

Distribution and Roost Site Selection of Bats in Eastern South Dakota
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Introduction

Since 1861, 24 studies have focused on the bats of the western half of South Dakota; while only Jones and Genoways (1967) and Findley (1956) describe a detailed account of bats found in the eastern half of the state. These research efforts focused on the distribution of bats within South Dakota using mist net captures at foraging sites but did not take into consideration foraging activity or possible hibernacula and roosts. More than 30 years have passed since these data were collected and a much more thorough study needed to be done to document distribution and life history data for those species of bats known to occur in eastern South Dakota.

The literature was reviewed to increase the database of knowledge on bat life history traits and to create a profile of foraging habitat that bats select. In general, temperate bats selected forested areas and lake/river habitat edges, than open prairie or open marsh (Barclay, 1984 and Everette et al., 2001). Sites were selected that are widely distributed across eastern South Dakota to obtain an accurate representation of distribution. A large percentage of the woodland habitat in South Dakota occurs on state and federal land, most of these lands are nearby a water source and are distributed widely across eastern South Dakota. Hence, sites were in several state parks (S.P.) state recreation areas (S.P.) and national wildlife refuges (N.W.R.) throughout eastern South Dakota

A checklist of bats of South Dakota lists eleven species of bat (Choate and Jones Jr, 1981). These species include *Myotis evotis*, *Myotis septentrionalis*, *Myotis ciliolabrum*, *Myotis lucifugus*, *Myotis thysanodes*, *Myotis volans*, *Lasiurus noctivagans*, *Eptesicus fuscus*, *Lasiurus borealis*, *Lasiurus cinereus*, and *Corynorhinus townsendii*. Five of these (*Myotis septentrionalis*, *Myotis lucifugus*, *Eptesicus fuscus*, *Lasiurus borealis*, and *Lasiurus cinereus*) occur state-wide. The South Dakota Natural Heritage Program monitors five species: *C. townsendii*, *M. evotis*, *M. thysanodes* (subspecies *pahasapensis*), *M. septentrionalis* and *L. noctivagans* (Stukel and Backlund, 1997). Of the afore mentioned species, the first three have only been captured in the western part of the state and are commonly found in the Black Hills (Jones and Genoways, 1967; Turner and Jones, 1968). The last species, *L. noctivagans* (long term concern by the South Dakota Natural Heritage Program; Stukel and Backlund, 1997) may occur randomly across the state during seasonal migrations and breeds in the Black Hills.

Objectives for this project were to:

- 1) resample the sites visited by Jones and Genoways and Findley

- 2) document which species of bats are present in eastern South Dakota by sampling several state parks and wildlife refuges
- 3) determine the current distribution of resident bats
- 4) locate possible roosts (trees, cliffs or rock quarries).

Species Accounts

Several state parks or recreation areas and four wildlife refuges exist in eastern South Dakota, of these, 35 sites were sampled. Bats were captured at 18 of these sites during the period of April 15 to August 30th of 2001 (See Appendix 1). Seventy nights were spent sampling, amounting to 370 hours of census time (mist netting and acoustic sampling) and 9,000 miles were traveled. This does not include time spent analyzing ANABAT calls. The species with the highest capture rate was *M. lucifugus*, possibly biased by the placement of mist nets in the La Framboise Recreation area. Of the 52 bats that were captured during 2000 and 2001, *M. lucifugus* made up the largest percentage (35%) of total captures (see Figure 1).

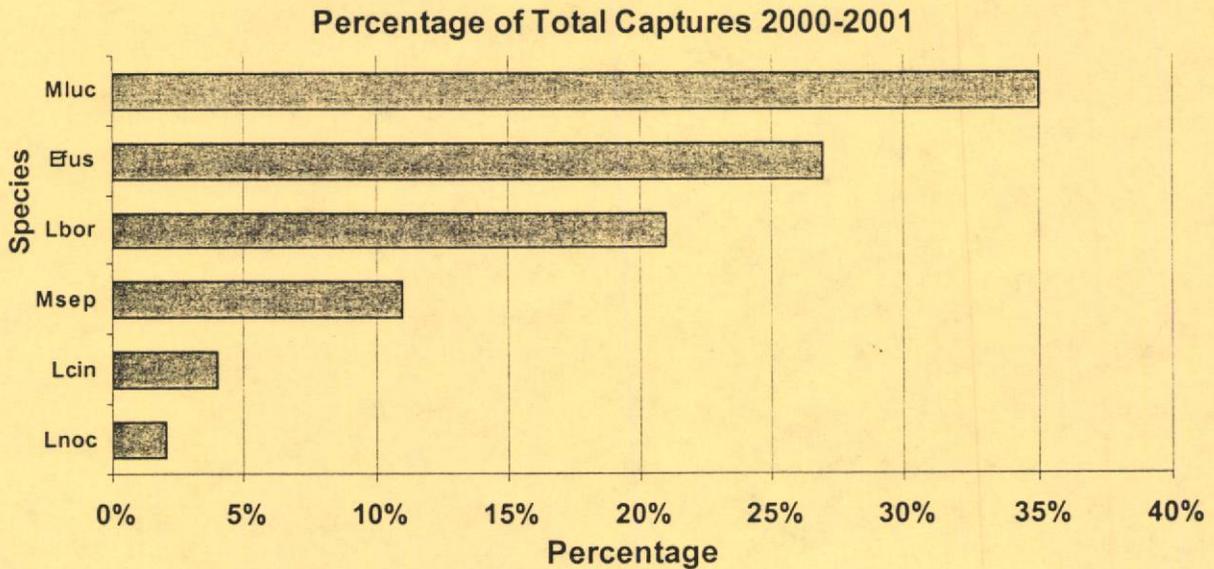


Figure 1: Total captures of bats by species, Eastern South Dakota 2000-2001

Eptesicus fuscus: Big Brown Bat

Distribution in Eastern South Dakota

Findley (1956) mentions that *E. fuscus* is quite common in the city of Vermillion. Capture records exist from Sand Creek Park, Springfield and 3 miles southwest of Springfield (Bon Homme Co.) on

July 22 to 27, 1965 (Jones and Genoways, 1967) and on June 4 1965 from Union County State Park (Union Co.). During the summer of 2000, two male *E. fuscus* were captured at Pioneer City Park in Brookings SD on August 22 2000 (Pedersen, 2000). During the summer of 2001, *E. fuscus* was captured at Cotton Park (Clay Co.), West Bend R.A. (Hughes Co.), Union Co. State Park (Union Co.), Karl Mundt NWR (Gregory Co.), Hitchcock Park in Mitchell (Davison Co.) and Newton Hills State Park (Lincoln, Co.) from June 19 to August 28, 2001. Of the 52 bats that were captured during 2000 and 2001, *E. fuscus* made up the second largest (27%) percentage of total captures (see Figure 1).

