Final Report
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"Species of Greatest Conservation Need (SGCN) Research and Management"

Final Segment Report
September 1, 2015 – August 31, 2016

NJ Department of Environmental Protection

DIVISION OF FISH AND WILDLIFE
ENDANGERED AND NONGAME SPECIES PROGRAM
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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)

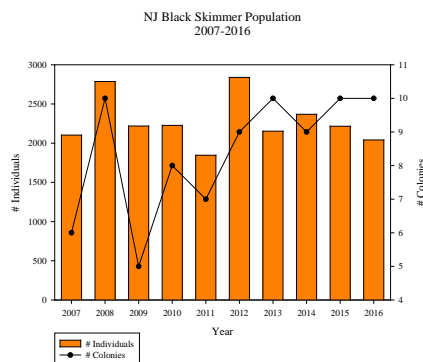**Prepared by**: Christina Davis, Environmental Specialist II
Beach nesting Birds (Piping Plover, Black Skimmer and Least Tern)
Project Leaders: Christina Davis and Dave Jenkins
The portions of this job applying to Piping Plover are jointly supported by State Wildlife Grants and ESA Section Six funding.
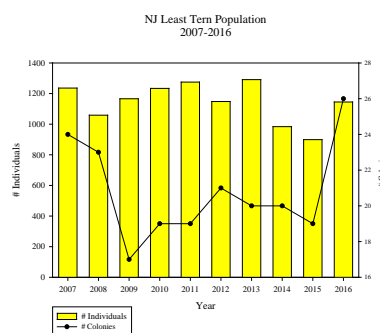
Key Findings:

Black Skimmer

NJ Black Skimmer Population
2007-2016

- Black skimmer breeding surveys were conducted approximately every two weeks from mid-May until the end of September on beaches along the entire Atlantic coast and marsh islands from Barnegat Bay south. Surveys took place at 18 sites and active nesting (at least one nest with eggs) was observed at 10 sites. Observations were made at these locations for the duration of active nesting at each site. A total of 2,041 adults were present at the active sites. This figure is the cumulative total of site counts that occurred in the peak survey period, which took place 1-15 August. The cumulative peak adult number from each site was 2,163. A large the difference between these two numbers can suggest failure at a given colony and then relocation/renesting to another colony. Given these two are so similar, the data (corroborated by field observations) suggests that this was not prevalent in 2016. As has been the case in recent years, the majority (82%) of the state's known population was present at just one site, which continued to be Seaview Harbor Marina in Longport (1,681).
- A peak count of 401 incubating adult black skimmers was tallied. 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 many colonies blocked observers from garnering an accurate count of these ground nesters. However, predator pressure was so intense that it was not worth increasing the vulnerability of the colony by walking through it to count nests (which ENSP biologists have never found to be a particularly effective count method).
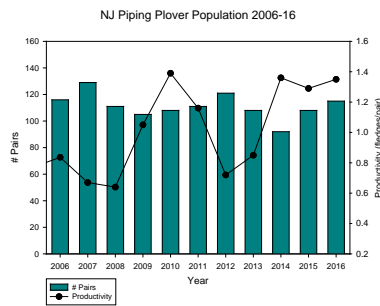
- Black skimmer productivity appeared to be high, with 1,089 fledglings produced statewide. This translates to 2.71 chicks per pair, a figure that is likely an overestimate given the issues in the pair count numbered detailed above. If we simply halve the total adult number and use that as pair count, the productivity is 1.07. The true rate is likely somewhere in the middle but even 1.07 represents an excellent year for this species. Six sites fledged young (an improvement over the two in 2015) but almost all the young (89%) were produced at one site, Seaview Harbor Marina. Predation 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 predation.
- New Jersey ENSP, in cooperation with NJ Audubon Society and The Wetlands Institute, banded 34 Black Skimmer chicks at Belmar – Shark River Inlet in a pilot year project. Long-term goals of banding include better understanding of site fidelity and inter-state movements (particularly with New York breeding birds). After banding, weekly resight surveys were instituted at Belmar and were also conducted in Cape May City, a well-known staging area for this species. This data has not yet compiled (surveys continued beyond the grant time period).

