Federal Aid in Wildlife Restoration

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Species of Greatest Conservation Need Mammal Research and Management

Interim Report

for

January 1, 2020–December 31, 2020

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 continue as part of a partnership between ENSP and the University of Delaware (UDel) whereby UDel has funded a Master's degree student and ENSP provided additional support this Fall 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 inform bobcat recovery plan metrics. The student is planning to defend her thesis in early 2021; G. Fowles is serving on her graduate committee. She presented her research at the national Wildlife Society conference and the Northeastern Transportation and Wildlife Conference this Fall.
    - A weighted habitat suitability index (HSI) for bobcats has been completed (Fig. 1).
    - Landscape connectivity analyses have been completed using the HSI to identify discrete "core" habitat patches for bobcats across the state as well as the inverse of HSI values to evaluate landscape resistance and movement potential across the landscape (Fig. 2). Additional centrality and bottleneck analyses are being completed.
    - Lastly, spatially explicit, individual-based simulation models are being finalized that examine the possibility of the establishment of bobcat populations in central and southern NJ under different management actions.

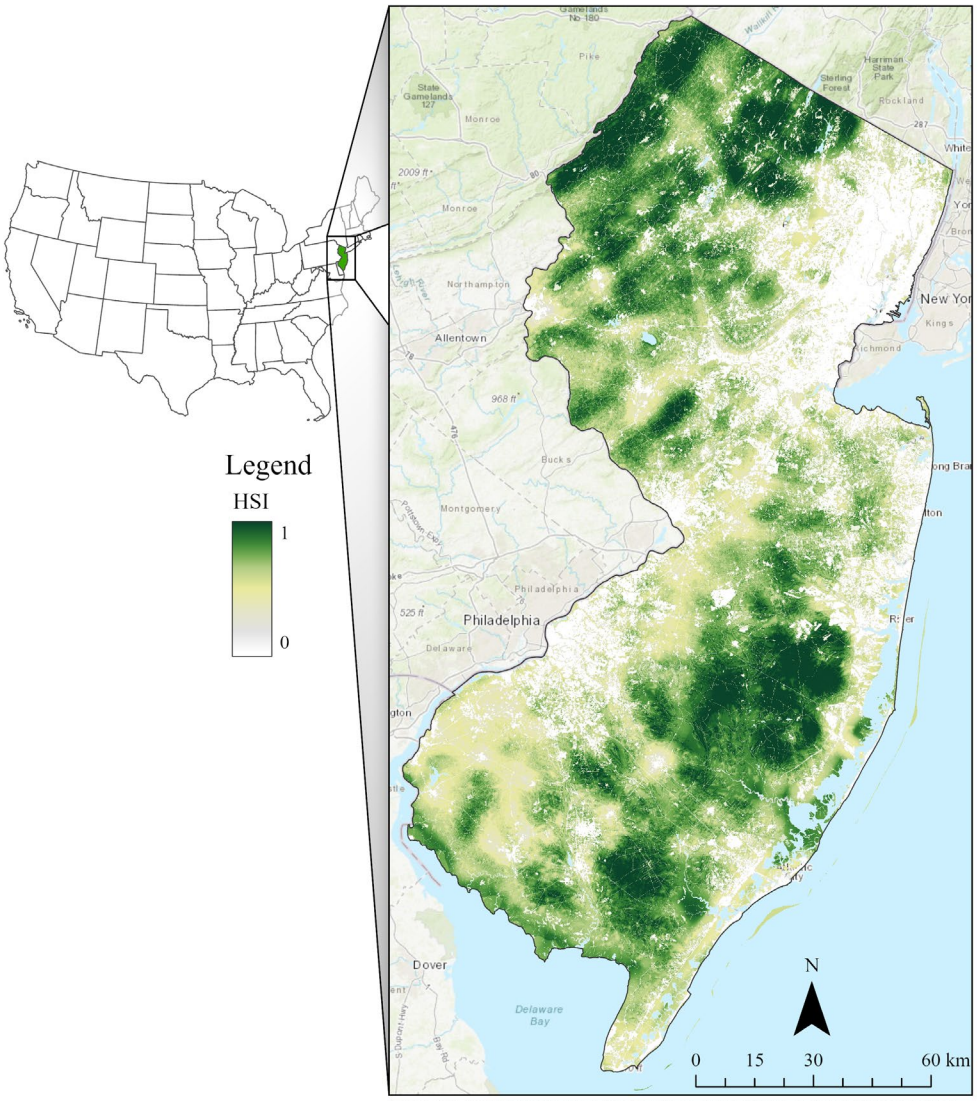

Figure 1. Habitat suitability index for bobcats in New Jersey with higher values represented by dark green color indicating higher likelihood of habitat suitable for bobcats.

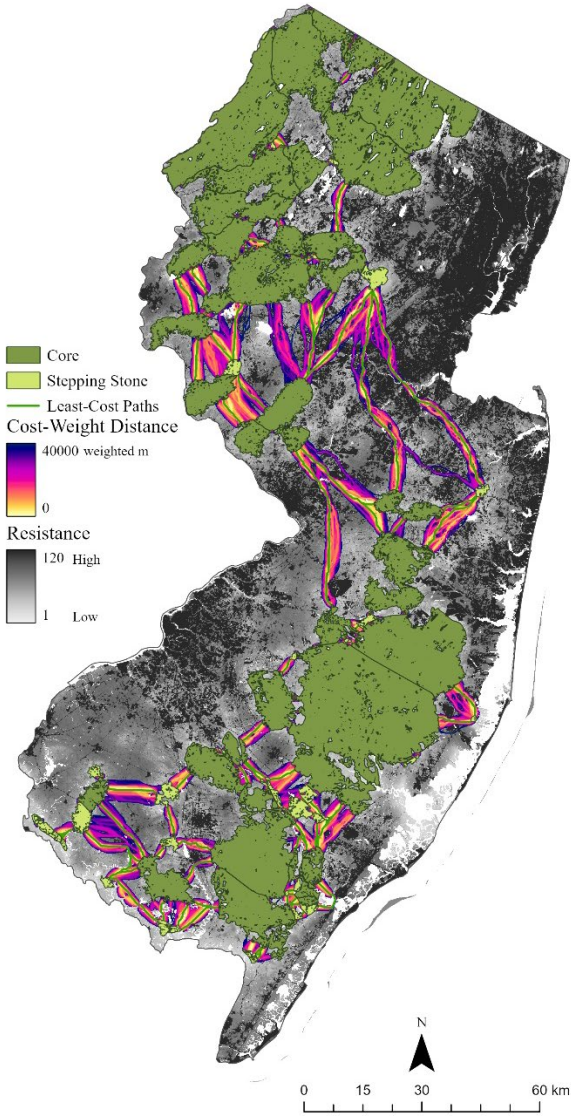

Figure 2. Corridors with least-cost paths (LCPs) connecting all bobcat habitat patches in New Jersey. Green lines represent the LCPs and lower CWD (cost-weighted distances) for bobcat movement is represented by yellow and orange with higher CWD values indicated by purple and dark blue

