Genetic Provenance Implications for Ecological Restoration: an International Perspective

Global Perspectives Report - 2011

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1980 Alcoa bauxite mining

2001 post-restoration

Photos courtesy of J. Koch, Alcoa

Background

In September 2011, I traveled to Perth, Western Australia to work with colleagues at the University of Western Australia, Kings Park and Botanic Garden, and Alcoa World Alumina Australia to assess different seed sources for ecological restoration of post-mined lands. Restoration often requires the introduction of seed stock to replace or augment native plant populations. Generally accepted best practice recognizes that the source - or provenance - of materials used for restoration should be restricted to collections near the restoration site to preserve local biodiversity and avoid the introduction of plants maladapted to local environments. However, native plant seeds are scarce and seed stock is often derived from unknown or distant sources adapted to different environments. Potential problems with long-distance seed introductions include significant declines in germination and establishment of introduced plants and their progeny and, ultimately, revegetation failures.

Outside of its urban capital Perth, Western Australia is very remote and population density is low (0.9 people per km^2 compared to ≥2 people per km^2 in Wyoming). The economies of both Western Australia and Wyoming are dominated by energy and resource extraction, including mining of oil and natural gas, uranium and mineral ores. Reclamation and restoration efforts are regulated in both countries and cost-effective tools are needed for the successful revegetation and conservation of native plant biodiversity. My trip was an opportunity to discuss both the science and the management behind current seed sourcing practices relevant to both regions of the world.

Perth, Western Australia

Objectives

My objectives for the trip were twofold. First I aimed to complete a test study of different provenances (seed sources) of our study species, *Stylidium hispidum* (the white butterfly triggerplant). The plant family Stylidiaceae is one of the largest in Southwest Australia, and triggerplants commonly grow in sites targeted for revegetation in post-mine reclamation in the West Australian jarrah (*Eucalyptus marginata*) forest. To accomplish my objective, I worked

with Dr. Siegy Krauss at Kings Park and Botanic Garden, Dr. Hans Lambers and Dr. Erik Veneklaas (both at the University of Western Australia) and Louisa Cockram, a postgraduate student at the university. Our research answers the question: does seed source affect population fitness, and therefore the success of ecological restoration? Based on data from two separate studies, the answer is yes. The source of seeds for restoration can have a significant, and often negative, impact on germination and survival of plants. We have detected as much as a 50% reduction in seed germination and seedling survival if plants are derived from seeds sourced at long distances from restoration sites. In addition, if seed sources are mixed, the offspring of parents adapted to different environments are much less likely to germinate and survive at the outset.

Stylidium hispidum

Louisa Cockram is currently finishing a second, field study of local and non-local plants, as well as their offspring, in the field. Her thesis has recently been submitted to the University of Western Australia, and her project will contribute to restoration seed sourcing studies of this "test" species. Results of our combined work have been presented to Alcoa World Alumina Australia collaborators, and data will contribute to Alcoa's protocols for mine site restoration.

Submitted manuscript: Inbreeding and outbreeding depression in *Stylidium hispidum*: implications for seed sourcing for ecological restoration, Kristina. M. Hufford, Siegfried L. Krauss, and Erik J. Veneklaas (journal of Evolutionary Applications)

Submitted thesis: The consequences of local adaptation and mixing seed provenance for ecological restoration of *Stylidium hispidum* Lindl. (Stylidiaceae): a reciprocal transplant of local and hybrid genotypes at short and long distances, Louisa Cockram, School of Plant Biology, University of Western Australia (K. Hufford, S. Krauss and E. Veneklaas, supervisors)

Louisa Cockram, UWA postgraduate student, at an Alcoa forest restoration site.

The second objective of the trip was to investigate the potential for an international research program to investigate both global and unique regional applications for the preservation of plant biodiversity in ecological restoration. Meetings among the different groups (including Kings Park and Botanic Garden, the University of Western Australia, Alcoa World Alumina Australia, and also Worsley Alumina (BHP)) resulted in several discussions for future collaborative work. I also presented both my research results and an introduction to Wyoming on several occasions while in Australia. The group has agreed to pursue future grant opportunities for studies of seed sourcing and ecological restoration in the face of climate change. Our ultimate goal is to eventually apply for a National Science Foundation Partnerships

for International Research and Education (PIRE) award, and joint efforts would include education as well as research and outreach in both regions of the world.

Activities:

3 presentations: “Outbreeding depression in the Stylidiaceae”

2 presentations: “Introduction to Wyoming”

Meetings with personnel from UWA, Kings Park, Alcoa and Worsley

Dr. Siegy Krauss and Louisa Cockram, field monitoring in late winter

Future objectives

A large collaborative effort between groups in Western Australia and Wyoming will involve many people and my next objective is to seek funding for a workshop that will bring researchers from both hemispheres together to discuss plans for a joint research and education program. If efforts to obtain future research grant funding are successful, I anticipate a long-term collaboration that will contribute to improved restoration outcomes and outreach for

both Wyoming and Western Australia, with the potential to impact restoration efforts worldwide.