.488587 | 9.5283 | 144.8 | 94.641 | 150.5 | LN_QJF LN_QSO LN_QND |
| 3 | 0.539665 | 0.488517 | 9.5328 | 144.8 | 94.654 | 150.5 | LN_QJF LN_QMJ LN_QSO |
| 3 | 0.528584 | 0.476205 | 10.3159 | 145.5 | 96.932 | 151.2 | LN_QJF LN_QMA LN_QSO |
| 4 | 0.612311 | 0.552667 | 6.3987 | 141.5 | 82.782 | 148.6 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.608328 | 0.548071 | 6.6802 | 141.8 | 83.633 | 148.9 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.576356 | 0.511180 | 8.9398 | 144.2 | 90.460 | 151.4 | LN_QJF LN_QMJ LN_QJA LN_QSO |
| 4 | 0.576070 | 0.510851 | 8.9599 | 144.2 | 90.521 | 151.4 | LN_QJF LN_QJA LN_QSO LN_QND |
| 5 | 0.649853 | 0.579824 | 5.7456 | 140.3 | 77.757 | 148.9 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.631075 | 0.557290 | 7.0727 | 141.9 | 81.927 | 150.5 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.626029 | 0.551235 | 7.4293 | 142.3 | 83.047 | 150.9 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.590349 | 0.508419 | 9.9509 | 145.2 | 90.971 | 153.8 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 6 | 0.660403 | 0.575504 | 7.0000 | 141.3 | 78.556 | 151.4 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

| OBS | _MODEL_ | _TYPE_ | _DEPVAR_ | _RMSE_ | INTERCEP | LN_QJF | LN_QMA | LN_QMJ | LN_QJA | LN_QSO |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MODEL1 | PARMS | SQRT_CRA | 11.2257 | 11.7738 | 6.22279 | . | . | . | . |
| 2 | MODEL1 | PARMS | SQRT_CRA | 11.9862 | 11.5134 | . | . | . | . | 4.82037 |
| 3 | MODEL1 | PARMS | SQRT_CRA | 12.1030 | 12.2115 | . | . | . | 5.46394 | . |
| 4 | MODEL1 | PARMS | SQRT_CRA | 12.1637 | 10.3069 | . | . | . | . | . |
| 5 | MODEL1 | PARMS | SQRT_CRA | 10.0611 | -1.6713 | 5.33547 | . | . | . | 3.79521 |
| 6 | MODEL1 | PARMS | SQRT_CRA | 10.6345 | 2.5764 | 5.02502 | . | . | 3.57505 | . |
| 7 | MODEL1 | PARMS | SQRT_CRA | 10.6527 | 1.1381 | 5.07758 | . | . | . | . |
| 8 | MODEL1 | PARMS | SQRT_CRA | 10.9860 | -0.7227 | . | . | . | 4.37095 | 3.92993 |
| 9 | MODEL1 | PARMS | SQRT_CRA | 9.6923 | -7.5081 | 4.48109 | . | . | 2.83919 | 3.38097 |
| 10 | MODEL1 | PARMS | SQRT_CRA | 9.7284 | -8.4391 | 4.54350 | . | . | . | 3.36686 |
| 11 | MODEL1 | PARMS | SQRT_CRA | 9.7290 | 4.8555 | 6.75749 | . | -3.31682 | . | 4.62529 |
| 12 | MODEL1 | PARMS | SQRT_CRA | 9.8454 | 0.4339 | 7.03717 | -2.91186 | . | . | 4.18126 |
| 13 | MODEL1 | PARMS | SQRT_CRA | 9.0985 | -7.7717 | 6.68282 | -4.12409 | . | . | 3.76716 |
| 14 | MODEL1 | PARMS | SQRT_CRA | 9.1451 | -1.9551 | 6.08118 | . | -3.92487 | . | 4.27067 |
| 15 | MODEL1 | PARMS | SQRT_CRA | 9.5110 | -1.1782 | 5.79477 | . | -2.75155 | 2.39387 | 4.13456 |
| 16 | MODEL1 | PARMS | SQRT_CRA | 9.5142 | -12.1660 | 3.96344 | . | . | 2.38477 | 3.09333 |
| 17 | MODEL1 | PARMS | SQRT_CRA | 8.8180 | -2.9131 | 7.41592 | -3.25154 | -3.02654 | . | 4.37941 |
| 18 | MODEL1 | PARMS | SQRT_CRA | 9.0513 | -10.5842 | 6.02218 | -3.67246 | . | 1.75286 | 3.52227 |
| 19 | MODEL1 | PARMS | SQRT_CRA | 9.1130 | -5.4231 | 5.47681 | . | -3.44505 | 1.71186 | 3.96383 |
| 20 | MODEL1 | PARMS | SQRT_CRA | 9.5379 | -0.6458 | 6.67662 | -1.83953 | -2.20831 | 2.26183 | 4.26175 |
| 21 | MODEL1 | PARMS | SQRT_CRA | 8.8632 | -5.5473 | 6.83813 | -2.99449 | -2.72260 | 1.33772 | 4.13103 |

| OBS | LN_QND | SQRT_CRA | _IN_ | _P_ | _EDF_ | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | . | -1 | 1 | 2 | 29 | 126.016 | 0.34174 | 0.31904 | 19.5203 | 151.861 | 154.729 |
| 2 | . | -1 | 1 | 2 | 29 | 143.670 | 0.24952 | 0.22365 | 26.0376 | 155.926 | 158.794 |
| 3 | . | -1 | 1 | 2 | 29 | 146.482 | 0.23483 | 0.20845 | 27.0758 | 156.527 | 159.395 |
| 4 | 6.46199 | -1 | 1 | 2 | 29 | 147.955 | 0.22714 | 0.20049 | 27.6194 | 156.837 | 159.705 |
| 5 | . | -1 | 2 | 3 | 28 | 101.226 | 0.48947 | 0.45300 | 11.0801 | 145.983 | 150.285 |
| 6 | . | -1 | 2 | 3 | 28 | 113.093 | 0.42962 | 0.38887 | 15.3102 | 149.419 | 153.721 |
| 7 | 4.23355 | -1 | 2 | 3 | 28 | 113.481 | 0.42766 | 0.38678 | 15.4483 | 149.525 | 153.827 |
| 8 | . | -1 | 2 | 3 | 28 | 120.693 | 0.39129 | 0.34781 | 18.0188 | 151.435 | 155.737 |
| 9 | . | -1 | 3 | 4 | 27 | 93.941 | 0.54313 | 0.49237 | 9.2878 | 144.540 | 150.276 |
| 10 | 3.29795 | -1 | 3 | 4 | 27 | 94.641 | 0.53973 | 0.48859 | 9.5283 | 144.770 | 150.506 |
| 11 | . | -1 | 3 | 4 | 27 | 94.654 | 0.53967 | 0.48852 | 9.5328 | 144.774 | 150.510 |
| 12 | . | -1 | 3 | 4 | 27 | 96.932 | 0.52858 | 0.47620 | 10.3159 | 145.512 | 151.248 |
| 13 | 4.42569 | -1 | 4 | 5 | 26 | 82.782 | 0.61231 | 0.55267 | 6.3987 | 141.450 | 148.620 |
| 14 | 3.90188 | -1 | 4 | 5 | 26 | 83.633 | 0.60833 | 0.54807 | 6.6802 | 141.767 | 148.937 |
| 15 | . | -1 | 4 | 5 | 26 | 90.460 | 0.57636 | 0.51118 | 8.9398 | 144.199 | 151.369 |
| 16 | 2.72503 | -1 | 4 | 5 | 26 | 90.521 | 0.57607 | 0.51085 | 8.9599 | 144.220 | 151.390 |
| 17 | 4.65280 | -1 | 5 | 6 | 25 | 77.757 | 0.64985 | 0.57982 | 5.7456 | 140.293 | 148.897 |
| 18 | 3.88109 | -1 | 5 | 6 | 25 | 81.927 | 0.63108 | 0.55729 | 7.0727 | 141.912 | 150.516 |
| 19 | 3.41680 | -1 | 5 | 6 | 25 | 83.047 | 0.62603 | 0.55124 | 7.4293 | 142.333 | 150.937 |
| 20 | . | -1 | 5 | 6 | 25 | 90.971 | 0.59035 | 0.50842 | 9.9509 | 145.158 | 153.762 |
| 21 | 4.21437 | -1 | 6 | 7 | 24 | 78.556 | 0.66040 | 0.57550 | 7.0000 | 141.344 | 151.382 |

Parameter Estimates

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | -5.547346 | 8.27632970 | -0.670 | 0.5091 | 0.00000000 |
| LN_QJF | 1 | 6.838129 | 1.84333240 | 3.710 | 0.0011 | 2.11926153 |
| LN_QMA | 1 | -2.994494 | 1.92126480 | -1.559 | 0.1322 | 2.12233960 |
| LN_QMJ | 1 | -2.722601 | 1.89112107 | -1.440 | 0.1629 | 1.84508996 |
| LN_QJA | 1 | 1.337721 | 1.54924221 | 0.863 | 0.3964 | 1.33424556 |
| LN_QSO | 1 | 4.131035 | 1.29867256 | 3.181 | 0.0040 | 1.27996433 |
| LN_QND | 1 | 4.214366 | 1.89405111 | 2.225 | 0.0357 | 1.37909672 |

Collinearity Diagnostics(intercept adjusted)

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop LN_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop LN_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.80032 | 1.00000 | 0.0380 | 0.0393 | 0.0406 | 0.0198 | 0.0292 | 0.0395 |
| 2 | 0.99800 | 1.67509 | 0.0026 | 0.0445 | 0.0805 | 0.5069 | 0.0115 | 0.0452 |
| 3 | 0.85234 | 1.81258 | 0.0747 | 0.0244 | 0.0194 | 0.0119 | 0.6945 | 0.0163 |
| 4 | 0.66973 | 2.04481 | 0.1236 | 0.0001 | 0.0040 | 0.1094 | 0.0052 | 0.7765 |
| 5 | 0.39655 | 2.65739 | 0.0085 | 0.3828 | 0.7623 | 0.0449 | 0.1678 | 0.0074 |
| 6 | 0.28307 | 3.14528 | 0.7525 | 0.5088 | 0.0932 | 0.3070 | 0.0918 | 0.1152 |

| Variable | DF | Variable Label |
|---|---|---|
| INTERCEP | 1 | Intercept |
| LN_QJF | 1 | Ln (January-February Inflows) |
| LN_QMA | 1 | Ln (March-April Inflows) |
| LN_QMJ | 1 | Ln (May-June Inflows) |
| LN_QJA | 1 | Ln (July-August Inflows) |
| LN_QSO | 1 | Ln (September-October Inflows) |
| LN_QND | 1 | Ln (November-December Inflows) |

## 7.3 Model 7: Variables Transformed According to Box-Cox Analysis

### 7.3.1 Variables Transformed According to Box-Cox Analysis: 1968 Omitted

N = 32 Regression Models for Dependent Variable: $(CRAB)^{0.6}$

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.317517 | 0.294767 | 12.3287 | 212.7 | 725.72 | 215.7 | $(QJF)^{0.1}$ |
| 1 | 0.211727 | 0.185451 | 18.5799 | 217.3 | 838.21 | 220.3 | LN_QJA |
| 1 | 0.161797 | 0.133857 | 21.5303 | 219.3 | 891.30 | 222.2 | $(QSO)^{0.1}$ |
| 1 | 0.150992 | 0.122692 | 22.1688 | 219.7 | 902.79 | 222.6 | $(QND)^{-0.1}$ |
| 2 | 0.416963 | 0.376753 | 8.4523 | 209.7 | 641.35 | 214.1 | $(QJF)^{0.1}$ $(QSO)^{-0.1}$ |
| 2 | 0.398978 | 0.357529 | 9.5150 | 210.7 | 661.13 | 215.1 | $(QJF)^{0.1}$ LN_QJA |
| 2 | 0.359385 | 0.315205 | 11.8546 | 212.7 | 704.69 | 217.1 | $(QJF)^{0.1}$ $(QND)^{-0.1}$ |
| 2 | 0.350379 | 0.305577 | 12.3868 | 213.1 | 714.59 | 217.5 | $(QJF)^{0.1}$ LN_QMA |
| 3 | 0.484424 | 0.429183 | 6.4660 | 207.7 | 587.40 | 213.6 | $(QJF)^{0.1}$ LN_QMA $(QSO)^{0.1}$ |
| 3 | 0.468707 | 0.411783 | 7.3947 | 208.7 | 605.30 | 214.6 | $(QJF)^{0.1}$ LN_QJA $(QSO)^{0.1}$ |
| 3 | 0.454771 | 0.396353 | 8.2182 | 209.5 | 621.18 | 215.4 | $(QJF)^{0.1}$ $(QMJ)^{0.2}$ $(QSO)^{0.1}$ |
| 3 | 0.439210 | 0.379125 | 9.1377 | 210.4 | 638.91 | 216.3 | $(QJF)^{0.1}$ $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.543252 | 0.475586 | 4.9897 | 205.9 | 539.65 | 213.2 | $(QJF)^{0.1}$ LN_QMA $(QSO)^{0.1}$ $(QND)^{0.1}$ |
| 4 | 0.523687 | 0.453123 | 6.1458 | 207.2 | 562.76 | 214.5 | $(QJF)^{0.1}$ LN_QMA LN_QJA $(QSO)^{0.1}$ |
| 4 | 0.500790 | 0.426832 | 7.4989 | 208.7 | 589.82 | 216.0 | $(QJF)^{0.1}$ LN_QMA $(QMJ)^{0.2}$ $(QSO)^{0.1}$ |
| 4 | 0.492953 | 0.417835 | 7.9620 | 209.2 | 599.08 | 216.5 | $(QJF)^{0.1}$ $(QMJ)^{0.2}$ LN_QJA $(QSO)^{0.1}$ |
| 5 | 0.563576 | 0.479648 | 5.7888 | 206.4 | 535.47 | 215.2 | $(QJF)^{0.1}$ LN_QMA LN_QJA $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.562397 | 0.478243 | 5.8584 | 206.5 | 536.91 | 215.3 | $(QJF)^{0.1}$ LN_QMA $(QMJ)^{0.2}$ $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.533327 | 0.443582 | 7.5762 | 208.6 | 572.58 | 217.4 | $(QJF)^{0.1}$ LN_QMA $(QMJ)^{0.2}$ LN_QJA $(QSO)^{0.1}$ |
| 5 | 0.511002 | 0.416964 | 8.8954 | 210.1 | 599.97 | 218.9 | $(QJF)^{0.1}$ $(QMJ)^{0.2}$ LN_QJA $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 6 | 0.576924 | 0.475386 | 7.0000 | 207.4 | 539.85 | 217.7 | $(QJF)^{0.1}$ LN_QMA $(QMJ)^{0.2}$ LN_QJA $(QSO)^{0.1}$ $(QND)^{-0.1}$ |

### 7.3.2 Variables Transformed According to Box-Cox Analysis: 1988 Omitted

N = 32 Regression Models for Dependent Variable: $(CRAB)^{0.6}$

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.358233 | 0.336841 | 17.1997 | 210.5 | 677.81 | 213.5 | $(QJF)^{0.1}$ |
| 1 | 0.258170 | 0.233442 | 24.2471 | 215.2 | 783.49 | 218.1 | $(QND)^{-0.1}$ |
| 1 | 0.220373 | 0.194385 | 26.9092 | 216.8 | 823.41 | 219.7 | LN_QJA |
| 1 | 0.118213 | 0.088820 | 34.1043 | 220.7 | 931.30 | 223.6 | $(QSO)^{0.1}$ |
| 2 | 0.450828 | 0.412954 | 12.6782 | 207.6 | 600.01 | 211.9 | $(QJF)^{0.1}$ $(QND)^{-0.1}$ |
| 2 | 0.440702 | 0.402130 | 13.3914 | 208.1 | 611.07 | 212.5 | $(QJF)^{0.1}$ LN_QJA |
| 2 | 0.437735 | 0.398959 | 13.6003 | 208.3 | 614.32 | 212.7 | $(QJF)^{0.1}$ $(QSO)^{0.1}$ |
| 2 | 0.380354 | 0.337619 | 17.6417 | 211.4 | 677.01 | 215.8 | $(QJF)^{0.1}$ $(QMJ)^{0.2}$ |
| 3 | 0.519669 | 0.468205 | 9.8298 | 205.3 | 543.54 | 211.1 | $(QJF)^{0.1}$ $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 3 | 0.511459 | 0.459116 | 10.4079 | 205.8 | 552.83 | 211.7 | $(QJF)^{0.1}$ $(QMJ)^{0.2}$ $(QSO)^{0.1}$ |
| 3 | 0.505259 | 0.452251 | 10.8447 | 206.2 | 559.85 | 212.1 | $(QJF)^{0.1}$ LN_QJA $(QND)^{-0.1}$ |
| 3 | 0.492160 | 0.437748 | 11.7672 | 207.0 | 574.67 | 212.9 | $(QJF)^{0.1}$ LN_QJA $(QSO)^{0.1}$ |
| 4 | 0.606621 | 0.548343 | 5.7057 | 200.9 | 461.63 | 208.2 | $(QJF)^{0.1}$ $(QMJ)^{0.2}$ $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.571428 | 0.507936 | 8.1844 | 203.6 | 502.93 | 210.9 | $(QJF)^{0.1}$ LN_QMA $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.553652 | 0.487526 | 9.4363 | 204.9 | 523.79 | 212.2 | $(QJF)^{0.1}$ LN_QJA $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.547331 | 0.480269 | 9.8815 | 205.4 | 531.21 | 212.7 | $(QJF)^{0.1}$ $(QMJ)^{0.2}$ LN_QJA $(QSO)^{0.1}$ |
| 5 | 0.634161 | 0.563808 | 5.7660 | 200.6 | 445.83 | 209.3 | $(QJF)^{0.1}$ LN_QMA $(QMJ)^{0.2}$ $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.623700 | 0.551335 | 6.5028 | 201.5 | 458.57 | 210.2 | $(QJF)^{0.1}$ $(QMJ)^{0.2}$ LN_QJA $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.591329 | 0.512738 | 8.7827 | 204.1 | 498.02 | 212.9 | $(QJF)^{0.1}$ LN_QMA LN_QJA $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.549102 | 0.462391 | 11.7568 | 207.2 | 549.48 | 216.0 | $(QJF)^{0.1}$ LN_QMA $(QMJ)^{0.2}$ LN_QJA $(QSO)^{0.1}$ |
| 6 | 0.645038 | 0.559847 | 7.0000 | 201.6 | 449.87 | 211.8 | $(QJF)^{0.1}$ LN_QMA $(QMJ)^{0.2}$ LN_QJA $(QSO)^{0.1}$ $(QND)^{-0.1}$ |

### 7.3.3 Variables Transformed According to Box-Cox Analysis: 1968 and 1988 Omitted

N = 31 Regression Models for Dependent Variable: $(CRAB)^{0.6}$

| In | R-square | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.344031 | 0.321411 | 18.4390 | 204.0 | 677.282 | 206.9 | $(QJF)^{0.1}$ |
| 1 | 0.240257 | 0.214059 | 25.6274 | 208.5 | 784.427 | 211.4 | LN_QJA |
| 1 | 0.224418 | 0.197674 | 26.7246 | 209.2 | 800.781 | 212.1 | $(QND)^{-0.1}$ |
| 1 | 0.201628 | 0.174098 | 28.3033 | 210.1 | 824.312 | 213.0 | $(QSO)^{0.1}$ |
| 2 | 0.473316 | 0.435696 | 11.4834 | 199.2 | 563.217 | 203.5 | $(QJF)^{0.1}$ $(QSO)^{0.1}$ |
| 2 | 0.439655 | 0.399631 | 13.8151 | 201.1 | 599.213 | 205.4 | $(QJF)^{0.1}$ LN_QJA |
| 2 | 0.424751 | 0.383662 | 14.8475 | 201.9 | 615.151 | 206.2 | $(QJF)^{0.1}$ $(QND)^{-0.1}$ |
| 2 | 0.358671 | 0.312862 | 19.4249 | 205.3 | 685.815 | 209.6 | $(QJF)^{0.1}$ LN_QMA |
| 3 | 0.533008 | 0.481120 | 9.3486 | 197.5 | 517.881 | 203.2 | $(QJF)^{0.1}$ LN_QJA $(QSO)^{0.1}$ |
| 3 | 0.525818 | 0.473132 | 9.8466 | 197.9 | 525.854 | 203.7 | $(QJF)^{0.1}$ $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 3 | 0.525662 | 0.472958 | 9.8574 | 197.9 | 526.027 | 203.7 | $(QJF)^{0.1}$ $(QMJ)^{0.2}$ $(QSO)^{0.1}$ |
| 3 | 0.512837 | 0.458707 | 10.7458 | 198.8 | 540.250 | 204.5 | $(QJF)^{0.1}$ LN_QMA $(QSO)^{0.1}$ |
| 4 | 0.599552 | 0.537945 | 6.7390 | 194.7 | 461.165 | 201.9 | $(QJF)^{0.1}$ LN_QMA $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.596550 | 0.534481 | 6.9470 | 194.9 | 464.622 | 202.1 | $(QJF)^{0.1}$ $(QMJ)^{0.2}$ $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 4 | 0.568329 | 0.501918 | 8.9019 | 197.0 | 497.123 | 204.2 | $(QJF)^{0.1}$ $(QMJ)^{0.2}$ LN_QJA $(QSO)^{0.1}$ |
| 4 | 0.567277 | 0.500705 | 8.9747 | 197.1 | 498.334 | 204.3 | $(QJF)^{0.1}$ LN_QJA $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.638666 | 0.566399 | 6.0296 | 193.5 | 432.766 | 202.1 | $(QJF)^{0.1}$ LN_QMA $(QMJ)^{0.2}$ $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.623245 | 0.547894 | 7.0978 | 194.8 | 451.235 | 203.4 | $(QJF)^{0.1}$ LN_QMA LN_QJA $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.619014 | 0.542817 | 7.3909 | 195.1 | 456.303 | 203.8 | $(QJF)^{0.1}$ $(QMJ)^{0.2}$ LN_QJA $(QSO)^{0.1}$ $(QND)^{-0.1}$ |
| 5 | 0.582478 | 0.498973 | 9.9218 | 198.0 | 500.062 | 206.6 | $(QJF)^{0.1}$ LN_QMA $(QMJ)^{0.2}$ LN_QJA $(QSO)^{0.1}$ |
| 6 | 0.653530 | 0.566912 | 7.0000 | 194.2 | 432.254 | 204.2 | $(QJF)^{0.1}$ LN_QMA $(QMJ)^{0.2}$ LN_QJA $(QSO)^{0.1}$ $(QND)^{-0.1}$ |

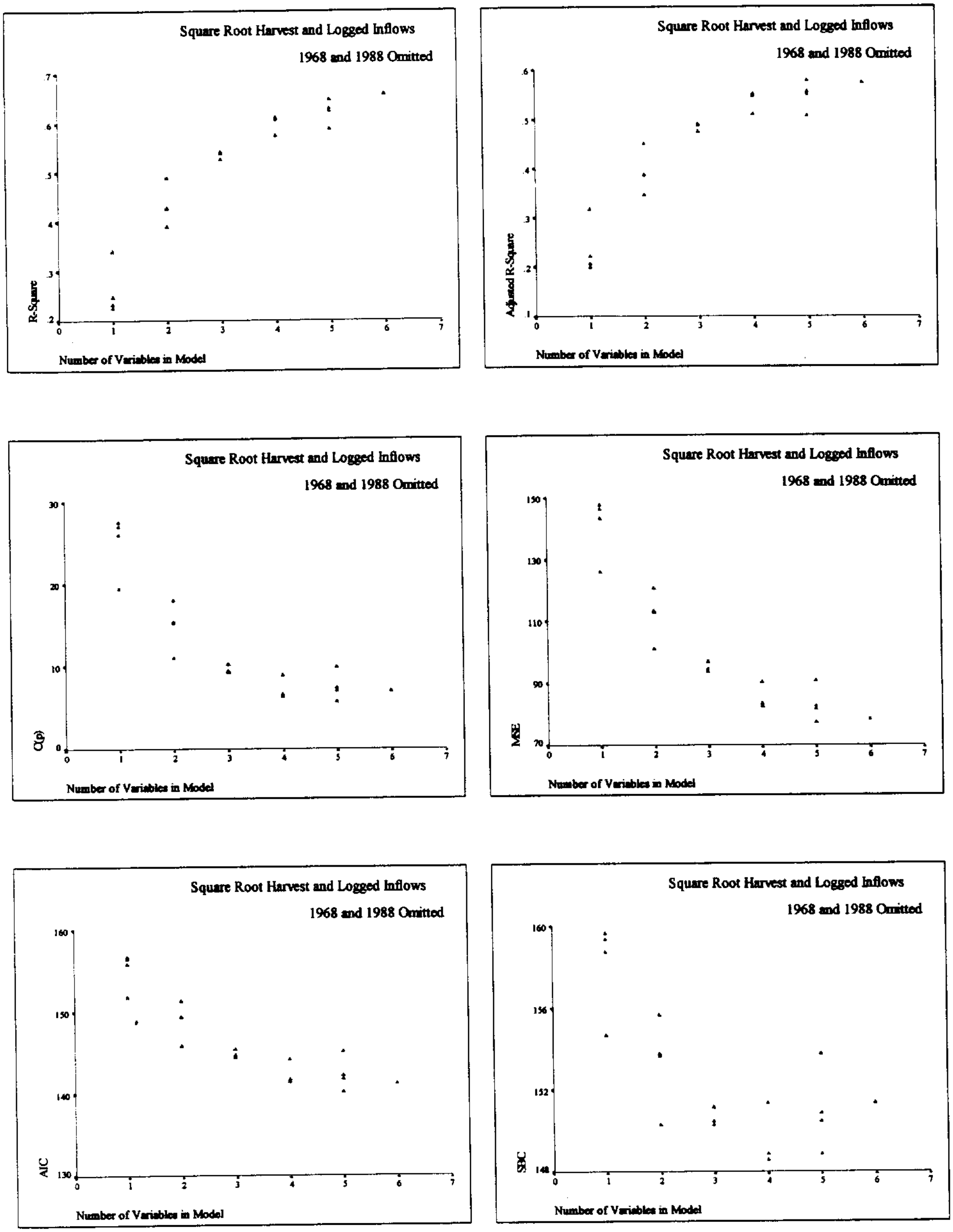



Fig. 7.1. Examining Subsets of Square Root Harvest and Logged Inflows Data: 1968 and 1988 Omitted.

# Flounder Harvests in Corpus Christi Bay:
# A Regression Analysis

## Harvest vs Freshwater Inflows

F. Michael Speed
Michael Longnecker
Birgir Hrafnkelsson

*Department of Statistics*
*Texas A&M University*

# FLOUNDER HARVESTS IN CORPUS CHRISTI BAY:

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*Department of Statistics*
*Texas A&M University*
May 1997

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# 1. SUMMARY REPORT

## 1.1 Description of the Problem[1]

Bimonthly freshwater inflows into Corpus Christi Bay were recorded for the years 1961 to 1993. These variables, and various transformations of them, were used to construct a model for the annual harvest of flounder.

## 1.2 Constructing Models - General Discussion

Stability of coefficient estimates and accuracy of predicted values are primary goals in constructing models for prediction. To this end, the data must be examined from three points of view: individual observations (to detect outliers or influential points); variables, individually and in groups (to select an optimal set of predictors); and the interaction of these two, which produces the overall structure of the data set (to determine whether multicollinearity is present or not). The first two of these were examined by both graphic and quantitative means; the third by quantitative means only.

### 1.2.1 Detecting Influential Points and Outliers

The structures of individual variables were examined via box plots and histograms, as well as by all the usual numerical measures. For each pair of variables, 99 % prediction ellipses and 95% confidence regions were plotted in a further effort to look for unusual points. For example, suppose large values of Variable A are generally associated with large values for Variable B. If an observation consisted of a large value for Variable A but a small value for Variable B, that point would be considered unusual, even though it was well within the range of data for both variables and could not be considered an outlier.

In addition, a number of residual analysis techniques were employed. A large residual indicates a point not well-fit by the model. The deleted residual, however, is somewhat more useful in the search for influential points. The model is fitted without a given observation, and the predicted response and corresponding residual are calculated for that observation. The Studentized deleted residual is scaled to have a Student's $t$ distribution. Histograms and normal P-P plots of the residuals were also examined.

Other quantities, such as the Mahalanobis distance, Cook's distance, the leverage value, standarized values for the *Dffits* (to measure the influence of a given observation on the predicted response) and the *Dfbetas* (to measure the influence of a given observation on the calculated coefficients) were also used to build a general picture of the influence of individual points. Plots were made of the standardized *Dffits* value for each model against the standardized *Dfbeta* values for each predictor in the model. Points which were extreme indicated observations which had strong effects on both predicted values and coefficient estimates.

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1 The following discussion, prepared by Jacqueline Kiffe, was taken from Seatrout Harvest in Galveston Bay: A Regression Analysis, by F. Michael Speed, Sr. and Jacqueline Kiffe.

### 1.2.2 Variable Selection

For each regression, residuals were plotted against each of the independent variables to look for nonlinear relationships between the response variable and individual predictors. Partial residual plots were employed to examine the overall relationship between the response and individual predictors. A partial residual is a corollary to the deleted residual. That is, the model is fitted without a given variable and the predicted response and corresponding residual are calculated for each observation. This seeks to answer the question, "What is the relationship of this predictor to the response variable, taking all other variables into account?" Thus, it examines the marginal relationship of a given predictor to the response.

Numerous measures have been developed over the years to assess the adequacy of a given model. We examined a number of these, including $R^2$ and mean squared error (*MSE*), and several others which directly incorporate penalties for having too many predictors in the model, such as adjusted $R^2$, *Cp*, *AIC*, and *SBC*. It is well-established that too many predictors in a model can lead to bad prediction, just as too few can, and these measures are used as part of the attempt to find an optimal model.

### 1.2.3 Multicollinearity

Multicollinearity arises when one or more variables are nearly closely approximated by linear combinations of the remaining variables, resulting in unstable coefficient estimates. The variance inflation factor (*VIF*) was calculated for each coefficient estimate to measure this instability, which is not usually considered profound for *VIF*'s less than 10. No problems were found with this data. Additionally, the condition index (a ratio of eigenvalues of the covariance matrix, with the largest eigenvalue always on top) was calculated. A ratio greater than 30 is considered cause for concern. Again, no evidence of multicollinearity was found.

### 1.2.4 Other Procedures

Several other miscellaneous diagnostics, including the Durbin-Watson test for serial autocorrelation were performed, and no general problems were detected. The Box-Cox procedure, used to find a transformation to normality, was also performed.

## 1.3 How the Final Model Was Chosen

### 1.3.1 Selecting the Data Set Used

First, the variables were explored thoroughly, individually and in pairs, in a first effort to detect outliers. The SAS® programming language allows a number of diagnostics to be calculated for a group of models on a given data set without actually performing a formal regression, thus allowing one to examine a large number of models quite efficiently. The Box-Cox procedure was performed to find if a transformation to normallity was suggested. The log transform was suggested for some variables, and the squared root for others. At this point, there were several data sets for which the diagnostic series was calculated:

1. Untransformed flounder data and untransformed inflow data
2. Log of flounder data and untransformed inflow data
3. Log of flounder data and log of inflow data
4. Log of flounder data and square root of inflow data
5. Square root of flounder data and log of inflow data
6. Various transformation suggested by Box-Cox

### 1.3.2 Selecting the Points to be Omitted

The full regression with all diagnostics was performed for these models, each one contained all variables in its corresponding data set. All diagnostics were generated, and influential points were determined for each model.

***Table 1.1*** *$R^2$ and Adjusted $R^2$ for full data sets.*

| Data Set | $R^2$ | Adj. $R^2$ |
|---|---|---|
| 1 | 0.1499 | -0.0463 |
| 2 | 0.2123 | 0.0306 |
| 3 | 0.3048 | 0.1444 |
| 4 | 0.2510 | 0.0782 |
| 5 | 0.2137 | 0.0323 |
| 6 | 0.2269 | 0.0485 |

Data sets 3 and 4 presented the highest $R^2$ values. These two models were considered final candidates. The observations flagged as potentially influential are given in the summary table below, for each model.

***Table 1.2*** *Summary of points flagged by Boxplots.*

| Year | Variable |
|---|---|
| 1964 | Ln(January-February),Ln(May-June) |
| 1968 | Sqrt(Jan-Feb) |
| 1969 | Sqrt(Jan-Feb) |
| 1970 | Sqrt(Jan-Feb) |
| 1971 | Sqrt(July-Aug) |
| 1972 | Sqrt(July-Aug) |
| 1973 | Sqrt(July-Aug) |
| 1977 | Ln(Mar-Apr), Sqrt(Mar-Apr) |
| 1978 | Ln(Mar-Apr), Sqrt(Mar-Apr) |
| 1979 | Ln(Mar-Apr), Sqrt(Mar-Apr) |
| 1992 | Ln(Jan-Feb), Sqrt(Jan-Feb), Ln(Mar-Apr), Sqrt(Mar-Apr) |
| 1993 | Ln(Jan-Feb), Sqrt(Jan-Feb), Ln(Mar-Apr), Sqrt(Mar-Apr) |

***Table 1.3*** *Summary of points flagged by 99% prediction ellipses.*

| Year | Variable |
|---|---|
| None | None |

***Table 1.4*** *Outliers of data set 3.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1964 | 2 | | | | | | | | 2 |
| 1967 | | | 1 | | | | 1 | | 2 |
| 1971 | | | | | | | 1 | | 1 |
| 1977 | 1 | | | | | | | | 1 |
| 1978 | 1 | | | | | | | | 1 |
| 1979 | 1 | | | | | | | | 1 |
| 1992 | 2 | | | | | | | | 2 |
| 1993 | 2 | | | | | | | | 2 |

***Table 1.5*** *Outliers of data set 4.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1967 | | | 1 | | | | 1 | | 2 |
| 1968 | 1 | | | | | | | | 1 |
| 1969 | 1 | | | | | | | | 1 |
| 1970 | 1 | | | | | | | | 1 |
| 1971 | 1 | | | | | | 1 | | 2 |
| 1972 | 1 | | | | | | | | 1 |
| 1973 | 1 | | | | | | | | 1 |
| 1977 | 1 | | | | | | | | 1 |
| 1978 | 1 | | | | | | | | 1 |
| 1979 | 1 | | | | | | | | 1 |
| 1992 | 2 | | | | | | | | 2 |
| 1993 | 2 | | | | | | | | 2 |

***A Key to Abbreviations:***

BOX Box plot
SRE Studentized residual
SDR Studentized deleted residual
LEV Leverage value
MAH Mahalanobis distance
COO Cook's distance
SDF Standardized Dffits value
SDB Standardized Dfbeta value

### 1.3.3 Selecting the Final Candidate Models

After the subset analysis led us to two models, Data Set 3 with none omitted and Data Set 4 with none omitted.

***Table 1.6*** *$R^2$ and Adjusted $R^2$ for data sets number 3 and 4.*

| **Data set** | **Observations omitted** | $R^2$ | **Adj.** $R^2$ |
|---|---|---|---|
| 3 | None | 0.2553 | 0.1782 |
| 4 | None | 0.2150 | 0.1338 |

### 1.3.4 Selecting the Final Models

It appears that Data set 3 with none omitted is the best model. Regression was performed using this model, and the deleted residuals were calculated.

Ln(Flounder Harvest) = 1.61307 + 0.46979*Ln(Jul-Aug Inflows)
- 0.40834*Ln(Sep-Oct Inflows)
+ 0.38435*Ln(Nov-Dec Inflows)

## 1.4 Best Model: Logged Harvest and Logged Inflows

### 1.4.1 Summary Information

***Table 1.7*** *Descriptive statistics for dependent and independent variables.*

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| Ln(Flounder Harvest) | 2.968871 | 1.261922 | 33 |
| Ln(July-August Inflows) | 4.078720 | .985247 | 33 |
| Ln(September-October Inflows) | 4.668572 | 1.163962 | 33 |
| Ln(November-December Inflows) | 3.501969 | .925540 | 33 |

***Table 1.8*** *Model summary for the final model.*

**Model Summary[a,b]**

| Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| Ln(November-December), Ln(July-August), Ln(September-October)[c,d] | .505 | .255 | .178 | 1.143945 | 1.004 |

a. Dependent Variable: Ln(Flounder Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Ln(November-December Inflows), Ln(July-August Inflows), Ln(September-October Inflows)

d. All requested variables entered.

***Table 1.9*** *Anova for the final model.*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 13.009 | 3 | 4.336 | 3.314 | .034[b] |
| | Residual | 37.950 | 29 | 1.309 | | |
| | Total | 50.958 | 32 | | | |

a. Dependent Variable: Ln(Flounder Harvest)

b. Independent Variables: (Constant), Ln(November-December Inflows), Ln(July-August Inflows), Ln(September-October Inflows)

***Table 1.10*** *Parameter estimates for the final model.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | 1.613 | 1.114 | | 1.448 | .158 | -.665 | 3.891 |
| Ln(July-August) | .470 | .217 | .367 | 2.170 | .038 | .027 | .913 |
| Ln(September-October) | -.408 | .194 | -.377 | -2.102 | .044 | -.806 | -.011 |
| Ln(November-December) | .384 | .247 | .282 | 1.557 | .130 | -.120 | .889 |

a. Dependent Variable: Ln(Flounder Harvest)

***Table 1.11*** *Residuals statistics for the final model.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 1.607572 | 4.332468 | 2.968871 | .637589 | 33 |
| Std. Predicted Value | -2.135 | 2.139 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | .224300 | .563986 | .389221 | 8.6E-02 | 33 |
| Adjusted Predicted Value | 1.640258 | 4.840693 | 2.992274 | .657367 | 33 |
| Residual | -2.592221 | 1.865273 | -2.4E-16 | 1.089003 | 33 |
| Std. Residual | -2.266 | 1.631 | .000 | .952 | 33 |
| Stud. Residual | -2.408 | 1.695 | -.009 | 1.015 | 33 |
| Deleted Residual | -2.927616 | 2.016157 | -2.3E-02 | 1.239373 | 33 |
| Stud. Deleted Residual | -2.646 | 1.755 | -.018 | 1.052 | 33 |
| Mahal. Distance | .261 | 6.808 | 2.909 | 1.685 | 33 |
| Cook's Distance | .000 | .262 | .035 | .057 | 33 |
| Centered Leverage Value | .008 | .213 | .091 | .053 | 33 |

a. Dependent Variable: Ln(Flounder Harvest)

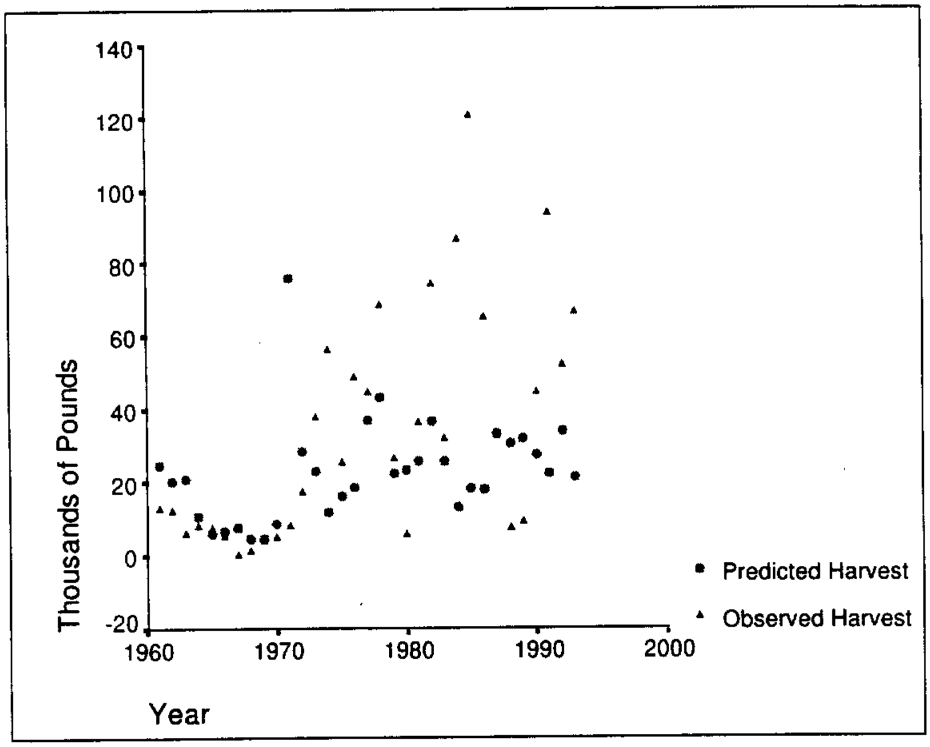


***Figure 1.1*** *Predicted and observed values for the harvest.*

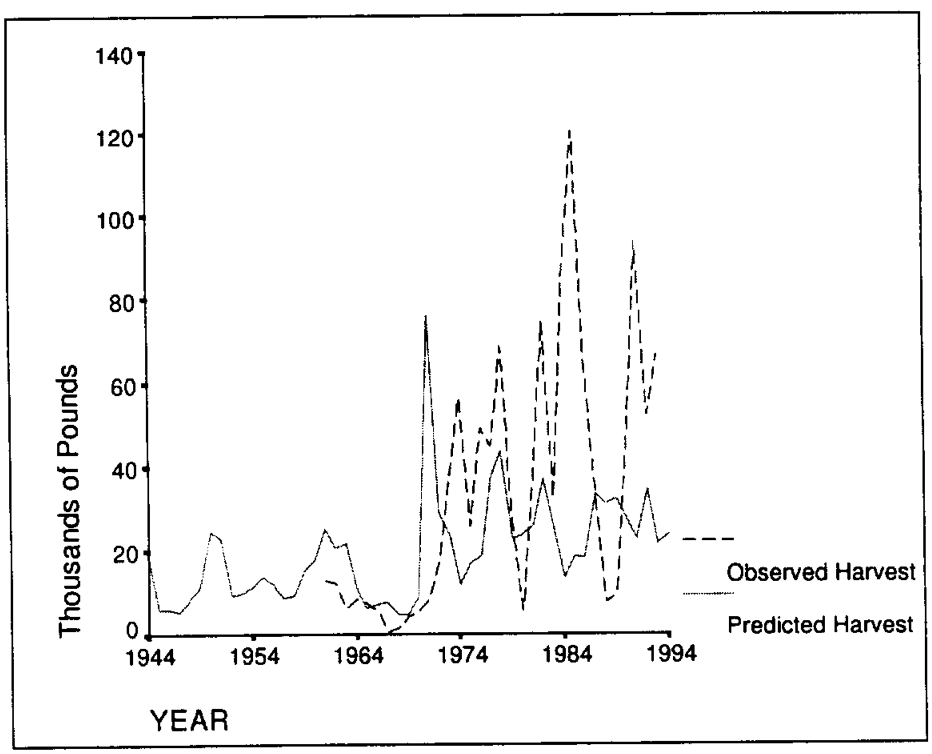


***Figure 1.2*** *Predicted and observed values for the harvest.*

***Table 1.14*** *Prediction Intervals for Red fish Fish Harvest based on the final model.*

| YEAR | *RED* | *PRE_1* | *LICI_1* | *UICI_1* |
|---|---|---|---|---|
| 1961 | 13.10 | 25.26 | .9020 | 707.37 |
| 1962 | 12.40 | 20.76 | .8041 | 535.86 |
| 1963 | 6.50 | 21.53 | .8086 | 573.01 |
| 1964 | 8.50 | 11.19 | .3327 | 376.41 |
| 1965 | 7.60 | 6.52 | .2208 | 192.75 |
| 1966 | 5.80 | 7.22 | .2516 | 207.20 |
| 1967 | .60 | 8.02 | .2872 | 223.69 |
| 1968 | 1.50 | 5.06 | .1590 | 161.16 |
| 1969 | 4.40 | 4.99 | .1564 | 159.23 |
| 1970 | 5.30 | 9.06 | .3151 | 260.76 |
| 1971 | 8.50 | 76.13 | 2.4483 | 2367.36 |
| 1972 | 17.50 | 28.90 | .9711 | 860.11 |
| 1973 | 38.00 | 23.47 | .7593 | 725.61 |
| 1974 | 56.30 | 12.15 | .4272 | 345.63 |
| 1975 | 25.70 | 16.76 | .6540 | 429.73 |
| 1976 | 49.10 | 19.02 | .7291 | 496.00 |
| 1977 | 44.90 | 37.53 | 1.3549 | 1039.56 |
| 1978 | 68.70 | 43.50 | 1.5459 | 1224.19 |
| 1979 | 26.80 | 22.69 | .7778 | 661.87 |
| 1980 | 5.90 | 23.73 | .7521 | 748.78 |
| 1981 | 36.60 | 26.03 | .8207 | 825.32 |
| 1982 | 74.40 | 37.03 | 1.3490 | 1016.37 |
| 1983 | 32.20 | 25.99 | 1.0457 | 646.18 |
| 1984 | 86.80 | 13.66 | .5255 | 354.94 |
| 1985 | 120.60 | 18.68 | .7105 | 490.89 |
| 1986 | 65.40 | 18.30 | .6910 | 484.57 |
| 1987 | 33.10 | 33.62 | 1.2833 | 880.65 |
| 1988 | 7.80 | 31.06 | 1.1762 | 820.17 |
| 1989 | 9.60 | 32.33 | 1.2054 | 867.13 |
| 1990 | 44.80 | 27.66 | .9947 | 769.15 |
| 1991 | 93.80 | 22.69 | .7995 | 643.65 |
| 1992 | 52.20 | 34.32 | 1.3055 | 902.42 |
| 1993 | 66.70 | 21.68 | .8288 | 567.38 |
| 1994 | . | 23.92 | .9034 | 633.24 |

| | |
|---|---|
| *RED* | Observed red fish fish harvest |
| *PRE_!* | Predicted flounder harvest |
| *LICI_*1 | Lower limit for 99% prediction interval for the flounder harvest. |
| *UICI_*1 | Upper limit for 99% prediction interval for the flounder harvest. |

# 2. EXPLORING THE DATA

## 2.1 Listing of data

***Table 2.1*** *The flounder data and the inflow data.*

| Year | *Flounder* | *JF_inflow* | *MA_inflow* | *MJ_inflow* | *JA_inflow* | *SO_inflow* | *ND_inflow* |
|---|---|---|---|---|---|---|---|
| 1961 | 13.10 | 58.45 | 13.11 | 42.66 | 68.59 | 274.80 | 148.90 |
| 1962 | 12.40 | 49.25 | 12.81 | 38.52 | 52.35 | 178.60 | 78.65 |
| 1963 | 6.50 | 48.48 | 13.28 | 33.71 | 32.81 | 88.84 | 72.87 |
| 1964 | 8.50 | 5.49 | 6.64 | 7.72 | 10.11 | 9.91 | 5.45 |
| 1965 | 7.60 | 26.72 | 15.50 | 74.65 | 10.70 | 68.57 | 9.75 |
| 1966 | 5.80 | 27.01 | 20.93 | 166.41 | 12.65 | 68.66 | 10.36 |
| 1967 | .60 | 28.09 | 22.47 | 168.79 | 14.00 | 69.73 | 12.21 |
| 1968 | 1.50 | 89.91 | 21.03 | 219.30 | 27.86 | 670.67 | 17.64 |
| 1969 | 4.40 | 91.93 | 18.46 | 128.91 | 26.74 | 675.78 | 18.02 |
| 1970 | 5.30 | 95.26 | 25.37 | 211.69 | 38.31 | 693.83 | 56.42 |
| 1971 | 8.50 | 12.76 | 18.29 | 94.70 | 307.47 | 34.80 | 46.74 |
| 1972 | 17.50 | 21.69 | 17.45 | 147.81 | 310.47 | 612.72 | 78.25 |
| 1973 | 38.00 | 19.03 | 9.52 | 155.96 | 338.40 | 605.99 | 40.51 |
| 1974 | 56.30 | 23.79 | 19.07 | 158.31 | 73.99 | 816.37 | 64.29 |
| 1975 | 25.70 | 19.24 | 17.38 | 175.19 | 92.49 | 289.82 | 37.63 |
| 1976 | 49.10 | 17.23 | 16.72 | 105.85 | 126.23 | 285.93 | 35.21 |
| 1977 | 44.90 | 37.15 | 104.82 | 149.46 | 105.12 | 158.61 | 138.05 |
| 1978 | 68.70 | 30.44 | 104.63 | 105.60 | 101.84 | 103.47 | 133.86 |
| 1979 | 26.80 | 34.14 | 123.11 | 169.20 | 31.74 | 134.64 | 135.35 |
| 1980 | 5.90 | 13.59 | 24.89 | 171.41 | 202.89 | 72.81 | 8.20 |
| 1981 | 36.60 | 16.38 | 25.72 | 382.28 | 253.39 | 89.12 | 9.85 |
| 1982 | 74.40 | 31.23 | 10.21 | 331.11 | 249.34 | 116.25 | 33.34 |
| 1983 | 32.20 | 28.63 | 12.46 | 285.47 | 92.17 | 93.12 | 35.41 |
| 1984 | 86.80 | 34.54 | 12.84 | 49.24 | 22.02 | 90.72 | 37.14 |
| 1985 | 120.60 | 19.90 | 18.82 | 67.95 | 35.13 | 30.08 | 14.66 |
| 1986 | 65.40 | 20.90 | 17.17 | 68.31 | 25.67 | 77.10 | 55.45 |
| 1987 | 33.10 | 30.39 | 23.44 | 247.73 | 67.77 | 66.52 | 70.43 |
| 1988 | 7.80 | 28.55 | 15.19 | 193.85 | 54.64 | 65.06 | 72.84 |
| 1989 | 9.60 | 25.99 | 14.61 | 189.23 | 52.14 | 24.36 | 30.15 |
| 1990 | 44.80 | 10.17 | 17.54 | 21.55 | 66.60 | 20.56 | 12.44 |
| 1991 | 93.80 | 11.04 | 26.79 | 42.61 | 68.94 | 24.99 | 8.76 |
| 1992 | 52.20 | 112.42 | 114.69 | 207.59 | 75.05 | 31.59 | 29.75 |
| 1993 | 66.70 | 114.36 | 111.81 | 255.68 | 29.91 | 37.19 | 32.98 |

| | |
|---|---|
| Flounder | Flounder harvest (thousands of pounds) |
| JF_inflow | Lagged January-February inflows (thousands of acre-feet) |
| MA_inflow | Lagged March-April inflows (thousands of acre-feet) |
| MJ_inflow | Lagged May-June inflows (thousands of acre-feet) |
| JA_inflow | Lagged July-August inflows (thousands of acre-feet) |
| SO_inflow | Lagged September-October inflows (thousands of acre-feet) |
| ND_inflow | Lagged November-December inflows (thousands of acre-feet) |

## 2.2 Examination of Individual Variables

***Table .2.2*** *Test of Normality for the flounder data and the inflow data.*

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Flounder Harvest | .177 | 33 | .010 | .884 | 33 | .010** |
| Ln(Flounder Harvest) | .140 | 33 | .100 | .932 | 33 | .053 |
| Square Root of Flounder Harvest | .144 | 33 | .080 | .948 | 33 | .198 |
| January-February Inflows | .266 | 33 | .000 | .773 | 33 | .010** |
| Ln(January-February Inflows) | .131 | 33 | .166 | .960 | 33 | .377 |
| Square Root of January-February Inflows | .201 | 33 | .002 | .883 | 33 | .010** |
| March-April Inflows | .405 | 33 | .000 | .576 | 33 | .010** |
| Ln(March-April Inflows) | .250 | 33 | .000 | .803 | 33 | .010** |
| Square Root of March-April Inflows | .336 | 33 | .000 | .673 | 33 | .010** |
| May-June Inflows | .091 | 33 | .200* | .956 | 33 | .315 |
| Ln(May-June Inflows) | .198 | 33 | .002 | .904 | 33 | .010** |
| Square Root of May-June Inflows | .143 | 33 | .086 | .974 | 33 | .661 |
| July-August Inflows | .243 | 33 | .000 | .760 | 33 | .010** |
| Ln(July-August Inflows) | .080 | 33 | .200* | .958 | 33 | .349 |
| Square Root of July-August Inflows | .165 | 33 | .023 | .882 | 33 | .010** |
| September-October Inflows | .277 | 33 | .000 | .712 | 33 | .010** |
| Ln(September-October Inflows) | .122 | 33 | .200* | .947 | 33 | .175 |
| Square Root of September-October Inflows | .213 | 33 | .001 | .835 | 33 | .010** |
| November-December Inflows | .181 | 33 | .008 | .838 | 33 | .010** |
| Ln(November-December Inflows) | .120 | 33 | .200* | .949 | 33 | .213 |
| Square Root of November-December Inflows | .108 | 33 | .200* | .926 | 33 | .039 |

**. This is an upper bound of the true significance.

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

***Table .2.3*** *Percentiles of the flounder data and the inflow data.*

**Percentiles**

| | | Percentiles | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 10 | 25 | 50 | 75 | 90 | 95 |
| Weighted Average(Definition 1) | Flounder Harvest | 1.2300 | 4.7600 | 7.7000 | 26.8000 | 54.2500 | 81.8400 | 101.8400 |
| | Ln(Flounder Harvest) | .130578 | 1.556045 | 2.041136 | 3.288402 | 3.992889 | 4.401946 | 4.616559 |
| | Square Root of Flounder Harvest | 1.089700 | 2.179440 | 2.774829 | 5.176872 | 7.364145 | 9.040208 | 10.0741 |
| | January-February Inflows | 8.7660 | 11.7280 | 19.1350 | 28.0900 | 42.8150 | 93.9280 | 113.0020 |
| | Ln(January-February Inflows) | 2.134488 | 2.459441 | 2.951504 | 3.335414 | 3.748058 | 4.542377 | 4.727375 |
| | Square Root of January-February Inflows | 2.935253 | 3.422435 | 4.374341 | 5.300000 | 6.528919 | 9.691279 | 10.6302 |
| | March-April Inflows | 8.6560 | 11.1100 | 13.9450 | 18.2900 | 25.1300 | 109.0140 | 117.2160 |
| | Ln(March-April Inflows) | 2.145310 | 2.403030 | 2.633983 | 2.906354 | 3.224017 | 4.690978 | 4.763486 |
| | Square Root of March-April Inflows | 2.932861 | 3.329134 | 3.733238 | 4.276681 | 5.012926 | 10.4397 | 10.8252 |
| | May-June Inflows | 17.4010 | 35.6340 | 68.1300 | 155.9600 | 200.7200 | 273.5540 | 346.4610 |
| | Ln(May-June Inflows) | 2.762407 | 3.571148 | 4.221414 | 5.049600 | 5.301325 | 5.610053 | 5.845561 |
| | Square Root of May-June Inflows | 4.083085 | 5.966198 | 8.254083 | 12.4884 | 14.1655 | 16.5335 | 18.6031 |
| | July-August Inflows | 10.5230 | 13.1900 | 28.8850 | 66.6000 | 103.4800 | 285.8380 | 318.8490 |
| | Ln(July-August Inflows) | 2.353228 | 2.578217 | 3.362692 | 4.198705 | 4.639253 | 5.650998 | 5.763930 |
| | Square Root of July-August Inflows | 3.243647 | 3.630673 | 5.373630 | 8.160882 | 10.1722 | 16.8882 | 17.8528 |
| | September-October Inflows | 17.3650 | 24.6120 | 51.1250 | 89.1200 | 280.3650 | 673.7360 | 730.5920 |
| | Ln(September-October Inflows) | 2.804407 | 3.203156 | 3.895675 | 4.489984 | 5.635895 | 6.512831 | 6.591019 |
| | Square Root of September-October Inflows | 4.118424 | 4.960951 | 7.082169 | 9.440339 | 16.7433 | 25.9564 | 27.0101 |
| | November-December Inflows | 7.3750 | 9.1560 | 13.5500 | 35.4100 | 71.6350 | 134.7540 | 141.3050 |
| | Ln(November-December Inflows) | 1.981579 | 2.213024 | 2.603020 | 3.566994 | 4.271442 | 4.903436 | 4.950314 |
| | Square Root of November-December Inflows | 2.704852 | 3.024837 | 3.677938 | 5.950630 | 8.463447 | 11.6083 | 11.8854 |
| Tukey's Hinges | Flounder Harvest | | | 7.8000 | 26.8000 | 52.2000 | | |
| | Ln(Flounder Harvest) | | | 2.054124 | 3.288402 | 3.955082 | | |
| | Square Root of Flounder Harvest | | | 2.792848 | 5.176872 | 7.224957 | | |
| | January-February Inflows | | | 19.2400 | 28.0900 | 37.1500 | | |
| | Ln(January-February Inflows) | | | 2.956991 | 3.335414 | 3.614964 | | |
| | Square Root of January-February Inflows | | | 4.386342 | 5.300000 | 6.095080 | | |
| | March-April Inflows | | | 14.6100 | 18.2900 | 24.8900 | | |
| | Ln(March-April Inflows) | | | 2.681706 | 2.906354 | 3.214466 | | |
| | Square Root of March-April Inflows | | | 3.822303 | 4.276681 | 4.988988 | | |
| | May-June Inflows | | | 68.3100 | 155.9600 | 193.8500 | | |
| | Ln(May-June Inflows) | | | 4.224056 | 5.049600 | 5.267085 | | |
| | Square Root of May-June Inflows | | | 8.264986 | 12.4884 | 13.9230 | | |
| | July-August Inflows | | | 29.9100 | 66.6000 | 101.8400 | | |
| | Ln(July-August Inflows) | | | 3.398193 | 4.198705 | 4.623403 | | |
| | Square Root of July-August Inflows | | | 5.469004 | 8.160882 | 10.0916 | | |
| | September-October Inflows | | | 65.0600 | 89.1200 | 274.8000 | | |
| | Ln(September-October Inflows) | | | 4.175310 | 4.489984 | 5.616044 | | |
| | Square Root of September-October Inflows | | | 8.065978 | 9.440339 | 16.5771 | | |
| | November-December Inflows | | | 14.6600 | 35.4100 | 70.4300 | | |
| | Ln(November-December Inflows) | | | 2.685123 | 3.566994 | 4.254619 | | |
| | Square Root of November-December Inflows | | | 3.828838 | 5.950630 | 8.392258 | | |

### 2.2.1 The flounder data

***Table .2.4*** *Descriptives for the flounder data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| Flounder Harvest | Mean | | 34.2758 | 5.4058 |
| | 95% Confidence Interval for Mean | Lower Bound | 23.2644 | |
| | | Upper Bound | 45.2871 | |
| | 5% Trimmed Mean | | 31.9177 | |
| | Median | | 26.8000 | |
| | Variance | | 964.363 | |
| | Std. Deviation | | 31.0542 | |
| | Minimum | | .60 | |
| | Maximum | | 120.60 | |
| | Range | | 120.00 | |
| | Interquartile Range | | 46.5500 | |
| | Skewness | | .985 | .409 |
| | Kurtosis | | .376 | .798 |

***Table .2.5*** *Extreme Values for the flounder data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| Flounder Harvest | Highest | 1 | 25 | 1985 | 120.60 |
| | | 2 | 31 | 1991 | 93.80 |
| | | 3 | 24 | 1984 | 86.80 |
| | | 4 | 22 | 1982 | 74.40 |
| | | 5 | 18 | 1978 | 68.70 |
| | Lowest | 1 | 7 | 1967 | .60 |
| | | 2 | 8 | 1968 | 1.50 |
| | | 3 | 9 | 1969 | 4.40 |
| | | 4 | 10 | 1970 | 5.30 |
| | | 5 | 6 | 1966 | 5.80 |

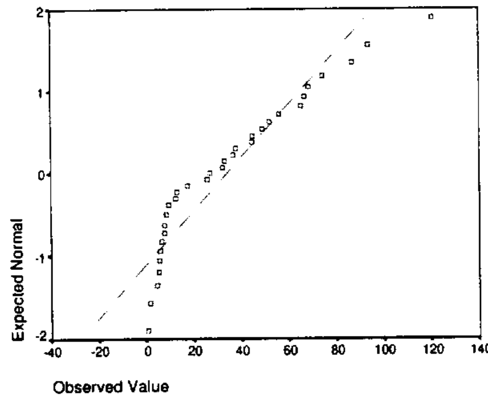


***Figure 2.1*** *Normal Q-Q Plot of Flounder Harvest.*

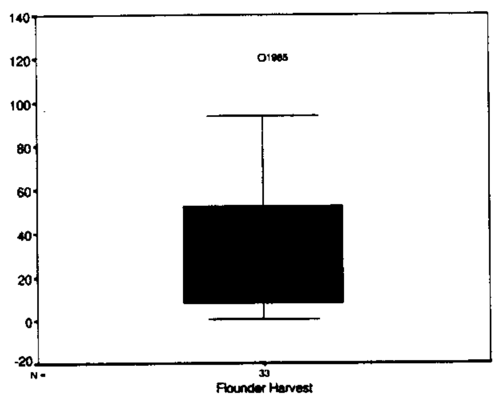


***Figure 2.2*** *BoxPlot of Flounder Harvest.*

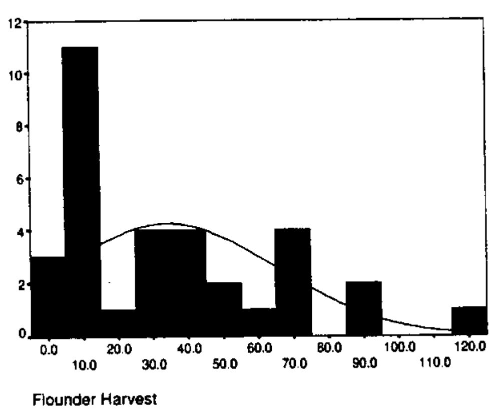


***Figure 2.3*** *Histogram of Flounder Harvest.*

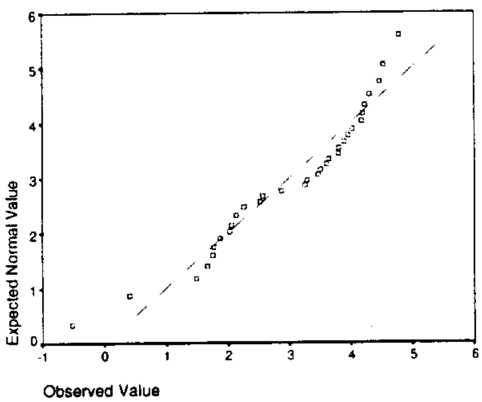


***Figure 2.4*** *Normal Q-Q Plot of Ln(Flounder Harvest).*

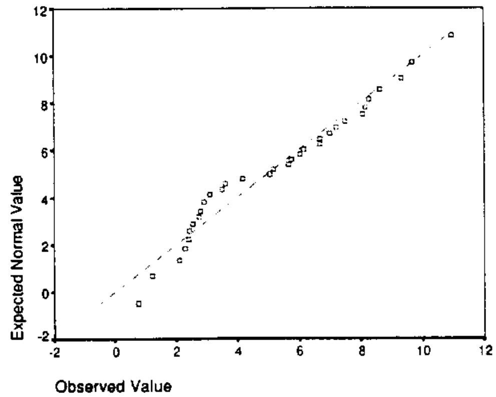


***Figure 2.5*** *Normal Q-Q Plot of Sqrt(Flounder Harvest).*

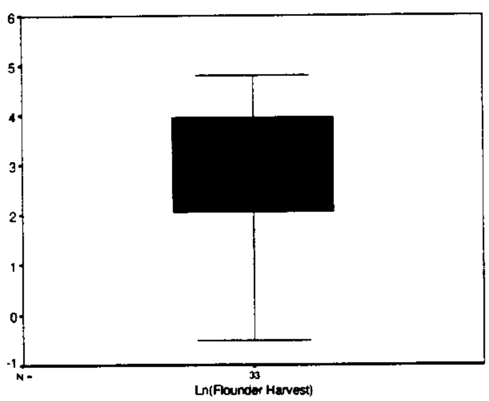


***Figure 2.6*** *BoxPlot of Ln(Flounder Harvest).*

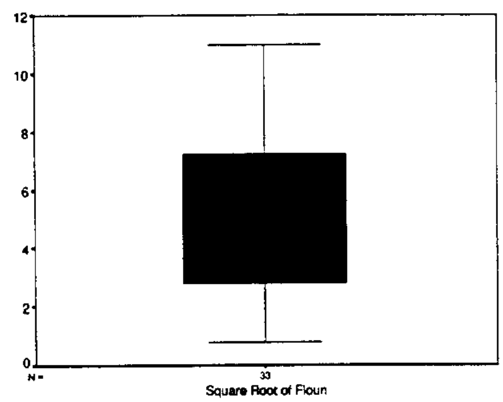


***Figure 2.7*** *BoxPlot of Sqrt(Flounder Harvest).*

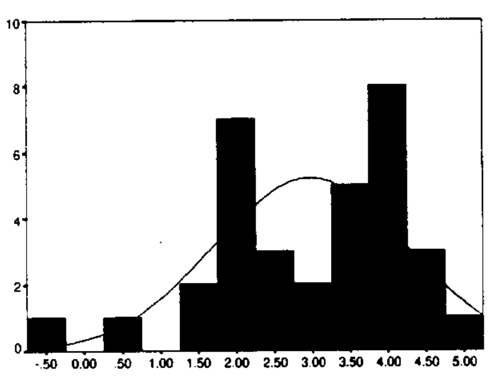


***Figure 2.8*** *Histogram of Ln(Flounder Harvest).*

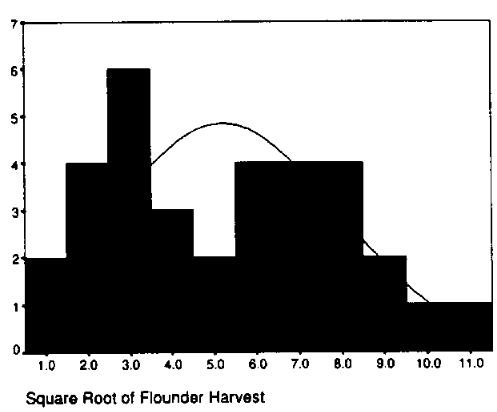


***Figure 2.9*** *Histogram of Sqrt(Flounder Harvest).*

### 2.2.2 The January-February Inflows data

***Table .2.6*** *Descriptives for the January-February Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| January-February Inflows | Mean | | 37.3985 | 5.1713 |
| | 95% Confidence Interval for Mean | Lower Bound | 26.8650 | |
| | | Upper Bound | 47.9320 | |
| | 5% Trimmed Mean | | 34.8356 | |
| | Median | | 28.0900 | |
| | Variance | | 882.482 | |
| | Std. Deviation | | 29.7066 | |
| | Minimum | | 5.49 | |
| | Maximum | | 114.36 | |
| | Range | | 108.87 | |
| | Interquartile Range | | 23.6800 | |
| | Skewness | | 1.572 | .409 |
| | Kurtosis | | 1.457 | .798 |

***Table .2.7*** *Extreme Values for the January-February Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| January-February Inflows | Highest | 1 | 33 | 1993 | 114.36 |
| | | 2 | 32 | 1992 | 112.42 |
| | | 3 | 10 | 1970 | 95.26 |
| | | 4 | 9 | 1969 | 91.93 |
| | | 5 | 8 | 1968 | 89.91 |
| | Lowest | 1 | 4 | 1964 | 5.49 |
| | | 2 | 30 | 1990 | 10.17 |
| | | 3 | 31 | 1991 | 11.04 |
| | | 4 | 11 | 1971 | 12.76 |
| | | 5 | 20 | 1980 | 13.59 |

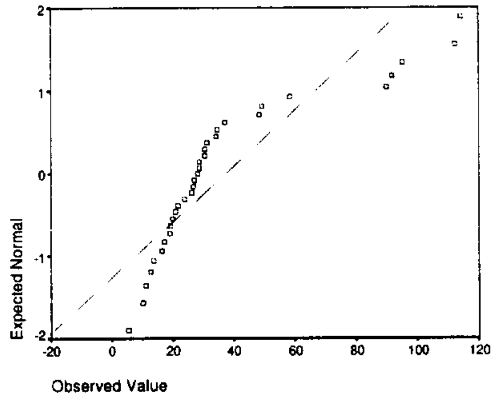


***Figure 2.10*** *Normal Q-Q Plot of January-February Inflows.*

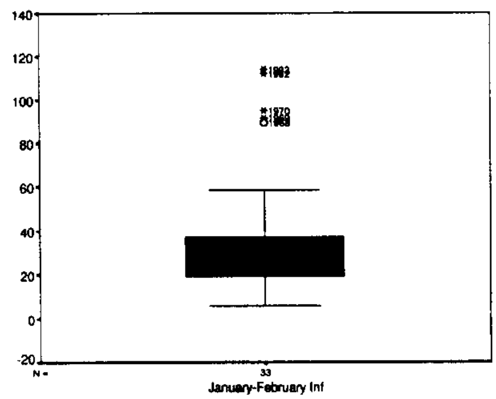


***Figure 2.11*** *BoxPlot of January-February Inflows.*

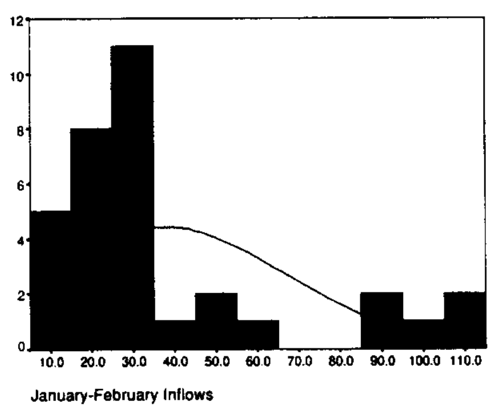


***Figure 2.12*** *Histogram of January-February Inflows.*

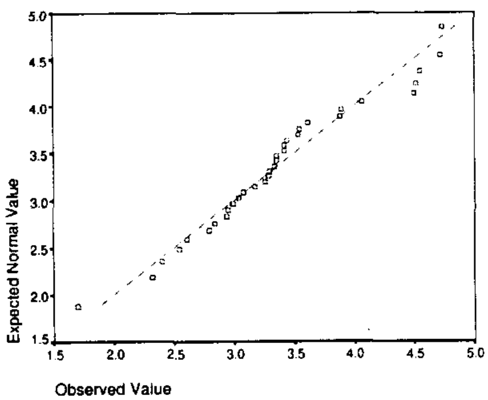


***Figure 2.13*** *Normal Q-Q Plot of Ln January-February Inflows).*

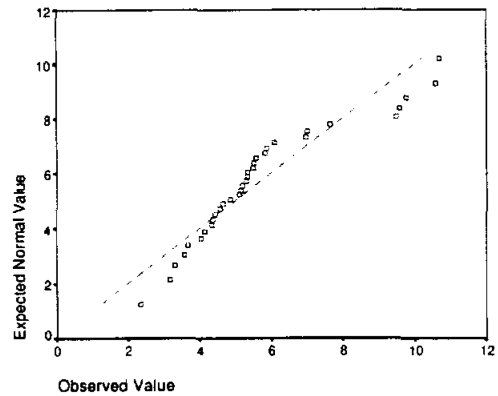


***Figure 2.14*** *Normal Q-Q Plot of Sqrt( January-February Inflows).*

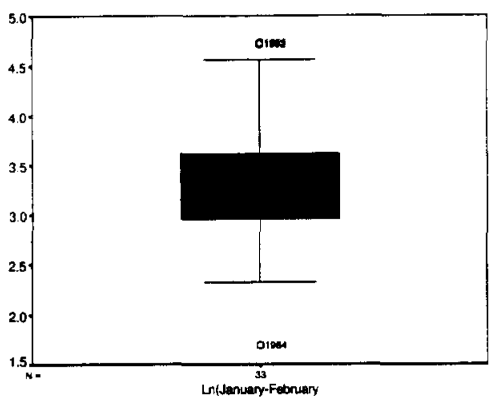


***Figure 2.15*** *BoxPlot of Ln(January-February Inflows).*

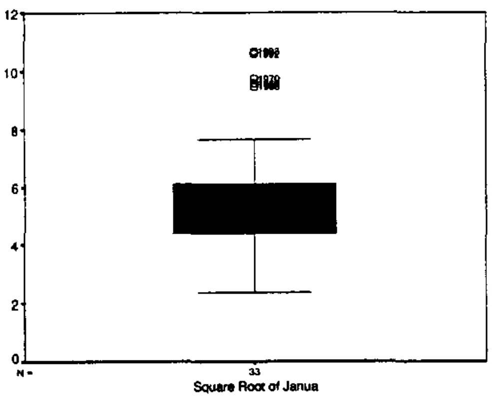


***Figure 2.16*** *BoxPlot of Square Root of January-February Inflows.*

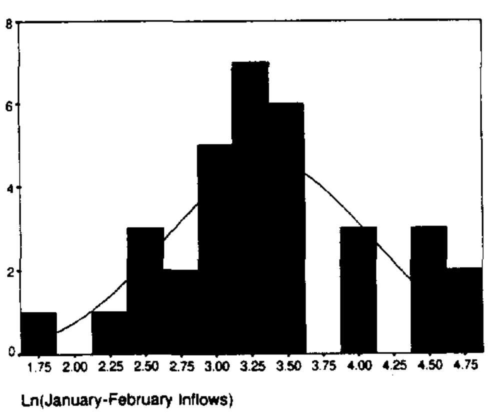


***Figure 2.17*** *Histogram of Ln(January-February Inflows).*

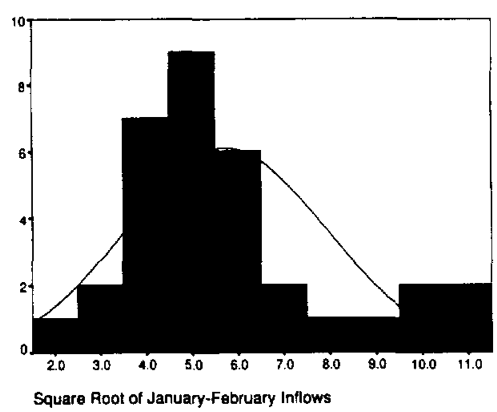


***Figure 2.18*** *Histogram of Sqrt(January-February Inflows).*

### 2.2.3 The March-April Inflows data

***Table .2.8*** *Descriptives for the March-April Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| March-April Inflows | Mean | | 31.7203 | 6.0582 |
| | 95% Confidence Interval for Mean | Lower Bound | 19.3802 | |
| | | Upper Bound | 44.0604 | |
| | 5% Trimmed Mean | | 28.1577 | |
| | Median | | 18.2900 | |
| | Variance | | 1211.149 | |
| | Std. Deviation | | 34.8016 | |
| | Minimum | | 6.64 | |
| | Maximum | | 123.11 | |
| | Range | | 116.47 | |
| | Interquartile Range | | 11.1850 | |
| | Skewness | | 1.984 | .409 |
| | Kurtosis | | 2.279 | .798 |

***Table .2.9*** *Extreme Values for the March-April Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| March-April Inflows | Highest | 1 | 19 | 1979 | 123.11 |
| | | 2 | 32 | 1992 | 114.69 |
| | | 3 | 33 | 1993 | 111.81 |
| | | 4 | 17 | 1977 | 104.82 |
| | | 5 | 18 | 1978 | 104.63 |
| | Lowest | 1 | 4 | 1964 | 6.64 |
| | | 2 | 13 | 1973 | 9.52 |
| | | 3 | 22 | 1982 | 10.21 |
| | | 4 | 23 | 1983 | 12.46 |
| | | 5 | 2 | 1962 | 12.81 |

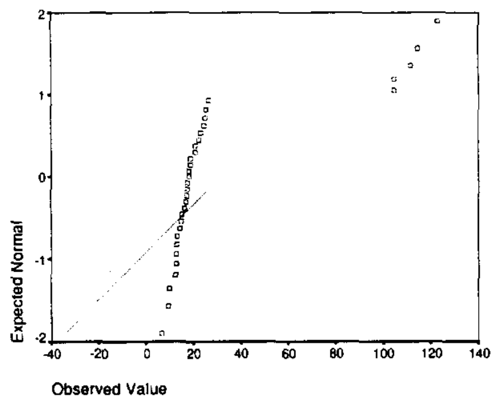


***Figure 2.19*** *Normal Q-Q Plot of March-April Inflows.*

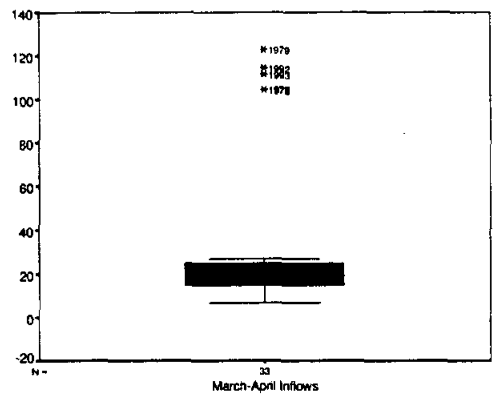


***Figure 2.20*** *BoxPlot of March-April Inflows.*

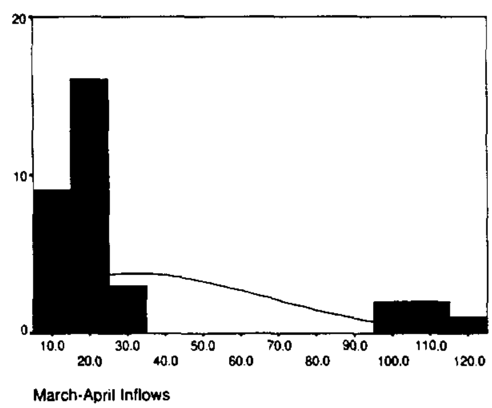


***Figure 2.21*** *Histogram of March-April Inflows.*

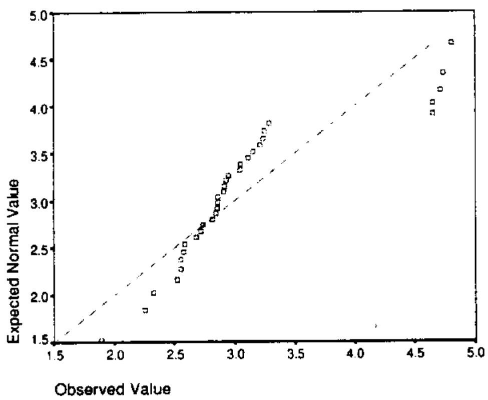


*Figure 2.22 Normal Q-Q Plot of Ln(March-April Inflows).*

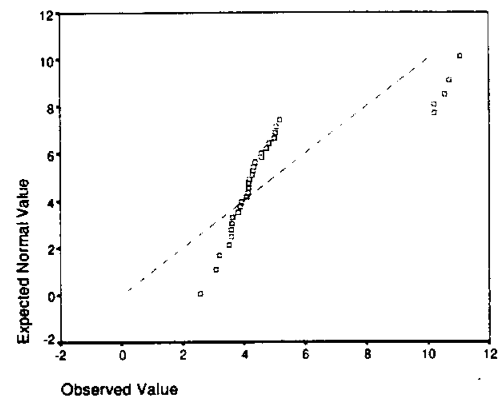


*Figure 2.23 Normal Q-Q Plot of Sqrt( March-April Inflows).*

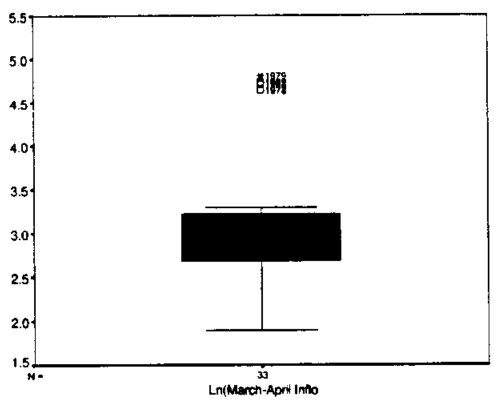


*Figure 2.24 BoxPlot of Ln(March-April) Inflows.*

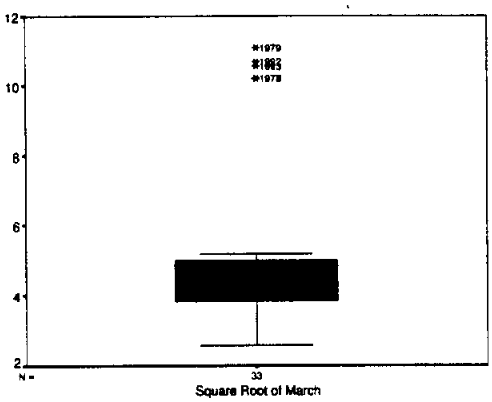


*Figure 2.25 BoxPlot of Square Root of March-April Inflows.*

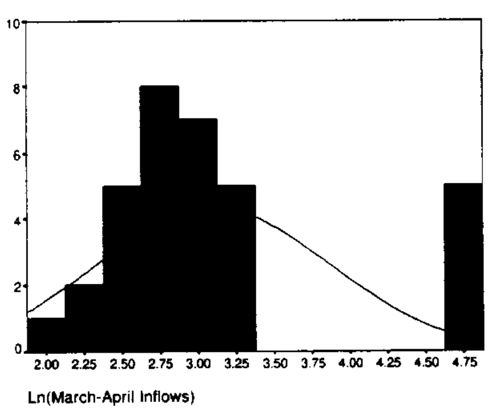


*Figure 2.26 Histogram of Ln(March-April Inflows).*

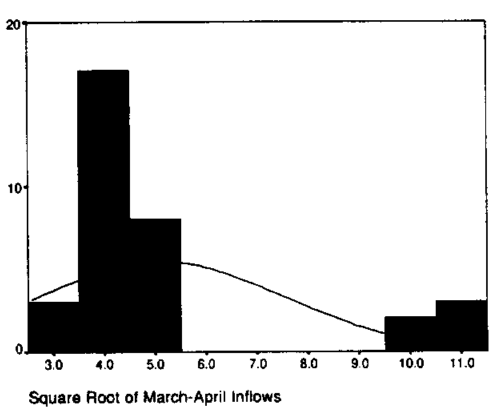


*Figure 2.27 Histogram of Sqrt(March-April Inflows).*

### 2.2.4 The May-June Inflows data

***Table .2.10*** *Descriptives for the May-June Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| May-June Inflows | Mean | | 147.5288 | 15.8596 |
| | 95% Confidence Interval for Mean | Lower Bound | 115.2238 | |
| | | Upper Bound | 179.8338 | |
| | 5% Trimmed Mean | | 143.0714 | |
| | Median | | 155.9600 | |
| | Variance | | 8300.399 | |
| | Std. Deviation | | 91.1065 | |
| | Minimum | | 7.72 | |
| | Maximum | | 382.28 | |
| | Range | | 374.56 | |
| | Interquartile Range | | 132.5900 | |
| | Skewness | | .557 | .409 |
| | Kurtosis | | .110 | .798 |

***Table .2.11*** *Extreme Values for the May-June Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| May-June Inflows | Highest | 1 | 21 | 1981 | 382.28 |
| | | 2 | 22 | 1982 | 331.11 |
| | | 3 | 23 | 1983 | 285.47 |
| | | 4 | 33 | 1993 | 255.68 |
| | | 5 | 27 | 1987 | 247.73 |
| | Lowest | 1 | 4 | 1964 | 7.72 |
| | | 2 | 30 | 1990 | 21.55 |
| | | 3 | 3 | 1963 | 33.71 |
| | | 4 | 2 | 1962 | 38.52 |
| | | 5 | 31 | 1991 | 42.61 |

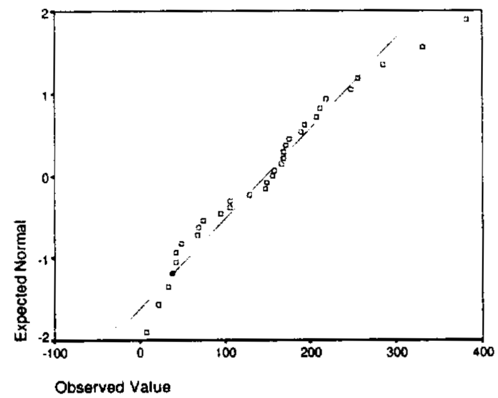


***Figure 2.28*** *Normal Q-Q Plot of May-June Inflows.*

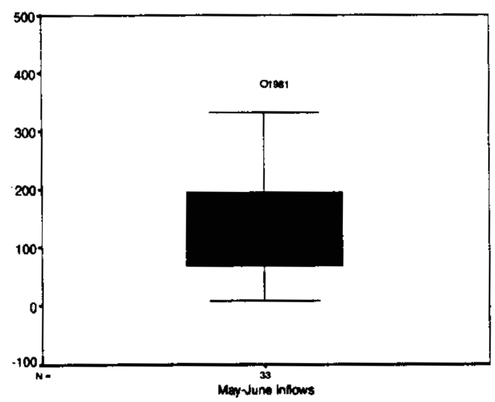


***Figure 2.29*** *BoxPlot of May-June Inflows.*

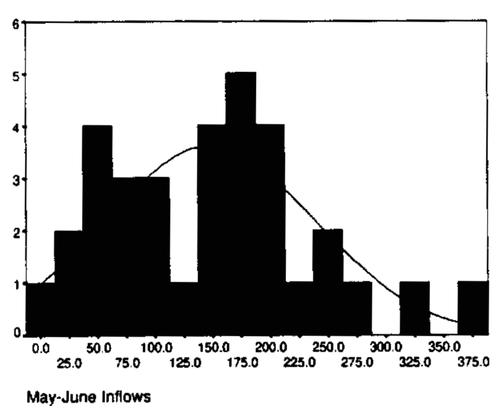


***Figure 2.30*** *Histogram of May-June Inflows.*

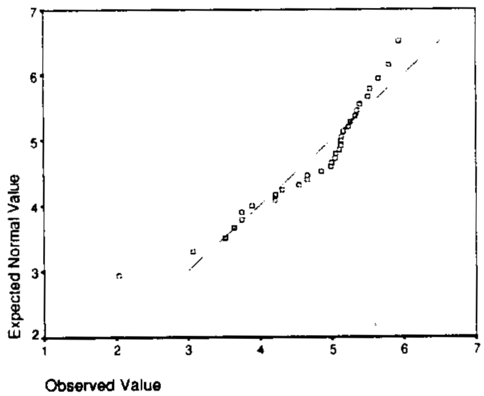


***Figure 2.31*** *Normal Q-Q Plot of Ln(May-June Inflows).*

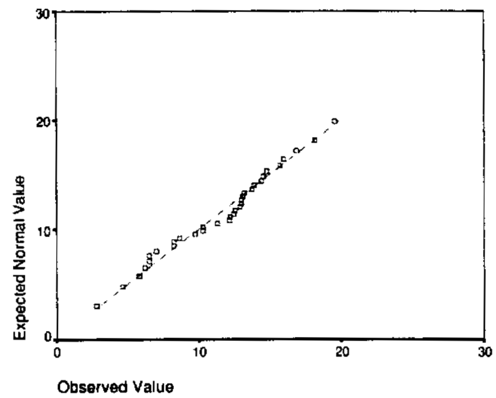


***Figure 2.32*** *Normal Q-Q Plot of Sqrt( May-June Inflows).*

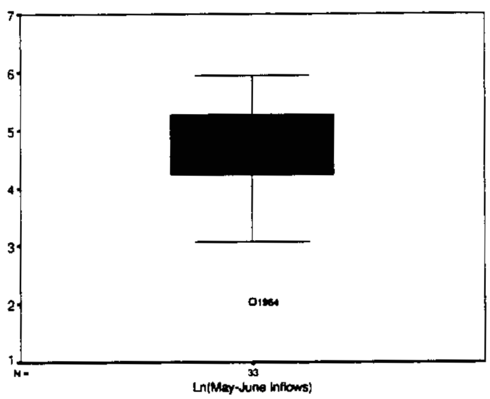


***Figure 2.33*** *BoxPlot of Ln(May-June) Inflows.*

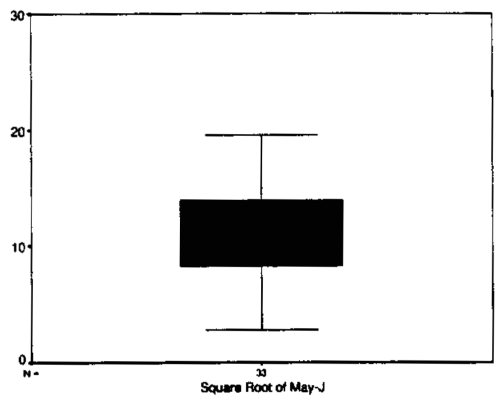


***Figure 2.34*** *BoxPlot of Square Root of May-June Inflows.*

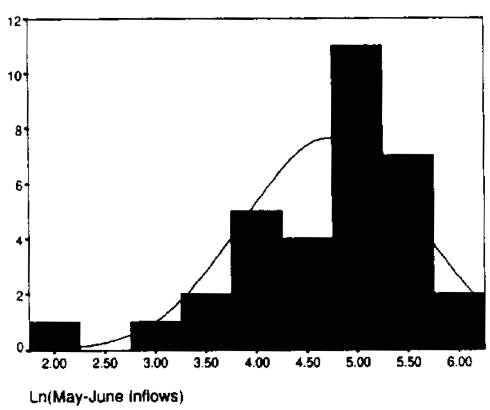


***Figure 2.35*** *Histogram of Ln(May-June Inflows).*

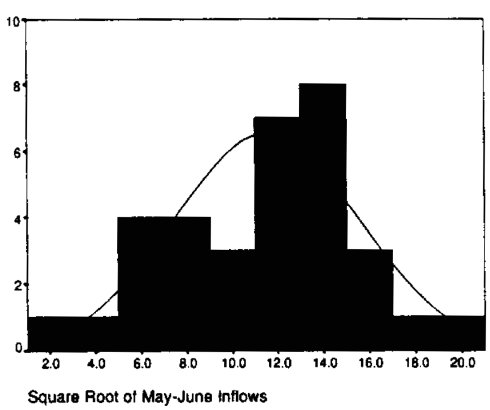


***Figure 2.36*** *Histogram of Sqrt(May-June Inflows).*

### 2.2.5 The July-August Inflows data

***Table .2.12*** *Descriptives for the July-August Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| July-August Inflows | Mean | | 93.2585 | 16.4947 |
| | 95% Confidence Interval for Mean | Lower Bound | 59.6599 | |
| | | Upper Bound | 126.8570 | |
| | 5% Trimmed Mean | | 84.8572 | |
| | Median | | 66.6000 | |
| | Variance | | 8978.443 | |
| | Std. Deviation | | 94.7546 | |
| | Minimum | | 10.11 | |
| | Maximum | | 338.40 | |
| | Range | | 328.29 | |
| | Interquartile Range | | 74.5950 | |
| | Skewness | | 1.538 | .409 |
| | Kurtosis | | 1.221 | .798 |

***Table .2.13*** *Extreme Values for the July-August Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| July-August Inflows | Highest | 1 | 13 | 1973 | 338.40 |
| | | 2 | 12 | 1972 | 310.47 |
| | | 3 | 11 | 1971 | 307.47 |
| | | 4 | 21 | 1981 | 253.39 |
| | | 5 | 22 | 1982 | 249.34 |
| | Lowest | 1 | 4 | 1964 | 10.11 |
| | | 2 | 5 | 1965 | 10.70 |
| | | 3 | 6 | 1966 | 12.65 |
| | | 4 | 7 | 1967 | 14.00 |
| | | 5 | 24 | 1984 | 22.02 |

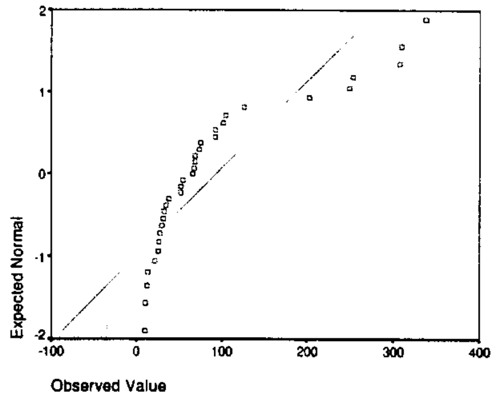


***Figure 2.37*** *Normal Q-Q Plot of July-August Inflows.*

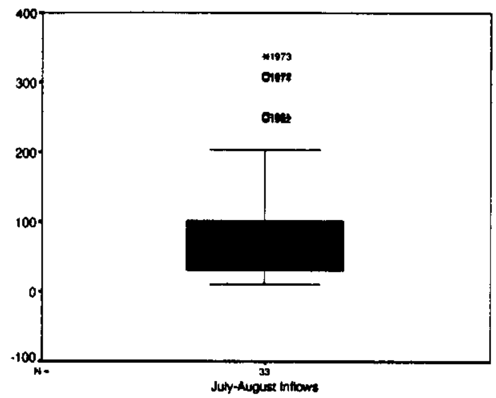


***Figure 2.38*** *BoxPlot of July-August Inflows.*

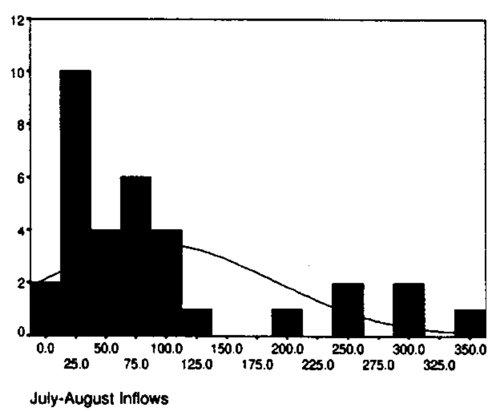


***Figure 2.39*** *Histogram of July-August Inflows.*

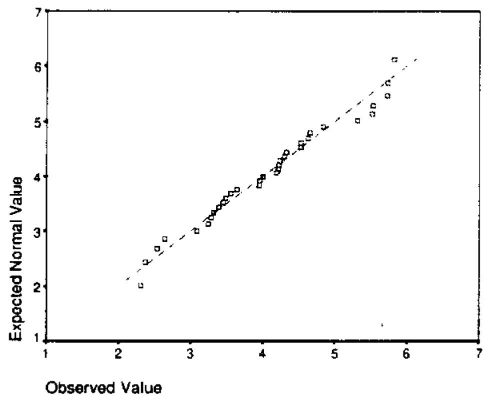


*Figure 2.40* *Normal Q-Q Plot of Ln(July-August Inflows).*

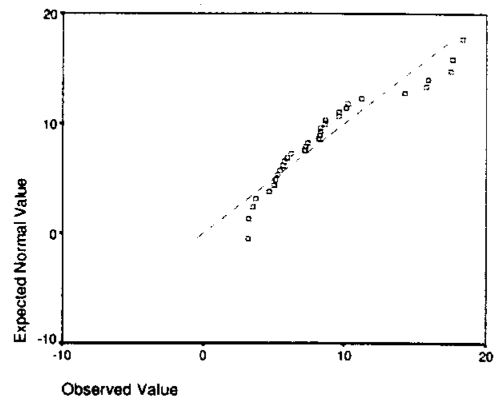


*Figure 2.41* *Normal Q-Q Plot of Sqrt( July-August Inflows).*

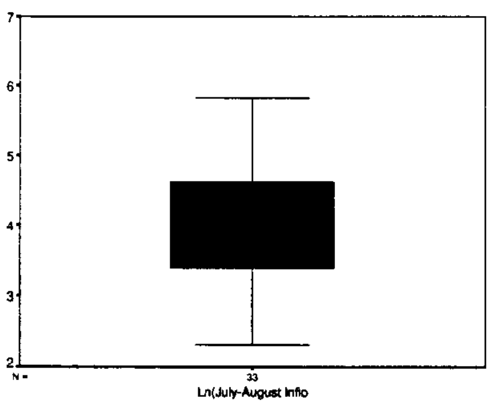


*Figure 2.42* *BoxPlot of Ln(July-August) Inflows.*

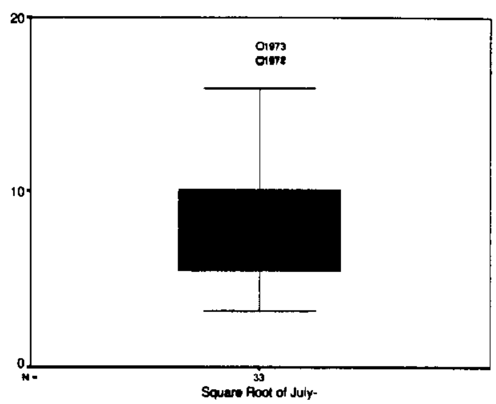


*Figure 2.43* *BoxPlot of Square Root of July-August Inflows.*

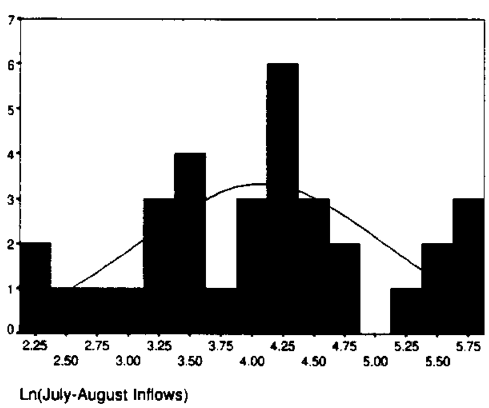


*Figure 2.44* *Histogram of Ln(July-August Inflows).*

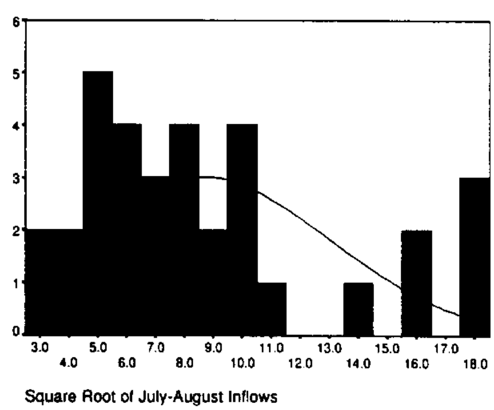


*Figure 2.45* *Histogram of Sqrt(July-August Inflows).*

### 2.2.6 The September-October Inflows data

***Table .2.14*** *Descriptives for the September-October Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| September-October Inflows | Mean | | 202.4609 | 41.9475 |
| | 95% Confidence Interval for Mean | Lower Bound | 117.0167 | |
| | | Upper Bound | 287.9051 | |
| | 5% Trimmed Mean | | 181.5009 | |
| | Median | | 89.1200 | |
| | Variance | | 58066.4 | |
| | Std. Deviation | | 240.9698 | |
| | Minimum | | 9.91 | |
| | Maximum | | 816.37 | |
| | Range | | 806.46 | |
| | Interquartile Range | | 229.2400 | |
| | Skewness | | 1.491 | .409 |
| | Kurtosis | | .770 | .798 |

***Table .2.15*** *Extreme Values for the September-October Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| September-October Inflows | Highest | 1 | 14 | 1974 | 816.37 |
| | | 2 | 10 | 1970 | 693.83 |
| | | 3 | 9 | 1969 | 675.78 |
| | | 4 | 8 | 1968 | 670.67 |
| | | 5 | 12 | 1972 | 612.72 |
| | Lowest | 1 | 4 | 1964 | 9.91 |
| | | 2 | 30 | 1990 | 20.56 |
| | | 3 | 29 | 1989 | 24.36 |
| | | 4 | 31 | 1991 | 24.99 |
| | | 5 | 25 | 1985 | 30.08 |

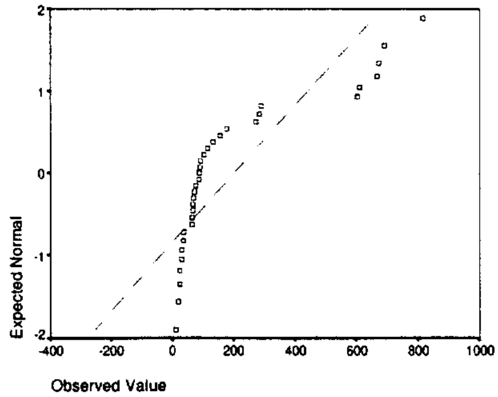


***Figure 2.46*** *Normal Q-Q Plot of September-October Inflows.*

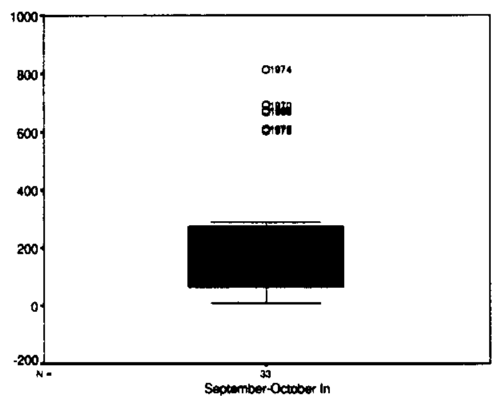


***Figure 2.47*** *BoxPlot of September-October Inflows.*

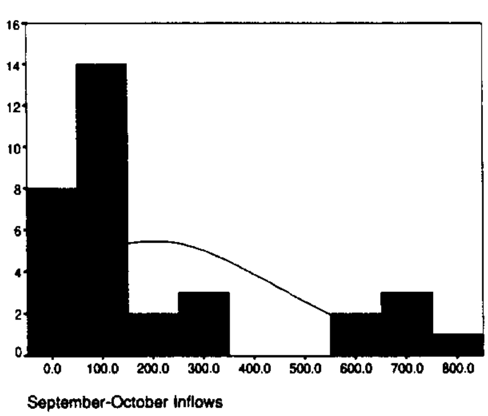


***Figure 2.48*** *Histogram of September-October Inflows.*

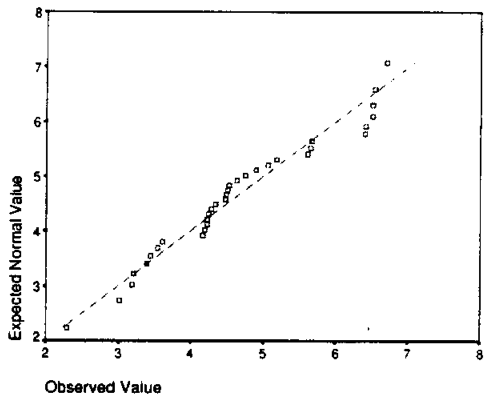


**Figure 2.49** *Normal Q-Q Plot of Ln(September-October Inflows).*

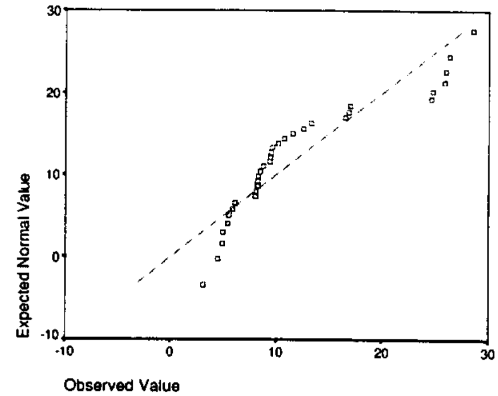


**Figure 2.50** *Normal Q-Q Plot of Sqrt( September-October Inflows).*

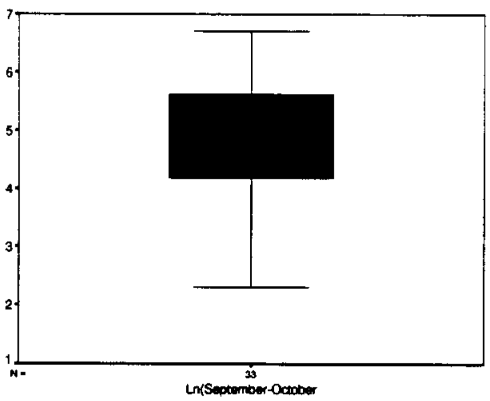


**Figure 2.51** *BoxPlot of Ln(September-October) Inflows.*

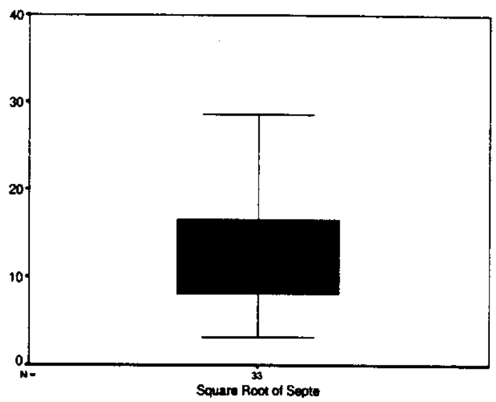


**Figure 2.52** *BoxPlot of Square Root of September-October Inflows.*

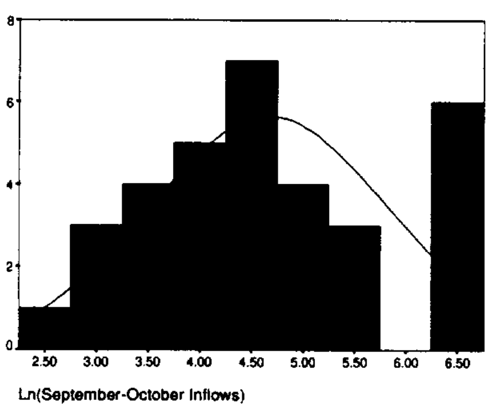


**Figure 2.53** *Histogram of Ln(September-October Inflows).*

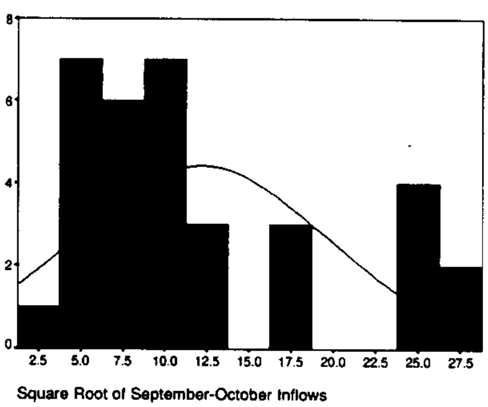


**Figure 2.54** *Histogram of Sqrt(September-October Inflows).*

### 2.2.7 The November-December Inflows data

***Table .2.16*** *Descriptives for the November-December Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| November-December Inflows | Mean | | 48.2291 | 7.1324 |
| | 95% Confidence Interval for Mean | Lower Bound | 33.7009 | |
| | | Upper Bound | 62.7573 | |
| | 5% Trimmed Mean | | 45.1902 | |
| | Median | | 35.4100 | |
| | Variance | | 1678.734 | |
| | Std. Deviation | | 40.9724 | |
| | Minimum | | 5.45 | |
| | Maximum | | 148.90 | |
| | Range | | 143.45 | |
| | Interquartile Range | | 58.0850 | |
| | Skewness | | 1.234 | .409 |
| | Kurtosis | | .755 | .798 |

***Table .2.17*** *Extreme Values for the November-December Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| November-December Inflows | Highest | 1 | 1 | 1961 | 148.90 |
| | | 2 | 17 | 1977 | 138.05 |
| | | 3 | 19 | 1979 | 135.35 |
| | | 4 | 18 | 1978 | 133.86 |
| | | 5 | 2 | 1962 | 78.65 |
| | Lowest | 1 | 4 | 1964 | 5.45 |
| | | 2 | 20 | 1980 | 8.20 |
| | | 3 | 31 | 1991 | 8.76 |
| | | 4 | 5 | 1965 | 9.75 |
| | | 5 | 21 | 1981 | 9.85 |

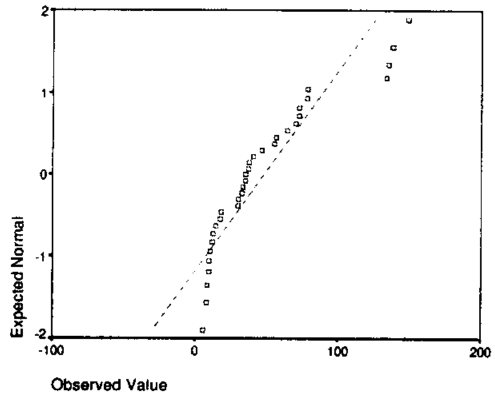


*Figure 2.55* *Normal Q-Q Plot of November_December Inflows.*

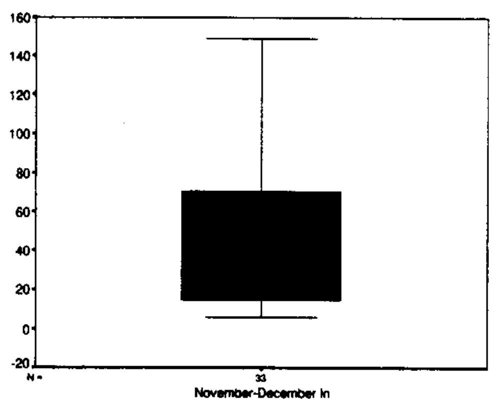


*Figure 2.56* *BoxPlot of November_December Inflows.*

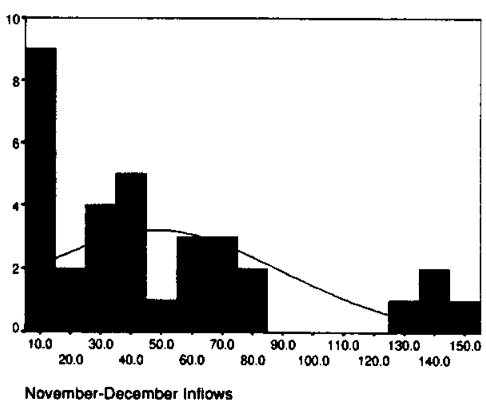


*Figure 2.57* *Histogram of November_December Inflows.*

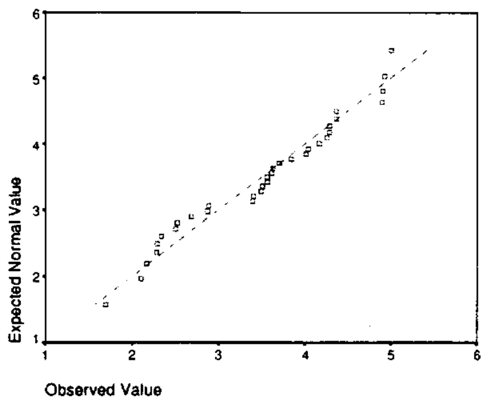


***Figure 2.58*** *Normal Q-Q Plot of Ln(November_December Inflows).*

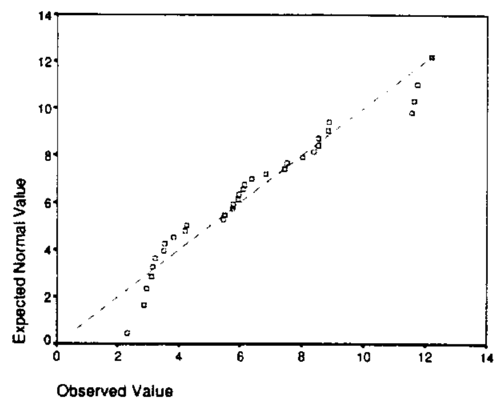


***Figure 2.59*** *Normal Q-Q Plot of Sqrt( November_December Inflows).*

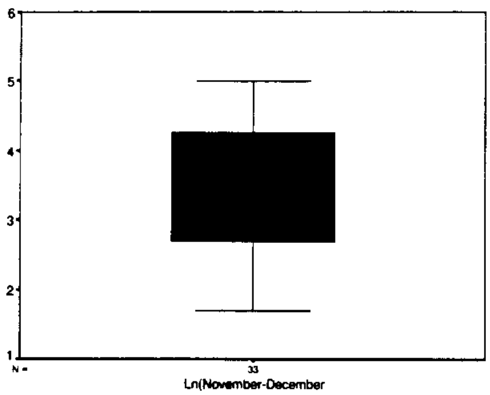


***Figure 2.60*** *BoxPlot of Ln(November _December) Inflows.*

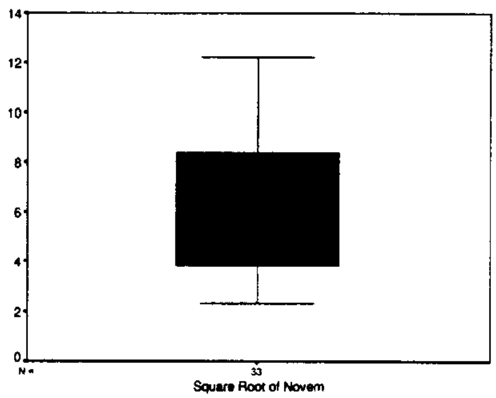


***Figure 2.61*** *BoxPlot of Square Root of November_December Inflows.*

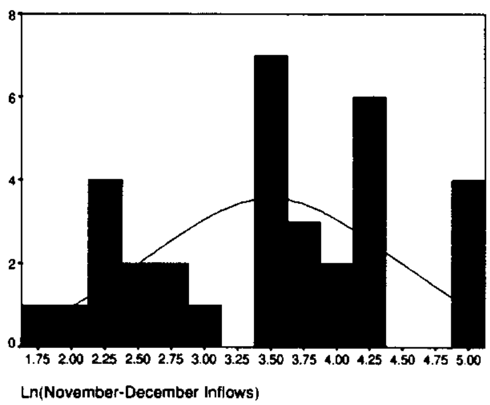


***Figure 2.62*** *Histogram of Ln(November_ December Inflows).*

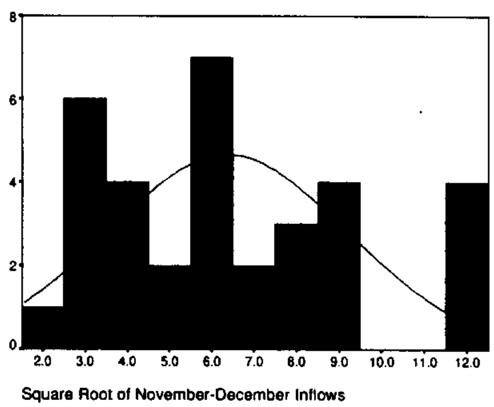


***Figure 2.63*** *Histogram of Sqrt(November_ December Inflows).*

## 3. PREDICTION ELLIPSES AND CONFIDENCE REGIONS

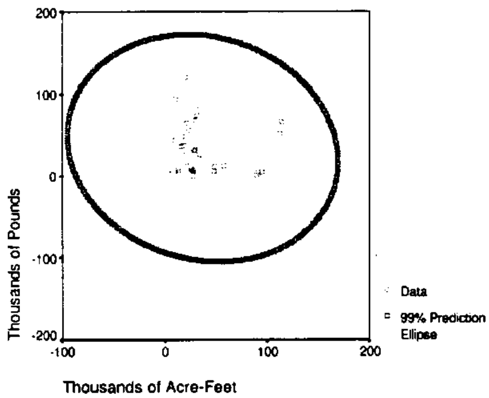


***Figure 3.1*** *Flounder Harvest vs. January-February Inflows, PE.*

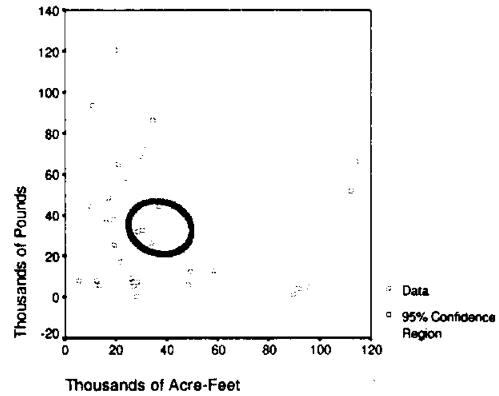


***Figure 3.2*** *Flounder Harvest vs. January-February Inflows, CR.*

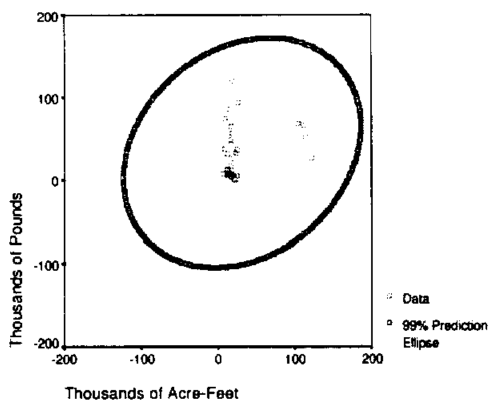


***Figure 3.3*** *Flounder Harvest vs. March-April Inflows, PE.*

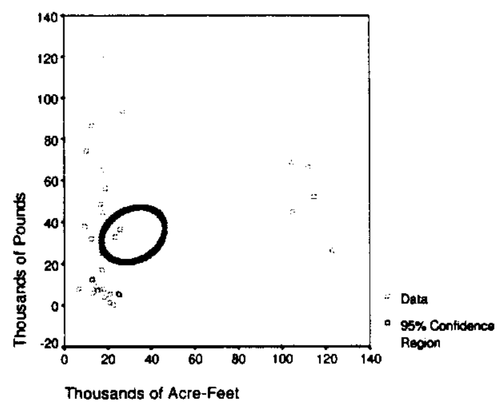


***Figure 3.4*** *Flounder Harvest vs. March-April Inflows, CR.*

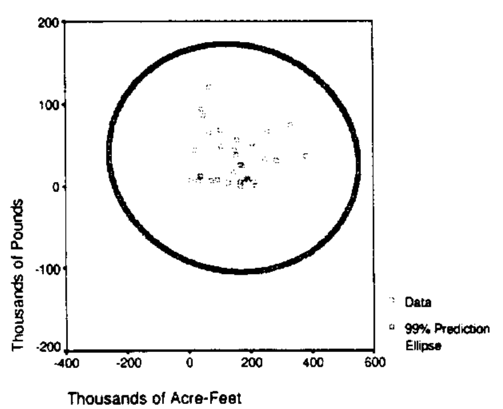


***Figure 3.5*** *Flounder Harvest vs. May-June Inflows, PE.*

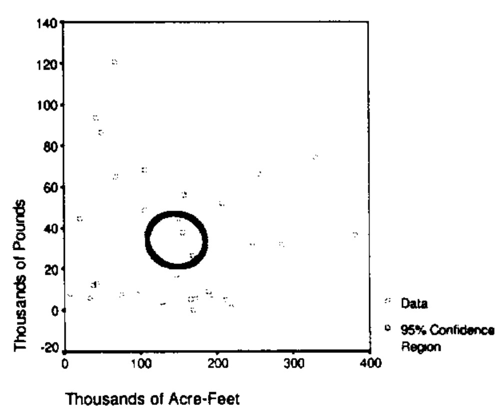


***Figure 3.6*** *Flounder Harvest vs. May-June Inflows, CR.*

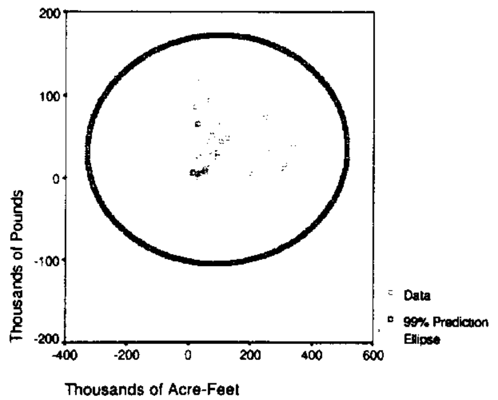


***Figure 3.7*** *Flounder Harvest vs. July-August Inflows, PE.*

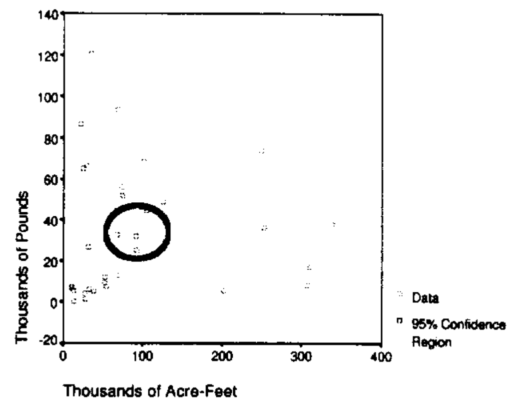


***Figure 3.8*** *Flounder Harvest vs. July-August Inflows, CR.*

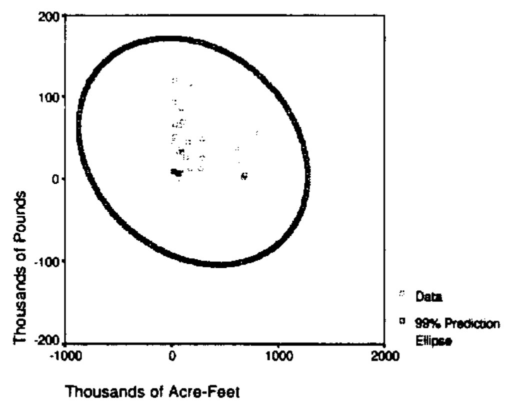


***Figure 3.9*** *Flounder Harvest vs. September-October Inflows, PE.*

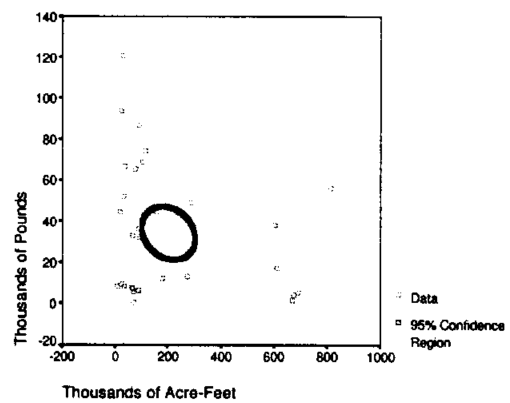


***Figure 3.10*** *Flounder Harvest vs. September-October Inflows, CR.*

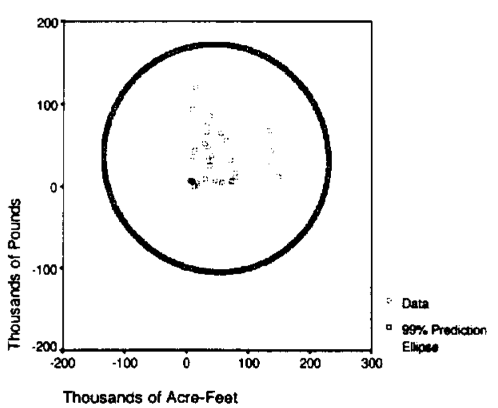


***Figure 3.11*** *Flounder Harvest vs. November-December Inflows, PE.*

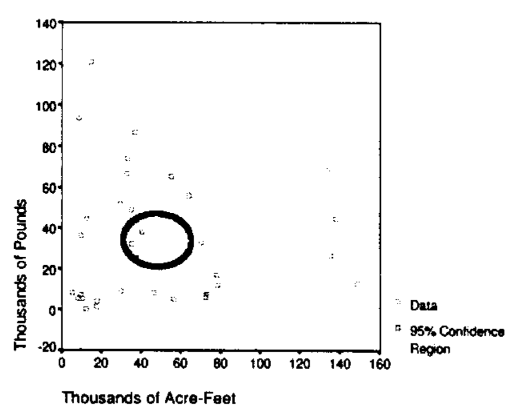


***Figure 3.12*** *Flounder Harvest vs. November-December Inflows, CR.*

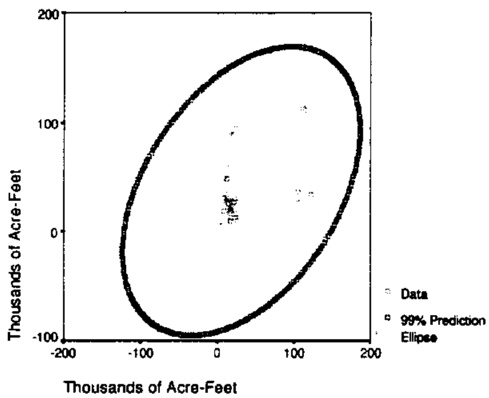


***Figure 3.13*** *January-February Inflows vs. March-April Inflows, PE.*

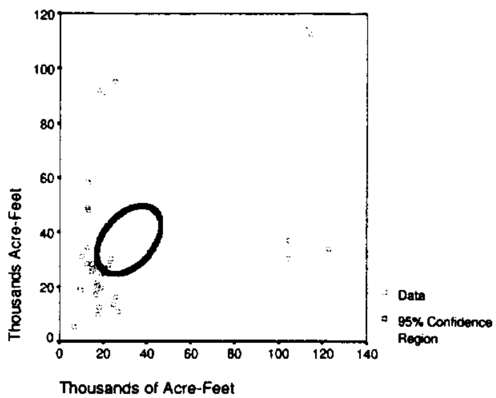


***Figure 3.14*** *January-February Inflows vs. March-April Inflows, CR.*

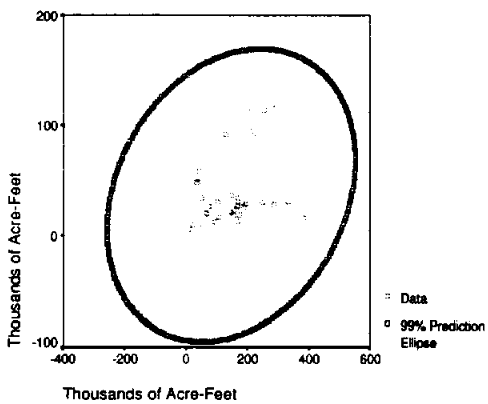


***Figure 3.15*** *January-February Inflows vs. May-June Inflows, PE.*

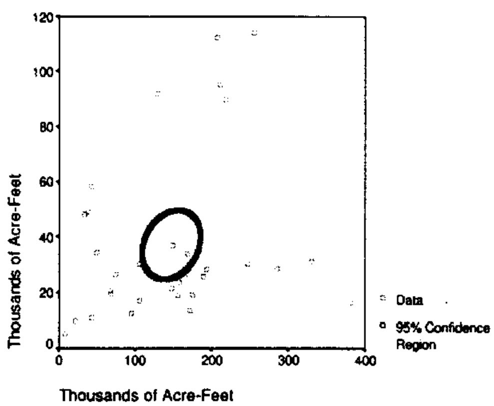


***Figure 3.16*** *January-February Inflows vs. May-June Inflows, CR.*

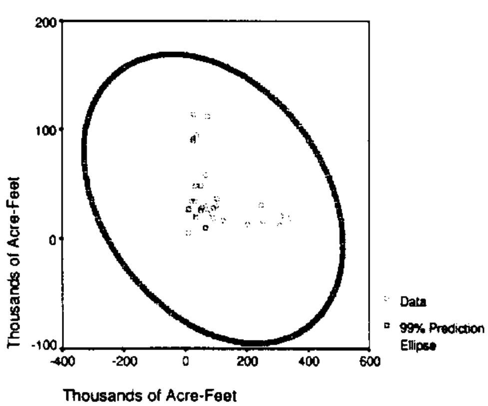


***Figure 3.17*** *January-February Inflows vs. July-August Inflows, PE.*

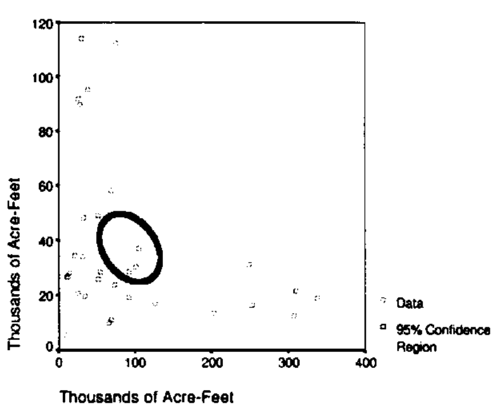


***Figure 3.18*** *January-February Inflows vs. July-August Inflows, CR.*

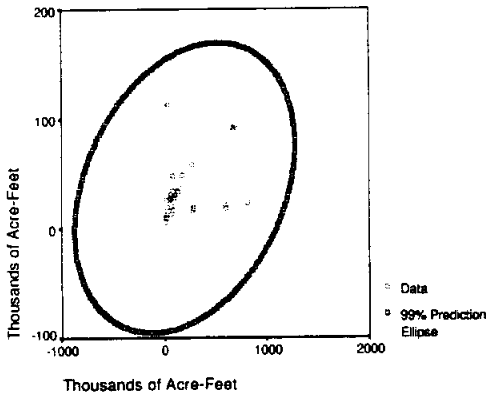


***Figure 3.19*** *January-February Inflows vs. September-October Inflows, PE.*

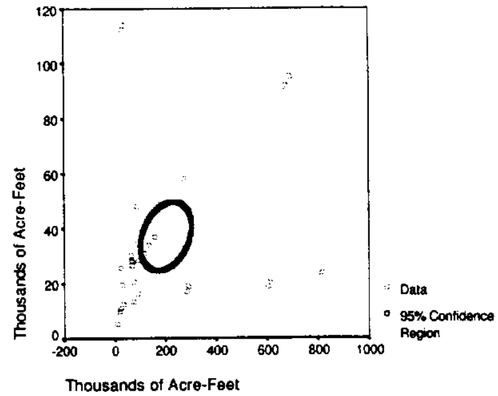


***Figure 3.20*** *January-February Inflows vs. September-October Inflows, CR.*

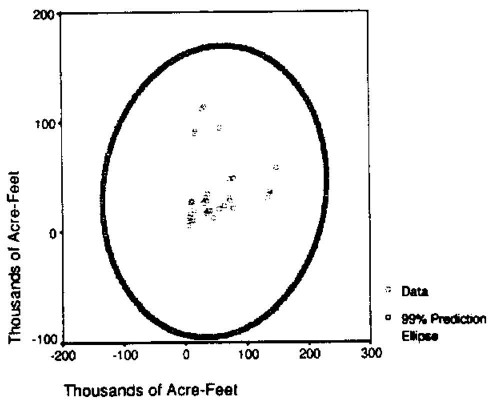


***Figure 3.21*** *January-February Inflows vs. November-December Inflows, PE.*

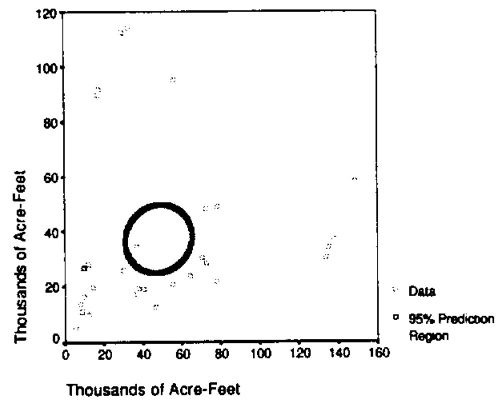


***Figure 3.22*** *January-February Inflows vs. November-December Inflows, CR.*

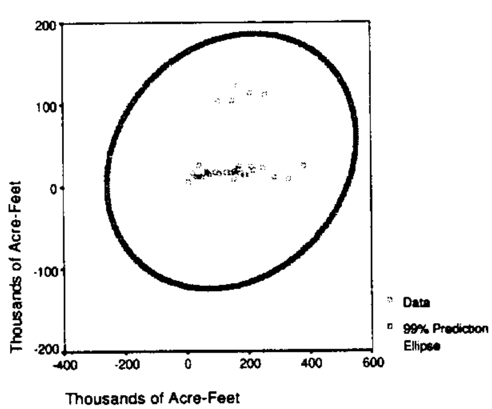


***Figure 3.23*** *March-April Inflows vs. May-June Inflows, PE.*

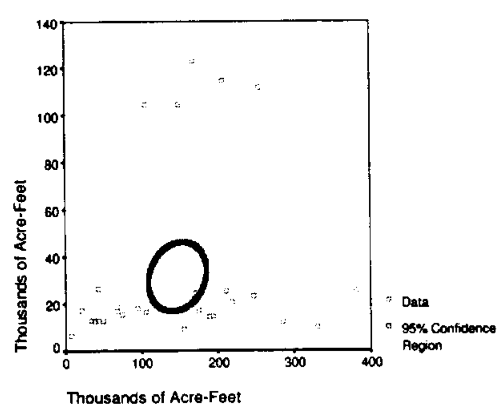


***Figure 3.24*** *March-April Inflows vs. May-June Inflows, CR.*

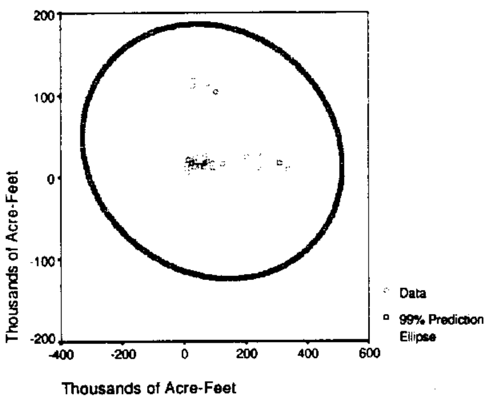


*Figure 3.25* *March-April Inflows vs. July-August Inflows, PE.*

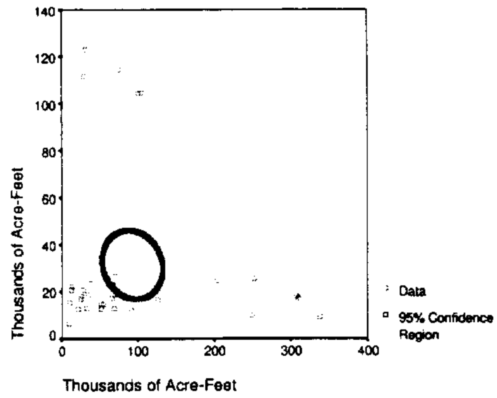


*Figure 3.26* *March-April Inflows vs. July-August Inflows, CR.*

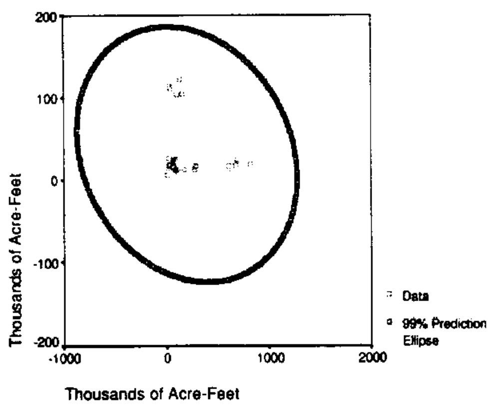


*Figure 3.27* *March-April Inflows vs. September-October Inflows, PE.*

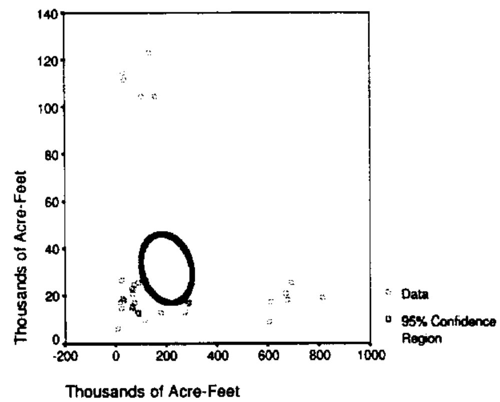


*Figure 3.28* *March-April Inflows vs. September-October Inflows, CR.*

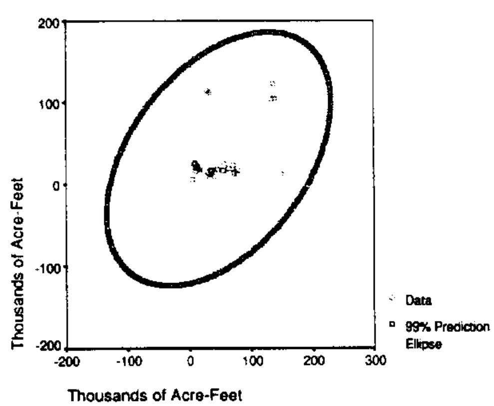


*Figure 3.29* *March-April Inflows vs. November-December Inflows, PE.*

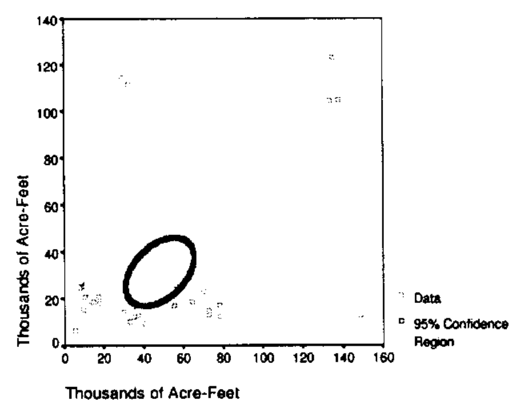


*Figure 3.30* *March-April Inflows vs. November-December Inflows, CR.*

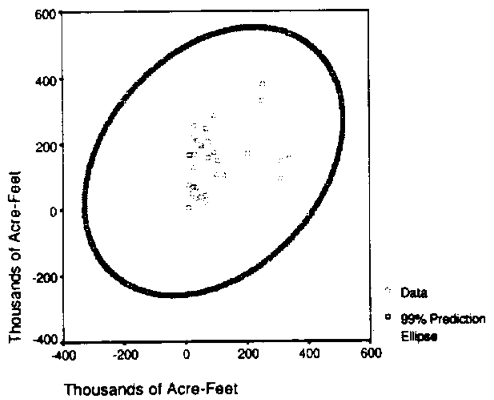


***Figure 3.31*** *May-June Inflows vs. July-August Inflows, PE.*

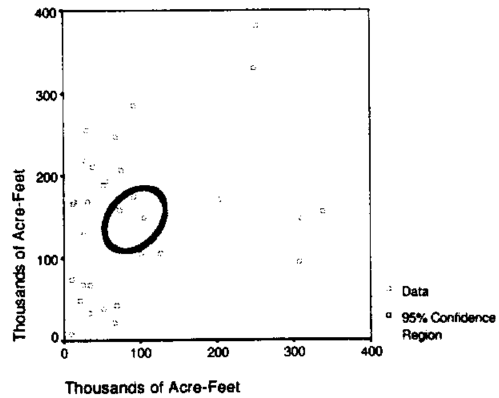


***Figure 3.32*** *May-June Inflows vs. July-August Inflows, CR.*

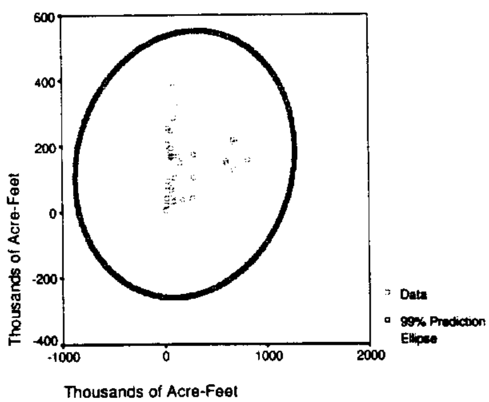


***Figure 3.33*** *May-June Inflows vs. September-October Inflows, PE.*

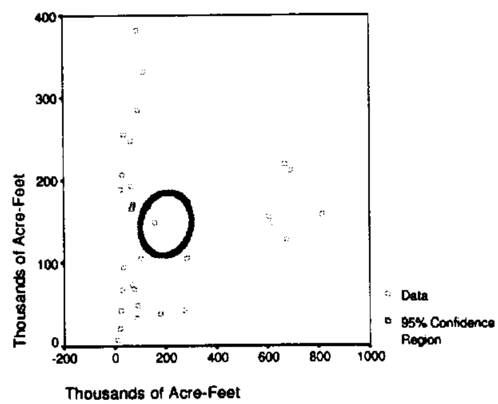


***Figure 3.34*** *May-June Inflows vs. September-October Inflows, CR.*

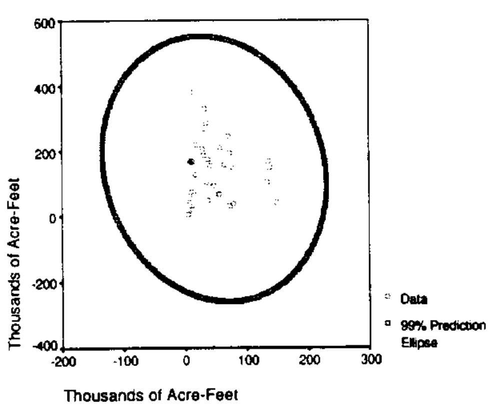


***Figure 3.35*** *May-June Inflows vs. November-December Inflows, PE.*

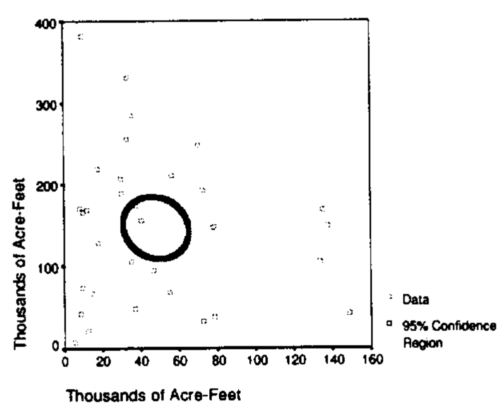


***Figure 3.36*** *May-June Inflows vs. November-December Inflows, CR.*

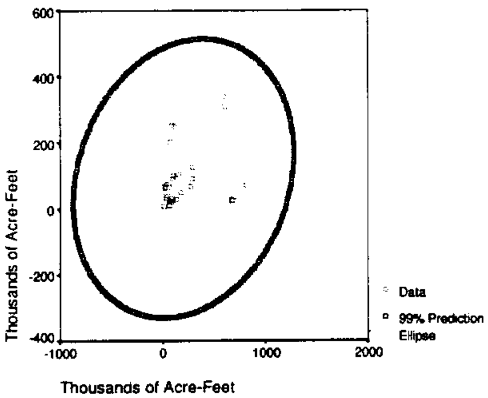


***Figure 3.37*** *July-August Inflows. vs. September-October Inflows, PE.*

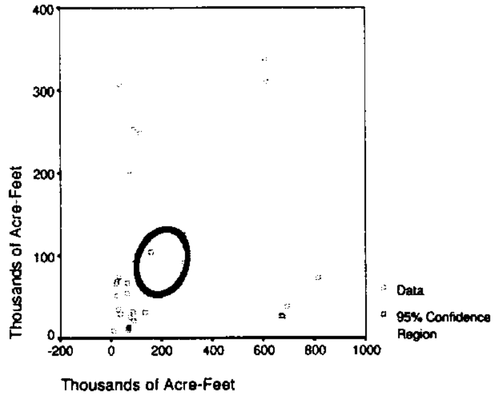


***Figure 3.38*** *July-August Inflows. vs. September-October Inflows, CR.*

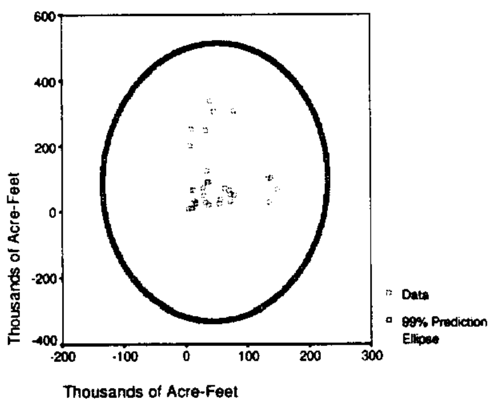


***Figure 3.39*** *July-August Inflows. vs. November-December Inflows, PE.*

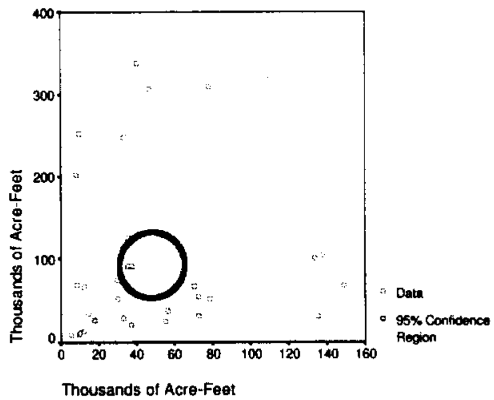


***Figure 3.40*** *July-August Inflows. vs. November-December Inflows, CR.*

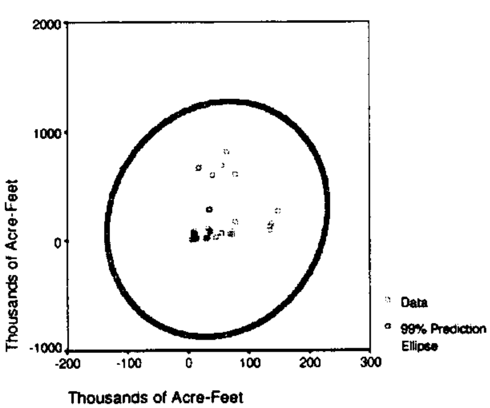


***Figure 3.41*** *September-October Inflows vs. November-December Inflows, PE.*

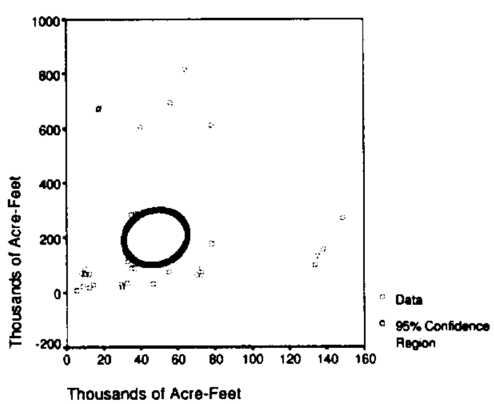


***Figure 3.42*** *September-October Inflows vs. November-December Inflows, CR.*

## 4. Box-Cox Analysis

***Table .4.1*** *Mean Square Error from Box-Cox transformation of the flounder data and the inflow data for different lambda.*

| Lam. | Flounder | JF_inflow | MA_inflo | MJ_inflow | JA_inflow | SO_inflow | ND_inflow |
|---|---|---|---|---|---|---|---|
| -2.0 | 3213967 | 5149.1 | 532.4 | 4434304 | 64631.5 | 1190074 | 15460.9 |
| -1.9 | 1780064 | 4119.6 | 469.2 | 2873672 | 50836.7 | 828109 | 12277.5 |
| -1.8 | 991869 | 3316.8 | 416.2 | 1873264 | 40195.7 | 580522 | 9817.3 |
| -1.7 | 556429 | 2689.0 | 371.7 | 1229209 | 31963.8 | 410344 | 7907.6 |
| -1.6 | 314538 | 2196.6 | 334.3 | 812620 | 25576.7 | 292755 | 6418.8 |
| -1.5 | 179344 | 1809.2 | 303.2 | 541771 | 20606.3 | 211042 | 5252.8 |
| -1.4 | 103272 | 1503.5 | 277.3 | 364682 | 16726.8 | 153914 | 4335.6 |
| -1.3 | 60147 | 1261.8 | 256.1 | 248179 | 13690.1 | 113716 | 3610.8 |
| -1.2 | 35495 | 1070.1 | 238.9 | 171014 | 11306.9 | 85241 | 3035.7 |
| -1.1 | 21274 | 917.9 | 225.3 | 119524 | 9432.2 | 64935 | 2577.6 |
| -1.0 | 12985 | 796.9 | 214.9 | 84887 | 7955.3 | 50357 | 2211.5 |
| -0.9 | 8099 | 701.0 | 207.6 | 61384 | 6791.1 | 39829 | 1918.0 |
| -0.8 | 5183 | 625.0 | 203.2 | 45284 | 5874.3 | 32190 | 1682.5 |
| -0.7 | 3419 | 565.3 | 201.5 | 34145 | 5155.0 | 26636 | 1493.6 |
| -0.6 | 2336 | 518.9 | 202.6 | 26358 | 4594.8 | 22606 | 1342.3 |
| -0.5 | 1662 | 483.7 | 206.6 | 20857 | 4164.9 | 19712 | 1222.1 |
| -0.4 | 1236 | 457.8 | 213.7 | 16930 | 3843.3 | 17682 | 1127.7 |
| -0.3 | 963 | 440.2 | 224.2 | 14100 | 3614.1 | 16334 | 1055.1 |
| -0.2 | 788 | 429.7 | 238.6 | 12045 | 3465.9 | 15545 | 1001.4 |
| -0.1 | 675 | 426.0 | 257.2 | 10545 | 3391.5 | 15239 | 964.6 |
| 0.0 | 604 | 428.5 | 281.0 | 9449 | 3387.1 | 15380 | 943.1 |
| 0.1 | 562 | 437.2 | 310.8 | 8654 | 3452.0 | 15960 | 936.2 |
| 0.2 | 542 | 452.2 | 347.8 | 8089 | 3589.1 | 17003 | 943.7 |
| 0.3 | 539 | 473.7 | 393.6 | 7705 | 3804.3 | 18563 | 965.8 |
| 0.4 | 551 | 502.3 | 450.2 | 7466 | 4107.2 | 20729 | 1003.2 |
| 0.5 | 577 | 538.7 | 519.9 | 7351 | 4511.8 | 23627 | 1057.5 |
| 0.6 | 617 | 583.8 | 606.0 | 7344 | 5037.0 | 27435 | 1130.5 |
| 0.7 | 673 | 639.0 | 712.3 | 7438 | 5708.1 | 32397 | 1225.0 |
| 0.8 | 747 | 705.8 | 844.0 | 7628 | 6558.0 | 38839 | 1344.6 |
| 0.9 | 843 | 786.1 | 1007.6 | 7914 | 7629.6 | 47199 | 1493.9 |
| 1.0 | 964 | 882.5 | 1211.1 | 8300 | 8978.4 | 58066 | 1678.7 |
| 1.1 | 1119 | 997.8 | 1465.3 | 8794 | 10676.2 | 72231 | 1906.5 |
| 1.2 | 1314 | 1135.9 | 1783.7 | 9406 | 12815.5 | 90755 | 2186.4 |
| 1.3 | 1561 | 1301.0 | 2183.6 | 10150 | 15516.4 | 115072 | 2530.1 |
| 1.4 | 1874 | 1498.8 | 2687.5 | 11043 | 18934.3 | 147116 | 2952.4 |
| 1.5 | 2274 | 1736.0 | 3324.3 | 12108 | 23271.1 | 189509 | 3471.5 |
| 1.6 | 2783 | 2020.8 | 4131.4 | 13373 | 28788.9 | 245813 | 4110.5 |
| 1.7 | 3436 | 2363.3 | 5157.5 | 14870 | 35829.8 | 320878 | 4898.4 |
| 1.8 | 4277 | 2776.0 | 6465.6 | 16640 | 44840.1 | 421326 | 5871.7 |
| 1.9 | 5362 | 3274.2 | 8137.6 | 18730 | 56403.6 | 556221 | 7076.4 |
| 2.0 | 6769 | 3876.8 | 10280.6 | 21201 | 71285.5 | 737997 | 8570.4 |

