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Concurrent Sessions
Abstracts

Adams, Ginny L. Population dynamics, habitat requirements and natural history of cavefish. Southern Illinois University, Department of Zoology Mailcode 6501, Carbondale, Illinois 62901.

Family Amblyopsidae, cavefishes and swampfishes, is comprised of four genera and six species found in the eastern United States. Four of the six species in this family are restricted to caves, one is restricted to spring/cave habitats and the other is found in swamps. Since their discovery and description in 1842, cavefish have elicited considerable interest from the scientific community, yet little is known about the basic biology and life history of these unique species. Discrete habitat requirements and limited range of cavefish have resulted in federal listing of two species (*Amblyopsis rosae* and *Speoplatyrhinus poulsoni*) and state listings of five species (*A. rosae*, *A. spelaea*, *Typhlichthys subterraneus*, *S. poulsoni* and *Forbesichthys agassizi*). The purpose of this talk is to characterize population dynamics, habitat requirements and natural history of cavefish with implications for conservation measures and land management. Species adapted to stable cave and spring environments provide excellent indicators of water quality because they are not able to withstand large shifts in environmental parameters. Cavefish have been found to exhibit increased sensitivity to changes in dissolved oxygen and temperature when compared to epigean (surface) species, making them susceptible to anthropogenic disturbance from agricultural runoff and related land–use practices. A better understanding of habitat requirements and life history is especially crucial for spring cavefish, *F. agassizi*, which is not only found in caves but also associated surface-spring habitats which may be more susceptible to local water-level manipulations. Factors most likely to limit or cause decline within cavefish populations are 1) destruction of habitat through land use practices, alteration of surface drainage and sedimentation; 2) over-collecting for commercial purposes and scientific research; 3) disturbance by humans, either indirect or direct.

Ashley, David C. An introduction to caves and karst. Biology Department, Missouri Western State College, 4525 Downs Dr., St. Joseph, Missouri 64507.

Karst is a term for a landscape that may be characterized by the presence of springs, caves, sinkholes and losing streams. The attribute these natural features have in common is the subsurface movement of water through solutionally-defined cavities. The biotic communities associated with cave environments often include endemic species and species with unique evolutionary adaptations. This presentation will focus on caves and karst and the organisms typically found inhabiting cave and karst habitats. The presentation will provide a useful introduction to many of the additional presentations in this session. Terminology useful to resource specialists will be defined and illustrated with a variety of images. Cave zonation and physical features of cave habitats will be discussed as they relate to the distribution of cave inhabitants. An overview of cave biota will be presented and the general categories of cave organisms will be described. The link between cave communities and surface habitats will be explained. Trophic interactions and movement of pollutants depend upon this link. Information provided should help individuals responsible for managing karst resources better understand the unique biotic and abiotic factors associated with this land form.

Becker, Randall J. Future agency partnering initiatives in natural area/ecosystem management. U.S. Army Corps of Engineers, Little Rock District, 700 West Capital, Little Rock, Arkansas 72203-0867.

While records indicate the benefits of habitat enhancement programs to wildlife species, overall species diversity is declining. Managing for diversity on private lands is dependent upon the willingness and education of the landowner. Natural area and ecosystem management on public lands has increased along with a corresponding increase in ecological research and understanding. Cooperative Management Agreements are initiated on Little Rock District lands where significant ecological areas have been identified. The Nature Conservancy (TNC) assists the Arkansas Heritage Commission in the management of the Saratoga Blackland Prairie in Southwest Arkansas. This area is a high complex of communities including both dry prairie and dry mesic forest. TNC conducts regular prescribed burns to control invading species and to perpetuate and maintain the natural qualities of this ecologically significant area. District personnel are promoting a graduate student project to conduct an inventory of a special wetland high mountain sedge-shrub fen. In addition to protecting sites that are of natural significance, Little Rock District is partnering with Missouri Department of Conservation (MDC) to incorporate ecosystem management principles. Managing for native communities such as Ozark Glade and Savannah types relies on vegetative control and prescribed burning to provide habitat conditions that perpetuate more desirable (diverse) species. A Memorandum of Agreement with Southwest Missouri State University and MDC established an outdoor classroom-research center field station that has its own web site www.cnas.smu.edu/bullshoals/concepts.htm. This partnership will greatly enhance both agencies' missions of ecosystem management and protection of "special status species."

Beverl, Tammie R., David J. Gibson, Mark A. Basinger and Jody P. Shimp. Habitat and life history characteristics of *Dioscorea oppositifolia* L., an invasive exotic plant species, in southern Illinois. Department of Plant Biology, Southern Illinois University, Carbondale, Illinois 62901-6509 (TRB, DJG, MAB). Illinois Department of Natural Resources, Rt. 2, Box 177, Golconda, Illinois 62938 (JPS).

The invasion of exotic species is one of the most serious threats to Illinois forests and natural areas. Over 27% of the total flora of Illinois are exotic species that have escaped cultivation. These exotics can alter ecosystem functions and reduce biodiversity. *Dioscorea oppositifolia* L. is an invasive exotic that is an increasing problem in natural areas in southern Illinois. It is native to China and was introduced in the U.S. as an ornamental vine. It is a member of the Dioscoreaceae (yam family) and has a persistent tuber that resprouts yearly. This species has the potential to spread rapidly through the production of axillary tubers called bulbils, which are modified stems produced in the leaf axils. Each vine produces numerous bulbils and each bulbil has the potential to produce a new plant. Virtually no studies have been done on the ecology of this species in the US. Our study will describe the habitat of *D. oppositifolia* L. in southern Illinois and examine some of its life history characteristics including bulbil production, survivorship and growth. Community types will be described and species diversity will be examined to determine whether *D. oppositifolia* L. is eliminating native plant species. Knowledge of the species' life history will help in the assessment of its potential to spread and threaten native ecosystems and rare species. It will also help us to develop control methods.

Blair, Robert B. Looking beyond the habitat island: landscape heterogeneity and birds in urbanizing environments. Department of Zoology, Miami University, Plarnon Hall Rm. 212, Oxford, Ohio 45056.

Many conservation biologists and natural areas managers view today's landscape as one of pristine habitat islands surrounded by an "uninhabitable" sea and, consequently, focus their attention on the "pristine habitats." Here, I reverse this view by examining the uninhabitable sea along a gradient of urban land uses. Specifically, I explore the Disturbance Heterogeneity Hypothesis (DHH), which suggests that biodiversity patterns along urban gradients can be explained by changes in the heterogeneity of a landscape as a non-linear response to disturbance. This implies that as a landscape is converted from wildland to urban, the heterogeneity of the landscape first increases and then decreases. I explore this idea by examining the distribution of resident bird populations and woody plants across an urban gradient of six sites of former woodlands in Butler County, Ohio. Both birds and woody plants shift from predominantly native species in the undisturbed areas to invasive species in the urban sites. Bird and plant species richness, woody plant density and bird biomass peak at moderately disturbed sites. These results support the DHH and suggest that bird composition is directly related to habitat heterogeneity in urbanizing systems. The implication for natural areas management is that the "uninhabitable sea" is a dynamic part of the landscape that cannot be ignored. Additionally, it demonstrates that high species richness (of either birds or woody plants) does not indicate pristine habitat.

Blake, John G. Restoration of an oak forest in east-central Missouri: early effects of prescribed burning on birds and woody vegetation. Department of Biology, University of Missouri-St. Louis, 8001 Natural Bridge Rd., St. Louis, Missouri 63121.

Prescribed burning often is used as a restoration tool in parks and reserves but effects on woody vegetation and birds in closed-canopy oak forests are not well studied. A program of prescribed burning in forest understory was instituted in Cuivre River State Park (2,750 ha), Lincoln County, Missouri in 1989. I sampled woody vegetation and birds in two burned and two unburned sections of the park. Burned areas had experienced two to four burns at the time vegetation was sampled in 1996. To date, differences between burned and unburned areas of the park are most noticeable in the understory structure and, to a lesser extent, in the species composition of small to medium-sized (<10 cm dbh) trees. There were no differences in overstory structure or species composition that could be attributed to burning. Although total number of bird species and individuals recorded during point counts (1996 - 2000) were comparable on burned and unburned areas, substantial differences existed in species composition and in abundance of individual bird species. Nest site location and foraging behavior appeared to influence degree of response by bird species. Species nesting on the ground or in saplings were less common on burned areas. Canopy foragers and nesters showed little response to burning. Results to date reflect relatively short-term (< 10 years) responses to burning. It is expected that changes in canopy composition and structure will occur over time with further impacts on bird species.

Borneman, David G. "Its not that easy being green," and other lamentations of a city Natural Areas Program. City of Ann Arbor, Parks and Recreation Department, Natural Area Preservation Division, Ann Arbor, Michigan 48105.

The citizens of Ann Arbor, Michigan (pop. 110,000) have always been proud of their urban park system and have consistently supported ballot initiatives to increase park acreage and funding. An additional property tax millage that passed in 1993 created a new division within the Parks Department designed to protect and restore the 1000 acres of natural parkland. The Natural Area Preservation Division (NAP) now supports a staff of 15 full- and part-time employees with an annual budget of $300,000.
But, despite its support at the ballot box, the public has, at times, been critical of NAP's restoration activities, such as the use of prescribed fire, herbicides and mechanical removal to control invasive shrubs and trees. Other challenges have come from within the department itself, as traditional city parks staff question and resist NAP's proposals to cut back on mowing and leaf blowing in natural areas. The presentation will focus on strategies developed to overcome these challenges and thrive within the fishbowl of public life.

Borneman, David G. Teach me to restore and I'll be a steward for a lifetime. City of Ann Arbor, Parks and Recreation Department, Natural Area Preservation Division, Ann Arbor, Michigan 48105.

Because urban natural areas are so accessible to high numbers of visitors, they often suffer tremendously from overuse and abuse. The high human population density does, however, offer at least one opportunity not present in more remote sites - regular volunteers.
In the seven years that Ann Arbor's Natural Area Preservation Division (NAP) has been restoring urban natural lands, we have shifted our focus from staff-led restoration activities to volunteer-led efforts. We've even changed our mission statement to reflect our greater emphasis on fostering an environmental ethic among the public. We've developed a Volunteer Park Steward program and are collaborating with other agencies to create a Volunteer Stewardship Network. Volunteers are beginning to run their own work days and special projects, while still participating in staff-led activities, such as prescribed burning. The presentation will focus on NAP's evolving volunteer program and discuss why empowering citizen volunteers is critical to the conservation of urban natural areas and is more important than just having them show up at your workdays.

Brucker, Maury. Capital values of natural diversity, 6606 North Allen Road, Unit 92, Peoria, Illinois 61614.

Natural communities are considered part of the total value of the land upon which they reside. Since the values of intact, diverse communities are often not appreciated by the public or realtors, direct measurement of this component by comparing similar sales may not be meaningful yet. Another approach to measuring value is estimating income and a rate of return to calculate a capital value. While income from farm commodities can be readily estimated, income from other natural products, genetic materials or ecological services is much harder to quantify. For the cost method, reproduction of a complete high quality natural community is an impossibility, myths of easy restorations aside. However, despite the lack of clear economic incentives, many natural areas are being held by owners for a perceived personal intrinsic value. As a real estate broker, I am seeing some knowledgeable buyers selecting land for natural quality. Natural areas managers usually have the role of buyers rather than sellers. Discussing information about bargains but not about premiums paid for quality land is human nature but reduces the public perception of the value of natural diversity. Worse, some state purchasing systems require limiting maximum prices for natural areas to appraised "comparable" parcels without consideration of natural quality. Instead, a premium should be paid for the highest quality natural areas as their highest and best use is to be preserved undisturbed. Premium prices in our land market would be communicated automatically and widely as many people understand and use land prices. With more economic incentives for land with intact plant communities, more investment in protection, restoration and erosion control would be made in the remaining natural areas.

Bruhn, Johann N., James J. Wetteroff, Jr., Jeanne D. Mihail, Randy G. Jensen and James B. Pickens. Harvest-related disturbance to tree populations in upland Ozark forests of MOFEP. Department of Plant Microbiology and Pathology, University of Missouri, Columbia, Missouri 65211 (JNB, JJW, JDM). Missouri Department of Conservation, Ellington, Missouri 63638 (RGJ). School Forestry and Wood Products, Michigan Technological University, Houghton, Michigan 49931 (JBP).

The Missouri Ozark Forest Ecosystem Project (MOFEP) is a long term, multi-disciplinary, landscape-level research program studying effects of even-aged, uneven-aged and non-manipulative silviculture on forest communities. The first set of MOFEP timber harvests occurred between early May and mid-November 1996. Harvest-related disturbance occurred on 69 of the 180 permanent 0.2 ha vegetation study plots on which the interactions between *Armillaria* populations, forest structure and forest management activities are being studied. Our objectives concerning MOFEP harvests are to characterize the harvest-associated disturbance on these long-term study plots. On these plots, we have inventoried and mapped 1) all injured or destroyed trees > 5.0 cm dbh, 2) all stumps and girdled cull trees and 3) all vehicle paths associated with harvest activity (haul roads, multiple-pass trails and single-use trails). All stem injuries have been noted and measured for reference. Below-ground woody roots and their harvest-related injuries were characterized in 0.05 m^3 excavations (0.5 m x 0.5 m x 0.2 m deep) immediately adjacent to study plots within vehicle paths which passed through those plots. Analyses evaluate harvest disturbance relationships with vehicle activity, slope characteristics, stump population characteristics, logging crews, harvest dates, silvicultural objectives and stand structure. Overall, disturbance was very strongly associated with characteristics of vehicle activity.

Chen, Jiquan and C.D. Huebner. Plant distribution across a southeastern Ozark landscape. School of Forestry and Wood Products, Michigan Technological University, Houghton, Michigan 49931 (JC). USDA NRI, Washington, DC 20250 (CDH).

Distribution, abundance and diversity of plant species in a landscape are related to many factors such as disturbance history, land form, etc. In examining the potential effects of various types of landscape structure on plant species, a 10,000 m transect was laid out in a south-north direction in the southeast Ozarks. In 1997, two 1x1 m plots were placed every 10 m along the transect to tally canopy cover, overstory type, coverage of all understory species and other micro-topographic features. Multivariate analysis and wavelet transforms were applied to examine changes in several functional groups with structural variables across scales. Among the 332 species recorded along the transect, 104 species occurred only once along the transect. *Desmodium nudiflorum* and *Parthenocissus quinquefolia* were the most frequent species (48.8% and 37.0%, respectively), while 323 of the 332 species occurred within <10% of the plots. Seventy-one plots contained no species and another 71 plots had only 1 species. Most plots contained 1-7 species. Over 95% of the total species were found in <10% of the quadrats. Species richness, Shannon diversity index and Simpson's diversity index all had

negative correlations with elevation. Land form alone explained the distribution of plant species in the landscape well ($R^2 = 0.78$). Plots near small streams contained more species (>30 species/plot) than any other plots along the transect. Changes in wavelet variance suggest that a variable-scale should be applied when exploring potential influences of landscape structure on species.

Clawson, Richard L., John Faaborg, Wendy K. Gram, and Paul A. Porneluzi. Landscape-level effects of forest management on bird species in the Ozarks of southeastern Missouri. Wildlife Research Section, Missouri Department of Conservation, Columbia, Missouri 65201 (RLC). Division of Biological Sciences, University of Missouri, Columbia, Missouri 65211 (JF). Sam Noble Oklahoma Museum of Natural History, University of Oklahoma, Norman, Oklahoma 73072 (WKG). Division of Science and Math, Central Methodist College, Fayette, Missouri 65248 (PAP).

Many fragmented forests in the Midwest do not support self-sustaining populations of certain forest interior songbirds. This study was designed to experimentally test whether bird populations in an extensively forested landscape with small (group selection) and large (clearcut) openings exhibited the same demographic patterns that were observed in highly fragmented landscapes. Using 5 years of pre-treatment data (1991-1995) and 3 years of post-treatment data (1997-1999), our objectives were to test the landscape-level effects of even-aged and uneven-aged forest management relative to no-harvest management on population density and reproductive success for forest interior and second growth bird species. Our data show that populations of forest interior species have declined throughout the area during the period of the study. Treatment effects significant at the 0.10 level were found for the following forest interior species: ovenbird *(Seiurus aurocapillus)* decline on even-aged sites, and wood thrush (*Hylocichla mustelina*) and Kentucky warbler (*Oporornis formosus*) increase on both treatments. For second growth species, treatment effects were significant for the following: indigo bunting (*Passerina cyanea*) and yellow-breasted chat (*Icteria virens*) increased on both treatments, and prairie warbler (*Dendroica discolor*) increased on even-aged sites. Analyses of the nesting data are underway. Neither nest predation rates nor nest parasitism rates increased following treatment. From a landscape-level perspective, our findings indicate that the short-term effects of even-aged management may be more negative for forest interior species than uneven-aged management, but the response by second growth species is greater for even-aged than for uneven-aged management.

Clinebell II, Richard R. Niche partitioning among sympatric species of bumblebees (*Bombus* sp., Apidae) in the tallgrass prairies of Missouri and Kansas. Research Department, Missouri Botanical Garden, St. Louis, Missouri 63116.

At least six species of bumblebees (*Bombus* spp. *bimaculatus, fraternus, griseocollis, impatiens, nevadensis* and *pennsylvanicus*) are commonly sympatric in the tallgrass prairies of Missouri and Kansas. We present here comparative data on foraging preferences of these species collected 1994-present. The species roughly sort out into four preference groups, the groupings being statistically significant by Chi-square analysis. The species with the longest tongues, *B. nevadensis* and *B. pennsylvanicus*, are most frequently encountered on flowers with long floral tubes (e.g., *Penstemon* and *Delphinium* spp. in May, *Monarda fistulosa* in June). *Bombus fraternus* is often a milkweed (*Asclepias* sp.) specialist. *Bombus bimaculatus* and *B. impatiens*, which possess the shortest tongue lengths in the group, are specialists on flowers with short floral tubes (e.g., *Blephilia ciliata* in May, *Veronicastrum virginicum* in June-July). *Bombus griseocollis* is a true generalist, with a foraging niche that overlaps broadly with all the others. We also report here the first Missouri collections of *B. affinis* at Litzsinger Road Ecology Center, St. Louis County. Finally, some examples of specialized, remnant-dependent hymenoptera in other groups (including an example of sexual dimorphism in foraging behavior) will be presented. These data validate the hypothesis that high plant species diversity is a necessary precondition for high bee species diversity in tallgrass prairies.

Cordell, Timothy. Environmental communicators: they should be out, standing in your field. Indiana DNR - Division of State Parks and Reserves, P.O. Box 908, North Liberty, Indiana 46554.

Effectively spreading the word of the importance of natural diversity starts within your own organization. I will reveiw the benefits of providing first-hand resource management experiences for the interpreters within the Indiana DNR Division of State Parks and Reservoirs. These interpreters have contact with hundreds of thousands of people a year to whom they can communicate the agency's information regarding natural diversity and resource management. Interpreters who had first-hand experiences not only communicated natural diversity issues more accurately but more often than those without such experiences.

DePhilip, Michele M. and Heather A. Potter. Identifying high priority sites for aquatic biodiversity conservation in the Great Lakes Basin. The Nature Conservancy, Great Lakes Program, 8 S. Michigan Avenue Suite 2301, Chicago, Illinois 60603.

Our goal was to identify a suite of sites that together capture the full range of aquatic biodiversity across the U.S. portion of the Great Lakes basin. The lack of data on aquatic species distributions and the lack of a standard method to identify and describe aquatic communities led to the development of a GIS-based aquatic habitat classification that was used as a conservation planning tool. This classification describes stream, lake and nearshore areas in terms of variables that are known to influence the distribution and abundance of aquatic biota. Stream, lake and nearshore systems were selected as conservation targets, under the assumption that by selecting a full range of aquatic systems, the full range of aquatic biodiversity in the Great Lakes basin would be

captured. The results of this classification as well as land use/land cover data, locations of dams, presence of exotic species and expert knowledge were used to identify important aquatic conservation sites in the Great Lakes basin. This process resulted in the identification of over 190 sites with high aquatic biodiversity value. The Nature Conservancy will focus its conservation efforts at a subset of these sites over the next 5-10 years. This collection of aquatic conservation sites complements a group of sites previously identified as important for conserving more terrestrially-based species, natural vegetation communities and declining and vulnerable birds. In many cases, there is considerable overlap between sites containing important species and/or natural vegetation communities and sites containing important aquatic habitats. This overlap will be considered and conservation strategies will be designed to address threats to a range of targets.

Diamond, David D., Taisia Gordon, Diane True, Scott Sowa, and Tim Nigh. Conservation opportunity areas for the Ozark Highlands: an ecoregion-based assessment. Missouri Resource Assessment Partnership, 4200 New Haven Road, Columbia, Missouri 65201 (DDD, TG, DT). Missouri Department of Conservation, P.O. Box 180, Jefferson City, Missouri 65102 (TN).

We review different approaches to conducting biodiversity conservation assessments and employ a new approach to identify conservation opportunity areas for the Ozark Highlands ecological section. Opportunity areas are identified using GIS to intersect core forest (more than 90 m from an edge) from TM satellite classification with low road density (<1%). These opportunity areas circumscribe less than 20% of the ecoregion. The selected polygons are further ranked by attaching to each one a value for a suite of variables. These attributes are in turn calculated based on how well each opportunity area polygon represents enduring features (subsections and land type associations) and on how well they represent the regional biota. Biota evaluated included rare species and selected vertebrate species. The results help provide the data needed for further modeling, set the stage for refinements at the subsection level and provide the context for site-level preserve design.

Djupstrom, Bob. Essential elements for state natural area programs. Scientific and Natural Areas Program, Minnesota Department of Natural Resources, St. Paul, Minnesota 55155.

Minnesota's first dedicated natural area was established 26 years ago. Comprised of 130 sites, the system protects habitats for rare species of plants and animals, geological features and natural communities across the state. Sites vary from 6 to 84,000 acres. All areas are open to the general public for nature observation, education and research activities. Public support and other ingredients of a successful natural areas program will be discussed, including legislation, long range planning, management strategies, communication and cooperation with partners, education and interpretive efforts, public relations and opportunities for volunteers.

Drees, Daniel G. Monitoring threats to populations of wild American ginseng. 205 Leaning Oak Drive, Union, Missouri 63084.

American ginseng (*Panax quinquefolius*) has declined nationally from many of its preferred habitats. It remains an uncommon plant on state lands in the northern Ozarks despite protection from harvest, livestock, logging and fire for over 70 years. Ginseng populations appear to be impeded from occupying many favorable habitat niches by low fecundity, poor seed dispersal, root poaching, stress from white-tailed deer browse, disease and consumption of the roots by rodents. Field data was collected for an average of 200 plants in several dispersed locations for six years (1995-2000), including a 184 ha natural area. Observation of growing season dormancy led to refinements in methodology whereby plants were individually numbered. Data collected for each plant included the number of prongs, sub-leaflets, pedicels, maturing drupes and browsed sub-leaflets. The percent of browse and whether the browse was vertebrate or invertebrate was recorded for each sub-leaflet. The height of each emerged plant was measured and dormancy, poaching or rodent consumption of the root was recorded for non-emerged plants. The data indicated that ginseng populations expand very slowly under favorable conditions but can also decline in habitat with favorable environmental conditions.

Dyke, Fara L. Evaluation of cave programs: impact on tourists' cave knowledge and attitudes. Department of Biology, Southwest Missouri State University, Springfield, Missouri 65804.

Recreation has a profound influence on the quality of our lives and our world's resources. Parks and other natural recreation resources offer a wide range of activities. Programs designed to inform us about a habitat or an ecosystem should lead to a better understanding of that habitat and to a more positive treatment of that system. This study focused on programs designed to inform tourists about the cave ecosystem. A questionnaire, which included 12 knowledge questions and 4 attitude questions, was designed to measure the effectiveness of interpretive programming of 10 commercial caves in Missouri. Commercial caves are caves that provide a guided tour for a fee. The participating caves consisted of two management groups, public (owned by a government agency) and private (owned by a private individual or corporation). The pre-questionnaire was distributed prior to the cave tours between July and November 1998, and the post-questionnaire was later mailed to participants. A total of 167 respondents completed and returned the post-questionnaire. Overall, the trend for both groups was a positive knowledge gain and a slight increase in their attitude levels. Knowledge scores exhibited by the public cave respondents were higher, both before and after their tours, than the private cave visitors. However, the private cave tour respondents showed the larger gain in knowledge after attending the tours. Attitude pre-tour and post-tour scores were also higher in the public cave respondents. The amount of gain in attitude was not significantly different between the two cave audiences, who exhibited high pre-scores.

