

**PENNSYLVANIA GAME COMMISSION
BUREAU OF WILDLIFE MANAGEMENT
PROJECT ANNUAL JOB REPORT**

PROJECT CODE NO.: 06714

TITLE: Indiana Bat Research/Management

JOB CODE NO.: 71402

TITLE: Indiana Bat (*Myotis sodalis*) Summer Roost Investigations

PERIOD COVERED: 1 January 2015 to 31 December 2015

COOPERATING AGENCIES: U.S. Fish and Wildlife Service; Pennsylvania Department of Conservation and Natural Resources, Bureau of State Parks, Bureau of Forestry; and Western Pennsylvania Conservancy.

WORK LOCATION(S): Statewide.

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DATE: 29 July 2016

ABSTRACT Pennsylvania Game Commission Wildlife Diversity staff conducted bat mist-net surveys on 17 separate nights in the summer of 2015 across Berks, Centre, Erie, and Huntingdon counties. Sites that were targeted warrant this additional survey efforts because they are of specific scientific value (i.e. understand White-nose Syndrome [WNS] survivorship, calculating Indiana bat maternity colony success, and understanding fall migratory movements). Netting and banding at these sites can show year to year changes in bat populations as well as their movements within and amongst landscapes. During these efforts, 106 total bats were captured, which included 16 federally-endangered Indiana bats (*Myotis sodalis*). In addition, Environmental Consultants conducted their annual summer bat surveys from 15 May to 15 August, following the U.S. Fish and Wildlife Service Range-Wide Indiana Bat Survey Guidelines. Due to limited staff, these 2015 data are only partially entered ($n = 53$ net nights) into the comprehensive net and trap database. This leaves >90% of the total amount of contractor data submitted still needing entered and analyzed. In addition, although final tallies of these numbers are currently not available, it appears that at least 180 Northern long-eared bats (*Myotis septentrionalis*) were captured. The number of Indiana (*Myotis sodalis*; federally-endangered) and eastern small-footed bats (*Myotis leibii*; state-threatened) caught during consultant surveys cannot be determined at this time. The bat boxes being used at the Indiana bat maternity colony in Oley Township, Berks County, Pennsylvania have proven successful again in 2015, with 33 total bats (16 Indiana and 17 little brown) being caught during 1 night of diversity staff trapping at this location. Wildlife Diversity staff had success in recapturing 1 previously-banded Indiana bat, originally caught and banded 18 June 2013. All 15 new Indiana bats caught during summer netting were banded, with the goal of hopefully recapturing in future surveys. In addition, a previously-banded Indiana bat had been discovered

this year by Kentucky Department of Natural Resources researchers in Carter County, Kentucky, during a hibernaculum survey, representing the furthest known migratory movement of an Indiana bat to-date. Its hibernaculum is 418 miles southwest of its original capture location in Berks County, Pennsylvania. In addition, summer bat box temperatures of those boxes being used at the Oley maternity colony in Berks, County were monitored. It appears that the aluminum box retains heat longer and remains warmer into the evening, which could explain why, to-date, no bats have used the BrandenBark™ roosting structure.

OBJECTIVES

1. Measure the impacts of White-Nose Syndrome (WNS) on Indiana bat colonies through netting/trapping surveys and other research efforts.
2. To locate, protect, and manage Indiana bat summer colonies.
3. To maintain baseline population data on summer Indiana bat colonies for the future.

INTRODUCTION

Diversity staff caught 106 total bats during summer netting efforts, including 16 Indiana bats. Surveys took place in Berks, Centre, Erie, and Huntingdon counties. All 16 Indiana bats were captured at the Berks County maternity area (Angstadt Farm) which confirmed the continued use of installed bat boxes at this location by both reproductive Indiana and little brown bats. This location was first discovered in April 2006, when a spring migration study was conducted on a female Indiana bat exiting site 40-004-M in Luzerne County and tracked to this summer habitat in Berks County (Butchkoski and Turner 2006) 90 km (56 mi) from the hibernaculum.

In addition, Diversity staff requires the submission of all capture reports from private environmental consultants conducting bat work within Pennsylvania as a requirement of their state permits. Reported summer mist-net survey results are in the process of being entered into the Pennsylvania Game Commission database that currently contains over 755 Diversity staff surveys and 11,955 consultant surveys, totaling 161,870 bats captured, all-inclusive across years during any season (including spring emergence, summer maternity, and fall swarming). In 2015, environmental contractors conducted, at a minimum, 316 net-nights of trapping, capturing over 2,747 bats, and performing 181 roost tree and emergence surveys. Although these environmental contractors conducted less surveys (net-nights) than in recent, post white-nose syndrome (WNS) years (2008-14 average = 1,083), more bats were caught than pre-WNS levels (2003-07 average = 1,845). It must be noted, however, that 1,875 of these captures came from 2 very large survey projects at proposed and existing pipelines within Washington, Armstrong, and Indiana counties that had a combined effort of 262 net-nights at 48 different sites, making up >80% of all summer surveys by contractors. Preliminary analysis of the mandatory reporting by these consultants to the Game Commission suggests that the 2015 consultant effort trends continue to show that little brown (*Myotis lucifugus*), northern long-eared (*M. septentrionalis*), and tri-colored bats (*Perimyotis subflavus*) require increasing effort to capture, which is still likely a lasting effect of WNS (Fig. 1, shows trend data through 2014). White-nose syndrome is an emerging bat disease with an associated fungus causing devastating losses in hibernacula (Gargas et al. 2009). First

