

Appendix 1. Summary of sites examined for bats during study.
(Included are sites that were not located and
those in which access was prohibited).

Season-year censused	Species	Estimated total number	Importance of site to bats
<u>Brown County</u>			
Comfrey High School W-83	<u>Eptesicus fuscus</u> <u>Lasiurus borealis</u>	10-25	Seasonal, minor importance
<u>Chisago County</u>			
Taylor's Falls tunnel Sp-83	No bats	---	Not important
<u>Dakota County</u>			
Korneski's Caves Su-83	No bats (droppings)	---	Frequent vandalism, winter bat use
<u>Fillmore County</u>			
Bat River Cave Sp, Su-83 Sp-84	<u>Myotis lucifugus</u> <u>Myotis keenii</u> <u>Eptesicus fuscus</u>	unknown, possibly several hundred	Potentially important
Bedrock Split Su-83	(Not located)	---	Unknown
Big Spring Su-83	No bats	---	Not important
Breezeway Cave Su-83 Sp-84	No bats (droppings)	---	Minor importance
Brightsdale Tunnel Sp, Su, W-84	<u>Myotis lucifugus</u> <u>Pipistrellus subflavus</u> <u>Eptesicus fuscus</u>	300-500	Very important

Season-year censused	Species	Estimated total number	Importance of site to bats
<u>Fillmore County</u> (continued)			
Cabin Spring Cave Su-83	(Not located)	---	Unknown
Canfield Creek Cave Su-83	No bats	---	Not important
Coon Cave Su-83	(Not located)	---	Unknown
Copeman's Cave Su-83 Sp-84	No bats (droppings)	---	Minor importance
Deep Lake Cave Su-83	(Not located)	---	Unknown
Forestville State Park Su-83	<u>Myotis lucifugus</u> <u>Lasiurus borealis</u>	Numerous throughout park	Seasonally important
Franke residence Su-83	No bats (old sign)	---	Not important
Hidden Vallley Cave Su-83	No bats (droppings)	---	Minor importance
Hole-in-the-Wall Cave Su-83	(Not located)	---	Unknown
Hurricane Well Su-83	(Not accessible)	---	Unknown
Landsteiner residence Su-83	<u>Myotis lucifugus</u>	Few individuals	Not important
Love Cave Su-83	(Not located)	---	Unknown
Mahood Cave Su-83	(Not accessible)	---	Probably not important

Season-year censused	Species	Estimated total number	Importance of site to bats
<u>Fillmore County (continued)</u>			
Mystery Cave W, Sp, Su-83 W, Sp-84	<u>Myotis lucifugus</u> <u>Myotis keenii</u> <u>Pipistrellus subflavus</u> <u>Eptesicus fuscus</u>	Several 1000	Very important
Nash Residence Su-83	<u>Myotis lucifugus</u>	Few individuals	Moderate importance
Niagara Cave Su-83	(No access)	---	Unknown
Old Mystery Cave Su-83 Sp-84	<u>Myotis lucifugus</u> <u>Eptesicus fuscus</u>	15-25	Moderate importance
Old Sink Cave Su-83	(Not accessible)	---	Unknown
Old Still Cave Su-83 Sp-84	<u>Myotis lucifugus</u> <u>Pipistrellus subflavus</u>	<10	Minor importance
Petrified Indian Cave Su-83 Sp-84	No bats (droppings)	---	Minor importance
Pine Tree Cave Su-83 Sp-84	No bats	---	Not important
Preston Library Su-83	<u>Myotis lucifugus</u>	Few individuals	Minor importance
Quarry Spring Cave Su-83	(Not located)	---	Unknown

Season-year censused	Species	Estimated total number	Importance of site to bats
<u>Fillmore County (continued)</u>			
Spring Valley Caverns Sp, Su-83; Sp, W-84	<u>Myotis lucifugus</u> <u>Myotis keenii</u> <u>Pipistrellus subflavus</u>	10-25	Very important
Stagecoach Spring Cave Su-83	<u>Myotis lucifugus</u>	Few individuals	Moderate importance
Three York Caves Su-83	(Not accessable)	---	Unknown
Tunnel Mill Su-83 Sp-84	<u>Eptesicus fuscus</u>	Few individuals	Minor importance
Two Skull Cave Su-83 Sp-84	No bats	---	Minor importance
Tyson's Spring Cave Su-83 Sp-84	No bats	---	Not important
White Residence Su-83	<u>Myotis lucifugus</u>	30-50	Seasonal, large maternity group
Zimmer's Cave Su-83	(No access)	---	Unknown
<u>Goodhue County</u>			
Red Wing Sand Mine Throughout year 1983 1984	<u>Myotis lucifugus</u> <u>Myotis keenii</u> <u>Pipistrellus subflavus</u> <u>Eptesicus fuscus</u>	300-700	Very important

Season-year censused	Species	Estimated total number	Importance of site to bats
<u>Hennepin County</u>			
Channel Rock Cavern Sp-84	No bats	---	Not accessible by bats
Eckhardt residence Su-83	<u>Myotis lucifugus</u>	Few individuals	Minor importance
Farmers and Mechanics Bank Cave W-83	No bats	---	Not useable
<u>Houston County</u>			
Beaver Creek Valley State Park Su-83	Bats flying (no captures)	Few individuals	Minor importance
Helke residence Su-83	<u>Myotis lucifugus</u>	200	Seasonal, major summer group (maternity?)
Indian Treasure Cave Su-83	(Not located)	---	Unknown
Knip residence Su-83	<u>Myotis lucifugus</u>	15-25	Seasonal, summer roost
Krage residence Su-83	<u>Myotis lucifugus</u> <u>?Eptesicus fuscus</u>	<100	Seasonal, large maternity colony
Thomford residence Su-83	<u>Myotis lucifugus</u>	<50	Seasonal roost site
Yucatan Cave Su-83	No bats (droppings)	---	Minor importance
<u>Nicollet County</u>			
St. Peter sewer Sp-83	<u>Pipistrellus subflavus</u>	Few individuals	Minor importance