- ENSP partnered with Montclair State University (MSU) and MSU funded a Master's degree student to conduct bobcat research. The student defended her thesis in May 2020 and sent ENSP a copy of it. She focused on within home range habitat selection of 13 bobcats in northwestern NJ that ENSP collared over recent years.
- ENSP began surveying for bobcat scat using the new detection dog, 'Fly', acquired in June 2019 from Working Dogs for Conservation (WD4C). A trainer from WD4C spent a couple of days in early 2020 with the team to get Fly started in the field. She concluded that Fly was ready to go, but while the focus of her efforts was to survey for bobcat scat in central and southern NJ where there are very few confirmed records, it would be important to survey with her in northern NJ where she would have a greater likelihood of finding bobcat scat, to keep her confidence high, particularly with her being new to detection work. The detection

team surveyed approximately 50 sites (N = 30 north of Rte. 78, N = 20 south of Rte. 78) (Fig. 3). The northern sites were selected based on past experience having success detecting bobcat scat with ENSP's previous detection dog, 'Bear', or where recent activity was reported. The southern sites were selected based on representing suitable bobcat habitat and where possible (mostly unconfirmed) bobcat activity has been reported in recent years. All samples collected were GPSed and submitted to the National Genomics Center for Wildlife and Fish Conservation for DNA analysis. At the sites north of Rte. 78, 44 bobcat scats were confirmed, representing 17 individuals. At the sites south of Rte. 78, one bobcat scat was confirmed located approximately 1.4 miles from Rte. 78. The results were added to ENSP's bobcat database. The detection team had two opportunities to provide staff with demonstrations of Fly's detection work prior to surveying (Fig. 4), prior to COVID.

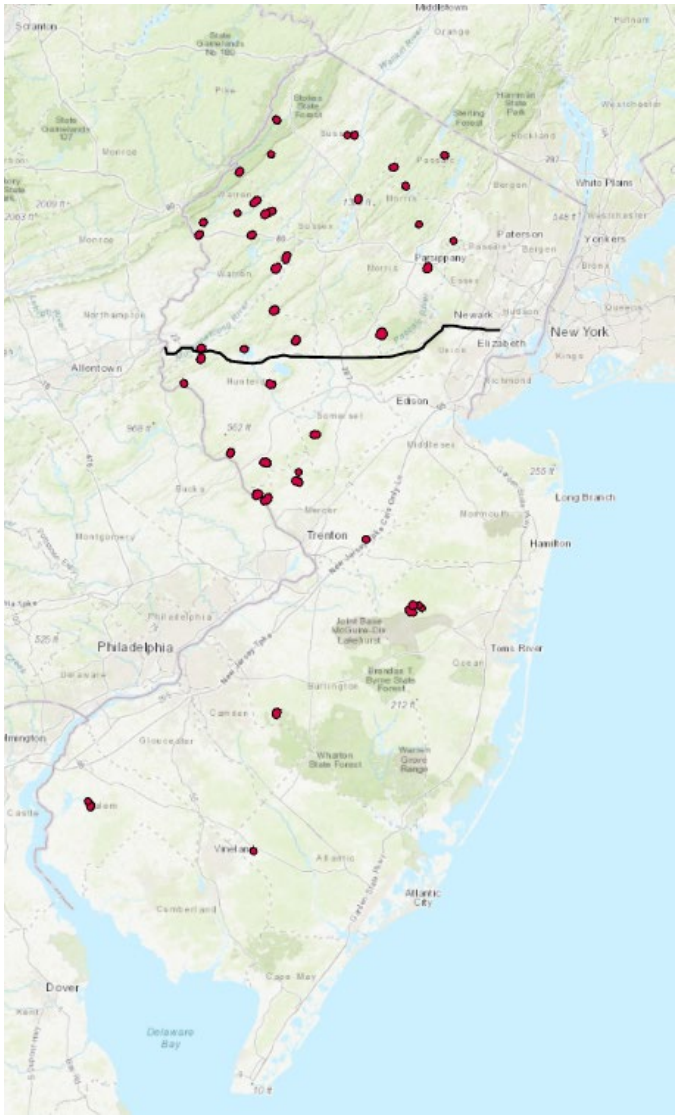

Figure 3. Sites surveyed by detection dog team for bobcat scat in NJ in 2020 (red polygons). Approximately 30 sites were surveyed north or Rte. 78 (black line) and 20 south of Rte. 78.

Figure 4. Detection dog survey demonstrations held with staff at 2 sites: Somerset County Parks (left) and Watershed Institute (right) prior to surveys of the sites.

- ENSP is collaborating with two Wildlife Conservation Corps (WCC) volunteers to conduct camera monitoring at a few sites in southern NJ for bobcats. There were 3 cameras each set up near Buena and Cape May, from July to November where there were reports of potential bobcats observed. The 6 cameras were then moved in November to a state park between the two sites where there have been reports of a possible bobcat in the last couple of years. There have been no bobcat pictures on the cameras so far.
- Portions of 67 carnivore scats (bobcat, red fox, coyote) collected during the course of surveys with Fly were frozen and given to the University of Delaware, Department of Entomology and Wildlife Ecology for a project using gas chromatography to identify species based on volatiles in scat. The technique was previously piloted using captive carnivore species and we are now providing wild-collected scats that have been genetically verified to validate the technique. Ultimately the technique is a cheaper method for distinguishing felid and canid scats and could lead to a simple field test that would save money and help with detection dog training.
- Locational data for 33 genetically confirmed bobcat samples collected as part of bobcat hair snare study in NJ in 2018 and 2019 was shared with ENSP. ENSP also worked with the genetics lab at East Stroudsburg University, which had analyzed the DNA data, to share the extracted DNA with the lab ENSP has been using for bobcat genetics work - the National Genomics Center for Wildlife and Fish Conservation. There was enough quality DNA to identify individuals from 4 of the samples. Those individuals were added to ENSP's bobcat database.
- Twenty-six tissue samples were collected from animals hit by cars (N = 5), accidentally trapped (N = 20), and a bobcat found illegally captured and held since a kitten (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. During this reporting period, ENSP

began collaborating with researchers at Black Rock Forest near Cornwall, NY, who are initiating a bobcat collaring project and are interested in habitat connectivity issues. The researchers have agreed to collect bobcat DNA samples that can be incorporated in the gene flow analyses.

