

## BATS OF CAMP ATTERBURY IN SOUTH-CENTRAL INDIANA

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**ABSTRACT.** Eight species of bats were found at Camp Atterbury, a military training facility in Bartholomew, Brown, and Johnson counties, Indiana. Listed in approximate order of decreasing abundance they are the big brown bat (*Eptesicus fuscus*), red bat (*Lasiurus borealis*), eastern pipistrelle (*Pipistrellus subflavus*), northern myotis (*Myotis septentrionalis*), Indiana myotis (*Myotis sodalis*), little brown myotis (*Myotis lucifugus*), evening bat (*Nycticeius humeralis*), and hoary bat (*Lasiurus cinereus*). The first seven of these produce young on the facility.

**Keywords:** Bats, Indiana, Chiroptera, roosts

Camp Atterbury Joint Maneuver Training Center is a military training facility in Bartholomew, Brown, and Johnson counties, Indiana. In August 1997, 3D/International, Inc. conducted a mist net survey of bats at Camp Atterbury, capturing 13 endangered Indiana myotis, including reproductive females. This prompted the Military Department of Indiana (MDI), at the request of USFWS, to initiate radio-telemetry studies of the Indiana myotis at Camp Atterbury. The goal was to identify roost trees and their locations, and to characterize the habitat surrounding the roost trees in an effort to better understand summer habitat use by the species. Results from the study were to allow integration of management for the Indiana myotis into the facility's Natural Resources Management Plan.

During the summer of 1998, MW Consulting (1999) conducted the initial radio-telemetry study on the installation. A mist net survey of 18 sites resulted in capture of 23 Indiana myotis and 5 state-endangered evening bats. During this study, bats were found night-roosting under bridges. Therefore, MW Consulting occasionally monitored under bridges on or near the post and found a total of 82 night-roosting Indiana myotis (Kiser et

al. 2002). Seven Indiana myotis captured in mist nets or under bridges were fitted with radio-transmitters and tracked to roost trees.

In 2002, Indiana State University was contracted by MDI to perform a maternity roost study on Indiana myotis and evening bats. The goals of the study were to 1) gather information about the overall bat community on Camp Atterbury, 2) determine the location and habitat of roost sites on Camp Atterbury, and 3) estimate use of roost sites through emergence counts. Roosting behavior of these two species will be described in a later paper. The objective of this paper is to summarize the results of these studies.

**Description of area.**—Camp Atterbury is located in south-central Indiana, approximately 56 km south of Indianapolis, and comprises 13,408 ha of mostly forested land. The post is divided into four main areas (Fig. 1): the cantonment area, impact area of the air to ground range, multi-impact training range, and battalion training area. With the exception of the impact area of the air to ground range, most of the installation was accessible except when deemed unsafe during training activities.

The landscape on Camp Atterbury varies from relatively flat terrain with gently rolling

