FULL TITLE OF PROCEEDINGS ABSTRACTED IN THIS ISSUE

Abstracts of the Ecological Society of America International Conference: Ecology in the Era of Globalization. Held January 8-12, 2006 at the Universidad Autónoma de Yucatán and the Centro de Investigaciones Científicas de Yucatán in Mérida, Mexico. Abstracts available online: abstracts.co.allenpress.com/pweb/esai2006

12th Annual Society for Ecological Restoration-California Chapter (SERCAL) Meeting. Held October 19-22, 2005 in Bass Lake, CA. www.sercal.org.

Abstracts of the Ecological Society of America 90th Annual Meeting. Held August 7-12, 2005 in Montreal, Canada. Meeting held jointly with the Ninth International Congress of Ecologists. Abstracts available online: abstracts.co.allenpress.com/pweb/esa2005

GRASSLANDS

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FROM: SERCAL 12th Annual Meeting

144.1

Prescribed Burning for Native Grassland Restoration: Central Valley, Tulare County. Kamansky, B., James K. Herbert Wetland Prairie Preserve, P.O. Box 731, Three Rivers, CA 93271; and R.B. Hansen. P. 24.

Kamansky and Hansen conducted prescribed burns over a two-year period at different seasons in an effort to reduce fuel accumulations from exotic annual grasses and restore saltgrass (*Distichlis spicata*)—a native perennial. They found that early spring burns in moist areas led to the greatest saltgrass increases, although prescribed burning regardless of season improved saltgrass vigor and reproduction. Summer burns removed the most grass litter, but native plants recovered more slowly. The authors suggest that prescribed burning is effective in site preparation because it can control exotic plants and prevent additions to the seedbank. In addition, prescribed burning can maintain restoration sites by enhancing native species at the expense of exotic species.

144.2

Native Plant Restoration Through Seeding Method and Soil Type Study. Magill, E., Endangered Species Recovery Program, California State University, Stanislaus, 1900 N. Gateway Blvd., Fresno, CA 93727; J.V.H. Constable and N. Ritter. P. 25.

The authors hypothesized that broadcast seeding would result in greater seedling establishment compared to drill and imprint techniques, since it most closely resembles natural dispersal patterns. They found that both of the native species monitored—great valley phacelia (*Phacelia ciliata*) and spikeweed (*Hemizonia pungens*)—had higher percent cover when broadcast seeded, although the results did not differ significantly from imprinting phacelia or from drilling spikeweed. The authors also hypothesized that phacelia would experience optimal growth in untilled soil while the invasive foxtail chess (*Bromus madritensis*) would grow optimally in retired agricultural fields. They found that both species had similar photosynthetic rates when grown in agricultural soil in a greenhouse, but foxtail chess experienced 400 percent greater photosynthesis in untilled, native soil. They suspect this may be due to a much greater root-to-shoot ratio, which could facilitate early germination and greater water uptake.

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FROM: Ecological Society of America 90th Annual Meeting

145.1

Effects of Plant Species Seed Size on Behavior in Prairie Restoration. Carrington, M., Governors State University, University Park, IL. http://abstracts.co.allenpress.com/pweb/esa2005/document/?ID=49377.

Carrington conducted an experiment in an Illinois oldfield to test how restoration techniques influenced the successful establishment of three prairie plant species chosen to represent different seed sizes: large—prairie dock (*Silphium terebinthinaceum*), medium—wild quinine (*Parthenium integrifolium*), small—smooth blue aster (*Aster laevis*). She hypothesized that smaller seeds would have poorer establishment in vegetated areas due to competition and greater establishment in bare areas because of reduced predation. Aster seedling density was similar across treatments, so small seeds appeared unaffected by restoration method. Prairie dock and wild quinine seedling densities showed the influence of competition, however. Seedlings of both species were more prevalent in tilled areas, while prairie dock was more successful than wild quinine in mowed areas. Artificially shaded areas also reduced seedling establishment for large- and medium-seed species.

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Changes in Soil Microbial Community Structure in a Tallgrass Prairie Chronosequence. 2005. Allison, V.J., Environmental Research Division, Argonne National Lab, Argonne, IL 60439-4843, allisonv@landcareresearch.co.nz; R.M. Miller, J.D. Jastrow, R. Matamala and D.R. Zak. **Soil Science Society of America Journal** 69(5):1412-1421.

These scientists hypothesized that fungal abundance relative to bacteria will continuously increase as tallgrass prairie replaces agricultural fields due to increasing soil organic carbon (SOC) over time and a lack of tilling. Phospholipid fatty acid analyses of soil samples from restoration sites of different ages at the Fermi National Accelerator Laboratory indicated that total microbial biomass and relative abundance of fungi, especially arbuscular mycorrhizae, increased in surface soils, largely caused by a lack of soil disturbance. However, the relative abundance of fungi then decreased over time as SOC increased. Plant characteristics, such as tissue nutrient content, also affected the microbial community with bacteria in agricultural fields showing signs of stress, probably due to a fertilizer-induced low carbon-to-nitrogen ratio. Fungi can improve carbon sequestration by providing recalcitrant inputs from chitin and melanin residues and improving soil structure through extraradical hyphae.

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***Tetramorium tsushimae*, a New Invasive Ant in North America.** 2006. Steiner, F.M., Dept. of Integrative Biology, Institute of Zoology, Boku, University of Natural Resources and Applied Life Sciences Vienna, Gregor-Mendel-Str. 33, 1180 Vienna, Austria, Fax: +43-1-47654-3203, h9304696@edv1.boku.ac.at; B.C. Schlick-Steiner, J.C. Trager, K. Moder, M. Sanetra, E. Christian and C. Stauffer. **Biological Invasions** 8(2):117-123.

Based on molecular and morphometric analyses, the authors describe a common Japanese ant species (*Tetramorium tsushimae*), which was first documented in 1988 in urban St. Louis, Missouri, and most recently in nearby Illinois and other areas of Missouri near St. Louis, including a xeric calcareous grassland. The species may have been inadvertently imported with nursery stock from Japan in the mid-1980s. *Tetramorium tsushimae* has removed native ant colonies (including *Formica* spp. and *Myrmica* spp.) in areas where it has become established and should be monitored. *T. tsushimae* can be distinguished from the native *T.* cf. *caespitum* by its social organization (polygynous, not monogynous), by genetic analysis using restriction fragment length polymorphism, and by morphometric analysis of workers using the discriminance function program found at homepage.boku.ac.at/h505t3/DiscANT/.

148

Forb Response to Herbicides in a Degraded Tallgrass Prairie. 2006. Tunnell, S.J., Dept. of Agronomy and Horticulture, University of Nebraska, P.O. Box 830915, Lincoln, NE 68583-0915, stunnell2@unl.edu; J. Stubbendieck, S. Palazzolo and R.A. Masters. **Natural Areas Journal** 26(1):72-77.

The researchers documented a very low forb frequency and species richness in areas of tallgrass prairie remnant in Kansas where smooth sumac (*Rhus glabra*) was growing. Experiments tested various formulations of 2,4-D, picloram, triclopyr, and glyphosate, using spray or wick applications at rates ranging from 0.01 to 0.32 kg of active ingredient per square meter (0.19 to 0.59 lb/yd^2). Two years after treating the sumac with herbicide, forb species richness had increased and no additional interventions were needed. They did find, however, that broadcast spraying decreased forb frequencies and species richness more than wick application. Removing the dense stands of smooth sumac increased light and water availability and reduced competition, which may have contributed to increased densities of species, such as leadplant (*Amorpha canescens*). The authors also suggest that, given sufficient precipitation, forbs may recover in herbicide-treatment areas from the soil seedbank, as demonstrated by the significant increase of annual sunflower (*Helianthus annuus*).

WOODLANDS

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Evidence for Genetic Differentiation of Iowa and Minnesota Populations of Two Forest Herbs: Implications For Restoration

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The use of non-local seeds for restoration projects may be a problem because plant species can develop genetically distinct local populations. Non-local genotypes may be maladapted to restoration sites and fail as a result, or they may swamp local populations, resulting in species-wide loss of genetic diversity. Documenting the source and performance of plants used in restoration, would result in more biologically informed guidelines for collection zones, and would help integrate the research perspectives of ecological genetics and restoration ecology (Hufford and Mazer 2003, McKay and others 2005).

We tested whether two candidate species for woodland restoration, hairy woodmint (*Blephilia hirsuta*) and zigzag goldenrod (*Solidago flexicaulis*), from central Iowa and sites near the eastern Minnesota-Iowa border (hereafter, "Minnesota") were genetically differentiated. Because passive seed dispersal should result in reduced gene flow compared to wind dispersal, we also tested whether wind-dispersed zigzag goldenrod is less genetically differentiated than passively dispersed hairy woodmint.

We grew the goldenrod and woodmint in a common greenhouse garden, which allowed us to infer that any morphological differences between Iowa and Minnesota plants were the result of genetic differentiation. We did not test for differentiation using genetic markers because the relationship between genetic markers and differentiation in traits related to plant performance is unclear. We collected Iowa seeds from natural populations in Polk County in central Iowa and purchased Minnesota seeds from Prairie Moon Nursery (www.prairiemoon.com). The nursery obtained woodmint seeds from Winona County in southeast Minnesota, and the goldenrod from nearby Clayton County in northeast Iowa. In April 2004, we cold-stratified the seeds for six weeks and sowed them in a greenhouse at Iowa State University in Ames. In June 2004, we randomly selected 24 individuals of each species from both the Iowa and Minnesota populations for inclusion in the study.

We measured eight plant performance traits in hairy woodmint and five in zigzag goldenrod. We measured leaf number of both species in June and August 2004. Stem height was measured in June and August for woodmint, but in August only for goldenrod. In September 2004, we estimated flower number of goldenrod. In September, we also harvested a subset of woodmint and goldenrod, and dried and weighed them to estimate final biomass. At the same time, we harvested ten cauline leaves from a subset of the woodmint plants, measured leaf size, and dried and weighed the leaves. Leaf mass per area was calculated as dry leaf weight divided by leaf area. Finally, we counted how many of the unharvested woodmint plants flowered in spring.

We found evidence that hairy woodmint, but not zigzag goldenrod, was genetically differentiated between Iowa and Minnesota. The goldenrod from Iowa and Minnesota did not differ for any of the performance traits. In contrast, six out of eight traits differed between Iowa and Minnesota populations of the woodmint (Table 1).

Table 1. Mean (±95 percent confidence interval) for performance traits of hairy woodmint (*Blephilia hirsuta*) and zigzag goldenrod (*Solidago flexicaulis*) from Iowa and Minnesota. If confidence intervals for plants from Iowa and Minnesota did not overlap, then plants were inferred to be genetically differentiated for that trait. Because percent flowering was calculated from dichotomous data (flowered or not), a Fisher's exact test was used to determine that this trait differed significantly between Iowa and Minnesota ($p < 0.05$). Sample size is in parentheses.

Hairy woodmint	Iowa	Minnesota
June 2004 height (cm)	1.16 ±0.11 (24)	1.73 ±0.12 (24)
June 2004 leaf number	4.7 ±0.38 (12)	6.0 ±0.00 (12)
August 2004 height (cm)	26.9 ±1.68 (12)	36.7 ±2.96 (12)
August 2004 main stem leaf number	69.8 ±6.2 (12)	55.3 ±3.22 (12)
Aboveground biomass (g)	11.4 ±0.82 (6)	8.8 ±0.06 (6)
Belowground biomass (g)	2.5 ±0.26 (6)	2.2 ±0.29 (6)
Leaf biomass (g)	0.19 ±0.02 (4)	0.12 ±0.03 (4)
Leaf size (cm^2)	13.9 ±1.55 (4)	6.9 ±1.43 (4)
Leaf mass per area (g/cm^2)	1.36 ±0.23 (4)	1.77 ±0.35 (4)
Percent flowering	100 (12)	17.0 (12)
Zigzag goldenrod		
June 2004 leaf number	4.1 ±0.26 (24)	4.1 ±0.31 (24)
August 2004 height (cm)	35.6 ±8.4 (12)	33.3 ±10.2 (12)
August 2004 leaf number	28.7 ±2.3 (12)	26.1 ±2.3 (12)
Aboveground biomass (g)	5.6 ±1.2 (6)	6.6 ±1.1 (6)
Belowground biomass (g)	2.3 ±0.37 (6)	2.5 ±0.48 (6)
Flower number	165.0 ±103 (12)	198.0 ±107 (12)

Our results support the recommendations of Hufford and Mazer (2003) and McKay and others (2005) that the reproductive biology of desired species needs to be considered when restoring plant populations. Specifically, using local seed sources for restoration may be less important for wind-dispersed species, such as zigzag goldenrod, if they are consistently found to be less genetically differentiated than passively dispersed species. However, because hairy woodmint and zigzag goldenrod are in different plant families, other traits may influence the scale of genetic differentiation. Consequently, we are initiating a common garden study of target species for woodland restoration that differ in their reproductive biology, but are in the same plant families.

Our results also suggest that Minnesota hairy woodmint may be unsuitable for Iowa restorations. Although Minnesota woodmint seedlings were taller and had more leaves than Iowa seedlings, by the end of the first growing season, Iowa plants had more and larger leaves and accumulated significantly more aboveground biomass than Minnesota plants. Moreover, all Iowa woodmint flowered by the end of the second season, while only two Minnesota plants had flowered (Table 1). Finally, we observed that Minnesota woodmint was more likely to wilt during droughty weather than woodmint plants from Iowa. Etterson (2004) likewise found that partridge pea (*Chamaecrista fasciculata*) from Minnesota had reduced performance when planted in Kansas and Oklahoma prairies because the Minnesota plants were less drought tolerant, suggesting that water stress could be an important cause of reduced fitness when non-local seed sources are used for restoration.

Acknowledgment

We thank the Iowa Army National Guard for funding.

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McKay, J.K., C.E. Christian, S. Harrison and K.J. Rice. 2005. How local is local? A review of practical and conceptual issues in the genetics of restoration. *Restoration Ecology* 13:432-440.

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Assessing Restoration Needs for National Forests: A Survey of Natural Resource Professionals in the Eastern United States

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In 2004, the Eastern Region of the U.S. Forest Service developed a framework for restoring National Forest lands infested with exotic species, with the primary goal of "maintaining biodiversity and ecosystem health through use of locally adapted populations of native species for restoration, rehabilitation, and revegetation" (USFS 2004). In order to attain this goal, the agency contracted JFNew to provide guidelines that will aid personnel working in the Eastern Region's 15 National Forest units to develop native plant programs.

The forest units occur within eight ecoregions or "provinces" (McNab and others 2005) in the area east of the Mississippi River and north of the Ohio River, and Missouri. To assess the needs for specific forests across such a wide range of ecological conditions, we sent a written survey to 49 Forest Service personnel and 473 natural resource professionals throughout the Eastern Region. The mailing list was compiled through suggestions from the Forest Service, online searches of nonprofit organizations and government agencies, and our own database. We gathered additional information through phone interviews, online research, books, and scientific literature. Here, we present a summary of responses to our survey questions.

We received surveys from 18 Forest Service employees representing all 15 forest units. Nearly all units reported conducting some native plantings, most of which were less than 1 acre (0.4 ha) in size, with the largest being 570 acres (230.6 ha). The top three goals across units were to 1) restore areas after human disturbance, 2) provide erosion control, and 3) prevent the introduction of invasive species. The most important native plant regimes cited were riparian areas or stream edges, mesic and dry deciduous forest, and generic erosion control or disturbed-area mixes. In addition, respondents repeatedly indicated the need for various types of native grassland communities. The most commonly cited reasons for not having as comprehensive a native plant program as desired were lack of staff time and lack of availability of native plant material. Most respondents (72 percent) indicated that plant material for restorations was purchased from nurseries, 39 percent collected seed from wild populations, and 17 percent used plant materials grown in the field or greenhouses.

A total of 53 natural resource professionals returned completed surveys. Most of these respondents work within the Laurentian Mixed Forest Province (Wisconsin, Michigan, Minnesota) or the Central Interior Broadleaf Forest Province (southern Illinois, Indiana, and Missouri). Each of the other five provinces was evenly represented among the remaining respondents (data from Finger Lakes and Green Mountain National Forests, which occur in two different provinces, were lumped together). Most respondents (63 percent) worked for local, state, or federal (non-Forest Service) agencies, 19 percent worked for non-profit groups, and the remainder represented private foresters, academic institutions, nurseries, and arboreta.

A majority of these respondents (81 percent) indicated that their organization was conducting native plantings, and the primary goal for most was to restore pre-settlement plant communities. More than half say they want to restore vegetation following human disturbance (57 percent) and to restore wildlife habitat (53 percent). The most common plant communities being restored were prairie (47 percent), emergent wetland (38 percent), and riparian areas or stream edges (38 percent). Most projects were small (1 acre or less), although a few large-scale restorations of 1,800-2,700 acres (728-1,093 ha) were being undertaken in the Midwest. Respondents reported that most of their plant material came from nurseries (55 percent), although 40 percent reported collecting seed from the wild for restorations or production. A few stated that they grew their own plants in greenhouses (15 percent), produced plants in the field (11 percent), and/or contracted with local growers or farmers (8 percent).

We also asked survey participants to provide species lists for native plant regimes in their region, and to rank each species by how easy it is to collect, propagate, and grow in the field. We used this information to generate a list of "workhorse" species for use by the forest units in each province. We discovered a bias towards prairie species while preparing these lists. This may be because most native plant restorations occur in the Midwest, where prairie communities are more common, and the nursery trade is geared toward providing those species. We also discovered that there is a great need for forest species, and that locally adapted plant material for forests is sorely lacking. This may be due to the prairie bias, but it may also be due to the fact that woodland species were reported to be difficult to propagate.

Because very few woodland species were included on the workhorse species lists, we also generated lists of species that are or will be in demand for each province but are difficult to propagate. These lists should guide future research on plant propagation and provide nurseries with target species for new production. The species lists are contained in Sherfinski and others (2006) along with general guidelines for collection of seed and propagation, installation, and maintenance of native plant species. Readers may obtain a copy of this document in the "documents section" of JFNew's Web site, www.jfnew.com.

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Sherfinski K., N. Kalkbrenner and R. Allison. 2006. Guidelines for national forests starting a native seed program: R9 Eastern Region. Madison, WI: JFNew.

U.S. Forest Service (USFS) R9—Eastern Region. 2004. Native plant framework. www.fs.fed.us/r9/wildlife/plants_botany/native_species/r9_native%20_framework_04march03_web2.pdf .

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FROM: Ecological Society of America 90th Annual Meeting

151.1

Prescribed Burns and Cattle Grazing in Ponderosa Pine Forests: Implications for the Herbaceous Understory. Kerns, B., U.S. Forest Service, Corvallis, OR; W. Thies and C. Niwa. abstracts.co.allenpress.com/pweb/esa2005/document/?ID=51561.

The authors report preliminary data from a field experiment in eastern Oregon ponderosa pine (*Pinus ponderosa*) forests that compares combinations of spring and fall prescribed burning with cattle grazing. They measured understory species richness and cover one year before and two years after burn treatments. The authors found that fall prescribed burns significantly increased the cover of understory species in the absence of grazing, while species richness was unchanged. Burning in spring or not burning resulted in no difference in either species richness or cover between grazed and ungrazed areas. Excluding cattle grazing did not reduce the cover of exotic species, such as cheatgrass (*Bromus tectorum*).

