TEXAS WATER DEVELOPMENT BOARD

REPORT 182

WOODY PHREATOPHYTES ALONG THE COLORADO RIVER FROM SOUTHEAST RUNNELS COUNTY TO THE HEADWATERS IN BORDEN COUNTY, TEXAS

By

D. C. Larner, R. M. Marshall,
Atlan E. Pfluger, and Seth C. Burnitt

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INTRODUCTION

Before implementation of a State Water Plan involving import water from out-of-state sources, it will be necessary to take into account full practicable development and conservation of all water sources now available within the State. Future development and management of water resources in Texas will need to consider the effects on the water regime of phreatophytes and other plants that have high water requirements and are of low economic value.

The spread of phreatophytes (primarily saltcedar) along the streams in the western part of the State, coupled with greater demands for water, indicates a need for inventories including data on the location, extent, species, and densities of phreatophytes. This information will provide a basis for determining the possible need and location of future phreatophyte-control programs and the quantities of water savings to be expected from such programs.

Gatewood and others (1950) found in their study of water use by bottomland vegetation in the lower Safford Valley, Arizona, that saltcedar consumptively used from 5 to 7 acre-feet of water annually per acre when growing on sites having high water tables or along streams. From these and similar studies, it was also determined that approximately 50 percent of the water consumed by saltcedar can be saved for other uses when the saltcedar is replaced with Bermuda grass or other adapted grasses.

The Bureau of Reclamation and Geological Survey, both of the U.S. Department of Interior, have a number of programs in progress in the western United States dealing with inventory, research, and control of phreatophytes, but very little information is available on Texas conditions.

At the time this study was made (1969), the Pecos River Basin Water Salvage Project, New Mexico-Texas, conducted by the U.S. Bureau of Reclamation and involving the control of 70,000 acres of saltcedar of varying densities, was nearing completion. Of that acreage, 7,900 acres are between Mentone, Texas and the Texas-New Mexico line. The Bureau of Reclamation based this project on an expected 2.18 acre-feet of water salvage annually for each acre of control.

The Colorado River Municipal Water District has estimated that saltcedar is growing on approximately 2,000 acres in the upper part of the lake bed and along the shoreline of Lake J. B. Thomas where a full supply of water is readily available. The saltcedar on this acreage could reasonably be expected to be using as much as 10,000 acre-feet of water annually.

At least another 5,000 acre-feet of water is probably being consumed annually by the 1,121 acres of phreatophytes, dominantly saltcedar, growing along the banks of the Colorado River in this survey area.

Most of the remaining 905 acres of phreatophytes found in the upper Colorado River flood plain could be replaced with grasses or other more desirable vegetation. If 1 acre-foot of water per acre could be salvaged through a control program on this flood-plain area, and as much as 3 acre-feet per acre along the river banks and in Lake J. B. Thomas, a total of at least 10,200 acre-feet of water could be saved annually and made available for other uses.

HISTORY OF PHREATOPHYTE SPREAD ALONG THE COLORADO RIVER

Phreatophyte is the name generally given to plants that send their roots down to the water table or capillary fringe just above the water table, which provides a ready supply of water. The term, derived from two Greek words, means "well plant" (Fletcher and Elmendorf, 1955). Phreatophytes form a definite group of plants but do not belong to any specific family. Their common characteristic is their use of a large supply of water. They have invaded and replaced the native vegetation in many places, and control and management measures are already being undertaken by some local organizations and water districts. Large sections of the upper Colorado River flood plain are covered with almost pure stands of heavy mesquite, but saltcedar is the primary phreatophyte on which this survey was based. From recent estimates and reports, Texas now has, by far, more saltcedar acreage than any other state.

Saltcedar is a shrub first introduced from the Old World which has spread profusely until it now occupies nearly a million acres of flood-plain lands in the western United States. It did not attract much attention between 1877, when it was first grown in a naturalized state by J. R. Joor on Galveston Island, and 1915 when it was beginning to be recognized as a potential problem plant in the delta of Lake McMillan in New Mexico. Since then it has spread to all the major streams in New Mexico and western Texas (Koogler, 1968).

Based on their 1964 reconnaissance survey of brush in Texas, Rechenthin and Smith (1967) of the Soil Conservation Service of the U.S. Department of Agriculture reported in "Grassland Restoration—Part V—Effect on Water Yield and Supply" that saltcedar of various densities is growing on more than half a million acres, along the streams and around the lakes and reservoirs, in the western half of Texas.

It is difficult to determine just when saltcedar first appeared along the upper Colorado River, but based on oral and written reports received from agricultural workers in the area and from landowners along the river, scattered individual plants were observed in Borden, Scurry, and Mitchell Counties 40 to 50 years ago. It has spread gradually until it now appears as single plants and small clumps or thickets as far downstream as southeast Runnels County.

Reports indicate that the spread was slow until about 15 years ago when the increase became much more rapid. Before 1950, saltcedar was confined to small thickets along the river and to low areas where water stood for a period of time following overflows. The general opinion of farmers and ranchers in the upper portion of the study area is that the acreage of saltcedar has increased at least five times since 1950. The density of saltcedar growth in most areas has also decidedly increased.

The increase in saltcedar acreage, as reported, corresponds closely with the construction dates of reservoirs along this section of the river. Lake Colorado City was completed in 1949, Lake J. B. Thomas in 1952, and Champion Creek Reservoir in 1959. A decrease in the magnitude and frequency of floods, because of reservoir construction, is favorable to a more rapid spread of phreatophytes in the stream below the reservoir. One rancher in Mitchell County reported, "All small streams and draws now have some saltcedar and it is spreading at an alarming rate and will soon have the entire river channel choked up."

