Interim Report
Federal Aid in Wildlife Restoration
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"Species of Greatest Conservation Need (SGCN) Research and Management"

Interim Report for Project Year
September 1, 2012 – August 31, 2013

NJ Department of Environmental Protection

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

JOB 1A: Bobcat Conservation
Project Leader: Mick Valent

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:

- A within-home-range habitat use analysis continued. After consultation with a statistician at Rutgers University, we designed an analysis to compare habitats used by bobcats and a random representation of habitats within each bobcat's home range defined by a 95% minimum convex polygon. The analysis compares actual habitat use to randomly generated points across all eight bobcat home ranges, examine each bobcat individually, bobcats grouped by sex, and grouped by season. The within-home-range analysis will help validate the mapping approach being developed by the statewide connectivity map working group (NJ T-1-6 SWG, Job 3F). It remains likely that the mapping approach chosen will serve the needs for a landscape level bobcat habitat map and corridor model.
    - Habitats used by bobcats were from 8 bobcats (4 males, 4 females) from 2002 to 2011 (Fig. 1); one additional animal (collar 151.382) was left out of this dataset but will be added to the final analysis. Six hundred random points were generated at least 60m away from any existing bobcat location within each home range. Location data from 2002–2004 and from 2005–2011 were related to 2002 and 2007 Land Use Land Cover data, respectively. GIS layers were generated (using ArcGIS 10.1 and Fragstats 4.1) for 15 habitat variables and statistical comparisons between used and unused locations were assessed (Table 1). Two seasonal divisions (based on date of cat location) were assigned to the dataset to test which of the variables may be more of a predictor of seasonal differences in habitat use (Table 2). Seasons were assigned to random points by calculating the percentage of locations with each season for each bobcat and applying those same percentages to assign seasons for each of the 600 randomly generated points per bobcat.

Preliminary analysis of the data indicates the following trends:

- When reviewing data of all the bobcats combined (Fig. 2), used locations have a higher percentage of wetlands and are closer to wetlands than unused locations. Used locations also have a lower percentage of urban, and a higher diversity index of agriculture, wetlands, and forest (meaning larger number of different patch types and/or more equitable distribution of area among patch types) compared to unused locations. Used locations have a lower percentage of forested land compared to unused locations.
- Individual cats seem to vary in their habitat use patterns (Fig. 3). In general, used locations of each bobcat have a higher percentage of wetlands, are closer to wetlands, and have a higher diversity index of agriculture, wetlands, and forest than unused locations, but the difference is much more pronounced in some cats and not significant in others. The percentage of urban area is generally lower around used locations for individual bobcats, but for a couple of bobcats, the percentage of urban area is higher around used locations compared to unused locations.
- There seem to be seasonal difference in habitat use patterns (Fig. 4), though across all seasons used locations have a similar diversity index of agriculture, wetlands and forest compared to unused locations. During the breeding season/winter months (whether defined as 2/1–4/30 or 11/1–4/30), used locations are closer to wetlands and have a higher percentage of wetlands compared to the other seasons and compared to unused locations.
- Habitat change analyses will not be completed until a landscape level predictive habitat model is produced.

- Staff continued to monitor three potential wildlife crossing structures under Route 23, a high volume road in northern NJ, using remotely triggered cameras. The road is slated for improvements by NJDOT and also intersects areas with high probability of bobcat use based on the 2006 predictive habitat model. In addition, staff monitored six potential wildlife crossing structures under Interstate 80 and a section of Route 206, without existing structures, that is a documented 'hotspot' for road mortality where bobcats, timber rattlesnakes, and northern copperheads have been hit by cars (Fig. 5). Unfortunately, cameras placed along Route 206 had to be removed in June because four of the cameras were stolen despite being in locked, steel, anti-theft boxes mounted on trees. Prior to their removal, the cameras did capture a picture of a bobcat; it was the only camera to capture a bobcat photograph during the reporting period (Fig. 6). Staff is developing a camera monitoring protocol to standardize the data that are collected to answer questions about structure effectiveness and maintain comparability between monitoring projects (T-11-T-2 Job 3).
- The dog-handler team, cameras, and collar data were not used to help validate the bobcat corridor mapping, but will be used once an updated predictive habitat model has been incorporated into the corridor modeling effort.
- Bobcat location data that was reported by individuals, derived from scat collected by the dog-handler team in 2012 and from tissue collected from 2012 and 2013 (n=107) have been entered into the Biotics database.
- No live-trapping or GPS collar deployment was conducted during the reporting period; however, four new GPS collars were purchased for future use.
- A status assessment and recovery plan have not been completed for bobcats because vital baseline data are still being gathered and analyzed and this information is needed to inform both the assessment and recovery plan. The baseline data include the results of the regional genetic variability study, the updated landscape level predictive model, and bobcat corridor model that will assess 1) distribution of habitat, 2) habitat change over time, and 3) distribution of remaining protected, suitable areas for bobcats in northern New Jersey. In addition, biological information (sex ratio, population size, and survival rate estimates from the capture-recapture model, and age structure, fecundity, and pregnancy rate estimates from the tooth and reproductive tract analyses) will be crucial information to incorporate into the status assessment and recovery plan.

Conclusions:

- The data for the within home range habitat analysis have been generated, compiled and sent to the statistician at Rutgers for further analysis. It will be completed in 2014, and will take into account factors such as sex, seasonality, and individual bobcats. The trends observed in the dataset to date demonstrate a strong association with wetland habitats and a preference for a mix of habitat types at the smaller, within home range scale. There also appear to be individual and seasonal differences in habitat use.
- Monitoring nine structures under high volume roads in northern NJ with remotely triggered cameras resulted in no documented evidence of a bobcat using these structures. There was one picture of a bobcat using one of the crossing structures during the last reporting period. There was one picture of a bobcat in a known crossing "hotspot" where no crossing structures exist. Unfortunately, the cameras were removed because of theft issues, but staff will attempt to improve security and re-deploy them to monitor the frequency of road crossings by target wildlife. The monitoring effort will help biologists make recommendations to NJDOT regarding wildlife/road mitigation measures as they plan road improvements along these sections of roadways.

