Current Status and Conservation Strategy for the Eastern Small-footed Myotis (*Myotis leibii*)

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Current Status and Conservation Strategy for the Eastern Small-footed Myotis (*Myotis leibii*)

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INTRODUCTION

The eastern small-footed myotis (*Myotis leibii* Audubon and Bachman) is found throughout much of the northeastern United States. It ranges from southern Quebec, southwest along the Appalachian Mountains to northern Georgia, and west to eastern Oklahoma. Populations of this tiny bat are thought to have declined in recent years and it is now recognized as a species of concern across its range.

Most often, the eastern small-footed myotis is found in rocky, mountainous areas, in both natural and man-made roost sites. Due to the wide variability in roost site types, and inherent problems with comprehensive surveys, much basic ecology and natural history information about this bat remains unknown. Range-wide, forested lands such as those held and managed by the USDA Forest Service, and other large-acreage land management agencies and landowners are likely of critical importance to the long-term survival of this species. A conservation strategy and planning effort should help enable the Forest Service and other land management agencies to adequately plan for and manage areas known to support this bat.

Development of this strategy involved several steps. Research biologists and land managers throughout the known range of the eastern small-footed myotis were surveyed by telephone or electronic mail and were asked a short battery of questions. Appendix A lists individuals contacted and their responses. Questions were designed to obtain information pertaining to current and potential threats to remaining populations of the eastern small-footed myotis. Information and recommendations were sought regarding perceptions of long-term protection and management issues. Finally, a literature search was conducted targeting the eastern small-footed myotis, cave protection and management, and bat habitat conservation.

LIFE HISTORY AND ECOLOGY

Taxonomy: The eastern small-footed myotis (*Myotis leibii*) is the smallest myotis in eastern North America, and one of North America's smallest chiropteran species. The generic name is derived from the Latin *Myotis*, meaning "mouse eared." *Myotis leibii* was originally described as an eastern subspecies of the small-footed myotis (*Myotis subulatus*), but Glass and Baker (1968) showed that *M. subulatus* was probably an earlier name for *M. yumanensis* (H. Allen) (a western species), leaving *M. leibii* as the earliest available name for this species. Van Zyll de Jong (1984) considered the western form of *M. leibii* to be a separate species, *M. ciliolabrum* (Merriam). This interpretation was accepted by Jones *et al*. (1992), but not Wilson and Reeder (1993). More information is needed before taxonomic consensus can be reached. For purposes of this report, we accept the determination of Jones *et al*., but draw upon literature of *M. ciliolabrum* and *M. subulatus* to support what is known of *M. leibii*.

General Characteristics: The eastern small-footed myotis is a tiny bat, with dark brown or golden-tinted fur (paler and more buffy ventrally), black ears, and a black facial mask.
Although the eastern small-footed myotis may resemble the little brown myotis (*Myotis lucifugus*)(LeConte), it can be distinguished by its smaller size: generally, feet of adults are less than 8 mm (0.31 in) long, ears are less than 15 mm (0.59 in) long, and forearms are less than 35 mm (1.37 in) long. Total length is 73 – 85 mm (2.87-3.34 in), forearm length is 30 – 35 mm (1.18-1.37 in), and body weights range from 3 – 7 grams (0.12-.25 oz)(Choate *et al*. 1994; Wilson and Ruff 1999). The calcar of the eastern small-footed myotis is strongly keeled and wings are blackish brown, as are interfemoral membranes (Whitaker and Hamilton 1999).

Distribution and Abundance: Until recently, all North American small-footed myotis were thought to be *Myotis leibii*, and the subsequent 'historic range' would have included the present eastern range, small, disjunct populations in the Midwest, plus southern British
Columbia, Alberta, and Saskatchewan to the southwestern United States (Barbour and Davis 1969; Harvey *et al*. 1999). Western populations are now considered a separate species, the western small-footed myotis (*Myotis ciliolabrum*). Therefore, the current range of the eastern small-footed myotis includes New England, southeastern Ontario and southwestern Quebec south and west to Arkansas, Kentucky, and through the southern Appalachians to Georgia and northern Alabama (Figure 1) (Harvey 1992; Harvey *et al*. 1999). Within the known range, distribution is spotty and the bat is considered rare to uncommon (Choate *et al*. 1994). The majority of documented occurrences and largest populations are in the mountains of New York, Pennsylvania, West Virginia, and Virginia (BCI 2001; Butchkoski, pers. comm.; Hicks pers. comm.; NatureServe 2001).

Abundance of the eastern small-footed myotis is extremely difficult to assess or predict. The species has always been considered uncommon or rare throughout its range (Choate *et al*. 1994; Wilson and Ruff 1999), and populations and occurrences of this bat are relatively scattered and small. The eastern small-footed myotis is often overlooked or incorrectly identified in traditional bat surveys particularly during hibernation. This is because, unlike many cave-roosting bats (found most often on cave ceilings and walls),

