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

Interim Report for September 1, 2017 – September 30, 2018

NJ Department of Environmental Protection

DIVISION OF FISH AND WILDLIFE
ENDANGERED AND NONGAME SPECIES PROGRAM
P.O. BOX 420
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NEW JERSEY DIVISION OF
Fish and Wildlife

SPORT FISH & WILDLIFE RESTORATION

Project 1. SGCN Birds Conservation and Management, grant organization:
Job A. Birds
Subjob A.1. Shore & Marsh Birds (was 1. Colonial Waterbirds, 2. Migratory Shorebirds, 4. Secretive/Coastal Marsh Birds)
Subjob A.2. Raptors (was Woodland Raptors)

PROJECT 1: SGCN BIRDS

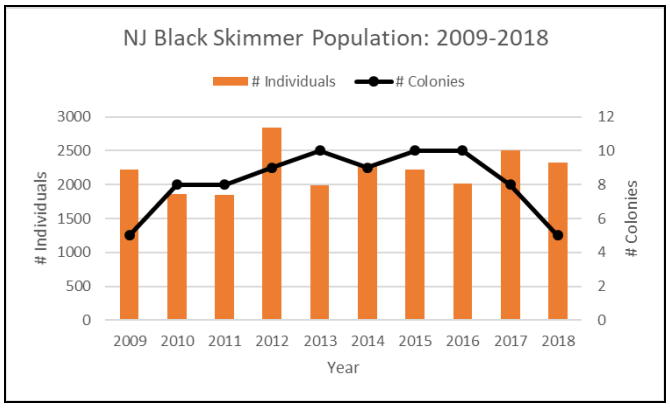
Job Number and Title: A.1. SHORE AND MARSH BIRDS

Beach nesting Birds (Piping Plover, Black Skimmer and Least Tern)

Prepared by: Christina Davis, Environmental Specialist II
Beach nesting Birds (Piping Plover, Black Skimmer and Least Tern)
Project Leaders: Christina Davis
The portions of this job applying to Piping Plover are jointly supported by ESA Section Six funding.

Key Findings:

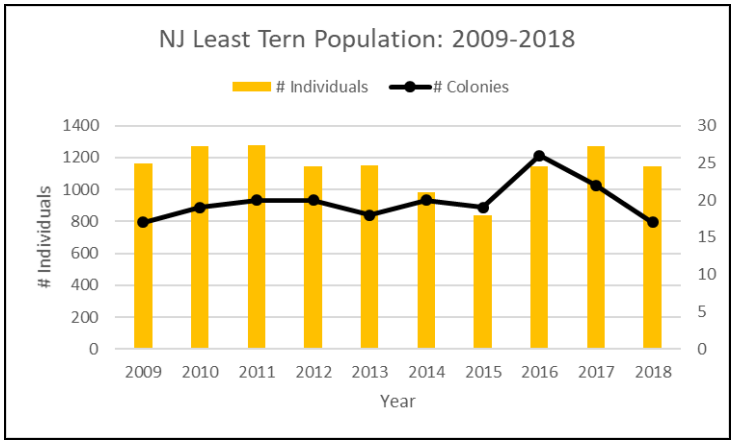
Black Skimmer



- Black skimmer breeding bird counts were conducted approximately every week at active sites from arrival (mid-May) until nesting ceased (mid-September, just beyond scope of this report timeframe but still reported here for continuity) on beaches along the entire Atlantic coast and marsh islands from Barnegat Bay south; other marsh islands were surveyed as resources allowed. Ground surveys took place at eight sites and active nesting (at least one nest with eggs) was observed at five sites. An aerial survey took place once in late May and once in July and there were very few skimmers noted, an unusual outcome. These five sites were also visited 3-7x/week for management and outreach for the duration of the nesting season.
- A total of 2,330 adults were present at the active sites. This figure is the cumulative total of site counts that occurred in the peak survey period, 30 July – August 5. The sum of the peak adult number from each site was 2,676. A large difference between these two numbers can suggest failure at any given colony and then relocation/renesting to another colony. Since 2010, the majority (80%) of the state's known population was present at just one site, which continued to be Seaview Harbor Marina in Longport (2,123 peak adult count). Skimmers were documented continuing to use the sandy restored areas of marsh islands (Ring Island [no nest hatched] and Mordecai Island [no confirmed nesting documented]), although with less success than last year.

- A peak count of 827 incubating adult black skimmers was tallied in the 9-15 July survey period. The incubation number was lower than might be expected given the number of adults present and was likely lower than what actually nested. As is generally the case, the vegetation at the largest colony blocked observers from garnering an accurate count of these ground nesters but walk-through colony counts have not shown to be effective in NJ.
- Black Skimmer statewide productivity appeared to be relatively high, with 941 fledglings produced statewide. This translates to 1.14 fledglings/pair if use peak incubating adult count. If we simply halve the peak period total adult number and use that as pair count, the productivity is 0.81. The true rate is likely somewhere in the middle. Three sites (the two mentioned below and Holgate) fledged young and the majority were produced at one site, Seaview Harbor Marina (82%). Notably, Stone Harbor Point produced a strong number of the state's fledges (17%) which was a true success at one of the most variable sites in the state for productivity consistency. Depredation was the primary factor responsible for nest and chick loss on beach strand sites. For the marsh nesting birds, the lower number of observations at these sites meant it was difficult to ascertain reasons for failures but it was likely a combination of flooding and depredation. Two-thousand eighteen also saw a stark lack of nesting in the marsh islands, continuing a downward trend that started years ago but was especially obvious this year.
- NJDFW, The Wetlands Institute (TWI) and the Conserve Wildlife Foundation of NJ worked cooperatively to band 47 Black Skimmer near-fledglings on Stone Harbor Point (TWI also banded one adult on Ring Island). This effort was the most fruitful since banding began in 2016, owing largely to the success of the colony at Stone Harbor Point. It was determined that nocturnal efforts for banding yielded better results in terms of reduced colony and chick stress. Long-term goals of banding include better understanding of site fidelity and inter-state movements (particularly with New York breeding birds).
- Over the course of fall 2017-summer 2018, seven of the 35 chicks banded in Belmar in 2016 (note: this is the same number as reported 2017 report but different individuals) and one adult from 2017 were observed either on migration or wintering grounds. Multiple NY-banded birds were observed in NJ as migrants.

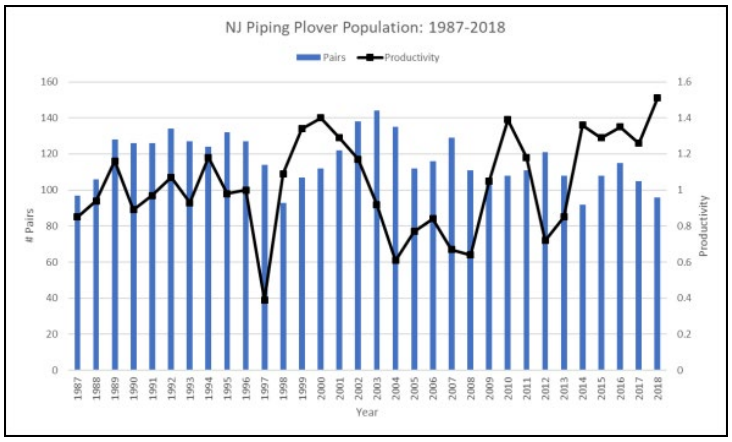
Least Tern



- Least tern breeding bird surveys were conducted every week from mid-May until the end of August at beaches along the entire Atlantic coast. Colonies were located at 17 sites and observations were made at these locations for the duration of the season. These 17 sites were also visited 3-7x/week for management and outreach for the duration of the nesting season.
- A total of 1,143 adults were present at these sites (based on a cumulative total of peak site counts that occurred in the 18-24 June survey period). The summed peak adult number from each site was 1,912. A large difference between these two numbers can suggest failure at a given colony and then relocation/renesting to another colony, which given the data and on-the-ground observations appears to have happened in 2018.
- The population was distributed fairly evenly throughout the state and eight colonies had >100 with one colony 300+. The largest colony was at Stone Harbor Point, with 305 adults on its peak count, followed by Holgate – North with 260 adults at its peak. The statewide adult number was about the same as recent years and more in line with the longer-term trend. As always, there was some difficulty tallying birds in dense vegetation.

- A peak of 625 adult least terns were observed incubating in the census period 18-24 June. Productivity was poor for least terns with 199 fledglings produced statewide (0.32 fledglings/pair, based on the peak number of incubating adults). The fledge rate continues the dip from last year and illustrates an increased issue with depredation and flooding.

Piping Plover (*Full Piping Plover reporting can be found in NJ E-1-40*)



- Ninety-six (96) pairs of piping plovers nested in New Jersey in 2018, a 9% decrease from 2017 (105) and a 17% decrease from 2016 (115). This continued decrease, despite excellent reproductive success, is now a cause for full alarm.
- The total number of adults recorded for the entire nesting season (195) was somewhat higher than during the date-restricted survey conducted June 1-9 (184). The number of pairs tallied during the entire nesting season (96) was similar to the pairs recorded during the date-restricted census (87). There were 10 unpaired adults observed during the census, compared to 3 that remain unpaired by season's end. This figure was more in line with previous year's totals and much lower than in 2017 when end of season unpaired tally was 17. However, this difference makes the decline of adults more apparent (195 vs 227 in 2017 and 232 in 2016).
- Pairs nested at 19 sites statewide, one less than 2017 and well below the peak count of 30 sites recorded in both 2004 and 2005. Much of this loss has been sustained at Cape May County sites, which is now down to one active site (Stone Harbor Point).
- Statewide pair-nest success (the percentage of pairs that successfully hatch at least one nest) increased in 2018 compared to 2017 (91% vs. 78%, respectively), and well above-average for the period since federal listing (69%). Looking at just NJDFW-monitored sites, 2018 pair-nest success (96%) was slightly higher than the state-wide tally and higher when compared to the period since federal listing (67%) and in 2017 (86%).
- The statewide productivity rate was 1.51 fledglings/pair, an increase from 2017 (1.29 fledglings/pair). Productivity at NJDFW - ENSP-monitored sites (1.59 fledglings/pair for 27 pairs) was below the 2017 metric (1.79 fledglings/pair) but slightly above the 2017 statewide tally, an unusual occurrence.
- NJDFW continued to use predator exclosures in 2018 with 71% of nesting attempts exclosed (statewide was 75%). The exclosed hatch rate for NJDFW nests was 92% (statewide was 85%). The NJDFW unexclosed hatch rate was 40% (statewide was 32%) and of the NJDFW nests not exclosed, 50% were lost to depredation (statewide was 48%). The abandonment rate for NJDFW exclosed nests was 0%, compared to 5% statewide.
- NJDFW purchased GPS data loggers in support of the State University of New York (SUNY)–Syracuse's piping plover research project. In 2018, three adults returned to the NJ breeding grounds with loggers that were attached in 2017 (2 others were observed on wintering grounds but not seen after). In 2018, 6 adult females were outfitted with GPS data loggers for the short-term (~2-3 weeks) and 15 adults (13 females, 2 males) were outfitted for the long-term (to be retrieved next year) using a leg harness attachment technique. No problems were detected with this method, but the data is not yet available to share.

