

Federal Aid in Wildlife Restoration  
W-71-R-2  
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**Species of Greatest Conservation Need  
Mammal Research and Management**

Final Report  
for  
September 1, 2016–December 31, 2018

NJ Department of Environmental Protection

DIVISION OF FISH AND WILDLIFE  
ENDANGERED AND NONGAME SPECIES PROGRAM  
P.O. BOX 420  
TRENTON, NJ 08625



## PERFORMANCE REPORT

**STATE:** New Jersey

**PROJECT NUMBER:** W-71-R-2

**PROJECT TYPE:** Research and/or Management

**PROJECT TITLE:** SGCN Mammal Research and Management

**STUDY NUMBER AND TITLE:** 1. Mammals

**PERIOD COVERED:** September 1, 2016 to December 31, 2018

**JOB NUMBER AND TITLE:** 1A. Bobcat Conservation

Prepared by: Gretchen Fowles

**OBJECTIVE:** Determine the distribution, minimum size, population and genetic structure, and habitat needs of New Jersey's bobcat population and use the information to preserve the habitat necessary to maintain a viable population.

### Key Findings:

- Habitat analyses began as part of a partnership between ENSP and the University of Delaware (UDel) whereby UDel has funded a Master's degree student to conduct bobcat research. A student began in September 2018 with a project to analyze regional habitats in NJ with a focus on interconnectivity and the options for the establishment and maintenance of a central and southern bobcat population. These analyses will help us better understand the amount and spatial distribution of habitat for bobcats across the state, will help validate the connectivity mapping (of core habitat and the corridors connecting them) being developed statewide as part of the Connecting Habitat Across New Jersey Project (Grant NJ T-11-T-2 Job 3), and will inform bobcat recovery plan metrics.
- Related work, ENSP's Habitat Change Analysis Project data for bobcat, was completed and is reported under NJ T-11-T-1.
- ENSP partnered with Montclair State University (MSU) and MSU funded a Master's degree student to conduct bobcat research. A student worked 2016-2018 to quantify habitat, sex, temporal, and seasonal variables associated with the collar data by ENSP.
- The detection dog that ENSP has utilized for the detection of bobcat scat since 2006 passed away in November 2017. A new detection dog is in training to continue scat detection work focused in central and southern NJ.
- ENSP collaborated with a statistician in the DEP's Division of Science, Research, and Environmental Health to complete a spatially explicit mark-recapture analysis using all bobcat individual data (from tissues and scats) collected to date (2002 – 2016) to estimate population size and density over time within northwestern New Jersey for the first time. Of four techniques attempted, the Bayesian Spatial Capture-Recapture models run using bobcat scat data only resulted in the most appropriate conservation metric estimates. A fifth technique, a hierarchical Bayesian Spatial Capture-Recapture model, had been the planned estimator to use for the analysis because it takes into account individuals from previous years

and thus is less crucial to have many recaptures in a given year. The program would not run because of the intensity of the analysis and had to be abandoned, unfortunately. The Division of Science, Research, and Environmental Health wrote a final report describing the analysis that they provided to ENSP.

- The yearly density estimates ranged from 0.05 to 0.09 bobcats/km<sup>2</sup> and the yearly population sizes in the study area ranged from 179 to 355 bobcats (Fig. 1, Table 1).

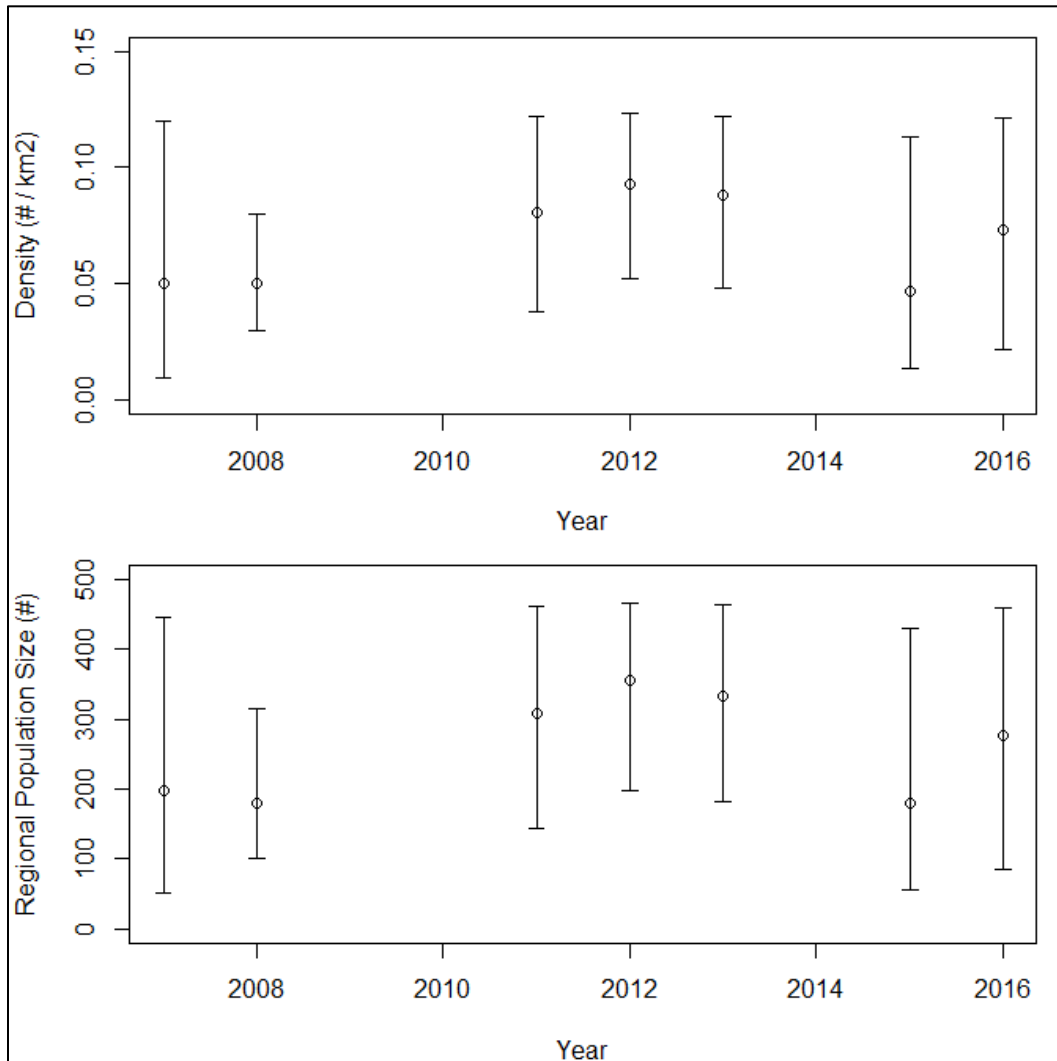


Figure 1. Results from Bayesian Spatial Capture-Recapture (SCR) Models using bobcat scat data. Bayesian spatial capture-recapture models were performed to estimate the density (bobcats/km<sup>2</sup>) and the population size (#) of bobcats in northwestern New Jersey Error bars display 95% Credibility Intervals.