recorded in New York on 16 February 2006 it currently has been detected in 29 states and 5 Canadian Provinces. It was first detected in Pennsylvania the winter of 2008-09, and becoming statewide by 2011. Compared to the 6-year average pre-WNS years (2003-2008), capture rates for little brown bats had declined 99%, northern long-eared bats had declined 94%, and tri-colored bats had declined 99% by the summer of 2014.

Other work initiated by the Game Commission during 2015 included the trapping for migratory tree bats at Presque Isle State Park, Erie County and the monitoring of bat box temperatures at the Oley Township maternity colony, Berks County. The Presque Isle State Park netting was in an effort to better understand the migratory movements of these tree bats across Lake Erie to inform the decision-making process when siting wind turbines off the shoreline of the lake. Canada already has Motus receiving stations (aka towers) in place along their boundary of the lake to pick up the pulse-patterns of Nanotags attached to bats (and birds). The purpose of these towers is facilitate landscape-scale research (both spatial and temporal) on migratory animals. Each telemetry station can detect signals from active tags at distances of up to 15 km. These towers make it possible to track bats in a way that was not previously possible, by eliminating the need to manually follow the subject across the landscape.

METHODS

Netting of Summer Habitats by Diversity Staff and Environmental Contractors

Data collected from Pennsylvania Game Commission staff and environmental consulting contractor netting is stored in a Game Commission Wildlife Diversity database. Private consultants are required under their permit to submit data for inclusion in this database. Since 1999, the Game Commission has required specific protocols for reporting effort for permitted netting activities. Effort is monitored to insure consulting companies are conducting adequate work for projects under environmental review. New for 2015 was the inclusion of Northern long-eared bats to the mandatory reporting to both the U.S. Fish and Wildlife Service and Game Commission within 72 hours of its capture. This species is of particular interest to both agencies due to its recent (April 2015) listing as a federally-threatened species under the Endangered Species Act, primarily due to its recent decline in numbers since the onset of WNS.

Diversity staff also mist-net and harp-trap for bats throughout the year to supplement these netting efforts at select locations. Sites that are targeted warrant additional survey efforts because they are of specific scientific value (i.e. WNS survivorship or Indiana bat maternity colony success). Netting and banding at such sites can show year to year changes in Indiana bat populations.

RESULTS

Summer Netting Overview

In 2015, Diversity staff conducted 17 total nights of bat netting at 15 different sites across 4 counties in Pennsylvania, including Berks, Centre, Erie, and Huntingdon counties. A total of 106 bats were caught during these efforts, including: 41 little brown bats (*Myotis lucifugus*), 1 eastern small-footed bat (*M. leibii*), 16 Indiana bats (*M. sodalis*), 44 big brown bats (*Eptesicus fuscus*), 2 eastern red bats (*Lasiurus borealis*), 1 hoary bat (*L. cinereus*), and 1 silver-haired bat (Table 1).

No northern long-eared (*M. septentrionalis*) or tricolored (*Perimyotis subflavus*) bats were caught during these surveys. Diversity staff totaled 12,415.6 units of effort (1 unit of effort is equal to 1 square meter of net or trap surface in a set position for 1 hour) during these surveys.

In 2015, environmental consultants conducted >316 netting sessions between 15 May and 15 August. Due to the inability to fully enter this data, calculations such as units of total effort, units of effort/survey, and units of effort/bat captured are not able to be calculated and compared to previous years (Table 2). However, due to mandatory reporting, it is known that >180 Northern long-eared bats were caught by these consultants in 2015 (97 female, 75 male, 18 unknown). At least 57 of these bats were fitted with radio-transmitters, but roost information is not available at this time. It has been shown that consultant effort trends through 2014 indicate little brown (*Myotis lucifugus*), Northern (N.) long-eared (*M.septentrionalis*), and tricolored (*Perimyotis subflavus*) bat capture rates continue to steadily decline per 1,000 units of effort since WNS became statewide in 2011 (Fig. 2). All available data at this time suggests this trend continued in 2015.

2015 Recaptures

The Indiana bat (651PA) recaptured by Diversity staff, while netting at the Angstadt Farm maternity colony, Berks County, was originally banded as an adult pregnant female on 18 June 2013. Despite all other morphometric data being available, the bat's weight at time of original capture was not recorded. When recaptured on 13 July 2015, it was post-lactating and weighed 6.81 grams (Table 3). It was noted that this bat was given a wing-score of zero, indicating that no visible lesions indicative of WNS were visible at this time.

