Federal Aid in Wildlife Restoration

W-71-R-3

F18AF01008

Species of Greatest Conservation Need
Mammal Research and Management

Interim Report

for

January 1, 2019–December 31, 2019

Revised on 12/21/2022

NJ Department of Environmental Protection

DIVISION OF FISH AND WILDLIFE

ENDANGERED AND NONGAME SPECIES PROGRAM

P.O. BOX 420

TRENTON, NJ 08625

Project 1. SGCN Mammal Research and Management

The objectives of this grant are to:

1. Identify and monitor the distribution, abundance and density, population and genetic structure, demographics, mortality factors, stressors, and habitat needs of New Jersey's bobcat population, and use the information to guide recovery and inform management decisions.
2. Understand the size and trend of NJ's Allegheny woodrat (*Neotoma magister*) population, and assess and mitigate threats including those posed by raccoon roundworm (*Baylisascaris procyonis*) and genetic bottleneck(s).
3. Develop and implement survey and habitat sampling protocols for several species of terrestrial small mammals that can be used to measure and monitor small mammal populations statewide.
4. Identify, characterize, monitor, and manage the seasonal habitats and needs of New Jersey's bat species, particularly those impacted by White-nose Syndrome, such as little brown bats (*Myotis lucifugus*) and the federally listed Indiana (*M. sodalis*) and northern long-eared (*M. septentrionalis*) bats.

Objective 1 – Bobcat population management

Prepared by: Gretchen Fowles

Key Findings:

- Habitat analyses continued 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, help validate the connectivity mapping (of core habitat and the corridors connecting them) 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.
    - A habitat suitability index for bobcats has been developed (Fig. 1). The next steps include validation with known bobcat locations making adjustments to the model as needed. The layer will be used to evaluate bobcat-specific connectivity between suitable habitat patches, and then evaluate potential future bobcat populations in central and southern New Jersey under different management scenarios.

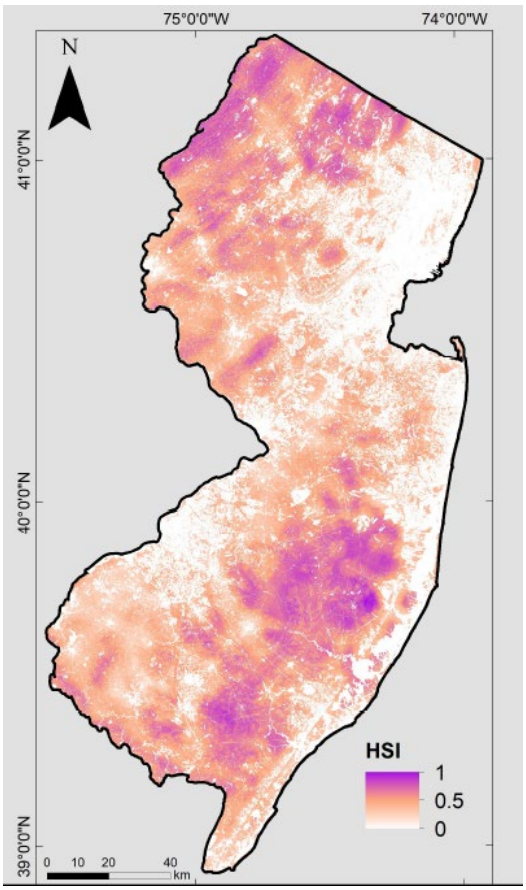

Figure 1. Habitat suitability index for bobcats in New Jersey with values ranging from 0 (unsuitable habitat) to 1 (optimal habitat).

- ENSP continues to partner with Montclair State University (MSU) and MSU funded a Master's degree student to conduct bobcat research. A student is currently working on quantifying habitat, sex, temporal, and seasonal variables associated with the collar data collected by ENSP over the past several years.
- ENSP acquired a new detection dog, 'Fly,' in June 2019 from Working Dogs for Conservation (WD4C), to continue scat detection work begun by the previous detection dog, though focused in central and southern NJ this time (Fig. 2). Since June, the focus has been continuing to train Fly to bobcat scats, and WD4C came to NJ in August to help transition Fly to finding bobcat scats in the field. The transition went smoothly and by the end of the reporting period the dog-handler team have collected 19 DNA-confirmed bobcat scats from eight sites in northern NJ. All samples were submitted to the National Genomics Center for Wildlife and Fish Conservation for DNA analysis.

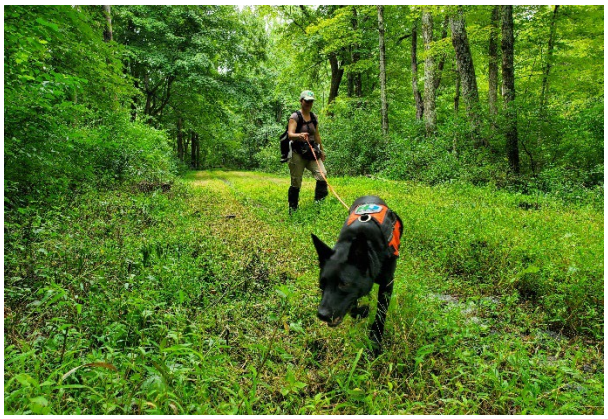

Figure 2. Fly, ENSP's new wildlife detection dog acquired from Working Dogs for Conservation, with her handler searching for bobcat scat in August 2019.

