# NOTES & ABSTRACTS

## GRASSLANDS

### 75

### Reverse Fertilization Reduces Cover of Weedy Species in Tallgrass Prairie Restoration (Ohio)

*Jack M. Averett, Robert A. Klips, and Peter S. Curtis, The Ohio State University, Department of Evolution, Ecology, and Organismal Biology, 1735 Neil Avenue, Columbus, Ohio 43210-1293, averett.1@osu.edu*

Disturbed tallgrass prairie remnants and prairie restoration sites often have high levels of nitrogen from agrochemical fertilizers and atmospheric deposition that facilitate the rapid growth of weedy species, which in turn exclude slower-growing prairie species that are adapted to low nitrogen soils (Wedin and Tilman 1990, Morgan 1994). At the Ohio State University at Marion Prairie and Nature Center in Marion, Ohio, we are conducting experiments to determine whether reverse fertilization, or "soil impoverishment," can provide a partial solution to this problem (Morgan 1994, Baer and others 1999). This technique involves incorporating recalcitrant carbon into the soil to stimulate microbial growth, which then immobilizes nitrogen.

In December 2000, we tilled 1.2 lbs/ft$^2$ (6 kg/m$^2$) hardwood sawdust into the top 6 inches of 16 2-m x 2-m plots in an abandoned agricultural field, thus increasing the level of soil carbon nearly 70 percent. We also established an equal number of untreated plots. Figure 1 shows the equations we used to calculate the amount of sawdust needed in order to achieve our targeted soil carbon concentration. In January 2001, we planted all plots with a prairie species mix consisting of six forbs and four grasses, all of local genotypes. Using the buried bag procedure (Eno 1960, Robertson and others 1999), we determined that soil nitrogen availability was reduced 90 percent during the first growing season (July–October). In the sawdust treated plots, 1.3 mg N per kg soil was mineralized over that period compared with 13.9 mg N per kg soil in untreated plots.

Our preliminary plant growth data suggest that reverse fertilization promotes conditions amenable to tallgrass prairie restoration. Although soil moisture on carbon plots increased approximately 10 percent in treated plots, the carbon amendment reduced the aboveground biomass of non-prairie species and prairie grasses by approximately 65 percent and prairie forbs by 35 percent. In addition, it reduced total plant cover, total stem density, and the leaf nitrogen concentration of four target species: Canada thistle (*Cirsium arvense*), wild radish (*Raphanus raphanistrum*), Riddell's goldenrod (*Solidago riddellii*), and common wheat (*Triticum aestivum*).

If our high carbon treatment has a lasting effect, we predict that plants growing in these plots will continue to produce slowly decaying, low nitrogen litter, thus establishing the positive feedback that maintains low soil nitrogen in natural

**Figure 1. A simple method for calculating the amount of sawdust needed for reverse fertilization in prairie restoration. Numerical examples are drawn from the Ohio State University at Marion prairie restoration site.**

1. Calculate the amount of carbon (C, in lbs or kg) present in your restoration site soil before adding sawdust. You must know the total volume of soil to be treated (V, in ft$^3$ or m$^3$), the bulk density of that soil (D, in lbs/ft$^3$ or kg/m$^3$), and the fraction soil organic matter (O). County soil surveys will provide some of the needed information. We assume the carbon concentration of soil organic matter is 50 percent.

$$C = V \times D \times O \times 0.5$$

Example: The restoration site is 128 m$^2$ and will be treated to a depth of 15 cm, so V = 19.2 m$^3$. The soil bulk density is 1.2 g/cm$^3$, so D = 1,200 kg/m$^3$. Soil organic matter is 6.2 percent, so O = 0.062. Therefore:

$$C = 19.2 \times 1{,}200 \times 0.062 \times 0.5 = 714 \text{ kg carbon } (1{,}571 \text{ lbs})$$

2. Calculate the amount of sawdust (S, in lbs or kg) needed to double (2x) the carbon concentration of your restoration site soil. We assume the carbon concentration of sawdust is 50 percent.

$$(2 \times C - C)/0.5 \times S$$

Example: If C = 714 kg, then

$$S = (2 \times 714 - 714)/0.5 = 1{,}428 \text{ kg } (3{,}142 \text{ lbs}) \text{ sawdust}$$

This would be spread over 128 m$^2$ (1,378 ft$^2$), or at a coverage of 11.2 kg/m$^2$ (2.3 lbs/ft$^2$).

If the carbon concentration of your soil organic matter or sawdust is other than 50 percent, replace the "0.5" in equations 1 and 2 respectively with the appropriate values. If your target soil carbon concentration is other than doubling the initial concentration, replace the "2" in equation 2 with the appropriate value (e.g., 1.5 for a 50-percent increase).

At the OSU Marion prairie we added 6 kg sawdust per m$^2$ (1.2 lbs/ft$^2$) for a targeted 52 percent increase in soil carbon concentration based on the above calculations. Combustion analysis showed our sawdust-amended soils contained on average 5.2 percent carbon, compared to an average of 3.1 percent carbon in the unamended soils, a 68 percent increase. There was considerable variation among plots and the median increase in soil carbon among 16 pairs of experimental plots was 55 percent, very close to our target value.

prairies. Our results, and those of similar studies (Reynolds and others 1997; Zink and Allen, 1998; Corbin and D'Antonio, 2000; Haubensak and D'Antonio, 2000), suggest a bright future for reverse fertilization as a tool in ecological restoration.

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## 76

**An 11-Year Ecological Study of a Rare Prairie Perennial (Asclepias meadii): Implications for Monitoring and Management.** 2000. Kettle, W.D., H.M. Alexander, Dept. of Ecology and Evolutionary Biology, University of Kansas, Lawrence, KS 66045; and G.L. Pittman. **American Midland Naturalist** 144(1):66-77.

After 11 years of monitoring an existing population of Mead's milkweed (*Aclepias meadii*) at the Kansas Ecological Reserves, the authors note that detection of the rare milkweed population has improved. This is largely because they marked individual patches of milkweed during years when the stems were flowering, allowing them in later years to find the nonflowering stems, which are difficult to detect in dense prairie vegetation. The researchers also found that burning has enhanced seed production at the site and that patch survivorship of Mead's milkweed is high. However, because seed production is low in most years, the population's long-term viability is still of concern.

## 77

**Effects of Water Table, Clipping, and Species Interactions on *Carex nebrascensis* and *Poa pratensis* in Riparian Meadows.** 2001. Martin, D.W. and J.C. Chambers, USDA Forest Service, Rocky Mountain Research Station, 920 Valley Rd., Reno, NV 89512. **Wetlands** 21(3):422-430.

The authors studied the responses of two widespread riparian species—Nebraska sedge (*Carex nebrascensis*) and Kentucky bluegrass (*Poa pratensis*)—to water-table depth, grazing, and removal of competing plants in wet riparian meadows in central Nevada. Water-table depth had no effect on Nebraska sedge, while more shallow water tables at least initially severely restricted the growth and tillering of Kentucky bluegrass. Over time, however, tiller numbers of Kentucky bluegrass increased in low-water-table sites but decreased in mid-water-table sites. Clipping done near the end of the growing season did not affect either species. Both species, especially Kentucky bluegrass, responded favorably to the removal of other plants, indicating that Kentucky bluegrass can respond more rapidly to disturbances that remove neighbors. Interaction between the two species limited tiller production of Nebraska sedge, probably due to Kentucky bluegrass's greater growth rates and increased competitive ability at lower water-table levels.

## 78

**Responses of the Codominant Grassland Species Andropogon gerardii and Sorghastrum nutans to Long-Term Manipulations of Nitrogen and Water.** 2001. Silletti, A.M. and A.K. Knapp, Division of Biology, Kansas State University, Manhattan, KS 66506, 785/532-7094, Fax: 785/532-6653, aknapp@ksu.edu. **American Midland Naturalist** 145(1):159-167.

This study focuses on the possible effects of changes in the availability and distribution of water and nitrogen on big bluestem (*Andropogon gerardii*) and Indiangrass (*Sorghastrum nutans*). Long-term irrigation leads to increased water potential (ability of the water to move) for both species, while increased fertilization leads to decreased water potentials for both. However, Indiangrass responded to both water and nitrogen addition with increases in net photosynthesis and stomatal conductance, whereas big bluestem, which is currently more abundant than Indiangrass, was relatively unresponsive to such manipulations. Noting that net photosynthesis has been positively related to plant productivity, the authors conclude that changes in resource availability may alter the pattern of abundance for these two species. The results also indicate that these two grasses should not be considered ecological equivalents.

## 79

**A Literature Review of Insect Responses to Fire, Compared to Other Conservation Managements of Open Habitat.** 2001. Swengel, A.B., 909 Birch St., Baraboo, WI 53913. **Biodiversity and Conservation** 10(7):1141-1169.

Swengel reviewed the literature regarding insect response to fire and other management techniques, including mowing and grazing. She found that many insect groups decline significantly just after a fire. The rate of population growth after fire relates to a species' ability to access new vegetation. A lesser decline in insect numbers and a quicker recovery time usually follows mowing, with the affect on particular species depending on the scale and season of the cutting. On the other hand, insect response to grazing depends on the type of grazing. Factors associated with insect response to fire include: 1) the degree of exposure to lethal temperature and stress in the post-fire site, 2) habitat suitability of the post-treatment vegetation, and 3) ability of insect survivors or colonizers to repopulate at the site. Swengel finds that these factors also apply to the other management methods and concludes that managers should take them into account when setting their management plans.

## 80

**Diversity and Productivity in a Long-Term Grassland Experiment.** 2001. Tilman, D., Dept. of Ecology, Evolution, and Behavior, University of Minnesota, St. Paul, MN 55108, tilman@umnedu; P.B. Reich, J. Knops, D. Wedin, T. Mielke and C. Lehman. **Science** 294(5543):843-845.

In a seven-year experiment to determine the effect of plant diversity on productivity, the authors seeded each plot with between one and 16 species, from a pool of 18 grassland perennials. Plots seeded with greater numbers of species attained more than twice as much biomass over the seven years than did monoculture plots. The results indicate that even the best-chosen monocultures do not achieve the productivity or carbon storage capacity as sites with higher plant diversity. They also noted that the effects of plant diversity strengthen over time. The increased productivity at higher diversity seems to be due to niche complementarity, in which species have interspecific differences in requirements or have positive interactions.

# WOODLANDS

## 81

### Should Bark Beetle Outbreaks in Mountain Spruce Forests be Treated as a Natural Process? (Czech Republic)

*Magda Jonasova, MSc., Faculty of Biological Sciences, University of Ceske Budejovice, Branisovska 31, 370 05 Ceske Budejovice, Czech Republic, +420-38-777 31 20, (Fax)+420-38-53 00 366, jonasova @pf.jcu.cz*

Since the mid-1990s, a massive bark beetle (*Ips typographus*) outbreak has devastated an extensive area of mountain spruce (*Picea abies*) forests in the Sumava Mountains, which extend from Germany to the Czech Republic and represent the largest forested area in Central Europe. Although some natural, spruce-dominated forests still exist at altitudes of 3,936 feet (1,200 m) and above, most spruce stands at lower altitudes were planted during the last two centuries in areas that were originally beech (*Fagus sylvatica*) woodlands. These monospecific, even-aged plantations are especially sensitive to bark beetle outbreaks.

Park authorities on each side of the German-Czech border have taken different approaches to dealing with this problem. Since the 1970s, staff of the Bayerischer Wald National Park in Germany have viewed outbreaks as natural processes that do not require human intervention (Bibelriether 1991, Nüßlein and Faißt 1998, Fischer and others 1990). Meanwhile, foresters working in the Sumava National Park in the Czech Republic usually harvest infested trees and plant new spruce saplings. Unfortunately, this approach is so widely practiced that few uncut tracts remain in the park.

We decided to evaluate how these two approaches influence the natural establishment and growth of spruce forests in Sumava National Park. From 1997 to 2000 we tracked and compared differences in population size and age structure of species growing in two types of permanent, 400-$m^2$ research plots: 1) unmanaged, beetle-infested sites where the canopy had been dead since 1996 and 2) clear-cut areas where infested trees had been harvested. We established eight plots on unmanaged sites and five on clear-cut sites. The differences we observed between the two types of plots were striking and suggest that nonintervention is the most reasonable approach for preserving and enhancing the natural structure of mountain forests.

Importantly, we found that the die-off of the overstory canopy in unmanaged areas did not spell the end of a forest. In fact, the presence of a large amount of dead wood provided conditions that favored the establishment of spruce, beech and rowan (*Sorbus aucuparia*) (Jonasova 2001), species typically found in climax spruce forests. Several studies have reported the important role that decaying wood plays in providing favorable microsites for spruce seedling establishment (Ponge and others 1998, Hofgaard 1993, Szewczyk and Szwagrzyk 1996), and indeed spruce accounted for the greatest number of seedlings (an average of 3,221 seedlings /acre {7,957/ha}) found on the unmanaged plots. Four years after the overstory die-off, older, but relatively short, spruce seedlings that had survived in closed stands began to grow taller once the canopy opened, with mean annual growth increasing from 1 inch (2.5 cm) to 3 inches (8 cm).

The open canopy also improved conditions for establishment of rowan (*S. aucuparia*), a bird-dispersed species that regenerates very well. We found that downed trunks and branches protected seedlings from deer browse, enabling rowan on unmanaged plots

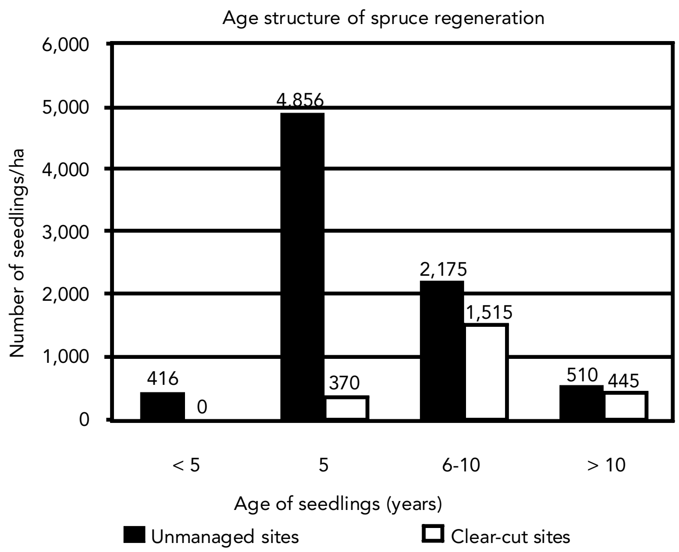


**Figure 1. Numbers of spruce (*Picea abies*) seedlings by age class on unmanaged and clear-cut sites infested by bark beetles (*Ips typographus*).**

to reach an average 2.2 feet (0.67 m) in height compared to those on the clear-cut plots, which averaged 1.5 feet (0.45 m). Beech, which was more abundant in forests in the early 19th century, was missing in most stands. Therefore, we were surprised to find beech seedlings in unmanaged stands that had no mature beech trees. It is possible that birds dispersed beech seed from a distant site with mature beeches, the nearest of which was some 2 miles (3 kilometers) from the plots.

The most conspicuous difference between the two plot types was the near absence of 0 to 5-year-old spruce seedlings on clear-cut plots (Figure 1). We determined that mechanical harvesting and subsequent changes in abiotic conditions had destroyed these seedlings (often more than 90 percent) in most plots. The majority of newly established seedlings on these sites were willow (*Salix aurita*), aspen (*Populus tremula*) and birch (*Betula pendula*), all of which are wind-dispersed species that are not components of climax spruce stands.

Our results clearly indicate that bark beetle-infested spruce forests can successfully regenerate without active restoration. Moreover, we believe that bark beetle outbreaks can help create a more natural forest structure in semi-natural forests and spruce plantations. Finally, because some resistant spruces (1-5 percent) survive outbreaks, a nonmanagement approach may lead to the creation of forest stands that are more resistant to potential bark beetle attacks in the future and, consequently, to a forest with a more diverse age structure.

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## 82

### Restoration of Closed-Canopy Forest in a Mugwort-Dominated Fill Site (New York)


*Paul Kortebein, Forester, Tim Wenskus, Senior Forester, and Marc Matsil, Chief, Natural Resources Group, City of New York Parks & Recreation,1234 5th Avenue, New York, New York 10029, 212/360-1465, (Fax) 212/360-1426, paul.kortebein@parks.nyc.gov*


Givens Creek Woods, a 12-acre abandoned fill site located in the north Bronx, exemplifies the condition of thousands of acres of "reclaimed," fresh- and saltwater wetlands in New York City that have hampered restoration efforts because of degraded soils and aggressive populations of exotic species. In the approximately 30 years since dumping last occurred at Givans Creek Woods, mugwort (*Artemisia vulgaris*)—a particularly invasive perennial that thrives in disturbed areas (Uva and others 1997)—has formed thick, rhizomatous stands. Rather than let this site remain idle, we are attempting to convert it into productive and useable park land by establishing native species and eventually creating a closed-canopy forest.

Because the Bronx Borough Commissioner restricts Parks staff from using foliar herbicides, we are limited to physical and vegetative control options. We initially mowed the mugwort with no effect on stem density or height. Since this species is difficult to control using conventional methods (Neal and Adkins 2001), but is fairly intolerant to shade (Fern 1997), our working hypothesis it that establishment of an overstory canopy will reduce mugwort populations and enable us to reintroduce more desirable native species. To establish canopy cover, we are comparing the effectiveness of bareroot and containerized native tree seedlings. Containerized species include hackberry (*Celtis occidentalis*), box elder (*Acer negundo*), eastern red cedar (*Juniperus virginianus*), and black cherry (*Prunus serotina*). Bareroot species include black walnut (*Juglens nigra*), silver maple (*Acer saccharinum*), black locust (*Robinia pseudoacacia*), and a cottonwood hybrid (*Populus* spp.). This study is a first attempt at restoring these abandoned fill sites.

In 1999, we installed a set of 16 permanent plots for each planting method. Each set of plots contained 640 trees (40 trees per plot), and within each set we tested four different treatments: 1) a myccorhizal root inoculation, using a powder formulation for the containerized seedlings and a root dip for the bareroot species; 2) a 3-inch layer of wood chip mulch around each tree; 3) a 50/50 mix of sand and peat moss to backfill each planting hole; and 4) a control, where we did nothing to alter the existing soil conditions. At the end of each growing season we measure tree height and mortality/dieback.

When we compared annual increments, or yearly growth, between soil treatments for 2001, we found no pattern of statistical significance between the control and the treatments for both the bareroot and containerized species. When we compared annual increment results between years (2000 and 2001), a general trend of significant positive growth appeared for the year, but the pattern was not uniform. For example, in most cases the control performed as well as, if not better than, the other treatments. Finally, and perhaps most importantly, survival by species remained high for both bareroot and containerized species (Table 1). Survival by treatment also remained fairly high, which supported our previous growth-by-treatment results (Table 2). The control plots performed as well as, if not better than, the other treatments. In fact, for treatments in 2001,

**Table 1. Percent survival by species**

| Year | | | | |
|---|---|---|---|---|
| **Bareroot species** | | | | |
| Year | *Juglens nigra* | *Acer saccharinum* | *Robinia pseudoacacia* | *Populus* spp. |
| 2000 | 98 | 98 | 90 | 90 |
| 2001 | 84 | 90 | 69 | 35 |
| **Containerized species** | | | | |
| Year | *Celtis occidentalis* | *Acer negundo* | *Juniperus virginianus* | *Prunus serotina* |
| 2000 | 100 | 98 | 80 | 92 |
| 2001 | 100 | 93 | 66 | 81 |

**Table 2. Percent survival by treatment**

| | | | | |
|---|---|---|---|---|
| **All containerized species** | | | | |
| Year | Control | Sand and Peat | Myccorhizae | Woodchips |
| 2000 | 93 | 90 | 89 | 98 |
| 2001 | 84 | 86 | 85 | 91 |
| **All bareroot species** | | | | |
| Year | Control | Sand and Peat | Myccorhizae | Woodchips |
| 2000 | 96 | 95 | 94 | 93 |
| 2001 | 75 | 76 | 64 | 63 |

survival of bareroot species in the control plots was significantly higher than in plots with mycchorizae and woodchips.