Season-year censused	Species	Estimated total number	Importance of site to bats
<u>Nicollet County</u> (continued)			
Seven Caves Sp-83	<u>Myotis lucifugus</u>	Few individuals	Minor importance
Seven Mile Cave Sp-83	No bats	---	Highly disturbed
<u>Olmstead County</u>			
Carly State Park Su-83	<u>Myotis lucifugus</u>	Few individuals	Seasonal, minor importance
First Presbyterian Church Su-83	No bats	---	Minor importance
Quarry Hill Cave Su-83	No bats (droppings)	---	Highly disturbed
<u>Pine County</u>			
Hell's Gate Cave Sp-83	No bats	---	Not important
Robinson's Ice Cave F, W, Sp-83, 84	<u>Myotis lucifugus</u> <u>Myotis keenii</u> <u>Eptesicus fuscus</u>	1-2,000	Very important
<u>Ramsey County</u>			
Bear Cave, St. Paul W-83	No bats	---	Highly disturbed
Carver's Cave W-83	No bats	---	Not important
Echo Sand Mine F, W-81 W-83	<u>Eptesicus fuscus</u> <u>Myotis keenii</u>	0-50*	*Approx. 50 killed in 1981, none found in 1983

Season-year censused	Species	Estimated total number	Importance of site to bats
<u>Ramsey County</u> (continued)			
Ford Sand Mine Sp-83	(No access)	---	Unknown
Hobbit Hole W-83	No bats	---	Not important
Horseshoe Sand Mine W-83	No bats	---	Highly disturbed
Indian Mounds Cave W-83	No bats	---	Not important
Jolly Roger Cave W-83	No bats	---	Not important
Stever residence Su-83	<u>Eptesicus fuscus</u>	Few individuals	Minor importance
Stoney's Cave W-83	<u>Eptesicus fuscus</u>	Few individuals	Not important
Unnamed Cave W-83	No bats	---	Highly disturbed
<u>Scott County</u>			
Jordon Brewery Cave Sp-83	(No access, bats reported)	---	Unknown
<u>St. Louis County</u>			
Ely, Main Street Su-83	No bats (droppings)	---	Seasonal, minor importance
Idington Evangelical Su-83	Lutheran Church No bats (droppings)	---	Minor importance
Minntac plant Su-83	Bats reported (no access)	---	Unknown

Season-year censused	Species	Estimated total number	Importance of site to bats
<u>St. Louis County (continued)</u>			
Pioneer Mine Su-83	No bats (past reports)	---	Flooded, no longer important
Potlatch Oxboard Plant Su, F-83	<u>Myotis lucifugus</u> <u>Myotis keenii</u>	2-5,000	Seasonal, hibernating site
Tower Soudan Mine Sp, Su-83 Sp, Su-84	<u>Myotis lucifugus</u> <u>Myotis keenii</u>	several 1000	Extremely important
<u>Wabasha County</u>			
Bear Valley Cave Sp-83	No bats	---	Not important
Evers residence Su-83	<u>Myotis lucifugus</u>	Few individuals	Seasonal, minor importance
Kellog Caverns Su-83	(Not located)	---	Unknown
Kruger's Cave Su-83 Sp-84	No bats	---	Not important
Mazeppa Sink Hole Sp-83	Bats reported (not located)	---	Unknown
Whipoorwill Campground Su-83	<u>Lasionycteris</u> <u>noctivagans</u>	Few individuals	Minor importance
<u>Washington County</u>			
Boom Hollow Cave Sp-83	No bats (reported present)	---	Highly disturbed

Season-year censused	Species	Estimated total number	Importance of site to bats
<u>Washington County</u> (continued)			
Callas residence Su-83	<u>Eptesicus fuscus</u>	<10	Seasonal, maternity colony
Holm residence Su-83	<u>Myotis lucifugus</u>	15-25	Seasonal, maternity colony
Leslie Cave Sp-83 Sp-84	<u>Myotis lucifugus</u> <u>Myotis keenii</u> <u>Pipistrellus subflavus</u>	<10	Moderately disturbed, minor importance
Lindberg residence Su-83	<u>Myotis lucifugus</u>	Few individuals	Seasonal, small maternity group
<u>Winona County</u>			
Anderson residence Su-83	Previously many bats (exterminated)	---	Probably not important
Beseke residence Su-83	Large number bats reported (not located)	---	Unknown
Carlin Caverns Su-83 Sp-84	No bats	---	Not important
Crystal Springs DNR Su-83	Fisheries Station <u>Myotis lucifugus</u> <u>Eptesicus fuscus</u> <u>Lasiurus borealis</u>	<25	Seasonal, minor importance
Devil's Cave Su-83	No bats	---	Highly disturbed
Elba Church Su-83	(No access)	---	Unknown
Elba brick house (owner unidentified) Su-83	Bats reported (no access)	---	Unknown

Season-year censused	Species	Estimated total number	Importance of site to bats
<u>Winona County</u> (continued)			
Gainy Gold Mine Su-83	(No access)	---	Unknown
Hiawatha Caverns Su-83	(No access)	---	Unknown
O.H. Kipp State Park Su-82	<u>Myotis lucifugus</u> <u>Lasiurus borealis</u>	<10	Seasonal, moderate importance
Prigge Caves Su-83 Su-84	No bats	---	Not important
Rupprecht Cave Su-83 Su-84	No bats	---	Not important
St. Mary's College Su-83	Bats reported (no access)	---	Unknown
Sen residence Su-83	<u>Myotis lucifugus</u>	Few individuals	Seasonal, minor importance
Skunk Hollow Cave Su-83 Sp-84	No bats (previous reports)	---	Minor importance
Whitewater State Park Su-83	<u>Myotis lucifugus</u>	20-50	Seasonal, maternity group
Winona Senior Citizens Rec. Bldg. Su-83	No bats (swallows)	---	Not important
Farm house Su-83	<u>Myotis</u> sp. <u>Eptesicus fuscus</u>	Few individuals	Minor importance

