THE SALTCEDAR MANAGEMENT WORKSHOP

PROCEEDINGS OF THE
SALTCEDAR MANAGEMENT WORKSHOP
JUNE 12, 1996
MARRIOTT'S RANCHO LAS PALMAS RESORT
RANCHO MIRAGE, CALIFORNIA

SPONSORED BY

UNIVERSITY OF CALIFORNIA &
COOPERATIVE EXTENSION,
IMPERIAL COUNTY AND UC DAVIS

CALIFORNIA
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PREFACE

The Saltcedar Management Workshop was a huge success, attracting more than 150 people from 10 western states. Nine federal agencies were represented, along with four Native American tribes, four state agencies from California and Arizona, numerous local government entities, private consultants, pest control advisors, landscape and nursery businesses, three NGO's (nongovernmental organizations), and three Universities. The extent and severity of the saltcedar problem in the western US is apparent by the interest shown in this workshop.

The Saltcedar Management Workshop happened because of the hard work and thoughtful input by the organizing committee. These people came together one day last March, and in two hours, had outlined the whole workshop and suggested most of the speakers. The members of the organizing committee are listed on the following page. Most of these individuals were also speakers at the workshop. The papers included in this Proceedings should serve as an excellent reference both for workshop attendees and to those who could not join us in Rancho Mirage.

Additional copies of the proceedings are available; to order, send a check payable to the Ag Extension Trust Fund for $10.00 per copy to Carl E. Bell, Cooperative Extension, 1050 E. Holton Rd., Holtville, CA 92250. Proceedings Editors are Joe DiTomaso and Carl E. Bell

SALTCEDAR MANAGEMENT WORKSHOP

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ORIGIN, HISTORY AND CURRENT RANGE OF SALT CEDAR IN THE U.S.

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I. ORIGIN/TAXONOMY

The genus *Tamarix* (common name "tamarisk") contains many species (as many as 54 are formally recognized) originating from widely dispersed areas located in arid and semi-arid regions of the Old World (Baum, 1967; DeLoach, 1989). Examples are *Tamarix pentandra* from the Middle East, *T. articulata* and *T. tetragyna* from Israel, *T. articulata-africana* from the Libyan Sahara, *T. aphylla, T. ericoides* and *T. dioica* from India and Pakistan, *T. chinensis* , *T. parviflora* and *T. ramosissima* from southwestern Asia, *T. taklamakanensis* from the Sinkiang, *T. gallica* from Sicily and Morocco and *T. gallica canariensis* from the Canary Islands (DeLoach, 1989). There are no species of tamarisk native to the New World (DeLoach, 1989).

II. HISTORY/IMPORT INTO THE U.S.

Eight tamarisk species were introduced in the U.S. in the early 1800's, mostly from Asia (DeLoach, 1989). Some were introduced for their ornamental values (e.g., *T. chinensis* and *T. ramosissima*), others for planting in wind breaks (e.g., *T. aphylla*) or to stabilize eroding stream banks (Neill, 1985).

III. PRESENT DISTRIBUTION IN THE U.S.

While *T. aphylla* (a large evergreen tree often planted along railroad tracks and referred to as "athel") has invaded some riverain ecosystems in Australia (Griffin et. al., 1989), it has not acquired weedy habits in North America. This is not the case for *T. chinensis*, *T. parviflora* and *T. ramosissima* (small deciduous trees or shrubs often called "salt cedar") which are invasive weeds throughout the southwestern United States (Kerpez and Smith, 1987; Kunzmann *et al.*, 1989). They have successfully invaded nearly every drainage system in arid and semi-arid areas, occupying over 607,050 hectares (Brotherson and Field, 1987), including approximately 6,475 hectares in California (Johnson, 1987). Today, salt cedar occupies suitable habitat west of the Great Plains, north into Montana and south into northwestern Mexico (DeLoach, 1989).

