FINAL REPORT:

SUMMER 2008 BAT SURVEY AND RADIOTELEMETRY STUDY CONDUCTED AT FORT DRUM, JEFFERSON AND LEWIS COUNTIES, NEW YORK

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*****NOTE*****

This report has been modified from its original version. All sensitive information regarding Fort Drum Military Installation and/or the federally endangered Indiana bat has been removed. This may include, but is not limited to, aerial photography, maps, photos, and/or coordinates of roost locations.

Abstract

In May 2008, Copperhead Environmental Consulting, Inc. (Copperhead Consulting) was contracted by the United States Army to conduct a mist net and radiotelemetry study (henceforth referred to as the 2008 Fort Drum Bat Survey) of the federally endangered Indiana bat (*Myotis sodalis*) on Fort Drum Military Installation (Fort Drum). The 2008 Fort Drum Bat Survey was designed to investigate the distribution of Indiana bats and their use of habitats for roosting within the installation boundaries, specifically the Training Area, of which 29,383 hectares (72,608 ac) is generally accessible. Information on the presence and distribution of other chiropterans was also obtained as a secondary goal of the project.

Project methodology for the 2008 Fort Drum Bat Survey involved the capture of bats in mist nets and the fitting of Indiana bats with radio-transmitters. Indiana bats were subsequently tracked to day roosts and emergence counts were conducted on all trees in which Indiana bats were present (up to a maximum of 4 different roosts per radio-tagged bat). The netting effort of the 2008 Fort Drum Bat Survey followed protocols established by the United States Fish and Wildlife Service (USFWS). Net sites were located in areas most likely to result in Indiana bat captures, based upon the presence of suitable roosting habitat, travel corridors, and foraging areas.

All mist netting conducted during summer 2008 at Fort Drum was completed within the Training Area and was centered on specific areas that either received little or no netting effort or on sites that were especially productive during a similar survey conducted in 2007. A total of 380 bats representing 7 species was captured at 41 sites (164 complete net nights). Species included the big brown bat (*Eptesicus fuscus*; *n* = 215), little brown bat (*Myotis lucifugus*; *n* = 104), northern long-eared myotis (*Myotis septentrionalis*; *n* = 37), red bat *(Lasiurus borealis; n* = 14), hoary bat (*Lasiurus cinereus*; *n* = 5), silver-haired bat (*Lasionycteris noctivagans*; *n* = 3), and the Indiana bat (*n* = 2).

Overall, two Indiana bats were captured, fitted with radio-transmitters, and subsequently tracked to eight day roosts of three tree species. The tree species used as roosts by Indiana bats at Fort Drum were quaking aspen (*Populus tremuloides; n = 4*), slippery elm (*Ulmus rubra*; *n* = 1), and a maple (*Acer* sp.; n=1). Two roosts were too decayed to identify. All roosts were characterized as “snag”. The mean diameter at breast height (dbh) and height of roost trees was 38.4 cm (15.1 in) and 18.8 m (61.7 ft), respectively.

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Regulatory Setting

Of the nine bat species known from New York, the Indiana bat is the only species listed as federally and state endangered. The Indiana bat was first described by Miller and Allen in 1928 and the species formally attained endangered species status on March 11, 1967. First codified into law in 1973, the Endangered Species Act (ESA) provides for the conservation and recovery of listed plants and animals. Section 7(a)(2) of the ESA mandates that federal agencies insure that all actions they authorize, fund, or carry out are not likely to jeopardize the existence of a listed species or its designated critical habitat. Section 9 of the Act prohibits the take of listed species, including actions or activities that "…harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" and any harm that may result in the modification, loss, or destruction of habitat.

Fort Drum's Fish and Wildlife Management Program manages fish and wildlife species (including those listed as endangered) and their habitats on Fort Drum and reviews proposed actions for potential impacts to wildlife and their habitats. In 2001, Fort Drum developed an Integrated Natural Resources Management Plan (INRMP) in cooperation with the New York State Department of Environmental Conservation (NYSDEC) and USFWS. One of the goals of the INRMP is to ensure the installation is meeting all of its obligations under the ESA by minimizing potential impacts that Army activities may have on the Indiana bat and its habitat. The INRMP is currently being revised and will be completed in 2009. Fort Drum is also currently in Section 7 consultation with the USFWS and is developing an installation-wide Biological Assessment (BA) for all activities that may impact the Indiana bat during the next three years. Information from the 2008 Fort Drum Bat Survey will be incorporated in the BA.

Project Setting

In April 2008, Copperhead Consulting was contracted by Fort Drum to conduct a mist net survey and radiotelemetry study designed to document the distribution, density, and habitat use of the endangered Indiana bat known to be present on the installation. This survey represents ongoing efforts to gather additional information on Indiana bats first documented on Fort Drum during summer 2006.

While records exist for the Indiana bat from nearby Glen Park Cave (located approximately 10 km [6 mi] southwest of Fort Drum), the species was not known from Fort Drum until 2006 when Environmental Solutions and Innovations, Inc. (ESI) documented two Indiana bats (captured as part of an unrelated mist net survey being conducted nearby) foraging and one bat roosting on the installation (ESI 2006). The first installation-wide Indiana bat survey was conducted by ESI in 2007. During this survey, ESI captured 17 Indiana bats in the Cantonment Area (CA), 1 in the Training Area (TA), located 24 roost trees, and established the presence of a maternity colony in the Cantonment Area (ESI 2008).

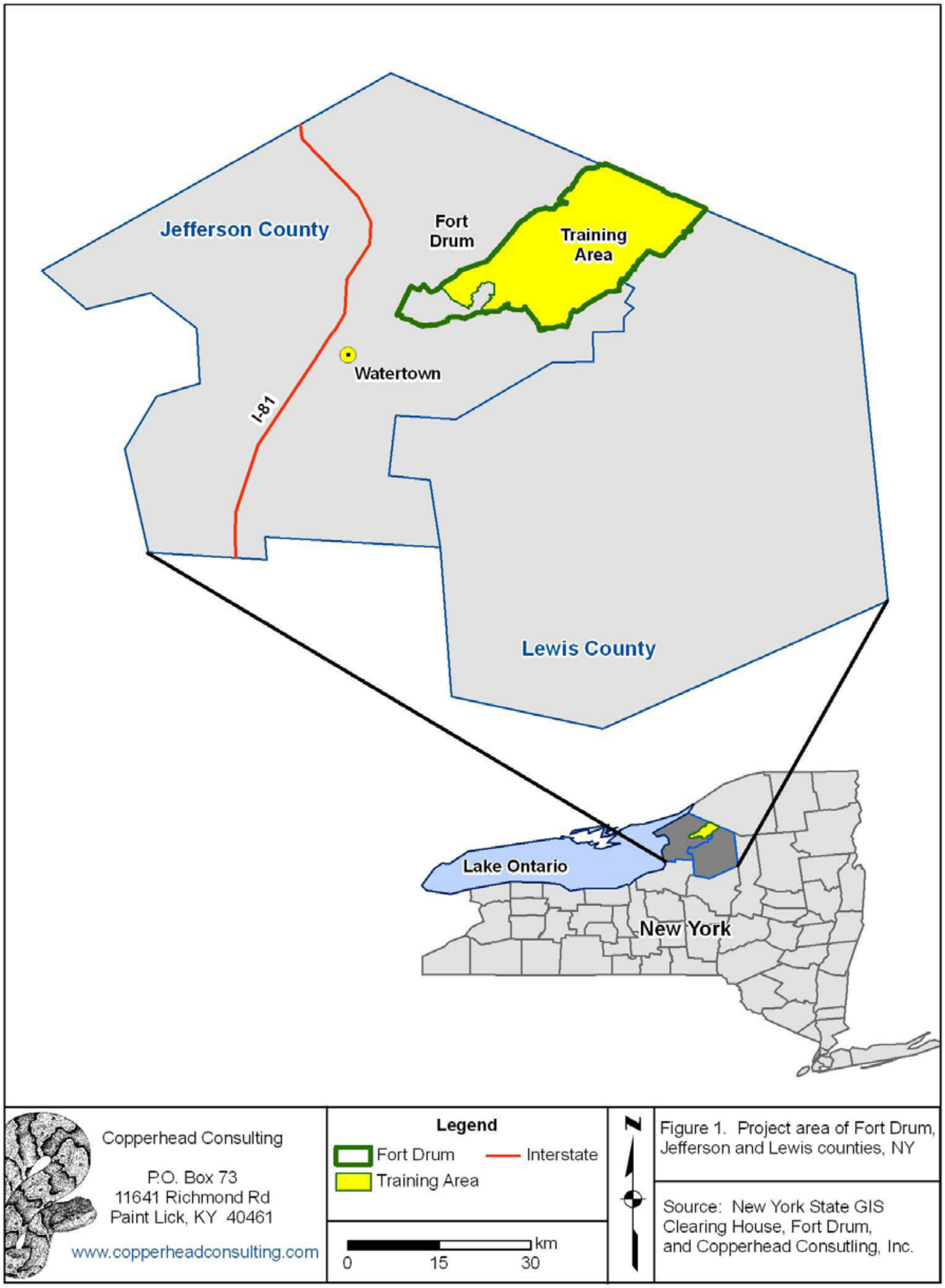
All field activities associated with the summer 2008 Fort Drum Bat Survey were conducted under the authorization and direction of Federal Fish and Wildlife Permit (#TE070584-2) and New York State Fish and Wildlife Licenses (#s 1281 & 149) administered by NYSDEC.

