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FINAL REPORT

SUMMER MIST NET SURVEYS FOR THE INDIANA BAT (*MYOTIS SODALIS*) ON FORT DRUM MILITARY INSTALLATION, JEFFERSON AND LEWIS COUNTIES, NEW YORK

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VOLUME 1 OF 2

Prepared for:

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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 bat roost locations.

EXECUTIVE SUMMARY

The Endangered Species Act stipulates that all federal agencies, including the Department of Defense, have certain responsibilities with regard to endangered species. Fort Drum is a U.S. Army installation within the known range of the Indiana bat (*Myotis sodalis*), a federally endangered species. Indiana bats were first documented on Fort Drum in the summer of 2006, and subsequently have been using the installation for foraging and roosting (including summer maternity roosting). Studies on Fort Drum in 2007 and 2008 documented Indiana bat foraging and roosting in concentrated portions of the Cantonment Area and in the southern portion of the Training Area. Environmental Solutions & Innovations, Inc. (ESI) was contracted in 2009 and 2010 to further identify the potential distribution of federally endangered Indiana bats on the installation, particularly to document the presence of a suspected maternity colony. Additional information was also obtained on the presence and distribution of other native bat species at sampling locations.

Because of declining populations due to White-nose Syndrome (WNS), ESI was contracted in 2010 to radio-track and find maternity roosts of little brown (*Myotis lucifugus*), and northern (*Myotis septentrionalis*) bats, in addition to Indiana bats.

Eighty-six mist net sites were positioned in suitable habitat across both the Training Area and Cantonment Area of Fort Drum. One of these 86 sites was not completed; however, bat captures were still included in the total catch. Most sites were located in the Training Area; 15 of those sites with high capture numbers in 2007 were attempted to be repeated in order to collect data for future trend analyses, especially due to the documented presence of WNS on the Installation. Twelve Cantonment Area sites from 2007 were repeated in order to gain more data, particularly on myotid bats. Mist netting efforts for the 85 completed sites complied with all guidelines set forth by the U.S. Fish and Wildlife Service and the Indiana Bat Recovery Team to survey summer habitat for the presence/absence of the Indiana bat.

Bat sampling was conducted from 15 June to 14 August 2010. Two Indiana bats (*Myotis sodalis*) were captured. During mist netting, 652 bats representing all nine species known from New York were captured, including 492 big brown bats

(*Eptesicus fuscus*), 87 eastern red bats (*Lasiurus borealis),* 52 little brown bats, 6 hoary bats (*Lasiurus cinereus*), 5 silver-haired bats (*Lasionycteris noctivigans*), 5 northern bats, 2 eastern small-footed bats (*Myotis leibii*), 2 Indiana bats, and 1 eastern pipistrelle (*Perimyotis subflavus)*. Big brown bats accounted for 76 percent of the total captures, and collectively, big brown, little brown and eastern red bats accounted for over 96 percent of total captures. The average capture rate (7.58 bats per site) was lower than 2007 but higher than 2009. Wing scarring was noted on select bats throughout the summer, suggesting WNS has impacted bat numbers across the installation.

ACKNOWLEDGEMENTS

Environmental Solutions & Innovations, Inc. (ESI) extends gratitude to the organizations and individuals who contributed time and support for this project.

Most importantly, we thank Fort Drum again for providing us the opportunity to be involved in this survey. Among the individuals who contributed their time and talent toward the completion of this project, we especially thank Raymond Rainbolt and Chris Dobony of Fort Drum's Fish and Wildlife Management Program, for their coordination efforts and unending guidance and support during field activities and reporting. We also thank the individuals and officers of the Fort Drum Range Control and Military Police, for their cooperation and patience during the scheduling of mist net activities. We also thank Robyn Niver with the U.S. Fish and Wildlife Service and Al Hicks (retired biologist with the New York State Department of Environmental Conservation) for their continuing support of our biological studies.

The authors extend personal thanks to ESI's staff, particularly the members of the Fort Drum 2010 field crew (Jack Basiger, Erin Basiger, Daniel Judy, Joslyn Roberts, Sheila Captain, Michael Farmer, Julia Nawrocki, Jennifer Strong, Erica Welker, Shane Brodnick, and Beth Meyer).

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1.0 Regulatory Setting

The Federal Endangered Species Act [16 U.S.C. 1531 *et seq*.] was codified into law in 1973. This law provides for the listing, conservation, and recovery of endangered and threatened species of plants and wildlife. In Section 2c of the ESA, it is declared to be the policy of Congress that "all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of this Act".

Section 7(a)(2) of the ESA states that each federal agency shall insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in destruction or adverse modification of designated critical habitat. Federal actions include (1) expenditure of federal funds for roads, buildings, or other construction projects, and (2) approval of a permit or license, and the activities resulting from such permit or license. Compliance is required regardless of whether involvement is apparent, such as issuance of a federal permit, or less direct, such as federal oversight of a state-operated program. The ESA requires that Federal agencies consult with the USFWS to "ensure that they are not undertaking, funding, permitting, or authorizing actions likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat".

Section 9 of the ESA prohibits the "take" of listed species. "Take" is defined by the ESA as "*to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect*" [16 U.S.C. 1532(19)]. USFWS further defines "harm" to include significant habitat modification or degradation [50 CFR §17.3]. Actions of federal agencies that do not result in jeopardy or adverse habitat modification, but that could result in a take, must also be addressed under Section 7.

The Indiana bat is a federally endangered species with a wide-ranging summer distribution. A known winter hibernaculum is located less than 10 km (6 mi) from Fort Drum, and Indiana bats have the potential to use most forested habitat on Fort Drum for summer roosting (including maternity roosting). Mist net surveys on Fort Drum in 2007 and 2008 documented Indiana bat foraging and/or roosting in concentrated portions of the Cantonment Area and in the southwestern portion of the Training Area.

Environmental Solutions & Innovations, Inc. (ESI) was contracted in 2009 and 2010 to further identify the potential distribution of federally endangered Indiana bats on the installation. Because of the declining populations due to White-nose Syndrome (WNS), ESI was contracted to radio-track and find maternity roosts of little brown

(*Myotis lucifugus*) and northern (*Myotis septentrionalis*) bats, in addition to Indiana bats.

ESI completed field studies in accordance with its USFWS Federal Fish and Wildlife Permit (#TE02373A-0) and a New York State Department of Environmental Conservation (NYSDEC) Collect or Possess Permit (#1187) and Endangered/ Threatened Permit (#166).

2.0 Project Setting

2.1 Project Background and Location

Fort Drum is a U.S. Army installation in northern New York, near Canada with the Saint Lawrence River to the north, Lake Ontario to the west, and the Adirondacks to the east. Fort Drum consists of over 43,300 ha (107,000 ac) (Figure 1). Its mission includes commanding active component units assigned to the installation, providing administrative and logistical support to tenant units, providing support to active and reserve units from all services in training at Fort Drum, and providing planning and support for the mobilization and training of nearly 80,000 troops annually. Fort Drum has been used as a military training site since 1908. For more detailed information on the physiography of Fort Drum refer to the Integrated Natural Resources Management Plan.

Figure 1. Location of Fort Drum, Jefferson and Lewis counties, New York.

NO MAP PROVIDED

3.0 Ecological Setting

3.1 Description

The Indiana bat is a medium-sized bat in the genus *Myotis*. The forearm length has a range of 35 to 41 mm (1.4 – 1.6 in). The head and body length range from 41 to 49 mm (1.6 – 1.9 in). Its appearance most closely resembles that of congeners little brown bat (*M. lucifugus*) and northern bat (*M. septentrionalis*). Indiana bats differ from similar *Myotis* species in that they have a distinctly keeled calcar (cartilage that extends from the ankle to support the tail membrane). Other minor differences include smaller and more delicate hind feet, shorter hairs on the feet that do not extend past the toenails, and a pink nose. The fur lacks luster, and the wing and ear membranes have a dull, flat coloration that does not contrast with the fur (USFWS 2007) . Fur on the chest and belly is lighter than fur on the back, but is not as strongly contrasting as that of similar *Myotis* species. Overall, color is slightly grayer, while the little brown bat and northern bat are browner. The skull has a crest and tends to be smaller, flatter, and narrower than that of the little brown bat (USFWS 2007) . The Indiana bat is a "tree bat" in summer and a "cave bat" in winter. Like most bats in North America, it is insectivorous and gives birth to one pup. The USFWS Recovery Plan (2007) provides additional information of the Indiana bat's life history.

3.2 Summer Roosting Ecology

The summer range of the Indiana bat is large and includes much of the eastern deciduous forestlands between the Appalachian Mountains and Midwest prairies (Figure 2). Distribution throughout the range is not uniform and summer occurrences are more frequent in southern Iowa and Michigan, northern Missouri, Illinois, and Indiana. Greater tree densities do not equate to more bats (Brack et al. 2002). Cooler summer temperatures associated with latitude or altitude likely affect reproductive success and the summer distribution of the species (Brack et al. 2002).

3.2.1 Males

Some males remain near hibernacula throughout summer, while others migrate varying distances (Whitaker and Brack 2002). Males can be caught at hibernacula on most nights during summer (Brack 1983, Brack and LaVal 1985), although there may be a large turnover of individuals between nights (Brack 1983). Woodland roosts for males appear similar to maternity roosts trees.

Figure 2. Range-wide distribution of the Indiana bat during summer, showing counties with reproductive (adult female and/or young-of-the-year) and non-reproductive records.

NO MAP PROVIDED

(Kiser and Elliott 1996, Schultes and Elliott 2002, Brack and Whitaker 2004, Brack et al. 2004), although smaller diameter may be used. Less space may be required for a single bat than a colony of bats, or thermal requirements may differ. Males appear somewhat nomadic; over time, the number of roosts and the size of an area used increases. Activity areas encompass roads of all sizes, from trails to interstate highways. Roosts have also been located near roads of all sizes (Kiser and Elliott 1996, Schultes and Elliott 2002, Brack et al. 2004), including adjacent to an interstate highway (Brack et al. 2004).

3.2.2 Females and Maternity Colonies

When female Indiana bats emerge from hibernation, they migrate to maternity colonies that may be located up to several hundred miles from the hibernacula (Kurta and Murray 2002, Winhold and Kurta 2006). Females form nursery colonies under exfoliating bark of dead, dying, and living trees in a variety of habitat types, including uplands and riparian habitats. A wide variety of tree species (Kurta 2004), occasionally including pines (Britzke et al. 2003), are used as nursery colonies indicating that it is tree form, not species that is important for roosts (Kurta 2004, Winhold 2007, Whitaker and Sparks 2008). Because many roosts are in dead or dying trees, they are often ephemeral. Roost trees may be habitable for one to several years, depending on the species and condition of the tree (Callahan et al. 1997, Gumbert et al. 2002, Sparks 2003). Indiana bats exhibit strong site fidelity to summer roosting and foraging areas (Kurta and Murray 2002, Kurta et al. 2002, Sparks et al. 2004, Whitaker et al. 2004, Winhold et al. 2005, Whitaker and Sparks 2008, Sparks et al. 2009). This fidelity is to a larger landscape which can change over time. Between the discovery of a colony near the Indianapolis International Airport in 1994 and 2008, this colony of bats essentially abandoned foraging areas north of the expanded Interstate 70 and shifted their center of activity into a conservation area that was designed and managed for them (Sparks et al. 2009). This indicates that it is possible to move colonies of Indiana bats across a developing landscape if suitable long-term habitat is available or developed during the move.

A maternity colony typically consists of 20 to 100 adult females (Kurta 2004) but may contain over 300 individuals (Whitaker and Brack 2002). Nursery colonies often use several roost trees (Kurta et al. 1993, Foster and Kurta 1999, Kurta and Murray 2002, Whitaker and Sparks 2008), moving among roosts within a season. Most members of a colony coalesce into one or a few roost trees about the time of parturition. Once young are volant, the bats spend less time in these major roosts and more time in minor roosts—often roosting alone under the bark of live trees. Roosts that contain large numbers of bats (more than 20 bats) are often called primary roosts, while secondary roosts hold fewer bats. Primary roost trees are often greater than 46 cm (18 in) dbh and secondary roost trees are often greater than 23 cm (9 in) dbh (Gardner et al. 1991, Callahan et al. 1997, Kurta et al. 2002, Miller et al. 2002, Carter 2003). Numerous suitable roosts may be needed to support a single nursery colony, possibly about 45 stems per ha (20/ac) (Gardner et al. 1991, Miller et al. 2002, Carter 2003).

Roost trees often have 10 hours of solar exposure per day, with 20 to 80 percent canopy closure (Humphrey et al. 1977, Gardner et al. 1991, Kurta et al. 1993, Kurta et al. 1996, Kurta et al. 2002, Carter 2003), but the need for solar exposure may vary with latitude. Although Indiana bats typically roost under the exfoliating bark of dead and dying trees, they have also been found roosting in a variety of cracks and hollows in trees (L. C. Watkins in Humphrey et al. 1977, Kurta et al. 1993, Butchkoski and Hassinger 2002, Kurta et al. 2002, Kurta 2004), utility poles (ESI 2004, Hendricks et al. 2004), buildings (Butchkoski and Hassinger 2002, V. Brack Unpublished data, A. C. Hicks Personal communication), and bat boxes (Butchkoski and Hassinger 2002, Carter 2002, Butchkoski 2005, Ritzi et al. 2005, Whitaker et al. 2006). The colony of bats near the Indianapolis Airport have used a combination of both natural roosts (trees) and bat boxes every year since 2003 (Sparks et al. 2008).

Females are pregnant when they arrive at maternity roosts. Females produce one young per year, typical for the genus *Myotis* (Asdell 1964, Hayssen et al. 1993). Parturition typically occurs between late June and early July. Lactating females have been caught mid-June to early August (Humphrey et al. 1977, LaVal and LaVal 1980, Brack 1983, Clark et al. 1987, ESI 2006a; 2008). Juveniles become volant between early July and early August. Reproductive phenology is likely dependent upon seasonal temperatures and the thermal character of the roost (Humphrey et al. 1977, Kurta et al. 1996). Like many microchiropterans, Indiana bats are thermal conformists (Stones and Wiebers 1967), with prenatal, neonatal, and juvenile development temperature dependent (Racey 1982). Cooler summer temperatures associated with latitude or altitude likely affect reproductive success and therefore the summer distribution of the species (Brack et al. 2002).

Nightly non-foraging behavior of Indiana bats is poorly documented. In Michigan, pregnant bats from a maternity colony foraged most of the night, but lactating females returned two to four times to feed young. Both pregnant and lactating females roosted up to six times per night for 14 minutes (SD = 1) each (Murray and Kurta 2004). Foraging areas were 0.5 to 4.2 km (0.3 – 2.5 mi) from diurnal roosts. Kiser et al. (2002) found 82 bats under three bridges over a 6-night period in late July and August. Temperatures under the bridges were warmer and less variable than ambient, apparently providing a location to roost and digest food between foraging bouts. These bridges were 1.0 to 1.9 km (0.6 – 1.2 mi) from diurnal roost trees. Additional unpublished information about night roosting is available from the long-term study of a colony near the Indianapolis International Airport (D.W. Sparks Unpublished data). These bats regularly night roosted within wooded areas. When biologists entered woodlots to locate tagged bats to a specific tree, the bats moved to new roosts; this behavior was greatly reduced when human activity in the woodlot was restricted. When bats were located to a specific tree, they were hanging exposed on the tree rather than under bark. More rarely, individual bats night roosted in bat boxes. In one case, an Indiana bat night roosted in a prairie, apparently on big bluestem (*Andropogon gerardii*) or evening primrose (*Oenothera* sp.).

Indiana bats live on anthropogenic landscapes and recent research indicates females include roads in their active area. Although bats do cross roads, the studies that document this behavior were typically not designed to gauge a graded response. On Camp Atterbury, Indiana, female and juvenile Indiana bats routinely night roosted under bridges on 2-lane paved roads (Kiser et al. 2002). Activity areas of nursery colonies in Illinois (Gardner et al. 1991) and Michigan (Kurta et al. 2002) included paved roads. On the campus of Wright State University, Ohio, a roost tree was at the edge of a large parking lot, and about 20 m (60 ft) from a moderately traveled road. Emerging bats crossed the parking lot and radio-tagged bats crossed Highway 444, a four-lane divided highway, to forage in a 73-ha (180 ac) woodlot (Brown et al. 2001). In eastern Indiana, adjacent to Newport Chemical Depot, a reproductive female Indiana bat was radio-tracked across a 4-lane divided highway to a maternity colony in a small, 0.7-ha (1.7 ac) isolated woodlot (Brack and Whitaker 2006). The roost tree was on the west edge of the woodlot (adjacent to the highway) and the woodlot was surrounded on other sides by open, farmed agricultural lands. Based on Euclidean distance analysis, small, unimproved roads were the most preferred foraging habitat at Fishhook Creek Watershed in Illinois (Menzel et al. 2005).

Research into the response of Indiana bats to roadways has been ongoing in Indiana during the past decade. Indiana bats foraging near the Indianapolis airport cross roads ranging from unimproved tire paths to Interstate highways an average of 11.97 times per night, but most of this activity (11.54 crossings per night) is restricted to small rural roads, and this pattern holds when corrected for the much greater abundance of smaller roads (M. McGuire Unpublished data). Similarly, bats at this site were much more likely to abort attempts to cross a roadway when vehicles were present (Zurcher et al. 2010). By combining species-specific patterns of movement with these observations, it is possible to mathematically model the impacts of roadways on bats. The willingness of a bat to cross a roadway is in part determined by three factors: value of the habitat on the opposite side of the road, size of the road, and intensity of traffic (V. J. Bennett Personal communication). These results suggest that utility corridors are less of a barrier than roadways because they lack traffic. In addition, Indiana bats have been observed using such corridors as both commuting and foraging habitat (Brack and Whitaker 2006) As such, reasonable efforts to avoid and minimize effects of utility corridors include the sharing of a corridor by multiple lines.