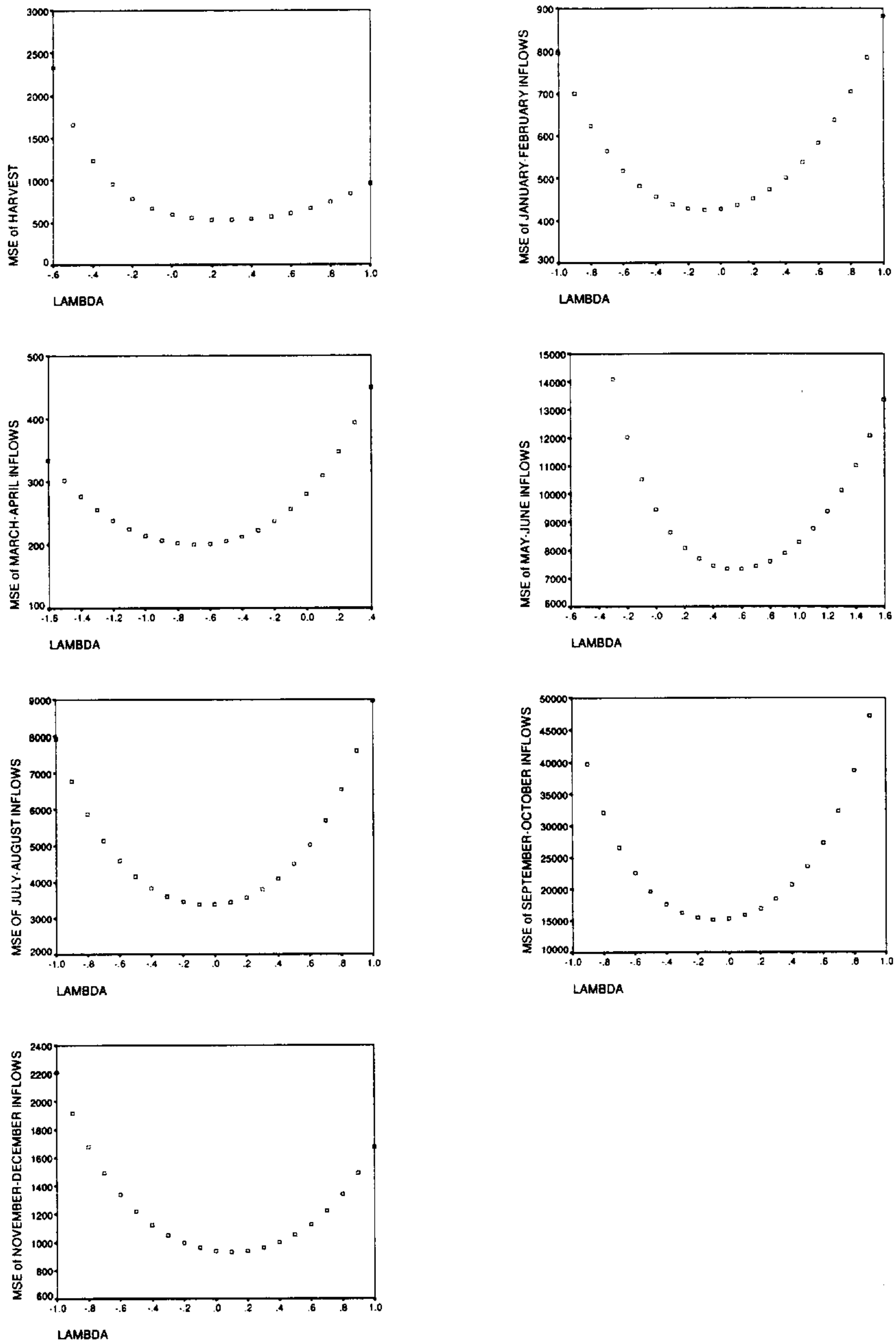


***Figure 4.1*** *Box-Cox Transformation - MSE of Flounder vs. Lambda and MSE of Inflow data vs. Lambda.*

# 5. Model Choice Diagnostics

## 5.1 Untransformed flounder data and untransformed inflow data

***Table 5.1*** *Regression Models for Dependent Variable: FLOUNDER on INFLOWS*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.0533 | 0.0228 | -0.046 | 227.9 | 942.4 | 230.9 | QMA_LAG |
| 1 | 0.0478 | 0.0171 | 0.123 | 228.1 | 947.9 | 231.1 | QSO_LAG |
| 1 | 0.0134 | -.0184 | 1.174 | 229.3 | 982.1 | 232.3 | QJF_LAG |
| 1 | 0.0035 | -.0287 | 1.479 | 229.6 | 992.0 | 232.6 | QMJ_LAG |
| 2 | 0.1089 | 0.0494 | 0.255 | 227.9 | 916.7 | 232.4 | QJF_LAG QMA_LAG |
| 2 | 0.0856 | 0.0246 | 0.967 | 228.8 | 940.6 | 233.3 | QMA_LAG QSO_LAG |
| 2 | 0.0728 | 0.0110 | 1.357 | 229.2 | 953.7 | 233.7 | QMA_LAG QND_LAG |
| 2 | 0.0639 | 0.0015 | 1.630 | 229.6 | 962.9 | 234.1 | QMA_LAG QMJ_LAG |
| 3 | 0.1381 | 0.0489 | 1.362 | 228.8 | 917.2 | 234.8 | QJF_LAG QMA_LAG QND_LAG |
| 3 | 0.1165 | 0.0252 | 2.020 | 229.7 | 940.1 | 235.6 | QJF_LAG QMA_LAG QSO_LAG |
| 3 | 0.1126 | 0.0208 | 2.140 | 229.8 | 944.3 | 235.8 | QJF_LAG QMA_LAG QMJ_LAG |
| 3 | 0.1096 | 0.0175 | 2.233 | 229.9 | 947.5 | 235.9 | QJF_LAG QMA_LAG QJA_LAG |
| 4 | 0.1480 | 0.0263 | 3.059 | 230.5 | 939.0 | 237.9 | QJF_LAG QMA_LAG QMJ_LAG QND_LAG |
| 4 | 0.1395 | 0.0165 | 3.319 | 230.8 | 948.4 | 238.3 | QJF_LAG QMA_LAG QSO_LAG QND_LAG |
| 4 | 0.1384 | 0.0153 | 3.352 | 230.8 | 949.6 | 238.3 | QJF_LAG QMA_LAG QJA_LAG QND_LAG |
| 4 | 0.1195 | -.0062 | 3.929 | 231.5 | 970.4 | 239.0 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG |
| 5 | 0.1488 | -.0088 | 5.033 | 232.4 | 972.8 | 241.4 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.1485 | -.0092 | 5.043 | 232.4 | 973.2 | 241.4 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 5 | 0.1395 | -.0198 | 5.318 | 232.8 | 983.5 | 241.8 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.1242 | -.0380 | 5.787 | 233.4 | 1001.0 | 242.3 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.1499 | -.0463 | 7.000 | 234.4 | 1009.0 | 244.9 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 33

## 5.2 Log of flounder data and untransformed inflow data

***Table 5.2*** *Regression Models for Dependent Variable: Ln(FLOUNDER) on INFLOWS*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.0817 | 0.0521 | 1.312 | 15.53 | 1.509 | 18.52 | QMA_LAG |
| 1 | 0.0396 | 0.0086 | 2.703 | 17.01 | 1.579 | 20.00 | QSO_LAG |
| 1 | 0.0340 | 0.0029 | 2.887 | 17.20 | 1.588 | 20.19 | QJA_LAG |
| 1 | 0.0308 | -.0005 | 2.994 | 17.31 | 1.593 | 20.30 | QJF_LAG |
| 2 | 0.1886 | 0.1345 | -0.215 | 13.44 | 1.378 | 17.93 | QJF_LAG QMA_LAG |
| 2 | 0.1307 | 0.0727 | 1.696 | 15.72 | 1.477 | 20.21 | QMA_LAG QJA_LAG |
| 2 | 0.1040 | 0.0443 | 2.575 | 16.71 | 1.522 | 21.20 | QMA_LAG QSO_LAG |
| 2 | 0.0896 | 0.0289 | 3.052 | 17.24 | 1.546 | 21.73 | QJA_LAG QSO_LAG |
| 3 | 0.2055 | 0.1233 | 1.226 | 14.75 | 1.396 | 20.73 | QJF_LAG QMA_LAG QJA_LAG |
| 3 | 0.1887 | 0.1048 | 1.781 | 15.44 | 1.426 | 21.42 | QJF_LAG QMA_LAG QSO_LAG |
| 3 | 0.1886 | 0.1047 | 1.783 | 15.44 | 1.426 | 21.43 | QJF_LAG QMA_LAG QND_LAG |
| 3 | 0.1886 | 0.1047 | 1.784 | 15.44 | 1.426 | 21.43 | QJF_LAG QMA_LAG QMJ_LAG |
| 4 | 0.2089 | 0.0958 | 3.115 | 16.61 | 1.440 | 24.09 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG |
| 4 | 0.2085 | 0.0954 | 3.128 | 16.62 | 1.441 | 24.11 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG |
| 4 | 0.2055 | 0.0920 | 3.226 | 16.75 | 1.446 | 24.23 | QJF_LAG QMA_LAG QJA_LAG QND_LAG |
| 4 | 0.1888 | 0.0730 | 3.776 | 17.43 | 1.476 | 24.91 | QJF_LAG QMA_LAG QSO_LAG QND_LAG |
| 5 | 0.2123 | 0.0665 | 5.001 | 18.46 | 1.487 | 27.44 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.2092 | 0.0628 | 5.103 | 18.59 | 1.492 | 27.57 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.2087 | 0.0621 | 5.122 | 18.62 | 1.494 | 27.59 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.1889 | 0.0387 | 5.773 | 19.43 | 1.531 | 28.41 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 6 | 0.2123 | 0.0306 | 7.000 | 20.46 | 1.544 | 30.94 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 33

## 5.3 Log of flounder data and log of inflow data

***Table** 5.3 Regression Models for Dependent Variable: Ln(FLOUNDER) on Ln(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.1248 | 0.0966 | 3.731 | 13.94 | 1.439 | 16.93 | LN_QJA |
| 1 | 0.0545 | 0.0240 | 6.360 | 16.49 | 1.554 | 19.48 | LN_QMA |
| 1 | 0.0510 | 0.0204 | 6.492 | 16.61 | 1.560 | 19.60 | LN_QND |
| 1 | 0.0311 | -.0002 | 7.236 | 17.30 | 1.593 | 20.29 | LN_QJF |
| 2 | 0.1930 | 0.1392 | 3.180 | 13.26 | 1.371 | 17.75 | LN_QJA LN_QSO |
| 2 | 0.1756 | 0.1206 | 3.834 | 13.97 | 1.400 | 18.46 | LN_QMA LN_QJA |
| 2 | 0.1545 | 0.0981 | 4.622 | 14.80 | 1.436 | 19.29 | LN_QMJ LN_QJA |
| 2 | 0.1423 | 0.0852 | 5.076 | 15.27 | 1.457 | 19.76 | LN_QJF LN_QMA |
| 3 | 0.2553 | 0.1782 | 2.852 | 12.61 | 1.309 | 18.60 | LN_QJA LN_QSO LN_QND |
| 3 | 0.2515 | 0.1741 | 2.993 | 12.78 | 1.315 | 18.76 | LN_QMA LN_QMJ LN_QJA |
| 3 | 0.2357 | 0.1566 | 3.586 | 13.47 | 1.343 | 19.46 | LN_QMA LN_QJA LN_QSO |
| 3 | 0.2240 | 0.1437 | 4.023 | 13.97 | 1.364 | 19.96 | LN_QJF LN_QMA LN_QJA |
| 4 | 0.2759 | 0.1725 | 4.080 | 13.68 | 1.318 | 21.17 | LN_QMA LN_QMJ LN_QJA LN_QSO |
| 4 | 0.2712 | 0.1671 | 4.257 | 13.90 | 1.326 | 21.38 | LN_QMA LN_QJA LN_QSO LN_QND |
| 4 | 0.2635 | 0.1583 | 4.543 | 14.24 | 1.340 | 21.73 | LN_QJF LN_QMA LN_QMJ LN_QJA |
| 4 | 0.2623 | 0.1569 | 4.590 | 14.30 | 1.343 | 21.78 | LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.2970 | 0.1668 | 5.291 | 14.71 | 1.327 | 23.69 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.2915 | 0.1603 | 5.497 | 14.97 | 1.337 | 23.95 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.2782 | 0.1446 | 5.993 | 15.58 | 1.362 | 24.56 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.2773 | 0.1435 | 6.029 | 15.62 | 1.364 | 24.60 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 6 | 0.3048 | 0.1444 | 7.000 | 16.34 | 1.363 | 26.82 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 33

## 5.4 Log of flounder data and square root of inflow data

***Table 5.4*** *Regression Models for Dependent Variable: Ln(FLOUNDER) on Sqrt(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.0714 | 0.0414 | 3.234 | 15.89 | 1.526 | 18.89 | SQR_QMA |
| 1 | 0.0699 | 0.0399 | 3.285 | 15.95 | 1.529 | 18.94 | SQR_QJA |
| 1 | 0.0397 | 0.0087 | 4.335 | 17.00 | 1.579 | 20.00 | SQR_QND |
| 1 | 0.0359 | 0.0048 | 4.468 | 17.13 | 1.585 | 20.13 | SQR_QSO |
| 2 | 0.1786 | 0.1238 | 1.514 | 13.85 | 1.395 | 18.34 | SQR_QJF SQR_QMA |
| 2 | 0.1516 | 0.0950 | 2.450 | 14.91 | 1.441 | 19.40 | SQR_QMA SQR_QJA |
| 2 | 0.1313 | 0.0734 | 3.156 | 15.69 | 1.476 | 20.18 | SQR_QJA SQR_QSO |
| 2 | 0.1023 | 0.0424 | 4.163 | 16.78 | 1.525 | 21.27 | SQR_QSO SQR_QND |
| 3 | 0.2150 | 0.1338 | 2.248 | 14.35 | 1.379 | 20.33 | SQR_QJF SQR_QMA SQR_QJA |
| 3 | 0.2013 | 0.1187 | 2.725 | 14.92 | 1.403 | 20.91 | SQR_QMA SQR_QMJ SQR_QJA |
| 3 | 0.1963 | 0.1132 | 2.899 | 15.13 | 1.412 | 21.11 | SQR_QJF SQR_QMA SQR_QND |
| 3 | 0.1957 | 0.1125 | 2.918 | 15.15 | 1.413 | 21.14 | SQR_QMA SQR_QJA SQR_QSO |
| 4 | 0.2345 | 0.1252 | 3.572 | 15.52 | 1.393 | 23.00 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA |
| 4 | 0.2296 | 0.1195 | 3.743 | 15.73 | 1.402 | 23.21 | SQR_QMA SQR_QMJ SQR_QJA SQR_QSO |
| 4 | 0.2241 | 0.1133 | 3.933 | 15.96 | 1.412 | 23.45 | SQR_QJF SQR_QMA SQR_QJA SQR_QND |
| 4 | 0.2234 | 0.1124 | 3.960 | 16.00 | 1.413 | 23.48 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO |
| 5 | 0.2426 | 0.1023 | 5.293 | 17.17 | 1.430 | 26.15 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO |
| 5 | 0.2397 | 0.0989 | 5.391 | 17.29 | 1.435 | 26.27 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.2381 | 0.0970 | 5.449 | 17.37 | 1.438 | 26.34 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QND |
| 5 | 0.2368 | 0.0955 | 5.492 | 17.42 | 1.440 | 26.40 | SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 6 | 0.2510 | 0.0782 | 7.000 | 18.80 | 1.468 | 29.28 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

N = 33

## 5.5 Square root of flounder data and log of inflow data

***Table 5.5*** *Regression Models for Dependent Variable: Sqrt(FLOUNDER) on Ln(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.0646 | 0.0344 | 1.931 | 66.88 | 7.155 | 69.87 | LN_QMA |
| 1 | 0.0603 | 0.0300 | 2.072 | 67.03 | 7.188 | 70.02 | LN_QJA |
| 1 | 0.0379 | 0.0069 | 2.814 | 67.80 | 7.359 | 70.80 | LN_QSO |
| 1 | 0.0206 | -.0110 | 3.385 | 68.39 | 7.492 | 71.38 | LN_QJF |
| 2 | 0.1374 | 0.0799 | 1.525 | 66.20 | 6.819 | 70.69 | LN_QJF LN_QMA |
| 2 | 0.1302 | 0.0722 | 1.761 | 66.48 | 6.875 | 70.96 | LN_QJA LN_QSO |
| 2 | 0.1221 | 0.0635 | 2.031 | 66.78 | 6.940 | 71.27 | LN_QMA LN_QJA |
| 2 | 0.0964 | 0.0362 | 2.880 | 67.73 | 7.142 | 72.22 | LN_QMA LN_QSO |
| 3 | 0.1829 | 0.0984 | 2.019 | 66.41 | 6.681 | 72.40 | LN_QMA LN_QJA LN_QSO |
| 3 | 0.1750 | 0.0896 | 2.282 | 66.73 | 6.746 | 72.72 | LN_QMA LN_QMJ LN_QJA |
| 3 | 0.1701 | 0.0842 | 2.443 | 66.93 | 6.786 | 72.91 | LN_QJF LN_QMA LN_QJA |
| 3 | 0.1569 | 0.0697 | 2.879 | 67.45 | 6.894 | 73.43 | LN_QJA LN_QSO LN_QND |
| 4 | 0.2058 | 0.0923 | 3.264 | 67.48 | 6.726 | 74.96 | LN_QMA LN_QMJ LN_QJA LN_QSO |
| 4 | 0.1922 | 0.0767 | 3.713 | 68.04 | 6.842 | 75.52 | LN_QJF LN_QMA LN_QMJ LN_QJA |
| 4 | 0.1918 | 0.0764 | 3.723 | 68.05 | 6.844 | 75.53 | LN_QJF LN_QMA LN_QJA LN_QSO |
| 4 | 0.1906 | 0.0749 | 3.766 | 68.10 | 6.855 | 75.59 | LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.2086 | 0.0620 | 5.169 | 69.36 | 6.951 | 78.34 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.2083 | 0.0617 | 5.179 | 69.37 | 6.953 | 78.35 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.2043 | 0.0569 | 5.312 | 69.54 | 6.988 | 78.52 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.1931 | 0.0436 | 5.683 | 70.00 | 7.087 | 78.98 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 6 | 0.2137 | 0.0323 | 7.000 | 71.14 | 7.171 | 81.62 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 33

## 5.6 Various transformation suggested by Box-Cox

***Table 5.6*** *Regression Models for Dependent Variable: $(FLOUNDER)^{0.3}$ on variously transformed INFLOWS.*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 6 | 0.2735 | 0.0659 | 7.000 | -86.42 | 0.0369 | -77.09 | QR_QJF QR_QMA QR_QMJ QR_QJA |
| 1 | 0.0846 | 0.0551 | 1.785 | -8.988 | 0.7182 | -5.995 | LN_QJA |
| 1 | 0.0388 | 0.0078 | 3.327 | -7.375 | 0.7541 | -4.382 | QR_QMA |
| 1 | 0.0306 | -.0007 | 3.601 | -7.096 | 0.7605 | -4.103 | QR_QSO |
| 1 | 0.0242 | -.0072 | 3.815 | -6.880 | 0.7655 | -3.887 | QR_QND |
| 2 | 0.1514 | 0.0948 | 1.539 | -9.487 | 0.6880 | -4.998 | LN_QJA QR_QSO |
| 2 | 0.1177 | 0.0589 | 2.673 | -8.202 | 0.7153 | -3.713 | QR_QMA LN_QJA |
| 2 | 0.1044 | 0.0447 | 3.120 | -7.708 | 0.7261 | -3.219 | QR_QJF QR_QMA |
| 2 | 0.1026 | 0.0428 | 3.179 | -7.644 | 0.7275 | -3.155 | QR_QMJ LN_QJA |
| 3 | 0.1899 | 0.1061 | 2.245 | -9.019 | 0.6794 | -3.033 | LN_QJA QR_QSO QR_QND |
| 3 | 0.1866 | 0.1024 | 2.356 | -8.885 | 0.6822 | -2.899 | QR_QMA LN_QJA QR_QSO |
| 3 | 0.1607 | 0.0739 | 3.226 | -7.852 | 0.7039 | -1.866 | QR_QMA QR_QMJ LN_QJA |
| 3 | 0.1583 | 0.0712 | 3.307 | -7.757 | 0.7059 | -1.771 | QR_QMJ LN_QJA QR_QSO |
| 4 | 0.2108 | 0.0981 | 3.539 | -7.885 | 0.6855 | -0.403 | QR_QMA QR_QMJ LN_QJA QR_QSO |
| 4 | 0.2097 | 0.0968 | 3.579 | -7.836 | 0.6865 | -0.354 | QR_QMA LN_QJA QR_QSO QR_QND |
| 4 | 0.1925 | 0.0772 | 4.155 | -7.128 | 0.7014 | 0.355 | QR_QMJ LN_QJA QR_QSO QR_QND |
| 4 | 0.1905 | 0.0749 | 4.222 | -7.047 | 0.7031 | 0.435 | QR_QJF LN_QJA QR_QSO QR_QND |
| 5 | 0.2236 | 0.0798 | 5.110 | -6.423 | 0.6993 | 2.556 | QR_QMA QR_QMJ LN_QJA QR_QSO QR_QND |
| 5 | 0.2196 | 0.0751 | 5.246 | -6.252 | 0.7030 | 2.727 | QR_QJF QR_QMA LN_QJA QR_QSO QR_QND |
| 5 | 0.2110 | 0.0648 | 5.536 | -5.890 | 0.7107 | 3.089 | QR_QJF QR_QMA QR_QMJ LN_QJA QR_QSO |
| 5 | 0.1925 | 0.0430 | 6.155 | -5.128 | 0.7273 | 3.851 | QR_QJF QR_QMJ LN_QJA QR_QSO QR_QND |
| 6 | 0.2269 | 0.0485 | 7.000 | -4.563 | 0.7232 | 5.913 | QR_QJF QR_QMA QR_QMJ LN_QJA QR_QSO QR_QND |

N = 28

Dependent Variable: $(FLOUNDER)^{0.3}$

Independent Variables:
*QR_QJF*=$(\text{January-February Inflows})^{-0.1}$
*QR_QMA*=$(\text{March-April Inflows})^{-0.7}$
*QR_QMJ*=$(\text{May-June Inflows})^{0.6}$
*QR_QSO*=$(\text{September-October Inflows})^{-0.1}$
*QR_QND*=$(\text{November-December Inflows})^{0.1}$

# 6. REGRESSION FOR THE BEST MODELS

## 6.1 Regression - Log of flounder data on log of inflow data

### 6.1.1 ANOVA and Parameter Estimates

***Table 6.1*** *Model Summary for log of flounder data on log of inflow data.*

**Model Summary[a,b]**

| | Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|
| | Ln(November-December), Ln(May-June), Ln(March-April), Ln(July-August), Ln(September-October), Ln(January-February)[c,d] | .552 | .305 | .144 | 1.167286 | .929 |

a. Dependent Variable: Ln(Flounder Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Ln(November-December Inflows), Ln(May-June Inflows), Ln(March-April Inflows), Ln(July-August Inflows), Ln(September-October Inflows), Ln(January-February Inflows)

d. All requested variables entered.

***Table 6.2*** *ANOVA table of log of flounder data on log of inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 15.532 | 6 | 2.589 | 1.900 | .119[b] |
| | Residual | 35.426 | 26 | 1.363 | | |
| | Total | 50.958 | 32 | | | |

a. Dependent Variable: Ln(Flounder Harvest)

b. Independent Variables: (Constant), Ln(November-December Inflows), Ln(May-June Inflows), Ln(March-April Inflows), Ln(July-August Inflows), Ln(September-October Inflows), Ln(January-February Inflows)

*Table 6.3 Table of coefficients for log of flounder data on log of inflow data.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | 1.679 | 1.543 | | 1.088 | .286 | -1.493 | 4.851 |
| Ln(January-February) | -.238 | .441 | -.134 | -.539 | .594 | -1.144 | .669 |
| Ln(March-April) | .430 | .345 | .258 | 1.246 | .224 | -.279 | 1.139 |
| Ln(May-June) | -.233 | .331 | -.159 | -.705 | .487 | -.914 | .447 |
| Ln(July-August) | .474 | .284 | .370 | 1.666 | .108 | -.111 | 1.059 |
| Ln(September-October) | -.238 | .239 | -.219 | -.997 | .328 | -.728 | .253 |
| Ln(November-December) | .297 | .293 | .218 | 1.014 | .320 | -.305 | .898 |

a. Dependent Variable: Ln(Flounder Harvest)

### 6.1.2 Collinearity Diagnostic

*Table 6.4 Variance Inflation for log of flounder data on log of inflow data.*

**Coefficients[a]**

| | | Collinearity Statistics | |
|---|---|---|---|
| | t | Tolerance | VIF |
| (Constant) | 1.088 | | |
| Ln(January-February) | -.539 | .430 | 2.327 |
| Ln(March-April) | 1.246 | .626 | 1.597 |
| Ln(May-June) | -.705 | .525 | 1.904 |
| Ln(July-August) | 1.666 | .542 | 1.844 |
| Ln(September-October) | -.997 | .552 | 1.810 |
| Ln(November-December) | 1.014 | .581 | 1.723 |

a. Dependent Variable: Ln(Flounder Harvest)

*Table 6.5 Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(FLOUNDER) on Ln(INFLOWS):*

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop LN_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop LN_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.35780 | 1.00000 | 0.0397 | 0.0309 | 0.0482 | 0.0127 | 0.0446 | 0.0503 |
| 2 | 1.30200 | 1.34570 | 0.0715 | 0.0929 | 0.0037 | 0.2075 | 0.0323 | 0.0029 |
| 3 | 1.01015 | 1.52778 | 0.0293 | 0.2076 | 0.0621 | 0.0760 | 0.1640 | 0.0203 |
| 4 | 0.80602 | 1.71033 | 0.0129 | 0.0460 | 0.2281 | 0.0105 | 0.0277 | 0.3678 |
| 5 | 0.29821 | 2.81184 | 0.1632 | 0.6220 | 0.1632 | 0.0042 | 0.7204 | 0.2076 |
| 6 | 0.22582 | 3.23127 | 0.6833 | 0.0006 | 0.4948 | 0.6890 | 0.0110 | 0.3511 |

### 6.1.3 Residuals Diagnostics

***Table 6.6*** *Residuals Diagnostics for log of flounder data on log of inflow data.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 1.541609 | 4.319248 | 2.968871 | .696684 | 33 |
| Std. Predicted Value | -2.049 | 1.938 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | .321586 | .775887 | .528380 | .100745 | 33 |
| Adjusted Predicted Value | 1.630640 | 4.807626 | 2.997863 | .730390 | 33 |
| Residual | -2.521428 | 1.972818 | -7.1E-16 | 1.052178 | 33 |
| Std. Residual | -2.160 | 1.690 | .000 | .901 | 33 |
| Stud. Residual | -2.375 | 1.782 | -.011 | .997 | 33 |
| Deleted Residual | -3.047079 | 2.193346 | -2.9E-02 | 1.292584 | 33 |
| Stud. Deleted Residual | -2.631 | 1.865 | -.019 | 1.037 | 33 |
| Mahal. Distance | 1.459 | 13.168 | 5.818 | 2.601 | 33 |
| Cook's Distance | .000 | .168 | .032 | .041 | 33 |
| Centered Leverage Value | .046 | .412 | .182 | .081 | 33 |

a. Dependent Variable: Ln(Flounder Harvest)

***Table 6.7*** *Case Values for Residuals Diagnostics for log of flounder data on log of inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1961 | 3.09524 | -.5226 | -.7074 | 3.2800 | .1814 | -.4477 | -.5209 | -.5135 |
| 1962 | 2.93480 | -.4171 | -.5178 | 3.0355 | -.0489 | -.3573 | -.3981 | -.3916 |
| 1963 | 2.90710 | -1.0353 | -1.2993 | 3.1711 | -.0887 | -.8869 | -.9936 | -.9933 |
| 1964 | 2.66520 | -.5251 | -.9408 | 3.0809 | -.4359 | -.4499 | -.6021 | -.5946 |
| 1965 | 1.86320 | .1649 | .1958 | 1.8324 | -1.5870 | .1413 | .1540 | .1510 |
| 1966 | 1.89959 | -.1417 | -.1759 | 1.9338 | -1.5348 | -.1214 | -.1353 | -.1327 |
| 1967 | 2.01060 | -2.5214 | -3.0471 | 2.5363 | -1.3755 | -2.1601 | -2.3746 | *-2.6312 |
| 1968 | 1.54161 | -1.1361 | -1.5143 | 1.9197 | -2.0486 | -.9733 | -1.1237 | -1.1296 |
| 1969 | 1.58943 | -.1078 | -.1490 | 1.6306 | -1.9800 | -.0924 | -.1086 | -.1065 |
| 1970 | 2.10466 | -.4369 | -.5202 | 2.1879 | -1.2405 | -.3743 | -.4084 | -.4018 |
| 1971 | 4.27235 | -2.1323 | -2.6676 | 4.8076 | 1.8710 | -1.8267 | -2.0432 | -2.1867 |
| 1972 | 3.49777 | -.6356 | -.7761 | 3.6383 | .7592 | -.5445 | -.6017 | -.5942 |
| 1973 | 3.10402 | .5336 | .6768 | 2.9608 | .1940 | .4571 | .5148 | .5074 |
| 1974 | 2.69173 | 1.3390 | 1.6726 | 2.3581 | -.3978 | 1.1471 | 1.2820 | 1.2989 |
| 1975 | 2.87166 | .3748 | .4174 | 2.8291 | -.1395 | .3211 | .3389 | .3330 |
| 1976 | 3.12976 | .7641 | .8513 | 3.0425 | .2309 | .6546 | .6909 | .6838 |
| 1977 | 4.11419 | -.3098 | -.4010 | 4.2054 | 1.6440 | -.2654 | -.3019 | -.2966 |
| 1978 | 4.31925 | -.0895 | -.1193 | 4.3490 | 1.9383 | -.0767 | -.0885 | -.0868 |
| 1979 | 3.64000 | -.3516 | -.5506 | 3.8390 | .9633 | -.3012 | -.3769 | -.3706 |
| 1980 | 3.36224 | -1.5873 | -2.0358 | 3.8107 | .5646 | -1.3598 | -1.5400 | -1.5840 |
| 1981 | 3.25638 | .3437 | .4545 | 3.1455 | .4127 | .2944 | .3386 | .3327 |
| 1982 | 3.03049 | 1.2790 | 1.6795 | 2.6299 | .0884 | 1.0957 | 1.2556 | 1.2703 |
| 1983 | 2.77035 | .7016 | .8277 | 2.6443 | -.2850 | .6011 | .6528 | .6455 |
| 1984 | 2.49079 | 1.9728 | 2.1933 | 2.2703 | -.6862 | 1.6901 | 1.7820 | 1.8651 |
| 1985 | 2.91893 | 1.8735 | 2.0274 | 2.7651 | -.0717 | 1.6050 | 1.6697 | 1.7328 |
| 1986 | 2.88899 | 1.2915 | 1.4799 | 2.7006 | -.1147 | 1.1064 | 1.1844 | 1.1941 |
| 1987 | 3.19912 | .3004 | .3556 | 3.1439 | .3305 | .2574 | .2800 | .2750 |
| 1988 | 2.99800 | -.9439 | -1.1703 | 3.2244 | .0418 | -.8086 | -.9004 | -.8970 |
| 1989 | 2.95879 | -.6970 | -.8827 | 3.1444 | -.0145 | -.5971 | -.6720 | -.6647 |
| 1990 | 3.66124 | .1410 | .1822 | 3.6200 | .9938 | .1208 | .1373 | .1347 |
| 1991 | 3.53048 | 1.0107 | 1.2650 | 3.2762 | .8061 | .8658 | .9687 | .9675 |
| 1992 | 3.58129 | .3738 | .6316 | 3.3235 | .8791 | .3202 | .4162 | .4095 |
| 1993 | 3.07347 | 1.1267 | 1.6076 | 2.5926 | .1501 | .9653 | 1.1530 | 1.1606 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that obs. |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.

[2]This is flagged if it exceeds $t_{n-p-2,\alpha}=t_{25,0.01}=2.485$.

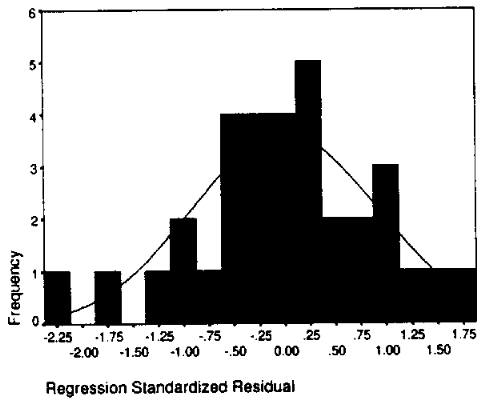


***Figure 6.1*** *Histogram of Standardized Residuals.*

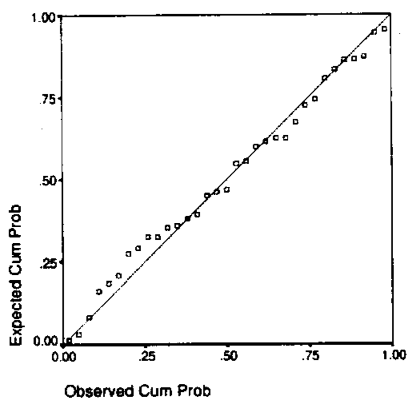


***Figure 6.2*** *Normal P-P Plot of Residuals.*

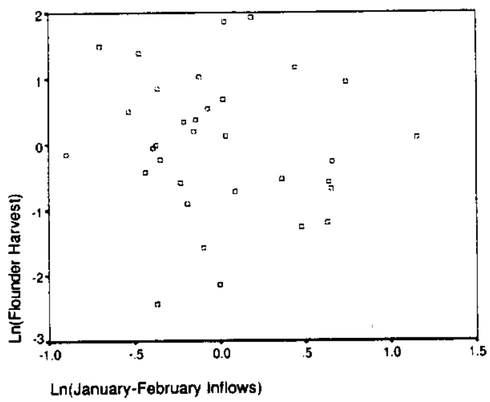


***Figure 6.3*** *Partial Residual Plot for Ln(January-February Inflows).*

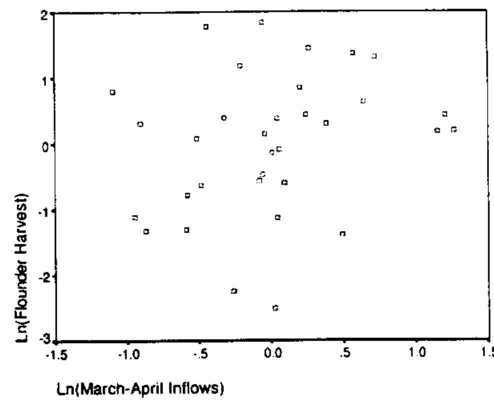


***Figure 6.4*** *Partial Residual Plot for Ln(March-April Inflows).*

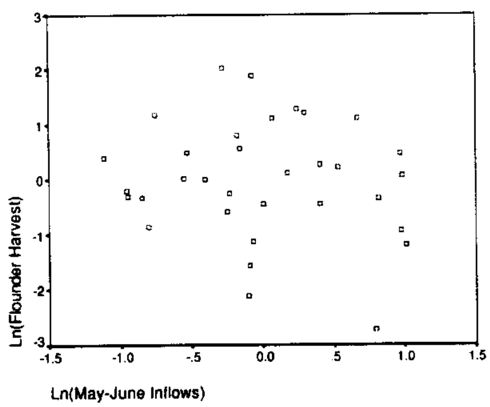


***Figure 6.5*** *Partial Residual Plot for Ln(May-June Inflows).*

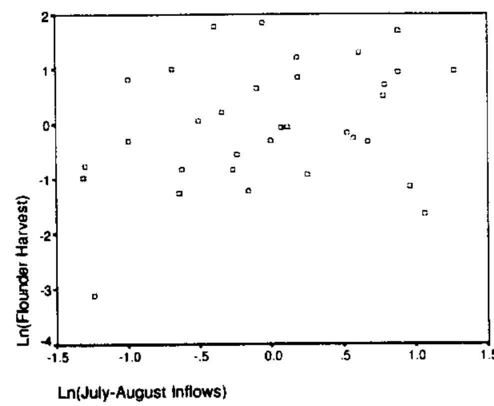


***Figure 6.6*** *Partial Residual Plot for Ln(July-August Inflows).*

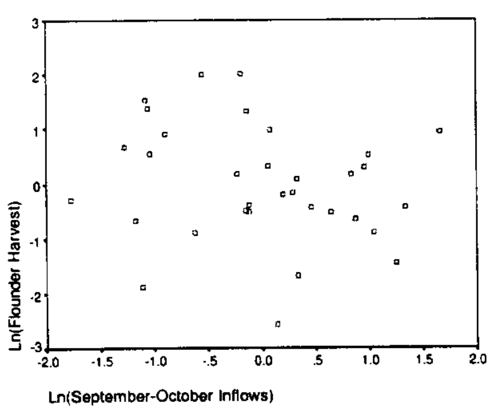


***Figure 6.7*** *Partial Residual Plot for Ln(September-October Inflows).*

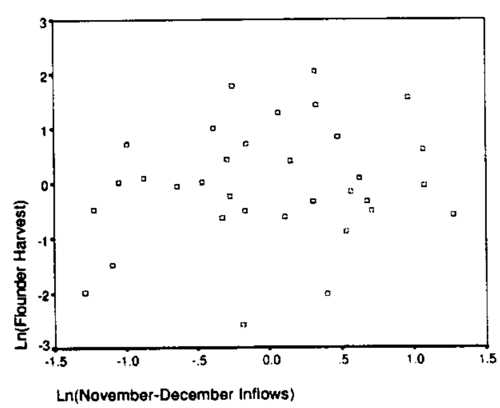


***Figure 6.8*** *Partial Residual Plot for Ln(November-December Inflows).*

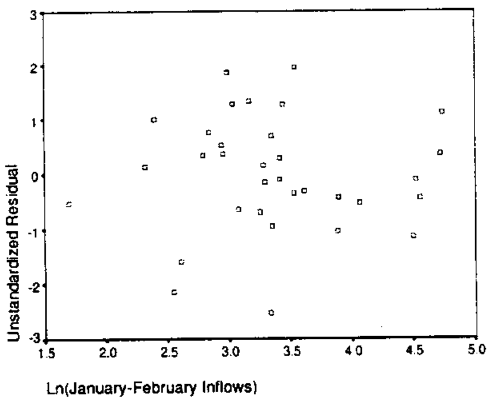


***Figure 6.9*** *Residuals Plot for Ln(January-February Inflows).*

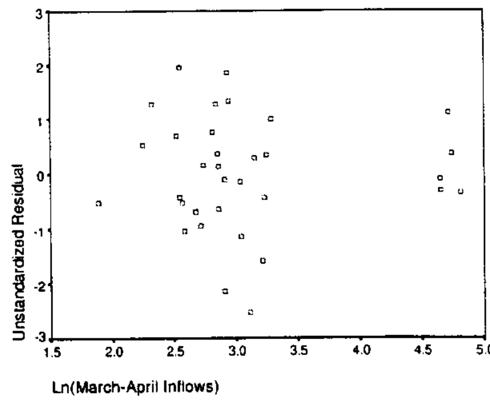


***Figure 6.10*** *Residuals Plot for Ln(March-April Inflows).*

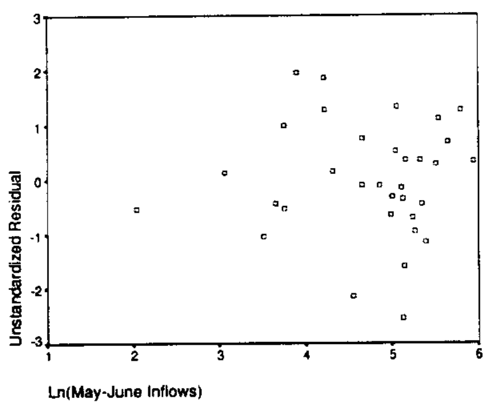


***Figure 6.11*** *Residuals Plot for Ln(May-June Inflows).*

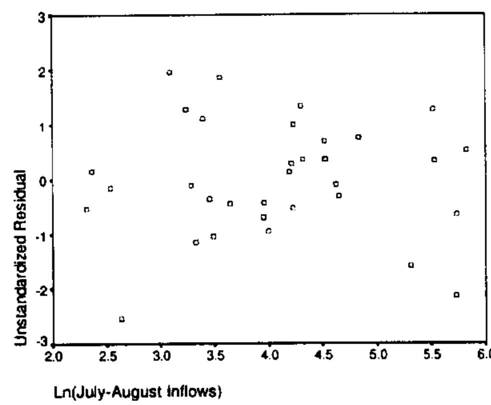


***Figure 6.12*** *Residuals Plot for Ln(July-August Inflows).*

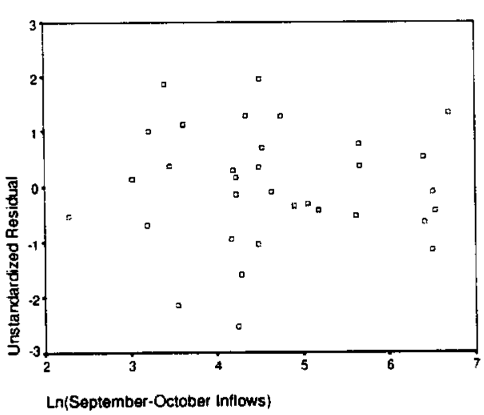


***Figure 6.13*** *Residuals Plot for Ln(September-October Inflows).*

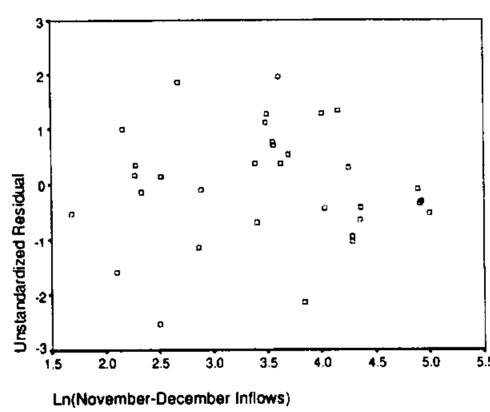


***Figure 6.14*** *Residuals Plot for Ln(November-December Inflows).*

### 6.1.4 Prediction Intervals for Flounder Harvest

***Table 6.8*** *Prediction Intervals for Flounder Harvest.*

| YEAR | *LICI_1* | *LN_FLOUN* | *UICI_1* |
|---|---|---|---|
| 1961 | -.5474 | 2.5726 | 6.7379 |
| 1962 | -.6101 | 2.5177 | 6.4797 |
| 1963 | -.6508 | 1.8718 | 6.4650 |
| 1964 | -1.2295 | 2.1401 | 6.5599 |
| 1965 | -1.6265 | 2.0281 | 5.3529 |
| 1966 | -1.6453 | 1.7579 | 5.4445 |
| 1967 | -1.5016 | -.5108 | 5.5228 |
| 1968 | -2.0844 | .4055 | 5.1676 |
| 1969 | -2.0752 | 1.4816 | 5.2541 |
| 1970 | -1.3889 | 1.6677 | 5.5982 |
| 1971 | .7182 | 2.1401 | 7.8265 |
| 1972 | -.0273 | 2.8622 | 7.0228 |
| 1973 | -.4663 | 3.6376 | 6.6744 |
| 1974 | -.8606 | 4.0307 | 6.2441 |
| 1975 | -.5333 | 3.2465 | 6.2766 |
| 1976 | -.2759 | 3.8939 | 6.5354 |
| 1977 | .5206 | 3.8044 | 7.7078 |
| 1978 | .6931 | 4.2297 | 7.9453 |
| 1979 | -.1446 | 3.2884 | 7.4246 |
| 1980 | -.2208 | 1.7750 | 6.9453 |
| 1981 | -.3611 | 3.6000 | 6.8739 |
| 1982 | -.5792 | 4.3095 | 6.6402 |
| 1983 | -.7115 | 3.4720 | 6.2522 |
| 1984 | -.9119 | 4.4636 | 5.8935 |
| 1985 | -.4455 | 4.7925 | 6.2833 |
| 1986 | -.5548 | 4.1805 | 6.3328 |
| 1987 | -.2872 | 3.4995 | 6.6855 |
| 1988 | -.5454 | 2.0541 | 6.5414 |
| 1989 | -.6096 | 2.2618 | 6.5272 |
| 1990 | .0693 | 3.8022 | 7.2532 |
| 1991 | -.0242 | 4.5412 | 7.0852 |
| 1992 | -.2677 | 3.9551 | 7.4303 |
| 1993 | -.6235 | 4.2002 | 6.7704 |

*LICI_1* Lower limit for 99% prediction interval for the natural log of flounder harvest.

*LN_FLOUNDER* Natural log of flounder harvest

*UICI_1* Upper limit for 99% prediction interval for the natural log of flounder harvest.

### 6.1.5 Outliers and Influential Point Detection

***Table 6.9*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1961 | 7.3889 | .0137 | .2309 | .3895 | .0000 |
| 1962 | 5.2527 | .0055 | .1641 | .6292 | .0000 |
| 1963 | 5.5326 | .0360 | .1729 | .5953 | .0001 |
| 1964 | 13.1684 | .0410 | .4115 | .0681 | .0001 |
| 1965 | 4.0713 | .0006 | .1272 | .7715 | .0000 |
| 1966 | 5.2530 | .0006 | .1642 | .6291 | .0000 |
| 1967 | 4.5506 | .1679 | .1422 | .7146 | .0104 |
| 1968 | 7.0208 | .0600 | .2194 | .4267 | .0004 |
| 1969 | 7.8788 | .0006 | .2462 | .3434 | .0000 |
| 1970 | 4.1531 | .0045 | .1298 | .7620 | .0000 |
| 1971 | 5.4514 | .1497 | .1704 | .6050 | .0074 |
| 1972 | 4.8256 | .0114 | .1508 | .6812 | .0000 |
| 1973 | 5.8034 | .0102 | .1814 | .5629 | .0000 |
| 1974 | 5.4128 | .0585 | .1691 | .6097 | .0004 |
| 1975 | 2.2945 | .0019 | .0717 | .9418 | .0000 |
| 1976 | 2.3091 | .0078 | .0722 | .9408 | .0000 |
| 1977 | 6.3106 | .0038 | .1972 | .5040 | .0000 |
| 1978 | 7.0236 | .0004 | .2195 | .4264 | .0000 |
| 1979 | 10.5957 | .0115 | .3311 | .1573 | .0000 |
| 1980 | 6.0798 | .0957 | .1900 | .5305 | .0019 |
| 1981 | 6.8341 | .0053 | .2136 | .4464 | .0000 |
| 1982 | 6.6621 | .0705 | .2082 | .4649 | .0007 |
| 1983 | 3.9053 | .0109 | .1220 | .7906 | .0000 |
| 1984 | 2.2477 | .0507 | .0702 | .9449 | .0002 |
| 1985 | 1.4591 | .0327 | .0456 | .9837 | .0001 |
| 1986 | 3.1041 | .0292 | .0970 | .8752 | .0000 |
| 1987 | 4.0001 | .0021 | .1250 | .7798 | .0000 |
| 1988 | 5.2205 | .0278 | .1631 | .6331 | .0000 |
| 1989 | 5.7606 | .0172 | .1800 | .5680 | .0000 |
| 1990 | 6.2734 | .0008 | .1960 | .5082 | .0000 |
| 1991 | 5.4636 | .0337 | .1707 | .6036 | .0001 |
| 1992 | 12.0912 | .0171 | .3779 | .0976 | .0000 |
| 1993 | 8.6015 | .0810 | .2688 | .2825 | .0011 |

*MAH_1* Mahalanobis distance

*COOK_1* Cook's distance

*LEV_1* Leverage value

*MAHA_PV* P-value associated with the Mahalanobis distance

*COOK_P* P-value associated with Cook's distance

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.

[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n-p-1$ denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.10*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1961 | -.3053 | .0145 | -.1470 | .1019 |
| 1962 | -.1924 | -.0156 | -.1046 | .0620 |
| 1963 | -.5016 | -.1150 | -.2644 | .1934 |
| 1964 | -.5290 | -.5022 | .1305 | .0184 |
| 1965 | .0653 | .0406 | -.0095 | -.0018 |
| 1966 | -.0652 | -.0267 | .0218 | -.0004 |
| 1967 | *-1.2014 | -.4649 | .4063 | -.0230 |
| 1968 | -.6517 | .1462 | -.2336 | -.0167 |
| 1969 | -.0658 | .0105 | -.0310 | -.0021 |
| 1970 | -.1754 | .0685 | -.0598 | .0068 |
| 1971 | *-1.0956 | -.0214 | .0008 | .1878 |
| 1972 | -.2794 | .0899 | .0575 | -.0186 |
| 1973 | .2629 | -.0538 | -.0153 | -.0543 |
| 1974 | .6483 | -.0300 | -.3857 | .1140 |
| 1975 | .1122 | .0027 | -.0711 | .0044 |
| 1976 | .2311 | .0075 | -.0999 | .0434 |
| 1977 | -.1610 | .0611 | .0443 | -.1149 |
| 1978 | -.0501 | .0131 | .0141 | -.0357 |
| 1979 | -.2788 | .0284 | .1570 | -.1734 |
| 1980 | -.8420 | .0498 | .0631 | -.2617 |
| 1981 | .1890 | -.0412 | -.0202 | .0270 |
| 1982 | .7109 | -.1729 | .2404 | -.4706 |
| 1983 | .2736 | -.0071 | .0057 | -.1862 |
| 1984 | .6236 | .3354 | .1382 | -.2553 |
| 1985 | .4966 | .3183 | .0204 | -.0286 |
| 1986 | .4561 | .2481 | -.2287 | -.0787 |
| 1987 | .1179 | -.0035 | -.0239 | -.0454 |
| 1988 | -.4393 | -.0563 | .0708 | .2560 |
| 1989 | -.3430 | -.0704 | -.0252 | .2082 |
| 1990 | .0729 | .0383 | .0021 | .0173 |
| 1991 | .4853 | .1913 | -.0489 | .2299 |
| 1992 | .3401 | -.1470 | .2322 | .1006 |
| 1993 | .7582 | -.2695 | .3859 | .2342 |

*SDFFITS* Standardized *dffits* value
*SDFBET_0* Standardized *dfbeta* for the intercept term
*SDFBET_1* Standardized *dfbeta* for log of January-February inflows
*SDFBET_2* Standardized *dfbeta* for log of March-April inflows

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p + 1) / n}$ for a large data set. The cutoff used here is 1.

***Table 6.11*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1961 | .1606 | -.0832 | .0140 | -.1022 |
| 1962 | .1183 | -.0560 | .0107 | -.0337 |
| 1963 | .2535 | -.0675 | .1413 | -.1481 |
| 1964 | .1917 | .1207 | .0240 | .0648 |
| 1965 | .0080 | -.0398 | .0110 | -.0190 |
| 1966 | -.0344 | .0466 | -.0058 | .0101 |
| 1967 | -.6519 | .8702 | -.0828 | .1363 |
| 1968 | .0262 | .0496 | -.3343 | .3579 |
| 1969 | .0195 | -.0035 | -.0343 | .0384 |
| 1970 | -.0004 | .0255 | -.0782 | .0182 |
| 1971 | .0710 | -.6333 | .5542 | -.2432 |
| 1972 | .0459 | -.1076 | -.1404 | -.0177 |
| 1973 | -.0258 | .1228 | .1122 | -.0420 |
| 1974 | .0990 | -.2414 | .4939 | .1208 |
| 1975 | .0403 | -.0292 | .0600 | .0128 |
| 1976 | -.0366 | .0332 | .1469 | -.0282 |
| 1977 | .0224 | -.0002 | -.0314 | -.0479 |
| 1978 | .0115 | -.0016 | -.0058 | -.0157 |
| 1979 | -.0531 | .1478 | -.0615 | -.1249 |
| 1980 | .0479 | -.4194 | -.1220 | .5789 |
| 1981 | .0575 | .0734 | .0048 | -.1000 |
| 1982 | .2765 | .3134 | -.3197 | .0230 |
| 1983 | .1933 | -.0164 | -.1283 | .0836 |
| 1984 | -.1532 | -.1861 | -.0767 | .1568 |
| 1985 | -.0382 | -.0231 | -.2009 | -.1140 |
| 1986 | .1065 | -.3084 | -.0364 | .3101 |
| 1987 | .0835 | -.0366 | -.0632 | .0803 |
| 1988 | -.2864 | .1563 | .2401 | -.3195 |
| 1989 | -.2069 | .0486 | .2704 | -.1331 |
| 1990 | -.0483 | .0290 | -.0072 | -.0246 |
| 1991 | -.2320 | .1610 | .0179 | -.2669 |
| 1992 | -.0795 | .1646 | -.1381 | -.1167 |
| 1993 | .0266 | .0615 | -.2998 | -.1344 |

*SDFBET_3* Standardized *dfbeta* for log of May-June inflows
*SDFBET_4* Standardized *dfbeta* for log of July-August inflows
*SDFBET_5* Standardized *dfbeta* for log of September-October inflows
*SDFBET_6* Standardized *dfbeta* for log of November-December inflows

[*]Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p + 1) / n}$ for a large data set. The cutoff used here is 1.

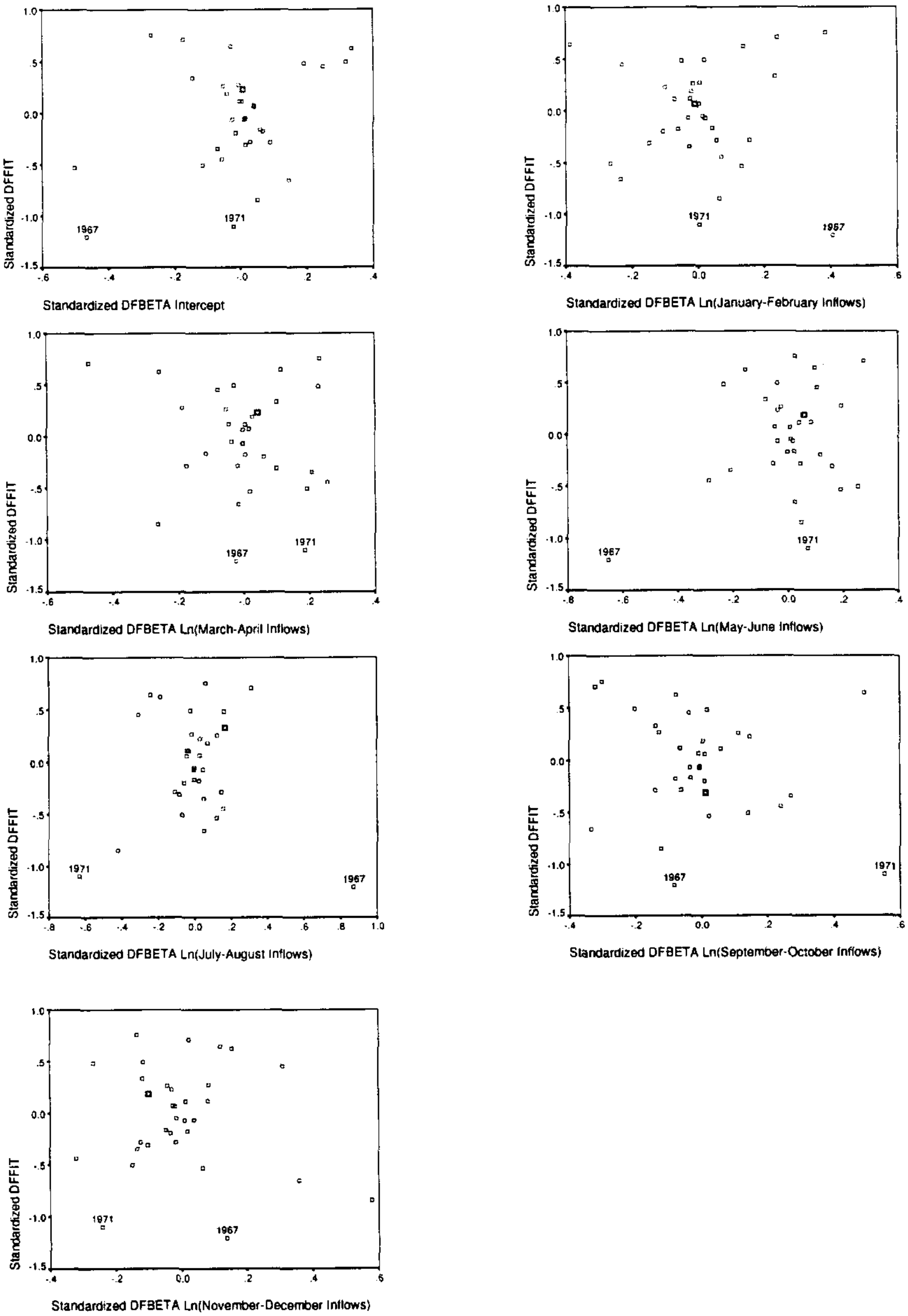


***Figure 6.15*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of log of inflow variables.*

## 6.2 Regression - Log of flounder data on square root of inflow data

### 6.2.1 ANOVA and Parameter Estimates

***Table 6.12*** *Model Summary for log of flounder data on square root of inflow data.*

**Model Summary[a,b]**

| Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| Sqrt(November-December), Sqrt(May-June), Sqrt(September-October), Sqrt(July-August), Sqrt(March-April), Sqrt(January-February)[c,d] | .501 | .251 | .078 | 1.211606 | .826 |

a. Dependent Variable: Ln(Flounder Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of May-June Inflows, Square Root of September-October Inflows, Square Root of July-August Inflows, Square Root of March-April Inflows, Square Root of January-February Inflows

d. All requested variables entered.

***Table 6.13*** *ANOVA table of log of flounder data on square root of inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 12.791 | 6 | 2.132 | 1.452 | .233[b] |
| | Residual | 38.168 | 26 | 1.468 | | |
| | Total | 50.958 | 32 | | | |

a. Dependent Variable: Ln(Flounder Harvest)

b. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of May-June Inflows, Square Root of September-October Inflows, Square Root of July-August Inflows, Square Root of March-April Inflows, Square Root of January-February Inflows

***Table 6.14*** *Table of coefficients for log of flounder data on square root of inflow data.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | 2.398 | .942 | | 2.545 | .017 | .461 | 4.336 |
| Sqrt(January-February) | -.100 | .143 | -.171 | -.702 | .489 | -.393 | .193 |
| Sqrt(March-April) | .171 | .118 | .329 | 1.451 | .159 | -.071 | .414 |
| Sqrt(May-June) | -4.2E-02 | .067 | -.133 | -.626 | .537 | -.178 | .095 |
| Sqrt(July-August) | 8.5E-02 | .064 | .293 | 1.330 | .195 | -.046 | .215 |
| Sqrt(September-October) | -2.5E-02 | .037 | -.145 | -.670 | .509 | -.100 | .051 |
| Sqrt(November-December) | 5.0E-02 | .092 | .111 | .541 | .593 | -.139 | .238 |

a. Dependent Variable: Ln(Flounder Harvest)

### 6.2.2 Collinearity Diagnostic

***Table 6.15*** *Collinearity Diagnostic for log of flounder data on square root of inflow data.*

**Coefficients[a]**

| | | Collinearity Statistics | |
|---|---|---|---|
| | t | Tolerance | VIF |
| (Constant) | 2.545 | | |
| Sqrt(January-February) | -.702 | .485 | 2.061 |
| Sqrt(March-April) | 1.451 | .560 | 1.785 |
| Sqrt(May-June) | -.626 | .637 | 1.569 |
| Sqrt(July-August) | 1.330 | .594 | 1.684 |
| Sqrt(September-October) | -.670 | .615 | 1.627 |
| Sqrt(November-December) | .541 | .684 | 1.462 |

a. Dependent Variable: Ln(Flounder Harvest)

***Table 6.16*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(FLOUNDER) on Sqrt(INFLOWS).*

| *Condition* | Var Prop | Var Prop | Var Prop | Var Prop | Var Prop | Var Prop | | |
|---|---|---|---|---|---|---|---|---|
| Number | *Eigenvalue* | *Index* | *SQR_QJF* | *SQR_QMA* | *SQR_QMJ* | *SQR_QJA* | *SQR_QSO* | *SQR_QND* |
| 1 | 1.91956 | 1.00000 | 0.0755 | 0.0657 | 0.0553 | 0.0015 | 0.0384 | 0.0658 |
| 2 | 1.43262 | 1.15754 | 0.0326 | 0.0432 | 0.0524 | 0.2180 | 0.0640 | 0.0000 |
| 3 | 1.06613 | 1.34183 | 0.0335 | 0.1378 | 0.0665 | 0.0564 | 0.2590 | 0.0015 |
| 4 | 1.00755 | 1.38028 | 0.0460 | 0.0092 | 0.1865 | 0.0200 | 0.0001 | 0.3794 |
| 5 | 0.31616 | 2.46404 | 0.0313 | 0.4102 | 0.5553 | 0.2871 | 0.1424 | 0.5333 |
| 6 | 0.25798 | 2.72777 | 0.7811 | 0.3339 | 0.0840 | 0.4170 | 0.4960 | 0.0200 |

### 6.2.3 Residuals Diagnostics

***Table 6.17*** *Residuals Diagnostics for log of flounder data on square root of inflow data.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 1.637388 | 4.350613 | 2.968871 | .632223 | 33 |
| Std. Predicted Value | -2.106 | 2.186 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | .348090 | .788428 | .545885 | .117559 | 33 |
| Adjusted Predicted Value | 1.802186 | 4.720810 | 2.979324 | .707085 | 33 |
| Residual | -2.935338 | 1.883268 | 2.2E-16 | 1.092127 | 33 |
| Std. Residual | -2.423 | 1.554 | .000 | .901 | 33 |
| Stud. Residual | -2.600 | 1.627 | -.004 | 1.000 | 33 |
| Deleted Residual | -3.382002 | 2.087097 | -1.0E-02 | 1.350702 | 33 |
| Stud. Deleted Residual | -2.964 | 1.683 | -.014 | 1.044 | 33 |
| Mahal. Distance | 1.672 | 12.581 | 5.818 | 2.813 | 33 |
| Cook's Distance | .001 | .169 | .034 | .044 | 33 |
| Centered Leverage Value | .052 | .393 | .182 | .088 | 33 |

a. Dependent Variable: Ln(Flounder Harvest)

***Table 6.18*** *Case Values for Residuals Diagnostics for log of flounder data on square root of inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1961 | 2.8811 | -.3085 | -.4607 | 3.0333 | -.1388 | -.2546 | -.3111 | -.3057 |
| 1962 | 2.7751 | -.2574 | -.3135 | 2.8312 | -.3064 | -.2125 | -.2345 | -.2302 |
| 1963 | 2.7613 | -.8895 | -1.1090 | 2.9808 | -.3283 | -.7341 | -.8197 | -.8144 |
| 1964 | 2.7975 | -.6575 | -.9079 | 3.0480 | -.2710 | -.5426 | -.6377 | -.6302 |
| 1965 | 2.4245 | -.3964 | -.4480 | 2.4761 | -.8610 | -.3271 | -.3478 | -.3418 |
| 1966 | 2.3825 | -.6247 | -.7279 | 2.4858 | -.9274 | -.5156 | -.5566 | -.5490 |
| 1967 | 2.4245 | -2.9353 | -3.3820 | 2.8712 | -.8610 | -2.4227 | -2.6005 | *-2.9645 |
| 1968 | 1.6374 | -1.2319 | -1.6675 | 2.0730 | -2.1060 | -1.0168 | -1.1830 | -1.1925 |
| 1969 | 1.7118 | -.2302 | -.3206 | 1.8022 | -1.9884 | -.1900 | -.2242 | -.2200 |
| 1970 | 1.9284 | -.2607 | -.3311 | 1.9988 | -1.6458 | -.2151 | -.2425 | -.2380 |
| 1971 | 4.0468 | -1.9067 | -2.5807 | 4.7208 | 1.7050 | -1.5737 | -1.8309 | -1.9236 |
| 1972 | 3.4637 | -.6015 | -.7885 | 3.6507 | .7827 | -.4965 | -.5684 | -.5608 |
| 1973 | 3.2379 | .3997 | .5450 | 3.0926 | .4255 | .3299 | .3852 | .3788 |
| 1974 | 2.5587 | 1.4720 | 2.0871 | 1.9436 | -.6488 | 1.2149 | 1.4467 | 1.4794 |
| 1975 | 2.8228 | .4237 | .4652 | 2.7813 | -.2310 | .3497 | .3664 | .3602 |
| 1976 | 3.0851 | .8087 | .8815 | 3.0124 | .1839 | .6675 | .6969 | .6898 |
| 1977 | 4.1762 | -.3718 | -.4925 | 4.2970 | 1.9097 | -.3069 | -.3532 | -.3472 |
| 1978 | 4.3506 | -.1209 | -.1642 | 4.3939 | 2.1855 | -.0998 | -.1163 | -.1140 |
| 1979 | 3.9438 | -.6554 | -1.0587 | 4.3471 | 1.5421 | -.5410 | -.6875 | -.6804 |
| 1980 | 3.4771 | -1.7021 | -2.0399 | 3.8148 | .8039 | -1.4049 | -1.5379 | -1.5817 |
| 1981 | 3.3191 | .2809 | .3815 | 3.2186 | .5540 | .2318 | .2702 | .2653 |
| 1982 | 2.9866 | 1.3228 | 1.7704 | 2.5391 | .0281 | 1.0918 | 1.2630 | 1.2784 |
| 1983 | 2.6350 | .8370 | 1.0045 | 2.4675 | -.5281 | .6908 | .7568 | .7504 |
| 1984 | 2.5978 | 1.8658 | 2.0603 | 2.4033 | -.5869 | 1.5399 | 1.6182 | 1.6733 |
| 1985 | 2.9092 | 1.8833 | 2.0630 | 2.7295 | -.0944 | 1.5544 | 1.6268 | 1.6832 |
| 1986 | 2.8898 | 1.2908 | 1.4304 | 2.7501 | -.1251 | 1.0653 | 1.1215 | 1.1273 |
| 1987 | 2.9341 | .5654 | .6888 | 2.8107 | -.0550 | .4667 | .5151 | .5077 |
| 1988 | 2.8030 | -.7489 | -.9193 | 2.9734 | -.2624 | -.6181 | -.6848 | -.6776 |
| 1989 | 2.7329 | -.4711 | -.5415 | 2.8033 | -.3733 | -.3888 | -.4169 | -.4102 |
| 1990 | 3.3581 | .4441 | .5448 | 3.2574 | .6156 | .3666 | .4060 | .3994 |
| 1991 | 3.4080 | 1.1331 | 1.3794 | 3.1617 | .6946 | .9352 | 1.0319 | 1.0332 |
| 1992 | 3.4390 | .5161 | .8951 | 3.0599 | .7436 | .4260 | .5610 | .5535 |
| 1993 | 3.0732 | 1.1270 | 1.7114 | 2.4888 | .1650 | .9302 | 1.1463 | 1.1535 |

*PRE_1* Predicted value of harvest
*RES_1* Ordinary residuals: observed harvest minus predicted harvest
*DRE_1* Deleted residuals: residuals obtained when the model is fitted without that observation
*ADJ_1* Adjusted predicted value: predicted value of harvest when the model is fitted without that observation
*ZPR_1* Z-score of the predicted value of harvest
*ZRE_1* Z-score of the residual
*SRE_1* Studentized residual
*SDR_1* Studentized deleted residuals

[1]Values greater than 3 are flagged.
[2]This is flagged if it exceeds $t_{n-p-2,\alpha}=t_{25,0.01}=2.485$.

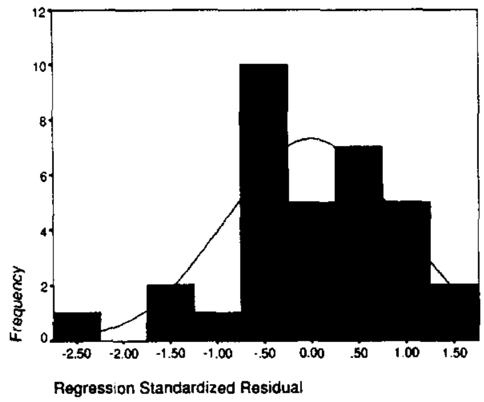


***Figure 6.16*** *Histogram of Standardized Residuals.*

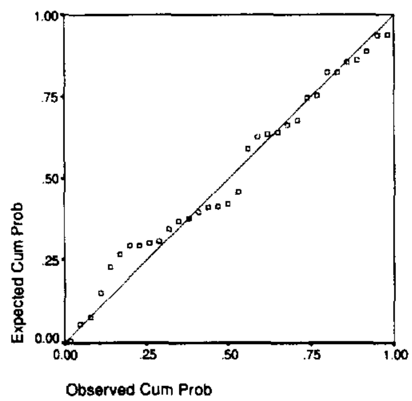


***Figure 6.17*** *Normal P-P Plot of Residuals.*

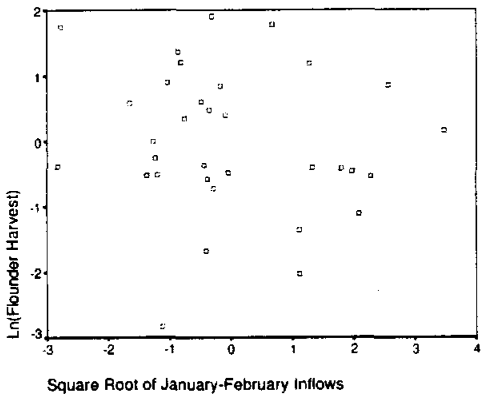


*Figure 6.18* *Partial Residual Plot for Sqrt(January-February Inflows).*

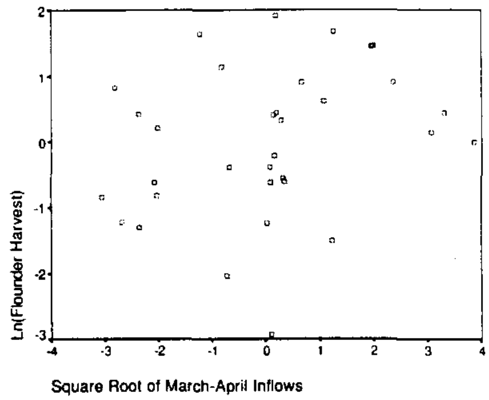


*Figure 6.19* *Partial Residual Plot for Sqrt(March-April Inflows).*

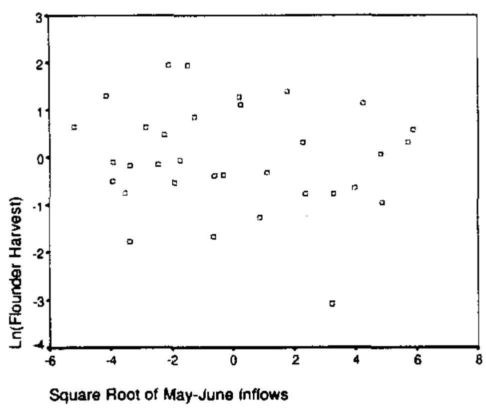


*Figure 6.20* *Partial Residual Plot for Sqrt(May-June Inflows).*

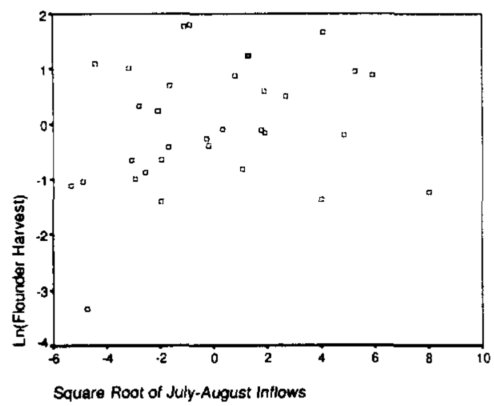


*Figure 6.21* *Partial Residual Plot for Sqrt(July-August Inflows).*

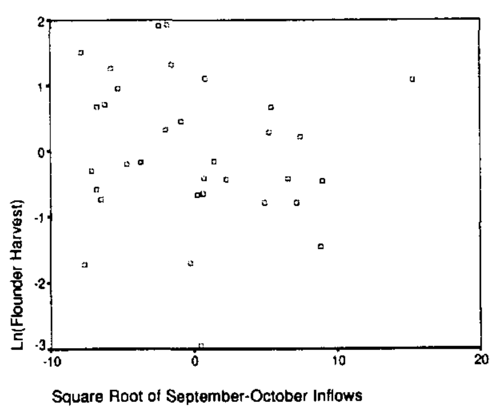


*Figure 6.22* *Partial Residual Plot for Sqrt(September-October Inflows).*

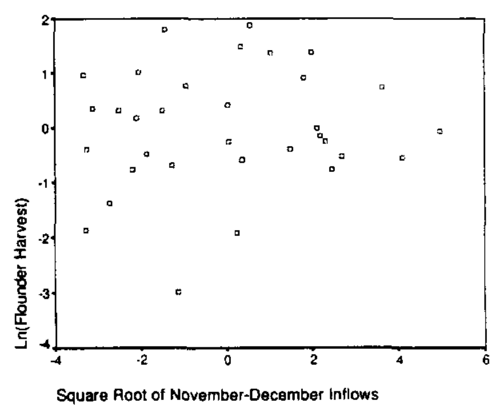


*Figure 6.23* *Partial Residual Plot for Sqrt(November-December Inflows).*

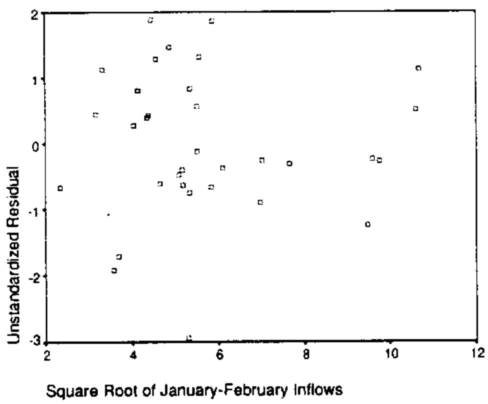


***Figure 6.24*** *Residuals Plot for Sqrt(January-February Inflows).*

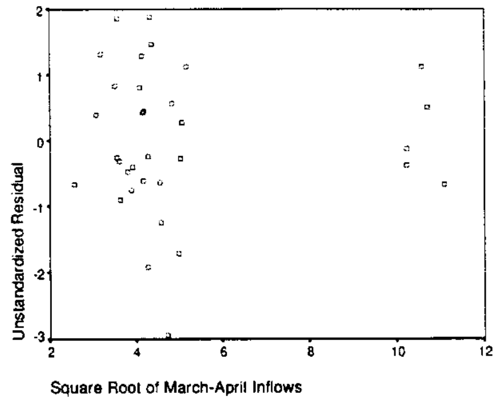


***Figure 6.25*** *Residuals Plot for Sqrt(March-April Inflows).*

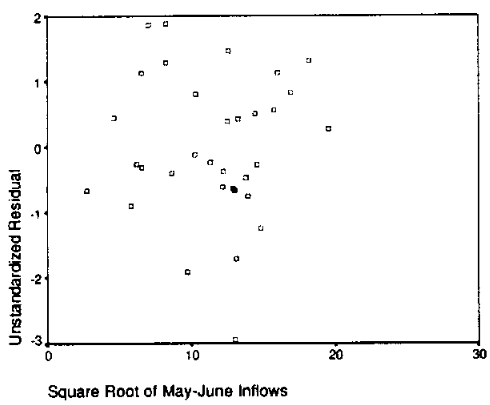


***Figure 6.26*** *Residuals Plot for Sqrt(May-June Inflows).*

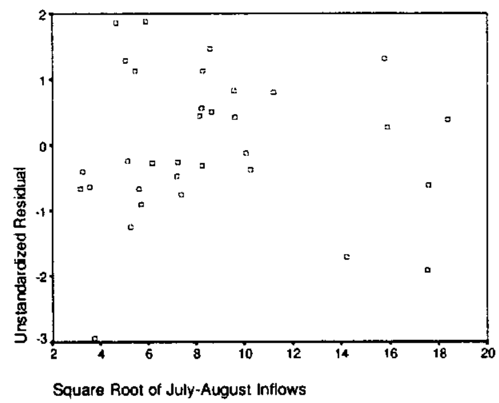


***Figure 6.27*** *Residuals Plot for Sqrt(July-August Inflows).*

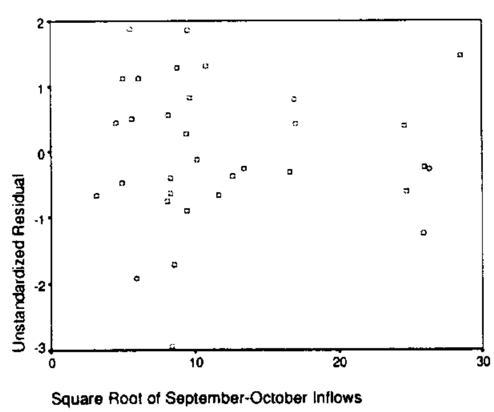


***Figure 6.28*** *Residuals Plot for Sqrt(September-October Inflows).*

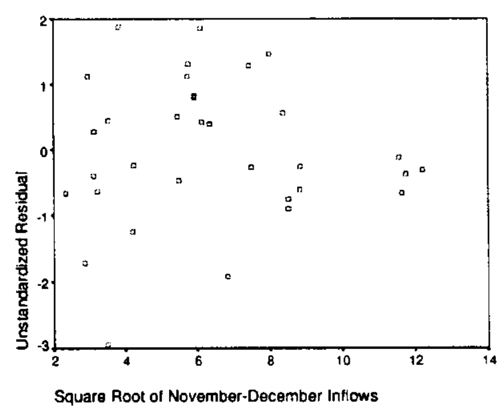


***Figure 6.29*** *Residuals Plot for Sqrt(November-December Inflows).*

### 6.2.4 Prediction Intervals for Flounder Harvest

***Table 6.19*** *Prediction Intervals for Flounder Harvest.*

| YEAR | *LICI_1* | *LN_FLOUN* | *UICI_1* |
|---|---|---|---|
| 1961 | -1.0020 | 2.5726 | 6.7642 |
| 1962 | -.8802 | 2.5177 | 6.4305 |
| 1963 | -.9236 | 1.8718 | 6.4461 |
| 1964 | -1.0052 | 2.1401 | 6.6003 |
| 1965 | -1.1310 | 2.0281 | 5.9800 |
| 1966 | -1.2151 | 1.7579 | 5.9801 |
| 1967 | -1.1576 | -.5108 | 6.0066 |
| 1968 | -2.1436 | .4055 | 5.4184 |
| 1969 | -2.1003 | 1.4816 | 5.5238 |
| 1970 | -1.7791 | 1.6677 | 5.6358 |
| 1971 | .2659 | 2.1401 | 7.8277 |
| 1972 | -.2809 | 2.8622 | 7.2084 |
| 1973 | -.5512 | 3.6376 | 7.0270 |
| 1974 | -1.2721 | 4.0307 | 6.3895 |
| 1975 | -.6910 | 3.2465 | 6.3366 |
| 1976 | -.4178 | 3.8939 | 6.5880 |
| 1977 | .4195 | 3.8044 | 7.9330 |
| 1978 | .5658 | 4.2297 | 8.1354 |
| 1979 | -.0125 | 3.2884 | 7.9001 |
| 1980 | -.1576 | 1.7750 | 7.1118 |
| 1981 | -.4655 | 3.6000 | 7.1037 |
| 1982 | -.7817 | 4.3095 | 6.7550 |
| 1983 | -1.0016 | 3.4720 | 6.2716 |
| 1984 | -.9242 | 4.4636 | 6.1198 |
| 1985 | -.6011 | 4.7925 | 6.4195 |
| 1986 | -.6375 | 4.1805 | 6.4170 |
| 1987 | -.7217 | 3.4995 | 6.5899 |
| 1988 | -.8624 | 2.0541 | 6.4685 |
| 1989 | -.8459 | 2.2618 | 6.3117 |
| 1990 | -.3065 | 3.8022 | 7.0226 |
| 1991 | -.2469 | 4.5412 | 7.0629 |
| 1992 | -.5778 | 3.9551 | 7.4557 |
| 1993 | -.8262 | 4.2002 | 6.9726 |

*LICI_1* Lower limit for 99% prediction interval for the log of flounder harvest.

*LN_FLOUN* Log of flounder harvest

*UICI_1* Upper limit for 99% prediction interval for the log of flounder harvest.

### 6.2.5 Outliers and Influential Point Detection

***Table 6.20*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1961 | 9.6005 | .0068 | .3000 | .2124 | .0000 |
| 1962 | 4.7521 | .0017 | .1485 | .6902 | .0000 |
| 1963 | 5.3639 | .0237 | .1676 | .6157 | .0000 |
| 1964 | 7.8567 | .0221 | .2455 | .3454 | .0000 |
| 1965 | 2.7194 | .0023 | .0850 | .9097 | .0000 |
| 1966 | 3.5700 | .0073 | .1116 | .8278 | .0000 |
| 1967 | 3.2566 | .1470 | .1018 | .8603 | .0070 |
| 1968 | 7.3898 | .0707 | .2309 | .3894 | .0007 |
| 1969 | 8.0566 | .0028 | .2518 | .3276 | .0000 |
| 1970 | 5.8363 | .0023 | .1824 | .5590 | .0000 |
| 1971 | 7.3879 | .1693 | .2309 | .3896 | .0107 |
| 1972 | 6.6182 | .0143 | .2068 | .4697 | .0000 |
| 1973 | 7.5631 | .0077 | .2363 | .3727 | .0000 |
| 1974 | 8.4609 | .1249 | .2644 | .2937 | .0043 |
| 1975 | 1.8876 | .0019 | .0590 | .9658 | .0000 |
| 1976 | 1.6716 | .0062 | .0522 | .9758 | .0000 |
| 1977 | 6.8747 | .0058 | .2148 | .4420 | .0000 |
| 1978 | 7.4723 | .0007 | .2335 | .3814 | .0000 |
| 1979 | 11.2194 | .0415 | .3506 | .1293 | .0001 |
| 1980 | 4.3283 | .0670 | .1353 | .7413 | .0006 |
| 1981 | 7.4671 | .0037 | .2333 | .3819 | .0000 |
| 1982 | 7.1201 | .0771 | .2225 | .4165 | .0009 |
| 1983 | 4.3662 | .0164 | .1364 | .7368 | .0000 |
| 1984 | 2.0512 | .0390 | .0641 | .9570 | .0001 |
| 1985 | 1.8180 | .0361 | .0568 | .9692 | .0001 |
| 1986 | 2.1551 | .0194 | .0673 | .9508 | .0000 |
| 1987 | 4.7614 | .0083 | .1488 | .6891 | .0000 |
| 1988 | 4.9613 | .0152 | .1550 | .6647 | .0000 |
| 1989 | 3.1890 | .0037 | .0997 | .8670 | .0000 |
| 1990 | 4.9425 | .0053 | .1545 | .6670 | .0000 |
| 1991 | 4.7438 | .0331 | .1482 | .6912 | .0001 |
| 1992 | 12.5807 | .0330 | .3931 | .0830 | .0001 |
| 1993 | 9.9576 | .0973 | .3112 | .1910 | .0020 |

| | |
|---|---|
| *MAH_1* | Mahalanobis distance |
| *COOK_1* | Cook's distance |
| *LEV_1* | Leverage value |
| *MAHA_PV* | P-value associated with the Mahalanobis distance |
| *COOK_PV* | P-value associated with Cook's distance |

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.

[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n-p-1$ denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.21*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1961 | -.2147 | .03040 | -.1009 | .1110 |
| 1962 | -.1074 | -.00876 | -.0594 | .0512 |
| 1963 | -.4046 | -.06749 | -.2242 | .2086 |
| 1964 | -.3890 | -.37629 | .1189 | -.0254 |
| 1965 | -.1234 | -.10051 | .0189 | -.0028 |
| 1966 | -.2232 | -.12408 | .0827 | -.0050 |
| 1967 | *-1.1564 | -.61518 | .4209 | -.0328 |
| 1968 | -.7091 | .07923 | -.1838 | -.0036 |
| 1969 | -.1379 | .00385 | -.0550 | -.0041 |
| 1970 | -.1237 | .04042 | -.0421 | .0180 |
| 1971 | *-1.1437 | .06514 | -.2957 | .1584 |
| 1972 | -.3127 | .08214 | .0282 | -.0208 |
| 1973 | .2284 | -.03606 | -.0044 | .0065 |
| 1974 | .9563 | .10957 | -.5746 | .2166 |
| 1975 | .1128 | .02948 | -.0732 | .0072 |
| 1976 | .2069 | .07081 | -.0868 | .0468 |
| 1977 | -.1978 | .05922 | .0584 | -.1198 |
| 1978 | -.0683 | .01210 | .0199 | -.0430 |
| 1979 | -.5337 | .04639 | .2876 | -.3270 |
| 1980 | -.7046 | -.11314 | .0818 | -.2080 |
| 1981 | .1588 | -.02314 | -.0276 | .0086 |
| 1982 | .7436 | -.25100 | .2240 | -.4063 |
| 1983 | .3357 | -.01618 | -.0162 | -.1896 |
| 1984 | .5402 | .31695 | .1428 | -.2104 |
| 1985 | .5200 | .42729 | -.0631 | .0340 |
| 1986 | .3708 | .22716 | -.1197 | -.0940 |
| 1987 | .2371 | -.02192 | -.0316 | -.1095 |
| 1988 | -.3232 | -.00889 | .0240 | .1960 |
| 1989 | -.1585 | -.03671 | .0014 | .0866 |
| 1990 | .1901 | .13743 | -.0185 | .0462 |
| 1991 | .4817 | .32309 | -.1089 | .2222 |
| 1992 | .4743 | -.18812 | .2987 | .1682 |
| 1993 | .8307 | -.31429 | .4309 | .2728 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for square root of January-February inflows |
| *SDFBET_2* | Standardized *dfbeta* for square root of March-April inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p + 1) / n}$ for a large data set. The cutoff used here is 1.

***Table 6.22*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1961 | .0692 | -.0379 | .0524 | -.1407 |
| 1962 | .0548 | -.0239 | .0285 | -.0424 |
| 1963 | .1777 | -.0516 | .1782 | -.1698 |
| 1964 | .1602 | .0986 | -.0060 | .1226 |
| 1965 | .0121 | .0583 | -.0079 | .0510 |
| 1966 | -.1064 | .1519 | -.0116 | .0572 |
| 1967 | -.5664 | .7887 | -.0446 | .2691 |
| 1968 | -.0676 | .1421 | -.3734 | .2870 |
| 1969 | .0350 | .0035 | -.0709 | .0640 |
| 1970 | -.0166 | .0235 | -.0535 | -.0011 |
| 1971 | .4144 | -.9423 | .5149 | -.0444 |
| 1972 | .0677 | -.1637 | -.1394 | -.0186 |
| 1973 | -.0545 | .1377 | .1001 | -.0496 |
| 1974 | .1728 | -.4087 | .8184 | .0474 |
| 1975 | .0475 | -.0408 | .0603 | .0015 |
| 1976 | -.0499 | .0308 | .1187 | -.0502 |
| 1977 | .0070 | .0037 | -.0279 | -.0700 |
| 1978 | .0127 | -.0025 | -.0058 | -.0212 |
| 1979 | -.1117 | .2415 | -.1300 | -.1765 |
| 1980 | .0610 | -.3649 | .0115 | .4288 |
| 1981 | .0822 | .0440 | -.0181 | -.0487 |
| 1982 | .3471 | .3188 | -.3493 | .1170 |
| 1983 | .2666 | -.0700 | -.1307 | .1135 |
| 1984 | -.2017 | -.1001 | -.1292 | .0734 |
| 1985 | -.1405 | -.0789 | -.0995 | -.1912 |
| 1986 | .0145 | -.1969 | -.0535 | .1802 |
| 1987 | .1766 | -.0822 | -.1051 | .1548 |
| 1988 | -.2015 | .1159 | .1544 | -.2329 |
| 1989 | -.0956 | .0448 | .0950 | -.0498 |
| 1990 | -.1261 | .0443 | -.0118 | -.0835 |
| 1991 | -.2590 | .0810 | .0290 | -.2863 |
| 1992 | -.1134 | .2027 | -.1484 | -.1718 |
| 1993 | .0211 | .0953 | -.2468 | -.2173 |

*SDFBET_3* Standardized *dfbeta* for square root of May-June inflows
*SDFBET_4* Standardized *dfbeta* for square root of July-August inflows
*SDFBET_5* Standardized *dfbeta* for square root of September-October inflows
*SDFBET_6* Standardized *dfbeta* for square root of November-December inflows

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p + 1) / n}$ for a large data set. The cutoff used here is 1.

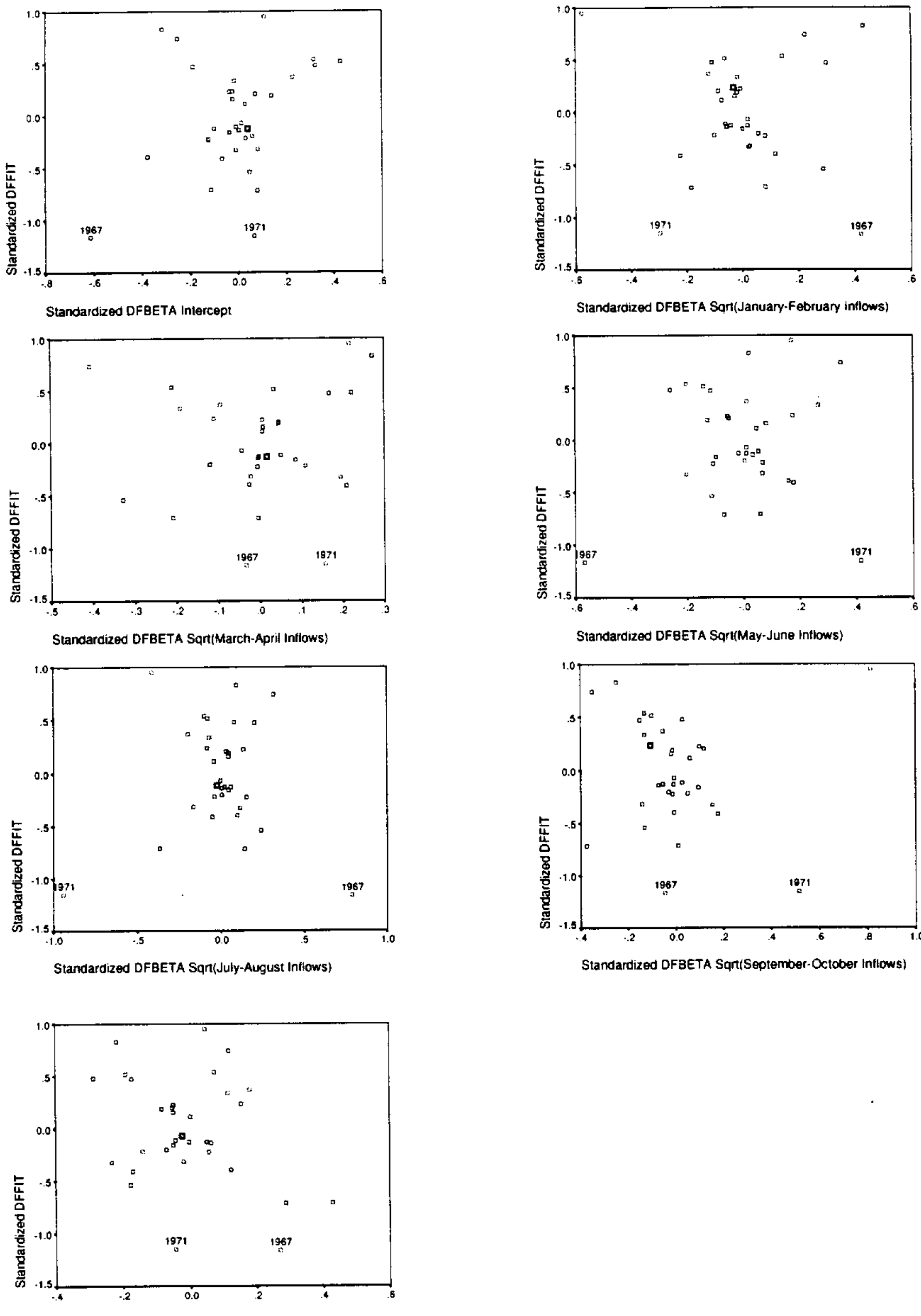


***Figure 6.30*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of square root of inflow variables.*

# 7. Examining Subsets of the Data

## 7.1 Log of flounder data and log of inflow data: None Omitted

***Table 7.1*** *Regression Models for Dependent Variable: Ln(FLOUNDER) on Ln(INFLOWS): None Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.1248 | 0.0966 | 3.731 | 13.94 | 1.439 | 16.93 | LN_QJA |
| 1 | 0.0545 | 0.0240 | 6.360 | 16.49 | 1.554 | 19.48 | LN_QMA |
| 1 | 0.0510 | 0.0204 | 6.492 | 16.61 | 1.560 | 19.60 | LN_QND |
| 1 | 0.0311 | -.0002 | 7.236 | 17.30 | 1.593 | 20.29 | LN_QJF |
| 2 | 0.1930 | 0.1392 | 3.180 | 13.26 | 1.371 | 17.75 | LN_QJA LN_QSO |
| 2 | 0.1756 | 0.1206 | 3.834 | 13.97 | 1.400 | 18.46 | LN_QMA LN_QJA |
| 2 | 0.1545 | 0.0981 | 4.622 | 14.80 | 1.436 | 19.29 | LN_QMJ LN_QJA |
| 2 | 0.1423 | 0.0852 | 5.076 | 15.27 | 1.457 | 19.76 | LN_QJF LN_QMA |
| 3 | 0.2553 | 0.1782 | 2.852 | 12.61 | 1.309 | 18.60 | LN_QJA LN_QSO LN_QND |
| 3 | 0.2515 | 0.1741 | 2.993 | 12.78 | 1.315 | 18.76 | LN_QMA LN_QMJ LN_QJA |
| 3 | 0.2357 | 0.1566 | 3.586 | 13.47 | 1.343 | 19.46 | LN_QMA LN_QJA LN_QSO |
| 3 | 0.2240 | 0.1437 | 4.023 | 13.97 | 1.364 | 19.96 | LN_QJF LN_QMA LN_QJA |
| 4 | 0.2759 | 0.1725 | 4.080 | 13.68 | 1.318 | 21.17 | LN_QMA LN_QMJ LN_QJA LN_QSO |
| 4 | 0.2712 | 0.1671 | 4.257 | 13.90 | 1.326 | 21.38 | LN_QMA LN_QJA LN_QSO LN_QND |
| 4 | 0.2635 | 0.1583 | 4.543 | 14.24 | 1.340 | 21.73 | LN_QJF LN_QMA LN_QMJ LN_QJA |
| 4 | 0.2623 | 0.1569 | 4.590 | 14.30 | 1.343 | 21.78 | LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.2970 | 0.1668 | 5.291 | 14.71 | 1.327 | 23.69 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.2915 | 0.1603 | 5.497 | 14.97 | 1.337 | 23.95 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.2782 | 0.1446 | 5.993 | 15.58 | 1.362 | 24.56 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.2773 | 0.1435 | 6.029 | 15.62 | 1.364 | 24.60 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 6 | 0.3048 | 0.1444 | 7.000 | 16.34 | 1.363 | 26.82 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 33

***Table** 7.2 Analysis of Variance for Dependent Variable: Ln(FLOUNDER) on Ln(INFLOWS): None Omitted*

| Source | *DF* | *Sum of Squares* | *Mean Square* | *F* Value | Prob>*F* |
|---|---|---|---|---|---|
| Model | 6 | 15.53181 | 2.58863 | 1.900 | 0.1189 |
| Error | 26 | 35.42650 | 1.36256 | | |
| C Total | 32 | 50.95831 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 1.16729 | R-square | 0.3048 |
| Dep Mean | 2.96887 | Adj R-sq | 0.1444 |
| C.V. | 39.31752 | | |

***Table** 7.3 Parameter Estimates for Dependent Variable: Ln(FLOUNDER) on Ln(INFLOWS): None Omitted*

| Variable | *DF* | *Parameter Estimate* | *Standard Error* | *T* for H0: *Parameter=0* | Prob > \|*T*\| | *Variance Inflation* |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 1.679298 | 1.54309401 | 1.088 | 0.2865 | 0.00000000 |
| LN_QJF | 1 | -0.237775 | 0.44103432 | -0.539 | 0.5944 | 2.32676131 |
| LN_QMA | 1 | 0.429735 | 0.34485041 | 1.246 | 0.2238 | 1.59708162 |
| LN_QMJ | 1 | -0.233456 | 0.33116594 | -0.705 | 0.4871 | 1.90365640 |
| LN_QJA | 1 | 0.473914 | 0.28442019 | 1.666 | 0.1077 | 1.84419155 |
| LN_QSO | 1 | -0.237710 | 0.23852259 | -0.997 | 0.3281 | 1.81022057 |
| LN_QND | 1 | 0.296768 | 0.29261039 | 1.014 | 0.3198 | 1.72252324 |

***Table** 7.4 Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(FLOUNDER) on Ln(INFLOWS): None Omitted*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *LN_QJF* | Var Prop *LN_QMA* | Var Prop *LN_QMJ* | Var Prop *LN_QJA* | Var Prop *LN_QSO* | Var Prop *LN_QND* |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.35780 | 1.00000 | 0.0397 | 0.0309 | 0.0482 | 0.0127 | 0.0446 | 0.0503 |
| 2 | 1.30200 | 1.34570 | 0.0715 | 0.0929 | 0.0037 | 0.2075 | 0.0323 | 0.0029 |
| 3 | 1.01015 | 1.52778 | 0.0293 | 0.2076 | 0.0621 | 0.0760 | 0.1640 | 0.0203 |
| 4 | 0.80602 | 1.71033 | 0.0129 | 0.0460 | 0.2281 | 0.0105 | 0.0277 | 0.3678 |
| 5 | 0.29821 | 2.81184 | 0.1632 | 0.6220 | 0.1632 | 0.0042 | 0.7204 | 0.2076 |
| 6 | 0.22582 | 3.23127 | 0.6833 | 0.0006 | 0.4948 | 0.6890 | 0.0110 | 0.3511 |

***Table** 7.5 Parameter Estimates of Models for Dependent Variable: Ln(FLOUNDER) on Ln(INFLOWS): None Omitted*

| OBS | _RMSE_ | INTERCEP | LN_QJF | LN_QMA | LN_QMJ | LN_QJA | LN_QSO | LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.19944 | 1.12331 | . | . | . | 0.45248 | . | . |
| 2 | 1.24668 | 1.76154 | . | 0.38964 | . | . | . | . |
| 3 | 1.24899 | 1.89062 | . | . | . | . | . | 0.30790 |
| 4 | 1.26203 | 4.01865 | -0.31174 | . | . | . | . | . |
| 5 | 1.17079 | 2.13674 | . | . | . | 0.53871 | -0.29240 | . |
| 6 | 1.18339 | -0.01428 | . | 0.37603 | . | 0.44572 | . | . |
| 7 | 1.19843 | 2.05411 | . | . | -0.27152 | 0.53902 | . | . |
| 8 | 1.20700 | 3.01238 | -0.57313 | 0.60882 | . | . | . | . |
| 9 | 1.14394 | 1.61307 | . | . | . | 0.46979 | -0.40834 | 0.38435 |
| 10 | 1.14683 | 1.03342 | . | 0.56011 | -0.46807 | 0.59159 | . | . |
| 11 | 1.15892 | 1.03160 | . | 0.34563 | . | 0.52743 | -0.27523 | . |
| 12 | 1.16775 | 1.21630 | -0.43808 | 0.54567 | . | 0.37683 | . | . |
| 13 | 1.14795 | 1.51826 | . | 0.49896 | -0.36541 | 0.61543 | -0.18806 | . |
| 14 | 1.15169 | 0.99138 | . | 0.22586 | . | 0.47565 | -0.37487 | 0.31060 |
| 15 | 1.15772 | 1.51198 | -0.24335 | 0.61832 | -0.37648 | 0.52478 | . | . |
| 16 | 1.15872 | 1.99320 | . | . | -0.13868 | 0.50632 | -0.37607 | 0.37748 |
| 17 | 1.15185 | 1.40080 | . | 0.37703 | -0.30116 | 0.55889 | -0.28240 | 0.24630 |
| 18 | 1.15636 | 1.54566 | -0.35568 | 0.35554 | . | 0.37653 | -0.27692 | 0.36447 |
| 19 | 1.16714 | 1.49946 | -0.39051 | 0.57712 | -0.31043 | 0.42704 | . | 0.20619 |
| 20 | 1.16790 | 1.63874 | -0.09468 | 0.52990 | -0.34369 | 0.58620 | -0.16257 | . |
| 21 | 1.16729 | 1.67930 | -0.23778 | 0.42974 | -0.23346 | 0.47391 | -0.23771 | 0.29677 |

***Table** 7.6 Criteria Statistics of Models for Dependent Variable: Ln(FLOUNDER) on Ln(INFLOWS): None Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 1.43866 | 0.12481 | 0.09657 | 3.73142 | 13.9393 | 16.9323 |
| 2 | 1.55420 | 0.05452 | 0.02402 | 6.36014 | 16.4886 | 19.4816 |
| 3 | 1.55999 | 0.05100 | 0.02038 | 6.49179 | 16.6112 | 19.6042 |
| 4 | 1.59272 | 0.03108 | -0.00017 | 7.23650 | 17.2965 | 20.2895 |
| 5 | 1.37075 | 0.19301 | 0.13922 | 3.18045 | 13.2617 | 17.7512 |
| 6 | 1.40041 | 0.17555 | 0.12059 | 3.83350 | 13.9681 | 18.4576 |
| 7 | 1.43625 | 0.15446 | 0.09809 | 4.62244 | 14.8019 | 19.2914 |
| 8 | 1.45685 | 0.14233 | 0.08515 | 5.07597 | 15.2718 | 19.7613 |
| 9 | 1.30861 | 0.25528 | 0.17824 | 2.85179 | 12.6119 | 18.5979 |
| 10 | 1.31523 | 0.25151 | 0.17408 | 2.99269 | 12.7784 | 18.7644 |
| 11 | 1.34310 | 0.23565 | 0.15658 | 3.58581 | 13.4703 | 19.4563 |
| 12 | 1.36363 | 0.22397 | 0.14369 | 4.02283 | 13.9710 | 19.9570 |
| 13 | 1.31779 | 0.27592 | 0.17248 | 4.07996 | 13.6844 | 21.1670 |
| 14 | 1.32638 | 0.27119 | 0.16708 | 4.25659 | 13.8990 | 21.3815 |
| 15 | 1.34031 | 0.26354 | 0.15833 | 4.54276 | 14.2437 | 21.7262 |
| 16 | 1.34263 | 0.26227 | 0.15688 | 4.59045 | 14.3007 | 21.7833 |
| 17 | 1.32676 | 0.29702 | 0.16684 | 5.29066 | 14.7083 | 23.6873 |
| 18 | 1.33717 | 0.29151 | 0.16030 | 5.49696 | 14.9662 | 23.9453 |
| 19 | 1.36221 | 0.27824 | 0.14458 | 5.99320 | 15.5786 | 24.5576 |
| 20 | 1.36400 | 0.27729 | 0.14346 | 6.02862 | 15.6218 | 24.6009 |
| 21 | 1.36256 | 0.30479 | 0.14436 | 7.00000 | 16.3414 | 26.8170 |

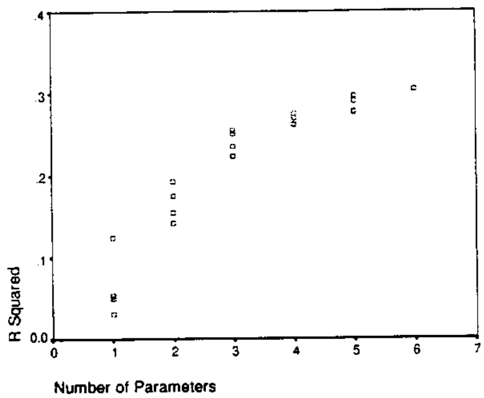


***Figure 7.1*** *The $R^2$ criteria vs. Number of parameters.*

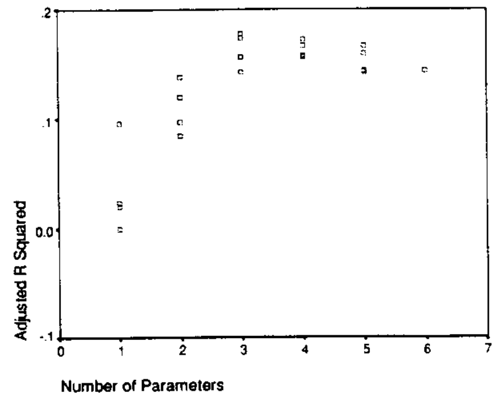


***Figure 7.2*** *The Adjusted $R^2$ criteria vs. Number of parameters.*

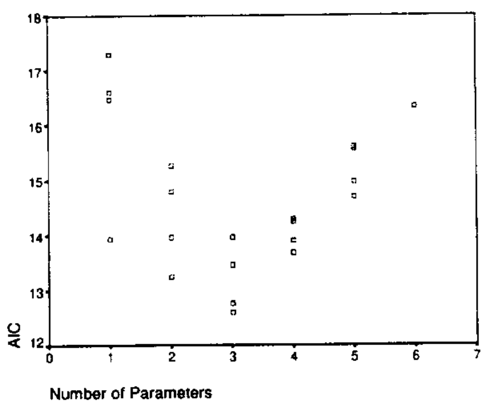


***Figure 7.3*** *The AIC criteria vs. Number of parameters..*

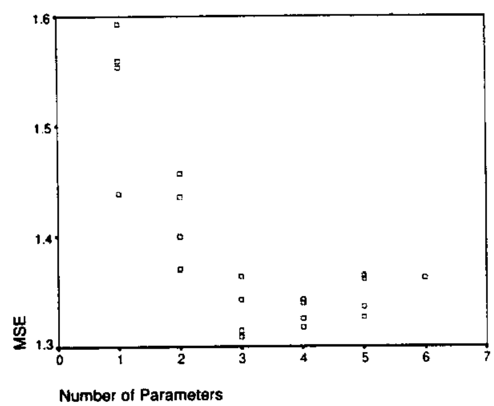


***Figure 7.4*** *MSE vs. Number of parameters.*

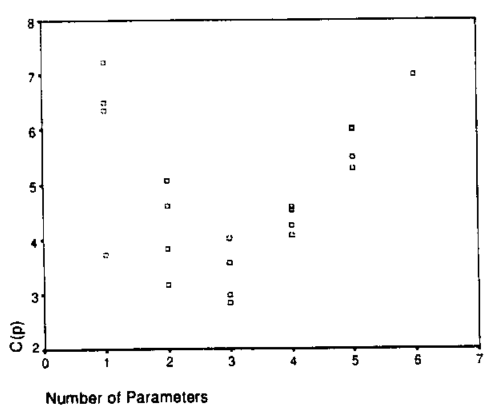


***Figure 7.5*** *The C(p) criteria vs. Number of parameters.*

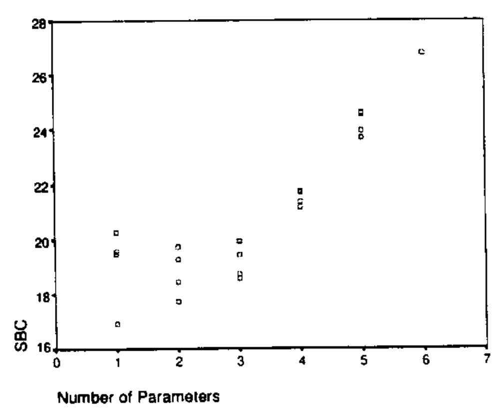


***Figure 7.6*** *The SBC criteria vs. Number of parameters.*

## 7.2 Log of flounder data and square root inflow data: None Omitted

***Table** 7.7 Regression Models for Dependent Variable: Ln(FLOUNDER) on Sqrt(INFLOWS): None Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.0714 | 0.0414 | 3.234 | 15.89 | 1.526 | 18.89 | SQR_QMA |
| 1 | 0.0699 | 0.0399 | 3.285 | 15.95 | 1.529 | 18.94 | SQR_QJA |
| 1 | 0.0397 | 0.0087 | 4.335 | 17.00 | 1.579 | 20.00 | SQR_QND |
| 1 | 0.0359 | 0.0048 | 4.468 | 17.13 | 1.585 | 20.13 | SQR_QSO |
| 2 | 0.1786 | 0.1238 | 1.514 | 13.85 | 1.395 | 18.34 | SQR_QJF SQR_QMA |
| 2 | 0.1516 | 0.0950 | 2.450 | 14.91 | 1.441 | 19.40 | SQR_QMA SQR_QJA |
| 2 | 0.1313 | 0.0734 | 3.156 | 15.69 | 1.476 | 20.18 | SQR_QJA SQR_QSO |
| 2 | 0.1023 | 0.0424 | 4.163 | 16.78 | 1.525 | 21.27 | SQR_QSO SQR_QND |
| 3 | 0.2150 | 0.1338 | 2.248 | 14.35 | 1.379 | 20.33 | SQR_QJF SQR_QMA SQR_QJA |
| 3 | 0.2013 | 0.1187 | 2.725 | 14.92 | 1.403 | 20.91 | SQR_QMA SQR_QMJ SQR_QJA |
| 3 | 0.1963 | 0.1132 | 2.899 | 15.13 | 1.412 | 21.11 | SQR_QJF SQR_QMA SQR_QND |
| 3 | 0.1957 | 0.1125 | 2.918 | 15.15 | 1.413 | 21.14 | SQR_QMA SQR_QJA SQR_QSO |
| 4 | 0.2345 | 0.1252 | 3.572 | 15.52 | 1.393 | 23.00 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA |
| 4 | 0.2296 | 0.1195 | 3.743 | 15.73 | 1.402 | 23.21 | SQR_QMA SQR_QMJ SQR_QJA SQR_QSO |
| 4 | 0.2241 | 0.1133 | 3.933 | 15.96 | 1.412 | 23.45 | SQR_QJF SQR_QMA SQR_QJA SQR_QND |
| 4 | 0.2234 | 0.1124 | 3.960 | 16.00 | 1.413 | 23.48 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO |
| 5 | 0.2426 | 0.1023 | 5.293 | 17.17 | 1.430 | 26.15 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO |
| 5 | 0.2397 | 0.0989 | 5.391 | 17.29 | 1.435 | 26.27 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.2381 | 0.0970 | 5.449 | 17.37 | 1.438 | 26.34 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QND |
| 5 | 0.2368 | 0.0955 | 5.492 | 17.42 | 1.440 | 26.40 | SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 6 | 0.2510 | 0.0782 | 7.000 | 18.80 | 1.468 | 29.28 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

N = 33

***Table 7.8*** *Analysis of Variance for Dependent Variable: Ln(FLOUNDER) on Sqrt(INFLOWS): None Omitted*

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 6 | 12.79059 | 2.13177 | 1.452 | 0.2334 |
| Error | 26 | 38.16771 | 1.46799 | | |
| C Total | 32 | 50.95831 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 1.21161 | R-square | 0.2510 |
| Dep Mean | 2.96887 | Adj R-sq | 0.0782 |
| C.V. | 40.81033 | | |

***Table 7.9*** *Parameter Estimates for Dependent Variable: Ln(FLOUNDER) on Sqrt(INFLOWS): None Omitted*

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 2.398384 | 0.94240473 | 2.545 | 0.0172 | 0.00000000 |
| SQR_QJF | 1 | -0.100136 | 0.14270557 | -0.702 | 0.4891 | 2.06116662 |
| SQR_QMA | 1 | 0.171497 | 0.11818700 | 1.451 | 0.1587 | 1.78541470 |
| SQR_QMJ | 1 | -0.041636 | 0.06655322 | -0.626 | 0.5370 | 1.56928968 |
| SQR_QJA | 1 | 0.084586 | 0.06360620 | 1.330 | 0.1951 | 1.68402320 |
| SQR_QSO | 1 | -0.024577 | 0.03668987 | -0.670 | 0.5088 | 1.62676579 |
| SQR_QND | 1 | 0.049675 | 0.09174928 | 0.541 | 0.5928 | 1.46202763 |

***Table 7.10*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(FLOUNDER) on Sqrt(INFLOWS): None Omitted*

| Number | Eigenvalue | Condition Index | Var Prop SQR_QJF | Var Prop SQR_QMA | Var Prop SQR_QMJ | Var Prop SQR_QJA | Var Prop SQR_QSO | Var Prop SQR_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.91956 | 1.00000 | 0.0755 | 0.0657 | 0.0553 | 0.0015 | 0.0384 | 0.0658 |
| 2 | 1.43262 | 1.15754 | 0.0326 | 0.0432 | 0.0524 | 0.2180 | 0.0640 | 0.0000 |
| 3 | 1.06613 | 1.34183 | 0.0335 | 0.1378 | 0.0665 | 0.0564 | 0.2590 | 0.0015 |
| 4 | 1.00755 | 1.38028 | 0.0460 | 0.0092 | 0.1865 | 0.0200 | 0.0001 | 0.3794 |
| 5 | 0.31616 | 2.46404 | 0.0313 | 0.4102 | 0.5553 | 0.2871 | 0.1424 | 0.5333 |
| 6 | 0.25798 | 2.72777 | 0.7811 | 0.3339 | 0.0840 | 0.4170 | 0.4960 | 0.0200 |

***Table** 7.11 Parameter Estimates of Models for Dependent Variable: Ln(FLOUNDER) on Sqrt(INFLOWS): None Omitted*

| OBS | _RMSE_ | INTERCEP | SQR_QJF | SQR_QMA | SQR_QMJ | SQR_QJA | SQR_QSO | SQR_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.23549 | 2.25835 | . | 0.13925 | . | . | . | . |
| 2 | 1.23646 | 2.30859 | . | . | . | 0.07637 | . | . |
| 3 | 1.25641 | 2.40203 | . | . | . | . | . | 0.08907 |
| 4 | 1.25891 | 3.36033 | . | . | . | . | -0.032102 | . |
| 5 | 1.18121 | 3.07033 | -0.21067 | 0.21692 | . | . | . | . |
| 6 | 1.20045 | 1.49860 | . | 0.14926 | . | 0.08197 | . | . |
| 7 | 1.21476 | 2.70417 | . | . | . | 0.09105 | -0.042846 | . |
| 8 | 1.23486 | 2.74497 | . | . | . | . | -0.043926 | 0.11935 |
| 9 | 1.17444 | 2.37666 | -0.17051 | 0.20922 | . | 0.05814 | . | . |
| 10 | 1.18467 | 1.98239 | . | 0.18586 | -0.077745 | 0.10764 | . | . |
| 11 | 1.18838 | 2.82995 | -0.21739 | 0.19134 | . | . | . | 0.06435 |
| 12 | 1.18879 | 1.92073 | . | 0.13392 | . | 0.09397 | -0.036703 | . |
| 13 | 1.18030 | 2.50873 | -0.13283 | 0.22063 | -0.052402 | 0.08071 | . | . |
| 14 | 1.18409 | 2.25164 | . | 0.16757 | -0.065540 | 0.11342 | -0.030014 | . |
| 15 | 1.18829 | 2.27451 | -0.17972 | 0.19130 | . | 0.05195 | . | 0.04713 |
| 16 | 1.18889 | 2.39530 | -0.13230 | 0.18795 | . | 0.06960 | -0.018728 | . |
| 17 | 1.19564 | 2.52611 | -0.09553 | 0.19965 | -0.052031 | 0.09182 | -0.018413 | . |
| 18 | 1.19787 | 2.25984 | -0.12864 | 0.15354 | . | 0.06588 | -0.026863 | 0.06623 |
| 19 | 1.19917 | 2.42645 | -0.14336 | 0.20762 | -0.046075 | 0.07396 | . | 0.03060 |
| 20 | 1.20016 | 2.12157 | . | 0.14016 | -0.056548 | 0.10771 | -0.036218 | 0.04584 |
| 21 | 1.21161 | 2.39838 | -0.10014 | 0.17150 | -0.041636 | 0.08459 | -0.024577 | 0.04967 |

***Table** 7.12 Criteria Statistics of Models for Dependent Variable: Ln(FLOUNDER) on Sqrt(INFLOWS): None Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 1.52644 | 0.07140 | 0.04145 | 3.23437 | 15.8938 | 18.8868 |
| 2 | 1.52884 | 0.06994 | 0.03994 | 3.28508 | 15.9457 | 18.9387 |
| 3 | 1.57857 | 0.03969 | 0.00871 | 4.33521 | 17.0020 | 19.9950 |
| 4 | 1.58484 | 0.03588 | 0.00477 | 4.46767 | 17.1329 | 20.1259 |
| 5 | 1.39526 | 0.17859 | 0.12383 | 1.51364 | 13.8464 | 18.3359 |
| 6 | 1.44109 | 0.15161 | 0.09505 | 2.45032 | 14.9130 | 19.4025 |
| 7 | 1.47564 | 0.13127 | 0.07335 | 3.15626 | 15.6947 | 20.1842 |
| 8 | 1.52489 | 0.10227 | 0.04243 | 4.16274 | 16.7781 | 21.2676 |
| 9 | 1.37931 | 0.21504 | 0.13384 | 2.24816 | 14.3483 | 20.3343 |
| 10 | 1.40345 | 0.20131 | 0.11869 | 2.72497 | 14.9207 | 20.9068 |
| 11 | 1.41225 | 0.19630 | 0.11315 | 2.89897 | 15.1272 | 21.1132 |
| 12 | 1.41322 | 0.19574 | 0.11255 | 2.91812 | 15.1498 | 21.1359 |
| 13 | 1.39311 | 0.23453 | 0.12517 | 3.57184 | 15.5188 | 23.0014 |
| 14 | 1.40208 | 0.22960 | 0.11954 | 3.74288 | 15.7306 | 23.2131 |
| 15 | 1.41204 | 0.22413 | 0.11329 | 3.93280 | 15.9641 | 23.4467 |
| 16 | 1.41345 | 0.22335 | 0.11240 | 3.95981 | 15.9972 | 23.4797 |
| 17 | 1.42956 | 0.24256 | 0.10229 | 5.29313 | 17.1709 | 26.1499 |
| 18 | 1.43490 | 0.23973 | 0.09893 | 5.39138 | 17.2940 | 26.2730 |
| 19 | 1.43802 | 0.23807 | 0.09698 | 5.44872 | 17.3656 | 26.3446 |
| 20 | 1.44039 | 0.23682 | 0.09549 | 5.49237 | 17.4200 | 26.3991 |
| 21 | 1.46799 | 0.25100 | 0.07816 | 7.00000 | 18.8009 | 29.2765 |

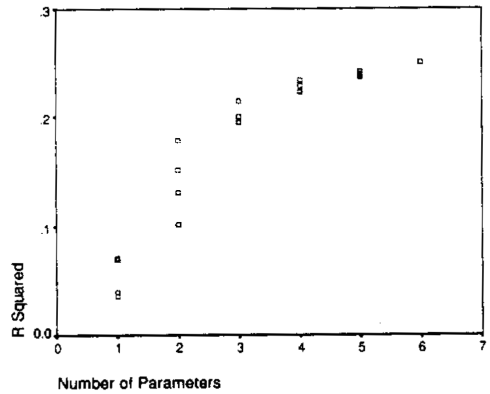


***Figure 7.7*** *The $R^2$ criteria vs. Number of parameters.*

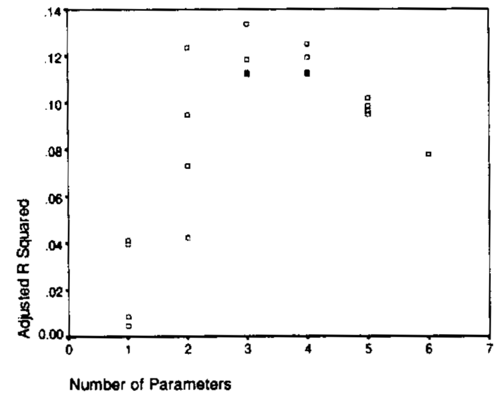


***Figure 7.8*** *The Adjusted $R^2$ criteria vs. Number of parameters.*

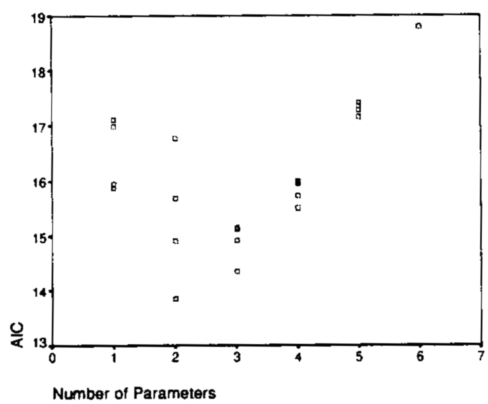


***Figure 7.9*** *The AIC criteria vs. Number of parameters..*

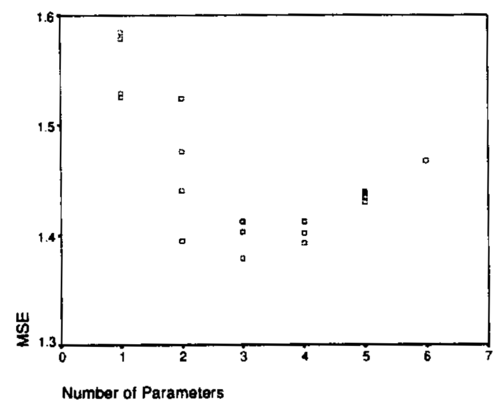


***Figure 7.10*** *MSE vs. Number of parameters.*

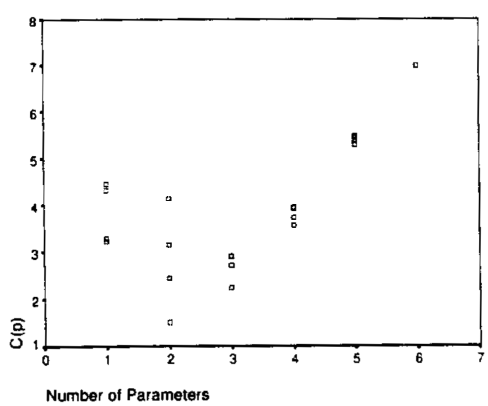


***Figure 7.11*** *The C(p) criteria vs. Number of parameters.*

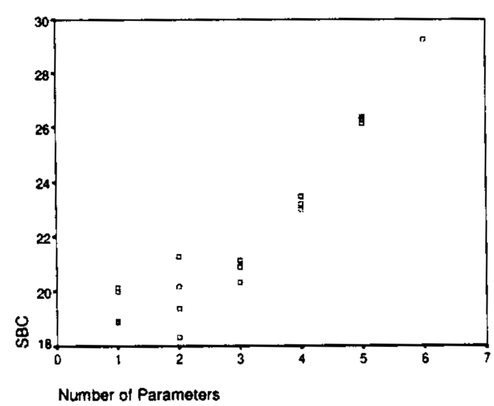


***Figure 7.12*** *The SBC criteria vs. Number of parameters.*

# Flounder Harvests in Aransas Bay: A Regression Analysis

## Harvest vs Freshwater Inflows

F. Michael Speed
Michael Longnecker
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*Department of Statistics*
*Texas A&M University*

# FLOUNDER HARVESTS IN ARANSAS BAY:

# A Regression Analysis

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*Department of Statistics*
*Texas A&M University*
May 1997

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# I. SUMMARY REPORT

## 1.1 Description of the Problem[1]

Bimonthly freshwater inflows into Aransas Bay were recorded for the years 1962 to 1994. These variables, and various transformations of them, were used to construct a model for the annual harvest of flounder.

## 1.2 Constructing Models - General Discussion

Stability of coefficient estimates and accuracy of predicted values are primary goals in constructing models for prediction. To this end, the data must be examined from three points of view: individual observations (to detect outliers or influential points); variables, individually and in groups (to select an optimal set of predictors); and the interaction of these two, which produces the overall structure of the data set (to determine whether multicollinearity is present or not). The first two of these were examined by both graphic and quantitative means; the third by quantitative means only.

### 1.2.1 Detecting Influential Points and Outliers

The structures of individual variables were examined via box plots and histograms, as well as by all the usual numerical measures. For each pair of variables, 99 % prediction ellipses and 95% confidence regions were plotted in a further effort to look for unusual points. For example, suppose large values of Variable A are generally associated with large values for Variable B. If an observation consisted of a large value for Variable A but a small value for Variable B, that point would be considered unusual, even though it was well within the range of data for both variables and could not be considered an outlier.

In addition, a number of residual analysis techniques were employed. A large residual indicates a point not well-fit by the model. The deleted residual, however, is somewhat more useful in the search for influential points. The model is fitted without a given observation, and the predicted response and corresponding residual are calculated for that observation. The Studentized deleted residual is scaled to have a Student's $t$ distribution. Histograms and normal P-P plots of the residuals were also examined.

Other quantities, such as the Mahalanobis distance, Cook's distance, the leverage value, standarized values for the *Dffits* (to measure the influence of a given observation on the predicted response) and the *Dfbetas* (to measure the influence of a given observation on the calculated coefficients) were also used to build a general picture of the influence of individual points. Plots were made of the standardized *Dffits* value for each model against the standardized *Dfbeta* values for each predictor in the model. Points which were extreme indicated observations which had strong effects on both predicted values and coefficient estimates.

1 The following discussion, prepared by Jacqueline Kiffe, was taken from Seatrout Harvest in Galveston Bay: A Regression Analysis, by F. Michael Speed, Sr. and Jacqueline Kiffe.

### 1.2.2 Variable Selection

For each regression, residuals were plotted against each of the independent variables to look for nonlinear relationships between the response variable and individual predictors. Partial residual plots were employed to examine the overall relationship between the response and individual predictors. A partial residual is a corollary to the deleted residual. That is, the model is fitted without a given variable and the predicted response and corresponding residual are calculated for each observation. This seeks to answer the question, "What is the relationship of this predictor to the response variable, taking all other variables into account?" Thus, it examines the marginal relationship of a given predictor to the response.

Numerous measures have been developed over the years to assess the adequacy of a given model. We examined a number of these, including $R^2$ and mean squared error (*MSE*), and several others which directly incorporate penalties for having too many predictors in the model, such as adjusted $R^2$, *Cp*, *AIC*, and *SBC*. It is well-established that too many predictors in a model can lead to bad prediction, just as too few can, and these measures are used as part of the attempt to find an optimal model.

### 1.2.3 Multicollinearity

Multicollinearity arises when one or more variables are nearly closely approximated by linear combinations of the remaining variables, resulting in unstable coefficient estimates. The variance inflation factor (*VIF*) was calculated for each coefficient estimate to measure this instability, which is not usually considered profound for *VIF*'s less than 10. No problems were found with this data. Additionally, the condition index (a ratio of eigenvalues of the covariance matrix, with the largest eigenvalue always on top) was calculated. A ratio greater than 30 is considered cause for concern. Again, no evidence of multicollinearity was found.

### 1.2.4 Other Procedures

Several other miscellaneous diagnostics, including the Durbin-Watson test for serial autocorrelation were performed, and no general problems were detected. The Box-Cox procedure, used to find a transformation to normality, was also performed.

## 1.3 How the Final Model Was Chosen

### 1.3.1 Selecting the Data Set Used

First, the variables were explored thoroughly, individually and in pairs, in a first effort to detect outliers. The SAS® programming language allows a number of diagnostics to be calculated for a group of models on a given data set without actually performing a formal regression, thus allowing one to examine a large number of models quite efficiently. The Box-Cox procedure was performed to find if a transformation to normallity was suggested. The log transform was suggested for some variables, and the squared root for others. At this point, there were several data sets for which the diagnostic series was calculated:

1. Untransformed flounder data and untransformed inflow data
2. Log of flounder data and untransformed inflow data
3. Log of flounder data and log of inflow data
4. Log of flounder data and square root of inflow data
5. Square root of flounder data and log of inflow data
6. Various transformation suggested by Box-Cox

### 1.3.2 Selecting the Points to be Omitted

The full regression with all diagnostics was performed for these models, each one contained all variables in its corresponding data set. All diagnostics were generated, and influential points were determined for each model.

***Table 1.1*** *$R^2$ and Adjusted $R^2$ for full data sets.*

| Data Set | $R^2$ | Adj. $R^2$ |
|---|---|---|
| 1 | 0.1749 | -0.0155 |
| 2 | 0.2264 | 0.0479 |
| 3 | 0.2515 | 0.0787 |
| 4 | 0.2336 | 0.0568 |
| 5 | 0.2189 | 0.0387 |
| 6 | 0.2214 | 0.0418 |

Data sets 2, 3, and 4 presented the highest $R^2$ values. These three models were considered final candidates. The observations flagged as potentially influential are given in the summary table below, for each model.

***Table 1.2*** *Summary of points flagged by Boxplots.*

| Year | Variable |
|---|---|
| 1962 | Nov.-Dec. Inflows |
| 1968 | Sept-Oct Inflows |
| 1969 | Ln(Flounder Harvest), Sept-Oct Inflows |
| 1981 | July-Aug Inflows |
| 1990 | Ln(Flounder Harvest), Nov.-Dec. Inflows |
| 1992 | March-April Inflows, Sqrt(Mar-Apr) |
| 1993 | March-April Inflows, Sqrt(Mar-Apr), Jan.-Feb. Inflows |

***Table 1.3*** *Summary of points flagged by 99% prediction ellipses.*

| Year | Variable |
|---|---|
| None | None |

***Table 1.4*** *Outliers of data set 2.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1962 | 1 | | | | | | | | 1 |
| 1968 | 1 | | | | | | | | 1 |
| 1969 | 2 | | | | | | 1 | | 3 |
| 1981 | 1 | | | | | | | | 1 |
| 1990 | 2 | | 1 | | | | 1 | 1 | 5 |
| 1992 | 1 | | | | | | | | 1 |
| 1993 | 2 | | | 1 | 1 | | | | 4 |

***Table 1.5*** *Outliers of data set 3.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1966 | | | | | | | 1 | | 1 |
| 1969 | 1 | | | | | | 1 | | 2 |
| 1990 | 1 | | 1 | | | | 1 | | 3 |

***Table 1.6*** *Outliers of data set 4.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1966 | | | 1 | | | | 1 | | 2 |
| 1969 | 1 | | | | | | 1 | | 2 |
| 1990 | 1 | | 1 | | | | 1 | 1 | 4 |
| 1992 | 1 | | | | | | | | 1 |
| 1993 | 1 | | | | | | | | 1 |

***A Key to Abbreviations:***

BOX Box plot

SRE Studentized residual

SDR Studentized deleted residual

LEV Leverage value

MAH Mahalanobis distance

COO Cook's distance

SDF Standardized Dffits value

SDB Standardized Dfbeta value

### 1.3.3 Selecting the Final Candidate Models

After the subset analysis led us to four models, Data Set 2 with 1990 omitted; Data Set 3 with 1990 omitted and Data Set 4 with 1990 omitted.

***Table 1.7*** *$R^2$ and Adjusted $R^2$ for data sets number 2, 3, 4 and 6.*

| Data set | Observations omitted | $R^2$ | Adj. $R^2$ |
|---|---|---|---|
| 2 | 1990 | 0.3197 | 0.2189 |
| 3 | 1990 | 0.2853 | 0.2081 |
| 4 | 1990 | 0.3422 | 0.2157 |

### 1.3.4 Selecting the Final Models

It appears that Data set 2 with 1990 omitted is the best model. Regression was performed using this model, and the deleted residuals were calculated.

Ln(Flounder Harvest) = 3.85961 - 0. 0012434*(May-June)
+ 0.0015722*(July-Aug. Inflows)
- 0.0006671*(Sept.-Oct. Inflows)
+ 0.0039004*(Nov.-Dec. Inflows)

## 1.4 Best Model: Logged Harvest and Untransformed Inflows

### 1.4.1 Summary Information

***Table 1.8*** *Descriptive statistics for dependent and independent variables.*

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| Ln(Flounder Harvest) | 3.840610 | .598187 | 32 |
| May-June Inflows | 158.4475 | 146.3186 | 32 |
| July-August Inflows | 69.0175 | 79.0445 | 32 |
| September-October Inflows | 187.9413 | 215.8244 | 32 |
| November-December Inflows | 49.9650 | 49.6336 | 32 |

***Table 1.9*** *Model summary for the final model.*

**Model Summary[a,b]**

| | Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|
| | November-December Infl., July-August Inflows, September-October Infl., May-June Inflows[c,d] | .565 | .320 | .219 | .528688 | 1.220 |

a. Dependent Variable: Ln(Flounder Harvest)

b. Method: Enter

c. Independent Variables: (Constant), November-December Inflows, July-August Inflows, September-October Inflows, May-June Inflows

d. All requested variables entered.