Recommendations:

- Complete the within home range habitat analysis and produce a predictive habitat model at the within home range scale if the classification accuracy is adequate. Compare habitat use across all bobcats, by sex, season, and individual bobcat. The results will inform a landscape level analysis.
    - Compare habitat use by each bobcat, by sex, and season.

- Use the results to inform a landscape level analysis, either to help validate the mapping approach being developed by the statewide connectivity map working group (NJ T-1-6 SWG, Job 3F), or if that approach does not serve the needs of a landscape level bobcat habitat map, to inform the development of a predictive landscape level map.

- Use the updated landscape level predictive habitat map to inform the bobcat corridor modeling effort, either as part of the statewide connectivity mapping project or independently.
- Continue monitoring potential wildlife crossing structures under Routes 23 and 80 to assess use by bobcats and other species. Develop adequate security protocols so that cameras can be deployed at locations without being vandalized. Finalize the camera monitoring protocol to standardize data collection and compilation for all road monitoring projects (T-11-T-2 Job 3). Document and compile all camera data collected to date.
- When finalized, assess the nine structures currently being monitored using the culvert inventory protocol that was developed by the Roads and Wildlife Working Group (T-11-T-2 Job 3). Begin monitoring other potential wildlife crossing structures using the culvert inventory protocol in areas where the updated bobcat corridor model intersects roads. Document culvert/structure use and suitability and make recommendations intended to increase road permeability for bobcats.
- Use the dog-handler team, cameras, and collar data to help validate bobcat corridor mapping when it is complete.
- Continue to update the Biotics database with data collected by the public and staff survey efforts.
- Live-trap and deploy GPS collars to collect data on bobcat habitat use near heavily used road corridors and to help determine whether high traffic volume roads act as barriers to bobcat movements and dispersal.
- Develop a status assessment and recovery plan for bobcats in New Jersey, once the habitat, genetic, and demographic information have all been gathered and analyzed.

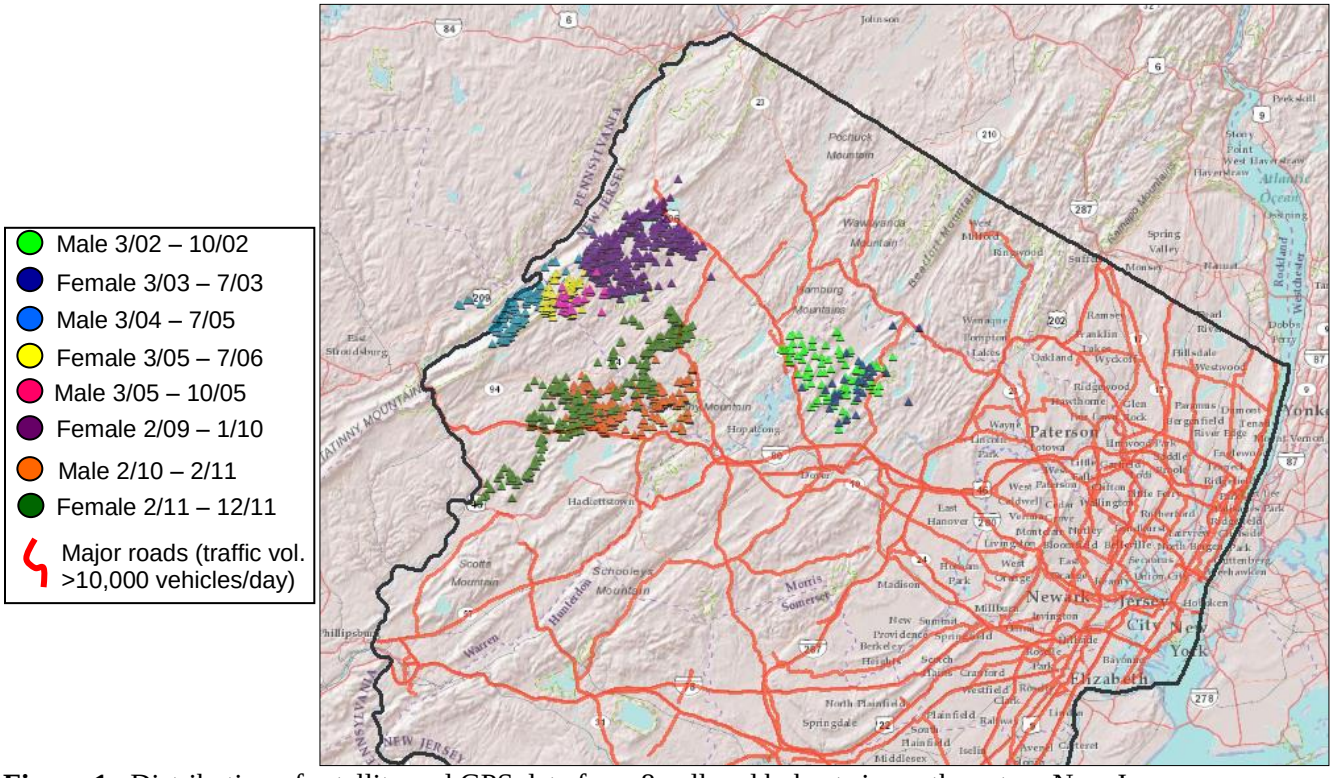

Figure 1. Distribution of satellite and GPS data from 8 collared bobcats in northwestern New Jersey between 2002 and 2011.

Table 1. Habitat variables that were chosen to compare between used and unused bobcat locations within 8 home ranges in northwestern New Jersey. Diversity indices and percentage cover values were calculated based on 100m radii from the location point.

Variables
Distance to all roads
Distance to high volume roads
Distance to streams
Distance to streams
Distance to urban
Distance to forest
Distance to wetlands
Distance to agriculture
Forest/Agriculture/Wetlands diversity index
Forest/Wetlands diversity index
Forest/Agriculture/Wetlands focal variety
Percentage urban
Percentage forest
Percentage wetlands
Percentage agriculture

Table 2. Two different season divisions that were assigned to all known and randomly generated bobcat locations in Northwestern New Jersey.

