Washington Invasive Ranking System

Washington Natural Heritage Program

Tamarix ramosissima (Salt Cedar)

Assessed by
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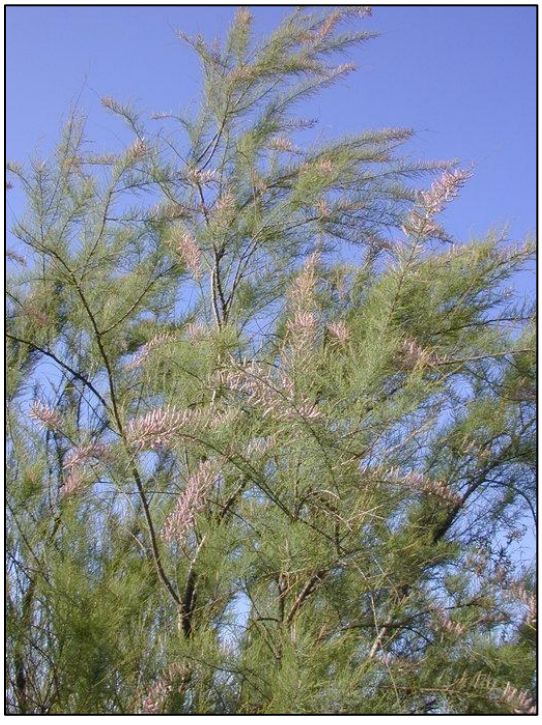
Ecological Impact Rank: **High** (71)	Confidence: **Moderate** (50)
Management Difficulty Rank: High (88)	Confidence: Moderate (50)
Biological Characteristics of Invasiveness: High (70)	Confidence: High (80)
Concern Related to Distribution and Abundance: High (76)	Confidence: High (70)



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Ranking Notes

Tamarix is taxonomically difficult and there is some debate about whether the common species of *Tamarix* in the western U.S. is *T. ramosissima* or *T. chinensis* (Young et al., 2004). These two species also hybridize in their invasive range (Zouhar, 2003). Most of the information on *Tamarix* is provided by genus. Most data is from the southwest, but *Tamarix* invasions may behave differently elsewhere (Stromberg et al., 2007).

Legal Listings

Washington State Weed Board: Class B, Washington State quarantine list

Washington Invasive Species Council: Yes

Section 1: Distribution and Abundance

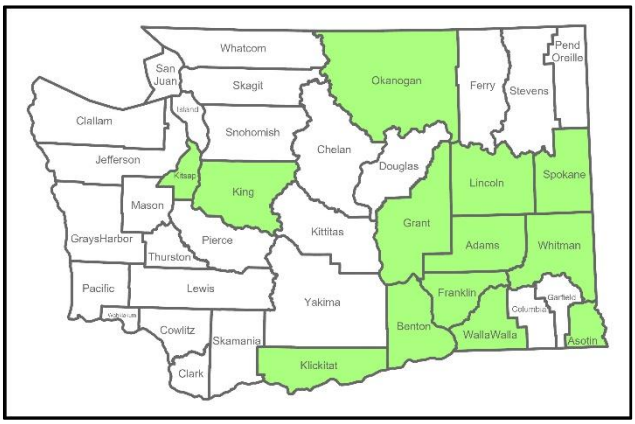

Figure 1. Distribution of counties where *Tamarix ramosissima* has been documented in Washington State (CPNWH, 2023; EDDMapS, 2023; iNaturalist Contributors, 2023).

Q1: Current Range Size in Washington

Rating: Moderate

Confidence: Moderate

Tamarix ramosissima is documented in 33% of Washington counties (CPNWH, 2023; EDDMapS, 2023; iNaturalist Contributors, 2023).

Source: Herbarium records and reported observations

Q2: Current Trend in Total Range

Rating: Moderate

Confidence: Moderate

Tamarix ramosissima is currently most abundant in southeastern Washington, particularly on the Columbia Plateau, but it appears to be expanding into the rest of the state (EDDMapS, 2023). No information on the rate of spread was found. However, ecological factors likely constrain *T. ramosissima* and its hybrids mostly to riparian areas in arid parts of Washington, where it is better able to outcompete native vegetation for resources (Stromberg et al., 2007; Kerns et al., 2009; Lehnhoff et al., 2011).

