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BAT SURVEYS AT
BADLANDS NATIONAL PARK
SOUTH DAKOTA

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Much remains to be learned about the natural history of bats in South Dakota and of possible threats to their continued existence. The 11 species of bats known from South Dakota (Choate and Jones 1981, Jones et al. 1983) are all insectivorous and eight of them likely hibernate in winter roosts near their summering grounds; the remaining three species are thought to migrate to the south in winter. Most published information on South Dakota bats is from the more topographically varied western part of the state, particularly the Black Hills and Badlands (Choate and Jones 1981, and references therein). Turner (1974), in his compendium on mammals of the Black Hills, provides considerable information on bats of that area. Tuttle and Heaney (1974) report on maternity habits and roosts of Myotis ciliolabrum in the Badlands, and Farney and Jones (1980) report on the capture of five species from Badlands National Park. Yet, there appears to be no recent published assessment of the status and distribution of bats anywhere in South Dakota, despite considerable interest by a variety of state, Federal, and private biologists.

Bat populations and communities are thought to be strongly influenced by the presence of secure roosting sites (Humphrey 1975). In general, roosts are important for bats as protection from the elements and predators, secure sites for maternity roosts, sites for resting between nocturnal foraging bouts, and sites for winter hibernation for some species. Exact characteristics of preferred roosting sites vary among bat species and for many bats our understanding of their specific roosting needs is quite imperfect. Tuttle and Heaney (1974) found 12 active summer roosts containing 27 M. ciliolabrum in the Badlands. Most roosts contained solitary individuals or a female with young. They believe that M. ciliolabrum exercises considerable selectivity in choice of roost sites; active roosts tended to be small, dry, shallow, and of uniform high temperature (average 29° C).

Our survey of bats at Badlands National Park was initiated in response to a request from National Park Service (NPS) staff for: a current assessment of bats on the Park, especially species that might be of concern; information on bat use of various habitats; and a search for, and evaluation of, bat roosts that might be damaged or destroyed by vandals, construction, or natural erosion. Given observations on roosts in the Badlands (Tuttle and Heaney 1974), and the preponderance of seemingly available habitat, it seemed likely that Badlands National Park might have a diverse bat community, although only five species had been reported previously: M. ciliolabrum, M. thysanodes, M. volans, Eptesicus fuscus, and Plecotus townsendii (Farney and Jones 1980). Two of these species are possible species of concern. M. thysanodes pahasapensis is a Fish and Wildlife Service (FWS) Category 2 Candidate Species, whereas P. townsendii is listed as a sensitive species by the U.S. Forest Service (USFS). The resident race of Townsend's Big-eared bat, P. t. pallescens, is the only race of this species in the U.S. that is not listed as a candidate or endangered species by FWS, but it is a species of concern in several western states. We were particularly interested in obtaining new information on these two species.

Our goals were to: 1) assess species composition, distribution, and relative abundance of bats on the Park; 2) monitor bat activity in different habitats where possible; and 3) search for roosts that might deserve protection. A preliminary report (Bogan et al., 1993) was provided to the Park at the end of the first year of field work.

METHODS

We studied bats at Badlands National Park for portions of two seasons: 25 June

to 15 August 1992 and 20 May to 19 August 1993. During an initial visit we selected sites that looked favorable for capturing bats, e.g., water sources, flyways, and near potential roosts. In general, most sites were in the eastern part of the Park, although we also netted elsewhere. At each site we set three to six mist nets (6, 10, and 14 m in length), opening nets just before sunset and tending them until activity diminished; only rarely were nets left up all night. We netted each site about every 10 days to avoid undue disturbance and to prevent diminished capture success (Kunz and Kurta 1988).

We identified each captured bat and recorded sex, age, reproductive condition, and miscellaneous remarks. Bats were released unharmed after examination. In connection with other work, eight P. townsendii were banded with bands provided by the USFS (Appendix I). One or two vouchers of each species captured were retained and deposited in the vertebrate collection at Badlands National Park or in the Biological Surveys Collection in Albuquerque, New Mexico. We determined sex by examination of primary sexual characteristics and age by the degree of fusion of the phalangeal epiphyses (Anthony 1988). Lactating females were characterized by swollen mammary glands, presence of milk, or absence of hair around the nipples; we determined pregnancy by palpation. We examined males to determine if the reproductive glands (testes, epididymides, or caudae) were enlarged, although we did not measure the testes; enlargement is indicative of spermatogenesis (Racey 1988).

