HABITAT MANAGEMENT GUIDELINES FOR BATS OF ONTARIO

ONTARIO MINISTRY OF NATURAL RESOURCES

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MNR # 51602
ISBN 0-7794-2347-X (Internet)

August 1984

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Introduction

In 1969, Fenton (1969a) estimated that there were 10,000 bats hibernating in an abandoned mine at Craigmont in Renfrew County. Today less than 1,000 bats spend the winter there (M.B. Fenton, pers. comm.). In 1937, a cave full of an estimated 5,000 bats was discovered north of Thunder Bay (Allin 1942). In 1942 the estimate for the same cave was 1,500 bats (Allin 1942) and in 1972 only 188 bats were counted there (Woodside and Buchanan 1975). The Bonnechere caves harboured 400 bats, including 142 Small-footed Bats, the largest concentration of this species reported in North America (Hitchcock 1945), until the caves were commercialized in 1955. Tyendinaga cave, which was once used by about 150 hibernating bats (Hitchcock 1949), today is used by less than twenty (20) bats (M.B. Fenton, pers. comm.). At a summer roosting site the number of Little Brown Myotis decreased from about 1,500 in 1975 to 900 in 1983 (J. Fullard, pers. comm.). These observations of marked reductions in numbers of bats in Ontario indicate that populations of several species of bats are declining.

Eight (8) species of bats occur in Ontario. The Little Brown Myotis formerly called the Little Brown Bat (*Myotis lucifugus*), Keen’s Myotis (*M. keenii*), Least or Small-footed Bat (*M. leibii*), Eastern Pipistrelle *(Pipstrellus subflavus*), and Big Brown Bat (*Eptesicus fuscus*) hibernate in Ontario during the winter. When food becomes scarce in autumn, these bats seek out cool and humid sites in caves and abandoned mines. In these hibernacula, the bats enter a state of torpor by allowing their body temperatures to drop to the temperature of their surroundings.

The Silver-haired Bat (*Lasionycteris noctivagans*) , Red Bat (*Lasiurus borealis*), and Hoary Bat (*L. cinereus*) spend only the summers in Ontario; they avoid winter conditions by migrating south in the autumn. Little is known about these migratory bats since they are solitary, tree-dwelling species, which are rarely observed.

Population declines of bats are not limited to Ontario. In just ten (10) years the little brown myotis population in Indiana and northern Kentucky declined by about eighty percent (80%) (Humphrey and Cope 1976). The Gray Bat, Indiana Bat, Hawaiian Hoary Bat and two (2) eastern subspecies of the Western Big-eared Bat are listed as officially endangered in the United States (U.S. Fish and Wildlife Service 1978; 1979, cited by Humphrey 1982). Declines in bat populations have also been noted in the Netherlands (Daan 1980) , France (Beaucournu 1962, cited by Stebbings 1969), Poland (Krzanowski 1959, cited by Stebbings 1969), and Britain (Stebbings 1969).

There are several factors responsible for the decline of bat populations; these factors probably vary from species to species and area to area. The most important threats to the survival of bats are disturbance or destruction of hibernating bats and nursery colonies, habitat loss, pesticides in the food web, and exploitation.

Because large numbers of bats frequently hibernate in relatively small, confined areas, bats are highly vulnerable to extermination. Disturbance of hibernating bats by bat researchers, caving enthusiasts, and vandals may have a great impact on bat populations. Before hibernation, bats accumulate a large supply of fat. This fat is the bats' food reserve for the entire winter. When people enter hibernacula and pass by hibernating bats, the bats may arouse from torpor, fly about, and eventually recluster and reenter torpor. Since the energy for these events comes from stored fat, frequent human visits to a hibernating population can deplete the energy supply of the bats and thereby reduce their chances of surviving the winter (Humphrey 1982). Juvenile bats are most susceptible to disturbance, since they may not accumulate sufficient food reserves to last the entire hibernation period (Stebbings 1969).

Stebbings (1969) has shown the tremendous impact that banding and censusing studies have had on bat populations. Each time a hibernating bat is aroused for banding or checking of bands, it metabolizes relatively large amounts of energy equivalent to energy losses of several days torpor. In bats that are disturbed six (6) or more times during hibernation, food reserves are reduced by an equivalent of at least three to four (3-4) weeks.

In the summer, Little Brown Myotis and Big Brown Bats frequently form nursery colonies in buildings. A major cause of population decline is extermination of these nursery colonies. Humphrey (1982) suggests that most Little Brown Myotis that are excluded from their nursery roosts disperse, but presumably die since marked animals do not return to their traditional hibernation sites. Fenton (pers. comm.) is using radio transmitters to study the fate of Big Brown Bats that are excluded from their nursery roosts.

Other causes of decline are undoubtedly insecticides in the food web (Cockrum 1970; Geluso and Altenbach 1976; Clark and Kroll 1977) and loss of foraging habitat due to urban and agricultural developments (Humphrey 1982).

Collection of bats for research and museum specimens, and anti-bat programs in which large numbers of bats are destroyed because they are considered public health threats also deplete populations (Stebbings 1980; Fenton 1983).

In many parts of the world, bats suffer from a bad reputation. They are regarded as carriers of rabies, blood-eaters, and beasts that tangle themselves in people's hair. In fact, rabies is uncommon in most of the world's bats; only three (3) of the more than 850 species of bats in the world are vampires; and bats do not deliberately tangle themselves in people's hair (Fenton 1983).

On the contrary, bats are extremely beneficial animals, since they prey on insects. Some of the insects eaten by bats are pests, such as mosquitoes, which are consumed by Little Brown Myotis (Buchler 1976; Anthony and Kunz 1977), and alfalfa weevils, which are eaten by Big Brown Bats (Belwood 1979, cited by Humphrey 1982). Laidlaw and Fenton (1971) calculated that a colony of 100 Little Brown Myotis would eat about nineteen (19) kg or forty-two (42) pounds of insects over a four month period.

Along with birds, bats play an important role in the ecosystem as insect predators. Hundreds of scientific studies conclude that insect epidemics are prevented by the maintenance of rich and diverse communities so that biological forces such as insectivorous birds and bats, parasites, predatory insects, other small mammals, and microbes can exert control on destructive forest insects (Thomas et al. 1979a).

In a recent national survey on the importance of wildlife to Canadians, about eighty percent (80%) of the Canadian population felt that it was important to maintain abundant wildlife (Filion et al. 1983). Many an outdoors enthusiast has enjoyed the sight of bats feeding at dusk over streams, ponds, lakes and fields. Even city dwellers who rarely encounter wildlife, can experience the thrill of watching the erratic flight of bats as they feed above lamplit streets.

Because of their unique and diverse specializations, bats have long been the subject of scientific studies. In several universities in Ontario and even in some high schools the study of bats is part of the educational programme.

Bats are a distinct and fascinating group of mammals that have achieved the ability to fly and use echolocation to guide them and to detect and capture their prey. Their role as major predators of night-flying insects is shared only with small owls, caprimulgiform birds, and nocturnal spiders (Humphrey 1975).

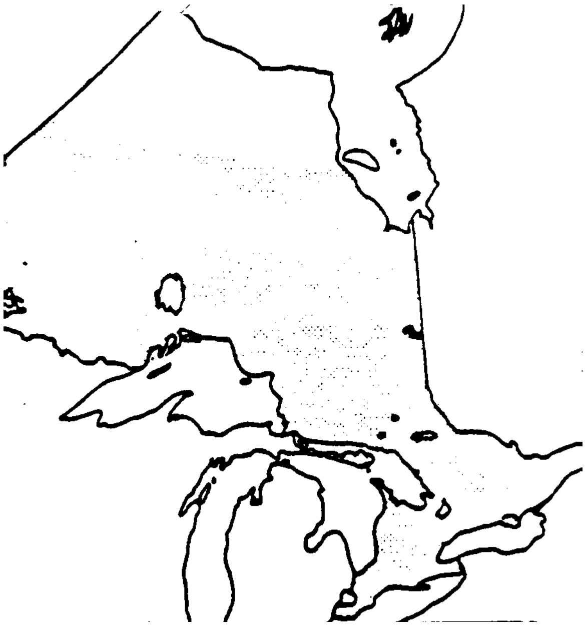
Concentration in small areas, sensitivity to disturbance, and low natality make the Little Brown Myotis, Keen's Myotis, Small-footed Bat, and Eastern Pipistrelle particularly vulnerable to human activities. Management decisions that affect caves and mines where bats hibernate, summer roosts where bats have their young, and forests where bats forage should take into account the beneficial role of bats and the decline of populations across Ontario.

