Saltcedar (*Tamarix ramosissima*)
Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, March 2011
Revised, May 2019
Web Version, 9/20/2021

Organism Type: Plant
Overall Risk Assessment Category: High

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1 Native Range and Status in the United States

Native Range

From Villar García and Beech (2017):

"Southeastern Europe is the westernmost range of the natural distribution of this widespread species. Within the European region, this species occurs in the Balkans, Ukraine, Romania, Moldova and southern European Russia (Baum 1978, Sokolov et al. 1986). The species is recorded in Bulgarian floras, however herbarium material should be checked and it is possible that records may refer instead to *T. smyrnensis* (A. Petrova pers. comm. 2016). In Greece the plant is recorded from seven regions (southern and eastern parts of the mainland, the East Aegean Islands, the Cyclades and the West Aegean Islands; Dimopoulos et al. 2013), though it might have also been confused with *T. smyrnensis* or even *T. nilotica*. There are also two records of this species from FYR Macedonia (V. Matevski pers. comm. 2016) and Serbia (see Villar 2017). Records from European Turkey also refer to *T. smyrnensis*.

Outside Europe it is found from China westwards in most Central Asian countries."

In addition to the locations listed above, GISD (2017) lists *Tamarix ramosissima* as native in Afghanistan, Armenia, Azerbaijan, Iran, Iraq, Kazakhstan, North Korea, South Korea, Kyrgyzstan, Mongolia, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan. CABI (2019) lists *Tamarix ramosissima* as native in Georgia.

Status in the United States

From Kennedy et al. (2005):

"It is currently the dominant tree of riparian forests along streams and rivers throughout the western United States, covering over 600 000 ha of this habitat (DiTomaso 1998), and it is also common along springs and springbrooks throughout this region (Sada et al. 2001)."

GISD (2017) lists *Tamarix ramosissima* as introduced and established in Arizona, Arkansas, California, Colorado, Georgia, Hawaii, Kansas, Louisiana, Mississippi, Montana, Nebraska, Nevada, New Mexico, North Carolina, North Dakota, Oklahoma, Oregon, South Carolina, South Dakota, Texas, Utah, Virginia, Washington, and Wyoming. Additionally, CABI (2019) lists *Tamarix ramosissima* as introduced in Idaho, and Missouri.

According to USDA, NRCS (2019), *Tamarix ramosissima* is a B list noxious weed in Colorado; a Category 2 noxious weed in Montana; a noxious weed in Nebraska, Nevada, North Dakota, South Dakota, Texas, and Wyoming; a Class C noxious weed in New Mexico; a "B" designated weed in Oregon; a Class B noxious weed in Washington; and a quarantine species in Oregon and Washington.

T. ramosissima is listed as a Noxious Weed in California (California Department of Food and Agriculture 2015).

T. ramosissima is in trade in the United States (e.g., Klyn Nurseries 2021; Plant Delight Nursery 2021).

Means of Introductions in the United States

From Kennedy et al. (2005):

"Saltcedar (*Tamarix ramosissima* (Ledeb)), […] was intentionally introduced to arid regions of the western United States in the mid-1800s as an ornamental tree and to prevent soil erosion (Everitt 1980)."

Remarks

From GSID (2017):

"There are few plants that are true genetic species of *Tamarix ramosissima* in infested areas, at least in North America. Most of what is called *T. ramosissima* represents a variety of hybrids, including haplotypes of *T. ramosissima*, *T. chinensis*, *T. gallica* and others (Gaskin and Schaal 2002); it even hybridizes with athel (*T. aphylla*), an evergreen species, in some southwest U.S. locations (Gaskin and Shafroth, in press). The most common genotype in the U.S. is a morphologically cryptic hybrid of *T. ramosissima* and *T. chinensis* not detected in Eurasia (Gaskin & Schaal, 2002)."

From CABI (2019):

"*Tamarix* spp. are difficult to differentiate in the field, and also often in the laboratory. Within their native distribution in the Old World, many species of *Tamarix* can be distinguished by gross morphological characters of the flowers, stems and leaf bracts, or by foliage coloration, time of blooming or shape and size of the plant. However, a group of several species, including *T. ramosissima*, are quite similar and can be distinguished only by taxonomic specialists, and especially by the structure of the androecium, visible only with a hand lens or dissecting microscope."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

According to WFO (2021), *Tamarix ramosissima* Ledeb. is the accepted name for this species.

From ITIS (2019):

Kingdom Plantae
  Subkingdom Viridiplantae
    Infrakingdom Streptophyta
      Super Division Embryophyta
        Division Tracheophyta
          Subdivision Spermatophytina
            Class Magnoliopsida
              Superorder Caryophyllanae
                Order Caryophyllales
                  Family Tamaricaceae
                    Genus *Tamarix*
                      Species *Tamarix ramosissima* Ledeb.

Size, Weight, and Age Range
From CABI (2019):

"*T. ramosissima* is a shrub or shrubby tree, 1-5(-6) m high, […]"

Environment
From GSID (2017):

"*Tamarix ramosissima* is a facultative phreatophyte, meaning that its roots are able to reach deep water tables but it is capable of tolerating periods without access to water (Carpenter 2003)."

From CABI (2019):

"Plants can survive up to 70 days of complete submergence and up to 98 days if part of the canopy is exposed (Warren and Turner, 1975); however, seedlings can be killed by 30 days submergence (Horton et al., 1960; Gladwin and Roelle, 1998)."

"Saltcedars probably grow best in silty alluvial soils but they can grow on a wide range of soil textures from clay to sand, and at relatively high pH levels, and at elevations from sea level up to 2500 m."