3.2.3 Food Habits and Foraging Ecology

The diet of Indiana bats varies substantially among bats of different ages and genders, and in relation to the availability of insects within different habitat types.

Based on diets of males, Brack and LaVal (1985) considered the species selective opportunists. In Indiana, aquatic-based insects were more common in the diet of a maternity colony than in the diet of males collected at caves (Brack 1983). The maternity colony was located along the Big Blue River, where only about 11 percent of the land within 3.2 km (2 mi) of the roost was forested (most was riparian), whereas males were caught at a cave where 42 percent of the area within 3.2 km (2 mi) was forested and only a small portion was riparian. In late summer, the diets of males, females, and juveniles captured at caves were similar to one another and to males' summer diets. Diets reported by Belwood (1979) from a colony along a stream and by Kurta and Whitaker (1998) from a colony within a wooded wetland contained more aquatic-based insects than diets of males foraging in an upland habitat (Brack and LaVal 1985). The repeated seasonal occurrence of the Asiatic oak weevil (*Cyrtepistomus castaneus*) and sporadic abundance of hymenopterans in the diet (Brack 1983, Brack and LaVal 1985, Brack and Whitaker 2004, Tuttle et al. 2006, Brack In press) are both indicative of opportunistic feeding. Insects may be less common late at night, forcing bats to eat a greater variety of insects (Brack 1983). Diet varied across weeks at a maternity colony in Indiana (Tuttle et al. 2006). The diet contains less diversity late in the season (Brack 1983, Brack and LaVal 1985). Diet also varies by lunar cycle (Brack 1983, Brack and LaVal 1985), because the cycle affects insects. Murray and Kurta (2002) found that the diet was flexible across the range and potentially affected by regional and local differences in bat assemblages and availability of foraging habitat and prey. Despite variability of the diet, it should be noted that this variability is a result of eating different amounts of insects belonging to five orders: Lepidoptera (moths), Coleoptera (beetles), Diptera (true flies), Trichoptera (caddisflies), and Hymenoptera (wasps and ants) (Tuttle et al. 2006).

Using a variety of techniques, authors have reported that Indiana bats travel a wide range of distances from their roosts, and the inherent benefits and biases of these techniques must be considered when interpreting the data (Sparks et al. 2004). Using reflective wristbands, Humphrey et al. (1977) found that a maternity colony foraged in areas ranging from 1.5 to 4.5 ha (3.7 – 11.1 ac). Using telemetry, much larger distances have been recorded. In Illinois, individuals traveled up to 4 km (2.5 mi) from maternity colonies (Gardner et al. 1991). In Michigan, foraging areas were 0.5 to 4 km (0.3 to 2.5 mi) from diurnal roosts (Murray and Kurta 2004), and members of a maternity colony moved a maximum distance among roosts of 5.8 km (3.6 mi) overnight, but 9.2 km (5.7 mi) over 4 years (Kurta et al. 2002). In Missouri, adult males traveled 5 km (3.1 mi) while foraging LaVal and LaVal (1980), and Brack (1983) observed foraging light-tagged bats within 3.22 km (2 mi) of caves used during autumn swarming. In Hoosier National Forest, the mean active foraging area of four adult male bats ranged from 95.1 to 151.9 ha (235 – 375 ac) based on the method of estimation, while the means of individual bats across three methods of estimation (95% minimum convex polygon, capture radius, and non-circular) ranged from 43.1 to 314.2 ha (107 – 776 ac) (Brack et al. 2004). At the Indianapolis Airport

(Sparks et al. 2004, Sparks et al. 2005), maximum distance flown by Indiana bats averaged 3 km (1.86 mi) but ranged from 0.8 to 8.4 km (0.5 – 5.41 mi). Similarly, using 95 percent minimum convex polygons, home range size averaged 412 ha (1081.07 ac) but ranged from 50 to 1168 ha (123.55 – 2886.19 ac), and home ranges of individuals often overlapped (Sparks et al. 2004, Sparks et al. 2005). Individuals of many species of bats that roost colonially forage independently of one another (Kerth et al. 2001). Like many other species of microchiropterans, the Indiana bat often uses travel corridors that consist of open flyways such as streams, woodland trails, small infrequently used roads, and possibly utility corridors, regardless of suitability for foraging or roosting (Brown and Brack 2003). Such corridors may play an important role in allowing bats to access isolated foraging areas (Murray and Kurta 2004, Sparks et al. 2004), but may not be essential as Indiana bats have been tracked crossing large open areas (Brack 1983).

Members of maternity colonies forage in a variety of woodland settings, including upland and floodplain forest (Humphrey et al. 1977, Brack 1983, Gardner et al. 1991). Foraging activity is concentrated above and around foliage surfaces, such as over the canopy in upland and riparian woods, around crowns of individual or widely spaced trees, and along edges (LaVal et al. 1977). They forage less frequently over old fields, and occasionally over bushes in open pastures (Brack 1983). Forest edges, small openings, and woodlands with patchy trees provide more foraging opportunities than dense woodlands. Most species of woodland bats forage prominently along edges, less in openings, and least within forests (Grindal 1996). Openings also provide a better supply of insects than do wooded areas (Tibbels and Kurta 2003).

When habitat selection is examined at the landscape scale, the species makes preferential use of forested habitat for foraging in both Illinois and Indiana (Menzel et al. 2005, Sparks et al. 2005). The Illinois study was on a wildlife management area with substantial blocks of bottomland hardwood forest. In this landscape, bats foraged closer to roads, forest, and riparian areas than chance alone would predict. Grassland was used in proportion to availability and agricultural areas were avoided. In suburban Indianapolis, Indiana bats preferentially used woodlands more than agricultural, low density residential, and open water, and these habitats more than pasture, parks, and commercial lands, with high density residential least preferred. It should be noted, however, that at this study site most such neighborhoods were new developments within what were previously large agricultural fields. The authors suggest that this pattern might not hold for residential areas where woodland habitat is retained. Finally, it is likely that in heavily forested areas, open habitats would be preferentially used by foraging Indiana bats (Sparks et al. 2004).

3.3 Status

The USFWS listed the Indiana bat (*Myotis sodalis*) as endangered on 11 March 1967. The most current range-wide estimate of the population is 387,835 individuals

(USFWS 2010) which represents less than half of the estimated population of 1965 and a 17 percent decline from 2007.

Critical habitat was designated on 24 September 1976, and included 11 caves and 2 abandoned mines in Illinois, Indiana, Kentucky, Missouri, Tennessee, and West Virginia. No additional critical habitat has been designated. A recovery plan for the species was completed on 14 October 1983. In October 1996, the Indiana Bat Recovery Team released a Technical Draft Indiana Bat Recovery Plan. In October 1997, a preliminary version entitled "Agency Draft of the Indiana Bat Recovery Plan," which incorporated changes from the 1996 Technical Draft, was released. An agency draft entitled "Indiana Bat (*Myotis sodalis*) Revised Recovery Plan" was distributed for comments in March 1999. A new draft of the revised recovery was released in April 2007.

> Federal Register Documents
>
> 41 FR 41914; 24 September 1976: Final Critical Habitat, Critical habitat-mammals
>
> 40 FR 58308 58312; 16 December 1975: Proposed Critical Habitat, Critical habitat-mammals
>
> 32 FR 4001; 11 March 1967: Final Listing, Endangered

3.3.1 Causes of Past/Current Decline

Long-term, detailed documentation of population changes are lacking across most of its range, with the exception of the state of Indiana (Brack et al. 1984, Johnson et al. 2002, Brack et al. 2003). Summer habitat degradation (USFWS 2007), pesticides, and winter disturbance (Johnson et al. 1998) are believed to have contributed to an overall decline. Beginning in 2006, bats (including Indiana bats) hibernating in mines near Albany, New York were observed with fungal disease that is now known as White-nose Syndrome (WNS), which has been responsible for dramatic declines in bats throughout the Northeast (Blehert et al. 2008; 2009).

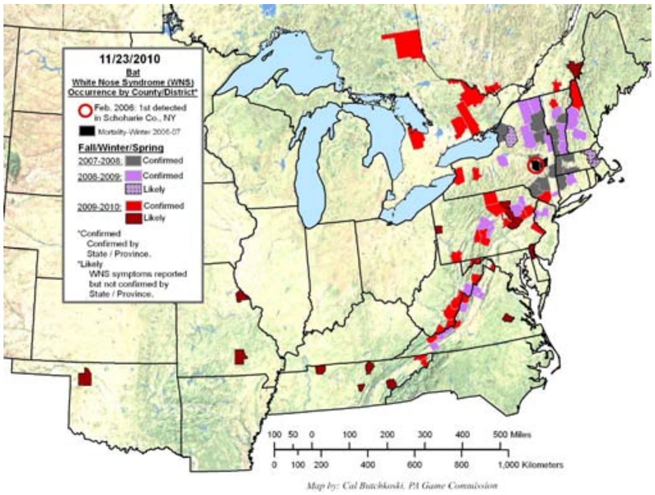
The Indiana bat uses a variety of wooded summer habitats, from large tracts of woodlands to riparian strips and woodlots on a man-dominated landscape. Summer habitat losses include tree removal or land clearing for a variety of land use practices: agriculture, urban development, surface mining, and utility and transportation ROWs. Removal of standing dead trees, especially during summer months, is potentially harmful for Indiana bats. Removal of riparian forest along streams and ditches also degrades summer habitat. Loss of wooded lands can lead to increased forest fragmentation, and a compounding of adverse effects. In many portions of their core range, Indiana bats utilize savanna-like habitats, with large trees, an open canopy, and an uncluttered understory. However, suppression of fire and removal of dominant grazing herbivores, combined with frequent tree harvest, has often produced wooded lands of smaller trees with a closed canopy and a cluttered understory, which may have affected the quality of maternity habitat (USFWS 2007) .

Chemical contamination in non-winter habitats has been implicated in the decline of most North American bats (USFWS 2007). Lethal concentrations of a number of pesticides have been found in several other species of bats that overlap substantially with Indiana bats in foraging habitat and thus have similar risk of exposure (Schmidt et al. 2001, O'Shea and Clark 2002, Schmidt et al. 2002). Of particular concern are organophosphates, which have been detected in the guano of Indiana bats and may indirectly cause mortality or decreased production by causing bats to become torpid or unconscious for long periods, potentially leading to indirect mortality through predation, exposure or death of dependent offspring (Eidels et al. 2006). However, the importance of this group of contaminates on a species-by-species basis is not clearly documented, and additional studies are needed.

Documented threats to winter habitats, caused by humans, include: (1) disturbance and vandalism, (2) improper cave gates and structures, (3) indiscriminate collecting, and (4) flooding of caves from reservoir construction. Natural hazards include flash flooding of hibernacula (Brack et al. 2005a), ceiling collapse of mines and caves (Elliot 2007), colder or warmer than average winters, and severe summer storms. Natural and/or human-caused changes in the microclimate of caves and mines used as hibernacula can adversely affect the species (Richter et al. 1993).

Populations of hibernating bats in the northeastern United States have been dying in record numbers, and the specific cause of the deaths is unknown. However, this crisis is directly associated with WNS, named for a white fungus evident on the muzzles and wings of affected bats (Meteyer et al. 2009). This affliction was first documented at four sites in eastern New York in the winter of 2006-07 (Blehert et al. 2008; 2009). Since then, WNS has rapidly spread to multiple sites throughout the northeast. Researchers associate WNS with a newly identified fungus (*Geomyces destructans*) that thrives in the cold and humid conditions characteristic of the caves and mines used by bats (Gargas et al. 2009). Bats apparently have a reduced immune response while hibernating (Carey et al. 2003), which may predispose them to infection by *G. destructans.* Further, colonial bat species (such as the Indiana bat) are the most likely to be infected by the disease and also likely to decline to such numbers where maternity colonies are no longer viable (Brack et al. 2010).

In the U.S., biologists and/or cavers have documented WNS in bat hibernacula in New Hampshire, Vermont, New York, Massachusetts, Connecticut, New Jersey, Pennsylvania, West Virginia, and Virginia, and most recently, Maryland, Delaware, Tennessee, Missouri, Oklahoma, and the Canadian provinces of Ontario and Quebec. The disease can lead to severe wing damage (Reichard and Kunz 2009) which can be used as a “red flag” for infected individuals, although the majority of bats within an infected area have only slightly damaged or undamaged wings (Francl et al. 2011). By combining sensitive molecular techniques (Lorch et al. 2010) with field observations of damaged wings, the fungal agent of WNS has now been documented as far west as Oklahoma.



During the winter of 2008/2009, WNS-related mortality was documented at all but one Indiana bat hibernacula in New York (including Glen Park, the Indiana bat hibernaculum near Fort Drum).

3.3.2 Survivorship

Detailed studies of survivorship of the Indiana bat have not been completed. Paradiso and Greenhall (1967) and Humphrey and Cope (1977) determined a terminal age of between 12 and 13 years after marking. Brack et al. (2005b) found that survivorship of white and leucistic *M. sodalis* was low, about 7.7 percent (assuming individuals were 0.5 year old when first found). This calculated rate may be low because bats may have been 1.5 years of age when first found, and they may have survived an additional year without being found. Low survivorship during adolescence is representative of many mammalian species, although white coloration may make bats more susceptible to predation by visually oriented nocturnal predators.

Extensive winter banding records were used by Humphrey and Cope (1977) to estimate survival between winters. Survival rates were high for years one through six after banding, 75.9 percent annually for females and 69.9 percent for males (72.9% combined), lower after six years, at 66.0 percent for females and 36.3 percent for males (51.2% combined), and only 4.1 percent (females) after 10 years. Humphrey and Cope (1977) could not determine survivorship for young-of-the-year, but total survival was much lower the first year after marking (ca. 41%), which was attributed to low survivorship of young-of-the-year. Using more modern approaches, young-of-the-year survival rate is now estimated at 65 percent (Boyles et al. 2007). Because of substantially increased survival during the first winter, this analysis predicts a greater number of bats from each cohort surviving. Unfortunately, as noted by both sets of authors (Humphrey and Cope 1977, Boyles et al. 2007), these samples are inherently biased by the inability to reliably distinguish age classes among hibernating bats.

3.3.3 Regional Species Occurrence

The Indiana bat is known to occur in many areas of the northeast, including parts of northern New York (Figure 3). Historically, there are 15 known Indiana bat hibernacula in seven counties in New York. Indiana bats continue to use nine hibernacula in five counties. Active hibernacula are known from Jefferson County as

Figure 3. Location of Fort Drum and counties with hibernacula, summer maternity, and other summer (non-reproductive) records for the Indiana bat (*Myotis sodalis*).

NO MAP PROVIDED

well as Onondaga, Warren, Albany, Essex, and Ulster counties. In 2005, approximately 41,000 Indiana bats (9% of the range-wide total) were known to hibernate in caves and mines of New York (Hicks and Novak 2002, Hicks et al. 2005, USFWS 2007). Due to WNS, that number has greatly decreased in the last 4 years.

Evidence of reproduction and maternity colonies exists in nine counties in New York (Figure 3). Summer maternity records are known from Cayuga, Columbia, Dutchess, Essex, Jefferson, Onandaga, Orange, Oswego, and Ulster counties.

3.3.4 Local Species Occurrence

The Glen Park hibernaculum, located approximately 9.6 km (6 mi) southwest of the project area along the Black River, once harbored a consistent annual winter population of approximately 1,700 to 2,000 bats. In 2006/2007, Glen Park hosted about 1,928 Indiana bats (Hicks and Newman 2007). Data from the latest census survey in 2009/2010 revealed approximately 509 Indiana bats (pers. comm. Al Hicks – NYSDEC).

Spring emergence studies performed by the NYSDEC in 2005 found bats traveling from the Glen Park hibernaculum in Jefferson County to maternity roosts approximately 8 km (4.8 mi) west of Fort Drum, and one location near the hibernaculum (Hicks et al. 2005, Hicks et al. 2006).

Prior to 2006, no Indiana bats or any other resident federally endangered species were documented on the installation. A limited mist net survey was conducted in 1999 surveying eight sites over a 2-week period. Five bat species were captured including little brown bats, northern bats, big brown bats, one silver-haired bat, and one hoary bat; no Indiana bats were captured during this effort (BHE Environmental 1999). However, in 2003 to 2006 Fort Drum personnel documented suspected Indiana bat call sequences by conducting bat acoustical sampling (using Anabat® II detectors) on several different areas of the installation. In 2006, ESI confirmed the presence of Indiana bats on Fort Drum during radio-tracking efforts originating from an adjacent project. In August 2006, four Indiana bats were captured by ESI (2006b) approximately 2 km (1.2 mi) west of the Cantonment Area of Fort Drum on the project area for Eagle Ridge Townhomes, a proposed residential housing development. These Indiana bats, including three adult males and one post-lactating female, were all captured within a 6-ha (15-ac) deciduous woodlot surrounded by agricultural hayfields. The bats were tracked daily, and consistently roosted in an area of private property between 0.8 and 1.2 km (0.5 and 0.7 mi) away from the Cantonment Area. Sixteen roosts were documented on the private property. Starting on 18 August 2006, one of the males began roosting within a deciduous woodlot in Fort Drum's Cantonment Area. ESI performed nighttime telemetry on the four Indiana bats, and documented occasional use of the Cantonment Area for foraging activities by at least two of the bats, including the female.

