FORAGING ECOLOGY OF THE ENDANGERED INDIANA BAT

Dale W. Sparks and John O. Whitaker, Jr.
Department of Life Sciences
Indiana State University
Terre Haute, Indiana
and
Christopher M. Ritzi
Department of Biology
Sul Ross State University
Alpine, Texas

Abstract

Like most North American bats, the Indiana bat (Myotis sodalis) is a nocturnal insectivore. It emerges shortly after sunset and begins feeding on a variety of insects, which are captured and consumed while flying. Its diet varies through time and across the geographic range of the species. The most common foods are beetles, moths, caddisflies, ants, and wasps. Some Indiana bats forage 10 km away from their roost, but most travel less than half that distance. Size of foraging areas varies from 7 to over 3000 ha and bats return to these areas on subsequent nights and years. Formal studies of habitat selection have been conducted in western Illinois and at the Indianapolis International Airport. In both areas, Indiana bats preferentially used woodlands as foraging and commuting areas, although other habitats including old fields and cropland were also used. Near Indianapolis, bats avoided ponds and developed land such as warehouses, shopping centers, and neighborhoods. We suspect the perfect foraging habitat for this species would include forested streams interspersed with grasslands, croplands, or shrublands.

Introduction

Bat biologists have long focused management and research efforts on the biology of bats in the roost because roosts are widely thought to be the most important factor controlling distribution of bat species (Humphrey 1975). Also, nocturnal telemetry on foraging bats is technologically challenging and man-power intensive. One result of this focus on roost management has been a lack of information about the foraging behaviors of many North American bats. Fortunately, the Indiana bat (Myotis sodalis) is an exception, mainly due to its status as a Federally endangered species, although much of this information includes unpublished technical reports and graduate theses. Much of the unpublished information included here results from work we have conducted near the Indianapolis International Airport (IND) since 1997. During this work, we often had difficulty distinguishing between foraging bats and bats conducting other behaviors such as checking and night roosting. Thus, this review will include comments about behaviors of Indiana bat from when they emerge until they return to the roost. We present these data in two major sections: nocturnal behaviors including emergence, habitat selection, night roosting, and return flights; and diet throughout the range.

Nocturnal Behaviors

General Methods

Data on nocturnal activities of free-ranging Indiana bat were first obtained by observing unmarked bats using both vision and ultrasonic detectors in areas where similar species were rare or absent (Cope et al.1974, Humphrey et al. 1977). Almost immediately, researchers began using marking techniques such as reflective tape attached to bands (Humphrey et al.1977) and chemical lights glued directly to the bat (LaVal et al.1977, LaVal and LaVal 1980, Brack 1983) to mark Indiana bats. These early techniques provided good information about behavior near roosts or other centers of activity (Cope et al.1974, Humphrey et al. 1977, LaVal et al.1977, LaVal and LaVal 1980, Brack 1983, Viele et al.2002, Sparks 2003, Sparks et al.2003, Murray and Kurta 2004), but are of limited value when bats fly in cluttered habitats or move rapidly between areas.

Gardner et al. (1991a,b) pioneered use of radiotelemetry to locate roosts and determine foraging ranges of free-ranging Indiana bats during the late 1980s. Radiotelemetry is also useful for documenting landscape-level patterns of habitat use and behavior of individual bats (Gardner et al. 1991a,b, Hobson and Holland 1995, Kiser and Elliot...
Radiotelemetry is limited by cost of equipment and personnel, range of transmitters, and telemetry error. We used all of these techniques at IND as well as using thermal imagers and night vision scopes to enhance visual observations. All techniques used to examine nocturnal biology of Indiana bats have inherent biases and potential behavioral impacts.

Nightly Emergence

Indiana bats begin to emerge from roosts shortly after sunset. Studies conducted in Michigan and Illinois noted Indiana bats began leaving their roosts an average of 18-19 minutes after sunset, emergence peaked at 21-26 minutes after sunset, and the average bat left the roost 23-25 minutes after sunset (Viele et al. 2002). Timing of first emergence was significantly correlated with the time of sunset and the end of civil twilight. In western Illinois, emergence averaged 21 minutes after sunset and peaked 30-45 minutes after sunset (Gardner et al. 1991b). Near Knightstown, Indiana median emergence occurred 38-71 minutes after sunset (Brack 1983). At IND in 1999, we found that average initial emergence began 2.6 minutes after sunset and ranged from 37 minutes before sundown to 22 minutes after sunset (Figure 1), but this result is complicated by interactions between the bats and red-bellied woodpeckers (Melanerpes carolina) (Sparks et al. 2003).