A first phase of the spread of salt cedar in the southwestern U.S. affected the floodplains of major drainages. By the 1940s, saltcedar had spread through extensive areas along the Gila, Salt, Pecos and Colorado River, as well as the Rio Grande (Horton, 1977). Less severe and seasonally altered flooding regimes brought about by the dams and flood control structures constructed along these rivers provided ideal conditions for the establishment, reproduction and spread of salt cedar (DeLoach, 1989; Kerpez and Smith, 1987). It is estimated that 1400 square miles of floodplain land in the western U.S. was occupied by salt cedar by 1961 (Neill, 1985). Large intermittent desert streams, such as the Mojave River near Barstow, California, have seen their original riparian vegetation of willows and cottonwoods replaced by salt cedar, but disturbances other than flood control may have favored that process. In Afton Canyon, 70% of the original native vegetation has been replaced by salt cedar, mostly since the 1960s. Reduced river flows, off-road vehicle disturbance, year-round grazing and native tree cutting are hypothesized to have contributed to that vegetation type conversion (Lovich et al., 1994).

A3

A3

More recently, salt cedar has expended its range into interior desert riparian habitats that are otherwise unaffected by human activities. This invasion of desert riparian areas by salt cedar has occurred fairly recently, during the last couple of decades (Lovich et al., 1994). In the Colorado Desert of southern California, *Tamarix ramosissima* can now be found in many of the springs (e.g., Buzzard Spring in the Eagle Mountains), streams (e.g., Palm Canyon in the Santa Rosa Mountains), and in some of the more mesic desert washes (e.g., Thousand Palm Canyon in the Coachella Valley, prior to eradication).

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IDENTIFICATION, BIOLOGY AND ECOLOGY OF SALT CEDAR

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Taxonomy

Tamarix (salt cedar) is one of four genera of Tamaricaceae and is represent by 90 species worldwide. The genus was named after the Tamaris River in Spain and consists of halophytic shrubs and small trees native to Western Europe, the Mediterranean, North Africa, and northeast China and India (Baum 1967). Eight species of *Tamarix* have been introduced into the United States, primarily as ornamentals or for wind breaks and shade. Of these species, five are present in California. Most species are weedy, particularly *T. parviflora*, previously known as *T. tetrandra*, and *T. ramosissima*, previously known as *T. pentandra*. One species which is less weedy is the large evergreen tree, athel (*T. aphylla*). Table 1 compares the morphology, distribution and abundance of the salt cedar species found in California.

Table 1. Comparison of the naturalized five California *Tamarix* species.

Species	Height	Leaves	Flowers	Range	Abundance
T. aphylla	tree <12 m	not overlapping, strongly clasping	5-parted, nectar disk lobes wider than long, stamens alternate disk lobes	San Joaquin valley to desert	escaped populations uncommon, often cultivated
T. chinensis	tree <10 m	overlapping, oblong to narrowly lanceolate	5-parted, nectar disk lobes wider than long, stamens alternate disk lobes	Southern California, primarily desert	uncommon
T. gallica	shrub or tree <8 m	overlapping, linear to narrowly lanceolate	5-parted, nectar disk lobes longer than wide, stamens together with disk lobes	primarily in Southern California, as far north as San Francisco Bay	uncommon
T. parviflora	shrub or tree 1.5-5 m	overlapping, linear	4-parted, nectar disk lobes longer than wide, stamens together with disk lobes	throughout Northern and Southern California	common, serious weed problem
T. ramosissima	shrub or tree <8 m	overlapping, ovate	5-parted, nectar disk lobes wider than long, stamens alternate disk lobes	San Joaquin valley to desert, uncommon in Northern California	common, serious weed problem

Biology

Salt cedar species are phreatophytes (deep-rooted to reach water table) that depend on groundwater for their water supply. However, under some conditions salt cedar can grow where no groundwater is accessible. Thus, it is classified as a facultative rather than obligate phreatophyte (Kerpez and Smith 1987).

Shoot Growth. Weedy salt cedars can grow to heights of 3 to 4 m in a single growing season under favorable conditions (Sisneros 1991). Furthermore, mature salt cedar is remarkably tolerant to a variety of stress conditions, including heat, cold, drought, flood, and high concentrations of dissolved solids. By dropping its leaves and halting growth, salt cedar can withstand lengthy periods of drought. In contrast, mature plants can also survive complete submergence for as long as 70 days (Kerpez and Smith 1987).

