Bat Captures and Niche Partitioning Along Portions of Three Rivers in Southern Michigan

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In spring, the Indiana bat (Myotis sodalis), an endangered species, migrates as far north as southern Michigan, where parturition and raising of young occurs. Prior to 1978, the species had been found in Michigan on only 9 occasions. In 1978 and 1979, however, a survey to determine the status of the Indiana bat in Michigan resulted in 16 captures in 4 counties (Kurta 1980). Ten of the 16 captures were at 4 different locations along the Thornapple River within 5 km of each other, just southeast of Vermontville, Eaton County. These recent captures evoked concern regarding potential impacts on the Indiana bat by proposed Lansing area I-69 and US-27 freeway construction. These projects would include crossings of the Thornapple River a short distance upstream from the 1979 captures, and portions of the Looking Glass and Maple rivers with similar stream width and riparian vegetation.

Indiana bats have most frequently been captured along waterways. Outside of Michigan, these captures have been in Illinois (Brack 1979; Gardner and Gardner 1980), Indiana (Mumford and Cope 1958; Cope, Richter, and Mills 1974; Cope, Richter, and Seerly 1978; Crope, Brack, and Mills 1980; Brack and Holmes 1982), and Missouri (Easterla and Watkins 1969; LaVal and LaVal 1980). Similarly, all nursery colonies located have been found in riparian habitat, either under the bark of a dead tree or in a tree hollow (Cope et al. 1974, 1978; Humphrey, Richter, and Cope 1977). A variety of other bat species also use riparian habitat.

This study was designed to sample the chiropterofauna along those portions of the Thornapple, Looking Glass, and Maple rivers which might be affected by proposed freeway crossings. Special emphasis was placed on determination of the possible presence of the Indiana bat. Interspecific partitioning of resources was examined by looking at the heights of capture, times of capture, and diets.
Study Areas

The Thornapple sample area was in Sec. 8, T3N, R4W, Needmore quadrangle, United States Geological Survey (U.S.G.S.), Eaton County. The river had a mud bottom and varied in width from 6 to 12 m, and in depth from 0.5 to 2.0 m. The dominant overstory tree in the area was silver maple (*Acer saccharinum*). Red ash (*Fraxinus pennsylvanica*) was also common, although few other species were present. A complement of dead trees was present, providing potential roost sites.

The Looking Glass area was in Sec. 2, T5N, R2W. Lansing North quadrangle, U.S.G.S., Clinton County. The river's width varied from approximately 25 m to slightly less than 13 m. The bottom was sand or gravel and the depth of the river varied between 0.5 and 1.0 m. The most common overstory trees in the area were red ash, northern red oak (*Quercus rubra*), and silver maple. Boxelder (*Acer negundo*) and black willow (*Salix nigra*) were found in smaller numbers. Large dead trees were present.

Sampling was also conducted in Sec. 29, T9N, R2W, Pompeii quadrangle, U.S.G.S., Gratiot County, along Maple River. The width of the river was about 25 m in most of the area, and depth varied between 1.2 and 1.7 m. The bottom was mud. In contrast to the Thornapple and Looking Glass sites, nearly 75% (3 of 4 quadrants) of the riparian area lacked woody vegetation. Trees were almost exclusively silver maple, with a few black willow. In the wooded quadrant, a complement of dead trees was present.

Bat Capture

Bats were mist-netted a total of 18 net nights, 6 at each sample area. Twelve sites were netted; 5 at Thornapple, 3 at Looking Glass, and 4 at the Maple River. Bats were netted from 28 July through 2 August 1982. The length and height of the net was adjusted at each site to close off the space between opposing sets of bank vegetation, and between the water surface and the canopy, except at 2 of the Maple River sites where river width was greater than the longest nets available. At these 2 sites the nets were hung parallel to the bank from overhanging vegetation. The nets at 1 of these sites closed off the space above a small tributary to the river. Mist net lengths varied between 5.5 and 18.3 m, and heights varied between 6.4 and 12.8 m. Nets were raised and lowered with a simple rope-pulley system and they were usually tended from dusk until dawn.