We used a narrow-band ultrasonic detector (Skye-Probetech Model 1200, Perkasio, PA) to monitor bat activity at netting sites, potential roosting sites, and elsewhere to gain information on differential habitat use by flying and foraging bats. We recorded numbers of bat passes per unit time while

scanning from 20 kHz to 70 kHz. Bats were identified when possible, based on the frequency of their ultrasonic emissions.

We searched for day roosts in crevices and caves formed by erosion of the Badlands formations. Outcrops of this formation are more common in the eastern part of the Park and that is where we spent most time searching. We looked and listened for bats or searched for guano. Most crevices and caves could not be entered safely; in some instances we positioned ourselves outside a likely spot and watched for an exit flight of bats in the evening. Where we observed bats or signs of use, we recorded crevice or cave size and aspect. Most searches for roosts were conducted in 1992.

RESULTS AND DISCUSSION

Mist netting.--We spent approximately 60 nights netting or listening to bats; additional days were spent searching for roosts. We captured 405 individual bats (Table 1) at nine sites during the study, including five species previously known from the Park (Farney and Jones 1980). We also captured four species not previously recorded from the Park: M. lucifuqus, M. septentrionalis, Lasionycteris noctivagans, and Lasiurus cinereus. Bessken (in litt.) reported that pellets, likely from a long-eared owl and collected on the Park in September 1993, also contained the skull of a single L. cinereus. The most common bat we captured was M. ciliolabrum, followed by E. fuscus, P. townsendii, M. thysanodes, and M. lucifuqus (Table 1). Farney and Jones (1980) likewise found M. ciliolabrum to be the most common bat in the Park; they captured "several hundred," most of which were released, some with bands. We captured no banded bats.

Exact comparisons of time spent netting in our study and that of Farney and Jones (1980) cannot be made but it appears that the rank order of other species captured is different between the two studies. Farney and Jones (1980) indicate they captured about 50 M. volans, 29 E. fuscus, 10 M. thysanodes, and five Plecotus. We captured surprisingly fewer M. volans and notably more M. thysanodes, Eptesicus, and Plecotus (Table 1). Reasons for these difference are unknown to us but perhaps the bat community in the area is dynamic. We netted more sites than Farney and Jones, but there was water at Cliff Shelf when they netted; these circumstances may account for some of the differences in capture rates.

Of 405 bats captured, 390 were taken at just four locations: Norbeck Pond, 183; Cliff Shelf West, 113; Cliff Shelf, 68; and Close Spring, 26. Farney and Jones netted only at Cliff Shelf and Close Spring, which are described in their paper. Norbeck Pond is located about 0.5 km east of Norbeck Pass in one of two small groves of cottonwoods that are apparently nourished by the occasional pools of water that form here. Cliff Shelf West, where we netted openings among coniferous trees, is located west across Route 240 from the Cliff Shelf Nature Trail. Norbeck Pond and the Cliff Shelf localities are characterized by their proximity to broken and eroded Badlands formations and by presence of mature cottonwood or coniferous trees, among which we have observed bats foraging for insects. The presence of water at these sites appears to be ephemeral. Close Spring, on the western edge of the Park, is some distance from Badlands habitat; its attractive feature to bats may be that it appears to have permanent water. Netting at other sites on the Park was generally unproductive, probably due to a combination of factors, including: greater distance from roosts and other more favorable habitat, absence of predictable sources of water, absence of trees (habitat too open),

and large expanses of open water that were unproductive to net. Nonetheless, we frequently heard or observed bats at these sites. These additional sites are listed in Bogan et al. (1993).

Farney and Jones (1980) noted that most of the bats they captured have western affinities, except for E. fuscus pallidus, which they characterized as widespread in distribution. The four additional species taken by us, and previously unknown from Badlands, include two widespread species, L. cinereus and L. noctivagans, both presumed tree-roosting and migratory species, and a species with more eastern affinities, M. septentrionalis, although this species also is known from the Black Hills (Turner 1974). We suspect that M. septentrionalis is thinly distributed across South Dakota in areas of suitable habitat. Our records of M. lucifugus are from the hiatus between the eastern subspecies lucifugus and the western race carissima (Hall 1981). We tentatively assign our single specimen of lucifugus to the western race, carissima. Although M. thysanodes was once thought to be restricted to the Black Hills, from where the subspecies pahasapensis was named (Jones and Genoways 1967), it is now known from western Nebraska (Czaplewski et al. 1979), southeastern Wyoming (Boyce 1980, Clark and Stromberg 1987), and perhaps northeastern Colorado (Bogan, unpublished).