As requested by Fort Drum, this report closely follows many elements of form and structure employed during the writing of the report from the summer 2007 mist net survey conducted by ESI (ESI 2008). As such, the authors of this report attempted to borrow from the formatting of the ESI report, while respecting authorship and maintaining the integrity of the data found in both.

Study Area

Fort Drum is located approximately 10 km (6 mi) northeast of Watertown, New York (Figure 1). The installation covers approximately 43,301 ha (107,000 ac) in Jefferson and Lewis counties. Fort Drum includes or is adjacent to the towns of LeRay, Black River, Antwerp, Wilna, Philadelphia, and Champions in Jefferson County and the town of Diana in Lewis County, New York. Fort Drum lies within the Eastern Great Lakes and Hudson Lowlands ecoregion with local physiography that was highly affected by glacial activity (Omernick 1987). The area is made up of irregular plains bordered by hills and generally contains less surface irregularity and more agricultural activity and population density than the adjacent Northeastern Highlands and Northern Appalachian Plateau Uplands ecoregions (Omernick 1987). The agriculture of the area is predominately associated with dairy operations. Portions of this ecoregion that lie in close proximity to the Great Lakes experience an increased growing season, more winter cloudiness, and greater snowfall than surrounding areas (Omernick 1987).

Figure 1. Project area of Fort Drum, Jefferson and Lewis counties, NY.



Ecological Setting

Natural History

Indiana bats use caves and abandoned mine portals as hibernacula. They have very specific hibernation requirements and occupy areas in caves that maintain a narrow temperature and humidity range. As such, very few sites provide adequate microclimate for hibernating Indiana bats (USFWS 1999). After hibernation, females leave hibernacula and fly to nursery sites to raise their young. Although some males may leave with females, others stay in or near the hibernaculum throughout the summer months (Barbour and Davis 1969, Gumbert 2001).

While a number of studies have documented the summer distribution of the species in New York, the use of summer habitat is often highly dynamic and can change over time due to a variety of anthropogenic and natural environmental factors. The summer distribution of the Indiana bat is spread out through the state with 31 maternity records in 7 counties including Cayuga, Dutchess, Essex, Jefferson, Onondaga, Orange, and Oswego counties. Non-reproductive records (e.g., bachelor males) are known from Albany, Seneca, and Ulster counties (USFWS 2007).

After leaving the hibernaculum, Indiana bats migrate to their summer grounds where they typically live under the exfoliating bark of trees (Kurta and Kennedy 2002). Indiana bats are known to exhibit fidelity to summer roost areas and even to specific trees from year to year (Gardner and Gardner 1992, Gumbert et al. 2002). Early research suggested that floodplain forests were important habitats for Indiana bats (Humphrey et al. 1977), but recent studies indicate that upland habitats are also important (Kiser and Elliott 1996, MacGregor et al. 1999, Gumbert 2001, Britzke et al. 2003, Sewell et al. 2007). Most maternity roosts have been located in or near wooded areas where some light gap is present allowing full or partial solar exposure to the roost site. Each adult female within a maternity colony bears one young in May or June. Pups generally take their first flights between early to mid-July and early August but the timing of volancy may vary according to latitude, altitude, and local weather conditions (Brack et al. 2002, Humphrey et al. 1977, Kurta et al. 1996, USFWS 2007). Maternity colonies typically roost under the exfoliating bark of dead or live trees, but they may also use cavities as roost sites (Gardner et al. 1991, Kurta and Williams 1992, Callahan 1993). In rare cases, Indiana bats use human made structures as maternity roosts (Butchkoski and Hassinger 2002, ESI 2006).

Indiana bats leave their maternity grounds between mid-August and late September and migrate toward their hibernacula where they swarm near cave openings until they enter hibernation (Barbour and Davis 1969). The fall swarming season is a highly dynamic time for Indiana bats as they must replenish fat reserves lost during migration, mate, and find suitable hibernacula all before winter hibernation (Hawkins et al. 2005). Mating occurs during this period and females store sperm through hibernation until they inseminate themselves in the spring prior to spring migration (Barbour and Davis 1969).

Until recently, Indiana bat populations comprising the proposed Northeast Management Region (New York, Vermont, Massachusetts, and Connecticut) were thought to travel much shorter distances between summer roosting grounds and hibernacula (USFWS 2007). Genetic analysis has led some authors to suggest that the populations of the region are genetically isolated, less genetically diverse, and are of a more recent origin from those of other proposed regional management units (i.e., Appalachian Mountain, Midwest, and Ozark-Central Recovery Units; USFWS 2007). However, currently emerging evidence suggests that maternity populations from within the Northeast Management Region may have some members that overwinter (and therefore mate) in other regions, including the southern extent of the range (Eric Britzke, personal communication 2009).

Important identifying characteristics of the Indiana bat include short, sparse toe hairs that do not extend past knuckle joints, the presence of a keeled calcar, and pinkish pigmentation around the mouth and nose.

Regional and Local Occurrence

The 2005 winter census estimate of the Indiana bat population range-wide was 457,000 individuals with records of extant populations at approximately 281 hibernacula in 19 states (USFWS 2007). To date, 269 distinct maternity colonies have been documented in 16 states. The distribution of the Indiana bat includes most of the eastern United States from Oklahoma, Iowa, and Wisconsin east to Vermont, and south to northwestern Florida (Barbour and Davis 1969; Hall 1981; Kurta and Kennedy 2002; USFWS 2007).

In New York, the Indiana bat's winter distribution is fairly well documented and includes 15 hibernacula with records since 1960 (USFWS 2007). Of these, 11 have documented occurrences since 1995 with a combined population estimate of 31,921 individuals (USFWS 2007). In 2005, the estimated Indiana bat winter population in New York was 41,702 (representing 9% of the range-wide estimated population of 457,374; USFWS 2007). Located approximately 10 km (6 mi) to the southwest of Fort Drum, Glen Park Cave is the closest known hibernaculum to the project area. This Priority 2 hibernaculum has had a maximum winter population of 2,460 bats since 2000 (USFWS 2007). Survey counts conducted during the winter of 2006 – 2007 documented 1,928 bats (ESI 2008 from Hicks and Newman 2007) at Glen Park Cave and approximately 1,300 Indiana bats were encountered there in a count conducted in 2008 (Al Hicks, personal communication with Fort Drum biologists). Additional Indiana bat hibernacula are known from Onondaga, Warren, Albany, Essex, and Ulster counties in New York.

Summer maternity records of the Indiana bat are known from Cayuga (n = 1), Dutchess (5), Essex (1), Jefferson (9), Onondaga (4), Orange (8), and Oswego (3) counties. Non-reproductive (adult males and non-reproductive females captured between May 15 and August 15) records exist from Seneca and Ulster counties. One known maternity colony has been identified on Fort Drum.

White-nose Syndrome

First documented in 2006, White-nose Syndrome (WNS) has made a significant impact on several chiropteran populations of the northeastern U.S. To date, the disease has resulted in the death of approximately 90 percent of all bats in some hibernacula and is apparently spreading rapidly (Reeder and Turner 2008). The disease was named for the characteristic white fungus that often grows on the muzzle and ears of infected bats. Additional symptoms include damage (i.e., lesions or holes) to wings, reduced ability to arouse from torpor, depletion of fat reserves, and starvation. To date, evidence of WNS has been found in six bat species, including big brown, small-footed (*Myotis leibii*), little brown, northern, eastern pipistrelle (*Perimyotis subflavus*), and Indiana bats. As of fall 2008, WNS has been identified at 18 sites in New York, 5 in Vermont, 3 in Massachusetts, 1 in Connecticut, and 3 potential locations in Pennsylvania (Reeder and Turner 2008). The disease has been documented locally at nearby Glen Park Cave and has the potential to affect bat populations present at Fort Drum.

Methods

During the summer of 2008, mist net surveys and a radiotelemetry project were conducted on the Fort Drum Military Installation. Objectives included 1) determining bat species presence, 2) identifying day roosts of Indiana bats, and 3) performing exit counts on known Indiana bat roosts. The netting effort followed protocols established by the USFWS as outlined in Appendix 5 of *Indiana Bat (Myotis sodalis) Draft Recovery Plan: First Revision (*USFWS 2007*)*.