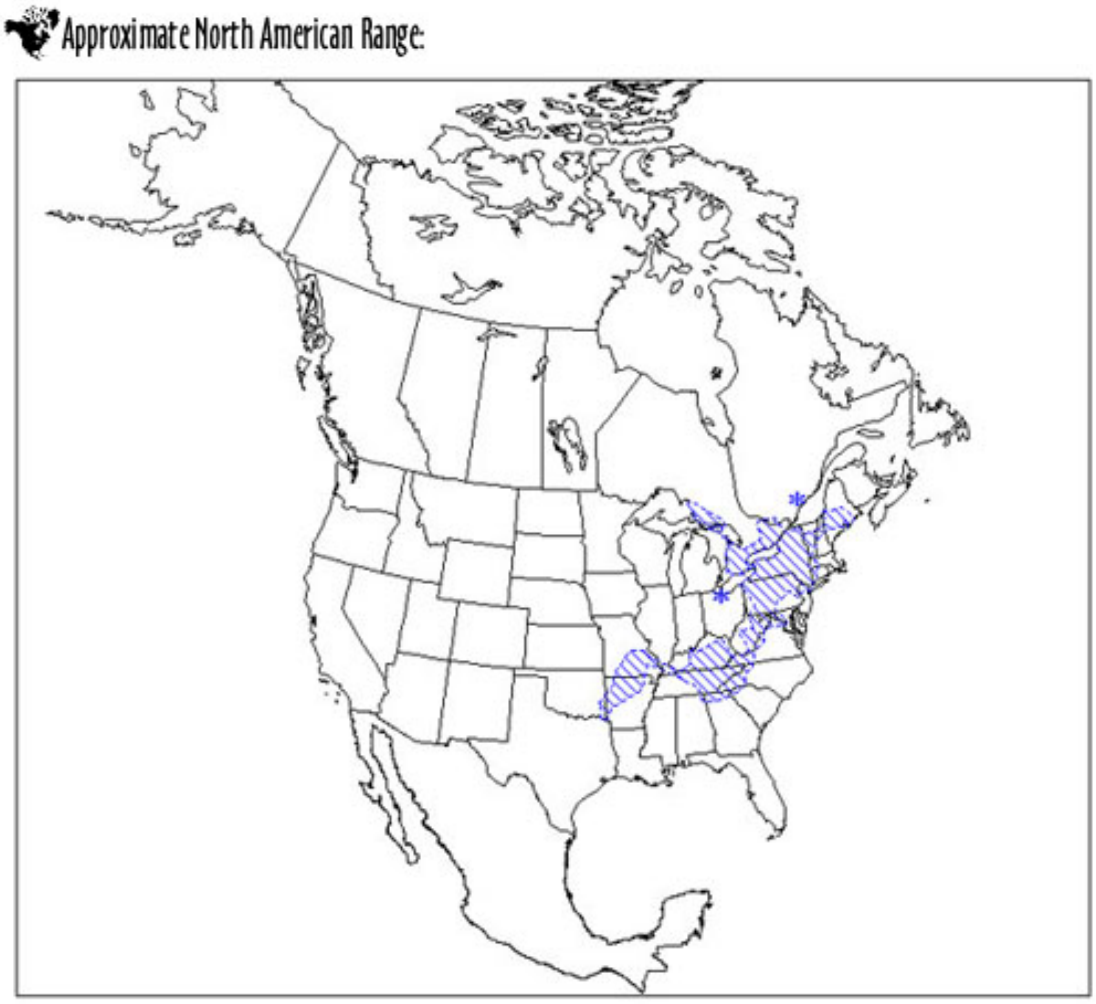

Figure 1. Present approximate distribution of the eastern small-footed myotis (*Myotis leibii*) (used with permission of Bat Conservation International, 2001). Within the range, distribution is spotty and the bulk of the occurrences and largest populations are in New York, Pennsylvania, West Virginia, and Virginia.

the eastern small-footed myotis is sometimes found under rocks and talus on cave floors, or wedged into cracks in cave walls and ceilings (Krutzsch 1966; Libby, pers. comm.; MacGregor, pers. comm.).

Until recently, mist netting efforts have concentrated on streams or ponds, but relatively new information suggests that numbers of captures of the eastern small-footed myotis in these habitats may be limited.

Conservation Status: Throughout the range of the eastern small-footed myotis there is some conservation concern for the species and its habitats. The species is not protected by federal law, but was a former C2 candidate for listing prior to the abolishment of that category by the U.S. Fish and Wildlife Service (USFWS) in 1996. The lead USFWS Region is R5 (northeast). The United States National Conservation Status Rank is given as N3, and the Canadian National Conservation Status Rank is given as N2N3 (NatureServe 2001). The Natural Heritage Global Rank is G3. Explanations of the Natural Heritage ranking system can be found in Appendix B.

Some states (e.g. Pennsylvania) have given the species legal protection while others have recognized its apparently low numbers and consider the eastern small-footed myotis a species of concern. In the report "Species of Special Concern in Pennsylvania" by Genoways and Brenner (1985), the Pennsylvania Biological Survey assigned Myotis leibii the status of "threatened." It is clear, however, that additional work needs to be done with appropriate survey and monitoring techniques throughout the species' range before the true status can be determined. Only then can available data be compared and used properly. It is also clear that some populations may be more vulnerable than others based on population size and viability, threats, surrounding land uses, and available habitat.

Natural Heritage state ranks (Appendix B) follow: Alabama, S1; Arkansas, S1; Connecticut, SHN; Delaware, SU; Georgia, S2; Kentucky, S1S2; Maine, S1S2; Maryland, S1B, S2N; Massachusetts, S1; Missouri, SU; New Hampshire, S1; New Jersey, S1; New York, S2; North Carolina, SUB, S2N; Ohio, SH; Oklahoma, S1; Ontario, S2S3; Pennsylvania, S1B, S1N; Quebec, S3; South Carolina, S1; Tennessee, S2; Vermont, S1; Virginia, S1; West Virginia, S1.

Summer Ecology and Behavior: Very little is known about the summer ecology of the eastern small-footed myotis. During this portion of their life cycle, these bats (considered by Choate *et al*. (1994) to be a saxicolous, or "rock-loving" species) are sometimes found in unusual roost sites such as under rocks on exposed ridges, in cracks in rock faces and outcrops, and in bridge expansion joints, abandoned mines, and buildings (Harvey 1992; Kiser, pers. comm.; MacGregor, pers. comm.; Novak, pers. comm.; Stihler, pers. comm.). In Pennsylvania, a pregnant female and a male were captured on a talus slope below a small cliff overhanging a stream bottom (Butchkoski, pers. comm.). Summer roosts are often in trees, buildings, behind loose bark, on rock outcrops, and on rocky ridges (Barbour and Davis 1969; Tuttle 1964; Whitaker and Hamilton 1999). In Tennessee, both males and females were found using bridge expansion joints as day roosts from June through September (Libby, pers. comm.; Pistrang, pers. comm.).

The eastern small-footed myotis is believed to feed primarily on flying insects such as beetles, mosquitoes, moths, and flies, and are apparently capable of filling their stomachs within an hour after the onset of foraging activity (Barbour and Davis 1969; Harvey *et al*. 1999; Linzey 1998; Merritt 1987). Foraging in and along wooded areas at and below canopy height, over streams and ponds, and along cliffs

and ledges (Choate *et al*. 1994), these bats emerge to forage shortly after sunset and fly in a characteristically slow and erratic pattern (Harvey *et al*. 1999).

Winter Ecology and Behavior: During hibernation, some bat species form mixed sex colonies that can be quite large, consisting of up to several thousand individuals. However, this species does not seem to form large colonies during hibernation. Although groups of 50 or more small footed-myotis may pack into crevices at some sites (Barbour and Davis 1969), researchers are more likely to find a single individual or small group wedged in a crevice with only the blackish mask and ears visible upon careful inspection. Occasionally, individuals can be found mixed with other species of bats or hanging singly.

The eastern small-footed myotis seems to be more tolerant of winter temperature extremes than most other bat species, and is often found very close to the entrance of caves or mines where air temperatures can vary greatly (sometimes dipping below freezing) and humidity is relatively low (Barbour and Davis 1969; Merritt 1987; Harvey 1992). Stihler (pers. comm.) reports having found these bats in cold caves with considerable airflow. As a very small bat, it is unusual to note that the eastern small-footed myotis is among the last to move into hibernacula in the fall, seldom appearing in caves and other hibernacula before mid-November in Virginia and parts of New England, and leaving by March (Barbour and Davis 1969; Dalton 1987; Whitaker and Hamilton 1999). Mohr (1936) noted that in Pennsylvania, no least bats (eastern small-footed myotis) were found in hibernacula during April checks, even if other bat species were still present.