- Necropsies were conducted on 9 bobcat carcasses during the sampling period. Condition assessment was made on each individual. DNA samples were taken, teeth were extracted for aging analysis, liver samples were collected, and reproductive tracts of females were analyzed.
    - Teeth from 31 bobcats collected between 2018 and 2020 were submitted to Matson's Laboratory for aging analysis this reporting period. The results will be compiled with the results from the 100 previous samples collected since 2007 to better understand the age structure of the NJ bobcat population.
    - ENSP collaborated with the veterinarian performing the bobcat necropsies and the Division's wildlife pathologist to submit liver samples from 38 bobcats collected between since 2018 for rodenticide testing. This will be a continuation of rodenticide testing on bobcat carcasses (N = 43 between 2013 and 2017) to better understand the trend in exposure to include in the bobcat assessment/recovery plan.
- A bobcat was released this spring that had been at a rehabilitation facility since the summer after being abandoned as a kitten when its mother was hit by a car.
- 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 21 trapped bobcats were reported by trappers during the reporting period. Five (24%) died and 16 (76%) were released successfully. Ear tags were attached and DNA samples were taken from all bobcats.
- There were 5 road-killed bobcat carcasses recovered by ENSP and 1 reported with photos, but carcass was not found during the reporting period.
- No bobcats were collared during the reporting period.
- G. Fowles continued to update the draft bobcat status assessment with new data and literature references.

Conclusions:

- ENSP continues close collaboration with partners at the University of Delaware where a master's degree student will be defending her thesis early the next reporting period. The analyses she has conducted on a statewide bobcat habitat suitability index, statewide habitat connectivity assessment, and spatially explicit simulation modeling focused on establishment of bobcat populations in central and southern NJ will be very informative for the bobcat recovery plan.
- A new wildlife detection dog, 'Fly', is proving effective at surveying for bobcat scat in northern and southern New Jersey. She has done well finding scat in northern NJ (44 bobcat scats, representing 17 individuals), but has found only one bobcat scat in southern NJ so far where there are very few confirmed records. Fly is proving to be an effective PR tool as well, with a temperament compatible with demonstrations of her work to partners.
- Remotely triggered cameras have been deployed in southern NJ and are being maintained by WCC volunteers as another tool to try to better understand bobcat distribution in the state.

- Scat samples were provided to the University of Delaware for a study on developing a technique to distinguish felid and canid scats in the field.
- DNA results from bobcat tissue, scat, and hair samples collected in NJ were added to the long-term NJ bobcat database that ENSP maintains.
- ENSP continues to collaborate with the National Genomics Center for Wildlife and Fish Conservation on evaluating the substructure and gene flow of the NJ bobcat population. A new collaboration with researchers at Black Rock Forest in NY should result in bobcat DNA samples from the southern portion of NY where we currently are lacking samples for the analyses.
- The necropsies and sample analyses (DNA, teeth, reproductive tracts, rodenticide testing of livers) are improving our understanding of bobcat status and health and are contributing valuable information to the bobcat assessment and recovery plan.
- A draft of a bobcat status assessment continues to be updated.

Recommendations:

- Continue to collaborate with partners at the University of Delaware on the statewide bobcat habitat suitability and connectivity assessments as well as the simulations modeling and use those results to update the bobcat assessment and inform the recovery metrics.
- Continue to conduct bobcat scat surveys using the new wildlife detection dog, targeting areas especially in central and southern NJ. Confirmed bobcat scats will confirm 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, which is useful for the gene flow analyses, to evaluate recaptures over time and space, etc. Also continue the camera monitoring in southern NJ and if there is a confirmed bobcat photo, survey the area with the dog to hopefully acquire a DNA sample.
- 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 particularly as new samples are acquired from new partners in southern NY, as well as in areas of NJ (i.e., east of Route 287 and south of Route 78) where we currently have very few samples.
- Continue to opportunistically collect tissue samples from live and dead bobcats 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, and to identify and implement ways of decreasing the rate of injury and mortality to bobcats accidentally trapped in New Jersey.
- Continue collecting and analyzing teeth, reproductive tracts and liver samples to better understand the age structure, fecundity, and pregnancy rates of the population, and to evaluate rate of exposure to rodenticides, and incorporate the results in the bobcat assessment/recovery plan.
- 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.

- 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 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 (Fig. 1), 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 during the reporting period.
- ENSP and volunteers collected and GPSed 37 raccoon scats at the Palisades in March (N = 3), September (N = 22), and October (N = 12) (Fig. 1) to evaluate the prevalence of *B. procyonis* egg loads in the scat. Another 5 scats were collected in November from Yards Creek, a site in the vicinity of historic woodrat sites in northwestern NJ that we monitored with cameras. The scats were sent to Wheaton College for analysis. The results are not yet available.