All mist netting completed at Fort Drum during summer 2008 was conducted within 72,608 acres of the Training Area (north of State Route 26 and the Cantonment Area; Figure 1) that is accessible (i.e., outside of the Main Impact Area). Emphasis was placed on areas that either received little or no netting effort during the 2007 mist net survey or on sites that were markedly productive during 2007.

Mist Net Surveys

A mist net survey was conducted at 41[1] sites within the Training Area with the main objective of determining the presence of Indiana bats and locating Indiana bat roosts and roosting habitat (Figure 2). Net sites were located in areas most likely to result in Indiana bat captures, based upon the presence of suitable roosting habitat, travel corridors, and foraging areas. Each mist net location was surveyed for two nights and each survey site location was recorded in Universal Trans Mercator coordinates using a handheld Global Positioning System (GPS) unit. Mist nets were set prior to sunset and deployed at dusk and left open for at least five hours from sunset each night. Nets were checked every 10 - 15 minutes and disturbance near the nets was kept to a minimum. Weather data was recorded for each site on an hourly basis to monitor the conditions throughout the night (Appendix A).

Low visibility nylon nets, 2.6 - 12 m (9 - 40 ft) in length (depending upon the width of the corridor) were used. A one, two, or three tier set (3, 7, or 9 m [20 - 30 ft] high), with nets stacked on top of one another, constituted a net night. Netting at each site consisted of a minimum of two mist net sets placed no closer together than 30 m (100 ft). In some cases, additional nets were set in conjunction with other nets in order to maximize capture along suspected flight corridors. Data recorded for captured bats included time of capture, species, sex, age (adult or juvenile), reproductive condition (pregnant, lactating, post-lactating, scrotal, non-reproductive), mass (g), and forearm length (mm). Important comments (when applicable), the height of captured bats, and the identity of net sets used to capture them was also recorded (Appendix A). All captured Indiana bats (and several individuals of other species per NYSDEC permit requirements) were fitted with numbered aluminum bands (obtained from NYSDEC and provided by the Fort Drum Fish and Wildlife Management Program) and released at the point of capture within 45 minutes.

Biological Samples

Biological samples were collected from selected bats of all species encountered in an effort to collect data for several ongoing projects. Guano and blood samples were obtained from bats to collect base-line data for a long-term study being conducted by the U.S. Army Corps of Engineer's Engineer Research Development Center, Construction Engineering Research Laboratory (ERDC-CERL) to compare stress hormone levels and immunological function in response to anthropogenic stimuli. Hair tissues were collected from all species captured for a

[1] At the request of Fort Drum, an additional site was added to the netting effort (of 40 sites originally outlined in the contract) to cover a site that was initially surveyed in the incorrect location.

multi-year, stable isotope study being coordinated by Dr. Eric Britzke (ERDC-CERL). Tissue samples were collected from select species as a requirement of our NYDEC endangered/threatened species permit and as part of an ongoing effort being coordinated by the American Museum of Natural History to collect and store DNA for current and future studies. In general, bats were chosen in an effort to obtain multiple samples from both sexes of a wide variety of species. As a requirement of our New York Wildlife License, tissue and hair samples were taken from all red, hoary, silver-haired, and eastern pipistrelle bats. As congeners of the Indiana bat, emphasis was given to little brown and northern long-eared bats when collecting blood samples.

Selected myotine bats of both sexes were held in cloth holding bags or metal minnow traps for as long as 1.5 hours (except Indiana bats which were released within 45 minutes of capture) in an effort to obtain guano. Pellets were collected from individuals at one hour intervals (or as produced). Collected fecal samples were stored individually in 2.0 ml (0.07 oz) cryovials (Sarstedt, Inc., manufacturer) containing 1.0 ml (0.03 oz) of 95% ethanol and immediately placed in charged Cryo Express CX100 cryoshippers (Taylor-Wharton, manufacturer). Data used to identify the sample were written on cryovials which included date, time of capture, bat ID (i.e. band number), and study site. Cyroshippers were mailed to Dr. Chris Richardson (Boston University) when filled to capacity. All containers (holding bags and traps) were sterilized on a daily basis using 20% bleach solution.

Blood samples were collected from selected bats within three minutes of capture (when logistically feasible). Samples were collected by venipuncture of a small vein of the interfemoral membrane using a 26-gauge needle. Methodologies used for the collection and processing of blood samples followed instructions obtained via email correspondence dated 11 May 2008 from Mr. Matt Hohmann (ERDC/CERL). Blood samples were collected in separate plastic heparinized, mico-hematocrit tubes (Fisher Scientific Co., manufacturer). Blood smears were placed on slides immediately following capture and the date, time, bat ID #, and project location was written in pencil on each slide. The day following collection, blood smears were fixed in histological methanol for three minutes and air dried. Duplicate slides were made when feasible and all blood smears were shipped to Dr. Mary Mendonca (Auburn University) on a weekly basis.

Hair was collected from a 1.5 cm^2 area between the scapulae and placed in empty vials. Efforts were made to obtain as much of the hair (as close to the follicle) as possible without endangering bats. Vials were labeled with the date, species, sex, age, band number (or other unique identifier), and location of capture.

Tissue samples were obtained from wing membranes of selected bats within each wing (when feasible) with 3-mm (0.1 in) biopsy punches (Huot Instruments, LLC). Biopsy punches were wiped with alcohol swabs, flame-sterilized, and allowed to cool before each use. Bats were then placed on a flat, hard surface (i.e. cutting board or clipboard) and tissue samples were taken from the stretched wing membrane (in the lower plagiopatagium near the legs). Care was taken to avoid blood vessels and muscle striations of sampled bats. Cross contamination was minimized through sterilization of all cutting surfaces with alcohol swabs. Both collected samples (if applicable) were placed in small vials (provided by American Museum of Natural History) filled with DMSO solution and stored either refrigerated or frozen. Vials were labeled with a unique identifier for each bat (i.e. capture or band number), date, location, species, sex, reproductive condition, and age) and samples will ultimately be shipped to NYSDEC and/or Dr. Nancy Simmons (American Museum of Natural History).

In addition to the information collected above, digital photographs were taken of certain species. High-quality digital photographs were taken of all Indiana bats highlighting head profiles, frontal view, foot size, toe hair length, and calcar (Appendix C). Representative photographs were also taken of other species captured during netting.

Radiotelemetry and Emergence Counts

Captured Indiana bats were fitted with radio-transmitters with the expressed goal of identifying diurnal roost sites and characterizing habitat use of roosting Indiana bats. After collecting morphometric data, Indiana bats were fitted with 0.47-gram (0.016 oz) radio-transmitters (Holohil Systems, Ltd., Ontario, Canada; LB-2 model) with unique frequencies (172.000 - .999 MHz). Transmitters were activated and tested before being attached to bats. A small interscapular area was trimmed of fur and the transmitter affixed to this area with non-toxic Skin-Bond® cement (Smith and Nephew, Inc., manufacturer). The weight of the transmitter and glue never exceeded 10 percent of the bat's body weight. Indiana bats were released at point of capture within 45 minutes. Radio-tagged Indiana bats were tracked the following day to diurnal roosts. Indiana bats were tracked to a maximum of four different roost trees or until transmitters failed, whichever occurred first.

Roost and Habitat Characteristics

A plot was established around each roost tree to determine stand characteristics and basal density. The center of the plot was established as close as possible to the center of the roost tee (typically 1 - 2 m (3.3 to 6.6 ft.)). Focal trees (those to be included in plot analysis) were determined using a 10-factor English prism (Cruise Master Prisms, Inc.). Basal area prism are used as a variable plot sampling method that selects surrounding trees based on their distance from the center of the plot (roost location) and their DBH. During this analysis, larger trees and trees closer to the roost are selected above smaller trees or trees further from the plot center. The number of trees selected by the prism can then be multiplied by a factor of ten to give an estimate of basal area in square feet per acre. Plot size varies by the number and size of trees present and additional information was recorded for each tree in the plot (including the roost tree). Data recorded included species, dbh, tree height, roost height, snag condition (snag, live, or damaged), % bark cover (high, moderate, or low), tree ranking (canopy, sub-canopy, or understory), habitat type (interior, edge, or open), canopy cover at roost, (open, intermediate, or closed), and roost location (bark, cavity, or crevice; Appendix B). The location of roost trees used by Indiana bats were recorded with handheld GPS units and subsequently plotted on a 1:24,000 7.5 minute USGS topographic quadrangle in ArcMap (v. 9.1 ESRI, Redlands, CA). This data is included in the draft and final reports.

Data Analysis

Chi-square tests and diversity indices were used to analyze bat capture data. In order to determine significant differences in captures among sites and between sexes, we used chi-square analysis using $\chi^2 = \Sigma\ [(O - E)^2 / E]$, where O is the observed frequency and E is the expected frequency. For captures among sites, the null hypothesis was tested where species were evenly distributed among all sites netted. The comparison between sexes was tested against the null where there was no difference in the number of male and females bats captured from the population. Therefore, the expected value was half of the total captures of adult bats.