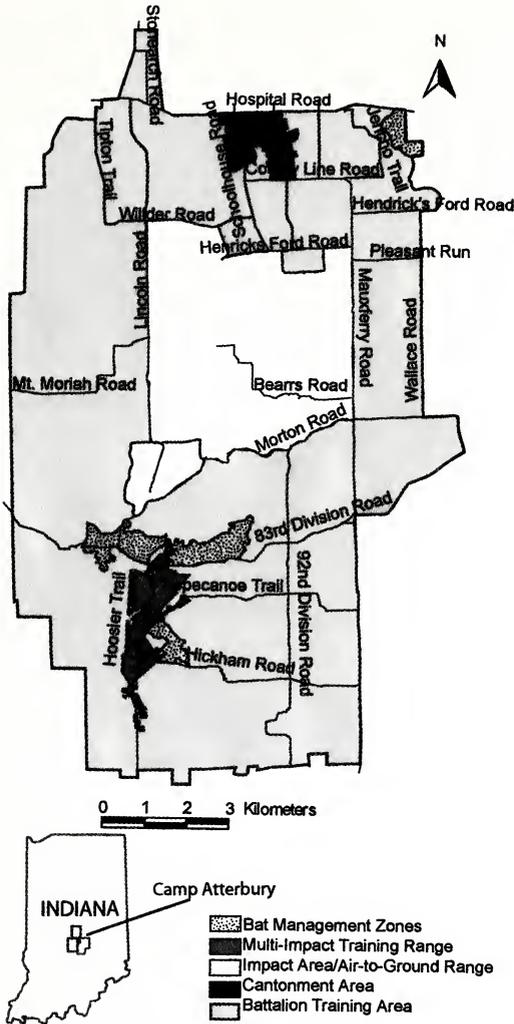


Figure 1.—Area and zones of Camp Atterbury, Indiana.

hills in the north to steep hills and narrow ravines in the south. Camp Atterbury lies at the intersection of three primary natural regions: 1) Central Till Plain Natural Region (Tipton Till Plain Section)—extensive beech/maple/oak forest, with poorly-drained flatwoods communities; 2) Highland Rim Natural Region (Brown County Hills Section)—deeply dissected uplands with well-drained soils. Natural communities are oak-hickory forest in uplands and beech, red oak, sugar maple, and white ash in bottomlands; 3) Bluegrass Natural Region (Scottsburg Lowland Section)—wide alluvial and lacustrine plains bordering major streams. Predominant natural commu-

nities here are floodplain forests and swamps (Homoya et al. 1985).

On Camp Atterbury today, the Central Till Plain Natural Region is dominated by rough-leaf dogwood, black cherry and ash. The Highland Rim Natural Region is dominated by flowering dogwood, sugar maple, red maple, sassafras and American beech. The Bluegrass Natural Region is dominated by green ash, eastern redcedar and tulip tree. Oldfield habitats are mixed with forestland associations which vary from pioneer hardwoods through mature woods, with age and stand composition often a product of past uses, which include farming and grazing. About 1600 ha of forest are in natural areas and old-growth. Forests on Camp Atterbury are managed in a multiple use context which includes commercial harvest, wildlife habitat, watershed protection, recreation, and aesthetics, in addition to supporting the primary mission of the facility as a training site.

Surface water on the installation is in the form of streams, ponds, and beaver impoundments. Several primary streams flow from west to east across the installation and drain into the Driftwood River. As part of a plan to improve *Indiana myotis* habitat on the southern part of the installation, bat management zones have been set aside and ponds created in three areas near the multi-impact training range (Fig. 1). In the late summer the only natural surface water in this area is from small pools along intermittent streams of narrow drainages.

METHODS

**Bat survey.**—Fifty-five sites were netted in summers of 1997 (4–14 August), 1998 (9 July–9 August), and 2002 (5 June–15 August); 22 sites were netted in 1997; 19 sites were netted in 1998, including 11 of the sites netted in 1997; and 17 sites were netted in 2002 (Fig. 2), generally at or near sites netted in previous years. In 1997, two nets were run for two nights at each site, for a total of 88 net-nights of effort. In 1998, two sites were netted for three nights with two nets (six net-nights each), seven sites were netted two nights (28 net-nights), and 10 sites were netted for one night (20 net-nights), for a total of 60 net-nights. In 2002, 15 sites were netted twice and two sites were netted once, for a total of 64 net-nights. Net sites were distrib-