Seasonal Division I	
Breeding (br)	2/1 – 4/30
Young-rearing (yr)	5/1 – 9/30
Fall-Winter (fw)	10/1 – 1/31

Seasonal Division II	
Fall-Winter (fw)	11/1 – 4/30
Spring-Summer (ss)	5/1 – 10/31

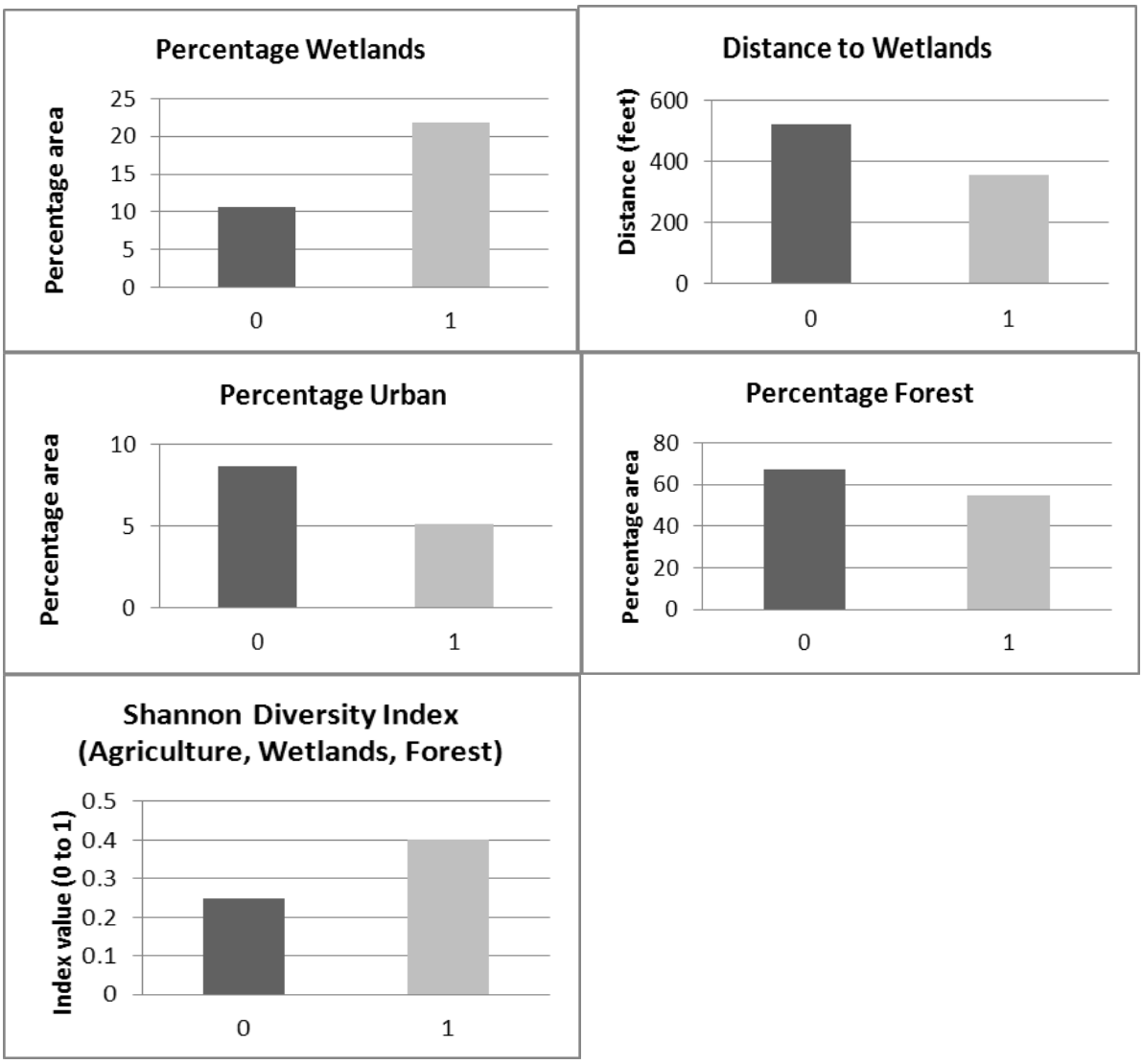

Figure 2. Results of habitat variable comparisons of all used locations (1) of eight collared bobcats in northern New Jersey compared to randomly selected, unused locations (0) within each bobcat home range. The habitat variable percentages and diversity index were calculated within a 100m radius applied to each used and unused bobcat location.