The high rates of survival for nearly all the species is much better than we had anticipated. On restoration sites that are less disturbed than Givans Creek Woods, we consider a survival rate of 80-85 percent after five years to be a successful. Although we are only in the second growing season of this study, we believe that the survival rates of nearly all of the species bode well for the overall success of the project. It is difficult to say why survival has remained high for most species on such a severely disturbed site, but we speculate that the elevated nutrient levels probably played a significant role in this outcome. We were surprised by the low survival and growth of the planted cottonwoods (Table 1), especially because several large cottonwood are present on the site. This may be due to the extremely patchy hydrology of the site, though we have not confirmed this.

Our preliminary data suggest that the individual soil treatments had little effect on growth of both containerized and bareroot seedlings, leading us to postulate that the growth characteristics of individual tree species determine success on this site. If this trend continues during subsequent growing seasons, it would suggest that we could significantly lower the cost-per-acre of restoration on similar fill sites around the city by eliminating the need to use expensive soil amendments

At present, the planted trees do not provide sufficient cover to affect mugwort growth. Assuming current rates of growth and survival, we are estimating that within six to eight years we will begin to see significant control of the mugwort in the project area. We may be able to shorten this timeframe by planting shrub species, which may provide greater shade in a shorter period of time. Future attempts will include densely planting a variety of shrub species in an effort to create an "instant canopy," however we have yet to experiment with this method.

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## 83

**Inca Agroforestry: Lessons from the Past.** 2000. Chepstow-Lusty, A., Cory Laboratory, University Botanic Garden, Dept. of Plant Sciences, 47 Bateman Street, Cambridge CB2 1JF, England, ajc14@cus.cam.ac.uk; and M. Winfield. **Ambio** 29(6):322-328.

Historical evidence suggests that the Inca practiced land management and carried out some planting in order to restore deforested and unproductive land. Native trees, such as aliso (*Alnus acuminata*) and molle (*Schinus molle*), seem to have been important. After the arrival of the Spanish in the 1530s, the forests became overexploited. Today, Peru is again facing large-scale environmental problems. The widespread planting of the non-native *Eucalyptus*, for example, is at the cost of native trees. The authors suggest that information on the historical diversity of native species can be used to support the policymakers and nongovernment organizations who are promoting the use of native species in management and reforestation programs.

## 84

**Seed Dispersal of the Chinese Tallow Tree (Sapium sebiferum (L.) *Roxb.*) by Birds in Coastal South Carolina.** 2000. Renne, I.J. and S.A. Gauthereaux, Jr., Dept. of Biological Sciences, Clemson University, Clemson, SC 29442. **American Midland Naturalist** 144(1):202-215.

The authors studied seed dispersal of the non-native Chinese tallow tree by birds in coastal South Carolina during the 1995-96 fruiting season. Certain birds, including the northern flicker (*Colaptes auratus*) and American robin (*Turdus migratorius*), were heavy consumers of tallow tree seeds, while other birds, such as the red-winged blackbird (*Agelaius phoeniceus*) and boat-tailed grackle (*Quiscalus major*), were effective seed dispersers. Results indicate that birds may prefer the high-lipid and high-protein seeds of the tallow tree to native plants, meaning that the tallow tree competes for dispersal agents with native plants. The authors warn that given the heavy consumption and high dispersal rate by birds, tallow trees will likely become more problematic in the coastal forests and surrounding areas of South Carolina.

## 85

**Effect of Garlic Mustard {Alliaria petiolata (Beib. Cavara & Grande)} Extracts on Plants and Arbuscular Mycorrhizal (AM) Fungi.** 2001. Roberts, K.J., Dept. of Biology and Horticulture, Prince George's Community College, 301 Largo Rd., Largo, MD 20774-2199, 301/386-7539, Fax: 301/386-7529, robertkj@mail.pg.cc.md.us; and R.C. Anderson. **American Midland Naturalist** 146(1):146-152.

Roberts and Anderson studied the effects of garlic mustard leachates on arbuscular mycorrhizal fungi under laboratory and field conditions. Their results indicate that garlic mustard may reduce the competitive ability of native plants by impeding root growth and the formation of mycorrhizal associations with plants.

## 86

**Restoring Forest Cover on Degraded Land: Three-Dimensional Plantations.** 2001. Soni, V., National Physical Laboratory, K.S. Krishnan Marg, New Delhi 110016 India, vsoni@de13.vsnl.net.in. **Ambio** 30(3):167.

Soni outlines a new method of reclaiming forest land that has become degraded to barren scrub. In the traditional method, plantations are laid out on two-dimensional grids, creating homogenous croppings. However, the author points out that this is not necessarily the best approach for forest reclamation. In his proposed "three-dimensional plantations," shallow digging or quarrying of the underground rock creates crags and cracks in which seeds of surrounding tree species become trapped and eventually germinate, leading to natural regeneration. This method is particularly appropriate in semi-arid climates where the land includes rock deposits of quartzite, sandstone, or limestone. Soli notes that forest regeneration has occurred naturally under these conditions in the Arravalli hills around Delhi. Landscapes regenerated in this manner will still require protection from cattle.

## 87

**Locating Seed Sources for Scottish Native Trees.** 2001. Wilson, S.M. **Reforesting Scotland** 26:43-44.

This article discusses the Scottish Forestry Trust's creation of a database that lists natural tree populations in Scotland as potential sources of native seed. The author identified more than 800 tree populations that included at least 40 populations for each species targeted and at least 30 unrelated individuals to ensure internal genetic variation. People who access the database can also examine site photographs for many of the populations and generate distribution maps in order to query the database via a Geographical Information System (GIS). A copy of the full report, *Locations of Populations of Scottish Native Trees*, is available through the Scottish Forestry Trust, 5 Dublin Street Lane South, Edinburgh EH1 3PX (Tel: 0131-478-7044). The Trust will make the database, which contains information not included in the published report, available to three Scottish research organizations: Forest Research, Scottish Natural Heritage, and the Royal Botanic Garden, Edinburgh.

# WETLANDS

## 88

**Muddy Water: Letting the Gulf of Mexico Breathe Again.** 2001. Anon. **ScienceDaily,** www.sciencedaily.com/releases/2001/06/010619072410.htm.

Environmental researchers led by William Mitsch of Ohio State University have recommended creating or restoring up to 13 million acres (5 million ha) of wetlands and 48 million acres (19 million ha) of streamside forest in midwestern United States in order to save the Gulf of Mexico. This amounts to almost 25 times the number of wetlands that have already been created or restored in that region. Mitsch states that such efforts are required to cause the needed drop in nitrogen levels in the Gulf of Mexico. The findings appeared in the May 2001 issue of *BioScience*. The original news release is at www.osu.edu/researchnews/archive/moreacre.htm.

## 89

**The Process of Selecting a Wetland Assessment Procedure: Steps and Considerations.** 2000. Bartoldus, C.C., P.O. Box P, St. Michaels, MD 21663, 410/745-9620, Fax: 410/745-3517. **Wetland Journal** 12(4):4-40.

Bartoldus presents a series of ten steps for selecting an appropriate wetland function assessment procedure. The steps include: 1) define the specific goals of the assessment; 2) select the preferred procedure approach(es); 3) select the applicable geographic area; 4) select applicable general habitat types; 5) considering the available resources, define the desired level of detail and sensitivity and select the maximum allotted time for the assessment; 6) determine if the measure of function should include the size of the habitat; 7) identify the desired function categories; 8) determine whether the functions should have separate measures or be combined into one measure; 9) determine any need to compare different habitat types or habitats from different regions; and 10) determine if the procedure is suitable to meet the assessment's specific goals. Tables summarizing aspects of the 39 standard wetland assessment procedures that are currently available in the United States guide the reader through each step. This information is also available at www.wes.army.mil/el/emrrp/emrishelp6/selection_of_wetland_assessment_methods_tools.htm.

## 90

**Zooplankton Communities of Restored Depressional Wetlands in Wisconsin, USA.** 2001. Dodson, S.I., Zoology Dept., Birge Hall, University of Wisconsin-Madison, 430 Lincoln Dr., Madison, WI 53706-1381; and R.A. Lillie. **Wetlands** 21(2):292-300.

The authors examined the makeup of zooplankton communities in 56 wetlands across Wisconsin, representing three categories: 1) agricultural, 2) least-impacted, and 3) restored (from agricultural use). Agricultural sites showed significantly lower taxon richness compared with the other sites. Species richness increased in restored sites with time, resembling the least-impacted sites within six to seven years.

## 91

**Corporate Partners Aid Wetland Restoration.** 2001. Foote-Smith, C., Massachusetts Wetlands Restoration Program, Massachusetts Executive Office of Environmental Affairs, Boston, MA. **National Wetlands Newsletter** 23(3):5-7.

Foote-Smith discusses the history and present status of Corporate Wetlands Restoration Partnership, an association of businesses, governments, and non-profit agencies whose goal is to restore wetlands throughout the United States. The national program is based on a partnership begun in Massachusetts in 1998, involving the Massachusetts Executive Office of Environmental Affairs, the U.S. Environmental Protection Agency, and the Gillette Company, whereby a combination of corporate and non-corporate contributions fund agreed-upon restoration projects. Other states, including Connecticut and Maine, launched similar partnerships. The national program, in cooperation with Coastal America—a collaboration between private organizations and federal, state, and local agencies—began in May 2000 and has a goal of raising $1 million for restoration in each state. Other countries are considering the Corporate Wetlands Restoration Partnership model. More information can be found at www.coastalamerica.gov.

## 92

**Is Purple Loosestrife (*Lythrum salicaria*) an Invasive Threat to Freshwater Wetlands? Conflicting Evidence from Several Ecological Metrics.** 2001. Farnsworth, E.J., New England Wild Flower Society, 180 Hemenway Rd., Framingham, MA 01701, efarnswo@mtholyoke.edu; and D.R. Ellis. **Wetlands** 21(2):199-209.

Noting that inconsistent measures in previous studies have led to conflicting interpretations regarding the impact of purple loosestrife on native species in freshwater wetlands, Farnsworth and Ellis used a variety of methods at five wetlands in Connecticut to determine how to best measure the plant's effect. Different ecological measures showed varying correlations between purple loosestrife and other species, but purple loosestrife clearly had a negative impact on the total biomass of surrounding plant species. When only one-time studies are feasible, the authors suggest that researchers use a range of parameters to measure the effect of invasive plants. In particular, they propose that standing biomass is a reliable indicator of purple loosestrife's potential to outcompete other plant species.

## 93

**Colonization of Restored Wetlands by Amphibians in Minnesota.** 2001. Lehtinen, R.M., University of Michigan, Museum of Zoology, Division of Reptiles and Amphibians, Ann Arbor, MI 48109-1079, rmlehtin@umich.edu; and S.M. Galatowitsch. **American Midland Naturalist** 145(2):388-396.

This study assessed amphibian colonization at seven recently restored and five reference wetlands in central and southern Minnesota during the 1998 breeding season. Results indicate that the restored wetlands provide suitable habitat for at least some amphibians in the region. Eight species rapidly colonized and established breeding populations at the restored wetlands, whereas the reference wetlands contained 12 species, including four not found in the restored wetlands. Size, spatial isolation, and habitat suitability were important predictors of species richness in the restored wetlands. The two restored wetlands in urban areas had the lowest species richness.

## 94

**Influence of a Willow Canopy on Tree Seedling Establishment for Wetland Restoration.** 2001. McLeod, K.W., Savannah River Ecology Laboratory, University of Georgia, P.O. Drawer E, Aiken, SC 29802; M.R. Reed and E.A. Nelson. **Wetlands** 21(3):395-402.

In a three-year study, the authors examined the response of seedlings of four tree species—overcup oak (*Quercus lyrata*), baldcypress (*Taxodium distichum*), water hickory (*Carya aquatica*), and laurel oak (*Q. laurifolia*)—to a black willow (*Salix nigra*) canopy. Laurel oak was killed during the first growing season by flooding. Although the height of baldcypress seedlings under the willow canopy was less than for seedlings planted where the willow had been removed, overcup oak, baldcypress, and water hickory survival was not affected by the existing willow stand. The authors conclude that willow removal is unnecessary for successful outplanting.

## 95

**Soil Development in Phosphate-Mined Created Wetlands of Florida,** USA. 2001. Nair, V.D., D.A. Graetz, K.R. Reddy and O.G. Olila, Soil and Water Science Dept., 106 Newell Hall, University of Florida, P.O. Box 110510, Gainesville, FL 32611-0510, vdna@mail.ifas.ufl.edu. **Wetlands** 21(2):232-239.

The authors compared soil from numerous created wetlands in phosphate-mined areas with soil from native wetlands in central and north Florida. They measured a number of parameters, including soil compaction, bulk density, carbon and nitrogen content, carbon-nitrogen ratio, and nutrient contents, and conclude that created wetlands are slowly gaining the characteristics of the natural wetlands. They suggest that minimizing soil compaction, incorporating organic matter, and fertilization could increase the rate of change.

## 96

**Marsh Terracing as a Wetland Restoration Tool for Creating Fishery Habitat.** 2001. Rozas, L.P. and T.J. Minello, NOAA/National Marine Fisheries Service, Southeast Fisheries Science Center, 4700 Avenue U, Galveston, TX 77551-5997, Lawrence.Rozas@noaa.gov. **Wetlands** 21(3):327-341.

Rozas and Minello evaluated the habitat value of marsh terracing (in which existing bottom sediments are used to form terraces or ridges at marsh elevation) for fishery species at Sabine National Wildlife Refuge in Louisiana. Densities of many nakton species, including white shrimp (*Litopenaeus setiferus*), brown shrimp (*Farfantepenaeus aztecus*), and blue crab (*Callinectes sapidus*), were significantly higher in the terrace marsh than in the reference pond's nonvegetated mud bottom. However, the terrace marsh was not functionally equivalent to the nearby natural marsh based on densities and biomass of certain crustaceans and fish. The authors conclude that terrace fields support higher densities of most fishery species than do similarly sized, shallow marsh ponds. They suggest that increasing the proportion of marsh in terrace fields in future restoration projects could enhance their habitat value for these species.

## 97

**Growth of Southern Cattail (*Typha domingensis* Pers.) Seedlings in Response to Fire-Related Soil Transformations in the Northern Florida Everglades.** 2001. Smith, S.M. and S. Newman, Watershed Management Division, Everglades Dept., South Florida Water Management District, 3301 Gun Club Rd., West Palm Peach, FL 33406. Wetlands 21(3):363- 369.

Analysis of southern cattail seedlings planted in soil in the Florida Everglades shows that seedlings in muck-burned soil plots developed larger rhizomes, thicker hairless roots, and proportionally more aboveground biomass than seedlings in soil burned or not-burned plots. Seedlings in muck-burned soil also contained significantly more phosphorus. The authors conclude that muck fires, which occur frequently in overdrained regions of the Everglades, provide a competitive advantage for southern cattail by creating an opening in the landscape and increasing the availability of soil phosphorus.

## 98

**Dynamics of Mixtures of Typha latifolia and Schoenoplectus tabernaemontani in Nutrient-Enrichment Wetland Experiments.** 2001. Svengsouk, L. and W.J. Mitsch, Olentangy River Wetland Research Park, School of Natural Resources, The Ohio State University, 2021 Coffey Rd., Columbus, OH 43210, Fax: 614/292-9773, mitsch.1@osu.edu. **American Midland Naturalist** 145(2):309-324.

The authors compared the responses of broadleaf cattail (*Typha latifolia*) and softstem bulrush (*Schoenoplectus tabernaemontani*) to the addition of nitrogen and phosphorus. Cattail experienced increased growth due to additional nutrients, although the presence of the sedge and the termination of nutrients reduced or halted its growth. Although efforts are currently underway to control the spread of cattail in the Florida Everglades by controlling phosphorus, the results of this study indicate that nitrogen should also be controlled for better effectiveness.

## 99

**Restoration of Wetland Vegetation on the Kissimmee River Floodplain: Potential Role of Seed Banks.** 2001. Wetzel, P.R., Dept. of Biological Sciences, East Tennessee State University, Johnson City, TN 37614, wetzelpr@etsu.edu; A.G. van der Valk and L.A. Toth. **Wetlands** 21(2):189-198.

As part of an effort to restore the drained Kissimmee River floodplain in Florida, the authors analyzed the seedbanks of drained areas that are currently pasture and existing stands of the floodplain's historical three major plant communities—wet prairie, broadleaf marsh, and wetland shrub. They found the seedbanks of the former wet prairie sites and existing wet prairie sites each contained about 50 percent of the seeds characteristic of the community type. However, former and existing broadleaf marsh and wetland shrub sites contained few seeds of plants characteristic of those communities. The authors conclude that seedbanks will likely play a major role only for the natural reestablishment of the wet prairie plants, while reestablishment of wetland shrub and broadleaf marsh communities will depend on seed dispersal from off-site sources.

## 100

### Restoring a Complex of Backwater Lakes, Wetlands, and Prairie on the Illinois River

*Gary Sullivan, The Wetlands Initiative, 53 West Jackson Boulevard, Chicago, IL 60604, 312/922-0777, Fax: 312/922-1823, gsullivan@wetlands-initiative.org*

The Illinois River once supported an extensive system of highly productive and diverse backwater lakes nested within a complex mosaic of riparian forests, fens, bogs, marshes, and prairie. After 150 years of agricultural development and hydrologic modification, the few remaining lakes are highly degraded and most are functionally equivalent to aquatic deserts (Havera and Bellrose 1985). Among these are Hennepin Lake and Hopper Lake, two adjoining basins that were drained after construction of a levee in 1912 to form the 2,600-acre (1,050-ha) Hennepin Drainage and Levee District in Putnam County, Illinois. The Wetlands Initiative is in the process of restoring the diversity of communities, habitats, and functions that this ecosystem complex once provided. This project not only offers us a unique opportunity to restore a system that no longer exists at virtually any scale in this region, it also allows us to investigate how these systems develop, what functions can be restored, and how best to conduct similar restoration projects in the future.

Our primary restoration goal is to reestablish biodiversity across a range of habitats. We began surveying the site in 2000 in order to prepare comprehensive maps of soil type, elevational contours, hydrologic sources and drainages, remnant plant communities, and current plant and animal distributions. We then used these factors to design a projected landscape of plant communities (Figure 1).

In April 2001, we began restoring the hydrology to presettlement conditions. Levee pumps were turned off so that springs, seeps, and rainfall could naturally fill the former lake beds. Removal or disabling of drain tiles enabled groundwater to recharge channels and fill depressions. The lake had filled by February 2002, covering approximately 1,300 acres (525 ha). The levee remains in place because damming, dredging, and agricultural runoff have so drastically altered water levels on the Illinois River. Since there is no longer a lake outlet, the lake is lowered in early summer, simulating seasonal drawdowns that previously occurred after the river fell below the outlet and evapotranspiration dominated the hydrologic balance. Our lake management strategy calls for deeper drawdowns in drier years to simulate natural hydrologic dynamics, facilitate seedling establishment, and promote greater diversity.