Season-year censused	Species	Estimated total number	Importance of site to bats
<u>Wright County</u>			
Buffalo, white house, (owner unidentified) Su-83	Bats present (no access)	---	Unknown
Lindstrom residence Su-83	<u>Myotis lucifugus</u>	30-50	Seasonal, large maternity group
Rogers, farm (owner unidentified) Su-83	<u>Myotis lucifugus</u> <u>Eptesicus fuscus</u>	Few individuals	Seasonal, minor importance
<u>Pierce County, Wisconsin</u>			
Maiden Rock Mine Throughout year 1983 1984	<u>Myotis lucifugus</u> <u>Myotis keenii</u> <u>Pipistrellus subflavus</u> <u>Eptesicus fuscus</u>	150,000 - 250,000	Extremely important
Bay City Mine Sp-83 Sp, W-84	<u>Myotis lucifugus</u> <u>Myotis keenii</u> <u>Pipistrellus subflavus</u> <u>Eptesicus fuscus</u>	5,000-10,000	Very important

APPENDIX 2. Species Accounts

Myotis lucifugus (Le Conte)

Little Brown Bat



Description: A medium-sized bat, pelage varies from dark sooty brown, reddish brown, to pale or yellowish brown. Similar in appearance to other Myotis, it can be distinguished from M. keenii by shorter ears (do not extend much past the nose) and short, blunt tragus. Females are slightly larger than males. Adult measurements (dimensions in millimeters, weight in grams): head and body length, 41-54; forearm, 33-41; ear, 11.0-15.5; tragus, 7-9; weight of Minnesota bats, winter - 5.5-9.5 males, 6.25-10.75 females; summer - 4.7-14.0 males, 5.3-12.3 females.

Distribution: M. lucifugus can be found throughout most of North America, from Alaska and the Northwest Territories south into Mexico. There appears to be little change between winter and summer ranges.

Natural history: M. lucifugus occurs in a wide variety of habitats that vary with the season. It is a colonial hibernator and may be found in groups ranging from a few individuals to several thousand. During the winter, it hibernates in caves and

mines where humidity is high ($\geq 90\%$) and temperatures are above freezing. Hibernation extends from September until May in northern regions and may last only from November until March in the south, depending on local weather conditions. In the summer M. lucifugus may be found in any suitable shelter. Males and nonparous females roost in buildings, trees, woodpiles, rocks, and caves. Nursery colonies are usually located in warm portions of buildings, such as in attics, under tar paper, siding, or shingles, but are also found in hollow trees or rock crevices with suitable temperatures. Colonies tend to be located near water where they forage over water or within forest openings. M. lucifugus feeds on a variety of flying insects and tends to exploit patches of insects, such as mating swarms or collections around street lamps.

Myotis lucifugus may be the most abundant bat in North America. Higher densities are found near areas of water. The limiting factor to its distribution and numbers appears to be the availability of roost sites rather than food. Although not considered migratory, females will travel several hundred kilometers between winter and summer roosts. Its life span is quite long, with the longest reliable records being over 30 years.

Most mating occurs in the fall prior to hibernation, but males will mate with torpid females during the winter. Sperm is stored in the female until ovulation occurs in spring. The exact timing of ovulation and fertilization depends on location and local weather conditions, resulting in latitudinal variation in

the birth of young. Following a gestation of 50-60 days, a single young is born. Young are reared in maternity colonies made up almost exclusively of pregnant females, and are weaned and volant within a month.

Conservation: Myotis lucifugus is numerous and widespread. Much of its abundance may reflect its adaptability to human activities. It is found hibernating predominantly in man-made caves and mines and it is rare to find nurse colonies in sites other than buildings. This has consequently increased the probability of human contact and made it quite vulnerable to eradication efforts and other forms of human disturbance. Although humans may have played an important role in this species increase, they are also the major cause of its mortality. Populations of M. lucifugus have drastically declined in many parts of its range due, in large part, to its close association with man.

Selected references: Fenton and Barclay, 1980; Humphrey and Cope, 1976; Barbour and Davis, 1969.

Myotis keenii (Merriam)

Keen's Myotis



Description: A medium-sized bat with brown pelage similar in appearance to other Myotis.

Distinguished from M. lucifugus by longer ears (which extend 4 mm beyond the nose) and long, pointed tragus. Adult measurements (dimensions in millimeters, weight in grams): head and body, 40.4-55.0; forearm, 33.3-38.8; ear, 14.2-19.0; tragus, 10-12; weight of Minnesota bats, winter - 5.0-7.25 males, 7.0-8.0 females; summer - 5.0-12.0 males, 5.0-13.0 females.

Distribution: The eastern race of M. keenii ranges from Saskatchewan and Newfoundland south to northern Florida and west to Wyoming.

Natural history: Myotis keenii may be found in a variety of shelters. A colonial hibernator, it is rarely abundant (concentrations over 100 are unusual). It can be found hibernating with the other Minnesota cave bat species in mines and caves. Although occasionally found roosting in clusters with M. lucifugus, M. keenii appears to be less gregarious and is most

frequently found hanging singly or in small groups. Compared to M. lucifugus, it seems to show a preference for cooler hibernation sites where the air is still. Summer roosts vary widely, including tree bark, window shutters, and old buildings. Caves and mines also are used, primarily as night roosts. The smaller summer day roosts are usually occupied by one bat.

This species has been found foraging over trees and ponds, as well as beneath the canopy above shrub level. One of the two peak bouts of foraging appears just after dusk and the other just prior to dawn. Nothing is known about the type of insects taken.

Although not especially rare, this species appears to have an irregular and localized distribution. Some investigators have suggested from the seasonal abundance of M. keenii at certain sites that it may be migratory. Although known to travel distances between summer and winter sites, little is known of its movement patterns or population structure.

Reproductive information is scarce, but is presumed similar to M. lucifugus. Females segregate into small maternity colonies in barns and under bark and shingles.