With the construction of additional reservoirs along the river, the channel area below the reservoirs becomes much more favorable for saltcedar spread. The shoreline of each new reservoir also adds to the increased area of potential spread of this water-loving plant. Mr. O. H. Ivie, General Manager of the Colorado River Municipal Water District, reported in April 1969 on the saltcedar situation in Lake J. B. Thomas as follows: "With reference to your letter pertaining to saltcedar along the Colorado River through Runnels, Coke, Mitchell, Scurry, and Borden Counties, please be advised that the District is well aware of this condition and has been considerably disturbed with the rate of growth of the saltcedar not only along the river, but also around the shoreline. We are now engaged in root plowing saltcedar around the shoreline of Lake Thomas. We have approximately 2,000 acres that we will plow."

From the small acreage of saltcedar scattered along the Colorado River in 1950, it has spread to more than 4,000 acres in 1969. Farmers and ranchers along the river feel that the saltcedar will soon spread to the recently completed E. V. Spence Reservoir at Robert Lee, and that the streambed proper will soon become clogged with saltcedar below the reservoir.

DESCRIPTION OF THE AREA

Physiography

The Colorado River basin, above southeast Runnels County, lies in the southeastern extension of the Great Plains physiographic province and the southwestern extension of the Central Lowlands physiographic province (Fenneman, 1931). The Colorado River proper heads in north-central Dawson County, Texas about 8 miles northeast of Lamesa, at an elevation of about 3,000 feet above mean sea level. It flows in a generally southeasterly direction along its entire length (Figure 1).

The High Plains, a segment of the Great Plains physiographic province, extends southward to the Edwards Plateau, the most southern division of the Great Plains, and eastward to the Rolling Plains, a segment of the Central Lowlands province. The sediment of the High Plains was formed chiefly during Pliocene time by a great series of sediment-laden streams flowing eastward from the Rocky Mountains. The major geologic formation is the Ogallala made up of clays, silts, sand, and gravel. Most of the sediment is somewhat calcareous and the soils that have developed from these sediments range from clays to sands, calcareous to neutral in the surface soils.

The High Plains is sharply outlined on the east by steeply sloping escarpments, bordering the Rolling Plains which is several hundred feet lower. On the south, the High Plains merges with the Edwards Plateau which in a few places in this area has well defined escarpments.

The Edwards Plateau is a greatly dissected, high limestone plain in central-western Texas. The original tableland surface of the Plateau has been largely removed by erosion, and the Colorado—along with other streams crossing the Edwards Plateau—has carved deep, steep-walled valleys, which as a rule have narrow strips of bottomland. This dissection has given a relief of hilly broken lands. Most of the soils have formed from limestones and interbedded chalks and marls of the Lower Cretaceous, and are therefore thin and stony with limestone bedrock outcropping in many areas. Most of the Edwards Plateau soils in the part of the basin under study are in Coke County.

Lying at elevations below the Edwards Plateau are the Rolling Plains. The topography is typically undulating to rolling, with variations from smooth, nearly level areas of fine-textured soils developed from stream deposits to rough and broken areas developed from interbedded shales and sandstones of the Permian red beds. Some areas are characterized by gypsum formations, fairly well cemented sandstones, and unconsolidated sands. Erosion has been rapid in some areas, resulting in high sedimentation rates.

The resulting alluvial soils along the study reach of the Colorado River are therefore a mixture of the soil materials of the High Plains, Edwards Plateau, and Rolling Plains.

The contributing drainage area of the Colorado River at Ballinger, Runnels County, is 5,240 square miles. The three major reservoirs (not including the new E. V. Spence), Lake J. B. Thomas, Lake Colorado City, and Champion Creek Reservoir, partly control runoff from 1,427 square miles, or 27 percent of the area.

The survey area covers 256 river miles with 46,063 acres of flood-plain soils. Soil surveys which show the limits of the flood-plain soils are being made or have been completed by the U.S. Soil Conservation Service in each of the five counties through which the study area passes. The Mitchell County soil survey has been published; and for the other counties field mapping and final correlation of soil nomenclature are completed, and the reports are in various stages of completion being readied for publication. The flood plain varies greatly in width, from a maximum of about one mile in portions of Borden County to very narrow in Scurry County where the river runs in a narrow gorge with rough and broken land reaching down to the river channel.

Climate

The climate of the study area is characterized by extremes in both temperature and precipitation. The average annual precipitation in the survey area ranges from less than 16 inches in western Borden County to about 24 inches in Runnels County for the period 1931-60 (Table 1). The annual normal precipitation for the Rolling Plains land-resource area is 23 inches (Carr, 1967). Most of the survey area is in this land-resource area.

Table 1.—Variations of Temperature and Precipitation in the Study Area

	BALLINGER, RUNNELS COUNTY	ROBERT LEE, COKE COUNTY	COLORADO CITY, MITCHELL COUNTY	SNYDER, SCURRY COUNTY	GAIL, BORDEN COUNTY
Average Annual Precipitation (in.)	23.21(65)*	16.28(11)	20.36(53)	19.95(48)	16.59(20)
Average Annual Mean Temperature (°F)	64.8 (63)	–	65.2 (39)	62.6 (48)	–
Average Annual Mean Daily Maximum Temperature (°F)	78.6 (58)	–	79.9 (39)	76.6 (47)	–
Average Annual Mean Daily Minimum Temperature (°F)	51.2 (58)	–	50.6 (39)	48.0 (47)	–
Record Highest Temperature (°F)	116 (63)	–	115 (39)	115 (46)	–
Record Lowest Temperature (°F)	- 9 (63)	–	- 7 (39)	- 10 (47)	–

Data from "Climatic Summary of the U.S.—Supplement for 1951-1960, Texas," by the U.S. Department of Commerce, Weather Bureau.

* Numbers in parentheses refer to number of years of record.

