HABITAT HANDBOOK

ABOUT

The New Mexico Department of Game and Fish Habitat Handbooks provide conservation measures to minimize impacts of land use and development projects on wildlife and wildlife habitats. This Habitat Handbook addresses non-native tree species removal and habitat restoration in riparian areas. For more information on this topic, please call 505-476-8160.

ERT for NM

The Environmental Review Tool (ERT) for New Mexico is a web-based system that quickly screens land use and development projects for potential impacts to wildlife and wildlife habitats. The ERT provides best management practices and guidance to mitigate these impacts. Evaluate your project with the ERT at: www.wildlife.state.nm.us/conservation/habitat-information

EEP DIVISION

The Ecological and Environmental Planning Division coordinates the Department's environmental review process, and works with community, private sector, state and federal government, nongovernmental organizations, and other project proponents to protect and enhance wildlife habitats. The Division implements the Share with Wildlife program and maintains BISON-M, a database of New Mexico's wildlife species. It also participates in the development and application of wildlife-related information management and planning tools.

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Habitat Restoration and Management of Native and Non-native Trees in Southwestern Riparian Ecosystems

Tamarisk in flower. M. Volke

Non-native trees, including tamarisk (also known as salt cedar; *Tamarix* spp.), Russian olive (*Elaeagnus angustifolia*), and Siberian elm (*Ulmus pumila*) have naturalized in riparian areas throughout the western United States replacing woodlands once dominated by cottonwood (*Populus* spp.) and willow (*Salix* spp.). The expansion of non-native riparian trees has been promoted by anthropogenic modifications to flood regimes (e.g., dams, withdrawals, and diversions) and extensive clearing of native riparian vegetation for agriculture, livestock grazing, and urban expansion (Lovich and De Gouvenain 1998, Glenn and Nagler 2005, Shafroth et al. 2005). The most widely naturalized non-native species are tamarisk and Russian olive, which are now the second and fifth most abundant woody riparian plants across the western landscape, respectively (Friedman et al. 2005). Tamarisk and Russian olive are relatively drought tolerant and can establish and survive along highly altered rivers where native riparian trees (e.g., cottonwood, willow) cannot (Shafroth et al. 2008, Stromberg et al. 2009, Nagler et al. 2011). In some areas non-native trees can form large monotypic stands that cover thousands of hectares (e.g., tamarisk along the lower Pecos River in New Mexico). While non-native trees have expanded in range and increased in dominance, native riparian woodlands have sharply declined (Knopf et al. 1988, Graf 1992, Busch and Smith 1995). In the arid southwestern United States, the loss of native riparian vegetation has been linked to a decline in many riparian wildlife populations, particularly breeding and migratory birds (McGrath et al. 2009, Johnson et al. 2010).

Although non-native trees often have lower habitat value than native riparian vegetation, they can provide important habitat for some wildlife species, especially where native riparian vegetation has difficulty persisting (USFWS 2002, Walker 2006). In many areas, non-native vegetation may provide the only available habitat for some species of wildlife (Katz and Shafroth 2003). Non-native trees can provide cover, nesting structure, roost sites, and foraging opportunities for many wildlife species. In mixed stands of native and non-native riparian trees, wildlife diversity can rival that of purely native stands (van Riper et al. 2008). Evidence suggests that non-native trees are most valuable to generalist species, but may be unsuitable for species with specific habitat requirements, such as cavity nesting birds (Sogge et al. 2008, Bateman et al. 2013a).

Tamarisk

Tamarisk is a non-native shrub or tree that was intentionally introduced to the United States from Eurasia in the 1800s, originally as an ornamental plant, and later used for erosion control in the arid west (Robinson 1965). Due to its deep root system, tolerance of saline conditions, and prolific seed production, tamarisk has naturalized throughout riparian areas, reservoir margins, and other wetlands of the west.

Russian olive

Russian olive is a small tree native to southern Europe and central and eastern Asia (Hansen 1901, Shishkin 1949, Little 1961). It was intentionally introduced to western North America prior to 1900, but was not common outside of cultivated areas until 20 to 50 years later (Christensen 1963, Olson and Knopf 1986). This spreading, sometimes shrub-like tree tolerates a wide range of soil and moisture conditions and commonly occurs in southwestern riparian and wetland areas.