Conclusions:

- Although NJDFW-ENSP continues to be concerned that the majority of **black skimmers** are at just one site and that the overall colony number was quite low, in 2018 a significant colony (at Stone Harbor Point) was successful, which was a heartening change from previous years. However, other nesting areas that would have contributed to a diversity of successful nesting sites failed to produce fledglings, due in large part to predators.
- The impact of sea-level rise in the marsh islands may be affecting occupied nesting areas. The largest colonies continue to be located either on the beach strand or on large, relatively stable marsh islands with sandy substrate. There was almost no activity in the traditional marsh colony areas (smaller islands that are more susceptible to flooding) as two aerial surveys and follow-up ground surveys failed to detect any successful nesting colonies and very little activity overall. This appears to represent a true move away from nesting on wrack in marsh colonies. NJDFW-ENSP will be closely tracking this emerging pattern in future years to better understand shifting distribution. The sandy restoration areas did not have as much success as last year, but given the apparent lack of other options in the marshes, NJDFW-ENSP remains committed to continuing to experiment with restoring habitat in this fashion.
- The effort to band black skimmers took a significant leap forward this year: project partners banded their largest number of chicks yet (48, 29% of total fledglings at Stone Harbor Point), gained more experience and honed techniques that will serve the project well (such as nocturnal banding). Relatively speaking, the resight rate has been quite high, helping to answer basic questions about post-breeding dispersal and wintering locations.
- The statewide **least tern** breeding population continued to be relatively stable, although reproductive success is much lower than desired. Depredation was a major factor in the failure of this species and a better effort must be made if high productivity is to be achieved. Predator management is occurring at many locations in the state, but there are key places where it is not tenable, and the result is outcomes like low productivity. In other cases, predator management occurred but was not able to successfully capture key predators.
- The number of active least tern colonies (17) decreased in 2018 to a tie for the 10-year low. However, the colony counts fluctuate year to year and the species is distributed rather fairly across sites and the state, in terms of location and number of individuals in colonies, so this did not raise a huge call for alarm.
- The state recorded its fifth consecutive year of strong productivity for **piping plover**, above the long-term average in New Jersey (1.02 fledges/pair) and well above the levels believed necessary to maintain a recovery unit-wide stationary population (~1.00-1.245 fledglings/pair). It also marked the first time, in 30+ years, that the recovery goal of 1.5 fledglings/pair was met and exceeded. This makes it even more alarming that for the second year a dip in the population was recorded. The same pattern was observed in 2017, but it appears more serious this year because there weren't as many unpaired adults to make up some of the difference in the pair tally. Surrounding states do not seem to be experiencing this issue and there are now critical questions about the fitness of NJ birds and their survivorship rates versus those in other regions as well as about habitat suitability in the state.
- The majority of plovers (72%) are still nesting at two federal sites (Gateway NRA – Sandy Hook and EB Forsythe NWR) and the severe decline of nesting plovers in Cape May County continues to be of dire concern (three pairs in 2018, compared to 43 pairs in 2002).
- Hatch success was very high this year and a reduced abandonment rate bode well for confidence in biologist's decisions about where and when to place exclosures. Chick mortality continues to be the primary factor limiting productivity in the state but the bigger issues are now with understanding adult mortality and survivorship, as it appeared many of the breeding adults in the NJ population were rather young and quite a few (of all ages) appear to have been lost entirely.
- This chick mortality project for which transmitters/loggers were deployed on plover adults and juveniles is on-going and final results are not yet available. The leg harness GPS logger deployment, however, appeared to be a success, adding another tool to the tracking tool box.
- Seaview Harbor Marina's importance to beach nesting species continued unabated yet again this year. In addition to housing the majority of the black skimmer adults and fledges, it also hosted a common tern colony and American oystercatchers.

Recommendations:

- Continue to periodically monitor back bay island complexes within the coastal region of the state (aerially, if possible) to ensure that large numbers of skimmers are not nesting in these areas. When sites are identified include them in the ground surveys.
- Continue intensive monitoring of piping plover populations and reproductive success, and continue monitoring to ascertain causes of nest failure and brood loss. Encourage research projects focusing on improving reproductive success for all three species by reaching out to potential collaborators, supporting their proposals and providing technical guidance as needed.
- Continue to incorporate management strategies for piping plovers, black skimmers and least terns into comprehensive beach management plans for municipalities in the coastal zone. Develop similar plans for state managed parks and natural areas.
- Continue to refine a comprehensive predator management plan (including components such as removal, aversion and reducing site attractiveness) as it is a primary means forward to recover these species. Work within and among DEP Divisions to obtain permission and create action plans for state lands, continue to encourage federal partners to do the same and work on initiatives to complete more aggressive and/or focused predator management on municipal lands.
- Lead and/or coordinate large-scale restoration efforts to improve beach nesting bird habitat. Targeted sites include Barnegat Light, Malibu Beach WMA, Cape May Point State Park and carefully selected marsh islands. Conduct smaller efforts to control vegetation as needed (for example, at Seven Presidents Oceanfront County Park and Belmar – Shark River Inlet).
- Continue to make every effort to allow Seaview Harbor Marina's beach nesting birds to flourish. This includes continuing intensive predator management but also considering undertaking vegetation thinning to ensure the habitat stays suitable for as long as possible.
- Continue to work with regional partners, through in-person meetings and conference calls, to ensure that NJ is making the best decisions possible when it comes to predator exclosures.
- Continue to follow the piping plovers that were banded in 2012-13 and 2015-18 (though the aforementioned SUNY research project). Monitor arrival and departure dates and local movements of all banded birds. Peruse records of observations of birds on their migratory stopover and wintering grounds through birding listservs, eBird, social media and other online documentation tools. Enlist volunteers to help with survey efforts. Work towards analyzing and publishing piping plover migration data. Use this date to better understand survivorship and make progress towards understanding the population decline in recent years.
- Continue to work with partners to play an active role in regional coordination, research and protection efforts for black skimmers. Formalize research questions to be answered by banding and participate in the creation of a database where banding resights can be entered, accessed and stored. Consider doing the same for least terns.
- Engage and seek out data and research on the impacts of sea-level rise, subsidence and mad-made efforts to stabilize the coastal zone in an effort to ensure habitat persists in the coming decades for these highly vulnerable species.
- Continue to coordinate management with municipalities, as well as county, state and federal landowners.
- Continue to incorporate breeding data into NJ DEP's Landscape Project and Biotics database.

Colonial Waterbirds

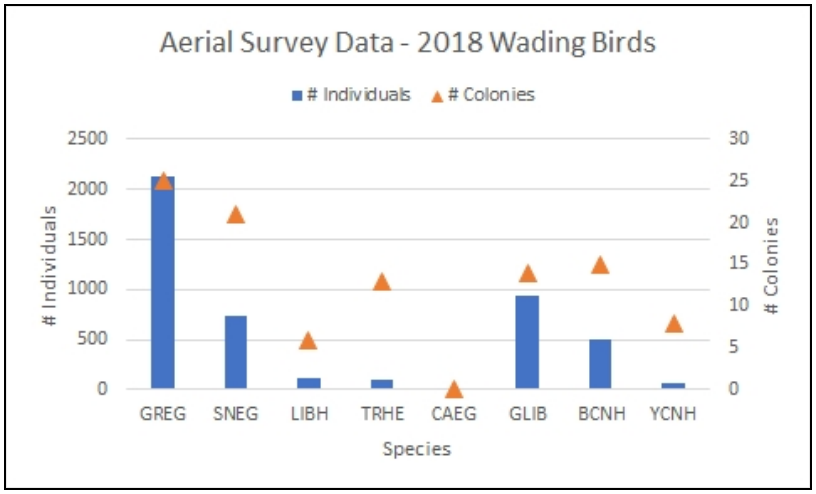
Prepared by: Christina Davis, Environmental Specialist II

Job Objective: Census long-legged wading birds nesting on Atlantic coastal marsh islands, via aerial survey.

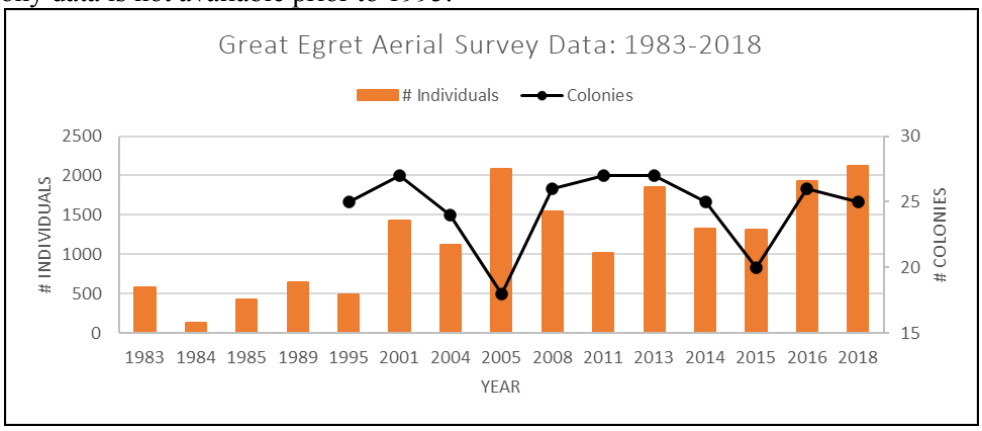
Key Findings:

- 4,581 individual wading birds were counted on the aerial survey in 31 colonies. Of the 4,581, 2,122 (47%) were great egrets, 744 (16%) were snowy egrets, 930 (20%) were glossy ibis, 505 (11%) were black-

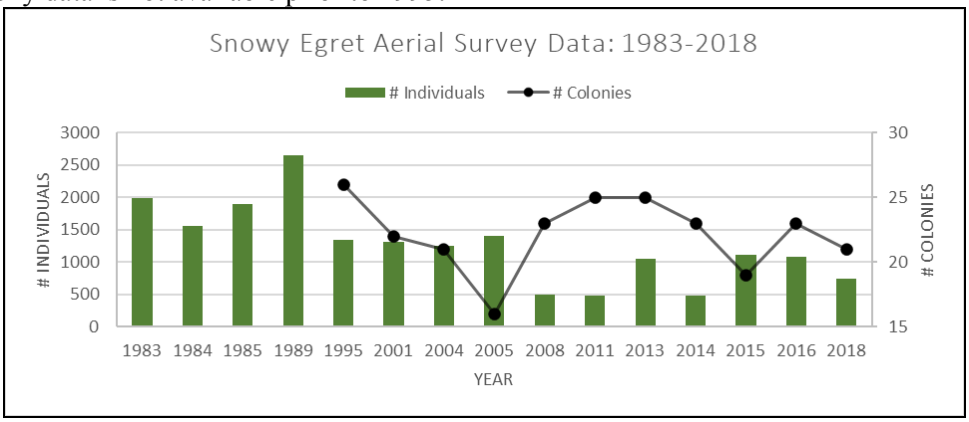
crowned night-herons, 71 (2%) yellow-crowned night-herons, 107 (2%) little blue herons, 102 (2%) tricolored herons and 0 (0%) cattle egrets.



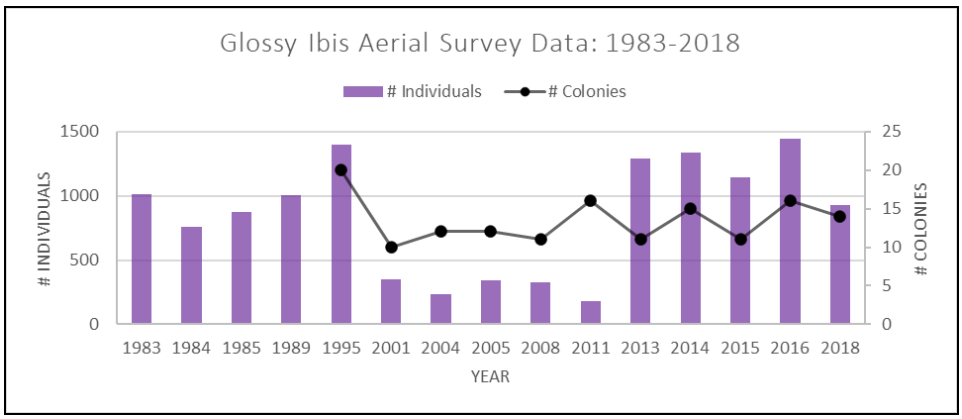
- There were 2,122 individual great egrets observed in 25 colonies. Due to changes in methodology, please note that colony data is not available prior to 1995.



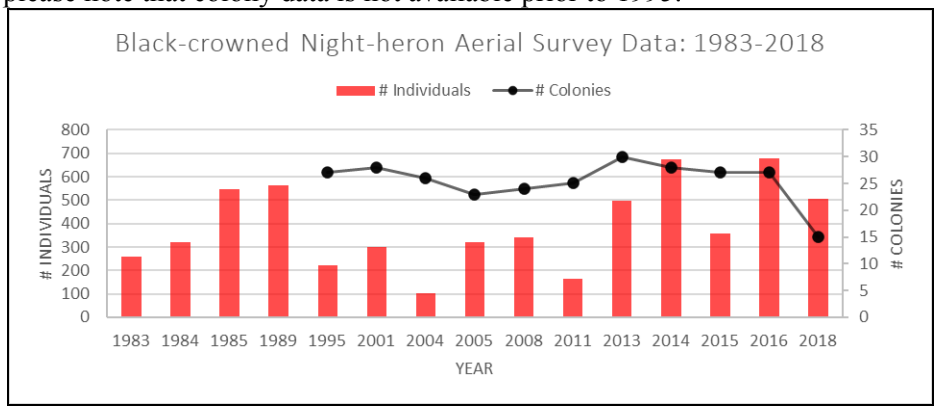
- There were 744 individual snowy egrets observed in 21 colonies. Due to changes in methodology, please note that colony data is not available prior to 1995.