Climate
From CABI (2019):

"In the Old World, *T. ramosissima* is adapted to a very wide range of [air] temperatures, from 45°C or more in summer to -20°C or less in winter."

Distribution Outside the United States
Native
From Villar García and Beech (2017):

"Southeastern Europe is the westernmost range of the natural distribution of this widespread species. Within the European region, this species occurs in the Balkans, Ukraine, Romania, Moldova and southern European Russia (Baum 1978, Sokolov et al. 1986). The species is recorded in Bulgarian floras, however herbarium material should be checked and it is possible that records may refer instead to *T. smyrnensis* (A. Petrova pers. comm. 2016). In Greece the plant is recorded from seven regions (southern and eastern parts of the mainland, the East Aegean Islands, the Cyclades and the West Aegean Islands; Dimopoulos et al. 2013), though it might have also been confused with *T. smyrnensis* or even *T. nilotica*. There are also two records of this species from FYR Macedonia (V. Matevski pers. comm. 2016) and Serbia (see Villar 2017). Records from European Turkey also refer to *T. smyrnensis*.

Outside Europe it is found from China westwards in most Central Asian countries."

In addition to the locations listed above, GISD (2017) lists *Tamarix ramosissima* as native in Afghanistan, Armenia, Azerbaijan, Iran, Iraq, Kazakhstan, North Korea, South Korea, Kyrgyzstan, Mongolia, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan. CABI (2019) lists *T. ramosissima* as native in Georgia.

Introduced

From GISD (2017):

"*Tamarix ramosissima* has shown weedy tendencies in both New South Wales and Western Australia, […]"

From CABI (2019):

"*T. ramosissima* has recently invaded South Africa, where it has become weedy and is damaging grazing lands and natural areas (John Hoffmann, University of Cape Town, South Africa, personal communication, 2004; USDA-NRCS, 2007)."

Gullón and Verloove (2015) list *Tamarix ramosissima* as present and naturalized in Spain.

Marlin et al. (2017) list *T. ramosissima* as introduced in Mozambique, Namibia, and Zimbabwe, and present in Botswana.

In addition to the locations listed above, GISD (2017) lists *Tamarix ramosissima* as introduced and established in Argentina, Canada (Manitoba), Mexico; as introduced but present only in containment facilities in Canada (Alberta). CABI (2019) lists *Tamarix ramosissima* as introduced in Mexico, and Italy; and present in Qatar but does not specify native or non-native status. DAISIE (2019) lists *Tamarix ramosissima* as introduced but not established in Austria and France.

Means of Introduction Outside the United States

From GSID (2017):

"Introduced as ornamentals and for windbreaks (Sobhian et. al 1998)."

Short Description

From GSID (2017):

"*Tamarix ramosissima* is a semi-deciduous, loosely branched shrub or small to medium-sized tree. The branchlets are slender with minute, appressed scaly leaves. The leaves are rhombic to ovate, sharply pointed to gradually tapering, and 0.5 - 3.0mm long. The margins of the leaves are thin, dry and membranaceous. Flowers are whitish or pinkish and borne on slender racemes 2-5cm long on the current year's branches and are grouped together in terminal panicles. The pedicels are short. The flowers are most abundant between April and August, but may be found any time of the year. Petals are usually retained on the fruit. The seeds are borne in a lance-ovoid capsule 3-4mm long; the seeds are about 0.45mm long and 0.17mm wide and have unicellular hairs about 2mm long at the apical end. The seeds have no endosperm and weigh about 0.00001 gram. (Carpenter, 2003; Dudley, pers. comm.).”

Biology

From GSID (2017):

“*Tamarix ramosissima* will produce roots from buried or submerged stems or stem fragments. This allows the species to produce new plants vegetatively following floods from stems torn from the parent plants and buried by sediment. Ideal conditions for first-year survival are saturated soil during the first few weeks of life, a high water table, and open sunny ground with little competition from other plants. The seedlings of this species grow more slowly than many native riparian plant species and it is highly susceptible to shading (Carpenter, 2003).”

“*Tamarix ramosissima* is highly fecund. It produces massive quantities of minute seeds that are readily dispersed by wind (Carpenter 2003) but are usually only viable for a few days (Dudley pers. comm.). *T. ramosissima* seeds have no dormancy or after-ripening requirements. Germination can occur almost immediately upon reaching a moist site, and germination conditions are broad, good germination being found from 10 to 35°C [air temperature], but mid-summer seed collections indicated poorer germination rates than those collected in late spring (Young et al. 2004). *T. ramosissima* flowered in two flushes, one in April-May and another in late July in northern Arizona, presumably reflecting availability of spring snowmelt and summer monsoon moisture. This species flowered continuously under favourable environmental conditions but the flowers require insect pollination to set seed (Carpenter 2003).”

From Villar García and Beech (2017):

“*Tamarix* plants have salt glands and exert salt causing salt rain under their shrubs. Therefore, these plants need leaching by freshwater during their life cycle (Akhani 2014).”

From CABI (2019):

“Saltcedars are fire adapted and resprout readily from the basal stem buds after the above-ground plant has burned (Busch and Smith, 1992). Regrowth can reach 3 m high the first year after burning.”

Human Uses

From GSID (2017):

“Often planted as an ornamental and to prevent erosion in arid areas. […] and is widely used in the old world for furniture making and for firewood, for tannin extraction, and for cover for livestock (Dudley, pers. comm.). *T. ramossisima* may also be useful for bioremediation, for instance it takes up perchlorate from groundwater, perchlorate being a pollutant derived from jet fuel (Urbansky et al. 2000).”