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Effects of Repeated Prescribed Fires on the Structure, Composition, and Regeneration of Mixed-oak Forests in Ohio. 2005. Hutchinson, T.F., U.S. Forest Service, Northeastern Research Station, 359 Main Rd., Delaware, OH 43015, 740/368-0090, thutchinson@fs.fed.us; E.K. Sutherland and D.A. Yaussy. **Forest Ecology and Management** 218(1-3):210-228.

These researchers present the results of an eight-year study, comparing units in oak (*Quercus* spp.)-hickory (*Carya ovata*) forests with closed canopies and understories dominated by shade-tolerant woody species that were burned annually in the spring for four years, burned twice over four years, or went unburned. While red maple (*Acer rubrum*) seedling mortality was generally high in burned areas, the canopy remained closed, oak and hickory seedling density and size were not affected, and red maple understory dominance was reestablished two years after burning. The authors suggest that a long-term burning regime of moderate-intensity fires in mid- to late-April at two- to five-year intervals could create and maintain an open forest canopy that favors oak and hickory regeneration.

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Plant Community Attributes 12 to 14 Years Following Precommercial Thinning in a Young Lodgepole Pine Forest. 2006. Lindgren, P.M.F., Applied Mammal Research Institute, 11010 Mitchell Avenue, Summerland, BC V0H 1Z8, Canada, tom.sullivan@ubc.ca; D.S. Ransome, D.S. Sullivan and T.P. Sullivan. **Canadian Journal of Forest Research** 36(1):48-61.

This article describes long-term effects of three levels of pre-commercial thinning compared to unthinned and old-growth lodgepole pine (*Pinus contorta*) stands. The researchers found that thinning to low density (1,235 stems/acre or 500 stems/ha) increased structural diversity, promoted the rapid development of large trees with full crowns, facilitated the establishment of a shade-tolerant subalpine fir understory, and increased herb abundance. In addition, tall shrubs were reduced due to damage from the thinning process, moose browsing, and possibly mid-size shrub competition. Over the long term they expect that thinning will promote a longer herb-shrub stage of seral development and provide a unique plant community of both early- and late-seral plant species, many of which are not found in old-growth stands.

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Restoration Treatment Effects on the Understory of Ponderosa Pine/ Douglas-fir Forests in Western Montana. 2006. Metlen, K.L., University of Montana, College of Forestry and Conservation, Missoula, MT 59812, 406/243-5198, Fax: 406/243-4845, kerry.metlen@cfc.umt.edu; and C.E. Fiedler. **Forest Ecology and Management** 222(1-3):355-369.

Metlen and Fiedler hypothesized that a combined treatment of prescribed burning and thinning would increase understory species diversity and decrease tree recruitment in overstocked ponderosa pine (*Pinus ponderosa*)-Douglas fir (*Pseudotsuga menziesii*) forests (see *ER* 24(1):44-45). As expected, the combined treatment best approximated reference conditions, although it also resulted in the highest level of non-native plant invasion. The authors suggest that multiple prescribed burns or single prescribed burns with more moderate to severe fire behavior may enhance the effectiveness of burning without thinning. They also recommend employing a mosaic of treatment combinations to facilitate large-scale changes in the heterogeneity and long-term sustainability of these forests.

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Effects of Post-fire Conditions on Germination and Seedlings Success of Diffuse Knapweed in Northern Arizona. 2005. Wolfson, B.A.S., Northern Arizona University, School of Forestry, Box 15018, Flagstaff, AZ 86011, 928/556-2157, bswolfson@fs.fed.us; T.E. Kolb, C.H. Sieg and K.M. Clancy. **Forest Ecology and Management** 216(1-3):342-358.

The authors evaluated the risk of diffuse knapweed (*Centaurea diffusa*) invasion in ponderosa pine (*Pinus ponderosa*) forests of northern Arizona. Their experiments determined that this exotic plant had higher germination rates and developed more biomass in severely burned soils, likely due to increased soil temperature, moisture, and nutrients. It also germinated earlier and survived extremes of soil moisture and temperature that eliminated many native plants and arbuscular mycorrhizae populations. The authors recommend interagency cooperative management policies that incorporate efforts to prevent and control diffuse knapweed as part of wildfire rehabilitation and fuel reduction activities, since fire activity can facilitate establishment of diffuse knapweed in the wildland-urban interface and its eventual spread into interior forests.

WETLANDS

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FROM: SERCAL 12th Annual Meeting

156.1

Mitigation of Groundwater Withdrawal Impacts to a Fen in Yosemite National Park. Roche, J.W., Yosemite National Park, El Portal, CA 95318; D.J. Cooper, E.C. Wolf, R. Chimner and J. Meyer. P. 22.

These scientists monitored the effects of daytime pumping by a water-supply well on the shallow groundwater dynamics of an adjacent fen and meadow at Crane Flat in Yosemite National Park. The well drew down 11.7-23.4 inches (30-60 cm) of groundwater each day, resulting in a seasonal drawdown of 19.5-58.5 inches (50-150 cm). The establishment of plant species and animal burrows within the peat indicate surface drying of the fen, and a cumulative loss of carbon indicates that the peat is degrading as a result of the groundwater pumping. Proposed management activities include water conservation efforts to reduce demand, changing the pumping schedule to allow water table recovery and summertime fen saturation, and establishing a deeper well that pumps groundwater from bedrock fractures

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A Comparison of Plant Communities in Mitigation and Reference Wetlands in the Mid-Appalachians. 2005. Balcombe, C.K., Bureau of Reclamation, 300 E. 8th St., Ste. G-169, Austin, TX 78701, jander25@uwv.edu; J.T. Anderson, R.H. Fortney, J.S. Rentch, W.N. Grafton and W.S. Kordek. **Wetlands** 25(1):130-142.

These scientists found that total plant species evenness, richness, and diversity were greater in West Virginia mitigated wetlands than natural sites, although percent cover and percent hydrophytic vegetation were similar. The mitigated wetlands are young, include more species associated with disturbance, and show more even distributions of species, due to lack of dominance or monocultures. Generally, mitigated wetlands had established submerged aquatic vegetation, important for water quality and wildlife habitat, and woody vegetation. However, they also had more non-native species, higher bulk densities and matrix chroma, lower organic matter, and more rock fragments. The authors recommend assessing mitigation sites at least ten years after establishment and manually seeding native species into constructed wetlands to prevent colonization by exotic or aggressive clonal species.

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Effect of Area and Insolation on Species Richness and Indices of Floristic Quality in Illinois, USA Wetlands. 2005. Matthews, J.W., Illinois Natural History Survey, 607 E. Peabody Dr., Champaign, IL 61820; P.A. Tessene, S.M. Wiesbrook and B.W. Zercher. **Wetlands** 25(3):607-615.

These researchers found that species richness correlated with the total perimeter or wetland size, but not with site isolation, which was generally low in the sampled wetlands. Increasing wetland size or perimeter increased the average coefficient of conservatism (mean C), while increasing isolation decreased mean C, increased the likelihood of exotics, and lowered the proportion of obligate wetland species. Decreased site area and increased site isolation will both decrease FQI, due to both species composition and richness, reflecting the reduced conservation value of the site. However, the FQI can be confounded by sampling date, community type, and sampling area. Emergent wetlands require late-season sampling or multiple sampling dates to avoid FQI errors. Community types display different characteristic species richness that prevent direct comparison of FQI values. Artificial subdivisions of plant communities through wetland delineation procedures can reduce assessed conservation values based on FQI, but not mean C.

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Effect of NaCl and Typha angustifolia L. on Marsh Community Establishment: A Greenhouse Study. 2005. Miklovic, S. and S.M. Galatowitsch, Dept. of Horticultural Science, University of Minnesota, 305 Alderman Hall, 1970 Folwell Ave., St. Paul, MN 55108, galat001@umn.edu. **Wetlands** 25(2):420-429.

Using greenhouse microcosms, Miklovic and Galatowitsch assessed the potential effects of road salt (NaCl) on native wetland ecosystems, both directly and indirectly through competition with narrow-leaved cattail (*Typha angustifolia*). Softstem bulrush (*Scirpus validus*) tolerated higher NaCl concentrations with slightly higher biomass in the 1000 mg/L treatment, but was very sensitive to competition from the cattail. Concentrations of 500 mg/L and 1000 mg/L reduced native plant establishment, species richness and diversity, although evenness increased, due to decreased dominance by American mannagrass (*Glyceria grandis*). The authors conclude that road salt, especially at levels of 1,000 mg/L or above, is a stressor that can interact with cattail competition to change the native species composition in wetland restorations, once species-dependent threshold concentrations are reached.

160

Restoration of Wetlands in the Mississippi-Ohio-Missouri (MOM) River Basin: Experience and Needed Research. 2006. Mitsch, W.J., Olentangy River Wetland Research Park, School of Natural Resources, The Ohio State University, 352 W. Dodridge St., Columbus, OH 43202, 614/292-9774, Fax: 614/292-9773, mitsch.1@osu.edu; and J.W. Day, Jr. **Ecological Engineering** 26(1):55-69.

The authors propose restoration in the Mississippi-Ohio-Missouri drainage basin to reduce the hypoxic zone in the Gulf of Mexico. They recommend 1) changing agronomic practices to reduce fertilizer usage, 2) creating or restoring wetlands amidst agricultural fields to filter ground and surface waters, and 3) creating diversion backwaters along rivers to filter floodwaters. They estimate that 5.4 million acres (2.2 million ha) of functional wetlands would use 1 percent of the land area and remove 40 percent of the total nitrogen flow. They believe that, when combined with agronomic practices to reduce an additional 20 percent of the total nitrogen flow, this effort would significantly reduce Gulf hypoxia without adverse economic impacts that mandatory fertilizer restrictions would impose. Additional benefits include reducing drinking water and wastewater treatment costs; increasing wildlife habitat, particularly for migratory species; and mitigating flood impacts.

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Seed Dispersal Into Wetlands: Techniques and Results for a Restored Tidal Freshwater Marsh. 2005. Neff, K.P. and A.H. Baldwin, Dept. of Biological Resource Engineering, University of Maryland, Bldg. 142, College Park, MD 20742, Baldwin@umd.edu. **Wetlands** 25(2):392-404.

Neff and Baldwin recommend seed dispersal studies prior to restoration to reduce cost and increase success. They document seed dispersal into Kingman Marsh in Washington, D.C.—a restoration site that was created on dredge material—and found that the species composition of collected seeds there differed from those collected at Kenilworth Marsh, a restored wetland, and at natural tidal wetlands. They point to water as the primary dispersal mechanism, although goose feces may be an important vector for some species. Seed dispersal studies can indicate invasive threats to the site and help determine species composition of restoration plantings. The authors recognize that, although it identifies the propagule pool, a seed dispersal study does not determine the actual species that will become established since animals and hydrological factors strongly influence recruitment on wetland sites. They consider drift-line sampling the most cost-effective method for qualitative identification of water-dispersed species, although additional wind- and animal-dispersal samples will provide the most complete data.

LAKES, RIVERS & STREAMS

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Root Elongation of Black Willow Stakes in Response to Cutting Size and Soil Moisture Regime (Tennessee)

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Unrooted black willow (*Salix nigra*) cuttings are often used in streambank restoration efforts (Shields and others 1995). Restorationists think that larger cuttings are more effective because protruding posts can reduce near-bank current velocities and thus are less likely to be washed away (Hoag and Landis 2001). Larger cuttings also have greater food and water reserves. However, the influence of cutting diameter under a range of soil moisture regimes on root development has not been reported. To consider this question, we examined root development of three sizes of willow cuttings subjected to three moisture regimes in a laboratory experiment.

We collected 3.3-ft (1-m) long, non-dormant black willow cuttings with basal diameters of 0.4, 2, or 4 inches (1, 5, or 10 cm) from a population on a river in western Tennessee. The cuttings were planted in 2-ft-long by 6-inch-diameter (0.6-m by 15-cm) pots filled with sand, placed in an air-conditioned greenhouse with natural light, and fertilized once every two weeks with 6.7 oz (200 mL) of 20-20-20 fertilizer at 0.2 oz/gal (1.25g/L) of water.

Using a random block design, we placed 16 cuttings of each diameter in each of three water regimes: periodic flooding (PF;

one day flooded, six days drained), control (C; well-watered, well-drained), and drought (DR; watering only when predawn leaf water potential reached below –5 bar). Water regimes were intended to represent those found at a range of elevations along banks of incised streams in the southeastern Coastal Plain (Pezeshki and Shields in press).

On 7, 14, 21, and 28 days after treatment began, we sampled four randomly selected cuttings of each diameter from each moisture treatment. We determined the depth interval from 0-18 inches (45 cm) at which rooting occurred along the cuttings below the soil surface, counted the number of roots, measured maximum root length, and oven-dried and weighed the roots. We used multivariate ANOVA to test for differences in belowground parameters and depth of root initiation between cutting diameters and soil moisture treatments. Tukey's Studentized range test was used to identify differences in the pair-wise comparisons, with significance set at $p < 0.05$.

Cutting diameter and moisture treatment each had a significant effect on root parameters. Maximum root length (Figure 1A) and root biomass of larger-diameter cuttings were greater than 0.4-inch cuttings, although cuttings under DR treatment had lower maximum root length than the cuttings under C and PF treatments. However, the PF treatment cuttings had similar root length to the C treatment cuttings irrespective of diameter, probably due to the short duration of flooding. By the end of the study (day 28), root length of cuttings in all moisture treatments was not significantly different (Figure 1B).

Treatment and cutting diameter also influenced the depth at which roots developed. Vertical distributions of roots were non-uniform for cuttings in the C and DR treatment but not in the PF treatment. In the C treatment, 0.4-inch-diameter cuttings produced a higher percentage of roots (44.9 percent) at a depth of 0-12 inches (30 cm) compared to 4-inch-diameter cuttings, which produced 50 percent of the root mass at 12-18 inches. In the DR treatment, larger-diameter cuttings also produced a significantly greater percentage of the root mass (65.7 percent) at the 12-18-inch depth than 0.4-inch-diameter cuttings (24.5 percent). Cuttings in the PF treatment produced a similar amount of roots at each depth interval irrespective of diameter size. Only smaller-diameter cuttings differed in the vertical distribution of roots across moisture treatments, with a greater percentage of the root mass occurring from 0-6 inches (15 cm) in the PF treatment than the DR treatment.

Larger-diameter willow cuttings (greater than 2 inches) appear to be a better choice for streambank plantings than 0.4-inch-diameter stakes due to the more rapid development of the root biomass, the production of longer roots, and the concentration of roots at depths greater than 12 inches below the soil surface. Although cutting size and soil moisture were the focus of this study, it should be noted that field conditions, such as soil texture and nutrient content may also influence root development of willows. While this was only a month-long, greenhouse study, the results suggest that restorationists may want to consider planting a combination of different-sized cuttings. For example, near the bank toe, larger-diameter cuttings would reduce water velocities and allow time for small cuttings to establish. At mid-elevation zones, soil moisture is usually favorable, and different patterns of root development of 0.4-inch- and 4-inch-diameter cuttings might protect the banks from both surficial erosion and deeper-seated sliding. Nearer the top of the bank, where drought conditions are likely, the low initial water demand of small-diameter cuttings and superior root elongation of large-diameter cuttings might be desirable.

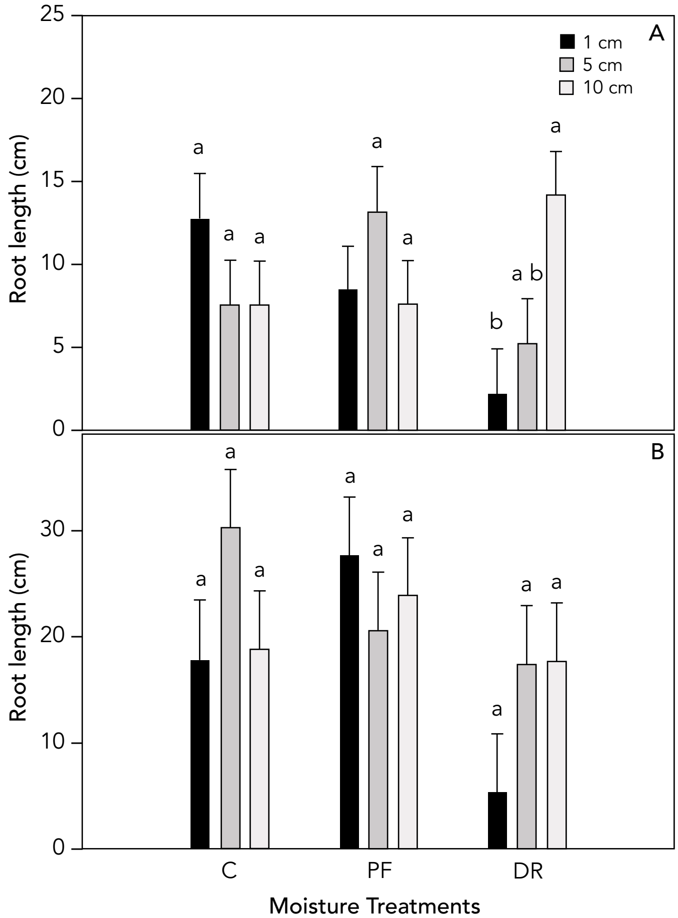

Figure 1. Mean (± s.d.) maximum root length for 1-cm, 5-cm and 10-cm black willow cuttings grown under control (C), periodic flooding (PF), and drought (DR) moisture treatment for (A) 14 days and (B) 28 days. Significant differences are indicated by different letters.

Acknowledgments

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FROM: SERCAL 12th Annual Meeting

163.1

Lessons Learned From Eleven Years of Long-term Riparian Restoration Monitoring at Guadalupe River Park, Downtown San Jose. Busnardo, M., H.T. Harvey & Associates. 3150 Almaden Expressway, San Jose, CA 95118; D. Stephens, P. Reynolds and K. Bear. P. 27.

The authors monitored a 1-acre (0.4-ha) riparian area for 11 years following a four-year restoration project along a 4-mile (6.44-km) reach of the Guadalupe River. Development had narrowed the river channel and increased the slope of riverbanks due to concrete and other fill deposits, in addition to introducing invasive species, such as tree-of-heaven (*Ailanthus altissima*) and English ivy (*Hedera helix*). Restoration entailed removing fill materials, creating wider and more stable slopes, and planting native trees and shrubs. The high-density plantings of large-stock riparian trees, particularly Fremont cottonwood (*Populus fremontii*), rapidly reached an average height of 51.8 ft (15.8 m) and 74 percent canopy cover, which has created bird habitat and improved aquatic habitat through shading. Shrub understory establishment has been limited due to competition from weeds, flooding, trampling, and insufficient irrigation. Floods have caused small-scale bank collapses with concomitant vegetation loss. Other management activities also have affected restoration plantings.