Edds, David R. Stream studies in Kansas. Division of Biological Sciences, Emporia State University, Emporia, Kansas 66801.

Kansas' streams are some of the most polluted in the United States. Over the past 10 years, we have studied aquatic communities in eastern Kansas rivers and streams to document species diversity, endangered species' distributions and to investigate faunal decline and human influences on these systems. Surveys of unionid mussels in the Neosho River basin revealed substantial range reductions and a decrease in historical species richness, likely resulting from nutrient and sediment loading, dams, channel alteration and over-harvesting. Mussel and fish populations have been decimated in areas of the Spring River drainage affected by coal and lead mining operations. Mainstem reservoirs have shrunk the range of the endemic Neosho madtom, leading to its federal listing as a threatened species. We studied the biology of this fish and monitored the effectiveness of construction of an artificial riffle as mitigation for commercial gravel mining operations. Aquatic turtle assemblages were impacted more by urbanization than by agriculture and had significantly greater rates of anatomical abnormalities downstream from Wichita, a major urban center on the Arkansas River.

Elliott, William R. Conservation of cave life. Missouri Department of Conservation, Natural History Division, P.O. Box 180, Jefferson City, Missouri 65102-0180.

In general, the most dramatic declines in cave faunas have been caused by the direct disturbance and killing of bats, and massive kills of aquatic troglobites from water projects, sewage and chemicals. Perhaps five North American cave species became extinct as a result of human activities, and it is possible that other extinctions have occurred. Local extirpations of several species of bats, cavefishes and crustaceans have been documented. However, the subtle and inexorable decline of some cave communities over decades may go unnoticed because of a lack of baseline surveys and systematic monitoring. Nutrient stress is a problem that few cave biologists have studied, but the long baselines in Mammoth Cave and Carlsbad Cavern have afforded us a few insights into this subtle process. Baseline cave biology surveys usually are directed towards endangered species and their communities. The Missouri Biospeleological Database is one example of an effort to document cave species across an entire state.
Although many cave management plans have been devised across North America and 20 species are protected, there is a huge need for more protection. Cave species comprise 50% of all species of concern in Natural Heritage databases, but less than 4% of these species have federal status. It is more obvious than ever that regional karst ecosystem management and protection strategies should be encouraged, while still funding the small cave preserves that can protect locally endemic species with a minimum investment.

Emken, Claudia and Carl Becker. Public/private partnerships as an effective tool in obtaining funding for natural area acquisition. The Nature Conservancy - Illinois Chapter, 301 SW Adams St., Suite 1007, Peoria, Illinois 61602 (CE). Illinois Department of Natural Resources, 320 West Washington St., Springfield, Illinois 62704 (CB).

Ninety-five percent of the land in Illinois is in private ownership, and fewer than 28,000 acres of natural areas are owned by the State of Illinois. Nearly 70,000 acres of natural areas listed on the Illinois Natural Areas Inventory are unprotected. While there is a dedicated source of revenue for natural area protection, approximately 70 percent of that funding has gone to pay for staff in recent years, not for acquisition. In 1998, The Nature Conservancy pulled together a coalition of outdoor recreationists, conservation and agriculture interests to promote dedicated funding for land acquisition. This presentation will discuss building the broad-based coalition, working with elected officials to create the Open Land Trust Act and facing the challenges of implementing this $160 million program.

Fantz, Debby K. and Rochelle B. Renken. Short-term responses of the small mammal community to forest management within the Missouri Ozark Forest Ecosystem Project (MOFEP) sites. Missouri Department of Conservation, Conservation Research Center, 1110 S. College Ave., Columbia, Missouri 65201.

We conducted a capture-recapture study on northeast-facing slopes to determine the short-term landscape-scale effect of even- and uneven-aged forest management upon the small mammal communities on the MOFEP sites in south central Missouri. Pre-treatment sampling occurred in 1994 and 1995 and post-treatment sampling in 1998 and 1999. Species richness ranged from two to six species per site per year, with seven different species caught across all nine sites. Overall small mammal relative abundance estimates ranged from 0.35 (s.e. = 0.12) to 7.75 (s.e. = 4.17) individuals captured per 100 trap nights. A randomized complete block Analysis of Variance (ANOVA) model was used to test the change in relative abundance from pre-treatment to post-treatment periods among treatment types. Results indicate that forest management had a significant effect upon total small mammal relative abundance and on the *Peromyscus* sp. focal group three years after harvest. Even-aged management, and uneven-aged management to a lesser extent, dampened an observed natural decline in small mammal relative abundance.

Figg, Dennis E. From Costa Rica to Cole Camp: Successful nature viewing opportunities are as close as the back door. Missouri Department of Conservation, Natural History Division, P.O. Box 180, Jefferson City, Missouri 65102-0180.

Ecotourists view the resplendent quetzal long the trails of Monteverde Cloud Forest Reserve, within walking distance of Monteverde, Costa Rica. Nature tourism to this remote part of Costa Rica increased dramatically in the 1980s, from 8,000 to over 50,000 people annually. Though the cloud forest supports a tremendous diversity of plants and animals, high levels of nature tourism are

largely attributed to this one bird species. Once visitors get to Monteverde, they can also visit hummingbird gardens, butterfly rearing facilities, living orchid collections and take forest canopy tours to learn about tropical forest ecology. The economic benefit to the region is reinvestment of tourism spending to plant and animal conservation.
In contrast, Cole Camp, Missouri, is a predictable location to view scissor-tailed flycatchers, greater prairie chickens and other grassland birds. Hi Lonesome Prairie Conservation Area, Paint Brush Prairie Natural Area and other tallgrass prairie remnants, both public and private, offer tremendous wildlife viewing opportunities. Only recently is the community of Cole Camp realizing the potential value of what lies just beyond their own back door. The economic benefit of this prairie resource is small and untapped. Nature tourism is strongly supported in Costa Rica and the economic benefit from these conserved resources grows annually, becoming the economic base for some communities. Nature tourism can transform tourism for communities like Cole Camp and provide much needed dollars to invest in conservation and natural community restoration.

Fink, Alix D., April A. Woodward, and Frank R. Thompson, III. Habitat use and reproductive success of shrubland songbirds in the Missouri Ozarks. Department of Fisheries and Wildlife Sciences, University of Missouri at Columbia, Missouri 65211(ADF, AAW). U.S.D.A. Forest Service, North Central Research Station, Columbia, Missouri (FRT).

Shrubland-nesting birds, like many other Neotropical migrant species, have shown consistent population declines over the last 30+ years. In an effort to understand breeding ground factors affecting population levels of these birds, we intensively monitored demography of a suite of shrubland- nesting species with emphasis on yellow-breasted chat (*Icteria virens*), prairie warbler (PRAW, *Dendroica discolor*), and indigo bunting (INBU, *Passerina cyanea*) in 1997-1999. We determined nest success, cause-specific nest-failure rates, seasonal fecundity and return rates of adults in 3 habitat types: 3- to 5-year old regenerating forest, glade and forest-pasture edge. Demographic parameters varied among species, habitats and years. Mean nest success of all species was 44%, 30% and 35% in 3- to 5-year old forest, glades and forest-pasture edge, respectively. Breeding densities of all 3 species were greatest in 3- to 5-year old forest and only INBU occurred regularly in forest-pasture edge. Reproductive success and density were positively correlated, indicating birds selected habitats in which reproductive success was maximized. Return rates varied among species; PRAW males returned at very high rates (>90%) in the first year after banding. Given that naturally-occurring glade habitats are limited in distribution, young regenerating forests may provide important, though ephemeral, habitat for these species.

Fraker, Guy. Land trusts in Illinois and the role of The Nature Conservancy. The Nature Conservancy, Illinois Chapter, 301 SW Adams St., Suite 1007, Peoria, Illinois 61602.

There is growing recognition of the importance and valuable role that land trusts play in the conservation of important natural areas. As we learn more about the ever increasing, pervasive threats faced by our valuable natural areas, more resources are being directed not only towards abating threats but enhancing protection activities as well. Land trusts are generally small, locally-based groups that are formed to protect land within a relatively small target area. They can move quickly and efficiently to protect tracts that are often outside the scope of activities undertaken by government agencies or national NGO's. Land trusts need to expand to areas not currently covered by other organizations, supplementing and not competing with other governmental and non-governmental organizations. The important identification and inventory needs at such sites demonstrate a vital role for land trusts. To improve efficiency in the overall goal of protecting natural areas, a network should be established that clearly defines roles of these different groups and serves to improve communication and coordination of efforts. The status of land protection efforts in the state and the role of The Nature Conservancy in Illinois will be discussed in this context.

Frankland, Faye A. and Thomas A. Nelson. Monitoring the impacts of deer on wildflower communities. Department of Biological Sciences, Eastern Illinois University, Charleston, Illinois 61920 (FAF, TAN).

High densities of white-tailed deer (*Odocoileus virginianus*) on nature preserves and state forests throughout Illinois have prompted concerns that deer are impacting the growth, survival and reproduction of some spring wildflowers. We used a series of 1-m^3 temporary exclosures and 1-m^2 open plots to quantify the extent of deer foraging on under story plants at Beall Woods Nature Preserve in southeastern Illinois. Widespread and locally heavy grazing of several species was evident. Red trillium (*Trillium recurvatum*), Jacob's ladder (*Polemonium reptans*) and dwarf larkspur (*Delphinium tricorne*) were heavily grazed, significantly reducing the growth, survival and seed production of these species. However, species such as green dragon (*Arisaema dracontium*), Dutchman's breeches (*Dicentra cucullaria*) and toothwort (*Dentaria laciniata*) appeared to be avoided by deer. This study demonstrates that small, portable exclosures are a practical method for monitoring the impacts of deer on herbaceous plant communities.

Glazer, Alexander N. University of California Natural Reserve System (UC NRS). University of California, Office of the President, 1111 Franklin Street, Oakland, California 94607.

UC NRS is the largest and most ecologically diverse, university-operated system of natural areas in the world. Created in 1965 by the UC Regents, the NRS currently encompasses over 125,000 acres divided among 33 major reserves and several satellite sites located throughout California. All NRS sites support university-level teaching and research, enabling scientists to tackle long-term projects with assurance their studies will not be disturbed. The NRS also plays an important role in

public education and K-12 outreach, frequently well beyond reserve boundaries, into local communities and classrooms. The NRS constituency is as broad and diverse as the reserves themselves. Administering such a system is a complex process that requires intricate collaborations between the University, federal, state and local agencies, private conservation organizations and individual landowners. This is so not only because each NRS reserve is an island in an ocean of other properties and land uses, but also because UC owns only about one-fifth of the land administered by the NRS. Most reserve land is made available through use agreements and conservation easements. NRS sites annually host about 150 multidisciplinary UC courses and provide field study opportunities to 3,500 undergraduate and graduate students and support several hundred research projects by UC researchers and others. Many governmental agencies and conservation organizations regularly monitor environmental conditions and conduct species inventories at NRS sites. Each year over 23,000 people use NRS reserves. The NRS experience in administering its broad suite of functioning ecosystems and on-site facilities offers reason for realistic optimism: creative interagency collaboration can support a vastly complicated system that, in turn, provides unparalleled possibilities for investigating the processes that govern both earth and humankind.

Grady, Joanne and Jane Ledwin. Pallid sturgeon research and policy in the Lower Missouri River. U.S. Fish & Wildlife Service, 608 E. Cherry St., Room 200, Columbia, Missouri 65201.

Without comprehensive, reliable datasets for threatened and endangered species, tools to address public concerns are limited. The U.S. Fish & Wildlife Service's Fishery Resources office recently participated in cooperative sturgeon sampling in the lower Missouri and middle Mississippi rivers. Results of this cooperative sampling indicate pallid sturgeon populations are continuing to decrease while hybridization with shovelnose sturgeon has increased. Pallid sturgeon sampling was last conducted on the lower Missouri River in the late 1970s. Unfortunately, due to a lack of data archiving by natural resource agencies, statistical tests could not be used to compare recent work with historic samples. Decisions regarding Endangered Species Act listing, consultation and recovery are based on the best available science. Limited information fosters greater controversy. Natural resource agencies are forced to spend more time and money on conflict resolution than on species management and restoration. Using the pallid sturgeon as our example, we will examine database limitations in regards to species management specifically as relates to issues associated with the Endangered Species Act.

Gram, Wendy K. and Victoria L. Sork. Evaluating the effects of forest management treatments on animal communities in Missouri Ozark forests. Sam Noble Oklahoma Museum of Natural History, University of Oklahoma, 2401 Chautauqua Ave., Norman, Oklahoma 73072. (WKG). Department of Biology, University of Missouri - St. Louis, 8001 Natural Bridge Rd., St. Louis, Missouri 63121 (VLS).

A primary goal of ecosystem management is conservation of biodiversity. This priority has prompted research about the impacts of management practices on many aspects of an ecosystem. In the Missouri Ozark Forest Ecosystem Project (MOFEP), over 25 investigators are experimentally testing the effects of even-aged and uneven-aged forest management on different ecosystem components. In collaboration with several investigators, we integrated a subset of these studies to evaluate the landscape-scale, short-term (one and two years post-treatment) consequences of forest management on community-level animal densities. Using meta-analysis, we statistically combined changes in densities (pre- to post-treatment differences) across multiple species groups and assessed the overall impacts of management treatments on the animal community. Our findings demonstrate that, in the short-term, even-aged and uneven-aged forest management caused changes in animal community density relative to no-harvest control sites. Even-aged management sites showed greater changes than uneven-aged management sites after harvesting, and changes in species' group densities were larger two years post-treatment than one year post-treatment. When species groups were evaluated independently, we found significant treatment effects for toads, forest interior birds and early successional birds. These results contrast with our expectation that most species' groups would not exhibit treatment effects because relatively little forest area was removed per site (10%), forest cover at the regional landscape level remained high and the time scale was relatively short. It is premature to conclude whether these short-term impacts will produce further changes in animal communities through indirect effects and species interactions or whether they will dissipate as the forest regenerates.

Guyette, Richard P., John M. Kabrick and Johann N. Bruhn. Long-term disturbance frequency and species distributions at the Missouri Ozark Forest Ecosystem Project. The School of Natural Resources, 203 ABNR, University of Missouri, Columbia, Missouri 65211 (RPG). Missouri Department of Conservation, 1110 S. College Ave., Columbia, Missouri 65201 (JMK). Plant Pathology, 109 Waters, University of Missouri, Columbia, Missouri 65211 (JNB).

Quantitative information on the long-term frequency, spatial distribution and continuity of forest disturbances provides a valuable a perspective on the present state of Ozark ecosystems. We use a significant correlation matrix of diverse variables to support a central hypothesis: the composition and structure of Ozark forests result from the long-term frequency of disturbance as mitigated by topographic roughness. Abrupt ring-width reductions in shortleaf pine (*Pinus echinata*), dated fire scars and historical data are used to determine the frequency of disturbance events. Disturbance frequency among study sites varied by a factor of more than four. The frequency of disturbance variables is significantly correlated with topographic roughness, forest bird territory density, lizard and skink captures, blueberry fruit abundance, *Armillaria* spp. abundance and three indices of forest succession derived from over story tree species, oak over story species and tree species ground

flora. These three indices of forest succession, based solely on shade tolerance, are significantly correlated with the mean number of over story tree species, the density of forest bird territories, lizard and skink captures, topographic roughness, blueberry fruit abundance and the abundance of two *Armillaria* spp. long-lived tree species were highly associated with the long-term frequency of disturbance. Significant associations among disturbance variables and species abundances support the hypothesis that the species composition of Ozark forests is, at least partly, a function of the long-term interactions of anthropogenic disturbance and topographic roughness. Topographic roughness provides long-term continuity to forests and disturbance regimes.

Hamilton, David A., Daniel J. Witter and Theresa L. Goedeke. Balancing public opinion in managing river otters in Missouri. Missouri Department of Conservation, Conservation Research Center, 1110 S. College Ave., Columbia, Missouri 65201 (DAH). Missouri Department of Conservation, P.O. Box 180, Jefferson City, Missouri 65102 (DJW). Department of Rural Sociology, University of Missouri - Columbia, 102 Sociology Bldg., Columbia, Missouri 65211 (TLG).

River otter populations have been widely restored across Missouri's aquatic habitats, in numbers that exceed earlier expectations. However, with ever increasing diversity of cultures and perspectives, this success now comes at a cost of social conflict. The issue is polarized and the Missouri Department of Conservation (MDC) is striving to manage the population to meet a variety of expectations. After four years of regulated trapping seasons, these debates continue and are frequently exposed in the local media, pitting animal protectionists, anglers and the MDC over proper otter management. Anglers and pond owners contend that MDC operated recklessly in restoring otters to the Ozarks where game fish are vulnerable to otter predation, and thus degrade fisheries. Fishermen are increasingly asking the MDC to do something about the otter population and impacts on fish. Local and national animal rights groups have targeted Missouri's river otter trapping program in efforts to sway public opinion and, ultimately, change trapping policies. Two lawsuits have been filed in attempts to ban otter trapping in Missouri, and additional efforts are now underway via ballot initiative to allow Missouri citizens to vote to ban otter trapping. In response to these controversies, the MDC created a diverse panel of citizens and biologists (River Otter Advisory committee) to review the problem, explore options and make recommendations. Alternative management options have been debated within this group and the MDC as they struggle to meet a wide range of public expectations.
We describe the central points of disagreement between these parties and perspectives gained through the River Otter Advisory committee meetings. We offer encouraging recommendations to others facing similar challenges.

Herbert, Matthew E. and Timothy H. Tear. Are rivers products of their watershed? Complexity in the relationship between land use and stream ecosystems. The Nature Conservancy, Illinois Chapter, 301 SW Adams St., Ste. 100, Peoria, Illinois 61602.

It has long been hypothesized that rivers are products of their watershed. Evidence certainly suggests that intensive land use practices are detrimental to the water quality and biological integrity of rivers, but researchers have had difficulty correlating these relationships among watersheds. The Mackinaw River in central Illinois stands testament that this hypothesis needs further examination. The Mackinaw River remains a high quality prairie stream despite dramatic conversion (over 80% of the historic natural land cover) to row crop agriculture. Relative to rivers in other agriculturally-dominated landscapes, it has high water quality and retains diverse assemblages of fish and mussels. However, altered hydrologic conditions and poor agricultural and urban land practices threaten many of these biotic communities. The Mackinaw River Partnership is working with local landowners to implement agricultural best management practices designed to alleviate some of the threats to the river system. Considerable effort has been committed to encourage conservation practices in the upper watershed due to highly altered stream systems (channelization and tiling) and the large-scale and intensive agricultural practices in this section of the watershed. This paper describes the preliminary results of a long-term project to improve our understanding of headwater streams and thus to improve conservation efforts. Results from two tributary streams with extensive tiling and 97% of their watershed in row crop agriculture will be presented that indicate water quality and biotic communities in the upper watershed are better than expected. Possible explanations for these results will be discussed in the context of the watershed, along with the implications for conservation of aquatic resources.

Herbert, Matthew H., Timothy H. Tear, Mike Goodwin and Karen Billo. Achieving locally-based planning goals in the Mackinaw River Watershed: monitoring to evaluate the impact of conservation practices on aquatic resources in an agriculturally dominated watershed. The Nature Conservancy Illinois Chapter, 301 SW Adams St. Suite 100, Peoria, Illinois 61602. (MEH, THT). The Nature Conservancy Illinois Chapter, Eureka, Illinois 61530 (MG, KB).

In agriculturally dominated regions, aquatic ecosystems have experienced major changes in structure and function due to direct alterations (e.g., wetland drainage, stream channelization) and indirect influences from intensive land use (e.g., altered hydrologic processes, increased sedimentation and eutrophication). In response, rivers experience more extreme flooding and drought conditions, organic pollution and reduced biological integrity. Locally-based watershed planning efforts that recognize such problems have called for corrective action. One approach is to intensify agricultural best management practices (BMPs) that are designed to retain soil and nutrients within terrestrial systems and may lead to increased water retention. However, due to the random implementation of BMPs through voluntary efforts, it is not clear if

implementation results in noticeable improvements in water quality at the watershed level. Appropriate monitoring to assess the effectiveness of BMPs is difficult to establish due to high costs and extreme variability in many aspects including implementation, climate, soils, topography, hydrology and aquatic organisms. This paper describes a monitoring effort to address achieving the goals of a watershed planning effort in the Mackinaw River Watershed in Illinois. A project to evaluate BMP implementation and subsequent effects on stream ecosystems has been initiated. We will describe efforts to improve BMP implementation following an intensive outreach effort and the concurrent monitoring program to evaluate subsequent abiotic and biotic responses within streams in the project area. Preliminary results indicate that the paired watershed design is appropriate, and the issue of spatial scale and its relation to monitoring will be discussed.

Herkert, James R., and William D. Glass. A 10-year study of the effects of prescribed fire on prairie birds. Illinois Endangered Species Protection Board, Springfield, Illinois 62701 (JRH). Illinois Department of Natural Resources, Wilmington, Illinois 60481 (WDG).

We studied the effects of prescribed fire on breeding birds in a 650+ ha native tallgrass prairie remnant in northeastern Illinois between 1991-2000. Burn responses of the 15 most commonly encountered species varied. Some species increased in abundance immediately following spring fires, others decreased in abundance immediately following fires and still others were unaffected by prescribed fires. Our data suggest that some fire-sensitive species shift their distributions within this prairie in response to prescribed burning, colonizing adjacent unburned areas as portions of this site were burned. Spring precipitation also appeared to influence species abundance following burning, with burn response being greatest in dry years. Analyses of longer-term burn responses showed that some species that declined in abundance immediately following fires, ultimately peaked in abundance two to four years post-fire and then declined in abundance in subsequent years. Thus evaluations of the effects of prescribed fire on prairie birds should be based on long-term data sets and consider both short- and longer-term responses to fire.

Jeffords, M.R., S.L. Post, R.N. Wiedenmann and D.J. Voegtlin. Biodiversity, wetlands, and biological control: purple loosestrife, a case study. Illinois Natural History Survey, 607 E. Peabody, Champaign, Illinois 61820.

A unique component of the Illinois purple loosestrife program involves 150 Illinois high schools who are actively participating in loosestrife biological control. Each January for the last three years, groups of high school teachers from the actively infested area gather for a Saturday workshop. Here they are taught the fundamentals of biodiversity and why it is important, are trained in wetland ecology, look in detail at a major problem involving invasive species (loosestrife) and receive information and materials for rearing a biological control agent (Gallerucella) in their classrooms. The workshop takes a pyramidal approach to learning, starting with the overriding issue of biodiversity and ending with an action project involving beetle release and habitat monitoring. Each level has background information and teaching activities. Schools are then partnered with natural resource professionals in their area for locating beetle release sites. This program has proven so successful that it now serves as a model for development of other educational programs on such exotic species as gypsy moth, garlic mustard and Asian long-horned beetle. In addition, the pyramidal model for course development is being used in a new Illinois program called ENTICE (Environment and Nature Training Institute for Conservation Education). The program of the Illinois Department of Natural Resources forms an umbrella under which all or most environmental and natural resource education in state government can be housed.

Jensen, Randy G. and John M. Kabrick. Tree cavity estimation and verification in the Missouri Ozarks. Missouri Department of Conservation, Rt. 2 Box 198, Ellington Missouri 63638 (RGJ). Missouri Department of Conservation, 1110 S. College Ave., Columbia, Missouri 65201 (JMK).

Missouri forest management guidelines require providing cavity trees for wildlife. However, there is little information about the reliability of cavity estimates or the tree species that contain the most useable cavities. Timber harvests on the Missouri Ozark Forest Ecosystem Project offered an opportunity to verify the accuracy of cavity estimation procedures and to identify the most beneficial cavity trees. Approximately 75 trees $\geq$ 11 cm diameter breast height on 24, 0.2 ha plots were intensively examined for tree cavities and potential tree cavities (pre-cavities) during the winter of 1995 and 1996 and then dissected with a chain saw to verify cavities after clearcutting in the summer of 1996. Overall, there were twice as many cavities than detected by our original survey. However, only 55% of openings initially judged to lead to a tree cavity actually did. Conversely, 18% of openings estimated to be pre-cavities were actually cavities. Many of the cavities found would not be useable to specific secondary cavity users. Only 13 % of the estimated cavities and 23% of the actual cavities fit the criteria of having a hole at least 2.5 cm diameter, 3 m or more above ground and with a 5x5x10 cm cavity. Additional information on tree cavity characteristics should help forest managers select the trees most beneficial to wildlife species.