Another Indiana bat (681PA) was rediscovered this year during a winter hibernacula survey on 3 Feb 2015 at Carter Caves located in Carter County, Kentucky by Kentucky Department of Natural Resources staff. This bat was also originally caught and banded at the Angstadt Farm maternity colony, Berks County, as an adult lactating female weighing 7.7 grams. This recovery represents a migration of over 418 miles between summer and winter habitat (Fig 2). It was noted that this bat appeared to not have any visible signs of WNS during the winter survey. This is particularly noteworthy since this cave system was counted as having over 23,000 other bats during the winter 2013 hibernacula survey season.

2015 New Captures

Diversity staff netted for 1 night, 13 July 2015, at the Angstadt Farm, a property within Oley Township, Berks County. This is a known maternity colony of both Indiana and little brown bats. In total, 33 bats were captured during this netting session, consisting of 16 Indiana and 17 little brown bats (Table 1). Of the 16 Indiana bats caught, only 1 was a previously-banded individual (651PA; a post-lactating female). The other 15 Indiana bats included: 4 post-lactating females, 4 juvenile females, and 8 juvenile males. The 17 little brown bats captured were all new individuals and included: 8 post-lactating females, 4 non-reproductive females, 4 juvenile females, and 1 adult male (unknown reproductive condition).

At this maternity colony, 237 total bats were counted exiting these boxes at dusk on 2 July, whereas only 148 bats were counted on 15 July, 2 nights after harp-trapping. It is suspected that the minor disturbance to the bats from the harp-trapping session may have caused some of the bats to disperse to other roost locations. It must be noted, however, that prior telemetry found that many

shagbark hickory trees were used prior to the installation of the bat boxes at this location, so plenty of alternate roost locations are available at this site. A third emergence count, conducted 17 August, counted only 102 bats, but this decrease can safely be attributed to dispersal of both adults and juveniles after pups become volant.

Migratory Bat Monitoring at Lake Erie

Diversity staff also mist-netted at Presque Isle State Park for 5 nights (21 April, 13 May, 14 May, 28 May, and 29 May) in an effort to catch and radio-track the spring migratory movements of tree bats across Lake Erie. Tree bats make longer migratory movements than cave-dwelling bats, often traveling as far as the southern United States and Mexico to the northern United States and Canada annually. Due to their higher and faster flying than cave bats, they are often-times quite difficult to catch. During this netting, 4 total bats were captured, including: 2 big brown, 1 little brown, and 1 silver-haired bat (*Lasionycteris noctivagans*), 1 of our target species. The silver-haired bat (an adult scrotal male) weighing 10.91 grams, was fitted with a Nanotag. A Nanotag allows for the passive monitoring of bats without having to follow them via traditional telemetry. Motus towers already in place on the Canadian-side of Lake Erie can pick up signals from this transmitter at distances as great as 15 kilometers. However, after this silver-haired bat's release on the morning of 29 May, its signal was not received by any of these towers, making its movements unknown.

Evening Bat Captures within Pennsylvania

Evening bats are very similar in appearance to big brown bats but are slightly smaller, making the 2 species difficult to distinguish without morphometric data (particularly forearm length, which averages only 36 mm in Evening bats compared to 45 mm in big brown bats). These captures are interesting because Evening bats are not normally found within Pennsylvania. Historically, they are in maximum abundance in the southeastern United States, except for the Appalachian Mountains. Much fewer are found the northern portion of its range, with this species even listed as state-endangered in Indiana, therefore little is known about its life history in these areas. It is suspected that they form maternity colonies in trees or buildings. In 2015, 2 female Evening bats (*Nycticeius humeralis*) were captured during summer mist-netting efforts by 2 different environmental consultants (Table 5). On 30 May, an adult pregnant female was captured in Schuylkill County weighing 12.5 grams. On 21 June, an adult post-lactating female was captured in Greene County, weighing 9.4 grams. These bats had transmitters attached by consultants, but they were unable to find the maternity colonies.

Bat Box Temperature Monitoring

Diversity staff installed their first ever BrandenBark™ roost structure at the Angstadt Farm property in Berks County in 2014. It was placed in close proximity to the occupied aluminum shell bat box currently being used by the Indiana and little brown bat maternity colony. It has been accepted by the U.S. Fish and Wildlife Service as a mitigation tool, used to replace lost roosting habitat for bark-roosting bats. It has been shown that Indiana, N. long-eared, and little brown bats will use BrandenBark™ as a roosting structure (Copperhead 2014). During the summer of 2015, MadgeTech TransiTemp II dataloggers (measuring temperature) were placed within both the aluminum shell bat box and the BrandenBark™ roost structure to better understand the site selection by these bats. Emergence surveys for Appalachian Bat Counts have shown that nearly all bats exit one aluminum, 14-chamber box, and none appear from the BrandenBark™. Upon

analysis of the temperature data, it appears that both boxes warm up similarly during the day, but that the aluminum boxes maintain that heat longer into the evening (cool down at a slower rate) and do not reach as cold of minimum temperature as the BrandenBark™. These 2 factors combined may help explain this colony's preference to choose the aluminum box for rearing their pups.

