Federal Aid in Wildlife Restoration

W-71-R-1

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Species of Greatest Conservation Need
Mammal Research and Management

Final Segment Report

Project Year September 1, 2015–August 31, 2016

NJ Department of Environmental Protection

DIVISION OF FISH AND WILDLIFE
ENDANGERED AND NONGAME SPECIES PROGRAM
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NEW JERSEY DIVISION OF Fish and Wildlife

Conserve Wildlife
New Jersey Division of Fish & Wildlife
Endangered & Nongame Species Program

SPORT FISH & WILDLIFE RESTORATION

PERFORMANCE REPORT

STATE: New Jersey **PROJECT NUMBER:** W-71-R-1

PROJECT TYPE: Research and/or Management

PROJECT TITLE: SGCN Mammal Research and Management

STUDY NUMBER AND TITLE: 1. Mammals

PERIOD COVERED: September 1, 2014 to August 31, 2015

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:

- The dog-handler team conducted bobcat scat surveys throughout northern New Jersey. The survey effort was prioritized to focus on areas where, since 2006, a) the dog-handler team found a bobcat scat for which the genetics lab was able to get an individual ID, b) the dog-handler team found a bobcat scat, c) a bobcat was recently reported being observed. This prioritization was done to increase the likelihood of "recapturing" individuals to feed into the capture-recapture analysis.
    - The dog-handler team ran 42 transects that were, on average, 2.4 km in length and intersected with 46 of the 5 km grid cells that were overlaid on the existing predictive habitat model. Transects were run in 40 of the 52 grid cells where the dog-handler team has found a scat representing a unique individual in the past and in 42 of the 61 grid cells where the dog-handler team has found a bobcat scat in the past. The scat surveys were conducted from January 14 to June 10, 2016.
    - The dog-handler team collected and submitted 113 scats to the Rocky Mountain Research Lab for DNA analysis from the survey effort. The results are as follows:
        - 75 (66%) of the scats contained adequate DNA for species identification.
        - 42 of the scats were confirmed as bobcat.
        - The team collected verified bobcat scats in 22 of the 46 grid cells surveyed.
    - The GPS locations of all scats were recorded and the DNA results were linked to the resulting shapefile.
- Eighteen tissue samples were collected from animals hit by cars (N = 8), accidentally trapped (N = 10), during the reporting period for a total of 129 tissue samples to date. All samples were submitted to the Rocky Mountain Research Lab for DNA analysis. The data have been incorporated into the dataset being used for the capture-recapture analysis.
- ENSP biologists compiled all of the scat survey data to date (2004–2015) along with the tissue, and collar data to date (2002–2015) and continue to work with a statistician from Rutgers University to develop a spatially explicit capture-recapture model to evaluate sex

ratio, population size, density, and survival rate of the bobcat population in Northern New Jersey over time. Different iterations of the model will include all samples versus only scat data, and different grid sizes (1 km^2, 6.25 km^2, and 25km^2) will test for best fit. The 2016 data will be incorporated once it has been finalized and compiled.
  - As of 2015, 487 bobcat scats have been collected by the dog-handler team and have resulted in the identification of 174 unique individuals (90 females, 84 males).
  - The compiled bobcat dataset, representing both scat and tissue samples collected 2002-2015, includes 261 unique individuals (128 females, 133 males).
  - ENSP is collaborating with the Rocky Mountain Research Station and a mammologist at Montclair State University to develop a plan for analyzing information on parent-offspring relationships based on the scat and tissue samples.
- The Rocky Mountain Research Station Genetics Lab finalized the regional genetic analysis that includes scat and tissue samples collected 2002-2016 from New Jersey (261), and tissue samples collected 1998-2010 from neighboring Pennsylvania (N= 75) and New York (N=60), as well as samples from Maine (N=28), which was the source population of the New Jersey bobcat reintroduction, 1978-1982. ENSP found and submitted 8 additional tissue samples from 3 historic New Jersey bobcat specimens to represent the baseline bobcat genetic profile prior to the reintroduction, but it was not possible to extract quality DNA from the samples. The lab used a 10 microsatellite loci panel to evaluate the population structure of bobcats sampled in New Jersey with respect to bobcats in the neighboring states of New York and Pennsylvania, as well as from the source population of Maine.
  - Measures of genetic variation, including number of alleles, and observed and expected heterozygosity were similar among sampling locations. Measures of effective numbers of alleles were slightly lower in bobcats from Maine than the other states.
  - The bobcats sampled in New Jersey are genetically closer to bobcats in neighboring Pennsylvania and New York rather than Maine based on measures of gene flow (Fst), principle coordinates analysis (PCA), and cluster analysis using the program STRUCTURE.
  - The bobcats sampled in New Jersey appear to have their own unique population signal (represented in blue in Figure 1).
  - There is evidence of a mixing zone in New York from bobcats in all four states.
  - The bobcats in New Jersey do not appear to be structured by roads, but there is less of the unique population signal, the farther east you go.
- The statewide Connecting Habitat Across New Jersey (CHANJ) working group (NJ T-11-T-1, Job 3, Habitat Connectivity Project) is developing a mapping approach that will likely serve the needs for a landscape level bobcat habitat map and corridor model. Bobcat location data is being used to validate the CHANJ core and corridor mapping being developed as a pilot in the Skylands region of New Jersey. Therefore, we have not yet created an updated landscape predictive habitat model for bobcat as initially proposed in this project.
- An analysis of habitat change over time has not been completed and is pending the predictive model development.
- ENSP plans to conduct a GIS analysis of the bobcat collar data to date. Two scales of habitat analysis are planned.

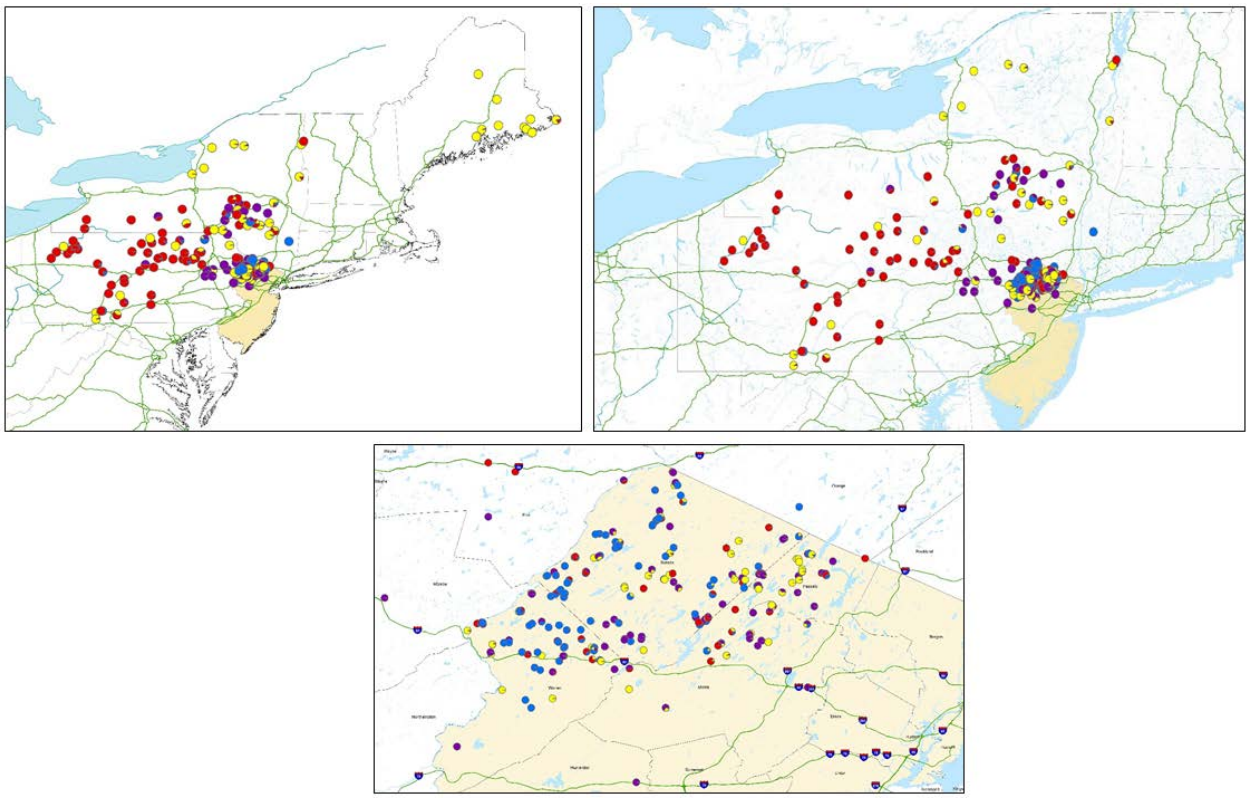


Figure 1. Distribution of genetic samples from New Jersey, Pennsylvania, New York, and Maine, showing the membership of each individual with a pie chart representing the proportion of membership to each of the 4 genetic clusters identified in the dataset. Three different scales are depicted: large scale (top left), regional (top right), and local, NW New Jersey (bottom).