Table 1. Estimates from the Bayesian Spatial Capture-Recapture (SCR) Models. Bayesian spatial capture-recapture models were performed using bobcat scat data to estimate the density (bobcats/km<sup>2</sup>) and the population size (#) of bobcats in northwestern New Jersey (LCL = Lower Confidence Level; UCL = Upper Confidence Level).

Year	Density	D_LCL	D_UCL	Pop	P_LCL	P_UCL
2007	0.05	0.01	0.12	197	51	447
2008	0.05	0.03	0.08	179	102	315
2011	0.08	0.04	0.12	308	145	462
2012	0.09	0.05	0.12	355	197	466
2013	0.09	0.05	0.12	334	183	463
2015	0.05	0.01	0.11	180	55	430
2016	0.07	0.02	0.12	276	85	459

- Fifty-nine tissue samples were collected from animals hit by cars (N = 30), accidentally trapped (N = 26), dispatched due to rabies (N = 1), an abandoned kitten (N = 1), and a kitten that had been shot (N = 1) during the reporting period. All samples were submitted to the National Genomics Center for Wildlife and Fish Conservation for DNA analysis.
- ENSP continued to work with the National Genomics Center for Wildlife and Fish Conservation to evaluate the genetic structure of bobcats in the region, as well as the substructure and gene flow of the NJ bobcat population to determine if there are impediments to movement that are resulting in genetic substructuring. The lab completed analyses using the samples previously collected from NY, PA, and ME between 2003 and 2010, and then additional NJ samples collected through 2017, for a total of 315 unique bobcats from New Jersey included in the analyses. A report was written by the lab and provided to ENSP describing the analyses and results.
  - The lab completed an updated STRUCTURE analysis, a Geneland analysis that evaluates the genetic structure of a population by taking into account both genotypes and location information, and provided population cluster assignments for each bobcat individual in order for ENSP to evaluate the within NJ variability in more detail and in relation to suspected movement barriers.
  - ENSP is collaborating with a graduate student at Cornell University who is conducting a regional bobcat genetic study centered around NY. ENSP shared samples with her and she shared NY bobcat samples in return that help fill in some gaps. The National Genomics Center for Wildlife and Fish Conservation will update the analysis with the new NY samples and NJ samples collected through early 2019.
- ENSP collaborated with the Division's Bureau of Wildlife Management to develop a habitat stratification grid across northern NJ to guide distribution of hair snare/camera grids aimed at surveying for bobcats as part of another study conducted by the Division. ENSP also participated in the hair snare/camera sampling and anticipates receiving the locational data of bobcat observations sampled in the study to add to the Biotics database, as well as extracted DNA from the bobcat-positive hair samples from the East Stroudsburg genetics lab, which is conducting the genetic analyses for the study, so that

the samples can be added to NJ bobcat genetic library housed at the National Genomics Center and be used for survival estimates, recapture, and movement analyses.

- Eight reproductive tracts and teeth from 38 animals were collected opportunistically from bobcat carcasses during the sampling period. The reproductive tracts were analyzed by a veterinarian to inspect for placental scars indicative of litter size and fecundity. Teeth samples collected between 7/26/2016 and 5/3/2018 were prepared and submitted to the laboratory to estimate age of each animal from which teeth were extracted during this reporting period. A report was provided to ENSP describing the results. A total of 99 teeth samples have been aged as of the end of the sampling period (Fig. 2), results of which are being incorporated into the bobcat status assessment.

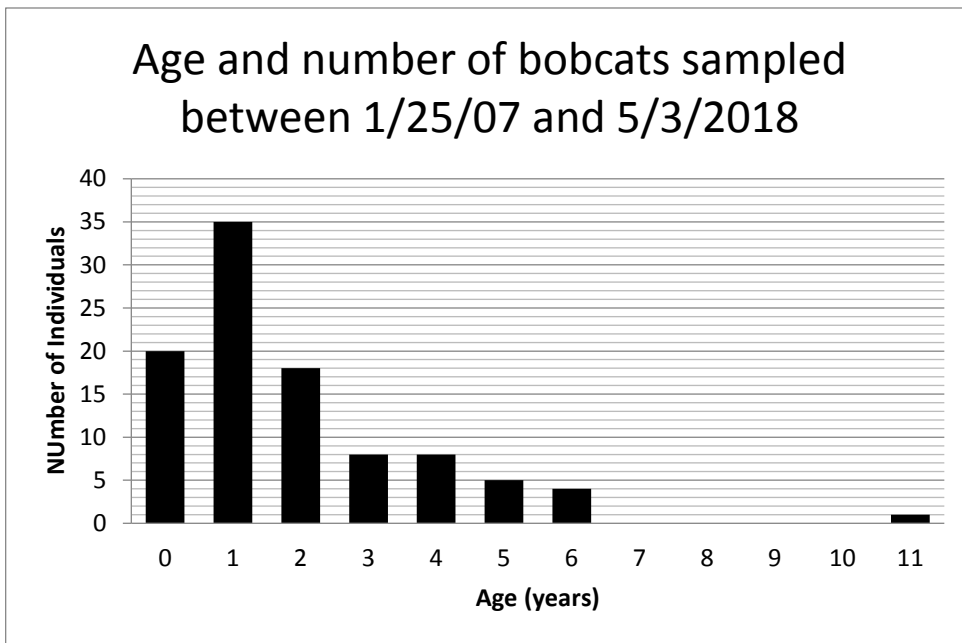


Figure 2. Results of teeth aging analysis of bobcats in northwestern New Jersey sampled between 1/25/2007 and 5/3/2018. Sixty-four (65%) individuals in the dataset were hit by vehicles, 35 (35%) were killed in traps.

- Opportunistically collected bobcat carcasses were also tested for rodenticide exposure (Fish and Wildlife Health Project, FW69-R-19). In 2016 and 2017, 9/12 (25%) and 12/15 (20%), respectively, of samples tested positive for exposure to at least one rodenticide.
- The bobcat biologist within the Endangered & Nongame Species Program (ENSP) again collaborated with Bureau of Wildlife Management (BWM) biologists to respond to bobcats accidentally captured in cable restraints.
  - A total of 28 trapped bobcats (Fig. 1) were reported by trappers during the reporting period. Eleven (39%) died and 17 (61%) were released successfully. Ear tags were attached and DNA samples were taken from all bobcats.
- There were 26 road-killed bobcat carcasses recovered by ENSP during the reporting period. Two other vehicle struck bobcats were injured, successfully treated, and released. In 2016, 2017 and 2018 there were 11, 11, and 13 confirmed vehicle-struck bobcats.
- There were two rabies-positive bobcats for the first time since at least 1932 when rabies documentation began.