RECOMMENDATIONS

1. Continue to enter the remaining environmental contract datasheets (including site and capture data, emergence forms, and roost tree information) for 2015 into their respective Game Commission databases. This information is necessary for analysis of trend data within Pennsylvania, entry in the Pennsylvania Natural Diversity Inventory (maintained by the Pennsylvania Natural Heritage Program), and to show tasks are being completed for the acquisition of future grants. In addition, Angstadt bat boxes are planned to be repainted and the rubber cap removed from the BrandenBark™ roost structure to help increase air flow and see if bat begin to use this roost.

2. Develop a fillable database (via either Microsoft Access or Excel) that would allow contractors to enter and submit all bat-related capture data to Game Commission. This would allow Diversity staff to check the data without having to enter it, saving time, reducing errors, and allowing more effort to be spent on data analysis.

3. Continue to band, collect recapture data, and monitor artificial roosts at all Indiana bats maternity sites, including 07-018-M, 40-004-M, and the Angstadt Farm property.

4. Continue to work with the U.S. Fish and Wildlife Service, The Nature Conservancy, the Western Pennsylvania Conservancy, and other potential partners to obtain easements or purchases of important Indiana bat summer habitats.

5. Continue to share recapture data with adjacent states to track seasonal movement of Indiana bats.

6. Continue to work with other researchers (state, federal, and university-level) to solve problems related to white-nose syndrome. This includes, but is not limited to, collecting samples such as wing punches and blood and the writing and peer-reviewing of WNS-related research papers.

7. Continue to seek out opportunities, and locations, for the installation of Motus towers on the Pennsylvania-side of Lake Erie for migratory movements of bats. These towers have the ability to receive signals from transmitters attached to birds also.

8. Continue to evaluate why certain core locations are more preferred over others for Indiana bats. The 2 recaptures at from Oley banding in New York and Kentucky may support previous hypotheses that survivors may be retracting to core areas, at least in winter months.

9. Continue to explore Evening bat hypotheses explaining their occurrences in Pennsylvania. In New Jersey and Michigan, influxes of reproductive females support our data

showing that females may be migrating further north in recent years expanding their range.

LITERATURE CITED

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Gargas, A., M. T. Trest, M. Christensen, T. J. Volk, and D. S. Blehert, 2009. *Geomyces destructans* sp. nov. associated with bat white-nose syndrome. *Mycotaxon* 108:147-154.

Table 1. Pennsylvania Game Commission Diversity staff summer bat netting ($n = 17$ net-nights) in 2015. Note: no Indiana, tricolored, or silver-haired were captured in 2015 and thus not included in this table; Presque Isle State Park trapping was conducted at 4 separate sites over 5 nights of trapping.

County	Location	Date	Effort ^a	Species ^b							Total
				MYLU	MYLE	MYSO	EPFU	LABO	LACI	LANO	
Erie	Presque Isle S.P.	21-Apr	702	0	0	0	0	0	0	0	0
Erie	Presque Isle S.P.	13-May	1638	0	0	0	1	0	0	0	1
Erie	Presque Isle S.P.	14-May	1392.3	0	0	0	0	0	0	0	0
Erie	Presque Isle S.P.	28-May	707	0	0	0	0	0	0	1	1
Erie	Presque Isle S.P.	29-May	1025	1	0	0	1	0	0	0	2
Berks	Angstadt Farm	13-Jul	13.4	17	0	16	0	0	0	0	33
Berks	Grings Mill Red Bridge	14-Jul	655.2	3	0	0	10	0	1	0	14
Berks	DiCellos, Lobachville	15-Jul	643.5	0	0	0	7	0	0	0	7
Huntingdon	Raystown Lake, FMA 5	4-Aug	390	0	0	0	4	0	0	0	4
Huntingdon	Raystown Lake, FMA 17	5-Aug	390	0	0	0	3	0	0	0	3
Huntingdon	Raystown Lake, FMA 11	12-Aug	631.8	0	0	0	0	0	0	0	0
Huntingdon	Juniata Valley High School	24-Aug	297.4	9	0	0	0	0	0	0	9
Centre	Laurel Run Preserve	27-Aug	919.6	0	0	0	2	2	0	0	4
Centre	Porter Property	31-Aug	1276.8	0	0	0	15	0	0	0	15
Huntingdon	Huntingdon 4 th St. Bridge	17-Sept	641.6	11	0	0	1	0	0	0	12
Huntingdon	Harbison Tract	21-Sept	526.5	0	0	0	0	0	0	0	0
Huntingdon	Harbison Tract	24-Sept	565.5	0	1	0	0	0	0	0	1
12,415.6				41	1	16	44	2	1	1	106

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

^bMYLU=*Myotis lucifugus*; MYLE=*Myotis leibii*; MYSO=*Myotis sodalis*; EPFU=*Eptesicus fuscus*; LABO=*Lasiurus borealis*; LACI=*Lasiurus cinereus*; LANO=*Lasionycteris noctivagans*

Table 2. Summary of summer (5/15-8/15) contractor netting activities by year since 2003. Table only includes those conducting environmental review surveys with effort reporting. Note: 2015 data is not comprehensive.