- Thirty tissue samples were collected from animals hit by cars (N = 14), accidentally trapped (N = 14), found shot (N = 1), and an abandoned kitten (mother confirmed hit by car) (N = 1) during the reporting period. All samples were submitted to the National Genomics Center for Wildlife and Fish Conservation for DNA analysis. Individual identification of bobcats has no yet been completed.
- ENSP continued to work with the National Genomics Center for Wildlife and Fish Conservation (Lab) 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 an update to analyses previously run, this time using an additional 32 samples from NJ, 35 from NY, and 1 from PA. ENSP shared 31 samples from NJ with the student conducting the NY study. The analysis now includes 195 samples collected from NY (N = 90), PA (N = 77), and ME (N = 28) between 2003 and 2018, and a total of 347 unique bobcats from NJ (with samples through 2018) included in the analyses (Fig. 3). The Lab's report to ENSP described the analyses and results.

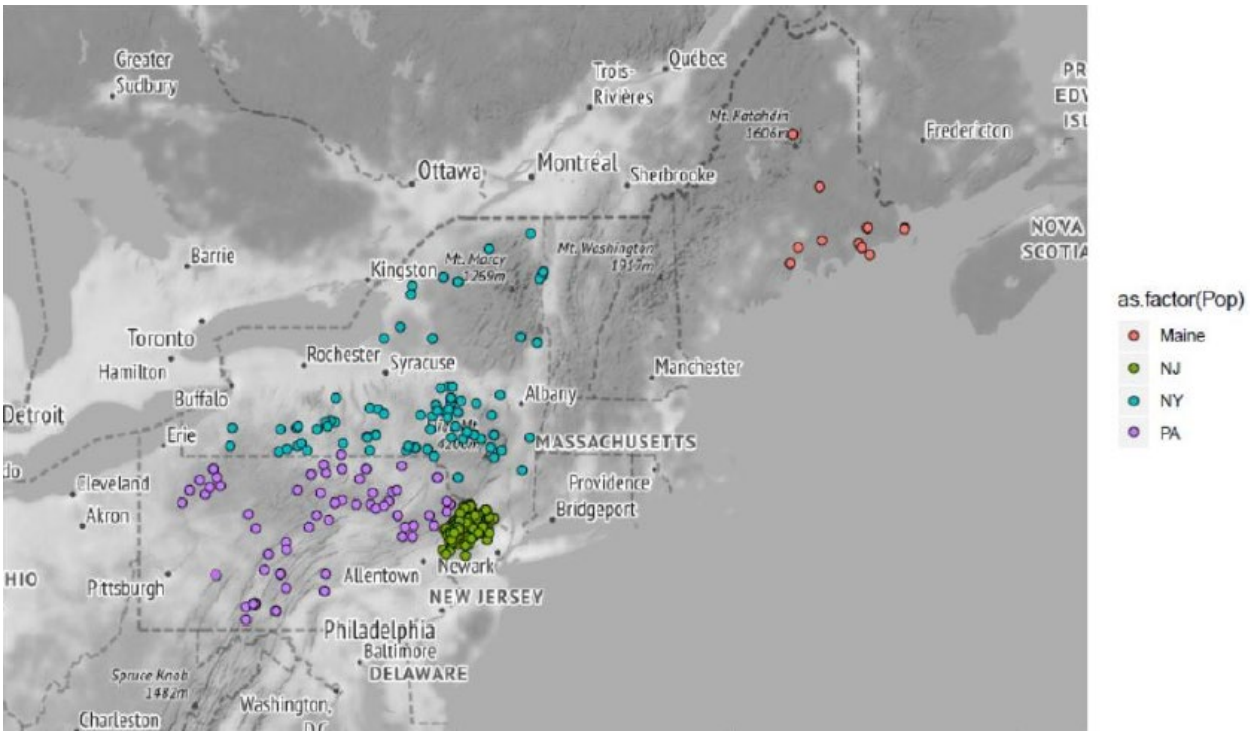

Figure 3. Sample locations (N=542) used for the regional bobcat genetic analysis.

- The lab completed an updated gene flow analysis (Fst), principle coordinates analysis, STRUCTURE analysis, and 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.
    - The results indicate that bobcats in NJ have some connectivity with neighboring populations in NY and PA, with more connectivity to NY than PA (Fig. 4). There appear to be 3 genetic clusters, which correspond geographically to bobcats sampled in NJ/Southern NY, upper NY/ME, and PA (Fig. 5 and 6). There is evidence of a mixing zone in NY from bobcats in ME and those from PA and northern NJ. And there is also evidence of bobcats in NJ having their own population signal, possibly indicative of a remnant NJ bobcat population that is present in neighboring sampling locations in less frequency (represented in pink in Figure 5).