Of the nine species now known from Badlands National Park, we think six have western affinities at the specific or subspecific level, two (L. cinereus and L. noctivagans) are widespread, and one (M. septentrionalis) has eastern affinities. We did not capture the Long-eared Myotis, M. evotis, which has a restricted distribution in the western part of South Dakota (Jones and Choate 1978), nor did we capture the Eastern Red Bat, Lasiurus borealis, known from scattered localities statewide (Mattson and Bogan 1993).

Males dominated our samples of five species and represented 76.3% of all bats captured. We captured more female than male M. volans and P. townsendii, and only female L. noctivagans and L. cinereus. Two of our netting sites may have been near maternity colonies. Adult female M. volans were slightly more common than adult males at Norbeck Pond and 35 of 37 female Plecotus were captured near Cliff Shelf. Female hoary bats taken in mid-August and a female silver-haired bat captured in late May were likely migrating individuals. Farney and Jones (1980) found males to be more common than females among their samples of M. ciliolabrum, M. thysanodes, and Eptesicus.

We captured pregnant females of M. ciliolabrum (n = 1), Eptesicus (3), and Plecotus (3). Both voucher specimens of P. townsendii contained a single fetus. We captured lactating females of all species except for Eptesicus and Lasionycteris. Hoary bats were postlactating when captured. Starting in late July, our samples contained volant young-of-the-year. We captured juvenile bats of the following species: M. ciliolabrum (n = 13), P. townsendii (4), M. volans (2), E. fuscus (2), M. septentrionalis (1), and M. thysanodes (1). Males with enlarged reproductive glands were first captured in early August with the proportion of such males increasing until netting was concluded each year. In general, our observations on reproduction are in accord with those of Tuttle and Heaney (1974) and Farney and Jones (1980) and suggest that most summer-resident bats at Badlands National Park reproduce on the Park or nearby. Farney and Jones (1980) report a maternity colony of Eptesicus 2 mi E Cottonwood, Jackson County, that contained adult females and nursing young on 5 July. We suspect that migratory species are raising young away from the Park (e.g., the Black Hills; Mattson and Bogan 1993).

Echolocation surveys. --We monitored bat echolocation calls at 16 sites on 24

nights. On many of these nights we also netted bats. The detector did not allow an actual census of bats or the determination of densities, but data on time and relative levels of bat activity, determined from the number of passes, was obtained. Bat detectors were useful in revealing bat activity at sites where netting was non-productive (e.g., large bodies of water) or impossible. For example, bat activity was high at Bighorn and Elizabeth's dams, two large pools of water where no bats were caught.

Overall, our use of the detectors was not consistent enough to provide other than mostly anecdotal observations on bat activity. It was our feeling that bat activity was higher in the eastern portion of the Park, where presumably there is more roosting habitat. Our observations are biased by the fact that we worked more in the eastern part, although we heard bats throughout the park. Additional information is in Bogan et al. (1993). We think detectors can be a useful adjunct in field studies of bats but require a more dedicated effort than we were able to provide. More sophisticated equipment is necessary before actual bat identification would be possible.

Roost searches.--Relative to time expended, few bat roosts were located during our searches. Bat sign (guano) was noted at 24 small crevices in canyon walls; bats, most likely M. ciliolabrum, may have been using these areas as night roosts. Four small unnamed caves that were located all showed signs of use by bats and bats were observed exiting each of these caves. Two larger caves near Saddle Pass Trail and Door Trailhead, also contained bat droppings; we netted M. lucifugus (1) and M. ciliolabrum (5) at the cave near Door Trailhead. We found no maternity roosts. On 21 January 1994, Tigner and Bessken (in litt.) found a solitary Plecotus in a cave near Norbeck Pass; three other caves (Canyon Climb, Saddle Pass, and near Pinnacles Grade)

searched at the same time yielded no wintering bats.

The relative paucity of active roosts that we found, in contrast to good samples of reproductively-active bats we netted, suggests that bats are roosting wherever they find suitable habitat, especially in the eastern portion of the Park. Trees are likely providing roosting habitat as well, especially for maternity colonies. Bat roosts may be inaccessible and difficult or impossible for us to locate. For example, it seems probable that there is a Plecotus roost in the cliffs above Cliff Shelf, an area we chose not to search due to the steep topography and dangerous conditions. Given that we were unable to find significant numbers of roosting bats, the casual Park visitor may be equally unlikely to find, or vandalize, a roost. We suspect that the number and location of suitable bat roosts is dynamic in the Park, given the constantly eroding nature of the Badlands formation. However, sites targeted for development or construction by NPS should be surveyed for bat roosts prior to construction.