Root Growth. The root system of salt cedar is extensive, and is largely responsible for its competitiveness and survival under stress. Initially, the primary root grows steadily downward with little branching until it reaches the water table, which can be at depths of 3 m or deeper (Brotherson and Winkel 1986). Once the water table is reached, secondary root branching becomes profuse.

Adventitious roots easily develop from submerged or buried salt cedar stems. Thus, expansion in salt cedar infested areas can also be through vegetative growth (Kerpez and Smith 1987).

Reproduction. Seedlings mature rapidly and produce small, white or pinkish flowers often by the end of the first year of growth (Neill 1985). Flowers have four or five sepals and petals, three to five styles, and stamens borne on a fleshy, lobed, hypogynous disk. The flowers produce many 3 to 5-valved capsule fruit usually having a tuft of hair on the end to aid in wind dispersal (Kerpez and Smith 1987). Seeds can also be carried and deposited along sandbars and riverbanks by water (Brotherson and Field 1987). A single large salt cedar plant can produce a half million seeds per year, primarily from late May to October.

Germination. Seeds which develop from mature plants are quite small and light (0.1 mg) (Sisneros 1991), and will germinate on saturated soils or while afloat. Once wetted, fresh seeds usually germinate within 24 h (Kerpez and Smith 1987). Due to their short-lived viability, salt cedar seeds must come in contact with suitable moisture within a few weeks of dispersal. Seedling mortality is high when soils are scoured, dry up too quickly, or submergence for four to six weeks following germination (Shrader 1977).

After summer rains, salt cedar seedlings can rapidly colonize new moist areas because flowering and fruiting cycles provide a continual supply of available seeds (Engel-Wilson and Ohmart 1978). This strategy is of considerable advantage over native riparian species since salt cedar can exploit suitable germinating conditions over a longer time interval (Howe and Knopf 1991).

Seedling Establishment. Establishment of salt cedar seedlings occurs in high seasonally saturated soils (Brotherson and Winkel 1986, Brotherson and Field 1987). This requirement is most often met along river or reservoir banks where slowly receding water levels create optimum seed beds. In the initial stages of establishment, roots grow slowly the first two to four weeks, and will not survive more than one day if the soil dries. Although the seedlings can survive submerged for several weeks, they are easily uprooted by even a weak current and do not tolerate flooding within a period of several months subsequent to germination (Kerpez and Smith 1987).

On some occasions salt cedar can become established in typically dry locations if these areas experience an unusually wet spring and early summer, or if rivers or lakes temporarily flood their boundaries (Carman and Brotherson 1982). Once established, salt cedar can survive almost indefinitely in the absence of surface saturation of the soil (Brotherson and Field 1987).

Ecology

Salt cedar grows to about 1,650 m (5,400 ft) in elevation (Brotherson and Winkel 1986) and prefers very saline soils. Typically, salt cedar occupy sites with intermediate moisture, high water tables, and little erosion. However, mature plants can withstand long periods of water inundation (70-90 days). They can resprout vegetatively after fire, severe flood, or treatment with herbicides and are able to accommodate wide variations in soil and mineral gradients (Brotherson and Field 1987).

Soil. Successful stands of salt cedar are generally found in non-rocky soils composed of silt loams and silt clay loams high in organic matter (Brotherson and Field 1987).

Salinity. Salt cedar is not an obligate halophyte but can survive in areas where groundwater concentration of dissolved solids approaches 15,000 ppm (Carman and Brotherson 1982), but typically occur in areas averaging about 6,000 ppm salt (Brotherson and Winkel 1986).

Following fire, higher alluvium salinity and elevated concentrations of phytotoxic boron can delay the reestablishment of native trees and shrubs, particularly *Populus* and *Salix*. These areas are very susceptible to invasion by salt tolerance species of *Tamarix* (Busch and Smith 1993).

Acidity. Salt cedar has a slight preference for alkaline conditions (pH = 7.5) compared to other native shrubs (Brotherson and Winkel 1986).