Nocturnal Flights

Upon emerging from their roosts, Indiana bats may fly directly to their foraging ranges (Hobson and Holland 1995) or they may forage near roost trees (Murray and Kurta 2004; Sparks, Whitaker, and Ritzi Unpublished). At least some time spent around roosts includes behaviors other than foraging. Checking, a behavior wherein bats return to the roost one or more times after emerging at dusk, has been recorded in Illinois (Gardner et al. 1991b), Michigan (Murray and Kurta 2004), and Indiana (Humphrey et al. 1977, Brack 1983, Sparks, Whitaker, and Ritzi Unpublished). At IND, we use large enough crews to allow emergence counts at a roost and simultaneous radiotracking. We frequently record bats near roosts that are not conducting checking behaviors (See Figures 2-4). These data lead us to suspect that most bats conduct an initial foraging bout in the area immediately surrounding their roost, which is why we start collecting triangulations when the bats emerge. Given that some bats never leave the vicinity of the roost (Table 1), it seems likely that most bats do some foraging near their roosts.

Selection of Habitat Types

Indiana bats forage primarily in and around forested habitat (Cope et al. 1974, Humphrey et al. 1977, LaVal et al. 1977, LaVal and LaVal 1980, Gardner et al. 1991a,b, Hobson and Holland 1995, Kiser and Elliot 1996, Butchkoski and Hassinger 2002, Romme et al. 2002, Murray and Kurta 2004, Sparks et al. In Press). Early studies in Indiana suggested Indiana bats foraged mostly along riparian streams in close proximity to the roost (Cope et al. 1974, Humphrey et al. 1977), and frequently foraged above the canopy. Simultaneous studies conducted in Missouri (LaVal et al. 1977) indicated that Indiana bats captured at a cave along the Meramec River foraged in more upland situations, although follow-up studies indicated some used floodplain forest (LaVal and LaVal 1980). The results of light-tagging studies conducted near hibernacula in Indiana closely resemble the results from Missouri (Brack 1983). All of these studies provided evidence that once Indiana myotis arrive in their foraging areas they make multiple loops through a relatively small portion of that area. These studies also concluded that Indiana bats forage around and within forested areas, which continues to be supported by recent work.

More recently, radiotelemetry has been the technique of choice for studying the foraging of Indiana bat. Radiotelemetry studies have revealed Indiana bats foraging in areas as far as 10.3 km away from their roosts, although most travel less than half that distance (Table 1). As in the earlier studies, most foraging is associated with wooded areas (Gardner et al. 1991a, b, Hobson and Holland 1995, Butchkoski and Hassinger 2002, Romme’ et al. 2002, Brack and Whitaker 2004, Brack et al. 2004, Murray and Kurta 2004, Sparks et al. In Press), although the type of woodland used may vary throughout the range. In western Illinois, floodplain forest was the most preferred habitat type (Gardner et al. 1991a,b). Near hibernacula in Kentucky, Missouri and West Virginia as well as at a maternity roost in Pennsylvania, upland forest was extensively used (Hobson and Holland 1995, Kiser and Elliot 1996, Butchkoski and Hassinger 2002, Romme’ et al. 2002). In Michigan, forested wetlands were extensively used by a maternity colony, while the bats used floodplain forest primarily as a commuting corridor (Murray and Kurta 2004). Near Indianapolis (Figures 2-4), woodlands are preferentially used over other land covers for both foraging
and commuting, although we did not separate these woodlands into habitat types because so little woodland is present (Sparks et al. In Press, Sparks, Whitaker, and Ritzi Unpublished).