Source: Published research, Model predictions

Q3: Proportion of Potential Range Currently Unoccupied

Rating: High

Confidence: High

In 2009, less than 1% of suitable habitat for *Tamarix* in the northwest was occupied (Kerns et al., 2009). Models predict that *T. ramosissima* is likely expand to all counties in Washington (EDDMapS, 2023), though it is most likely to be dominant east of the Cascades (Kerns et al., 2009). A 2009 study also predicts a 2-10x expansion of suitable habitat for *Tamarix* in central Washington and Oregon by 2099, due to climate change (Kerns et al., 2009).

Tamarix species have generally been regarded as poorly adapted to cold climates. However, *T. ramosissima* and *T. chinensis* both originate from cold desert environments that can experience severe winters. Hybridization between these two species has likely increased genetic and phenotypic diversity of invasive *Tamarix* in the U. S., allowing expansion into colder environments (Kerns et al., 2009; Lehnhoff et al., 2011).

Source: Published research, Model predictions

Q4: Local Range Expansion or Change in Abundance

Rating: High

Confidence: Moderate

The earliest record of *Tamarix* from Washington in the Consortium of Pacific Northwest Herbaria (CPNWH) is from 2005. iNaturalist observations suggest increased abundance in the last 20 years. Model scenarios predict *Tamarix* to gain and maintain at least 5% cover east of the Cascades, particularly in the Columbia Plateau ecoregion (EDDMapS, 2023), and as of 2009, less than 1% of suitable habitat for *Tamarix* was occupied (Kerns et al., 2009), suggesting that local range and abundance could increase rapidly for this genus.

Source: Published research, Model predictions

Q5: Diversity of Ecosystems Invaded

Ecosystem types: Emergent Open Wetland, Forested Wetland

Rating: Low

Confidence: High

Tamarix is restricted by availability of suitable habitat, preferring riparian areas in relatively warm and dry ecosystems (Kerns et al., 2009). *Tamarix* is also found in playas, alkali sinks, lowland woody communities, saline marshes and meadows, and prairies. Associated species are generally species of arid and semi-arid habitats or found in riparian areas or wetlands in areas that are otherwise arid or semi-arid. In these areas, *Tamarix* species are usually found in habitats that are seasonally submerged (Zouhar, 2003).

Source: Published research, Informal publication

Section 2: Biological Characteristics

Q6: Aggressive Mode of Reproduction

Rating: Yes

Confidence: High

Tamarix ramosissima, *T. chinensis*, and their hybrids are self-compatible and usually reproduce by seed. One tree can produce hundreds of thousands of seeds in a growing season. Stress, including fire, drought, or damage, can induce further flowering and seed production. Seeds are very small, with short hairs that aid in wind and water dispersal (Zouhar, 2003). One study documented 4,600 seeds in one square meter under a *Tamarix* stand, with 2,400 seeds per square meter at a distance of 0.1 kilometers from the stand, and 51 seed per square meter 8 kilometers from the stand (Young et al., 2004). *Tamarix* can produce seeds up to 5.5 months of the year, peaking in late spring and early summer. While seeds are the most common way for *Tamarix* to disperse, they can also resprout from the roots and grow from root and stem fragments. Sources differ on how likely vegetative reproduction through lateral roots is in *Tamarix* species (Zouhar, 2003; Young et al., 2004; Kerns et al., 2009).

Reliable information on pollination in *Tamarix* is not available, but experimental exclusion of insect pollinators suggests that wind pollination is unlikely (Stevens, 1989).

Source: Published research, Informal publication

Q7: Innate Potential for Long-Distance Dispersal

Rating: Yes

Confidence: High

Tamarix seeds have small hairs that aid in wind dispersal and can also be dispersed by water (Zouhar, 2003; Young et al., 2004). Seeds have been documented traveling at least 8 km from their source, allowing *Tamarix* species to invade adjacent stream reaches (Zouhar, 2003; Young et al., 2004). At least one source also suggested that birds aid in seed dispersal for this genus (Lehnhoff et al., 2011).

Source: Published research, Informal publication

Q8: Potential to be Spread by Human Activities

Rating: Yes

Confidence: High

Tamarix was introduced in the U.S. to stabilize soil and is also used as a windbreak and an ornamental (Zouhar, 2003; Stromberg et al., 2007). *Tamarix* is usually found in areas of anthropogenic disturbance. Human activity appears to be the main driver of habitat suitability for *Tamarix* species in the southwest. Changes in stream flow patterns, reduced water tables, and increased soil and water salinity all favor *Tamarix* over native cottonwood and willow species in the southwest. Livestock grazing also favors *Tamarix*, since livestock preferentially graze native riparian vegetation (Stromberg et al., 2007).