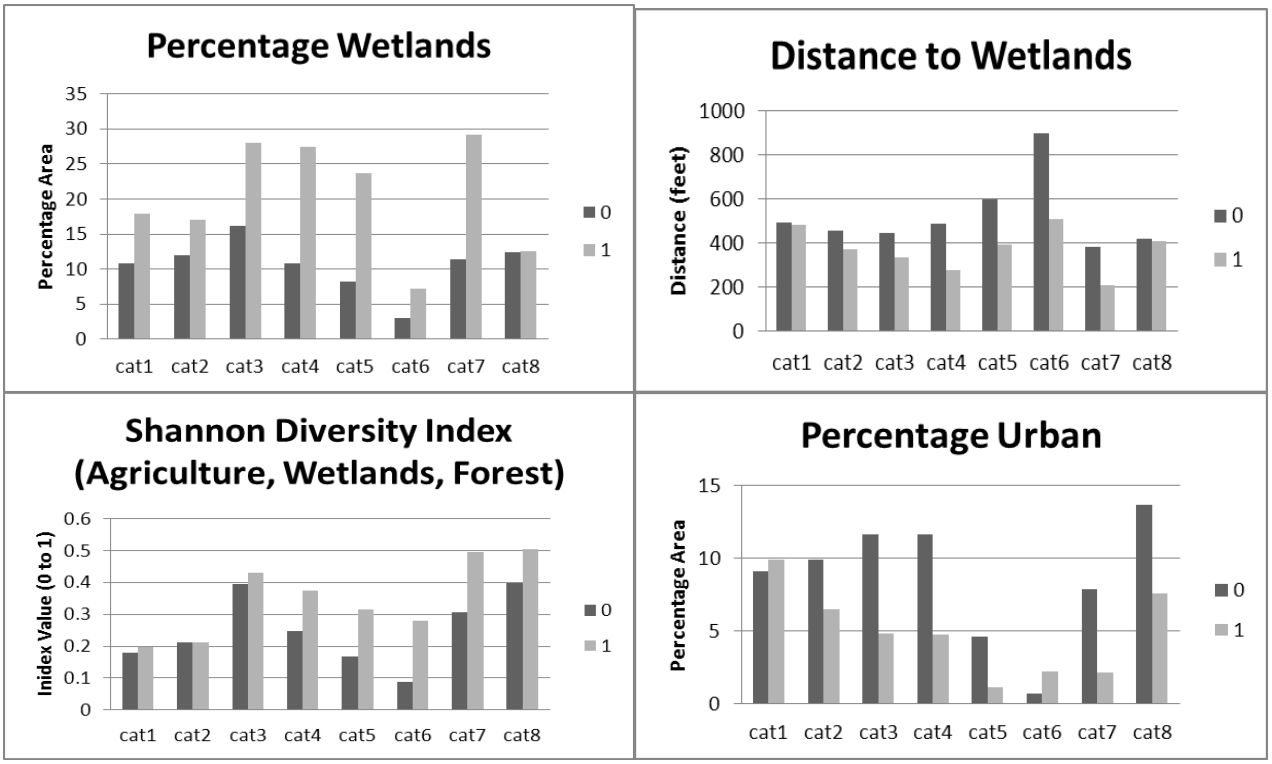

Figure 3. Results of habitat variable comparisons of used locations (1) of eight collared bobcats in northern New Jersey compared to randomly generated unused locations (0) for each bobcat individually. The percentage habitat variables and diversity index were calculated within a 100m radius buffer around each used and unused location.

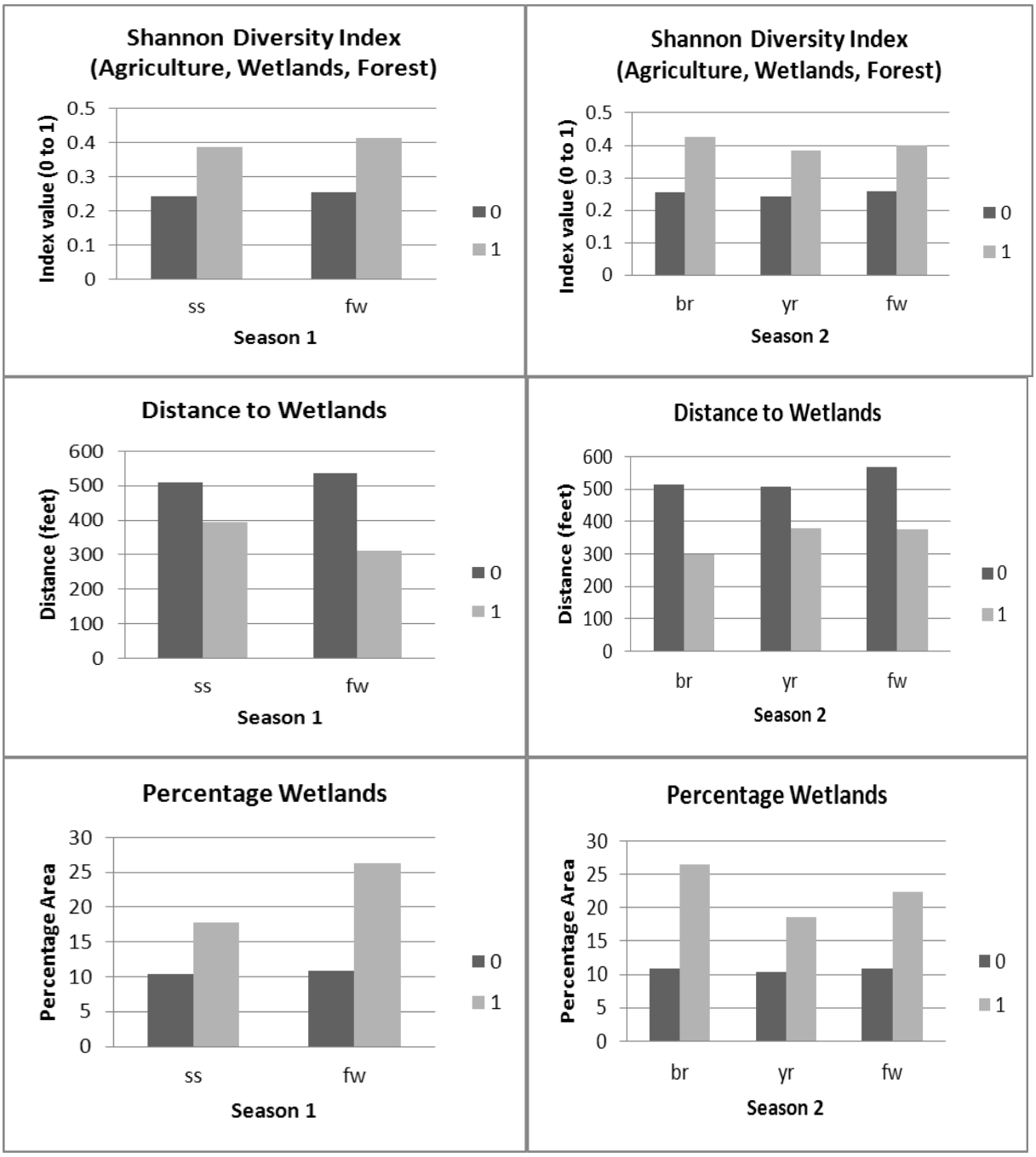

Figure 4. Results of habitat variable comparisons of all used locations (1) of eight collared bobcats in northern New Jersey compared to randomly generated unused locations (0) within each home range. Two different seasonal breakdowns are presented. Season 1: ss = 5/1 – 10/31, fw = 11/1 – 4/30, and for Season 2: br = 2/1 – 4/30, yr = 5/1 – 9/30, and fw = 10/1 – 1/31. The percentage habitat variables and diversity index were calculated within a 100m radius buffer around each used and unused location.