Conservation: Very little is known about the habits of this bat and its current status. Because it appears to roost in man-made shelters, it is potentially vulnerable to human disturbance.

Selected references: Fitch and Shump, 1979; Barbour and Davis, 1969.

Pipistrellus subflavus (F. Cuvier)

Eastern Pipistrelle

Description: A small bat, distinguished from Myotis by distinctly tri-colored hair (dark at base, lighter yellow-brown middle band, dark at tip). Pelage can vary from a pale yellow-orange to dark reddish brown. Anterior third of interfemoral membrane furred. Ear tapers to a narrow rounded tip, tragus blunt, extends about half the length of the ear. Females consistently heavier than males. Adult measurements (dimensions in millimeters, weight in grams): total length, 77-89; tail, 34-41; forearm, 31.4-34.1; ear, 12.4-14.1; tragus, 6.4-6.8; weight of Minnesota bats, winter - 5.5-8.0 males, 5.5-9.0 females; summer - 6.0-9.4 males, 6.0-10.3 females.



Distribution: Pipistrellus subflavus can be found throughout most of eastern North and Central America from Nova Scotia to Honduras and west to Minnesota and Texas. Summer and winter ranges appear to coincide.

Natural history: A cave hibernator, Pipistrellus is found in

small numbers in caves, rock crevices, mines, and other man-made caves and tunnels, frequently in association with the other Minnesota cave bats. It normally does not hibernate in clusters, roosting singly in deeper portions of the hibernaculum where temperatures and humidity are higher. During summer, females disperse to maternity roosts, such as barns and other man-made structures, and possibly trees, caves, and rock crevices. Little is known of the summer day roosts. Single individuals have been found hanging on abandoned buildings or beneath porches. Its appearance at tree tops to forage suggests that they may also roost in foliage. Although not strongly migratory, Pipistrellus has been recorded to fly as far as 53 km to its winter hibernaculum.

Pipistrellus most commonly forages early in the evening over waterways and along forest edges, flying in a slow, erratic pattern. It appears to feed primarily on beetles, cicadillids, dipterans, ants, and moths.

Mating occurs in the fall and again at the time of ovulation in the spring. Sperm are stored overwinter by females. Two to seven ova may be shed, but typically only two young are born. Gestation lasts at least 44 days, the time of parturition is dependent upon location, and it has been suggested that births occur later and are more highly synchronized in northern populations. Young are volant by three weeks of age.

Conservation: Pipistrellus is quite abundant in portions of its range, but distinctly rare in others. Comparatively little is

known of its movement patterns, locations of maternity roosts, and other aspects of its natural history. More needs to be learned about its habitat requirements and the current status of its population levels.

Selected references: Fujita and Kunz, 1984; Barbour and Davis, 1965.

Eptesicus fuscus (Palisot de Beauvois)

Big Brown Bat



Description: A large, brown bat, with uniformly-colored pelage that varies from russet to dark brown. Ears thick, darkly pigmented, tragus broad with a gradually rounded tip. Females larger than males. Adult measurements (dimensions in millimeters, weight in grams): total length, 87-138; tail, 44-50; forearm, 39-53.6; ear 17.5-19.5; tragus, 7.8-8.3; weight of Minnesota bats, winter - 12.25-21.0 males, 13.0-24.0 females; summer - 13.7-24.0 males, 14.1-21.6 females.

Distribution: Widespread from Alaska and Canada south to northern South America. Abundant throughout most its range but local and scarce in the deep south and far north. Winter and summer ranges are identical.

Natural history: Eptesicus is closely associated with humans and occupies a variety of man-made structures. Before man's alteration of its habitat, it roosted in tree hollows and foliage during the summer, but now is found most commonly in buildings.

Maternity colonies are found in attics, barns, under shingles and eaves, or behind shutters. Males roost away from the females as single individuals or in small groups, utilizing buildings, bridges, trees, caves, and mines. Although largely a cave hibernator, Eptesicus also regularly hibernates in buildings, cellars, and tunnels. In caves and mines, they frequently roost in semi-darkness near the entrance where temperature and humidity are often lower than farther inside. It appears fairly sedentary, rarely traveling more than 20 miles from the roost.

Eptesicus forages early in the evening, flying in a slow, steady manner over open meadows with scattered trees, or along tree-lined streets. Primary food items include beetles, flying ants, wasps, dipterans, and mayflies. No lepidopterans have been recorded as eaten by Eptesicus.

Mating likely occurs in the fall, with sperm storage by females until ovulation occurs in the spring. Four to seven ova are released and one to four young may be born. Eastern populations normally have two young, whereas western bats typically have one. Gestation is approximately two months, the date of parturition varying with latitude. Within a month, young are weaned and volant.

Conservation: The abundance of Eptesicus coupled with its predilection for man-made structures leads to frequent encounters with humans. Its potential for becoming a nuisance as well as its

reliance upon buildings for hibernation and rearing of young create numerous problems for the management of this species.

Selected references: Banfield, 1974; Barbour and Davis, 1965.

Lasionycteris noctivagans (Le Conte)

Silver-haired Bat



Description: A medium-sized bat with dark brown, almost black, pelage tipped with white; ears and wing membranes are dark. Ears are short and rounded with a broad, blunt tragus. Interfemoral membrane is furred over approximately 75% of its length. Adult measurements (dimensions in millimeters, weight in grams): total length, 92-115; tail, 35-45; forearm 37-44; weight, 8-11.

Distribution: Lasionycteris occurs in suitable habitat across the United States and southern Canada. Its summer distribution is primarily north of a line from Pennsylvania, across the Great Plains and the southern Rocky Mountains, to Oregon. During winter, it is found south of New York and southeastern regions of the plains, extending into northern Mexico.