	ME	NY	PA	NJ
ME	0.000			
NY	0.027	0.000		
PA	0.039	0.009	0.000	
NJ	0.032	0.010	0.017	0.000

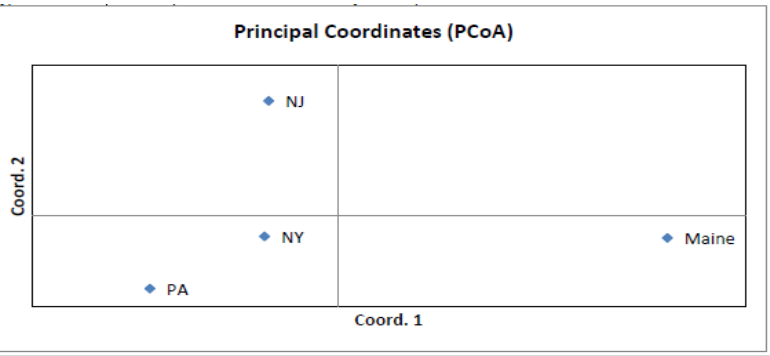

Figure 4. Genetic subdivision of bobcat populations as measured by Fst (table on the left). Numbers around 0 suggest complete gene flow, whereas higher numbers indicate some substructure. All measures in the table are significant (p-values .0080). Principle coordinates analysis (figure on the right) of bobcats sampled by state.

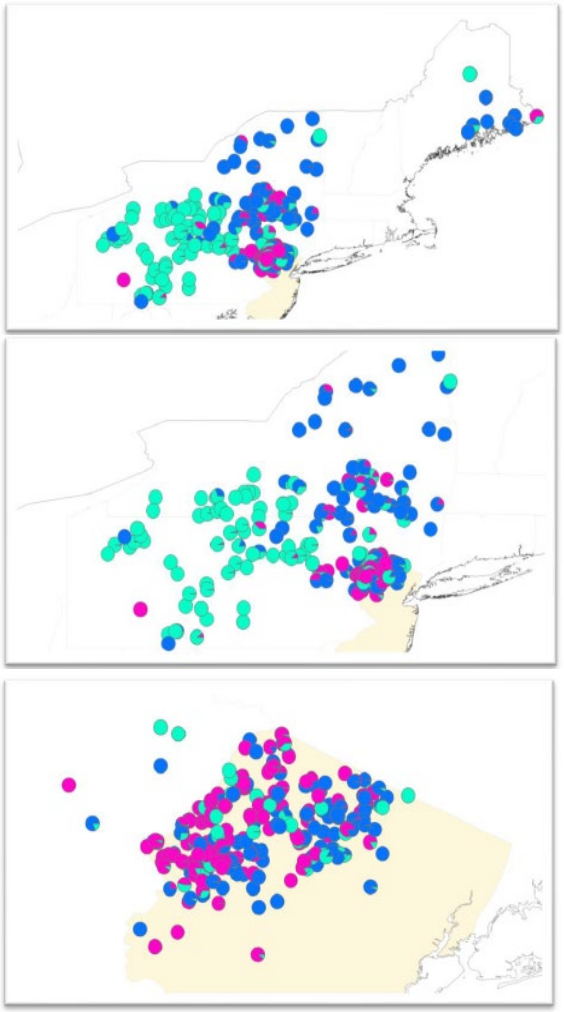

Figure 5. Maps for K=3 (most supported) genetic clusters based on STRUCTURE analyses representing large (top), regional (middle) and local (bottom) scales.

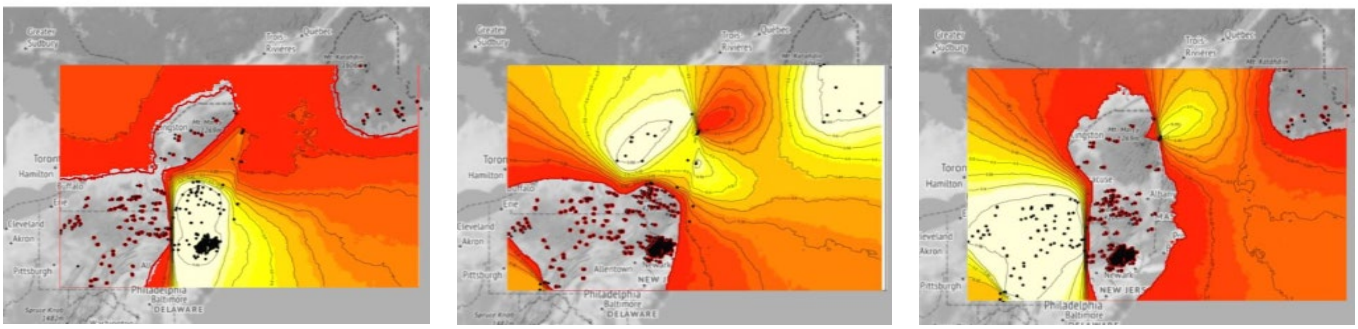

Figure 6. Maps showing the posterior probabilities of cluster membership, based on GENELAND analyses, to three groups: NJ / SE NY (left), NY / ME (middle), and PA / SW NY (right). Individuals in areas with white shading indicate bobcats that had a high probability of assignment to that genetic group.