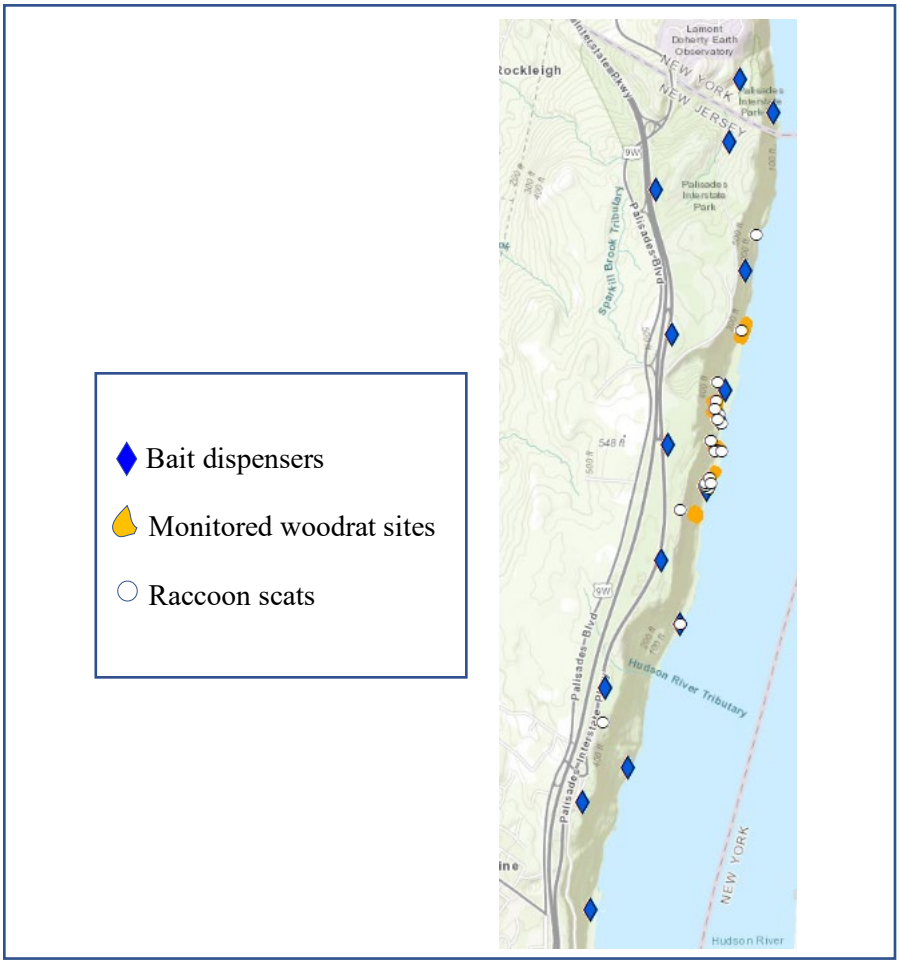

Figure 1. The locations of 16 raccoon roundworm bait dispensers, the monitored Allegheny woodrat sites, and the locations of the 37 raccoon scats collected in 2020 to monitor raccoon roundworm load at the Palisades.

- NJ DFW's efforts to monitor the woodrat population at the Palisades and the work being done by Wheaton College specifically related to raccoon roundworm, were the subject of a chapter of a book published in 2020: "Who Gives a Poop?" by Heather L. Montgomery.
- Standard trapping protocol was conducted at six separate talus slope sites in the Palisades Interstate Park during September 2020. 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.
    - Fifteen unique individuals were captured in 2020. The capture index (# of individuals captured/10 trap nights) was 1.79 (Fig. 2).
    - Eighteen grey squirrels, two chipmunks, and one flying squirrel were also captured, which is a significantly higher number of nontargets that have ever previously been captured.
    - All captured woodrats 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.

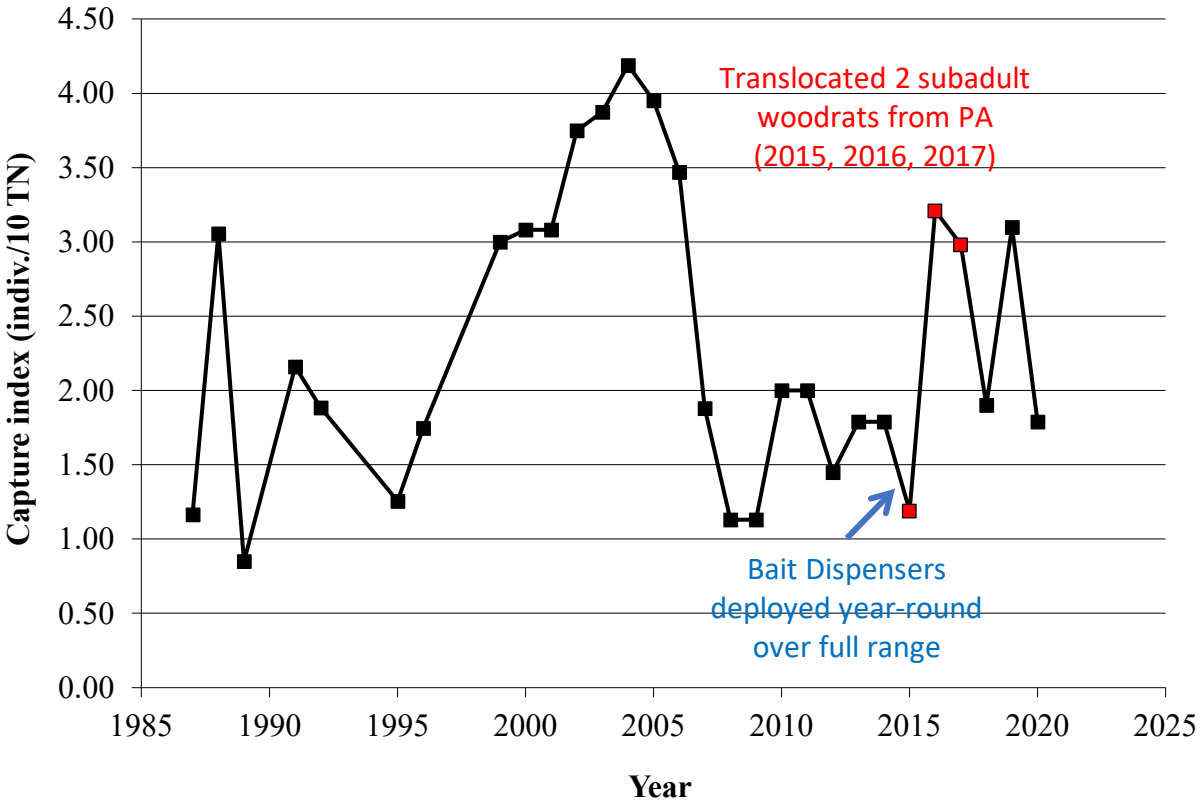

Figure 2. The results of ENSP's trapping effort in the Palisades over the last several years, setting 42 traps for two consecutive days in six trap areas in the fall, for a total of 84 trap-nights of sampling effort/year. Translocations of 2 subadult woodrats from Pennsylvania occurred in 2015, 2016, and 2017 (■).