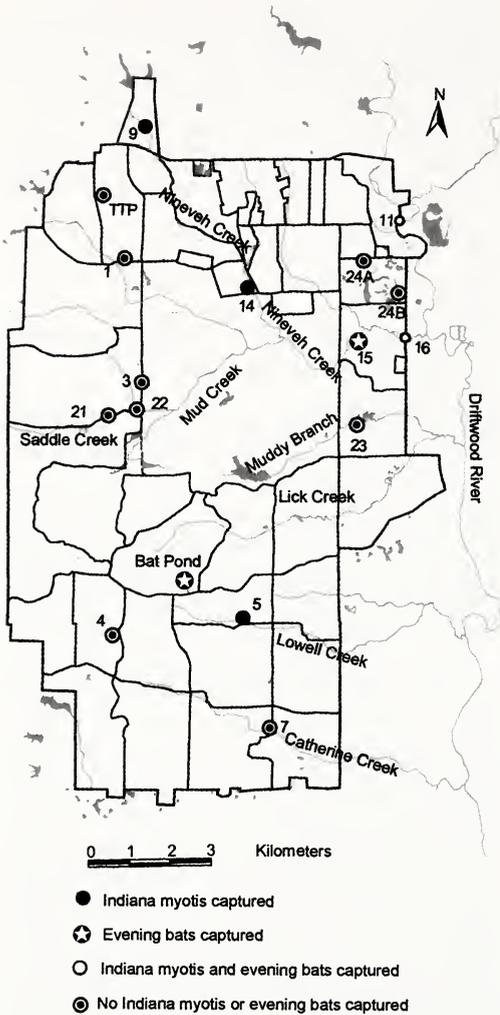


Figure 2.—Mist net sites at Camp Atterbury, Indiana.

uted across the facility (Fig. 2). In 1997, all net sites were over streams. In 1998, 11 were over streams and 7 were over upland corridors. In 2002, most sites ( $n = 12$ ) were over streams; but two were placed over ponds and three over upland corridors. Chi square analysis was used to compare the number of bats caught by species across the three years of sampling and the number of bats caught per net-night, by species, across years.

All sites were netted with 2 or 3 tier 9 m  $\times$  3 m mist nets suspended by a pole and pulley system. Nets were set so that the bottom was near the ground or water and the top extended to the canopy if possible, so as to block off as much of the corridor as possible. The

two nets comprising each site were set  $\sim$ 30 m apart. Nets were open from dusk until 0200 h. Bats were banded; and species, band number, weight, right forearm measurement, gender, age, reproductive condition, time of capture, and capture location were recorded for each bat captured. In 1998, reproductive female and juvenile Indiana myotis at least 6 g were radio-tagged and tracked to diurnal roosts; and in 2002 Indiana myotis and evening bats were tagged and tracked. Radio-tracking was accomplished using 0.47 g transmitters (frequency 150.0–151.9 kHz) from Holohil Systems, Ltd. (Carp, Ontario, Canada). Transmitters were affixed with colostomy glue after hair in the mid-dorsal portion of the bat's body was removed with surgical scissors. TRX-2000 receivers (Wildlife Materials, Inc., Carbondale, Illinois) were used to track the bats.

In 1998 and 2002, emergence counts were completed at diurnal roosts of the Indiana myotis and evening bat from approximately 20 minutes before sunset until 10 minutes after last emergence. These occurred for one to several days, as long as transmitters were active. Additional emergence counts were conducted late in the season at roosts that had contained significant numbers of Indiana myotis earlier in the summer. Night vision scopes were used during some counts in 2002. Inability to access an area due to weather, army training exercises, and limited manpower sometimes prevented emergence counts.

## RESULTS

Eight of 12 species of bats recently occurring in Indiana were caught at Camp Atterbury, all in each of the three years of study (Table 1). The four most common species were the big brown bat ( $n = 139$ ), red bat ( $n = 129$ ), eastern pipistrelle ( $n = 116$ ), and northern myotis ( $n = 100$ ; Table 1). Evidence of reproduction (pregnant, lactating, or post-lactating females, or juveniles) was found for all eight species in all three years. Two endangered species, the Indiana myotis (federally listed) and the evening bat (state listed), were both moderately common ( $n = 43$  and  $n = 24$ , respectively). The two least commonly caught species over the three years were the little brown myotis ( $n = 21$ ) and hoary bat ( $n = 16$ ).