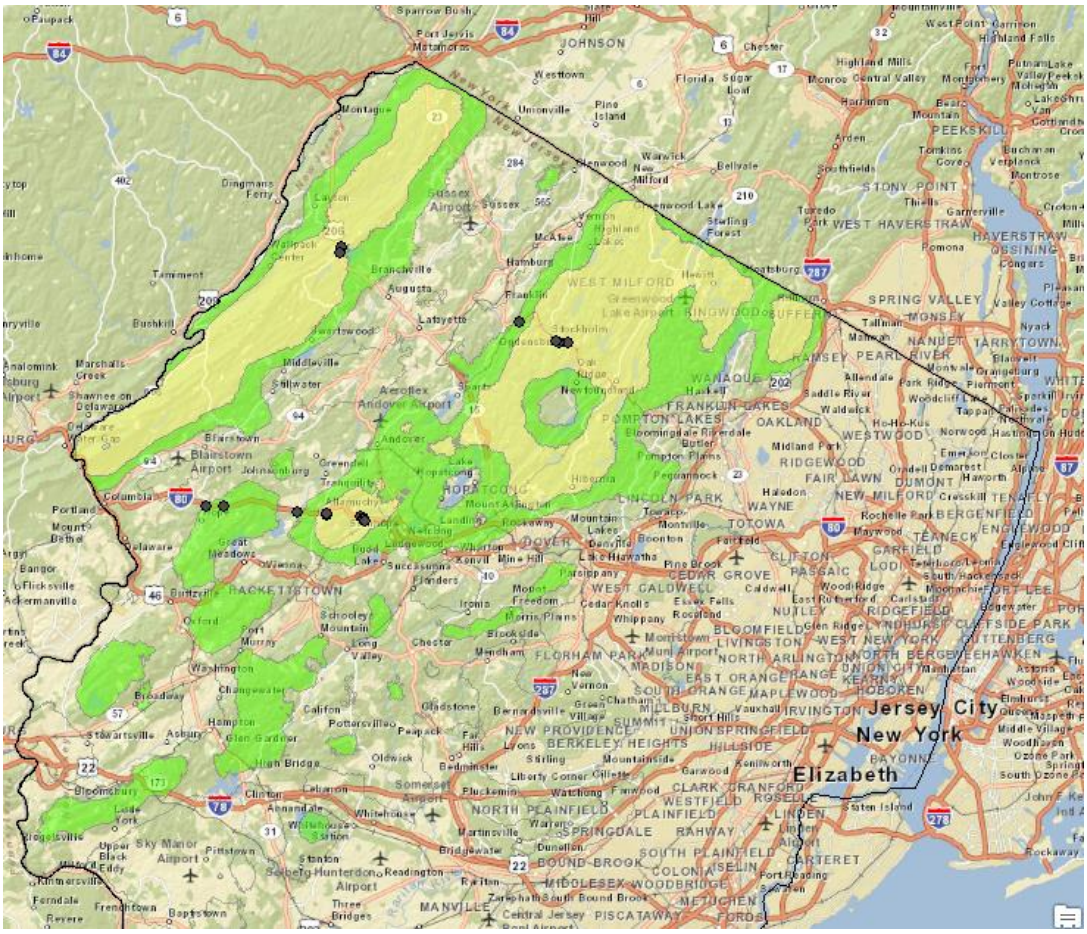

Figure 5. Locations of nine potential wildlife crossing structures and one high wildlife mortality site that were monitored using remotely triggered cameras along state routes 23 and 206 and Interstate 80 in northwestern New Jersey. The yellow and green shading depicts areas that have a high probability of bobcat use based on a predictive habitat distribution model.

Figure 6. A bobcat captured by a remotely triggered camera deployed along Route 206 in northern New Jersey.

JOB 1B: Allegheny Woodrat Conservation
Project Leader: Mick Valent

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:

- Standard trapping protocol was conducted at six separate talus slope sites at the base of the Palisades Interstate Park on October 11 - 13, 2012. 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 for a total of 80 trap-nights of sampling effort.
- Trapping success in 2012 declined slightly from the previous two years with the capture of just 12 unique individuals. Woodrat numbers (based on capture index) had been declining at the Palisades site from 2006 to 2009 but then began a gradual increase in 2010. The capture index (# of individuals captured/10 trap nights) in 2012 dropped to1.5, down from 2.0 over the previous two years. The lower capture index may be attributed to an unusually high rate of trap disturbance, presumably by raccoons. Several traps each night were disturbed and closed and therefore not available to woodrats.
    - Captured animals consisted of seven adult males and five adult females.
    - Five males were recaptures from 2011 and one had been captured in 2010.
    - Two females were recaptures from previous years as identified from the round biopsy punch holes in their ears.
- All captured animals were held for several minutes prior to their release to determine if they exhibited any symptoms of infection by *B. procyonis*; none did. All animals were sexed and weighed at the point of capture. In addition, a 2 mm tissue punch was used to collect two tissue samples (one from each ear) from each animal for genetic testing. Animals with biopsy punch holes in their ears from previous sampling efforts were not sampled again but ear tags were affixed to these individuals. All animals were released at the site of capture.
- Due to the downward trend in the population over the past few years, piperazine-treated fishmeal/polymer baits were again distributed in the areas surrounding the active woodrat sites in an effort to interrupt egg shedding by infected raccoons. PVC bait dispensers that were developed by researchers to dispense rabies vaccine to raccoons in suburban areas (Boulanger, et al. 2006) were used. Treated baits were placed into each of six PVC bait dispensers (approx. 40 baits per dispenser) during the spring (4/17/13). Motion sensitive cameras were again used to monitor PVC bait dispensers to determine what species were taking the baits. Raccoon was the only species documented consuming the baits at all stations while the cameras were deployed.
- Supplemental feeding was not conducted during the fall of 2012 due to Hurricane Sandy that hit the area in late October.
- Likewise, no fall raccoon scat searches were conducted at the Palisades during the project year due to Hurricane Sandy. The use of anthelminthic-treated baits is being used to control the *B. procyonis* egg loads in raccoon scat.
- No progress was made on the Allegheny woodrat management plan for the Palisades Interstate Park.