Source: Published research, Informal publication

Q9: Allelopathy

Rating: No

Confidence: Moderate

Soil leachate from *Tamarix* was not found to impede germination of *Tamarix* seeds. However, plants in this genus excrete salt from their leaves, which can increase soil salinity, especially in habitats where flooding is regulated by dams or other human activities. Increased soil salinity can give *Tamarix* a competitive advantage over native riparian plant species (Zouhar, 2003).

Source: Informal publication

Q10: Competitive for Limiting Abiotic Factors

Rating: Yes

Confidence: Moderate

Tamarix's slow growth and shade intolerance ultimately make species in this genus poor competitors with non-stressed native riparian vegetation (Zouhar, 2003; Stromberg et al., 2007). However, deep taproots, high water use efficiency, and salt tolerance mean that *Tamarix* is generally less sensitive to water stress than the native species it occurs with (Zouhar, 2003; Stromberg et al., 2007). *Tamarix* species also produce lateral roots that can behave like rhizomes and are capable of extracting water from unsaturated soil (Zouhar, 2003; Stromberg et al., 2007). These traits allow *Tamarix* species to outcompete native riparian vegetation in areas where human activities or climate change have reduced

waterflow, lowered the water table, or changed the timing of flood events (Zouhar, 2003; Stromberg et al., 2007).

Tamarix ramosissima is deciduous. However, *Tamarix* species have physiological traits that allow them to continue to photosynthesize in dryer conditions than native riparian vegetation, giving them an advantage during droughts and where human disturbance and climate change have reduced water availability (Zouhar, 2003; Gafke et al., 2022). This provides a similar advantage in climates where growth and survival are affected by drought more than cold.

Source: Published research, Informal publication

Q11: Growth Form

Rating: Yes

Confidence: Moderate

Under favorable conditions, *Tamarix* species form monospecific stands (or nearly so). However, *Tamarix* is often unable to outcompete native riparian vegetation for sunlight in ecosystems that are not experiencing water stress (Zouhar, 2003; Stromberg et al., 2007).

Source: Published research, Informal publication

Q12: Germination Requirements

Rating: No

Confidence: High

Tamarix seeds generally germinate post-flood and prefer bare fine silt soils. Evidence suggests seedlings don't establish well in leaf litter or under shaded conditions (Zouhar, 2003; Lehnhoff et al., 2011).

Source: Published research, Informal publication

Q13: Invasiveness of Other Plants in Genus

Rating: Yes

Confidence: High

Up to 12 species of *Tamarix* are present in the U.S., but only four of those species are highly invasive. *Tamarix ramosissima* and *T. chinensis* are the most aggressive *Tamarix* species that occur in North America. High genetic diversity, phenotypic plasticity, and hybridization contribute to the success of invasive *Tamarix* species (Zouhar, 2003; Kerns et al., 2009).

Source: Published research, Informal publication

Q14: Shade Tolerance

Rating: Low/Insignificant

Confidence: Moderate

Tamarix species prefer open disturbed sites and are not shade tolerant. A study in Montana found populations of *Tamarix* that hadn't recruited new individuals in up to 27 years, likely due to the combination of thick litter under the canopy and adults outcompeting seedlings for light (Lehnhoff et al., 2011). Under the right conditions, native riparian vegetation can also shade out *Tamarix* seedlings, even if *Tamarix* establishes first. Adult *Tamarix* may also be susceptible to shading (Zouhar, 2003).

Source: Published research, Informal publication

Q15: Disturbance Tolerance

Rating: Yes

Confidence: Moderate

Tamarix can grow in highly disturbed areas, including mine tailings, and survives in saline and alkali environments. Wind-borne seeds and high seed production make *Tamarix* an excellent pioneer species. Anthropogenic changes to stream and groundwater hydrology enable the spread of *Tamarix* species in the western U.S. (Zouhar, 2003; Kerns et al., 2009). *Tamarix* is also more likely than native riparian vegetation to survive and increase post-fire (Gafke et al., 2022).