Natural history: Lasionycteris is typically found foraging in or near forests, both coniferous and deciduous, adjacent to ponds, streams, or other bodies of water. It has been associated with open areas near water in Quetico Provincial Park, but not

found in the forest there. Little is known about the population dynamics or relative abundance of Lasionycteris across its range. A summer resident in Minnesota, it has been variously reported as the second most numerous bat in Sherburne County, common near the Great Lakes, but relatively rare state-wide. It is considered locally abundant in the northern plains states, common throughout Iowa, and rare in Wisconsin.

Lasionycteris is a relatively slow flyer, often flying close to the ground. It appears to forage after other species have begun feeding. Although some believe Lasionycteris to be a moth specialist, studies have shown that it feeds on a wide variety of insects including moths, caddisflies, dipterans, and beetles. Considered a solitary, tree-roosting species, it typically roosts under loose bark, but a wide variety of shelters are used, including woodpecker houses, lumber piles, and buildings. Lasionycteris makes regular seasonal migrations, with the species range shifting northward in spring and southward in fall. During winter, it roosts in mines, caves, hollow trees, rock crevices, and buildings, and does not appear to form large aggregations.

The breeding habits of Lasionycteris are poorly known. They probably mate in the fall when the sexes congregate during migration. Sperm remains viable in females during winter hibernation and ovulation occurs in the spring. Following a gestation of 50-60 days, one or more (commonly two) young are born in late June to early July. There have been reports of young

being born in nursery colonies, but no reliable information is available on where females give birth. The young are nursed for approximately a month and are flying by late July - early August.

Conservation: Due to its solitary habits and associations with forested habitats, Lasionycteris rarely comes into contact with man. However, extensive deforestation throughout its range and current forest management practices may have greatly reduced the available roosting sites.

Selected references: Kunz, 1982b; Barbour and Davis, 1969.

Lasiurus borealis (Müller)

Red Bat

Description: A medium sized bat with long, pointed wings and fully-furred interfemoral membrane. Ear low, broad and rounded, tragus triangular. Pelage varies from

brick red to yellow brown; washed with white. Males are more brightly colored, whereas females have paler, more frosted fur. Red bats fly with the tail extended, unlike close relatives. Adult measurements (dimensions in millimeters, weight in grams): total length, 95-112; tail, 45-62; forearm, 35-45; weight, 9-15. Females are about 8% larger than males.



Distribution: L. borealis is widely distributed, found from southern Canada southward to Argentina and Chile, and absent from arid regions in the western U.S. In the winter, their range contracts southward from the Ohio River Valley in the east and along the coast south of San Francisco in the west.

Natural history: This bat is most abundant in the central U.S. and is commonly associated with hardwood forest clearings near water courses. It has also adapted well to urban life and

often can be found foraging near street lights. In Minnesota, it is most common in the southern portion of the state. During summer, it roosts singly or in family groups among foliage that provide dense shade and cover. Although its winter roosting sites have not been found, it probably resides in trees.

L. borealis typically begins foraging 1-2 hours after sunset. It has been observed flying in a slow erratic manner at tree top height, and also in a swift, straight path close to the ground. The diet is not as broad as other sympatric bats but food items appear to be selected according to size. Insects taken by L. borealis include moths, beetles, dipterans, and some ground-dwelling insects.

L. borealis is variably migratory, some populations traveling great distances with others remaining in one area. Generally solitary, they seem to migrate in groups, with females and males migrating at different times and to different regions.

L. borealis breeds in late summer, females store sperm over winter, and fertilization takes place in the spring. Gestation is 80-90 days with partuition occurring from late May through early July, depending on the location. One to four young ($\bar{X} = 3.2$) are born and nursed for about a month. By August the young are volant and family members disperse.

Conservation: This bat appears to be relatively common throughout its range and does not appear to have been as adversely affected by increased urbanization as other species.

Its solitary habits and secretive roost sites minimize the number of contacts with humans.

Selected references: Shump and Shump, 1982a; Barbour and Davis, 1969.

Lasiurus cinereus (Palisot de Beauvois)

Hoary Bat



Description: One of the largest bats in North America. Pelage is banded dark and light at base and tinged with white to produce a frosted effect. Interfemoral membrane fully furred. Ears short, rounded, and edged with black; tragus short and broad. Adult measurements (dimensions in millimeters, weight in grams): total length, 130-144; tail, 55-66; forearm, 46-58; weight 20-35.

Distribution: Most widespread of American bats, ranging from treeline in Canada southward to Argentina and Chile. L. cinereus is rare throughout most of the eastern U.S. and northern Rocky Mountains and is more common in prairie states, the Pacific Northwest, and the Southwest. Summer range is throughout the northern U.S. and Canada. It winters in southern California, southeastern U.S., and Mexico, although a number of northern winter records suggest that it may be distributed farther north than L. borealis.

Natural history: L. cinereus is a solitary, tree-roosting bat, where it hangs concealed by foliage along forest edges. In

northern portions of its range it appears to prefer coniferous forest, whereas further south it utilizes deciduous trees.

L. cinereus emerges late in the evening to forage and is a swift, steady flier. Little is known about its food habits. It seems to feed on relatively few orders of insects, apparently preferring moths. However, beetles, dipterans, grasshoppers, and hymenopterans have been taken.

Wintering sites are poorly documented and no specific migration routes have been plotted. Nevertheless, L. cinereus is considered the most migratory bat species in North America, and may be found moving in large groups during spring and autumn. The sexes are generally separated during warm months. Some may remain in northern areas and hibernate, but this practice is uncommon and probably is rarely, if ever, successful.

Mating probably occurs during autumn migration followed by delayed implantation. Parturition occurs from mid-May until early July and, in every known case, two young are born. Volant young have been taken by mid-July.

Conservation: This bat generally is rare throughout its range, solitary, and usually concealed during the day; thus is rarely comes into contact with humans. It is not known what impact deforestation and other human activities have on the availability of suitable habitat.

Selected references: Shump and Shump, 1982b; Barbour and Davis, 1969.

