United States
Department of
Agriculture

Forest Service

Rocky
Mountain
Region

Black Hills
National
Forest

Custer,
South Dakota

April 2003

Conservation Assessment for the Small-Footed Myotis in the Black Hills National Forest South Dakota and Wyoming

Dr. Cheryl A. Schmidt

Conservation Assessment
for the
Western
Small-Footed Myotis
in the
Black Hills National Forest,
South Dakota and Wyoming

Dr. Cheryl A. Schmidt
BS Biological Services
RR 1 Box 11
Newell, SD 57760

Under a personal services contract with:

Stanley H. Anderson,
Wyoming Cooperative Fish and Wildlife Research Unit,
Box 3166, University of Wyoming,
Laramie, WY 82071-3166

Dr. Cheryl A. Schmidt received her Ph.D. from Texas Tech University in 1995 under the direction of Dr. Robert J. Baker. She has conducted surveys of small mammals and bats, and worked on the ecology of these groups in South America, Mexico, the southwestern United States, Missouri, and the northern Great Plains, including the Black Hills region. Dr. Schmidt is currently an Associate Professor of Biology at Central Missouri State, an adjunct faculty member at Black Hills State University, and a consultant for BS Biological Services. In the summer of 2002 she began small mammal and bat inventories of National Park Service lands in the Northern Great Plains under a cooperative agreement between the National Park Service, the Rocky Mountain Research Station in Rapid City, SD and Colorado State University. She is a member of a team of biologists from South Dakota working with the SD Game Fish & Parks to develop a statewide management plan for bats. In addition, she is working with several groups in western South Dakota to develop research projects addressing foraging habitats and diet for bats in the Black Hills and other areas of western South Dakota.

Table of Contents

Tables and Figures

INTRODUCTION

This conservation assessment addresses the biology of the western small-footed myotis (*Myotis ciliolabrum*) across its range in North America, with emphasis on its biology and conservation status in the Black Hills of South Dakota and Wyoming. The purpose of this assessment is to assimilate current knowledge about this species from various sources to provide an informed and objective overview of this species' status within the Black Hills. Primary literature (peer-reviewed scientific publications) was the main information source utilized and all sources are cited. However, to ensure as complete coverage as possible, other sources such as reports submitted to various agencies such as the Black Hills National Forest and the South Dakota Game Fish and Parks, were examined and information used from these sources is cited so that the reader can individually assess the value of such information. Information from academic documents such as Masters Theses and Doctoral Dissertations was also considered and incorporated where appropriate, with full citations.

While there is some information for *Myotis ciliolabrum* from the Black Hills region, extrapolation about certain aspects of this bat's biology from other areas within its range was necessary. Where specific kinds of information were lacking for the Black Hills region, such information from other parts of its range was provided when available. Furthermore, even when certain aspects of this bat's biology are reported from the Black Hills region, information about variation in those aspects across the range of the species are included, to provide a comprehensive view of *Myotis ciliolabrum.*

CURRENT MANAGEMENT SITUATION

Management Status

In Alberta, Canada Myotis *ciliolabrum* is on the Yellow B list (Alberta Wildlife Management Division 1996) indicating that this species is considered 1) naturally rare, 2) naturally rare with clumped breeding distributions, or 3) to be associated with habitats or habitat elements that are, or may be, deteriorating. The western small-footed myotis was a United States Federal Category 2 candidate species (US Fish and Wildlife Service 1994), indicating a species of concern for which there is insufficient information to add them to the endangered species list. *Myotis ciliolabrum* is not monitored by the South Dakota Natural Heritage Program (SD NHP Rare Mammals website; SD NHP Report 2002), but is considered a Non-game Species of Special Concern – 3 species by the Wyoming Game and Fish Department (Luce et al. 1999). In general, this species is considered widely distributed but not abundant.

Existing Management Plans, Assessments, Or Conservation Strategies

No existing management plans, assessments, or conservation strategies were found for this species.

REVIEW OF TECHNICAL KNOWLEDGE

Systematics

The genus *Myotis* is in the chiropteran family Vespertilionidae. *Myotis* is the most widespread genus of bats in the world, both spatially and temporally, with the genus occupying virtually the entire geographic range of Vespertilionidae, and fossil *Myotis* dating back to the middle Oligocene of Europe (Vaughan 1986). The taxonomic history of *M. ciliolabrum* is contorted. Although this species has been assigned six different names through time, most of the available literature refers to it by the last three. Early literature (pre-1965) refers to this bat as *Myotis subulatus*. Literature from the period between 1965 and 1984 refer to it as *M. leibii.* In 1984, van Zyll de Jong concluded that the western populations of *M. leibii* were distinct from the eastern populations and recognized the western populations as *Myotis ciliolabrum* (van Zyll de Jong 1984). *Myotis ciliolabrum* is the only species assigned to the subgenus *Selysius* within the Black Hills region (Nowak 1991; Nowak 1994). There are two subspecies in western North America: *M. ciliolabrum ciliolabrum,* and *M. c. melanorhinus* (Holloway and Barclay 2001) and their distributions are described below. Vernacular names for this species include small-footed myotis and western small-footed myotis, with the latter being more correct.