However, *Tamarix* may be less resilient to natural disturbance regimes, and may not be able to outcompete native vegetation in areas with frequent, severe flooding (Zouhar, 2003). On free-flowing perennial waterways, *Tamarix* may struggle to establish seedlings. A study comparing river reaches with altered flows against free-flowing reaches found *Tamarix* less common where natural river dynamics

were intact (Stromberg et al., 2007). *Tamarix* may also be less competitive after flooding disturbances in areas where biocontrols have been successfully established (Gafke et al., 2022).

Source: Published research, Informal publication

Q16: Propagule Persistence

Rating: < 5 years

Confidence: High

Tamarix seeds are short-lived, loosing viability in as few as 24 days when exposed to direct sunlight. In ideal conditions they can persist for up to 130 days. Seeds do not exhibit dormancy and *Tamarix* species do not have a persistent seed bank (Zouhar, 2003; Young et al., 2004).

Seeds require only moisture to germinate and generally do so within 24 hours of receiving moisture. They can have up to 98–100% germination rates under the right conditions. Seeds are capable of germination and establishment over a wide range of temperature regimes (Zouhar, 2003; Young et al., 2004).

Source: Published research, Informal publication

Q17: Palatability

Rating: Yes, plant is unpalatable

Confidence: High

Grazers and browsers, including livestock, prefer native trees and shrubs to *Tamarix*. Grazing practices are implicated in the spread and abundance of *Tamarix* in the southwest (Zouhar, 2003; Stromberg et al., 2007).

Source: Published research, Informal publication

Section 3: Ecological Impact

Q18: Impact on Ecosystem Abiotic Processes

Abiotic Processes Impacted: Fire, Hydrology, Nutrient dynamics, Light availability, Soil salinity

Rating: High

Confidence: Moderate

Tamarix can lower water tables through high evapotranspiration rates (Zouhar, 2003; Gafke et al., 2022). Accumulation of *Tamarix* leaves can also alter soil salinity, particularly in areas where dams have halted annual flooding, impairing germination and growth of native species (Zouhar, 2003; Gafke et al., 2022). *Tamarix* also burns readily, changing fire frequency and extent where it occurs (Zouhar, 2003; Gafke et al., 2022). Riparian corridors invaded by *Tamarix* spread fire instead of functioning as a barrier to fire (Zouhar, 2003; Gafke et al., 2022). Monospecific stands of *Tamarix* also reduce light availability for other species (Zouhar, 2003; Gafke et al., 2022). Effects on nutrient cycling and mycorrhizal associations need more study, but it seems likely that *Tamarix* dominance also affects these, with interactions making soil conditions less hospitable to native plants (Zouhar, 2003; Gafke et al., 2022).

However, dominance of *Tamarix* species is likely a response to anthropogenic changes in hydrology and river flow, not a cause of those changes (Zouhar, 2003; Gafke et al., 2022). Effects on abiotic processes caused by *Tamarix* might be reversible when coupled with efforts to restore more natural hydrological regimes, but political and economic impediments to restoring historical river conditions coupled with climate change may make this process difficult.

Source: Informal publication

Q19: Impact on Ecosystem Structure

Rating: Moderate

Confidence: Moderate

Tamarix invasions in the western U.S. simplify riparian ecosystem structure, affecting habitat quality for many species (Gafke et al., 2022). Some sources also document *Tamarix* replacing grassland community types (Zouhar, 2003), but this genus appears to most commonly simplify the structure of existing riparian woodland communities.

Source: Informal publication

Q20: Impact on Ecosystem Composition

Rating: High

Confidence: Moderate

Tamarix reduces native species diversity where hydrologic conditions allow it to establish dominance. Invasive species such as *Cirsium arvense* and *Rhaponticum repens* are more common in association with *Tamarix* species than with native communities (Zouhar, 2003; Gafke et al., 2022).

Source: Informal publication

Q21: Impact on Particular Native Species

Rating: Unknown

Confidence: Not Rated

No information was available for the impact of *Tamarix* invasions on particular Washington species. However, where *Tamarix* is abundant in the southwest, it can provide habitat for the federally endangered Southwest Willow Flycatcher, complicating efforts to treat *Tamarix* invasions (Stromberg et al., 2007; Gafke et al., 2022).

Source: Published research, Informal publication

Q22: Observed Ability to Invade Undisturbed Ecosystems

Rating: Low

Confidence: Moderate

Tamarix is shade intolerant and depends on floods or human disturbance to create suitable germination conditions (Zouhar, 2003). Given these traits, *Tamarix* species' ability to invade intact undisturbed areas is likely limited.