***Table 1.10*** *Anova for the final model.*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 3.546 | 4 | .886 | 3.171 | .029[b] |
| | Residual | 7.547 | 27 | .280 | | |
| | Total | 11.093 | 31 | | | |

a. Dependent Variable: Ln(Flounder Harvest)

b. Independent Variables: (Constant), November-December Inflows, July-August Inflows, September-October Inflows, May-June Inflows

***Table 1.11*** *Parameter estimates for the final model.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | 3.860 | .191 | | 20.218 | .000 | 3.468 | 4.251 |
| May-June Inflows | -1.2E-03 | .001 | -.304 | -1.701 | .100 | -.003 | .000 |
| July-August Inflows | 1.6E-03 | .001 | .208 | 1.307 | .202 | -.001 | .004 |
| September-October Infl. | -6.7E-04 | .000 | -.241 | -1.382 | .178 | -.002 | .000 |
| November-December Infl. | 3.9E-03 | .002 | .324 | 1.868 | .073 | .000 | .008 |

a. Dependent Variable: Ln(Flounder Harvest)

***Table 1.12*** *Residuals statistics for the final model.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 3.052921 | 4.474547 | 3.840610 | .338204 | 32 |
| Std. Predicted Value | -2.329 | 1.874 | .000 | 1.000 | 32 |
| Standard Error of Predicted Value | .123782 | .358255 | .201004 | 5.8E-02 | 32 |
| Adjusted Predicted Value | 3.007345 | 4.543574 | 3.846694 | .340880 | 32 |
| Residual | -1.136381 | 1.200665 | -3.3E-16 | .493402 | 32 |
| Std. Residual | -2.149 | 2.271 | .000 | .933 | 32 |
| Stud. Residual | -2.263 | 2.412 | -.005 | 1.004 | 32 |
| Deleted Residual | -1.263178 | 1.354134 | -6.1E-03 | .572873 | 32 |
| Stud. Deleted Residual | -2.468 | 2.672 | -.008 | 1.051 | 32 |
| Mahal. Distance | .731 | 13.266 | 3.875 | 2.999 | 32 |
| Cook's Distance | .000 | .306 | .032 | .061 | 32 |
| Centered Leverage Value | .024 | .428 | .125 | .097 | 32 |

a. Dependent Variable: Ln(Flounder Harvest)

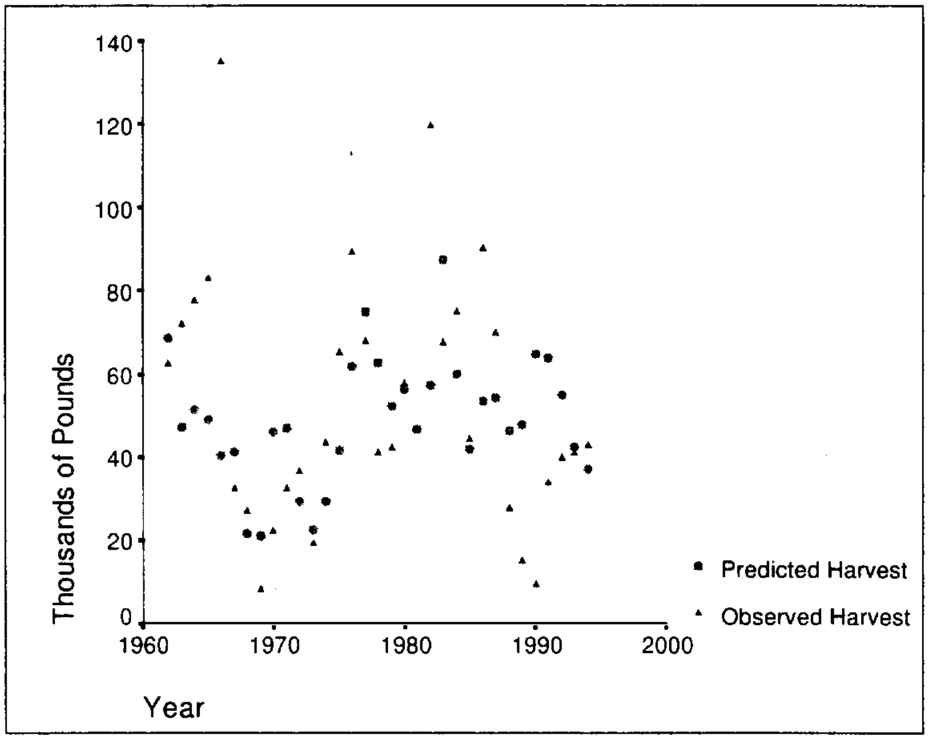


***Figure 1.1*** *Predicted and observed values for the harvest.*

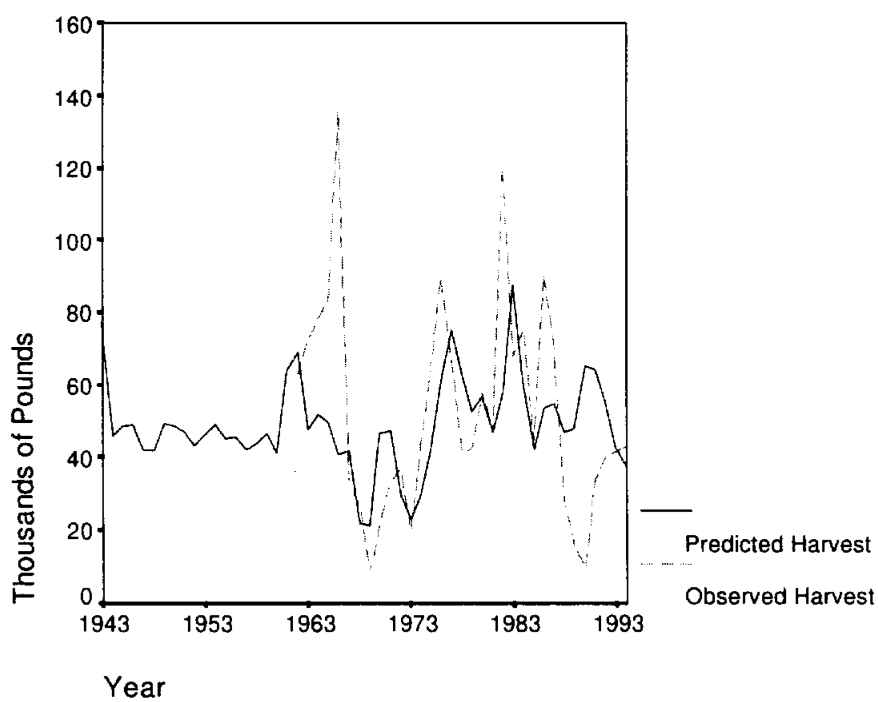


***Figure 1.2*** *Predicted and observed values for the harvest.*

***Table 1.13*** *Prediction Intervals for Flounder Harvest based on the final model.*

| YEAR | *FLOU* | *PRE_1* | *LICI_1* | *UICI_1* |
|---|---|---|---|---|
| 1962 | 62.80 | 69.01 | 12.76 | 373.07 |
| 1963 | 72.20 | 47.60 | 10.20 | 222.19 |
| 1964 | 77.90 | 51.71 | 11.16 | 239.50 |
| 1965 | 83.30 | 49.39 | 10.64 | 229.18 |
| 1966 | 135.50 | 40.78 | 8.69 | 191.31 |
| 1967 | 32.70 | 41.60 | 8.90 | 194.45 |
| 1968 | 27.20 | 21.81 | 4.23 | 112.50 |
| 1969 | 8.40 | 21.18 | 4.07 | 110.21 |
| 1970 | 22.60 | 46.34 | 10.13 | 212.04 |
| 1971 | 32.70 | 47.26 | 10.44 | 213.96 |
| 1972 | 36.90 | 29.55 | 6.12 | 142.59 |
| 1973 | 19.60 | 22.92 | 4.61 | 113.97 |
| 1974 | 43.50 | 29.52 | 6.35 | 137.11 |
| 1975 | 65.50 | 41.71 | 8.61 | 202.01 |
| 1976 | 89.50 | 62.22 | 13.56 | 285.46 |
| 1977 | 68.10 | 75.14 | 15.83 | 356.68 |
| 1978 | 41.20 | 63.12 | 13.19 | 302.06 |
| 1979 | 42.40 | 52.48 | 11.66 | 236.23 |
| 1980 | 58.00 | 56.76 | 11.65 | 276.42 |
| 1981 | 47.00 | 46.90 | 8.27 | 266.09 |
| 1982 | 119.90 | 57.72 | 11.78 | 282.93 |
| 1983 | 67.80 | 87.75 | 17.51 | 439.91 |
| 1984 | 75.20 | 60.28 | 12.49 | 290.89 |
| 1985 | 44.60 | 42.10 | 9.01 | 196.69 |
| 1986 | 90.50 | 53.79 | 11.81 | 245.04 |
| 1987 | 70.10 | 54.67 | 12.13 | 246.43 |
| 1988 | 27.90 | 46.67 | 10.26 | 212.33 |
| 1989 | 15.40 | 47.98 | 10.34 | 222.70 |
| 1990 | 9.70 | 65.06 | 13.37 | 316.64 |
| 1991 | 34.00 | 64.28 | 13.26 | 311.67 |
| 1992 | 40.10 | 55.14 | 11.53 | 263.81 |
| 1993 | 41.30 | 42.83 | 7.30 | 251.30 |
| 1994 | 43.00 | 37.26 | 7.56 | 183.61 |

| | |
|---|---|
| *FLOU* | Observed flounder harvest |
| *PRE_!* | Predicted flounder harvest |
| *LICI_1* | Lower limit for 99% prediction interval for the flounder harvest. |
| *UICI_1* | Upper limit for 99% prediction interval for the flounder harvest. |

# 2. EXPLORING THE DATA

## 2.1 Listing of data

***Table 2.1*** *The flounder data and the inflow data.*

| Year | *Flounder* | *JF_inflow* | *MA_inflow* | *MJ_inflow* | *JA_inflow* | *SO_inflow* | *ND_inflow* |
|---|---|---|---|---|---|---|---|
| 1962 | 62.80 | 101.62 | 8.13 | 22.26 | 13.73 | 286.38 | 146.58 |
| 1963 | 72.20 | 1.24 | 2.09 | 12.16 | 2.40 | 36.80 | 10.03 |
| 1964 | 77.90 | 3.06 | 3.19 | 6.75 | 39.26 | 11.26 | 10.30 |
| 1965 | 83.30 | 15.50 | 4.71 | 30.83 | 39.44 | 5.03 | 5.09 |
| 1966 | 135.50 | 22.85 | 53.73 | 171.90 | 12.23 | 7.49 | 12.36 |
| 1967 | 32.70 | 11.25 | 52.24 | 165.90 | 22.84 | 6.84 | 11.14 |
| 1968 | 27.20 | 9.83 | 4.45 | 308.94 | 48.16 | 735.03 | 5.56 |
| 1969 | 8.40 | 54.63 | 29.10 | 316.63 | 40.24 | 750.61 | 6.28 |
| 1970 | 22.60 | 55.55 | 54.13 | 105.72 | 16.43 | 21.54 | 24.73 |
| 1971 | 32.70 | 10.45 | 29.66 | 82.72 | 29.17 | 63.92 | 24.55 |
| 1972 | 36.90 | 13.22 | 21.79 | 186.87 | 46.60 | 595.65 | 21.22 |
| 1973 | 19.60 | 15.96 | 28.76 | 409.35 | 42.60 | 562.30 | 22.94 |
| 1974 | 43.50 | 8.32 | 12.59 | 271.14 | 16.99 | 304.44 | 9.96 |
| 1975 | 65.50 | 6.13 | 6.20 | 46.73 | 8.42 | 439.28 | 53.58 |
| 1976 | 89.50 | 4.45 | 13.50 | 35.02 | 127.65 | 178.24 | 59.71 |
| 1977 | 68.10 | 29.96 | 48.51 | 152.22 | 131.89 | 67.60 | 124.81 |
| 1978 | 41.20 | 41.79 | 39.51 | 158.18 | 12.04 | 63.88 | 129.69 |
| 1979 | 42.40 | 63.16 | 32.13 | 85.82 | 88.02 | 62.04 | 28.32 |
| 1980 | 58.00 | 111.42 | 31.82 | 59.09 | 214.91 | 212.52 | 14.50 |
| 1981 | 47.00 | 77.77 | 17.95 | 305.34 | 304.68 | 244.25 | 13.32 |
| 1982 | 119.90 | 101.88 | 29.18 | 338.25 | 179.88 | 187.08 | 117.59 |
| 1983 | 67.80 | 105.36 | 29.86 | 76.67 | 200.04 | 107.60 | 119.87 |
| 1984 | 75.20 | 78.59 | 19.09 | 37.88 | 196.61 | 283.59 | 42.69 |
| 1985 | 44.60 | 70.47 | 115.47 | 37.90 | 9.60 | 340.91 | 35.86 |
| 1986 | 90.50 | 16.42 | 113.88 | 50.42 | 14.71 | 107.66 | 60.71 |
| 1987 | 70.10 | 30.46 | 5.11 | 130.03 | 31.50 | 64.87 | 76.16 |
| 1988 | 27.90 | 25.69 | 5.44 | 120.87 | 27.08 | 26.54 | 27.93 |
| 1989 | 15.40 | 6.06 | 2.78 | 21.82 | 17.08 | 31.01 | 8.23 |
| 1990 | 9.70 | 12.34 | 30.45 | 16.36 | 193.50 | 22.82 | 12.06 |
| 1991 | 34.00 | 21.30 | 60.09 | 35.14 | 190.31 | 8.15 | 13.73 |
| 1992 | 40.10 | 164.68 | 236.13 | 298.03 | 35.59 | 80.72 | 133.00 |
| 1993 | 41.30 | 237.91 | 269.63 | 607.54 | 32.58 | 93.11 | 170.21 |
| 1994 | 43.00 | 90.63 | 88.99 | 382.20 | 15.88 | 27.78 | 58.23 |

| | |
|---|---|
| Flounder | Flounder harvest (thousands of pounds) |
| JF_inflow | Lagged January-February inflows (thousands of acre-feet) |
| MA_inflow | Lagged March-April inflows (thousands of acre-feet) |
| MJ_inflow | Lagged May-June inflows (thousands of acre-feet) |
| JA_inflow | Lagged July-August inflows (thousands of acre-feet) |
| SO_inflow | Lagged September-October inflows (thousands of acre-feet) |
| ND_inflow | Lagged November-December inflows (thousands of acre-feet) |

## 2.2 Examination of Individual Variables

***Table .2.2*** *Test of Normality for the flounder data and the inflow data.*

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Flounder Harvest | .156 | 33 | .041 | .941 | 33 | .094 |
| Ln(Flounder Harvest) | .107 | 33 | .200* | .949 | 33 | .214 |
| Square Root of Flounder Harvest | .105 | 33 | .200* | .981 | 33 | .855 |
| January-February Inflows | .213 | 33 | .001 | .801 | 33 | .010** |
| Ln(January-February Inflows) | .115 | 33 | .200* | .972 | 33 | .598 |
| Square Root of January-February Inflows | .144 | 33 | .078 | .931 | 33 | .050 |
| March-April Inflows | .262 | 33 | .000 | .655 | 33 | .010** |
| Ln(March-April Inflows) | .150 | 33 | .057 | .963 | 33 | .417 |
| Square Root of March-April Inflows | .173 | 33 | .013 | .870 | 33 | .010** |
| May-June Inflows | .165 | 33 | .023 | .855 | 33 | .010** |
| Ln(May-June Inflows) | .102 | 33 | .200* | .961 | 33 | .396 |
| Square Root of May-June Inflows | .117 | 33 | .200* | .942 | 33 | .100 |
| July-August Inflows | .317 | 33 | .000 | .761 | 33 | .010** |
| Ln(July-August Inflows) | .129 | 33 | .182 | .947 | 33 | .177 |
| Square Root of July-August Inflows | .238 | 33 | .000 | .862 | 33 | .010** |
| September-October Inflows | .243 | 33 | .000 | .780 | 33 | .010** |
| Ln(September-October Inflows) | .100 | 33 | .200* | .952 | 33 | .248 |
| Square Root of September-October Inflows | .159 | 33 | .033 | .906 | 33 | .010 |
| November-December Inflows | .237 | 33 | .000 | .795 | 33 | .010** |
| Ln(November-December Inflows) | .134 | 33 | .144 | .933 | 33 | .057 |
| Square Root of November-December Inflows | .177 | 33 | .010 | .876 | 33 | .010** |

*. This is a lower bound of the true significance.

**. This is an upper bound of the true significance.

a. Lilliefors Significance Correction

***Table .2.3*** *Percentiles of the flounder data and the inflow data.*

**Percentiles**

| | | Percentiles | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 10 | 25 | 50 | 75 | 90 | 95 |
| Weighted Average(Definition 1) | Flounder Harvest | 9.3100 | 17.0800 | 32.7000 | 43.5000 | 71.1500 | 90.1000 | 124.5800 |
| | Ln(Flounder Harvest) | 2.228958 | 2.830832 | 3.487375 | 3.772761 | 4.264681 | 4.500905 | 4.823352 |
| | Square Root of Flounder Harvest | 3.049620 | 4.125446 | 5.718391 | 6.595453 | 8.434816 | 9.492067 | 11.1571 |
| | January-February Inflows | 2.5140 | 5.0940 | 10.8500 | 25.6900 | 78.1800 | 108.9960 | 186.6490 |
| | Ln(January-February Inflows) | .847424 | 1.616426 | 2.383485 | 3.246102 | 4.359000 | 4.690937 | 5.214371 |
| | Square Root of January-February Inflows | 1.558566 | 2.250384 | 3.293374 | 5.068530 | 8.841915 | 10.4391 | 13.6102 |
| | March-April Inflows | 2.5730 | 3.6940 | 7.1650 | 29.1800 | 52.9850 | 114.8340 | 246.1800 |
| | Ln(March-April Inflows) | .936865 | 1.293174 | 1.960055 | 3.373484 | 3.969910 | 4.743465 | 5.504183 |
| | Square Root of March-April Inflows | 1.600838 | 1.915435 | 2.670648 | 5.401852 | 7.278900 | 10.7160 | 15.6827 |
| | May-June Inflows | 10.5370 | 18.5440 | 36.5100 | 105.7200 | 284.5850 | 364.6200 | 468.8070 |
| | Ln(May-June Inflows) | 2.321569 | 2.910034 | 3.596882 | 4.660794 | 5.649915 | 5.897081 | 6.133025 |
| | Square Root of May-June Inflows | 3.220406 | 4.295325 | 6.041287 | 10.2820 | 16.8649 | 19.0866 | 21.5572 |
| | July-August Inflows | 6.6140 | 10.5760 | 16.1550 | 35.5900 | 129.7700 | 198.6680 | 241.8410 |
| | Ln(July-August Inflows) | 1.754068 | 2.352352 | 2.782085 | 3.572065 | 4.865630 | 5.291599 | 5.474932 |
| | Square Root of July-August Inflows | 2.495965 | 3.246980 | 4.019183 | 5.965735 | 11.3913 | 14.0948 | 15.4984 |
| | September-October Inflows | 6.2970 | 7.7540 | 27.1600 | 80.7200 | 284.9850 | 582.3100 | 739.7040 |
| | Ln(September-October Inflows) | 1.830577 | 2.047348 | 3.301485 | 4.390986 | 5.652425 | 6.366606 | 6.606204 |
| | Square Root of September-October Inflows | 2.503567 | 2.784000 | 5.211186 | 8.984431 | 16.8814 | 24.1287 | 27.1972 |
| | November-December Inflows | 5.4190 | 7.0600 | 11.6000 | 24.7300 | 68.4350 | 131.6760 | 153.6690 |
| | Ln(November-December Inflows) | 1.689102 | 1.945536 | 2.450218 | 3.208017 | 4.219472 | 4.880268 | 5.032410 |
| | Square Root of November-December Inflows | 2.327407 | 2.651115 | 3.405207 | 4.972927 | 8.259316 | 11.4748 | 12.3889 |
| Tukey's Hinges | Flounder Harvest | | | 32.7000 | 43.5000 | 70.1000 | | |
| | Ln(Flounder Harvest) | | | 3.487375 | 3.772761 | 4.249923 | | |
| | Square Root of Flounder Harvest | | | 5.718391 | 6.595453 | 8.372574 | | |
| | January-February Inflows | | | 11.2500 | 25.6900 | 77.7700 | | |
| | Ln(January-February Inflows) | | | 2.420368 | 3.246102 | 4.353756 | | |
| | Square Root of January-February Inflows | | | 3.354102 | 5.068530 | 8.818730 | | |
| | March-April Inflows | | | 8.1300 | 29.1800 | 52.2400 | | |
| | Ln(March-April Inflows) | | | 2.095561 | 3.373484 | 3.955848 | | |
| | Square Root of March-April Inflows | | | 2.851315 | 5.401852 | 7.227724 | | |
| | May-June Inflows | | | 37.8800 | 105.7200 | 271.1400 | | |
| | Ln(May-June Inflows) | | | 3.634423 | 4.660794 | 5.602635 | | |
| | Square Root of May-June Inflows | | | 6.154673 | 10.2820 | 16.4663 | | |
| | July-August Inflows | | | 16.4300 | 35.5900 | 127.6500 | | |
| | Ln(July-August Inflows) | | | 2.799109 | 3.572065 | 4.849292 | | |
| | Square Root of July-August Inflows | | | 4.053394 | 5.965735 | 11.2982 | | |
| | September-October Inflows | | | 27.7800 | 80.7200 | 283.5900 | | |
| | Ln(September-October Inflows) | | | 3.324316 | 4.390986 | 5.647530 | | |
| | Square Root of September-October Inflows | | | 5.270674 | 8.984431 | 16.8401 | | |
| | November-December Inflows | | | 12.0600 | 24.7300 | 60.7100 | | |
| | Ln(November-December Inflows) | | | 2.489894 | 3.208017 | 4.106108 | | |
| | Square Root of November-December Inflows | | | 3.472751 | 4.972927 | 7.791662 | | |

### 2.2.1 The flounder data

***Table .2.4*** *Descriptives for the flounder data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| Flounder Harvest | Mean | | 52.9242 | 5.1810 |
| | 95% Confidence Interval for Mean | Lower Bound | 42.3709 | |
| | | Upper Bound | 63.4776 | |
| | 5% Trimmed Mean | | 51.1232 | |
| | Median | | 43.5000 | |
| | Variance | | 885.806 | |
| | Std. Deviation | | 29.7625 | |
| | Minimum | | 8.40 | |
| | Maximum | | 135.50 | |
| | Range | | 127.10 | |
| | Interquartile Range | | 38.4500 | |
| | Skewness | | .866 | .409 |
| | Kurtosis | | .790 | .798 |

***Table .2.5*** *Extreme Values for the flounder data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| Flounder Harvest | Highest | 1 | 5 | 1966 | 135.50 |
| | | 2 | 21 | 1982 | 119.90 |
| | | 3 | 25 | 1986 | 90.50 |
| | | 4 | 15 | 1976 | 89.50 |
| | | 5 | 4 | 1965 | 83.30 |
| | Lowest | 1 | 8 | 1969 | 8.40 |
| | | 2 | 29 | 1990 | 9.70 |
| | | 3 | 28 | 1989 | 15.40 |
| | | 4 | 12 | 1973 | 19.60 |
| | | 5 | 9 | 1970 | 22.60 |

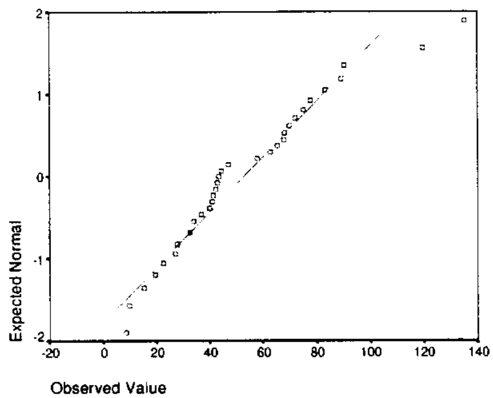


***Figure 2.1*** *Normal Q-Q Plot of Flounder Harvest.*

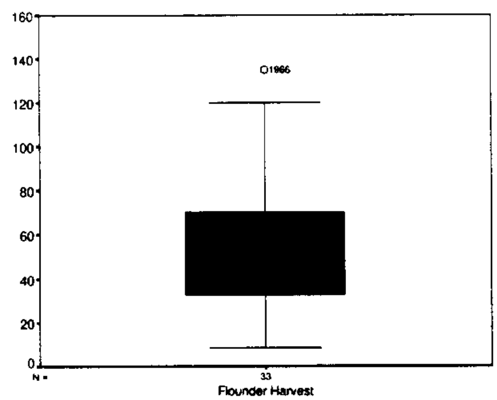


***Figure 2.2*** *BoxPlot of Flounder Harvest.*

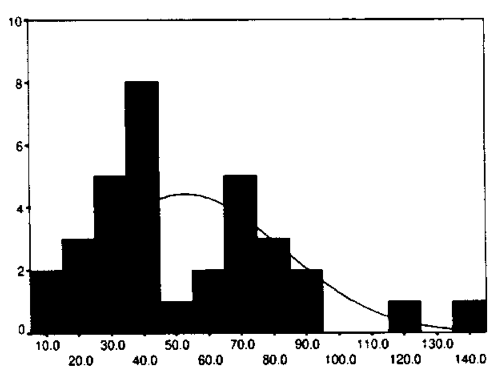


***Figure 2.3*** *Histogram of Flounder Harvest.*

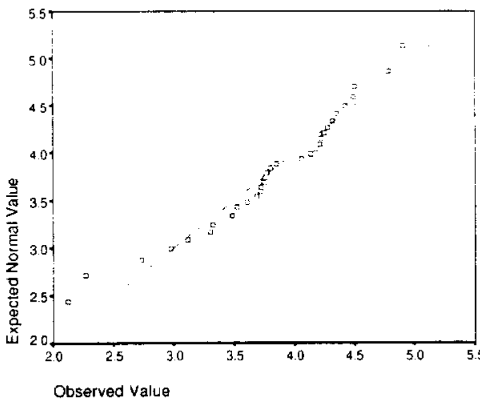


***Figure 2.4*** *Normal Q-Q Plot of Ln(Flounder Harvest).*

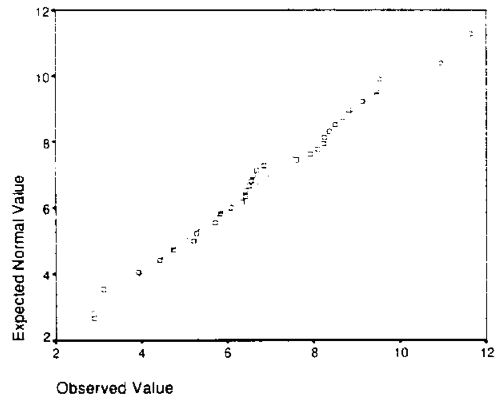


***Figure 2.5*** *Normal Q-Q Plot of Sqrt(Flounder Harvest).*

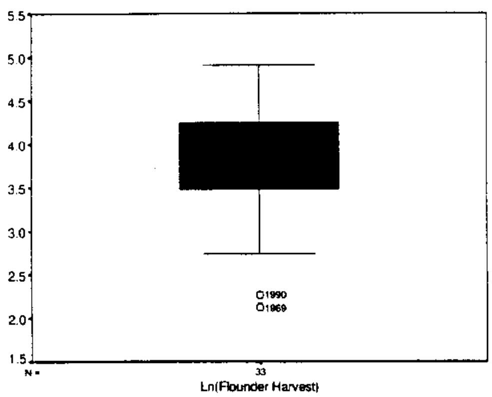


***Figure 2.6*** *BoxPlot of Ln(Flounder Harvest).*

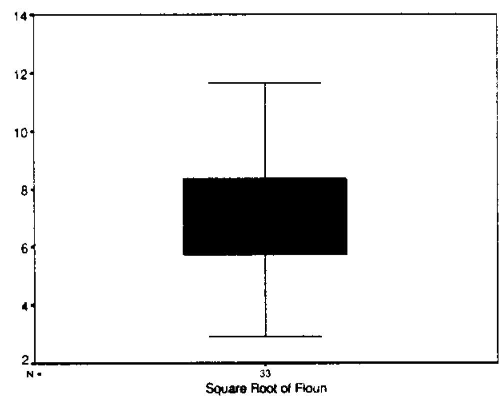


***Figure 2.7*** *BoxPlot of Sqrt(Flounder Harvest).*

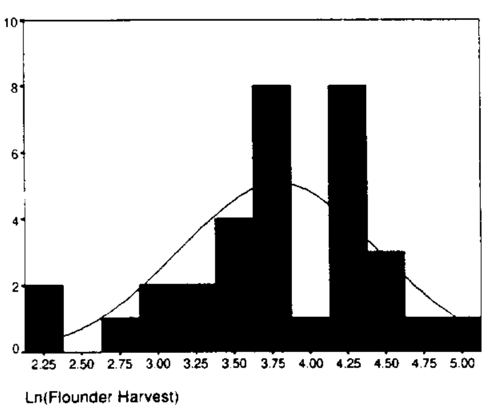


***Figure 2.8*** *Histogram of Ln(Flounder Harvest).*

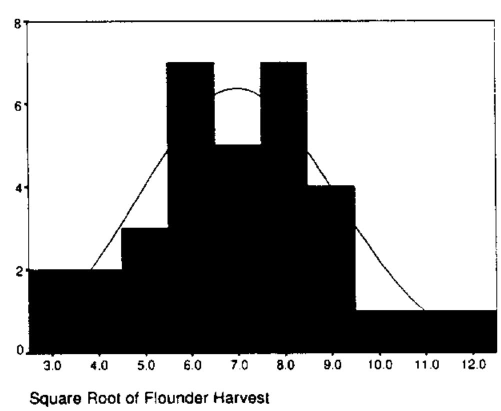


***Figure 2.9*** *Histogram of Sqrt(Flounder Harvest).*

### 2.2.2 The January-February Inflows data

***Table .2.6*** *Descriptives for the January-February Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| January-February Inflows | Mean | | 49.0894 | 9.2671 |
| | 95% Confidence Interval for Mean | Lower Bound | 30.2128 | |
| | | Upper Bound | 67.9660 | |
| | 5% Trimmed Mean | | 42.8205 | |
| | Median | | 25.6900 | |
| | Variance | | 2834.040 | |
| | Std. Deviation | | 53.2357 | |
| | Minimum | | 1.24 | |
| | Maximum | | 237.91 | |
| | Range | | 236.67 | |
| | Interquartile Range | | 67.3300 | |
| | Skewness | | 1.798 | .409 |
| | Kurtosis | | 3.895 | .798 |

***Table .2.7*** *Extreme Values for the January-February Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| January-February Inflows | Highest | 1 | 32 | 1993 | 237.91 |
| | | 2 | 31 | 1992 | 164.68 |
| | | 3 | 19 | 1980 | 111.42 |
| | | 4 | 22 | 1983 | 105.36 |
| | | 5 | 21 | 1982 | 101.88 |
| | Lowest | 1 | 2 | 1963 | 1.24 |
| | | 2 | 3 | 1964 | 3.06 |
| | | 3 | 15 | 1976 | 4.45 |
| | | 4 | 28 | 1989 | 6.06 |
| | | 5 | 14 | 1975 | 6.13 |

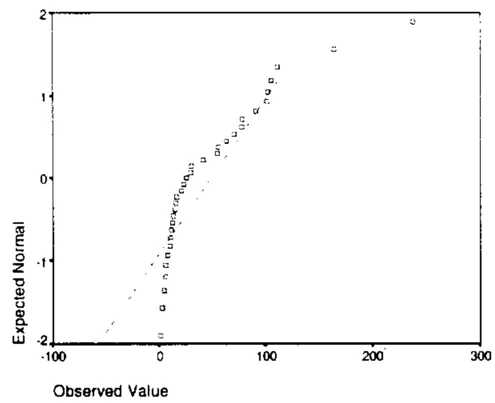


***Figure 2.10*** *Normal Q-Q Plot of January-February Inflows.*

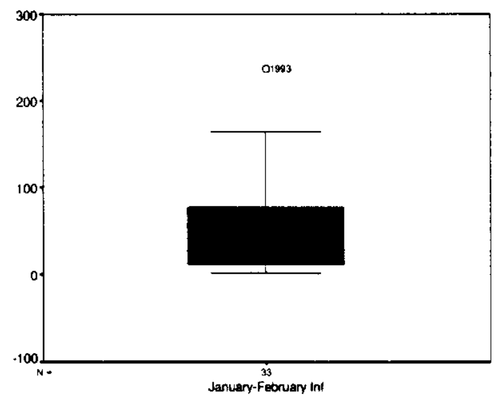


***Figure 2.11*** *BoxPlot of January-February Inflows.*

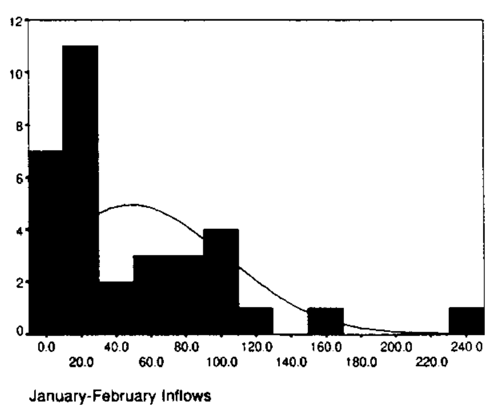


***Figure 2.12*** *Histogram of January-February Inflows.*

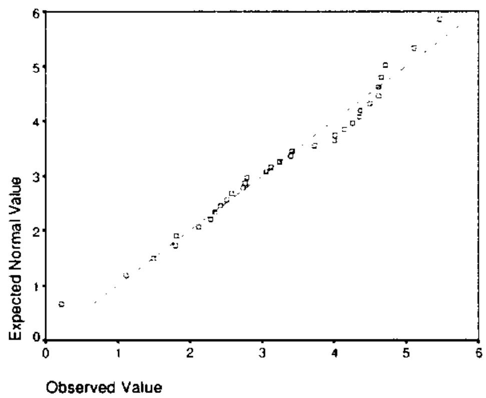


***Figure 2.13*** *Normal Q-Q Plot of Ln January-February Inflows).*

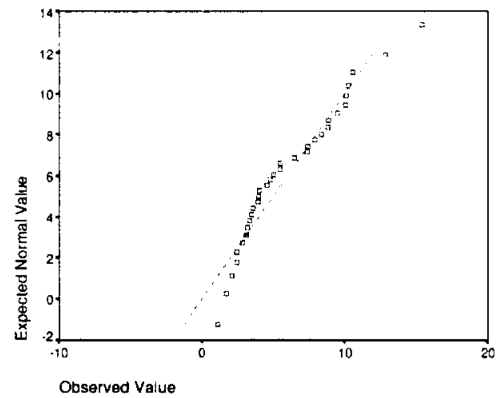


***Figure 2.14*** *Normal Q-Q Plot of Sqrt( January-February Inflows).*

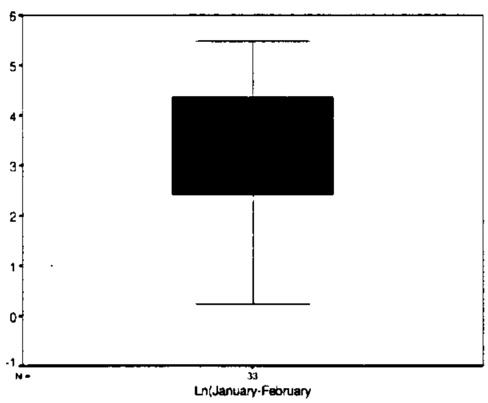


***Figure 2.15*** *BoxPlot of Ln(January-February Inflows).*

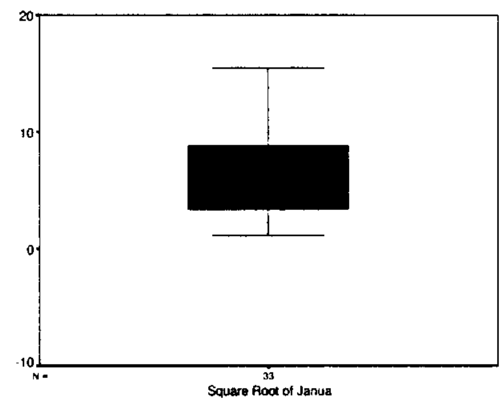


***Figure 2.16*** *BoxPlot of Square Root of January-February Inflows.*

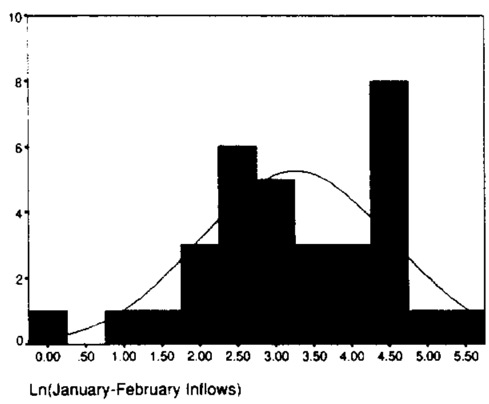


***Figure 2.17*** *Histogram of Ln(January-February Inflows).*

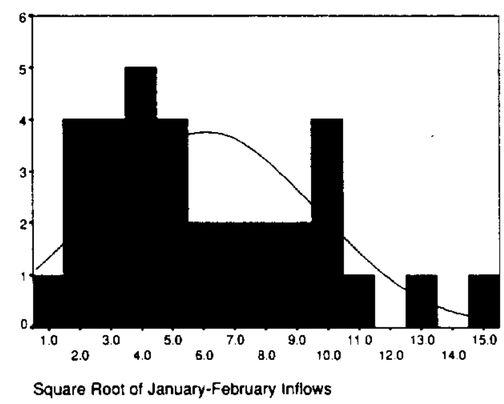


***Figure 2.18*** *Histogram of Sqrt(January-February Inflows).*

### 2.2.3 The March-April Inflows data

***Table .2.8*** *Descriptives for the March-April Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| March-April Inflows | Mean | | 45.4633 | 10.6395 |
| | 95% Confidence Interval for Mean | Lower Bound | 23.7915 | |
| | | Upper Bound | 67.1352 | |
| | 5% Trimmed Mean | | 36.1373 | |
| | Median | | 29.1800 | |
| | Variance | | 3735.540 | |
| | Std. Deviation | | 61.1191 | |
| | Minimum | | 2.09 | |
| | Maximum | | 269.63 | |
| | Range | | 267.54 | |
| | Interquartile Range | | 45.8200 | |
| | Skewness | | 2.649 | .409 |
| | Kurtosis | | 7.303 | .798 |

***Table .2.9*** *Extreme Values for the March-April Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| March-April Inflows | Highest | 1 | 32 | 1993 | 269.63 |
| | | 2 | 31 | 1992 | 236.13 |
| | | 3 | 24 | 1985 | 115.47 |
| | | 4 | 25 | 1986 | 113.88 |
| | | 5 | 33 | 1994 | 88.99 |
| | Lowest | 1 | 2 | 1963 | 2.09 |
| | | 2 | 28 | 1989 | 2.78 |
| | | 3 | 3 | 1964 | 3.19 |
| | | 4 | 7 | 1968 | 4.45 |
| | | 5 | 4 | 1965 | 4.71 |

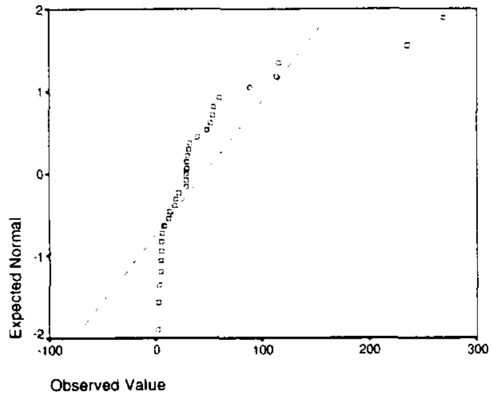


*Figure 2.19* Normal Q-Q Plot of March-April Inflows.

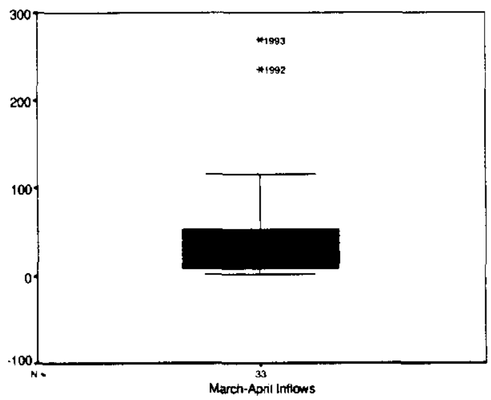


*Figure 2.20* BoxPlot of March-April Inflows.

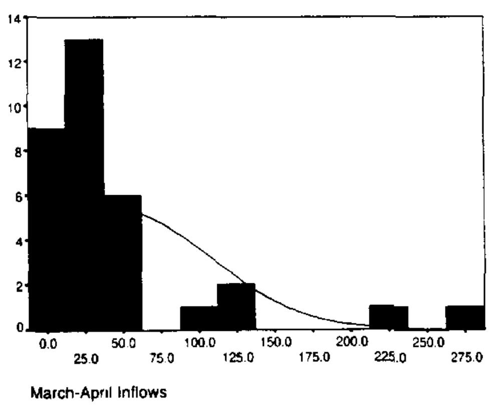


*Figure 2.21* Histogram of March-April Inflows.

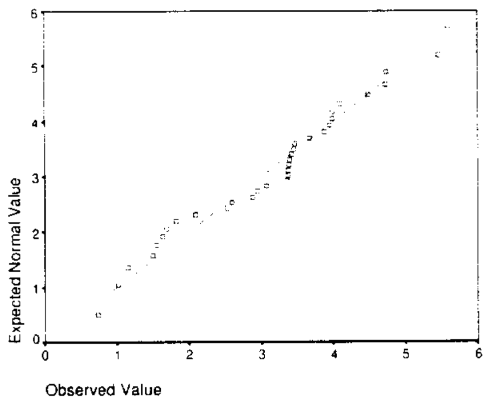


***Figure 2.22*** *Normal Q-Q Plot of Ln(March-April Inflows).*

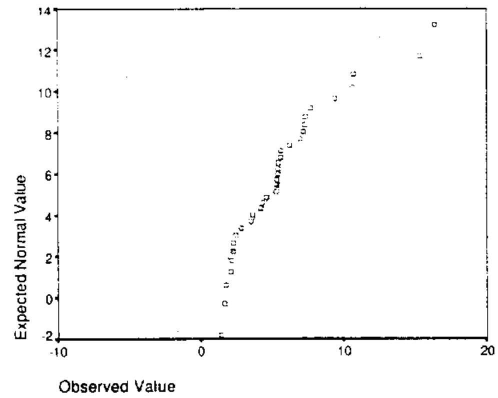


***Figure 2.23*** *Normal Q-Q Plot of Sqrt( March-April Inflows).*

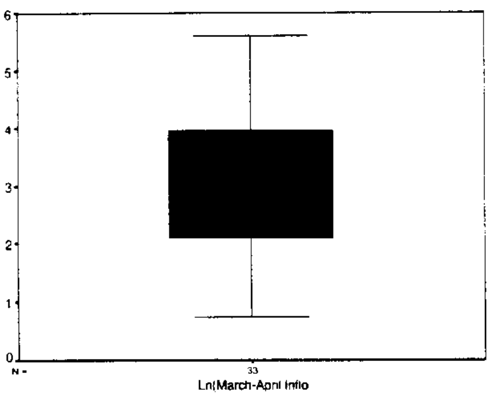


***Figure 2.24*** *BoxPlot of Ln(March-April) Inflows.*

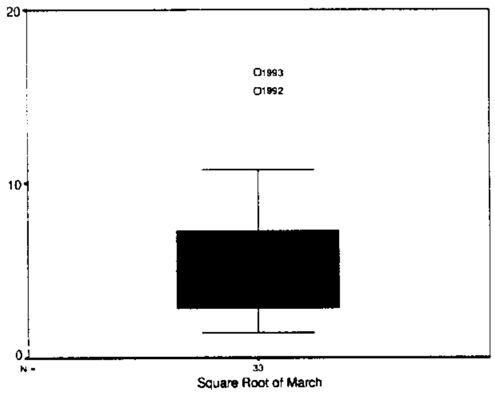


***Figure 2.25*** *BoxPlot of Square Root of March-April Inflows.*

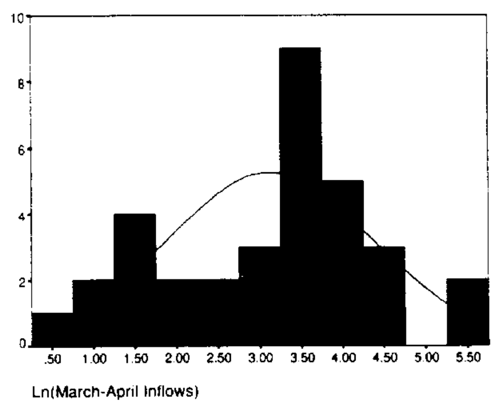


***Figure 2.26*** *Histogram of Ln(March-April Inflows).*

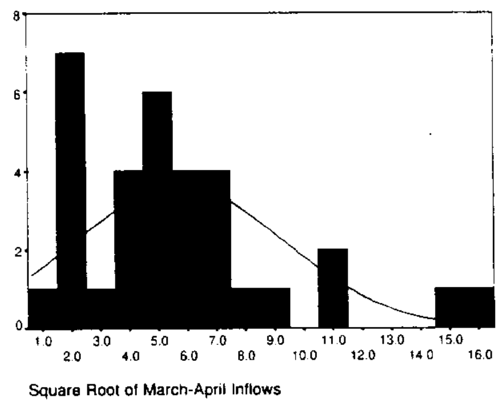


***Figure 2.27*** *Histogram of Sqrt(March-April Inflows).*

### 2.2.4 The May-June Inflows data

***Table .2.10*** *Descriptives for the May-June Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| May-June Inflows | Mean | | 154.1418 | 25.4367 |
| | 95% Confidence Interval for Mean | Lower Bound | 102.3289 | |
| | | Upper Bound | 205.9547 | |
| | 5% Trimmed Mean | | 141.3606 | |
| | Median | | 105.7200 | |
| | Variance | | 21351.9 | |
| | Std. Deviation | | 146.1228 | |
| | Minimum | | 6.75 | |
| | Maximum | | 607.54 | |
| | Range | | 600.79 | |
| | Interquartile Range | | 248.0750 | |
| | Skewness | | 1.256 | .409 |
| | Kurtosis | | 1.331 | .798 |

***Table .2.11*** *Extreme Values for the May-June Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| May-June Inflows | Highest | 1 | 32 | 1993 | 607.54 |
| | | 2 | 12 | 1973 | 409.35 |
| | | 3 | 33 | 1994 | 382.20 |
| | | 4 | 21 | 1982 | 338.25 |
| | | 5 | 8 | 1969 | 316.63 |
| | Lowest | 1 | 3 | 1964 | 6.75 |
| | | 2 | 2 | 1963 | 12.16 |
| | | 3 | 29 | 1990 | 16.36 |
| | | 4 | 28 | 1989 | 21.82 |
| | | 5 | 1 | 1962 | 22.26 |

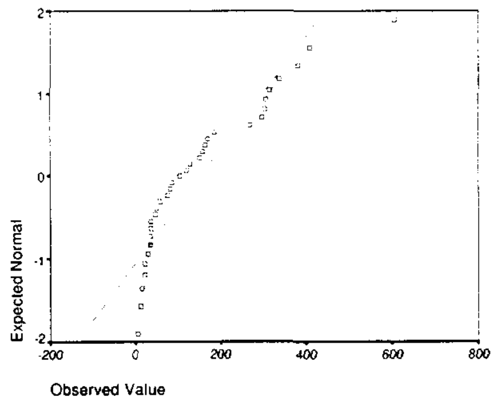


***Figure 2.28*** *Normal Q-Q Plot of May-June Inflows.*

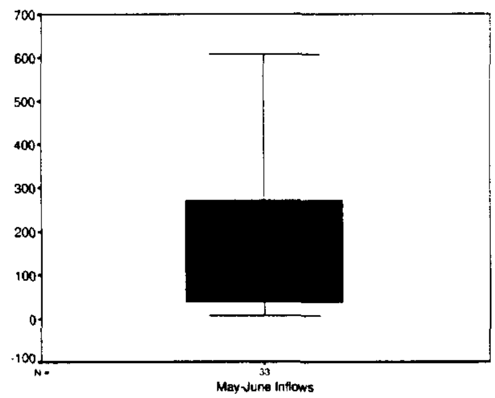


***Figure 2.29*** *BoxPlot of May-June Inflows.*

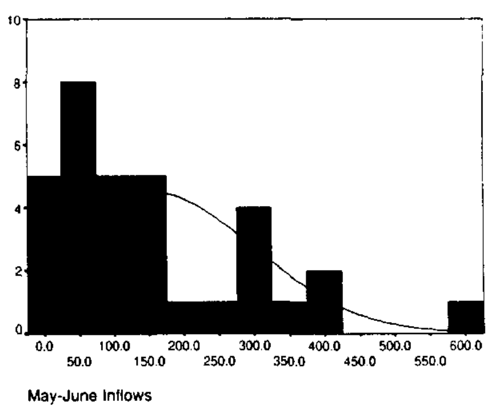


***Figure 2.30*** *Histogram of May-June Inflows.*

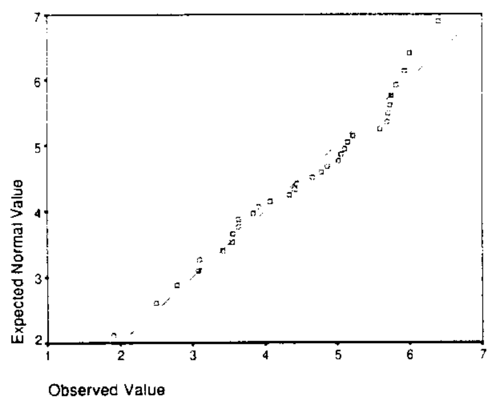


***Figure 2.31*** *Normal Q-Q Plot of Ln(May-June Inflows).*

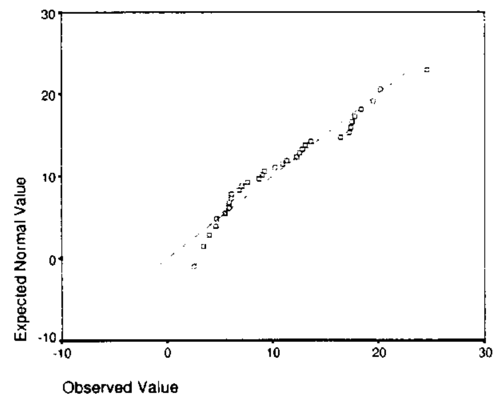


***Figure 2.32*** *Normal Q-Q Plot of Sqrt( May-June Inflows).*

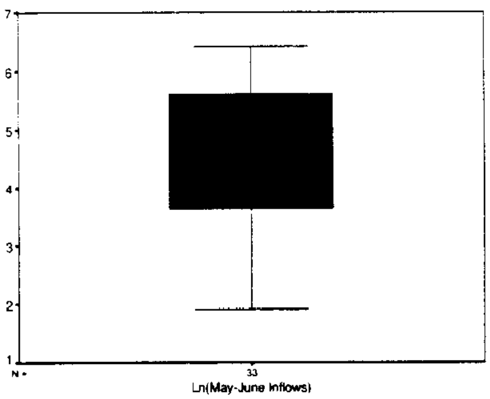


***Figure 2.33*** *BoxPlot of Ln(May-June) Inflows.*

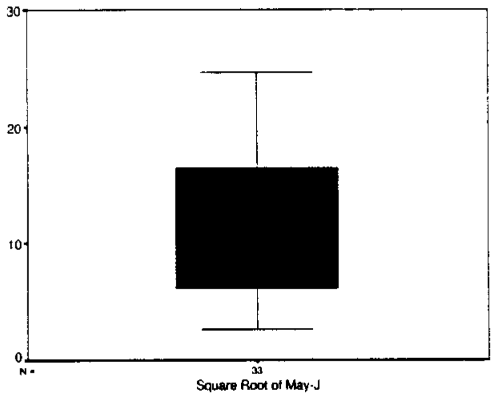


***Figure 2.34*** *BoxPlot of Square Root of May-June Inflows.*

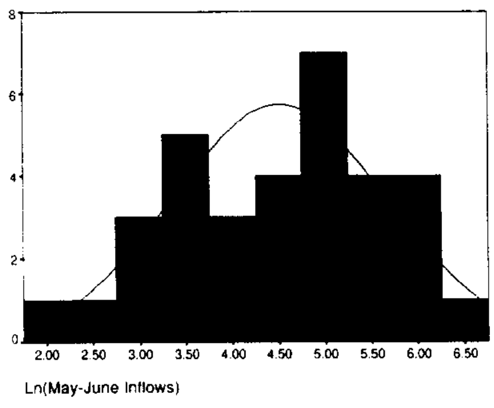


***Figure 2.35*** *Histogram of Ln(May-June Inflows).*

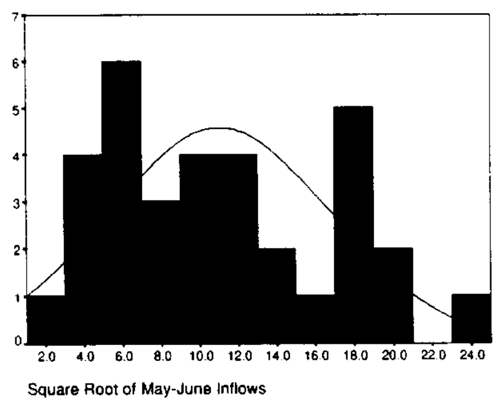


***Figure 2.36*** *Histogram of Sqrt(May-June Inflows).*

### 2.2.5 The July-August Inflows data

***Table .2.12*** *Descriptives for the July-August Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| July-August Inflows | Mean | | 72.7897 | 14.0587 |
| | 95% Confidence Interval for Mean | Lower Bound | 44.1531 | |
| | | Upper Bound | 101.4263 | |
| | 5% Trimmed Mean | | 65.6504 | |
| | Median | | 35.5900 | |
| | Variance | | 6522.352 | |
| | Std. Deviation | | 80.7611 | |
| | Minimum | | 2.40 | |
| | Maximum | | 304.68 | |
| | Range | | 302.28 | |
| | Interquartile Range | | 113.6150 | |
| | Skewness | | 1.339 | .409 |
| | Kurtosis | | .709 | .798 |

***Table .2.13*** *Extreme Values for the July-August Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| July-August Inflows | Highest | 1 | 20 | 1981 | 304.68 |
| | | 2 | 19 | 1980 | 214.91 |
| | | 3 | 22 | 1983 | 200.04 |
| | | 4 | 23 | 1984 | 196.61 |
| | | 5 | 29 | 1990 | 193.50 |
| | Lowest | 1 | 2 | 1963 | 2.40 |
| | | 2 | 14 | 1975 | 8.42 |
| | | 3 | 24 | 1985 | 9.60 |
| | | 4 | 17 | 1978 | 12.04 |
| | | 5 | 5 | 1966 | 12.23 |

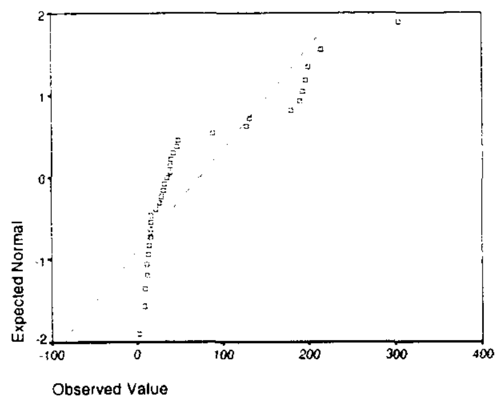


***Figure 2.37*** *Normal Q-Q Plot of July-August Inflows.*

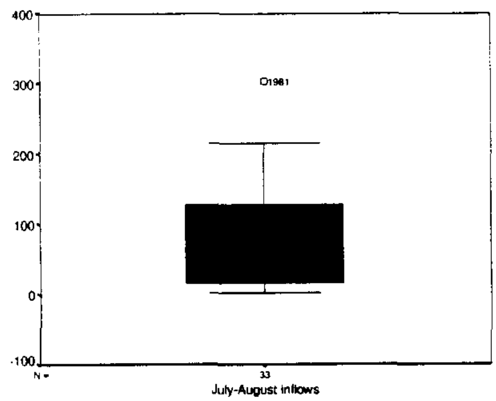


***Figure 2.38*** *BoxPlot of July-August Inflows.*

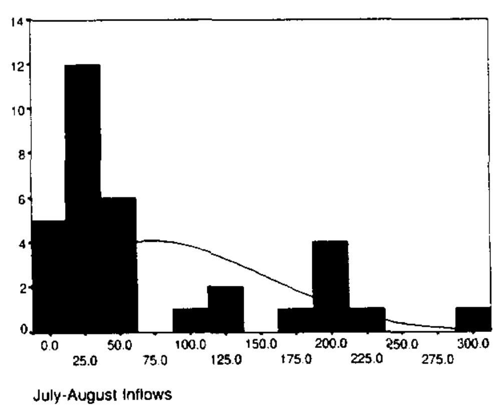


***Figure 2.39*** *Histogram of July-August Inflows.*

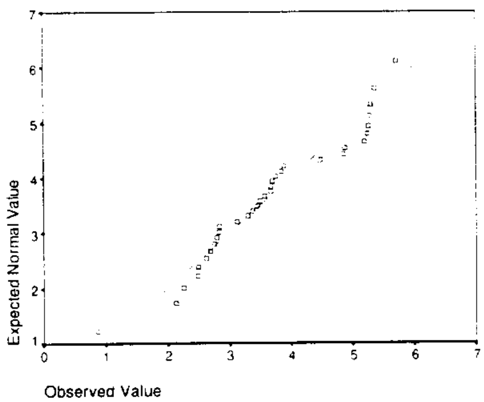


***Figure 2.40*** *Normal Q-Q Plot of Ln(July-August Inflows).*

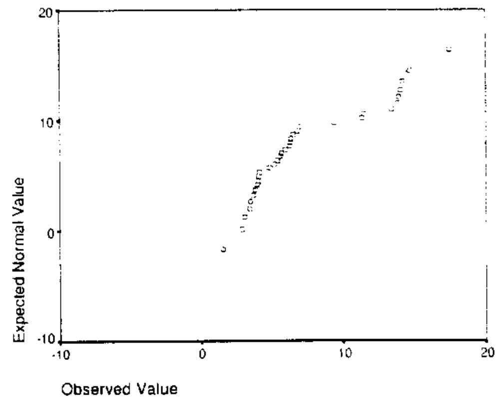


***Figure 2.41*** *Normal Q-Q Plot of Sqrt( July-August Inflows).*

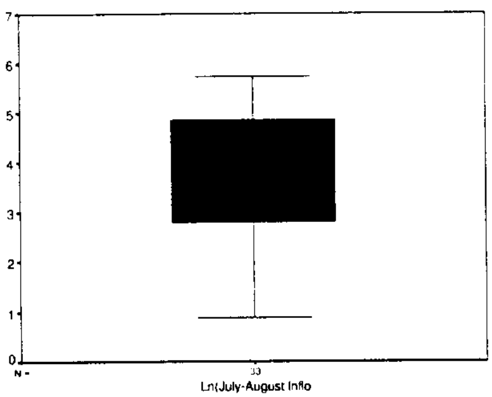


***Figure 2.42*** *BoxPlot of Ln(July-August) Inflows.*

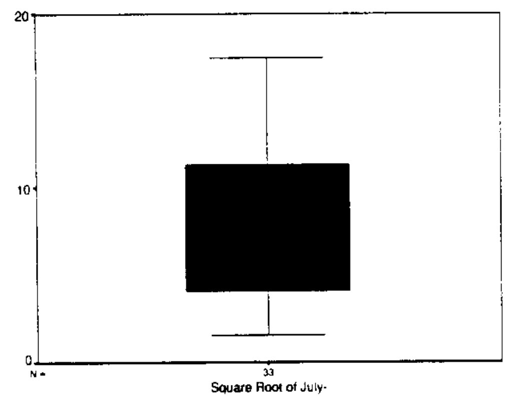


***Figure 2.43*** *BoxPlot of Square Root of July-August Inflows.*

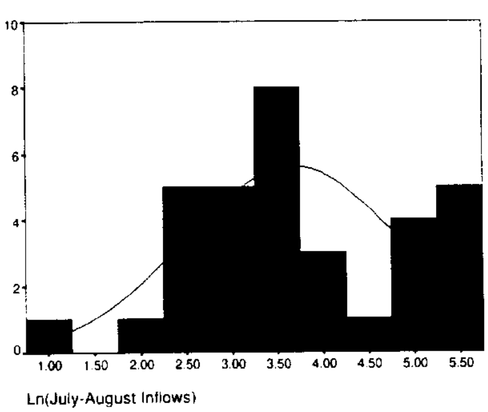


***Figure 2.44*** *Histogram of Ln(July-August Inflows).*

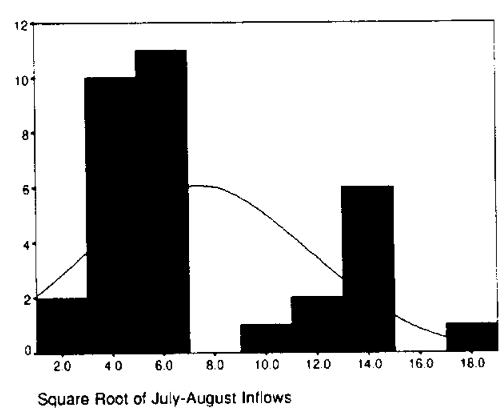


***Figure 2.45*** *Histogram of Sqrt(July-August Inflows).*

### 2.2.6 The September-October Inflows data

***Table .2.14*** *Descriptives for the September-October Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| September-October Inflows | Mean | | 182.9376 | 37.3155 |
| | 95% Confidence Interval for Mean | Lower Bound | 106.9284 | |
| | | Upper Bound | 258.9468 | |
| | 5% Trimmed Mean | | 161.5853 | |
| | Median | | 80.7200 | |
| | Variance | | 45950.8 | |
| | Std. Deviation | | 214.3613 | |
| | Minimum | | 5.03 | |
| | Maximum | | 750.61 | |
| | Range | | 745.58 | |
| | Interquartile Range | | 257.8250 | |
| | Skewness | | 1.488 | .409 |
| | Kurtosis | | 1.363 | .798 |

***Table .2.15*** *Extreme Values for the September-October Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| September-October Inflows | Highest | 1 | 8 | 1969 | 750.61 |
| | | 2 | 7 | 1968 | 735.03 |
| | | 3 | 11 | 1972 | 595.65 |
| | | 4 | 12 | 1973 | 562.30 |
| | | 5 | 14 | 1975 | 439.28 |
| | Lowest | 1 | 4 | 1965 | 5.03 |
| | | 2 | 6 | 1967 | 6.84 |
| | | 3 | 5 | 1966 | 7.49 |
| | | 4 | 30 | 1991 | 8.15 |
| | | 5 | 3 | 1964 | 11.26 |

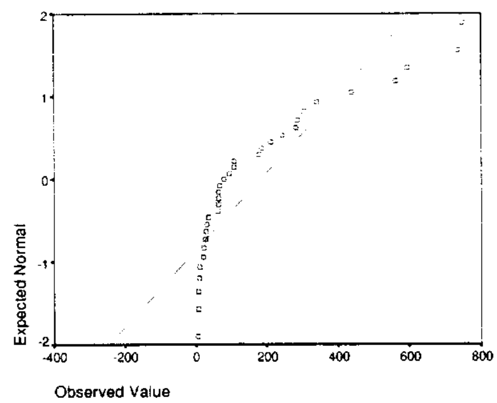


***Figure 2.46*** *Normal Q-Q Plot of September-October Inflows.*

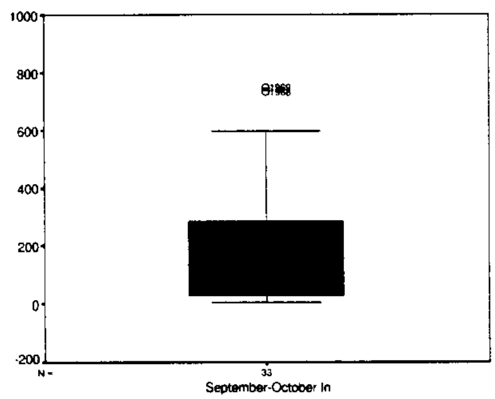


***Figure 2.47*** *BoxPlot of September-October Inflows.*

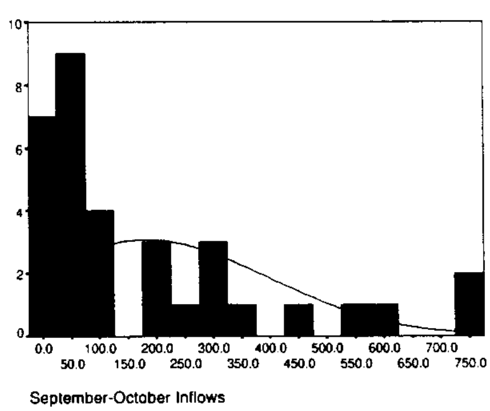


***Figure 2.48*** *Histogram of September-October Inflows.*

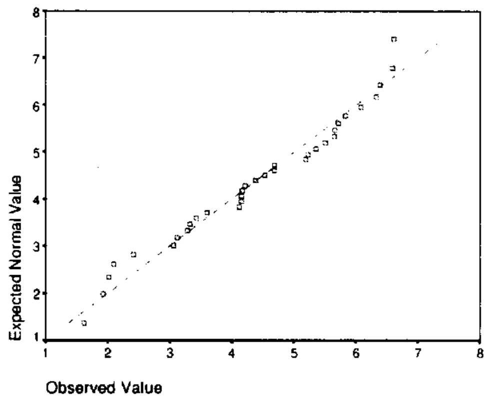


***Figure 2.49*** *Normal Q-Q Plot of Ln(September-October Inflows).*

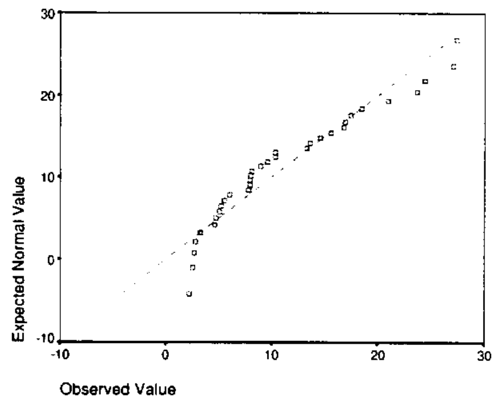


***Figure 2.50*** *Normal Q-Q Plot of Sqrt( September-October Inflows).*

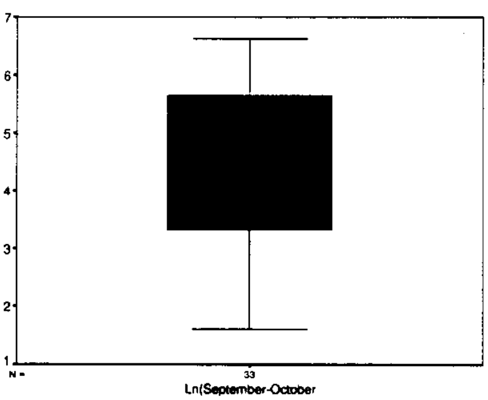


***Figure 2.51*** *BoxPlot of Ln(September-October) Inflows.*

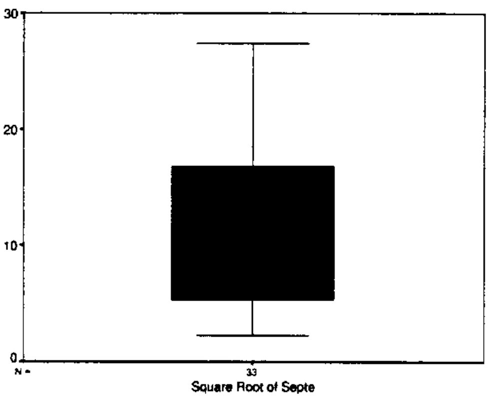


***Figure 2.52*** *BoxPlot of Square Root of September-October Inflows.*

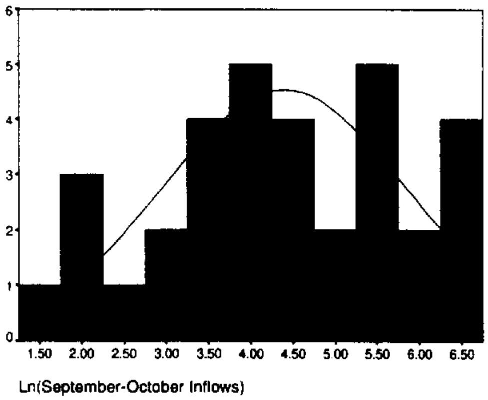


***Figure 2.53*** *Histogram of Ln(September-October Inflows).*

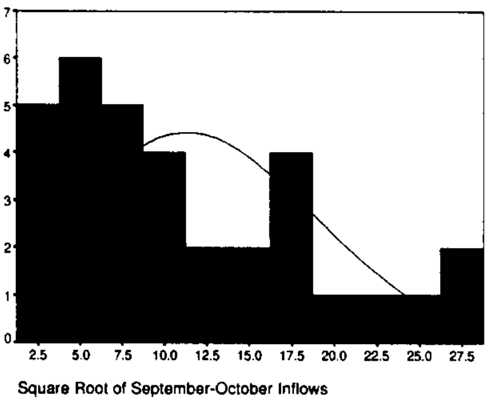


***Figure 2.54*** *Histogram of Sqrt(September-October Inflows).*

### 2.2.7 The November-December Inflows data

***Table .2.16*** *Descriptives for the November-December Inflow data.*

**Descriptives**

| | | | | Statistic | Std. Error |
|---|---|---|---|---|---|
| November-December Inflows | Mean | | | 48.8164 | 8.5813 |
| | 95% Confidence Interval for Mean | Lower Bound | | 31.3369 | |
| | | Upper Bound | | 66.2958 | |
| | 5% Trimmed Mean | | | 45.0084 | |
| | Median | | | 24.7300 | |
| | Variance | | | 2430.054 | |
| | Std. Deviation | | | 49.2956 | |
| | Minimum | | | 5.09 | |
| | Maximum | | | 170.21 | |
| | Range | | | 165.12 | |
| | Interquartile Range | | | 56.8350 | |
| | Skewness | | | 1.152 | .409 |
| | Kurtosis | | | -.013 | .798 |

***Table .2.17*** *Extreme Values for the November-December Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| November-December Inflows | Highest | 1 | 32 | 1993 | 170.21 |
| | | 2 | 1 | 1962 | 146.58 |
| | | 3 | 31 | 1992 | 133.00 |
| | | 4 | 17 | 1978 | 129.69 |
| | | 5 | 16 | 1977 | 124.81 |
| | Lowest | 1 | 4 | 1965 | 5.09 |
| | | 2 | 7 | 1968 | 5.56 |
| | | 3 | 8 | 1969 | 6.28 |
| | | 4 | 28 | 1989 | 8.23 |
| | | 5 | 13 | 1974 | 9.96 |

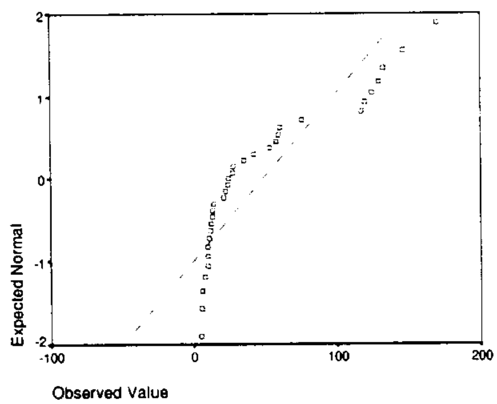


***Figure 2.55*** *Normal Q-Q Plot of November_December Inflows.*

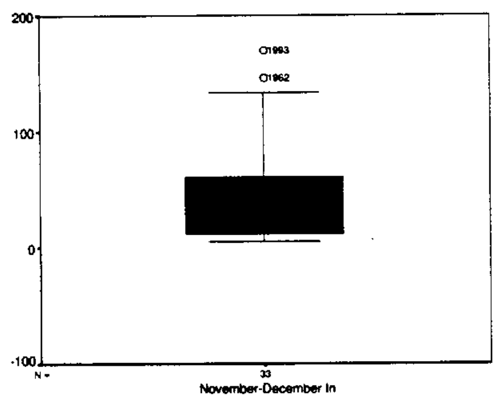


***Figure 2.56*** *BoxPlot of November_December Inflows.*

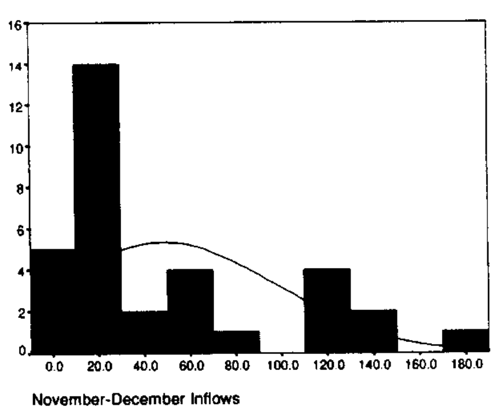


***Figure 2.57*** *Histogram of November_December Inflows.*

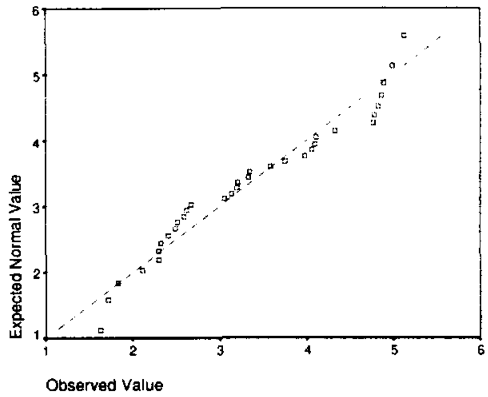


**Figure 2.58** *Normal Q-Q Plot of Ln(November_December Inflows).*

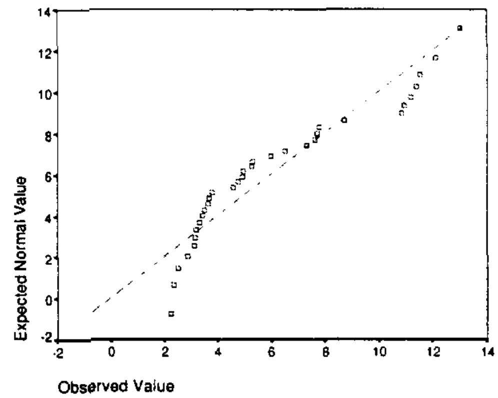


**Figure 2.59** *Normal Q-Q Plot of Sqrt( November_December Inflows).*

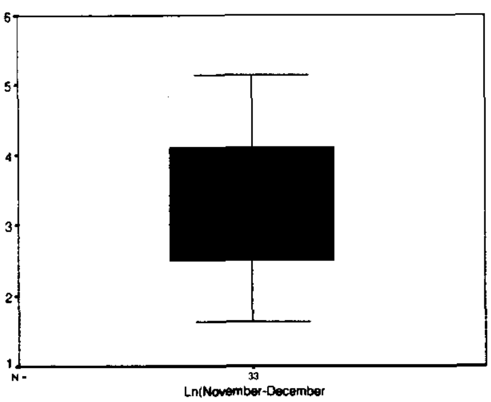


**Figure 2.60** *BoxPlot of Ln(November _December) Inflows.*

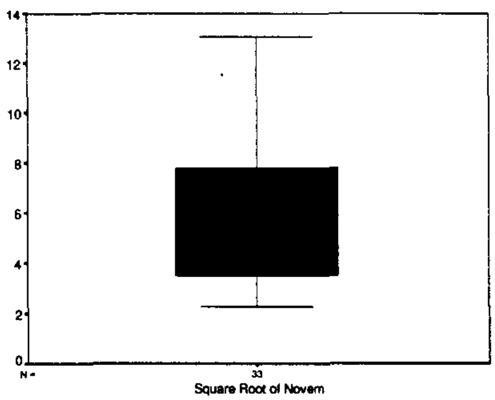


**Figure 2.61** *BoxPlot of Square Root of November_December Inflows.*

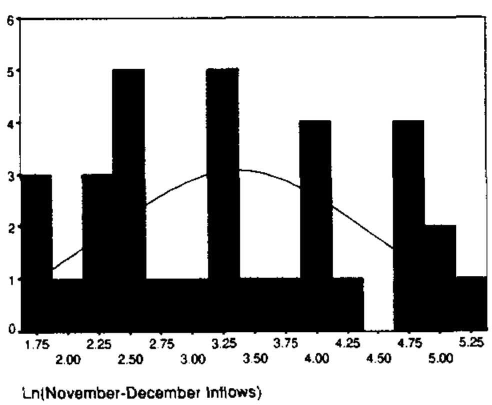


**Figure 2.62** *Histogram of Ln(November_ December Inflows).*

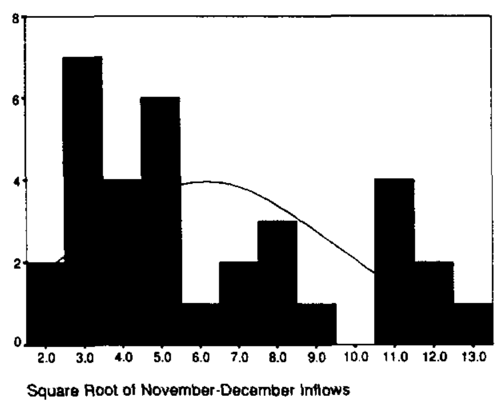


**Figure 2.63** *Histogram of Sqrt(November_ December Inflows).*

# 3. Prediction Ellipses and Confidence Regions

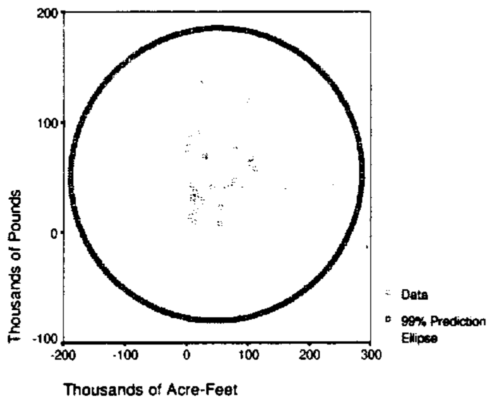


***Figure 3.1*** *Flounder Harvest vs. January-February Inflows, PE.*

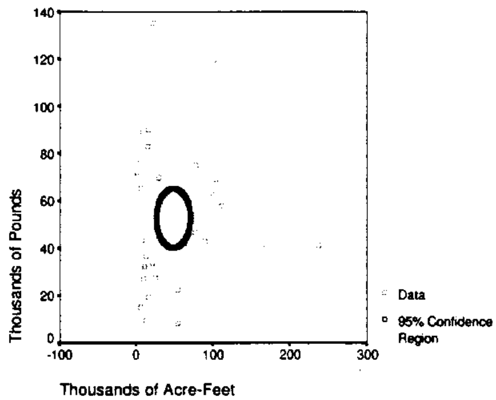


***Figure 3.2*** *Flounder Harvest vs. January-February Inflows, CR.*

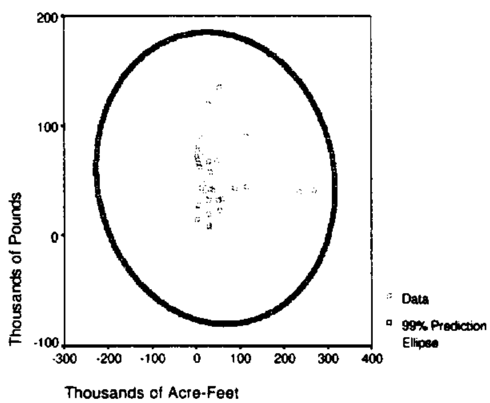


***Figure 3.3*** *Flounder Harvest vs. March-April Inflows, PE.*

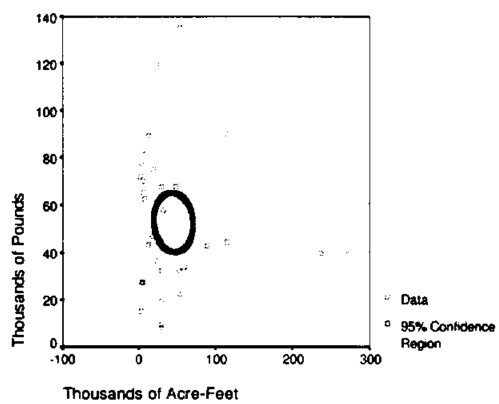


***Figure 3.4*** *Flounder Harvest vs. March-April Inflows, CR.*

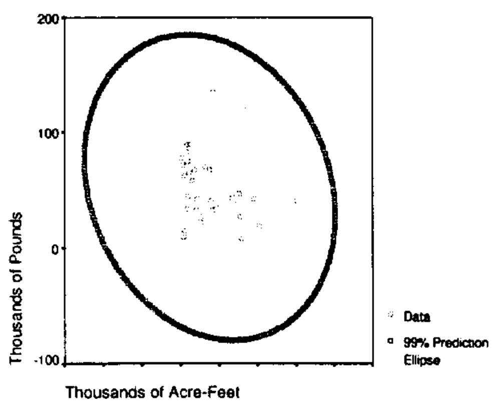


***Figure 3.5*** *Flounder Harvest vs. May-June Inflows, PE.*

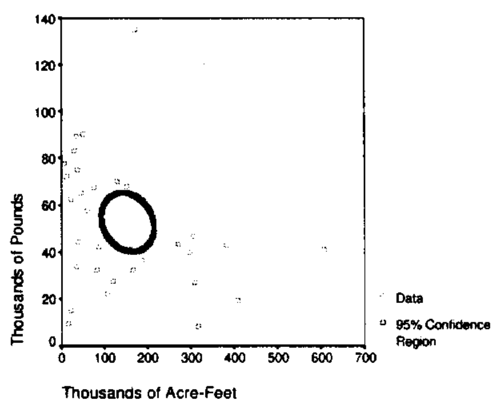


***Figure 3.6*** *Flounder Harvest vs. May-June Inflows, CR.*

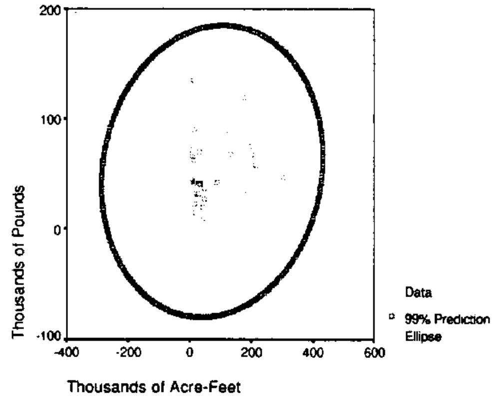


***Figure 3.7*** *Flounder Harvest vs. July-August Inflows, PE.*

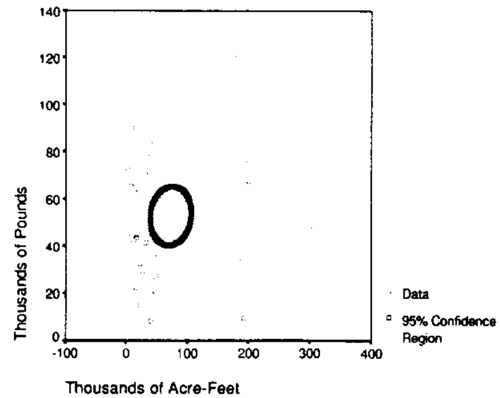


***Figure 3.8*** *Flounder Harvest vs. July-August Inflows, CR.*

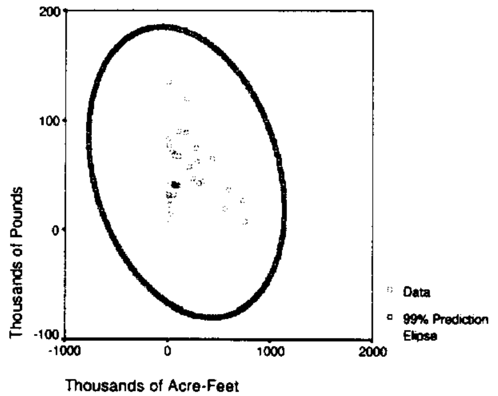


***Figure 3.9*** *Flounder Harvest vs. September-October Inflows, PE.*

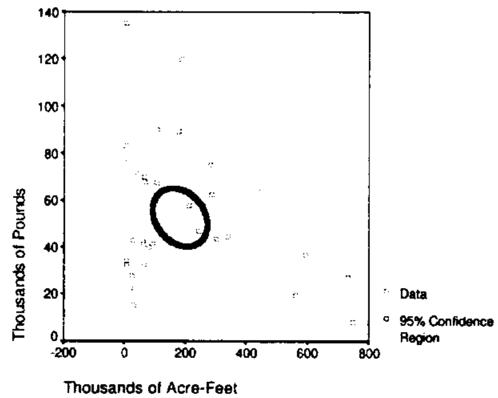


***Figure 3.10*** *Flounder Harvest vs. September-October Inflows, CR.*

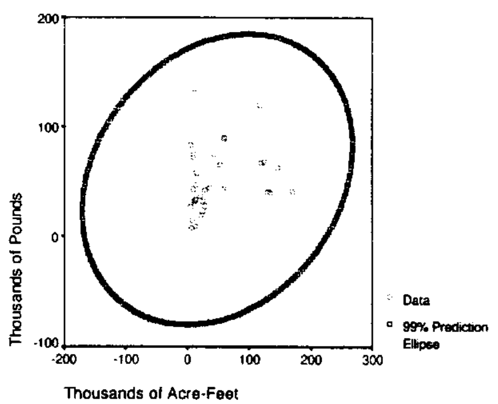


***Figure 3.11*** *Flounder Harvest vs. November-December Inflows, PE.*

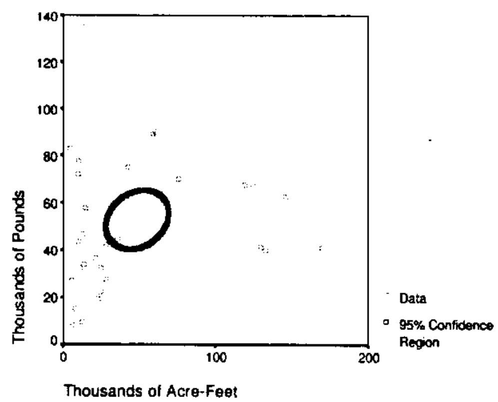


***Figure 3.12*** *Flounder Harvest vs. November-December Inflows, CR.*

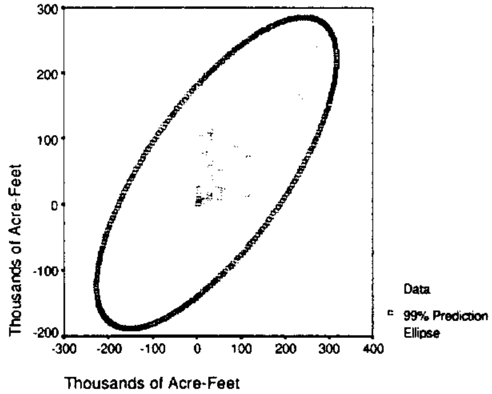


***Figure 3.13*** *January-February Inflows vs. March-April Inflows, PE.*

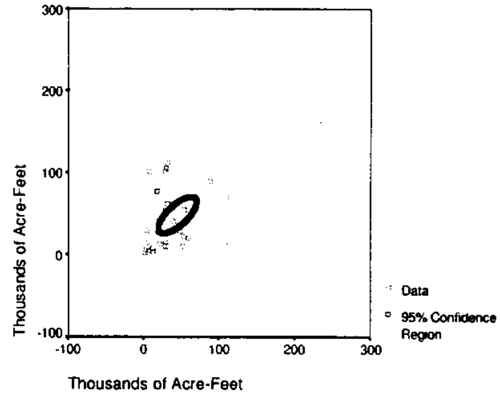


***Figure 3.14*** *January-February Inflows vs. March-April Inflows, CR.*

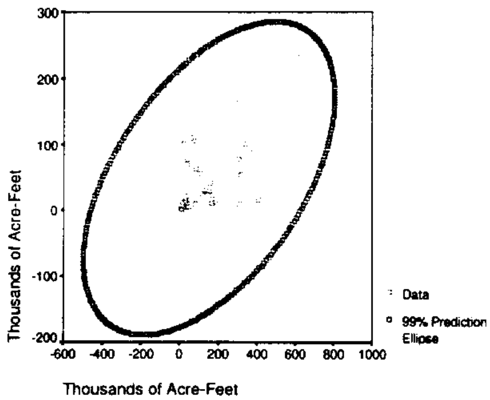


***Figure 3.15*** *January-February Inflows vs. May-June Inflows, PE.*

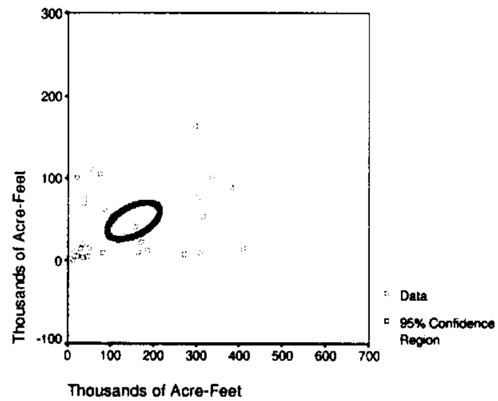


***Figure 3.16*** *January-February Inflows vs. May-June Inflows, CR.*

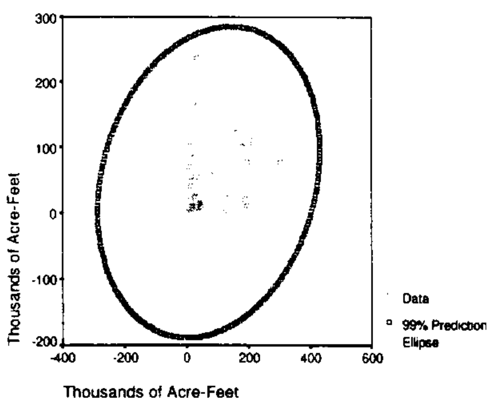


***Figure 3.17*** *January-February Inflows vs. July-August Inflows, PE.*

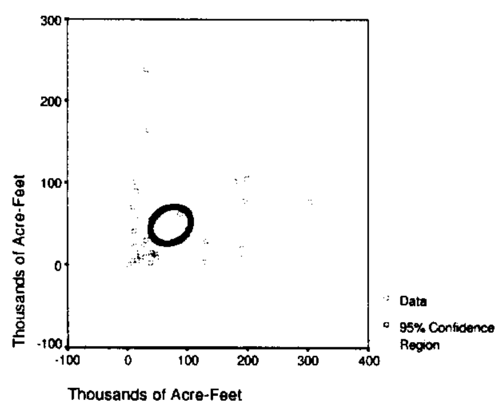


***Figure 3.18*** *January-February Inflows vs. July-August Inflows, CR.*

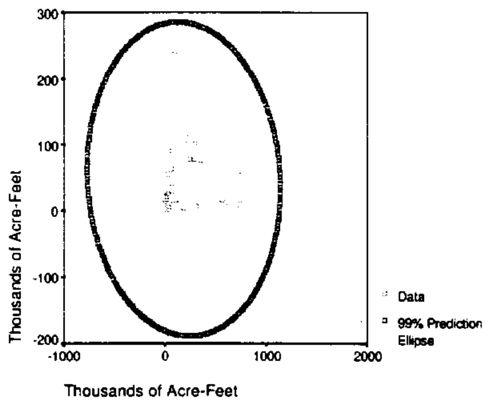


*Figure 3.19* *January-February Inflows vs. September-October Inflows, PE.*

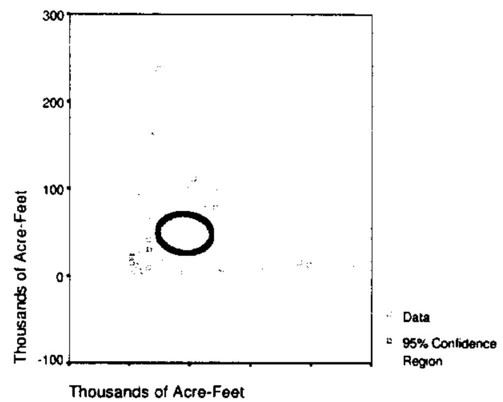


*Figure 3.20* *January-February Inflows vs. September-October Inflows, CR.*

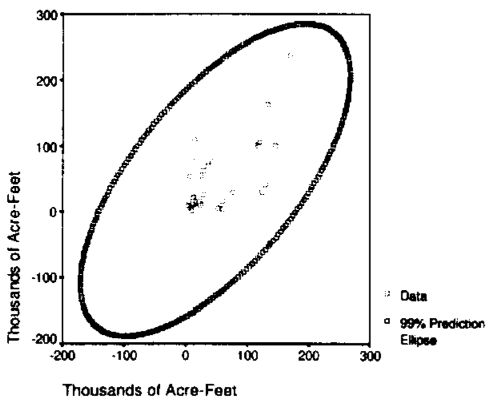


*Figure 3.21* *January-February Inflows vs. November-December Inflows, PE.*

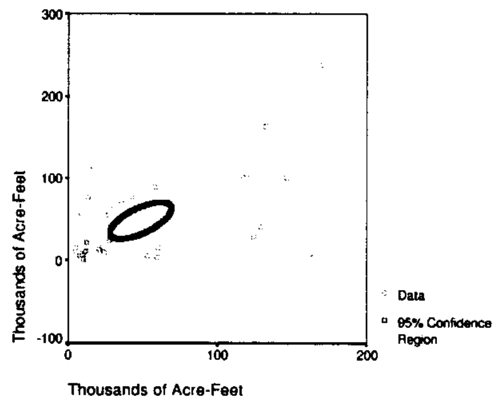


*Figure 3.22* *January-February Inflows vs. November-December Inflows, CR.*

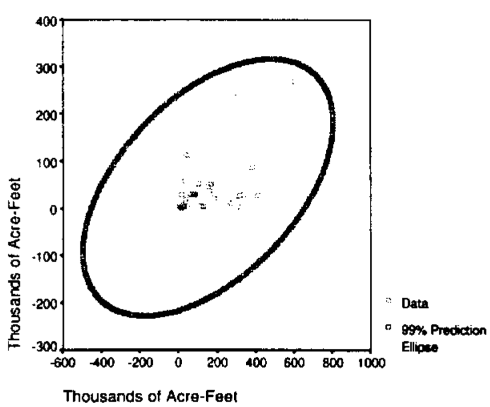


*Figure 3.23* *March-April Inflows vs. May-June Inflows, PE.*

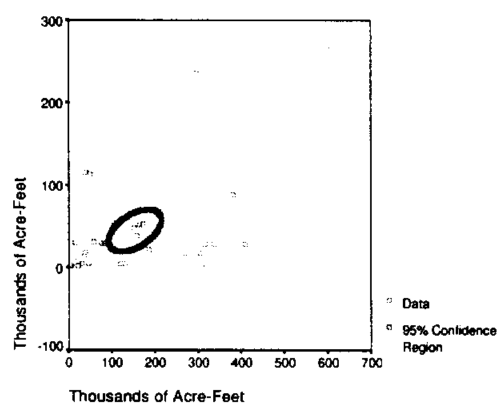


*Figure 3.24* *March-April Inflows vs. May-June Inflows, CR.*

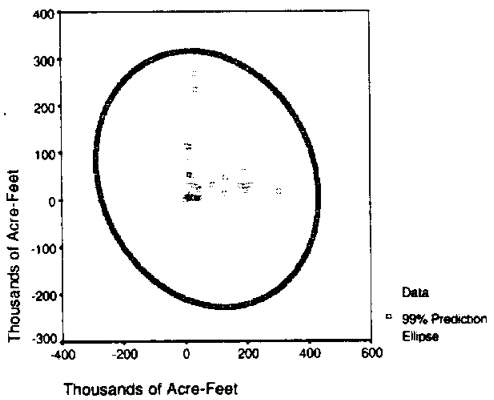


***Figure 3.25*** *March-April Inflows vs. July-August Inflows, PE.*

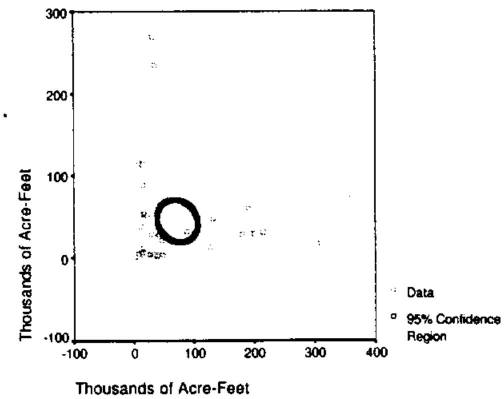


***Figure 3.26*** *March-April Inflows vs. July-August Inflows, CR.*

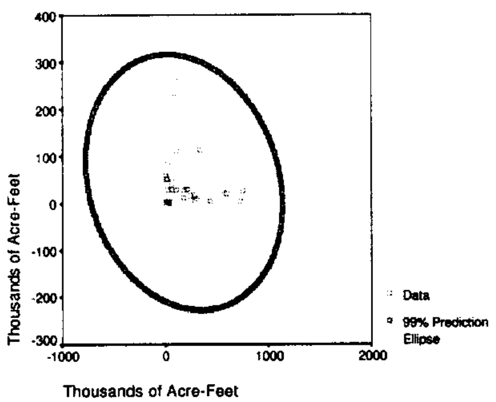


***Figure 3.27*** *March-April Inflows vs. September-October Inflows, PE.*

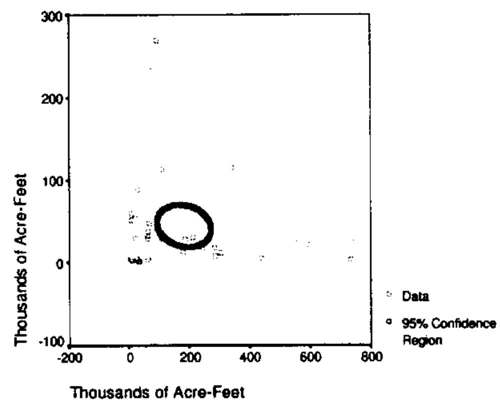


***Figure 3.28*** *March-April Inflows vs. September-October Inflows, CR.*

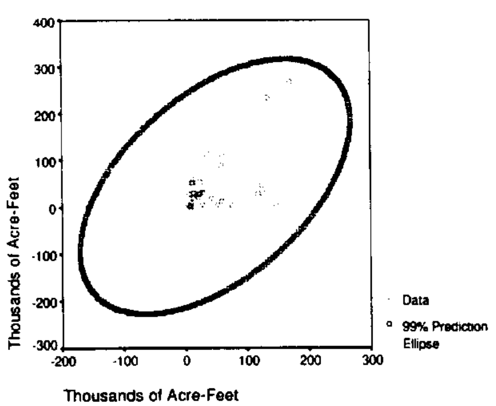


***Figure 3.29*** *March-April Inflows vs. November-December Inflows, PE.*

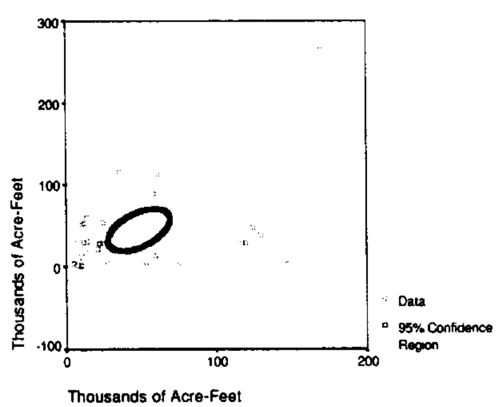


***Figure 3.30*** *March-April Inflows vs. November-December Inflows, CR.*

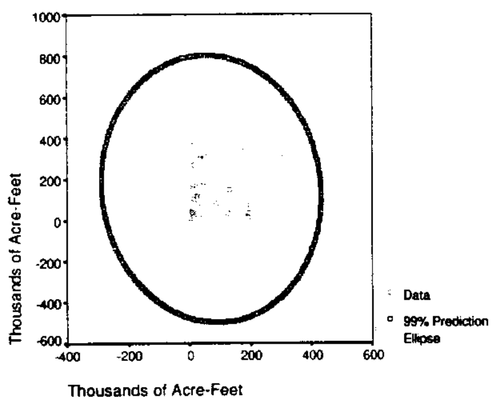


***Figure 3.31*** *May-June Inflows vs. July-August Inflows, PE.*

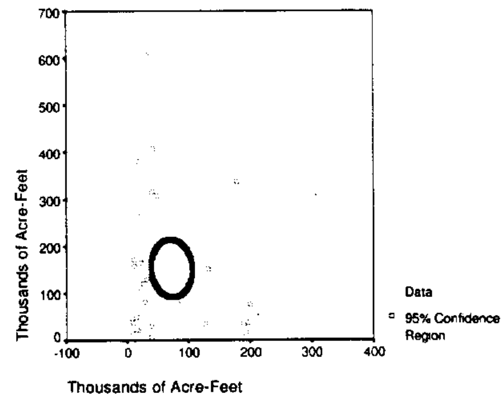


***Figure 3.32*** *May-June Inflows vs. July-August Inflows, CR.*

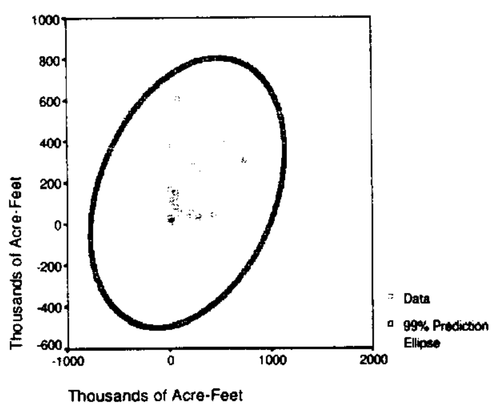


***Figure 3.33*** *May-June Inflows vs. September-October Inflows, PE.*

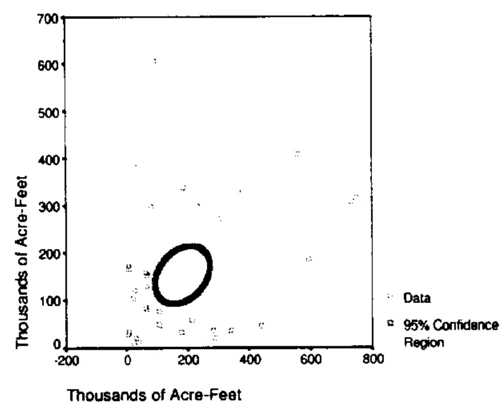


***Figure 3.34*** *May-June Inflows vs. September-October Inflows, CR.*

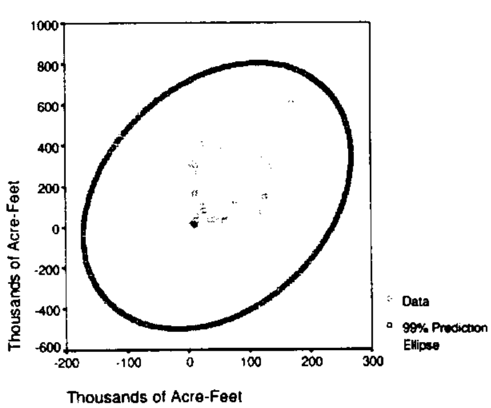


***Figure 3.35*** *May-June Inflows vs. November-December Inflows, PE.*

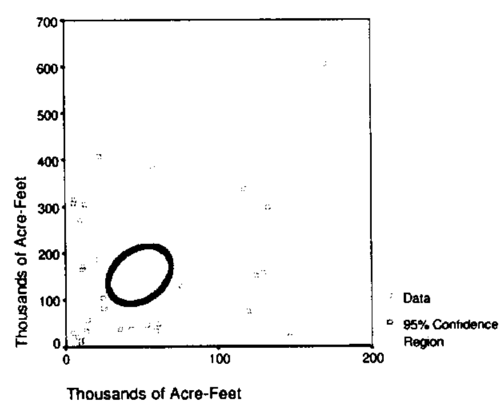


***Figure 3.36*** *May-June Inflows vs. November-December Inflows, CR.*

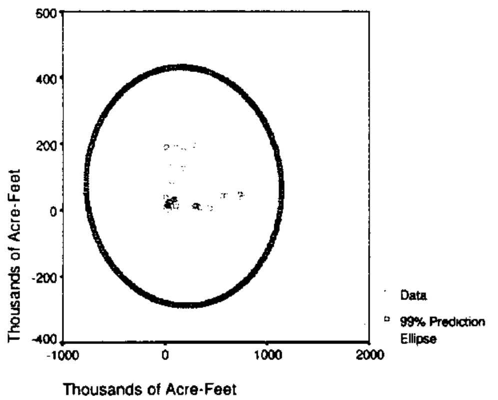


***Figure 3.37*** *July-August Inflows. vs. September-October Inflows, PE.*

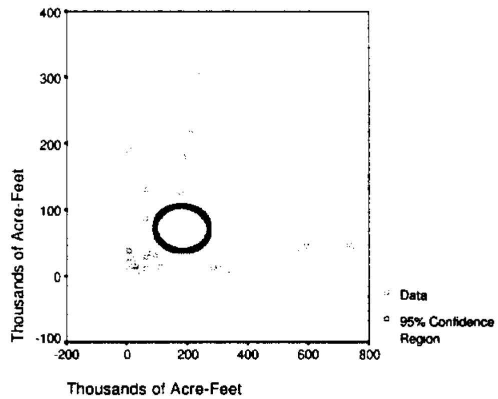


***Figure 3.38*** *July-August Inflows. vs. September-October Inflows, CR.*

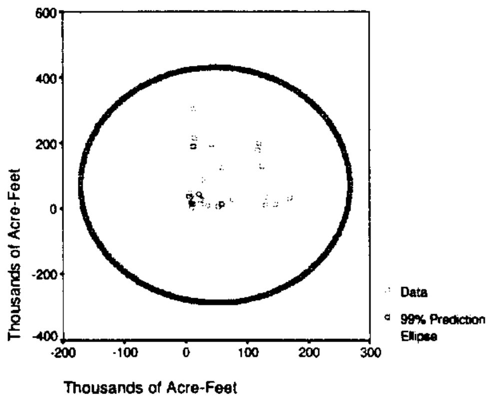


***Figure 3.39*** *July-August Inflows. vs. November-December Inflows, PE.*

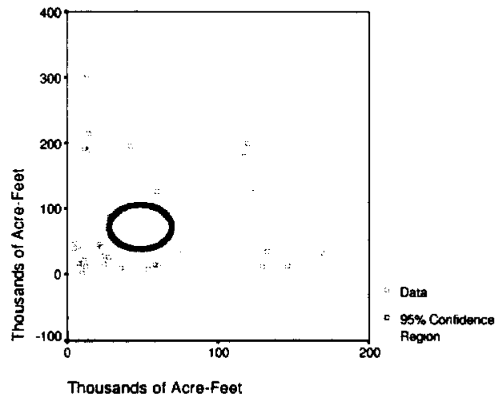


***Figure 3.40*** *July-August Inflows. vs. November-December Inflows, CR.*

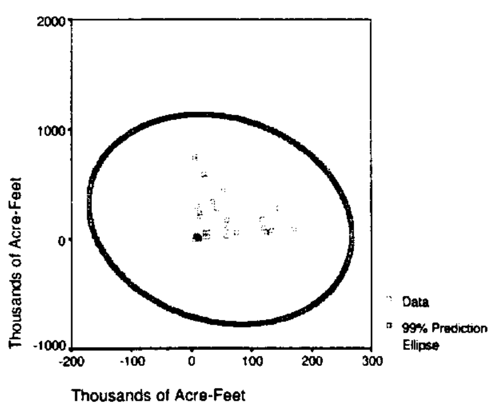


***Figure 3.41*** *September-October Inflows vs. November-December Inflows, PE.*

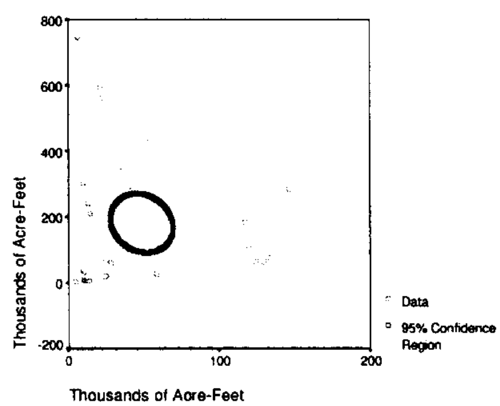


***Figure 3.42*** *September-October Inflows vs. November-December Inflows, CR.*

# 4. BOX-COX ANALYSIS

***Table .4.1*** *Mean Square Error from Box-Cox transformation of the flounder data and the inflow data for different lambda.*

| Lam | Flounder | JF_inflow | MA_inflo | MJ_inflow | JA_inflow | SO_inflow | ND_inflow |
|---|---|---|---|---|---|---|---|
| -2.0 | 17102.6 | 1054158 | 78386.1 | 2212213 | 836817.5 | 5131715 | 12818.3 |
| -1.9 | 13670.2 | 636109 | 55266.9 | 1472829 | 529247.2 | 3345762 | 10212.3 |
| -1.8 | 10979.9 | 386295 | 39247.1 | 987656 | 336641.4 | 2196066 | 8186.3 |
| -1.7 | 8865.4 | 236282 | 28088.7 | 667661 | 215525.5 | 1452004 | 6606.3 |
| -1.6 | 7198.6 | 145714 | 20273.4 | 455433 | 139017.5 | 967725 | 5370.2 |
| -1.5 | 5881.0 | 90709 | 14767.5 | 313828 | 90446.9 | 650628 | 4400.0 |
| -1.4 | 4836.1 | 57081 | 10864.4 | 218724 | 59443.3 | 441667 | 3636.2 |
| -1.3 | 4005.1 | 36372 | 8079.8 | 154399 | 39534.4 | 303031 | 3033.2 |
| -1.2 | 3342.2 | 23516 | 6079.6 | 110562 | 26666.1 | 210394 | 2555.8 |
| -1.1 | 2811.9 | 15463 | 4633.1 | 80446 | 18289.5 | 148027 | 2177.2 |
| -1.0 | 2386.4 | 10370 | 3579.8 | 59581 | 12795.2 | 105712 | 1876.5 |
| -0.9 | 2044.1 | 7115 | 2807.6 | 45001 | 9162.9 | 76774 | 1637.8 |
| -0.8 | 1768.2 | 5011 | 2238.2 | 34723 | 6742.7 | 56826 | 1448.9 |
| -0.7 | 1545.5 | 3635 | 1816.2 | 27419 | 5118.5 | 42973 | 1300.1 |
| -0.6 | 1365.5 | 2726 | 1502.6 | 22192 | 4022.9 | 33292 | 1184.2 |
| -0.5 | 1220.2 | 2119 | 1269.8 | 18432 | 3282.9 | 26500 | 1095.8 |
| -0.4 | 1103.0 | 1712 | 1098.3 | 15724 | 2786.7 | 21735 | 1030.6 |
| -0.3 | 1008.9 | 1438 | 974.5 | 13783 | 2461.5 | 18421 | 985.8 |
| -0.2 | 934.1 | 1257 | 889.0 | 12416 | 2260.4 | 16170 | 959.3 |
| -0.1 | 875.3 | 1142 | 835.9 | 11490 | 2153.7 | 14727 | 949.9 |
| 0.0 | 830.1 | 1077 | 811.9 | 10915 | 2123.0 | 13928 | 957.0 |
| 0.1 | 796.6 | 1051 | 816.0 | 10634 | 2158.4 | 13678 | 980.9 |
| 0.2 | 773.4 | 1060 | 849.8 | 10612 | 2256.2 | 13935 | 1022.6 |
| 0.3 | 759.5 | 1101 | 917.3 | 10836 | 2417.5 | 14701 | 1083.7 |
| 0.4 | 754.0 | 1177 | 1025.7 | 11305 | 2648.3 | 16023 | 1166.8 |
| 0.5 | 756.5 | 1290 | 1186.4 | 12035 | 2959.0 | 17995 | 1275.5 |
| 0.6 | 766.6 | 1448 | 1416.5 | 13057 | 3365.4 | 20769 | 1414.5 |
| 0.7 | 784.4 | 1663 | 1740.9 | 14419 | 3889.5 | 24565 | 1590.1 |
| 0.8 | 809.9 | 1949 | 2196.2 | 16188 | 4561.3 | 29700 | 1810.4 |
| 0.9 | 843.6 | 2329 | 2835.3 | 18458 | 5421.0 | 36620 | 2085.9 |
| 1.0 | 885.8 | 2834 | 3735.5 | 21352 | 6522.4 | 45951 | 2430.1 |
| 1.1 | 937.4 | 3508 | 5009.9 | 25035 | 7937.1 | 58567 | 2860.2 |
| 1.2 | 999.3 | 4410 | 6824.0 | 29725 | 9761.2 | 75696 | 3398.7 |
| 1.3 | 1072.7 | 5626 | 9422.0 | 35711 | 12123.4 | 99065 | 4074.3 |
| 1.4 | 1159.0 | 7274 | 13164.3 | 43379 | 15196.9 | 131107 | 4924.2 |
| 1.5 | 1260.0 | 9523 | 18586.1 | 53238 | 19215.6 | 175265 | 5996.5 |
| 1.6 | 1377.8 | 12609 | 26483.8 | 65972 | 24496.3 | 236427 | 7353.5 |
| 1.7 | 1515.0 | 16870 | 38047.1 | 82492 | 31470.2 | 321548 | 9076.2 |
| 1.8 | 1674.6 | 22786 | 55059.2 | 104023 | 40725.6 | 440560 | 11270.1 |
| 1.9 | 1860.3 | 31043 | 80200.0 | 132214 | 53068.5 | 607682 | 14073.0 |
| 2.0 | 2076.1 | 42628 | 117509.2 | 169292 | 69606.7 | 843332 | 17664.9 |

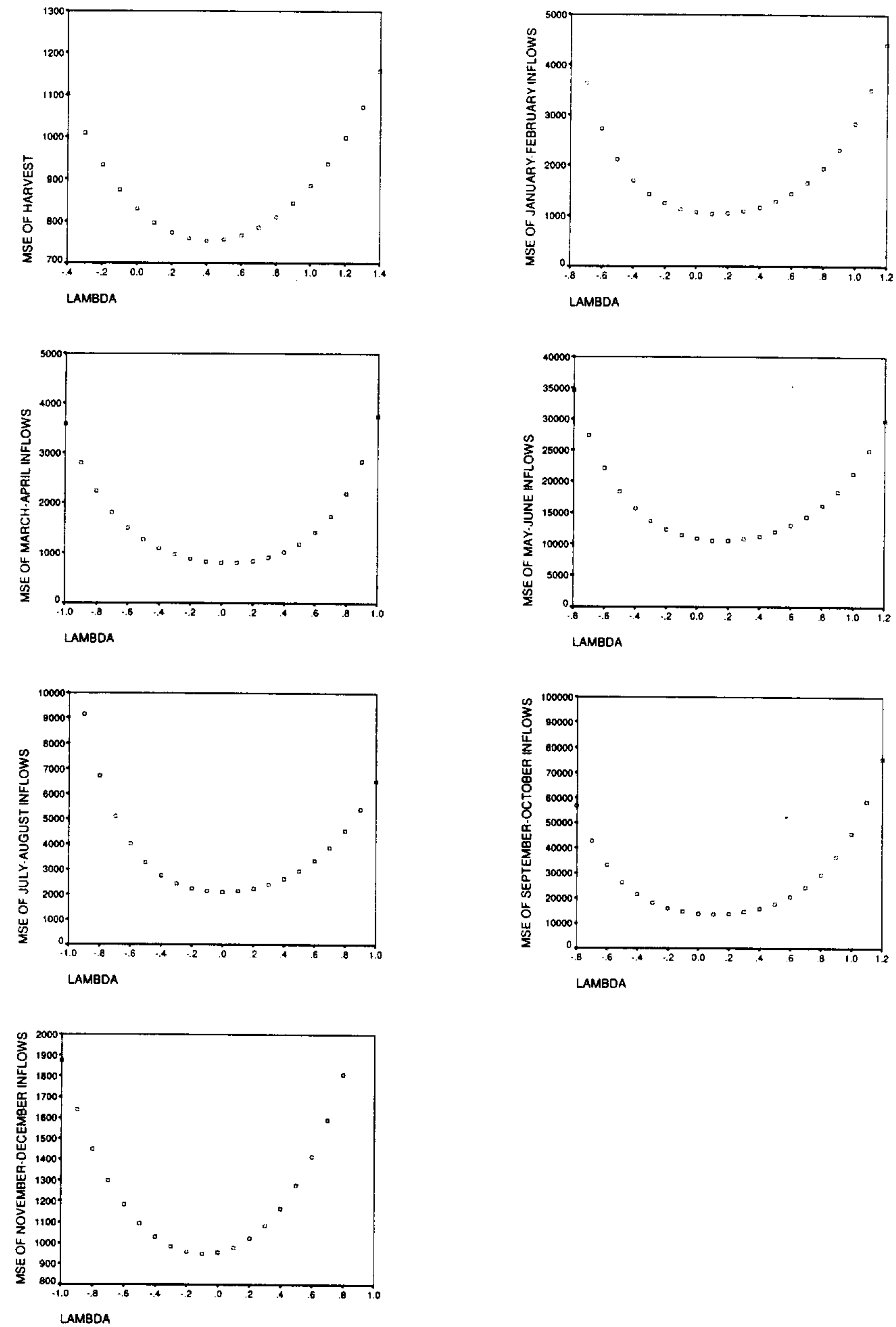


***Figure 4.1*** *Box-Cox Transformation - MSE of Flounder vs. Lambda and MSE of Inflow data vs. Lambda.*

# 5. Model Choice Diagnostics

## 5.1 Untransformed flounder data and untransformed inflow data

***Table 5.1*** *Regression Models for Dependent Variable: FLOUNDER on INFLOWS*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.0655 | 0.0354 | 0.445 | 224.7 | 854.4 | 227.7 | QSO_LAG |
| 1 | 0.0525 | 0.0219 | 0.856 | 225.2 | 866.4 | 228.2 | QND_LAG |
| 1 | 0.0329 | 0.0017 | 1.474 | 225.8 | 884.3 | 228.8 | QMJ_LAG |
| 1 | 0.0098 | -.0222 | 2.203 | 226.6 | 905.5 | 229.6 | QJA_LAG |
| 2 | 0.1216 | 0.0630 | 0.679 | 224.7 | 830.0 | 229.2 | QMJ_LAG QND_LAG |
| 2 | 0.1030 | 0.0432 | 1.265 | 225.4 | 847.5 | 229.8 | QMA_LAG QND_LAG |
| 2 | 0.1021 | 0.0422 | 1.294 | 225.4 | 848.4 | 229.9 | QSO_LAG QND_LAG |
| 2 | 0.0884 | 0.0276 | 1.725 | 225.9 | 861.3 | 230.4 | QJF_LAG QND_LAG |
| 3 | 0.1645 | 0.0781 | 1.326 | 225.0 | 816.6 | 231.0 | QMA_LAG QSO_LAG QND_LAG |
| 3 | 0.1387 | 0.0496 | 2.141 | 226.0 | 841.9 | 232.0 | QMJ_LAG QSO_LAG QND_LAG |
| 3 | 0.1369 | 0.0477 | 2.196 | 226.1 | 843.6 | 232.1 | QMA_LAG QMJ_LAG QND_LAG |
| 3 | 0.1334 | 0.0437 | 2.308 | 226.2 | 847.1 | 232.2 | QJF_LAG QSO_LAG QND_LAG |
| 4 | 0.1699 | 0.0513 | 3.157 | 226.8 | 840.4 | 234.3 | QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 4 | 0.1670 | 0.0480 | 3.249 | 226.9 | 843.3 | 234.4 | QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.1655 | 0.0463 | 3.296 | 227.0 | 844.8 | 234.5 | QJF_LAG QMA_LAG QSO_LAG QND_LAG |
| 4 | 0.1548 | 0.0341 | 3.631 | 227.4 | 855.6 | 234.9 | QJF_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.1727 | 0.0195 | 5.068 | 228.7 | 868.5 | 237.7 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.1709 | 0.0174 | 5.125 | 228.8 | 870.4 | 237.7 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.1701 | 0.0164 | 5.151 | 228.8 | 871.3 | 237.8 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 5 | 0.1638 | 0.0089 | 5.350 | 229.0 | 877.9 | 238.0 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.1749 | -.0155 | 7.000 | 230.6 | 899.6 | 241.1 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 33

## 5.2 Log of flounder data and untransformed inflow data

***Table 5.2*** *Regression Models for Dependent Variable: Ln(FLOUNDER) on INFLOWS*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.0987 | 0.0696 | 1.295 | -28.98 | 0.3919 | -25.98 | QND_LAG |
| 1 | 0.0863 | 0.0568 | 1.709 | -28.53 | 0.3973 | -25.54 | QSO_LAG |
| 1 | 0.0344 | 0.0032 | 3.456 | -26.70 | 0.4198 | -23.71 | QMJ_LAG |
| 1 | 0.0078 | -.0242 | 4.350 | -25.81 | 0.4314 | -22.81 | QJF_LAG |
| 2 | 0.1850 | 0.1307 | 0.392 | -30.30 | 0.3662 | -25.81 | QMJ_LAG QND_LAG |
| 2 | 0.1599 | 0.1038 | 1.238 | -29.30 | 0.3775 | -24.81 | QSO_LAG QND_LAG |
| 2 | 0.1390 | 0.0816 | 1.939 | -28.49 | 0.3868 | -24.00 | QMA_LAG QND_LAG |
| 2 | 0.1251 | 0.0668 | 2.404 | -27.96 | 0.3930 | -23.47 | QJF_LAG QND_LAG |
| 3 | 0.2121 | 0.1306 | 1.482 | -29.42 | 0.3662 | -23.43 | QMA_LAG QSO_LAG QND_LAG |
| 3 | 0.2058 | 0.1237 | 1.692 | -29.16 | 0.3691 | -23.17 | QMJ_LAG QSO_LAG QND_LAG |
| 3 | 0.1918 | 0.1082 | 2.162 | -28.58 | 0.3756 | -22.59 | QMA_LAG QMJ_LAG QND_LAG |
| 3 | 0.1891 | 0.1053 | 2.254 | -28.47 | 0.3769 | -22.48 | QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.2249 | 0.1141 | 3.053 | -27.95 | 0.3731 | -20.47 | QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 4 | 0.2132 | 0.1008 | 3.444 | -27.46 | 0.3787 | -19.98 | QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.2122 | 0.0997 | 3.478 | -27.42 | 0.3792 | -19.94 | QJF_LAG QMA_LAG QSO_LAG QND_LAG |
| 4 | 0.2098 | 0.0969 | 3.559 | -27.32 | 0.3804 | -19.84 | QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.2264 | 0.0831 | 5.001 | -26.02 | 0.3862 | -17.04 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.2251 | 0.0816 | 5.046 | -25.96 | 0.3868 | -16.98 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 5 | 0.2163 | 0.0712 | 5.340 | -25.59 | 0.3912 | -16.61 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.2142 | 0.0687 | 5.410 | -25.51 | 0.3922 | -16.53 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.2264 | 0.0479 | 7.000 | -24.02 | 0.4010 | -13.55 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 33

## 5.3 Log of flounder data and log of inflow data

***Table 5.3*** *Regression Models for Dependent Variable: Ln(FLOUNDER) on Ln(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.1379 | 0.1101 | 0.943 | -30.45 | 0.3748 | -27.45 | LN_QND |
| 1 | 0.0223 | -.0092 | 4.959 | -26.29 | 0.4251 | -23.30 | LN_QMJ |
| 1 | 0.0113 | -.0206 | 5.341 | -25.92 | 0.4299 | -22.93 | LN_QSO |
| 1 | 0.0030 | -.0292 | 5.631 | -25.65 | 0.4335 | -22.65 | LN_QMA |
| 2 | 0.1969 | 0.1433 | 0.896 | -30.78 | 0.3608 | -26.29 | LN_QMA LN_QND |
| 2 | 0.1939 | 0.1401 | 1.000 | -30.66 | 0.3622 | -26.17 | LN_QMJ LN_QND |
| 2 | 0.1853 | 0.1310 | 1.297 | -30.31 | 0.3660 | -25.82 | LN_QJF LN_QND |
| 2 | 0.1729 | 0.1178 | 1.727 | -29.82 | 0.3716 | -25.33 | LN_QSO LN_QND |
| 3 | 0.2419 | 0.1634 | 1.333 | -30.69 | 0.3524 | -24.70 | LN_QMA LN_QSO LN_QND |
| 3 | 0.2180 | 0.1371 | 2.161 | -29.67 | 0.3634 | -23.68 | LN_QMA LN_QMJ LN_QND |
| 3 | 0.2126 | 0.1311 | 2.349 | -29.44 | 0.3660 | -23.45 | LN_QJF LN_QSO LN_QND |
| 3 | 0.2091 | 0.1273 | 2.470 | -29.29 | 0.3676 | -23.31 | LN_QJF LN_QMJ LN_QND |
| 4 | 0.2468 | 0.1392 | 3.161 | -28.90 | 0.3625 | -21.42 | LN_QMA LN_QMJ LN_QSO LN_QND |
| 4 | 0.2463 | 0.1387 | 3.177 | -28.88 | 0.3628 | -21.40 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.2424 | 0.1342 | 3.313 | -28.71 | 0.3647 | -21.23 | LN_QMA LN_QJA LN_QSO LN_QND |
| 4 | 0.2253 | 0.1146 | 3.910 | -27.97 | 0.3729 | -20.49 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 5 | 0.2494 | 0.1105 | 5.070 | -27.02 | 0.3747 | -18.04 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.2489 | 0.1098 | 5.088 | -27.00 | 0.3749 | -18.02 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.2474 | 0.1080 | 5.142 | -26.93 | 0.3757 | -17.95 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.2276 | 0.0845 | 5.830 | -26.07 | 0.3856 | -17.09 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.2515 | 0.0787 | 7.000 | -25.11 | 0.3880 | -14.63 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 33

## 5.4 Log of flounder data and square root of inflow data

***Table 5.4*** *Regression Models for Dependent Variable: Ln(FLOUNDER) on Sqrt(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.1240 | 0.0958 | 0.718 | -29.92 | 0.3809 | -26.93 | SQR_QND |
| 1 | 0.0367 | 0.0056 | 3.682 | -26.78 | 0.4188 | -23.79 | SQR_QSO |
| 1 | 0.0310 | -.0003 | 3.874 | -26.59 | 0.4213 | -23.60 | SQR_QMJ |
| 1 | 0.0056 | -.0265 | 4.736 | -25.73 | 0.4323 | -22.74 | SQR_QJF |
| 2 | 0.1955 | 0.1419 | 0.292 | -30.73 | 0.3614 | -26.24 | SQR_QMJ SQR_QND |
| 2 | 0.1709 | 0.1157 | 1.127 | -29.74 | 0.3725 | -25.25 | SQR_QMA SQR_QND |
| 2 | 0.1583 | 0.1022 | 1.555 | -29.24 | 0.3781 | -24.75 | SQR_QSO SQR_QND |
| 2 | 0.1560 | 0.0997 | 1.634 | -29.15 | 0.3792 | -24.66 | SQR_QJF SQR_QND |
| 3 | 0.2175 | 0.1366 | 1.546 | -29.64 | 0.3637 | -23.66 | SQR_QMA SQR_QSO SQR_QND |
| 3 | 0.2104 | 0.1287 | 1.787 | -29.35 | 0.3670 | -23.36 | SQR_QMA SQR_QMJ SQR_QND |
| 3 | 0.2053 | 0.1231 | 1.960 | -29.13 | 0.3693 | -23.15 | SQR_QMJ SQR_QSO SQR_QND |
| 3 | 0.2019 | 0.1194 | 2.075 | -28.99 | 0.3709 | -23.01 | SQR_QJF SQR_QMJ SQR_QND |
| 4 | 0.2311 | 0.1212 | 3.086 | -28.22 | 0.3701 | -20.74 | SQR_QMA SQR_QMJ SQR_QSO SQR_QND |
| 4 | 0.2191 | 0.1075 | 3.493 | -27.71 | 0.3759 | -20.23 | SQR_QJF SQR_QMA SQR_QSO SQR_QND |
| 4 | 0.2189 | 0.1073 | 3.499 | -27.70 | 0.3760 | -20.22 | SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 4 | 0.2124 | 0.0999 | 3.721 | -27.43 | 0.3791 | -19.94 | SQR_QJF SQR_QMJ SQR_QSO SQR_QND |
| 5 | 0.2323 | 0.0901 | 5.045 | -26.27 | 0.3832 | -17.29 | SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.2314 | 0.0891 | 5.075 | -26.24 | 0.3837 | -17.26 | SQR_QJF SQR_QMA SQR_QMJ SQR_QSO SQR_QND |
| 5 | 0.2225 | 0.0785 | 5.377 | -25.85 | 0.3881 | -16.88 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.2184 | 0.0736 | 5.517 | -25.68 | 0.3902 | -16.70 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 6 | 0.2336 | 0.0568 | 7.000 | -24.33 | 0.3973 | -13.85 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

N = 33

## 5.5 Square root of flounder data and log of inflow data

***Table 5.5*** *Regression Models for Dependent Variable: Sqrt(FLOUNDER) on Ln(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.1031 | 0.0741 | 0.857 | 47.22 | 3.944 | 50.21 | LN_QND |
| 1 | 0.0288 | -.0025 | 3.328 | 49.85 | 4.271 | 52.84 | LN_QMJ |
| 1 | 0.0150 | -.0168 | 3.788 | 50.31 | 4.332 | 53.31 | LN_QSO |
| 1 | 0.0047 | -.0274 | 4.130 | 50.65 | 4.377 | 53.65 | LN_QMA |
| 2 | 0.1636 | 0.1078 | 0.841 | 46.92 | 3.801 | 51.40 | LN_QMJ LN_QND |
| 2 | 0.1578 | 0.1016 | 1.036 | 47.15 | 3.827 | 51.63 | LN_QMA LN_QND |
| 2 | 0.1491 | 0.0924 | 1.324 | 47.48 | 3.867 | 51.97 | LN_QJF LN_QND |
| 2 | 0.1402 | 0.0829 | 1.619 | 47.82 | 3.907 | 52.31 | LN_QSO LN_QND |
| 3 | 0.2049 | 0.1226 | 1.468 | 47.25 | 3.738 | 53.23 | LN_QMA LN_QSO LN_QND |
| 3 | 0.1835 | 0.0990 | 2.179 | 48.12 | 3.838 | 54.11 | LN_QMA LN_QMJ LN_QND |
| 3 | 0.1794 | 0.0945 | 2.315 | 48.29 | 3.857 | 54.27 | LN_QMJ LN_QSO LN_QND |
| 3 | 0.1784 | 0.0935 | 2.347 | 48.32 | 3.862 | 54.31 | LN_QJF LN_QSO LN_QND |
| 4 | 0.2120 | 0.0995 | 3.229 | 48.95 | 3.836 | 56.43 | LN_QMA LN_QMJ LN_QSO LN_QND |
| 4 | 0.2095 | 0.0966 | 3.314 | 49.05 | 3.849 | 56.54 | LN_QJF LN_QMA LN_QSO LN_QND |
| 4 | 0.2070 | 0.0937 | 3.396 | 49.16 | 3.861 | 56.64 | LN_QMA LN_QJA LN_QSO LN_QND |
| 4 | 0.1937 | 0.0785 | 3.839 | 49.71 | 3.926 | 57.19 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 5 | 0.2151 | 0.0697 | 5.127 | 50.82 | 3.963 | 59.80 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.2144 | 0.0689 | 5.151 | 50.85 | 3.967 | 59.83 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.2140 | 0.0685 | 5.162 | 50.86 | 3.968 | 59.84 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.1986 | 0.0502 | 5.675 | 51.50 | 4.046 | 60.48 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.2189 | 0.0387 | 7.000 | 52.66 | 4.095 | 63.13 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 33

## 5.6 Various transformation suggested by Box-Cox

***Table 5.6*** *Regression Models for Dependent Variable: (FLOUNDER)$^{0.3}$ on variously transformed INFLOWS.*

| In | *Rsq* | *Adj Rsq* | *C(p)* | *AIC* | *MSE* | *SBC* | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.1098 | 0.0811 | 0.728 | 7.103 | 1.169 | 10.10 | QR_QND |
| 1 | 0.0315 | 0.0002 | 3.344 | 9.886 | 1.272 | 12.88 | QR_QMJ |
| 1 | 0.0164 | -.0153 | 3.847 | 10.40 | 1.292 | 13.39 | QR_QSO |
| 1 | 0.0045 | -.0276 | 4.246 | 10.79 | 1.308 | 13.79 | LN_QMA |
| 2 | 0.1710 | 0.1157 | 0.686 | 6.754 | 1.125 | 11.24 | QR_QMJ QR_QND |
| 2 | 0.1671 | 0.1116 | 0.815 | 6.908 | 1.131 | 11.40 | LN_QMA QR_QND |
| 2 | 0.1503 | 0.0937 | 1.374 | 7.565 | 1.153 | 12.05 | QR_QJF QR_QND |
| 2 | 0.1435 | 0.0864 | 1.601 | 7.828 | 1.163 | 12.32 | QR_QSO QR_QND |
| 3 | 0.2097 | 0.1280 | 1.391 | 7.174 | 1.110 | 13.16 | LN_QMA QR_QSO QR_QND |
| 3 | 0.1928 | 0.1093 | 1.955 | 7.871 | 1.134 | 13.86 | LN_QMA QR_QMJ QR_QND |
| 3 | 0.1838 | 0.0994 | 2.256 | 8.238 | 1.146 | 14.22 | QR_QMJ QR_QSO QR_QND |
| 3 | 0.1818 | 0.0971 | 2.325 | 8.322 | 1.149 | 14.31 | QR_QJF QR_QMJ QR_QND |
| 4 | 0.2175 | 0.1057 | 3.132 | 8.848 | 1.138 | 16.33 | LN_QMA QR_QMJ QR_QSO QR_QND |
| 4 | 0.2125 | 0.1000 | 3.298 | 9.058 | 1.145 | 16.54 | QR_QJF LN_QMA QR_QSO QR_QND |
| 4 | 0.2114 | 0.0987 | 3.335 | 9.104 | 1.147 | 16.59 | LN_QMA LN_QJA QR_QSO QR_QND |
| 4 | 0.1952 | 0.0803 | 3.875 | 9.774 | 1.171 | 17.26 | QR_QJF QR_QMJ QR_QSO QR_QND |
| 5 | 0.2189 | 0.0743 | 5.083 | 10.79 | 1.178 | 19.77 | LN_QMA QR_QMJ LN_QJA QR_QSO QR_QND |
| 5 | 0.2186 | 0.0739 | 5.094 | 10.80 | 1.179 | 19.78 | QR_QJF LN_QMA QR_QMJ QR_QSO QR_QND |
| 5 | 0.2163 | 0.0712 | 5.172 | 10.90 | 1.182 | 19.88 | QR_QJF LN_QMA LN_QJA QR_QSO QR_QND |
| 5 | 0.1981 | 0.0497 | 5.778 | 11.65 | 1.209 | 20.63 | QR_QJF QR_QMJ LN_QJA QR_QSO QR_QND |
| 6 | 0.2214 | 0.0418 | 7.000 | 12.68 | 1.220 | 23.16 | QR_QJF LN_QMA QR_QMJ LN_QJA QR_QSO QR_QND |

N = 33

Dependent Variable: (*FLOUNDER*)$^{0.4}$

Independent Variables:
*QR_QJF*=(January-February Inflows)$^{0.1}$
*QR_QMJ*=(May-June Inflows)$^{0.2}$
*QR_QND*=(September-October Inflows)$^{0.1}$
*QR_QND*=(November-December Inflows)$^{-0.1}$

# 6. Regression for the Best Models

## 6.1 Regression - Log of flounder data on inflow data

### 6.1.1 ANOVA and Parameter Estimates

***Table 6.1*** *Model Summary for log of flounder data on inflow data.*

**Model Summary[a,b]**

| Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| November-December Inflows, July-August Inflows, September-October Inflows, May-June Inflows, March-April Inflows, January-February Inflows[c,d] | .476 | .226 | .048 | .633254 | 1.042 |

a. Dependent Variable: Ln(Flounder Harvest)

b. Method: Enter

c. Independent Variables: (Constant), November-December Inflows, July-August Inflows, September-October Inflows, May-June Inflows, March-April Inflows, January-February Inflows

d. All requested variables entered.

***Table 6.2*** *ANOVA table of log of flounder data on inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 3.052 | 6 | .509 | 1.268 | .306[b] |
| | Residual | 10.426 | 26 | .401 | | |
| | Total | 13.478 | 32 | | | |

a. Dependent Variable: Ln(Flounder Harvest)

b. Independent Variables: (Constant), November-December Inflows, July-August Inflows, September-October Inflows, May-June Inflows, March-April Inflows, January-February Inflows

***Table 6.3** Table of coefficients for log of flounder data on inflow data.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | 3.804 | .238 | | 15.960 | .000 | 3.314 | 4.294 |
| January-February Infl. | -1.4E-04 | .004 | -.012 | -.033 | .974 | -.009 | .008 |
| March-April Infl. | -1.8E-03 | .003 | -.173 | -.583 | .565 | -.008 | .005 |
| May-June Infl. | -6.7E-04 | .001 | -.151 | -.640 | .528 | -.003 | .001 |
| July-August Infl. | 3.5E-04 | .002 | .043 | .215 | .832 | -.003 | .004 |
| September-October Infl. | -6.3E-04 | .001 | -.208 | -1.031 | .312 | -.002 | .001 |
| November-December Infl. | 5.6E-03 | .003 | .424 | 1.773 | .088 | -.001 | .012 |

a. Dependent Variable: Ln(Flounder Harvest)

## 6.1.2 Collinearity Diagnostic

***Table 6.4** Variance Inflation for log of flounder data on inflow data.*

**Coefficients[a]**

| | | Collinearity Statistics | |
|---|---|---|---|
| | t | Tolerance | VIF |
| (Constant) | 15.960 | | |
| January-February Inflows | -.033 | .251 | 3.991 |
| March-April Inflows | -.583 | .336 | 2.972 |
| May-June Inflows | -.640 | .536 | 1.866 |
| July-August Inflows | .215 | .734 | 1.362 |
| September-October Inflows | -1.031 | .731 | 1.368 |
| November-December Infl. | 1.773 | .520 | 1.924 |

a. Dependent Variable: Ln(Flounder Harvest)

***Table 6.5** Collinearity Diagnostics(intercept adjusted) for Dependent Variable: LN(FLOUNDER) on INFLOWS.*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *QJF_LAG* | Var Prop *QMA_LAG* | Var Prop *QMJ_LAG* | Var Prop *QJA_LAG* | Var Prop *QSO_LAG* | Var Prop *QND_LAG* |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.64689 | 1.00000 | 0.0299 | 0.0357 | 0.0357 | 0.0000 | 0.0005 | 0.0442 |
| 2 | 1.26720 | 1.44526 | 0.0011 | 0.0011 | 0.1060 | 0.0261 | 0.3744 | 0.0187 |
| 3 | 1.07062 | 1.57235 | 0.0099 | 0.0156 | 0.0009 | 0.5898 | 0.0308 | 0.0003 |
| 4 | 0.53542 | 2.22341 | 0.0000 | 0.0867 | 0.1333 | 0.0258 | 0.1804 | 0.5607 |
| 5 | 0.32444 | 2.85626 | 0.0615 | 0.2578 | 0.7220 | 0.0003 | 0.3626 | 0.1177 |
| 6 | 0.15543 | 4.12664 | 0.8976 | 0.6030 | 0.0020 | 0.3580 | 0.0513 | 0.2584 |

### 6.1.3 Residuals Diagnostics

***Table 6.6*** *Residuals Diagnostics for log of flounder data on inflow data.*

**Residuals Statistics**[a]

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 3.107211 | 4.403322 | 3.793080 | .308826 | 33 |
| Std. Predicted Value | -2.221 | 1.976 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | .161340 | .473655 | .281979 | 7.6E-02 | 33 |
| Adjusted Predicted Value | 3.125647 | 4.631145 | 3.799013 | .342543 | 33 |
| Residual | -1.583461 | 1.253555 | -7.9E-16 | .570808 | 33 |
| Std. Residual | -2.501 | 1.980 | .000 | .901 | 33 |
| Stud. Residual | -2.781 | 2.102 | -.004 | .998 | 33 |
| Deleted Residual | -1.959099 | 1.413094 | -5.9E-03 | .702537 | 33 |
| Stud. Deleted Residual | -3.254 | 2.262 | -.019 | 1.061 | 33 |
| Mahal. Distance | 1.108 | 16.933 | 5.818 | 3.698 | 33 |
| Cook's Distance | .000 | .262 | .033 | .056 | 33 |
| Centered Leverage Value | .035 | .529 | .182 | .116 | 33 |

a. Dependent Variable: Ln(Flounder Harvest)

***Table 6.7*** *Case Values for Residuals Diagnostics for log of flounder data on inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 4.4033 | -.2634 | -.4912 | 4.6311 | 1.9760 | -.4159 | -.5680 | -.5604 |
| 1963 | 3.8257 | .4538 | .5119 | 3.7676 | .1055 | .7166 | .7611 | .7547 |
| 1964 | 3.8574 | .4980 | .5502 | 3.8052 | .2083 | .7864 | .8266 | .8214 |
| 1965 | 3.8116 | .6108 | .6861 | 3.7364 | .0600 | .9646 | 1.0223 | 1.0232 |
| 1966 | 3.6554 | 1.2536 | 1.4131 | 3.4959 | -.4458 | 1.9795 | 2.1017 | 2.2620 |
| 1967 | 3.6611 | -.1737 | -.1968 | 3.6842 | -.4274 | -.2743 | -.2920 | -.2868 |
| 1968 | 3.1726 | .1306 | .1776 | 3.1256 | -2.0092 | .2063 | .2405 | .2361 |
| 1969 | 3.1072 | -.9790 | -1.3717 | 3.4999 | -2.2209 | -1.5460 | -1.8300 | -1.9225 |
| 1970 | 3.7561 | -.6382 | -.7175 | 3.8355 | -.1196 | -1.0078 | -1.0686 | -1.0717 |
| 1971 | 3.7997 | -.3123 | -.3340 | 3.8214 | .0214 | -.4932 | -.5100 | -.5026 |
| 1972 | 3.3967 | .2116 | .2540 | 3.3542 | -1.2837 | .3341 | .3661 | .3599 |
| 1973 | 3.2636 | -.2881 | -.3835 | 3.3590 | -1.7145 | -.4549 | -.5249 | -.5174 |
| 1974 | 3.4680 | .3048 | .3481 | 3.4246 | -1.0526 | .4813 | .5144 | .5070 |
| 1975 | 3.7862 | .3958 | .4744 | 3.7076 | -.0222 | .6251 | .6843 | .6772 |
| 1976 | 4.0209 | .4734 | .5512 | 3.9431 | .7376 | .7475 | .8066 | .8010 |
| 1977 | 4.3091 | -.0881 | -.1265 | 4.3474 | 1.6710 | -.1392 | -.1667 | -.1636 |
| 1978 | 4.3080 | -.5896 | -.7511 | 4.4695 | 1.6674 | -.9310 | -1.0508 | -1.0530 |
| 1979 | 3.8283 | -.0812 | -.0892 | 3.8364 | .1142 | -.1282 | -.1344 | -.1318 |
| 1980 | 3.7122 | .3483 | .5185 | 3.5420 | -.2620 | .5500 | .6710 | .6638 |
| 1981 | 3.5821 | .2681 | .4327 | 3.4174 | -.6833 | .4234 | .5379 | .5304 |
| 1982 | 4.1111 | .6756 | .9095 | 3.8771 | 1.0298 | 1.0668 | 1.2378 | 1.2512 |
| 1983 | 4.3544 | -.1378 | -.1773 | 4.3939 | 1.8176 | -.2176 | -.2469 | -.2423 |
| 1984 | 3.8608 | .4594 | .5590 | 3.7611 | .2193 | .7254 | .8002 | .7945 |
| 1985 | 3.5452 | .2525 | .3581 | 3.4396 | -.8025 | .3987 | .4749 | .4677 |
| 1986 | 3.8348 | .6705 | .9168 | 3.5886 | .1352 | 1.0588 | 1.2381 | 1.2515 |
| 1987 | 4.0989 | .1510 | .1706 | 4.0793 | .9903 | .2385 | .2535 | .2488 |
| 1988 | 3.8583 | -.5296 | -.5926 | 3.9212 | .2111 | -.8364 | -.8847 | -.8809 |
| 1989 | 3.8159 | -1.0816 | -1.2101 | 3.9444 | .0740 | -1.7080 | -1.8066 | -1.8944 |
| 1990 | 3.8556 | -1.5835 | -1.9591 | 4.2312 | .2024 | -2.5005 | -2.7813 | *-3.2540 |
| 1991 | 3.8046 | -.2783 | -.3619 | 3.8883 | .0374 | -.4394 | -.5011 | -.4938 |
| 1992 | 3.8511 | -.1597 | -.2484 | 3.9398 | .1878 | -.2522 | -.3145 | -.3090 |
| 1993 | 3.7708 | -.0499 | -.1134 | 3.8342 | -.0721 | -.0789 | -.1188 | -.1165 |
| 1994 | 3.6848 | .0764 | .0966 | 3.6646 | -.3505 | .1206 | .1356 | .1330 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that observation |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.