163.2

Beaver and Stream Corridor Restoration: Compatibility and Conflict. Mahacek, V., Valley and Mountain Consulting, valley_mountainconsulting@yahoo.com. Pp. 16-17.

Four presentations addressed the positive and negative effects of beaver (*Castor canadensis*) activity. Busher suggested that introducing beavers can be a cost-effective means of slowing water flow rates and increasing sedimentation, but cautioned that beaver behavioral ecology and potential conflict with human activities need to be considered during planning. Mahacek and Schupbach concluded that beavers enhance stream restorations in the Upper Truckee River and Lake Tahoe Basin, but stressed the need for a regional policy. Alternatively, Taylor and Barry recommended limiting beaver activity in this region, since it could lead to local extirpations of the mountain yellow-legged frog (*Rana muscosa*) and the expansion of non-native amphibian and fish species, such as bullfrog (*Rana catesbeiana*), brown bullhead (*Ameiurus nebulosus*), and largemouth bass (*Micropterus salmoides*). Ross and colleagues suggested that a growing beaver population in the American River Parkway interferes with wetland mitigation projects and may be depleting willow (*Salix* spp.) and cottonwood (*Populus* spp.) stands.

163.3

Road-To-Trail Conversion and Environmentally-Sensitive Techniques to Restore Urban Streams. McCullah, J., Salix Applied Earthcare, 225 Locust St., Ste. 203, Redding, CA 96001; and K. Dettman. P. 28.

The Environmentally Sensitive Streambank Stabilization project, funded by the National Cooperative Highways Research Program, developed techniques to reduce erosion and sedimentation, enhance anadromous fish habitat, and restore hydrologic processes. The authors converted a highway abandoned in 1934 into a trail by ripping and recontouring the road surface and stabilizing the fill with vegetated earth. Moreover, they replaced clogged culverts, removed homesite debris from the streambed, constructed cross vanes to define the stream channel, and planted willows (*Salix* spp.) and native grasses along the streambank. Two years after these activities, the vegetation is well-established, erosion and sedimentation have diminished, and steelhead (*Oncorhynchus mykiss*) and salmon (*Oncorhynchus* spp.) have returned after a 70-year absence.

163.4

Geomorphic Restoration of a Montane Meadow/Creek in Washoe Meadows State Park. Walck, C., California Dept. of Parks & Recreation, P.O. Box 16, Tahoe City, CA 96145. P. 22.

Walck documents a $550,000 project to reduce erosion, restore wetland and riparian vegetation, and decrease the risk of accidental sewage releases into Angora Creek, which flows into Lake Tahoe. In the 1960s, the South Tahoe Public Utility District installed a sewer line in the meadow, which resulted in the stream leaving its meandering channel to follow the sewer line downslope for 2,000 feet (610 m), cutting down two feet (61 cm) deeper than its original streambed, and drying out the adjacent meadow. The project created a 3,800-ft (1,158-m) shallow, meandering channel that provides periodic inundations of the meadow, thereby raising the water table, increasing sediment deposition, improving nutrient filtration, and enhancing the plant community.

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FROM: Ecological Society of America 90th Annual Meeting

164.1

Evaluating Ecosystem Function in Urban Stream Restoration. Audia, S., California State University, Los Angeles, CA; and J. Gamon. http://abstracts.co.allenpress.com/pweb/esa2005/document/?ID=51866.

Audia and Gamon analyzed the success of a mitigation project aimed at restoring riparian vegetation of Arroyo Seco in Pasadena, California. The project was considered a successful model due to initial vegetation establishment and growth. However, these indices declined after the five-year monitoring period ended. The authors suggest that mitigation projects should entail long-term monitoring that measures aspects of ecosystem function, including improved water quality, increased wildlife habitat, and long-term persistence of the plant community.

164.2

Restoring Fluvial Processes: The Role of Flood Inundation in the Distribution and Abundance of a Common Riparian Shrub. Fremier, A., University of California, Davis, CA; and T. Talley. abstracts.co.allenpress.com/pweb/esa2005/document/?ID=50849.

Fremier and Talley compared populations of blue elderberry (*Sambucus mexicana*) from upper reaches of dammed and unaltered rivers in California. They found that the proportion of younger and smaller shrubs—from 0.8-2.7 inches (2-7 cm) basal diameter—increased as distance to river channel decreased, while older and larger shrubs—greater than 4.3 inches (11 cm) basal diameter—were located at higher elevations and greater distances from river channels. Shrubs from dammed river populations tended to be larger than those from uncontrolled river areas. The authors conclude that flooding facilitates elderberry seedling establishment while restricting long-term survival of older shrubs, which suggests that flooding historically maintained heterogeneous structures of various riparian species populations.

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Eradication of Invasive *Tamarix ramosissima* Along a Desert Stream Increases Native Fish Density. 2005. Kennedy, T.A., Grand Canyon Monitoring and Research Center, U.S. Geological Survey, 2255 N. Gemini Dr., Flagstaff, AZ 86001, tkennedy@usgs.gov; J.C. Finlay and S.E. Hobbie. **Ecological Applications** 15(6):2072-2083.

The authors removed saltcedar trees from a 1.9-mile (3-km) reach of Jack Rabbit Spring in the Mojave Desert in Nevada and measured the effects on carbon cycling in the aquatic food web. Algae productivity increased, resulting in significantly higher densities of federally endangered Ash Meadows pupfish (*Cyprinodon nevadensis mionectes*) and exotic screw snail (*Melanoides tuberculata*), and significantly lower density of exotic crayfish (*Procambarus clarkii*)–a species that depends on saltcedar leaf litter in the winter. Bulrush (*Scirpus americanus*) and endangered Ash Meadows speckled dace (*Rhinichthys osculus*) populations also increased, while the exotic mosquitofish (*Gambusia affinis*) decreased. Saltcedar removal was effective in restoring native species, but could also result in endemic mollusk declines, due to increased screw snail competition.

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Regeneration of Native Trees in the Presence of Invasive Saltcedar in the Colorado River Delta, Mexico. 2005. Nagler, P.L., Environmental Research Laboratory, 2601 E. Airport Dr., Tucson, AZ 85706, pnagler@ag.arizona.edu; O. Hinojosa-Huerta, E.P. Glenn, J. Garcia-Hernandez, R. Romo, C. Curtis, A.R. Huete and S.G. Nelson. **Conservation Biology** 19(6):1842-1852.

These scientists estimated the population dynamics of willow (*Salix gooddingii*) and cottonwood (*Populus fremontii*) and their responses to fire, pulse floods, groundwater recharge, and salinity. Results indicated that salt-tolerant shrubs covered nearly half of the study area with saltcedar (*Tamarix ramosissima*) the most common woody species (35 percent cover). Major water releases (more than 1,766 ft^3/s or 50 m^3/s) led to native tree seedling establishment and increased summer biomass accumulation in riparian vegetation. These releases correlated with the number of years with flood events more than with the previous winter's total flow volume, however. The authors suggest that delta floodplains be managed to control fire and provide variable flood regimes to restore native riparian vegetation and enhance a significant habitat corridor for migratory songbirds.

167

Compromised Rivers: Understanding Historical Human Impacts on Rivers in the Context of Restoration. 2005. Wohl, E., Dept. of Geosciences, Colorado State University, Ft. Collins, CO 80523-1482, ellenw@cnr.colostate.edu. **Ecology and Society** 10(2):2. www.ecologyandsociety.org/vol10/iss2/art2/.

Wohl defines a compromised river as having a simplified appearance and lost hydrologic and geomorphic processes, which results in reduced ecological integrity. Wohl points out, however, that the public tends to associate superficial attractiveness of compromised rivers with health and that they ignore the effect of historic land uses on river function. Wohl warns that restoration goals (aesthetic, water quality, habitat quality, or safety) that are developed without a historical context may not be achievable because of flawed assumptions about reference conditions and persistent influences of land uses, such as logging, mining, grazing, dams, and water diversions.

COASTAL COMMUNITIES

168

Chesapeake Bay Restoration: A Model of What? 2005. Powledge, F., fredpowledge@nasw.org. **BioScience** 55(12):1032-1038.

Powledge discusses problems with the Chesapeake Bay Program—a high-profile restoration program that began in the 1980s and involves the Chesapeake Bay Foundation, the Virginia Institute of Marine Science, and local, state, and federal agencies. Powledge points out that 1) agreements to reduce nitrogen and phosphorus point-source contributions set unachievable goals, while discounting the large role of non-point sources; 2) early static models from the 1950s ignored the influence of climate, salinity, human activities, and stochastic events; 3) more recent computer modeling was based on flawed assumptions that led to unrealistic predictions and diverted funding from monitoring; 4) the program has a non-integrated approach, regularly inflates progress reports, and has insufficient public communications; and 5) state agencies and the U.S. Environmental Protection Agency have failed to enforce current water quality regulations.

169

Long-Term Growth and Succession in Restored and Natural Mangrove Forests in Southwestern Florida. 2005. Proffitt, C.E., Wetland Ecology Branch, USGS/BRD, National Wetlands Research Center, 700 Cajundome Blvd., Lafayette, LA 70506, 337/266-8509, edward_proffitt@usgs.gov; and D.J. Devlin. **Wetlands Ecology and Management** 13(5):531-551.

Proffitt and Devlin compared an 18-year-old restored mangrove site with a natural mangrove forest. Physiochemical site conditions determined tree seedling establishment, while density-dependent self-thinning of white mangrove (*Laguncularia racemosa*) affected long-term stand development. Colonization and growth rates for white mangrove and red mangrove (*Rhizophora mangle*) were slower in the natural forest gaps than at the restored site, probably due to shading from adjacent adult trees. Moreover, black mangrove (*Avicennia germinans*) did not establish seedlings in forest gaps, possibly due to low propagule density in the forest. The restoration had higher tree densities, smaller tree sizes, and greater total basal area than the natural forest. Although the restored mangrove site has quickly developed some features of natural forest, such as species richness, other characteristics, including soil structure and tree size, may require decades to develop.

OTHER COMMUNITIES

170

FROM: Ecological Society of America 90th Annual Meeting

170.1

Experimental Restoration of Florida Sandhill Using Subcanopy Felling and Burning. Rickey, M., Archbold Biological Station, Venus, FL; E. Menges and C. Weekley. http://abstracts.co.allenpress.com/pweb/esa2005/document/?ID=48428.

The authors tested the effects of prescribed burning and burning in combination with thinning hardwood understory trees as part of longleaf pine (*Pinus palustris*) sandhill ecosystem restoration efforts. The combined treatment resulted in higher pine mortality and elimination of the hardwood trees as well as lichens, while the burn-only treatment produced lower pine mortality, reduced the size of sub-canopy trees, and decreased the density of lichens. Shrubs declined the first year after both treatments, then increased to levels higher than in the control areas. Meanwhile, tree species recruitment was higher than the control in both treatment categories. Groundcover species did not respond to treatments. The authors recommend thinning part of the subcanopy and multiple prescribed burns as early restoration activities in areas that have a long history of fire suppression.

171

Responses of Diversity and Invasibility to Burning in a Northern Oak Savanna. 2005. MacDougall, A.S., Dept. of Botany, University of British Columbia, Vancouver, British Columbia V6T 1Z4 Canada. **Ecology** 86(12):3354-3363.

MacDougall tested the diversity-stability model, which holds that greater species richness will increase the resistance of an ecosystem to invasion due to the fact that the positive effects of sudden disturbance on some species compensate for negative effects on other species. The study site was a fire-suppressed oak (*Quercus* spp.) in British Columbia with a diversity gradient ranging from cool-season, grass-dominated (*Poa* spp. and *Dactylis* spp.), low-diversity areas on deep, mesic soils to high-diversity, low-population, forb-dominated areas on shallow, drier soils was burned in the summer. MacDougall found that plants in the diverse areas were adapted to summer drought conditions and expanded after a burn, reducing available resources and inhibiting invasion. Fire negatively affected plants in the low-diversity areas, probably because they were drought stressed, allowing Scotch broom (*Cytisus scoparius*) and thistles (*Cirsium* spp.) to invade the openings. MacDougall concludes that support for the diversity-stability model depends on the species' evolutionary histories and disturbance severity.

CONTROL OF PEST SPECIES

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Integrating Weed Management and Restoration on Western Rangelands

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Cheatgrass (*Bromus tectorum*) dominates 3 million acres (1.2 million ha), has heavily infested 17 million acres (7 million ha), and threatens another 60 million acres (24 million ha) of rangelands in the Great Basin of western North America (Pellant and Hall 1994). An exotic annual, cheatgrass produces prolific seed, is highly competitive, and perpetuates large, frequent fires (Knapp 1998, Smith and others 2000). These characteristics accelerate the loss of perennial species, increase cheatgrass dominance, and facilitate invasion of other rangeland weeds. The change from perennial to annual dominance and the altered fire cycle result in a "vegetation conversion" (Keeley 2006) that makes it difficult to restore native vegetation.

In 2003, we began experiments to control cheatgrass and restore native species on Great Basin rangelands with the intention of 1) controlling cheatgrass by reducing its seed production and competitive ability and 2) investigating whether "transitional communities" facilitate restoration of native plants. We established two common experiments at eight sites in Nevada, Oregon, Idaho and Utah, plus a third, large-scale experiment in Nevada. All sites were originally Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) and native bunchgrass communities, but had converted to essentially cheatgrass monocultures. We repeated the first two experiments in 2003 and 2004, and established the third experiment in 2004.

Experiment 1 (Transition Species) tested establishment of 25 seed varieties (crested wheatgrass [*Agropyron cristatum* x *desertorum*] as a benchmark because it is an introduced grass commonly used to suppress cheatgrass, several native species, and sterile annual cover crops) with and without cheatgrass. We used a Truax Rough Rider range drill to seed each variety into 10-ft x 20-ft (3-m x 6-m) plots arranged in six blocks per site. Three blocks were treated with glyphosate (Roundup at 0.5 lb ai/acre or 0.7 kg/ha) to kill cheatgrass in the spring prior to seeding, and three blocks were not sprayed. Density of seeded varieties and density and biomass of cheatgrass and other species were monitored after seeding.

Experiment 2 (Functional Groups) used six native species with different growth forms to examine 1) how different growth forms reduce cheatgrass individually compared to a mix of species and 2) if decreased soil nitrogen (N) availability decreases cheatgrass competition. We seeded 4-ft x 8-ft (1.25-m x 2.5-m) plots by hand, and applied granulated sugar (3.9 oz/ft or 360 g/m) to stimulate microbial growth and immobilize soil N. On some sites, we also examined interactions with secondary weeds, such as medusahead (*Taeniatherum caput-medusae*) and rush skeleton weed (*Chondrilla juncea*).

Experiment 3 (Management Options) investigated prescribed fire and herbicide applied at a larger scale (12-acre or 5-ha plots) to reduce cheatgrass density and seed bank. In fall 2004, a "transition species" (a sterile annual hybrid) was planted on a subset of plots to immobilize soil N and provide additional fuel for a fall 2005 prescribed fire. We applied Roundup at 0.5 ai/acre in spring 2005 to a different subset of plots to reduce cheatgrass seed production. We compared the six best performers from Experiment 1 to the six-species mix from Experiment 2, and drill-seeded the mixtures in late fall 2005.

After two years, we have identified several promising plant materials comparable to crested wheatgrass, including native sources of bluebunch wheatgrass (*Pseudoroegneria spicata*), western wheatgrass (*Pascopyrum smithii*) and Snake River wheatgrass (*Elymus wawawaiensis*), that might serve as transition communities for converting cheatgrass back to native vegetation. We also found that nitrogen limitation dramatically reduced cheatgrass seed output in the current year and density in the next year, although cheatgrass density rebounded the following year. In addition, personnel from the USDA-NRCS Aberdeen Plant Materials Center in Idaho, in cooperation with Mr. Jim Truax, modified the design of the Rough Rider drill to increase the flow of seed from the seed box to the ground, create a wider disc opening so more seed gets buried, and cause the press wheel to more accurately close soil around the seed.

We will continue to monitor our Transition Species and Functional Group experiments. We will also collect information on our third experiment to determine the effectiveness of site preparation and seeding treatments. In addition, we are using partnerships among governmental agencies, universities, and cooperative extension services to convey our findings to private and public land managers. Other partnerships with educators will help to increase public awareness of invasive species and native plant restoration issues. Finally, we are developing models of the economic and social effects of restoration in order to assess the net minimum costs to ranchers and to examine the degree of social acceptability among key stakeholders.

Acknowledgments

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Nitrogen Fixation by Kudzu: Impacts on Invaded Communities and Ecosystems

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Kudzu (*Pueraria montana*), a vine native to Asia, covers more than 7 million acres (3 million ha) in the United States and is expanding by more than 123,500 acres per year (50,000 ha/yr), mostly in the South (Forseth and Innis 2004). This legume packs a one-two punch with its impressive growth rates (up to 100 ft or 30 m in a single growing season) and its ability to fix nitrogen (Forseth and Innis 2004). We are exploring how these characteristics combine to alter community composition and disrupt ecosystem properties where it invades, particularly with respect to nitrogen cycling and accumulation. Various scientists (Vitousek and others 1997, Matson and others 2002) have noted that additions of nitrogen can lead to altered nitrogen accumulation and cycling in soils and streams, changes in plant and microbial community structure, increased invasion by exotic species, acidification of soils, acidification and eutrophication of downstream aquatic and marine systems, and increased emissions of trace gases that contribute to global warming and the production of tropospheric ozone.

In August and September 2005, we collected preliminary data to determine how kudzu is affecting the plant community and ecosystems at two sites in the Maryland Department of Natural Resources' McKee-Beshers Wildlife Management Area near Gaithersburg. Kudzu has formed dense carpets and thoroughly covers trees in several spots along the edge of the oak/hardwood forest typical of this region, where white and red oaks (*Quercus alba* and *Q. rubra*), box elder (*Acer negundo*), sassafras (*Sassifras albidum*), American elm (*Ulmus americana*), and hickory (*Carya* spp.) are common. We paired sites invaded by kudzu with nearby uninvaded sites that were similar in slope, aspect, topography and land-use history, and sampled three 1-m^2 plots within each site. By comparing community and ecosystem variables in the invaded sites to those in the uninvaded sites, we can detect the effects of kudzu invasion. At each site, we used standard quadrat methods to estimate species composition and cover, collected leaves from kudzu and the common tree species listed above to measure foliar nutrient concentrations, and took soil samples to measure the soil pools of carbon and nitrogen as well as the microbial processes responsible for nitrogen cycling in the soil (potential net nitrogen mineralization, potential net nitrification, and denitrification).

Preliminary results strongly support our hypothesis that kudzu invasion is altering community composition as well as nutrient pools and cycling. For example, we found only 20 percent as many juvenile trees in invaded sites as in uninvaded sites. In addition, foliar nitrogen concentrations were significantly higher in kudzu leaves (3.67 percent) than in the leaves of the common tree species (mean of 2.18 percent), suggesting that kudzu is indeed contributing high levels of nitrogen to invaded sites. We also found higher rates of nitrogen cycling in the sites invaded by kudzu.

However, our statistical tests had very low power because we only sampled two site pairs. Starting in May 2006, we are expanding the study to include six pairs of invaded and uninvaded sites in order to increase the likelihood of finding a significant result. Even so, these preliminary data help paint a picture of how kudzu invasion is disrupting communities and ecosystems.

