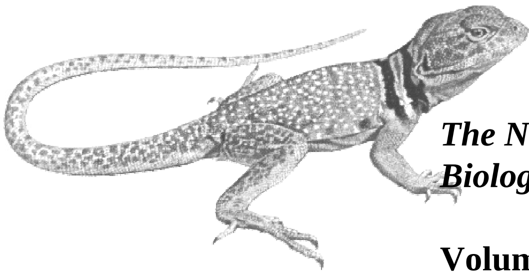


The Glade

The Newsletter of the Missouri Chapter of the Society for Conservation Biology

Volume 4, Number 1 **April 2001**

The Corner

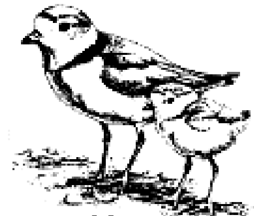
David Giblin, Vice-President of MOSCB, Division of Biological Sciences, University of Missouri, Columbia, MO 65211; deg0f3@mizzou.edu

This past March the membership was asked for the first time ever to vote on an advocacy issue. In this instance the issue was a petition initiated by the California Native Plant Society supporting the equal protection of plants under the Federal Endangered Species Act. A total of 34 votes were cast, with an overwhelming majority of the votes in favor of MOSCB becoming a signatory to the petition. Thirty-four votes is roughly 15% of the membership, so it is unclear as to whether our becoming a signatory to the petition truly reflects the view held by the majority of the membership. Moreover, there was no discussion or debate of this matter over the list-serve. One possible explanation for these two events is the lack of anonymity with respect to expressing one's views or one's vote. Whether or not this contributed to the light turn-out is unclear, but it is a concern that the Board will be considering in the near future. Any comments or suggestions as to how to improve the process would be greatly appreciated. Please send them to the chapter email address at *moscb@showme.missouri.edu*.

There are still many opportunities for members to get involved in the chapter. We are in particular need of a member with web page design experience to apply their skills to redesigning and managing the chapter web page. If interested, please contact us at *moscb@showme.missouri.edu*. Additional help is need with fund-raising for future newsletters, as well as individuals willing to submit articles for publication in *The Glade*. Members interested in any of these opportunities should contact us at *moscb@showme.missouri.edu*.

By the time that this issue arrives spring will have finally commenced after a seemingly long wait. Hopefully, all of us will have the opportunity to experience some of Missouri's natural areas this spring, and in the process be reminded of why we are committed to conserving this natural heritage.

Using Optimization to Define Cost-Efficient Conservation Strategies for Threatened and Endangered Species



Mike Larson[1,2], Mark Ryan[1], and Bob Murphy[3]
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Conservation biologists often have sufficient technical ability to successfully recover populations of threatened and endangered species. The financial means to implement conservation prescriptions, however, are usually limited. Agencies and organizations that fund conservation efforts are faced with many conservation emergencies and there is a need to prioritize potential projects for action. To make those decisions, it is essential to have information about the feasibility of recovery, risk of project failure, and whether or not proposed activities constitute the most cost-effective approach.

Optimization modeling provides an excellent framework for linking the economic and demographic aspects of conservation activities in an analysis of recovery feasibility. It is analogous to a cost-benefit analysis. In optimization, you can either maximize a desired outcome or minimize an unwanted one. Optimal solutions, however, are constrained by limitations on available resources or the level of risk that can be tolerated.

We applied an optimization modeling approach to the management of piping plovers in the Great Plains. Piping plovers are small (~17 cm long) migratory shorebirds found in three main populations. The Great Plains and Atlantic Coast populations are listed as threatened under the Endangered Species Act, and the Great Lakes population, which is often lumped with the Great Plains population, is endangered. In the Great Plains population, which is distributed from Nebraska to Saskatchewan during the summer and is declining at a rate of 2-8% annually, plovers nest on the open beaches of alkaline and freshwater wetlands and sandbars associated with major rivers and reservoirs. Human-modified fluctuations in water levels along rivers have caused reproductive failure and have negatively affected nesting habitat. Low reproductive success due to predation on eggs and chicks, however, is a more ubiquitous problem. To exclude predators, managers can place a wire cage over an individual nest or erect a temporary or permanent electric fence around a beach containing several plover nests. Nest cages do not restrict the movement of incubating adults to and from the nest.