- One reproductive tract (for a total of 4 to date that were read immediately rather than frozen) and teeth from 10 animals (for a total of 76), were collected opportunistically from bobcat carcasses during the sampling period. The reproductive tract was analyzed by a veterinarian and found to have 6 placental scars indicating that the 5 year old female had successfully bred within the last year and had as many as 6 fetuses. Twenty-nine of the teeth samples (for a total of 74 collected between 2007 and 2016)) were submitted to a laboratory to estimate the age of each animal from which teeth were extracted.
  - Fifty-five percent of the teeth samples were from individuals less than 2 years of age, the majority of which from that age group were killed by vehicles (Fig. 2). Seventy-two percent of individuals struck and killed by vehicles are less than 2 years of age and have a fairly even sex ratio (Fig. 2 and 3).
  - The maximum age of an individual in the sample was 11 years old and the next oldest was 6 years old (Fig. 2).
  - A disproportionate number of 2-3 year old males are killed by traps (9/10) and a disproportionate number of 1 year old females (4/5) are killed in traps.

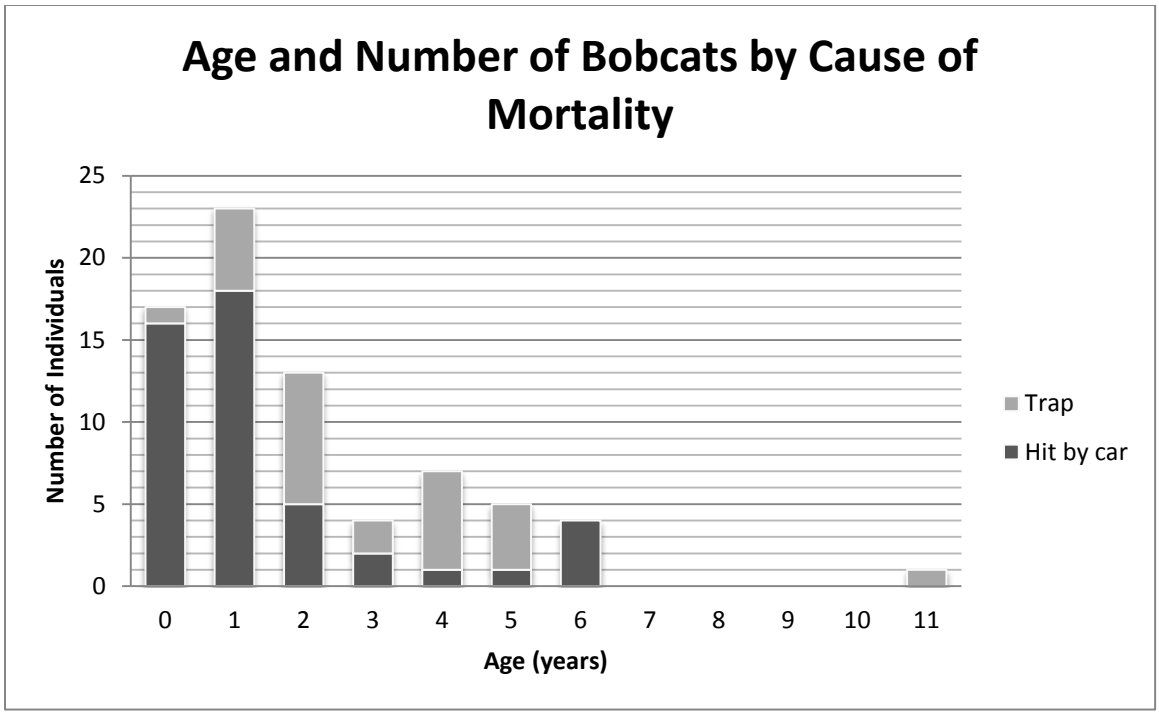


Figure 2. Number of bobcats by age in years and the cause of mortality based on 74 teeth samples collected between 2007 and 2016.

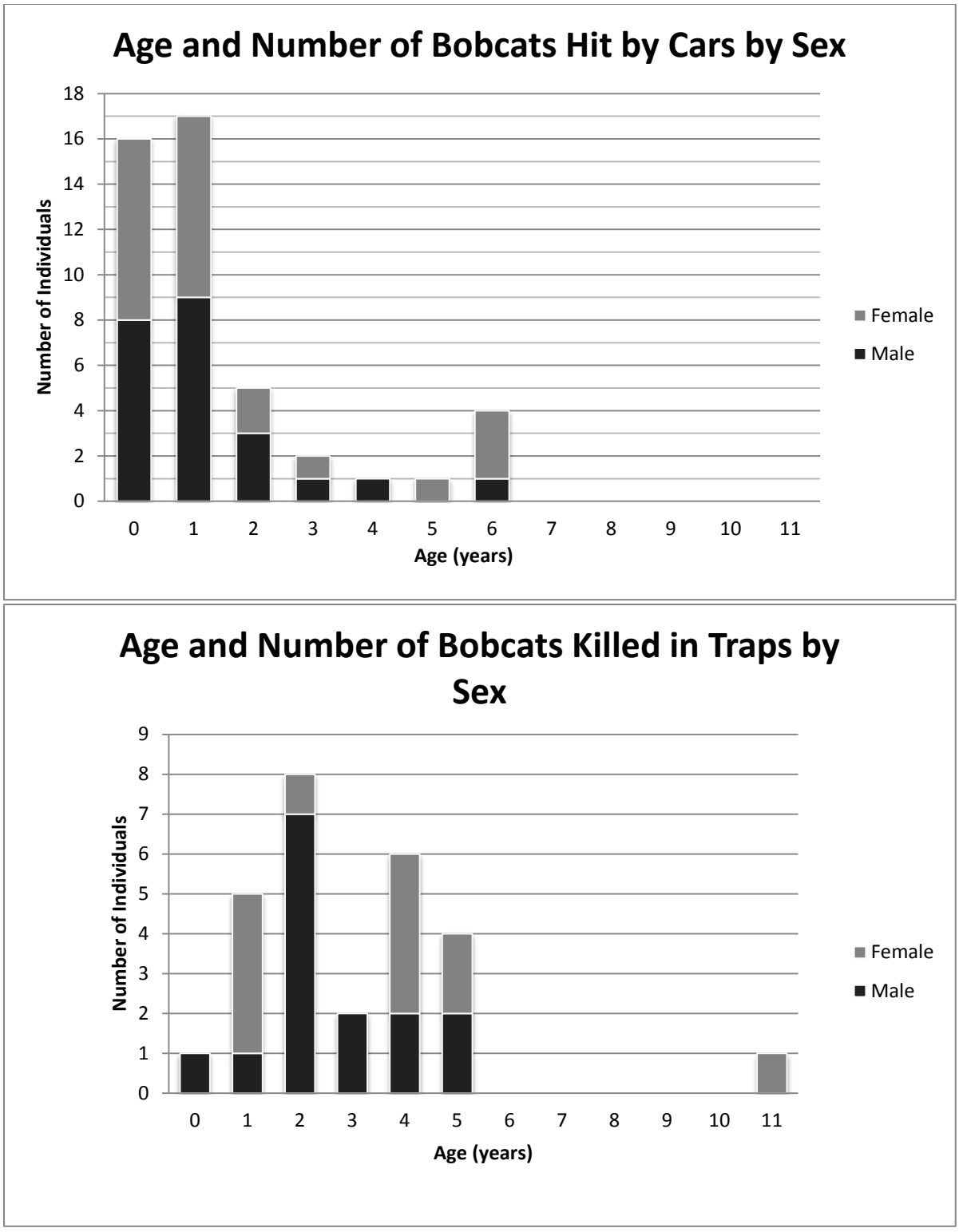


Figure 3. Number of bobcats by age in years and sex and divided into two charts based on the cause of mortality (top: hit by car, bottom: killed in a trap) based on 73 teeth samples (one tooth sample included in Fig. 1 was from an individual of unknown sex) collected between 2007 and 2016.