[2]This is flagged if it exceeds $t_{n-p-2,a}=t_{25,0.01}=2.485$.

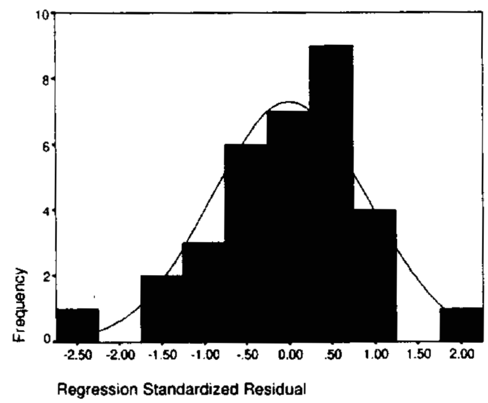


***Figure 6.1*** *Histogram of Standardized Residuals.*

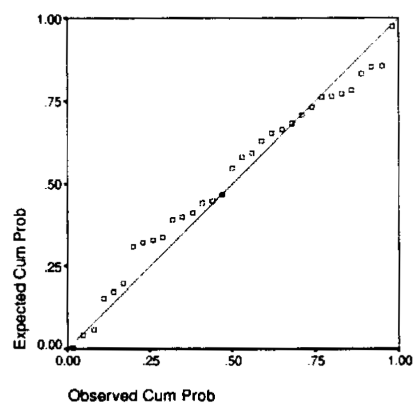


***Figure 6.2*** *Normal P-P Plot of Residuals.*

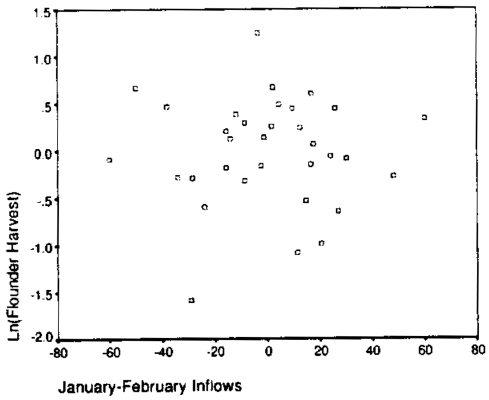


***Figure 6.3*** *Partial Residual Plot for January-February Inflows.*

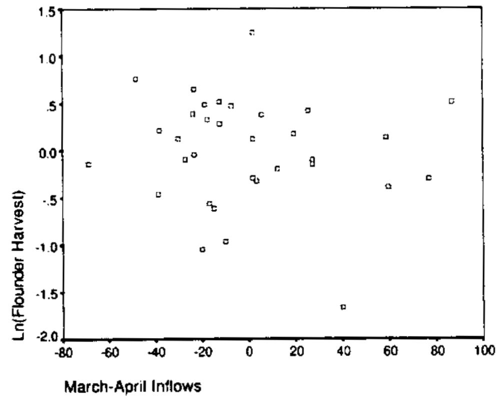


***Figure 6.4*** *Partial Residual Plot for March-April Inflows.*

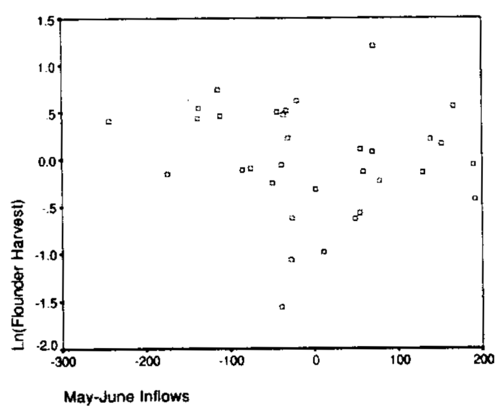


***Figure 6.5*** *Partial Residual Plot for May-June Inflows.*

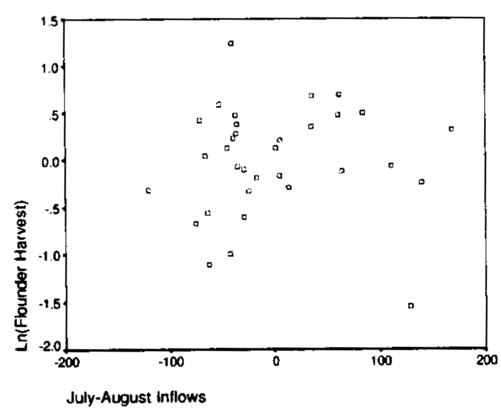


***Figure 6.6*** *Partial Residual Plot for July-August Inflows.*

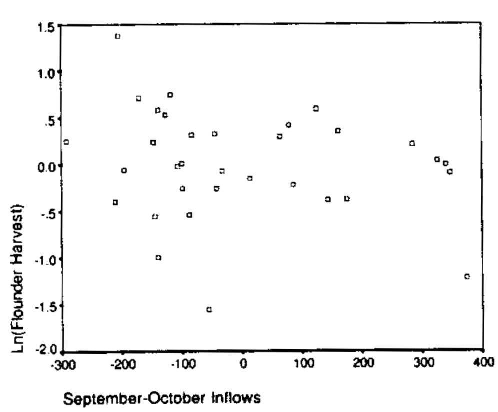


***Figure 6.7*** *Partial Residual Plot for September-October Inflows.*

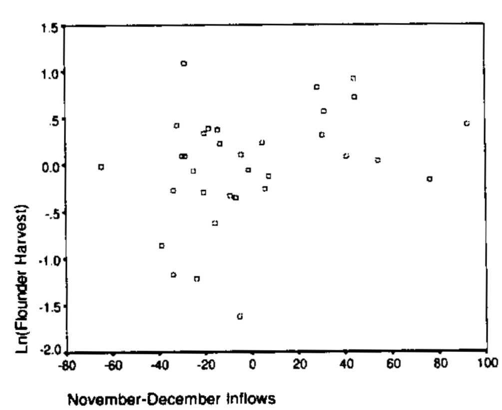


***Figure 6.8*** *Partial Residual Plot for November-December Inflows.*

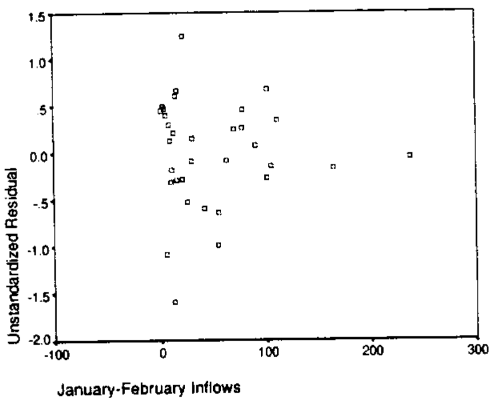


***Figure 6.9*** *Residuals Plot for January-February Inflows.*

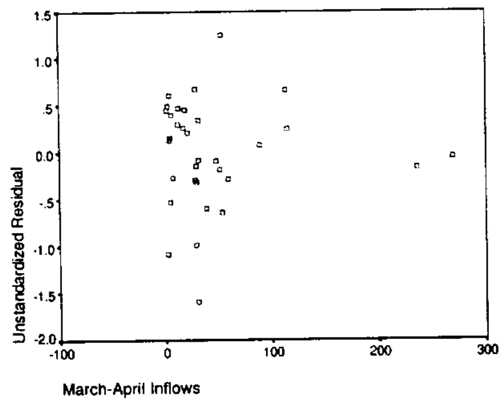


***Figure 6.10*** *Residuals Plot for March-April Inflows.*

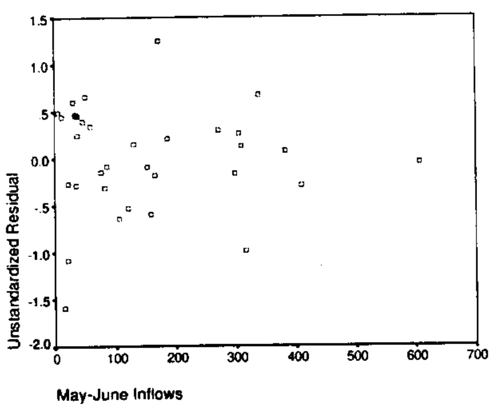


***Figure 6.11*** *Residuals Plot for May-June Inflows.*

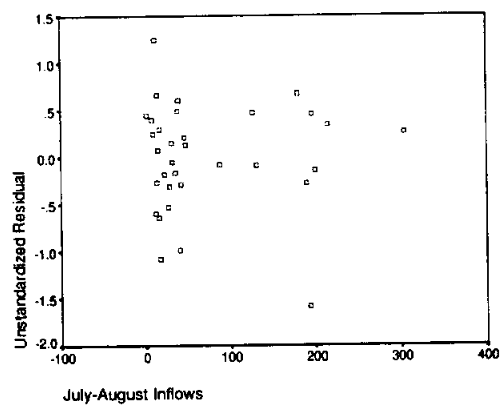


***Figure 6.12*** *Residuals Plot for July-August Inflows.*

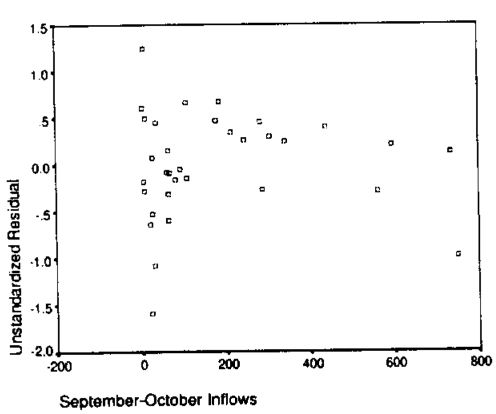


***Figure 6.13*** *Residuals Plot for September-October Inflows.*

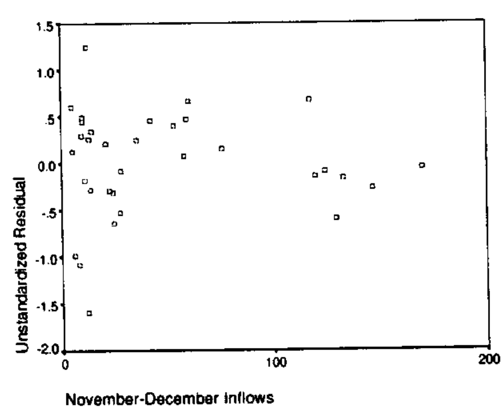


***Figure 6.14*** *Residuals Plot for November-December Inflows.*

### 6.1.4 Prediction Intervals for Flounder Harvest

***Table 6.8*** *Prediction Intervals for Flounder Harvest.*

| YEAR | *LICI_1* | *LN_FLOU* | *UICI_1* |
|---|---|---|---|
| 1962 | 2.2744 | 4.1400 | 6.5323 |
| 1963 | 1.9688 | 4.2794 | 5.6825 |
| 1964 | 2.0162 | 4.3554 | 5.6986 |
| 1965 | 1.9580 | 4.4224 | 5.6652 |
| 1966 | 1.7991 | 4.9090 | 5.5117 |
| 1967 | 1.8010 | 3.4874 | 5.5211 |
| 1968 | 1.1940 | 3.3032 | 5.1511 |
| 1969 | 1.1115 | 2.1282 | 5.1029 |
| 1970 | 1.9018 | 3.1179 | 5.6105 |
| 1971 | 1.9838 | 3.4874 | 5.6155 |
| 1972 | 1.4956 | 3.6082 | 5.2977 |
| 1973 | 1.2973 | 2.9755 | 5.2299 |
| 1974 | 1.6020 | 3.7728 | 5.3340 |
| 1975 | 1.8864 | 4.1821 | 5.6860 |
| 1976 | 2.1412 | 4.4942 | 5.9006 |
| 1977 | 2.3005 | 4.2210 | 6.3177 |
| 1978 | 2.3684 | 3.7184 | 6.2476 |
| 1979 | 1.9912 | 3.7471 | 5.6655 |
| 1980 | 1.6842 | 4.0604 | 5.7401 |
| 1981 | 1.5146 | 3.8501 | 5.6495 |
| 1982 | 2.1381 | 4.7867 | 6.0841 |
| 1983 | 2.4087 | 4.2166 | 6.3001 |
| 1984 | 1.9507 | 4.3202 | 5.7709 |
| 1985 | 1.5428 | 3.7977 | 5.5477 |
| 1986 | 1.8529 | 4.5053 | 5.8168 |
| 1987 | 2.2410 | 4.2499 | 5.9568 |
| 1988 | 2.0076 | 3.3286 | 5.7090 |
| 1989 | 1.9652 | 2.7344 | 5.6667 |
| 1990 | 1.9347 | 2.2721 | 5.7765 |
| 1991 | 1.8522 | 3.5264 | 5.7571 |
| 1992 | 1.8013 | 3.6914 | 5.9009 |
| 1993 | 1.5734 | 3.7209 | 5.9682 |
| 1994 | 1.7498 | 3.7612 | 5.6199 |

*LICI_1* Lower limit for 99% prediction interval for the natuaral log of flounder harvest.
*LN_FLOU* Log of flounder harvest
*UICI_1* Upper limit for 99% prediction interval for the natural log of flounder harvest.

### 6.1.5 Outliers and Influential Point Detection

***Table 6.9*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1962 | 13.8725 | .0399 | .4335 | .0535 | .0001 |
| 1963 | 2.6631 | .0106 | .0832 | .9143 | .0000 |
| 1964 | 2.0651 | .0102 | .0645 | .9562 | .0000 |
| 1965 | 2.5400 | .0184 | .0794 | .9241 | .0000 |
| 1966 | 2.6431 | .0803 | .0826 | .9159 | .0011 |
| 1967 | 2.7870 | .0016 | .0871 | .9040 | .0000 |
| 1968 | 7.4881 | .0030 | .2340 | .3799 | .0000 |
| 1969 | 8.1922 | .1919 | .2560 | .3159 | .0154 |
| 1970 | 2.5686 | .0203 | .0803 | .9218 | .0000 |
| 1971 | 1.1075 | .0026 | .0346 | .9929 | .0000 |
| 1972 | 4.3794 | .0038 | .1369 | .7352 | .0000 |
| 1973 | 6.9900 | .0130 | .2184 | .4299 | .0000 |
| 1974 | 3.0164 | .0054 | .0943 | .8835 | .0000 |
| 1975 | 4.3319 | .0133 | .1354 | .7409 | .0000 |
| 1976 | 3.5466 | .0153 | .1108 | .8303 | .0000 |
| 1977 | 8.7256 | .0017 | .2727 | .2730 | .0000 |
| 1978 | 5.9103 | .0432 | .1847 | .5503 | .0001 |
| 1979 | 1.9121 | .0003 | .0598 | .9645 | .0000 |
| 1980 | 9.5334 | .0314 | .2979 | .2166 | .0000 |
| 1981 | 11.2053 | .0254 | .3502 | .1299 | .0000 |
| 1982 | 7.2627 | .0758 | .2270 | .4020 | .0009 |
| 1983 | 6.1557 | .0025 | .1924 | .5217 | .0000 |
| 1984 | 4.7362 | .0199 | .1480 | .6921 | .0000 |
| 1985 | 8.4699 | .0135 | .2647 | .2930 | .0000 |
| 1986 | 7.6265 | .0804 | .2383 | .3667 | .0011 |
| 1987 | 2.7045 | .0012 | .0845 | .9109 | .0000 |
| 1988 | 2.4280 | .0133 | .0759 | .9324 | .0000 |
| 1989 | 2.4286 | .0554 | .0759 | .9324 | .0003 |
| 1990 | 5.1660 | .2622 | .1614 | .6397 | .0368 |
| 1991 | 6.4279 | .0108 | .2009 | .4908 | .0000 |
| 1992 | 10.4550 | .0078 | .3267 | .1642 | .0000 |
| 1993 | 16.9330 | .0026 | *.5292 | *.0178 | .0000 |
| 1994 | 5.7279 | .0007 | .1790 | .5719 | .0000 |

*MAH_1* Mahalanobis distance

*COOK_1* Cook's distance

*LEV_1* Leverage value

*MAHA_PV* P-value associated with the Mahalanobis distance

*COOK_P* P-value associated with Cook's distance

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.

[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n-p-1$ denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.10*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1962 | -.5212 | -.0773 | -.2459 | .2619 |
| 1963 | .2701 | .2675 | .0505 | -.0746 |
| 1964 | .2659 | .2553 | .0249 | -.0527 |
| 1965 | .3591 | .3484 | .1208 | -.1255 |
| 1966 | .8070 | .5940 | -.0549 | .0270 |
| 1967 | -.1046 | -.0669 | .0315 | -.0191 |
| 1968 | .1415 | -.0196 | -.0253 | .0028 |
| 1969 | *-1.2177 | .0660 | -.3110 | .1122 |
| 1970 | -.3779 | -.3225 | -.2042 | .0841 |
| 1971 | -.1324 | -.1110 | .0296 | -.0088 |
| 1972 | .1612 | -.0122 | -.0409 | .0385 |
| 1973 | -.2977 | .0477 | .1122 | -.0056 |
| 1974 | .1912 | .0722 | -.0300 | -.0474 |
| 1975 | .3018 | .0498 | -.0574 | .0222 |
| 1976 | .3247 | -.0119 | -.2190 | .1099 |
| 1977 | -.1078 | .0283 | .0782 | -.0267 |
| 1978 | -.5511 | -.0523 | .1889 | .0998 |
| 1979 | -.0415 | -.0292 | -.0278 | .0161 |
| 1980 | .4640 | .0760 | .3234 | -.0965 |
| 1981 | .4156 | -.0966 | .0079 | -.0415 |
| 1982 | .7364 | -.2073 | .0215 | -.3474 |
| 1983 | -.1297 | .0188 | -.0301 | .0373 |
| 1984 | .3701 | .0008 | .1507 | -.0318 |
| 1985 | .3025 | .0534 | .0459 | .1640 |
| 1986 | .7585 | .0581 | -.4857 | .6350 |
| 1987 | .0896 | .0431 | -.0019 | -.0503 |
| 1988 | -.3036 | -.2570 | -.0906 | .1799 |
| 1989 | -.6530 | -.6496 | -.1523 | .1992 |
| 1990 | *-1.5849 | -.1770 | .6944 | -.7272 |
| 1991 | -.2708 | -.0132 | .1274 | -.1678 |
| 1992 | -.2303 | .0435 | .0058 | -.1480 |
| 1993 | -.1313 | .0341 | -.0282 | -.0240 |
| 1994 | .0684 | .0225 | .0176 | -.0226 |

*SDFFITS* Standardized *dffits* value
*SDFBET_0* Standardized *dfbeta* for the intercept term
*SDFBET_1* Standardized *dfbeta* for January-February inflows
*SDFBET_2* Standardized *dfbeta* for March-April inflows

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

***Table 6.11*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1962 | .2200 | .2357 | -.1295 | -.2075 |
| 1963 | -.0473 | -.1458 | -.0978 | -.0804 |
| 1964 | -.0468 | -.0812 | -.1147 | -.0776 |
| 1965 | -.0364 | -.1451 | -.1776 | -.1712 |
| 1966 | .2837 | -.2453 | -.4725 | -.3388 |
| 1967 | -.0397 | .0129 | .0574 | .0312 |
| 1968 | .0318 | .0014 | .0923 | -.0054 |
| 1969 | -.0426 | .2435 | -.8212 | .3810 |
| 1970 | .0512 | .2172 | .1572 | .2191 |
| 1971 | -.0012 | .0320 | .0491 | .0168 |
| 1972 | -.0200 | .0057 | .1295 | .0096 |
| 1973 | -.1897 | -.0206 | -.0826 | -.0189 |
| 1974 | .1241 | -.0496 | -.0231 | -.0353 |
| 1975 | -.1357 | -.0673 | .2039 | .1172 |
| 1976 | -.0622 | .1864 | .0661 | .1918 |
| 1977 | -.0190 | -.0557 | .0061 | -.0901 |
| 1978 | -.0968 | .0877 | .0995 | -.4517 |
| 1979 | .0089 | .0102 | .0142 | .0229 |
| 1980 | -.1841 | .0728 | .0495 | -.2588 |
| 1981 | .1697 | .2903 | -.0536 | -.0995 |
| 1982 | .3996 | .2305 | -.1632 | .3209 |
| 1983 | .0342 | -.0453 | -.0038 | -.0563 |
| 1984 | -.1971 | .1362 | .1364 | -.0611 |
| 1985 | -.2237 | -.0552 | .1754 | -.0784 |
| 1986 | -.2754 | .1338 | .1766 | .2091 |
| 1987 | .0243 | -.0303 | -.0373 | .0406 |
| 1988 | -.0848 | .1507 | .1882 | .0723 |
| 1989 | .0930 | .3202 | .2681 | .2374 |
| 1990 | .2372 | *-1.1940 | .1925 | .0958 |
| 1991 | .0460 | -.2006 | .0222 | .0252 |
| 1992 | .0541 | -.0051 | -.0321 | -.0147 |
| 1993 | -.0378 | .0156 | .0167 | .0008 |
| 1994 | .0471 | -.0252 | -.0419 | -.0184 |

*SDFBET_3* Standardized *dfbeta* for May-June inflows
*SDFBET_4* Standardized *dfbeta* for July-August inflows
*SDFBET_5* Standardized *dfbeta* for September-October inflows
*SDFBET_6* Standardized *dfbeta* for November-December inflows

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

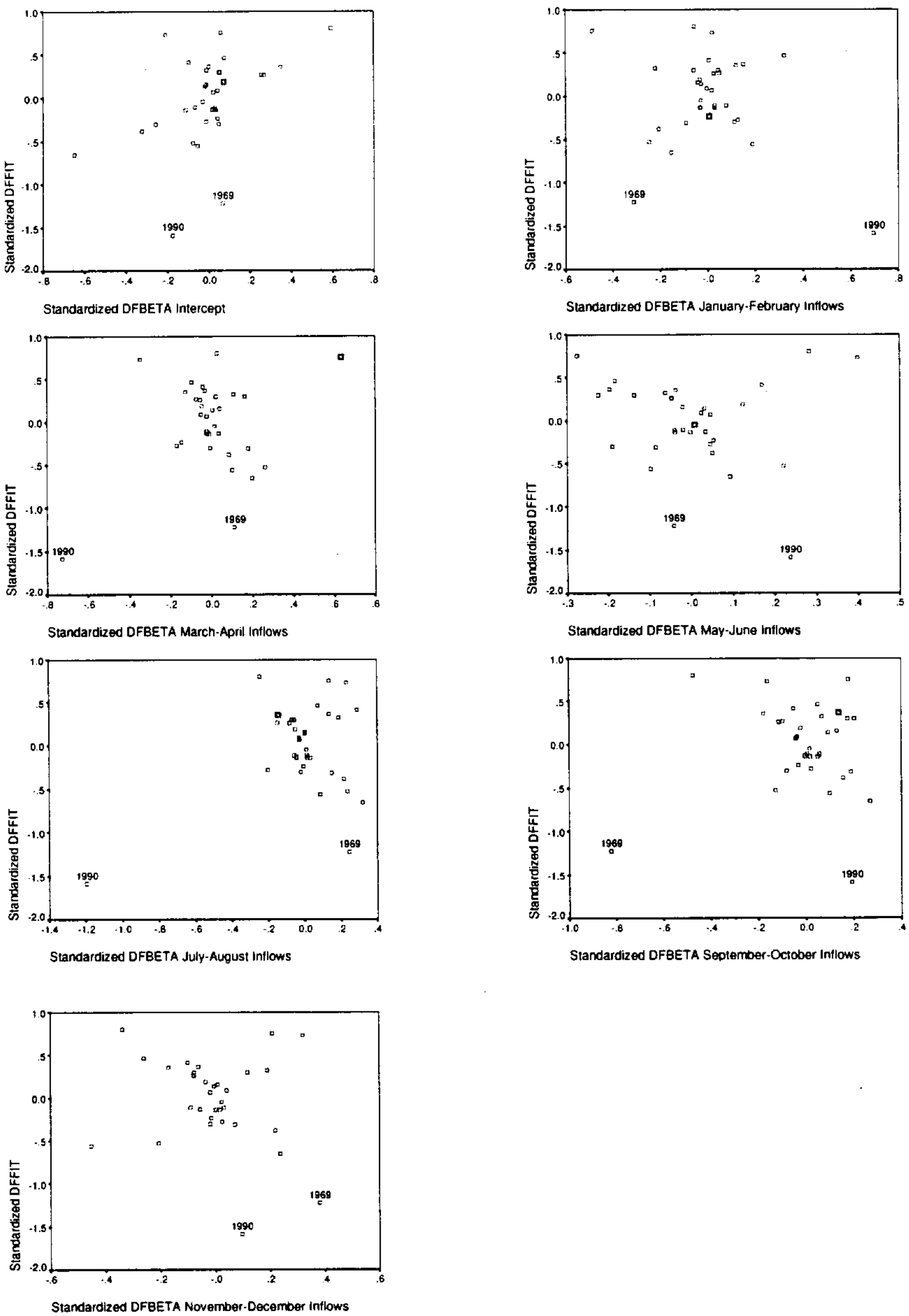


***Figure 6.15.*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of inflow variables.*

## 6.2 Regression - Log of flounder data on log of inflow data

### 6.2.1 ANOVA and Parameter Estimates

***Table 6.12*** *Model Summary for log of flounder data on log of inflow data.*

**Model Summary[a,b]**

| | Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|
| | Ln(November-December), Ln(July-August), Ln(September-October), Ln(May-June), Ln(March-April), Ln(January-February)[c,d] | .501 | .251 | .079 | .622930 | .992 |

a. Dependent Variable: Ln(Flounder Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Ln(November-December Inflows), Ln(July-August Inflows), Ln(September-October Inflows), Ln(May-June Inflows), Ln(March-April Inflows), Ln(January-February Inflows)

d. All requested variables entered.

***Table 6.13*** *ANOVA table of log of flounder data on log of inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 3.389 | 6 | .565 | 1.456 | .232[b] |
| | Residual | 10.089 | 26 | .388 | | |
| | Total | 13.478 | 32 | | | |

a. Dependent Variable: Ln(Flounder Harvest)

b. Independent Variables: (Constant), Ln(November-December Inflows), Ln(July-August Inflows), Ln(September-October Inflows), Ln(May-June Inflows), Ln(March-April Inflows), Ln(January-February Inflows)

***Table 6.14*** *Table of coefficients for log of flounder data on log of inflow data.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | 3.587 | .637 | | 5.629 | .000 | 2.277 | 4.897 |
| Ln(January-February) | -5.2E-02 | .139 | -.101 | -.377 | .709 | -.338 | .233 |
| Ln(March-April) | -.113 | .124 | -.218 | -.911 | .371 | -.368 | .142 |
| Ln(May-June) | -3.6E-02 | .122 | -.064 | -.296 | .770 | -.288 | .215 |
| Ln(July-August) | 2.7E-02 | .103 | .049 | .264 | .794 | -.185 | .239 |
| Ln(September-October) | -8.4E-02 | .085 | -.188 | -.992 | .330 | -.259 | .090 |
| Ln(November-December) | .347 | .129 | .572 | 2.695 | .012 | .082 | .611 |

a. Dependent Variable: Ln(Flounder Harvest)

### 6.2.2 Collinearity Diagnostic

***Table 6.15*** *Variance Inflation for log of flounder data on log of inflow data.*

**Coefficients[a]**

| | | Collinearity Statistics | |
|---|---|---|---|
| | t | Tolerance | VIF |
| (Constant) | 5.629 | | |
| Ln(January-February) | -.377 | .403 | 2.482 |
| Ln(March-April) | -.911 | .502 | 1.993 |
| Ln(May-June) | -.296 | .613 | 1.630 |
| Ln(July-August) | .264 | .832 | 1.201 |
| Ln(September-October) | -.992 | .799 | 1.251 |
| Ln(November-December) | 2.695 | .639 | 1.566 |

a. Dependent Variable: Ln(Flounder Harvest)

***Table 6.16*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(FLOUNDER) on Ln(INFLOWS):*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *LN_QJF* | Var Prop *LN_QMA* | Var Prop *LN_QMJ* | Var Prop *LN_QJA* | Var Prop *LN_QSO* | Var Prop *LN_QND* |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.58650 | 1.00000 | 0.0467 | 0.0460 | 0.0448 | 0.0156 | 0.0162 | 0.0427 |
| 2 | 1.03986 | 1.57714 | 0.0051 | 0.0763 | 0.0272 | 0.0410 | 0.5351 | 0.0216 |
| 3 | 0.98197 | 1.62296 | 0.0077 | 0.0003 | 0.0270 | 0.6806 | 0.0485 | 0.0488 |
| 4 | 0.76699 | 1.83637 | 0.0019 | 0.0322 | 0.3337 | 0.0110 | 0.0405 | 0.4003 |
| 5 | 0.33971 | 2.75930 | 0.0064 | 0.6845 | 0.4582 | 0.0179 | 0.3579 | 0.2218 |
| 6 | 0.28498 | 3.01268 | 0.9321 | 0.1606 | 0.1090 | 0.2339 | 0.0018 | 0.2649 |

### 6.2.3 Residuals Diagnostics

***Table 6.17*** *Residuals Diagnostics for log of flounder data on log of inflow data.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 2.966592 | 4.318057 | 3.793080 | .325439 | 33 |
| Std. Predicted Value | -2.540 | 1.613 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | .158688 | .396763 | .282216 | 5.2E-02 | 33 |
| Adjusted Predicted Value | 3.203713 | 4.439629 | 3.781019 | .358662 | 33 |
| Residual | -1.437908 | 1.353388 | -6.6E-16 | .561502 | 33 |
| Std. Residual | -2.308 | 2.173 | .000 | .901 | 33 |
| Stud. Residual | -2.649 | 2.439 | .009 | 1.019 | 33 |
| Deleted Residual | -1.894348 | 1.705259 | 1.2E-02 | .718652 | 33 |
| Stud. Deleted Residual | -3.041 | 2.723 | .002 | 1.082 | 33 |
| Mahal. Distance | 1.107 | 12.012 | 5.818 | 2.454 | 33 |
| Cook's Distance | .000 | .318 | .041 | .069 | 33 |
| Centered Leverage Value | .035 | .375 | .182 | .077 | 33 |

a. Dependent Variable: Ln(Flounder Harvest)

***Table 6.18*** *Case Values for Residuals Diagnostics for log of flounder data on log of inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 4.3181 | -.1781 | -.2997 | 4.4396 | 1.6131 | -.2859 | -.3709 | -.3646 |
| 1963 | 3.9204 | .3591 | .5338 | 3.7456 | .3912 | .5764 | .7028 | .6958 |
| 1964 | 4.0317 | .3237 | .4213 | 3.9341 | .7333 | .5196 | .5928 | .5853 |
| 1965 | 3.6715 | .7509 | 1.0276 | 3.3948 | -.3736 | 1.2055 | 1.4102 | 1.4389 |
| 1966 | 3.5556 | 1.3534 | 1.7053 | 3.2037 | -.7298 | 2.1726 | 2.4387 | 2.7230 |
| 1967 | 3.5858 | -.0984 | -.1259 | 3.6133 | -.6370 | -.1580 | -.1787 | -.1753 |
| 1968 | 3.2341 | .0691 | .0962 | 3.2070 | -1.7176 | .1109 | .1309 | .1284 |
| 1969 | 2.9666 | -.8384 | -1.1718 | 3.3000 | -2.5396 | -1.3458 | -1.5911 | -1.6422 |
| 1970 | 3.6852 | -.5672 | -.6448 | 3.7628 | -.3316 | -.9106 | -.9709 | -.9698 |
| 1971 | 3.7709 | -.2836 | -.3061 | 3.7934 | -.0680 | -.4552 | -.4729 | -.4658 |
| 1972 | 3.5381 | .0701 | .0813 | 3.5269 | -.7836 | .1126 | .1212 | .1189 |
| 1973 | 3.4978 | -.5223 | -.6289 | 3.6044 | -.9072 | -.8385 | -.9200 | -.9172 |
| 1974 | 3.3779 | .3949 | .4767 | 3.2960 | -1.2758 | .6339 | .6965 | .6894 |
| 1975 | 4.0707 | .1113 | .1418 | 4.0403 | .8531 | .1787 | .2017 | .1979 |
| 1976 | 4.1975 | .2967 | .4377 | 4.0566 | 1.2427 | .4763 | .5785 | .5710 |
| 1977 | 4.2379 | -.0169 | -.0210 | 4.2420 | 1.3668 | -.0271 | -.0302 | -.0297 |
| 1978 | 4.1952 | -.4767 | -.5543 | 4.2728 | 1.2356 | -.7653 | -.8252 | -.8200 |
| 1979 | 3.7485 | -.0013 | -.0014 | 3.7486 | -.1370 | -.0021 | -.0022 | -.0022 |
| 1980 | 3.4219 | .6385 | .8303 | 3.2301 | -1.1404 | 1.0250 | 1.1689 | 1.1775 |
| 1981 | 3.4144 | .4358 | .5547 | 3.2955 | -1.1637 | .6996 | .7893 | .7834 |
| 1982 | 4.1044 | .6823 | .8403 | 3.9464 | .9565 | 1.0953 | 1.2155 | 1.2273 |
| 1983 | 4.2100 | .0066 | .0079 | 4.2087 | 1.2810 | .0106 | .0116 | .0114 |
| 1984 | 3.8615 | .4586 | .5611 | 3.7591 | .2103 | .7362 | .8143 | .8089 |
| 1985 | 3.5055 | .2922 | .4792 | 3.3185 | -.8836 | .4691 | .6007 | .5932 |
| 1986 | 3.8642 | .6411 | .8305 | 3.6749 | .2186 | 1.0292 | 1.1714 | 1.1802 |
| 1987 | 4.2906 | -.0407 | -.0521 | 4.3020 | 1.5288 | -.0653 | -.0739 | -.0725 |
| 1988 | 4.0187 | -.6901 | -.8390 | 4.1676 | .6933 | -1.1078 | -1.2215 | -1.2337 |
| 1989 | 3.7832 | -1.0488 | -1.2332 | 3.9676 | -.0303 | -1.6837 | -1.8257 | -1.9174 |
| 1990 | 3.7100 | -1.4379 | -1.8943 | 4.1665 | -.2552 | -2.3083 | -2.6495 | *-3.0407 |
| 1991 | 3.7082 | -.1818 | -.2400 | 3.7664 | -.2609 | -.2918 | -.3353 | -.3295 |
| 1992 | 3.9168 | -.2254 | -.2687 | 3.9601 | .3800 | -.3618 | -.3951 | -.3886 |
| 1993 | 3.9277 | -.2069 | -.2624 | 3.9832 | .4137 | -.3321 | -.3740 | -.3677 |
| 1994 | 3.8311 | -.0699 | -.0839 | 3.8451 | .1169 | -.1123 | -.1230 | -.1206 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that observation |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.
[2]This is flagged if it exceeds $t_{n-p-2,\alpha}=t_{25,0.01}=2.485$.

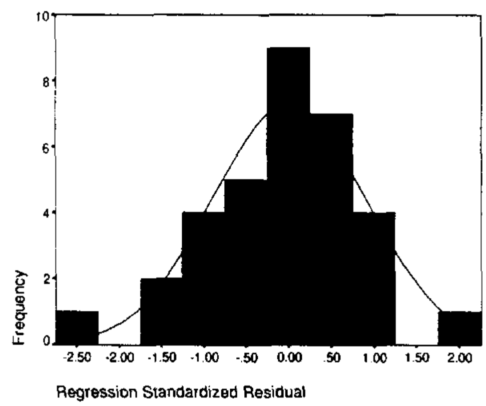


***Figure 6.16*** *Histogram of Standardized Residuals.*

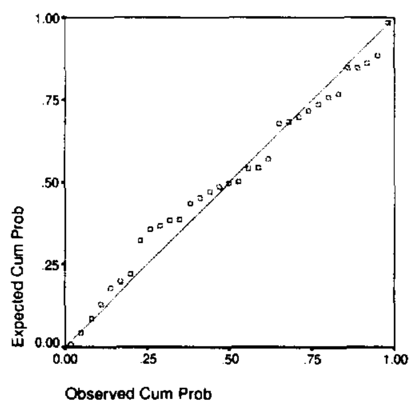


***Figure 6.17*** *Normal P-P Plot of Residuals.*

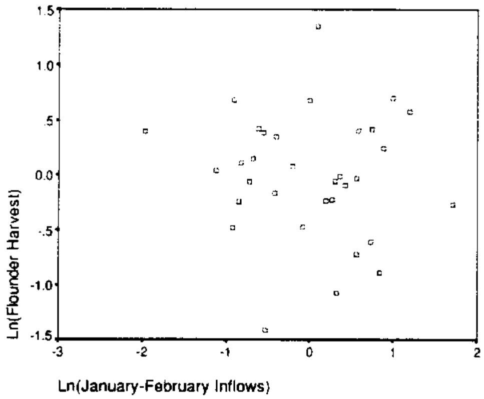


***Figure 6.18*** *Partial Residual Plot for Ln(January-February Inflows).*

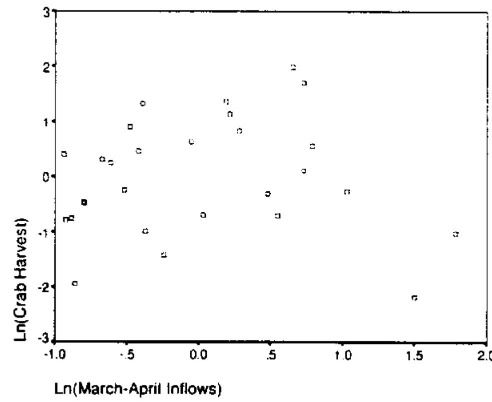


***Figure 6.19*** *Partial Residual Plot for Ln(March-April Inflows).*

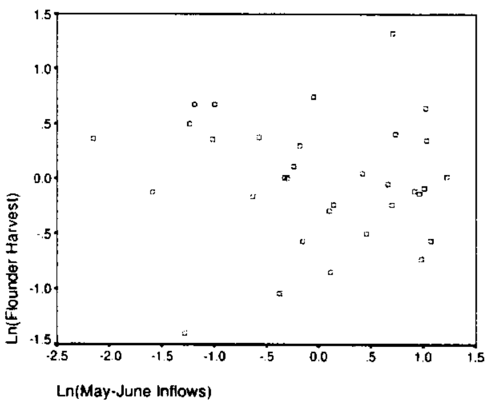


***Figure 6.20*** *Partial Residual Plot for Ln(May-June Inflows).*

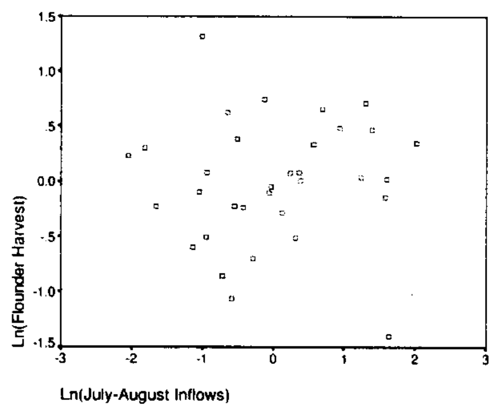


***Figure 6.21*** *Partial Residual Plot for Ln(July-August Inflows).*

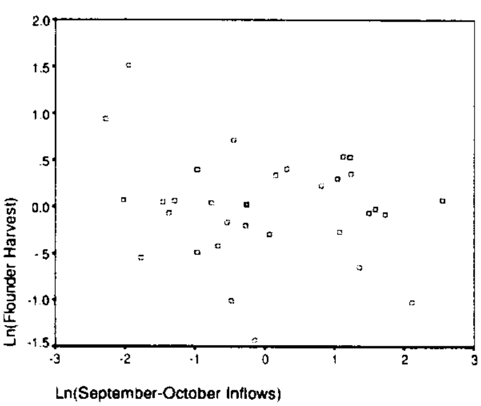


***Figure 6.22*** *Partial Residual Plot for Ln(September-October Inflows).*

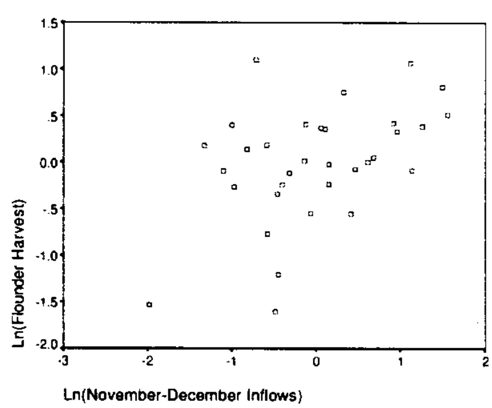


***Figure 6.23*** *Partial Residual Plot for Ln(November-December Inflows).*

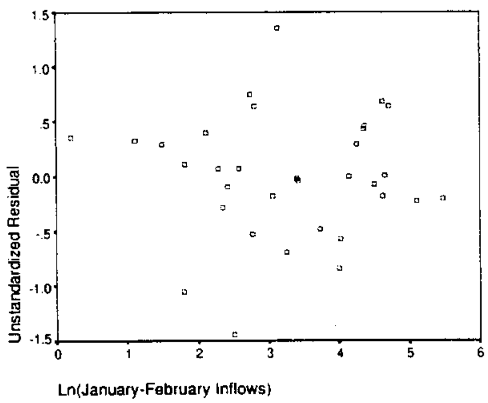


***Figure 6.24*** *Residuals Plot for Ln(January-February Inflows).*

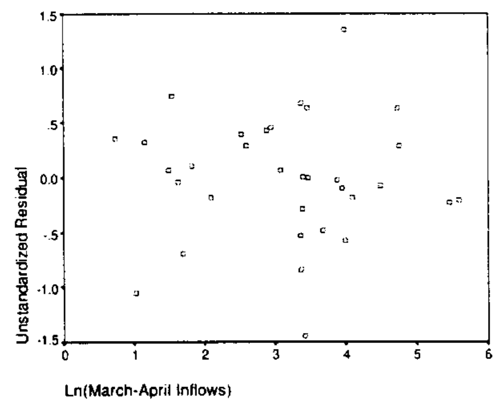


***Figure 6.25*** *Residuals Plot for Ln(March-April Inflows).*

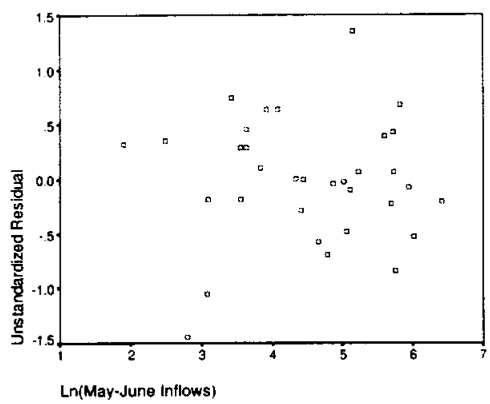


***Figure 6.26*** *Residuals Plot for Ln(May-June Inflows).*

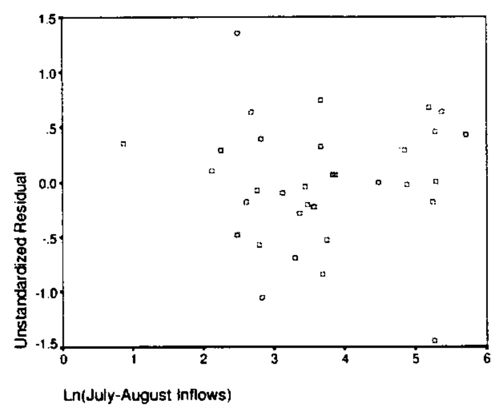


***Figure 6.27*** *Residuals Plot for Ln(July-August Inflows).*

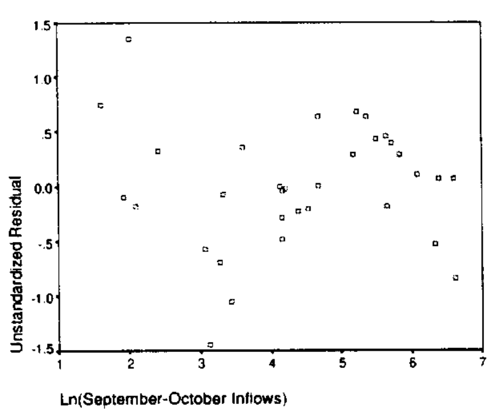


***Figure 6.28*** *Residuals Plot for Ln(September-October Inflows).*

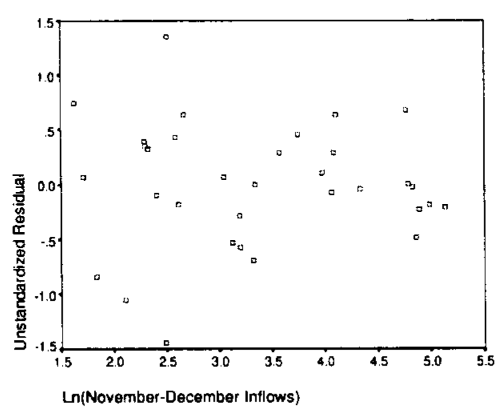


***Figure 6.29*** *Residuals Plot for Ln(November-December Inflows).*

### 6.2.4 Prediction Intervals for Flounder Harvest

***Table 6.19*** *Prediction Intervals for Flounder Harvest.*

| YEAR | *LICI_1* | *LN_FLOU* | *UICI_1* |
|---|---|---|---|
| 1962 | 2.2658 | 4.1400 | 6.3703 |
| 1963 | 1.9261 | 4.2794 | 5.9146 |
| 1964 | 2.1107 | 4.3554 | 5.9528 |
| 1965 | 1.7214 | 4.4224 | 5.6216 |
| 1966 | 1.6544 | 4.9090 | 5.4567 |
| 1967 | 1.6752 | 3.4874 | 5.4963 |
| 1968 | 1.2747 | 3.3032 | 5.1935 |
| 1969 | 1.0048 | 2.1282 | 4.9284 |
| 1970 | 1.8530 | 3.1179 | 5.5173 |
| 1971 | 1.9776 | 3.4874 | 5.5643 |
| 1972 | 1.6925 | 3.6082 | 5.3837 |
| 1973 | 1.6260 | 2.9755 | 5.3697 |
| 1974 | 1.5042 | 3.7728 | 5.2516 |
| 1975 | 2.1631 | 4.1821 | 5.9784 |
| 1976 | 2.2073 | 4.4942 | 6.1878 |
| 1977 | 2.3458 | 4.2210 | 6.1300 |
| 1978 | 2.3471 | 3.7184 | 6.0433 |
| 1979 | 1.9623 | 3.7471 | 5.5347 |
| 1980 | 1.5014 | 4.0604 | 5.3424 |
| 1981 | 1.5069 | 3.8501 | 5.3218 |
| 1982 | 2.2177 | 4.7867 | 5.9910 |
| 1983 | 2.3425 | 4.2166 | 6.0774 |
| 1984 | 1.9792 | 4.3202 | 5.7439 |
| 1985 | 1.4646 | 3.7977 | 5.5464 |
| 1986 | 1.9461 | 4.5053 | 5.7824 |
| 1987 | 2.3796 | 4.2499 | 6.2016 |
| 1988 | 2.1404 | 3.3286 | 5.8970 |
| 1989 | 1.9274 | 2.7344 | 5.6390 |
| 1990 | 1.7818 | 2.2721 | 5.6383 |
| 1991 | 1.7787 | 3.5264 | 5.6376 |
| 1992 | 2.0514 | 3.6914 | 5.7821 |
| 1993 | 2.0225 | 3.7209 | 5.8330 |
| 1994 | 1.9613 | 3.7612 | 5.7010 |

*LICI_1* Lower limit for 99% prediction interval for the natural log of flounder harvest.
*LN_FLOU* Natural log of flounder harvest
*UICI_1* Upper limit for 99% prediction interval for the natural log of flounder harvest.

### 6.2.5 Outliers and Influential Point Detection

***Table 6.20*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1962 | 12.0121 | .0134 | .3754 | .1002 | .0000 |
| 1963 | 9.5067 | .0343 | .2971 | .2183 | .0001 |
| 1964 | 6.4446 | .0151 | .2014 | .4889 | .0000 |
| 1965 | 7.6462 | .1047 | .2389 | .3648 | .0025 |
| 1966 | 5.6333 | .2209 | .1760 | .5832 | .0230 |
| 1967 | 6.0156 | .0013 | .1880 | .5379 | .0000 |
| 1968 | 8.0362 | .0010 | .2511 | .3294 | .0000 |
| 1969 | 8.1358 | .1438 | .2542 | .3208 | .0066 |
| 1970 | 2.8823 | .0184 | .0901 | .8957 | .0000 |
| 1971 | 1.3811 | .0025 | .0432 | .9861 | .0000 |
| 1972 | 3.4106 | .0003 | .1066 | .8446 | .0000 |
| 1973 | 4.4528 | .0247 | .1391 | .7264 | .0000 |
| 1974 | 4.5249 | .0144 | .1414 | .7177 | .0000 |
| 1975 | 5.8970 | .0016 | .1843 | .5518 | .0000 |
| 1976 | 9.3356 | .0227 | .2917 | .2294 | .0000 |
| 1977 | 5.2671 | .0000 | .1646 | .6274 | .0000 |
| 1978 | 3.5088 | .0158 | .1096 | .8343 | .0000 |
| 1979 | 1.1069 | .0000 | .0346 | .9929 | .0000 |
| 1980 | 6.4224 | .0586 | .2007 | .4914 | .0004 |
| 1981 | 5.8897 | .0243 | .1841 | .5527 | .0000 |
| 1982 | 5.0462 | .0489 | .1577 | .6543 | .0002 |
| 1983 | 4.2776 | .0000 | .1337 | .7473 | .0000 |
| 1984 | 4.8729 | .0212 | .1523 | .6755 | .0000 |
| 1985 | 11.5172 | .0330 | .3599 | .1176 | .0001 |
| 1986 | 6.3258 | .0579 | .1977 | .5023 | .0004 |
| 1987 | 6.0322 | .0002 | .1885 | .5360 | .0000 |
| 1988 | 4.7104 | .0460 | .1472 | .6953 | .0002 |
| 1989 | 3.8140 | .0837 | .1192 | .8009 | .0012 |
| 1990 | 6.7407 | .3183 | .2106 | .4564 | .0611 |
| 1991 | 6.7901 | .0051 | .2122 | .4511 | .0000 |
| 1992 | 4.1930 | .0043 | .1310 | .7573 | .0000 |
| 1993 | 5.7989 | .0054 | .1812 | .5634 | .0000 |
| 1994 | 4.3715 | .0004 | .1366 | .7361 | .0000 |

*MAH_1* Mahalanobis distance

*COOK_1* Cook's distance

*LEV_1* Leverage value

*MAHA_PV* P-value associated with the Mahalanobis distance

*COOK_P* P-value associated with Cook's distance

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.

[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n-p-1$ denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.21*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1962 | -.3013 | -.0802 | -.1806 | .1243 |
| 1963 | .4854 | .3537 | -.1049 | -.0615 |
| 1964 | .3214 | .2086 | -.0598 | -.0442 |
| 1965 | .8734 | .5927 | .3743 | -.3828 |
| 1966 | *1.3885 | .5933 | .0652 | .2676 |
| 1967 | -.0926 | -.0223 | .0320 | -.0298 |
| 1968 | .0803 | -.0087 | -.0069 | -.0247 |
| 1969 | *-1.0357 | -.0406 | -.3646 | -.1033 |
| 1970 | -.3587 | -.1822 | -.1694 | -.0532 |
| 1971 | -.1311 | -.0118 | .0911 | -.0664 |
| 1972 | .0473 | -.0159 | -.0236 | .0120 |
| 1973 | -.4143 | .1868 | .2079 | -.0778 |
| 1974 | .3139 | -.0048 | -.1039 | .0047 |
| 1975 | .1034 | .0112 | -.0341 | -.0130 |
| 1976 | .3935 | -.1187 | -.3042 | .0797 |
| 1977 | -.0146 | .0081 | .0083 | -.0014 |
| 1978 | -.3308 | .0188 | .0166 | .0385 |
| 1979 | -.0006 | -.0001 | -.0003 | .0000 |
| 1980 | .6454 | .0503 | .3573 | .0499 |
| 1981 | .4092 | -.1340 | .1139 | -.1227 |
| 1982 | .5905 | -.3900 | .0013 | -.2418 |
| 1983 | .0050 | -.0018 | .0010 | -.0013 |
| 1984 | .3823 | -.0264 | .1503 | -.0373 |
| 1985 | .4745 | .1552 | .1502 | .2511 |
| 1986 | .6413 | .0557 | -.2727 | .5034 |
| 1987 | -.0383 | .0023 | -.0056 | .0315 |
| 1988 | -.5731 | -.1265 | -.1702 | .4659 |
| 1989 | -.8038 | -.6455 | -.1542 | .3823 |
| 1990 | *-1.7132 | -.3874 | .4119 | -.7994 |
| 1991 | -.1864 | -.0323 | .0357 | -.0849 |
| 1992 | -.1704 | .0529 | -.0180 | -.0691 |
| 1993 | -.1904 | .0773 | -.0251 | -.0440 |
| 1994 | -.0540 | -.0004 | -.0127 | .0002 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for log of January-February inflows |
| *SDFBET_2* | Standardized *dfbeta* for log of March-April inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

***Table 6.22*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1962 | .1479 | .1291 | -.0697 | -.0662 |
| 1963 | -.0957 | -.2545 | .0178 | .0108 |
| 1964 | -.1332 | .0628 | -.0878 | .0152 |
| 1965 | -.0184 | -.0326 | -.5225 | -.3455 |
| 1966 | .4258 | -.5086 | -.8141 | -.4443 |
| 1967 | -.0375 | .0018 | .0549 | .0163 |
| 1968 | .0366 | .0061 | .0310 | -.0301 |
| 1969 | -.0443 | .2271 | -.5600 | .7922 |
| 1970 | .0307 | .1938 | .1358 | .1226 |
| 1971 | -.0095 | -.0104 | -.0041 | -.0149 |
| 1972 | .0105 | .0079 | .0303 | -.0035 |
| 1973 | -.2124 | -.0542 | -.1869 | .0128 |
| 1974 | .1541 | -.0626 | .1080 | -.0905 |
| 1975 | -.0105 | -.0345 | .0486 | .0423 |
| 1976 | -.0249 | .2320 | .0772 | .2147 |
| 1977 | -.0043 | -.0087 | .0034 | -.0106 |
| 1978 | -.0797 | .1385 | .0809 | -.2078 |
| 1979 | .0001 | -.0001 | .0001 | .0001 |
| 1980 | -.3126 | .1539 | .2250 | -.3651 |
| 1981 | .1283 | .2042 | .0385 | -.1494 |
| 1982 | .2740 | .2940 | -.0836 | .3145 |
| 1983 | -.0008 | .0026 | -.0004 | .0025 |
| 1984 | -.2166 | .1389 | .1506 | -.0213 |
| 1985 | -.3213 | -.2563 | .2640 | -.1716 |
| 1986 | -.2625 | -.1416 | .2071 | .0914 |
| 1987 | -.0163 | .0005 | .0144 | -.0214 |
| 1988 | -.2641 | .0628 | .3294 | -.1149 |
| 1989 | .1533 | .1998 | .1358 | .1911 |
| 1990 | .8787 | -.9429 | .0698 | .3466 |
| 1991 | .0470 | -.0990 | .0708 | .0353 |
| 1992 | -.0118 | .0296 | .0162 | -.0404 |
| 1993 | -.0570 | .0373 | .0304 | -.0524 |
| 1994 | -.0239 | .0227 | .0264 | -.0041 |

*SDFBET_3* Standardized *dfbeta* for log of May-June inflows
*SDFBET_4* Standardized *dfbeta* for log of July-August inflows
*SDFBET_5* Standardized *dfbeta* for log of September-October inflows
*SDFBET_6* Standardized *dfbeta* for log of November-December inflows

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

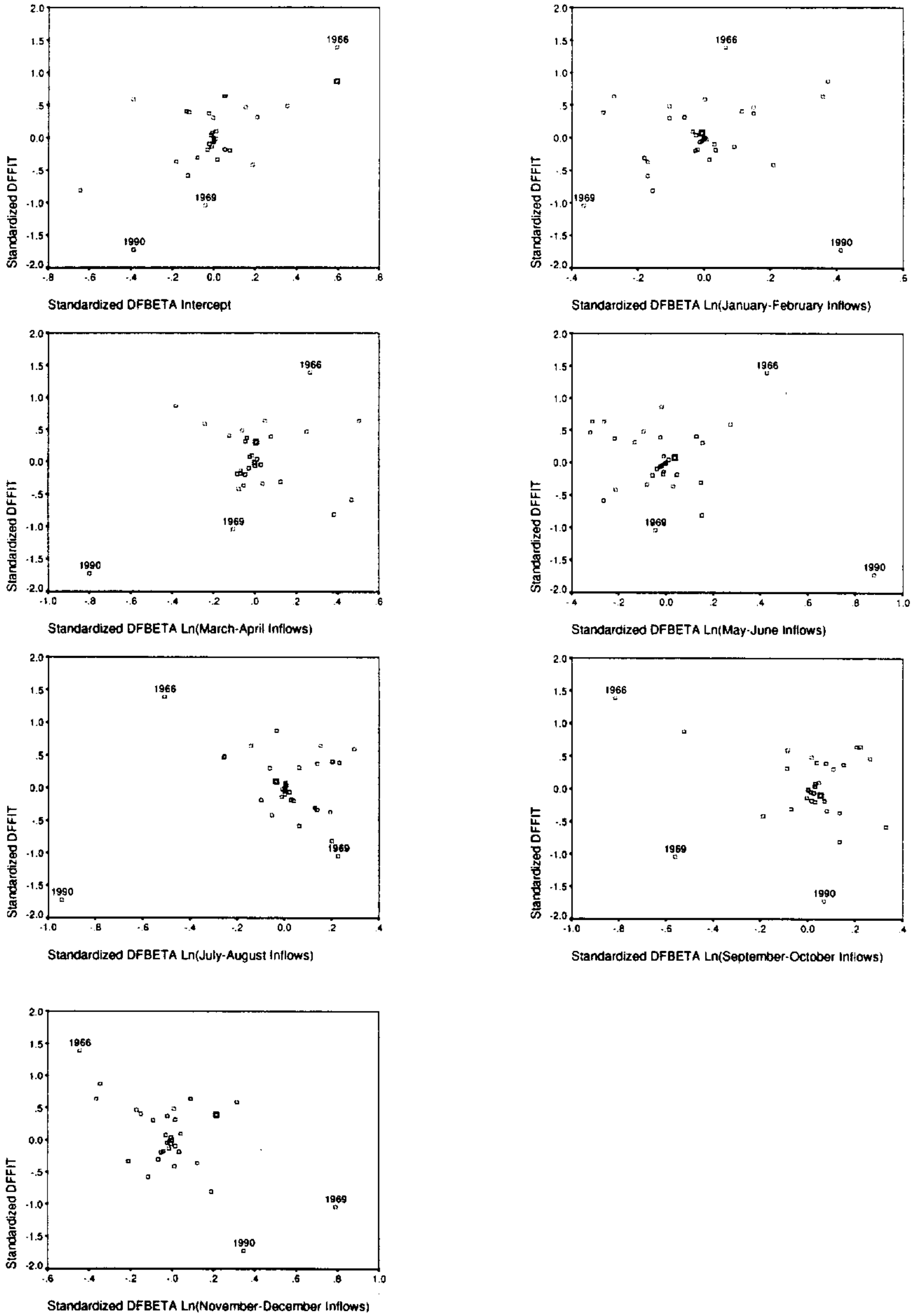


***Figure 6.30*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of log of inflow variables.*

## 6.3 Regression - Log of flounder data on square root of inflow data

### 6.3.1 ANOVA and Parameter Estimates

***Table 6.23*** *Model Summary for log of flounder data on square root of inflow data.*

**Model Summary[a,b]**

| Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| Sqrt(November-December), Sqrt(September-October), Sqrt(July-August), Sqrt(May-June), Sqrt(March-April), Sqrt( January-February)[c,d] | .483 | .234 | .057 | .630306 | 1.023 |

a. Dependent Variable: Ln(Flounder Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of September-October Inflows, Square Root of July-August Inflows, Square Root of May-June Inflows, Square Root of March-April Inflows, Square Root of January-February Inflows

d. All requested variables entered.

***Table 6.24*** *ANOVA table of log of flounder data on square root of inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 3.149 | 6 | .525 | 1.321 | .283[b] |
| | Residual | 10.329 | 26 | .397 | | |
| | Total | 13.478 | 32 | | | |

a. Dependent Variable: Ln(Flounder Harvest)

b. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of September-October Inflows, Square Root of July-August Inflows, Square Root of May-June Inflows, Square Root of March-April Inflows, Square Root of January-February Inflows

***Table 6.25*** *Table of coefficients for log of flounder data on square root of inflow data.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | 3.712 | .381 | | 9.733 | .000 | 2.928 | 4.495 |
| Sqrt(January-February) | -1.1E-02 | .053 | -.061 | -.212 | .834 | -.120 | .098 |
| Sqrt(March-April) | -3.2E-02 | .045 | -.180 | -.719 | .479 | -.125 | .060 |
| Sqrt(May-June) | -1.5E-02 | .025 | -.134 | -.614 | .545 | -.066 | .035 |
| Sqrt(July-August) | 7.8E-03 | .028 | .052 | .274 | .787 | -.051 | .066 |
| Sqrt(September-October) | -1.4E-02 | .017 | -.160 | -.826 | .416 | -.049 | .021 |
| Sqrt(November-December) | 9.8E-02 | .044 | .501 | 2.248 | .033 | .008 | .187 |

a. Dependent Variable: Ln(Flounder Harvest)

### 6.3.2 Collinearity Diagnostic

***Table 6.26*** *Collinearity Diagnostic for log of flounder data on square root of inflow data.*

**Coefficients[a]**

| | | Collinearity Statistics | |
|---|---|---|---|
| | t | Tolerance | VIF |
| (Constant) | 9.733 | | |
| Sqrt(January-February) | -.212 | .358 | 2.791 |
| Sqrt(March-April) | -.719 | .469 | 2.133 |
| Sqrt(May-June) | -.614 | .620 | 1.613 |
| Sqrt(July-August) | .274 | .819 | 1.221 |
| Sqrt(September-October) | -.826 | .788 | 1.269 |
| Sqrt(November-December) | 2.248 | .593 | 1.687 |

a. Dependent Variable: Ln(Flounder Harvest)

***Table 6.27*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(FLOUNDER) on Sqrt(INFLOWS).*

| Condition | Var Prop | Var Prop | Var Prop | Var Prop | Var Prop | Var Prop | | |
|---|---|---|---|---|---|---|---|---|
| Number | Eigenvalue | Index | SQR_QJF | SQR_QMA | SQR_QMJ | SQR_QJA | SQR_QSO | SQR_QND |
| 1 | 2.46585 | 1.00000 | 0.0469 | 0.0503 | 0.0447 | 0.0027 | 0.0018 | 0.0531 |
| 2 | 1.21968 | 1.42187 | 0.0003 | 0.0244 | 0.0853 | 0.0253 | 0.4388 | 0.0247 |
| 3 | 1.07106 | 1.51732 | 0.0152 | 0.0128 | 0.0506 | 0.6315 | 0.0076 | 0.0007 |
| 4 | 0.64635 | 1.95321 | 0.0011 | 0.0847 | 0.1961 | 0.0556 | 0.1620 | 0.4586 |
| 5 | 0.36115 | 2.61301 | 0.0349 | 0.4097 | 0.6190 | 0.0126 | 0.3467 | 0.2037 |
| 6 | 0.23591 | 3.23301 | 0.9016 | 0.4181 | 0.0043 | 0.2722 | 0.0430 | 0.2592 |

### 6.3.3 Residuals Diagnostics

***Table 6.28*** *Residuals Diagnostics for log of flounder data on square root of inflow data.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 3.097085 | 4.411806 | 3.793080 | .313689 | 33 |
| Std. Predicted Value | -2.219 | 1.972 | .000 | 1.000 | 33 |
| Standard Error of Predicted Value | .159773 | .421966 | .284641 | 5.8E-02 | 33 |
| Adjusted Predicted Value | 3.230684 | 4.632599 | 3.791583 | .350281 | 33 |
| Residual | -1.541234 | 1.353873 | 1.5E-16 | .568150 | 33 |
| Std. Residual | -2.445 | 2.148 | .000 | .901 | 33 |
| Stud. Residual | -2.765 | 2.327 | .001 | 1.007 | 33 |
| Deleted Residual | -1.970034 | 1.588647 | 1.5E-03 | .712067 | 33 |
| Stud. Deleted Residual | -3.226 | 2.564 | -.010 | 1.075 | 33 |
| Mahal. Distance | 1.086 | 13.372 | 5.818 | 2.736 | 33 |
| Cook's Distance | .000 | .304 | .036 | .061 | 33 |
| Centered Leverage Value | .034 | .418 | .182 | .086 | 33 |

a. Dependent Variable: Ln(Flounder Harvest)

***Table 6.29*** *Case Values for Residuals Diagnostics for log of flounder data on square root of inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1962 | 4.4118 | -.27185 | -.4926 | 4.6326 | 1.9724 | -.4313 | -.5806 | -.5731 |
| 1963 | 3.8368 | .44265 | .5327 | 3.7467 | .1393 | .7023 | .7704 | .7642 |
| 1964 | 3.9106 | .44479 | .5133 | 3.8422 | .3748 | .7057 | .7580 | .7517 |
| 1965 | 3.7513 | .67118 | .8009 | 3.6216 | -.1333 | 1.0648 | 1.1632 | 1.1715 |
| 1966 | 3.5551 | 1.35387 | 1.5886 | 3.3203 | -.7587 | 2.1480 | 2.3268 | *2.5641 |
| 1967 | 3.5722 | -.08482 | -.1006 | 3.5879 | -.7041 | -.1346 | -.1465 | -.1437 |
| 1968 | 3.2489 | .05436 | .0725 | 3.2307 | -1.7349 | .0862 | .0996 | .0977 |
| 1969 | 3.0971 | -.96885 | -1.3247 | 3.4529 | -2.2187 | -1.5371 | -1.7974 | -1.8833 |
| 1970 | 3.6872 | -.56928 | -.6464 | 3.7644 | -.3374 | -.9032 | -.9624 | -.9610 |
| 1971 | 3.7765 | -.28916 | -.3090 | 3.7964 | -.0527 | -.4588 | -.4743 | -.4671 |
| 1972 | 3.4762 | .13199 | .1572 | 3.4510 | -1.0101 | .2094 | .2285 | .2243 |
| 1973 | 3.3757 | -.40021 | -.5112 | 3.4867 | -1.3304 | -.6349 | -.7176 | -.7107 |
| 1974 | 3.4128 | .35998 | .4212 | 3.3516 | -1.2124 | .5711 | .6178 | .6103 |
| 1975 | 3.9462 | .23587 | .3009 | 3.8811 | .4881 | .3742 | .4227 | .4159 |
| 1976 | 4.1370 | .35721 | .4671 | 4.0272 | 1.0965 | .5667 | .6480 | .6406 |
| 1977 | 4.3055 | -.08455 | -.1140 | 4.3350 | 1.6336 | -.1341 | -.1558 | -.1528 |
| 1978 | 4.2748 | -.55640 | -.6717 | 4.3902 | 1.5358 | -.8827 | -.9699 | -.9688 |
| 1979 | 3.7822 | -.03504 | -.0380 | 3.7851 | -.0347 | -.0556 | -.0579 | -.0568 |
| 1980 | 3.5770 | .48345 | .6786 | 3.3818 | -.6889 | .7670 | .9087 | .9056 |
| 1981 | 3.4857 | .36442 | .5215 | 3.3286 | -.9798 | .5782 | .6916 | .6845 |
| 1982 | 4.1195 | .66718 | .8744 | 3.9122 | 1.0405 | 1.0585 | 1.2118 | 1.2233 |
| 1983 | 4.3231 | -.10658 | -.1333 | 4.3499 | 1.6898 | -.1691 | -.1891 | -.1856 |
| 1984 | 3.8906 | .42955 | .5305 | 3.7897 | .3109 | .6815 | .7573 | .7510 |
| 1985 | 3.5284 | .26936 | .4323 | 3.3654 | -.8439 | .4274 | .5414 | .5339 |
| 1986 | 3.8604 | .64499 | .8905 | 3.6149 | .2145 | 1.0233 | 1.2024 | 1.2132 |
| 1987 | 4.1890 | .06088 | .0726 | 4.1773 | 1.2623 | .0966 | .1055 | .1034 |
| 1988 | 3.8985 | -.56984 | -.6614 | 3.9900 | .3360 | -.9041 | -.9740 | -.9730 |
| 1989 | 3.7944 | -1.06001 | -1.2168 | 3.9512 | .0041 | -1.6817 | -1.8018 | -1.8887 |
| 1990 | 3.8134 | -1.54123 | -1.9700 | 4.2422 | .0647 | -2.4452 | -2.7645 | *-3.2261 |
| 1991 | 3.7488 | -.22243 | -.2951 | 3.8214 | -.1412 | -.3529 | -.4064 | -.3998 |
| 1992 | 3.8578 | -.16642 | -.2257 | 3.9171 | .2063 | -.2640 | -.3075 | -.3021 |
| 1993 | 3.8197 | -.09886 | -.1611 | 3.8819 | .0849 | -.1568 | -.2002 | -.1965 |
| 1994 | 3.7074 | .05381 | .0663 | 3.6949 | -.2732 | .0854 | .0947 | .0929 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that observation |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.

[2]This is flagged if it exceeds $t_{n-p-2,\alpha}=t_{25,0.01}=2.485$.

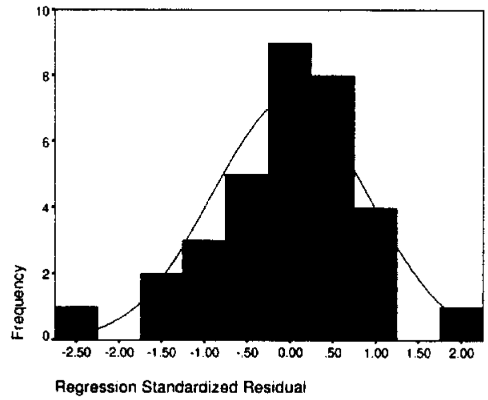


***Figure 6.31*** *Histogram of Standardized Residuals.*

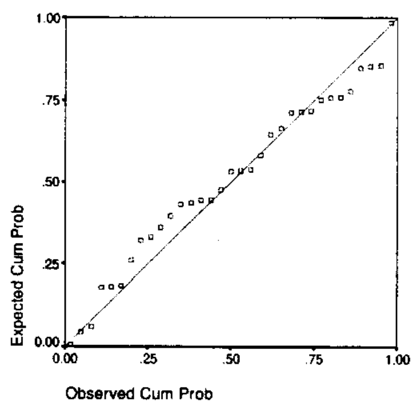


***Figure 6.32*** *Normal P-P Plot of Residuals.*

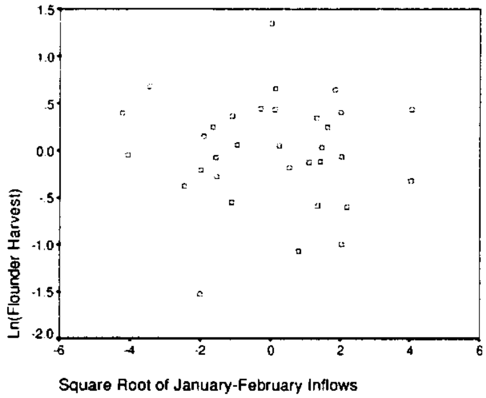


***Figure 6.33*** *Partial Residual Plot for Sqrt(January-February Inflows).*

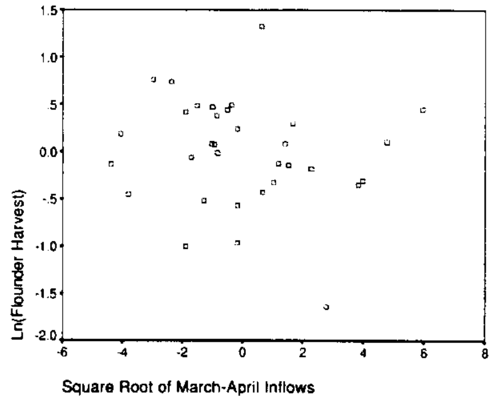


***Figure 6.34*** *Partial Residual Plot for Sqrt(March-April Inflows).*

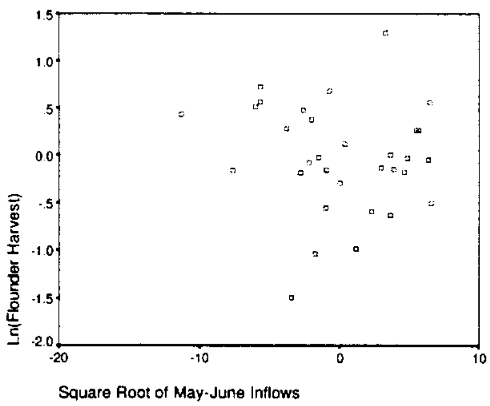


***Figure 6.35*** *Partial Residual Plot for Sqrt(May-June Inflows).*

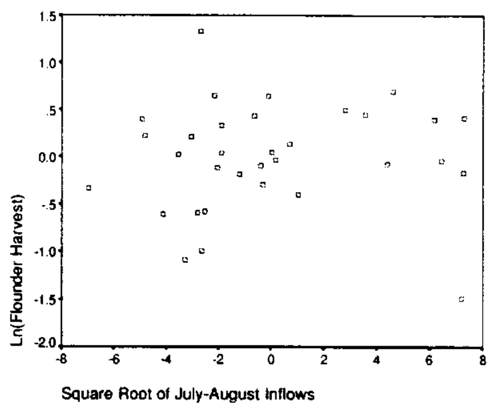


***Figure 6.36*** *Partial Residual Plot for Sqrt(July-August Inflows).*

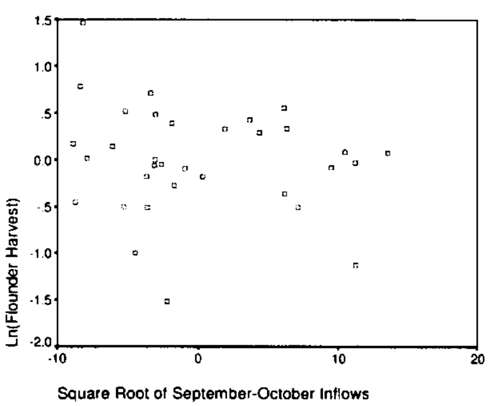


***Figure 6.37*** *Partial Residual Plot for Sqrt(September-October Inflows).*

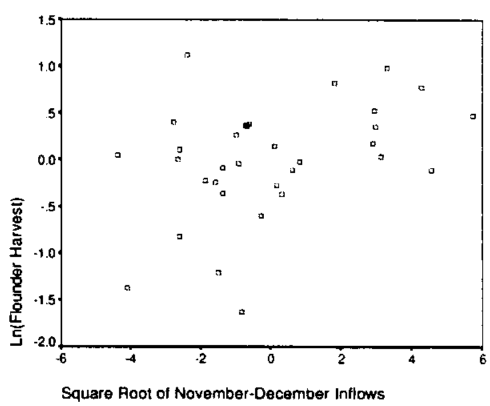


***Figure 6.38*** *Partial Residual Plot for Sqrt(November-December Inflows).*

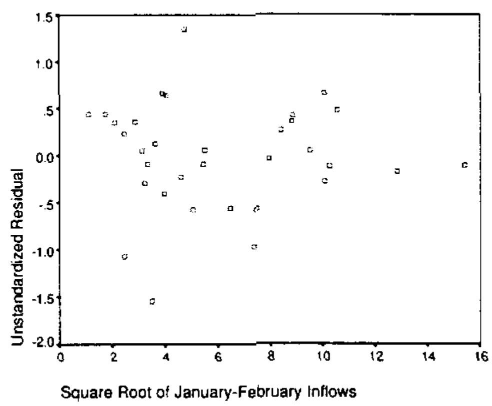


*Figure 6.39* Residuals Plot for Sqrt(January-February Inflows).

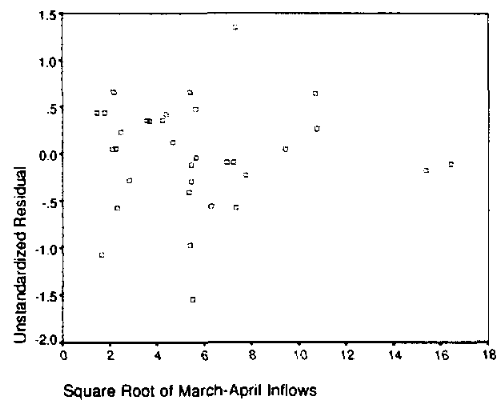


*Figure 6.40* Residuals Plot for Sqrt(March-April Inflows).

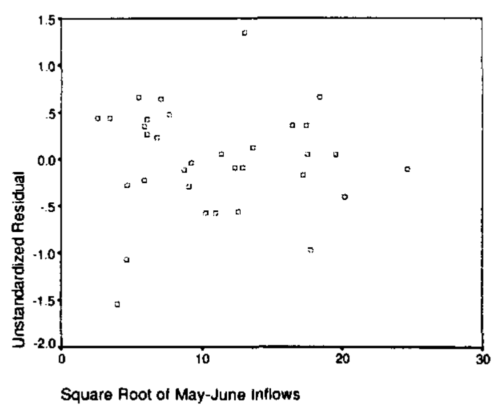


*Figure 6.41* Residuals Plot for Sqrt(May-June Inflows).

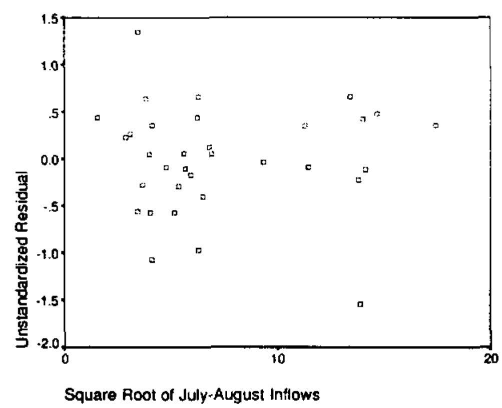


*Figure 6.42* Residuals Plot for Sqrt(July-August Inflows).

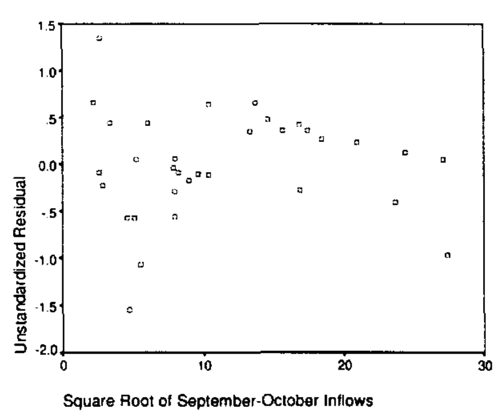


*Figure 6.43* Residuals Plot for Sqrt(September-October Inflows).

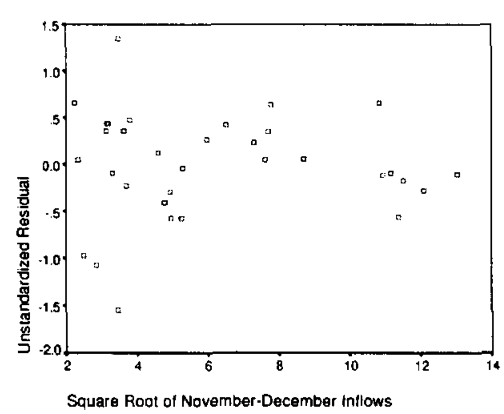


*Figure 6.44* Residuals Plot for Sqrt(November-December Inflows).

### 6.3.4 Prediction Intervals for Flounder Harvest

***Table 6.30*** *Prediction Intervals for Flounder Harvest.*

| YEAR | *LICI_1* | *LN_FLOU* | *UICI_1* |
|---|---|---|---|
| 1962 | 2.3041 | 4.1400 | 6.5195 |
| 1963 | 1.9431 | 4.2794 | 5.7305 |
| 1964 | 2.0460 | 4.3554 | 5.7753 |
| 1965 | 1.8633 | 4.4224 | 5.6392 |
| 1966 | 1.6787 | 4.9090 | 5.4315 |
| 1967 | 1.6887 | 3.4874 | 5.4557 |
| 1968 | 1.2903 | 3.3032 | 5.2074 |
| 1969 | 1.1244 | 2.1282 | 5.0698 |
| 1970 | 1.8342 | 3.1179 | 5.5402 |
| 1971 | 1.9697 | 3.4874 | 5.5834 |
| 1972 | 1.5895 | 3.6082 | 5.3630 |
| 1973 | 1.4435 | 2.9755 | 5.3080 |
| 1974 | 1.5384 | 3.7728 | 5.2871 |
| 1975 | 2.0147 | 4.1821 | 5.8777 |
| 1976 | 2.1905 | 4.4942 | 6.0835 |
| 1977 | 2.3407 | 4.2210 | 6.2703 |
| 1978 | 2.3790 | 3.7184 | 6.1707 |
| 1979 | 1.9643 | 3.7471 | 5.6001 |
| 1980 | 1.5896 | 4.0604 | 5.5644 |
| 1981 | 1.4878 | 3.8501 | 5.4836 |
| 1982 | 2.1715 | 4.7867 | 6.0675 |
| 1983 | 2.4040 | 4.2166 | 6.2423 |
| 1984 | 1.9798 | 4.3202 | 5.8014 |
| 1985 | 1.4732 | 3.7977 | 5.5836 |
| 1986 | 1.8822 | 4.5053 | 5.8385 |
| 1987 | 2.3017 | 4.2499 | 6.0764 |
| 1988 | 2.0298 | 3.3286 | 5.7672 |
| 1989 | 1.9335 | 2.7344 | 5.6553 |
| 1990 | 1.8807 | 2.2721 | 5.7460 |
| 1991 | 1.7937 | 3.5264 | 5.7039 |
| 1992 | 1.8897 | 3.6914 | 5.8259 |
| 1993 | 1.7576 | 3.7209 | 5.8818 |
| 1994 | 1.7984 | 3.7612 | 5.6164 |

*LICI_1* Lower limit for 99% prediction interval for the natural log of flounder harvest.

*LN_FLOU* Log of flounder harvest

*UICI_1* Upper limit for 99% prediction interval for the natural log of flounder harvest.

### 6.3.5 Outliers and Influential Point Detection

***Table 6.31*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1962 | 13.3720 | .0391 | .4179 | .0635 | .0001 |
| 1963 | 4.4394 | .0172 | .1387 | .7280 | .0000 |
| 1964 | 3.2997 | .0126 | .1031 | .8560 | .0000 |
| 1965 | 4.2130 | .0374 | .1317 | .7549 | .0001 |
| 1966 | 3.7594 | .1341 | .1175 | .8070 | .0053 |
| 1967 | 4.0375 | .0006 | .1262 | .7755 | .0000 |
| 1968 | 7.0466 | .0005 | .2202 | .4240 | .0000 |
| 1969 | 7.6260 | .1695 | .2383 | .3667 | .0107 |
| 1970 | 2.8495 | .0179 | .0890 | .8986 | .0000 |
| 1971 | 1.0864 | .0022 | .0340 | .9933 | .0000 |
| 1972 | 4.1659 | .0014 | .1302 | .7605 | .0000 |
| 1973 | 5.9776 | .0204 | .1868 | .5424 | .0000 |
| 1974 | 3.6799 | .0093 | .1150 | .8158 | .0000 |
| 1975 | 5.9472 | .0070 | .1858 | .5459 | .0000 |
| 1976 | 6.5559 | .0184 | .2049 | .4765 | .0000 |
| 1977 | 7.3017 | .0012 | .2282 | .3982 | .0000 |
| 1978 | 4.5250 | .0279 | .1414 | .7177 | .0000 |
| 1979 | 1.5058 | .0000 | .0471 | .9821 | .0000 |
| 1980 | 8.2330 | .0476 | .2573 | .3125 | .0002 |
| 1981 | 8.6693 | .0295 | .2709 | .2773 | .0000 |
| 1982 | 6.6151 | .0652 | .2067 | .4700 | .0005 |
| 1983 | 5.4533 | .0013 | .1704 | .6048 | .0000 |
| 1984 | 5.1183 | .0193 | .1599 | .6455 | .0000 |
| 1985 | 11.0926 | .0253 | .3466 | .1346 | .0000 |
| 1986 | 7.8516 | .0786 | .2454 | .3459 | .0010 |
| 1987 | 4.1903 | .0003 | .1309 | .7576 | .0000 |
| 1988 | 3.4586 | .0218 | .1081 | .8396 | .0000 |
| 1989 | 3.1542 | .0686 | .0986 | .8704 | .0006 |
| 1990 | 5.9955 | .3038 | .1874 | .5403 | .0542 |
| 1991 | 6.9062 | .0077 | .2158 | .4387 | .0000 |
| 1992 | 7.4371 | .0048 | .2324 | .3848 | .0000 |
| 1993 | 11.3898 | .0036 | .3559 | .1225 | .0000 |
| 1994 | 5.0466 | .0003 | .1577 | .6543 | .0000 |

| | |
|---|---|
| *MAH_1* | Mahalanobis distance |
| *COOK_1* | Cook's distance |
| *LEV_1* | Leverage value |
| *MAHA_PV* | P-value associated with the Mahalanobis distance |
| *COOK_PV* | P-value associated with Cook's distance |

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p$+1 degrees of freedom. Small values indicate a problem.

[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p$+1 numerator degrees of freedom and $n$-$p$-1 denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.32** Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1962 | -.5164 | -.0952 | -.2622 | .2419 |
| 1963 | .3447 | .3216 | .0076 | -.0902 |
| 1964 | .2949 | .2488 | -.0205 | -.0576 |
| 1965 | .5150 | .4501 | .1999 | -.2158 |
| 1966 | *1.0678 | .6100 | .0039 | .1250 |
| 1967 | -.0619 | -.0267 | .0205 | -.0172 |
| 1968 | .0565 | -.0035 | -.0092 | -.0081 |
| 1969 | *-1.1414 | .0186 | -.3773 | .0262 |
| 1970 | -.3538 | -.2332 | -.1894 | .0116 |
| 1971 | -.1224 | -.0631 | .0625 | -.0358 |
| 1972 | .0981 | -.0170 | -.0392 | .0248 |
| 1973 | -.3743 | .1040 | .1655 | -.0390 |
| 1974 | .2516 | .0549 | -.0615 | -.0397 |
| 1975 | .2184 | .0334 | -.0651 | -.0060 |
| 1976 | .3552 | -.0687 | -.2606 | .0873 |
| 1977 | -.0902 | .0363 | .0609 | -.0151 |
| 1978 | -.4411 | -.0180 | .1011 | .0977 |
| 1979 | -.0164 | -.0067 | -.0102 | .0035 |
| 1980 | .5754 | .0320 | .3668 | -.0277 |
| 1981 | .4494 | -.1158 | .0918 | -.1111 |
| 1982 | .6818 | -.3186 | .0149 | -.2987 |
| 1983 | -.0930 | .0257 | -.0192 | .0252 |
| 1984 | .3640 | -.0359 | .1413 | -.0297 |
| 1985 | .4153 | .0542 | .0927 | .2313 |
| 1986 | .7485 | -.0046 | -.4139 | .6078 |
| 1987 | .0454 | .0126 | .0021 | -.0328 |
| 1988 | -.3899 | -.2472 | -.1180 | .2840 |
| 1989 | -.7264 | -.6980 | -.1377 | .2719 |
| 1990 | *-1.7017 | -.1727 | .6180 | -.7249 |
| 1991 | -.2285 | -.0093 | .0773 | -.1263 |
| 1992 | -.1803 | .0567 | -.0161 | -.1001 |
| 1993 | -.1559 | .0608 | -.0301 | -.0412 |
| 1994 | .0447 | .0064 | .0127 | -.0067 |

*SDFFITS* Standardized *dffits* value
*SDFBET_0* Standardized *dfbeta* for the intercept term
*SDFBET_1* Standardized *dfbeta* for square root of January-February inflows
*SDFBET_2* Standardized *dfbeta* for square root of March-April inflows

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

***Table 6.33*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1962 | .2300 | .2424 | -.1276 | -.1672 |
| 1963 | -.0849 | -.1860 | -.0676 | -.0398 |
| 1964 | -.0827 | -.0228 | -.1124 | -.0338 |
| 1965 | -.0356 | -.1234 | -.2869 | -.2439 |
| 1966 | .3573 | -.3358 | -.6092 | -.4570 |
| 1967 | -.0240 | .0028 | .0332 | .0170 |
| 1968 | .0215 | .0002 | .0288 | -.0107 |
| 1969 | -.1033 | .2606 | -.6657 | .6233 |
| 1970 | .0403 | .1897 | .1444 | .1830 |
| 1971 | -.0004 | .0068 | .0218 | -.0062 |
| 1972 | .0038 | .0078 | .0736 | .0024 |
| 1973 | -.2069 | -.0374 | -.1536 | -.0183 |
| 1974 | .1431 | -.0558 | .0335 | -.0439 |
| 1975 | -.0697 | -.0640 | .1326 | .0960 |
| 1976 | -.0574 | .2040 | .0855 | .2175 |
| 1977 | -.0209 | -.0516 | .0125 | -.0705 |
| 1978 | -.0956 | .1204 | .1030 | -.3366 |
| 1979 | .0035 | -.0005 | .0049 | .0075 |
| 1980 | -.2389 | .1365 | .1047 | -.3243 |
| 1981 | .1818 | .2698 | -.0409 | -.1468 |
| 1982 | .3559 | .2917 | -.1255 | .3224 |
| 1983 | .0180 | -.0413 | .0053 | -.0419 |
| 1984 | -.1972 | .1343 | .1418 | -.0381 |
| 1985 | -.2976 | -.1464 | .2466 | -.1236 |
| 1986 | -.3167 | -.0057 | .2341 | .1803 |
| 1987 | .0161 | -.0096 | -.0184 | .0234 |
| 1988 | -.1490 | .1322 | .2443 | .0185 |
| 1989 | .1372 | .2986 | .2419 | .2064 |
| 1990 | .4963 | *-1.1827 | .2150 | .2052 |
| 1991 | .0503 | -.1512 | .0453 | .0435 |
| 1992 | .0128 | .0191 | -.0032 | -.0155 |
| 1993 | -.0460 | .0231 | .0210 | -.0147 |
| 1994 | .0257 | -.0163 | -.0244 | -.0064 |

*SDFBET_3* Standardized *dfbeta* for square root of May-June inflows
*SDFBET_4* Standardized *dfbeta* for square root of July-August inflows
*SDFBET_5* Standardized *dfbeta* for square root of September-October inflows
*SDFBET_6* Standardized *dfbeta* for square root of November-December inflows

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

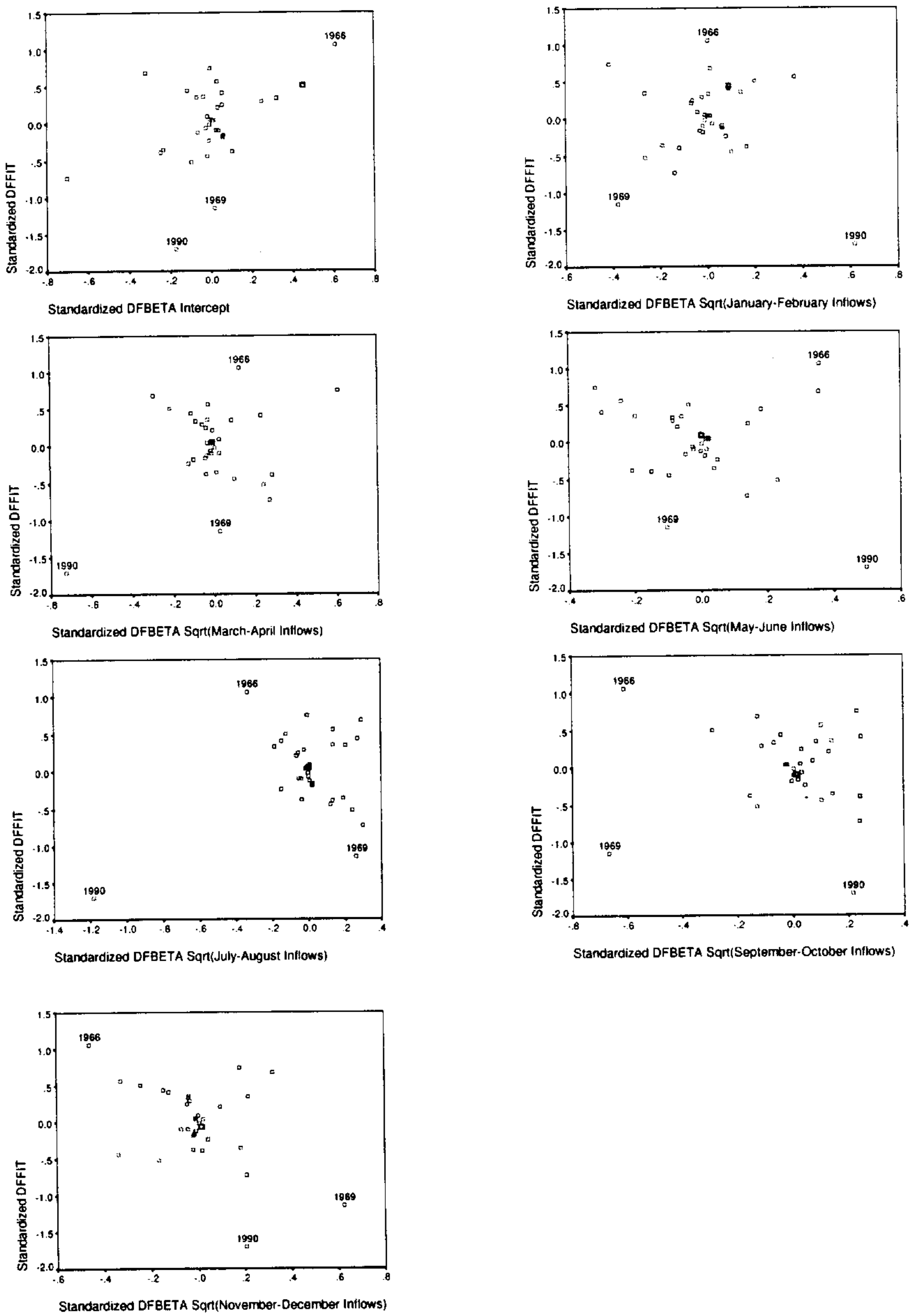


***Figure 6.45*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of square root of inflow variables.*

# 7. EXAMINING SUBSETS OF THE DATA

## 7.1 Log of flounder data and untransformed inflow data: 1990 Omitted

***Table 7.1*** *Regression Models for Dependent Variable: Ln(FLOUNDER) on INFLOWS: 1990 Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.1518 | 0.1235 | 4.117 | -35.17 | 0.3136 | -32.24 | QSO_LAG |
| 1 | 0.0823 | 0.0517 | 6.746 | -32.65 | 0.3393 | -29.72 | QMJ_LAG |
| 1 | 0.0822 | 0.0516 | 6.751 | -32.65 | 0.3394 | -29.72 | QND_LAG |
| 1 | 0.0487 | 0.0169 | 8.021 | -31.50 | 0.3518 | -28.57 | QJA_LAG |
| 2 | 0.2304 | 0.1773 | 3.139 | -36.28 | 0.2944 | -31.89 | QMJ_LAG QND_LAG |
| 2 | 0.2015 | 0.1464 | 4.235 | -35.10 | 0.3054 | -30.70 | QJA_LAG QSO_LAG |
| 2 | 0.2004 | 0.1453 | 4.274 | -35.06 | 0.3058 | -30.66 | QSO_LAG QND_LAG |
| 2 | 0.1831 | 0.1268 | 4.930 | -34.37 | 0.3125 | -29.98 | QMJ_LAG QSO_LAG |
| 3 | 0.2766 | 0.1991 | 3.391 | -36.26 | 0.2866 | -30.40 | QMJ_LAG QSO_LAG QND_LAG |
| 3 | 0.2715 | 0.1935 | 3.583 | -36.04 | 0.2886 | -30.18 | QMJ_LAG QJA_LAG QND_LAG |
| 3 | 0.2609 | 0.1817 | 3.986 | -35.58 | 0.2928 | -29.71 | QMA_LAG QSO_LAG QND_LAG |
| 3 | 0.2468 | 0.1661 | 4.520 | -34.97 | 0.2984 | -29.11 | QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.3197 | 0.2189 | 3.760 | -36.23 | 0.2795 | -28.90 | QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.3127 | 0.2109 | 4.024 | -35.90 | 0.2824 | -28.57 | QJF_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.2911 | 0.1861 | 4.841 | -34.91 | 0.2912 | -27.58 | QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 4 | 0.2906 | 0.1855 | 4.859 | -34.89 | 0.2914 | -27.56 | QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.3397 | 0.2127 | 5.002 | -35.18 | 0.2817 | -26.39 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.3261 | 0.1966 | 5.515 | -34.53 | 0.2875 | -25.74 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.3142 | 0.1823 | 5.967 | -33.97 | 0.2926 | -25.18 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.2911 | 0.1548 | 6.841 | -32.91 | 0.3024 | -24.12 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 6 | 0.3397 | 0.1813 | 7.000 | -33.19 | 0.2930 | -22.93 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 32

***Table 7.2** Analysis of Variance for Dependent Variable: Ln(FLOUNDER) on INFLOWS: 1990 Omitted*

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 6 | 3.76851 | 0.62809 | 2.144 | 0.0836 |
| Error | 25 | 7.32413 | 0.29297 | | |
| C Total | 31 | 11.09264 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 0.54126 | R-square | 0.3397 |
| Dep Mean | 3.84061 | Adj R-sq | 0.1813 |
| C.V. | 14.09314 | | |

***Table 7.3** Parameter Estimates for Dependent Variable: Ln(FLOUNDER) on INFLOWS: 1990 Omitted*

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 3.840198 | 0.20402674 | 18.822 | 0.0001 | 0.00000000 |
| QJF_LAG | 1 | -0.002634 | 0.00367158 | -0.717 | 0.4798 | 4.10889624 |
| QMA_LAG | 1 | 0.000121 | 0.00276549 | 0.044 | 0.9654 | 3.11448277 |
| QMJ_LAG | 1 | -0.000882 | 0.00089693 | -0.983 | 0.3348 | 1.82248037 |
| QJA_LAG | 1 | 0.001998 | 0.00147293 | 1.357 | 0.1870 | 1.43434263 |
| QSO_LAG | 1 | -0.000730 | 0.00052303 | -1.396 | 0.1750 | 1.34836419 |
| QND_LAG | 1 | 0.005329 | 0.00269374 | 1.978 | 0.0590 | 1.89152101 |

***Table 7.4** Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(FLOUNDER) on INFLOWS: 1990 Omitted*

| Number | Eigenvalue | Condition Index | Var Prop QJF_LAG | Var Prop QMA_LAG | Var Prop QMJ_LAG | Var Prop QJA_LAG | Var Prop QSO_LAG | Var Prop QND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.63960 | 1.00000 | 0.0294 | 0.0342 | 0.0352 | 0.0005 | 0.0010 | 0.0450 |
| 2 | 1.25802 | 1.44853 | 0.0002 | 0.0014 | 0.1165 | 0.0002 | 0.3988 | 0.0209 |
| 3 | 1.09251 | 1.55438 | 0.0091 | 0.0185 | 0.0031 | 0.5650 | 0.0026 | 0.0004 |
| 4 | 0.53173 | 2.22804 | 0.0000 | 0.0648 | 0.1367 | 0.0356 | 0.2236 | 0.5694 |
| 5 | 0.32917 | 2.83179 | 0.0684 | 0.2391 | 0.7083 | 0.0000 | 0.3314 | 0.1451 |
| 6 | 0.14898 | 4.20928 | 0.8929 | 0.6419 | 0.0002 | 0.3987 | 0.0425 | 0.2193 |

***Table** 7.5 Parameter Estimates of Models for Dependent Variable: Ln(FLOUNDER) on INFLOWS: 1990 Omitted*

| OBS | _RMSE_ | INTERCEP | QJF_LAG | QMA_LAG | QMJ_LAG | QJA_LAG | QSO_LAG | QND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.56004 | 4.04353 | . | . | . | . | -.0010797 | . |
| 2 | 0.58250 | 4.02648 | . | . | -.0011731 | . | . | . |
| 3 | 0.58254 | 3.66795 | . | . | . | . | . | .0034556 |
| 4 | 0.59310 | 3.72539 | . | . | . | .0016694 | . | . |
| 5 | 0.54256 | 3.85903 | . | . | -.0016424 | . | . | .0048398 |
| 6 | 0.55267 | 3.92778 | . | . | . | .0016873 | -.0010834 | . |
| 7 | 0.55302 | 3.88761 | . | . | . | . | -.0009686 | .0027027 |
| 8 | 0.55898 | 4.13456 | . | . | -.0007599 | . | -.0009234 | . |
| 9 | 0.53534 | 3.96389 | . | . | -.0012705 | . | -.0006532 | .0040186 |
| 10 | 0.53721 | 3.75500 | . | . | -.0016237 | .0015356 | . | .0047414 |
| 11 | 0.54112 | 3.94201 | . | -.0027828 | . | . | -.0010404 | .0044424 |
| 12 | 0.54626 | 3.78118 | . | . | . | .0016301 | -.0009761 | .0026092 |
| 13 | 0.52869 | 3.85961 | . | . | -.0012434 | .0015722 | -.0006671 | .0039004 |
| 14 | 0.53138 | 3.79139 | -.0039956 | . | . | .0022280 | -.0009402 | .0054613 |
| 15 | 0.53966 | 3.97492 | . | -.0015941 | -.0009353 | . | -.0007776 | .0046680 |
| 16 | 0.53985 | 3.84798 | . | -.0024124 | . | .0013293 | -.0010370 | .0041346 |
| 17 | 0.53077 | 3.84262 | -.0025359 | . | -.0008712 | .0019691 | -.0007368 | .0053240 |
| 18 | 0.53619 | 3.87543 | . | -.0010869 | -.0010170 | .0014472 | -.0007508 | .0043525 |
| 19 | 0.54092 | 3.80731 | -.0033909 | -.0006307 | . | .0020589 | -.0009615 | .0054285 |
| 20 | 0.54994 | 3.97496 | -.0000359 | -.0015802 | -.0009330 | . | -.0007774 | .0046829 |
| 21 | 0.54126 | 3.84020 | -.0026338 | 0.0001211 | -.0008821 | .0019983 | -.0007302 | .0053286 |

***Table** 7.6 Criteria Statistics of Models for Dependent Variable: Ln(FLOUNDER) on INFLOWS: 1990 Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 0.31364 | 0.15175 | 0.12348 | 4.11747 | -35.1692 | -32.2377 |
| 2 | 0.33931 | 0.08233 | 0.05174 | 6.74593 | -32.6520 | -29.7205 |
| 3 | 0.33936 | 0.08221 | 0.05162 | 6.75061 | -32.6477 | -29.7162 |
| 4 | 0.35176 | 0.04866 | 0.01695 | 8.02091 | -31.4988 | -28.5673 |
| 5 | 0.29437 | 0.23042 | 0.17734 | 3.13903 | -36.2835 | -31.8863 |
| 6 | 0.30544 | 0.20146 | 0.14639 | 4.23535 | -35.1016 | -30.7044 |
| 7 | 0.30584 | 0.20044 | 0.14530 | 4.27412 | -35.0606 | -30.6634 |
| 8 | 0.31246 | 0.18312 | 0.12678 | 4.92987 | -34.3749 | -29.9777 |
| 9 | 0.28659 | 0.27658 | 0.19908 | 3.39096 | -36.2632 | -30.4003 |
| 10 | 0.28860 | 0.27152 | 0.19347 | 3.58252 | -36.0402 | -30.1772 |
| 11 | 0.29281 | 0.26088 | 0.18169 | 3.98554 | -35.5760 | -29.7130 |
| 12 | 0.29840 | 0.24678 | 0.16607 | 4.51959 | -34.9711 | -29.1081 |
| 13 | 0.27951 | 0.31966 | 0.21886 | 3.76009 | -36.2276 | -28.8989 |
| 14 | 0.28237 | 0.31270 | 0.21088 | 4.02354 | -35.9020 | -28.5733 |
| 15 | 0.29124 | 0.29112 | 0.18610 | 4.84073 | -34.9126 | -27.5839 |
| 16 | 0.29144 | 0.29062 | 0.18553 | 4.85941 | -34.8903 | -27.5616 |
| 17 | 0.28172 | 0.33968 | 0.21270 | 5.00192 | -35.1835 | -26.3891 |
| 18 | 0.28750 | 0.32614 | 0.19655 | 5.51458 | -34.5340 | -25.7396 |
| 19 | 0.29260 | 0.31419 | 0.18230 | 5.96722 | -33.9713 | -25.1769 |
| 20 | 0.30244 | 0.29112 | 0.15480 | 6.84059 | -32.9127 | -24.1183 |
| 21 | 0.29297 | 0.33973 | 0.18127 | 7.00000 | -33.1860 | -22.9258 |

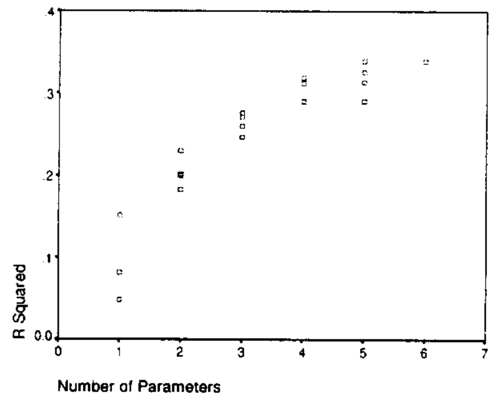


*Figure 7.1* *The $R^2$ criteria vs. Number of parameters.*

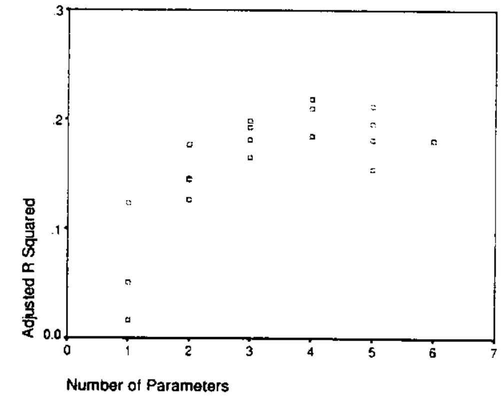


*Figure 7.2* *The Adjusted $R^2$ criteria vs. Number of parameters.*

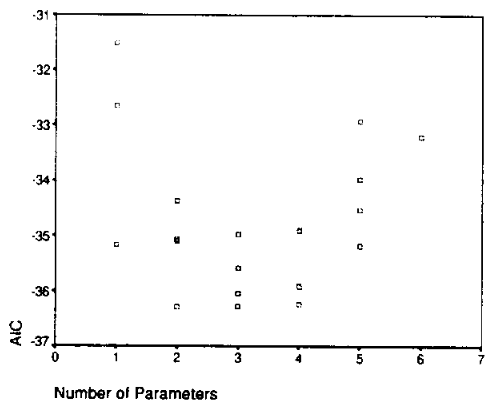


*Figure 7.3* *The AIC criteria vs. Number of parameters..*

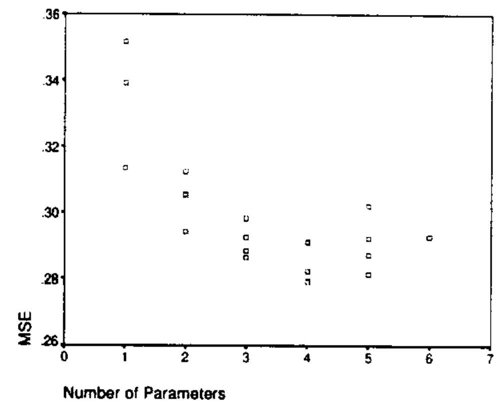


*Figure 7.4* *MSE vs. Number of parameters.*

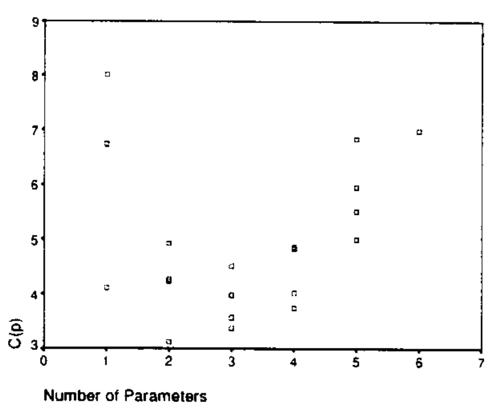


*Figure 7.5* *The C(p) criteria vs. Number of parameters.*

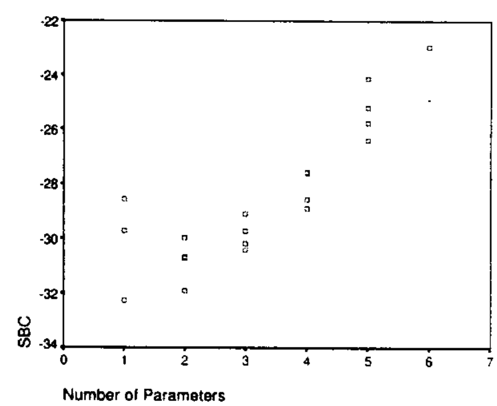


*Figure 7.6* *The SBC criteria vs. Number of parameters.*

## 7.2 Log of flounder data and log of inflow data: 1990 Omitted

***Table** 7.7 Regression Models for Dependent Variable: Ln(FLOUNDER) on Ln(INFLOWS): 1990 Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.1193 | 0.0899 | 5.162 | -33.97 | 0.3257 | -31.03 | LN_QND |
| 1 | 0.0901 | 0.0597 | 6.261 | -32.92 | 0.3365 | -29.99 | LN_QMJ |
| 1 | 0.0371 | 0.0050 | 8.255 | -31.11 | 0.3560 | -28.18 | LN_QSO |
| 1 | 0.0085 | -.0246 | 9.333 | -30.18 | 0.3666 | -27.24 | LN_QJA |
| 2 | 0.2576 | 0.2064 | 1.953 | -37.43 | 0.2840 | -33.04 | LN_QMJ LN_QND |
| 2 | 0.1880 | 0.1320 | 4.574 | -34.57 | 0.3106 | -30.17 | LN_QSO LN_QND |
| 2 | 0.1842 | 0.1280 | 4.716 | -34.42 | 0.3120 | -30.02 | LN_QJF LN_QND |
| 2 | 0.1678 | 0.1104 | 5.333 | -33.78 | 0.3183 | -29.38 | LN_QMA LN_QND |
| 3 | 0.2853 | 0.2088 | 2.909 | -36.65 | 0.2831 | -30.79 | LN_QMJ LN_QSO LN_QND |
| 3 | 0.2736 | 0.1958 | 3.350 | -36.13 | 0.2878 | -30.27 | LN_QMJ LN_QJA LN_QND |
| 3 | 0.2664 | 0.1878 | 3.620 | -35.82 | 0.2906 | -29.95 | LN_QJF LN_QMJ LN_QND |
| 3 | 0.2598 | 0.1805 | 3.869 | -35.53 | 0.2932 | -29.67 | LN_QMA LN_QMJ LN_QND |
| 4 | 0.3064 | 0.2037 | 4.114 | -35.61 | 0.2849 | -28.28 | LN_QMJ LN_QJA LN_QSO LN_QND |
| 4 | 0.2971 | 0.1930 | 4.465 | -35.18 | 0.2888 | -27.86 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 4 | 0.2951 | 0.1907 | 4.540 | -35.09 | 0.2896 | -27.77 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.2940 | 0.1894 | 4.583 | -35.04 | 0.2901 | -27.71 | LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.3345 | 0.2065 | 5.057 | -34.93 | 0.2839 | -26.14 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.3174 | 0.1862 | 5.701 | -34.12 | 0.2912 | -25.33 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.2996 | 0.1650 | 6.370 | -33.30 | 0.2988 | -24.51 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.2984 | 0.1635 | 6.416 | -33.24 | 0.2993 | -24.45 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 6 | 0.3360 | 0.1767 | 7.000 | -33.01 | 0.2946 | -22.75 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 32

***Table 7.8*** *Analysis of Variance for Dependent Variable: Ln(FLOUNDER) on Ln(INFLOWS): 1990 Omitted*

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 6 | 3.72745 | 0.62124 | 2.109 | 0.0881 |
| Error | 25 | 7.36519 | 0.29461 | | |
| C Total | 31 | 11.09264 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 0.54278 | R-square | 0.3360 |
| Dep Mean | 3.84061 | Adj R-sq | 0.1767 |
| C.V. | 14.13259 | | |

***Table 7.9*** *Parameter Estimates for Dependent Variable: Ln(FLOUNDER) on Ln(INFLOWS): 1990 Omitted*

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 3.801824 | 0.55969052 | 6.793 | 0.0001 | 0.00000000 |
| LN_QJF | 1 | -0.102156 | 0.12203290 | -0.837 | 0.4105 | 2.49740165 |
| LN_QMA | 1 | -0.026627 | 0.11184912 | -0.238 | 0.8138 | 2.12712888 |
| LN_QMJ | 1 | -0.129999 | 0.11107498 | -1.170 | 0.2529 | 1.63908092 |
| LN_QJA | 1 | 0.111930 | 0.09405532 | 1.190 | 0.2452 | 1.23821160 |
| LN_QSO | 1 | -0.089465 | 0.07404216 | -1.208 | 0.2382 | 1.22089788 |
| LN_QND | 1 | 0.307688 | 0.11273617 | 2.729 | 0.0115 | 1.55236727 |

***Table 7.10*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(FLOUNDER) on Ln(INFLOWS): 1990 Omitted*

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop LN_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop LN_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.61795 | 1.00000 | 0.0452 | 0.0430 | 0.0435 | 0.0212 | 0.0148 | 0.0400 |
| 2 | 1.06698 | 1.56640 | 0.0028 | 0.0665 | 0.0132 | 0.1630 | 0.4075 | 0.0436 |
| 3 | 0.90777 | 1.69822 | 0.0119 | 0.0001 | 0.0234 | 0.5312 | 0.2456 | 0.0487 |
| 4 | 0.79746 | 1.81186 | 0.0037 | 0.0293 | 0.3382 | 0.0281 | 0.0297 | 0.3589 |
| 5 | 0.32903 | 2.82075 | 0.0489 | 0.4418 | 0.5802 | 0.0317 | 0.2897 | 0.4081 |
| 6 | 0.28082 | 3.05330 | 0.8874 | 0.4193 | 0.0016 | 0.2247 | 0.0128 | 0.1007 |

***Table** 7.11 Parameter Estimates of Models for Dependent Variable: Ln(FLOUNDER) on Ln(INFLOWS): 1990 Omitted*

| OBS | _RMSE_ | INTERCEP | LN_QJF | LN_QMA | LN_QMJ | LN_QJA | LN_QSO | LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.57066 | 3.19067 | . | . | . | . | . | 0.19174 |
| 2 | 0.58005 | 4.56984 | . | . | -0.15976 | . | . | . |
| 3 | 0.59668 | 4.19226 | . | . | . | . | -0.07922 | . |
| 4 | 0.60549 | 3.66752 | . | . | . | 0.04778 | . | . |
| 5 | 0.53289 | 3.97652 | . | . | -0.20163 | . | . | 0.23142 |
| 6 | 0.55731 | 3.58354 | . | . | . | . | -0.10976 | 0.21957 |
| 7 | 0.55861 | 3.36014 | -0.14227 | . | . | . | . | 0.27989 |
| 8 | 0.56419 | 3.34289 | . | -0.11623 | . | . | . | 0.25367 |
| 9 | 0.53210 | 4.13561 | . | . | -0.17588 | . | -0.07249 | 0.24473 |
| 10 | 0.53644 | 3.79875 | . | . | -0.21300 | 0.06676 | . | 0.22781 |
| 11 | 0.53908 | 3.94381 | -0.05913 | . | -0.17517 | . | . | 0.26285 |
| 12 | 0.54151 | 3.95897 | . | -0.02833 | -0.18761 | . | . | 0.24375 |
| 13 | 0.53380 | 3.94534 | . | . | -0.18657 | 0.07710 | -0.07933 | 0.24182 |
| 14 | 0.53738 | 3.65321 | -0.10413 | . | -0.17201 | 0.09979 | . | 0.28137 |
| 15 | 0.53814 | 4.10395 | -0.06228 | . | -0.14755 | . | -0.07377 | 0.27807 |
| 16 | 0.53857 | 4.12337 | . | -0.05792 | -0.14338 | . | -0.08326 | 0.27193 |
| 17 | 0.53284 | 3.79612 | -0.11419 | . | -0.13976 | 0.11404 | -0.08495 | 0.30155 |
| 18 | 0.53965 | 3.92071 | . | -0.06542 | -0.15047 | 0.08147 | -0.09189 | 0.27237 |
| 19 | 0.54662 | 3.49034 | -0.13360 | -0.07493 | . | 0.11441 | -0.11815 | 0.33438 |
| 20 | 0.54710 | 4.10395 | -0.04598 | -0.03919 | -0.13297 | . | -0.08072 | 0.28775 |
| 21 | 0.54278 | 3.80182 | -0.10216 | -0.02663 | -0.13000 | 0.11193 | -0.08946 | 0.30769 |

***Table** 7.12 Criteria Statistics of Models for Dependent Variable: Ln(FLOUNDER) on Ln(INFLOWS): 1990 Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 0.32566 | 0.11926 | 0.08990 | 5.16176 | -33.9664 | -31.0349 |
| 2 | 0.33646 | 0.09006 | 0.05973 | 6.26137 | -32.9225 | -29.9910 |
| 3 | 0.35603 | 0.03712 | 0.00502 | 8.25467 | -31.1129 | -28.1814 |
| 4 | 0.36662 | 0.00848 | -0.02457 | 9.33278 | -30.1752 | -27.2437 |
| 5 | 0.28397 | 0.25760 | 0.20640 | 1.95287 | -37.4345 | -33.0372 |
| 6 | 0.31059 | 0.18800 | 0.13200 | 4.57359 | -34.5667 | -30.1695 |
| 7 | 0.31204 | 0.18421 | 0.12795 | 4.71627 | -34.4177 | -30.0205 |
| 8 | 0.31831 | 0.16783 | 0.11044 | 5.33316 | -33.7814 | -29.3842 |
| 9 | 0.28313 | 0.28533 | 0.20876 | 2.90885 | -36.6525 | -30.7896 |
| 10 | 0.28777 | 0.27362 | 0.19580 | 3.34971 | -36.1325 | -30.2696 |
| 11 | 0.29061 | 0.26644 | 0.18784 | 3.62017 | -35.8176 | -29.9547 |
| 12 | 0.29323 | 0.25982 | 0.18052 | 3.86943 | -35.5301 | -29.6672 |
| 13 | 0.28494 | 0.30645 | 0.20370 | 4.11377 | -35.6123 | -28.2836 |
| 14 | 0.28878 | 0.29711 | 0.19298 | 4.46547 | -35.1842 | -27.8555 |
| 15 | 0.28959 | 0.29513 | 0.19070 | 4.54008 | -35.0941 | -27.7654 |
| 16 | 0.29006 | 0.29398 | 0.18939 | 4.58316 | -35.0422 | -27.7135 |
| 17 | 0.28392 | 0.33452 | 0.20655 | 5.05667 | -34.9346 | -26.1402 |
| 18 | 0.29122 | 0.31742 | 0.18615 | 5.70077 | -34.1224 | -25.3280 |
| 19 | 0.29880 | 0.29965 | 0.16497 | 6.36978 | -33.3001 | -24.5057 |
| 20 | 0.29932 | 0.29842 | 0.16350 | 6.41620 | -33.2438 | -24.4494 |
| 21 | 0.29461 | 0.33603 | 0.17668 | 7.00000 | -33.0071 | -22.7469 |

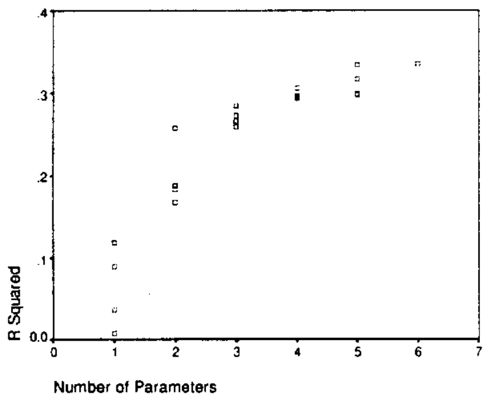


***Figure 7.7*** *The $R^2$ criteria vs. Number of parameters.*

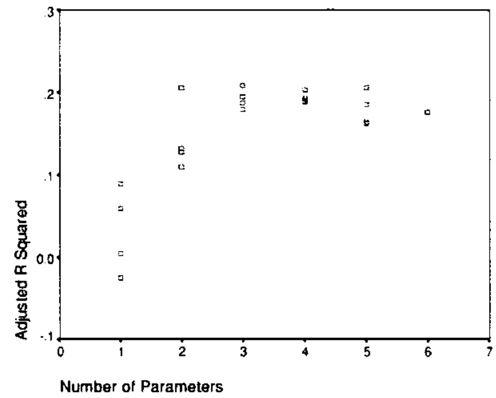


***Figure 7.8*** *The Adjusted $R^2$ criteria vs. Number of parameters.*

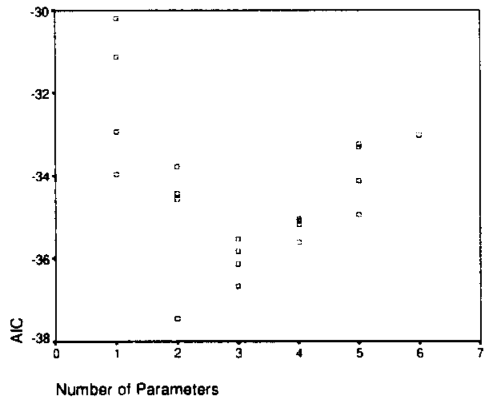


***Figure 7.9*** *The AIC criteria vs. Number of parameters..*

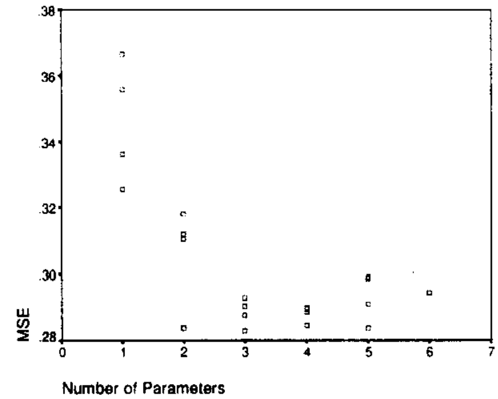


***Figure 7.10*** *MSE vs. Number of parameters.*

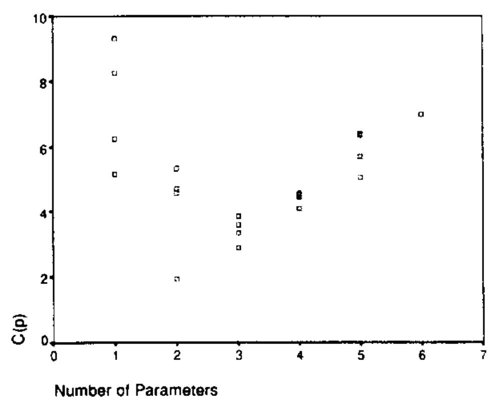


***Figure 7.11*** *The C(p) criteria vs. Number of parameters.*

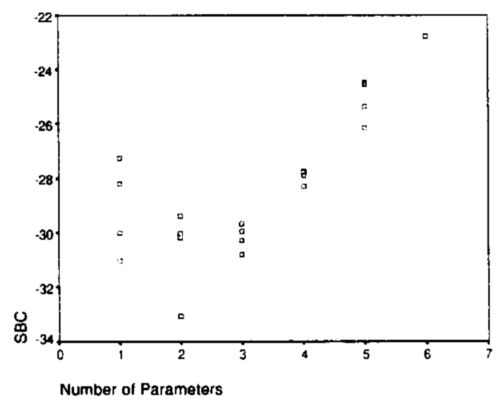


***Figure 7.12*** *The SBC criteria vs. Number of parameters.*

## 7.3 Log of flounder data and square root inflow data: 1990 Omitted

***Table 7.13*** *Regression Models for Dependent Variable: Ln(FLOUNDER) on Sqrt(INFLOWS): 1990 Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.1050 | 0.0752 | 6.031 | -33.45 | 0.3309 | -30.52 | SQR_QND |
| 1 | 0.0917 | 0.0614 | 6.537 | -32.98 | 0.3358 | -30.05 | SQR_QMJ |
| 1 | 0.0833 | 0.0527 | 6.857 | -32.69 | 0.3390 | -29.75 | SQR_QSO |
| 1 | 0.0344 | 0.0022 | 8.715 | -31.02 | 0.3570 | -28.09 | SQR_QJA |
| 2 | 0.2499 | 0.1981 | 2.523 | -37.10 | 0.2869 | -32.71 | SQR_QMJ SQR_QND |
| 2 | 0.1807 | 0.1242 | 5.152 | -34.28 | 0.3134 | -29.88 | SQR_QSO SQR_QND |
| 2 | 0.1534 | 0.0950 | 6.191 | -33.23 | 0.3238 | -28.83 | SQR_QJF SQR_QND |
| 2 | 0.1500 | 0.0914 | 6.319 | -33.10 | 0.3251 | -28.71 | SQR_QMA SQR_QND |
| 3 | 0.2814 | 0.2044 | 3.326 | -36.47 | 0.2847 | -30.61 | SQR_QMJ SQR_QJA SQR_QND |
| 3 | 0.2756 | 0.1980 | 3.544 | -36.22 | 0.2870 | -30.36 | SQR_QMJ SQR_QSO SQR_QND |
| 3 | 0.2559 | 0.1762 | 4.295 | -35.36 | 0.2948 | -29.50 | SQR_QJF SQR_QMJ SQR_QND |
| 3 | 0.2536 | 0.1737 | 4.380 | -35.26 | 0.2957 | -29.40 | SQR_QMA SQR_QMJ SQR_QND |
| 4 | 0.3139 | 0.2123 | 4.087 | -35.96 | 0.2819 | -28.63 | SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 4 | 0.3047 | 0.2017 | 4.439 | -35.53 | 0.2857 | -28.20 | SQR_QJF SQR_QMJ SQR_QJA SQR_QND |
| 4 | 0.2973 | 0.1932 | 4.721 | -35.19 | 0.2887 | -27.86 | SQR_QJF SQR_QJA SQR_QSO SQR_QND |
| 4 | 0.2887 | 0.1833 | 5.047 | -34.80 | 0.2922 | -27.47 | SQR_QMA SQR_QMJ SQR_QSO SQR_QND |
| 5 | 0.3422 | 0.2157 | 5.012 | -35.31 | 0.2806 | -26.51 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.3235 | 0.1934 | 5.722 | -34.41 | 0.2886 | -25.62 | SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.3061 | 0.1727 | 6.384 | -33.60 | 0.2960 | -24.80 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QND |
| 5 | 0.3047 | 0.1710 | 6.437 | -33.53 | 0.2966 | -24.74 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 6 | 0.3425 | 0.1847 | 7.000 | -33.32 | 0.2917 | -23.06 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

N = 32

***Table 7.14*** *Analysis of Variance for Dependent Variable: Ln(FLOUNDER) on Sqrt(INFLOWS): 1990 Omitted*

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 6 | 3.79951 | 0.63325 | 2.171 | 0.0803 |
| Error | 25 | 7.29313 | 0.29173 | | |
| C Total | 31 | 11.09264 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 0.54012 | R-square | 0.3425 |
| Dep Mean | 3.84061 | Adj R-sq | 0.1847 |
| C.V. | 14.06328 | | |

***Table 7.15*** *Parameter Estimates for Dependent Variable: Ln(FLOUNDER) on Sqrt(INFLOWS): 1990 Omitted*

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 3.767977 | 0.32722207 | 11.515 | 0.0001 | 0.00000000 |
| SQR_QJF | 1 | -0.039384 | 0.04633613 | -0.850 | 0.4034 | 2.84239296 |
| SQR_QMA | 1 | -0.004405 | 0.03958498 | -0.111 | 0.9123 | 2.24032535 |
| SQR_QMJ | 1 | -0.025581 | 0.02134010 | -1.199 | 0.2419 | 1.57258708 |
| SQR_QJA | 1 | 0.036560 | 0.02592478 | 1.410 | 0.1708 | 1.28446266 |
| SQR_QSO | 1 | -0.017056 | 0.01449966 | -1.176 | 0.2506 | 1.24237256 |
| SQR_QND | 1 | 0.090192 | 0.03737842 | 2.413 | 0.0235 | 1.65740458 |

***Table 7.16*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(FLOUNDER) on Sqrt(INFLOWS): 1990 Omitted*

| Number | Eigenvalue | Condition Index | Var Prop SQR_QJF | Var Prop SQR_QMA | Var Prop SQR_QMJ | Var Prop SQR_QJA | Var Prop SQR_QSO | Var Prop SQR_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.46686 | 1.00000 | 0.0464 | 0.0480 | 0.0437 | 0.0064 | 0.0011 | 0.0528 |
| 2 | 1.25082 | 1.40435 | 0.0000 | 0.0259 | 0.0604 | 0.0984 | 0.3848 | 0.0253 |
| 3 | 1.04287 | 1.53801 | 0.0142 | 0.0166 | 0.1087 | 0.4903 | 0.0529 | 0.0089 |
| 4 | 0.64665 | 1.95317 | 0.0003 | 0.0529 | 0.1846 | 0.0834 | 0.2366 | 0.4439 |
| 5 | 0.36499 | 2.59975 | 0.0607 | 0.3558 | 0.6024 | 0.0078 | 0.2827 | 0.2786 |
| 6 | 0.22781 | 3.29066 | 0.8784 | 0.5008 | 0.0003 | 0.3136 | 0.0419 | 0.1905 |

***Table 7.17*** *Parameter Estimates of Models for Dependent Variable: Ln(FLOUNDER) on Sqrt(INFLOWS): 1990 Omitted*

| OBS | _RMSE_ | INTERCEP | SQR_QJF | SQR_QMA | SQR_QMJ | SQR_QJA | SQR_QSO | SQR_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.57526 | 3.47759 | . | . | . | . | . | 0.058018 |
| 2 | 0.57952 | 4.19867 | . | . | -0.031777 | . | . | . |
| 3 | 0.58220 | 4.10869 | . | . | . | . | -0.023152 | . |
| 4 | 0.59752 | 3.65264 | . | . | . | 0.026169 | . | . |
| 5 | 0.53566 | 3.84522 | . | . | -0.040876 | . | . | 0.072874 |
| 6 | 0.55980 | 3.74644 | . | . | . | . | -0.022091 | 0.055930 |
| 7 | 0.56906 | 3.57943 | -0.046858 | . | . | . | . | 0.088009 |
| 8 | 0.57019 | 3.57609 | . | -0.039184 | . | . | . | 0.078194 |
| 9 | 0.53357 | 3.68334 | . | . | -0.041494 | 0.025096 | . | 0.071049 |
| 10 | 0.53570 | 3.95786 | . | . | -0.034972 | . | -0.013618 | 0.069442 |
| 11 | 0.54295 | 3.85246 | -0.017947 | . | -0.037344 | . | . | 0.083078 |
| 12 | 0.54377 | 3.84975 | . | -0.012415 | -0.037910 | . | . | 0.078189 |
| 13 | 0.53090 | 3.79305 | . | . | -0.034882 | 0.027848 | -0.015409 | 0.066965 |
| 14 | 0.53448 | 3.64419 | -0.037933 | . | -0.034238 | 0.033540 | . | 0.092001 |
| 15 | 0.53732 | 3.60681 | -0.063454 | . | . | 0.042405 | -0.022533 | 0.093038 |
| 16 | 0.54059 | 3.99181 | . | -0.024264 | -0.027861 | . | -0.016651 | 0.079065 |
| 17 | 0.52976 | 3.75822 | -0.041903 | . | -0.026358 | 0.037388 | -0.016593 | 0.089796 |
| 18 | 0.53722 | 3.82933 | . | -0.020847 | -0.028777 | 0.026647 | -0.017937 | 0.075339 |
| 19 | 0.54409 | 3.63081 | -0.043282 | 0.008957 | -0.035372 | 0.035441 | . | 0.091069 |
| 20 | 0.54464 | 3.67121 | -0.049169 | -0.019941 | . | 0.037989 | -0.023835 | 0.094401 |
| 21 | 0.54012 | 3.76798 | -0.039384 | -0.004405 | -0.025581 | 0.036560 | -0.017056 | 0.090192 |

***Table 7.18*** *Criteria Statistics of Models for Dependent Variable: Ln(FLOUNDER) on Sqrt(INFLOWS): 1990 Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 0.33092 | 0.10501 | 0.07518 | 6.03117 | -33.4529 | -30.5214 |
| 2 | 0.33585 | 0.09170 | 0.06142 | 6.53741 | -32.9804 | -30.0489 |
| 3 | 0.33895 | 0.08330 | 0.05275 | 6.85672 | -32.6859 | -29.7544 |
| 4 | 0.35703 | 0.03442 | 0.00223 | 8.71549 | -31.0234 | -28.0919 |
| 5 | 0.28693 | 0.24987 | 0.19813 | 2.52335 | -37.1026 | -32.7054 |
| 6 | 0.31338 | 0.18072 | 0.12422 | 5.15249 | -34.2811 | -29.8839 |
| 7 | 0.32383 | 0.15340 | 0.09501 | 6.19144 | -33.2313 | -28.8341 |
| 8 | 0.32511 | 0.15005 | 0.09143 | 6.31892 | -33.1048 | -28.7076 |
| 9 | 0.28470 | 0.28136 | 0.20436 | 3.32592 | -36.4750 | -30.6120 |
| 10 | 0.28698 | 0.27561 | 0.19800 | 3.54427 | -36.2203 | -30.3574 |
| 11 | 0.29479 | 0.25588 | 0.17615 | 4.29457 | -35.3603 | -29.4974 |
| 12 | 0.29569 | 0.25362 | 0.17365 | 4.38045 | -35.2633 | -29.4004 |
| 13 | 0.28186 | 0.31394 | 0.21231 | 4.08677 | -35.9600 | -28.6313 |
| 14 | 0.28567 | 0.30467 | 0.20166 | 4.43947 | -35.5303 | -28.2016 |
| 15 | 0.28871 | 0.29726 | 0.19315 | 4.72119 | -35.1911 | -27.8624 |
| 16 | 0.29223 | 0.28869 | 0.18331 | 5.04698 | -34.8033 | -27.4746 |
| 17 | 0.28064 | 0.34220 | 0.21570 | 5.01238 | -35.3059 | -26.5114 |
| 18 | 0.28861 | 0.32353 | 0.19344 | 5.72242 | -34.4101 | -25.6157 |
| 19 | 0.29603 | 0.30614 | 0.17270 | 6.38368 | -33.5979 | -24.8035 |
| 20 | 0.29663 | 0.30474 | 0.17103 | 6.43695 | -33.5333 | -24.7389 |
| 21 | 0.29173 | 0.34253 | 0.18473 | 7.00000 | -33.3217 | -23.0616 |

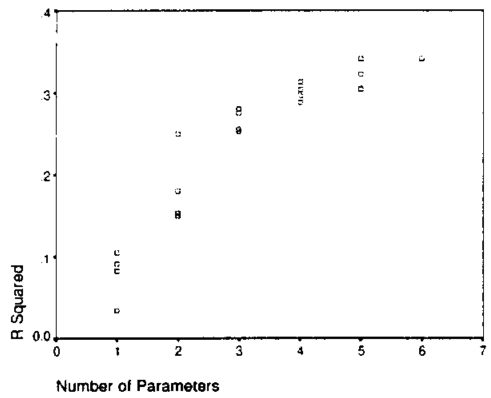


***Figure 7.13*** *The $R^2$ criteria vs. Number of parameters.*

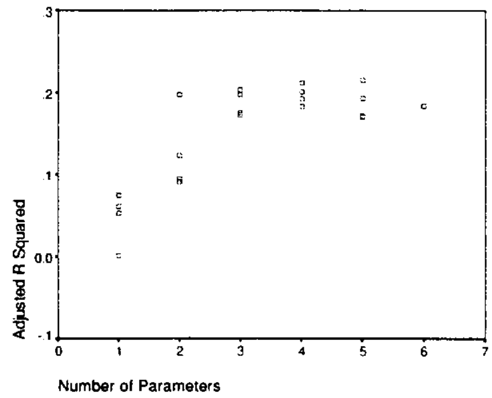


***Figure 7.14*** *The Adjusted $R^2$ criteria vs. Number of parameters.*

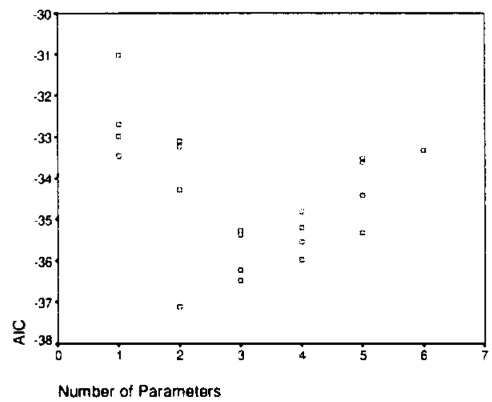


***Figure 7.15*** *The AIC criteria vs. Number of parameters..*

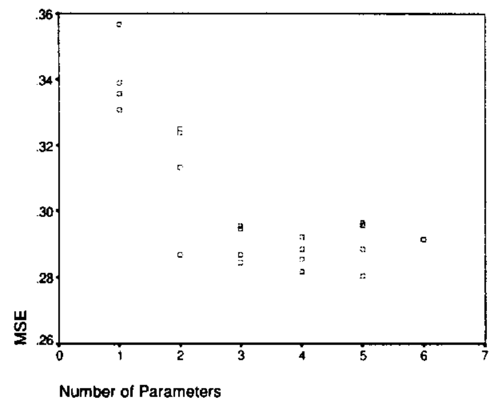


***Figure 7.16*** *MSE vs. Number of parameters.*

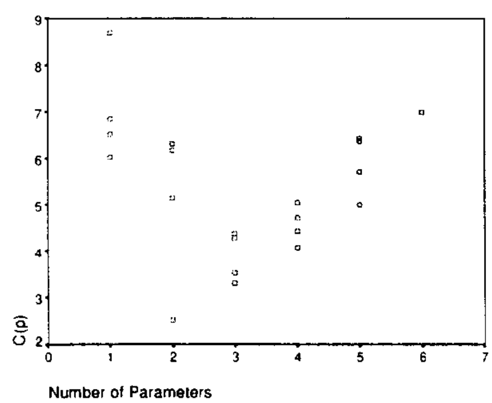


***Figure 7.17*** *The C(p) criteria vs. Number of parameters.*

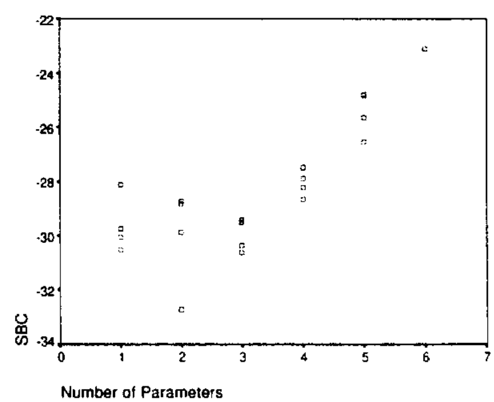


***Figure 7.18*** *The SBC criteria vs. Number of parameters.*

# Trout Harvests in Corpus Christi Bay: A Regression Analysis

## Harvest vs Freshwater Inflows

F. Michael Speed
Michael Longnecker
Birgir Hrafnkelsson

*Department of Statistics*
*Texas A&M University*

# TROUT HARVESTS IN CORPUS CHRISTI BAY:

# A Regression Analysis

## Harvest vs. Freshwater Inflows

F. Michael Speed
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*Department of Statistics*
*Texas A&M University*
March 1997

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# 1. SUMMARY REPORT

## 1.1 Description of the Problem[1]

Bimonthly freshwater inflows into Corpus Christi Bay were recorded for the years 1961 to 1980. These variables, and various transformations of them, were used to construct a model for the annual harvest of trout.

