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Seed Islands May Promote Establishment and Expansion of Native Species in Reclaimed Mine Sites (Montana)

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Restoring diverse native plant communities to reclaimed mining areas can be challenging, especially when there is not enough locally adapted seed available to restore large areas. One possibility may be to seed native species in small patches, or "islands," and allow them to recruit by natural dispersal to adjacent sites. We tested this technique in order to restore mixed-grass prairie species to two reclaimed coal mine sites near Colstrip in southeast Montana that were strip-mined from 1980 to 1983.

The first site (Basin) is fairly level (0-2 percent slope) and was reseeded in 1990 and 1991 with 12 native grass species and five native forbs. The second site (NE Slope) was recontoured with a 20-degree slope and revegetated with seven native grasses and one native forb in 1993. Soils consisted of homogenized overburden subsoil covered with a 6- to 12-inch (15- to 30-cm) layer of sandy loam topsoil. The Basin site was rotation grazed during the experiment, but the NE Slope was not grazed. In fall 1998, we tilled 18 9-m^2 seed islands, placed 210 ft (64 m) from each other, at each site. In February 1999, we hand-broadcast the islands with a monoculture of either purple coneflower (*Echinacea angustifolia*) at 2,133 seeds/m^2, white sagebrush (*Artemisia ludoviciana*) at 161 seeds/m^2, or large Indian breadroot (*Pediomelum esculentum*) at 161 seeds/m^2. None of these species were included in previous revegetation seed mixes nor did they occur at the site prior to planting. The seeds were purchased from vendors in Wyoming and Minnesota, and seeding rates were determined by the number of seeds in each package.

In 2002 and 2003, we surveyed the sites and mapped all recruit patches of the seeded species. We defined recruit patches as individual plants or plants clusters located less than 1 meter from each other. We measured the number of recruit patches and the distance from each recruit patch to the nearest seed island. We used ANOVA to test the effect of year and site on the number and distance of recruit patches, and ArcView 9.0 to determine whether the distribution of the recruit patches was random or clumped.

The untreated breadroot seeds established poorly in the islands and did not recruit outside the islands in either 2002 or 2003. In July 1999, 20 percent of the purple coneflowers and 32 percent of sagebrush established in the seed islands. However, after this initial census, a heavy rainstorm in mid-August reduced survival to 2 percent for purple coneflower and 3 percent for sagebrush. At both sites, we mapped a total of 146 coneflower recruit patches in 2002 and 113 in 2003. Sagebrush, which we seeded at 7.5 percent of the density of purple coneflower, produced 14 patches in 2002 and six in 2002. We found no significant difference in the number of recruit patches between years for either species. The recruitment distance did not differ significantly between years for sagebrush, but we found that the purple coneflower recruit patches were significantly farther from the plantings in 2003 than in 2002 (Figure 1). The purple coneflower recruit patches were highly clumped during both years, suggesting that it was finding suitable areas to establish new patches. The sagebrush recruit patches appeared clumped, but the low number of individuals only tested as clumped in 2002. Sagebrush seed was probably wind-dispersed, while livestock may have spread purple coneflower seed at the Basin site.

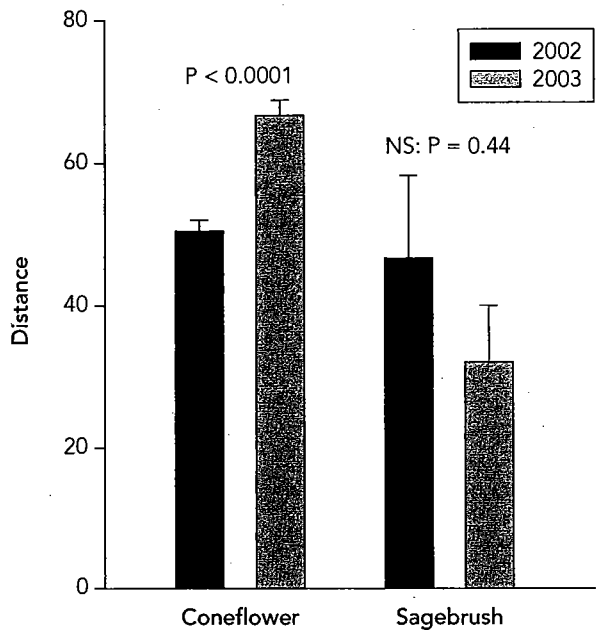

Figure 1: Mean recruitment distance for purple coneflower (*Echinacea angustifolia*) and white sagebrush (*Artemisia ludoviciana*) in 2002 and 2003 at both sites. Error bars = mean standard errors.

Site differences appeared to influence recruitment. Purple Sagebrush recruitment was greater at the NE Slope site, while purple coneflower recruitment was greater at the Basin site. According to Morgan (1997), sagebrush grows best in mesic prairie and purple coneflower grows better in dry prairie. Our study sites were too close together to differ much in climate, but north-facing slopes tend to be cooler and more mesic, which may explain sagebrush's preference for the NE Slope site. It appeared that purple coneflower recruits established best on a disturbed bench and at the bottom of a draw where grasses did not establish well.

These results suggest that native species can expand from seed islands into a restored site, especially if the islands are

heavily seeded. Our experience with Indian breadroot suggests that some species may not recruit quickly using this method. Unlike the other two species, breadroot has a thick seed coat and establishes best if scarified, stratified, and inoculated (Steffen 1997). Untreated breadroot seed produced by seed islands may be slow to break dormancy, resulting in slow recruitment outside of seed islands.

