Tamarix aphylla (L.) Karst.; athel tamarisk
Tamarix chinensis Lour.; Chinese tamarisk
Tamarix gallica L.; French tamarisk
Tamarix parviflora DC.; smallflower tamarisk
Tamarix ramosissima Ledeb.; saltcedar, and hybrids of *T. ramosissima, T. gallica,* and *T. chinensis*

Saltcedar and tamarisk

Family: Tamaricaceae
Range: All western and southwestern states, some species widely planted.
Habitat: River, lake and pond margins, washes, roadsides, ditches, flats, sand dunes, desert springs. Grows best in alkaline soil, but tolerates salinity and acidity. Mature plants survive desert heat, below-freezing temperatures, periodic flooding, drought, burning.
Origin: Native to eastern Asia, northern Africa, the Middle East, India, and southern Europe. *Tamarix* species were introduced as landscape ornamentals and have escaped cultivation in many states, especially in the southwest. Athel tamarisk is still widely sold as an ornamental, but is not as invasive as the other species.
Impacts: All species are facultative phreatophytes that can use both surface and groundwater. The presence of numerous trees along riparian corridors or around desert springs can seriously reduce underground water tables and surface water availability, drying up wetlands, and reducing flows. Roots extract salts from deep soil layers and excrete it from the leaves. Salt is deposited on the soil surface with the leaf litter. The increased salinity of the upper soil profile inhibits the growth, survival, and recruitment of desirable native vegetation. Although some animals will seek cover or nest in *Tamarix* thickets, most wildlife does not consume *Tamarix* foliage, fruits, or seeds. *Tamarix* species can increase flooding in riparian areas by narrowing channel width. In addition, the plants are flammable and can introduce fire into wetland and riparian communities that are not adapted to periodic burning.
Western states listed as Noxious Weed: *T. parviflora*, California, Colorado, Montana, Nevada, New Mexico, North Dakota, South Dakota, Wyoming. *T. ramosissima* and hybrids, California, Colorado, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, Wyoming. *T. chinensis*, California, Colorado, Montana, New Mexico, North Dakota, South Dakota, Wyoming. *T. gallica*, California, Montana, New Mexico, South Dakota, Wyoming
California Invasive Plant Council (Cal-IPC) Inventory: *T. parviflora* and *T. ramosissima*, High Invasiveness; *T. aphylla*, Limited Invasiveness

Tamarix species are small trees or shrubs with tiny scale- or awl-like leaves. Smallflower tamarisk is the shortest of the species and grows to about 15 ft tall. Saltcedar, Chinese tamarisk, and French tamarisk grow to about 20 ft tall. All four of these species are deciduous and have awl-like twig leaves that strongly overlap each other and have acute tips. The foliage of saltcedar, Chinese tamarisk, and French tamarisk is usually more bluish-green than smallflower tamarisk. Athel tamarisk grows to 40 ft tall and is evergreen or semi-evergreen. Its twig leaves are scale-like, not or barely overlapping, and appear like small segments along a stem. *Tamarix* species typically develop an efficient, deep root system (> 15 ft deep) and have a high evapotranspiration rates

in arid climates during the warm season. This occurs because once the roots are within the water table they branch profusely into numerous lateral roots to several feet long.

The inflorescences of *Tamarix* species consist of racemes, mostly 3 to 5 mm wide, typically simple, but occasionally compound and panicle-like. The flowers have a nectar disc at the base which is useful for species identification. Flowers of saltcedar, Chinese tamarisk, and French tamarisk are white, pale or dark pink, mostly with 5 sepals, petals, and stamens. Flowers of smallflower tamarisk are typically pale to dark pink, mostly with 4 sepals, petals, and stamens. Athel tamarisk flowers are white to pale pink, mostly with 5 sepals, petals, and stamens. Plants all reproduce by seed, although seed production is not common in athel tamarisk, and sometimes vegetatively from root sprouts and stem fragments. Stem fragments can take root when buried in a moist substrate, such as might occur with a flooding event. The fruit is a small capsule, often less than 5 mm long, with numerous minute seeds. One mature saltcedar plant can produce about 500,000 seeds per year. Seeds disperse primarily with wind and water, and germination occurs shortly after seed dispersal in spring through summer. Seeds lack a dormancy period, and most germinate within 24 hours after contacting water. Seeds typically survive for only 5 weeks. Individual trees can live 75 to 100 years or more.

Although saltcedar (*T. ramosissima*) and Chinese tamarisk (*T. chinensis*) do not hybridize in their native range, they appear to hybridize extensively in the United States. This hybrid is the most common invasive *Tamarix* species from Oklahoma to Washington to California. Seed viability is high in the hybrids. Less extensively, hybrids between saltcedar and Chinese tamarisk with smallflower tamarisk (*T. parviflora*), Canary Island tamarisk (*T. canariensis*) and French tamarisk (*T. gallica*) also occur. The abundance of invasive hybrids may explain the confusion associated with the identification of *Tamarix* species in the western states.