- Opportunistically collected bobcat carcasses were also tested for rodenticide exposure (Fish and Wildlife Health Project, FW69-R-19). Twenty-one carcasses collected between 4/1/13 and 2/8/16 were tested and 7 (33%) were found to have exposure to rodenticides. There was no evident spatial clustering of positive samples.
- An ad was again published in the Division of Fish and Wildlife's Hunting Digest that requested information on bobcat sightings, vehicle mortality and accidental trapping and described the reporting mechanisms.
- The bobcat biologist within the Endangered & Nongame Species Program (ENSP) continued to collaborate with Bureau of Wildlife Management (BWM) biologists to respond to bobcats accidentally captured in cable restraints. ENSP continues to work on developing mechanisms to better understand and minimize injury and mortality resulting from accidental capture.
    - A similar protocol was followed by the ENSP and BWM biologists responding to bobcat calls as last trapping season, though some additional recommendations were added by ENSP based on the injuries noted from bobcats the previous year, to try to improve our response efforts. The protocol follows the latest recommendations from Safe-Capture International, Inc. training, and helps insure that standardized data are collected and samples and recorded information get to the appropriate ENSP biologist.
    - A total of 11 trapped bobcats (Fig. 4) were reported by trappers during the reporting period; 1 in a cage trap, 10 in cable restraints. The bobcat in the cage trap was released without immobilization and a scat was collected for DNA analysis. Of the 10 bobcats in cable restraints, 4 (40%) died and 6 (60%) were successfully released. One of the 6 required medical attention. Ear tags were put in all of the bobcats handled and released successfully by ENSP/BWM and DNA samples were taken from all bobcats and carcasses handled by ENSP/BWM, except one that was a recapture and already had ear tags and DNA sample taken (5/10 and N = 10, respectively.). All but one of the bobcats reported trapped was in Warren County. That follows a trend of a disproportionate number of trapped bobcats being reported in that one county over the past several years.
    - Game code changes recommended by ENSP went into effect in the 2015-2016 trapping season. They include mandatory reporting of trapped bobcats within 24 hours, and require the use of relaxing locks on cable restraints. A recommendation to avoid the possibility of entanglement of the anchoring system or cable, as recommended in AFWA's Best Management Practices (http://jjcdev.com/~fishwild/?section=best_management_practices), was also posted on the Division of Fish & Wildlife's website for avoiding injury or mortality of bobcats accidentally trapped in cable restraints.
    - ENSP and BWM biologists, managers, and veterinarian met in March to review the bobcat response that occurred during the 2015-2016 trapping season to discuss changes that could be made to the response protocol to enable a more effective response and data collection. Results of the necropsies and injuries observed from bobcats that required medical attention were reviewed.

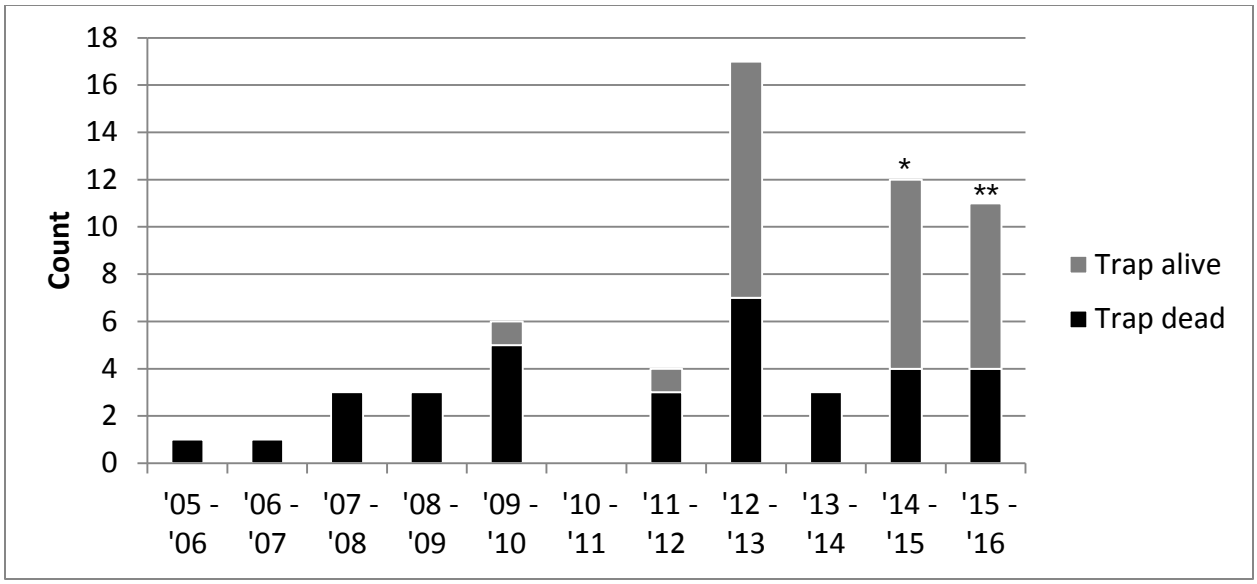


Figure 4. Number of bobcats trapped accidentally in New Jersey over the past 11 reporting periods from September 1 to August 31 each year. The '09 – '10 year was the first year of a trapper response team available to help release bobcats. The '15 – 16 year was the first year of mandatory reporting of bobcats.

* - 1 alive released by trapper, not sure of condition
** - 1 alive caught in cage trap

- There were 8 road-killed bobcat carcasses recovered by ENSP during the reporting period (Fig. 5), from which tissue samples, teeth, reproductive tracts (females) were taken and rodenticide testing was performed. Two other road-killed bobcats were reported to ENSP from credible sources, but were unable to be located.

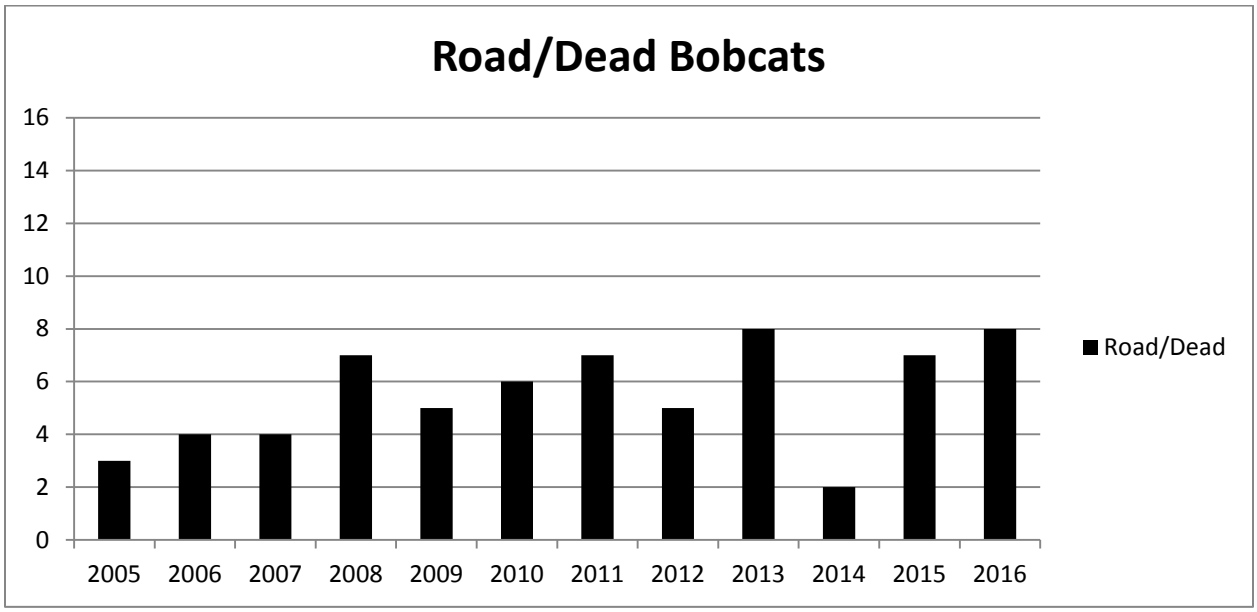
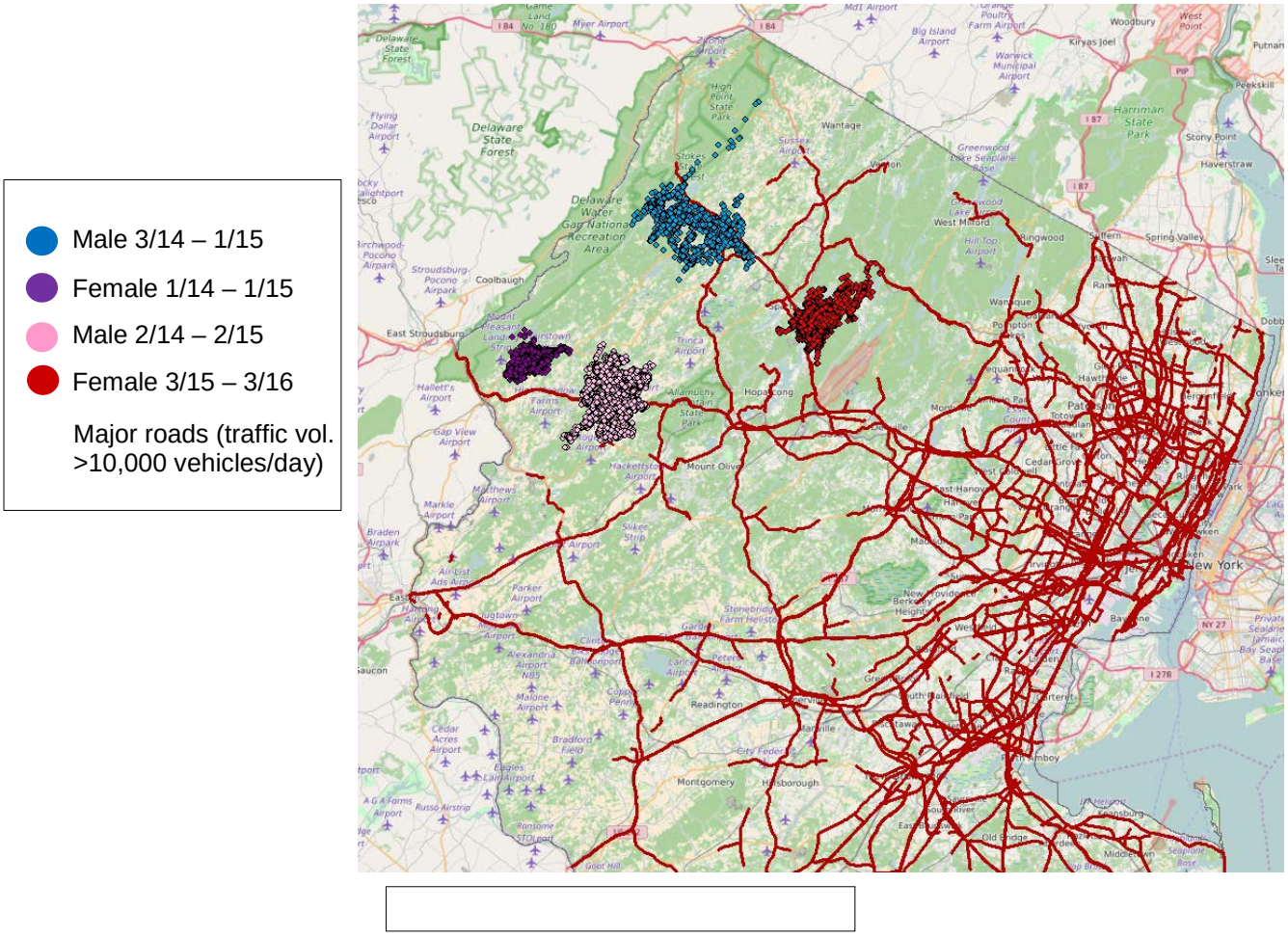