During a mist net survey along the Northern Alternative (NC4) of the Fort Drum Connector, a proposed limited-access highway connecting Interstate 81 with the Cantonment Area gate along US Hwy 11, five reproductive female Indiana bats were captured during June and July 2007 at three sites ranging from 1.0 to 4.4 km (0.6 – 2.6 mi) west of the Cantonment Area (Gress Engineer Inc. and FMSM Engineers Inc 2007). Most of these bats roosted west of Fort Drum; however, one female roosted in three trees within the Cantonment Area (Gress Engineer Inc. and FMSM Engineers Inc 2007).

In summer of 2007, ESI conducted mist net surveys on the Cantonment and Training Areas of the installation as well as sampled at two known artificial bat roosting locations (the bat condo and LeRay Mansion both in the Historic LeRay District) with known bat populations. Eight bat species were captured, including 17 Indiana bats in the Cantonment Area and one in the Training Area. These captures included 10 reproductive adult females, 1 non-reproductive female, 2 adult males, 3 juvenile females and 2 juvenile males. Captured Indiana bats were radio-tagged and tracked to document roosting behavior for nine reproductive (adult female or juvenile) bats. Twenty-four maternity roosts were located (Figure 4) and all possessed high concentrations of deciduous snags. Radio-telemetry results provided evidence that Indiana bats roosted within a relatively small area of Fort Drum, namely along the northern and western periphery of the Cantonment Area, including a small portion of the Training Area along Route 26 (Figure 4). In 2007, all but one roost tree were located in the Cantonment Area. Roost emergence counts ranged from 1 to 44 bats.

In fall of 2007, ESI performed additional mist net and radio-telemetry surveys to identify roost sites, foraging areas, and relationships between Indiana bats on Fort Drum and the Glen Park hibernaculum. Mist netting was conducted for six calendar nights (from 11 September to 1 October 2007) at six mist net sites. During mist netting, 35 bats were captured, including three Indiana bats. Between 12 September and 12 October, all three bats were radio-tagged and subsequently tracked to a combined total of 29 diurnal roost trees of five different tree species. Multi-station foraging telemetry efforts were performed. Foraging data were collected on 26 nights, and home ranges for each bat were calculated for every week of the study. One bat (a juvenile female) was documented traveling to Glen Park hibernaculum at the end of the study period.

In summer of 2008, Copperhead Consulting, Inc. conducted mist net surveys at 41 sites on the Training Area. Two non-reproductive adult Indiana bats (one male and one female) were captured at one site on the western periphery of the Training Area. The bats were tracked to a combined total of eight roosts, including one maternity roost from the 2007 ESI study (Figure 4). Similar to 2007, the Indiana bats roosted within the same general area of Fort Drum, but were concentrated on the border of the Cantonment and Training Areas near Route 26 (Figure 4). Roost emergence counts ranged from one to six bats.

Figure 4. Indiana bat capture sites and roosts on Fort Drum during the 2007 and 2008 studies.

NO MAP PROVIDED

Surveys in 2009 were conducted to further identify the potential distribution of Indiana bats on the installation and to investigate a possible maternity colony suspected to be present in the southeastern portion of the Training Area. Eighty-five sites were surveyed in the Training area, focusing mainly in the southeastern portion. Though nets caught 389 bats of seven species, no Indiana bats were captured.

4.0 Methods

4.1 Mist Net Survey

Efforts to survey for endangered bats are difficult to standardize because of the large amount of variability that exists at an individual survey site or between survey sites in the same project area. However, a number of practices used for summer surveys for Indiana bats have provided structure for implementation of netting guidelines provided by the Indiana Bat Recovery Team in the 2007 Indiana Bat Draft Recovery Plan (First Revision) and Draft Survey Protocol (Table 1). As such, these guidelines were followed for all mist netting on this project.

4.1.1 Site Selection

Eighty-six mist net sites were selected on Fort Drum: 16 within the Cantonment Area and 70 within the Training Area. Of the 16 in the Cantonment Area, Site CA-13 was only netted for half of one night before surveyors ceased netting activities. Captures for this partial net night were included with the results. With the exception of sites CA-25, CA-26, and CA-27, all sites within the Cantonment Area were previously surveyed in 2007. Of the 70 sites within the Training Area, 15 were previously surveyed in 2007 and 2009. All other sites in 2010 were new. Locations of these sampling sites are provided in Table 2 and Figure 5.

Mist net sites were selected based upon expectation of bat activity and an effort to provide coverage of the project area in potentially suitable habitat for Indiana bats. As mentioned above, certain sites (*n*=15) in the Training Area with high capture numbers in 2007 were attempted to be repeated in order to collect data for future trend analyses, especially due to the documented presence of WNS on the Installation. Other specific mist net locations were established based upon the availability of suitable netting conditions in forested habitat. No sites were placed within the 8,000-ha (20,000-ac) Main Impact Area. Limited sampling occurred in areas frequently used for training activities, as these areas were often off-limits due to live ammunition firing or other training exercises. Many of these high-activity locations were concentrated on the periphery of the Main Impact Area.

Table 1. USFWS mist netting guidelines, 2007.

NETTING GUIDELINES

1. Netting Season: 15 May to 15 August, when Indiana bats occupy summer habitat
2. Equipment (Mist Nets): constructed of the finest, lowest visibility mesh commercially available – monofilament or black nylon – with the mesh size approximately 38 mm (1.5 in)
3. Net Placement: mist nets extend approximately from water or ground level to tree canopy and are bounded by foliage on the sides. Net width and height are adjusted for the fullest coverage of the flight corridor at each site. A "typical" net set consists of three (or more) nets "stacked" on top of one another; width may vary up to 18 m (60 ft)
4. Net Site Spacing:
    - ♦ Streams – one net site per 1 km (0.6 mi)
    - ♦ Land Tracts – two net sites per 1 km^2 (247 ac)
5. Minimum Level of Effort Per Net Site:
    - ♦ Two net locations (sets) per net site, with locations (sets) at least 30 m apart
    - ♦ Two (calendar) nights of netting
    - ♦ At least four net–nights (1 net–night = 1 net set deployed for 1 night); typically, two net sets are deployed at one site for two nights, resulting in four net nights
    - ♦ Sample Period: begin at dusk and net for 5 h(approximately 0200h)
    - ♦ Nets are monitored at approximately 20-minute intervals
    - ♦ No disturbance near the nets between checks
6. Weather Conditions: net only if the following weather conditions are met:
    - ♦ No precipitation
    - ♦ Temperature $\geq$ 10° C (50° F)
    - ♦ No strong winds

Source: U.S. Fish and Wildlife Service, 2007

Table 2. Bat sampling locations on Fort Drum in summer of 2010 (UTM; NAD 83).

Site Name	Easting	Northing	Site Name	Easting	Northing
CA-01 (CR)			TA-09A-11		
CA-04 (CR)			TA-09B (TR)		
CA-05 (CR)			TA-09B-04		
CA-09 (CR)			TA-09C-01		
CA-10 (CR)			TA-09C-02		
CA-12 (CR)			TA-10B (TR)		
CA-13 (CR)			TA-10B-02		
CA-14 (CR)			TA-10C-01		
CA-15 (CR)			TA-11A		
CA-16 (CR)			TA-11B-03		
CA-20 (CR)			TA-11B-04		
CA-21 (CR)			TA-12B		
CA-22 (CR)			TA-12C-01		
CA-25			TA-13A-03		
CA-26			TA-13A-04		
CA-27			TA-13A-05		
TA-03A (TR)			TA-13B-01		
TA-03D			TA-13B-02		
TA-04A-03			TA-14A-01 (TR)		
TA-04B-02			TA-14B-01 (TR)		
TA-04B-03			TA-14B-08		
TA-04D (TR)			TA-14C-02		
TA-04E			TA-14C-03		
TA-05D (TR)			TA-14D-02 (TR)		
TA-06A-02 (TR)			TA-14F-01		
TA-07C-03			TA-14F-02		
TA-07C-04			TA-14G-03		
TA-07E-01 (TR)			TA-14G-04		
TA-08A (TR)			TA-14G-05		
TA-08A-04			TA-15B-02		
TA-08B-06			TA-15D-01		
TA-08B-07			TA-15E-01 (TR)		
TA-08B-08			TA-16A-01 (TR)		
TA-08B-09			TA-16C-01		
TA-08C-07			TA-16C-02		
TA-08C-08			TA-17A-02		
TA-08C-09			TA-19A-01		
TA-08C-10			TA-19A-02		
TA-08C-11			TA-19A-03		
TA-08C-12			TA-19A-04		
TA-08C-13			TA-19D-03 (TR)		
TA-08C-14			TA-19D-04 (TR)		
TA-09A-10			TA-19D-05		

(CR) Cantonment Area Repeat Site – netted in 2007
(TR) Training Area Repeat Site – netted in 2007 and 2009.

Figure 5. Bat sampling locations on Fort Drum in summer 2010.

NO MAP PROVIDED

Site nomenclature of the Cantonment Area was based on previous sites from 2007. The three new sites were named based on sequential numbering. Site nomenclature for the Training Area was determined first by the sub-training area number/letter designation (e.g., 09A) followed by sequential numbering in the order sampled. To avoid duplicating designations used in the 2007 and 2009 sampling events, 2010 numbering began with the next highest number on sub-training sites where previous sampling had been conducted. For example, on sub-training area 09A, mist netting in 2007 and 2009 was conducted at sites 09A-01through 09A-09; therefore, the 2010 sampling nomenclature began with 09A-10, followed by 09A-11.

All bat sampling was conducted between 15 June and 14 August 2010. Minimum survey efforts at each mist net site consisted of two net sets monitored for two complete 5-hour nights, for a total of four complete net nights per site. More than two nets were sometimes used at different sites in order to sample various habitat or landscape features within sites. Data from all nets were summarized in the results.

Mist net site selection was also based on past experience of ESI and Fort Drum personnel as well as new habitat information in current scientific literature. Habitat with the following characteristics was selected to the degree feasible:

- Large trees (>40 cm dbh) frequently used for maternity roosts;
- An open canopy, apparently important for warming roost sites; and
- An open, uncluttered understory, used for traveling and foraging.

Exact net placement at each site was based upon canopy cover, presence of a flight corridor, water, and habitat conditions near the site. Nets were set to maximize coverage of flight paths along suitable corridors. Riparian corridors often provide successful mist net sites; however, few such suitable corridors existed on Fort Drum. Due to topographic features, many streams are low in slope and/or often associated with open wetlands, rather than defined corridors. Therefore, upland corridors (e.g., gravel roads, dirt trails, recreational paths, or logging roads) provided more suitable sampling sites on the installation. On terrestrial corridors, road ruts and other areas of standing water were used whenever possible to facilitate bat capture, as all bats are known to use such water sources for drinking. Figure 5 provides locations of mist net sites, and Appendix A contains site descriptions.

4.1.2 Bat Capture

The netting setup allows bats to be caught live and released unharmed near the point of capture. Bats were identified to species using a combination of morphological characteristics (e.g., ear and tragus, calcar, pelage, size/weight, length of right forearm, and overall appearance of the animal). The species, sex, reproductive condition, age, weight, length of right forearm, and time and location of capture were recorded for all bats captured while mist netting.

Age (adult or juvenile) of bats was determined by examining ephiphyseal-diaphyseal fusion (calcification) of long bones in the wing. Weight was measured to the nearest 0.5 g using Pesola spring scales. Length of right forearm was measured to the nearest 0.1 mm (using calipers) or 1.0 mm (using metric rulers). The reproductive condition of captured bats was classified as non-descended male, descended male, non-reproductive female, pregnant female (based on gentle abdominal palpation), lactating female, or post-lactating female.

Bats were banded based on NYSDEC permit requirements or desires of Fort Drum. Bands were placed on the right forearms of males and left forearms of females. Bats recaptured from previous sites or dates in 2010 were recorded on data sheets; however, these recaptures were not included in the total bat capture numbers for the year. Band numbers for 2010 are provided for each species in Appendix B.

Processing and data collection were usually completed within 30 minutes of the time each bat was removed from the net. Morphometric data recorded in the field are provided on Bat Capture Data sheets in Appendix C and net site photos are in Appendix D.

4.1.3 Data Analyses

Bat capture data from mist netting were analyzed using chi-square tests and diversity indices. Chi-square analysis, where $\chi^2 = \sum [(O - E)^2 / E]$, where O is the observed frequency and E is the expected frequency was used to test for statistically significant differences between the catch of sexes and species. For comparison of sexes, the null hypothesis was that there are equal numbers of males and females in the bat population, so the expected value is one-half of the total capture of adult bats.

The species diversity index of MacArthur (1972), similar to the reciprocal of the Simpson (1949) index was used, where Diversity = $l/\sum Pi^2$, where Pi is the proportion of bats belonging to species i. The value of this index starts with 1 as the lowest possible figure, which would represent a community containing only one species. The higher the value, the greater the diversity. The maximum value is the number of species in the sample (species richness).

Species Equitability Index or Simpson's Evenness Index, where Evenness = $(l/\sum Pi^2)/D_{max}$ (i.e., MacArthur Index/Species richness), gives a measure of the relative abundance of the different species making up the richness of an area. Maximum diversity for any level of richness is achieved when there is an equal distribution of individuals among species, so this value can range from 0 percent to 100 percent.

4.1.4 Habitat Assessment

Concurrent with netting, a habitat assessment was completed for each site location. The emphasis of this assessment is habitat form: size and relative abundance of large trees and snags that potentially serve as roost trees, canopy closure, understory clutter/openness, water availability, and flight corridors. Habitat form is emphasized because the Indiana bat roosts in many different species of trees. Tree species composition is included in the assessment.

ESI's habitat characterization does more than emphasize species of large trees near the net. It identifies components of the canopy and subcanopy layers. All trees that reach into the canopy are canopy trees, regardless of their diameter/size. As defined in the Indiana Bat Habitat Suitability Index Model, dominant trees are the large trees in the canopy (>40 cm dbh) that have the greatest likelihood of being used by maternity colonies of Indiana bats. Many smaller trees are often also found in the canopy, and in some situations, the canopy can be entirely composed of smaller-diameter trees. ESI's habitat characterization identifies dominant and subdominant elements of the canopy.

The subcanopy, or understory, vegetation layer is well defined in classical ecological literature. It is that portion of the forest structure between the ground vegetation (to approximately 0.6 m (1.9 ft) and the canopy layers, usually beginning at about 7.6 m (24.93 ft). Vegetation in the understory may come from lower branches of overstory trees, small trees that will grow into the overstory, and small tress and shrubs that are confined to the understory. The amount of understory, or clutter, is also recorded, as many bat species, including the Indiana bat, tend to avoid areas of high clutter.

Roost potential is characterized by three categories: high, moderate, and low. The determination of roost potential is based on the individual bat biologist at each site. Certain criteria are evaluated to help in the determination. ESI uses a combination of tree species composition, presence/absence and/or abundance of snags in the immediate area, canopy closure (i.e. solar exposure), and degree of clutter.

Each net site was documented with a sketch on the Net Site Habitat Description data sheet (Appendix A).

4.1.5 White-nose Syndrome Monitoring

In response to the current WNS issue, ESI biologists followed the Disinfection Protocol for Bat Field Research/Monitoring, finalized by USFWS in June 2009. ESI biologists also categorized wing damage using the "Wing-damage Index Used for Characterizing Wing Condition of Bats Affected by White-nose Syndrome" and recorded Wing Damage Indices (WDI) for all bats (whenever feasible) (Reichard 2008). WDI scores were recorded on Bat Capture Data sheets (Appendix C) and photos of bat wings are provided in Appendix E. The index was developed based on the conditions seen in a maternity colony of little brown bats where WNS infection rates were high. Few efforts have been made to examine the index's viability for use on such a large scale.

WDI was based on the following criteria:

- 0 - No damage. Fewer than 5 small scar spots are present on the membranes.
- 1 - Light damage. Less than 50% of flight membrane is depigmented (splotching), which is often visible only with translumination.
- 2 - Moderate damage. Greater than 50% of wing membrane covered with scar tissue (splotching). Scarring is visible without translumination. Membrane exhibits some necrotic tissue and possibly few small holes (<0.5 cm diameter). Forearm skin may be flaking and discolored along the majority of the forearm.
- 3 - Heavy damage. Deteriorated wing membrane and necrotic tissue. Isolated holes >0.5 cm are present in membranes. Necrotic or receding plagiopatagium and/or chiropatagium are evident.

4.1.6 Weather and Temperature

Weather conditions were monitored each night of survey to ensure compliance with USFWS guidelines. Conditions recorded included: temperature, wind speed and direction, percent cloud cover, and moon phase (if visible). A digital thermometer was used to record temperature, wind speed was determined by use of the Beaufort wind scale, and cloud cover was estimated visually. Weather data are provided in Appendix C.

4.2 Radio-telemetry Survey

4.2.1 Transmitter Attachment

After collecting morphometric data, certain captured Indiana bats, northern bats, and little brown bats were fitted with 0.35-g radio-transmitters (Blackburn Transmitters®; Nacogdoches, Texas). Bats were selectively radio-tagged based on criteria established by Fort Drum. The primary goal of the project was to document maternity colonies of these three myotids on the installation; therefore, only adult females were tracked until August. Because transmitters remained after 1 August, adult males and juvenile males and females were also tracked. A maximum of two individuals were tagged per night per site to ration the supply of transmitters. In addition, transmitters were not placed on bats that weighed less than 6.0 g (to avoid substantial weight burden by the 0.35-g transmitter).

Each transmitter had a unique frequency that allows bats to be tracked individually and independently of one another. Transmitters were activated and tested before attachment to bats. Fur was trimmed from a small interscapular area, and the transmitter was attached with either non-toxic TORBOT liquid bonding cement (Torbot Group, Inc., Cranston, Rhode Island) or non-toxic Skin-Bond surgical glue (Smith & Nephew, London, United Kingdom). This latex adhesive degrades over time and the transmitter eventually falls off the bat. Bats were released unharmed at the points of capture. Photographs of Indiana bats are in Appendix F.