- No bobcats were collared during the reporting period.
- ENSP updated the bobcat fact sheet (<https://www.nj.gov/dep/fgw/ensp/pdf/end-thrtened/bobcat.pdf>) to include an update on research, as well as a link to the DEP Podcast about bobcats in New Jersey recorded in March 2017 (<http://www.nj.gov/dep/podcast/>), and a link to the Creature Show episode ENSP participated in and released in 2018 about bobcats in New Jersey (<http://www.creatureshow.com/bobcat>), including the use of a detection dog in our research.
- Two trail camera photos were submitted to ENSP during the reporting period that document occupancy of habitat by bobcats for the first time in over a decade; one in northeastern NJ and the other in north central NJ in the area of the Sourlands Mountains.
- A first draft of a bobcat status assessment has been completed.

### Conclusions:

- Sample analysis – DNA from live bobcats, and teeth, reproductive tracts, DNA, and rodenticide testing of dead bobcats – are all improving our understanding of bobcat status and health. Analysis of spatial data and documentation of threats also contribute to the information necessary for our bobcat status assessment.
- ENSP continues close collaboration with partners at University of Delaware and Montclair State University. Both universities have continued interest in bobcat research.
- Population and density estimates for bobcats in northern New Jersey per year over seven different years between 2007 and 2016 have now been completed by a statistician at DEP's Division of Science, Research, and Environmental Health in collaboration with ENSP. A final report was prepared detailing the analyses and results and shared with ENSP. This is the first time these estimates have been achieved for bobcats in New Jersey.
- Several analyses in collaboration with the National Genomics Center for Wildlife and Fish Conservation were completed that evaluated the substructure and gene flow of the NJ bobcat population. Updates to the analyses are planned to incorporate additional samples from NY and NJ.
- We have seen a decrease in exposure to rodenticides since the ban effective March 2015.
- The number of bobcats struck by vehicles has increased over the past three years and 2018 (N = 13) represented the highest number on record in NJ.
- The number of non-target bobcats reported in traps has fluctuated over time, including over this reporting period.
- A first draft of a bobcat status assessment has been completed.

### Recommendations:

- Continue to collaborate with the National Genomics Center for Wildlife and Fish Conservation to update the substructure and gene flow analyses of the NJ bobcat population using new samples from NY and NJ.
- Continue to use scat, tissue, remotely triggered camera, and GPS collar data to help validate CHANJ core and corridor modeling and to inform guidance on increasing the permeability of the landscape for bobcats.

- Deploy a new wildlife detection dog, targeting areas where density may be low such as central and southern NJ. The dog will also be useful finding scats along possible movement corridors to evaluate functional connectivity, which is extremely beneficial for validating and prioritizing the CHANJ modeling, and informing the accompanying guidance.
- Continue to opportunistically collect tissue samples from live and dead bobcats, and to acquire the extracted DNA from the bobcat hair snare study, to add to long-term NJ bobcat genetic library housed at the National Genomics Center, from which we can glean movement patterns over time, age, and parentage of individuals.
- Continue to collaborate with the Bureau of Wildlife Management to respond to bobcats accidentally captured in traps and work to collect data, tag, and safely release the animals.
- Continue to try to work with the Bureau of Wildlife Management and trappers, ideally in collaboration with the authors of AFWA's Best Management Practices for Trapping in the United States ([http://jjcdev.com/~fishwild/?section=best\\_management\\_practices](http://jjcdev.com/~fishwild/?section=best_management_practices)) to identify and implement ways of decreasing the rate of injury and mortality to bobcats accidentally trapped in New Jersey.
- Continue collecting and analyzing reproductive tracts and teeth to gain a better understanding of the age structure, fecundity, and pregnancy rates of the population, and to evaluate rate of exposure to rodenticides.
- Collect bobcat roadkill data to measure trend in road mortality, to validate the CHANJ core and core modeling, and to help prioritize mortality hot spots to focus road mitigation efforts. Continue to reach out to agencies and the public to increase the recovery rate of bobcat roadkill data and carcasses.
- Continue to collaborate with partners at University of Delaware and Montclair State University on bobcat research that will inform the bobcat status assessment and recovery plan.
- Finalize a draft of the bobcat status assessment, develop the recovery plan component, and seek input from experts in the field. Develop outreach information based on the analyses and assessment to distribute to trappers, state and municipal police, and animal control officers to inform them about the health and status of the New Jersey bobcat population and the important contribution samples from both road-killed and trapped bobcats have been making to our understanding of the population to encourage increased reporting.

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**PROJECT TYPE:** Research and/or Management

**PROJECT TITLE:** SGCN Mammal Research and Management

**STUDY NUMBER AND TITLE:** 1. Mammals

**PERIOD COVERED:** September 1, 2016 to December 31, 2018

**JOB NUMBER AND TITLE:** 1B. Allegheny Woodrat Conservation

Prepared by: Gretchen Fowles

**OBJECTIVE:** Annually monitor NJ's Allegheny woodrat (*Neotoma magister*) population and assess the potential exposure risk to raccoon roundworm (*Baylisascaris procyonis*). Actively manage raccoon roundworm levels in the raccoon population at New Jersey's last remaining Allegheny woodrat population through the use of medicated raccoon baits.

Key Findings:

- ENSP has continued to implement a year-round roundworm mitigation plan at the Palisades habitat in collaboration with a researcher now at the National Wildlife Research Center. Sixteen dispensers, deployed since 11/18/2016 for delivery of pyrantel pamoate-treated fishmeal/polymer baits to free-ranging raccoons, are spaced approximately 1km apart above and below the Palisades cliffs along the length of the habitat area. The dispensers were continuously re-loaded on a 6-8 week schedule with approximately 50 baits each, year-round. The baits each have approximately 50mg of pyrantel pamoate, which is the low end of the recommended dose range for raccoons. During this reporting period we ordered a new batch of baits in coordination with Ohio DNR Division of Wildlife, which is starting a medicated baiting program with a higher dose of pyrantel pamoate, 150mg, per bait, to dose raccoons of slightly above average body size. We began distributing the second batch of baits on 8/27/18.
- ENSP and volunteers collected and GPSed 205 raccoon scats at the Palisades between 9/2/2016 and 10/24/2018, to evaluate the prevalence of *B. procyonis* egg loads in the scat. The scats were sent to Wheaton College for analysis. Only one of the scats was positive (collected 9/2/2016). An additional three raccoon scats from the Palisades in 2013 were discovered in the office freezer, and all three were positive.
- Standard trapping protocol was conducted at six separate talus slope sites in the Palisades Interstate Park during October in 2016, 2017, and 2018. Tomahawk TM Model 201 (5"x5"x16") Collapsible and Standard Single-door Live Traps were used for sampling. The traps were baited with apple slices and peanut butter.
  - Forty-two traps were set for two nights for a total of 84 trap-nights of sampling effort each year.
  - Twenty-seven, 25, and 16 unique individuals were captured in 2016, 2017, and 2018 respectively. The capture index (# of individuals captured/10 trap nights) in each of those years was 3.21, 2.98, and 1.90 respectively (Fig. 1).



- All captured animals were held for several minutes prior to their release to determine if they exhibited any symptoms of infection by *B. procyonis*. No animals displayed any symptoms. All animals were sexed, weighed and ear-tagged at the point of capture. An ear punch from each ear was taken from each newly captured individual for genetic analysis.