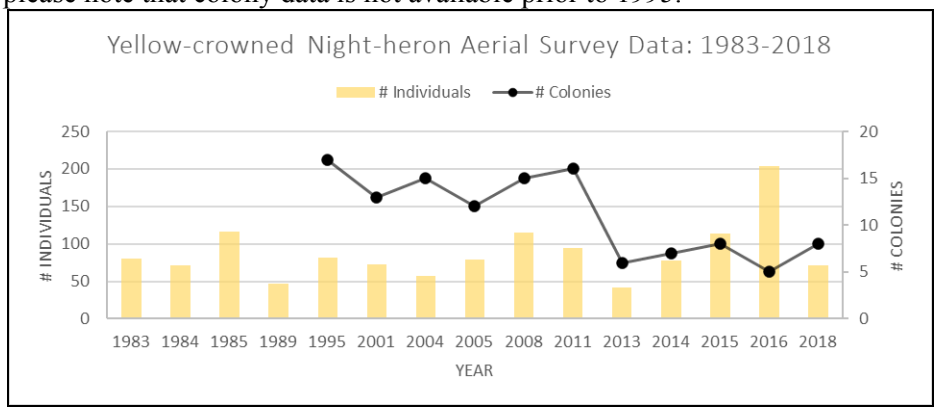
- There were 930 individual glossy ibis observed in 14 colonies. Due to changes in methodology, please note that colony data is not available prior to 1995.



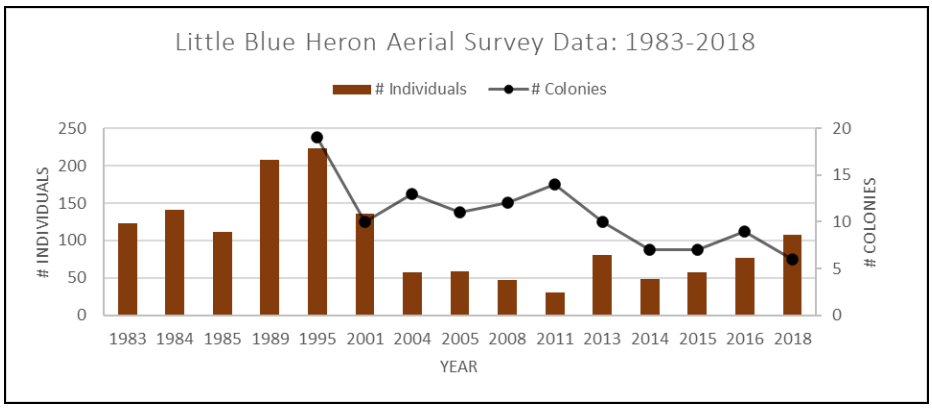
- There were 505 individual black-crowned night-herons observed in 15 colonies. Due to changes in methodology, please note that colony data is not available prior to 1995.



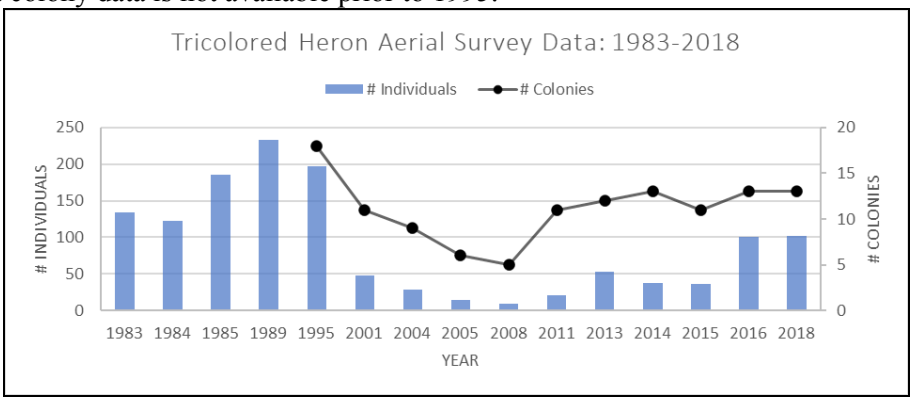
- There were 71 individual yellow-crowned night-herons observed in 8 colonies. Due to changes in methodology, please note that colony data is not available prior to 1995.



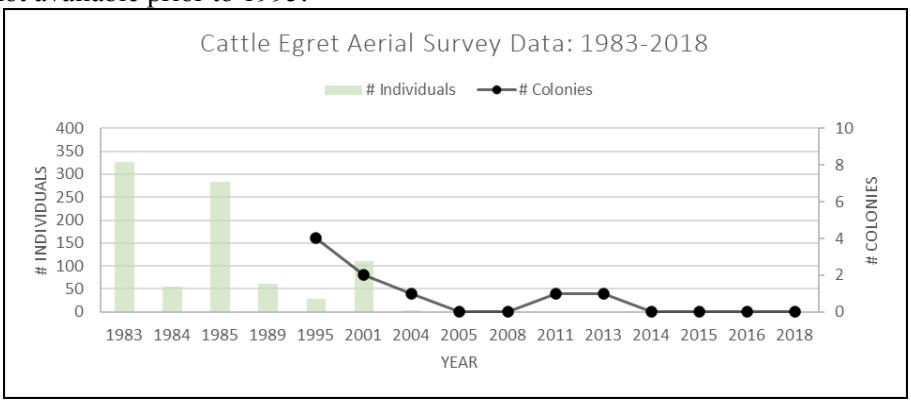
- There were 107 individual little blue herons observed in 6 colonies. Due to changes in methodology, please note that colony data is not available prior to 1995.



- There were 102 individual tricolored herons observed in 13 colonies. Due to changes in methodology, please note that colony data is not available prior to 1995.



- There were zero cattle egrets observed in zero colonies. Due to changes in methodology, please note that colony data is not available prior to 1995.



- The continuation of the active colony of double-crested cormorants (which both compete with wading birds for nesting space and destroy habitat substrate with their caustic droppings) at one of the largest, and longest running, colonies in the state, Gull Island (near Stone Harbor) has continued to be a source of grave concern for state biologists. In 2018, the cormorants expanded their use of the site to 2 sub-colonies, rather than just the one they were previously utilizing. The trees in these sub-colonies are all but condemned to mortality and the cormorants are using nesting habitat formerly occupied by wading birds.

Conclusions:

- The aerial survey of the Atlantic coastal marshes by helicopter continues to be the most efficient way to survey the large area in a short period of time. Downsides include that it represents a snapshot of the season

and can only be considered an inventory count (versus an index or census) and that dark-plumaged bird numbers are likely underestimated since they blend into the surrounding vegetation so well (Kushlan 2011).

- The consecutive counts that took place from 2013-2016 were interrupted in 2017 due to lack of staff. In 2018, only wading bird data was collected (no gulls or terns). Due to constraints of the survey, it continues to be difficult to determine trends and population estimates and few statistically sound conclusions can be drawn. Nonetheless, the survey provides the only comprehensive dataset on the NJ Atlantic coast wading birds and some trends are apparent. For example, great egret numbers appear to be on the rise, while snowy egrets have apparently declined. Cattle egrets have not been detected in significant numbers in many years and it appears they have largely disappeared as a breeding bird in the coastal marshes
- The snapshot technique is useful to show occupancy and distribution, however, which will become increasingly important as sea level rise and subsidence continue to change the coastal landscape. In 1995, there were 43 occupied colonies (defined as one or more pairs nesting) and in 2018 there were 31. There has been a gradual decline in the number of colonies (with some variability) over the last 20 years and it appears from visual examination of the habitat that this is at least partially due to erosion/increase of flooding at and in nesting areas. A long-term trend of eroding and disappearing islands is noticeable, especially in the Barnegat Bay and around Atlantic City. Some islands that are on maps have disappeared entirely; others exist as shrinking versions of themselves. A complete analysis of this trend has not yet been undertaken, but in looking at aerial photos from years past, the change is evident. The snapshot survey also provides critical information used for environmental review, where presence/absence and suitable habitat can surpass individual counts in levels of importance.
- The cormorants at Gull Island are an issue because the caustic defecation causes the nesting trees and shrubs to die, rendering them unusable by all species in a matter of years. The loss of this colony would be devastating to the state's nesting wading bird population, as there is not another site nearby that would likely handle the emigration (unless birds could be persuaded to return to Stone Harbor Bird Sanctuary but they have not yet responded to the measures some organizations are taking to entice them back). To wit, in 2018 there were 1,109 individuals at this colony which equates to 24% of the detected population. In 2018, the DFW worked with USDA-WS (unrelated to this funding source) to control this colony with limited success.
- Determining the best method to survey this species continues to present a challenge. Although aerial surveys are the most efficient method to survey the colonies, as well producing a dataset with the least amount of disturbance/destruction (ground perimeter counts are not as reliable and walk-through counts impossible due to nesting substrate), they are cost prohibitive to repeat within a season. Without repeated measures, no population estimates can be produced.

Recommendations:

- Continue the aerial survey effort until such time that a superior method is devised.
- Continue to investigate alternative survey methods to the aerial survey, including the practicality of using drones. At this point, nebulous regulations for flying aircraft and concerns for the safety of the birds are leading ENSP to proceed cautiously but as protocols are developed, this may become a viable option.
- Examine the variables that may be impacting the future status of wading birds including 1) investigating the role eroded/flooded marshes are having in site selection and function and 2) fine-tuning techniques to control the cormorant colony to ensure it does not permanently alter the nesting habitat and leave it unsuitable.
- Attend regional waterbird meetings to create partnerships with other states to find solutions to declining populations. These meetings are critical to establishing and maintaining cooperative efforts and to the continued exchange of information.
- Continue to incorporate breeding data into the Landscape Project and NJ DEP's Biotics database.

Kushlan J. A. 2011. Heron count protocols: inventory, census, and monitoring of herons. Heron Conservation. www.HeronConservation.org Accessed 2 October 2018..

Migratory Shorebirds & Red Knot Management

Prepared by: Amanda Dey, Principal Zoologist

OBJECTIVES: 1) Monitor recovery of red knot and other shorebirds (ruddy turnstone, sanderling) on the Delaware Bay migration stopover: monitor mass gain and year-to-year trend; estimate stopover population size by two methods: baywide aerial and ground survey, and mark-and-resighting methods; 2) monitor horseshoe crab egg densities (an index of shorebird foraging conditions); 3) protect critical habitats to improve foraging conditions for migratory shorebirds.

Key Findings:

Mass Gain and Peak Abundance from Aerial Survey: The proportion of red knots reaching 180 grams at normal departure time (May 26-28) is a useful index of year-to-year feeding conditions because it is statistically linked to surface egg densities. In 2018 the proportion of red knots reaching ≥180 grams was 0.45, above the 0.20 observed in the poor feeding conditions of 2017, but still below prior years of 2015 and 2016 (Figure 1). In 2018, egg resources built steadily through the season (Figure 2), a greater number of red knots remained in the bay (Table 1), leading to improvement in the proportion that achieved ≥180 grams by normal departure time (Figure 1).

Stopover Population Size from Aerial Surveys: Peak abundance counts, taken from aerial and ground surveys, and are single-day counts that do not account for turnover during the May stopover. The average peak abundance of the last six years was 21,832 (SD=4,890; Table 1), which is 23% of historic peak of 94,460 in 1989. In 2018, more birds remained in the bay to take advantage of available eggs; the peak count was 32,930 -- the highest recorded in 16 years.

Figure 1. Proportion of red knots in the >180g body-mass category in Delaware Bay near the usual departure time (26-28 May), 1997–2018. Sources: DE Division of Fish & Wildlife and NJ Division of Fish & Wildlife.

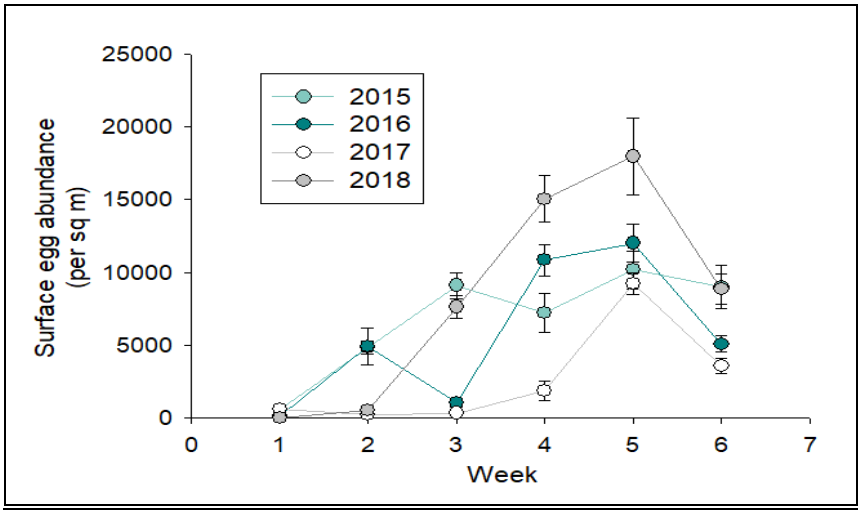


Figure 2. Weekly surface egg abundance (eggs/m^2) in top 5 cm of sand, 2015-2018. Sources: NJ Division of Fish & Wildlife.