Regarding acoustic censusing, the echolocation call of *E. fuscus* has been described as a 'put' sound with a maximum frequency of 28 kHz (Fenton and Bell, 1981). Big Brown bats were either captured or the 28 kHz 'put' sound was heard on the Bat Box III at 17 out of the 35 study sites. The sites where *E. fuscus* was heard, but not captured, in 2001 include: Clay County Park (Clay Co.), Lake Andes NWR (Charles Mix Co.), La Framboise R.A. (Hughes Co.), Waubay NWR (Day Co.), Sioux Falls (Minnehaha Co.), Dell Rapids quarry (Minnehaha Co.), Brookings (Brookings Co.), Adams Homestead and Nature Preserve (Union Co.), Hartford Beach (Roberts Co.), American Creek Recreation Area (Brule Co.), and Ft. Sisseton Historic Park (Marshall Co.) (see distribution map in Appendix 4).

Habitat

Based on acoustic, capture, and Department of Health data from 2000 and 2001, *E. fuscus* seems to predominate within city parks, or areas with nearby human structures. This is evident with the amount of house extractions within the city of Sioux Falls each year. In 2000, out of 251 bats captured and tested for rabies in Sioux Falls, 243 were *E. fuscus* (97% of all captures).

On August 8th, big brown bats were found foraging in Drake Springs Park, Sioux Falls, and on June 19, 2001, in Cotton Park in Vermillion. The *E. fuscus* in Sioux Falls are probably very similar to the *E. fuscus* in Vermillion, roosting in human made structures and then foraging within city parks. The parks being a few places in the city with tree cover, abundance of insects, and an open water source.

Other 'city' parks include Adams Homestead and Nature Area (Union Co.), Cotton Park (Clay Co.), and Hitchcock Park (Davison Co.). The first *E. fuscus* heard during the census was at Adams Homestead and Nature Preserve (Union Co.) on June 17, 2001. The preserve is located within the city of McCook Lake, right at the southeastern most tip of South Dakota. Many different habitats are found throughout the preserve, including marsh, prairie and cottonwood stands. A predominant

cottonwood grove (named Cottonwood crossing, see Appendix 3) seemed to be selected as a foraging site for the bats. During the twilight hours, bats could be seen foraging along the canopy level. The species, *E. fuscus* also seems to select rivers as foraging areas. During censuses at Drake Springs Park and Cotton Park, bats were seen foraging along the Big Sioux and Vermillion River, respectively. At least six bats were foraging over the Vermillion River during the evening of June 19, 2001 and a net was placed parallel to the river and a single male *E. fuscus* was captured.

Karl Mundt NWR seems to be a popular habitat for many species of bat, including *E. fuscus*. All resident bat species that are known to occur in eastern South Dakota were captured at Karl Mundt NWR (see Figure 2). The refuge is one of the few places in eastern South Dakota that is continuous tract of deciduous forest that is located along the Missouri River. Many bats, including *E. fuscus* were heard or captured along this bottomland riparian forest consisting of mostly cottonwood trees. In particular, the bats were captured in an open corridor of the forest leading to the Missouri River.

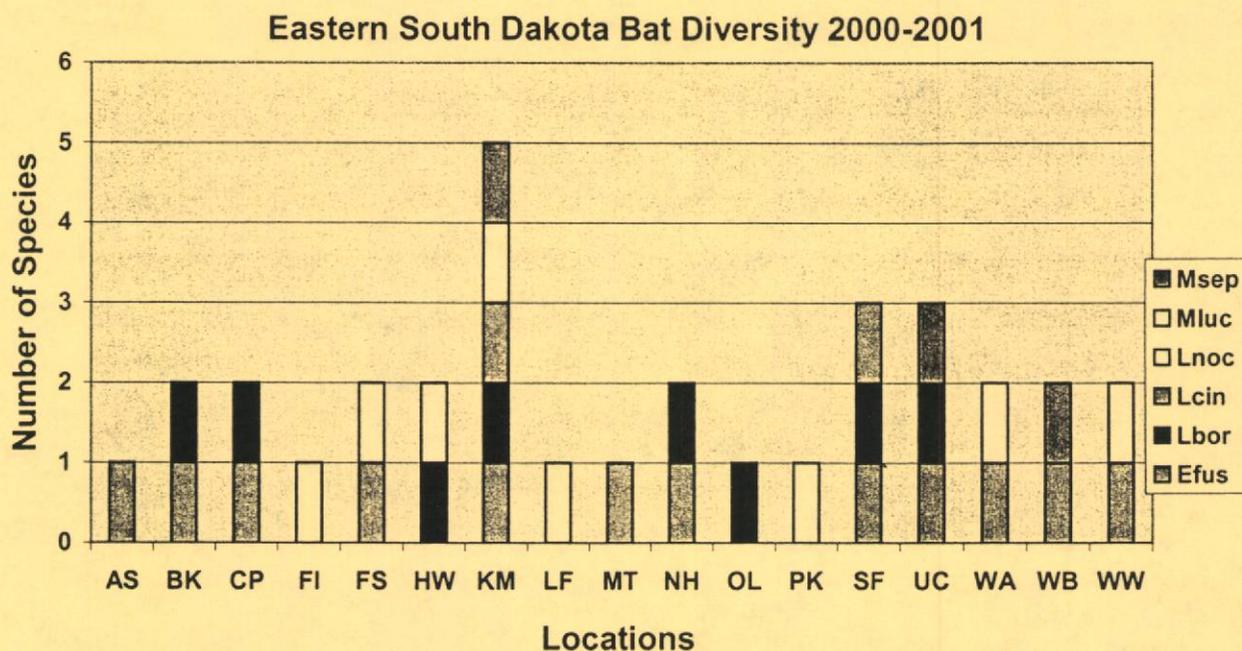


Figure 2: Number of bat species per location, Eastern South Dakota 2000-2001

Abbreviations: (AS-Astoria; BK-Brookings; CP-Cotton Park; FI-Farm Island; FS-Fort Sisseton; HW-Hiddenwood; KM-Karl Mundt NWR; LF-La Framboise; MT-Mitchell Hitchcock Park; NH-Newton Hills; OL-Oak Lake; PK-Pollock; SF-Sioux Falls; UC-Union County; WA-Waubay NWR; WB-West Bend; WW-West Whitlocks)

Reproduction

The most complete life history data has been from Department of Health bats that were collected from Sioux Falls and tested for rabies at the South Dakota Animal Disease Research and Diagnostic

Laboratory, Department of Veterinary Science at South Dakota State University. Bats that tested negative for rabies in 2000 were collected and reproductive data was taken on each specimen. Lactating females were collected from June 19 to July 14, juveniles on June 23 and scrotal males on August 8 (Pedersen, 2000).