- ENSP continued our collaboration with a geneticist at Towson University who maintains the Allegheny woodrat genetic library, including all past NJ Palisades samples.
  - The mean observed heterozygosity (Ho) was evaluated through 2019 using tissue samples, which were genotyped using a panel of SNPs, showing sustained higher levels since the translocation of woodrats from PA between 2015 and 2017 (Fig. 3).

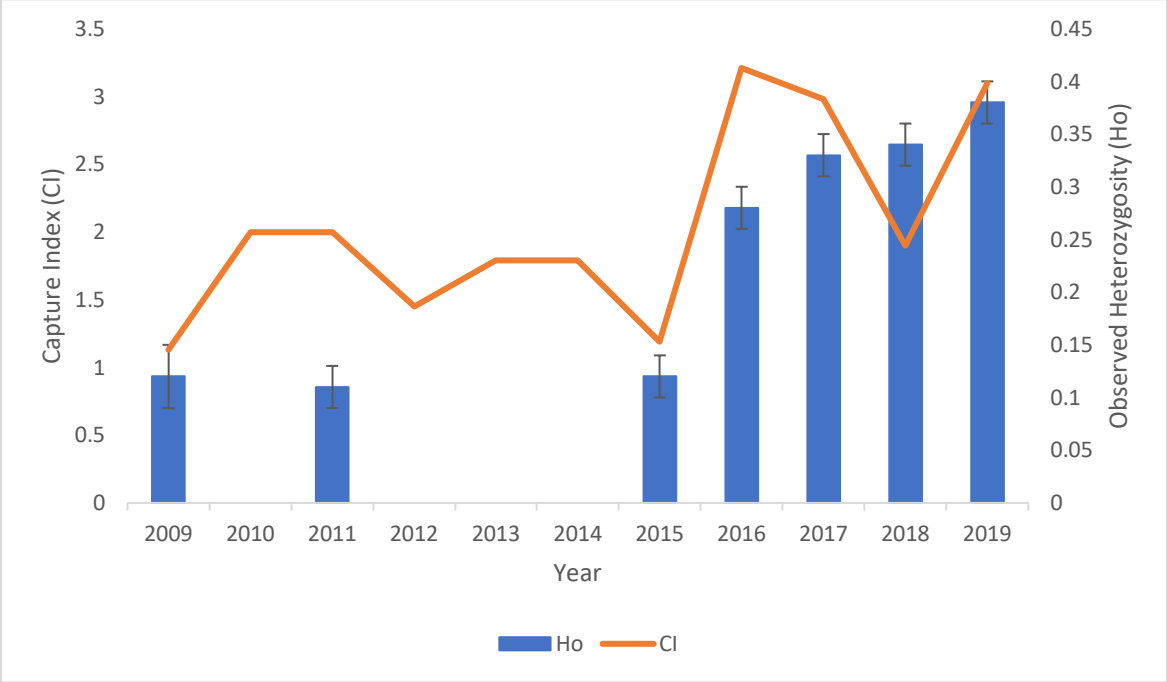

Figure 3. Observed heterozygosity (Ho) and capture index (CI) of the Allegheny woodrat population in the Palisades, NJ over time.

  - A manuscript was drafted describing the SNP assay used to analyze the variability of the Palisades woodrat population and will be finalized and submitted in early 2021. G. Fowles will be a co-author.
  - We sent tissue samples from 10 new individuals and 19 fresh scat samples from beneath traps collected during the annual trapping effort in 2020 to Towson for analysis, but do not have the results back yet. The tissues will all by genotyped using a panel of SNPs and mean observed heterozygosity (Ho) will be evaluated to compared to the past few 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 pre and post translocation.
  - Fresh appearing woodrat scats (N = 44) were also collected in January across 2 of the trap sites and sent to Towson. Towson will also sequence the chloroplast DNA in the scats to reveal diet composition. The scats collected helped complete a sampling of scats during the winter for all sites for a potential seasonal diet comparison. ENSP plans to collect additional scat samples in the spring to complete a dataset across 4 seasons (winter, spring, summer, and fall) started in 2020. Towson plans to work on the chloroplast DNA sequencing in the summer of 2021.

- Towson identified individuals from the tissue and scat data collected during trapping in 2019 and those have been added to ENSP's woodrat database. A sex marker has not been established yet for the scat, but will be worked on by Towson in 2021.
- Unfortunately the genotyping of scat collected outside of trapping sessions has not worked well, so we will not be able to run a capture-recapture analysis in collaboration with Towson and the Office of Science and Research using scat samples collected in 2019 for that purpose. The scats collected will be evaluated for chloroplast DNA however still.

- ENSP continued to collaborate with a statistician in the DEP Office of Science and Research on a capture-recapture analysis using live capture data. Annual trap data from the years 2015 – 2019 was compiled in the format needed and the analysis was run, but due to too few captures and recaptures, the data was not adequate to estimate population abundance.

- Motion-triggered cameras were deployed at one historic woodrat locations and 2 locations with suspected old woodrat sign (Fig. 4) this reporting period following a standardized woodrat camera monitoring protocol. No woodrats were identified. Monitoring of additional historic locations had been planned but were not completed due to COVID concerns.