“*Tamarix ramosissima* is reported being sold in garden centers and nurseries throughout Alberta [Canada].”

From CABI (2019):

"From central Texas to southern California they are used to a minor extent for honey production and somewhat more for pollen and colony maintenance by honeybees. The honey is off-colour and off-flavour and is not of table grade but is used in the baking industry."

Diseases

According to Poelen et al. (2014), *Tamarix ramosissima* is parasitized by *Phoradendron californicum*.

Threat to Humans

No records of threats to humans from *Tamarix ramosissima* were found.

3 Impacts of Introductions

From Cleverly et al. (1997):

"Because of its ability to maintain sap flows at high canopy level transpiration rates (Sala et al. 1996), *Tamarix* can desiccate floodplains and lower water tables (Blackburn et al. 1982). This creates an environment to which *Tamarix* is better adapted than are the native phreatophytes, which are more intolerant of water stress (Busch and Smith 1995) and do not utilize unsaturated soil moisture sources when water tables become depressed (Busch et al. 1992)."

From Lovell et al. (2009):

"In fact, invasive species can directly alter environmental conditions to promote their own establishment and persistence through time. *Tamarix ramosissima* (Tamaricaceae) is such a species; it has caused massive changes to riparian ecosystems and stream bank structures over the last century throughout the southwestern United States (Robinson, 1965; Stromberg, 1998; Pearce and Smith, 2002). Growing as either small trees or dense stands of shoots, *T. ramosissima* can displace or actively outcompete native species of willow (*Salix exigua*) and cottonwood (*Populus deltoides*) in the western United States (Robinson, 1965)."

From Kennedy et al. (2005):

"Saltcedar removal was a highly effective restoration tool because it led to significant increases in pupfish abundance and significant decreases in crayfish abundance. Further, the response of speckled dace (increase) and mosquitofish [also non-native in this system] (decrease), though not statistically significant, was also consistent with the restoration goal of increasing native fish abundance and decreasing exotic consumer abundance. Algal productivity increased significantly following saltcedar removal (Kennedy and Hobbie 2004), and stable isotope analysis provides conclusive evidence that this drove significant increases in pupfish and screw snail density, both of which are strongly dependent on algae-derived carbon. Saltcedar removal had a significant negative impact on crayfish density during the winter sampling period because crayfish consume saltcedar leaf litter and are not strongly dependent on algae-derived carbon."

From Marlin et al. (2017):

“A preliminary study of arthropods, identified mainly to morphospecies, associated with *T. usneoides* and *T. ramosissima* growing together at the Vaal River Mining Operations, Gauteng province, South Africa, showed relatively low species richness and abundance on *T. ramosissima* (Buckham 2011). This suggests that the majority of indigenous insects which utilise the indigenous *T. usneoides* as a host, are not able to use the alien *T. ramosissima* as a host, […]”

From GSID (2017):

“Kennedy and Hobbie (2004) observe that the spread of salt cedar has shifted reaches of Jackrabbit Spring in the Ash Meadows National Wildlife Refuge, from a system based on autochthonous production to dependence on allochthonous inputs, with salt cedar sites having lower temperature-adjusted chlorophyll and macrophyte production rates and greater allochthonous inputs than virtually all native and cleared sites. The effects of the spread of salt cedar on macrophyte and algal inputs probably resulted from dense shading by the trees, because stream nitrogen and phosphorus concentrations were not affected by the large salt cedar stands or by its removal (Kennedy, 2002).”

“Control of the flood regime by large dams and river channelisation has removed the dominant fluvial processes of the lower Colorado River s [*sic*] riparians areas, leading to the desiccation and salinisation of riparian habitats and an almost complete lack of native gallery forest regeneration. These conditions facilitated invasion by the exotic tree *T. ramosissima* and its displacement of native Fremont cottonwood and Goodding s [*sic*] willow trees (Ellingson and Andersen 2002).”

“*Tamarix ramosissima* and *T. chinensis* have been declared as Category 1 weeds in Northern, Eastern and Western Cape, category 3 weeds in other parts of South Africa. (Category 1 Plants. […] These plants may not occur on any land or inland water surface other than in a biological control reserve. Except for the purposes of establishing a biological control reserve, one may not plant, maintain, multiply or propagate such plants, import or sell or acquire propagating material of such plants except with the written exception of the executive officer. Category 3 Plants. The regulations regarding these plants are the same as for category 1, except that plants already in existence at the time of the commencement of these regulations are exempt, unless they occur within 30 metres of a 1:50 year flood line of river, stream etc) (SANBI, 2001).”

From CABI (2019):

“The list of plants, both indigenous and introduced, that are displaced by saltcedar invasions would include virtually every plant known in riparian areas of the western USA and northern Mexico. The invasion and domination of native riparian plant communities most often follows the recession of flood waters or wildfires, which kill the native plants, and then allows the saltcedar seedlings to establish without competition.”

“In a 3-year comparison of insect populations on saltcedar compared with native willows (*Salix* spp.), poplar/cottonwood (*Populus* spp.) and seepwillow baccharis (*Baccharis salicifolia*) in northwestern and southwestern Texas and southern New Mexico, USA, both species diversity and populations of native herbivorous insects (immature specimens and adults) were significantly greater on the native plants than on saltcedar. […] Although many nectar and pollen feeding insects were abundant on saltcedar flowers, all of these developed as immatures on nearby native plants.”

