SUBMIT OPTION SUBMITTAL FORM BY:
1. EMAIL TO: COLORADORIVERBASINSTUDY@USBR.GOV
2. U.S. MAIL TO: BUREAU OF RECLAMATION, ATTENTION MS. PAM ADAMS, LC-2721, P.O. BOX 61470, BOULDER CITY, NV 89006-1470
3. FACSIMILE TO: 702-293-8418

Option Submittal Form

Contact Information (optional): ☐ **Keep my contact information private.**

Contact Name: Title:

Affiliation:

Address:

Telephone: E-mail Address:

Date Option Submitted: February 1, 2012

Option Name:

Augmentation and Protection of Colorado River Basin Water Supply Through Strategic Management of Tamarisk (*Tamarix* spp.)

Description of Option:

Since its introduction into the United States, tamarisk (*Tamarix* spp.) has spread over many arid and semi-arid river systems and become the dominant or sub-dominant species in many of them. A conservative estimate of tamarisk cover in the Colorado River Basin is 250,000 acres. Tamarisk is expected to continue its spread in the Colorado River Basin if it is not managed. The control and restoration of tamarisk-infested lands within the Colorado River Basin presents a unique opportunity to not only gain potential water savings, but additionally enhance the health and utility of riparian corridors, benefiting wildlife and humans alike. Unless otherwise noted, the information provided here can be cited from a Tamarisk Coalition report titled, *Colorado River Basin Tamarisk and Russian Olive Assessment* (Tamarisk Coalition [TC] 2009).

The greatest potential opportunity for water savings through restoration of tamarisk-infested lands in the Colorado River Basin involves targeting higher elevation fluvial surfaces (upper terraces) along the river corridors. Potential water savings could be accomplished through the replacement of tamarisk in these areas with less water consumptive xeric upland species. While tamarisk is able to access deeper groundwater from these upper terraces (Shafroth et al. 2010), the priority for replacement vegetation would be on species with less ability to access deeper groundwater.

This opportunity differs from those outlined in the Augmentation Study (Gorham et al. 2007) which stated that, “the upland forest management option seemed least practicable (p ES-1).” The research cited in this option paper was compiled and/or conducted by the US Bureau of Reclamation, US Geological Survey, and Tamarisk Coalition since the completion of the Augmentation Study in 2007, and thus represents new information that should be considered.

The method of tamarisk control advocated would be dependent on site factors such as accessibility and infestation density. Options could include hand cutting with herbicide, mechanical removal, aerial herbicide application, or biological control. The method of revegetation post-control would be comprised of active revegetation using upland xeric species, or passive revegetation when it is clear that desirable species are able to colonize the site naturally.

SUBMIT OPTION SUBMITTAL FORM BY:
1. EMAIL TO: COLORADORIVERBASINSTUDY@USBR.GOV
2. U.S. MAIL TO: BUREAU OF RECLAMATION, ATTENTION MS. PAM ADAMS, LC-2721, P.O. BOX 61470, BOULDER CITY, NV 89006-1470
3. FACSIMILE TO: 702-293-8418

While restoration of the tamarisk-infested upper terraces likely have the most potential for water savings, it should be noted that restoration of the entire river bottomland (not just the upper terraces) could be highly beneficial for enhancing riparian health and benefiting humans and wildlife. To the extent possible, efforts to restore the upper terraces for the purpose of potential water savings should be coordinated with those community groups focusing on restoring the lower, wetter portions of the bottomland in order to minimize costs and maximize benefits to the entire river corridor. While water savings from restoration of the wetter riparian areas is considered to be negligible as transpiration rates of typical native riparian species may be similar to that of tamarisk (Shafroth et al. 2010), coordinated restoration efforts could benefit many more users of the Colorado River Basin.

From an ecologic and economic perspective it could be important to consider managing Russian olive, another riparian invasive commonly associated with tamarisk. It is important to note that less is known about the potential water savings if Russian olive is replaced.