Note:
Week 1: May 1- 7
Week 2: May 8 – 14
Week 3: May 15 – 21
Week 4: May 22 – 28
Week 5: May 29- Jun 4
Week 6: Jun 5 - 11

Population Estimate from Resightings of Marked Birds: In 2009, the USFWS/USGS led a Structured Decision Making process resulting in an Adaptive Resource Management (ARM) Model used to predict maximum horseshoe crab harvest that should not cause further red knot decline. The ARM model uses population estimates of female horseshoe crabs and red knots. The estimate of red knots is derived from resightings of individually-marked birds, and accounts for turnover (or total throughput) of red knots during the stopover period (Lyons et al. 2016). Since 2011, the mark-resighting stopover population estimate has remained relatively stable except for 2015 (Table 1) and averaged 47,905 individuals.

Table 1. Stopover (passage) population estimate using mark-resight methods compared to peak-count index using aerial- or ground-survey methods. The mark-resight estimate of stopover (passage) population accounts for population turnover during migration; peak-count index, a single count on a single day, does not account for turnover; (Lyons 2018).

Year	Stopover population[a] (mark-resight)	95% CI Stopover population	Peak-count index (aerial [A] or ground [G])	
2011	43,570	40,880–46,570	12,804	A[b]
2012	44,100	41,860–46,790	25,458	G[c]
2013	48,955	39,119–63,130	25,596	A[d]
2014	44,010	41,900–46,310	24,980	A[c]
2015	60,727	55,568–68,732	24,890	A[c]
2016	47,254	44,873–50,574	21,128	A[b]
2017	49,405	46,368–53,109	17,930	A[f]
2018	45,221	42,568–49,508	32,930	A[b]

a Estimate for entire season including pop turnover
b 23-May
c 24-May
d 28-May
e Data managed to reduce bias from field recording errors
f 26-May

Shorebird food availability: Horseshoe crab egg densities on NJ beaches were much improved in 2018 compared to 2017. Egg densities in 2018 (mean 8,998 eggs/m^2) built through the season providing available food throughout the stopover period (Figure 3).

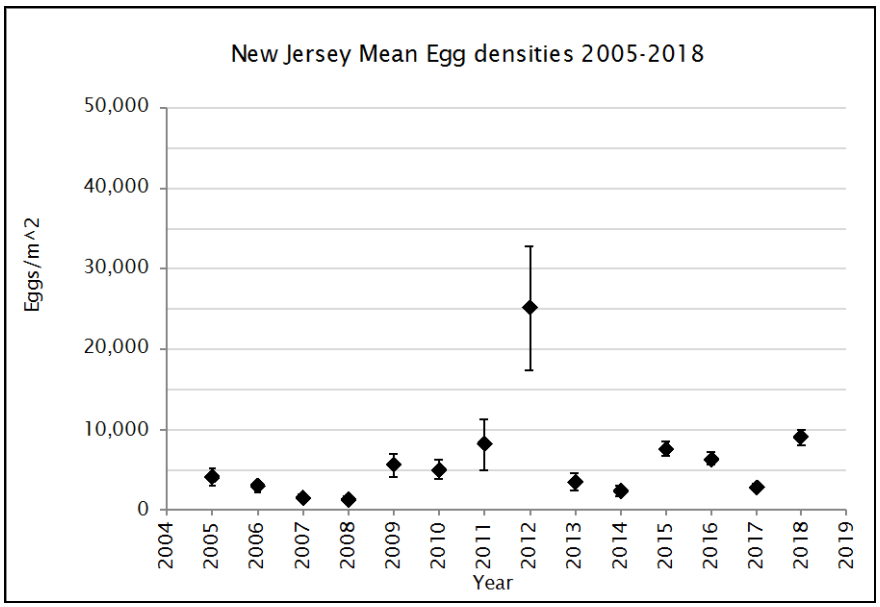


Figure 3. Mean density of horseshoe crab eggs in the top 5 cm of sand, May through early June 2005-2018 on bay beaches of New Jersey. Error bars are 90% CI. High mean abundance in 2012 was due to high egg densities on one site (Moore's Beach).

Source: New Jersey Division of Fish Wildlife, American Littoral Society.

Habitat Management: To improve shorebird access to limited egg resources, New Jersey restricts pedestrian beach access on 13 sites on Delaware Bay during May. ENSP and staff from Conserve Wildlife Foundation of NJ (CWF) recruited and train volunteer shorebird stewards to staff beaches. Reduction of human disturbance allows shorebirds to forage, dawn to dusk, on limited egg resources over a wide geographic area, which reduces interspecific and gull competition and risk from aerial predators.

Discussion and Conclusions:

The year-to-year differences in foraging conditions (i.e., surface eggs) is generally reflected in the peak count of red knots, generally correlated with within-season population estimates by J. Lyons (2011 - 2018). The disparity in peak counts in 2017 and 2018 reinforced this perception.

It should be noted that storms, wind-driven waves and fluctuations in water temperatures are normal in Delaware Bay and can reduce, or temporarily interrupt, crab spawning. Coupled with a diminished crab population, however, normal perturbations can result in perilously-low food resources for migrating shorebirds. Despite 21 years of harvest management, aimed primarily at restoring female horseshoe crabs, surface egg densities remain an order of magnitude below historic estimates for New Jersey beaches (100,000 eggs/m^2; Botton et al. 1994). We estimate 50,000 eggs/m^2 on 50 percent of suitable spawning beaches is necessary to begin red knot recovery (Niles et al. 2009).

The implications of low food resources are reduced adult survival (Baker et al. 2004) and Arctic productivity (Duijns et al. 2017) for lower-weight birds. Red knots remaining in the Bay into early June may have achieved 180 grams and ultimately completed Arctic migration; however, there may be a cost for late-arrival in the Arctic (reduced opportunity for high quality territories, mates, timely nesting, adequate food resources for young, etc.).

Red knots that leave Delaware Bay at ≥180 g have a higher survival (Baker et al. 2004) and are more likely to be detected on southward migration (Duijns et al. 2017) than birds departing at lower weights. In the last four years, we have seen a wide swing, and no significant upward trend, in the proportion of birds reaching ≥180

grams. Moreover, there is no trend in egg densities, female horseshoe crab abundance, spawning crab densities (Zimmerman et al. 2017), red knot peak counts or mark-resight population estimates, all of which indicate conditions on Delaware Bay have not improved for shorebirds. Counts on the main red knot wintering area in Tierra del Fuego (by others), conducted in January 2018, were among the lowest observed in the time series (9,840 individuals; range: 53,232 in 1986 to 9,840 in 2018), also indicating no improvement in red knot numbers and no increasing trend over time.

Habitat management accomplished by seasonally-restricted access enforced by volunteer Shorebird Stewards, and beach restoration, have been the major methods to maintain red knot stability by improving shorebird access to egg resources. The Shorebird Steward Program continues to enjoy wide support from bayshore communities, visitors and conservation partners. However, without increases in crabs and egg resources, this program alone cannot stave off further declines of red knots and other shorebirds.

Recovery of red knots and the migration stopover will rely on restoring horseshoe crab populations in Delaware Bay, and elsewhere, to maximize weight gain of Arctic-breeding shorebirds just prior to breeding. Improving conditions on Delaware Bay can help counter other negatives that birds experience elsewhere in the Western Atlantic Flyway.

The management objective, of the Atlantic States Marine Fisheries Commission (ASFMC), is to maximize bait harvest of horseshoe crab constrained by red knots, it is not the rapid restoration of horseshoe crabs to begin red knot recovery, (ASMFC 2016). Twenty-one years of harvest reductions, primarily aimed at increasing mature females, have shown no sign of improving female crab abundance (2001 – 2018) according to the Virginia Tech Atlantic Coast Benthic trawl survey designed to monitor horseshoe crabs (Hata and Hallerman 2018).

Bait harvest management included major harvest reductions in 2004, where harvests were nearly halved (Addendum III); female harvest was prohibited in 2006 (NJ and DE, Addendum IV) and in 2013 (MD and VA, Addendum VII). While the ARM Model, implemented in 2013, was a positive development, the lack of increase in female crabs since 2004 strongly suggests that bait harvest management alone is not working to increase females. Mortality from other sources must be considered in management, including biomedical bleeding, fisheries bycatch, unquantified take of Delaware Bay Origin crabs from federal waters, and illegal harvest including take-and-use at sea. The former two are known and estimable, the latter two are more difficult to quantify.

Since 2015, intertidal structural oyster aquaculture has expanded on Delaware Bay and on inland bays of New Jersey's Atlantic Coast. The planned expansion of aquaculture poses a new threat by covering intertidal foraging habitat with rebar growing structures and bottom cages, daily disturbance from tending activity (on foot, with ATVs and power-washers), potential obstruction/impedance of crab passage to spawning beaches, and impact to benthic invertebrate prey of horseshoe crabs from intertidal driving. ENSP's technical guidance on this issue was carried out under NJ T-11-T and is reported there.

Recommendations:

- Continue monitoring of shorebird weights and abundance and egg densities on Delaware Bay stopover including individual marking of birds, and resightings surveys, to produce population and survival estimates.
- Shift the goal of horseshoe crab management to a rapid recovery of red knots in 10 years; this could be achieved by suspending coastwide bait harvest and reduced biomedical mortality via better practices. Maintain monitoring of horseshoe crab surface eggs as an index of foraging conditions.
- Improve understanding of the biomedical industry's use of Delaware Bay Origin (DBO) crabs by documentation of origin (lat/long) of collected crabs, and institution of chain-of-custody for the sale of crabs or crab blood. Develop estimates of bycatch mortality and include biomedical and bycatch mortality in bait harvest management under ARM Model.

- Continue management of beach habitats to reduce human disturbance in important shorebird foraging areas. Increased disturbance management on important foraging beaches in Delaware would help provide improved foraging and increase the number of birds reaching adequate departure weight.
- Identify habitat restoration opportunities to improve habitat for spawning horseshoe crabs and foraging shorebirds.
- Fund studies on impacts of oyster aquaculture structures on red knot habitat to focus and manage this activity in a manner that to reduces impacts.
- Encourage full and stable funding for the Virginia Tech Atlantic Coast Benthic Trawl.

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Secretive and Coastal Marsh Birds

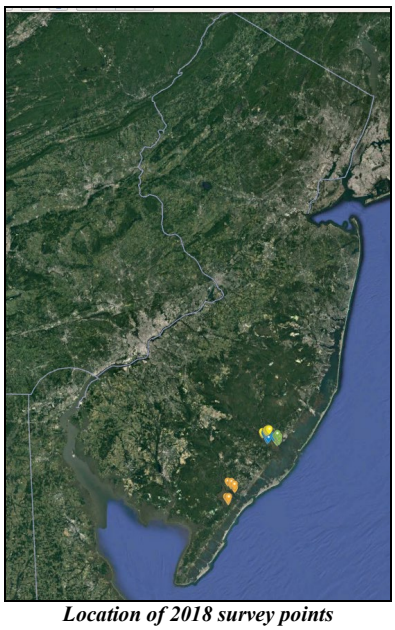
Prepared by: Christina Davis, Environmental Specialist II

Job Objectives: 1) To determine the efficacy of the acoustic monitoring of secretive marsh birds in New Jersey, and 2) to determine the relative abundance and distribution of New Jersey's marsh birds, particularly those that are state-listed and of regional and continental concern (black rail, Virginia rail, king rail, sora, common moorhen, least bittern and American bittern).

Key Findings:

- A focused black rail survey was initiated in 2015 and continued 2018 as concerns over the security of the black rail population along the eastern seaboard, and particularly the mid-Atlantic, heighten.
- ENSP biologists were able to fine tune their suitable habitat map (used to select survey points) by replacing the Land Use Land Cover (LULC) GIS layer with a recently published Marsh Zone Map (publicly available from the Saltmarsh Habitat & Avian Research Program website). This allowed a greater ability to select points in high marsh, where black rail are most likely to be detected.