Year	Netting Sessions	Effort ^b	Total Bats	Bats/Survey	Species ^a Totals Per Year								
					MYLU	MYSE	MYLE	MYSO	EPFU	PESU	LABO	LACI	LANO
2003	161	111,621	840	5.22	239	247	3	0	254	3	81	6	7
2004	153	116,348	1,547	10.11	493	292	3	0	642	15	90	6	6
2005	511	261,647	2,713	5.31	1,080	691	14	0	701	34	180	11	2
2006	390	246,265	2,082	5.34	563	500	1	0	825	28	151	11	3
2007	301	212,916	2,045	6.79	790	477	0	7	595	9	152	12	3
2008	931	573,746	5,161	5.54	1,645	1,324	13	15	1,762	55	299	33	15
2009	1,651	991,191	6,826	4.13	2,635	1,435	30	6	2,147	70	424	48	31
2010	1,444	1,049,209	7,114	4.93	2,572	1,861	21	6	1,819	56	636	86	57
2011	1,158	891,895	4,263	3.68	505	1,090	10	3	2,182	36	368	46	23
2012	1,087	824,980	4,223	3.89	426	699	29	8	2,122	19	796	104	20
2013	894	170,548	3,197	3.58	209	349	13	16	1,887	49	633	25	16
2014	417	132,151	2,170	5.20	4	88	5	0	1,715	7	332	10	3
2015	>316	Unk.	>2747	Unk.	Unk.	>180	Unk.	Unk.	Unk.	Unk.	Unk.	Unk.	Unk.

^a MYLU=*Myotis lucifugus*; MYSE=*Myotis septentrionalis*; MYLE=*Myotis leibii*; MYSO=*Myotis sodalis*; EPFU=*Eptesicus fuscus*; PESU=*Perimyotis subflavus*; LABO=*Lasiurus borealis*; LACI=*Lasiurus cinereus*; LANO=*Lasionycteris noctivagans*.

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

Table 3. All 2015 Indiana bat (*Myotis sodalis*) netting recaptures by Pennsylvania Game Commission Diversity staff. Note: 681PA was captured by Kentucky Department of Natural Resources and is not included in this table.

County	Site	2015 Date	Original Band Date	Band No	Original Weight (grams)	Current Weight (grams)	Sex	Age	Repro. Cond.
Berks	Angstadt Farm	13-Jul	6/18/13	651PA	Unk.	6.81	F	Adult	Post-lactating

Table 4. New Indiana bat (*Myotis sodalis*) netting captures ($n = 15$) by Pennsylvania Game Commission Diversity staff in 2015. All of these were unbanded individuals that were banded after initial capture.

County	Site Name	Date	Band No	Weight (grams)	Sex	Age	Repro. Cond.
Berks	Angstadt Farm Bat Boxes	13-Jul	653PA	7.88	Female	Adult	Post-lactating
Berks	Angstadt Farm Bat Boxes	13-Jul	654PA	7.03	Female	Adult	Post-lactating
Berks	Angstadt Farm Bat Boxes	13-Jul	743PA	7.37	Female	Adult	Post-lactating
Berks	Angstadt Farm Bat Boxes	13-Jul	655PA	5.37	Female	Juv.	Non-repro.
Berks	Angstadt Farm Bat Boxes	13-Jul	744PA	7.05	Female	Juv.	Non-repro.
Berks	Angstadt Farm Bat Boxes	13-Jul	747PA	6.20	Female	Juv.	Non-repro.
Berks	Angstadt Farm Bat Boxes	13-Jul	739PA	5.71	Female	Juv.	Non-repro.
Berks	Angstadt Farm Bat Boxes	13-Jul	656PA	5.70	Male	Juv.	Non-repro.
Berks	Angstadt Farm Bat Boxes	13-Jul	658PA	5.46	Male	Juv.	Non-repro.
Berks	Angstadt Farm Bat Boxes	13-Jul	738PA	6.33	Male	Juv.	Non-repro.
Berks	Angstadt Farm Bat Boxes	13-Jul	740PA	5.94	Male	Juv.	Non-repro.
Berks	Angstadt Farm Bat Boxes	13-Jul	742PA	5.97	Male	Juv.	Non-repro.
Berks	Angstadt Farm Bat Boxes	13-Jul	745PA	5.52	Male	Juv.	Non-repro.
Berks	Angstadt Farm Bat Boxes	13-Jul	746PA	6.23	Male	Juv.	Non-repro.
Berks	Angstadt Farm Bat Boxes	13-Jul	Unk.	Unk.	Male	Juv.	Non-repro.

Table 5. Evening bat (*Nycticeius humeralis*) netting captures ($n = 2$) by environmental contractors in 2015. Both Evening bats were fitted with transmitters in efforts of finding their daytime roost locations.