Evaporation is high. The long-term average of annual gross lake-surface evaporation (1940-65) is approximately 80 inches throughout the survey area (Kane, 1967, pl. 6).

Surface-Water Quality

Saltcedar will establish itself and spread rapidly in areas of ample water supply, whether the water is of good quality or relatively saline as in the section of the river extending 75 to 100 miles below Lake J. B. Thomas. The study revealed that this part of the river had not only some of the densest growth of saltcedar, but according to local residents, it has shown the most rapid spread during recent years of any portion of the study area.

A reconnaissance of surface-water quality by Leifeste and Lansford (1968) indicates that surface water in most of the Colorado River basin is relatively low in dissolved solids. Inflows of saline water in the upper Colorado River basin below Lake J. B. Thomas seriously degrade the quality of the water in the mainstem for about 100 miles downstream. The principal salt-contributing area lies between Lake J. B. Thomas and Colorado City, in northern Mitchell county. The salt load is of both natural and man-made origin.

Lake J. B. Thomas, a 203,600 acre-feet capacity lake constructed in 1952 for municipal and industrial water supply storage, has in the past contained water of less than 250 mg/l (milligrams per liter) dissolved solids. During water years 1957 through 1966, the Colorado River at Colorado City—approximately 35 river miles below Lake J. B. Thomas—contain dissolved-solids concentrations ranging from 150 to 48,600 mg/l. Chloride and sulfate concentrations were very high, and according to U.S. Public Health Service drinking water standards (1962) the water was unsuitable for municipal uses at least 95 percent of the time.

The Colorado River near Silver, about 35 miles downstream from Colorado City, contained dissolved-solids concentrations ranging between 225 and 15,000 mg/l, with concentrations of about 3,000 occurring 50 percent of the time.

Beals Creek, a large tributary, has its headwaters in a natural depression known as Natural Dam Salt Lake. It contributes to the salt load of the Colorado River as it enters the mainstem below Colorado City. Fortunately, runoff within Beals Creek drainage area below Natural Dam Salt Lake is generally low in dissolved solids, and the frequently saline low flows contributed to the Colorado River from Beals Creek have not appreciably affected the quality of the river since records have been kept.

The quality of the water near Silver is representative of the quality of the water impounded in E. V. Spence Reservoir, a 488,760 acre-feet capacity reservoir near Robert Lee. Since the water from this reservoir is to be used for municipal and industrial supply, the quality of the water is of critical importance.

Downstream from Silver the saline flows from the upper basin continually degrade the quality of the mainstem water. Inflows from Pecan Bayou farther downstream, in northern Mills county, have low dissolved solids and here the quality of the water of the mainstem improves and is suitable for a wide variety of uses most of the time.

Much of the dissolved-solids load below Lake J. B. Thomas is contributed by base flow of the river and runoff of local rainstorms. High dissolved-solids concentrations in local runoff generally occur following periods when the mainstem has no flow or very low flow and result from solution of salt left by evaporation of the saline base flow and past surface discharges of oil-field wastes.

The Colorado River Municipal Water District has formulated a plan for partial control of the salt load of the river and improvement of the river flows entering E. V. Spence Reservoir. The salt-control project constructed by the Colorado River Municipal Water District will help alleviate both natural and man-made salinity in this segment of the river. All improvements in the water quality will increase the variety of water uses and the adaptability of grasses and other crops when used for agriculture.

METHODS AND PROCEDURES OF STUDY

Aerial photographs, flown in 1963 and 1964, at a scale of 1:15,840 (4 inches equal 1 mile) were used as base maps for the survey. Soil survey field sheets covering the flood plain of the river, provided by the U.S. Soil Conservation Service, showed the limits of the flood plain soils. The flood plain is the major potential area for the growth and spread of phreatophyte vegetation, so the boundaries of the flood-plain soils were transferred from the soil survey field sheets to the base maps using a stereoscope. The land uses and phreatophyte vegetation were examined stereoscopically on the aerial photographs, and the kinds and density of the vegetation along the river and in the flood plain were preliminarily delineated. Field surveys were then made to verify the vegetative species and their location and density. Cropland and improved pastures were outlined on the field sheets to complete the land-use picture.

The fieldwork was detailed, permitting an examination of all the flood-plain area. Symbols were devised for mapping the phreatophyte species and combinations of species, the density of the vegetation, the areas where a narrow fringe bordered the river (extent and species), and the kinds of brush control work that had been done by the landowners and operators in the study area (Figures 16-23). It was planned to study the plant heights, densities, and species composition along transect lines across the flood plain, but the areas of the phreatophytes were found to be narrow and transect lines were not needed. All of the vegetation and open areas in the flood plain were examined and mapped.

All fieldwork was inked on the aerial photographs; the delineations were planimetered; and determinations were tabulated to show the density and extent of each phreatophyte species, the acreage of each soil type, and the acreage of cropland and improved pasture as well as the brush-control work accomplished.

RESULTS AND DISCUSSION

Saltcedar and willow are the principal phreatophyte species in the study area. These typically form a narrow fringe along the stream channel or on the river bank, extending to the level of the flood plain. The saltcedar occurs in pure stands and in combination with willow, the mixture being dominated by saltcedar in some areas and by willow in others. Mesquite dominates most of the flood plain, but is considered to be growing as a phreatophyte in only a few small areas. The areas occupied by these plants are mapped on Figures 16-23, and the acreages are summarized in Tables 2 and 3.

Saltcedar occurrence in Runnels County ranged from scattered individual plants and occasional clumps in the lower part of the county to a narrow fringe along the river banks intermingled with a waterline growth of willows at the Runnels-Coke County line (Figures 2 and 3). No areas of saltcedar were found along the river in Runnels County that could be considered as more than seed source areas.