We focused on defining optimal strategies for applying predator exclusion management at alkaline wetland sites. Our objectives were to maximize the fledging rate (i.e., the average number of young raised to independence by each breeding pair in a given year) and to minimize the cost of predator exclusion management. We gathered data on the fledging rate of plovers under four types of predator exclusion: no protection, nest cages, electric fencing, and cages and fencing. We also collected data on the costs of materials, labor, and transportation associated with applying management and calculated the total cost of each management type over a 50-year period. The optimization model we developed allocated each plover pair in the population to one of the four management categories. The model had four main constraints: (1) initial annual expenditures were restricted to <$235,000 based on previous expenditures by the U.S. Fish and Wildlife Service; (2) the fledging rate was restricted to >1.24 fledglings/pair, which would prevent further population declines; (3) the proportion of pairs that could receive predator exclusion was restricted to <78% based on a GIS analysis of the distributions of breeding plovers and natural resource agency field offices; and (4) the proportion of pairs that could receive fencing was restricted to <35% based on our opportunistic placement of fences, which was determined largely by the shape of beaches and the density of nests on them.

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Cost-Efficient Conservation Strategies (continued from page 2)

Predator exclusion increased the baseline fledging rate (0.89 fledglings/pair) to 1.15-2.25 fledglings/pair, with the combination of nest cages and electric fencing being the most effective. It cost $180-230/year to protect a single plover pair, most of which went toward employing technicians to apply management and monitor pairs throughout the breeding season. In the optimal management strategy that maximized the fledging rate, 22% of pairs received no protection, 43% received nest cages, and 35% received cages and fencing. That strategy would result in a fledging rate of 1.38 and a population growth rate of 2.5%/year at a cost of approximately $175,000 the first year and $14.2 million over 50 years. In the optimal management strategy that minimized costs, 59% of pairs received no protection, 6% received nest cages, and 35% received cages and fencing. That strategy would result in a fledging rate of 1.24 and a population size that neither grows nor declines (because that was the constraint) at a cost of approximately $100,000/year and $5 million over 50 years.

The combination of cages and fencing was the most cost-efficient technique in terms of dollars/fledgling. The use of fencing alone was so cost-inefficient that it was not included in either optimal strategy. Obviously, this is very practical information that could be of use to managers immediately. From a policy standpoint, we now know that it would be demographically feasible to recover the population in a relatively short time frame using predator exclusion. [We do recommend, however, the consideration of alternative forms of management to alleviate other potential limiting factors (e.g., water level management in rivers) for the population.] Also, we have defined upper and lower boundaries for an extensive management plan for piping plovers in the Great Plains. Decision makers now have quantitative information about a range of options from which they can select a course of action based on the availability of funding, and the priority of plover recovery relative to competing issues.

The application of optimization to endangered species management is an underutilized technique. Understandably, sufficient data do not exist for many conservation problems. When adequate data are available, however, optimization is a powerful tool for helping to make difficult conservation decisions. Optimal decision-making that results in the most efficient use of conservation resources will have a substantial effect on the conservation of threatened and endangered species. Risks to species recovery will be minimized, the number of populations and ecosystems that are directly managed toward recovery will increase, and conservation biologists will retain their credibility as responsible stewards of the public's natural and financial resources.

Announcements

- As of March 28, 2001, MOSCB became an official signatory to the Equal Protection for Plants under the Federal Endangered Species Act Petition. To view the petition visit: http://www.cnps.org/legislation/petition.html.

- The Missouri Prairie Foundation is sponsoring a workday at Stillwell Prairie on May 19, 2001. This prairie is approximately eight miles NW of Nevada, MO. If you are interested in participating see their website at http://www.moprairie.org for more details or call Wayne Morton at 417-646-2450 before 7:45 a.m. or between 8 and 10 p.m.