County	Date	Weight (grams)	Forearm (mm)	Sex	Age	Repro. Cond.
Schuylkill	30-May	12.5	38	Female	Adult	Pregnant
Greene	21-June	9.4	34	Female	Adult	Post-lactating

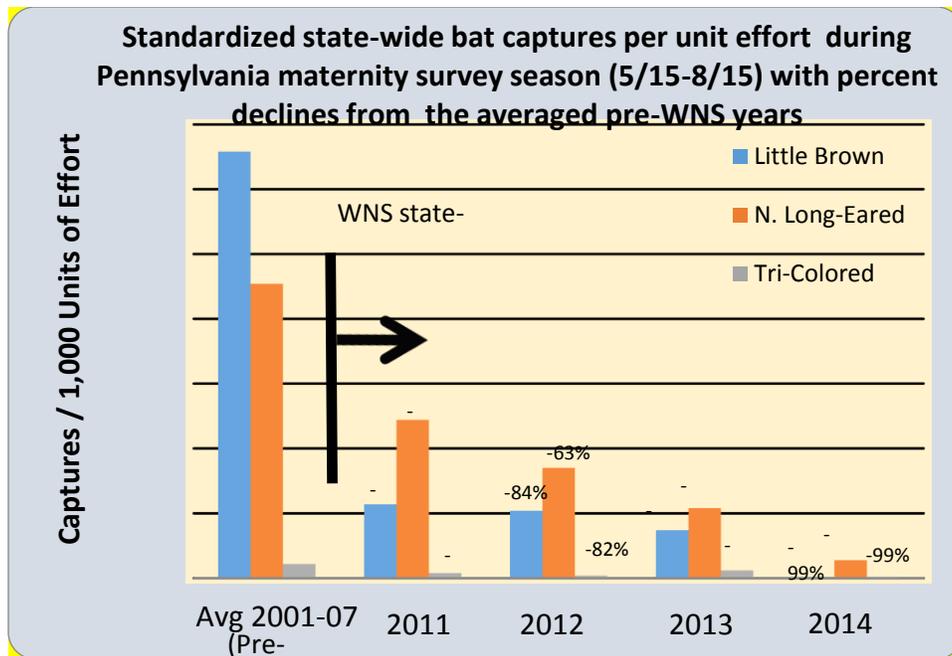


Figure 1. Post-White-nose Syndrome (WNS) (2011-14) capture rates compared to average pre-WNS (2001-07) capture rates for the 3 species having the most severe decline (little brown bat -99%, northern long-eared bat -94%, and tricolored bat -99%).

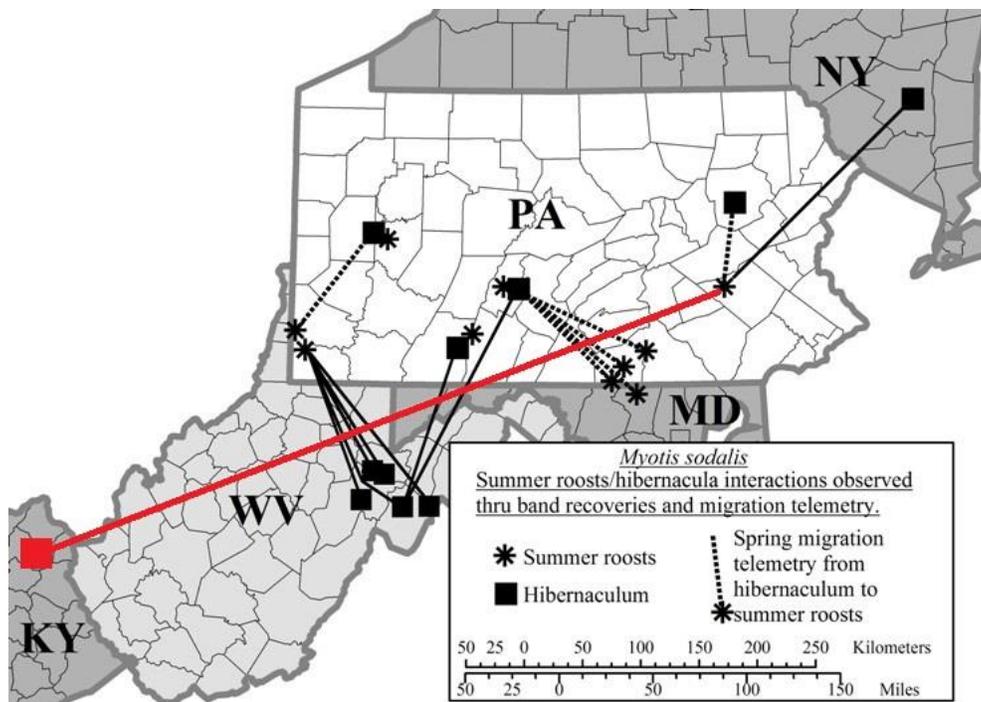


Figure 2. Indiana bat movements between seasons up to and including the summer of 2015. In 2015, an Indiana bat that was originally banded during the maternity season within the summer of 2013 in Berks County, Pennsylvania was found during a winter hibernacula survey by the Kentucky Department of Natural Resources within a cave system in Carter County, Kentucky. This capture represents the largest known migratory movement (highlighted in red) of any Indiana bat to-date, with a total distance of 418 miles southwest of the original capture location.