- Points were selected from a "universe of points" file created in 2015. Each is located at least 400m from one another and coded as either "water" or "road". Points were also segregated into their Watershed Management Areas (Mullica, Great Egg Harbor, Cape May and Maurice-Salem- Cohansey). For example, point GEH-W-208 was point #208 in the Great Egg Harbor Watershed Management Area and was accessible by water. In 2018, only "water" based points were selected.
- Survey protocol was compatible with that being used elsewhere along the east coast. Surveys were a call-playback consisting of a combination of passive listening and recordings (of black and Virginia rails). The survey window in 2018 was April 29 – June 30 and three surveys (at least 7-10 days apart) were taken at each point. The survey period was ten minutes (plus a two-minute settling in period prior) and calls were recorded in the minute they occurred. Surveys took place between 10pm and 3am. Surveys took place in low wind conditions with little/no precipitation and on a rising or high tide (to allow boat access in shallow waterbodies). Black rail data was given the priority, but rail calls of all species were recorded by observers. Site and weather data were recorded for each point as well.
- ENSP staff carried out the surveys with the assistance of six contracted freelance biologists at 40 water-based points. Survey points consisted of a combination of those that had "hits" in 2015 or 2016 and/or warranted another survey (no boat-based surveys were conducted in 2017 due to lack of staff) and/or represented new locations in suitable habitat. This resulted in 23 previously surveyed points and 17 new ones. Alarmingly, there were zero black rail detections at any of the points, even on those that previously had detections.
- Thirty of the survey points were surveyed three times, which was the goal. Ten of the points were only surveyed two times. There were extended periods of poor weather that made surveying impossible on many nights and there was also a mechanical failure with the boat that delayed a few surveys. The first survey period had extremely cold temperatures in the first half of the week and mechanical failure in second half of week. The second survey period was entirely rained out. The fourth survey period was fully completed. The fourth and fifth survey periods had some nights lost to rain.



Location of 2018 survey points

- Although no black rails were detected, many other species were heard. This list includes seven species of ducks/geese/swan, three species of nighthawk/nightjar, eight species of shorebirds, three species of gulls, two species of wading birds, three species of owl/raptor, and 11 species of passerine. Further, 13 points had clapper rail, one had king rail, one had least bittern, 10 had Virginia rail and four had saltmarsh sparrow (a species that rivals black rail for risk of extinction). Marsh wren was the species that was detected on the highest number of survey points (37) followed by seaside sparrow at 33 points.
- No acoustic recording units (ARUs) were deployed in 2018, due to lack of staff resources to place and maintain the units in the difficult-to-access areas.

Conclusions:

- It is now understood that night is the best time to survey this species in New Jersey (black rails in the southeastern US appear to call diurnally as well), but this poses many logistical challenges. Important components for successful boat-based surveys were an understanding of the waterways (accomplished through daylight recon trips), appropriate lighting system and spotlight on the boat, reliable GPS or electronic mapping system (such as Google Earth on smartphone) to follow in real time, and ability to track weather through radar during the survey. Our challenges included having only one boat operator and being limited to nights with good weather *and* the necessary high tides. In 2015 and 2016, weather-related challenges were present but not to the degree that they plagued the survey in 2018.
- The lack of black rail detections is extremely alarming. In 2015 and 2016, our surveys detected black rails even though numbers were obviously extremely low. Many of the contractors were the same as in 2015 and 2016, and new observers were considered expert-level birders, so the issue was not with observer skill. In addition, there were only two non-survey black rail detections (reported in eBird, birding networks, etc.) of which only one was confirmed. A weather-related hypothesis could help explain it: in 2015 and 2016, the earlier boat-based survey periods netted the most detections. In 2018, the first two survey periods were either very cold or rainy, and those conditions early in the season may have negatively impacted the results (other survey periods had better weather and still no black rails). There is also some (unpublished) data across the range to suggest that rails do not call as much once they have a mate, so an optimistic reading of zero detections is that there were black rails present but not calling. A final hypothesis is that there were so few birds in the state this year that they were not detected in locations they previously occupied or in highly suitable habitat. The relatively small number of points surveyed limits our ability to draw conclusions, though the lack of detections at recently occupied locations/in highly suitable habitat is discouraging.
- The promise of acoustic recording units has yet to be fulfilled for this project. Although they represent a substantial benefit in being able to collect data on a scale that far exceeds that of traditional call-playback, the enormous time expenditure needed to analyze the data is a difficult hurdle.

Recommendations:

- Since boat-based surveys are crucial to assess and survey this species' habitat, consider hiring additional boat operators so that evenings with good conditions (clear and still, high tide) could be maximized by fielding multiple crews. Without more crews, the number of points that can be surveyed in one season using this methodology is limited.
- Deploy acoustic units again and place earlier in the season (have them all out by May 15) to ensure early callers are recorded. Conceive and employ an anti-theft deterrent system.
- Continue to focus survey efforts in the southern regions of the state and prioritize boat-based surveys. Use road-based surveys to complement boat-based and to cover as much habitat as possible. Consider other means of surveying (continuous transects playing calls while motoring in electric boat) to increase survey area.
- Complete the acoustic unit recording analysis from 2015 to determine if any black rails were captured on those recordings.
- Continue engagement with the Black Rail Working Group to help determine what management actions can be taken to help recover this species and contribute to the status assessment that is currently being undertaken by the USFWS.
- Compare the non-target species data (diversity and abundance) from 2015-16 to 2018 to determine if there were changes that might be explained by cold and wet weather (i.e., were there fewer birds calling overall in 2018 versus 2015-16).
- Continue to incorporate breeding data into the Landscape Project and NJ DEP's Biotics database.

Job Number and Title: A.2. RAPTORS

Bald Eagle

Prepared by: Kathleen Clark, Supervising Zoologist

Job Objective: To conserve and manage a self-sustaining bald eagle population in New Jersey; to determine the threat of environmental contaminants to survival of bald eagles along the lower Delaware River and upper Delaware Bay; and to monitor and conserve the wintering population of bald eagles in New Jersey.

Key Findings:
Population monitoring:

- ENSP biologists monitored all nesting pairs known and continued the tracking in list format. Eighty eagle project volunteers conducted most of the monitoring in the state and reported on nests on a weekly or bi-weekly basis from January through fledging in July.
    - In 2018, 204 eagle nests were monitored during some or all of the season, of which 185 were active (exhibiting incubation), and 19 were territorial (maintaining a nest area). Forty-two more territories remained on our list but were unknown (pair or nest could not be found, or we lacked observation effort). These figures represent a 20% jump in active nests from 2017, after four consecutive years of the eagle population at about 150 active pairs.
    - One hundred twenty-one of 182 known-outcome nests produced 172 young, for a productivity rate of 0.94 young per known-outcome, active nest (Fig.1). This represents a large drop below the 10-year median productivity rate of about 1.25. Overall nest success rate was 66%, below the long term average of 75%. The reduced success and young fledged is a reflection of poor weather during the late winter and early spring, around the time of hatching and early brooding in particular.
    - Thirty new eagle nests were discovered this season, and many nests remained tracked from last year, resulting in a higher number of total documented nests. Still, some previously known nests were in the "unknown" category because they could not be relocated or otherwise observed.
    - We documented 61 (33%) nest failures, well above the average in NJ of approximately 20%.
- ENSP biologists went to fewer nests than usual to band young and take blood samples. In 2018 we banded eight eaglets at five nests. We banded two additional eagles: one hatching-year eagle recovered with a fractured leg, suspected to have fledged nearby; and one four year old eagle recovered in Salem County and treated for poisoning. The latter eagle was also tagged with a satellite transmitter and his movements and habitat use are being recorded across southern NJ. We took blood from all of the banded nestlings and stored it for future analyses. A portion of some samples will be used for DNA analysis by a cooperating researcher who will be analyzing the genetic heritage of eagles across the country.
- Relationships with landowners, whether private citizens, conservation organization, or public agencies, all required attention and directed management to ensure protection from disturbance or significant habitat alterations. Most nests (68%) were located on private, non-conserved land, with the balance on state, federal, and conservation-organization lands.
- The ENSP did not participate in the standard, national, Midwinter Eagle Survey since 2013 due to the limitations of the survey transects and lack of funding for survey coordinators. Instead, we directed our Eagle Project volunteers to record eagles in likely communal roosting areas. Documented roost areas will be entered into the DEP's Biotics database. Twelve roosts were selected for surveys on a quarterly basis to document use by eagles in different seasons.

Nest site protection:

- Nest areas were posted against trespassing in all cases where a nest is highly visible and where law enforcement officers specifically recommended.
- Staff provided technical assistance to owners and clients of cell towers, and distributed guidelines for managers of man-made structures (especially cell and transmission towers), who must deal with osprey and eagle nests on those structures. Staff worked regularly with NJ power companies to identify high-risk power

infrastructure for mitigation; power supply and distribution lines pose dangers of electrocution and collision, which can be addressed when the particular risk is high.

- ENSP staff worked with Bureau of Law Enforcement to address specific problems at nest sites; most problems arose from people approaching nests that are highly visible. Law Enforcement officers were included in the pre-season eagle project orientation meeting held February 3, 2018, attended by approximately 50 project volunteers.
- Staff worked regularly with USFWS-NJFO and Region 5 offices to address issues related to USFWS Bald Eagle Management Guidelines and BGEPA permits in NJ.

Habitat protection and planning:

- New nests were GPS'd in the non-nesting season and added to the database. Revised Landscape Project mapping that included new nests was provided to DEP offices for use in environmental review.
- Site-specific habitat management plans were provided to the NJDEP permit reviewers for a few sites due to pending development applications. ENSP also worked with the USFWS regional office to condition permits granted under BGEPA.
- Bald eagle was one of the species considered in the status assessment of birds conducted by ENSP during 2017-2018. That assessment resulted in a recommendation for upgrading from endangered to threatened (breeding season) and from threatened to special concern for non-breeding season. The legal status will not change until the DEP writes new regulations. However, it is still an ENSP goal to prepare a status assessment as part of a Bald Eagle Recovery and Management Plan.

Conclusions:

- The population of "active" eagle nests – those with eggs –had been stable the last four years at about 150 pairs, but rose in 2018 to 185 pairs. On average, the population is still increasing but the rate of growth has slowed, likely due to increasing density leading to competition among eagles. Eagles continue to establish new nests in areas with high eagle density (such as the Delaware Bay region) where competition might be greatest. In other areas of the state, eagles are slowly pioneering into areas of high human density where they may be subject to disturbances, although there is a general tendency for eagles that settle in busy areas to tolerate higher levels of human activity.
- New Jersey maintains a "list" approach to monitoring the population, largely thanks to the highly skilled volunteer force; however, it is difficult to maintain all nests "on the radar" when some pairs move to remote locations. ENSP and partner Conserve Wildlife Foundation of NJ have been successful in determining the location and outcome of approximately 85% of eagle pairs, which has been important for maintaining our database and meeting the eagle protection requirements under NJ regulations. We would need one additional staff to expand the volunteer program and help survey and document new nests. Eagles change nest trees between 5% and 10% each year, and keeping track of those changes is important to using the list method.
- Maintaining the eagle recovery depends on cooperation from private landowners, where most of the nests are located. Nest site protection is accomplished with a combination of local landowners and nest observers, Division law enforcement, and land use regulatory protection, all essential ingredients in the current recovery and necessary to sustain it. With federal delisting and strengthening of the federal Bald and Golden Eagle Act, we continue to have regular coordination with the USFWS in select cases to minimize disturbance and habitat loss to development and other activities.
- Disturbance is a major management issue at about 8% of NJ nests, especially those most visible and near roads. Posting and regular surveillance by staff and nest observers have been essential to ensuring or maintaining nest success.

Recommendations:

- Maintain efforts to monitor population size, nest activity, and productivity through weekly or bi-weekly observations of nests by volunteers. Continue to improve online reporting by all observers using the web application NestStory, which stores observer data as well as volunteer time and mileage. Continue coordination with the U. S. Fish and Wildlife Service in accordance with the post-delisting monitoring recommendations, via conference calls and regional/subregional meetings.
- Expand efforts to identify and document communal roosts. In 2018 we established a standardized survey method to survey roosts on a quarterly basis, to obtain documentation to support roost delineations in the NJ

Biotics database. We need to continue to map those areas that may be significant to maintaining the local and regional populations of bald eagles, and prioritize them for protection through management and acquisition.