Missouri Department of Conservation's Endangered Species Program

Peggy Horner, Endangered Species Coordinator, Missouri Department of Conservation, 2901 W. Truman Blvd, Jefferson City, MO 65109, hornep2@mail.conservation.state.mo.us

Missouri's state Endangered Species Program is nestled within the Natural History Division of the Department of Conservation (MDC). Part of the mission of both MDC and the Natural History Division is to protect, conserve, and enhance wildlife diversity resources and natural ecosystems. One of the strategies to accomplish this mission is to recover declining species.

The goal of the Endangered Species Program is two-fold. The first goal is to restore those species officially protected as endangered or threatened by the U. S. Fish and Wildlife Service (FWS) or MDC by addressing the threats to the species. Many of these threats, and the actions needed to alleviate the threats, are already identified in federal and/or state recovery plans. Through partnerships with the FWS, other states, and other natural resource organizations, populations are stabilized and hopefully increased, thereby removing them from the federal and state lists. The second goal is to identify those species not yet officially protected but whose populations appear to be declining. Initially, the focus is to confirm the decline of the species and identify the threats, then develop and implement actions that will reverse the trend *before* the need to officially protect the species through additional regulations.

In Missouri, there are 31 extant species that are endangered, threatened, or considered candidates for listing by the FWS. MDC also has the authority to provide regulatory protection under the Missouri Wildlife Code. There are 63 species protected as endangered (there is no threatened designation in the Wildlife Code), and all federally protected species are also state protected. In addition to those species with special regulatory protection, there are over 900 species that have been identified as “species of conservation concern” by MDC.

Identifying and alleviating threats to restore declining populations is no easy task, but Missouri is active in endangered species conservation and management. Public lands make up only about 7% of Missouri; the rest of the state is in private ownership. With the help of our partners and by providing management guidelines and cost-share incentives to both public and private land managers, we are beginning to see positive results.

One example involves two stream fish, the Topeka shiner found in northwestern and central Missouri and the Niangua darter in southwestern and central Missouri. MDC provides both technical and financial assistance to private landowners to stabilize stream banks in areas where these species currently exist, and these actions decrease the threat of sedimentation, turbidity and pollution due to run-off. Stream bank stabilization is also a management practice for many of our mussel species, including the proposed endangered scaleshell mussel found in the Osage and Bourbeuse Rivers.

Another example includes the gray bat population in Missouri. Gray bats appear to have stabilized in the past few years, possibly due to efforts to protect cave entrances with gates to reduce disturbance during hibernation and the maternity season. Also, prairie restoration for the greater prairie chicken, a state protected species that is not federally protected, is slowing the decline of this species. By restoring prairies, other endangered species, like the western prairie-fringed orchid and Mead's milkweed, benefit too.

(continued on page 5)

Endangered Species Program (continued from page 4)

Some federally protected species known mostly from other states, but with a small number of known populations in Missouri, need additional surveys. Three species, the Hine's emerald dragonfly, the Virginia sneezeweed, and Hall's bulrush are examples. Their primary threats are fragmentation and loss of habitat, and efforts are being made to identify suitable habitat and discover new populations in order to protect their habitat.

Efforts to restore species by captive propagation, reintroduction, and experimental populations are currently underway for a few species. The new state fish hatchery, Lost Valley, is beginning to learn how to propagate Topeka shiners in captivity, and the Blind Pony State Fish Hatchery is producing pallid sturgeon fingerlings for release into the Missouri and Mississippi rivers. Freshwater mussels require a host fish to reproduce, and both the FWS and MDC are supporting research to determine fish hosts for our rarest mussels with hopes of augmenting declining mussel numbers. Experimental populations of two plants, pondberry and running buffalo clover, have been established on suitable department lands within the historic ranges of the species.

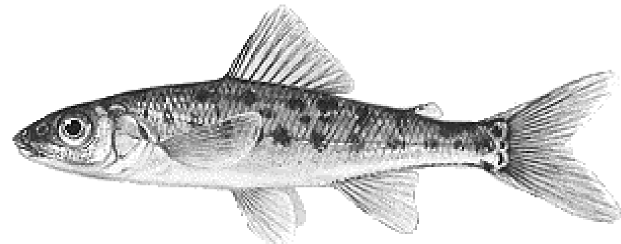
MDC is committed to the conservation of our rare flora and fauna. By developing partnerships with other organizations, institutions, and private landowners, and through public education, we plan to make positive steps in the recovery of Missouri's declining and rarest species to maintain a healthy, biologically diverse environment.