Figure 5. Number of bobcats struck and killed by cars in New Jersey over the past 11 years, through 8/31/16.

- The final collar from a small study to evaluated bobcat movements relative to high-volume traffic roadways became available on 3/8/16 as scheduled. The 4 collars deployed since 2014 for this study were programmed to capture location data once every hour for 350 days following deployment. These four bobcats were tracked using an ATS receiver every 7 to 21 days to make certain the animals are still alive and to track their movement patterns to aid in collar recovery after drop-off. Two of the collars, previously deployed, dropped off as scheduled around 1/15/15 and 2/1/15 and were recovered by ENSP. The third collar was on a bobcat that died in a trap on 1/1/15 (11 weeks before scheduled drop off) and ENSP recovered the carcass and collar from the trapper.
    - The collar data indicate that for 3 of 4 bobcats in the study, major roadways seem to influence their movements with only very infrequent crossing of the roadway, yet movement right up to it. Surprisingly, one bobcat's home range was bisected by a major east-west running interstate that seemed to be a barrier to the movement of previously collared bobcats. We had deployed 4 motion-triggered cameras in structures under the highway in that area and they only picked the bobcat up one time and he had climbed up the structure to the road surface rather than using the structure.



- The Biotics database has not been updated with all of the bobcat observations received from the public and the tissue samples due to turnover in data manager staffing. The bobcat scat data collected in 2016 has not been entered into the database during the reporting period because the DNA results were still pending.
- Work was not done on the bobcat status assessment and recovery plan.

Conclusions:

- The survey effort in 2016 by the dog-handler team was more extensive than in 2015, mainly due to better weather conditions more conducive for working by an aging wildlife detection dog. The team surveyed approximately 77% of the grid cells where individual IDs of bobcats have been obtained in previous years (up from 62% in 2015) and collected verified bobcat scats at approximately 48% of the grid cells surveyed (down from 57% in 2015). Despite the increased effort, this was likely the last year that the working dog will be able to cover that much ground due to the arthritis in his hind legs and general aging. However, his desire for the work has not decreased with time!
- The drying technique ENSP started using 4 years ago was in use, but only 66% of scats had adequate DNA for species identification, compared to 80% in 2015 and 95% in 2013. In 2016, the final sets of scats collected over 4 days in May and June did not perform well in terms of having adequate DNA for analysis. Only 10/25 (40%) of the samples had adequate DNA, which skews the overall total. It is difficult to explain and correct, as there are many factors that contribute to scat degradation, including a lot of rain, or conversely dry conditions that enable scat to remain in the landscape longer, but where they are exposed to the elements for a longer period of time.
- The opportunistic collection of DNA samples from live bobcats as well as teeth, reproductive tracts, DNA samples, and rodenticide testing, including the spatial locations of those samples, are all contributing valuable information to increase our understanding of the status and health of the New Jersey bobcat population.
- A compiled dataset of individual IDs, sex, and spatial locations of bobcats collected between 2002 and 2015 is being analyzed by a statistician at Rutgers University to evaluate sex ratio, population size, density, and survival rate of the bobcat population in Northern New Jersey over time, and 2016 data will be incorporated as well once it is compiled.
- The regional genetic analysis was recently finalized by the Rocky Mountain Research Station. It is encouraging that the genetic variation measured in the populations from each of the states (NJ, PA, NY, and ME) were similar, with those from Maine being the lowest. It is also encouraging that the bobcats in New Jersey do not appear structured by anthropogenic influences such as roads, though we do know that roads represent the highest source of mortality for bobcats in the state (65% between 2005 and 2016), and that the movement patterns of most of the collared bobcats to date seem negatively influenced by high traffic volume roadways. Bobcats with the unique population signal are predominantly in the western portion of the New Jersey range and occur less frequently in the eastern portion. It is unclear if that is the result of anthropogenic influences. The Delaware River on the western border of New Jersey does provide a significant natural movement barrier between New Jersey and eastern Pennsylvania. The identification of the unique population signal in the New Jersey population may be

indicative of a remnant population in New Jersey prior to the translocation of individuals from Maine, or be a result of the addition of bobcats from Maine and migration of individuals from neighboring states into New Jersey that mixed, or a combination of both. There also were few samples collected in southern New York, which may have helped add more clarity to the results.

- The majority of our dataset of opportunistically collected bobcat carcasses (roadkills or died in traps) between 2007 and 2016 have been young cats, <2 years old and with the exception of one 11 year old bobcat, the next oldest bobcat in the dataset is just 6 years old, reflecting a young population, particularly when bobcats are known to live in the wild for 12-13 years. Generally unexploited populations consist largely of older individuals and in exploited populations, young animals dominate. Based on the age class data to date, New Jersey matches the exploited population model better. The fact that such a large portion of young cats were killed on the roadways is expected due to naivety to roads as well as the fact that they are dispersing at that age. The fact that a disproportionate number of 2-3 year old males have been killed in traps may relate to the spatial clustering of bobcats reported in traps. If a male is killed, a young male still looking for a territory will likely move in to claim the now vacant territory. It is concerning that about 1/3 of the bobcat carcasses tested (7/21) show rodenticide exposure.
- The number of bobcats reported struck by vehicles and carcasses recovered has remained fairly consistent for the past 10 years. The number of bobcats reported in traps has fluctuated over time. There was not an increase in the number reported this past trapping season even though it was the first season where reporting was required in the game code. It is unclear if this was a result of trappers not being aware of the need to report these incidents or if there simply weren't more bobcats accidentally trapped this reporting period compared to last trapping season. Anecdotally there are trappers that still are not reporting bobcat catches despite the regulations. It is unclear if the disproportionate number of bobcats reported in traps coming from Warren County is due to differing trap effort in that county compared to the others or some other explanation such as non-reporting. We are working with the Bureau of Wildlife Management to attain estimates of trap effort in each county.
- The rate of successfully releasing bobcats caught in cable restraint traps was 60% (6/10) during this reporting period, which was lower than last year (67%). Over the past 5 years, the rate of successful release has always fallen below 70% (25%, 0%, 59%, 67%, and 60%).
- The second year of the collaborative effort of biologists within ENSP and Bureau of Wildlife Management biologists to respond to bobcats accidentally captured in traps was generally successful in providing a standardized response and data collection when bobcats are accidentally trapped in cable restraints. Improvements to the protocol were discussed and will be implemented in the 2016-2017 trapping season.
- Based on four bobcats telemetered near highways, we have data that are useful in examining the barrier effect of high-volume roadways to bobcat movements, and to identify potential crossing corridors. These data will be used in combination with bobcat roadkill data, the habitat corridor mapping, and data from remotely-triggered cameras at structures under two of the high volume highways in northern New Jersey that bisect suitable bobcat habitat.