Allelopathy

Salt cedar exudes excess salt crystals from openings in its scale-like leaves (Neill 1985). It has been reported to contain 41,000 ppm dissolved solids in the guttation sap (Duncan et al. 1993). Not only can these glands concentrate salt, but they also secrete various other ions, including boron (Busch and Smith 1993). These salts are eventually deposited on the soil surface under the plant, sometimes forming a hard crust (Kerpez and Smith 1987). Such deposits of salt-encrusted needles can inhibit the germination of other species (Egan et al. 1993). A combination of this allelopathic effect and the extensive lateral root system contribute to the ability of salt cedar to out compete other vegetation for space and water (Brotherson and Field 1987). In some communities, salt cedar is the dominant overstory species, whereas salt tolerant grasses, such as saltgrass (*Distichlis spicata*), are dominant in the understory (Brotherson and Winkel 1986).

Water Acquisition. The longer the community has been invaded by salt cedar the greater will be the capacity to lower the water table in the soil (Brotherson et al. 1984). With this overall drying out of the habitat, more xeric plant species which occupy the understory in established salt cedar stands.

A dense stand of salt cedar will grow where the water table is between 1.5 and 6 m from the surface (Table 1). Water use of salt cedar is generally considered high, but evapotranspiration rates can vary with water table depth and soil salinity. Under dry or extremely hot conditions, salt cedar does not always transpire at potential rates (Davenport et al. 1982). Water conservation under these situations is of ecological significance as it enables *Tamarix* species which grow in hot desert environments to open their stomata just at daybreak during the coolest and most humid hours of the day. This allows the plants to acquire adequate CO_2 without losing much water. The stomata close during the hotter afternoon hours, further reducing water loss (Hagemeyer and Waisel 1990). Summer evapotranspiration rates can also vary considerably with stand density and other stress conditions (Davenport et al. 1982).

As a facultative phreatophyte, *Tamarix* species are capable of extracting soil moisture from less saturated soils in areas with deeper water tables. This appears to be an adaptation that obligate native phreatophytes such as *Populus* and *Salix* do not possess (Busch et al. 1992), and may partially explain the competitive exclusion of these native shrubs by salt cedar in southwestern riparian areas.

Table 2. Characteristics of floodplain zones at varying groundwater depths (from Shrader 1977).

Zone	Depth to groundwater (m)	Salt cedar growth	Other vegetation	Water salvage prospects	Other uses
1	1	dwarfed & multi-stemmed	vigorous saltgrass & bermudagrass	little	good grazing, flood passage, minimal wildlife use
2	1.5-2.5	major stands	excellent saltgrass	large savings	wildlife utilization (doves), some grazing, bees
3	2.5-6	major stands	xeric types	great water savings	wildlife utilization (doves), bees
4	>6	scattered individuals	xeric types	none expected	limited use

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SALTCEDAR IMPACTS ON SALINITY, WATER, FIRE FREQUENCY, AND FLOODING

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The biological characteristics of saltcedar (*Tamarix ramosissima*) that make it an aggressive weed also can cause undesirable physical changes in the plant's environment. The four most-common physical changes are briefly described here. They are: (1) increased soil salinity inhibiting native plant germination and growth, (2) increased water consumption and loss, (3) increased wildfire frequency, and (4) increased frequency and intensity of flooding.

Suggested by its name, saltcedar has the ability to excrete salts from glands on its leaves allowing the plant to tolerate saline soils and groundwater. Rather than excluding salts from the roots as do most plants, saltcedar freely takes up salts and then voids them aboveground. The ions excreted (eg. Na, K, Ca, Cl) are the same as those found in the soil surrounding the plant's roots (Berry 1970). The plant therefore acts as a conduit transporting salts from the groundwater to the leaf surface. The process also concentrates the salts; salt-gland exudate containing 41,000 ppm total solids has been measured on plants rooted in groundwater containing 2,000 ppm total solids (Gatewood et al. 1950). Because saltcedar is deciduous, all of the salts exuded eventually reach the soil surface, and salinity beneath the plant can increase as dropped leaves accumulate year after year until rainfall carries the salts through the soil and back to the groundwater.