As the survey continued upstream through Coke County, the fringe along the river banks became almost continuous with the saltcedar ranging from seedlings to plants 15 to 20 feet in height. The density and percentage of saltcedar increased in about the same proportion as the willow decreased. Since the river at most points has a well defined channel 15 to 25 feet deep, the saltcedar growth is generally restricted to a narrow fringe along the river banks and to sand bars in the river channel. Figure 4 is a representative view of the fringe of saltcedar and willow along the river in Coke County.

Near Silver, in northwest Coke County, an increase of saltcedar was found along the river banks with an increase in seedlings in the river bed (Figure 5). In a few places in the upper part of Coke County the river channel had become partly clogged by a dense growth of saltcedar 5 to 10 feet high. This area will be in the delta portion of E. V. Spence Reservoir at approximately the 1,900-foot elevation.

Table 2.—Acreage of Saltcedar and Willow, by County, 1969

	RUNNELS COUNTY	COKE COUNTY	MITCHELL COUNTY	SCURRY COUNTY	BORDEN COUNTY	TOTAL
Approximate river miles per county	59	54	71	16	56	256
Saltcedar1/	—	112	351	28	2885/	779
Saltcedar-willow2/	—	37	—	—	—	37
Willow-saltcedar3/	—	—	—	—	89	89
Stream bank fringe4/	319	258	289	60	195	1,121
Total Acres	319	407	640	88	572	2,026

1/ Pure stand.
2/ Mixture, saltcedar dominant.
3/ Mixture, willow dominant.
4/ Stream bank fringe of dominantly saltcedar and some willow.
5/ Not included is an estimated 2,000 acres of dense saltcedar in the upper end of Lake J. B. Thomas which is inundated when the lake is full.

Saltcedar

The growth of saltcedar has crowded the river channel, causing excessive cutting of the river bank and sloughing in some areas. Most sand bars in the river channel above Runnels County have a dense growth of young saltcedar that has apparently taken over since the most recent high water stage of the river.

The extent and density of saltcedar continued to increase upstream, with some of the heaviest spread in Mitchell County (Figure 6). The greatest concentration of saltcedar occurs in Borden County in the upper end of Lake J. B. Thomas. This area is under water when the

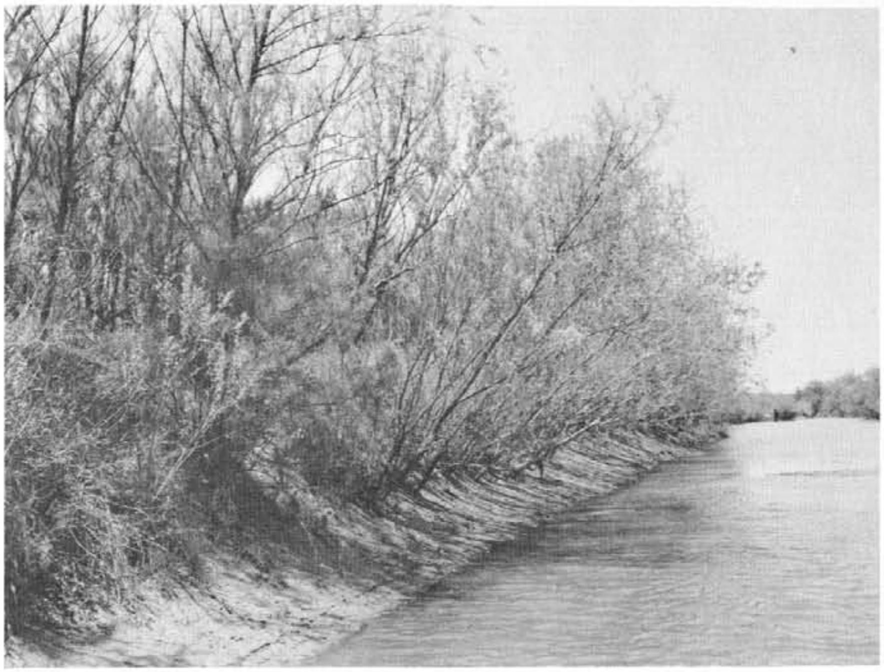

Figure 2.--Fringe of Willows and Scattered Individual Saltcedar Plants. Representative of Phreatophyte Conditions Along the Colorado River in Runnels County. April 1969.

Figure 3.—Individual Saltcedar Plants Serving as Seed Sources. Note Young Seedlings in Foreground. Representative of River Bed Section Near the Runnels-Coke County Line. April 1969.

Figure 4.—Fringe of Saltcedar and Willow With Saltcedar Dominant as Found in the Coke County Section of the River. April 1969.

Figure 5.—Saltcedar Along the River Banks Near Silver in Northwest Coke County. As the Survey Progressed Upstream, a Gradual Increase of Saltcedar Plants Along the River Banks and a Definite Increase in Seedlings in the River Bed Were Observed. Note Young Plants and Seedlings Crowding and Blocking the Channel. April 1969.

Table 3.—Acreage of Flood-Plain Mesquite, by County, 1969

	RUNNELS COUNTY	COKE COUNTY	MITCHELL COUNTY	SCURRY COUNTY	BORDEN COUNTY	TOTAL
Untreated						
Light density1/	321	—	439	63	—	823
Medium density2/	345	395	317	99	—	1,156
Heavy density3/	2,689	2,190	1,468	—	1,036	7,383
Subtotal	3,355	2,585	2,224	162	1,036	9,362
Controlled						
Cleared4/	3,258	5,489	3,301	961	7,530	20,539
Sprayed5/	1,132	837	1,213	96	1,846	5,124
Subtotal	4,390	6,326	4,514	1,057	9,376	25,663
Total	7,745	8,911	6,738	1,219	10,412	35,025

1/ Less than 10 percent crown cover.
2/ 10-30 percent crown cover.
3/ More than 30 percent crown cover.
4/ Root plowed, cabled, chained, or tree dozed.
5/ Aerial or ground application.

lake is full. Due to the rainfall pattern, high evaporation from the lake, and low runoff during the past few years, the water level of this lake was below the spillway elevation from October 1962 until completion of this survey in August 1969. The lake level was down 30 feet at the end of August 1969. At that time, saltcedar was growing on approximately 2,000 acres along the shoreline and in the upper end of the lake (Figure 7). The plants are large enough to require root plowing as a means of control (Figure 10). No water releases had been made from Lake J. B. Thomas since the completion of the lake in 1952. The development of more or less stationary sand bars in the river channel below the dam has contributed to a favorable condition for the spread of saltcedar, particularly in Scurry and Mitchell Counties.