As climate change progresses, kudzu is poised to become an even greater problem. Nitrogen fixers are expected to exhibit more sustained positive responses to elevated atmospheric carbon dioxide (CO_2), and are expected to become more abundant as a consequence of global climate change (Soussana and Hartwig 1996). Kudzu responds strongly and quickly to enriched CO_2, quickly increasing biomass, stem number, and stem length by more than 50 percent. Moreover, increasing global temperatures are likely to extend kudzu's northern range (reviewed in Forseth and Innis 2004). A tripling in the number of populations found on Long Island, New York between 1989 and 2001 may reflect a beginning of this expansion (Lamont and Young, 2001). We plan to expand our research to sites in New York to understand how the northward migration of kudzu will affect invaded environments.

We hope that this research will provide modelers and land managers with a more complete understanding of the effects of kudzu on communities and ecosystems, and help in the development of predictive models and management plans to control the spread of this species.

Acknowledgments

We are grateful to the Groffman and Lerdau laboratories for suggestions and assistance.

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Combination of Stem-boring Weevil and Native Grasses Reduces Root Biomass of Canada Thistle in Greenhouse Experiment (Wyoming)

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Canada thistle (*Cirsium arvense*) is a colony-forming, exotic perennial found throughout much of the United States and Canada. Listed as a noxious weed in 43 states and six provinces, Canada thistle is one of the most pervasive weeds in North America. Vegetative spread from an extensive lateral root system makes this species highly invasive and frequently dominant in both grassland and riparian ecosystems.

Chemical control of Canada thistle is often problematic because of chemical non-selectivity, high cost, and difficulties in achieving long-term suppression due to regeneration from thistle roots. Biological control using exotic insects has also been thought to provide inadequate Canada thistle control, although some authors (for example, Coombs and others 2004) have argued that the introduced stem-mining weevil, *Ceutorhynchus litura*, may provide some suppression of Canada thistle infestations. However, late-season carbohydrate levels in Canada thistle indicate that thistle roots often manage to recover shortly after the weevil's larval feeding period (Hein and Robert 2004). This suggests the potential for combining biological control with competition from desirable plant species as an effective approach for reducing Canada thistle dominance in invaded plant communities (Friedli and Bacher 2001).

Beginning in May 2005, we evaluated the potential for combining *C. litura* with competition from two native bunchgrass species: the cool-season grass, needle-and-thread (*Hesperostipa comata*), and the warm-season grass, alkali sacaton (*Sporobolus airoides*). These species are known to grown within 30- to 80-year-old stands of Russian knapweed (*Acroptilon repens*) (Mealor and others 2004), a colony-forming, invasive perennial in the same family as Canada thistle. We conducted a greenhouse experiment at the University of Wyoming in which Canada thistle was grown either 1) alone, 2) with one of the two bunchgrass species, or 3) with a combination of both bunchgrass species. The bunchgrasses were collected from native rangelands in Wyoming, Colorado, and Idaho. Within each of five replicate blocks, half of the thistle plantings were then subjected to the stem-boring weevil. Twenty weeks after infestation with weevils, we evaluated thistle growth (root and shoot biomass) and mortality. Treatment effects on thistle growth were analyzed using ANOVA for a randomized complete block experimental design and mortality was evaluated using a Chi-square analysis.

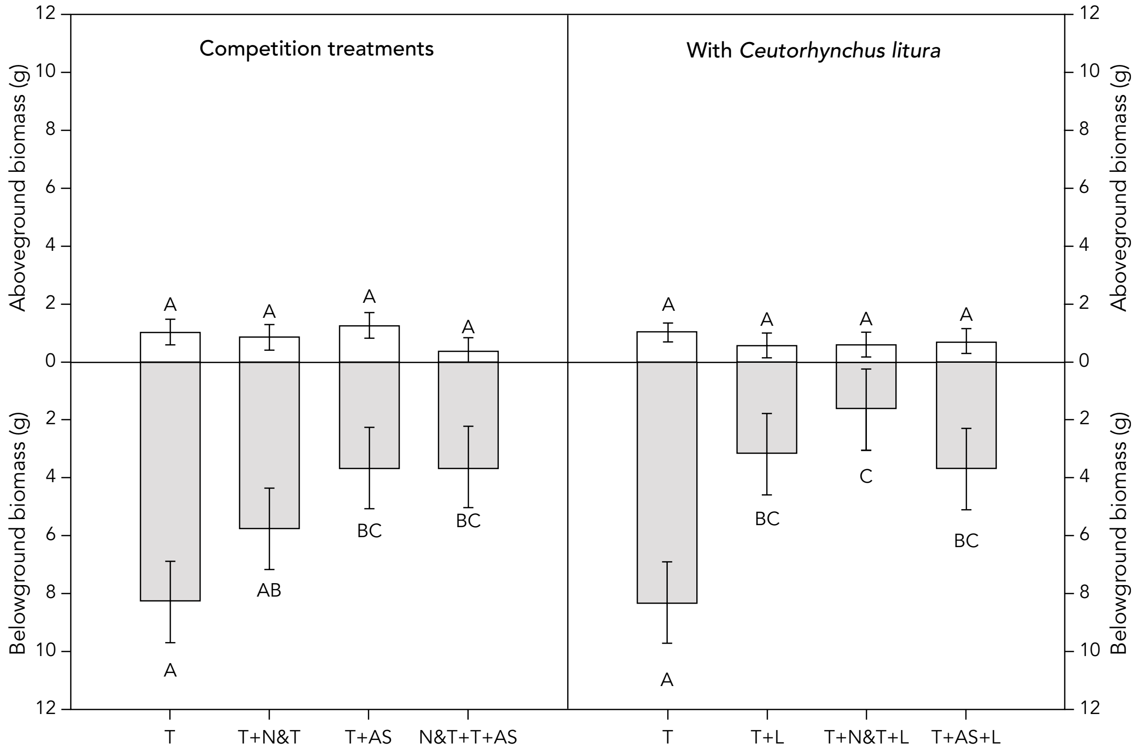

Figure 1. Above- and belowground biomass of Canada thistle (*Cirsium arvense*) in native bunchgrass competition and weevil herbivory treatments (T = Canada thistle, N&T = Needle-and-thread grass (*Hesperostipa comata*), AS = Alkali sacaton grass (*Sporobolus airoides*), L = the weevil, *Ceutorhynchus litura*); $p < 0.01$; df = 6 .

None of the treatments significantly reduced shoot size (aboveground biomass) of Canada thistle. However, root biomass was reduced by several of the treatment combinations (Figure 1). Alkali sacaton alone, and both grasses combined, significantly suppressed root growth (55.4 and 84.0 percent, respectively), but competition from needle-and-thread grass alone did not. Reduced thistle root growth may be attributed to competition from warm-season grasses later in the growing period. When *C. litura* was present, either alone or in combination with the grasses, Canada thistle roots were significantly smaller. It is interesting to note that while competition from needle-and-thread grass alone did not reduce root growth, thistle roots were reduced 80.6 percent when we added the weevil in combination with the cool-season grass. The significant reduction in root biomass relative to controls, or to cool-season competition alone, suggests that the combined effect of *C. litura* and needle-and-thread, has increased effectiveness. The synergistic effect on Canada thistle root biomass may occur because the timing of weevil effects coincides with competitive stress from the cool-season grass. Thistle mortality was significantly greater (Chi square analysis) when weevil herbivory and competitive grasses were combined. Mortality of thistle with the insect alone was 10 percent, compared to 40 percent when needle-and-thread grass and the weevil were combined.

Given the importance of belowground competition for long-lived perennial weeds in grassland ecosystems, reduced root growth is likely to be critical for long-term weed suppression. Our results suggest that *C. litura* herbivory may have caused Canada thistle to compensate for tissue loss, thereby stressing the plant and enhancing the impacts of grass competition on root growth. This phenomenon, combined with increased thistle mortality, suggests that the integration of insect biocontrol with grass competition may represent a successful approach for reducing Canada thistle infestations and achieving restoration of Canada thistle-invaded plant communities.

Acknowledgments

We thank the Strategic Environmental Research and Development Program (SERDP SI-1389) and U.S. Army Corps of Engineers (ERDC-CERL) for funding of this project.

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Investigation of Shading as a Method for Controlling Wild Sugarcane on Abandoned Lands (Panama)

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During the last several decades, wild sugarcane (*Saccharum spontaneum*) has expanded across deforested and abandoned areas of the Panama Canal watershed. This invasive grass species, which is presumed to have originated in southern Asia, is also reported to be invasive in South America, Puerto Rico, Florida, and Hawaii (Hammond 1999). Jones (2004) found that tree species and structure significantly affected regeneration of understory grassland and woody species on abandoned lands overrun by sugarcane, and a study by Hooper and others (2002) suggested that shading markedly reduced sugarcane density while facilitating tree recruitment. Hooper and others (2005) recommend natural regeneration as a cost-effective and practical way of restoring native species to large areas in Panama where wild sugarcane occurs.

In 2003, researchers from the Native Species Reforestation Project (PRORENA) established a series of research plots in a 730-acre (300-ha) wild sugarcane-dominated grassland located within Soberania National Park, in the central region of the Panama Canal watershed. The site was presumably cleared for agriculture but abandoned sometime after 1960 (M. Wishnie, pers. comm.) and subsequently colonized by the sugarcane.

The PRORENA research team planted 4,500 seedlings of 25 tree species in 225 1,938-ft^2 (180-m^2) plots. Each plot contained 20 individuals of a given species planted at a 3-m x 3-m spacing, with nine plots per species. In August 2005, about two years after initial clearing and planting, we selected ten tree species that represented a wide range of canopy diameters and crown densities in order to determine which might be the most effective at reducing sugarcane cover.

To determine the extent of wild sugarcane cover in the plots, we used calipers to measure the basal diameter of all sugarcane clumps within randomly located, 1-m quadrats. We measured two quadrats for each plot (total of nine plots and 18 quadrats per species). To measure crown density, we visually assessed leaf and limb cover of individual species by standing beneath the tress, and then categorized them according to four degrees of density (density scalar): 1 = 0-25 percent, 2 = 25-50 percent, 3 = 50-75 percent, and 4 = 75-100 percent. Using this information, we developed a Crown Density Index (CDI) (density scalar x [(total height – height to crown) x (average crown

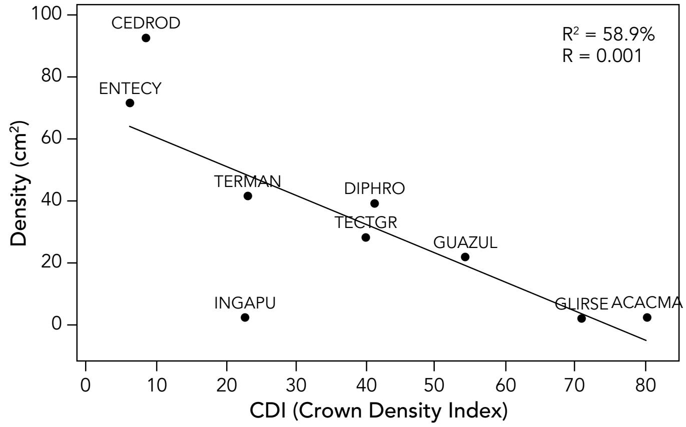

Figure 1. Regression of density (cm²) and CDI (crown density index). The density of wild sugarcane (*Saccahrum spontaneum*) was reduced with the increase of CDI. *Acacia mangium* (ACACMA), *Cedrela odorata* (CEDROD), *Diphysa robinioides* (DIPHRO), *Enterolobium cyclocarpum* (ENTECY), *Gliricidia sepium* (GLIRSE), *Guazuma ulmifolia* (GUAZUL), *Inga punctata* (INGAPU), *Tectona grandis* (TECTGR), and *Terminalia amazonia* (TERMAN).

width)]). We used ANOVA to analyze the correlation of wild sugarcane density and CDI.

Our results showed a significant relationship between density of wild sugarcane and CDI (R^2 = 58.9 percent, p = 0.001), with sugarcane density significantly decreasing as CDI increased. These results also correspond well with the outcomes of previous research (Hooper 2002 and Jones 2004). Crown density is presumed to have affected sugarcane density by blocking light. Of the ten species that we assessed, balo (*Gliricidia sepium*), black wattle (*Acacia mangium*), and guajiniquil (*Inga punctata*) (Figure 1) appear best suited for reforestation projects designed to restore native species to grasslands currently occupied by wild sugarcane.

Acknowledgments

This work was supported by the Programa de Investigación y Restauración Forestal (PIRFOR) of the National Environmental Authority of Panama and the Smithsonian Tropical Research Institute, the Tropical Resources Institute at the Yale School of Forestry & Environmental Studies and PRORENA (The Native Species Reforestation Project, a collaboration between Yale School of Forestry & Environmental Studies and The Smithsonian Tropical Institute). I would like to thank Mark Ashton and Mark Wishnie for valuable advice.

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Combining Herbicides and Goat Grazing to Control Saltcedar (Utah)

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Saltcedar (*Tamarix* spp.), a Eurasian shrub-tree that was introduced to North America as an ornamental plant and later used for windbreaks and stream bank stabilization (Di Tomaso 1998), is now considered a noxious weed in most western states. Saltcedar invades riparian areas and creates dense, impenetrable stands that degrade wildlife habitats and displace native plants. In this note, we report on the results of a study in which we compared herbicide treatments to control by goat grazing and grazing followed by herbicide application in preparation for pasture renovation.

We established 52.4-ft² (4.87-m²) plots, in a poorly managed, irrigated pasture in Lake Shore, Utah. In late May 2004, we thoroughly wet the foliage of saltcedar trees 8 to 10-ft (2.4 to 3.0-m) tall, and then treated four plots with a 1-percent solution of triclopyr amine (Garlon 3A) plus 0.5-percent solution of methylated seed oil (MSO). We treated four other plots with imazapyr (Arsenal) plus a 0.5-percent solution of MSO. In plots not treated with herbicide, Boer goats (*Capra hircus*) grazed four times from May through September 2004. The goats ate the stems, bark, and foliage of the saltcedar. The original grazing period of 24 hours was gradually reduced to 12 hours by the end of the season because plant biomass was limited. To provide equivalent animal biomass, 10 to 12 goats grazed in each plot.

In late June 2005, we treated regrowth from plots that were grazed in 2004 with a 2-percent solution of one of the test herbicides plus MSO. We conducted visual evaluations of foliage density and color, and new stem development 5, 12, and 17 months after the initial treatments (Burrill and others 1976, Frans and others 1986).

Five months after treatment, we observed that grazing had reduced saltcedar by 84 percent, imazapyr by 68 percent, and triclopyr by 56 percent (Table 1). Twelve months after treatment, all saltcedar were gone in plots treated with imazapyr, which was significantly better than in either grazed (76 percent controlled) or triclopyr plots (58 percent) (Table 1). In our final visual evaluations, 17 months after treatment, imazapyr still provided the highest level of control (Table 1). Plots that were grazed in 2004 and treated with herbicide in 2005 had 6 percent (imazapyr) and 11 percent (triclopyr) cover of saltcedar 17 months after the initial grazing treatment. The most successful treatments—imazapyr alone and grazing followed by imazapyr or triclopyr application—were not significantly different from each other. At our final evaluation, we found that triclopyr alone provided 45 percent control, while saltcedar plots that were grazed and not treated with any secondary control measure reduced saltcedar by only 29 percent.

Table 1. Saltcedar (*Tamarix* spp.) visual control ratings 5, 12, and 17 months after initial treatment in May 2004. Means followed by the same letter in each column are not significantly different.

Treatment	Rate or Timing	Oct. 2004	May 2005	Oct. 2005
		% control		
Untreated control		0c	0c	0d
Triclopyr amine	1% solution	53b	58b	45b
Imazapyr	1% solution	68ab	100a	98a
Grazing (2004)	5/31, 6/30, 8/4, 9/6	84a	76b	29c
Grazing (2004) + Imazapyr (2005)	2% solution	-	-	94a
Grazing (2004) + Triclopyr (2005)	2% solution	-	-	89a
Local standard deviation (0.05)		27	19	10

Grazing alone did not maintain an acceptable level of saltcedar control for more than one year, while imazapyr applied once in the spring provided the highest level of control at the end of the evaluation period. However, grazing did reduce plant biomass, which in turn reduced the amount of herbicide required to control saltcedar from 10 ml for ungrazed plots to 2 ml for plots that had been previously grazed. These results suggest that grazing, in combination with herbicides, is a potential component in the development of a successful saltcedar integrated weed management plan for pasture restoration.

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Deer Density Reduction Without a 12-Gauge Shotgun (Wisconsin)

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Many land mangers in eastern North America must cope with overabundant white-tailed deer (*Odocoileus virginianus*) populations, particularly in parks and natural areas where hunting is limited. Overabundant deer often limit management and restoration options, given their pervasive influence on plant composition (Rooney and others 2004), rare species, forest renewal, and successional trajectories (Côté and others 2004). In some cases, restoring ecologically appropriate deer densities is a prerequisite for restoring plant species and communities. Here, I describe a successful deer density reduction approach that did not involve translocations or hunting.

In 1999, the governing body of The Dairymen's Club (TDC), a private resort near Boulder Junction in Vilas County, contracted me to determine if the deer population on the property was "too high." The governing body wanted to restore a white pine (*Pinus strobus*) stand on sandy loam soil occupied by quaking aspen (*Populus tremuloides*), but were advised by a forester to suspend the plan until deer densities could be reduced.

Acquired in the 1920s, the 6,175-acre (2,500-ha) property contains deep and shallow marshes, sedge meadows, hardwood and conifer swamps, lakes, and northern hardwood forest. Development is limited to a few dozen cabins in a concentrated area. The club is managed as a private game refuge, with hunting of all animals prohibited. When the property was acquired, Wisconsin's deer population was at a historic low, and private game refuge establishment was popular among the conservation-minded. Members also engaged in liberal deer feeding, establishing a tradition that continued over multiple generations. In 1949, ecologists John Curtis, Roger Bray, and Robert McIntosh visited a relict old-growth pine stand to conduct a survey for *The Vegetation of Wisconsin* (Curtis 1959). Their unpublished field notes indicate that deer-browse damage in the stand was extensive. My 1999 resurvey revealed that it maintained its old-growth structure and character, but species richness in the groundlayer flora had declined more than 60 percent since 1949.

To monitor deer abundance, I conducted fecal pellet group counts in six permanent 0.12-acre (0.05-ha) plots scattered throughout the property, using the fecal standing crop method developed by Campbell and others (2004). Mean pellet group counts were much higher on the property (35.2 pellet groups per plot) than counts in six reference plots surrounding the property (18.2 per plot). The club recognized the need to reduce deer densities on the property, but the members rejected all options related to hunting or culling. Despite some opposition, TDC banned all deer feeding on the property and I monitored the response of the deer population by conducting pellet group counts in permanent plots over the next several years. No deer population reduction strategy has been proven as effective as hunting (Brown and others 2000) and I was skeptical that the feeding ban would have a strong influence on deer densities.