Unlike many cave-roosting bats which are most often found on cave ceilings and walls, the eastern small-footed myotis is frequently observed on cave floors, under talus, or in cracks in the substrate, requiring an effort to search less prominent locations. In Pennsylvania, eastern small-footed myotis have been captured or observed in a wide range of mines, tunnels, and caves (Butchkoski, pers. comm.). For these reasons, their small size, and an apparent tendency to roost singly or in small groups sparingly scattered among other species, the eastern small-footed myotis is often overlooked, or mis-identified, particularly in surveys of hibernacula.

In four Pennsylvania counties, many hibernacula of the eastern small-footed myotis have been in caves within hemlock forests at elevations of approximately 609.6 meters (2,000 feet) (Merritt 1987). Caves, mines, and buildings harboring this species in other parts of its range are found at a variety of elevations in a variety of forest types and situations, from mountainous ridges to rocky foothills and somewhat open farmland (Novak and Norris 1992).

Ecologic and Economic Importance: The eastern small-footed myotis is a predator of nocturnal flying insects, such as beetles, mosquitoes, moths, flies, and occasionally ants (Barbour and Davis 1969; Linzey 1998; Merritt 1987). As with many insectivores, the eastern small-footed myotis could be considered an 'indicator' species for ecosystem health.

Bats are susceptible to many mammalian diseases, the most notable being rabies. The public perception that bats pose a substantial health risk by being carriers of rabies is exaggerated and poorly grounded in fact. Some individuals of vampire bat species have been documented as vectors of rabies, but these are uncommon. Most bats are susceptible to rabies in the same way that other mammals are, and there are relatively few instances of transmission to humans (Hill and Smith 1984).

Bats are often the recipients of "bad press" and are frequently accused of attacking humans and pets. Even rabid vampire bats rarely attack humans, and most alleged attacks by bats are the result of encounters with screech owls (Hill and Smith 1984).

Ontogeny and Reproduction: Little is known about the reproductive ecology of the eastern small-footed myotis. The species breeds in the fall, sperm are stored in the uterus over the winter, and typically a single offspring is produced annually between late May and July, depending upon latitude (Barbour and Davis 1969; Merritt 1987; Wilson and Reeder 1999). In southwestern Virginia, a female eastern small-footed myotis carrying a single newborn offspring was captured in a mist net in June, and several females with evidence of recent nursing activity were captured in July (Hobson 1998).

During the breeding season, some *Myotis* species such as the gray bat (*Myotis grisescens*) (Howell) and southeastern bat (*Myotis austroriparius*)(Rhoads) may form large colonies consisting of thousands of individuals, usually made up of one sex or the other. However, available data regarding the eastern small-footed myotis suggests that females of this species form small colonies, with males roosting singly or in small groups.

There have been several reports of small maternity colonies found in association with man-made structures. Merritt (1987) reported that small maternity colonies had been located in buildings in Pennsylvania. Barbour and Davis (1969) cite two instances where nursery colonies of this species were found in buildings, and Harvey *et al*. (1999) reported a small summer colony behind a sliding door of a barn. In Kentucky, MacGregor and Kiser (1998, 1999) observed maternity colonies in bridge expansion joints.

Small maternity groups have been found under exposed rocks on open ridges. In Virginia, most reproductively active females captured in mist nets have been along forested ridgetops in proximity to abundant exposed rock outcrops (Hobson, pers. obs.). Recorded daytime temperatures at one nursery site in a Kentucky bridge were 37.7º - 39.4º C (00º F - 103º F) (MacGregor and Kiser 1998, 1999). These observations suggest that rocky areas or bridges with sun exposure in a forested landscape may be important to females of this species in selecting maternity sites.

Proximity to water may be another factor in selecting nursery sites. While some nursery colonies may use bridges directly over streams or streamside rock outcrops, natural water sources may be a limiting factor in some areas. Water-filled road ruts and man-made "wildlife ponds" may be important as alternate or primary sources of water for this species during the breeding season, especially in areas where water is limited. These sites can be excellent places to use mist nets to capture eastern small-footed myotis and other bat species such as *Myotis septentrionalis* (Trouessart) (Hobson, pers. obs., MacGregor and Kiser 1999).

Males have been captured in mist nets at the entrances of abandoned mines, railroad tunnels, and caves during the breeding season, and may form small colonies or may live singly in these and other more natural roost sites such as sandstone rock shelters, cliffs, caves, and even trees (MacGregor and Kiser 1999).

Predators: Human predation and destruction present a very grave danger to bats throughout the world. In many countries, bats are regularly consumed, and entire populations have been decimated by the food

trade. In North America, however, the most common bat predators include domestic cats, chipmunks, foxes, opossums, owls, raccoons, skunks, snakes, weasels, and woodrats. While most of these predators are opportunistic and take the occasional bat when possible, there are many documented instances of mammalian predators (opossums, raccoons, weasels, and woodrats) using bat gates to enhance their ability to prey upon bats (Gillette and Kimbrough 1970; Hammer and Arlettaz 1998). Snakes have also been documented using gates for access, enabling them to seize flying bats and to subsequently impact bat populations (Hammer and Arlettaz 1998; White and Seginak 1987). Thus, care should be taken when constructing and installing cave gates and grills.

DISCUSSION AND MANAGEMENT RECOMMENDATIONS

A distinct paucity of information on eastern small-footed myotis ecology is evident, and certainly efforts to further describe and elucidate natural history details should be pursued. Until specific details are known certain activities have been identified which threaten the eastern small-footed myotis. Reasonable efforts can be made to mitigate or alleviate impacts from these activities.

Threats: Humans present, by far, the greatest threat to this tiny bat, by destruction of natural habitat, destruction of artificial habitats, disturbance at roost or hibernation sites, and outright killing of bats (Hill and Smith 1984; Kunz and Racey 1999). Natural habitats may be destroyed by permanent large-scale landscape changes such as strip mining, land clearing and development for housing, quarrying, collapse or closure of caves and mines, clear cutting and alteration of lands surrounding roosting caves and other hibernacula, land use changes, and management activities which introduce contaminants such as pesticides and other biocides that become integrated into bat prey or water sources. Artificial habitats such as mines, abandoned railroad tunnels, and bridge expansion joints are sometimes closed, destroyed, or altered without first surveying for the eastern small-footed myotis (Hill and Smith 1984; Tuttle and Taylor 1994). Changes in landscape which alter habitat parameters such as humidity and temperature in and around hibernacula and roost sites may expose bats to temperature extremes, causing death or site abandonment. Natural flooding of caves, and flooding exacerbated by land use alterations affect, and often result in grave consequences for populations of this bat as well.