Location: Describe location(s) where option could be implemented and other areas that the option would affect, if applicable. Attach a map, if applicable.

Restoration efforts would be Basin wide. Restoration sites would necessarily need to be prioritized based on factors such as tamarisk density, accessibility, and predicted water savings tied to site hydrology.

Quantity and Timing: Roughly quantify the range of the potential amount of water that the option could provide over the next 50 years and in what timeframe that amount could be available. If option could be implemented in phases, include quantity estimates associated with each phase. If known, specify any important seasonal (e.g., more water could be available in winter) and/or frequency (e.g., more water could likely be available during above-average hydrologic years) considerations. If known, describe any key assumptions made in order to quantify the potential amount.

The range of potential expected water savings is large and is dependent on site ecology, hydrology, and the type of replacement vegetation used. In order to accomplish water savings, tamarisk must be replaced with plant species that require less water. The most commonly used method for assessing potential expected water savings through tamarisk removal is the use of relative evapotranspiration measurements. Stand-level tamarisk evapotranspiration is estimated to average approximately 1 meter per year in dense stands of tamarisk (range 0.75-1.45) (Shafroth et al. 2010). Conversely, potential replacement species such as mesquite or sacaton grass are estimated to have relative evapotranspiration values that are half the average amount of tamarisk (Shafroth et al. 2010).

The Colorado River Basin Tamarisk and Russian Olive Assessment estimates that , "dependent on site factors, species used for revegetation, and conditions such as seasonal groundwater depth variability" potential expected water savings through restoration of tamarisk-infested land is estimated to range from a maximum of 50 to 60% of the value of tamarisk evapotranspiration to less than zero (if replacement vegetation has a higher evapotranspiration rate than tamarisk). Given this wide range, it is clear that further investigation is necessary before on-the-ground water savings projects are implemented.

Conservatively, total stand acreage (aerial extent) of mapped tamarisk in the Colorado River Basin is estimated to be 250,000. It is difficult to determine exactly how much of this acreage is located in the upper terraces, but it is likely to be a significant amount throughout the Basin.

Regarding the timeframe of expected water savings, it is likely that implementation of restoration efforts would be conducted in phases, and thus the timing of expected water savings would be dependent on acreage restored within each phase.

Additional Information

Technical Feasibility: Describe the maturity and feasibility of the concept/technology being proposed, and what research and/or technological development might first be needed.

It should be noted that localized site factors can play a role in potential expected water savings, and further investigations into changes in other components of the water budget (besides evapotranspiration) such as subsurface storage, streamflow, and hydrologic connectivity are recommended in order to gain a more complete picture of the true water savings that could be experienced for the Colorado River Basin (Shafroth et al. 2010).

Tamarisk and Russian olive control and removal activities are for the most part well researched and practiced as are secondary weed management and revegetation principles. The critical factor to note is that methods and treatment prescriptions may have to be adapted dramatically based on pre-site evaluation information (e.g. soil salinity, site accessibility). Additionally, one control method, tamarisk biological control is vastly under-studied. While considerable research is being conducted, many short-term impacts of the tamarisk leaf beetle on riparian areas are not understood.

Timing of restoration activities is an important consideration for this project. Table 1 is a generalization of restoration activities over a 5-year timeframe. The timeframe is flexible, the importance of this discussion is to demonstrate the ordering and sequence for restoration activities to achieve success. Given the scale of a potential Basin-wide project, this staged approach would need to be extended in order to address appropriate wildlife breeding impacts and other considerations.