Diversity and evenness values were calculated using the MacArthur Index (1972) and Simpson's Evenness Index, respectively (CITE). The MacArthur index was calculated using Diversity = $1/\Sigma Pi^2$, where Pi is the proportion of bats belonging to species i. The value reached represents the level of diversity, where a greater value represents greater diversity. A value of 1 would represent a community of one species and the maximum value is the species richness (number of species in the sample).

Evenness of species, i.e. a measurement of the relative abundance of the different species making up the richness of an area in the sample, was calculated using Evenness = $(1/\Sigma Pi2)/Dmax$. This formula represents species richness within the MacArthur Index/species richness. The proportion given is reported as a percentage of diversity of species in the population. A higher value reflects a more even representation of species across the population in question.

White-nose Syndrome

To limit the risk of transferring pathogens, several precautions were made when handling and processing captured bats during this study. All bats were handled with sterile latex gloves and weighed in unused freezer bags. When multiple bats were captured, individuals (awaiting processing) were held separately in small, steel minnow traps. Minnow traps used to hold bats were sterilized on a daily basis with a 20% bleach solution. Outstanding or remarkable anomalies encountered in bats captured during this survey were described and recorded on data sheets from the onset of field activities. Refer to Appendix G for handling protocol in areas with white nose syndrome.

Results

Bat Capture

A total of 380 bats representing 7 species (Table 1) was captured at 41 sites (164 complete net nights; Figure 2) over the 36-day study period. The species complement included the big brown bat (*n* = 215), little brown bat (*n* = 104), northern bat (*n* = 37), red bat *(n* = 14), hoary bat (*n* = 5), silver-haired bat (*n* = 3), and the Indiana bat (*n* = 2). Seventeen bats escaped before age or sex could be determined (Table 1). Sixteen nights of netting (at 18 sites) had no bat captures.

Table 1. Summary of bat captures at Fort Drum during summer 2008.

Species	Adult Female[1]				Adult Male	Juvenile		Unknown[2]	Total
	P	L	PL	NR		M	F		
Eptesicus fuscus	3	59	27	8	68	21	20	9	**215**
Myotis lucifugus	-	18	4	2	51	20	6	3	**104**
Myotis septentrionalis	2	14	-	3	12	2	1	3	**37**
Lasiurus borealis	-	3	1	1	7	-	1	1	**14**
Lasiurus cinereus	-	1	-	1	2	-	-	1	**5**
Lasionycteris noctivagans	-	1	-	-	-	1	1	-	**3**
Myotis sodalis	-	-	-	1	1	-	-	-	**2**
Total	**5**	**96**	**32**	**16**	**141**	**44**	**29**	**17**	**380**

[1]Adult Female = P(pregnant), L(lactating), PL(post-lactating), NR(non-reproductive)

[2] Unknown = bats escaped before sex or age could be determined

The number of individual bats captured was not evenly distributed between species ($\chi 2$ = 14.067; P = 0.0004). The little brown bat was the most widely distributed bat species, found at 70.7% (*n* = 29) of all sites sampled, followed by the big brown bat which was encountered at 60.9% (*n* = 25) of sites. The MacArthur Diversity Index was 2.48 and the species equitability (E_D) was 0.35 which indicates that 35 % of all species were equally represented.

Bat Capture by Sex and Age

Of the 363 bats processed for biological data, 149 (41.0%) were adult female, 141 (38.8%) were adult male, and 73 (20.1%) were juvenile. Of the 149 adult females captured, 133 (89.3%) were classified as reproductive. Overall, there were no significant differences between the number of male and female bats captured ($\chi 2$ = 0.2207; P = 0.5). However, there were more female big brown bats captured than males ($\chi 2$ = 5.10; P > 0.02) and more male little brown bats captured than females ($\chi 2$ = 9.72; P > 0.001). The sample size of silver-haired bats, hoary bats, and Indiana bats were too small to allow for comparison.

Bat Capture by Site

The mean number of bats and species captured per site during summer 2008 was 9.3 (SD = 6.0) and 2.2 (SD = 1.1), respectively. In general, the most productive sites were those found in southern areas of the Training Area (Table 2; Figure 2). Several of these locations were netted during the summer 2007 survey season and were chosen (for resampling) based on their relative capture success. Site FD 32 produced the most bats (*n* = 39) followed by sites FD 28 (*n* = 34) and FD 36 (*n* = 34). Site FD 21 was the most diverse, producing 5 species over two nights of netting.

Figure 2. Mist net site locations sampled at Fort Drum during summer 2008.

NO MAP PROVIDED

Table 2. Bat captures and species richness by site at Fort Drum during summer 2008.

Date (2008)	Site Name (FD)	Area	Habitat[1]	MYSO	MYLU	MYSE	LABO	LACI	EPFU	LANO	Total Captures	Species Richness
28-Jun	1	12A	C, S		1						1	
30-Jun	1	12A	C, RR								0	1
19-Jun	2	5C	C		2				1		3	
20-Jun	2	5C	C						2		2	2
19-Jun	3	13B	C						1		1	
20-Jun	3	13B	C						1		1	1
21-Jun	4	4A	C			2					2	
22-Jun	4	4A	C								0	1
21-Jun	5	4A	C			1			1		2	
22-Jun	5	4A	C		1	1			1		3	3
30-Jun	6	3A	C, RR			2					2	
1-Jul	6	3A	C. RR		1						1	2
2-Jul	7	4D	C			2					2	
3-Jul	7	4D	C								0	1
3-Jul	8	4E	C								0	
13-Jul	8	4E	C		1	1					2	2
16-Jul	9	6A	C		2						2	
17-Jul	9	6A	C			1	1				2	3
23-Jun	10	17B	C		3						3	
24-Jun	10	17B	C		2						2	1
7-Jul	11	17C	C		1		1				2	
8-Jul	11	17C	C						1		1	3
25-Jun	12	3B	C, S	2	1						3	
26-Jun	12	3B	C. S								0	
27-Jun	12	3B	C, S		1						1	2
2-Jul	13	4B	C		2	4	1		4		11	
3-Jul	13	4B	C			3					3	4
1-Jul	14	4D & 4E	C, S		1				28		29	
2-Jul	14	4D & 4E	C, P		1			1	21		23	3

Date (2008)	Site Name (FD)	Area	Habitat[1]	MYSO	MYLU	MYSE	LABO	LACI	EPFU	LANO	Total Captures	Species Richness
30-Jun	15	4A	C, RR						2		2	
1-Jul	15	4A	C, RR								0	1
23-Jul	16	16C	C		1						1	
24-Jul	16	16C	C		1				1		2	
25-Jul	16	16C	C		3		1		1		5	3
17-Jul	17	14B	C		3	1					4	
18-Jul	17	17C	C			1					1	2
4-Jul	18	19B	C, RR		1	2					3	
5-Jul	18	19B	C, P, RR			2					2	2
4-Jul	19	19D	C						1		1	
5-Jul	19	19D	C						1		1	1
4-Jul	20	14D	C								0	
5-Jul	20	14D	C								0	0
17-Jul	21	19D	S		2			1	2		5	
18-Jul	21	19D	S		8	1			4	2	15	5
19-Jul	22	19A	C		1	1			4		6	
20-Jul	22	19A	C		1				5		6	3
19-Jul	23	18A	C		1				1		2	
20-Jul	23	18A	C		1				3		4	2
6-Jul	24	17C	C								0	
7-Jul	24	17C	C		5	5			1		11	3
6-Jul	25	17D	C			1			1		2	
7-Jul	25	17D	C								0	2
6-Jul	26	17C & A	C		1						1	
9-Jul	26	17A & C	C								0	1
9-Jul	27	14G	C			1		1			2	
10-Jul	27	14G	C								0	2
8-Jul	28	7F & 7E	C, S		16	1			3	1	21	
16-Jul	28	7F & 7E	C, S		8				5		13	4
10-Jul	29	9C	C								0	
11-Jul	29	9C	C								0	0

Date (2008)	Site Name (FD)	Area	Habitat[1]	MYSO	MYLU	MYSE	LABO	LACI	EPFU	LANO	Total Captures	Species Richness
8-Jul	30	17D	C								0	
9-Jul	30	17D	C						1		1	1
12-Jul	31	8B	C						8		8	
13-Jul	31	8B	C						4		4	1
14-Jul	32	5B & 5D	C		1				14		15	
16-Jul	32	5B & 5D	C		1			1	22		24	3
12-Jul	33	11A	C		1		1		7		9	
13-Jul	33	11A	C						3		3	3
14-Jul	34	8C & 8B	C						3		3	
15-Jul	34	8C & 8B	C		1	1			4		6	3
18-Jul	35	7A & 7B	C						4		4	
19-Jul	35	7A & 7B	C				1		4		5	2
21-Jul	36	8C & 9B	C		3		2		13		18	
22-Jul	36	8C & 9B	C		3		1		12		16	3
11-Jul	37	14D & 14F	C		4	1			6		11	
12-Jul	37	14D & 14F	C		6				2		8	3
10-Jul	38	9A & 14E	C					1	3		4	
11-Jul	38	9A & 14E	C		1				6		7	3
21-Jul	39	15C	C		2		1		1		4	
22-Jul	39	15C	C		2	1	3		2		8	4
20-Jul	40	10C	C								0	
23-Jul	40	10C	C		1		1				2	2
14-Jul	41	8C	C, RR		4	1					5	
15-Jul	41	8C	C, RR		1						1	2
Total =				**2**	**104**	**37**	**14**	**5**	**215**	**3**	**380**	

