PENNSYLVANIA GAME COMMISSION
BUREAU OF WILDLIFE MANAGEMENT
RESEARCH DIVISION
PROJECT ANNUAL JOB REPORT

PROJECT CODE NO.: 06714

TITLE: Indiana Bat Research/Management

JOB CODE NO.: 71402

TITLE: Indiana Bat (*Myotis sodalis*) Investigations at Canoe Creek, Blair County Pennsylvania

PERIOD COVERED: 1 July 2004 to 30 June 2005

COOPERATING AGENCIES: PA Dept. of Transportation; U.S. Fish and Wildlife Service (USFWS); PA Dept. of Conservation and Natural Resources, Bureau of State Parks.

FIELD PERSONNEL: PGC Biologists – Greg Turner, Cal Butchkoski, Patti Barber; PGC Biologist Aides – Stacey Wolbert, John Chenger, Chris Sanders, Jessica Kapp, Mick O'Mahony, Dave Wayland; PA Dept of Transportation (PaDot) Pilots – Jim Burton, Bill Slabonik and Joe O'Donnell; PaDot Aviation Mechanics – Terry Sipe and Vic Abels; PaDot Interns – Jessica Taylor and Rick Monahan; Eads Group (Altoona office) – Chris Johnson and Ken Smith; and numerous volunteers.

WORK LOCATION(S): Blair County, concentrated within and near Canoe Creek State Park

PREPARED BY: Cal Butchkoski and Greg Turner

DATE: 11 July 2005

Abstract: Indiana bats (*Myotis sodalis*) have a maternity roost in the Canoe Creek Church attic and a hibernaculum at the Hartman Mine. In 2004, work pertaining to this study site included: monitoring of the Canoe Creek Church and adjacent roosts, radio-tagging and monitoring 3 Indiana (*Myotis lucifugus*) bats at the Canoe Creek summer habitat, estimating snag density on the Indiana bat foraging area, highway walks for roadkills on U.S. Rt. 22, trapping the Hartman mine, and a spring migration study of female Indiana bats (M*yotis sodalis*) exiting the Hartman Mine. Since 1999, 59 Indiana bats have been documented using the church attic, bat boxes, and condo with 2 new individuals found in 2004 including 1 adult female (lactating) trapped exiting the condo, and 1 juvenile male trapped exiting the church attic. Seven previously banded females were captured at Canoe Creek bat maternity roost structures. Four adult females (2 lactating, 1 post-lactating, 1 non-reproductive) were recaptured in the attic; 2 originally banded in the attic in 2001 as adults; 1 initially banded in the attic in 2002 as a juvenile; and 1 adult first captured at the Hartman Mine in the spring of 2002. Three adult lactating females were captured exiting a large aluminum-shell bat box located between the church and condo; 1 initially banded in the church attic in 2001, 1 banded in the attic in 2002 and 1 banded in the attic in 2003. From 22 June through 23 July 2004, 3 lactating Indiana bats were captured at the Canoe Creek maternity roosts, radio-tagged, and followed to gain more

information on that species' foraging habitat. Two were captured exiting a large aluminum-shell bat box and the third was captured by hand within the church attic. All 3 bats showed exclusive and/or significant use of other artificial roosts at Canoe Creek (bat boxes and condo) during the 2004 reproductive season. To evaluate natural maternity roost potential within foraging areas, 5 transects sampling 24.5 ha were conducted in the summer of 2004. Four-hundred and eight snags were tallied over 2 m in height and >10.16 cm dbh. Of these, 2 snags were >22 cm dbh, >3m high, with 25%+ exfoliating bark and received significant solar exposure (0.08 snags/ha), far below the recommended 12/hectare. Highway searches of U.S. Route 22 for roadkill bats were conducted on 18 days from 8 June to 29 July. Nineteen road-kill bats were found on 10 of those days that included 15 little brown bats (*Myotis lucifugus*), 2 bats of unknown species, 1 red bat (*Lasiurus borealis*), and 1 hoary bat (*Lasiurus cinereus*). Counts of traveling bats crossing U.S. Route 22 as they exited roosts at Canoe Creek were conducted on 3 evenings: 6 July, 2,101 tallied; 7 July, 1,979 tallied; and 8 July, 2,230 tallied. Trapping of the Hartman Mine was conducted on 15 evenings and resulted in captures of 8,409 bats of 6 species including 40 Indiana bats of which 11 were recaptures of previously banded Indiana bats (8 females, 3 males). Six of the female Indiana bats exiting the mine in April 2005 were radio tagged, 1 of these was intensively followed with aircraft and ground support. Two of the 6 bats were found in Carroll County, Maryland in 2 different roost trees, 135 and 148 km from the Hartman mine. None of the migrating radio-tagged bats remained at Canoe Creek, suggesting that most of the Indiana bats travel elsewhere for the summer with few staying at Canoe Creek.

OBJECTIVES

1. To assess micro- and macro-habitats used by Indiana bats at the Canoe Creek study site.

2. To develop management options for Indiana bats in their maternity habitats.

3. To assess the impacts of a proposed highway upgrade of U.S. Route 22 on the Canoe Creek bat colony.

INTRODUCTION

The Canoe Creek Indiana bat study site is unique in that all habitats are in close proximity to each other (Butchkoski and Hassinger 2002). The Hartman limestone mine hibernaculum is located in Canoe Creek State Park. The Canoe Creek Church attic maternity roost, also on park property, is located 2.3 km from the hibernaculum. Other documented summer roosts include the Traxler garage beside the church; the bat condo, a large artificial bat roost, located 300 m from the church; and various bat boxes located between the church and condo. The center of the Indiana bat maternity colony's foraging area is located ~1.3 km southwest of the church roost. A timber stand analysis of the foraging area was conducted in 2001 (Butchkoski and Lewis 2002). In 2003 insect sampling was conducted on the foraging area (Butchkoski and Mehring 2004). Although this report covers the periods from 1 July 2004 to 30 June 2005, in some cases, data is included from May 2004 to provide a complete view of the 2004 maternity season to avoid fragmenting projects or data collection seasons.

METHODS

Canoe Creek Church and Adjacent Roosts

Known Indiana bat roosts at Canoe Creek now include the church attic, bat condo erected in 1996, 2 aluminum-shell bat boxes (Fig. 1 and 2) erected in September 2002, and the Traxler garage attic located beside the church. Garage management began in spring of 2004 when roosting baffles (sandwiched plywood with ~1.9 cm roosting crevices) were installed.

The church attic was entered 3 times to collect data. One of these entries was to select an Indiana bat for radio-tagging (12 July). The attic was also entered on 30 July and 18 August to band adult and juvenile Indiana bats. During entries the attic was scanned for high and low temperatures, using an infrared thermometer (Model PM20, Raytek, Inc., Santa Cruz, California) with an accuracy of 1% or ±1°C to measure surface temperatures. All scanned surfaces were wooden. Additionally, temperature was measured at the site where an Indiana bat was captured, with the infrared unit located 250 to 1,000 mm from the surface, giving a sampling area 21 to 24 mm in diameter.

Trapping of exiting bats was conducted using Austbat and Forest Strainer harp traps at the 7-chamber aluminum-shell bat box on 1 night (8 July 2004), 14-chamber aluminum-shell bat box on 1 night (22 June 2004), the church attic/Traxler garage on 3 nights (7, 27, and 28 July 2004), and the Canoe Creek condo on 3 nights (21 June, 6 and 29 July 2004).

Visual observations were also conducted of the bat boxes, condo, and Traxler garage. These were conducted during daylight hours by shining a bright light into the roosting crevices. Yellow bands (Indiana bats), and estimates of total roosting bats were recorded. The 7-chamber aluminum-shell bat box was inspected 3 times (24 May 2004, 10 June 2004, and 23 June 2004); the 14-chamber aluminum-shell bat box was inspected 5 times (24 May 2004; 10, 21, and 23 June 2004; and 10 May 2005). Inspections within the condo were conducted on 2 days (7 June 2004 and 15 May 2005). The Traxler garage attic was inspected on 3 days (17 June 2004, 12 July 2004, and 10 May 2005).

Indiana Bat Foraging Telemetry at Canoe Creek

In June and July 2004, 3 female Indiana bats were followed using Holohil LB-2 transmitters (Holohil Systems Ltd, Ontario, Canada) and Telonics TR-4 receivers with AVM 3-element collapsible antennas. A 0.48 g (10-day battery) transmitter was attached to each bat. A small patch of fur was removed from the mid-dorsal region using scissors. The transmitter was then glued to the bat's skin with Skin-Bond® cement (Smith & Nephew, Inc., Largo, Florida), a latex medical adhesive recommended by Holohil Systems Ltd. These animals were banded with numbered, yellow-colored celluloid bands. Female bats are banded on the left forearm, males on the right. Bats numbered 215PGC, 221PGC and 309PGC were lactating females with respective weights of 6.7 g, 6.9 g, and 6.5 g. Bats numbered 215PGC and 309PGC were trapped exiting a large 14-chamber aluminum-shell bat box (Fig. 1). To capture the bats, 3 large harp traps, 1 Austbat (Faunatech/Austbat Research Equipment, Bairnsdale Victoria, Australia), and 2 Forest Strainers (Bat Conservation and Management, Carlisle, PA), had been placed <1 m from the bottom of the bat box to capture exiting bats. As in the year 2000, 2 to 4 surveyors followed the bats and collected data points through triangulation and walk-in fixes. Data points were plotted with 2 to 4 GPS receiver readings and digitized

using Missouri's GTMv2.3.x software (Sartwell 1999). The resulting database of points was processed using ArcView GIS. Maps of foraging areas (minimum convex polygons of foraging points) and fixed kernel home range (core areas) of 50% utilization distribution (UD) were created using ArcView's Animal Movement extension (Hooge et al. 1999).

