Bat Habitat Restoration and Management Opportunities on Corps of Engineers Projects

PURPOSE: This technical note is a product of the Ecosystem Management and Restoration Research Program (EMRRP) work unit titled "Improved Methods for Ecosystem-Based Habitat Management at Corps Projects." The objective of the work unit is to provide appropriate technology on managing wildlife species and their habitats using ecosystem-based strategies. The emphasis is on methods that improve natural resources for a variety of animals rather than single species. Although bats have not traditionally been addressed in Corps of Engineers planning and natural resources management efforts, the recent focus on ecosystem management and inclusion of nongame species in management plans has provided opportunities to improve the restoration and management of natural resources for this very important group of animals. This note provides an overview of the status of bats at Corps projects, identifies protected species and species of concern, describes examples of bat conservation and management programs at selected projects, and provides general information on restoration and management opportunities that may be considered for improving bat habitat at Corps projects.

BACKGROUND: Bat conservation and management has become an issue on Federal lands throughout the United States. Bats represent an important component of all forested ecosystems and western deserts and rangelands, and contribute significantly to a region's biodiversity. Although bats often suffer from an undeserved negative public image, the majority of North American bat species are insectivorous and extremely beneficial because they consume large quantities of moths, flies, mosquitoes, beetles, and other insects. Bats typically consume more than 50 percent of their body weight in insects each night, and nursing females have been reported to eat enough insects to equal their body weight (Harvey, Altenbach, and Best 1999). Thus, the amount of insects consumed by all bats occurring in an area can be significant.

Numerous Federal and state agencies have become actively involved in bat conservation. According to Harvey, Altenbach, and Best (1999), these include the U.S. Fish and Wildlife Service (USFWS), U.S. Forest Service, National Park Service, Bureau of Land Management, U.S. Army Corps of Engineers (USACE), Biological Resources Division of the U.S. Geological Survey, state parks, and state natural heritage commissions. Additionally, all service branches of the U.S. Department of Defense have recently undertaken numerous actions to inventory and manage bats on their installations (Martin 2000, Martin and Wolters 2000). Private organizations concerned with bat issues include Bat Conservation International (BCI), The Nature Conservancy, The National Speleological Society, The Cave Research Foundation, The American Cave Conservation Association (Harvey, Altenbach, and Best 1999), and The North American Bat Conservation Partnership (NABCP). The NABCP is a tri-national alliance that fosters communication among working groups, bat researchers, non-governmental organizations, and state and Federal agencies

from Mexico, Canada, and the United States.[1] Also, regional bat conservation groups have been established for several regions of the United States.

LISTED SPECIES: Forty-five species of bats have been documented in the United States. Of these, seven species or subspecies are listed as threatened or endangered by the U.S. Fish and Wildlife Service (FWS). These are the Indiana bat (*Myotis sodalis*), gray bat (*Myotis grisescens*), Virginia big-eared bat (*Corynorhinus townsendii virginianus*), Ozark big-eared bat (*Corynorhinus townsendii ingens*), greater long-nosed bat (*Leptonycteris nivalis*), lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*), and Hawaiian hoary bat (*Lasiurus cinereus semotus*).

