

# The Development and Perpetuation of the Permanent Tamarisk Type in the Phreatophyte Zone of the Southwest<sup>1</sup>

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Abstract.--Several species of tamarisk were introduced into the United States in the 19th century for ornamental use. Saltcedar (*Tamarix chinensis* Lour.) became naturalized and by the 1920's was a dominant shrub along the Southwestern rivers. Its aggressive characters suit it to be a permanent dominant in much of the phreatophyte vegetation of this region. Successful management of this vegetation for any resource must carefully consider its ecological characteristics.

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## INTRODUCTION

Tamarisk (*Tamarix* spp.), first introduced into the United States for ornamental uses in the early 1800's (Horton 1964), soon spread throughout the nation. Most dramatic, however, was its invasion onto the flood plains of the Southwestern rivers, where it soon became a major vegetation type. These stands attracted little attention until it was realized they were using large amounts of water (Horton 1973). Their aggressive spread, associated with local water shortages, resulted in many action programs to remove phreatophytes.

Robinson (1965) reported that saltcedar, as the aggressive tamarisk (*Tamarix chinensis* Lour.) is often called, was occupying an estimated 900,000 acres of flood-plain land by 1961. Although this acreage has now been considerably reduced by agricultural and industrial developments and various projects for control of the species for water salvage, the remaining stands are becoming increasingly important for wildlife and other resource management. In many cases, these values outweigh those of the water that might be saved by eradication of the cover. Most of these values are discussed in accompanying papers. It should be kept in mind that flood-

plain vegetation can be managed for perpetuation of wildlife habitat and still reduce water losses (Horton and Campbell 1974).

## SPECIES CHARACTERISTICS

To become an aggressive part of any vegetation community, a species must establish itself successfully under existing conditions or to spread into new habitats created by man's modifications. Of primary importance are seed production and germination, followed by successful seedling establishment.

Many phreatophyte species--such as saltcedar, cottonwood (*Populus* spp.), willow (*Salix* spp.) and seepwillow (*Baccharis glutinosa* Pers.)-- are spread primarily by abundant wind-borne seeds which germinate quickly on water or moist soil. Seeds of these species will usually lose viability rapidly, and must germinate within 2 to 4 months (Horton et al. 1960). Though the seeds will germinate rapidly, the new seedlings require wet soils for several weeks. These species thrive best in open sun, such as along sandbars or areas disturbed by floodflows. Of the species disseminated by wind-borne seed, tamarisk is the most aggressive, and when conditions are ideal, invasion will be rapid.

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Seed germination of mesquite (*Prosopis juliflora* (Swartz) DC.) and associates is not dependent on such rigid soil-moisture conditions. While germination may be started by floodflow, especially in gravel washes, seeds are spread more by animal activity, such as defecation by cattle, coyotes, etc. Thus, mesquite has spread into the grasslands and hillsides of southern Arizona where summer rains are more frequent (Schuster 1969). In the drier areas of central Arizona, however, the species is more common in alluvial soils above the deeper groundwater tables.

Root systems of phreatophyte species vary greatly. Mesquite is usually deep rooted and saltcedar can also be deep rooted. In contrast, seepwillow is shallow rooted, growing only where the groundwater is close to the surface. Arrowweed (Pluchea sericea (Nutt.) Coville) shrubs send out lateral roots just below the surface of the soils which sprout to form dense clusters over relatively large areas (Gary 1963). Some seedlings of this species have been noted, but the dense thickets are probably caused by lateral spread.

All of the aboveground portions of saltcedar will develop adventitious roots and form new shrubs if kept wet in moist soil. Gary and Horton (1965) found that 100 percent of stem cuttings would sprout at all times of the year if they are kept moist and warm. If the stem cuttings are allowed to dry, even as short a period as one day, the sprouting ability is quickly reduced. Root cuttings did not show any signs of sprouting. Wilkinson (1966), however, reported that a small percentage of completely buried root cuttings formed stem sprouts in a mist-bed in the greenhouse. How frequently similar conditions might occur in the field is not known. Spreading by lateral roots from established saltcedar shrubs has never been observed.

After burning or cutting, saltcedar shrubs redevelop rapidly; the sprouts from the root crown will grow as much as 10 to 12 feet in a year under favorable conditions. In a study of the effect of grazing upon resprouting tamarisk shrubs, cattle removed approximately 50 percent of the foliage produced. The shrubs still grew vigorously, however, and by the second year the stand became so dense that cattle would not enter the area (Gary 1960).