Snag Evaluation

In the summer of 2004, 5 north/south transects were walked by Biologist Aides and PaDot interns to collect data standing dead or dying trees because of their potential as Indiana bat roost trees where these bats do most of their foraging. This primary portion of the foraging area is approximately 580 ha in size, and delineated by: U.S. Route 22 to the north; Juniata Valley Road (SR2022) to the east; an abandoned railroad grade on the south; and a stream drainage (0.5 km northeast of the village of Reese) on the west. A total of 8.15 km were walked. All snags (trees 〈 50% dead, >10.16 cm dbh, and >2 m in height) within 15 m of the transect were recorded for a total of 24.45 ha sampled. For each snag, distance from transect, dbh, total height, estimated percent live, decay class, estimated percentage of exfoliating bark, estimated hours of solar exposure, presence of bole cavities, latitude/longitude, and tree species were recorded. Decay classes were: 1 - snags that have recently died, have little decay, and retain their bark; 2 - snags that show some evidence of decay, have lost some bark, lost some branches, may have lost portions of top, and have some decay; 3 - snags that have extensive decay, are missing the bark, are missing most of the branches and have a broken top. Using these criteria, surveyors placed each snag within the best-suited decay class (1-3).

Roadkills

Indiana bats, as well as little brown bats, cross Route 22 to travel to foraging areas. A major upgrade is planned for this portion of highway. To monitor highway impacts of bats crossing Route 22 at Canoe Creek, searches for roadkills were conducted on 4.3 km (2.7 mi) of highway. The length consists of 2.7 km (1.7 mi) west and 1.6 km (1.0 mi) east of the Route 22 bridge over the Canoe Creek. On 18 days between 8 June and 29 July 2004, a surveyor walked on each side of the highway searching for all roadkills. Latitude and longitude were recorded with a Magellan 315 GPS unit. Species were identified as closely as possible and removed from the highway. All bats found were collected, tagged, and frozen.

Evening counts of traveling bats exiting the Canoe Creek roosts were conducted at the U.S. Route 22 Canoe Creek bridge on 3 evenings (6, 7, and 8 July 2004). Four stations established in 2001 were used for monitoring (Butchkoski and Hassinger, 2002b). One surveyor was positioned at each of the 4 stations with a tally counter and survey form. Surveyors arrived 30 minutes prior to sunset for dusk counts. Temperature, wind, and sky conditions were recorded prior to the count. Counts began as the first bat was seen crossing the highway. The time of the first count was recorded, and tallies were grouped by 10-minute intervals until crossing activity ceased.

Hartman Mine Trapping

Sampling of bats "swarming" at the Hartman Mine entrances was done using harp traps (Tuttle 1974) during spring (March to May) or fall (August to November). Traps were placed at dusk and monitored and tended at least hourly. We recorded habitat, species information, and effort.

Indiana Bat Migration Study

In April 2005, a total of 6 Indiana bats were radio-tagged and released as they exited the Hartman Mine in an attempt to find additional local maternity roosts and/or follow them to more distant summer roosts. On the evening of capture they were radio-tagged with 0.4 g Holohil LB-2N (Holohil Systems Ltd, Ontario, Canada) transmitters with a 21-day battery. All transmitters were programmed to the same frequency (172.170 MHz) to eliminate the need for scanning during searches. Twenty transmitters were tested for signal strength and accuracy at 172.170 MHz using project receivers. Because of variances among transmitters and receivers, only 6 of the 20 transmitters were selected for this project. To reduce stress and provide energy before release, captured bats were fed meal worms and wax worms, which they readily accepted after their ~6 month fast. Six ground-tracking vehicles were outfitted with Telonics TR-4 receivers (Telonics Inc., Mesa, AZ), 3-element collapsible antennas (AVM Instrument Co., Ltd, Colfax, CA), GPS units with real-time feed into laptop computers loaded with digital topographic maps (Terrain Navigator, Maptech, Inc., Amesbury, MA) for location information, and transceiver radios for communication. A Commonwealth of Pennsylvania aircraft, Cessna 182, was outfitted with new cables, left/right/both switch box, 2 antenna strut mounts, and 2 4-element antennas (Advanced Telemetry Systems (ATS), Isanti, MN). Antennas were mounted in accordance with: *Procedures for the Use of Aircraft in Wildlife Telemetry Studies* (Gilmer et al. 1981). The ATS left/right/both switch box proved far superior to others tested. The aircraft cockpit was equipped much as the ground-tracking vehicles with a transceiver radio for communication, laptop with digital maps and GPS for real-time tracking of the aircraft's location. Also within the aircraft for signal detection, a Model R1000 telemetry receiver (Communication Specialists, Inc., Orange, CA) was attached to the ATS switchbox, followed by a Telonics TNR-3000 sound filter (to filter out background noise) and headphones. Antennas and receivers were all tuned to the 172 MHz range. In addition to Terrain Navigator software, the aircrafts laptop contained ArcGIS 9.0 (Environmental Systems Research Institute Inc., Redlands CA). ArcGIS 9.0 was used with real-time GPS tracking to lay out and fly search grids. Once detection occurred, Terrain Navigator was used to view and record detailed locations on USGS topographic quadrangles. After extensive testing, consistent signal detection was found to have a range of 4.8 km (3 mi.) off each wing at 762 m (2,500ft.) above ground level (AGL). Standard search protocol was to fly 762 m AGL using 6.4 km (4 mi) transects.

The initial plan was to release the radio-tagged bats around midnight with the plane in the air and ground vehicles strategically stationed on high points. The ground crew would track 1 to 2 bats and collect as much behavior information as possible. The aircraft would keep track of as many bats as possible. Should the animals spread apart, attention would focus on the bat or bats that move out the earliest and farthest with the aircraft being the primary tracking vehicle and continually directing the ground crew to the animal's location during night movements. The aircraft was also the primary search vehicle during the day, flying grid patterns for lost animals in an attempt to find roosting bats.

RESULTS

Canoe Creek Church and Adjacent Roosts

Since 1999, 59 Indiana bats have been documented using the church attic, bat boxes, and condo with 2 new individuals found in 2004, including 1 adult female (lactating) harp trapped exiting the condo, and 1 juvenile male harp trapped exiting the church attic. Seven previously banded females were captured at Canoe Creek bat maternity roost structures. Four adult females (2 lactating, 1 post-lactating, 1 non-reproductive) were recaptured in the attic; 2 originally banded in the attic in 2001 as adults; 1 initially banded in the attic in 2002 as a juvenile; and 1 adult first captured at the Hartman mine in the spring of 2002. Three adult lactating females were captured exiting a large aluminum-shell bat box (Fig. 1) located between the church and condo; 1 initially banded in the church attic in 2001, 1 banded in the attic in 2002, and 1 banded in the attic in 2003.

Visual observations were also conducted of the bat boxes, condo, and Traxler garage. These were performed during daylight hours by shining a bright light into the roost crevices. Yellow bands (Indiana bats), and estimates of total roosting bats were recorded. When possible, sex of banded bats was determined by band placement (males are banded on the right forearm and females the left). On 24 May 2004, 1 banded female Indiana was found in the 7-chamber aluminum-shell bat box with ~80 other bats; the 14-chamber aluminum bat box contained ~200 bats with 4 yellow bands, 3 female and 1 male Indiana bat. The bat condo was inspected on 7 June 2004 with 1 female Indiana bat found among ~3,000 total bats. On 10 June: the 7-chamber box was inspected again with 2 female Indiana bats found among an estimated 30 other bats; the 14-chamber bat box contained ~200 bats with no yellow bands found. The Traxler garage baffles were inspected on 17 June with a count of ~50 bats including 1 banded male Indiana. The 14-chamber aluminum bat box was observed after the dusk exit (21:10 h) on 21 June and 1 banded female Indiana bat was observed with a pup under the left wing among ~20 other bats. The 7-chamber and 14-chamber aluminum bat boxes were observed on 23 June with respective counts of 50 and 100 bats including 3 and 1 female Indiana bats. On 12 July 2004 the Traxler garage baffles showed use by ~300 bats including 1 male and 2 female Indiana bats. On 10 May 2005: the 14-chamber aluminum bat box was found to contain ~200 bats with 3 female Indiana bats and 1 Indiana bat of undetermined sex; in the bat condo 1 female Indiana bat was observed among many other bats.

Temperature profiles of Indiana bat roosts within the attic were updated during the course of banding and recording recaptures. When entering the attic, we recorded the temperature range within the attic and the temperature of bat’s roost as documented in Butchkoski and Hassinger (2002). The average roosting temperature of 103 samples is 35.7°C ± 2.67.

Canoe Creek State Park personnel and volunteers annually conduct a count of the total number of bats exiting the church attic at dusk. The 2004 count was conducted on 23 July, resulting in 18,965 bats tallied.