[1] Habitat = C (corridor), P (pond), RR (road rut), S (stream)

Radiotelemetry

Two Indiana bats captured at Fort Drum during summer 2008 and fitted with radio-transmitters. Both individuals (a non-reproductive male and non-reproductive female) were captured on 25 June 2008 at Site FD12. Radiotagged bats were tracked (and successfully relocated) for a total of 21 days. The last day contact was made with either bat was during an emergence count (conducted on Bat #5038) that occurred on 5 July 2008 (Table 3). Efforts to locate radiotagged Indiana bats were made in the vicinity of the eight known roosts each day for an additional eight days (which represented the probable lifespan of the transmitters) following 5 July, but neither bat was relocated.

Indiana Bat #5050

Bat #5050 was a non-reproductive male captured at 2115 h on 25 June 2008 at Site FD12. This site was chosen based on the presence of the tributary of Pleasant Creek which ran through it. This stream runs north/south and parallel to Simonet Road, located approximately 30 m (≈100 ft) away. The habitat of this stretch of the stream was very lush with excellent cover from larger canopy trees and a thick undergrowth of cinnamon (*Osmunda cinnamomea*) and sensitive (*Onoclea sensibilis*) ferns. Bat #5050 was captured approximately 1 foot off the surface of the stream in a 6 m (19.7 ft) x 6 m (19.7 ft) net set. Digital photographs were immediately taken. After hair and blood samples were obtained from Bat #5050, it was fitted with an aluminum band (AL NY #5050) and transmitter (frequency #172.462) and subsequently released within 45 minutes of capture. Although the evening was relatively cool, the bat remained active and its flight after release was normal.

Bat #5050 was subsequently tracked (and successfully relocated) for 10 days, ultimately leading Copperhead biologists to 4 roost trees (Table 3). The last contact made with this individual was on an emergence count of Roost 713 on 4 July. Diurnal telemetry efforts on this individual continued for another 9 days but were unsuccessful.

Indiana Bat #5038

Bat #5038 was a non-reproductive female captured at 2210 h on 25 June 2008 at Site FD12. This individual was captured approximately three m (≈10 ft) off the surface of the stream in a 6 m (19.7 ft) x 6 m (19.7 ft) net set. Digital photographs were immediately taken. After hair and blood samples were taken from Bat #5038, it was fitted with an aluminum band (AL NY #5038) and transmitter (frequency #172.521). The bat was somewhat listless when handled, so an effort was made to warm it in a cloth bag for approximately 15 minutes. Bat #5038 was released at 2255 and it flew strongly away to the north.

Bat #5038 was subsequently tracked (and successfully relocated) for 11 days, ultimately leading Copperhead biologists to 4 roost trees (Table 3). The last contact made with this individual was on an emergence count conducted at Roost 783 on 5 July. Diurnal telemetry efforts on this individual continued for another 9 days but were unsuccessful.

Roost Trees

A total of 8 Indiana bat diurnal roosts were located (Tables 3 and 4; Figure 3). All roosts were located in snags of 3 species. The most common tree species used as roosts by focal bats was quaking aspen (*P. tremuloides; n = 4*), followed by slippery elm (*U. rubra*; *n* = 1). One roost was found in an unknown maple and two roosts were too decayed to identify to species. All (100%) roosts were characterized as snag or dead. The mean dbh and height of roost trees was 38.4 cm (15.1 in) and 18.8 m (61.7 ft), respectively (Table 4). By contrast, trees surrounding roost trees had a mean dbh of 39.6 cm (15.6 in) and height of 14.7 m (48.2 ft). At Fort Drum, radiotagged Indiana bats spent at total of 18 bat days (1 day spent by 1 bat in a particular roost

= 1 bat day) in 8 roosts, switched roosts a total of 9 times, and spent an average of 1.8 consecutive days in a particular roost before moving.

Table 3. Roost tree use by focal bats at Fort Drum during summer 2008.

Date (2008)	Roost Name	Bat Name	New Roost?	Easting	Northing	Emergence #
26-Jun	100	♂/5050	Yes			3
27-Jun	100	5050	No			1
28-Jun	100	5050	No			1
29-Jun	769	5050	Yes			rain out
30-Jun	769	5050	No			2
1-Jul	100	5050	No			1
2-Jul	100	5050	No			1
3-Jul	784	5050	Yes			1
4-Jul	713	5050	Yes			1
27-Jun	036-1	♀/5038	Yes[1]			5
28-Jun	036-1	5038	No			6
29-Jun	785	5038	Yes			rain out
30-Jun	85	5038	Yes			1
1-Jul	785	5038	No			3
2-Jul	036-1	5038	No			3
3-Jul	036-1	5038	No			3
4-Jul	036-1	5038	No			2
5-Jul	783	5038	Yes			1

[1]Roost 036-1 was first located by ESI as part of the summer 2007 bat survey (ESI 2008)

Figure 3. Roost tree locations for *Myotis sodalis* captured on Fort Drum during summer of 2008.

NO MAP PROVIDED

Table 4. Roost tree characteristics of Indiana bats at Fort Drum during summer 2008.

Roost #/type			Height (ft)			% Bark Cover[1,2]			
Roost #	**Species**	**dbh (cm)**	**Tree**	**Roost**	**Condition**	**Usable**	**Total**	**Tree Ranking**	**Bat freq. (172.xxx)**
36-1	*Populus tremuloides*	36.5	80	unknown	Snag	moderate	high	Canopy	521
769	*Ulmus rubra*	53.0	45	unknown	Snag	high	high	Canopy	462
100	unknown	74.0	65	unknown	Snag	high	high	Canopy	462
784	unknown	26.0	60	unknown	Snag	low	moderate	Canopy	462
713	*Acer* sp.	23.1	55	unknown	Snag	moderate	high	Canopy	462
783	*Populus tremuloides*	27.7	75	35	Snag	high	high	Canopy	521
785	*Populus tremuloides*	38.5	70	60	Snag	moderate	high	Canopy	521
85	*Populus tremuloides*	28.2	45	40	Snag	moderate	high	Canopy	521
	Mean =	**38.4**	**61.9**	**45.0**					

[1]%Bark Cover = Usable (proportion of bark suitable for use by roosting bats, i.e., sloughing or peeling bark), Total (amount of the tree bole still covered with bark)
[2]%Bark Cover = low (<10), moderate (≥10 - <25), high (≥25)

Emergence Counts

Sixteen emergence counts were conducted at eight roosts at Fort Drum during summer 2008 (Table 3). Of these, seven were conducted in conjunction with counts at other trees, i.e., two roosts simultaneously. The maximum number of bats seen to emerge from observed roosts was seven on 28 June. On average, two bats exited day roosts with a maximum number of bats (*n* = 6) emerging from Roost 036-1 on 28 June. No emergence counts were conducted (at Roost 769 or 765) on 29 June due to inclement weather. However, the presence of the radiotagged Indiana bats within both roosts was confirmed earlier that day.