The basic biology of each species is described below and recommended protective measures and management guidelines follow.

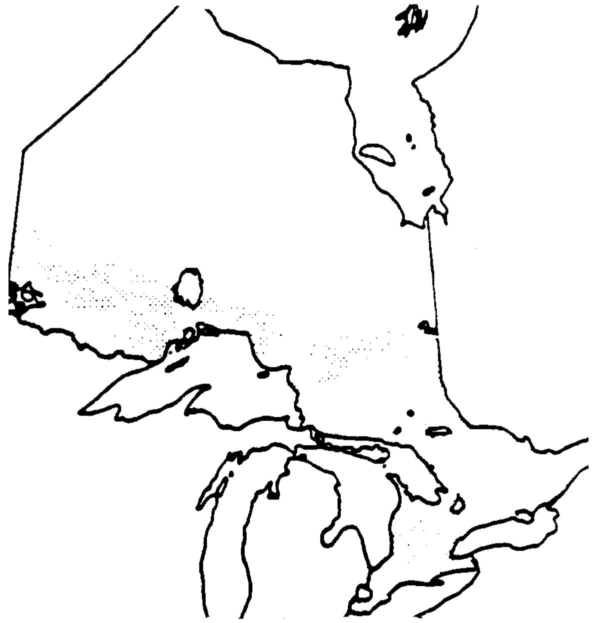
The Species

Distribution

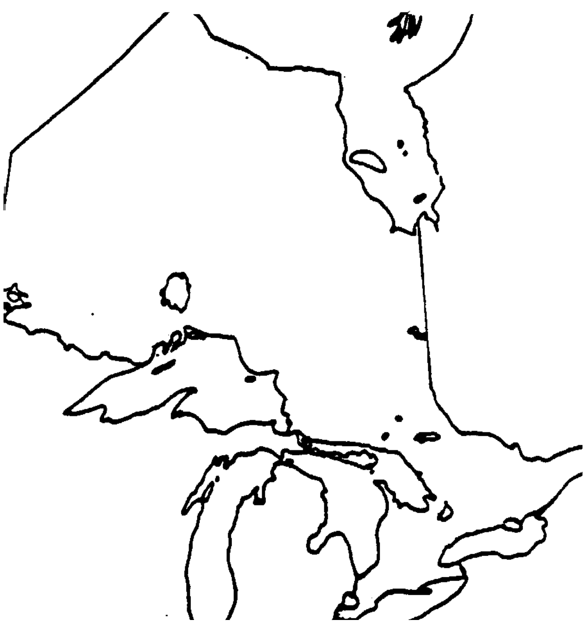
Distribution of each species is shown in Figure 1.



Little Brown Myotis (*Myotis lucifugus*)



Keen's Myotis (*Myotis keenii*)



Small-footed Bat (*Myotis leibii*)

Silver-haired Bat (*Lasionycteris noctivagans*)

Figure 1 Distribution of bats in Ontario

Eastern Pipistrelle (Pipistrellus subflavus)

Big Brown Bat (Eptesicus fuscus)

Red Bat (Lasiurus borealis)

Hoary Bat (Lasiurus cinereus)

Figure 2 Distribution of bats in Ontario, continued

(Peterson 1966; Banfield 1974; Humphrey 1982)

Habits, Diet, and Habitat

Little Brown Myotis (*Myotis lucifugus)*

Habits

Our most common and best studied bat, the Little Brown Myotis, is a gregarious species, which generally roosts in colonies of a few individuals to hundreds of individuals. In the spring, females gather together in nursery colonies. At this time the males are segregated from the females and roost singly or in small groups of two to twenty (2-20) individuals. The young are born in June and by late July, the nursery colonies are abandoned for other roasts (Fenton 1969a; Banfield 1974).

Throughout the spring and summer, the bats spend the daylight hours in their roosts and emerge at dusk to search for food. Between feeding bouts, the bats eat and digest their food on temporary night roosts (Banfield 1974; Fenton 1983).

The bats move to their hibernation sites in August and breed there. They congregate in large numbers and fly into and out of the caves and mines at night, but do not roost in these sites during the day. This "swarming" behaviour seems to bring together widely dispersed individuals and likely facilitates matefinding, outbreeding (Humphrey and Cope 1976), and familiarizing inexperienced young with locations of hibernacula (Fenton 1969b).

Hibernation begins in September. The bats remain torpid until spring, although they may arouse occasionally during warmer weather. Females leave the hibernacula in mid-April and fly to the nurseries. Males remain torpid until mid-May. Since caves and abandoned mines are not always readily available near suitable nursery roosts and foraging areas, some bats must migrate to their summer roosts in the spring and back to their winter roosts in autumn. Migration distances recorded by Fenton (1970) ranged from ten (10) to 220 km.

Diet

Little Brown Myotis feed on chironomids, mosquitoes, tipulids, mayflies, moths, beetles, caddis flies and a variety of other flying insects. These bats are opportunistic feeders, eating the most abundant insects, although some individuals, especially females, may hunt selectively (Cahn 1937; Belwood and Fenton 1976; Buchler 1976; Anthony and Kunz 1977).

Little Brown Myotis capture prey at an impressive rate of about seven (7) insects per minute. In one (1) study, pregnant females, lactating females, and juveniles ate an average of two and one half (2.5) g, three point seven (3.7), and one point eight (1.8) g of insects per night, respectively (Anthony and Kunz 1977).

Foraging Habitat

The Little Brown Myotis hunts mainly over water, although it will also forage among trees in fairly open areas (Barbour and Davis 1969; Belwood and Fenton 1976).

Roosting Habitat

The bats require hot, dark, poorly ventilated areas with several small access holes for nursery roost sites (Humphrey 1982). Attics or other spaces associated with buildings best fulfil these requirements. Only one (1) of 196 nursery colonies examined in Alberta was found in a tree (Schowalter et al. 1979). Nursery colonies are generally close to forested areas with large lakes.

Males, which are segregated from the females and young in nursery colonies, roost in a variety of structures such as rock crevices, attics, behind shutters, under bark, behind siding, and under shingles (Barbour and Davis 1969).

In the winter Little Brown Myotis seek out caves and abandoned mines with cool and stable temperatures. They hibernate in those parts of mines or caves where temperatures are between one and five degrees C (1^{o}-5^{o} C) (Fenton 1983) and relative humidity is eighty-five to one hundred percent (85-100%) (Barbour and Davis 1969).

Keen’s Myotis (*Myotis keenii*)

Habits

Although Keen’s Myotis is never abundant, it is the only species besides the Little Brown Myotis that is encountered regularly in the northern hibernacula (Fenton 1969a). The largest number estimated at a hibernation site is 230 (Hitchcock 1949), but much lower numbers are usually encountered. Little is known about summer habits. Summer colonies have not been found in Ontario (Fenton 1969a), but elsewhere small maternity colonies have been recorded. Mumford and Cope (1964) discovered a nursery colony of about thirty (30) animals beneath the bark of a dead elm tree.

Keen’s Myotis generally roost singly. They spend daylight hours in the roosts and begin feeding at early dusk (Banfield 1974).

Swarming behaviour in August is similar to that of the Little Brown Myotis. The bats begin hibernation at the end of October and leave the hibernacula in early May (Banfield 1974).

Diet

Keen’s Myotis feeds on flying insects (Banfield 1974) .