“The greatest economic losses caused by saltcedars relate to the large losses of streamflow and ground water, especially in arid areas of the western USA and in northern Mexico. This entire area is experiencing severe water shortages for agricultural irrigation and for municipal use. […] The US Bureau of Reclamation in Albuquerque, New Mexico estimates that one-third of the total amount of water allowed to be taken from the Rio Grande is used by saltcedar (S Hansen, US Bureau of Reclamation, Albuquerque, New Mexico, USA, personal communication, 2002). Zavaleta (2000) estimated water losses from saltcedar at US $133 to 285 million annually, and this does not include losses in Mexico. Saltcedar also reduces water quality by increasing the salinity of stream flow and ground water.”

“The increased frequency of wildfires caused by saltcedar damages fences and sometimes farm buildings, other buildings and kills livestock. These damages are probably relatively small and economic analyses are not known.”

“Saltcedars cause economic losses by reducing the utilization of parks and natural areas by hunters, fishers, campers, bird watchers, wildlife photographers and others (USDI Fish and Wildlife Service, 1988). In an attempt at determining the proportion of losses caused by saltcedar, DeLoach (1989) estimated losses to these non-consumptive, recreational-type uses in Arizona, USA, at US$29.5 million and in New Mexico at probably US$15.8 million annually, and twice that if the value of the time of the participants were included.”

“Dense thickets of saltcedar along streams cause increased sedimentation, bank aggradation, narrowing and deepening of channels, filling in of backwaters, modification or elimination of riffle structure, overgrowth of sand and gravel bars, and changes in turbidity and temperature of the water. Channels are sometimes completely blocked with debris and overbank flooding is more severe (Busby and Schuster, 1971; Burkham, 1972, 1976; Graf, 1978). Saltcedars are probably the greatest users of scarce groundwater in the infested desert ecosystems (reviewed by DeLoach et al., 2000). Estimates of groundwater use from a number of experiments averaged 1676 mm per year along the lower Colorado River near Blyth, California, USA (the hottest area, lowest elevation and longest growing season in the southwestern USA) to 940 mm per year along the middle Rio Grande, New Mexico at a higher elevation and shorter growing season.”

“Saltcedars increase the natural salinity level by using saline ground water and excreting the excess salts through leaf glands. The salt then drips to the soil surface or falls with the foliage in the autumn, forming a layer of saline litter and soil under the trees in which only saltcedar can survive.”

"The dry foliage and twigs that accumulate under the deciduous saltcedars are highly flammable. Saltcedar thickets burn more intensely and more frequently than native riparian plant communities in North America (which only rarely burn) (Agee, 1988). This situation, like that of soil salinity, is further worsened by the additional interaction with altered hydrologic cycles below dams, preventing the natural spring floods from washing out the accumulated litter (DeLoach et al., 2000)."

"In North America, the greatest direct negative environmental impact of the saltcedar invasion is the displacement of native riparian plant communities by dense thickets of saltcedar, that now cover an estimated 800,000 ha of prime bottomlands along major rivers, small streams and lakeshores. Along many major rivers, saltcedar thickets occupy 50-60% of all the vegetative area (summarized by DeLoach, 1991) and 93% on the Pecos River of Texas and New Mexico (Hildebran[d]t and Ohmart, 1982)."

"The most seriously affected plants are the obligate phreatophytic trees and shrubs, especially poplars/cottonwoods (*Populus* spp.), willows (*Salix* spp.), screwbean mesquite (*Prosopis pubescens*), seepwillow baccharis (*Baccharis salicifolia*) and a few others. The large (to 20 m tall) stands of poplar/cottonwood trees which formally comprised the dominant upper canopy in most areas, are now reduced to small, scattered trees except for one remaining stand of ca. 115 ha at the confluence of the Bill Williams river of Arizona and the Colorado River. Willows, screwbean mesquite and seepwillow baccharis also have been displaced by saltcedars but to a somewhat lesser extent because they are less sensitive to some of the environmental changes than are poplars/cottonwoods. Some other important plants have been harmed to a lesser extent than the obligate phreatophytes, such as honey mesquite and velvet mesquite (*Prosopis glandulosa* and *P. velutina*) and quailbush (*Atriplex lentiformis*) which can also occupy higher terraces (Wiesenborn, 1995)."

"One effect of the saltcedar invasion has been to cause some rare plant species to become more rare and some to become endangered. For example, the threatened Pecos sunflower (*Helianthus paradoxus*) was believed to be extirpated from areas of the Pecos River until saltcedar was cleared, and then it reappeared as a common plant."

"The major effect of the saltcedar invasion on native plant communities has been the drastic degradation of wildlife habitat (Kerpez and Smith, 1987, and reviewed by DeLoach et al., 2000). The population of all birds found in saltcedar on the lower Colorado, USA, was only 39% of the levels in native vegetation during the winter and 68% during the rest of the year; and the number of bird species found in saltcedar was less than half that in native vegetation during the winter (Anderson and Ohmart, 1977, 1984). Saltcedar was the most important negatively correlated variable identified with bird populations (Anderson and Ohmart, 1984). Frugivores, granivores and cavity dwellers (woodpeckers, bluebirds and others) are absent, and insectivores are reduced in saltcedar stands (Cohan et al., 1979). At Camp Cady in southern California, the bird population was only 49% as great in saltcedar as in cottonwood/willow/mesquite (Schroeder, 1993). Bird preference for saltcedar was much lower than for native vegetation along the middle Rio Grande, Texas (Engle-Wilson and Ohmart, 1978) and somewhat lower on the middle Pecos River (Hildebrandt and Ohmart, 1982). Recent surveys at release sites in northwestern Texas showed that both the number of birds and the number of bird species per point count were twice as great in 2003 (a dry year) in native vegetation compared to near pure saltcedar stands. In 2004 (a wet year), populations were 37% greater in the native vegetation (T Robbins and K Johnson, USDA-ARS, Temple, Texas, USA, unpublished data, 2002-2004)."