## 1.2 Constructing Models - General Discussion

Stability of coefficient estimates and accuracy of predicted values are primary goals in constructing models for prediction. To this end, the data must be examined from three points of view: individual observations (to detect outliers or influential points); variables, individually and in groups (to select an optimal set of predictors); and the interaction of these two, which produces the overall structure of the data set (to determine whether multicollinearity is present or not). The first two of these were examined by both graphic and quantitative means; the third by quantitative means only.

### 1.2.1 Detecting Influential Points and Outliers

The structures of individual variables were examined via box plots and histograms, as well as by all the usual numerical measures. For each pair of variables, 99 % prediction ellipses and 95% confidence regions were plotted in a further effort to look for unusual points. For example, suppose large values of Variable A are generally associated with large values for Variable B. If an observation consisted of a large value for Variable A but a small value for Variable B, that point would be considered unusual, even though it was well within the range of data for both variables and could not be considered an outlier.

In addition, a number of residual analysis techniques were employed. A large residual indicates a point not well-fit by the model. The deleted residual, however, is somewhat more useful in the search for influential points. The model is fitted without a given observation, and the predicted response and corresponding residual are calculated for that observation. The Studentized deleted residual is scaled to have a Student's $t$ distribution. Histograms and normal P-P plots of the residuals were also examined.

Other quantities, such as the Mahalanobis distance, Cook's distance, the leverage value, standarized values for the *Dffits* (to measure the influence of a given observation on the predicted response) and the *Dfbetas* (to measure the influence of a given observation on the calculated coefficients) were also used to build a general picture of the influence of individual points. Plots were made of the standardized *Dffits* value for each model against the standardized *Dfbeta* values for each predictor in the model. Points which were extreme indicated observations which had strong effects on both predicted values and coefficient estimates.

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1 The following discussion, prepared by Jacqueline Kiffe, was taken from Seatrout Harvest in Galveston Bay: A Regression Analysis, by F. Michael Speed, Sr. and Jacqueline Kiffe.

### 1.2.2 Variable Selection

For each regression, residuals were plotted against each of the independent variables to look for nonlinear relationships between the response variable and individual predictors. Partial residual plots were employed to examine the overall relationship between the response and individual predictors. A partial residual is a corollary to the deleted residual. That is, the model is fitted without a given variable and the predicted response and corresponding residual are calculated for each observation. This seeks to answer the question, "What is the relationship of this predictor to the response variable, taking all other variables into account?" Thus, it examines the marginal relationship of a given predictor to the response.

Numerous measures have been developed over the years to assess the adequacy of a given model. We examined a number of these, including $R^2$ and mean squared error (*MSE*), and several others which directly incorporate penalties for having too many predictors in the model, such as adjusted $R^2$, *Cp*, *AIC*, and *SBC*. It is well-established that too many predictors in a model can lead to bad prediction, just as too few can, and these measures are used as part of the attempt to find an optimal model.

### 1.2.3 Multicollinearity

Multicollinearity arises when one or more variables are nearly closely approximated by linear combinations of the remaining variables, resulting in unstable coefficient estimates. The variance inflation factor (*VIF*) was calculated for each coefficient estimate to measure this instability, which is not usually considered profound for *VIF*'s less than 10. No problems were found with this data. Additionally, the condition index (a ratio of eigenvalues of the covariance matrix, with the largest eigenvalue always on top) was calculated. A ratio greater than 30 is considered cause for concern. Again, no evidence of multicollinearity was found.

### 1.2.4 Other Procedures

Several other miscellaneous diagnostics, including the Durbin-Watson test for serial autocorrelation were performed, and no general problems were detected. The Box-Cox procedure, used to find a transformation to normality, was also performed.

## 1.3 How the Final Model Was Chosen

### 1.3.1 Selecting the Data Set Used

First, the variables were explored thoroughly, individually and in pairs, in a first effort to detect outliers. The SAS® programming language allows a number of diagnostics to be calculated for a group of models on a given data set without actually performing a formal regression, thus allowing one to examine a large number of models quite efficiently. The Box-Cox procedure was performed to find if a transformation to normality was suggested. The log transform was suggested for some variables, and the squared root for others. At this point, there were several data sets for which the diagnostic series was calculated:

1. Untransformed trout data and untransformed inflow data
2. Log of trout data and untransformed inflow data
3. Log of trout data and log of inflow data
4. Log of trout data and square root inflow data
5. Square root of trout data and untransformed inflow data
6. Square root of trout data and log of inflow data
7. Square root of trout data and square root inflow data
8. Various transformation suggested by Box-Cox

### 1.3.2 Selecting the Points to be Omitted

The full regression with all diagnostics was performed for these models, each one contained all variables in its corresponding data set. All diagnostics were generated, and influential points were determined for each model.

***Table 1.1*** *$R^2$ and Adjusted $R^2$ for full data sets.*

| Data Set | $R^2$ | Adj. $R^2$ |
|---|---|---|
| 1 | 0.8255 | 0.7449 |
| 2 | 0.8776 | 0.8211 |
| 3 | 0.9060 | 0.8626 |
| 4 | 0.9103 | 0.8688 |
| 5 | 0.8969 | 0.8493 |
| 6 | 0.8525 | 0.7844 |
| 7 | 0.8866 | 0.8342 |
| 8 | 0.8709 | 0.8113 |

Data sets 3, 4 and 5 presented the highest $R^2$ values. These three models were considered final candidates. The observations flagged as potentially influential are given in the summary table below, for each model.

***Table 1.2*** *Summary of points flagged by Boxplots.*

| Year | Variable |
|---|---|
| 1964 | Ln(March-April), Ln(May-June), Sqrt(May-June) |
| 1970 | January-February inflows. |
| 1971 | July-August inflows. |
| 1972 | July-August inflows. |
| 1973 | Harvest, July-August inflows. |
| 1977 | March-April inflows. Ln(March-April), Sqrt(March-April) |
| 1978 | March-April inflows. Ln(March-April), Sqrt(March-April) |
| 1979 | March-April inflows. Ln(March-April), Sqrt(March-April) |

***Table 1.3*** *Summary of points flagged by 99% prediction ellipses.*

| Year | Variable |
|---|---|
| None | None |

***Table 1.4*** *Outliers of data set 3.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1964 | 2 | | | 1 | 1 | | 1 | 2 | 7 |
| 1968 | | | | | | | 1 | | 1 |
| 1969 | | | | 1 | | | 1 | 2 | 4 |
| 1971 | | | | | | | 1 | 3 | 4 |
| 1977 | 1 | | | | | | | | 1 |
| 1978 | 1 | | | | | | | | 1 |
| 1979 | 1 | | | | | | | | 1 |
| 1980 | | | | 1 | | | 1 | 2 | 4 |

***Table 1.5*** *Outliers of data set 4.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1964 | 1 | | | 1 | | | 1 | 1 | 4 |
| 1968 | | | 1 | | | | 1 | | 2 |
| 1969 | | | | | | | 1 | 4 | 5 |
| 1971 | | | | | | | 1 | 2 | 3 |
| 1977 | 1 | | | | | | | | 1 |
| 1978 | 1 | | | | | | | | 1 |
| 1979 | 1 | | | | | | | | 1 |
| 1980 | | | | | | | 1 | | 1 |

***Table 1.6*** *Outliers of data set 5.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1968 | | | | | | | 1 | | 1 |
| 1970 | | | | | | | | | 1 |
| 1971 | 1 | | | | | | | | 1 |
| 1972 | 1 | | | | | | 1 | | 2 |
| 1973 | 1 | | | | | | 1 | | 2 |
| 1977 | 1 | | | | | | | | 1 |
| 1978 | 1 | | | | | | | | 1 |
| 1979 | 1 | | | | | | | | 1 |

***A Key to Abbreviations:***

BOX Box plot
SRE Studentized residual
SDR Studentized deleted residual
LEV Leverage value
MAH Mahalanobis distance
COO Cook's distance
SDF Standardized Dffits value
SDB Standardized Dfbeta value

### 1.3.3 Selecting the Final Candidate Models

After the subset analysis led us to three models, Data Set 3 with 1964 omitted; Data Set 4 with 1969 omitted and Data Set 5, no observation omitted.

***Table 1.7*** *$R^2$ and Adjusted $R^2$ for data sets number 3, 4 and 5.*

| Data set | Observations omitted | $R^2$ | Adj. $R^2$ |
|---|---|---|---|
| 3 | 1964 | 0.8912 | 0.8493 |
| 4 | 1969 | 0.9299 | 0.9030 |
| 5 | None | 0.8968 | 0.8600 |

### 1.3.4 Selecting the Final Models

It appears that Data set 4 with 1969 omitted is the best model. Regression was performed using this model, and the deleted residuals were calculated.

Ln(Trout Harvest) = 0.3433 - 0.3792*Sqrt(Jan-Feb Inflows)
+ 0.2969*Sqrt(May-Jun Inflows)
+ 0.0590*Sqrt(Jul-Aug Inflows)
+ 0.0440*Sqrt(Sep-Oct Inflows)
+ 0.1415*Sqrt(Nov-Dec Inflows)

## 1.4 Best Model: Logged Harvest and Square Root of Inflow

### 1.4.1 Summary Information

***Table 1.8*** *Descriptive statistics for dependent and independent variables.*

**Descriptive Statistics**

| | N | Mean | Std. Deviation |
|---|---|---|---|
| Ln(Trout Harvest) | 19 | 3.5881 | 1.4260 |
| Sqrt( January-February Inflows) | 19 | 5.5803 | 1.9158 |
| Sqrt(May-June Inflows) | 19 | 10.7525 | 3.3351 |
| Sqrt(July-August Inflows) | 19 | 8.9310 | 4.9583 |
| Sqrt(Sepember-October Inflows) | 19 | 14.7551 | 7.8252 |
| Sqrt(November-December Inflows) | 19 | 7.0231 | 3.2760 |

***Table 1.9*** *Model summary for the final model.*

**Model Summary[a,b]**

| | Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|
| | Sqrt( January-February Inflows) Sqrt(May-June Inflows) Sqrt(July-August Inflows) Sqrt(Sepember-October Inflows) Sqrt(November-December Inflows)[c,d] | .964 | .930 | .903 | .4442 | 2.039 |

a. Dependent Variable: Ln(Trout Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of May-June Inflows, Square Root of July-August Inflows, Square Root of Sepember-October Inflows, Square Root of January-February Inflows

d. All requested variables entered.

***Table 1.10*** *Anova for the final model.*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 34.040 | 5 | 6.808 | 34.502 | .000[b] |
| | Residual | 2.565 | 13 | .197 | | |
| | Total | 36.605 | 18 | | | |

a. Dependent Variable: Ln(Trout Harvest)

b. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of May-June Inflows, Square Root of July-August Inflows, Square Root of Sepember-October Inflows, Square Root of January-February Inflows

***Table 1.11*** *Parameter estimates for the final model.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| (Constant) | .343 | .528 | | .650 | .527 | -.798 | 1.485 |
| Sqrt(January-February Inflows) | -.379 | .084 | -.509 | -4.510 | .001 | -.561 | -.198 |
| Sqrt(May-June Inflows) | .297 | .038 | .694 | 7.781 | .000 | .214 | .379 |
| Sqrt(July-August Inflows) | 5.9E-02 | .030 | .205 | 1.994 | .068 | -.005 | .123 |
| Sqrt(Sepember-October Inflows) | 4.4E-02 | .019 | .241 | 2.320 | .037 | .003 | .085 |
| Sqrt(November-December Inflows) | .141 | .039 | .325 | 3.651 | .003 | .058 | .225 |

a. Dependent Variable: Ln(Trout Harvest)

***Table 1.12*** *Residuals statistics for the final model.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | .9358 | 5.5647 | 3.5881 | 1.3752 | 19 |
| Std. Predicted Value | -1.929 | 1.437 | .000 | 1.000 | 19 |
| Standard Error of Predicted Value | .1527 | .3446 | .2449 | 4.97E-02 | 19 |
| Adjusted Predicted Value | .9061 | 5.7733 | 3.5875 | 1.3771 | 19 |
| Residual | -.5983 | .7378 | 3.7E-16 | .3775 | 19 |
| Std. Residual | -1.347 | 1.661 | .000 | .850 | 19 |
| Stud. Residual | -1.551 | 2.087 | .000 | 1.031 | 19 |
| Deleted Residual | -.7928 | 1.1644 | 5.9E-04 | .5598 | 19 |
| Stud. Deleted Residual | -1.650 | 2.458 | .016 | 1.103 | 19 |
| Mahal. Distance | 1.180 | 9.882 | 4.737 | 2.270 | 19 |
| Cook's Distance | .000 | .419 | .083 | .110 | 19 |
| Centered Leverage Value | .066 | .549 | .263 | .126 | 19 |

a. Dependent Variable: Ln(Trout Harvest)

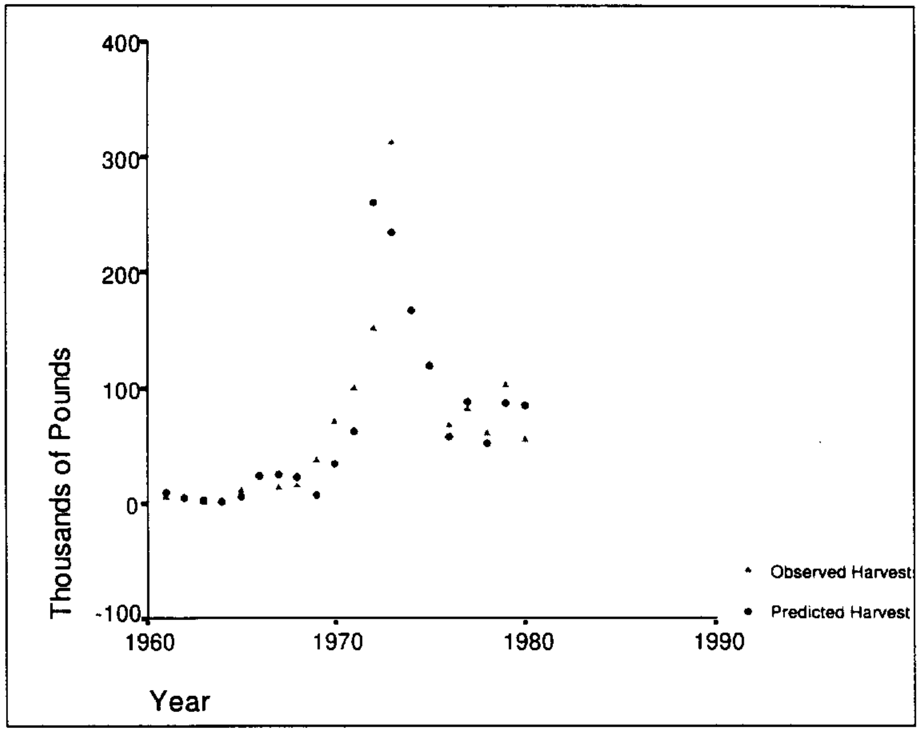


***Figure 1.1*** *Predicted and observed values for the harvest.*

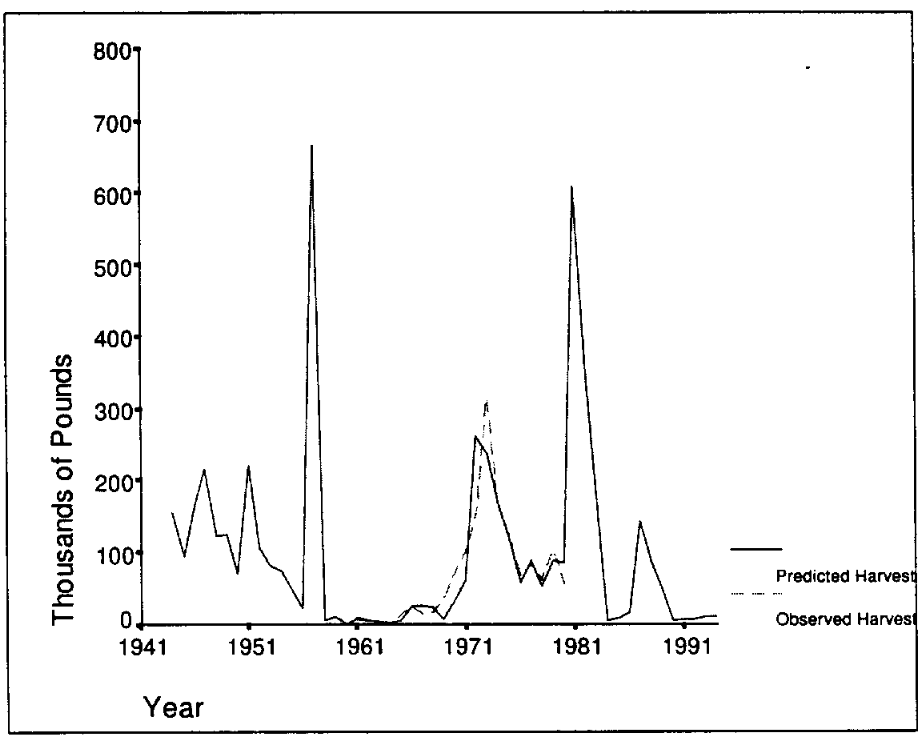


***Figure 1.2*** *Predicted and observed values for the harvest.*

***Table 1.13*** *Prediction Intervals for Trout Harvest based on the final model.*

| YEAR | *TROUT* | *PRE_1* | *LICI_1* | *UICI_1* |
|---|---|---|---|---|
| 1961 | 7.00 | 10.24 | 2.19 | 47.81 |
| 1962 | 6.40 | 6.01 | 1.36 | 26.59 |
| 1963 | 2.80 | 4.00 | .89 | 17.93 |
| 1964 | 2.60 | 2.55 | .47 | 13.86 |
| 1965 | 13.20 | 7.01 | 1.63 | 30.20 |
| 1966 | 25.40 | 25.32 | 5.66 | 113.17 |
| 1967 | 14.50 | 26.38 | 5.93 | 117.41 |
| 1968 | 16.70 | 24.24 | 4.79 | 122.76 |
| 1969 | 38.70 | 8.39 | 1.58 | 44.42 |
| 1970 | 72.60 | 34.71 | 7.26 | 165.88 |
| 1971 | 101.50 | 62.67 | 12.73 | 308.63 |
| 1972 | 153.30 | 261.06 | 57.40 | 1187.40 |
| 1973 | 314.10 | 235.91 | 50.31 | 1106.35 |
| 1974 | 167.60 | 168.40 | 32.48 | 873.01 |
| 1975 | 121.90 | 120.59 | 28.77 | 505.54 |
| 1976 | 68.70 | 58.48 | 14.21 | 240.71 |
| 1977 | 83.40 | 88.38 | 19.85 | 393.53 |
| 1978 | 62.40 | 53.56 | 12.19 | 235.23 |
| 1979 | 103.70 | 88.00 | 17.90 | 432.67 |
| 1980 | 56.90 | 85.80 | 18.05 | 407.74 |

*TROUT* Observed trout harvest
*PRE_!* Predicted trout harvest
*LICI_*1 Lower limit for 99% prediction interval for the trout harvest.
*UICI_*1 Upper limit for 99% prediction interval for the trout harvest.

# 2. EXPLORING THE DATA

## 2.1 Listing of data

***Table 2.1*** *The trout data and the inflow data.*

| Year | *Trout* | *JF_inflow* | *MA_inflow* | *MJ_inflow* | *JA_inflow* | *SO_inflow* | *ND_inflow* |
|---|---|---|---|---|---|---|---|
| 1961 | 7.00 | 58.45 | 13.11 | 42.66 | 68.59 | 274.80 | 148.90 |
| 1962 | 6.40 | 49.25 | 12.81 | 38.52 | 52.35 | 178.60 | 78.65 |
| 1963 | 2.80 | 48.48 | 13.28 | 33.71 | 32.81 | 88.84 | 72.87 |
| 1964 | 2.60 | 5.49 | 6.64 | 7.72 | 10.11 | 9.91 | 5.45 |
| 1965 | 13.20 | 26.72 | 15.50 | 74.65 | 10.70 | 68.57 | 9.75 |
| 1966 | 25.40 | 27.01 | 20.93 | 166.41 | 12.65 | 68.66 | 10.36 |
| 1967 | 14.50 | 28.09 | 22.47 | 168.79 | 14.00 | 69.73 | 12.21 |
| 1968 | 16.70 | 89.91 | 21.03 | 219.30 | 27.86 | 670.67 | 17.64 |
| 1969 | 38.70 | 91.93 | 18.46 | 128.91 | 26.74 | 675.78 | 18.02 |
| 1970 | 72.60 | 95.26 | 25.37 | 211.69 | 38.31 | 693.83 | 56.42 |
| 1971 | 101.50 | 12.76 | 18.29 | 94.70 | 307.47 | 34.80 | 46.74 |
| 1972 | 153.30 | 21.69 | 17.45 | 147.81 | 310.47 | 612.72 | 78.25 |
| 1973 | 314.10 | 19.03 | 9.52 | 155.96 | 338.40 | 605.99 | 40.51 |
| 1974 | 167.60 | 23.79 | 19.07 | 158.31 | 73.99 | 816.37 | 64.29 |
| 1975 | 121.90 | 19.24 | 17.38 | 175.19 | 92.49 | 289.82 | 37.63 |
| 1976 | 68.70 | 17.23 | 16.72 | 105.85 | 126.23 | 285.93 | 35.21 |
| 1977 | 83.40 | 37.15 | 104.82 | 149.46 | 105.12 | 158.61 | 138.05 |
| 1978 | 62.40 | 30.44 | 104.63 | 105.60 | 101.84 | 103.47 | 133.86 |
| 1979 | 103.70 | 34.14 | 123.11 | 169.20 | 31.74 | 134.64 | 135.35 |
| 1980 | 56.90 | 13.59 | 24.89 | 171.41 | 202.89 | 72.81 | 8.20 |

| | |
|---|---|
| Trout | Trout harvest (thousands of pounds) |
| JF_inflow | Lagged January-February inflows (thousands of acre-feet) |
| MA_inflow | Lagged March-April inflows (thousands of acre-feet) |
| MJ_inflow | Lagged May-June inflows (thousands of acre-feet) |
| JA_inflow | Lagged July-August inflows (thousands of acre-feet) |
| SO_inflow | Lagged September-October inflows (thousands of acre-feet) |
| ND_inflow | Lagged November-December inflows (thousands of acre-feet) |

## 2.2 Examination of Individual Variables

***Table .2.2*** *Test of Normality for the trout data and the inflow data.*

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Trout Harvest | .182 | 20 | .080 | .818 | 20 | .010** |
| Ln(Trout Harvest) | .177 | 20 | .101 | .938 | 20 | .289 |
| Square Root of Trout Harvest | .125 | 20 | .200* | .950 | 20 | .403 |
| January-February Inflows | .205 | 20 | .027 | .834 | 20 | .010** |
| Ln(January-February Inflows) | .088 | 20 | .200* | .965 | 20 | .626 |
| Square Root of January-February Inflows | .151 | 20 | .200* | .925 | 20 | .156 |
| March-April Inflows | .417 | 20 | .000 | .579 | 20 | .010** |
| Ln(March-April Inflows) | .272 | 20 | .000 | .815 | 20 | .010** |
| Square Root of March-April Inflows | .355 | 20 | .000 | .681 | 20 | .010** |
| May-June Inflows | .188 | 20 | .062 | .931 | 20 | .213 |
| Ln(May-June Inflows) | .223 | 20 | .010 | .774 | 20 | .010** |
| Square Root of May-June Inflows | .214 | 20 | .017 | .885 | 20 | .021 |
| July-August Inflows | .228 | 20 | .008 | .772 | 20 | .010** |
| Ln(July-August Inflows) | .093 | 20 | .200* | .947 | 20 | .376 |
| Square Root of July-August Inflows | .149 | 20 | .200* | .886 | 20 | .023 |
| SeptemberOctober Inflows | .217 | 20 | .015 | .825 | 20 | .010** |
| Ln(September-October Inflows) | .154 | 20 | .200* | .929 | 20 | .191 |
| Square Root of Sepember-October Inflows | .177 | 20 | .101 | .901 | 20 | .044 |
| November-December Inflows | .144 | 20 | .200* | .866 | 20 | .010** |
| Ln(November-Desember Inflows) | .128 | 20 | .200* | .929 | 20 | .197 |
| Square Root of November-December Inflows | .142 | 20 | .200* | .924 | 20 | .144 |

**. This is an upper bound of the true significance.

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

***Table .2.3*** *Percentiles of the trout data and the inflow data.*

**Percentiles**

| | | Percentiles | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 10 | 25 | 50 | 75 | 90 | 95 |
| Weighted Average(Definition 1) | Trout Harvest | 2.6100 | 3.1600 | 13.5250 | 59.6500 | 103.150 | 166.170 | 306.775 |
| | Ln(Trout Harvest) | .9592 | 1.1123 | 2.6037 | 4.0874 | 4.6361 | 5.1127 | 5.7183 |
| | Square Root of Trout Harvest | 1.6155 | 1.7590 | 3.6769 | 7.7213 | 10.1562 | 12.8896 | 17.4840 |
| | January-February Inflows | 5.8535 | 12.8430 | 19.0825 | 27.5500 | 49.0575 | 91.7280 | 95.0935 |
| | Ln(January-February Inflows) | 1.7451 | 2.5526 | 2.9488 | 3.3158 | 3.8930 | 4.5188 | 4.5548 |
| | Square Root of January-February Inflows | 2.4045 | 3.5835 | 4.3683 | 5.2486 | 7.0041 | 9.5774 | 9.7515 |
| | March-April Inflows | 6.7840 | 9.8490 | 13.8350 | 18.3750 | 24.2850 | 104.801 | 122.195 |
| | Ln(March-April Inflows) | 1.9111 | 2.2831 | 2.6249 | 2.9110 | 3.1889 | 4.6521 | 4.8050 |
| | Square Root of March-April Inflows | 2.6023 | 3.1348 | 3.7174 | 4.2866 | 4.9268 | 10.2372 | 11.0526 |
| | May-June Inflows | 9.0195 | 34.1910 | 79.6625 | 148.635 | 169.098 | 208.040 | 218.920 |
| | Ln(May-June Inflows) | 2.1175 | 3.5311 | 4.3723 | 5.0015 | 5.1305 | 5.3362 | 5.3887 |
| | Square Root of May-June Inflows | 2.9299 | 5.8461 | 8.9129 | 12.1915 | 13.0037 | 14.4182 | 14.7958 |
| | July-August Inflows | 10.1395 | 10.8950 | 27.0200 | 60.4700 | 120.953 | 310.170 | 337.004 |
| | Ln(July-August Inflows) | 2.3164 | 2.3870 | 3.2964 | 4.0930 | 4.7924 | 5.7371 | 5.8199 |
| | Square Root of July-August Inflows | 3.1842 | 3.2996 | 5.1979 | 7.7586 | 10.9896 | 17.6116 | 18.3569 |
| | SeptemberOctober Inflows | 11.1545 | 38.1770 | 70.5000 | 168.605 | 611.038 | 692.025 | 810.243 |
| | Ln(September-October Inflows) | 2.3563 | 3.6174 | 4.2554 | 5.1258 | 6.4151 | 6.5396 | 6.6967 |
| | Square Root of Sepember-October Inflows | 3.2856 | 6.1373 | 8.3961 | 12.9791 | 24.7191 | 26.3062 | 28.4606 |
| | November-December Inflows | 5.5875 | 8.3550 | 13.5675 | 43.6250 | 78.5500 | 137.780 | 148.358 |
| | Ln(November-Desember Inflows) | 1.7160 | 2.1214 | 2.5942 | 3.7731 | 4.3637 | 4.9256 | 4.9995 |
| | Square Root of November-December Inflows | 2.3610 | 2.8895 | 3.6707 | 6.6007 | 8.8628 | 11.7379 | 12.1798 |
| Tukey's Hinges | Trout Harvest | | | 13.8500 | 59.6500 | 102.600 | | |
| | Ln(Trout Harvest) | | | 2.6272 | 4.0874 | 4.6308 | | |
| | Square Root of Trout Harvest | | | 3.7205 | 7.7213 | 10.1290 | | |
| | January-February Inflows | | | 19.1350 | 27.5500 | 48.8650 | | |
| | Ln(January-February Inflows) | | | 2.9515 | 3.3158 | 3.8890 | | |
| | Square Root of January-February Inflows | | | 4.3743 | 5.2486 | 6.9903 | | |
| | March-April Inflows | | | 14.3900 | 18.3750 | 23.6800 | | |
| | Ln(March-April Inflows) | | | 2.6635 | 2.9110 | 3.1633 | | |
| | Square Root of March-April Inflows | | | 3.7906 | 4.2866 | 4.8646 | | |
| | May-June Inflows | | | 84.6750 | 148.635 | 168.995 | | |
| | Ln(May-June Inflows) | | | 4.4318 | 5.0015 | 5.1299 | | |
| | Square Root of May-June Inflows | | | 9.1857 | 12.1915 | 12.9998 | | |
| | July-August Inflows | | | 27.3000 | 60.4700 | 115.675 | | |
| | Ln(July-August Inflows) | | | 3.3067 | 4.0930 | 4.7466 | | |
| | Square Root of July-August Inflows | | | 5.2247 | 7.7586 | 10.7440 | | |
| | SeptemberOctober Inflows | | | 71.2700 | 168.605 | 609.355 | | |
| | Ln(September-October Inflows) | | | 4.2662 | 5.1258 | 6.4124 | | |
| | Square Root of Sepember-October Inflows | | | 8.4417 | 12.9791 | 24.6850 | | |
| | November-December Inflows | | | 14.9250 | 43.6250 | 78.4500 | | |
| | Ln(November-Desember Inflows) | | | 2.6862 | 3.7731 | 4.3625 | | |
| | Square Root of November-December Inflows | | | 3.8471 | 6.6007 | 8.8572 | | |

### 2.2.1 The trout data

***Table .2.4** Descriptives for the trout data.*

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| Trout Harvest | Mean | | 71.6700 | 17.0465 |
| | 95% Confidence Interval for Mean | Lower Bound | 35.9913 | |
| | | Upper Bound | 107.349 | |
| | 5% Trimmed Mean | | 62.0389 | |
| | Median | | 59.6500 | |
| | Variance | | 5811.65 | |
| | Std. Deviation | | 76.2342 | |
| | Minimum | | 2.60 | |
| | Maximum | | 314.10 | |
| | Range | | 311.50 | |
| | Interquartile Range | | 89.6250 | |
| | Skewness | | 1.843 | .512 |
| | Kurtosis | | 4.395 | .992 |

***Table .2.5** Extreme Values for the trout data.*

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| Trout Harvest | Highest | 1 | 13 | 1973 | 314.10 |
| | | 2 | 14 | 1974 | 167.60 |
| | | 3 | 12 | 1972 | 153.30 |
| | | 4 | 15 | 1975 | 121.90 |
| | | 5 | 19 | 1979 | 103.70 |
| | Lowest | 1 | 4 | 1964 | 2.60 |
| | | 2 | 3 | 1963 | 2.80 |
| | | 3 | 2 | 1962 | 6.40 |
| | | 4 | 1 | 1961 | 7.00 |
| | | 5 | 5 | 1965 | 13.20 |

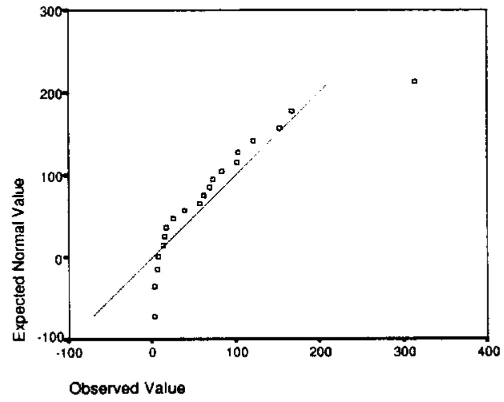


***Figure 2.1*** *Normal Q-Q Plot of Trout Harvest.*

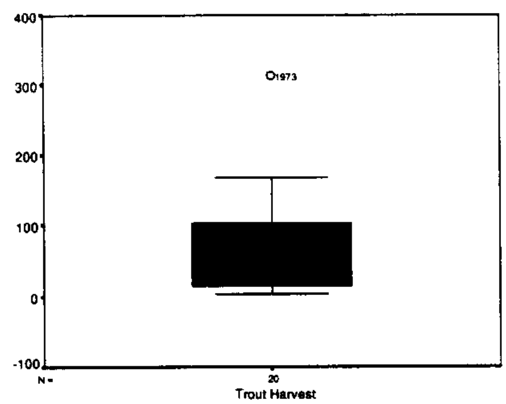


***Figure 2.2*** *BoxPlot of Trout Harvest.*

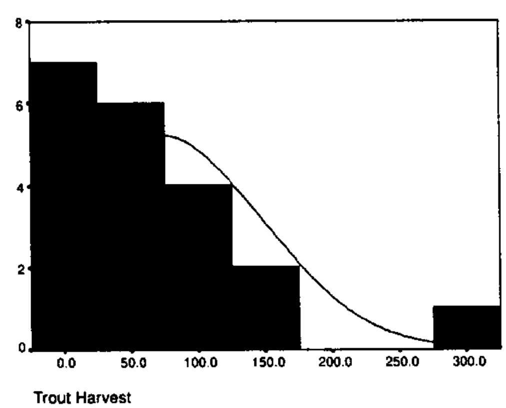


***Figure 2.3*** *Histogram of Trout Harvest.*

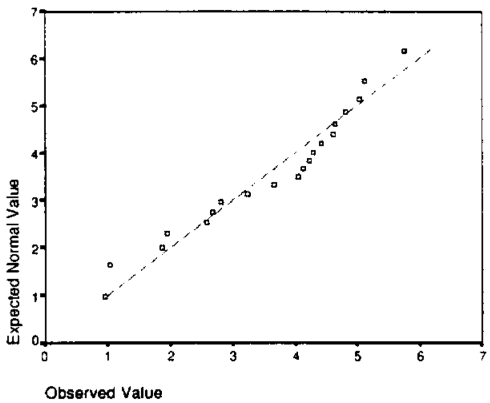


***Figure 2.4*** *Normal Q-Q Plot of Ln(Trout Harvest).*

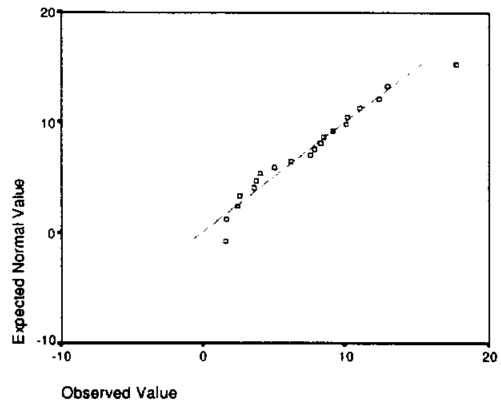


***Figure 2.5*** *Normal Q-Q Plot of Sqrt(TroutHarvest).*

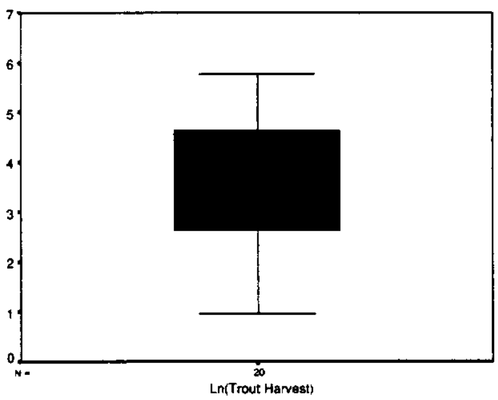


***Figure 2.6*** *BoxPlot of Ln(Trout Harvest).*

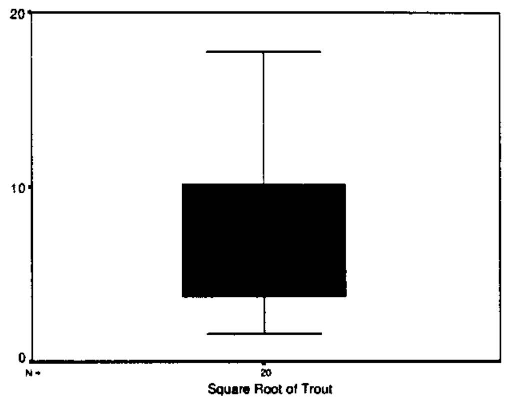


***Figure 2.7*** *BoxPlot of Sqrt(Trout Harvest).*

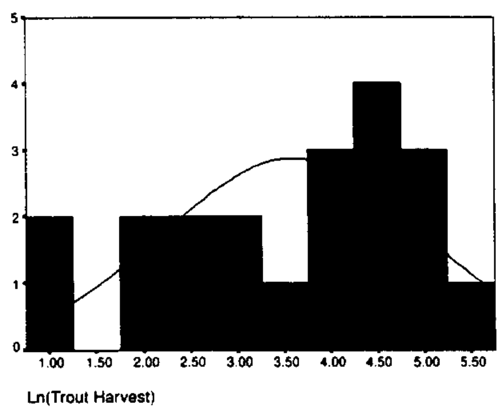


***Figure 2.8*** *Histogram of Ln(Trout Harvest).*

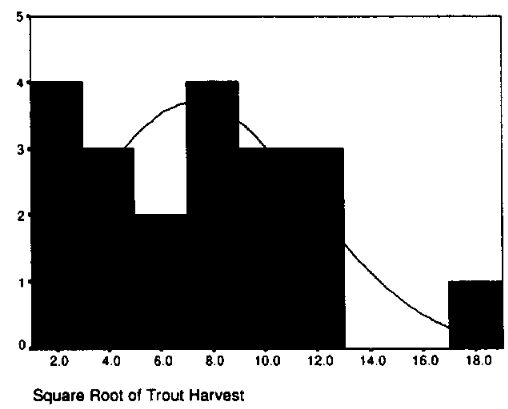


***Figure 2.9*** *Histogram of Sqrt(Trout Harvest).*

### 2.2.2 The January-February Inflows data

***Table .2.6*** *Descriptives for the January-February Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| January-February Inflows | Mean | | 37.4825 | 6.0374 |
| | 95% Confidence Interval for Mean | Lower Bound | 24.8461 | |
| | | Upper Bound | 50.1189 | |
| | 5% Trimmed Mean | | 36.0500 | |
| | Median | | 27.5500 | |
| | Variance | | 728.999 | |
| | Std. Deviation | | 27.0000 | |
| | Minimum | | 5.49 | |
| | Maximum | | 95.26 | |
| | Range | | 89.77 | |
| | Interquartile Range | | 29.9750 | |
| | Skewness | | 1.243 | .512 |
| | Kurtosis | | .537 | .992 |

***Table .2.7*** *Extreme Values for the January-February Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| January-February Inflows | Highest | 1 | 10 | 1970 | 95.26 |
| | | 2 | 9 | 1969 | 91.93 |
| | | 3 | 8 | 1968 | 89.91 |
| | | 4 | 1 | 1961 | 58.45 |
| | | 5 | 2 | 1962 | 49.25 |
| | Lowest | 1 | 4 | 1964 | 5.49 |
| | | 2 | 11 | 1971 | 12.76 |
| | | 3 | 20 | 1980 | 13.59 |
| | | 4 | 16 | 1976 | 17.23 |
| | | 5 | 13 | 1973 | 19.03 |

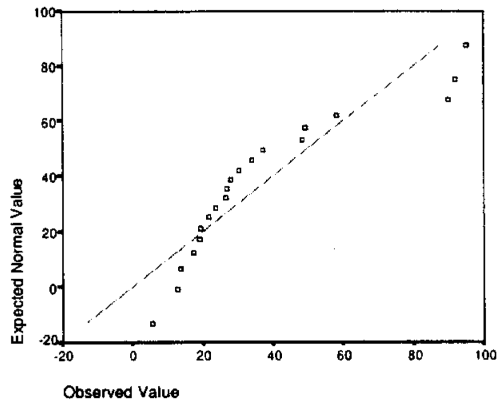


***Figure 2.10*** *Normal Q-Q Plot of January-February Inflows.*

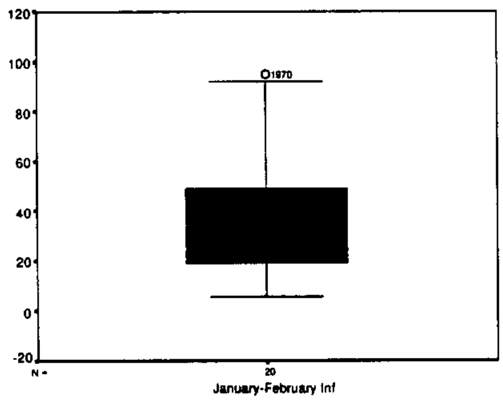


***Figure 2.11*** *BoxPlot of January-February Inflows.*

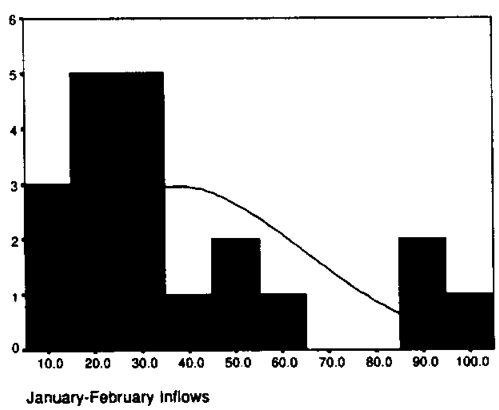


***Figure 2.12*** *Histogram of January-February Inflows.*

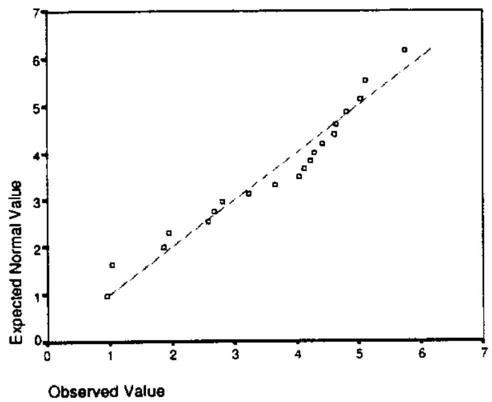


***Figure 2.13*** *Normal Q-Q Plot of Ln January-February Inflows).*

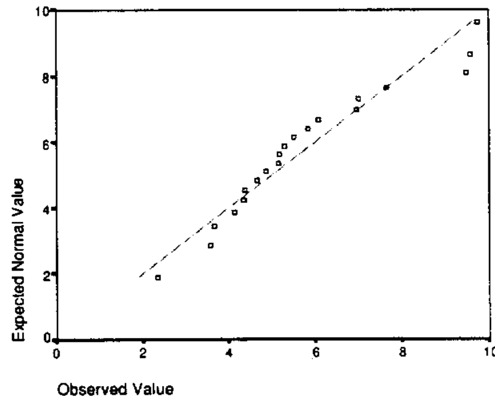


***Figure 2.14*** *Normal Q-Q Plot of Sqrt( January-February Inflows).*

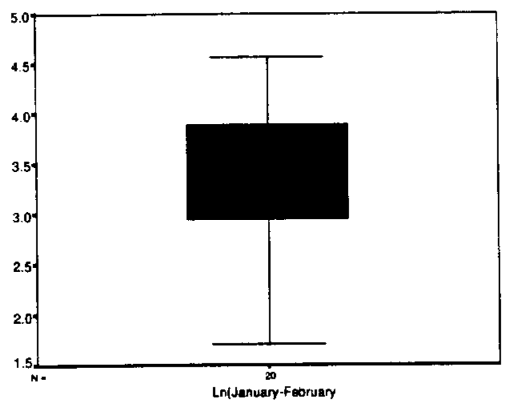


***Figure 2.15*** *BoxPlot of Ln(January-February Inflows).*

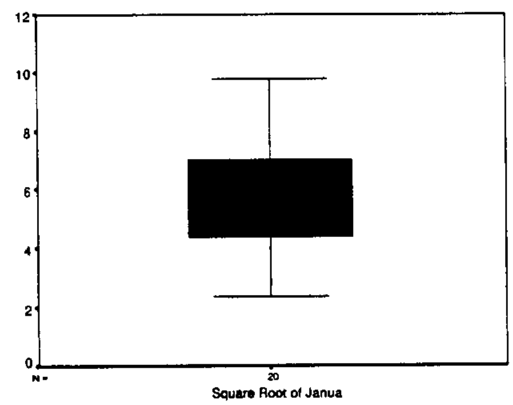


***Figure 2.16*** *BoxPlot of Square Root of January-February Inflows.*

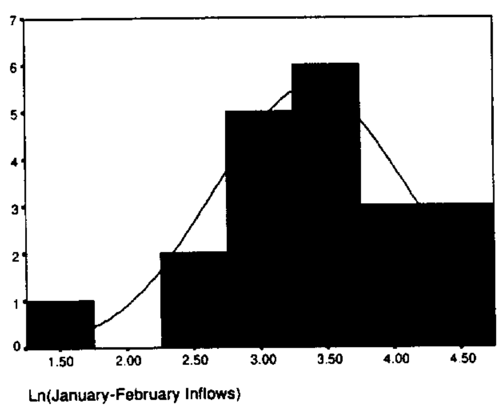


***Figure 2.17*** *Histogram of Ln(January-February Inflows).*

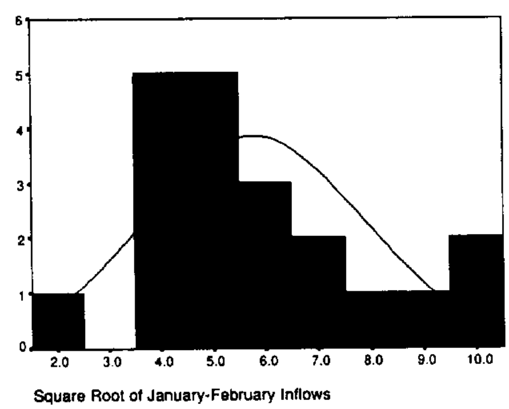


***Figure 2.18*** *Histogram of Sqrt(January-February Inflows).*

### 2.2.3 The March-April Inflows data

***Table .2.8*** *Descriptives for the March-April Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| March-April Inflows | Mean | | 31.2740 | 7.7782 |
| | 95% Confidence Interval for Mean | Lower Bound | 14.9940 | |
| | | Upper Bound | 47.5540 | |
| | 5% Trimmed Mean | | 27.5406 | |
| | Median | | 18.3750 | |
| | Variance | | 1210.01 | |
| | Std. Deviation | | 34.7852 | |
| | Minimum | | 6.64 | |
| | Maximum | | 123.11 | |
| | Range | | 116.47 | |
| | Interquartile Range | | 10.4500 | |
| | Skewness | | 2.087 | .512 |
| | Kurtosis | | 2.902 | .992 |

***Table .2.9*** *Extreme Values for the March-April Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| March-April Inflows | Highest | 1 | 19 | 1979 | 123.11 |
| | | 2 | 17 | 1977 | 104.82 |
| | | 3 | 18 | 1978 | 104.63 |
| | | 4 | 10 | 1970 | 25.37 |
| | | 5 | 20 | 1980 | 24.89 |
| | Lowest | 1 | 4 | 1964 | 6.64 |
| | | 2 | 13 | 1973 | 9.52 |
| | | 3 | 2 | 1962 | 12.81 |
| | | 4 | 1 | 1961 | 13.11 |
| | | 5 | 3 | 1963 | 13.28 |

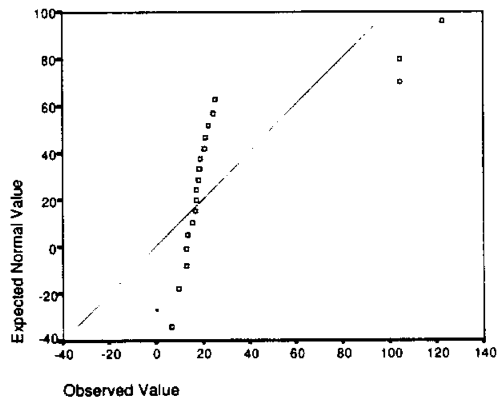


***Figure 2.19*** *Normal Q-Q Plot of March-April Inflows.*

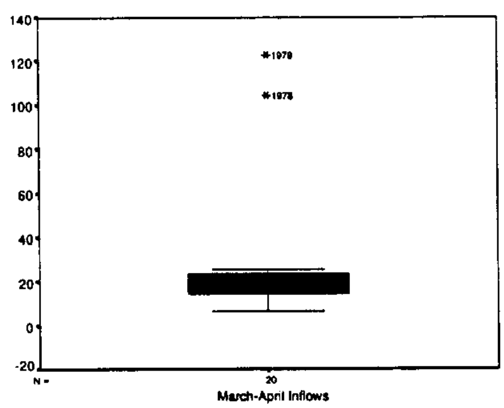


***Figure 2.20*** *BoxPlot of March-April Inflows.*

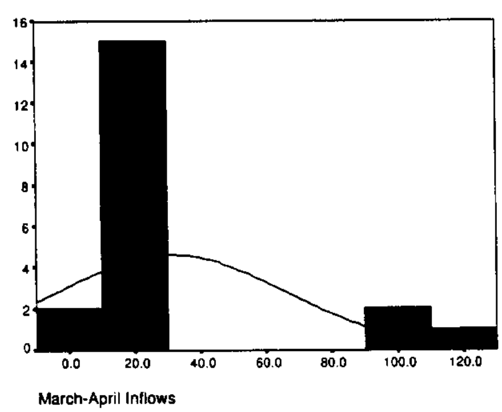


***Figure 2.21*** *Histogram of March-April Inflows.*

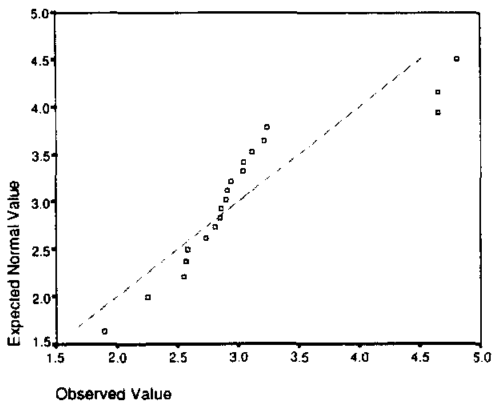


***Figure 2.22*** *Normal Q-Q Plot of Ln(March-April Inflows).*

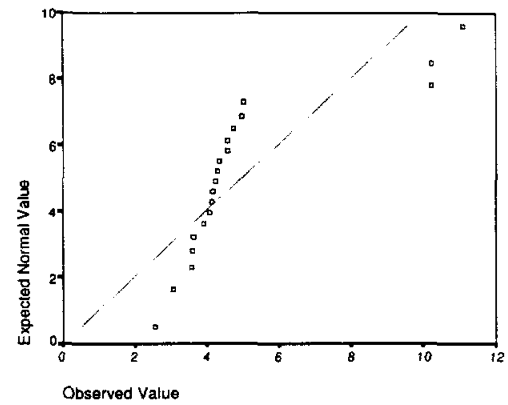


***Figure 2.23*** *Normal Q-Q Plot of Sqrt( March-April Inflows).*

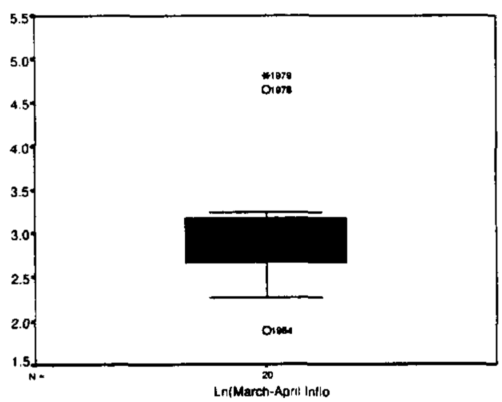


***Figure 2.24*** *BoxPlot of Ln(March-April) Inflows.*

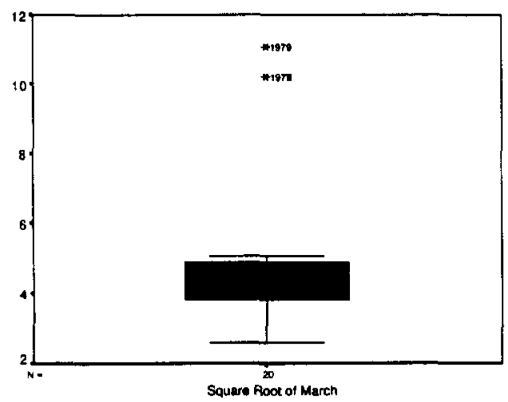


***Figure 2.25*** *BoxPlot of Square Root of March-April Inflows.*

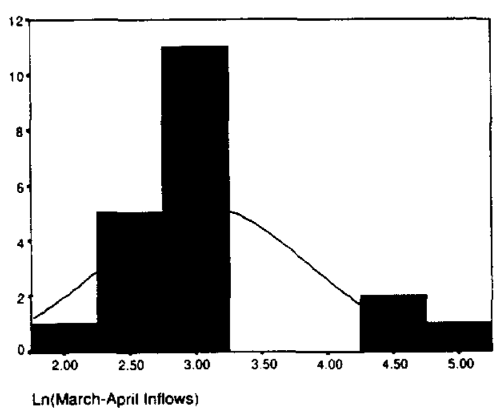


***Figure 2.26*** *Histogram of Ln(March-April Inflows).*

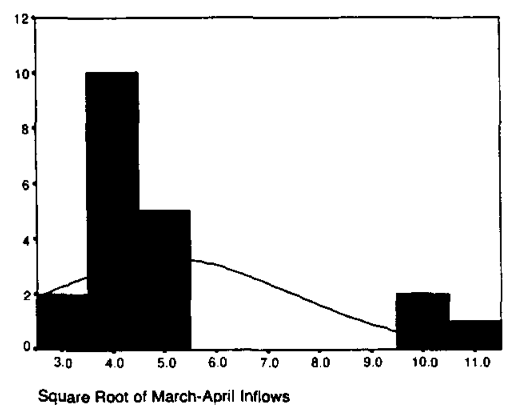


***Figure 2.27*** *Histogram of Sqrt(March-April Inflows).*

### 2.2.4 The May-June Inflows data

***Table .2.10*** *Descriptives for the May-June Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| May-June Inflows | Mean | | 126.293 | 13.6091 |
| | 95% Confidence Interval for Mean | Lower Bound | 97.8084 | |
| | | Upper Bound | 154.777 | |
| | 5% Trimmed Mean | | 127.713 | |
| | Median | | 148.635 | |
| | Variance | | 3704.13 | |
| | Std. Deviation | | 60.8616 | |
| | Minimum | | 7.72 | |
| | Maximum | | 219.30 | |
| | Range | | 211.58 | |
| | Interquartile Range | | 89.4350 | |
| | Skewness | | -.511 | .512 |
| | Kurtosis | | -.710 | .992 |

***Table .2.11*** *Extreme Values for the May-June Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| May-June Inflows | Highest | 1 | 8 | 1968 | 219.30 |
| | | 2 | 10 | 1970 | 211.69 |
| | | 3 | 15 | 1975 | 175.19 |
| | | 4 | 20 | 1980 | 171.41 |
| | | 5 | 19 | 1979 | 169.20 |
| | Lowest | 1 | 4 | 1964 | 7.72 |
| | | 2 | 3 | 1963 | 33.71 |
| | | 3 | 2 | 1962 | 38.52 |
| | | 4 | 1 | 1961 | 42.66 |
| | | 5 | 5 | 1965 | 74.65 |

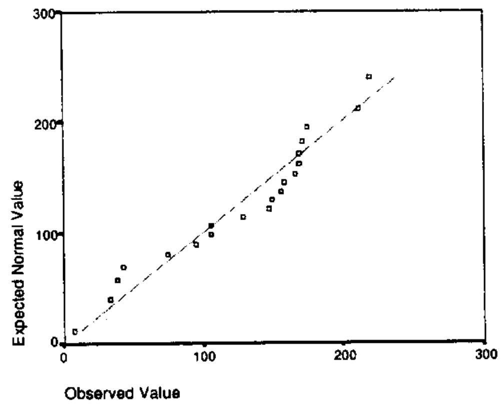


***Figure 2.28*** *Normal Q-Q Plot of May-June Inflows.*

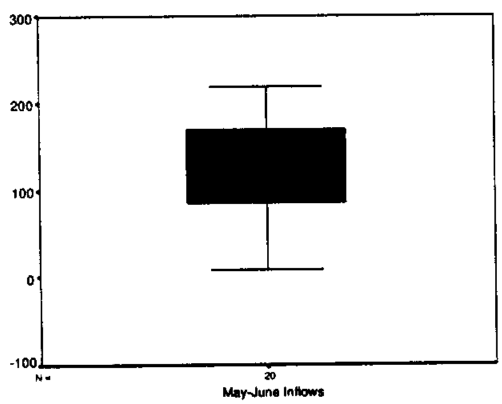


***Figure 2.29*** *BoxPlot of May-June Inflows.*

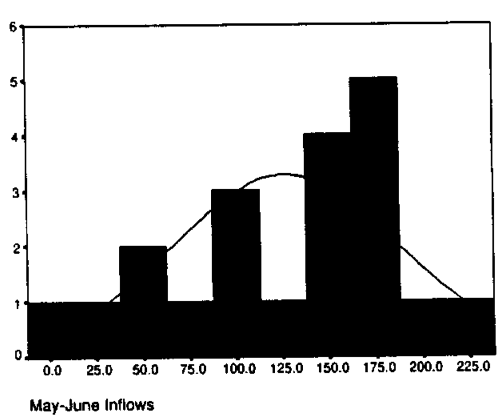


***Figure 2.30*** *Histogram of May-June Inflows.*

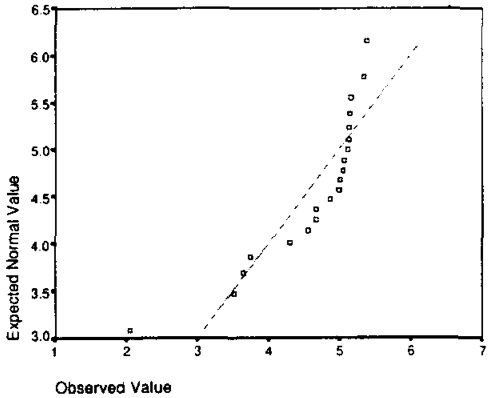


*Figure 2.31* *Normal Q-Q Plot of Ln(May-June Inflows).*

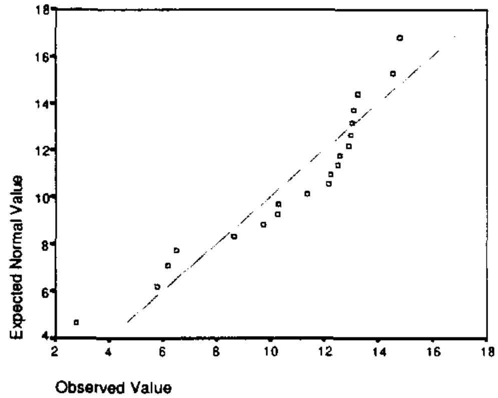


*Figure 2.32* *Normal Q-Q Plot of Sqrt( May-June Inflows).*

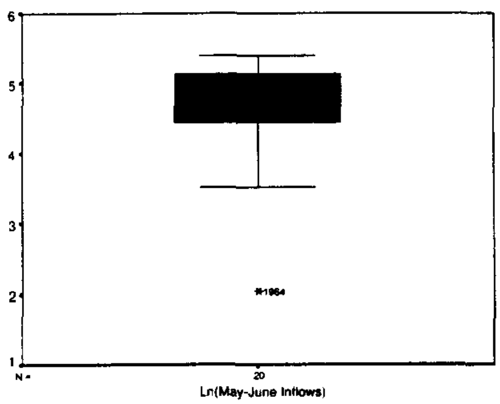


*Figure 2.33* *BoxPlot of Ln(May-June) Inflows.*

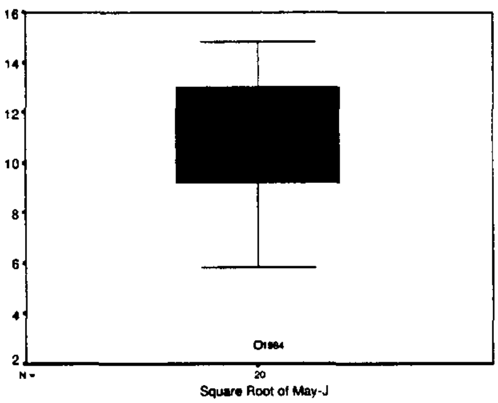


*Figure 2.34* *BoxPlot of Square Root of May-June Inflows.*

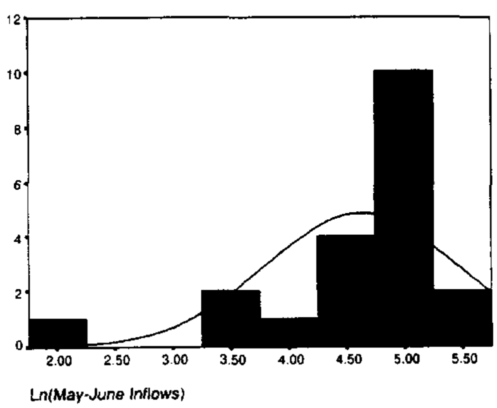


*Figure 2.35* *Histogram of Ln(May-June Inflows).*

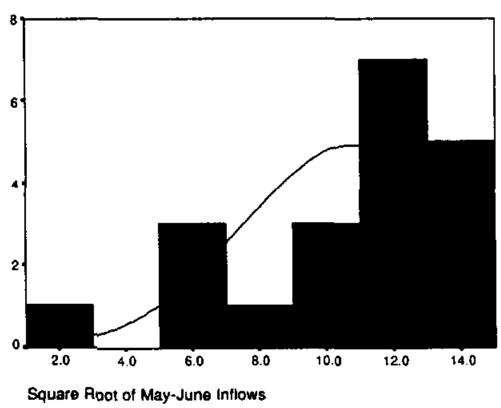


*Figure 2.36* *Histogram of Sqrt(May-June Inflows).*

### 2.2.5 The July-August Inflows data

***Table .2.12*** *Descriptives for the July-August Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| July-August Inflows | Mean | | 99.2380 | 23.7359 |
| | 95% Confidence Interval for Mean | Lower Bound | 49.5581 | |
| | | Upper Bound | 148.918 | |
| | 5% Trimmed Mean | | 90.9028 | |
| | Median | | 60.4700 | |
| | Variance | | 11267.9 | |
| | Std. Deviation | | 106.150 | |
| | Minimum | | 10.11 | |
| | Maximum | | 338.40 | |
| | Range | | 328.29 | |
| | Interquartile Range | | 93.9325 | |
| | Skewness | | 1.412 | .512 |
| | Kurtosis | | .788 | .992 |

***Table .2.13*** *Extreme Values for the July-August Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| July-August Inflows | Highest | 1 | 13 | 1973 | 338.40 |
| | | 2 | 12 | 1972 | 310.47 |
| | | 3 | 11 | 1971 | 307.47 |
| | | 4 | 20 | 1980 | 202.89 |
| | | 5 | 16 | 1976 | 126.23 |
| | Lowest | 1 | 4 | 1964 | 10.11 |
| | | 2 | 5 | 1965 | 10.70 |
| | | 3 | 6 | 1966 | 12.65 |
| | | 4 | 7 | 1967 | 14.00 |
| | | 5 | 9 | 1969 | 26.74 |

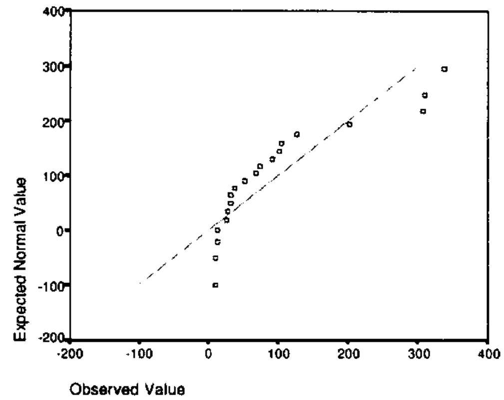


***Figure 2.37*** *Normal Q-Q Plot of July-August Inflows.*

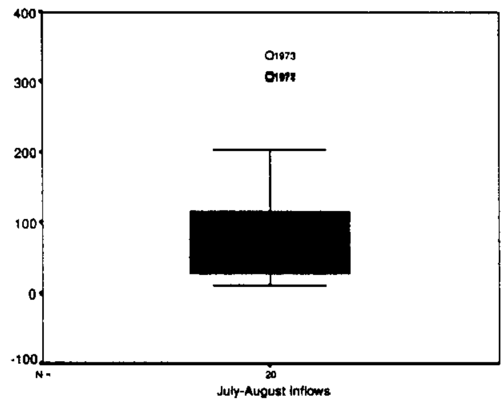


***Figure 2.38*** *BoxPlot of July-August Inflows.*

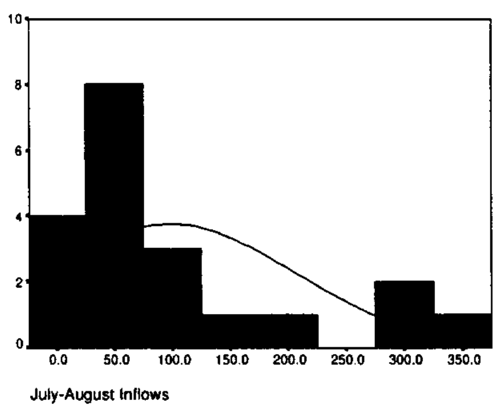


***Figure 2.39*** *Histogram of July-August Inflows.*

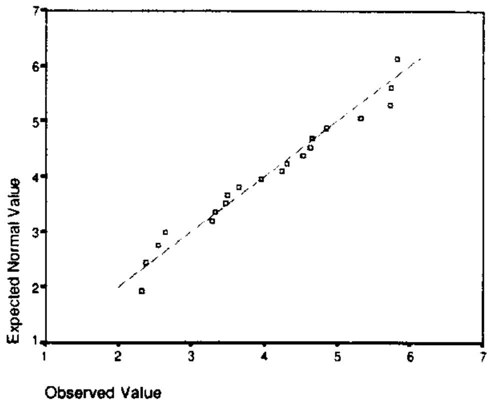


***Figure 2.40*** *Normal Q-Q Plot of Ln(July-August Inflows).*

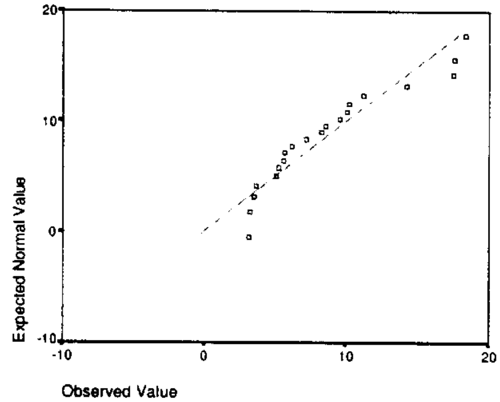


***Figure 2.41*** *Normal Q-Q Plot of Sqrt( July-August Inflows).*

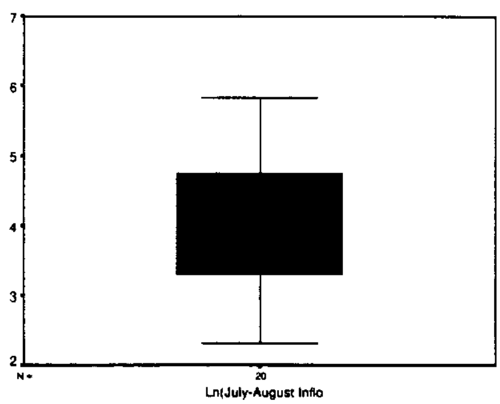


***Figure 2.42*** *BoxPlot of Ln(July-August) Inflows.*

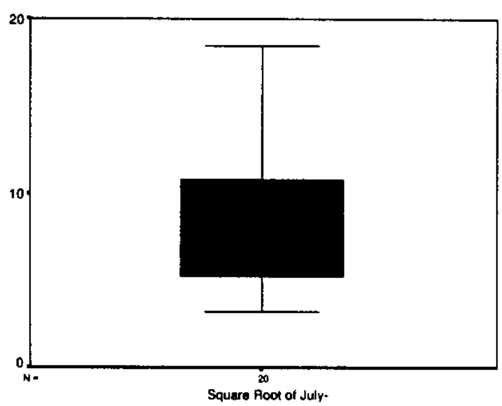


***Figure 2.43*** *BoxPlot of Square Root of July-August Inflows.*

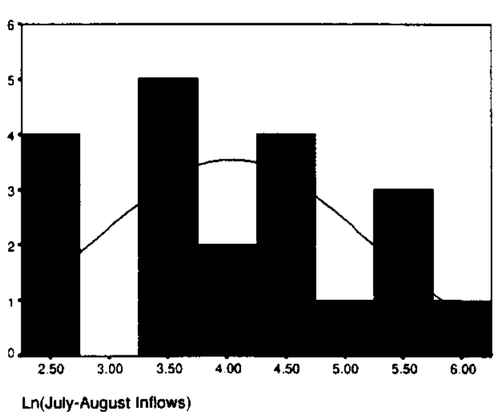


***Figure 2.44*** *Histogram of Ln(July-August Inflows).*

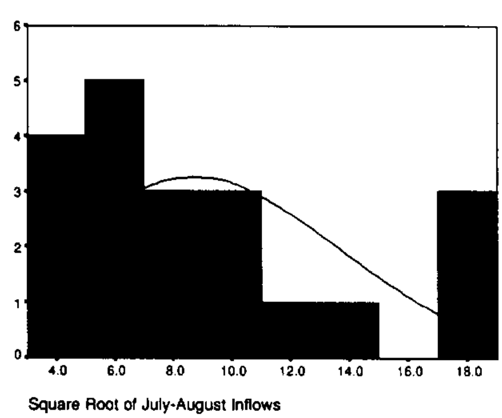


***Figure 2.45*** *Histogram of Sqrt(July-August Inflows).*

### 2.2.6 The September-October Inflows data

***Table .2.14*** *Descriptives for the September-October Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| SeptemberOctober Inflows | Mean | | 295.728 | 60.7806 |
| | 95% Confidence Interval for Mean | Lower Bound | 168.512 | |
| | | Upper Bound | 422.943 | |
| | 5% Trimmed Mean | | 282.682 | |
| | Median | | 168.605 | |
| | Variance | | 73885.7 | |
| | Std. Deviation | | 271.819 | |
| | Minimum | | 9.91 | |
| | Maximum | | 816.37 | |
| | Range | | 806.46 | |
| | Interquartile Range | | 540.538 | |
| | Skewness | | .763 | .512 |
| | Kurtosis | | -1.095 | .992 |

***Table .2.15*** *Extreme Values for the September-October Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| SeptemberOctober Inflows | Highest | 1 | 14 | 1974 | 816.37 |
| | | 2 | 10 | 1970 | 693.83 |
| | | 3 | 9 | 1969 | 675.78 |
| | | 4 | 8 | 1968 | 670.67 |
| | | 5 | 12 | 1972 | 612.72 |
| | Lowest | 1 | 4 | 1964 | 9.91 |
| | | 2 | 11 | 1971 | 34.80 |
| | | 3 | 5 | 1965 | 68.57 |
| | | 4 | 6 | 1966 | 68.66 |
| | | 5 | 7 | 1967 | 69.73 |

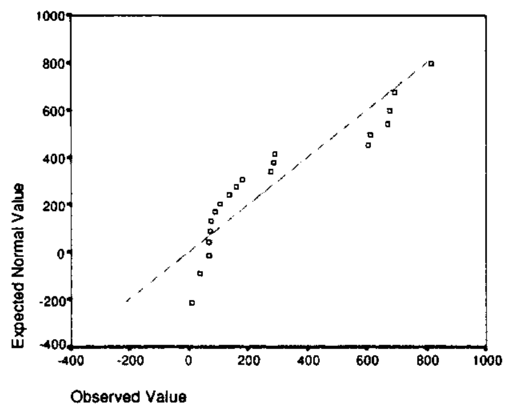


***Figure 2.46*** *Normal Q-Q Plot of September-October Inflows.*

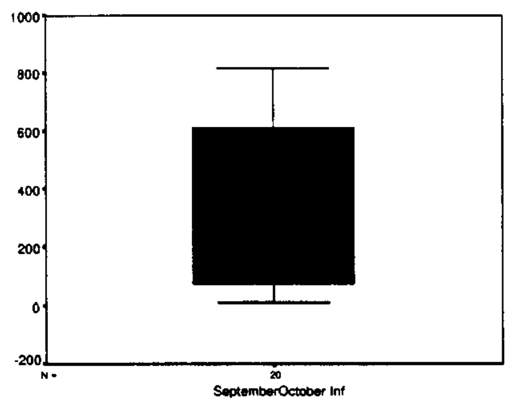


***Figure 2.47*** *BoxPlot of September-October Inflows.*

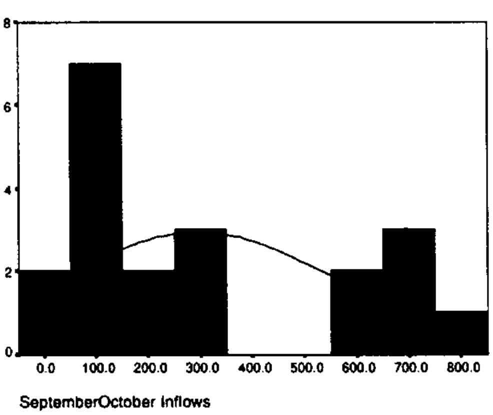


***Figure 2.48*** *Histogram of September-October Inflows.*

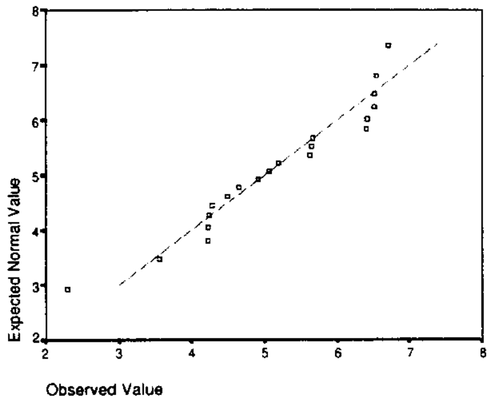


*Figure 2.49* Normal Q-Q Plot of Ln(September-October Inflows).

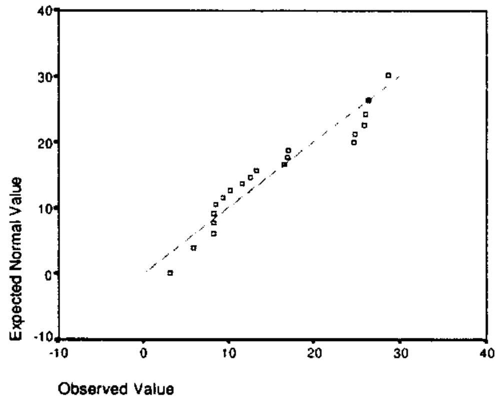


*Figure 2.50* Normal Q-Q Plot of Sqrt( September-October Inflows).

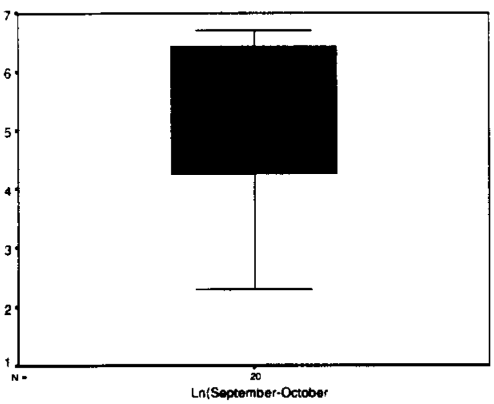


*Figure 2.51* BoxPlot of Ln(September-October) Inflows.

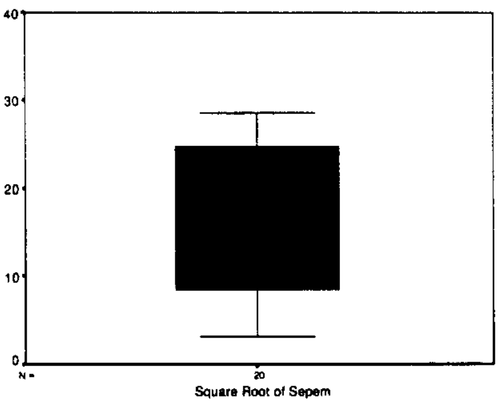


*Figure 2.52* BoxPlot of Square Root of September-October Inflows.

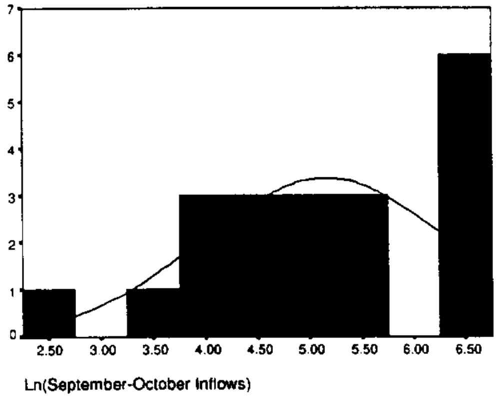


*Figure 2.53* Histogram of Ln(September-October Inflows).

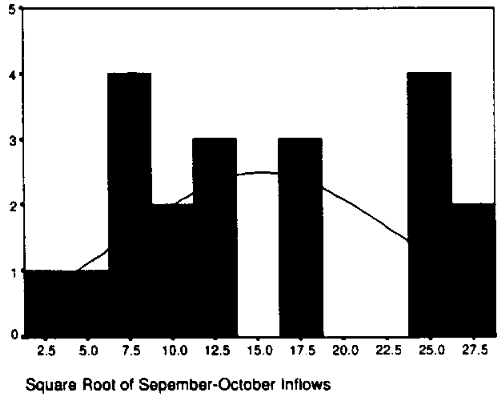


*Figure 2.54* Histogram of Sqrt(September-October Inflows).

## 2.2.7 The November-December Inflows data

***Table .2.16*** *Descriptives for the November-December Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| November-December Inflows | Mean | | 57.4180 | 10.7644 |
| | 95% Confidence Interval for Mean | Lower Bound | 34.8878 | |
| | | Upper Bound | 79.9482 | |
| | 5% Trimmed Mean | | 55.2228 | |
| | Median | | 43.6250 | |
| | Variance | | 2317.46 | |
| | Std. Deviation | | 48.1400 | |
| | Minimum | | 5.45 | |
| | Maximum | | 148.90 | |
| | Range | | 143.45 | |
| | Interquartile Range | | 64.9825 | |
| | Skewness | | .796 | .512 |
| | Kurtosis | | -.626 | .992 |

***Table .2.17*** *Extreme Values for the November-December Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| November-December Inflows | Highest | 1 | 1 | 1961 | 148.90 |
| | | 2 | 17 | 1977 | 138.05 |
| | | 3 | 19 | 1979 | 135.35 |
| | | 4 | 18 | 1978 | 133.86 |
| | | 5 | 2 | 1962 | 78.65 |
| | Lowest | 1 | 4 | 1964 | 5.45 |
| | | 2 | 20 | 1980 | 8.20 |
| | | 3 | 5 | 1965 | 9.75 |
| | | 4 | 6 | 1966 | 10.36 |
| | | 5 | 7 | 1967 | 12.21 |

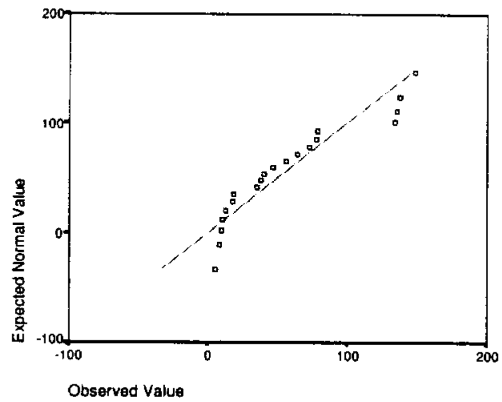


***Figure 2.55*** *Normal Q-Q Plot of November_December Inflows.*

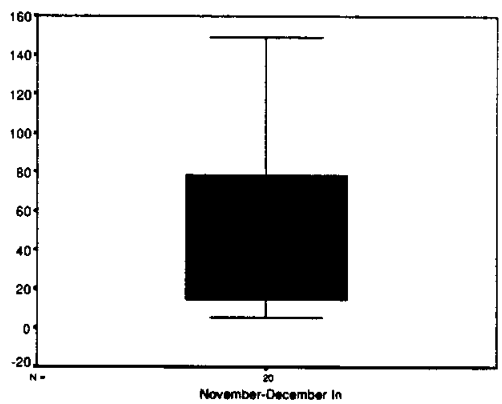


***Figure 2.56*** *BoxPlot of November_December Inflows.*

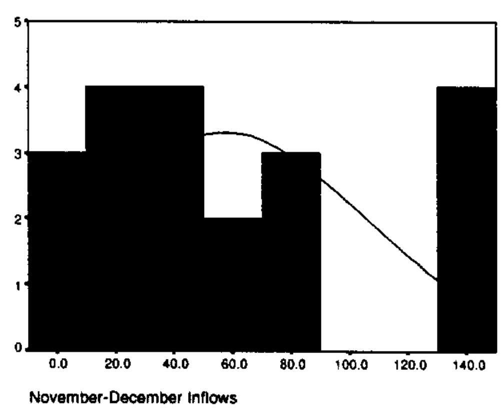


***Figure 2.57*** *Histogram of November_December Inflows.*

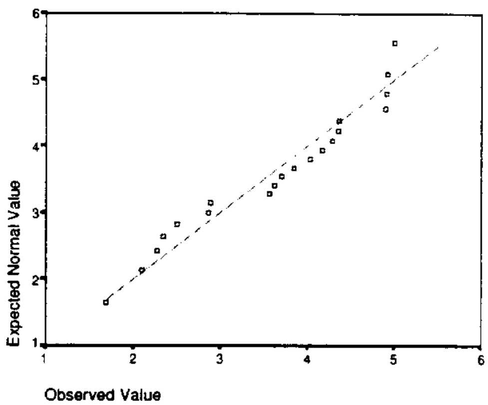


*Figure 2.58* *Normal Q-Q Plot of Ln(November_December Inflows).*

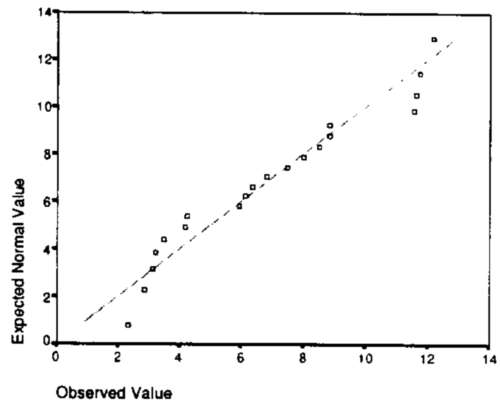


*Figure 2.59* *Normal Q-Q Plot of Sqrt( November_December Inflows).*

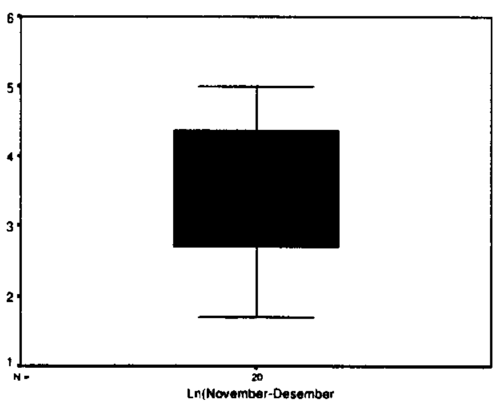


*Figure 2.60* *BoxPlot of Ln(November _December) Inflows.*

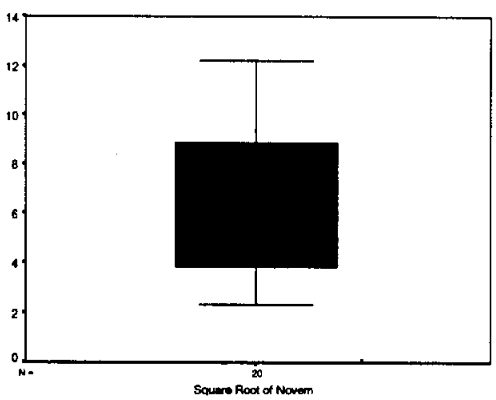


*Figure 2.61* *BoxPlot of Square Root of November_December Inflows.*

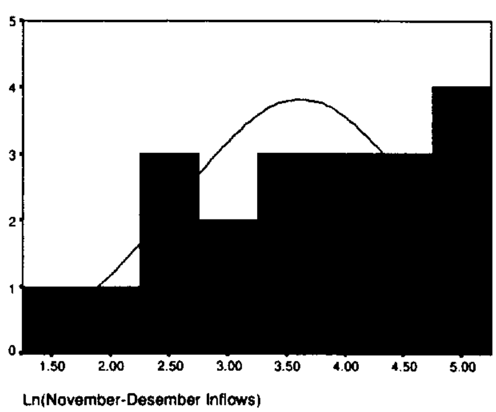


*Figure 2.62* *Histogram of Ln(November_ December Inflows).*

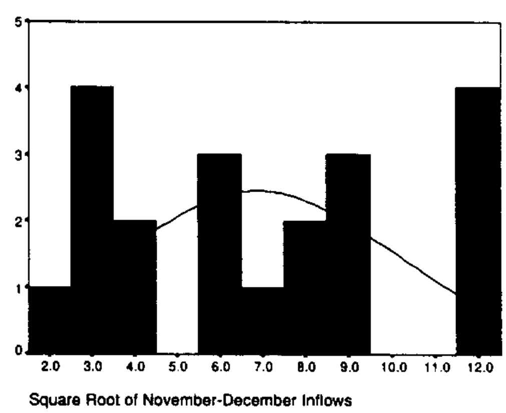


*Figure 2.63* *Histogram of Sqrt(November_ December Inflows).*

# 3. Prediction Ellipses and Confidence Regions

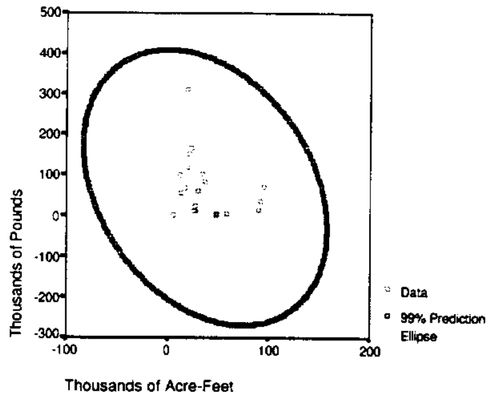


***Figure 3.1*** *Trout Harvest vs. January-February Inflows, PE.*

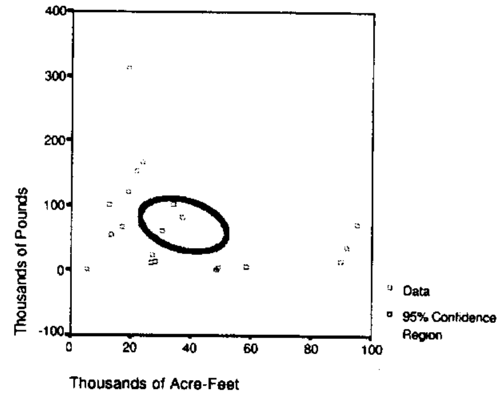


***Figure 3.2*** *Trout Harvest vs. January-February Inflows, CR.*

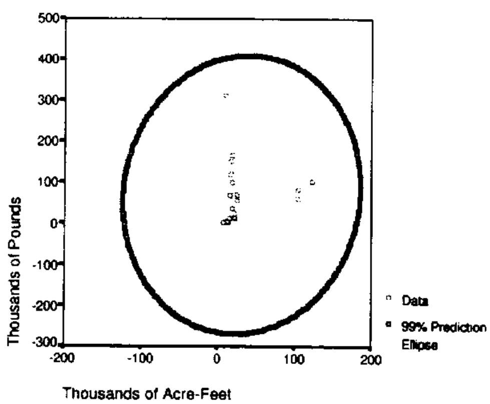


***Figure 3.3*** *Trout Harvest vs. March-April Inflows, PE.*

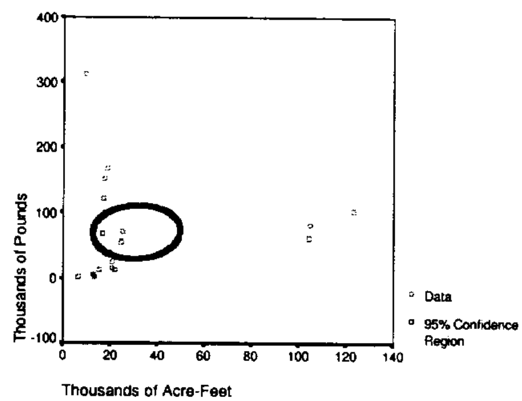


***Figure 3.4*** *Trout Harvest vs. March-April Inflows, CR.*

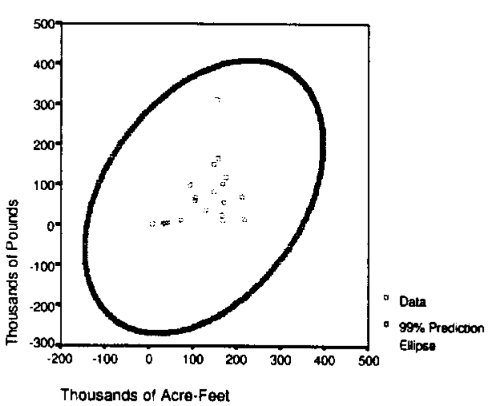


***Figure 3.5*** *Trout Harvest vs. May-June Inflows, PE.*

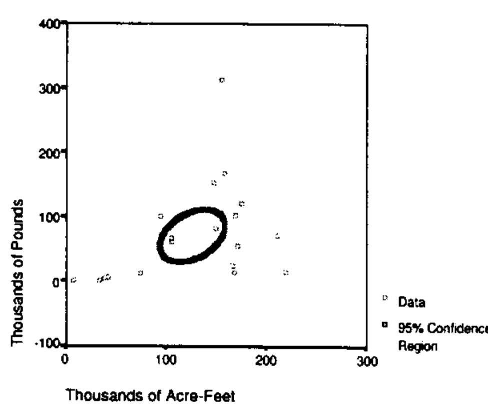


***Figure 3.6*** *Trout Harvest vs. May-June Inflows, CR.*

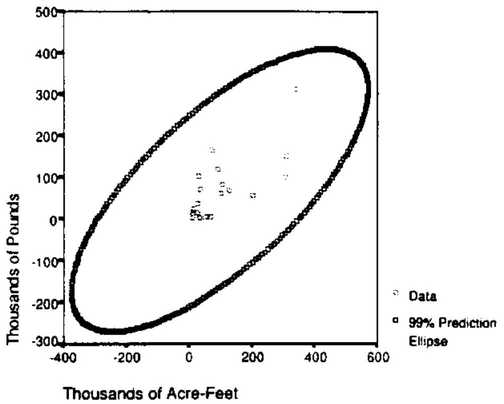


***Figure 3.7*** *Trout Harvest vs. July-August Inflows, PE.*

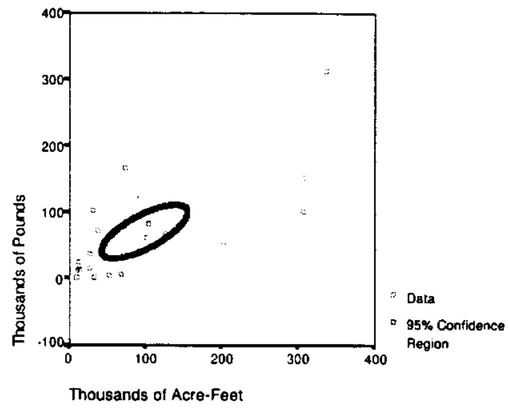


***Figure 3.8*** *Trout Harvest vs. July-August Inflows, CR.*

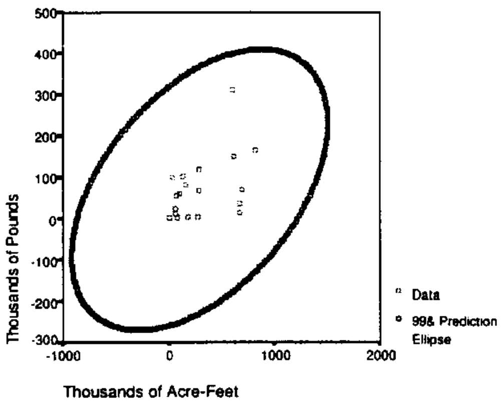


***Figure 3.9*** *Trout Harvest vs. September-October Inflows, PE.*

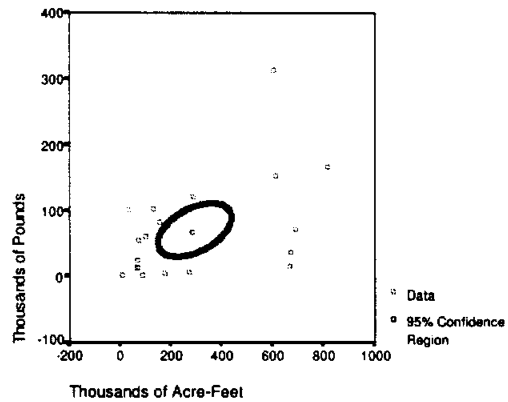


***Figure 3.10*** *Trout Harvest vs. September-October Inflows, CR.*

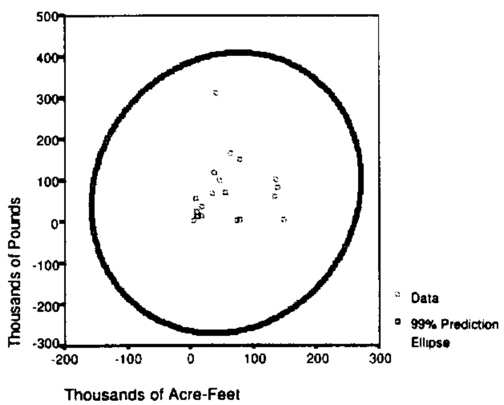


***Figure 3.11*** *Trout Harvest vs. November-December Inflows, PE.*

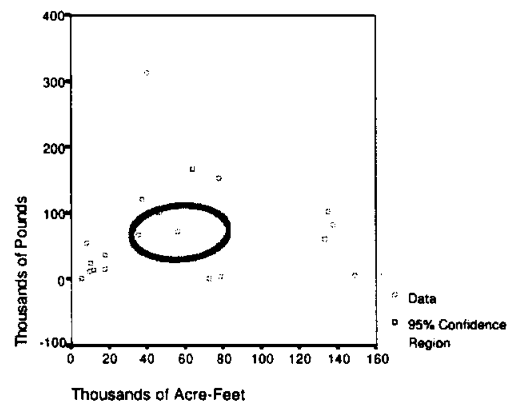


***Figure 3.12*** *Trout Harvest vs. November-December Inflows, CR.*

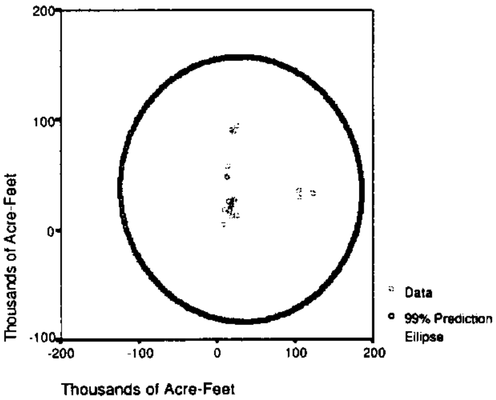


***Figure 3.13*** *January-February Inflows vs. March-April Inflows, PE.*

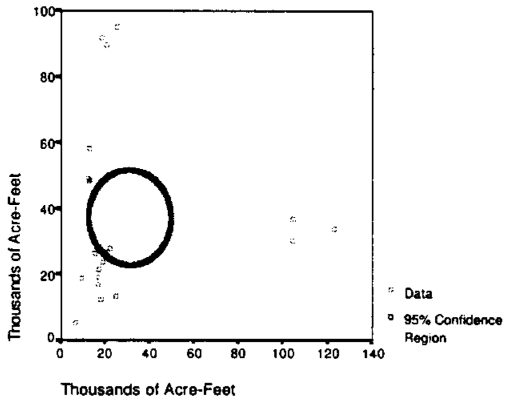


***Figure 3.14*** *January-February Inflows vs. March-April Inflows, CR.*

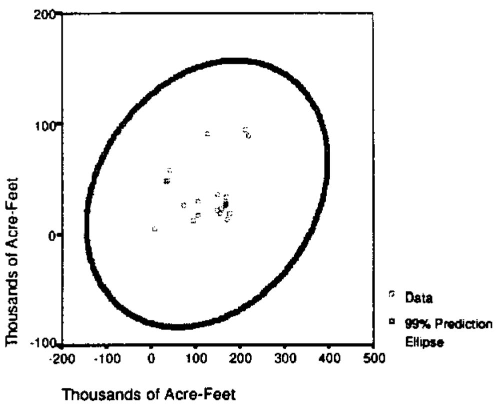


***Figure 3.15*** *January-February Inflows vs. May-June Inflows, PE.*

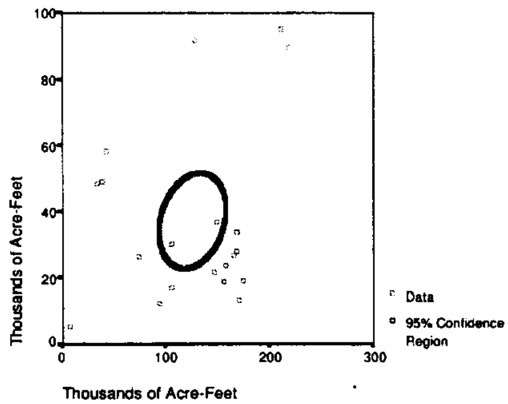


***Figure 3.16*** *January-February Inflows vs. May-June Inflows, CR.*

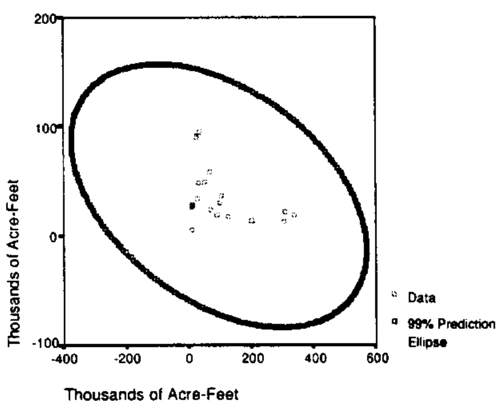


***Figure 3.17*** *January-February Inflows vs. July-August Inflows, PE.*

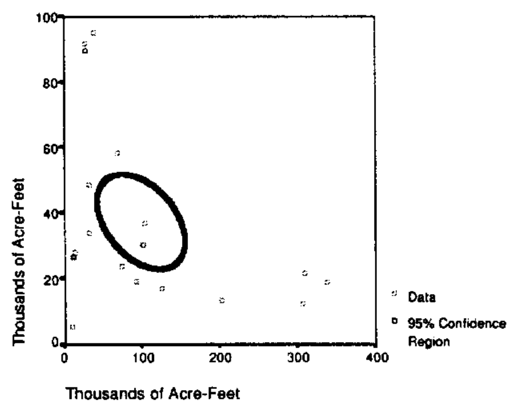


***Figure 3.18*** *January-February Inflows vs. July-August Inflows, CR.*

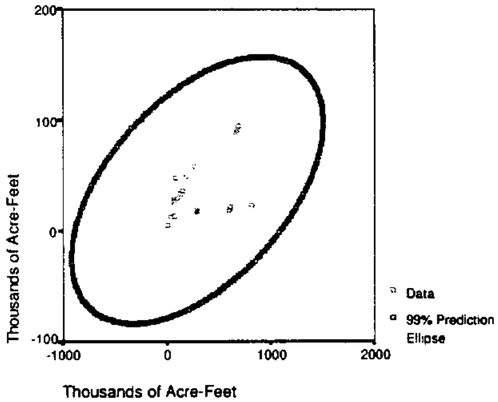


*Figure 3.19* *January-February Inflows vs. September-October Inflows, PE.*

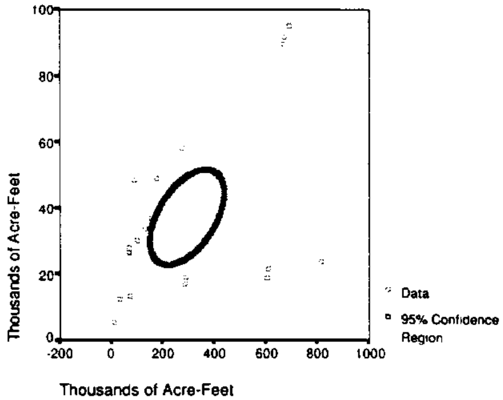


*Figure 3.20* *January-February Inflows vs. September-October Inflows, CR.*

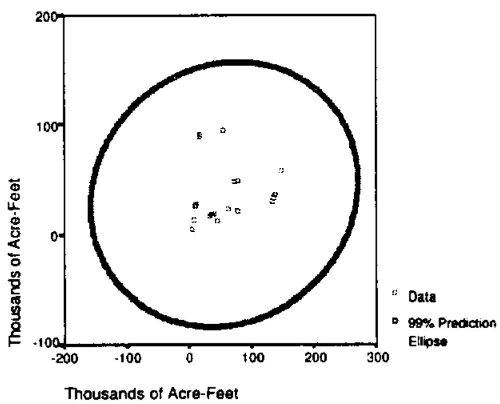


*Figure 3.21* *January-February Inflows vs. November-December Inflows, PE.*

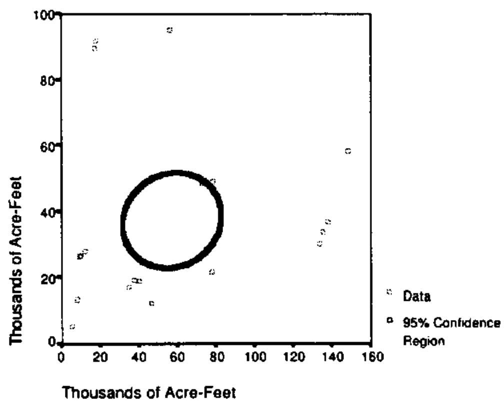


*Figure 3.22* *January-February Inflows vs. November-December Inflows, CR.*

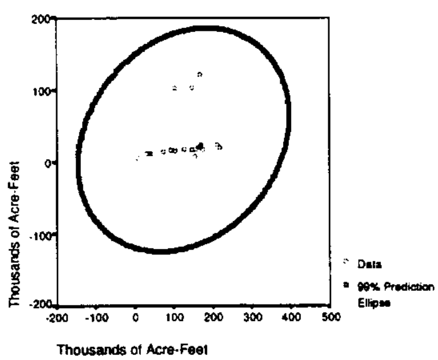


*Figure 3.23* *March-April Inflows vs. May-June Inflows, PE.*

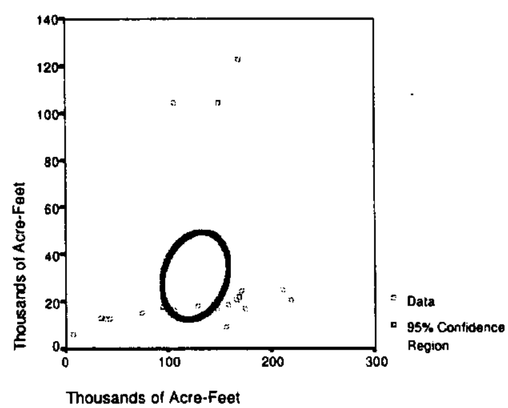


*Figure 3.24* *March-April Inflows vs. May-June Inflows, CR.*

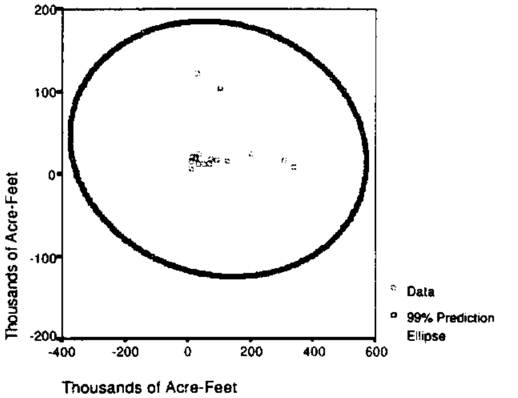


***Figure 3.25*** *March-April Inflows vs. July-August Inflows, PE.*

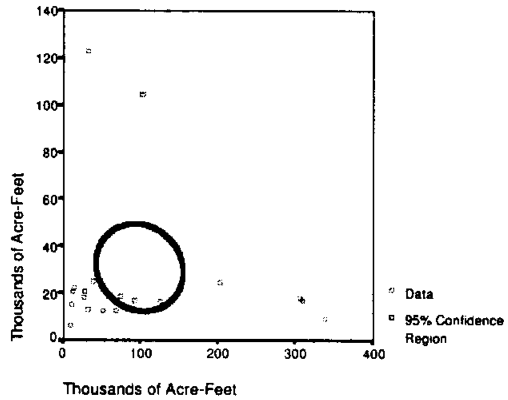


***Figure 3.26*** *March-April Inflows vs. July-August Inflows, CR.*

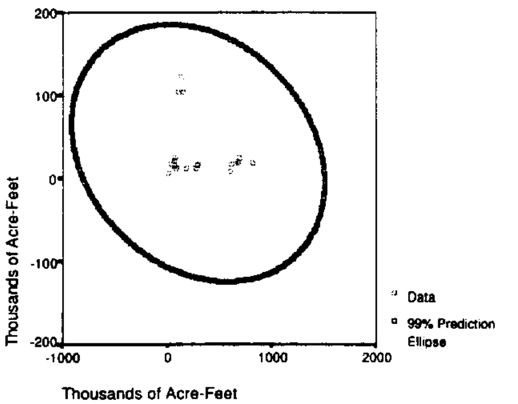


***Figure 3.27*** *March-April Inflows vs. September-October Inflows, PE.*

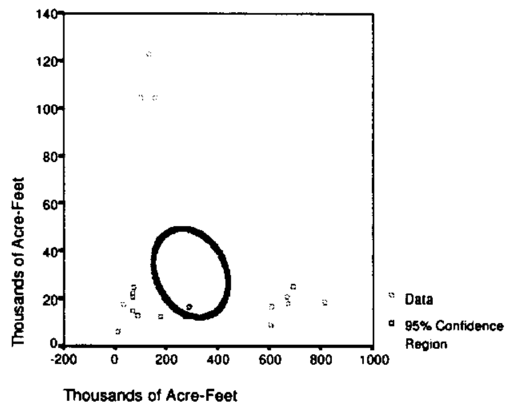


***Figure 3.28*** *March-April Inflows vs. September-October Inflows, CR.*

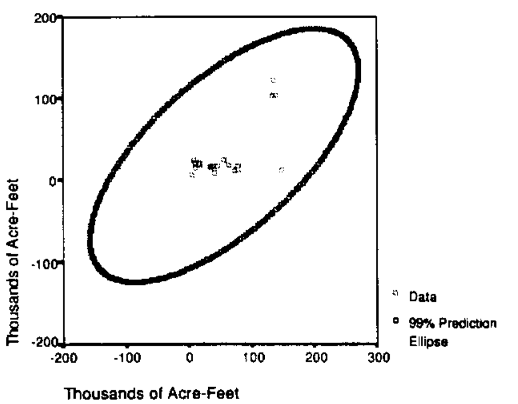


***Figure 3.29*** *March-April Inflows vs. November-December Inflows, PE.*

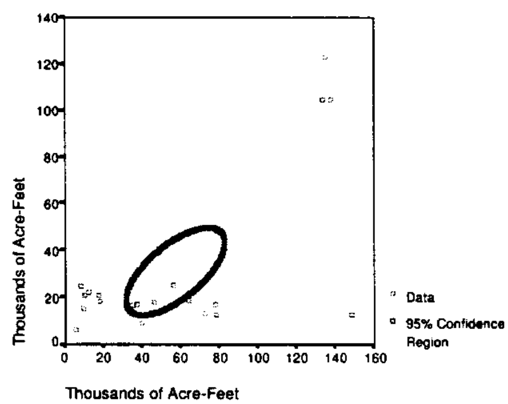


***Figure 3.30*** *March-April Inflows vs. November-December Inflows, CR.*

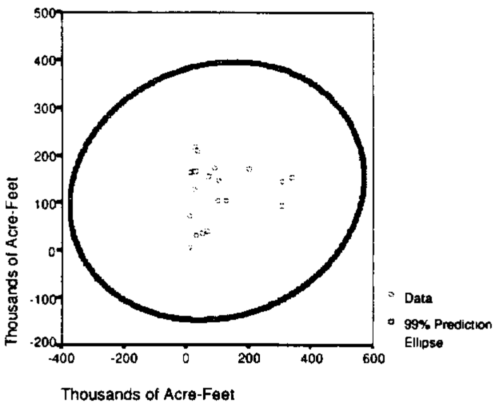


***Figure 3.31*** *May-June Inflows vs. July-August Inflows, PE.*

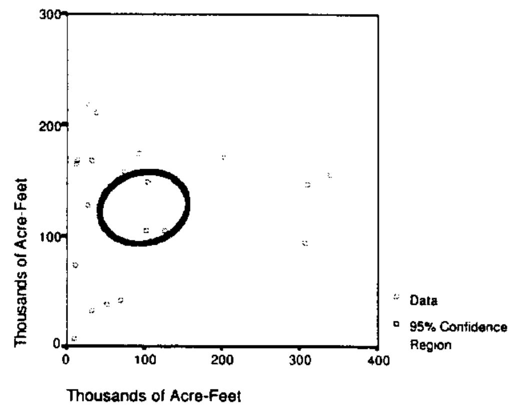


***Figure 3.32*** *May-June Inflows vs. July-August Inflows, CR.*

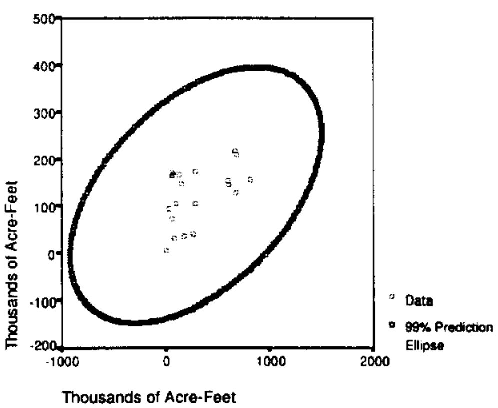


***Figure 3.33*** *May-June Inflows vs. September-October Inflows, PE.*

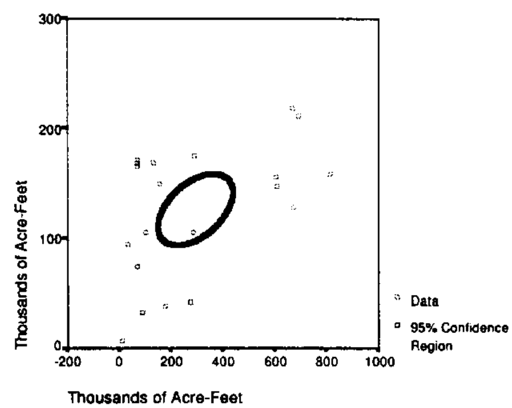


***Figure 3.34*** *May-June Inflows vs. September-October Inflows, CR.*

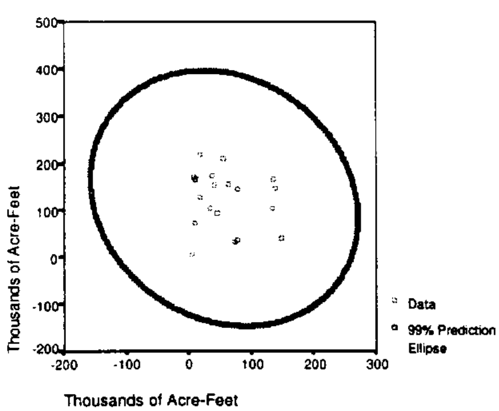


***Figure 3.35*** *May-June Inflows vs. November-December Inflows, PE.*

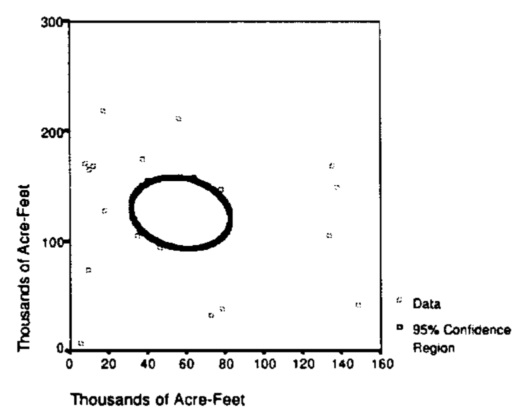


***Figure 3.36*** *May-June Inflows vs. November-December Inflows, CR.*

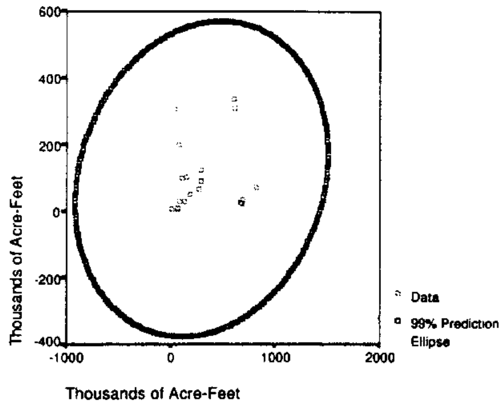


***Figure 3.37*** *July-August Inflows. vs. September-October Inflows, PE.*

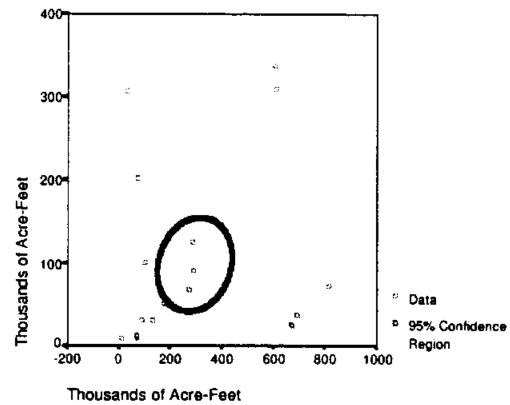


***Figure 3.38*** *July-August Inflows. vs. September-October Inflows, CR.*

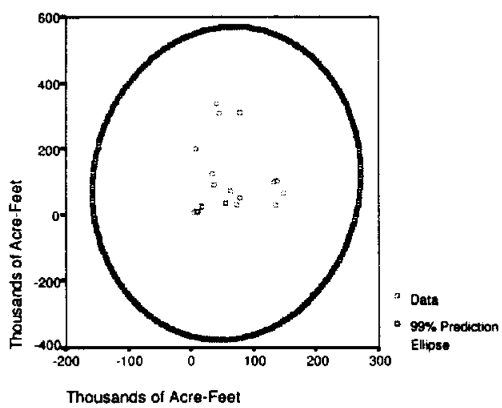


***Figure 3.39*** *July-August Inflows. vs. November-December Inflows, PE.*

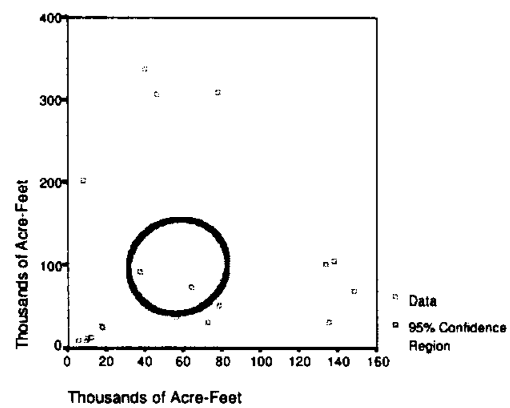


***Figure 3.40*** *July-August Inflows. vs. November-December Inflows, CR.*

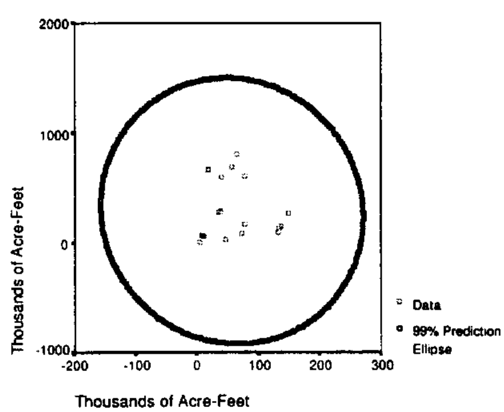


***Figure 3.41*** *September-October Inflows vs. November-December Inflows, PE.*

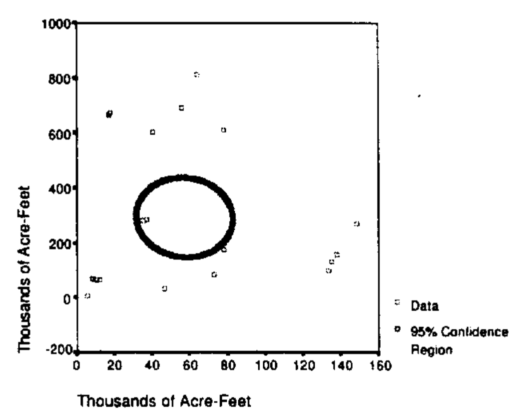


***Figure 3.42*** *September-October Inflows vs. November-December Inflows, CR.*

# 4. Box-Cox Analysis

***Table .4.1*** *Mean Square Error from Box-Cox transformation of the trout data and the inflow data for different lambda.*

| *Lam.* | *Trout* | *JF_inflow* | *MA_inflow* | *MJ_inflow* | *JA_inflow* | *SO_inflow* | *ND_inflow* |
|---|---|---|---|---|---|---|---|
| -2.0 | 1007046 | 8802.03 | 683.70 | 3973331 | 78647.81 | 35125032 | 44224.87 |
| -1.9 | 661901.8 | 6934.11 | 596.41 | 2618877 | 62167.31 | 21901470 | 33949.73 |
| -1.8 | 437495.5 | 5490.95 | 523.05 | 1734879 | 49380.12 | 13728189 | 26236.63 |
| -1.7 | 290979.1 | 4373.10 | 461.42 | 1155699 | 39431.52 | 8655697 | 20421.99 |
| -1.6 | 194882.6 | 3504.95 | 409.71 | 774646.5 | 31669.86 | 5493596 | 16018.95 |
| -1.5 | 131543.7 | 2828.90 | 366.42 | 522815.7 | 25597.49 | 3512848 | 12669.35 |
| -1.4 | 89571.94 | 2301.03 | 330.32 | 355572.9 | 20833.58 | 2265553 | 10108.99 |
| -1.3 | 61597.20 | 1887.78 | 300.42 | 243918.1 | 17086.22 | 1475597 | 8142.37 |
| -1.2 | 42834.12 | 1563.45 | 275.88 | 168947.8 | 14131.23 | 972149.1 | 6624.44 |
| -1.1 | 30163.97 | 1308.34 | 256.05 | 118296.1 | 11796.18 | 649106.6 | 5447.18 |
| -1.0 | 21546.04 | 1107.33 | 240.42 | 83844.21 | 9948.23 | 440292.3 | 4529.96 |
| -0.9 | 15639.33 | 948.78 | 228.59 | 60240.23 | 8484.94 | 304247.6 | 3812.35 |
| -0.8 | 11558.66 | 823.72 | 220.28 | 43941.45 | 7327.31 | 214874.8 | 3248.94 |
| -0.7 | 8716.92 | 725.25 | 215.31 | 32592.08 | 6414.44 | 155662.4 | 2805.50 |
| -0.6 | 6722.80 | 648.03 | 213.60 | 24618.09 | 5699.56 | 116107.4 | 2456.18 |
| -0.5 | 5314.23 | 587.97 | 215.18 | 18962.39 | 5146.93 | 89491.39 | 2181.42 |
| -0.4 | 4314.86 | 541.89 | 220.17 | 14911.17 | 4729.59 | 71492.48 | 1966.41 |
| -0.3 | 3605.64 | 507.39 | 228.82 | 11979.62 | 4427.67 | 59315.09 | 1799.96 |
| -0.2 | 3106.07 | 482.64 | 241.51 | 9836.45 | 4227.15 | 51142.47 | 1673.68 |
| -0.1 | 2761.92 | 466.25 | 258.75 | 8253.81 | 4118.98 | 45790.62 | 1581.33 |
| 0.0 | 2537.16 | 457.23 | 281.25 | 7073.92 | 4098.61 | 42488.60 | 1518.39 |
| 0.1 | 2408.71 | 454.89 | 309.95 | 6186.75 | 4165.65 | 40738.76 | 1481.74 |
| 0.2 | 2363.12 | 458.79 | 346.02 | 5515.00 | 4323.96 | 40227.58 | 1469.41 |
| 0.3 | 2394.54 | 468.72 | 391.00 | 5003.98 | 4581.89 | 40769.06 | 1480.40 |
| 0.4 | 2503.81 | 484.66 | 446.85 | 4614.70 | 4952.84 | 42269.01 | 1514.66 |
| 0.5 | 2698.25 | 506.78 | 516.06 | 4319.17 | 5456.18 | 44703.32 | 1572.97 |
| 0.6 | 2992.30 | 535.43 | 601.81 | 4097.16 | 6118.57 | 48105.47 | 1657.00 |
| 0.7 | 3408.96 | 571.14 | 708.15 | 3933.99 | 6975.76 | 52560.76 | 1769.30 |
| 0.8 | 3982.11 | 614.65 | 840.24 | 3818.94 | 8075.05 | 58205.40 | 1913.45 |
| 0.9 | 4760.22 | 666.88 | 1004.71 | 3744.21 | 9478.61 | 65229.86 | 2094.16 |
| 1.0 | 5811.65 | 729.00 | 1210.01 | 3704.13 | 11267.89 | 73885.72 | 2317.46 |
| 1.1 | 7232.38 | 802.45 | 1467.04 | 3694.63 | 13549.48 | 84496.52 | 2590.95 |
| 1.2 | 9157.00 | 888.98 | 1789.80 | 3712.84 | 16462.94 | 97472.61 | 2924.13 |
| 1.3 | 11774.61 | 990.69 | 2196.34 | 3756.86 | 20191.14 | 113330.9 | 3328.80 |
| 1.4 | 15351.41 | 1110.10 | 2710.01 | 3825.53 | 24974.09 | 132720.7 | 3819.55 |
| 1.5 | 20263.25 | 1250.26 | 3361.06 | 3918.30 | 31127.33 | 156456.1 | 4414.45 |
| 1.6 | 27042.33 | 1414.79 | 4188.73 | 4035.16 | 39066.46 | 185558.9 | 5135.76 |
| 1.7 | 36444.38 | 1608.02 | 5244.10 | 4176.54 | 49339.91 | 221311.7 | 6011.04 |
| 1.8 | 49545.67 | 1835.15 | 6593.74 | 4343.30 | 62672.75 | 265326.7 | 7074.30 |
| 1.9 | 67883.04 | 2102.39 | 8324.60 | 4536.69 | 80025.37 | 319633.5 | 8367.61 |
| 2.0 | 93656.71 | 2417.17 | 10550.47 | 4758.34 | 102672.2 | 386790.3 | 9943.03 |

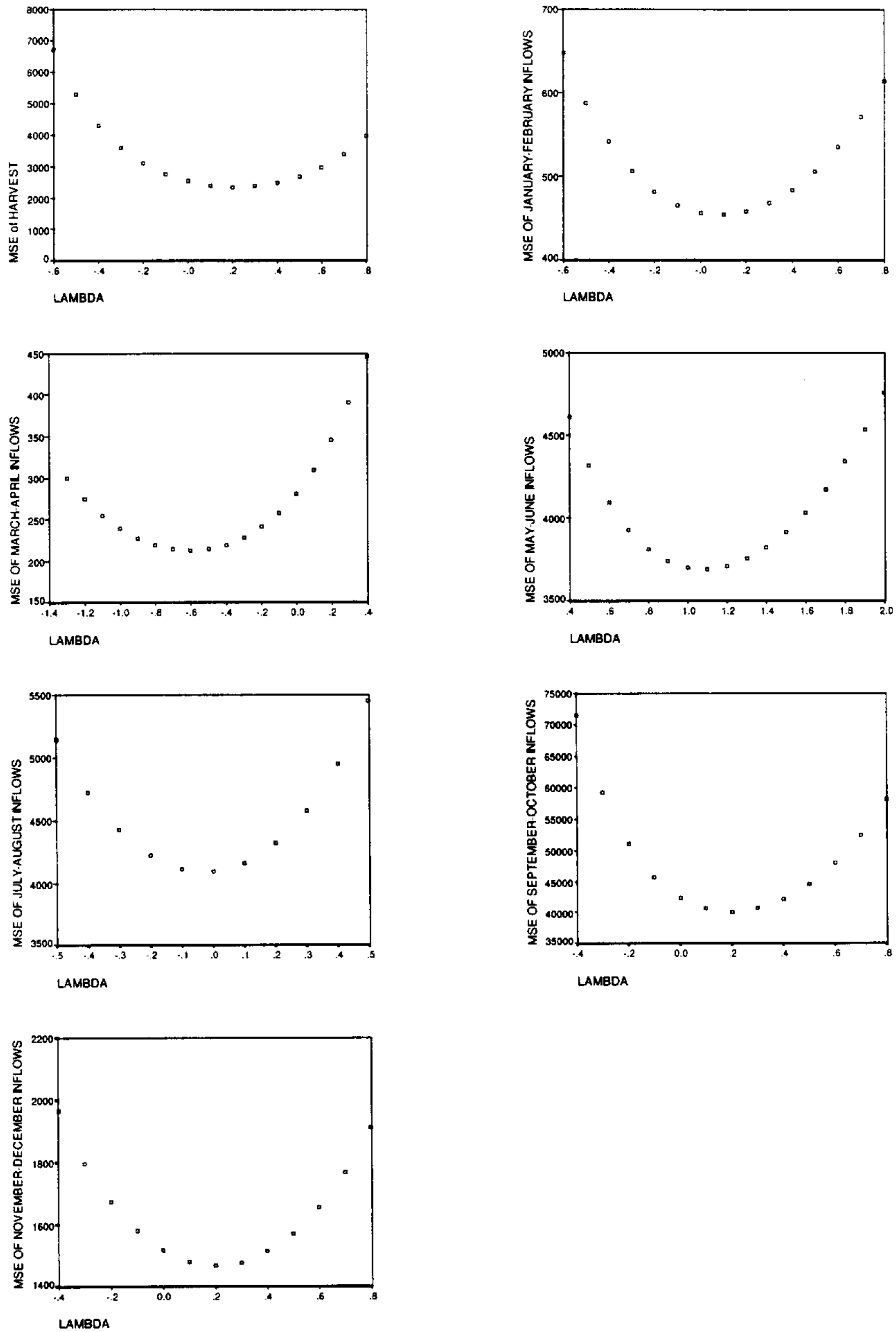


***Figure 4.1*** *Box-Cox Transformation - MSE of Trout vs. Lambda and MSE of Inflow data vs. Lambda.*

# 5. Model Choice Diagnostics

## 5.1 Untransformed trout data and untransformed inflow data

***Table 5.1*** *Regression Models for Dependent Variable: TROUT on INFLOWS*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.5215 | 0.4949 | 19.64 | 161.6 | 2935 | 163.6 | QJA_LAG |
| 1 | 0.2285 | 0.1857 | 41.47 | 171.1 | 4733 | 173.1 | QSO_LAG |
| 1 | 0.1495 | 0.1022 | 47.35 | 173.1 | 5217 | 175.1 | QMJ_LAG |
| 1 | 0.0943 | 0.0439 | 51.47 | 174.3 | 5556 | 176.3 | QJF_LAG |
| 2 | 0.6582 | 0.6179 | 11.46 | 156.9 | 2220 | 159.8 | QJA_LAG QSO_LAG |
| 2 | 0.6422 | 0.6001 | 12.65 | 157.8 | 2324 | 160.8 | QJF_LAG QSO_LAG |
| 2 | 0.6150 | 0.5697 | 14.68 | 159.2 | 2501 | 162.2 | QMJ_LAG QJA_LAG |
| 2 | 0.5385 | 0.4842 | 20.38 | 162.9 | 2998 | 165.8 | QMA_LAG QJA_LAG |
| 3 | 0.7591 | 0.7139 | 5.944 | 151.9 | 1663 | 155.8 | QJF_LAG QJA_LAG QSO_LAG |
| 3 | 0.7054 | 0.6502 | 9.943 | 155.9 | 2033 | 159.9 | QJF_LAG QMA_LAG QSO_LAG |
| 3 | 0.7048 | 0.6494 | 9.992 | 155.9 | 2038 | 159.9 | QMA_LAG QJA_LAG QSO_LAG |
| 3 | 0.6864 | 0.6275 | 11.36 | 157.1 | 2165 | 161.1 | QJF_LAG QSO_LAG QND_LAG |
| 4 | 0.8215 | 0.7739 | 3.296 | 147.9 | 1314 | 152.8 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG |
| 4 | 0.7830 | 0.7251 | 6.166 | 151.8 | 1598 | 156.8 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 4 | 0.7814 | 0.7232 | 6.280 | 151.9 | 1609 | 156.9 | QJF_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.7288 | 0.6564 | 10.20 | 156.2 | 1997 | 161.2 | QJF_LAG QMJ_LAG QSO_LAG QND_LAG |
| 5 | 0.8253 | 0.7629 | 5.016 | 149.4 | 1378 | 155.4 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.8223 | 0.7589 | 5.236 | 149.8 | 1401 | 155.7 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.8145 | 0.7483 | 5.817 | 150.6 | 1463 | 156.6 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.7289 | 0.6321 | 12.19 | 158.2 | 2138 | 164.2 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 6 | 0.8255 | 0.7449 | 7.000 | 151.4 | 1482 | 158.4 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 20

## 5.2 Log of trout data and untransformed inflow data

***Table 5.2*** *Regression Models for Dependent Variable: Ln(TROUT) on INFLOWS*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.4336 | 0.4021 | 44.15 | 4.723 | 1.152 | 6.714 | QMJ_LAG |
| 1 | 0.3824 | 0.3481 | 49.59 | 6.453 | 1.256 | 8.445 | QJA_LAG |
| 1 | 0.1995 | 0.1550 | 69.01 | 11.64 | 1.628 | 13.63 | QSO_LAG |
| 1 | 0.0887 | 0.0381 | 80.78 | 14.23 | 1.853 | 16.23 | QMA_LAG |
| 2 | 0.7322 | 0.7007 | 14.44 | -8.260 | 0.577 | -5.273 | QMJ_LAG QJA_LAG |
| 2 | 0.5632 | 0.5118 | 32.39 | 1.526 | 0.941 | 4.514 | QJF_LAG QMJ_LAG |
| 2 | 0.5141 | 0.4570 | 37.60 | 3.654 | 1.046 | 6.642 | QMA_LAG QJA_LAG |
| 2 | 0.5079 | 0.4500 | 38.26 | 3.908 | 1.060 | 6.896 | QJA_LAG QSO_LAG |
| 3 | 0.7858 | 0.7456 | 10.75 | -10.72 | 0.490 | -6.742 | QMA_LAG QMJ_LAG QJA_LAG |
| 3 | 0.7705 | 0.7274 | 12.38 | -9.342 | 0.525 | -5.360 | QMJ_LAG QJA_LAG QND_LAG |
| 3 | 0.7466 | 0.6991 | 14.91 | -7.362 | 0.580 | -3.379 | QJF_LAG QMJ_LAG QJA_LAG |
| 3 | 0.7390 | 0.6901 | 15.72 | -6.773 | 0.597 | -2.790 | QMJ_LAG QJA_LAG QSO_LAG |
| 4 | 0.8202 | 0.7723 | 9.089 | -12.23 | 0.439 | -7.253 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 4 | 0.7969 | 0.7428 | 11.57 | -9.792 | 0.496 | -4.813 | QJF_LAG QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.7932 | 0.7380 | 11.97 | -9.425 | 0.505 | -4.447 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG |
| 4 | 0.7870 | 0.7302 | 12.62 | -8.835 | 0.520 | -3.856 | QMA_LAG QMJ_LAG QJA_LAG QND_LAG |
| 5 | 0.8775 | 0.8337 | 5.012 | -17.90 | 0.320 | -11.92 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.8439 | 0.7882 | 8.573 | -13.06 | 0.408 | -7.085 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.8253 | 0.7630 | 10.55 | -10.81 | 0.457 | -4.833 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.8191 | 0.7544 | 11.21 | -10.10 | 0.473 | -4.127 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.8776 | 0.8211 | 7.000 | -15.92 | 0.345 | -8.945 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 20

## 5.3 Log of trout data and log of inflow data

***Table 5.3*** *Regression Models for Dependent Variable: Ln(TROUT) on Ln(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.5580 | 0.5335 | 45.12 | -0.239 | 0.899 | 1.752 | LN_QMJ |
| 1 | 0.4469 | 0.4162 | 60.48 | 4.247 | 1.125 | 6.238 | LN_QJA |
| 1 | 0.2524 | 0.2109 | 87.38 | 10.27 | 1.520 | 12.26 | LN_QSO |
| 1 | 0.1449 | 0.0974 | 102.3 | 12.96 | 1.739 | 14.95 | LN_QMA |
| 2 | 0.7729 | 0.7462 | 17.40 | -11.56 | 0.489 | -8.572 | LN_QMJ LN_QJA |
| 2 | 0.7057 | 0.6710 | 26.70 | -6.368 | 0.634 | -3.381 | LN_QJF LN_QMJ |
| 2 | 0.6003 | 0.5533 | 41.27 | -0.251 | 0.861 | 2.736 | LN_QMJ LN_QND |
| 2 | 0.5641 | 0.5128 | 46.28 | 1.485 | 0.939 | 4.473 | LN_QMJ LN_QSO |
| 3 | 0.8342 | 0.8031 | 10.93 | -15.84 | 0.379 | -11.86 | LN_QJF LN_QMJ LN_QND |
| 3 | 0.8279 | 0.7956 | 11.80 | -15.10 | 0.394 | -11.12 | LN_QJF LN_QMJ LN_QJA |
| 3 | 0.8191 | 0.7852 | 13.01 | -14.11 | 0.414 | -10.12 | LN_QJF LN_QMJ LN_QSO |
| 3 | 0.7937 | 0.7550 | 16.53 | -11.48 | 0.472 | -7.496 | LN_QJF LN_QMA LN_QSO |
| 4 | 0.8943 | 0.8661 | 4.617 | -22.85 | 0.258 | -17.87 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.8800 | 0.8481 | 6.588 | -20.32 | 0.293 | -15.34 | LN_QJF LN_QMA LN_QMJ LN_QSO |
| 4 | 0.8630 | 0.8265 | 8.943 | -17.67 | 0.334 | -12.69 | LN_QJF LN_QMJ LN_QJA LN_QSO |
| 4 | 0.8566 | 0.8184 | 9.824 | -16.76 | 0.350 | -11.78 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 5 | 0.9032 | 0.8686 | 5.392 | -22.60 | 0.253 | -16.63 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.8997 | 0.8638 | 5.877 | -21.89 | 0.262 | -15.92 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.8967 | 0.8597 | 6.291 | -21.30 | 0.270 | -15.33 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.8590 | 0.8086 | 11.50 | -15.09 | 0.369 | -9.114 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 6 | 0.9060 | 0.8626 | 7.000 | -21.20 | 0.265 | -14.23 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 20

## 5.4 Log of trout data and square root of inflow data

***Table 5.4*** *Regression Models for Dependent Variable: Ln(TROUT) on Sqrt(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.5233 | 0.4968 | 53.05 | 1.273 | 0.969 | 3.265 | SQR_QMJ |
| 1 | 0.4300 | 0.3983 | 66.57 | 4.849 | 1.159 | 6.840 | SQR_QJA |
| 1 | 0.2233 | 0.1802 | 96.52 | 11.04 | 1.580 | 13.03 | SQR_QSO |
| 1 | 0.1107 | 0.0613 | 112.8 | 13.75 | 1.809 | 15.74 | SQR_QMA |
| 2 | 0.7968 | 0.7729 | 15.44 | -13.78 | 0.438 | -10.79 | SQR_QMJ SQR_QJA |
| 2 | 0.6460 | 0.6043 | 37.28 | -2.677 | 0.762 | 0.310 | SQR_QJF SQR_QMJ |
| 2 | 0.5868 | 0.5382 | 45.86 | 0.416 | 0.890 | 3.403 | SQR_QMJ SQR_QND |
| 2 | 0.5518 | 0.4991 | 50.93 | 2.042 | 0.965 | 5.029 | SQR_QMA SQR_QJA |
| 3 | 0.8197 | 0.7859 | 14.12 | -14.17 | 0.413 | -10.19 | SQR_QMA SQR_QMJ SQR_QJA |
| 3 | 0.8128 | 0.7776 | 15.13 | -13.42 | 0.428 | -9.433 | SQR_QJF SQR_QMJ SQR_QJA |
| 3 | 0.8108 | 0.7754 | 15.40 | -13.21 | 0.433 | -9.228 | SQR_QMJ SQR_QJA SQR_QND |
| 3 | 0.8011 | 0.7638 | 16.81 | -12.21 | 0.455 | -8.226 | SQR_QMJ SQR_QJA SQR_QSO |
| 4 | 0.8599 | 0.8225 | 10.30 | -17.22 | 0.342 | -12.24 | SQR_QJF SQR_QMJ SQR_QSO SQR_QND |
| 4 | 0.8482 | 0.8077 | 11.99 | -15.61 | 0.370 | -10.63 | SQR_QJF SQR_QMJ SQR_QJA SQR_QND |
| 4 | 0.8456 | 0.8044 | 12.37 | -15.27 | 0.377 | -10.29 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO |
| 4 | 0.8453 | 0.8040 | 12.41 | -15.23 | 0.378 | -10.25 | SQR_QJF SQR_QMA SQR_QMJ SQR_QSO |
| 5 | 0.9103 | 0.8782 | 5.000 | -24.13 | 0.235 | -18.15 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO |
| 5 | 0.8888 | 0.8491 | 8.113 | -19.83 | 0.291 | -13.86 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.8645 | 0.8162 | 11.62 | -15.89 | 0.354 | -9.915 | SQR_QJF SQR_QMA SQR_QMJ SQR_QSO SQR_QND |
| 5 | 0.8593 | 0.8091 | 12.38 | -15.13 | 0.368 | -9.159 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 6 | 0.9103 | 0.8688 | 7.000 | -22.13 | 0.253 | -15.16 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

N = 20

## 5.5 Square root of trout data and untransformed inflow data

***Table 5.5*** *Regression Models for Dependent Variable: Sqrt(TROUT) on INFLOWS*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.4992 | 0.4714 | 47.15 | 47.59 | 9.83 | 49.59 | QJA_LAG |
| 1 | 0.2709 | 0.2304 | 75.93 | 55.11 | 14.31 | 57.10 | QMJ_LAG |
| 1 | 0.2264 | 0.1834 | 81.55 | 56.29 | 15.18 | 58.28 | QSO_LAG |
| 1 | 0.0789 | 0.0278 | 100.1 | 59.78 | 18.07 | 61.77 | QJF_LAG |
| 2 | 0.6949 | 0.6591 | 24.47 | 39.68 | 6.34 | 42.67 | QMJ_LAG QJA_LAG |
| 2 | 0.6360 | 0.5932 | 31.90 | 43.21 | 7.56 | 46.20 | QJA_LAG QSO_LAG |
| 2 | 0.6004 | 0.5533 | 36.39 | 45.08 | 8.30 | 48.07 | QJF_LAG QSO_LAG |
| 2 | 0.5683 | 0.5175 | 40.43 | 46.62 | 8.97 | 49.61 | QMA_LAG QJA_LAG |
| 3 | 0.7597 | 0.7147 | 18.30 | 36.90 | 5.30 | 40.89 | QMA_LAG QJA_LAG QSO_LAG |
| 3 | 0.7486 | 0.7015 | 19.70 | 37.81 | 5.55 | 41.79 | QJF_LAG QMA_LAG QSO_LAG |
| 3 | 0.7277 | 0.6766 | 22.34 | 39.41 | 6.01 | 43.40 | QMJ_LAG QJA_LAG QSO_LAG |
| 3 | 0.7241 | 0.6724 | 22.78 | 39.67 | 6.09 | 43.65 | QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.8671 | 0.8316 | 6.764 | 27.07 | 3.13 | 32.05 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG |
| 4 | 0.8156 | 0.7664 | 13.25 | 33.62 | 4.34 | 38.59 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 4 | 0.7963 | 0.7420 | 15.68 | 35.60 | 4.80 | 40.58 | QJF_LAG QMJ_LAG QSO_LAG QND_LAG |
| 4 | 0.7918 | 0.7363 | 16.25 | 36.04 | 4.90 | 41.02 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.8968 | 0.8600 | 5.010 | 24.00 | 2.60 | 29.97 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.8779 | 0.8343 | 7.393 | 27.36 | 3.08 | 33.34 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.8731 | 0.8278 | 7.996 | 28.13 | 3.20 | 34.11 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.8006 | 0.7293 | 17.15 | 37.18 | 5.03 | 43.16 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 6 | 0.8969 | 0.8493 | 7.000 | 25.98 | 2.80 | 32.95 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 20

## 5.6 Square root of trout data and log of inflow data

***Table 5.6*** *Regression Models for Dependent Variable: Sqrt(TROUT) on Ln(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.5051 | 0.4776 | 27.61 | 47.36 | 9.71 | 49.35 | LN_QJA |
| 1 | 0.3356 | 0.2987 | 42.55 | 53.25 | 13.04 | 55.24 | LN_QMJ |
| 1 | 0.2344 | 0.1919 | 51.47 | 56.08 | 15.02 | 58.07 | LN_QSO |
| 1 | 0.1023 | 0.0524 | 63.11 | 59.27 | 17.62 | 61.26 | LN_QND |
| 2 | 0.6507 | 0.6096 | 16.78 | 42.39 | 7.26 | 45.38 | LN_QMJ LN_QJA |
| 2 | 0.6429 | 0.6008 | 17.47 | 42.83 | 7.42 | 45.82 | LN_QJF LN_QSO |
| 2 | 0.5737 | 0.5235 | 23.57 | 46.38 | 8.86 | 49.36 | LN_QJA LN_QSO |
| 2 | 0.5251 | 0.4692 | 27.85 | 48.53 | 9.87 | 51.52 | LN_QMA LN_QJA |
| 3 | 0.7791 | 0.7377 | 7.463 | 35.22 | 4.88 | 39.20 | LN_QJF LN_QMA LN_QSO |
| 3 | 0.7616 | 0.7169 | 9.013 | 36.75 | 5.26 | 40.74 | LN_QJF LN_QMJ LN_QSO |
| 3 | 0.7160 | 0.6628 | 13.03 | 40.25 | 6.27 | 44.23 | LN_QJF LN_QJA LN_QSO |
| 3 | 0.7138 | 0.6601 | 13.23 | 40.41 | 6.32 | 44.39 | LN_QJF LN_QMJ LN_QJA |
| 4 | 0.8504 | 0.8105 | 3.183 | 29.43 | 3.52 | 34.41 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.8107 | 0.7602 | 6.682 | 34.14 | 4.46 | 39.12 | LN_QJF LN_QMJ LN_QJA LN_QSO |
| 4 | 0.8083 | 0.7572 | 6.892 | 34.39 | 4.51 | 39.37 | LN_QJF LN_QMA LN_QJA LN_QSO |
| 4 | 0.8040 | 0.7518 | 7.271 | 34.83 | 4.61 | 39.81 | LN_QJF LN_QMA LN_QMJ LN_QSO |
| 5 | 0.8524 | 0.7997 | 5.004 | 31.16 | 3.72 | 37.13 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.8505 | 0.7971 | 5.175 | 31.42 | 3.77 | 37.39 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.8347 | 0.7757 | 6.564 | 33.42 | 4.17 | 39.40 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.8087 | 0.7404 | 8.855 | 36.34 | 4.83 | 42.32 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 6 | 0.8525 | 0.7844 | 7.000 | 33.15 | 4.01 | 40.12 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 20

## 5.7 Square root of trout data and square root of inflow data

***Table 5.7*** *Regression Models for Dependent Variable: Sqrt(TROUT) on Sqrt(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.5224 | 0.4959 | 38.73 | 46.64 | 9.37 | 48.64 | SQR_QJA |
| 1 | 0.3243 | 0.2867 | 61.45 | 53.59 | 13.26 | 55.58 | SQR_QMJ |
| 1 | 0.2385 | 0.1962 | 71.28 | 55.98 | 14.94 | 57.97 | SQR_QSO |
| 1 | 0.0738 | 0.0223 | 90.16 | 59.89 | 18.17 | 61.88 | SQR_QJF |
| 2 | 0.7117 | 0.6777 | 19.05 | 38.55 | 5.99 | 41.54 | SQR_QMJ SQR_QJA |
| 2 | 0.6438 | 0.6019 | 26.83 | 42.78 | 7.40 | 45.77 | SQR_QJA SQR_QSO |
| 2 | 0.6205 | 0.5759 | 29.50 | 44.05 | 7.88 | 47.03 | SQR_QJF SQR_QSO |
| 2 | 0.5682 | 0.5174 | 35.49 | 46.63 | 8.97 | 49.62 | SQR_QMA SQR_QJA |
| 3 | 0.7803 | 0.7391 | 13.18 | 35.12 | 4.85 | 39.10 | SQR_QJF SQR_QMA SQR_QSO |
| 3 | 0.7433 | 0.6951 | 17.42 | 38.23 | 5.67 | 42.21 | SQR_QJF SQR_QMJ SQR_QSO |
| 3 | 0.7375 | 0.6883 | 18.09 | 38.68 | 5.79 | 42.66 | SQR_QMJ SQR_QJA SQR_QSO |
| 3 | 0.7330 | 0.6830 | 18.60 | 39.01 | 5.89 | 43.00 | SQR_QJF SQR_QJA SQR_QSO |
| 4 | 0.8570 | 0.8189 | 6.386 | 28.52 | 3.37 | 33.50 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO |
| 4 | 0.8445 | 0.8030 | 7.827 | 30.21 | 3.66 | 35.19 | SQR_QJF SQR_QMJ SQR_QSO SQR_QND |
| 4 | 0.8325 | 0.7879 | 9.195 | 31.69 | 3.94 | 36.67 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO |
| 4 | 0.8120 | 0.7619 | 11.54 | 34.00 | 4.43 | 38.98 | SQR_QJF SQR_QMA SQR_QMJ SQR_QSO |
| 5 | 0.8850 | 0.8439 | 5.182 | 26.17 | 2.90 | 32.15 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO |
| 5 | 0.8768 | 0.8329 | 6.116 | 27.54 | 3.11 | 33.52 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.8654 | 0.8174 | 7.424 | 29.31 | 3.39 | 35.29 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.8449 | 0.7895 | 9.781 | 32.16 | 3.91 | 38.13 | SQR_QJF SQR_QMA SQR_QMJ SQR_QSO SQR_QND |
| 6 | 0.8866 | 0.8342 | 7.000 | 27.89 | 3.08 | 34.86 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

N = 20

## 5.8 Various transformation suggested by Box-Cox

***Table 5.8*** *Regression Models for Dependent Variable: (TROUT)$^{0.2}$ on variously transformed INFLOWS.*

| Rsq In | Adj | C(p) Rsq | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|
| 1 | 0.4846 | 0.4560 | 35.89 | -34.23 | 0.1643 | -32.24 LN_QJA |
| 1 | 0.3516 | 0.3155 | 49.29 | -29.64 | 0.2067 | -27.65 QR_QMJ |
| 1 | 0.2421 | 0.2000 | 60.31 | -26.52 | 0.2416 | -24.53 QR_QSO |
| 1 | 0.1230 | 0.0743 | 72.30 | -23.60 | 0.2795 | -21.61 QR_QMA |
| 2 | 0.7359 | 0.7048 | 12.59 | -45.60 | 0.0891 | -42.61 QR_QMJ LN_QJA |
| 2 | 0.5679 | 0.5170 | 29.51 | -35.76 | 0.1458 | -32.77 LN_QJA QR_QSO |
| 2 | 0.5565 | 0.5043 | 30.66 | -35.24 | 0.1497 | -32.25 QR_QMA LN_QJA |
| 2 | 0.5449 | 0.4914 | 31.82 | -34.72 | 0.1536 | -31.73 QR_QJF QR_QSO |
| 3 | 0.8152 | 0.7806 | 6.607 | -50.75 | 0.0663 | -46.76 QR_QJF QR_QMA QR_QSO |
| 3 | 0.7671 | 0.7235 | 11.45 | -46.12 | 0.0835 | -42.14 QR_QJF QR_QMJ LN_QJA |
| 3 | 0.7385 | 0.6895 | 14.33 | -43.80 | 0.0938 | -39.82 QR_QMJ LN_QJA QR_QND |
| 3 | 0.7380 | 0.6888 | 14.38 | -43.76 | 0.0940 | -39.78 QR_QMJ LN_QJA QR_QSO |
| 4 | 0.8430 | 0.8012 | 5.805 | -52.01 | 0.0600 | -47.03 QR_QJF QR_QMA LN_QJA QR_QSO |
| 4 | 0.8291 | 0.7836 | 7.205 | -50.31 | 0.0654 | -45.33 QR_QJF QR_QMJ QR_QSO QR_QND |
| 4 | 0.8231 | 0.7759 | 7.813 | -49.62 | 0.0677 | -44.64 QR_QJF QR_QMA QR_QMJ QR_QSO |
| 4 | 0.8167 | 0.7679 | 8.452 | -48.91 | 0.0701 | -43.93 QR_QJF QR_QMA QR_QSO QR_QND |
| 5 | 0.8663 | 0.8185 | 5.465 | -53.21 | 0.0548 | -47.24 QR_QJF QR_QMA QR_QMJ LN_QJA QR_QSO |
| 5 | 0.8550 | 0.8032 | 6.598 | -51.60 | 0.0594 | -45.62 QR_QJF QR_QMJ LN_QJA QR_QSO QR_QND |
| 5 | 0.8461 | 0.7911 | 7.499 | -50.40 | 0.0631 | -44.43 QR_QJF QR_QMA LN_QJA QR_QSO QR_QND |
| 5 | 0.8457 | 0.7905 | 7.540 | -50.35 | 0.0632 | -44.37 QR_QJF QR_QMA QR_QMJ QR_QSO QR_QND |
| 6 | 0.8709 | 0.8113 | 7.000 | -51.92 | 0.0570 | -44.95 QR_QJF QR_QMA QR_QMJ LN_QJA QR_QSO QR_QND |

N = 20

Dependent Variable: (*TROUT*)$^{0.2}$

Independent Variables: *QR_QJF*=(January-February Inflows)$^{0.1}$

*QR_QMA*=(March-April Inflows)$^{-0.6}$

*QR_QMJ*=(May-June Inflows)$^{1.1}$

*QR_QMJ*=(September-October Inflows)$^{0.2}$

*QR_QND*=(November-December Inflows)$^{0.2}$

# 6. REGRESSION FOR THE BEST MODELS

## 6.1 Regression - Log of trout data on log of inflow data

### 6.1.1 ANOVA and Parameter Estimates

***Table 6.1*** *Model Summary for log of trout data on log of inflow data.*

**Model Summary[a,b]**

| Model | Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|
| 1 | Ln(January-February ), Ln(March-April), Ln(May-June), Ln(July-August), Ln(September-October), Ln(November-Desember)[c,d] | .952 | .906 | .863 | .5145 | 1.643 |

a. Dependent Variable: Ln(Trout Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Ln(September-October Inflows), Ln(March-April Inflows), Ln(July-August Inflows), Ln(November-Desember Inflows), Ln(January-February Inflows), Ln(May-June Inflows)

d. All requested variables entered.