Captured bats were identified to species, sex, and age. The heights, times, and sites of capture were noted. Feces were collected from red bats (*Lasiurus borealis*), hoary bats (*Lasiurus cinereus*), and from Keen's bats
*Myotis keenii*. Insect remains from these feces were identified to order (and sometimes family) and were quantified by percent volume. When diet analysis of 2 or more bats were combined, each bat's feces was weighted equally regardless of the number of feces of each.

Differences in the times and heights of capture of each species were examined with chi-square tests. Height intervals corresponded to the 3 foliage layers present in temperate deciduous forests (MacArthur and MacArthur 1961): the herbaceous, subcanopy, and canopy layers. Times of capture were separated into 4 approximately equal periods extending throughout the night. The diversity index of MacArthur (1972), \( D = 1/\sum P_i^2 \), where \( P \) equals the proportion of individuals belonging to species \( i \), was used to determine the number of equally represented species in each area.

Results

Although no Indiana bats were caught, 120 bats of 5 species were captured. On the Thornapple, where diversity was the highest (2.57), 25 little brown bats (*Myotis lucifugus*), 4 Keen's bats, 11 big brown bats (*Eptesicus fuscus*), and 5 red bats were caught. On the Looking Glass 3 little brown bats, 30 big brown bats, 4 red bats, and 1 hoary bat were captured. The diversity was 1.56. The diversity was lowest, 1.12 on the Maple River where only 1 little brown bat, 1 red bat, and 35 big brown bats were captured. The overall diversity was 2.14. The only hoary bat captured was a juvenile female. Three Keen's bats were female adults and 1 was a male juvenile. No adult male red bats were captured. Little brown bats and big brown bats of all combinations of sex and age were captured.

Feces of the single hoary bat consisted of over 90% Coleoptera (beetles). Remains of carabid (ground) beetles were identified 3 times and elaterid (click) beetle remains were identified once. Over 4% of the fecal remains were Lepidoptera (moths). Homoptera (leaf hoppers) composed 2.5% of the diet, while Neuroptera (lace wings) comprised over 2%, and Diptera (flies) made up less than 0.5% of the diet. Twelve fecal pellets were analyzed.

Diets of the 3 adult female Keen's bats captured over the Thornapple, determined from 10 feces, contained over 36% Diptera, 21% Homoptera, 17% Lepidoptera, and 6% Coleoptera. About 18% of the fecal material was mist net. Three feces from the juvenile Keen's bat contained 45% of each Lepidoptera and Coleoptera, and 1% mist net.

The diet of the red bat was examined by sex and age groups, and by place of capture (Figure 1). Sixteen feces from 3 juveniles caught along Thornapple contained predominately Lepidoptera (62%), although
FIGURE 1. Food habits of red bats captured along the Maple, Looking Glass, and Thornapple rivers in southern Michigan. Food habits of adult females are histograms of solid lines and food habits of juveniles are histograms of dashed lines. The number of bats (number of feces) are indicated for each sample, and sample numbers of juveniles are prefaced by three dashes.

Coleoptera (15%), Homoptera (9%), Diptera (4%), and miscellaneous other (2%) were also present. Along Looking Glass, the single female captured ate 55% Homoptera, while 2 juveniles ate 88% Lepidoptera. Coleoptera and mist net strands were also found in the feces of each, as well as Diptera in the adult female's feces. The juvenile captured along Maple River had eaten 38% Diptera, 30% Coleoptera, 15% Lepidoptera, and 14% Homoptera. In the Coleoptera eaten by red bats, Carabidae was identified once and Elateridae 3 times. A total of 35 red bat feces was analyzed.

The times of capture of big brown bats were significantly different than random (equal) throughout the night (Table I). The capture was greatest in early evening and continually decreased thereafter. The capture times of red bats and little brown bats were random. The catches of Keen's and hoary bats were inadequate for tests of randomness, either in times or heights of capture. The heights of big brown, little brown, and red bat capture were all significantly different than random (Table II). The big brown bat was captured in both the subcanopy and canopy.
layers. The subcanopy layer was used most frequently by both the little brown and red bats.