Foraging Habitat

M. keenii feeds above glades and rivers in forests (Banfield 1974).

Roosting Habitat

During the summer days Keen's Myotis roost under the bark of trees, in holes, in brush, in rock crannies (Banfield 1974), under shingles (Brandon 1961), behind shutters, or in barns (Barbour and Davis 1969). In Ontario, *M. keenii* was found under rocks and under the loose bark of an elm tree (Fenton 1969a).

Keen's Myotis often hibernate in the same caves and mines as Little Brown Myotis, although they prefer cooler hibernation sites with high relative humidity (Barbour and Davis 1969). Individuals generally roost closer to entrances of hibernacula than Little Brown Myotis (Barbour and Davis 1969; Fenton 1969a).

Small-footed Bat (Myotis leibii)

Habits

Little is known of this uncommon species. Only one summer aggregation has been recorded in Ontario (Fenton 1969a). During winter, the Small-footed Bat occurs in small numbers in most Ontario hibernacula (Fenton 1969a). The largest number ever reported at one site was 142, but most hibernation sites harbour only a few individuals (Hitchcock 1945; 1965). Hibernation does not begin until late November and by mid-April the bats have usually left their winter roosts (Fenton 1969a)

The Small-footed Bat occurs along the east shore of Lake Superior and the north shore of Lake Huron in summer, but has not been found in these areas in winter (Fenton 1972). Known hibernacula are located in the hills bordering the Ottawa Valley (Banfield 1974).

Diet

Cockrum (1952, cited by Barbour and Davis 1969) found flies, beetles and ants in the stomachs of two (2) specimens from Kansas.

Foraging and Roosting Habitat

This species seems to prefer coniferous forest in hilly country (Banfield 1974).

Observations of this species outside of its hibernacula are rare. In Ontario, Hitchcock (1955) found a small maternity colony of Small-footed Bats behind a sliding door on a barn. The species has also been found on the outside of a cabin (Peterson 1966) and under rocks (Barbour and Davis 1969; Fenton 1969a).

Small-footed Bats tolerate a wide temperature range and low relative humidity. They remain in hibernation at temperatures between minus nine degrees and ten degrees (-9^{o} and 10^{o}) and are more common in drier passages. These bats occupy smaller caves that are subject to more air movement (Fenton 1969a; 1983).

Silver-haired Bat (Lasionycteris noctivagans)

Habits

Fenton (1969a) rarely encountered this species in mist nets set in various habitats at night, or in day roosts. Silver-haired bats are generally solitary, but often roost in groups of two to four (2-4) (Barbour and Davis 1979). A small nursery colony was recently discovered in a hollow basswood tree in southern Ontario. The colony consisted of at least eleven (11) adults and twelve (12) young (E. Kaiser, pers. comm.).

These bats gather in flocks in August and September and breed at this time. They migrate south to the United States where they hibernate in trees, buildings, rock crevices and other protected shelters (Barbour and Davis 1969), and return to Ontario in late May and June (Peterson 1966; Banfield 1974).

Diet

Since Silver-haired Bats forage over lakes and streams, they may prefer emerging aquatic insects (Banfield 1974).

Foraging Habitat

This species usually forages over woodland lakes and streams (Barbour and Davis 1969).

Roosting Habitat

During the summer days, individuals roost under loose bark on trees, in hollow trees, in woodpecker holes, and in birds' nests. They have been found in numerous other shelters, including open sheds, garages and outbuildings during migration (Barbour and Davis 1969; Banfield 1974).

Eastern Pipistrelle (*Pipistrellus subflavus*)

Habits

Small numbers of Eastern Pipistrelles, the smallest of the eastern Canadian bats, are found throughout southern Ontario in the winter, but there is little information on summer roosts (Fenton 1969a). Single animals or small groups have been found occasionally during the summer (Barbour and Davis 1969).

These bats feed in the early evening and catch as much as three point three g (3.3) of insects per hour, which accounts for about one half (1/2) of their body weight (Gould 1955; Peterson 1966).

Eastern Pipistrelles join the other swarming species of bats in late summer and enter the hibernation sites in October, remaining until the end of April (Fenton 1969a).

Diet

Pipistrelles feed on moths (Barbour and Davis 1969), flies, beetles, ants and ichneumonid flies (Banfield 1974).

Foraging Habitat

Eastern Pipistrelles often forage over water courses. They never forage in deep woods or open fields unless large trees are nearby (Davis and Mumford 1962; Barbour and Davis 1969).

Roosting Habitat

Pipistrelles rarely roost in buildings, but there are records of small nursery colonies in buildings in the United States. These colonies are usually in open areas of buildings that are more exposed to light than the roosting sits of other species (Barbour and Davis 1969).

P. subflavus hibernates in caves and abandoned mines and within these sites the species selects warm, draftless, humid spots. A few are found in small caves that are unsuitable for other species, although they also hibernate in larger caves (Hitchcock 1949; Barbour and Davis 1969).

Big Brown Bat (*Eptesicus fuscus*)

Habits

The Big Brown Bat is a common species, which regularly roosts in buildings. Males roost separately from nursery colonies of females and young. As the young mature, the sexes reunite (Barbour and Davis 1969).

E. fuscus begins foraging at dusk and can capture two point seven g (2.7) of insects per hour (Gould 1955). After feeding, the bats rest on night roosts.

This hardy species enters hibernation in late November and leaves the hibernacula by early April (Fenton 1969a).

Recoveries of banded bats show that they do not migrate long distances between winter hibernacula and the summer range; most recoveries of banded bats were within sixty km (60) of the banding site (Davis et al. 1968; Barbour and Davis 1969).

Diet

The Big Brown Bat eats mainly beetles (Belwood 1979, cited by Humphrey 1982), but also feeds on flying ants, ichneumonids, flies, stoneflies, mayfies, true bugs, caddis flies, lace-wing flies, scorpion flies and orthopterous insects (Hamilton 1933).

Foraging Habitat

E. fuscus forages above meadows, tree-lined streets of cities and towns, pastures, ponds, creeks, and rivers (Barbour and Davis 1969; Humphrey 1982).

Roosting Habitat

The Big Brown Bat prefers to roost in buildings. In the summer, nursery colonies are situated in attics and barns, behind shutters and sliding doors, and between building wings (Barbour and Davis 1969; Fenton 1969a). Such nursery colonies are frequently near extensive fields with stream drainage (Fenton 1969a). Roosts are also occasionally found in hollow trees, under the bark of trees, in rock crevices, and beneath bridges (Peterson 1966; Barbour and Davis 1969). The Big Brown Bat roosts in cooler places than the Little Brown Myotis and will move to cooler areas when temperatures rise above thirty-three to thirty-five degrees (33^o-35^o). The solitary males roost in buildings, bridges, rock crevices, and trees (Humphrey 1982).

Typical night summer roosts include porches of stucco or brick houses, open garages, and breezeways (Barbour and Davis 1969).

The Big Brown Bat hibernates in caves and abandoned mines and is the only species that also regularly hibernates in buildings. This species tolerates a greater temperature range and lower relative humidity during the winter than the other hibernating species, except for *M. subulatus*, which often hibernates at the same sites as *E. fuscus* (Barbour and Davis 1969).

Red Bat (*Lasiurus borealis*)

Habits

The Red Bat is a long-distance migrant, which flies into Ontario in late May. This solitary bat hangs in a tree during the day and begins to hunt early in the evening. The

Red Bat migrates to the southern United States in early September and hibernates there in trees (Peterson 1966; Barbour and Davis 1969; Banfield 1974). Red Bats are regularly taken in mist nets as they migrate through Point Pelee and Long Point on the northern shore of Lake Erie (Peterson 1966).

Diet

Red bats feed on a variety of hard and soft insects including crickets, flies, bugs, beetles, cicadas and moths (Lewis 1940; Hamilton 1943; Jackson 1961).