Activities associated with recreational climbing and caving can be compatible with bat conservation and protection efforts. However, there have been reported instances of people using bleach and scrubbing techniques to remove mosses and lichens from climbing rocks. Vegetation is also routinely removed from the vicinity of popular climbing areas to provide better access (Kiser, pers. comm.). These harmful practices should be discouraged, as they may adversely affect habitat for a variety of cliff-dwelling species.

New, bat-friendly methods of mine construction exist today, as do alternatives for reclamation and closure. Prior to closure or reclamation activities, abandoned mines and railroad tunnels should be comprehensively surveyed for bats (Tuttle and Taylor 1995). When structures are found that support bats, and specifically the eastern small-footed myotis, appropriate gating and/or protection is recommended, rather than arbitrary closure or reclamation. If closure, reclamation, or destruction of roost sites is unavoidable, the construction of alternative habitats is suggested. Much research has been done that supports use of alternative habitats, and bat roost enhancement projects are in use all over the country.

Valuable information can be found in: "Bats in American Bridges" (Keeley and Tuttle 1999), and in "Bats and Mines" (Tuttle and Taylor 1995).

When timber harvesting activities occur near summer bat roosts, caves, and foraging areas, use of buffers and minimal disturbance zones is strongly recommended. Timber harvesting techniques that leave snags, and trees with cavities and exfoliating bark are potentially beneficial, and are recommended in areas known to support eastern small-footed myotis. Use of broad spectrum insecticides (such as Dimilin, or *Bacillus thurengensis* var. *israelensis* – BTI – *B. t.* var. *kurstaki* - BTK) over large areas near, and within drift distances of identified summer bat roosts, hibernacula, and foraging areas should be avoided whenever possible. Biological controls that are specific to the pest insect being suppressed are the preferred control measure when controls are deemed to be necessary.

Prescribed burning of areas immediately surrounding known roosts and hibernacula should be undertaken with care. While effects of fire on the eastern small-footed myotis are largely unknown, vegetation changes that ultimately alter the microclimate (temperature, humidity, cover, etc.) could have negative effects. Timing of burns, and adequate buffers should be considered prior to this management activity.

To obtain additional information on the eastern small-footed myotis, and to do so with as little harm as possible, mammalogists and bat biologists are encouraged to be especially cognizant of season when visiting possible roost sites, and to minimize disturbance to the greatest extent possible. Additionally, researchers are encouraged to include bats in small mammal surveys when possible, and to explore alternative methods of sampling to include talus, rocky ridgetops, rock outcrops, abandoned mines and railroad tunnels, crevices, cracks, bridge expansion-joints, and previously un-examined areas in caves and mines.

Bats are threatened by disturbance (especially when roosting). Therefore, when a structure (such as a cave or mine) or an area (such as a ridgetop, cliff face, or quarry wall) is known to support eastern small-footed myotis, seasonal caving restrictions (November through March), climbing closures or restrictions (May through August), and other appropriate protective measures such as gating, fencing, posting, and placement of educational signs are recommended.

Although a variety of organizations and programs have been successful in educating people about bats, there remains a negative public perception of these animals. Bats are often regarded as vermin, dirty, or dangerous animals, and a variety of negative stereotypes are associated with them. These attitudes are clearly challenges and threats to bats, and must be altered to ensure more frequent positive outcomes of bat/human interactions. Continuing efforts to educate the public, as well as federal and state agencies and land managers (through brochures, presentations, exhibits, and emerging natural history information about bats) is a crucial first step towards promoting a better understanding of these animals.

CONSERVATION AND PROTECTION

Recommendations: Some known and presumed threats to eastern small-footed myotis are not easily addressed, and are further complicated by a lack of information. Our survey has gleaned "accumulated wisdom" of scientists and land managers in multiple states based on their experiences with management and protection of this and other bat species. This experience, when combined with additional information

from the literature, offers practical and reasonable conservation measures which should contribute to management and protection of the eastern small-footed myotis.

We recommend the following conservation and protection measures:

1) Recognition of the importance and development of management guidelines for rocky ridgetops, caves, quarries, cliff faces, rock walls, and outcrops. These guidelines should specifically address conservation and protection of these areas and the various flora and fauna they support.

2) Development of bat survey guidelines for rocky ridgetops, quarries, cliff faces, rock walls, outcrops, and caves.

3) When an area (such as a cave, mine, or rock outcrop) is known or suspected to support eastern small-footed myotis, we strongly recommend site-by-site evaluation and assessment of the feasibility of seasonal or complete closure, or caving and climbing restrictions. Upon determination that seasonal or complete cave closure, or caving and climbing restrictions are appropriate protection measures, we recommend the subsequent gating of caves, and enforcement of seasonal or complete restrictions. [Seasonal closure for caves serving as hibernacula – November through March] [Seasonal climbing restrictions for ridgetops, rock faces, cliff walls, outcrops serving as summer or maternity roosts – May through August]

4) Avoiding destruction of known roosts is critically important. When an area has been documented as an eastern small-footed myotis roost, protection measures are suggested for the roost site and adjacent lands, which serve as buffers and foraging habitat that maintain conditions favorable for continued use by bats.

5) The eastern small-footed myotis is thought to forage in a variety of habitats and have been documented foraging over and near water. Protection of water quality that maintains or increases insect populations in areas known to support these bats will benefit not only the eastern small-footed myotis, but a plethora of other organisms, in addition to addressing surface and groundwater concerns in the area.

6) Plans for maintenance and management of cave and mine gates should be developed for each cave or mine gate constructed. Gates may be vandalized or breached. Reconstruction may be necessary and involvement by law enforcement officers needed to end or control such activities.

Information needs: Additional survey and monitoring work and research is critical to understanding ecological, life history, and reproductive details. A preliminary list of immediate information needs follows:

1) Basic life history, population, and ecology information about eastern small-footed myotis.

2) Information about types and characteristics of summer and maternity roosts across the range of eastern small-footed myotis is needed and will be critical to future protection and conservation efforts. Characterization of summer and maternity roosts should include the relationship of these sites to hibernacula. Information on proximity of hibernacula to summer roosts and associated movement distances and patterns is critical.

3) Foraging habitats and habits, movement patterns and roosting and resting habits need to be investigated further.