"Populations of game animals, furbearers and small rodents are lower in saltcedar than in other vegetation types on the Rio Grande of western Texas (Engle-Wilson and Ohmart, 1978) and on the Pecos of New Mexico (Hildebrant and Ohmart, 1982). In Big Bend National Park, Ord's kangaroo rat and beavers have been nearly eliminated because of the saltcedar invasion (Boeer and Schmidly, 1977)."

"Along the Gila River near Florence, Arizona, Jakle and Gatz (1985) trapped three- to five-times as many lizards, snakes and frogs in native vegetation types as in saltcedar."

"DeLoach and Tracy (1997) and Anon. (1995) reviewed 51 listed or proposed threatened and endangered species that occupy western riparian areas infested by saltcedar. These included two mammals, six birds, two reptiles, two amphibians, one arthropod and four plants. Some 34 species of threatened and endangered fish are found in saltcedar infested areas. Their habitat is seriously degraded by reduced water levels, modified channel morphology, silted backwaters, altered water temperature, and probably by reduced and modified food resources. Several of these threatened and endangered species may utilize saltcedar to some extent, but not to a degree that would make it appear important to them or as valuable as the native vegetation it has replaced (Anon., 1995)."

"A very unusual wildlife situation involves the interaction between the proposed biological control programme and the southwestern willow flycatcher (*Empidonax trailii extimus*) that was listed as endangered in 1995 and that had begun nesting in saltcedar in Arizona (though little or none in neighbouring states) (DeLoach et al., 2000). Extensive population surveys during several years throughout its breeding range revealed that most of the known mortality factors of the flycatcher could be made worse by its association with saltcedar. Yet, in spite of these losses, the birds almost entirely selected saltcedar trees for nesting even in sites where abundant healthy native willows were present. Apparently, the birds had developed a very high preference for the almost ideal branching structure of saltcedar for nest placement."

"*T. ramosissima* is […] a declared noxious weed in South Africa, category 1 in Northern, Eastern and Western Cape, category 3 in other parts of South Africa."

4 History of Invasiveness

Tamarix ramosissima is native to much of Eurasia. It is introduced and established in many U.S. States, and there are numerous regulations on the plant. *T. ramosissima* has been introduced for ornamental and soil erosion purposes. It is also established outside of its native range in Australia, many places in Africa, Canada and Mexico. Impacts are well established and include altering hydrology and stream banks, competition with native plants, impacts to water quality, and increased fire risk. The history of invasiveness for this species is classified as High.

5 Global Distribution

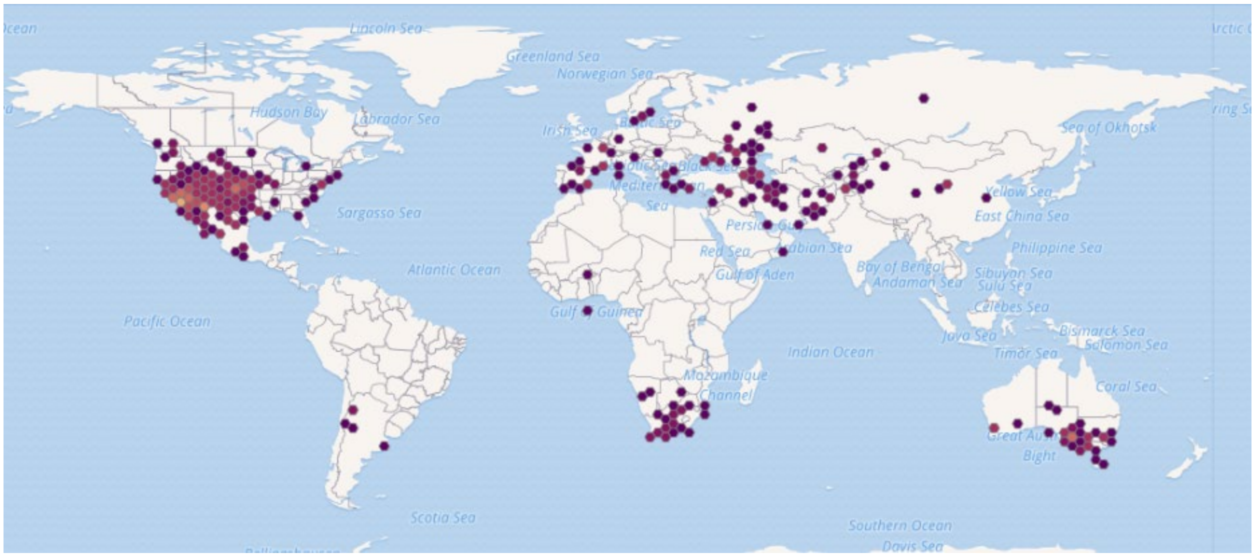

Figure 1. Known global distribution of *Tamarix ramosissima*. Map from GBIF Secretariat (2019). The locations in the ocean to the west of Africa and in Burkina Faso (western Africa) were not used to select source points for the climate match. The specimens those records are based on were collected in New Mexico and Utah. The location in southern Ontario, Canada was not used to select source points for the climate match, the observation information for that location indicates that the observer was unsure about the identification and there are no other records in Ontario. Locations in Bulgaria, Greece, and European (western) Turkey were not used to select source points for the climate match. According to Villar García and Beech (2017), those observations are most likely of other *Tamarix* spp. and not *T. ramosissima*. Locations in France and Austria were not used to select source points; *T. ramosissima* is not established in those countries (CABI 2019).