***Table 6.2*** *ANOVA table of log of trout data on log of inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 33.168 | 6 | 5.528 | 20.881 | .000[b] |
| | Residual | 3.442 | 13 | .265 | | |
| | Total | 36.609 | 19 | | | |

a. Dependent Variable: Ln(Trout Harvest)

b. Independent Variables: (Constant), Ln(September-October Inflows), Ln(March-April Inflows), Ln(July-August Inflows), Ln(November-Desember Inflows), Ln(January-February Inflows), Ln(May-June Inflows)

***Table 6.3*** *Table of coefficients for log of trout data on log of inflow data.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| (Constant) | -1.627 | .900 | | -1.807 | .094 | -3.572 | .318 |
| Ln(January-February) | -1.213 | .293 | -.631 | -4.136 | .001 | -1.846 | -.579 |
| Ln(March-April) | .342 | .301 | .189 | 1.136 | .276 | -.308 | .992 |
| Ln(May-June) | .907 | .310 | .537 | 2.923 | .012 | .236 | 1.577 |
| Ln(July-August) | .174 | .186 | .141 | .936 | .366 | -.228 | .577 |
| Ln(September-October) | .549 | .215 | .469 | 2.549 | .024 | .084 | 1.014 |
| Ln(November-December) | .150 | .239 | .113 | .626 | .542 | -.366 | .666 |

a. Dependent Variable: Ln(Trout Harvest)

### 6.1.2 Collinearity Diagnostic

***Table 6.4*** *Variance Inflation for log of trout data on log of inflow data.*

**Coefficients[a]**

| | t | Collinearity Statistics | |
|---|---|---|---|
| | | Tolerance | VIF |
| (Constant) | -1.807 | | |
| Ln(January-February) | -4.136 | .311 | 3.219 |
| Ln(March-April) | 1.136 | .261 | 3.837 |
| Ln(May-June) | 2.923 | .214 | 4.669 |
| Ln(July-August) | .936 | .317 | 3.157 |
| Ln(September-October) | 2.549 | .214 | 4.684 |
| Ln(November-Desember) | .626 | .223 | 4.477 |

a. Dependent Variable: Ln(Trout Harvest)

***Table 6.5*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(TROUT) on Ln(INFLOWS):*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *LN_QJF* | Var Prop *LN_QMA* | Var Prop *LN_QMJ* | Var Prop *LN_QJA* | Var Prop *LN_QSO* | Var Prop *LN_QND* |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.60545 | 1.00000 | 0.0186 | 0.0124 | 0.0170 | 0.0097 | 0.0199 | 0.0162 |
| 2 | 1.27071 | 1.43192 | 0.0886 | 0.0010 | 0.0007 | 0.1287 | 0.0050 | 0.0145 |
| 3 | 1.03622 | 1.58568 | 0.0000 | 0.1484 | 0.0008 | 0.0279 | 0.0540 | 0.0113 |
| 4 | 0.87177 | 1.72878 | 0.0319 | 0.0142 | 0.1208 | 0.0002 | 0.0004 | 0.0945 |
| 5 | 0.14329 | 4.26420 | 0.8404 | 0.0159 | 0.0028 | 0.5403 | 0.4530 | 0.0831 |
| 6 | 0.07256 | 5.99211 | 0.0205 | 0.8082 | 0.8578 | 0.2932 | 0.4675 | 0.7803 |

### 6.1.3 Residuals Diagnostics

***Table 6.6*** *Residuals Diagnostics for log of trout data on log of inflow data.*

**Residuals Statistics**[a]

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | .7242 | 5.3245 | 3.5915 | 1.3212 | 20 |
| Std. Predicted Value | -2.170 | 1.312 | .000 | 1.000 | 20 |
| Standard Error of Predicted Value | .2024 | .4677 | .2981 | 6.34E-02 | 20 |
| Adjusted Predicted Value | -.3766 | 5.4120 | 3.5245 | 1.4883 | 20 |
| Residual | -.6128 | .7807 | 5.6E-16 | .4256 | 20 |
| Std. Residual | -1.191 | 1.517 | .000 | .827 | 20 |
| Stud. Residual | -1.545 | 2.013 | .040 | 1.080 | 20 |
| Deleted Residual | -1.2037 | 1.5490 | 6.7E-02 | .7708 | 20 |
| Stud. Deleted Residual | -1.643 | 2.332 | .067 | 1.159 | 20 |
| Mahal. Distance | 1.991 | 14.750 | 5.700 | 2.989 | 20 |
| Cook's Distance | .000 | .791 | .148 | .242 | 20 |
| Centered Leverage Value | .105 | .776 | .300 | .157 | 20 |

a. Dependent Variable: Ln(Trout Harvest)

***Table 6.7*** *Case Values for Residuals Diagnostics for log of trout data on log of inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1961 | 2.29087 | -.34496 | -.51264 | 2.45855 | -.98438 | -.67043 | -.81729 | -.80622 |
| 1962 | 2.01897 | -.16267 | -.21381 | 2.07011 | -1.19017 | -.31616 | -.36247 | -.35002 |
| 1963 | 1.45329 | -.42368 | -.61715 | 1.64677 | -1.61831 | -.82342 | -.99381 | -.99329 |
| 1964 | .72418 | .23133 | 1.33207 | -.37656 | -2.17015 | .44959 | 1.07887 | 1.08631 |
| 1965 | 2.31094 | .26928 | .33386 | 2.24636 | -.96919 | .52334 | .58274 | .56733 |
| 1966 | 3.16634 | .06841 | .10304 | 3.13171 | -.32176 | .13295 | .16317 | .15693 |
| 1967 | 3.20669 | -.53254 | -.78596 | 3.46011 | -.29122 | -1.03501 | -1.25739 | -1.28898 |
| 1968 | 3.42819 | -.61278 | -.89347 | 3.70888 | -.12358 | -1.19095 | -1.43807 | -1.50669 |
| 1969 | 2.87515 | .78069 | 1.34428 | 2.31156 | -.54216 | 1.51728 | 1.99101 | 2.29445 |
| 1970 | 3.63830 | .64667 | .81557 | 3.46940 | .03544 | 1.25681 | 1.41143 | 1.47367 |
| 1971 | 3.92715 | .69291 | 1.54896 | 3.07110 | .25406 | 1.34669 | 2.01348 | 2.33199 |
| 1972 | 5.32453 | -.29213 | -.37956 | 5.41195 | 1.31169 | -.56776 | -.64717 | -.63204 |
| 1973 | 5.23517 | .51454 | .73842 | 5.01129 | 1.24407 | 1.00001 | 1.19798 | 1.22031 |
| 1974 | 5.18308 | -.06150 | -.10037 | 5.22195 | 1.20464 | -.11952 | -.15269 | -.14683 |
| 1975 | 4.89100 | -.08780 | -.10862 | 4.91182 | .98357 | -.17063 | -.18980 | -.18260 |
| 1976 | 4.59160 | -.36185 | -.42812 | 4.65787 | .75697 | -.70326 | -.76496 | -.75207 |
| 1977 | 4.44930 | -.02566 | -.03731 | 4.46096 | .64927 | -.04986 | -.06013 | -.05778 |
| 1978 | 4.13069 | .00288 | .00455 | 4.12901 | .40812 | .00560 | .00704 | .00676 |
| 1979 | 4.41752 | .22398 | .39855 | 4.24295 | .62521 | .43531 | .58068 | .56528 |
| 1980 | 4.56641 | -.52511 | -1.20371 | 5.24501 | .73790 | -1.02057 | -1.54517 | -1.64309 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that observation |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.
[2]This is flagged if it exceeds $t_{n-p-2,a}=t_{12,0.01}=2.681$.

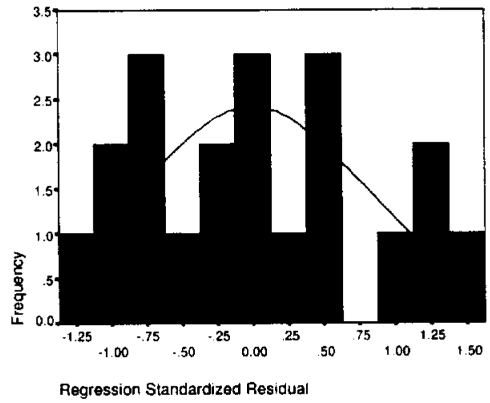


***Figure 6.1*** *Histogram of Standardized Residuals.*

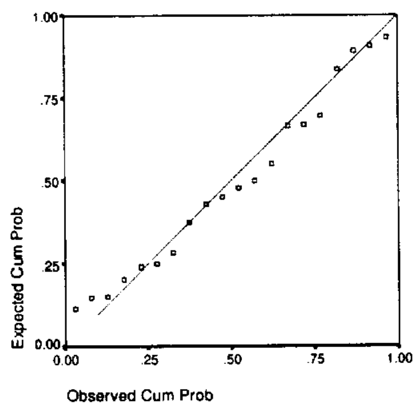


***Figure 6.2*** *Normal P-P Plot of Residuals.*

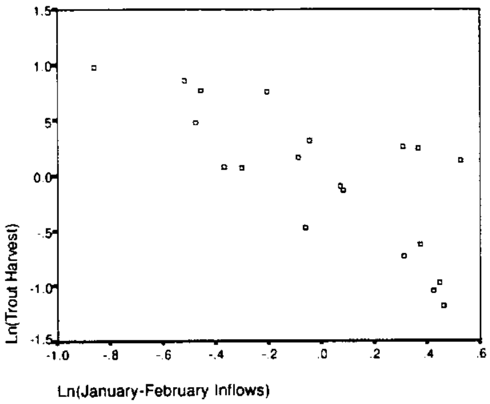


*Figure 6.3* *Partial Residual Plot for Ln(January-February Inflows).*

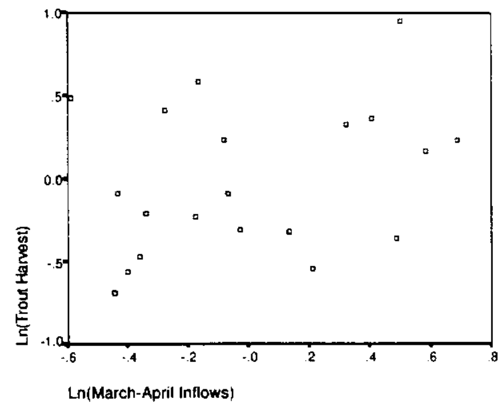


*Figure 6.4* *Partial Residual Plot for Ln(March-April Inflows).*

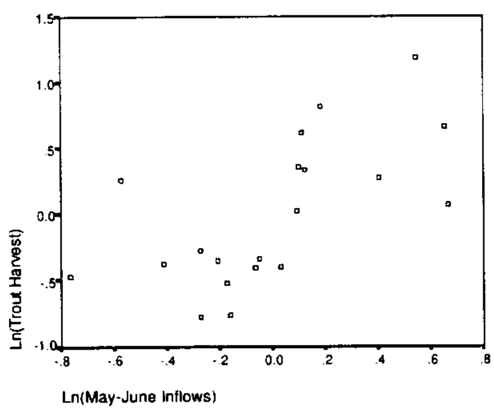


*Figure 6.5* *Partial Residual Plot for Ln(May-June Inflows).*

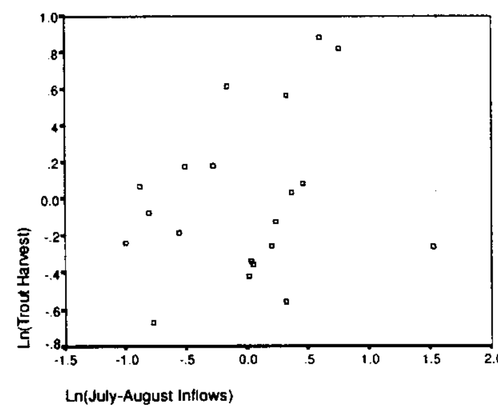


*Figure 6.6* *Partial Residual Plot for Ln(July-August Inflows).*

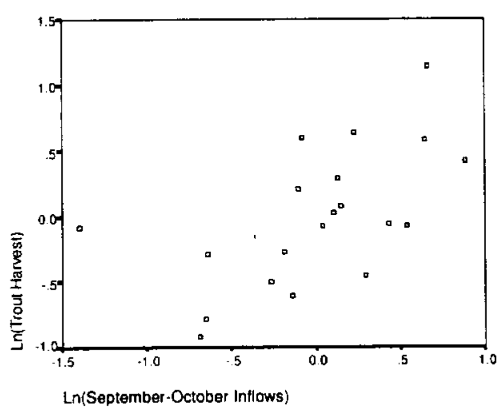


*Figure 6.7* *Partial Residual Plot for Ln(September-October Inflows).*

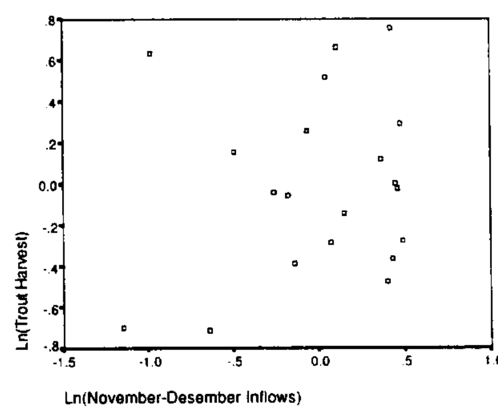


*Figure 6.8* *Partial Residual Plot for Ln(November-December Inflows).*

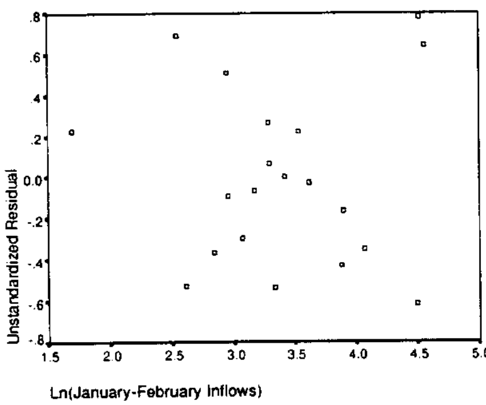


***Figure 6.9*** *Residuals Plot for Ln(January-February Inflows).*

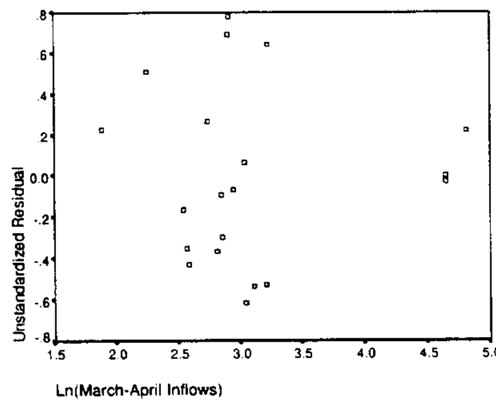


***Figure 6.10*** *Residuals Plot for Ln(March-April Inflows).*

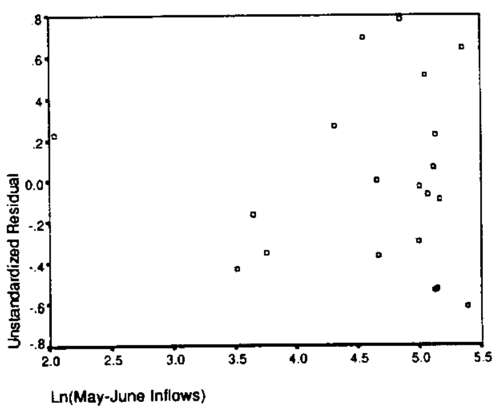


***Figure 6.11*** *Residuals Plot for Ln(May-June Inflows).*

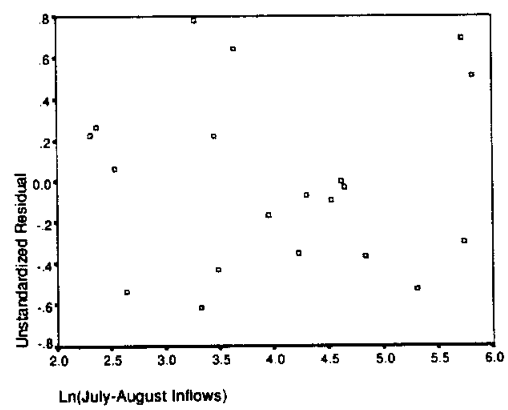


***Figure 6.12*** *Residuals Plot for Ln(July-August Inflows).*

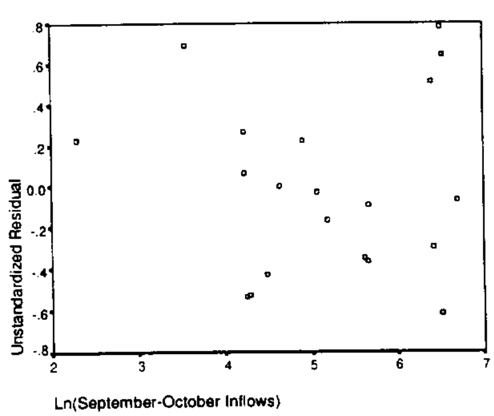


***Figure 6.13*** *Residuals Plot for Ln(September-October Inflows).*

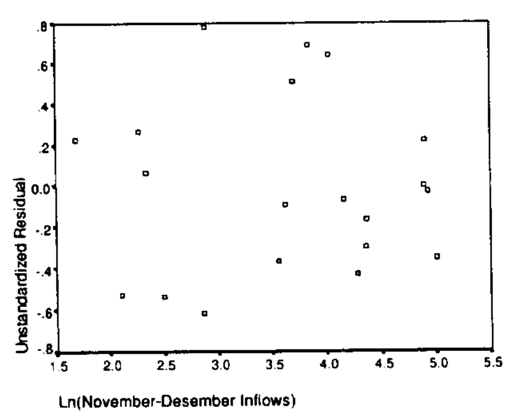


***Figure 6.14*** *Residuals Plot for Ln(November-December Inflows).*

### 6.1.4 Prediction Intervals for Trout Harvest

***Table 6.8*** *Prediction Intervals for Trout Harvest.*

| YEAR | *LICI_1* | *LN_TROUT* | *UICI_1* |
|---|---|---|---|
| 1961 | .5054 | 1.9459 | 4.0764 |
| 1962 | .2936 | 1.8563 | 3.7443 |
| 1963 | -.3230 | 1.0296 | 3.2296 |
| 1964 | -1.3704 | .9555 | 2.8188 |
| 1965 | .6177 | 2.5802 | 4.0041 |
| 1966 | 1.3748 | 3.2347 | 4.9579 |
| 1967 | 1.4243 | 2.6741 | 4.9890 |
| 1968 | 1.6514 | 2.8154 | 5.2049 |
| 1969 | 1.0287 | 3.6558 | 4.7216 |
| 1970 | 1.9354 | 4.2850 | 5.3412 |
| 1971 | 1.9959 | 4.6201 | 5.8584 |
| 1972 | 3.6054 | 5.0324 | 7.0437 |
| 1973 | 3.4658 | 5.7497 | 7.0045 |
| 1974 | 3.3576 | 5.1216 | 7.0086 |
| 1975 | 3.1990 | 4.8032 | 6.5830 |
| 1976 | 2.9260 | 4.2297 | 6.2572 |
| 1977 | 2.6738 | 4.4236 | 6.2248 |
| 1978 | 2.3184 | 4.1336 | 5.9430 |
| 1979 | 2.5589 | 4.6415 | 6.2761 |
| 1980 | 2.6282 | 4.0413 | 6.5046 |

*LICI_1* Lower limit for 99% prediction interval for the natural log of trout harvest.

*LN_TROUT* Natural log of trout harvest

*UICI_1* Upper limit for 99% prediction interval for the natural log of trout harvest.

### 6.1.5 Outliers and Influential Point Detection

***Table 6.9*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1961 | 5.26486 | .04639 | .27710 | .6277 | .0002 |
| 1962 | 3.59440 | .00590 | .18918 | .8251 | .0000 |
| 1963 | 5.00646 | .06443 | .26350 | .6592 | .0006 |
| 1964 | 14.75044 | .79121 | *.77634 | *.0393 | .3925 |
| 1965 | 2.72555 | .01164 | .14345 | .9092 | .0000 |
| 1966 | 5.43568 | .00193 | .28609 | .6070 | .0000 |
| 1967 | 5.17620 | .10748 | .27243 | .6385 | .0033 |
| 1968 | 5.01890 | .13532 | .26415 | .6577 | .0066 |
| 1969 | 7.01579 | .40882 | .36925 | .4272 | .1198 |
| 1970 | 2.98488 | .07433 | .15710 | .8864 | .0010 |
| 1971 | 9.55054 | .71551 | *.50266 | .2155 | .3388 |
| 1972 | 3.42646 | .01791 | .18034 | .8430 | .0000 |
| 1973 | 4.81066 | .08921 | .25319 | .6831 | .0018 |
| 1974 | 6.40796 | .00211 | .33726 | .4930 | .0000 |
| 1975 | 2.69316 | .00122 | .14175 | .9119 | .0000 |
| 1976 | 1.99115 | .01531 | .10480 | .9603 | .0000 |
| 1977 | 4.98448 | .00023 | .26234 | .6619 | .0000 |
| 1978 | 6.02884 | .00000 | .31731 | .5364 | .0000 |
| 1979 | 7.37221 | .03754 | .38801 | .3912 | .0001 |
| 1980 | 9.76137 | .44078 | *.51376 | .2025 | .1406 |

*MAH_1* Mahalanobis distance
*COOK_1* Cook's distance
*LEV_1* Leverage value
*MAHA_PV* P-value associated with the Mahalanobis distance
*COOK_P* P-value associated with Cook's distance

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.
[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.
[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n-p-1$ denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.10*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1961 | -.56210 | -.01657 | -.17457 | .20626 |
| 1962 | -.19625 | -.02218 | -.08585 | .04124 |
| 1963 | -.67123 | -.11135 | -.30524 | .27928 |
| 1964 | *2.36964 | *2.11453 | -.77014 | .62005 |
| 1965 | .27785 | .15188 | -.01646 | -.02948 |
| 1966 | .11165 | .02378 | -.00947 | -.04900 |
| 1967 | -.88918 | -.15628 | .05336 | .40536 |
| 1968 | *-1.01972 | .36924 | -.48014 | -.22749 |
| 1969 | *1.94949 | -.44012 | .90503 | .88217 |
| 1970 | .75314 | -.34852 | .29176 | -.15838 |
| 1971 | *2.59201 | -.27003 | .72866 | *-1.19737 |
| 1972 | -.34576 | .03061 | .12408 | .01073 |
| 1973 | .80496 | -.03180 | -.17268 | -.23652 |
| 1974 | -.11673 | -.03066 | .09189 | .00716 |
| 1975 | -.08894 | -.01689 | .05511 | .04026 |
| 1976 | -.32185 | -.08716 | .17189 | -.06546 |
| 1977 | -.03894 | .01444 | -.00325 | -.02392 |
| 1978 | .00515 | -.00122 | .00034 | .00344 |
| 1979 | .49905 | -.01332 | -.19571 | .14242 |
| 1980 | *-1.86785 | .37813 | -.60423 | -.70853 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for log of January-February inflows |
| *SDFBET_2* | Standardized *dfbeta* for log of March-April inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

***Table 6.11*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1961 | .03714 | -.01236 | .10858 | -.22329 |
| 1962 | .05020 | -.03444 | .03186 | -.02881 |
| 1963 | -.02330 | -.00740 | .32457 | -.24063 |
| 1964 | *-1.20076 | -.25623 | .70480 | -.59358 |
| 1965 | .03839 | -.11461 | -.02706 | -.01808 |
| 1966 | .07626 | -.05591 | -.05154 | .03265 |
| 1967 | -.62953 | .43661 | .44946 | -.29212 |
| 1968 | .17320 | -.21116 | -.22525 | .54273 |
| 1969 | *-1.03830 | .66125 | .83984 | *-1.36895 |
| 1970 | .18607 | -.09037 | -.05440 | .08654 |
| 1971 | *1.15050 | .96643 | *-2.03357 | .69346 |
| 1972 | .02013 | -.05376 | -.13106 | -.02568 |
| 1973 | .09996 | .17274 | .14106 | .03128 |
| 1974 | -.01061 | .06788 | -.06963 | -.03893 |
| 1975 | -.04973 | .04094 | -.00367 | -.04332 |
| 1976 | .08349 | -.01556 | -.18594 | .05296 |
| 1977 | .01133 | -.00933 | -.00319 | .00569 |
| 1978 | -.00210 | .00143 | .00054 | -.00102 |
| 1979 | .05718 | -.24035 | .04216 | .16846 |
| 1980 | .40665 | *-1.37829 | .14606 | *1.32382 |

| | |
|---|---|
| *SDFBET_3* | Standardized *dfbeta* for log of May-June inflows |
| *SDFBET_4* | Standardized *dfbeta* for log of July-August inflows |
| *SDFBET_5* | Standardized *dfbeta* for log of September-October inflows |
| *SDFBET_6* | Standardized *dfbeta* for log of November-December inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

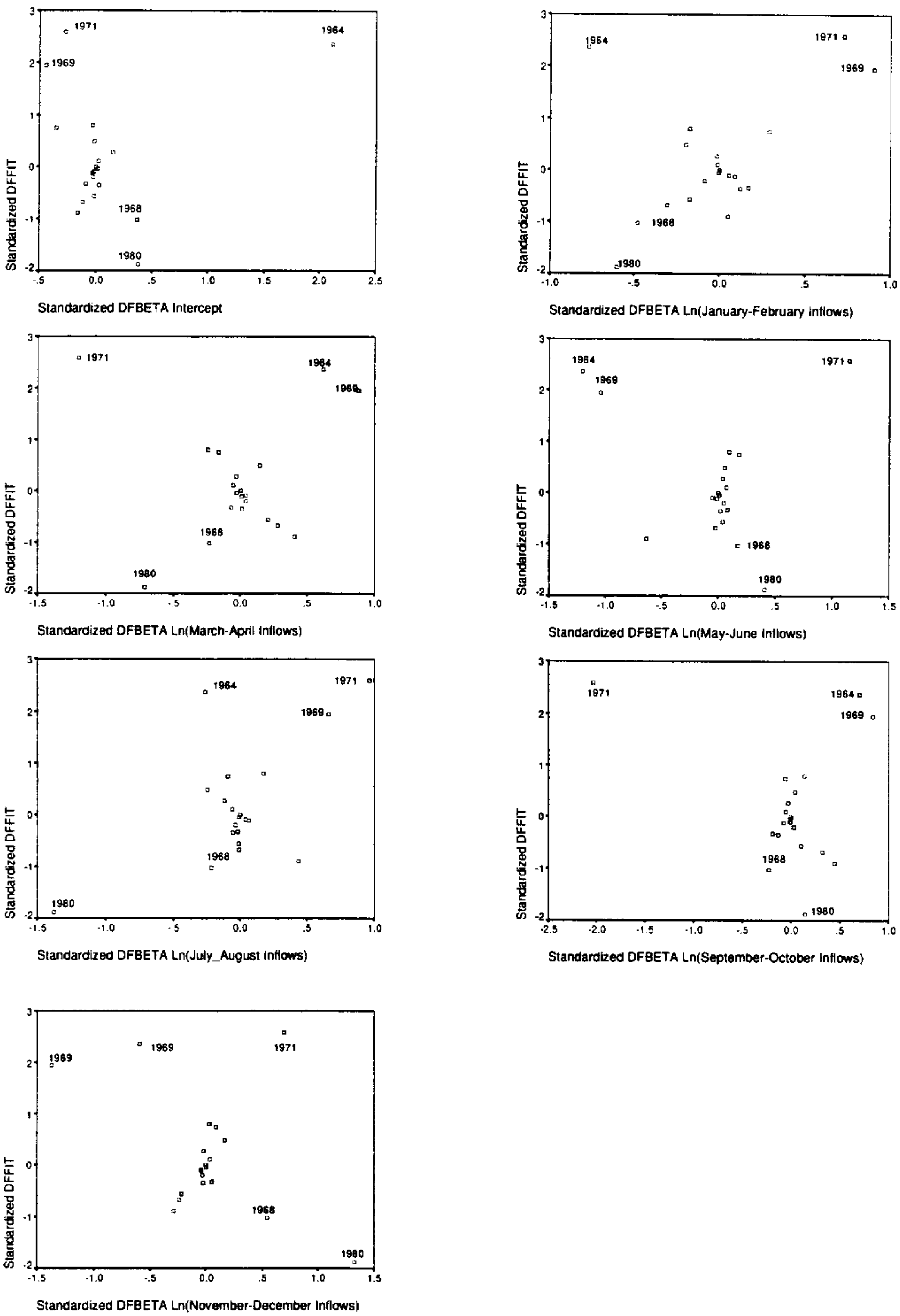


***Figure 6.15.** Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of log of inflow variables.*

## 6.2 Regression - Log of trout data on square root of inflow data

### 6.2.1 ANOVA and Parameter Estimates

***Table 6.12*** *Model Summary for log of trout data on square root of inflow data.*

**Model Summary[a,b]**

| Model | Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|
| 1 | Sqrt(January-February), Sqrt(March-April), Sqrt(May-June), Sqrt(July-August), Sqrt(Sepember-October), Sqrt(November-December)[c,] | .954 | .910 | .869 | .5027 | 1.982 |

a. Dependent Variable: Ln(Trout Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of May-June Inflows, Square Root of July-August Inflows, Square Root of Sepember-October Inflows, Square Root of January-February Inflows, Square Root of March-April Inflows

d. All requested variables entered.

***Table 6.13*** *ANOVA table of log of trout data on square root of inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 33.324 | 6 | 5.554 | 21.978 | .000[b] |
| | Residual | 3.285 | 13 | .253 | | |
| | Total | 36.609 | 19 | | | |

a. Dependent Variable: Ln(Trout Harvest)

b. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of May-June Inflows, Square Root of July-August Inflows, Square Root of Sepember-October Inflows, Square Root of January-February Inflows, Square Root of March-April Inflows

**Table 6.14** *Table of coefficients for log of trout data on square root of inflow data.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | .325 | .598 | | .543 | .596 | -.968 | 1.618 |
| Sqrt(January-February) | -.274 | .089 | -.409 | -3.082 | .009 | -.466 | -.082 |
| Sqrt(March-April) | .174 | .098 | .304 | 1.764 | .101 | -.039 | .386 |
| Sqrt(May-June) | .182 | .067 | .427 | 2.717 | .018 | .037 | .327 |
| Sqrt(July-August) | 9.3E-02 | .036 | .328 | 2.574 | .023 | .015 | .171 |
| Sqrt(Sepember-October) | 7.8E-02 | .026 | .452 | 2.998 | .010 | .022 | .135 |
| Sqrt(November-December) | -7.7E-04 | .071 | -.002 | -.011 | .991 | -.154 | .153 |

a. Dependent Variable: Ln(Trout Harvest)

### 6.2.2 Collinearity Diagnostic

**Table 6.15** *Collinearity Diagnostic for log of trout data on square root of inflow data.*

**Coefficients[a]**

| | | Collinearity Statistics | |
|---|---|---|---|
| | t | Tolerance | VIF |
| (Constant) | .543 | | |
| Sqrt(January-February) | -3.082 | .393 | 2.547 |
| Sqrt(March-April) | 1.764 | .233 | 4.298 |
| Sqrt(May-June) | 2.717 | .280 | 3.574 |
| Sqrt(July-August) | 2.574 | .424 | 2.358 |
| Sqrt(Sepember-October) | 2.998 | .304 | 3.293 |
| Sqrt(November-December) | -.011 | .250 | 4.006 |

a. Dependent Variable: Ln(Trout Harvest)

**Table 6.16** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(TROUT) on Sqrt(INFLOWS):*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *SQR_QJF* | Var Prop *SQR_QMA* | Var Prop *SQR_QMJ* | Var Prop *SQR_QJA* | Var Prop *SQR_QSO* | Var Prop *SQR_QND* |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.98368 | 1.00000 | 0.0421 | 0.0145 | 0.0332 | 0.0026 | 0.0411 | 0.0187 |
| 2 | 1.50719 | 1.14723 | 0.0355 | 0.0487 | 0.0031 | 0.0262 | 0.0310 | 0.0472 |
| 3 | 1.33244 | 1.22015 | 0.0551 | 0.0138 | 0.0179 | 0.1757 | 0.0160 | 0.0049 |
| 4 | 0.89306 | 1.49037 | 0.0202 | 0.0431 | 0.1311 | 0.0258 | 0.0262 | 0.0668 |
| 5 | 0.20068 | 3.14400 | 0.7977 | 0.0061 | 0.0065 | 0.4967 | 0.4872 | 0.0316 |
| 6 | 0.08296 | 4.89003 | 0.0494 | 0.8739 | 0.8082 | 0.2730 | 0.3986 | 0.8308 |

### 6.2.3 Residuals Diagnostics

***Table 6.17*** *Residuals Diagnostics for log of trout data on square root of inflow data.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 1.1768 | 5.5738 | 3.5915 | 1.3243 | 20 |
| Std. Predicted Value | -1.823 | 1.497 | .000 | 1.000 | 20 |
| Standard Error of Predicted Value | .1748 | .4135 | .2926 | 5.47E-02 | 20 |
| Adjusted Predicted Value | 1.5019 | 5.7657 | 3.5926 | 1.3149 | 20 |
| Residual | -.9195 | .6704 | 3.6E-16 | .4158 | 20 |
| Std. Residual | -1.829 | 1.334 | .000 | .827 | 20 |
| Stud. Residual | -2.251 | 1.804 | .000 | 1.045 | 20 |
| Deleted Residual | -1.3926 | 1.3013 | -1.E-03 | .6751 | 20 |
| Stud. Deleted Residual | -2.769 | 2.002 | -.010 | 1.143 | 20 |
| Mahal. Distance | 1.347 | 11.906 | 5.700 | 2.447 | 20 |
| Cook's Distance | .000 | .492 | .097 | .142 | 20 |
| Centered Leverage Value | .071 | .627 | .300 | .129 | 20 |

a. Dependent Variable: Ln(Trout Harvest)

***Table 6.18*** *Case Values for Residuals Diagnostics for log of trout data on square root of inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1961 | 2.10619 | -.16028 | -.30188 | 2.24779 | -1.12152 | -.31884 | -.43757 | -.42354 |
| 1962 | 1.86556 | -.00926 | -.01200 | 1.86830 | -1.30321 | -.01842 | -.02097 | -.02015 |
| 1963 | 1.37082 | -.34120 | -.47231 | 1.50193 | -1.67679 | -.67874 | -.79856 | -.78677 |
| 1964 | 1.17680 | -.22129 | -.68436 | 1.63987 | -1.82329 | -.44020 | -.77412 | -.76151 |
| 1965 | 2.11604 | .46418 | .57023 | 2.00999 | -1.11408 | .92336 | 1.02342 | 1.02545 |
| 1966 | 3.02258 | .21217 | .31235 | 2.92240 | -.42956 | .42205 | .51209 | .49704 |
| 1967 | 3.06185 | -.38770 | -.56492 | 3.23907 | -.39991 | -.77123 | -.93096 | -.92583 |
| 1968 | 3.73494 | -.91953 | -1.39257 | 4.20798 | .10833 | -1.82917 | -2.25103 | *-2.7686 |
| 1969 | 3.02355 | .63229 | 1.30134 | 2.35450 | -.42883 | 1.25779 | 1.80444 | 2.00247 |
| 1970 | 3.80662 | .47835 | .67471 | 3.61025 | .16246 | .95155 | 1.13011 | 1.14339 |
| 1971 | 3.94968 | .67037 | 1.17659 | 3.44347 | .27048 | 1.33354 | 1.76669 | 1.94714 |
| 1972 | 5.55873 | -.52633 | -.73327 | 5.76566 | 1.48545 | -1.04700 | -1.23580 | -1.26388 |
| 1973 | 5.57383 | .17588 | .26188 | 5.48783 | 1.49686 | .34988 | .42693 | .41309 |
| 1974 | 5.06896 | .05262 | .10926 | 5.01232 | 1.11564 | .10467 | .15083 | .14504 |
| 1975 | 4.48091 | .32229 | .42048 | 4.38272 | .67160 | .64112 | .73230 | .71855 |
| 1976 | 4.13596 | .09379 | .10668 | 4.12307 | .41114 | .18657 | .19898 | .19147 |
| 1977 | 4.58945 | -.16580 | -.23875 | 4.66240 | .75356 | -.32982 | -.39578 | -.38257 |
| 1978 | 4.18656 | -.05299 | -.08367 | 4.21724 | .44935 | -.10542 | -.13246 | -.12735 |
| 1979 | 4.44278 | .19873 | .34676 | 4.29474 | .64281 | .39531 | .52219 | .50705 |
| 1980 | 4.55758 | -.51628 | -.82015 | 4.86145 | .72950 | -1.02701 | -1.29443 | -1.33249 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that observation |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.
[2]This is flagged if it exceeds $t_{n-p-2,a}=t_{12,0.01}=2.681$.

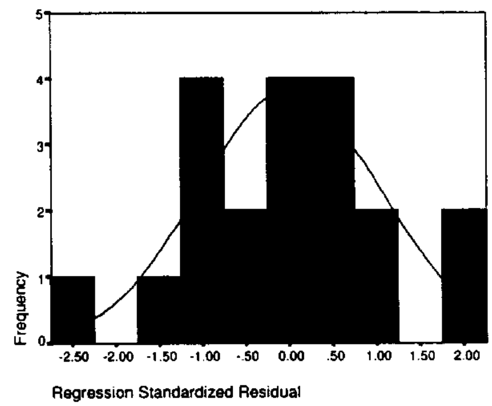


***Figure 6.16*** *Histogram of Standardized Residuals.*

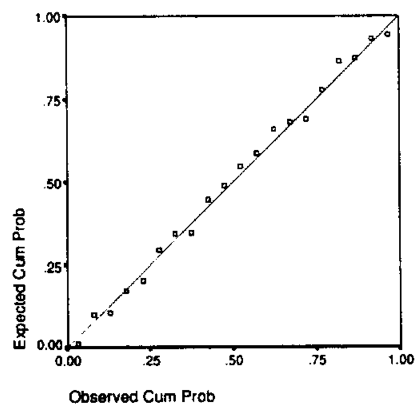


***Figure 6.17*** *Normal P-P Plot of Residuals.*

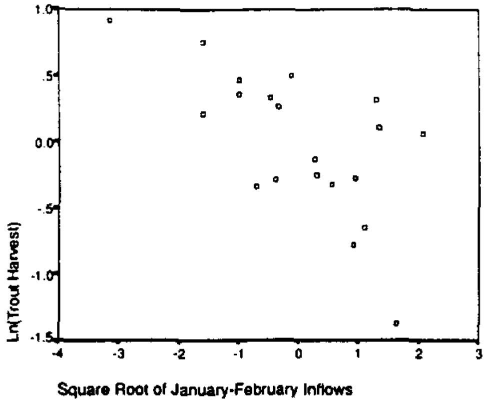


***Figure 6.18*** *Partial Residual Plot for Sqrt(January-February Inflows).*

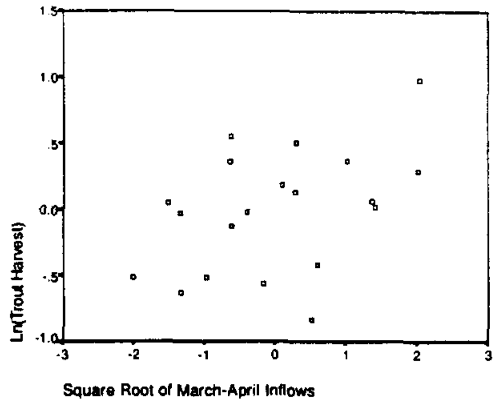


***Figure 6.19*** *Partial Residual Plot for Sqrt(March-April Inflows).*

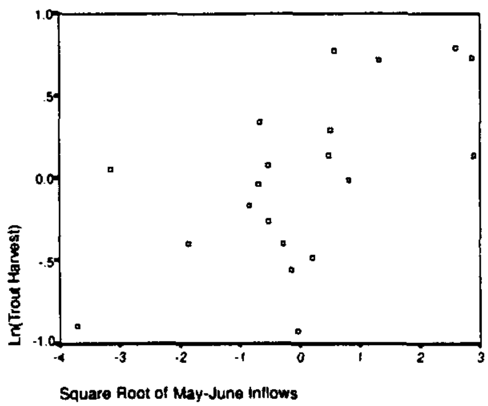


***Figure 6.20*** *Partial Residual Plot for Sqrt(May-June Inflows).*

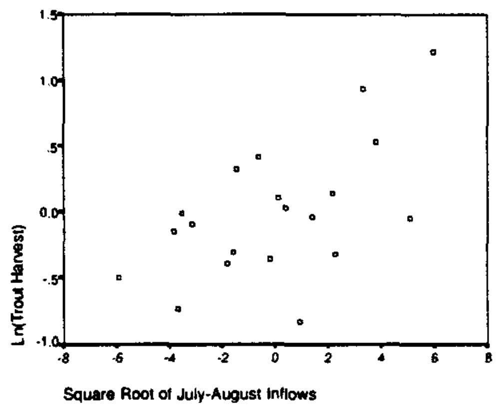


***Figure 6.21*** *Partial Residual Plot for Sqrt(July-August Inflows).*

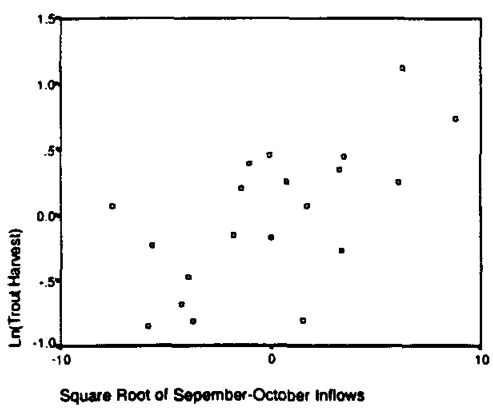


***Figure 6.22*** *Partial Residual Plot for Sqrt(September-October Inflows).*

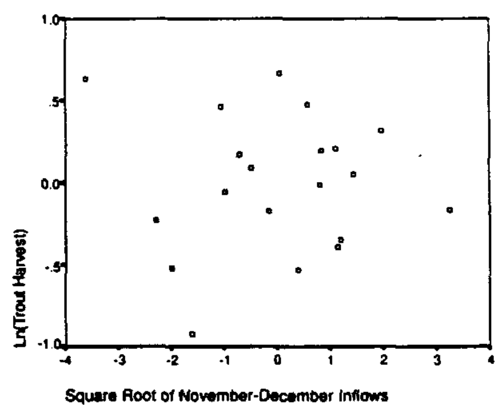


***Figure 6.23*** *Partial Residual Plot for Sqrt(November-December Inflows).*

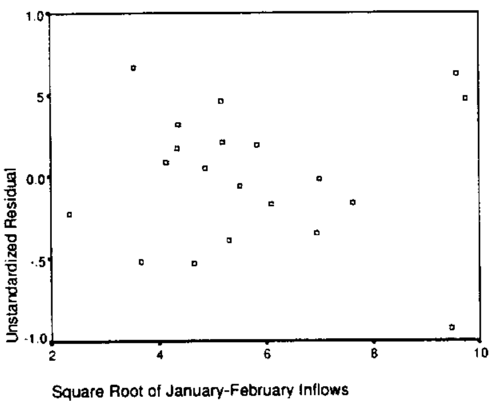


*Figure 6.24* *Residuals Plot for Sqrt(January-February Inflows).*

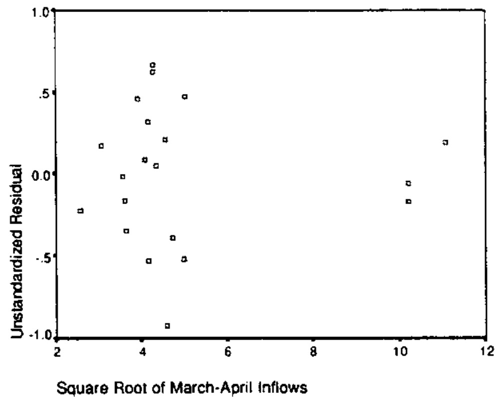


*Figure 6.25* *Residuals Plot for Sqrt(March-April Inflows).*

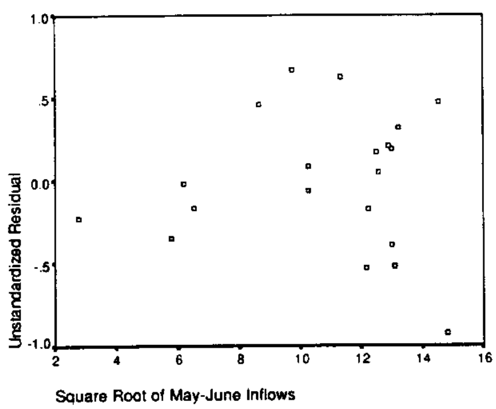


*Figure 6.26* *Residuals Plot for Sqrt(May-June Inflows).*

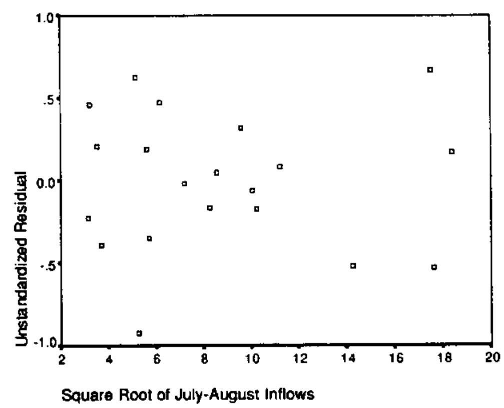


*Figure 6.27* *Residuals Plot for Sqrt(July-August Inflows).*

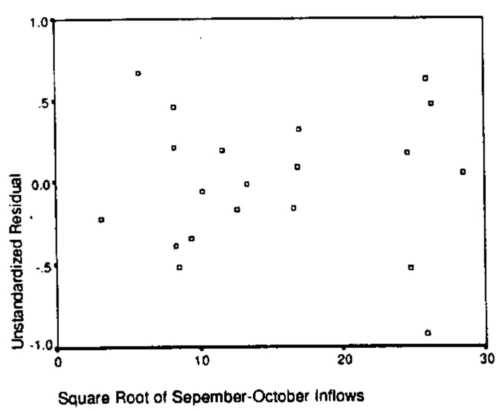


*Figure 6.28* *Residuals Plot for Sqrt(September-October Inflows).*

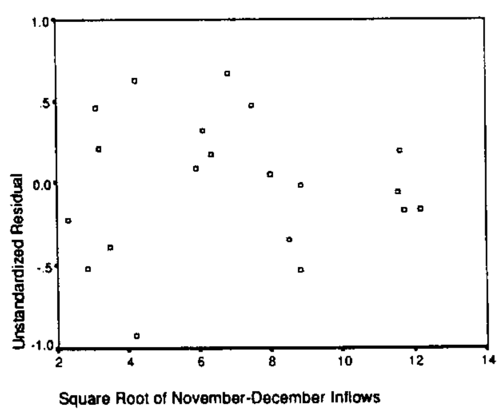


*Figure 6.29* *Residuals Plot for Sqrt(November-December Inflows).*

### 6.2.4 Prediction Intervals for Trout Harvest

***Table 6.19*** *Prediction Intervals for Trout Harvest.*

| YEAR | *LICI_1* | *LN_TROUT* | *UICI_1* |
|---|---|---|---|
| 1961 | .2708 | 1.9459 | 3.9416 |
| 1962 | .1874 | 1.8563 | 3.5437 |
| 1963 | -.3408 | 1.0296 | 3.0824 |
| 1964 | -.7840 | .9555 | 3.1376 |
| 1965 | .4669 | 2.5802 | 3.7651 |
| 1966 | 1.2823 | 3.2347 | 4.7628 |
| 1967 | 1.3262 | 2.6741 | 4.7975 |
| 1968 | 1.9822 | 2.8154 | 5.4876 |
| 1969 | 1.1602 | 3.6558 | 4.8869 |
| 1970 | 2.0860 | 4.2850 | 5.5272 |
| 1971 | 2.1387 | 4.6201 | 5.7606 |
| 1972 | 3.8440 | 5.0324 | 7.2734 |
| 1973 | 3.8285 | 5.7497 | 7.3191 |
| 1974 | 3.2030 | 5.1216 | 6.9349 |
| 1975 | 2.7991 | 4.8032 | 6.1627 |
| 1976 | 2.5328 | 4.2297 | 5.7392 |
| 1977 | 2.8592 | 4.4236 | 6.3197 |
| 1978 | 2.4163 | 4.1336 | 5.9568 |
| 1979 | 2.6339 | 4.6415 | 6.2516 |
| 1980 | 2.7848 | 4.0413 | 6.3303 |

| | |
|---|---|
| *LICI_1* | Lower limit for 99% prediction interval for the natural log of trout harvest. |
| *LN_TROUT* | Natural log of trout harvest |
| *UICI_1* | Upper limit for 99% prediction interval for the natural log of trout harvest. |

### 6.2.5 Outliers and Influential Point Detection

***Table 6.20*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1961 | 7.96206 | .02416 | .41906 | .3360 | .0000 |
| 1962 | 3.38550 | .00002 | .17818 | .8472 | .0000 |
| 1963 | 4.32411 | .03500 | .22758 | .7418 | .0001 |
| 1964 | 11.90631 | .17915 | *.62665 | .1037 | .0149 |
| 1965 | 2.58367 | .03419 | .13598 | .9207 | .0001 |
| 1966 | 5.14397 | .01769 | .27074 | .6424 | .0000 |
| 1967 | 5.01058 | .05660 | .26371 | .6587 | .0004 |
| 1968 | 5.50413 | .37239 | .28969 | .5987 | .0974 |
| 1969 | 8.81831 | .49218 | .46412 | .2660 | .1759 |
| 1970 | 4.57963 | .07490 | .24103 | .7111 | .0011 |
| 1971 | 7.22450 | .33669 | .38024 | .4059 | .0772 |
| 1972 | 4.41206 | .08578 | .23221 | .7313 | .0016 |
| 1973 | 5.28937 | .01273 | .27839 | .6247 | .0000 |
| 1974 | 8.89968 | .00350 | .46840 | .2599 | .0000 |
| 1975 | 3.48673 | .02334 | .18351 | .8366 | .0000 |
| 1976 | 1.34694 | .00078 | .07089 | .9871 | .0000 |
| 1977 | 4.85552 | .00985 | .25555 | .6776 | .0000 |
| 1978 | 6.01600 | .00145 | .31663 | .5379 | .0000 |
| 1979 | 7.16133 | .02902 | .37691 | .4123 | .0000 |
| 1980 | 6.08960 | .14088 | .32051 | .5293 | .0074 |

*MAH_1* Mahalanobis distance
*COOK_1* Cook's distance
*LEV_1* Leverage value
*MAHA_PV* P-value associated with the Mahalanobis distance
*COOK_P* P-value associated with Cook's distance

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.

[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n-p-1$ denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.21*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1961 | -.39809 | .01730 | -.05731 | .22828 |
| 1962 | -.01096 | -.00204 | -.00379 | .00277 |
| 1963 | -.48770 | -.08559 | -.18069 | .17660 |
| 1964 | *-1.10159 | *-1.03902 | .38015 | -.36679 |
| 1965 | .49016 | .33810 | -.02438 | .06527 |
| 1966 | .34154 | .04936 | -.05146 | -.15822 |
| 1967 | -.62596 | -.06667 | .07880 | .29296 |
| 1968 | *-1.98575 | .63261 | -.98224 | -.33672 |
| 1969 | *2.05984 | -.06997 | *1.05202 | *1.14301 |
| 1970 | .73257 | -.38132 | .32104 | -.16907 |
| 1971 | *1.69202 | -.31250 | .59217 | -.31578 |
| 1972 | -.79250 | .07141 | .18916 | .04743 |
| 1973 | .28885 | -.01231 | -.03018 | .00966 |
| 1974 | .15048 | .05379 | -.11680 | -.01621 |
| 1975 | .39660 | .05542 | -.23216 | -.24330 |
| 1976 | .07100 | .03939 | -.03577 | .01111 |
| 1977 | -.25376 | .08119 | -.02453 | -.12200 |
| 1978 | -.09689 | .00934 | -.00738 | -.06356 |
| 1979 | .43764 | -.04116 | -.11889 | .13393 |
| 1980 | *-1.02226 | .10630 | -.27398 | -.19669 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for square root of January-February inflows |
| *SDFBET_2* | Standardized *dfbeta* for square root of March-April inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p + 1) / n}$ for a large data set. The cutoff used here is 1.

***Table 6.22*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1961 | -.06349 | .06533 | .11856 | -.26841 |
| 1962 | .00257 | -.00068 | .00213 | -.00263 |
| 1963 | .03343 | .01053 | .20511 | -.15654 |
| 1964 | .66134 | .17081 | -.42192 | .43231 |
| 1965 | -.09965 | -.11805 | -.00437 | -.16884 |
| 1966 | .23168 | -.16549 | -.17655 | .09429 |
| 1967 | -.43427 | .29429 | .33953 | -.18220 |
| 1968 | .01318 | -.23492 | -.26632 | .77634 |
| 1969 | *-1.20518 | .68507 | .93640 | *-1.46166 |
| 1970 | .24181 | -.05849 | -.07321 | .11087 |
| 1971 | .20310 | *1.10656 | *-1.00780 | .02190 |
| 1972 | .02758 | -.24380 | -.25967 | -.08230 |
| 1973 | -.03488 | .13901 | .09167 | -.05027 |
| 1974 | .01372 | -.08876 | .09582 | .04299 |
| 1975 | .28513 | -.20777 | -.06117 | .22865 |
| 1976 | -.01878 | .00190 | .03503 | -.01347 |
| 1977 | .03187 | -.04594 | .00041 | .00931 |
| 1978 | .03954 | -.02494 | -.01406 | .02194 |
| 1979 | .04671 | -.15030 | .02667 | .07960 |
| 1980 | -.04677 | -.61750 | .32587 | .47388 |

| | |
|---|---|
| *SDFBET_3* | Standardized *dfbeta* for square root of May-June inflows |
| *SDFBET_4* | Standardized *dfbeta* for square root of July-August inflows |
| *SDFBET_5* | Standardized *dfbeta* for square root of September-October inflows |
| *SDFBET_6* | Standardized *dfbeta* for square root of November-December inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

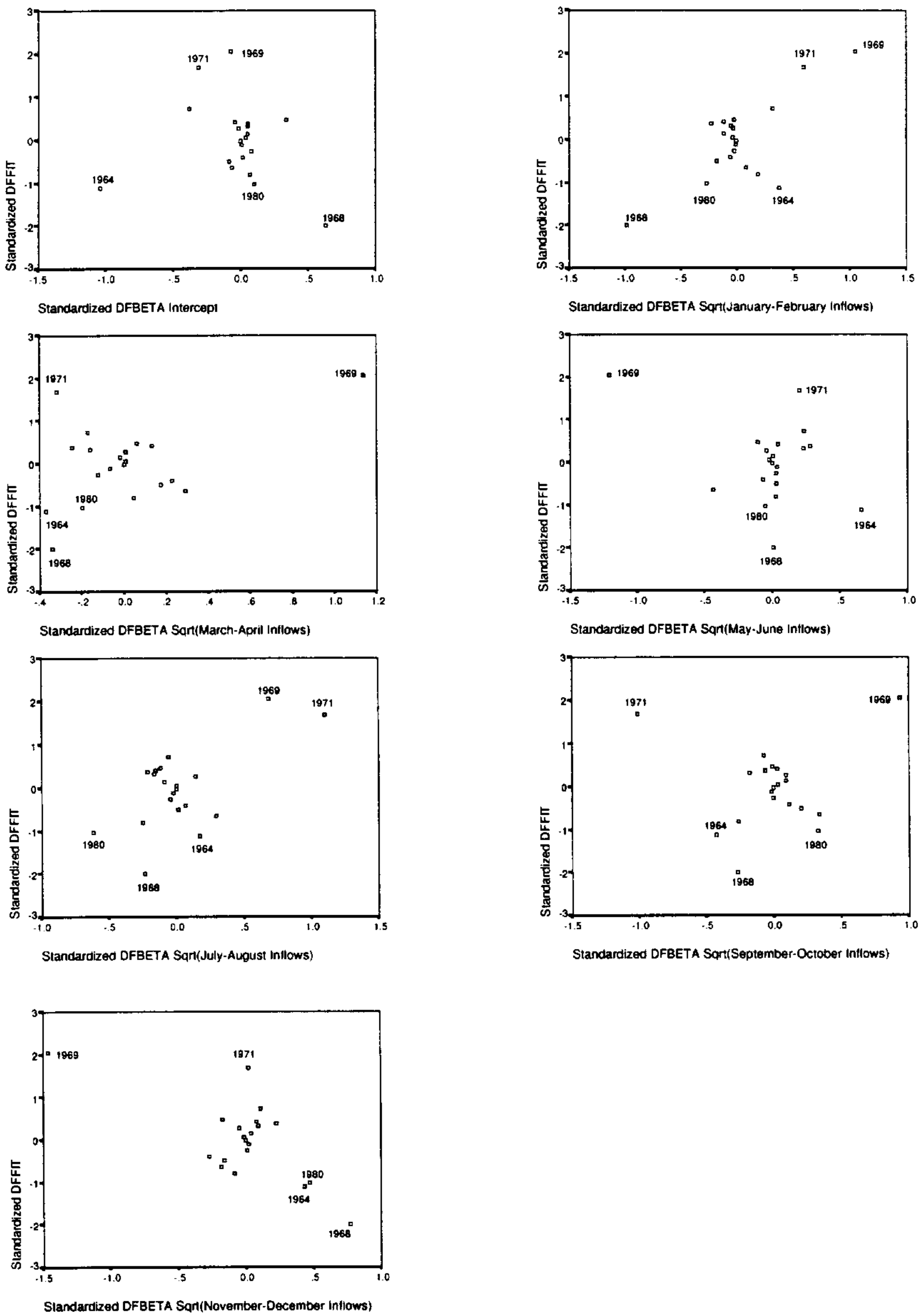


***Figure 6.30*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of square root of inflow variables.*

## 6.3 Regression - Square Root of trout data on inflow data

### 6.3.1 ANOVA and Parameter Estimates

***Table 6.23*** *Model Summary for square root of trout data on inflow data.*

**Model Summary**[a,b]

| Model | Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|
| 1 | January-February, March-April, May-June, July-August, SeptemberOctober, November-December[c,d] | .947 | .897 | .849 | 1.6736 | 2.472 |

a. Dependent Variable: Square Root of Trout Harvest

b. Method: Enter

c. Independent Variables: (Constant), November-December Inflows, SeptemberOctober Inflows, July-August Inflows, May-June Inflows, January-February Inflows, March-April Inflows

d. All requested variables entered.

***Table 6.24*** *ANOVA table of square root of trout data on inflow data*

**ANOVA**[a]

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 316.786 | 6 | 52.798 | 18.849 | .000[b] |
| | Residual | 36.413 | 13 | 2.801 | | |
| | Total | 353.200 | 19 | | | |

a. Dependent Variable: Square Root of Trout Harvest

b. Independent Variables: (Constant), November-December Inflows, SeptemberOctober Inflows, July-August Inflows, May-June Inflows, January-February Inflows, March-April Inflows

***Table 6.25*** *Table of coefficients for square root of trout data on inflow data.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | 2.339 | 1.258 | | 1.860 | .086 | -.378 | 5.056 |
| January-February | -7.6E-02 | .021 | -.474 | -3.545 | .004 | -.122 | -.030 |
| March-April | 3.8E-02 | .022 | .306 | 1.731 | .107 | -.009 | .085 |
| May-June | 1.6E-02 | .010 | .224 | 1.547 | .146 | -.006 | .038 |
| July-August | 1.7E-02 | .005 | .416 | 3.486 | .004 | .006 | .027 |
| SeptemberOctober | 9.8E-03 | .002 | .616 | 4.247 | .001 | .005 | .015 |
| November-December | 1.5E-03 | .015 | .017 | .102 | .920 | -.030 | .033 |

a. Dependent Variable: Square Root of Trout Harvest

## 6.3.2 Collinearity Diagnostic

***Table 6.26*** *Collinearity Diagnostic for square root of trout data on inflow data.*

**Coefficients[a]**

| | | Collinearity Statistics | |
|---|---|---|---|
| | t | Tolerance | VIF |
| (Constant) | 1.860 | | |
| January-February | -3.545 | .444 | 2.251 |
| March-April | 1.731 | .254 | 3.941 |
| May-June | 1.547 | .377 | 2.653 |
| July-August | 3.486 | .557 | 1.796 |
| SeptemberOctober | 4.247 | .377 | 2.650 |
| November-December | .102 | .295 | 3.385 |

a. Dependent Variable: Square Root of Trout Harvest

***Table 6.27*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Sqrt(TROUT) on INFLOWS: None Omitted*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *QJF_LAG* | Var Prop *QMA_LAG* | Var Prop *QMJ_LAG* | Var Prop *QJA_LAG* | Var Prop *QSO_LAG* | Var Prop *QND_LAG* |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.86647 | 1.00000 | 0.0619 | 0.0077 | 0.0450 | 0.0010 | 0.0804 | 0.0094 |
| 2 | 1.68991 | 1.05094 | 0.0256 | 0.0657 | 0.0088 | 0.0116 | 0.0011 | 0.0674 |
| 3 | 1.29792 | 1.19919 | 0.0529 | 0.0044 | 0.0413 | 0.2647 | 0.0135 | 0.0038 |
| 4 | 0.80254 | 1.52503 | 0.0350 | 0.0335 | 0.1812 | 0.0675 | 0.0580 | 0.0826 |
| 5 | 0.23546 | 2.81549 | 0.7824 | 0.0001 | 0.0087 | 0.5234 | 0.5484 | 0.0205 |
| 6 | 0.10770 | 4.16295 | 0.0422 | 0.8885 | 0.7151 | 0.1318 | 0.2986 | 0.8163 |

### 6.3.3 Residuals Diagnostics

***Table 6.28*** *Residuals Diagnostics for square root of trout data on inflow data.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 1.2437 | 15.4368 | 7.3492 | 4.0833 | 20 |
| Std. Predicted Value | -1.495 | 1.981 | .000 | 1.000 | 20 |
| Standard Error of Predicted Value | .5493 | 1.3435 | .9710 | .1985 | 20 |
| Adjusted Predicted Value | 1.1148 | 16.3399 | 7.3723 | 4.0774 | 20 |
| Residual | -2.7837 | 2.2860 | -3.E-15 | 1.3844 | 20 |
| Std. Residual | -1.663 | 1.366 | .000 | .827 | 20 |
| Stud. Residual | -2.062 | 1.724 | -.005 | 1.023 | 20 |
| Deleted Residual | -4.2792 | 3.6412 | -2.E-02 | 2.1354 | 20 |
| Stud. Deleted Residual | -2.415 | 1.886 | -.023 | 1.110 | 20 |
| Mahal. Distance | 1.097 | 11.293 | 5.700 | 2.676 | 20 |
| Cook's Distance | .000 | .326 | .079 | .096 | 20 |
| Centered Leverage Value | .058 | .594 | .300 | .141 | 20 |

a. Dependent Variable: Square Root of Trout Harvest

***Table 6.29*** *Case Values for Residuals Diagnostics for square root of trout data on inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1961 | 3.15991 | -.51416 | -1.42051 | 4.06626 | -1.02596 | -.30721 | -.51064 | -.49560 |
| 1962 | 2.45949 | .07033 | .08880 | 2.44102 | -1.19749 | .04202 | .04722 | .04537 |
| 1963 | 1.24373 | .42959 | .55853 | 1.11479 | -1.49523 | .25669 | .29268 | .28213 |
| 1964 | 2.57437 | -.96191 | -1.88323 | 3.49569 | -1.16936 | -.57475 | -.80420 | -.79261 |
| 1965 | 2.95815 | .67503 | .84576 | 2.78743 | -1.07537 | .40334 | .45147 | .43720 |
| 1966 | 4.63546 | .40438 | .55832 | 4.48152 | -.66459 | .24162 | .28391 | .27362 |
| 1967 | 4.68606 | -.87818 | -1.21076 | 5.01865 | -.65220 | -.52472 | -.61612 | -.60078 |
| 1968 | 6.87027 | -2.78370 | -4.27922 | 8.36579 | -.11728 | -1.66328 | -2.06222 | -2.41541 |
| 1969 | 5.21482 | 1.00611 | 2.11467 | 4.10626 | -.52270 | .60116 | .87154 | .86294 |
| 1970 | 6.97012 | 1.55044 | 2.38699 | 6.13358 | -.09283 | .92640 | 1.14946 | 1.16517 |
| 1971 | 9.17870 | .89602 | 1.52345 | 8.55127 | .44806 | .53538 | .69809 | .68364 |
| 1972 | 15.05712 | -2.67568 | -3.95843 | 16.33987 | 1.88770 | -1.59874 | -1.94456 | -2.21859 |
| 1973 | 15.43682 | 2.28605 | 3.64117 | 14.08170 | 1.98069 | 1.36592 | 1.72387 | 1.88574 |
| 1974 | 13.09842 | -.15237 | -.42846 | 13.37450 | 1.40801 | -.09104 | -.15267 | -.14681 |
| 1975 | 8.77754 | 2.26330 | 2.97206 | 8.06878 | .34982 | 1.35233 | 1.54968 | 1.64896 |
| 1976 | 8.33086 | -.04231 | -.04742 | 8.33597 | .24042 | -.02528 | -.02676 | -.02572 |
| 1977 | 9.41313 | -.28077 | -.39940 | 9.53176 | .50547 | -.16776 | -.20009 | -.19253 |
| 1978 | 8.61600 | -.71664 | -1.08420 | 8.98357 | .31026 | -.42819 | -.52668 | -.51150 |
| 1979 | 9.17014 | 1.01318 | 1.79184 | 8.39147 | .44597 | .60538 | .80507 | .79352 |
| 1980 | 9.13192 | -1.58871 | -2.23195 | 9.77516 | .43660 | -.94926 | -1.12514 | -1.13782 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that observation |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.
[2]This is flagged if it exceeds $t_{n-p-2,\alpha}=t_{12,0.01}=2.681$.

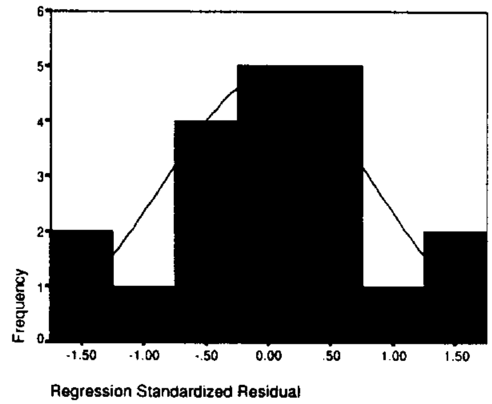


***Figure 6.31*** *Histogram of Standardized Residuals.*

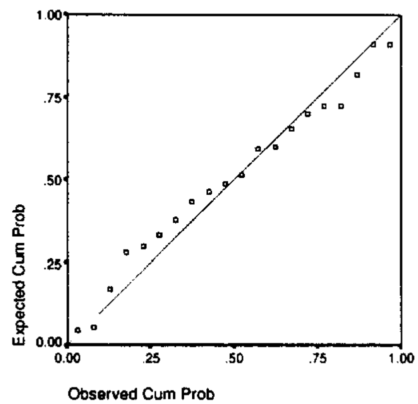


***Figure 6.32*** *Normal P-P Plot of Residuals.*

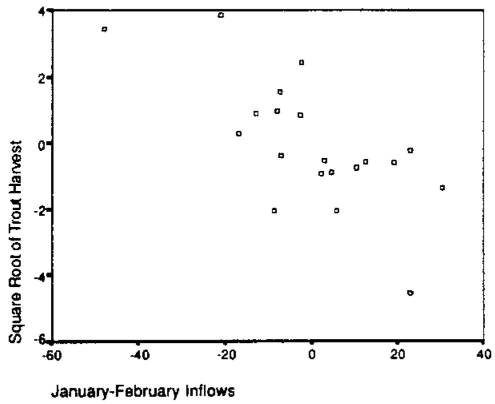


*Figure 6.33* Partial Residual Plot for January-February Inflows.

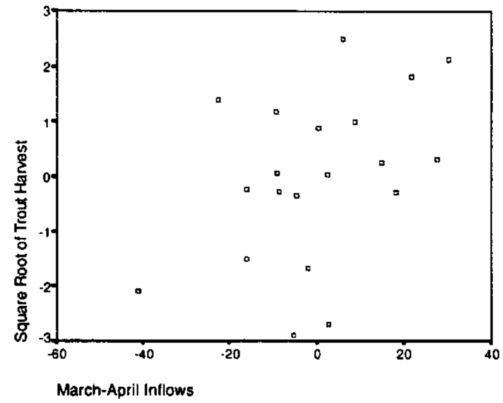


*Figure 6.34* Partial Residual Plot for March-April Inflows.

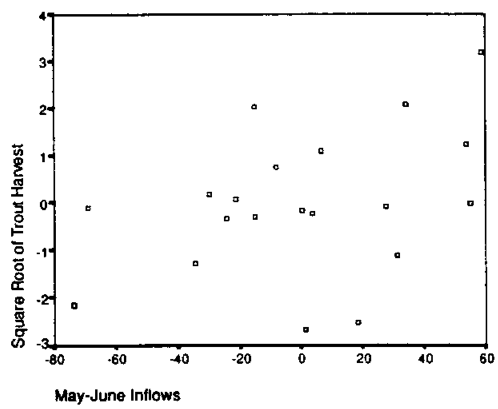


*Figure 6.35* Partial Residual Plot for May-June Inflows.

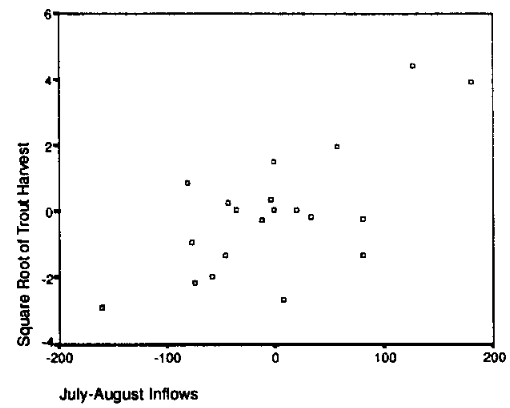


*Figure 6.36* Partial Residual Plot for July-August Inflows.

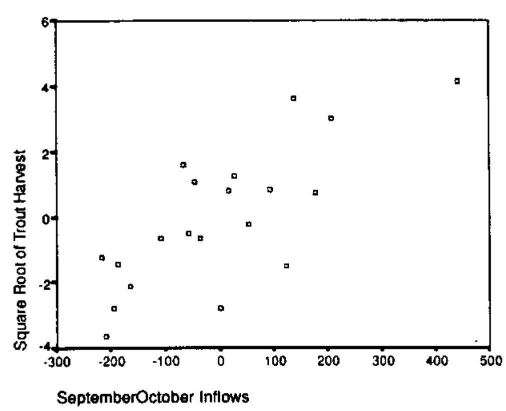


*Figure 6.37* Partial Residual Plot for September-October Inflows.

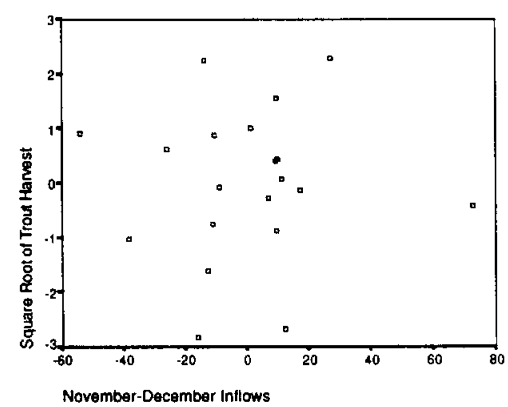


*Figure 6.38* Partial Residual Plot for November-December Inflows.

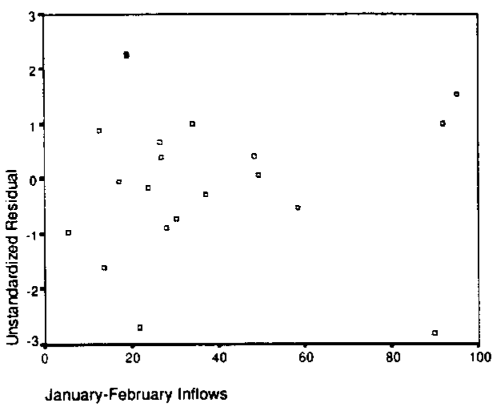


***Figure 6.39*** *Residuals Plot for January-February Inflows.*

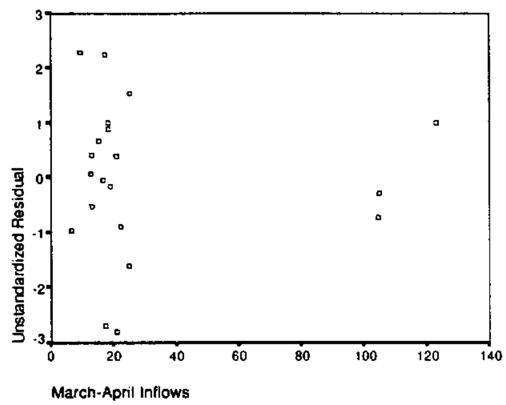


***Figure 6.40*** *Residuals Plot for March-April Inflows.*

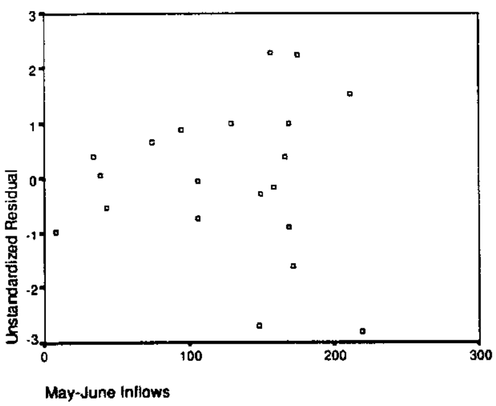


***Figure 6.41*** *Residuals Plot for May-June Inflows.*

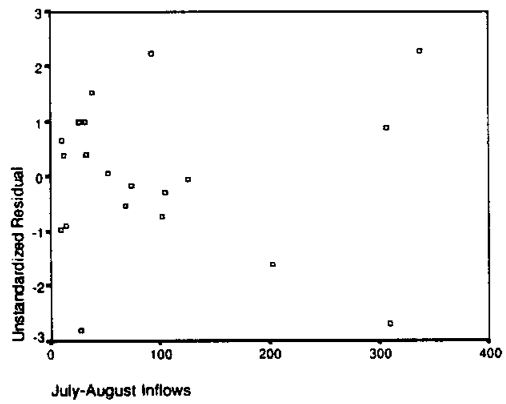


***Figure 6.42*** *Residuals Plot for July-August Inflows.*

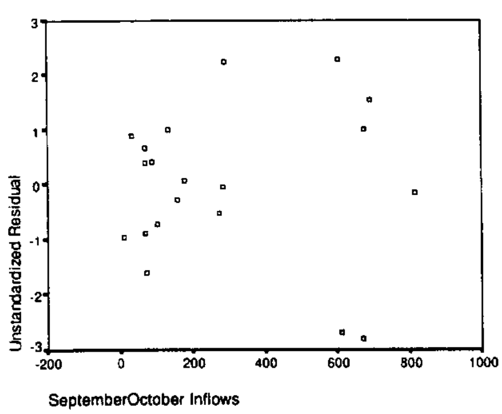


***Figure 6.43*** *Residuals Plot for September-October Inflows.*

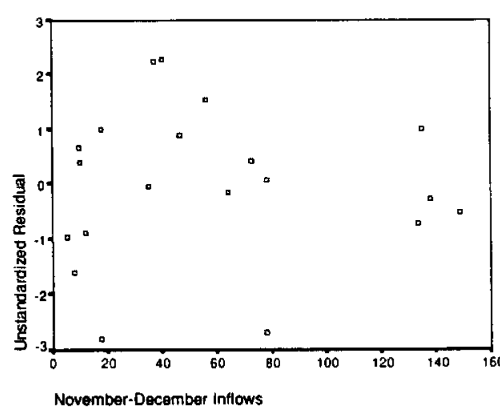


***Figure 6.44*** *Residuals Plot for November-December Inflows.*

### 6.3.4 Prediction Intervals for Trout Harvest

***Table 6.30*** *Prediction Intervals for Trout Harvest.*

| YEAR | *LICI_1* | *SQ_TROUT* | *UICI_1* |
|---|---|---|---|
| 1961 | 0.0000 | 2.6458 | 9.6122 |
| 1962 | 0.0000 | 2.5298 | 8.0005 |
| 1963 | 0.0000 | 1.6733 | 6.8368 |
| 1964 | 0.0000 | 1.6125 | 8.7266 |
| 1965 | 0.0000 | 3.6332 | 8.4850 |
| 1966 | 0.0000 | 5.0398 | 10.3296 |
| 1967 | 0.0000 | 3.8079 | 10.3779 |
| 1968 | 1.0138 | 4.0866 | 12.7267 |
| 1969 | 0.0000 | 6.2209 | 11.4389 |
| 1970 | 1.1115 | 8.5206 | 12.8287 |
| 1971 | 3.1884 | 10.0747 | 15.1690 |
| 1972 | 9.2561 | 12.3814 | 20.8582 |
| 1973 | 9.5313 | 17.7229 | 21.3423 |
| 1974 | 6.6337 | 12.9460 | 19.5632 |
| 1975 | 3.1671 | 11.0408 | 14.3880 |
| 1976 | 3.0249 | 8.2885 | 13.6369 |
| 1977 | 3.6716 | 9.1324 | 15.1547 |
| 1978 | 2.7823 | 7.8994 | 14.4497 |
| 1979 | 3.1319 | 10.1833 | 15.2084 |
| 1980 | 3.4100 | 7.5432 | 14.8539 |

*LICI_1* Lower limit for 99% prediction interval for the square root of trout harvest.

*LN_TROUT* Square root of trout harvest

*UICI_1* Upper limit for 99% prediction interval for the square root of trout harvest.

### 6.3.5 Outliers and Influential Point Detection

***Table 6.31*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1961 | 11.17282 | .06566 | *.58804 | .1313 | .0007 |
| 1962 | 3.00234 | .00008 | .15802 | .8848 | .0000 |
| 1963 | 3.43604 | .00367 | .18084 | .8420 | .0000 |
| 1964 | 8.34522 | .08849 | .43922 | .3031 | .0018 |
| 1965 | 2.88532 | .00736 | .15186 | .8954 | .0000 |
| 1966 | 4.28854 | .00438 | .22571 | .7460 | .0000 |
| 1967 | 4.26914 | .02054 | .22469 | .7483 | .0000 |
| 1968 | 5.69019 | .32639 | .29948 | .5764 | .0717 |
| 1969 | 9.01021 | .11956 | .47422 | .2519 | .0045 |
| 1970 | 5.70872 | .10184 | .30046 | .5741 | .0028 |
| 1971 | 6.87509 | .04875 | .36185 | .4420 | .0003 |
| 1972 | 5.20704 | .25897 | .27405 | .6347 | .0404 |
| 1973 | 6.12118 | .25166 | .32217 | .5257 | .0375 |
| 1974 | 11.29296 | .00603 | *.59437 | .1263 | .0000 |
| 1975 | 3.58101 | .10743 | .18847 | .8266 | .0033 |
| 1976 | 1.09663 | .00001 | .05772 | .9931 | .0000 |
| 1977 | 4.69376 | .00242 | .24704 | .6973 | .0000 |
| 1978 | 5.49138 | .02033 | .28902 | .6002 | .0000 |
| 1979 | 7.30667 | .07116 | .38456 | .3977 | .0009 |
| 1980 | 4.52573 | .07322 | .23820 | .7176 | .0010 |

*MAH_1* Mahalanobis distance
*COOK_1* Cook's distance
*LEV_1* Leverage value
*MAHA_PV* P-value associated with the Mahalanobis distance
*COOK_PV* P-value associated with Cook's distance

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.
[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.
[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n-p-1$ denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

*Table 6.32 Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1961 | -.65800 | .09065 | -.04990 | .44243 |
| 1962 | .02325 | .00866 | .00683 | -.00561 |
| 1963 | .15456 | .06006 | .05235 | -.03786 |
| 1964 | -.77571 | -.77122 | .23939 | -.26512 |
| 1965 | .21987 | .19149 | -.01647 | .05679 |
| 1966 | .16882 | .02318 | -.03260 | -.06750 |
| 1967 | -.36972 | -.03957 | .06284 | .14772 |
| 1968 | *-1.77042 | .51643 | -.87417 | -.10995 |
| 1969 | .90580 | .17330 | .48749 | .49508 |
| 1970 | .85586 | -.42528 | .42432 | -.17248 |
| 1971 | .57207 | -.01693 | .21936 | .00446 |
| 1972 | *-1.53614 | .23931 | .30230 | .18581 |
| 1973 | *1.45188 | -.05883 | -.07301 | .18856 |
| 1974 | -.19762 | -.05708 | .15023 | .01470 |
| 1975 | .92276 | .01139 | -.50980 | -.55744 |
| 1976 | -.00893 | -.00658 | .00448 | -.00095 |
| 1977 | -.12516 | .02876 | -.00863 | -.04517 |
| 1978 | -.36633 | -.03592 | -.01857 | -.22754 |
| 1979 | .69565 | -.05788 | -.09798 | .30204 |
| 1980 | -.72400 | .03591 | -.10061 | .03263 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for January-February inflows |
| *SDFBET_2* | Standardized *dfbeta* for March-April inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

***Table 6.33*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1961 | -.13942 | .10972 | .18474 | -.52661 |
| 1962 | -.00756 | -.00009 | -.00396 | .00511 |
| 1963 | -.04217 | -.00288 | -.04763 | .02846 |
| 1964 | .50134 | .18466 | -.27255 | .37169 |
| 1965 | -.08966 | -.04999 | .01078 | -.10982 |
| 1966 | .10664 | -.07168 | -.08266 | .02656 |
| 1967 | -.23895 | .15122 | .18804 | -.06085 |
| 1968 | -.33766 | -.06682 | -.00721 | .41490 |
| 1969 | -.52963 | .21015 | .35663 | -.59177 |
| 1970 | .30333 | -.00332 | -.09143 | .12438 |
| 1971 | -.04484 | .46605 | -.26513 | -.08108 |
| 1972 | -.02220 | -.63595 | -.45597 | -.29789 |
| 1973 | -.22218 | .87949 | .45120 | -.28402 |
| 1974 | -.00045 | .11429 | -.14964 | -.03758 |
| 1975 | .68092 | -.44186 | -.17326 | .45121 |
| 1976 | .00250 | .00093 | -.00348 | .00206 |
| 1977 | -.00506 | -.01338 | .01124 | -.01443 |
| 1978 | .13367 | -.06032 | -.04655 | .05993 |
| 1979 | .04186 | -.12980 | .03992 | .01597 |
| 1980 | -.25851 | -.31668 | .38609 | .14879 |

*SDFBET_3* Standardized *dfbeta* for May-June inflows
*SDFBET_4* Standardized *dfbeta* for July-August inflows
*SDFBET_5* Standardized *dfbeta* for September-October inflows
*SDFBET_6* Standardized *dfbeta* for November-December inflows

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

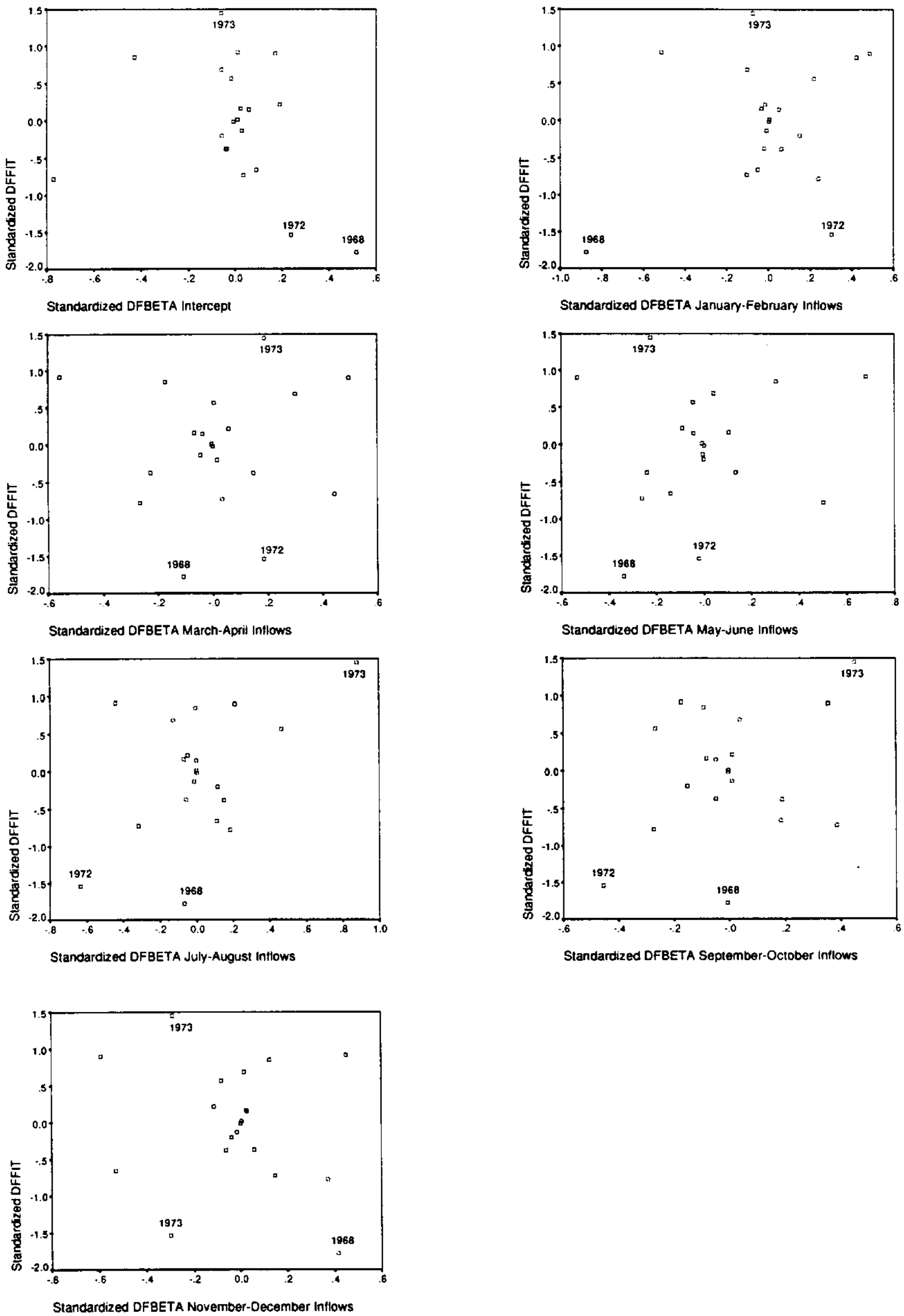


***Figure 6.45*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of inflow variables.*

# 7. EXAMINING SUBSETS OF THE DATA

## 7.1 Log of trout data and log of inflow data: 1964 Omitted

***Table 7.1*** *Regression Models for Dependent Variable: Ln(TROUT) on Ln(INFLOWS): 1964 Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.4785 | 0.4478 | 43.51 | -0.143 | 0.899 | 1.746 | LN_QMJ |
| 1 | 0.3696 | 0.3326 | 55.72 | 3.459 | 1.086 | 5.348 | LN_QJA |
| 1 | 0.2252 | 0.1796 | 71.93 | 7.379 | 1.335 | 9.268 | LN_QJF |
| 1 | 0.1139 | 0.0618 | 84.41 | 9.928 | 1.527 | 11.82 | LN_QSO |
| 2 | 0.8017 | 0.7769 | 9.251 | -16.51 | 0.363 | -13.68 | LN_QMJ LN_QJA |
| 2 | 0.6331 | 0.5873 | 28.16 | -4.825 | 0.672 | -1.992 | LN_QJF LN_QMJ |
| 2 | 0.6166 | 0.5687 | 30.01 | -3.990 | 0.702 | -1.157 | LN_QMJ LN_QND |
| 2 | 0.5848 | 0.5329 | 33.58 | -2.475 | 0.760 | 0.359 | LN_QJF LN_QSO |
| 3 | 0.8235 | 0.7882 | 8.801 | -16.73 | 0.345 | -12.95 | LN_QMJ LN_QJA LN_QND |
| 3 | 0.8159 | 0.7791 | 9.651 | -15.93 | 0.360 | -12.15 | LN_QJF LN_QMJ LN_QND |
| 3 | 0.8134 | 0.7761 | 9.935 | -15.67 | 0.364 | -11.89 | LN_QJF LN_QMJ LN_QJA |
| 3 | 0.8075 | 0.7690 | 10.60 | -15.08 | 0.376 | -11.30 | LN_QMA LN_QMJ LN_QJA |
| 4 | 0.8804 | 0.8462 | 4.421 | -22.12 | 0.250 | -17.40 | LN_QJF LN_QMJ LN_QSO LN_QND |
| 4 | 0.8628 | 0.8237 | 6.387 | -19.52 | 0.287 | -14.80 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 4 | 0.8522 | 0.8100 | 7.578 | -18.10 | 0.309 | -13.38 | LN_QJF LN_QMA LN_QMJ LN_QSO |
| 4 | 0.8507 | 0.8081 | 7.746 | -17.91 | 0.312 | -13.19 | LN_QJF LN_QMA LN_QMJ LN_QND |
| 5 | 0.8912 | 0.8493 | 5.207 | -21.92 | 0.245 | -16.25 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.8828 | 0.8377 | 6.154 | -20.50 | 0.264 | -14.83 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.8809 | 0.8351 | 6.362 | -20.20 | 0.268 | -14.53 | LN_QJF LN_QMA LN_QMJ LN_QSO LN_QND |
| 5 | 0.8713 | 0.8218 | 7.440 | -18.73 | 0.290 | -13.06 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 6 | 0.8930 | 0.8396 | 7.000 | -20.24 | 0.261 | -13.63 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 19

***Table 7.2** Analysis of Variance for Dependent Variable: Ln(TROUT) on Ln(INFLOWS): 1964 Omitted*

| Source | *DF* | *Sum of Squares* | *Mean Square* | *F* Value | Prob>*F* |
|---|---|---|---|---|---|
| Model | 6 | 26.16180 | 4.36030 | 16.698 | 0.0001 |
| Error | 12 | 3.13349 | 0.26112 | | |
| C Total | 18 | 29.29529 | | | |

| | | | |
|---|---|---|---|
| *Root MSE* | 0.51100 | *R-square* | 0.8930 |
| *Dep Mean* | 3.73020 | *Adj R-sq* | 0.8396 |
| *C.V.* | 13.69906 | | |

***Table 7.3** Parameter Estimates for Dependent Variable: Ln(TROUT) on Ln(INFLOWS): 1964 Omitted*

| Variable | *DF* | *Parameter Estimate* | *Standard Error* | *T* for H0: *Parameter=0* | Prob > \|*T*\| | *Variance Inflation* |
|---|---|---|---|---|---|---|
| *INTERCEP* | 1 | -3.517683 | 1.95665727 | -1.798 | 0.0974 | 0.00000000 |
| *LN_QJF* | 1 | -0.988338 | 0.35688627 | -2.769 | 0.0170 | 3.37895919 |
| *LN_QMA* | 1 | 0.156560 | 0.34408817 | 0.455 | 0.6572 | 4.41061732 |
| *LN_QMJ* | 1 | 1.276628 | 0.45924657 | 2.780 | 0.0167 | 4.69711204 |
| *LN_QJA* | 1 | 0.221759 | 0.19002445 | 1.167 | 0.2659 | 2.89908810 |
| *LN_QSO* | 1 | 0.398161 | 0.25489736 | 1.562 | 0.1443 | 4.50689378 |
| *LN_QND* | 1 | 0.290379 | 0.27030963 | 1.074 | 0.3038 | 4.72557828 |

***Table 7.4** Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(TROUT) on Ln(INFLOWS): 1964 Omitted*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *LN_QJF* | Var Prop *LN_QMA* | Var Prop *LN_QMJ* | Var Prop *LN_QJA* | Var Prop *LN_QSO* | Var Prop *LN_QND* |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.61070 | 1.00000 | 0.0952 | 0.0011 | 0.0002 | 0.0771 | 0.0141 | 0.0014 |
| 2 | 1.54720 | 1.02031 | 0.0113 | 0.0142 | 0.0000 | 0.0296 | 0.0296 | 0.0690 |
| 3 | 1.34592 | 1.09395 | 0.0015 | 0.0086 | 0.1142 | 0.0008 | 0.0189 | 0.0162 |
| 4 | 1.27534 | 1.12381 | 0.0008 | 0.1047 | 0.0011 | 0.0321 | 0.0454 | 0.0035 |
| 5 | 0.15597 | 3.21360 | 0.7059 | 0.0144 | 0.0009 | 0.8488 | 0.1342 | 0.1890 |
| 6 | 0.06488 | 4.98243 | 0.1853 | 0.8570 | 0.8836 | 0.0117 | 0.7579 | 0.7209 |

***Table 7.5*** *Parameter Estimates of Models for Dependent Variable: Ln(TROUT) on Ln(INFLOWS): 1964 Omitted*

| OBS | _RMSE_ | INTERCEP | LN_QJF | LN_QMA | LN_QMJ | LN_QJA | LN_QSO | LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.94799 | -3.66592 | . | . | 1.55255 | . | . | . |
| 2 | 1.04224 | 0.76117 | . | . | | 0.71870 | . | . |
| 3 | 1.15551 | 7.12264 | -0.97584 | . | . | . | . | . |
| 4 | 1.23568 | 1.45155 | . | | . | . | 0.42927 | . |
| 5 | 0.60261 | -6.09055 | . | . | 1.47776 | 0.67316 | . | . |
| 6 | 0.81959 | -0.31785 | -0.81472 | . | 1.44429 | . | . | . |
| 7 | 0.83780 | -6.94854 | . | . | 1.83772 | . | . | 0.51734 |
| 8 | 0.87189 | 4.67970 | -1.56283 | . | . | . | 0.84465 | . |
| 9 | 0.58711 | -7.23728 | . | . | 1.61149 | 0.59273 | . | 0.22638 |
| 10 | 0.59959 | -3.64088 | -0.93311 | . | 1.75951 | . | . | 0.60039 |
| 11 | 0.60370 | -4.71443 | -0.26459 | . | 1.45151 | 0.59297 | . | . |
| 12 | 0.61318 | -6.27082 | . | 0.14047 | 1.41729 | 0.67957 | . | . |
| 13 | 0.50032 | -2.81507 | -1.22440 | . | 1.43432 | . | 0.41110 | 0.48040 |
| 14 | 0.53573 | -5.19535 | -0.54565 | . | 1.65017 | 0.37154 | . | 0.38352 |
| 15 | 0.55607 | -0.39062 | -1.48873 | 0.57618 | 0.68196 | . | 0.79782 | . |
| 16 | 0.55888 | -4.29778 | -0.92168 | -0.40944 | 2.02801 | . | . | 0.76871 |
| 17 | 0.49517 | -3.87008 | -0.94133 | . | 1.45027 | 0.20573 | 0.31439 | 0.38854 |
| 18 | 0.51402 | -2.72981 | -0.99723 | 0.45158 | 0.89608 | 0.31383 | 0.55404 | . |
| 19 | 0.51807 | -2.58709 | -1.26063 | 0.08213 | 1.34257 | . | 0.45900 | 0.43266 |
| 20 | 0.53856 | -5.19431 | -0.63207 | -0.23164 | 1.82829 | 0.28247 | . | 0.53074 |
| 21 | 0.51100 | -3.51768 | -0.98834 | 0.15656 | 1.27663 | 0.22176 | 0.39816 | 0.29038 |

***Table 7.6*** *Criteria Statistics of Models for Dependent Variable: Ln(TROUT) on Ln(INFLOWS): 1964 Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 0.89868 | 0.47850 | 0.44782 | 43.5071 | -0.1430 | 1.7459 |
| 2 | 1.08626 | 0.36964 | 0.33256 | 55.7191 | 3.4588 | 5.3477 |
| 3 | 1.33521 | 0.22518 | 0.17960 | 71.9266 | 7.3794 | 9.2683 |
| 4 | 1.52692 | 0.11393 | 0.06181 | 84.4071 | 9.9285 | 11.8173 |
| 5 | 0.36314 | 0.80167 | 0.77688 | 9.2506 | -16.5117 | -13.6784 |
| 6 | 0.67172 | 0.63313 | 0.58727 | 28.1589 | -4.8254 | -1.9921 |
| 7 | 0.70191 | 0.61664 | 0.56872 | 30.0084 | -3.9902 | -1.1569 |
| 8 | 0.76019 | 0.58481 | 0.53291 | 33.5798 | -2.4746 | 0.3587 |
| 9 | 0.34469 | 0.82351 | 0.78821 | 8.8005 | -16.7283 | -12.9506 |
| 10 | 0.35950 | 0.81592 | 0.77911 | 9.6514 | -15.9289 | -12.1512 |
| 11 | 0.36445 | 0.81339 | 0.77607 | 9.9354 | -15.6694 | -11.8916 |
| 12 | 0.37599 | 0.80748 | 0.76898 | 10.5984 | -15.0770 | -11.2992 |
| 13 | 0.25032 | 0.88037 | 0.84619 | 4.4209 | -22.1173 | -17.3951 |
| 14 | 0.28700 | 0.86284 | 0.82366 | 6.3874 | -19.5193 | -14.7971 |
| 15 | 0.30921 | 0.85223 | 0.81001 | 7.5782 | -18.1031 | -13.3809 |
| 16 | 0.31234 | 0.85073 | 0.80809 | 7.7461 | -17.9117 | -13.1895 |
| 17 | 0.24520 | 0.89119 | 0.84934 | 5.2070 | -21.9186 | -16.2519 |
| 18 | 0.26422 | 0.88275 | 0.83766 | 6.1540 | -20.4990 | -14.8324 |
| 19 | 0.26839 | 0.88090 | 0.83509 | 6.3619 | -20.2011 | -14.5344 |
| 20 | 0.29005 | 0.87129 | 0.82178 | 7.4400 | -18.7268 | -13.0601 |
| 21 | 0.26112 | 0.89304 | 0.83956 | 7.0000 | -20.2436 | -13.6325 |

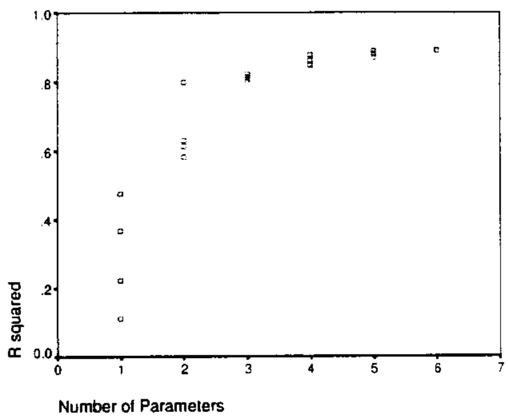


***Figure 7.1*** *The $R^2$ criteria vs. Number of parameters.*

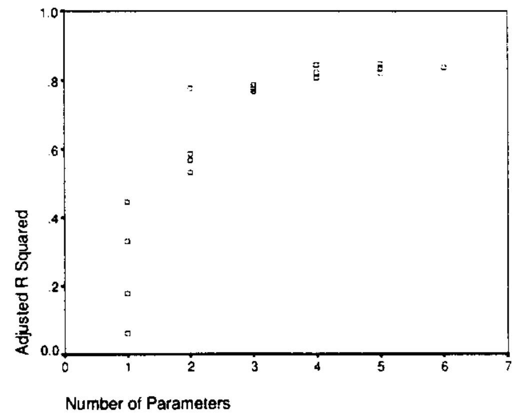


***Figure 7.2*** *The Adjusted $R^2$ criteria vs. Number of parameters.*

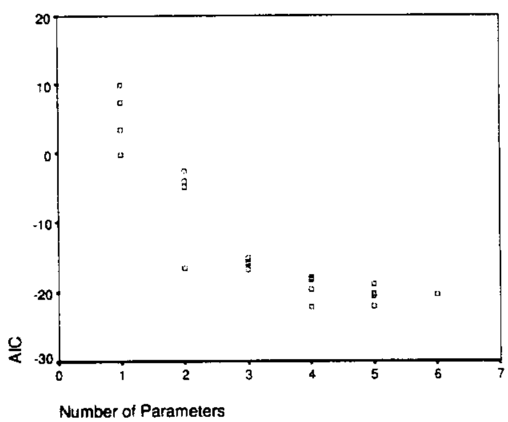


***Figure 7.3*** *The AIC criteria vs. Number of parameters..*

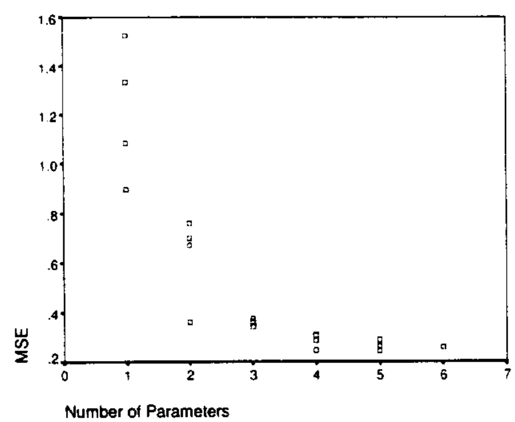


***Figure 7.4*** *MSE vs. Number of parameters.*

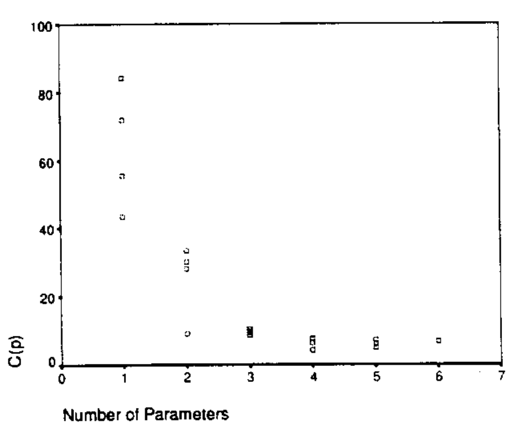


***Figure 7.5*** *The C(p) criteria vs. Number of parameters.*

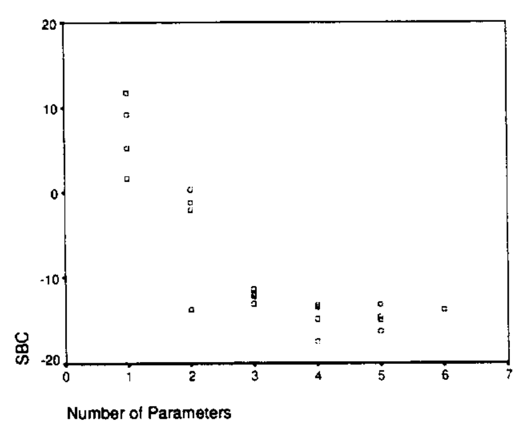


***Figure 7.6*** *The SBC criteria vs. Number of parameters.*

## 7.2 Log of trout data and square root inflow data

***Table** 7.7 Regression Models for Dependent Variable: Ln(TROUT) on Sqrt(INFLOWS): 1969 Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.5236 | 0.4956 | 69.98 | 2.370 | 1.026 | 4.258 | SQR_QMJ |
| 1 | 0.4456 | 0.4130 | 83.89 | 5.250 | 1.194 | 7.139 | SQR_QJA |
| 1 | 0.2441 | 0.1996 | 119.8 | 11.14 | 1.628 | 13.03 | SQR_QSO |
| 1 | 0.1119 | 0.0596 | 143.4 | 14.21 | 1.912 | 16.09 | SQR_QMA |
| 2 | 0.8029 | 0.7782 | 22.17 | -12.39 | 0.451 | -9.561 | SQR_QMJ SQR_QJA |
| 2 | 0.6679 | 0.6264 | 46.23 | -2.488 | 0.760 | 0.346 | SQR_QJF SQR_QMJ |
| 2 | 0.5876 | 0.5360 | 60.57 | 1.631 | 0.944 | 4.464 | SQR_QMJ SQR_QND |
| 2 | 0.5754 | 0.5223 | 62.75 | 2.186 | 0.972 | 5.019 | SQR_QMA SQR_QJA |
| 3 | 0.8436 | 0.8123 | 16.90 | -14.79 | 0.382 | -11.01 | SQR_QJF SQR_QMJ SQR_QND |
| 3 | 0.8326 | 0.7992 | 18.86 | -13.51 | 0.408 | -9.727 | SQR_QJF SQR_QMJ SQR_QJA |
| 3 | 0.8289 | 0.7947 | 19.52 | -13.08 | 0.418 | -9.307 | SQR_QMA SQR_QMJ SQR_QJA |
| 3 | 0.8202 | 0.7843 | 21.07 | -12.15 | 0.439 | -8.367 | SQR_QMJ SQR_QJA SQR_QND |
| 4 | 0.9085 | 0.8823 | 7.326 | -22.97 | 0.239 | -18.25 | SQR_QJF SQR_QMJ SQR_QSO SQR_QND |
| 4 | 0.9009 | 0.8726 | 8.676 | -21.46 | 0.259 | -16.74 | SQR_QJF SQR_QMJ SQR_QJA SQR_QND |
| 4 | 0.8852 | 0.8524 | 11.49 | -18.66 | 0.300 | -13.94 | SQR_QJF SQR_QMA SQR_QMJ SQR_QND |
| 4 | 0.8594 | 0.8193 | 16.07 | -14.82 | 0.368 | -10.10 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA |
| 5 | 0.9299 | 0.9030 | 5.501 | -26.05 | 0.197 | -20.38 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.9250 | 0.8962 | 6.371 | -24.77 | 0.211 | -19.10 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO |
| 5 | 0.9091 | 0.8741 | 9.220 | -21.10 | 0.256 | -15.43 | SQR_QJF SQR_QMA SQR_QMJ SQR_QSO SQR_QND |
| 5 | 0.9064 | 0.8704 | 9.692 | -20.55 | 0.263 | -14.89 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QND |
| 6 | 0.9327 | 0.8991 | 7.000 | -24.82 | 0.205 | -18.21 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

N = 19

**Table 7.8** *Analysis of Variance for Dependent Variable: Ln(TROUT) on Sqrt(INFLOWS): 1969 Omitted*

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 6 | 34.14250 | 5.69042 | 27.731 | 0.0001 |
| Error | 12 | 2.46240 | 0.20520 | | |
| C Total | 18 | 36.60489 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 0.45299 | R-square | 0.9327 |
| Dep Mean | 3.58808 | Adj R-sq | 0.8991 |
| C.V. | 12.62485 | | |

**Table 7.9** *Parameter Estimates for Dependent Variable: Ln(TROUT) on Sqrt(INFLOWS): 1969 Omitted*

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 0.362981 | 0.53961788 | 0.673 | 0.5139 | 0.00000000 |
| SQR_QJF | 1 | -0.358494 | 0.09055391 | -3.959 | 0.0019 | 2.64007754 |
| SQR_QMA | 1 | 0.072216 | 0.10203365 | 0.708 | 0.4926 | 5.66666585 |
| SQR_QMJ | 1 | 0.255180 | 0.07057655 | 3.616 | 0.0035 | 4.86004312 |
| SQR_QJA | 1 | 0.070725 | 0.03442809 | 2.054 | 0.0624 | 2.55616956 |
| SQR_QSO | 1 | 0.056220 | 0.02595537 | 2.166 | 0.0512 | 3.61861438 |
| SQR_QND | 1 | 0.092818 | 0.07927408 | 1.171 | 0.2644 | 5.91636935 |

**Table 7.10** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(TROUT) on Sqrt(INFLOWS): 1969 Omitted*

| Number | Eigenvalue | Condition Index | Var Prop SQR_QJF | Var Prop SQR_QMA | Var Prop SQR_QMJ | Var Prop SQR_QJA | Var Prop SQR_QSO | Var Prop SQR_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.07329 | 1.00000 | 0.0361 | 0.0119 | 0.0201 | 0.0039 | 0.0315 | 0.0166 |
| 2 | 1.42511 | 1.20616 | 0.0078 | 0.0328 | 0.0168 | 0.0570 | 0.0432 | 0.0188 |
| 3 | 1.30572 | 1.26010 | 0.0945 | 0.0146 | 0.0001 | 0.1279 | 0.0084 | 0.0129 |
| 4 | 0.91579 | 1.50464 | 0.0170 | 0.0361 | 0.0978 | 0.0218 | 0.0199 | 0.0405 |
| 5 | 0.22374 | 3.04410 | 0.6349 | 0.0115 | 0.0108 | 0.4206 | 0.4175 | 0.0152 |
| 6 | 0.05635 | 6.06580 | 0.2097 | 0.8931 | 0.8545 | 0.3688 | 0.4796 | 0.8960 |

***Table** 7.11 Parameter Estimates of Models for Dependent Variable: Ln(TROUT) on Sqrt(INFLOWS): 1969 Omitted*

| OBS | _RMSE_ | INTERCEP | SQR_QJF | SQR_QMA | SQR_QMJ | SQR_QJA | SQR_QSO | SQR_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.01279 | 0.26115 | . | . | 0.30941 | . | . | . |
| 2 | 1.09255 | 1.87337 | . | . | . | 0.19200 | . | . |
| 3 | 1.27579 | 2.25959 | . | . | . | . | 0.090036 | . |
| 4 | 1.38289 | 2.61048 | . | 0.19147 | . | . | . | . |
| 5 | 0.67156 | -0.60925 | . | . | 0.26129 | 0.15539 | . | . |
| 6 | 0.87159 | 1.46474 | -0.29081 | . | 0.34839 | . | . | . |
| 7 | 0.97136 | -0.57578 | . | . | 0.31524 | . | . | 0.11024 |
| 8 | 0.98565 | 0.78459 | . | 0.20633 | . | 0.19595 | . | . |
| 9 | 0.61783 | 0.49295 | -0.41558 | . | 0.37549 | . | . | 0.19602 |
| 10 | 0.63908 | 0.12672 | -0.14576 | . | 0.28817 | 0.13170 | . | . |
| 11 | 0.64619 | -0.87966 | . | 0.09865 | 0.23497 | 0.16097 | . | . |
| 12 | 0.66236 | -1.00511 | . | . | 0.26734 | 0.14597 | . | 0.05909 |
| 13 | 0.48917 | 0.83941 | -0.48823 | . | 0.31263 | . | 0.059737 | 0.17516 |
| 14 | 0.50899 | -0.10811 | -0.28203 | . | 0.32738 | 0.08759 | . | 0.13777 |
| 15 | 0.54795 | 0.42611 | -0.45579 | -0.16479 | 0.42638 | . | . | 0.27938 |
| 16 | 0.60623 | -0.13809 | -0.14767 | 0.10012 | 0.26180 | 0.13705 | . | . |
| 17 | 0.44421 | 0.34333 | -0.37915 | . | 0.29686 | 0.05895 | 0.043955 | 0.14146 |
| 18 | 0.45941 | 0.42563 | -0.30508 | 0.17579 | 0.18918 | 0.09528 | 0.073347 | . |
| 19 | 0.50599 | 0.79166 | -0.48777 | -0.02905 | 0.32812 | . | 0.053536 | 0.19202 |
| 20 | 0.51329 | 0.00282 | -0.33185 | -0.07534 | 0.36198 | 0.06697 | . | 0.18959 |
| 21 | 0.45299 | 0.36298 | -0.35849 | 0.07222 | 0.25518 | 0.07072 | 0.056220 | 0.09282 |

***Table** 7.12 Criteria Statistics of Models for Dependent Variable: Ln(TROUT) on Sqrt(INFLOWS): 1969 Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 1.02574 | 0.52363 | 0.49561 | 69.978 | 2.3696 | 4.2584 |
| 2 | 1.19366 | 0.44564 | 0.41303 | 83.890 | 5.2502 | 7.1391 |
| 3 | 1.62764 | 0.24410 | 0.19963 | 119.843 | 11.1422 | 13.0310 |
| 4 | 1.91237 | 0.11186 | 0.05961 | 143.433 | 14.2053 | 16.0942 |
| 5 | 0.45100 | 0.80287 | 0.77823 | 22.165 | -12.3948 | -9.5615 |
| 6 | 0.75967 | 0.66795 | 0.62644 | 46.234 | -2.4876 | 0.3457 |
| 7 | 0.94354 | 0.58758 | 0.53603 | 60.571 | 1.6306 | 4.4640 |
| 8 | 0.97151 | 0.57535 | 0.52227 | 62.752 | 2.1858 | 5.0191 |
| 9 | 0.38171 | 0.84358 | 0.81230 | 16.903 | -14.7901 | -11.0123 |
| 10 | 0.40842 | 0.83264 | 0.79917 | 18.855 | -13.5052 | -9.7275 |
| 11 | 0.41756 | 0.82889 | 0.79467 | 19.523 | -13.0847 | -9.3069 |
| 12 | 0.43872 | 0.82022 | 0.78426 | 21.071 | -12.1452 | -8.3674 |
| 13 | 0.23929 | 0.90848 | 0.88233 | 7.326 | -22.9739 | -18.2517 |
| 14 | 0.25907 | 0.90091 | 0.87260 | 8.676 | -21.4645 | -16.7423 |
| 15 | 0.30025 | 0.88516 | 0.85235 | 11.485 | -18.6616 | -13.9394 |
| 16 | 0.36751 | 0.85944 | 0.81928 | 16.074 | -14.8213 | -10.0991 |
| 17 | 0.19732 | 0.92992 | 0.90297 | 5.501 | -26.0457 | -20.3791 |
| 18 | 0.21105 | 0.92505 | 0.89622 | 6.371 | -24.7675 | -19.1008 |
| 19 | 0.25603 | 0.90907 | 0.87410 | 9.220 | -21.0973 | -15.4307 |
| 20 | 0.26347 | 0.90643 | 0.87044 | 9.692 | -20.5527 | -14.8861 |
| 21 | 0.20520 | 0.93273 | 0.89910 | 7.000 | -24.8228 | -18.2117 |

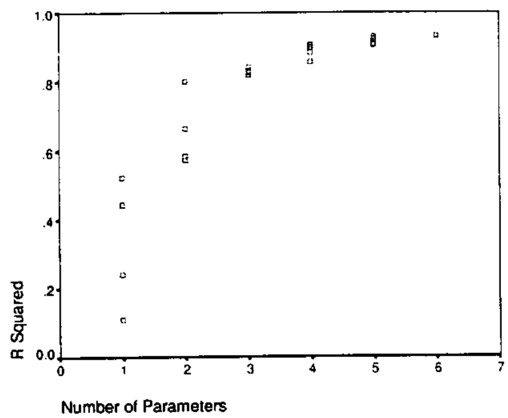


***Figure 7.7*** *The $R^2$ criteria vs. Number of parameters.*

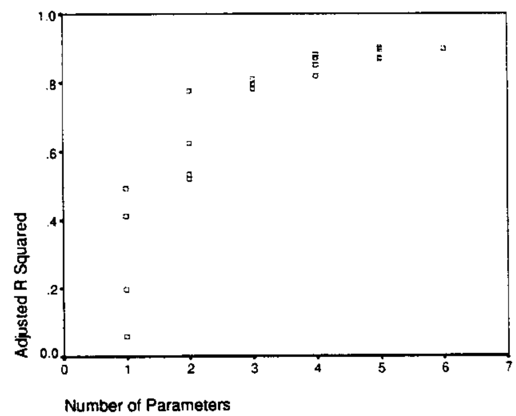


***Figure 7.8*** *The Adjusted $R^2$ criteria vs. Number of parameters.*

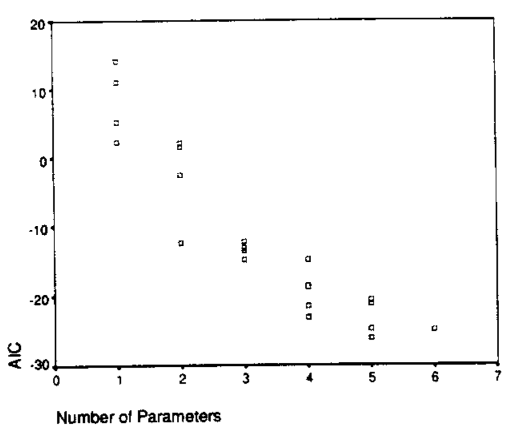


***Figure 7.9*** *The AIC criteria vs. Number of parameters..*

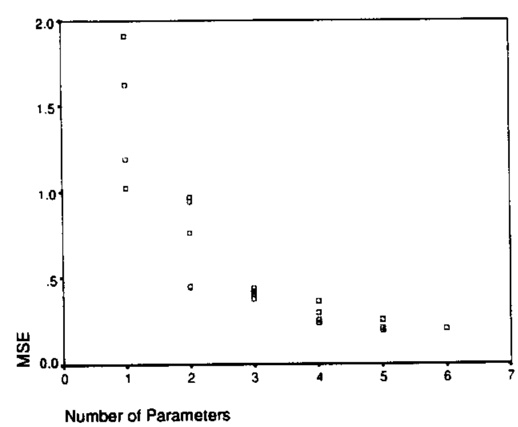


***Figure 7.10*** *MSE vs. Number of parameters.*

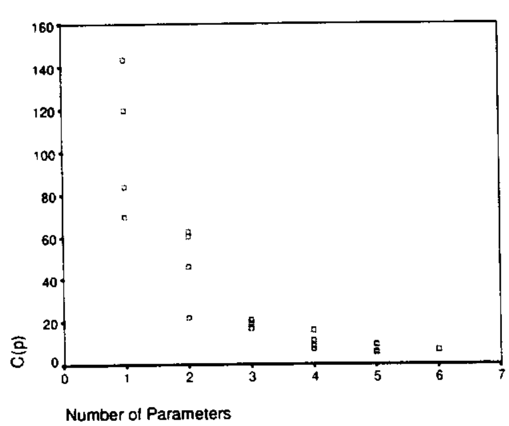


***Figure 7.11*** *The C(p) criteria vs. Number of parameters.*

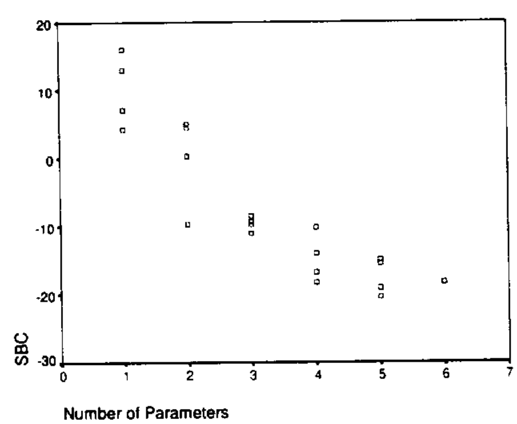


***Figure 7.12*** *The SBC criteria vs. Number of parameters.*

## 7.3 Square root of trout data and untransformed inflow data

***Table 7.13*** *Regression Models for Dependent Variable: Sqrt(TROUT) on INFLOWS: None Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.4992 | 0.4714 | 47.15 | 47.59 | 9.83 | 49.59 | QJA_LAG |
| 1 | 0.2709 | 0.2304 | 75.93 | 55.11 | 14.31 | 57.10 | QMJ_LAG |
| 1 | 0.2264 | 0.1834 | 81.55 | 56.29 | 15.18 | 58.28 | QSO_LAG |
| 1 | 0.0789 | 0.0278 | 100.1 | 59.78 | 18.07 | 61.77 | QJF_LAG |
| 2 | 0.6949 | 0.6591 | 24.47 | 39.68 | 6.34 | 42.67 | QMJ_LAG QJA_LAG |
| 2 | 0.6360 | 0.5932 | 31.90 | 43.21 | 7.56 | 46.20 | QJA_LAG QSO_LAG |
| 2 | 0.6004 | 0.5533 | 36.39 | 45.08 | 8.30 | 48.07 | QJF_LAG QSO_LAG |
| 2 | 0.5683 | 0.5175 | 40.43 | 46.62 | 8.97 | 49.61 | QMA_LAG QJA_LAG |
| 3 | 0.7597 | 0.7147 | 18.30 | 36.90 | 5.30 | 40.89 | QMA_LAG QJA_LAG QSO_LAG |
| 3 | 0.7486 | 0.7015 | 19.70 | 37.81 | 5.55 | 41.79 | QJF_LAG QMA_LAG QSO_LAG |
| 3 | 0.7277 | 0.6766 | 22.34 | 39.41 | 6.01 | 43.40 | QMJ_LAG QJA_LAG QSO_LAG |
| 3 | 0.7241 | 0.6724 | 22.78 | 39.67 | 6.09 | 43.65 | QMJ_LAG QJA_LAG QND_LAG |
| 4 | 0.8671 | 0.8316 | 6.764 | 27.07 | 3.13 | 32.05 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG |
| 4 | 0.8156 | 0.7664 | 13.25 | 33.62 | 4.34 | 38.59 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 4 | 0.7963 | 0.7420 | 15.68 | 35.60 | 4.80 | 40.58 | QJF_LAG QMJ_LAG QSO_LAG QND_LAG |
| 4 | 0.7918 | 0.7363 | 16.25 | 36.04 | 4.90 | 41.02 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.8968 | 0.8600 | 5.010 | 24.00 | 2.60 | 29.97 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.8779 | 0.8343 | 7.393 | 27.36 | 3.08 | 33.34 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.8731 | 0.8278 | 7.996 | 28.13 | 3.20 | 34.11 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.8006 | 0.7293 | 17.15 | 37.18 | 5.03 | 43.16 | QJF_LAG QMA_LAG QMJ_LAG QSO_LAG QND_LAG |
| 6 | 0.8969 | 0.8493 | 7.000 | 25.98 | 2.80 | 32.95 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

*N* = 20

***Table 7.14*** *Analysis of Variance for Dependent Variable: Sqrt(TROUT) on INFLOWS: None Omitted*

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 6 | 316.78642 | 52.79774 | 18.849 | 0.0001 |
| Error | 13 | 36.41325 | 2.80102 | | |
| C Total | 19 | 353.19967 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 1.67362 | R-square | 0.8969 |
| Dep Mean | 7.34915 | Adj R-sq | 0.8493 |
| C.V. | 22.77303 | | |

***Table 7.15*** *Parameter Estimates for Dependent Variable: Sqrt(TROUT) on INFLOWS: None Omitted*

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 2.339180 | 1.25755916 | 1.860 | 0.0856 | 0.00000000 |
| QJF_LAG | 1 | -0.075618 | 0.02133383 | -3.545 | 0.0036 | 2.25061968 |
| QMA_LAG | 1 | 0.037929 | 0.02191200 | 1.731 | 0.1071 | 3.94086323 |
| QMJ_LAG | 1 | 0.015895 | 0.01027592 | 1.547 | 0.1459 | 2.65317111 |
| QJA_LAG | 1 | 0.016898 | 0.00484793 | 3.486 | 0.0040 | 1.79635553 |
| QSO_LAG | 1 | 0.009765 | 0.00229947 | 4.247 | 0.0010 | 2.65004848 |
| QND_LAG | 1 | 0.001496 | 0.01467420 | 0.102 | 0.9204 | 3.38499802 |

***Table 7.16*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Sqrt(TROUT) on INFLOWS: None Omitted*

| Number | Eigenvalue | Condition Index | Var Prop QJF_LAG | Var Prop QMA_LAG | Var Prop QMJ_LAG | Var Prop QJA_LAG | Var Prop QSO_LAG | Var Prop QND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.86647 | 1.00000 | 0.0619 | 0.0077 | 0.0450 | 0.0010 | 0.0804 | 0.0094 |
| 2 | 1.68991 | 1.05094 | 0.0256 | 0.0657 | 0.0088 | 0.0116 | 0.0011 | 0.0674 |
| 3 | 1.29792 | 1.19919 | 0.0529 | 0.0044 | 0.0413 | 0.2647 | 0.0135 | 0.0038 |
| 4 | 0.80254 | 1.52503 | 0.0350 | 0.0335 | 0.1812 | 0.0675 | 0.0580 | 0.0826 |
| 5 | 0.23546 | 2.81549 | 0.7824 | 0.0001 | 0.0087 | 0.5234 | 0.5484 | 0.0205 |
| 6 | 0.10770 | 4.16295 | 0.0422 | 0.8885 | 0.7151 | 0.1318 | 0.2986 | 0.8163 |

***Table** 7.17 Parameter Estimates of Models for Dependent Variable: Sqrt(TROUT) on INFLOWS: None Omitted*

| OBS | _RMSE_ | INTERCEP | QJF_LAG | QMA_LAG | QMJ_LAG | QJA_LAG | QSO_LAG | QND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | 3.13475 | 4.50121 | . | . | . | 0.028698 | . | . |
| 2 | 3.78229 | 2.69214 | . | . | 0.036875 | . | . | . |
| 3 | 3.89609 | 5.11716 | . | . | . | . | 0.007547 | . |
| 4 | 4.25126 | 9.03084 | -0.04487 | . | . | . | . | . |
| 5 | 2.51754 | 0.72255 | . | . | 0.031550 | 0.026624 | . | . |
| 6 | 2.74995 | 2.98064 | . | . | . | 0.026319 | 0.005940 | . |
| 7 | 2.88154 | 7.66715 | -0.11375 | . | . | . | 0.013342 | . |
| 8 | 2.99481 | 3.36782 | . | 0.032756 | . | 0.029796 | . | . |
| 9 | 2.30295 | 1.10469 | . | 0.044904 | . | 0.027321 | 0.007199 | . |
| 10 | 2.35556 | 5.89166 | -0.12265 | 0.049420 | . | . | 0.015248 | . |
| 11 | 2.45193 | 0.71432 | . | . | 0.024556 | 0.025760 | 0.003304 | . |
| 12 | 2.46769 | -0.37047 | . | . | 0.033559 | 0.026091 | . | 0.015537 |
| 13 | 1.76929 | 3.42820 | -0.07586 | 0.049216 | . | 0.017524 | 0.011788 | . |
| 14 | 2.08386 | 2.92022 | -0.06832 | . | 0.025087 | 0.016839 | 0.007271 | . |
| 15 | 2.18989 | 3.35411 | -0.12120 | . | 0.030190 | . | 0.010646 | 0.027466 |
| 16 | 2.21417 | 0.05496 | . | 0.035151 | 0.015789 | 0.026744 | 0.005231 | . |
| 17 | 1.61339 | 2.39194 | -0.07506 | 0.039769 | 0.015220 | 0.017071 | 0.009843 | . |
| 18 | 1.75490 | 3.48780 | -0.07067 | 0.061692 | . | 0.018867 | 0.011709 | -0.013136 |
| 19 | 1.78897 | 1.76321 | -0.08132 | . | 0.028366 | 0.014407 | 0.007895 | 0.022418 |
| 20 | 2.24316 | 3.69650 | -0.12168 | 0.015260 | 0.025299 | . | 0.011590 | 0.019400 |
| 21 | 1.67362 | 2.33918 | -0.07562 | 0.037929 | 0.015895 | 0.016898 | 0.009765 | 0.001496 |

***Table** 7.18 Criteria Statistics of Models for Dependent Variable: Ln(TROUT) on INFLOWS: None Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 9.8267 | 0.49921 | 0.47139 | 47.148 | 47.5948 | 49.5862 |
| 2 | 14.3057 | 0.27094 | 0.23044 | 75.932 | 55.1059 | 57.0974 |
| 3 | 15.1795 | 0.22641 | 0.18343 | 81.547 | 56.2918 | 58.2832 |
| 4 | 18.0732 | 0.07894 | 0.02777 | 100.143 | 59.7814 | 61.7729 |
| 5 | 6.3380 | 0.69494 | 0.65905 | 24.467 | 39.6810 | 42.6682 |
| 6 | 7.5622 | 0.63602 | 0.59320 | 31.897 | 43.2129 | 46.2001 |
| 7 | 8.3033 | 0.60035 | 0.55333 | 36.394 | 45.0827 | 48.0699 |
| 8 | 8.9689 | 0.56831 | 0.51753 | 40.434 | 46.6249 | 49.6121 |
| 9 | 5.3036 | 0.75975 | 0.71470 | 18.295 | 36.9048 | 40.8877 |
| 10 | 5.5487 | 0.74864 | 0.70151 | 19.695 | 37.8083 | 41.7913 |
| 11 | 6.0120 | 0.72766 | 0.67659 | 22.342 | 39.4122 | 43.3951 |
| 12 | 6.0895 | 0.72415 | 0.67242 | 22.784 | 39.6684 | 43.6513 |
| 13 | 3.1304 | 0.86706 | 0.83160 | 6.764 | 27.0696 | 32.0482 |
| 14 | 4.3425 | 0.81558 | 0.76640 | 13.255 | 33.6153 | 38.5939 |
| 15 | 4.7956 | 0.79634 | 0.74202 | 15.682 | 35.6004 | 40.5791 |
| 16 | 4.9025 | 0.79179 | 0.73627 | 16.254 | 36.0415 | 41.0201 |
| 17 | 2.6030 | 0.89682 | 0.85997 | 5.010 | 24.0000 | 29.9744 |
| 18 | 3.0797 | 0.87793 | 0.83433 | 7.393 | 27.3629 | 33.3373 |
| 19 | 3.2004 | 0.87314 | 0.82784 | 7.996 | 28.1322 | 34.1066 |
| 20 | 5.0318 | 0.80055 | 0.72932 | 17.150 | 37.1819 | 43.1563 |
| 21 | 2.8010 | 0.89690 | 0.84932 | 7.000 | 25.9840 | 32.9541 |

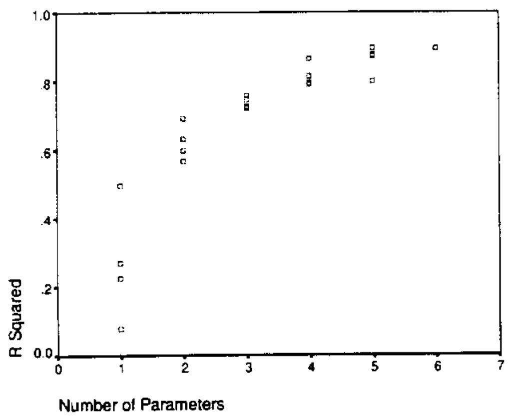


***Figure 7.13*** *The $R^2$ criteria vs. Number of parameters.*

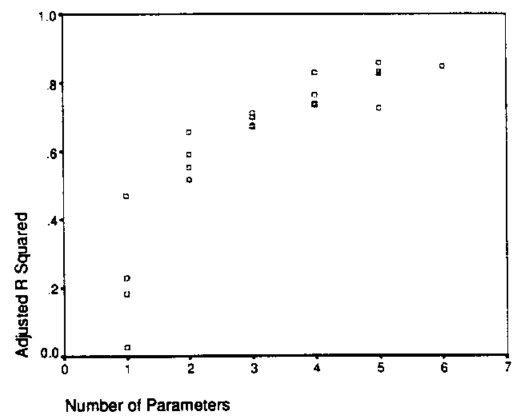


***Figure 7.14*** *The Adjusted $R^2$ criteria vs. Number of parameters.*

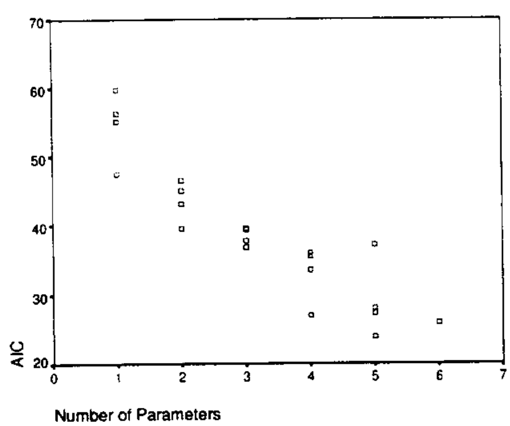


***Figure 7.15*** *The AIC criteria vs. Number of parameters..*

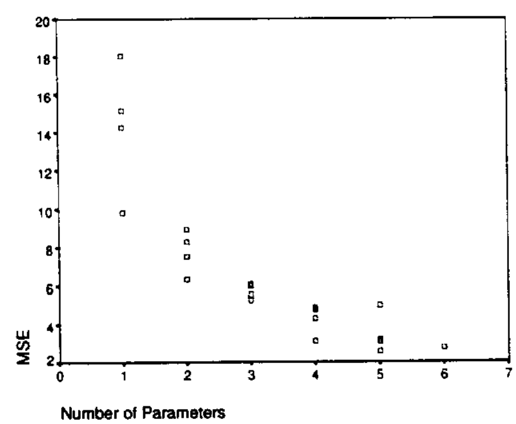


***Figure 7.16*** *MSE vs. Number of parameters.*

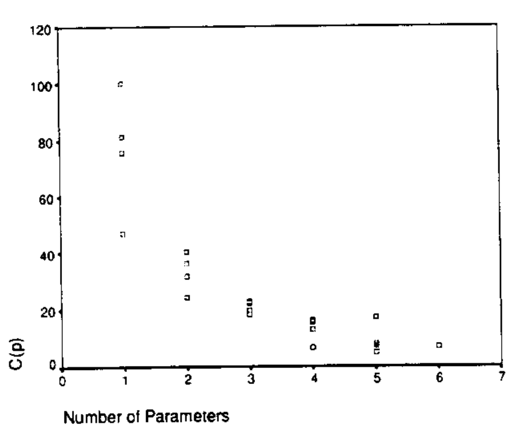


***Figure 7.17*** *The C(p) criteria vs. Number of parameters.*

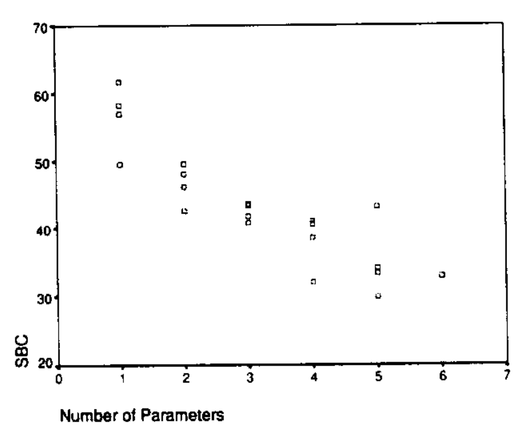


***Figure 7.18*** *The SBC criteria vs. Number of parameters.*

# Trout Harvests in Aransas Bay: A Regression Analysis

## Harvest vs Freshwater Inflows

F. Michael Speed
Michael Longnecker
Birgir Hrafnkelsson

*Department of Statistics*
*Texas A&M University*

# TROUT HARVESTS IN ARANSAS:



# A Regression Analysis
## Harvest vs. Freshwater Inflows

F. Michael Speed
M. Longnecker
Birgir Hrafnkelsson

*Department of Statistics*
*Texas A&M University*
May 1997

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# 1. SUMMARY REPORT

## 1.1 Description of the Problem[1]

Bimonthly freshwater inflows into Aransas were recorded for the years 1961 to 1980. These variables, and various transformations of them, were used to construct a model for the annual harvest of trout.