- Necropsies were conducted on 22 bobcat carcasses during the sampling period. Condition assessment was made on each individual. Teeth from all 22 animals were collected for aging analysis. The samples are pending submittal to the Lab. Nine reproductive tracts were analyzed by a veterinarian to inspect for placental scars indicative of litter size and fecundity. The livers of opportunistically-collected bobcat carcasses were collected to test at a later date for rodenticide exposure. ENSP shared rodenticide exposure data in bobcats in 2016-2018 with a graduate student from the University of FL for a northeast-wide study she is conducting of rodenticide exposure.
- Project leader G. Fowles continued to collaborate with Bureau of Wildlife Management (BWM) biologists to respond to bobcats accidentally captured in cable restraints. A total of 14 trapped bobcats (Fig. 1) were reported by trappers during the reporting period. Seven (50%) died and 7 (50%) were released successfully. Ear tags were attached and DNA samples were taken from all bobcats.
- Vehicle strikes accounted for 15 dead bobcat carcasses recovered by ENSP during the reporting period.
- No bobcats were collared during the reporting period.
- G. Fowles continues to update the draft bobcat status assessment with new data and literature references.

Conclusions:

- ENSP continues close collaboration with partners at University of Delaware and Montclair State University. The current Montclair State University student will be finished in May 2020 and the University of Delaware student will be finished in the fall of 2020. Both universities have continuing interest in bobcat research.
- A draft habitat suitability index was developed by a Master's Degree student at the University of Delaware, which will be validated further and then used for additional analyses to inform bobcat recovery plan metrics.
- A new wildlife detection dog is proving effective at finding bobcat scat in northern New Jersey.

- Updates to 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. The analyses incorporated additional samples from NY and NJ, though the distribution of NJ samples are confined to northwestern NJ (north of Route 78 and west of Route 287).
- Sample analysis (DNA from live bobcats; and teeth, reproductive tracts, DNA, rodenticide testing, and condition analysis of dead bobcats) is 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.
- The number of bobcats struck by vehicles (N = 15) was the highest number on record in NJ.
- The number of non-target bobcats reported in traps has fluctuated over time, though the mortality rate was the highest it has been in the last few years.
- A draft of a bobcat status assessment continues to be updated.

Recommendations:

- Continue to collaborate with partners at the University of Delaware and Montclair State University on their respective bobcat research projects.
- Continue to conduct bobcat scat surveys using the new wildlife detection dog, targeting areas where density may be low such as central and southern NJ. Confirmed bobcat scats will document presence in an area, and will be added to the long-term bobcat DNA database housed at the National Genomics Center for Wildlife and Fish Conservation. These documented samples are useful for the gene flow analyses, and to evaluate recaptures over time and space. The dog will also be useful in 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 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 NJ, particularly if DNA samples (scat or tissue) are acquired from outside of northwestern New Jersey (i.e., east of Route 287 and south of Route 78).
- 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.
- 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) 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 better understand 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 update the bobcat status assessment and incorporate the research currently being conducted by partners at University of Delaware and Montclair State University to inform the bobcat status assessment and develop the recovery plan.
- Finalize a draft of the bobcat status assessment and 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.

Objective 2 – Allegheny Woodrat research and management

Prepared by: Gretchen Fowles

Key Findings:

- ENSP 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, spaced 1km apart above and below the cliff, have been deployed since 11/18/2016 to deliver pyrantel pamoate-treated fishmeal/polymer baits to free-ranging raccoons. The dispensers were continuously re-loaded on a 6-8 week schedule with approximately 50 baits each, year-round during 2019.
- ENSP staff and volunteers GPSed and collected 38 raccoon scats at the Palisades between October and December 2019, to evaluate the prevalence of *B. procyonis* egg loads in the scat. The scats were sent to Wheaton College for analysis; results are not yet available.
- Standard trapping protocol was conducted at six separate talus slope sites in the Palisades Interstate Park during October 2019. 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-six unique individuals were captured in 2019. The capture index (# of individuals captured/10 trap nights) was 3.10 (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.