Prior to restoring the upland habitats, we are applying herbicides in order to reduce the native and exotic weeds that would compete with our plantings. By spring 2001, a number of weeds had already colonized the former agricultural fields. During summer 2001, we used backpack sprayers to apply Roundup® Prodry mixed at one packet (1.5 oz) per gallon of water to patches of Canada thistle (*Cirsium arvense*), common reed grass (*Phragmites australis*), and reed canarygrass (*Phalaris arundinacea*). In August, we hired a local farmer to mow these areas to inhibit reproduction of larger annuals. In November, we contracted with a local agricultural service to spray all unflooded areas with a combination of 3 quarts of Roundup® and one quart of 2, 4-D per acre in order to kill germinating winter annuals and perennials. Between May and September 2002, we will attempt

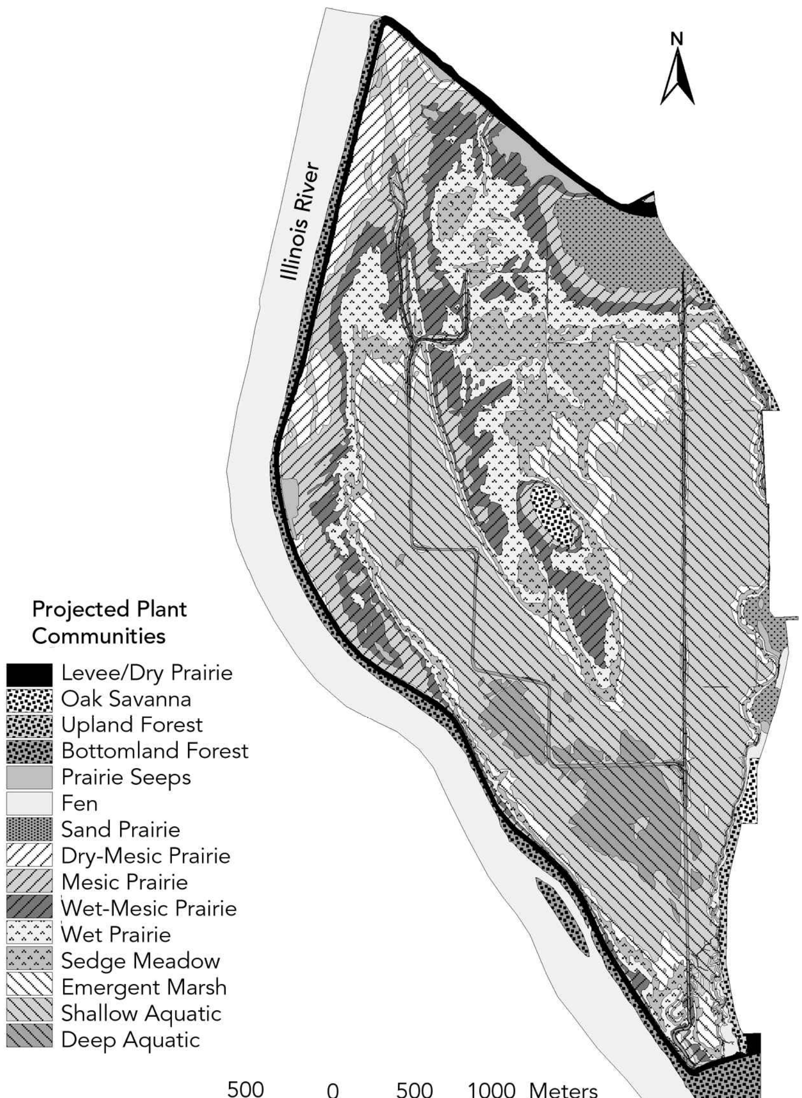


**Figure 1. Model of plant communities for the Hennepin and Hopper Lakes restoration project.**

to eliminate most of the remaining seed bank by applying Roundup® and 2, 4-D at up to twice the previous concentration every six to eight weeks to newly sprouted weeds once they grow 6-8 inches (15-20 cm) tall.

Due to funding restrictions, we will frost-seed a 1:1 ratio of forb and grass seeds in a single planting in November 2002 at a rate of approximately 3.5 pounds/acre (3.9 kg/ha). This will allow successive freezing and thawing cycles to work the seed into the soil. Before seeding, we will burn thatch in areas that have sufficient fuel. We will then use a 60-ft boom air-flow spreader to disperse the seed mixed with powdered mycorrhizae at 0.25 pounds/acre (0.28 kg/ha) and a potash carrier at 150 pounds/acre (168 kg/ha).

We will delay introducing some native species until 2003, especially those that are extremely aggressive and those that germinate better under the soil temperature and light conditions found in later successional communities. Besides seeding, we will plant plugs during summer 2002 in order to increase plant diversity in the marsh and lake. In spring 2003, we will also plant several nursery-grown prairie species that are difficult to establish from seed. Once the sites are planted, we will adaptively manage the site using techniques such as mowing, seasonal burning, and spot herbicide treatments to promote development of the wetland and prairie communities.

Because applied and basic research are among our primary goals, we are establishing study plots at different spatial scales and levels of diversity within each habitat type. We are investigating how restored communities develop with: 1) different levels of species and functional group diversity, 2) the addition of mycorrhizae, and 3) different mowing and burning regimes. We are especially interested in the development of plant community productivity, animal habitat quality, wetland and prairie soil characteristics, nitrogen storage capacity, and resistance to exotic invasion. Ultimately, we will apply the lessons that we learn from this project to similar and larger restorations within this region.

## Reference

Havera, S.P. and F.C. Bellrose. 1985. The Illinois River: A lesson to be learned. *Wetlands* 4:29- 41.

### 101

**Georgia Jumps on the Rosgen Restoration Bandwagon.** 2001. Anon. **Nonpoint Source News-Notes** 65:18-20.

In 1996 the Upper Chattahoocee Riverkeeper, a non-profit organization in Georgia, received funding from the Environmental Protection Agency to restore an eroded area of the Soque River in northeastern Georgia, one of the Chattahoocee's headwater streams. After locating a private landowner willing to volunteer his portion of the stream, Riverkeeper restored the stream bank using David Rosgen's stream restoration principles, which are based on applied geomorphology—examining the existing landscape to determine the proper channel geometry. The project generated much interest among local landowners and created numerous educational opportunities. Its success also prompted a number of other local restoration projects. More information can be found at the Riverkeeper's web site, www.ucriverkeeper.org.

### 102

**Empirically Derived Survival Rates of a Native Mussel, *Amblema plicata*, in the Mississippi and Otter Tail Rivers,** Minnesota. 2001. Hart, R.A., Minnesota Department of Natural Resources, Division of Ecological Services, Brainerd, MN 56401; J.W. Grier, A.C. Miller and M. Davis. **American Midland Naturalist** 146(2):254-263.

Using a mark-recapture method, the authors directly measured the annual survival of the native threeridge mussel (*Amblema plicata*) in areas of low, moderate, and high infestation of zebra mussels (*Dreissena polymorpha*) in the Otter Tail and Mississippi Rivers in Minnesota. The native mussels had a high survival rate in natural habitats not colonized by the zebra mussel. Survival rates declined significantly as the density of the zebra mussels increased. The authors recommend that management practices aimed at diminishing the effects of the zebra mussel should include translocating threeridge into suitable habitats with low risk of zebra mussel invasion.

# COASTAL COMMUNITIES

### 103

**Virginia Revives Its Heritage Through Oysters.** 2001. Anon. **Coastal Services** 4(6):2-3.

The Virginia Oyster Heritage Program, a large-scale oyster restoration program begun in 1999 and led by Virginia's coastal resource managers, seems to be working. They have constructed nine 1-acre (.4-ha) reefs and planted adjacent to the reefs 25-acre (10-ha) beds of flat shells, where harvesting will be allowed. Volunteers from the Chesapeake Bay Foundation are growing and planting seed oysters on the reefs. The biggest hurdle has been getting enough shells. The state of Virginia is dredging shell from its rivers and exploring other alternatives, including broken concrete, other types of shells, and porcelain. Monitoring indicates that young oysters colonized the seaside reefs but that reefs in the mouth of the Rappahannock River were less successful. It is not yet clear whether the reefs are improving water quality. More information can be found at www.deq.state.va.us/oysters/.

### 104

**Toward Ecosystem-Based Recovery of Marine Biomass Yield.** 2001. Sherman, K., USDOC/NOAA/NMFS/Northeast, Fisheries Science Center, Narragansett Laboratory, 28 Tarzwell Dr., Narragansett, RI 02882, Kenneth.Sherman@noaa.gov; and A.M. Duda. **Ambio** 30(3):168-169.

The authors discuss the state of the world's 50 large marine ecosystems (LMEs), which provide 95 percent of the world's annual catch of marine biomass. They point out that significant declines in the yields of 33 of these LMEs demonstrate that countries need to take an ecosystem-based approach to recovering and sustaining long-term yields of fisheries while also conserving biodiversity. Principal factors behind the declines include 1) overfishing, 2) climate regime shifts, and 3) pollution and eutrophication. In partnership with other agencies, the Global Environment Facility, a multinational organization based in Washington, D.C., is assisting 52 countries in LME pilot projects. While each project is tailored to its particular situation, the overall goal is to facilitate work between countries and to link freshwater system with marine ecosystem management. For example, five governments in Africa are working to manage and protect the Benguela Current LME.

## OTHER COMMUNITIES

### 105

### Can Rotational Grazing Restore Degraded Oak Savannas? (Wisconsin)

*John A. Harrington, Department of Landscape Architecture, College of Agricultural and Life Sciences, 25 Agriculture Hall, University of Wisconsin-Madison, Madison, WI 53706, 608/263-4587, Fax: 608/265-6262, jaharrin@facstaff.wisc.edu*

It is estimated that several hundred thousand acres of degraded oak savanna exist in southern and central Wisconsin, with the vast majority located on private land (Henderson 1995). For many private landowners, prescribed burning—the management tool most commonly used to restore savanna ecosystems—is not always feasible or desirable. Therefore, in collaboration with private landowners, researchers affiliated with the University of Wisconsin System and the Wisconsin Department of Natural Resources* recently launched a multiyear project to investigate the use of rotational grazing as a method for removing aggressive shrubs and saplings in oak savannas. We believe that grazing may be a more acceptable approach to landowners because 1) it does not have the same liability and safety issues as fire, and 2) it has the potential to provide additional pasture for landowners raising certain breeds of cattle. However, we do not approach grazing management as a substitute for fire, but as an additional tool that may benefit cattle producers.

In theory, rotational grazing—or regularly moving livestock among a series of small paddocks for relatively short periods of time—enables regrowth of vegetation during ungrazed intervals. Whether restorationists can use rotational grazing as a management tool without causing loss of vegetative cover, erosion, and other problems associated with continual grazing (Fleischner 1994) has not been carefully studied in the eastern tallgrass prairie/savanna complex. One question we will explore is whether certain densities of cattle or seasonal grazing times more effectively remove brush and are less damaging to the ground layer.

In 2001, we implemented a rotational grazing experiment on three degraded savannas in southern Wisconsin—one on public land and the other two on private properties. We are using Scottish Highland cattle, a breed that readily browses on prickly ash (*Zanthoxylum americanum*), box elder (*Acer negundo*), hazelnut (*Corylus americana*), and other woody species that typically invade oak savannas. Moreover, the lean meat and hardiness of this particular breed is of interest to organic and hobby farmers.

At the Yellowstone Lake Wildlife Area in Lafayette County, we divided hill slopes of overgrown savanna into five sets of four 1-acre (0.4-ha) paddocks. We randomly assigned three treatments (spring fire, grazing, and spring fire plus grazing) and one control to each paddock within each set. Cattle spend two days in each paddock of one set, followed by one day on adjacent pasture, and then are moved to the next set of paddocks. The cycle is repeated once the livestock have rotated through all the sets, resulting in four rotational cycles and eight total grazing days per applicable paddock.

We divided each of the two privately owned savannas (located in Lafayette and Iowa Counties) into five sets of three 1-acre paddocks. We established one paddock in each set as a control, and randomly assigned light and moderate grazing periods to the remaining paddocks. At one site, these consist of one- and three-day grazing periods; at the other, two- and four-day periods (differences in grazing periods are related to site productivity).

In 2000, we began sampling all sites for the presence of herbaceous and woody species, tree basal area, shrub cover, shrub and sapling height, density and—for select shrub species—biomass. In addition, we collected data on aboveground herbaceous biomass, plant nutrients, litter depth, percent canopy or sky blockage, soil compaction, levels of pH, organic matter and fertility, insects dwelling in woody debris, and mammal populations. We monitor cattle for dietary intake by examining cattle forage in the field, taking tissue samples of browse, and assessing the physical condition of individual cattle.

By summer of 2003, we expect to have preliminary answers to such questions as: Can grazing significantly reduce shrub and sapling growth within degraded savannas? If so, what combination of grazing and controlled burning works best? How do grazing and burning alter herbaceous composition, fertility, soil compaction

**A Scottish Highland cow, grazes in an overgrown oak savanna on Mary and Peter Rathbun's farm in Hollandale, Wisconsin.** *Photo by Peter Rathbun*

*Participants in this research include: Peter and Mary Rathbun and Ron and Sally Niemann (landowners); John Harrington, Josh Posner, Martha Rosemeyer, Janet Hedtcke, Emily Kathol, and Devin Biggs (University of Wisconsin-Madison); Tom Hunt and Marlene Sorenson (UW- Platteville); Peggy Compton (UW-Extension); and Bruce Folley and Jackie Curry (Wisconsin DNR) and erosion, and how do they affect insects and small mammals? How do grazing and burning of degraded oak savanna affect forage production and quality? Will livestock maintain or increase body mass relative to cattle maintained solely on pasture? After only two years of rotational grazing, we don't expect that the cattle will have opened enough canopy to facilitate the regeneration of many of the native species that were once common to this landscape. Therefore, we eventually may need to include thinning and seeding, along with a rotational grazing regime.

## Acknowledgment

This research is funded by the Partnership for Wildlife Program (Wisconsin Department of Natural Resources), University of Wisconsin Consortium Grant Program, and the Multi-Agency Land and Water Education Grant Program/Environmental Quality Incentives Program (USDA/NRCS)

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Henderson, Richard. 1995. Oak savanna communities. Pages 88-96 in Wisconsin Biodiversity as a Management Issue: A Report to Department of Natural Resource Managers. Wisconsin Department of Natural Resources, Madison, WI.

## 106

**Pine/Little Bluestem Savanna Restoration.** 2001. Anon. **Native Warm-Season Grass Newsletter** 20(2).

The Missouri Department of Conservation's (MDC) Wildlife, Forestry, and Protection Divisions conducted a 700-acre (280-ha) prescribed burn on MDC's Peck Ranch in the Ozarks as part of an ongoing effort to restore a shortleaf pine (*Pinus echinata*)-little bluestem (*Andropogon scoparius*) plant community. As a first step, the MDC removed declining stands of black (*Quercus velutina*) and scarlet oak (*Q. coccinea*), which provides increased sunlight, less leaf litter, and warmer soil for the little bluestem and other native grasses and forbs. Eventually, a high-canopy shortleaf pine and herbaceous plant community is expected to develop. The U.S. Forest Service will provide an additional 200 acres (80 ha) to the savanna.

## 107

**Competition between Alien Annual Grasses and Native Annual Plants in the Mojave Desert.** 2000. Brooks, M.L., U.S. Geological Survey, Western Ecological Research Center, Box Springs Field Station, 6221 Box Springs Blvd., Riverside, CA 92507, 559/561-6511, matt_brooks@usgv.gov. **American Midland Naturalist** 144(1):92-108.

Results of a two-year study at three sites in the Mojave Desert indicate that two widespread non-native annual grasses—red brome (*Bromus madritensis* ssp. *rubens*) and Mediterranean grass (*Schismus* spp.)—compete with native annual plants. During the year of high annual plant productivity, thinning the non-native grasses increased density and biomass of native annuals at all three sites. The common native forb fiddle-neck (*Amsinckia tesselata*) showed the greatest increase. The density and biomass of the non-native filaree (*Erodium cicutarium*) also increased with thinning of red brome and Mediterranean grass. Because this study only evaluated the net effects of competition, further study is needed to determine its mechanisms.

## 108

**Determining Landscape Function and Ecosystem Dynamics: Contribution to Ecological Restoration in the Southern Namib Desert.** 2001. Burke, A., EnviroScience, P.O. Box 90230, Klein Windhoek, Namibia, enviroscience@iafrica.com.na. **Ambio** 30(1):29-36.

Burke summarizes the current state of ecological knowledge of the southern Namib Desert in southern Africa and proposes research priorities for ecological restoration. Knowledge of the area's ecosystems is minimal at present due in part to security restrictions imposed by the mining industry. Burke proposes a twofold approach for a long-term restoration ecology research program: 1) academic research that focuses on understanding processes on different scales to develop restoration methods suitable for the southern Namib ecosystems; and 2) development of practical methods that focus on facilitating various processes, including natural succession, restoration of biologically active substrate, and concentration of limited resources, such as water and soil nutrients.

## 109

**Productivity and Species Richness across an Environmental Gradient in a Fire-Dependent Ecosystem.** 2001. Kirkman, L.K., Joseph W. Jones Ecological Research Center, Ichauway, Route 2, P.O. Box 2324, Newton, GA 31770, kkirkman@jonesctr.org; R.J. Mitchell, R.C. Helton and M.B. Drew. **American Journal of Botany** 88(11):2119-2128

The authors examined the community structure and plant diversity of a longleaf pine (*Pinus palustris*)-wiregrass (*Aristida beyrichiana*) savanna in the southeastern United States. Wet-mesic sites had the most aboveground cover biomass and the highest diversity. Wiregrass was dominant across site types, independent of species richness. Site types throughout the savanna were characterized by many perennial species that occurred infrequently. The authors conclude that numerous species can coexist because the high rate of fire removes competing hardwood vegetation and litter and because certain fire-adapted perennial species can persist once established. They suggest that longleaf pine-wiregrass savanna conservation and restoration focus on preserving a range of site types in the landscape in order to maximize local diversity.

# CONTROL OF PEST SPECIES

## 110

### Herbicide, Mechanical Treatments, and Constant Monitoring Reduce Japanese Knotweed in Fairmount Park (Pennsylvania)

*Joe Berg, Senior Ecologist, Biohabitats, Inc., 15 West Aylesbury Road, Timonium, MD 21093, 410/337-3659, Fax: 410/583-5678, joe@biohabitat.com; Tom Witmer, Restoration Manager; and Mark Focht, Program Administrator, Fairmount Park Commission, Natural Lands Restoration and Environmental Education Program, Memorial Hall/West Park, P.O. Box 21601, Philadelphia, PA 19131-0901*

Japanese knotweed (*Polygonum cuspidatum*) is one of the more problematic species in Philadelphia's Fairmount Park system, an approximately 8,900-acre (3,560-ha) network of neighborhood and regional stream valley parks (*ER* 17(1&2):8-14). Frequent flooding of streams in the park creates unshaded areas of rich mineral soil that favor the establishment of Japanese knotweed propagules. Once established, these plants spread rapidly through rhizomes, forming large, monotypic clones along the stream banks. These clones often extend into the forested floodplains where they displace native shrubs, tree seedlings, and herbs.

As part of the overall strategy of Fairmount Park Commission's Natural Lands Restoration and Environmental Education Program (NLREEP), we evaluated the literature on knotweed control and developed a comprehensive management strategy that includes: 1) a foliar application of 2 to 4 percent glyphosate solution after flowering, 2) repeated mowing and/or physical removal of root crown and rhizome, 3) a relatively high-density planting of 1,200 to 2,000 native trees and shrubs per acre (3,000-5,000/ha), and 4) long-term monitoring and spot treatments to kill or remove any existing knotweed.