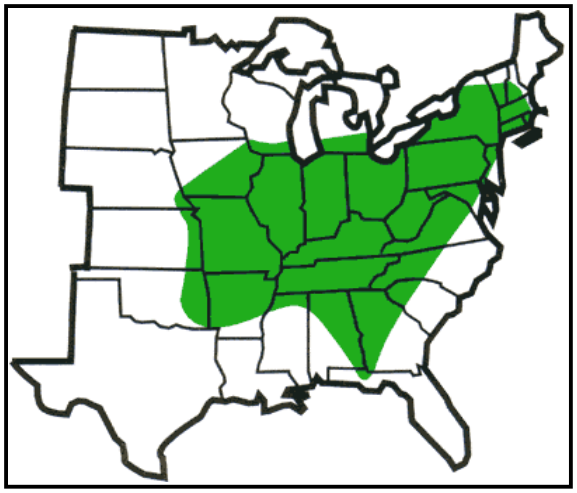

Figure 1. Approximate geographic range of the Indiana bat

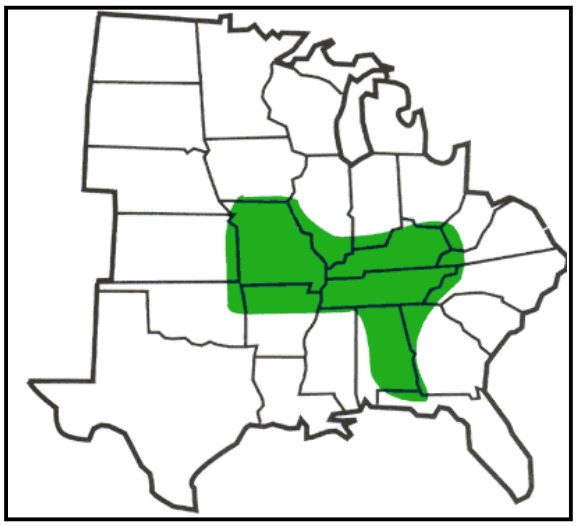

Figure 2. Approximate geographic range of the gray bat (all range maps after Harvey, Altenbach, and Best, 1999)

At present, populations of the Indiana bat and gray bat represent the primary concerns on Corps projects in the Eastern United States. Indiana bats typically winter in caves and abandoned mineshafts but form maternity roosts under loose bark and in hollow trees. The main breeding and hibernating areas for the species appear to be associated with major cavernous limestone regions in the Midwestern and Eastern states (Figure 1), and more than 85 percent of the population hibernates at only seven locations in Missouri, Kentucky, and Indiana. The gray bat occurs in cavernous regions of Arkansas, Missouri, Kentucky, Tennessee, and Alabama, with occasional colonies in adjacent states (Figure 2). Figure 3 shows a cave used by both Indiana and gray bats in northeastern Alabama. The Virginia and Ozark big-eared bats represent isolated populations of the Townsend's big-eared bat reported almost exclusively from caves (Figure 4). The lesser and greater long-nosed bats are essentially nectivorous species that occur in desert regions of the Southwest (Figure 5). Both species feed on the nectar and pollen of agaves but will also eat insects and cactus fruits. The Hawaiian hoary bat is the only mammal native to the Hawaiian islands.

[1] Personal Communication, August 2000, Brian Keeley, Bat Conservation International.

Figure 3. Blowing Wind Cave in northeastern Alabama used as a roost site by both gray And Indiana bats

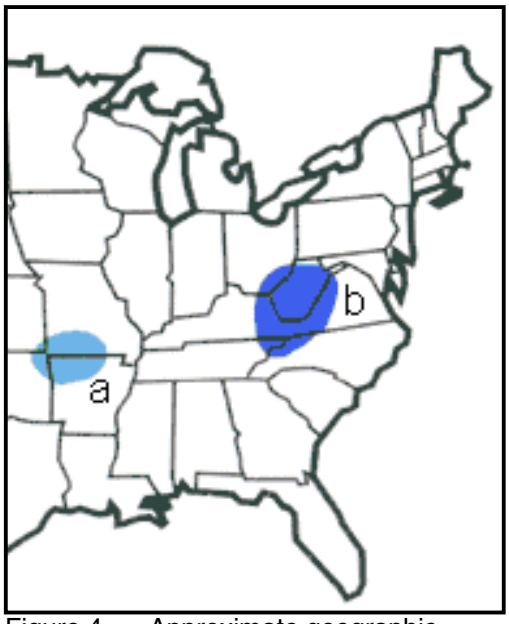

Figure 4. Approximate geographic range of (a) Ozark, and (b) Virginia big-eared bat

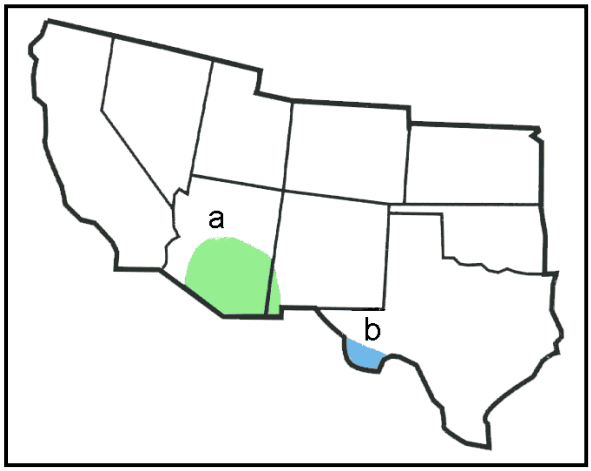

Figure 5. Approximate geographic range of the (a) lesser, and (b) greater long-nosed bat