Siberian elm

A native of eastern Asia, Siberian elm was introduced to the United States in the 1860s for its hardiness, fast growth, and ability to grow in various moisture conditions. Siberian elm tolerates a wide range of soil and moisture conditions, and can establish and spread rapidly, particularly in disturbed areas. It is widespread and abundant in the Southwest (USFS 2014). Very little is known about the interactions between Siberian elm and wildlife.

Birds

Forty-nine species of birds are known to use tamarisk as breeding habitat. In Arizona and New Mexico, 11 bird species of regional or national concern breed in tamarisk (Sogge et al. 2008), including at least five New Mexico Species of Greatest Conservation Need (NMDGF 2016). Critical habitat for the endangered southwestern willow flycatcher (*Empidonax traillii extimus*) and threatened western yellow-billed cuckoo (*Coccyzus americanus*) populations includes tamarisk-dominated riparian woodlands (USFWS 2005, 2014). Approximately 28 percent of known southwestern willow flycatcher territories are found in such habitat (Durst 2007).

Many wildlife species are known to use Russian olive as a source of food or cover. Russian olive produces abundant fruit that is eaten by over 50 species of birds and mammals (Borell 1962). Thirty-five species of breeding birds were observed using Russian olive-cottonwood forests along the middle Rio Grande in New Mexico (Freehling 1982), and 11 bird species were found nesting in Russian olive along the Gila River in New Mexico. Mourning dove (*Zenaida macroura*), yellow-breasted chat (*Icteria virens*),

Swainson's hawk nest in tamarisk. R. Kellermueller

Black-tailed gnatcatcher in tamarisk. J. Stuart

Mourning dove nest in Russian olive. J. Stuart

Southwestern willow flycatcher. M. Watson

and southwestern willow flycatcher preferentially placed their nests in Russian olive along the Gila River (Stoleson and Finch 2001).

Non-native trees can provide important structural habitat for some avian species. Russian olive is a small, thicket-forming tree, and its branches are armed with spines, which may provide good protective cover for nests (Stoleson and Finch 2001). Non-native trees can also add habitat complexity by providing an understory to mature native riparian forests, supporting a greater diversity of lower- and mid-story avian species (Knopf and Olson 1984). Russian olive often establishes along the edges of native riparian forests, increasing the spatial extent of woody habitat that favors avian species that use tall shrub vegetation. However, establishment of non-native trees in previously unwooded areas can have negative consequences to many taxa, including ducks and prairie grouse (Rumble and Flake 1983, Gazda et al. 2002). Tamarisk, Russian olive, and Siberian elm provide insufficient habitat structure for cavity nesters, woodpeckers, or raptors that require large branches to support their nests (Bateman and Paxton 2009).

Mammals

Twenty-five species of mammals have been observed using tamarisk habitats along the middle Rio Grande in New Mexico; however, it is likely that some of these were only traveling through tamarisk (Hink and Ohmart 1984, Bateman et al. 2013a). Beavers (*Castor canadensis*) can occur along river reaches dominated by tamarisk, and are known to use tamarisk for dam building and include limited amounts in their diets. However, beavers exhibit a strong dietary preference for native tree species, particularly cottonwood and willow, which may facilitate invasion of non-native trees (Lesica and Miles 2004, Kimball and Perry 2008). Bats have been observed foraging along the middle Rio Grande above the canopy of mixed stands of cottonwood, tamarisk, and Russian olive (Chung-MacCoubrey and Bateman 2006). Non-native riparian trees appear to support a greater proportion of desert-adapted and generalist mammal species than native riparian vegetation (Bateman and Paxton 2009).

Common muskrat feeding on Russian olive. J. Stuart

Herpetofauna

Several species of amphibians, lizards, and snakes have been documented in mixed stands with a native cottonwood overstory and non-native tamarisk and Russian olive understory along the middle Rio Grande. Eleven species of lizards (Bateman et al. 2008a), nine species of amphibians (Bateman et al. 2008b), and 13 species of snakes (Bateman et al. 2009) were found at mixed sites. Evidence suggests that non-native trees can support high numbers of generalist herpetofauna, but species dependent upon large woody debris or open understories may avoid dense, monotypic stands of non-natives (Bateman and Ostoja 2012).