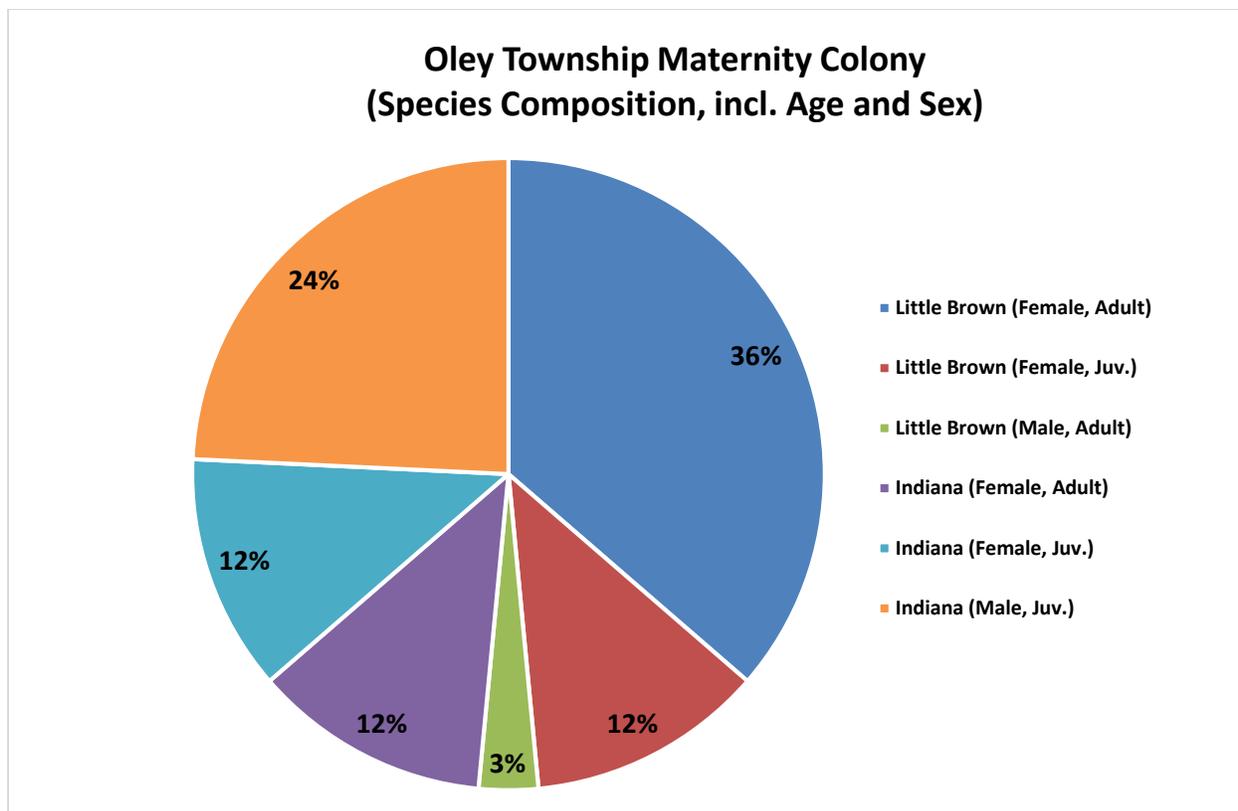


Figure 3. Species composition ($n = 33$, Indiana bats and little brown bats) at the Angstadt Farm property bat boxes, Oley Township, Berks County, Pennsylvania in 2015.