SPECIES OF CONCERN: Twenty additional species or subspecies of United States bats are considered to be of special concern and may be considered for future listing. These include the California leaf-nosed bat (*Macrotus californicus*), Mexican long-tongued bat (*Choeronycteris mexicana*), spotted bat (*Euderma maculatum*), Allen's big-eared bat (*Idionycteris phyllotis*), southeastern bat (*Myotis austroriparius*), western small-footed bat (*Myotis ciliolabrum*), western long-eared bat (*Myotis evotis*), eastern small-footed bat (*Myotis leibii*), Arizona bat (*Myotis lucifugus occultus*), fringed bat (*Myotis thysanodes*), cave bat (*Myotis velifer*), long-legged bat (*Myotis volans*), Yuma bat (*Myotis yamenensis*), Rafinesque's big-eared bat (*Corynorhinus rafinesquii*), western big-eared bat (*Corynorhinus townsendii pallescens*), Townsend's big-eared bat (*Corynorhinus townsendii townsendii*), Florida mastiff bat (*Eumops glaucinus floridanus*), western mastiff bat (*Eumops perotis californicus*), Underwood's mastiff bat (*Eumops underwoodi*), and big free-tailed bat (*Nyctinomops macrotis*) (Harvey, Altenbach, and Best 1999).

Although "Species of Concern" are not officially protected under the Endangered Species Act, they represent species that could affect Federal actions in the future. Therefore, it is important that agencies be aware of their status. Besides these species, states may also recognize other bats as threatened, endangered, or sensitive species. For example, the pallid bat (*Antrozous pallidus*) is

considered a state species of concern in California although the species is fairly common over most of its range. State fish and wildlife agencies and natural heritage commissions can provide information regarding protected species within state boundaries. Harvey, Altenbach, and Best (1999) reported that several Federal and state agencies have initiated studies to determine the distribution and status of endangered and special-concern species. Studies are also under way to obtain information on various aspects of the ecology of these species and to formulate management recommendations.

IMPACTS TO BAT POPULATIONS: Drastic reductions in bat populations have been reported in recent years both within the United States and worldwide (Harvey, Altenbach, and Best 1999). The long-term decline of bat populations throughout the United States has resulted from several natural and human-induced factors. Natural factors include flooding, cave-ins, freezing, and disease, but these are rare occurrences. However, several instances of bat mortality have resulted from the flooding of hibernacula (DeBlase et al. 1965, USFWS 1999). Human factors are the main causes of decline in most species and include intentional eradication, cave commercialization and exploration, physical modifications to cave entrances, deforestation and land clearing, degradation of riparian habitats, stream modification, strip-mining, improper use of pesticides, and urbanization. Use of fog-oil for combat training and readiness exercises may also be potentially harmful to bats on military installations. Disturbances to hibernating bats and maternity colonies are especially destructive to bat populations.

Tuttle (1997) stated that millions of bats have been burned, poisoned, or dynamited in senseless acts of destruction. For example, in the 1960s the largest known colony of free-tailed bats (in Eagle Creek Cave, Arizona) was reduced from 30 million to 30,000 bats in just 6 years; pesticide poisoning and intentional eradication were implicated in their demise. Millions of Brazilian free-tailed bats (*Tadarida brasiliensis*) have been burned or dynamited in their overwintering caves in Mexico (Tuttle 1997). Many local populations are eradicated annually due to unsubstantiated fears and ignorance regarding bats and rabies and other health concerns. Although bats can contract and transmit rabies, fewer than 40 people in the United States are known to have contracted rabies from bats during the past 40 years (Harvey, Altenbach, and Best 1999).