Recommendations:

- Determine whether the mapping approach chosen by the statewide connectivity map working group will serve the needs for a landscape level bobcat habitat map and corridor model. If not, develop an updated landscape level habitat predictive map to feed into bobcat specific corridor modeling effort. Develop a within home range predictive model now that all of the collar data is available. Identify and prioritize corridors among core bobcat habitat areas to focus on for working to protect land and increase safe passageways through roadways in those areas.
- Continue to use scat, tissue, remotely triggered camera, and GPS collar data to help validate CHANJ core and corridor modeling.
- Shift focus of work with the wildlife detection dog to central and southern New Jersey to make the best use of this tool while the dog is still able. There continue to be very few and very scattered reports of bobcats in central and southern New Jersey, so using the dog to assess some of the more probable areas would be beneficial in both identifying presence/absence, as well as incorporating any samples collected into future iterations of the genetic variability analysis to assess whether there are distinct groupings in the different regions of the state and to evaluate gene flow.
- Given the lower success rate of extracting quality DNA for species identification from scat, be cognizant of drying the scats as quickly as possible after they have been collected to avoid DNA degradation and collect the freshest scats possible.
- Continue to opportunistically collect tissue samples from live and dead bobcats to add to the capture-recapture database.
- Continue to work with the statistician at Rutgers University to develop the spatially explicit capture-recapture model using the compiled bobcat dataset from 2002 to 2016, and estimate sex ratio, population size, density, and survival rate of the bobcat population in Northern New Jersey over time.
- Continue to work with the mammologist at Montclair State University and the Rocky Mountain Research Station to implement the plan we develop for evaluating the parent-offspring relationship data gleaned from the 2002–2016 bobcat genetics dataset.
- Continue to work with the Rocky Mountain Research Station to insure accurate interpretation of the regional genetic analysis results for incorporation into a bobcat status assessment and recovery plan, and distribute the resultant report to collaborators in NY, PA, and ME for their information and input. Seek out historical New Jersey bobcat samples from <1978 to represent the baseline genetic profile in New Jersey prior to the translocation to incorporate into future analyses. Consider collecting data from neighboring states and Maine again in a few years and re-running the regional genetic variability analysis to assess the influence of time on results.
- Continue to collaborate with biologists from the Bureau of Wildlife Management to implement recommended changes to the bobcat trap response protocol for the upcoming trapping season.
- 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) to decrease the rate of injury and mortality to bobcats accidentally trapped in New Jersey.

- Continue collecting and analyzing reproductive tracts and teeth to evaluate age structure, fecundity, and pregnancy rates of the population, and test bobcat carcasses for rodenticide exposure to assess the extent of this risk factor.
- Compile the various analyses in a bobcat status assessment/recovery plan. Develop outreach information 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 information they can contribute with samples from road-killed and trapped bobcats.

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 partnered with a professor at Montclair State University and AmeriCorps members working with that same professor to conduct research on woodrats in New Jersey. ENSP and Montclair State University also began working with researchers in the region (Pennsylvania and Maryland) to conduct habitat inventories and evaluate vulnerability to infestation by raccoon roundworm at active and inactive woodrat sites.
- ENSP has continued to implement a year-round roundworm mitigation plan at the Palisades habitat in collaboration with Purdue University. The 6 bait dispensers deployed in May 2015 for delivery of pyrantel pamoate-treated fishmeal/polymer baits to free-ranging raccoons were redistributed and an additional 7 dispensers were deployed in June 2016 to provide more thorough coverage, now approximately 1km apart above and below the Palisades cliffs along the entire length of the Palisades habitat area (Fig. 1). All of the dispensers are re-loaded on a 6-8 week schedule with approximately 50 baits each, year-round. The baits each have approximately 150mg of pyrantel pamoate. In April 2016 we began using baits with pyrantel pamoate powder manufactured directly into the fishmeal/polymer casings. Prior to that, a marshmallow or piece of cake with injected pyrantel pamoate paste was inserted into the fishmeal/polymer casing and then sealed with wax. ENSP has been collaborating with NY biologists, who also invested in bait dispensers to provide additional coverage on the north end/NY side of the Palisades, contiguous with NJ woodrat habitat. In addition, ENSP, Montclair State University, AmeriCorps members, and volunteers collected 25 raccoon scats at the Palisades between 10/5/15 and 8/25/16 to evaluate the prevalence of *B. procyonis* egg loads in the scat. The scats were sent to Wheaton College for analysis and 2/25 (8%) came back positive. Both positive samples were collected in August 2016. Last year, 15 raccoon scat samples all tested negative.

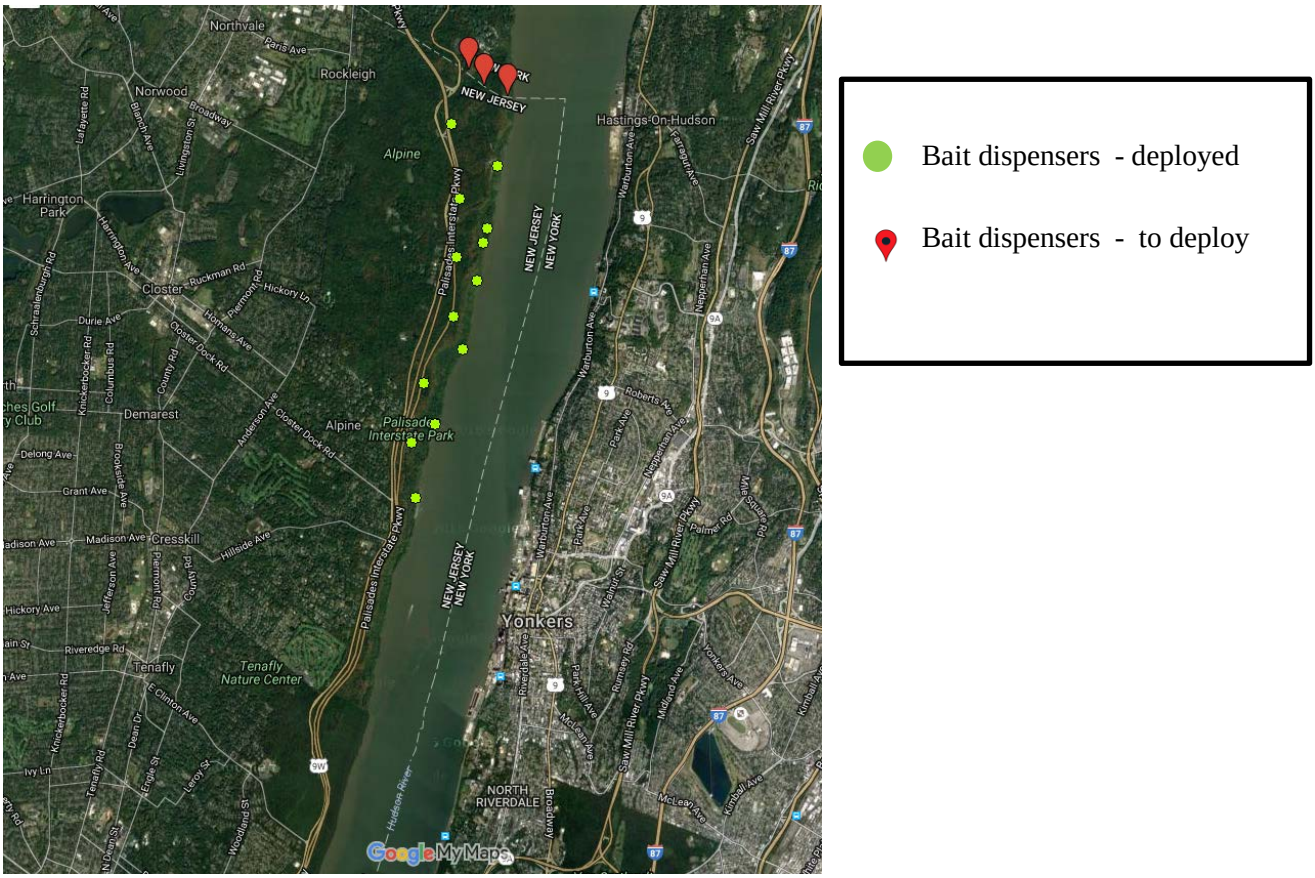


Figure 1. The distribution of the anthelmintic bait dispensers deployed for delivery of pyrantel pamoate-treated fishmeal/polymer baits to free-ranging raccoons in the Palisades Insterstate Park.