Conclusions:

- Allegheny woodrat captures declined for the first time in three years and may be cause for concern due to the findings that the population is suffering from inbreeding depression.

- Additional DNA sampling has supported the initial results that indicate that the Palisades woodrat population is suffering from inbreeding depression. The Palisades population is totally isolated from any other extant population of Allegheny woodrats.
- Several individuals were recaptured from previous years suggesting that adult animals within the population are surviving more than one year and not succumbing to *B. procyonis* infection or other factors. Additionally, none of the captured animals exhibited any symptoms of infection by *B. procyonis.*

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, woodrat/raccoon population monitoring at the Palisades Interstate Park site should continue. Periodic searches for raccoon evidence should continue and should include scat analysis for *B. procyonis* egg prevalence.
- The number of raccoons documented at feeding stations by motion-sensitive cameras again suggests that a healthy raccoon population exists at the Palisades. In 2008 we documented a decline in the percentage of raccoon scats that tested positive for *B. procyonis* eggs after putting out treated baits. This suggested that treatment of the population with medicated baits can successfully reduce *B. procyonis* egg loads in the environment. Therefore, it is recommended that fishmeal/polymer baits, treated with the anthelminthic drug piperazine, be distributed at regularly scheduled time intervals throughout the year in an effort to interrupt the egg-shedding cycle. The use of polyvinyl chloride bait stations has replaced the use of broadcast baiting as they have proved to be more effective at targeting the raccoon population. Piperazine was chosen as the treatment drug due to its high efficacy in clearing roundworms and its low toxicity (LoGuidice 2000). However, we plan to alternate the use of piperazine and pyrantel pamoate to prevent the possibility of developing anthelminthic resistant *B. procyonis.*
- Genetic testing has indicated that inbreeding depression is a serious threat to the population. Therefore, we have begun planning to acquire animals from another population to release at the Palisades site. Research has shown that the release of just a limited number of individuals can result in restoration of allelic richness and heterozygosity and lead to numeric recovery in a population (Smyser 2010).
- We will continue to consult with other experts in the field to determine the appropriate next steps to take to improve the health of the woodrat population at the Palisades.
- Complete the Allegheny woodrat management plan for the Palisades Interstate Park during the 2013-2014 segment.

Literature Cited

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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.

Smyser, T. 2010. The conservation of Allegheny woodrats in Indiana. Ph.D. dissertation, Purdue University, West Lafayette, Indiana.

JOB 1C: Small Mammal Survey
Project Leader: Mick Valent

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

Key Findings:
- No activity was scheduled to be conducted during the reporting period. Surveys are scheduled for several sites during the spring and summer of 2014.

Recommendations:
- Given the large number of species (11 of 39) that received an "Undetermined" status in the recently completed status review of the terrestrial nongame mammals, further sampling is needed across the state to gain a better understanding of the range and abundance of these species. Once adequate data for these species is available we can assign an appropriate status for each.
- Continue to conduct small mammal sampling across the state in representative habitats to gather data on species occurrence and relative abundance, especially for those species who were assigned an "Undetermined" status in the recent Delphi status review of terrestrial nongame mammals.
- Continue to gather data that will enable us to develop models that predict the distribution and abundance of small mammal species, or suites of species, over the broader region. These models will also be useful in targeting areas for small mammal surveys.
- Survey a minimum of 2 sites during the 2013-2014 project period using protocols previously developed.

JOB 2A: Bat Conservation and Management
Project Leader: Mick Valent

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 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 the USFWS database.

Key Findings:
- At the time that our current W-71-R-1 proposal was written, funding under the 2012-13 Grants to States for WNS was uncertain. Therefore, some of the work previously conducted under the Grants to States was included in the current grant proposal. However, since NJ was later awarded funding under the Grants to States this work was again funded under that grant. The work covered under the Grants to States included the Summer Bat Count and summer maternity colony monitoring.
- No searches for new hibernacula were conducted during the reporting period.
- An internal survey was conducted at Hibernia Mine on 3/21/13 as part of our *Myotis lucifugus* banding/survival project funded under the 2012 Grants to States for White-nosed Syndrome. A total of 574 bats were tallied and consisted of 572 *M. lucifugus*, 1 *M. leibii* and 1 *Perimyotis subflavus*. No Indiana bats were observed during the survey, however, several large clusters of bats were located in 6-in. diameter drill holes near the ceiling of the mine tunnel making absolute identification difficult for some of the bats.
- New data loggers (11) were installed in Hibernia Mine to record relative humidity and temperature.

- Internal surveys were conducted at nine abandoned mines/tunnels that have not been monitored since WNS was confirmed in the state (January 2009). These included mostly small sites that in the past supported relatively low numbers of bats. All of the sites had either greatly reduced numbers of bats compared to pre-WNS counts, or no longer supported any bats (Table 1).

Table 1. Pre- and Post WNS survey counts at NJ hibernacula.

Site	Species											
	Myotis lucifugus		*Myotis septentrionalis*		*Myotis leibii*		*Perimyotis subflavus*		*Myotis sodalis*		*Eptesicus fuscus*	
	Pre-WNS	Post-WNS	Pre-WNS	Post-WNS	Pre-WNS	Post-WNS	Pre-WNS	Post-WNS	Pre-WNS	Post-WNS	Pre-WNS	Post-WNS
ACOE Tunnel	133	5	6	0	-	-	22	0	-	-	-	-
Asbury Mine	145	4	-	-	-	-	8	1	-	-	-	-
Coggill Lower	20	0	2	0	-	-	4	0	-	-	-	-
Coggill Upper	7	0	-	-	-	-	-	-	-	-	-	-
Jugtown Tunnel	125*	1	-	-	-	-	-	-	-	-	0	29
Leigh Cave	333	0	15	0	-	-	29	0	-	-	-	-
Roomy Mine	13	2	1	0	-	-	7	1	-	-	-	-
Stanhope Mine	55	0	-	-	-	-	-	-	-	-	-	-
Stirling Hill Mine	18	4	4	0	-	-	25	4	-	-	0	57