References

Morgan, J.P. 1997. Plowing and seeding. Pages 193-215 *in* S. Packard and C. F. Mutel (eds.), The tallgrass restoration handbook. Washington, D.C.: Island Press

Steffen, J.F. 1997. Seed treatment and propagation methods. Pages 151-162 *in* S. Packard and C. F. Mutel (eds.), The tallgrass restoration handbook. Washington, D.C.: Island Press

ENDANGERED SPECIES

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Experimental Comparison of Reintroduction Methods for the Endangered *Echinacea laevigata* (Boynton and Beadle) Blake. 2004. Alley, H., State Botanical Garden of Georgia, University of Georgia, 2450 S. Milledge Ave., Athens, GA 30605, 706/542-6448, Fax: 706/542-3091, alley@uga.edu; and J.M. Affolter. **Natural Areas Journal** 24(4):345-350.

These researchers tested propagation techniques for smooth coneflower (*E. laevigata*), a federally endangered species of the southeastern United States Piedmont. Two 15-m x 18-m test sites in Georgia were cleared and planted in 2000 and 2001 to compare 1) transplanting bare-root seedlings with seedlings rooted in potting soil; 2) clustering with individual planting; and 3) planting seedlings compared with one- to three-year-old plants. Survival rates ranged from 75-100 percent, with most losses due to herbivory. The authors suggest that the best method may be to plant one-year-old (or older) bare-root plants in spring, but that, due to the high survival rates for all methods tested, restorationists should be able to choose strategies based on logistical costs and benefits.

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Close Encounters of an Avian Kind. 2004. Canright, A. **California Coast & Ocean** 20(2):22-27.

Canright describes the process of raising, releasing, and monitoring six California condors (*Gymnogyps californianus*) at Pinnacles National Monument. The year-old birds were transferred to the Big Sur Condor Reintroduction Project site for instruction by a "mentor" condor and interaction with previously released, free-flying condors. Then they were released from a net-covered flight cage at Pinnacles. Two of the condors were recaptured, one for approaching climbers and the other for competing poorly for food and roosting on the ground (an open invitation to predators). Both birds are being reconditioned and will be released again. As of spring 2004, about 100 condors had been set free in Arizona, California, and Mexico.

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Colonization History and Noninvasive Monitoring of a Reestablished Wolverine Population. 2004. Flagstad, Ø., Centre for Ecological and Evolutionary Synthesis, Dept. of Biology, P.O. Box 1066, Blindern, N-0316 Oslo, Norway, oystein.flagstad@bio.uio.no; E. Hedmark, A. Landa, H. Brøseth, J. Persson, R. Andersen, P. Segerström and H. Ellegren. **Conservation Biology** 18(3):676-688.

These researchers report on a large-scale monitoring project assessing population characteristics of southern Norwegian wolverines (*Gulo gulo*) through genetic tagging of individuals, with feces as a DNA source. Results suggested that male wolverines can disperse up to 311 miles (500 km), and that the southern population is being augmented by northern wolverine immigrants. The authors simulated genetic drift for 100 generations to determine whether the current migration rate (6.2 percent) of northern animals is enough to maintain genetic variability in the southern population. They found that variability was reduced by only 10 percent at the current rate, but that if no migration occurred, almost all variability would be lost.

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Constraints for Re-establishing a Meta-population of the European Bison in Ukraine. 2004. Perzanowski, K., Carpathian Wildlife Research Station, Museum and Institute of Zoology, Polish Academy of Sciences, 38-700 Ustrzyki Dolne, Poland, +48-134612251, StacjaKarpacka@miiz.waw.pl; W. Olech and I. Kozak. **Biological Conservation** 120(3):345-353.

These authors analyzed the spatial distribution and genetic structure in reintroduced herds of European bison (*Bison bonasus*) to assess restoration of a viable population across the bison's former range in Ukraine. Results showed that long distances between herds and low bison numbers may prevent further development of the populations and natural gene exchange. The authors conclude that active management is required, including continued monitoring of genetic structure, exchanging animals among the herds, and facilitating contacts with free-ranging herds in neighboring countries.

EDUCATION & SOCIAL SCIENCE

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FROM: Proceedings of the Fifth Biennial Conference on University Education in Natural Resources

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An Uncommon Undergraduate Experience: Conducting Research and Fieldwork in Ecological Restoration. Long, R., Ecological Research Institute, Northern Arizona University, Flagstaff, AZ 86011, 928/523-7187, Robin.Long@nau.edu; and P. Fulé. P. 74.

The Ecological Research Institute (ERI) offers an interdisciplinary program that integrates research with formal studies. The program, open to all majors, encourages undergraduates and minorities and provides mentoring by a team of faculty, staff, and graduate students. Selected students work as year-round researchers in campus labs and on summer field crews at Colorado Plateau research sites. Required coursework covers ecological restoration principles and applications. Senior projects may be independent work or internships with agencies committed to forest restoration, and, under ERI sponsorship, may be presented at conferences. So far, the program has helped 55 students in 18 majors with financial support.

180.2

Building Intercontinental Learning Bridges in Natural Resources Education for Diverse Culture. Phillips, V., University of Wisconsin-Stevens Point, 800 Reserve St., Stevens Point, WI 54481, 715/346-4617, vphillip@uwsp.edu. Pp. 20-27.