Foraging Habitat

Red Bats have been observed feeding near or above tree top level over streams, lakes, and rivers and over riparian, flood plain and hill forest (Cahn 1937; La Val and La Val 1979). They also forage in towns under streetlights (Barbour and Davis 1969) and 100 to 200 m above streams, ponds, pastures and forests (Humphrey 1982).

Roosting Habitat

During the summer days Red Bats roost in the foliage of trees, singly or as a family of mother and young (Barbour and Davis 1969; Humphrey 1982). These bats usually hang by one foot from the petioles of leaves, or occasionally from twigs or branches. In this position the bats are well concealed and they resemble dead leaves. The bats prefer deciduous trees, particularly American Elm. In one study, the greatest numbers of Red Bats roosted in forest edges and fence rows (Constantine 1966).

Hoary Bat (*Lasiurus cinereus*)

Habits

The Hoary Bat is a solitary, tree-roosting species, which spends the summer days among the leaves of trees and usually emerges to hunt late in the evening (Peterson 1966; Barbour and Davis 1969; Banfield 1974).

This species migrates to the southern United States in September and October and returns to Ontario by late May (Banfield 1974).

Diet

Little is known of the Hoary Bat's diet. The stomach of one specimen contained a large bug and mosquito (Poole 1932, cited by Barbour and Davis 1969) and Dalquest (1953) observed a Hoary Bat chasing a large moth. Two (2) records indicate that the Hoary Bat occasionally preys on smaller bats (Bishop 1947; Orr 1950).

Foraging Habitat

The Hoary Bat is most often observed foraging over glades or lakes in forested areas (Banfield 1974).

Roosting Habitat

During the summer days, the Hoary Bat roosts among the foliage of coniferous or deciduous trees. Roost sites are open from below, but well covered above and usually at the edges of clearings (Constantine 1966). This species prefers coniferous regions, but also inhabits the more southern deciduous forests, or shaded village streets (Banfield 1974).

Reproduction and Mortality

All eight (8) species of bats in Ontario belong to the family *Vespertilionidae*, or plain-nosed bats as they are commonly called. These bats generally mate in the fall, before hibernation or migration, but fertilization is delayed for several months. Females store spermatozoa in the vagina or uterus during the winter and ovulate in the spring. The young are born in May, June, or early July (Humphrey 1982).

Sexual maturity is generally reached at the age of one (1) year. Natality rates are low; bats produce only one (1) litter of one to three (1-3) young per year. Colonial species tend to have single young, whereas solitary species have litters of two or three (2-3) young (Humphrey 1975).

Humphrey (1975) suggested that the differences in litter sizes between species are related to survival rates of the species. By selecting protective roosts such as caves, mines and buildings, and by hibernating during the winter, colonial bats reduce their exposure to predators and climatic extremes and therefore, increase their survival rate. Banding studies in Ontario have shown that several species of bats have especially long life spans for mammals of their size. Two (2) Little Brown Myotis were recaptured twenty-nine and thirty (29 and 30) years after being banded, although the average life expectancy is three to five (3-5) years (Keen and Hitchcock 1980). In contrast, the solitary species presumably have lower survival rates since they roost in the open and migrate long distances. These habits expose them to more agents of mortality. Larger litter sizes may compensate for the lower survival rates of these species (Humphrey 1975). Since protected roosts enhance the survival of colonial species, reduced biotic potential may have evolved to assure stable populations (Humphrey and Cope 1975).

This aspect of the biology of bats has important implications for the survival of colonial species. Species with low natality rates cannot as easily withstand the impact of human activities as more prolific species.

Critical Habitat

Caves and Mines

Caves and abandoned mines are used as winter roosts by five (5) of Ontario's species of bats. These protected sites provide stable environments, shelter from extreme weather conditions, and protection against predators (Maser et al. 1979). Not all caves and mines are suitable as winter hibernacula; bats choose sites where temperatures usually stay above freezing and relative humidity is high. This ensures that their reserve of fat lasts the duration of the hibernation period (Fenton 1983).

The availability of suitable winter hibernacula is limited. Consequently, those caves and mines that are presently used by hibernating bats are critical to the survival of the existing populations.

In Ontario, mines harbour the greatest concentrations of hibernating Little Brown Myotis. Before the presence of these mines, part of the population may have migrated to more southerly hibernacula in the United States (Fenton 1970). At least some bats occupied the sparsely distributed, small caves in Ontario (Churcher and Fenton 1968, cite by Fenton 1970).

Buildings

The Little Brown Myotis and the Big Brown Bat regularly roost in buildings. Attics and barns are used as nursery roosts because they are dark, hot and poorly ventilated (Humphrey 1982). These conditions speed up the growth of the young, which have only a short time to build up their fat reserves between weaning and hibernation (Fenton 1983). Little Brown Myotis establish nurseries in buildings near lakes and forested regions, whereas Big Brown Bats select buildings surrounded by fields (Fenton 1970).

The Big Brown Bat is the only species that hibernates in buildings during the winter.

Snags

Snags, which are dead or partly dead trees that are still standing, are used by a large number of invertebrate, amphibian, reptile, bird, and mammal species for feeding, nesting, roosting and shelter (Davis 1983). Bats roost in tree cavities and under loose bark. Such sites protect bats against predators and bad weather and dampen fluctuations in temperature and humidity (Thomas et al. 1979a; Kunz 1982).

Small nursery colonies of Big Brown Bats (Christian 1956), Silver-haired Bats (E. Kaiser, pers. comm.), and Keen's Myotis (Mumford and Cope 1964) have been found in tree cavities or beneath loose bark on trees. A nursery colony of Little Brown Myotis in a tree was reported only once (Schowalter et al. 1979), but males of this species have been found roosting under loose bark and in tree hollows (Krutzch 1961; Barbour and Davis 1969; Schowalter et al. 1979).

Fenton (1970) has suggested that Little Brown Myotis used hollow trees or spaces under bark for nursery colonies before European settlers erected buildings in North America. Since bats quickly exploit new roosting sites, they may have switched from trees to buildings where the environment may allow more efficient rearing of young. Extensive logging operations during the 19th century may have accelerated this move since the number of hollow trees suitable for nursery colonies must have been severely reduced (Fenton 1970).

Riparian and Aquatic Habitat

Vegetation communities adjacent to lakes, ponds, rivers, streams, and springs constitute riparian habitat. Although riparian habitat makes up only a small portion of the total area, it is disproportionately more important to wildlife than other habitat types (Thomas et al. 1979b).

Riparian habitat, with its large amount of edge and many vegetative strata, provides diverse feeding opportunities for bats (Thomas et al. 1979b). Riparian forests help to preserve water quality by erosion control (James 1984a). and thereby maintain a diverse and abundant aquatic insect fauna. Six (6) of the eight (8) Ontario species of bats regularly forage over aquatic and adjacent riparian habitat. In addition, riparian zones along streams and rivers provide migration routes for bats (Thomas et al. 1979b).

Protective Measures Instituted

Protection of Bats in Abandoned Mines

The Abandoned Mines Program has evolved from Section 161 of the *Mining Act (R.S.O. 1980)*. Entrances to abandoned mines that are considered hazardous must be secured.

Just this year, the Ontario Ministry of Natural Resources, (OMNR) Pembroke District Office was informed of the importance of a hibernaculum in an abandoned mine in Renfrew County. About 15,000 bats hibernate there each winter and researchers and students of Carleton University have used the site for the study of bat ecology and behaviour since 1965 (Hehn 1984).

Instead of blasting shut the entrances to the mine, university biologists and OMNR engineers designed a method of securing the mine, which allows bats to fly in and out, but keeps people out. They erected high chain-link fences around the three shaft openings and barricaded the adit (horizontal passage) with two (2) steel grillwork gates, fifty (50) feet apart (Hehn 1984).

Another abandoned mine in Pembroke District was also “gated” after it was identified by local people as a hibernaculum for bats. A concrete wall with ventilation holes at the bottom and a ten (10) inch gap with steel bars at the top was placed across the opening to the mine (F. Hehn, pers. comm.).