Table 1: Time Distribution of Restoration Activities by Year

Restoration Activity	Y 1	Y 2	Y 3	Y 4	Y 5
Pre-site evaluation (e.g. monitoring wells installed)	■				
Development of tree and shrub plant materials (3 years minimum)	■	■	■	■	■
Tamarisk and Russian olive removal (via mechanical and hand cutting methods)	■	■	■		
Tamarisk and Russian Olive re-sprout treatments		■	■	■	
Secondary invasive weed treatments (in coordination with other control activities)		■	■	■	■
Native grass seeding (used in concert with secondary weed treatments)		■	■		
Planting of tree and shrub materials			■	■	■
Monitoring and Maintenance (ongoing beyond 5-year period)	■	■	■	■	■

Costs: Provide cost and funding information, if available, including capital, operations, maintenance, repair, replacement, and any other costs and sources of funds (e.g., public, private, or both public and private). Identify what is and is not included in the provided cost numbers and provide references used for cost justification. Methodologies for calculating unit costs (e.g., $/acre-foot or $/million gallons) vary widely; therefore, do not provide unit costs without also providing the assumed capital and annual costs for the option, and the methodology used to calculate unit costs.

Costs for the project would be phased over multiple years, as likely all restoration projects would not be conducted at once. There are many factors that can affect the cost per acre for tamarisk removal and restoration, such as tamarisk density, control method, site accessibility, soil characteristics, and water availability. It is also important to remember that tamarisk removal and biomass reduction make up only a portion of a comprehensive and successful restoration effort. Revegetation, monitoring, and maintenance are other critical components that must be included in a restoration project. Considering all of these elements, it is estimated that overall costs per acre could range from $700 to $1450 per acre. For example, on the Gunnison and Uncompahgre Rivers in Colorado it is estimated that it would cost $700 per acre to restore these tamarisk-infested rivers and their major tributaries (Colorado River District [CRD] et al. 2007). The average cost per acre for the Colorado main stem and its major tributaries from Glenwood Springs to the Colorado/Utah border is estimated to cost approximately $1000 per acre (CRD et al. 2007). On the high end, it is estimated that a large-scale river restoration project currently being conducted along the Dolores River (a tributary of the Colorado River) will cost $5,203,566 to restore 3,602 tamarisk-infested acres (both upland and riparian lands) (Tamarisk Coalition [TC] 2010). The costs of restoration on this river are likely higher than what would be typical because of issues with soil salinity and lack of overbank flooding that can impact revegeation success and accessibility issues since the geographic location is remote and defined by canyon topography in many places.

The work that is already being conducted in the various watersheds needs to be considered as part of this cost estimate and could therefore reduce portions of the estimate to capture the work that has already been completed in these areas.

Permitting: List the permits and/or approvals required and status of any permits and/or approvals received.

There are several permitting and consultation considerations potentially associated with this option such as:

- National Environmental Policy Act (NEPA)
- Endangered Species Act (ESA)
- Each of the seven states within the Basin also has its own state environmental compliance laws, which may have oversight and permitting requirements (e.g. the California Environmental Quality Act [CEQA]).
- U.S. Army Corps of Engineers, Clean Water Act Section 404 permit
- National Historic Preservation Act
- Research permits may be mandated on federal and Tribal lands, and separate Tribal agreements

Legal / Public Policy Considerations: Describe legal/public policy considerations associated with the option. Describe any agreements necessary for implementation and any potential water rights issues, if known.

We do not believe there are any legal or policy issues as long as proper permitting requirements are adhered to.

Implementation Risk / Uncertainty: Describe any aspects of the option that involves risk or uncertainty related to implementing the option.

There are not significant implementation risks. These include:

- Possible erosion and increased sediment loads if tamarisk removal and subsequent revegetation is not carefully planned/implemented. Erosion may be minimized by revegetating controlled areas quickly, using control methods that preserve beneficial bank vegetation, coordinating reach treatments so that entire watersheds are not treated at once, and avoiding river systems that are especially susceptible to erosion.

- Removal areas may become re-infested with tamarisk if follow-up monitoring and maintenance are not conducted. It is critical that controlled areas are closely monitored and maintained, particularly for several years post-treatment.

Reliability: Describe the anticipated reliability of the option and any known risks to supply or demand, such as: drought risk, water contamination risk, risk of infrastructure failure, etc.