4) Development of effective mitigation as a tool for conserving eastern small-footed myotis.

5) Further information and work is needed to determine appropriate mine, road, bridge and dam designs that accommodate bats, as well as effective management of these structures so that they might support bats, and specifically the eastern small-footed myotis.

6) Additional survey work is necessary to locate hibernacula, summer, and maternity roosts, and to characterize foraging habitats.

7) Information regarding protection techniques such as seasonal cave closure and climbing prohibition needs to be studied further and applied where appropriate to protect known occurrences of eastern small-footed myotis.

8) Eastern small-footed myotis calls need to be added to the *Myotis* call library for Anabat reference collections.

9) An assessment of the effects of strip mining and reversal/reclamation on small-footed myotis habitat would be useful.

10) An assessment of the effects of timber harvest (including various harvesting techniques) on eastern small-footed myotis would be useful.

11) An assessment of the effects of gypsy moth treatments on eastern small-footed myotis would be useful.

Although we have attempted to summarize current information about the eastern small-footed myotis, there is much about this small bat that is not known. Additionally, we have attempted to provide recommendations and suggested management strategies for potential survey sites as well as known roost and maternity sites. Efforts to further describe and elucidate natural history details should be pursued, and known populations of the eastern small-footed myotis should be protected. Through our survey of other states and land managers, we were able to compile quite a bit of "accumulated wisdom" based on experience, management, and protection efforts in other places. This experience, when combined with additional information from the literature, offers us practical and reasonable conservation measures and guidelines. Conservation and management will certainly play an important role in the continued long-term viability of eastern small-footed myotis populations.

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APPENDICES

Appendix A - Survey form
- List of Personal Contacts and Plan Reviewers
- Responses to survey form

Appendix B - Explanation of the Natural Heritage Ranking System

Appendix C - Abstract of Poster presented at The 80th Annual Meeting of the American Society of Mammalogists, New Hampshire.

Appendix A – Survey Form

***Myotis leibii* (eastern small-footed myotis)**

Researcher / individual interviewed: _____

1 – What are your top 3 conservation concerns for this species?

2 – In your state, what types of habitats are used?

3 – What types of management do you think might be necessary?

4 – What types of protection measures would you recommend?

5 – Do you have an idea of general abundance and distribution in your state?

6 – Have you published on this species, and are reprints available?

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Responses to survey forms: *Myotis leibii* (eastern small-footed myotis)

Researcher / individual interviewed: Troy Best (Alabama)

1 – What are your top 3 conservation concerns for this species?

unknown

2 – In your state, what types of habitats are used?

unknown

3 – What types of management do you think might be necessary?

unknown

4 – What types of protection measures would you recommend?

none, status is unknown

5 – Do you have an idea of general abundance and distribution in your state?

I know of no specimens from AL.

6 – Have you published on this species, and are reprints available?

Jason Jennings and I prepared the account for Mammalian Species. Also some info was included in Harvey et al.'s Bats of the US. You should have both of these sources.

Researcher / individual interviewed: Cal Butchkoski (Pennsylvania)

1 – What are your top 3 conservation concerns for this species?

A. The big concern is not enough information on the summer habitats.
B. Protection of known hibernacula.
C. Possible use of other hibernation sites such as rock crevices and cliffs.

2 – In your state, what types of habitats are used?

They've been captured and observed in limestone caves, sandstone caves, abandoned anthracite and bituminous coal mines, iron ore mines, limestone mines, and abandoned tunnels (railroad, turnpike tunnels) during fall trapping and entry counts.

During summer mist netting they've been captured primarily in deciduous and mixed forest near or along small streams. On one occasion a pregnant female and male were captured on a talus slope below a small cliff and overlooking a hemlock, mountain–laurel stream bottom.

Another capture was in a transitional bottomland setting surrounded by agriculture (over a stream). This was during a drought year.

3 – What types of management do you think might be necessary?

Management needs guidelines and we don't have good ones other than protecting the hibernation sites. I think we need research on summer habitats (telemetry) to gain some base information.

4 – What types of protection measures would you recommend?

At this point I can only recommend protecting the hibernation sites, this may include gating.

My guess is that some good telemetry work will point to managing rock outcrops in forest habitat. Possibly a conifer (E. hemlock) component may be important.

5 – Do you have an idea of general abundance and distribution in your state?

They seem to be low in numbers but somewhat widespread. Our work has increased their range and numbers within the state when compared to historical records.

6 – Have you published on this species, and are reprints available?

No.

Researcher / individual interviewed: Joel Dunn (Massachusetts)

1 – What are your top 3 conservation concerns for this species?
Refer to element stewardship abstract and global ranking form

2 – In your state, what types of habitats are used?
Refer to element stewardship abstract and global ranking form

3 – What types of management do you think might be necessary?
Refer to element stewardship abstract and global ranking form

4 – What types of protection measures would you recommend?
Refer to element stewardship abstract and global ranking form

5 – Do you have an idea of general abundance and distribution in your state?
Refer to element stewardship abstract and global ranking form

6 – Have you published on this species, and are reprints available?
no

Researcher / individual interviewed: Al Hicks (New York)

1 – What are your top 3 conservation concerns for this species?
I suspect that *Myotis leibii* is far more common than people think it is. No hard numbers but it seems to be found too frequently in the summer to suggest a rarity implied by winter records. Therefore, the first order of business is to determine if the animal is rare or not. No recovery will be needed if it is as common as I think it is.

2 – In your state, what types of habitats are used?
We have only winter records (no summer work has been done). We have somewhere in the area of 3,000 – 3,500 in winter sites in the state, the largest being nearly 2,000.

3 – What types of management do you think might be necessary?
None, at least until we determine the status.

4 – What types of protection measures would you recommend?
None for the same reason.

5 – Do you have an idea of general abundance and distribution in your state?
Not much, see above.

6 – Have you published on this species, and are reprints available?
Nothing yet other than federal aide annual reports.

Researcher / individual interviewed: James Kiser (Kentucky)

1 – What are your top 3 conservation concerns for this species?
Closing abandoned mines / cold caves
Strip mining – mountaintop mining – mining preferred habitat
Reclamation of high walls
Large-scale logging (*elimination of water sources)

2 – In your state, what types of habitats are used?
Cracks – sandstone/limestone trees?
Cold caves – mines *extensive areas of exposed rock/caves/ridgetops
Coal mining high walls Bridges (summer)

3 – What types of management do you think might be necessary?

Protect caves Bat friendly bridges

4 – What types of protection measures would you recommend?

Cave protection Ridgetop preservation / protection

5 – Do you have an idea of general abundance and distribution in your state?