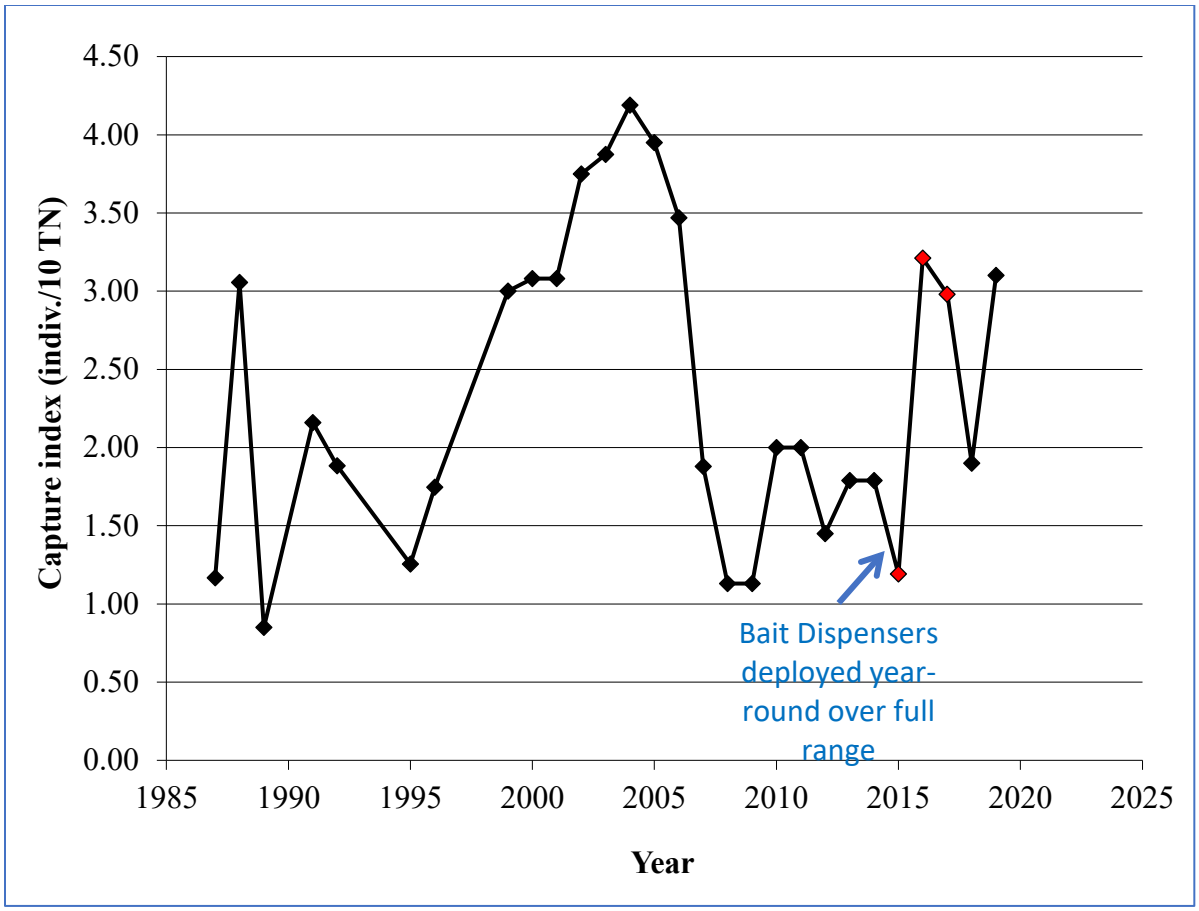

Figure 1. The results of ENSP's trapping effort in the Palisades since 1985, setting 42 traps for two consecutive days in six areas each fall, for a total of 84 trap-nights of sampling effort/year. Translocations of two subadult woodrats from PA occurred in 2015, 2016, and 2017 (●).

- ENSP collaborated with a statistician in the DEP Office of Science and Research and compiled annual trap data from years 2015–2019 in the format needed for a capture-recapture analysis. The statistician will run the analysis and determine if there is adequate data to estimate population abundance.
- ENSP continued our collaboration with a geneticist at Towson University who maintains the Allegheny woodrat genetic library, including all past NJ Palisades samples. The following samples were sent to Towson for analysis; we are awaiting results.
  - We sent tissue samples from 18 individuals that were trapped in 2019 for the first time. We also sent 4 duplicate tissue samples from the 2017 trapping because the original samples had poor DNA. The tissues will all be genotyped using a panel of SNPs, and mean observed heterozygosity (Ho) will be evaluated to compare to recent years. Also, parentage will be evaluated to assess pedigree of the newly captured individuals and how they may relate to the translocated individuals. The lab will also quantify genetic variability at toll-like receptor genes, which are integral to immune function, to see how the variability has changed post-translocation.
  - Fresh woodrat scats (N = 203) were also collected across the trap sites and sent to Towson. The scats were collected at 3 of the trap sites on 4 different days, approximately 1-2 weeks apart. Towson will conduct the SNP genotyping with these scats, which was

fairly successful in 2018. We expect to the results to run a capture-recapture analysis in collaboration with the DEP Office of Research and Science to compare population analyses using live trap data vs. scat data. Towson will also sequence the chloroplast DNA in the scats to reveal diet composition. ENSP plans to collect additional scat samples in the winter and spring so that we can conduct a seasonal diet comparison.