## 1.2 Constructing Models - General Discussion

Stability of coefficient estimates and accuracy of predicted values are primary goals in constructing models for prediction. To this end, the data must be examined from three points of view: individual observations (to detect outliers or influential points); variables, individually and in groups (to select an optimal set of predictors); and the interaction of these two, which produces the overall structure of the data set (to determine whether multicollinearity is present or not). The first two of these were examined by both graphic and quantitative means; the third by quantitative means only.

### 1.2.1 Detecting Influential Points and Outliers

The structures of individual variables were examined via box plots and histograms, as well as by all the usual numerical measures. For each pair of variables, 99% prediction ellipses and 95% confidence regions were plotted in a further effort to look for unusual points. For example, suppose large values of Variable A are generally associated with large values for Variable B. If an observation consisted of a large value for Variable A but a small value for Variable B, that point would be considered unusual, even though it was well within the range of data for both variables and could not be considered an outlier.

In addition, a number of residual analysis techniques were employed. A large residual indicates a point not well-fit by the model. The deleted residual, however, is somewhat more useful in the search for influential points. The model is fitted without a given observation, and the predicted response and corresponding residual are calculated for that observation. The Studentized deleted residual is scaled to have a Student's $t$ distribution. Histograms and normal P-P plots of the residuals were also examined.

Other quantities, such as the Mahalanobis distance, Cook's distance, the leverage value, standarized values for the *Dffits* (to measure the influence of a given observation on the predicted response) and the *Dfbetas* (to measure the influence of a given observation on the calculated coefficients) were also used to build a general picture of the influence of individual points. Plots were made of the standardized *Dffits* value for each model against the standardized *Dfbeta* values for each predictor in the model. Points which were extreme indicated observations which had strong effects on both predicted values and coefficient estimates.

1 The following discussion, prepared by Jacqueline Kiffe, was taken from Seatrout Harvest in Galveston Bay: A Regression Analysis, by F. Michael Speed, Sr. and Jacqueline Kiffe.

### 1.2.2 Variable Selection

For each regression, residuals were plotted against each of the independent variables to look for nonlinear relationships between the response variable and individual predictors. Partial residual plots were employed to examine the overall relationship between the response and individual predictors. A partial residual is a corollary to the deleted residual. That is, the model is fitted without a given variable and the predicted response and corresponding residual are calculated for each observation. This seeks to answer the question, "What is the relationship of this predictor to the response variable, taking all other variables into account?" Thus, it examines the marginal relationship of a given predictor to the response.

Numerous measures have been developed over the years to assess the adequacy of a given model. We examined a number of these, including $R^2$ and mean squared error (*MSE*), and several others which directly incorporate penalties for having too many predictors in the model, such as adjusted $R^2$, *Cp*, *AIC*, and *SBC*. It is well-established that too many predictors in a model can lead to bad prediction, just as too few can, and these measures are used as part of the attempt to find an optimal model.

### 1.2.3 Multicollinearity

Multicollinearity arises when one or more variables are nearly closely approximated by linear combinations of the remaining variables, resulting in unstable coefficient estimates. The variance inflation factor (*VIF*) was calculated for each coefficient estimate to measure this instability, which is not usually considered profound for *VIF*'s less than 10. No problems were found with this data. Additionally, the condition index (a ratio of eigenvalues of the covariance matrix, with the largest eigenvalue always on top) was calculated. A ratio greater than 30 is considered cause for concern. Again, no evidence of multicollinearity was found.

### 1.2.4 Other Procedures

Several other miscellaneous diagnostics, including the Durbin-Watson test for serial autocorrelation were performed, and no general problems were detected. The Box-Cox procedure, used to find a transformation to normality, was also performed.

## 1.3 How the Final Model Was Chosen

### 1.3.1 Selecting the Data Set Used

First, the variables were explored thoroughly, individually and in pairs, in a first effort to detect outliers. The SAS® programming language allows a number of diagnostics to be calculated for a group of models on a given data set without actually performing a formal regression, thus allowing one to examine a large number of models quite efficiently. The Box-Cox procedure was performed to find if a transformation to normallity was suggested. The log transform was suggested for some variables, and the squared root for others. At this point, there were several data sets for which the diagnostic series was calculated:

1. Untransformed trout data and untransformed inflow data
2. Log of trout data and untransformed inflow data
3. Log of trout data and log of inflow data
4. Log of trout data and square root of inflow data
5. Square root of trout data and square root of inflow data
6. Various transformation suggested by Box-Cox

### 1.3.2 Selecting the Points to be Omitted

The full regression with all diagnostics was performed for these models, each one contained all variables in its corresponding data set. All diagnostics were generated, and influential points were determined for each model.

***Table 1.1*** *$R^2$ and Adjusted $R^2$ for full data sets.*

| Data Set | $R^2$ | Adj. $R^2$ |
|---|---|---|
| 1 | 0.5863 | 0.3954 |
| 2 | 0.7345 | 0.6119 |
| 3 | 0.7048 | 0.5686 |
| 4 | 0.7503 | 0.6351 |
| 5 | 0.6727 | 0.5216 |
| 6 | 0.6343 | 0.4655 |

Data sets 2, 3, and 4 presented the highest $R^2$ values. These three models were considered final candidates. The observations flagged as potentially influential are given in the summary table below, for each model.

***Table 1.2*** *Summary of points flagged by Boxplots.*

| Year | Variable |
|---|---|
| 1980 | Ln(Trout), July-August Inflows, Sqrt(July-August) |

***Table 1.3*** *Summary of points flagged by 99% prediction ellipses.*

| Year | Variable |
|---|---|
| None | None |

***Table 1.4*** *Outliers of data set 2.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1961 | | | | | | | 1 | | 1 |
| 1963 | | | | | | | 1 | | 1 |
| 1976 | | | | 1 | | | 1 | | 2 |
| 1980 | 2 | | | 1 | 1 | | | | 4 |

***Table 1.5*** *Outliers of data set 3.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1961 | | | | | | | 1 | | 1 |
| 1963 | | | 1 | 1 | | 1 | 1 | 5 | 9 |
| 1964 | | | | 1 | | | | | 1 |
| 1975 | | | | | | | 1 | | 1 |
| 1976 | | | | | | | 1 | | 1 |
| 1980 | 1 | | | 1 | | | 1 | | 3 |

***Table 1.6*** *Outliers of data set 4.*

| Year | BOX | *SRE* | *SDR* | *LEV* | *MAH* | *COO* | *SDF* | *SDB* | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1961 | | | | | | | 1 | | 1 |
| 1963 | | | 1 | | | | 1 | 4 | 6 |
| 1976 | | | | | | | 1 | | 1 |
| 1980 | 2 | | | 1 | | | | | 3 |

***A Key to Abbreviations:***

BOX Box plot
SRE Studentized residual
SDR Studentized deleted residual
LEV Leverage value
MAH Mahalanobis distance
COO Cook's distance
SDF Standardized Dffits value
SDB Standardized Dfbeta value

### 1.3.3 Selecting the Final Candidate Models

After the subset analysis led us to four models, Data Set 2 with none omitted; Data Set 3 with 1963 omitted and Data Set 4 with 1963 omitted.

***Table 1.7*** *$R^2$ and Adjusted $R^2$ for data sets number 2, 3 and 4.*

| Data set | Observations omitted | $R^2$ | Adj. $R^2$ |
|---|---|---|---|
| 2 | None | 0.7291 | 0.6324 |
| 3 | 1963 | 0.8477 | 0.7715 |
| 4 | 1963 | 0.8793 | 0.8190 |

### 1.3.4 Selecting the Final Models

It appears that Data set 4 with 1963 omitted is the best model. Regression was performed using this model, and the deleted residuals were calculated.

Ln(Trout Harvest) = 6.27401 - 0.083477*Sqrt(Jan.-Feb. Inflows)
+ 0.11770*Sqrt( March-April Inflows)
- 0.09539*Sqrt(May-June Inflows)
- 0.21394*Sqrt(Jul-Aug Inflows)
+ 0.053512*Sqrt(Sep-Oct Inflows)
+ 0.068904*Sqrt(Nov.-Dec. Inflows)

## 1.4 Best Model: Logged Harvest and Square Root of Inflows

### 1.4.1 Summary Information

***Table 1.8*** *Descriptive statistics for dependent and independent variables.*

**Descriptive Statistics**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| Ln(Trout Harvest) | 5.086102 | .520164 | 19 |
| Sqrt( January-February Inflows) | 5.049526 | 2.321081 | 19 |
| Sqrt(March-April Inflows) | 4.750408 | 1.522770 | 19 |
| Sqrt(May-June Inflows) | 11.2119 | 4.162315 | 19 |
| Sqrt(July-August Inflows) | 6.430674 | 2.253051 | 19 |
| Sqrt(September-October Inflows) | 13.6319 | 7.417221 | 19 |
| Sqrt(November-December Inflows) | 5.663156 | 2.916187 | 19 |

***Table 1.9*** *Model summary for the final model.*

**Model Summary[a,b]**

| | Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|---|
| | Sqrt(November-December), Sqrt(September-October), Sqrt(March-April), Sqrt(July-August), Sqrt(January-February), Sqrt(May-June)[c,d] | .938 | .879 | .819 | .221297 | 2.765 |

a. Dependent Variable: Ln(Trout Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of September-October Inflows, Square Root of March-April Inflows, Square Root of July-August Inflows, Square Root of January-February Inflows, Square Root of May-June Inflows

d. All requested variables entered.

***Table 1.10*** *Anova for the final model.*

**ANOVA**[a]

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 4.283 | 6 | .714 | 14.575 | .000[b] |
| | Residual | .588 | 12 | 4.9E-02 | | |
| | Total | 4.870 | 18 | | | |

a. Dependent Variable: Ln(Trout Harvest)

b. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of September-October Inflows, Square Root of March-April Inflows, Square Root of July-August Inflows, Square Root of January-February Inflows, Square Root of May-June Inflows

***Table 1.11*** *Parameter estimates for the final model.*

**Coefficients**[a]

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | 6.274 | .246 | | 25.516 | .000 | 5.738 | 6.810 |
| Sqrt(January-February) | -8.3E-02 | .028 | -.372 | -2.965 | .012 | -.145 | -.022 |
| Sqrt(March-April) | .118 | .066 | .345 | 1.789 | .099 | -.026 | .261 |
| Sqrt(May-June) | -9.5E-02 | .032 | -.763 | -2.982 | .011 | -.165 | -.026 |
| Sqrt(July-August) | -.214 | .027 | -.927 | -7.885 | .000 | -.273 | -.155 |
| Sqrt(September-October) | 5.4E-02 | .014 | .763 | 3.834 | .002 | .023 | .084 |
| Sqrt(November-December) | 6.9E-02 | .021 | .386 | 3.239 | .007 | .023 | .115 |

a. Dependent Variable: Ln(Trout Harvest)

***Table 1.12*** *Residuals statistics for the final model.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 3.694492 | 5.877695 | 5.086102 | .487772 | 19 |
| Std. Predicted Value | -2.853 | 1.623 | .000 | 1.000 | 19 |
| Standard Error of Predicted Value | .106250 | .193234 | .132707 | 2.1E-02 | 19 |
| Adjusted Predicted Value | 3.641087 | 5.869698 | 5.071822 | .505107 | 19 |
| Residual | -.348173 | .352254 | 1.2E-15 | .180688 | 19 |
| Std. Residual | -1.573 | 1.592 | .000 | .816 | 19 |
| Stud. Residual | -1.869 | 1.858 | .024 | 1.014 | 19 |
| Deleted Residual | -.491294 | .495014 | 1.4E-02 | .281582 | 19 |
| Stud. Deleted Residual | -2.125 | 2.108 | .035 | 1.079 | 19 |
| Mahal. Distance | 3.202 | 12.777 | 5.684 | 2.270 | 19 |
| Cook's Distance | .000 | .371 | .080 | .095 | 19 |
| Centered Leverage Value | .178 | .710 | .316 | .126 | 19 |

a. Dependent Variable: Ln(Trout Harvest)

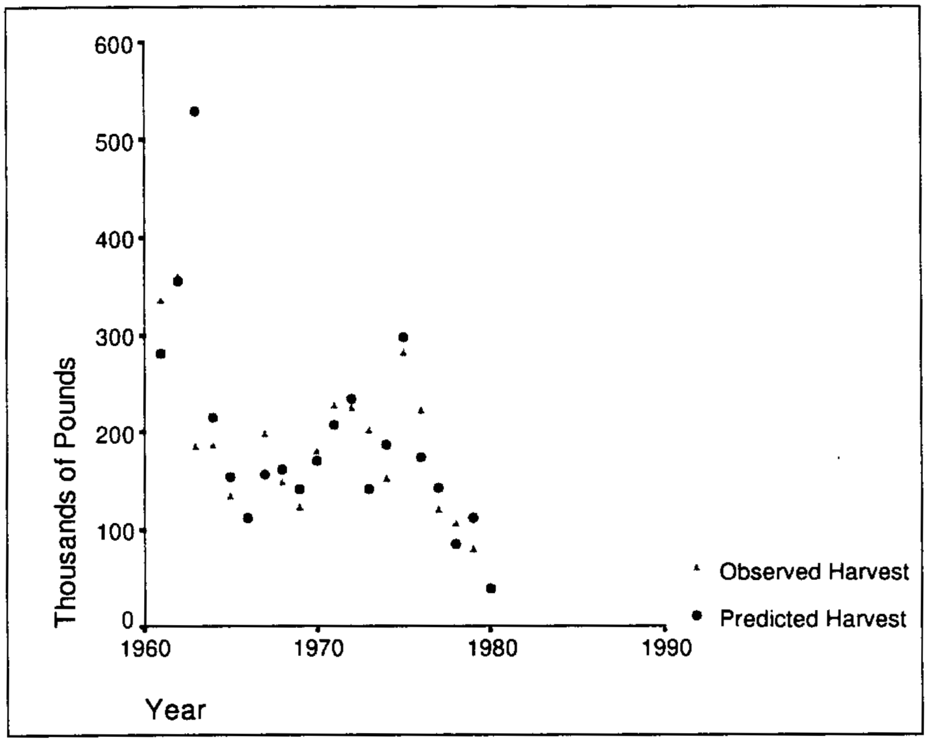


***Figure 1.1*** *Predicted and observed values for the harvest.*

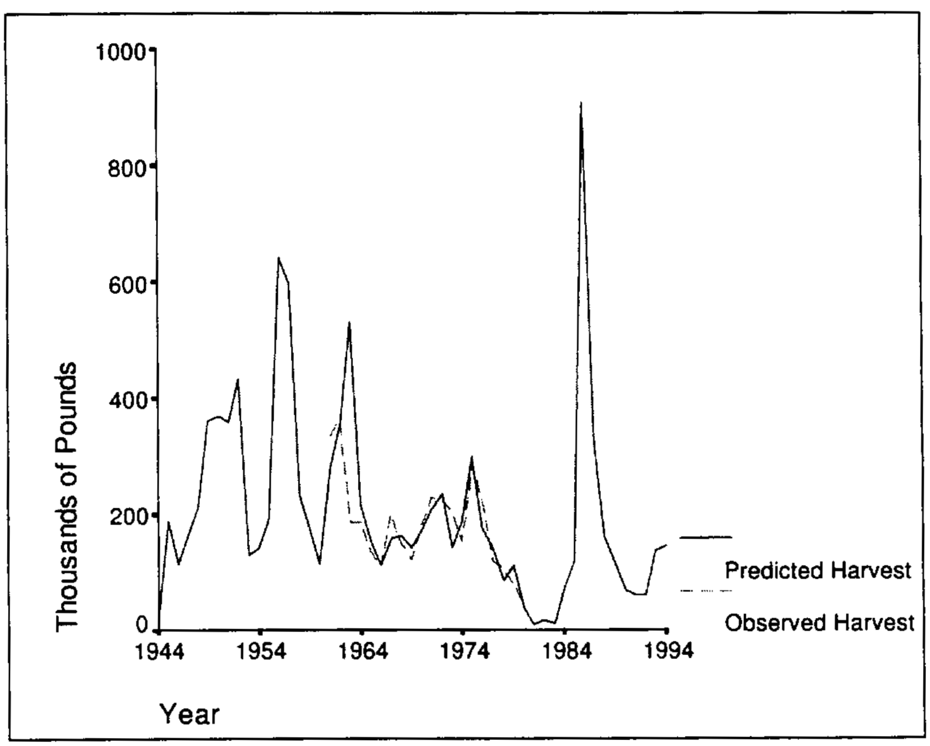


***Figure 1.2*** *Predicted and observed values for the harvest.*

***Table 1.14*** *Prediction Intervals for Trout Harvest based on the final model.*

| YEAR | *TROUT* | *PRE_1* | *LICI_1* | *UICI_1* |
|---|---|---|---|---|
| 1961 | 335.80 | 282.89 | 125.94 | 635.44 |
| 1962 | 360.70 | 356.99 | 158.81 | 802.45 |
| 1963 | 185.30 | 530.35 | 216.98 | 1296.28 |
| 1964 | 187.00 | 216.58 | 96.24 | 487.40 |
| 1965 | 134.40 | 155.10 | 70.09 | 343.22 |
| 1966 | 110.80 | 112.50 | 52.14 | 242.72 |
| 1967 | 199.00 | 157.79 | 71.88 | 346.37 |
| 1968 | 148.70 | 163.08 | 76.97 | 345.56 |
| 1969 | 123.00 | 141.96 | 65.90 | 305.78 |
| 1970 | 181.00 | 171.57 | 81.06 | 363.16 |
| 1971 | 228.10 | 208.29 | 93.18 | 465.57 |
| 1972 | 225.50 | 236.11 | 109.65 | 508.41 |
| 1973 | 202.50 | 142.38 | 66.54 | 304.64 |
| 1974 | 152.80 | 187.98 | 88.63 | 398.67 |
| 1975 | 283.20 | 298.80 | 136.57 | 653.77 |
| 1976 | 223.10 | 175.84 | 76.43 | 404.53 |
| 1977 | 120.60 | 143.41 | 64.86 | 317.10 |
| 1978 | 106.00 | 86.44 | 38.73 | 192.91 |
| 1979 | 79.60 | 112.75 | 52.30 | 243.06 |
| 1980 | 40.90 | 40.23 | 16.40 | 98.68 |

*TROUT* Observed trout harvest
*PRE_!* Predicted trout harvest
*LICI_*1 Lower limit for 99% prediction interval for the trout harvest.
*UICI_*1 Upper limit for 99% prediction interval for the trout harvest.

# 2. EXPLORING THE DATA

## 2.1 Listing of data

***Table 2.1*** *The trout data and the inflow data.*

| Year | *Trout* | *JF_inflow* | *MA_inflow* | *MJ_inflow* | *JA_inflow* | *SO_inflow* | *ND_inflow* |
|---|---|---|---|---|---|---|---|
| 1961 | 335.80 | 85.35 | 12.53 | 76.10 | 22.09 | 261.57 | 102.55 |
| 1962 | 360.70 | 71.46 | 11.40 | 58.42 | 16.61 | 238.01 | 99.51 |
| 1963 | 185.30 | 68.35 | 6.21 | 16.04 | 9.88 | 197.47 | 102.87 |
| 1964 | 187.00 | 2.27 | 2.73 | 11.40 | 27.05 | 25.49 | 8.41 |
| 1965 | 134.40 | 10.94 | 3.93 | 21.76 | 27.02 | 9.91 | 8.54 |
| 1966 | 110.80 | 16.67 | 37.16 | 117.89 | 33.60 | 5.95 | 9.96 |
| 1967 | 199.00 | 16.39 | 36.63 | 127.86 | 16.07 | 6.96 | 9.10 |
| 1968 | 148.70 | 12.89 | 36.99 | 303.30 | 39.42 | 492.61 | 10.27 |
| 1969 | 123.00 | 37.58 | 20.20 | 224.35 | 34.75 | 502.38 | 5.04 |
| 1970 | 181.00 | 42.43 | 38.25 | 263.17 | 35.14 | 502.41 | 19.33 |
| 1971 | 228.10 | 37.99 | 37.01 | 73.54 | 22.08 | 54.97 | 17.70 |
| 1972 | 225.50 | 14.82 | 33.38 | 176.66 | 39.38 | 399.10 | 29.29 |
| 1973 | 202.50 | 11.60 | 20.10 | 275.96 | 39.53 | 415.48 | 16.51 |
| 1974 | 152.80 | 13.40 | 22.00 | 302.27 | 31.27 | 559.45 | 19.57 |
| 1975 | 283.20 | 6.87 | 9.71 | 182.54 | 14.08 | 311.23 | 38.09 |
| 1976 | 223.10 | 5.73 | 11.83 | 52.72 | 87.96 | 303.41 | 44.08 |
| 1977 | 120.60 | 21.29 | 33.65 | 103.25 | 90.67 | 153,34 | 114.66 |
| 1978 | 106.00 | 29.50 | 34.03 | 127.02 | 90.38 | 53.14 | 94.82 |
| 1979 | 79.60 | 60.44 | 46.07 | 137.12 | 64.26 | 75.87 | 93.72 |
| 1980 | 40.90 | 83.81 | 22.90 | 64.94 | 145.73 | 149.76 | 21.28 |

| | |
|---|---|
| Trout | Trout harvest (thousands of pounds) |
| JF_inflow | Lagged January-February inflows (thousands of acre-feet) |
| MA_inflow | Lagged March-April inflows (thousands of acre-feet) |
| MJ_inflow | Lagged May-June inflows (thousands of acre-feet) |
| JA_inflow | Lagged July-August inflows (thousands of acre-feet) |
| SO_inflow | Lagged September-October inflows (thousands of acre-feet) |
| ND_inflow | Lagged November-December inflows (thousands of acre-feet) |

## 2.2 Examination of Individual Variables

***Table .2.2*** *Test of Normality for the trout data and the inflow data.*

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Trout Harvest | .132 | 20 | .200* | .960 | 20 | .527 |
| Ln(Trout Harvest) | .132 | 20 | .200* | .947 | 20 | .379 |
| Square Root of Trout Harvest | .110 | 20 | .200* | .983 | 20 | .948 |
| January-February Inflows | .220 | 20 | .013 | .857 | 20 | .010** |
| Ln(January-February Inflows) | .109 | 20 | .200* | .953 | 20 | .434 |
| Square Root of January-February Inflows | .183 | 20 | .079 | .929 | 20 | .197 |
| March-April Inflows | .209 | 20 | .022 | .914 | 20 | .080 |
| Ln(March-April Inflows) | .210 | 20 | .021 | .865 | 20 | .010** |
| Square Root of March-April Inflows | .217 | 20 | .015 | .909 | 20 | .063 |
| May-June Inflows | .145 | 20 | .200* | .918 | 20 | .092 |
| Ln(May-June Inflows) | .129 | 20 | .200* | .911 | 20 | .070 |
| Square Root of May-June Inflows | .091 | 20 | .200* | .955 | 20 | .455 |
| July-August Inflows | .306 | 20 | .000 | .800 | 20 | .010** |
| Ln(July-August Inflows) | .179 | 20 | .094 | .965 | 20 | .623 |
| Square Root of July-August Inflows | .246 | 20 | .002 | .901 | 20 | .044 |
| September-October Inflows | .149 | 20 | .200* | .907 | 20 | .056 |
| Ln(September-October Inflows) | .201 | 20 | .033 | .852 | 20 | .010** |
| Square Root of September-October Inflows | .109 | 20 | .200* | .922 | 20 | .123 |
| November-December Inflows | .257 | 20 | .001 | .778 | 20 | .010** |
| Ln(November-December Inflows) | .187 | 20 | .066 | .902 | 20 | .046 |
| Square Root of November-December Inflows | .214 | 20 | .017 | .843 | 20 | .010** |

*. This is a lower bound of the true significance.

**. This is an upper bound of the true significance.

a. Lilliefors Significance Correction

***Table .2.3*** *Percentiles of the trout data and the inflow data.*

**Percentiles**

| | | Percentiles | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 10 | 25 | 50 | 75 | 90 | 95 |
| Weighted Average(Definition 1) | Trout Harvest | 42.8350 | 82.2400 | 121.2000 | 183.1500 | 224.9000 | 330.5400 | 359.4550 |
| | Ln(Trout Harvest) | 3.744424 | 4.405657 | 4.797406 | 5.210237 | 5.415645 | 5.799480 | 5.884470 |
| | Square Root of Trout Harvest | 6.521639 | 9.059258 | 11.0090 | 13.5331 | 14.9966 | 18.1752 | 18.9587 |
| | January-February Inflows | 2.4430 | 5.8440 | 11.9225 | 18.9800 | 55.9375 | 82.5750 | 85.2730 |
| | Ln(January-February Inflows) | .866077 | 1.763860 | 2.477367 | 2.935924 | 4.013202 | 4.412611 | 4.445850 |
| | Square Root of January-February Inflows | 1.551006 | 2.416475 | 3.451974 | 4.348500 | 7.459195 | 9.084642 | 9.234320 |
| | March-April Inflows | 2.7900 | 4.1580 | 11.5075 | 22.4500 | 36.9000 | 38.1410 | 45.6790 |
| | Ln(March-April Inflows) | 1.022519 | 1.414392 | 2.442870 | 3.111090 | 3.608203 | 3.641252 | 3.820861 |
| | Square Root of March-April Inflows | 1.668779 | 2.033379 | 3.392161 | 4.737905 | 6.074523 | 6.175783 | 6.757347 |
| | May-June Inflows | 11.6320 | 16.6120 | 60.0500 | 122.4550 | 213.8975 | 299.6390 | 303.2485 |
| | Ln(May-June Inflows) | 2.450687 | 2.805584 | 4.094110 | 4.807048 | 5.361648 | 5.702214 | 5.714552 |
| | Square Root of May-June Inflows | 3.407819 | 4.070973 | 7.747107 | 11.0640 | 14.6114 | 17.3085 | 17.4140 |
| | July-August Inflows | 10.0900 | 14.2790 | 22.0825 | 34.1750 | 58.0775 | 90.6410 | 142.9770 |
| | Ln(July-August Inflows) | 2.308225 | 2.657975 | 3.094785 | 3.531353 | 4.041468 | 4.506906 | 4.958029 |
| | Square Root of July-August Inflows | 3.173701 | 3.777973 | 4.699202 | 5.845732 | 7.583997 | 9.520556 | 11.9444 |
| | September-October Inflows | 6.0005 | 7.2550 | 53.5975 | 217.7400 | 411.3850 | 502.4070 | 556.5980 |
| | Ln(September-October Inflows) | 1.791231 | 1.975516 | 3.981394 | 5.378950 | 6.019379 | 6.219411 | 6.321577 |
| | Square Root of September-October Inflows | 2.449208 | 2.689165 | 7.320833 | 14.7400 | 20.2819 | 22.4144 | 23.5908 |
| | November-December Inflows | 5.2085 | 8.4230 | 10.0375 | 20.4250 | 94.5450 | 102.8380 | 114.0705 |
| | Ln(November-December Inflows) | 1.643007 | 2.130955 | 2.306240 | 3.015883 | 4.549063 | 4.633154 | 4.736546 |
| | Square Root of November-December Inflows | 2.277745 | 2.902233 | 3.168131 | 4.518412 | 9.723394 | 10.1409 | 10.6797 |
| Tukey's Hinges | Trout Harvest | | | 121.8000 | 183.1500 | 224.3000 | | |
| | Ln(Trout Harvest) | | | 4.802332 | 5.210237 | 5.412970 | | |
| | Square Root of Trout Harvest | | | 11.0362 | 13.5331 | 14.9766 | | |
| | January-February Inflows | | | 12.2450 | 18.9800 | 51.4350 | | |
| | Ln(January-February Inflows) | | | 2.503728 | 2.935924 | 3.924753 | | |
| | Square Root of January-February Inflows | | | 3.498071 | 4.348500 | 7.144074 | | |
| | March-April Inflows | | | 11.6150 | 22.4500 | 36.8100 | | |
| | Ln(March-April Inflows) | | | 2.452126 | 3.111090 | 3.605758 | | |
| | Square Root of March-April Inflows | | | 3.407933 | 4.737905 | 6.067106 | | |
| | May-June Inflows | | | 61.6800 | 122.4550 | 203.4450 | | |
| | Ln(May-June Inflows) | | | 4.120561 | 4.807048 | 5.310088 | | |
| | Square Root of May-June Inflows | | | 7.850917 | 11.0640 | 14.2445 | | |
| | July-August Inflows | | | 22.0850 | 34.1750 | 51.8950 | | |
| | Ln(July-August Inflows) | | | 3.094899 | 3.531353 | 3.919999 | | |
| | Square Root of July-August Inflows | | | 4.699468 | 5.845732 | 7.151761 | | |
| | September-October Inflows | | | 54.0550 | 217.7400 | 407.2900 | | |
| | Ln(September-October Inflows) | | | 3.989859 | 5.378950 | 6.009323 | | |
| | Square Root of September-October Inflows | | | 7.351947 | 14.7400 | 20.1804 | | |
| | November-December Inflows | | | 10.1150 | 20.4250 | 94.2700 | | |
| | Ln(November-December Inflows) | | | 2.313902 | 3.015883 | 4.546146 | | |
| | Square Root of November-December Inflows | | | 3.180315 | 4.518412 | 9.709233 | | |

### 2.2.1 The trout data

***Table .2.4*** *Descriptives for the trout data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| Trout Harvest | Mean | | 181.4000 | 18.1365 |
| | 95% Confidence Interval for Mean | Lower Bound | 143.4400 | |
| | | Upper Bound | 219.3600 | |
| | 5% Trimmed Mean | | 179.2444 | |
| | Median | | 183.1500 | |
| | Variance | | 6578.623 | |
| | Std. Deviation | | 81.1087 | |
| | Minimum | | 40.90 | |
| | Maximum | | 360.70 | |
| | Range | | 319.80 | |
| | Interquartile Range | | 103.7000 | |
| | Skewness | | .612 | .512 |
| | Kurtosis | | .312 | .992 |

***Table .2.5*** *Extreme Values for the trout data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| Trout Harvest | Highest | 1 | 2 | 1962 | 360.70 |
| | | 2 | 1 | 1961 | 335.80 |
| | | 3 | 15 | 1975 | 283.20 |
| | | 4 | 11 | 1971 | 228.10 |
| | | 5 | 12 | 1972 | 225.50 |
| | Lowest | 1 | 20 | 1980 | 40.90 |
| | | 2 | 19 | 1979 | 79.60 |
| | | 3 | 18 | 1978 | 106.00 |
| | | 4 | 6 | 1966 | 110.80 |
| | | 5 | 17 | 1977 | 120.60 |

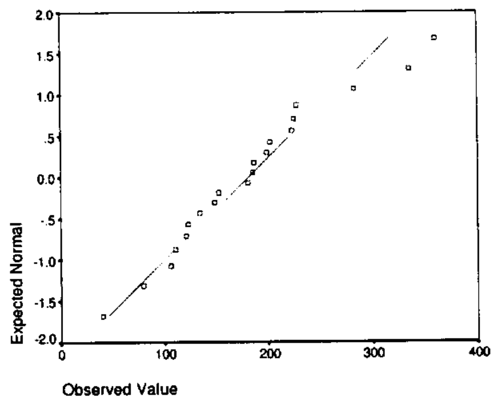


***Figure 2.1*** *Normal Q-Q Plot of Trout Harvest.*

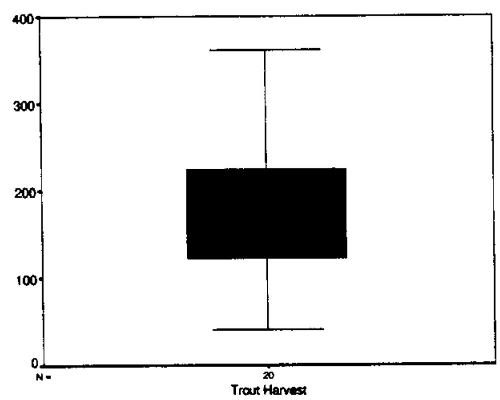


***Figure 2.2*** *BoxPlot of Trout Harvest.*

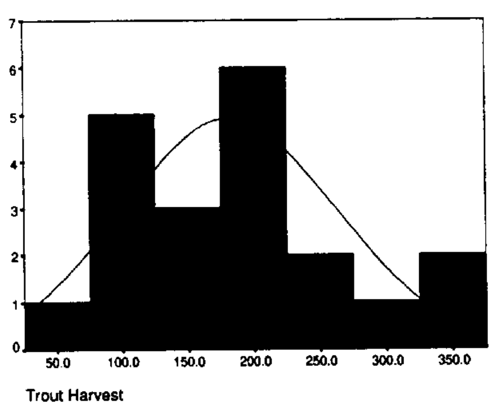


***Figure 2.3*** *Histogram of Trout Harvest.*

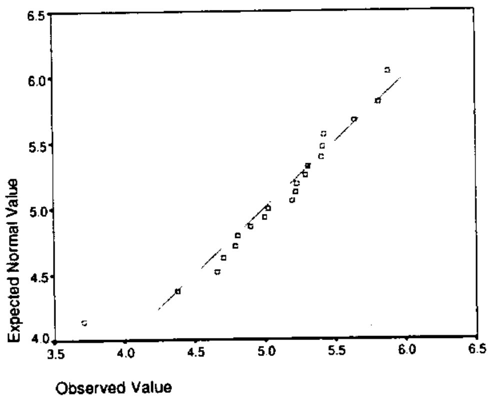


***Figure 2.4*** *Normal Q-Q Plot of Ln(Trout Harvest).*

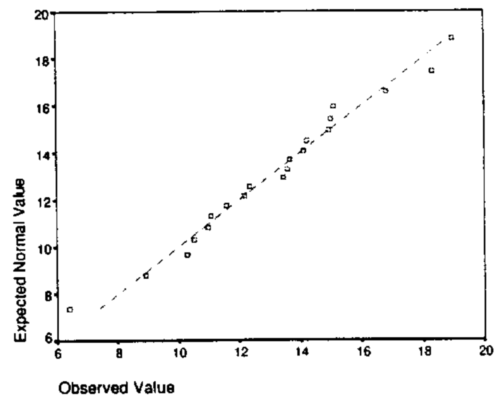


***Figure 2.5*** *Normal Q-Q Plot of Sqrt(Trout Harvest).*

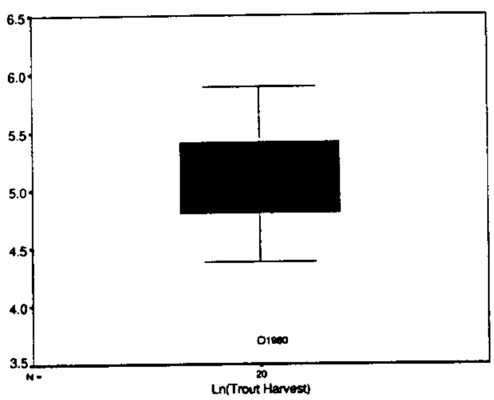


***Figure 2.6*** *BoxPlot of Ln(Trout Harvest).*

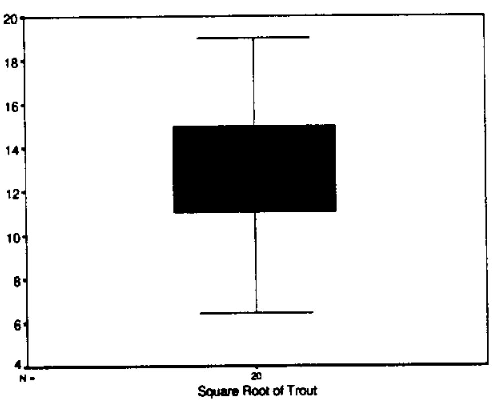


***Figure 2.7*** *BoxPlot of Sqrt(Trout Harvest).*

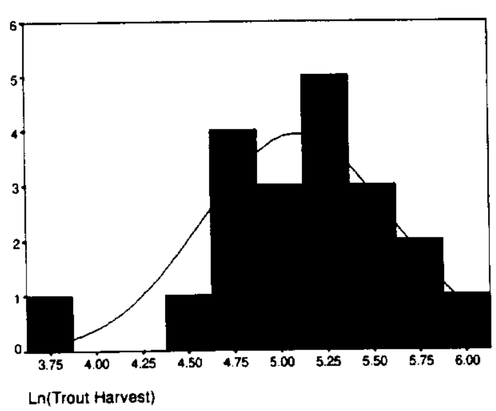


***Figure 2.8*** *Histogram of Ln(Trout Harvest).*

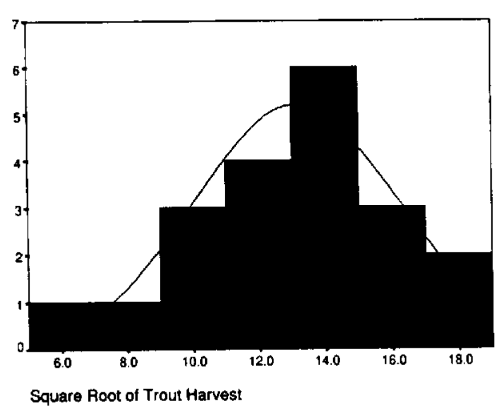


***Figure 2.9*** *Histogram of Sqrt(Trout Harvest).*

### 2.2.2 The January-February Inflows data

***Table .2.6*** *Descriptives for the January-February Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| January-February Inflows | Mean | | 32.4890 | 6.0827 |
| | 95% Confidence Interval for Mean | Lower Bound | 19.7577 | |
| | | Upper Bound | 45.2203 | |
| | 5% Trimmed Mean | | 31.2311 | |
| | Median | | 18.9800 | |
| | Variance | | 739.994 | |
| | Std. Deviation | | 27.2028 | |
| | Minimum | | 2.27 | |
| | Maximum | | 85.35 | |
| | Range | | 83.08 | |
| | Interquartile Range | | 44.0150 | |
| | Skewness | | .869 | .512 |
| | Kurtosis | | -.632 | .992 |

***Table .2.7*** *Extreme Values for the January-February Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| January-February Inflows | Highest | 1 | 1 | 1961 | 85.35 |
| | | 2 | 20 | 1980 | 83.81 |
| | | 3 | 2 | 1962 | 71.46 |
| | | 4 | 3 | 1963 | 68.35 |
| | | 5 | 19 | 1979 | 60.44 |
| | Lowest | 1 | 4 | 1964 | 2.27 |
| | | 2 | 16 | 1976 | 5.73 |
| | | 3 | 15 | 1975 | 6.87 |
| | | 4 | 5 | 1965 | 10.94 |
| | | 5 | 13 | 1973 | 11.60 |

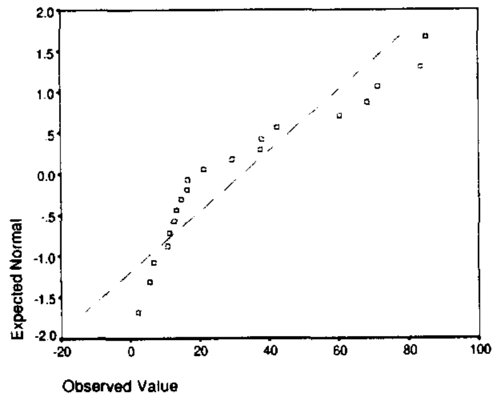


***Figure 2.10*** *Normal Q-Q Plot of January-February Inflows.*

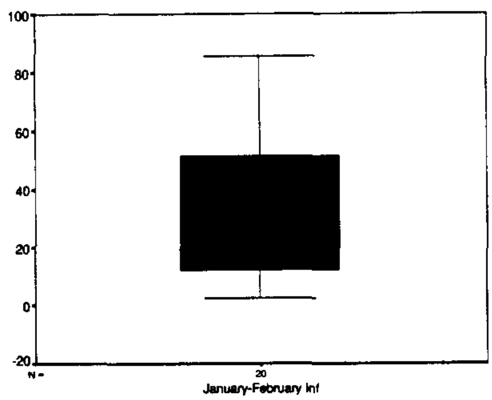


***Figure 2.11*** *BoxPlot of January-February Inflows.*

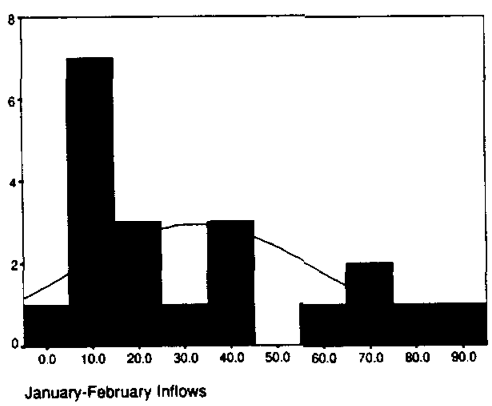


***Figure 2.12*** *Histogram of January-February Inflows.*

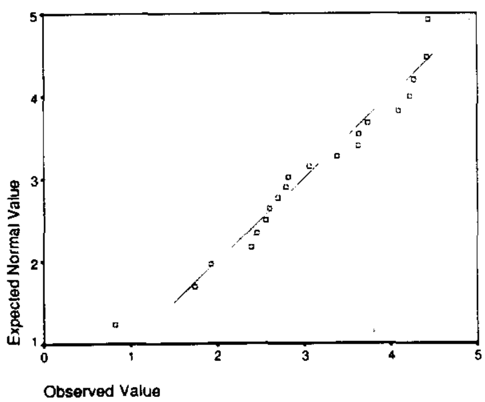


***Figure 2.13*** *Normal Q-Q Plot of Ln January-February Inflows).*

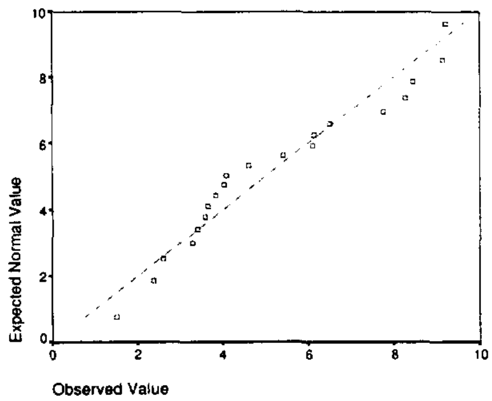


***Figure 2.14*** *Normal Q-Q Plot of Sqrt( January-February Inflows).*

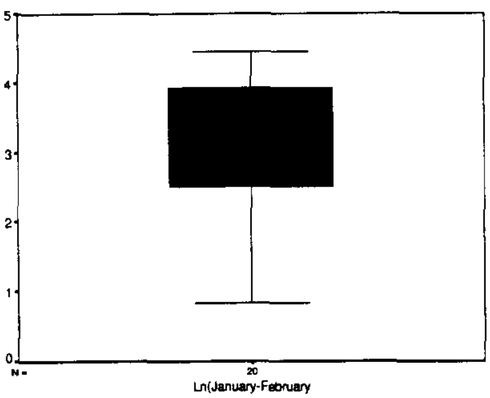


***Figure 2.15*** *BoxPlot of Ln(January-February Inflows).*

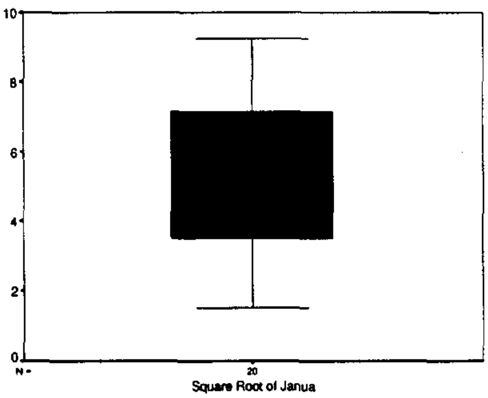


***Figure 2.16*** *BoxPlot of Square Root of January-February Inflows.*

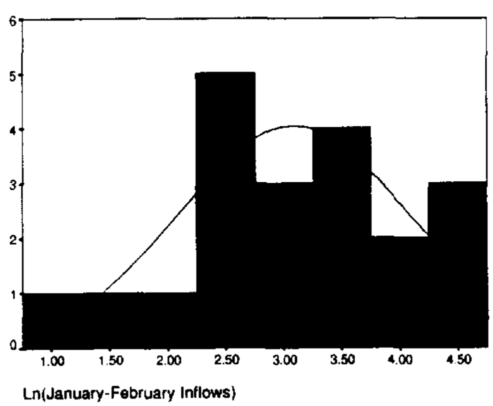


***Figure 2.17*** *Histogram of Ln(January-February Inflows).*

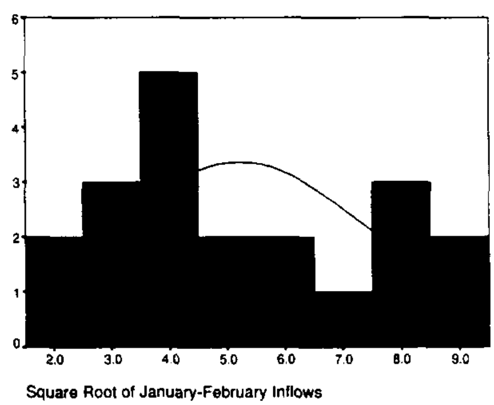


***Figure 2.18*** *Histogram of Sqrt(January-February Inflows).*

## 2.2.3 The March-April Inflows data

***Table .2.8*** *Descriptives for the March-April Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| March-April Inflows | Mean | | 23.8355 | 3.0311 |
| | 95% Confidence Interval for Mean | Lower Bound | 17.4914 | |
| | | Upper Bound | 30.1796 | |
| | 5% Trimmed Mean | | 23.7728 | |
| | Median | | 22.4500 | |
| | Variance | | 183.748 | |
| | Std. Deviation | | 13.5554 | |
| | Minimum | | 2.73 | |
| | Maximum | | 46.07 | |
| | Range | | 43.34 | |
| | Interquartile Range | | 25.3925 | |
| | Skewness | | -.115 | .512 |
| | Kurtosis | | -1.426 | .992 |

***Table .2.9*** *Extreme Values for the March-April Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| March-April Inflows | Highest | 1 | 19 | 1979 | 46.07 |
| | | 2 | 10 | 1970 | 38.25 |
| | | 3 | 6 | 1966 | 37.16 |
| | | 4 | 11 | 1971 | 37.01 |
| | | 5 | 8 | 1968 | 36.99 |
| | Lowest | 1 | 4 | 1964 | 2.73 |
| | | 2 | 5 | 1965 | 3.93 |
| | | 3 | 3 | 1963 | 6.21 |
| | | 4 | 15 | 1975 | 9.71 |
| | | 5 | 2 | 1962 | 11.40 |

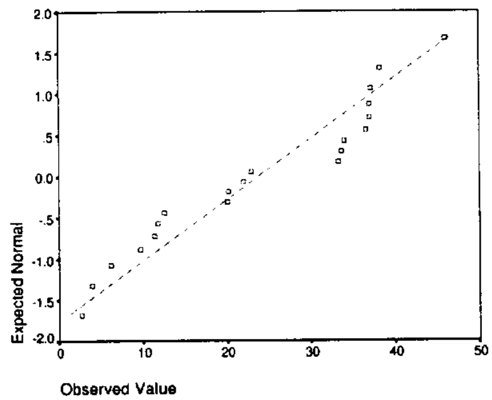


***Figure 2.19*** *Normal Q-Q Plot of March-April Inflows.*

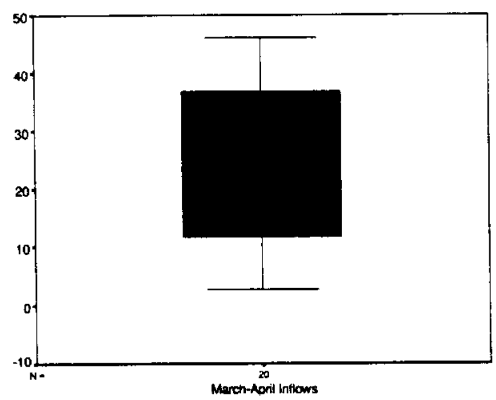


***Figure 2.20*** *BoxPlot of March-April Inflows.*

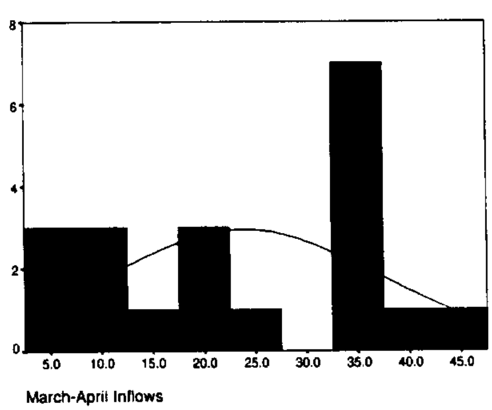


***Figure 2.21*** *Histogram of March-April Inflows.*

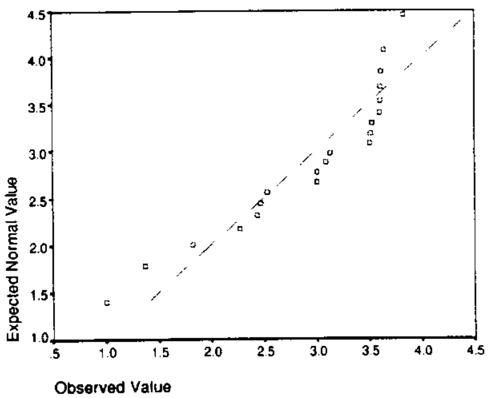


***Figure 2.22*** *Normal Q-Q Plot of Ln(March-April Inflows).*

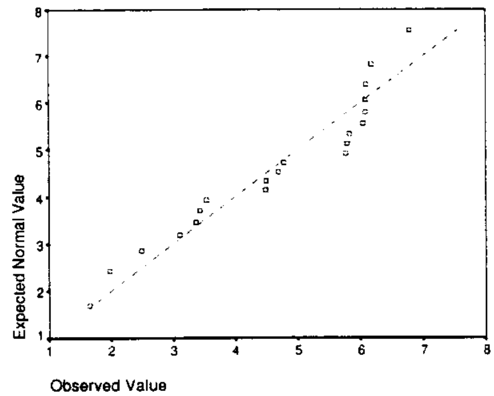


***Figure 2.23*** *Normal Q-Q Plot of Sqrt( March-April Inflows).*

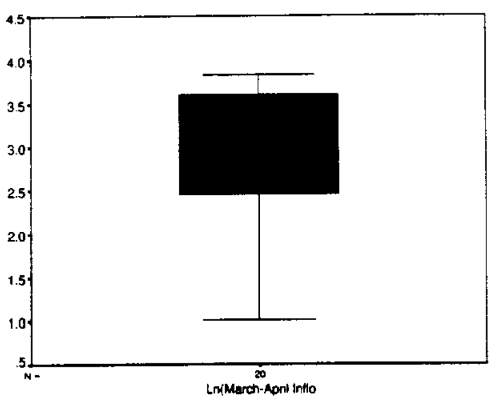


***Figure 2.24*** *BoxPlot of Ln(March-April) Inflows.*

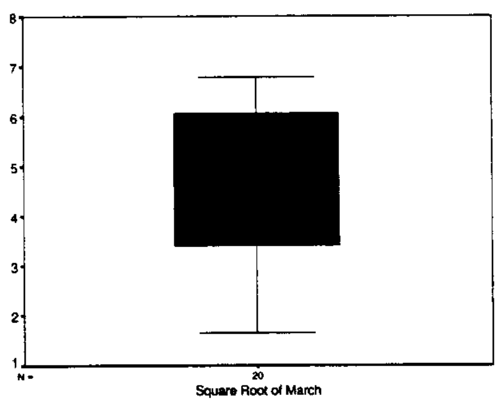


***Figure 2.25*** *BoxPlot of Square Root of March-April Inflows.*

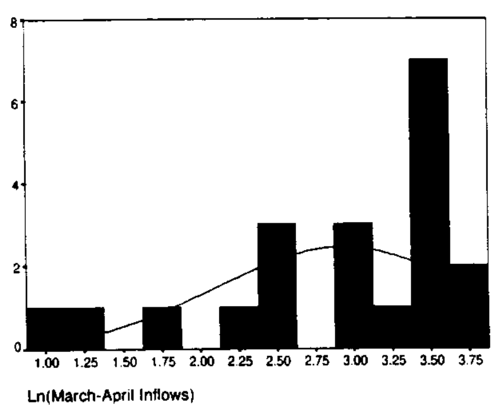


***Figure 2.26*** *Histogram of Ln(March-April Inflows).*

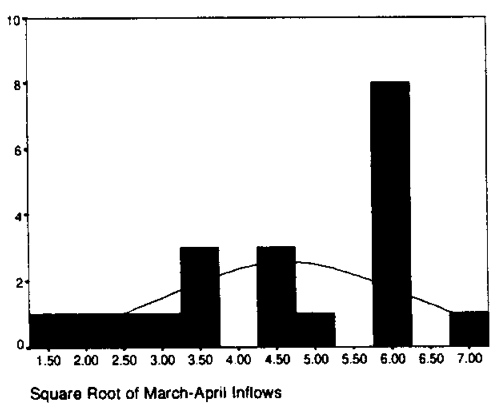


***Figure 2.27*** *Histogram of Sqrt(March-April Inflows).*

### 2.2.4 The May-June Inflows data

***Table .2.10*** *Descriptives for the May-June Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| May-June Inflows | Mean | | 135.8155 | 21.3386 |
| | 95% Confidence Interval for Mean | Lower Bound | 91.1532 | |
| | | Upper Bound | 180.4778 | |
| | 5% Trimmed Mean | | 133.4228 | |
| | Median | | 122.4550 | |
| | Variance | | 9106.752 | |
| | Std. Deviation | | 95.4293 | |
| | Minimum | | 11.40 | |
| | Maximum | | 303.30 | |
| | Range | | 291.90 | |
| | Interquartile Range | | 153.8475 | |
| | Skewness | | .537 | .512 |
| | Kurtosis | | -.904 | .992 |

***Table .2.11*** *Extreme Values for the May-June Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| May-June Inflows | Highest | 1 | 8 | 1968 | 303.30 |
| | | 2 | 14 | 1974 | 302.27 |
| | | 3 | 13 | 1973 | 275.96 |
| | | 4 | 10 | 1970 | 263.17 |
| | | 5 | 9 | 1969 | 224.35 |
| | Lowest | 1 | 4 | 1964 | 11.40 |
| | | 2 | 3 | 1963 | 16.04 |
| | | 3 | 5 | 1965 | 21.76 |
| | | 4 | 16 | 1976 | 52.72 |
| | | 5 | 2 | 1962 | 58.42 |

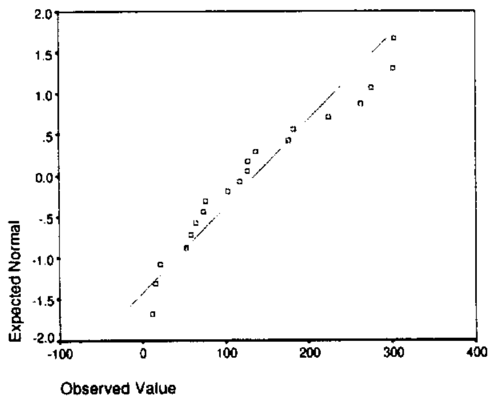


***Figure 2.28*** *Normal Q-Q Plot of May-June Inflows.*

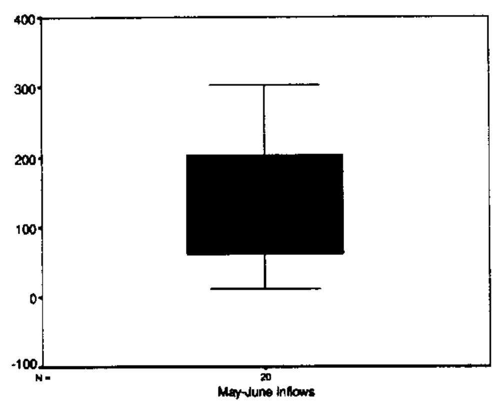


***Figure 2.29*** *BoxPlot of May-June Inflows.*

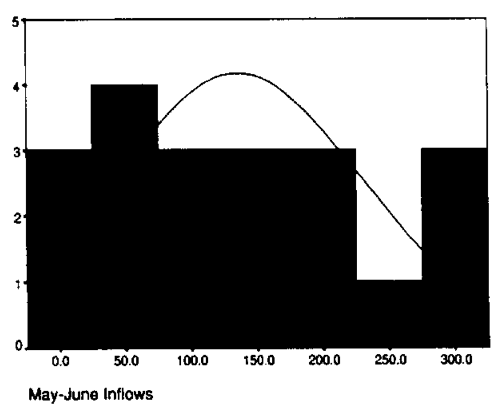


***Figure 2.30*** *Histogram of May-June Inflows.*

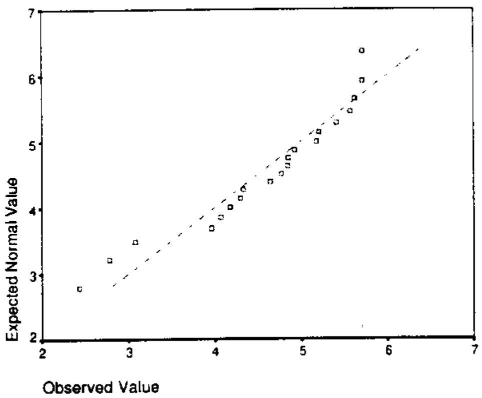


*Figure 2.31* Normal Q-Q Plot of Ln(May-June Inflows).

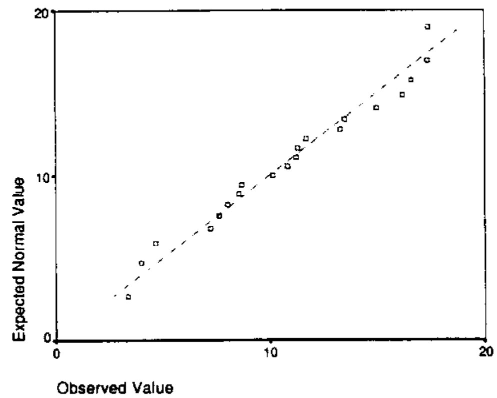


*Figure 2.32* Normal Q-Q Plot of Sqrt( May-June Inflows).

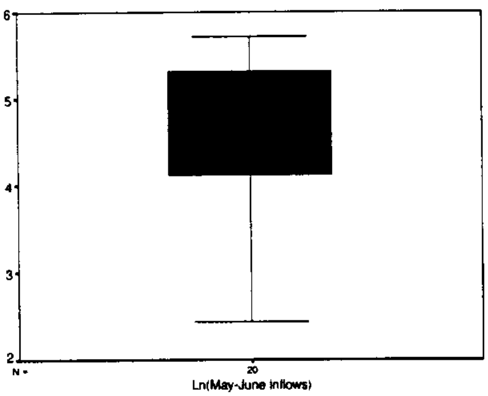


*Figure 2.33* BoxPlot of Ln(May-June) Inflows.

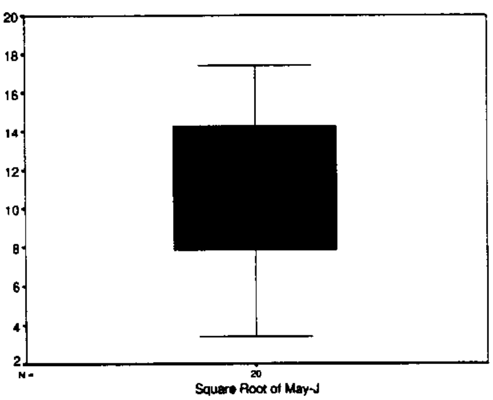


*Figure 2.34* BoxPlot of Square Root of May-June Inflows.

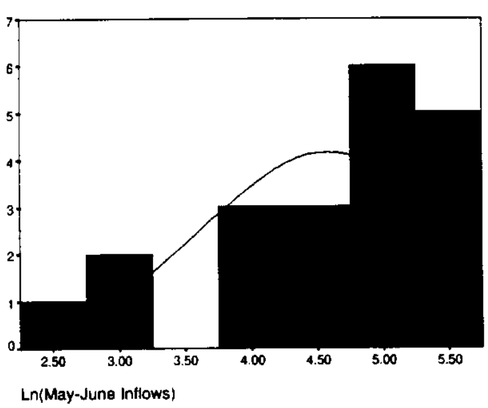


*Figure 2.35* Histogram of Ln(May-June Inflows).

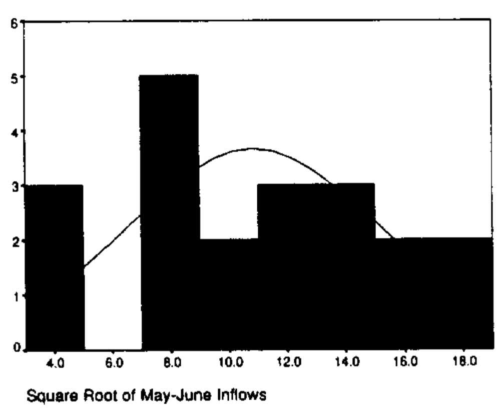


*Figure 2.36* Histogram of Sqrt(May-June Inflows).

## 2.2.5 The July-August Inflows data

***Table .2.12*** *Descriptives for the July-August Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| July-August Inflows | Mean | | 44.3485 | 7.7189 |
| | 95% Confidence Interval for Mean | Lower Bound | 28.1926 | |
| | | Upper Bound | 60.5044 | |
| | 5% Trimmed Mean | | 40.6311 | |
| | Median | | 34.1750 | |
| | Variance | | 1191.638 | |
| | Std. Deviation | | 34.5201 | |
| | Minimum | | 9.88 | |
| | Maximum | | 145.73 | |
| | Range | | 135.85 | |
| | Interquartile Range | | 35.9950 | |
| | Skewness | | 1.676 | .512 |
| | Kurtosis | | 2.704 | .992 |

***Table .2.13*** *Extreme Values for the July-August Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| July-August Inflows | Highest | 1 | 20 | 1980 | 145.73 |
| | | 2 | 17 | 1977 | 90.67 |
| | | 3 | 18 | 1978 | 90.38 |
| | | 4 | 16 | 1976 | 87.96 |
| | | 5 | 19 | 1979 | 64.26 |
| | Lowest | 1 | 3 | 1963 | 9.88 |
| | | 2 | 15 | 1975 | 14.08 |
| | | 3 | 7 | 1967 | 16.07 |
| | | 4 | 2 | 1962 | 16.61 |
| | | 5 | 11 | 1971 | 22.08 |

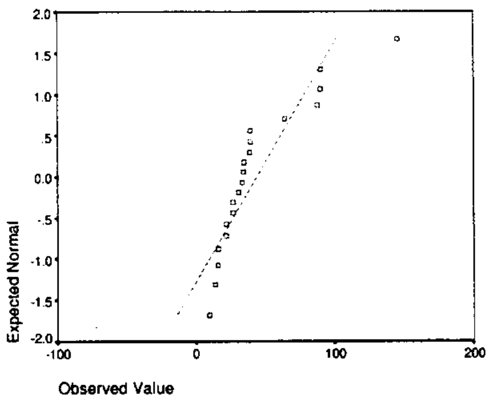


***Figure 2.37*** *Normal Q-Q Plot of July-August Inflows.*

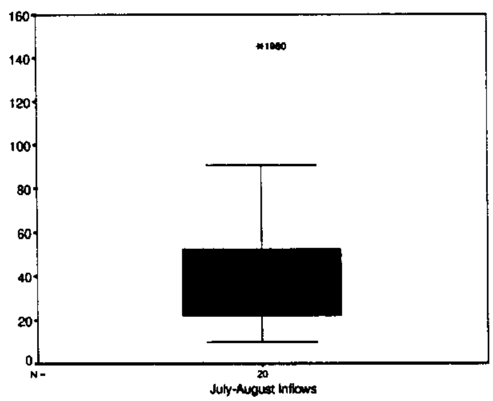


***Figure 2.38*** *BoxPlot of July-August Inflows.*

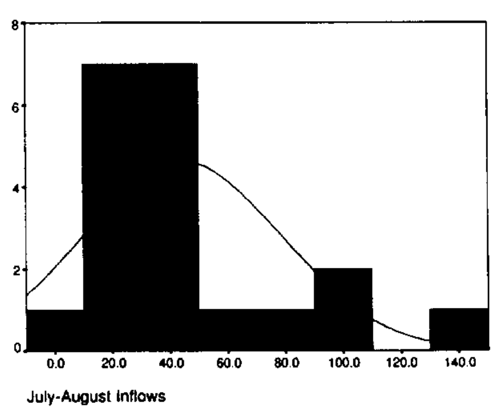


***Figure 2.39*** *Histogram of July-August Inflows.*

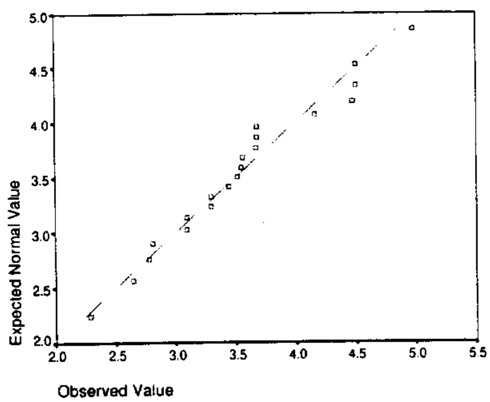


***Figure 2.40*** *Normal Q-Q Plot of Ln(July-August Inflows).*

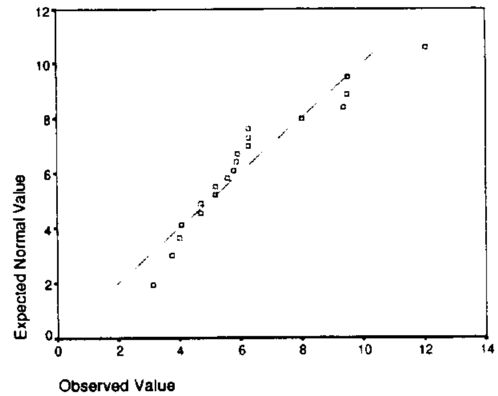


***Figure 2.41*** *Normal Q-Q Plot of Sqrt( July-August Inflows).*

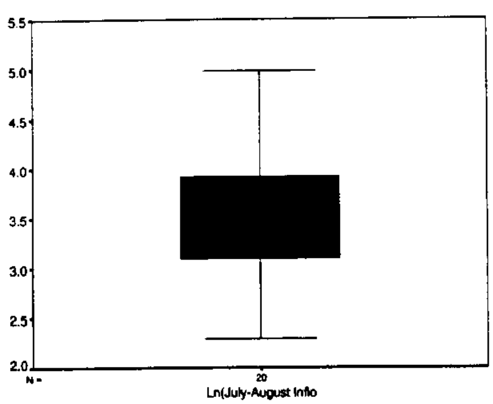


***Figure 2.42*** *BoxPlot of Ln(July-August) Inflows.*

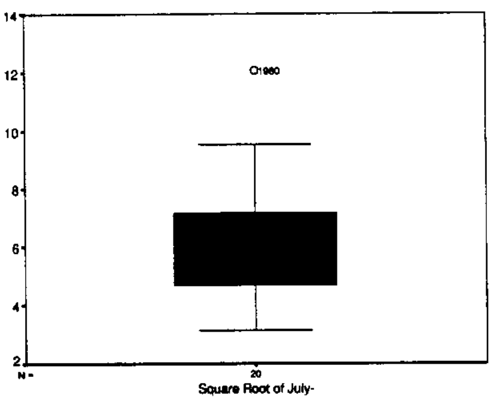


***Figure 2.43*** *BoxPlot of Square Root of July-August Inflows.*

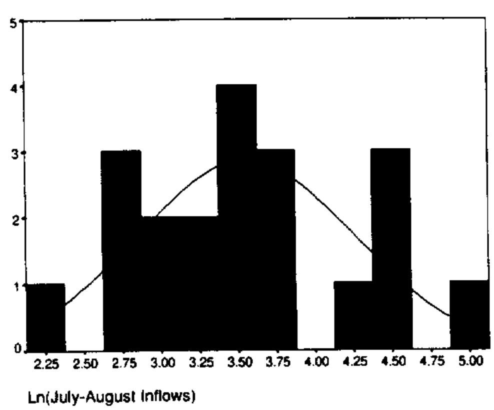


***Figure 2.44*** *Histogram of Ln(July-August Inflows).*

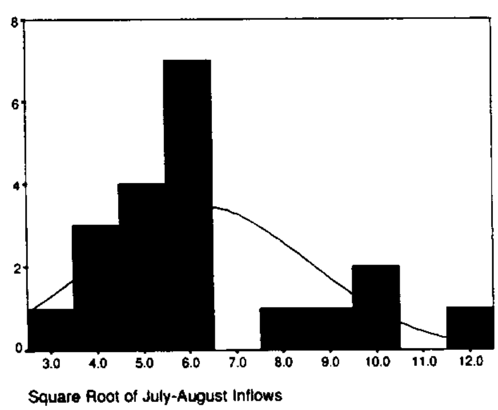


***Figure 2.45*** *Histogram of Sqrt(July-August Inflows).*

## 2.2.6 The September-October Inflows data

***Table .2.14*** *Descriptives for the September-October Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| September-October Inflows | Mean | | 235.9255 | 42.6274 |
| | 95% Confidence Interval for Mean | Lower Bound | 146.7053 | |
| | | Upper Bound | 325.1457 | |
| | 5% Trimmed Mean | | 230.7283 | |
| | Median | | 217.7400 | |
| | Variance | | 36341.9 | |
| | Std. Deviation | | 190.6356 | |
| | Minimum | | 5.95 | |
| | Maximum | | 559.45 | |
| | Range | | 553.50 | |
| | Interquartile Range | | 357.7875 | |
| | Skewness | | .313 | .512 |
| | Kurtosis | | -1.338 | .992 |

***Table .2.15*** *Extreme Values for the September-October Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| September-October Inflows | Highest | 1 | 14 | 1974 | 559.45 |
| | | 2 | 10 | 1970 | 502.41 |
| | | 3 | 9 | 1969 | 502.38 |
| | | 4 | 8 | 1968 | 492.61 |
| | | 5 | 13 | 1973 | 415.48 |
| | Lowest | 1 | 6 | 1966 | 5.95 |
| | | 2 | 7 | 1967 | 6.96 |
| | | 3 | 5 | 1965 | 9.91 |
| | | 4 | 4 | 1964 | 25.49 |
| | | 5 | 18 | 1978 | 53.14 |

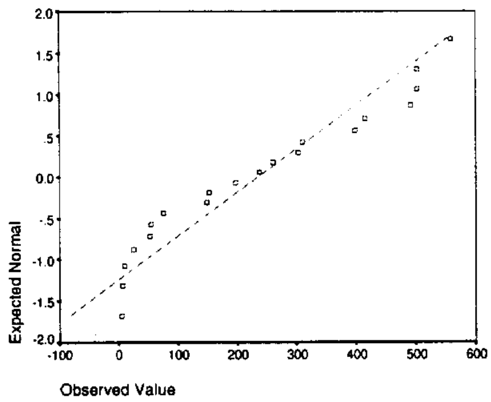


***Figure 2.46*** *Normal Q-Q Plot of September-October Inflows.*

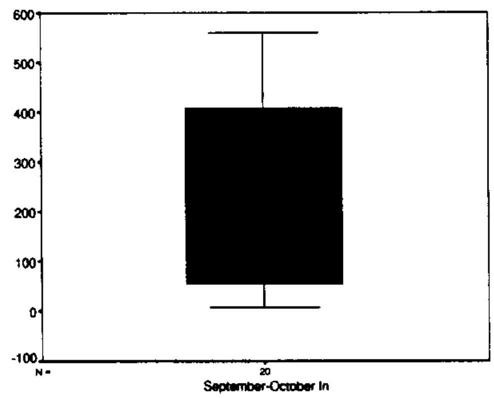


***Figure 2.47*** *BoxPlot of September-October Inflows.*

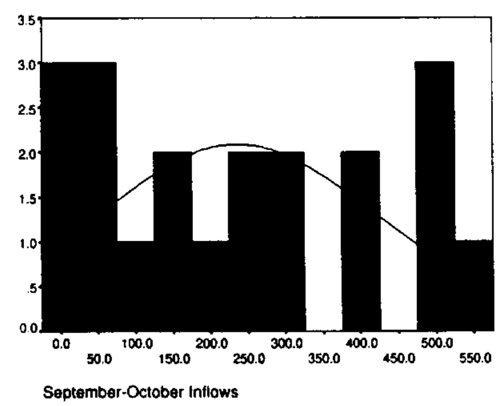


***Figure 2.48*** *Histogram of September-October Inflows.*

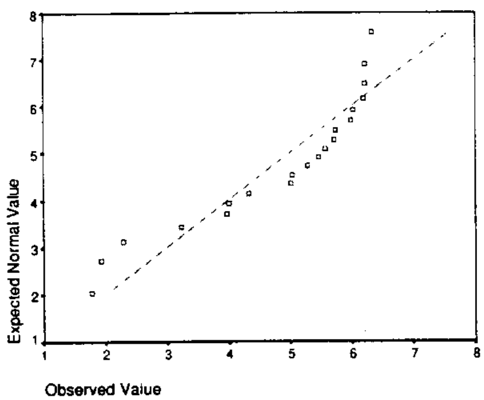


***Figure 2.49*** *Normal Q-Q Plot of Ln(September-October Inflows).*

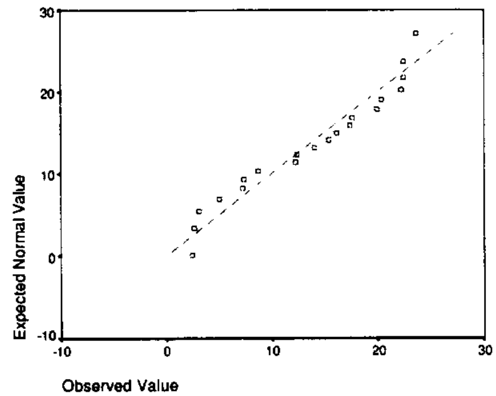


***Figure 2.50*** *Normal Q-Q Plot of Sqrt( September-October Inflows).*

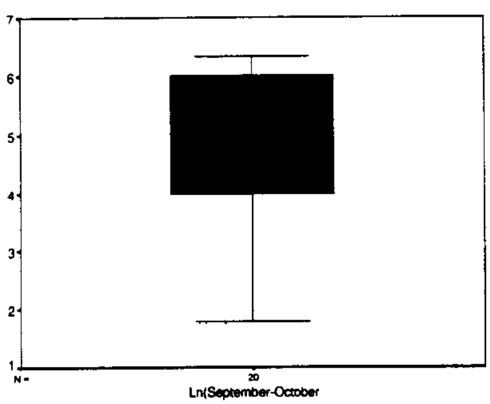


***Figure 2.51*** *BoxPlot of Ln(September-October) Inflows.*

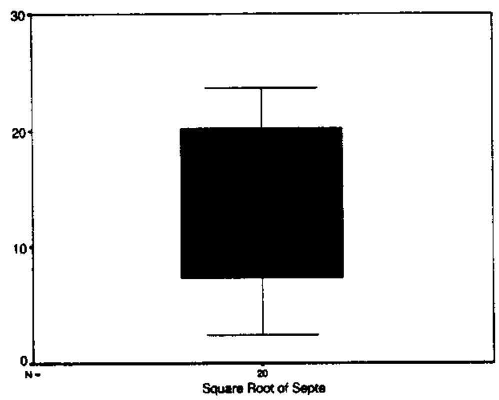


***Figure 2.52*** *BoxPlot of Square Root of September-October Inflows.*

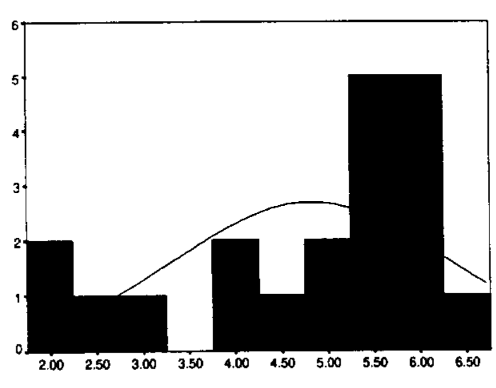


***Figure 2.53*** *Histogram of Ln(September-October Inflows).*

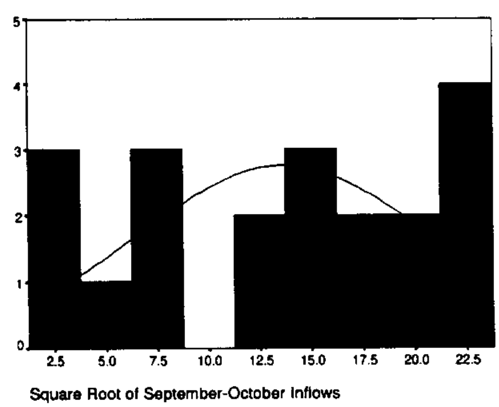


***Figure 2.54*** *Histogram of Sqrt(September-October Inflows).*

### 2.2.7 The November-December Inflows data

***Table .2.16*** *Descriptives for the November-December Inflow data.*

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| November-December Inflows | Mean | | 43.2650 | 9.0305 |
| | 95% Confidence Interval for Mean | Lower Bound | 24.3640 | |
| | | Upper Bound | 62.1660 | |
| | 5% Trimmed Mean | | 41.4222 | |
| | Median | | 20.4250 | |
| | Variance | | 1630.981 | |
| | Std. Deviation | | 40.3854 | |
| | Minimum | | 5.04 | |
| | Maximum | | 114.66 | |
| | Range | | 109.62 | |
| | Interquartile Range | | 84.5075 | |
| | Skewness | | .798 | .512 |
| | Kurtosis | | -1.225 | .992 |

***Table .2.17*** *Extreme Values for the November-December Inflow data.*

**Extreme Values**

| | | | Case Number | Year | Value |
|---|---|---|---|---|---|
| November-December Inflows | Highest | 1 | 17 | 1977 | 114.66 |
| | | 2 | 3 | 1963 | 102.87 |
| | | 3 | 1 | 1961 | 102.55 |
| | | 4 | 2 | 1962 | 99.51 |
| | | 5 | 18 | 1978 | 94.82 |
| | Lowest | 1 | 9 | 1969 | 5.04 |
| | | 2 | 4 | 1964 | 8.41 |
| | | 3 | 5 | 1965 | 8.54 |
| | | 4 | 7 | 1967 | 9.10 |
| | | 5 | 6 | 1966 | 9.96 |

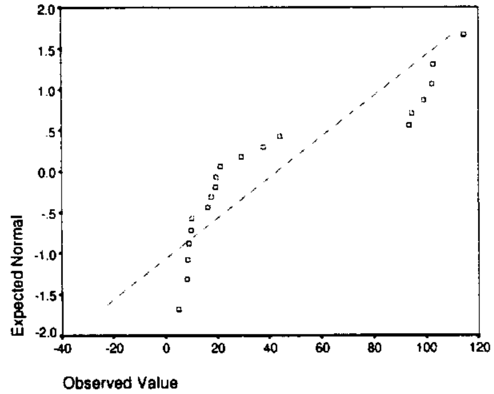


***Figure 2.55*** *Normal Q-Q Plot of November_December Inflows.*

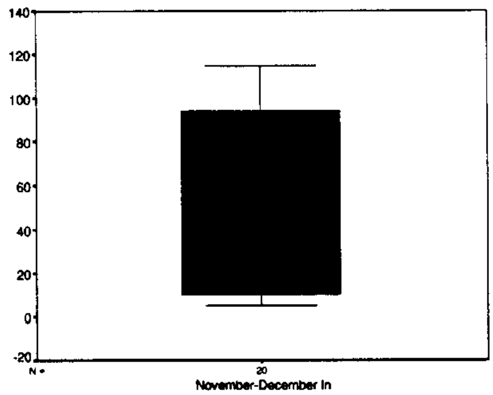


***Figure 2.56*** *BoxPlot of November_December Inflows.*

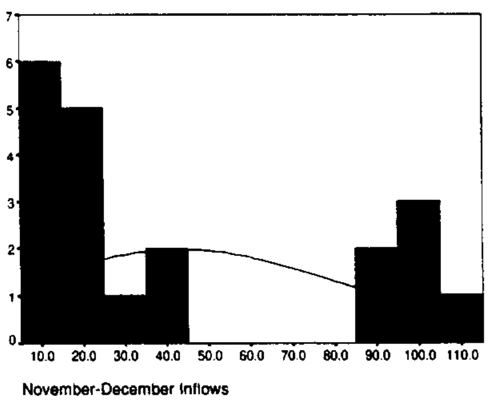


***Figure 2.57*** *Histogram of November_December Inflows.*

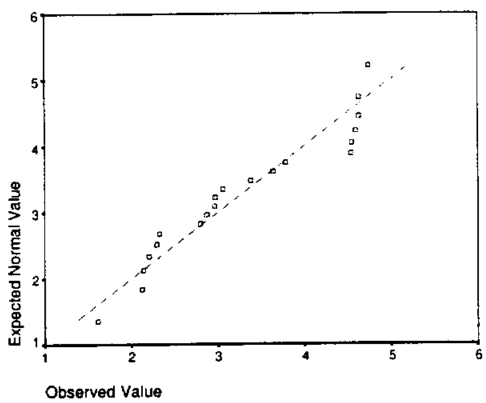


***Figure 2.58*** *Normal Q-Q Plot of Ln(November_December Inflows).*

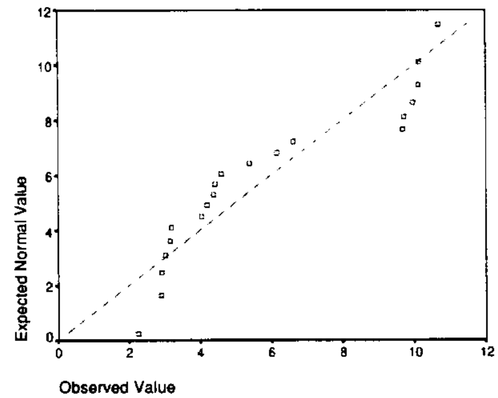


***Figure 2.59*** *Normal Q-Q Plot of Sqrt( November_December Inflows).*

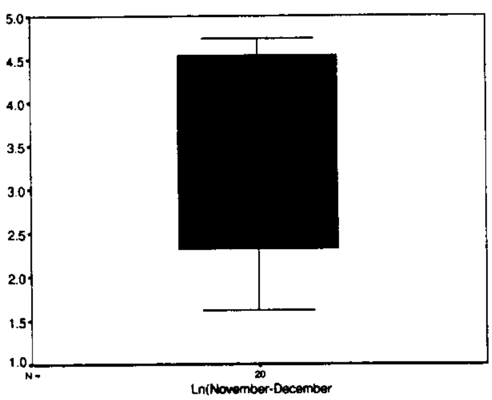


***Figure 2.60*** *BoxPlot of Ln(November _December) Inflows.*

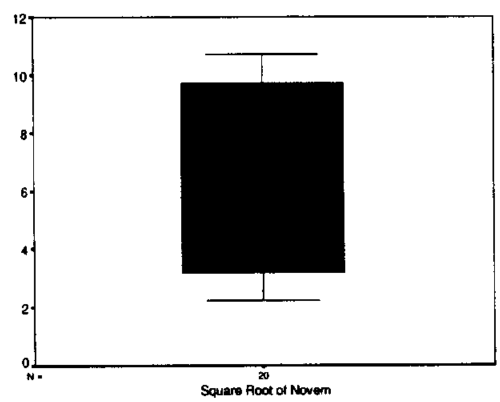


***Figure 2.61*** *BoxPlot of Square Root of November_December Inflows.*

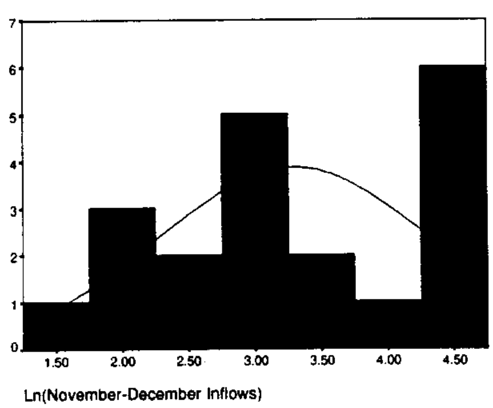


***Figure 2.62*** *Histogram of Ln(November_ December Inflows).*

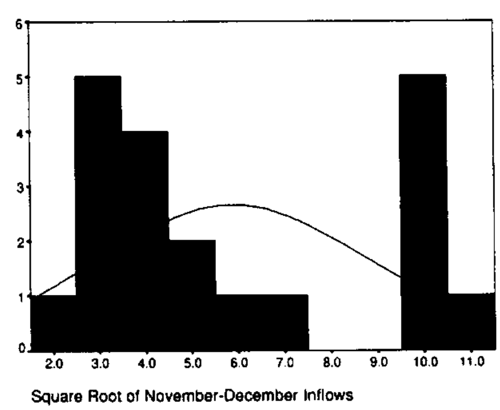


***Figure 2.63*** *Histogram of Sqrt(November_ December Inflows).*

# 3. PREDICTION ELLIPSES AND CONFIDENCE REGIONS

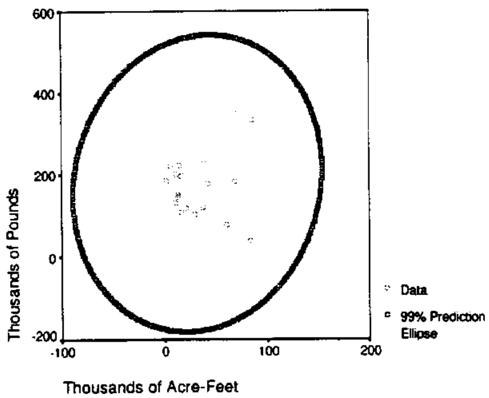


*Figure 3.1* Trout Harvest vs. January-February Inflows, PE.

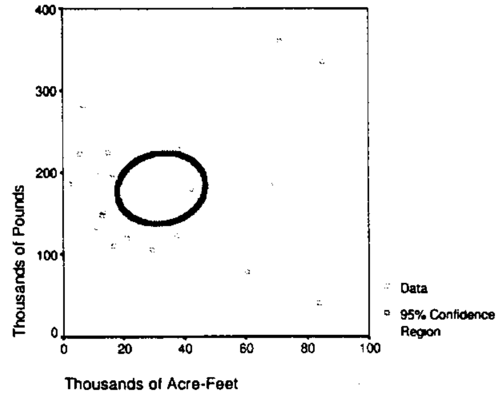


*Figure 3.2* Trout Harvest vs. January-February Inflows, CR.

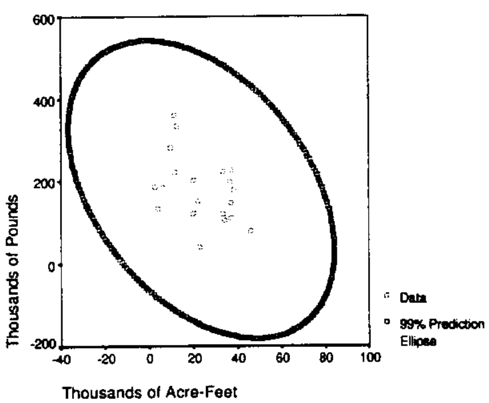


*Figure 3.3* Trout Harvest vs. March-April Inflows, PE.

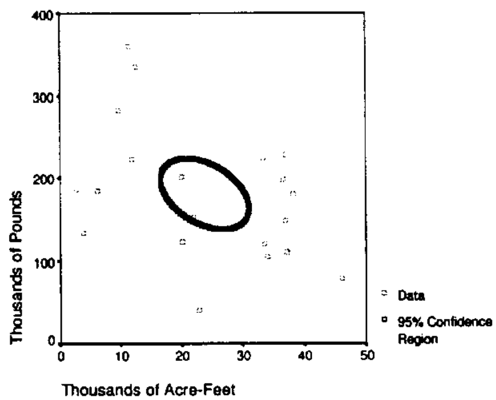


*Figure 3.4* Trout Harvest vs. March-April Inflows, CR.

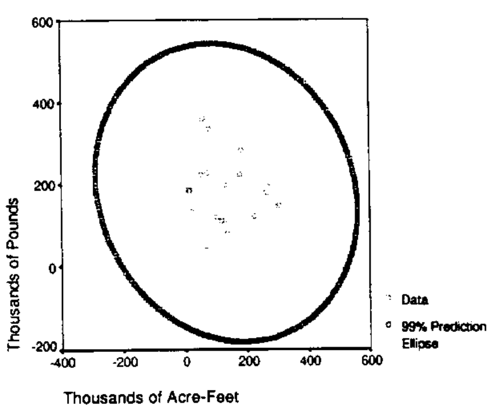


*Figure 3.5* Trout Harvest vs. May-June Inflows, PE.

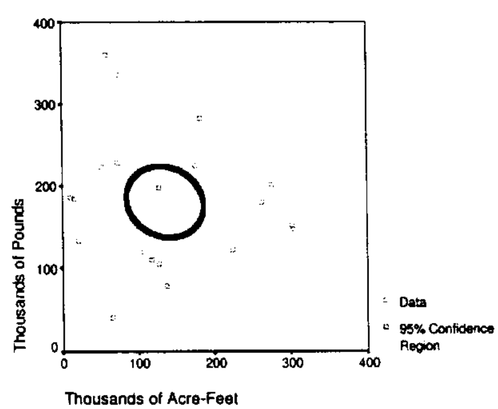


*Figure 3.6* Trout Harvest vs. May-June Inflows, CR.

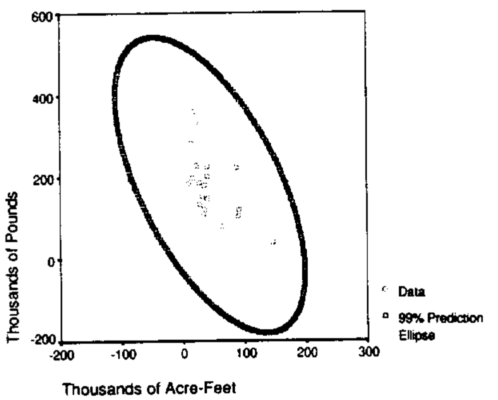


***Figure 3.7*** *Trout Harvest vs. July-August Inflows, PE.*

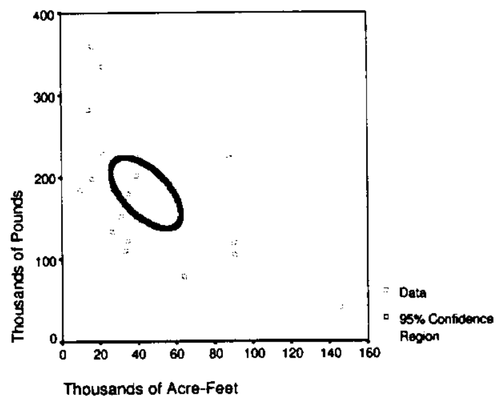


***Figure 3.8*** *Trout Harvest vs. July-August Inflows, CR.*

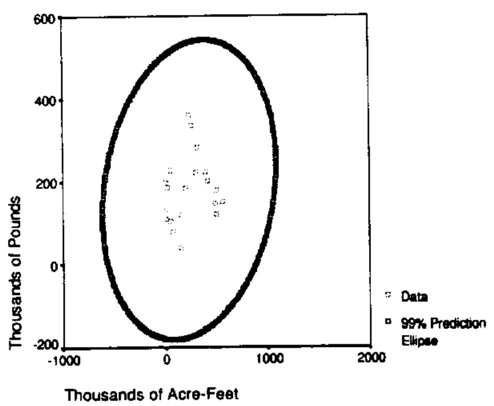


***Figure 3.9*** *Trout Harvest vs. September-October Inflows, PE.*

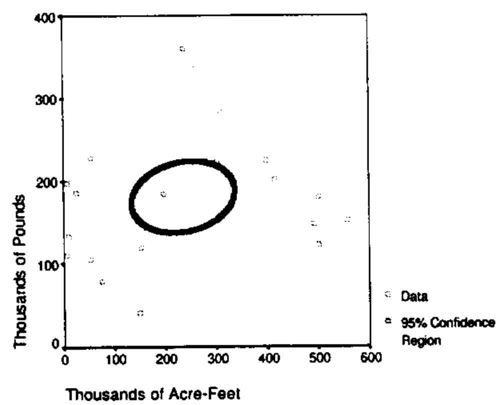


***Figure 3.10*** *Trout Harvest vs. September-October Inflows, CR.*

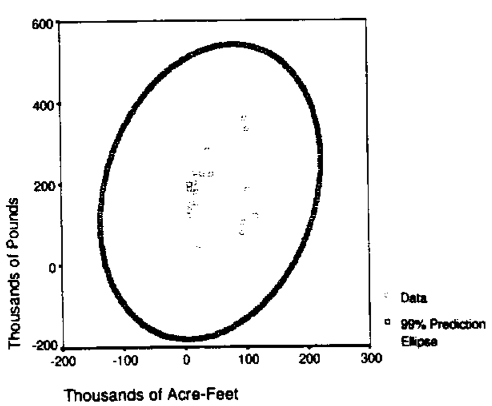


***Figure 3.11*** *Trout Harvest vs. November-December Inflows, PE.*

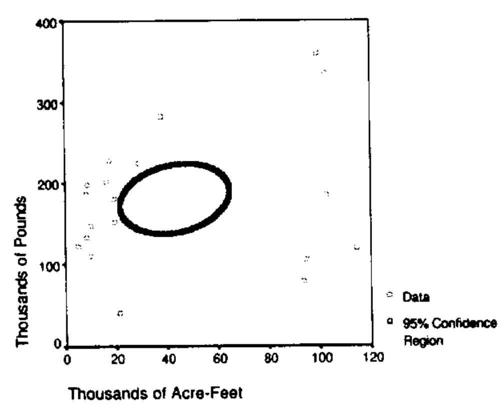


***Figure 3.12*** *Trout Harvest vs. November-December Inflows, CR.*

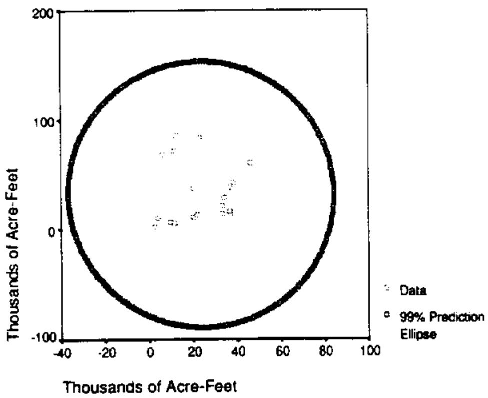


***Figure 3.13*** *January-February Inflows vs. March-April Inflows, PE.*

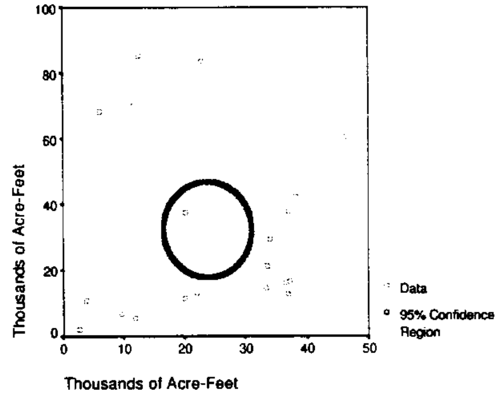


***Figure 3.14*** *January-February Inflows vs. March-April Inflows, CR.*

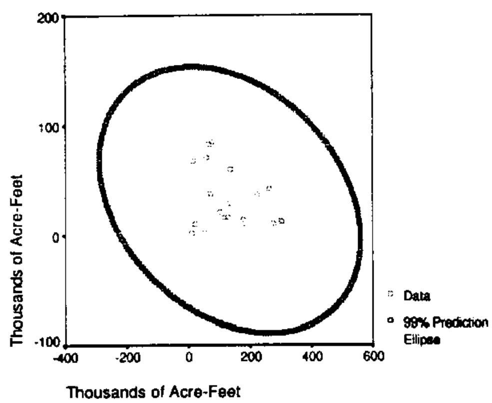


***Figure 3.15*** *January-February Inflows vs. May-June Inflows, PE.*

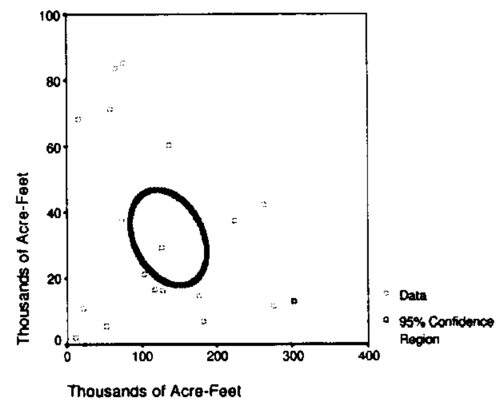


***Figure 3.16*** *January-February Inflows vs. May-June Inflows, CR.*

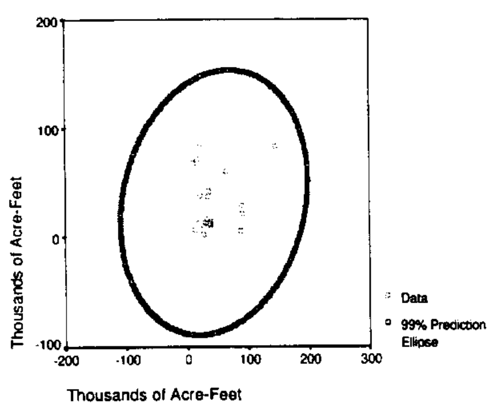


***Figure 3.17*** *January-February Inflows vs. July-August Inflows, PE.*

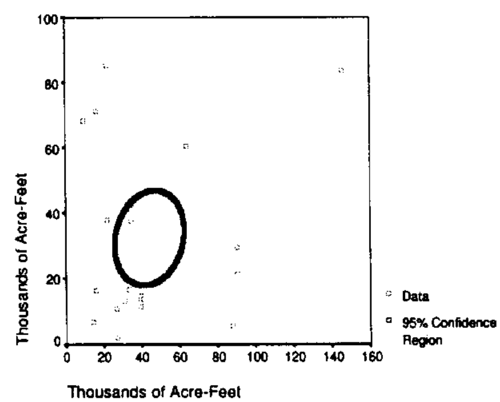


***Figure 3.18*** *January-February Inflows vs. July-August Inflows, CR.*

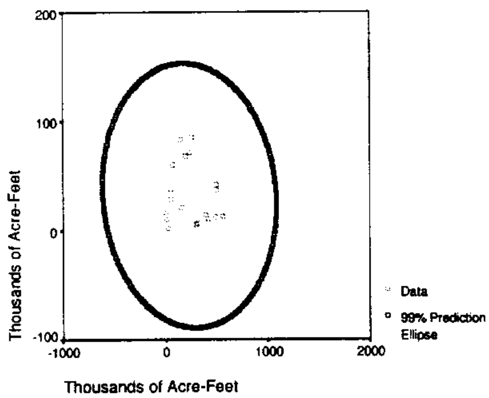


***Figure 3.19*** *January-February Inflows vs. September-October Inflows, PE.*

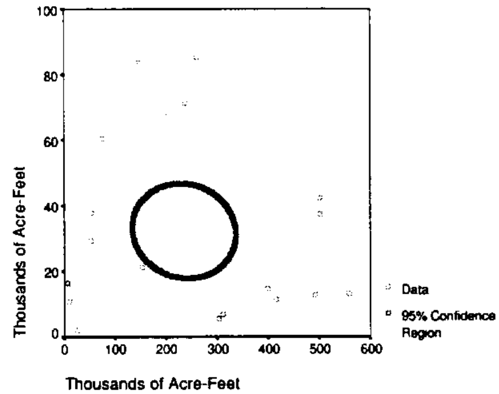


***Figure 3.20*** *January-February Inflows vs. September-October Inflows, CR.*

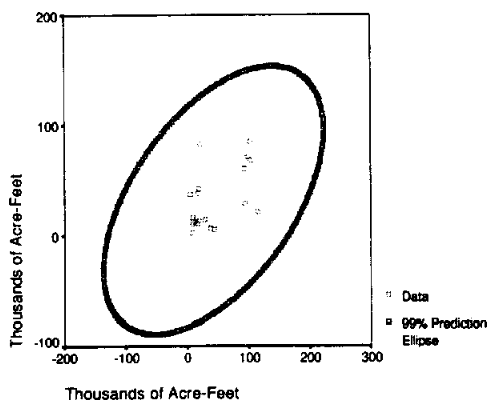


***Figure 3.21*** *January-February Inflows vs. November-December Inflows, PE.*

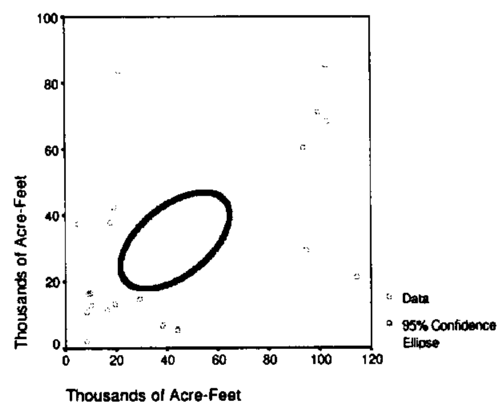


***Figure 3.22*** *January-February Inflows vs. November-December Inflows, CR.*

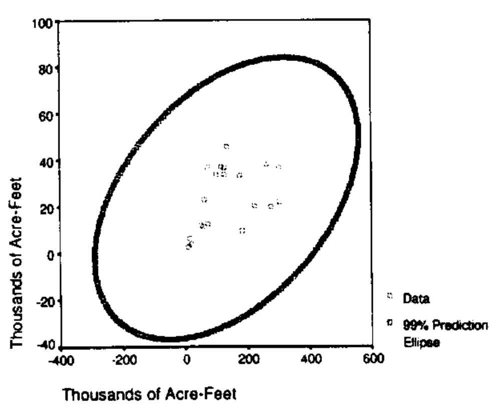


***Figure 3.23*** *March-April Inflows vs. May-June Inflows, PE.*

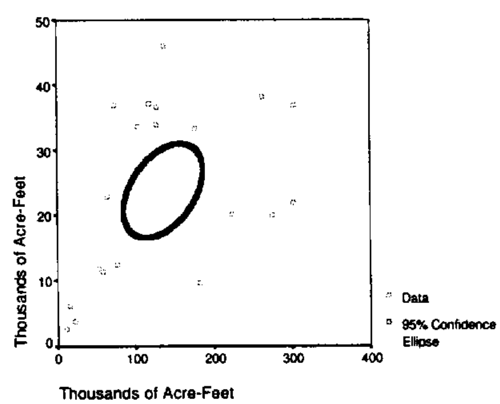


***Figure 3.24*** *March-April Inflows vs. May-June Inflows, CR.*

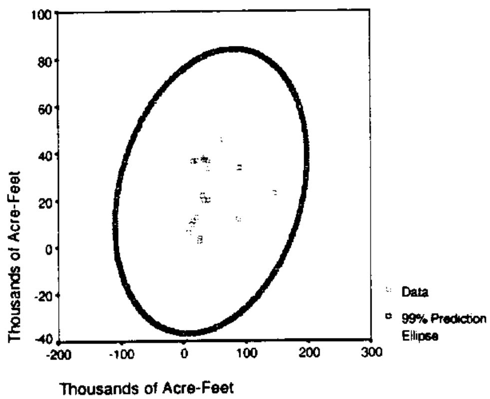


*Figure 3.25* *March-April Inflows vs. July-August Inflows, PE.*

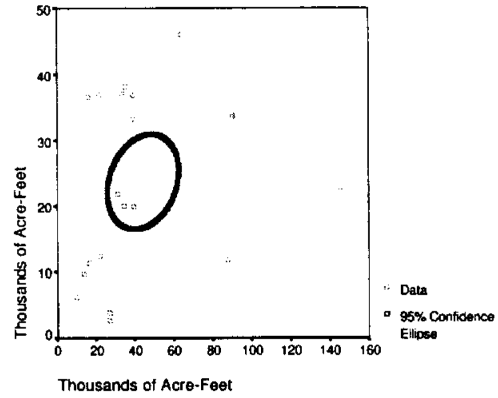


*Figure 3.26* *March-April Inflows vs. July-August Inflows, CR.*

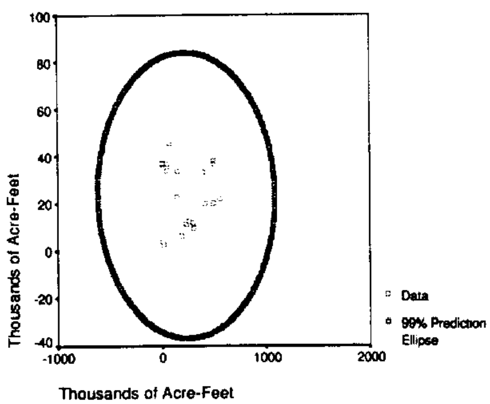


*Figure 3.27* *March-April Inflows vs. September-October Inflows, PE.*

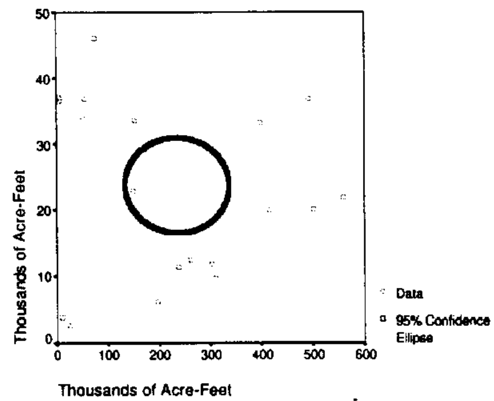


*Figure 3.28* *March-April Inflows vs. September-October Inflows, CR.*

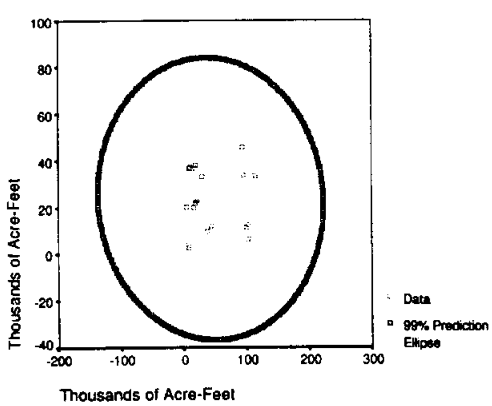


*Figure 3.29* *March-April Inflows vs. November-December Inflows, PE.*

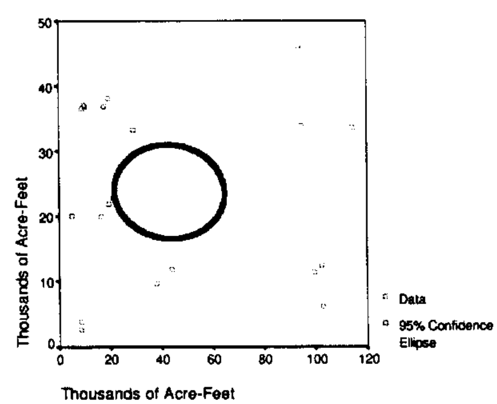


*Figure 3.30* *March-April Inflows vs. November-December Inflows, CR.*

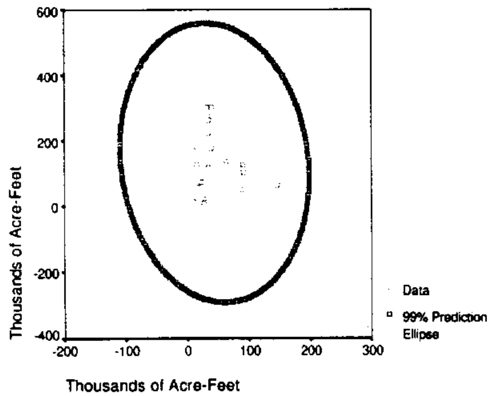


***Figure 3.31*** *May-June Inflows vs. July-August Inflows, PE.*

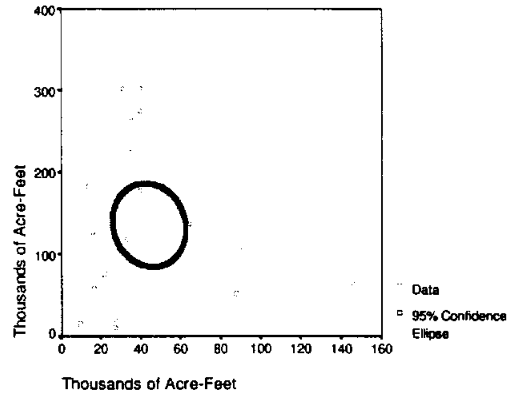


***Figure 3.32*** *May-June Inflows vs. July-August Inflows, CR.*

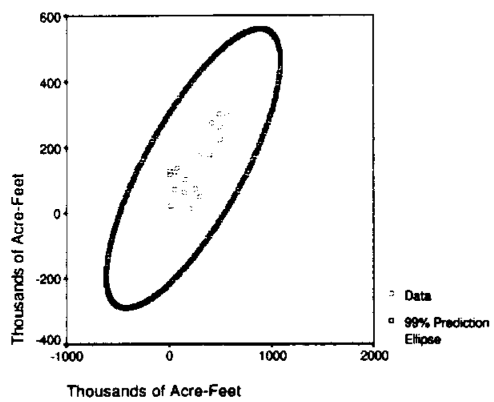


***Figure 3.33*** *May-June Inflows vs. September-October Inflows, PE.*

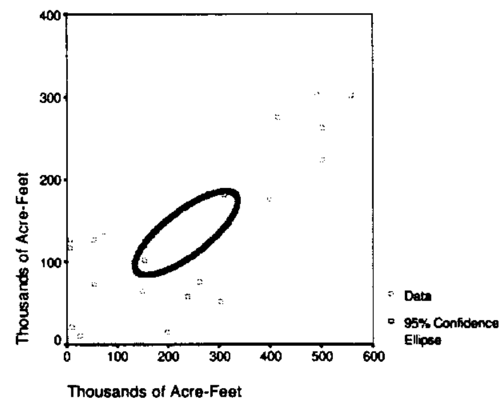


***Figure 3.34*** *May-June Inflows vs. September-October Inflows, CR.*

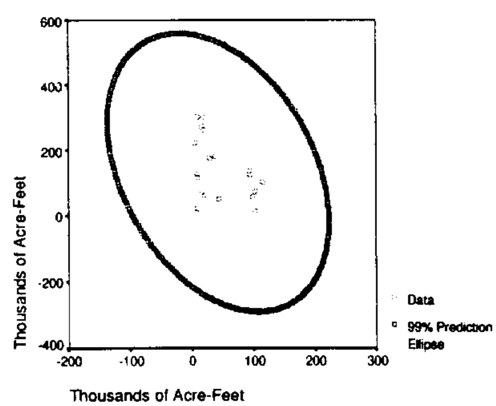


***Figure 3.35*** *May-June Inflows vs. November-December Inflows, PE.*

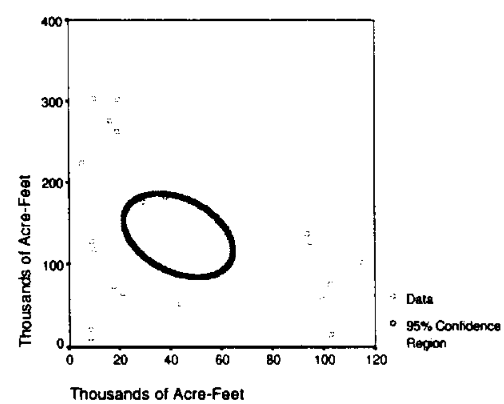


***Figure 3.36*** *May-June Inflows vs. November-December Inflows, CR.*

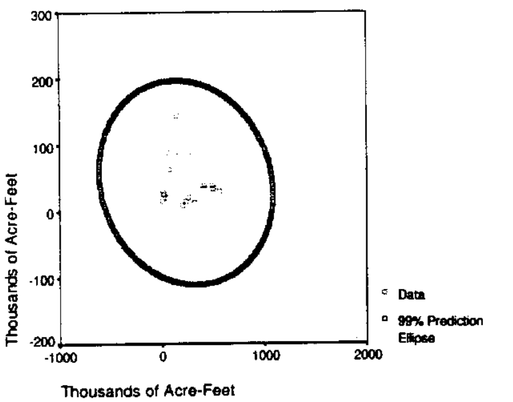


***Figure 3.37*** *July-August Inflows. vs. September-October Inflows, PE.*

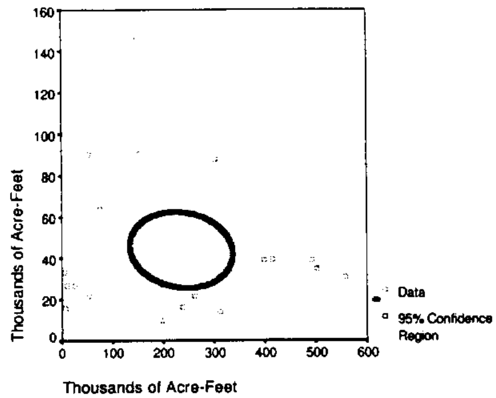


***Figure 3.38*** *July-August Inflows. vs. September-October Inflows, CR.*

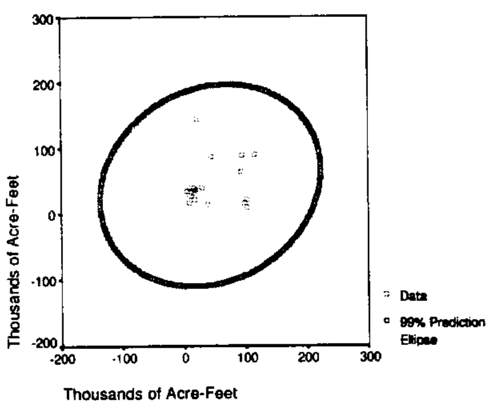


***Figure 3.39*** *July-August Inflows. vs. November-December Inflows, PE.*

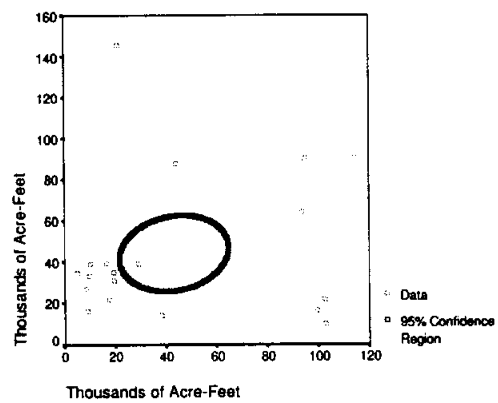


***Figure 3.40*** *July-August Inflows. vs. November-December Inflows, CR.*

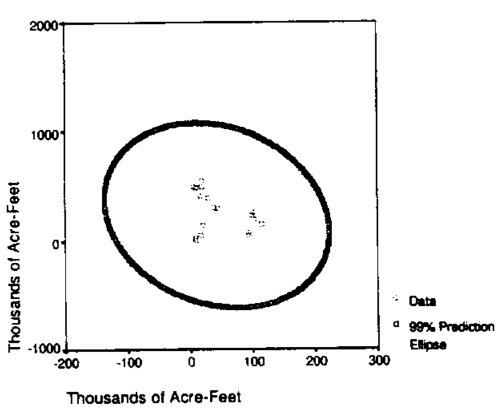


***Figure 3.41*** *September-October Inflows vs. November-December Inflows, PE.*

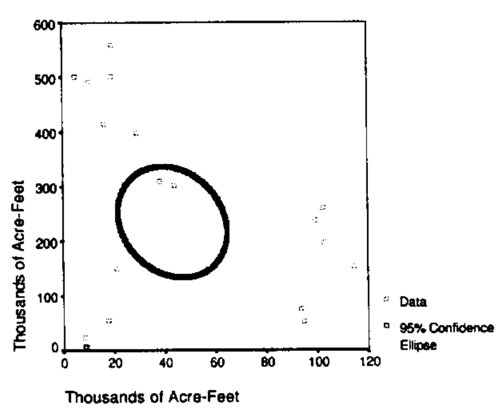


***Figure 3.42*** *September-October Inflows vs. November-December Inflows, CR.*

## 4. BOX-COX ANALYSIS

***Table .4.1*** *Mean Square Error from Box-Cox transformation of the trout data and the inflow data for different lambda.*

| Lam. | Trout | JF_inflow | MA_inflo | MJ_inflow | JA_inflow | SO_inflow | ND_inflow |
|---|---|---|---|---|---|---|---|
| -2.0 | 77552.6 | 50708.9 | 11029.2 | 752149 | 2628.4 | 53961199 | 8343.5 |
| -1.9 | 64668.9 | 35668.4 | 8383.1 | 549366 | 2277.7 | 33067621 | 6719.1 |
| -1.8 | 54156.2 | 25230.2 | 6406.9 | 403544 | 1983.7 | 20385066 | 5447.7 |
| -1.7 | 45561.0 | 17958.9 | 4925.6 | 298249 | 1736.8 | 12649071 | 4449.2 |
| -1.6 | 38519.4 | 12873.4 | 3811.1 | 221888 | 1529.3 | 7905462 | 3662.3 |
| -1.5 | 32738.8 | 9301.4 | 2969.2 | 166258 | 1354.6 | 4980172 | 3040.0 |
| -1.4 | 27983.8 | 6780.9 | 2330.5 | 125539 | 1207.6 | 3165084 | 2546.5 |
| -1.3 | 24064.6 | 4993.8 | 1843.8 | 95586 | 1083.9 | 2031339 | 2153.8 |
| -1.2 | 20828.0 | 3720.1 | 1471.4 | 73441 | 980.0 | 1318060 | 1840.6 |
| -1.1 | 18150.2 | 2807.5 | 1185.1 | 56982 | 892.8 | 865806 | 1590.4 |
| -1.0 | 15931.3 | 2150.0 | 963.9 | 44685 | 819.9 | 576637 | 1390.4 |
| -0.9 | 14089.9 | 1673.8 | 792.3 | 35448 | 759.4 | 390069 | 1230.6 |
| -0.8 | 12560.3 | 1327.0 | 658.5 | 28475 | 709.7 | 268535 | 1103.5 |
| -0.7 | 11289.1 | 1073.3 | 553.6 | 23185 | 669.5 | 188557 | 1002.9 |
| -0.6 | 10232.8 | 887.2 | 471.1 | 19155 | 637.7 | 135368 | 924.5 |
| -0.5 | 9355.9 | 750.4 | 406.0 | 16074 | 613.6 | 99615 | 864.5 |
| -0.4 | 8629.7 | 650.1 | 354.4 | 13713 | 596.5 | 75334 | 820.5 |
| -0.3 | 8030.8 | 577.1 | 313.4 | 11904 | 586.0 | 58690 | 790.4 |
| -0.2 | 7539.9 | 525.1 | 280.7 | 10522 | 581.9 | 47200 | 772.9 |
| -0.1 | 7141.6 | 489.2 | 254.8 | 9474 | 584.1 | 39246 | 767.0 |
| 0.0 | 6823.3 | 466.4 | 234.2 | 8693 | 592.6 | 33763 | 772.3 |
| 0.1 | 6574.7 | 454.3 | 218.0 | 8126 | 607.8 | 30053 | 788.7 |
| 0.2 | 6387.8 | 451.6 | 205.4 | 7736 | 630.0 | 27653 | 816.6 |
| 0.3 | 6255.9 | 457.2 | 195.7 | 7497 | 659.8 | 26261 | 856.6 |
| 0.4 | 6174.0 | 470.7 | 188.6 | 7390 | 698.1 | 25685 | 909.7 |
| 0.5 | 6138.1 | 492.2 | 183.6 | 7401 | 746.0 | 25810 | 977.6 |
| 0.6 | 6145.5 | 521.8 | 180.5 | 7522 | 804.8 | 26577 | 1062.3 |
| 0.7 | 6194.1 | 560.3 | 179.1 | 7752 | 876.4 | 27973 | 1166.3 |
| 0.8 | 6282.6 | 608.5 | 179.3 | 8089 | 962.8 | 30020 | 1292.8 |
| 0.9 | 6410.8 | 667.9 | 180.8 | 8538 | 1066.7 | 32779 | 1446.1 |
| 1.0 | 6578.6 | 740.0 | 183.7 | 9107 | 1191.6 | 36342 | 1631.0 |
| 1.1 | 6787.0 | 827.1 | 188.0 | 9805 | 1341.6 | 40841 | 1853.8 |
| 1.2 | 7037.4 | 931.9 | 193.6 | 10648 | 1521.7 | 46450 | 2122.3 |
| 1.3 | 7331.8 | 1057.8 | 200.6 | 11654 | 1738.3 | 53395 | 2445.9 |
| 1.4 | 7672.8 | 1209.0 | 208.9 | 12844 | 1999.2 | 61965 | 2836.2 |
| 1.5 | 8063.6 | 1390.4 | 218.8 | 14247 | 2314.2 | 72525 | 3307.8 |
| 1.6 | 8508.2 | 1608.5 | 230.2 | 15896 | 2695.3 | 85533 | 3878.3 |
| 1.7 | 9011.1 | 1871.0 | 243.3 | 17831 | 3157.7 | 101571 | 4569.9 |
| 1.8 | 9577.7 | 2187.3 | 258.2 | 20099 | 3720.0 | 121369 | 5409.8 |
| 1.9 | 10214.0 | 2569.3 | 275.2 | 22757 | 4405.7 | 145847 | 6431.8 |
| 2.0 | 10927.3 | 3031.3 | 294.4 | 25875 | 5244.0 | 176165 | 7677.8 |

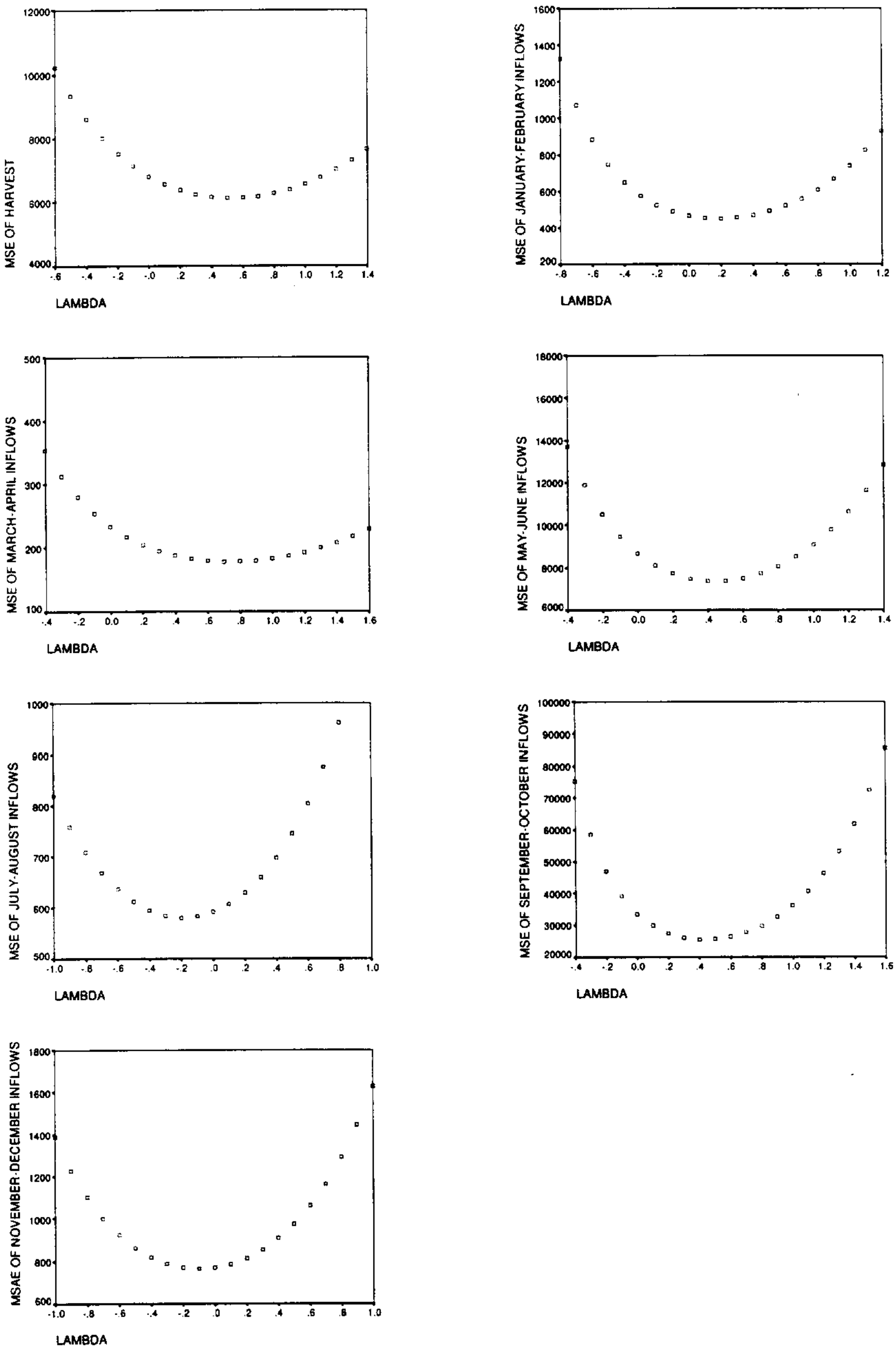


***Figure 4.1*** *Box-Cox Transformation - MSE of Trout vs. Lambda and MSE of Inflow data vs. Lambda.*

# 5. Model Choice Diagnostics

## 5.1 Untransformed trout data and untransformed inflow data

***Table 5.1*** *Regression Models for Dependent Variable: TROUT on INFLOWS*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.3539 | 0.3180 | 4.303 | 170.1 | 4486 | 172.1 | QJA_LAG |
| 1 | 0.1692 | 0.1230 | 10.11 | 175.1 | 5769 | 177.1 | QMA_LAG |
| 1 | 0.0471 | -.0058 | 13.94 | 177.8 | 6617 | 179.8 | QND_LAG |
| 1 | 0.0322 | -.0215 | 14.41 | 178.2 | 6720 | 180.1 | QSO_LAG |
| 2 | 0.4514 | 0.3869 | 3.239 | 168.8 | 4033 | 171.8 | QJA_LAG QND_LAG |
| 2 | 0.4308 | 0.3638 | 3.887 | 169.5 | 4185 | 172.5 | QMA_LAG QJA_LAG |
| 2 | 0.3935 | 0.3222 | 5.058 | 170.8 | 4459 | 173.8 | QJF_LAG QJA_LAG |
| 2 | 0.3872 | 0.3151 | 5.257 | 171.0 | 4506 | 174.0 | QMJ_LAG QJA_LAG |
| 3 | 0.5414 | 0.4555 | 2.410 | 167.2 | 3582 | 171.2 | QMJ_LAG QJA_LAG QSO_LAG |
| 3 | 0.5156 | 0.4248 | 3.223 | 168.3 | 3784 | 172.3 | QMA_LAG QJA_LAG QND_LAG |
| 3 | 0.4793 | 0.3817 | 4.363 | 169.8 | 4068 | 173.7 | QJA_LAG QSO_LAG QND_LAG |
| 3 | 0.4650 | 0.3647 | 4.812 | 170.3 | 4180 | 174.3 | QJF_LAG QMA_LAG QJA_LAG |
| 4 | 0.5840 | 0.4731 | 3.072 | 167.3 | 3466 | 172.2 | QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.5439 | 0.4223 | 4.332 | 169.1 | 3800 | 174.1 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 4 | 0.5437 | 0.4221 | 4.338 | 169.1 | 3802 | 174.1 | QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.5429 | 0.4210 | 4.364 | 169.1 | 3809 | 174.1 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.5863 | 0.4385 | 5.000 | 169.2 | 3694 | 175.1 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.5843 | 0.4359 | 5.063 | 169.2 | 3711 | 175.2 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.5449 | 0.3823 | 6.302 | 171.1 | 4063 | 177.0 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.5444 | 0.3817 | 6.317 | 171.1 | 4068 | 177.1 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 6 | 0.5863 | 0.3954 | 7.000 | 171.2 | 3978 | 178.1 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 20

## 5.2 Log of trout data and untransformed inflow data

***Table 5.2*** *Regression Models for Dependent Variable: Ln(TROUT) on INFLOWS*

| In | *Rsq* | *Adj Rsq* | *C(p)* | *AIC* | *MSE* | *SBC* | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.5266 | 0.5003 | 7.175 | -39.14 | 0.1285 | -37.15 | QJA_LAG |
| 1 | 0.1314 | 0.0832 | 26.52 | -27.00 | 0.2359 | -25.01 | QMA_LAG |
| 1 | 0.0505 | -.0023 | 30.49 | -25.22 | 0.2578 | -23.22 | QSO_LAG |
| 1 | 0.0210 | -.0334 | 31.93 | -24.60 | 0.2658 | -22.61 | QJF_LAG |
| 2 | 0.5794 | 0.5299 | 6.592 | -39.50 | 0.1209 | -36.51 | QJA_LAG QND_LAG |
| 2 | 0.5646 | 0.5134 | 7.317 | -38.81 | 0.1252 | -35.82 | QMA_LAG QJA_LAG |
| 2 | 0.5467 | 0.4934 | 8.192 | -38.00 | 0.1303 | -35.02 | QJA_LAG QSO_LAG |
| 2 | 0.5349 | 0.4802 | 8.768 | -37.49 | 0.1337 | -34.50 | QMJ_LAG QJA_LAG |
| 3 | 0.6443 | 0.5776 | 5.416 | -40.85 | 0.1087 | -36.87 | QMJ_LAG QJA_LAG QSO_LAG |
| 3 | 0.6130 | 0.5405 | 6.945 | -39.17 | 0.1182 | -35.19 | QJA_LAG QSO_LAG QND_LAG |
| 3 | 0.6108 | 0.5378 | 7.055 | -39.05 | 0.1189 | -35.07 | QMA_LAG QJA_LAG QND_LAG |
| 3 | 0.6071 | 0.5335 | 7.234 | -38.87 | 0.1200 | -34.88 | QJF_LAG QJA_LAG QND_LAG |
| 4 | 0.6702 | 0.5823 | 6.145 | -40.37 | 0.1075 | -35.39 | QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.6653 | 0.5760 | 6.388 | -40.07 | 0.1091 | -35.09 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 4 | 0.6462 | 0.5519 | 7.319 | -38.96 | 0.1153 | -33.98 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 4 | 0.6447 | 0.5499 | 7.397 | -38.87 | 0.1158 | -33.89 | QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.7291 | 0.6324 | 5.261 | -42.30 | 0.0946 | -36.33 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.6760 | 0.5603 | 7.863 | -38.72 | 0.1131 | -32.75 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.6756 | 0.5597 | 7.884 | -38.69 | 0.1133 | -32.72 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.6702 | 0.5524 | 8.145 | -38.37 | 0.1151 | -32.39 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.7345 | 0.6119 | 7.000 | -40.70 | 0.0998 | -33.73 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 20

## 5.3 Log of trout data and log of inflow data

***Table 5.3*** *Regression Models for Dependent Variable: Ln(TROUT) on Ln(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.4713 | 0.4420 | 7.284 | -36.93 | 0.1436 | -34.94 | LN_QJA |
| 1 | 0.0907 | 0.0401 | 24.05 | -26.08 | 0.2469 | -24.09 | LN_QMA |
| 1 | 0.0458 | -.0072 | 26.02 | -25.12 | 0.2591 | -23.13 | LN_QSO |
| 1 | 0.0402 | -.0131 | 26.27 | -25.00 | 0.2606 | -23.01 | LN_QJF |
| 2 | 0.5530 | 0.5004 | 5.687 | -38.28 | 0.1285 | -35.30 | LN_QJA LN_QSO |
| 2 | 0.5225 | 0.4663 | 7.031 | -36.96 | 0.1373 | -33.98 | LN_QJA LN_QND |
| 2 | 0.5060 | 0.4479 | 7.756 | -36.29 | 0.1420 | -33.30 | LN_QJF LN_QJA |
| 2 | 0.4797 | 0.4184 | 8.918 | -35.25 | 0.1496 | -32.26 | LN_QMJ LN_QJA |
| 3 | 0.6271 | 0.5572 | 4.424 | -39.91 | 0.1139 | -35.93 | LN_QJF LN_QJA LN_QND |
| 3 | 0.6117 | 0.5389 | 5.103 | -39.10 | 0.1186 | -35.12 | LN_QJF LN_QJA LN_QSO |
| 3 | 0.5773 | 0.4981 | 6.616 | -37.40 | 0.1291 | -33.42 | LN_QJA LN_QSO LN_QND |
| 3 | 0.5561 | 0.4729 | 7.549 | -36.42 | 0.1356 | -32.44 | LN_QMA LN_QJA LN_QSO |
| 4 | 0.6937 | 0.6120 | 3.491 | -41.84 | 0.0998 | -36.86 | LN_QJF LN_QJA LN_QSO LN_QND |
| 4 | 0.6624 | 0.5723 | 4.870 | -39.90 | 0.1100 | -34.92 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 4 | 0.6396 | 0.5436 | 5.871 | -38.59 | 0.1174 | -33.61 | LN_QJF LN_QMA LN_QJA LN_QND |
| 4 | 0.6132 | 0.5101 | 7.035 | -37.18 | 0.1260 | -32.20 | LN_QJF LN_QMA LN_QJA LN_QSO |
| 5 | 0.7035 | 0.5977 | 5.057 | -40.50 | 0.1035 | -34.52 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.6984 | 0.5907 | 5.283 | -40.15 | 0.1053 | -34.18 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.6654 | 0.5459 | 6.737 | -38.08 | 0.1168 | -32.10 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QND |
| 5 | 0.6325 | 0.5013 | 8.185 | -36.20 | 0.1283 | -30.23 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 6 | 0.7048 | 0.5686 | 7.000 | -38.58 | 0.1110 | -31.61 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 20

## 5.4 Log of trout data and square root of inflow data

***Table 5.4*** *Regression Models for Dependent Variable: Ln(TROUT) on Sqrt(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.5126 | 0.4855 | 9.380 | -38.55 | 0.1324 | -36.56 | SQR_QJA |
| 1 | 0.1182 | 0.0692 | 29.92 | -26.69 | 0.2395 | -24.70 | SQR_QMA |
| 1 | 0.0576 | 0.0053 | 33.07 | -25.37 | 0.2559 | -23.38 | SQR_QSO |
| 1 | 0.0301 | -.0237 | 34.50 | -24.79 | 0.2634 | -22.80 | SQR_QJF |
| 2 | 0.5723 | 0.5220 | 8.270 | -39.17 | 0.1230 | -36.18 | SQR_QJA SQR_QND |
| 2 | 0.5687 | 0.5180 | 8.457 | -39.00 | 0.1240 | -36.01 | SQR_QJA SQR_QSO |
| 2 | 0.5255 | 0.4697 | 10.71 | -37.09 | 0.1364 | -34.10 | SQR_QJF SQR_QJA |
| 2 | 0.5250 | 0.4691 | 10.74 | -37.07 | 0.1366 | -34.08 | SQR_QMA SQR_QJA |
| 3 | 0.6493 | 0.5836 | 6.260 | -41.14 | 0.1071 | -37.16 | SQR_QJF SQR_QJA SQR_QND |
| 3 | 0.6262 | 0.5561 | 7.463 | -39.86 | 0.1142 | -35.88 | SQR_QJA SQR_QSO SQR_QND |
| 3 | 0.6089 | 0.5355 | 8.367 | -38.95 | 0.1195 | -34.97 | SQR_QMJ SQR_QJA SQR_QSO |
| 3 | 0.5849 | 0.5071 | 9.614 | -37.77 | 0.1268 | -33.78 | SQR_QJF SQR_QJA SQR_QSO |
| 4 | 0.7105 | 0.6333 | 5.075 | -42.97 | 0.0943 | -37.99 | SQR_QJF SQR_QJA SQR_QSO SQR_QND |
| 4 | 0.6526 | 0.5600 | 8.090 | -39.33 | 0.1132 | -34.35 | SQR_QJF SQR_QMJ SQR_QJA SQR_QND |
| 4 | 0.6510 | 0.5580 | 8.171 | -39.24 | 0.1137 | -34.26 | SQR_QJF SQR_QMA SQR_QJA SQR_QND |
| 4 | 0.6435 | 0.5485 | 8.563 | -38.81 | 0.1162 | -33.83 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO |
| 5 | 0.7316 | 0.6358 | 5.974 | -42.49 | 0.0937 | -36.51 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.7129 | 0.6104 | 6.950 | -41.14 | 0.1002 | -35.16 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.6769 | 0.5615 | 8.825 | -38.78 | 0.1128 | -32.80 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO |
| 5 | 0.6631 | 0.5428 | 9.543 | -37.94 | 0.1176 | -31.97 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QND |
| 6 | 0.7503 | 0.6351 | 7.000 | -41.93 | 0.0939 | -34.96 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

N = 20

## 5.5 Square root of trout data and square root of inflow data

***Table 5.5*** *Regression Models for Dependent Variable: Sqrt(TROUT) on Ln(INFLOWS)*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.4513 | 0.4208 | 5.792 | 35.83 | 5.457 | 37.82 | SQR_QJA |
| 1 | 0.1352 | 0.0872 | 18.35 | 44.93 | 8.601 | 46.92 | SQR_QMA |
| 1 | 0.0593 | 0.0071 | 21.36 | 46.61 | 9.356 | 48.60 | SQR_QSO |
| 1 | 0.0362 | -.0173 | 22.28 | 47.10 | 9.586 | 49.09 | SQR_QND |
| 2 | 0.5374 | 0.4830 | 4.372 | 34.42 | 4.871 | 37.40 | SQR_QJA SQR_QND |
| 2 | 0.5092 | 0.4515 | 5.492 | 35.60 | 5.168 | 38.59 | SQR_QJA SQR_QSO |
| 2 | 0.4745 | 0.4127 | 6.870 | 36.97 | 5.534 | 39.95 | SQR_QMA SQR_QJA |
| 2 | 0.4539 | 0.3896 | 7.690 | 37.74 | 5.751 | 40.72 | SQR_QMJ SQR_QJA |
| 3 | 0.5926 | 0.5162 | 4.181 | 33.88 | 4.559 | 37.86 | SQR_QJA SQR_QSO SQR_QND |
| 3 | 0.5781 | 0.4989 | 4.758 | 34.58 | 4.721 | 38.56 | SQR_QMJ SQR_QJA SQR_QSO |
| 3 | 0.5703 | 0.4898 | 5.065 | 34.94 | 4.808 | 38.92 | SQR_QJF SQR_QJA SQR_QND |
| 3 | 0.5545 | 0.4710 | 5.692 | 35.66 | 4.984 | 39.65 | SQR_QMA SQR_QJA SQR_QND |
| 4 | 0.6303 | 0.5317 | 4.682 | 33.93 | 4.412 | 38.91 | SQR_QJF SQR_QJA SQR_QSO SQR_QND |
| 4 | 0.6202 | 0.5190 | 5.083 | 34.47 | 4.533 | 39.45 | SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 4 | 0.6123 | 0.5090 | 5.397 | 34.88 | 4.627 | 39.86 | SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 4 | 0.5864 | 0.4761 | 6.426 | 36.18 | 4.936 | 41.16 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO |
| 5 | 0.6642 | 0.5443 | 5.336 | 34.01 | 4.294 | 39.98 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.6415 | 0.5135 | 6.238 | 35.32 | 4.584 | 41.29 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.6203 | 0.4848 | 7.079 | 36.47 | 4.855 | 42.44 | SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.6048 | 0.4637 | 7.696 | 37.27 | 5.054 | 43.24 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO |
| 6 | 0.6727 | 0.5216 | 7.000 | 35.50 | 4.508 | 42.47 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

N = 20

## 5.6 Various transformation suggested by Box-Cox

***Table 5.6*** *Regression Models for Dependent Variable: Sqrt(TROUT) on variously transformed INFLOWS.*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.4214 | 0.3893 | 4.566 | 36.89 | 5.755 | 38.88 | QR_QJA |
| 1 | 0.1461 | 0.0987 | 14.35 | 44.68 | 8.493 | 46.67 | QR_QMA |
| 1 | 0.0609 | 0.0088 | 17.38 | 46.58 | 9.340 | 48.57 | QR_QSO |
| 1 | 0.0487 | -.0041 | 17.81 | 46.84 | 9.461 | 48.83 | QR_QND |
| 2 | 0.5003 | 0.4415 | 3.763 | 35.96 | 5.263 | 38.95 | QR_QJA QR_QSO |
| 2 | 0.4923 | 0.4325 | 4.048 | 36.28 | 5.347 | 39.27 | QR_QJA QR_QND |
| 2 | 0.4388 | 0.3728 | 5.948 | 38.28 | 5.910 | 41.27 | QR_QMA QR_QJA |
| 2 | 0.4323 | 0.3655 | 6.181 | 38.51 | 5.979 | 41.50 | QR_QJF QR_QJA |
| 3 | 0.5576 | 0.4747 | 3.725 | 35.52 | 4.950 | 39.51 | QR_QJF QR_QJA QR_QND |
| 3 | 0.5556 | 0.4722 | 3.798 | 35.62 | 4.973 | 39.60 | QR_QJA QR_QSO QR_QND |
| 3 | 0.5249 | 0.4358 | 4.887 | 36.95 | 5.316 | 40.93 | QR_QMJ QR_QJA QR_QSO |
| 3 | 0.5175 | 0.4270 | 5.151 | 37.26 | 5.399 | 41.24 | QR_QJF QR_QJA QR_QSO |
| 4 | 0.6272 | 0.5277 | 3.253 | 34.10 | 4.450 | 39.08 | QR_QJF QR_QJA QR_QSO QR_QND |
| 4 | 0.5706 | 0.4561 | 5.262 | 36.93 | 5.124 | 41.91 | QR_QJF QR_QMJ QR_QJA QR_QND |
| 4 | 0.5690 | 0.4540 | 5.321 | 37.00 | 5.144 | 41.98 | QR_QMA QR_QJA QR_QSO QR_QND |
| 4 | 0.5616 | 0.4447 | 5.582 | 37.34 | 5.232 | 42.32 | QR_QMJ QR_QJA QR_QSO QR_QND |
| 5 | 0.6324 | 0.5011 | 5.066 | 35.82 | 4.700 | 41.79 | QR_QJF QR_QMJ QR_QJA QR_QSO QR_QND |
| 5 | 0.6285 | 0.4958 | 5.206 | 36.03 | 4.751 | 42.01 | QR_QJF QR_QMA QR_QJA QR_QSO QR_QND |
| 5 | 0.5924 | 0.4469 | 6.487 | 37.89 | 5.212 | 43.86 | QR_QJF QR_QMA QR_QMJ QR_QJA QR_QND |
| 5 | 0.5695 | 0.4158 | 7.301 | 38.98 | 5.504 | 44.95 | QR_QMA QR_QMJ QR_QJA QR_QSO QR_QND |
| 6 | 0.6343 | 0.4655 | 7.000 | 37.72 | 5.037 | 44.69 | QR_QJF QR_QMA QR_QMJ QR_QJA QR_QSO QR_QND |

N = 20

Dependent Variable: Sqrt(*TROUT*)

Independent Variables:
*QR_QJF*=(January-February Inflows)$^{0.2}$
*QR_QMA*=(March-April Inflows)$^{0.7}$
*QR_QMJ*=(May-June Inflows)$^{0.4}$
*QR_QMJ*=(July-August Inflows)$^{-0.2}$
*QR_QND*=(September-October Inflows)$^{0.4}$
*QR_QND*=(November-December Inflows)$^{-0.1}$

# 6. REGRESSION FOR THE BEST MODELS

## 6.1 Regression - Log of trout data on inflow data

### 6.1.1 ANOVA and Parameter Estimates

***Table 6.1*** *Model Summary for log of trout data on inflow data.*

**Model Summary[a,b]**

| Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| November-December Inflows, March-April Inflows, September-October Inflows, July-August Inflows, January-February Inflows, May-June Inflows[c,d] | .857 | .734 | .612 | .315969 | 2.095 |

a. Dependent Variable: Ln(Trout Harvest)

b. Method: Enter

c. Independent Variables: (Constant), November-December Inflows, March-April Inflows, September-October Inflows, July-August Inflows, January-February Inflows, May-June Inflows

d. All requested variables entered.