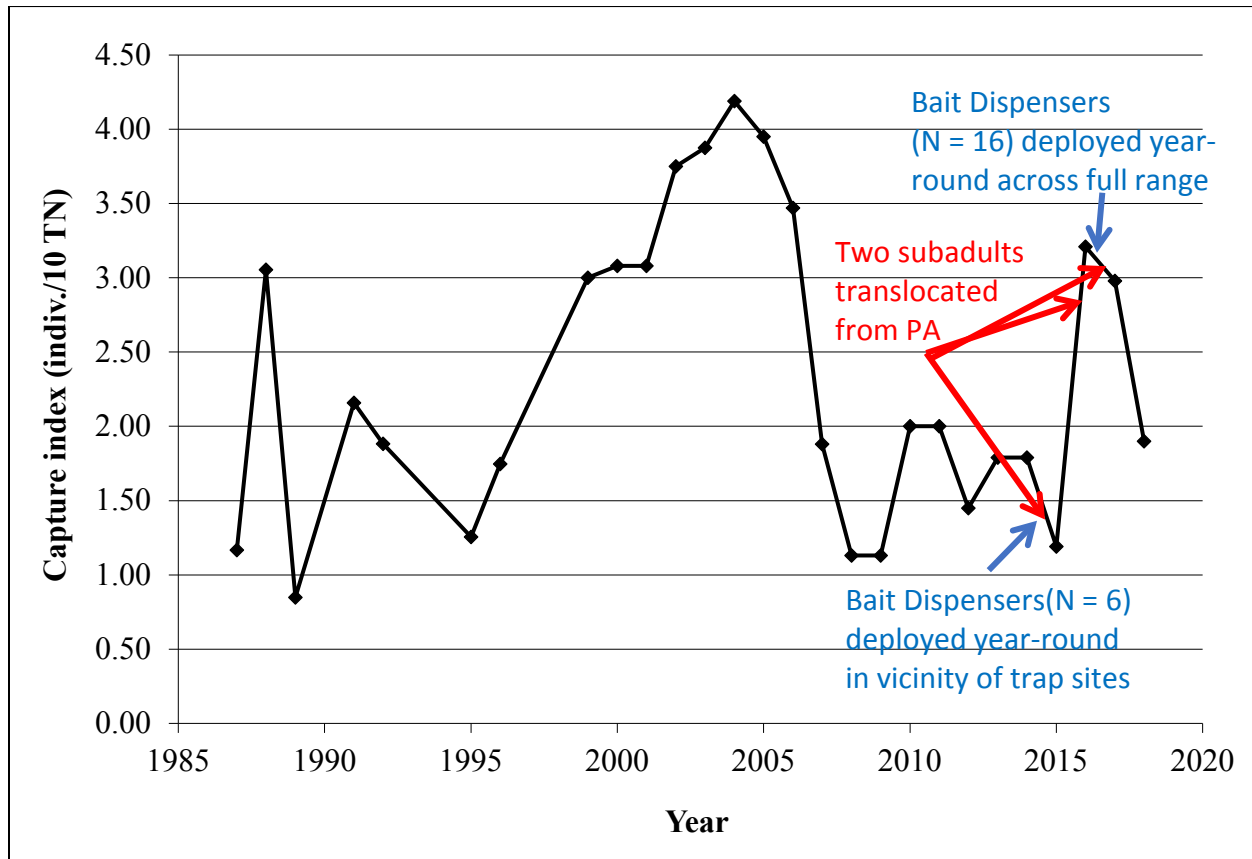


Figure 1. The results of ENSP's trapping effort in the Palisades over the last several years, setting 42 traps for two consecutive days in six trap areas in the fall, for a total of 84 trap-nights of sampling effort/year.

- A third translocation was conducted in 2017, of two subadult individuals from two active woodrat sites in Huntingdon County, PA, in collaboration with the Pennsylvania Game Commission. In collaboration with Montclair State University and AmeriCorps members, we closely monitored the two individuals as we did during previous translocations, with telemetry and motion-triggered cameras.
- Monitoring of the translocated individuals from 2015, 2016, and 2017 ended in the summer of 2018. We confirmed the deaths of the 2016 and 2017 males within approximately two months of their release into the Palisades.
- A translocation was not conducted in 2018, as the plan was to conduct them for three consecutive years and then evaluate the results.
- We continued our collaboration with a geneticist at Towson University who maintains the Allegheny woodrat genetic library, including all past NJ Palisades samples. Towson conducted the following analyses and submitted a report with the findings to ENSP.

- The geneticist successfully genotyped 72 woodrat tissue samples collected at the Palisades in 2009 (n=5), 2011 (n=13), 2015 (n=9), 2016 (n=18), 2017 (n=11) and 2018 (n=16) at 146 SNP loci.
  - Mean observed heterozygosity ( $H_O$ ) in the Palisades woodrat population increased in 2016 and remained at that level in 2017 and 2018 following the introduction of translocated individuals from Pennsylvania in 2015, 2016 and 2017 (Fig. 2 and 3).
  - Parentage analysis indicated that 7 individuals captured in 2016 were fathered by a male translocated into the population in 2015. A female also translocated into the population in 2015 had mothered 6 offspring trapped in 2016, 2017 and 2018. Of the 13 hybrid offspring, 6 have produced offspring of their own (trapped in 2017 and 2018). No offspring of the four adults translocated into the population in 2016 and 2017 have been identified, though two of those individuals are known to have settled into areas outside of the trapping sites, thus their offspring would be less likely to be sampled.
  - Samples from Pennsylvania (N = 89) and Indiana (N = 333) were also genotyped at 146 SNP loci for comparison to the New Jersey data. When comparing discrete populations, Pennsylvania-captured individuals showed greater genetic variability than those captured in either New Jersey or Indiana (Fig. 3). Genetic differentiation amongst populations in Indiana, New Jersey and Pennsylvania was high prior to the 2015-2017 translocations ( $F_{ST} \geq 0.13$  for all pairwise comparisons). However, genetic differentiation between New Jersey and Pennsylvania decreased following the translocations ( $F_{ST} = 0.09$ ) (Fig. 3).
  - In addition to the SNP genotyping, the lab compared genetic variability at four toll-like receptor genes, which are integral to immune function, in woodrats sampled in both Pennsylvania and New Jersey. Native Pennsylvanian woodrats had more variable toll-like receptor genes than woodrats sampled in New Jersey prior to the translocations. These results indicate that introducing Pennsylvanian woodrats to New Jersey will likely increase genetic diversity at genes implicated in immune function. Preliminary analyses utilizing hybrid offspring of PA x NJ crosses support this argument.
- The geneticist also analyzed woodrat scat samples that ENSP collected in the summer and fall of 2018 (N = 100).
  - 50 of the scats were processed; 19 were successful for DNA extraction and genotyping at 146 SNP loci, and could therefore be assigned to individuals.
  - The lab also conducted preliminary laboratory work throughout 2018 aimed at exploring the use of chloroplast *trnL* intron sequencing for Allegheny woodrat as a means of identifying dietary items present in the scat samples.