Gray fox in Russian olive. J. Stuart

Control and management of non-native riparian trees

Non-native riparian trees, particularly tamarisk and Russian olive, are targets of large-scale chemical, physical, and biological control efforts costing millions of dollars per year (Zavaleta 2000). The primary stated reasons for controlling non-native trees are to increase water yield, improve wildlife habitat, restore native vegetation, and decrease riparian wildfire frequency and severity (Shafroth et al. 2005, Shafroth et al. 2008). In many cases, these objectives are difficult to achieve without rigorous restoration planning, implementation, monitoring, and

Southwestern plateau lizard on tamarisk. National Park Service maintenance that consider non-native removal merely as a first step in a multi-factor, multi-phase restoration process (Figure 1). Removal sites may be unsuitable for the desired replacement vegetation if environmental conditions favoring non-natives (e.g., soil salinity, deep groundwater, stabilized streambanks, infrequent or absent flooding) preclude establishment and survival of native riparian plants (Briggs 1996, Glenn and Nagler 2005). In most cases, non-native removal alone is not enough to restore desirable native vegetation to a site (Nagler et al. 2011). Therefore, the ultimate goal of riparian restoration projects should be the reestablishment of native riparian plant communities and a return to a more natural flow regime.

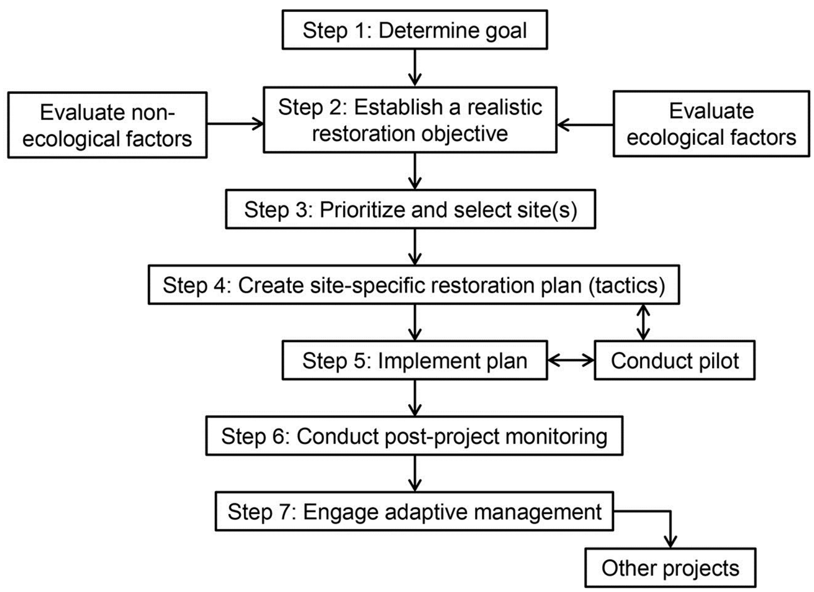


Figure 1. A flow diagram of the steps for effective restoration following removal of non-native riparian trees. Adapted from Shafroth et al. 2008.

Given the vast extent of tamarisk, Russian olive, and Siberian elm on the landscape and the extensive efforts to control or eradicate these species, it is important to fully understand the costs and benefits of non-native vegetation management to wildlife. Non-native vegetation removal may have unintended consequences, including habitat loss and expansion of other exotic species (Zavaleta 2000, Sogge et al. 2008, González et al. 2017). Clearing of non-native vegetation under mature cottonwood forests in New Mexico led to a decrease in lower- and mid-story bird species, presumably due to the loss of intermediate height habitat structure. Removal of non-native plants can also change the ground surface and thermal environments used by reptiles and aerial foraging habitats for bats (Bateman et al. 2008a). Further, non-native removal may facilitate colonization or expansion of other exotic plants such as kochia (*Kochia scoparia*) that provide little habitat value (D'Antonio and Meyerson 2002, Harms and Hiebert 2006, Shafroth et al. 2008, Ostoja et al. 2014, González et al. 2017). If desired replacement vegetation is not quickly restored, non-native removal could lead to temporary habitat loss and a reduction or loss of local wildlife populations (Fleishman et al. 2003). For rare or endangered species, even temporary habitat loss may jeopardize recovery (Paxton et al. 2011). Resource managers should carefully balance non-native removal with protecting critical habitat.


Complete defoliation of a large monotypic tamarisk stand following beetle occupation. Tamarisk Coalition.