- Standard trapping protocol was conducted at six separate talus slope sites at the base of the Palisades Interstate Park from October 5 through October 7, 2015. 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 traps were set for two consecutive days (October 5 and October 6) for a total of 80 trap-nights of sampling effort.
  - Trapping success in 2015 was the lowest it has been since 2009 with the capture of just 10 unique individuals. Woodrat numbers (based on capture index) had been declining at the Palisades site from 2006 to 2009 but then increased in 2010 and 2011, went down slightly in 2012 and then back up in 2013 and 2014. The capture index (# of individuals captured/10 trap nights) in 2015 was 1.3, down from 1.87 in 2014 and 2013, 1.50 in 2012, and 2.0 in 2010 and 2011, though slightly higher than it was in 2008 and 2009: 1.13 (Fig. 2).

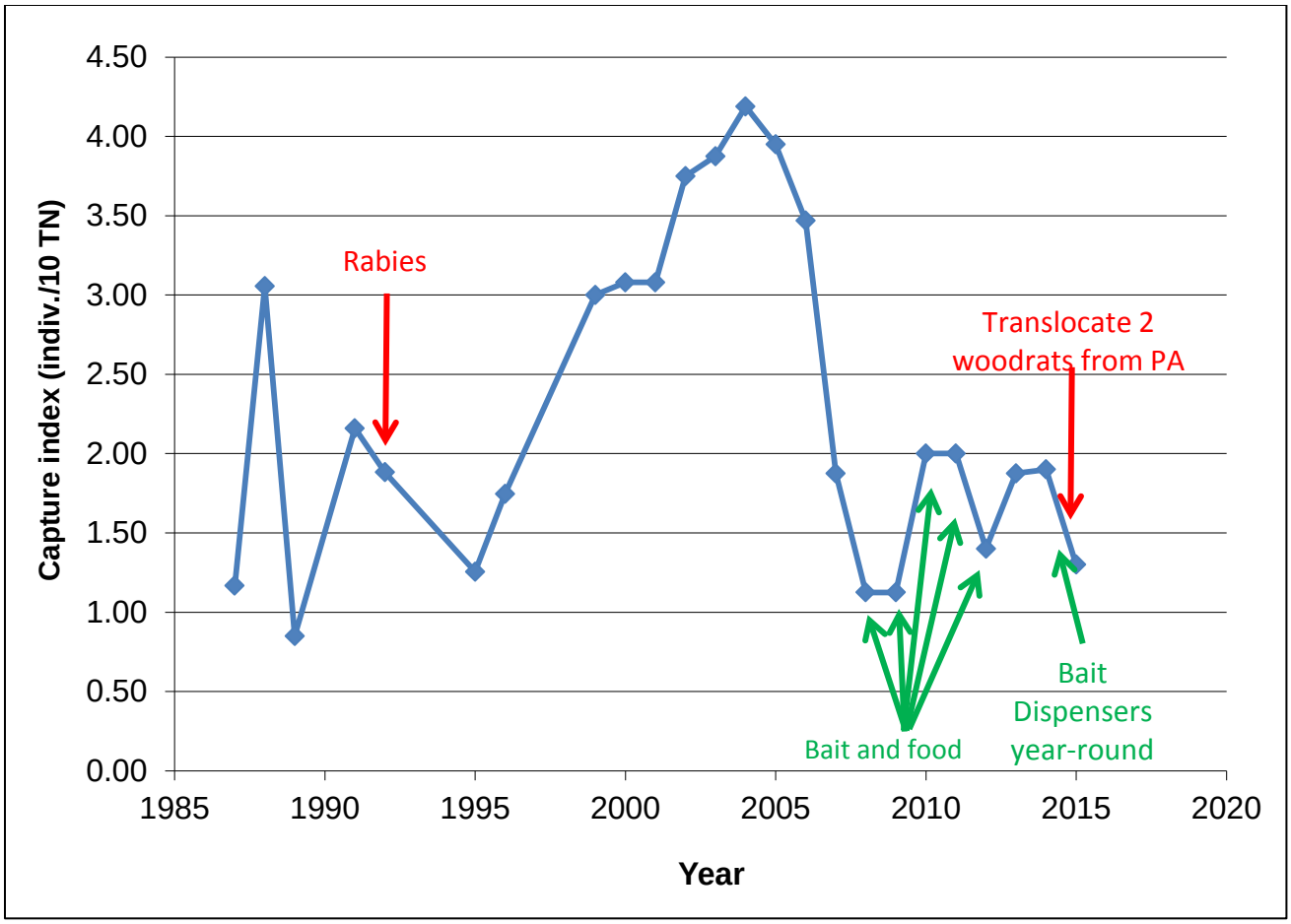


Figure 2. The results of ENSP's trapping effort in the Palisades over the last several years, setting forty traps for two consecutive days in 6 trap areas in the fall, for a total of 80 trap-nights of sampling effort.

- Captured animals consisted of six adult males, three adult females and one sub-adult female.
- Two animals (1 male and 1 female) were recaptures from 2013, two were recaptures from 2014 (1 male and 1 female), five animals were first time captures (4 males and 1 female). One of the individuals captured was the female translocated from Pennsylvania in July 2015; we removed her collar. The translocated male (based on telemetry and camera tracking) was not present in any of the active trapping sites during trap nights; his collar had been removed previously.
- 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 captured individual to serve as a pre-translocation genetic assessment.
- Woodrat scats (N=60) were collected at the active sites, to add to the 12 collected at 2 sites in 2014, and will be sent to a geneticist to extract DNA to evaluate whether the non-invasive technique of scat analysis could be an effective method of monitoring

the population status in the future. We need to develop a new collaboration with a geneticist at Towson University, Jacqueline Doyle, who had worked with Purdue geneticist, Tim Smyser; Dr. Smyser has taken another position and is no longer available for our work.

- Monitoring of the translocated male and female from July 2015 has continued through the year with two motion-triggered cameras positioned where the animals were last located with telemetry before we removed their collars. Both were visible on camera through winter 2015-16, but as of spring 2016, the female has gone unidentified because she is no longer at that location, has died, or has lost her center ear tags. The male was identifiable through the end of the reporting period.
- A second translocation effort was conducted at the end of July 2016.
  - ENSP, in collaboration with Montclair State University and biologists from Pennsylvania Game Commission, trapped two sub-adult Allegheny woodrats (a male and a female) over one trap night at two active woodrat sites in Huntingdon County, Pennsylvania, on July 25 and 26, 2016. The two sites were chosen because the populations could sustain the removal of two sub-adults, and Purdue and Indiana University of PA recommended these woodrats for the genetic infusion they would provide.
  - The two sub-adults were transported to New Jersey on July 26 and received a health assessment by a wildlife veterinarian. Ear tags were attached, ears were unique-notched identification on camera, they were fitted with ATS telemetry collars, and genetic samples were obtained from each.
  - The two individuals were released in the Palisades on July 27, 2016, into sites with suitable habitat known to be occupied by woodrats, with unoccupied dens, but with no visible active latrines. The female was released outside of an active site, one north of where the translocated female was released in 2015, and the male was released one active site north of there.
  - ENSP, in collaboration with Montclair State University and AmeriCorps members, closely monitored the two individuals with telemetry (locations were recorded) and by setting up and moving as needed, four motion-triggered cameras (two at each site where telemetry indicated the individual was located) set to capture 10-second videos when triggered. The telemetry and video review took place every day for the first week, and then every 2-3 days through the end of the reporting period. The two translocated woodrats were identifiable on the videos by their collars and unique ear tags and notches. Both individuals moved up toward the base of the cliffs to areas we had not previously monitored. The female took approximately 1 month to settle into an area where we consistently located her, moving approximately 0.9 km from the release site. The male settled into an area approximately 0.18 km from his release site within approximately 2 weeks. Monitoring continued past this reporting period.
- Historic records were reviewed and we created a map of the historic sites on an interactive mapping site that includes notes on what information is known about the sites, and dates last woodrat sign was observed at the locations, for an easily accessible database that could be sent to collaborators. In collaboration with Montclair State University, we plan to conduct woodrat scat surveys and set up motion-triggered cameras for a two week period each at the historic sites to evaluate the sites for presence/absence.