Abundant / common in east Kentucky near Pine/Black Mountains – western edge of Cumberland Plateau – Mammoth Caves – distributed based on preferred habitat availability

6 – Have you published on this species, and are reprints available?

Researcher / individual interviewed: Gary Libby (Kentucky)

1 – What are your top 3 conservation concerns for this species?

The ESF bat is a very hard, tiny, and elusive animal. It seems to have a great conservation strategy by design. My primary concern is finding additional colonies in the eastern US and learning more about the life history of this species in this part of its range.

For example, Eco-Tech has been conducting bat surveys in the Cherokee National Forest (CNF), Tennessee, for the last four years. We have six locations for eastern small-footed (ESF) bat, two of these are essentially bachelor colonies (living in expansion joints in bridges) where we have counted bats at various times during the year. These summer colonies are each occupied by roughly 4-12 bats from April to October. We have also captured ESF bats at mine portals and cave entrances, high elevation rock outcrops, and road or stream corridors/water holes near these habitat types. We have even attached a transmitter (0.35 grams) to an ESF bat and attempted to track it to a roost. Although we suspected that the colony was in a high elevation rock outcrop near the capture site, no signals could be detected. This was likely due to the fact that ESF bats crawl back into narrow crevices to roost, making radio telemetry difficult. Nonetheless, we would like to try radio telemetry on ESF bats again.

If we concentrated our efforts specifically on locating ESF bats in the CNF, I feel certain that with what we now know about this species in this part of it's range, we could locate additional roosts. This is likely the case in other NF System Lands in the southeast. Having this type of information and using it should be the most effective tool for promoting the conservation of this interesting bat.

2 – In your state, what types of habitats are used?

The areas where I have the most experience with ESF bats are Kentucky, Tennessee, and western North Carolina. In my experience, three types of habitats are used: (1) expansion joints in the top sides of concrete bridges (I can provide more specific information on these), (2) abandoned mine portals and caves, usually near the entrance, and (3) rock outcrops in high elevations.

3 – What types of management do you think might be necessary?

While I believe we could use additional life history information first, there are a few places where we could actually benefit this species. First, we need to have more critical review of abandoned mine portal closures specifically for this species. This should be encouraged by federal and state mining agencies/division. Second, if known roosts are receiving too much disturbance/visitation, access should be restricted to the extent feasible/possible. Third, within the range of ESF bat, at least near known records, highway projects should be encouraged (when/where feasible), to use bridges with expansion joints as used by ESF bats in Kentucky and Tennessee.

4 – What types of protection measures would you recommend?

See above

5 – Do you have an idea of general abundance and distribution in your state?

Yes, but I believe there is still a great deal that we don't know.

6 – Have you published on this species, and are reprints available?

We (Eco-Tech) have written technical reports for numerous mist netting and telemetry studies as well as abandoned mine portal evaluations for several thousand portals over the last ten years. We were contracted in Alabama to write a guide to evaluating mine portals for rare bats and also presented a workshop on the subject. We have a limited amount of data, but we are gradually accumulating more, and hope to present and/or publish someday.

I hope that some of this information is useful. Please don't hesitate to call me if you have any questions. I am always glad to discuss bats with anyone that's interested.

Researcher / individual interviewed: Rod D. McClanahan (North Carolina)

1 – What are your top 3 conservation concerns for this species?

We know very, very, very little about the habitat relationships for this uncommon member of the genus Myotis. We know very little about what kind of sites this species utilizes for winter roost sites, what types of habitats it uses for foraging during the summer, or how our management activities may impact this species. In a nutshell, there is a tremendous need to conduct extensive field research on this species.

Potential impacts on summer roost sites from rock climbers, since we suspect that this species roosts in the cracks/crevices of cliffs and rock faces-extremely difficult to survey effectively.

Population status – what is range-wide population status and what are the population trends?

2 – In your state, what types of habitats are used?

Keep in mind that this is a somewhat rare bat throughout the Southern Appalachian Mountains. We have less than a dozen element occurrence records for all of western North Carolina. We have captured individuals of *M. leibii* while mist netting, but always males. Where we have captured them, it has been fairly close to rocky structures/cliff habitats. We have captured a total of 4 individuals while mist netting. We have captured/banded over 20 using concrete bridges. In fact, we found the largest summer maternity colony in the southeast this past summer roosting in the expansion joints of a concrete bridge.

3 – What types of management do you think might be necessary?

1-Look into potential impacts of rock climbing on this species – we have had reports of climbers disturbing "small black-faced bats" from the crevices on cliff faces. May need to look at restricting climbing where this species is present.

2-Survey concrete bridges on national forest lands before permitting any maintenance/repairs to concrete bridges. Need comprehensive bridge surveys to determine bat use/presence.

3-Restrict public access to caves during winter hibernation period – not just caves with federally listed bats. This species has also been known to use rock shelters, so need survey of these sites and may require restricting public access.

We don't know enough about what types of habitats they use during summer months to know if any management/restrictions are needed. No one really knows where they forage in the summer,

or where they roost during summer months. Major information gaps. Difficult to study this bat in the Southern Appalachians due to too low population numbers to work with, and problems with being able to use radio telemetry (transmitters too heavy for this small bat).

4 - What types of protection measures would you recommend?

1-Restrict public access into caves/mines/rock shelters known to harbor *M. leibii* in winter months.
2-Leave all snags >9"dbh.
3-Possibly restrict rock climbing on cliffs known/thought to harbor *M. leibi*i during summer months.
4-Require bat surveys of all bridges on forests prior to conducting any maintenance/repairs/replacement. If concrete bridge, and has any expansion joints, and in the mountains, good chance that *M. leibii* may be using the bridge for summer roosting.

5 – Do you have an idea of general abundance and distribution in your state?

No earthly idea. Not very many records for this species. Feel the species is rare in most areas, with the exception of areas in vicinity of rock cliffs/caves/etc., and then may be locally common in these areas. Where we have captured *M. leibii*, there have been cliff habitats within several miles.

6 – Have you published on this species, and are reprints available?

No

Additional comments: We developed a species conservation assessment for this species. In talking to the usual bat authorities (Dr. Michael Harvey, Bob Currie, and John MacGregor), it became readily apparent that we know very little about this interesting myotis. It would be extremely valuable for someone to fund a telemetry study in an area where there is a good likelihood that enough bats could be captured and monitored with radio telemetry. To my knowledge, no one has undertaken this. The Daniel Boone NF may be a good place to do this type of study. We have summer maternity roost located on the forest, but attaching radio transmitters to these females and young would be bad – roosting in expansion joints and may impede the ability of these bats to continue using these cracks. I would highly suggest that all forests in the Southern Appalachian mountains start surveying concrete bridges on their forests – if the right type of bridge, they most likely will find this species using the bridges.