Protection of Bats in Natural Caves

North America's largest granite cave, on the shore of Cavern Lake near Dorion, was originally used as a hibernaculum by an estimated 5,000 bats (Allin 1942). By 1972, the population declined to less than 200 bats (Woodside and Buchanan 1975). The cause of the decline seems to be disturbance by man. Garbage, matches, fires, and remains of snowmobile flares in the cave entrance are evidence of heavy use of the cave. A passable roadway and two (2) trails leading to the cave make it easily accessible. This and the wide knowledge of the cave and its bats make the population of bats in the cave highly susceptible to disturbance and vandalism (Woodside and Buchanan 1975).

Cavern Lake Provincial Nature Reserve was established in 1975 to protect the declining bat population. Unauthorized entrance to the cave is prohibited. Installation and maintenance of a gate at the cave entrance will be considered when funding becomes available; in the meantime, park staff will allow trails to deteriorate and post signs near and at the cave entrance to deter people from entering the cave (Ontario Ministry of Natural Resources 1984).

Management Guidelines

Protection of Roosts

Roost availability is the main factor limiting populations of bats. Since one of the major causes of population decline is destruction of roosts or disturbance of bats in their roosts, the survival of bats depends on the protection of roosts.

Hibernacula

Each OMNR district office should prepare a list of the locations of caves and mines in which bats hibernate during the winter. This information can be obtained from bat researchers, spelunkers, and naturalist groups. Fish and Wildlife Supervisors should make District Managers aware of abandoned mines that are used as hibernacula by bats, especially if those mines are scheduled for closing. Major hibernacula can be protected by land acquisition, signs, fences or gates.

Protection of marginal hibernacula may also be important in bat conservation. If populations in major hibernacula decline drastically because of disturbance, then bats in minor hibernacula may be able to recolonize the major hibernacula. Loss of minor hibernacula leads to increased distance between suitable hibernacula and between hibernacula and suitable summer habitat. This could result in a contracted distribution, especially near the periphery of a species' range. Marginal hibernacula may also promote or maintain genetic diversity (Gates et al. 1984).

Land Acquisition

When an abandoned mine on patented land is declared to be hazardous and the entrances must be closed, the landowner is responsible for doing the job. If the mine serves as a hibernaculum for bats, then the only method that can be used to shut the entrances and, at the same time, allow bats access to the mine, is installation of gates or fences across the openings. The simplest and most economical methods of securing mines are blasting the openings shut with dynamite, blocking the entrances with cement, and erecting fences around the openings (W. Good, pers. comm.). Compared to these methods, gating is costly and most landowners would probably not be willing to incur the expenses. For example, the Craigmont mine in Pembroke District, which is privately owned, is used as a hibernaculum by about 1,000 bats (M.B. Fenton, pers. comm.). The owner of the mine is required to close the entrance (F. Hehn, pers. comm.), but is under no obligation to use the more expensive method of gating to preserve the hibernaculum for the bats.

Natural caves that serve as hibernacula may be threatened by land development. The Moira cave near Belleville is a good example. Its winter population of about 200 Little Brown Myotis is the largest cave population in southern Ontario (Fenton 1970). Moira cave, which is privately owned, is both biologically and geologically unique. The bat population in the cave is threatened by vandals and visits by various groups of interested people who don’t realize the effects that the have on the bats. There is already an urban population near the cave, and future land-use may place additional stress upon the bat population.

In the situations described above, acquisition of a hibernaculum and surrounding land may be necessary to prevent the destruction of that winter roost, and subsequent loss of a large bat population. However, public ownership of land may not be enough to protect a hibernaculum. Posting signs, or more stringent protective measures such as gating, are usually also required.

Signs

In some situations, signs alone will reduce or prevent human disturbance of bats in caves and mines. If a sign at an entrance is likely to call unnecessary attention to a cave or mine, then the sign should be placed inside the hibernaculum (Brady et al. 1983).

For caves and mines that are well known as bat hibernacula, signs with a warning message in large letters and an interpretative message beneath the warning may be appropriate. The message below is similar to that used by the Missouri Department of Conservation for the protection of Indiana Bats (Brady et al. 1983):

ATTENTION!

DO NOT ENTER THIS CAVE BETWEEN

SEPTEMBER 1 AND APRIL 30.

The bats that hibernate in this cave must survive winter on stored fat. When disturbed, they arouse, using up precious fat. Bats that have been aroused two or three times may die before the insects on which they feed are again available in the spring.

Figure 3 Sample Sign

In some areas, the mention of bats may actually attract people to a cave or mine, by informing people of the bats' presence. To avoid this situation, a sign simply warning of hazardous conditions or falling rocks in a mine or cave may be adequate as a deterrent.

Signs should be fixed solidly in place so that vandalism is minimized, and placed where they can be seen by potential visitors, but not where bat movement or air flow might be impeded. If a gate or fence is used, a sign should be placed just behind it (Brady et al. 1983).

Gates and Fences

When entrances to an abandoned mine that is used by bats as a hibernaculum must be closed for safety reasons, gates or fences should be installed in or around the mine entrances as an alternative to blasting. Most caves in Ontario are difficult to protect by gating because of their many irregular and often small openings.

Gate design should be specific for each mine or cave and will depend on entrance size and shape, air flow, and number of bats. However, Tuttle (1977) and Brady et al. (1983) have made certain generalizations about gate design, which are outlined below:

- Use welded steel bar gates with bars that are three quarters to one inch (3/4 – 1) in diameter.

- Grout free ends of all bars into solid rock. A concrete footing may be required, but it should not rise above ground level.

- Use durable hinges, hasps, and locks on access openings in gates. In areas where vandalism is a problem, the lock or hasp should be relatively weak so that the main gate, which is difficult to repair, will not be destroyed.

- Distance between bars is a compromise between minimizing interference with the bats and maximizing protection against vandals breaking or squeezing through the gate. Distance between horizontal bars should be six (6) inches and there should be twenty-four to forty-eight (24-48) inches between vertical bars, depending on the strength of the bars. Distances greater than twenty-four (24) inches increase the likelihood of spreading the bars with hydraulic jacks.

Each gate should be inspected routinely so that a damaged gate can be repaired promptly.

Gates can have detrimental effects on bat populations if improperly used or designed. Tuttle (1977) has observed four (4) instances of gating, which led to abandonment of caves by bats. Gates of improper design or gates in small entrances are likely to restrict bat movement, impede air flow, and increase the vulnerability of bats to predation (Tuttle 1977; Tuttle and Stevenson 1978; Brady et al. 1983). Gates should not be used in entrances that are smaller than six (6) feet in diameter and horizontal gates should not be placed across vertical entrances (Brady et al. 1984).

Although fences are easy to climb or cut, their presence makes it clear that entry is prohibited. Fences can be used when gating is considered too expensive, when size, configuration or number of entrances make it impractical to gate, or when gating is likely to result in abandonment of the mine or cave by bats (Brady et al. 1983).

Chain-link fences with posts set in concrete, and topped with barbed wire are most effective in reducing human disturbance. The barbed wire should not extend into the bats' flight space (Brady et al. 1983).

Once gates or fences have been erected, their effects, if any, on the bats should be studied. Such observations will ensure that barriers that have a negative impact on the bats will be removed or the design will be changed before the population of bats is destroyed (Tuttle 1977; Tuttle 1979; Brady et al. 1983).

Information exchange between bat researchers, naturalist groups, caving groups, and OMNR staff will help to detect and avoid potential problems (Tuttle 1979).

Approaches to Hibernacula

Trails and roads increase the accessibility of hibernacula. If feasible, such approaches should be blocked or allowed to deteriorate (Brady et al. 1983).