Given the large and variable distribution (Gardner and Cook 2002, Brack et al. 2002) of the species, it should come as no surprise that differences in foraging habitat have been recorded between different parts of the summer range, or between bats on the maternity range and near hibernacula. Such differences in the type of woodland used by Indiana bats as foraging habitat may be caused by competition with other species (LaVal et al. 1977, Murray and Kurta 2002) or differences in habitat between different sites. For example there are few forested wetlands similar to those used for foraging by Indiana bats in Michigan (Murray and Kurta 2004) in central Indiana where the species has been most intensively studied (Cope et al.1974, Humphrey et al.1977, Brack 1983, Sparks et al In Press, Sparks, Whitaker, and Ritzi Unpublished). The fact that bats in Michigan rarely foraged in floodplain forests (Murray and Kurta 2004) may simply be the result of the forested wetlands being an even more preferred habitat type. In addition, competition with other bats in different parts of the range may lead to differences in the habitat used by Indiana bat across the range (LaVal et al. 1977, Murray and Kurta 2002). Indiana bats may limit competition with other species in Indiana by feeding on different prey or at different times (Belwood 1979, Lee 1993, Whitaker 2004). Future studies of the foraging ecology of Indiana bats should continue to explore the impacts of differing landscapes and communities of bats.

Although most authors have commented on the availability and use of different habitats for foraging, formal statistical analysis of habitat used relative to habitat available have been conducted in western Illinois (Gardner et al.1991a,b) and at IND (Sparks et al In Press). Gardner et al.(1991a,b) compared the proportions of habitat available within Fishhook Creek Wildlife Area to habitat contained in foraging areas (delineated by 100% Minimum Convex Polygons). They found that floodplain forest was most preferred followed by ponds, oldfields, rowcrops, upland forests, pastures, and other habitats (including developed areas). At IND, comparisons were made at 2 scales. The larger scale compared habitat available within 8.37 km of any roost and habitat contained within foraging areas delineated using 95% MCPs. Indiana bats selected foraging areas containing woodlands significantly more than agriculture, low density residential, open water, and these significantly more than pasture, parks, and commercial lands with high density residential being the least important. At a finer scale, point data were compared to habitats available within the foraging areas. At this scale, woodlands were most preferred and open water least preferred. In both Indiana and Illinois, agricultural fields and oldfields were an important habitat component. In addition at IND, we suspect the bats are frequently foraging along wooded edges, although telemetry error makes this distinction impossible (Sparks et al. In Press). We suspect that in heavily forested landscapes such open habitats may provide critical foraging habitat.

Size of foraging areas varies widely, ranging from a core area of 7 ha (Kiser and Elliot 1996) to a home range of 3026 ha (Romme’ et al.2002). Although some of these differences are due to differences in techniques and the terrain in which the bats were tracked, the variation seen in other studies also indicates that these differences are real. A major question that needs to be addressed is how foraging areas change as bats change in age and reproductive condition. On the summer range in Illinois, Gardner et al.(1991a) noted that post-lactating females had the largest foraging ranges (438 ha), followed by lactating females (344 ha), adult males (193 ha), juvenile males (177 ha), pregnant females (159 ha) while juvenile females had used the smallest foraging areas (120 ha). Work in Michigan found that lactating bats made longer commutes than pregnant bats, but this difference was not significant (Murray and Kurta 2004). Preliminary analysis of data collected in Pennsylvania (Butchkoski and Hassinger 2002), in Missouri (Romme’ et al. 2002), and by us at IND show no clear association between size of foraging area and sex, age, or reproductive class. Fidelity to foraging areas between years by bats in different reproductive classes also suggests differences in the sizes of foraging ranges may be related to factors other than reproductive class. We intend to address this question using data from IND once we have an adequate sample of post-lactating bats. Ultimately, the important question is how individual bats change their behavior throughout a field season. Thus, information about how the same bat uses its foraging habitat during different parts of the year is critical.