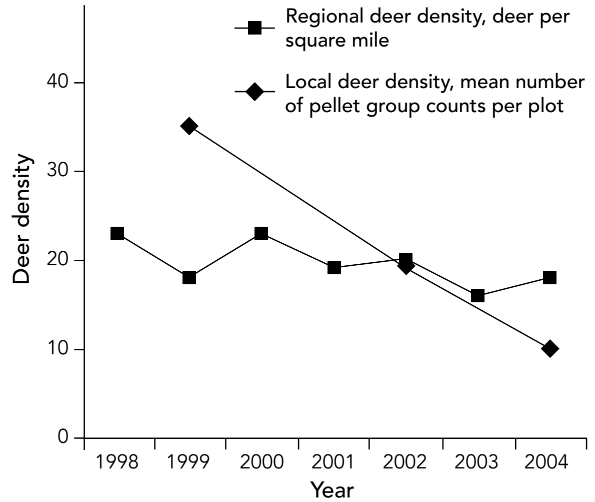

Figure 1. The mean number of fecal pellet group counts in permanent 0.12-acre (0.05-ha) plots at The Dairyman's Club (local deer density) relative to the number of deer per mi² in the 400-mi² (1,036-km²) deer management unit that contains TDC (regional deer density).

I was wrong. While deer densities remained relatively constant in the 400-mi² (1,036-km²) deer management unit that contains the resort, deer densities at TDC declined more than 70 percent between 1999-2004 (Figure 1). Animals did not die of starvation. Instead, they ceased aggregating in feeding areas near cabins and dispersed more widely across the landscape and to adjacent properties. As deer densities declined, TDC proceeded with their white pine restoration plan.

Recreational deer feeding is a popular activity in the resort areas of northern Wisconsin. Supplemental feeding increases carrying capacity locally (perhaps as much as tenfold, according to wildlife biologist Tim Van Deelen). Deer feed on natural vegetation between feeding events, and given their high densities, browsing effects appear quickly. Based on my findings in this case study, the cessation of feeding can cause deer populations to drop through time. In places where deer populations constrain restoration efforts and deer feeding is common, the elimination of feeding could provide a non-lethal solution to overabundance in areas that are a few thousand acres or smaller.

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FROM: Ecology in the Era of Globalization

178.1

Allelopathy as a Mechanism for the Invasion of *Typha angustifolia*. Jarchow, M., Minnesota State University; and B. Cook. abstracts.co.allenpress.com/pweb/esai2006/document/?ID=58808.

Jarchow and Bradley determined that narrow-leaved cattail (*Typha angustifolia*) produces allelopathic, soluble phenolic compounds when grown with bulrush (*Bolboschoenus fluviatilis*). Competition from cattail reduced the biomass of bulrush when they were grown together, although the presence of activated charcoal in the soil diminished this effect. Additionally, the nature and concentration of allelopathic compounds produced depended on whether cattails were growing in monoculture or with another species.

178.2

Exotic Plant Invasion Alters Soil Microbial Population Dynamics. Martin, M., University of Florida, Gainesville, FL; J. Sickman and P. Tipping. http://abstracts.co.allenpress.com/pweb/esai2006/document/?ID=59061.

The authors used phospholipids fatty acid analyses to assess the effects of punktree (*Melaleuca quinquenervia*) invasion of pondcypress (*Taxodium ascendens*) areas. Initial data indicate that punktree decreases carbon, phosphorus, and nitrogen components of the soil microbial biomass. The authors hypothesize that punktree litter is lower quality relative to native leaf litter and that this changes microbial species composition and decreases soil microbial biomass, mineralization capacities, and microbial biodiversity.

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FROM: Ecological Society of America 90th Annual Meeting

179.1

Overstory and Understory Plant Competition Inhibits *Rhamnus cathartica*, an Invasive Shrub. Knight, K., Dept. of Forest Resources, St. Paul, MN; and P. Reich. http://abstracts.co.allenpress.com/pweb/esa2005/document/?ID=49171.

Knight and Reich studied the growth of common buckthorn (*Rhamnus cathartica*) seedlings along a light gradient in an oak (*Quercus* spp.) forest in Minnesota. Buckthorn seedlings showed greater establishment, survival, and growth in less-shaded areas and in proximity to mature buckthorn plants. While above- and belowground competition from native groundcover and tree canopy negatively affected buckthorn seedlings, groundcover diversity had no effect. Growth chamber experiments demonstrated that buckthorn seedlings cultured in soil taken from around mature buckthorn plants had lower growth rates than those cultured in soil from European sources, refuting the hypothesis that successful invasion is due to escape from soil pathogens. Moreover, growth rates were reduced in both sterilized and live North American soils, providing evidence against the idea of a positive feedback loop with soil microbes near established plants.

179.2

Effects of Soil Amendments on the Nitrogen Dynamics of Japanese Barberry (*Berberis thunbergii*) and Japanese Stiltgrass (*Microstegium vimineum*) in New Jersey Forests. Ross, K., Rutgers University, New Brunswick, NJ; J. Ehrenfeld and M. Patel. http://abstracts.co.allenpress.com/pweb/esai2006/document/?ID=58831.

The authors hypothesized that amending the soil to reduce available nitrogen would increase competition from native species and reduce the success of two invasive species—Japanese barberry and Japanese stiltgrass. They tested four soil treatments by removing the nitrogen-rich, top 2 inches (5 cm) of soil; adding a compound to inhibit nitrification; adding wood chips to change the carbon-to-nitrogen ratio; and adding aluminum sulfate to acidify the soil. In addition, they tested two plant treatments—removal of Japanese barberry and removal followed by planting of native understory species. They found that removing the surface soil and adding woodchips reduced extractable nitrates, and removing Japanese barberry increased native plant seedling diversity within one year.

179.3

Sugar Application and Nitrogen Pools in Wyoming Big Sagebrush Communities and Exotic Annual Grasslands. Witwicki, D., Oregon State University; P. Doescher, D. Pyke and S. Perakis. abstracts.co.allenpress.com/pweb/esa2005/document/?ID=49679.

The authors tested the ability of a carbon-rich soil amendment to alter nitrogen availability in Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) shrubland in the Great Basin, with the goal of reducing the dominance of two invasive species—cheatgrass (*Bromus tectorum*) and medusahead (*Taeniatherum caput-medusae*). Their experiments in Oregon and Idaho showed that late-fall sugar applications essentially removed inorganic nitrogen in the top 4 inches (10 cm) of soil within one week. Nitrogen levels remained low for six months, reducing the productivity of both sagebrush and cheatgrass.

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When Landscaping Goes Bad: The Incipient Invasion of *Mahonia bealei* in the Southeastern United States. 2006. Allen, C.R., USGS South Carolina Cooperative Fish and Wildlife Research Unit, Fax: 864/656-1034, allencr@clemson.edu; A.S. Garmestani, J.A. LaBram, A.E. Peck and L.B. Prevost. **Biological Invasions** 8(2):169-176.

These researchers document the presence of leatherleaf mahonia (*Mahonia bealei*)—a popular ornamental clonal shrub, native to China—in 87 percent of 15 suburban woodlots sampled in Clemson, South Carolina. This species is very shade tolerant and can take advantage of small light gaps in the forest canopy, possibly inhibiting native midstory shrub species. The measured population structure indicates that these populations were newly established and that rapid expansion is possible. Disturbances and widespread plantings associated with continued human population growth and expansion may facilitate propagule pressure by this species into woodlots. In addition, pollination and dispersal by songbirds could greatly increase the geographic range of invasion. The authors recommend local and regional monitoring of this species as well as collaborative efforts to reduce horticultural activity with this species.

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DNA Barcodes for Insect Pest Identification: A Test Case with Tussock Moths (*Lepidoptera: Lymantriidae*). 2006. Ball, S.L., Molecular Diagnostics Lab, National Centre for Advanced Bio-Protection Technologies, Box 84, Lincoln University, Canterbury, New Zealand, ball@lincoln.ac.nz; and K.F. Armstrong. **Canadian Journal of Forest Research** 36(2):337-350.

Ball and Armstrong recommend DNA barcodes to provide fast (within 24 hours), accurate, cost-effective, reliable identification of insect pest species. A DNA barcode is a short fragment of about 650 bp of the mitochondrial cytochrome c oxidase 1 (COI) gene. The authors tested this method using samples of 20 species from five genera (*Dasychira*, *Euproctis*, *Lymantria*, *Orgyia*, and *Teia*) in the Lymantriidae Family and 125 species from three closely related families. All of the DNA-based identifications matched morphology-based identifications by taxonomists. This method can distinguish closely related species and identify egg and larval samples, which are the most commonly detected life stages and the most difficult to identify morphologically. A global database of COI sequences is being developed (www.barcodinglife.com) and new species can be easily added to it as they are discovered, making DNA barcodes a potentially universal and anticipatory detection system.

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Characterized and Projected Costs of Nonindigenous Species in Canada. 2006. Colautti, R.I., Great Lakes Institute for Environmental Research, University of Windsor, Windsor, Ontario N9B 3P4, Canada, 519/971-3616, colautti@botany.utoronto.edu.ca; S.A. Bailey, C.D.A. van Overdijk and K. Amundsen. **Biological Invasion** 8(1):45-59.

The authors used case studies and empirical modeling to estimate the economic impacts of nuisance nonindigenous species in Canada. Although some negative impacts are counterbalanced by positive outcomes, the researchers claim these nuisance species also create an "invisible tax" by decreasing natural resource production capacities in economic sectors such as agriculture, forestry, and fisheries. They estimated $187 million CDN per year, with an additional projected $13.3 to $34.5 billion CDN of "invisible tax" per year. They recommend establishing a coordinated, continent-scale biosecurity program as the most cost-effective method to balance the benefits of increased trade revenues with the costs of new nuisance species.

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Responses of a Willow (*Salix caroliniana* Michx.) Community to Roller-chopping. 2006. Ponzio, K.J., St. Johns River Water Management District, P.O. Box 1429, Palatka, FL 32178-1429, 386/329-4331, kponzio@sjrwmd.com; S.J. Miller, E. Underwood, S.P. Rowe, D.J. Voltolina and T.D. Miller. **Natural Areas Journal** 26(1):53-60.

The authors found that roller-chopping during drought conditions eradicated local willow populations, allowing restoration of native herbaceous marsh species. However, this method is feasible only in areas that will support heavy machinery, and is often not possible on peat soils. Dry conditions cannot be induced without control of water levels, further limiting potential application. Although relatively inexpensive ($800/acre or $325/ha), roller-chopping can change the topography and drainage patterns, and compact soil. Moreover, willow stands are important components of the wetland complex and eradication may not be as desirable as creating openings and edge habitat.

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A Weed, a Fly, a Mouse and a Chain of Unintended Consequences. 2006. Robbins, T. **New York Times** April 4, 2006: D.2.

Dean Pearson of the U.S. Forest Service Rocky Mountain Research Station is the first person to document altered ecosystem function caused by a host-specific biological control agent's effects on a non-target species. The larvae of the gall fly (*Urophora quadrifasciata*), introduced to control spotted knapweed (*Centaurea maculosa*) in western North America, have provided a winter food source across a large, contiguous areas of the continent for the hantavirus-carrying deer mouse (*Peromyscus maniculatus*). This creates a potential and wholly unintended public health risk.

WILDLIFE HABITAT

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Habitat Restoration for the Threatened Utah Prairie Dog on a Private Ranch (Utah)

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In March 2005, Allen Henrie signed an agreement with the U.S. Fish & Wildlife Service (USFWS) and the Utah Division of Wildlife (UDWR) to restore the federally threatened Utah prairie dog (*Cynomys parvidens*) to part of his 900-acre (360-ha) ranch in Panguitch, Utah. The project, the first of its kind in Utah, is part of a recent effort by state and government agencies and Environmental Defense to use Safe Harbor agreements to develop new, incentive-based partnerships with private landowners, and work toward full recovery of the species. In this case, the Safe Harbor Agreement has enabled Mr. Henrie to take advantage of a variety of federal, state, and private funds to restore part of his property for the prairie dog and reintroduce a new colony on his land, while greatly improving his livestock forage. In addition, it ensures that he and his family will be able to use the land as they wish after the 15-year restoration period.

The Utah prairie dog is found only in southwest Utah, where it is adapted to grassy, relatively brush-free openings within sagebrush ecosystems (Crocker-Bedford 1976). It requires well-drained, deep soils; moist, nutritious vegetation throughout the summer; and high plant species richness (Crocker-Bedford and Spillett 1981, Player and Urness 1982). Low vegetation height and open conditions, especially for shrubs, permit prairie dogs to detect predators. Livestock grazing at low stocking rates is compatible with prairie dog use on dry rangelands, and is necessary on irrigated lands to prevent vegetation from becoming too high or dense (Cheng 2000).

The recovery strategy for the Utah prairie dog has primarily been to relocate colonies threatened by development to public lands. While this approach has reduced conflicts with developers and helped established new colonies, it has only stabilized population numbers rather than pushing them closer to recovery goals. Private farms and ranches still provide 74 percent of the best remaining habitat for the Utah prairie dog. Yet to most farmers and ranchers, prairie dogs are simply pests that damage crops and compete with livestock for forage.

Our project goal was to improve forage quality and quantity through brush management and reseeding, and to reintroduce a self-sustaining prairie dog colony in a 180-acre (73-ha) pasture on Mr. Henrie's property. Most of the pasture is a mountain big sagebrush (*Artemesia tridentata*) plant community that is unsuitable for prairie dogs due to its slope and rocky soils. However, the 60-acre (24-ha) treatment area was considered excellent potential habitat for reintroduction, but had been considerably altered

Table 1. Species planted and seeding rates used in November 2005 to create Utah prairie dog habitat on the Henrie ranch.

Species	Seeding rate lb/acre	Purity/ germination (%)	Number of seeds/lb
Grasses			
Bouteloua gracilis	1.0	80/80	825,000
Bromus carinatus	2.0	95/90	90,000
Oryzopsis hymenoides	1.0	96/80	630,000
Elymus elymoides	1.0	82/85	192,000
Elymus trachycaulus	3.0	96/95	159,000
Agropyron riparian	2.0	96/90	156,000
Elymus lanceolatus	1.0	96/93	154,000
Pascopyrum smithii	2.0	95/85	110,000
Forbs			
Symphyotrichum ascendens	1.0	20/85	2,680,000
Linum lewisii	1.0	98/97	293,000
Sphaeralcea coccinea	1.0	80/74	500,000
Lupinus sericeus	1.0	98/87	12,900
Penstemon cyananthus	1.0	96/90	550,000
Hedysarum boreale var. *utahensis*	1.0	90/87	33,600

through past plowing, seeding, grazing, and repeated brush treatments. Its dense cover of rabbit brush (*Chrysothamnus nauseosus*) and lack of native vegetative diversity also made it unsuitable for prairie dogs. The most common plants were rabbit brush and non-native grasses, including crested wheatgrass (*Agropyron cristatum*), intermediate wheatgrass (*Thinopyrum intermedium*), Russian wildrye (*Elymus junceus*), and smooth brome (*Bromus inermis*). Western wheatgrass (*Pascopyrum smithii*) was also common, along with a few sparsely scattered native grasses and forbs.

Our objectives were to reduce the treatment area's brush cover to less than 3 percent; augment existing forage plants by inter-seeding with a native mix of four warm-season grasses, four cool-season grasses, and six forbs (Table 1); prepare a site within the treatment area for prairie dog reintroduction; and manage the restored vegetation and prairie dog habitat using prescribed grazing. While we are aware of successful habitat restoration and reintroductions on public lands, we decided to incorporate a strong monitoring component into the project.

Mechanical and herbicide treatments began in spring 2005. Following the brush treatments, we reseeded one-third of the treatment area in parallel strips to retain some of the existing vegetation and reduce costs. Livestock grazing was excluded from the entire pasture for the entire year. Full exclusion will continue for two more years to allow for plant recovery and then will resume at a reduced rate for two additional years. Thereafter, stocking rates will be prescribed to encourage prairie dog expansion.

In year four, after vegetation recovery, artificial prairie dog burrows will be dug in a roughly 2-acre (0.8-ha) site within the treatment area. Prairie dogs will be captured and released under UDWR protocol for three consecutive years or more until a self-sustaining colony has been established (the nearest colony is too distant for natural migration and colonization to occur). If sylvatic plague or some other factor decimates the animals, USFWS or UDWR may re-release animals for up to 15 years under the agreement.

Word of this project has spread quickly across Utah, and other agencies have joined the effort by setting aside special funding for additional projects and contributing staff time. At present, four additional projects are underway. With several years of concerted effort, we hope to bring the Utah prairie dog significantly closer to recovery.

Acknowledgments

Thanks to the National Fish and Wildlife Foundation, the Sand County Foundation, and the U.S. Fish & Wildlife Service for their support of this work. Thanks also to Margaret McMillan for reviewing this manuscript and to Stephen B. Monsen for helping develop the management plan.

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The Role of Wildlife Science in Wetland Ecosystem Restoration: Lessons from the Everglades. 2006. Gawlik. D.E., Dept. of Biological Sciences, Florida Atlantic University, 777 Glades Rd., Boca Raton, FL 33431-0991, 561/297-3333, Fax: 561/297-2749, dgawlik@fau.edu. **Ecological Engineering** 26(1):70-83.

Gawlik recommends integrating wildlife science into wetland ecosystem restorations that are characterized by large geographic scope and a focus on ecosystem function, and explicitly incorporate societal values. He believes that 1) wildlife science contributes to conceptual models that are the foundation of planning because wildlife data sets are often long-term and provide an opportunity to identify slower ecosystem and landscape processes; 2) wildlife performance measures provide a large menu of options in terms of structure, function, and spatial and temporal scales to assess ecosystem restoration success; and 3) linking scientifically important ecological processes to socially valued resources, such as charismatic wildlife species, can enhance the social feasibility of ecosystem restoration projects by maximizing long-term public funding support.

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Integrating Forest Restoration Treatments with Mexican Spotted Owl Habitat Needs. 2005. James, M.A., Ecological Restoration Institute, Northern Arizona University, P.O. Box 15017, Flagstaff, AZ 86011-5017, 928/523-7182, www.eri.nau.edu. **Working Papers in Southwestern Ponderosa Pine Forest Restoration No. 14.**

Restoration activities to reduce the fire risk in ponderosa pine (*Pinus ponderosa*) forests can also improve habitat for the federally threatened

Mexican spotted owl (*Strix occidentalis lucida*), according to James. These activities should 1) be large and significant enough to reduce potential wildfire, 2) be located downslope and upwind of primary owl habitat, 3) be burned to create snags and downed woody debris, 4) have a target canopy closure of 40 percent in pine-oak and 55 percent in mixed conifer, 5) retain large trees (more than 24 inches or 61 cm DBH) and protect those larger than 18 inches (46 cm) from damage in restricted owl habitat, and 6) occur in fall and winter and retain trees larger than 9 inches (23 cm) in Protected Activity Areas. James recommends no restoration in the central 100 acres (40 ha) of Protected Activity Areas.