Indiana Bat Foraging Telemetry at Canoe Creek

From 22 June through 23 July 2004, 3 lactating Indiana bats were captured at the Canoe Creek maternity roosts, radio-tagged, and followed to gain more information on that species’ foraging habitat. Two were captured

exiting a large aluminum-shell bat box (Fig. 1) and the third was captured by hand within the church attic. All 3 bats showed exclusive and/or significant use of other artificial roosts at Canoe Creek (bat boxes and condo) during the 2004 reproductive season.

Figures 4 through 6 are maps illustrating foraging areas with activity schedules for each of the 3 radio-tracked Indiana bats. Table 2 describes foraging area size, cover type, and distance to the church roost. Detected visits to day roosts during the night, night roosting >1 h, use of day roosts, and travel/foraging time are summarized in Table 3.

Two of 3 lactating Indiana bats captured exiting a 14-chamber bat box were radio tagged on 22 June 2004. Bat 309PGC (Fig. 4) exhibited erratic behavior upon release. It is suspected that she moved her pup to the condo, demonstrated by the returns visits to nurse. This bat's major foraging area is located west of Canoe Creek on the U.S. Route 22 corridor.

Bat 215PGC was lost for 2 days (Fig 5) after release. It is believed she moved her pup to the smaller 7-chamber bat box. The apparent loss of 215PGC's signal was explained when she was found. During the day of 24 June a faint signal was discovered near the church. The signal was then tracked to the 7-chamber bat box after a frustrating search. It was discovered that when the transmitter is within the aluminum-shell bat boxes, the signal does not emit well and at times does not escape at all. This bat probably used the 7-chamber box the first 2 days but went undetected. Bat 215PGC's major foraging area is located just upstream of a pond.

The last Indiana bat tracked, 221PGC, was also lactating (Fig. 6). She was captured by hand in the church on 12 July. On 17 July she ended her nightly visits to the church roost and began using the condo roost. Given the mid-July date, it is suspected that her pup began to fly and the pair moved to the condo roost. Young are usually volant by early to mid-July (Humphrey and Cope 1977). The major foraging area used was similar to bat No. 309PGC and bisected by the U.S. Route 22 corridor west of Canoe Creek. This bat was also tracked the farthest distance from her roost of any of the Canoe Creek Indiana bats monitored thus far, at 6.7 km to a minor foraging area on Lock Mountain.

In 2004, Indiana bats continue to use foraging habitats similar to those found in 2000 (Butchkoski and Hassinger 2002) but with the availability of additional artificial roosts, the colony is spreading out and using them. This demonstrates the importance of having a variety of roosts, both primary and alternate, to satisfy maternity needs (Callahan et al. 1997)

During 22 full nights of monitoring in 2004, the 3 Indiana bats averaged 7.9 h ± 1.01 out of the day roost (Table 3). By comparison, during 21 full nights of monitoring in 2002, 3 Indiana bats averaged 6.3 h ± 2.1 out of the day roost. In 2000 nocturnal activity of Indiana bats was monitored on 53 nights and time spent out of the day roost each night averaged 7.1 h ± 2.1 (Butchkoski and Hassinger 2002). During 17 full nights of monitoring in 2003, the 2 pregnant little brown bats averaged only 2.18 h ± 2.04 out of the day roost. Also, in 2001, 5 little brown bats were followed for 31 nights, averaging 4.2 h ± 2.8 out of the day roost. Foraging by Indiana bats (Humphrey and Cope 1977) and little browns may be influenced by the time of summer and development of young. Although our sample is still small, the data suggests that little browns spend less time foraging, however cool, wet weather may have had an influence on foraging time. Another explanation for

this variance is that the little brown bats are exploiting a higher insect biomass available at the larger riparian areas. This partitioning of habitats is illustrated in the side-by-side comparison of core (50%UD) Indiana bat and little brown primary foraging areas (both also had minor foraging areas) collected at the Canoe Creek study area (Fig. 7). Little browns focus on the larger riparian areas (river and lake) whereas Indiana bats primarily forage in the upland forest habitats. This larger foraging biomass at prime riparian sites may reduce the amount of foraging time required by little browns and suggests competition between Indiana bats and little browns for prime foraging locations.

Snag Evaluation

To evaluate natural maternity roost potential within foraging areas, 5 transects sampling 24.5 ha were conducted in the summer of 2004. Four-hundred and eight standing dead or dying trees over 2 m in height and >10.16 cm dbh were tallied. Indiana bats are specific in roost tree requirements used for maternity colonies (Farmer et al. 2002). Necessary traits for a typical maternity roost tree include a diameter of 22 cm or greater (64/ha recommended), height of 3 m or more, and exfoliating bark of at least 25% (Gardner et al. 1991), and a density of at least 12 such trees/ha (Farmer et al. 2002). Our samples found 15 snags, 0.61/ha, that were >22 cm dbh, >3m high, and with 25%+ exfoliating bark, far below the recommended 12/hectare (Table 6). In addition, most primary roosts are well exposed to solar radiation (Menzel et al. 2001). Only 2 trees meeting the aforementioned criteria also received an estimated 4 or more hours of solar exposure resulting in 0.08 trees/ha (Table 6). This apparent lack of suitable natural roosts may explain the high success rate of artificial structures at the Canoe Creek study site.

Roadkills

Highway searches of U.S. Route 22 for roadkilled bats were conducted on 18 days from 8 June to 29 July (Table 4). Nineteen bat road-kills were found on 10 of those days that included 15 little brown bats (*Myotis lucifugus*), 2 unknowns, 1 red bat (*Lasiurus borealis*), and 1 hoary bat (*Lasiurus cinereus*). Counts of traveling bats crossing U.S. Route 22 exiting roosts at Canoe Creek were conducted on 3 evenings at the Canoe Creek/U.S. Route 22 bridge (Table 5). Results for the respective dates were: 6 July, 2,101 tallied; 7 July, 1,979 tallied; and 8 July, 2,230 tallied.

Hartman Mine

The Hartman Mine was trapped 15 times to sample Indiana bat swarms at the entrances (Table 1). The swarm was sampled on 13 evenings in September of 2004 and April 2005 resulting in 40 Indiana bats captured. Twenty-nine females were trapped; all but one was captured in April 2005. Of the females captured, 8 were recaptures, 2 of which had been previously documented using the church attic and originally banded in 2000 and 2001. The remaining 6 female recaptures were originally banded at the mine, 1 in 2000, 3 in 2002, and 2 in 2004. Three of the 11 males trapped were recaptures, 2 previously banded at the Hartman Mine in 1999 and 1 again at the mine in 2001.

The biannual interior winter bat count for the Hartman Mine was conducted on 22 February 2005. The survey tallied 26,582 visible bats including 665 Indiana bats. Yellow bands were found on 24 of the Indiana bats; 8 were on the left forearm (females), 8 on the right (males) and 8 for

which the band's side could not be determined. It is difficult to pick out Indiana bats in most Pennsylvania hibernacula. The Hartman Mine has high ceilings (>10m) and Indiana bats are mixed in with the little browns. This is the only Indiana bat hibernaculum, of 13 in Pennsylvania, in which some pure clusters (N=3) are found. However, even within the Hartman mine, the pure clusters only account for ~100 bats. Extensive experience is required to recognize Indiana bats within little brown clusters. This mixing behavior is theorized to be an adaptation for survival of low populations of Indiana bats. The Hartman Mine continues to have the largest known hibernating population of Indiana bats in Pennsylvania.

Indiana Bat Migration Study

In an attempt to locate new summer habitats, 6 female Indiana bats were radio-tagged as they exited the Hartman Mine on 17 April 2005. Bat band numbers and weights were: 262PGC, 6.4 g; 388PGC, 6.9 g; 390PGC, 6.8 g; 360PGC, 7.0 g; 331PGC, 7.1 g; 332PGC, 7.0 g. Only 1 bat, 262PGC was a recapture first caught at the mine in 2002. This bat was actually captured before midnight on 16 April and held in a cooler with ice until the release.

Bat 262PGC was released at 23:00 on 17 April and the ground crew followed this bat a short distance where it stalled and day-roosted on State Game Lands (SGL) 147 in Blair County (~16 km southwest of the mine). By midnight the aircraft was in the air. The remaining 5 bats were radio-tagged and released between midnight and 02:00 on 18 April. The ground crew focused on a fresh bat that was heading east while the aircraft monitored 4 others that were staying somewhat together near the mine. It is believed that the ground crew's bat was 331PGC, released at 00:45 h. By 01:18 this bat was 11.5 km southeast of the mine near Shelleytown, Blair County. It became apparent this bat was moving out very quickly while the others were not. All attention of both aircraft and ground crew was focused on this animal. The ground crew lost the bat as it approached the Raystown Lake. At 01:39 the aircraft found it near James Creek on the lake and tracked it to the other side. By 02:41 it was northwest of Three Springs on Jacks Mountain, ~37 km from the mine. The aircraft eventually found the bat at roost on South Mountain north of U.S. Route 30 near Caledonia Park, Franklin County at 05:27 on 18 April (~92 km from the mine). On the evening of 18 April, the bat exited the roost ~20:17, appeared to forage, and by 21:40 was on the move heading toward Gettysburg. By 22:30 it was on the historic battlefield between Round Top and Gettysburg. At 23:46, tracked by air, it crossed the Mason-Dixon line into Carroll County, MD, and was found foraging near Wentz, MD at 00:27 on 19 April. The bat stayed in this location (~148 km from the mine) using 4 different roost trees before consistently roosting alone under the exfoliating bark of a dead mockernut hickory snag (13 m high with 25 cm dbh) alone. Eventually the roost grew in numbers with 22 bats emerging, including the radio-tagged bat, on 26 April. An informal count of the roost during the week of 16 May (John Chenger, pers. comm.) estimated 40 bats exiting the tree. By the end of May, leaf-out had shaded this roost and a report was received that the colony vacated that tree (John Chenger, pers. comm.). The approximate route this Indiana bat traveled is illustrated in Figure 3.