- Seek partnerships to continue eagle telemetry that helps identify suitable habitats in migration and wintering areas to support long term planning for eagle population recovery.
- Continue to monitor population health indicators by visiting a representative sample of nests to band nestlings with USFWS bands and state color bands, take measurements and blood samples. Seek assistance with contaminant analysis from researchers interested in any and all aspects of contamination issues.
- Continue to work with law enforcement, private landowners, nest observers, conservation organizations, and local governments to ensure protection of nesting and foraging sites.
- Work with the NJ Field Office of the USFWS to maintain essential nesting habitat free from disturbance, in accordance with state law and the federal Bald and Golden Eagle Act. Develop proactive planning to identify and conserve suitable bald eagle habitat in anticipation of a fully recovered eagle population.

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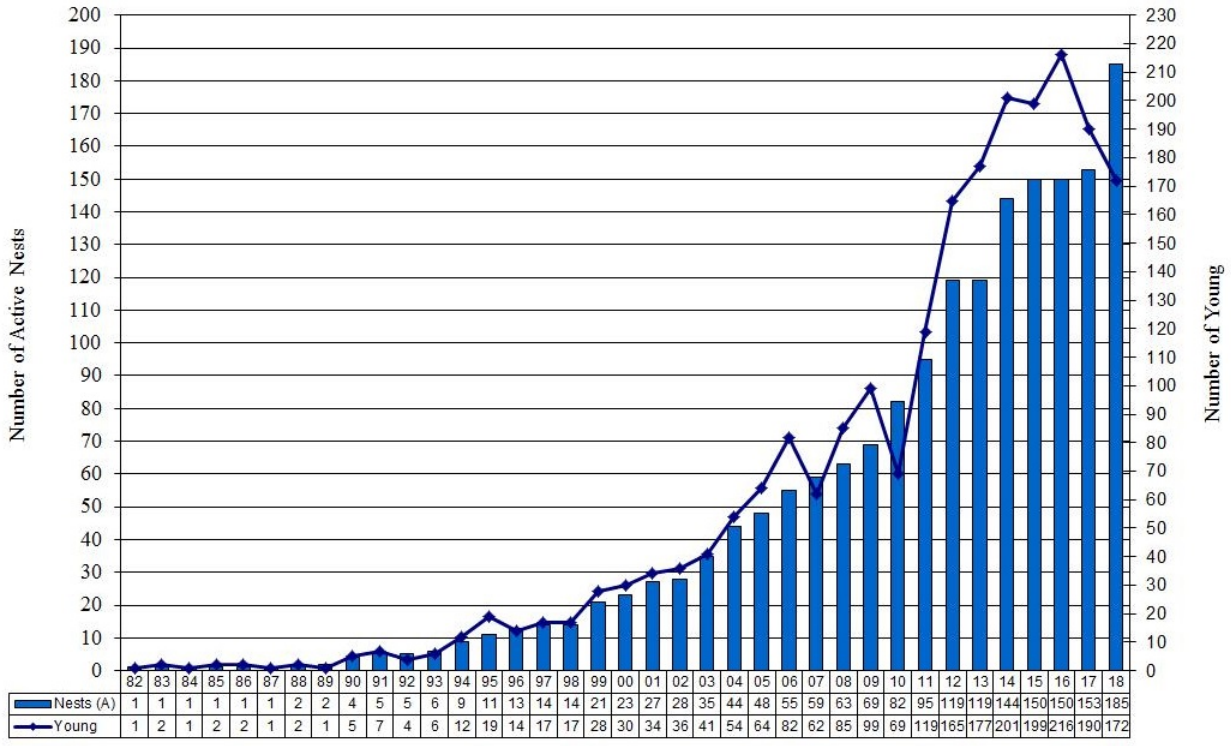

Figure 1. Bald eagle nesting population and young produced in New Jersey, 1982-2018.

Peregrine Falcon

Prepared by: Kathleen Clark, Supervising Zoologist

Objective: To conserve and manage the New Jersey Peregrine Falcon (*Falco peregrinus anatum*) population at a self-sustaining level.

Key Findings:

- The 2018 New Jersey peregrine falcon population increased slightly to 40 known pairs with 37 active (known to lay eggs). Twenty-eight pairs were successful in producing 75 young, for a productivity rate of 2.32 young per active nest and a success rate of 76% (Table 1). However, when we accounted for known young lost around fledging, the productivity rate dropped to 2.03 young per active nest. A brief summary of data collected during the 2018 nesting season follows.
  - Twenty pairs (up from 17 last year) nested on towers and buildings and continued to be the core of the nesting population, producing 45 young, for a productivity rate of 2.25 young per active nest (2.05 fledged young/nest). We used bird-lice spray at some nests pre-season, and treated <2-week old hatchlings at several sites to reduce infestations of parasitic flies (*Carnus hemapterus*). These flies were especially abundant in the Marmora nest where two hatchlings had stunted growth and retarded feather development at 7-21 days of age; we suspect two other young hatched and died prior to our nest visit at approx. 7 days. Flies were not particularly bad at other sites, although they were found in all but two coastal nests.
  - Nine pairs, six of which were known active, occupied territories in natural cliff habitat in northeastern NJ. Four nests were successful in producing 12 young for a productivity rate of 2.00 young per active nest. This represents one of the most successful years for cliff-nesting falcons.
  - Eleven pairs of falcons were known to nest on bridges this year. Seven of those bridges lie completely within the boundaries of NJ, while four span the Delaware River between NJ and PA and were monitored by NJ. All bridge pairs produced 26 young, but only 16 were confirmed fledged, for a productivity rate of 2.36 (1.45 fledged) young per active nest. Bridges can be difficult to monitor and confirm nest results, as the nest sites are often located out of sight or on inaccessible sections of the bridge. Two recently occupied bridges are low to the water (~20-25 ft) and fledging was probably unsuccessful. At one bridge on webcam (T-P) one young fledged very early and was not resighted on camera, and another was observed with symptoms of lead poisoning and died within ~1 day. Some previously occupied bridges were not tracked due to lack of volunteers; other bridges may have been occupied, but the project lacked monitors in urban locations to document all possible sites.
- In 2017 we documented a nestling death in Elizabeth that resulted from lead-poisoned prey. In 2018, the Tacony-Palmyra Bridge nest, also on webcam, had a similar death of a near-fledgling that exhibited signs of lead poisoning and died within about 24 hr. The carcass could not be retrieved for testing because the other young were close to fledging, but it highlighted the threat of lead-contaminated prey in urban nest situations. At the last four nests where we banded chicks, we also collected 0.3 ml blood from 12 chicks that we tested for Pb. The results ranged from <0.01 to 0.088 ppm. The lowest levels were at coastal salt marsh nests, and the highest at an urban nest site. This deserves further investigation to understand the risk and possible sources of Pb for urban peregrines.
- We banded 59 of the 82 documented young produced (not necessarily fledged), using both a federal band and an auxiliary, bicolor band with an alpha-numeric code following USGS Bird Banding Lab protocol.
- Twenty addled eggs were collected from 11 nest sites this season, and were held in the freezer at NJDFW-Tuckahoe. Addled eggs may be held for contaminant analysis to Dr. Da Chen at Southern Illinois University, who has analyzed eggs from previous years.
- We continued to use remote, motion-activated cameras to photograph peregrines at nests. Using this method we read the leg bands on 19 breeding adults at 10 nest sites. An additional 11 adults were identified using optics. A minimum of 11 adults (27%) were unbanded. The oldest female identified was a 15-year old who nested successfully at Manahawkin; last year's oldest female (19) was not at her Atlantic City nest site in 2018, evidently replaced by a new and unbanded female. The median age of males and females was 7.0 and 6.0, respectively. The information that these identifications provide is valuable for relating peregrine origin and age to nest success, site fidelity and turnover rate in the population.

- In addition to the birds we recorded at NJ nest sites, we received reports of peregrines sighted here and elsewhere:

    - A/15 Dividing Creek 2009 female continued to nest on a marsh in VA, where she's been since 2013.
    - 90/AN Marmora WMA 2015 female nested unsuccessfully at Drag Island after an initial attempt in 2017 on an OC osprey platform, also unsuccessful.
    - BD/25 Logan 2016 female was seen on the PA DEC Rachel Carson building in January 2018.
    - BD/48 Logan 2017 female was resighted in Bronx, NY in November 2017 and in January 2018.
    - BD/62 Jersey City 2017 female was resighted DeKorte Park Sept 2017, and Newark Airport July 2018.
    - BD/70 Tacony-Palmyra female 2018 was killed by vehicle strike in Queens, NY, Nov 2018.
    - BD/74 and BD/76, Jersey City 2018 females, were resighted on buildings near Jersey City in July 2018.
    - BD/85 Burlington-Bristol 2018 female was sighted at Palisades State Line lookout, Oct 2018.
    - BD/87 Tuckahoe 2018 female was sighted at Deveaux beach, SC, in Nov 2018.
    - BD/89 and BD/91, Seaview 2018 females, were sighted at Forsythe and Brigantine, respectively, in July and Sept 2018.
    - BD/95 AC Water Tower/Rt. 72 2018 female was photographed at Jones Beach, NY, Nov 2018.
    - BD/96 AC Water Tower 2018 female was photographed at G. Bay Blvd, Aug 2018.
    - 48/Y Ocean Gate 2007 male has been nesting at the Walt Whitman Bridge since 2015 (or earlier).
    - X/97 Swan Bay 2009 male continued to nest at Manahawkin since 2012.
    - 76/W Dividing Creek male continued to nest at Stone Harbor, since 2012.
    - 08/AM Stone Harbor 2011 male nested at Marmora WMA in 2017 and 2018, after nesting in Wildwood Crest in 2014.
    - 10/AM Forsythe 2011 male has been nesting at Atlantic City since 2014.
    - 15/AM Atlantic City 2012 male has been resighted multiple times at Stone Harbor; no nest site was known until 2018, when he was recorded at Dividing Creek with another male and one female.
    - 38/AM Ocean Gate 2013 male was recorded at Dividing Creek nest with a female and male
    - 46/AM Tuckahoe 2013 male nested unsuccessfully with 42/AX (a NY-origin female) in 2018 in AC.
    - 72/AM Paulsboro 2015 male nested in downtown Phila, PA in 2018.
    - 78/AM Swan Bay 2015 male nested at Tuckahoe in 2018.
    - 99/AM Ocean Gate 2016 male nested at Sedge in 2018.
    - BE/19 Sea Isle 2017 male was found injured in AC, and died, in March 2018.
    - BE/39 Union Co. court house 2018 male was photographed at Liberty S.P. in Oct 2018.
    - BE/45 Stone Harbor 2018 male was photographed in Stone Harbor, Aug 2018.
    - BE/46 Stone Harbor 2018 male was sighted in Stone Harbor, Oct 2018.
    - BE/47 Burl-Bristol 2018 male was found dead in Port Mahon, DE, possibly predated.
    - BE/50 Brig-Seaview 2018 male was photographed at Forsythe in Sept 2018.

Conclusions:

- The peregrine population increased in 2018, with better nest success than 2017. Nest success improved notably at natural/cliff nest sites, despite early spring bad weather. Across all sites – towers, buildings, bridges and cliffs – nest success was 76% and 2.32 (2.05 fledged) young per active site, figures that are above and an improvement over 2017. The tower and building nest sites are the consistent core of the population in NJ, without which the population would fluctuate widely year to year. Management of nest sites, mainly to provide safe, undisturbed nesting environments for the birds, continues to be the predominant factor in a stable and productive population.
- Nest success at cliff and quarry sites improved, with four of six active nests successful in producing 12 young. We do not have data on post-fledging resightings to assess fledging success at most of these sites. Observations continued to be difficult in the more remote locations and where nest sites cannot be viewed after leaf-out. The highly variable nest success observed at the cliff territories is a problem if we consider occupancy of historic habitat important to a fully recovered population. Targeted investigations and site improvements are necessary to improved management.

- Management of nesting pairs and nest sites is essential to maintain peregrines in New Jersey. Bridge-nesting birds are especially vulnerable to nest-site problems that come with bridge maintenance and painting; man-made structures without a regular maintenance presence tend to remain unknown in terms of occupancy and outcome. Nest sites that are properly managed tend to have consistent success and contribute to population viability and stability. Managers of buildings, in particular, are key partners in improving some nest sites and expanding the potential peregrine population.