4.2.2 Diurnal Roost Locations

Subsequent to radio-transmitter attachment, biologists tracked the Indiana, northern, and little brown bats during daylight hours in an attempt to locate diurnal roosts. Tracking was completed on foot and in vehicles and included use of the following radio receivers: Wildlife Materials, Inc. ® (Murphysboro, Illinois) TRX-2000S PLL Synthesized Tracking Receiver, Advanced Telemetry Systems®, Inc. (Isanti, Minnesota) Model R2000 Scanning Receiver, Titley Electronics® (Ballina, Australia) Australis 26k Scanning Receiver, and Communication Specialist, Inc. R-1000 Telemetry Receiver. These receivers were connected to either hand-held three-element or five-element yagi directional antennas (Wildlife Materials or Titley Electronics) or multi-directional omni antennae (Wildlife Materials). The omni-directional whip antennas, designed to receive nearby signals in any direction, were used to scan for bats while traveling in vehicles. Three-element yagi directional antennas were used to locate the general direction of signals heard using the whip antennas, to periodically scan in all directions at fixed positions, and to pinpoint individual roost trees while searching on foot.

On 12 August, aerial telemetry was used in an attempt to locate transmittered bats, since ground telemetry failed to detect transmitter signals for several individuals. Aerial telemetry was also used to verify locations of bats tracked successfully on the ground. Aerial telemetry was performed by attaching two 4-element yagis to the wing struts of a chartered Cessna airplane. Inside the cockpit, the biologist could selectively listen to telemetry signals from both antennas or each one individually (to determine the approximate direction of signal). The aerial telemetry flyover covered an extensive area ranging west from the Glen Park hibernaculum, north to Elm Lane in the Training Area, south to the village of Black River, and east to the Wheeler-Sack Airport. This included the entire Cantonment Area. At the time of the survey, northern and eastern portions of the Training Area were off limits to non-military aircraft.

Biologists tracked both Indiana bats and one northern bat to at least three roosts. The only roost located for little brown bats was a human-made bat box. Once a roost tree was located, data were collected on the specific tree, as well as surrounding habitat, and recorded on Roost Tree Data sheets (Appendix G). Roost data focused primarily on characteristics of the particular tree, including: roost tree species, tree size (dbh), height of roosting site on the tree, percent of exfoliating bark, presence of roosting features, other indications of current bat use (guano, vocalizations), etc. General habitat characteristics near each roost were also evaluated, including:

species composition, canopy closure, slope, distance to water, and distance to flight corridors. Each roost location was documented with a sketch (Appendix G), photographs (Appendix H), and GPS coordinates.

Roost nomenclature was based primarily on designations of radio-tagged bats using the trees, and secondly by chronological order. Bat and roost names were based on transmitter frequencies. As an example, the bat with the transmitter frequency 150.517 occupied several trees. The first roost located was named 517R1, the second roost was 517R2, and so on.

4.2.3 Diurnal Roost Emergence Counts

Emergence counts were completed visually while sitting near or under a roost in order to determine the number of bats emerging from each roost tree. These counts give a preliminary assessment of the relative value of certain trees to serve as maternity roosts. Those trees containing more individuals are likely to be more important for the local population of bats.

Emphasis was placed on obtaining emergence data on days that radio-tagged bats occupied individual trees, since the bats roost colonially and often move among different trees on daily bases. At least one emergence count was performed for each roost tree. Counts were not completed during inclement weather, according to the same guidelines used for mist netting (Table 1).

Emergence counts were completed by silhouetting the tree against the sky and recording the time and number of bats exiting the roost (if applicable). Bats were tallied only if emerging from the roost, not merely flying in the vicinity. Beginning at sunset, counts lasted approximately 1 to 1.5 hours until bats finished emerging and/or darkness precluded accurate counting. Direction of bat emergence (as feasible) and other specific comments were also noted on the Roost Tree Emergence Data sheets (Appendix G).

5.0 Results

5.1 Mist Netting Survey

5.1.1 Bat Capture

Six hundred fifty-two bats representing nine species were captured over 356 complete and 46 partial net nights: 492 big brown bats (*Eptesicus fuscus*), 87 eastern red bats (*Lasiurus borealis),* 52 little brown bats (*Myotis lucifugus*), 6 hoary bats (*Lasiurus cinereus*), 5 northern bats (*Myotis septentrionalis*), 5 silver-haired bats (*Lasionycteris noctivigans*), 2 eastern small-footed bats (*Myotis leibii*), 2 Indiana bats (*Myotis sodalis*), and 1 eastern pipistrelle (*Perimyotis subflavus)* (Table 3). Representative photographs of all captured bat species are provided in Appendix I.

Big brown bats accounted for 76 percent of the total bat captures. Big brown, eastern red, and little brown bats accounted for over 96 percent of the total captures (Figure 6). The average capture rate was 7.58 bats per site. Among individuals recaptured, two big brown bats and one eastern red bat were recaptured at sites other than those where they were originally banded.

Table 3. Total bat captures on Fort Drum in summer 2010.

	Adult	Adult Female[1]						Juvenile			
Species	Male	All	PG	L	PL	NR	UNK	Male	Female	Unknown[2]	Total
Big brown bat[3]	155	195	2	42	118	33	1	49	64	28	492
Eastern red bat[3]	23	25	0	5	15	6	0	11	13	14	87
Little brown bat	21	10	0	0	5	5	0	9	12	0	52
Hoary bat	2	3	0	1	2	0	0	1	0	0	6
Silver-haired bat	1	2	0	0	2	0	0	2	0	0	5
Northern bat	0	2	0	0	1	1	0	1	2	0	5
Eastern small-footed bat	1	0	0	0	0	0	0	1	0	0	2
Indiana bat	1	0	0	0	0	0	0	0	1	0	2
Eastern pipistrelle	0	1	0	0	1	0	0	0	0	0	1
Total	204	240	2	48	144	45	1	74	92	42	652

[1] PG = pregnant; L = lactating; PL = post-lactating; NR = non-reproductive; M = male; F = female
[2] Unknown = escaped from net or hand before processing was complete. One big brown bat was an adult and two were males. One eastern red bat was an adult.
[3] Bats recaptured in 2010 are included once

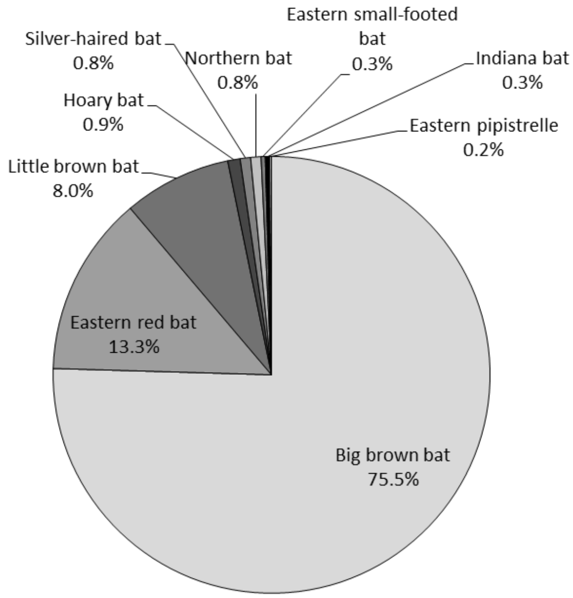


Figure 6. Percent bat captures by species on Fort Drum in summer 2010.

5.1.2 Species Distributions

Nine species of bats were captured on Fort Drum in the summer of 2010. Big brown bats were the most widely distributed bat species; documented at 69 percent (*n*=59) of the 86 net sites (Table 4). This was followed by eastern red and little brown bats at 43 and 21 percent, respectively. The least commonly captured species included hoary bats at 7 percent, northern bats at 5 percent, silver-haired bats at 4 percent, eastern small-footed bats at 2 percent, Indiana bats at 2 percent, and eastern pipistrelle at 1 percent of the sites. Figures 7 through 15 show the distribution of captured species throughout Fort Drum.

Table 4. Species of bat captured by number of sites on Fort Drum in summer 2010.

Species	# of Sites Where Captured
Big brown bat	59
Eastern red bat	37
Little brown bat	18
Hoary bat	6
Northern bat	4
Silver-haired bat	3
Eastern small-footed bat	2
Indiana bat	2
Eastern pipistrelle	1

Figure 7. Indiana bat capture sites and roosts on Fort Drum in summer 2010.
Figure 8. Northern bat capture sites and roosts on Fort Drum in summer 2010.
Figure 9. Little brown bat capture sites and roost on Fort Drum in summer 2010.
Figure 10. Eastern small-footed bat capture sites on Fort Drum in summer 2010.
Figure 11. Big brown bat capture sites on Fort Drum in summer 2010.
Figure 12. Eastern red bat capture sites on Fort Drum in summer 2010.
Figure 13. Hoary bat capture sites on Fort Drum in summer 2010.
Figure 14. Silver-haired bat capture sites on Fort Drum in summer 2010.
Figure 15. Eastern pipistrelle capture site on Fort Drum in summer 2010.

NO MAPS PROVIDED

5.1.3 Data Analyses

5.1.3.1 Occurrence by Sex and Age

Adult bats comprised 73 percent of captures (Table 3). Females comprised 54 percent (*n*=332) of bat captures and males 46 percent (*n*=280). Forty-two bats escaped before determination of sex, age, and morphometric data could be collected (Table 3). Of the 42 escaped bats, partial data was collected for five. Two escaped big brown bats were male, 1 big brown bat and 1 eastern red bat were adults (see footnote in Table 3).

As a whole, there were no significant differences between adult female bats captured and adult males (χ^2 = 2.77; P = 0.0963). Female big brown bats were significantly more abundant than males (χ^2 = 4.79; P= 0.0286). No difference between the number of adult males and females was found among eastern red bats (χ^2 = 0.18; P = 0.6682). Male little brown bats were significantly more abundant than females (χ^2 = 3.90; P = 0.0482). Comparisons between male and female captures could not be made for hoary bats, silver-haired bats, northern bats, eastern small-footed bats, Indiana bats, and eastern pipistrelles due to small sample sizes.

During the first four survey weeks, only adult bats were captured (Figure 16). Juveniles were first captured the week of 12 July. The proportion of juveniles captured peaked the following survey week (week of 19 July) at 52 percent, then slowly declined to 24 percent by early August, and increased slightly to 28 percent by survey's end. Percentage of adults captured never fell below 48 percent for the entire survey.

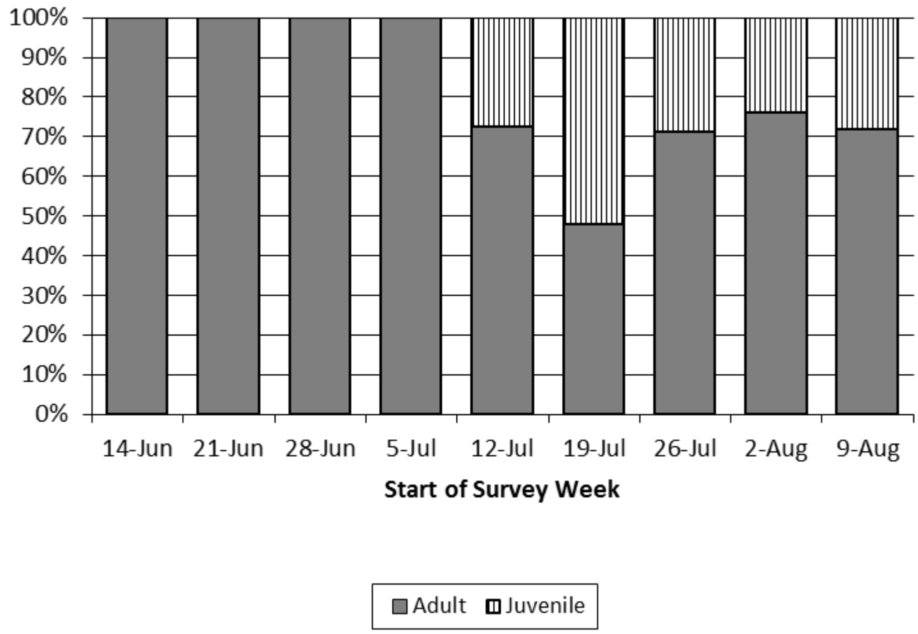


Figure 16. Proportion of adult and juvenile bats captured each survey week on Fort Drum in summer 2010.

5.1.3.2 Occurrence by Reproductive Status

Female bats captured during 7 survey weeks were analyzed according to reproductive phenology (Figure 17). Approximately 59 percent of adult females (n=194) were reproductively active. During the first 3 survey weeks, lactating bats formed the majority (83%; n=38) of the females captured. Due to timing of survey initiation, pregnant bats never comprised the majority of captures and were last captured on 24 June. By July, post-lactating females comprised most of the captures of adult females, gradually decreasing in proportion as the season progressed and non-reproductive females became more prevalent.

Reproductive (scrotal) males were more common throughout the survey season than non-reproductive males (Figure 18). The first reproductive male was captured on 17 June. Reproductive males comprised 50 to 79 percent of adult males captured in the first 3 weeks and increased to 83 to 100 percent the remainder of the survey period.

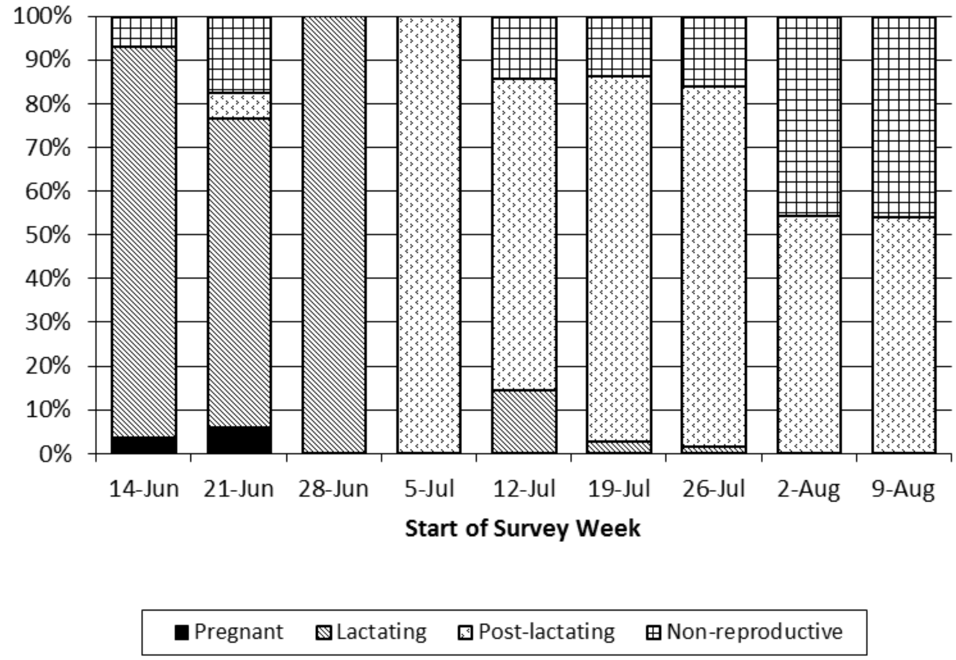


Figure 17. Reproductive proportion of adult females captured weekly on Fort Drum in summer 2010.

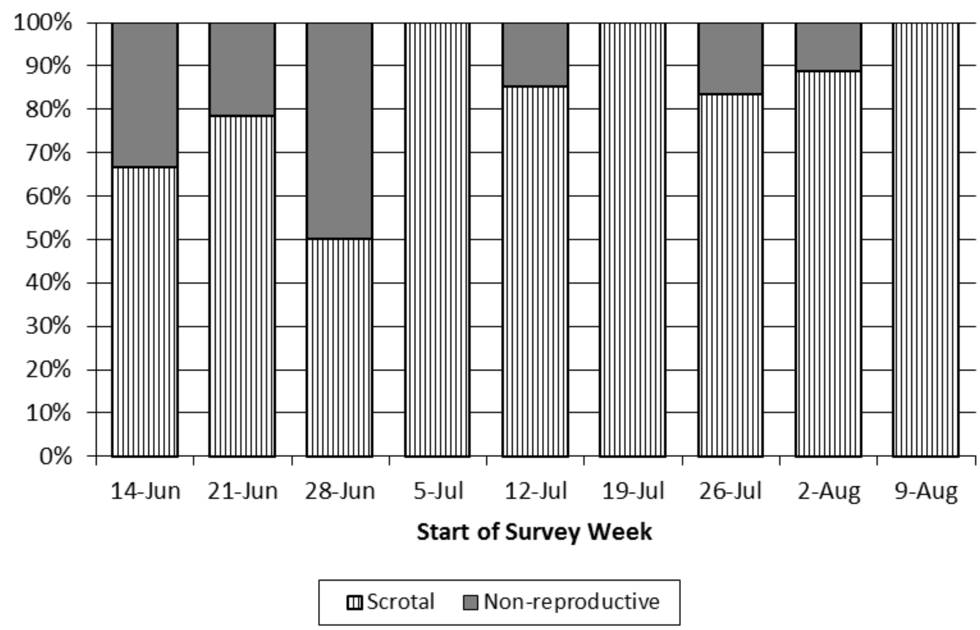


Figure 18. Reproductive proportion of adult males captured weekly on Fort Drum in summer 2010.

5.1.3.3 Species Diversity

Nine species of bats were captured on Fort Drum in summer 2010 (Table 3). The number of individuals captured was not evenly distributed across species (χ^2 = 2832.49; *P* <0.0001). The MacArthur Diversity Index was 1.7 and species equitability (E_D) was 0.1871, implying that approximately 18.71 percent of species were equally represented. Mean species richness per site was 1.5 (SD=1.1) and mean number of bats captured per site was 7.58 (SD=9.7). Site TA-14D-02 had the most bat captures (*n*=48), followed by TA-09B, TA-14C-02, and TA-04D with 35, 34, and 33 bats, respectively. No bats were captured at 16 sites. Nine sites had only one bat capture per site. Table 5 and Figure 19 display total bat capture numbers by site. Site CA-05 had the highest species richness (*n*=5), while 27 sites captured only one species.

