Tamarix: Impacts of a Successful Weed

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Saltcedar (*Tamarix* sp.) is an introduced shrub and phreatophyte of western North America where it occupies in excess of one and one-half million acres (Robinson 1965). It is a vigorous, woody invader of moist pastures, rangelands, and riparian habitats; it is poor in forage value and, as a weed, it is continually causing management problems.

Originally thought to have been introduced by the Spaniards, it is now believed that the first introduction of saltcedar to North America was made by nurserymen on the east coast of the United States in 1823. In 1828, Bartram's nursery of Philadelphia was selling saltcedar and in 1868, the U.S. Department of Agriculture began raising saltcedar and reported that six different species were growing in the Department Arboretum (Horton 1964).

Although saltcedar was planted as an ornamental in the western United States during the latter half of the 1800's, it apparently did not escape cultivation until the 1870's. The only accurate information concerning its escape is found in herbarium collections. Little attention was paid to the increasing spread of saltcedar for the next several decades, and there is no record that anyone was aware that a problem was in the making. For example, in the early 1900's farmers were using this plant for erosion control (Everett 1980). However, it became clear by the 1920's that saltcedar was becoming a serious problem for it was spreading rapidly from one watershed to another.

During this time, early pioneers throughout the Southwest and in the Colorado River Basin began to populate preferred areas along the various waterways. The native woody plants along these rivers and flood plains were harvested for building materials and fuel, as well as cut to allow for agricultural development and subsequent overgrazing (Horton and Campbell 1974). Later in the early 1900's, these same lands were left barren because of upstream water use, damming, and the abandonment of tilled land during the Great Depression. Increasing soil salinity also contributed to the decline of the indigenous riparian forests (Engel-Wilson and Ohmart 1978).

Saltcedar's ability to colonize riparian areas (Figure 1) rapidly as well as accommodate wide variation in its environment has led to its being classified as a troublesome weed. The characteristics of saltcedar that have enabled river bank and shoreline dominance are numerous. Baker (1974) developed a list of characteristics that is evidenced in "the ideal weed." He indicated there are no species which fill all of the categories; instead, the greater the number of weed-like characteristics combined in a single species, the more serious a weed the plant should be. Saltcedar as a species combines 9 of his 12 characteristics (Table 1). To Baker's 9 we have added 4 additional characteristics (Table 1) that appear equally important to saltcedar's success as a weed.

Table 1. Characteristics of saltcedar which contribute to its success as a weed. The (*) corresponds to Baker's (1974) criteria of the ideal weed.

*1.	Continuous seed production for as long as growing season permits.
*2.	Cross-pollination by the wind.
*3.	Self-compatible when cross-pollination unavailable.
*4.	High seed output in favorable environmental circumstances.
*5.	Ability to produce seed under a wide range of environmental conditions.
*6.	Adapted for long or short range dispersal.
*7.	Vigorous vegetative reproduction capability.
*8.	Brittleness in its stems and not easily drawn from the ground.
*9.	Competes interspecifically by allelochemics due to presence of salt-glands.
10.	Capability for tolerating extreme range of environmental conditions.
11.	Vigorous root sprouter following fire.
12.	"Facultative phreatophyte" due to ability to live totally inundated or in total absence of saturated soils.
13.	Difficult to control with foliar chemicals.

Foremost, saltcedar has the capacity to produce enormous numbers of seed during an extended production season of late May to October. One mature saltcedar plant can produce up to 500,000 seeds per season. The tiny seeds have high viability and long hairs allowing for wind distribution, but may also be carried and deposited along sandbars and riverbanks by water (Tomanek and Ziegler 1960).

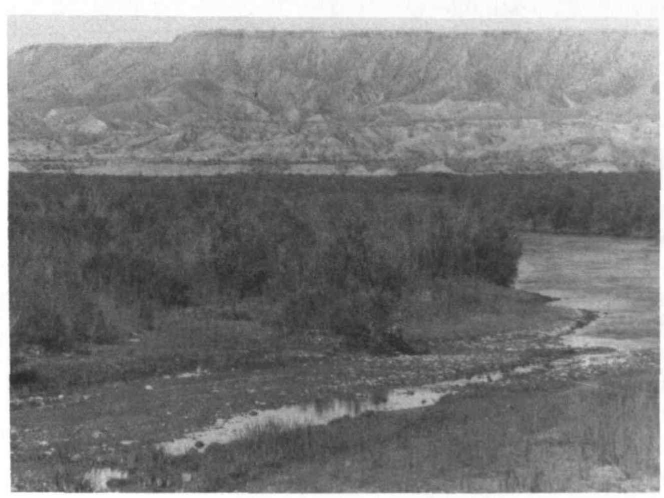

Fig. 1. *Established stands of saltcedar along the floodplain of the Virgin river in southern Nevada.*