- ENSP, in collaboration with the geneticist at Towson University and biologist from the PA Game Commission, will be leading a symposium on Allegheny Woodrat research at the annual Northeast Association of Fish & Wildlife Agencies (NEAFWA), which the NJ Division of Fish & Wildlife is hosting in April, 2020.
- Planning has begun for deploying motion-triggered cameras in historic woodrat locations in NJ starting in early 2020. Similar cameras have been successful in documenting woodrats in known-occupied sites, and may prove effective in surveying unknown sites.

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.
- Allegheny woodrat captures were at a high level again after they inexplicably fell back in 2018. The increases since 2016 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 look forward to receiving the results from the 2019 trapping effort and hope they reflect a continuation of the higher heterozygosity numbers similar to recent years after the first woodrat translocation.
- 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. We look forward to the updated analysis using the 2019 samples.
- We look forward to learning if Towson researchers have continued success genotyping woodrat scat to identify individuals. If successful, we will compare population abundance estimates derived from capture-recapture analyses using the scat data and live-trapping data, then evaluate which is a more effective option.
- Also in 2018, Towson conducted preliminary work on extracting chloroplast DNA from woodrat scat as a means of identifying dietary items in the scat samples, which would inform our Palisade population habitat management plan. Additional samples in spring and summer, 2020, will add to this data source.
- The Allegheny woodrat symposium we will be hosting at the NEAFWA conference in the spring will bring together the woodrat biologists from across the region for the first time in many years to share our work.

Recommendations:

- 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 and the DEP Office of Science and Research to analyze both the data derived from live trapping as well as from scat collection through the capture recapture framework to compare the approaches and to hopefully achieve a population estimate for the first time.
- Continue to collaborate with Towson University on the genetic analysis of woodrat scat samples with the goal of using scat to test its use in a capture-recapture modeling framework as described. Collaborate on the exploration of chloroplast sequencing of woodrat scat as a means of identifying particular dietary items, seasonally, which would help inform habitat management efforts.
- Initiate assessment of historic woodrat sites using baited motion-triggered cameras.

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.

Objective 3 – Small mammal populations

Prepared by: Gretchen Fowles

Key Findings:

This job was inactive during 2019.

Objective 4 – Bat conservation and management

Prepared by: MacKenzie Hall

Key Findings:

Interagency Consultations & Coordination

- ENSP, NJDFW's Bureau of Lands Management, and the NJ Green Acres program celebrated a long-awaited acquisition in September of a large, privately-owned land parcel containing the Mt. Hope Mine. This former iron mine in Morris County is one of the two most significant bat hibernacula in New Jersey, and is the only site known to still

support a hibernating population of Indiana Bats. The parcel was added to Wildcat Ridge Wildlife Management Area.

- The NJ Department of Health Rabies Lab continued to hold all rabies-negative bat specimens of interest (such as *Myotis* species) for the ENSP to analyze. No new *Myotis* bats were submitted by the public (and/or saved by Lab personnel) during 2019. However, several non-Myotis, migratory bats – seven silver-haired bats, six Eastern red bats, and one hoary bat were submitted; half of these bats were received during the winter months of January, February, and early March 2019. Combined with reports from wildlife rehabilitation centers and the public, an unusually high total of 22 silver-haired bats were "sighted" during the fall and winter of 2018-19 across NJ.
- ENSP continued its successful bats-in-buildings program, offering guidance to homeowners and Nuisance Wildlife Control Operators (NWCOs) on effective, bat-friendly exclusion practices. Seasonal email updates were sent to our NWCO contact list and were also shared by the NJ Pest Management Association with their entire membership. ENSP fielded approximately 85 calls from the public and from NWCOs in 2019 regarding our bat exclusion guidance and resources. We worked with two NWCO companies to conduct early winter acoustic surveys in attic spaces where exceptional situations led us to allow untimely exclusions of big brown bats to take place. Acoustic surveys are proving successful for documenting the presence and arousal/activity patterns of bats hibernating in structures; we are cautious but intrigued by this new application.
- ENSP collaborated with the USFWS NJ Field Office in finalizing guidance on bats-in-bridges issues for transportation management agencies. We held two more training workshops (on August 27 and September 4, 2019) for NJ Department of Transportation engineers and Environmental Program personnel (approx. 30 attendees) and consulting firms (approx. 30 attendees) on bat ecology, federal and state endangered/nongame species laws, how to survey bridges for bats prior to disturbance-causing activities (Fig. 1), and how to report results using our new survey form. ENSP is working with our agency's Office of GIS on a mobile data entry system as well as a Web Viewer for relevant parties to be able to access current presence/absence results for bridges across the state.

Figure 1. Bridge inspection field training with the US Fish and Wildlife Service and NJ Department of Transportation. At left, a remote-controlled camera on a telescoping pole captures images of bat guano on the pier cap; at right, big brown bats roosting in a parapet gap of the same bridge in Millville, NJ.