When applying glyphosate, we have found that it is best to remove any old plant material before the initial herbicide application in early spring. This is accomplished either by mulch-mowing or by collecting and transporting the cut plants to a landfill or other safe site. By doing so, we ensure that the new season's growth receives a thorough wetting and the maximum amount of the herbicide's active ingredient. We then thoroughly wet all Japanese knotweed stems that are present in the treatment area. Two weeks following the initial application, we monitor the treated areas and treat the plants that we inadvertently missed. Following the initial application, we allow the knotweed to regenerate before making a second herbicide application in the late spring or early summer. We then apply a third glyphosate application in the early fall and remove any above-ground knotweed prior to establishing a native plant community. We have found that the cost of herbicide application is inexpensive, about $7.00 per 1,000 ft$^2$.

Mechanical treatments, along with or in place of the herbicide application, have been especially effective in mixed plant communities or in areas where only a few knotweed plants have become established. Physical control includes repeated cutting of above ground stems during the growing season, excavation of the root crown (which contains much of the plant's stored energy reserve), and removal of rhizomes. We have found that simply removing below-ground plant material is not a successful strategy, since it takes very little root material to generate a new knotweed colony. Therefore, we apply herbicide to regrowth or continue to cut above-ground growth until the remaining root reserves have been exhausted. Both Fairmount Park staff and volunteers coordinated by Park staff have participated in the mechanical removal of Japanese knotweed.

The oldest NLREEP knotweed control project in the Fairmont Park system was implemented in 1999 on an approximately 1,500-ft (492-m) stream bank in Tacony Creek Park that had a nearly 100-percent cover of knotweed. A combination of glyphosate application, installation of a black fabric weed barrier, followed by diligent physical removal efforts have resulted in a nearly knotweed-free area. In spring 2001, we planted the stream bank with a diverse native plant community. To prevent the establishment of new knotweed colonies, we covered a portion of the bank with a coir fabric that traps knotweed seeds as they are deposited on the site by floodwaters.

Since our initial control effort, staff of the NLREEP have treated approximately 163 acres of knotweed-infested park lands. We remain concerned, however, about the long-term effectiveness of our efforts and realize that if the environmental conditions that support the growth and spread of Japanese knotweed do not change, our strategy may not be effective or may become cost prohibitive over time.

The NLREEP is funding a study by the Philadelphia Academy of Natural Sciences to investigate an adaptive management approach for controlling Japanese knotweed. The results from this study should be released in late spring to early summer of 2002 (Bram personal communication). The conclusions of this study will be considered in combination with field observations of treated areas to refine Fairmount Park's approach to Japanese knotweed control.

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## 111

### Controlling Russian Olives within Cottonwood Gallery Forests along the Middle Rio Grande Floodplain (New Mexico)

*Todd Caplan, Restoration Division Manager, Pueblo of Santa Ana Department of Natural Resources, 221 Ranchitos Road, Santa Ana Pueblo, New Mexico 87004, 505/867-0615, Fax: 505/867-0833, tcaplan@santaana.org*

The diverse riparian and wetland plant communities of the Rio Grande floodplain have virtually disappeared following a century of flood control and channelization that drastically changed the river's natural hydrologic regimes (Crawford and others 1993). Today, remnant gallery forests of Fremont cottonwood (*Populus deltoides* v. *wislizeni*) are all that remain, and even these are being replaced by non-native Russian olives (*Eleagnus angustifolia*) and saltcedar (*Tamarisk* spp). In 1998, the Pueblo of Santa Ana of central New Mexico developed a comprehensive program that includes the removal of these two exotic species and the restoration of native vegetation communities on the floodplain located within reservation. In this note, we highlight our efforts to control Russian olive in an 80-acre (32-ha) cottonwood gallery forest on the reservation.

In the 1920s, shade-tolerant Russian olive began to appear in the Middle Rio Grande floodplain. Today it is the co-dominant tree, along with Fremont cottonwood, in the gallery forests (Hink and Ohmart 1984). These mixed stands form dense, fire-prone thickets that often become monospecific stands of Russian olives because of vigorous root-sprout growth following a fire. One of Santa Ana's goals is to remove Russian olives from the cottonwood forests before a catastrophic fire occurs. However, we were concerned that methods traditionally used to kill monospecific stands, such as bulldozing or aerial herbicide spraying, would also destroy the cottonwoods. Since we could not find any documented case studies addressing this problem, we experimented with a variety of mechanical and herbicide treatments to remove the unwanted trees and control root sprouts without damaging stands of cottonwood.

In 1998, we contracted four tractors with front-mounted, flail-type mower heads that can mulch woody trunks and stems up to approximately 8 inches (20 cm) in diameter. We knew from our previous experience controlling saltcedar trees that it is difficult to effectively kill sprouts from large root crowns. Therefore, we decided to mow Russian olives that were less than 4 inches (10 cm) in diameter and remove larger trees with chainsaws.

From November 1998 through February 1999, crews cleared small-diameter Russian olives and woody debris from the site using the mulching tractors. At the same time, eight workers equipped with chainsaws and herbicide backpacks worked in the thinned-out stand to fell and treat larger Russian olive trees. Within five minutes after cutting each tree, they sprayed the cut-stump surface with a 50-percent solution of Garlon-4®. Next, they cut and removed usable firewood from the forest. The mulching tractors then made a second pass through the stand to pulverize the remaining tree waste.

By summer 1999, there were Russian olive root sprouts throughout the project site. Because Russian olive trees have long, shallow root systems, we could not determine conclusively whether the root sprouts were from the small-diameter trees that were mowed or from the larger trees that received cut-stump herbicide treatments. We observed very few root sprouts within a 10-foot (3-m) radius of sprayed stumps that were less than 8 inches in diameter. However, we found numerous root sprouts within close proximity of larger, sprayed stumps. This lead us to suspect that a 50-percent solution of Garlon-4® is not effective on Russian olive stumps that exceed 8 inches in diameter.

From June 15, 1999 through July 16, 1999, an eight-person ground crew used backpack spray units to apply a 25-percent solution of Garlon-4® to the leaves of Russian olive root sprouts. The following summer, root sprouts were substantially less prolific. We repeated identical herbicide applications (but with fewer workers) during a two-week period in early summer 2000, and again, during a five-day period in the summer of 2001. While sprouts of Russian olive are now under control, averaging less than three sprouts per acre, we will continue monitoring and applying herbicide to sprouts as they occur. During the first year of implementation, we spent approximately $1,632/acre ($4,031/ha) to control Russian olive. In 2000, we spent about $40/acre ($100/ha) to treat root sprouts and, in 2001, about $17/acre ($42.50/ha).

We have also experimented with other mechanical treatments in an effort to compare cost and project management efficiency. These include traditional logging equipment, such as log-loaders, and stationary grinders to remove and mulch Russian olive and saltcedar on a 450-acre (182-ha) site. We are also establishing experimental plots to test the effectiveness of various herbicides on Russian olive root-sprouts (McDaniel and others in press). Nonetheless, we believe that the methods described in this note can successfully control Russian olive in cottonwood gallery forests.

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Hink, V.C. and R.D. Ohmart, 1984. Middle Rio Grande biological survey. Final Report to the U.S. Army Corps of Engineers, Albuquerque, N.M. 193 pages.

McDaniel, K., T. Caplan and J. Taylor. In press. Control of Russian olive and saltcedar resprouts with early and late summer herbicide applications. *Western Society of Weed Science Bulletin*.


## 112

### Simple and Cost-Effective Methods Control Fountain Grass in Dry Forests (Hawaii)


*Susan Cordell, Research Ecologist, USDA Forest Service, Institute of Pacific Islands Forestry, 23 E. Kawili St., Hilo, HI 96720, 808/933-8121, cordell@hawaii.edu; Robert J. Cabin, Department of Biology, Plattsburgh State University, Plattsburgh, NY 12901; Stephen G. Weller, Department of Ecology and Evolutionary Biology, University of California, Irvine, CA 92697; and David H. Lorence, National Tropical Botanical Garden, 3530 Papalina Road, Kalaheo, HI 96741*


Fountain grass (*Pennisetum setaceum*), a highly invasive and fire-promoting species, poses the most serious threat to the restoration and preservation of native dry forest communities on the island of Hawaii. Originally introduced in the early 1900s, this drought-adapted perennial bunchgrass now dominates pastures, forest understories, and barren lava flows on the leeward side of the Big Island (Degener 1940, Wagner and others 1990). Our research has shown that fountain grass not only increases the frequency and intensity of fires, but also alters basic ecosystem properties such as light availability, soil water holding capacity, nutrient uptake, and various microclimatic variables (Cordell and others in review). We have found, however, that simple and relatively inexpensive techniques can both control fountain grass and facilitate the establishment of key native dry forest species (Cabin and others 2000).

In 1995 we implemented an aggressive fountain grass control program within the 6-acre (2.43-ha) Kaupulehu Dry Forest Preserve, an enclosed site on the leeward side of the island that has some of the highest quality dry forest habitat in the state (Allen 2000, Cabin and others 1999, 2000). Using weed whackers and multiple follow-up applications of Fusilade® at the manufacturer's recommended rate, we managed to reduce fountain grass cover from 90 percent cover to 10 percent after 10 months (Cabin and others 2000).

This technique is most effective during the active growth stage of fountain grass, which appears to be related to rainfall and is not necessarily seasonal. After cutting fountain grass with weed whackers, we wait for the grass to resprout before applying herbicide. We have found that three or four subsequent applications over a three to four month period are required to effectively eliminate any new growth. The herbicide treatment does not appear to damage native vegetation, although this has not been quantitatively tested. We have made several refinements that reduced our initial weed control effort from a cost of more than $5,000 per acre ($12,500/ha) to less than $800 per acre ($2,000/ha), including 1) replacing Fusilade® with a more cost-effective, glyphosate-based herbicide (Roundup® at a rate of 1.5-2 percent) and 2)

**A student worker cuts fountain grass (*Pennisetum setaceum*) with a weed whacker before applying herbicide.** *Photo by Susan Cordell*

purchasing our own weedwhackers, backpack sprayers, and other equipment rather than contracting out the work. This method has facilitated the natural regeneration of native species, such as ´aheahea (*Chenopodium oahuense*) and awikiwiki (*Canavalia hawaiiensis*), which had been suppressed by monocultures of fountain grass.

We continue to control fountain grass by spot herbicide application and/or hand pulling approximately two times each year. After five years, fountain grass no longer invades areas it once dominated. We are surprised by this result and at present do not understand the causal mechanism behind it. The low germination of seeds in soil that we removed from areas where fountain grass is abundant suggests that the spread of this species is potentially limited by seed viability (Sanford and Cordell unpublished data). Paradoxically, Goergen and Daehler (2001) have determined that seed production and seed viability of fountain grass is prolific relative to native grasses.

We are also pursuing other, possibly more cost-effective, methods for restoring larger tracts of invaded forest land. For example, we have recently found that bulldozing infested sites and suffocating fountain grass with plastic mulch may be viable approaches on certain sites (Cabin and others in press). In addition, we are currently working with the U.S. Fish and Wildlife Service to reduce roadside fuels and promote native plant restoration by embedding native plants within a matrix of 12 different fountain grass control treatments, including grazing, burning, herbicide application and various combinations of these three treatments. Results from this study may provide important information that will help us develop methods for restoring severely degraded landscapes on a much larger scale.

## Acknowledgments

We thank Don Goo, Lisa Hadway, Brian Kiyabu, and Alan Urakami for their technical support and dedication to the preservation and restoration of Hawaii's dry forest ecosystems. We would like to acknowledge the support and encouragement of the members of the Kona Dryland Forest Working Group and the Kamehameha Schools for permission to use their lands for this research project.

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## 113

**Rensselaer Effort to "Pull Mussels" at Lake George Looks Promising.** 2001. Anon. **ScienceDaily,** www.sciencedaily.com/releases/2001/06/010612070141.htm.

Rensselaer Polytechnic Institute (RPI) in Troy, New York, is attempting to reduce the number of zebra mussels (*Dreissena polymorpha*) in nearby Lake George by manually removing the mollusks. In spring 2000, divers pulled more than 19,000 zebra mussels from the lake. They have collected less than 400 mussels since April 2001, indicating that the technique is working. In addition, most of the mussels pulled in

2001 were born before the 2000 harvest, suggesting that that harvest occurred before the mussels reproduced. In addition to spearheading this effort, RPI's Darrin Fresh Water Institute is providing the public with educational pamphlets and mussel identification kits. The original press release concerning this project can be found at www.rpi.edu/web/News/ press_releases/2001/zebra.html.

## 114

**Teamwork Extended.** 2001 Anon. **Leafy Spurge News** 23(4):1-2.

The Ecological Area-Wide Management of Leafy Spurge program (TEAM Leafy Spurge), set to expire in 2001, has been extended for another year. This federal program will continue to support land managers and ranchers in Montana, North Dakota, South Dakota, and Wyomin. In addition, the updated version of TEAM Leafy Spurge's database, "Purge Spurge: Leafy Spurge Database," is now available. This reference and educational tool contains more than 900 journal articles, workshop proceedings, extension bulletins, and other publications. It is available through the Northern Plains Agricultural Research Laboratory, 1500 North Central Ave., Sidney, MT 59270; 406/433-2020, Fax: 406/433-5038; bredlin@sidney.ars.usda.gov or jmiller@sidney.ars.usda.gov; or through TEAM Leafy Spurge's Web site: www.team.ars.usda.gov.

## 115

**Teasel: Finally a Noxious Weed.** 2001. Anon. **Native Warm-Season Grass Newsletter** 20(2).

In June 2001, Missouri added common teasel (*Dipsacus follonum*) and cutleaf teasel (*D. laciniatus*) to its noxious weed list, together with kudzu (*Pueraria montana* var. *lobata*). All Missouri landowners, government and nongovernment, are now required to control teasel, a member of the thistle family that began spreading in Missouri in the 1970s. Plants should not be cut after flowering has begun since seed can still mature and disperse. According to this article, the best control method is to spray the rosettes in the fall with triclopyr (Remedy®), triclopyr +2,4-D (Crossbow®), picloram (Tordon®), glyphosate (Roundup®), or sulfosate (Touchdown®).

## 116

**Salt Cedar Negatively Affects Biodiversity of Aquatic Macroinvertebrates.** 2001. Bailey, J.K., J.A. Schweitzer and T.G. Whitham, Dept. of Biological Sciences and the Merriam Powell Center for Environmental Research, Northern Arizona University, Flagstaff, AZ 86011, jkb22@dana.ucc.nau.edu. **Wetlands** 21(3):442-447.

According to this study, saltcedar (*Tamarix ramosissima*) alters stream leaf litter decomposition rates along streams in the southwestern United States and affects stream macroinvertevrates dependent on leaf litter as a food source. The authors found that the faster decomposition of saltcedar litter compared with the native tree Fremont cottonwood (*Populus fremotii*) leads to a twofold decrease in macroinvertebrate richness and a fourfold decrease in overall macroinvertebrate abundance.

## 117

**Damn the Torpedograss!** 2001. Bodle, M. and C. Hanlon, South Florida Water Management District, 3301 Gun Club Rd., West Palm Beach, FL 33416, mbodle@sfwmd.gov. **Wildland Weeds** 4(4):6-12.

This article describes the characteristics and habitat of torpedograss (*Panicum repens*), a non-native plant that has invaded much of Florida's farmland and 70 percent of the state's public waters. Research by the South Florida Water Management District indicates that the most effective control method seems to be burning followed by herbicide treatment Arsenal®. To date, biocontrol methods have not shown promise.

## 118

**Invasive Carp in the Mississippi River Basin.** 2001. Chick, J.H., Great Rivers Field Station, Illinois Natural History Survey, 8450 Montclair Ave., Brighton, IL 62012, chick@inhs.uiuc.edu; and M.A Pegg. **Science** 292(5525):2250-2251.

Addressing concerns raised in a previous article that black carp pose a threat to the Mississippi River Basin (Ferber, "Will Black Carp Be the Next Zebra Mussel?" *Science* 292{5515}:203), the authors note that two other introduced Asian carp—the bighead and silver carp—are already causing problems in the area. If allowed to enter the Great Lakes, they may be impossible to eradicate. As the authors note, however, a workable solution for extirpating them may not exist. They use this example to underline the importance of laws and management in preventing the introduction of non-native species.

## 119

**Review of Ecological Restoration Programme on Subantarctic Macquarie Island: Pest Management Progress and Future Directions.** 2001. Copson, G. and J. Whinam, Dept. of Primary Industries, Water and Environment, Nature Conservation Branch, G.P.O. Box 44, Hobart, Tasmania 7001, Australia, Geof.Copson@dpiwe.tas.gov.au. **Ecological Management and Restoration** 2(2):129-138.

Restoration efforts on Macquarie Island, a nature reserve managed by the Tasmanian Parks and Wildlife Service, have focused on 1) managing the area as a natural habitat for indigenous species and 2) preventing introductions of non-native species and attempting to eradicate or control non-natives that are affecting native species. According to the authors, an integrated approach to pest management—monitoring the responses of both target and nontarget species—is the most effective way to restore the area. For example, controlling European rabbits (*Oryctolagus cuniculus*) has led to the recovery of adversely affected species to varying degrees. Reduced grazing by rabbits has allowed reestablishment of the native tall tussock (*Poa foliosa*) grassland and the subsequent spread of the introduced ship rat (*Rattus rattus*). Monitoring has also demonstrated the need to control the numbers of feral cats (*Felis catus*) because of their increased predation of native burrow-nesting birds.

## 120

**Effects of the Exotic Invasive Shrub Lonicera maackii on the Survival and Fecundity of Three Species of Native Annuals.** 2000. Gould, A.M.A. and D.L. Gorchov, Dept. of Botany, Miami University, Oxford, OH 45056, 513/529-4205, Fax: 513/529-4243, gorchodl@muohio.edu. **American Midland Naturalist** 144(1):36-50.

The authors studied the effects of Amur honeysuckle (*Lonicera maackii*), an invasive shrub throughout the eastern United States, on three annuals with different leaf phenologies and shade tolerance: cleavers (*Galium aparine*), pale touch-me-not (*Impatiens pallida*), and clearweed (*Pallida pumila*). They examined plant interactions in two forest stands in Ohio, one highly disturbed with a high density of amur honysuckle and the other less disturbed with a lower density of the shrub. In plots established in each stand, the honeysuckle was either 1) removed, 2) present, or 3) absent (less-disturbed stand only). In both stands, reproduction increased for all three annuals in the absence of honeysuckle. Amur honeysuckle's negative impact on shade-intolerant or early-season annuals suggests that other annuals with similar properties may also decline in the presence of shrubs with early leaf expansion.

## 121

**Weed-Eating Insects Munch Wrong Plants.** 2001. Jensen, M.N. **Academic Press Daily InScight** August 2, www.academicpress.com/inscight/08022001/grapha.htm.

Ecologist Svata Louda has discovered that the non-native weevil (*Larinus planus*), released in 1992 in Colorado to control the weed

Canada thistle, has begun feeding on the native Tracy's thistle (*Cirsium tracyi*). Research indicates that biocontrol agents are the cause of more than 50 percent of the insect damage to seeds of Tracy's thistle. According to some ecologists, this situation underscores the need for more stringent criteria that take into account native species when screening potential insect releases for biological control purposes.