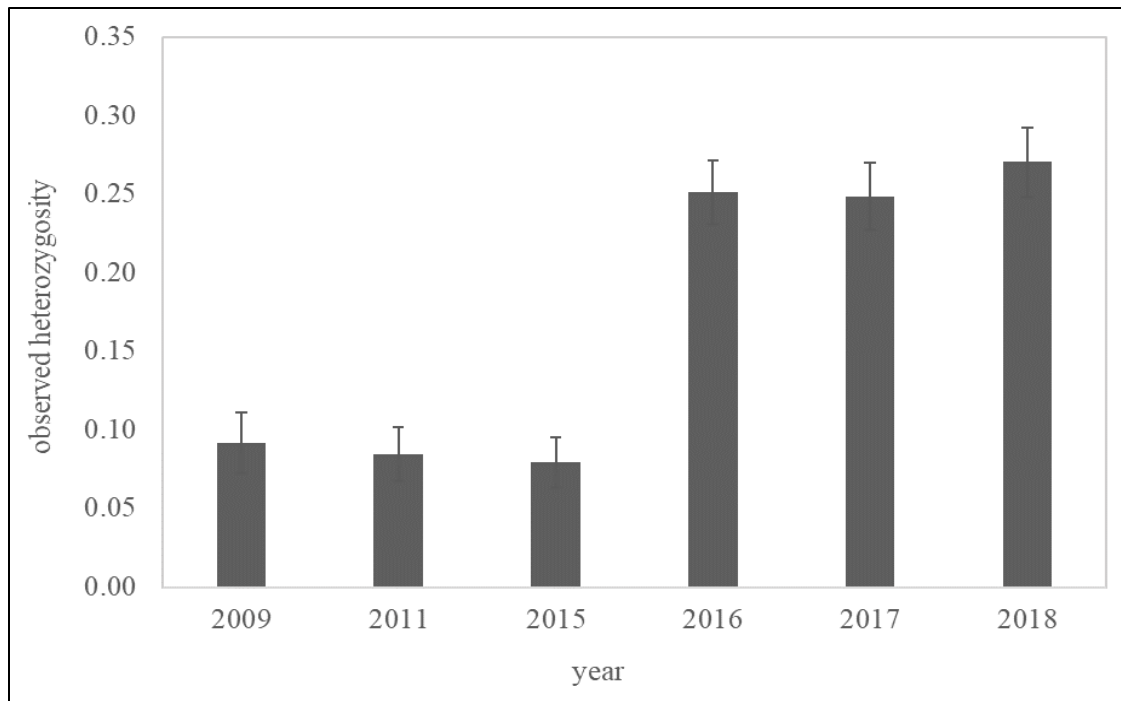


Figure 2. Mean observed heterozygosity ( $H_o$ )  $\pm$  SE for Allegheny woodrats (*Neotoma magister*) captured in 2009 (n=5), 2011 (n=13), 2015 (n=9), 2016 (n=18), 2017 (n=11) and 2018 (n=16) at the Palisades and genotyped at 146 SNP loci.

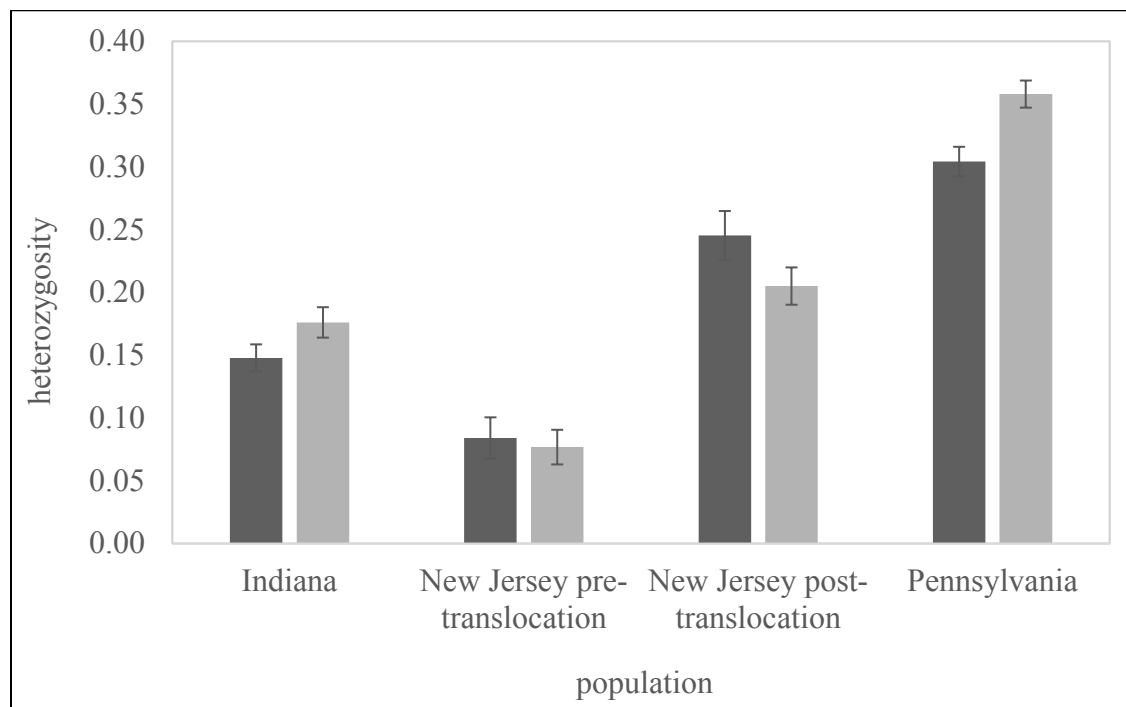


Figure 3: Mean observed heterozygosity ( $H_o$ )  $\pm$  SE (dark grey bars) and mean expected heterozygosity ( $H_e$ )  $\pm$  SE (light grey bars) for Allegheny woodrats from New Jersey, Pennsylvania, and Indiana genotyped at 146 SNP loci.

- Montclair State University funded two graduate students to work on Allegheny woodrat projects in collaboration with ENSP during the reporting period. Both students successfully completed their theses in May 2018 and copies are on file with ENSP.
  - One student GPSed the perimeters of and monitored 9 suitable talus slope sites within the Palisades range, but outside of the six sites ENSP has trapped annually, using 4-5 motion-triggered cameras at each site baited with peanut butter suet. The cameras were deployed for two weeks, and batteries, memory cards, and bait were refreshed after 1 week. She recorded woodrat activity at 5 of 9 sites monitored, and 2 of the sites had at least one juvenile present.
  - The second student evaluated habitat quality, prevalence of *B. procyonis* egg loads in raccoon scat (N = 150 total samples), and presence of predators/competitors using baited motion-triggered cameras at 4 historic woodrat sites. The 4 sites are located along the same ridge system in northern New Jersey and were known historic sites with evidence of woodrats until the mid-1980s. The student provided a suitability analysis to rank the 4 sites for further investigation as potential reintroduction sites. No woodrats were documented on camera.