Table 5. Bat captures and species richness by site on Fort Drum in summer 2010.

Site Name	Big brown bat	Eastern red bat	Little brown bat	Hoary bat	Silver-haired bat	Northern bat	Eastern small-footed bat	Indiana bat	Eastern pipistrelle	Total Capture	Species Richness
CA-01 (CR)	5	6	-	-	-	-	-	-	-	11	2
CA-04 (CR)	-	-	-	-	-	-	-	-	-	0	0
CA-05 (CR)	3	3	1	-	1	-	-	1	-	9	5
CA-09 (CR)	1	6	-	-	-	1	-	-	-	8	3
CA-10 (CR)	-	2	-	-	-	-	-	-	-	2	1
CA-12 (CR)	21	1	8	1	-	-	-	-	-	31	4
CA-13 (CR)	-	-	-	-	-	-	-	-	1	1	1
CA-14 (CR)	11	2	2	-	-	-	-	-	-	15	3
CA-15 (CR)	14	-	1	-	-	-	-	-	-	15	2
CA-16 (CR)	10	8	-	-	-	-	-	-	-	18	2
CA-20 (CR)	-	-	-	-	-	1	-	-	-	1	1
CA-21 (CR)	-	1	-	-	-	-	-	-	-	1	1
CA-22 (CR)	-	3	-	-	-	-	-	-	-	3	1
CA-25	-	-	-	-	-	-	-	-	-	0	0
CA-26	-	-	-	-	-	-	-	-	-	0	0
CA-27	1	-	-	-	-	-	-	-	-	1	1
TA-03A (TR)	1	1	-	-	-	-	-	-	-	2	2
TA-03D	14	-	1	-	-	-	-	-	-	15	2
TA-04A-03	6	2	-	-	-	1	-	-	-	9	3
TA-04B-02	9	1	-	-	-	-	-	-	-	10	2
TA-04B-03	6	-	-	-	-	-	-	-	-	6	1
TA-04D (TR)	30	-	1	-	-	2			-	33	3
TA-04E	11	-	-	-	-	-	-	-	-	11	1
TA-05D (TR)	9	1	-	-	-	-	-	-	-	10	2
TA-06A-02 (TR)	2	2	-	-	-	-	-	-	-	4	2
TA-07C-03	4	1	-	-	-	-	-	-	-	5	2
TA-07C-04	14	-	-	-	-	-	-	-	-	14	1
TA-07E-01 (TR)	-	-	-	-	-	-	-	-	-	0	0
TA-08A (TR)	11	1	-	-	-	-	-	-	-	12	2
TA-08A-04	4	-	-	-	-	-	-	-	-	4	1

Site Name	Big brown bat	Eastern red bat	Little brown bat	Hoary bat	Silver-haired bat	Northern bat	Eastern small-footed bat	Indiana bat	Eastern pipistrelle	Total Capture	Species Richness
TA-08B-06	3	-	-	1	-	-	-	-	-	4	2
TA-08B-07	4	-	-	-	-	-	-	-	-	4	1
TA-08B-08	1	-	-	-	-	-	-	-	-	1	1
TA-08B-09	14	4	-	-	-	-	-	1	-	19	3
TA-08C-07	6	-	-	-	-	-	-	-	-	6	1
TA-08C-08	4	1	-	-	-	-	-	-	-	5	2
TA-08C-09	2	1	-	-	-	-	-	-	-	3	2
TA-08C-10	20	-	1	-	-	-	-	-	-	21	2
TA-08C-11	4	2	1	-	-	-	-	-	-	7	3
TA-08C-12	9	1	-	-	-	-	-	-	-	10	2
TA-08C-13	8	-	-	-	-	-	-	-	-	8	1
TA-08C-14	-	-	-	-	-	-	-	-	-	0	0
TA-09A-10	2	-	-	-	-	-	-	-	-	2	1
TA-09A-11	-	-	-	-	-	-	-	-	-	0	0
TA-09B (TR)	28	5	1	1	-	-	-	-	-	35	4
TA-09B-04	9	1	1	1	-	-	-	-	-	12	4
TA-09C-01	1	1	-	-	-	-	-	-	-	2	2
TA-09C-02	5	-	-	1	-	-	-	-	-	6	2
TA-10B (TR)	2	-	-	-	-	-	-	-	-	2	1
TA-10B-02	-	-	-	-	-	-	-	-	-	0	0
TA-10C-01	19	2	-	-	-	-	-	-	-	21	2
TA-11A	17	1	-	-	-	-	-	-	-	18	2
TA-11B-03	3	-	-	-	-	-	-	-	-	3	1
TA-11B-04	-	-	-	-	-	-	-	-	-	0	0
TA-12B	-	-	1	-	-	-	-	-	-	1	1
TA-12C-01	4	-	-	-	-	-	-	-	-	4	1
TA-13A-03	1	-	-	-	-	-	-	-	-	1	1
TA-13A-04	-	-	-	-	-	-	-	-	-	0	0
TA-13A-05	-	-	-	-	-	-	-	-	-	0	0
TA-13B-01	-	-	-	-	-	-	-	-	-	0	0
TA-13B-02	9	-	1	-	-	-	-	-	-	10	2

Site Name	Big brown bat	Eastern red bat	Little brown bat	Hoary bat	Silver-haired bat	Northern bat	Eastern small-footed bat	Indiana bat	Eastern pipistrelle	Total Capture	Species Richness
TA-14A-01 (TR)	2	2	1	-	-	-	-	-	-	5	3
TA-14B-01 (TR)	3	-	-	-	-	-	-	-	-	3	1
TA-14B-08	1	-	-	-	1	-	-	-	-	2	2
TA-14C-02	27	4	-	-	3	-	-	-	-	34	3
TA-14C-03	1	-	-	-	-	-	-	-	-	1	1
TA-14D-02 (TR)	35	10	2	1	-	-	-	-	-	48	4
TA-14F-01	-	-	-	-	-	-	-	-	-	0	0
TA-14F-02	-	-	-	-	-	-	-	-	-	0	0
TA-14G-03	5	-	-	-	-	-	-	-	-	5	1
TA-14G-04	-	-	-	-	-	-	-	-	-	0	0
TA-14G-05	-	-	-	-	-	-	-	-	-	0	0
TA-15B-02	-	1	-	-	-	-	-	-	-	1	1
TA-15D-01	-	2	-	-	-	-	-	-	-	2	1
TA-15E-01 (TR)	1	1	-	-	-	-	-	-	-	2	2
TA-16A-01 (TR)	-	1	1	-	-	-	-	-	-	2	2
TA-16C-01	-	2	-	-	-	-	1	-	-	3	2
TA-16C-02	-	2	-	-	-	-	-	-	-	2	1
TA-17A-02	1	-	-	-	-	-	1	-	-	2	2
TA-19A-01	26	-	1	-	-	-	-	-	-	27	2
TA-19A-02	11	-	1	-	-	-	-	-	-	12	2
TA-19A-03	4	-	-	-	-	-	-	-	-	4	1
TA-19A-04	-	-	-	-	-	-	-	-	-	0	0
TA-19D-03 (TR)	6	1	-	-	-	-	-	-	-	7	2
TA-19D-04 (TR)	1	-	26	-	-	-	-	-	-	27	2
TA-19D-05	6	1	-	-	-	-	-	-	-	7	2

(CR) Cantonment Area Repeat Site – netted in 2007
(TR) Training Area Repeat Site – netted in 2007 and 2009.

Figure 19. Bat captures by site on Fort Drum in summer 2010.

NO MAP PROVIDED

5.1.4 White-nose Syndrome Wing Damage Index Scores

WDI scores were recorded for 598 bats (Tables 6 and 7). Seventy-two percent (*n*=432) of bats across the project received a score of 0 (no wing damage), 25 percent (*n*=150) received a score of 1 (minor wing damage), and 3 percent of bats (*n*=16) scored a 2 (moderate wing damage). No bat received a score of 3 (severe wing damage). Though proportions varied slightly month to month (e.g., 38 percent of scored bats received a score of 1 in June, 19 percent in July, and 35 percent in August), variances are likely due to differences in sample size rather than changing proportions of wing damage in the bat community (Table 7).

Four species had WDI scores greater than 0: big brown, eastern red, little brown, and hoary bats. Three percent (*n*=4) of adult male and four percent (*n*=8) of adult female big brown bats received WDI of 2 (Table 8). The only other bats to receive a WDI of 2 were an adult male little brown bat, an adult female little brown bat, and an adult female hoary bat. Of the juvenile bats captured, one big brown bat received a WDI greater than 1 (Table 8).

Table 6. Wing Damage Index scores for bats captured on Fort Drum in summer 2010.

	Wing Damage Index Score				
Species	0	1	2	3	Total
Big brown bat	310	134	13	-	457
Eastern red bat	63	7	-	-	70
Little brown bat	41	8	2	-	51
Hoary bat	4	1	1	-	6
Northern bat	5	-	-	-	5
Silver-haired bat	4	-	-	-	4
Eastern small-footed bat	2	-	-	-	2
Indiana bat	2	-	-	-	2
Eastern pipistrelle	1	-	-	-	1
Total	432	150	16	0	598

Table 7. Monthly Wing Damage Index scores for bats captured on Fort Drum in summer 2010.

		Proportion of Wing Damage Index Scores % (*n*)				
Month	Number of Days Surveyed	0	1	2	3	Total
June	12	60 (50)	38 (32)	2 (2)	0 (0)	100 (84)
July	20	79 (295)	19 (69)	2 (8)	0 (0)	100 (372)
August	13	61 (87)	35 (49)	4 (6)	0 (0)	100 (142)
Total	45	72 (432)	25 (150)	3 (16)	0 (0)	100 (598)

Table 8. Wing Damage Index scores by sex and age for all bats on Fort Drum in summer 2010.

		WDI 1		WDI 2	
Species	Sex	Adult	Juvenile	Adult	Juvenile
Big brown bat	Male	48	9	4	0
	Female	69	7	8	1
Eastern red bat	Male	4	0	0	0
	Female	3	0	0	0
Little brown bat	Male	6	0	1	0
	Female	1	1	1	0
Hoary bat	Male	0	0	0	0
	Female	1	0	1	0

5.1.5 Habitat Assessment

Habitats at mist net locations at Fort Drum were predominantly mature and young upland forest, mature and young lowland forest, and woodlot/forest edges. Other habitat types included old fields, recently logged forest, deepwater lake/pond, emergent wetland, pine plantation and stream/river (riparian), scrub/shrub, forested swamps, vernal pools, and sand/waste habitats (Appendix A). Using the Indiana Bat Habitat Suitability Index Model (Rommé et al. 1995), biologists categorized habitat components, while at each site, by assessing the surrounding conditions. The variety, character, and prevalence of these habitat types make the area suitable for many woodland bats of the region.

Young and mature upland forest comprised the majority of net site habitat at 22 (*n*=19) and 40 (*n*=34) percent, respectively. Thirty-four percent (*n*=29) of sites were characterized as having low roost potential for the Indiana bat, 50 percent (*n*=43) had moderate roost potential, and 16 percent (*n*=14) had high roost potential (Table 9). Fifty-one percent (*n*=44) of the sites had both large trees and snags that could serve as potential roosts. The remaining roost composition was characterized as snags (30%), large trees (12%), or neither trees nor snags (7%). Canopy closure was primarily described as moderate (63%). The most common dominant canopy species were sugar maple (*Acer saccharum*), white pine (*Pinus strobus*), and red maple (*Acer rubrum*). The most common subdominant canopy species were sugar maple, birches (*Betula* spp.), white pine, and poplars (*Populus* spp.) (Table 10). Sixty-seven percent (*n*=58) of subcanopy clutter was characterized as moderate with 21 percent (n=18) described as closed. Branches and saplings accounted for 35 percent (*n*=30) of subcanopy clutter followed by saplings (22%, *n*=19). Subcanopy species observed most frequently were sugar maple, American elm (*Ulmus americana*), birches, poplars, American basswood (*Tilia americana*), and red maple (Table 10). The majority of herbaceous cover at net sites was characterized as moderate (56%, *n*=48). Thirty percent of the remainder was described as dense (*n*=26) and 13 percent (*n*=11) ranked as sparse (Table 9). Tree and shrub composition are provided in Table 10 and representative photographs of net sites are provided in Appendix D.

Table 9. Habitat components at net sites on Fort Drum in summer 2010.

Site Name	Roost Tree Potential		Canopy Closure	Subcanopy Clutter		Herb Cover
	Rank	Composition		Rank	Composition	
CA-01 (CR)	L	Snags	M	C	Branches & Saplings	D
CA-04 (CR)	M	Lrg trees & snags	M	M	Shrubs & Saplings	M
CA-05 (CR)	L	Snags	C	M	Branches Shrubs & Saplings	M
CA-09 (CR)	M	Lrg trees & snags	C	C	Branches & Saplings	M
CA-10 (CR)	L	Snags	C	M	Branches & Saplings	D
CA-12 (CR)	H	Snags	M	M	Shrubs & Saplings	S
CA-13 (CR)	M	Lrg trees & snags	M	M	Branches & Saplings	M
CA-14 (CR)	H	Lrg trees & snags	M	M	Shrubs & Saplings	D
CA-15 (CR)	H	Lrg trees & snags	M	M	Branches Shrubs & Saplings	M
CA-16 (CR)	M	Lrg trees & snags	C	M	Shrubs & Saplings	M
CA-20 (CR)	M	Snags	M	M	Branches Shrubs & Saplings	D
CA-21 (CR)	L	None	C	C	Saplings	S
CA-22 (CR)	L	Lrg trees & snags	C	M	Branches & Saplings	S
CA-25	H	Lrg trees & snags	C	M	Branches & Saplings	S
CA-26	M	Lrg trees & snags	C	O	Saplings	S
CA-27	H	Snags	C	O	Saplings	S
TA-03A (TR)	M	Snags	M	M	Saplings	M
TA-03D	L	Snags	O	M	Shrubs & Saplings	D
TA-04A-03	H	Lrg trees & snags	C	O	Branches & Saplings	M
TA-04B-02	M	Lrg trees & snags	M	O	Shrubs & Saplings	M
TA-04B-03	M	Lrg trees & snags	M	O	Shrubs & Saplings	M
TA-04D (TR)	L	Snags	M	M	Branches & Saplings	M
TA-04E	L	Snags	O	M	Branches Shrubs & Saplings	D
TA-05D (TR)	H	Lrg trees & snags	M	C	Branches & Saplings	M
TA-06A-02 (TR)	M	None	M	M	Branches Shrubs & Saplings	M
TA-07C-03	M	Snags	M	M	Branches	M
TA-07C-04	M	Lrg trees & snags	C	C	Saplings	M
TA-07E-01 (TR)	L	Lrg trees & snags	M	C	Branches Shrubs & Saplings	D
TA-08A (TR)	L	Snags	C	C	Branches & Saplings	M
TA-08A-04	L	Lrg trees	O	M	Saplings	S
TA-08B-06	L	Lrg trees & snags	M	M	Saplings	M
TA-08B-07	M	Lrg trees & snags	C	M	Branches & Saplings	M
TA-08B-08	M	Lrg trees	M	M	Branches & Saplings	M
TA-08B-09	L	Lrg trees	M	M	Saplings	M
TA-08C-07	L	Lrg trees	M	C	Branches & Saplings	M
TA-08C-08	L	Lrg trees & snags	M	M	Branches & Saplings	M
TA-08C-09	M	Lrg trees & snags	M	C	Branches Shrubs & Saplings	S
TA-08C-10	M	Lrg trees & snags	M	M	Saplings	M
TA-08C-11	M	Lrg trees & snags	M	M	Saplings	M