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Does Restoration of Structural Heterogeneity in Streams Enhance Fish and Macroinvertebrate Diversity? 2005. Lepori, F., Dept. of Ecology and Environmental Science, Umeå University, SE-901 87 Umeå Sweden, Fabio.lepori@emg.umu.se; D. Palm, E. Brännäs and B. Malmqvist. **Ecological Applications** 15(6):2060-2071.

These scientists tested the hypothesis that increasing the structural heterogeneity of channelized streams by bankment removal and boulder placement would increase fish and invertebrate diversity. Comparing restored sites to channelized and natural streams in the Ume River basin of northern Sweden three to eight years after the restoration projects were completed, they found that although structural heterogeneity was greater in restored areas than unrestored and reference sites, fish and invertebrate diversity was similar in all sites. The authors suggest that restoration occurred at biologically insignificant spatial scales and, as a result, no new habitat types were created that would attract new colonizers. They also suggest that invertebrate diversity is more a function of watershed-scale factors than the within-watershed reach and patch scales explored in this study.

TOOLS & TECHNOLOGY

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The NSW Environmental Services Scheme: Results for the Biodiversity Index, Lessons Learned, and the Way Forward. 2005. Oliver, I., Department of Natural Resources, P.O. Box U245, University of New England, Armidale, NSW 2351, Australia, +61 2 6773 5271, ian.oliver@dipnr.nsw.gov.au; A. Ede, W. Hawes and A. Grieve. **Ecological Management & Restoration** 6(3):197-205.

These researchers argue that administering a landowner incentive program to change land uses or management practices for environmental services enhancement requires a simple, transparent, cheap, and reliable methodology to assess environmental quality. They developed the Biodiversity Benefits Index to measure current biodiversity, predict biodiversity under different conditions, and estimate potential conservation benefit. Using this technique, two locally knowledgeable field personnel can complete a vegetation condition assessment in one day by taking readings of the richness and cover of benchmarked plant groups, woody species recruitment, percent cover of organic litter and exotic groundcover species, density of large and hollow-bearing trees, and wood load. The authors found that by using five condition categories (very low to very high) to represent data ranges in each attribute reduced dependence on expert personnel, reduced sampling errors between personnel, and made the methodology more accessible to a larger audience.

CULTURAL RESTORATION

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Integrating Sacred Knowledge for Conservation: Cultures and Landscapes in Southwest China. 2006. Xu, J., Kunming Institute of Botany, International Centre for Integrated Mountain Development, P.O. Box 3226, Kathmandu, Nepal, +97701 552 2839, Fax: +97701 554 3227, jxu@icimod.org; E.T. Ma, D. Tashi, Y. Fu, Z. Lu and D. Melick. **Ecology and Society** 10(2):7. www.ecologyandsociety.org/vol10/iss2/art7/.

The authors report that historical efforts to assimilate indigenous groups and simplify land-use practices in southwest China have had negative effects on local environments and cultures. Current central government policies aimed at conservation have also led to poor outcomes. They recommend a pluralistic conservation approach derived from both scientific and traditional knowledge—a synthetic knowledge that would then be used by local governmental and traditional institutions to make and implement policy decisions. They point out that incorporation of indigenous knowledge into policy processes requires identifying local environmental specialists, documenting their knowledge, and clarifying legal and land tenure rights and responsibilities.

MANAGEMENT & MONITORING

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Vegetation Structure, Species Diversity, and Ecosystem Processes as Measures of Restoration Success. 2005. Ruiz-Jaén, M.C., Dept. of Biology, 1205 Dr. Penfield, McGill University, Montreal, Canada H3A 1B1, 514/398-3730, Fax: 514/398-5069, mcruizjaen@gmail.com; and T.M. Aide. **Forest Ecology and Management** 218(1-3):159-173.

After planting woody pioneer species in a former grassy park in a subtropical moist forest region of Puerto Rico, the authors compared vegetation structure, species diversity, and ecosystem processes between the study site and unrestored and natural reference sites. They found that the vertical structure and canopy cover increased rapidly, with concomitant increases in litter cover and depth, and a decrease in herbaceous cover. Litter turnover rates, nitrogen and phosphorus soil inputs, C_4 to C_3 conversion of soil organic matter in the topsoil increased, and the 4-8 inch (10-20 cm) soil profile showed few changes in carbon cycling due to greater bulk density and an absence of earthworms. Ant and herpetofauna diversity increased, facilitated by the short distance to intact forest. Avian diversity showed little improvement, since frugivore species remained absent. The authors recommend the Subjective Bray-Curtis Ordination to compare many different indicators, quantitatively determine success, and identify future management targets.

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Vegetation Development in Created, Restored, and Enhanced Mitigation Wetland Banks of the United States. 2005. Spieles, D.J., McPhail Center for Environmental Studies, Denison University, Granville, OH 43023. **Wetlands** 25(1):51-63.

Spieles used species richness, percentage of non-native species, and the Prevalence Index, which indicates hydrophytic vegetation relative to upland vegetation, as criteria to measure success and to compare wetland projects that differed in location, size, age, geomorphology, vegetation type, and project type. Surveying data from 45 sites enrolled in mitigation bank programs in the United States, he found that 49 percent of all projects were successful, with a 63-percent success rate for wetlands five years and older. The author suggests that projects based on area considerations alone are inadequate and recommends vegetation monitoring for more than five years as an essential requirement for mitigation bank projects.

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Tropical Forest Restoration Within Galapagos National Park: Application of a State-Transition Model. 2005. Wilkinson, S.R., Dept. of Renewable Resources, University of Alberta, Rm. 751 GSB, Edmonton, Alberta, Canada T6G 2H1, +780 492 9088, sarah.wilkinson@ualberta.ca; M.A. Naeth and F.K.A. Schmiegelow. **Ecology and Society** 10(1):28. www.ecologyandsociety.org/vol10/iss1/art28/

The state-transition model maintains that disturbances cause a plant community to transition between stable states. In theory, this suggests that restoration creates a transition to a desired state once an irreversible threshold has been passed. The authors created a model of daisy tree (*Scalesia pedunculata*) forest zones on Santa Cruz Island of Galapagos with nine stable states: two desirable native communities, two slightly degraded and capable of restoration, and five requiring many resources to restore past irreversible thresholds. Four transition processes were barriers (natural canopy gaps, limited management resources, clearcutting, unrestricted access) and four provided opportunities (natural regeneration, active planting, protection, control of invasives). When used in conjunction with a regional map that delineated patches of each stable state, this model provided a decision-making tool that allowed managers to tailor activities for cost-effectiveness. The authors found that access and non-native species introductions were the largest threats, and that these occurred at a regional level.

ENDANGERED SPECIES

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Burning Trends and Potential Negative Effects of Suppressing Wetland Fires on Flatwoods Salamanders. 2005. Bishop, D.C., Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, dabishop@vt.edu; and C.A. Haas. **Natural Areas Journal** 25(3):290-294.

The federally threatened flatwoods salamander (*Ambystoma cingulatum*) breeds in ephemeral wetlands of longleaf pine (*Pinus palustris*) forests and savannas. Although Bishop and Haas found little direct evidence that wetland fire suppression has negative effects on flatwoods salamanders, they warn against creating firebreaks around wetlands, since these can alter the hydrology and increase amphibian mortality. Moreover, they suggest that managers vary both season and frequency of burning and allow fires to encroach on wetlands, since even peripheral wetland changes can improve flatwoods salamander habitat.

EDUCATION & SOCIAL SCIENCES

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Natural Areas and Urban Populations: Communication and Environmental Education Challenges and Actions in Outdoor Recreation. 2005. Chavez, D.J., Pacific Southwest Research Station, USDA Forest Service, 4955 Canyon Crest Dr., Riverside, CA 92507, dchavez@fs.fed.us. **Journal of Forestry** 103(8):407-409.

Chavez discusses environmental education opportunities in urban national forests and the complex information challenges associated with Latinos and other minority groups. She presents the "I Triad" (Invitation, Involvement, Inclusion) and adds Innovation as a strategy to increase Latino participation in natural resources use and decision-making. The author provides several examples of existing programs, including The Forest Information Van, which is a mobile information display that provides bilingual educational materials and staff to the Latino community, and Eco-Teams, which consist of local Latino youth hired and trained to interact with visitors.

ORGANIZATIONAL PROGRAMS

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Six Degrees West: Rona—Rebirth and Regeneration of an Island. 2006. Dixon, R., +01880-821-133, jrobindixon@hotmail.com. **Reforesting Scotland** 34:38-39.

Dixon describes the history of Rona Island, including recent ecological restoration efforts. The original settlement was abandoned in the 1930s and the island reverted to public land. The island was then managed as sheep pasture until it was sold in 1993 to a landowner who wanted to restore the island ecosystem. Today, both planted and remnant woodlands are expanding in the absence of sheep grazing. In 1994, a small herd of Highland cattle was introduced with no negative effects on woodland regeneration. A small herd of red deer was reintroduced in 2003, with plans to maintain low deer density. Three buildings have been restored to provide lodging for the caretaker, the visiting landowners, tourists, and school and work groups. All other structures are ruins, which have cultural values that attract some visitors. For more information, visit www.isleofrona.com or contact the author or the caretaker: Bill Cowie, +07775-593-055, ronalodge@tiscali.co.uk.

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Miles of Isles. 2005. Nissen, R., Mississippi River Team, Wisconsin Department of Natural Resources. **Wisconsin Natural Resources** 29(5):17-21.

Nissen describes the U.S. Army Corps of Engineers Environmental Management Program (EMP), a 50-year vision for ecological restoration and navigation improvement on the Upper Mississippi River. Established in 1986, the program is a regional collaborative effort among U.S. Army Corps of Engineers, the U.S. Geological Survey, state agencies, non-governmental organizations, and private individuals. The EMP's Habitat Rehabilitation and Enhancement Projects staff have completed 46 projects covering 66,600 acres (26,950 ha) since 1987. These projects consist of seeding islands, dredging backwaters, stabilizing shorelines, and building water-level control structures. The Stoddard and Pool 8 Islands Phase I projects received national engineering awards in 2002 and 2004. Phase III of the latter will restore 5,000 acres (2,000 ha), which will be the largest restoration project in Wisconsin.

PLANNING & POLICY

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Latent Preferences and Valuation of Wetland Ecosystem Restoration. 2006. Milon, J.W., Dept. of Economics, University of Central Florida, P.O. Box 161400, Orlando, FL 32816-1400; and D. Scrogin. **Ecological Economics** 56(2):162-175.

In order to test how the presentation of ecological information as well as socioeconomic and other personal factors influence attitudes, Milon and Scrogin conducted household surveys that assessed preferences and willingness to pay for Everglades ecosystem restoration. The authors used a latent class choice model that combines survey responses and demographic information to classify groups clustered by common preferences. They found that people with similar incomes and ages tended to share preferences for restoration options. They also noted that wetland description significantly affected people's preferences with restoration plans based on structural descriptions receiving more support than function-based plans.

ISSUES & PERSPECTIVES

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Remembering "Common" Species During Ecological Restoration: Lessons from Egmont Key (Florida)

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Removing nonindigenous vegetation and restoring native communities are limited by two sets of constraints. Biological constraints are set by organisms, and comprise the suite of habitat requirements and life history traits ecologists must consider when planning to restore species or communities. The financial, logistic, administrative, and legal mandates guiding restoration efforts form additional boundaries within which restoration must be carried out. Considering both sets of constraints and determining objectives accordingly are vital in order to measure restoration progress. However, I suggest that there is more to evaluating restoration projects than measuring objectives related to the taxa directly involved. I posit that erroneous perceptions and narrowly focused restoration goals may have negative consequences to some of our "common" species.

Ecological restoration often targets imperiled species, communities, or ecosystems. However, what role should common species play in the planning process, and what can their study tell us about the success or failure of community level restoration? Since 1991, I have studied a population of Florida box turtles (*Terrapene carolina bauri*) on an island off the west coast of Florida (Dodd 2001, Dodd and Griffey 2005). I believe the results from this long-term study, carried out during periods of intensive disturbance, including the removal of exotic vegetation with a future intent of ecological restoration, lend insights into the importance of keeping "common" species common (Dodd and others in press).

Egmont Key is a small (less than 445 acres or 180 ha) island situated at the mouth of Tampa Bay. It has a long history of human occupancy, but little is known of its flora and fauna prior to extensive modifications made in connection with military use that began in the mid-1800s. In 1974, Egmont Key became a National Wildlife Refuge and has been cooperatively managed by the U.S. Fish & Wildlife Service (USFWS) and the Florida Department of Environmental Protection (DEP) for more than 15 years. When I began my study in 1991, the island was a thick jungle of Australian pine (*Casuarina equisetifolia*), Brazilian pepper (*Schinus terebinthifolius*), and sabal palm (*Sabal palmetto*). It provided an ideal habitat for Florida box turtles, which were more abundant and easily observed than at any other box turtle population site previously known.

In the intervening years, my colleagues and I marked more than 2,500 box turtles, with more than 5,400 captures recorded. Our research has yielded a wealth of information (see http://cars.er.usgs.gov/Center_Publications/Herp_ Publications/herp_publications.html), and has made these box turtles the best-studied population of this long-lived, charismatic turtle. Since box turtles play key roles in seed dispersal and other ecological functions, this research supports the statutory mandate of USFWS to ensure the integrity, diversity, and environmental health of ecosystems (Dodd 2000, USFWS 2001, Meretsky and others 2006).

A major objective of the USFWS and DEP has been to restore the habitat of Egmont Key to its pre-European contact conditions. Although agency personnel have removed extensive stands of non-indigenous Australian pine and Brazilian pepper, either by tree ringing or by spraying or injecting herbicides, no formal plan has ever guided resource planning, funding, and management. Although incorrectly touted as "restoration," activities thus far have been aimed solely at the removal of exotics. There is no vegetation restoration nor has anyone decided what the restored vegetation composition and structure should be. Restoration is not proceeding in a scheduled and orderly fashion, and the timing and placement of herbicide treatments has been haphazard. As a result, sections of the island contain a huge amount of potentially hazardous fuel loads and the long intervals between treatments have allowed for re-sprouting of invasive exotics. Lack of supervision resulted in the occasional loss of certain native plants, such as red cedar (*Juniperus virginiana*), which may be important in vegetation restoration.

Vegetative cover continues to be removed and herbicides sprayed, but native vegetation remains unplanted. This has led to increased soil surface temperatures and decreased humidity, both of which adversely affect turtles. No decisions have been made about management objectives between the time exotic vegetation is removed and subsequently burned and the time native vegetation is replanted and grows to a mature habitat structure. Because of a reluctance by USFWS to be perceived as adopting "single-species" management and a lack of legal mandates, the USFWS does not see the need for special planning to conserve box turtles or other resident species, except nesting shorebirds and sea turtles. Moreover, the island is eroding at an alarming rate, despite intensive renourishment efforts.

Misperceptions concerning the status of box turtles and, perhaps, other species stem from memories of past times and places that many people have brought with them to a new home. People have a vision of box turtles as being a common species because turtles were common when and where they grew up. Perceptions may be right or wrong, but they are just that, *perceptions* of commonness (Dodd and Franz 1993). So labeled, box turtles face the *dilemma of the common species*, namely, if a species is perceived as common, there is no financial or administrative incentive to give it any special consideration when planning ecological restoration efforts.

In order to restore an ecosystem, we must understand the functional biodiversity of the present ecosystem, including the role of common native species. It is ironic that the concept of ecosystem management and the laudable goals of ecosystem restoration sometimes should be used as a basis for *not* taking the abundance and biomass of common species into special consideration during ecological restoration planning. Certain places can and should be maintained where presently common species can be appreciated and protected in their sheer numbers and diversity, and where abundance can be managed as a national asset. Box turtles, fence lizards, sparrows, and other perceptively common native species should not be forgotten or shown lesser importance in decision planning for restoration, especially when there is concern that they too might join the ever-increasing ranks of imperiled species.

The lessons from Egmont Key are simple, yet bear repeating: 1) If the physical habitat is not protected, there will be nothing left to restore; 2) all ecological restoration efforts must be coordinated (physical, historical, biotic); 3) successful ecological restoration starts with good data; ecological restoration requires an overall plan with clear goals, timetables, and funding; 4) ecological restoration is more than simply killing exotic vegetation; and 5) common species may be critically important in defining and measuring restoration goals and in preserving ecosystem function. They, too, are valuable national and state assets, and they should be recognized for their 'commonness.'

Acknowledgments

I thank the Florida Park Service and U.S. Fish & Wildlife Service (Egmont Key National Wildlife Refuge and State Park) for issuing permits to work on Egmont Key, and the FPS park rangers who have furnished transport and lodging facilities during many stays on the island. I thank Marian Griffey for her comments on this manuscript. These comments are mine alone and do not represent the position of the U.S. Geological Survey.

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Meretsky, V.J., R.L. Fiscman, J.R. Karr, D.M. Ashe, J.M. Scott, R.F. Noss and R.L. Schroeder. 2006. New directions in conservation for the National Wildlife Refuge system. *BioScience* 56:135-143.

U.S. Fish & Wildlife Service (USFWS). 2001. Policy on maintaining the biological integrity, diversity, and environmental health of the National Wildlife Refuge system. *Federal Register* 66:3810-3823.

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Nipped in the Bud: Why Regional Scale Adaptive Management Is Not Blooming. 2005. Allan, C., Charles Sturt University, P.O. Box 789, Albury, NSW 2640, Australia, callan@csu.edu.au; and A. Curtis. **Environmental Management** 36(3):414-425.

Allan and Curtis reviewed records and interviewed participants in two large-scale restoration projects in southeastern Australia. Despite stated project goals, the authors documented that the projects demonstrated a lack of experimentation, social learning, and planning-management feedback loops. To explain these results, they describe the assumptions and metaphors used by people involved in the projects. These are 1) projects are "voyages" moving forward to well-known goals and learning is an unnecessary reflective activity that slows progress; 2) the desire for control leads to "door" and "gatekeeper" mentalities that maintain hierarchies and limit officially recognized information; 3) the pursuit of "clarity" and "focus" simplifies perceptions and discourages learning leading to management complexity; 4) communication becomes one-way "commerce" with managers selling ideas to stakeholders; 5) resource management is a competitive "game" that inhibits collaboration; 6) institutions are smooth, efficient "machines" that discourage approaches that do not mesh with their operation; and 7) staying inside comfort zones leads to denial and deception, "spinning" information, and refusals to address difficult concepts.

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Naturalizing Non-local Native Trees at Botany Bay: The Long-term Impact of Historical Plantings. 2005. Benson, D., Botanic Gardens Trust, Mrs Macqauries Rd., Sydney NSW 2000, Australia, doug.benson@rbgsyd.nsw.gov.au; and G. Eldershaw. **Ecological Management & Restoration** 6(3):163-171.

Benson and Eldershaw explore the problems inherent in restoration of native plant communities that have been compromised by plantings species that are not biologically native to the region, but have been in place for a long enough time that most residents consider them "native." They cite the Kurnell Peninsula in New South Wales, Australia as an example. A 70-year tree planting program begun there in 1905 to ameliorate grazing impacts introduced tallowwood (*Eucalyptus microcorys*) and other Australian species that were not native to the region into bushland characterized by the coast banksia-monotoca (*Banksia integrifolia-Monotoca elliptica*) scrub community. Decades later, such a program has been recognized as short-sighted, and efforts to reverse its effects, including tallowwood removal and propagation of banksias, monotoca, and other local native species are proving costly, in part due to resistance by the local community.