In 1997, 208 bats were captured in 88 net-

Table 1.—Comparison of capture results for mist netting from 1997, 1998 and 2002 at Camp Atterbury, Indiana.

Species	1997 (88 net-nights)		1998 (60 net-nights)		2002 (64 net-nights)		Totals (212 net-nights)	
	# captured	#/net-night	# captured	#/net-night	# captured	#/net-night	# captured	#/net-night
<i>Eptesicus fuscus</i> (Big brown bat)	66	0.75	40	0.67	33	0.52	139	0.66
<i>Lasiurus borealis</i> (Red bat)	34	0.39	31	0.52	64	1.00	129	0.61
<i>Pipistrellus subflavus</i> (Eastern pipistrelle)	41	0.47	44	0.73	31	0.48	116	0.55
<i>Myotis septentrionalis</i> (Northern myotis)	31	0.35	33	0.55	36	0.56	100	0.47
<i>Myotis sodalis</i> (Indiana myotis)	13	0.15	23	0.38	7	0.11	43	0.20
<i>Nycticeius humeralis</i> (Evening bat)	11	0.12	5	0.08	8	0.13	24	0.11
<i>Myotis lucifugus</i> (Little brown myotis)	6	0.07	11	0.18	4	0.06	21	0.10
<i>Lasiurus cinereus</i> (Hoary bat)	6	0.07	9	0.15	1	0.02	16	0.08
Overall	208	2.36	196	3.27	184	2.88	588	2.77

nights for a rate of 2.36 bats/net-night (Table 1), and the most common bat taken was the big brown bat ( $n = 66$ ), followed by the eastern pipistrelle, red bat, and the northern myotis. In 1998, 196 bats were captured in 60 net-nights (3.27 bats/net-night) and the most common species was the eastern pipistrelle ( $n = 44$ ) followed by the big brown bat, northern myotis, and red bat. In 2002, 184 bats were captured in 64 net-nights at a rate of 2.88 bats/net-night (Table 1); and the red bat was the most common bat taken, followed by the northern myotis, big brown bat, and eastern pipistrelle. The number of bats captured per net-night was greatest in 1998, followed by 2002, and was least in 1997. This difference was significant ( $\chi^2 = 10.2$ , 2 *df*,  $P = 0.01$ ) but the reason for the difference is not known.

The big brown bat is the most abundant bat in Indiana during summer (Mumford & Whitaker 1982; Whitaker et al. 2002), and was the most abundant species at Camp Atterbury (Table 1). The variation in catch among years ( $n = 66$ , 40, and 33 in 1997, 1998, and 2002, respectively) was not significant ( $\chi^2 = 3.1$ , 2 *df*,  $P = 0.05$ ). In 2002, when netting was conducted across the summer season, two pregnant big brown bats were captured on 12 June, one lactating female on 7 July, and eight post-lactating females were captured 25 July–26 August. Twelve juveniles were captured 12 July–6 August.

Red bats were captured at a rate of 1.00 bats per net-night in 2002 (Table 1) as compared to 0.52 in 1998 and 0.39 in 1997, a difference that was significant ( $\chi^2 = 24.1$ , 2 *df*,  $P =$

0.01). This may indicate that red bats were increasing over time. In 2002, a pregnant red bat was captured 5 June, a lactating female was captured 25 July, and 25 juveniles were captured 21 July–15 August.

The eastern pipistrelle was the third most commonly caught species. Eastern pipistrelles sometimes roost in buildings, but most roost in clusters of leaves in woods (Veilleux et al. 2003). They hibernate in caves and mines, usually within about 95 km of where they spend the summer. The catch of eastern pipistrelles was greatest in 1998, but the catch did not vary greatly among years ( $\chi^2 = 5.32$ , 2 *df*,  $P < 0.05$ ). In 2002, when netting was completed across the summer season, a pregnant female was captured on 7 June, three post-lactating individuals were taken 21 July–5 August, and 21 juveniles were captured 21 July–15 August.