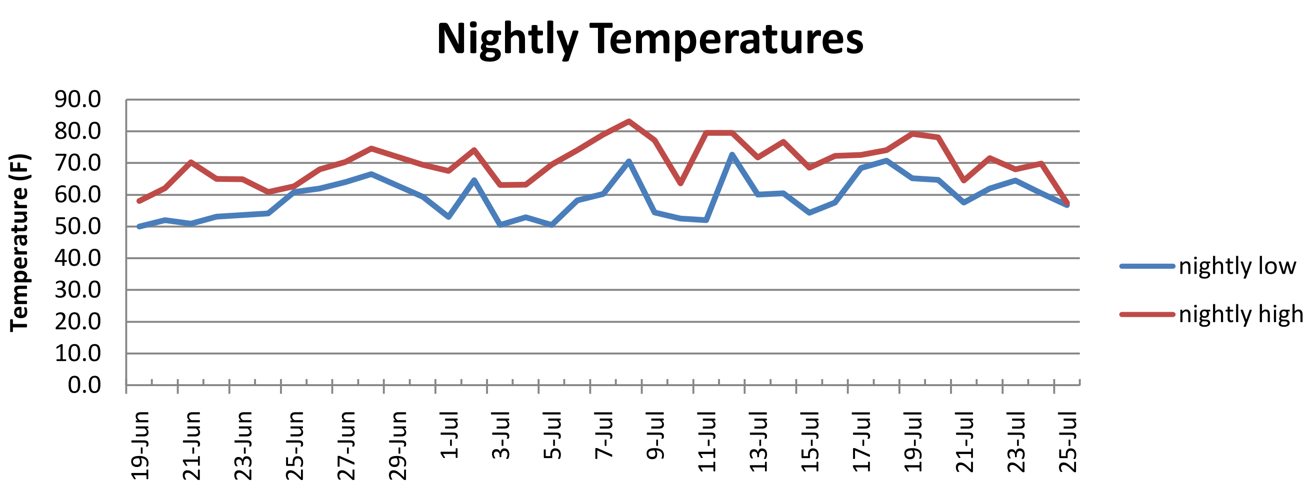
Biological Samples

Guano, hair, blood, and tissue samples were obtained while processing captured bats for morphometrics. Biological samples were taken from 143 bats during the 2008 Fort Drum Bat Survey (this data may be found in the excel file that accompanies this document). Guano samples from 21 bats were collected, flash frozen, and sent to Dr. Chris Richardson for analysis. Blood samples were taken from 38 captured bats at Fort Drum. Collected blood was applied to slides and mailed to Dr. Mary Mendonca for analysis. In total, 111 hair samples were collected from bats captured at Fort Drum. All hair was stored in small vials and subsequently shipped to Dr. Eric Britzke. Tissue samples were obtained from 77 bats captured during the 2008 Fort Drum Bat Survey. Tissue samples were stored in vials filled with DMSO solution and subsequently shipped to NYSDEC. In cases where multiple samples were taken from individual bats, samples were also mailed to Dr. Nancy Simmons (American Museum of Natural History). Any additional data obtained from analysis conducted on biological samples is proprietary and is not included in this report.

Weather

All netting during the summer 2008 bat survey was conducted within guidelines established by USFWS. Nightly minimum and maximum temperatures are provided in Figure 4. Two nights of netting were ended prematurely due to inclement weather.

Figure 4. Nightly high and low temperatures during summer 2008 on Fort Drum.



Discussion

Chiropterofauna on Fort Drum

The results of this study suggest that the composition and number of bats captured at Fort Drum was typical for the geographic location and habitats found there. Of the 363 bats processed for biological data, 149 (41.0%) were adult female and 73 (20.1%) were juvenile. Of the 149 adult females captured, 133 (89.3%) were classified as reproductive. Specifically, evidence of reproduction was found in big brown, little brown, northern long-eared, red, hoary and silver-haired bats. This data suggests that individuals of these species are currently using habitat in or around the Fort Drum installation for maternity roosting.

Overall, the total number and variety of bats was lower than that encountered during the 2007 bat survey. The mean number of bats and species per site in 2008 was 9.3 and 2.2, respectively. By comparison, the mean number of bats and species captured during the 2007 survey was 17.0 and 3.1, respectively (ESI 2008). However, it should be noted that there was very little overlap of sites netted between the two surveys and many of the areas netted during the summer 2008 field season could be characterized as of lower quality. This was done (at the request of Fort Drum) in an effort to survey areas that had not been sampled during the 2007 survey. In general, the most productive sites (e.g., FD14, 21, 28, 32, and 36) of 2008 were those that were also netted during 2007. These sites were netted relatively late during the survey and were chosen based on their productivity during the previous year. It may also be important to note that several of the most productive sites, including the only site that produced Indiana bats, were located over or very near streams. Other factors that could have influenced capture rate during this study may have included increased precipitation compared to the summer of 2007 and/or potential impacts related to white nose syndrome.

Indiana Bats on Fort Drum

The capture of two Indiana bats in mist nets in the Training Area is double the number of bats captured in this area during the 2007 survey. Even though only two Indiana bats were captured during this survey effort, this study expanded the range of known roosts in the Training Area on Fort Drum. Because both captured Indiana bats were non-reproductive, all roosts used by these individuals were not classified as maternity roosts. However, Indiana bats are known to exhibit roost fidelity between years (Humphrey et al. 1977, Callahan et al. 1997, Timpone 2004), and individual roost trees have been occupied for up to six years (Kurta and Murray 2002). Because Roost 036-1 was considered a maternity roost in the summer of 2007, it is possible that it may have served a similar function in 2008.

Summer Maternity Roosts

Despite decades of protection, the Indiana bat remains extremely vulnerable to population declines because of their very narrow habitat requirements and low fecundity. One key element in the management of local bat populations in summer involves understanding the specific needs of these maternity colonies. Reproductive colonies of bats may be highly philopatric, often roosting in the same area over successive years. The availability of suitable roosts (both in terms of quality and quantity) in their home range is critical for bats, especially reproductive females. Maternity roosts offer suitable conditions for rearing young and provide protection from predators and the elements. Because of this, roost trees can be a limiting factor for many woodland bats and the ephemeral nature of roosts coupled with their importance to bats in the reproductive season makes identifying and protecting this valuable resource an important component of any management plan. Locating roost sites within a particular management area is the first step in protecting this critically important resource and can help ensure that human activities do not damage roosts or force colonies to abandon roost sites.

Roost Tree Characteristics

Roost suitability depends on many factors including whether the tree is alive or dead, the extent of exfoliating bark, solar exposure, distance to water resources, and season (USFWS 1983). Indiana bats probably utilize tree species according to their availability; roost choice is probably more a reflection of roost character (i.e., structure, amount of solar exposure, and size) than species (Callahan et al.1997, Gardner et al. 1991b, Humphrey et al. 1977, USFWS 2007). Gumbert (2001) suggested that preferences of roosting bats for specific roost characteristics may also vary over time with variables such as species, usable bark cover, roosting location, and canopy cover apparently changing seasonally.

Overall, radiotelemetry efforts conducted at Fort Drum resulted in the location of 8 day roosts of 3 tree species; all (100%) roosts located were characterized as "snag". Indiana bats are most often found roosting in dead or nearly dead trees (Timpone 2004, USFWS 2007). The thermodynamic characteristics of live and dead trees may differ and each may provide different levels of solar exposure due to canopy cover. Dead or dying trees presumably heat up faster and their senescent bark provides roost sites for adult bats and their young (Gardner et al. 1991). Live trees are thought to provide protection against inclement weather, e.g., high temperatures or precipitation (Callahan et al. 1997, Humphrey et al. 1977). When live trees are used, roosting often occurs in shagbark hickories (*Carya ovata*) or large oaks (*Quercus* sp.; Callahan et al. 1997). .

Overall, roosts located during the summer 2008 bat survey were of slightly smaller diameter (38.4 cm [15.1 in]) than surrounding trees (39.6 cm [15.6 in]). However, roost trees were taller than nearby trees (within data plots) at Fort Drum (18.8 vs. 14.7 m; 61.7 vs. 48.2 ft). Sections of taller trees undoubtedly rise above the surrounding canopy and may therefore receive more solar exposure. Roost trees usually receive direct sunlight for more than half a day (USFWS 2007) and patterns documented in the use of primary (those harboring at least 30 bats) and secondary roosts have been linked to weather conditions with increased use of shorter, more sheltered secondary roosts during periods of high precipitation and temperature (Callahan et al. 1997).

Studies suggest that pregnant Indiana bats and their young are inefficient thermoregulators whose pre- and postnatal growth is controlled by metabolic rate and body temperature (Racey 1982, Speakman and Thomas 2003, USFWS 2007). Larger diameter trees may offer thermal characteristics that maximize the growth rates of developing young and offer more space for roosting bats. Larger roosts may also allow bats to congregate in larger clusters, thereby raising and maintaining roost temperatures and minimizing the thermoregulatory costs of young bats (Humphrey et al. 1977, Speakman and Thomas 2003). Romme' et al. (1995) suggested that most females were found roosting in trees greater than 22 centimeters (8.7 in) dbh and that habitat containing overstory trees with the mean dbh of 40 centimeters (15.8 in) was optimal.

Rangewide, Indiana bats have been found to roost in over 33 species of trees (Kurta 2005). Romme' et al. (1995) developed a habitat suitability index (HSI) for the Indiana bat that identified three classes of tree species based on their suitability to provide roosting habitat. Class I species are considered optimal based on the presence of exfoliating bark and their propensity to develop scales or sloughing bark as they age and die. This list includes the silver maple (*Acer saccharinum*), bitternut hickory (*Carya cordiformis*), eastern cottonwood (*P. deltoides*), white oak (*Quercus alba*), shagbark hickory (*C. ovata*), green ash (*Fraxinus pennsylvanica*), northern red oak (*Q. rubra*), slippery elm (*Ulmus rubra*), shellbark hickory (*C. laciniosa*), white ash (*F. americana*), post oak (*Q. stellata*), and American elm (*U. americana*).

