Abstracts — Session 4: *Tamarix* Distribution and Ecology The 2006 Tamarisk Research Conference: Current Status and Future Directions

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Session 4: *Tamarix* Distribution and Ecology—Abstracts *(alphabetical by first author)*

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Modeling invasive species using remote sensing: an example using *Tamarix*

Tracy Davern[1,2], Tom Stohlgren[1], Robin Reich[2]

[1]US Geological Survey, Fort Collins, CO. tracy.davern@Colostate.edu, tom_stohlgren@usgs.gov. [2]Colorado State University, Fort Collins, CO. robin.reich@colostate.edu.

Abstract:

Determining the species-environment relationship is an important question in ecology, especially in invasion ecology. Determining which factors in the environment affect the distribution and abundance of an invasive species is important for early detection and rapid response. The main objective of this study was to develop a methodology that can be used to find the potential habitat and percent cover of *Tamarix* sp., an invasive riparian tree, using a combination of remote sensing, field data, and predictive modeling. We examined two different geographic locales that *Tamarix* sp. inhabits to evaluate the consistency of predictor variables over a larger geographic region. We used regression techniques that model spatial relationships between field data, environmental variables and Landsat TM images. Our overall accuracy in predicting the presence or absence of *Tamarix* sp. was as high as 97%. Likewise, up to 89% of the variation in the foliar cover of *Tamarix* sp. could be explained by predictor variables. Variables selected in the models were not the same for the two geographic regions suggesting that locally derived models may improve regional assessments of plant invasions.

Soil nitrogen dynamics in stands of *Populus deltoides* ssp. *wislizenii* and *Tamarix chinensis* with differing flood regimes

Jennifer J. Follstad Shah[1] and Cliff N. Dahm[1]

[1]Department of Biology, University of New Mexico, Albuquerque,NM,87131. follstad@unm.edu, cdahm@sevilleta.unm.edu.

Abstract:

The biotic structure and function of semi-arid riparian forests around the world are strongly organized by flood pulses. Flow management has reduced the exchange of water, energy, and materials from rivers and floodplains, caused declines in native plant populations, and advanced the spread of non-native plants. Naturalized flow regimes are regarded as a means to restore degraded riparian areas around the world. We examined the effects of flood regime on litter production and soil nitrogen dynamics in riparian forests along the middle Rio Grande of New Mexico dominated by native *Populus deltoides* ssp. wislizenii and non-native *Tamarix chinensis*. Feedbacks between litter production and soil inorganic nitrogen determined the degree of nitrogen accumulation within all riparian study sites. *P. deltoides* and *T. chinensis* flood sites had consistently lower potential net nitrogen mineralization rates than their respective non-flood sites. Flood regime also promoted differences in riparian soil nitrogen concentrations within stands dominated by each species, but flood effects contrasted across species. *P. deltoides* flood sites had low soil nitrogen concentrations, likely due to increased nitrogen uptake by plant and microbial communities, denitrification, and nitrogen export to surface and ground water that are associated with flooding. Litter production was suppressed at *P. deltoides* flood sites relative to *P. deltoides* non-flood sites, although roots from *P. deltoides* flood sites showed a greater capacity to take up inorganic nitrogen. *P. deltoides* non-flood sites had higher soil nitrogen concentrations compared to *P. deltoides* flood sites due to elevated nitrogen inputs associated with increased litterfall and the lack of transport associated with flooding. In contrast, *T. chinensis* flood sites were characterized by greater litter production, nitrogen inputs via litterfall, and concentrations of

soil inorganic nitrogen relative to *T. chinensis* non-flood sites. *T. chinensis* has the ability to produce adventitious roots at the elevation of floodwaters, an adaptation that may help to support leaf production during inundation. Litter production at *T. chinensis* non-flood sites was potentially limited by increased competition for nitrogen between plants and microbes, as inferred from soil C:N molar ratios much greater than
25:1. The practice of spring-time naturalized flows within the rivers of semi-arid regions ought to continue when adequate water supplies permit. Flood events associated with these flows promote increased recruitment of native plant seedlings, as well as increased mobilization of nutrients at a time most conducive to plant growth. However, flood inundation may be less important for the preservation of mature forests dominated by *P. deltoides* than the maintenance of shallow groundwater tables that have been shown to support high leaf production. Flood inundation, particularly if long in duration, also promotes increased losses of soil nitrogen and reduces leaf and litter production within stands of *P. deltoides*. Additional research is required to determine the thresholds at which extended flood duration does more harm than good for the conservation of *P. deltoides* along rivers of the U.S.