For more information about endangered species in Missouri, contact Peggy Horner, Endangered Species Coordinator, MDC, P.O. Box 180, Jefferson City, MO 65102 or view **www.conservation.state.mo.us/** and type *endangered species* as the keyword.

"We should be blessed if we live in the present always, and took advantage of every accident that befell us, like the grass which confesses the influence of the slightest dew that falls on it; and did not spend our time in atoning for the neglect of past opportunities, which we call our duty. We loiter in winter while it is already spring. In a pleasant spring morning all men's sins are forgiven. Such a day is a truce to vice."

excerpt from "Spring" in *Walden*
by Henry David Thoreau

Missouri Fishes: Threats and Declines



Jeff Ray, Missouri Department of Conservation, 1110 S. College Ave., Columbia, Missouri 65201, rayj@mail.conservation.state.mo.us

Missouri is home to more than 200 fish species, and some are found nowhere else in the world. There are at least 19 species endemic (restricted) to the Ozark streams of Missouri, Arkansas, and Oklahoma, including the checkered madtom and Ozark cavefish. Other species like the bluestripe darter and Niangua darter have ranges completely within the state.

The list of factors threatening our native species is extensive, including siltation, turbidity, toxins, channelization, impoundments, water diversions, nutrient enrichment, and introduced species. Siltation and nutrients are two of the greatest threats to fishes. The EPA found that silt and nutrients affect 40% and 35% of flowing waters, respectively (US EPA 1998). Excessive siltation (primarily from agriculture) has been implicated as the major factor responsible for the range reduction and disappearance of many native species. Siltation reduces or eliminates spaces in the substrate that provide vital habitat for benthic organisms, fish nesting and nursery sites, and hiding spaces (Burr and Page 1986).

Over the past few decades, some improvements in water quality have occurred as many point sources of pollution (straight pipes) have been reduced, but many non-point sources have increased and are generally more difficult to eliminate. Soil conservation programs and implementation of best management practices have helped slow erosion in the U.S. by an estimated one billion tons per year, but even reduced amounts can transport pesticides, nutrients, and other toxins that threaten aquatic organisms (NRCS 1997).

The first documented fish collections in Missouri for scientific purposes were conducted around the 1880's. These were not statewide or specific stream surveys, but general collecting at scattered sites. In the 1930's and 1940's, the first statewide surveys were conducted, but sustained efforts have only occurred since the 1960's. Therefore, the effect on fishes caused by dramatic and large-scale landscape changes that began prior to 1900 were generally undocumented (Pflieger 1997).

In Missouri, 22 species have shown significant declines in collections made in the 1990's compared to the 1940's. Of these, 14 species have shown declines of greater than 50%, including the Topeka shiner, western silvery minnow, and plains minnow. The pallid shiner has not been collected since 1956 and is considered extirpated (Matthew Winston, Missouri Department of Conservation, *personal communication*). Illinois, subjected to even greater landscape alterations, has experienced a more drastic decline in its fauna with at least 11 fish species extirpated from the state (INHS 2001).

One species that has experienced a marked decline (approximately 90% reduced presence in collections) in Missouri is the trout-perch, *Percopsis omiscomaycus*. Its range includes Alaska, Canada, and the upper half of the Mississippi River basin. In Missouri, the trout-perch was historically found in tributaries to the Grand and Chariton Rivers, streams in the Columbia area east to St. Charles, and at other scattered localities. This species is typically associated with slack water habitats over sand or gravel and is apparently very sensitive to disturbances. At present, it is only consistently found in a few reaches of the Grand River system; the trout-perch is on the verge of disappearing from our state (Matthew Winston, *personal communication*). Its decline is probably related to pesticides, siltation, and especially channelization (Pflieger 1997).