Discussion

No Indiana bats were captured despite the recent captures of Kurta (1980) in southern Michigan some of which were along the Thornapple River approximately 18.5 km downstream. Habitat at the Thornapple site appeared adequate for the Indiana bat. Competition from the little brown bat and Keen’s bat, which were relatively common, was perhaps partially responsible for the absence of the Indiana bat. The Looking Glass and Maple rivers are both further north than the Indiana bat has been captured in Michigan to date. The habitat at the Looking Glass sites was similar to that used by the Indiana bat in other areas. The Maple

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<th>22:30 to 24:30</th>
<th>24:30 to 02:30</th>
<th>02:30 to Dawn</th>
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River habitat was unsuitable for the Indiana bat since it lacked both adequate forage areas and roost sites. This area was also unsuitable for most other species, as indicated by the low species diversity index.

The big brown bat was captured at all 3 sites regardless of habitat. This was probably because of frequent use of non-tree roost sites. One such roost was in a barn near the Looking Glass site. Similar to the bats observed by Kunz (1973) in Iowa, the big brown bat was most active during early evening, and became less active as the night progressed. Most activity of the big brown bat was in the subcanopy space at Thornapple and Looking Glass rivers. This space was probably used as a travel way. Most captures along Maple River were at canopy height, indicating that the bats foraged around the small amount of vegetation available. Past studies (Hamilton 1933, Ross 1967; Black 1972, 1974; Whitaker 1972) have shown that Coleoptera is the major component of the diet of the big brown bat.

In contrast, the diet of the little brown bat usually consists of aquatic associated insects, captured over streams or ponds (Buchler 1976; Belwood and Fenton 1976; Anthony and Kunz 1977). The little brown bat was captured most frequently in the subcanopy layer, where presumably individuals were foraging. Foraging was constant throughout the night; Kunz (1973) found that an Iowa population was most active during the first 3 hours after dusk, and totally inactive the latter half of the night.

The diet of the Keen's bat is poorly known, but past studies (Whitaker 1972; LaVal and LaVal 1980) have indicated, as was found here, that Lepidoptera, Homoptera, Diptera, and Hemiptera (true bugs) are eaten. LaVal et al. (1977) reported that Keen's bats frequently feed around the crowns of understory vegetation in nonriparian areas. Thus the bats along Thornapple may have come to drink, or use the river as a travel way. One capture was only 0.3 m above the water. The other 3 were caught in the open subcanopy space.

Capture of red bats was most common in the open subcanopy layer. It is probable that this layer was used as a flight space, as indicated by the few captures of this ubiquitous and common species. Also, the diet consisted largely of Lepidoptera, Homoptera, and Coleoptera, which are terrestrial associated insects. This diet was similar to that found by Ross (1967) and Whitaker (1972). LaVal et al. (1977) and LaVal and LaVal (1979) reported that red bats feed high over trees and pastures. Similarly, Mumford and Whitaker (1982) reported average feeding heights of 35 to 45 feet (10.7 to 13.7 m), usually around trees and woodlots, although sometimes near streams. Although the small catch precludes statistical analysis, there was a trend toward a greater catch early in the evening, which is similar to the observations of Kunz (1973) in Iowa.
The information acquired on the hoary bat was limited but interesting. Unlike bats in past food habits studies, which have found Lepidoptera as the major food item of the hoary bat (Ross, 1967; Black, 1972, 1974), the single bat captured had eaten predominately Coleoptera. This diet corresponds to the diet expected from tooth and cranial morphology (Freeman 1981).

Summary

No endangered Indiana bats were caught in the survey. It is reasonable to assume that the competitive exclusion principle operates in Michigan, as it does in other areas. Thus, of the bats captured, the diets, heights, and times of capture varied by species. Also, a greater bat species diversity was coincident with better habitat, indicating that habitat quality is an important determinant in both species composition and numbers.

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REFERENCES


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