The northern myotis was the fourth most abundant bat at Camp Atterbury. It roosts in a variety of situations, in holes or cracks or under sloughing bark of trees. Capture success for the northern myotis was significantly lower in 1997 ( $\chi^2 = 4.55$ , 2 *df*,  $P < 0.05$ ). In 2002, a pregnant female was captured 6 June, a lactating female was captured 7 July, and 15 post-lactating females were captured 22 July–12 August. Nine juveniles were captured 12 July–7 August.

The Indiana myotis is federally endangered, but is moderately common in Indiana and regularly occurs at Camp Atterbury. Areas north, northeast, and east of the Impact Area appear important for the species, especially along

Nineveh Creek (Figs. 2, 3). Indiana myotis were captured at a significantly greater rate of 0.38 bats per net-night in 1998 as compared to 0.11 and 0.15 in 2002 and 1997, respectively ( $\chi^2 = 11.2$ , 2 *df*,  $P = 0.01$ ). However, half the netting effort in 1998 was completed when juvenile Indiana myotis were initiating flight and are more easily caught; 17 of 21 Indiana myotis, 9 of them juvenile, were captured during this time. In addition, net sites in 1998 were concentrated in locations that produced Indiana myotis in 1997. Twenty roost trees used by this species were found in 1998, and 26 roost trees were found in 2002 (Fig. 3). In 2002, the first pregnant, lactating, and juvenile Indiana myotis were captured on 8 June, 8 July, and 24 July, respectively, indicating parturition was between 8 June–8 July and that juvenile bats became volant between 8–24 July. Three juveniles were captured 24 July–2 August.

The evening bat is state endangered. Moderate numbers were found at Camp Atterbury, and they used 11 roost trees. Capture success was similar in all three years (Table 1), ranging from 0.08 to 0.13 bats/net-night. A pregnant evening bat was captured on 12 June 2002, two lactating individuals were taken on 7–8 July, and five juveniles were captured 21–30 July. Captures of evening bats were common along the Driftwood River east of the Impact area. This appeared to be a prime area for the species, as evening bats often reside along tributaries of major rivers.

In 1997, 11 evening bats were caught at four sites along the northeast edge of the facility. In 2002, ten evening bats (two juveniles, two males and three females) were captured at the Bat Pond net site on 83<sup>rd</sup> Division Road near the MPTR on 21 and 30 July, respectively. This area is approximately 7 km west of roosting areas along the Driftwood River (Fig. 2).

The little brown myotis is a common bat in Indiana, but few individuals were caught at Camp Atterbury. Post-lactating females were captured during all three survey years (beginning on 14 July in 1998 and continuing through mid-August in all three years) and juveniles were captured in 1997.

Hoary bats are uncommon (or at least are uncommonly netted) in Indiana. Thus it is noteworthy that, in the three years of survey, 16 individuals were caught, including nine in

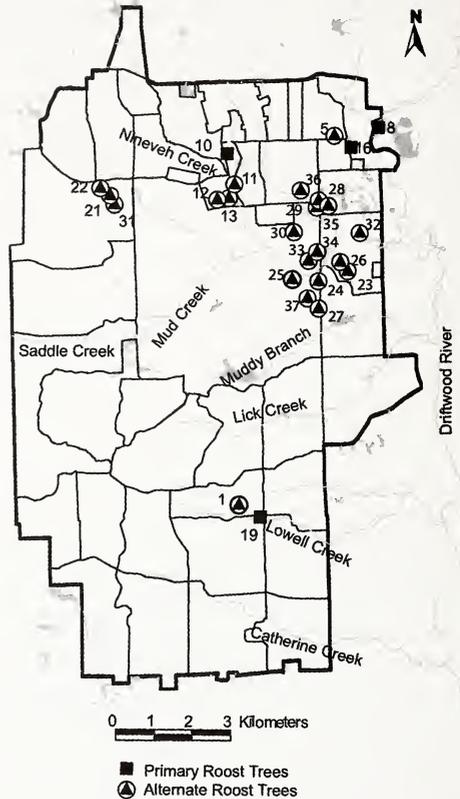


Figure 3.—Indiana myotis roost trees at Camp Atterbury, Indiana.