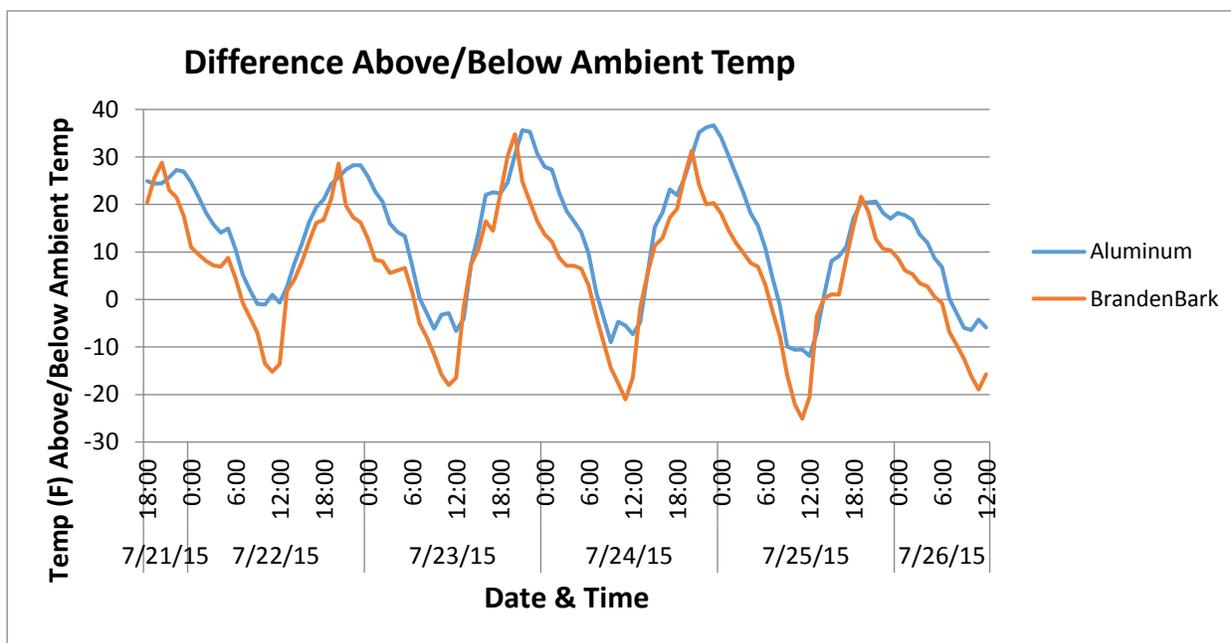


Figure 4. Temperature fluctuations within the 14-chamber aluminum box and the BrandenBark™ roost structure (shown as degrees F above or below ambient air temperature), for a subset of summer days.

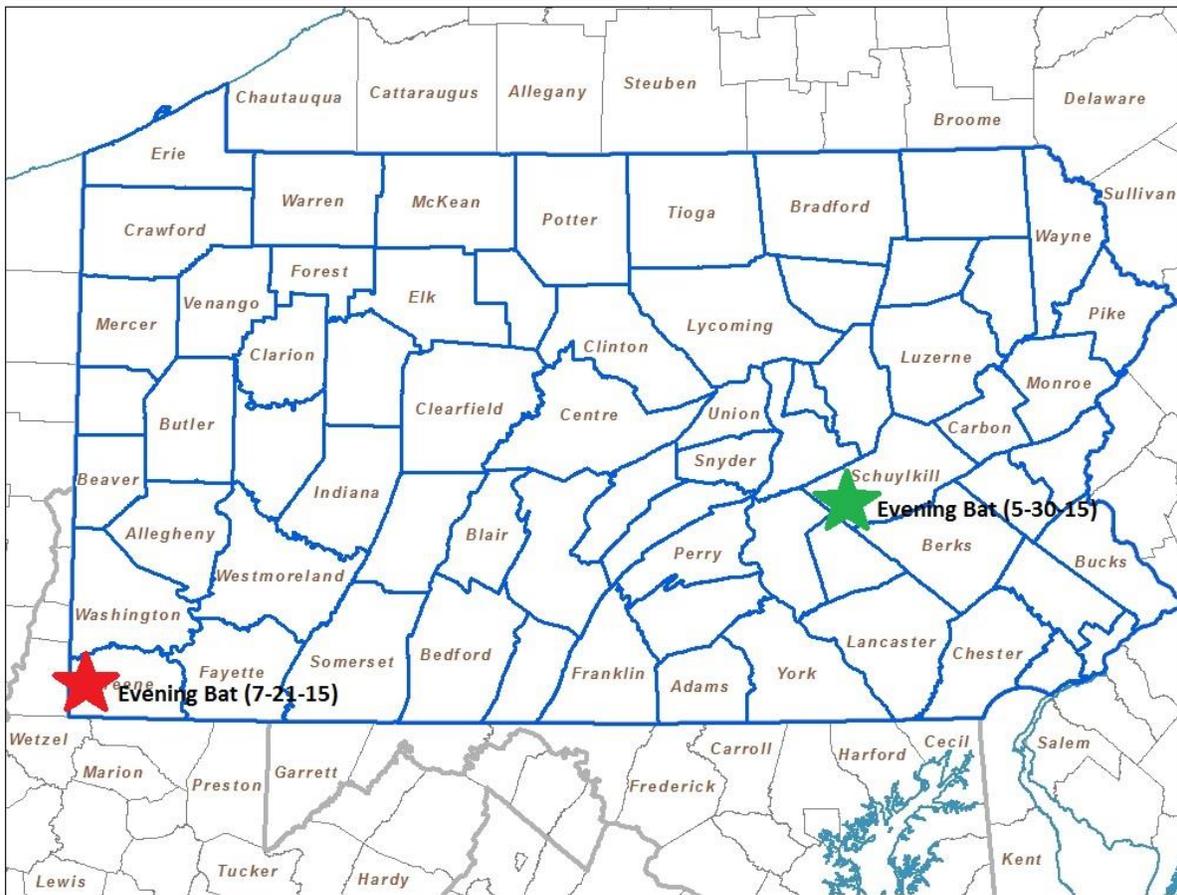


Figure 5. Evening bat capture locations during summer 2015 contractor mist-netting. The capture on 30 May was located in Schuylkill County, near the southwest boundary with Lebanon County. The capture on 21 July was located in Greene County, close to the border with West Virginia.