Nursery Colonies in Buildings

The most frequently observed and largest nursery colonies are those established in attics of buildings, and in barns. Although many people coexist with bats without problems, some property owners may want to exclude bats from their buildings because of noise, odor, and the possibility of disease. Homeowners who are considering bat control should be informed that a bat colony in a building is not a health threat. Attacks on humans by rabid bats are extremely rare, especially by bats in nursery roosts, and colonies do not experience rabies outbreaks (Tuttle and Kern 1981). If bats are still considered a nuisance, a homeowner can exclude them from their roost by closing all of the bat entrances to the building. This control method is much more effective than killing bats (Humphrey 1982; Fenton 1983; Greenhall 1983; Tuttle 1984). Bat problems in buildings are discussed in greater detail in the section, Bat Control and Public Health.

Snags

Although large bat colonies such as those found in attics have not been found in tree cavities, there are references in the literature to individual bats or small groups of bats roosting in snag cavities or under loose bark (Barbour and Davis 1969; Fenton 1969a).

Snags are probably much more important to bats than the few references in the literature indicate; bat roosts in snags are not easily observed. Even a relatively large nursery roost (over twenty [20] individuals) of Silver-haired Bats in an area visited frequently by people went unnoticed until the snag was cut down (E. Kaiser, pers. comm.).

Current forest management practices tend to remove snags, reduce recruitment of new snags, and decrease the probability of trees ever growing large enough to become large snags. Woodlands and forests must be managed for snags, since snags are vital to the survival of many species (Thomas et al. 1979a; Davis 1983). All snags should be left standing in any type of management practice, and some healthy trees should be allowed to grow to a large size to provide future snags. More detailed habitat management guidelines for species that use snags are provided by Thomas et al. (1979a), Davis et al. (1983), and James (1984a).

Protection of Feeding Areas – Aquatic and Riparian Habitat

Degradation of water quality may lead to reduced aquatic insect diversity and abundance. Since most species of bats in Ontario include aquatic insects in their diet, good water quality in prime feeding areas should be maintained.

Riparian zones should be left uncut, if possible. At the least, leave fifty (50) meters uncut on either side of a river or lake, do not cut forest on steep banks, and limit timber harvest to selective cutting (James 1984b).

Research

Unnecessary arousal of bats in hibernacula, entry into nursery roosts, and specimen collection should be avoided. Instead, researchers can use traps and mist nets to capture and band bats outside of their roosts, in foraging areas, or at cave entrances during swarming. Such disturbances should not be repeated nightly (Tuttle 1979; M.B. Fenton, pers. comm.).

Provision of Bat Houses

Since availability of roost sites is a limiting factor and bats are quick to take advantage of new roost sites, the provision of bat houses may be helpful in countering the loss of bats as nursery colonies in man-made structures are excluded or destroyed. La Val and La Val (1980, cited by Greenhall 1983) reported that a colony of Little Brown Myotis quickly occupied an artificial roost after the colony was excluded from its original roost site. Bat houses, which are similar in design to bird nesting boxes, are used in Europe and Australia for a variety of species (Fenton 1983).

Landowners may wish to attract bats to their property for insect control, by providing bat houses. Suggestions for building bat houses and attracting bats are outlined in Appendix I.

Public Education

There is a need for educational materials about the ecological role of bats, the rarity of disease transmission to man, and the ineffectiveness of pesticides applied to bat roosts (Tuttle and Kern 1981). A brochure prepared by Bat Conservation International, Inc. is shown in Appendix II.

When bats are part of the mammalian fauna in provincial parks, information on bats should be included in the interpretive programs (Woodside and Buchanan 1975).

Bat Control and Public Health

Bats and Disease

Most bat-human contact involves the Little Brown Myotis and Big Brown Bat, which regularly roost in buildings. Despite what many people believe, bats rarely transmit disease to humans (Tuttle and Kern 1981). Unfounded fear of parasites and diseases, mainly rabies and histoplasmosis, has been used as justification for anti-bat programs in which thousands of these beneficial animals have been killed. This greatly exaggerated threat is fueled by the media, pest control companies, and misinformed government agencies. The exaggerated and inappropriate response of the public to bat “problems” is frequently far more damaging to public health than the actual health problems posed by bats (D.G. Constantine, letter to W. Weber, 26 August 1982, cited by Tuttle 1984).

Bat Ectoparasites

Although bats are host to many species of ectoparasites, none of these are of significance to human health (Marshall 1982). Bat parasites are specialized to live and feed on bats and cannot survive for very long without their hosts. Ectoparasites of bats do not transmit disease to humans (Strohm 1982).

Histoplasmosis

Histoplasmosis is a fungus disease which effects the lungs. The fungus spores are frequently found in bird and bat droppings and in soils enriched by droppings. In temperate regions, histoplasmosis from bat droppings is not a health hazard. Fenton (1983) was never exposed to histoplasmosis during his ten (10) years of work in Little Brown and Big Brown bat nursery colonies in Ontario.

Rabies

Infection rates in North American bats are usually less than one half (0.5) percent in a random sample of seemingly normal bats. The incidence increases to three to ten percent (3-10%) in samples of sick, dead, or suspect bats. Sampling biases, such as mixing of suspect and apparently normal bats and small sample sizes, often result in higher rates of the disease in wild populations (Tuttle and Kern 1981).

Healthy bats never attack people and attacks by rabid bats are extremely rare. Only the occasional bat in a colony becomes infected with rabies and outbreaks of the disease in bat colonies do not occur (Tuttle and Kern 1981; D.G. Constantine, letter to W. Weber, 26 August 1982, cited by Tuttle 1984).

Bats are not carriers or reservoirs of rabies. As in other mammals, infected bats soon become paralyzed and die. Bats are much less of a threat to public health than other animals such as foxes, cows, and skunks, which account for most cases of rabies reported in eastern Canada (Tuttle and Kern 1981; Fenton 1983). Of the bat specimens that are brought in for testing and found to be positive for rabies, ninety-five percent (95%) are Big Brown Bats (D. Johnston, pers. comm.).

Since rabid bats rarely attack people, most humans are exposed by handling bats. For example, in 1983, fourteen (14) people from the city of Scarborough received post-exposure anti-rabies vaccine because of suspected exposure to rabid bats. All of these suspected exposures resulted from handling bats, not attacks by bats (Gorman 1983). In Ontario, a girl playing by a stream was bitten by a rabid bat floating in the water and she died in Montreal. This is the only case of rabies caused by the bite of a bat in Ontario, which resulted in death (D. Johnston, pers. comm.).

Treatment of Human Exposure to Rabies

A person who is bitten by a bat should wash the wound thoroughly, capture the animal for testing without destroying the head if possible, and seek medical treatment. Bat specimens should be picked up with gloves or forceps, put in a glass jar, kept cool, and submitted to the Department of Agriculture in Ottawa or a local office.

Prevention of Human Exposure

People should not handle bats that are behaving abnormally. Bats should be excluded from human living quarters by putting screens on doors, windows, and ventilation systems, placing draft guards beneath attic doors, and covering chimneys with a quarter inch (1/4) hardware cloth (Tuttle and Kern 1981; Greenhall 1983). Since bats can move in the walls from the attic to the basement, basement doors should be kept shut and fit tightly (Fenton 1983).

Bat Control

In deciding whether bats should be excluded from attics, eaves or behind chimneys, informed homeowners should consider the value of bats in insect control (Tuttle and Kern 1981). There is often no reason to exclude bats from a building, especially an abandoned one. Bats do not cause structural damage by gnawing, like rodents do (Fenton 1983).

In some situations it will be necessary to evict bats from a building. Although there are many control methods including “bat proofing” (sealing entrances), placing repellents such as naphthalene, sticky deterrents, high frequency sound, and lights in the roost, using pesticides to kill bats, and trapping bats, the only safe, effective and long-term solution is to seal all entrance and exit holes that are wider than five (5) millimetres. Holes should only be sealed in the night after bats have departed to feed or in the autumn when the colony has dispersed. To avoid sealing flightless young inside a building, do the work in the early spring before the young are born or later in the summer when the young can fly (Tuttle and Kern 1981; Greenhall 1982; Fenton 1983).