Appendix 3. Description of Hibernacula

Maiden Rock Mine

Pierce County, Wisconsin

Maiden Rock is a large sand mine located in the bluffs overlooking Lake Pepin, and was actively worked until the early 1960's. The removal of sand from the mine has produced an irregular grid of passages estimated to total 12-15 miles. The passages are approximately 10 feet wide and 15 feet tall, although ceiling height varies from 8 to over 20 feet. The walls and ceilings are generally smooth, with occasional pockets or drill holes, and ledges form along the ceiling from collapsed sand. Although the mine is stable, for the most part, small collapses of the walls and ceilings occur frequently and a major cave-in has been noted during this study.

A number of small openings around the walled-off entrances on the north side of the mine allow the passage of bats. Two larger openings form the major entrances on this side providing access for both bats and humans and allowing for appreciable air exchange. A single entrance, apparently opened by mining activities, is found at the opposite end of the mine. The difference in elevations of the entrances at either end of the mine produces a cold air flow from south to north. Two low passages just inside the front entrance are the coldest areas inside the mine and are the only locations where Eptesicus occurs. Temperatures and humidities are fairly stable in the interior portions. Most of the mine is dry, except for one major seepage

area and a few minor spots of dripping water. Little to no standing water exists. Raccoons and white-footed mice frequent the passages of the cave and may be important predators on low-roosting bats or those that fall while torpid. Rock doves nest in the upper portions just inside the back entrance.

This mine may well be the single most important hibernaculum for the three-state area. All four species of cave bat, including over 150,000 Myotis lucifugus and several hundred Eptesicus, hibernate in this mine, making it the largest hibernating population of bats in the region. Band recoveries have shown that bats foraging in much of southern Minnesota during the summer use this mine as a winter hibernaculum. At this time, the mine is largely undisturbed by human activities and can be closed off fairly easily to protect the bats from human disturbance. Clearly, the destruction or development of this mine would have seriously detrimental effects upon our state's bat fauna.

The present owners of this mine are the Gore family, Red Wing, Minnesota. The status of future development of this mine is unclear at the time of writing. There appears to be no interest to mine the site further. Recent attempts to purchase the mine for use in cheese storage appear to have been abandoned. The Wisconsin Nature Conservancy has expressed interest in purchasing the mine, but no significant progress has been made to date toward its preservation.

Bay City Mine

Pierce County, Wisconsin

This mine is the only active, underground mine in Wisconsin and has been mined since 1919. It is located along the eastern bank of Lake Pepin, eight miles northwest of Maiden Rock Mine. Bay City extends for over 12 miles of passage through the same sandstone formation as Maiden Rock and is similar in appearance. Older portions of the mine are composed of much narrower and lower passages than some of the more recently mined areas, which may open up into large chambers with ceilings over 50 feet tall. Small collapses of the ceiling and walls occur, especially in the newly mined areas, and major cave-ins have occurred in the past.

Four large entrances open on one side of the mine. The mine slopes down from the entrances, making the main passages appreciably colder than side branches during the winter. Unlike most caves and mines examined, large clusters of Eptesicus can be found deep in the mine where cold air sinks to a low, dead-end passage. The isolated sections of the old mine are much warmer and less drafty and support a number of Pipistrellus. The distribution of bats in this mine is concentrated in the inactive sections and to passages off the main thoroughfares. Few bats are found in the areas that have been mined recently. Like Maiden Rock, most of the mine is dry, except for localized sections of water seepage. Signs of raccoons and mice have been observed in the mine.

Bay City is estimated to have several thousand bats, making it one of the more important sites examined. The majority of these are Myotis lucifugus, but several hundred Eptesicus and a number of Pipistrellus and M. keenii also are found. In areas where present, bats tend to occur in high densities, often in large clusters. This site has not been fully assessed to determine what proportion is being used by bats. It is not known to what extent this mine is used during the summer, nor do we have any evidence to indicate that bats move between Bay City and Maiden Rock. Additional work here may reveal the answers to these questions.

The mine is operated by Bay City Silica, a subsidiary of Treco, Inc., Bartlesville, Oklahoma. The market for this particular type of sand has been drastically reduced in recent years. As a result, only three employees currently work the mine and the continuation of mining at this site is uncertain. Entry is restricted by locked gates when the mine is not being actively worked. The foreman has allowed free access to the mine for the purposes of this study. Thus this site should remain open to additional bat work, as well as be relatively protected from vandalism. The continuation of mining at this site, however, is uncertain.

Brightsdale Tunnel

Fillmore County, Minnesota

The Brightsdale Tunnel was originally dug through the hillside to connect an oxbow of the Root River. The diversion of water through a power plant at one end of the tunnel produced the electricity for the surrounding townships. The power plant and tunnel were constructed in 1912, began operations in 1915, and remained in use until the mid-1940's. The diversion dam has since been torn down and the river has returned to its original course.

The tunnel is approximately one-third mile long and forms a rectangular channel through firm rock. The passage is approximately 10 feet wide and the height varies from five to 15 feet. Bats hang from ledges on the walls and ceilings, in depressions drilled into the rock, or in natural cracks. At the high end of the tunnel, the remains of the two-story powerhouse stand at the edge of the river. The opposite end is walled off by plywood and is some distance from the river. The majority of the passage is flooded year-round and at times may be several feet deep, but it does not appear to flood completely to the ceiling. The presence of standing waters makes this a very humid roost site for the bats. Temperatures are variable within the tunnel, with extremes at the two ends and relatively stable temperatures in the interior of the tunnel. Local roost sites for the bats reflect the variation in temperature and humidity in the tunnel. During the winter, Eptesicus are found at either end of the tunnel where

temperatures are coldest, and Myotis and Pipistrellus are concentrated in the central portions.

Although this tunnel is not large and, therefore, houses fewer total bats than other hibernacula, the densities within the tunnel are quite high. It has the largest population of hibernating Pipistrellus yet found in the state. The especially high humidity of this tunnel may be a critical factor in use of the tunnel by this species. Three species of cave bats, all except M. keenii, have been found here and M. keenii may also be discovered in future visits.