Myotis ciliolabrum can be distinguished from other North American congeners by the combination of its small size, short hind feet, noticeably keeled calcar, yellowish pelage that is slightly lighter ventrally and contrasts markedly with black ears, tragus, and wing membranes as well as with the blackish brown sides of the face from muzzle to ears (Holloway and Barclay 2001). In the northern Great Plains, the dorsal pelage is pale yellowish brown to golden brown (Jones et al. 1983).

Geographic variation in size from north to south occurs in *Myotis ciliolabrum*, with individuals from the southern United States being larger than those from the northern US and Canada (Holloway and Barclay 2001). Average and extreme external measurements (in mm) for six specimens from northwestern Nebraska are: total length 87.2 (82-89); tail length 38.0 (34-44); hind foot length 8.2 (7-9); ear length 14.3 (13-15); and forearm length 31.8 (30.8-32.9) (Jones et al. 1983).

Distribution And Abundance

Distribution Recognized In Primary Literature

Overall Range

Myotis ciliolabrum ranges across most of western North America, extending from central British Columbia, southern Alberta and southwestern Saskatchewan, south to the central States of northern Mexico (Jones et al. 1983; Holloway and Barclay 2001). This species does not occur along the Pacific coast from British Columbia south to central California (Holloway and Barclay 2001). The eastern border of this species' range across the northern Great Plains is approximately the Missouri River (Holloway and Barclay 2001). The subspecies occupying British Columbia, most of the western United States including the panhandles of Oklahoma and Texas, and Mexico, is *M. c. melanorhinus;* while the subspecies occupying Alberta, Saskatchewan, Montana, Wyoming, northeastern Colorado, and the western portions of the Dakotas, Nebraska and Kansas, including the Black Hills region is *M. c. ciliolabrum* (Holloway and Barclay 2001).

Local Distribution

Myotis ciliolabrum has been reported from all five South Dakota counties of the Black Hills

(Turner 1974) as well as from Bad Lands National Park (Bogan et al. 1996). Luce et al. (1999) reported records of *M. ciliolabrum* from latilongs 7, 21 and 28 (3 of the 4 latilongs bordering the South Dakota state line), with apparently no records from southern Weston or northern Niobrara Counties in Wyoming; however, since the latilongs do not correspond to county boundaries, it is difficult to determine for which counties records have been reported. Clark and Stromberg's (1987) map of occurrences of this species in Wyoming is more useful, and showed that there were no records of *M. ciliolabrum* from either Weston or Niobrara counties. However, review of Turner (1974) indicated that indeed seven individuals had been collected at or near the deserted Cambria Coal Mine complex in Weston County, Wyoming.

Additional Information From Federal, State, And Other Records

Information from federal and state records (US and Canada) are incorporated in the section Management Status, above. No additional information from other state, or from federal records was found.

Estimates Of Local Abundance

Although Barclay (1993) characterized *M. ciliolabrum* as a colonial species, some authors (e.g. Foresman 2001) describe this species as being much less communal than other *Myotis*, preferring to roost solitarily or in small numbers. For the Black Hills, Turner (1974) noted that "Although widespread throughout the Hills, populations of the small-footed myotis are relatively small." Mattson and Bogan (1993) captured 13 males and 7 females of this species during mist-netting over 22 different water sources in the southern Black Hills. Cryan (1997), based on combined data from various researchers mist-netting during May-September in the Black Hills from 1989 to 1996, reported capture of a total of 48 males and 21 adult females, and 1 juvenile female over the 7 year period, with most net-nights in which *M. ciliolabrum* were captured producing only one individual (range was 1-5 individuals) of this species. During that same 7-year timespan, 42 females and 457 males (total of 499) were captured at the entrance to Jewel Cave (Cryan 1997).

Habitat Associations

Myotis ciliolabrum is found in a variety of habitats ranging from arid desert and badland habitats (Tuttle and Heaney 1974), and riparian zones in badlands and grasslands (Holloway and Barclay 2000), to higher elevation conifer and deciduous woodlands (Turner and Jones 1968; Thomas 1988). As a saxicolous species, it is usually associated with rocky areas (e.g. bluffs, dissected breaks, ridges, cliffs, major rock outcroppings) within these habitats (Jones et al. 1983). Kuenzi et al. (1999), working in west central Nevada, captured *M. ciliolabrum* over water sources surrounded by desert shrubs, over higher-elevation water sources surrounded by pinyon-juniper, and over streams lined with deciduous trees. In the Black Hills region, this species has been captured at elevations ranging from 3800ft to 6000ft (Turner and Jones 1968).

Roosting Ecology

Maternity Roosts

Very few maternity colonies of this species have been documented. Before the work of Tuttle and Heaney (1974), the only maternity colony documented in the primary literature was found behind the wallpaper in an abandoned house in California (Koford and Koford 1948).

Tuttle and Heaney (1974) conducted a survey in and near the Badlands of South Dakota to locate

roosts of *M. ciliolabrum*. The remainder of this paragraph summarizes their findings. Although 35 roost sites were identified based on the presence of guano, only 12 were occupied. Those 12 roosts produced a total of 27 bats including seven lactating females, two postlactating females, one nonreproductive female, one adult male, four juvenile females, and 7 juvenile males. The single adult male was found alone in a horizontal crack in rock on a hillside, and about a quarter-mile from the nearest occupied roost. Two roosts, including the male roost just mentioned, were in "horizontal fractures in large, flat, siltstone boulders…" One roost was in a small crevice in a hard, whitish-gray Oligocene sediment. Other roosts were found in early Miocene deposits of clay and volcanic ash which contained numerous small cavities. These deposits occurred in open grassland, about 0.3 miles from the nearest water source. Six of the roosts were in crevices in vertical banks at heights ranging from 51 to 340 centimeters above dry streambeds. Six of the 12 occupied roosts faced west, two faced southwest, and one faced south. In general, the roosts were characterized as small, dry, shallow, and maintaining a fairly uniform high temperature (26^{o}C-33^{o}C).

Hibernacula

Myotis ciliolabrum hibernates in caves and mines (Barbour and Davis 1969). Unlike *Myotis lucifugus* and Corynorhinus *townsendii* who also hibernate in caves, *M. ciliolabrum* is generally not found in large aggregations during hibernation. Nagorsen et al. (1993) reported this species hibernating in a number of caves and mines in British Columbia. Foresman (2001) indicated that this species occurs year-round, including hibernation, in an abandoned coal mine in Musselshell County, Montana. Szewczak et al. (1998) commonly found *M. ciliolabrum* hibernating in caverniculous structures in the White-Inyo Range of California and Nevada. Kuenzi et al. (1999) found this species to be common hibernators in mines in west central Nevada. Turner (1974) reported this species hibernating in caves in Lawrence, Meade, Pennington, and Custer Counties of South Dakota. Jewel Cave in Custer Co., South Dakota apparently supports year-round residency of some of these bats (Turner 1974). Martin and Hawks (1972) reported that this species typically hibernates wedged solitarily in tiny cracks and crevices. Aggregations of 3-4 individuals were observed in larger crevices (Martin and Hawks 1972). Micro-habitat selection by *M. ciliolabrum* provides it with the least exposure to climatic fluctuations; a critical factor as this species is very small and consequently has a restricted winter energy budget (Martin and Hawks 1972). *M. ciliolabrum* were found in the warmer regions of most caves, with a minimum temperature of 7^{o}C (Martin and Hawks 1972); although Turner (1974) reported ambient temperatures as low as 5.6^{o}C for hibernating *M. ciliolabrum* in Jewel Cave.

Summer (Day) Roosts (Of Males And Non-Reproductive Females)

Davis and Cockrum (1963) reported that *Myotis ciliolabrum* only rarely utilizes bridges as day roosts. Tuttle and Heaney (1974) reported day roosts of males and non-reproductive females in the same settings as reproductive females (see Maternity Roosts above). Jones et al. (1983) described reports of day roosts for this species including buildings, behind bark of pine trees, in rock crevices, under rocks on the ground, in holes in banks and hillsides, and in abandoned swallow nests.

Night Roosts

Western small-footed bats utilize mines, caves, rock overhangs, and buildings as night roosts (Jones et al. 1983; Turner and Jones 1968; Turner 1974; Cryan 1997).

Interim Roosts

No studies elucidating the use of interim roosts by this species were found.

Foraging Habits

Szewczak et al. (1998) found *M. ciliolabrum* foraging throughout the Great Basin scrub and pinyon-juniper zone of the White-Inyo Range of California and Nevada, with an emphasis over wooded riparian areas. Elevations at which these bats were observed foraging ranged from 1080m to 2740m (Szewczak et al. 1998). Holroyd et al. (1994) reported that these bats foraged primarily over the edges of rocky bluffs, and rarely over open water. Kuenzi et al. (1999) captured foraging *M. ciliolabrum* over water sources at a variety of elevations and surrounded by desert scrub, pinyon-juniper, and deciduous trees. Fenton et al. (1980) described these bats foraging along cliffs and rocky slopes at one site, and along the margin of some trees over a small pond at another site. At the margin of the woods at the latter site, these bats foraged from about 1m off the ground up to the top of the canopy; and within about 1m of the surface of the pond (Fenton et al. 1980).

Thomas (1988) examined activity of a community of bats, including *M. ciliolabrum*, in different-age Douglas fir stands in the Pacific Northwest. Thomas (1988) reported that bat activity was 3-10 times greater in old-growth forest than in younger forests. His results also indicated that the bats did most of their foraging over water within the old-growth forest (Thomas 1988).

Foresman (2001) indicated that foraging for this species in Montana typically begins just after sunset. Fenton et al. (1980) reported that *M. ciliolabrum* emerged around 21:35. Foraging flight for this species has been described as slow and maneuverable, with erratic flight patterns (Holloway and Barclay 2001).