Air searches during the daylight hours of 18 April found 2 bats day roosting near the Hartman mine, 1 on SGL 147 (presumably bat no. 262PGC) and another along the river near the village of Frankstown. Two additional roosting bats were located on the path of the Wentz, MD bat (presumably

331PGC), 1 in Huntingdon County near Shirleysburg and the other in Franklin County, west of the Blue/Kittatinny mountain turnpike tunnels.

Air support was provided for the Wentz, MD bat on the evening of 19 April in case it continued to travel, which it did not. While flying support, the aircraft located another bat on the southern portion of South Mountain, Adams County at 01:27. The aircraft was unable to approach the location due to flight restrictions around Camp David. This bat was found to be day-roosting by the ground crew in the same general area on 19 April. This may be the bat that was later found by air near Taneytown, MD.

Air search was conducted again during the day on 19 April. Although close approach was not possible, the Camp David bat was found to be roosting somewhere within the Camp David flight restriction zone. However, another bat was located on the west shore of the lower Susquehanna River at the Conowingo Reservoir. This bat was not recovered after detection that day. Signal interference from the nearby power plant may have hampered ground crew tracking and by the time the aircraft began intensive searches, the bat may have entered restricted air space to the south and east.

Due to unsuitable weather and pilot unavailability, the next air search was not conducted until 27 April when an additional roost tree was located near Taneytown, Carroll County MD (135 km from the mine). This live shagbark hickory (23 m high and 84 cm dbh) had an exit count of 63 bats (including the radio-tagged bat) on 27 April. This bat also used another live shagbark hickory (27 m high and 160 cm dbh) but emergence counts at that tree were not successful when being used by the radio tagged bat due to weather conditions. One emergence count was conducted on the second tree but, due to cold weather, no bats emerged. Air searches were also conducted at previously located day roosts in Pennsylvania, all transmitter signals were gone from these locations which included the Hartman mine area, Shirleysburg area, Blue/Kittatinny mountain turnpike tunnel area, South Mountain, and the lower Susquehanna River.

The last air search was conducted on 27 April when preferred search locations were found to be within restricted air space around Camp David, Washington DC, Baltimore, and Philadelphia. It is likely that more animals continued south and east but the aircraft was unable to conduct searches in these areas. However, efforts were successful with finds of 2 roosts in Carroll County, MD (Fig. 3). Maryland plans to continue monitoring and attempt to capture and radio-tag Indiana bats on these newly found summer ranges. The project is also successful in following migrating Indiana bats for a record 135 km (84 mi) and 148 km (92 mi) from a hibernaculum.

RECOMMENDATIONS

1. Continue to band and collect recapture data on Indiana bats using the Canoe Creek Church attic.

2. Investigate and plan for another migration telemetry project at other Indiana bat hibernacula within the state.

3. Share information and techniques learned in tracking migrating Indiana bats with adjacent states.

4. In 2006, continue sampling for road-killed bats.

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Table 1. Foraging area size, cover type, and distance to day roost for 3 female Indiana bats radio-tracked in 2004.

Myotis sodalis Band No.	Foraging Area[a]	Data Points[b]	Foraging Area[c] (Hectares)	Radio Tracking Dates	Prevalent Cover-Type[d]	Core Area to Roost[e] (Kilometers)
215PGC	A	90	62	22 June - 1 July	415	2.4
221PGC	A	157	166	12 - 22 July	415	1.6
221PGC	B	55	142	12 - 22 July	415	5.3
309PGC	A	53	78	22-27 June	415	1.3

[a]Where bat spent most of its foraging time. A=Primary Area, B=Minor Area

[b]Points within main foraging area used to compute core areas. Points were derived from radio telemetry triangulation and walking in on animal with receiver.

[c]Main foraging area in hectares, i.e. the area where the bat spent most of its foraging time.

[d]Anderson Level III classification code for main foraging area (Anderson et al. 1976). Code 415 = Deciduous forest, mature stage, shrub layer moderate to dense.

[e]Measurement (km) taken from largest core area if multiple.

Table 2. Dates, roosting and foraging times, and weather data for 3 Indiana bats radio-tracked in 2004.

Bat No.	Date	Roost Exit Time	Night Roosting >1 hr (hrs)	Day Roost Time On	Day Roost Type	Foraging Time (hr)[a]	Weather Max/Min Temperatures[b]	Remarks[c]
309PGC[d]	22-23 June	22:50		05:20	church	6.50	26.7/17.5°C	PC
	23-24 June	20:57	condo (2.36)	05:23	condo	6.07	26.3/13.7°C	PC
	24-25 June	21:16		05:24	condo	8.13	27.5/17.1°C	PC
	25-26 June	21:11	condo (1.25)	05:33	condo	7.11	22.9/18.3°C	OC
	26-27 June	21:10	not monitored intensively	05:23	condo		22.8/10.2°C	CS
	27-28 June	21:00	condo (1.60)	05:24	condo	6.44	22.1/12.2°C	PC
	28-29 June		transmitter recovered in condo				19.8/12.6°C	CS
215PGC[e]	22-23 June		not monitored				26.7/17.5°C	PC
	23-24 June		not monitored		bat box		26.3/13.7°C	PC
	24-25 June	21:00		05:37	bat box	8.61	27.5/17.1°C	PC
	25-26 June	20:48	not monitored	05:42	bat box		22.9/18.3°C	OC
	26-27 June	20:52		02:08	bat box	5.27	22.8/10.2°C	CS
	27-28 June	20:54		01:58	bat box	5.06	22.1/12.2°C	PC
	28-29 June	20:57		02:21	bat box	5.04	19.8/12.6°C	CS
	29-30 June	20:50		03:08	bat box	6.30	23.2/12.6°C	CS, FG
	30-1 July	20:55		05:40	bat box	8.75	25.2/14.5°C	CS, FG
	1-2 July	20:54		03:33	bat box	6.65	27.5/14.5°C	CS
	2-5 July		not monitored					
			transmitter recovered under bat box on 6 June					

Table 2 (cont.). Dates, roosting and foraging times, and weather data for 3 Indiana bats radio-tracked in 2004.

Bat No.	Date	Roost Exit Time	Night Roosting >1 hr (hrs)	Day Roost Time On	Day Roost Type	Foraging Time (hr)[a]	Weather Max/Min Temperatures[b]	Weather Remarks[c]
221PGC[f]	12-13 July	21:01		05:48	church	8.78	23.6/21.3°C	OC, FG
	13-14 July	20:59		05:41	church	8.70	26.3/20.6°C	OC, FG
	14-15 July	20:57		05:45	church	8.78	22.5/19.0°C	OC, FG
	15-16 July	21:02	church (1.05)	05:51	church	7.77	19.0/17.1°C	OC, DZ
	16-17 July	21:22		05:46	church	8.40	25.2/15.2°C	PC
	17-18 July	21:07		05:55	condo	8.80	19.8/17.9°C	RA, DZ, OC
	18-19 July	21:11		05:44	condo	8.55	20.9/18.3°C	RA, DZ, OC
	19-20 July	21:09		05:42	condo	8.55	24.0/16.4°C	RA, DZ, PC
	20-21 July	21:09		05:39	condo	8.50	24.8/17.1°C	PC, FG
	21-22 July	21:04	not monitored intensively		condo		27.9/19.8°C	PC
	22-23 July	21:06	Tree (1.33)	05:55	condo	7.49	23.6/21.3°C	RA, FG
	23-25 July		bat not monitored					
			no signal obtained after 25 July					

[a]Foraging time in hours: includes travel to & from foraging sites & short periods of undetected and/or unverified tree roosting of less than one hour.

[b]Temperatures were recorded with HOBO® Temp data loggers (Onset Computer Corp.) at church.

[c]Weather remarks were obtained from surveyors notes with following codes: PC=partly cloudy; OC=full cloud cover; DZ=drizzle; FG=fog; HZ=haze; RA=rain; TS=thunderstorms; CS=clear sky

[d]Lactating adult female weighing 6.5g. Captured exiting bat box.

[e]Lactating adult female weighing 6.6g. Captured exiting bat box.

[f]Lactating adult female weighing 6.9g. Captured by hand in church attic.

Table 3. Results of snag transect survey sampling 24.45 ha within a 580 ha portion of known Indiana bat foraging habitat.

	Total Snags: 50%+ dead, >2 m high, and >10.16 cm dbh	Snags >22 cm dbh	And snags 3+ m in height	And with 25%+ Exf. Bark	And estimated 4 or more hrs. Solar Exposure
No. Snags:	408.00	120.00	118.00	15.00	2.00
Snags/Hectare:	16.69	4.91	4.83	0.61	0.08
Recommended:		64.00		12.00	

Table 4. Results of highway searches of U.S. Route 22 for roadkill bats conducted on 18 days from 8 June to 29 July, 2004.

