Revegetation of Tamarisk Infestation Sites and Implications for Water Use and Habitat Restoration

'Extended' Abstract
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A. Water Use and Salvage in Relation to Tamarisk Control and Site Restoration

The assertion that water saved by conversion of tamarisk to native species will be lost to evapotranspiration (ET) by other species or from bare ground is invalid in many instances. Two oft-made assumptions are that: a) replacement of tamarisk following control measures by cottonwood (*Populus*), willow (*Salix*), and/or other phreatophytes, either through natural regeneration or by artificial revegetation, will result in negligible ET savings because these latter species exhibit transpiration rates equal to or exceeding tamarisk; or b) tamarisk control, especially as typified by large-scale clearing of monotypic stands across broad floodplain expanses, essentially always leads to bare soil or secondary invasives, and thus evapotranspiration (ET) rates equal to or greater than prior consumptive use.

While phreatophytic species such as cottonwood or willow may exhibit transpiration rates equal to or exceeding tamarisk on a per-plant or per-unit-leaf-area basis on mesic sites ***at stand maturity*** (i.e., approaching full ecological niche occupancy, with corresponding canopy closure), this is not necessarily true during earlier seral stages of recovery. There may be a period of several (5-15) years following initiation of recovery, as cotton / willow associations expand and mature, that their ET rate, although increasing, is still significantly less on a per-unit-land-area basis than the dense tamarisk stands they have replaced.

As tamarisk stands mature on many Southwestern riparian systems, they often become dense and approach monotypic occupation of whole floodplains and tributary watersheds. This is particularly true on historic, secondary-level floodplain terraces that are no longer conducive to cottonwood and willow sustainability primarily because of increased depth to groundwater, elevated soil salinity, and/or absence of seasonal overbank flows. In these situations, tamarisk ET on either a per-unit-leaf-area or per-unit-land-area basis may far exceed that of native species (shrub / forb or shrub / grass) associations that seldom achieve tamarisk densities and resultant cumulative leaf area. These upper floodplain terraces comprise the vast bulk (possibly greater than 90%) of tamarisk infestation acreage across the southwest. As such, they represent where substantial water savings can be potentially achieved, in contrast to the narrow, moist or mesic riparian fringe near perennial or active river channels where phreatophytic species may dominate. If tamarisk management is conducted with ecological knowledge of the resource, in concert with sound planning and implementation, significant water savings may well be possible over large spatial and temporal scales.

From strictly a site restoration standpoint, a significant portion of the literature on water use and salvage in tamarisk infestations often represents poor technique, poor ecological understanding, and/or poor planning by those who conducted the cited research and land treatment. In many cases, sites reverted to various proportions of bare ground and secondary invasives in the absence of native plant community restoration following tamarisk control. As such, these studies were often cited as exhibiting no net savings in water use, particularly if immediate, often monotypic replacement by these secondary invasives occurred [e.g., perennial pepperweed (*Lepidium latifolium*); Russian knapweed (*Acroptilon repens*); kochia (*Kochia scoparia*); five-hook bassia (*Bassia hyssopifolia*); water hemp (*Sesbania* spp.)]. On occasion, tamarisk has been replaced by certain native species, through natural recovery from remnant populations, that also tend to monotypically dominate and elevate stand ET on the site over time. Similarly, this typically occurs in the absence of designed site restoration measures incorporating a more diverse and compatible mixture of native species. Examples of this latter scenario include unmanaged recovery of species such as quailbush (*Atriplex lentiformis*) and arrowweed (*Pluchea sericea*).

To cite these as "typical" examples of results from tamarisk treatment, and to leave the impression that the same results will occur even when treatment and site restoration is science-based, timely and well planned, introduces strong bias and inappropriately skews perceptions. More importantly, replacement of tamarisk with upland (non-phreatophytic) native vegetation that is diverse and adapted to upper floodplain terraces exhibiting deeper water tables and/or higher soil salinity can achieve significant water savings from reduced ET. These native species and plant community associations exhibit ET values ranging roughly from 75% to as little as 25% of mean tamarisk stand values often cited in the literature.

The author is presently reviewing the literature in an effort to comprehensively address estimated ET for individual native species, including existent and projected native plant community types (i.e., a range of variable composition among grasses, forbs and shrub) that are reasonably expected to result from natural recovery and anthropogenic revegetation following tamarisk control measures. The resultant study will compare these values to native and exotic phreatophytic plants and associations commonly encountered in mesic and arid riparian zones, so that estimates of potential savings can be more readily perceived. This review will add additional upland species and species associations (commonly used in tamarisk infestation site restoration) to Table 1 from Shafroth et al. (2005)[1]. Examples will be provided at the Conference.