*Partial survey conducted

- Biologists improved access for bats at the Asbury Mine by digging out soil that had washed down the slope and partially covered the mine portal. Only a small opening remained and it was covered by leaves and other debris. We dug out the rocks, soil and debris and inserted an 18" diameter culvert pipe into the opening to prevent surface runoff and sediment from covering the mine opening. A bat-friendly gate was constructed inside the pipe to prevent unauthorized access into the mine. Previously, no gate was present to prevent people from entering the mine.
- During our visit to the Asbury Mine we noticed that air flow had changed since our previous visit. We determined that a decrease in airflow was the result of fine sediment washing down slope and sealing rock openings that used to exist at the back end of the mine where it connected to the surface excavation. The "fines" have essentially plugged all or most of the spaces between the loose rocks at the back end of the mine impeding air flow from the surface. As a result, the internal temperatures and humidity have changed.
- Staff biologist attended he Northeast Bat Working Group Meeting in Carlisle, PA (1/9 – 1/11). Assisted with a presentation on the use of UV light in detecting *P. destructans* infection in bats.

Conclusions:

- To date, the majority of mines mapped by the NJ Department of Labor have been investigated for their suitability as bat hibernation sites. The primary focus of the investigation has been directed at those mines that were described as large operations that reported underground workings. Many of the mapped mines have been previously closed and openings are no longer visible at the surface. Others were primarily surface excavations that had no underground components.
- Declines in the bat population at the Asbury Mine are undoubtedly due, at least in part, to WNS-associated mortality. However, the internal conditions at the mine have also changed due to sediment "plugging" the back end of the mine and impeding airflow that previously existed when bat numbers were higher. It is difficult to determine whether the lower bat numbers are due entirely to WNS related mortality or a combination of that and changing internal mine conditions.

Recommendations:

- Continue to assess abandoned mines for their potential to support winter bat populations. Although the majority of the major mine sites have been investigated, it is occasionally reported that subsidence events occur that sometimes result in the reopening of underground workings. We will continue to

investigate these reports to determine the potential suitability of the site for supporting hibernating bats.

- Continue to monitor known hibernacula at two year intervals to assess bat populations.
- We plan to restore airflow to the Asbury Mine by removing accumulated sediment at the back end of the mine and installing a small pipe to the surface to return airflow. This will prevent future erosion within the surface excavation from plugging the spaces between rocks and impeding airflow. We will install data loggers to monitor conditions once the work is complete so that we can compare temperature and humidity with historic temperature and humidity conditions within the mine.

Job 3. Identify and Mitigate Threats to Sea Turtles in NJ Waters

Project leader: Jeanette Bowers-Altman

Objective:

- To identify and address major threats to sea turtles associated with power plant impingements.

Key Findings:

- Conserve Wildlife Foundation (CWF) staff continued entering sea turtle impingement/sightings data from the Oyster Creek Nuclear Generating Station (OCNGS) into the ENSP's Biotics database. The ENSP receives copies of all incidental "takes" reported to the National Marine Fisheries Service (NMFS) by AmerGen Energy. Data included date and time of impingement/take, species, carapace length, weight, condition (live vs. dead), intake of impingement (circulation water intake vs. dilution water intake), number of pumps running (cwi vs. dwi) and water temperature. Conserve Wildlife Foundation staff have now compiled and entered data for three sea turtle species (Atlantic Green, Atlantic Loggerhead, and Kemp's Ridley) impinged at the OCNGS between 1992 and 2013.
- We continued analysis of sea turtle impingements recorded at the OCNGS versus weather/meteorological factors with the goal of developing a predictive model that would determine when captures are most likely to occur at the power plant. Data from 2012-2013 were analyzed separately, and then combined with the existing dataset to cover 1992 – 2013. We used Microsoft Excel graphing and regression software to analyze data and identify trends.
- The following factors were used during the analyses in comparison to available capture data from the OCNGS: 1) wind speed and direction 2) air temperature parameters, including mean daily temperature, maximum daily temperature, minimum daily temperature, daily Delta T (max minus min), daily Delta T from two days prior to capture 3) thermal minima and maxima effects (i.e. cold shock, heat shock) 4) hurricanes 5) nor'easter storms 6) intervals of vulnerability (i.e. periods of abundance) 7) direct human interaction (i.e. boating effects) and 8) moon phase (2012-2013 only).
- We identified factors associated with each sea turtle capture. In addition, we identified captures that showed no apparent association with selected factors. Each sea turtle capture was compared to weather parameters as recorded by www.wunderground.com at the Atlantic City airport. Air temperature was used in the analysis because sea surface temperature was not available. It is presumed that air temperature is indicative either of sea surface temperature, or an indirect measure of surface coastal water transport through Barnegat Inlet, or bay water transport toward the Forked River intake canal through which cooling waters are channeled.

Conclusions

2012-2013

- Factors affecting sea turtle takes at OCNGS during 2012-2013 included the following 1) high east winds and falling air temperatures (nine of 15 takes), 2) high wind gusts (two takes), 3) rapid air temperature drops (two takes), 4) a rapid drop of barometric pressure (one take), and 4) unexplained (one take).
- For 2012-2013, there were no apparent effects from July 4th boat traffic. Although earlier analyses (when stratified by month) indicated a correlation between July 4th boat traffic and sea turtles takes, the lack of a relationship in 2012 and 2013 may be due to the following: 1) in 2012, July 4th fell on a Wednesday, and it rained the day before and during the holiday, with winds reaching 29 mph for three days in a row. These factors might be expected to cause reduced boat traffic in the bay, resulting in fewer collisions with sea turtles. 2) In 2013, many boats that would have normally been used in the bay had been either damaged or destroyed by Superstorm Sandy. Further, it is presumed that with fewer rental properties available in the area, boating traffic compared to earlier years had decreased, although we have no data to show this.