NON-CHEMICAL CONTROL

Mechanical (pulling, cutting, disking)	Mechanical control methods include mowing, burning, chopping, chaining, and disking. However, these methods usually only suppress saltcedar temporarily and will not eradicate infestations. Saltcedar is also able to resprout vigorously from the root crown following mechanical control methods. These methods can be labor intensive and expensive and may be more effective on small infestations. Hand pulling can be an effective way to control tamarisk in situations where plants are small, where access is difficult, or where herbicides cannot be used. Hand pulling is generally used to control new *Tamarix* seedlings and small plants around isolated desert springs in national parks after the larger plants have been killed with other techniques. Mowing is occasionally useful to reduce the volume of tamarisk before treatment with herbicide, especially in relatively level sites where prescribed burning is not feasible. However, a single cutting of tamarisk is ineffective, because tamarisks resprout vigorously. By comparison, cutting combined with herbicide treatment can be a very effective integrated approach. In addition, cutting tamarisk can reduce consumption of ground water, through removal of transpiring leaves. Heavy equipment can be used to remove entire plants. However, this is expensive, and any fragments that move into the water column may resprout and form new populations. This technique also causes considerable soil disturbance and ecosystem disruption. A root plow pulled by a bulldozer has become a standard method for saltcedar control, providing good to excellent control. Root plowing is most effective when the soil is relatively dry and when combined with follow-up treatments such as hand grubbing resprouts or applying herbicides. Root plowing may affect desirable vegetation and could lead to wind erosion. Another technique uses site preparation tractors or skid steers equipped with forestry mulching attachments, such as a hydro-ax. These are adapted to forestry brush and tree clearing. The hydro-ax can mow or chip either living or dead saltcedar at about 1 acre/hr on level terrain.
Cultural	Cattle, goats, and sheep will graze saltcedar plants if desirable vegetation is lacking. Saltcedar has little nutritional value and cattle will only graze young seedlings early in the year. Goats might be able to control dense stands of tamarisk where little native vegetation is present, particularly if the stands are cut or burned first, with goats eating the regrowth. As a stand-alone strategy, burning has not been successful. Saltcedar is generally top-killed by burning, but plants readily resprout from the remaining root crown and adventitious buds on the lateral roots. Repeated yearly burns can suppress saltcedar and kill some of the plants after 3 to 4 years. Furthermore, burning may suppress saltcedar infestations by eliminating the closed canopy, slowing the rate of invasion, and allowing desirable vegetation to respond, thereby increasing biodiversity. Prescribed burns can be followed up with herbicide treatments to control resprouting plants. One strategy is to cut 20 to 25% of the largest tamarisk plants in stands several months before burning to create enough dry ground fuel to carry a fire. For greatest

	efficacy, burning should be conducted during the hottest part of summer, when plants experience the greatest water stress. If floods occur during the period of poplar/cottonwood (*Populus* spp.) or willow (*Salix* spp.) seeding (which precedes saltcedar seeding), then natural revegetation will consist of almost pure stands of those, with very little saltcedar. Young seedlings of saltcedar can be controlled by flooding for 1 month.
Biological	The release of the saltcedar leaf beetle (*Diorhabda carinulata*) from China has made significant impacts on many populations of saltcedar. This insect feeds on the leaves of saltcedar and slowly reduces plant vigor. Tamarisk does not usually die from a single defoliation from tamarisk beetles, and it can resprout within several weeks of defoliation. Repeated defoliation of individual tamarisk trees can lead to severe dieback the next season and death of the tree within several years. Data indicate that 4 years of defoliation can result in about 60% mortality. Biological control will not eradicate tamarisk but it has the potential to suppress tamarisk populations by 75 to 85%. Since its release, the beetle has defoliated tens of thousands of acres of tamarisk in Nevada, Utah, Colorado and Wyoming. The insect spreads rapidly but is poorly adapted to more southern regions of the U.S. This led to further exploration to find better adapted biotypes or species of *Diorhabda*. In this process, five sibling species were found to comprise a new *Diorhabda* species group. Each species has unique biogeographical traits suiting them to different regions invaded by tamarisk in North America. Four species were previously tested and verified as specific feeders of tamarisk, and released in North America under the name *D. elongata*. *D. carinulata* from China and Kazakhstan (old name *D. e. deserticola*), is successfully suppressing tamarisk over large areas of the Great Basin desert. The true *D. elongata* is establishing well in California and parts of west Texas and is best suited for Mediterranean habitats. *D. sublineata* has potential for the Sonoran and southeastern Chihuahuan deserts. *D. carinata* should be best suited for the Great Plains grasslands and the Mojave and northern Chihuahuan deserts. A fifth species, *D. meridionalis*, may be suited to subtropical maritime deserts but has yet to be safety tested. One controversial aspect of the release of the tamarisk beetle is that defoliation can locally reduce nesting habitat for riparian woodland birds until native woodland flora recover. This has primarily centered on the federally endangered southwestern willow flycatcher, *Empidonax traillii* ssp. *extimus*. The beetles have defoliated some tamarisk nest trees of the southwestern willow flycatcher on the Virgin River in southern Utah, and actions to protect the flycatcher are under consideration. In some areas, tamarisk may be replaced by grasslands or shrublands, resulting in losses of riparian forest habitat for birds.