SUMMARY AND RECOMMENDATIONS

In general, the bat community at Badlands National Park appears healthy and without obvious threats. The number of bats we captured was probably close to or greater than that of Farney and Jones (1980). We captured more species, partially as a result of netting more sites and spending more time on the Park. There is the possibility that more bats are using the Park now than in 1970 and 1972 when Farney netted there. M. ciliolabrum continues to be the most common bat and is likely favored by the abundance of small cracks and crevices available for roosting. There appear to be no obvious threats to such roosts, at least in the short term.

We caught fewer M. volans than Farney and Jones; no obvious reason exists for this although subtle differences (such as no water at Cliff Shelf but often abundant water in small pools elsewhere when we netted) may explain the disparity. We are not aware of any threats to M. volans. We apparently netted more individuals of other species, especially M. thysanodes (29) and P. townsendii (43). The Fringed myotis was the fourth most common bat, Townsend's big-eared bat the third most common species. Plecotus is often characterized as being difficult to capture and this seems to be especially true in the Black Hills (Mattson and Bogan 1993), although it is undoubtedly present there. The proportion of bats in a given area that can be captured by efforts like ours is probably small and without marking bats no information on this can be obtained. Even with marking the returns are dismally small. Thus, we assume that there are greater numbers of all these species on the Park. Badlands National Park may be marginal habitat for the two resident species with the smallest numbers of captures (M. lucifugus and M. septentrionalis) but we are aware of no threats to their existence elsewhere in the region. All resident species appear to be reproducing on, or at least near, the Park and we found no evidence of sick or injured bats.

We have no direct evidence of specific habitat use by the different species but inferentially it appears their habitat needs are being met by current resources on the Park. Major construction or road projects near Cliff Shelf, and perhaps Norbeck Pass, should be carefully evaluated for possible negative impacts to bats as there may be significant roosts in these areas. It is our impression that the significance of Cliff Shelf and Norbeck Pass to bats resides in the presence of both deciduous and coniferous trees as well as the presence of water. Changes in water availability at these sites might affect either bats or trees and should be carefully considered. Other planned

habitat modifications, e.g., prescribed burning that might affect forested areas, should likewise consider possible effects on bats.

Further research on bats at Badlands National Park could include detailed studies of one or more species, identifying roosting sites (especially maternity roosts) and habitat use through radio telemetry or Cyalume capsules, and elaboration of the bat fauna of the southern unit of the Park, if that is a priority for NPS. Periodic monitoring (perhaps in alternate years) of the more productive sites (Cliff Shelf, Norbeck Pass, and Close Spring) would provide information that might allow establishment of population trends. If significant roosts, especially those used by pregnant or lactating females, are found, steps should be taken to protect the roosts and keep disturbance to a minimum while females are using them.

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Table 1. Captures of bats at Badlands National Park, South Dakota, 1992-1993. Common and scientific names follow Jones et al. (1992).

Species	Males	Females	Total
<u>Myotis ciliolabrum</u> (Western Small-footed bat)	171	27	198
<u>M. lucifugus</u> (Little Brown Myotis)	15	3	18
<u>M. septentrionalis</u> (Northern Myotis)	8	1	9
<u>M. thysanodes</u> (Fringed Myotis)	24	5	29
<u>M. volans</u> (Long-legged Myotis)	4	9	13
<u>Lasionycteris noctivagans</u> (Silver-haired Bat)		1	1
<u>Eptesicus fuscus</u> (Big Brown Bat)	81	10	91
<u>Lasiurus cinereus</u> (Hoary Bat)		3	3
<u>Plecotus townsendii</u> (Townsend's Big-eared Bat)	6	37	43
TOTAL	309	96	405

Two other species known from South Dakota (Choate and Jones 1981), M. evotis and L. borealis, were not captured during our study.

Appendix I. Data on individual Plecotus townsendii banded with USFS aluminum bands during 1993 at Badlands National Park by Jeff Osborne. Abbreviations: F = female; M = male; A = adult; J = volant juvenile (young of year)

Band Number	Sex	Age	Location
0351	F	A	Cliff Shelf West
0352	F	A	Cliff Shelf West
0353	F	A	Cliff Shelf West
0354	M	J	Norbeck Pond
0356	F	A	Norbeck Pond
0357	F	J	Cliff Shelf West
0358	F	J	Cliff Shelf West
0359	M	J	Cliff Shelf West

(Cliff Shelf West is west across Route 240 from Cliff Shelf Nature Trail; Norbeck Pond is a small, occasionally intermittent, pool about 0.5 km east of Norbeck Pass)