Lacking a similar adaptation to saline soils, many native riparian plants can be affected by the salts transported by saltcedar to the soil surface. Growth by cottonwood (*Populus fremontii*) and Goodding's willow (*Salix gooddingii*) is inhibited by salinity greater than 1,500 ppm, whereas saltcedar can tolerate soil salinity up to 36,000 ppm (Jackson et al. 1990). We examined the soil salinity and the groundwater depth and fluctuation, two additional factors critical to riparian plant growth, in areas dominated by saltcedar on the lower Colorado River floodplain to estimate site suitability for restoring native plants. Of the 18,762 acres evaluated, 10 percent was found suitable for cottonwood or willow (*Salix gooddingii* or *S. exigua*), 45 percent was found suitable for honey mesquite (*Prosopis glandulosa*) or screwbean mesquite (*P. pubescens*), and 45 percent was found suitable for quailbush (*Atriplex lentiformis*) (Bureau of Reclamation 1995).

Water consumption has been saltcedar's most-studied physical property, primarily resulting from interest in removing or replacing the plant to conserve water. The term evapotranspiration is used to describe water loss per land area and includes evaporation from soil and transpiration, the biological process whereby plants lose water from their stomates while taking up carbon dioxide. Saltcedar is atypical, because it loses water by transpiration *and* evaporation due to the water evaporated from the salt glands.

Evapotranspiration is easy to understand but difficult to measure. Most studies have used one of four techniques: (1) planting plants in tanks and measuring water loss within the tank, (2) measuring the flow of xylem from the roots to the leaves, (3) measuring the decrease in flow within a stream and crediting part of the decrease to evapotranspiration, and (4) measuring microclimate to estimate the movement of water vapor upwards from the plant canopy. Each method has its advantages and disadvantages. For example, one can accurately measure xylem flow within several branches, but extrapolating the measurement over an entire acre may be difficult.

Differences between methods of measuring evapotranspiration and study sites has produced a wide range of water uptake estimates for saltcedar, varying from 1.4 feet per year to 10.5 feet per year (Bureau of Reclamation 1992). A recent study by Desert Research Institute (Ball et al. 1994) using the Bowen Ratio/Energy Balance method estimated an evapotranspiration rate of 2.3-2.5 feet per year from monotypic stands of saltcedar adjacent to the lower Colorado River near Blythe, California. The Bowen Ratio/Energy Balance method estimates evapotranspiration by measuring the amount of energy (mostly sunlight) absorbed by the plant community and used to evaporate water. As a comparison, the same study estimated an evapotranspiration rate of 1.6 feet per year for honey mesquite and 2.3 feet per year for quailbush. Maximum evapotranspiration by saltcedar was observed in the early morning when salt gland exudate was most visible, suggesting that the glands may contribute more to saltcedar's water loss than do the stomates.

The most observable impact of saltcedar on available water has been instances where surface water has visibly increased following plant removal. Two notable examples include saltcedar management projects at Eagle Borax Works Springs in Death Valley National Park (Rowlands 1990) and at Spring Lake near Artesia, New Mexico (Keith Duncan, *pers. comm.*). At Eagle Borax Works Springs, historical records described a natural spring and its associated ponds progressively drying-up concurrent with the spread of saltcedar beginning in 1950. In 1971, the park staff conducted a controlled burn of 10 acres to restore the site, and 8 weeks later the water elevation had risen 1.2 feet and a 1-acre pond had reappeared. At Spring Lake, saltcedar had invaded and covered a 13-acre spring-fed lake, eliminating its surface water by 1968. Saltcedar was effectively controlled with herbicides in 1989, and by 1992 the water table had resurfaced.

Wildfires are an increasingly common occurance in saltcedar along the lower Colorado River, partly the result of increasing population densities along the river's shorelines. The prevalence of fires in saltcedar has been attributed to the accumulation of leaf litter (Kerpez and Smith 1987) and dead and scenescent woody material (Busch 1995). Between 1981 and 1992, fires burned 9,281 acres, or 35 percent, of saltcedar-dominated vegetation on the lower Colorado River floodplain (Busch 1995). By comparison, fires in communities of honey or screwbean mesquite during the same period destroyed 629 acres, or 2 percent of the existing mesquite acreage. Assuming that the fires during the 12 years examined are representative and did not significantly overlap, a given stand of saltcedar would be expected to burn every 34 years.