CHEMICAL CONTROL

The following specific use information is based on publications and reports by researchers and land managers. These are the products that provide effective control. Those that do not provide sufficient control have been omitted from the table. Other trade names may be available, and other compounds also are labeled for this weed. Directions for use may vary between brands; see label before use. Herbicides are listed by mode of action and then alphabetically. The order of herbicide listing is not reflective of the order of efficacy or preference. The best publication for the management of saltcedar species is published through Colorado State University, entitled *Tamarisk: Best Management Practices in Colorado Watersheds*.

GROWTH REGULATORS	
Triclopyr *Garlon 3A, Garlon 4 Ultra, Pathfinder II*	**Rate:** Cut stump treatment: 50% to undiluted *Garlon 3A* (in water) or 25 to 100% *Garlon 4 Ultra* (in oil). Basal bark treatment: 20 to 30% *Garlon 4 Ultra* in oil on young trees without well-developed bark. **Timing:** While many sources indicate that applications can be applied year round, it is best to apply in summer or fall when plants are still growing and not water stressed. At this time, the greatest amount of herbicide will translocate to the below-ground tissues. **Remarks:** Cut stump treatments can be very effective. Cut stems horizontally at or near ground level, and immediately apply herbicide solution to cover the outer 20% of the stump face. Can be mixed with a color dye to determine which trees have been treated. Basal bark treatments should be made to smaller trees with thin bark. Spray the lower trunk, including the root collar, to a height of 12 to 15 inches from the ground; the spray should thoroughly wet the lower stem but not to the point of runoff. For smaller trees 3 to 4 ft tall, a foliar treatment of 7 oz aminopyralid (*Milestone*) + 3 qt *Garlon 4 Ultra*/acre with 0.25% non-ionic surfactant or 1 qt/acre seed oil surfactant gives good control. Follow-up treatment of resprouts with this mixture will be necessary. This mixture is selective and will not injure desirable grasses.

AROMATIC AMINO ACID INHIBITORS	
Glyphosate *Rodeo, Aquamaster*	**Rate:** Broadcast foliar treatment: 1.5 to 3.3 qt product (*Roundup ProMax*)/acre (1.7 to 3.7 lb a.e./acre). Cut stump treatment: 100% of concentrated product to wet the cambial area of the stump face. **Timing:** Broadcast treatments should be made in late summer or early fall when plants are translocating carbohydrates to the below-ground tissues. Cut stump treatments can be made year-round but avoid treatment under drought conditions. **Remarks:** Glyphosate provides only partial control of *Tamarix* species. Because the herbicide precipitates out when in contact with divalent and trivalent salts, the salty excretions on the foliar glands will reduce the effectiveness of glyphosate. Foliar treatment with glyphosate will probably be most effective if applied shortly after a rainfall event.
BRANCHED-CHAIN AMINO ACID INHIBITORS	
Imazapyr *Arsenal AC, Habitat, Stalker, Chopper, Polaris*	**Rate:** Broadcast foliar treatment: 1 qt product (*Arsenal AC*)/acre or 2 qt product (*Habitat*)/acre (1 lb a.i./acre). Spot treatment: 1% v/v *Habitat* spray-to-wet or 3 to 5% for low volume treatments in 10 gal water per acre (GPA). Cut stump treatment: 10% v/v of concentrate on outer cambial region. **Timing:** Late summer or early fall when plants are fully expanded and are translocating carbohydrates to the below-ground tissues. **Remarks:** Imazapyr is the most widely used herbicide to control saltcedar. Both conventional and low-volume applications can give good control. For foliar broadcast or spot treatments add 1% v/v of a non-ionic surfactant or methylated seed oil. Imazapyr is relatively nonselective and can damage or kill other desirable non-target species through direct contact or drift. Low volume treatments are applied to the upper portions of the plant, with coverage not exceeding 30%. Low volume treatments can be very effective on previously burned, recovering plants 6 to 10 ft tall. Spot treatments can be made using a drizzle gun. In addition to ground equipment, treatments can be made by aerial equipment. Helicopter treatments are considered better than fixed-wing as they allow for more consistent results. Herbicide activity may be reduced as saltcedar height and stem number increase. Plants should not be removed for at least 2 years to ensure good control. ALS-resistant kochia has invaded some locations after control of *Tamarix* with imazapyr.
Imazapyr + glyphosate	**Rate:** Broadcast foliar treatment: 1.5 to 2 pt *Habitat*/acre plus 1 to 2 pt glyphosate product/acre. Spot foliar treatment: 0.5% v/v of each product for most consistent results. Apply with 0.25% v/v non-ionic surfactant. **Timing:** Postemergence treatments should be made in late summer or early fall when plants are translocating carbohydrates to the below-ground tissues. **Remarks:** This combination is nonselective. Spot treatments can be made using a drizzle gun. Plants should not be removed for at least 2 years to ensure good control.

RECOMMENDED CITATION: DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States*. Weed Research and Information Center, University of California. 544 pp.