- For 2012-2013, analysis of the effects of moon phase showed no correlation with sea turtle take.
- For 2012-2013, there was only one take in June, a reversal of the trend outlined in last year's report. In previous years, takes were occurring earlier in June, probably in response to earlier warming of the coastal water mass. It now appears that during the last two years, June temperatures have actually been getting colder.
- For 2012-2013, no hurricane effects were noted. Despite hurricanes and nor'easter storms showing an effect on takes in earlier analyses, no sea turtles were impinged at the plant during Superstorm Sandy (30 October 2012). The OCNGS was shut down for refueling, with no pumps operating, beginning 22 Oct, which most likely protected turtles during the event. Sea turtles were apparently in the area during this time; there were anecdotal accounts of sea turtles found dead in the sand in Holgate, Long Beach Island, plus a verified report of six sea turtles found inside St. Rose High School in Belmar, NJ.

1992-2013

- Our records indicate that sea turtles were taken on 83 dates between June 1992 and September 2013. There may be additional records from OCNGS for which the ENSP did not receive reports, especially from the 1990's. We made every attempt to compile all available data. Multiple catches (> 1 turtle per day) were reported on three dates throughout the interval, resulting in a total of 86 turtles taken at the plant.
- For 1992-2013, east winds were associated with 39 dates of turtle impingement, whereas 44 dates were associated with all other winds. Forty-two turtles (48%) were impinged during east wind conditions. All multiple turtle catches occurred during east winds. Maximum wind speeds ranged from 9 mph (miles per hour) to 51 mph on the dates of turtle capture. All multiple catches occurred at speed greater than 20 mph.
- For 1992-2013, sea turtles were taken at maximum air temperatures from 55 F to 102 F, with heat shock occurring at higher temperatures. Multiple takes occurred between 73 F and 85 F.
- Minimum air temperatures ranged from 28 F to 77 F during turtle takes, with multiple takes ranging from 57 F to 74 F, and cold shock occurring at lower temperatures. Turtle take vs. air temperature delta T ranged from 4 F to 32 F, with multiple takes ranging from 4 F to 19 F.
- Two sea turtles were taken during Hurricane Irene when it struck the NJ coast in late August 2011; these takes were associated with maximum wind speeds of 55 mph. Air temperature became relatively stable throughout the day, resulting in a low delta T. The stable air temperature during this time may provide insight into why some takes are not associated with high delta T's such as storm passages, during which temperature remains rather uniform.
- There were 10 sea turtle takes reported this year (with the possibility of additional reports coming into the office during early November) making 2013 the second highest year for sea turtle takes at the plant. Similarly, there were two sea turtle takes at the Salem Nuclear Power Plant in southern NJ this year, the first time since a sea turtle has been reported there since 2001. A high number of turtles present at the OCNGS and the take of two sea turtles at Salem may provide insight as to coastal sea turtle abundance. More research is necessary to determine if increased captures is a reflection of increasing abundance or increasing range, or is due to other factors such as climate change or location of the Gulf Stream and its associated gyres. According to the National Marine Fisheries Service (NMFS), nesting numbers for many sea turtle species in the southeast are up (J. Crocker, NMFS, 2013, pers. comm.). In addition, there are recent reports of attempted nesting by sea turtles along mid-Atlantic beaches, including in NJ and DE.
- It is also perhaps worth noting that the effects of Superstorm Sandy could have changed the dynamics in and around Barnegat Inlet to allow for easier passage of sea turtles into the bay. According to J. Vouglitois (NJDEP, pers. comm.), no sea turtles had been reported at OCNGS prior to 1992, when a major dredging project by the Army Corp of Engineers (ACOE) occurred in the inlet. Reconfiguration of the south jetty in 1991 combined with the 1992 dredging of a 91 m wide x 3 m

deep channel increased the tidal prism to what it was in the 1930's, increasing flow efficiency (Kennish 2000). It is possible that once the stabilization and dredging occurred, it allowed sea turtles easier access to the bay. Similarly, Superstorm Sandy could have created even more of a pathway through the inlet, however, the scenario has yet to be investigated.

- Sea turtle catch at the OCNGS is primarily affected by local abundance and distribution. Gusty east winds, especially during storms, may drive turtles into the intake canal, but there are many more instances where despite such winds, no turtles are captured, presumably because they are not the area at that time. According to Tatham et al. (1977), northeast winds (particularly storm conditions) coincided with greater impingement at the plant. These findings, specific to finfish and macroinvertebrates, concur with the findings of this project; whether turtles are pushed along with wind-blown currents, or whether they are following prey items into the intake canal (or a combination of the two) has yet to be determined. Another possibility is that it may be extremely difficult for plant personnel to actually spot turtles during certain conditions (e.g. during increased turbidity and/or high influxes of detritus such as eelgrass or sea lettuce that can be blown in from the bay during storms and/or east winds).
- The OCNGS will remain in operation until 2019. Given the remaining life of the plant, combined with increased catches of sea turtles for whatever reason, strategies to help further reduce take could potentially prevent injury/mortality to > 30 individuals. In addition, application of our methods at the Salem plant and other coastal energy facilities with water intakes may be feasible and worth further investigation.

Recommendations:

- Continue compiling data for OCNGS sea turtle impingements and enter in the Biotics database.
- Continue analysis of sea turtle impingements vs. variables such as proximity to Gulf Stream, species movements coastally, and prey abundance and distribution. Discontinue using moon phase as a variable in the analysis.
- Build files to show surface oceanic temperatures along sea turtle migration routes over time through 1992-present; in addition, build files to measure distance from Barnegat Light to Gulf Stream during times of turtle takes in order to examine whether the variable has any impact on catch.
- Continue with model development; test with impingement data from 2014. Investigate whether the approach can be applied to sea turtles and listed species (e.g. sturgeon) at Salem Nuclear Power Plant in southern NJ and at other power facilities along the east coast.
- Continue to gather information from the NMFS to determine coast-wide population trends.
- Schedule meeting with OCGNS staff to present preliminary results and discuss protocols that could be easily implemented during predicted times of likely sea turtle occurrence. Possible protocols aimed at minimizing sea turtle impingements may include a) increased inspection and cleaning of the trash racks at dilution water and circulatory water intakes b) increased inspection of canals by boat c) inspection of intake and discharge canals from bridges along Route 9 and d) video camera surveillance of the intake canal.

Literature Cited

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