Other researchers have found that baited motion-triggered cameras are as effective as trapping for detecting woodrat presence. Survey work has not yet begun.

Conclusions:

- The planned collaborative efforts with Montclair State University and researchers in Maryland and Pennsylvania will be useful for developing a management plan for the conservation of woodrats and their habitat at the Palisades and for evaluating historic sites and determining if they could support woodrats again in the future.
- The anthelmintic bait coverage is now much more extensive across the NJ portion of the Palisades and the re-loading of the bait dispensers at regular 6-8 week intervals year-round, provide a more thorough temporal and spatial coverage of roundworm de-worming than ever before. This is necessary to reduce the roundworm mortality factor, and conserve this last remaining Allegheny woodrat population in NJ, and give the translocation/genetic rescue efforts every chance of success. While the baseline prevalence of roundworm eggs in raccoon scat collected at the Palisades woodrat sites in May 2015 was zero, unfortunately there were two (8% of samples) positive raccoon scat samples collected in August 2016 even with this extensive de-worming effort. It is a low percentage, but we have started to re-evaluate our methodology of baiting (e.g., emptying the bait dispenser of any remaining baits before refilling, testing the effectiveness of the baits with the drug manufactured into them at de-worming captive raccoons, etc.) to increase success going forward.
- Allegheny woodrat captures dropped to a low level again in 2015, which is a cause for concern, particularly knowing that the population is suffering from significant genetic isolation. The time for intervention with our translocation effort and more thorough roundworm de-worming efforts is certainly now. The fall 2016 trapping effort should give us a good indication of whether these efforts are starting to show some success.
- The genetic analysis of woodrat scat will help determine whether this can be used as a mechanism for surveying and monitoring woodrat populations in the future.
- ENSP an our partners have coordinated, for two consecutive years, the translocation of Allegheny woodrats to the last remaining population of woodrats in New Jersey, in an attempt to increase the genetic diversity of the isolated population. The fact that the translocated individuals survived at least over the winter is a very good sign. The fact that the 2 individuals translocated in 2016 had survived a month post-release gives them the same chances of survival as the other individuals in the population. Our use of telemetry and cameras to track movements, behaviors, and confirm survival has proven successful. Both individuals translocated in 2016, and the male from 2015 settled into areas never previously monitored by ENSP, which is an added benefit of closely monitoring movements of individuals.

Recommendations:

- Continue the collaborative planning efforts with Montclair State University, Maryland, and Pennsylvania to 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. Continue to collaborate with biologists from the NY side of the Palisades Interstate Park to deploy additional anthelmintic bait dispensers on the NY side of the range and follow the same standardized protocol of re-baiting.

- Genetic testing has indicated that inbreeding depression is a serious threat to the population. The two translocation attempts of individuals from nearby PA woodrat populations have gone well. ENSP should continue to monitor the movement, condition, and survival of the translocated individuals as long as possible throughout the upcoming year. Collect genetic samples from all individuals trapped during the next annual trapping in the fall of 2016 so that they can be compared to the baseline samples collected last year, as well as to the specific translocated individuals to assess the effectiveness of this genetic rescue effort. Continue the translocation efforts into the future, in collaboration with the regional team of experts who have agreed that regular influxes of new genes would be advantageous to the genetic health of the Palisades population.
- Begin the assessment of historic woodrat sites using visual survey of latrines as well as baited motion-triggered cameras.
- Continue collaborating with Montclair State University, which is planning to fund two graduate students starting in fall, 2016, to assist with varying aspects of the expanding Allegheny woodrat project in New Jersey.

Literature Cited

Boulanger, J. R., L. L. Bigler, P. D. Curtis, D. H. Lein and A. J. Lembo Jr. 2006. A PVC bait station for dispensing rabies vaccine to raccoons in suburban landscapes. Wildlife Society Bulletin 34:1206-1211.

Castleberry, S. B., T. L. King, P. B. Wood, and W. M. Ford. 2002. Microsatellite DNA analysis of population structure in Allegheny woodrats (Neotoma magister). Journal of Mammalogy 83: 1058-1070.

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.

JOB NUMBER AND TITLE: 1C. Small Mammal Survey
Prepared by: Gretchen Fowles

OBJECTIVE: To develop survey and habitat sampling protocols for several species of terrestrial small mammal that can be used for sampling statewide.

Key Findings:

- Due to staff reductions, ENSP biologists have not had the capacity to complete the surveys that ultimately are needed to better understand the status of many small species in the state.

Conclusions/Recommendations:

- ENSP has the responsibility to assess the populations of small mammals, particularly species that may face threats to population viability in the state. But the limitations of staff and funding suggest that this work will be postponed until funding is sufficient for contracted surveys.

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:

- The ENSP and our contractors (Conserve Wildlife Foundation of NJ (CWF)) and volunteers monitored summer bat colonies via emergence counts and acoustic surveys. We compiled data from 15 previously monitored sites and 4 new sites in 2016. Colonies of Little Brown Bats (*Myotis lucifugus*) are increasingly scarce to discover and monitor due to catastrophic losses from White-nose Syndrome (WNS). All newly reported colonies were found to be Big Brown Bats (*Eptesicus fuscus*), whose numbers have increased by nearly 20% in NJ since the arrival of WNS in 2009.
- Despite the overall scarcity of Little Brown Bat colonies, bi-weekly counts and mid-July recapture surveys at three primary roost locations showed stable or increasing numbers in 2016 along with high ratios of reproductive females (87-90% of captured adult females had been lactating). One colony, in a church steeple in Sussex County, nearly doubled in number from 2014 (86 bats) to 2016 (159 bats) and has rebounded to one-third its pre-WNS size. Another colony, in a bat house on Morris County Parks property, grew 20% from 2015 to 2016. Though encouraging, we recognize that these increases may be the result of nearby colonies fusing together.
- The ENSP and our partners from Rutgers University, CWF, BATS Research Center, and Sanders Environmental continued long-term population monitoring at NJ's two most important winter bat hibernacula, both former iron mines in Morris County. Bat numbers have plummeted as a result of WNS, with 98-99% declines in Little Brown Bats at both locations (Figure 1 shows the long-term population trend at Hibernia Mine).

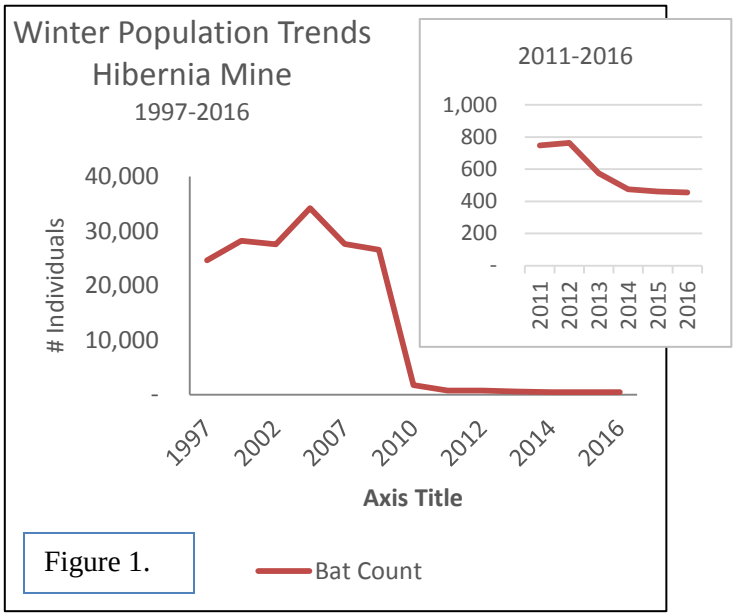


Figure 1.

- While Indiana Bat (*M. sodalis*) numbers had been slowly climbing at Hibernia Mine prior to WNS, with a high of 148 in January 2009, only one individual was observed inside this Mine in 2015. The nearby Mt. Hope Mine remains NJ's stronghold for wintering Indiana Bats, with just under 200 individuals (36% of the pre-WNS population) remaining as of Fall 2015, based on 8 nights of mist-net/harp-trap surveys by volunteers from Sanders Environmental. Sanders' post-WNS trend data from Mt. Hope Mine shows a lag effect in the decline of Indiana Bats – and a possible stabilization of their numbers – in contrast to the already-collapsed populations of other cave bat species (Figure 2).