Evolution of cold hardiness in North American *Tamarix ramosissima*

Jonathan M. Friedman[1], James M. Roelle[1], Julie Roth[2], and John F. Gaskin[3]

[1]US Geological Survey, 2150 Centre Avenue, Building C, Fort Collins, CO 80526. jonathan_friedman@usgs.gov, butch_roelle@usgs.gov. [2]IAP World Services, 2150 Centre Avenue, Building C, Fort Collins, CO 80526. julie_roth@usgs.gov. [3]US Department of Agriculture, 1500 N. Central Avenue, Sidney, MT 59270. jgaskin@sidney.ars.usda.gov

Abstract:
Native woody plants often demonstrate inherited latitudinal variation in cold hardiness. How long does it take for such variation to evolve in introduced species? We compared cold hardiness in the native *Populus deltoides* subsp. *monilifera* (plains cottonwood) and the introduced *Tamarix ramosissima* (saltcedar). In February and March 2005, we collected cuttings of 25 individuals of each species from 15 sites in the central US ranging in latitude from 29°N to 48°N. Cuttings were rooted in a greenhouse beginning on March 17 and then moved to a shadehouse in Fort Collins, CO, latitude 41°N, on May 31. Sixteen times between September 2005 and June 2006, we exposed stem sections of northern and southern individuals of both species to a range of cold temperatures and determined the killing temperature by measuring freeze-induced electrolyte leakage. Although *Tamarix* was slightly more cold hardy in the early fall and late spring, *Populus* hardened off more rapidly and deeply. In midwinter, *Populus* was unharmed by cooling to -70°C, while *Tamarix* was killed at -30 to -40°C. There is strong inherited latitudinal variation in both the timing and extent of cold hardiness for both species. Northern individuals survive colder temperatures earlier in the season than southern individuals. Analysis of 9 microsatellite DNA loci shows a north-south genetic gradient in *Tamarix* in the central United States; southern *Tamarix* is more closely related to *T. chinensis* and northern *Tamarix* is more closely related to T. *ramosissima*. Hybridization between these two *Tamarix* species has apparently introduced the genetic variability necessary for rapid evolution of the latitudinal gradient in cold hardiness.

Invasion process of tamarisk and Russian olive into Canyon de Chelly National Monument

Lindsay V. Reynolds[1]

[1]Graduate Degree Program in Ecology, Colorado State University, Fort Collins, CO.
lindsayr@warnercnr.colostate.edu

Abstract:

Canyon de Chelly National Monument in northeastern Arizona has been invaded by tamarisk and Russian olive, resulting in the development of predominantly exotic riparian vegetation and river channel change. Tamarisk and Russian olive first established in the canyons between 1920 and 1940, and have since expanded throughout the canyons. Concurrent with the introduction of these exotic plants has been dramatic stream channel change. Historically, the stream beds in Canyon de Chelly contained wide, open, braided channels, as evidenced in historical photographs. In most of the upper canyons the stream beds are channelized and incised. This appears to have resulted in a water table decline on floodplains. Irrigation and traditional farming practices of the Navajo canyon residents have become nearly impossible. The changes in vegetation and stream channel morphology have inspired efforts to study the causes of these changes and develop strategies to mitigate their negative effects. I am investigating three components of exotic plant invasion in Canyon de Chelly and the role of exotic plants in the riparian landscape; (1) the historic patterns and processes of exotic plant invasion to understand the timing of exotic plant invasion relative to the timing of climate changes, river regulation and purposeful introductions, (2) processes that allowed tamarisk and Russian olive to successfully invade Canyon de Chelly and the characteristics of the floodplain that made it invasible, and (3) the biotic and abiotic characteristics of the floodplain that will shape future plant communities, and whether native riparian plant communities could be restored.

Historic establishment patterns of exotic plants throughout the canyon will be determined by precision aging of tamarisk and Russian olive plants in selected locations around the canyon to understand the temporal and spatial pattern of invasion, correspondence with climate, and whether tamarisk and Russian olive invaded before or after they were planted in the canyon. To understand why tamarisk and Russian olive were successful, I am testing research questions involving seedling establishment requirements of both native and exotic riparian plants as well as assessing available habitat in the canyon to understand where empty ecological niches exist in the canyon. I am also studying the biotic and abiotic characteristics of the riparian habitat that will shape future plant communities after tamarisk and Russian olive have been removed from our study sites. I am comparing the effect of two removal methods (cut-stump and whole-plant extraction) on the composition of vegetation in our study sites, as well as on airborne seed availability and the ground water table. Preliminary results suggest tamarisk seed rain is dramatically reduced in cleared areas and the ground water table is too deep for riparian plant establishment in the future. Thus, in areas cleared of tamarisk and Russian olive there may only be potential for the return of a xeric, rather than a riparian plant community. I am analyzing the soil seed bank throughout the canyon to understand the role of the seed bank in recovery of the native vegetation following exotic plant removal. Preliminary seed bank results indicate the existence of historic wetland plant species as well as native and exotic grasses. These results allow me to develop an understanding of why tamarisk and Russian olive have been successful colonists in southwestern floodplains, and inform future management and restoration of riparian habitats.