If all of the appropriate considerations are taken, the water savings could accrue to the entire system and help meet water rights while benefiting the river, wildlife and people recreating on and around rivers.

Water Quality: Identify key water quality implications (salinity and other constituents) associated with the option in all of the locations the option may affect.

There is a potential for increased sediment loading if restoration is not carefully planned. Other water quality impacts would be negligible.

Energy Needs: Describe, and quantify if known, the energy needs associated with the option. Include any energy required to obtain, treat, and deliver the water to the defined location at the defined quality.

Energy Required	Source(s) of Energy
None	

Hydroelectric Energy Generation: Describe, and quantify if known, any anticipated increases or decreases in hydroelectric energy generation as a result of the option.

Location of Generation	Impact to Generation
	No Impact

Recreation: Describe any anticipated positive or negative effects on recreation.

Location(s)	Anticipate Benefits or Impacts
Basin-wide	This would benefit recreational use of the river, allowing better access to camps and beaches (TC 2009).

Environment: Describe any anticipated positive or negative effects on ecosystems within or outside of the Colorado River Basin.

Location(s)	Anticipated Benefits or Impacts
Basin-wide	This would greatly benefit riparian forest health and could be expected to increase flows in certain locations.

Socioeconomics: Describe anticipated positive or negative socioeconomic (social and economic factors) effects.

This will improve the recreational experience when river rafting, wildlife viewing, and other river-centric recreation activities, which should improve local recreational economies. It will also provide jobs to implement restoration activities locally.

- Jobs for Conservation Corps youth
- Jobs for local contractors

- Increased property values of landowners where tamarisk is controlled and land revegetated with desirable plant species
- Potential for increased income for animal producers with shift to desirable forage for grazing animals (versus tamarisk presence)
- With improvement to wildlife habitat (shift from trees to shrubs/grasses), potential for increased wildlife in area which could improve hunting opportunities in area
- Local involvement on restoration projects can help build community and enhance pride in town or region

Other Information: Provide other information as appropriate, including potential secondary benefits or considerations. Attach supporting documentation or references, if applicable.

We recognize this cannot be modeled in Colorado River Simulation System (CRSS). We also recognize that there is uncertainty in how much water will be available and when. Yet, there is the potential for water to accrue to the system. Additionally, a large-scale restoration approach is already being undertaken in various watersheds throughout the Colorado River Basin. These watersheds include: Dolores River, Verde River, Escalante River, Virgin River, portions of the Colorado main stem in Colorado and Utah, and other areas. Both public land managers and private landowners are collaborating to achieve ecological riparian restoration goals at the watershed scales. There is a great opportunity to leverage and learn from their work to aid in the implementation of this option.

The Tamarisk Coalition would like to offer their assistance to the project team to help expand on any scientific, feasibility or other information provided in this option paper. Thank you for considering this option.

Citations

Colorado River District, The Nature Conservancy, and Tamarisk Coalition. 2007. Colorado Headwaters Invasives Partnership: A consolidated woody invasive species management plan for Colorado's Colorado, Gunnison, Uncompahgre, and Dolores watersheds.

Gorham, J., Mengel, D., Mader, S., and Bays, J. 2007. Technical evaluation of options for long-term augmentation of the Colorado River system. Vegetation management to augment runoff and water yield technical memorandum. C2HM Hill.

Shafroth, P.B., Brown, C.A., and Merritt, D.M., eds. 2010. Saltcedar and Russian olive control demonstration act science assessment: U.S. Geological Survey Scientific Investigations Report 2009–5247.

Tamarisk Coalition. 2009. Colorado River Basin Tamarisk and Russian Olive Assessment. Available from http://www.tamariskcoalition.org/ColoradoRiver.html

Tamarisk Coalition. 2010. Dolores River Riparian Action Plan: Recommendations for Implementing Tamarisk Control and Restoration Efforts. Available from http://ocs.fortlewis.edu/drrp/