Cattle and probably sheep will also browse heavily on young seedlings as well as the more mature plants if the stand is open.

Mature saltcedar shrubs are more drought resistant than the native species. They are also long lived and will mature into small trees. In New Mexico, individual trees reportedly 75 to 100 years of age have not yet shown signs of deterioration due to age.

#### VEGETATION OF THE PHREATOPHYTE FLOOD PLAINS

The original vegetation of the flood-plain areas was determined primarily by the water supply available to the plant roots. Undoubtedly the rivers flowed rather constantly and the water tables were high in much of the valley area. The area close to the river was usually dominated by a wide band of trees, principally

Fremont cottonwood (Populus fremontii Wats.), with associated willows. On the higher ground were large areas dominated by mesquite. Arrowweed was dominant in many areas. In the more saline sites, there were large patches of salt-tolerant grasses such as saltgrass (Distichlis stricta (Torr.) Rydb.), surrounded by saltbushes (Atriplex spp.) and other salt-tolerant plants.

The early pioneers used the cottonwood, mesquite, and other trees and larger shrubs for fuel and for building their homes. In the Arizona desert, the lands dominated by mesquite were some of the best soils in the valley and were soon cleared for farming. Along the Rio Grande, the first and finest farmland was created by removal of cottonwood.

These activities soon removed or at least greatly reduced the natural wooded areas along the rivers. Thus, the saltcedar found conditions ideal for rapid invasion of the flood plains. Shortly after the turn of the century saltcedar began spreading aggressively. By the 1940's, extensive areas were dominated by saltcedar along the Gila (Marks 1950, Haase 1972, Turner 1974), Salt (Turner and Skibitzke 1952, Gary 1965), and Rio Grande (Campbell and Dick-Peddie 1964) as well as along the Pecos and Colorado (Robinson 1965). It is now also found along many smaller streams, around springs and seeps, by roadsides, and in many other areas of the West wherever there is sufficient moisture to germinate the seeds and establish the seedlings.

In recent years, much of the land dominated by saltcedar has been converted to farms or industrial use near the towns and cities, or cleared for water salvage projects.

In spite of these major changes, there are still large areas occupied by wildland vegetation, although they are usually altered by man. Haase (1972), in his study of the lower Gila River, indicates that saltcedar occupies about 50 percent of the total bottom-land area. Under present conditions he feels this dominance will not be changed unless there is some marked fluctuation in the water table or in other environmental conditions. His analysis and breakdown of the communities is very similar to Marks (1950).

Somewhat similar communities were studied along the Salt River above Granite Reef dam east of Tempe (Gary 1965). The saltcedar communities were separate and distinct from the arrowweed, and occupied sites with shallower water tables and a silt loam soil, contrasted to the sandy loam found under the arrowweed and mature mesquite. There were a few cottonwood

trees, but not enough to be included in the analysis.

Along the Rio Grande, Campbell and Dick-Peddie (1964) found that saltcedar was the major dominant in southern New Mexico, but that cottonwood, Russian-olive (Eleagnus angustifolia L.), and other species increased upstream. These authors observed that cottonwood assumes dominance over saltcedar if the cottonwood is left to develop into a full tree without disturbance. In mature stands of cottonwood, saltcedar grows only in natural openings and along the outer edge of the cottonwood stand.

Along some flood-plain reaches, dropping water tables have reduced the stand of saltcedar, because ground water is now apparently out of reach of its roots. In the 1940's a dense stand of saltcedar extended along the Salt River from east of Mesa through Tempe and Phoenix to its confluence with the Gila River. Shrubs are now growing along this river only as widely spaced desert-type plants dependent on floodflows and rain for survival. In dry periods, these saltcedar shrubs will make almost no growth and tend to drop their leaves. They leaf out quickly when water becomes available, however.

Fires burning through such stands kill a fairly large number of plants and create an even more open stand. It is probable, in this desert climate, that shrubs must be spaced 15 or 20 feet or more apart to have sufficient root systems to withstand lengthy droughts. A heavy, dense stand will survive only where the water table is within 15 or 20 feet of the surface.