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Novel Ecosystems: Theoretical and Management Aspects of the New Ecological World Order. 2006. Hobbs, R.J., School of Environmental Science, Murdoch University, Murdock, WA 6150, Australia, rhobbs@murdoch.edu.au; S. Arico, J. Aronson, J.S. Baron, P. Bridgewater, V.A. Cramer, P.R. Epstein, J.J. Ewel, C.A. Clink, A.E. Lugo, D. Norton, D, Ojima, D.M. Richardson, E.W. Sanderson, F. Valladares, M. Vilà, R. Zamora and M. Zobel. **Global Ecology and Biogeography** 15(1):1-7.

These scientists define novel ecosystems as new species assemblages resulting from human activities that degrade the abiotic environment, create dispersal barriers, or change the biota through local extinctions or new species introductions. Conceptually, novel ecosystems lie between intensively managed systems and "wild" or "natural" systems. Examples of novel ecosystems include New Zealand rain-shadow tussock grasslands that were created by historic land uses, and the almost entirely non-native flora of the San Francisco Bay estuary. A novel ecosystem may result from crossing an environmental threshold that prevents original species from persisting or reestablishing. The creation of such a system also suggests that the removal of invasive species may not reverse ecosystem changes. The authors contend that land managers need to accept inevitable change and value ecosystems based on services gained or lost relative to others.

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When Is Restoration Not? Incorporating Landscape-Scale Processes to Restore Self-Sustaining Ecosystems in Coastal Wetland Restoration. 2006. Simenstad, C., School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA 98195-5020, simenstd@u.washington.edu; D. Reed and M. Ford. **Ecological Engineering** 26(1):27-39.

The authors define restoration as reactivating ecosystem processes, reintroducing native species, and reversing the ecosystem trajectory back across a threshold of irreversibility. They then discuss four types of restoration: 1) passive restoration, which reinstates ecosystem processes through incidental removal of barriers or of degrading land uses; 2) active restoration, which intentionally removes barriers or enhances processes to achieve specific goals; 3) creation restoration, which establishes a completely new wetland structure in a site, with little focus on process or function; and 4) sustainable restoration, which focuses on reinstating ecosystem processes, including disturbances and fluctuations that vary in spatial scale and intensity, both locally and across the landscape, requiring strategic planning at the regional level. The authors contend that true restoration of ecosystem structure and function may not be an achievable goal, given historical, social, economic, and landscape constraints. In these cases, management must be recognized as rehabilitation or a focus on short-term outcomes aimed at managing a single ecosystem service or set of species.

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Dawning of a Botanist. 2006. Wilhelm, G. **Wild Ones Journal** 19(2):3-5.

In this essay, Jerry Wilhelm describes his first exposure to botany when in the 1970s, as a member of the U.S. Army Corps of Engineers, he consulted with the late Floyd Swink and late Ray Schulenberg of the Morton Arboretum. Thus began their lifelong collaboration, including the writing of *Plants of the Chicago Region*, a seminal text that continues to have a profound influence on concepts essential to ecological restoration: distinguishing between native and adventive or introduced plant species, placing values on plant communities rather than considering them random assemblages of plant species, and developing the Coefficient of Conservatism and the Floristic Quality Index methodology to assess plant communities.

BOOK REVIEWS

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Tending the Wild: Native American Knowledge and the Management of California's Natural Resources

M. Kat Anderson. 2005. Berkeley: University of California Press. Cloth, $50. ISBN: 0-520-23856-7. Paper, $19.95. ISBN: 0-520-24851-1. 555 pages.

In *Tending the Wild: Indigenous Management of California's Natural Resources and Biodiversity*, ethnobotanist M. Kat Anderson documents the astonishing diversity of ways that California Indians managed an equally impressive number of plant species and habitats that sustained their tribal economies for more than 12,000 years. She presents a California of Eden-like biological richness at the time of European contact, and portrays the native inhabitants as its gardeners and tenders. To most modern ears, this scenario seems as counter-intuitive as it did to the Spaniards who first arrived in the late eighteenth century and who were as impressed with the land's bountiful fertility as they were puzzled by its apparent lack of Old World-type cultivation by the aboriginal inhabitants.

California still possesses 25 percent of the biological diversity found in the United States, and it once supported the highest density of Indians north of central Mexico. As its native inhabitants living in the densely populated coastal regions came under control of the Spanish missionaries and their soldiers, an unprecedented ecological process began that would transform California into a version of Mediterranean Europe—a process that historian Alfred Crosby, Jr., in *The Columbian Exchange* (1972), has called "the greatest biological revolution in the Americas since the end of the Pleistocene era."

The negative ecological consequences resulting from the Spanish, then Mexican and American rule of California were extensive and include: the type conversion of nearly all lower-elevation, Serengeti-like perennial grasslands and savannas supporting large herds of native ungulates to less-productive, alien Mediterranean-type annual grasses and shrublands; the closing-up of millions of acres of fire-maintained chaparral, forest openings, and ecotones once dominated by species-rich, herbaceous understories; and the loss of countless montane meadows and balds due to invasion by shade-tolerant and disease-prone conifer species in the absence of fire. As Anderson points out, all of this began, not with modern fire suppression efforts, but with the forcible disruption of traditional Indian burning.

This idea, however, leads Anderson into an area of some academic controversy—one that she has largely avoided. Fire ecologists now acknowledge that Indians in California, as in most of North America, did some lower-elevation burning near villages for hunting and gathering purposes, but disagree on how extensive it was and in what plant communities it occurred. While it could be argued that Anderson has not sufficiently examined the current academic opinion about fire ecology, archaeology, and optimal foraging theory, it could also be argued with at least equal validity that these same academics too often lack cultural and historical context for evaluating the effects of indigenous peoples on the land. Nevertheless, Anderson would probably have achieved more scientific credibility had she dealt more with the state of current fire ecology thinking with respect to Indian burning and optimal foraging theory with respect to sustainable harvesting. (For a different view on Indian fire, see Krech III 1999 and Vale 2002; for optimal foraging theory, see works by ecological and evolutionary anthropologists, Eugene Hunn [University of Washington] and Emilio Moran [University of Indiana]; for a critique of optimal foraging theory, see Winterhalder 1981 and Kennett and Winterhalder 2006.)

Anderson does, however, provide the context needed to understand how critical fire and other management activities were to sustaining tribal economies in California, and by extension, their far-reaching effects on the California landscape. Few academics understand the spiritual context that guided the harvesting of plants and animals, let alone know what it is like to live in a way that is directly dependent on the land and do it sustainably. (John Muir, who did live much of the time in the wild, marveled at how successfully Indians lived in what for him was a "food poor but rich wilderness," especially when his own food supplies from town failed to arrive on time. (Muir 1911, 1944; quoted by Anderson, p. 110)

The historical picture presented by Anderson suggests that the disruption of Indian cultural land practices and despiritualization brought on by forced conversion to Christianity beginning in the early nineteenth century led to a positive feedback loop of downward spiraling ecological degradation interacting with increased Indian cultural disruption—including the suppression of periodic burning—that destroyed the health of aboriginal populations and led to increased vulnerability to European diseases even as cultural plants and animals became scarce and depression, suicide, and starvation became pandemic. (The California indigenous population, conservatively estimated as 310,000 at European contact crashed to 15,500 by 1900.) This is one of several important reasons—although not one mentioned by prominent California historian James J. Rawls (2000) or any others that I am aware of—why an Indian population outnumbering Spaniards by forty to one was unable to effectively resist colonization despite valiant and unrelenting efforts.

What is the cultural/spiritual context for these historical assertions by the author? What were indigenous methods of land management and how did they maintain ecological productivity and healthy tribal economies in such a densely populated land over millennia? And what kind of land ethic guided their stewardship of the natural world?

The bulk of *Tending the Wild* details the highly sophisticated management techniques used by native Californians. Anderson provides extensive, specific information about Indian burning, selective harvesting, pruning, seed sowing, weeding, irrigating, coppicing, and transplanting of a wide variety of herbaceous, shrub, and tree species. She also examines the ecological effects of these activities at the species, patch, community, and landscape levels. These cultural practices took place within a land tenure system of "usufruct rights" that was founded on the idea of local responsibility for local resources. In this system, individuals and families took responsibility for the management of resources in their "turf," while also sharing during hard times with other band members.

According to Anderson, California Indian management systems, such as frequent low-intensity fire, were a kind of "regular intermediate-intensity, spatially heterogeneous disturbance" that promoted structurally and compositionally diverse mosaics of vegetation types (p. 153). Other ecological benefits included "stimulated seed germination rates of seral and serotinous species, recycled nutrients,…altered insect populations [e.g. breaking up the overwintering cycle of worms that prey on acorns], and increased biodiversity" (p. 238). These activities enhanced plant species in ten major cultural use categories making hundreds of plant species from numerous plant communities available for use by California Indians (78 species were used in basketry alone).

Additionally, California Indians actually moved culturally important species around the landscape, slowly increasing their ecological amplitude. This has led some modern botanists to label them "floristic anomalies" because they were often found in unexpected places outside "natural" ranges. As Indians were prevented from tending those plant patches, their ranges began shrinking and, in some cases, they simply disappeared (for example, *Nicotiana quadrivalvis*, their favorite tobacco species, is now virtually extinct). Although not mentioned by Anderson, animals also participated in the dispersal of cultural plant propagules. For example, acorns and pine nuts were cached and then forgotten by Steller's, scrub, and pinyon jays and Clark's nutcrackers—a coevolutionary process for both the birds and the trees not so different from the co-adaptation between Indians and the plants and animals they tended and depended upon.

These kinds of intermediate-level disturbances contributed, along with natural lightning regimes, to the maintenance of highly productive early and mid-successional stages of vegetation development. Without such disturbances, Europeans would have encountered a very different, vegetatively overgrown landscape. Indian burning was frequent throughout the Holocene, especially in areas of low-lightning frequency—coastal regions, maintained grasslands, oak/pine savanna and woodlands, wetlands, and montane meadows. Chaparral communities and conifer forests were perforated with culturally and ecologically productive gaps and openings. Even in places where lightning-ignited fires were fairly frequent (middle elevations in the Sierra Nevada, Klamath and Cascade mountains), Indian fires often were more frequent than lightning fires, as evidenced by fire-scar studies in the Sierra Nevadas (Kilgore 1972) that show a three- to ten-year frequency at King Mountain while lightening fire frequency in any one place occurred from 25 to 50 years as measured since 1900.

One must remember, as Anderson points out, that many low-intensity Indian burns do not appear in the pyrodendrochronological record. Most Indian burning took place on the average of every one to five years in a rotational pattern following seasonal harvesting and burning rounds from snowmelt to snowfall up to about 7,000 feet or higher. The overall effect of this kind of burning regime multiplied ecologically productive edge effects even in less culturally important plant communities. For instance, one fire set to rejuvenate elk and deer habitat could burn hundreds to thousands of acres.

The overarching harvesting rule was "Spare plants or plant parts; do not harvest everything." Indian gatherers and hunters were expert in knowing when to harvest according to plant phenology and animal life cycles, and when and how to burn culturally important plants. But more than technique was involved. Anderson uses the concept of "kincentricity" to explain the spiritual context for this kind of respectful harvesting—the belief that humans are related to all other species and, therefore, have a family obligation to show thankfulness and restraint in what we take from nature. If they did this, Native Americans believed, the plants and animals would continue to sustain them, but if they did not, the plants and animals would disappear or not return. (I coined the term "kincentricity" to describe an indigenous stewardship way that contrasts with the Western mindset of either separating humans from nature [biocentricity] or including them as rightful exploiters of nature [anthropocentricity]. It first appeared in the literature in the *Karuk Tribal Module* in 1995, when I served on the Karuk Tribal Team that wrote the *Module*.)

Current scientific orthodoxy has a different view of Indians as conservationists. Charles Kay, Thomas Newmann, William Preston, and others argue that the European diseases that killed great numbers of native people also dramatically reduced hunting pressures on prey animals, which led to atypically high numbers of wildlife following European contact (Kay and others 2002). But did this happen in California? Anderson notes (p. 5) a few instances in which overharvesting may have occurred—flightless goose extinction on San Miguel Island (Gutherie 1992, 1993) and black abalone overharvesting on San Clemente and Santa Catalina Islands (Porcasi and others 2004)—but the documented evidence for human-caused extinctions in California stops there. (It is important to note that Guthrie's work covers the late Pleistocene Period, which is a relatively early period in terms of indigenous exploration of North America, and one in which these people may have lacked experience with local wildlife, as happened in Polynesia).

I think that *Tending the Wild* would have benefited from a broader discussion than one page on such a contentious topic as overharvesting, but examples are present in the text that contradict the prevailing assumption, based on optimal foraging theory, of unsustainable maximum pressure on resources by *all* indigenous peoples. For example, while the first *documented* evidence of disease pandemics in California are in the period from 1833 to 1837, Sir Frances Drake commented in 1579 on the "infinite number of deer" and the "great assembling" of native people (Penzer 1926, quoted by Anderson, p. 66). Likewise, the Jesuit priest, Geronimo Boscana, observed in the period from 1812 to 1826 an "abundance of game" in the vicinity of Mission San Juan Capistrano (Boscana 1933, 1978; quoted by Anderson, p. 73). Where there is good documentation for Indian overharvesting, it usually follows a despiritualization process coupled with market dependence that led to a loss of restraint in harvesting, as evidenced by the seventeenth and eighteenth century fur trade (Martin 1982, White 1991). (For the best exposition that I'm aware of the full spiritual context for Indian resource use—including numerous tribal stories from the Pacific Northwest—see *The Earth's Blanket* by Nancy J. Turner.)

Anderson waffles a little on the subject of whether California Indians were agriculturists or hunter-gatherers. For example, she writes "It is highly likely that over centuries or perhaps millennia of indigenous management, certain plant communities came to *require* human tending and use for their continued fertility and renewal and for maintenance of the abundance patterns needed to support human populations" (p. 156). Indeed, there are several examples supporting her assertion that California Indians widened the ecological amplitude of native species by introducing them to new areas, including devil's claw (*Proboscidia parviflora*), desert fan palm (*Washingtonia filifera*), native tobacco (*Nicotiana clevelandii*), blue elderberry (*Sambucus mexicana*), edible camas (*Camassia quamash*), Catalina Island foxes (*Urocyon litoralis*), and others. Yet, Anderson still refers to the kind of horticultural agroecology practiced by California Indians—which included burning as an agent of fertilization, direct sowing of crop seeds, and development of new varieties of crop plants—as "proto" agriculture, that is, an evolutionary development that stopped short of "true" Old World agriculture. I think the difference is hardly in favor of "true agriculture" as a more highly evolved kind of food production system given the high level of indigenous management sophistication without the need for animals or exhausting labor. Moreover, indigenous "agriculture" did not suffer from the weather problems, pest damage, and periodic starvation due to the failure of monotypic crops that is typical of "true agriculture." The tired Western paradigm of a linear evolutionary progression from savagery to civilization, based on nineteenth-century Social Darwinism, still seems to have a powerful hold—usually unconsciously—on many modern thinkers. I know that Anderson doesn't believe in the supremacy of Western agriculture, but apparently she finds it necessary for establishing credibility, especially when it perhaps places California Indian culture on an "upward" path to what many today regard as the pinnacle of agricultural progress.

I really believe that *Tending the Wild* has radical and profound implications for ecological restoration and its practitioners who are unused to working with cultural landscapes because Anderson so strongly encourages the recognition of California Indians (and indigenous peoples elsewhere in the world) as keystone players influencing ecosystem structure and composition, and enhancing their function. If climate and geology are not the only primary factors in determining where plants grow (for instance, it was once thought that the lack of trees in California coastal prairies—repeatedly burned by California Indians—was the result of soil infertility), then indigenous humans with sustainable cultural practices may have to be included in the reference ecosystems that guide restoration practices and projects. Moreover, indigenous cultural practices, where sustainable and ecologically appropriate over substantial time can be viewed as having *ecological* values worth mimicking in *ecological* restoration.

It is often assumed that, unlike Europe with its millennia of cultural impacts and semi-natural landscapes, North America offers mainly "wilderness" as a reference restoration condition (Van Diggelen 2006). *The SER International Primer* (2004), in its extended definition of ecological restoration, asserts that the restoration of ecological integrity is complete when "autogenic processes [have] progressed to the point where *assistance from restorationists is no longer needed*" (my italics). Yet, at a recent meeting of Parks Canada that I attended as a consultant, we developed standards for ecological restoration that included "appropriate cultural practices of great antiquity as *ecological* values to be restored." Not only is the goal of a self-sustaining restoration project probably impossible in today's environment of numerous degrading external influences, but the extended definition also dismisses the possibility of cultural landscapes—which were partly the result of periodic human intervention—as coming under the Society for Ecological Restoration International's definition of *ecological* restoration. (The 1996 SER definition does include "sustainable cultural practices" as part of the definition of ecological integrity and can be found in the *Primer,* although this definition was replaced in 2002 by a shorter more ambiguous one that does not mention culture. I wrote the section on cultural landscapes, and while it is in the *Primer,* it is considered separately from *ecological* restoration.)

A better way to think about cultural landscapes, which includes California's most ecologically productive ecosystems, is as part of a continuum where autogenic nature is at one end, inappropriate cultural practices or purely historical landscapes are at the other end, and in between is a significant part of the continuum where natural and cultural factors merge and appropriate cultural practices have an ecological value.

Tending The Wild, through its exhaustive cataloging of ecologically sustainable California Indian cultural practices, debunks the wilderness myth while affirming the necessity for restoration practitioners to include these kinds of cultural landscapes in reference ecosystems. Indeed, good restoration science requires it and indigenous cultural survival depends on it. Although not widely known, indigenous peoples today face fundamentally the same crisis as in times past—most are prevented from accessing cultural and natural resources on their ancestral lands because those lands have become private real estate or have been ceded to public agencies.

For those restoration practitioners working in areas where indigenous peoples no longer reside, Anderson has contributed to historical ecology by offering, indirectly, a way to reconstruct something of the composition and structure of the traditionally managed landscapes by offering a plethora of quantitative information about the number of plants or plant parts required for making cultural items and the number of patches of culturally important species that need to be burned on a regular basis in order to be useful. For example, she notes that it took 35,000 stalks of milkweed (*Asclepias* spp.) or dogbane (*Apocynum* spp.) burned the year before to make a 40-foot net (see also Anderson and Blackburn 1993).

Traditional ecological knowledge of indigenous peoples is a fragile living library whose survival depends on the survival of its practitioners in their ancestral homelands. Kat Anderson has taken an important step in the direction of affirming the valuable ecological roles of indigenous peoples—a step that, I hope, will prevent their removal from protected areas and nature reserves in the name of "pure" scientific research and will also conserve a way of life that offers a much needed model of how to use and preserve or restore our natural resources in a manner derived from our human kincentric obligations to our relatives in the natural world.