If blocking entrances is impractical, then illumination can be used as a repellent. In the study on the effect of artificial light on nursery colonies in attics, treated bat colonies decreased by fifty-three to ninety-six percent (53-96%) whereas untreated colonies grew by fifty-seven to ninety-seven percent (57-97%) (Laidlaw and Fenton 1971). Incandescent 100-watt bulbs seem to be most effective if they are positioned so they do not cast shadows (Fenton 1983).

The use of DDT or any other pesticide to control bats is not recommended under any conditions (Laidlaw and Fenton 1971; Kunz et al. 1977; Barclay et al. 1980; Tuttle and Kern 1981; Strohm 1982; Fenton 1983; Tuttle 1984). Study after study has shown that DDT is not only ineffective as a means of controlling bats in buildings, but that bat-human contacts are increased after treatment (Kunz et al. 1977; Barclay et al. 1980; Tuttle and Kern 1981; Tuttle 1984). DDT causes bats to fall to the ground where they may be picked up by humans or pets (Tuttle and Kern 1981). Moreover, DDT and other pesticides may actually be the cause of an increase in the incidence of rabies, since “physiological stress imposed by sublethal levels of pesticide toxicity may activate latent viral infections", such as rabies (Kunz et al. 1977). If entrances are not sealed after the application of DDT, bats may recolonize the roost several years later. Pesticides needlessly destroy bats when they can just as easily be excluded and still have the chance to function as insect predators (Tuttle and Kern 1981).

Use of DDT in Ontario

The Ontario Ministry of the Environment (MOE) allows the use of DDT for control of bats in some circumstances. Licenced exterminators must be granted a permit before they can apply the pesticide in a building. Use of DDT is permitted because bats are considered to be vectors of rabies and they carry parasites (Pesticide Control Office, Ministry of the Environment, pers. comm.). When a permit is issued, MOE requires that entrances used by bats be sealed after the application of DDT to prevent subsequent infestation.

Since MOE requires that bat entrances be sealed after DDT is applied, there is really no need to apply DDT in the first place. Once entrances are sealed, the bats will not be able to get back in the roost.

Summary

Populations of four (4) cave-dwelling species of bats in Ontario seem to be declining: Little Brown Myotis, Keen's Myotis, Small-footed Bat, and Eastern Pipistrelle. Since all of these species are roost-limited and highly vulnerable to human disturbance in their roosts, protection of roosts is necessary to ensure the continuation of healthy populations of these species, including our most common bat, the Little Brown Myotis.

Acknowledgements

I would like to thank M.B. Fenton, Carleton University, who provided information for this report and reviewed the manuscript. J. Fullard, University of Toronto also contributed information. I am grateful to I. Bowman, Ontario Ministry of Natural Resources for suggesting that I prepare the report and for her helpful comments.

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Appendix I

Suggestions for Building Bat Houses and Attracting bats

Bat houses of the designs illustrated for models one and two (1 and 2) (see attached plans) have been used successfully for a variety of bat species in Europe. Their exact size and shape probably are not important except for the width of the entry space. This should not exceed one (1) inch, with the ideal width being only three quarters (3/4) of an inch. Regardless of the kind of house built, all inner surfaces must be rough enough to permit the bats to climb on them with ease, and rough outer surfaces are preferred.

Young bats grow best where daytime temperatures are in the eighty to ninety degree (80-90^{o}) range. For this reason maternity colonies are most likely to use bat houses that either provide temperatures in this range or that are so well insulated that body warmth is easily trapped. Europeans often cover their bat houses on top and for an inch or two (1-2) down the sides with two (2) or more pieces of tar paper. The dark covering absorbs heat from the sun by day and provides added insulation by night, in addition to protecting the bats from rain.

Several means of insulating or providing a range of temperatures in bat houses are available but as yet largely untested. One involves covering bat houses with styrofoam on top and on all four (4) sides. An additional covering of dark coloured shingles or tar paper might prove helpful, especially in northern areas where the bats may need higher temperatures. Also making bat house model one (1) two feet (2') tall, with only the upper six (6) inches and top covered with dark material might provide a better range of temperature. By moving up and down and from front to back bats could find roost temperatures more continuously to their liking. Paint or varnish reportedly is somewhat repellent to bats, at least until well cured.

Bat houses should be fastened securely to a tree trunk or the side of a building roughly twelve to fifteen feet (12-15') above ground, preferably where they will receive morning sun but will be shaded during the afternoon. Inside temperatures above ninety degrees F (90^{o}) generally are intolerable. For this reason a well insulated bat house that receives only morning sun would prove most suitable. Male bats do not live with the females while young are being reared, and these bachelor colonies may be attracted to sheltered, cooler locations. Additionally, most bats seem to prefer sites that are relatively protected from wind.

It is important to note that bats can live only where local food supplies are adequate. For this reason most colonial bats are found near places such as rivers, lakes, bogs or marshes where insect populations are high. The closer bat houses are to such places the greater the probability of being used. Those located more than a half (1/2) mile from these habitats have greatly reduced probability of being occupied unless alternate food sources are available.

Sometimes bats occupy a bat house within a few weeks. Often, however, bats require a year or two (1-2) to find the new house. Chances of early occupancy probably are increased if houses are hung before or by early April and also if bats already live in barns or attics in adjacent areas.

Since use of bat houses is very new in the United States, we have much to learn about local bat preferences. Your reporting of successes and failures in building houses for bats could contribute measurably to our knowledge of how to attract bats. Write to Bat Conservation International, c/o Milwaukee Public Museum, Milwaukee, WI 53233.