Researcher / individual interviewed: Paul Novak (New York)

1 – What are your top 3 conservation concerns for this species?

Location of maternity colonies and summer sites
Lots of unknowns with this species
Protection of known, large colonies

2 – In your state, what types of habitats are used?

Caves Mines
Old/abandoned railroad tunnels / abandoned aqueducts (?)

3 – What types of management do you think might be necessary?

Gating Prohibiting access to colonies
Obtaining information on summer sites/maternity colonies

4 – What types of protection measures would you recommend?

See above

5 – Do you have an idea of general abundance and distribution in your state?
No real idea – check global ranking form numbers for New York
6 – Have you published on this species, and are reprints available?

Researcher / individual interviewed: Mark Pistrang (Tennessee)

1 – What are your top 3 conservation concerns for this species?
2 – In your state, what types of habitats are used?
3 – What types of management do you think might be necessary?
4 – What types of protection measures would you recommend?
5 – Do you have an idea of general abundance and distribution in your state?
6 – Have you published on this species, and are reprints available?
Additional comments: In the year 2000, there were 4 element occurrence records turned in. A total of 4 sites were visited, several sites were visited several times from June through October, 3 of the sites were bridges. A total of 42 animals (and 1 carcass) was counted. Three of these individuals were banded. It isn't known if unbanded individuals were counted on multiple visits.

Researcher / individual interviewed: Craig Stihler (West Virginia)

1 – What are your top 3 conservation concerns for this species?
Protection of rock outcrops, hibernacula, ridgetop water sources
2 – In your state, what types of habitats are used?
*a-Rock outcrops on ridges, xeric habitats, ridges, streams,
winter: caves, "north fork"
b-bridges (males, non-repro females) when rocks not available
c-cliffs / rock shelters / talus
d-rocks / under rocks in forested / dry habitats
3 – What types of management do you think might be necessary?
Limiting rock climbing in suitable habitat
4 – What types of protection measures would you recommend?
Acquisition of ridgetop habitats, rock outcrops
5 – Do you have an idea of general abundance and distribution in your state?
Concentrated with widely distributed individual records mostly during breeding
6 – Have you published on this species, and are reprints available?

Researcher / individual interviewed: David Webster (North Carolina)

1 – What are your top 3 conservation concerns for this species?
Protection of roosts
Use of, and capture of information in databases
2 – In your state, what types of habitats are used?
Caves Bridges
Old buildings
3 – What types of management do you think might be necessary?
Protection of caves and roosts
Bat friendly bridges

4 – What types of protection measures would you recommend?
See above
5 – Do you have an idea of general abundance and distribution in your state?
In relation to other bats, it's rare – still gathering information – David (at UNC Wilmington) examines / identifies bats collected by the state for rabies concerns
6 – Have you published on this species, and are reprints available?
Not specifically on this species – additional comments – BCI has recently updated range maps for the east – David has had most luck capturing these bats w/mist nets over creeks. Currently working on a manuscript that will include info on this bat.

Researcher / individual interviewed: Cindy Wentworth (Georgia)
1 – What are your top 3 conservation concerns for this species?
2 – In your state, what types of habitats are used?
3 – What types of management do you think might be necessary?
4 – What types of protection measures would you recommend?
5 – Do you have an idea of general abundance and distribution in your state?
6 – Have you published on this species, and are reprints available?
Additional comments: We only have historic records of this species in the state. I will go ahead and fill out the form anyway, if you wish. Shall I forward this to Jon Ambrose at our Natural Heritage Program, or has he already been contacted? You might be interested that Dr. Susan Loeb of our FS research station at Clemson, will be doing some mist netting, acoustic sampling, and checking of bridges for bat inventory work this July. I'll be sure we keep you informed of any *M. leibii* found.

Researcher / individual interviewed: John Whitaker (Indiana)
1 – What are your top 3 conservation concerns for this species?
We know so little about it – where does it form maternity colonies, where does it hibernate, and on what does it feed? I do not think there is very much information on any of these. Hibernacula in New York perhaps could be protected.
2 – In your state, what types of habitats are used?
No Leib's bat has ever been found in Indiana.
3 – What types of management do you think might be necessary?
None here except keep watch for them (which we do).
4 – What types of protection measures would you recommend?
None here. Protect known hibernacula and maternity roosts (if known) elsewhere.
5 – Do you have an idea of general abundance and distribution in your state?
Never found here – we keep watching.
6 – Have you published on this species, and are reprints available?
I do not believe that I have published anything on this species.

Appendix B – Explanation of the Natural Heritage Ranking System

Each of the significant natural features (species, community type, etc.) monitored by DCR-DNH is considered an element of natural diversity, or simply an element. Each element is assigned a rank that indicates its relative rarity on a five-point scale (1 = extremely rare; 5 = abundant; Table 1). The primary criterion for ranking elements is the number of occurrences, i.e., the number of known distinct localities or populations. Also of great importance is the number of individuals at each locality or, for highly mobile organisms, the total number of individuals. Other considerations include the condition of the occurrences, the number of protected occurrences, and threats. However, the emphasis remains on the number of occurrences, so that ranks essentially are an index of known biological rarity. These ranks are assigned in terms of the element's rarity within Virginia (its State or S-rank), the element's rarity within a Nation (its National or N-rank), and the element's rarity across its entire range (its Global or G-rank). Subspecies and varieties are assigned a Taxonomic (T-) rank in addition to their G-rank. A Q indicates taxonomic uncertainty. Taken together, these ranks give an instant picture of an element's rarity. For example, a designated rank of G5S1 indicates an element which is abundant and secure range-wide, but rare in Virginia. In some cases, ranks are provisional or lacking, due to ongoing efforts by the Natural Heritage network to classify community syntaxa and cryptic plants or animals. Rarity ranks used by DCR-DNH are not legal designations, and they are continuously updated to reflect new information.

Table 1. Definition of Natural Heritage state rarity ranks. Global ranks are similar to state ranks, but refer to a species' range-wide status. Note that GA and GN are not used and GX means extinct. GM and GW are ranks used only for communities, and refer to highly modified (GM) and ruderal (GW) vegetation respectively. National ranks are similar as well, and refer to a species' rarity within a nation, such as the United States or Canada. Sometimes ranks are combined (e.g., S1S2) to indicate intermediate or somewhat unclear status. Elements with uncertain taxonomic validity are denoted by the letter Q, after the global rank. These ranks should not be interpreted as legal designations.

S1 Extremely rare; usually 5 or fewer occurrences in the state, or in the case of communities, covering less than 50 hectares in aggregate; or may have a few remaining individuals; often especially vulnerable to extirpation.