Thus, although saltcedar has aggressively spread over a large portion of the western flood plains, it has probably reached its maximum spread or is being reduced in most of the area. However, it will always threaten to invade aggressively after any change in local conditions. Its ecology must be understood if management of flood-plain vegetation is to be successful.

#### FUTURE OF TAMARISK STANDS

Future changes in the vegetation cover of flood plains now dominated by saltcedar is a concern of many land managers. The aggressiveness of saltcedar suggests that it will remain a dominant in most areas if conditions remain as at present and often may invade where conditions change in other types.

Seeds of cottonwood, willow, and seepwillow have characteristics similar to saltcedar. Thus, in theory they are highly competitive. However, saltcedar produces seed

over a much longer period and also can become established after a summer recession flow when seeds of the other species are not present. In addition, tamarisk seedlings can tolerate drying at an earlier stage and, while often grazed, are less sought after than cottonwood and willow. Also the mature shrubs are more drought resistant which tends to eliminate many of the competing native shrubs and trees.

With the characteristics of the various species in mind, let us consider the different types of vegetation along the rivers. A dense, mature stand of tamarisk would not have any bare soil underneath, and thus there would be no opportunity for regeneration of any species. Unless subjected to fire or flood, the stand would not deteriorate. However, if cottonwood was present in the initial seedling establishment stage, there can be a gradual increase of dominance of this species as the tree grows. This relationship can often be observed along the Rio Grande south of Albuquerque and, very rarely, at lower elevations such as along the San Pedro River, south of Winkelman, Arizona. Thus, mature saltcedar stands should not be expected to yield to any invading vegetation type unless the water table drops or the existing stand is altered by man, fire, or flood.

Lowering water tables may kill a large portion of the shrubs. The degree of damage would depend upon the rapidity of the drop and the depth of the final water table. In some cases, shrubs may die back but readjust to the lower groundwater if it stabilizes at 20 feet or so. The resulting stand after the root systems are extended downwards may be nearly as dense as had previously existed.

If the water table is at 5 feet or less, saltcedar does not develop densely and the intershrub spaces are usually dominated by saltgrass or Bermudagrass (Cynodon dactylon (L.) Pers.) Dropping water tables in such an area will allow the saltcedar to grow dramatically and replace the grass.

Fire burning through a saltcedar stand will not kill the shrubs, as they tend to sprout vigorously unless they are growing under stress. Then as many as half of the shrubs may not survive.

Floods do, at times, remove large areas of saltcedar. If this occurs during or just before the seeds are flying, seedlings will likely be established along the edges of the receding flows more aggressively than other species. Sometimes, such as after flash summer floods, drying is too rapid for seedling survival. Buried root crowns or above-ground portions of branches and smaller stems will often sprout, however, even if conditions are not favorable for seedling establishment.

## STUDIES IN TAMARIX TAXONOMY

The identification of saltcedar and its proper relationship to Old World form has long been confused. The taxonomy of Tamarix is difficult primarily because of the lack of distinct identifying floral characteristics, and the great variation among plants in the same community. Major confusion is caused by the length of the blooming season (March to October in desert climates) with changing inflorescence types and floral characters as the season progresses. Thus, accurate species identification requires several collections from a shrub to sample seasonal variations.

The early floras usually listed T. gallica as the introduced species. This terminology continued until McClintock (1951), in a study of horticultural tamarisks, stated that T. gallica was a rare shrub in the West, and the common aggressive saltcedar was Tamarix pentandra Pall.

Baum (1966), after extensive study of the genus Tamarix at the Hebrew Univeristy, Jerusalem abandoned the name T. pentandra because it did not follow the standard rules of nomenclature. He considered the widespread American tamarisk, after examining material from various American herbaria, as consisting of two species: Tamarix ramosissima Lebed. and Tamarix chinensis Lour. (Baum 1967). T. gallica was reported as occurring mostly on the Texas Gulf Coast. Tamarix africana Poiret and several others were reported as horticultural species.

After detailed studies of many shrubs of diverse species and forms obtained from various American and Old World localities and grown on the Arizona State Univeristy Farm as well as herbarium specimens collected elsewhere in the United States, I feel that our aggressive saltcedar, though extremely variable, should be considered as one species and not two as outlined by Baum. The oldest synonym applied to the aggressive tamarisk group is Tamarix chinensis Lour.; thus this name should now be accepted for the species so commonly naturalized in the West.

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