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1491: New Revelations of the Americas Before Columbus

Charles C. Mann. 2005. New York: Knopf. Cloth, $30. ISBN: 1-4000-4006-X. Paper, $14.95. ISBN: 1-4000-3205-9. 480 pages.

More than 50 years ago, Gordon M. Day (1953) argued that "a knowledge of local archaeology and history should be part of the ecologist's equipment." Charles Mann's *1491* is a modern-day prerequisite toward attaining that knowledge—a thoroughly researched and highly readable book that focuses on the burgeoning body of research about pre-Columbian American cultures and their relationships with their environments. *1491* shows us that human history is really at the center of the practice of restoration, and understanding this history is *essential* to fully understand the ecological systems and relationships that existed in the Americas prior to the Columbian Exchange. What emerges from this book is nothing less than a paradigm shift for the popular understanding of American history and nature, with important conclusions directly relevant to ecological restoration and sustainable development. This new understanding means everything to restoration goals predicated upon assumptions of pre-European settlement conditions, and will undoubtedly lead to shifts in how we perceive restoration and management goals. Indeed, Mann's conclusions go to the heart of the age-old philosophical discussion about the human/nature relationship.

Mann organizes his book thematically, demonstrating both his mastery of the subject and creating an immersive and richly detailed mental environment for the reader. His central argument revolves around an overarching conceptual theme that he calls "Holmberg's Mistake"—a two-part belief that includes both "the dreamy stereotype of the Indian as a Noble Savage" as well as the view of Indians as "incurably vicious barbarians" (p. 12). "Positive or negative," says Mann, "in both images Indians lacked what social scientists call *agency*—they were not actors in their own right, but passive recipients of whatever windfalls or disasters happenstance put in their way" (p. 12). Holmberg's Mistake (named for anthropologist Allan Holmberg) remains alive and well today, particularly in the environmental field: we've all experienced volunteers on restoration projects or students in classrooms who believe—sometimes very strongly, regardless of their cultural background—that Indians lived in balance with nature, and that the American target for restoration and our ideal relationship with nature in the future should reflect that which existed prior to 1492. The other side of the coin emerges when someone suggests the idea of "overshoot," where civilizations destroy themselves by unthinkingly destroying their environment; the Maya are often cited as a case in point. Throughout the book, Mann dismisses both sides of that singular belief with meticulously detailed research that supports the theory that economic conditions are paramount to understanding the culture-nature link. Every culture starts with the basic need to make a living, and the people of that culture structure their activities to do so as best they can, inevitably, and for better or worse, constrained by a dominant cultural perspective and the conditions of their locale. "Native Americans' interactions with their environments were as diverse as Native Americans themselves," says Mann, and "sifting through the evidence, it is apparent that many though not all Indians were superbly active land managers—they did not live lightly on the land" (p. 248). The history of these interactions in the Americas—the heart of the book—has a lot to tell us about the future of environmental management.

In the book's opening section, Mann explores the context of early post-contact relationships between Europeans and Indians, focusing on the Indians of New England and Peru as paradigmatic cases for the effects of European contact on cultures throughout the Americas: initial trade and mutual suspicion, the concomitant use of the other to improve their own political positions, and (soon thereafter) vast and profound destruction of Indian societies from disease, followed by large alterations in the biota of these landscapes—mostly as a result of Indian depopulation. In Part Two, Mann surveys the age, diversity, and social and technological sophistication of many of the cultures of the pre-contact America, providing surprising insights into how these cultures approached land management and economic development. In a key point, Mann reports that current interpretations of archaeological evidence dispel the popular notion that environmental degradation was a primary cause of the collapse of American civilizations like the Maya. Mann reports that the Maya had a detailed and sophisticated understanding of what the Yucatan's ecology would permit, which resulted in a highly developed and practical comprehension of how to manage their lands. Their collapse "was due not to surpassing inherent ecological limits but the political failure to find solutions" (p. 272) to the effects of extended warfare on the social conventions that structured land management.

The book's third section, aptly titled "Landscape with Figures," brings to the forefront the issue of the interactions between Indian cultures and their diverse landscapes, particularly the mistaken "idea that native cultures did not or could not control their environment" (p. 320). Mann's summary of the gist of research in the field may surprise some readers: "At the time of Columbus the Western Hemisphere had been thoroughly painted with the human brush. Agriculture occurred in as much as two-thirds of what is now the continental United States . . . Indians had converted the Mexican basin and Yucatan into artificial environments suitable to farming . . . Indians had converted perhaps a quarter of the Amazon forest into farms and agricultural forests" (p. 320). A major portion of this section delves into the history of the Amazon basin, perhaps the archetypal image of wild, pristine nature. Here, too, new evidence suggests widespread and sophisticated human manipulation of the environments of the region, dating back in some locations as far back as 13,000 years ago. "For a long time, clever people who knew tricks we have yet to learn used big chunks of Amazonia non-destructively. Faced with an ecological problem [poor soils], the Indians *fixed* it. Rather than adapt to nature, they *created* it" (p. 311).

What does *1491* imply for restoration? Strictly in terms of human impact on the environment, the America of the 1700s was actually more "pristine" than that of 1491, largely from massive depopulation of native peoples and the "ecological releases" of suppressed species (for example, Mann cites, among others, Charles Kay's hypothesis about pre-contact bison populations and Thomas Nuemann's theory about passenger pigeons) that many ecosystems felt when their most important "keystone species" disappeared. Drawing from a vast body of research from throughout the Americas, Mann encapsulates the new understanding of pre-Columbian American ecosystems: "[E]cologists and archaeologists increasingly agree that the destruction of Native Americans also destroyed the ecosystems they managed" (p. 323). Mann believes that all of this evidence has profound implications for the practice of ecological restoration and management: "Native Americans ran the continent as they saw fit. If [modern nations] want to return as much of the landscape as possible to its state in 1491, they will have to create the world's largest gardens" (p. 326).

All cultures affect and manipulate their environments, and successful cultures are the ones that understand their environment well enough to support extensive agricultural systems and maintain them even with increased population density for millennia. Some cultures in the Americas did this for thousands of years, and therein may lie the lessons that can serve to support humanity and wild nature alike. "If there is a lesson" in the historical roles of humans in the Americas, says Mann, "it is that to think like the original inhabitants of these lands we should not set our sights on rebuilding an environment from the past but concentrate on shaping a world to live in for the future" (p. 326).

I strongly recommend this book—it is well written, making it easy and enjoyable to read, even for time-challenged people. It covers the majority view of the topic admirably and accurately, and provides a good introduction to the literature. For restorationists in particular, it has important implications that *will* bear directly on any restoration project in the Americas. Buy one for yourself, and buy another one for someone else in the environmental field. A lesson of Mann's book is that we must include history and archaeology alongside ecology as essential—not tangential—parts of our work. The applied lesson of *1491* for restoration is that by having a more accurate picture of Indian relationships to their environments and the effects of European contact on those relationships, we can dismiss the widespread and popular myths that actively hinder environmental projects and preclude political effectiveness. Further, this more accurate understanding can give us a real foundation for understanding how we restorationists might build the first *workable* mental framework for a sustainable future. Restoration is at the leading edge of integrating nature and culture, and Mann's book brings us one step closer to a true fit.

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RECENTLY RECEIVED TITLES

If you are interested in reviewing any of the following books, please contact the editors at webmaster@ecologicalrestoration.info or 608/262-9591.

Foundations of Restoration Ecology

Donald A. Falk, Margaret A. Palmer and Joy B. Zedler, editors. 2006. Washington, D.C.: Island Press. Cloth, $90. ISBN: 1-59726-016-9. Paper, $45. ISBN: 1-59726-017-7. 364 pages.

Nature's Restoration: People and Places on the Front Lines of Conservation

Peter Friederici. 2006. Washington, D.C.: Island Press. Cloth, $25.95. ISBN: 1-55963-085-X. 308 pages.

Ecology and Management of a Forested Landscape: Fifty Years on the Savannah River Site

John C. Kilgo and John I. Blake. 2005. Washington, D.C.: Island Press. Cloth, $79.95 . ISBN: 1-59726-010-X. Paper, $44.95. ISBN: 1-29726-011-8. 479 pages.

WORLD WIDE WEB

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Organization Sites

Hotspots Fire Project (Australia)

http://www.nccnsw.org.au/index.php?option=com_content&task=view&id=1115&Itemid=642

The Nature Conservation Council of New South Wales developed this unique project to help land managers and communities safely and effectively manage prescribed burns. The Hotspots team works with ecologists, government agencies, landowners, rangers, and fire fighters to produce case studies, manuals, workshops, and other tools that promote best practices for recovering and conserving native plants and wildlife habitat in the state's four regions. The group's Web site includes access to its newsletter, regional fact sheets and guidelines, and resource links.

Invasive Species in Canada (Canadian Wildlife Federation)

http://www.cwf-fcf.org/invasive/chooseSC.asp

The Canadian Wildlife Federation hosts this database of some 500 invasive terrestrial and aquatic plants, animals, and pathogens that have become established in Canada. Users can search by a number of criteria, including type of species, species name, taxonomy, native or invasive range, year of introduction, status, and control measures. While the data files lack detail, the site's simple-to-use search parameters make it a good introduction to these species before embarking on a more comprehensive search.

Large Herbivore Foundation

www.largeherbivore.org/

The Large Herbivore Foundation has developed or supported several projects involving the restoration of European bison (*Bison bonasus bonasus*), Mongolian gazelle (*Procapra gutturosa*), and other Eurasian grazers. In addition, the foundation supports the use of native horses and cattle for restoring historical habitat conditions. This site includes organizational information, downloads of project reports and the foundation's newsletter, links to European and Asian conservation organizations, and a page about its various projects.

Wildlands CPR: Reviving Wild Places

http://www.wildlandscpr.org/Search/search.php

Wildlands CPR maintains and frequently updates a bibliographic database of more than 12,000 citations documenting the physical and ecological effects of roads and off-road vehicles. This database was created to help people access relevant scientific literature on such issues as erosion, fragmentation, sedimentation, pollution, effects on wildlife, and aquatic and hydrologic effects. The database contains citations (in most cases with accompanying abstracts) from scientific and "gray" literature, including journal articles, conference proceedings, books, lawsuits, and agency reports.

Government Sites

Casual Analysis/Diagnosis Decision Information System (CADDIS)

http://cfpub.epa.gov/caddis/

This online tool enables scientists and engineers to conduct causal assessments of biological impairments in aquatic systems and watersheds. The application, which uses the U.S. Environmental Protection Agency's "stressor identification" method, features a guide for conducting a causal analysis, sample worksheets, a library of conceptual models, and links to information resources. CADDIS is a work-in-progress, with new features (for example, databases and modules on deriving empirical stressor-response relationships) currently being developed.

DCNR Invasive Exotic Plant Tutorial for Natural Lands Managers

http://www.dcnr.state.pa.us/forestry/invasivetutorial/index.htm

While the Mid-Atlantic Exotic Pest Plant Council prepared this exotic plants tutorial for managers of natural areas in Pennsylvania, many of these lessons could easily be applied to other parts of North America. The tutorial materials can be accessed 1) by topic, for those who are already familiar with managing invasive species or 2) through a series of "guidance questions," for the novice. Topics include an introduction to invasive species management; establishing a philosophy and setting goals; inventory, mapping, and ranking; management tools; management and control information for 60 species that have established in Pennsylvania and 16 others on that state's "watch" list; prevention and early detection; planning, monitoring, and evaluation; and ecological restoration.

HydroSHEDS

http://hydrosheds.cr.usgs.gov/

HydroSHEDS, which stands for "**Hydro**logical data and maps based on **SH**uttle Elevation Derivatives at multiple Scales," is an online tool from the World Wildlife Fund and several partners that enables scientists and natural resource managers to create digital river and watershed maps. Users can apply the maps in conjunction with other geo-spatial datasets or in computer simulations (for example, to estimate flow regimes). HydroSHEDS uses elevation data collected by the Space Shuttle Endeavor in February 2000. Data for South America and Asia are currently available, and data for Europe, Africa, Australia, and North America will be added between fall 2006 and spring 2007.

Education Sites

ForestERA: Forest Ecosystem Restoration Analysis

http://jan.ucc.nau.edu/~fera-p/overview_intro.htm

This project, based at the University of Northern Arizona in Flagstaff, helps stakeholders living and working in regions of the southwestern United States dominated by ponderosa pine (*Pinus ponderosa*) ecosystems to collaborate on developing management plans that reduce the risk of wildfires while restoring natural fire regimes and wildlife habitat. The ForestERA Web site provides descriptions of software that have been used to create forest management scenarios at the project's first study area in Flagstaff, downloadable data layers and maps, documents produced by the ForestERA team, and news updates.

OdonataCentral: Dragonflies and Damselflies of North America

http://odonatacentral.bfl.utexas.edu/

John C. Abbott, an entomologist at the University of Texas in Austin, is the webmaster of this impressive compilation of dragonfly and damselfly data and checklists from the United States, Canada, and Mexico. Clickable maps enable users to search for checklists and statistics by state, province, or county. By clicking on the photo icon that appears next to most of the species names, users can find general information as well as "dot maps" of species distributions in Texas, Louisiana, Arkansas, Oklahoma, and New Mexico. The site also includes a remarkable photo gallery featuring multiple shots of many species, a field guide to Odonata of Texas, bibliographical resources, a directory of entomologists, Web links, and a form for submitting potentially new data of local Odanata occurrences.

Revegetation Equipment Catalog

http://reveg-catalog.tamu.edu/

The Rangeland Equipment and Technology Council, in partnership with the USDA Forest Service and USDI Bureau of Land Management, created this one-stop resource of equipment and materials available for restoring or revegetating disturbed rangelands. The site is organized by categories, including Global Positioning Systems, controlling unwanted plants (mechanically, chemically, by fire), site preparation, seeding, fertilizing and mulching, seed harvesting, and more. Each piece of equipment includes a photo, a physical description and explanation of how it is used, and links to manufacturers and suppliers.

2006

September 5-9. **2006 Annual Conference of the Floodplain Management Association** will gather in Coronado, California. For information, visit www.floodplain.org.

September 10-15. **First Annual Regional Wetland Restoration Institute** will be presented at the Daniel Boone National Forest in eastern Kentucky. Contact Anne Hoover at aghoov2@uky.edu or 859/257-8637, or download the brochure at http://tfce.uky.edu/wri.htm.

September 18-20. **Littoral 2006: Coastal Innovations and Initiatives** will take place in Gdansk, Poland. For information, visit www.littoral2006.gda.pl/index.html.

September 18-20. **2006 American Water Resources Association Wetland Restoration Dialogue** will meet in Fort Lauderdale, Florida. Details are available at www.awra.org/meetings/Wetlands2006/index.html.

September 18-21. **14th Annual Conference of the North American Weed Management Association** will meet in Calgary, Alberta. For information, contact Kim Nielsen at 403/845-4444 or knielsen@county.clearwater.ab.ca.

September 19-22. **6th European Coral Reef Conference** will take place in Bremen, Germany. For details, see the conference Web site at http://isrs2006.zmt.uni-bremen.de/.

September 23-27. **13th Annual Conference of the Wildlife Society** will gather in Anchorage, Alaska. For more information, visitww.wildlife.org/conference/index.cfm?tname=2006cfs.

September 24-28. **15th Australia Weeds Conference** will meet in Adelaide, South Australia. Conference details are posted at www.plevin.com.au/15AWC2006/.

October 2-5. **Boreal Conference 2006** will meet in Conchrane, Ontario. For information, visit www.borealconference2006.ca/English/boreal_conference_2006_home.htm.

October 3-4. **The 2006 Tamarisk Research Conference: Current Status and Future Directions** will meet in Fort Collins, Colorado. Information is available at www.tamarisk.colostate.edu/.

October 11-13. **The 2006 Annual Conference of the National Roadside Vegetation Management Association** will be held in Des Moines, Iowa. For details, visit www.nrvma.org/pages/6/index.htm.

October 12-15. **2006 Land Trust Alliance Meeting** will be held in Nashville, Tennesee. For details, see www.lta.org/training/index.html.

October 15-20. **Third International Tropical Marine Ecosystems Management Symposium** will convene in Cozumel, Mexico. For more information, go to www.itmems.org/.

October 24-26. **Conserving and Restoring Frequent Fire Landscapes of the West** will be held in Flagstaff, Arizona. For additional information, contact eri-conference@for.nau.edu or visit www.eri.nau.edu/cms/content/view/740/952/.

October 26-28. **California Society for Ecological Restoration (SERCAL) 2006 Conference** will gather in Santa Barbara, California. Check the SERCAL Web site, www.sercal.org, for details.

November 2-3. **33rd Annual Conference on Ecosystems Restoration and Creation** will meet at Hillsborough Community College in Plant City, Florida. For more information, visit the conference Web site at www.hccfl.edu/depts/detp/ecoconf.html or call 813/253-7523.

November 7-9. **Shortleaf Pine Symposium** will meet in Springfield, Missouri. For information, visit http://mdc.mo.gov/science/sl_pine/.

November 12-15. **Defenders of Wildife's Carnivores 2006: Habitats, Challenges, and Possibilities** will be held in St. Petersburg, Florida. For additional information, contact Aimee Delach at adelach@defenders.org or visit the meeting Web site at www.carnivoreconference.org.

November 13-14. **2006 Conference of the Wildlife Habitat Council** will be held in Baltimore, Maryland. For information, check www.wildlifehc.org.

November 13-17. **3rd International Fire Ecology & Management Congress** will convene in San Diego, California. Information is available on the conference Web site, http://emmps.wsu.edu/fire-congress/.

December 9-13. **3rd National Conference and Expo on Coastal and Estuarine Habitat Restoration** will meet in New Orleans, Louisiana. Details are posted on www.estuaries.org/?id=4.

2007

March 1-3. **8th Prairie Conservation and Endangered Species Conference & Workshop** will meet in Regina, Saskatchewan. Information is available at www.pcesc.ca/index.html.

April 16-20. **International Coastal Symposium** will gather in Gold Coast, Australia. For additional information, visit www.griffith.edu.au/school/eng/ics2007/.

April 16-22. **Second International Symposium on Ecological Restoration**, hosted by the Cuban Group of Ecological Restoration and the National Enterprise for the Protection of Flora and Fauna, will convene at the Bolivar Convention Center, Santa Clara City, Villa Clara, Cuba. For information, contact M. Sc. Grécia Montalvo Fernández or Alberto Torres Bilbao at sisre@ccb.vcl.cu.

May 21-26. **Ecosystem Based Management: Beyond Boundaries,** hosted by Science and Management of Protected Areas Association, will meet in Wolfville, Nova Scotia, Canada. For details, visit www.sampaa.org/sampaa_conference.htm.

May 22-27. **EcoSummit 2007: Ecological Complexity and Sustainability: Challenges and Opportunities for 21st-Century's Ecology** will meet at the Beijing International Convention Center, Beijing, PR China. Information is available at www.ecosummit2007.elsevier.com.

July 22-26. **Coastal Zone 07** will take place in Portland, Oregon. For details, see www.csc.noaa.gov/cz/ .

Visit **www.ecologicalrestoration.info/meetings.asp** to view a comprehensive list of restoration-related meetings with links to conference Web sites.