During the summer of 2001, one young of the year female was captured in Union County State Park on July 29. Past reproduction data include a gravid female that was captured on June 4 1965 from Union County State Park (Jones and Genoways, 1967).

Roosts

The big brown bat is considered a communal rooster throughout South Dakota. Females will roost together, forming maternity colonies in attics, (a colony was roosting in building #51 in Ft. Meade within the Black Hills until October 2; Herren and Luce, 1997) barns and occasionally tree cavities (Barbour and Davis, 1969). Two male *E. fuscus* were radio tracked in the city of Brookings during the summer of 2000. The bats were found roosting in houses and foraging in Pioneer and Sexhaur Parks; two Brookings city parks composed of mature cottonwood and oak trees (Pedersen, 2000).

Not surprisingly, the bat has been found roosting in many different human made structures in Sioux Falls. On August 9, one female *E. fuscus* was extracted from the Old Courthouse Museum attic in downtown Sioux Falls. This species continues to be found in houses in Sioux Falls as late as November based on DOH data. Also the species was heard at Ft. Sisseton Historic Park (Marshall Co.) on August 23, 2001. The maintenance crew at Fort Sisseton was in the process of repairing some of the historic buildings within the park and had found bats roosting in the buildings in the past.

Parasites

During a census at Hitchcock Park in Mitchell, a male *E. fuscus* was captured with six bat ticks (possibly *Ornithodoros kelleyi*). This species of tick has been reported on other *E. fuscus* captured at Union Co. State Park (Jones and Genoways, 1967).

Myotis lucifugus: Little Brown Bat

Distribution in Eastern South Dakota

No previous capture data exist for this species in eastern South Dakota. Clay County does have a museum specimen (Higgins et al., 2000). The first bat captured during the study was a female *M.*

lucifugus, captured on May 11 2001 at Farm Island Recreation Area, Hughes Co. Another *M. lucifugus* was also captured at Farm Island on July 9, 2001.

This species (*M. lucifugus*) echolocation call has been described as a sharp tick at 40 kHz (Fenton and Merriam, 1983). During a census at Pollock (Campbell Co.) on May 22, 2001, bats were seen and heard on the Bat Box III at 40 kHz. This species was later captured at the Pollock city park on July 14, 2000. On May 23, 2001 another individual was captured at West Whitlocks Bay, Potter Co and on June 23, 2001 at Karl Mundt National Wildlife Refuge (Gregory Co.).

Habitat

Little brown bats will forage over water, or forage among trees in open areas. The sites where *M. lucifugus* was captured are all located near the Missouri River, which could be used as a water source and a foraging area for the *M. lucifugus*. This species, *M. lucifugus* seemed to select larger bodies of water such as the Missouri River and Hiddenwood Lake instead of smaller streams like the Vermillion or Big Sioux rivers (based on capture and acoustic sampling; see distribution map Appendix 4).

The species was consistently captured along the edges or between tree stands. At Farm Island R.A. and West Whitlocks R.A., the capture location was at the edge of a forested walking trail. The bat species was not heard on the Bat Box III in open areas (campgrounds) of various parks but if any tree grove or windbreak existed near a large body of water, *M. lucifugus* could be found.

The species was also captured at Karl Mundt National Wildlife Refuge. The refuge is one of the few places in eastern South Dakota that is a continuous tract of deciduous forest along the Missouri River. The mix of habitats (stand of continuous forest and a large body of water) at this site provided suitable habitat for *M. lucifugus*.

Reproduction

Few reproduction records exist for *M. lucifugus* in South Dakota, especially eastern S.D. In southern Illinois, *M. lucifugus* colonies were formed by the first of April and parturition dates occurred from May 17 to July 12 (Barbour and Davis, 1969).

On May 23, 2001 a gravid female was captured at West Whitlocks Bay R.A. and two post lactating females were captured at La Framboise Recreation Area (Hughes Co.) on July 10, 2001.

Roosts

In western South Dakota, this species has been found to roost in the Coolidge Store in Custer State Park (Herren and Luce, 1997) and roosted in Jewel Cave (Black Hills) from early June to early

August (Martin and Hawks, 1972). This commensal species, roosts together in colonies, and the females often form maternity colonies. On June 2, 2001 while a census was taking place at Waubay National Wildlife Refuge, Day Co., a bat was extracted from a building on the site. This individual was found crawling on the basement floor and was very dehydrated. The bat was a female and her weight (5.5 grams) was below the other individuals that had been captured. She seems to have been trapped in the basement and was slowly weakening due to lack of food and water. The bat was given water but she expired the following day. It is currently a voucher specimen at South Dakota State University Natural History Collection.

Also in the summer of 2001, *M. lucifugus* were found to be roosting in picnic shelters in two parks in eastern South Dakota. The bats were found using one shelter at La Framboise Recreation Area (Hughes Co.) on July 10, 2001 as a night roost. La Framboise R.A. is located within the city of Pierre, SD. Seven females and one male were captured by the picnic shelter. After the bats were released, most returned to the picnic shelter and huddled near the apex of the ceiling. A *M. lucifugus* carcass was found on the floor of the shelter and was also taken as a voucher specimen.

On July 15, 2001, two female *M. lucifugus* were found roosting in the cracks between the support beams and the ceiling of a picnic shelter at Hiddenwood State Park (Walworth Co.). Park personnel commented that the bats had been previously found in the same structure. Even though, *M. lucifugus* is known to roost and even form maternity colonies in human structures (Barbour and Davis, 1969), the species will also roost in trees. Both La Framboise and Hiddenwood had what appeared to be available tree roosts but the picnic shelters were selected instead. Ambient temperature seems to be the most important factor in selection of a roost and day roosts (Fenton, 1970). Because temperature and exposure are associated with roost selection, data loggers will be placed in the roost at La Framboise Recreation area in the future to examine these possible factors.

Parasites

Of the two *M. lucifugus* that were captured at Karl Mundt National Wildlife Refuge. One was a female and its weight was greater than any other little brown bats captured (7.1 grams), the other was a male of average weight (6.0 grams) but it was covered with many white mites.

Myotis septentrionalis: Northern Myotis

Distribution in Eastern South Dakota

Previous capture records exist from Sand Creek Recreation Area and three miles southwest of the city of Springfield (Bon Homme Co.) on July 26, 1965 (Jones and Genoways, 1967). During the summer of 2001, *M. septentrionalis* was only captured at three locations, 11% of the total captures (see Figure 1). The species was first captured on June 16, 2001 at Union County State Park (Union Co.). A male *M. septentrionalis* was captured and later retained as a voucher specimen. Another male was captured on July 29, 2001 in the same net location as the previous capture. On June 23 and August 13 2001, *M. septentrionalis* was captured at Karl Mundt NWR. The last location that *M. septentrionalis* was captured was West Bend Recreation Area on August 19, 2001.