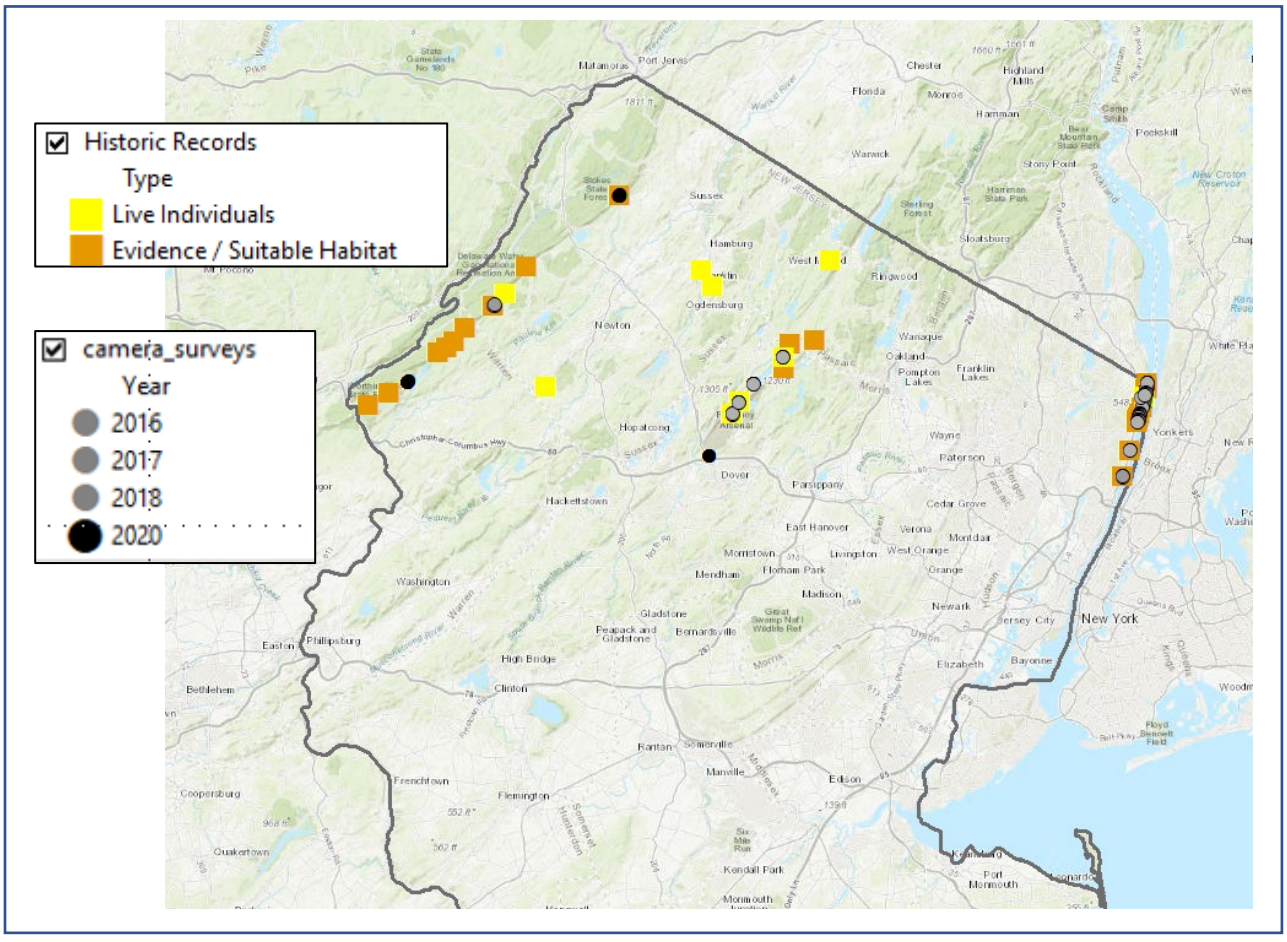

Figure 4. Historic Allegheny woodrat locations in NJ and camera monitoring efforts to survey them between 2016 and 2020.

- ENSP, in collaboration with the geneticist at Towson University and biologist from the PA Game Commission had organized a symposium on Allegheny Woodrat research for the annual Northeast Association of Fish & Wildlife Agencies (NEAFWA), which the NJ Division of Fish & Wildlife was planning to host in April 2020. Due to COVID, the conference was cancelled, but we held the Allegheny woodrat symposium virtually in April separately. The symposium consisted of 12 talks by biologists in IN, OH, PA, VA, MD, and NJ. G. Fowles gave one of the talks on the last remaining woodrat population in New Jersey. The virtual symposium has led to a regional working group that G. Fowles along with a biologist from the PA Game Commission and Towson University are leading, which has consisted of monthly or bi-monthly topic-specific calls with approximately 50 biologists across the region (12 states).
    - An example of one of the collaborative efforts resulting from the regional working is that a biologist at Radford University in Virginia asked biologists from across the region to collect any botfly larva found in woodrats handled for a study she is conducting. During our trapping efforts this year we collected one (Fig. 5) and it was identified as *Cuterebra emasculator*, typically a squirrel bot. These data may be incorporated in a manuscript the researcher is drafting and will help better understand the dynamics occurring in the woodrat populations.

Figure 5. Botfly larva collected from a woodrat during the annual trapping effort in the Palisades, NJ and sent to Radford University, VA for research on woodrats and botflies.

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 back at a low level this year, the same that they had been in 2013 and 2014 before the translocation efforts began. It was an unusual year because we trapped 2-3 weeks earlier than usual to avoid scheduling conflicts and caught far more

nontarget species than ever before (N = 21 captures), including 18 grey squirrels when it is very unusual to catch one grey squirrel in the course of this annual trapping. Anecdotal reports suggest there was an unusually abundant grey squirrel population in northern NJ in 2020. Those nontarget captures represented approximately 25% of the trap nights. In addition, many more traps were disturbed than usual that likely negatively affected their likelihood of catching a woodrat. The team was seeing a lot of fresh woodrat scat at each of the sites, so we are hopeful that it was just a bad trapping year and the capture index this year was not a good reflection of the population numbers.

- The genetic analyses conducted by Towson University have been very successful in understanding of the genetic variability in the New Jersey population. The results from the 2019 trapping effort were very positive, with a continuing upward trend of the heterozygosity numbers since the translocation efforts began in 2015. We look forward to receiving the 2020 results to see if that trend continues.
- We look forward to learning if the extraction of chloroplast DNA from woodrat scat as a means of identifying dietary items in the scat samples will be effective. We will have scat samples collected across 4 seasons to test for seasonal differences if the analyses do work, 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.
- We are disappointed that it seems like quality DNA can only be extracted from very fresh woodrat scat (deposited within 24 hours), which has us re-thinking whether the non-invasive scat collection approach would be an effective alternative to live trapping woodrats in order to evaluation population abundance. We did learn that data gathered during our annual live trapping is insufficient to provide an estimate of population abundance using a capture-recapture model.
- We were not able to conduct as much camera monitoring at historic woodrat sites as planned due to COVID concerns.
- We organized a successful virtual regional Allegheny woodrat symposium in the spring, which led to the formation of a regional working group with representatives from 12 states for the first time. The group has held topic specific calls once every 1 to 2 months, which has helped already with collaborative efforts, standardized protocols, data sharing, and generation of new ideas.