Site Name	Roost Tree Potential		Canopy Closure	Subcanopy Clutter		Herb Cover
	Rank	Composition		Rank	Composition	
TA-08C-12	M	Snags	M	M	Branches Shrubs & Saplings	D
TA-08C-13	M	Lrg trees & snags	M	C	Saplings	M
TA-08C-14	M	Lrg trees	C	O	Branches Shrubs & Saplings	M
TA-09A-10	M	Snags	M	C	Branches & Saplings	M
TA-09A-11	M	Lrg trees & snags	O	C		D
TA-09B (TR)	H	Lrg trees & snags	M	M	Shrubs & Saplings	D
TA-09B-04	L	Lrg trees & snags	M	C	Branches & Saplings	M
TA-09C-01	L	None	M	M	Shrubs & Saplings	M
TA-09C-02	H	Lrg trees & snags	M	M	Branches & Saplings	M
TA-10B (TR)	L	Lrg trees & snags	M	M	Branches & Shrubs	M
TA-10B-02	L	Lrg trees & snags	M	M	Branches & Saplings	S
TA-10C-01	L	Snags	O	C	Branches Shrubs & Saplings	D
TA-11A	M	Lrg trees & snags	M	C	Branches & Saplings	D
TA-11B-03	M	Snags	M	M	Saplings	M
TA-11B-04	M	Snags	O	O	Branches & Shrubs	D
TA-12B	L	Snags	M	O	Shrubs & Saplings	D
TA-12C-01	M	Snags	M	C	Shrubs & Saplings	D
TA-13A-03	M	Lrg trees & snags	M	M	Branches Shrubs & Saplings	D
TA-13A-04	M	Lrg trees & snags	M	C	Branches Shrubs & Saplings	D
TA-13A-05	M	Lrg trees & snags	C	O	Branches & Saplings	D
TA-13B-01	M	Snags	O	M	Saplings	M
TA-13B-02	M	Lrg trees	M	M	Branches & Saplings	D
TA-14A-01 (TR)	M	Lrg trees & snags	M	M	Branches & Saplings	M
TA-14B-01 (TR)	M	Lrg trees & snags	M	M	Saplings	M
TA-14B-08	L	Lrg trees	M	M	Saplings	M
TA-14C-02	M	Lrg trees & snags	M	M	Shrubs & Saplings	M
TA-14C-03	L	Snags	M	M	Shrubs & Saplings	M
TA-14D-02 (TR)	M	Lrg trees	M	M	Branches & Saplings	D
TA-14F-01	L	None	C	M	Branches & Saplings	S
TA-14F-02	H	Lrg trees & snags	C	M	Branches & Saplings	D
TA-14G-03	M	Snags	O	M	Branches Shrubs & Saplings	M
TA-14G-04	H	Lrg trees & snags	M	M	Shrubs	
TA-14G-05	H	Lrg trees & snags	M	M	Branches Shrubs & Saplings	D
TA-15B-02	M	Lrg trees & snags	C	M	Branches & Saplings	M
TA-15D-01	L	Snags	M	M	Saplings	M
TA-15E-01 (TR)	M	Lrg trees & snags	M	M	Branches & Saplings	D
TA-16A-01 (TR)	M	Lrg trees & snags	M	M	Branches & Saplings	M
TA-16C-01	L	None	O	C	Branches & Saplings	S
TA-16C-02	L	None	M	M	Saplings	M
TA-17A-02	L	Lrg trees	O	O	Shrubs & Saplings	M
TA-19A-01	M	Lrg trees & snags	M	M	Branches Shrubs & Saplings	M
TA-19A-02	M	Lrg trees & snags	O	M	Shrubs & Saplings	D
TA-19A-03	M	Snags	M	M	Shrubs & Saplings	M

Site Name	Roost Tree Potential		Canopy Closure	Subcanopy Clutter		Herb Cover
	Rank	Composition		Rank	Composition	
TA-19A-04	M	Snags	O	M	Shrubs & Saplings	D
TA-19D-03 (TR)	H	Lrg trees & snags	C	M	Saplings	M
TA-19D-04 (TR)	L	Lrg trees & snags	M	M	Branches & Saplings	M
TA-19D-05	H	Snags	O	M	Saplings	D

(CR): Cantonment Area Repeat Site – netted in 2007
(TR): Training Area Repeat Site – netted in 2007 and 2009.
Roost Potential Rating: H = High; M = Moderate; L = Low
Canopy Closure/Subcanopy Clutter: C = Closed; M = Moderate; O = Open
Herb (Herbaceous) Cover: S = Sparse, M = Moderate, D = Dense

Table 10. Tree and shrub composition at net sites on Fort Drum in summer 2010.

Site Name	Canopy Trees		Subcanopy Trees and Shrubs
	Dominant	Subdominant	
CA-01 (CR)	*Salix nigra, Populus deltoides*	*Acer saccharum*	*Acer saccharum*
CA-04 (CR)	*Pinus sylvestris, Carya cordiformis, Acer saccharum*	*Populus tremuloides, Prunus serotina, Ulmus americana*	*Acer saccharum*
CA-05 (CR)	*Acer saccharum, Carya cordiformis*	*Betula populifolia, Carya cordiformis, Acer saccharum*	*Carya cordiformis, Acer saccharum*
CA-09 (CR)	*Acer saccharum*	*Carya* sp., *Acer rubrum, Populus tremuloides*	*Acer negundo*
CA-10 (CR)	*Fagus grandifolia, Juglans nigra, Fraxinus americana*	*Ostrya virginiana, Acer saccharum*	*Acer saccharum, Rubus* sp., *Lonicera maackii*
CA-12 (CR)	*Salix nigra, Pinus strobus, Prunus serotina*	*Juglans cinerea, Acer rubrum, Tilia americana*	*Hamamelis virginiana, Ulmus americana, Tsuga canadensis*
CA-13 (CR)	*Acer saccharum*	*Acer negundo, Ulmus americana, Acer saccharum*	*Acer saccharum, Crataegus* sp., *Acer negundo*
CA-14 (CR)	*Acer saccharum, Populus grandidentata, Quercus alba, Tsuga canadensis, Fagus grandifolia, Pinus strobus, Populus tremuloides*	*Fraxinus americana, Prunus serotina, Ulmus americana*	*Fraxinus americana, Acer pensylvanicum, Tsuga canadensis, Cornus alterniflora, Tilia americana, Fagus grandifolia, Lonicera maackii, Quercus rubra, Carya cordiformis, Juglans cinerea*

Site Name	Canopy Trees		Subcanopy Trees and Shrubs
	Dominant	Subdominant	
CA-15 (CR)	*Acer saccharum, Pinus strobus, Pinus resinosa*	*Betula allegheniensis, Populus tremuloides, Tsuga canadensis, Fraxinus americana*	*Lonicera maackii, Acer saccharum, Fagus grandifolia, Betula allegheniensis, Rubus* sp., *Tsuga canadensis, Fraxinus americana*
CA-16 (CR)	*Acer saccharum, Celtis occidentalis, Pinus strobus*	*Acer rubrum, Acer saccharum*	
CA-20 (CR)	*Acer saccharum, Ulmus americana, Prunus serotina, Pinus strobus*	*Fraxinus americana, Pinus strobus, Acer saccharum, Ulmus americana*	*Lonicera maackii, Rhamnus* sp., *Prunus serotina, Cornus drummundi, Fraxinus americana*
CA-21 (CR)	*Acer saccharum*	*Ostrya virginiana, Ulmus americana*	*Caulophyllum thalictroides*
CA-22 (CR)	*Acer saccharum*	*Acer saccharum, Acer nigrum, Carya cordiformis*	*Crataegus* sp., *Acer saccharum, Ulmus americana*
CA-25	*Juglans nigra, Juglans cinerea, Acer saccharum, Fagus grandifolia*	*Carya cordiformis, Acer saccharum, Tilia americana, Ostrya virginiana*	*Acer saccharum*
CA-26	*Acer saccharum, Fagus grandifolia*	*Acer saccharum*	*Acer saccharum, Rubus* sp.
CA-27	*Acer saccharum, Prunus serotina*	*Carya* sp., *Acer saccharum*	*Rubus* sp., *Acer saccharum*
TA-03A (TR)	*Quercus alba, Quercus rubra*	*Pinus strobus, Betula papyrifera, Acer saccharinum*	*Quercus alba, Acer saccharinum, Pinus strobus*
TA-03D	*Populus grandidentata, Salix nigra*	*Salix nigra, Populus grandidentata, Acer saccharum, Populus deltoides*	*Rhus typhina, Lonicera maackii*
TA-04A-03	*Acer saccharum, Fagus grandifolia, Tsuga canadensis, Quercus velutina*	*Betula allegheniensis, Tsuga canadensis, Fagus grandifolia*	*Acer saccharinum, Rubus* sp.
TA-04B-02	*Quercus rubra, Pinus strobus, Quercus coccinea*	*Pinus sylvestris, Pinus strobus, Quercus alba, Acer rubrum*	*Vaccinium* sp., *Amelanchier arborea, Betula populifolia, Acer rubrum, Pinus strobus, Quercus alba, Quercus rubra, Pinus sylvestris*

Site Name	Canopy Trees		Subcanopy Trees and Shrubs
	Dominant	Subdominant	
TA-04B-03	*Tsuga canadensis, Quercus rubra, Quercus coccinea, Pinus sylvestris, Pinus strobus*	*Quercus rubra, Tsuga canadensis, Fagus grandifolia*	*Fagus grandifolia, Betula populifolia, Tsuga canadensis, Quercus alba, Quercus coccinea, Acer rubrum*
TA-04D (TR)	*Tsuga canadensis*	*Betula allegheniensis, Tsuga canadensis*	*Betula allegheniensis, Acer rubrum*
TA-04E	*Populus tremuloides*	*Prunus serotina, Betula populifolia*	*Viburnum dentatum, Amelanchier arborea, Prunus serotina, Lonicera maackii*
TA-05D (TR)	*Pinus strobus, Quercus rubra, Populus grandidentata, Quercus alba*	*Quercus rubra, Acer saccharum, Tsuga canadensis*	*Quercus alba, Hamamelis virginiana, Acer saccharum, Betula papyrifera, Amelanchier arborea, Acer rubrum, Populus deltoides, Prunus serotina, Ostrya virginiana, Betula populifolia*
TA-06A-02 (TR)	*Pinus strobus, Acer saccharum, Populus grandidentata, Prunus serotina*	*Acer saccharum, Carya cordiformis, Acer rubrum, Betula populifolia*	*Populus grandidentata, Carya cordiformis, Cornus alternifolia, Amelanchier arborea*
TA-07C-03	*Populus tremuloides, Pinus strobus, Acer rubrum, Betula papyrifera*	*Populus tremuloides, Acer rubrum*	*Populus tremuloides, Robinia pseudoacacia, Ulmus rubra*
TA-07C-04	*Acer saccharum, Populus tremuloides, Pinus strobus*	*Acer saccharum, Populus tremuloides, Robinia pseudoacacia*	*Cornus florida, Pinus strobus, Acer saccharum*
TA-07E-01 (TR)	*Ulmus americana, Tilia americana, Fraxinus americana, Pinus strobus, Quercus alba*	*Betula allegheniensis, Fraxinus americana, Acer saccharum, Prunus serotina, Ulmus americana*	*Acer saccharum, Fraxinus americana, Ulmus americana, Fraxinus nigra, Amelanchier arborea, Ostrya virginiana, Tilia americana, Sambucus canadensis, Acer negundo, Hamamelis vriginiana, Cornus sericea, Cornus alternifolia, Betula populifolia, Corylus americana, Alnus serrulata*

Site Name	Canopy Trees		Subcanopy Trees and Shrubs
	Dominant	Subdominant	
TA-08A (TR)	*Quercus rubra*	*Betula populifolia, Quercus rubra, Acer saccharum, Pinus strobus, Populus tremuloides*	*Pinus strobus, Quercus rubra, Acer saccharum*
TA-08A-04	*Pinus resinosa, Pinus strobus, Quercus alba*	*Quercus rubra, Quercus alba, Acer saccharum*	*Betula populifolia, Quercus rubra*
TA-08B-06		*Pinus strobus, Betula populifolia, Quercus velutina*	*Acer rubrum, Quercus velutina, Betula populifolia*
TA-08B-07	*Pinus strobus, Quercus rubra*	*Acer rubrum, Quercus rubra, Populus grandidentata*	*Acer rubrum, Fagus grandifolia*
TA-08B-08	*Quercus velutina*	*Quercus rubra, Quercus alba, Populus grandidentata, Prunus serotina*	*Hamamelis virginiana, Acer rubrum, Quercus velutina*
TA-08B-09	*Acer saccharum, Pinus strobus, Quercus rubra*	*Fagus grandifolia, Betula populifolia*	*Rubus* sp., *Vaccinium vacillans, Quercus rubra*
TA-08C-07	*Acer saccharinum, Salix nigra, Populus tremuloides*	*Acer saccharinum, Salix nigra*	*Populus tremuloides, Betula papyrifera, Salix nigra*
TA-08C-08	*Pinus strobus, Acer rubrum*	*Populus tremuloides, Acer rubrum*	*Populus tremuloides, Fagus grandifolia, Quercus rubra*
TA-08C-09	*Populus tremuloides, Quercus rubra, Pinus strobus*	*Ulmus americana*	*Populus tremuloides, Quercus rubra, Pinus strobus*
TA-08C-10	*Pinus strobus*	*Pinus strobus, Acer rubrum, Betula populifolia*	*Pinus strobus, Betula populifolia, Acer rubrum*
TA-08C-11	*Pinus strobus*	*Acer rubrum, Betula populifolia*	*Fagus grandifolia, Pinus strobus*
TA-08C-12	*Prunus serotina, Populus grandidentata*	*Acer rubrum, Salix nigra, Populus grandidentata, Pinus virgininana, Corylus americana*	*Lonicera maackii, Acer rubrum*
TA-08C-13	*Pinus strobus*	*Acer rubrum, Prunus serotina, Acer saccharum*	*Fagus grandifolia, Acer rubrum, Ostrya virginiana*
TA-08C-14	*Pinus strobus, Tsuga canadensis, Fagus grandifolia*	*Prunus serotina, Tsuga canadensis, Fagus grandifolia*	*Acer rubrum, Prunus serotina*

Site Name	Canopy Trees		Subcanopy Trees and Shrubs
	Dominant	Subdominant	
TA-09A-10	*Pinus strobus, Acer rubrum*	*Acer rubrum, Tsuga canadensis, Prunus serotina, Betula populifolia, Pinus resinosa, Acer saccharum*	*Acer rubrum, Ulmus americana*
TA-09A-11	*Acer saccharum, Prunus serotina*	*Prunus serotina, Populus tremuloides, Acer rubrum, Pinus strobus, Betula populifolia, Acer saccharum*	*Acer rubrum*
TA-09B (TR)	*Acer saccharum, Prunus serotina, Pinus virginiana*	*Fraxinus americana, Populus grandidentata, Populus deltoides, Pinus strobus*	*Acer saccharum, Acer rubrum, Rhamnus* sp., *Ulmus americana, Salix nigra, Alnus serrulata*
TA-09B-04	*Pinus strobus, Prunus serotina, Acer rubrum, Populus tremuloides*	*Populus tremuloides, Acer rubrum, Prunus serotina*	*Populus tremuloides, Acer rubrum*
TA-09C-01		*Populus tremuloides, Fraxinus pennsylvanica*	*Crataegus* sp., *Populus tremuloides, Fraxinus pennsylvanica*
TA-09C-02	*Acer saccharum*	*Acer saccharum, Prunus serotina*	*Acer saccharum, Crataegus* sp.
TA-10B (TR)	*Acer saccharum*	*Acer saccharum, Betula populifolia*	*Acer saccharum, Rubus* sp.
TA-10B-02	*Acer saccharum*	*Acer saccharum*	*Ulmus americana, Acer saccharum*
TA-10C-01	*Populus deltoides, Populus grandidentata*	*Salix nigra, Betula populifolia, Pinus strobus*	*Salix nigra, Betula populifolia, Alnus serrulata, Rhus typhina, Rhamnus* sp.
TA-11A	*Pinus strobus, Quercus rubra, Populus grandidentata, Prunus serotina, Acer saccharum*	*Tsuga canadensis, Betula allegheniensis, Acer saccharum*	*Prunus serotina, Hamamelis virginiana, Tsuga canadensis, Acer pennsylvanicus, Betula populifolia, Salix* sp., *Acer rubrum, Pinus strobus, Amelanchier arborea, Populus grandidentata, Cornus sericea, Alnus americana, Fraxinus nigra*

Site Name	Canopy Trees		Subcanopy Trees and Shrubs
	Dominant	Subdominant	
TA-11B-03	*Pinus strobus*	*Populus grandidentata, Pinus strobus, Prunus serotina*	*Hamamelis virginiana, Betula populifolia, Acer rubrum*
TA-11B-04	*Salix nigra*	*Populus grandidentata, Ulmus americana, Acer rubrum*	*Prunus* sp., *Crataegus* sp., *Acer rubrum*
TA-12B	*Salix nigra*	*Salix nigra, .Prunus serotina*	*Salix nigra, Prunus serotina*
TA-12C-01	*Salix nigra*	*Salix nigra*	*Salix nigra*
TA-13A-03	*Acer saccharum, Carya cordiformis*	*Acer saccharum, Carya cordiformis, Tilia americana, Juglans cinerea, Fraxinus nigrum*	*Rubus* sp., *Fraxinus americana, Eleagnus umbellata, Carya cordiformis*
TA-13A-04	*Acer saccharum, Prunus serotina*	*Acer saccharum, Cornus* sp., *Fraxinus nigra, Juglans cinerea, Ostrya virginiana, Betula populifolia*	*Elaeagnus umbellata, Crataegus* sp., *Quercus macrocarpa, Carya cordiformis*
TA-13A-05	*Acer saccharum, Carya cordiformis*	*Ostrya virginiana, Acer saccharum, Fraxinus americana*	*Crataegus* sp., *Fraxinus americana, Quercus rubra, Acer saccharum, Ostrya virginiana, Prunus serotina*
TA-13B-01		*Ulmus americana, Robinia pseudoacacia, Populus tremuloides*	*Rhus glabra, Populus balsamifera, Robinia pseudoacacia*
TA-13B-02	*Populus deltoides, Populus tremuloides, Salix nigra*	*Robinia pseudoacacia, Populus tremuloides, Acer rubrum*	*Robinia pseudoacacia, Populus balsamifera, Acer rubrum*
TA-14A-01 (TR)	*Acer saccharum, Acer rubrum*	*Acer rubrum, Prunus serotina*	*Ulmus americana*
TA-14B-01 (TR)	*Populus tremuloides, Acer rubrum, Fraxinus pennsylvanica*	*Populus tremuloides, Fraxinus pennsylvanica*	*Acer rubrum, Cercis canadensis*
TA-14B-08	*Acer saccharum*	*Acer saccharum, Acer negundo, Fraxinus* sp., *Populus grandidentata*	*Acer negundo, Acer saccharum, Betula* sp.
TA-14C-02	*Acer saccharum, Prunus serotina*	*Fraxinus americana, Tsuga canadensis, Tilia americana*	*Rubus* sp., *Tilia americana, Acer saccharum*
TA-14C-03	*Acer saccharum*	*Acer saccharum, Tilia americana, Betula populifolia, Fraxinus americana*	*Rubus* sp., *Tilia americana, Fraxinus americana*