#### Conclusions:

- The anthelmintic bait coverage provides a thorough temporal and spatial coverage of roundworm de-worming to keep this serious mortality factor at bay. The de-worming effort has been effective as measured by low prevalence of roundworm eggs in raccoon scat collected at the Palisades woodrat sites.
- ENSP translocated two woodrats per year for three years from a genetically healthy population in PA to the last remaining population in New Jersey. In 2018 we and our partners decided to monitor the genetics and capture rate for a couple of years and then re-group to discuss future management strategies for the population.
- Allegheny woodrat captures were at the highest level in the past 10 years in 2016 and 2017, and inexplicably fell back to 2011 levels in 2018. The increases are a good indication that the roundworm mitigation and translocation efforts may be having a positive effect on the population. The variation, however, underscores the need for annual monitoring.
- The genetic analyses conducted by Towson University have been very successful in understanding of the genetic variability in the New Jersey population. We have learned that, as expected, the overall observed heterozygosity of the New Jersey population indicates relatively low genetic variability prior to the translocations. However, heterozygosity has increased markedly since 2015 and several offspring of translocated woodrats have been identified.
- Towson's preliminary evaluation of the genetic variability at four toll-like receptor genes, which are integral to immune function, suggest that as a result of the translocation efforts, the genetic diversity at the genes will increase in the New Jersey population, and have a positive influence on the population's persistence.
- In 2018 Towson had success genotyping woodrat scat to identify individuals for the first time, which opens up new population monitoring options.
- Also in 2018, Towson conducted some preliminary work on extracting chloroplast DNA from woodrat scat as a means of identifying dietary items in the scat samples, which would enable us to better understand which plant species make up the bulk of the woodrats' diet in the Palisades so we can develop an informed management plan.

- The camera monitoring work of one of the MSU graduate students has documented a slightly wider distribution woodrats in the Palisades range than the six areas ENSP has monitored with annual live trapping for decades
- The camera work, habitat evaluation, and prevalence of raccoon roundworm at four historic woodrat sites by another MSU graduate student has provided helpful data regarding the suitability and ranking of those sites in regard to future management actions.

#### Recommendations:

- Continue the collaborative efforts with Montclair State University, Pennsylvania, and Ohio to conduct research and develop management plans for the conservation of woodrats.
- Research suggests that *B. procyonis* infection in Allegheny woodrat populations is a serious mortality factor and can result in rapid population declines for the intermediate host (LoGuidice 2000, McGowan 1993). Therefore, continue to implement the year-round raccoon roundworm mitigation effort and collect and analyze raccoon scat for *B. procyonis* egg prevalence on an annual basis at least as well as opportunistically when in the field at the Palisades to monitor the effectiveness of the strategy.
- Continue to conduct the annual trapping effort to collect genetic samples as well as to evaluate capture success trends over time as one means of evaluating status of the population.
- Genetic testing has indicated that inbreeding depression was a serious threat to the NJ population. Introductions of animals from the PA population improved heterozygosity. We recommend continued monitoring of genetic samples from all trapped individuals, and the analysis of parentage to specifically identify the extent to which translocated woodrats have bred. Continue to collaborate with the regional team of experts to decide on a plan forward regarding future translocation efforts.
- Continue to collaborate with Towson University on the genetic analysis of woodrat scat samples with the goal of using scat to inform our understanding of the minimum population size in the Palisades. Collaborate on the exploration of chloroplast sequencing of woodrat scat as a means of identifying particular dietary items, which would help inform habitat management efforts.
- Further assess historic woodrat sites using baited motion-triggered cameras.
- Encourage our partners at Montclair State University to support other graduate students focusing on woodrat research.

#### **Literature Cited**

- LoGuidice, K. 2000. *Baylisascaris procyonis* and the decline of the Allegheny woodrat (*Neotoma magister*). Ph.D. dissertation, Rutgers, The State University of New Jersey, 101pp.
- McGowan, E. 1993. Experimental release and fate study of the Allegheny woodrat (*Neotoma magister*). Unpublished report of New York State Department of Environmental Conservation, Endangered Species Unit. 15 pp.

STATE: New Jersey

PROJECT NUMBER: W-71-R-2

PROJECT TYPE: Research and/or Management

PROJECT TITLE: SGCN Mammal Research and Management

STUDY NUMBER AND TITLE: 1. Mammals

PERIOD COVERED: September 1, 2016 to December 31, 2018

JOB NUMBER AND TITLE: 2A. Bat Conservation and Management

Prepared by: MacKenzie Hall

OBJECTIVE 1: To identify, characterize and monitor summer bat colonies roosting within man-made structures and to provide guidance for proper management of those sites, especially where the federal endangered Indiana bats roost or maternity colonies exist.

OBJECTIVE 2: To identify, characterize, and monitor important winter habitats of New Jersey's bat species, including the federal endangered Indiana bat; and to gather Indiana bat winter population counts to contribute to USFWS database.

OBJECTIVE 3: To identify, characterize and monitor summer roost selections and maternity colonies of White-nose Syndrome affected bat species, including the little brown bat, Indiana bat, and the newly federally listed northern long-eared bat.

Key Findings:

#### **Interagency Consultations & Coordination**

- To begin investigating the presence of northern long-eared bats and their seasonal use of urban-suburban forested stream course areas in NJ's Inner Coastal Plain region, we gained permission from local open space agencies to do acoustic surveillance on three township properties in Evesham and Washington Twps, each along a forested stream. Results from our initial surveys (Oct 4-26, 2018) included northern long-eared bat passes at each of the three sites – with one site having at least 26 possible northern/Myotis calls and the other two sites having just 1-3 calls each – confirming late-season presence of the species.
- The NJ Department of Health Rabies Lab resumed in-house testing in Oct 2018, following almost two years of outsourcing specimens. The new staff agreed to hold all rabies-negative bat specimens of interest (such as *Myotis* species) for the ENSP to analyze. Noteworthy submissions from buildings during Oct-Dec 2018 included two northern long-eared bats (one from coastal south Jersey and one from the same Inner Coastal Plain geographic area as above), six silver-haired bats and one hoary bat.
- ENSP has established a successful bats-in-buildings program, offering guidance to homeowners and Nuisance Wildlife Control Operators (NWCOs) on effective, bat-friendly exclusion practices. Our new informative [webpages](#), seasonal email updates to NWCOs, free bat house offer for eviction sites, and recent introduction of NWCOs to acoustic survey methods all invite dialogue and cooperation on these topics.

- ENSP's bat biologist attended annual Northeast Bat Working Group meetings and participated in regular (approx. bi-weekly) WNS calls for agency personnel.
- ENSP collaborated with the USFWS NJ Field Office to develop guidance on bats-in-bridges issues for transportation management agencies. On Sept 5, we held a training session for NJ Department of Transportation engineers and Environmental Program personnel (approx. 30 attendees) on bat ecology, federal and state endangered/nongame species laws, and how to survey bridges for bats prior to disturbance-causing activities (Figure 1). We are in the process of developing a framework for reporting and querying this survey data, as well as conservation measures to be followed when bats are found to be using a bridge.