Not only does saltcedar readily burn, its adaptation to saline conditions allows it to thrive in the elevated soil salinities that fires often produce (Busch and Smith 1993). In addition, the plant can quickly resprout from below ground after its above-ground parts have been completely burned away. Saltcedar's greater propensity to burn, and its tolerance for post-fire conditions, suggests that fires may be a significant factor promoting the plant's spread along the lower Colorado River.

Saltcedar also has been implicated to increase the frequency and intensity of flooding resulting in increased soil erosion. Dense stands of saltcedar covering a river's floodplain can impede high flows and cause the water to spread out and inundate areas not normally flooded (Robinson 1965). Saltcedar's restriction of the river channel also increases sedimentation, further intensifying flooding, and causing flows to meander outside the original channel and erode soil. The progression of saltcedar encroachment and its effect on sedimentation and flooding on the Brazos River in north-central Texas has been described by Blackburn et al. (1982). As saltcedar deposited onto the floodplain prior to 1941 began to spread, the width of the river channel began to narrow. In 1941, the river channel's mean width along a 75-mile reach was 515 feet, but by 1979 the mean width had reduced to 220 feet. Saltcedar's encroachment also increased sediment deposition onto the floodplain, and flood events with similar flow rates produced flood stages of 10.2 feet in 1941 compared to 18.4 feet in 1971. Higher flood stage in 1971 caused a greater area to be inundated.

Clearing saltcedar has been used as a means of restoring the river channel's original flow capacity. A comparison of cleared and uncleared reaches of the Gila River near Safford, Arizona, found that clearing saltcedar increased flow velocity by 30 percent and decreased water depth by 13 percent (Great Western Research 1989). As an example of a full-scale project removing saltcedar to accomodate high flows, the Flood Control District of Maricopa County mechanically cleared a 1,000-foot wide corridor within approximately 34 miles of the Gila River near Phoenix, Arizona (Dick Perreault, *pers. comm.*). The corridor succeeded in reducing flooding, however an extreme flood in 1993 exceeded the corridor's flow capacity and caused erosion and property damage at the floodplain's margins. The cleared corridor has not been rehabilitated since the 1993 floods due to increased regulatory requirements.

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A BRIEF OVERVIEW OF THE IMPACT OF TAMARISK INFESTATION ON NATIVE PLANTS AND ANIMALS

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One of most significant threats to global biodiversity is the invasion of exotic species into natural areas due to human activities and commerce (Clout, 1995). Insidious effects of invasive exotic species often include the inexorable displacement, or replacement, of native plant and animal species, disruptions in nutrient and fire cycles, and changes in the pattern of plant succession. The objective of this paper is to provide a brief summary of some of the impacts of tamarisk or salt cedar (genus *Tamarix*) invasion on native plants and animals, with an emphasis on the southwestern United States. This paper summarizes information previously presented by Lovich *et al.* (1994).

Tamarisk invasion has serious consequences on the structure and stability of native plant communities. The decline of riparian stands of cottonwood (*Populus fremontii*) along the Rio Grande in New Mexico is partially attributable to the invasion of tamarisk. The thick stands of exotic plants along the floodplain have severely limited the number of germination sites that are suitable to cottonwood (Howe and Knopf, 1991). Similarly, in the desert region of Australia tamarisk is capable of displacing native plant species, resulting in the dominance of native vegetation by a relatively few species of introduced and salt-tolerant plants. Tamarisk dominance also results in a reduction in the numbers of native birds and reptiles (Griffin *et al.*, 1989) relative to native ecosystems.

A secondary effect of tamarisk invasion is related to increased frequency of fire in impacted areas. The drought-deciduous nature of tamarisk contributes to a heavy fuel load in infested areas, promoting a fire rotation of about 10 to 20 years (Kerpez and Smith, 1987; Rosenberg *et al.*, 1991). The fire tolerance of tamarisk coupled with the fire intolerance of many native shrubs in the southwestern deserts effectively leads to tamarisk dominance in native plant communities in a relatively short time period.