- ENSP assisted NJDOT personnel with four bridge inspections for bats where maintenance activities were imminent, helping to build their confidence and competency with conducting these surveys on their own in the future. So far, approx. 40 bridges have been surveyed by NJDOT and consultants, resulting in five confirmed bat roosts. Which species are present and the colony size at each location will be determined in the coming active season. Fall swarming was observed at one bridge – which carries a state highway – during a return visit on September 25, 2019, suggesting that bats could be hibernating very close by and/or using the bridge as a hibernation site. This possibility will be explored in the next work period.
- ENSP's bat biologist attended the annual Northeast Bat Working Group meeting and participated in regular (approx. bi-weekly) WNS calls for agency personnel.

<u>Summer Surveys</u>

- NJ's acoustic data collected during 2017 and 2018 under the North American Bat Monitoring Program (NABat) were classified, manually vetted, and uploaded into the NABat database during this work period.
  NABat now provides some instant data analysis, including "heat maps" of stationary point results (Fig. 2), annual species result tables (Fig. 3), and other metrics for comparing results across the continent and for assessing long-term bat community trends.

Figure 2. Map showing the abundance of bat detections at each of New Jersey's North American Bat Monitoring Program (NABat) stationary acoustic points. There are 24 long-term monitoring points within twelve randomly chosen grid cells across the state.

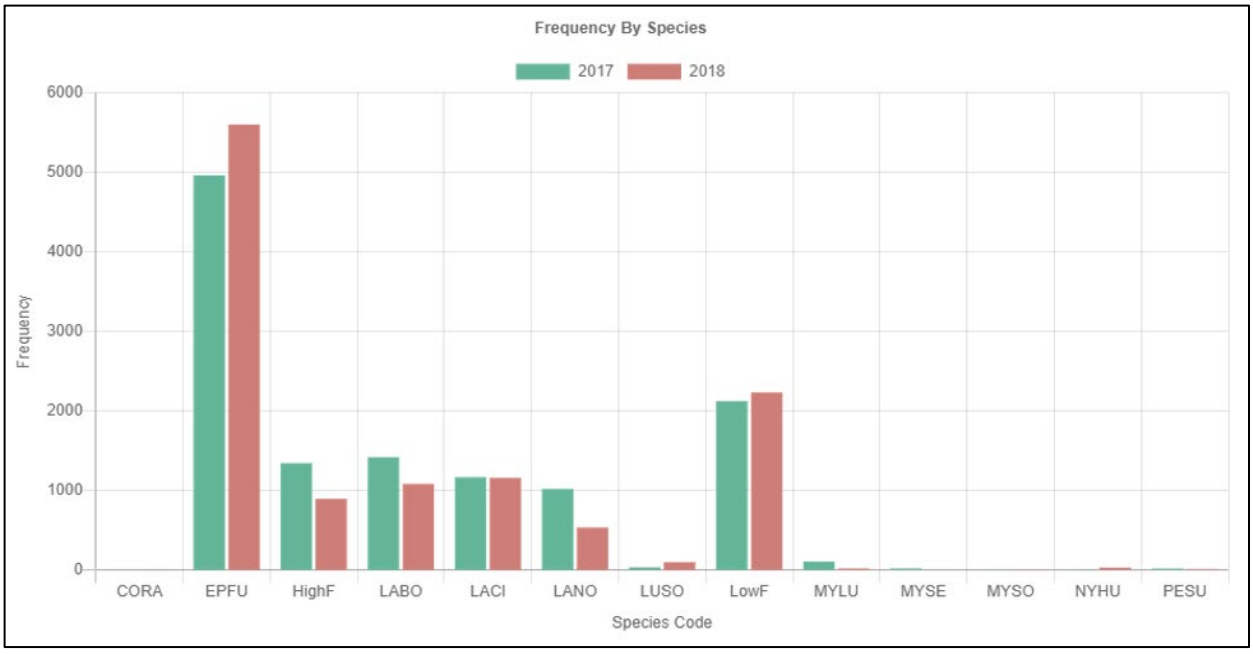

Figure 3. Overall species composition results from NJ's 2017 and 2018 NABat stationary acoustic surveys. Big brown bat calls made up 48% of all bat activity during these two years.

- With the help of a seasonal employee, a contractor, and more than 20 volunteers, we completed our third consecutive year of NABat acoustic monitoring in 2019. Data from

the 2019 survey year are now being vetted and will be uploaded into NABat early in the next work period.

- Summer mist-netting efforts by ENSP and other permittees across the state in 2019 returned a very low number of species of interest (four northern long-eared bats, one little brown bat) but did add one new northern long-eared bat occurrence area to our mapping, from bats caught by Rutgers University at an urban-surrounded location approximately 10-15 km from the next nearest documentation of that species. Two males were radio-tracked to tree roosts within the forested parcel.

  The one little brown bat was caught within the Great Swamp National Wildlife Refuge and was radio-tracked to a bat house on a barn on a private farm just off the Refuge, where a maternity colony of 30 individuals were roosting. Interestingly, a colony of Indiana Bats had been discovered using this same barn several years ago, under different ownership and prior to the bat house being installed.