Habitat

The species, *M. septentrionalis* was captured near water sources in mature deciduous forested areas as *M. septentrionalis* seems to select larger, older trees with a DBH of 39 cm (Cryan, 1997). Union Co. State Park is a continual pocket of deciduous trees located in the valley between the Vermillion River and the Big Sioux River. It is in the southeastern corner of South Dakota and nine miles from the Missouri River. Karl Mundt NWR is one of the few places in eastern South Dakota that is continuous tract of deciduous forest with a mix of mature hardwoods and decaying trees along the Missouri River.

The other location that *M. septentrionalis* was captured was West Bend Recreation Area. On previous censuses, mist nets were placed in the newer region of the park, but the northern myotis was not captured. Yet, on August 19, 2001 a male was captured within the older region of the campground. Comparatively, the older region has more mature trees with a greater abundance of foliage while the newer campground has few young trees.

Roosts

In western S.D., this species has been found to roost in Ice Cave (Black Hills) in late July (Turner and Davis, 1970). Daytime roosts used were trees that were still living at a mean height of 4.3 meters and a DBH of 39 cm (Cryan, 1997). In Jewel Cave (Black Hills) males were found to roost alone from early June to early August (Martin and Hawks, 1972).

Reproduction

Few reproductive records exist for *M. septentrionalis* in South Dakota. Lactating females have been found in the Black Hills in late July (Cryan, 1997).

Lasiurus borealis: Eastern Red Bat

Distribution in Eastern South Dakota

In eastern South Dakota, this species has been previously captured in Brookings (Brookings Co.) on June 29, 1953 and also from three miles south west of Springfield (Jones and Genoways, 1967). In 1956, Findley reported that this species was common from the city of Vermillion. During the summer of 2000, *L. borealis* was captured in Brookings (June 14, July 17, and August 26) and at Oak Lake Field Station, SDSU (August 23). Also in 2000, one male and three females were collected from Sioux Falls by DOH and tested for rabies.

During the summer of 2001, *L. borealis* was either captured or heard via the Bat Box III at almost every site (25 out of the 35), more than any of the other species (see distribution map Appendix 4). Yet, during the summer of 2001, *L. borealis* was only captured at four sites (McCrary Gardens, Karl Mundt NWR, Newton Hills state park and Union Co. state park) and the specimens were immature. The one eastern red bat that was captured at McCrary Gardens in Brookings in 2001 was pregnant. Eastern red bats are difficult bats to capture. Only the inexperienced bats or the heavy laden (pregnant or carrying young) bats are commonly captured. Due to this difficulty, other means (echolocation calls and flight patterns) were used to identify eastern red bats.

The echolocation calls of *L. borealis* are described as a tonal chirp at 40 kHz (Fenton and Merriam, 1983). In eastern S.D, the tone was deeper (38 kHz) and the call duration was longer than that of other species such as *M. lucifugus*. The flight pattern of *L. borealis* was also very distinct: in open canopy sites the eastern red bat flies in large circles along the tree line. The bats would continue to fly in the same circle for a few minutes and then repeat that same pattern at a different location. Barbour and Davis describe a similar flight pattern (1969).

Habitat and Behavior

Eastern red bats select mature trees with large canopies and open areas to forage and their patterns are consistent among and between years (Kunz, 1973). For example, throughout the summer of 2001, *L. borealis* would repeatedly forage in the same locality. Nets set in McCrary Gardens (Brookings) that captured bats in 2000, also captured bats in 2001.

Reproduction

Based on reproductive data collected from the last two summers, *L. borealis* are gravid in early June, parturition dates are in mid-June, and juveniles are found flying around the end of July to early August. Past records indicate that a female carrying two young was captured on June 29, 1953 from Brookings (Jones and Genoways, 1967.). During the summer of 2000, a *L. borealis* and young was captured in Brookings on June 14 and a young of the year was captured at Oak Lake Field Station, SDSU on August 23. During the summer of 2001, a gravid female *L. borealis* was captured on June 7, 2001 at McCrory Gardens. A juvenile male was captured on July 29 at Union County State Park (Union Co.) and a young of the year female was captured at Newton Hills State Park (Lincoln Co.) on August 9. Based on reproductive data collected from the last two summers, *L. borealis* is gravid in early June, parturition dates are in mid June and juveniles are found flying around the end of July to August.

Migration

Eastern red bats may be migrating into eastern South Dakota by early June. Fifteen sites were censused between April 15 and June 3rd, but no eastern red bats were heard or captured until the 5th of June. However, Findley (1956) recorded eastern red bats active in the region as early as mid-April. During censuses on April 15 and 16th, the temperature at nine p.m. was 38.1 F, and no insects were observed. A week earlier, on April 10th 2001 (when the temperature was warmer), observations were made by local townspeople (including Dr. Dave Swanson and Erik Likeness, faculty at the University of South Dakota) of bats foraging around the street lights in Vermillion, S.D. Therefore, bats do seem to be active in early April. In other regions, *L. borealis* flew whenever the temperature rose above 55 F (Lewis, 1940). Due to the apparent influence of temperature on bat activity, bat censuses in 2002 will not begin until the night time temperature is up to 50 F.

The species may be migrating out of South Dakota by late August, early September. In 2001, sites were sampled from April 15 to August 30, 2001. After August 13, *L. borealis* was gone. McCrory Gardens were censused on August 14th but not a single *L. borealis* was captured or heard that night. Also, eastern red bats were foraging all throughout American Creek Recreation Area (Brule Co.) in July; however, on August 18 they were gone. During the summer of 2000, the latest date when a *L. borealis* was captured was August 26.

Lasiurus cinereus: Hoary Bat

Distribution in Eastern South Dakota

Early records report that a hoary bat was captured at Swan Creek Recreation Area (Walworth Co.) on July 9, 1904 (Visher, 1914). Findley (1956) also reported that this species was found in Clay County but was less commonly than *L. borealis*. In areas where *L. cinereus* has been found to be uncommon, *L. borealis* is abundant (Kunz, 1973). The species, *L. cinereus* has been captured at Sand Creek Recreation Area (Bon Homme Co.) on July 26, 1965 (Jones and Genoways, 1967). In the summer of 2000, one male and two females were collected from Sioux Falls for rabies testing. In the summer of 2001, *L. cinereus* was only captured at two locations. On June 23, the species was captured at Karl Mundt NWR (Gregory Co.) and on West Whitlocks Bay (Potter Co.) on July 16, 2001.

Habitat

A hoary bat was captured in bottomland forest of Karl Mundt NWR along with four species (*E. fuscus*, *L. borealis*, *M. lucifugus* and *M. septentrionalis*). The forested habitat of Karl Mundt NWR provides sufficient foraging and possibly roosting habitat for each of these species. The refuge is located along a riparian corridor and is one of the few continuous tracts of forested land in eastern South Dakota, making it prime habitat for many species of bats. Further investigation into roosts and movements of bats along the Missouri River will be emphasized next summer and particular attention will be paid to Karl Mundt NWR.