In the upper reaches of the river in Borden County, mature saltcedar was found to be common with tree diameters up to 8 inches and heights of 25 to 30 feet (Figure 8).

This survey was confined to the flood plain and channel of the river, but saltcedar occurs in varying amounts along most of the tributary creeks and intermittent streams in this part of the watershed. Although it was outside the survey area, saltcedar was observed in numerous places where seasonal seeps had developed in upland cultivated fields and around stock tanks. Several hundred acres of this type of saltcedar were observed in Runnels and Scurry Counties (Figure 9).

The control of saltcedar is a difficult problem. Results from sprays developed to date have been only partly conclusive. Root plowing and other mechanical methods are very expensive and would be difficult to use in most of the areas now in saltcedar in the study area. These methods still require frequent maintenance. The control of saltcedar in the lake bed of Lake J. B. Thomas is being done by root plowing (Figure 10).

There is strong indication that the section of the Colorado River from southeast Runnels County to the headwaters can become a serious saltcedar problem area in the years ahead. However, with the well defined channel and high stream banks, it is doubtful that the phreatophyte problem will ever approach the conditions on the Pecos River in New Mexico and Texas, where luxuriant growths of saltcedar blanketed much of the flood plain. It may be expected that similar conditions to those now existing in and around Lake J. B. Thomas will likely develop in the recently completed E. V. Spence Reservoir and in the streambed proper throughout this reach of the river.

Mesquite

Mesquite was the dominant vegetation on the flood plain and even though it is not growing as a phreatophyte in most areas, it does use a lot of water and is a plant of low economic value. The farmers and ranchers recognize it as a problem plant whose control is essential in grassland restoration.

Of the 46,063 acres of flood plain, 35,025 acres are or have been in mesquite (Table 3). As of 1969, 9,362 acres of mesquite of various densities have not been treated for control, while 25,663 acres have been treated—sprayed with chemicals, root plowed, cabled, chained, or tree dozed. Remaining untreated are 7,383 acres of mesquite of heavy density, 1,156 acres of medium density, and 823 acres of light density. Even

Figure 6.—Almost Pure Stand of Saltcedar Along the Stream Banks in Mitchell County. Note Spread of These Plants Onto Sand Bars in the River Bed. May 1969.

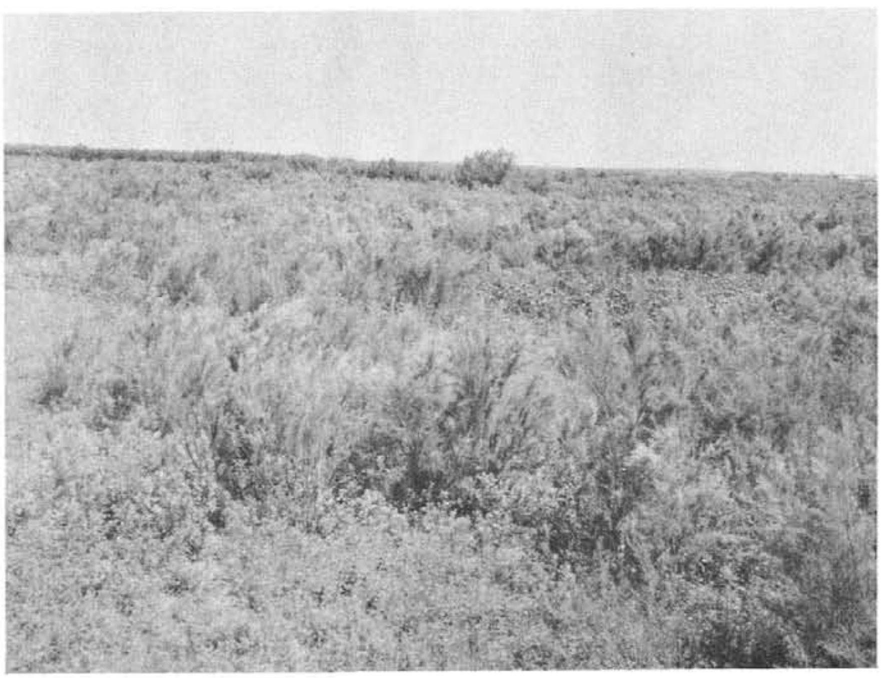

Figure 7.—Concentration of Young Saltcedars in the Bed of Lake J. B. Thomas. Much of the Upper Part of the Reservoir Has Become Occupied by a Heavy Growth of Young Saltcedar Since the Water Level Receded. May 1969.

Figure 8.—Seed Source Areas and Scattered Clumps of Old Mature Saltcedar Trees Were Found Along the Upper Reaches of the River in Borden County. The Largest Individual Plant in This Clump Measured Approximately 8 Inches in Diameter. Examination of a Nearby Plant, About 8 Inches Diameter, Revealed Growth Rings Indicating it to be About 25 Years of Age. April 1969.