Class II species were considered of lesser value and include sugar maple, shingle oak (*Q. imbricaria*), and sassafras (*Sassafras albidum*). The most common tree species used as roosts by Indiana bats during the 2008 Fort Drum Bat Survey was quaking aspen (*P. tremuloides; n = 4*), followed by slippery elm (*U. rubra*; *n* = 1). One roost was found in an unknown maple and two roosts were too decayed to identify to species.

Biologists from Copperhead Consulting measured relative tree density around known roosts in attempt to characterize the surrounding habitat and better understand the preferences of roosting bats at Fort Drum. The mean relative density of forested habitat surrounding diurnal roosts was 21.5 (SD = 11) square meters/hectare (93.8 square ft/ac). The relative density of the surrounding forest can impact roost suitability. Surrounding canopy can affect the amount of incidental light striking a roost, make them harder to enter or exit, and provide protection from predators. Because no attempt was made to compare habitat containing roost trees to randomly chosen plots in the surrounding habitat in this study, inferences made with this type of data should be done cautiously. One must also consider that both captured Indiana bats were nonreproductive and these individuals that may not be driven by the same considerations as their reproductive counterparts. However, generalizations can still be made regarding the habitat preferences of Indiana bats in and around Fort Drum.

Roost Switching

Several studies have documented the use of multiple roosts by Indiana bats during the summer maternity season (Gardner et al. 1991; Kurta et al. 1996; Kurta et al. 2002). A single colony may occupy multiple roosts on any given day and dozens of roosts over a reproductive season. In summer, Indiana bats typically choose from a pool of 10 to 20 roosts often alternating between them over the course of a season (Callahan et al. 1997, USFWS 2007). In general, larger maternity colonies switch roosts less frequently and utilize larger trees. Smaller groups and bachelor males use smaller trees and switch roosts more frequently possibly in response to ephemeral food sources or changes in weather.

At Fort Drum, radiotagged Indiana bats spent at total of 18 bat days in 8 roosts, switched roosts a total of 9 times, and spent an average of 1.8 consecutive days in a particular roost before moving. By comparison, Indiana bats switched roosts every 2 to 3 days in Indiana (Kurta 2005), every 2.2 days in Kentucky (Gumbert et al. 2002, Hawkins et al. 2008), and every 2.4 days in Michigan (Kurta 2002). Gumbert et al. (2002) found that individual bats used single roost trees over 2 to 12 consecutive days. Bats more frequently used roosts over nonconsecutive days, often returning to trees after roosting in another. Approximately 51 percent of all roost trees were used for only one day.

The reasons for roost switching remain unclear but it has been suggested that this behavior may promote social interactions or serve to maintain knowledge of available high-quality roosts (Lewis 1995, Kurta 2002). Kurta et al. (2002) found that lactating females switched roosts less frequently than did pregnant or post-lactating females. Reproductive females may move to find roosts with favorable thermodynamic characteristics for developing young. Other advantages of this behavior may include predator avoidance and parasite control (USFWS 2007).

Indiana bats may roost in many different group configurations over the course of a maternity season and the composition of the group may depend on many variables. Kurta et al. (2002) suggested that Indiana bats display a social organization reminiscent of the fission-fusion societies of primates and cetaceans. This type of social organization is characterized by a highly dynamic social structure with members coalescing into larger groups (fusion) and frequently splintering into smaller groups or solitary individuals (fission). Exactly why fluctuations of this type occur remains unknown but this behavior may be affected by weather, predation, parasite loads, type and condition of existing roost(s), and the changing thermodynamic requirements of developing young.

While roost trees may be habitable for years, most roosts are in dead or dying trees and are highly susceptible to damage or loss from weather and decay (Callahan et al. 1997; Kurta 2005). Kurta et al. (2002) suggested that bats may be motivated to switch roosts frequently because of the ephemeral nature of the roost itself. For example, Gardner and Hoffman (in Callahan et al. 1997) found that 30 percent of all roost trees deteriorated each year. It is possible that the temporary nature of the resource requires that colonies switch roosts frequently to maintain a continuous supply of roosts in the face of inevitable losses.

White Nose Syndrome

Overall, relatively few of the bats encountered during the 2008 Fort Drum Bat Study had any symptoms that may be attributed to WNS. While several bats encountered during the survey did have skin lesions or were underweight, attributing the cause of these indicators on bats encountered in the field to WNS is problematic, i.e., skin lesions can be a result of frostbite and low weight can be caused by any number of problems. It must also be noted that, because scoring criteria was not used in this study, no formal data is available for analysis. As the impact of this disease increases, it is likely that disinfection and scoring protocols will become an important component of future bat studies.

Literature Cited

Barbour, R. W., and W. H. Davis. 1969. Bats of America. University Press of Kentucky, Lexington, Kentucky.

Britzke, E. R., M. J. Harvey and S. C. Loeb. 2003. Indiana bat, Myotis sodalis, maternity roosts in the Southern United States. Southeastern Nat., 2:235–242.

Callahan, E.V. III. 1993. Indiana bat summer habitat requirements. Master of Science Thesis. University of Missouri, Columbia.

Callahan, E.V., R.D. Drobney, and R.L. Clawson. 1997. Selection of Summer Roosting Sites by Indiana Bats (Myotis sodalis) in Missouri. Journal of Mammalogy. 78:818-825.

ESI. 2006. Mist net and radio-telemetry surveys for the Indiana bat (Myotis sodalis) on Clover Construction Management's proposed Eagle Ridge Townhouses project., Jefferson County, New York. Authors: J. Duffey, A. Mann, T. Pankiewicz, and V. Brack, Jr. Final report to C&S Engineers, Inc., Syracuse, New York. Environmental Solutions & Innovations, Cincinnati, Ohio. 266 pp.

ESI. 2008. Summer Mist Net and Radio-telemetry Surveys for the Indiana Bat (Myotis sodalis) on Fort Drum, Jefferson and Lewis Counties, New York. Authors: A. Mann, E. Pfeffer, P. Kudlu, and V. Brack, Jr. Final report to Fort Drum Natural Resources, Fish and Wildlife Management Program. Environmental Solutions & Innovations, Inc. Cincinnati, Ohio.

Gardner, J.E., J.D. Garner, and J.E. Hofmann. 1991. Summary of Myotis sodalis Summer Habitat Studies in Illinois with Recommendations for Impact Assessment. Unpublished Report to the Indiana/Gray Bat Recovery Team. 26 p.

Gardner, J.W., J.D. Gardner, and J.E. Hoffman. 1991b. Summer roost selection and roosting behavior of Myotis sodalis (Indiana bat) in Illinois. Final report submitted to Endangered Species Coordinator, Region III, U.S. Department of the Interior, Fish and Wildlife Service, Twin Cities, Minnesota and Indiana/Gray Bat Recovery Team, U.S. Fish and Wildlife Service.

Gardner, J.D. and J.E. Gardner. 1992. Final report project E-3 Determination of summer distribution and habitat utilization of the Indiana bat (Myotis sodalis) in Illinois. Division of Natural Heritage Illinois Department of Conservation.

Gumbert, M. W. 2001. Seasonal roost tree use by Indiana bats in the Somerset Ranger District of the Daniel Boone National Forest, Kentucky. Masters Thesis. Eastern Kentucky University.

Gumbert, M. W., J. M. O'Keefe, and J. R. MacGregor. 2002. Roost fidelity in Kentucky. Pages 143-152 in The Indiana bat: biology and management of an endangered species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas.

Hall, E. R. 1981. The mammals of North America. Volume I. John Wiley & Sons, New York, NewYork.

Hawkins, J.A., J. Jaskula, A. Mann, and V. Brack, Jr. 2005. Habitat Conservation Plan: 2004 telemetry study of autumn swarming behavior of the Indiana bat (Myotis sodalis). Report prepared for the Indiana Department of Natural Resources, Indianapolis, IN. 25 pp. plus appendices.

Hawkins, J.A., P.S. Sewell, and M.W. Gumbert. 2008. Final report: Indiana bat survey and anthropogenic stimuli study conducted at the U.S. Army Garrison Fort Knox and Brashears Creek study sites during summer 2007. Copperhead Environmental Consulting, Inc.: 1-59.

Hicks, A., and D. Newman. 2007. Bat management and protection in New York State fiscal year April 1, 2006 - -April 1, 2007. 2007 annual report. New York State Department of Environmental Conservation. Albany, New York. 36pp.

Humphrey, S.R., A.R. Richter, and J.B. Cope. 1977. Summer habitat and ecology of the endangered Indiana bat, Myotis sodalis. Journal of Mammalogy 58:334-346.

Kiser, J.D. and C.L. Elliott. 1996. Foraging habitat, food habits, and roost tree characteristics of the Indiana bat (Myotis sodalis) during autumn in Jackson County, Kentucky. Unpublished report to the U.S. Forest Service, Daniel Boone National Forest, Winchester, Kentucky. 65pp.

Kurta A. and J. Kennedy, eds. 2002. The Indiana bat: biology and management of an endangered species. Bat Conservation International.