## 122

**A Case of Mistaken Identity: Native and Exotic "Boston Ferns" and "Sword Ferns" (*Nephrolepsis* spp.).** 2001. Langeland, K., University of Florida Center for Aquatic and Invasive Plants, 7922 NW 71st St., Gainesville, FL 32653, kal@gnv.ifas.ufl.edu. **Wildland Weeds** 4(4):13-17.

To aid consumers, growers and land managers, Langeland outlines the differences between Florida's native sword fern (also known as wild Boston fern; *Nephrolepsis exaltata*) and giant sword fern (*N. biserrata*) and the non-native tuberous sword fern (*N. cordifolia*) and Asian sword ferns (*N. multiflora*). He notes that tuberous sword fern is often mistakenly sold as native sword fern. Both non-native ferns are invasive. Tuberous sword fern can be hand pulled, although regrowth will occur from plant parts left in the ground. Application of herbicides containing 41 percent glyphosate diluted to 1.5 percent will kill the ferns, although follow-up applications may be necessary.

## 123

**Crayfish (*Orconectes rusticus*) Impacts on Zebra Mussel (*Dreissena polymorpha*) Recruitment, Other Macroinvertebrates and Algal Biomass in a Lake-Outlet Stream.** 2000. Perry, W.L., Dept. of Biological Sciences, Illinois State University, Normal, IL 61790, 309/438-8160, Fax: 309/438-3722, wlperry@ilstu.edu; D.M. Lodge and G.A. Lamberti. **American Midland Naturalist** 144(2):308-316.

The authors conducted a study to determine whether crayfish can significantly reduce zebra mussel recruitment in streams. Their results indicate that streams with moderate to high concentrations of crayfish may experience slower zebra mussel invasion and lower final densities of zebra mussels. Crayfish may also lower macroalgae (*Chara* and *Nitella*) biomass. The authors conclude that predation by crayfish can reduce the impact of zebra mussels in small inland lakes and streams, particularly where other predators are also present.

## 124

**Operations Component Contributions to Team Leafy Spurge, Area Wide Integrated Management of Leafy Spurge (*Euphorbia esula*).** 2001. Richard, R.D., C.W. Prosser, and C. O'Brien. P. 6. **Leafy Spurge Bio-Control in the Little Missouri River Drainage.** 2001. Kirby, D. P. 7. **Assessing Biological Control Agents for Area-Wide Control of Leafy Spurge with Foci in Montana and South Dakota.** 2001. Parker, M.S. and J.L. Butler. P. 7. **Wyoming Assessment Project and Remote Sensing of Leafy Spurge.** 2001. Williams, A.P. and D.J. Kazmer. P. 8. **Leafy Spurge News** 23(3).

This issue of *Leafy Spurge News* contains a portion of the proceedings of Spurgefest II, a symposium held June 19-21, 2001, in Medora, North Dakota. The research stems from work done through a federal program, The Ecological Area-Wide Management (TEAM) Leafy Spurge program. Richard (Bozeman Laboratory, Bozeman, MT), Prosser, and O'Brien discussed the aims of TEAM Leafy Spurge to develop and demonstrate ecologically based and affordable integrated pest management strategies to control leafy spurge (*Euphorbia esula*). TEAM Leafy Spurge operations have led to more than 13,000 releases of flea beetles (*Aphthona* spp.), a biological control agent, along the Little Missouri River in Wyoming, Montana, North Dakota, and South Dakota. Operations have also included the development of large-volume insect collection and delivery, tours and field demonstrations, and various media packages.

Kirby (Department of Animal and Range Sciences, North Dakota State University) details the results of a study to assess the impact of flea beetles on leafy spurge and the effects of leafy spurge on mixed-grass prairie. Leafy spurge control was considerable in 85 percent of the release sites after only two growing seasons and was similar across topographic positions and aspects, soil types, and range sites. However, more than 70 percent of seedlings that germinated across a range of light to heavy leafy spurge infestation were leafy spurge. These affected sites will require a long-term leafy spurge control program.

Parker and Butler (Department of Biology, Central Missouri State University) discuss the results of a study in Montana and South Dakota to documents the distribution, density, dynamics, and trends of leafy spurge populations after flea beetle release in 1998. Between 1999 and 2000, beetle numbers increased significantly, with no apparent affinity for site type. The increase in insect numbers corresponded to a decrease in foliar cover of leafy spurge. In response to the decrease, native vegetation increased in both frequency and abundance.

The Wyoming facet of the TEAM Leafy Spurge Project, discussed by Williams and Kazmer (Department of Botany, Department of Renewable Resources, University of Wyoming), saw large reductions of leafy spurge in release sites of mixed-species flea beetles (*A. nigriscutis* and *A. lacertosa*) after only two years. *A. lacertosa* appeared to be more effective in a wider variety of sites and also was found in higher numbers than A. nigriscutis. The authors used Airborne Visible/Infrared Imaging Spectrometer to detect and map the leafy spurge.

## 125

**The Utilization of Oberea Erythrocephala as an Additional Bio-Control Agent on Leafy Spurge in the Little Missouri River Basin, and in Southeast and North Central North Dakota.** 2001. Olson, D. and D. Mundal. P. 5. **Impact of Grasshopper Treatments on Established Populations of Biological Control Agents (*Aphthona* spp.) for Leafy Spurge.** 2001. Foster, R.N., K.C. Reuter, L.K. Winks, T.E. Reule and R.D. Richard. P. 6. **Nutritional Composition of Selected Invasive Species.** 2001. Sedivec, K. and C. Prosser. P. 7. **Evaluation of Diflufenzopyr Applied with Quinclorac and Dicamba for Leafy Spurge (*Euphorbia esula* L.) Control.** 2001. Deibert, K.J. and R.G. Lym. P. 8. **Leafy Spurge News** 23(4).

Continuing from *Leafy Spurge News* 23(3), this issue contains the remainder of the proceedings of Spurgefest II. Olson and Mundal (Department of Entomology, North Dakota State University) set out to determine whether the beneficial cerambycid beetle (*Oberea erythrocephala*) will work as a biocontrol agent for leafy spurge in habitats in which flea beetle populations do not establish well. The results of their study show that populations of this beetle can establish under different environmental conditions and will somewhat reduce leafy spurge stand counts.

Foster (USDA-APHIS-PPQ, Phoenix Plant Protection Laboratory, Phoenix, AZ) and colleagues are conducting experiments to determine whether insecticide treatments to control grasshopper populations in western rangelands are negatively affecting flea beetle populations. To date, tests indicate that diflubenzuron produces no or low mortality for the flea beetle, while malathion and carbaryl spray produce moderate and high mortality, respectively. Impacts after one year of treatment are still to be determined.

Sedivec (Department of Animal and Range Sciences, North Dakota State University) and Prosser evaluated the nutritional composition of various invasive weeds, including leafy spurge, to determine whether grazing can be a useful tool for an integrated pest management system. Compared with other species, leafy spurge provides a high crude protein content and a lower acid detergent fiber content during the second half of the growing season.

Deibert and Lym (Plant Sciences Department, North Dakota State University) evaluated the effect of applying quinclorac (an auxin herbicide) alone and with diflufenzopyr (an auxin transport inhibitor not currently available to land managers) or with diflufenzopyr with dicamba (available as a premix) on leafy spurge. Preliminary research shows that diflufenzopyr dramatically increases leafy spurge control. This study will help determine optimum treatment rates.

## 126

**Testing Control of Saltcedar Seedlings Using Fall Flooding.** 2001. Sprenger, M.D., U.S. Fish & Wildlife Service, HC5, P.O. Box 114, Martin, SD 57551, matt_sprenger@fws.gov; L.M. Smith and J.P. Taylor. **Wetlands** 21(3):437-441.

To determine if submersion is an effective way to control saltcedar (*Tamarix ramosissima*) in the Rio Grande floodplain of central New Mexico, the authors analyzed the effect of fall flooding on saltcedar and cottonwood (*Populus deltoides* subsp. *wislizenii*)—a native plant with similar germination requirements. The survival rate decreased for submerged saltcedar seedlings compared with unsubmerged seedlings. However, cottonwood seedlings did not survive total submergence. Therefore, the authors do not recommend flooding of saltcedar seedlings in areas where cottonwood seedlings would also be submerged.

## 127

**The Economic Value of Controlling an Invasive Shrub.** 2000. Zavaleta, E., Dept. of Biological Sciences, Stanford University, Stanford, CA 94305-5020, erika@jasper.stanford.edu **Ambio** 29(8):462-467.

Zavaleta examines the economic impact of tamarisk (*Tamarix* spp.), a woody shrub that has invaded riparian areas throughout the arid and semiarid regions of the western United States. Zavaleta calculates the annual cost of tamarisk to be over $385 per hectare ($156 per acre) of land currently infested. Although eradicating tamarisk and restoring native communities would cost about $7,400 per hectare ($3,000 per acre), Zavaleta estimates that the full cost could be recovered in 17 years and that the economic, ecological, and societal benefits would continue indefinitely.

# HABITAT RESTORATION

## 128

### Do Summer Burns Result in Adult Karner Blue Butterfly Mortality? (Wisconsin)

*Richard S. King, Necedah National Wildlife Refuge, W7996 20th Street West, Necedah, Wisconsin 54646-7531, 608/565-4402, Fax: 608/565-3160, richard_s_king@fws.gov*

Since 1993, annual surveys of the federally endangered Karner blue butterfly (*Lycaeides melissa samuelis*) on the Necedah National Wildlife Refuge (NWR) in Juneau County, Wisconsin have indicated that its populations remain robust immediately following prescribed burns. Our results are intriguing in light of research and reports claiming that fire kills Karner blues during all life stages and that frequent burns can lead to the loss of populations (Opler 1981, Premo and others 1994).

In summer 1994, we surveyed marked butterflies immediately following prescribed burns in an attempt to determine whether the Karner blue butterflies we captured were the same individuals we captured and marked before the fire or individuals recolonizing the sites from adjacent populations.

We conducted the experiments on two oak barrens, located approximately 5 miles (8 km) apart. Both sites had been restored about 20 years prior to the study with thinning and subsequent prescribed burns on a three-year rotation. Each site bordered Karner blue habitat of equal or greater size that was not burned and that could provide a source of colonizing butterflies following the burns. We conducted the burns on July 22 and 28, during the Karner blues' second flight. This brood usually has more individuals than the first (Cryan 1980, Swengel 1993), thus reducing the risk of killing a whole population while potentially maximizing our sample size and ability to observe the butterflies.

Using standard aerial butterfly nets, we captured 137 Karner blues on one site (Site A) and 90 on the other (Site B) until just before the burns were lit. We marked each butterfly with a unique 3-digit number using an ultra-fine point felt-tip pen. We did not observe any mortalities during this stage of the experiment. Just before lighting the fires, we moved behind the headfire. As the fires advanced across the units we began resurveying the burned areas just behind the flames. We followed the flames across the units until the burns were complete and then resumed random searching throughout the units. We resurveyed both study sites for approximately one hour after the burns were completed, noting the number of marked and unmarked butterflies. While following the flames across the units, we looked for Karner blue butterflies in front of and behind the flames.

The burns were over quickly (less than 10 minutes) since both units were small and dominated by warm-season grasses. Following just behind the flames, we observed Karner blue butterflies immediately in front of the flames, although we could not detect whether they were marked. We did not observe any of those butterflies flying into the flames. Immediately behind the flames, we recaptured four marked individuals (all males) on Site A, resulting in a recapture rate of 2.9 percent. On site B, we recaptured five males and one female for a recapture rate of 6.7 percent.

We did not capture any unmarked individuals on either study site following the fire. Moreover, we did not find any dead or partially burned Karner blues, nor did we observe butterflies leaving the study sites prior to the burns. These results indicate that the Karner blues seen immediately after summer prescribed burns are not recolonizers. In a subsequent mark-release-recapture study at Necedah NWR (King 1998), our recapture rate of Karner blues on an unburned site was 4.3 ± 0.9 percent ($\bar{x}$ ± SE; n = 90). Therefore, if the two 1994 burns resulted in individual Karner blue butterfly mortality, it was not reflected in our adult recapture rates.

Although we reject the hypothesis that *all* adult Karner blue butterflies are killed by summer burns, we acknowledge that the level of mortality, if any, associated with fire remains untested. All disturbances, especially prescribed burns, should be used cautiously. However, savannas and other grasslands are fire-dependent ecosystems, and so the species that evolved on these landscapes should be fire-tolerant, if not fire-dependent. Our observation of several butterflies flying in front of the flames but not into the flames suggests a behavioral adaptation to fire. A definitive answer regarding prescribed burns and Karner blue mortality will remain elusive without additional research that incorporates controls and replicates into the study design. Hopefully, our data will provide a starting point that other researchers can use to further test these effects.

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### 129

**Habitat Associations of Hypogeous Fungi in the Southern Appalachians: Implications for the Endangered Northern Flying Squirrel (Glaucomys sabrinus coloratus).** 2000. Loeb, S.C., USDA Forest Service, Southern Research Station, Dept. of Forest Resources, Clemson University, Clemson, SC 29634; F.H. Tainter and E. Cázares. **American Midland Naturalist** 144(2):286-296.

Spruce-fir (*Picea rubra, Abies fraseri*) and mixed spruce-fir and hardwood stands are important foraging sites for the two endangered species of northern flying squirrel (*Glaucomys sabrinus coloratus* and *G. s. fuscus*) found in the southern Appalachians. At the site level, spruce is the most important species in areas with high production of sporocarps of hypogeous mycorrhizal fungi (truffles), the squirrels' major food source. The authors assert that the recovery of the northern flying squirrel depends on the management and conservation of spruce-fir forests. They caution that the interdependence of northern flying squirrel, truffles, and spruce in the southern Appalachians means that a negative human impact on one of these components may negatively affect the other two.

### 130

**Grassland Bird Conservation: CP1 vs. CP2 Plantings in Conservation Reserve Program Fields in Missouri.** 2001. McCoy, T.D., School of Natural Resources, University of Missouri, Columbia, MO 65211, 573/884-8535, tdm550@mizzou.edu; M.R. Ryan, L.W. Burger, Jr. and E.W. Kurzejeski. **American Midland Naturalist** 145(1):1-17.

Between 1993 and 1995, the authors measured vegetation structure, bird abundance and reproductive success, and estimated reproduction on cool-season mixed-grass plantings (CP1) and warm-season single-species grass plantings (CP2) in 16 Conservation Reserve Program (CRP) fields in northern Missouri. Both types of plantings showed similar species richness, abundance, and nesting success during the breeding season for grassland birds and total bird use in winter. During breeding season, CP1 fields showed higher abundance of certain species, including the grasshopper sparrow (*Ammodramus savannarum*) and American goldfinch (*Carduelis tristis*), while CP2 fields showed a higher abundance of common yellowthroats (*Geothlypis trichas*). The more diverse CP1 fields provide equal or better habitat for grassland birds compared to the monotypic CP2 fields, suggesting that more diverse grassland CRP habitats will have greater potential benefits for wildlife.

## TOOLS & TECHNOLOGY

### 131

**GIS Modeling Program Identifies Landscape Restoration Opportunities (Ontario)**


*Ken Towle and Lionel Normand, Terrestrial Biologists, Toronto and Region Conservation Authority, 5 Shoreham Drive, Downsview Ontario, Canada, M3N 1S4, 416/661-6600, ktowle@trca.on.ca*


In 1996, the Toronto and Region Conservation Authority (TRCA) created the Natural Heritage Program in order to assess the condition of existing natural areas and identify potential opportunities for restoration within the nine watersheds that encompass the Greater Toronto Area. The program's challenge is to protect and augment as many habitat fragments as possible in one of Canada's fastest-growing metropolitan areas.

During the first phase of this program, we have been developing a method for assessing terrestrial conditions along with a modeling program that generates various scenarios of natural, agricultural, and urban cover distribution and configuration. The result is a tool that enables policymakers, stakeholders, and others to visualize landscape-scale restoration through maps that show both existing and potential habitat patches in relation to each other and in a regional context.

Using ArcView Geographic Information Systems software and color orthographic air photos, we digitally map habitat patches of forest, meadow, wetland and beach/bluff, with surrounding areas classified as either urban or agricultural. We then measure habitat patch characteristics and spatial relationships using landscape metrics derived from principles of conservation biology and landscape ecology. These presently include habitat patch size, shape, and matrix influence (we are presently developing a connectivity metric). *Size* is related to the principle that "the bigger the area the better" (Noss and Cooperrider 1994). *Shape* relates to the exposure of the patch to negative "edge effects," using a perimeter-to-area ratio measure (Forman 1995). For example, compact round or square patches receive high habitat-values scores, while convoluted and perforated patches receive lower scores. *Matrix influence* is an original measure that considers the relative amount of urban, agriculture, and natural cover within a 1.2-mile (2-km) radius of the outside edge of the habitat patch. It is a measure of the kinds of external influences on the patch, each of which is assigned a numerical value based on the degree to which those influences are positive or negative.

We divide the resulting numerical values into a range of scores from one (lowest) to five (highest), each with a corresponding color code. We then produce maps that show the color score values for the patch measures, as well as a combined total score value for each habitat patch. Because the individual patch values represent existing conditions, they provide a baseline for measuring and visualizing change.

Our modeling process shows how and where adding natural cover can improve landscape metric values (Figure 1). Unless site inventories suggest otherwise, forest will likely be the most appropriate habitat type to restore in our region. We can run scenarios to demonstrate the patch-value changes that occur when restorable lands are added to adjacent forest patches. Increasing the size of existing patches or adding natural cover to areas where none previously existed results in improved matrix values that can be seen not only for the restored patch, but also for other patches in the surrounding landscape. At the site level, we can further break down the five scoring colors into a series of hues or patterns that illustrate more detailed changes in the corresponding numerical values.

Our modeling approach is designed to improve land-use planning. Not only does it avoid the pitfalls of crisis management resulting from policies that attempt (and often fail) to protect only the most significant landscapes, it suggests that protection of areas that provide future opportunities for increasing natural cover are as important as the protection of existing natural areas.

## ACKNOWLEDGMENTS

Chris Gerstenkorn, Jason Tam, and Charles Kinsley of the TRCA provided GIS support for this project. Environment Canada's Great Lakes Sustainability Fund, the Toronto Remedial Action Plan, the Salamander Foundation, and the Richard Ivey Foundation have provided generous support to the TRCA's Natural Heritage Program..

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# ENDANGERED SPECIES

## 132

### Nursery-grown Plants Augment Endangered Populations of Robbin's Cinquefoil (New Hampshire)

*William Brumback, Conservation Director, New England Wild Flower Society, 180 Hemenway Road, Framingham, MA 01701-2699, 508/877-7630 ext. 3201, Fax: 508/877-3658, bbrumback@newfs.org*

Robbin's cinquefoil (*Potentilla robbinsiana*), a federally listed endangered species, is endemic to the alpine zones of Mt. Washington and Mt. Lafayette, both of which are in the White Mountain National Forest of New Hampshire. The largest population occurs in an area on Mt. Washington where winds that regularly average more than 45 miles per hour (72 kph; Mt. Washington Observatory 2001) blow the snow cover off the rocky soil.