### Fidelity to Foraging Areas

Colonies of Indiana bats appear to be loyal to a general foraging area within and between years (Cope et al. 1974, Humphrey et al. 1977, Gardner et al.1991a,b, Murray and Kurta 2004). For example, at IND we tracked a total of 43 bats between 1997 and 2004; all these bats foraged in the same general area, although home ranges were distinct (Figure 2).
Available data support the hypothesis that individual Indiana bats are faithful to their foraging areas between years. Gardner et al. (1991a) noted that females returned to roughly the same foraging areas between years regardless of whether these bats were initially captured as juveniles and then retracked as adults (their Figure 2) or if these bats were adults during both seasons they were tracked (their Figure 7). In Michigan, Indiana bats have been recaptured at and tracked to the same sites (Kurta and Murray 2002, Murray and Kurta 2004). At IND, we have had one opportunity to collect data on the same bat in 2 different years (Figure 3). Roosting and foraging habits of this bat were remarkably consistent between years including occasional nocturnal visits to a day roost on the opposite end of the colony’s foraging range, despite the fact that the bat was pregnant when tracked in 2003 and lactating in 2004.

In addition to returning to the same general foraging area in subsequent seasons, individual Indiana bats return to the foraging areas during subsequent nights (Gardner et al. 1991a,b, Murray and Kurta 2004). At IND we have found bats move through their foraging habitat so predictably that we are able to move trackers into position prior to the bat moving (Figure 4). We suspect each bat may have several foraging areas that it moves sequentially between in an order determined by food availability, and its current roost.

**Night Roosting**

After foraging for a period of time, Indiana bats frequently enter a night roost, which is usually located in the core of the foraging area (Butchkoski and Hassinger 2002, Kiser et al. 2002, Murray and Kurta 2004). Most Indiana bats apparently use trees as night roosts (Butchkoski and Hassinger 2002, Murray and Kurta 2004), although they do occasionally use bat boxes (Butchkoski and Hassinger 2002) and bridges (Kiser et al. 2002) as well. At IND, we observed bats night roosting almost exclusively in trees, despite an abundance of bridges. One exception was an individual night roosting in an oldfield without trees. Although we were unable to locate the exact roost, we suspect this bat was roosting in vegetation. Lactating females return multiple times to their day-roosts, or other day roosts between foraging bouts (Butchkoski and Hassinger 2002, Murray and Kurta 2004, Sparks, Whitaker, and Ritzl Unpublished), and at IND this included several bats that entered bat boxes known to also be day roosts. Murray and Kurta (2004) noted that Indiana bats night roosted 0-6 times per night, usually for an average 14 minutes per bout. Murray and Kurta (2004) used a single observer with a radio receiver to document night roost sites by approaching the bat as close as possible. Similar efforts to examine night roosting behavior were made in Pennsylvania (Butchkoski and Hassinger 2002) and by us at IND only to have the bats exit the roosts and either return to foraging or switch roosts. As such, studies of bats night roosting in trees remain a difficult undertaking.

Night roosting remains poorly understood. For Indiana bats, Murray and Kurta (2004) suggested the primary benefits to be resting, digesting newly captured food, and investigation of potential roosts. Because Indiana bats in Michigan occupied isolated roosts spread throughout the study area, they discounted the likelihood of bats using these roosts to exchange information about prey resources, or gain thermal or antipredator benefits from clustering. At Camp Atterbury, Indiana bats do roost in groups under bridges (Kiser et al.2002) where such benefits cannot be ruled out. Bats at Atterbury were also much less sensitive to disturbance than bats at IND (C. M. Ritzl Personal Observation).

**Return to the Roost**

Although lactating bats frequently return to the roost several times in a night (presumably to nurse pups), bats of other reproductive classes spend most of their nights in their foraging areas (Murray and Kurta 2004) and return to the roost immediately before dawn. Bats in Michigan returned to their roosts 10-40 minutes before daylight. Telemetry at the IND showed that most bats flew directly from distant foraging areas to the roost. On some occasions, however, we observed radio-tagged Indiana bats foraging over cropfields near their roosts in the early morning light. Also, checking behavior is common during the early morning at major roost trees, and may be participated in by numerous bats, even on days prior to nights when few or no bats emerge from the roost.