Tamarisk Beetles

Tamarisk beetles (*Diorhabda* spp.) were introduced to the southwestern United States in 2001 as a biocontrol for tamarisk. Tamarisk beetles are specialist herbivores that feed exclusively on tamarisk leaves, resulting in desiccated foliage that eventually falls from the tree (Lewis et al. 2003, Bloodworth et al. 2016). Repeat defoliations may result in tamarisk mortality, although mortality rates are highly variable and dependent on local site conditions. Plants exposed to additional stressors such as drought or highly saline soils may be more likely to die (Bloodworth et al. 2016).

Tamarisk beetle eggs. L. Murray

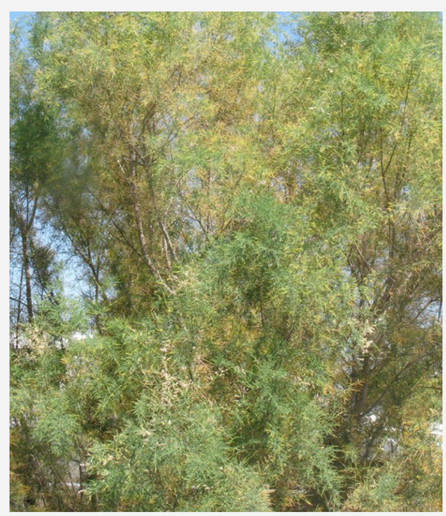
The tamarisk beetle now occupies the majority of New Mexico's major waterways and its range in the state continues to expand (Tamarisk Coalition 2016). Although the beetle is expected to reduce tamarisk populations and may help improve riparian habitat over time, it can also degrade or destroy large areas of existing habitat, especially where tamarisk is the dominant vegetation type or has completely replaced native riparian vegetation. Decreased tamarisk cover has been linked to a hotter drier microclimate, which may lead to reduced abundance and diversity of herpetofauna (Bateman et al. 2013b, Bateman et al. 2015) and avifauna. A study by Dobbs et al. (2012) documented a decline in the fledgling success of endangered southwestern willow flycatchers and yellow warblers in areas affected by beetles. Defoliation can be an ecological trap for birds that nest in leafy tamarisk early in the summer, then fail to fledge young after beetle defoliation due to changes in microclimate and increased exposure to predators. Wildlife species that use tamarisk extensively may experience significant population declines due to tamarisk biocontrol (Paxton et al. 2011).

Tamarisk beetle larva. J. Stuart

Tamarisk beetle adult. J. Stuart

Sites with beetle-defoliated and beetle-killed tamarisk are often unsuitable for natural recruitment of native vegetation, and require intensive restoration efforts to recover habitat (Harms and Hiebert 2006, Shafroth et al. 2008). Studies have shown that revegetation is likely to fail without further maintenance and management (Bay and Sher 2008). Moreover, beetle-induced tamarisk mortality can occur rapidly (within ~2-7 years) leaving little time to plan and implement habitat restoration at affected sites (Bloodworth et al. 2016). Defoliated or beetle-killed tamarisk also creates an elevated fire risk that can further threaten riparian habitat (Hultine et al. 2010, Drus 2013). There is an urgent need to restore habitat formerly and currently occupied by tamarisk to maintain local wildlife populations and prevent degradation of adjacent aquatic habitat, especially in the most hydrologically altered river systems where native riparian vegetation is in short supply.

Tamarisk mortality along the lower Pecos River in New Mexico following two beetle defoliation events. M. Volke



Partially defoliated tamarisk. J. Stuart

Non-native Vegetation Management and Riparian Restoration Recommendations

- Restore native riparian plants (e.g., cottonwood and willow) following non-native removal or biocontrol, and maintain an adequate water supply for native plants.

- Incorporate native drought-tolerant woody and herbaceous species in restoration plantings to address expected changes in climate and low water availability.

- Consider implementing streambank and floodplain modifications (e.g., bank softening, bank lowering) following non-native removal to ensure maintenance of overbank flows, river-floodplain connections, and native plant communities.

- Stage and balance tamarisk removal and native habitat restoration over time to avoid rapid loss of non-native woody riparian habitats for wildlife until alternative native habitats can be developed (Figure 2).

- Protect and sustain existing stands of native riparian vegetation that may serve as important refugia in areas currently or likely to be affected by non-native control efforts.

- In areas currently occupied or expected to be occupied by the tamarisk beetle, redirect mechanical and chemical tamarisk removal efforts to follow-up restoration treatments to promote a more gradual transition from tamarisk-dominated habitats to native habitats. Follow-up treatments should focus on removing beetle-killed tamarisk, planting native replacement vegetation, creating floodplain habitats and refugia (e.g., side channels, wetlands), and maintaining natural riparian processes (e.g., overbank flooding).