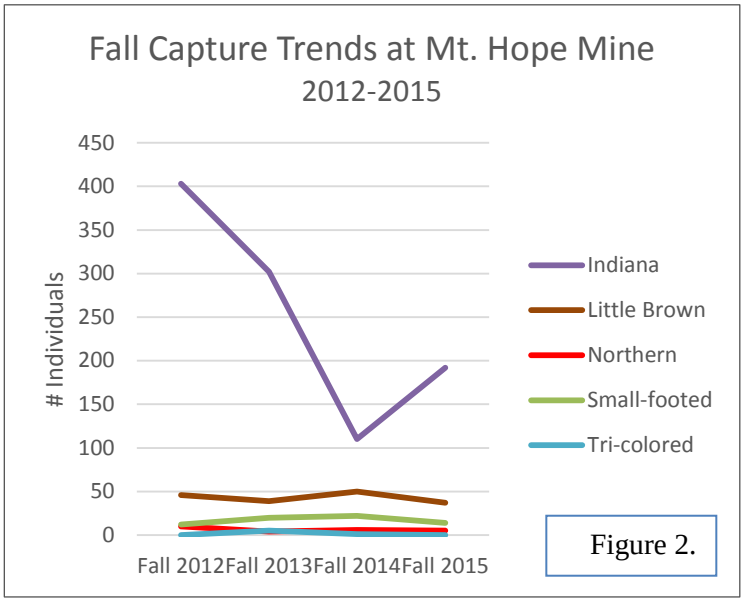


Figure 2.

- Fourteen Northern Long-eared Bats (*M. septentrionalis*) were captured during the Fall 2015 surveys at Mt. Hope Mine. This is the highest post-WNS annual capture rate for this species, which became federally listed in April 2015 due to their extreme decline from WNS. An average of 5 Northern Long-eared Bats were captured in each of the previous five years.
- The ENSP and our contractors completed internal surveys of seven additional hibernacula in northern NJ during the winter of 2015-2016, including five abandoned mines, one natural cave system, and a tunnel created by the Army Corps of Engineers as part of a geological investigation in the 1960s. Hibernating bats were absent from four of these locations and numbered fewer than 10 individuals in each of the other three (representing declines of ~96% or more since the pre-WNS era). Northern Long-eared Bats were historically documented at four of the sites but are now absent from all of them. A handful of other sites are inaccessible for internal surveys due to safety issues or permanent gates.
- Data loggers that were installed along the inner walls of Hibernia Mine are continuing to record temperature and humidity conditions. These data will be used to investigate correlations between microclimate and the bats' distribution within the mine throughout winter (Figure 3 shows the spatial distribution of bats during the winter of 2015-2016). These data will also serve as a baseline record for an air flow restoration project planned for 2017/2018, which aims to establish lower temperatures within the mine based on findings that lower hibernating roosting temperatures can reduce a bat's WNS fungal loads and enhance its chances of survival (Langwig et al. 2016).

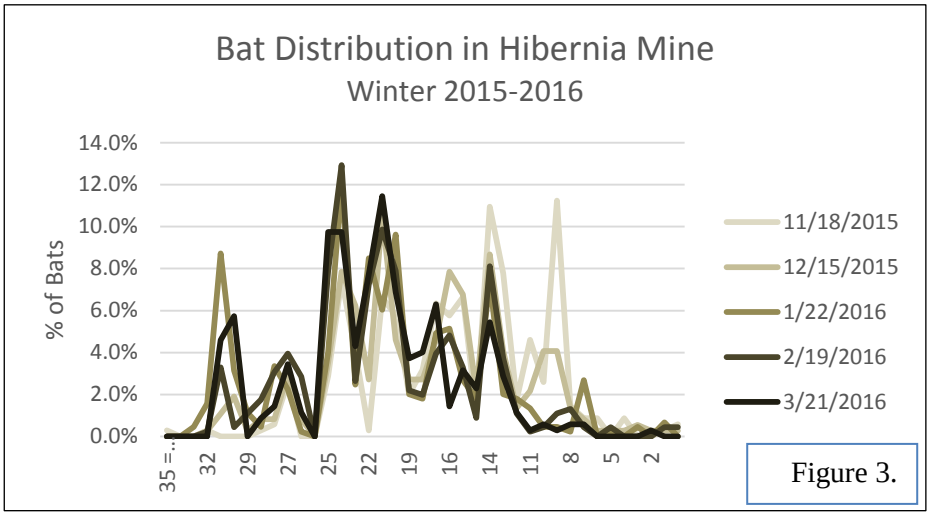


Figure 3.

- With the recent federal listing of the Northern Long-eared Bat, we have been working to build our database of occurrences and our general understanding of this beleaguered species. We have compiled survey records from researchers and consultants spanning multiple years, have undertaken our own summer mist-netting and radio-telemetry projects, and in January 2016 established a partnership with the NJ Department of Health's Rabies Lab personnel to share data, improve their bat identification skills, and allow the ENSP to physically identify all Rabies-negative bat specimens of small size

(i.e., WNS-vulnerable *Myotis*/*Perimyotis* species). We have added more than 100 Northern Long-eared Bat occurrence points to our Biotics database, including 53 points from 2015-2016. Sixteen points were collected by our team, 24 resulted from consultant surveys, and 13 were Rabies Lab submissions from NJ homes. Five of the Rabies Lab submissions were received during winter months (January to mid-March 2016) from central and southern NJ, mainly from the Coastal Plain/Pinelands physiographic zones where cave and mine hibernacula are not known to exist.

- ENSP's bat biologist participated in ongoing, bi-weekly White-nose Syndrome conference calls for agency personnel and researchers, which facilitate the exchange of timely news and strategies relevant to WNS response.

Conclusions:

- Little Brown Bats have become exceedingly rare since the arrival of White-nose Syndrome. Big Brown Bats appear to be expanding in number due to competitive release, as well as the species' inherent resistance to the disease (Frank et al. 2016, and others).
- Northern Long-eared Bats have suffered massive declines as well, though summer mist-netting surveys and our partnership with the NJDOH Rabies Lab have been productive, yielding quite a number of new records for this species. Netting is labor-intensive, so having the ability to contract out survey work and derive data from consultants is extremely valuable.
- Winter records of Northern Long-eared Bats from the Rabies Lab are especially intriguing, as they suggest that this species is probably taking advantage of buildings for hibernation. This is a behavior that has been suspected but not yet confirmed, to our knowledge.
- Hibernating bat populations appear to continue dropping at our primary monitoring locations, though the trend may be leveling for some WNS-affected species.

Recommendations:

- Continue to try to document occurrences of WNS-impacted bats through outreach to Nuisance Wildlife Control Operators, homeowners, wildlife rehabilitation centers, and the NJDOH Rabies Lab.
- Survey inaccessible bat hibernacula using acoustic detectors. For example, Pattenburg tunnel, Oxford tunnel, Mount Hope east shaft, Manunka Chunk tunnel, and Copper Mines.
- Use historical maps and written accounts to locate additional abandoned iron mines and caves. Search for existing openings that could provide entry for wintering Indiana bats or colonies of other species. Refer to Bat Conservation International's "Mine Portal Survey" and "External Mine Survey" guidance.
- For better efficiency, monitor prospective mist-netting locations with acoustic detectors, to "pre-screen" for presence of target species.
- Investigate the use of houses as winter refugia by Northern Long-eared Bats. Begin with locations provided by the NJDOH Rabies Lab, using passive acoustic detectors to record the vocalizations of active bats inside/outside the structures (this item is included in our current White-nose Syndrome Grants to States scope of work).

- Attempt to locate hibernating juvenile Little Brown Bats in Hibernia Mine, that were banded at the Morris County Park bat house colony. This presents a unique opportunity to test ultraviolet light photography as a method of confirming first-year bats during the winter and to observe the effects of WNS on known juveniles during hibernation.
- Continue the fall monitoring program at Mt. Hope Mine to follow the still-emerging trend in post-WNS Indiana Bat numbers.
- Pursue air flow modifications at hibernacula where internal temperatures are above the ideal threshold for bat hibernation and WNS-resistance. This may be a meaningful conservation strategy for impacted bats, especially since there is little else we can do to directly counter the deadly disease.

Literature Cited:

Frank, C.L., M.R. Ingala, R.E. Ravenelle, K. Dougherty-Howard, S.O. Wicks, C. Herzog, and R.J. Rudd. 2016. The effects of cutaneous fatty acids on the growth of *Pseudogymnoascus destructans*, the etiological agent of White-nose Syndrome (WNS). PLoS One 11(4):e0153535.

Langwig, K.E., W.F. Frick, J.R. Hoyt, K.L. Parise, K.P. Drees, T.H. Kunz, J.T. Foster, and A.M. Kilpatrick. 2016. Drivers of variation in species impacts for a multi-host fungal disease of bats. Philosophical Transactions of the Royal Society B: Biological Sciences 371:20150456.