Site Name	Canopy Trees		Subcanopy Trees and Shrubs
	Dominant	Subdominant	
TA-14D-02 (TR)	*Acer saccharum*	*Populus tremuloides, Prunus serotina, Acer saccharum*	*Acer negundo, Acer saccharum*
TA-14F-01	*Pinus strobus*	*Populus tremuloides, Pinus strobus*	*Pinus strobus, Populus tremuloides, Prunus serotina*
TA-14F-02	*Acer saccharum, Acer rubrum, Tsuga canadensis*	*Acer saccharum, Prunus serotina, Acer rubrum, Tilia americana, Tsuga canadensis, Betula* sp.	*Acer saccharum, Acer rubrum, Prunus serotina*
TA-14G-03	*Pinus strobus*	*Pinus strobus, Betula lenta*	*Larix laricina, Salix nigra, Betula lenta*
TA-14G-04	*Pinus strobus, Acer saccharum*	*Fraxinus pennsylvanica, Acer saccharum*	*Ulmus americana, Cornus sericea*
TA-14G-05	*Pinus strobus, Populus tremuloides, Prunus serotina*	*Picea abies, Betula papyrifera, Ulmus americana*	*Prunus serotina, Castanea dentata, Ulmus* sp.
TA-15B-02	*Acer saccharum, Acer rubrum, Prunus serotina*	*Acer rubrum, Acer saccharum*	*Fraxinus pennsylvanica, Acer rubrum*
TA-15D-01	*Acer saccharum*	*Acer saccharum, Prunus serotina, Tilia americana*	*Acer saccharum, Ostrya virginiana, Tilia americana*
TA-15E-01 (TR)	*Acer saccharum*	*Acer saccharum, Ostrya virginiana, Carya cordiformis, Fagus grandifolia*	*Acer saccharum, Fagus grandifolia, Ostrya virginiana*
TA-16A-01 (TR)	*Acer saccharum, Acer saccharinum*	*Ulmus americana*	*Acer saccharum, Carya cordiformis*
TA-16C-01		*Populus tremuloides, Populus grandidentata, Betula populifolia, Prunus serotina, Acer rubrum*	*Crataegus* sp., *Acer rubrum*
TA-16C-02	*Populus deltoides, Quercus rubra, Acer saccharinum, Betula papyrifera*	*Betula papyrifera, Quercus rubra*	*Rhus* sp., *Quercus alba, Acer saccharinum*
TA-17A-02	*Salix nigra*	*Populus deltoides, Robinia pseudoacacia, Acer nigrum*	*Crataegus* sp.
TA-19A-01	*Acer rubrum, Betula populifolia, Prunus serotina*	*Fraxinus americana, Prunus serotina, Acer rubrum, Fagus grandifolia, Betula allegheniensis*	*Acer pensylvanicum, Acer rubrum, Fagus grandifolia, Prunus serotina*

Site Name	Canopy Trees		Subcanopy Trees and Shrubs
	Dominant	Subdominant	
TA-19A-02	*Acer rubrum, Prunus serotina*	*Acer rubrum, Betula alleghaniensis, Prunus serotina, Fagus grandifolia*	*Fagus grandifolia, Acer pensylvanicum, Acer rubrum*
TA-19A-03	*Betula alleghaniensis, Acer saccharum, Acer rubrum, Fagus grandifolia*	*Tsuga canadensis, Acer rubrum*	*Rubus* sp., *Acer rubrum*
TA-19A-04	*Tilia americana, Prunus serotina, Acer saccharum*	*Fagus grandifolia, Quercus rubra, Acer saccharum, Acer rubrum*	*Tilia americana, Alnus serrulata, Fraxinus americana, Amelanchier arborea, Acer saccharum, Ostrya virginiana, Carpinus caroliniana, Acer rubrum, Quercus rubra*
TA-19D-03 (TR)	*Quercus rubra, Pinus strobus, Acer saccharum*	*Betula lenta, Tilia americana, Thuja occidentalis*	*Cornus alternifolia, Betula populifolia*
TA-19D-04 (TR)	*Pinus strobus*	*Pinus strobus, Acer saccharum, Acer rubrum, Ostrya virginiana, Prunus serotina, Betula populifolia*	*Acer saccharum, Ostrya virginiana, Pinus strobus*
TA-19D-05	*Pinus strobus*	*Tilia americana, Populus tremuloides, Acer rubrum, Populus grandidentata, Acer saccharum, Prunus serotina*	*Tilia americana, Acer saccharum, Acer pensylvanicum, Acer rubrum, Fraxinus americana*

(CR): Cantonment Area Repeat Site – netted in 2007
(TR): Training Area Repeat Site – netted in 2007 and 2009.

5.1.6 Weather

During the period when mist netting was successfully completed (between 15 June and 14 August 2010), temperatures ranged from 10.0° to 26.1° C (50.0° – 79.0° F). Figure 20 shows the daily high and low temperature records during the mist-netting survey. No surveys were conducted from 1 to 9 July. Surveys were cancelled on five nights due to rain (22, 23, and 27 June, 13 July, and 8 August) and one night due to strong wind (16 June), which resulted in incomplete survey nights. At no time did temperatures fall below 10° C (50° F) per USFWS mist netting guidelines (Table 1).

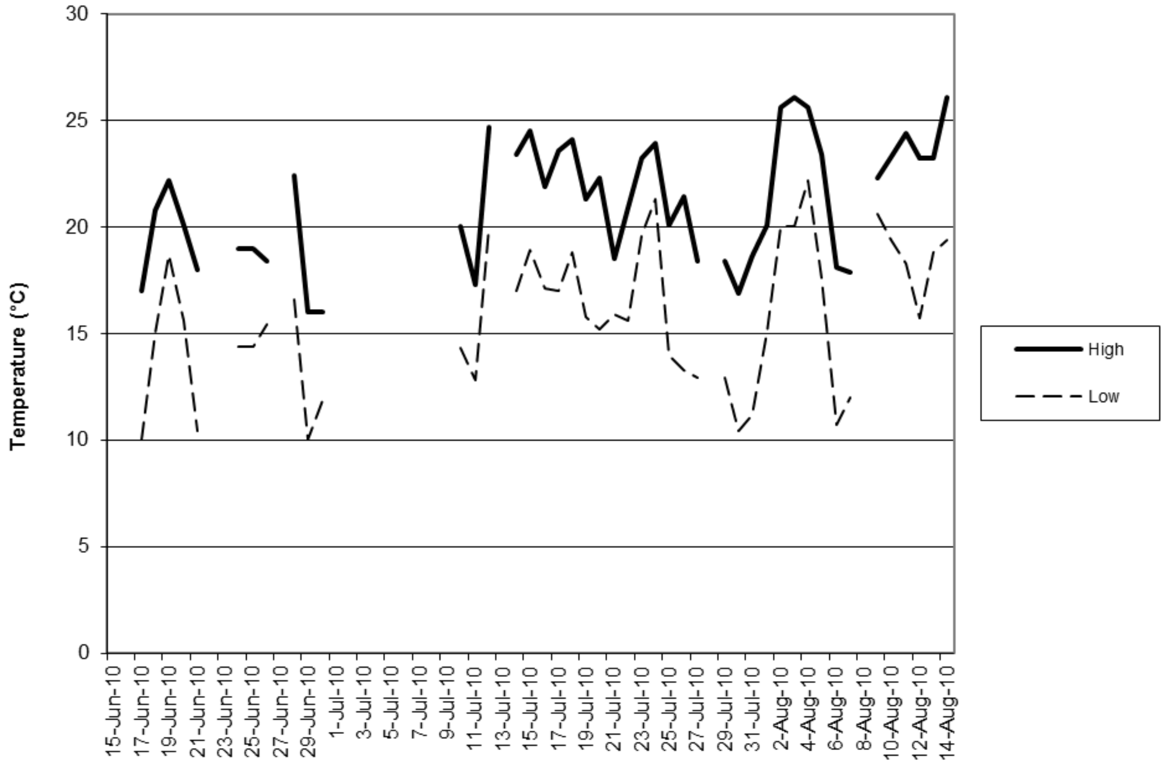


Figure 20. Weather data during the mist net survey on Fort Drum in summer 2010.

5.2 Radio-Telemetry Survey

Two Indiana bats, two northern bats, and six little brown bats were radio-tagged on Fort Drum in 2010 (Table 11). Indiana bats were captured at sites CA-05 and TA-08B-09, and transmitters were placed on both bats. Northern bats were captured at four sites; transmitters were placed on individuals from sites CA-20 and TA-04A-03. Little brown bats were captured at 21 percent of net sites (4 sites in the Cantonment Area and 14 sites in the Training Area). Transmitters were placed on little brown bats from sites CA-05, CA-12, CA-14, TA-3D, and TA-4D-02.

Table 11. Capture information for radio-tagged bats on Fort Drum in summer 2007.

Bat Name	Species	Capture Date	Transmitter Frequency (MHz)	Capture Site	Sex	Age	Repro Condition	Band #
Bat 517	Indiana bat	8/9/2010	150.517	TA-08B-09	F	Juvenile	Non-reproductive	5043
Bat 852	Indiana bat	8/11/2010	151.852	CA-05	M	Adult	Scrotal	31647
Bat 618	Northern bat	8/2/2010	151.618	CA-20	F	Adult	Non-reproductive	None
Bat 797	Northern bat	8/5/2010	151.797	TA-04A-03	F	Juvenile	Non-Reproductive	None
Bat 407	Little brown bat	7/21/2010	151.407	TA-03D	F	Adult	Non-reproductive	31033
Bat 450	Little brown bat	7/27/2010	151.450	TA-14D-02	F	Adult	Post-lactating	4950
Bat 488	Little brown bat	7/27/2010	151.488	CA-14	F	Adult	Non-reproductive	4915
Bat 537	Little brown bat	7/27/2010	151.537	CA-14	F	Adult	Non-reproductive	31039
Bat 728	Little brown bat	7/17/2010	151.728	CA-12	F	Adult	Post-lactating	None
Bat 975	Little brown bat	8/11/2010	150.975	CA-05	M	Adult	Scrotal	31646

5.2.1 Radio-tagged Indiana Bats

Two Indiana bats (Table 11) were captured on Fort Drum between 15 June and 14 August 2010, including one adult male and one juvenile female. The male was captured within the Cantonment area (Site CA-05) and the female was caught within the Training Area (Site TA-08B-09). Radio-transmitters were attached to both bats, and each was tracked to four roosts (Table 12). Both were banded with aluminum wing bands provided by the NYSDEC. Radio-tagged bats were assigned numbers corresponding to their transmitter frequency. Band numbers are listed in Appendix B.

Table 12. Summary data of Indiana bat roost trees on Fort Drum in summer 2010.

Roost Name	Tree Species	Tree Status	DBH (cm)	Exfoliating Bark (% of tree)	Canopy Closure (%)	Roost Height (m)	Emergence Counts
517R1	Butternut	Partially live	50	15	30	-	0
517R2	American elm	Dead	40	50	30	-	9
517R3	American elm	Dead	30	35	60	5.5	12, 8, 2, 4, 2
517R4	Black cherry	Partially live	40	10	60	-	2, 4
852R1	Bitternut hickory	Dead	15	70	50	-	1
852R2	Bitternut Hickory	Dead	30	50	80	10	0, 0
852R3	Sugar maple	Dead	30	75	50	-	0
852R4	American elm	Dead	40	20	25	-	0, 0

Bat photographs, roost data sheets, and roost photographs can be found in Appendices F through H.

5.2.1.1 Bat 517

Bat 517 was a juvenile female captured at 0110 h on the night of 9 August 2010, the second night of netting at Site TA-08B-09. The bat was caught in a 9-m (29.52 ft) wide by 6-m (19.7 ft) high mist net set across Tower Road near the intersection of Alexandria Road. The surrounding habitat consisted of young upland forest with abundant sugar maple, white pine, and northern red oak (*Quercus rubra*). The net site placement was approximately 50 m (164 ft) from West Branch Black Creek and approximately 200 m (656 ft) from a wetland.

The bat was fitted with a 0.35-g transmitter (150.517 MHz) and released near the capture site. Aluminum wing band # 5043 was placed on its left forearm.

Daytime radio-telemetry efforts were conducted from 10 to 22 August 2010. Extensive searches on the western portion of the Training Area on 10 August yielded no roost trees. On 11 August, the signal was pinpointed to Roost 517R1, a partially live butternut (*Juglans cinerea*) with exfoliating bark (Table 12). This roost (located in the same woodlot as many other Indiana bat roosts on the Cantonment Area) was approximately 12.9 km (8 mi) from the capture site. On 12 August 2010, the bat moved to Roost 517R2, a dead American elm with exfoliating bark. The bat moved to a third roost (another American elm snag) on 13 August, where it remained through 15 August. On 16 August, the bat moved to Roost 517R4, a partially live black cherry with exfoliating bark and crevices. It remained there for two days and then returned to Roost 517R3, where the transmitter detached in the tree. Roost 517R3 may be a primary roost, because the bat continued to return to that roost more often than any other roost located.

5.2.1.2 Bat 852

Bat 852 was a reproductive, adult male captured at 2310 h on the night of 11 August 2010, the first night of netting at Site CA-05. It was caught in a 9-m (29.52 ft) wide by 9-m (29.52 ft) high mist net set across a trail near North Memorial Road and Bedlam Road. The surrounding habitat consisted of mature upland forest with abundant sugar maple and bitternut hickory (*Carya cordiformis*). The trail is forested leads to an open field and is approximately 500 m (1,640 ft) from a wetland.

The bat was fitted with a 0.35-g transmitter (151.852 MHz) and released near the capture site. Aluminum wing band # 31647 was placed on its right forearm.

Daytime radio-telemetry efforts were conducted 12 to 22 August 2010. On 12 August, the signal was pinpointed to Roost 852R1, a dead bitternut hickory. The bat did not return to that roost that night, and was unable to be located for 2 days. The second roost (852R2) was found on 15 August, where the bat remained for 3 nights. Roost 852R2 was a dead bitternut hickory with exfoliating bark located just outside the Cantonment Area perimeter fence on private property. The bat moved to Roost 852R3, a dead sugar maple with crevices and exfoliating bark, on 18 August. On 19

August, the bat was found in a dead American elm, Roost 852R4, where it remained for at least 4 days until telemetry efforts ceased. Bats were not seen exiting three of the four roosts (Table 12), only one bat exited Roost 852R1, and the transmittered bat did not seem to remain in or revisit any but the last roost for more than 3 nights. With the limited data obtained from each roost, roost importance to the colony could not be determined.

5.2.2 Radio-tagged Northern Bats

Five northern bats (including one juvenile male and four females) were captured on Fort Drum between 15 June and 14 August 2010. The females included 2 adults and 2 juveniles. A juvenile male and non-reproductive, adult female were both captured within the Cantonment Area. The other three bats (2 juvenile females and a post-lactating, adult female) were captured in the Training Area. Radio-transmitters were attached to two bats captured in August: a non-reproductive, adult female and a juvenile female (Table 11). The juvenile female was tracked to three roosts (Table 13). The adult female was never located, despite extensive ground searches and aerial telemetry.

Table 13. Summary data of northern bat roost trees on Fort Drum in summer 2010.

Roost Name	Tree Species	Tree Status	DBH (cm)	Exfoliating Bark (% of tree)	Canopy Closure (%)	Roost Height (m)	Emergence Counts
797R1	Red maple	Dead	20	5	10	2.5	3
797R2	White pine	Dead	19	40	10	4.5	0
797R3	Eastern hemlock	Dead	24	0	0	3.0	4, 2, 4

5.2.2.1 Bat 618

Bat 618 was a non-reproductive, adult female captured at 2105 h on the night of 2 August 2010, the first night of netting at Site CA-20. It was caught in a 9-m (29.52 ft) wide by 6-m (19.7 ft) high mist net set across a gravel bike trail near the intersection of Enduring Freedom Road and Conway Road. The surrounding habitat consisted of young upland forest with abundant sugar maple, American elm, white pine, and black cherry (*Prunus serotina*). The bike trail is near open areas, small snags, an old field, and is approximately 100 m (328 ft) from Pleasant Creek.

The bat was fitted with a 0.35-g transmitter (151.618 MHz) and released near the capture site.

Daytime radio-telemetry efforts were conducted from 3 to 12 August 2010. After 9 days of attempting to locate the bat from the ground, aerial telemetry was performed on 12 August. Despite these efforts, the transmitter's signal was never located.

5.2.2.2 Bat 797

Bat 797 was a juvenile female captured at 2140 h on the night of 5 August 2010, the first night of netting at Site TA-04A-03. It was caught in a 9-m (29.52 ft) wide by 6-m (19.7 ft) high mist net set across a gravel road near Pleasant Street. The surrounding habitat consisted of open, mature upland forest with abundant sugar maple, black oak (*Quercus velutina*), American beech (*Fagus grandifolia*), and eastern hemlock (*Tsuga canadensis*). The net placement along the gravel access road was approximately 50 m (164 ft) from a small stream and over 100 m (328 ft) from Pleasant Creek.

The bat was fitted with a 0.35-g transmitter (151.797 MHz) and released near the capture site.

Daytime radio-telemetry efforts were conducted 6 to 10 August 2010. On 6 August, the signal was pinpointed to Roost 797R1, an unknown dead tree with a hollow. The tree was in an advanced stage of decay, making species identification difficult. The next day, the bat switched to Roost 797R2, a dead white pine with exfoliating bark and crevices. The bat remained in this tree for 1 day before switching to Roost 797R3 on 8 August. Roost 797R3 was another dead white pine with crevices. The transmitter signal remained in Roost 797R3 for multiple days and did not leave the tree at dusk. On 10 August, ESI presumed the transmitter had detached in the tree and ceased active tracking. Periodic checks in subsequent days (including during aerial telemetry on 12 August) confirmed that the transmitter was still in the tree and transmitting as late as 21 August.