***Table 6.2*** *ANOVA table of log of trout data on inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 3.590 | 6 | .598 | 5.993 | .003[b] |
| | Residual | 1.298 | 13 | 1.0E-01 | | |
| | Total | 4.888 | 19 | | | |

a. Dependent Variable: Ln(Trout Harvest)

b. Independent Variables: (Constant), November-December Inflows, March-April Inflows, September-October Inflows, July-August Inflows, January-February Inflows, May-June Inflows

***Table 6.3*** *Table of coefficients for log of trout data on inflow data.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | 5.550 | .214 | | 25.904 | .000 | 5.087 | 6.013 |
| January-February Infl. | -6.1E-03 | .003 | -.325 | -1.773 | .100 | -.013 | .001 |
| March-April Inflows | 4.4E-03 | .009 | .119 | .511 | .618 | -.014 | .023 |
| May-June Inflows | -3.5E-03 | .002 | -.659 | -1.698 | .113 | -.008 | .001 |
| July-August Inflows | -1.1E-02 | .002 | -.735 | -4.761 | .000 | -.016 | -.006 |
| September-October Infl. | 1.8E-03 | .001 | .680 | 2.119 | .054 | .000 | .004 |
| November-December Infl. | 3.7E-03 | .002 | .297 | 1.692 | .114 | -.001 | .009 |

a. Dependent Variable: Ln(Trout Harvest)

### 6.1.2 Collinearity Diagnostic

***Table 6.4*** *Variance Inflation for log of trout data on inflow data.*

**Coefficients[a]**

| | | Collinearity Statistics | |
|---|---|---|---|
| | t | Tolerance | VIF |
| (Constant) | 25.904 | | |
| January-February Infl. | -1.773 | .610 | 1.640 |
| March-April Inflows | .511 | .378 | 2.642 |
| May-June Inflows | -1.698 | .136 | 7.375 |
| July-August Inflows | -4.761 | .858 | 1.165 |
| September-October Infl. | 2.119 | .199 | 5.036 |
| November-December Infl. | 1.692 | .661 | 1.514 |

a. Dependent Variable: Ln(Trout Harvest)

***Table 6.5*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: LN(TROUT) on INFLOWS.*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *QJF_LAG* | Var Prop *QMA_LAG* | Var Prop *QMJ_LAG* | Var Prop *QJA_LAG* | Var Prop *QSO_LAG* | Var Prop *QND_LAG* |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.23431 | 1.00000 | 0.0411 | 0.0064 | 0.0220 | 0.0105 | 0.0204 | 0.0569 |
| 2 | 1.39421 | 1.26592 | 0.0656 | 0.0967 | 0.0083 | 0.1685 | 0.0045 | 0.0487 |
| 3 | 1.11529 | 1.41540 | 0.1145 | 0.0574 | 0.0029 | 0.1100 | 0.0555 | 0.0846 |
| 4 | 0.72226 | 1.75884 | 0.0068 | 0.1594 | 0.0008 | 0.6516 | 0.0272 | 0.0329 |
| 5 | 0.46125 | 2.20092 | 0.6120 | 0.0019 | 0.0020 | 0.0055 | 0.0009 | 0.7490 |
| 6 | 0.07268 | 5.54451 | 0.1601 | 0.6781 | 0.9640 | 0.0540 | 0.8915 | 0.0279 |

### 6.1.3 Residuals Diagnostics

***Table 6.6*** *Residuals Diagnostics for log of trout data on inflow data.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 3.694241 | 5.742424 | 5.092896 | .434676 | 20 |
| Std. Predicted Value | -3.218 | 1.494 | .000 | 1.000 | 20 |
| Standard Error of Predicted Value | .147076 | .296638 | .183999 | 3.4E-02 | 20 |
| Adjusted Predicted Value | 3.568744 | 6.014528 | 5.075135 | .477937 | 20 |
| Residual | -.520448 | .376390 | -1.6E-16 | .261360 | 20 |
| Std. Residual | -1.647 | 1.191 | .000 | .827 | 20 |
| Stud. Residual | -2.033 | 1.468 | .019 | 1.014 | 20 |
| Deleted Residual | -.792552 | .598149 | 1.8E-02 | .396956 | 20 |
| Stud. Deleted Residual | -2.364 | 1.544 | .006 | 1.064 | 20 |
| Mahal. Distance | 3.167 | 15.796 | 5.700 | 2.819 | 20 |
| Cook's Distance | .001 | .309 | .075 | .087 | 20 |
| Centered Leverage Value | .167 | .831 | .300 | .148 | 20 |

a. Dependent Variable: Ln(Trout Harvest)

***Table 6.7*** *Case Values for Residuals Diagnostics for log of trout data on inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1961 | 5.4401 | .3764 | .5717 | 5.2448 | .7988 | 1.1912 | 1.4682 | 1.5444 |
| 1962 | 5.5863 | .3018 | .4173 | 5.4707 | 1.1351 | .9550 | 1.1231 | 1.1355 |
| 1963 | 5.7424 | -.5204 | -.7926 | 6.0145 | 1.4943 | -1.6471 | -2.0326 | -2.3644 |
| 1964 | 5.2939 | -.0628 | -.0956 | 5.3268 | .4624 | -.1987 | -.2453 | -.2362 |
| 1965 | 5.1831 | -.2823 | -.4152 | 5.3161 | .2075 | -.8934 | -1.0836 | -1.0915 |
| 1966 | 4.8863 | -.1786 | -.2377 | 4.9454 | -.4753 | -.5651 | -.6520 | -.6369 |
| 1967 | 5.0385 | .2548 | .3615 | 4.9318 | -.1251 | .8063 | .9605 | .9574 |
| 1968 | 5.0772 | -.0753 | -.0971 | 5.0990 | -.0360 | -.2384 | -.2706 | -.2607 |
| 1969 | 5.1784 | -.3662 | -.4675 | 5.2797 | .1967 | -1.1590 | -1.3096 | -1.3504 |
| 1970 | 5.1424 | .0561 | .0772 | 5.1213 | .1139 | .1775 | .2082 | .2004 |
| 1971 | 5.1539 | .2759 | .4196 | 5.0102 | .1402 | .8733 | 1.0769 | 1.0842 |
| 1972 | 5.3956 | .0227 | .0334 | 5.3850 | .6963 | .0720 | .0872 | .0838 |
| 1973 | 4.9885 | .3222 | .4712 | 4.8396 | -.2401 | 1.0198 | 1.2332 | 1.2608 |
| 1974 | 5.2548 | -.2257 | -.3079 | 5.3371 | .3725 | -.7143 | -.8343 | -.8240 |
| 1975 | 5.4651 | .1811 | .2431 | 5.4031 | .8563 | .5730 | .6640 | .6490 |
| 1976 | 5.1470 | .2606 | .5981 | 4.8095 | .1245 | .8248 | 1.2496 | 1.2799 |
| 1977 | 4.9358 | -.1433 | -.2629 | 5.0554 | -.3615 | -.4534 | -.6142 | -.5989 |
| 1978 | 4.5523 | .1111 | .1812 | 4.4822 | -1.2437 | .3517 | .4492 | .4349 |
| 1979 | 4.7020 | -.3250 | -.4850 | 4.8620 | -.8992 | -1.0287 | -1.2565 | -1.2880 |
| 1980 | 3.6942 | .0169 | .1424 | 3.5687 | -3.2177 | .0535 | .1552 | .1493 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that observation |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.
[2]This is flagged if it exceeds $t_{n-p-2,\alpha}=t_{12,0.01}=2.681$.

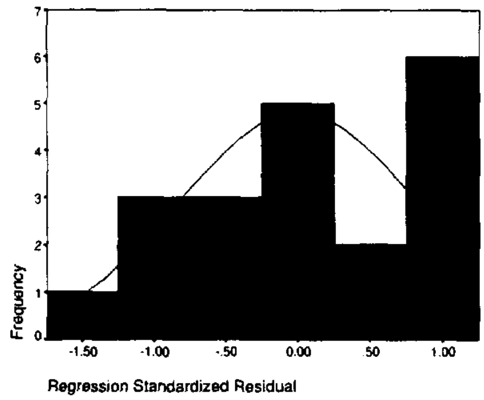


***Figure 6.1*** *Histogram of Standardized Residuals.*

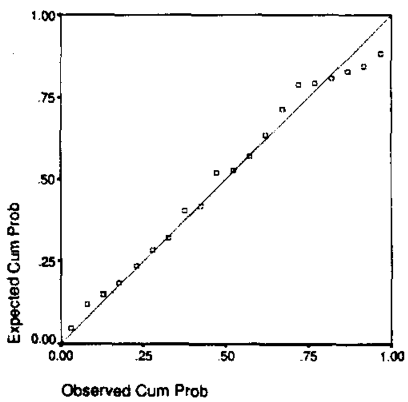


***Figure 6.2*** *Normal P-P Plot of Residuals.*

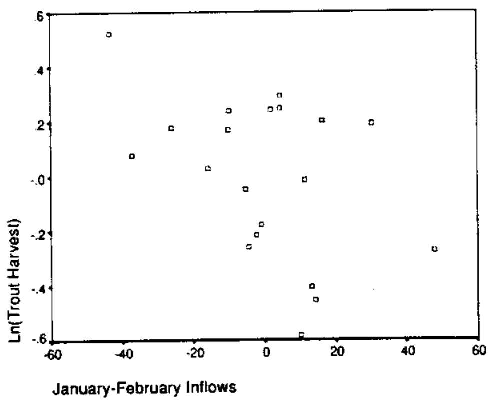


***Figure 6.3*** *Partial Residual Plot for January-February Inflows.*

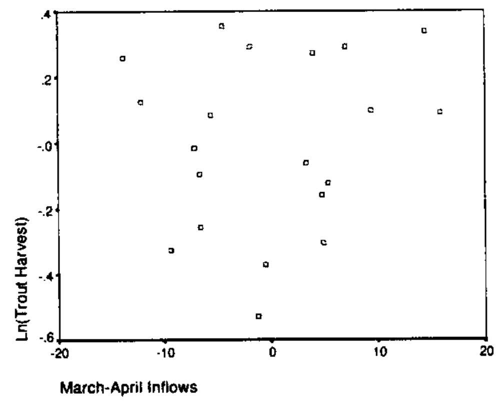


***Figure 6.4*** *Partial Residual Plot for March-April Inflows.*

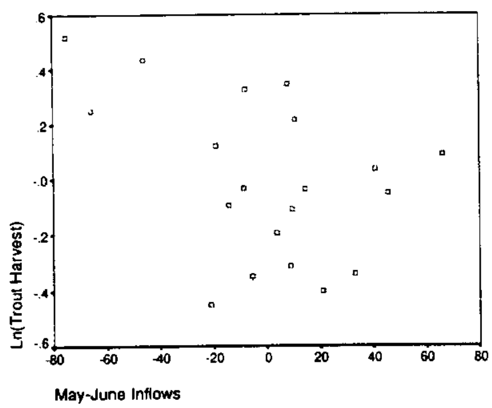


***Figure 6.5*** *Partial Residual Plot for May-June Inflows.*

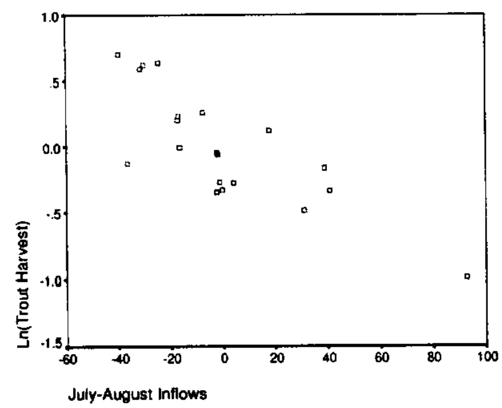


***Figure 6.6*** *Partial Residual Plot for July-August Inflows.*

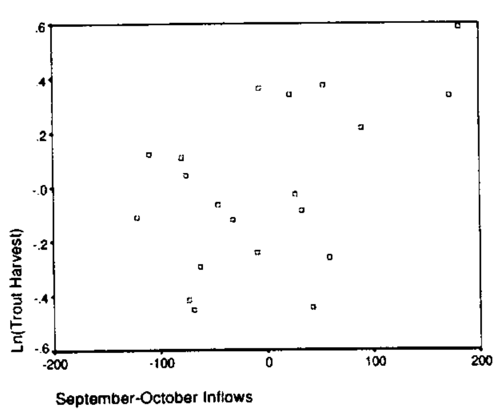


***Figure 6.7*** *Partial Residual Plot for September-October Inflows.*

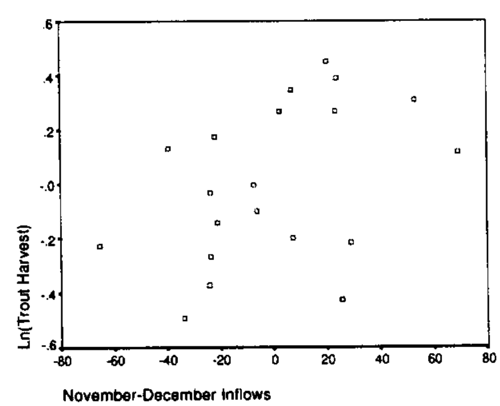


***Figure 6.8*** *Partial Residual Plot for November-December Inflows.*

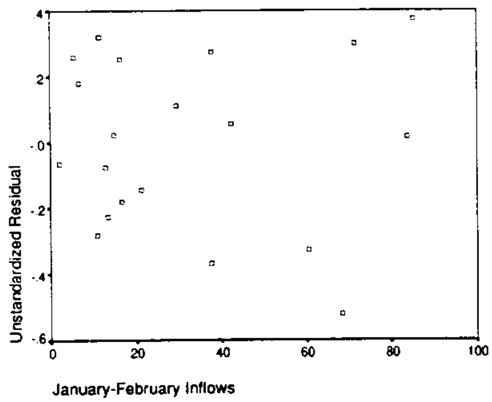


***Figure 6.9*** *Residuals Plot for January-February Inflows.*

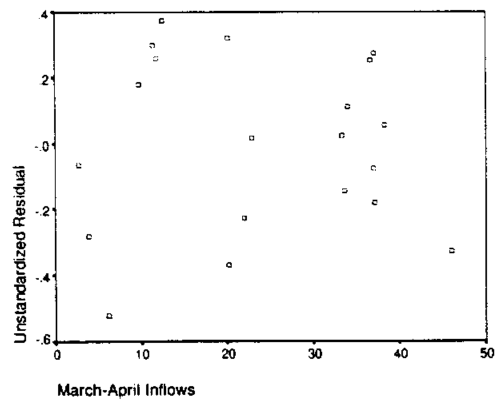


***Figure 6.10*** *Residuals Plot for March-April Inflows.*

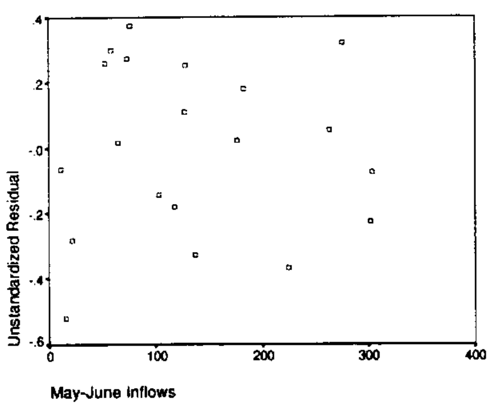


***Figure 6.11*** *Residuals Plot for May-June Inflows.*

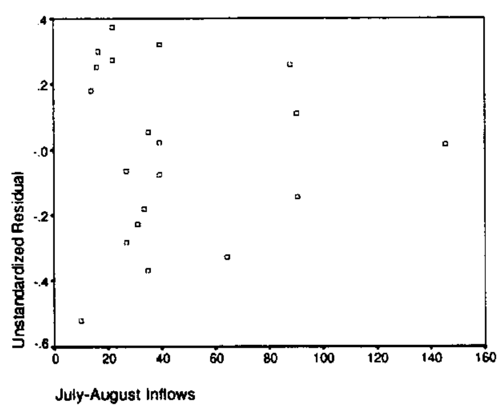


***Figure 6.12*** *Residuals Plot for July-August Inflows.*

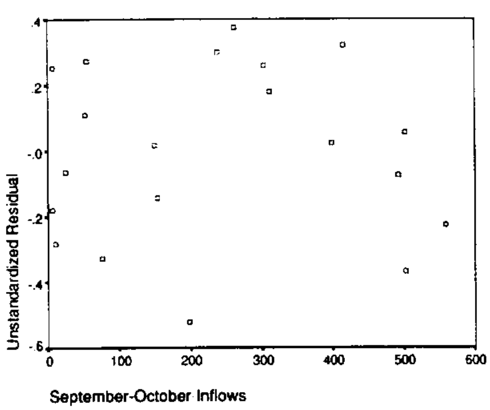


***Figure 6.13*** *Residuals Plot for September-October Inflows.*

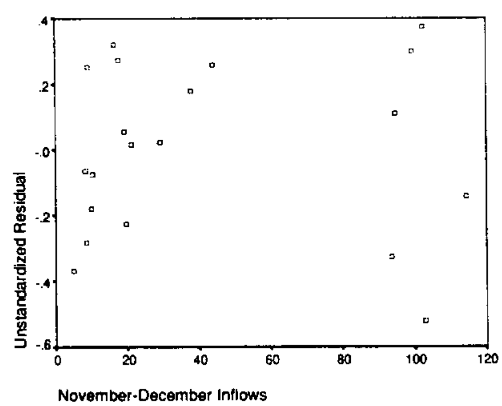


***Figure 6.14*** *Residuals Plot for November-December Inflows.*

### 6.1.4 Prediction Intervals for Trout Harvest

***Table 6.8*** *Prediction Intervals for Trout Harvest.*

| YEAR | *LICI_1* | *LN_TROUT* | *UICI_1* |
|---|---|---|---|
| 1961 | 4.3377 | 5.8165 | 6.5426 |
| 1962 | 4.5108 | 5.8880 | 6.6618 |
| 1963 | 4.6393 | 5.2220 | 6.8456 |
| 1964 | 4.1907 | 5.2311 | 6.3971 |
| 1965 | 4.0895 | 4.9008 | 6.2767 |
| 1966 | 3.8227 | 4.7077 | 5.9499 |
| 1967 | 3.9553 | 5.2933 | 6.1217 |
| 1968 | 4.0242 | 5.0019 | 6.1303 |
| 1969 | 4.1286 | 4.8122 | 6.2283 |
| 1970 | 4.0685 | 5.1985 | 6.2164 |
| 1971 | 4.0511 | 5.4298 | 6.2566 |
| 1972 | 4.3028 | 5.4183 | 6.4884 |
| 1973 | 3.8966 | 5.3107 | 6.0804 |
| 1974 | 4.1834 | 5.0291 | 6.3262 |
| 1975 | 4.3988 | 5.6462 | 6.5314 |
| 1976 | 3.9566 | 5.4076 | 6.3374 |
| 1977 | 3.7877 | 4.7925 | 6.0838 |
| 1978 | 3.4314 | 4.6634 | 5.6732 |
| 1979 | 3.6045 | 4.3770 | 5.7996 |
| 1980 | 2.3887 | 3.7111 | 4.9997 |

*LICI_1* Lower limit for 99% prediction interval for the natuaral log of trout harvest.
*LN_TROUT* Natural log of trout harvest.
*UICI_1* Upper limit for 99% prediction interval for the natural log of trout harvest.

### 6.1.5 Outliers and Influential Point Detection

***Table 6.9*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1961 | 5.5419 | .1598 | .2917 | .5941 | .0107 |
| 1962 | 4.3119 | .0690 | .2269 | .7432 | .0008 |
| 1963 | 5.5732 | .3086 | .2933 | .5904 | .0627 |
| 1964 | 5.5766 | .0045 | .2935 | .5900 | .0000 |
| 1965 | 5.1337 | .0790 | .2702 | .6436 | .0012 |
| 1966 | 3.7768 | .0201 | .1988 | .8051 | .0000 |
| 1967 | 4.6581 | .0552 | .2452 | .7016 | .0004 |
| 1968 | 3.3091 | .0030 | .1742 | .8550 | .0000 |
| 1969 | 3.1667 | .0678 | .1667 | .8692 | .0008 |
| 1970 | 4.2406 | .0023 | .2232 | .7517 | .0000 |
| 1971 | 5.5563 | .0863 | .2924 | .5924 | .0016 |
| 1972 | 5.0959 | .0005 | .2682 | .6483 | .0000 |
| 1973 | 5.0570 | .1004 | .2662 | .6530 | .0027 |
| 1974 | 4.1248 | .0362 | .2171 | .7653 | .0001 |
| 1975 | 3.8984 | .0216 | .2052 | .7914 | .0000 |
| 1976 | 9.7713 | .2889 | *.5143 | .2019 | .0533 |
| 1977 | 7.6950 | .0450 | .4050 | .3603 | .0002 |
| 1978 | 6.4000 | .0182 | .3368 | .4939 | .0000 |
| 1979 | 5.3165 | .1110 | .2798 | .6214 | .0036 |
| 1980 | 15.7963 | .0256 | *.8314 | *.0270 | .0000 |

*MAH_1* Mahalanobis distance
*COOK_1* Cook's distance
*LEV_1* Leverage value
*MAHA_PV* P-value associated with the Mahalanobis distance
*COOK_P* P-value associated with Cook's distance

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.

[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n-p-1$ denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.10*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1961 | *1.1126 | -.0249 | .6267 | -.2333 |
| 1962 | .7028 | .0893 | .2352 | -.0683 |
| 1963 | *-1.7096 | -.4762 | -.3186 | .0979 |
| 1964 | -.1709 | -.1647 | .0499 | .0532 |
| 1965 | -.7491 | -.7069 | .0626 | .3402 |
| 1966 | -.3665 | -.1508 | .0064 | -.0969 |
| 1967 | .6195 | .2725 | .0229 | .1259 |
| 1968 | -.1401 | .0335 | .0165 | -.0273 |
| 1969 | -.7102 | -.0253 | -.2352 | .0198 |
| 1970 | .1228 | -.0417 | .0288 | .0611 |
| 1971 | .7824 | .2354 | .0658 | .5311 |
| 1972 | .0572 | -.0004 | -.0283 | .0442 |
| 1973 | .8573 | .0670 | .0748 | -.5782 |
| 1974 | -.4974 | .0348 | .0236 | .1752 |
| 1975 | .3799 | .1828 | -.0805 | -.2509 |
| 1976 | *1.4565 | .3239 | -.9100 | .3766 |
| 1977 | -.5472 | .1178 | .3242 | -.1198 |
| 1978 | .3455 | -.0598 | -.0599 | -.0858 |
| 1979 | -.9035 | .3582 | -.2252 | -.2125 |
| 1980 | .4068 | -.0527 | .2243 | -.0848 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for January-February inflows |
| *SDFBET_2* | Standardized *dfbeta* for March-April inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

***Table 6.11** Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1961 | .1011 | -.3322 | -.0340 | .2741 |
| 1962 | -.0671 | -.2884 | .0804 | .2264 |
| 1963 | .4001 | .7628 | -.3364 | -.5243 |
| 1964 | .0165 | .0047 | .0246 | .0426 |
| 1965 | -.0768 | .0102 | .2605 | .2214 |
| 1966 | -.0180 | .0862 | .1238 | .1204 |
| 1967 | .0789 | -.2562 | -.2432 | -.1716 |
| 1968 | -.0186 | .0033 | -.0215 | .0123 |
| 1969 | .0537 | .0235 | -.2404 | .3586 |
| 1970 | -.0292 | -.0282 | .0571 | -.0386 |
| 1971 | -.4018 | -.3816 | .1941 | -.3644 |
| 1972 | -.0434 | -.0124 | .0473 | -.0049 |
| 1973 | .6593 | .1974 | -.4508 | .0778 |
| 1974 | -.2086 | -.0302 | .0233 | -.0500 |
| 1975 | .2010 | -.0399 | -.1522 | .1251 |
| 1976 | -.9489 | .5430 | .9532 | .0360 |
| 1977 | .0753 | -.1817 | -.0714 | -.3939 |
| 1978 | .1660 | .1633 | -.1825 | .2075 |
| 1979 | -.2158 | -.0007 | .2922 | -.3232 |
| 1980 | .0405 | .2885 | -.0529 | -.1977 |

| | |
|---|---|
| *SDFBET_3* | Standardized *dfbeta* for May-June inflows |
| *SDFBET_4* | Standardized *dfbeta* for July-August inflows |
| *SDFBET_5* | Standardized *dfbeta* for September-October inflows |
| *SDFBET_6* | Standardized *dfbeta* for November-December inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

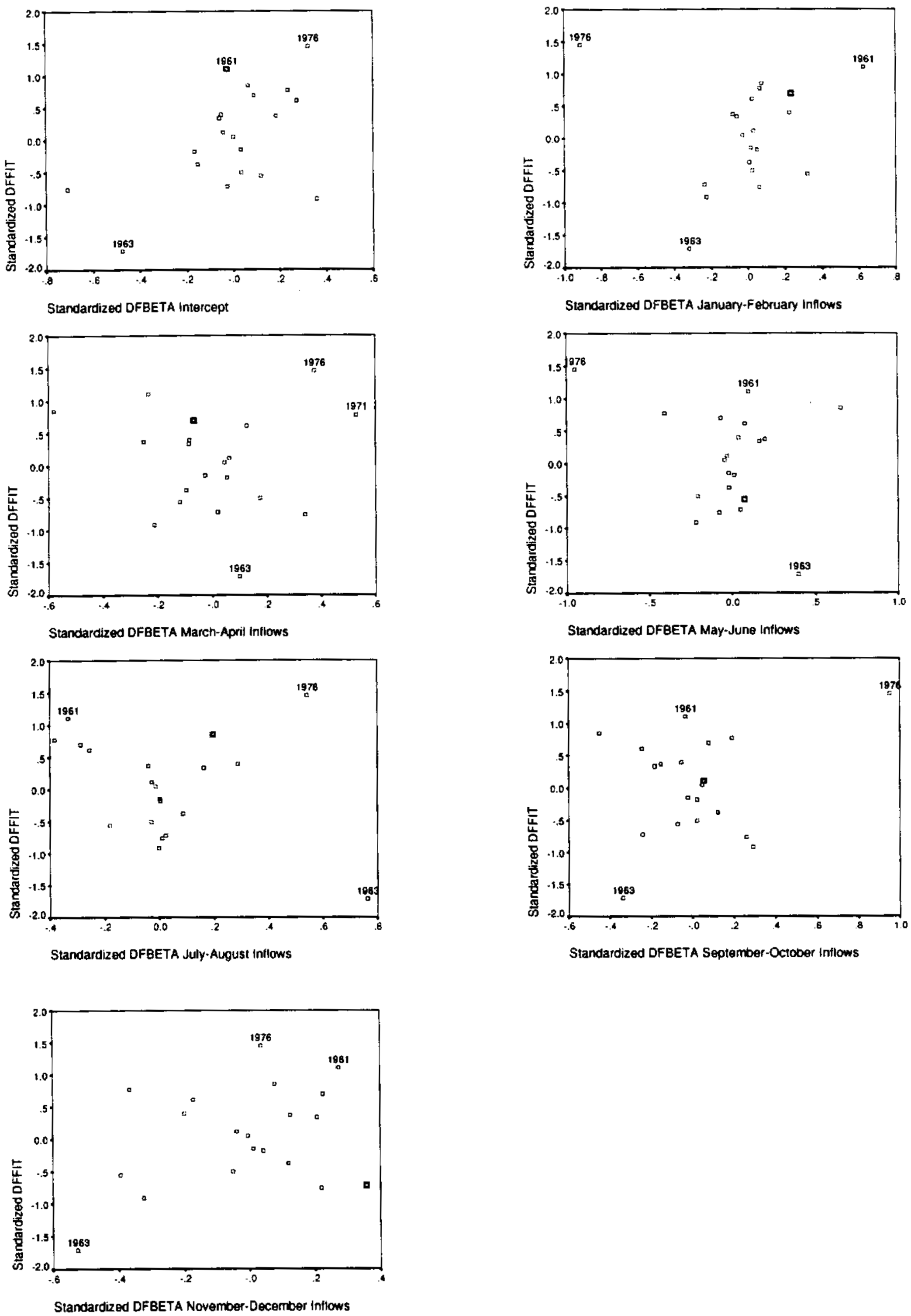


***Figure 6.15.*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of inflow variables.*

## 6.2 Regression - Log of trout data on log of inflow data

### 6.2.1 ANOVA and Parameter Estimates

***Table 6.12*** *Model Summary for log of trout data on log of inflow data.*

**Model Summary[a,b]**

| Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| Ln(November-December), Ln(March-April), Ln(September-October), Ln(July-August), Ln(January-February), Ln(May-June)[c,d] | .840 | .705 | .569 | .333133 | 1.693 |

a. Dependent Variable: Ln(Trout Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Ln(November-December Inflows), Ln(March-April Inflows), Ln(September-October Inflows), Ln(July-August Inflows), Ln(January-February Inflows), Ln(May-June Inflows)

d. All requested variables entered.

***Table 6.13*** *ANOVA table of log of trout data on log of inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 3.445 | 6 | .574 | 5.174 | .006[b] |
| | Residual | 1.443 | 13 | .111 | | |
| | Total | 4.888 | 19 | | | |

a. Dependent Variable: Ln(Trout Harvest)

b. Independent Variables: (Constant), Ln(November-December Inflows), Ln(March-April Inflows), Ln(September-October Inflows), Ln(July-August Inflows), Ln(January-February Inflows), Ln(May-June Inflows)

***Table 6.14*** *Table of coefficients for log of trout data on log of inflow data.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | 6.691 | .656 | | 10.201 | .000 | 5.274 | 8.108 |
| Ln(January-February) | -.234 | .105 | -.455 | -2.227 | .044 | -.461 | -.007 |
| Ln(March-April) | .122 | .229 | .196 | .532 | .604 | -.373 | .617 |
| Ln(May-June) | -4.7E-02 | .197 | -.089 | -.239 | .815 | -.471 | .378 |
| Ln(July-August) | -.582 | .130 | -.802 | -4.497 | .001 | -.862 | -.303 |
| Ln(September-October) | .104 | .079 | .305 | 1.318 | .210 | -.067 | .275 |
| Ln(November-December) | .166 | .093 | .338 | 1.785 | .098 | -.035 | .368 |

a. Dependent Variable: Ln(Trout Harvest)

## 6.2.2 Collinearity Diagnostic

***Table 6.15*** *Variance Inflation for log of trout data on log of inflow data.*

**Coefficients[a]**

| | | Collinearity Statistics | |
|---|---|---|---|
| | t | Tolerance | VIF |
| (Constant) | 10.201 | | |
| Ln(January-February) | -2.227 | .543 | 1.842 |
| Ln(March-April) | .532 | .167 | 6.006 |
| Ln(May-June) | -.239 | .165 | 6.067 |
| Ln(July-August) | -4.497 | .714 | 1.400 |
| Ln(September-October) | 1.318 | .424 | 2.358 |
| Ln(November-December) | 1.785 | .633 | 1.579 |

a. Dependent Variable: Ln(Trout Harvest)

***Table 6.16*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(TROUT) on Ln(INFLOWS):*

| Number | *Eigenvalue* | *Condition Index* | Var Prop *LN_QJF* | Var Prop *LN_QMA* | Var Prop *LN_QMJ* | Var Prop *LN_QJA* | Var Prop *LN_QSO* | Var Prop *LN_QND* |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.53959 | 1.00000 | 0.0057 | 0.0068 | 0.0426 | 0.0403 | 0.0415 | 0.0549 |
| 1 | 2.24535 | 1.00000 | 0.0274 | 0.0241 | 0.0212 | 0.0327 | 0.0247 | 0.0110 |
| 2 | 1.43658 | 1.25019 | 0.1023 | 0.0059 | 0.0160 | 0.0111 | 0.0095 | 0.2134 |
| 3 | 0.97499 | 1.51755 | 0.0190 | 0.0119 | 0.0139 | 0.2247 | 0.2166 | 0.0058 |
| 4 | 0.86292 | 1.61308 | 0.1375 | 0.0169 | 0.0042 | 0.3880 | 0.0761 | 0.0354 |
| 5 | 0.40587 | 2.35205 | 0.4349 | 0.0235 | 0.0207 | 0.1365 | 0.0844 | 0.6372 |
| 6 | 0.07428 | 5.49791 | 0.2789 | 0.9177 | 0.9240 | 0.2070 | 0.5886 | 0.0972 |

### 6.2.3 Residuals Diagnostics

***Table 6.17*** *Residuals Diagnostics for log of trout data on log of inflow data.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 3.969346 | 5.936247 | 5.092896 | .425818 | 20 |
| Std. Predicted Value | -2.639 | 1.981 | .000 | 1.000 | 20 |
| Standard Error of Predicted Value | .137965 | .252480 | .193745 | 3.7E-02 | 20 |
| Adjusted Predicted Value | 4.286778 | 6.473432 | 5.123577 | .496174 | 20 |
| Residual | -.560108 | .513780 | 4.7E-16 | .275558 | 20 |
| Std. Residual | -1.681 | 1.542 | .000 | .827 | 20 |
| Stud. Residual | -2.513 | 1.823 | -.034 | 1.063 | 20 |
| Deleted Residual | -1.251456 | .718034 | -3.1E-02 | .466684 | 20 |
| Stud. Deleted Residual | -3.367 | 2.030 | -.064 | 1.209 | 20 |
| Mahal. Distance | 2.309 | 9.964 | 5.700 | 2.483 | 20 |
| Cook's Distance | .000 | 1.114 | .114 | .248 | 20 |
| Centered Leverage Value | .122 | .524 | .300 | .131 | 20 |

a. Dependent Variable: Ln(Trout Harvest)

***Table 6.18*** *Case Values for Residuals Diagnostics for log of trout data on log of inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1961 | 5.3027 | .5138 | .7180 | 5.0985 | .4928 | 1.5423 | 1.8232 | 2.0304 |
| 1962 | 5.4964 | .3916 | .5267 | 5.3614 | .9477 | 1.1756 | 1.3633 | 1.4148 |
| 1963 | 5.7821 | -.5601 | -1.2515 | 6.4734 | 1.6185 | -1.6813 | -2.5132 | *-3.3675 |
| 1964 | 5.2787 | -.0476 | -.1117 | 5.3429 | .4363 | -.1428 | -.2188 | -.2106 |
| 1965 | 4.8293 | .0716 | .1405 | 4.7603 | -.6191 | .2148 | .3010 | .2902 |
| 1966 | 4.7706 | -.0629 | -.0974 | 4.8051 | -.7568 | -.1889 | -.2350 | -.2262 |
| 1967 | 5.1999 | .0934 | .1642 | 5.1291 | .2514 | .2802 | .3717 | .3590 |
| 1968 | 5.1582 | -.1563 | -.2059 | 5.2079 | .1534 | -.4692 | -.5385 | -.5233 |
| 1969 | 4.8052 | .0070 | .0122 | 4.8000 | -.6757 | .0211 | .0278 | .0267 |
| 1970 | 5.0642 | .1343 | .1621 | 5.0364 | -.0674 | .4031 | .4429 | .4288 |
| 1971 | 5.1713 | .2585 | .4213 | 5.0085 | .1841 | .7760 | .9906 | .9898 |
| 1972 | 5.2914 | .1269 | .1582 | 5.2601 | .4662 | .3810 | .4253 | .4115 |
| 1973 | 5.1726 | .1381 | .1713 | 5.1394 | .1873 | .4146 | .4617 | .4473 |
| 1974 | 5.3414 | -.3123 | -.3857 | 5.4148 | .5836 | -.9374 | -1.0418 | -1.0455 |
| 1975 | 5.9362 | -.2901 | -.5273 | 6.1734 | 1.9805 | -.8708 | -1.1740 | -1.1930 |
| 1976 | 5.0156 | .3920 | .6480 | 4.7596 | -.1815 | 1.1767 | 1.5130 | 1.6014 |
| 1977 | 4.8744 | -.0819 | -.1152 | 4.9077 | -.5131 | -.2459 | -.2916 | -.2811 |
| 1978 | 4.6495 | .0139 | .0207 | 4.6427 | -1.0412 | .0418 | .0510 | .0490 |
| 1979 | 4.7487 | -.3717 | -.4865 | 4.8635 | -.8083 | -1.1158 | -1.2765 | -1.3113 |
| 1980 | 3.9693 | -.2582 | -.5756 | 4.2868 | -2.6386 | -.7751 | -1.1573 | -1.1740 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that observation |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.
[2]This is flagged if it exceeds $t_{n-p-2,\alpha}=t_{12,0.01}=2.681$.

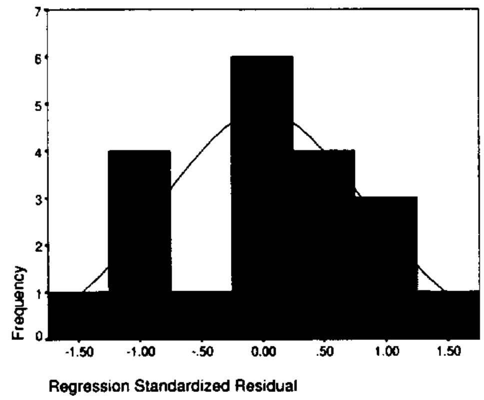


***Figure 6.16*** *Histogram of Standardized Residuals.*

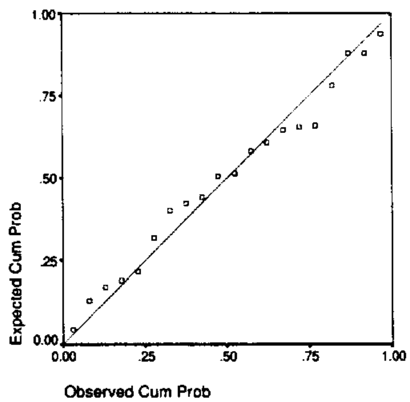


***Figure 6.17*** *Normal P-P Plot of Residuals.*

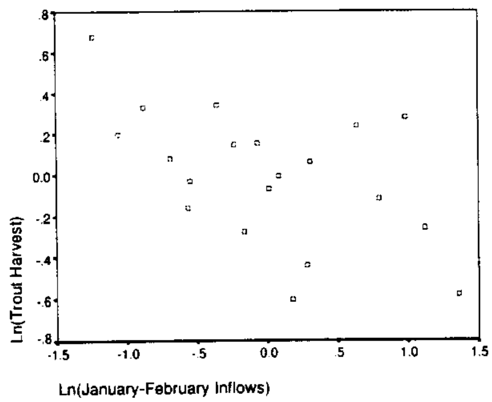


***Figure 6.18*** *Partial Residual Plot for Ln(January-February Inflows).*

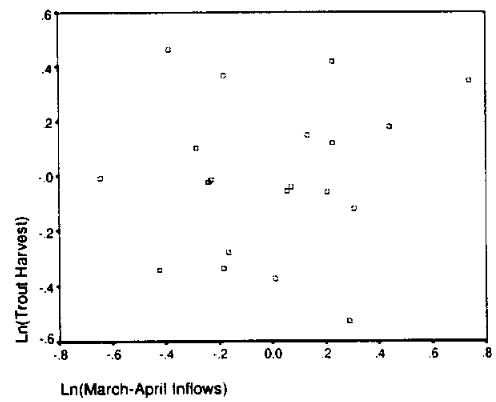


***Figure 6.19*** *Partial Residual Plot for Ln(March-April Inflows).*

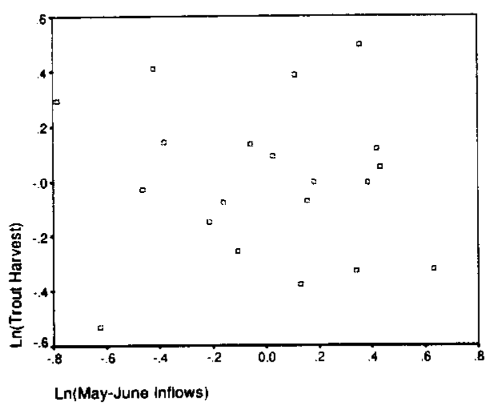


***Figure 6.20*** *Partial Residual Plot for Ln(May-June Inflows).*

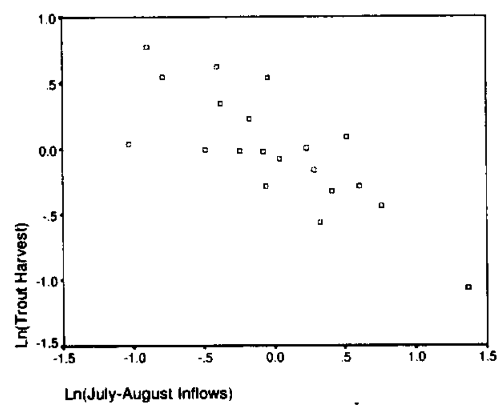


***Figure 6.21*** *Partial Residual Plot for Ln(July-August Inflows).*

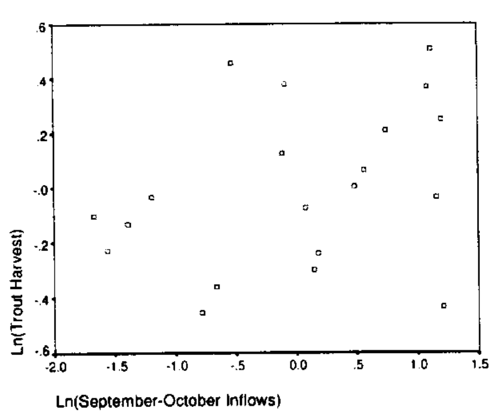


***Figure 6.22*** *Partial Residual Plot for Ln(September-October Inflows).*

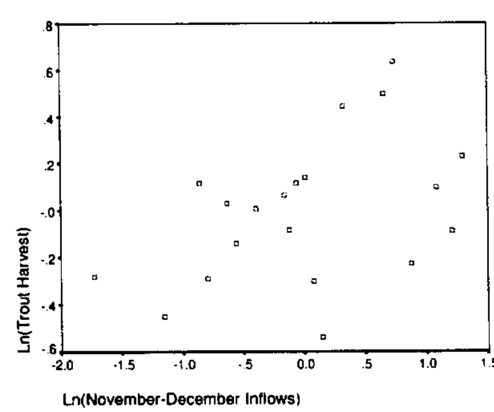


***Figure 6.23*** *Partial Residual Plot for Ln(November-December Inflows).*

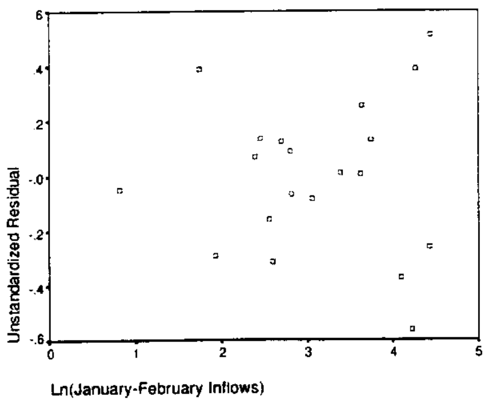


***Figure 6.24*** *Residuals Plot for Ln(January-February Inflows).*

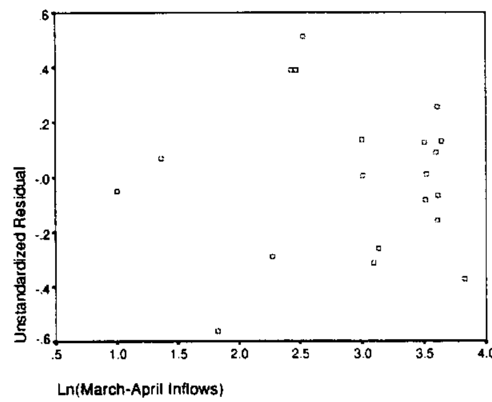


***Figure 6.25*** *Residuals Plot for Ln(March-April Inflows).*

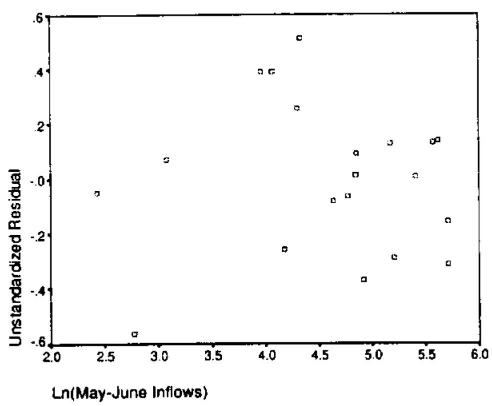


***Figure 6.26*** *Residuals Plot for Ln(May-June Inflows).*

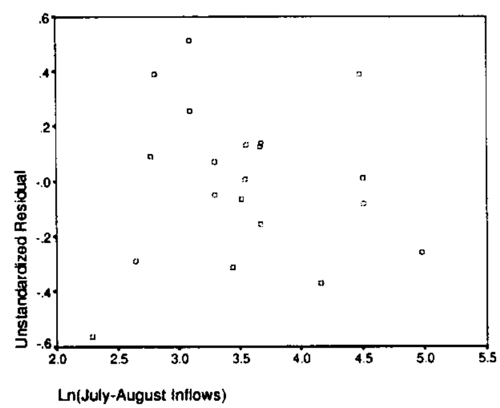


***Figure 6.27*** *Residuals Plot for Ln(July-August Inflows).*

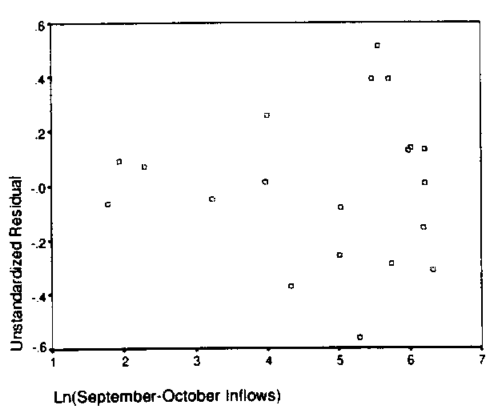


***Figure 6.28*** *Residuals Plot for Ln(September-October Inflows).*

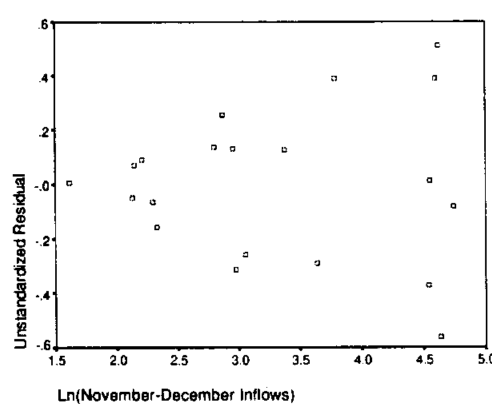


***Figure 6.29*** *Residuals Plot for Ln(November-December Inflows).*

### 6.2.4 Prediction Intervals for Trout Harvest

***Table 6.19*** *Prediction Intervals for Trout Harvest.*

| YEAR | *LICI_1* | *LN_TROUT* | *UICI_1* |
|---|---|---|---|
| 1961 | 4.1654 | 5.8165 | 6.4400 |
| 1962 | 4.3716 | 5.8880 | 6.6212 |
| 1963 | 4.5318 | 5.2220 | 7.0324 |
| 1964 | 4.0195 | 5.2311 | 6.5378 |
| 1965 | 3.6041 | 4.9008 | 6.0545 |
| 1966 | 3.6030 | 4.7077 | 5.9383 |
| 1967 | 3.9993 | 5.2933 | 6.4006 |
| 1968 | 4.0403 | 5.0019 | 6.2761 |
| 1969 | 3.6069 | 4.8122 | 6.0034 |
| 1970 | 3.9781 | 5.1985 | 6.1503 |
| 1971 | 3.9897 | 5.4298 | 6.3529 |
| 1972 | 4.1932 | 5.4183 | 6.3896 |
| 1973 | 4.0762 | 5.3107 | 6.2690 |
| 1974 | 4.2466 | 5.0291 | 6.4362 |
| 1975 | 4.7280 | 5.6462 | 7.1445 |
| 1976 | 3.8304 | 5.4076 | 6.2009 |
| 1977 | 3.7351 | 4.7925 | 6.0137 |
| 1978 | 3.4930 | 4.6634 | 5.8060 |
| 1979 | 3.6331 | 4.3770 | 5.8643 |
| 1980 | 2.7194 | 3.7111 | 5.2193 |

*LICI_1* Lower limit for 99% prediction interval for the natural log of trout harvest.
*LN_TROUT* Natural log of trout harvest
*UICI_1* Upper limit for 99% prediction interval for the natural log of trout harvest.

### 6.2.5 Outliers and Influential Point Detection

***Table 6.20*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1961 | 4.4548 | .1888 | .2345 | .7262 | .0172 |
| 1962 | 3.9221 | .0916 | .2064 | .7887 | .0020 |
| 1963 | 9.5463 | 1.1137 | *.5024 | .2158 | *.5895 |
| 1964 | 9.9637 | .0092 | *.5244 | .1906 | .0000 |
| 1965 | 8.3728 | .0125 | .4407 | .3009 | .0000 |
| 1966 | 5.7757 | .0043 | .3040 | .5662 | .0000 |
| 1967 | 7.2474 | .0150 | .3814 | .4036 | .0000 |
| 1968 | 3.6293 | .0132 | .1910 | .8214 | .0000 |
| 1969 | 7.1420 | .0001 | .3759 | .4143 | .0000 |
| 1970 | 2.3088 | .0058 | .1215 | .9408 | .0000 |
| 1971 | 6.3920 | .0883 | .3364 | .4948 | .0018 |
| 1972 | 2.8055 | .0064 | .1477 | .9024 | .0000 |
| 1973 | 2.7314 | .0073 | .1438 | .9087 | .0000 |
| 1974 | 2.6666 | .0365 | .1403 | .9140 | .0001 |
| 1975 | 7.5971 | .1610 | .3998 | .3695 | .0110 |
| 1976 | 6.5561 | .2135 | .3451 | .4765 | .0242 |
| 1977 | 4.5407 | .0049 | .2390 | .7158 | .0000 |
| 1978 | 5.2875 | .0002 | .2783 | .6249 | .0000 |
| 1979 | 3.5331 | .0719 | .1860 | .8317 | .0009 |
| 1980 | 9.5273 | .2352 | *.5014 | .2170 | .0314 |

*MAH_1* Mahalanobis distance

*COOK_1* Cook's distance

*LEV_1* Leverage value

*MAHA_PV* P-value associated with the Mahalanobis distance

*COOK_P* P-value associated with Cook's distance

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.

[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.

[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n-p-1$ denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.21** Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1961 | *1.2802 | -.3869 | .7489 | -.6379 |
| 1962 | .8309 | -.0074 | .3326 | -.2016 |
| 1963 | *-3.7412 | *-1.9653 | -.2805 | *-1.0040 |
| 1964 | -.2447 | -.1642 | .1079 | -.0159 |
| 1965 | .2848 | .0471 | .1022 | -.1794 |
| 1966 | -.1675 | -.0303 | -.0009 | -.0109 |
| 1967 | .3127 | .1321 | -.0348 | .0750 |
| 1968 | -.2949 | -.0437 | .1033 | -.1277 |
| 1969 | .0230 | -.0022 | .0125 | -.0057 |
| 1970 | .1951 | -.0222 | .0456 | .0432 |
| 1971 | .7855 | .5029 | -.1397 | .6443 |
| 1972 | .2042 | .0480 | -.1275 | .1391 |
| 1973 | .2193 | -.0778 | -.0103 | -.0967 |
| 1974 | -.5069 | .1318 | .0591 | .1458 |
| 1975 | *-1.0788 | .0641 | .2846 | .4663 |
| 1976 | *1.2941 | .1204 | -.7996 | .3230 |
| 1977 | -.1792 | .0499 | .0722 | -.0477 |
| 1978 | .0343 | -.0196 | .0016 | -.0093 |
| 1979 | -.7287 | .3426 | -.1341 | -.0120 |
| 1980 | *-1.3017 | .4147 | -.7527 | .1952 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for log of January-February inflows |
| *SDFBET_2* | Standardized *dfbeta* for log of March-April inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

***Table 6.22*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1961 | .5086 | -.0362 | -.3002 | .4967 |
| 1962 | .1100 | -.2572 | -.0363 | .3020 |
| 1963 | *1.8507 | *2.0050 | *-1.4498 | -.2099 |
| 1964 | .0880 | -.0053 | -.0370 | .0502 |
| 1965 | .1043 | .0961 | -.1606 | -.0445 |
| 1966 | -.0260 | .0081 | .1039 | .0094 |
| 1967 | .0080 | -.1458 | -.1349 | -.0213 |
| 1968 | .0744 | .0563 | -.1652 | .1334 |
| 1969 | .0038 | .0039 | .0047 | -.0170 |
| 1970 | -.0149 | -.0307 | .0831 | -.0829 |
| 1971 | -.5834 | -.4405 | .3257 | -.3016 |
| 1972 | -.1030 | -.0668 | .1310 | -.0079 |
| 1973 | .1240 | .0445 | -.0133 | .0022 |
| 1974 | -.2347 | .0240 | -.0401 | -.0243 |
| 1975 | -.6028 | .3042 | .2523 | -.5468 |
| 1976 | -.5088 | .4110 | .5476 | .1885 |
| 1977 | .0311 | -.0530 | -.0060 | -.1010 |
| 1978 | .0137 | .0177 | -.0197 | .0217 |
| 1979 | -.1160 | -.1885 | .2776 | -.3674 |
| 1980 | .1091 | -.9354 | -.0766 | .5641 |

*SDFBET_3* Standardized *dfbeta* for log of May-June inflows
*SDFBET_4* Standardized *dfbeta* for log of July-August inflows
*SDFBET_5* Standardized *dfbeta* for log of September-October inflows
*SDFBET_6* Standardized *dfbeta* for log of November-December inflows

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

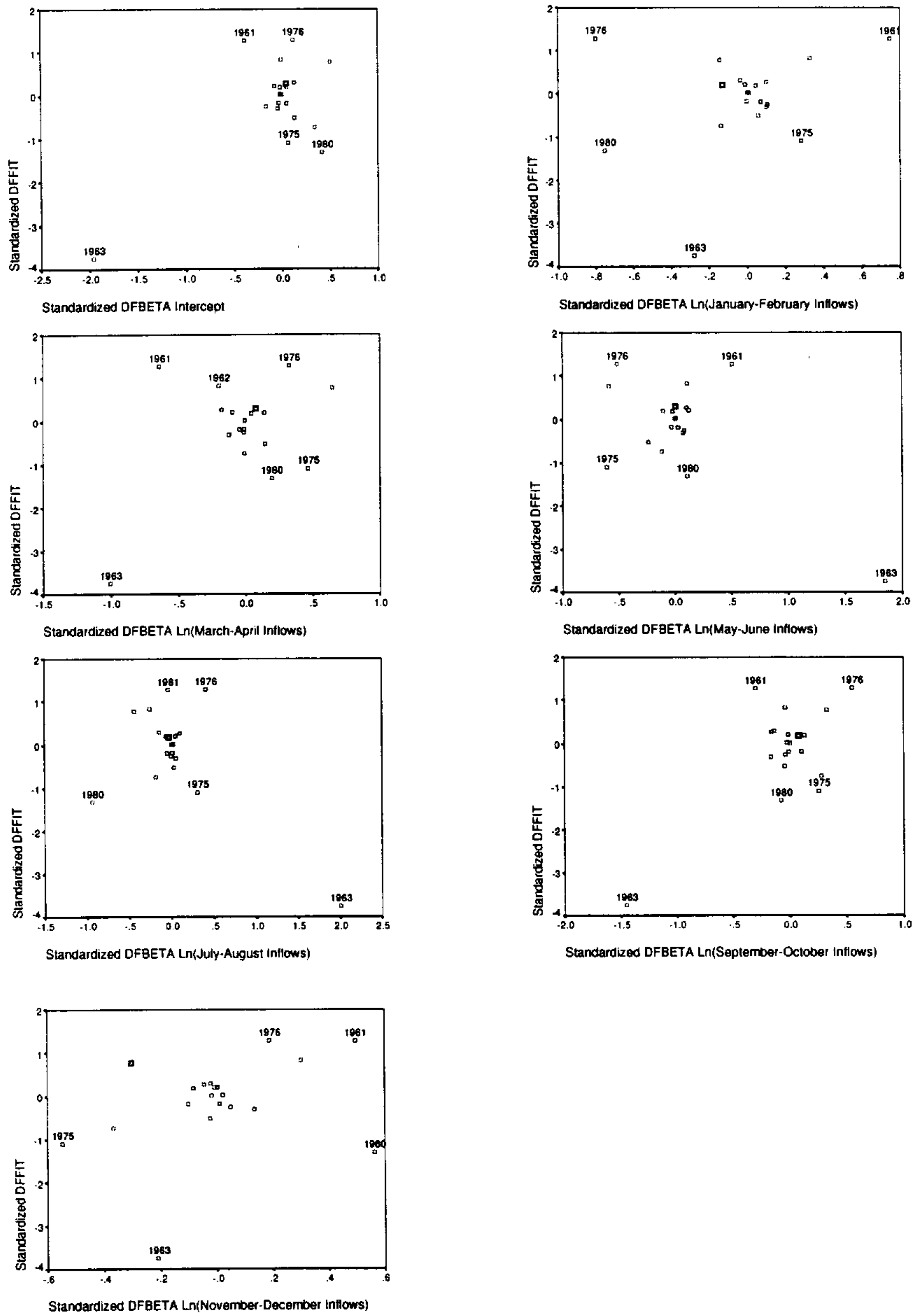


***Figure 6.30*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of log of inflow variables.*

## 6.3 Regression - Log of trout data on square root of inflow data

### 6.3.1 ANOVA and Parameter Estimates

***Table 6.23*** *Model Summary for log of trout data on square root of inflow data.*

**Model Summary[a,b]**

| Variables Entered | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| Sqrt(November-December), Sqrt(September-October), Sqrt(March-April), Sqrt(July-August), Sqrt(January-February), Sqrt(May-June)[c,d] | .866 | .750 | .635 | .306374 | 2.094 |

a. Dependent Variable: Ln(Trout Harvest)

b. Method: Enter

c. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of September-October Inflows, Square Root of March-April Inflows, Square Root of July-August Inflows, Square Root of January-February Inflows, Square Root of May-June Inflows

d. All requested variables entered.

***Table 6.24*** *ANOVA table of log of trout data on square root of inflow data*

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 3.668 | 6 | .611 | 6.512 | .002[b] |
| | Residual | 1.220 | 13 | 9.4E-02 | | |
| | Total | 4.888 | 19 | | | |

a. Dependent Variable: Ln(Trout Harvest)

b. Independent Variables: (Constant), Square Root of November-December Inflows, Square Root of September-October Inflows, Square Root of March-April Inflows, Square Root of July-August Inflows, Square Root of January-February Inflows, Square Root of May-June Inflows

***Table 6.25*** *Table of coefficients for log of trout data on square root of inflow data.*

**Coefficients[a]**

| | Unstandardized Coefficients | | Standardized Coefficients | | | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| (Constant) | 6.020 | .326 | | 18.462 | .000 | 5.316 | 6.725 |
| Sqrt(January-February) | -9.3E-02 | .039 | -.434 | -2.391 | .033 | -.177 | -.009 |
| Sqrt(March-April) | 8.9E-02 | .090 | .276 | .987 | .342 | -.106 | .285 |
| Sqrt(May-June) | -5.9E-02 | .042 | -.504 | -1.397 | .186 | -.149 | .032 |
| Sqrt(July-August) | -.175 | .034 | -.798 | -5.082 | .000 | -.250 | -.101 |
| Sqrt(September-October) | 4.0E-02 | .019 | .563 | 2.131 | .053 | -.001 | .080 |
| Sqrt(November-December) | 5.7E-02 | .029 | .338 | 1.956 | .072 | -.006 | .120 |

a. Dependent Variable: Ln(Trout Harvest)

## 6.3.2 Collinearity Diagnostic

***Table 6.26*** *Collinearity Diagnostic for log of trout data on square root of inflow data.*

**Coefficients[a]**

| | | Collinearity Statistics | |
|---|---|---|---|
| | t | Tolerance | VIF |
| (Constant) | 18.462 | | |
| Sqrt(January-February) | -2.391 | .583 | 1.714 |
| SqrtA(March-April) | .987 | .246 | 4.057 |
| Sqrt(May-June) | -1.397 | .148 | 6.772 |
| Sqrt(July-August) | -5.082 | .778 | 1.285 |
| Sqrt(September-October) | 2.131 | .275 | 3.635 |
| Sqrt(November-December) | 1.956 | .645 | 1.551 |

a. Dependent Variable: Ln(Trout Harvest)

***Table 6.27*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Sqrt(TROUT) on Sqrt(INFLOWS).*

| Number | Eigenvalue | Condition Index | Var Prop SQR_QJF | Var Prop SQR_QMA | Var Prop SQR_QMJ | Var Prop SQR_QJA | Var Prop SQR_QSO | Var Prop SQR_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.96860 | 1.00000 | 0.0052 | 0.0285 | 0.0354 | 0.0081 | 0.0287 | 0.0188 |
| 2 | 1.63314 | 1.09791 | 0.1383 | 0.0151 | 0.0000 | 0.0717 | 0.0008 | 0.1410 |
| 3 | 1.13754 | 1.31551 | 0.0325 | 0.0363 | 0.0020 | 0.2104 | 0.0932 | 0.0343 |
| 4 | 0.74148 | 1.62941 | 0.0937 | 0.0744 | 0.0024 | 0.4848 | 0.0628 | 0.0119 |
| 5 | 0.44471 | 2.10396 | 0.5038 | 0.0170 | 0.0063 | 0.0790 | 0.0108 | 0.7302 |
| 6 | 0.07452 | 5.13961 | 0.2265 | 0.8288 | 0.9539 | 0.1459 | 0.8037 | 0.0638 |

### 6.3.3 Residuals Diagnostics

***Table 6.28*** *Residuals Diagnostics for log of trout data on square root of inflow data.*

**Residuals Statistics[a]**

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 3.758675 | 5.823534 | 5.092896 | .439351 | 20 |
| Std. Predicted Value | -3.037 | 1.663 | .000 | 1.000 | 20 |
| Standard Error of Predicted Value | .145231 | .266378 | .179041 | 2.9E-02 | 20 |
| Adjusted Predicted Value | 3.905949 | 6.273537 | 5.096954 | .464298 | 20 |
| Residual | -.601558 | .455594 | -1.2E-15 | .253423 | 20 |
| Std. Residual | -1.963 | 1.487 | .000 | .827 | 20 |
| Stud. Residual | -2.596 | 1.785 | -.004 | 1.038 | 20 |
| Deleted Residual | -1.051561 | .656085 | -4.1E-03 | .403358 | 20 |
| Stud. Deleted Residual | -3.594 | 1.973 | -.039 | 1.204 | 20 |
| Mahal. Distance | 3.319 | 13.413 | 5.700 | 2.338 | 20 |
| Cook's Distance | .000 | .720 | .089 | .166 | 20 |
| Centered Leverage Value | .175 | .706 | .300 | .123 | 20 |

a. Dependent Variable: Ln(Trout Harvest)

***Table 6.29*** *Case Values for Residuals Diagnostics for log of trout data on square root of inflow data.*

| YEAR | *PRE_1* | *RES_1* | *DRE_1* | *ADJ_1* | *ZPR_1* | *ZRE_1* | *SRE_1*[1] | *SDR_1*[2] |
|---|---|---|---|---|---|---|---|---|
| 1961 | 5.3609 | .4556 | .6561 | 5.1604 | .6101 | 1.4871 | 1.7845 | 1.9731 |
| 1962 | 5.5537 | .3343 | .4579 | 5.4301 | 1.0489 | 1.0912 | 1.2771 | 1.3121 |
| 1963 | 5.8235 | -.6016 | -1.0516 | 6.2735 | 1.6630 | -1.9635 | -2.5960 | *-3.5940 |
| 1964 | 5.2843 | -.0532 | -.0927 | 5.3238 | .4357 | -.1736 | -.2292 | -.2206 |
| 1965 | 4.9978 | -.0969 | -.1557 | 5.0565 | -.2166 | -.3164 | -.4010 | -.3877 |
| 1966 | 4.8106 | -.1029 | -.1433 | 4.8510 | -.6425 | -.3358 | -.3963 | -.3831 |
| 1967 | 5.0965 | .1968 | .3032 | 4.9901 | .0083 | .6422 | .7972 | .7854 |
| 1968 | 5.1708 | -.1689 | -.2178 | 5.2198 | .1774 | -.5513 | -.6261 | -.6108 |
| 1969 | 4.9575 | -.1453 | -.2042 | 5.0164 | -.3083 | -.4742 | -.5622 | -.5469 |
| 1970 | 5.1165 | .0820 | .1064 | 5.0921 | .0537 | .2677 | .3050 | .2940 |
| 1971 | 5.1989 | .2309 | .3754 | 5.0544 | .2413 | .7535 | .9609 | .9578 |
| 1972 | 5.3996 | .0187 | .0261 | 5.3923 | .6981 | .0611 | .0721 | .0693 |
| 1973 | 5.0680 | .2428 | .3226 | 4.9882 | -.0568 | .7924 | .9134 | .9072 |
| 1974 | 5.2891 | -.2599 | -.3387 | 5.3679 | .4465 | -.8484 | -.9685 | -.9661 |
| 1975 | 5.6558 | -.0096 | -.0146 | 5.6607 | 1.2812 | -.0314 | -.0387 | -.0372 |
| 1976 | 5.1045 | .3031 | .6217 | 4.7859 | .0264 | .9894 | 1.4170 | 1.4805 |
| 1977 | 4.9464 | -.1539 | -.2472 | 5.0397 | -.3334 | -.5024 | -.6367 | -.6215 |
| 1978 | 4.5545 | .1090 | .1805 | 4.4830 | -1.2255 | .3557 | .4577 | .4433 |
| 1979 | 4.7104 | -.3334 | -.4703 | 4.8473 | -.8705 | -1.0883 | -1.2925 | -1.3302 |
| 1980 | 3.7587 | -.0475 | -.1948 | 3.9059 | -3.0368 | -.1552 | -.3141 | -.3030 |

| | |
|---|---|
| *PRE_1* | Predicted value of harvest |
| *RES_1* | Ordinary residuals: observed harvest minus predicted harvest |
| *DRE_1* | Deleted residuals: residuals obtained when the model is fitted without that observation |
| *ADJ_1* | Adjusted predicted value: predicted value of harvest when the model is fitted without that observation |
| *ZPR_1* | Z-score of the predicted value of harvest |
| *ZRE_1* | Z-score of the residual |
| *SRE_1* | Studentized residual |
| *SDR_1* | Studentized deleted residuals |

[1]Values greater than 3 are flagged.
[2]This is flagged if it exceeds $t_{n-p-2,a}=t_{12,0.01}=2.681$.

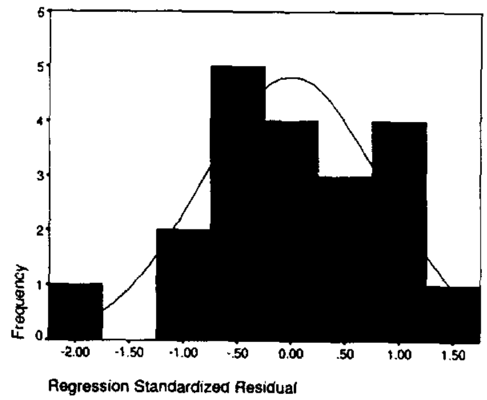


***Figure 6.31*** *Histogram of Standardized Residuals.*

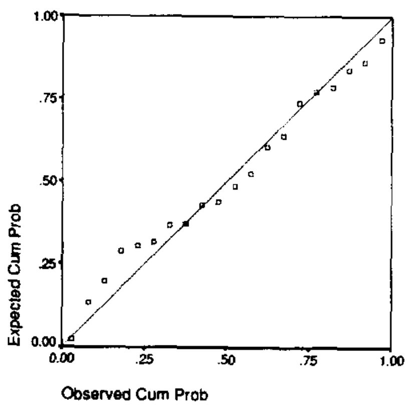


***Figure 6.32*** *Normal P-P Plot of Residuals.*

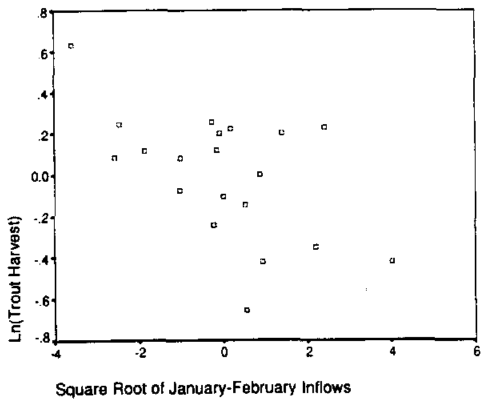


**Figure 6.33** *Partial Residual Plot for Sqrt(January-February Inflows).*

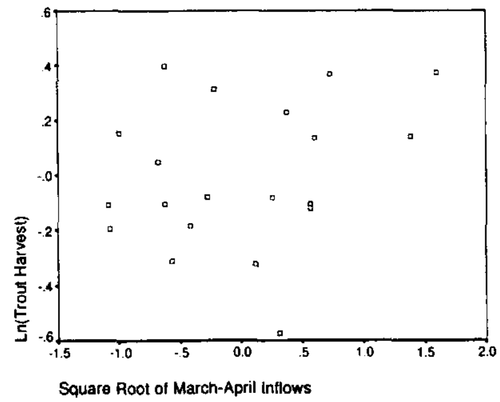


**Figure 6.34** *Partial Residual Plot for Sqrt(March-April Inflows).*

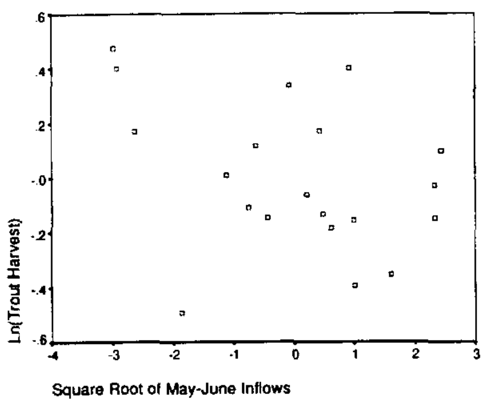


**Figure 6.35** *Partial Residual Plot for Sqrt(May-June Inflows).*

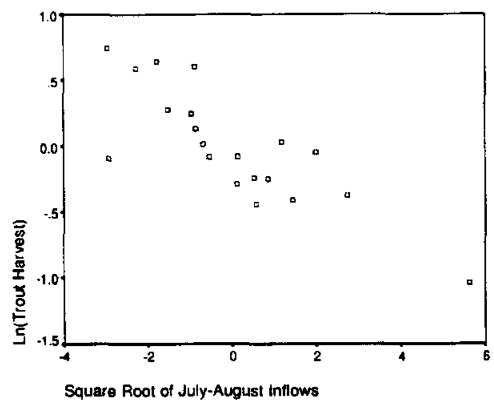


**Figure 6.36** *Partial Residual Plot for Sqrt(July-August Inflows).*

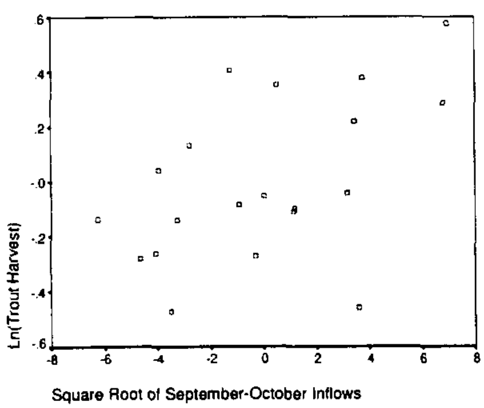


**Figure 6.37** *Partial Residual Plot for Sqrt(September-October Inflows).*

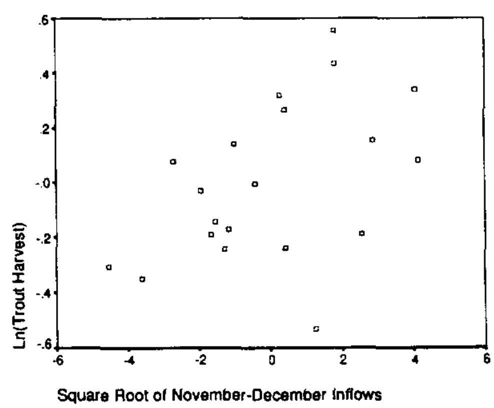


**Figure 6.38** *Partial Residual Plot for Sqrt(November-December Inflows).*

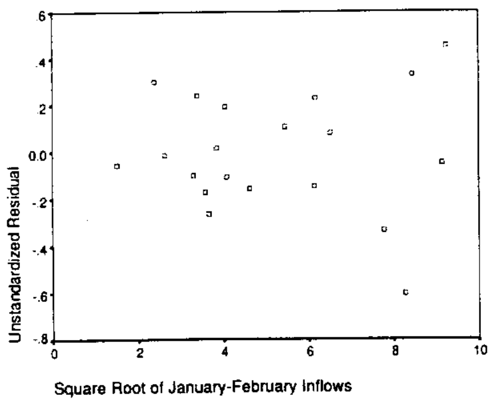


***Figure 6.39*** *Residuals Plot for Sqrt(January-February Inflows).*

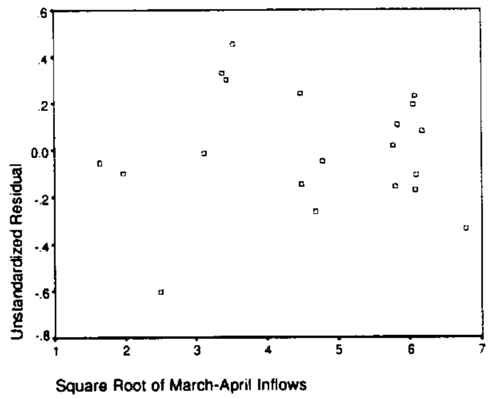


***Figure 6.40*** *Residuals Plot for Sqrt(March-April Inflows).*

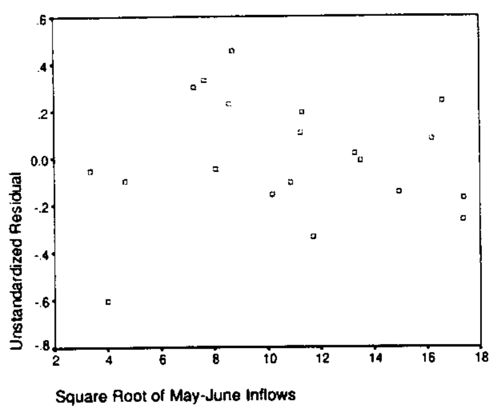


***Figure 6.41*** *Residuals Plot for Sqrt(May-June Inflows).*

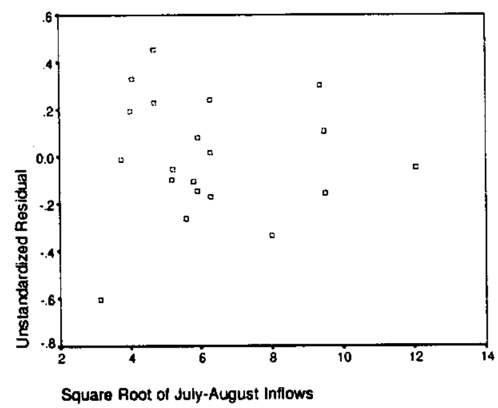


***Figure 6.42*** *Residuals Plot for Sqrt(July-August Inflows).*

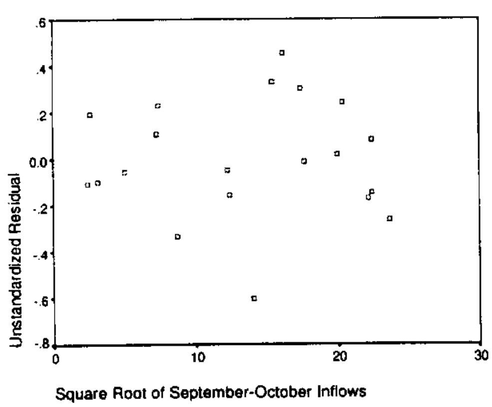


***Figure 6.43*** *Residuals Plot for Sqrt(September-October Inflows).*

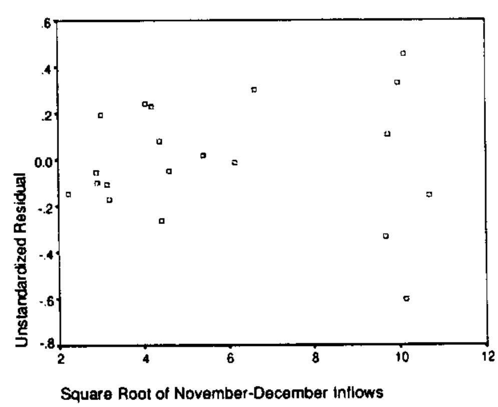


***Figure 6.44*** *Residuals Plot for Sqrt(November-December Inflows).*

### 6.3.4 Prediction Intervals for Trout Harvest

***Table 6.30*** *Prediction Intervals for Trout Harvest.*

| YEAR | *LICI_1* | *LN_TROUT* | *UICI_1* |
|---|---|---|---|
| 1961 | 4.3064 | 5.8165 | 6.4154 |
| 1962 | 4.5137 | 5.8880 | 6.5937 |
| 1963 | 4.7207 | 5.2220 | 6.9263 |
| 1964 | 4.1822 | 5.2311 | 6.3864 |
| 1965 | 3.9146 | 4.9008 | 6.0809 |
| 1966 | 3.7656 | 4.7077 | 5.8556 |
| 1967 | 4.0239 | 5.2933 | 6.1692 |
| 1968 | 4.1495 | 5.0019 | 6.1921 |
| 1969 | 3.9098 | 4.8122 | 6.0051 |
| 1970 | 4.0933 | 5.1985 | 6.1397 |
| 1971 | 4.1128 | 5.4298 | 6.2850 |
| 1972 | 4.3551 | 5.4183 | 6.4441 |
| 1973 | 4.0373 | 5.3107 | 6.0987 |
| 1974 | 4.2645 | 5.0291 | 6.3137 |
| 1975 | 4.5880 | 5.6462 | 6.7236 |
| 1976 | 3.9695 | 5.4076 | 6.2394 |
| 1977 | 3.8633 | 4.7925 | 6.0295 |
| 1978 | 3.4640 | 4.6634 | 5.6450 |
| 1979 | 3.6619 | 4.3770 | 5.7590 |
| 1980 | 2.5357 | 3.7111 | 4.9816 |

| | |
|---|---|
| *LICI_1* | Lower limit for 99% prediction interval for the natural log of trout harvest. |
| *LN_TROUT* | Natural log of trout harvest |
| *UICI_1* | Upper limit for 99% prediction interval for the natural log of trout harvest. |

### 6.3.5 Outliers and Influential Point Detection

***Table 6.31*** *Mahalanobis distance, Cook's distance, Leverage value and associated p-values*

| YEAR | *MAH_1* | *COOK_1* | *LEV_1*[1] | *MAH_PV*[2] | *COOK_PV*[3] |
|---|---|---|---|---|---|
| 1961 | 4.8562 | .2002 | .2556 | .6775 | .0203 |
| 1962 | 4.1783 | .0861 | .2199 | .7590 | .0016 |
| 1963 | 7.1808 | .7202 | .3779 | .4103 | .3421 |
| 1964 | 7.1443 | .0056 | .3760 | .4140 | .0000 |
| 1965 | 6.2220 | .0139 | .3275 | .5141 | .0000 |
| 1966 | 4.4101 | .0088 | .2321 | .7315 | .0000 |
| 1967 | 5.7183 | .0491 | .3010 | .5730 | .0003 |
| 1968 | 3.3194 | .0162 | .1747 | .8540 | .0000 |
| 1969 | 4.5354 | .0183 | .2387 | .7164 | .0000 |
| 1970 | 3.4054 | .0040 | .1792 | .8451 | .0000 |
| 1971 | 6.3644 | .0826 | .3350 | .4979 | .0014 |
| 1972 | 4.3870 | .0003 | .2309 | .7343 | .0000 |
| 1973 | 3.7488 | .0392 | .1973 | .8082 | .0001 |
| 1974 | 3.4696 | .0406 | .1826 | .8384 | .0001 |
| 1975 | 5.4839 | .0001 | .2886 | .6011 | .0000 |
| 1976 | 8.7860 | .3015 | .4624 | .2684 | .0592 |
| 1977 | 6.2203 | .0351 | .3274 | .5143 | .0001 |
| 1978 | 6.5784 | .0196 | .3462 | .4741 | .0000 |
| 1979 | 4.5784 | .0979 | .2410 | .7113 | .0025 |
| 1980 | 13.4131 | .0437 | *.7060 | .0627 | .0002 |

| | |
|---|---|
| *MAH_1* | Mahalanobis distance |
| *COOK_1* | Cook's distance |
| *LEV_1* | Leverage value |
| *MAHA_PV* | P-value associated with the Mahalanobis distance |
| *COOK_PV* | P-value associated with Cook's distance |

[1]This is flagged if it exceeds $(2p+1)/n$ or 0.5, whichever is smaller.
[2]*MAHA_PV* = 1-F(*MAH_1*), where F is the CDF of a Chi-squared random variable with $p+1$ degrees of freedom. Small values indicate a problem.
[3]*COOK_PV* = F(*COOK_1*), where F is the CDF of an F-ratio random variable with $p+1$ numerator degrees of freedom and $n-p-1$ denominator degrees of freedom. A value greater than 0.5 indicates a problem. A value less than 0.2 indicates no problem. Values in between are inconclusive.

***Table 6.32*** *Standardized dffits value and Standardized dfbeta values*

| YEAR | *SDFFITS* | *SDFBET_0* | *SDFBET_1* | *SDFBET_2* |
|---|---|---|---|---|
| 1961 | *1.3089 | -.1215 | .7297 | -.4351 |
| 1962 | .7978 | .0738 | .2731 | -.0953 |
| 1963 | *-3.1085 | *-1.0765 | -.3324 | -.4356 |
| 1964 | -.1901 | -.1672 | .0683 | .0237 |
| 1965 | -.3019 | -.2250 | -.0327 | .1551 |
| 1966 | -.2401 | -.0707 | -.0001 | -.0347 |
| 1967 | .5775 | .2222 | -.0086 | .1099 |
| 1968 | -.3288 | .0368 | .0894 | -.1155 |
| 1969 | -.3484 | .0035 | -.1813 | .0780 |
| 1970 | .1604 | -.0431 | .0368 | .0599 |
| 1971 | .7578 | .2418 | -.0411 | .5755 |
| 1972 | .0433 | .0022 | -.0254 | .0335 |
| 1973 | .5200 | -.0409 | .0262 | -.3068 |
| 1974 | -.5319 | .0536 | .0283 | .1839 |
| 1975 | -.0266 | -.0074 | .0058 | .0146 |
| 1976 | *1.5178 | .2654 | -.9585 | .4568 |
| 1977 | -.4839 | .1510 | .2574 | -.1322 |
| 1978 | .3592 | -.1393 | -.0100 | -.1138 |
| 1979 | -.8521 | .4317 | -.1880 | -.0556 |
| 1980 | -.5332 | .1396 | -.3132 | .1124 |

| | |
|---|---|
| *SDFFITS* | Standardized *dffits* value |
| *SDFBET_0* | Standardized *dfbeta* for the intercept term |
| *SDFBET_1* | Standardized *dfbeta* for square root of January-February inflows |
| *SDFBET_2* | Standardized *dfbeta* for square root of March-April inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p+1)/n}$ for a large data set. The cutoff used here is 1.

***Table 6.33*** *Standardized dfbeta values*

| YEAR | *SDFBET_3* | *SDFBET_4* | *SDFBET_5* | *SDFBET_6* |
|---|---|---|---|---|
| 1961 | .2980 | -.2335 | -.1751 | .4082 |
| 1962 | -.0160 | -.3056 | .0483 | .2641 |
| 1963 | *1.2145 | *1.5604 | *-1.0405 | -.5722 |
| 1964 | .0443 | -.0047 | -.0006 | .0425 |
| 1965 | -.0665 | -.0481 | .1379 | .0771 |
| 1966 | -.0294 | .0345 | .1107 | .0502 |
| 1967 | .0575 | -.2491 | -.2319 | -.0904 |
| 1968 | .0413 | .0406 | -.1344 | .0832 |
| 1969 | -.0547 | -.0389 | -.0463 | .2213 |
| 1970 | -.0285 | -.0357 | .0706 | -.0618 |
| 1971 | -.4893 | -.4055 | .2785 | -.3120 |
| 1972 | -.0294 | -.0138 | .0337 | -.0031 |
| 1973 | .3510 | .1400 | -.1755 | .0419 |
| 1974 | -.2433 | -.0163 | .0189 | -.0452 |
| 1975 | -.0146 | .0043 | .0090 | -.0125 |
| 1976 | -.8620 | .4778 | .8974 | .0586 |
| 1977 | .0813 | -.1282 | -.0549 | -.3117 |
| 1978 | .1819 | .1755 | -.2153 | .2206 |
| 1979 | -.2185 | -.1048 | .3325 | -.3843 |
| 1980 | -.0183 | -.3886 | .0338 | .2626 |

| | |
|---|---|
| *SDFBET_3* | Standardized *dfbeta* for square root of May-June inflows |
| *SDFBET_4* | Standardized *dfbeta* for square root of July-August inflows |
| *SDFBET_5* | Standardized *dfbeta* for square root of September-October inflows |
| *SDFBET_6* | Standardized *dfbeta* for square root of November-December inflows |

*Items are flagged if |*sdffits*| or |*sdfbeta*| exceed 1.0 for a small data set or $2\sqrt{(p + 1) / n}$ for a large data set. The cutoff used here is 1.

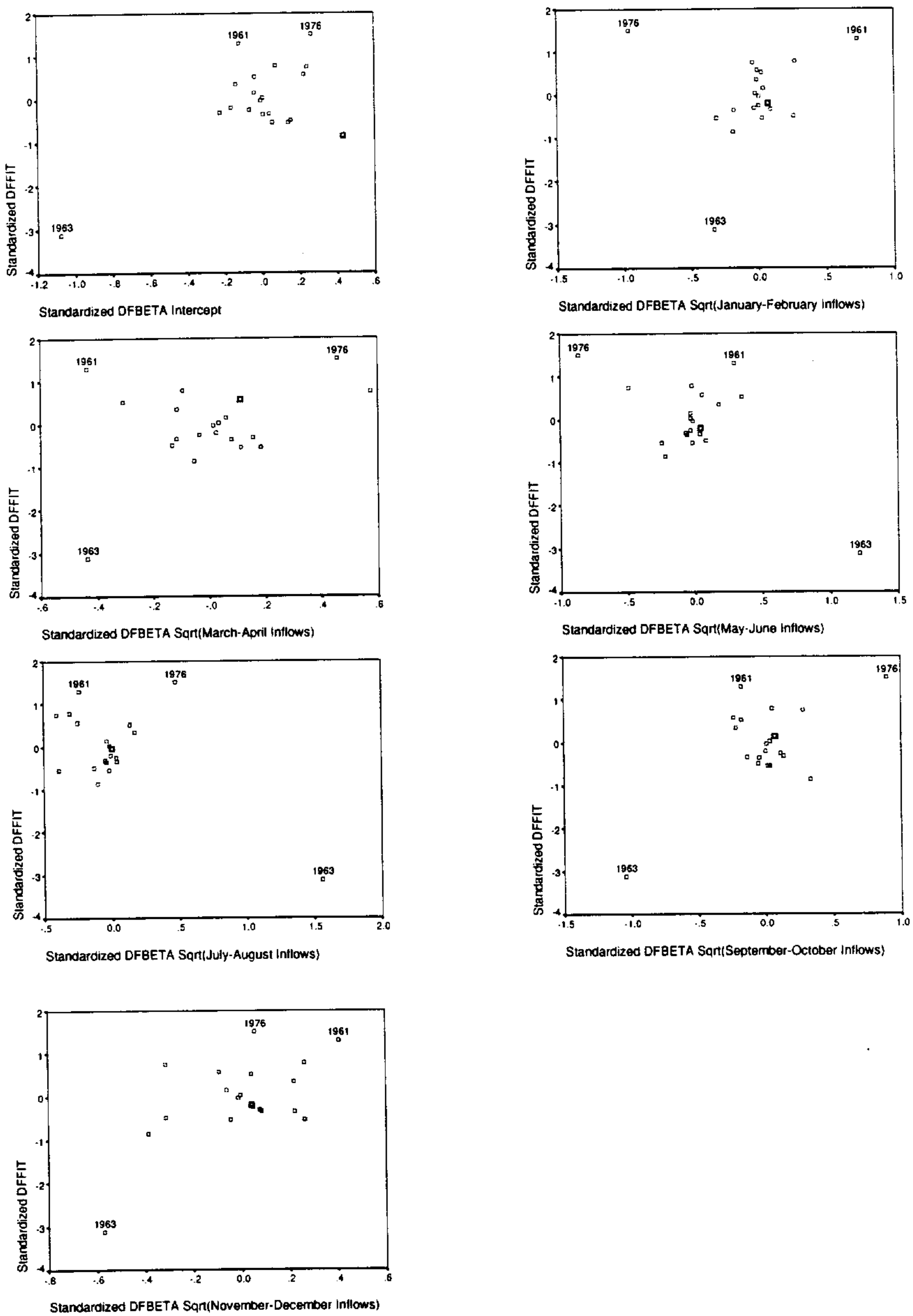


***Figure 6.45*** *Standardized DFFITS vs. Standardized DFBETA Intercept and vs. Standardized DFBETA of square root of inflow variables.*

# 7. Examining Subsets of the Data

## 7.1 Log of trout data and untransformed inflow data: None Omitted

***Table 7.1*** *Regression Models for Dependent Variable: TROUT on INFLOWS: None Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.5266 | 0.5003 | 7.175 | -39.14 | 0.1285 | -37.15 | QJA_LAG |
| 1 | 0.1314 | 0.0832 | 26.52 | -27.00 | 0.2359 | -25.01 | QMA_LAG |
| 1 | 0.0505 | -.0023 | 30.49 | -25.22 | 0.2578 | -23.22 | QSO_LAG |
| 1 | 0.0210 | -.0334 | 31.93 | -24.60 | 0.2658 | -22.61 | QJF_LAG |
| 2 | 0.5794 | 0.5299 | 6.592 | -39.50 | 0.1209 | -36.51 | QJA_LAG QND_LAG |
| 2 | 0.5646 | 0.5134 | 7.317 | -38.81 | 0.1252 | -35.82 | QMA_LAG QJA_LAG |
| 2 | 0.5467 | 0.4934 | 8.192 | -38.00 | 0.1303 | -35.02 | QJA_LAG QSO_LAG |
| 2 | 0.5349 | 0.4802 | 8.768 | -37.49 | 0.1337 | -34.50 | QMJ_LAG QJA_LAG |
| 3 | 0.6443 | 0.5776 | 5.416 | -40.85 | 0.1087 | -36.87 | QMJ_LAG QJA_LAG QSO_LAG |
| 3 | 0.6130 | 0.5405 | 6.945 | -39.17 | 0.1182 | -35.19 | QJA_LAG QSO_LAG QND_LAG |
| 3 | 0.6108 | 0.5378 | 7.055 | -39.05 | 0.1189 | -35.07 | QMA_LAG QJA_LAG QND_LAG |
| 3 | 0.6071 | 0.5335 | 7.234 | -38.87 | 0.1200 | -34.88 | QJF_LAG QJA_LAG QND_LAG |
| 4 | 0.6702 | 0.5823 | 6.145 | -40.37 | 0.1075 | -35.39 | QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 4 | 0.6653 | 0.5760 | 6.388 | -40.07 | 0.1091 | -35.09 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 4 | 0.6462 | 0.5519 | 7.319 | -38.96 | 0.1153 | -33.98 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 4 | 0.6447 | 0.5499 | 7.397 | -38.87 | 0.1158 | -33.89 | QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.7291 | 0.6324 | 5.261 | -42.30 | 0.0946 | -36.33 | QJF_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.6760 | 0.5603 | 7.863 | -38.72 | 0.1131 | -32.75 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG |
| 5 | 0.6756 | 0.5597 | 7.884 | -38.69 | 0.1133 | -32.72 | QJF_LAG QMA_LAG QJA_LAG QSO_LAG QND_LAG |
| 5 | 0.6702 | 0.5524 | 8.145 | -38.37 | 0.1151 | -32.39 | QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |
| 6 | 0.7345 | 0.6119 | 7.000 | -40.70 | 0.0998 | -33.73 | QJF_LAG QMA_LAG QMJ_LAG QJA_LAG QSO_LAG QND_LAG |

N = 20

***Table** 7.2 Analysis of Variance for Dependent Variable: Ln(TROUT) on INFLOWS: None Omitted*

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 6 | 3.58993 | 0.59832 | 5.993 | 0.0034 |
| Error | 13 | 1.29787 | 0.09984 | | |
| C Total | 19 | 4.88780 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 0.31597 | R-square | 0.7345 |
| Dep Mean | 5.09290 | Adj R-sq | 0.6119 |
| C.V. | 6.20411 | | |

***Table** 7.3 Parameter Estimates for Dependent Variable: Ln(TROUT) on INFLOWS: None Omitted*

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 5.549905 | 0.21425085 | 25.904 | 0.0001 | 0.00000000 |
| QJF_LAG | 1 | -0.006052 | 0.00341235 | -1.773 | 0.0996 | 1.63983261 |
| QMA_LAG | 1 | 0.004438 | 0.00869270 | 0.511 | 0.6182 | 2.64239063 |
| QMJ_LAG | 1 | -0.003503 | 0.00206288 | -1.698 | 0.1133 | 7.37521502 |
| QJA_LAG | 1 | -0.010793 | 0.00226692 | -4.761 | 0.0004 | 1.16542162 |
| QSO_LAG | 1 | 0.001808 | 0.00085334 | 2.119 | 0.0539 | 5.03638070 |
| QND_LAG | 1 | 0.003736 | 0.00220827 | 1.692 | 0.1145 | 1.51362492 |

***Table** 7.4 Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(TROUT) on INFLOWS: None Omitted*

| Number | Eigenvalue | Condition Index | Var Prop QJF_LAG | Var Prop QMA_LAG | Var Prop QMJ_LAG | Var Prop QJA_LAG | Var Prop QSO_LAG | Var Prop QND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.23431 | 1.00000 | 0.0411 | 0.0064 | 0.0220 | 0.0105 | 0.0204 | 0.0569 |
| 2 | 1.39421 | 1.26592 | 0.0656 | 0.0967 | 0.0083 | 0.1685 | 0.0045 | 0.0487 |
| 3 | 1.11529 | 1.41540 | 0.1145 | 0.0574 | 0.0029 | 0.1100 | 0.0555 | 0.0846 |
| 4 | 0.72226 | 1.75884 | 0.0068 | 0.1594 | 0.0008 | 0.6516 | 0.0272 | 0.0329 |
| 5 | 0.46125 | 2.20092 | 0.6120 | 0.0019 | 0.0020 | 0.0055 | 0.0009 | 0.7490 |
| 6 | 0.07268 | 5.54451 | 0.1601 | 0.6781 | 0.9640 | 0.0540 | 0.8915 | 0.0279 |

***Table** 7.5 Parameter Estimates of Models for Dependent Variable: Ln(TROUT) on INFLOWS: None Omitted*

| OBS | _RMSE_ | INTERCEP | QJF_LAG | QMA_LAG | QMJ_LAG | QJA_LAG | QSO_LAG | QND_LAG |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.35853 | 5.56576 | . | . | . | -0.010663 | . | . |
| 2 | 0.48565 | 5.41621 | . | -0.013565 | . | . | . | . |
| 3 | 0.50778 | 4.95187 | . | . | . | . | .0005977 | . |
| 4 | 0.51560 | 5.18071 | -.0027027 | . | . | . | . | . |
| 5 | 0.34775 | 5.46272 | . | . | . | -0.011187 | . | .0029196 |
| 6 | 0.35382 | 5.71349 | . | -0.007508 | . | -0.009958 | . | . |
| 7 | 0.36101 | 5.46544 | . | . | . | -0.010420 | .0003797 | . |
| 8 | 0.36567 | 5.63812 | . | . | -.0004872 | -0.010802 | . | . |
| 9 | 0.32966 | 5.58735 | . | . | -.0026057 | -0.010525 | .0013827 | . |
| 10 | 0.34382 | 5.31681 | . | . | . | -0.010941 | .0004985 | .0033214 |
| 11 | 0.34482 | 5.60381 | . | -0.006849 | . | -0.010513 | . | .0027406 |
| 12 | 0.34644 | 5.51532 | -.0036882 | . | . | -0.010928 | . | .0042082 |
| 13 | 0.32781 | 5.46582 | . | . | -.0021209 | -0.010852 | .0012752 | .0022091 |
| 14 | 0.33027 | 5.69596 | -.0029703 | . | -.0031047 | -0.010166 | .0015510 | . |
| 15 | 0.33952 | 5.55726 | . | 0.002511 | -.0030022 | -0.010779 | .0015324 | . |
| 16 | 0.34028 | 5.45792 | . | -0.006874 | . | -0.010264 | .0005002 | .0031430 |
| 17 | 0.30751 | 5.57760 | -.0055643 | . | -.0026899 | -0.010425 | .0015093 | .0038754 |
| 18 | 0.33633 | 5.65095 | -.0037885 | 0.006254 | -.0042295 | -0.010697 | .0019702 | . |
| 19 | 0.33655 | 5.50995 | -.0038966 | -0.006958 | . | -0.009973 | .0005182 | .0045168 |
| 20 | 0.33931 | 5.46476 | . | 0.000125 | -.0021424 | -0.010864 | .0012830 | .0022010 |
| 21 | 0.31597 | 5.54990 | -.0060517 | 0.004438 | -.0035030 | -0.010793 | .0018082 | .0037363 |

***Table** 7.6 Criteria Statistics of Models for Dependent Variable: Ln(TROUT) on INFLOWS: None Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 0.12854 | 0.52663 | 0.50033 | 7.1755 | -39.1372 | -37.1457 |
| 2 | 0.23586 | 0.13142 | 0.08317 | 26.5239 | -26.9978 | -25.0063 |
| 3 | 0.25784 | 0.05048 | -0.00228 | 30.4869 | -25.2157 | -23.2242 |
| 4 | 0.26584 | 0.02101 | -0.03338 | 31.9294 | -24.6045 | -22.6131 |
| 5 | 0.12093 | 0.57939 | 0.52991 | 6.5921 | -39.5009 | -36.5137 |
| 6 | 0.12519 | 0.56459 | 0.51337 | 7.3168 | -38.8092 | -35.8220 |
| 7 | 0.13033 | 0.54672 | 0.49339 | 8.1919 | -38.0045 | -35.0174 |
| 8 | 0.13371 | 0.53494 | 0.48023 | 8.7684 | -37.4916 | -34.5044 |
| 9 | 0.10867 | 0.64426 | 0.57756 | 5.4164 | -40.8508 | -36.8679 |
| 10 | 0.11821 | 0.61304 | 0.54048 | 6.9451 | -39.1682 | -35.1853 |
| 11 | 0.11890 | 0.61079 | 0.53782 | 7.0549 | -39.0527 | -35.0697 |
| 12 | 0.12002 | 0.60713 | 0.53347 | 7.2342 | -38.8653 | -34.8823 |
| 13 | 0.10746 | 0.67022 | 0.58228 | 6.1455 | -40.3663 | -35.3877 |
| 14 | 0.10908 | 0.66526 | 0.57600 | 6.3883 | -40.0678 | -35.0891 |
| 15 | 0.11527 | 0.64625 | 0.55191 | 7.3191 | -38.9629 | -33.9843 |
| 16 | 0.11579 | 0.64466 | 0.54990 | 7.3969 | -38.8732 | -33.8946 |
| 17 | 0.09456 | 0.72914 | 0.63241 | 5.2607 | -42.3030 | -36.3286 |
| 18 | 0.11312 | 0.67600 | 0.56028 | 7.8627 | -38.7197 | -32.7454 |
| 19 | 0.11327 | 0.67557 | 0.55970 | 7.8837 | -38.6933 | -32.7189 |
| 20 | 0.11513 | 0.67022 | 0.55245 | 8.1452 | -38.3666 | -32.3922 |
| 21 | 0.09984 | 0.73447 | 0.61191 | 7.0000 | -40.7001 | -33.7300 |

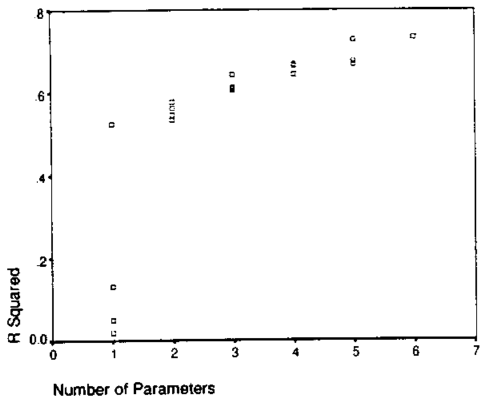


***Figure 7.1*** *The $R^2$ criteria vs. Number of parameters.*

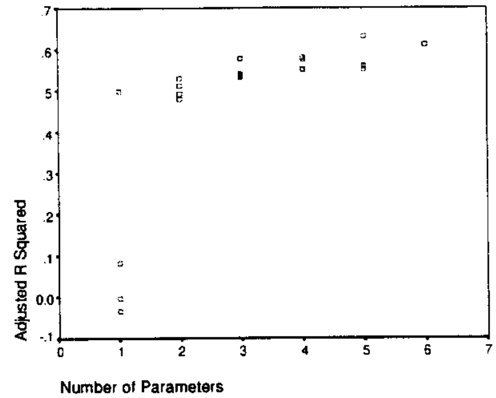


***Figure 7.2*** *The Adjusted $R^2$ criteria vs. Number of parameters.*

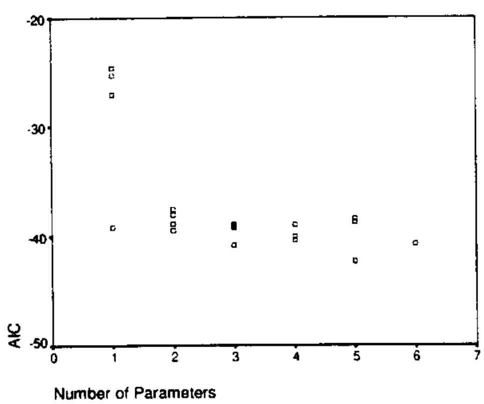


***Figure 7.3*** *The AIC criteria vs. Number of parameters..*

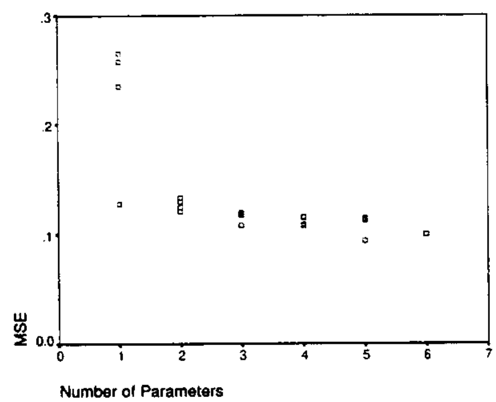


***Figure 7.4*** *MSE vs. Number of parameters.*

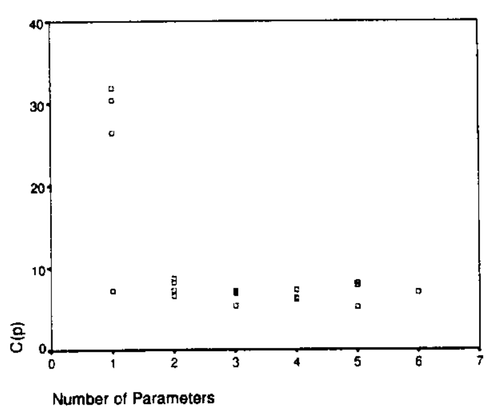


***Figure 7.5*** *The C(p) criteria vs. Number of parameters.*

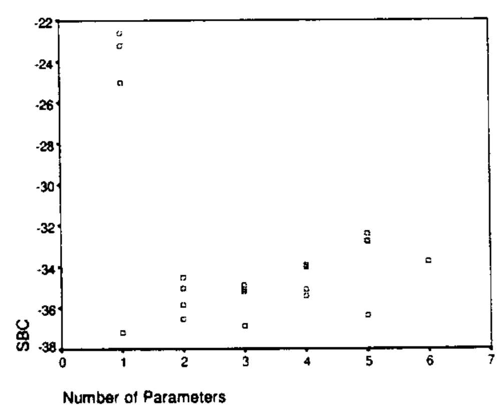


***Figure 7.6*** *The SBC criteria vs. Number of parameters.*

## 7.2 Log of trout data and log of inflow data: 1963 Omitted

***Table** 7.7 Regression Models for Dependent Variable: Ln(TROUT) on Ln(INFLOWS): 1963 Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.5353 | 0.5080 | 21.61 | -36.43 | 0.1331 | -34.54 | LN_QJA |
| 1 | 0.0888 | 0.0352 | 56.79 | -23.63 | 0.2610 | -21.74 | LN_QMA |
| 1 | 0.0510 | -.0049 | 59.77 | -22.86 | 0.2719 | -20.97 | LN_QJF |
| 1 | 0.0444 | -.0119 | 60.29 | -22.73 | 0.2738 | -20.84 | LN_QSO |
| 2 | 0.6606 | 0.6182 | 13.74 | -40.40 | 0.1033 | -37.56 | LN_QJA LN_QND |
| 2 | 0.6394 | 0.5943 | 15.41 | -39.24 | 0.1098 | -36.41 | LN_QJA LN_QSO |
| 2 | 0.5480 | 0.4915 | 22.62 | -34.95 | 0.1376 | -32.12 | LN_QJF LN_QJA |
| 2 | 0.5420 | 0.4848 | 23.09 | -34.70 | 0.1394 | -31.87 | LN_QMA LN_QJA |
| 3 | 0.7316 | 0.6779 | 10.15 | -42.85 | 0.0871 | -39.08 | LN_QJF LN_QJA LN_QND |
| 3 | 0.7213 | 0.6655 | 10.96 | -42.14 | 0.0905 | -38.36 | LN_QJA LN_QSO LN_QND |
| 3 | 0.6881 | 0.6257 | 13.57 | -40.00 | 0.1013 | -36.22 | LN_QMJ LN_QJA LN_QSO |
| 3 | 0.6738 | 0.6086 | 14.70 | -39.15 | 0.1059 | -35.37 | LN_QMA LN_QJA LN_QND |
| 4 | 0.8018 | 0.7451 | 6.618 | -46.61 | 0.0690 | -41.89 | LN_QJF LN_QJA LN_QSO LN_QND |
| 4 | 0.7539 | 0.6836 | 10.39 | -42.50 | 0.0856 | -37.78 | LN_QMJ LN_QJA LN_QSO LN_QND |
| 4 | 0.7398 | 0.6654 | 11.50 | -41.44 | 0.0905 | -36.72 | LN_QMA LN_QJA LN_QSO LN_QND |
| 4 | 0.7349 | 0.6592 | 11.89 | -41.09 | 0.0922 | -36.37 | LN_QJF LN_QMJ LN_QJA LN_QND |
| 5 | 0.8134 | 0.7416 | 7.706 | -45.76 | 0.0699 | -40.09 | LN_QJF LN_QMJ LN_QJA LN_QSO LN_QND |
| 5 | 0.8018 | 0.7255 | 8.618 | -44.61 | 0.0743 | -38.95 | LN_QJF LN_QMA LN_QJA LN_QSO LN_QND |
| 5 | 0.7622 | 0.6707 | 11.74 | -41.15 | 0.0891 | -35.49 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO |
| 5 | 0.7555 | 0.6615 | 12.26 | -40.63 | 0.0916 | -34.96 | LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |
| 6 | 0.8477 | 0.7715 | 7.000 | -47.62 | 0.0618 | -41.01 | LN_QJF LN_QMA LN_QMJ LN_QJA LN_QSO LN_QND |

N = 19

***Table 7.8*** *Analysis of Variance for Dependent Variable: Ln(TROUT) on Ln(INFLOWS): 1963 Omitted*

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 6 | 4.12850 | 0.68808 | 11.132 | 0.0003 |
| Error | 12 | 0.74176 | 0.06181 | | |
| C Total | 18 | 4.87026 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 0.24862 | R-square | 0.8477 |
| Dep Mean | 5.08610 | Adj R-sq | 0.7715 |
| C.V. | 4.88828 | | |

***Table 7.9*** *Parameter Estimates for Dependent Variable: Ln(TROUT) on Ln(INFLOWS): 1963 Omitted*

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 7.653418 | 0.56681333 | 13.503 | 0.0001 | 0.00000000 |
| LN_QJF | 1 | -0.212139 | 0.07872797 | -2.695 | 0.0195 | 1.71780914 |
| LN_QMA | 1 | 0.293556 | 0.17845732 | 1.645 | 0.1259 | 5.87922395 |
| LN_QMJ | 1 | -0.318307 | 0.16734013 | -1.902 | 0.0814 | 6.34868734 |
| LN_QJA | 1 | -0.776237 | 0.11249792 | -6.900 | 0.0001 | 1.55405540 |
| LN_QSO | 1 | 0.189748 | 0.06424118 | 2.954 | 0.0121 | 2.78004756 |
| LN_QND | 1 | 0.180971 | 0.06971210 | 2.596 | 0.0234 | 1.43683478 |

***Table 7.10*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(TROUT) on Ln(INFLOWS): 1963 Omitted*

| Number | Eigenvalue | Condition Index | Var Prop LN_QJF | Var Prop LN_QMA | Var Prop LN_QMJ | Var Prop LN_QJA | Var Prop LN_QSO | Var Prop LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.42549 | 1.00000 | 0.0436 | 0.0195 | 0.0157 | 0.0182 | 0.0204 | 0.0265 |
| 2 | 1.25186 | 1.39194 | 0.0332 | 0.0045 | 0.0364 | 0.1084 | 0.0072 | 0.2059 |
| 3 | 0.96025 | 1.58930 | 0.0555 | 0.0392 | 0.0003 | 0.0026 | 0.2263 | 0.0560 |
| 4 | 0.84979 | 1.68944 | 0.1703 | 0.0023 | 0.0004 | 0.4875 | 0.0007 | 0.0754 |
| 5 | 0.44129 | 2.34444 | 0.5055 | 0.0292 | 0.0157 | 0.0526 | 0.0815 | 0.5695 |
| 6 | 0.07132 | 5.83168 | 0.1918 | 0.9053 | 0.9316 | 0.3307 | 0.6639 | 0.0667 |

***Table** 7.11 Parameter Estimates of Models for Dependent Variable: Ln(TROUT) on Ln(INFLOWS): 1963 Omitted*

| OBS | _RMSE_ | INTERCEP | LN_QJF | LN_QMA | LN_QMJ | LN_QJA | LN_QSO | LN_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.36487 | 7.20635 | . | . | . | -0.58606 | . | . |
| 2 | 0.51092 | 5.66782 | . | -0.19469 | . | . | . | . |
| 3 | 0.52143 | 5.45035 | -0.12037 | . | . | . | . | . |
| 4 | 0.52324 | 4.74080 | . | . | . | . | 0.07203 | . |
| 5 | 0.32141 | 6.88228 | . | . | . | -0.66566 | . | 0.18981 |
| 6 | 0.33133 | 6.81162 | . | . | . | -0.62478 | 0.11156 | . |
| 7 | 0.37094 | 7.33855 | -0.06078 | . | . | -0.57176 | . | . |
| 8 | 0.37338 | 7.29915 | . | -0.05609 | . | -0.56539 | . | . |
| 9 | 0.29520 | 7.12051 | -0.15540 | . | . | -0.65361 | . | 0.24824 |
| 10 | 0.30083 | 6.62673 | . | . | . | -0.68269 | 0.08763 | 0.15788 |
| 11 | 0.31822 | 7.34369 | . | . | -0.15448 | -0.63691 | 0.16031 | . |
| 12 | 0.32543 | 7.00338 | . | -0.07907 | . | -0.63891 | . | 0.19550 |
| 13 | 0.26260 | 6.86107 | -0.16586 | . | . | -0.67115 | 0.09446 | 0.21776 |
| 14 | 0.29260 | 7.08414 | . | . | -0.12776 | -0.68728 | 0.13019 | 0.14304 |
| 15 | 0.30088 | 6.75868 | . | -0.09386 | . | -0.65172 | 0.09168 | 0.16316 |
| 16 | 0.30367 | 6.97436 | -0.16456 | . | 0.03519 | -0.65391 | . | 0.25150 |
| 17 | 0.26443 | 7.11916 | -0.14811 | . | -0.07909 | -0.67523 | 0.12008 | 0.20216 |
| 18 | 0.27251 | 6.86228 | -0.16528 | -0.00144 | . | -0.67072 | 0.09450 | 0.21763 |
| 19 | 0.29850 | 8.05950 | -0.16121 | 0.37916 | -0.43840 | -0.75959 | 0.24576 | . |
| 20 | 0.30263 | 7.18280 | . | 0.05579 | -0.17722 | -0.70747 | 0.14427 | 0.13416 |
| 21 | 0.24862 | 7.65342 | -0.21214 | 0.29356 | -0.31831 | -0.77624 | 0.18975 | 0.18097 |

***Table** 7.12 Criteria Statistics of Models for Dependent Variable: Ln(TROUT) on Ln(INFLOWS): 1963 Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 0.13313 | 0.53529 | 0.50796 | 21.6141 | -36.4252 | -34.5363 |
| 2 | 0.26104 | 0.08881 | 0.03521 | 56.7925 | -23.6316 | -21.7428 |
| 3 | 0.27188 | 0.05097 | -0.00486 | 59.7741 | -22.8585 | -20.9696 |
| 4 | 0.27378 | 0.04436 | -0.01186 | 60.2949 | -22.7266 | -20.8377 |
| 5 | 0.10331 | 0.66061 | 0.61819 | 13.7404 | -40.3961 | -37.5628 |
| 6 | 0.10978 | 0.63936 | 0.59428 | 15.4150 | -39.2421 | -36.4087 |
| 7 | 0.13759 | 0.54797 | 0.49147 | 22.6153 | -34.9507 | -32.1174 |
| 8 | 0.13941 | 0.54200 | 0.48475 | 23.0858 | -34.7014 | -31.8681 |
| 9 | 0.08714 | 0.73160 | 0.67792 | 10.1471 | -42.8549 | -39.0771 |
| 10 | 0.09050 | 0.72127 | 0.66553 | 10.9608 | -42.1376 | -38.3598 |
| 11 | 0.10126 | 0.68812 | 0.62574 | 13.5733 | -40.0019 | -36.2242 |
| 12 | 0.10590 | 0.67382 | 0.60859 | 14.6994 | -39.1505 | -35.3728 |
| 13 | 0.06896 | 0.80177 | 0.74513 | 6.6185 | -46.6128 | -41.8906 |
| 14 | 0.08561 | 0.75390 | 0.68359 | 10.3902 | -42.5029 | -37.7807 |
| 15 | 0.09053 | 0.73976 | 0.66541 | 11.5041 | -41.4416 | -36.7194 |
| 16 | 0.09222 | 0.73492 | 0.65918 | 11.8859 | -41.0910 | -36.3688 |
| 17 | 0.06992 | 0.81335 | 0.74157 | 7.7059 | -45.7567 | -40.0901 |
| 18 | 0.07426 | 0.80177 | 0.72553 | 8.6182 | -44.6132 | -38.9465 |
| 19 | 0.08910 | 0.76216 | 0.67069 | 11.7391 | -41.1518 | -35.4852 |
| 20 | 0.09158 | 0.75554 | 0.66152 | 12.2608 | -40.6301 | -34.9635 |
| 21 | 0.06181 | 0.84770 | 0.77154 | 7.0000 | -47.6202 | -41.0092 |

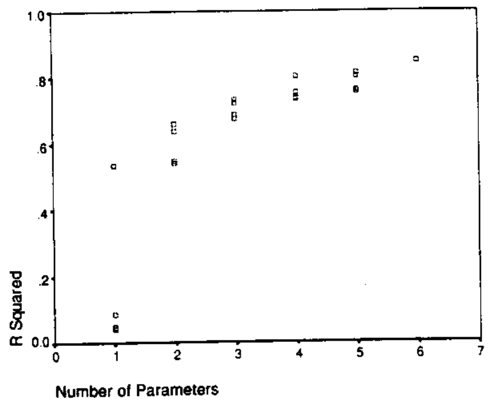


***Figure 7.7*** *The $R^2$ criteria vs. Number of parameters.*

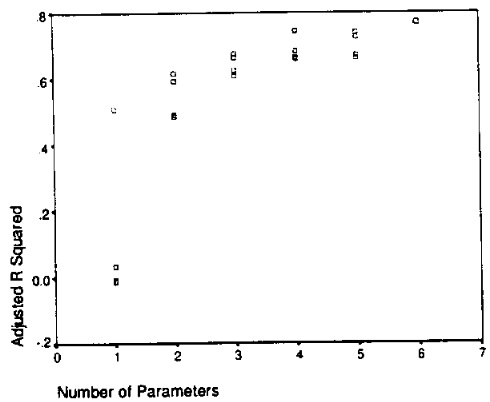


***Figure 7.8*** *The Adjusted $R^2$ criteria vs. Number of parameters.*

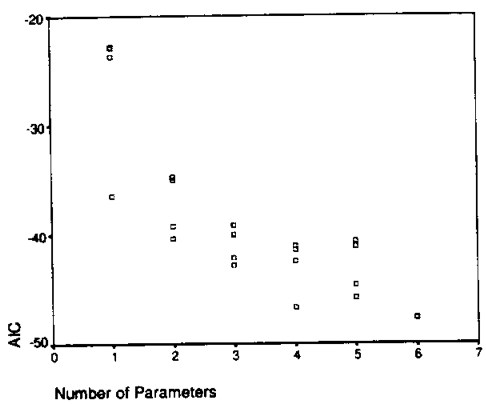


***Figure 7.9*** *The AIC criteria vs. Number of parameters..*

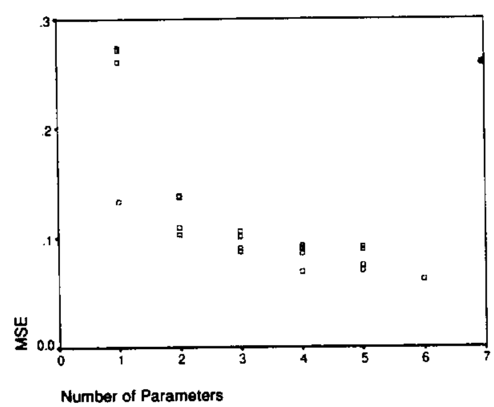


***Figure 7.10*** *MSE vs. Number of parameters.*

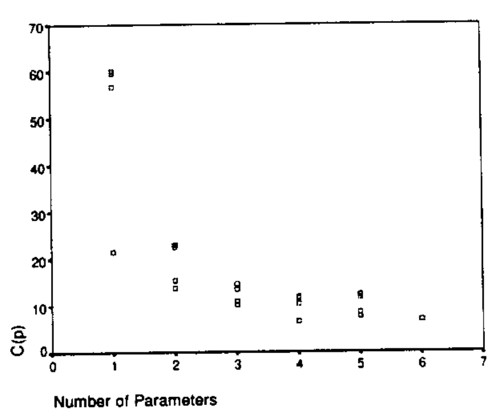


***Figure 7.11*** *The C(p) criteria vs. Number of parameters.*

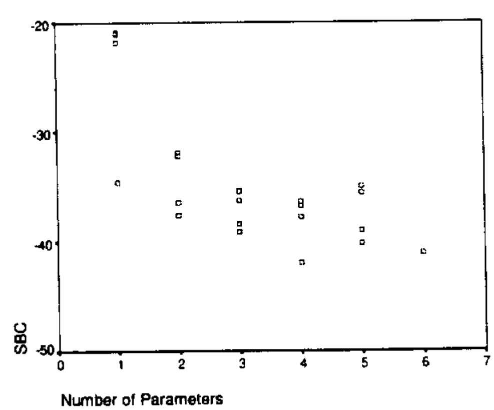


***Figure 7.12*** *The SBC criteria vs. Number of parameters.*

## 7.3 Log of trout data and square root of inflow data: 1963 Omitted

***Table** 7.13 Regression Models for Dependent Variable: Ln(TROUT) on Sqrt(INFLOWS): 1963 Omitted*

| In | Rsq | Adj Rsq | C(p) | AIC | MSE | SBC | Variables in Model |
|---|---|---|---|---|---|---|---|
| 1 | 0.5422 | 0.5153 | 30.53 | -36.71 | 0.1311 | -34.82 | SQR_QJA |
| 1 | 0.1179 | 0.0660 | 72.73 | -24.25 | 0.2527 | -22.36 | SQR_QMA |
| 1 | 0.0575 | 0.0020 | 78.74 | -22.99 | 0.2700 | -21.10 | SQR_QSO |
| 1 | 0.0407 | -.0158 | 80.41 | -22.65 | 0.2748 | -20.76 | SQR_QJF |
| 2 | 0.6622 | 0.6200 | 20.59 | -40.49 | 0.1028 | -37.65 | SQR_QJA SQR_QND |
| 2 | 0.5996 | 0.5496 | 26.82 | -37.26 | 0.1219 | -34.42 | SQR_QJA SQR_QSO |
| 2 | 0.5675 | 0.5135 | 30.01 | -35.79 | 0.1316 | -32.96 | SQR_QMA SQR_QJA |
| 2 | 0.5482 | 0.4917 | 31.93 | -34.96 | 0.1375 | -32.13 | SQR_QMJ SQR_QJA |
| 3 | 0.7169 | 0.6603 | 17.15 | -41.84 | 0.0919 | -38.07 | SQR_QJA SQR_QSO SQR_QND |
| 3 | 0.7137 | 0.6564 | 17.47 | -41.63 | 0.0930 | -37.85 | SQR_QJF SQR_QJA SQR_QND |
| 3 | 0.7113 | 0.6536 | 17.71 | -41.47 | 0.0937 | -37.69 | SQR_QMJ SQR_QJA SQR_QSO |
| 3 | 0.6906 | 0.6287 | 19.77 | -40.15 | 0.1005 | -36.37 | SQR_QMA SQR_QJA SQR_QND |
| 4 | 0.7876 | 0.7269 | 12.13 | -45.30 | 0.0739 | -40.58 | SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 4 | 0.7744 | 0.7100 | 13.43 | -44.16 | 0.0785 | -39.44 | SQR_QJF SQR_QJA SQR_QSO SQR_QND |
| 4 | 0.7489 | 0.6771 | 15.98 | -42.12 | 0.0874 | -37.40 | SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 4 | 0.7318 | 0.6552 | 17.67 | -40.87 | 0.0933 | -36.15 | SQR_QMA SQR_QMJ SQR_QJA SQR_QSO |
| 5 | 0.8471 | 0.7884 | 8.201 | -49.55 | 0.0573 | -43.89 | SQR_QJF SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.7909 | 0.7105 | 13.79 | -43.60 | 0.0783 | -37.93 | SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.7899 | 0.7091 | 13.89 | -43.51 | 0.0787 | -37.84 | SQR_QJF SQR_QMA SQR_QJA SQR_QSO SQR_QND |
| 5 | 0.7738 | 0.6869 | 15.49 | -42.11 | 0.0847 | -36.44 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO |
| 6 | 0.8793 | 0.8190 | 7.000 | -52.04 | 0.0490 | -45.43 | SQR_QJF SQR_QMA SQR_QMJ SQR_QJA SQR_QSO SQR_QND |

N = 19

***Table 7.14*** *Analysis of Variance for Dependent Variable: Ln(TROUT) on Sqrt(INFLOWS): 1963 Omitted*

| Source | DF | Sum of Squares | Mean Square | F Value | Prob>F |
|---|---|---|---|---|---|
| Model | 6 | 4.28260 | 0.71377 | 14.575 | 0.0001 |
| Error | 12 | 0.58767 | 0.04897 | | |
| C Total | 18 | 4.87026 | | | |

| | | | |
|---|---|---|---|
| Root MSE | 0.22130 | R-square | 0.8793 |
| Dep Mean | 5.08610 | Adj R-sq | 0.8190 |
| C.V. | 4.35101 | | |

***Table 7.15*** *Parameter Estimates for Dependent Variable: Ln(TROUT) on Sqrt(INFLOWS): 1963 Omitted*

| Variable | DF | Parameter Estimate | Standard Error | T for H0: Parameter=0 | Prob > \|T\| | Variance Inflation |
|---|---|---|---|---|---|---|
| INTERCEP | 1 | 6.274007 | 0.24588638 | 25.516 | 0.0001 | 0.00000000 |
| SQR_QJF | 1 | -0.083477 | 0.02815241 | -2.965 | 0.0118 | 1.56940335 |
| SQR_QMA | 1 | 0.117702 | 0.06578664 | 1.789 | 0.0988 | 3.68864144 |
| SQR_QMJ | 1 | -0.095386 | 0.03198437 | -2.982 | 0.0114 | 6.51430402 |
| SQR_QJA | 1 | -0.213935 | 0.02713175 | -7.885 | 0.0001 | 1.37347374 |
| SQR_QSO | 1 | 0.053512 | 0.01395765 | 3.834 | 0.0024 | 3.93939616 |
| SQR_QND | 1 | 0.068904 | 0.02127328 | 3.239 | 0.0071 | 1.41456316 |

***Table 7.16*** *Collinearity Diagnostics(intercept adjusted) for Dependent Variable: Ln(TROUT) on Sqrt(INFLOWS): 1963 Omitted*

| Number | Eigenvalue | Condition Index | Var Prop SQR_QJF | Var Prop SQR_QMA | Var Prop SQR_QMJ | Var Prop SQR_QJA | Var Prop SQR_QSO | Var Prop SQR_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.93013 | 1.00000 | 0.0197 | 0.0378 | 0.0301 | 0.0120 | 0.0321 | 0.0061 |
| 2 | 1.75815 | 1.04777 | 0.0975 | 0.0029 | 0.0110 | 0.0793 | 0.0101 | 0.1306 |
| 3 | 0.95214 | 1.42378 | 0.0466 | 0.1001 | 0.0002 | 0.0883 | 0.0809 | 0.1179 |
| 4 | 0.78828 | 1.56478 | 0.1564 | 0.0349 | 0.0005 | 0.5469 | 0.0356 | 0.0001 |
| 5 | 0.49481 | 1.97502 | 0.4972 | 0.0173 | 0.0053 | 0.0704 | 0.0112 | 0.7081 |
| 6 | 0.07649 | 5.02322 | 0.1826 | 0.8071 | 0.9529 | 0.2032 | 0.8301 | 0.0372 |

***Table 7.17*** *Parameter Estimates of Models for Dependent Variable: Ln(TROUT) on Sqrt(INFLOWS): 1963 Omitted*

| OBS | _RMSE_ | INTERCEP | SQR_QJF | SQR_QMA | SQR_QMJ | SQR_QJA | SQR_QSO | SQR_QND |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.36214 | 6.17934 | . | . | . | -0.17000 | . | . |
| 2 | 0.50270 | 5.64326 | . | -0.11729 | . | . | . | . |
| 3 | 0.51964 | 4.85695 | . | . | . | . | 0.016810 | . |
| 4 | 0.52425 | 5.31427 | -0.045187 | . | . | . | . | . |
| 5 | 0.32066 | 5.96702 | . | . | . | -0.19374 | . | 0.064447 |
| 6 | 0.34911 | 5.95025 | . | . | . | -0.16999 | 0.016800 | . |
| 7 | 0.36281 | 6.38363 | . | -0.05626 | . | -0.16021 | . | . |
| 8 | 0.37084 | 6.29805 | . | . | -0.00970 | -0.17156 | . | . |
| 9 | 0.30316 | 5.74557 | . | . | . | -0.19347 | 0.016411 | 0.063742 |
| 10 | 0.30489 | 6.11485 | -0.057521 | . | . | -0.18932 | . | 0.084613 |
| 11 | 0.30615 | 6.35465 | . | . | -0.05783 | -0.17925 | 0.039071 | . |
| 12 | 0.31696 | 6.18060 | . | -0.05957 | . | -0.18369 | . | 0.065286 |
| 13 | 0.27185 | 6.11068 | . | . | -0.04712 | -0.19694 | 0.034625 | 0.052657 |
| 14 | 0.28012 | 5.88984 | -0.060864 | . | . | -0.18878 | 0.017311 | 0.085041 |
| 15 | 0.29558 | 5.96502 | . | -0.06324 | . | -0.18279 | 0.016949 | 0.064609 |
| 16 | 0.30545 | 6.28571 | . | 0.08044 | -0.08840 | -0.19815 | 0.050151 | . |
| 17 | 0.23930 | 6.26297 | -0.061968 | . | -0.04782 | -0.19221 | 0.035811 | 0.074178 |
| 18 | 0.27987 | 6.09845 | . | 0.03440 | -0.06096 | -0.20377 | 0.039678 | 0.048933 |
| 19 | 0.28055 | 6.02862 | -0.052997 | -0.04537 | . | -0.18172 | 0.017581 | 0.082909 |
| 20 | 0.29108 | 6.45054 | -0.054607 | 0.14723 | -0.11826 | -0.20330 | 0.061997 | . |
| 21 | 0.22130 | 6.27401 | -0.083477 | 0.11770 | -0.09539 | -0.21394 | 0.053512 | 0.068904 |

***Table 7.18*** *Criteria Statistics of Models for Dependent Variable: Ln(TROUT) on Sqrt(INFLOWS): 1963 Omitted*

| OBS | _MSE_ | _RSQ_ | _ADJRSQ_ | _CP_ | _AIC_ | _SBC_ |
|---|---|---|---|---|---|---|
| 1 | 0.13115 | 0.54222 | 0.51530 | 30.5256 | -36.7106 | -34.8218 |
| 2 | 0.25271 | 0.11789 | 0.06600 | 72.7251 | -24.2479 | -22.3590 |
| 3 | 0.27003 | 0.05745 | 0.00201 | 78.7356 | -22.9888 | -21.0999 |
| 4 | 0.27484 | 0.04066 | -0.01578 | 80.4063 | -22.6531 | -20.7643 |
| 5 | 0.10282 | 0.66220 | 0.61997 | 20.5945 | -40.4850 | -37.6517 |
| 6 | 0.12187 | 0.59961 | 0.54956 | 26.8183 | -37.2557 | -34.4224 |
| 7 | 0.13163 | 0.56755 | 0.51349 | 30.0071 | -35.7919 | -32.9586 |
| 8 | 0.13752 | 0.54820 | 0.49172 | 31.9315 | -34.9602 | -32.1269 |
| 9 | 0.09190 | 0.71694 | 0.66033 | 17.1499 | -41.8445 | -38.0668 |
| 10 | 0.09296 | 0.71370 | 0.65644 | 17.4727 | -41.6279 | -37.8501 |
| 11 | 0.09373 | 0.71132 | 0.65359 | 17.7088 | -41.4710 | -37.6933 |
| 12 | 0.10047 | 0.69057 | 0.62869 | 19.7723 | -40.1522 | -36.3745 |
| 13 | 0.07390 | 0.78756 | 0.72687 | 12.1267 | -45.2977 | -40.5755 |
| 14 | 0.07847 | 0.77444 | 0.70999 | 13.4319 | -44.1587 | -39.4365 |
| 15 | 0.08737 | 0.74886 | 0.67711 | 15.9756 | -42.1178 | -37.3956 |
| 16 | 0.09330 | 0.73180 | 0.65517 | 17.6726 | -40.8688 | -36.1466 |
| 17 | 0.05726 | 0.84715 | 0.78836 | 8.2010 | -49.5520 | -43.8853 |
| 18 | 0.07833 | 0.79093 | 0.71051 | 13.7922 | -43.6009 | -37.9342 |
| 19 | 0.07871 | 0.78990 | 0.70910 | 13.8938 | -43.5082 | -37.8416 |
| 20 | 0.08473 | 0.77384 | 0.68686 | 15.4911 | -42.1086 | -36.4420 |
| 21 | 0.04897 | 0.87934 | 0.81900 | 7.0000 | -52.0446 | -45.4336 |

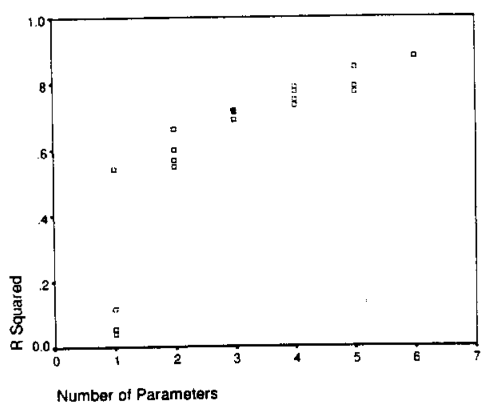


***Figure 7.13*** *The $R^2$ criteria vs. Number of parameters.*

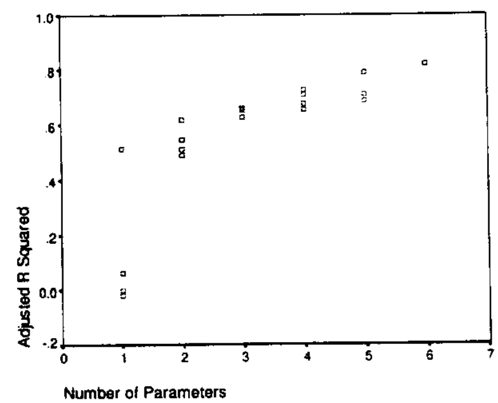


***Figure 7.14*** *The Adjusted $R^2$ criteria vs. Number of parameters.*

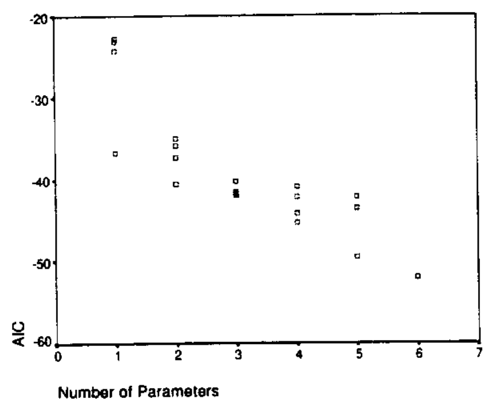


***Figure 7.15*** *The AIC criteria vs. Number of parameters..*

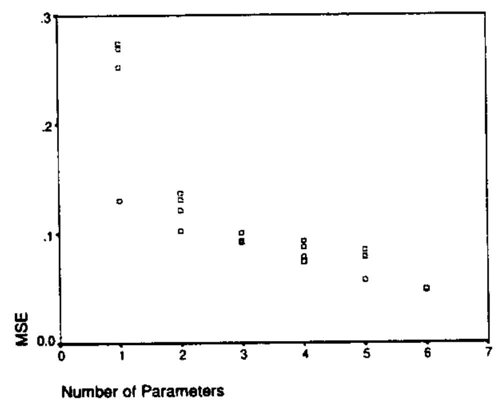


***Figure 7.16*** *MSE vs. Number of parameters.*

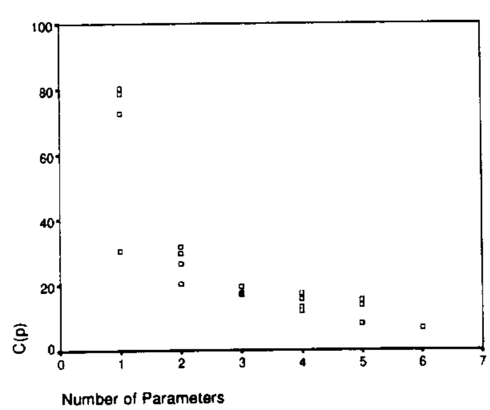


***Figure 7.17*** *The C(p) criteria vs. Number of parameters.*

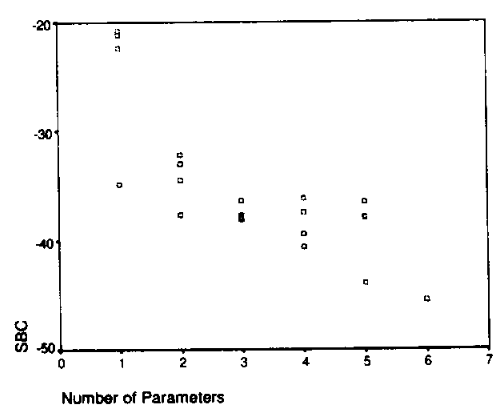


***Figure 7.18*** *The SBC criteria vs. Number of parameters.*