Final Technical Report for New Mexico Water Resources Institute

Grantee: Jennifer Follstad Shah

Title of Proposal: Mycorrhizal colonization in cottonwood and salt cedar stands along the middle Rio Grande: Implications for water quality and water consumption

Title of Dissertation: Effects of flood regime and riparian plant species on soil nitrogen cycling along the middle Rio Grande: Implications for restoration

Keywords: flood, natural flow regime, river, riparian, restoration, nitrogen uptake, soil nitrogen cycling, *Populus deltoides*, *Tamarix chinensis*, mycorrhizae

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Publication Stemming from WRRI-Funded Research:

Follstad Shah, J.J., C.N. Dahm, R.L. Sinsabaugh, and V.B. Beauchamp. Similarities in soil nitrogen resource acquisition and allocation by *Populus deltoides* ssp. *wislizenii* and *Tamarix chinensis.* (In Preparation)

Note: Chapter 4 of my dissertation is a version of this manuscript. Follstad Shah, Jennifer Jo. 2006. Effects Of Flood Regime And Riparian Plant Species On Soil Nitrogen Cycling Along The Middle Rio Grande: Implications For Restoration, PhD Dissertation, Biology Department, University of New Mexico, July 2006.

Presentation of WRRI-Funded Research:

Follstad Shah, J.J. 2006. Effects of flood regime and riparian plant species on soil nitrogen cycling along the middle Rio Grande: Implications for restoration. Dissertation defense at the Department of Biology, University of New Mexico, May 11, 2006.

Media Coverage of Dissertation Research:

Malakoff, D. “Measuring Success of River Restorations”, Morning Edition, National Public Radio, April 29, 2005

Research Summary: (Graphs of data can be found in Chapter 4 of my dissertation)

Plants within the middle Rio Grande (MRG) ecosystem have been historically limited by water and nitrogen. Nitrogen availability has increased within the system due to elevated atmospheric nitrogen deposition and effluent inputs from wastewater treatment plants and irrigation return flows. Concurrently, species composition has been altered such that the rise in salt cedar land

cover (by 5200 ha) has supplanted the loss of cottonwood land cover (by 5600 ha) since 1935. Riparian forests are known to be effective filters for surface water and groundwater. Therefore, it is important to understand whether different types of vegetation have varying filtering capacities, as well as the mechanisms that promote variation across vegetation types. The formation of mycorrhizal associations improves the filtering capacity of plants. Mycorrhizae are fungi that colonize plant roots and augment the capacity for plants to acquire water and nutrients in exchange for carbon fixed through photosynthesis. The trade-off for increased water and nutrient acquisition is typically 4-20% of carbon gain. Many studies have shown cottonwoods (*Populus* spp.) form associations with both arbuscular mycorrhizae (AM) or ectomycorrhizae (EM). Studies along the MRG have found AM colonization in Rio Grande cottonwood (*Populus deltoides* ssp. *wislizenii*) ranged from 15-45% of root intersections surveyed, while EM colonization rates ranged from 47-80%. A study of AM fungi in salt cedar (*Tamarix chinensis*) at Bosque del Apache National Wildlife Refuge found percent colonization was comparable to that of cottonwood (40-45%). However, studies in the Mojave Desert and along the Verde River have reported that salt cedar roots were non-mycorrhizal. The disparate results of these studies suggest that further investigation is needed to better ascertain whether salt cedar forms mycorrhizal associations in some locales but not others. Additional root samples from cottonwood and salt cedar trees along the MRG were collected in February and July 2005 to resolve whether or not these species form mycorrhizal associations to a similar degree. The data from February showed just 6% colonization of AM fungi in the roots of salt cedar, while EM fungi were altogether absent. In contrast, colonization by AM and EM colonization was 24% and 49%, respectively, of the cottonwood root intersections surveyed. These values were similar to those reported for cottonwood roots from a similar study. This data also demonstrated that salt cedar along the MRG do not form strong mycorrhizal associations, as previously reported. The samples collected in July 2006 are still being processed, but are expected to reveal similar trends. Other data collected as part of this study showed that cottonwood and salt cedar consume all forms of nitrogen (organic and inorganic) at comparable rates, despite differences in mycorrhizal association. Since the majority of nitrogen resources are thought to be delivered via bulk flow of water intercepted by plant roots, it is likely that both salt cedar and cottonwood are equally able to filter surface water and groundwater.

Plans for Future Employment:

I have been awarded a NSF Postdoctoral Fellowship in Bioinformatics. The Fellowship will commence on January 1, 2007 and end December 31, 2008. I will be assessing the degree to which the Metabolic Theory of Ecology is supported by data from fluvial ecosystems and developing a quantitative expression to better incorporate resource supply into the theory. The broader impacts of this research include: 1) the ability to better isolate the effects of body mass, temperature, or resources when examining the complexity inherent in nature; 2) improved model parameters to better simulate and predict the effects of global change dynamics (in terms of both elevated temperature and nutrients) within terrestrial and aquatic ecosystems; and 3) a framework with which to predict the outcomes of ecological restoration. The mentors of this Fellowship include: Dr. Emily Bernhardt (Duke University), Dr. James Brown (University of New Mexico), Dr. Geoff Poole (Eco-Informatics, Inc.), and Dr. Deanna Pennington (Long-Term Ecological Research Network; Science Environment for Ecological Knowledge Project). Upon

completion of my Fellowship, I will seek a tenure-track position at a leading academic institution or employment with a research-based governmental agency or consulting firm.

Name and contact of primary mentor: Dr. Emily Bernhardt, Professor, Department of Biology, Box 90338, Durham, NC 27708, emily.bernhardt@duke.edu

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