<u>Recommendations</u>:

- 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 has resulted in continued improvement of 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 exploration of chloroplast sequencing of woodrat scat as a means of identifying particular dietary items, seasonally, which would help inform habitat management efforts.
- Continue to collaborate with Towson University and the DEP Office of Science and Research to consider whether the collection of woodrat scat is would be a beneficial method for understanding woodrat populations better, e.g. achieving population estimates, knowing now that it is only very fresh scat that extract well for successful genotyping.
- Continue assessment of historic woodrat sites using motion-triggered cameras.
- Continue leading the new regional Allegheny woodrat working group.

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 2020.

Objective 4 – Bat conservation and management

Prepared by: MacKenzie Hall

Key Findings:

Interagency Consultations & Coordination

- 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. The lab currently has about a dozen specimens from 2020 awaiting our inspection, including at least one suspected Northern long-eared bat, but due to the COVID-19 pandemic we have put off visiting the lab until public health conditions improve.
- ENSP continued its successful bats-in-buildings program, offering guidance to homeowners and Nuisance Wildlife Control Operators (NWCOs) on effective, bat-friendly exclusion practices. ENSP's bat biologist coordinated and co-led a bat workshop in February 2020 for sixty Nuisance Wildlife Control professionals, to educate the group about bat ecology, regulations protecting bats and non-game wildlife, NJ's bat exclusion guidelines, and acoustic bat survey techniques. The workshop was hosted by the NJ Pest Management Association and co-led by John Chenger (Bat Conservation and Management, Carlisle PA) and Kathleen Kerwin (Rutgers University), along with the ENSP. Seasonal email updates, including correspondence about COVID-19 related bat exposure concerns and precautions, were sent to our NWCO contact list and shared by the NJ Pest Management Association with their entire membership. ENSP fielded approximately 85 calls from the public and from NWCOs in 2020 regarding our bat exclusion guidance and resources.
- ENSP collaborated with the USFWS NJ Field Office and NJ Department of Transportation to begin implementing our newly finalized guidance for how and in what circumstances to survey for bats roosting in bridges. During summer 2020, ENSP personnel assisted NJDOT by surveying approx. 53 bridge structures (Fig. 1) located within the range of federally listed bat species, all of which are scheduled for maintenance activities that could impact bats, if bats are present. Along with nearly 50 additional bridges surveyed by DOT consultants, bat colonies or bat evidence were confirmed at eight structures. Four of these structures had very minor/intermittent bat evidence and did not require follow-up. Emergence surveys were performed at the four structures where active bat colonies were suspected; colonies ranging from 8-30 bats (ave. 15 bats per bridge) were observed. Three of these bridges span water bodies while the fourth spans a state highway. Acoustic recordings confirmed the presence of common big brown bats; one bridge may also be used by Eastern red bat(s) and another

by evening bats, though the recordings were not archetypal enough to confirm the evening bats, which have only been physically documented in NJ one time previously.

- At the one southern NJ highway bridge where fall swarming had been observed in late September 2019, we coordinated with NJDOT and stationed an acoustic detector from January 9 to February 28, 2020 (49 days and nights) to investigate possible winter use by bats. Approx. 68 bat recordings were collected, suggesting that bats could be hibernating very close by and/or using the bridge as a hibernation site. Bat activity corresponded with daily high temperatures >50°F, as is typical for arousals from torpor, though not every day or evening above 50°F had bat activity.

Figure 1. Personnel using a telescoping video camera array to inspect bridge abutment ledges (at left) and pier caps (at right) during bridge bat surveys. A large pile of bat guano confirms the presence of bats in the photo at right.

- ENSP bat biologist M. Hall co-led a *Bats in Bridges* workshop with A. Protus of USFWS as part of the virtual Northeastern Transportation and Wildlife Conference in September 2020, which was attended by more than 100 people from across the region.
- ENSP bat biologist participated in various training opportunities, workshops, and DEP reviews related to the upcoming offshore wind energy development taking place off the NJ coast.
- ENSP assisted the Northeast Motus Collaboration in identifying locations for new automated telemetry receiver stations in NJ, which are intended to benefit migratory bat studies as well as those for other wildlife taxa. While our initial plans to install stations on State Forest Service fire towers fell through due to time constraints, three new stations were established on private lands/land trust preserves in late 2020.
- ENSP coordinated with USFWS and in-state researchers to format and submit long-term occurrence and trend data from New Jersey for Northern long-eared, tri-colored, and little brown bats as part of the Service's combined 3-species status assessment.
- ENSP and USFWS coordinated with a private land mitigation firm to work out details of a new Indiana bat/Northern long-eared bat mitigation framework for NJ.

- ENSP's bat biologist attended the annual Northeast Bat Working Group meeting and participated in regular (approx. bi-weekly) WNS calls for agency personnel.

Summer Surveys

- NJ's acoustic data collected during summer 2019 as part of the North American Bat Monitoring Program (NABat) were classified, manually vetted, and uploaded into the NABat database during this work period.
- With the help of a seasonal employee and a contractor, we completed our fourth consecutive year of NABat acoustic monitoring in summer 2020. Data from these surveys are now being vetted and will be uploaded into NABat early in the next work period. Typically, more than 20 volunteers help to complete our mobile acoustic bat surveys, but volunteer participation was quite limited during the pandemic.
- The Summer Bat Count got a slow start during this work period because NJDFW was prohibiting the use of volunteers due to the pandemic. With help from our contractor at the Conserve Wildlife Foundation, seven roost sites were monitored 2-4 times each during maternity season. ENSP is awaiting the raw count data, but we are told that little brown bat colony sizes increased by about 28% compared to 2019.
- Summer mist-netting efforts were cancelled in 2020 due to the COVID-19 pandemic, both because group field work was strongly discouraged and because of ongoing continent-wide concerns over the possible risk of transmitting the virus to native bats.
- Likewise, the late-summer nanotagging of migratory bats we had planned was postponed until 2021. This project is being done in cooperation with other east coast states and researchers from VA Tech/USGS in effort to learn about bats' migratory pathways relative to the imminent offshore wind energy development taking place in our region. ENSP did acquire 30 nanotags and related supplies for our part of this project, and the bat project team have been coordinating with our shorebird counterparts to ensure that strategic Motus receiver stations are in place and operational to meet each other's needs.
- Ticks opportunistically collected from big brown bats that our team mist-netted in 2019 from two different NJ counties (Mercer and Sussex) were confirmed to be "bat ticks" (*Carios kelleyi*) – the first official records of this soft-bodied ectoparasite species in the state. ENSP's bat biologist, M. Hall, coauthored a short communication on the discovery along with primary author James Occi (Center for Vector Biology, Department of Entomology, Rutgers University) and collaborators, which was published in the Journal of Medical Entomology in September 2020 (link).