This hibernaculum appears reasonably safe from future disturbance. It was purchased by the state in 1981 and is now part of the Southeastern Minnesota Forest Resource Center. Personnel at the Center are quite interested in the conservation of local bats and have erected a "bat condo" for summer residents. A large maternity colony was located in the attic of a nearby abandoned building, which was torn down in 1984. Females banded at the maternity site have been found hibernating in the tunnel. Is it not known where they now bear young, but there is some indication that they may be under the eaves and shingles of the manager's home.

Mystery Cave

Fillmore County, Minnesota

Mystery Cave is the largest natural cave in the state, ranking 32nd in the nation with over 12 miles of surveyed passage. The cave, which extends primarily through limestone and dolomite, was formed by solution of rock, incision by the Root River, and later collapse of overlying rock. The age of the cave is unknown, but there is evidence to suggest that Mystery Cave existed before the Pleistocene (Milske, 1982).

Two entrances to the cave are known and these are surrounded by locked buildings. Other entrances may exist in the cave that allow access by bats, but none has been found. Passages near these entrances are developed for commercial tours. Passages are quite variable in size and shape, ranging from large, high-ceiling rooms and tall, narrow passages to small crawlways. Numerous holes, ledges, and surface irregularities provide holds for roosting bats. Standing water is present in a number of pools and lakes and intermittent streams flow through portions of the cave. Temperature and humidity are quite stable throughout. The closed buildings over the entrances restrict cold air flow and may, in fact, prevent more use by bats. Although bats have been observed to fly through the half-inch space beneath the door, it is possible that many bats are reluctant to do this and will roost elsewhere.

All four cave bat species have been found in Mystery Cave,

but only Myotis lucifugus occurs in any numbers. The bats typically are found roosting on the ceiling or high along the walls of the larger passages. In the passages where Tallman has banded, bats are widely dispersed and hang singly. Although a large cluster has been reported by cavers in other parts of the cave, we have found clusters to be rare and made up of only a few individuals. Estimates of the total population are difficult to assess because of the great number of passages and the uneven distribution of bats within the cave. Densities of approximately 100 bats/km found along Tallman's banding route are thought to be the highest in the cave, and many passages have no roosting bats. It is not clear why so few bats use this cave or why they are predominantly male.

The cave is presently owned by Neil Davie, Cherry Grove, Minnesota, who also runs commercial tours through a small portion of the cave during the summer. Mr. Davie has taken an active interest in the bats and has given us permission to explore the cave for bats. However, this cave is currently for sale and future access to it is uncertain.

Spring Valley Caverns
Fillmore County, Minnesota

Spring Valley Caverns is a natural limestone cave with over a kilometer of passages. It was first discovered in 1966 and was commercialized for a short period. Passages in the cave are variable, ranging from low crawlways and large galleries to crevices that extend 80 feet from ceiling to floor (Alexander, 1984). The cave extends through the same rock formations as Mystery Cave and thus provides similar roosting sites for bats. The single entrance is enclosed by a building that probably restricts cold air flow into the cave during the winter. A considerable amount of dripping water occurs in portions of the cave, and in general, the cave is quite humid. Temperature in portions away from the entrance are fairly stable. Evidence of raccoons has been found in the cave.

The windows, doors, and vents in the building over the cave entrance were screened over at the beginning of this study and few bats were present in the cave. The owner agreed to remove the screens from the vents, and since that time the number of Pipistrellus has increased. This cave is an important hibernaculum for Pipistrellus, which makes up the majority of the bats therein. A few individuals of Myotis lucifugus and M. keenii have also been found. As with Mystery Cave, the total population of bats is quite low for the amount of apparently suitable passage. It is yet unclear whether the number of bats using this

cave will increase now that access to it has been improved, or if the number of bats will remain low.

The cave was recently purchased by James Manggaard, who runs a dairy farm on the surface. He has been very interested in the bats using the cave and has been very helpful in allowing us to explore the cave and informing us of bats in the area.

Unfortunately the cave has recently been entered without permission by individuals using the cave as a partying site and a potential for vandalism exists.

Red Wing Mine

Goodhue County, Minnesota

This old, abandoned sandmine sits atop a knoll that is surrounded by a residential area on the south side of town. No one recalls when it was last mined and the small and irregular tunnels, uneven levels of the floor, as well as its inaccessibility to vehicles, suggests that it was probably dug by hand. The sandstone comprising much of the mine is a soft crumbly type, similar to the mines at Maiden Rock and Bay City. The walls are largely smooth, with ledges formed by the collapse of sand. Twelve entrances of passable size were located around the hill. Most of these lead to small, isolated "caves." There are six separate mine sections, ranging from a small, straight extension less than 20 feet to a large, complex section with numerous passages and several exits. It is possible that at one time all these entrances were interconnected by a single mine complex. This mine is very unstable, and past collapses and cave-ins have given many of the passages the appearance of being formed naturally. During our study, several major cave-ins and numerous small collapses were noted. No running water was observed, but moist sand and topsoil were found inside the mines and humidity was moderately high.

The temperature and humidity was highly variable among the mine sections, depending on the size and exposure of the mine. Only the two largest portions were used by Myotis lucifugus, M.

keenii, and Pipistrellus. During the winter these bats selected the warmer and more humid higher passages and rooms and blind segments away from the colder main passage system. This is especially true of Pipistrellus, which roosted in the deepest and most remote sections of the mine. Eptesicus was quite abundant in the two main sections and occurred in two smaller sections as well. They were most commonly found roosting in the colder, more drafty portions of the cave.

This mine is the only sand mine in Minnesota known to have significant numbers of bats. All four species have been found here, with high numbers of Eptesicus. Its proximity to the large Wisconsin mines, situated across the Mississippi River from Red Wing, would suggest that this is an area of high bat densities and that Red Wing Mine provides an important roost site for them. This mine is also frequented by local youths who use it as a party site. Despite this problem, we have found no evidence that people are disturbing the bats. However, the instability of the passages and the continued entry by people present some serious problems in the use of the mine by bats.