Search	Species[a]				Sex			Age			Reproductive Condition			
Dates	*M.luc*	*L.bor*	*L.cin*	Unk.	M	F	Unk.	Ad.	Juv.	Unk.	Non-repro.	Post-lact.	Unk.	Total
8-Jun			1				1			1			1	1
15-Jun				1			1			1			1	1
17-Jun														0
28-Jun														0
21-Jun		1					1	1					1	1
25-Jun	6				1	2	3	1	2	3			6	6
28-Jun														0
30-Jun														0
7-Jul	2					2			2		2			2
9-Jul	1					1					1			1
13-Jul	1					1		1					1	1
15-Jul	1						1			1			1	1
16-Jul	1					1			1		1			1
20-Jul	3			1		2	2	1	1	2	2		2	4
21-Jul														0
23-Jul														0
27-Jul														0
29-Jul														0
Total														19

[a] *M.luc = Myotis lucifugus; L.bor = Lasiurus borealis; L.cin = Lasiurus cinereus.*

Table 5. Evening counts of traveling bats crossing U.S. Route 22 at the bridge over Canoe Creek after exiting roosts.

Date	Temp °C	Local Sunset (h)	First-Last Bat Time (h)	Duration in Hours	Station 1	2	3	4	Total
6-Jul-04	20.00	20:45	20:57-21:27	0.50	576	585	241	699	2,101
7-Jul-04	21.11	20:45	20:45-21:25	0.66	509	665	233	572	1,979
8-Jul-04	15.55	20:45	20:56-21:26	0.50	456	657	285	832	2,230
Station Total					1,541	1,907	759	2,103	6,310

Table 6. Summary of Hartman Mine trapping in fall 2004 and spring 2005.

Date	Units of Effort[a]	Species[b] *M.luc*	*M.sep*	*M.lei*	*M.sod*	*E.fus*	*P.sub*	Total
27-Sep-04	13.3	152			8		1	161
30-Sep-04	16.0	563			3			566
06-Apr-05	30.0	120	2	1	1			124
09-Apr-05	18.0	41						41
10-Apr-05	36.0	838	9	1	2	2		852
11-Apr-05	27.0	668	7		2			677
12-Apr-05	27.0	258	6		1			265
13-Apr-05	27.0	369	3			1		373
14-Apr-05	24.0	574	2		1			577
15-Apr-05	37.0	740	1		2			743
16-Apr-05	33.0	1,167	10	2	2		1	1,182
17-Apr-05	34.9	2,083	13		13	1		2,110
20-Apr-05	13.5	164	5		2			171
21-Apr-05	30.0	312	2		1			315
22-Apr-05	12.0	250			2			252
Total		8,299	60	4	40	4	2	8,409

[a]One unit of effort is equal to 1 square meter of net or trap surface in a set position for 1 hour.

[b]*M.luc = Myotis lucifugus; M.sep = Myotis septentrionalis; M.lei = Myotis leibii; M.sod = Myotis sodalis; E.fus = Eptesicus fuscus; P.sub = Pipistrellus subflavus.*

The success of bat boxes has opened up a new dilemma. All wood structures require maintenance. To reduce maintenance concerns, research is focusing on methods to make boxes more durable. The aluminum shell is a step in that direction. This design has proven successful in recent trials.

The design uses an aluminum shell, although steel would likely work too. The advantage of using aluminum is that it resists corrosion and should last a long time.

Bats enter through the bottom of the box. Four inches extend from the bottom for a landing plate.

You'll need to find a welding/machine shop or individual to construct the shell. When you receive the shell, it is likely that the dimensions will not be exact. There will probably be some minor variations that will require modifying the interior measurements. For this reason, measurments specified are a guide. Other variations could be yours. If different thickness of plywood are used, modifications will need to be made to insure that the roost provides for 3/4" (+/- 1/8") roosting crevices.

Preparation of Shell- The shell needs to be treated to allow it to absorb heat, reduce light in the roost, and protect the exterior.

1. Spray paint the interior with a light coat of black paint to reduce light reflections inside the structure.
2. Paint the top exterior black so that it absorbs heat. A durable material that could be used is plastic truck bed lining material available from automotive stores. Insure to treat the exterior of the back.
3. Paint the lower exterior a light color to provide cooler roosting environments on hot days. Insure to treat the back exterior.
4. Cut out the wooden interior roosting structure parts as indicated in the diagram. Use exterior grade yellow pine or spruce plywood. Do not use luan plywood. Modify the dimensions if necessary so that, once assembled, it will slide into the shell. Cut grooves in 4- 2X4's for baffle hangers.
5. Once all parts are cut out, Spray a light coat of black paint or brush a light coat of black laytex stain over the wooden parts. This will help to keep the interior dark.
6. After painting, score the wood with a sharp edge to provide secure roosting holds for the bats. You should be able to easily walk your, fingers up the wood using your finger nails. Scratches should be ~1/4" apart. This is an important, labor intensive part of bat box construction.
7. Using a staple gun, staple a 10" high X 1'-11" long piece of fiberglass window screening to the bottom of the back. This creates a stable landing platform for returning bat pups coming back to the roost when learning to fly.
8. Once the wood is good and rough, begin the assembly by attaching the baffle hangers to the plywood back with wood screws or galvanized drywall screws.
9. Install the roosting baffles. Four crevices have a closed top. This provides heat conserving crevices for bats to group together on cool, cloudy days. Use 3/4" X 1" strips of board to sandwich 2 baffles together. Start with the longer baffle in the back. Cut and attach the top strip with screws first. Measure the side strips to fit snug on top of baffle hangers.
10. Lay the wood interior assembly next to the shell. You want a **1/2" to 3/4" space at the top of the roost baffles** so that bats can move over the top of the roost baffles and get against the metal roof. This is a highly desirable spot on cool but sunny days. By laying the assembly beside the shell you can estimate how much of the roosting baffle needs to be above the upper baffle hangers. This will vary with each baffle since the roof has slope to it.
11. Once the wood interior is assembled, slide it into the metal shell. The bottom of the back should align with the bottom of the shell. Drill holes through the back, and using 1/2" screws, attach the back to the shell. Determine where the baffle hangers are located and drill holes in the shell to secure the hangers to the shell with 1" screws. Make certain the baffle hangers do not block the vent holes in the shell. Touch up exterior screws with paint.
12. Erect by drilling holes in the 2" top extension of the shell and also through the lower wood back / bottom portion of the shell.
13. Place where it gets plenty of sun on a pole or building. Orient the front of the box in a southerly direction. Preferred orientation is to the SE so that it warms up quickly in the morning. Box should get at least 7 hours of direct sun. Place within 10-20 yards of cover, such as trees. Bats prefer to dive into cover after exiting the roost to avoid predation. If erecting on a pole, the bottom of the box should be at least 10' off the ground.
14. Just add bats!

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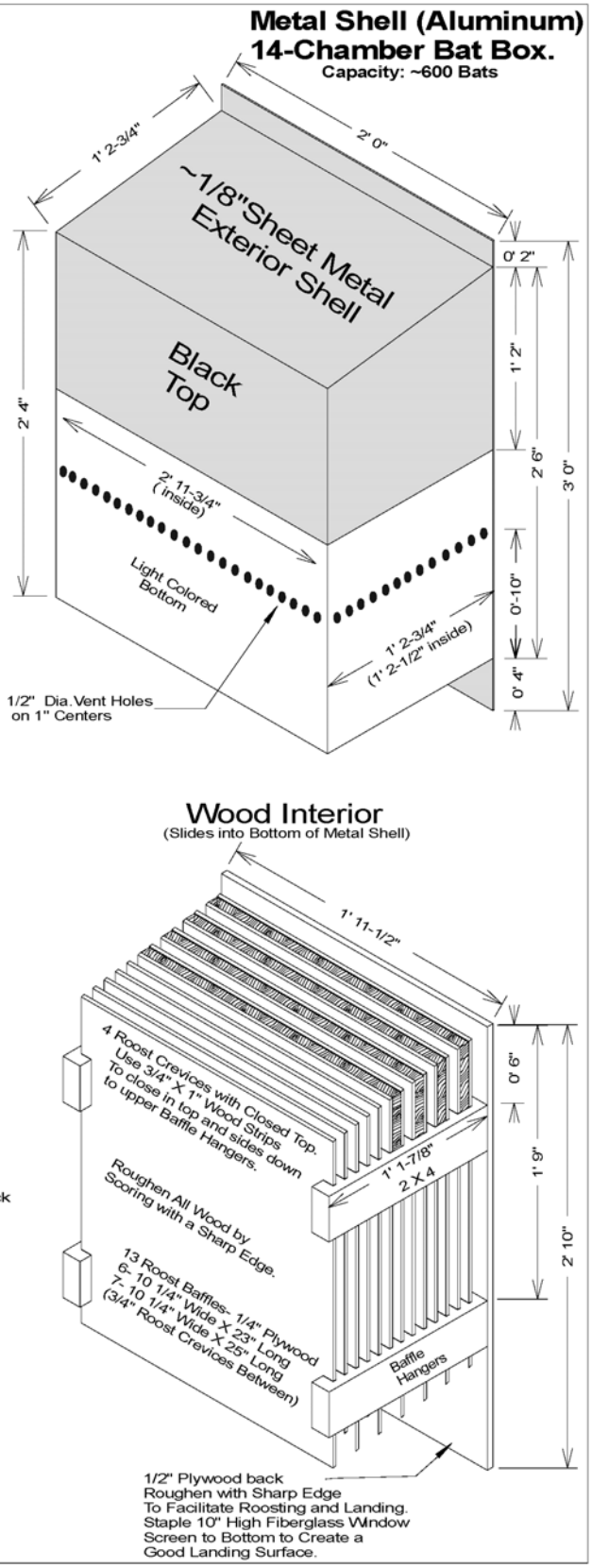

Figure 1. Description and plan for 14-chamber bat box used at Canoe Creek.