A hoary bat was also captured at West Whitlocks Bay Recreation Area (Potter Co.). Not surprisingly the bat was captured along the Missouri River, which seems to a mecca of bat activity. Also, West Whitlocks is only a few miles south of Visher's (1914) account of *L. cinereus* at Swan Creek.

Reproduction

A female *Lasiurus cinereus* was found on June 1, 1998 hanging from the steps of a wooden deck of a house in Mitchell, S.D (Mullican, 1999) with her torpid young. The best estimate for parturition date was the middle of May. This is the earliest record of reproduction of *L. cinereus* in the Northern Great Plains. In the Black Hills of South Dakota, a lactating and a pregnant female were found on June 13 (Turner, 1974)

Lasionycteris noctivagans: Silver-haired Bat

Distribution and Habitat in eastern South Dakota

Only one previous record of *Lasionycteris noctivagans* exists in eastern South Dakota and that was a female from Waubay National Wildlife Refuge on September 4, 1952 (Jones and Genoways, 1967). This female was probably a migrant but Jones and Genoways suggest that a residential (breeding) population could exist in northeastern South Dakota (1967). During the summer of 2001, a male *L. noctivagans* was captured on July 18 at Fort Sisseton Historic Park (Marshall Co.). The park is within close proximity to many different lakes and as these lakes have flooded many snag trees remain. The silver-haired bat is a cavity roosting tree bat that tends to select for standing dead trees for roosts. The captured silver-haired bat may have been a migrant but the fall migration period starts in late August or early September (Banfield, 1974).

Roosts

Maternity roost locations can be found in tree cavities within patches of forest with high snag densities of 21 snags per hectare (Mattson et al., 1994). Males roost exclusively in trees during summer and tend to select for standing dead trees of larger than average diameter (several dead limbs, multiple woodpecker holes) (Mattson et al., 1994). A silver-haired bat was also found hibernating in the Black Hills of S.D. in a small cave of Dark Canyon (Turner and Jones, 1968). Yet, during the winter of 1969 to 1970, every cave in Dark Canyon was surveyed starting in November and continuing throughout winter, but no silver-haired bats were found hibernating (Martin and Hawks, 1972). Martin and Hawks cited that the hibernating individual found by Turner and Jones to be a 'straggler' from the main populations that had already migrated out of the Black Hills. Although, possibilities for hibernaculum could exist in the Black Hills in larger, semi-hollow trees (Martin and Hawks, 1972).

Parasites

Three bat bugs (*Cimex adjunctus*) were found on the silver-haired bat that was captured at Fort Sisseton. These ectoparasites were feeding behind the bat's ears but when disturbed, they began to move about the bat's body. This bat bug has been reported on *L. noctivagans* previously (Usinger, 1966).

Distribution maps

Distribution maps have been constructed for each species. Drawing on previous literature (Jones and Genoways, 1969; Findley, 1956) and the last two recent summer data from 2000 and 2001. The maps are attached as Appendix 4.

Study Sites and BNN

At most sites capture rates (bats per net per night; (BNN) were quite low. In all but two locations, the BNN was less than one. The two locations with the highest capture rates were locations along the Missouri River: La Framboise Recreation Area and Karl Mundt National Wildlife Refuge (see Figure 3). Because mist nets were unknowingly placed next to a roost site of *M. lucifugus*, the capture rates at La Framboise were quite high.

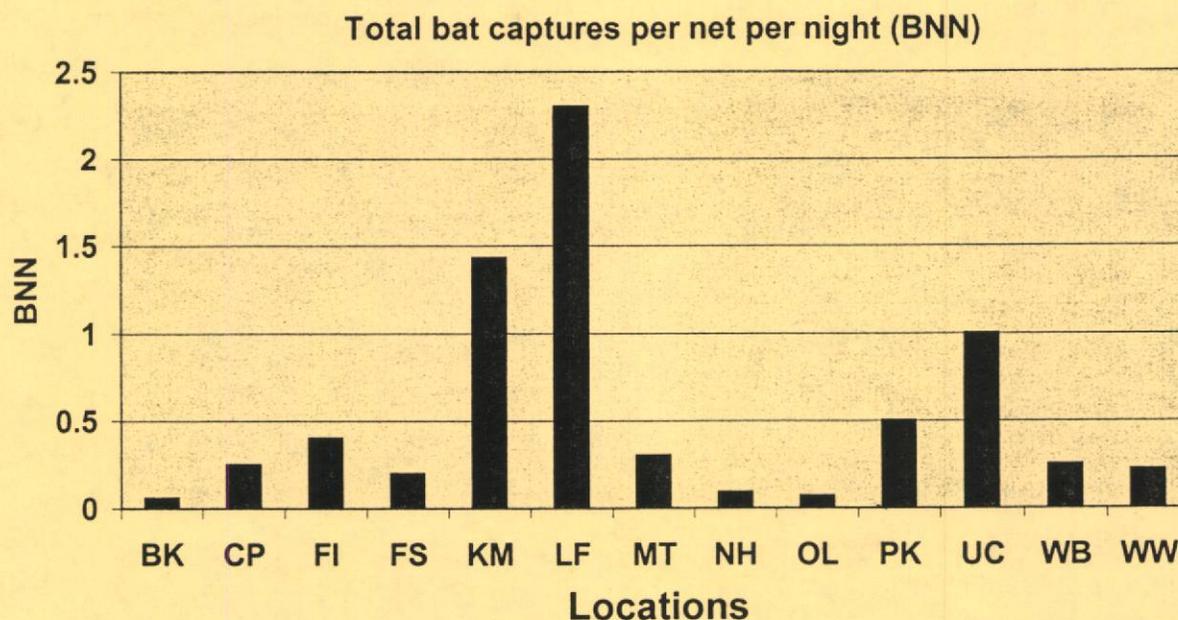


Figure 3: Bat captures per net per night (BNN) by Locations, Eastern South Dakota 2000-2001

Abbreviations: (BK-Brookings; CP-Cotton Park; FI-Farm Island; FS-Fort Sisseton; KM-Karl Mundt; LF-La Framboise; MT-Mitchell Hitchcock park; NH-Newton Hills; OL-Oak Lake; PK-Pollock; UC-Union County; WB-West Bend; WW-West Whitlock)

Although most of the 35 sites, at least one species of bat (usually a *L. borealis*) was either captured or heard on the Bat Box III, some sites were a total bust. These sites were Platte Creek Recreation Area (Charles Mix Co.) and Sand Lake National Wildlife Refuge. Platte Creek was censused on May 9, June 24, and August 17. On August 17th, the ANABAT did record a small number of calls but these calls remain to be analyzed. Platte Creek did not have any mature trees and is mostly

open habitat, which does not provide any cover or roosts for bats (see picture Appendix 3). Sand Lake National Wildlife Refuge was censused on May 29-30 and July 26-27. Tree groves along Sand Lake were specifically surveyed including those in the Columbia Recreation Area. Sand Lake NWR is an immense refuge and surveying all possible habitats was not possible in the limited amount of time and personnel. The biologist at the refuge, William Schultze, did photograph a bat roosting in a woodpile on the refuge in August 1987. The species appears to be a *L. noctivagans*.