**Food Habits**

Diet of the Indiana bat varies across the geographic range of the species, within a season, and even within a single night (reviewed in Murray and Kurta 2002). Variations within the diet may be linked to selection of particular prey items available in a foraging area, selection of foraging areas rich in particular prey items, changes in prey availability across time or geographic space, or a combination of these factors. Although the diet is variable, there are also striking patterns of similarity. Throughout the species range, and across multiple studies conducted over a
period of 30 years, the diet of this bat consists primarily of insects belonging to the orders Diptera (flies), Lepidoptera (moths), and Coleoptera (beetles) (Whitaker 1972, 2004, Belwood 1979, Brack 1983, Brack and LaVal 1985, Lee 1993, Kiser and Elliot 1996, Kurta and Whitaker 1998, N. M. Tuttle, Unpublished Data). Two other orders: Trichoptera (caddisflies), and Hymenoptera (wasps and ants), may be the predominant food when locally abundant (Kurta and Whitaker 1998, Murray and Kurta 2002, N. M. Tuttle Unpublished Data). The remaining portion of the diet consists of a wide variety of other insects along with the occasional spiders and mites (Table 2).

Several pest species are included in the diet. With the exception of one site in Michigan (Kurta and Whitaker 1998), mosquitoes (Diptera: Culicidae) represent only a small percent volume of the food consumed by Indiana bats. Indiana bat frequently forage in areas where mosquitoes are abundant. Mosquitoes are small and mostly solitary (except for male mosquitoes that advertise for mates by swarming) making it ecologically inefficient for bats to seek them out as food (Whitaker and Long 1998). Other pests documented in the diet include Asiatic oak weevil, Cyrtepistomus castaneus; spotted cucumber beetle (adult form of the southern corn rootworm,) Diabrotica undecimpunctata; and Hessian fly, Mayetoila destructor (Kiser and Elliot 1996, N. M. Tuttle Unpublished). While the spotted cucumber beetle and Hessian fly occurred only sporadically, the oak weevil was a frequent and sometimes dominant part of the diet at IND (N. M. Tuttle Unpublished). As such, the Indiana bat may be an important agent of biological control on this species. The Hessian fly is a characteristic pest of wheat, which is an uncommon crop in central Indiana. Because the wing venation of the Hessian fly is easily recognized, we encourage those conducting studies of the diet of Indiana bat in parts of the country where wheat is an important crop to be able to identify this serious pest.

As we learn to identify a greater percentage of the diet to the specific level, we expect the proportion of pest species will increase as well. Unfortunately, some studies failed to report the identity of food items below ordinal level. We encourage future researchers to identify food items to the lowest possible taxonomic level as suggested by Whitaker (1988). Lower taxonomic groups can then be lumped as needed for statistical examination.

Acknowledgements

We are indebted to the IND, which has supported our research with a series of grants from 1997-2004. We have obtained additional financial assistance over the years from the Department of Life Sciences, Indiana State University and the Indiana Academy of Science. We also thank J. L. Chew, B. L. Emery, B. L. Everson, B. J. Foster, C. L. Gummer, S. L. Gummer, J. A. Laborda, H. L. MacDonald, S. S. Nard, both other C. M. Ritzis, J. J. Sheets, M. T. Simmons, M. T. Slater, J. K. F. Sparks, E. R. Stinson, R. Wickens, and W. A. Ulrey for their field assistance. Thanks are also extended to our colleagues who have provided intense discussion on these issues particularly: V. Brack, R. L. Clawson, J. E. Gardner, J. R. MacGregor, R. R. Currie, L. Pruitt, S. Pruitt, A. Kurta, J. E. Duchamp, and E. W. Valdez.

Literature Cited


Kiser, J. D. and C. L. Elliot. 1996. Foraging habitat, food habits, and roost tree characteristics of the Indiana bat (*Myotis sodalis*) during autumn in Jackson County, Kentucky.


Sparks, D. W., C. M. Ritzi, Joseph E. Duchamp, and J. O. Whitaker, Jr. In Press. Foraging ecology of Indiana myotis at an urban/rural interface. Accepted to: Journal of Mammalogy


Dale W. Sparks started working with Indiana bats back in 1991 when he was a member of one of Bill Hendricks’s field crews. Today his study of Indiana bats near the Indianapolis International Airport is the longest-running and most intense study of its kind. He holds a BS from Murray State University, an MS from Fort Hays State University in Kansas, and a PhD from Indiana State University. While in Kansas, he studied the impact of settlement on the 13 species of bats present in the State, and desperately tried to make the Indiana bat the 14th species. At Indiana State University, he examined the response of bats to the development of suburban Indianapolis.
Summary of Techniques Used

Observation of spotlighted bats with reflective bands. As such all values are for the entire colony. N=80 bats banded.