At the time of its listing in 1980, the major threat to the Mt. Washington population was disturbance from hikers using a trail that ran through the middle of the habitat, which, coupled with collection of specimens for herbaria, reduced the numbers of the diminutive plant (Cogbill 1993). By 1983, there were only 1,537 Robbin's cinquefoil with a rosette diameter greater than 0.5 inch (14 mm; U.S. Fish and Wildlife Service 2001). In the early 1980s, the U.S. Fish and Wildlife Service (USFWS), U.S. Department of Agriculture Forest Service, and the Appalachian Mountain

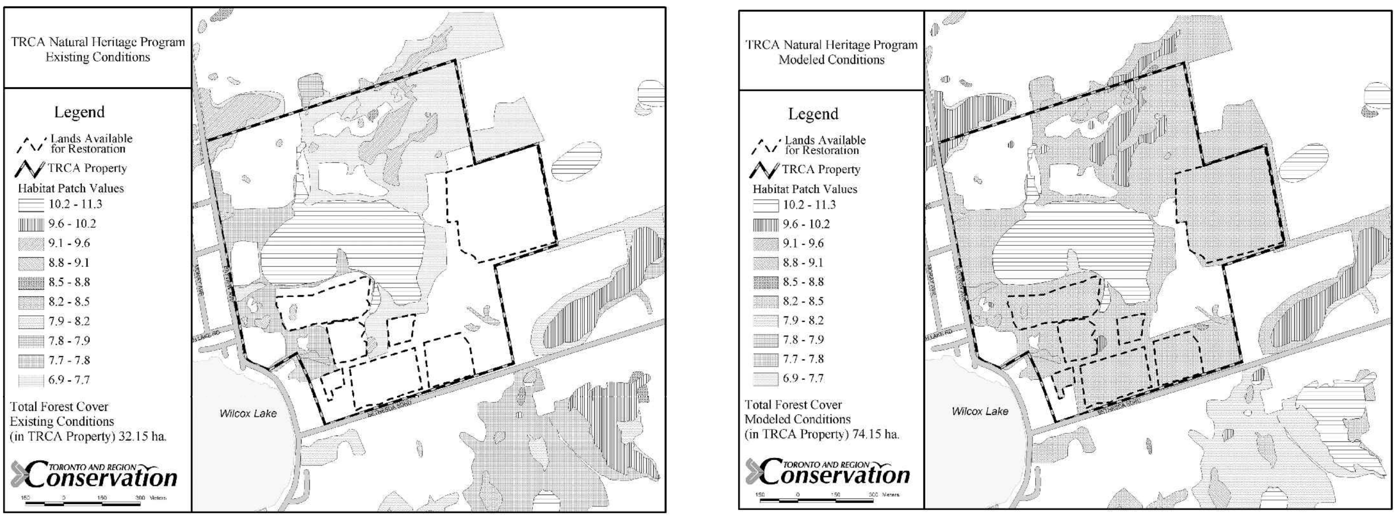
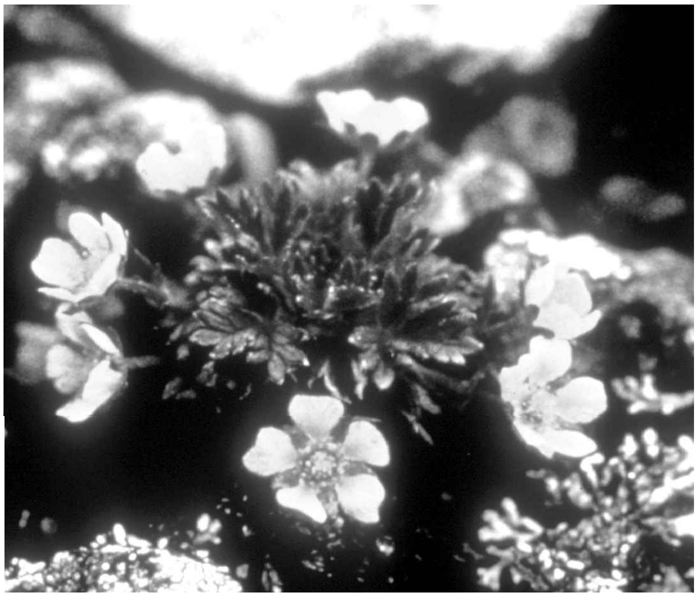



**Figure 1. These maps show how habitat patch values of existing agricultural fields (left) are improved after being restored to native forest (right). Restoration also improves patch values of areas surrounding the project site.**



**Thanks to removal of a hiking trail and a transplant program, yellow blooms of the diminutive Robbin's cinquefoil (*Potentilla robbinsiana*) have become more frequent on Mt. Washington in early June.** *Photo courtesy of The New England Wild Flower Society*

Club (AMC) collaborated to relocate the trail. In 1991, the New England Wild Flower Society (NEWFS) joined the collaboration to help reintroduce and augment populations of the plant.

For the past decade, staff of the NEWFS have used seed from the Mt. Washington population to germinate and grow Robbin's cinquefoil at the Garden in the Woods, the Society's botanic garden in Framingham, Massachusetts. The seed is collected under federal permit by members of the AMC, the organization that has taken the lead on monitoring the plants in the wild. We germinate seeds by either 1) treating them with Gibberellic acid ($GA_3$) before sowing in spring or 2) sowing seed outside in late fall, which subjects the seeds to natural freezing and thawing during winter. Both methods have produced plants, but recent results favor germination by pretreatment with $GA_3$. In one test, we achieved 80-96 percent germination of seed that had been collected in 1997, dried at 15-20 percent relative humidity, placed in a seedbank at approximately -4ûF (-20ûC), and then removed in 1999 and soaked in $GA_3$ for 24 hours at either 500 or 1000 ppm (Brumback 2000).

After the seeds germinate in May, we leave the seedlings in flats for one to two years and then repot them in well-drained soil. Growing an alpine species at near sea level, with the accompanying heat and humidity, results in high mortality of seedlings. Those plants that survive in the nursery often flower in the spring of the third year after germination. These plants are usually much larger than their counterparts in the wild, which need 8 to 13 years to reach blooming size in the harsh conditions of the alpine zone (K. Kimball personal communication to USFWS).

For our initial transplant efforts from 1993 through 1998, we stored two- to three-year-old potted plants in a freezer from the beginning of thaw in Framingham (approximately the end of February to mid-March) until we transplanted the plants just after snowmelt on Mt. Washington in early June, which coincides with the flowering period of wild populations. After initial successes, we eventually discontinued this freezer-storage method because an increasing number of transplants were not surviving through the first summer. As an alternative, in 1998, we began to experiment with summer transplanting. The transplants were held in cold frames over the winter and transplanted in July at the peak of their yearly growth. This method has proven more successful, with 74 of 75 plants transplanted to Mt. Washington in 1998, 1999, and 2000 alive two months after transplanting (Kimball personal communication). Preliminary figures indicate that 13 of 14 plants transplanted in 1998 survived their first winter in the wild (Kimball personal communication). Furthermore, because the transplants often bloom in the nursery in early May before being transplanted, they have produced seeds at the time of transplanting that have resulted in minute seedlings the next growing season (Kimball personal communication).

More than 14,000 Robbin's cinquefoil plants of various size classes are now present on Mt. Washington, including 4,556 with a rosette diameter greater than 0.5 inch, mainly because of natural increases in plant numbers after the relocation of the hiking trail. The transplant population continues to exceed the modeled minimum population size of 50 plants (Izard-Crowley and Kimball 1998). In addition, 169 plants grown from seed at NEWFS and introduced to another site near a small natural population on Mt. Lafayette have now increased to more than 300 individuals (Weihrauch and Kimball 2000).

The resurgence of the natural populations and apparent success of the transplants has led officials at the USFWS to propose that Robbin's cinquefoil be removed from the List of Endangered and Threatened Plants (U.S. Fish and Wildlife Service 2001). Although the objectives of the Recovery Plan have essentially been met, monitoring of this species (and if necessary, transplanting) should continue at regular intervals, given this species' relatively small populations and extremely limited range. Moreover, if global warming increases, it is unlikely that a species located on only two alpine peaks will be able to migrate northward in response to warmer temperatures.

## Acknowledgments

The collaboration of the organizations mentioned above is gratefully acknowledged. Thanks to Susi von Oettingen (USFWS), Ken Kimball and Doug Weihrauch (AMC), and Kathy Starke (USFS) for their help and guidance. Special thanks to Carol Fyler and Helga Andrews, volunteers at NEWFS, as well as NEWFS staff member Chris Mattrick. Partial funding for propagation and transplanting came from the USFWS, the National Forest Foundation, and the National Fish and Wildlife Foundation.

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## 133

### Seeding Trials Expand the Distribution of Sonoma Spineflower Populations on Point Reyes National Seashore (California)


*Michelle Coppoletta and Barbara Moritsch, Point Reyes National Seashore, Point Reyes, California 94956, 415/464-5221, Michelle_Coppoletta@nps.gov*


The Sonoma spineflower (*Chorizanthe valida*) is a federally endangered, annual species that is limited in its distribution to 2.5 acres (1 ha) of coastal prairie on the Point Reyes Peninsula, 40 miles north of San Francisco. This species was presumed to be extinct until 1980, when a group of amateur botanists found a population growing in a grazed pasture within Point Reyes National Seashore. It is believed the Sonoma spineflower is restricted to well-drained, disturbed, sandy soils and is dependent on grazing by cattle or other wildlife to reduce competition (Davis and Sherman 1992). These requirements, coupled with the spineflower's narrow endemism, make it particularly vulnerable to disease, fire, flood, or other events that could eliminate the population and cause extinction.

In 1988, Liam Davis, a graduate student at Sonoma State University, undertook the first effort to expand the boundaries of the Sonoma spineflower by hand-planting 1,000 seeds collected from the main population into three 2-m x 2-m plots. The plots were located within a short distance of the main population, close enough for insect pollinators to transfer genes between the two populations (Davis and Sherman 1992). Plants in all three plots were successful the first year, but after that the number of individuals in two plots decreased steadily while the number of individual plants in the remaining plot increased. When we visited the plots in 2000, we found that only one contained Sonoma spineflowers, although the population had increased to 691 individuals spread over a 38-$m^2$ area. We hypothesize that the two unsuccessful seed trial plots were on a more mesic soil type that has favored the colonization and dominance of non-native grass species.

In 1999, The U.S. National Park Service and the Point Reyes National Seashore Association began a cooperative effort to further expand the boundaries of the population. Using Davis' seed plot methods as a guideline, we established two more trial plots 492 feet (150 m) from the main population. After two years, each plot supported more than 50 mature individuals.

We also began to search for sites away from the main population that would be suitable for Sonoma spineflower reintroduction. We identified two sites after consulting historic records, soils maps, and local plant taxonomists and conducting field searches. The first site, located on a historic ranch nearly 1 mile (1.5 km) south of the main population, is believed to be the location where a Sonoma spineflower specimen was collected in 1903. In fall 1999, we removed cattle troughs and planted 1,000 seeds that had been collected from the main population into one 2-m x 2-m plot. In August 2000, we established two more plots on this site. By early summer 2001, the first trial plot contained 182 Sonoma spineflowers and had expanded beyond the original seed plot boundary. Of the two additional plots, only one was successful, with 77 Sonoma spineflower plants by June 2001. We speculate that plants did not establish in the third plot because of high levels of cattle activity in the surrounding area

The second trial site, approximately 1 mile north of the main population, is in a partially stabilized coastal dune community dominated by low-growing herbaceous perennials and open sand. We chose this site because it has been suggested that the Sonoma spineflower may grow in sandy habitats with wind and slope erosion, although it presently has no mechanism of dispersal to those sites (Baye personal communication). Our primary interest was to determine whether the lack of competition and the presence of natural disturbance would favor Sonoma spineflower establishment. In 1999, we established one 2-m x 2-m plot and planted 1,000 seeds. In 2000, we revisited this site and found no plants. The failure of this seed trial suggests that the Sonoma spineflower is unable to survive in this type of environment, possibly because of low nutrient levels, high infiltration rates, or high levels of disturbance.

The results of our seed trials suggest that we can expand the boundaries of the main population of Sonoma spineflower through seeding and that we can establish additional populations in suitable habitat. Although it is impossible to predict whether the new populations will persist over time, the establishment of a second population a mile or more away from the main population reduces the probability of extinction from catastrophe and moves us one step closer to the long-term conservation of this species.


## Acknowledgments

We gratefully acknowledge the generous support of the Point Reyes National Seashore Association and the hard work and dedication of Liam Davis, Brook Edwards, Bob Soost, and the many members of the Marin Chapter of the California Native Plant Society.

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## 134

### Restoring Habitat of Crinite Mariposa Lily, A Rare Endemic (Oregon)


*Russell N. Holmes and Gary Basham, Bureau of Land Management, 777 NW Garden Valley Blvd., Roseburg, OR 97470, 541/440-4930, Fax 541/440-4948, r1holmes@or.blm.gov, gbasham@or.blm.gov.*


First identified in the 1980s, the Crinite mariposa lily (*Calochortus coxii*) is a state-listed endangered species limited to a 10-mile (16 km) serpentine ridge system near Myrtle Creek in Douglas County, Oregon (Fredricks and others 1992). During the last century, fire suppression dramatically reduced the amount and availability of its habitat (Kagan 1993), which consists of forest, shrub, and meadow communities on serpentine soils. Other threats include logging, grazing, road construction, mining, noxious weed invasion, herbivory by deer and insects, and bulb collecting. A total of 24 occurrences currently are present on private and public lands, with the most vigorous occurrences growing in open forest and meadows on northerly aspects (Federicks 1989). In this note, we describe several activities that the Bureau of Land Management (BLM) has implemented to conserve and restore this species.

The agency's conservation strategy for Crinite mariposa lily (1998) identifies the following management actions for restoring habitat and maintaining or increasing population numbers on BLM-administered lands:

- Develop voluntary conservation agreements with adjacent land owners
- Collect seed for long-term storage at a Center for Plant Conservation Seed Bank
- Manage livestock to remove grazing impacts
- Restore native species to meadow habitat
- Conduct prescribed fire at 10-20 year frequencies and thin or girdle trees in order to maintain open forest and meadow habitat and to produce forest gaps
- Survey and control noxious weeds

Some of these actions were already in progress before the agency produced this document. For example, during five separate years since 1992, we collected seed of Crinite mariposa for storage at the Berry Botanic Garden in Portland, Oregon. In addition, since 1995, agency staff have used an integrated pest management approach to control yellow starthistle (*Centaurea solstitialis*), rush skeletonweed (*Chondrilla juncea*), and Italian thistle (*Carduus pycnocephalus*) growing within range of the Crinite mariposa lily. Treatments include 1) hand pulling of all three species, 2) the release of yellow starthistle hairy weevil (*Eustenopus villosus*) and other biocontrol agents, and 3) application of a 1-percent solution of Tordon 22K to individual yellow starthistle plants growing outside Crinite mariposa lily

population boundaries. Although we do not have data to show that these efforts have reduced the targeted plants, we have observed a significant decrease of star thistle on at least one site.

In 1999, we began habitat restoration on Langell Ridge. In the fall, we conducted a light, understory burn on approximately 3 acres (1.2 ha) of open forest habitat dominated by Jeffrey pines (*Pinus jeffreyi*). The burn destroyed small seedlings of Jeffrey pines and incense-cedar (*Calocedrus decurrens*), but maintained the surface duff layer that protects soils from winter rains. In spring 2000, we removed or girdled approximately 150 trees on a 1-acre (0.4-ha) portion of the site in an attempt to mimic canopy cover conditions of areas with the most robust occurrences of Crinite mariposa lily.

To determine population trends over time, we have been monitoring the treatment site on Langell Ridge every other year since 1994 and another occurrence on Bilger Ridge since 1992. Our specific monitoring objective is to detect a 30-percent change in population numbers, with a 10-percent chance of a missed-change error and a 10-percent chance of a false-change error over five data-collection years. Preliminary analysis indicates no significant change in either occurrence. In summer 2002, we will collect monitoring data at the Langell Ridge treatment site for the first time since the burning, thinning, and girdling treatments.

We plan to continue our efforts to increase populations of Crinite mariposa lily by establishing conservation agreements with adjacent private land owners, collecting native grass and forb seed for reintroduction into meadow habitat, performing additional prescribed fire and thinning projects (including continued management of the Langell Ridge site), and expanding current monitoring efforts to include methods that assess the effectiveness of habitat restoration treatments.

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## 135

**Swimming Performance of the Topeka Shiner (Notropis topeka) an Endangered Midwestern Minnow.** 2000. Adams, S.R., Dept. of Zoology and Fisheries and Illinois Aquaculture Center, Southern Illinois University, Carbondale, IL 62901, adamsr@siu.edu; J.J. Hoover and K.J. Killgore. **American Midland Naturalist** 144(1):178-186.

Using laboratory swim tunnels, the authors quantified swimming endurance and behavior for the Topeka shiner, a minnow endangered by changes in stream hydrology in the midwestern United States. Results show that Topeka shiners can swim at speeds faster than the water velocities they usually inhabit. The authors suggest that the use of fishways and culverts may thus aid in the minnow's dispersal and recolonization into former habitats. Using swimming endurance data, they assessed the optimal size and water velocities for these structures. Because other factors beyond the scope of their study affect swimming performance, the authors are recommending field tests to determine the efficiency of these fishways.

## 136

**Native Orchid Restoration Project.** 2001. Anon. **The Palmetto** 20(4):7.

Formed in January 2001 by the Naples Orchid Society Conservation Committee, the Native Orchid Restoration Project (NORP) is now a coalition of various conservation and botanical organizations. The NORP strives to address questions surrounding the declining native population of orchids in south Florida. Areas of concern include: 1) why native orchids do poorly in captivity, 2) how to increase the chances of survival for new colonies, 3) how the starting of new colonies can promote natural restoration, 4) finding the natural inoculation to prevent disease and pests, and 5) identifying the critical factors in reproduction and survival. For more information, contact the Native Orchid Restoration Project, PMB 134, 4888 Davis Blvd., Naples, FL 34104.

## 137

**A Demographic Analysis of Fire-Stimulated Seedling Establishment of *Sarracenia alata* (Sarraceniaceae).** 2001. Brewer, J.S., Dept. of Biology, University of Mississippi, University, MS 38677, Fax: 662/915-5144, jbrewer@olemiss.edu. **American Journal of Botany** 88(7):1250-1257.

Using a matrix model, Brewer examined the effects of fire-stimulated increases in seedling establishment of yellow trumpets (*Sarracenia alata*) in wet pine savannas in southeastern Mississippi. Although plant reproduction increases with fire, he found that fire-stimulated seedling establishment plays a relatively minor role in maintaining populations of the common species compared with the role adult survivorship plays. Nonetheless, fire may be useful for the conservation of certain rare species (e.g., crimson or white-top pitcher plant {*S. leucophylla*} and green pitcher plant {*S. oreophila*}) that have a morphology and life history similar to yellow trumpets, if fire increases the establishment of seedlings in these species as well. If so, then a decrease in the time between fires from seven to three years could increase population growth rates and promote colonization of suitable habitat patches. Fire-stimulated increases in seedling establishment may also increase genetic diversity. Brewer notes that habitat restoration should precede reintroduction efforts if the species' absence is due to habitat deterioration or removal by collectors.

## 138

**Allozymic Variation in the Endangered Delmarva Fox Squirrel (Sciurus niger cinereus): Genetics of a Translocated Population.** 2001. Moncrief, N.D., Dept. of Mammals, Virginia Museum of Natural History, 1001 Douglas Ave., Martinsville, VA 24112, 540/666-8614, Fax: 540/632-6487, moncrief@mail.evsc.virginia.edu; and R.D. Dueser. **American Midland Naturalist** 146(1):37-42.

The authors compared genetic variation in an isolated, translocated population of Delmarva fox squirrel in the Cincoteague National Wildlife Refuge, Virginia, with its source population in the Blackwater National Wildlife Refuge, Maryland. They found the genetic variation did not differ significantly between the two populations. However, because the long-term genetic consequences of translocation are uncertain for the Delmarva fox squirrel, the authors advise that the translocated population be tested periodically for any loss in genetic variation.