S2 Very rare; usually between 5 and 20 occurrences, or in the case of communities, covering less than 250 hectares in aggregate; or few occurrences with many individuals; often susceptible to becoming endangered.

S3 Rare to uncommon; usually between 20 and 100 occurrences; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances.

S4 Common; usually more than 100 occurrences, but may be fewer with many large populations; may be restricted to only a portion of the state; usually not susceptible to immediate threats.

S5 Very common; demonstrably secure under present conditions.

SA Accidental in the state.

SH Historically known from the state, but not verified for an extended period, usually more than 15 years; this rank is used primarily when inventory has been attempted recently.

SM Applied to vegetation extensively modified by disturbance but considered recoverable by management, time, or restoration of ecological processes.

SN Regularly occurring migrants or transient species which are non-breeding, seasonal residents. (Note that congregation and staging areas are monitored separately).

SU Status uncertain, often because of low search effort or cryptic nature of the element.

SW Applied to vegetation dominated by ruderal or exotic species.

SX Apparently extirpated from the state.

The spot on the landscape that supports a natural heritage resource is an element occurrence. DCR-DNH has mapped over 7,500 element occurrences in Virginia. Information on the location and quality of these element occurrences is computerized within the Division's BCD system, and additional information is recorded on maps and in manual files.

In addition to ranking each element's rarity, each element occurrence is ranked to differentiate large, outstanding occurrences from small, vulnerable ones. In this way, protection efforts can be aimed not only at the rarest elements, but at the best examples of each. Species occurrences are ranked in terms of quality (size, vigor, etc.) of the population; the condition (pristine to disturbed) of the habitat; the viability of the population; and the defensibility (ease or difficulty of protecting) of the occurrence. Community occurrences are ranked according to their size and overall natural condition. These element occurrence ranks range from A (excellent) to D (poor). Sometimes these ranks are combined to indicate intermediate or somewhat unclear status, (e.g., AB or CD). In a few cases, especially those involving cryptic animal elements, field data may not be sufficient to reliably rank an occurrence. In such cases a rank of E (extant) may be given. A rank of H (historical) is used to indicate an historical occurrence that could not be relocated by recent survey. Element occurrence ranks reflect the current condition of the species' population or community. A poorly-ranked element occurrence can, with time, become highly-ranked as a result of successful management or restoration.

Element ranks and element occurrence ranks form the basis for ranking the overall significance of sites. Site biodiversity ranks (B-ranks) are used to prioritize protection efforts, and are defined in Table 2.

Table 2. Biodiversity ranks used to indicate site significance.

B1 Outstanding Significance: only site known for an element; an excellent occurrence of a G1 species; or the world's best example of a community type.

B2 Very High Significance: excellent example of a rare community type; good occurrence of a G1 species; or excellent occurrence of a G2 or G3 species.

B3 High Significance: excellent example of any community type; good occurrence of a G3 species.

B4 Moderate Significance: good example of a community type; excellent or good occurrence of state-rare species.

B5 General Biodiversity Significance: good or marginal occurrence of a community type or state-rare species.

The U.S. Fish and Wildlife Service (USFWS) is responsible for the listing of endangered and threatened species under the Endangered Species Act of 1973, as amended. Federally listed species (including subspecific taxa) are afforded a degree of legal protection under the Act, and therefore sites supporting these species need to be highlighted. USFWS also maintains a review listing of potential endangered and threatened taxa known as candidate species. Table 3 illustrates the various status categories used by USFWS and followed in this report. The status category of candidate species is based largely on the Service's current knowledge about the biological vulnerability and threats to a species.

As of February 27, 1996, species formerly referred to as Category 2 (C2) candidates for listing as threatened or endangered are no longer considered "candidates" under the Endangered Species Act. The USFWS no longer maintains a formal, comprehensive list of such species. However, the Virginia Field Office of the USFWS intends to maintain an informal list of these and other "Species of Concern" that may warrant future consideration as candidates. These "Species of Concern" can be regarded as species for which the Service has insufficient scientific information to support a listing proposal. Former Category 1 (C1) species are now considered "candidates" (C) for listing. "Candidate" species are species for which the USFWS has enough scientific information to warrant a proposal for listing. The designation of Category 3 species (3A, 3B, 3C) has been discontinued. However, the USFWS will continue to maintain its files on these species in case new information indicates a need for reevaluation.

Table 3. U.S. Fish and Wildlife Service species status codes, with abbreviated definitions

LE	Listed endangered
LT	Listed threatened
PE	Proposed to be listed as endangered
PT	Proposed to the listed as threatened
C	Candidate: status data supports listing of taxon as endangered or threatened
SOC	Species of Concern: no official status, evidence of vulnerability, but insufficient data exists.

In Virginia, two acts have authorized the creation of official state endangered and threatened species lists. One act (Code of Virginia ' 29.1-563 through 570), administered by the Virginia Department of Game and Inland Fisheries (DGIF), authorizes listing of fish and wildlife species, not including insects. The other act (Code of Virginia ' 3.1-1020 through 1030), administered by the Virginia Department of Agriculture and Consumer Services (VDACS), allows for listing of plant and insect species. In general, these acts prohibit or regulate taking, possessing, buying, selling, transporting, exporting, or shipping of any endangered or threatened species appearing on the official lists. Species protected by these acts are indicated as either listed endangered (LE) or listed threatened (LT). Species under consideration for listing are indicated as candidates (C).

(November 2000)

Appendix C - Poster Abstract

Conservation strategy for the eastern small-footed bat (*Myotis leibii* Audubon and Bachman): a preliminary assessment. Sandra Y. Erdle and Christopher S. Hobson. Virginia Department of Conservation and Recreation, Division of Natural Heritage, 217 Governor Street, Richmond, VA 23219

The eastern small-footed bat (*Myotis leibii*) is found throughout much of the northeastern United States. It ranges from southern Quebec, southwest along the Appalachian Mountains to northern Georgia, and west to eastern Oklahoma. Populations of this tiny bat have declined in recent years, and it is now recognized as a species of concern across its range. Due to the nature of their roost sites and inherent problems with location and identification, few opportunities exist for comprehensive surveys. In an effort to develop information about the current status and draft a preliminary conservation plan for the eastern small-footed bat, we interviewed researchers and other knowledgeable individuals, and collected information from available sources of both white and gray literature. Funding support from the USDA Forest Service and George Washington/ Jefferson National Forests will assist development of a range-wide conservation strategy.

Presented at the 80th Annual Meeting of the American Society of Mammalogists, in Durham, New Hampshire June 2000, by Sandra Erdle.

Photo of poster presentation: