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Conservation Assessment for the Long-Eared Myotis in the Black Hills National Forest South Dakota and Wyoming

Dr. Cheryl A. Schmidt

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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.

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INTRODUCTION

This conservation assessment addresses the biology of the long-eared myotis (*Myotis evotis*) 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 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.

There are very few records of this species from the Black Hills region. Therefore, extrapolation about certain aspects of this bat's biology from other areas within its range was necessary. Although not very well-studied in any region, the paucity of information on *M. evotis* from the Black Hills region made it necessary to include as much information from other parts of its range as possible/available.

CURRENT MANAGEMENT SITUATION

Management Status

Myotis evotis is a former federal endangered species candidate. According to the South Dakota Natural Heritage Program, this species carries a Global Status of G5 indicating "demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery" (SDNHP Online 2002). The long-eared myotis occurs across the mountains of the western United States and adjacent Canada and Mexico. It is rarely abundant, but regularly distributed over this area (Barbour and Davis 1969). *Myotis evotis* is monitored by the South Dakota Natural Heritage Program (SDNHP 2002) and is given a State rank of S1, which indicates "Critically imperiled because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction" (SDNHP Online 2002). *Myotis evotis* has been recorded in 22 of the 28 latilongs established for Wyoming, however, 3 of those records are historical records with no recent data to suggest occurrence (Luce et al. 1999). The long-eared myotis is ranked as a Non-game Species of Special Concern – 2 (SSC2) by the Wyoming Game and Fish Department and is a Wyoming BLM Sensitive Species (WYNDD Online 2002).

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). *Myotis evotis* shares assignment to the subgenus *Myotis* with two other species from the Black Hills region, those being *M. thysanodes* and *M. septentronalis* [*keenii*] (Nowak 1991; Nowak 1994). There are four subspecies recognized in western North America: *M. evotis chrysonotus, M. e. evotis, M. e. jonesorum,* and *M. e. pacificus* (Manning 1993); individuals from the Black Hills probably belonging to *M. evotis chrysonotus*. Vernacular names for this species include long-eared myotis, and western long-eared myotis (Barbour and Davis 1969; Holroyd et al. 1994).

Myotis evotis can be difficult to distinguish from *M. septentrionalis* in Canada (Holroyd et al. 1994), and several specimens from South Dakota and Nebraska which were originally identified as *M. evotis* have turned out to be *M. thysanodes* upon further examination (Jones and Choate 1978). *Myotis evotis* is larger, both externally and cranially, than most of its congeners in North America, the exceptions being *M. thysanodes* and some *M. auriculus* (Manning and Jones 1989). Ranges of external measurements (in mm) for *Myotis evotis evotis* from northwestern South Dakota include: total length 87-100; tail length 34-45; hindfoot length 8-11; ear length 19-22; forearm length 36.9-39.3 (Jones and Genoways 1967). Weights of a series of adults from the Northern Plains (southeastern Montana) ranged from 5.7g to 7.6g (Jones et al. 1983). Sexual dimorphism does occur in this species, with females having longer forearms both in measurement and in proportion to body size (Williams and Findley 1979). Although *M. evotis* does have a faint fringe of minute hairs on the posterior edge of its uropatagium, it can be distinguished from *M. thysanodes* in that the latter species has a very conspicuous fringe of stiff hairs (Manning and Jones 1989). *M. evotis* has a dorsal pelage that is brown to straw-colored with a paler venter, and the pelage contrasts sharply with the blackish ears and membranes (Manning and Jones 1989). Both dorsal and ventral hairs have dusky slate-colored bases (Jones et al. 1983). Individuals from the Black Hills reportedly have a darker brown dorsum (Tigner 1997). Obviously, the fact that *M. thysanodes* has been mistaken for *M. evotis* on several occasions indicates that differentiating these two taxa in the field may be difficult.

Distribution And Abundance

Distribution Recognized In Primary Literature

Overall Range

Myotis evotis ranges across much of montane western North America, extending from central British Columbia, the southern half of Alberta, and the southwestern corner of Saskatchewan, south to Baja California along the Pacific Coast and along the western edges of the Dakotas and most of Wyoming and Colorado to northwestern New Mexico and northeastern Arizona (Manning and Jones 1989). The subspecies occupying most of the western United States, including the western edges of the Dakotas is *M. e. chrysonotus* (Manning 1993). It is interesting to note that Manning's (1993) distribution map for all subspecies of *M. evotis* did not include the Black Hills of South Dakota and Wyoming.

Local Distribution

For South Dakota, *M. evotis* is reported in the primary literature only from northwestern South Dakota (Jones and Genoways 1967), although there are unpublished reports of this species from the Black Hills (Meade, Custer and Fall River Counties, SD; Tigner 1992; Tigner and Aney 1993; Tigner and Aney 1994; SDNHP report 2002). Clark and Stromberg (1987) report *M. evotis* to occur in suitable habitat throughout Wyoming, although the majority of the records are from the western half of the state.

Additional Information From Federal, State, And Other Records

The only records of *M. evotis* from the Black Hills come from unpublished sources including the following: US Forest Service Progress Reports (Tigner 1992; Tigner and Aney 1993; Tigner and Aney 1994), including a small (approximately 20 individuals) maternity colony in a building near Sturgis, and a summer record of this species from a cave on the Nemo Ranger District in the northern Black Hills; a record in the SD Natural Heritage Program (SDNHP) database (SDNHP 2002) for a specimen from Custer County, SD attributed to Stebler; a record in the SDNHP database for a nonreproductive female caught in a mist net in Fall River Co., South Dakota; and a record in the SDNHP database indicating this species had been heard by Bob Luce (Wyoming Natural Heritage Program) during an Anabat Survey. No additional information from other state, or from federal records, was found.

Estimates Of Local Abundance

No estimates of local abundance were found in the literature for this species. In general, it is characterized as not occurring in large numbers. Barclay (1993) characterized *Myotis evotis* as a colonial species although the only aggregations known for this species are small maternity colonies of up to 30 individuals (Clark and Stromberg 1987; Fitzgerald et al. 1994).

Habitat Associations

Myotis evotis is primarily associated with coniferous montane forests across western North America (Barbour and Davis 1969). Jones (1965) reported that 100% of the *M. evotis* caught during an ecological study in New Mexico were caught in evergreen forest. In British Columbia, it is associated with ponderosa pine forests and rocky outcroppings in coniferous forests (Holroyd et al. 1994). In Alberta and Saskatchewan, western long-eared myotis are found in riparian areas within the arid badlands regions (Holroyd et al. 1994). In North Dakota, specimens were collected foraging among trees along the Little Missouri River, and from a sinkhole called Medicine Hole Cave (Genoways and Jones 1972). In southeastern Montana this bat was recorded as relatively common in wooded and rocky areas of the Long Pine Hills, the Ekalaka Hills, and Medicine Rocks, and over man-made reservoirs that were close to hills or ridges with pines (Jones et al. 1973). Lampe et al. (1974) reported capturing *M. evotis* over a spring-fed watering tank in a “brush-lined ravine” in Carter County, southeastern Montana. Kuenzi et al. (1999) reported mist netting *M. evotis* in pinyon-juniper woodlands and in riparian stream corridors of central Nevada. Szewczak et al. (1998) found *M. evotis* in the lower drainages of the White Mountains of California and Nevada, and extending up through the pinyon-juniper zone to a maximum elevation of 2470m. They reported a museum specimen from 2895m captured in 1954 along Cottonwood Creek in the White Mountains (Szewczak et al. 1998). Along the Pacific coast, this species extends down to near sea level (Manning and Jones 1989).

Roosting Ecology

Relative to many other species of North American bats, little is known about the roosting ecology of *Myotis evotis*. Reports on the roosting ecology of this species fall into two general categories: 1) anecdotal reports with little details about roost characteristics, and 2) more detailed reports addressing a suite of bats instead of *M. evotis* specifically.

Maternity Roosts

Reproductive females have been found in buildings, rock crevices, and hollow trees (Barclay 1993, Tigner 1997). Tigner (1997) reported a nursery roost of 20-25 individuals (including juveniles) in the attic of an old two-story brick building in Sturgis, South Dakota.

Rabe et al. (1998) reported characteristics of ponderosa pine snag roosts used by five species of reproductive bats, including *M. evotis*, on the Coconino National Forest in northern Arizona. While this study did not specifically address snag roosts used by long-eared myotis, but grouped snags used by all five species, in lieu of species-specific information about tree roosts used as maternity colonies, the information should be considered for *M. evotis.* The following is a bulleted summary of the findings of Rabe et al. (1998):

-Roost snags were larger in dbh than random snags.*

-Roost snags had more loose bark than random snags.*

-Roost snags sites were characterized by:

1). higher tree densities,

2). greater tree species diversity,

3). greater basal area,

4). higher density of snags* and logs,

5). greater slope, and

6). closer to water than random snag sites.

(*Indicate the three most important characteristics.)

See also Table 1 under Day Roosts (below).

Hibernacula

Martin and Hawks (1972) reported finding no *Myotis evotis* hibernating in Jewel Cave in the Black Hills. A survey of 70 mines in central Nevada found no hibernating *M. evotis* (Kuenzi et al. 1999). Foresman (2001) indicated that two long-eared myotis hibernated in a mine in Richards County, Montana, and suggested that many of these bats probably migrate out of Montana in the autumn. The winter range of *M. evotis* is not known and there is a dearth of literature on hibernation for this species. Navo et al. (2002) reported swarming activity of *M. evotis* at a cave on the White River Plateau of Colorado, which suggests that long-eared myotis may hibernate either in that cave or in others in the vicinity.

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

Mari (1994) reported radiotracking a long-eared myotis to a rock crevice on the ground in the

Coconino National Forest of northern Arizona. This record is included under summer (day) roosts because the gender and reproductive condition of the radiotagged bat was not provided. Other summer (day) roosts recorded in the literature for this species include buildings (often abandoned), under loose bark of trees, in hollow trees, among timbers of an unused railroad trestle, in caves and mines, in cliff fissures, and in a portable latrine (Armstrong 1982; Genoways and Jones 1972; Jones et al. 1973; Manning and Jones 1989).

Vonhof and Barclay (1996) examined roost-site selection and roosting ecology of four species of bats, including *Myotis evotis*, in southern British Columbia. They radiotagged and tracked both male and female *M. evotis*, so the discussion of their findings is included here instead of under maternity roosts *per se*. Vonhoff and Barclay (1996) found that these bats preferred snags in decay classes 4 and 5 (characterized generally by being dead, with reduced needles and twigs, bark loose, top often broken, heartwood hard to spongy, and sapwood spongy to soft), that were taller than surrounding trees (positively correlated with greater dbh), close to other available trees, and surrounded by a relatively open canopy.

Vonhof and Barclay (1997) examined the use of stumps in clearcuts by *M. evotis* in British Columbia. Of the1,542 stumps examined in 1994, only 14 stumps (0.9%) were used for roosting by this species. Ten of the 19 roosts found were used by adult males, while the other 9 were used by adult females which, with the exception of one pregnant female, were either nonreproductive or post-lactating. No lactating females were found in any of the stump roosts (Vohnof and Barclay 1997). Values for stump heights and diameters were not provided, but the authors did indicate that the bats preferred cavities on ponderosa pine and lodgepole pine stumps, while also using grand fir, western red cedar, and western white pine in proportion to their availability (Vohnof and Barclay 1997). All clearcuts examined in this study had a southerly aspect (SE to SW; Vohnof and Barclay 1997).

Waldien et al. (2000) examined day roosts used by female *M. evotis* in western Oregon. Their study included both reproductive and nonreproductive females, and roost type did not differ with reproductive condition; hence discussion of this study here as opposed to above under maternity roosts. Waldien et al. (2000) found that females tended to use conifer stumps as day roosts in watersheds dominated by younger forests. In watersheds with greater proportions of older forest, the bats switched to using primarily conifer snags, though some conifer stumps were still utilized. Roosts were mainly in upslope habitat and were an average of 0.59 ± 0.03km from available wter. Conifer stumps used as day roosts had an average height (on the downhill side) of 133 ± 9cm and an average dbh of 59 ± 4cm. Conifer snags used as day roosts had an average height of 34 ± 5m and an average dbh of 93 ± 12cm. Stumps were more likely to be used if they were taller, and if they were situated in a gap in the vegetation (Waldien et al. 2000).

Table 1 presents a comparison of studies which provided snag/stump roost heights and diameters. It should be recognized that these values are for forests that are quite distant from the Black Hills, have different species composition, and have different histories of both management and natural disturbance regimes. As such, the values presented in Table 1 are for reference only and should not be used as guidelines for the Black Hills unless these differences are accounted for.

Table 1. Summary comparison of day roosts used by M. evotis.

Study	Study Location	Type of Roost	Av. Height ± SE (range	Av. dbh ± SE (range) in cm
Rabe et al. 1998	Northern Arizona, Peaks area	Ponderosa Pine Snags	17.8 ± 1.1m (2.8-36.5m)	69.2 ± 2.0 (31.2-101.6)
Rabe et al. 1998	Northern Arizona, Bar M area	Ponderosa Pine Snags	18.8 ± 1.0m (9.1-35.0m)	66.0 ± 1.8 (45.7-91.4)
Waldien et al. 2000	Western Oregon	Conifer Snags	34 ± 5m (range not provided)	93 ± 12 (range not provided)
Waldien et al. 2000	Western Oregon	Conifer Stumps	59 ± 6 cm on uphill side (range not provided) 133 ± 9 cm on downhill side (range not provided)	59 ± 4 (range not provided)

Night Roosts

Myotis evotis apparently makes ready use of caves and mines as night roosts (Barbour and Davis 1969, and citations therein). Adam and Hayes (2000) examined the use of different types of bridges as night roosts by bats in the Oregon Coast Range. Of the bridge types examined (concrete cast-in-place with chambers on underside, concrete flat-bottom, I-beam with concrete or steel girders, and wooden), bats primarily used the concrete cast-in-place bridges as night roosts, probably because the chamber walls restricted airflow thereby conserving heat (Adam and Hayes 2000). Bat use of these bridges as night roosts peaked between 0300 and 0430h, with bats generally departing before 0600h, indicating that they were not used as day roosts (Adam and Hayes 2000).

Interim Roosts

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

Foraging Habits

Barbour and Davis (1969) reported observing this species foraging among the trees and over woodland ponds. Thomas (1988) examined activity of a community of bats, including *M. evotis*, 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).

Seidman and Zabel (2001) examined bat use of intermittent stream habitat in northwestern

California. They reported that *M.* evotis was captured most frequently along medium (mean channel width of 1.9 $\pm$ 0.0m) intermittent streams, and more frequently along medium and large (mean channel width of 7.0 $\pm$ 1.2m), than along smaller intermittent streams or in proximal upland habitats (Seidman and Zabel 2001).

Holloway and Barclay (2000) reported that wooded riparian areas serve as critical foraging habitat for prairie bats in southeastern Alberta, including *Myotis evotis*. Findley (1954) reported taking three male *M. evotis* over a water hole in a sage-covered area of Jackson Hole, Teton County, Wyoming. Fenton et al. (1980) reported capturing *M. evotis* over a talus slope with scrub, at an abandoned mine adit in ponderosa pine forest, at the mouth of a canyon through which flowed a fast-flowing creek bordered by alders and ponderosa pine, and over a narrow strip of desert near a lake.

Times reported for forage emergence of this species varies. Foraging emergence has been reported from well before dark (Hoffmeister 1970) to "late evening" (Armstrong 1982) and later (Manning and Jones 1989). Ingles (1949) reported that *M. evotis* foraging activity changed as the evening progressed, foraging higher (about 12m) above the ground early and moving closer to the ground as the temperature dropped. Ingles (1949) suggested that this change in foraging was in response to insect activity which would drop (both in height above the ground and in amount) as temperatures dropped during the night. Fenton et al. (1980) reported that *M. evotis* in south-central British Columbia emerged between "21:35 and 21:45."

Prey Species

Black (1974) characterized *M. evotis* as a beetle strategist with 92% frequency of occurrence of beetles in fecal pellets examined and 62% occurrence of moths. Warner (1985) reversed the prevalence, reporting Lepidoptera at 93% frequency of occurrence in dietary samples from *M. evotis*, and Coleoptera at 85%. Warner (1985) also reported 30%, 19%, 15% and 15% frequency of occurrence for Diptera, Neuroptera, Hymenoptera, and Homoptera, respectively. Whitaker et al. (1977 and 1981) reported that Lepidoptera comprised the majority (82.6%-84.6% frequency of occurrence) of the diet for this species, and that Coleoptera was a distant second at 21.5%-30.8% frequency of occurrence.

Characteristics Of Prey Species

Freeman (1981) conducted principal components analysis of 14 cranial measurements of 41 species of vespertilionid bats and then regressed the PC loadings against a prey hardness scale. The first principal components axis related to robustness of the skull, with bats on the negative end having more robust skulls, and bats on the positive end having more "gracile skulls" (Freeman 1981). *Myotis evotis* fell out on the first principal components axis at a value of about +0.40 indicating a moderately gracile skull. Freeman (1981) also ranked the hardness of the prey items for these 41 bat species on a scale of 1 (softest; e.g. Neuroptera and Diptera) to 5 (hardest; Coleoptera), and calculated a weighted average of the food habits for each species. According to this scheme, *M. evotis* prey items had a weighted average of 3.33, indicative of the this species' ability to take harder prey, such as beetles (Freeman 1981).

Reproduction And Development

Very little is known about the natural history of long-eared myotis. Manning and Jones (1989) reported that "All available reproductive data for *M. evotis* is anecdotal." While some information has been added since Manning and Jones (1989; e.g. report of swarming by Navo et

al. 2002), the basic status of our knowledge about *Myotis evotis* remains the same: there are large gaps in our knowledge about this species.

Life History Characteristics

Navo et al. (2002) have documented swarming behavior for this species at a cave on the White River Plateau in Colorado. In addition to the first evidence of swarming for this species, Navo et al.'s (2002) findings suggest that *M. evotis* might hibernate at that particular cave or others in the immediate vicinity. Hibernation of *M. evotis* in Colorado has not yet been documented (Navo et al. 2002).

Survival And Reproduction

Long-eared myotis can be long-lived, with a record longevity of 22 years reported for a male (Tuttle and Stevenson 1982 as cited in Manning and Jones 1989). As with most temperate zone vespertilionids, reproductive output is limited to one offspring per year (Barclay 1993).

Local Density Estimates

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

Limiting Factors

No studies found specifically addressed limiting factors for this species.

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

The yellow-bellied racer (*Coluber constrictor mormon*) has been reported to prey upon these bats in British Columbia (McIntosh and Gregory 1976, as cited in Manning and Jones 1989).

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 evotis* competed with moth specialists, specifically *Corynorhinus townsendii*, *Myotis volans*, and *M. thysanodes* for foraging habitat; and more so with *M. thysanodes* because the fringed bat, like *M. evotis*, utilizes gleaning as one foraging style. Reproductive female long-eared bats demonstrated foraging patterns which were significantly separated from male long-eared bats. Non-reproductive females and males showed

no such segregation. 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. In summary, *M. evotis* probably faces the greatest foraging competition from conspecifics and from *Myotis volans* and *M. thysanodes* due to their similar size and preference for Lepidopterans. Long-eared bats also probably compete for forage with another moth strategist, *Corynorhinus townsendii*. While competition for roost sites probably occurs, until roost site selection criteria for *M. evotis* -- and the other bat taxa with whom it is found -- are clearly elucidated, it is difficult to predict with whom they would compete the most.

Parasites, Disease

Ectoparasites recorded from *Myotis evotis* include:

-mites: *Macronyssus crosbyi* (Whitaker and Wilson 1974[1])

Spinturnix americanus (Whitaker and Wilson 1974[1])

-chiggers: *Leptotrombidium myotis* (Andersen and Jones 1971)

Rabies has been recorded in Myotis evotis (Maser et al. 1981[1]).

1 As cited in Manning and Jones (1989)

Other Complex Interactions. Include Interactions With Other Bat Species

No literature was found, other than Perkins' (1996) foraging and distribution studies (see above under Competition) which really *addressed* interaction of long-eared bats with other taxa. Just as the work by Cryan (1997) suggests that the long-legged bat *M. volans* has the potential to compete with other snag-roosting bats such as *Lasionycteris noctivagans* and *Myotis thysanodes*, it could be assumed that, if *M. evotis* does use snag roosts in the Black Hills as it does elsewhere, there may be the potential for competition between *M. evotis* and these other species of snag-roosting bats as well. There is insufficient information available on *M. evotis* to assess these kinds of interactions at this time.

Roost Site Vulnerability

The roosts of snag-roosting species are inherently vulnerable, particularly for those which roost underneath loose bark. The loose-bark stage of a snag is ephemeral, although no studies to date have quantified the longevity of this stage. This stage would undoubtedly vary by species, general climate, and microclimate. There is insufficient information available on roost site selection by *Myotis evotis* for all roost types to make any conclusions relative to roost site vulnerability at this time.

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 risk factors for *M. evotis* 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, are not anticipated to negatively impact long-eared bats. Regeneration openings may provide temporary foraging areas for *M. evotis*, particularly if they are close to roosting areas and standing, open water. Again, harvest activities of any sort which occurs close to known roosting sites of this species *during the maternity roosting period*, would be anticipated to have negative impacts. Furthermore, the avoidance of trees used as maternity roosts may be important because some species of bats have been documented to roost in the same tree over a period of years (Willis et al. 2002).

The 2001 Phase I Amendment to the LRMP increased minimum hard snag requirements to 2 snags/acre for Ponderosa Pine forest on south and west slopes, and 4 snags/acre on north and east slopes (US Forest Service 2001; 5 and 10 snags/ha, respectively). As such, the recommended snag densities approach those recommended by Rabe et al. (1998; 10.6snags/ha) for bats in northern Arizona, but are still well below that reported by Mattson et al. (1996; 21snags/ha) for silver-haired bats in the Black Hills. While Cryan (1997) described snag-roost plots as having a mean number of snags per unit area that was 8 times greater than random plots, no numerical snag densities were provided. No data on snag density requirements for *M. evotis* are available. The 2001 Phase I Amendment also specified that minimum snag diameter be greater than 25cm (10 inches), and requires that 25% of the snags be greater than 50cm (20 inches) in diameter, or in the largest size class available.

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

Assuming that *M. evotis* utilizes caves as hibernacula, the increased interest in spelunking in the United States has the potential to negatively impact *M. evotis* populations as, like most bats, they are very sensitive to disturbance during hibernation 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.

Livestock Grazing

Rabe et al. (1998) reported data which suggest that livestock grazing is negatively associated, either directly or indirectly, with use of snags as roosts by a suite of bats, including *M. evotis*. At one study site where grazed and ungrazed areas were available to bats, nine out of 54 snags used as roosts were located in areas grazed by cattle, whereas 45 snags used as roosts were located in areas not grazed by cattle. At a second study site, where the entire area was grazed by cattle, 43 snags were used as roosts by bats. Obviously, such results are more likely due to some combination of effects on vegetative structure and composition, and perhaps resulting insect prey communities, rather than to direct disturbance of the roosts themselves. 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 still needed.

Mining

No studies were found which addressed the impact of mining activities on *M. evotis.*.

Prescribed Fire

To date, studies directly assessing the impact of fire regimes on long-eared bats are not available. However, given that most bats prefer more open, mature forest with standing dead trees, such as might be maintained by regular prescribed burns, it could be argued that prescribed fire could benefit this species. If fires are frequent enough to reduce the fuel load such that fires are of low enough intensity that large snags are not burned, then the reduction in understory density and height, and the maintenance of a more open forest should provide more suitable roosting sites for *Myotis evotis.*.

Fire Suppression

As mentioned above, the impact of various fire regimes on *M. evotis* 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 the Black Hills can produce doghair stands of ponderosa pine which are not suitable roosting or foraging habitat for long-legged bats. While Bradshaw (1995) characterized *M. evotis* as being adapted morphologically to maneuvering in clutter, even this species avoided highly cluttered environments such as doghair stands. In addition, when fires do occur in areas where fire suppression has been practiced, the fires are more likely to be large, hot burning fires that would destroy suitable roosting habitat for snag-roosting species of bats. Thus, fire suppression in the Black Hills would probably be more of a detriment than a benefit to the long-eared bat populations of this region.

Non-Native Plant Establishment And Control

Characterized by some authors as a moth-strategist, and by others as a beetle specialist, *Myotis evotis* consumes a variety of 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). Henny et al. (1982) reported that *M. evotis* showed no significant increase in carcass residues of DDT and its metabolites after a single DDT spray application. 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

Fuelwood harvest which permits only the removal of downed trees, or of snags under some minimum dbh which has not yet been determined for *M. evotis*, [*Lasionycteris noctivagans* can utilize roosts down to 29cm dbh (Mattson et al. 1996)], may positively impact these bats by removing fuel load and thus reducing the potential for hot burning wildfires which would burn larger snags that serve as potential roost sites for these bats. However, fuelwood harvest in the vicinity of maternity roosts should be avoided during the late spring and through the summer.

Natural Disturbance

Insect Epidemics

No literature was found which dealt with the impact of insect epidemics on long-eared bats. Within the Black Hills, outbreaks of mountain pine beetle (*Dendroctonus ponderosae*) and pine engraver beetle (*Ips pini*) could be predicted to have a detrimental impact on *M. evotis* if the outbreaks went unchecked to the point that large areas of ponderosa pine were killed and downed. In the interim, die-off of trees might provide a larger number of potential roosting sites and reduce potential competition with other cavity-nesting species. It is not known whether or not long-eared bats take either mountain pine beetle or pine engraver beetle during normal foraging.

Wildfire

No literature is available which specifically addresses the impact of wildfires on populations of *Myotis evotis*. However, given that most bats appear to prefer mature, open forest with a relatively high density of snags for roosting sites, certain hypotheses about the role of wildfire in the habitat ecology of long-eared bats can be made. 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 roosting habitats for many snag-roosting 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 long-eared 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 roosting habitat by bats.

Wind Events

While no literature directly addresses the effects of wind events on long-eared bats, the spatial scale of such events would probably determine the consequences for *M. evotis.* Small-scale events which break or down occasional trees, or create small openings, would probably not have a detrimental effect on these bats, and may provide more roosting and foraging habitats. On the other hand, large-scale events which down all or most of the trees in a large area would be predicted to have a detrimental impact on this species.

Flooding

No literature is available that addresses the impact of flooding on *Myotis evotis*. Insufficient information is available about the location of rock crevice roosts to even predict whether or not flooding would be an issue for this species.

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 evotis ranges across much of montane western North America, extending from central British Columbia, the southern half of Alberta, and the southwestern corner of Saskatchewan, south to Baja California along the Pacific Coast and along the western edges of the Dakotas and most of Wyoming and Colorado to northwestern New Mexico and northeastern Arizona. The subspecies occupying most of the western United States, including the Black Hills region is *M. e. evotis.*

M. evotis is generally regarded as common but not occurring in large numbers. While characterized by some authors as a colonial species, records of aggregations of more than about 30 individuals were not found.

Relative to many other species of North American bats, little is known about the roosting ecology of *Myotis evotis*. Reports on the roosting ecology of this species fall into two general categories: 1) anecdotal reports with little details about roost characteristics, and 2) more detailed reports addressing a suite of bats instead of *M. evotis* specifically.

M. evotis consumes primarily moths when available, but is an opportunistic feeder on other invertebrates, including beetles. This species appears to forage primarily over vegetation associated with water, as well as over open areas such as campgrounds and small forest clearings.

REVIEW OF CONSERVATION PRACTICES

Management Practices

Although no conservation plans or other management outlines were found that directly addressed the needs of long-eared bats, Vonhoff (1996) did propose general management practices that, based on available research, should provide the best opportunity to conserve suitable roosting

habitat for snag-roosting bats. Vonhoff's (1996) recommendations included:

Selection Harvesting – following prescriptions that reduce understory and maintain areas of lower density, large-diameter trees with adequate canopy cover to retain a suitable microclimate.

Prescribed Fire – periodic, low-intensity burns to maintain open nature of forest stands.

Retention of large areas of forest with the above characteristics – small numbers of large trees left within cutblocks are not predicted to provide suitable roosting sites for snag-roosting species.

Recommendations made or implied by Rabe et al. (1998) reflect and expand upon the general guidelines put forth by Vonhoff (1996; above) and included the following:

-Sufficient numbers of large trees should be retained for snag recruitment and existing snags should be preserved.

-Fuelwood cutting of large trees (>30.5cm dbh) should be prohibited. (*Based on the work by Mattson et al. (1996) on* Lasionycteris noctivagans *(minimum maternity roost dbh was 29cm), and Cryan (1997) on* Myotis volans *(minimum roost dbh was 37cm)*, *to adapt this recommendation to the Black Hills National Forest, the minimum dbh would need to be decreased to* ***29****cm based on currently available data; minimum dbh for roost snags used by* M. evotis *has yet to be determined)*

-Thinning small trees to improve growth of remaining trees to expedite snag recruitment.

-Killing of large trees to create snags (in areas where natural processes have been impeded).

-Implementation of periodic prescribed fire to emulate historic fire regimes which thinned forests, promoted growth of large trees, and created snags by killing trees.

-Implementation of a long-term management plan to assure that sufficient numbers of large snags in the loose-bark stage are available to bats through time.

-Implementation of research to determine how long ponderosa pine snags remain in the loose-bark stage, and distribution of snag densities by snag stage.

Thomas (1988) concluded, based on his study of bat activity in different-age stands in the Pacific Northwest, that "management practices that remove old-growth and so reduce the overall age structure of forests will have a direct impact on bat populations in the Washington Cascades and the Oregon Coast Range." In addition to these reports which emphasize snags as roosts, Waldien et al. (2000) and Vonhoff and Barclay (1997) reported the use of stumps as ephemeral roosts (please see Day Roosts, above).

Models

Vonhof and Barclay (1997) used stepwise discriminant function analysis to elucidate important habitat features determining the use of stumps by bats in British Columbia. Only one variable significantly distinguished clearcuts used by bats from those not used by bats, and that variable was the proportion of stumps covered by vegetation. Within clearcuts used by bats, stump diameter was the only character that significantly discriminated between roost and random stumps, with bats selecting larger stumps. Also, within clearcuts used by bats, cavity depth and the height of the nearest herbaceous vegetation significantly discriminated between roost and

random cavities (Vonhof and Barclay 1997).

Rabe et al. (1998), based on their study of five species of bats *(including M. evotis*), constructed two different logistic models with characteristics of both snags and surrounding forest structure. The three variables common to both models (larger diameter, exfoliating bark, and higher snag densities) appeared to be the most critical factors in determining snag use as maternity roosts. Rabe et al. (1998) cautioned that application of their models to other forests would have to consider different management histories and consequent distributions of required snag types.

Waldien et al. (2000) used stepwise logistic regression to elucidate features important in selection of snags and stumps for roosting by *M. evotis* in western Oregon. Their analyses indicated that snag use was positively associated with the number of snags within 20m; after accounting for the watershed in which the snag was located, a conifer snag with 7.4 snags within 20m was 4.5 times more likely to be used than a snag having 3.7 snags within 20m. Also, snag use was negatively correlated with distance from the edge of a stand, with a snag located 0.186km from the stand edge being 1.8 times more likely to be used as a day roost than a snag located twice that distance from the edge (Waldien et al. 2000).

The cautionary advice of Rabe et al. (1998) concerning the relevance of these models to forests other than those for which they were developed deserves reiteration. These studies and the resulting models can serve as guides for research and development of such models for the Black Hills, but use of the above models without appropriate adjustments for the Black Hills system could lead to erroneous conclusions.

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 capture techniques yields slightly better results for *M. evotis* than acoustic detection. 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 long-eared bat habitat are known. Current information about roosting requirements for this species is insufficient to provide an adequate starting point for this form of habitat monitoring.

Methods previously discussed for determining presence/absence (mist-netting and acoustic

detection) might be used indirectly, under very 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 radiotelemetry 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

Reports of *M. evotis* from the Black Hills are few and mostly anecdotal. Intensive surveying for this species to determine its distribution and abundance in the Black Hills is necessary if management plans are to be developed for this species. At this time it is not known whether or not the individuals reported from the Black Hills represent a viable population.

Species Response To Stand Level Changes

As no literature was found which documented the response(s) of long-eared bats specifically 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. evots* in this area, assuming that it is ever determined that a viable population of this species even exists in the Black Hills.

Roosting Habitat Adaptability

Information on all aspects of roost selection, both during the reproductive season and during hibernation is needed for this species. At this time, there is insufficient information on any aspect of roost habitat adaptability on the part of long-eared bats to design management plans specifically for this species.

Movement Patterns

Nothing is known about the movement patterns of this species in the Black Hills.

Foraging Behavior

No studies were found which focused on the foraging behavior of long-eared bats occupying the Black Hills of South Dakota and Wyoming. Studies on insectivorous bats of northern forests in other regions indicate that stand type and vertical structure are important (Kalcounis et al. 1999). 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. evotis* remains to be achieved and could be critical in providing for better estimates of viability for this species in the Black Hills.

Table 2. Priorities and cost categories of research needs.

SUBJECT	PRIORITY*	JUSTIFICATION	COST**
Distribution	High	Determine presence/absence of a viable population of *M. evotis* in the Black Hills; Determine extent of BHNF, if any, to be managed for *M. evotis*	Moderate
Species Response to Stand Level Changes	High***	Understand the impact of stand level changes on distribution and foraging habitat	Moderate
Foraging Behavior	High***	Ensure management of all habitats required	Moderate
Demography and Metapopulation Structure	Intermediate***	Allow predictions about habitat change on demographic and genetic structure of BHNF population of *M. evotis*	High

*Low: would refine or improve long-eared bat 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.
***These research needs are based on first substantiating existence of population of *M. evotis* in the Black Hills.

LITERATURE CITED

Adam, M.D. and J.P. Hayes. 2000. Use of bridges as night roosts by bats in the Oregon coast range. Journal of Mammalogy 81:402-407.

Anderson, K. and J.K. Jones, Jr. 1971. Mammals of northwestern South Dakota. University of Kansas Museum on Natural History 19(5):361-393.

Armstrong, D. 1982. Mammals of the canyon country: a handbook of mammals of Canyonlands National Park and vicinity. Canyonlands Natural History Association, Moab, Utah, 236 pp.

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. Habitat use and response to patches of prey by desert insectivorous bats. 58:1876-1883.

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

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

Bradshaw, P. 1995. The physical nature of vertical forest habitat and its importance in shaping bat species assemblages. Pp. 199-212 *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.

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, 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.

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.

Findley, J. 1954. Reproduction in two species of *Myotis* in Jackson Hole, Wyoming. Journal of Mammalogy 35:434.

Fitzgerald, J., C. Meaney and D. Armstrong. 1994. Mammals of Colorado. Denver Museum of Natural History and University Press of Colorado, Denver. 467pp.

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

Freeman, P.W. 1981. Correspondence of food habits and morphology in insectivorous bats. Journal of Mammalogy 62:166-173.

Genoways, H. and J.K. Jones, Jr. 1972. Mammals from southwestern North Dakota. Occasional Papers The Museum Texas Tech University No.6, 36 pp.

Henny, C., C. Maser, J.O. Whitacker Jr., and T. Kaiser. 1982. Organochlorine residues in bats after a forest spraying with DDT. Northwest Science 56:329-337.

Hoffmeister, D.F. 1970. The seasonal distribution of bats in Arizona: a case for improving mammalian range maps. Southwestern Naturalist 15: 11-22.

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

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.

Ingles, L. 1949. Hunting habits of the bat, Myotis evotis. Journal of Mammalogy 30:197-198.

Jones, C. 1965. Ecological distribution and activity periods of bats of the Mogollon Mountains area of New Mexico and adjacent Arizona. Tulane Studies in Zoology 12:93-100.

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. and J. Choate. 1978. Distribution of two species of long-eared bats of the genus Myotis on the Northern Great Plains. Prairie Naturalist 10:49-52.

Jones, J.K.Jr. and H. Genoways. 1967. Annotated checklist of bats from South Dakota. Transactions of the Kansas Academy of Science, 70: 184-196.

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.

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

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

Lampe, R., J.K. Jones Jr., R. Hoffmann, and E. Birney. 1974. The mammals of Carter County, southeastern Montana. Occasional Papers of the Museum of Natural History, The University of Kansas, Lawrence, KS. No. 25, 39 pp.

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.

Manning, R. and J.K. Jones Jr. 1989. *Myotis evotis*. Mammalian Species Account No. 329. American Society of Mammalogists. 5 pp.

Mari, Murphy. 1994. On the track of forest bats. Bats 12:4-9.

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.

Maser, C., R. Mate, J. Franklin, and C. Dryness. 1981. Natural history of the Oregon coast mammals. Pacific Northwest Forest Range Experiment Station. USDA Forest Service, General Technical Report PNW-133:1-496.

Mattson, T., S. Buskirk, and N. Stanton. 1996. Roost sites of the silver-haired bat (*Lasionycteris noctivagans*) in the Black Hills, South Dakota. Great Basin Naturalist 56:247-253.

McIntosh, A. and P. Gregory. 1976. Predation on a bat by a yellow-bellied racer. Canadian Field-Naturalist 90:73.

Navo, K., S. Henry and T. Ingersoll. 2002. Observations of swarming by bats and band recoveries in Colorado. Western North American Naturalist 62:124-126.

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.

Rabe, M.J., T.E. Morrell, H. Green, J.C. DeVos Jr., and C.R. Miller. 1998. Characteristics of ponderosa pine snag roosts used by reproductive bats in northern Arizona. Journal of Wildlife Management 62:612-621.

Seidman, V. and C. Zabel. 2001. Bat activity along intermittent streams in northwestern California. Journal of Mammalogy 82:738-747.

South Dakota NHP Report. 14 March 2002. Locational records of bat species tracked by the South Dakota 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.

Tigner, J. 1992. Preliminary report: survey of bat roost sites on Nemo Ranger District, Black Hills National Forest, October 1992. Unpublished report submitted to Black Hills National Forest. 15pp.

Tigner, J. and W. Aney. 1993. Report of northern Black Hills bat survey, October 1992-October

1993. Unpublished report submitted to Black Hills National Forest. 11pp.

Tigner, J. and W. Aney. 1994. Report of Black Hills bat survey, October 1993-October 1994. Unpublished report submitted to Black Hills National Forest. 19pp.

Tigner, J. 1997. Bats of the Black Hills. Report submitted to the South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Tuttle, M. and D. Stevenson. 1982. Growth and survival of bats. Pp. 105-150, in Ecology of bats (T.H. Kunz, ed.). Plenum Press, New York, 425 pp.

U.S. Forest Service. 1997. Black Hills National Forest Land and Resource Management Plan Revision. U.S. Department of Agriculture, Custer, SD.

U.S. Forest Service. 2001. Black Hills National Forest Phase I Amendment 2001: 1997 Land and Resource Management Plan, Amendment 1 Decision Notice. U.S. Department of Agriculture, Custer, SD.

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

Vonhof, M. and R.M.R. Barclay. 1996. Roost-site selection and roosting ecology of forest-dwelling bats in southern British Columbia. Canadian Journal of Zoology 74:1797-1805.

Vonhof, M. and R.M.R. Barclay. 1997. Use of tree stumps as roosts by the western long-eared bat. Journal of Wildlife Management 61:674-684.

Waldien, D.L., J.P. Hayes, and E.B. Arnett. 2000. Day-roosts of female long-eared myotis in western Oregon. Journal of Wildlife Management 64:785-796.

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.

Whitaker, J.O., C. Maser and L. Keller. 1977. Food habits of bats of western Oregon. Northwest Science 51: 46-55.

Williams, D. and J. Findley. 1979. Sexual size dimorphism in Verspertilionid bats. American Midland Naturalist 102:113-126.

Willis, C.K., K.A. Kolar, A.L. Karst, M.C. Kalcounis-Rueppell and R.M. Brigham. 2002. Long term re-use of trembling aspen cavities by big brown bats (*Eptesicus fuscus*). Abstract of paper presented at the North American Symposium on Bat Research, Burlington, Vermont, 6-9 November, 2002.

Whitaker, J.O. and N. Wilson. 1974. Host and distribution lists of mites (Acari), parasitic and phoretic, in the hair of wild mammals of North America, north of Mexico. American Midland Naturalist 91:1-67.

Websites Cited

SDNHP Online. 2002. South Dakota Natural Heritage Program. 11 April 2002. Rare Mammals List. http://www.state.sd.us/gfp/Diversity/RareAnimal.htm#MAMMALS

WYNDD Online. 2002. Wyoming Natural Heritage Database. April 11, 2002. Species of Concern – Mammals. http://uwadmnweb.uwyo.edu/WYNDD/Mammals/mammals.htm