

Final Report of Research Activities

Center for Invasive Plant Management Information Synthesis Grant

Predictive models for restoration success in *Tamarix* and *Eleagnus* infested watersheds.

Funded period: 09-05 to 11/01/06

Date of report: 11/28/06

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Assistant Professor, University of Denver

Statement of the value of the CIPM grant to the research project

The CIPM-funding allowed us to look more closely at the responses of the ecosystem to riparian restoration involving woody invader removal, and to expand to include the less-studied *Elaeagnus angustifolia* (Russian olive), and to include sampling of restoration sites in six western states (AZ, CO, MT, NM, NV, and WY). Thus, we have been able to come to much broader conclusions regarding what aspects of the environment and land management choices influence restoration success. These findings have been of broad interest at regional and national conferences, and have both attracted other funding and been the foundation for new projects. Several manuscripts are in preparation for publication from this work. Below we have outlined the primary findings of the work and those accomplishments and activities which were directly impacted or a result from the funding of this project.

Primary Conclusions

- Environmental factors, especially moisture availability and soil texture, can be used to predict restoration success for areas controlled for *Tamarix spp.* and *E. angustifolia* invasions. In general, those site traits associated with native plant success (i.e. high richness and percent cover) were inversely related to those traits that predicted re-invasion, providing support for the idea that promotion of native species lessens problems with invasives. Lower soil salinity and pH and coarser soil texture as well as proximity to permanent water, sufficient precipitation, and good drainage all favored native species in areas where *Tamarix* had been removed. Factors that predict restoration success after *E. angustifolia* removal were less clear-cut than for *Tamarix*, possibly due to the more highly variable nature of restoration approaches for the former.
- In a survey of over 70 peer-reviewed papers on water use by riparian species, we concluded that proper data do not yet exist to quantify water salvage on a watershed level, and these data are badly needed. No studies have quantified water use by *E. angustifolia*. Our review did suggest very high water use by invasive *Tamarix*, especially relative to shrub communities it sometimes replaces, but not relative to native phreatophytes such as *Populus*.
- A meta-analysis of the impact of flooding in restoration revealed that flooding does both facilitate establishment and mortality of the common riparian tree species in the West, and that current data do not suggest a significant difference between the response of native and invasive species. Researchers studying response to flood need to better report sample sizes, flood magnitude, and

vegetation response in order to facilitate a cross-study analysis that will be able to test hypotheses regarding interactions between flood intensity and plant species response.

Deliverables

1) Publications:

“Two publications in the peer-reviewed literature, for the results of the literature reviews and models created with the field study”.

Bay, R. F. and A. A. Sher. 2006. What makes revegetation successful after Tamarisk (*Tamarix spp.*) removal in Southwestern riparian ecosystems? in W. R. Keammerer, editor. Proceedings: High Altitude Revegetation Workshop No. 17. Information Series No. 101. Pp 181-189 Colorado Water Resources Research Institute, Colorado State University, Fort Collins, Colorado, USA.

Bay, R.F., A.A. Sher. 2006. Success of active revegetation after *Tamarix spp.* removal in southwestern riparian ecosystems: A quantitative assessment of past restoration projects. M.S. Thesis. Is accepted pending final review for *Restoration Ecology*.

Additional papers in preparation for peer-reviewed publication

Gaddis, M.L., A.A. Sher. 2006. Understanding evapotranspiration in western riparian areas in the context of environmental variables and stand density: A review of published data. Will be submitted to the *Journal of Arid Environments*.

Gaddis, M.L., A.A. Sher. 2006. Flooding as a restoration technique in western riparian ecosystems: A quantitative review using meta-analysis software. Will be submitted to the *Journal of Arid Environments*.

2) Conference Presentations:

“Presentation of the results at regional, national, and international conferences to target both academic and land manager audiences”

2006. Ecological Society of America. Memphis, TN.

Poster: “Modeling revegetation success after tamarisk (*Tamarix spp.*) and Russian olive (*Elaeagnus angustifolia*) removal in the western U.S.A.”

Symposium: “Passengers versus drivers of ecosystem change: current debate on *Tamarix* and riparian invasion.”

2006. Guild of Rocky Mountain Ecologists and Evolutionary Biologists Meeting. Nederland, CO.

Oral presentation: “The trouble with Tamarisk.”

2006. Colorado Watersheds Conference. Breckenridge, CO.

Oral presentation: “Tamarisk (Tamarix spp.) and Russian olive (Elaeagnus angustifolia): Modeling restoration success in the Western United States.”

2006. Tamarisk Research Conference. Fort Collins, CO

- *Oral Presentation: “A review of the Ecological Society of America Symposium on Tamarisk Restoration”* Keynote address

- *Poster: “Modeling revegetation success after tamarisk (Tamarix spp.) and Russian olive (Elaeagnus angustifolia) removal in the southwestern US.”*

2006. Biology Reviews, University of Denver. Denver, CO.

Oral presentation: “Tamarisk (Tamarix spp.) and Russian olive (Elaeagnus angustifolia): Modeling restoration success in the Western United States.”

2005. Graduate Student Research Day, University of Denver. Denver, CO.

Poster: “Russian olive (Elaeagnus angustifolia): Measuring riparian restoration success in the western United States.”

3) Website Accessibility

“The models created to predict restoration success will be made publicly available on a website”

Since the model information is pending publication, we have taken material off-line until in print and copyright issues can be resolved. It will be posted again at that time.

4) Communicated to Policy Makers

“The results will be communicated to policy makers at the local and federal level primarily via communications by Co-PI Tim Carlson, CEO, Tamarisk Coalition, appointed member, ISAC of NISC”

These results are a part of the body of information that Tim Carlson has as support for his communication efforts in Washington, DC regarding restoration of these ecosystems and the need for more research. In part a result of these efforts, the Salt Cedar and Russian Olive Control Demonstration Act (PL 109-320) was signed in 2006.

Future Projects

Several projects will be directly building upon this work, both by University students and by Denver Botanic Gardens staff. We have begun three new projects to address important themes of soil chemistry and tropic effects resulting from restoration:

- 1) Creating a riparian restoration handbook with data from the CIPM project:
Michelle DePrenger Levin (researcher at Denver Botanic Gardens) is taking the findings from our multi-state survey of restoration success as the foundation for a best-management-practices handbook for managers. Due to the funding attracted (see below), the focus of this particular handbook will be the upper-Colorado River basin.
- 2) Understanding mechanisms of the patterns revealed by CIPM project:

- a. Maggie Gaddis (graduate student) is currently collecting soil chemistry data in *Elaeagnus angustifolia* stands to explore the plant community response to removal of this nitrogen-fixing exotic species from the riparian ecosystem.
- b. Michelle Cederborg (graduate student) has commenced a study looking at the effect of *Tamarix* spp. invasion and flooding on soil salinity.

Additional Funding Attracted

“Riparian Revegetation Best Management Practices Handbook”. Bureau of Reclamation Section 314c Program, Central Utah Project Completion Act. PI: Anna Sher. Project duration 9/06-9/07. Budget amount: \$33,000