  At a site in Mercer County where a large number of *Myotis* acoustic calls along a stream corridor led us to net one little brown and one northern long-eared bat in 2018, we re-surveyed in 2019 and neither caught nor recorded any *Myotis* bats.

- Three male big brown bats and one non-reproductive female big brown bat captured from three different counties in 2019 had engorged ticks on their bodies. ENSP collected and provided tick specimens to a NJDOH entomologist who identified them as larvae of a soft-bodied tick; most likely the "bat tick" (*Carios kelleyi*). When confirmed, these will be the first official records of this tick species in NJ.

<u>Hibernaculum Management & Winter Surveys</u>

- Given the continued declines in bat numbers within hibernacula ten years after the arrival of White-nose Syndrome, ENSP adopted a policy of surveying hibernating bat colonies less frequently (e.g., every 3-5 years) to limit our potential for unintended impacts.
- In accordance with our new policy, and for the first time in ten years, ENSP did not perform a winter bat census within Hibernia Mine (Morris County). We continued monitoring the temperature profile inside the mine with climate loggers to ensure that temperatures stayed within an ideal range for bats since the mine entrance was opened wider and re-gated in fall 2017. Temperatures appeared to have been favorable for hibernating bats throughout both winters since then.
- Similarly, in light of continued declines in vulnerable species including the Indiana bat, fall swarm trapping at the Mt. Hope Mine began a two-year hiatus in 2019 to limit our disturbance to those animals.
- A geological survey tunnel in Worthington State Forest was surveyed for hibernating bats (once every 3 years), where a very small remnant population of little brown and tricolored bats appears to be stable. A hibernation survey was attempted at the long-abandoned Oxford railroad tunnel, but only one big brown bat was observed before deep water and mucky substrate prevented the team from going further. A late-winter acoustic survey will be attempted instead in the next work period.

Conclusions:

- Our recent preservation of the Mt. Hope Mine property will enable our agency to carry out new monitoring and management activities for bats, possibly to include summer acoustic and/or mist-netting surveys, stabilization and gating of a secondary shaft, and revisiting past outreach to a neighboring landowner regarding access for an underground survey.
- The NJ Department of Health Rabies Lab has become a valuable source of occurrence data for bat species of interest, giving us new insights about habitat use and behavior across all seasons. The absence of *Myotis* bat specimens in 2019 could be a sign that White-nose Syndrome has now reached the last vestiges of the Northern long-eared bat population in NJ, where individuals had been holding out in suburban refugia and possibly overwintering in small numbers in buildings. An apparent increase in the number of migratory bats received by the Lab during the winter months over the past two years may point to a new behavioral trend, where bats are perhaps stopping short on their southbound migrations due to milder-than-normal fall/early winter temperatures or some other factor.
- Our outreach efforts and resources for homeowners and NWCOs are having a positive impact on bat conservation in nuisance situations. Through these contacts we are also learning more about winter behavior of bats in buildings.
- Bridges have been an untapped resource for our summer bat monitoring efforts, and they appear to be an important artificial roost type in NJ. New coordination between our agency, the US Fish and Wildlife Service and the NJ Department of Transportation is beginning to yield results of bats roosting in bridges, with approx. 12% of bridges surveyed so far being occupied by bats. A web-based system for reporting and mapping occupied/unoccupied structures is being developed to ensure that all managing parties have current information and are able to schedule maintenance activities appropriately.
- Populations of White-nose Syndrome-vulnerable species like the little brown and northern long-eared bat remain at very low numbers, though healthy and reproductive individuals do remain on the landscape. For northern long-eared bats, new records in 2019 support other recent findings that lesser-quality forested stream habitats in suburban/urban context are being used by this species.
- Hibernaculum surveys are now being conducted on a less frequent basis in order to limit our disturbance to already-stressed populations. We aim to perform surveys at each location every third year at the most, unless an exceptional scientific or conservation purpose arises.
- Internal surveys of abandoned railroad tunnels are proving difficult due to ground conditions and accessibility/visibility. Acoustic surveys may be more productive for detecting presence of rare species some sites.

Recommendations:

- Investigate summer use by bats across the newly preserved Mt. Hope Mine property and consider management activities like stabilizing and gating a secondary shaft on site.
- Continue training and assisting NJDOT and consultants to carry out bridge surveys for bats. Follow up on all reports of bats in bridges with emergence counts to determine colony sizes and species, and seasonal arrival, departure, and possible overwintering 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.
- Acoustically survey additional “gallery forest”/suburban-context riparian forests for possible northern long-eared bat populations; follow up with mist-netting if acoustic results are promising.
- Begin formal efforts to monitor and research migratory bat species behavior and migration patterns, in response to the recent up-tick in public sightings as well as New Jersey’s ambitious off-shore wind energy goals. Great opportunities exist right now for this type of research, with Virginia Tech/USGS undertaking a multi-year nanotag project in the region and five new Motus towers planned for deployment in NJ in 2020 to add nanotag receiver coverage across northern and south-central NJ.