Due to some apparent confusion and difficulty in *Tamarix* species identification (see Villar García and Beech 2017; CABI 2019 and references therein), locations in figure 1 outside the native range, where presence could not be confirmed with another source and not in close proximity to a verified location were not used to select source locations for the climate match. These locations not used are in Sweden, Germany, and Oman.

6 Distribution Within the United States

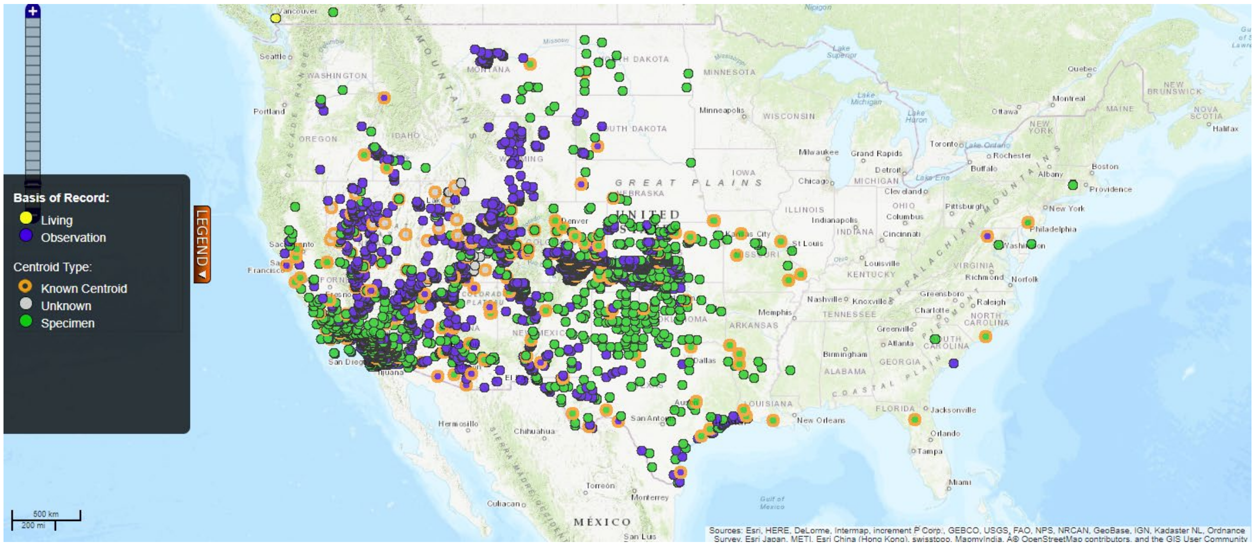

Figure 2. Known distribution of *Tamarix ramosissima* in the United States. Map from BISON (2019).

The following locations were not used to select source points for the climate match. Record information indicates that the record in Connecticut (figures 1, 2) it may be a captive specimen (GBIF Secretariat 2019). The specimens in New Jersey and Washington D.C. (figures 1, 2) belong to *Tamarix* spp. other than *Tamarix ramosissima* (GBIF Secretariat 2019). Locations near coastal North Carolina (figures 2, 3) are specimens in captivity (EDDMapS 2019). Locations in Florida (figures 1, 2) are held in captivity (GBIF Secretariat 2019).

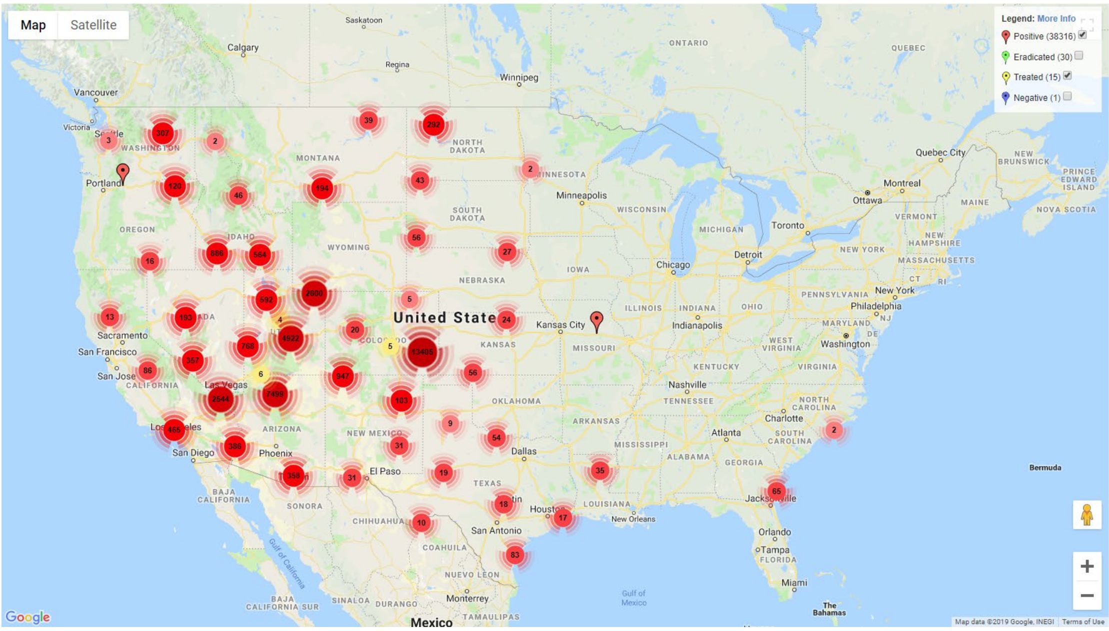

Figure 3. Additional data on the known distribution of *Tamarix ramosissima* in the United States. Map from EDDMapS (2019).