Recommendations:

- Continue to monitor the peregrine falcon nesting population to maintain the database of nest site occupancy and nest success.
- Investigate cliff-nesting sites to determine causes of nest losses and improve nest sites where possible. Deployment of cameras would be the best means of getting a better level of monitoring.
- Continue the identification of adult nesters to track breeding population turnover, age structure, and origin of successful nesters. The relation of age structure to nest success and contaminant levels will inform conservation decisions regarding species status and recovery planning. In addition, knowing the identity and source of breeding adults helps staff make decisions on the management of peregrine nesting in relation to other rare species conservation.
- Continue the investigation of contaminants in unhatched, salvaged eggs, as well as the close monitoring of nesting pairs to detect problems. Our partnership with Dr. Da Chen at Southern Illinois University to characterize the threat of organochlorine pesticides and brominated fire-retardant chemicals (polybrominated diphenyl ethers) is a cost-effective means of adding to the science concerning peregrine falcons.
- Partner with researcher(s) to investigate the prevalence and toxicity of Pb in nestlings, and possibly in samples of peregrine prey.
- Conduct nest maintenance to reduce or eliminate parasitic flies from nests by cleaning nest substrate during the non-nesting season. Reduce mortality of nestlings by monitoring nestlings in their first two weeks and treating infested young with an anti-lice spray.

Table 1. Site-specific results of peregrine falcon nesting in New Jersey, 2018.

Site Name	Occupied	Active	Young Hatched	Young @ Band Age	Young Fledged	2018 Comments
101 Hudson, Jersey City	Y	Y	1	3	3	3 fostered from Goethals; 1 native fostered @Sedge
Atlantic City – ACUA water tower	Y	Y	4	4	3	1 to TSBR that fledged at BOIS
Atlantic City –Hard Rock-new	Y	N				Nest box provided.
Atlantic City –old Plaza	Y	Y	0	0	0	Balcony nest found during incubation.
Bayside Prison Water Tower	Y	Y	3	3	2	1 fledgling electrocuted around fledging.
Drag Island	Y	Y	0	0	0	Adult male died and eggs were predated.
Egg Island WMA/Dividing Cr	Y	Y	2	2	2	
Elizabeth-Union County C.H.	Y	Y	4	4	4	
Forsythe NWR/Barnegat	Y	Y	3	3	3	
Forsythe NWR/Brig/Seaview Roof	Y	Y	2	4	4	Fostered 2 from Wildwood Crest
Great Bay WMA/Water Twr	N	N	-	-	-	
Hilton/Casino/Atl Club	Y	Y	2	2	2	New adult F. 1 of 2 fledglings died 2 wk >fledging.
Logan Generating Plant	Y	Y	3	3	3	
Ocean City marsh (osp nest)	N	N				
Marmora WMA	Y	Y	?	2	2	Extreme flies on 2 chicks.
Newark Downtown	Y	Y	?	2	2	Local observers saw 2 fledglings.
Ocean Gate	Y	Y	2	2	2	
Paulsboro Refinery	N	N				Pair still off-site at unk location.
Rt 72/Bonnet Island	Y	Y	1	1	2	Fledged 1+1 ACUA foster, plus 2 from Phila.
Sewaren Generating Station	N	N				No sign of nesting adults.
Sedge Island WMA	Y	Y	2	3	3	Fostered-in 1 JC chick.
Stone Harbor	Y	Y	3	3	3	
Swan Bay WMA	Y	Y	4	4	4	
Trenton-Roebling Bldg (box 2015)	N	N				
Tuckahoe WMA	Y	Y	3	3	3	
Wildwood Crest-Grand Condo	Y	Y	2	0	0	Male disappeared. Chicks fostered to Br/Seaview.
SUBTOTAL: TOWERS & BUILDINGS	***20***	***20***	***41+***	***48***	***47***	***Young/Active=2.25, Fledged/Active=2.05***
Delaware Water Gap	N	N				
Natural Site C-1	Y	Y		4	4	
Natural Site C-2	Y	Y		0	0	
Natural Site C-3	Y	Y		3	3	
Natural Site C-4	N	N				
Natural Site C-5	Y	Y		?	3	
Natural Site C-6	Y	Y		0	0	
Natural Site C-7	N	N				
Natural Site C-8	Y	Y		0	0	
Natural Site C-9	Y	N				
Natural Site C-10	Y	Y		2	2	
Natural Site C-11	Y	N				
SUBTOTAL: NATURAL SITES	***9***	***6***		***12***	***12***	***Young/Active=2.00 Fledged/Active=2.00***
Ben Franklin Br. (Del R)	PA					
Betsy Ross Bridge (Del R)	Y	Y	4	4	4	
Brigantine Bridge (A.C.)	U	U				
Burlington-Bristol (Del R)	Y	Y	3	3	3	
Commodore Barry (Del R)	PA					
G. Washington Br (Hudson R)	NY					
Newark Bay Br. (NJTP or Conrail)	U	U				
NJ-PA Turnpike Br. (Del R)	PA					
Ocean City-Longport Bridge	Y	Y	?	2	?	1 died in water at fledging; unknown others.
Pulaski Skyway Bridge	Y	Y	?	?	?	Falcons nesting, observed at distance.
Route 1/Raritan-New Brunswick	Y	Y	?	1	1	
Route 3/Hackensack NJDOT	Y	Y	4	4	4	1 p/u from water, rehabbed TRT, released back.
Route 35 Bridge-Belmar	Y	Y	?	0	0	Failed by mid-May.
Route 46 Br./Little Ferry-Ridgefield	N	N				
Scudders Falls Bridge	PA					
Secaucus-Kearny NJTP Bridge	U	U				
Tacony-Palmyra Br. (Del R)	Y	Y	4	4	3	1 died pre-fledging, lead poisoning 6/6/18
Trenton RR Br	U	U				
Vince Lombardi – NJTP Bridge	U	U				
Walt Whitman Bridge	Y	Y	2	2	2	On NJ tower.
NJTP Bridge/Rahway River	Y	Y	?	4	?	No birds obs around fledging time.
SUBTOTAL: NJ BRIDGES	***11***	***11***		***26***	***17+?***	***Young/Active=2.36 Fledged/Active=1.55***
TOTALS (NJ Only)	**40**	**37**		**86**	**76**	***Young/Active=2.32*, Fledged/Active=2.05**

Osprey

Prepared by: Kathleen Clark, Supervising Zoologist

Job Objective: To conserve and manage the New Jersey osprey population at a self-sustaining level.

Key Findings:

- In 2018, biologists and volunteers surveyed 583 nests and determined outcome at 508 nests (87%) across 12 major colonies on the Atlantic and Delaware Bay coasts and the Delaware River (Table 1). During ground surveys nestlings were banded with USGS leg bands by licensed bird banders.
- Biologists and volunteers conducted ground surveys in June and July to document nest occupancy and productivity at 508 nests (Table 1). We grouped nests by watershed or water-body areas to which they were closest. Nest success averaged 1.83 young per active nest, very close to the ten-year average of 1.80 young per active nest. Weather was mostly favorable with average temperatures and precipitation. Nest productivity varied by geographic area, with the lowest productivity (1.16 young/active) at 38 Raritan Bay nests, and the highest average at 78 Delaware Bay nests. Data were also submitted by citizen scientists who reported on nests using www.osprey-watch.org.
- 387 young were banded with USGS leg bands for future tracking. In addition, we continued to use an alpha-numeric color band on nestlings banded in Barnegat Bay nests (including Sedge Islands). Sixty-six red auxiliary bands were deployed this summer, making a total of 327 red bands deployed since 2014. A re-sighting project was advertised to help determine nest site fidelity, foraging habitat, and to engage the public in osprey conservation.
- Ten volunteer banders checked nests across ten colonies and donated approximately 250 hours in accomplishing this work. Orientation/training covered data filing using an Excel format, and reviewing survey and handling methods.
- All nest locations were maintained in Excel and GIS databases, tracking all occupied nests. Those databases will be used to update the state's Biotics database, which is the basis for the Landscape Project critical habitat mapping. Data from banders were compiled via Excel that most people provided electronically.
- NJ Nest locations are also maintained in the Center for Conservation Biology's "Osprey-Watch.org" website. This website facilitates citizen reports that help us census and maintain data on the population, but we do not know if this website will continue to be supported.
- CWF organized volunteers to install 12 new nest platforms along the Atlantic Coast. CWF also worked to maintain many of the existing platforms throughout New Jersey.

Conclusions:

- This year's ground surveys by volunteers and cooperators documented continued good nesting success rate for ospreys all along the coast for a population estimated at 650 pairs. While productivity varied among watersheds, none had an excessively low rate.
- The coordination of volunteers and licensed banders by CWF-NJ has made it possible to accurately track occupied nests and nest success as a measure of population stability.
- ENSP's partnership with the Conserve Wildlife Foundation of NJ has improved the availability of functional nest platforms for ospreys, which directly supports the stability and growth of the osprey population in the state. The population is approximately 90% reliant on unnatural or man-made structures for nesting, so maintenance of those structures is essential to a stable population.

Recommendations:

- The osprey population is estimated to be about 650 nesting pairs, which is probably the pre-DDT population for NJ. This species benefits from regulatory protections (e.g., MBTA and NJDEP land use regs) that avoid take and disturbance during the nesting season. Maintaining a database of nest locations is necessary to provide these nesting season protections for NJDEP permitting purposes.
- Continue to employ trained volunteers to measure annual productivity of ospreys to monitor regional conditions and trends (e.g., Atlantic vs. Delaware Bay regions, and Atlantic subregional comparisons), as

nest success is one of the most accurate means of monitoring threats and population stability. Recruit and train additional volunteers to conduct nest checks.

- Use the data on population size, distribution, and productivity to assess the conservation status of ospreys in NJ. Use these same data to assess the condition of prey resources, particularly because NJDFW is concurrently involved in marine fisheries management.
- Continue to refine the data-reporting system to improve data handling.
- Collect addled and unhatched eggs to archive for monitoring contaminant levels regionally and statewide.

Table 1. Osprey nesting and productivity in 2018 in all NJ nesting areas. Productivity determined by aerial and ground surveys in May-July. Productivity rates in 2017-2014 provided for comparison.

						Previous Years			
Nesting Area	**# Nests**	**Known-Outcome Nests**	**# Young**	**# Banded**	**Productivity 2018**	**2017**	**2016**	**2015**	**2014**
Delaware River & N. Jersey	2	2	4	n/a		1.62	2.00	2.00	n/a
Hackensack River/s	4	4	10	n/a	2.50	1.33	0.75	1.00	1.20
Raritan Bay & Cheesequake	45	38	44	8	1.16	2.06	1.73	1.93	1.92
Monmouth County	27	19	39	n/a	2.05	1.46	1.82	1.27	2.00
Barnegat Bay	50	38	70	45	1.84	1.34	1.78	1.33	1.48
Sedge Islands WMA	32	28	37	21	1.32	2.04	2.18	1.65	1.05
Great Bay to Atlantic City	88	65	107	13	1.65	1.46	2.05	1.46	1.84
Great Egg Harbor/Ocean City	83	81	161	67	1.99	1.90	2.16	1.83	2.30
Sea Isle City	43	42	61	15	1.45	1.95	1.29	1.87	2.43
Avalon/Stone Harbor Bays	86	80	153	79	1.91	1.85	1.54	1.75	2.12
Wildwood Bays & Cape May	45	35	74	8	2.11	1.81	1.33	1.88	2.46
Maurice River & Estuary Marshes	78	76	170	131	2.24	2.03	1.93	2.15	2.30
Salem Co./ Artificial Island / Delaware	-	-	-	-		-		1.60	2.50
Total of Study Areas	**583**	**508**	**930**	**387**	**1.83**	**1.73**	**1.79**	**1.74**	**2.02**
Atlantic Coast only	499	432	760	256	1.76	1.68	1.77	1.66	1.97
Delaware Bay only	78	76	170	131	2.24	2.03	1.93	2.11	2.32
Del River Basin/N. NJ	6	6	14	n/a	2.33				

Figure 1. An osprey nest is surveyed using a mirror on an extension pole. Photo by Ben Wurst.

American Kestrel

Prepared by: William Pitts, Senior Zoologist

Job Objectives:

Objective 1: To halt and reverse the decline of the American kestrel through a coordinated approach of population and habitat monitoring, threat assessment, habitat protection, management, research and education.

Objective 2: Gather and analyze data to inform conservation status and recovery plan actions of this species.