(continued on page 7)

Missouri Fishes (continued from page 6)

Fish communities and rare species are monitored in streams across the state. Since fishes are integral parts of stream ecosystems, they can be excellent environmental indicators. They reflect existing and previous watershed conditions because they are sensitive to changes from various chemical, physical, and biological factors. Although thousands of fish collections have been made, fishes and their communities are dynamic, and explanations for how and why many changes occur are still incomplete. As efforts to monitor fish communities and rare species continue, we must not only document changes, but also find ways to reverse this loss of genetic and biological diversity.

Burr, B.M. and L.M. Page. 1986. Zoogeography of fishes of the lower Ohio-upper Mississippi basin. Pages 287-324 *in* C.H. Hocutt and E.O. Wiley, editors. The zoogeography of North American freshwater fishes. John Wiley & Sons, New York.

Illinois Natural History Survey [INHS]. 2001. INHS reports, winter 2001. Critical trends assessment program update. INHS, Champaign.

Natural Resource Conservation Service [NRCS]. 1997. Water quality and agriculture: status, conditions, and trends. USDA, Washington, DC.

Pflieger, W.L. 1997. The Fishes of Missouri. Missouri Department of Conservation, Jefferson City.

United States Environmental Protection Agency [US EPA]. 1998. The quality of our nation's waters: a summary of the national water quality inventory: 1998 report to congress. (EPA841-S-00-001). US EPA, Washington, DC.

Resolving the Distinction Between Buffer Zones & Core Habitat Around Wetlands

Raymond D. Semlitsch[1] and John B. Jensen[2]

[1]Division of Biological Sciences, 105 Tucker Hall, University of Missouri, Columbia, MO 65211-7400, USA. email: SemlitschR@missouri.edu; [2]Georgia Department of Natural Resources, Nongame-Endangered Wildlife Program, 116 Rum Creek Drive, Forsyth, GA 31029, USA.

The Problem: The terrestrial habitats adjacent to and surrounding aquatic sites are of critical importance for two reasons. First, the land/water interface serves as the site of physical and chemical filtration that protects water resources (i.e., drinking water, fisheries) from adverse effects such as siltation and chemical pollution caused by human activities such as timber harvesting, road building, farming, and urbanization. Thus, patches or strips of terrestrial habitat adjacent to wetlands or streams function as protective barriers or buffer zones around core aquatic habitat to insure that surrounding land-use practices do not impact water resources.

The second reason for the importance of the adjacent terrestrial habitat is that it inherently serves as core habitat for many semi-aquatic species that occupy the mesic ecotone, and is, therefore, essential for maintaining biodiversity. Although the importance of this core habitat is quite clear, terms used to define this habitat, as well as regulations to protect it, are not. A problem for natural resource managers is created because although the adjacent terrestrial habitat is core habitat for a vast array of species, this habitat is defined in the literature by the terms "buffer zone" or "buffer strip," which denotes its primary use as a protective habitat for aquatic resources rather than necessary habitat for species. Unfortunately, natural resource managers are left using a guideline that was not designed to protect the core habitat of species, or to maintain biodiversity explicitly.

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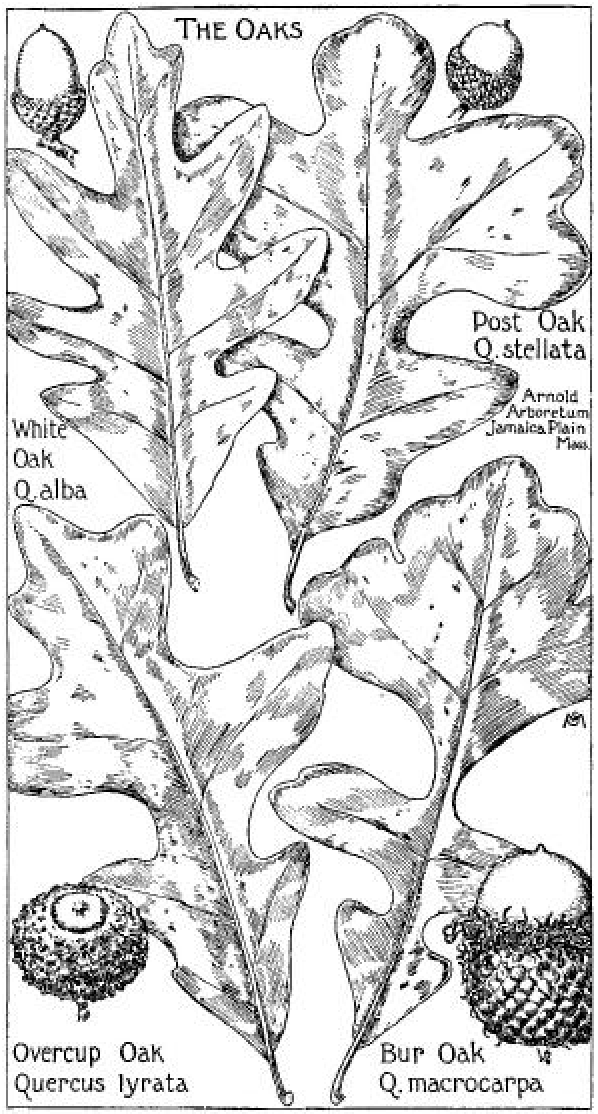
Y O U R L E T T E R S