The knoll is part of a parcel owned by the Red Wing Country Club, who have a golf course on the southwest end of the property. There appears to be no wish to develop the portion of land with the mine. Personnel from the Minnesota Nature Conservancy have worked with us to see whether the entrances to the mine could be gated or blocked to prevent human entry but allow bats to use the

passages. The number, size, and dimensions of the entrances make this suggestion unfeasible.

Robinson's Ice Cave

Pine County, Minnesota

This natural, sandstone cave is located on the west bluff of the Kettle River. Its name derives from the fact that cold air is trapped in the winter, forming large ice stalagmites. The large, single entrance of the cave is approximately six meters high and four meters across. The rest of the cave extends straight back for 64 meters. The large entrance and straight nature of the cave allow light to penetrate far back into it (Alexander, 1980). In parts of the cave the ceiling height exceeds 20 feet and most of the cave passages are quite spacious. The width of the cave varies, as does the level of the floor and ceiling, which affects the amount of cold air reaching certain sections. The walls and ceilings are composed of a hard sandstone with abrupt ledges and crevices that are used by the roosting bats.

Temperatures, humidities, and air flow vary dramatically among the different sections of the cave, as well as within these sections. Lower portions near the entrance fluctuate widely in temperature and during the winter are the coldest and most drafty portions in the cave. In contrast, a room and large crevice in the rear of the cave are separated from the rest of it by a small entrance. Here, winter temperatures and humidities are high. Water is continually dripping from the cave ceiling throughout its length. During the spring thaws, a sizeable stream flows across the entrance. In winter, huge accumulations of ice form over the

floor and some walls.

Three cave species, all except Pipistrellus, hibernate in this cave. The two species of Myotis are restricted to the ceiling and crevices of the rear portions of the cave. Eptesicus, frequently clustering in groups of several hundred, can be found in the cooler sections of the cave and in crevices and recesses near the entrance. This cave has one of the largest groups of hibernating Eptesicus found during this study. It is important, not only from the standpoint of having a large hibernating population of bats, but also because it is the northernmost natural hibernaculum known in the state.

Robinson's Ice Cave is located within Banning State Park and is accessible to the public. Although it provides a beautiful attraction to park visitors, the frequency of visitations and the depth in which people can explore the cave unaided by lights places the hibernating bats in serious jeopardy. A Wham-o wrist rocket wrapper has been found at the cave entrance and Eptesicus have been recovered from the cave that had obviously been killed by humans. One of our banded bats was among 50 killed in the cave during winter 1985. Portions of the wall where large numbers of Eptesicus roost are scorched, suggesting further vandalism to the hibernating bats. The location of this natural hibernaculum, its importance to bats as a year-round roost site, and the vulnerability of these bats to human disturbances indicate the necessity that access be restricted into this cave to ensure the conservation of these bats.

Tower Soudan Mine

St. Louis County, Minnesota

This large, underground iron ore mine was first opened in the late 1800's and was mined until the early 1960's (Eliseuson, 1976). The method of ore removal, drilling up and dropping the overlying rock into the horizontal drifts beneath it, ultimately produced the mine that is a half-mile deep, composed of 27 levels, and with passages that extend laterally for approximately 50 miles. Older and higher passages were abandoned as lower portions were mined. The rectangular passages are relatively uniform in shape and dimensions, approximately 15 feet tall and wide, there are occasional large rooms, or stopes, where an ore pocket was removed and the horizontal passages are interconnected by a large elevator shaft and numerous ore shafts. Pockets, drill holes, and ledges formed in the hard rock during the mining process form roosting spots for the bats. Ground water continually seeps into the mine and must be drawn out by a series of pumps. Dripping water, streams, and pools of standing water are found throughout the mine. Temperatures are quite stable and humidities high. One level that connects with a cold air shaft is colder in some of its passages and ice forms there during the winter.

Large populations of Myotis keenii and M. lucifugus use the mine year-round. To our knowledge, this is the largest known population of M. keenii in North America. This is also a very important hibernaculum, in terms of its location in the state.

Its northern position affords a hibernating site to bats that otherwise would be forced to migrate at least as far south as Robinson's Ice Cave. Its value as a unique and critical roost site is great.

Tower Soudan Mine is located in Tower Soudan State Park and serves as a tourist attraction. Tours of the mine during the summer do not appear to affect the roosting bats significantly. Although for safety reasons only a few levels are accessible, it appears that there are many suitable roost sites for bats. The future of bats populations in the mine appears to be secure.

Leslie Cave

Washington County, Minnesota

This cave is a small, natural, sandstone cave overlooking the St. Croix River. It has a large entrance that extends up to a higher chamber and a low, winding crawlway. The total extent of passage is 90 meters. The sandstone is similar to that found in Robinson's Ice Cave. Evidence of solution, erosion, and breakdown are found in this cave (Alexander, 1980). Dripping water is present in some portions.

Temperature and humidity vary dramatically among different portions, with the large entrance showing the greatest fluctuation and the more recessed portions being fairly uniform. The rear crawlway has the highest humidity and temperatures and the air is quite still.

Very few bats use this cave. We have recorded Myotis lucifugus, M. keenii, and Pipistrellus during this study. We also have specimens of Eptesicus found dead in this cave and turned into us by a MSS member. The importance of this site lies in part that it is the northernmost hibernaculum for Pipistrellus. We have consistently found a few individuals roosting in the crawlway portion of the cave and occasionally in the upper room.

Originally owned by the Clarke's, who live on the bluff above the cave, it now comes under the jurisdiction of the St. Croix National Scenic Waterway. The cave is highly visible from the river and is used by numerous individuals as a partying and

camping site. The bats in this cave are highly vulnerable to human disturbance. All the Pipistrellus hibernating in the rear passages can be easily reached. The scorched walls and burnt material in the upper room and rear crawlway indicate that people are entering these areas and may be harming the bats. The low number of bats in this cave and the lack of banded individuals returning may be the result of mortality suffered from human disturbance. Restricting human access to this cave is strongly recommended.