Prey Species

Black (1974) did not distinguish between *Myotis californicus* and *M. ciliolabrum*, but reported that this species pair had 94% frequency of occurrence of moths in fecal pellets examined and 69% occurrence of beetles. Whitaker et al. (1981) based on stomach analyses, reported frequencies of occurrence at 83.3%, 33.3%, and 16.7% for Lepidoptera, each of Hymenoptera and Hemiptera, and each of Coleoptera and Homoptera, respectively. Warner (1985) reported frequencies of occurrence as follows: Lepidoptera 100%, Coleoptera 88%, Diptera 63%, Neuroptera 25%, Hymenoptera 25%, and Hemiptera 38%. Hence the documented diet for this species is restricted to the class Insecta.

Characteristics Of Prey Species

Prey species are generally soft-bodied invertebrates. No studies were found which reported the natural history of prey species for *M. ciliolabrum*.

Reproduction And Development

Life History Characteristics

Perhaps because of this species' tendency toward a solitary nature, relatively little is known about the life history characteristics for this species.

Survival And Reproduction

As with most temperate zone vespertilionids, reproductive output is usually limited to one

offspring per year (Barclay 1993), although Tuttle and Heaney (1974) reported evidence of a pair of twins. Kuenzi et al. (1999) documented that 25% of the 51 *M. ciliolabrum* captured in June-August 1994 in west central Nevada were reproductive. No records of longevity or survival rates were found.

Local Density Estimates

No literature was found which provided local density estimates for *Myotis ciliolabrum.*

Limiting Factors

No studies found specifically addressed limiting factors for this species. It could be anticipated that availability of suitable hibernacula, maternity roosts, and foraging areas could serve as limiting factors. However, until the necessary criteria for these three site classes are elucidated, it is unknown which is/are acting as limiting factors.

Patterns Of Dispersal

No studies were found which addressed dispersal in this species.

Metapopulation Structure

As mentioned above, patterns of dispersal for this species are not known. To date, no studies have addressed population genetic structure of this species. The metapopulation structure of this species is an area in need of research.

Community Ecology

Predators

No reports of predation on western small-footed myotis were found in the literature. It can be assumed that they fall prey to the usual bat predators including raccoons, owls, and snakes.

Competitors (e.g. For Roost Sites And Food)

Perkins (1996) reported a study examining the relative influence of foraging competition and roost-site competition on the distribution of bats in northeastern Oregon. The remainder of this paragraph summarizes key findings from Perkins' report presented at the Bats and Forest Symposium in 1995. It should be noted that there are individuals who question whether or not Perkins was able to document competition *per se*. Nonetheless, given the difficulty of ever truly demonstrating competition, the results are provided here as they represent our current understanding of competition for this species. *Myotis ciliolabrum* was one of the least-caught species, and showed no segregation of foraging habitats by sex. Perkins (1996) suggested that this was because the prey base is not a critical factor when numbers of resident individuals are low. Based on the length of the forearm, Perkins (1996) divided bats in his northeastern Oregon study area into large- (*Eptesicus fuscus* and *Lasionycteris noctivagans*), medium- (*Myotis evotis*, *M. volans*, and *M. thysanodes*), and small- (*M. lucifugus, M. ciliolabrum*, and *M. californicus*) sized groups. He found that medium-sized bats and small bats were found foraging together less often than expected in 73% of cases (Perkins 1996). However, previous authors (e.g. Bell 1980) reported no such competition among paired bat species in habitats similar to that of Perkins (1996). Perkins (1996) suggested, therefore, that differences in distribution between bat species was more likely due to competition for roost sites than to competition for food resources.

Parasites, Disease

Ectoparasites recorded from *Myotis ciliolabrum* include:

-Liponyssinae (nymphal stage; Krutzsch 1955)

-*Spinturnix americanus* (Bradshaw and Ross 1961)

-*Spinturnix carloshoffmanni* (Bradshaw and Ross 1961)

-*Leptotrombidium myotis* (Jones et al. 1973)

-*Ornithodoros* sp. (Bradshaw and Ross 1961)

-*Trombicula myotis* (Bradshaw and Ross 1961)

Only two endoparasite documentations were found and those were for endoparasitic oocysts of *Eimeri pilarensis*, and the stomach nematode Longibucca *lasiura* (Holloway and Barclay 2001).

Other Complex Interactions. Include Interactions With Other Bat Species

No literature was found which addressed ecological interactions of *M. ciliolabrum* with other taxa.

Roost Site Vulnerability

As *M. ciliolabrum* uses caves as hibernacula and, occasionally as summer roosts, they face the same, primarily anthropogenic, challenges as other caverniculous hibernators (see Recreation below). The fact that this saxicolous species often roosts in sites at ground level also makes it very vulnerable to disturbance from a multitude of sources such as off-road vehicles, livestock trampling, flooding, etc.. Mine closures and reactivation of mines for strip mining purposes also have the potential to destroy roosting sites of this species. Additionally, natural processes such as rock slides and cave/mine collapses or closures, have the potential to reduce potential hibernacula and summer roost sites.

Risk Factors

Although no studies were found which specifically addressed risk factors for this species, it can be assumed that potential risk factors will be closely associated with limiting factors. Availability of suitable hibernacula, maternity roosting sites, and foraging areas all represent potential risk factors for *M. ciliolabrum* as they do for most species of bats.