Figure 1. Bridge inspection field training with the US Fish and Wildlife Service and NJ Department of Transportation. At right, big brown bats roosting in the parapet gap of a bridge in Cumberland County.

### Summer Surveys

- Summer Bat Count results show that big brown colonies grew by 15% since 2016 (n=3; based on seasonal high counts), and the one site monitored annually since pre-WNS grew by 44% overall. Little brown bat maternity colonies, on the other hand, have dropped by another 6% since 2016 and by 96% overall since pre-WNS (n=3).
- Maternity colony banding surveys have been largely discontinued, but two such surveys of little brown bat colonies during 2017 revealed healthy rates of reproduction and juvenile survival (i.e., banded juveniles returning in future years as adults), and only minor evidence of WNS wing damage these past few years.
- With the help of a seasonal employee, contractor, and more than 20 volunteers, we completed our first two years of acoustic monitoring within 12 grid cells across NJ in 2017 and 2018, following the North American Bat Monitoring Program (NABat) framework for mobile transects and stationary point surveys. In the two combined years our 12 mobile routes generated approximately 1,835 total bat call files, and our 24 stationary acoustic points generated approximately 24,000 total bat call files over the two years. Results were similar for the mobile and stationary methods, with big brown bats making up 48% of all recordings both years and WNS-impacted species making up approx. 2-3% (Figure 2).

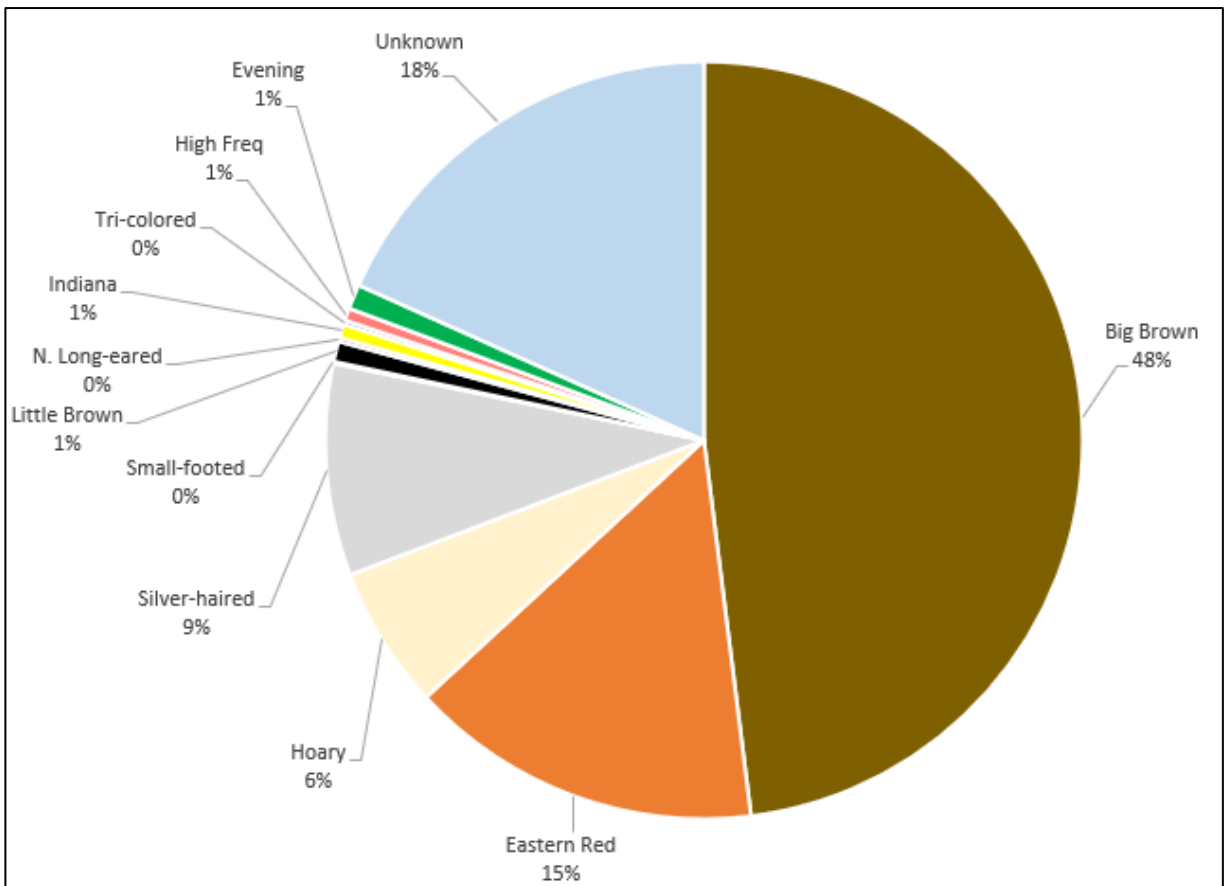


Figure 2. Average species composition from NJ's 2017 and 2018 NABat Stationary Acoustic Surveys.

- Our team and contractors completed 16 nights of mist-netting at 11 different sites under this grant during the reporting period, targeting northern long-eared bats in southern NJ and the suite of *Myotis* bats in northern NJ. Just 4 *Myotis* bats were captured, along with 62 big browns, 17 eastern reds, and 1 hoary bat.

### Hibernaculum Management & Winter Surveys

- ENSP and our contractors monitored the bat population, winter clustering behavior, and temperature profiles inside the Hibernia Mine (Morris County, NJ), related to an air flow modification project and re-gating of the mine completed under a Regional Conservation Needs grant. Temperatures appear to have been favorable for hibernating bats throughout the winter of 2017-2018 following modifications, with tunnel temperatures never dropping below 35°F and bats able to find ideal roosting temperatures of approx. 35° to 45°F by choosing either open (wall/ceiling) or insulated/clustered positions within drill holes.
- We continued post-WNS population and survivorship monitoring at Hibernia Mine with pre-emergence counts and banding surveys in March of 2017 and 2018. A total of 232



bats were tallied in March 2018 – a 35% drop from the 357 bats observed the previous year, and <1% of the pre-WNS population. The ratio of female bats has declined over the past several years, with females making up 18% of re-sightings and 26% of new bats in 2018 – the lowest ratios in the post-WNS era. On a positive note, almost 60% of the bats re-sighted in Hibernia Mine in March 2018 were originally banded at least six years prior (in 2010-2012), showing moderate survivorship of those earliest post-WNS individuals. Only four little brown bats (three of them believed to be first-year individuals) had minor fungal growth on their wings/forearm membranes consistent with WNS in March 2018.