# EDUCATION & SOCIAL SCIENCE

## 139

**The Holy Isle: A Religious Community Reforestation Project.** 2001. McColl, N. **Reforesting Scotland** 26:41-42.

Since the early 1990s, the Buddhist community that lives on Holy Isle, a small island off the west coast of Scotland, has combined conservation efforts with other projects to increase the community's self-sufficiency and provide areas for contemplation. Volunteers have planted about 30,000 trees to help restore deforested areas. Members of the community are also on the alert for invasive plants. The community plans education activities as well as a tree nursery.

# ORGANIZATIONAL PROGRAMS

## 140

### Save Ontario's Savannas: Promoting Voluntary Stewardship of Remnant Tallgrass Communities

*Lindsay Rodger, Senior Manager, Wildlife Conservation and Outreach, World Wildlife Fund Canada, 245 Eglinton Avenue East, Suite 410, Toronto, Ontario, M4P 3J1, lrodger@wwfcanada.org; and Todd Farrell, Save Ontario's Savannas Program Director, Tallgrass Ontario, 659 Exeter Road, London, Ontario, N6E 1L3, farrelltg@hotmail.com*

Agricultural land uses and urbanization have reduced tallgrass prairie and oak savanna plant communities in southern Ontario from approximately 247,000 acres (100,000 ha) to only 5,190 acres (2,100 ha)—or about two percent of its original extent (sources cited in Rodger 1998). These remnants, most of which are privately owned, are scattered across southern Ontario (Figure 1) and are considered among the most endangered ecological communities in Canada (Bakowsky 1999).

Tallgrass Ontario is a nonprofit association that is working to conserve, manage, and restore tallgrass prairie, savanna, and related ecological communities in Ontario. It was formed following the completion of a recovery plan for tallgrass communities in Southern Ontario (Rodger 1998) commissioned by World Wildlife Fund Canada and the Ontario Ministry of Natural Resources. The protection of remnant sites was cited as the plan's highest priority. Thus, in 2000-2001, Tallgrass Ontario developed and launched Save Ontario's Savannas (SOS), a program that 1) encourages landowners of tallgrass prairie and savanna remnants to be volunteer stewards and 2) offers information to assist participants with their conservation efforts.

To identify perspective participants, we first collected ecological, geographical, and land ownership information for each of the 180 known remnants. We created a database to organize all incoming information and maintained files for each remnant. We then prioritized the sites using a system that ranks remnants according to differences in size, quality, and landscape context (Bakowsky 1998).

For the second phase of the project, we drew on established landowner contact techniques (Hilts and others 1991). We sent out media releases, contacted landowners by letter, and visited owners of high-priority sites. During each site visit, we encouraged the landowner to show us the property. At the same time, we discussed tallgrass community ecology, plant and animal identification, and management options. We encouraged landowners to talk about their land, their lives, and their interests. We impressed upon them the uniqueness of these plant communities and we congratulated them for keeping the remnant intact.

If the landowners indicated an interest in conserving the remnant, we invited them to make a voluntary, verbal agreement to be actively involved in the conservation of the remnant ecosystem. As part of the agreement, Tallgrass Ontario provides the landowner with several items, including:

- A gate sign and a kit containing ecological information and options for managing and conserving a tallgrass prairie or savanna remnant
- A subscription to *The Bluestem Banner,* Tallgrass Ontario's newsletter, which contains current information about tallgrass wildlife, management, projects, and events around the province
- If desired, assistance obtaining additional biological and land management advice

During the first year of the SOS project, we mailed more than 300 initial contact letters and completed 58 landowner visits. These resulted in 33 voluntary stewardship agreements amounting to 320 acres (130 ha) of tallgrass remnants (Farrell 2001). Approximately 90 percent of the private landowners we contacted had been unaware of the existence of tallgrass communities in Ontario or that this unique community occurred on their property. Most, if not all, of the 33 stewards are owners of what we consider high-priority remnants.

We found that the landowners we visited have a healthy respect for their land, especially when they are aware that they own a very unique habitat. They take pride in what they have and are interested in conserving and restoring it. Several landowners pointed out plants that they remembered seeing as children. Often, these plants were classic prairie indicator species. With this knowledge, the landowner realized an instant connection to the prairie, his or her childhood, and the family's history. Indeed, landowners expressed a keen interest in conserving these special places for their children.

Many of the remnants we visited are seriously degraded and in need of management to restore their composition, structure, and historic disturbance cycles. Numerous landowners expressed the desire to engage in restoration activities, but will require advice and assistance to do so. In response, the staff of Tallgrass Ontario is planning to develop a landowner's remnant restoration and maintenance manual and intends to assist selected landowners with their management plans. We also intend to have ongoing contact with all voluntary stewards through letters and periodic visits.

Given the results of Tallgrass Ontario's SOS Program, the future of Ontario's tallgrass communities is much brighter. The program reached out to numerous landowners who had been unaware of the ecological importance of their property, assisted them with useful information, and successfully encouraged many of them to be the principle agents of conservation. We will continue to visit and encourage landowners to become voluntary stewards. We also plan to develop additional extension materials. To learn more about Tallgrass Ontario and follow our progress, visit our Web site at www.tallgrassontario.org.

## Acknowledgments

The Save Ontario's Savannas Project would not have been possible without the generous support of the Donner Canadian Foundation and Ontario's Living Legacy. We would like to thank the 33 landowners who have volunteered to conserve tallgrass remnants on their properties.

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# ISSUES & PERSPECTIVES

## 141

**Consensus versus Conservation in the Upper Colorado River Basin Recovery Implementation Program.** 2001. Brower, A., Dept. of Environmental Science, Policy, and Management, University of California-Berkeley, 135 Giannini Hall, Berkeley, CA 94720-3312, abrower@nature.berkeley.edu; C. Reedy and J. Yelin-Kefer. **Conservation Biology** 15(4):1001-1007.

Using the Colorado River Recovery Implementation Program as a case study, the authors examine the pros and cons of consensus-based management applied to environmental decision making. After reviewing information regarding the river's native fishes and interviewing 22 people involved in various aspects of the program, they conclude that the program facilitates agreement between constituencies. However, the fish populations are not recovering. The authors identify two major weaknesses: 1) political agendas take priority over recovery, and 2) the stakeholders do not carry equal power. They recommend the following changes for future consensus-based endeavors: 1) link program success to species population growth, 2) keep the right to water development tied to the status of the fish populations, switching the focus from politics to recovery, and 3) adjust funding to reduce the excessive power of groups primarily interested in water development.

## 142

**Should Wolves Be Reintroduced to the Highlands of Scotland?** 2001. Holt, D. **Reforesting Scotland** 26:38-40.

Holt examines the feasibility of introducing wolves into Scotland in light of the European Union's call for member countries to investigate reintroducing missing species. Those in favor of the reintroduction argue that wolves were an essential element of the Scottish forest ecosystem, as top predator, and that the country has an ethical imperative to reinstate them. Anti-wolf sentiment in Scotland runs deep, however. Sheep farmers fear that their industry could be ruined, and others point to the possible threat to humans. Although restoration is making the woodland habitat more suitable for reintroduction, groups hesitate to come out in favor of wolf reintroduction in the face of negative public opinion. Nonetheless, Holt encourages organizations to begin the needed research and local discussion, making clear to the public that wolf reintroduction is not an immediate goal.

## 143

**Biodiversity and Ecosystem Functioning: Current Knowledge and Future Challenges.** 2001. Loreau, M., Laboratoire d'Ecologie, UMR 7625, Ecole Normale Supérieure, 46 rue d'Ulm, F-75230 Paris Cedex 05, France, Loreau@ens.fr; S. Naeem, P. Inchausti, J. Bengtsson, J.P. Grime, A. Hector, D.U. Hooper, M.A. Huston, D. Raffaelli, B. Schmid, D. Tilman and D.A. Wardle. **Science** 294(5543):804-808.

This article discusses recent experimental and theoretical work focusing on the relationship between biodiversity and ecosystem functioning. Although major advances have been made in this area, it is not clear how to apply experimental results at the landscape and regional scales and how to generalize them across ecosystems. Although scientists disagree about the relative importance of declining species richness and functional substitutions as determinants of ecosystem functioning changes, both comparative studies and experimental studies indicate that a large pool of species is needed to sustain ecosystem processes in areas subject to increasing land use by humans. Devising functional classifications to replace species richness measures may prove more useful for predicting ecosystem responses under different global change scenarios or for developing management priorities. The authors conclude that coordinating observational, experimental, and theoretical studies could lead to a synthesis of community and ecosystem ecology.

# BOOK REVIEWS

## 144

**Large Mammal Restoration: Ecological and Sociological Challenges in the 21st Century**

*David S. Maehr, Reed F. Noss, and J.L. Larkin, editors. 2001. Washington, D.C.: Island Press. Cloth, $65. ISBN: 1-55963-816-8. Paper, $30. ISBN: 1-55963-817-6. 336 pages.*

Since the days of Aldo Leopold and his classic book, *Game Management* (1933), wildlife ecologists have pursued the restoration of huntable species through reintroductions and translocations, habitat manipulation, feeding programs, and other activities. Most traditional restorationists, however, did not embrace these activities as restoration per se. Now the field of ecological restoration is expanding beyond it historic emphasis on plants to incorporate animals and wildlife ecology into project planning and management.

Traditional wildlife ecologists are also making greater efforts to adopt a more holistic, ecological approach in both their research and management efforts. *Large Mammal Restoration*, which resulted from a symposium held at the 1999 annual meeting of The Wildlife Society, is clear evidence that the wildlife profession is embracing the field of ecological restoration within its ranks. This work purports to discuss the problems and prospects of planning, implementing, and restoring fundamental predator-prey systems, with an emphasis on North America and on larger herbivores and carnivores (page xii).

First, I want to compliment Maehr, Noss, and Larkin for bringing this volume to print within two years of the symposium—never an easy task. They have arranged this work into 16 chapters, separated into four sections: Feasibility, Practice, The Human Link, and Abetting Natural Colonization. I found no major difficulty with any individual chapter. Each presents some interesting data and insights into the specific species and location discussed.

*Large Mammal Restoration* does not, however, represent a comprehensive or synthetic work on large mammal restoration. Rather, the chapters describe the results of time, site, and species-specific studies with little or no reference as to how successes and failures can be used to advance the field. As a result, the book is essentially a compilation of case studies that lack an overall focus and structure. For example, *Large Mammal Restoration* does not explicitly cover the key issues of temporal and spatial scale, predator-prey dynamics, resource use and availability (and niche relationships), nutrition, succession, and so forth. Although readers can glean bits of useful information from each chapter, most would be more suitable as individual journal articles.

As is typical of edited volumes, the editors did little to link the chapters within each section. Although each section includes an introduction, these are overly brief and barely lay out the importance of the section, key issues of concern, and so on. Furthermore, there is no summary of each section—nothing to compare and synthesize the topics. What are the key messages between the chapters? What is not covered? What are the major tasks yet to be accomplished? The concluding commentary by David Maehr does not fulfill this role. Instead, Maehr largely restates the need to consider evolution in wildlife management, with an emphasis on large mammals. While this is an admittedly key point, Maehr's commentary does not provide specific recommendations related to restoration.

"Health Aspects of Large Mammal Restoration," by Joseph Gaydos and Joseph Corn, is a good example of a chapter that actually reviews and synthesizes a key theme. Many more such "theme" chapters would have been helpful. The book does include a chapter by Steven Fritts and ten co-authors on several methods for releasing animals into the environment. However, the authors only focus on one species and do not generalize the discussion to other species or locations. I was also disappointed that the central issue of planning mammal restorations on a broad-scale landscape context is mentioned in only a few places, for example, in "The Biotic Province: Minimum Unit for Conserving Biodiversity" by Larry Harris and six co-authors.

The editors could be very satisfied with their product, and I would not try to argue them out of their position. After all, they designed the effort and I assume peer reviewers were satisfied with the result. However, I envision a different approach that I think could better contribute to the continuing effort of creating stronger links between traditional restorationists and wildlife ecologists. First, such a work should begin by briefly reviewing the facts and fiction about predator-prey relationships, top-down versus bottom-up regulation, large mammal evolution, and other concepts that are central to large mammal ecology. This would establish a foundation of knowledge for a broad array of readers. Second, it should contain chapters that delve into scale-related (spatial and temporal) discussions of restoration as related to large mammals. It could also discuss specific management techniques, such as captive propagation, release methods, diseases and parasites, nutritional needs, and so forth. Finally, it should include case studies and, in fact, some of the chapters in *Large Mammal Restoration* could serve that purpose.

I wish to take issue with one of the rationale listed for the need to restore large mammals. Although I accept that maintaining and restoring populations of native animals is desirable, I recognize that not everyone holds such an opinion. Afterall, large mammals are difficult to study, restore and manage, and doing so often runs counter to the economic interests of some stakeholders. However, in the first sentence of the first chapter by Carlos Carroll and three co-authors entitled "Is the Return of the Wolf, Wolverine, and Grizzly Bear to Oregon and California Biologically Feasible?" we read, "Carnivores are *indicators* of *ecosystem function* and can serve as *keystones* in the *top-down regulation* of ecosystems" (page 25). I have added the italics to highlight the four controversial concepts that these authors use to support the need for restoration. There are many credible papers that present evidence questioning the validity of these concepts, and these papers could be used by critics of restoration to argue that large mammals really are not needed. I prefer that scientists stick closely to the data, rigorously define and apply terms, and avoid building arguments based on the layering of ecological concepts and jargon. This is especially true when one is trying to link disciplines. Further, the task of convincing the public and policymakers of the desirability to restore any animal population is only made more difficult when scientists develop well-intentioned yet weak arguments.

My comments should generally be taken as a desire for what could have been produced rather than criticism of this volume. Pulling together any collection of papers in a timely manner will certainly prove of value to some practitioners. However, this volume is not the comprehensive work on large mammal restoration that is currently needed.

*Michael L. Morrison*
*White Mountain Research Station*
*University of California*
*3000 East Line Street*
*Bishop, CA 93514*
*mike@wmrs.edu*

## 145

### Ground Work: Basic Concepts of Ecological Restoration in British Columbia

*Donald A. Gayton. 2001. Kamploops, British Columbia: Southern Interior Forest Extension and Research Partnership and Vancouver, British Columbia: Society for Ecological Restoration, BC Chapter. SIFERP Series 3. Paper, Free. ISBN: 1-894822-01-3. 25 pages.* (To order contact: Southern Interior Forest Extension and Research Partnership, 478 St. Paul St., Kamloops, BC V2C 2J6 Canada.)

*Ground Work* should help restorationists in British Columbia educate the general public about the need to restore damaged ecosystems. The booklet's attractive photographs and short, non-technical text make it a natural for handing out to clients, project shareholders, and volunteers. It could serve nicely as a template for similar publications in other locales.

As the title suggests, *Ground Work* covers the basic concepts of ecological restoration, but each only very briefly. Nonetheless, I think Don Gayton generally does a good job with few words. For example, the sections on definition, where to start with a restoration, adaptive management, local community involvement, and the need for monitoring are excellent. There are, however, a few areas that need to be rethought. For example, the information about succession theory and restoration is contradictory. On page 6, Gayton writes, "Restoration seeks to move a community … along a successional sequence toward a desired future condition. This condition is usually at or near the potential natural community." Whether or not one agrees with that statement, he then writes on page 10, "Potential natural community may not necessarily be the goal of every restoration project." This may be a case of needing to give a complex idea just a little more attention and space so as to instruct rather than confuse the reader. During his discussion of historic reference conditions (which I see as a welcome addition to any basic guide about ecological restoration), Gayton makes a common error—assuming that today's climate is similar to the climate in the near past. He writes, "Such historical benchmarks are generally selected from within our modern climatic period…. In British Columbia, this period is from about 1600 to 1800." (p. 8). Now, there is nothing wrong with gathering historic data from this period, but restorationists in the Northern Hemisphere should be aware that this period represents the latter two centuries of the Little Ice Age—a time when temperatures dropped 1 to 2ûF. Obviously, such a shift in temperature may make a difference in various aspects of historic plant and animal community composition, and may affect some ecological processes, such as fire and its return interval.

Those caveats aside, I recommend *Ground Work* to anyone involved in ecological restoration in British Columbia. In addition to the paper version, it is available as a PDF file at www.siferp.org/pubs/siferpseries/ss3.pdf. **D.E.**

## 146

### Heroic Tales of Wetland Restoration

*Esther Lev. 2001. Tualatin, Oregon: The Wetlands Conservancy. Paper, $15 plus shipping and handling. ISBN: 0-9660405-1-1. 75 pages. (To order contact: The Wetlands Conservancy, P.O. Box 1195, Tualatin, OR 97065; 503/691-1394, Fax 503/885-1084, info@wetlandsconservancy.org.)*

In 1933, Aldo Leopold wrote, "Those {nature lovers} of the greater degree insist that conservation is not mereley a thing to be enshrined in outdoor amusements, but a *way of living on the land;* that it must ultimately prevail on all lands, public and private, or go down in history as a pleasant but futile pipe-dream." (Game Cropping in Southern Wisconsin, *Friends of Native Landscape* newsletter). He would be pleased, I think, to read *Heroic Tales of Wetland Restoration*. It is an inspirational collection of stories about 12 landowners, located throughout rural Oregon, who have each undertaken a wetland restoration project. Thanks to Esther Lev, The Wetland Conservancy—an Oregon-based land trust—now has beautiful book to show other rural landowners and farmers who might be thinking about restoring parts of their property.

In the final third of the book, the text switches from motivational to practical. Topics here include: planning a wetland restoration, the pros and cons of different legal techniques for conserving private wetlands (conservation easements, management agreements, limited development strategies, remainder interests, and title transfers), a list and individual descriptions of grant and technical assistance programs available to Oregon landowners, and an overview of wetland restoration techniques. The final chapter highlights problems that the 12 landowners have faced during the process of restoring or attempting to restore their land. Their experience is a welcome addition not only for landowners who might use this book, but also for policymakers and natural resource agency staff to gain a better understanding of how they might help people interested in restoring a privately owned wetland. I suspect that The Wetlands Conservancy is going to advocate strongly for changes to streamline the regulatory and permitting process based on the experiences of these landowners.

As Lev points out, the tales told here could be told anywhere in the United States. Privately-owned wetlands represent 75 percent of the wetlands in the lower 48 states, making their owners key players—as Leopold pointed out nearly 70 years ago—in their conservation and restoration. **D.E.**

## 147

### Saving Louisiana? The Battle for Coastal Wetlands

*Bill Streever. 2001. Jackson, Mississippi: University Press of Mississippi. Cloth, $46. ISBN: 1-57806-329-9. Paper, $18. ISBN: 1-57806-348-5. 189 pages.*

Bill Streever's *Saving Louisiana: The Battle for the Coastal Wetlands* may be the restoration book of the year! It is a well-written, engaging, and thoughtful exposé about the multi-billion dollar effort to save and restore the coastal wetlands of Louisiana. Streever takes the reader along for the ride as he explores the bayou country from airboats, airplanes, motorboats, and his own kayak talking along the way with university and agency research scientists, conservation advocates, fishermen, and land managers. The result is a rich dialogue about the confusion, uncertainty, and hopes of the people who are trying to understand and work miracles with the seriously degraded and highly manipulated ecosystems of the Mississippi Delta.