Observations in the field indicate saltcedar seedling establishment most often occurs when soils are seasonally saturated at the surface such as where water has recently

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Fig. 2. *Young saltcedar plants which have recently established where flood water has receded.*

receded from flood or seasonal high water levels (Figure 2). Once established, the primary root of saltcedar grows steadily downward with little branching until it reaches the water table. Secondary branching of the root becomes profuse upon contact with the water (Tomanek and Ziegler 1960). The primary root of a tree in one study (Merkel and Hopkins 1957) was followed to a depth of 16 feet, where it was 3/16 inch in diameter and still descending. The water table, in this case, was located at a depth of 26 feet. Upon establishment, saltcedar rapidly dominates an area, forming dense stands (Figure 3). Mature plants reproduce vegetatively, by adventitious roots or by seed. Its extensive lateral root system plus its habit of dripping salt onto the soil beneath its canopy make it competitive with other vegetation for space and water and, therefore, restricts competitive undergrowth.

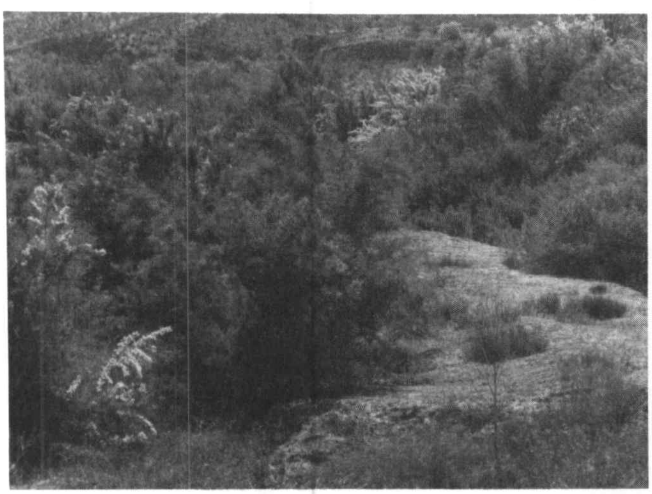

Fig. 3. *Dense stands of saltcedar along the floodplain of the Virgin river. Plants in foreground are in bloom.*

Only xeric species (plants requiring little water) or halophytes (salt-tolerant species) can tolerate the understory environment of saltcedar (Brotherson et al. 1984).

Saltcedar is also extremely adaptable and tolerant of a wide range of environmental conditions: (1) It prefers to grow in very saline soils (up to 15,000 ppm sodium) (Carmen and Brotherson 1982); (2) it can withstand inundation, which frequently occurs in its environment for long periods of time (70–90 days); (3) it can vegetatively resprout after fire, severe flood, or treatment with herbicides (Warren and Turner 1975); and it is able to accommodate wide variations in soil and mineral gradients in its environment (Brotherson and Winkel 1986).

The problems that are associated with saltcedar when found in dense stands are of major concern to resource managers. First, saltcedar has been labeled an "extreme phreatophyte" because of its ability to exploit deep water tables. However, once established, it can survive almost indefinitely in the absence of surface saturation of the soil (Everitt 1980). Among phreatophytes, saltcedar has very high transpiration rates. In one experiment, saltcedar transpired from 0.1 inch to 0.4 inch of water per day and from 4 ft to 13 ft of water per year (Davenport et al. 1982). Robinson (1965) showed that saltcedar in the Safford and Gila River valleys of Arizona used between 4 and 5 acre feet of water per acre per year. Along the Colorado River it has been estimated that up to 568,000 acre feet of water are lost per year to channel vegetation of which saltcedar is a major component (Van Hylckama 1976).

Following are some figures which give an estimated value of the water being lost because of saltcedar invasion. Agriculture uses approximately 177,000 acre feet of water per year from the Bonneville Unit of the Central Utah Water Project at a cost of $50 per acre foot. Another 91,000 acre feet of water are used annually for culinary purposes, at $200 per acre foot. Therefore, a total of 261,000 acre feet of water worth almost $27,000,000 is used annually from these projects. Robinson (1965) estimates that one acre of saltcedar consumes 4 to 5 acre feet of water per year which would be worth $200 to $1,000 per acre annually.