1998. A lactating female was caught on 10 July 1998, post-lactating females were caught in August in all three years, and a juvenile was caught in August 1997. Hoary bats were captured at a rate of 0.15 bats/net-night in 1998, as compared to 0.07 in 1997 and 0.02 in 2002. Numbers were too small for statistical testing.

## DISCUSSION

Eight of 12 species of bats common to Indiana were caught at Camp Atterbury. Of the four remaining species found in Indiana, three would not be expected there. The gray myotis (*Myotis grisescens*) occurs only along the Ohio River, primarily near Sellersburg in Clark County. Rafinesque's bat (*Corynorhinus rafinesquii*) is a rare visitor from Kentucky, and the southeastern myotis probably has been extirpated from the state. The silver-haired bat undoubtedly occurs on Camp Atterbury as a

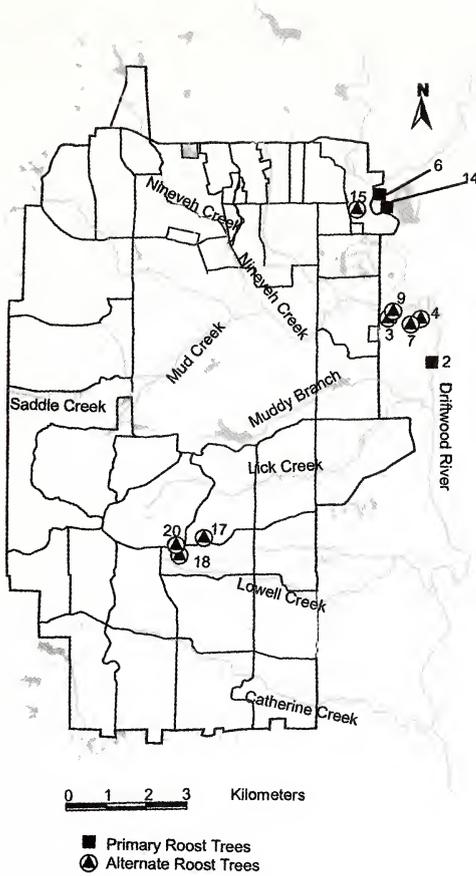


Figure 4.—Evening bat roost trees at Camp Atterbury, Indiana.

migrant through the region in spring and autumn, earlier and later, respectively, than netting was completed for this study. Evidence of reproduction was obtained for all eight species during each of the three years of sampling, indicating that this is an important area for all of these species.

It appears that at least three colonies of Indiana myotis and at least two colonies of evening bats exist on or near Camp Atterbury (Figs. 3, 4). Both species used multiple primary roost trees. Using the total of the highest counts from roost trees, it was estimated that the minimum number of Indiana myotis on or near Camp Atterbury in 2002 was 222 (post-volancy), and the minimum number of evening bats was 206, although the emergence count from one tree ( $n = 91$ ) was during the pre-volant period. Evening bats usually give birth to two offspring per gravid female.

Therefore, had the count been conducted after young were volant, the number of bats emerging from the roost could have been up to three times larger.

Clem (1993) found that the mean foraging distance of pregnant, lactating, and post-lactating female evening bats from a colony in Clay County was 2.25–2.50 km. Assuming juveniles captured at the Bat Pond site displayed similar foraging behavior, it is possible that the three alternate roost trees (numbers 17, 18, and 20) near the Bat Pond capture site provide further evidence of a second colony. All evening bat colonies found in Indiana before 1995 were in buildings, whereas those located since 1995 have been in trees, generally in cavities. All roosts for evening bats found on Camp Atterbury were in trees.