This is a story of a restoration experiment on a grand scale. It is about trying to fit the environmental aspirations of restorationists into the life of oil and natural gas producers, shrimp and oyster fishermen, and many other economic interests in Louisiana. Streever shows the reader how, from the days of Mark Twain until today, we have dramatically altered the course and sediment deposition rates of the lower Mississippi River and its delta. He also looks into the workings of the Coastal Wetland Protection, Planning and Restoration Act, the federal bill that will provide $14 billion over the next three decades to fund the study and restoration of the delta area. But Streever's journalistic approach to this material is the book's real strength. Rather than boring the readers with the facts as he sees them, Streever talks to the people involved, and it is from these conversations that the reader begins to see and appreciate the complexity and nuances of this project. Whether he is crammed into a small airplane shouting back and forth to Professor Gene Turner of Louisiana State University about crevasse splays experiments they are seeing at the Delta National Wildlife Refuge; on a boat checking fish traps on Calcasieu Lake with Professor Lawrence Rozas and his students; in an office discussing policy issues with Mark Davis, director of the Coalition to Restore Coastal Louisiana; or riding in a pickup truck talking with Norman Laigh, a farmer who buys unprofitable farms and converts the wet areas to bottomland hardwoods, Streever works wonders by asking the right questions and letting the other person tell their story.

While all the chapters are rich, two of them worked especially well for me—"Living in the Bayou," which is a conversation with Professor Denise Reed, a British-trained geomorphologist who now teaches at the University of New Orleans; and the concluding chapter, "Lessons from Louisiana." Ms. Reed spoke to me because she was not afraid to be a scientist as well as an advocate and facilitator—she serves as the science advisor for the Coalition to Restore Coastal Louisiana to help other scientists understand the need for freshwater diversion projects restore wetlands inundated with salt water. And I appreciated her honesty: "We're not really talking about a natural ecosystem here in Louisiana….The landscape has a certain pattern to it. It has a certain biodiversity. It has gradients. We have to develop an understanding of these attributes, then restore to maintain that landscape…. And that's where 'restore' is the wrong word. We're really talking about management. We're talking about moving away from a paradigm of restoration to one of management. We're not making something into what it once was. What we're doing is maintaining the system as what we want." (p. 146). Whereas the other chapters focus on conversations with one or two people about a specific topic, "Lessons from Louisiana" is a grab-bag of ideas and quotes. They are, nonetheless, revealing because they represent a diversity of opinion, often highlighting the disconnect between research and practice. I was also interested in several comments about the relation between Louisiana and similar large-scale, federally-funded efforts underway in the Everglades, Chesapeake Bay, the Pacific Northwest, and the San Francisco Bay area. For example, Greg Steyer of the Louisiana Department of Natural Resources noted that, "We looked at all the major restoration programs that were out there in order to see the different approaches. Most of what was going on was just planting…. Well, we don't do much planting in Louisiana. We do some planting, but we really need things here that go way beyond planting. And the majority of programs we looked at didn't even have a monitoring requirement…. So we didn't learn much from other projects…. We're guinea pigs for the nation when it comes to restoration and ecosystem management at this scale." (p. 173). And thankfully, this chapter contains a discussion, even though most of the quotes are anonymous, about failed projects and experiments— "The public feels the projects should be successful. They don't recognize that restoration is a new science, that what we're implementing here is truly experimental." That itself tells me that restoration in Louisiana may be on the right track.

I recommend this book highly and thank Bill Streever for giving us a much better idea of the complexities involved in a high-profile, large-scale restoration project in the United States. **D.E.**

## 148

### A Guide to Bottomland Hardwood Restoration

*J.A. Allen, B.D. Keeland, J.A. Stanturf, A.F. Clewell, and H.E. Kennedy, Jr. 2001. Reston, Virginia: United States Geological Survey. United States Geological Survey, Biological Resources Division of Information and Technology Report USGS/BRD/ITR-2000-0011, United States Department of Agriculture, Forest Service, Southern Research Station, General Technical Report SRS-40. 132 pages. (Limited number of copies are available by contacting: Library, U.S. Geological Survey, National Wetlands Research Center, 700 Cajundome Blvd., Lafayette, LA 70506 or e-mail: Judy_Buys@usgs.gov.)*

I have a hunch that *A Guide to Bottomland Hardwood Restoration* is going to turn into the classic text in its subject area. It certainly is authored by people who have spent considerable time studying, analyzing, implementing, and monitoring the various aspects of bottomland hardwood restoration. Moreover, it's practical, nut's-n-bolts approach should make it perfect for land managers and land owners who are interested in restoring these forests.

The chapters of the book follow the standard procedures for woodland restoration projects—general planning, site evaluation, species selection, site preparation, seed collecting and storage, planting and other revegetation methods (seeds, seedlings, cuttings, transplants, topsoiling, and natural regeneration), establishing native undergrowth, post-planting control of unwanted vegetation, site protection, and monitoring. Each chapter is relatively short (about five pages) with the exception of the chapter on species selection which contains a lengthy table that has information about trees species, their habitat, flood and shade tolerance, seed ripening dates, seed storage requirements, reproductive characteristics, suitability for direct seeding, wildlife use, and timber value. A concluding chapter discusses the rehabilitation and management of degraded existing bottomland hardwood forests.

Throughout the book, the text is nicely supplemented by good black-and-white photographs, diagrams, charts, tables, and illustrations. Several useful appendices round out the material, including a list of seed and seedling suppliers, species-site relationships in the mid-South and in the Southern Atlantic Coastal Plain.

I recommend this book to any restorationist, land manager, or land owner who is interested in bottomland hardwoods and lives or works along the streams and rivers in the lower Mississippi River or the southeastern United States. **D.E.**

# WORLD WIDE WEB

## 149

## Organization Sites

*CIESM Atlas of Exotic Species*

**www.ciesm.org/atlas**

Over the past several decades, numerous exotic species have migrated to the Mediterranean Basin from the Atlantic or through the Suez Canal, or else have been accidentally introduced by people. The International Commission for the Scientific Exploration of the Mediterranean Sea (CIESM) has begun posting information sheets about the most recent "immigrants," starting with crustaceans, fish, and mollusks. Information about individual species includes physical descriptions, ecology, distinguishing characteristics, habitat, a distribution map, and—when available—a photograph of the species. To keep abreast of changes in distribution and new species introductions, the CIESM encourages researchers and others to email observations to the authors through the Web site.

*Gulf Restoration Network*

**www.gulfrestorationnetwork.org**

The Gulf Restoration Network is made up of organizations and individuals from Florida, Alabama, Mississippi, Louisiana, and Texas who are working to restore and protect the natural resources of the Gulf of Mexico. This site provides information and reports relating to the organization's primary interests: wetland restoration, fisheries enhancement and protection, and strategies for reducing the nitrogen loading into the Mississippi River that has created the Gulf "Dead Zone"—one of the largest areas of hypoxic water in the world. Links are available to current "action alerts" and an archive of the *GRN Newsletter*.

*Institute for Regional Conservation (IRC) Floristic Inventory of South Florida*

**www.regionalconservation.org**

In 1994, George Gann and the staff of the Institute for Regional Conservation began an inventory of the native and naturalized taxa that occur in South Florida. The result is a searchable database of approximately 2,200 species (including extirpated species). Site visitors have the option of 1) viewing the list for the entire 11-county region; 2) calling up the species for individual conservation areas, counties, or habitats; or 3) searching by taxa. This project is still in progress and users are invited to submit data. Sections of this site are also available in the newly published manual, *Restoring South Florida's Native Plant Heritage*, which can be ordered by contacting irc@regionalconservation.org.

*A Sampling of Salmon Recovery Viewpoints*

**www.orednet.org/salmon**

Few issues have been as hotly debated as the effort to recover salmon in the Pacific Northwest. This site maintains hundreds of links to online opinions from all sides of this issue—including salmon recovery organizations, utilities, corporations, Native American tribes, government agencies, academic researchers, politicians, the clergy, and many more. Range Bayer, the Oregonian who created this site, provides a nice summary of the various political and scientific hot button issues and brief descriptions of each link. Kudos to Bayer for periodically updating the site and ensuring that all links are still active.

*World Biodiversity Database*

**www.eti.uva.nl/Database/WBD.html**

The Expert Center for Taxonomic Identification in Amsterdam, The Netherlands, is compiling a database of the world's approximately 1.7 million known organisms. So far, the database contains taxonomic, biological, and ecological descriptions of more than 200,000 species of animals, plants, bacteria, and fungi. These are derived from 39 projects with such titles as "Arthropods of Economic Importance" and "North Australian Sea Cucumbers." This site is fairly easy to navigate and most entries are in English. At this point, however, it contains almost nothing about native plant species of North America.

## Commercial Sites

*Jack Pizzo & Associates, Ltd.*

**www.Pizzo1.com**

Since 1987, Jack Pizzo & Associates, Ltd. of Leland, Illinois has provided restoration and native landscaping services to public and private landowners throughout the Chicago Region. The company's site presents brief descriptions of past projects (see *ER* 19(3):184-185), thumbnails of some of the forb and tree species available from its nursery, a primer on ecological restoration and management, and a listing of restoration-related publications and Web sites.

*The Native Grass Manager*

**www.prairiesource.com/newsletter.htm**

This quarterly newsletter written and edited by Jef Hodges, a natural resources consultant from Missouri, offers helpful advice on a variety of topics pertaining to warm-season grass establishment and management. Examples include tips for creating a cool-season grass fire lane, introducing forbs into existing stands of native grass, haying and mowing, and information on seed supplies. Issues date back to the early 90s, so there's plenty of reading material.

*TerraFly*

**www.terrafly.com**

The premise of this new site is intriguing: Type the street address or ZIP code of any location in the United States and then take a virtual flight over the area—actually high-resolution black and white images from the United States Geological Survey (USGS). Indeed, I was able to enjoy a "flight" over the University of Wisconsin-Madison Arboretum's Curtis Prairie and adjacent neighborhoods. However, the virtual turbulence (windows that suddenly popped open with lists of neighborhood parks and shopping centers) eventually had me looking for a virtual parachute. Still, this site offers interesting capabilities for restorationists. For example, users can pay for a service that allows them to integrate their own data with the USGS images in order to produce a customized overlay. This site is a project of the High-Performance Database Research Center at Florida International University.

## Government Sites

*Benthic Habitat Mapping Guidance*

**www.csc.noaa.gov/crs/bhm/bhmguide.pdf**

The staff of the NOAA Coastal Services Center developed this document primarily as a guide for mapping specialists who want to produce digital spatial data on seagrass communities and other benthic habitats. However, it can also benefit coastal resource managers with project planning and serve as a technical resource when preparing grants and contracts. The guide covers all aspects of the mapping process, including collecting and analyzing aerial photographs, digitizing and editing data, using supplementary mapping methods, and conducting field surveys. This document, along with additional resources specific to restoration, conservation, and management of seagrass habitats is also available on a CD-ROM, *Submerged Aquatic Vegetation: Data Development and Applied Uses.* Copies can be ordered through the Center's online clearinghouse at www.csc.noaa.gov/clearinghouse or by calling 843/740-1210.

*Nonpoint Source NEWS-NOTES*

**www.epa.gov/owow/info/NewsNotes**

Although the Terrene Institute of Alexandria, Virginia has ceased to publish a paper version of its periodic newsletter, the editors will continue to make it available as a free electronic publication on the Environmental Protection Agency's site. As its name suggests, *Nonpoint Source NEWS-NOTES* focuses on the condition of aquatic environments and strategies for controlling sources of nonpoint source pollution. In addition, it features articles on the management and restoration of watersheds. Aside from current issues, the newsletter's home page offers an archive of issues dating back to 1989.

*Rich Grasslands for Missouri Landowners*

**www.conservation.state.mo.us/documents/landown/grass/grassland.pdf**

The Missouri Department of Conservation produced this 35-page, illustrated guide for rural landowners and farmers interested in restoring and managing native warm-season grasses and forbs on their properties. The publication discusses basic prairie restoration techniques, including site preparation, seed sources and mixes, seeding methods, and post-planting management. In addition, farmers can find helpful information about establishing and managing a native hay prairie and incorporating grazing into a management plan. While a few sections of this publication are specific to Missouri, most of the information is applicable to any region where tallgrass prairie is part of the historical landscape.

*Wetland Mitigation in Canada: A Framework for Application*

**www.cws-scf.ec.gc.ca/habitat/publications/mitigation_e.pdf**

In an attempt to provide a standardized approach for wetland mitigation, the North American Wetlands Conservation Council (Canada) has published a set of principles and guidelines for North American Wildfowl Management Plan project wetlands. This concise, 93-page PDF document is divided into three sections: 1) an introduction to wetland mitigation, which includes a recommended definition of mitigation, a discussion of no net loss, and description of three mitigation processes (avoidance, minimizing, and compensation); 2) seven case studies from throughout Canada, each of which is an example of a different mitigation process; and 3) steps for implementing the mitigation process from developing a project team to post-mitigation monitoring, evaluation, and management.

## Education Sites

*Build-A-Prairie*

**www1.umn.edu/bellmuse/mnideals/prairie/build/index.html**

My nine-year-old junior naturalist found this interactive game from the University of Minnesota's Bell Museum to be an instructive way to "restore" a barren landscape to either a tallgrass or shortgrass prairie ecosystem. To do so, she had to select the appropriate mix of plants, mammals, birds, herps, and insects from among several choices. While some of the vocabulary and concepts in the pop-up field guide were beyond the scope of an elementary school student, our reviewer did enjoy the animated graphics and colorful photos. On the down side, she thought the game was not challenging enough for computer-savvy kids and was disappointed by the promise of a fire component that turned out to be a one-paragraph description of a prescribed burn.

*Checklist of Online Vegetation and Plant Distribution Maps*

**www.lib.berkeley.edu/EART/vegmaps.html**

When I recently typed the keywords "vegetation maps" into Google, the search engine spit out more than 280,000 sites. To save time, I checked out this site from the University of California-Berkeley's library, which contains links to more than 80 sites worldwide featuring an array of ecosystem and species distribution maps. These range from major biomes to individual countries, primarily in Africa and Asia. While some sites appear to be pages scanned from text books (or worse), others are full-blown databases that allow users to plot species distributions (including a few paleogeographic mapping systems).

*Listening to the Prairie: Farming in Nature's Image (National Museum of Natural History of the Smithsonian Institute and American Library Association {ALA})*

**www.mnh.si.edu/exhibits/prairie/index.html**

**www.ala.org/publicprograms/listeningprairie**

Through August 2004, libraries from Illinois to California will host a traveling exhibit from the Smithsonian Institute that explores the transformation of grasslands to agricultural lands through several media, including: 1) photos, 2) a mural and audio program from the Konza Prairie Biological Station, and 3) a touch-screen "shopping cart" of items made from prairie-derived ingredients. The exhibit also includes the stories of families who are integrating sustainable farming practices with tallgrass prairie restoration and management. Both the Smithsonian and ALA sites provide a list of the host libraries (most with links). The ALA site also profiles the management strategies of the four families who are featured in the exhibit.

Ecological Restoration's new Web site address is: www.ecologicalrestoration.info

# MEETINGS

**2002**

*June 2-7.* **23rd Annual Society of Wetland Scientists Conference** will be held in Lake Placid, New York. For information, visit the conference Web page at www.sws.org/lakeplacid.

*June 13-15.* **Info'Coast 2: 2nd European Symposium on Knowledge and Information for the Coastal Zone** will convene in Noordwijkerhout, The Netherlands. For more information, visit www.infocoast.org/programs/noflash.html or contact info@infocoast.org.

*June 23-27.* **18th North American Prairie Conference: Promoting Prairie** will meet in Kirksville, Missouri. For information, contact the Kirksville Chamber of Commerce at 660/665-3766 or kvacoc@kvmo.net, or visit www.napc2002.org.

*June 23-28.* **26th Annual Conference of the Association of State Floodplain Managers** will meet at the Downtown Hyatt Hotel in Phoenix, Arizona. For details, visit the organization's Web site at www.floods.org.

*July 14-18.* **16th Annual Meeting of the Society of Conservation Biology** will meet at the University of Kent in Canterbury, England. Information is available at www.ukc.ac.uk/anthropology/dice/scb2002.

*August 4-8.* **Annual Meetings of the Society for Ecological Restoration and Ecological Society of America** will convene at the Tucson Convention Center & Concert Hall, Tucson, Arizona. For information, visit the SER Web site at www.ser.org or the ESA Web site at www.esa.org.

*August 17-22.* **4th International Symposium on Ecosystem Behavior** will convene at the University of Reading, England. For more information, contact biogeomon@reading.ac.uk or visit the conference Web site at www.rdg.ac.uk/biogeomon.

*August 25-31.* **3rd European Conference on Restoration Ecology** will be held in Budapest, Hungary. Information is available from the Institute of Ecology and Botany, Hungarian Academy of Sciences, Vácrátót, 2163 Hungary, Fax: (36) 28-360 100, or check out the conference Web site at www.botanika.hu/restoration/index.html.

*September 8-13.* **The Restoration of Asian Wetland Structure and Function** will meet in Nanjing, China. For details, contact Kep Lagasca, Center for Forested Wetlands Research, USDA Forest Service, 2730 Savannah Hwy., Charleston, South Carolina, 29414, 843/727-4271 ext. 100, Fax: 843/727-4152, klagasca@fs.fed.us or visit www.sws.org/china.

*September 9-13.* **13th Australian Weeds Conference** will be held in Perth, Australia. For information, send e-mail to convlink@wantree.com.au or point your browser to http://members.iinet.net.au/~weeds/.

*September 19-21.* **The Symposium on Environment and Sustainable Development in the New Central Europe** will be held at the University of Minnesota, Minneapolis. For more information, contact Gary B. Cohen, Center for Austrian Studies, University of Minnesota, 267 19th Avenue S., Minneapolis, MN 55455, 612/624-9811, Fax: 612/626-9004, gcohen@umn.edu.

*October 1-3.* **3rd Eastern Native Grass Symposium** will meet in Chapel Hill, North Carolina. For more details contact Teresa Flora, North Carolina Botanical Garden, CB#3375, The University of North Carolina, Chapel Hill, NC 27599-3375, Fax: 919/962-3531, tflora@email.unc.edu or visit www.unc.edu/depts/ncbg/symposium.htm.

*October 2-5.* **29th Annual Natural Areas Association Conference** will convene in Asheville, North Carolina. For information, visit the association's Web site at www.natareas.org.

*October 7-9.* **2002 Annual Meeting of the Association for State Wetland Managers** will meet in The Westin Hotel, Indianapolis, Indiana. For more information, contact Tammy Taylor, taylor@ctic.purdue.edu.

*October 27-30.* **Janet Meakin Poor Research Symposium: Invasive Plants—Global Issues, Local Challenges,** hosted by the Chicago Botanic Garden, will be meet in the Congress Plaza, Chicago, Illinois. For details, check out www.chicagobotanic.org/symposia/jmpsymp.html, or contact the Botanic Garden's Continuing Education Department at 847/ 835-8261 or continuingeducation@chicagobotanic.org.

**2003**

*January 13-15.* **History and Forest Biodiversity Symposium** will be held at Katholieke Universiteit in Leuven, Belgium. For information, send email to forestbiodiv@agr.kuleuven.ac.be or visit www.agr.kuleuven.ac.be/lbh/lbnl/forestbiodiv.

*April 28-30.* **Second International Conference on River Basin Management,** organized by the Wessex Institute of Technology, will be held in Las Palmas, Gran Canaria. Information is available at www.wessex.ac.uk/conferences/2003/riverbasin-3/netscape6.html or by contacting wit@wessex.ac.uk.

*June 8-13.* **24th Annual Meeting of the Society of Wetland Scientists** will meet at the Hyatt Regency in New Orleans, Louisiana. For more information, see the conference Web site at www.sws.org/regional/southcentral/2003.html.