- Proactively restore native riparian vegetation in areas likely to be most altered either by the tamarisk beetle (i.e., large tamarisk-dominated stands in the most hydrologically altered river systems) or by chemical and mechanical control efforts.

- At sites where non-native trees are removed from the understory of mature riparian forests, consider planting native trees, shrubs, and herbaceous plants to maintain vertical habitat diversity and ground cover.

- In reservoirs that are predicted to have lower maximum pools in the future due to climate change and increased demands for water, consider planting drawdown areas with native riparian plants to supplant the establishment of non-native trees and other undesirable plants. The ideal sites for planting would be bottoms currently unvegetated or sparsely vegetated that do not experience prolonged reservoir inundation. Survival of native plantings could be improved through reservoir management (Volke et al. 2015).

- Make an appropriate plan for biomass management according to local site factors (Table 1).

- Contact native plant nurseries and seed producers in the early stages of restoration planning to ensure that the appropriate plant species and ecotypes are available in anticipated quantities for plantings (see vendor listing next page).

- Develop explicit, measurable goals and objectives, site-specific plans, and post-implementation monitoring and maintenance for all riparian restoration projects. Document and report restoration approaches used, including successes and failures (Figure 1).

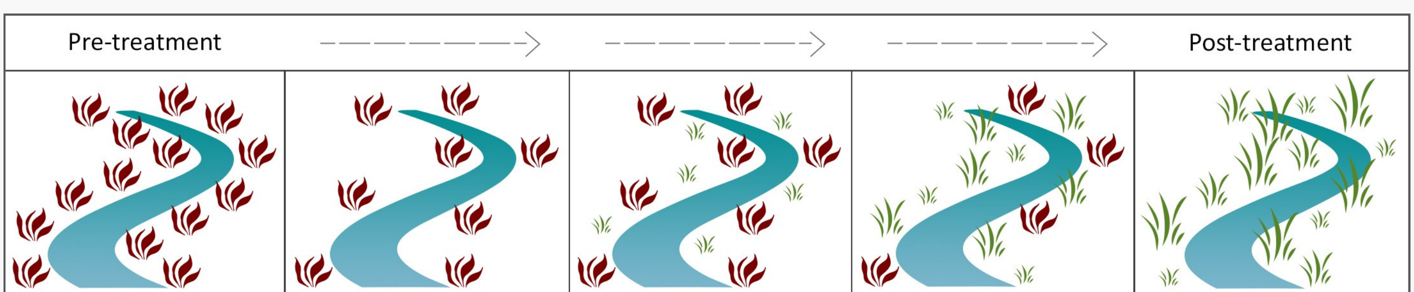


Figure 2. A generalized schematic depicting the removal of non-native vegetation and native plantings in a series of steps over time.

Table 1. Non-native vegetation biomass management at restoration sites. Adapted from Sher et al. 2010.

Handling of biomass	Pros	Cons
Off-site disposal	• Most aesthetic • Reduction of fire risk • Clears areas for active revegetation	• Generally highest cost • Lost benefit of biomass (see 'mulching' and 'piling' below)
Piling on site	• Creates wildlife habitat • Most cost effective	• Unsightly • May be a fire risk • Re-rooting or re-sprouting possible
Burning on site	• Reduces age-class of tamarisk, which may increase efficacy of herbicides and biological control • Low-cost means of rapidly reducing standing biomass	• Can adversely alter soil chemistry, making establishment of desirable species difficult • Stringent fire safety controls required • Site access not reliably safe for tires (puncture risk)
Mulching on site	• Moisture conservation • Moderation of temperature/wind extremes • Salinity remediation and reduced capillary rise of salts • Enhancement of microsite environment for seedlings • Provides weed suppression (particularly for annual and ruderal species)	• Cost of equipment • Covers bare soil, hinders reseeding (natural and assisted) • Reduces site access for some equipment • Heavier equipment needed for planting

Some native plant material vendors for the Southwest

The following list of vendors is provided to help land managers find local sources of native plant materials for habitat restoration projects. This list is neither inclusive nor does it represent endorsement of any particular vendor.