Some authors have suggested that invasion of tamarisk is a sign, not a cause, of habitat modification and degradation (Horton, 1977). Replacement of tamarisk by native plant species will likely require correcting environmental factors that favored the invasion of tamarisk in the first place (Anderson and Miller, 1990). Such factors will need to be identified (see Anderson and Miller, 1992) prior to active revegetation efforts. However, an area dominated by tamarisk is likely to remain so unless altered by natural cataclysms or man (Kerpez and Smith, 1987).

The suitability of tamarisk as wildlife habitat has been a subject of considerable debate. Naturally, it is utilized by wildlife in its native range in the old world. For example, elephants (*Loxodonta africana*) in Namibia, Africa exhibit a definite preference for *Tamarix usneoides* irrespective of plant availability or size (Viljoen, 1989). However, outside of its natural range in the southwestern United States it generally provides unsuitable habitat for most wildlife because neither its foliage nor its flowers (including seeds) have any significant forage value in contrast to native species such as mesquite (a notable exception being the fact that the exotic honeybee, *Apis mellifera*, utilizes the pollen). However, from a structural standpoint it does provide cover for some species, particularly birds. For example doves (*Zenaida macroura*), Mississippi Kites (*Ictinia mississippiensis*), and various passerine birds are known to nest in tamarisk dominated habitats (Glinske and Ohmart, 1983; Brown and Trosset, 1989; Rosenberg *et al.*, 1991). Rice *et al.* (1983) determined that tamarisk foliage height diversity was an important determinant of avian community organization, although native plant species were more important determinants.

The value of tamarisk to wildlife appears to vary geographically. Utilization of tamarisk by birds was high on the middle Pecos River, intermediate on the lower Rio Grande, and very low on the lower Colorado River. Avian use of tamarisk along the Pecos River may be enhanced due to the occurrence of seed producing shrubs and annuals within or adjacent to the exotic habitat (Hunter *et al.*, 1988). It is important to note that all published studies of the value of tamarisk as wildlife habitat have focused on birds. Purported benefits to selected birds do not necessarily extend to other animals. Additional research is needed on the relationship between tamarisk and other groups of species including invertebrates as compared to native vegetation types.

In spite of the value that tamarisk may have for wildlife cover, most authors have concluded that the invader has little value to native wildlife (Kerpez and Smith, 1987; Anderson and Miller, 1990; Rosenberg *et al.*, 1991). As tamarisk displaces native vegetation the value of the original habitat is progressively diminished for many native animal species.

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PARTNERSHIPS AND VOLUNTEERS FOR CONTROL OF SALT CEDAR

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I. PALM SPRINGS-SOUTH COAST RESOURCE AREA

In the Palm Springs-South Coast Resource Area, the Bureau has entered into several partnerships to control salt cedar on public lands:

(a) A memorandum of understanding (MOU) was signed in 1991 with the Management and Training Corporation (which manages the State's Eagle Mountain Community Correctional Facility) for the BLM to use a crew of inmates to remove salt cedar at the Dos Palmas ACEC. The BLM furnishes a commuter van, gas, and technical training and supervision, and the prison furnishes a crew of approximately 5-6 inmates, accompanied with their security guard, to carry out duties ranging from cutting tamarisk with chain saws or brush cutters, applying herbicide and stockpiling slash for burning. Inmate crews have proven to be extremely hard working and willing to put up with hot, uncomfortable working situations. With their help, approximately 150 acres of tamarisk-infested critical palm oasis habitat have been cleaned-up of the noxious shrub, resulting in an improvement in the water flow through the oases, an increase in the cover and vigor of native, desirable species, and a greater visual quality for visitors.

(b) Under an MOU signed with The Nature Conservancy (TNC), TNC volunteers have contributed many work days towards the removal of salt cedar from palm oases at Dos Palmas as well. Where the inmate crews have left at the end of the work week, TNC volunteers have often picked up during the weekend, supervised by a TNC and/or BLM foreman.