7 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Tamarix ramosissima* and the contiguous United States was high. There were areas of medium match in the Northeast, eastern Great Lakes and in patches down through the Appalachian Mountains. Southern Florida and the coastal areas of the Pacific Northwest also had medium matches. There were small areas of low match in the Olympic Peninsula, the northern Northeast, and a small area of the southern Appalachian Mountains. Everywhere else had a high match. The overall Climate 6 score (Sanders et al. 2018; 16 climate variables; Euclidean distance) for contiguous United States was 0.963, high. (Scores of 0.103 and greater are classified as high.) All States had a high individual climate match except for Maine, New Hampshire, and Rhode Island which had medium individual climate matches.

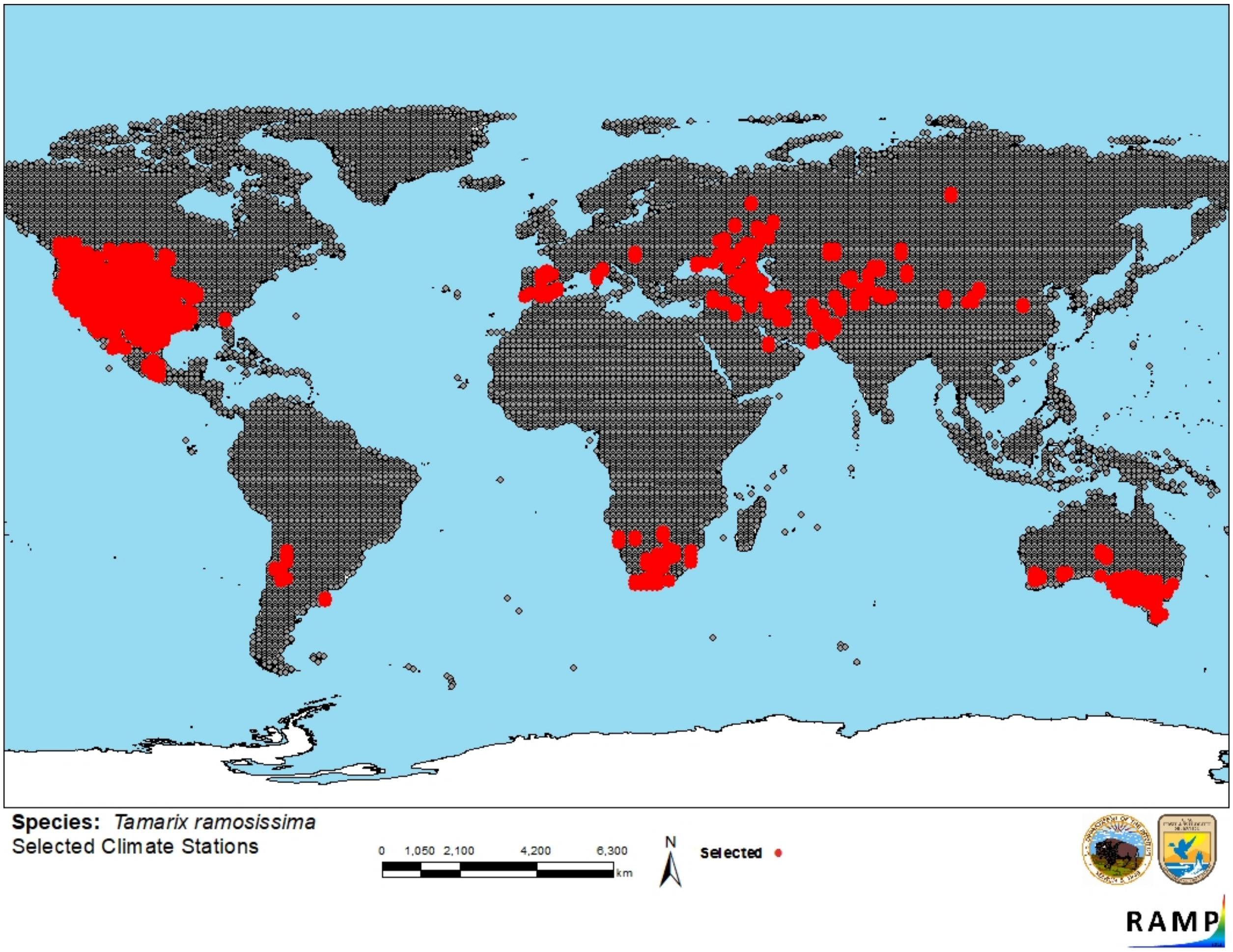

Figure 4. RAMP (Sanders et al. 2018) source map showing weather stations on all continents selected as source locations (red) and non-source locations (gray) for *Tamarix ramosissima* climate matching. Source locations from BISON (2019), EDDMapS (2019), and GBIF Secretariat (2019). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