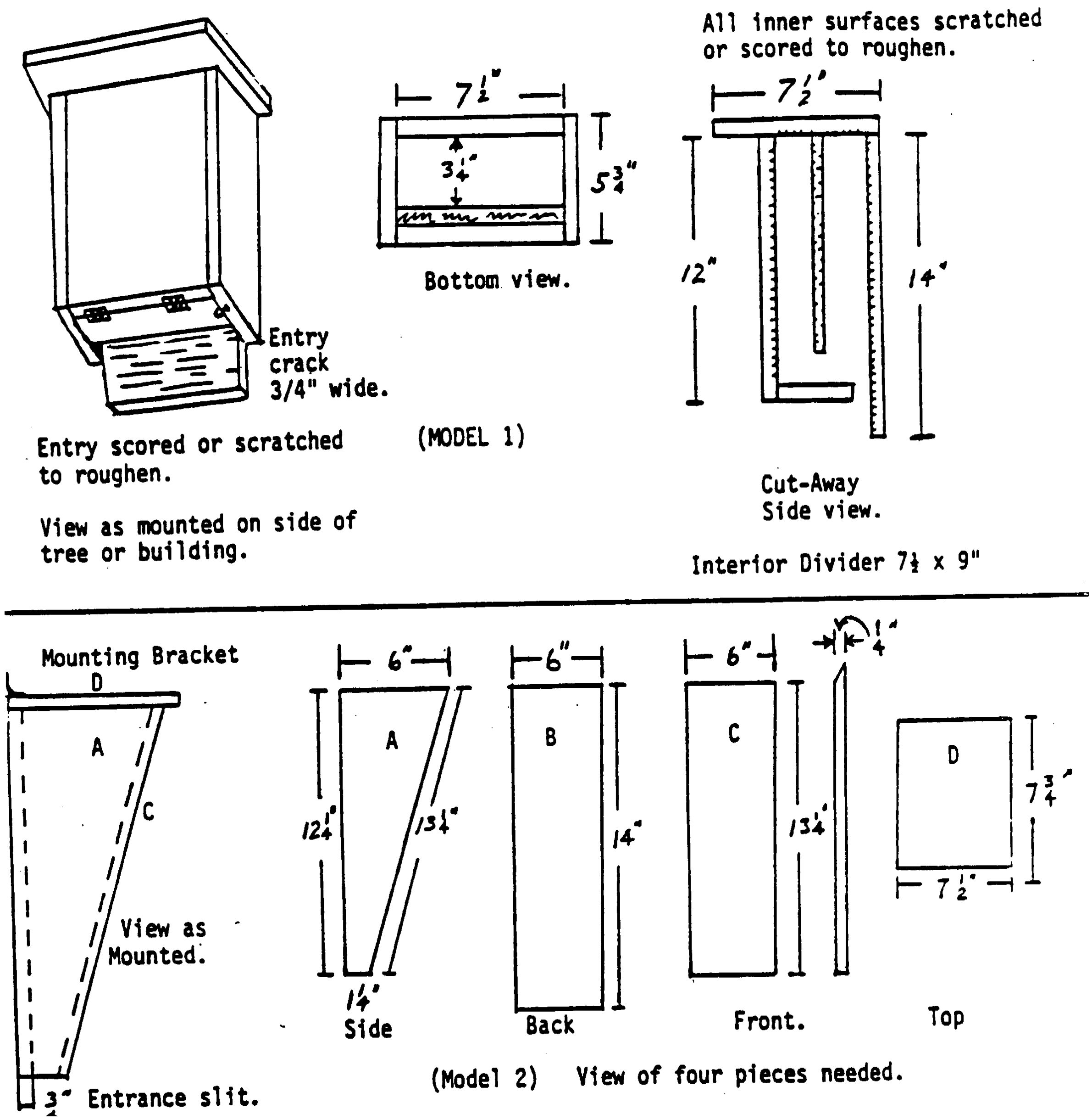

Figure 4 Bat House Plans

Courtesy of Bat Conservation International c/o The Milwaukee Public Museum, Milwaukee, Wisconsin 53233 USA

Appendix II

BATS & THEIR CONSERVATION

United States Department of the Interior
Fish and Wildlife Service
Washington, D.C. 20240

Figure 5 Big-eared Bat

Introducing Bats

Bats are among the world's most fascinating animals. Using sophisticated ultrasonic signals for navigation and communication, they have mastered the night skies just as dolphins have mastered the seas. Nearly a thousand kinds of bats comprise approximately a fourth (1/4) of all mammal species.

Because bats are secretive and active only at night, they often are misunderstood, feared and needlessly killed. Contrary to common myths, bats are neither blind nor dirty. They do not get caught in peoples' hair or infest homes with bedbugs. Like other mammals, a few (less than half (1/2) of one percent [1%]) contract rabies. But even those bats rarely become aggressive or transmit the disease to other animals. When people are endangered, it is usually because they have foolishly picked up a sick bat that bites in self-defense. Records show that even pet dogs are far more dangerous!

Most bats are harmless and highly beneficial, but their numbers are declining rapidly. Several species already are extinct. Others might soon become extinct if misconceptions are not corrected.

Commercial, Scientific and Ecological Values

Your Grocery Store Would Not be the Same Without Bats

Fruit-eating bats are nature's most important seed-dispersing mammals. And nectar-eating bats, along with some fruit bats that visit flowers, pollinate thousands of bat-dependent tropical and subtropical trees and shrubs.

The nearly endless list of valuable fruits, nuts and species from bat-dependent plants includes peaches, bananas, mangos, guavas, avocados, dates, figs, cashews, carob and cloves. Other commodities include plant fibers for surgical bandages, life preservers and rope, lumber for furniture and crafts, and even tequila liquor.

Many plants of economic importance continue to depend on bats. Regional harvests of Durian fruit in Southeast Asia and Iroko timber in West Africa each amount to annual sales of close to $100 million.

Bats are Extremely Valuable in Medical and Other Research

Because bats use highly sophisticated sonar for navigation and are exceptionally long-lived and disease resistant, they are increasingly important for research. They have contributed, for example, to development of navigational aids for the blind, vaccine development, drug testing, studies of ageing, artificial insemination and speech pathology.

Bat Guano is an Important Source of Fertilizer

In the southwestern U.S. 100,000 tons of bat guano were mined from a single cave. Guano continues to be a major source of fertilizer in developing countries, where it is used to fertilize a number of crops, including nearly a third (1/3) of the world supply of black and white peppers.

Bats are the Only Major Predators of Night-flying Insects

One endangered Gray Bat may eat up to 3,000 or more insects, including many mosquitoes, in a single night. Large bat colonies consume countless billions. The Bracken Cave (Texas) colony of Free-tailed Bats, numbering roughly twenty million individuals, eats up to a quarter of a million pounds of insects nightly!

Figure 6 Gray Bat

Threats to Bat Survival

Extermination

Grossly exaggerated “news” stories often lead to dangerous responses to minor or nonexistent problems. The only reasonable solution to occasional bat wanderers in human living quarters is to cover chimneys and vents with hardware cloth screens, to install draft guards beneath appropriate doors, and to seal other access holes, especially around windows and plumbing. Large colonies of bats in attics or walls can become a nuisance and might require eviction. In these instances careful observations must be made at dusk to find bat entry holes. These can be plugged while the bats are out feeding or during their winter absence. Poisoning used against “house bats” are costly, ineffective and often create problems far worse than those they are supposed to solve.

Human Disturbance

Millions of bats have been killed by people who explore caves. Although some people intentionally kill bats, many others are unaware of the damage they do. Each human entry into a winter hibernating cave causes bats to arouse and waste ten to thirty (10-30) days of stored fat reserve. Hibernating bats must conserve their limited fat supplies until spring or face starvation. In summer, flightless young may be dropped or abandoned when humans disturb their nursery roosts.

The relatively few caves that shelter bats seldom are used year-round. Warm summer nursery caves should not be explored from April through September. Colder hibernation caves should be avoided from late August through mid-May. Many important caves have signs explaining when they can be visited without harm to bats.

Pesticide Poisoning

In the early 1960’s an estimated 150 million Free-tailed Bats fed over farms of the southwestern U.S. and Mexico. They caught approximately a quarter million metric tons of insects annually. Since then, populations of these bats have declined drastically, some by as much as ninety-nine percent (99%). Most apparently died from eating insects contaminated by overuse of agricultural pesticides. Voracious appetites and slow reproduction (usually only one [1] young per year) make bats everywhere extremely vulnerable.

Habitat Loss

Some animals have become extinct from habitat loss alone. But for bats, this is only one (1) of many devastating threats.

Endangered U.S. Bats

Gray Bat

Approximately ninety-five percent (95%) of the known population hibernates in only nine (9) caves each winter, and fewer than five percent (5%) of available caves are suitable for Gray Bat occupancy at any time. Loss of critically important caves through human disturbance and vandalism poses the most serious threat to Gray Bats. In less than two (2) decades they have declined by an alarming eighty percent (80%).

Big-eared Bats

Like Gray Bats, Ozark and Virginia Big-eared Bats must find unique kinds of roosting caves year-round and are therefore vulnerable to human disturbance and vandalism. They are known from less than two (2) dozen small colonies, and almost nothing is known of their feeding requirements.

Indiana Bat

Unlike Gray and Big-eared Bats, Indiana Bats must concentrate in a few caves only in winter; in summer, they disperse. Although much of their decline is attributed to human disturbance and vandalism in their wintering caves, siltation and pollution of streams over which they feed likely caused additional harm. Another probable factor in Indiana Bat decline involves loss of native forest along waterways. Nursery colonies live beneath the flaking bark of old trees.

Figure 7 Indiana Bat

Protecting Endangered Bats

The Law

The *Endangered Species Protection Act* mandates stiff fines and possible imprisonment for those who kill or disturb endangered bats or harm their habitat.

Conservation Efforts

The U.S. Fish & Wildlife Service is coordinating recovery efforts with other federal, state and private agencies. These typically involve monitoring population trends, protecting critical feeding habitat, preventing human disturbance of roosts, enforcing laws to protect the bats, and encouraging cooperation and support from private landowners, cavers and the public.

MANY PROTECTED BAT POPULATIONS ARE MAKING A COMEBACK, BUT PUBLIC COOPERATION AND SUPPORT ARE VITAL TO CONTINUED SUCCESS.

For More Information

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This pamphlet was prepared for the U.S. Fish & Wildlife Service by Bat Conservation International, Inc., c/o Milwaukee Public Museum, Milwaukee, WI 53233