Response To Habitat Changes

Management Activities

Timber Harvest

The 2001 Phase I Amendment to the Land Resource Management Plan ROD 3/97 (LRMP-ROD 3/97; US Forest Service 1997), implementing the selected alternative (Alternative 2), increased the number of acres for Commercial Thinning and Regeneration Opening, while reducing the number of acres for Overstory Removal, Shelterwood Seed Cut, and Seed Tree Cut. Increased areas of commercial thinning, as long as these activities are not conducted close to roosting sites, should not negatively impact western small-footed bats. Regeneration openings may provide temporary foraging areas for *M. ciliolabrum*, particularly if they are close to roosting areas and

water sources. Again, harvest activities of any sort should be avoided close to known roosting sites of this species as they often roost on or close to ground level and hence could easily be disturbed, harmed, or killed by passage of large vehicles.

The Land and Resource Management Plan ROD 3/97 (LRMP-ROD 3/97) did address the need to protect caves for bats (page II-43) with Standard 3102 requiring protection of roosting caves and their microclimates during the design of timber harvest activities. Additional guidance in the LRMP on cave management, contained in Guideline 1401 (Page II-13) stated "Avoid ground disturbance within 100 feet of an opening of a natural cave." This distance was increased to 500 feet in the Phase I Amendment (US Forest Service 2001) and is to be treated as a standard.

Recreation

The increased interest in spelunking in the United States has the potential to negatively impact *M. ciliolabrum* populations as, like most bats, they are very sensitive to disturbance and their low reproductive output requires considerable time for a population to rebound from a drop in numbers. Members of the National Speleological Society, and comparable local groups such as the Paha Sapa Grotto, are typically very supportive of cave conservation and, as such, are important resources for management agencies. Unfortunately, some individuals who are not members of such conservation-minded organizations, explore and abuse cave habitats.

Other recreational activities which have the potential to negatively impact this species include: the use of off-road vehicles, rock climbing, and horseback riding.

Livestock Grazing

No studies were found which addressed the impact of livestock grazing on western small-footed myotis. Hypotheses of both positive and negative potential impacts of livestock grazing on these bats could reasonably be formulated. While trampling associated with livestock grazing could potentially be harmful to ground roosts of this species, lack of grazing could result in tall vegetation which would block access to ground roosts and create a higher fuel load and corresponding risk of fire. Livestock grazing may indirectly benefit bat species through the construction of additional water sources (Chung-MacCoubrey 1996). Detailed studies of the impacts of grazing on this species are needed.

Mining

No studies were found which addressed the impact of mining activities on *M. ciliolabrum,* although these bats do often use abandoned mine works as roosting sites.

Prescribed Fire

To date, studies directly assessing the impact of fire regimes on *M. ciliolabrum* are not available.

Fire Suppression

As mentioned above, the impact of various fire regimes on *M. ciliolabrum* has not been studied directly. However, Bock and Bock (1983) reported that fires occurred naturally in the Black Hills about every 10-25 years between 1820 and 1910. Brown and Sieg (1999) estimated fire intervals of 10-12 years in the ecotone between forest and prairie in the southeastern Black Hills, and intervals of roughly 19-24 years for more interior forest (near Jewel Cave) in the southern Black Hills. Suppression of fire in this region can produce doghair stands of ponderosa pine which are not suitable roosting or foraging habitat for any bats, including western small-footed

bats. Thus, fire suppression in the Black Hills would probably be more of a detriment than a benefit to the *M. ciliolabrum* populations of this region.

Non-Native Plant Establishment And Control

Myotis ciliolabrum consumes a variety of small, soft-bodied, invertebrate prey. As arthropod diversity correlates with plant species diversity, this dietary variability would suggest the need for a diverse forest flora. Non-native plant establishment tends to reduce native plant diversity and could thus negatively impact the prey base for this bat.

Pesticide Application

Organochlorines used in the past (DDT, dieldrin, endrin, and heptachlor) and suspected of causing large-scale die-offs of bat populations, are now used much less widely and are not considered a major threat to bat populations (Clark 1981). While bats are often thought of as being extraordinarily sensitive to insecticides, recent research does not support this assumption (Clark 1981). No studies were found which examined the impact of organophosphate and carbamate insecticides on bats, even though the use of these compounds increased markedly in replacing organochlorines for agricultural use (Clark 1981).

Fuelwood Harvest

As *M. ciliolabrum* is primarily a saxicolous species, the harvest of fuelwood would not seem to have a detrimental impact on this species as long as it did not occur in areas close to roost sites. Ground roosts of this species would be particularly vulnerable to vehicular disturbance and even trampling by bipeds.

Natural Disturbance

Insect Epidemics

No literature was found which dealt with the impact of insect epidemics on *M. ciliolabrum*.

Wildfire

No literature is available which specifically addresses the impact of wildfires on populations of *Myotis ciliolabrum.* Early photographs from the Black Hills region indicated that many forested areas were more open with snags (Knight 1994). As mentioned above under Prescribed Fire and Fire Suppression, fire suppression leads to doghair stands of ponderosa pine which are unsuitable as either roosting or foraging habitats for many species of bats. Furthermore, accumulation of fuel load results in wildfires burning much hotter and the potential for these wildfires to destroy large areas of suitable bat foraging habitat. Frequent fires, similar to the fire regime in pre-settlement times (every 5-25 years; Knight 1994) would keep the fuel load reduced while maintaining the more mature and open forest preferred as foraging habitat by bats.