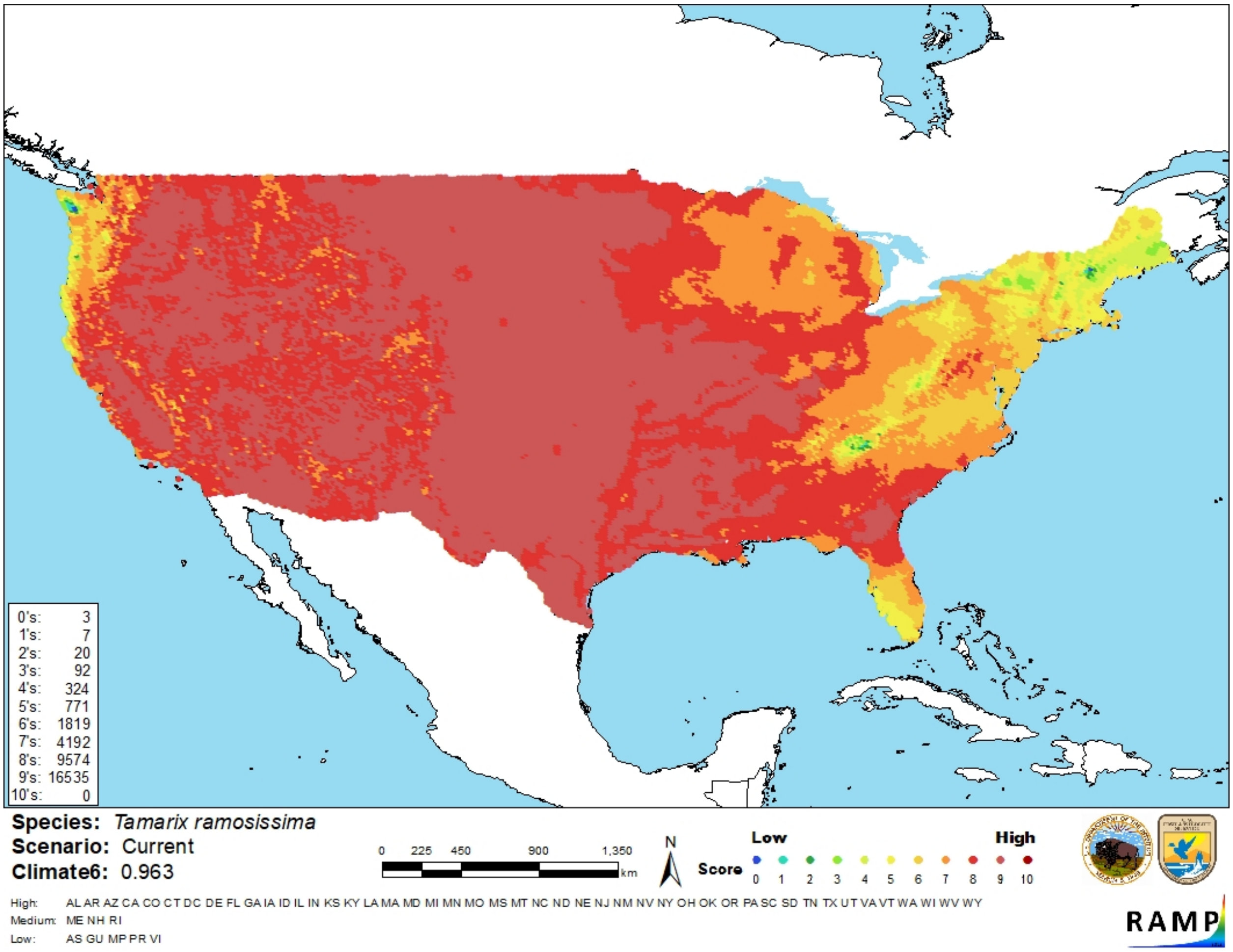

Figure 5. Map of RAMP (Sanders et al. 2018) climate matches for *Tamarix ramosissima* in the contiguous United States based on source locations reported by BISON (2019), EDDMapS (2019), and GBIF Secretariat (2019). Counts of climate match scores are tabulated on the left. 0/Blue = Lowest match, 10/Red = Highest match.

The High, Medium, and Low Climate match Categories are based on the following table:

Climate 6: (Count of target points with climate scores 6-10)/ (Count of all target points)	Overall Climate Match Category
0.000≤X≤0.005	Low
0.005<X<0.103	Medium
≥0.103	High

8 Certainty of Assessment

Information on the biology, invasion history and impacts of this species is substantial, including considerable peer-reviewed literature. There is enough information available to identify the risks posed by this species. Certainty of this assessment is high.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Saltcedar (*Tamarix ramosissima*) is a semi-deciduous shrub native to parts of Eastern Europe and Asia. It has been used as an ornamental and the wood has been used for various purposes including as fuel and for firewood. *Tamarix ramosissima* are tolerant of flooding and saline substrates. They have salt glands on the leaves that will excrete the excess salt which will then 'rain' onto the substrate below the plant. The history of invasiveness is classified as High. It has been introduced around the world as an ornamental, to create windbreaks, or to prevent erosion. This species has become established in many countries, including across the western half of the United States. This species, when introduced, has initiated a number of hydrological and ecological changes including reductions in plant and animal biodiversity, replacement of native riparian trees, and altering bank structure and geomorphological processes. The climate match for *T. ramosissima* is very high. There are few areas that had a medium match, mainly in northern areas, and even fewer locations of low match. The certainty of assessment is high. There is a large body of peer-reviewed literature about the species and its invasion history in the United States. The overall risk assessment category is high.

Assessment Elements

- **History of Invasiveness (Sec. 3): High**
- **Overall Climate Match (Sec. 6): High**
- **Certainty of Assessment (Sec. 7): High**
- **Remarks/Important additional information:** No additional comments.
- **Overall Risk Assessment Category: High**

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