Johnson, Erik D. What's in a name? Biodiversity conservation and the Florida State Park unit classification system. Florida Department of Environmental Protection, Division of Recreation and Parks, MS 530, 3900 Commonwealth Blvd., Tallahassee, Florida 32399-3000.

The Florida Park Service was established in 1935 to provide perpetual protection for representative portions of the state's original domain and to make those lands accessible for public enjoyment. Successful integration of these frequently competing goals is increasingly essential

for preservation of the public's natural heritage and their ability to experience quality resource-based recreation. The Florida State Park system has grown to encompass over 150 management units, with over 110 of those encompassing significant natural resource conservation lands. A Unit Classification System is currently used to place those lands into categories based primarily on resource significance, recreation potential and recreation suitability (i.e., relative amount of passive vs. active). Upper limits for infrastructure development are established (expressed as percent of land base). Because Florida's human population is projected to double from a current 15 million to nearly 21 million by 2025, adherence to an effective classification system will be critical. Advantages and limitations of the current system are discussed, and suggestions for refinements are proposed.

Kabrick, John M., Randy G. Jensen, David R. Larsen and Stephen R. Shifley. Effects of even-aged, uneven-aged and no-harvest management on woody vegetation at the Missouri Ozark Forest Ecosystem Project, 1991-1998. Missouri Department of Conservation, 1110 S. College Ave., Columbia, Missouri 65201 (JMK). Missouri Department of Conservation, R.R. 2, Box 198, Ellington, Missouri 63638 (RGJ). School of Natural Resources, 203 ABNR, University of Missouri, Columbia, Missouri 65211 (DRL). North Central Research Station, U.S. Forest Service, 202 ABNR, Columbia, Missouri 65211 (SRS).

Missouri Ozark Forest Ecosystem Project (MOFEP) is a landscape-scale experiment measuring the effects of even-aged, uneven-aged, and no-harvest management on ~800 acre sites (i.e., compartments). Knowledge of changes in the composition, abundance and diameter of woody vegetation is critical to interpretation of all other aspects of the experiment. In 1996, approximately 2.5 million board feet (3500 board feet per acre) were harvested from portions of even-aged sites, and 3.4 million board feet (1700 board feet per acre) were harvested from portions of uneven-aged sites. Our objectives were (1) to evaluate treatment effects at the site scale and (2) to quantify forest dynamics within and among sites including growth, ingrowth, mortality and changes in forest structure. At the site scale, the first harvest entry significantly decreased the number of stems ≥4.5 in diameter at breast height (dbh) and basal area of trees ≥1.5 in dbh for both even-aged and uneven-aged management treatments at landscape scales. The even-aged management treatment reduced the mean number of species per plot from 14.7 to 14.1 and quadratic mean diameter of trees ≥1.5 in dbh from 6.3 in to 6.2 in. Across all sites, *Quercus alba* L., *Q. coccinea* Muench. and *Pinus echinata* Mill. had the greatest increase in basal area.

Kalkbrenner, Nicole M. Restoration of a wet prairie along the Little Calumet River in Lake County, Indiana. J.F. New and Associates, 708 Roosevelt Road, Walkerton, Indiana 46574.

A phased restoration of a 230 acre wet prairie, formerly agricultural land, was begun in 1998. The site lies partially within the Little Calumet River 100 year floodplain in Lake Station, Lake County, Indiana. This area is a part of the Chicago Lake Plain Natural Region once consisting of a diversity of wet areas including swamps, marsh and wet prairies between Lake Michigan and the Valparaiso Moraine. Water levels have been continuously monitored since prior to the initial hydrological restoration that included ditch plugging and subsequent tile removal (Fall 1998, Fall 1999, Spring 2000). Water levels are also being monitored and compared with an adjacent control site owned by the Indiana Division of Nature Preserves. Both the restoration and control sites have expressed water levels at or near the ground surface during the spring and fall recharge period. However, water levels fluctuate more drastically in the restoration site than the control site, especially during the extreme drought conditions. As subsequent areas are phased into the restoration, this fluctuation is expected to be dampened. In 1998, the first phase of hydrological restoration (50 acres) was seeded and plugged with wet prairie species collected from local genotype sources. The first full growing season was completed in 1999, and approximately 52% of the species seeded were found with a mean C value of 2.9 and an FQI value of 18.6 after only one growing season (Wilhelm and Masters Floristic Quality Assessment Program). The remaining 180 acres were seeded in late 1999 and hydrology restored in early spring 2000.

Kennedy, Randall W. State of Hawaii Natural Area Reserves System. Natural Area Reserve System, 1151 Punchbowl St. Rm. 224, Honolulu, Hawaii 96822.

Established in 1970 by the state legislature, the Hawai'i Natural Area Reserves System (NARS) currently consists of 19 reserves on five islands. With a total of 109,165 acres containing examples of over 40% of Hawai'i's natural ecosystems, the system represents some of the finest native habitat remaining in Hawai'i. The reserve system is one of four major programs of the Division of Forestry and Wildlife within the Department of Land and Natural Resources. An 11 member Commission composed of six appointed scientists and five ex-officio positions recommends suitable areas, approves long range management plans and helps resolve policy issues. Annual program activities are based primarily on the long-term integrated management plans developed for each reserve. Major management activities include ungulate control, non-native plant control, monitoring, research and public education.
Also included under our program is the Natural Area Partnership Program (NAP). This innovative new program provides state funds to be matched by private funds on a two-to-one basis for the management of natural resources on private lands dedicated in perpetuity to conservation. This program complements the existing state reserve system by providing long-term protection and management of unique natural resources on private lands. Presently, the program has seven preserves covering over 25,000 acres with additional natural area projects funded at the watershed level. Activities on the NAP projects are similar to ones in the NARS and include non-native plant and animal control, research and monitoring, public education and restoration projects.

Kuchenreuther, Margaret A. Cattle grazing as a tool for managing remnants in the northern tallgrass prairie: a case study on private lands. Division of Science and Mathematics, University of Minnesota - Morris, Morris Minnesota 56267.

Though grazing was historically an important part of the disturbance regime of prairies, today grazing is seldom used as a management tool, especially in the northern tallgrass prairie. Additionally, there is considerable debate about the appropriate way to apply grazing treatments to native grasslands. This on-farm study investigates the effects of different cattle grazing regimes (season-long, long-rotation, short-rotation and ungrazed) on the vegetation structure and composition of native pastures in west-central Minnesota. Vegetative cover was estimated using a 10-point frame. The frequency of indicator species was measured using 0.5 m^2 quadrats. Results show that grazing markedly influences plant community structure. The proportion of points intercepting bare ground was significantly higher in grazed than in ungrazed areas. Ungrazed areas had a significantly higher cover of litter than grazed areas. While the cover of native grasses and forbs was about equal in the areas surveyed, the cover of introduced grasses was markedly higher in the season-long grazing treatment versus those grazed rotationally or left ungrazed. Fewer obvious effects were seen on plant frequency. While grazing increased the frequency of introduced grasses, such as foxtail (*Setaria* spp.), it also increased the frequency of native grama grasses (*Bouteloua* spp.). Bluegrass (*Poa* spp.) was ubiquitous, regardless of grazing regime. Introduced thistles (especially *Carduus*) were found at high frequency in pastures grazed season-long but were uncommon in short-rotation pastures and nearly absent from ungrazed areas. Only a few other forb species showed consistent trends in their frequencies relative to grazing regime. On the whole, the data suggest that short-term rotational grazing is preferable to season-long grazing.

Kyde, Kerrie L. and Douglas H. Boucher. Exotic plant invasion assessment and control in Catoctin Mountain Park, Maryland. Department of Biology, Hood College, Frederick, Maryland 21701.

Exotic invasive plant species represent a serious threat to biodiversity, habitat quality and ecosystem function around the globe, and control efforts are increasingly costly. High visitation and boundary development at Catoctin Mountain Park, Maryland, make it particularly susceptible to invasion. We are currently conducting a study to quantify the extent of exotic invasion in the park, the effects of invasive species on the park's rare and endangered species and the relative cost effectiveness of hand weeding, herbicide and flaming control techniques for four invasive species of special concern. We collected data from 77 plots located throughout the park, including matched vegetation plots and deer exclosures, plots located every quarter mile along paved and gravel roads, and plots located on a grid within the relatively unvisited interior. We compared species richness, density and percent cover in vegetation plots and deer exclosures. In the roadside and grid plots, we measured percent cover of eight exotic invasive species. Using GIS, we determined plot distances from the Park's nearest paved road, dirt road, old (historic) road and trail, to assess any relationship between invasion and known disturbance. Our preliminary findings indicate that: there are no significant differences in exotic species richness, density or percent cover inside and outside exclosures; both exotic and native species are browsed by deer, but natives are more heavily browsed; and some exotic invasive species, notably *Microstegium vimineum*, decrease in density with distance from dirt roads and trails. The efficacy of the control techniques will be assessed during this field season.

Ladd, Douglas and Jennifer K. Grabner. Lichens, lichens everywhere: baseline analysis of the lichens of the MOFEP compartments. The Nature Conservancy, St. Louis, Missouri 63144 (DL). Missouri Department of Conservation, Columbia, Missouri 65201 (JKG).

Little is known about the composition, dynamics, diversity and disturbance responses of the lichen biota in the Midwest, particularly in the Ozark Highlands. A comprehensive study of lichen vegetation of the MOFEP compartments was initiated in 1996. In addition to floristic surveys of all nine compartments, lichens were sampled at a subset of previously established vegetation plots. Trees were sampled for lichens at basal, mid-bole and canopy levels, and line transects were sampled for lichens on ground layer substrates. Results indicated a diverse and well-distributed lichen biota in all MOFEP compartments, with nearly 300 taxa documented. There was a high degree of similarity in lichen species composition and distribution patterns among the nine compartments. Corticolous (tree) and saxicolous (rock) substrates supported the highest lichen diversity, with 166 and 105 taxa, respectively. Approximately 10% of the species occurred on multiple substrates. Patterns in corticolous lichen composition were highly correlated with vertical location on the tree and, to a lesser extent, tree species. There was no strong relationship between tree size and lichen richness or composition, with a few exceptions related to bark traits. On all but the youngest canopy branches, macrolichens exhibited high relative importance values compared to the higher overall diversity of crustose taxa. We identified guilds of species associated with microhabitat. These included a suite of crustose taxa on small canopy branches, a diverse group of foliose taxa on tree trunks, and a suite of taxa, including gelatinous lichens, found on tree bases. Lichens are a significant component of biological diversity in the Ozarks, and we recommend that woodland management strategies include considerations for sustaining functional assemblages of lichens.

Lamb, Claudine. Blue River Glade Project: partnership between Kansas City Power & Light, Kansas City Harmony, Jackson County Parks and Recreation, The Nature Conservancy of Missouri, Missouri Department of Conservation, City of Kansas City, Missouri Parks & Recreation, Lakeside Nature Center and Kansas City Zoological Gardens. Missouri Department of Conservation, 6800 Zoo Drive, Kansas City, Missouri 64132.

The Blue River Glade Natural Area is a rare example of a limestone glade in northern Missouri. The Kansas City community almost lost this glade to aggressive, hard-to-control invasive plants and encroaching trees. But just in time, a diverse team (Blue River Glade Project partnership members) has come together to protect the glade. The Blue River Glade is much more than an endangered natural area. It is a rare opportunity to understand ecological diversity and the reasons nature actually favors a wide variety of species. And it is a chance for us to come together and restore a piece of our natural heritage through a multi-cultural, community-based effort.

Like other healthy natural communities, glades need to be managed. Today, a volunteer effort that crosses cultural, ethnic and racial boundaries is accomplishing management objectives for the natural community while providing other important benefits to the human community. Schools, businesses and neighborhood groups from the Kansas City area are attending workdays on the glade, cutting down and pulling out harmful plants and spreading seeds of native glade species. Our volunteers gain a great sense of accomplishment, and a renewed sense of the importance of ecological and cultural differences in a strong community.

We would like to introduce you to the Blue River Glade Project and how a diverse team of partners joined together to restore the glade and connect urban people to a rare natural community in their backyard.

Lang, Ronald. USDA biocontrol and how it might help you. USDA, APHIS, Forestry Sciences Laboratory, MSU, 1648 S. 7th Avenue, Bozeman, Montana 59717-2780.

Biological control of weeds is a viable management tool in the fight against weeds. USDA, APHIS joined the biological control effort in 1988 in a program against leafy spurge, diffuse and spotted knapweed. Thirteen biocontrol agents have been cleared and introduced in the United States for control of spotted and diffuse knapweed. Nine biocontrol agents have been cleared and introduced for the control of leafy spurge. APHIS is now moving into biocontrol programs for Russian knapweed, yellow and Dalmatian toadflax. Agents for Russian knapweed should be available for first release in 2001. The biocontrol of weeds program involves many federal, state and local groups and agencies.

Lerch, Robert N., Jeanne M. Erickson, Carol M. Wicks, William R. Elliott and Scott W. Schulte. Water quality in two karst basins of Boone County, Missouri. USDA-Agricultural Research Service, Cropping Systems and Water Quality Research Unit, Columbia, Missouri 65211 (RNL). Department of Plant Pathology, University of Missouri at Columbia, Columbia, Missouri 65211 (JME). Department of Geological Sciences, University of Missouri - Columbia, Columbia, Missouri 65211 (CMW). Missouri Department of Conservation, Natural History Section, Jefferson City, Missouri 65102 (WRE). Department of Natural Resources, Division of Parks, Columbia, Missouri 65203 (SWS).

Urbanization and agricultural land-use activities represent potential threats to the water quality and ecosystem integrity of Devils Icebox and Hunters Caves in Boone County. Both cave systems drain karst basins with surface and internally drained sources of water. Land use within the Devils Icebox watershed is primarily agricultural and urban while Hunters Cave is predominantly agricultural and forested. Since these cave systems have very similar geologic and hydrologic settings, the impact of different land-use on water quality can be compared. Year-round monitoring was initiated in April 1999 with the objective of characterizing the current water quality status of the main cave streams relative to nutrient, herbicide, and coliform bacterial contamination. In addition, hydrogeologic parameters, including dissolved O_2, pH, temperature, specific conductance and turbidity are being continuously monitored. Total nitrogen (N) and phosphorus (P) concentrations, from April-July 1999, were generally low at both locations, but median total N and P concentrations were consistently greater at the Devils Icebox. Herbicide contamination was also low at both sites, with significant levels of atrazine briefly present from late April through May 1999. Fecal coliform bacteria were consistently greater at the Devils Icebox with levels ranging from 166-21,920 cfu/100 mL. The extremely high fecal coliform levels at the Devils Icebox occurred in June 1999 following a runoff event. To date, contaminant data indicate that the water quality impairment is greater for Devils Icebox than for Hunters Cave. Fecal coliform bacteria, presumably resulting from discharge of on-site wastewater systems, represents the greatest water quality threat to the Devils Icebox.

Lewis, Carolyn N. and James B. Whitfield. Comparison of species and biology of braconid wasps (Hymenoptera: Braconidae) collected from different types of tallgrass prairie in the central United States. Department of Entomology, University of Arkansas, Fayetteville, Arkansas 72701.

The braconids (Hymenoptera: Braconidae) are a family of small to minute parasitic wasps that is species rich and abundant throughout the world, especially in temperate zones. They are of interest because they are ubiquitous in nature, having close biological linkages with their hosts that come from a broad range of insect orders and families and on whom they exercise natural population control. Our objective was to develop a species list of prairie wasps for an overview and comparison of species among different types of tallgrass prairie grasslands including both previously glaciated, unglaciated and sand prairies and for future comparisons with other plant communities and disturbed areas. The wasps were collected with Malaise traps from six prairies in Kansas (1), Illinois (1) and Missouri (4). In all, 1000 wasps were collected yielding approximately 130 species including several new species. Faunistic differences among the sampled prairies are summarized using complementarity measures.

Lewis, Julian J., Philip Moss, Diane Tecic, Matt Nelson and Allen Pursell. A model for conservation-focused cave bio-inventory by The Nature Conservancy.

the subterranean invertebrates of the Sinkhole Plain Karst of Western Illinois. J. Lewis, Ph.D. and Associates, Biological Consulting, 217 W. Carter Avenue, Clarksville, Indiana 47129 (JJL). Ozark Underground Laboratory (PM). Illinois Department of Natural Resources, Division of Natural Heritage (DT). The Nature Conservancy of Illinois (MN). The Nature Conservancy of Indiana (AP).

In 1998, attention was drawn to the western Illinois karst by the listing of the Illinois cave amphipod, *Gammarus acherondytes*, as an endangered species. It was suspected that much remained to be learned about the subterranean biota of the area, thus The Nature Conservancy initiated a bio-inventory of subterranean invertebrates in Monroe and St. Clair counties, Illinois. The project report was intended to serve as a new model for conservation-focused bio-inventories, with a key feature being the assignment of state and global ranks of rarity. Criteria for these ranks included the number of occurrences, definition of element occurrence, range and fecundity. Inherent to the assignment of these ranks was the ability to identify taxa to the species level, a goal becoming increasingly difficult with the pronounced decline in the availability of systematic zoologists. However, conservation efforts must intrinsically focus at the species level and bio-inventories done otherwise are of little value. Thus funding has been made available to taxonomists for identification of specimens as well as the description of new species discovered during the process of the inventories. All sites visited were rank-ordered as a function of globally rare species to provide priorities for conservation efforts (e.g., purchase, conservation easement). The southwestern Illinois initiative was intertwined with The Nature Conservancy's subterranean bio-inventory projects in Indiana to fill gaps needed for effective ecoregional planning for conservation of subterranean species on a larger scale.

Liebermann, Robert J. The benefit and applicability of landscape conservation in the Ukrainian Carpathians. Department of Geography, University of Georgia, Athens, Georgia 30502-2502.

The Ukrainian Carpathian Mountains have the most significant area of temperate forests remaining in Europe, a still largely intact natural landscape, a representative and well-arranged system of protected areas, and a long-established culture of sustainable rural agrosystems adapted to and coexisting with the local environment. The nature reserve archipelago here is a critical element for protection of the region's natural heritage, but the sanctuary of these islands is threatened if they remain isolated from one another by contrasting land uses or if they are immaterial to the local population. Long-term ecological integrity of the region may be enhanced using landscape and network-based conservation principles, promoting connectivity across non-reserved lands, "soft" transitions to cultural landscapes, the benefits of sustainable agriculture to natural systems and the role of culture in conservation. My ongoing research in this area examines the applicability of designating landscape elements as multiple-benefit areas (e.g., for watershed protection, traditional agriculture, sustainable forestry, recreational areas, floristic reserve, etc.), with the broader goal of using these areas to maintain ecological continuity between protected areas and thus to the region as a whole. This is particularly important at present because drastic changes in post-Soviet Ukrainian society have the potential to allow extensive landscape and cultural degradation, as well as the more optimistic vision of sound advance conservation planning in an area that will - ready or not - certainly see widespread land use change in the coming decades. Successful landscape conservation here could serve to protect the region's significant natural and cultural heritage alike, and thus serve as a model for Europe and the world.

Lill, John T. and Robert J. Marquis. Ecosystem engineering by leaftying caterpillars. University of Missouri-St. Louis, Department of Biology, St. Louis, Missouri 63121.

In addition to their trophic and competitive effects, shelter-building caterpillars can act as physical ecosystem engineers on their host plants by creating habitats that are subsequently colonized by an array of other organisms. We hypothesize that these engineering effects will influence the diversity and abundance of future arthropod colonists, as well as the amount of leaf damage experienced by their host plant. In Missouri, approximately 15 species of leaftying caterpillars are found on white oak (*Quercus alba*). One species in the genus *Pseudotelphusa* may act as a "keystone" engineer in that it creates the first wave of leafties in the early summer that are preferentially colonized by the remaining species. In order to examine the engineering effect of *Pseudotelphusa*, we conducted a field experiment in the summer of 1999 at Cuivre River State Park, Missouri, in which we manipulated the density of leafties on individual white oak saplings and observed the effects on (1) the abundance and composition of arthropod community, and (2) the amount of leaf damage accrued throughout the season. In order to separate the caterpillar's engineering effects from its trophic/competitive effects, we created artificial leafties both with and without caterpillars initially present. Compared to controls, the treatments in which we clipped 10% of the leaves into leafties had significantly greater density of arthropods as well as higher species richness and this effect persisted throughout the season, resulting in differential rates of herbivory. Furthermore, recruitment by leaftying caterpillars to artificial ties initially containing a single *Pseudotelphusa* larva was double that of initially empty ties, indicating a strong biotic effect (i.e., a colonization cue, such as damage, frass, or feeding-related volatiles). The results of this experiment suggest that maintaining shelter-building caterpillars in the oak herbivore community will indirectly maintain a diverse array of associated arthropods, many of which may be important competitors or natural enemies that prevent these species from reaching outbreak levels.

Magoulick, Daniel D. and Camille A. Flinders. Lotic crayfish community structure in the Ozark Mountains with a focus on the imperiled Mammoth Spring crayfish (*Orconectes marchandi*). Arkansas Cooperative Fish and Wildlife Research Unit, Department of Biological

Sciences, University of Arkansas, Fayetteville, Arkansas 72701 (DDM). Academy of Natural Sciences, Philadelphia, Pennsylvania 19103 (CAF).

Crayfish are vital links in food webs of freshwater ecosystems, yet little is known about factors that affect their populations in streams. The Ozark streams of Arkansas and Missouri have a particularly high density and diversity of crayfish species, many of which are indigenous. A few, like the Mammoth Spring crayfish, are considered rare and possibly endangered based on their narrow geographic distribution. Quantitative kicknet sampling and quadrat sampling were employed over two years in the Spring River drainage to determine the distribution, abundance and species associations of the Mammoth Spring crayfish, as well as gain information on habitat preferences and associations of other crayfish species. A total of nine species were collected in the Spring River watershed. The distribution of *Orconectes marchandi* was increased from the previously documented three locations to 20 streams in eight sub-watersheds. *Orconectes marchandi* was mainly found in smaller streams (order 1-3) in habitats consisting of slower moving, shallow water with gravel, pebble and cobble substrates. *Orconectes marchandi* was most often associated with *O. punctimanus*, *O. ozarkae* and *Cambarus hubbsi*. Crayfish species present in the Spring River drainage partitioned macrohabitats with percent emergent vegetation, current velocity and depth being the most important environmental variables in determining crayfish habitat selection. Vegetation and stream margin made up a small percentage of available macrohabitats but contained most crayfish. Conserving lotic crayfish may require an ecosystem focus to preserve critical habitats.

Marquis, Robert J., J.T. Lill and Josiane Le Corff. Impact of timber harvesting on insect herbivore populations of *Quercus* in the Missouri Ozarks. Department of Biology, University of Missouri-St. Louis, 8001 Natural Bridge Rd., St. Louis, Missouri 63121-4499 (RJM, JTL). I.N.S.H.P., 2 rue Le Notre, 49045 Angers Cedex 01, France (JL).

The nature of such possible landscape-scale effects on insect herbivores are not well known. We have been documenting the landscape effects of timber harvest on the abundance of insect herbivores on two deciduous tree species (*Quercus alba* and *Q. velutina*) of a deciduous forest of the Ozark plateau of southeastern Missouri. This study is part of larger multi-collaborator project called the Missouri Ozark Forest Ecosystem Project (MOFEP) run by the Missouri Department of Conservation. Replicate forest sites (three each per treatment, approximately 240 ha) underwent one of three harvesting treatments in 1996: control or no harvest, even-age management or approximately 10% of stands clearcut, and uneven age management or thinning of the forest. Insects were sampled without removal both on saplings and the canopy of adult trees. Effects of timber harvest are described for three years pre-harvest and three years post-harvest. Insect abundance declined 30-70% across all treatments following harvesting compared to pretreatment levels. Treatment effects appeared in both the understory and canopy in the first year following cutting (1997). Treatment effects were relatively weak in the understory (occurring in only 1/4 censuses each for both species), with cutting increasing the number of insects compared to controls for both *Q. alba* and *Q. velutina* when such effects did occur. In contrast, cutting reduced the number of insects encountered in the canopy compared to control sites in both 1997 and 1998, and then finally increased the number of insects at the end of 1999. Links to changes in insectivorous bird abundance as also affected by timber harvesting will be discussed.