We welcome your letters and comments on articles printed in *The Glade* or on conservation issues throughout the state. Letters should be mailed to Michelle Boone, USGS Columbia Environmental Research Center, 4200 New Haven Road, Columbia, MO 65201, to the return address on the newsletter, or to **moscb@showme.missouri.edu**.

Floodplain Oaks

I was perusing *The Glade* and became interested in the article concerned with the floodplain of the Missouri River. I was surprised to read that Dey et al. were placing so much emphasis on restoring 'oak hardwood' forests in the bottoms and somewhat discouraging the regeneration to willow, cottonwood, elm, and such in most areas. I'm the project director of the *Missouri Lewis and Clark Historic Landscape Project* in Geography at UMC. We are reading the original General Land Office field notes (1816-1817) and all of the earlier French and Spanish survey notes (1763-1816) for the Missouri River corridor and converting this information to a digital database for GIS analysis and mapping.

Our information shows that oaks were, generally, not dominant species in the bottoms. There were patches of concentrated white oak in some of the higher areas of the bottoms as the authors note. Pin oak or hickory (also mentioned as being restored) has not shown up as frequent dominant species. Our findings are showing dominant numbers and sizes in hackberry, sycamore, elm, cottonwood, and ash, mixed in with sugar maple, boxelder, linden, and (oh yes!) willow. This early bottomland species association is generally consistent from the Grand River confluence to the Mississippi. It is also important to note that early records tell that much of the landscape of St. Louis/St. Charles was considered rather open or even prairie!

--James D. Harlan, Assistant Program Director, Geographic Resources Center, Department of Geography, University of Missouri-Columbia; email: HarlanJ@missouri.edu

A Reply

We thank Mr. Harlan for his comments. He raised a few issues that require clarification. We did not intend to imply that oaks were dominant in the Missouri and Mississippi River floodplains. On the contrary, we pointed out that some oaks, hickories, and black walnut were members of diverse bottomland forests containing cottonwood, silver maple, and willow. These oaks, hickories, and walnut occurred on higher elevations that were flooded less frequently, and that had better drained soils. We know that oak species including swamp white, bur, and pin oak, and shellbark and shagbark hickory were present in the Missouri and Mississippi River floodplains based on analyses of General Land Office (GLO) surveys conducted in the early 1800s (Bragg and Tatschl 1977, Nelson 1997, Yin et al. 1997, Nelson et al. 1998), and considering the geographic distribution and silvics of native tree species (Burns and Honkala 1990). Oaks and hickories were common enough to be recorded on about one third of the survey transects of the Missouri River floodplain in the early 1800s and oak-hickory is a recognized floodplain forest type in the Upper Mississippi River before European settlement. Oaks were also associates in other floodplain forest types.

We also did not intend to appear "discouraging" about the regeneration of willow, cottonwood, and elm. As we stated in our article, these early-successional and flood-tolerant species were, and still are abundant in bottomland forests. However, these species are naturally regenerating or recolonizing bottomlands throughout Missouri. We do not recommend the wholesale regeneration of oaks over cottonwood, willow, and elm. In fact, we advocate the selection of native bottomland species that are best adapted to the current disturbance regime, hydrology, and soil conditions. Management objectives will drive afforestation efforts and define the future role of oaks in floodplains. Additionally, environmental factors that vary in complex patterns across the floodplain will influence restoration goals.