A second major problem created by saltcedar is the narrowing of river channels. The saltcedar slows the river flow,

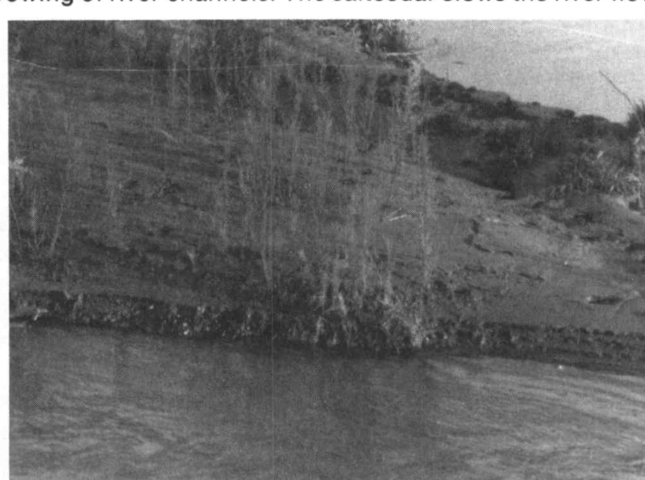

Fig. 4. *Saltcedar seedling establishment on sandbar of Virgin river following spring flooding.*

which increases deposition. When this occurs a number of times at high water, sediments build along the river bank. As the river recedes, saltcedar establishes itself further out into the channel (Figure 4). At the next high water event, more sedimentation occurs further narrowing the channel. This process continues until streamflow is severely reduced. On the Brazos River, in Texas, this trend has continued for over 40 years resulting in the river's width being reduced by up to 71% in some places (Blackburn et al. 1982). Similar problems have also occurred on the Salt and Gila Rivrs near Phoenix, Arizona (Graf 1980).

Saltcedar also effects local bird communities. In comparing the number of birds in native cottonwood, willow, mesquite and saltcedar stands, saltcedar was consistently more depauperate (Cohan et al. 1978). Doves and other granivores or ground-feeding birds were found to nest in saltcedar but forage in nearby agricultural fields. Other avian frugivores and insectivores tended to avoid saltcedar altogether.

Despite its many problems, saltcedar has some beneficial characteristics. It can tolerate harsh environments and has become established because of disturbances created in the riparian forests and thickets along riverbanks and flood plains. Saltcedar now provides some form of erosion control and wildlife habitat in riparian areas. Saltcedar's extensive root system is definitely more stable and resistant to erosion than the area was prior to colonization. The channel stabilization and increased sediment deposition reduces sedimentation of reservoirs further downstream. Saltcedar is also one of the few plants that can colonize and stabilize extremely saline soils (Campbell 1970).

In areas where saltcedar is a problem, it would be beneficial to have an effective control method. Several have been employed, including flooding, mechanical removal by cutting or shredding, biological control, burning and herbicides (Stott et al. 1982). Mechanical control by cutting or shredding serves only to break down the plant's brittle stems leaving the root system to vigorously resprout. The most successful control methods employed have been burning in combination with herbicides and/or root plowing in combination with herbicides (Howard et al. 1983). These methods were found to be from 85% to 100% effective. The success of root plowing in combination with herbicides is related to the fact that once saltcedar's roots are severed by a root plow, it must obtain water and nutrients from above the cut line. By placing the herbicide into the altered rooting zone, herbicide uptake is increased to lethal levels. However, this type of treatment, which is difficult and expensive, is limited in many areas because of terrain (Hollingsworth et al. 1979).

In reviewing the challenges of managing saltcedar, there appear to be no universal solutions. Each infested area has unique problems, sometimes the most pressing being flood control. In other situations, water conservation, wildlife habitat, beautification, alone or in combination with recreation, are the primary needs. In each case, something different may be required. Cost and various environmental considerations will determine the control method finally chosen. It is the author's opinion that saltcedar's invasion and ecological impacts have not received adequate attention. Inadequate information will continue to handicap control programs until the cost of the water and nuisance of floods becomes great enough to arouse the public as well as state and federal governments.

Available information demonstrates the need for better management of saltcedar along our waterways. Riparian zones are highly valuable resources, especially in the Southwest, and they should be managed wisely. Management of saltcedar has proved to be difficult and expensive. A firm commitment must be made concerning the control of saltcedar because of its unparralleled aggressiveness.

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