Wind Events

No literature directly addressed the effects of wind events on western small-footed myotis.

Flooding

No literature is available that addresses the impact of flooding on *Myotis ciliolabrum*. However, given that this species does utilize roost sites at ground level and only a half-meter above the bottoms of dry streambeds, it would seem that the potential impact of flooding could be significant.

Other Weather Events

As this species occupies the Black Hills and regions considerably north and south of the Black Hills during the summer, it must be assumed that it has evolved to cope with the range of summer weather conditions experienced by the Black Hills region. The effects of other weather events on this species are not known.

SUMMARY

Myotis ciliolabrum ranges across most of western North America, extending from central British Columbia, southern Alberta and southwestern Saskatchewan, south to the central States of northern Mexico. This species does not occur along the Pacific coast from British Columbia south to central California. The eastern border of this species' range across the northern Great Plains is approximately the Missouri River. The subspecies occupying the Black Hills region is *M. c. ciliolabrum*.

In Alberta, Canada *Myotis ciliolabrum* is on the Yellow B list, while in the United States it was a United States Federal Category 2 candidate species. The western small-footed myotis is not monitored by the South Dakota Natural Heritage Program but is considered a Non-game Species of Special Concern – 3 species by the Wyoming Game and Fish Department. In general, this species is considered widely distributed but not abundant.

This species forages in a variety of habitats across its range including arid desert and badland habitats, to pinyon-juniper zones, and ponderosa pines of higher elevations. Captures of this species in mist-nets are nearly always associated with water sources. The diet of *M. ciliolabrum* consists of a variety of small, soft-bodied invertebrate species. The western small-footed bat roosts in a variety of settings, usually associated with caverniculous structures or rock shelters (e.g. crevices, overhangs, under rocks). This is one of only a few species of bats which will actually roost in cavities at ground level.

This species, although characterized as colonial by some authors, does not often occur in large groups and in fact is normally seen roosting and hibernating solitarily. Because of this solitary nature, our knowledge of many aspects of this bat's biology is lacking.

REVIEW OF CONSERVATION PRACTICES

Management Practices

No management plans or other conservation practices were found for this species.

Models

No models pertaining to this species were found in the literature.

Inventory Methods

Inventory methods for bats traditionally included mist-netting over water sources, and more recently, the use of ultrasonic bat detectors. Mist-netting is limited in its effectiveness for most species by appropriate weather conditions and relative availability of water. Wind and rain make nets more visible to bats and reduce the ability to capture bats in the nets. In areas where numerous water sources are available, numbers of bats caught at any one water source can drop.

Acoustic inventory of bats provides advantages over mist-netting in that echolocating bats can be detected regardless of wind or rain. However, identification of echolocating bats to species requires the development of echolocation libraries for signal comparison, and the development of expertise on the part of the researcher in distinguishing among the echolocation sequences of the species in a given area. Incomplete call sequences can lead to erroneous species identification. A study conducted by O'Farrell and Gannon (1999) indicated that use of a combination of capture and acoustic detection yields markedly better results for *M. ciliolabrum* than either technique alone. Advances in molecular genetics are currently being implemented to facilitate determination of presence/absence based on assignment of fecal pellets from bridge and comparable roosts to species (Ormsbee et al. 2002)

Monitoring Methods

The use of Geographic Information Systems can greatly facilitate habitat monitoring, assuming the characteristics for high-quality *M. ciliolabrum* habitat are known. Current information about roosting requirements for this species may not provide an adequate starting point for this form of habitat monitoring.

Methods previously discussed for determining presence/absence (mist-netting and acoustic detection) can be used indirectly, under specific conditions, for evaluating population trends and persistence. However, no models are available to predict the amount of each method required to detect various percentages of change in population size. Monitoring methods based on radio telemetry and/or mark and recapture may provide more information, but would also be very expensive, primarily in terms of personnel (time).

Regardless of the methodologies employed for inventorying and monitoring, it is critical that the study be designed and conducted by individuals with first-hand experience with the various techniques and detailed understanding of their assumptions and limitations.

ADDITIONAL INFORMATION NEEDS

Distribution

While *M. ciliolabrum* is known to occur throughout the Black Hills and has been found hibernating in caves in most of the South Dakota counties of the Black Hills, the location, characteristics, and distribution of summer roosts for this species in the Black Hills are unknown. Elucidation of this information, particularly of maternity roosts, is important for any attempt at developing management plans for this species.

Species Response To Stand Level Changes

Thomas (1988) examined activity of a community of bats, including *M. ciliolabrum*, in different-age Douglas fir stands in the Pacific Northwest. Thomas (1988) reported that bat activity was 3-10 times greater in old-growth forest than in younger forests. His results also indicated that bats use the old-growth stands *per se* for roosting, but do most of their foraging over water within the old-growth forest (Thomas 1988).

As no other literature was found which documented the response(s) of western small-footed myotis to stand level changes, this information is desperately needed. Given the distinct isolation, topography and climate of the Black Hills, collection of these data in the Black Hills

would provide the best information upon which to base management plans for *M. ciliolabrum* in this area.