CORPS OF ENGINEERS PLANNING/MANAGEMENT ACTIONS: A recent survey conducted as part of the Ecosystem Management and Restoration Research Program indicated that bats were a concern on several Corps projects, especially in the East (Kasul, Martin, and Allen 2000). Ten projects in six Districts reported the occurrence of protected bat species on their projects; these included the Indiana bat (six projects), gray bat (three projects), and Rafinesque's big-eared bat (one project). Numerous additional projects likely support substantial bat populations, but adequate surveys have not been conducted. A study conducted by Allred (1996) indicated that gray bats potentially occur on at least 20 projects where recovery plan actions may be required. The Indiana bat was not mentioned in this report. Records maintained by Headquarters, USACE, show that gray bats and/or their habitats are being managed as part of recovery plan efforts on 15 projects in Kentucky, Tennessee, Missouri, Arkansas, and Kansas, and Indiana bat habitat is being managed on

two projects in Kentucky.[1] Information presented below summarizes known planning and management efforts regarding bat issues at selected Corps projects but is not a comprehensive assessment of activities throughout the United States.

Upper Mississippi River Navigation Study. Potential project impacts to the Indiana bat were addressed in the recent Biological Assessment of the Upper Mississippi River Navigation Project (USACE 1999). Although no major impacts were anticipated to Indiana bat populations from project construction, it was determined that there was potential to affect roosting or nursery trees if construction and maintenance of channel structures and revetments involved bankline grading and tree removal. Channel dredging and disposal over the life of the project could also disturb roosting bats. Conservation measures recommended for Indiana bats included (1) prohibiting tree removal/clearing from 1 April to 30 September in areas where roosting bats are expected to occur, (2) prohibiting tree removal/clearing from 1 April to 15 November if the site is within a 5-mile radius of a hibernaculum, (3) establishing forest management efforts to maintain tree species and size class diversity to ensure the long-term supply of potential roosting sites, and (4) evaluating current Corps operations and programs to determine if additional opportunities exist to promote hardwood regeneration and species diversity in floodplain forests.

Big Cypress Bayou Restoration Plan. An ecosystem restoration plan for Big Cypress Bayou, Jefferson County, Texas, was recently prepared by the Fort Worth District under the authority of Section 1135 of the Water Resources Development Act of 1986 (USACE 2000). The proposed plan consisted of restoration of approximately 40 acres of bottomland hardwood forests, emergent wetlands, urban wildscape, and instream spawning habitat. One component of this plan consisted of modifying an abandoned railroad bridge to provide bat roosting and nursery habitat. Design specifications called for constructing and attaching three types of roosting structures recommended by BCI; these included seven "Texas bat abodes," two "big-eared bat abodes," and twelve "Oregon bridge wedges." Construction details for these structures are provided in USACE (2000). The big-eared bat abodes were designed specifically for the Rafinesque's big-eared bat, which is a state-protected species in eastern Texas. Installation of roosting structures, coupled with BLH plantings and riparian habitat management, is expected to result in positive benefits for bat populations in the area.

Recovery Plan Activities. Several operational projects are involved with Recovery Plan efforts for endangered bat species. Corps actions undertaken for Indiana and gray bats include fencing known roost sites (primarily caves), installing and maintaining gates at the entrance of maternity caves and hibernacula, displaying signs at cave entrances to explain the importance of protecting bats, and preventing flooding of roost sites. For example, management of the gray bat at Truman Lake, Missouri, revolves primarily around activities at two gray bat maternity roost sites, Beck and Blackwell caves, which have been managed by the Corps and Missouri Department of Conservation since the late 1970s.[2] Beck Cave lies within the flood control pool of Truman Lake and is protected by an earthen levee; a three-stage pump station is located on the land side of the

[1] Personal Communication, July 2000, Denise White, Headquarters, U.S. Army Corps of Engineers, Washington, DC.
[2] Personal Communication, August 2000, Mike Watkins, U.S. Army Engineer District, Kansas City.

levee and is designed to transfer storm and spring drainage away from the cave. Both caves are inspected quarterly to ensure integrity of the security features and proper operation of pumps at the Beck site. Other practices that have been considered, but not implemented, include manipulating vegetation to encourage insect production and improving habitat conditions for foraging bats.

A cave at Nolin River Lake, Kentucky, supports a large colony of gray bats; an estimated 8,000 to 12,000 bats have historically used this cave as a maternity colony.[1] The cave was inadvertently inundated during storage of floodwaters during the summer of 1995 and a large number of immature gray bats were killed. Project personnel had not been aware of either the cave or bats prior to this incident. The District and project now coordinate closely with the FWS to aggressively manage for the bats and prevent flooding of the cave. Gray bats are also a concern at Ouachita Lake, Arkansas. Bat gates were installed at selected caves in the 1980s (Figure 6), and these sites are monitored annually to ensure that they are not disturbed.[2]

Figure 6. Bat gate installed to protect gray bat colony at Lake Ouachita, Arkansas. Photograph provided by Julie Marcy

RESTORATION AND MANAGEMENT OPPORTUNITIES: Although bat conservation has not historically been emphasized in Corps planning and management activities, there are many opportunities to maintain and improve habitat conditions for species that may occur on Corps projects. Many species depend on caves, caverns, or tunnels at least on a seasonal basis. Where these sites occur on Corps lands, they should be surveyed and evaluated as potential roost sites, and actions should be taken to protect maternity colonies and hibernacula. Old wells and cisterns also serve as potential roost sites for some species. Several species roost beneath bridges where conditions are favorable; BCI has recently provided information on bridge designs appropriate for bats (Keeley and Tuttle 1999).

Mature forested areas surrounding caves or located between caves are extremely important to many bat species, and wooded riparian corridors and aquatic areas are critical as foraging sites. Bats are often closely associated with riparian areas because of their need to drink surface water during evening activity periods, and many species congregate along streams and pools where water is available. Bats also use riparian areas as foraging habitat and movement corridors. For example, summer maternity colonies of Indiana bats are most often located in floodplain deciduous forests or upland stands adjacent to riparian or floodplain forests. Summer colonies of gray bats inhabit areas where streams, lakes, or reservoirs are reasonably close to roosting sites and maternal caves. When tree roosts are used, most species require large-diameter trees with large central cavities. Maternity roost sites for Indiana bats include hollow trees and sites under the loose bark of a variety of tree

[1] Personal Communication, July 2000, Robert VanHoff, U.S. Army Engineer District, Louisville.
[2] Personal Communication, August 2000, Julie Marcy, U.S. Army Engineer District, Vicksburg.

Figure 7. Management opportunities for bats on Corps projects include managing for mature hardwoods, snag management, riparian habitat management, and protection of roost sites (e.g., caves, cisterns, old buildings, bridges)

species. Therefore, forest management for bats should ensure an adequate supply of mature timber and snag trees.

Restoration and management actions that should be considered for bat conservation and habitat improvement at Corps projects include (Figure 7):

- Protection of maternity and wintering roost sites, especially caves.
- Restoration and maintenance of riparian habitats.
- Provision of mature hardwoods as potential roost sites.
- Snag management.
- Provision of artificial roost sites, where needed.
- Bridge design modifications.
- Water management.
- Restoration of foraging habitat.
- Education and awareness.

RESEARCH NEEDS: Corps projects have the potential to provide benefits to bat populations throughout the United States, but little information is available on how bats make use of natural

resources associated with project lands. Although the occurrence of endangered bat species and potential impacts of project construction and operation on listed species is generally addressed in environmental assessments and impact statements, few studies have been conducted to examine the effects of Corps projects on bats and their habitats. In fact, few field studies have been conducted to determine the presence of bat species on Corps lands. In contrast, a recent survey of 60 Department of Defense (DOD) military installations indicated that bat inventories had been performed on approximately 70 percent of the installations sampled. The emphasis of most inventories was to determine the presence of threatened and endangered species, but several installations have conducted extensive surveys for multiple species over a period of 2 to 7 years. Additionally, approximately 40 percent of the installations sampled reported that bats were included to some extent in their natural resource management plans (Martin and Wolters 2000).

Addressing the following research topics would benefit bat management and restoration efforts on Corps projects:

- Identify bat issues and concerns at Corps projects throughout the United States.
- Evaluate and refine methods used to conduct bat inventories.
- Characterize habitat features important to bats on Corps project lands.
- Determine impacts of project construction and operation on bat species.
- Provide guidelines for bat habitat restoration and management suitable for Corps lands.

Several methods are available for performing bat inventories. Conventional survey techniques include systematic roost searches, selective capture with mist-nets and harp traps, and radio telemetry. Scientists are now using ultrasonic sound detection methods such as the "Anabat System." The Anabat System incorporates a bat detector and software that processes echolocation signals into time/frequency graphs. Research is needed to determine the most appropriate method or combination of methods that can be cost-effectively applied on Corps projects.