The success of bat boxes has opened up a new dilemma. All wood structures require maintenance. To reduce maintenance concerns, research is focusing on methods to make boxes more durable. The aluminum shell is a step in that direction. This design has proven successful in recent trials.

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7. Using a staple gun, staple a 10" high X 1'-11" long piece of fiberglass window screening to the bottom of the back. This creates a stable landing platform for returning bat pups coming back to the roost when learning to fly.
8. Once the wood is good and rough, begin the assembly by attaching the baffle hangers to the plywood back with wood screws or galvanized drywall screws.
9. Install the roosting baffles. Every other crevice has a closed top. This provides heat conserving crevices for bats to group together on cool, cloudy days. Use 3/4" X 1" strips of board to sandwich 2 baffles together. Start with the longer baffle in the back. Cut and attach the top strip with screws first. Measure the side strips to fit snug on top of baffle hangers.
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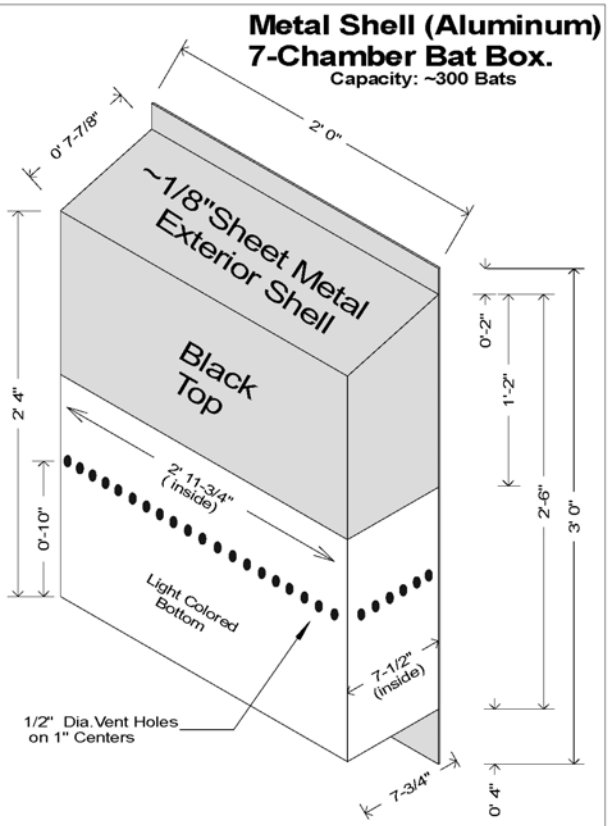


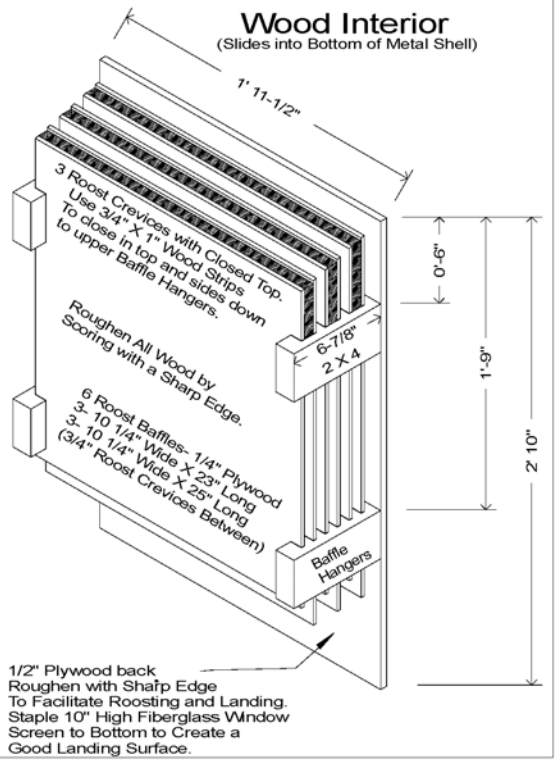
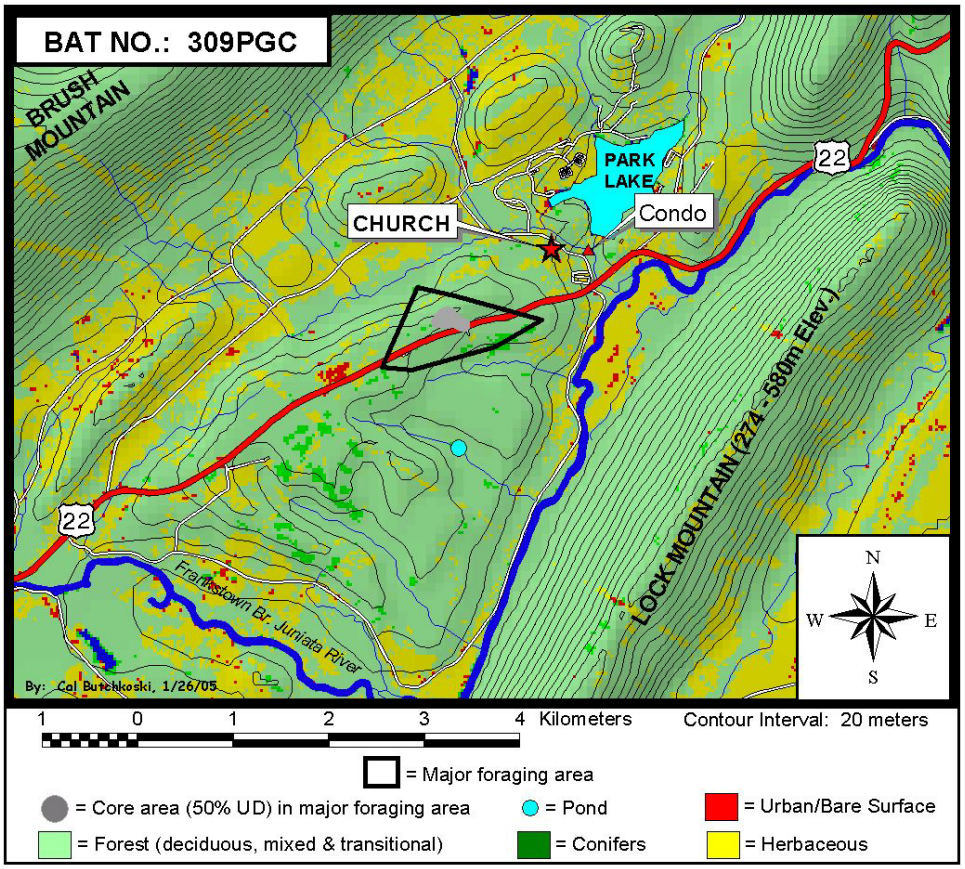


Figure 2. Description and plan for 7-chamber bat box used at Canoe Creek.



ACTIVITY SUMMARY

DATE	TIME (19:00 – 7:00)
22-23 June	*Tagged & released near bat boxes* (22:50 – (22:57) A (01:28) – E[a] – (02:06) A (04:38) – CO[b] – (05:20) CHURCH
23-24 June	CHURCH (20:57) – CO[c] – (22:01)A(23:38) – CO[d] – (00:55) A (03:44) – CO[e] – A[f] – (05:23) CONDO
24-25 June	CONDO (21:16) – A[g] – CO[h] – (23:42) A (02:49)[i] – (03:19)A(04:53) – (05:24) CONDO
25-26 June	CONDO (21:11) – (21:20) A (23:53) – CO[j] – (01:17) A (03:23) – CO[k] – A[l] – (05:33) CONDO
26-27 June	CONDO (21:10) – *not monitored from 21:10 to 03:10* – (03:10)CO(04:54) – A[m] – (05:23) CONDO
27-28 June	CONDO (21:00) – (21:06) A (23:30) – C0[n] – (00:10) A (03:14) – C0[o] – A – (05:24) CONDO
28-29 June	***Transmitter did not exit from roost. Transmitter found ~22:00 on floor inside condo.***

[a]Erratic behavior: Bat radio-tagged after being trapped exiting 15 chamber aluminum bat box. At 01:30 she was detected at bat box. From 01:34 - 01:41 bat was roosting in the condo. After exiting condo, it flew behind the church at 01:51 and continued on to faraging area A. It is suspected that between 01:30 and 01:34 she moved her pup from the previously disturbed bat box to the condo.

[b]Roosting in condo from 04:38 - 05:15.

[c]Roosting in condo from 21:05 - 21:45.

[d]Roosting in condo from 23:48 - 00:42.

[e]Roosting in condo from 03:53 - 04:41.

[f]On foraging area A from 04:42 - 05:16.

[g]On foraging area A from 21:26 - 22:50.

[h]Roosting in condo from 22:52 - 23:42.

[i]Roosting in condo from 02:50 - 03:00.

jRoosting in condo from 23:57 - 00:36.

[k]Roosting in condo from 03:26 - 04:02.