ACOUSTIC METHODS

The ANABAT system (Titley Electronics) is a popular acoustic sampling system used in bat censuses (Everette et al., 2001; Hayes, 1997; Murray et al., 2001). The ANABAT II bat detector (2001 SD Wildlife Diversity Small Grant) records the echolocation calls emitted by the bat via a broadband microphone and translates the calls into a frequency that is audible to the human ear. Due to the fact that only one researcher was actively conducting this study, mist nets and ANABAT were being used simultaneously, but the ANABAT was used remotely and the calls saved to a tape recorder (Radio Shack CTR 121). The calls are then downloaded into a laptop computer (Sony Vaio, 2000 SD Wildlife Diversity Small Grant) for subsequent analysis.

ANABAT detectors were placed in bat flyways to maximize the possibility of encountering at least one species of bat. The detectors were arranged throughout the study site and depending on the area of the site, up to three detectors were used at one time. The ANABAT bat detector, delay switch, batteries and tape recorder were placed inside a 42X29X15 cm (12 Quart) Tupperware container (see picture Appendix 3). The Tupperware containers were then duct taped to the shelf of a 6-foot ladder (see picture Appendix 3). In most cases, the detectors remained at the site overnight from 7 p.m. to 7 a.m. Yet, due to the fear of the detectors being damaged or stolen at many sites, some were taken down after mist netting was finished (around midnight or 1 a.m.).

The ANABAT system was used to determine the bat activity (i.e. number of passes and times of peak activity) in each location. Over 2,000 ANABAT files were analyzed. The number of acoustic passes over the ANABAT microphone is correlated with bat activity. These passes can be tallied and the total activity can be found for each study site. The two most active sites were Farm Island and Adams Homestead (see Figure 4), which are two of the few continuous tracts of forested land in eastern South Dakota and are located along the Missouri River corridor. Both sites had mature trees and Farm Island had an abundance of tree in various states of decay, which provide roosting habitat

for a variety of bat species (foliage roosters and cavity roosters). Further investigation into the roosts and movements of bats along the Missouri River are planned for summer 2002.

The large number of recorded calls are still being analyzed. I am currently trying to create reference calls for each species. Once my call library is complete, the ANABAT calls will be used to identify species recorded at each location. Parameters such as call frequency, duration, maximum and minimum frequency will be used to compare the recorded calls with reference calls.

ANABAT ACTIVITY

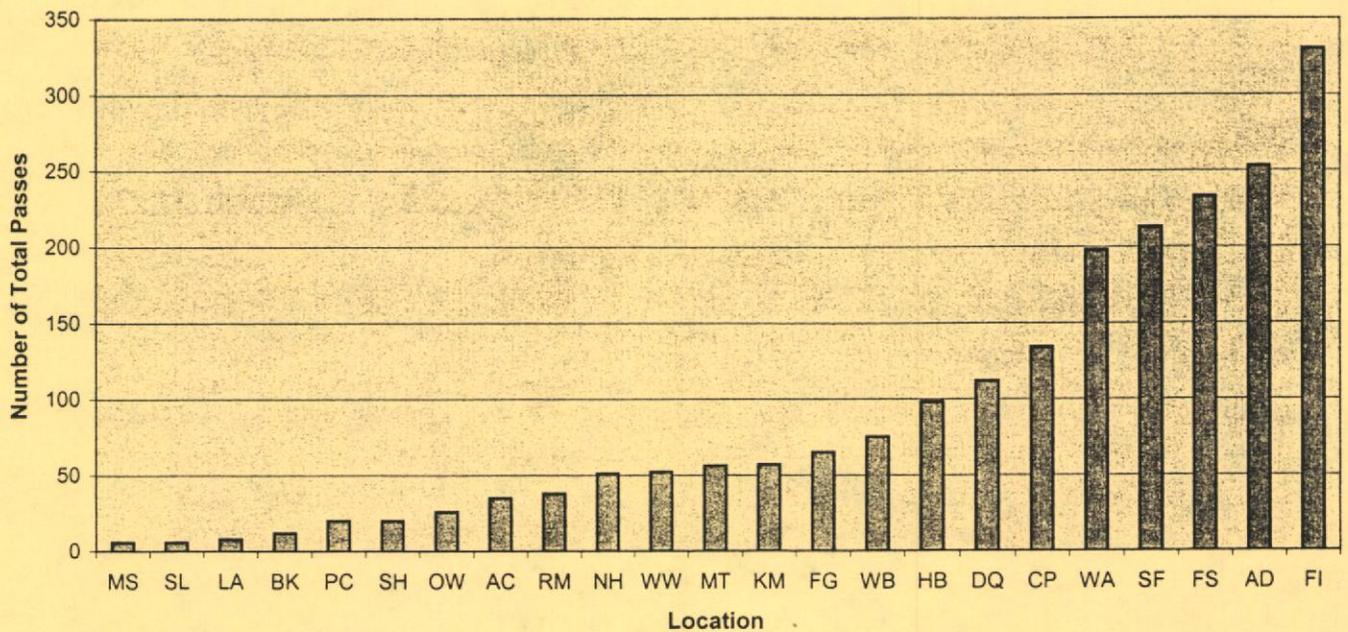


Figure 4: ANABAT activity by Location, Eastern South Dakota 2001

Abbreviations: (MS-Mina Lake; SL-Sand Lake; LA-Lake Andes; BK-Brookings; PC-Platte Creek; SH-Sica Hollow; OW-Oakwood; AC-American Creek; RM-Richmond Lake; NH-Newton Hills; WW-West Whitlocks; MT-Mitchell Hitchcock park; KM-Karl Mundt NWR; FG-Fisher Grove; WB-West Bend; HB-Hartford Beach; DQ-Dell Rapids Quarry; CP-Cotton Park; WA-Waubay NWR; SF-Sioux Falls; FS-Fort Sisseton; AD-Adams Homestead; and FI-Farm Island)

Conclusion

Bat populations in eastern South Dakota seem to be concentrated within the forested habitat bordering the Missouri River. Because these sites (Karl Mundt National Wildlife Refuge, Farm Island Recreation Area and La Framboise Recreation Area) are all located along the Missouri River, they have greater diversity and abundance of bats than other sites in eastern S.D. Not only are Karl Mundt, La Framboise and Farm Island important habitats for bats because of their proximity to the

Missouri River, both these sites have older trees and trees in some sort of decay stage. All species of bats found in eastern South Dakota will roost in trees and some particularly prefer older, larger trees.