Hibernaculum Management & Winter Surveys

- ENSP continued monitoring the temperature profile inside Hibernia Mine with climate loggers to ensure that temperatures stay within an ideal range for bats since the mine entrance was opened wider and re-gated in fall 2017. Temperatures appear to have been favorable for hibernating bats throughout the winters since then. A bat survey will not be done during the winter of 2020-21, again due to the pandemic and lingering questions about native bat vulnerability to the SARS-CoV-2 virus.
- ENSP used acoustic detectors to investigate bat use of three different abandoned railroad tunnels in late winter (February-March 2020). Two of the tunnels – Oxford and Manunka Chunk – are not fully visually surveyable due to degraded and/or flooded conditions. The third – Pattenburg – was known to be used by *Myotis* bat species

including little brown and northern long-eared bats prior to White-nose Syndrome, but only big brown bats have been visually observed since. Temperature and humidity data were also recorded at the detector locations using Lascar loggers.
Results confirmed the presence of *Myotis* bats in the Oxford and Manunka Chunk tunnels for the first time, as well as in the Pattenburg tunnel. High-frequency, likely *Myotis* calls accounted for about 4 (2.2%) of 185 bat recordings from Oxford, 30 (1.0%) of 3,000 bat recordings from Manunka Chunk (Fig. 2) and 23 (1.9%) of nearly 1,200 bat recordings from Pattenburg. Three recordings from Manunka Chunk were auto-classified as Northern long-eared bat with a high degree of confidence, using SonoBat 4.4.5 software. Temperature data shows that internal temperatures in the tunnels (at logger locations) occasionally dip below freezing, reaching a brief low of 24F in Oxford, although conditions almost certainly remain milder at depths farther from the entrances. Bat activity appears to correlate roughly with an increase in internal temperatures to around 40F (again, at logger locations).

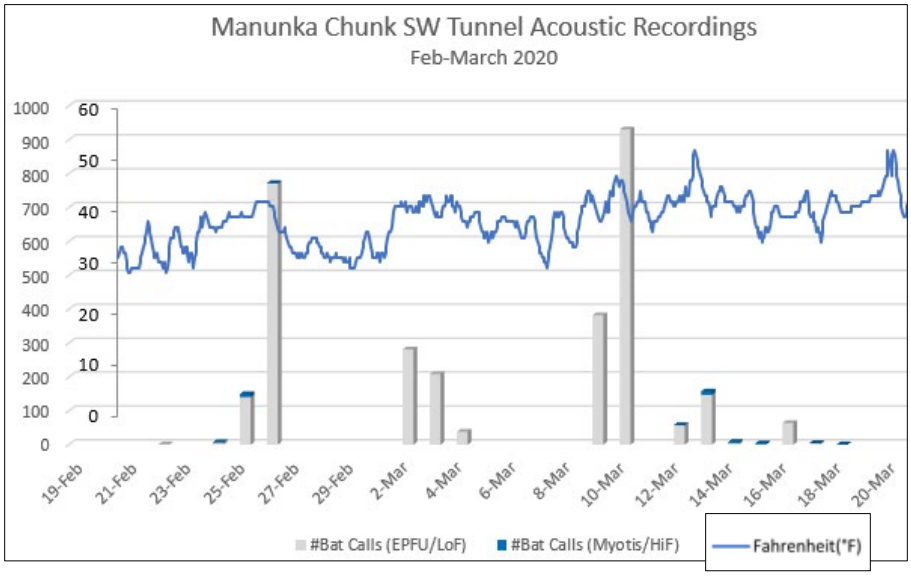

Figure 2. Bat call recordings and temperature graph from the abandoned Manunka Chunk tunnel, Warren Co. NJ, from late winter passive acoustic monitoring.

Conclusions:

- The NJ Department of Health Rabies Lab continues to be a valuable source of occurrence data for bat species of interest, giving us new insights about habitat use and behavior across all seasons. We were not able to review specimens during the work period due to the pandemic, but we expect to resume visiting the Lab in the next work period.
- Our outreach efforts and resources for homeowners and NWCOs are well received by both constituent groups and are having a positive impact on bat conservation in nuisance situations.
- Bridge-bat inspections are finally taking place in earnest, as a result of inter-agency consultation between ENSP, USFWS and NJDOT to identify bat-occupied bridge structures and develop avoidance and minimization measures for maintenance activities.

While bat colonies or bat evidence were found at a relatively small subset (8%) of bridges surveyed during summer 2020, the results are not negligible, particularly considering that the bridges surveyed were not chosen based on their suitability for bats but based on their location within federally listed bats' range. Bridges over water and those with more suitable roost characteristics appear to have higher occupancy rates.

- Projects requiring bat handling, such as summer mist-netting and nanotagging of migratory bats, were put on hold during 2020 due to the pandemic. We hope and plan to resume these efforts in the next work period. Supplies have been procured for nanotagging bats.
- 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.
- Acoustic surveillance of abandoned railroad tunnels, where visual survey options are limited, proved to be a successful method for confirming presence of bats, including the rare *Myotis* guild, during hibernation season. Acoustics also gave us a basic comparative measure of bat activity levels and arousal patterns at the three surveyed locations.
- Bat ticks (*Carios kelleyi*) are now documented in New Jersey, raising questions about their distribution, commonness, implications for bat (and possibly human) health, and whether factors like climate change are causing a range expansion.

Recommendations:

- Continue training and assisting NJDOT and consultants to carry out bridge surveys for bats. As time allows, focus more attention on bridges with greater likelihood of being used by bats, such as those along forested watercourses and/or those with favorable roosting characteristics (i.e., concrete box-beam expansion joints).
- 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 may analyze and glean information from Rabies-negative specimens of interest.
- When bat handling activities are allowed to resume, 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.
- Cooperate with entomologists and pathologists to further investigate questions related to our recent discovery of bat ticks in NJ.
- Collaborate on 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.
- Continue participating in trainings, workshops, and agency reviews related to the research/monitoring and minimization of offshore wind impacts on bats.