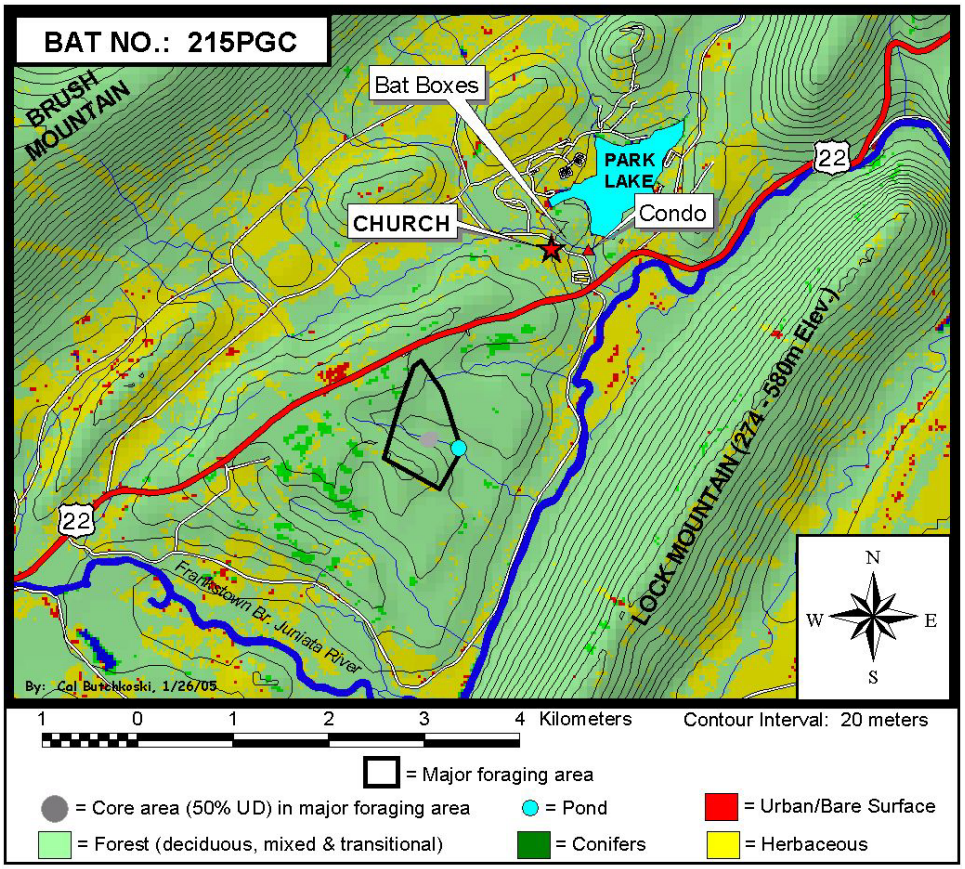
[l]On foraging area A from 04:08 - 05:20.

[m]On foraging area A from 04:54 - 05:23.

[n]Roosting in condo from 23:33 - 00:10.

[o]Roosting in condo from 03:14 - 04:13.

Figure 3. Activity Schedule for a 6.5g lactating female Indiana bat trapped while exiting a 14-chamber, aluminum-shell bat box located in wetland between the church and condo.



ACTIVITY SUMMARY

DATE	TIME (19:00 – 7:00)
22-23 June	*Tagged & released near bat boxes* (22:50) — *Lost near church at 23:00*[a]
23-24 June	*Bat not found on this date. On June 24 a weak signal found at 7 chamber aluminum box. Aluminum bat box shell found to block signal.*
24-25 June	7-BAT BOX (21:00) — CO[b] — (21:13) A (00:30) — CO[c] — (01:01) A (03:49) — (05:37) 7-BAT BOX
25-26 June	7-BOX (20:48) — *Not monitored. Attention was focused on Bat # 309PGC* — (05:42) 7-BAT BOX
26-27 June	7-BOX (20:52) — (21:20) A (23:32) — 7B[d] — C[d] — (02:08) 7-BAT BOX
27-28 June	7-BOX (20:54) — (21:37) A (01:58) — (01:58) 7-BAT BOX
28-29 June	7-BOX (20:57) — (21:30) A (01:58) — (02:21) 7-BAT BOX
29-30 June	7-BOX (20:50) — (21:30) A (02:56) — (03:08) 7-BAT BOX
30-1 July	7-BOX (20:55) — (21:30) A (04:15) — 7B[e] — A[e] — (05:40) 7-BAT BOX
1-2 July	7-BOX (20:54) — (21:00) A (23:00) — E[f] — (00:26) A (03:30) — (03:33) 7-BAT BOX
2-5 July	*Not monitored. Transmitter found on ground under 7-chamber bat box on evening of 6 July.*

[a]Bat radio-tagged after being trapped exiting 15 chamber aluminum bat box and immediately dissappeared. Later it was found that the radio signal will not penetrate the aluminum bat box shells. This bat probably eluded surveyors by dissappearing in bat box. It is believed that this bat moved its pup from the 15 chamber bat box to the 7 chamber bat box, then the condo, and back to the 7 chamber box.

[b]Roosting in condo from 21:08 - 21:13

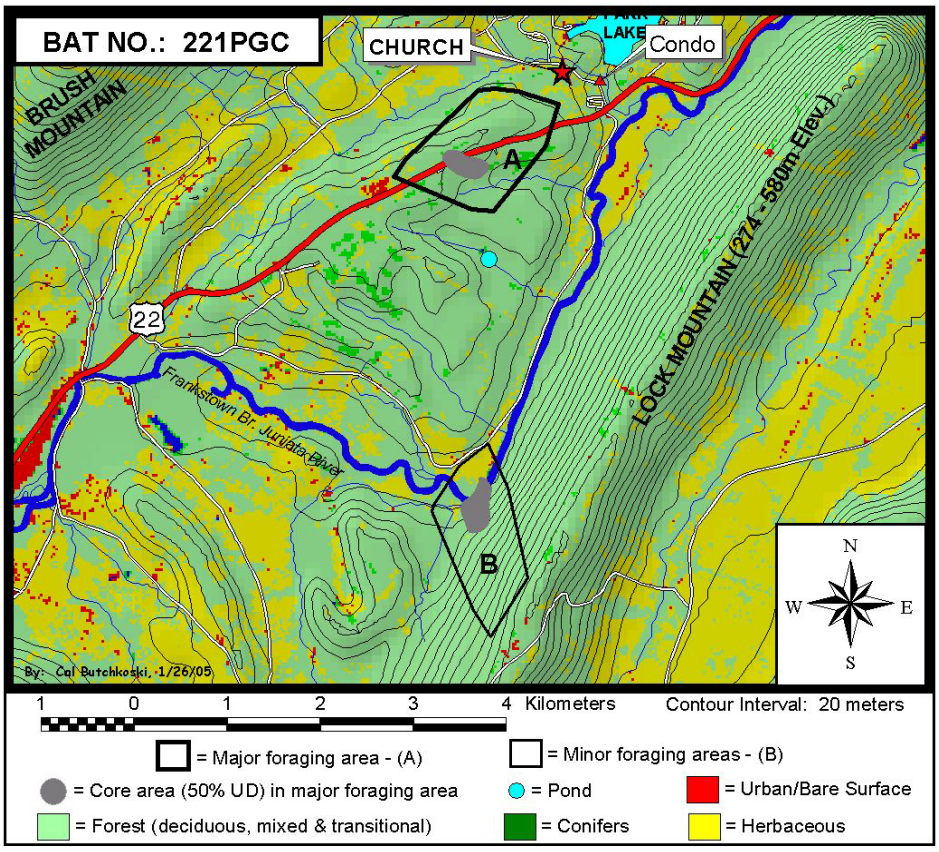
[c]Roosting in condo from 00:33 - 00:51

[d]Roosting in 7-chamber aluminum shell bat box from 00:38 - 00:48. It then moved to condo and roosted from 00:51 - 01:03.

[e]Roosting in 7-chamber aluminum shell bat box from 04:15 - 04:48; Foraged behind church and area A from 04:48 - 05:40.

fEratic Behavior: 23:16 flying behind church; Roosting in 7-chamber bat box from 23:20-23:29; Bat then flies behind church; Returns to roost in 7-chamber bat box from 23:32 - 23:35; Returns to roost in same bat box from 23:45 - 23:46; Returns to roost in 7-chamber box again from 23:58 - 00:04.

Figure 4. Activity Schedule for a 6.7g lactating female Indiana bat trapped while exiting a 14-chamber aluminum-shell bat box located in wetland between the church and condo.