(c) Volunteers from the Mountain Conservancy, a Coachella Valley-based interest group supporting the conservation of the Santa Rosa Mountains, have help the BLM control salt cedar on public lands.

II. BARSTOW RESOURCE AREA

The Barstow Resource Area is working with an ever expanding number of groups, organizations, individuals, corporations, local agencies and others to accomplish the very important task of saltcedar control in desert riparian areas. The Afton Canyon Restoration project, initiated in 1992, taxed the ability of the Barstow Project office to fund and complete all project components within the time frame restraints associated with saltcedar treatment. The realization that we could not accomplish a job of this magnitude by traditional means, caused us to search for new and innovative ways to get the job done. The results achieved during the last three years include the treatment/control of over 400 acres of saltcedar infested riparian habitat, the planting of over 5000 native willow/cottonwood poles and the construction of a three mile riparian protection fence. These accomplishments would have been inconceivable if not for the following community efforts, partnerships, grants and other cooperative ventures:

Cooperators:

* Mojave Desert Resource Conservation District (RCD)
* California Environmental Project (CEP)
* Quail Unlimited (QU)
* U.S. Fish and Wildlife Service (FWS)
* U.S. Army
* South Down Corporation (Portland Cement)
* San Bernardino County Range Improvement Advisory Committee (RIAC)
* Global ReLeaf Heritage Forests
* California State Prisons

Cooperator Contributions:

Mojave Desert RCD and **California State Prisons** - Through agreements with RCD and the Baker, CA state prison cleared/controlled approximately 300 acres of saltcedar infested riparian habitat within Afton Canyon. The cooperative effort involved the BLM providing funds to the RCD who, in turn, provided two RCD individuals to supervise an eight person prison labor crew.

The **CEP** has, to date, provided $10,000 service in kind through the work of their six person field crew. The CEP crew, who are from the Los Angeles area, are working on continuing saltcedar projects at the BLM Salt Creek Area of Critical Environmental Concern (ACEC) and Bitter Spring on the Fort Irwin U.S. Army base.

Quail Unlimited has contributed $8,000 to the Afton Canyon Restoration Project. These funds were utilized to clear and control saltcedar.

The U.S. FWS provided a grant of $30,000 for saltcedar control in Afton Canyon.

Funds utilized to pay RCD prison crew supervisors, provide necessary equipment and procure herbicide.

The **U.S. Army, Ft. Irwin**, has contributed $50,000 for saltcedar control on Ft. Irwin, within Afton Canyon and Salt Creek.

South Down Corporation, formerly Southwest Portland Cement, located along the Mojave River in Victorville, California has supplied nearly 5000 willow and cottonwood poles for transplantation into Afton Canyon.

The **San Bernardino RIAC**, in conjunction with the grazing lessee, provided $8,000 for the construction of a riparian exclosure fence in Afton Canyon.

American Forests, through the **Global ReLeaf** Program has committed to providing $5,000, one dollar for each tree, up to 5,000, planted in Afton Canyon.

This is a brief summary of partnerships and grants we have in the past, and are presently working with to cooperatively gain a small level of success in the treatment of saltcedar. The following are grants that the Barstow Resource Area has applied for the 1996-1997 grant years.

National Fish and Wildlife Foundation - Applied for $12,000 in matching funds from California Environmental Project to control saltcedar in wetland areas within the Barstow Resource Area.

CDFG/OHV Fund - Applied for $57,000 for land restoration and vehicle control structures. A portion of the requested funds are tied to riparian restoration and saltcedar control.

North American Wetlands Conservation Act - Small grant application request for $20,000 to continue Afton Canyon/Mojave River restoration and improvement.

III. TIPS ON FINDING PARTNERS

It is important to look for a "fit" for your project. A situation where your project meets the needs, concerns, emotions, expectations and vision of a "partner". Examples would be to involve schools and youth groups in restoration, tree planting and other "up" activities. In contrast, if your project involves heavy machinery, herbicides or other specialized equipment the primary providers of these items may be receptive to becoming contributors and/or partners in return for positive publicity. The following is a list of places to start looking for a environmental "partner" to help with your project.

* Prison Inmates