If census efforts were focused upon these habitats, more information regarding the roosting, foraging habitat, and feeding ecology of bats in eastern South Dakota could be collected. This information can provide important data for an appropriate management plan to protect existing bat habitat and maintain the current diversity of bats of South Dakota.

Acknowledgements

I would like to thank the South Dakota Game, Fish and Park for their financial support of this project (2001 SD Wildlife Diversity Small Grant) with special thanks to Eileen Dowd Stukel and Doug Backlund.

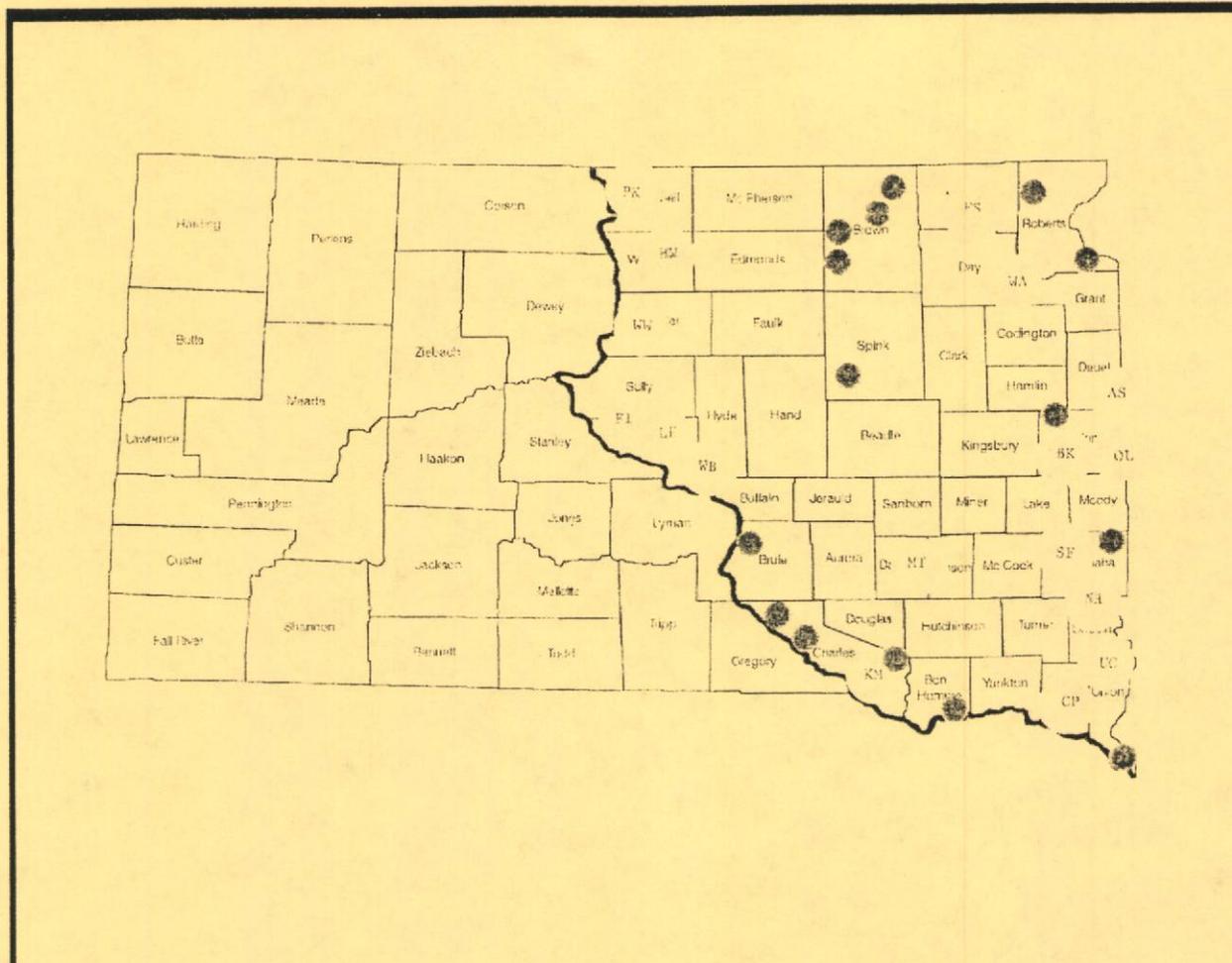
I would like also to express my appreciation to Dr. Kenneth Higgins for providing a state vehicle and fuel so I could reach my study sites and perform the survey. Without his support, I would not have been able to continue the fieldwork throughout the summer and I would also have much less data. I would still be stranded in Gettysburg South Dakota!

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Eastern South Dakota Sample sites

Yellow dots represent sample sites where bats were captured and detected with ANABAT: PK (Pollock), HW (Hiddenwood State Park), WW (West Whitlock), FI (Farm Island), LF (La Framboise Recreation Area), WB (West Bend), KM (Karl Mundt National Wildlife Refuge), MT (Mitchell), CP (Cotton Park), UC (Union County), NH (Newton Hills), SF (Sioux Falls), BK (Brookings), OL (Oak Lake), AS (Astoria), WA (Waubay National Wildlife Refuge), FS (Fort Sisseton)

Green dots represent sample sites where bats were not captured but detected with ANABAT: AD (Adams Homestead), SF (Sioux Falls), DQ (Dell Rapids Quarry), HB (Hartford Beach), FG (Fisher Grove), RM (Richmond), AC (American Creek), OW (Oakwood), SH (Sica Hollow), PC (Platte Creek), LA (Lake Andes NWR), SL (Sand Lake NWR), and MS (Mina State)