For best success in restoration, land managers should:

- Choose local sources when possible. Ask vendors where the plant materials originated.
- Request seed test results to avoid inadvertently introducing exotic species to project sites.
- Contact vendors at least one growing season before project implementation, especially for specialized or large orders.

Bamert Seed Company – Muleshoe, TX
bamertseed.com / 800.262.9892
Offers high quality seed for over 300 grass, forb, and woody species, as well as blends, with some local ecotypes available.

Borderlands Restoration – Patagonia, AZ
borderlandsrestoration.org / 520.216.4148
Provides restoration-quality plant materials for projects small and large, including locally-sourced, locally-adapted materials. Contract growing is available.

Curtis & Curtis, Inc. – Clovis, NM
curtisseed.com / 575.762.4759
Sells high quality grass, forb, and woody plant seed, including native species. Consulting, custom mixes, and planting services available.

Gila Watershed Partnership – Safford, AZ
gwpaz.org/nursery
Sells locally-adapted plant materials for riparian and other applications.

Granite Seed – Tempe, AZ & Lehi, UT & Denver, CO
graniteseed.com
Carries over 600 species and custom mixes of native and non-native grasses, forbs, and shrubs for upland and wetland applications.

Great Basin Seeds – Ephraim, UT
greatbasinseeds.com / 435.283.1411
Offers a variety of native and non-native grass, forb, and woody plant seeds and seed mixes for reclamation, revegetation, range, pasture, and wetland environments.

High Desert Native Plants – El Paso, TX
highdesertnativeplants.com / 915.490.8601
Native nursery stock for revegetation and ecological restoration projects.

HydraAquatic – Albuquerque, NM
hydraaquatic.com / 505.249.9139 or 505.249.9136
Specializes in growing native wetland and riparian plants, with custom growing and a complete catalog of seedlings, shrubs, and trees for wildlife habitat and water quality improvement.

Continued next page...

Some native plant material vendors for the Southwest *continued from previous page*

Lone Mountain Natives – Silver City, NM
lonemountainnatives.com / 575.538.4345
Nursery stock and seed for wildflower and woody species, with contract growing and consulting services available.

New Mexico State Forestry Conservation Seedling Program – Santa Fe, NM
www.emnrd.state.nm.us/SFD/treepublic/ConservationSeedlings.html
Offers over 60 different seedling species in small containers, large containers, and bare root.

Pawnee Buttes Seed Inc. – Greeley, CO
pawneebuttesseed.com / 800.782.5947
Sells native and non-native grass, forb, shrub, and wetland seed.

Plants of the Southwest – Santa Fe & Albuquerque, NM
plantsofthesouthwest.com
Large selection of seed and containerized native grasses, forbs, and woody species, including many local ecotypes and certified seed. Retail nurseries and online store, advice available.

Santa Ana Native Plants – Pueblo of Santa Ana, NM
505.867.1323
Provides a wide diversity of native grass, forb, and woody species in containers using primarily locally-sourced seed.

Southwest Seed – Dolores, CO
southwestseed.com / 800.543.1279
Produces over 40 grass and wildflower species for seed (all tested) on certified fields and offers advice for successful establishment and species selection.

Warner Brothers Seed – Lawton, OK
wbseedco.com / 800.467.7250
Offers native grass and forb seeds and seed mixes.

Western Native Seed – Coaldale, CO
westernnativeseed.com / 719.942.3935
Specializes in seeds of plants native to the Rocky Mountains, western Great Plains, and adjacent areas. Includes grasses, forbs, and woody plant seeds and seed mixes.

Striped meadowhawk dragonfly on Siberian elm. J. Stuart

Additional Resources

Tamarisk Coalition Resource Center

USFS Field Guide for Managing Salt Cedar in the Southwest

USFS Field Guide for Managing Russian Olive in the Southwest

USFS Field Guide for Managing Siberian Elm in the Southwest

Planning Riparian Restoration in the Context of *Tamarix* Control in Western North America

Best Management Practices for Revegetation after Tamarisk Removal

Tamarisk Best Management Practices in Colorado Watersheds

A Guide for Planning Riparian Treatments in New Mexico

Suggested Methodologies for Cottonwood Pole, Willow Whip, and Longstem Plantings

Tamarisk beetle (*Diorhabda* spp.) in the Colorado River basin: synthesis of an expert panel forum

Why Are My Trees Brown? Tamarisk and the Tamarisk Beetle

Western pondhawk dragonfly on Russian olive. J. Stuart

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