Project resources should be assessed to identify habitat features that are important to bats. These include caves and crevices, roost trees, snags, riparian areas, water developments, subimpoundments, and artificial structures. The potential use of these habitats by bats should be assessed in relation to the documented occurrence of bat species on the project, their known habitat requirements, and existing land uses. Potential improvements to bat habitat should then be examined in respect to a project's operational management plan. Existing timber management and wildlife habitat management practices should be evaluated to determine their compatibility with bat management needs.

SUMMARY: Bat conservation and management is an important issue on Federal lands throughout the United States. Of 45 species of bats documented in the United States, 7 species or subspecies are listed as threatened or endangered, and another 20 species or subspecies are considered to be species of concern. The Indiana bat and gray bat are presently of primary concern on Corps projects, and several Midwestern and Eastern projects are involved in recovery plans for these species. Numerous other species are expected to occur on Corps projects, but few inventories have been conducted on project lands. Bats have been addressed in several planning and management efforts

at Corps projects, but information on existing efforts is sparse and no attempt has been made to comprehensively examine the importance of Corps projects as habitat for a diversity of bat species.

Restoration and management actions that could be considered for bat conservation and habitat improvement at Corps projects include protection of maternity and wintering roost sites, restoration and maintenance of riparian habitats, protection of mature hardwood stands as potential roost sites, provision of artificial roosts, modification of bridges as roost sites, appropriate water management, and restoration of foraging habitat. Research needs include identifying bat issues and concerns at Corps projects, evaluating methods used to conduct bat inventories, characterizing habitat features important to bats, and developing guidelines for bat habitat restoration and management suitable for Corps projects. Developing a proactive bat management program has the potential to save the Corps substantial funds by providing cost-effective procedures for conducting inventories and managing existing habitat to avoid restrictions imposed for threatened and endangered species.

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REFERENCES

Allred, K. (1996). "Endangered species and North American waterfowl management plan joint venture areas," U.S. Army Corps of Engineers Water Resources Support Center, Institute of Water Resources, IWR Report 96-R-22.

DeBlase, A. F., Humphrey, S. R., and Drury, K. S. (1965). "Cave flooding and mortality in bats in Wind Cave, Kentucky," *J. Mammalogy* 46: 96.

Harvey, M. J., Altenbach, J. S., and Best, T. L. (1999). "Bats of the United States," Arkansas Game & Fish Commission; available from Bat Conservation International, Austin, TX.

Kasul, R. L., Martin, C. O., and Allen, H. H. (2000). "Characterization of sensitive species and habitats affected by operation of USACE water resource development projects," *EMRRP Technical Notes Collection* (ERDC TN-EMRRP-SI-10), U.S. Army Engineer Research and Development Center, Vicksburg, MS. *www.wes.army.mil/el/emrrp*

Keeley, B. W., and Tuttle, M. D. (1999). "Bats in American bridges," Resource Publication 4, Bat Conservation International, Austin, TX.

Martin, C. O. (2000). "Overview of bat research and management on DOD installations," Presentation at the 2000 National Military Fish and Wildlife Association Annual Meeting, Mar 2000, Chicago, IL.

Martin, C. O., and Wolters, M. S. (2000). "Bat conservation and management on Department of Defense installations," Presentation at the 7th Annual conference of The Wildlife Society, Sep 2000, Nashville, TN.

Tuttle, M. D. (1997). "America's Neighborhood Bats (revised)," Univ. of Texas Press, Austin.

U.S. Army Corps of Engineers. (1999). "Operation and maintenance of the Upper Mississippi River navigation project within the St. Paul, Rock Island, and St. Louis Districts, U.S. Army Corps of Engineers, a two-tiered biological assessment," U.S. Army Engineer Districts, St. Paul, Rock Island, and St. Louis.

U.S. Army Corps of Engineers. (2000). "Ecosystem restoration report and integrated environmental assessment for Big Cypress Bayou fish and wildlife habitat restoration, Jefferson, Texas," U.S. Army Engineer District, Fort Worth.

U.S. Fish and Wildlife Service. (1999). "Indiana bat (*Myotis sodalis*) revised recovery plan," (Agency Draft), Indiana Bat Recovery Team, U.S. Fish and Wildlife Service, Region 3, Fort Snelling, MN.

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