Figure 9.—Saltcedar Growing in a Seepy Area in a Cultivated Field Near Ballinger. Representative of Seasonal Seep Areas in Runnels and Scurry Counties. May 1969.

though 73.3 percent of the mesquite area has had control treatment applied one or more times (Table 3), 8,539 acres of medium and heavy density mesquite remain in the flood plain along the river (Figures 11 and 12).

Whether mesquite is growing under phreatophyte conditions depends on the age and size of the trees as well as the soils and geology, depth to the water table fringe, and other flood-plain conditions. Mesquite does not require the same favorable moisture conditions as saltcedar for establishing itself, and may make only seasonal growth from year to year, extending the tap root deeper and deeper into the flood-plain soils until it reaches moist or wet soil conditions. It may then definitely become a phreatophyte, transpiring rather large amounts of water. Some of the flood-plain mesquite in this survey area is growing under phreatophyte conditions as shown in Figures 13 and 14. A mesquite stand that has a canopy shading 50 percent of the soil can use as much as 9 inches of water per month during the growing season (Hoffman 1967). It was found in the Safford Valley, Arizona studies that mesquite used 32.5 inches of water per year while saltcedar used 72.4 inches under similar conditions and plant densities (Gatewood and others, 1950).

The flood-plain soils, where the mesquite is most vigorous, have a high capability for the production of grasses of high economic value as well as dense large mesquite. Following the control of the mesquite, some areas are seeded to adapted grasses (Figure 15), while others have enough of the native species left to establish themselves. These grasses are then managed carefully to insure a good stand of the desirable grasses. Management usually includes a rest period for the grass, which is of low vigor from competing with the brush for sunlight, moisture and plant nutrients or for young grass seedlings to become established if the area has been reseeded. Following rest and reestablishment, grazing must be controlled. Proper livestock numbers and seasonal grazing are essential.

Rangeland in good grass cover will reduce soil and water losses. Grass is a more efficient water user than mesquite and other woody plants, especially saltcedar and willow. According to Rechenthin and Smith (1967), "a grassland restoration program, involving the control of undesirable plants and replacing them with grass, would result in a saving of water, most of which would be available for deep percolation into underground aquifers and as return flow to streams."

Although parts of the flood plain are still covered with a heavy growth of mesquite, individual landowners with the assistance of the Brush Control and Grassland Restoration Programs of the U.S. Department of Agriculture are making much progress in controlling their river flood-plain mesquite and replacing the brush with grasses having lower water requirements and of economic value for grazing. Recurring maintenance operations will have to be carried out to control the mesquite and other brush species.

Soils

The soils of the flood plain may be broadly grouped into clayey alluvial soils and loamy alluvial soils.

The clayey alluvial soils are characterized by Mangum clay. These soils are deep, nearly level, calcareous, and clayey. The surface soil is reddish brown, light clay about 10 inches thick overlying firm, calcareous, reddish brown clay about 36 inches thick. Below this layer is a red, very compact calcareous clay.

These soils are occasionally flooded, about once in five years. They are difficult to farm because of the fine texture of the surface soil, but are productive when adequate water of good quality is available. The areas cropped are used for cotton and grain sorghum (U.S. Soil Conservation Service, 1969). Some of the clayey soils are cut by meandering channels of the river and tributary creeks and are dense, heavy clays, too rough for cultivation.

The loamy soils are characterized by the Yahola fine sandy loam, Spur loam, Spur clay loam, Spur-Clairemont soils, and the Colorado-Yahola soils. These are deep, calcareous, loamy alluvial materials deposited on the flood plains of the Colorado River and tributaries. The texture of the soil materials are loams, clay loams, and sandy loams. The soils are stratified and the layers vary in thickness from a few inches to several feet, overlying beds of water-worn gravel or sandstone strata.

The extent of the various flood-plain soils in the survey area is shown in Figures 16-23, and total acreages for each county are given in Table 4.

Summary of Land Use

The land use on the flood plain is summarized in Table 5. The total acres cropped and in improved Bermuda grass was 5,280, in untreated mesquite 9,362, saltcedar and willow 4,026, and there were 3,632 acres in roads, river channels, and built-up areas. There were 100 acres in open native grassland with no brush canopy, and 25,663 acres formerly in mesquite where control work had been done. There were 46,063 acres in the total flood plain, representing the survey and study area.

Of the 4,026 acres in saltcedar and willow, about 2,000 acres of saltcedar were in the dry part of the bed of Lake J. B. Thomas and a fringe area around the water. There were 779 acres of pure saltcedar along the river, and 1,121 equivalent acres of stream bank fringe,

Figure 10.—Root Plowing for Saltcedar Control, Lake J. B. Thomas. The Colorado River Municipal Water District Is Root Plowing Approximately 2,000 Acres of Saltcedar in the Lake Area. Several Hundred Additional Acres Were Covered With Young First and Second Year Seedlings Near the Water Level. April 1969.