Kurta, A. and S.W. Murray. 2002. Philopatry and migration of banded Indiana bats (*Myotis sodalis*) and effects of radio transmitters. Journal of Mammalogy 83:585-589.

Kurta, A. and K. Williams. 1992. Roost habitat, microclimate, and behavior of the endangered Indiana bat, Myotis sodalis, in southern Michigan. Final report submitted to the Nongame Program, Michigan Department of Natural Resources, Lansing, MI.

MacGregor, J.R., J.D. Kiser, M.W. Gumbert, and T.O. Reed. 1999. Autumn roosting habitat of male Indiana bats (Myotis sodalis) in a managed forest setting in Kentucky. Proceedings, 12th Central Hardwood Forest Conference; 1999 February 28-March 2; Lexington, Kentucky. General Technical Report SRS-24. Asheville, NC:L US Department of Agriculture, Forest Service, Southern Research Station. J.W. Stringer and D.L. Loftis, eds.

Omernik, J.M. 1987. Ecoregions of the conterminous United States. Map (scale 1:7,500,000). Annals of the Association of American Geographers 77(1):118-125.

Reeder, D.M. and G.R. Turner. 2008. Working together to combat white-nose syndrome: A report of a meeting on 9 – 11 June 2008, in Albany, New York. Bat Research News, 49: No.3, pp. 75 – 78.

Romme', R.C., K. Tyrell, and V. Brack, Jr. 1995. Literature summary and habitat suitability index model: components of summer habitat for the Indiana bat, Myotis sodalis. Report submitted to the Nongame Program, Indiana Department of Natural Resources, Bloomington, IN. 43 pp.

Sewell, P., M. Gumbert, P. Roby, and Douglas Foster. 2006. Mist net bat inventory and rare species telemetry for the Cherokee National Forest, Tennessee, 2006. Report prepared for the Cherokee National Forest by Copperhead Consulting.

Speakman, J.R. and D.W. Thomas. 2003. Physiological ecology and energetic of bats. Pp. 430 – 490 in T.G. Kunz and M.B. Fenton (eds.), Bat Ecology. University of Chicago Press, Chicago IL.

Timpone, J.D. 2004. Roost-site selection of bats in Northeast Missouri with emphasis on the endangered Indiana bat (Myotis sodalis). M.S. Thesis. Southwest Missouri State University, Springfield, MO. 63 pp.

(USFWS) United States Fish and Wildlife Service. 1983. Recovery Plan for the Indiana Bat. U.S. Fish and Wildlife Service. Washington D.C. 80 pp.

(USFWS) United States Fish and Wildlife Service. 1999. Agency Draft: Indiana Bat (Myotis sodalis) Revised Recovery Plan. USFWS. Ft. Snelling, MN.

(USFWS) United States Fish and Wildlife Service. 2007. Indiana Bat (Myotis sodalis) Draft Recovery Plan: First Revision. U.S. Fish and Wildlife Service, Fort Snelling, MN. 258 pp.

Appendix A

Completed Mist Netting Data Forms

Appendix B

Completed Roost Tree Data Forms

Appendix C

Representative Photographs: The Indiana bat (*Myotis sodalis*)

Appendix D

Representative Photographs: Other Chiropterofauna

Appendix E

Roost Tree Photographs

Appendix F

Net Site Photographs

Appendix G

Disinfectant Protocol

Appendix H

Additional Figures

Figure 5. *Myotis sodalis* capture sites at Fort Drum during summer 2008.
Figure 6. *Eptesicus fuscus* capture sites at Fort Drum during summer 2008.
Figure 7. *Myotis lucifugus* capture sites at Fort Drum during summer 2008.
Figure 8. *Myotis septentrionalis* capture sites at Fort Drum during summer 2008.

Figure 9. *Lasiurus borealis* capture sites at Fort Drum during summer 2008.

Figure 10. *Lasiurus cinereus* captures sites at Fort Drum during summer 2008.
Figure 11. *Lasionycteris noctivagans* capture sites at Fort Drum during summer 2008.

NO MAPS PROVIDED

Appendix I

Net Site Data Table

Table 5. Net sites sampled at Fort Drum during summer 2008.

Net Site	Name	Date	# Nets	County	Northing	Easting	Zone
FD 01	Black Creek	29/30-Jun-08	3	Jefferson			18T
FD 02	north/south running access road, training area 5C	19/20-Jun-08	2	Jefferson			18T
FD 03	Antwerp access road off Tank Trail Road, training area 13B	19/20-Jun-08	2	Jefferson			18T
FD 04	access road leading to forested area of training area 4A	21/22-Jun-08	2	Jefferson			18T
FD 05	access road cutting through fields, Training area 4A	21/22-Jun-08	2	Jefferson			18T
FD 06	Raod corridor, training area 3A	30-Jun/1-Jul-08	2	Jefferson			18T
FD 07	access road near Wheeler-Sack Airfield, training area 4D	2/3-Jul-08	2	Jefferson			18T
FD 08	gravel road off Pleasant Street, training area 4E	3/13-Jul-08	2	Jefferson			18T
FD 09	north east heading road along Black River, training area 6A	16/17-Jul-08	2	Jefferson			18T
FD 10	across atv trail branching from Carr Road, Training area 17B	23/24-Jun-08	2	Jefferson			18T
FD 11	gravel road corridor west of Carr Road, training area 17C	7/8-Jul-08	2	Jefferson			18T
FD 12	Tributary of Pleasant Creek,training area 3B	25/27-Jun-08	2	Jefferson			18T
FD 13	Corridor on roadway east of Pleasant Street, training area 4B	2/3-Jul-08	2	Jefferson			18T
FD 14	Elm Lane between 4D and 4E	01/02-Jul 08	4	Jefferson			18T
FD 15	access road leading to construction staging area off HWY 26	30-Jun/1-Jul-08	2	Jefferson			18T
FD 16	Access trail near FR 39 in TA 16C	24 - 25-July-08	3	Jefferson			18T
FD 17	FUSA road off access road to firing range 50, training area 14B	17/18-Jul-08	2 / 3	Jefferson			18T
FD 18	Gravel road off 51/51, training area 19B	4/5-Jul-08	3	Jefferson			18T
FD 19	Gravel road/Wooded Corridor just off of FUSA Road	4/5-Jul-08	2	Lewis			18T
FD 20	Alpine Road near Bonaparte Creek between 14D and 20	4/5-Jul-08	2	Lewis			18T
FD 21	Bonapart Creek west of Fusa Blvd	17/18-Jul-08	2	Lewis			18T
FD 22	corridor northeast of Fusa Blvd, training area 19	19/22-Jul-08	2	Lewis			18T
FD 23	corridor parallel to North Tank Trail Rd, training area 18A	19/20-Jul-08	2	Jefferson			18T
FD 24	near non-potable water station, training area 17C	6/7-Jul-08	2 / 3	Jefferson			18T
FD 25	road corridor leading on to ridgetop, training area 17D	6/7-Jul-08	2	Jefferson			18T
FD 26	gravel road corridor on line between 17A and 17C on Carr Rd	6/9-Jul-08	2	Jefferson			18T
FD 27	corridor between firing range and Military Blvd, TA 14G	9/10-Jul-08	2	Jefferson			18T
FD 28	creek crossing Lake School Road off 3A	8/16-Jul-08	3	Jefferson			18T
FD 29	logging road off US Military Hwy, training area 9C	10/11-Jul-08	2	Jefferson			18T
FD 30	corridor south of Weaver Road, training area 17D	8/9-Jul-08	2	Jefferson			18T
FD 31	gravel road off tank trail, training area 8B	12/13-Jul-08	3	Jefferson			18T
FD 32	Doonlin/Tank Trail Rd, training areas 5B and 5D	14/16-Jul-08	2	Jefferson			18T

Net Site	Name	Date	# Nets	County	Northing	Easting	Zone
FD 33	between Doonlins Rd and Reedville Rd, training area 11A	12/13-Jul-08	2	Jefferson			18T
FD 34	corridor along acess road across Alexandria and Tower rd	14/15-Jul-08	2	Jefferson			18T
FD 35	corridor along southern end of Alexandria Road	18/19-Jul-08	2	Jefferson			18T
FD 36	Lake School Road between TAs 8C and 9B	21/22-Jul-08	3 / 2	Jefferson			18T
FD 37	corridors along Russell Trunpike, training areas 14D and 14F	11/12-Jul-08	3	Jefferson			18T
FD 38	Gormly Rd and US Military Blvd, training area 9A and 14E	10/11-Jul-08	2 / 3	Jefferson			18T
FD 39	Cainfield Rd in training area 15C	21/22-Jul-08	2	Jefferson			18T
FD 40	Dirt road off Flick Road between training areas 10B and 10C	20/23-Jul-08	2 / 3	Jefferson			18T
FD 41	corridor off Lake School Road adjacent to Buck Creek	14/15-Jul-08	2 / 3	Jefferson			18T