Appendix 2

Species	Location	Date	Forearm	Mass	Reproductive Condition	Sex
Mluc	Farm Island	5/11/01	34 mm	5.8 g	nothing	Female
Mluc	West Whitlock	5/23/01	36 mm	6.3 g	pregnant	Female
Mluc	Waubay NWR	6/2/01	36 mm	5.5 g	nothing	Female
Lbor	McCrary Gardens	6/7/01	42 mm	20.8 g	pregnant	Female
Msep	Union Co. State Park	6/16/01	36 mm	6.5 g	nothing	Male
Efus	Cotton Park-Vermillion	6/19/01	46 mm	14.0 g	nothing	Male
Mluc	Karl Mundt NWR	6/23/01	35 mm	7.1 g	nothing	Female
Msep	Karl Mundt NWR	6/23/01	36 mm	7.6 g	nothing	Female
Mluc	Karl Mundt NWR	6/23/01	35 mm	6.0 g	nothing	Male
Lcin	Karl Mundt NWR	6/23/01	54 mm	26.0 g	nothing	Female
Efus	West Bend R.A.	7/8/01	46 mm	23.5 g	post lactating?	Female
Mluc	Farm Island	7/9/01	35 mm	7.0 g	nothing	Female
Mluc	La Framboise	7/10/01	38 mm	9.0 g	post lactating?	Female
Mluc	La Framboise	7/10/01	38 mm	9.0 g	nothing	Female
Mluc	La Framboise	7/10/01	36 mm	8.0 g	nothing	Female
Mluc	La Framboise	7/10/01	36 mm	9.0 g	nothing	Female
Mluc	La Framboise	7/10/01	39 mm	10.0 g	post lactating?	Female
Mluc	La Framboise	7/10/01	37 mm	5.0 g	nothing	Female
Mluc	La Framboise	7/10/01	36 mm	6.0 g	nothing	Male
Mluc	La Framboise	7/10/01	36 mm	9.0 g	nothing	Female
Mluc	Pollock town city	7/14/01	37 mm	7.0 g	nothing	Female
Mluc	Pollock town city	7/14/01	35 mm	7.0 g	nothing	Male
Mluc	Hiddenwood R.A.	7/16/01	36 mm	11.0 g	nothing	Female
Mluc	Hiddenwood R.A.	7/16/01	37 mm	11.0 g	nothing	Female
Lcin	West Whitlock	7/16/01	56 mm	39 g	post lactating?	Female
Lnoc	Fort Sisseton Historical	7/18/01	41 mm	11.0 g	nothing	Male
Lbor	Union Co. State Park	7/29/01	39 mm	9.0 g	YOY	Male
Lbor	Union Co. State Park	7/29/01	40 mm	12.0 g	nothing	Female
Lbor	Union Co. State Park	7/29/01	42 mm	13.0 g	nothing	Female
Efus	Union Co. State Park	7/29/01	44 mm	13.0 g	nothing	Male
Efus	Union Co. State Park	7/29/01	48 mm	17.0 g	nothing	Female
Msep	Union Co. State Park	7/29/01	34 mm	7.0 g	nothing	Male
Efus	Old Courthouse Museum	8/9/01	47 mm	17.7 g	YOY	Female
Lbor	Newton Hills State Park	8/9/01	39 mm	12.6 g	YOY	Female
Efus	Newton Hills State Park	8/9/01	47 mm	15.5 g	YOY	Female
Lbor	Karl Mundt NWR	8/13/01	37 mm	10.1 g	YOY	Male
Msep	Karl Mundt NWR	8/13/01	36 mm	6.3 g	nothing	Female
Msep	Karl Mundt NWR	8/13/01	34 mm	5.5 g	nothing	Male
Efus	Karl Mundt NWR	8/13/01	45 mm	15.6 g	nothing	Female
Efus	Karl Mundt NWR	8/13/01	46 mm	15.4 g	nothing	Female
Efus	Karl Mundt NWR	8/13/01	45 mm	20.4 g	nothing	Female
Msep	West Bend R.A.	8/19/01	36 mm	7.4 g	nothing	Male
Efus	19797 479th Ave-Astoria	8/24/01	45 mm	13.4 g	scrotal	Male
Efus	Hitchcock Park-Mitchell	8/28/01	42 mm	16.2 g	nothing	Male

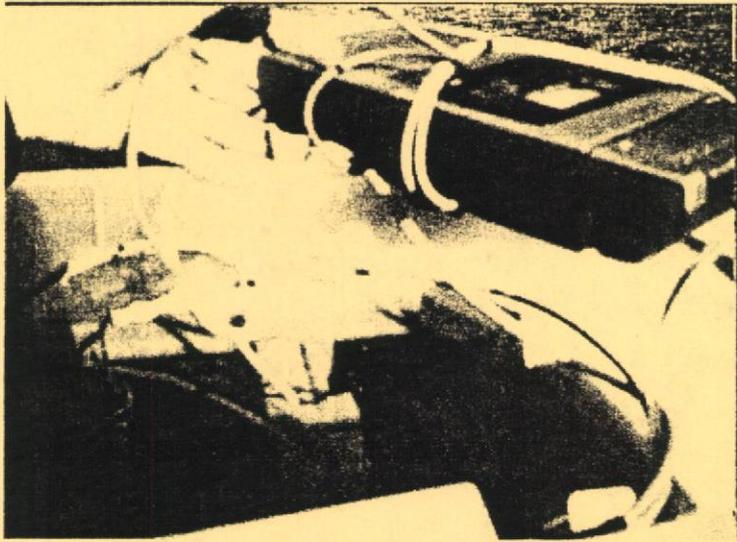
Appendix 3



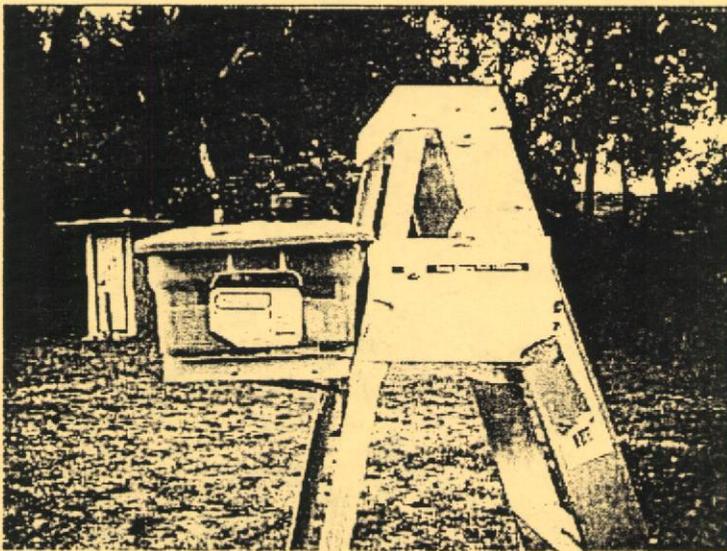
Cottonwood Crossing at Adams Homestead and Nature Preserve,
This is a typical type of habitat with many tree roosts that supports
high bat capture rates



Platte Creek Recreation Area A type of habitat, with no protection from
environmental conditions (i.e. wind) and does not have adequate roosts



ANABAT Tupperware: including ANABAT bat detector, delay switch, tape recorder and batteries (tape recorder and batteries shown)



Typical ANABAT set, ANABAT Tupperware attached to a tall ladder. The Tupperware is placed on the ladder in order to maximize the possibility of recording as many bats as possible. The ladder is set in an open area next to mist nets.

Myotis septentrionalis



Lasiurus cinereus



Lasionycteris noctivagans