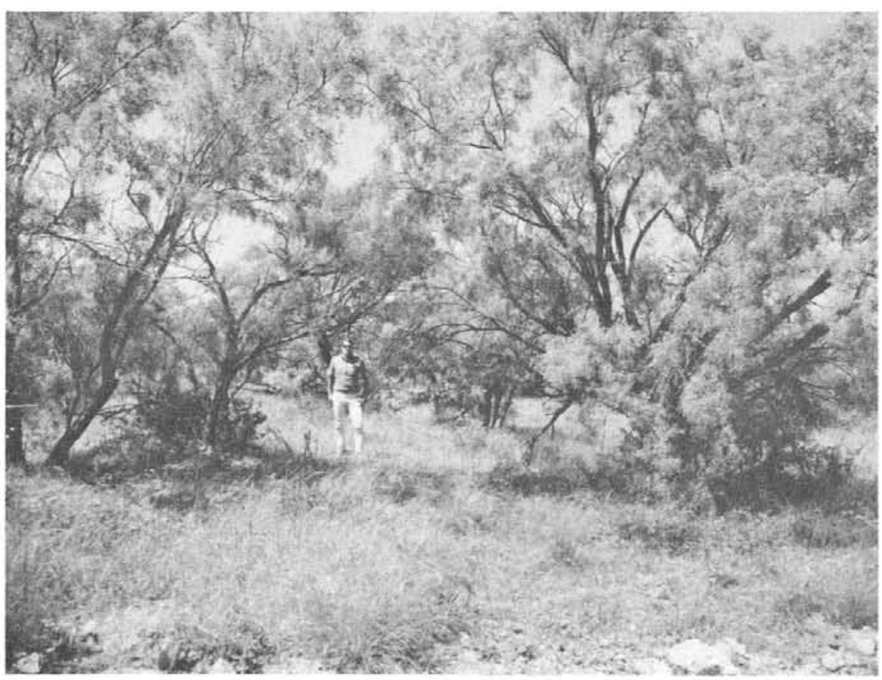

Figure 11.—Mesquite of Medium to Heavy Density. Some Areas Had 100 Percent Crown Cover. May 1969.

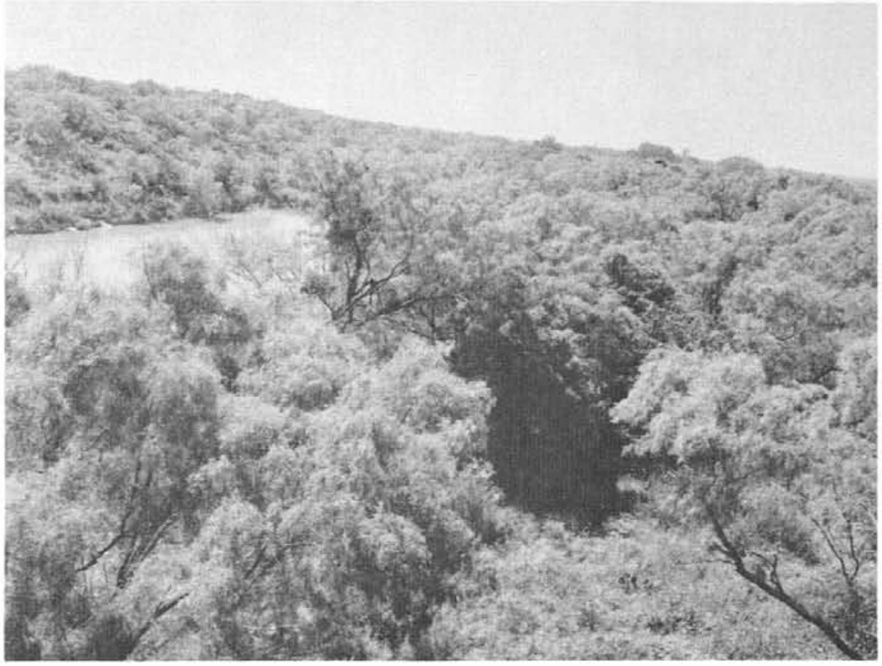

Figure 12.—Mesquite of Heavy Density. Representative of at Least 7,383 Acres in the Flood Plain of the Survey Area. May 1969.

Figure 13.—Mesquite on River Bank Extending Root System to the Water Line. In Much of the Area the Mesquite Was Growing Under Varying Degrees of Phreatophyte Conditions. July 1969.

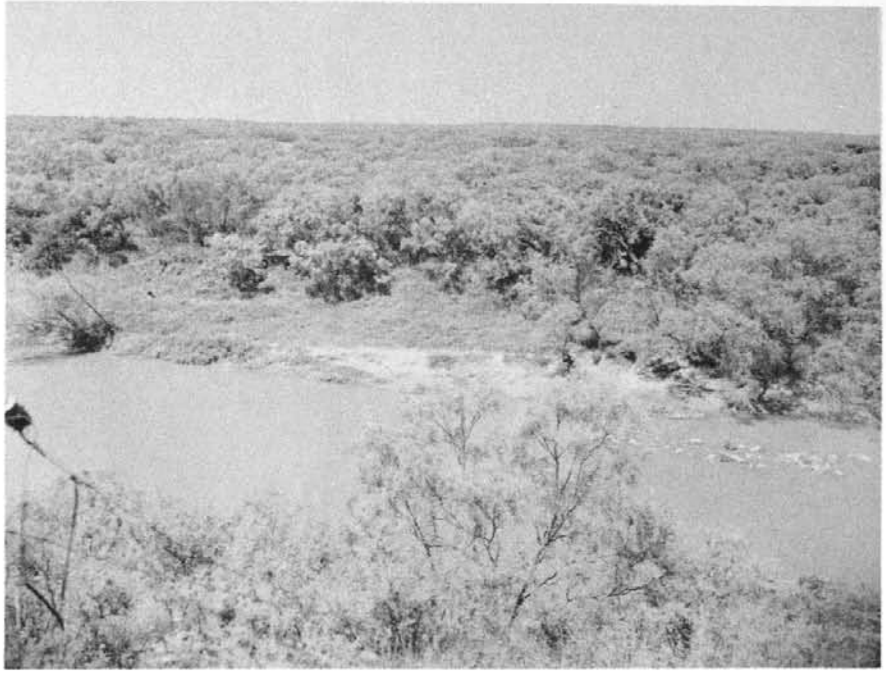

Figure 14.—Dense Mesquite on the Flood Plain Growing to the Edge of the River Banks, Taking Water Directly From the Water Table Fringe. May 1969.

Figure 15.—Root-Plowed Mesquite Area, Being Raked for Seeding to Range Grasses. Mechanical Brush Control (Root Plowing, Chaining, and Tree Dozing) Has Been Done on 20,539 Acres in the Flood Plain. May 1969.