Roosting Habitat Adaptability

Although this species has been documented to use a variety of settings for roosts (abandoned buildings, mines and caves, under loose bark of trees), most documented maternity roosts occur in rock crevices and similar features. The location, distribution and characteristics of summer roosts for this speices in the Black Hills National Forest is needed to develop management plans for this species. The use of interim roosts by this species has not been documented and is another area in which research is needed.

Movement Patterns

Virtually nothing is known of the movement patterns of this species in the Black Hills or elsewhere. Tracking of reproductive females, as well as males and nonreproductive females, from hibernacula to summer roosts is needed to provide a complete picture of movements of this species in the Black Hills. Unfortunately, current transmitters are still too large for this species.

Foraging Behavior

No studies were found which focused on the foraging behavior of the population of western small-footed myotis occupying the Black Hills of South Dakota and Wyoming. As such, this is an area requiring research. Bat foraging studies available in the literature often fail to collect and analyze data about insect diversity and availability in conjunction with the bat diet studies. This information is needed to elucidate not only dietary preference, but also many other aspects of foraging ecology such as seasonal variation, differences between reproductive classes of individuals, and the potential for competition within and among bat species, and with other insectivores such as crepuscular birds.

Demography

Elucidation of the age structure of populations of *M. ciliolabrum* remains to be achieved and could be critical in providing for better estimates of viability for this species in the Black Hills.

Table 1. Priorities and cost categories of research needs.

SUBJECT	PRIORITY*	JUSTIFICATION	COST**
Distribution Specifically of maternity roost sites	High	Determine extent of BHNF to be managed for *M. ciliolabrum*	Moderate
Species Response to Stand Level Changes	Intermediate	Understand the impact of stand level changes on distribution and foraging habitat	Moderate
Foraging Behavior	Intermediate	Ensure management of all habitats required	Moderate
Demography and Metapopulation Structure	Low	Allow predictions about habitat change on demographic and genetic structure of BHNF population of *M. ciliolabrum*	High

*Low: would refine or improve western small-footed myotis management strategies; Intermediate: is required to develop comprehensive management strategies; High: is required to develop minimal science-based management strategies.

**Low: estimated cost $5,000-$25,000; Moderate: estimated cost $25,000-$100,000; High: estimated cost >$100,000.

LITERATURE CITED

Alberta Wildlife Management Division. 1996. The status of Alberta wildlife. Alberta Environmental Protection, Natural Resources Service, Edmonton, Canada.

Barbour, R.W. and W.H. Davis. 1969. Bats of America. University of Kentucky Press, Lexington. 286pp.

Barclay, R.M.R. 1993. The biology of prairie bats. Proceedings of the 3rd Prairie Conservation and Endangered Species Workshop. Vol. 19: 353-357.

Bell, G.P. 1980. A possible case of interspecific transmission of rabies in insectivorous bats. Journal of Mammalogy 61: 528-530.

Black, H. 1974. A north temperate bat community: structure and prey populations. Journal of Mammalogy 55:138-157,

Bock, C.E. and J.H. Bock. 1983. Responses of birds and deer mice to prescribed burning in Ponderosa Pine. Journal of Wildlife Management 47:836-840.

Bogan, M., J. Osborne and J. Clarke. 1996. Observations on bats at Badlands National Park, South Dakota. The Prairie Naturalist 28: 115-123.

Bradshaw, G. and A. Ross. 1961. Ectoparasites of Arizona bats. Journal of Arizona Academy of Science 1:109-112.

Brown, P. and C. Sieg. 1999. Historical variability in fire at the ponderosa pine – Northern Great Plains prairie ecotone, southeastern Black Hills, South Dakota. Ecoscience 6: 539-547.

Chung, MacCoubrey, A. 1996. Grassland bats and land management in the southwest. Pp. 54-63 in D.M. Finch (ed.) Ecosystem disturbance and wildlife conservation in western grasslands. USFS, GTR-RM-285.

Clark, D. 1981. Bats and environmental contaminants: a review. US Dept. of Interior, US Fish & Wildlife Service, Washington, D.D. Special Scientific Report – Wildlife no. 235. 27 pp.

Clark, T. and M. Stromberg. 1987. Mammals in Wyoming. University of Kansas Museum of Natural History, Lawrence. 314pp.

Cryan, P. 1997. Distribution and roosting habits of bats in the southern Black Hills, South Dakota. Unpublished MS Thesis, University of New Mexico, Albuquerque, NM. 96 pp.

Davis, R. and E.L. Cockrum. 1963. Bridges utilized as day-roosts by bats. Journal of Mammalogy 44:428-430.

Fenton, B., C. Van Zyll De Jong, G. Bell, D. Campbell, and M. Laplante. 1980. Distribution, parturition dates, and feeding of bats in south-central British Columbia. Canadian Field Naturalist 94:416-420.

Foresman, K. 2001. The wild mammals of Montana. Special Publication No. 12. American Society of Mammalogists. 278 pp.

Holloway, G. and R.M.R. Barclay. 2000. Importance of prairie riparian zones to bats in southeastern Alberta. Ecoscience 7:115-122.