In floodplains, managers and landowners want to improve wildlife habitat, promote biodiversity, restore ecosystem process and function, provide recreation, and produce forest products using native species that are best adapted to specific site environments. They desire to supplement natural regeneration of cottonwood, willow, silver maple, and elm by planting native bottomland oaks. Our research will provide a number of methods for regenerating native oaks in the floodplains. How much oak, and where to regenerate oak, are management decisions.

--Dan Dey[1], Dirk Burhans, John Kabrick, Brian Root, Jennifer Grabner and Mike Gold; [1]U.S. Forest Service, North Central Research Station, email: ddey@fs.fed.us.

Bragg, T.B. and A.K. Tatschl. 1977. Changes in flood-plain vegetation and land use along the Missouri River from 1826 to 1972. Environmental Management 1: 343-348.

Burns, R.M. and B.H. Honkala. 1990. Silvics of North America. Volume 2, Hardwoods. Washington, DC: USDA Forest Service Agric. Handbook 654. 877 p.

Nelson, J.C. 1997. Presettlement vegetation patterns along the 5th Principal Meridian, Missouri Territory, 1815. American Midland Naturalist 137: 79-94.

Nelson, J.C., R.E. Sparks, L. DeHaan and L. Robinson. 1998. Presettlement and contemporary vegetation patterns along two navigation reaches of the Upper Mississippi River. P. 51-60 *in* Sisk, T.D., ed. Perspectives on the land use history of North America: a context for understanding our changing environment. U.S.G.S., Biological Resources Div., Biol. Sci. Rep. USGS/BRD/BSR-1998-0003.

Yin, Y., J.C. Nelson and K.S. Lubinski. 1997. Bottomland hardwood forests along the Upper Mississippi River. Natural Areas J. 17: 164-173.

Buffer Zones & Core Habitat (continued from page 7)

In the last ten years, a number of studies have been published documenting the use of terrestrial habitat adjacent to streams and wetlands by a broad range of taxa, including mammals, birds, reptiles, and amphibians (e.g., Rudolph & Dickson 1990; McComb et al. 1993; Burke & Gibbons 1995; Spackman & Hughes 1995; Madison 1997; Semlitsch 1998; Matthews & Pope 1999). Together these studies clearly illustrate the close dependence of semi-aquatic species on terrestrial habitats for critical life history functions, for example, nesting and hibernation by freshwater turtles (Burke & Gibbons 1995) and use of terrestrial habitats surrounding ponds by post-breeding salamanders (Semlitsch 1998). Further, these results demonstrate the dependence of wetland biodiversity on adequate amounts of upland habitats adjacent to wetlands.

<u>*Implications for management:*</u> It is not surprising that the terrestrial ecology of semi-aquatic species is often underappreciated or overlooked by managers and conservationists. Semi-aquatic reptiles make only brief visits to terrestrial habitats when nesting, and hibernacula are very rarely observed. Additionally, many pond-breeding amphibians are highly fossorial and are, therefore, infrequently seen in terrestrial habitats. Observations and studies of these animals are consequently concentrated at the stream and wetland sites where they are readily found, rather than in terrestrial habitats where detection is difficult, yet where much of their life history plays out.

A major point of this article is to raise awareness of the special needs of semi-aquatic organisms during their entire life cycle, and not just during the most obvious and most studied phase associated with aquatic habitats. Because the aquatic and terrestrial habitats of semi-aquatic species are explicitly linked by life cycle functions, they are both core habitats and cannot be managed separately (Semlitsch 2000). Another objective of this article is to highlight that “buffer zones” or “buffer strips” as used are really “core habitat,” and not buffers at all. Biological description of areas of terrestrial habitat used, for example, by salamanders and turtles *is not* a “buffer zone,” but rather *is* “core habitat” to maintain species populations. It is necessary to manage these habitats as such in order to maintain biodiversity. We suggest that this terminology be adopted to distinguish the two concepts.