Table 4.—Acreage of Flood-plain Soils, by County

	RUNNELS COUNTY	COKE COUNTY	MITCHELL COUNTY	SCURRY COUNTY	BORDEN COUNTY	TOTAL
89[1/] Colorado and Spur soils	–	–	5,684	1,030	6,884	13,598
21 Spur clay Loam	–	–	–	126	1,619	1,745
87 Mangum clay	–	–	1,798	164	2,481	4,443
33 Colorado-Yahola soils	5,968	6,202	–	–	–	12,170
24 Spur and Clairemont soils	127	1,592	–	–	–	1,719
38 Yahola fine sandy loam	289	3,078	–	–	–	3,367
26 Spur loam	5,509	–	–	–	–	5,509
River channel	734	955	833	132	858	3,512
Total	12,627	11,827	8,315	1,452	11,842	46,063

1/ Map symbol shown on Figures 16-23.

dominantly saltcedar with some willow, along the river. The fringe varied in width from 10 to 40 feet and averaged about 25 feet for the 256 river miles in the study area. This extensive distribution of saltcedar provides a large seed source for saltcedar spread.

SUMMARY AND CONCLUSIONS

The objectives of the survey were to determine the kinds, amounts, density, and distribution of the woody phreatophyte vegetation in the flood plain of the Colorado River from southeast Runnels County to the headwaters region in Borden County.

1. The phreatophytes mapped in the survey in 1969 included (a) pure stands of saltcedar, (b) a mixture of saltcedar and willow with the saltcedar dominant, (c) a mixture of willow and saltcedar with willow dominant, and (d) mesquite. Extensive areas of mesquite not growing as phreatophytes were also mapped in the flood plain.

   Saltcedar covered approximately 2,000 acres in the upper portion of Lake J. B. Thomas, and saltcedar and willow covered an additional 2,026 acres. Mesquite originally covered 35,025 acres, but 25,663 acres have had brush control work applied—aerial sprayed, root plowed, tree dozed, cabled, or chained—leaving 9,362 acres of untreated mesquite in the flood plain. There were 823 acres of light density, 1,156 acres of medium density, and 7,383 acres of heavy density mesquite untreated.

   There were 5,280 acres in cultivated crops and improved Bermuda grass pasture. There were 3,632 acres of river channel, roads, and built-up areas—such as along the river where it passes through Colorado City. There was a total of 46,063 acres in the flood plain of the river from southeastern Runnels County to the approximate upper end of the flood plain in Borden County.

2. The spread of phreatophytes and the greater public demand and concern for adequate supplies of high quality water will dictate the need for control programs of phreatophytes and other brush species for water salvage. These plants have high rates of water use and are of low economic value. Control programs should take into account the effects on the water regime, the wildlife, and the esthetic values involved. Study is needed on the best and most economical methods of control.

   Most of the saltcedar acreage, as revealed by the survey, is in reservoir areas and along the river channel where a full supply of water is readily available for use. From studies made by the U.S. Geological Survey and the U.S. Bureau of Reclamation in Arizona and California (Gatewood and others, 1950), as much as 3 acre-feet of annual water salvage per acre could

Table 5.—Summary of Flood-plain Land Use Acreage, by County, 1969

	RUNNELS COUNTY	COKE COUNTY	MITCHELL COUNTY	SCURRY COUNTY	BORDEN COUNTY	TOTAL
Cropland[1]	3,639	1,554	74	13	—	5,280
Mesquite, no control[2]	3,355	2,585	2,224	162	1,036	9,362
Mesquite, controlled[3]	4,390	6,326	4,514	1,057	9,376	25,663
Open[4]	70	—	30	—	—	100
Saltcedar and willow	319	407	640	88	572[6]	2,026
Other land[5]	854	955	833	132	858	3,632
Total acres	12,627	11,827	8,315	1,452	11,842	46,063

1/ Cropland—includes tilled crops and improved Bermuda grass.

2/ Mesquite—includes light, medium, and dense mesquite.

3/ Controlled, includes root plowed, cabled, chained, tree dozed, and sprayed.

4/ Open range areas. Native grass without brush cover.

5/ River channel, roads, and urban areas.

6/ 2,000 acres pure stand of saltcedar in Lake J. B. Thomas estimated by Colorado Municipal Water District is not included in total figures of saltcedar above.

be expected in these areas. One acre-foot saving per acre could also be made on the bottomlands by replacing the saltcedar with adapted grasses. Based on these findings, it can safely be assumed that at least 10,200 acre-feet of water could be saved annually with control programs.

3. The total acreage of saltcedar is less than earlier reconnaissance surveys and estimates had indicated, but the distribution is scattered throughout the channel and flood plain of the river in the study area. This broad distribution provides an effective seed source for spread of saltcedar when moisture and other conditions favor its spread. Based on the experience in the upper reaches of Lake J. B. Thomas where saltcedar has covered more than 2,000 acres since the water level lowered, it can be expected that the coverage of saltcedar will expand as the lake levels decline during summer and drought periods and the medium and low flows of the Colorado River continue. Before the dams were built for Lakes J. B. Thomas and Colorado City, and Champion Creek and E. V. Spence Reservoirs, it was reported that the occasional high runoff and floods on the river scoured out the young saltcedar and kept down rapid spread from seedlings. No doubt some of the saltcedar spread would have occurred even with no reservoir construction. Deliberate impoundment of water began July 1952 in Lake J. B. Thomas, April 1949 in Lake Colorado City, February 1959 in Champion Creek Reservoir, and December 1968 in E. V. Spence Reservoir.

Figures 16-23 show the distribution of each soil and phreatophyte species, the vegetative density, and the kind of vegetative control applied on the flood plain of the Colorado River as of 1969, from the south county line in Runnels County to the approximate upper end of the flood plain in Borden County.

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