Observation of bats with chemical lights from both the ground and a helicopter. N=35 bats.

Observation of bats with chemical lights from both the ground and a helicopter. N=bats.

Radio-triangulation w/ 100% minimum convex polygon used to delineate foraging ranges. Distance measured to center of foraging area. N=41 bats.


Radio-triangulation w/ 100% minimum convex polygon used to delineate foraging areas. Some bats frequently flew beyond detection range. N=15 bats.

Radio-triangulation w/50% Kernel estimator used to delineate major foraging areas, minor foraging areas outlined by hand.

Radio-triangulation w/90% minimum convex polygon used to delineate home ranges. N= 9 bats.

Radio-triangulation w/95% minimum convex polygon used to delineate home ranges. N= 4 bats.

Radio-telemetry used to closely approach bats-no triangulation. N= 13 bats

Radio-triangulation w/95% minimum convex polygon used to delineate home ranges. N= 41 bats.

Table 1. Summary of available data about foraging ranges used by Indiana bat throughout their range.

<table>
<thead>
<tr>
<th>Source</th>
<th>Location</th>
<th>Maximum Distance (km)</th>
<th>Total Area $^1$ (ha)</th>
<th>Summary of Techniques Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humphrey et al.1977</td>
<td>Indiana</td>
<td>&lt;0.8</td>
<td>1.47-4.54$^2$</td>
<td>Observation of spotlighted bats with reflective bands. As such all values are for the entire colony. N=80 bats banded.</td>
</tr>
<tr>
<td>LaVal et al.1977</td>
<td>Missouri</td>
<td>&lt;2</td>
<td>n/a</td>
<td>Observation of bats with chemical lights from both the ground and a helicopter. N=35 bats.</td>
</tr>
<tr>
<td>LaVal and LaVal 1980</td>
<td>Missouri</td>
<td>~5</td>
<td>n/a</td>
<td>Observation of bats with chemical lights from both the ground and a helicopter. N=bats.</td>
</tr>
<tr>
<td>Gardner et al.1991$^2$</td>
<td>Illinois</td>
<td>4.1</td>
<td>89(16-287)</td>
<td>Radio-triangulation w/ 100% minimum convex polygon used to delineate foraging ranges. Distance measured to center of foraging area. N=41 bats.</td>
</tr>
<tr>
<td>Kiser and Elliot 1996</td>
<td>Kentucky</td>
<td>2.1(0.8-2.85)</td>
<td>144(28-342)</td>
<td>Radio-triangulation w/100% minimum convex polygon used to delineate minimum foraging area. Some bats frequently flew beyond detection range. N=15 bats.</td>
</tr>
<tr>
<td>Butchkoski</td>
<td>Pennsylvania</td>
<td>&lt;4.5</td>
<td>(39-112)</td>
<td>Radio-triangulation w/50% kernel estimator used to delineate major foraging areas, minor foraging areas outlined by hand.</td>
</tr>
<tr>
<td>Romme’ et al. 2002</td>
<td>Missouri</td>
<td>(1.9-10.3)</td>
<td>(61-3026)</td>
<td>Radio-triangulation w/90% minimum convex polygon used to delineate home ranges. N= 9 bats.</td>
</tr>
<tr>
<td>Brack and Whitaker 2004</td>
<td>Indiana</td>
<td>194</td>
<td></td>
<td>Radio-triangulation w/95% minimum convex polygon used to delineate home ranges. N=1 bat.</td>
</tr>
<tr>
<td>Brack et al. 2004</td>
<td>Indiana</td>
<td>95.1(33-226)</td>
<td></td>
<td>Radio-triangulation w/95% minimum convex polygon used to delineate home ranges. N= 4 bats.</td>
</tr>
<tr>
<td>Murray and Kurta 2004</td>
<td>Michigan</td>
<td>5.2(0.5-4.2)</td>
<td></td>
<td>Radio-telemetry used to closely approach bats-no triangulation. N= 13 bats</td>
</tr>
<tr>
<td>Sparks, et al. Unpublished</td>
<td>Indiana</td>
<td>3(0.8-8.4)</td>
<td>412(50-1168)</td>
<td>Radio-triangulation w/95% minimum convex polygon used to delineate home ranges. N= 41 bats$^4$.</td>
</tr>
</tbody>
</table>