Environmental flows for riparian restoration and *Tamarix* management

Patrick B. Shafroth[1]

[1]USGS Fort Collins Science Center, Fort Collins, CO, 80526. pat_shafroth@usgs.gov

Abstract:

River scientists have increasingly advocated managing streamflow downstream of dams for ecological benefits. Flow management efforts that specifically target riparian vegetation have been relatively uncommon, however. The Bill Williams River in western Arizona, USA, has been dammed by a large flood control structure since 1968 (Alamo Dam). Dam operators and land and water managers along the river have been implementing managed flows, primarily to benefit native riparian vegetation, since the 1990's. To understand the dynamics of riparian vegetation and to evaluate the effects of flow management on the Bill Williams River system, we have analyzed historical and contemporary aerial photography and conducted various field studies over the past decade. Pulse flood releases from Alamo Dam in the early 1990's widened the river channel and resulted in the establishment of a new cohort of woody vegetation (primarily in the genera *Populus, Salix, Tamarix*). For the following nine years, low inflows did not allow for pulse flow releases, but baseflows were maintained at fairly high levels, largely to promote survival of the mid-1990's vegetation cohort. These steady low flows resulted in channel narrowing, extensive beaver pond creation, and dense vegetation growth. In 2005, extremely wet conditions and high inflows required large flow releases on the Bill Williams R., which were managed to promote establishment of a new cohort of the native *Populus fremontii* and *Salix gooddingii*, while discouraging establishment of the non-native *Tamarix ramosissima*. Whole river seedling surveys and analysis of post-flood aerial photography indicate that these flows again widened channels, destroyed beaver ponds, and created conditions suitable for new vegetation establishment. Seedlings of all three species commonly became established along the main channel and associated surfaces, but the early-dispersing *Populus* established three times more frequently on side channels and low floodplain surfaces than the later dispersing *Salix* and *Tamarix*. The mean height of the tallest *Populus* or *Salix* in sampled patches was more than twice that of the tallest *Tamarix*, potentially providing a competitive advantage of the native taxa over the alien. Our results illustrate the efficacy of this approach to influence riparian vegetation dynamics, including management of exotic species.

Tamarisk flowering and seed release phenology in relation to climate and Colorado River hydrography

Gibney Siemion[2] and Lawrence E. Stevens[1]

[1]Curator of Ecology and Conservation, Museum of Northern Arizona, 3101 N. Fort Valley Rd., Flagstaff, AZ, 86001. farvana@aol.com. [2]Grand Canyon Wildlands Council, Inc., P.O. Box 1594, Flagstaff, AZ, 86002. Gibneysiemion@aol.com

Abstract:

Non-native tamarisk (*Tamarix ramosissima*) colonized riparian habitats and reservoir shorelines throughout the western United States during the 20th Century; however, basic life history and regeneration requirements information are still lacking. We compiled elevation, date, and phenological data from 609 tamarisk specimens in southwestern herbaria to relate its reproductive phenology across elevation to hydrography and flow management in the Colorado River basin. We calculated the percentage of specimens releasing seed as a function of elevation and Julian day in three elevation belts: low (300-600 m), middle (1200-1500 m), and high (1800-2100 m) elevation. We compiled field observations on its distribution and phenology from 1984-2006, and

monitored recruitment on several debris-fan complexes. We compared recruitment responses in the pre-and post-dam Colorado River mainstream, Lake Mead and Lake Powell reservoirs, and in tributaries with low-or high-elevation headwaters. Flooding timed with seed release may result in tamarisk germination events. Conversely, planned floods that specifically avoid the May-June peak tamarisk seed release period permit little tamarisk recruitment. Failing recruitment in the post-dam Colorado River in Grand Canyon has occurred because the spring-summer hydrograph is generally unsuitable for tamarisk seedling establishment and mean sand particle size has coarsened. Hydrograph management may be used to manage tamarisk recruitment; nonetheless, flow regimes coupled with poorly-timed planned or unplanned floods c