Resolution of the problem for managers can be achieved by conserving this core habitat adjacent to wetlands plus an additional buffer zone to protect it from surrounding land-use practices. For example, forest edge effects that result from a variety of land-use practices vary greatly but commonly extend into natural habitats an average of 50 m (Murcia 1995). Reducing edge effects would require additional areas of protection around core habitat. It should be clear that core habitat for maintaining viable populations of species is not the same as a buffer zone for water resources. Yet, some may ask, can core habitat for maintaining biodiversity also be used to protect water resources and serve two purposes? Yes, but only if the criteria for the size and use of the terrestrial habitat fully satisfies the needs of both functions.

Can we develop a single universal size for core habitat around wetlands and streams? We doubt if one value can be used for all wetlands and streams or for all fauna and regions because of obvious differences among these factors. More research is needed on a variety of taxa in different regions before any single standard can be evaluated or set. With such information, the taxon with the greatest need for terrestrial habitat, that is the largest area, would likely encompass all other taxa and could be used universally.

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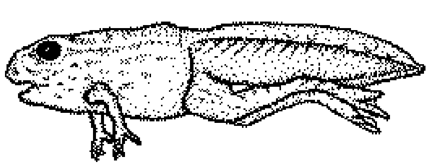
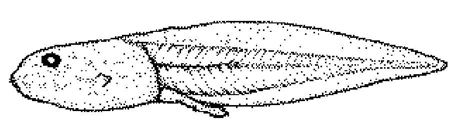
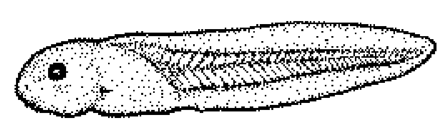

However, it is more likely that a scaled criterion would be used to accommodate primary factors. For example, in streams associated with forest management practices, deMaynadier & Hunter (1995) recommended criteria adjusted for stream attributes such as width, intensity of logging and slope adjacent to the stream. Although they provide no adjustment for taxonomic differences in core habitat, we fully agree with the idea of an adjusted scale. We also recommend adjusting the width of core terrestrial habitat according to wetland attributes, such as diversity of fauna using the wetland and the intensity of land-use practices being conducted in the surrounding areas. In addition, deMaynadier & Hunter (1995) recommend a two-tiered approach where the terrestrial habitat closest to the water is fully protected, while a second outer area has limited protection (e.g., forestry practice of light partial cutting -- removal of no more than 25% of the basal area). Although little data are available on how various organisms might respond to major land-use practices (e.g., logging, farming, residential development), it is reasonable to assume some activities, especially those not destroying essential habitat (e.g., for amphibians: vegetation canopy for shade, coarse woody debris and a litter layer for refugia and food sources), could be conducted in this outer zone of protection. For even more protection, Forman and Godran (1986) suggest a third area called a "transition zone" beyond the buffer zone that would be used for compatible land-use practices. We propose that stratification should include three terrestrial zones adjacent to core aquatic and wetland habitats: 1) a first terrestrial zone immediately adjacent to the aquatic habitat, designed to buffer the core aquatic habitat and protect inhabitants of the ecotone, 2) outward from the first, a second terrestrial zone to encompass the core terrestrial habitat defined by species use, and 3) a third outer zone that serves to buffer the core terrestrial habitat from land-use practices or edge effects.

It is not our intent to protect more habitat than is needed nor to exclude all activities from terrestrial areas around wetlands, but it is our intent to ensure managers recognize this habitat as absolutely essential for maintaining biodiversity, and that it must be managed to protect biodiversity. A sustainable balance between continued economic development and protecting natural resources is absolutely dependent on setting realistic and biologically-based criteria to attain the ultimate goal of conserving biodiversity.

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Membership Information

The goal of MOSCB is to promote communication among conservation biologists throughout the state of Missouri. Membership in MOSCB is free. To become a member send your name, address, phone number, and email address to: moscb@showme.missouri.edu or write to the address listed above. Membership must be renewed annually. Membership expires on August 1st of each year. Please visit the MOSCB web page for more detailed information (http://www.missouri.edu/~moscb/index.html).

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