$^1$Foraging areas include only areas of nocturnal activity, while home ranges include the roost. Mean values are listed followed by the range in parentheses.

$^2$Foraging ranges reported during early and mid summer.

$^3$Includes bats discussed in Gardner et al. (1991b).

$^4$Includes 11 bats reported in Sparks et al. (In Press), but excludes 2 bats illustrated in figure 1 from which too little data was collected.
Table 2. Foods Eaten by Indiana Bats.

<table>
<thead>
<tr>
<th>Food Item</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lepidoptera</td>
<td>0</td>
<td>57</td>
<td>48</td>
<td>83</td>
<td>42</td>
<td>31</td>
<td>23</td>
<td>14</td>
<td>30</td>
<td>22</td>
</tr>
<tr>
<td>Coleoptera</td>
<td>24</td>
<td>9</td>
<td>25</td>
<td>8</td>
<td>18</td>
<td>25</td>
<td>17</td>
<td>1</td>
<td>42</td>
<td>27</td>
</tr>
<tr>
<td>Diptera</td>
<td>8</td>
<td>18</td>
<td>9</td>
<td>1</td>
<td>10</td>
<td>25</td>
<td>33</td>
<td>26</td>
<td>4</td>
<td>46</td>
</tr>
<tr>
<td>Trichoptera</td>
<td>0</td>
<td>3</td>
<td>10</td>
<td>4</td>
<td>20</td>
<td>1</td>
<td>13</td>
<td>55</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Hymenoptera</td>
<td>50</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>10</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Homoptera</td>
<td>19</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>6</td>
<td>11</td>
<td>1</td>
<td>T</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Hemiptera</td>
<td>0</td>
<td>T</td>
<td>T</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>T</td>
<td>T</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Neuroptera</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>T</td>
<td>T</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>T</td>
</tr>
<tr>
<td>Plecoptera</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>T</td>
<td>0</td>
<td>T</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ephemeroptera</td>
<td>0</td>
<td>T</td>
<td>T</td>
<td>0</td>
<td>T</td>
<td>0</td>
<td>T</td>
<td>T</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Orthoptera</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>T</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Phthiraptera</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>T</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Araneida</td>
<td>0</td>
<td>0</td>
<td>T</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Acari</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>T</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>11</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>


T= Trace amount reported.
Figure 1. Comparison of times of initial emergence by Indiana bat to sunset at the Indianapolis International Airport in 1999. Time of sunset is indicated by a square and the time the first bat emerged is indicated by a triangle. The circled emergence is an evening when we observed a red-bellied woodpecker chase a bat from the roost.
Figure 2. Home Ranges of 43 Indiana bat radiotracked near the Indianapolis International Airport from 1997-2004. Home ranges are illustrated by 95% minimum convex polygons, and each year is color coded.
Figure 3. Data collected on the same bat in 2003 (when pregnant) and 2004 (when lactating). Note the overall similarity of the areas used between the 2 years. Also note the telemetry locations south of Interstate Highway-70. Although we were unable to obtain telemetry “fixes” on the bat in 2003 in both years it flew from its roosting area and then roosted in a second roost.
Figure 4. Example of a bat with multiple foraging areas. This bat (a juvenile female) would emerge and forage in the area surrounding its roost (area 1). It would then move south along the East Fork of White Lick Creek until it reached foraging area 2, in a series of constructed wetlands. The bat would then move across a county road and forage for a period near a small pond (area 3) before moving to a final foraging area (4) where it would usually night roost. On 2 nights (white symbols), the bat changed this pattern on 7 August, it passed through, but did not stay in area 3. On 9 August it night roosted in area 3 and never flew to area 4.