- ENSP and team investigated three abandoned railroad tunnels for hibernating bats during the grant period, via acoustics, internal surveys in winter and/or external mist-netting in fall. The Manunka Chunk tunnels (Warren Co., NJ) and Pattenburg Tunnel (Hunterdon Co., NJ) had acoustic recordings of *Myotis* bats, but internal surveys only confirmed big brown bats hibernating. Our first investigation of Oxford Tunnel (Warren Co., NJ) in early September 2018 using acoustics resulted in 30 recordings of tricolored bats as well as 27 *Myotis* calls (potential little brown/Indiana and northern long-eared bats) and 26 big brown bats in 6 nights, but only 2 big brown bat calls in 4 nights in mid-October. An internal survey will be attempted in 2019.
- Fall swarm monitoring of bats at the Mt. Hope Mine (Morris County, NJ) continued each fall during the grant period, by volunteers from Sanders Environmental. Indiana bats are still the most numerous species at this site, but their captures were 33% lower in 2018 than in 2017 and 85% lower than pre-WNS. Little brown bat numbers have remained basically stable since 2012, while eastern small-footed bat numbers are low but climbing (44 captures in 2018, compared to 12 in 2012) (Figure 3).

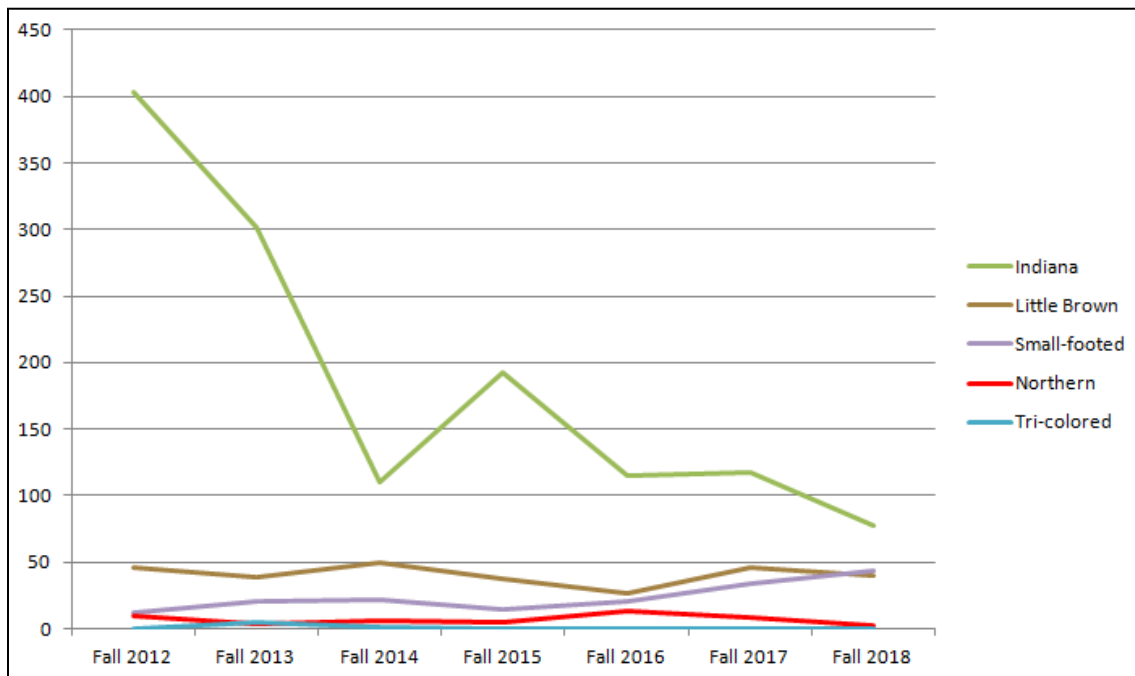


Figure 3. Fall bat capture trends at Mt. Hope Mine, 2012-2018.

## **Data Management**

- ENSP entered approximately 350 bat species occurrences (data point locations) into GIS from summer mist-netting surveys, consultant reports, hibernaculum searches, confirmed Rabies Lab records, maternity colony investigations, bridge surveys, sightings from the public, etc. These points were submitted in December 2018 for inclusion in ENSP's Biotics (NatureServe) database, which in turn is the basis for our public-access Landscape Project rare species habitat mapping program.
- Land Use/Land Cover habitat type justifications were completed for seven bat species during the project period. The justifications, based on extensive literature reviews, will provide the framework for ENSP's Landscape Project mapping of these species, which will now be added to the habitat mapping based on their proposed Endangered or Special Concern status.

## Conclusions:

- The NJ Department of Health Rabies Lab has become a valuable source of occurrence data for bat species of interest, particularly the northern long-eared bat, giving us new insights about habitat use and behavior.
- Bridges have been an untapped resource for our summer bat monitoring efforts. New coordination between our agency, the US Fish and Wildlife Service and the NJ Department of Transportation will enhance our documentation and protection of bats roosting in bridges.
- Populations of WNS-affected bat species have continued to decline, although their declines have slowed to the point of a possible stabilized level. Small remaining populations and colony sample sizes make it difficult to draw precise conclusions about the current trends. The population of WNS-resistant big brown bats is doing exceptionally well, making up about half of NJ's bat community.
- The significant drop in little brown bat numbers at Hibernia Mine between 2017 and 2018 (hibernation seasons) is likely attributed to more than WNS, so we need to consider the possible impacts of the new gated opening and our research visits that may alter the bats' use of the site.
- Several little brown bats from Hibernia Mine were re-sighted for the first time in six or more years, indicating that absence from one survey (or many) should not imply that individuals have perished. Bats may be using other hibernacula unknown to us or roosting in parts of the mine that we cannot access.
- While acoustic surveys detected *Myotis* bats outside of two abandoned railroad tunnels during spring/fall, only big browns were seen hibernating inside the tunnels. Further surveillance will be needed to confirm these sites as hibernaculum for *Myotis* bats.
- Little brown bats were mist-netted for the first time since 2015, showing that healthy individuals remain on the landscape and that acoustic scouting is a valuable way to pre-screen sites and target areas with high likelihood of presence. Likewise, healthy and reproductive northern long-eared bats remain on the landscape, including in lesser-quality forested stream habitats like those found in NJ's Inner Coastal Plain physiographic region.

## Recommendations:

- Continue annual, biweekly summer emergence counts at Little Brown Bat colonies - and other colonies of interest - to help ascertain trends in WNS-affected bat populations without disturbance to the animals.
- Survey and document additional bridge colonies via NJDOT inspections. Follow up on all reports of bats in bridges with emergence counts to determine colony sizes and species, and seasonal arrival and departure phenology as possible.
- Continue data-sharing with the NJ Department of Health Rabies Lab so that the ENSP has access to analyze and glean information from Rabies-negative specimens of interest.
- Use results of the NABat stationary monitoring program to focus netting efforts for species of interest/concern, like the Northern Long-eared Bat, Tri-colored Bat and Indiana Bat, in order to confirm the species' presence, radio-track bats to their roosts, and locate colonies for further monitoring.
- Adopt a policy of surveying hibernating bat colonies less frequently (e.g., every 3-5 years) to limit our potential for unintended impacts.