Key Findings:

- 2018 was yet another great year for the American kestrel nest box project. Of the 13 years, this was the second most productive season ever, with a total of 68 nesting attempts producing 211 fledglings. Over the course of the project, 1,477 fledglings have been banded, and 348 adults have been captured for banding or identification.
- In 2018, ENSP monitored the fewest boxes since 2012. We removed nest boxes from suboptimal locations, or where volunteer help or landowner support was lacking. In a few cases, nest boxes or their support structures had broken or fallen down and were not replaced. In all, ENSP selected 115 nest boxes for monitoring in 2018 (Figs. 1 and 2), focusing on the most productive boxes from our original study areas. Partners from Natural Lands Trust (NLT) monitored 50 boxes that they installed in Salem, Cumberland, and Cape May counties. This new study area expanded the study to include important habitat areas while maintaining representation within all previous study areas (Clinton, Amwell Valley, Assunpink, and Southern NJ). New study areas will be reassessed after four more years, when plans for continued monitoring will be based on kestrel activity (or lack thereof) and partner/volunteer support.
    - Two new volunteer monitors were recruited and trained in 2018.
    - A total of 115 nest boxes were monitored every 12-15 days from April through early August. Fifteen volunteers monitored 98 nest boxes and staff monitored 17 boxes.
        - Of the 115 nest boxes that ENSP actively monitored, 44 (38%) were occupied by American kestrels. Twenty-three of Natural Lands' 50 boxes (46%) were active and 20 had nestlings that were banded by ENSP in 2018.
        - Of 68 total nesting attempts, 54 (79%) were successful, as defined by nestlings that reached the bandable age of 14-22 days. Fourteen nests or nesting attempts (21%) failed. ENSP boxes had a 77% success rate (34 out of 44) while Natural Lands boxes had an 83% success rate (20 out of 24 attempts [one box had a failed renest attempt]).
        - Volunteers and staff entered nest-check data online through a Google documents interface, upon which timesheets were developed and signed as required.
    - ENSP nest success matched the project best of 77% in 2018. Total nesting attempts were much lower than the past two seasons of the project (n=44; Fig. 2). However, the additional 24 nest attempts from NLT's active boxes made the total nest attempts 68. Average productivity per successful nest was 3.91 in 2018, and productivity for all occupied nests was 3.10. When looking only at ENSP boxes these figures are slightly reduced at 3.74 young per successful box and 2.89 young across all active boxes.
    - We did not update the predictive American kestrel habitat patch model (patch sizes 0-250 ha, 250-1,000 ha, and >1,000 ha) with the 2012 LULC source for patches. This model may be revisited in the future, but currently there are no plans for this update.
    - Based on the existing habitat-patch model, 77% of the 2018 nest boxes were placed in the top two patch categories, 250-1,000 ha, and >1,000 ha, which is consistent with previous years' findings.

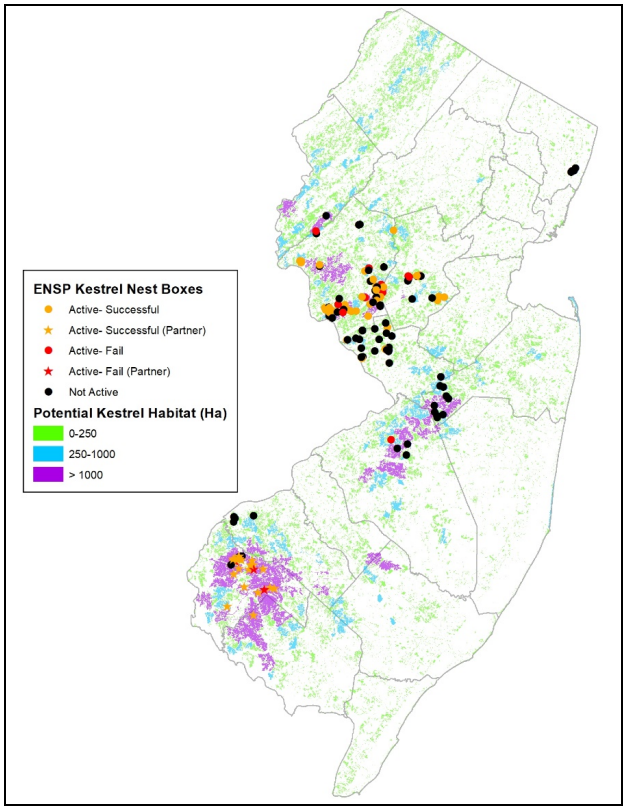

Figure 1. American kestrel nest boxes monitored in 2018

- In 2018, ENSP monitored the fewest boxes since 2012. We removed nest boxes from suboptimal locations, or where volunteer help or landowner support was lacking. In a few cases, nest boxes or their support structures had broken or fallen down and were not replaced. In all, ENSP selected 115 nest boxes for monitoring in 2018 (Figs. 1 and 2), focusing on the most productive boxes from our original study areas. Partners from Natural Lands Trust (NLT) monitored 50 boxes that they installed in Salem, Cumberland, and Cape May counties. This new study area expanded the study to include important habitat areas while maintaining representation within all previous study areas (Clinton, Amwell Valley, Assunpink, and Southern NJ). New study areas will be reassessed after four more years, when plans for continued monitoring will be based on kestrel activity (or lack thereof) and partner/volunteer support.

- We banded pre-fledged nestlings and breeding adults as follows:
  - 231 kestrels were newly banded: 211 young (110 females, 101 males) and 20 adults (16 female, 4 male) were banded at 54 nest boxes. 2018 marked the seventh consecutive year in which >100 fledglings were banded and the second consecutive year where >200 fledglings were banded.
  - 27 previously banded adults were recaptured (24 females, 3 males). This total accounts for 51% of all adults captured in 2018, the first time recaptured adults exceeded newly banded adults. Twenty-one (78%) of the recaptured adults (18 females, 3 males) were previously banded in ENSP monitored boxes, while 5 females (19%) were banded as young in Bucks or Northampton, PA, and 1 female (3%) was relocated from JFK Airport by USDA.
  - All banding data was supplied to the Bird Banding Lab via Bandit.
- In 2018, ENSP provided feather samples to the Bird Genoscape Project led by researchers from Boise State University. This project is mapping the population-specific migratory flyways of 100 species of birds using DNA from known populations. ENSP contributed samples from 25 locations in 2018, 20 locations in 2017, and 22 locations in 2016.

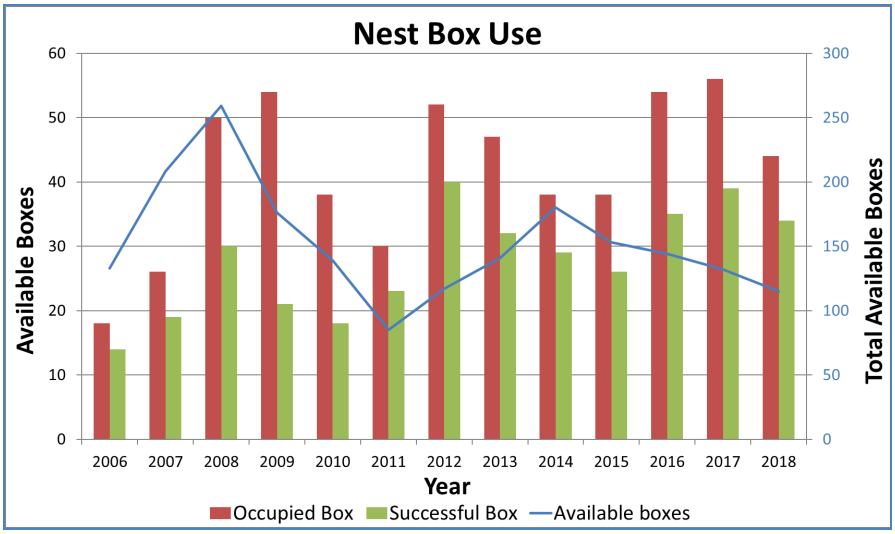

Figure 2. American kestrel nest box use (ENSP boxes only), 2006-2018.

Conclusions:

- Nest box placement has been successful; we have determined and maintain that open habitat patches >250 ha are the most suitable and should be the priority for kestrel management.
- Volunteers are a critical component for successful monitoring and data collection. ENSP must work on maintaining volunteer relationships because we do not have the staff resources to adequately monitor the current nest box program.
- Banding chicks and adults provides good baseline data for tracking survival, turnover, and breeding territory fidelity in the NJ population. This data may help identify problems related to population declines.
- Except for the 2009 breeding season, productivity of successful nest boxes has consistently been >3.0 young per box for the duration of the project, and when factoring in NLT boxes, three of the past five years have seen productivity at >4.0 young per box. This data suggests that incubation issues or low hatchling survival are not likely to be the primary reason for the American kestrel decline in NJ.
- 2018 had the highest percentage of recaptured adults (51%) since the inception of the project. This suggests that there was a high degree of survivorship over the 2017-2018 winter. However, this season also had the lowest number of previously unbanded adults (20) since 2011.
- Even with the continued reduction in nest boxes monitored, ENSP again had one of its most productive kestrel nesting season in 2018. The continued refinement of box movement and removal has allowed us to maximize staff and volunteer time as well as the number of kestrel pairs monitored. We will continue to refine our approach based on occupancy data.
- Natural Lands Trust continued its nest box program in 2018 and continued to increase their productivity, going from three active boxes in 2015, to five active boxes in 2016, to 16 active boxes in 2017, to 23 active boxes in 2018. As was the case last year, they have found that the most productive areas in Salem and Cumberland Counties for American kestrels tend to be closer to farmlands that are less intensively farmed (smaller scale operations) and/or areas of grazed pasture.
- The urban study area in Bergen County had no known nesting attempts in 2018. We were planning to drop these boxes from the study this year, but volunteers from Bergen County Audubon observed kestrels using one of them early in the breeding season. If there are no kestrel observations in 2019 these boxes will not be monitored.

Recommendations:

- Identify a sample of nest boxes in our most productive areas to determine occupancy by kestrels and competitors, kestrel productivity, and causes of mortality and nest failures. Use nest cameras to identify and quantify prey species and abundance at select nest boxes.

- Review historical data to further identify and characterize unproductive nest boxes and relocate them to locations in the largest patch size categories and to properties that are permanently protected from development in order to maximize use by kestrels.
- Investigate the possible effects of pesticides, cultivation practices, and other factors on kestrel success.
- Continue to evaluate the effectiveness of the nest box program in aiding kestrel recovery.
- Recruit and train additional Citizen Scientist volunteers to monitor nest box activity throughout the breeding season.
- Increase efforts to capture and band adult kestrels and maintain efforts to band all nestlings to enable evaluation of survival and site fidelity.
- Develop a framework and funding for investigating kestrels' use of habitats along their migration routes, and the significance of habitat loss along those routes, using geolocator data as examples.
- Draft an update to the comprehensive report and create a preliminary geolocator report with current findings to add to Raptor Webpage.
- Build relationships with other researchers across the northeast via the American Kestrel Northeast Working Group and continue relationships with the Peregrine Fund's Kestrel Program.
- Continue to contribute feather samples to The Bird Genoscape Project.

Woodland Raptors

Prepared by: Kathleen Clark, Supervising Zoologist

Objective: Gather and analyze data to inform conservation status and recovery plan actions of woodland raptor species.

Key Findings:
- Analysis of transect survey data was suspended after the preliminary analysis suggested that the data were not reliable enough to provide trends due to changes made in routes in response to habitat loss. The next step is to revisit the analyses for other conclusions and for informing redesigned survey methods. Additional work on the survey data was not completed due to time constraints that came with other work, including the barred owl research study and the NJ State Wildlife Action Plan revision.
- Staff plan to work on revised survey protocols that can make use of historic survey data as well as create useful information going forward. The distribution and abundance of woodland raptors (barred owl, red-shouldered hawk, Cooper's hawk, northern goshawk) are important data with which to monitor forest change and design forest management for SGCN species.
- Limited telemetry data recorded by the GPS units (Telemetry Solutions, LLC) showed a home range on two separate female barred owls, during the nesting season, that varied from ~250 acres (northern NJ, one 5-week period with 20% recording success) to ~600 acres (southern NJ, two 5-week periods with 20% recording success). We cannot make any conclusions about the home range and habitat use by barred owls based on this study to date.

Conclusions:
- Technology for telemetry is improving all the time, so in the near future it is likely that tracking devices will be available in the size range for barred owls. The project leader has discussed these issues with other researchers and with a different manufacturer who is developing a local, base-station system that can work on the limited home-range areas in which we are interested.
- ENSP has not had the staff time to devote to completing the analysis of raptor transect surveys, but we will be evaluating multiple survey techniques before adopting a method for future surveys.

Recommendations:

- We recommend pursuing the goals of this study, to adopt a survey protocol for woodland raptors for long term trend and distribution monitoring, and to identify the types of forest that will lead to beneficial forest management for these species.
- Seek to implement best management practices for forest-dependent SGCN birds within the state's forestry management system, and include species monitoring with the implementation of actions.