5.2.3 Radio-tagged Little Brown Bats

Fifty-two little brown bats were captured on Fort Drum between 15 June and 14 August 2010. Thirty males were captured, including 21 adults and 9 juveniles. Twenty-two females were captured, including 10 adults and 12 juveniles. Twelve bats were captured at four Cantonment Area sites and 40 bats were captured at 14 Training Area sites. Half of the total little brown bat captures in 2010 were at one site, TA-19D-04. Radio-transmitters were attached to six bats, including 1 adult male, 2 post-lactating adult females, and 3 non-reproductive adult females (Table 11). Two bats were tracked to the same roost, the human-made wooden bat box near LeRay Mansion. The other four bats were never located after the night of capture.

5.2.3.1 Bat 407

Bat 407 was a non-reproductive, adult female captured at 0030 h on the night of 21 July 2010, the second night of netting at Site TA-3D. It was caught in a 9-m (29.52 ft) wide by 6-m (19.7 ft) high mist net set across a gravel road near Pleasant Street. The surrounding habitat consisted of young lowland forest with abundant poplars (*Populus grandidentata* and *P. deltoides*). The nets were located approximately 5 m (16 ft) from an emergent wetland.

The bat was fitted with a 0.35-g transmitter (151.407 MHz) and released near the capture site. Aluminum wing band # 31033 was placed on its left forearm. At the time of release, the bat was active and alert, and flew west from the release point.

Daytime radio-telemetry efforts were conducted from 22 to 30 July 2010. Aerial telemetry on 12 August also scanned for the bat. Despite these efforts, the transmitter's signal was never located.

5.2.3.2 Bat 450

Bat 450 was a post-lactating, adult female captured at 2215 h on the night of 27 July 2010, the second night of netting at Site TA-14D-02. It was caught in a 6-m (19.7 ft) wide by 6-m (19.7 ft) high mist net set across Russell Turnpike near the intersection of Figert Road. The surrounding habitat consisted of woodlot edges and young upland forest with abundant sugar maple. The net was approximately 500 m (1,640 ft) from a pond.

The bat was fitted with a 0.35-g transmitter (151.450 MHz) and released near the capture site. Aluminum wing band # 4950 was placed on its left forearm.

Daytime radio-telemetry efforts were conducted from 28 July to 8 August 2010 using vehicles, ATVs, and pedestrian searches within training area interiors near the capture site. Due to restricted airspace issues, aerial telemetry was not performed for this bat on 12 August. Despite extensive ground telemetry efforts, the transmitter's signal was never located.

5.2.3.3 Bat 488

Bat 488 was a non-reproductive, adult female captured at 2140 h on the night of 27 July 2010, the second night of netting at Site CA-14. It was caught in a 9-m (29.52 ft) wide by 9-m (29.52 ft) high mist net set across a dirt foot path near 4th Street. The surrounding habitat consisted of mature upland forest with abundant sugar maple, poplars, white oak (*Quercus alba*), eastern hemlock, American beech, white pine, white ash (*Fraxinus americana*), and American elm. The net placement was approximately 100 m (328 ft) from Remington Pond and an associated wetland.

The bat was fitted with a 0.35-g transmitter (151.488 MHz) and released near the capture site. Aluminum wing band #4915 was placed on its left forearm.

Daytime radio-telemetry efforts were conducted from 28 July to 8 August 2010. On 2 August, the bat was found in the man-made bat house near LeRay. The bat house was in an open field with forested trails connecting the field to Remington Pond. Bat 488 intermittently returned to the bat box, but despite the fact that it was not always present in the bat house, it was never found using other roosts.

5.2.3.4 Bat 537

Bat 537 was a non-reproductive, adult female captured at 2140 h on the night of 27 July 2010, the second night of netting at Site CA-14. It was caught in the same 9-m (29.52 ft) wide by 9-m (29.52 ft) high mist net set as Bat 488

The bat was fitted with a 0.35-g transmitter (151.537 MHz) and released near the capture site. Aluminum wing band # 31039 was placed on its left forearm.

Daytime radio-telemetry efforts were conducted 28 July to 8 August 2010. Aerial telemetry on 12 August also scanned for the bat. Despite these efforts, the transmitter's signal was not located.

5.2.3.5 Bat 728

Bat 728 was a post-lactating, adult female captured at 2220 h on the night of 17 July 2010, the first night of netting at Site CA-12. It was caught in a 9-m (29.52 ft) wide by 9-m (29.52 ft) high mist net set across a gravel bike path near Remington Pond. The surrounding habitat consisted of young lowland forest with abundant black willow (*Salix nigra*), white pine, black cherry, white walnut (*Juglans cinerea*), red maple (*Acer rubrum*), and American basswood. The nets were less than 10 m (33 ft) from a stream and beaver wetland upstream of Remington Pond.

The bat was fitted with a 0.35-g transmitter (151.728 MHz) and released near the capture site.

Daytime radio-telemetry efforts were conducted 18 to 28 July 2010. On 18 July, the signal was pinpointed the man-made bat house also occupied intermittently by Bat 488. The bat house was the only roost found for the bat. Starting on 28 July, the bat never left the bat box. After a few days, the transmitter was found at the base of the roost, and it was assumed to have fallen off the bat on 28 July 2010.

5.2.3.6 Bat 975

Bat 975 was a reproductive, adult male captured at 0020 h on the night of 11 August 2010, the first night of netting at Site CA-05. It was caught in a 9-m (29.52 ft) wide by 9-m (29.52 ft) high mist net set across a trail near the Guthrie Clinic. The surrounding habitat consisted of mature upland forest with abundant sugar maple and shagbark hickory (*Carya cordiformis*). The forested trail leads into a valley with an open field. A wetland was located in the open area, approximately 500 m (1,640 ft) from the site.

The bat was fitted with a 0.35-g transmitter (150.975 MHz) and released near the capture site. Aluminum wing band # 31646 was placed on its right forearm.

Daytime radio-telemetry efforts were conducted 12 to 22 August 2010. Aerial telemetry was performed on 12 August, the first day after capture, but was unable to locate the bat. After aerial telemetry was performed, the biologists also scanned for the bat while performing roost searches for both Indiana bats. They also did regular checks of the bat box and the landscape surrounding the capture site. Despite these efforts, the transmitter's signal was never located after the night of capture.

6.0 Discussion

6.1 Mist Netting Survey

Mist netting efforts on Fort Drum in the summer of 2010 complied with all guidelines set forth by the USFWS and the Indiana Bat Recovery Team to survey summer habitat for the presence/absence of the federally endangered Indiana bat. Netting efforts indicated endangered Indiana bats and other myotids occupy portions of the Training Area and Cantonment Area during summer months. Results at net sites that did not capture Indiana bats or other myotids should be interpreted carefully. Many species of *Myotis* are rare in the environment, so they may have been present in the area, just not detected through this survey effort. Sometimes years of surveys are required to confirm presence of rare species like the Indiana bat. Absence of evidence is not evidence of absence.

6.1.1 Total Bat Capture

Species richness for the study was high, capturing all nine bat species known from New York.

The most abundant species captured on Fort Drum in 2010 was the big brown bat. Overall, the three most abundant species (big brown, eastern red, and little brown bats) accounted for over 96 percent of all bats captured. These species are members of the typical compliment of bat captures for most mist net surveys in the northeastern United States (ESI, unpublished data). Northern bats, hoary bats, and silver-haired bats, which are generally small components of mist net surveys, were only represented in small numbers. In the Training Area, Indiana bats were captured in 2007 (*n*=1), 2008 (*n*=2), and 2010 (*n*=1), but not in 2009. Summer 2010 was the first year small-footed bats have been captured on Fort Drum. Evidence of reproduction was documented for all species in 2010. Approximately 55 percent of captures were either reproductive females or juveniles, indicating that suitable habitat for bat maternity colonies exists in the immediate vicinity of numerous net site locations. Proportions of reproductive adults and juveniles have remained similar during all three survey years (Table 14).

Compared to previous years, the overall rate of 7.58 bats per site in 2010 was lower than the 17 bats per site rate in 2007, but higher than the 4.7 bats per site in 2009. However, a standard deviation of 9.7 bats indicates a great deal of variability in capture numbers among sites. Sixteen sites captured no bats, 9 sites captured one bat, and 11 sites captured two bats; therefore, 42 percent of all sites captured two bats or less. For all net sites combined, the MacArthur Diversity Index of 1.7 suggested low equitability among species; only 18.71 percent (E_D = 0.1871) of the species were equally represented. This is due in large part to the overabundance of a few species, particularly big brown bats (76% of the catch), and the scarce presence of others. Big brown bats are considered habitat generalists, and are often found in areas of human disturbance (Brack et al. 2005c). They have also shown less susceptibility to WNS, possibly due to their hibernation tactics (less clustering and the use of human-made structures).

Table 14. Reproductive status of bats captured 2007, 2009, and 2010.

Survey Year	Adult Male	Proportion of Reproductive Status % (*n*) Non-reproductive Adult Female	Reproductive Adult Female	Juvenile	Total
2007	37 (487)	4 (59)	36 (480)	23 (301)	100 (1327)
2009	26 (97)	7 (26)	34 (125)	33 (120)	100 (368)
2010	34 (204)	7 (45)	32 (194)	27 (166)	100 (609)
Total	34 (788)	6 (130)	35 (799)	25 (587)	100 (2304)

Several factors may have contributed to these results; however, the most obvious and likely factor influencing capture numbers is WNS, which has severely depleted numbers of hibernating bats across most of the northeast. Throughout the summer, individuals of different species displayed signs of wing damage, which may be due to WNS (Appendix C), though caution should be taken when interpreting WDI scores. The WDI was developed as a quick way to estimate the extent of the bat community affected by WNS. However, WDI scores include all tissues scars and discoloration as if they were damage caused by WNS. Scaring on the wing membranes also may be caused by collisions while flying, predators, or other sources unrelated to WNS (Reichard and Kunz 2009). The WDI also does not consider healed wing damage or bat mortality. Though wing damage may heal over the course of a summer, the discolored scar tissue is likely visible well into the summer and possibly into the fall (Faure et al. 2009). A decline in proportions of bat captures with wing damage later in the summer is likely due to bat mortality earlier in the summer or to an increase in volant juveniles, which would be unaffected by WNS (Reichard and Kunz 2009). Juveniles and tree bats (e.g., hoary bats) receiving a WDI of higher than 0 is an indication that the WDI method includes damage from other sources or natural discoloration in the membranes, since juveniles have not yet hibernated their first winter and tree bats do not hibernate in caves and mines where the WNS fungus thrives.

Proportions of WDI scores among bat captures in 2010 were similar to those in 2009. In 2010, 72 percent of scored bats had no signs of wing damage (WDI = 0), 25 percent had minor damage (WDI = 1), 3 percent had moderate damage (WDI = 2) and 0 percent had severe damage (WDI = 3). Likewise, 71 percent of bats in 2009 had no damage, 23 percent had minor damage, 6 percent had moderate damage, and 0 percent had severe damage. Because WNS was a new discovery in 2007 and the WDI system had not been developed, bats captured in 2007 were not scored for wing damage. Among bats captured in 2010, 13 big brown, 2 little brown, and 1 hoary bat received WDI of 2 (moderate wing damage). Similarly, 19 big brown bats, 2 little brown bats, and 1 northern bat received a WDI of 2 in 2009.

6.1.2 Indiana Bat Capture

Two Indiana bats were captured in the summer of 2010: one reproductive, adult male and one juvenile female. Both Indiana bats were captured in nets set across forested, gravel roads/trails. Habitat at capture sites consisted mainly of deciduous upland forest.

The juvenile female was captured at TA-04A-01, approximately 8 km (5 mi) from the nearest site that captured Indiana bats in 2007 or 2008. The adult male was captured at CA-05, a site near the Guthrie Clinic. ESI captured only nine bats at this site, yet it had the highest species richness, capturing five of the nine species in New York.

6.2 Radio-telemetry Survey

6.2.1 Diurnal Roosts

Roosting behavior was documented for two Indiana bats, one northern bat, and two little brown bats captured on Fort Drum in summer of 2010. Despite extensive search efforts, one northern bat and four little brown bats tagged were never located after the night of capture.

Most bats switched roosts often and did not stay in any one roost more than 2 days. Roost switching did not follow any discernable pattern. It is unknown exactly why bats switch roosts. Switching may be driven by changes in ambient temperature or rainfall, parasite loads, proximity to foraging grounds and/or predation, or an awareness of alternate roosts (Kunz 1982, Lewis 1995, Callahan et al. 1997, Kurta et al. 2002). Because many roosts are often dead or dying trees, bats may have evolved with this switching behavior as an adaptation to the ephemeral nature of their summer habitat. Another possibility is that switching could be related to an ongoing search for best available roosts.

Collectively, radio-tagged Indiana bats used eight roost trees of five different species, the northern bat used three roost trees of three different species, and little brown bats used one bat house. Choice and use of roosts by bats may be more influenced by roost characteristics than by the species of trees themselves (Menzel et al. 2001). Indiana bats use many different tree species as roosts. Kurta (2004) reported Indiana bats roosting in 44 species of trees and suggested that selection of roosts is probably related more to local availability of suitable roosts than choice. Thus, tree form, not species, is important (USFWS 2007). Roosts are ephemeral, as they are often dead or dying with sloughing or exfoliating bark. Roost suitability depends on whether the tree is alive or dead, the extent of exfoliating or sloughing bark, exposure to solar energy in relation to other trees, and distance to water resources (USFWS 2007).

6.2.2 Maternity Colonies

Maternity roosts are those used by reproductive females or juveniles during the summer season; therefore, four roosts of the Indiana bat, all three roosts of the northern bat, and the roost of the little brown bat found on Fort Drum in summer of 2010 were maternity roosts.

Not all maternity roosts are equal. Roost use probably varies from roosts that are used once by a single bat and those that are used by all the bats in a colony across one or more seasons. Roosts that are rarely used are termed alternate roosts, while those that are used more regularly and by a larger proportion of the colony are termed primary roosts. In the absence of detailed information about roosting behavior of a colony most authors follow the lead of Callahan et al. (1997) and consider a primary roost to be one that has 30 or more bats on more than one occasion. In New York, conversely, colonies appear smaller and roosts are considered to be primary roosts if they contain 20 or more Indiana bats, with those that contain less bats considered alternate roosts. The largest number of Indiana bats in a single 2010 roost at Fort Drum was 12 bats, which would indicate that this was an alternate roost (given the above definition). However, considering WNS has impacted the local population of Indiana bats, the definition may no longer apply, indicating that this particular roost may indeed be a primary roost. In general, many primary maternity roosts in New York may now contain fewer than 20 bats.

Perhaps the most noteworthy discovery of the 2010 study was the movement of bat 517 from a capture site in the Training Area to a known roosting area in the Cantonment Area north of Cool Road. Bat 517 traveled a minimum distance of 12.9 km (8 mi) between the capture location and the roosting area. Given that Indiana bats have been reported traveling across open fields (USFWS, available at http://www.fws.gov/midwest/News/release.cfm?rid=177), this bat may have traveled across the Wheeler-Sack Army Airfield and Cantonment Area buildings; however, it may also have gone around these open areas (along forested corridors or edges). Non-migratory Indiana bats have been known to travel up to 5 km (3.1 mi) between roosts (USFWS 2007). Further, most Indiana bats travel a maximum of 3.2 to 4 km (2–2.5 mi) between their roosts and foraging areas (Gardner et al. 1991, Kurta et al.

2002, Carter 2003, Sparks et al. 2004, Sparks et al. 2005), although some bats travel twice that far. As such, this was an unusually long trip for a single night.

Although this bat traveled a surprising distance, the fact that it roosted in the Cantonment Area was not unusual. Studies show that most roost trees used by one maternity colony are located close together, although this may range from a few meters to several kilometers. The western portion of the Cantonment Area has been known as a colony roosting area since 2007, and Indiana bats are known to display fidelity to a roosting area, returning to the same woodlot, wetland, or cluster of trees from year to year (Kurta and Murray 2002, Winhold et al. 2005, Whitaker and Sparks 2008).

Bat 852, the adult male Indiana bat, was captured near the Guthrie Clinic at CA-05, and was found roosting in a cluster of trees originally identified in 2007. In summer and fall of 2007, this cluster of roosts was only used by Indiana bats captured along Bedlam Road and north of Cool Road. Bats captured near the clinic tended to remain in the contiguous wooded area south of Guthrie Road, near the capture sites. However, independent telemetry studies by Fort Drum personnel have documented connectivity between these two roosting areas as a single maternity colony centered in the Cantonment Area.

The long-distance movement of Bat 517 is interesting because it questions whether a second maternity colony exists in the proximity of Training Area 7 (as assumed in the Biological Assessment and Biological Opinion [based on Anabat analyses]), or whether Indiana bats from the Cantonment Area colony are simply using these areas too. Due to the impact of WNS, this question will likely remain unresolved.

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APPENDIX A
COMPLETED HABITAT DESCRIPTION DATA SHEETS

APPENDIX B
BAT BAND NUMBERS

APPENDIX C
COMPLETED BAT CAPTURE AND WEATHER DATA SHEETS

APPENDIX D
REPRESENTATIVE NET SITE PHOTOGRAPHS

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REPRESENTATIVE PHOTOGRAPHS OF BAT WINGS ASSESSED FOR WHITE NOSE SYNDROME DAMAGE

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INDIANA BAT PHOTOGRAPHS

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COMPLETED ROOST HABITAT AND EMERGENCE DATA SHEETS

APPENDIX H
ROOST PHOTOGRAPHS

APPENDIX I
REPRESENTATIVE PHOTOGRAPHS OF BAT SPECIES CAPTURED DURING SURVEYS