Restored native vegetation should have a balanced composition, characterized by mesic to semi-arid grass / forb / shrub associations (e.g., Rio Grande, Pecos, Arkansas Rivers), or arid to xeric shrub / forb (alkali scrub, desert scrub) associations (e.g., Lower Colorado, Gila, Virgin Rivers), as examples. This composition not only lends diversity to the plant community, but also multi-layer, relatively fire-resistant canopy structure. This structure, upon plant community establishment, will reduce bare ground and thus soil surface evaporation that has been attributed to anticipated, compensatory water losses in the absence of tamarisk. In these scenarios, evaporation loss does not equally compensate for potential savings derived from the restored native plant community. Moisture thus conserved must reside in various "compartments" of availability within the soil profile (e.g., evaporation, vegetative use, bound water in the soil matrix, and water available for groundwater recharge and/or return flows), and can be quantified subject to the spatial and temporal constraints of long-term, landscape-scale studies.

B. Streambank Erosion Control

The argument that removal of tamarisk from streambanks, channels, canals, and other water conveyances will result in immediate and long-term erosion, sedimentation, debris accumulation and related damage to

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[1] Shafroth, P.B., Cleverly, J.R., Dudley, T.L., Taylor, J.P., van Riper III, C., Weeks, E.P., Stuart, J.N. 2005. Profile: Control of *Tamarix* in the Western United States: Implications for water salvage, wildlife use, and riparian restoration. Environ. Manage. 35(3): 231-246.

these structures is likewise not based on proper resource-based planning. Native species of grasses, forbs, shrubs and trees armored and protected these channel banks before the advent of tamarisk. Bank erosion, sloughing and sedimentation can possibly be expected if poorly planned and designed, large-scale (multi-mile) treatments occur, much as when these channels were first designed and installed. However, there are numerous ways to incorporate ***phased*** bioengineering approaches that can incrementally (spatially and temporally) establish stable vegetative protection and bank armoring similar to pre-tamarisk conditions over time. The argument that bank erosion and sedimentation should be expected from tamarisk removal inappropriately discounts the ecological scale and severity of the infestation problem, and the availability of sound treatment alternatives, while conversely encouraging retention of remnant tamarisk islands that promulgate the problem.

C. Research Needs

The relative absence of literature supporting documented, positive return flows to rivers and/or groundwater derived from tamarisk control measures is not only a function of the very complex dynamics of these flows, but also of instrumentation and funding available to quantify and compartmentalize these subsurface effects. This determination is furthermore a function of spatial and temporal scale over which these effects occur and can be detected. Control of tamarisk applied across several hundred to even a few thousand acres is relatively insignificant in effect compared to the tens- to hundreds of thousands of infested acres along major watersheds such as the Rio Grande, Lower Colorado, Pecos, Gila, Virgin, Muddy, etc. As such, potential impact on return flow and groundwater dynamics within the context of ***river (floodplain) reaches*** and ***basin-wide aquifer regimes*** will be incremental and gradual. As an example, it has been reported that on the Rio Grande system, snowmelt and runoff events in the upper watersheds (San Luis Valley, Colorado) may take 50 years or more to quantifiably impact groundwater dynamics in the Middle Rio Grande (roughly Santa Fe, New Mexico to El Paso, Texas).

From a temporal standpoint, much of the literature (and supporting research) pertaining to water use and salvage in tamarisk infestations relies on obtaining publishable (and policy-influencing) results within 2-3 years following onset of treatment. This time period is typically insufficient to determine effects upon groundwater and return flows, especially given the seasonal and annual variability of contributions from precipitation in the desert southwest. The same may be claimed for revegetation research, where grants or other forms of funding for land treatment often require reportable results within the same 2-3 year time period. This requirement is in strong contrast to the fact that site restoration under dryland conditions in the arid to xeric southwest may take 5-10 years before estimates of success or failure can be made. This reflects the need for a paradigm shift in these latter two arenas (water salvage and revegetation) that acknowledges the scientific methodology of, and addresses the need for ***longer-term studies***.

In contrast, there is also increasing anecdotal evidence that in younger, mixed stands of tamarisk and native species, moisture and/or shading dynamics of these mixed stands may be conducive to increased establishment and early sustainability of seeded natives. On the Pecos River near Artesia, New Mexico, selective removal of tamarisk from mixed stands of tamarisk and black willow (*Salix nigra*) resulted in 100% mortality of the remnant willows. In research conducted on the Middle Rio Grande near San Marcial, New Mexico, best establishment and early growth of seeded native shrub species (e.g., fourwing saltbush, *Atriplex canescens*; quailbush, *Atriplex lentiformis*; Anderson wolfberry, *Lycium andersonii*) occurred under the canopy of 1st and 2nd-year tamarisk regrowth following mechanical removal. These interactions between tamarisk and native species in younger, mixed stands needs additional study in order to determine and quantify a) influences of tamarisk age, density, stand composition, canopy cover, sub-canopy moisture and shading on establishment of seeded or transplanted natives; and b) interactions with effects of soil salinity, precipitation, and soil moisture availability.

D. Summary

Awareness of soil, water, and plant dynamics in heavily infested tamarisk areas must be increased so that decision- and policy-makers can be fully exposed to a) the complexity, scope and threat of unchecked tamarisk in our major watersheds; b) the availability of sound management measures that can restore native plant communities and wildlife habitat over time; and c) the results of sound management in terms of conservation of water, habitat, and other environmental values.