Primary roost trees of Indiana myotis and evening bats were found in the same area along the Driftwood River (Figs. 3, 4). Indiana myotis normally roost under sloughing bark on trees, whereas evening bats are normally in holes and cracks in trees. Indiana myotis normally feed on dipterans, homopterans, small beetles, and moths (Brack & Laval 1985; Kurta & Whitaker 1998; Murray & Kurta 2002), whereas evening bats feed heavily on beetles, hemipterans, and moths (Brack 1985; Whitaker & Clem 1992). Thus, these two species use different types of roosts and feed on different types of insects, reducing competitive overlap.

Two “house bats,” the big brown bat and little brown myotis, were captured: both are common in Indiana. However, the big brown bat was the species most often caught and the little brown myotis was the species least often caught. There are few houses or other structures on or near the post suitable for roosting. The difference in the catch of the two species may be related to roosting ecology. The big brown bat forms larger numbers of smaller colonies, whereas the little brown bat forms relatively fewer colonies that often are much larger (Whitaker & Gummer 1988), increasing the probability that colonies of big brown bats were located near the post. Also, the big brown bat will fly longer distances to forage (Everette et al. 2001).

The big brown bat is probably the most frequent competitor with the evening bat. They consume similar foods (including many hard insects, beetles, and hemipterans) and both

commonly forage over crop fields (Whitaker 1995; Whitaker & Clem 1992; Duchamp et al. 2004). They may also compete for roost sites. Until about 1995, all evening bat roosts found in Indiana were in buildings, although colonies located since that time have been in tree cavities (Whitaker & Gummer 2003). In contrast, the big brown bat has and continues to roost in buildings.

The northern myotis and little brown myotis are closely related taxonomically and ecologically to the Indiana myotis. Foods eaten by both species overlap heavily with foods of the Indiana myotis (Belwood 1979; Brack & Whitaker 2001). Although the little brown myotis typically roosts in buildings, the northern myotis typically roosts in trees. Like the Indiana myotis, the northern myotis sometimes roosts behind sloughing bark, but also frequents cracks and cavities in trees. However, the northern myotis is much less dependent on solar warming than is the Indiana myotis (Lacki & Schwierjohann 2001). The northern myotis was captured more frequently in the Hoosier National Forest (Brack et al. 2004) and at the Naval Surface Warfare Center at Crane (Brack & Whitaker 2004), both in southern Indiana, than they were at Camp Atterbury. In contrast, the relative capture rate of the Indiana myotis at Camp Atterbury was greater than at either of those locations. While this relationship may be coincidental, this may reflect greater amounts of woodland at Crane and at Hoosier National Forest. Another possibility is that there may be a competitive association between these species of *Myotis*.

Camp Atterbury presents a relatively contiguous landscape in which bats are doing well, even in the context of the military's training mission. Red bats may even be increasing. Red bats are solitary bats that roost in trees, and the increase could be related to changes in the forests at Camp Atterbury. The abundance and proximity of woodlands and caves probably accounts for the abundance of eastern pipistrelles. The abundance of forest accounts for the abundance of the northern myotis. Current and future training practices will affect the environment. An Endangered Species Management Plan (ESMP) was completed for the Indiana myotis in 2001 which will guide research and management activities on Camp Atterbury while maintaining the facility's military training mission. The ESMP

reflects the dedication of Camp Atterbury to the long-term conservation of the Indiana myotis, which should benefit other species of bats as well. Continued monitoring of all species of the bat community should continue to define relations between species and determine whether changes in populations occur as land use and management practices change. The presence of evening bats on and near Camp Atterbury presents an opportunity to collect valuable information on an uncommon, state-listed species. There are many other military bases around the country, and many of them contain excellent habitat for bats and other species, thus should be excellent places to learn more about our environment.

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