Holloway, G. and R.M.R. Barclay. 2001. *Myotis ciliolabrum*. Mammalian Species Account No. 670. American Society of Mammalogists 5pp.

Holroyd, S., R.M.R. Barclay, L. Merk and R. Brigham. 1994. A survey of the bat fauna of the dry interior of British Columbia. Wildlife Branch, Ministry of Environment, Land and Parks, Victoria, B.C. Wildlife Working Report No. WR-63. 73 pp.

Jones, J.K.Jr., D.M. Armstrong, R.S. Hoffmann and C. Jones. 1983. Mammals of the northern great plains. University of Nebraska Press, Lincoln. 378 pp.

Jones, J.K.Jr., R. Lampe, C. Spenrath, and T. Kunz. 1973. Notes on the distribution and natural history of bats in southeastern Montana. Occasional Papers The Museum Texas Tech University, No. 15, 12pp.

Knight, D. 1994. Mountains and plains: the ecology of Wyoming landscapes. Yale University Press, New Haven, CT. 338 pp.

Kuenzi, A., G. Downard, and M. Morrison. 1999. Bat distribution and hibernacula use in west central Nevada. Great Basin Naturalist 59:213-220.

Koford, C. and M. Koford. 1948. Breeding colonies of bats, *Pipistrellus hesperus* and *Myotis subulatus melanorhinus*. Journal of Mammalogy 29:417-418.

Krutzsch, P. 1955. Ectoparasites from some species of bats from western North America. Journal of Mammalogy 36:457-458.

Luce, B., A. Cerovski, B. Oakleaf, J. Priday, and L. Vanfleet. 1999. Atlas of birds, mammals, reptiles and amphibians in Wyoming. Wyoming Game and Fish Department, Lander, WY.

Martin, R. and B. Hawks. 1972. Hibernating Bats of the Black Hills of South Dakota. Bulletin of the New Jersey Academy of Science 17:24-30.

Mattson, T. and M. Bogan. 1993. Survey of bats and bat roosts in the southern Black Hills in 1993. Unpublished report presented to the Black Hills National Forest. 20 pp.

Nagorsen, D., A. Bryant, D. Kerridge, G. Roberts, A. Roberts, and M. Sarell. 1993. Winter bat records for British Columbia. Northwestern Naturalist 74:61-66.

Nowak, R.M. 1991. Walker's Mammals of the World – Volume I. John Hopkins University Press, Baltimore, MD. 655pp.

Nowak, R.M. 1994. Walker's Bats of the World. John Hopkins University Press, Baltimore, MD. 287pp.

O'Farrell, M. and W. Gannon. 1999. A comparison of acoustic versus capture techniques for the inventory of bats. Journal of Mammalogy 80:24-30.

Ormsbee, P., J. Zinck, and R. Hull. 2002. Methods for inventorying and monitoring bats using genetics. Abstract of paper presented at the North American Symposium on Bat Research, Burlington, Vermont, 6-9 November, 2002.

Perkins, J.M. 1996. Does competition for roosts influence bat distribution in a managed forest. Pp 164-172 *in* R.M.R. Barclay and R.M. Brigham (eds), Bats and Forest Symposium October 19-21, 1995 Victoria, British Columbia, Canada. British Columbia Ministry of Forests Research Branch, 172 pp.

South Dakota NHP Report. 14 March 2002. Locational records of bat species tracked by the SouthDakota Natural Heritage Database. Prepared for Dr. Cheryl Schmidt. 30pp.

Szewczak, J., S. Szewczak, M. Morrison and L. Hall. 1998. Bats of the White and Inyo Mountains of California-Nevada. Great Basin Naturalist 58:66-75.

Thomas, D. 1988. The distribution of bats in different ages of Douglas-fir forests. Journal of Wildlife Management 52:619-626.

Turner, R.W. 1974. Mammals of the Black Hills of South Dakota and Wyoming. University of Kansas Museum of Natural History Miscellaneous Publication No. 60, 178 pp.

Turner, R.W. and J.K. Jones Jr. 1968. Additional notes on bats from western South Dakota. Southwestern Naturalist 13:444-458.

Tuttle, M. and L. Heaney. 1974. Maternity habits of *Myotis leibii* in South Dakota. Bulletin of the Southern California Academy of Sciences. 73:80-83.

US Fish and Wildlife Service. 1994. Endangered and threatened wildlife and plants; annual candidate review for listing as endangered or threatened species; proposed rule. Federal Register 59:58982-59028.

van Zyll de Jong, C.G. 1984. Taxonomic relationships of Nearctic small-footed bats of the *Myotis leibii* group (Chiroptera: Vespertilionidae). Canadian Journal of Zoology 62:2519-2526.

Warner, R. 1985. Interspecific and temporal dietary variation in an Arizona bat community. Journal of Mammalogy 66: 45-51.

Whitaker, J.O., C. Maser and S. Cross. 1981. Food habits of eastern Oregon bats, based on stomach and scat analyses. Northwest Science 55: 281-292.

Vaughan, T. 1986. Mammalogy, 3rd ed. Saunders College Publishing, New York. 576 pp.