Mauger, David, Thomas P. Wilson and Donald M. Stillwaugh Jr. Translocation of spotted turtles (*Clemmys guttata*) to Lockport and Romeoville Prairie Nature Preserves. Forest Preserve District of Will County, P.O. Box 1069, Joliet, Illinois 60434-1069 (DM, DMSJ). Department of Biology, George Mason University, Fairfax, Virginia 22030-4444 (TPW).

Conservationists have great need for information and strategies that can be applied to programs and projects to establish new or augment existing populations of rare species. However, introduction or augmentation projects are unlikely to succeed unless factors facilitating decline, life history and ecology of the subject species are clearly understood. Augmentation programs to headstart sea turtles have been employed, but projects with semi-aquatic freshwater turtle species are lacking. Further, adults of some freshwater species are known to exhibit "homing" behavior site when translocated, leading to the perception that headstarting hatchlings is the only strategy that can be employed in programs to introduce or augment populations. We report results of radiotelemetry and census fieldwork that indicate that adult spotted turtles can be moved to new sites. The spotted turtle is a state endangered species in Illinois and only three extant populations have been documented. Our translocations were undertaken as an emergency action to salvage turtles from the third population that had been destroyed by ditching and mining. We moved them to the remaining two sites at Romeoville and Lockport Prairie Natures Preserves, located 3 and 9.5 km to the south of the destroyed site. We present factors that may explain our success and use the results to identify issues and propose protocols which need to be considered before implementing translocation actions, introductions or augmentation programs with rare turtle species. We discuss the need for greater collaboration among research biologists, preserve managers, educational institutions and zoological parks relative to rare turtle species conservation. Finally, we emphasize that a conservation partnership would have been a preferred strategy, and if collaboration and plans had already been established we would have been better prepared to respond with alternatives to translocation when the third site was destroyed.

McClain, William E., Jody Shimp and John E. Ebinger. The kudzu problem in Illinois, a call to action. Illinois Department of Natural Resources, 524 S. Second St., Springfield, Illinois 62701, and Professor Emeritus of Botany, Eastern Illinois University, Charleston, Illinois 61920 (WEM).

The woody vine kudzu (*Pueraria lobata* (Willd.) Ohwi) was widely planted for erosion control throughout the southeast during the 1930s and has since become a very invasive plant now estimated to cover more than 2.8 million hectares of land. It was not extensively planted in Illinois, but a statewide survey indicated over 70 colonies in 27 counties, mostly in the southern third of the state. All colonies were blooming, and many were producing viable seed, suggesting the potential of a rapid range expansion within Illinois. All public agencies having populations of kudzu on their lands were invited to a meeting to discuss kudzu control in Illinois.News articles were written and published on the kudzu problem to inform private landowners. Nearly 30 colonies have been treated thus far, and plans are underway to treat more this year. The project has had remarkable multi-agency cooperation and support. Funding was obtained to assist with the kudzu control. Due to the relatively small number of colonies and area currently occupied by this plant, optimism remains high for the eradication of this plant from the state.

McFall, Don. 300 Illinois Nature Preserves, an overview of the Illinois Nature Preserves Commission and its system of protected areas. Illinois Nature Preserves Commission, 524 South 2nd St., Springfield, Illinois 62701.

Illinois will celebrate the dedication of its 300th Nature Preserve in 2001.The Illinois Nature Preserves Commission was the first in the nation and became the model for 14 other state nature preserve systems.The Commission has developed a well-rounded natural area program over its 37-year history with natural area inventory, protection, stewardship and defense components. Our success is attributed to foresighted enabling legislation, an independent Nature Preserves Commission made up of unpaid, conservation minded citizens, a professional staff large enough to carry out the program and general public support for natural area protection. The Commission maintains a strong partnership with the Illinois Department of Natural Resources, the nature preserve owners, not for profit conservation groups, land managers and volunteer stewards. The Commission works extensively with private landowners and, in response to landowner requests, has developed a series of land protection programs that protect natural features, yet allow some level of private or public use. With 300 preserves, providing the preserve owners clear guidelines on how to manage their land and streamlining the land management approval process is key. Each preserve has a site management schedule including site management goals, a description of management units and specific management actions. The management schedule is approved by the landowner and the Commission and updated every three years.

McKenzie, Paul M. The sand prairies of the Missouri Bootheel - their contribution to the state's rich biological diversity and the desperate need for their protection, restoration and management. U.S.F.W.S. - Columbia Field Office, 608 E. Cherry Room 200, Columbia, Missouri 65201.

Survey work in the last 10 years have revealed that the sand prairies of the Missouri Bootheel are one of the most biologically diverse natural communities of the state. In addition to providing habitat for the state-listed Illinois chorus frog (*Pseudacris streckeri illinoensis*), this natural community also supports a rich botanical flora, many of which are imperiled (e.g., either S1 or S2) in Missouri due to agriculture, residential development and livestock grazing. To date, none of the areas has been designated as a natural area or placed under public ownership. Although most tracts of sand prairies have been degraded due to poor management and misuse, they have excellent restoration potential. In the absence of outright land acquisition, sand prairies could be properly managed through land owner contact programs such as one currently underway with one private land owner in Scott County. Regardless of what mechanism is instituted to protect or manage sand prairie habitats in the Missouri Bootheel, such efforts are essential if this area's contribution to the rich biological diversity of the state is to be preserved.

Menges, Eric S., Carl Weekley, Samara I. Hamzé and Pedro F. Quintana-Ascencio. Integrating long-term demographic monitoring and research in plant ecology: an example from the Florida scrub. Archbold Biological Station, P.O. Box 2057, Lake Placid, Florida 33862.

Basic ecological research and monitoring are sometimes considered as separate activities, but they should be integrated to provide both information on trends and possible mechanisms behind trends. Both can help land management satisfy its goals and objectives. In the Plant Ecology Laboratory at Archbold Biological Station, we have been monitoring population trends and individual fates in 21 plant species, some since 1988. Most are listed as federally-endangered and many are narrow habitat specialists. By following multiple populations in various fire regimes, we can link demographic parameters to fire management and model optimal fire return intervals to maximize population viability. Linked detailed studies and experiments can provide useful information for conservation planning and land management. For example, genetic surveys and breeding system experiments have identified a paucity of genotypes in the endangered shrub *Ziziphus celata* and the necessity for introductions and augmentations to increase genetic variation and population sizes. Studies of seed dispersal and seed banks in the endangered mint *Dicerandra frutescens* pinpoint the dangers of habitat fragmentation and fire suppression. Field seed germination experiments of the endangered annual mustard *Warea carteri* show that fire induces seed germination by increasing exposure of seeds to light, and demographic data show that population flushes are related to high seedling recruitment after fires. In these and other cases, long-term demographic monitoring has suggested more detailed studies and experiments to explain mechanisms behind the trend. Knowing the mechanism allows more precise management and helps avoid costly mistakes.

Mierzwa, Kenneth S., Beth M. Churchwell and Melissa R. Michelson. Amphibian and reptile response to prescribed fire in an Ozark woodland. TAMS

Consultants, Inc., 1 E. Wacker Drive Ste 1200, Chicago, Illinois 60601 (KSM). The Nature Conservancy, St. Louis, Missouri 63144 (BMC). California State University, Fresno, California (MRM).

In the lower Ozarks of Missouri, decades of fire suppression have resulted in gradual changes in vegetation structure. Various studies have shown that amphibian and reptile assemblages are affected by tree canopy cover, amount of herbaceous cover and other structural variables. From 1997 - 1999, we investigated the effects of prescribed fire on amphibians and reptiles at Chilton Creek Preserve in southeastern Missouri. Visual encounter surveys were used to sample amphibians and reptiles on randomly located plots within burn units and in nearby unburned areas. A total of 42 amphibian and reptile species were observed within the preserve boundaries. Overall species richness was higher on burned plots than on unburned plots, largely because of the presence of additional reptile species. *Plethodon albagula*, the most abundant amphibian on the site, did not differ significantly in abundance between burned and unburned plots. Two common salamanders, *Eurycea longicauda* and *E. lucifuga*, were less abundant on burned plots, while one snake, *Carphophis vermis*, was more common in burn units. After two years of prescribed fire, amphibian and reptile diversity had improved with small reptiles characteristic of more open conditions accounting for much of the change.

Nigh, Tim A., David D. Diamond, Diane C. True, Taisia B. Gordon and Scott P. Sowa. Extending an Ozark Highlands region-wide resource assessment into landscape and site level conservation in the Current River Hills Subsection. Missouri Department of Conservation, P.O. Box 180, Jefferson City, Missouri 65102-0180 (TAN). Missouri Resource Assessment Partnership, 4200 New Haven Rd., Columbia, Missouri 65201 (DDD, DCT, TBG, SPS).

The Ozark Highlands inventory and assessment process provided a coarse-scale identification of region-wide conservation priorities. These results were used as a framework for pursuing higher resolution assessment and planning within the Current River Hills ecological subsection. Region-wide conservation opportunity areas were further refined and characterized using ecological land types along with higher resolution land cover, heritage records, vertebrate distribution models and land ownership patterns. Representation analysis was performed to evaluate how well local conservation targets were represented by the refined conservation landscapes and sites. The process was evaluated as a pilot for further high resolution assessment and planning throughout the Ozark Highlands.

Nyberg, Dennis W. Accelerating woodland restoration with deadwood. Department of Biological Sciences, University of Illinois at Chicago, 845 W. Taylor St., Chicago, Illinois 60607.

While establishing trees on clear cut land is widely practiced commercially, people interested in the restoration of native communities have largely focused on grasslands. Undoubtedly, the avoidance of restoration of natural communities with trees is partly based on the long time it takes for an individual tree to mature. It may also be based on the notion, apparently widely held by forest preserve districts, that planting trees establishes a forest. Both areas planted with trees and successional processes that start with agricultural land lack appropriate understory plants and most animals. I observed that the amount of deadwood on the ground differentiates mature oak communities, where it covered 1.7% of the surface, from successional areas, where only 0.28% of the ground was covered with deadwood. The lack of snags and logs in the successional areas is expected to have a large impact on the fauna because so many species live in deadwood. I will present data on the dynamics of conversions from living tree to snag to down log in two oak woodland gaps created by *Armillaria*. The life expectancy of snags is about five years and the trunk persists on the ground as a log for 20 to 25 years. I advocate the movement of large diameter logs into successional areas to provide colonization sites for the diverse fauna that uses down logs.

Nyboer, Randy W. Controlling exotic bush honeysuckles in dry-mesic upland forests with prescribed burning. Illinois Department of Natural Resources, 2317 E. Lincolnway Ste. A, Sterling, Illinois 61081.

Exotic bush honeysuckles (*Lonicera tatarica* and *mackii*) are commonly planted ornamental shrubs that easily invade many natural community types in Illinois. In forest communities, disturbances such as grazing and logging will create opportunities for bush honeysuckle to invade, mainly by seed dispersal from birds and small mammals. However, even in undisturbed forest communities bush honeysuckle will establish easily along forest edges and, to a lesser degree, forest interiors, resulting in lower native plant diversity due to shading of the herbaceous understory and reducing hardwood regeneration. While labor-intensive hand pulling and mechanical cutting coupled with herbicide treatments are proven control methods for this exotic, prescribed burning can now be added to this list of control measures in forest communities. The use of two consecutive spring prescribed burns in a dry-mesic upland forest dominated by mature white and black oaks had the following results: in areas where cooler back fires were used, 76% of all age classes of bush honeysuckle were totally killed after two burns; in areas where hot headfires were used, two burns resulted in totally killing 98% of the honeysuckle. Two years after the burn treatments, native wildflowers such as mayapple, red trillium, false soloman's seal and jack-in-the-pulpit have reestablished themselves in the burn areas.

The Orion Society's Forgotten Language Tour. The scientist, the hunter and the poet: three writers explore how the culture we live in shapes our attitudes toward natural diversity, how specific kinds of learning affect our perceptions of nature and how direct, personal experience with nature can make natural diversity a fulcrum point of our lives. 195 Main St., Great Barrington, Massachusetts 01230.

In this session, Robert Michael Pyle, Richard Nelson and Pattiann Rogers will explore the roots of our personal and cultural estrangement from the natural diversity on which our lives depend. This inquiry will grow out of the writers' particular experiences as biologist and world-reknowned lepidopterist, as hunter and anthropologist and finally as the translator of our deepest human experience, the poet. Robert Pyle will speak about his experience studying butterflies, the monarch in particular, and how their distinctive needs broadly reflect the needs of other creatures and how their decline so clearly express the consequences of human attitudes toward the landscape. Hailing from Alaska and having lived many years of his life among the indigenous subsistence cultures of that region, Richard Nelson offers a dynamic understanding of our culture's multi-dimensional dependence on the deer. His 25 years of hunting will provide the foundation for a fascinating exploration of how our relationship to deer characterizes our relationship to natural diversity. And finally, poet Pattiann Rogers, perhaps the most empassioned voice on behalf of nature's unflagging creativity, will illuminate how the meaning of our lives is indivisible from natural diversity. After presentations by each speaker, the writers will open the session into a dialogue with the audience.

Panzer, Ron. Gauging restoration authenticity and conservation value using conservative plants and insects. College of Arts and Sciences, Northeastern Illinois University, Chicago, Illinois 60625.

Many plant and insect species are incapable of inhabiting severely altered habitats. These 'conservative' species are incapable of survival within human-dominated habitats and subsequently perish when natural areas are destroyed. These species comprise the bulk of the extinction-prone biodiversity surviving within severely fragmented regions and serve, in large part, to distinguish natural area remnants from the altered landscapes that restorations are intended to replace. Hence, their presence or absence must be considered in the assessment of restoration success. The number of conservative species recorded within a restoration can be summed and compared with appropriate reference values to obtain a measure of 'ecosystem assemblage authenticity.' Restoration sites must ultimately be assessed in terms of their contributions to the protection of imperiled species. To facilitate this assessment, species can be assigned 'conservation values' reflective of their local, and/or regional rarity. Conservation values can be summed to provide a 'conservation value index,' a second measure of conservation success. Conservative plant and insect richness data from seven Chicago-area prairie and/or sand savanna remnants and the Fermilab Prairie Restoration are presented to illustrate the utility of this approach.

Pearce, Cheryl M. and Derald G. Smith. Plains cottonwood's last stand: can it survive invasion of Russian olive on prairie river floodplains? Department of Geography, University of Western Ontario, London, Ontario N6A 5C2 (CMP). Department of Geography, University of Calgary, Calgary, AB T2N 1N4 (DGS).

Russian olive (*Elaeagnus angustifolia* L.) was introduced to North America for windbreaks, ornamental hedges and wildlife habitat in the late 1800's. It is still distributed at low cost to landowners, even though control and eradication once it is established is difficult and expensive. We compared distribution, density, age structure and mortality of Plains cottonwood (*Populus deltoides* Marsh.) and Russian olive on a 140 km reach of the Milk River (a tributary of the Missouri River) between the Pinhorn Ranch in southeastern Alberta and Chinook in north-central Montana. Russian olive was planted on the floodplain 10 km downstream from the Alberta/Montana border in 1950. Since then, it has dispersed upriver into Alberta and down river to the Fresno Reservoir and now comprises 34%, 62% and 61% of all seedlings, saplings and trees, respectively, compared to Plains cottonwood. Russian olive out-competes cottonwood on the Milk River because its seeds are easily dispersed by wildlife, floodwaters and ice-rafts; seeds are viable for up to 3 years; seed germination can take place on both bare and well-vegetated soils; and saplings and trees are less palatable to livestock and beaver. We believe that, without control, Russian olive will be dominant on the Milk River floodplain in all age classes within 10 yrs and will replace Plains cottonwood along most Montana rivers within this century. Government agencies in North America must officially declare Russian olive an invasive, undesirable tree that will replace diverse native riparian ecosystems, shut down its distribution completely and develop and finance programs for its control and eradication.

Pergams, Oliver and Dennis Nyberg. Museum collections reveal an exceptional decline of prairie mammals in the Chicago region. University of Illinois at Chicago, Department of Biological Sciences (MC 066), 845 W. Taylor St., Chicago, Illinois 60607.

Museum collections examined for specimens of *Peromyscus* from the six Illinois counties of the Chicago region identified 701 individuals. The prairie deer mouse (*Peromyscus maniculatus bairdii*), which prefers prairie habitat, was more common than the northern white-footed mouse (*P. leucopus noveboracensis*) in collections prior to 1920, but constitutes only 5% of specimens deposited since 1970. As the northern white-footed mouse prefers woodlands and the prairie deer mouse is limited to open areas, the change in proportions is likely driven by vegetation changes. The decline of the prairie vole (*Microtus ochrogaster*) relative to the meadow vole (*M. pennsylvanicus*), and the lack of recent specimens of Franklin's ground squirrel (*Spermophilus franklinii*), corroborate the hypothesis that prairie habitats have declined more so than wooded ones in the Chicago region. Based on the museum records, it is possible that *S. franklinii* is already locally extirpated and that *P. maniculatus bairdii* will become so.

Podraza, Cynthia J., Ed Collins and Thomas Simpson. A field study of the re-introduction of the species *Elliptio dilatata* in the main branch of the Nippersink Creek,

McHenry County, Illinois. Department of Geography and Environmental Studies, Northeastern Illinois University, Chicago, Illinois 60625 (CJP, TS). McHenry County Conservation District, Ringwood, Illinois 60072 (EC).

Elliptio dilatata (Rafinesique 1820), commonly known as the spike or lady finger mussel, is currently on the Illinois Threatened and Endangered Species List. Since the 1960s, *E. dilatata* has been extirpated from the main branch of the Nippersink Creek in Northeastern Illinois, McHenry County as a result of agricultural run-off and the use of rotenone to remove unwanted fish species. A total of 240 mussels were re-introduced into the Nippersink Creek in an effort to examine the short-term influence of re-introduction techniques and habitat variability on their recovery and survival. The mussels were randomly selected from a donor site, the Mukwonago River in Waukesha County, Wisconsin. Both the donor site and the Nippersink Creek have similar site characteristics and are situated within the Fox River watershed. Mussels were tagged and assigned to one of four groups in spring and fall, which included the following parameters: habitat (pool vs. riffle) and substrate (sand vs. gravel). Each group was then sampled monthly from May 1998 until September 1998 and then again in May and July 1999. Water quality parameters measured included dissolved oxygen, pH, nitrates, ammonia, silica, CO_2, total water hardness and phosphorus. Stream characteristics measured for each sampling plot and each sampling period, included water temperature, velocity, depth and turbidity. Initial results show that habitat, substrate and date of sample have a statistically significant impact (p-value < 0.10) on the rate of recovery and adjusted survival (attributes loss of marked mussels to mortality). The results of this study demonstrate that ecological requirements such as habitat and substrate type do play a significant role when managers plan for the successful re-introduction of the mussel species *Elliptio dilatata*.

Porneluzi, Paul and John Faaborg. Ovenbird season-long fecundity, survival and viability in fragmented and unfragmented landscapes. Division of Science and Math, Central Methodist College, Fayette, Missouri 65248 (PAP). Division of Biological Sciences, University of Missouri-Columbia, Columbia, Missouri 65211 (JF).

Our purpose was to measure the extent that negative effects of fragmentation on nests affect individual bird's annual productivity. We compared season-long fecundity of marked ovenbirds (*Seiurus aurocapillus*) on three sites in large (>2000 ha) forest patches in the fragmented landscape of Boone, Howard and Randolph counties in central Missouri with four sites in the more contiguously forested landscape of Carter, Reynolds and Shannon counties in the Ozarks. We determined the proportion of territorial males that ultimately succeeded in raising young in a season and multiplied this proportion by the average brood size obtained from nest observations. Fewer pairs successfully raised young in the fragmented landscape (50 $\pm$ 11%) than in the unfragmented landscape (70 $\pm$ 7%). In the fragmented landscape, 25 $\pm$ 6% of pairs raised at least one brown-headed cowbird (*Molothrus ater*), whereas only 1 $\pm$ 1% of pairs raised cowbirds in the unfragmented landscape. Lower season-long success and increased brood parasitism led to annual productivity of 0.70 and 1.47 juvenile females per female in the fragmented and unfragmented landscapes, respectively. Territory size (mean = 2.76 ha) was not affected by landscape, but density was lower in the fragmented landscape (1.6 $\pm$ 0.41 males per 10 ha) than in the unfragmented landscape (2.2 $\pm$ 0.32). Male pairing success (67 $\pm$ 6%) and survival (0.621 $\pm$ 0.21) was not affected by landscape. We concluded that it was unlikely that sites in the fragmented landscape contained viable ovenbird source populations, whereas populations in the unfragmented Ozark region were likely to be sources in most years. Nevertheless, any changes in the Ozarks that increase nest predation or parasitism may have consequences for the regional population of ovenbirds and other forest breeding Neotropical migrants in the Midwest.

Pyle, Robert Michael. Walking the high ridge: integrating science and poetics in nature writing. c/o The Orion Society, 195 Main Street, Great Barrington, Massachusetts 01230.

Novelist/Lepidopterist Vladimir Nabokov asked, "Does there not exist a high ridge where the mountainside of 'scientific' knowledge joins the opposite slope of 'artistic' imagination?" As a scientist and essayist, I believe such a meeting point exists and may be employed to great advantage in communicating the importance of biodiversity. But this requires careful attention to the separate roles and responsibilities of repeatable fact and lyric response and especially to the context in which they may coexist. I will discuss several writers of ambidextrous sensibilities who manage this tricky synergism to good effect. Through specific examples from nature and literature, I will show how scientific and lyrical approaches can complementarily illuminate the same organisms, habitats and processes.

Radwell, Andrea and Thomas J. Kwak. Ecological integrity assessment of Ozark rivers to determine suitability for protective status. Arkansas Cooperative Fish and Wildlife Research Unit, Department of Biological Sciences, University of Arkansas, Fayetteville, Arkansas 72701 (AR). U.S. Geological Survey, North Carolina Cooperative Fish and Wildlife Research Unit, Box 7617, NC State University, Raleigh, North Carolina 27695 (TJK).

The Wild and Scenic Rivers Act of 1968 was passed to protect free-flowing rivers with outstanding ecological and social values and requires suitability studies as part of the designation process. An objective, quantitative method to determine suitability based on ecological integrity was developed and tested using 10 Ozark rivers, five with Wild and Scenic status. Thirty-four variables representing macroinvertebrate and fish assemblage characteristics, instream habitat, riparian vegetation, water quality and watershed attributes were quantified for each river and analyzed using two multivariate approaches. Cluster analysis identified two groups, and discriminant analysis identified only one variable (% forested watershed) that reliably distinguished groups.

The second approach compared variables for each river to conceptually ideal conditions that were developed as a composite of the optimal conditions among the 10 rivers, which may serve as least-disturbed ecoregion reference conditions. The composite distance of each river from ideal was then calculated using multidimensional scaling. Two rivers without Wild and Scenic designation ranked highest in ecological integrity, and two others ranked lowest in ecological integrity. Fish density, number of intolerant fish species and invertebrate density were influential biotic variables for scaling. Contributing physical variables included riparian forest cover, nitrate concentration, turbidity, percentage of forested watershed, percentage of private land ownership and road density. This research may provide a framework for refinement and application in other regions to facilitate the process of identifying rivers for protection, use as least-disturbed reference streams in biomonitoring, or providing benchmarks for restoration efforts.

Reeves, Christopher D. and Alan Journet. Monitoring composition, recruitment and regeneration in the bottomland hardwood and swamp forest communities of Big Oak Tree State Park, Mississippi County, southeast Missouri. Department of Biology, Southeast Missouri State University, Cape Girardeau, Missouri 63701.

Big Oak Tree State Park (Mississippi County, southeast Missouri) is an old growth remnant of the once extensive bottomland forest of the Mississippi valley. Historically, it was subjected to extensive flooding and probably to frequent fire by Native Americans. Studies were done to explore vegetation patterns in the park prior to the imposition of modified hydrology and to determine the potential role of fire in restoring earlier vegetation structure to the park. Studies included randomly-chosen nested circular plots for which a series of both quantitative and qualitative measurements were taken. Statistical analyses involved the use of canonical discriminant analysis that was used to generate a scatter plot of quadrats on multivariate canonical axes to determine if the sampled plots where significantly different, and if so, which species contributed to this difference. Vegetation patterns indicate a marked difference in structure and composition between the swamp forest and the wet bottomland forest canopy and sub-canopy. Flood intolerant species (*Celtis laevigata, Acer negundo*, and *Asimina triloba*) were found in greater abundance in the wet bottomland forest community, which will be most affected by the hydrology modification project. Results from the fire study indicate that both woody and herbaceous vegetation were significantly different in treatment plots from the control group with slight increases in the mean [C] values indicating *Asimina triloba* and *Arundinaria gigantea* being correlated with control plots, *Celtis laevigata, Acer rubra, Toxicodendra radicans, Menispermum canadense* and *Boehmeria cylindrica* tending to occur in control plots that were cleared of understory woody species only by cutting, while *Acer saccharinum* and *Pilea pumila* occurred in control plots that were both cut and burned.

Renken, Rochelle B. and Debra K. Fantz. Immediate, landscape-scale impacts of even-aged and uneven-aged forest management on herpetofaunal communities during 1997-1999. Missouri Department of Conservation, 1110 S. College Ave., Columbia, Missouri 65201.

The objectives of the Missouri Ozark Forest Ecosystem Project (MOFEP) herpetofaunal community research are to determine the impacts of even-aged and uneven-aged forest management upon the species composition, species richness and relative abundance of amphibian and reptile communities in the Ozark forests of southern Missouri. Pre-treatment information on amphibian and reptile communities was collected during 1992 through 1995. For this paper, post-treatment conditions of herpetofaunal communities during 1997 through 1999 are compared to pre-treatment conditions. Even-aged and uneven-aged forest management did not have an immediate, landscape-scale impact upon the species composition, species richness and relative abundance of overall amphibian and reptile abundance. However, even-aged and uneven-aged forest management did have an immediate impact upon the relative abundance of some groups of amphibians and reptiles. The impact varied depending upon number of years following cutting (treatment) and slope type (north and east-facing slopes or south and west-facing slopes). We speculate that forest management can have immediate, landscape-scale impacts upon the food resources or movements of certain amphibian and reptile groups.

Richardson, Larry. Florida panthers - sentinel and harbinger for biodiversity. U.S. Fish and Wildlife Service, Ste 300, Florida Panther NWR, 3860 Tollgate Blvd., Naples, Florida 34114.

Data of Florida panther (*Puma concolor coryii*) radio telemetry were integrated with GIS-generated aerial photography, spanning 50 years, to identify landscape preferences for panthers, changes in habitats affecting component species diversity and to correlate changes in habitats due to human-caused activities. Panthers have acquired precarious distinction as charismatic mega-fauna; their beauty and mystery contributing to the public's sentiment for recovery. Twenty years of panther data, about 45,000 locations, and GIS technology, have allowed biologists to: 1) identify life-history needs and preferences for natural areas and limitations on genetic integrity as a sub-species at the landscape level, 2) identify the ancillary benefits of natural areas for component fauna and flora afforded by their status, 3) expand the purview of single species recovery of the panther to include all native fauna and flora under an ecosystem approach to habitat conservation and restoration, and 4) associate gross and subtle changes over landscapes caused by human development to losses in species diversity, particularly from changed hydrology and natural fire regimes. The panther has become a sentinel for biodiversity, underscoring the importance of large tracts of wilderness which harbor all native genera; emphasizing the imperative need for ecosystem management that benefits all species. They have also become harbingers to environmental degradation, underscoring their intolerance, and that of other species, for landscapes significantly affected by development.

Richardson, Larry W. Using animal magnetism to sell conservation. North American Nature Photography Association, 10200 W 44TH Ave. Ste 304, Wheat Ridge, Colorado 80033-2840.

Building environmental stewardship within society remains a major obstacle for realizing conservation goals. Strong public support often advances decisions that impact natural resource management on local, regional and national scales. To marshal this support, techniques and strategies are needed to enhance educational opportunities and effectiveness. Using photographic imagery of keystone and high-profile species, now available through many sources and formats, biologists - as environmental communicators - can draw greater attention from convening audiences in a variety of venues. By using provocative imagery, biologists can translate greater scientific detail of critical environmental concerns. The results can lead to increased community sentiment and constituency growth, and educate laypersons with factual material from which they might not otherwise benefit.

Roberts, Andrew D. The influence of an isolated locality record on the proposed listing of the scaleshell mussel (*Leptodea leptodon*) as an endangered species. U.S. Fish and Wildlife Service, Ecological Services, Columbia, Missouri 65201-7712.

The scaleshell mussel historically occurred in 54 rivers including 13 states of the eastern United States. Within the last 50 years, this species has become increasingly rare and its range greatly restricted. Currently, extremely small populations are known to exist in 15 streams in Missouri, Arkansas, and Oklahoma. On August 13, 1999, the U.S. Fish and Wildlife Service (Service) published a proposal to list the scaleshell as a federally endangered species. The Service announced the proposal in 60 newspapers and requested comments from appropriate federal and state agencies, county governments, scientific organizations and other interested parties. During the initial comment period, the Service received letters in support of the listing from five natural resource agencies and seven malacologists and 182 letters opposing the listing from citizens with business interests along the Missouri River. These citizens primarily responded to a 1982 record of scaleshell from the Missouri River that was described in the proposal. That record is unusual because scaleshell normally occur in streams different than the Missouri River. In December 1999, the Service hosted a hearing to provide the public an opportunity to comment orally. The hearing included an informal informational session and a question and answer period in which some concerns were alleviated. However, various issues and concerns were still raised at the formal hearing. The Service has responded to these comments in the final report, which is currently in "in house" review, with a publication deadline of August 13, 2000. At that time, the Service will announce the decision to list or not to list the scaleshell as an endangered species.

Root, Brian G. The Riparian Ecosystem Assessment and Management project: project overview and summaries of 1994-2000 vegetation and vertebrate data. Missouri Department of Conservation, 1110 S. College Avenue, Columbia, Missouri 65201.

The Riparian Ecosystem Assessment and Management project was initiated in 1994 to describe floral and faunal communities occurring in northern Missouri bottomland forests, provide a platform for researching water quality issues and aid the development of Best Management Practice guidelines concerning riparian forest management and its impacts on flood plain vegetation structure, in-stream habitat conditions (including water quality) and selected wildlife communities (songbirds, herpetofauna, small mammals). Various study sites will provide case-study examples of different silvicultural management practices (e.g., small clearcuts, commercial and pre-commercial thinnings, no-harvest), and the long-term responses of vegetation (esp. tree species) and vertebrate communities to these practices. Baseline (pre-treatment) information has been collected through 1999 at all study sites, and descriptions of vegetation, songbird, herpetofauna and small mammal communities will be presented. In general, woody and herbaceous vegetation communities are diverse (>300 total species). However, silver maple (*Acer saccharinum*) and American elm (*Ulmus americana*) are the most numerous trees in all stands, whereas hard-mast producing species (e.g., oaks [*Quercus* spp.]) are uncommon in the understory, suggesting that recent conditions have been poor for regeneration. Breeding songbird communities also are diverse (approx. 90 species), with cavity nesters making up 20-25% of the total species. Several less-common bird species occur in these northern Missouri bottomland forests (e.g., Cerulean warbler [*Dendroica cerulea*], Acadian flycatcher [*Empidonax virescens*]), and their responses to forest management will be important factors directing development of future management practices. Herpetofauna and small mammals are abundant, but their communities are relatively less diverse. Commercial timber harvest occurred at one study site during 1999/2000, and initial post-treatment impacts on vegetation, songbirds and herpetofauna will be presented.

Ross, Laurel M. Chicago wilderness: challenges for the future. The Nature Conservancy, Illinois Chapter, 8 S. Michigan Avenue, Chicago, Illinois 60603.

In spring of 1995, a major new conservation partnership was announced in northeastern Illinois. Thirty-four conservation-conscious agencies and institutions active in the Chicago metropolitan area joined forces to work toward the common goal of biodiversity protection. Partners included research and education institutions, major public land owners, local, state and federal governmental agencies, the regional planning agency and several conservation not-for-profit organizations. Their stated mission, "to protect the natural communities of the Chicago region and restore them to long-term viability, in order to enrich the quality of life of its citizens, and to contribute to the preservation of global biodiversity," embraced the fact that in addition to significant natural resources, there were also eight million people living in the region. Since that announcement, the partnership has flourished. A Regional Biodiversity Recovery Plan was

completed and adopted in December 1999. Nearly 200 projects both on-the-ground and educational are underway; a regional Atlas of Biodiversity was created and is being widely distributed; funding from state, federal and local sources has supported these and other major efforts; new members have joined the partnership raising the total to 107 participating groups. In the fifth year of work the partnership is assessing progress and setting goals for the future. This paper will discuss some of the new work that is expected to be generated throughout Chicago Wilderness as it continues to grow.

Saunders, Sari C., Mo R. Mislivets, David T. Cleland and Jiquan Chen. Impacts of roads on landscape structure within nested ecological units of the Northern Great Lakes Region, USA. School of Forestry, Michigan Technological University, Houghton, Michigan 49931 (SCS, JC). USDA Forest Service, North Central Research Station, Houghton, Michigan 49931 (MRM, DTC).

We examined the impact of roads at different ecological levels on landscape structure in the northern Great Lakes Region. We used TM imagery and GIS to calculate the number of patches, patch size and patch shape by land cover type (n=8) within two nested ecological levels (landtype associations, 23-3816 km^2; n= 171; subsections, 1406-13,174 km^2; n=17). Based on estimates of depths-of-edge influence for different ecological variables, we used a range of buffer widths (15 m through 300 m) to assess the percentage of area that is affected by roads. Within landtype associations of a subsection, roads increased the number of patches, decreased patch size and simplified patch shape (decreased mean shape index). The detection of these significant ($p<0.05$) changes was dependent on the ecological level at which the analysis was undertaken. Road density (0.16- 2.07 km/km^2) also varied by location, ecological unit and forest type. However, at both the landtype association and subsection level, densities in white-red-jack pine forest were relatively high (12.8% and 15.4% respectively). Changes in landscape metrics also varied geographically and by landcover class, occurring primarily in four of six forest systems; oak-hickory and elm-ash-cottonwood were relatively unaffected. Some forest cover types existed completely as road-influenced systems, when edge effects were hypothesized to extend >100 m from the road edges. Our results indicate the necessity of examining the impacts of roads by forest type, ecological variable of concern and across multiple ecological levels to highlight differences in these impacts across space and scales.

Sawin, Elizabeth. Inspiring a love of the natural world. Department of English, Missouri Western State College, St. Joseph, Missouri 64507.

If we want to communicate the importance of natural diversity to life on earth and inspire students to care about our fragile planet, then we need field experiences that allow students a chance to discover for themselves a sense of the interrelatedness of the individual and the natural world. Information alone will not make people care about the environment. Too frequently, however, education addresses only the cognitive and not the affective or pyscho-motor domains of whole human beings. Attitudes toward the natural world formed during a multi-disciplinary, 15-hour outdoor semester will be presented with relevant slides and entries from the journals of students who made a 17-day trek through the Great Plains of North America. Students took classes on outdoor education, read Native American literature, studied travel and tourism and critiqued interpretive services on their journeys. Physically demanding and cooperative activities led to an expanded sense of self. Physical activity before journal writing heightened student awareness of the natural world. Encounters with the unfamiliar, the unknown and the uncontrolled led to a sense of humility about humanity's place in the universe. Students with many different majors (business, biology, technical writing, art, physical education) began the life-long process of developing an ecological conscience.

Sheriff, Steven L. Missouri Ozark Forest Ecosystem Project: the experiment. Missouri Department of Conservation, 1110 S College Ave, Columbia, Missouri 65201.

The Missouri Ozark Forest Ecosystem Project (MOFEP) is designed as an experiment in forest management. The emphasis of MOFEP is on learning while managing the forest at a large scale. MOFEP is unique in that an experimental design using replicate forest management units is the primary mechanism used in this learning process. The goal for MOFEP is to learn about the impacts of management practices on a forest system. Competing forest management practices (uneven-aged, even-aged and no harvest management) were randomly assigned to nine forest management sites using a randomized complete block design. Unique features of the MOFEP experimental design include collection of pre-treatment information and the long term nature of this project. The design of MOFEP also allows for three complete rotations of treatments to the forests within each site. Given the periods between the application of even-aged and uneven-aged harvest practices will be 10-15 years, we expect the life of MOFEP to be 300-450 years. During the entire life of this project, results will provide information valuable in understanding and designing forest management practices that will benefit the health of the forest ecosystem. The objective of this presentation is to present the experimental design of MOFEP, what was done right and lessons from our mistakes, so that others might apply experimentation while managing ecosystems in a manner where learning can be emphasized. This opportunity for learning about the impacts of management on ecosystems is easier than one might expect given the MOFEP experience.

Smith, Lisa L. Getting the job done: land steward volunteers. Western Pennsylvania Conservancy, Land Stewardship Program, Fallingwater, P.O. Box R, Mill Run, Pennsylvania 15464.

Western Pennsylvania Conservancy is a private, non-profit land conservation organization that has protected

204,500 acres of land in western Pennsylvania since 1932. Stewardship of the ecological, recreational and scenic values of this land is a key goal for WPC, but limited staff and financial resources make achieving this goal a challenge. The Land Steward Volunteer program, launched in 1999, trains volunteers to be highly qualified monitors to assist in the management of WPC's holdings. Responsibilities include identifying threats to ecological resources, human health and safety and real estate (property boundaries and facilities). Volunteers receive extensive training. To date, WPC benefits from more than 50 volunteers who actively monitor assigned natural areas and conservation easements. Within six months of volunteering, many land stewards expressed a desire to do more. As a result, training was done on topics such as invasive exotic species, impacts of deer on forest regeneration and ecological restoration. This has further been the basis for management activities, such as invasive species management, in which the land stewards actively participate. Engaging these volunteers in the monitoring and management activities of WPC's stewardship program has not only accomplished a tremendous amount of work but also promises to have lasting benefits to WPC. Land stewards are a key link to the public and an effective tool to engage the public in the type of conservation that is being promoted by WPC. Through this program, land stewards develop their land ethic and are a mechanism for encouraging and transferring a land ethic to others.

Smith, Lisa L., Susan Kalisz, Tiffiany Kight and Joann Davis. Recipe for invasive spread: venison with garlic mustard. Western Pennsylvania Conservancy, Mill Run, Pennsylvania 15464 (LLS). Department of Biological Sciences, University of Pittsburgh, Pittsburgh, Pennsylvania 15260 (SK, TK). Audubon Society of Western Pennsylvania, Beechwood Farms, Pittsburgh, Pennsylvania 15238 (JD).

Garlic mustard (*Alliaria petiolata*) was first introduced to North America from Europe in 1868 but remained relatively quiescent until the 1950s. Garlic mustard is now replacing native herbaceous vegetation in mature forests, despite the fact that recent experiments have shown it to be an inferior competitor to native species in greenhouse experiments. Over the same 50-year period, white-tailed deer (*Odocoileus virginianus*) have increased to historically unprecedented numbers throughout North America and are causing the alarming decrease in both the abundance and biodiversity of native plant communities via herbivory and trampling. We hypothesized that deer have a stronger negative impact on native herbs, which directly decreased native species' competitive ability relative to garlic mustard, and thereby facilitated garlic mustard's invasion. To test this hypothesis, in 1994 we established three 100m^2 fenced plots (deer absent) paired with control plots (deer present) at Trillium Trail, a natural area in southwestern Pennslyvania with elevated deer abundance since 1990. Fenced plots only restrict access of deer, allowing free access of the other fauna. In all plots, we monitored the relative area occupied by each herbaceous species (n=32), as well as species richness and reproductive status, for six years. Garlic mustard became more abundant with deer present, while the native herbs became more abundant with deer absent. Since the difference between plots is presence/absence of deer, these results indicate that deer promote the increase in garlic mustard. It is likely that the sensitivities of the native species to both deer browsing and trampling, relative to garlic mustard, decrease their competitive edge over the introduced species when deer are present. While many environmentalists are concerned about detrimental effects of both deer overabundance and garlic mustard's invasive spread, this is the first study to link these problems.

Smith, Ryan K., Paul L. Freeman, Braven B. Beaty, Thomas W. Fitzhugh and Mary Lammert. Conservation assessment and planning in the cumberlands and southern ridge and valley ecoregion. Southern Resource Office, 6114 Fayetteville Rd. Ste. 109, Durham, North Carolina 27713 (RKS, PLF). Freshwater Initiative, 8 S. Michigan Ave St.e 2301, Chicago, Illinois 60603-3318 (TWF, ML). Clinch Valley Program, 146 East Main St., Abingdon, Virginia 24210 (BBB).

The distributions of 192 rare and endangered fishes, mussels and snails were evaluated across the three major drainages that intersect in the Cumberlands and Southern Ridge and Valley (CSRV) ecoregion. Working with regional experts, goals for the number of occurrences for each species were developed, and sites were selected to protect the best examples of the target species. In addition, the representative fauna were captured using a hierarchical aquatic ecosystem classification framework that defined and mapped ecological systems. Systems were identified using landform, geology and hydrography data in an automated GIS. We conducted a gap analysis to identify the representative ecological systems and more common species and communities that were not incorporated into the conservation plan by selecting streams and rivers through species targets. Additional examples of ecological system types were included in the plan to develop a comprehensive aquatic biodiversity portfolio. A total of 48 sites were identified as critical conservation sites. This ecoregional planning process illustrates ways to deal with overlapping drainages and physiographic boundaries that do not correspond, and require extending the evaluation of aquatic biodiversity patterns beyond the ecoregion to develop a more robust ecoregional plan.

Sork, Victoria L., Victoria J. Apsit and Rodney J. Dyer. Variation in pollen movement within forest tree species in the Missouri Ozark Forest Ecosystem Project (MOFEP). Department of Biology, University of Missouri-St. Louis, St. Louis, Missouri 63121-4499.

The conservation of genetic variation is a goal for many management projects. For tree species, a critical factor determining the amount and quality of genetic variation is pollen movement. It is known that landscape alteration can influence pollen movement by changing the number of potential pollen donors and the movement of wind-borne and insect-carried pollen. One way to assess gene movement is to analyze seed genotypes using isozymes as genetic markers. First, we present pretreatment data on *Quercus alba*, *Pinus echinata* and *Cornus florida* to

document variation in two elements of pollen movement--structure of the pollen pool and patterns of mating. Then, we test whether pollen donor density and forest structure affects these two elements of pollen movement using a new landscape scale statistical model that allows the statistical examination of pollen movement and a mating system model. For all three species, pollen movement is relatively restricted. In addition, we find that local donor density and forest structure influence pollen pool structure, outcrossing rate and the number of effective pollen donors. Finally, we present results concerning the impact of forest management treatment on pollen movement in *Cornus florida* where we sampled ~2500 seeds from trees distributed across forest management treatment. We find significant differences in average distance pollen movement, pollen pool structure and effective number of donors. We conclude that pollen pool movement can vary tremendously across the Ozark landscape. As part of MOFEP, the goal of this project will be to integrate results from several years to evaluate the extent to which forest management treatment will influence genetic variation of future populations.

Sowa, Scott. Challenges and opportunities for biodiversity assessments in aquatic environments. Missouri Resource Assessment Partnership, 4200 New Haven Road, Columbia, Missouri 65201.

Interest in the conservation of aquatic biodiversity has increased dramatically over the last five to ten years. However, rapid declines in the health of our nation's aquatic ecosystems necessitates that we move rapidly from the "arm-waving stage" to a more concerted nationwide effort to conserve these important resources. Such an effort presents several major challenges. Some of the most pressing challenges include a) establishing a central forum for the exchange of ideas and information among the numerous resource agencies and aquatic resource professionals across the nation, b) establishing a common coarse-filter assessment strategy to prioritize conservation efforts, and c) establishing conservation strategies that effectively deal with the diffuse, diverse and often distant threats to our aquatic resources. The National Gap Analysis Program is ideally situated to help us meet many of these challenges and the initiation of Aquatic GAP pilot projects in New York and Missouri are an important and necessary first step, but many challenges remain. Aquatic biodiversity conservation efforts also present some unique opportunities. For instance, our nation is mandated by law in the Clean Water Act to maintain the biological integrity of our nation's waters. This legislative mandate has the potential to be powerful tool in the conservation of not just our aquatic, but also our terrestrial, resources. This presentation will briefly describe some of the major challenges to, and opportunities for, effectively conserving aquatic biodiversity in the United States. It will also cover the theoretical and technical aspects behind the coarse-filter assessment strategy that has been developed in the Missouri Aquatic GAP Pilot Project.

Spratt, Henry G., Jr. The impact of timber harvest on surface soil microbial community activity in selected Missouri Ozark Forest Ecosystem Project plots. Department of Biological and Environmental Sciences, University of Tennessee, Chattanooga, Tennessee 37403.

Evidence for significant effects of timber harvest on surface soil microbial communities has been documented in Europe and North America. This study focuses on factors that affect microbial activity in surface soils (0 to 5 cm below litter) of plots in three watersheds (treatments = control, clear-cut [C-C] and selective cut [S-C]) located within the Missouri Ozark Forest Ecosystem Project in southeast Missouri. Transformations of C, S, N, K and Mg, and microbial activity were determined from May 1995 - June 1999. The disturbances occurred in 1996. Two years post harvest, total S and N and exchangeable K and Mg all decreased in C-C soils from plots high in the landscape compared with controls (by 35%, 24%, 54% and 11%, respectively). For C-C soils from low in the landscape these elements were also lost (by 70%, 65%, 54% and 30%, respectively). In S-C plots the effect on these soil elements was mixed, some increasing, some decreasing. Indicators of soil microbial community activity also declined post harvest. Lignin mineralization declined on most sample dates post-harvest (maximum reduction, 33-fold). Microbial organic S production was nearly 55% lower post-harvest. In short-term *in vitro* experiments, the addition of Mg and K to C-C soils (to levels approximating control soils) resulted in increased microbial organic S production and lignin mineralization (by 70%, and 35 fold, respectively). These data suggest that by two years post disturbance in C-C surface soils, loss of organic matter, including organic S, resulted in leaching of Mg and K to levels limiting to microbial activity, potentially affecting microbial community structure.

Stambaugh, Michael C. and Rose-Marie Muzika. Forest gap dynamics in shortleaf pine communities of the Ozark Highlands. Department of Forestry, 203 ABNR, University of Missouri-Columbia, Columbia, Missouri 65211.

Late successional shortleaf pine (*Pinus echinata* Mill.) forests are one of the rarest forest types in the Ozark Highlands; therefore interest has arisen in perpetuating these shortleaf pine-oak mix communities and their successional dynamics. We investigated the processes of forest gap dynamics, specifically examining the potential of shortleaf pine regeneration and recruitment to the overstory by means of gap disturbances. In the Ozark Highlands of Missouri, gaps were inventoried and mapped within study sites at the Peter A. Eck Natural Area and a candidate natural area within the Indian Trails Conservation Area. Variables describing the gap (e.g. gap size, spatial arrangement, age, aspect, slope) show correlation with species abundance and regeneration. Gap distributions show distinct patterns related to aspects and slope positions, (i.e. gaps were most prevalent on shoulder slopes and ridgetops). Gap specific variables such as litter depth and type of litter were measured because of their likely influence on pine regeneration success. Pine regeneration was absent in gaps with average litter depths > 6 cm. Shortleaf pine regeneration abundance was greatest in gaps that were

located around the most xeric aspect (205 degrees). The mean age of replacement pines within gaps was 53 years old and mean height was 9 meters. Fifty-four percent of gaps occurred by a single tree fall, 27% by 2-3 trees, and 19% by 4 or more trees. Management implications to be discussed are adequate gap sizes needed for successful regeneration, proximal seed sources and the importance of litter.

Steiner, Warren E. What flightless beetles in eastern U.S. "micro deserts" tell us about climatic history and species distribution after the Ice Age. Department of Entomology, NHB-187, Smithsonian Institution, Washington, DC 20560.

Collection records and field observations across the eastern U.S. show that "micro deserts"--the dry sandy deposits, shale barrens and rock outcrops--are isolated habitats for a few odd species of flightless darkling beetles (Coleoptera: Tenebrionidae). The cryptic sand specialist, *Ammodonus fossor* (LeConte), exemplifies this pattern, having disjunct populations in open sand barrens that are separated by vast areas of mesic forest not suitable for survival. How a flightless insect arrived at these isolated sites, some within formerly glaciated areas, has been puzzling. *Ammodonus fossor* is known from pure sand microsites in scattered localities in Texas to Wisconsin and Ohio, eastward to New York and the Carolinas. The distribution of this and other beetles restricted to dry open soil suggests that suitable habitat must have been widespread, contiguous or nearly so, and probably after the last glacial interval. Geological and palynological evidence has been found to support this hypothesis. Psammophiles and other xeric-adapted species in the Appalachians and surrounding northern areas are evidently relicts of the postglacial Hypsithermal Interval, a relatively recent period from 9,000 to 5,000 yr BP that appears to have been much more severe than previously described, e.g., widespread desertification that has had a profound effect on the present distribution of species. Conservation of the assemblages of specialized insects in these shrinking ecological islands, which usually harbor other unique animals and plants, may be dependent on the occurrence of fire (either natural or managed) and on the suppression of "weed" species such as invasive plants that cover naturally exposed "micro deserts."

Taft, John B. Fire effects on community structure, composition and diversity in a flatwoods remnant in southern Illinois. Illinois Natural History Survey, 607 E. Peabody Drive, Champaign, Illinois 61820.

Fire effects on community structure, compositionand diversity were examined at Mt. Vernon Flatwoods (MVF), an old second-growth stand in Jefferson County, Illinois. Among the over-story strata prior to fire, MVF demonstrated both compositional and structural instability. A great majority of trees were in small size-classes and these mostly were species other than the dominant over-story oak species. Also, the ground cover vegetation was sparse and dominated by woody vines. To determine whether prescribed fire was effective at restoring stability to the over-story and diversity to the ground cover, MVF was treated with two spring burns and a late winter burn with the initial prescribed fire in 1990. Vegetation was monitored in fire-treatment and control units following each fire using permanent plots. Tree stem density declined significantly at the fire-treatment unit and decline occurred among all species except *Acer saccharum*. However, the decline mostly was limited to small trees; total basal area of trees actually increased. Most shrub/sapling species also declined at MVF; however, total stem density increased greatly after three fires as two species, *Rubus allegheniensis* and *Sassafras albidum,* increased dramatically. Recruitment of *Quercus stellata* into the ground cover and sapling strata remained absent following fire treatments. Ground cover diversity increased following fire treatment; the increase in diversity included typical flatwoods species and also ruderal taxa. Numerous flatwoods sedge species that were absent prior to management emerged from the seed bank following fire management; however, several typical grass and forb species that are characteristic of flatwoods remained absent. These results suggest that following long fire-free intervals at some sites habitat management may be more rehabilitation than complete restoration.

Taylor, Steven J., Donald W. Webb, Samuel V. Panno and Robert N. Lerch. Microbial contamination of shallow karst aquifers in Illinois and southeastern Missouri. Center for Biodiversity, Illinois Natural History Survey, 607 E. Peabody Dr., Champaign, Illinois 61820 (SJT, DWW). Illinois State Geological Survey, 615 E. Peabody Dr., Champaign, Illinois 61820 (SVP). USDA-Agricultural Research Service, 1406 E. Rollins St. Rm 265, Columbia, Missouri 65211 (RNL).

Spring and cave waters in Illinois and southeastern Missouri karst regions are typically contaminated with high levels of bacteria. Fecal coliform and fecal streptococcus bacteria have been identified in water from many springs and caves in Illinois and southeastern Missouri. Among the taxa commonly encountered are *Enterococcus faecalis, E. facium, Escherichia coli, Pseudomonas aeruginosa* and *Klebsiella pneumoniae*. Sinkholes and relatively porous, fractured calcareous bedrock provide a setting where contaminants enter the groundwater with little or no filtration. Sources of water borne fecal bacteria can include native wildlife, livestock and private septic systems. Use of contaminated groundwater as a drinking water source may pose health risks, as can visiting caves with extremely high fecal coliform counts. Fecal coliform contamination is indicative of possible nutrient enrichment, which can adversely affect aquatic cave community structure and, at high levels, may result in reduced availability of dissolved oxygen. An overview of microbial contamination across several karst regions in Illinois and southeastern Missouri is presented, and seasonal fluctuations in microbial contamination and potential sources are discussed.

Tear, Timothy H., Wayne Ostlie and Jonathan Haferman. The role of restoration in ecoregional planning: an example from the Central Tallgrass Prairie Ecoregion. The Nature Conservancy, Illinois Chapter,

301 SW Adams St. Ste. 1007, Peoria, Illinois 61602 (THT). Boulder, Colorado (WO). The Nature Conservancy, Minneapolis, Minnesota (JH).

The Nature Conservancy has embraced ecoregions as the large-scale planning unit for developing a comprehensive approach to conserving biological diversity. Efforts in the Central Tallgrass Prairie Ecoregion highlight the profound challenges and opportunities of conserving biological diversity in highly altered landscapes. The process identified coarse-filter (community-level) and fine-filter (species-level) conservation targets, established numeric goals based primarily on global distribution patterns in relation to the ecoregion and selected sites to best achieve these goals. Numeric goals were achieved for only 25% of the species and 19% of the terrestrial community types. Based on a survey of Heritage Biologists, additional inventory could improve that status of terrestrial communities by approximately 50%, leaving a substantial role for large-scale restoration efforts if the ecoregional goals are to be achieved. The current role of large-scale restoration efforts was quantified, and potential restoration areas identified. In order to achieve the goals outlined in this plan, all 167 conservation areas must be conserved, additional inventory efforts must be carried out and large-scale restoration efforts must be initiated. Priority restoration projects and potential restoration areas were identified. Conservation success will require substantial and unprecedented cooperation and coordination among all organizations interested in conserving natural resources.

Templeton, Alan R., Robert Robertson, Jennifer Brisson and Jared Strasburg. The impact of fire management on habitat fragmentation of collared lizards in the Ozarks. Washington University, Department of Biology, P.O. Box 1137, St. Louis, Missouri 63130-4899 (ART).

The role of fire in ecosystem management is a major question for land managers. One aspect of fire management that has been rarely addressed is its impact on genetic diversity within local populations. Such intraspecific genetic diversity provides the raw material for all evolutionary change, and hence is the ultimate basis for biodiversity at all higher levels. We studied this question at the Missouri Department of Conservation's Peck Ranch and adjoining properties owned by The Nature Conservancy and the National Parks System. Dendrochronology studies documented a several hundred year fire history of high frequency/low intensity fires, but recent human activities have suppressed fires. Fire suppression had a deleterious impact on glade habitats, open rocky areas with a xeric flora and fauna. One of the glade species, the collared lizard (*Crotophytus collaris*) was no longer present on the glades in this area by 1980. After a glade restoration program, populations were successfully translocated there between 1984 and 1989. However, there was no movement of animals between the translocated populations, nor any colonization of nearby but empty glades from 1984-1993. This extreme habitat fragmentation also characterized natural populations of this species in the Ozarks. Starting in 1994, the management policy was altered to include burning large areas, both the glades and the intervening forests. We show that fire management allows dispersal through the forest, thereby restoring high levels of genetic diversity in local glade populations and allowing successful colonization of empty glades. We anticipate that this may be a common response of species that have lived in and adapted to landscapes that had burned on a regular basis since the end of the Pleistocene.

Thom, Richard H. Showcasing the Missouri Natural Areas System. Missouri Conservation Department, P.O. Box 180, Jefferson City, Missouri 65102-0180.

The Missouri Conservation Department (MDC) set up a natural areas program within its lands in 1970. In 1977, the Missouri Department of Natural Resources joined MDC in an agreement, later including the U.S. Forest Service and the National Park Service, which created the Missouri Natural Areas System and the interagency Missouri Natural Areas Committee. Missouri natural areas can be designated on any qualifying public or private land. Over the history of the program, selection of natural areas has evolved from relatively small areas that represent a single natural community to larger areas that include many natural features of native Missouri landscapes. Today there are 171 Missouri natural areas with 52,339 acres. This presentation will showcase the range of natural features contained within Missouri's Natural Areas System.

True, Diane, Taisia Gordon and David D. Diamond. A customized inventory and analysis tool for land planners and novice GIS users. Missouri Resource Assessment Partnership, 4200 New Haven Road, Columbia, Missouri 65201.

The system developed incorporates a GIS decision support tool with ecoregional assessments for the land use planner. This customized ArcView software is designed to provide the inventory and assessment of biotic and abiotic features of Missouri in an easy to view format. The tool allows land use managers and planners with little GIS experience or knowledge to access data with easy, goal-oriented tools. Tools and functions featured include a land cover density calculator, species distribution statistics, model builder, map designer and various other features germain to ecoregional assessment.

Urich, David, Karen Kramer and Terry Showers. Development of a standardized vegetation monitoring process for Missouri. Missouri Department of Conservation, P.O. Box 180, Jefferson City, Missouri 65102-0180.

Vegetation monitoring of management on natural areas and other sites since 1988 has produced significant long-term data sets. There has been a lack of consistency in procedures and definitions among monitoring projects, especially as project managers change. Resource management agencies in Missouri also use different monitoring procedures and definitions, making comparison of monitoring data among projects and agencies difficult. The Missouri Department of

Conservation led an interagency effort to standardize vegetation monitoring terminology, sampling parameters, definitions and taxonomic codes. The objective of this effort was to produce a vegetation monitoring manual with standard codes, parameters, documentation procedures and terminology. Procedural recommendations for three levels of vegetation monitoring were developed including qualitative observations, qualitative observations with photography and quantitative vegetation sampling. Because monitoring projects are often long-term, occurring over many budget cycles, and may involve changes in responsible personnel, data must be managed in a manner that allows retrieval and analysis for years in the future. Procedures must be well documented so that future personnel can understand how field work was carried out. A standard process for evaluating the need and design of new monitoring projects was proposed to protect the long-term financial commitment associated with vegetation monitoring. A companion computer program was developed to manage, report and store vegetation monitoring data including metadata associated with project design and history of vegetation management activities.

Vokoun, J.C. and C.F. Rabeni. Delayed recovery of prairie fish assemblages at the transition from channelized to unchannelized: implications for conservation of natural channels. University of Missouri, Missouri Cooperative Fish & Wildlife Research Unit, 302 ABNR, Columbia, Missouri 65211-7240.

The fish assemblages around seven transitions from channelized to unchannelized were sampled in north Missouri. Streams ranged in size from 4th to 8th order and were located in the central dissected till plains including the Grand River Basin, Chariton River Basin, Salt River Basin and Fabius River Basin. A general pattern was recorded in the number and kinds of species found along this linear continuum. Fish assemblages reached maximum species richness approximately 3-5 km downstream from the end of channelization. Commonalities of species added to the assemblage are discussed. Agencies and groups interested in protecting the relatively few remaining natural channels in the Missouri prairie region should consider distance to channelization when judging the conservation potential of particular reaches.

Warriner, Michael D., Thomas E. Nebeker, Theodor D. Leininger and James S. Meadows. The effects of thinning on cerambycidae and carabidae in bottomland hardwood forests. Department of Entomology and Plant Pathology, Mississippi State University, Mississippi 39762 (MDW, TEN). U.S.F.S. Southern Research Station, Stoneville, Mississippi 38776 (TDL, JSM).

The bottomland hardwood forests of the southeast comprise one of the most dynamic and productive ecosystems within the continental U.S. The remaining stands of bottomland hardwood forests provide important habitat for a wide range of species, and strong economic pressures still exist for utilization of this resource. Consequently, concern exists over how management practices may impact specific taxa. Terrestrial insects represent a dominant component of most bottomland hardwood forests yet they have rarely been considered in light of their response to forest management. We examined the response of two beetle families, the wood-feeding Cerambycidae and ground-dwelling Carabidae, to a partial cutting technique (thinning) applied to major and minor stream bottom sites in Mississippi. Overall, species diversity of cerambycids and carabids did not differ significantly between thinned and control (unthinned) stands. Abundances of some cerambycid species did differ significantly one year following treatment, with larger numbers of individuals present in the thinned stand. Cerambycids feeding primarily on dead wood dominated trap catches. The second year following thinning, cerambycid numbers were not significantly different between treatment and control stands. Carabid abundance also did not differ between treatment and control stands. Faunal composition of cerambycids was relatively similar between minor and major stream bottom sites, while carabid species composition differed. Both beetle families exhibited some response to thinning. Cerambycids appeared to respond to the initial input of large amounts of larval host material, whereas certain carabid species responded to habitat changes brought about by the thinning process.

Weaver, Jan, Sarah Heyman, Renee Feldman and Nsikan Ekpo. The impact of logging on ant communities of Missouri Ozark Forest. Division of Biological Sciences, University of Missouri at Columbia, Columbia, Missouri 65211.

As part of the Missouri Ozark Forest Ecosystem Project, we sampled ant communities in control, 10% clear cut and 10% selectively logged forests before and after logging to evaluate forest level effects of logging on ants. Ants were sampled in June 1993, 1994 and 1995 (pre-treatment) and 1997, 1998 and 1999 (post-treatment) by Tullgren funnel extraction of ants from 0.08 sq m of leaf litter per plot. There were 12 plots in each forest, 36 plots total. The plots were placed randomly with respect to the logging treatments. Ant numbers in pre-treatment forests ranged from 10 to 60 ants per plot but did not vary significantly among forests. After logging, average ant numbers in treated forests were approximately half the number in control forest in 1997 (significantly lower) and 1998. By 1999, ant numbers in both treated forests were virtually identical to numbers in the control. Ant species richness followed a similar pattern, with richness significantly lower for both 1997 and 1998. By 1999 richness in both treated forests was similar to the control richness. Ant species were differentially affected, with *Smithistruma* sp. and *Ponera* sp. declining following logging and other species appearing unaffected. Because only a small number of the sample plots were directly disturbed by logging, it appears that logging had a strong, indirect but transient effect on forest ant communities.

Weilbacher, Ed. Lessons learned in the development of the Kaskaskia River corridor stewardship plan. Southwestern RC&D, 406 E. Main, Mascoutah, Illinois 62298.

The Kaskaskia River corridor between Carlyle Lake and Fayetteville, Illinois is a 58 mile, free-flowing river segment and is distinguished by having the largest acreage of contiguous forest in Illinois. Because of the significance of the Kaskaskia Forest, the Fish and Wildlife Service in 1992 proposed the creation of a 10,240-acre National Wildlife Refuge to "preserve valuable bottomland habitat along a portion of the Kaskaskia River." The idea of a refuge was flatly rejected by the landowners who were unaware of the significance of the resource on a national level. With determination and pride, the landowners chose to develop a plan that would insure the protection of the resource without government ownership. The development of the Kaskaskia River Corridor Stewardship Plan began a public engagement process that would eventually take three years to complete. The Southwestern Illinois RC&D, Inc. was viewed as a neutral party and was requested to facilitate meetings between various groups and to provide a sense of reality to the powder keg of emotions. The public engagement process called for three public meetings, a questionnaire mailed to 2400 landowners, personal face to face interviews held with 50 landowners and input from the technical community. The end result was a Kaskaskia River Corridor Stewardship Plan that calls for the implementation of ideas and components all rooted in keeping the land in private ownership, the creation of OKAW and a land trust, the designation of the area as an Ecosystem Partnership, an EQIP area, cooperative research projects and a pilot watershed designation just to name a few. The cooperation and success of the Kaskaskia Stewardship Plan has now spread to other reaches of the river.

Wieland, Ronald G. Ecological evaluation of Lefleur's Bluff Sate Park, Jackson, Mississippi. Mississippi Museum of Natural Science, 2148 Riverside Dr., Jackson, Mississippi 39202-1353.

Ecological evaluation of the landscape, soils, hydrology, flora and vegetation of Lefleur's Bluff State Park, Jackson, Mississippi, was conducted during a 14 month period from September 1995 - November 1996. Of the park's 200 ha (494 ac) area, studies included a 158 ha natural area but excluded the golf course. With the help of ordination programs, landscape position, flooding frequency and duration, spring ground water level and soil series and texture were demonstrated to be associated to vegetation composition. Over 450 species of plants were tabulated. Bottomland hardwood forest of several moisture zones forms a major part of the vegetation mantle. Most extensive of the ecological communities include: oak - mixed hardwood ridge bottom forest (44 ha), sugarberry - American elm - green ash bottomland forest (27 ha), wet hardwood bottom forest (11 ha) and bald cypress - water tupelo swamp (9 ha), in total 57 % of the study area. The remaining area includes several oxbow lakes, the Pearl River, special use areas, freshwater mussel bed, freshwater marsh, buttonbush shrub wetland and mesic calcareous bluff forest, a rare community of Mississippi. The uplands, floodplain and river channel provide habitat for species of special concern: a coneflower, an orchid, three fish, two reptiles and two mussels. The natural area will provide opportunities for fields studies implemented through the Mississippi Museum of Natural Science, which opened at its new location in Lefleur's Bluff State Park on 3 March, 2000.

Willson, Gary D. and F. Adnan Akyuz. Western prairie fringed orchid monitoring at Pipestone National Monument, Minnesota. U.S. Geological Survey, Northern Prairie Wildlife Research Center, Missouri Project Office, 200 Gentry Hall, University of Missouri, Columbia, Missouri 65211 (GDW). Missouri Climate Center, 100 Gentry Hall, University of Missouri, Columbia, Missouri 65211 (FAA).

A small, isolated population of the western prairie fringed orchid (*Platanthera praeclara*, Sheviak & Bowles), a federally listed threatened plant, occurs in a wet prairie-sedge meadow in Pipestone National Monument, Minnesota. In late spring, managers periodically burn the area where the orchid occurs to control the cool-season exotic smooth brome (*Bromus inermis* Leyss), which has invaded the prairie. In July 1999, flowering western prairie fringed orchids were counted for the seventh consecutive year as part of a long-term ecological monitoring program in the monument. In addition, the presence or absence of flowering and non-flowering plants in permanently marked locations where orchids flowered in 1994 and 1995 was recorded. In 1999, 17 flowering orchids were found. The number of flowering orchids in the monument was largest two years after a prescribed burn in 1996. Also, two years after a prescribed burn in 1999, the unexpected low number of flowering orchids may have been attributable to the date of the count. The number of orchids was greater in 1999 than 1998 at both the 1994 and 1995 marked location. The increase in 1999 at the 1994 marked locations occurred after a declining abundance during four consecutive years and was similar to an increase in the fifth year for a population in the Sheyenne National Grassland, North Dakota. At the 1994 marked locations, five non-flowering orchids occurred in 1998 but three non-flowering and three flowering orchids occurred in 1999. No orchids had flowered there since 1996. At the 1995 marked locations, nine non-flowering orchids occurred in 1998 and 11 non-flowering orchids in 1999.

Wilm, Brian W. Prevalence of exotic vegetation in Illinois wetlands. Illinois Natural History Survey, 607 E. Peabody Dr., Champaign, Illinois 61820.

Exotic, non-native vegetation is known to be a threat to native plant communities, including wetlands, across the United States. In Illinois, where well over 90% of the original wetland acreage has already been lost and the majority of the remaining substantially degraded, the threat posed by exotic plant species is great. A data set of over 2500 wetlands was analyzed, based on information collected from wetland delineations throughout Illinois. In this analysis, only "dominant" plant species, as defined by the Army Corps of Engineers Wetland Delineation Manual, were considered. Dominant plant species are major components of the plant community, contributing more to the character of the community than

other species present. Seventy-seven species not native to Illinois were identified as dominant in wetlands from throughout the state. Reed canary grass (*Phalaris arundinacea*) was the most prevalent species overall, occurring as a dominant in 30% of all wetlands and in 48% of Chicago-area wetlands. Narrow-leaf cattail (*Typha angustifolia*) was dominant in about 10% of all wetlands. Overall, 52% of all wetlands had at least one dominant, exotic species. In the Chicago region of northeastern Illinois, 76% of wetlands contained dominant exotic species, compared to only 37% for the rest of the state. Chicago-area marshes and herbaceous wetlands (e.g., wet meadows, sedge meadows) showed the highest rates of exotic dominance (81%), followed by forested wetlands (71%). By comparison in the rest of the state, herbaceous wetlands had an exotic dominance of 54%; marshes were at 39% and forested wetlands at 24%. Overall, levels of exotic species dominance are troublesome, particularly in the Chicago region where prevalence is very high. Reed canary grass appears to be the biggest threat, likely beyond control throughout most of Illinois.

Ashley, David, C. Hawkmoths (Lepidoptera: Sphingidae) associated with three prairies in northwest Missouri. Department of Biology, Missouri Western State College, 4525 Downs Dr., St. Joseph, Missouri 64507.

Studies in 1989, 1995 and 1997 focused on the natural history of an endangered prairie orchid (*Platanthera praeclara*) found at three locations in northwest Missouri. Insect collections were conducted during studies on the pollination biology of the orchid at Helton Prairie Natural Area (Harrison Co.), Tarkio Prairie Natural Area (Atchison Co.) and Little Tarkio Prairie (Holt Co.). Moths were collected from light traps (black-light bucket traps and mercury vapor sheet traps) during several visits to each prairie. Fifteen species of sphingid moths were collected during the course of the study. Three of these species (*Darapsa myron*, *Laothoe juglandis* and *Pachysphinx modesta*) were only collected at traps utilizing the mercury vapor lamps. The most common hawkmoth encountered during the study was *Ceratomia hageni*. The hawkmoth diversity and abundance at Helton Prairie seemed greater than at either of the other two prairies that were sampled. Two species, *Sphinx eremitis* and *Sphecodina abbottii*, were only collected at Helton Prairie during the study.

Ashley, David, C. Monitoring studies on the white fringed prairie orchid (*Platanthera praeclara*) at three prairies in northwest Missouri. Department of Biology, Missouri Western State College, 4525 Downs Dr., St. Joseph, Missouri 64507.

Studies in the growing seasons of 1998 and 1999 focused on the natural history of a state-endangered prairie orchid (*Platanthera praeclara*). Populations of the western prairie fringed orchid (*P. praeclara*) were monitored at three prairies in northwest Missouri. Helton Prairie Natural Area (Harrison Co.), Tarkio Prairie Natural Area (Atchison Co.) and Little Tarkio Prairie (Holt Co.) contain the only known populations of *P. praeclara* in Missouri. A permanent reference point system was established on each prairie. This allowed researchers to measure distance and compass coordinates from each individual plant observed to two of the reference points. All orchids that were located on the prairies were marked with permanent aluminum tags. A total of 304 plants have been marked at Little Tarkio Prairie, 184 plants marked at Helton Prairie and 7 plants marked at Tarkio Prairie. Both vegetative and flowering plants were marked. Plants were also measured and the number of buds, flowers and mature seedpods present were counted and analyzed to evaluate population parameters at the different prairies.

Ashley, David, Paul McKenzie, Pam Haverland and Tom Aley. Progress report on a monitoring project for an Ozark endemic: the Tumbling Creek cavesnail (Hydrobiidae: *Antrobia culveri*). Department of Biology, Missouri Western State College, 4525 Downs Dr., St. Joseph, Missouri 64507 (DA). Ecological Services, U.S. Fish and Wildlife Service (PM). Midwest Science Center National Biological Service (PH). Ozark Underground Laboratory (TA).

The Tumbling Creek cavesnail was described in 1971 based on specimens recovered from Tumbling Creek Cave (TCC) in Taney Co., Missouri. No specimens of this species have ever been found outside of TCC. A stratified sampling scheme was developed to monitor the population of this endemic snail. Permanent markers divide an accessible stretch of Tumbling Creek into seven variable-length sections of alternating "favorable" and "marginal" habitat. Favorable habitat is characterized as riffle habitat with gravel to large rocks and medium to fast stream flow. Marginal habitat is characterized as large pool (deeper than .6 m) and minimal flow, or riffle habitat with a solid rock bottom. A PVC frame (approximately .09 m^2) is used as a sampling square. Rocks within a square are examined and the number of snails observed is recorded. The number of plots in each section constitutes approximately 3% or 1% of substrate area (for favorable and marginal habitats, respectively) within that section. Individual snails were carefully measured using a dissecting microscope with an ocular micrometer and then returned to the rock and section of the stream from which they were recovered.

Ashley, David, John Rushin, Tim Ripperger and Rodney Green. Conservation partnerships: the Missouri Department of Conservation Public Service Center on the campus of Missouri Western State College. Biology Department, Missouri Western State College, 4525 Downs Dr., St. Joseph, Missouri 64507 (DA, JR). Missouri Department of Conservation, Northwest Regional Service Center, 701 N. College Drive, St. Joseph, Missouri 64507 (TR, RG).

In 1991, a unique conservation partnership was established with the dedication of the Missouri Department of Conservation Public Service Center on the campus of Missouri Western State College. The construction of this facility was a result of a collaborative effort among members of the MDC and administration and faculty of MWSC. The placement of this building on the college campus provides easy access for MDC educational programs to the college's 25 acre Nature Study Area and to several ponds on campus. The MDC headquarters facility provides MWSC with additional teaching classrooms, research laboratories and storage space. Equally as important, the proximity of the MDC Regional Headquarters has facilitated a variety of innovative programs (many relating to education and research on natural areas) and student employment opportunities for MWSC. The authors will discuss the history of the partnership and present case studies concerning the unique benefits of the collaboration that have been realized by MDC and MWSC.

Blodgett, K. Douglas, Tharran Hobson, Timothy H. Tear, and Matthew E. Herbert. Spunky Bottoms: a landscape scale restoration in the Illinois River floodplain. Great Rivers Area Office, The Nature Conservancy, Illinois Chapter. 220 W. Main St., Havana, Illinois 62644 (KDB, TH). The Nature Conservancy, 301 SW Adams St. Ste. 1007, Peoria, Illinois 61602 (THT, MEH).

The Illinois Chapter of The Nature Conservancy is undertaking a landscape scale restoration project at its 1157-acre Spunky Bottoms Preserve along the Illinois River in Brown Co., Illinois. The property is in the natural floodplain of the Illinois River but was leveed in the early 1900s and has been used for intensive rowcrop agriculture since. At the site, we are restoring upland prairie, wet to mesic prairie, marsh, open water, and bottomland hardwood forest habitats. An important feature of the project will be a controlled reconnection to the Illinois River that will provide riverine aquatic organisms access to restored habitats within the leveed area; such habitats are important for spawning or nesting, feeding, wintering and as nursery areas for many river and wetland associated organisms. In addition to restoring and conserving biodiversity, reconnecting large floodplain rivers to restored floodplain habitats will help stabilize unnatural water level fluctuations, reduce flood heights and improve water quality in the rivers. While reconnecting rivers to their floodplains has been identified as an important technique for restoring large floodplain river ecosystems, such projects are rare. Therefore, we are monitoring water quality, vegetation, amphibians, reptiles, fishes, nesting and migratory birds and mammals to document changes, provide guidance for adaptive management, evaluate success and facilitate the export of lessons learned.

Brewer, Lawrence G. and Steven D. Olson. Factors affecting the distribution of *Hydrastis canadensis* (Goldenseal) in Hoosier National Forest, Indiana. BHE Environmental, Cincinnati, Ohio 45246 (LGB). Hoosier National Forest, Tell City, Indiana 47586 (SO).

Due to habitat destruction and harvesting for medicinal purposes, *Hydrastis canadensis* has been declining throughout its range. Consequently, various states have added it to their rare plant lists. In order to monitor population changes and determine causes for its distribution within Hoosier National Forest, populations of *H. canadensis* within a six square miles area were mapped in 1998 using a GPS receiver. A total of 266 populations were located with the greatest number being found on north and east facing slopes. To determine species associated with *H. canadensis* frequency data were gathered on canopy, understory, shrub and herb layers within 158 populations. The most common canopy trees were *Acer saccharum*, *Prunus serotina*, *Quercus alba* and *Lirodendron tulipifera*, while the understory was dominated by *A. saccharum*, with lesser amounts of *Ulmus rubra*, *Cercis canadensis*, *Caprinus caroliniana* and *Fraxinus americana*. The shrub layer was dominated by *A. saccharum*, *Lindera benzoin*, *Asimina triloba* and *Cornus florida*, and the herb layer (including seedlings) by *Polystichum acrostichoides*, *Agrimonia pubescens*, *Galium concinnum*, *L. benzoin*, *Panicum boscii* and *Toxicodendron radicans*. In 1999, a total of 182,081 stems of *H. canadensis* in 142 populations were counted. The average number of double-leaved stems (potential flowering stems) per population was 12 percent with the largest amount being found in bottomlands (19 percent). The average percentage of stems producing fruit was only 1.8% per population with the greatest percentage in bottomlands (4.6 %). In Hoosier National Forest, *H. canadensis* grows best in bottomlands but occasional flooding may result in most populations being found on low to mid slopes (80%) where it survives in clones.

Bulger, Angela G., Chris D. Wilkinson, David R. Edds and Mark L. Wildhaber. Reproductive biology and behavior of the threatened Neosho madtom. Division of Biological Sciences, Emporia State University, Emporia, Kansas 66801 (AGB, CDW, DRE). U.S. Geological Survey, Columbia Environmental Research Center, Columbia, Missouri 65201 (MLW).

The Neosho madtom, *Noturus placidus*, is a small, threatened catfish found only in the Neosho, Cottonwood and Spring rivers of Kansas, Oklahoma and Missouri. Little is known of its breeding biology and behavior. In 1996 and 1998, Neosho madtoms were held in labs at Emporia State University and the USGS Columbia Environmental Research Center to document spawning behavior, parental care, clutch size, egg size and embryonic and larval development and growth, and to investigate use of synthetic hormone to induce spawning. Carousel and tail curl breeding behaviors were observed in males and females. Three clutches were laid, of approximately 30, 32 and 60 eggs, including one following injection with hormone (32 eggs); mean chorion diameter ranged 3.1 - 3.7 mm. Male parental care was documented, and eggs hatched in 8 - 9 days at 25 - 28° C. After hatching, larvae remained in the nest with the male until yolk-sac absorption in 7 - 9 days, after which larvae dispersed into the gravel throughout the tank.

Butler, Dorothy J. The Missouri Natural Heritage Database. Missouri Department of Conservation, P.O. Box 180, Jefferson City, Missouri 65102-0180.

The Missouri Natural Heritage Database tracks known locations of high-quality natural communities and Missouri Species of Conservation Concern. Heritage information is used to target land acquisition, identify potential impacts to sensitive species during project development and assist in public land management. Within the past few years, a geographic information system (GIS) point coverage was developed from the latitude and longitude coordinates of Heritage element occurrences. To overcome the interpretation problems inherent in a point coverage, the Database is being converted into a regions (polygonal) GIS coverage. A regions coverage will provide a more accurate depiction of Heritage elements and a more efficient electronic method of dissemination.

Cashatt, Dr. Everett D. and Timothy E. Vogt. Hine's emerald dragonfly (*Somatochlora hineana* Williamson), a federally listed species. Illinois State Museum, Research and Collection Center, 1011 E. Ash St. Springfield, Illinois 62703.

The Hine's emerald dragonfly has been discovered in recent years in calcareous wetlands in Illinois (1983), Wisconsin (1987), Michigan (1997) and Missouri (1999). Prior to its recent discovery, the larva of Hine's emerald dragonfly was unknown. Knowledge of the larva, adult, habitat and potential range are vital to protecting and managing this species. Information on the identification of the larva and adult of this species is necessary to separate *S. hineana* larvae from other related species. Figures of identifying characters of the adults and larvae of associated species of *Somatochlora* will be displayed. A diagnostic table of characters and measurements will be presented that will help to separate the *S. hineana* larva from related *Somatochlora* species.

Clinebell II, Richard R. Pollination biology of *Gaura villosa villosa* (Onagraceae) in the Permian Basin of western Texas. Research Department, Missouri Botanical Garden, St. Louis, Missouri 63166.

The data reported here extend a survey of the pollination ecology of the genus *Gaura* begun in the mid-1960s by Raven and Gregory. *Gaura villosa* is a large, woody perennial species abundant in sandy areas of the southwestern Great Plains and western Texas. The species blooms from May to September, and the pollinator assemblage varies seasonly, in terms both of major pollinating groups of insects and of the species in those groups most active in pollination. Raven and Gregory collected a large array of noctuid moths in May between the hours of 8:00 p.m. and midnight in the sandhills near Monahans, Texas. Additional suites of pollinators were collected near these earlier study areas in June and September. In the early morning (5:00 - 8:30 a.m.), halictid bees (*Evylaeus* and *Sphecodogastra*) were common floral visitors in June and September, not only to *Gaura* but also to the co-blooming onagrad *Calylophus berlandieri berlandieri*. In September, adult antlions (*Scotoleon minusculus*) visited *Gaura* flowers between 2:00 and 5:00 a.m. All the above insects were laden with onagrad pollen and observed to contact receptive stigmas, thus being true pollinators by definition. The moths and antlions were foraging for nectar, and passively collected pollen – mostly on the proboscis in the case of the moths and on the ventral body surface in the case of the antlions. The halictid bees were engaged in pollen collection and did not always attempt to obtain nectar from the floral tubes, which are at least 10 times as long as the tongues of these bees. This documentation of pollination by adult antlions appears to be the first report of pollination by any member of the family Myrmeliontidae, and of the order Neuroptera.

DeBarthe, Gina. M., Cary D. Chevalier, Eugene Vale and Jennifer Woods. Vegetation diversity of managed glades compared to unmanaged glades. Department of Biology, Missouri Western State College, St. Joseph, Missouri 64057 (GMD, CDC). Onondaga Cave State Park, Leasburg, Missouri 65535 (EV, JW).

Glades are a specialized xeric habitat type that normally occur on the southwest slopes in Missouri's predominately oak-hickory forests. Historically glades were exposed to periodic burns which cleared out excessive woody encroachment. Since fires have been repressed, woody encroachment, especially eastern red cedar (*Juniperus virginiana*), has displaced many native glade species. Various agencies in Missouri have begun to restore glades by removing eastern red cedars and then following up with prescribed burns to restore the natural biodiversity of glades. The purpose of this study was to assess the vegetation diversity of managed glades compared to unmanaged glades. Linear transects (100 m in length) were set up on three glades. Glade 1 and Glade 2 had previously been managed with fire and the removal of woody vegetation. Glade 3 had never been actively managed and was considered the control. Twenty quadrants were placed at randomly-assigned distances along each transect to assess vegetation structure and diversity. We calculated mean percent cover for each glade (10.3, 11, 8.4 for glades 1, 2, 3, respectively). We calculated Simpson and Shannon species diversity indices for Glade 1 (burned; Simpson = 85.3; Shannon = 4.1) and Glade 3 (no burn; Simpson = 49.1; Shannon = 1.7). No difference in percent cover was detected across management treatments ($p = 0.56$), but fire-managed glades showed greater species diversity (measured by both diversity indices) than glades not fire managed ($p < 0.05$).

Eilers, Henry. Pictoral overview and accompanying text of Shoal Creek Conservation Area. Illinois TNC Volunteer Stewardship Network, Shoal Creek Volunteers, Inc., 1302 E. Union Avenue, Litchfield, Illinois 62056.

Shoal Creek Conservation Area is owned by the City of Litchfield. The 250 acre tract is located on the northwest edge of the southern Illinois till plain. It consists of open woodlands, flatwoods and several category A barrens communities. Nearly 700 species of plants and 70 species of butterflies have been documented. The poster provides an overview of this diversity and 10 years of management activities. These include the use of fire, removal of undesirable vegetation, removal of artifacts and debris from prior agricultural land use, continual reintroduction of appropriate plants by seed and plants. The poster and additional display literature also emphasize community outreach and education.

Gerwein, Joel B. and Richard V. Kesseli. Effects of historic deforestation on genetic diversity of old-growth and secondary red oak (*Quercus rubra*). Biology Department, University of Massachusetts at Boston, 100 Morrissey Blvd. Boston, Massachusetts 02125.

Most forests of New England were cleared in the last 200 years. The genetic consequences of this massive deforestation are unknown. This study compares genetic

diversity of old-growth and secondary red oak populations in two areas, Princeton and Stockbridge, Massachusetts. Leaf material was collected from adult and juvenile individuals in paired old-growth and secondary stands. Individuals were genotyped using three nuclear microsatellite markers and two chloroplast markers, a microsatellite and a PCR-RFLP. Preliminary results from two nuclear microsatellites indicate that these markers are extremely variable and suggest higher allelic diversity in old-growth than in secondary stands. The old-growth population showed 11 alleles in 10 individuals for microsatellite A and 10 alleles in 12 individuals for microsatellite B, or an average of 0.95 unique alleles per individual. The secondary population showed eight alleles in 13 individuals for both microsatellites A and B, or an average of 0.62 unique alleles per individual. Maps of area forest cover in 1830 were digitized and analyzed to assess the degree and pattern of historic deforestation. According to valuation records and 1830 maps, Princeton was more severely deforested than Stockbridge (20% vs. 31% forest cover) but reforested more quickly. Bootstrapping will be used to test for correlation between degree of historic deforestation and reduced genetic diversity in secondary vs. old-growth stands. This study represents the first attempt to pair genetic and historical analyses of deforestation effects. Results will indicate whether old-growth stands may be reservoirs of genetic diversity and whether deforestation may lead to long-term losses of genetic diversity. These results will have important implications for forest management.

Gordon, Taisia. Missouri land cover applications of inventory and assessment. Missouri Resource Assessment Partnership, 4200 New Haven Rd., Columbia, Missouri 65201.

A statewide land cover mapping effort was completed in December 1999 by the Missouri Resource Assessment Partnership (MoRAP). The land cover database serves many scales of need, from statewide summaries to more site-specific analyses and is a useful component of natural resource inventory and assessment. Applications of the land cover include visual display, calculations of area within polygons (such as watersheds or ecoregions) and landscape characterization for planning and management. This poster displays some of the potential applications of the land cover data including land use classes area and distribution, grassland patch size, core forested regions and patches of land cover classes with low road densities. Evaluation of land cover within the Missouri Ozark Highlands Section reveals differences in patchiness and patch structure. For example, the forest within the Current River Hills Subsection is over 80% core forest and, of that core, over 20% has a low road density. In contrast, the forest in the Prairie Ozark Border Subsection is less than 20% core forest and, of that core, less than 10% has a low road density.

Grabner, Keith W., Cindy E. Buck and Tim A. Nigh. Methods for installing permanent plots within a disturbance prone riparian zone. U.S. Geological Survey: Northern Prairie Wildlife Research Center, Missouri Project Office, 301 Gentry Hall, University of Missouri, Columbia, Missouri 65211 (KWG, CEB). Missouri Department of Conservation, Policy and Coordination Division, 305 Gentry Hall, University of Missouri, Columbia, Missouri 65211 (TAN).

A riparian Ecological Classification System (ECS) was developed for the riparian zone within the Ozark National Scenic Riverways (OZAR) in southeastern Missouri, using permanent plots. The vegetation and physical site data collected were used to develop a riparian ECS and also can be used as an initial inventory for long-term riparian plant community monitoring within OZAR. Our objective was to develop methods for long-term monitoring of riparian zone vegetation and physical characteristics using permanent plots. Using permanent plots for long-term monitoring of riparian plant communities can be challenging due to periodic flooding. Flooding can disrupt plot markers, witness trees and alter vegetation and surface features, making plot relocation difficult. Our methods permit the relocation of monitoring plots by using three reference points, one of which is located outside of the riparian zone to enable plot relocation after major flooding events. While developing these methods, we incorporated lessons learned from past riparian work including locating historic riparian vegetation sampling plots. Advantages and disadvantages of these methods and their influence on data collected are discussed.

Hauge, Erik R. RCAPS and the E-Team: a progress report. 30378 Appaloosa Dr., Evergreen, Colorado 80439-8635.

I began to organize Regional Clear Air Partnerships (RCAPs) a decade ago in the U.S. They are voluntary cooperative associations of land managing and air regulatory agencies, indigenous peoples, industry and citizen group representatives that deal with air pollution and its impacts on national parks and other protected areas on a regional basis. They share the responsibility and costs of planning, monitoring, research, regulatory review and outreach programs. There are several RCAPs in North America, including international partnerships with Canada and Mexico. They have served as models for the Regional Air Management Partnerships now required under the EPA's regional haze regulations.
Last year, I helped organize the first RCAP outside North America in South Africa's Eastern Cape Province. Additional South African partnerships will follow. More than 160 nations have established national parks. However, many of those nations are rushing to industrialize without adequate environmental controls. This not only affects public health but the awesome natural and cultural resources of the parks they created. To help these nations deal with this problem, I formed the E-Team (Earth Team), a non-profit organization of 28 internationally experienced experts who can provide assistance in developing environmental and sustainable economic programs. The E-Team will be funded primarily through donations from individuals, foundations and corporations. The team will begin its work this year in South Africa, conducting an air quality training course. Additional work in Asia, Eastern Europe and Latin America is under discussion.

Kalkbrenner, Nicole M. Restoration of remnant dune and swale communities in Lake County, Indiana. J.F. New and Associates, 708 Roosevelt Rd., Walkerton, Indiana 46574.

Planning for the restoration of two remnant dune and swale properties (51 acres and 81 acres) in Lake County, Indiana began in 1998. The sites were inventoried for existing botanical information, endangered species, topographic features, exotic species and land use degradation. The sites contain remnant high quality plant communities but have also experienced land use degradation including absence of fire, encroachment of invasive exotics, dumping and off-road vehicle use. Site one is home to 158 plant species, with 93% native and site two has 249 species, with 88% native. Analysis of the quality of sites was done using the Floristic Quality Assessment for the Chicago Region (Wilhelm and Masters) with the sites registering 64.5 and 75.4, respectively. One site is home to the endangered Karner Blue Butterfly and will be managed to improve its habitat. Restoration of the sites will begin in 2000 and will include removal of trash from the sites, control of invasive exotic species, installation of native plant species collected from local ecotype sources, burning and monitoring.

Keddy-Hector, Dean P., David D. Diamond and C. Diane True. The golden-cheeked warbler (*Dendroica chrysoparia*): focal species for central Texas ecological restoration. Department of Math/Sciences, Austin Community College—Riverside Campus, 1020 Grove Blvd., Austin, Texas 78704 (DPKH). Missouri Resource Assessment Partnership, 4200 New Haven Rd., Columbia, Missouri 65201 (DDD, CDT).

The golden-cheeked warbler is a federally endangered migratory songbird endemic to only about 30 counties of the Edwards Plateau bioregion of central Texas. The Recovery Plan for this species links its delisting to protection of eight warbler populations, each large enough for long-term viability, and inter-connected by dispersal corridors. The spatial requirements of these populations coupled with ecological requirements of other listed and candidate species provide a critical basis for restoration of degraded forest and grassland communities and protection of other central Texas endemics. As a step toward this conservation objective, we present and evaluate ongoing golden-cheek conservation efforts and present a map of available warbler habitat. This Thematic Mapper-based map discloses only 546,000 ha of extant, highly fragmented, juniper-oak woodland habitat scattered in a thin crescent along the western margin of the Edwards Plateau. These woodlands are currently threatened by federal-state efforts to increase aquifer recharge rates through removal of ashe juniper. Juniper removal programs have already eliminated warbler habitat on private and public lands. This has occurred despite evidence that fragmentation reduces warbler productivity, and suggests that aggressive measures are needed to protect this and other central Texas endemics from extinction.

Kettle, W. Dean and Henry S. Fitch. Land use history in natural area research and management: case study at the Fitch Natural History Reservation. Kansas Biological Survey, Lawrence, Kansas 66047 (WDK). Division of Biological Sciences, University of Kansas, Lawrence, Kansas 66047 (HSF).

Historic land use has persistent and diverse effects on ecosystems. The objective of this study was to provide a land use database for an intensively-studied research site, the Fitch Natural History Reservation (FNHR). FNHR is part of the Kansas Ecological Reserves, a 730 ha biological field station operated by the Kansas Biological Survey. We compiled data from a variety of sources and used GIS to organize the database. As a former farm of the first Governor of Kansas, FNHR was used for agriculture, primarily grazing but with some tillage and hay meadows, from the 1860s until 1948. In 1948, all agricultural operations ceased and the entire 240 ha FNHR was protected as a reservation where ecological relationships of plants and animals might be studied with minimal human disturbance. Initially, in the late 1940s, FNHR consisted of cultivated fields, pastures dominated by introduced cool-season grasses, native prairie, reseeded prairie and wooded hillsides that were fenced to exclude cattle in the mid-1930s. However, because there has been no direct human intervention (e.g., mowing, burning, tilling) during the last 52 years, secondary succession has proceeded with many formerly open areas now dominated by woody vegetation. On a broad scale, initial conditions of soil and vegetation greatly influenced vegetation change at FNHR. Smaller-scale disturbances (e.g., areas stripped for sod, roads, various farmstead features) have also affected plant and animal distributions. Knowledge of land-use history is essential for research and management planning on natural areas.

Malmborg, Patti. The Illinois Natural Areas Inventory. Illinois Department of Natural Resources, 524 S. 2nd St., Springfield, Illinois 62701.

The Illinois Natural Areas Inventory is a list of natural areas that represent the best examples of natural communities and natural features existing in the state. Information gathered on inventory sites since 1978 includes significant features, species lists, sampling data, maps and summaries of various natural resources issues regarding the site. Each site must contain at least one significant natural feature to be eligible for inclusion on the Inventory. The Natural Areas Evaluation Committee oversees the updating of the Inventory. The Inventory is maintained by the Department and is continually updated using specific criteria required for site qualification. Currently, there are 1,185 natural areas contained in the Inventory. The objective of the Inventory is to provide current accurate scientific information on natural areas in the state and to use this information for accounting, tracking and monitoring purposes. The Inventory is also used as a tool to guide the Department and other agencies and organizations in the protection of Illinois' natural resources.

McGrane, M. Catherine and Patricia R. Schuba. Survey of birds using newly established sand prairie on Darst Bottom in St. Charles County, Missouri. Department of Biology, University of Missouri-St. Louis, 8001 Natural Bridge Rd., St. Louis, Missouri 63121.

Darst Bottom is a 283 ha early successional sand prairie acquired by the Conservation Department. The sandy alluvium was deposited by Missouri River flooding that blew out the levee near Defiance. Missouri sand prairies are rare and the bird survey provides the opportunity to document avian diversity and habitat use for scientific reference and land management. Data will be collected by surveying 25 m on either side of 10 500 m transects crossing all major areas of the study plot. Surveys will be done twice per month for the months of May, June, July and August 2000. Information sought includes birds and fledglings sighted or heard, foraging behaviors and nests found along transects. A preliminary survey of resident and migratory birds revealed a diverse assemblage of birds including lark sparrows (*Chondestes grammacus*), vesper sparrows (*Pooectes gramineus*) and dickcissels (*Spiza american*) using a variety of microhabitats. Both sparrows and the dickcissel are uncommon in the Ozark Border region of the state and the lark sparrow nests in a small percentage of areas occupied. Although the dickcissel is widely distributed, its numbers are declining due to control practices on Venezuelan wintering grounds. The habitat at Darst may allow closer observation of nesting and breeding behaviors for such birds as the dickcissel. Together with the information from studies of the Lisbon Bottom site in central Missouri, we will have a better sense of both the waterbirds and land birds using these rare Missouri habitats.

Navarrete-Tindall, Nadia E., Jerry W. Van Sambeek and Robert L. McGraw. Propagation, nodulation and shade tolerance of four *Amorpha* species. Department of Agronomy, University of Missouri-Columbia, Columbia, Missouri 65211 (NENT, RLM). USDA Forest Service, Columbia, Missouri 65211 (JWVS).

Amorpha nitens C. Boynt. a riparian legume species, endangered in Illinois, and three related species, *A. fruticosa*, *A. canescens* Pursh and *A. nana* Nutt. were propagated from seeds stratified for 10 days at 5°C in sterile-moist conditions. Fifteen-days after stratification, 86% of the *A. nitens* seeds exposed to light germinated and only 40% of the seeds germinated in pots filled with vermiculite. Between 95% and 100% of the seeds of *A. nana*, *A. canescens*, and *A. fruticosa* germinated at day 9 under light. Rhizobia strains were isolated from root nodules of *A. nitens* plants in southern Illinois. Ninety-days after inoculation, nodulation on *A. nitens* seedlings was different among strains. Seedlings averaged 34 - 55 nodules with no nodules on non-inoculated seedlings. No differences were observed for shoot growth. Strains were evaluated for symbiotic promiscuity on *A. canescens*, *A. fruticosa* and *A. nana*. Nodulation was different on each species. Shade tolerance was also tested on the four Amorpha species. Nodulation and plant growth was higher for seedlings grown under 100 or 45% light than under 20% light.

Possessky, Sharon L., Charles E. Williams and Willam J. Moriarity. Effects of glossy buckthorn (*Rhamnus frangula* L.) invasion on herbaceous layer vegetation in Allegheny Plateau riparian savanna. Department of Biology, Clarion University, Clarion, Pennsylvania 16214 (CEW, SLP). U.S. Forest Service, Allegheny National Forest, Warren, Pennsylvania 16365 (WJM).

The alien shrub *Rhamnus frangula*, glossy buckthorn, is an invasive pest in both upland and wetland plant communities of eastern North America. We have recently documented that glossy buckthorn is an impending threat to the species-rich riparian plant communities of the northern unglaciated Allegheny Plateau of northwestern Pennsylvania. Our previous research has shown that riparian plant communities are hot spots for vascular plant richness: over 200 species have been documented in the herbaceous layer (all vascular plant species < 1 m tall) of Allegheny Plateau riparian forests. To assess effects of glossy buckthorn invasion on herbaceous layer vegetation (all vascular plant species < 1 m tall), we quantified vegetation composition, soil moisture, and canopy density within plots invaded by glossy buckthorn versus non-invaded plots. We assessed potential allelopathic effects of glossy buckthorn on vegetation by a laboratory study of seed germination using leaf and root extracts of glossy buckthorn. Our field data showed dramatic differences in composition of riparian herbaceous layer vegetation between invaded and noninvaded plots, negatively correlated with increasing glossy buckthorn stem and canopy densities. We found no negative effects of glossy buckthorn extracts on laboratory seed germination. Thus it appears that glossy buckthorn may influence species composition of riparian plant communities by altering light availability but not by allelopathy.

Prato, Tony A. Multiple attribute scoring test for carrying capacity in protected natural areas. Center for Agricultural, Resource and Environmental Systems, University of Missouri-Columbia, Columbia, Missouri 65211.

The 1978 National Parks and Recreation Act requires the development of a general management plan for each park that includes "identification of and implementation commitments for visitor carrying capacities for all areas of the unit." This requires that carrying capacity be defined and used to determine whether park visitation patterns are consistent with ecological and social limits of carrying capacity. The traditional concept of carrying capacity is the number of visitors an area can sustain without degrading natural resources and visitor experiences. Increased understanding of the complex interactions among biophysical processes, socio-psychological motivators of recreational behavior and satisfaction and management actions has resulted in new carrying capacity concepts that defines carrying capacity in terms of the acceptability of natural resource and human impacts of visitation. Unacceptable impacts reduce ecological integrity and visitor satisfaction, and, therefore, require management actions that reduce those impacts to acceptable levels. The newer approaches to carrying capacity recognize that biophysical

characteristics of an area such as vegetation type, topography and land form and human factors, such as mode of travel, season of use, group size and behavior, and management policies are more important than simply the numbers of visitors in an area. Ecological integrity and visitor satisfaction are complex because they vary over time and space. While significant advancements have been made in defining and applying carrying capacity, improvement is needed. The proposed method improves and extends the concept of carrying capacity for units of the National Park System using multiple attribute decision theory. The method allows a park manager to determine whether current impacts exceed the limits established for carrying capacity and, in cases where they are exceeded, to rank alternative management actions for reducing those impacts based on a multiple attribute scoring test.

Price, Jason L. and Ronald Wieland. Implementing a Geographic Information System (GIS) to improve data manipulation and reporting for the Biological and Conservation Database System (BCD). Mississippi Natural Heritage Program. Department of Wildlife Fisheries and Parks, 1505 Eastover Drive, Jackson, Mississippi 39211.

The Mississippi Natural Heritage Program is part of a network of data centers affiliated with the Association of Biodiversity Information and The Nature Conservancy. Heritage programs manage provincial inventories of biological/ecological features using the Biological and Conservation Database System (BCD). The BCD is the network's standard data management application and is a leading source for current, accurate and complete conservation information. Using standard heritage program methodology, documenting an element occurrence record (EOR) involves manual tabulation of geographic information - county, township, section, range, meridian, topographic map, watershed and EOR centrum (latitude and longitude). The tedious and time consuming process of manual tabulation, typically requiring several hours, reduces staff availability for performing other more urgent tasks. Using ESRI's ArcView software, we have creatively scripted a special "Heritage" extension that automates the process of capturing these data. The extension enables rapid data entry, searching and reporting functionality and conveniently collects geographic information in DBASE format for uploading into the BCD. This new method of point data acquisition returns BCD tabulated information in less than five seconds. The Heritage extension has greatly increased the efficiency of BCD by enabling timely input of new records and processing a large backlog of one thousand EORs and sub-EORs within the past year. The extension also permits the production and printing of species' range maps.

Purtell, Regina and Malcolm L. Hunter, Jr. Exploring grassroots efforts to monitor wildlife. Department of Wildlife Ecology, University of Maine, Orono, Maine 04469.

Natural resource managers and scientists are often faced with the challenge of insufficient monitoring data. Partnerships, such as the Natural Heritage Program that brought together The Nature Conservancy and state conservation departments, have been able to institute focused inventory or monitoring programs by pooling personnel and resources. However, local groups of amateur naturalists that systematically record observations are often overlooked as a potential partner. To explore the value that grassroots wildlife monitoring groups may have to scientists, I interviewed a representative of every group found in Maine. I identified 26 groups through a snowball sampling method; 25 interviews were used in the qualitative analysis. The leader or coordinator of each group completed a preliminary, written questionnaire followed by an extensive, semi-structured, topical interview. Interviewees responded to open-ended questions in four topic areas of particular relevance to potential partners: the nature of the group (mission, participants, infrastructure), monitoring (focus, parameters, location, study design), data (management, use, results) and support (technical and financial). The 25 groups fell into four mission categories: monitoring mission, stewardship mission, education mission and hobbyist mission. Natural resource managers and scientists should evaluate the type of data they are seeking and choose a grassroots group partnership based on the required level of skill, training, continuity, time commitment, data complexity and program infrastructure.

Rhoades, Chuck, Susan Miller, Margaret Shea and Tara Eckart. Soil properties and plant communities across limestone barrens ecotones in Kentucky. Departments of Forestry and Agronomy, University of Kentucky, Lexington, Kentucky 40546 (CR, SM). Bernheim Arboretum and Research Forest, Clermont, Kentucky 40110 (MS). Department of Biology, University of Louisville, Louisville, Kentucky 40292 (TE).

In central Kentucky, limestone barrens support isolated grass-dominated communities embedded within the forest matrix. Edaphic and topographic conditions determine the general location of the openings within the region; previous land use and disturbance appears to determine their specific local position and extent. To enhance local plant species diversity, Kentucky's natural area managers expand the barrens openings through prescribed burning. In addition to the direct effect of fire on woody plant invaders, fire-mediated changes in abiotic and soil conditions will alter the development of herbaceous barrens vegetation. We monitored the effect of a single spring fire on both the plant communities and soil processes of three neighboring barrens systems. Prior to prescribed burning, distinct soil conditions corresponded to the forest-grass margin. Soils from the forest interior and edge produced five to six times more plant available nitrogen than barrens interior soils during aerobic and anaerobic mineralization assays. Soil respiration increased two-fold moving across the ecotone from grassland to forest. Soil temperature decreased by 30% (from 17 to 13°C) and soil pH declined by 0.7 units. To evaluate the effect of prescribed fire on barrens species, we will monitor light levels, herbaceous plant cover,

and soil conditions in adjacent burned and unburned areas. We will also assess the mycorrhizal innoculum potential of the dominant grass species, *Andropogon scoparius*, in burned and unburned forest margin soils. Our results address how shifting forest-grassland ecotones influences ecosystem function and will help natural areas managers design fire programs to expand these limestone barrens.

Rizzo, William M. and Gary D. Willson. Monitoring and managing stream water quality: examples from studies in five National Park Service Units. U.S. Geological Survey, Northern Prairie Wildlife Research Center, Missouri Project Office, University of Missouri-Columbia, 302 Gentry Hall, Columbia, Missouri 65212.

Different types of water quality monitoring including chemical and physical measurements and/or monitoring biological response variables have been carried out in the streams of five National Park Service units within the past 5-10 years to detect current or possible impacts to these ecosystems. The study streams represent diverse ecoregions, including prairie (Pipestone National Monument; Homestead National Monument), Ozark highland (Wilson's Creek National Battlefield) and coastal plain (Congaree Swamp National Monument, Big Thicket National Preserve). Indications of impaired water quality (high nutrient concentrations, anoxia, algal blooms) were found in each unit, though not in all streams within a unit. Water quality impairment ranged from moderate to severe. Each park is treated as a case study where the monitoring data, in conjunction with local hydrologic and land-use information, is used to: 1) illustrate what conclusions may be drawn directly from the different types of monitoring data, 2) illustrate the biological response of the stream in areas where water quality has been impaired (where possible), 3) identification of sources of impact (e.g. point, non-point) and 4) evaluate what management strategies may effect the greatest improvement in water quality (e.g., load reduction, hydrologic impacts, buffer zones).

Rushin, John W., Jerome Hernandez and Terry L. Elder. Effect of two different burn treatments on the vegetation in a successional prairie site after seven years. Biology Department, Missouri Western State College, 4525 Downs Dr., St. Joseph, Missouri 64507.

Based on pre-treatment comparisons of species overlap and index of commonness values, the three vegetation transects used in this study were considered similar in initial plant composition. Treatments consisted of a fall burn followed by a spring burn on one sampling transect, two spring burns on another sampling transect and a control transect that remained unburned throughout the study. Although index of commonness values showed little bluestem (*Andropogon scoparious*) to be the major species on all transects before and after treatments, commonness results also showed that the study area was undergoing natural successional changes with Jerusalem artichoke (*Helianthus tuberosus*) and grass-leaved goldenrod (*Solidago graminifolia*) increasing in all transects. In addition, Indian grass (*Sorghastrum nutans*), a native tallgrass, and the weedy species sericea lespedeza (*Lespedeza cuneata*) both showed dramatic increases in the two burn treatment areas over the control. Several experimental control methods for sericea lespedeza on prairie sites, including late summer burning, are given. Perturbations in commonness values of several other plant species were also observed over the seven-year study period.

Russell, Emily W.B., Scott D. Stanford and Kathleen S. Walz. The vegetation, fire history and geomorphology of a New Jersey Pine barren savanna. Rutgers University, Department of Geological Services, Newark, New Jersey 07102 (EWBR). NJDEP Division of Science, Research and Technology, New Jersey Geological Survey, Trenton, New Jersey 08625-0427 (SDS). NJDEP Division of Parks and Forestry, Office of Natural Lands Management, Natural Heritage Program, Trenton, New Jersey 08625-0404 (KSW).

Pine barren savannas are riverside seepage fen communities dominated by sedges and grasses with scattered trees and shrubs, found on the floodplains of rivers on the outer coastal plain of New Jersey. There has been some debate over the origin of savannas. Some ecologists believe that land use history (bog iron mining, Atlantic white cedar logging, turf cutting for cranberry bog berms) has had a major impact on the formation and maintenance of savannas. Others suggest that continual groundwater seepage, oligotrophic conditions, deer browsingand/or fire history maintain these open, graminoid communities. Paleoecological and geomorphological studies were conducted at one savanna, "Above Buck Run" in the Oswego River Natural Area of Wharton State Forest, in an attempt to answer some of these questions. Geomorphological transects indicate no surface disturbance to the savanna. The thickest peats define a buried channel with dimensions similar to the modern main stream channels and likely represent channel networks etched during the latest stage of floodplain incision, prior to sea-level and water-table rise and organic accretion. Results of pollen and charcoal analyses of a peat core suggest that savanna vegetation has been present in the landscape for approximately 8000 years, and that fire may play a role in maintaining the open, graminoid vegetation. The findings of this study may have implications for management of this globally imperiled community and associated rare species in the natural area.

San Diego, Nick M. and G.R. Camilo. Management regime, scale and diversity of leaflitter arthropod communities of an Ozark forest. Department of Biology, Saint Louis University, 3507 Laclede Ave., St. Louis, Missouri 63103 (NMS, GRC).

The impact of forest management practices, such as clear-cutting, is known to have an effect on the spatial patterns and composition of soil arthropod communities. However, how forest stand composition influences the spatial structuring of these communities is not well understood. The objectives of our study were to assess the spatial scale at which forest canopy structure changes and how those changes affect abiotic

parameters, which in turn alter the leaflitter invertebrate community diversity. We determined the invertebrate communities in three forest management regimes in the Missouri Ozarks; preservation, selective logging (mainly oak) and clear-cutting sites. Within these areas, two 400m^2 grids were mapped out in addition to a 160m x 5m transect, each divided into 5m x 5m squares. Abiotic parameters measured included soil temperature, relative humidity and direct sunlight. Invertebrate specimens were collected via litterbag sampling and berlese funnel extraction. Specimens were identified at least to family. Results of invertebrate abundances suggest that selectively logged forest represent a more efficient use of natural resources, concurrent with diversity conservation objectives. Variability associated with each abiotic parameter changed significantly as we increase scale, and transitioned around 25m^2. A major result was that in the clear cut site, increased variance in relative humidity traveled further into nearby forest (>100m) and had a longer temporal footprint (>30 years) than any of the other forest management regimes.

Solecki, Mary Kay and Patti Malmborg. Illinois' Land and Water Reserves - a successful conservation easement program. Illinois Nature Preserves Commission. 1 North Street, Sidney, Illinois 61877 (MKS). Illinois Department of Natural Resources, Division of Natural Heritage, 524 S. 2nd Street, Springfield, Illinois 62701-1787 (PM).

Illinois' Register of Land and Water Reserves is an innovative public/private partnership that provides protection and management for lands and waters supporting significant natural heritage or archaeological resources. The agreement to register an area as a Land and Water Reserve is similar to a conservation easement and is between the landowner and the Illinois Department of Natural Resources and the Illinois Nature Preserves Commission. Reserves may be in private or public ownership. Lands and waters eligible for registration include the following: lands and waters included on the Illinois Natural Areas Inventory; habitats of state listed threatened or endangered plants or animals; forest at least 100ac that support breeding populations of area sensitive forest wildlife; grasslands at least 80ac that support breeding populations of area sensitive grassland wildlife; wetlands totaling at least 50ac; degraded but restorable prairie at least 20ac; degraded but restorable railroad prairies at least 1mi in length; and areas supporting unusual concentrations of wildlife. Since inception of the Land and Water Reserve program in 1995, more than 40 different sites statewide have been registered as Land and Water Reserves. These reserves total over 16,855acs and range in size from 1 to 9,274 acres, with an average size of 421ac. The success of this program is due in part to its flexibility in allowing uses compatible with protection of the qualifying natural features such as hunting, trapping, fishing, canoeing and primitive camping.

Stephens, Scott, Nancy Honerkamp and Cary D. Chevalier. A survey of the small mammal community at Weston Bend State Park, Platte County, Missouri. Department of Biology, Missouri Western State College, 4525 Downs Dr., St. Joseph, Missouri 64507 (SS, CDC). Weston Bend State Park, Missouri 64098 (NH).

The purpose of this study was to inventory the small mammal communities in five different habitats throughout the park. We sampled the small mammal community during two seasons summer (July 5 through August 11,1999) and winter (December 20 through December 29 1999). We sampled by trapping, direct observation, and indirect observation (such as sound, burrow type, runways, tracks, scat, etc.). We trapped for a total of 3528 trap-nights (1476 summer, 2052 winter), caught 270 specimens, and documented the presence of 9 genera: *Blarina brevicauda* (winter only: number trapped [n] = 1; relative density [RD] = 0.01); *Didelphis virginianus* (winter only: n = 8; RD = 0.07); *Peromyscus* sp. (summer: n =123; RD = 0.8; winter: n = 84; RD = 0.72); *Procyon lotor* (winter only: n = 1; RD = 0.01); *Sciurus niger* (winter only: n = 1; RD = 0.01); *Sigmodon hispidus* (winter only : n = 18; RD = 0.12); *Microtis ochrogaster* (summer: n = 6; RD = 0.04; winter: n = 19; RD = 0.17); *Microtis pinetorum* (summer: n = 5; RD = 0.03; winter: n = 1; RD = 0.01); *Tamias striatus* (summer only: n = 1; RD = 0.01); *Zapus hudsonius* (summer only: n = 1; RD = 0.01). Simpson and Shannon-Weaver Diversity Indices were 1.53 and 0.32, respectively, for summer and 1.79 and 0.31, respectively, for winter. We also noted the presence of *Sylvilagus floridanus* (direct obs.; several); *Sciurus carolinensis* (direct obs., several); *Odocoileus virginianus* (indirect obs., bed sites, scat, and tracks); and *Lynx rufus* (indirect obs., tracks). No statistical difference was found between seasonal diversity by either of these indices ($P > 0.05$). This survey is part of a long-term monitoring effort of the biodiversity at Weston Bend State Park.

Stroh, Esther D. Habitat microclimate and population demographics of *Zigadenus elegans* ssp. *glaucus*, a state-endangered Pleistocene relict plant in southern Missouri. U.S. Geological Survey, Northern Prairie Wildlife Research Center, Missouri Project Office, 303 Gentry Hall, University of Missouri, Columbia, Missouri 65211.

Disjunct populations of plant species often occur far from their typical ranges, usually in small refugia with localized microclimates atypical of surrounding habitat. In southern Missouri, *Z. elegans* occurs with other Pleistocene relict species (*Campanula rotundifolia* and *Galium boreale*) on north-facing dolomite bluffs along the Jacks Fork River in Ozark National Scenic Riverways. Disjunct Pleistocene relict populations may have persisted for thousands of years in their refugia, yet little is known about abiotic conditions that facilitate this persistence. Relict populations present an important opportunity to examine micro-climatic thresholds and species' ability to persist in small islands of suitable habitat.
The objectives of this study-in-progress are to: 1) characterize and compare microclimate inside and outside population boundaries of Z. elegans sp. glaucus in three known refugia; 2) describe population demographics in each refuge; 3) assess genetic diversity and gene flow between the three Missouri populations;

and 4) compare genetic diversity of Missouri populations to disjunct and non-disjunct populations of the same subspecies in other states.
I used small Hobo® data loggers to record temperature, relative humidity and light intensity on three bluffs that support populations of Z. elegans, and I censussed population demographics along vertical belt transects on each bluff. Genetic diversity, similarity and gene flow between populations were assayed using starch gel electrophoresis to resolve ten enzymes. Initial analyses show similar demographic structure and low genetic diversity in Missouri populations, and complex and unexpected microclimate patterns in population refugia. Two-year microclimate and demographic results and further genetic analyses of Missouri populations are reported.

Steiner, Warren E. and Jil M. Swearingen. An entomological survey of Navassa Island, with notes on species richness and endemism. Department of Entomology, NHB-187, Smithsonian Institution, Washington, DC 20560 (WES). Center for Urban Ecology, U.S. National Park Service, 4598 MacArthur Blvd., N.W., Washington, DC 20007 (JMS).

The invertebrate fauna of Navassa, the small isolated island between Hispaniola, Jamaica and Cuba, has been virtually unknown in spite of historical U.S. occupation. A survey of the biodiversity, geology and other natural resources of Navassa was summoned after administration of the 5.2 square km island was given (1996) to the U.S. Department of the Interior. We joined a team of scientists working on the island and surrounding marine habitats from 24 July to 5 August 1998. Arthropod collecting techniques and traps included 3 Malaise traps with flight intercept pans, sets of pitfall traps, yellow pan traps, black lights and various manual methods to sample leaf litter, soil, rotten wood, fungi, foliage, air and water. Traps were placed for coverage of the major habitat types, e.g., weedy flats on the lower rim, forest-savanna edges and forest interior. We found Navassa to be more diverse in terrain and vegetation types than expected, in spite of the absence of sand beach habitats, scarcity of fresh water, and effects of historical human disturbance. The rugged karst surface and abrupt vertical cliffs with an undercut base at sea level make Navassa a "fortress" for its surprisingly rich biota. A total of 649 species of terrestrial arthropods, including 541 insects, were taken. New species endemic to Navassa may make up 30 percent of those discovered, based on present knowledge of selected taxa, e.g., 3 out of 11 species of tenebrionid beetles, 25 out of 76 species of spiders. Some exotic introduced insects were also found to be established.

Taft, John B. Fire effects on community structure, composition, and diversity in a barrens remnant in southern Illinois. Illinois Natural History Survey, 607 E. Peabody Drive, Champaign, Illinois 61820.

Effects of prescribed fire on community structure, compositionand diversity were examined at Gibbons Creek Barrens (GCB), a dry sandstone barrens community in southern Illinois. A fire-free control area was established at a barrens (FSB) nearby the fire-treatment site for comparative monitoring. Among the overstory strata prior to fire, both barrens demonstrated compositional stability and structural instability. GCB was treated with a fall and a spring burn. Vegetation was monitored for three and two years, respectively, following each fire using permanent plots in a stratified-random sampling design with nested plots for shrub/sapling and ground-cover strata within larger tree plots. Fire effects on canopy structure mostly were limited to small-sized stems as total basal area of trees increased despite significant reductions in stem density. Differences in overstory fire effects were greatest among the shrub/sapling strata. Fire effects on composition and diversity were greatest in the ground-layer vegetation as there were significant increases in species density, diversity and percent cover. There also were changes in rank abundance among dominant species. Most species increased in frequency and cover at the fire-treatment unit while a large proportion of species declined in frequency and cover in the fire-free control unit. Most increase in species diversity at GCB appears to be from the soil seed bank and among species typical for the habitat. Changes among species included a trend towards greater dominance of C_3 graminoid species compared to the former dominance of C_4 species. Decline in C_4 grasses occurred at both the fire-treatment and control areas.

Walz, Kathleen S. and Thomas F. Breden. Protection of globally imperiled wetland communities in the Kittatiny Valley of New Jersey: calcareous fens and sinkhole ponds. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Office of Natural Lands Management, Natural Heritage Program, P.O. Box 404, Trenton, New Jersey 08625-0404.

The Kittatiny Valley of northwestern New Jersey contains a small-scale, karst landscape that harbors wetlands of global significance for the conservation of biological diversity. A number of calcareous fen and sinkhole pond community types found in the Kittatiny Valley have been determined by the Natural Heritage Program to be globally imperiled. Preserve designs have been developed for twenty of the highest ranked fen and sinkhole pond sites, describing the biological diversity of the wetlands, identifying threats and management needs, and delineating adjacent watershed lands needed to sustain the ecosystem quality. The preserve designs and information fact sheets on fens and sinkhole ponds are being distributed to public and private land-owners, local land use planners and conservation organizations best positioned to provide protection to these important natural communities, endangered species, karst features, ground-watershedsand adjacent uplands.

Walz, Kathleen S., Thomas F. Breden and Tara Bowers. Classification, protection and monitoring of significant wetlands in New Jersey: non-tidal floodplain forest communities. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Office of Natural Lands Management, Natural Heritage Program, P.O. Box 404, Trenton, New Jersey

08625-0404.
Floodplain forest communities provide significant wetland functions in the landscape as well as habitat for biological diversity. The New Jersey Natural Heritage Database lists fifty-seven rare plant species known to occur in floodplain forests, twenty-five of which are listed as state endangered. Only a handful of examples of these dynamic communities remain in excellent condition in New Jersey; many more have been impacted by hydrological modification, water quality degradation, habitat loss, and non-native species invasion. A preliminary classification of rural, non-tidal, floodplain forest communities is presented from sites in fifteen of the state's watershed management areas. This project will further the protection of these floodplain wetlands by 1) documenting the uniqueness of these communities and establishing their significant contribution to our biodiversity; 2) identification of reference wetlands as benchmarks for comparison with impacted examples in need of restoration work; 3) assessment of the current status of threats, management needs, and adjacent buffer lands needed to maintain the quality of these wetlands; 4) establishing the base plots and planning for a permanent monitoring program to track the status of these wetland communities in New Jersey; 5) develop site boundaries for the best sites and distribute this information to those best positioned to provide protection to the wetlands. The results of this project will be shared with local, county and state stakeholders and other colleagues at local conservation forums.

Wiedenmann, Robert N., David, J. Voegtlin, Judy D. Parrish and Susan L. Post. Effects of biological control agents on purple loosestrife in Illinois. Illinois Natural History Survey, 607 E. Peabody, Champaign, Illinois 61820 (RNW, DJV). Millikin University, Decatur, Illinois (JDP, SLP).

Purple loosestrife (*Lythrum salicaria*) is an exotic wetland plant that has spread throughout North America. Biological control efforts, releasing two species of leaf-feeding beetles (*Galerucella* spp.) at several sites, have resulted in reductions of flowering of loosestrife and changes in the plant composition at the sites. Feeding on meristems of loosestrife plants has caused direct reduction of flowering and reduction in biomass of flowering spikes over several years. At one location, large-scale emergence of beetle populations has caused widespread defoliation of loosestrife. As loosestrife has diminished, native plants have returned and are common again. Even more important, other exotic species at the site have not filled the void caused by less loosestrife.

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