ACTIVITY SUMMARY

DATE	TIME 19:00 – 20:00 – 21:00 – 22:00 – 23:00 – 00::00 – 1:00 – 2:00 – 3:00 – 4:00 – 5:00 – 6:00 – 7:00
12-13 July	CHURCH (21:01) | (21:12) A (02:11) | CH[a] | (02:56) A (05:39) | (05:48) CH
13-14 July	CHURCH (20:59) | A[b] | (22:28) B (01:18) | CH[c] | (02:30) A (05:33) | (05:41) CHURCH
14-15 July	CHURCH (20:57) | (21:03) A (00:54) | CH[d] | A[e] | CH[f] | A[g] | (05:45) CH
15-16 July	CHURCH (21:02) | (21:06) A (04:20) | CH[h] | A[i] | (05:51) CH
16-17 July	CHURCH (21:22) | A[j] | (22:14) B (00:48) | (01:03) A (02:51) | CH[k] | (04:10)A(04:36) | (05:46) CH
17-18 July	CHURCH (21:07) | (21:15) A (05:45) | (05:55)CONDO
18-19 July	CONDO (21:11) | (22:09) B (01:55) | (02:09) A (05:44) | (05:44) CONDO
19-20 July	CONDO (21:09) | (21:20) A (05:30) | (05:42) CONDO
20-21 July	CONDO (21:09) | (22:22) B (01:32) | (01:32) A (05:36) | (05:39) CONDO
21-22 July	CONDO (21:04) | (21:04) A (00:15 +) | *~not monitored remainder of night~* | (?) CONDO
22-23 July	CONDO (21:06) | (21:20) A[l] (00:40) | (00:47) A (05:45) | (05:55) CONDO
23-25 July	***bat not monitored. No signal obtained after July 25 and transmitter not recovered.***

[a]Roosting in church from 02:15 - 02:45.
[b]On foraging area A from 21:06 - 22:09.
[c]Roosting in church from 01:45 - 02:24
[d]Roosting in church from 00:58 - 01:52
[e]On foraging area A from 02:05 - 03:08
[f]Roosting in church from 03:17 - 04:26
[g]On foraging area A from 04:30 - 05:45.
[h]Bat flew around church, bat boxes, and condo from 04:22 - 05:02. Roosted in church from 05:02 - 05:13. Eratic behavior noted.
iOn foraging area A from 05:16 - 05:51. Found roosting in church at 05:51.
[j]On foraging area A from 21:30 - 22:00.
[K]Roosting in church from 03:09 - 03:58.
[l]Bat appears to be roosting during this time period in hollow west of church. Signal is steady with rain and fog. Rain stops at 00:12. This night roost was probably a tree and was not located due to rain.

Figure 5. Activity Schedule for a 6.9g lactating female Indiana bat captured by hand in the Canoe Creek Church attic.

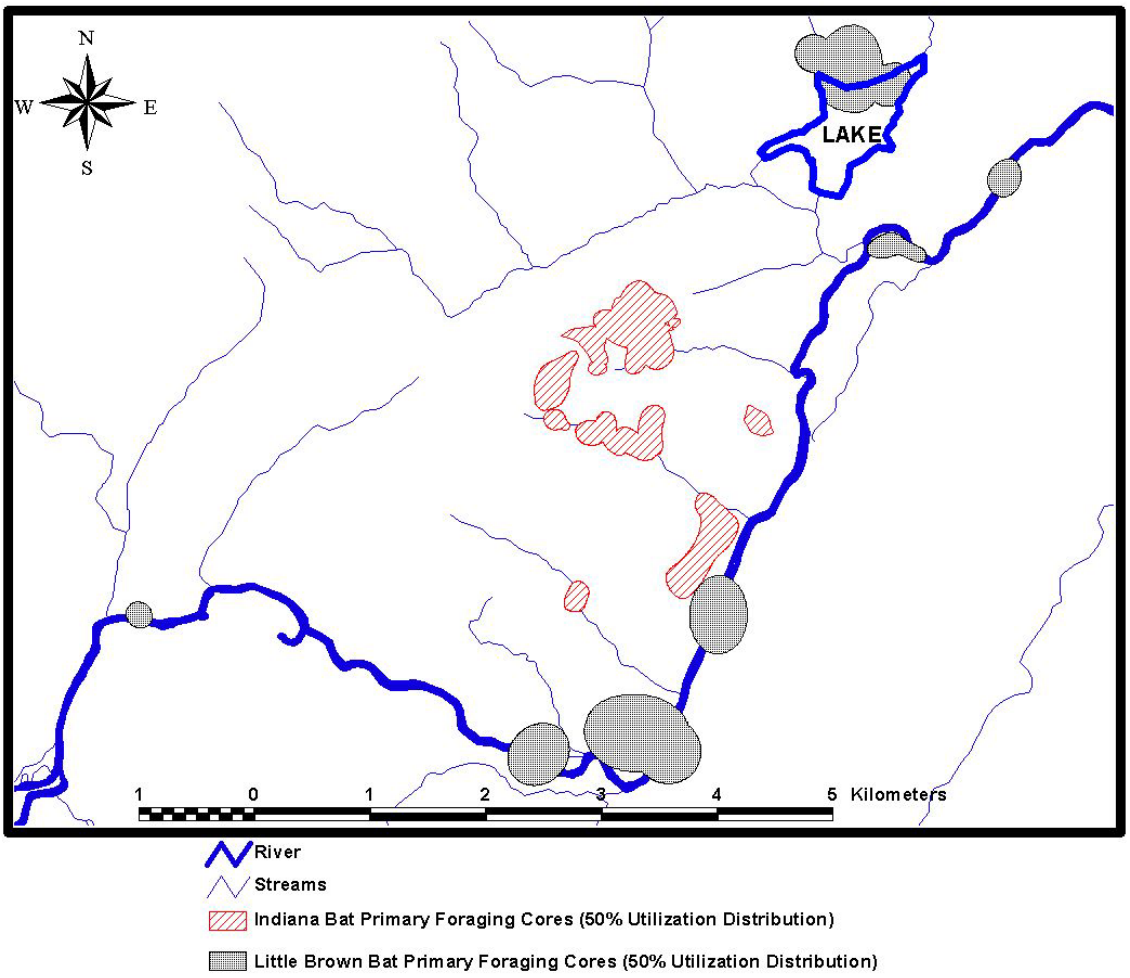


Figure 6. Primary foraging area cores (50% Utilization Distribution) for 12 Indiana bats and 8 little brown bats at Canoe Creek study site in Blair County, Pennsylvania. Both Indiana and little brown bats also had minor foraging areas. Only Primary (where they spent most time foraging) foraging area cores are illustrated. Primary foraging cores for little brown bats are on and adjacent to major bodies of water (river and lake) while Indiana bat cores are located on intermittent streams and dry forested hillsides. The above data was collected through 5 years summers of telemetry (2000 thru 2004).

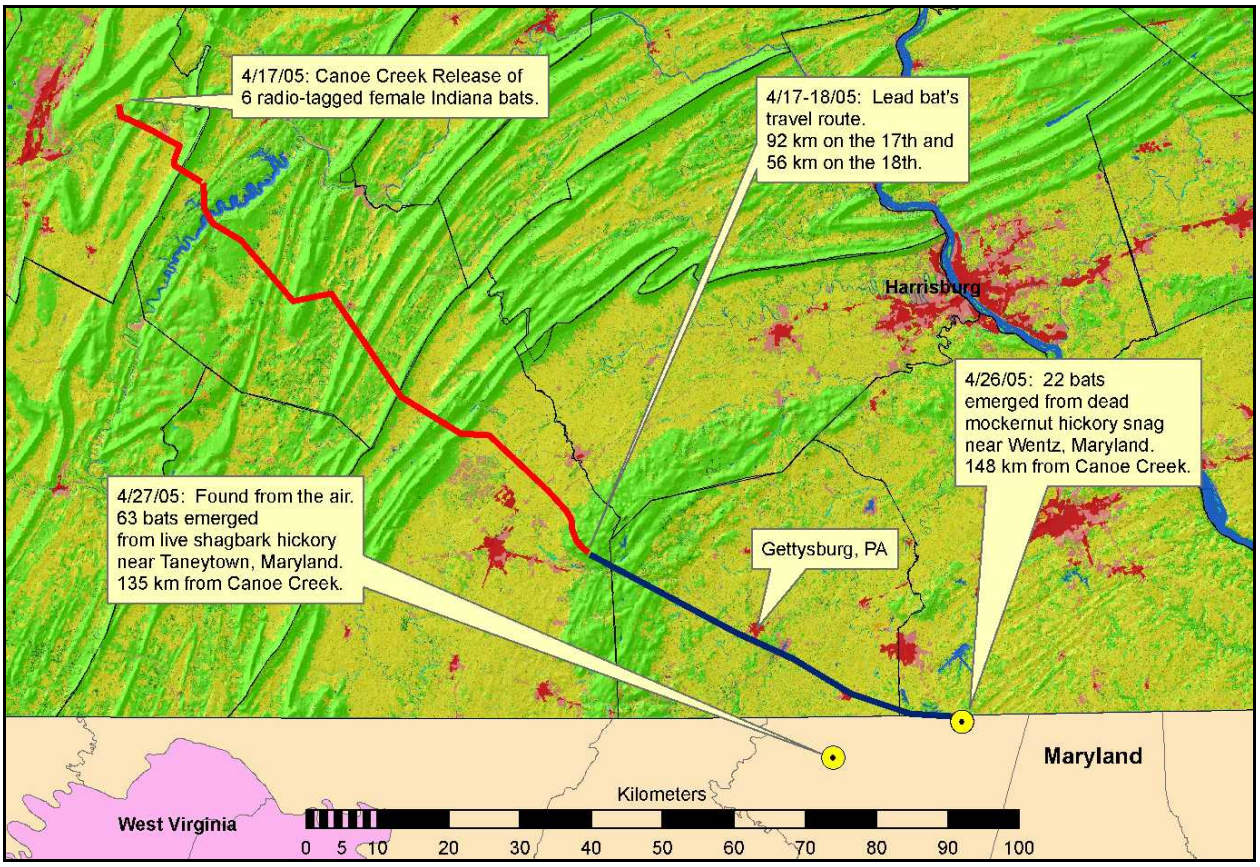


Figure 7. Route taken by lead Indiana bat as it exited the Hartman Mine, Blair Co. PA, and location of 2 new Indiana bat roosts found in Carroll Co., MD.