Source: Informal publication

Q23: Observed Ability to Invade Naturally Disturbed Ecosystems

Rating: Yes

Confidence: High

Tamarix species are more likely to invade stream reaches with altered hydrological conditions but are still capable of establishing on perennial streams with unaltered hydrologic conditions (Zouhar, 2003; Stromberg et al., 2007; Lehnhoff et al., 2011). *Tamarix* species benefit from moderate flooding, which deposits substrate for seeds to germinate on and provides the moisture needed to induce germination. However, in areas where hydrologic conditions are unaltered, *Tamarix* appears to have difficulty establishing as a dominant and where present may remain subdominant to native riparian trees (Zouhar, 2003; Stromberg et al., 2007; Lehnhoff et al., 2011).

Source: Published research, Informal publication

Section 4: Management Difficulty

Q24: General Management Difficulty

Rating: High

Confidence: High

In 2001, the cost of mitigating or treating *Tamarix* in the western U.S. was estimated to be $280–$450 per hectare of land (Kerns et al., 2009).

Tamarix dominance is frequently driven by altered hydrological conditions that prevent native riparian trees from reestablishing and thriving. Coupling removal with restoration of historical hydrological regimes and native riparian vegetation is suggested for successfully managing *Tamarix* invasions in the long-term. Post-restoration monitoring is also required, especially early on, to prevent *Tamarix* from reestablishing (Stromberg et al., 2007; Lehnhoff et al., 2011). Biocontrols have shown some success but have been difficult to establish in the northern part of *Tamarix's* U.S. range. Biocontrol effectiveness also varies by target species (Gafke et al., 2022).

Source: Published research; Informal publication

Q25: Minimum Time Commitment

Rating: High

Confidence: High

Coupling *Tamarix* removal with stream restoration efforts and post-restoration monitoring likely requires an ongoing time commitment for *Tamarix* removal projects (Lehnhoff et al., 2011), but none of the sources found in the literature search provided a specific time commitment.

Source: Published research

Q26: Impacts of Management on Native Species

Rating: Moderate

Confidence: Low

No information was available on the effect *Tamarix* management could have on native species that occur in Washington. Restoration of historical hydrological regimes and native riparian vegetation may be the most effective treatment for *Tamarix* invasions (Stromberg et al., 2007). While the heavy equipment required for initial removal and restoration activities may have a negative effect on remaining native species in areas colonized by Tamarix, it is expected that the native riparian vegetation will recover quickly once removal and restoration efforts are complete. However, in the southwest, *Tamarix* removal is complicated due to their importance as habitat for the federally endangered Southwest Willow Flycatcher. For example, use and transportation of biocontrol agents in the western U.S. were halted after Southwest Willow Flycatcher nests were lost when *Tamarix* trees were defoliated (Gafke et al., 2022).

Source: Published research, Informal publication, Professional expertise

Q27: Inaccessibility of Invaded Areas

Rating: Low

Confidence: Low

As of 2009, most records of *Tamarix* presence and abundance in the Northwest were from relatively accessible areas (Kerns et al., 2009). However, further establishment in many of the canyons of eastern Washington would be difficult to access.

Source: Published Research

Q28: Sociopolitical Implications of Management

Rating: High

Confidence: Moderate

Successful *Tamarix* management is likely to rely on restoring natural water flows and hydrological regimes and potentially changing livestock grazing practices (Stromberg et al., 2007). Grazing and water issues are historically fraught in the western U.S., suggesting that an important part of any work with *Tamarix* removal needs to include building relationships and buy in from stakeholders.

Research on and use of biocontrol agents is restricted in a portion of *Tamarix*'s range in the western U.S. due to lawsuits to protect the Southwest Flycatcher. The result of these lawsuits restricts federal funding on research into *Tamarix* biocontrols as well as interstate transport of biocontrols (Gafke et al., 2022). While the Southwest Flycatcher does not occur in Washington, some of these restrictions may limit the tools available to manage *Tamarix* invasions in the state.

While *Tamarix* management may not be opposed by the general public, dealing with complex water issues and the current regulations on biocontrol agents that target *Tamarix* species could still make management sociopolitically difficult.

Source: Published research, Informal publication, Professional expertise

Additional Comments

None

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