Least Tern

NJ Least Tern Population
2007-2016

- Least tern breeding surveys were conducted approximately every two weeks from mid-May until the end of August at beaches along the entire Atlantic coast. Colonies were located at 26 sites and observations were made at these locations for the duration of the season. A total of 1145 adults were present at these sites (based on a cumulative total of peak site counts that occurred in the 1-15 June survey period). The cumulative peak adult number from each site was 1,713. A large the difference between these two numbers can suggest failure at a given colony and then relocation/renesting to another colony, which given the data appears to have happened to some degree in 2016.
- The population was distributed fairly evenly throughout the state and four colonies had >100 adults with two colonies at 300+. The largest colony was located in Seaview Harbor Marina, with 359 adults on its peak count followed by Holgate – North End with 350 adults at its peak. The adult numbers were higher than 2014-2015 and more in line with a longer term trend. As always, there was some difficulty tallying birds in dense vegetation.
- A peak (census period of 1-15 June) of 604 adult least terns were observed incubating. Productivity was high for least terns with 657 fledglings produced statewide (1.09 chicks per pair, based on the peak number of incubating adults). The fledge rate represents high productivity for this species in New Jersey and was considered a successful season. Low levels of flooding and increased predation management were likely to have influenced this outcome.

Piping Plover (*Full Piping Plover reporting can be found in NJ E-1-38*)

NJ Piping Plover Population 2006-16

- One hundred fifteen (115) pairs of piping plovers nested in New Jersey in 2016, a 6% increase from 2015 (108) but a 25% increase from 2014's dismal showing of 92, the all-time low since formal observations began in 1987.
- The total number of adults recorded for the entire nesting season (232) was somewhat higher than during the date-restricted survey conducted June 1-9 (226). Likewise, the number of pairs tallied during the entire nesting season (115) was higher than the pairs recorded during the date-restricted census (109).
- Pairs nested at 20 sites statewide, up from 19 site from 2015 but well below the peak count of 30 sites recorded in both 2004 and 2005.
- Statewide pair-nest success (the percentage of pairs that successfully hatch at least one nest) increased in 2016 compared to 2015 (90% vs. 79%, respectively), and well above-average for the period since federal listing (68%). Looking at just ENSP-monitored sites, 2016 pair-nest success (93%) was higher than the state-wide tally, and much higher compared to the period since federal listing (66%), 2015 and 2014 (65% and 47% respectively).
- The statewide productivity rate, which incorporates data collected by all the state cooperators, was 1.35 fledges/pair, a slight increase from 2015 (1.29 fledges/pair). Productivity at ENSP-monitored sites (1.89 fledges/pair for 27 pairs) was above the 2015 metric (1.41 fledges/pair) and also the 2016 statewide tally, an unusual occurrence.
- ENSP continued to use predator exclosures judiciously in 2016 with 69% of nesting attempts were exclosed (statewide was 65%). The exclosed hatch rate for ENSP nests was 96% (statewide was -88%). The ENSP unexclosed hatch rate was 40% (statewide was 36%) and of the ENSP nests not exclosed, 40% were lost to predation (statewide was 56%).
- ENSP purchased radio transmitters in support of the State University of New York (SUNY)–Syracuse's piping plover chick mortality research project. Prior research had shown, to meet the objectives of this study, that nanotags were more effective for adults while traditional VHF tags were better suited for chicks. In 2016, 25 adults were outfitted with nanotags and 21 chicks were equipped with traditional VHF tags.

Conclusions:
- In the 2014 and 2015 reports, there was question whether the dip in the **black skimmer** population observed in those years was part of a new downward trend or normal fluctuations. The population "increased" in 2016 back towards long-tern averages, assuaging some of those concerns. Black skimmer productivity continued to be on the high side, furthering alleviating trepidation about the robustness of the NJ population. The increase is at least partially attributed to another year of low flood rates and a focused predator management effort at some key sites. Predator management must remain at the forefront of recovery strategy and be sustained if skimmers are to continue to be successful statewide.
- Although ENSP is less concerned about the small number of nesting colonies than it was in the first decade of the 2000s (down to five colonies in some years), the fact that the majority of the birds are at just one site continues to be a cause for concern. Recent regional coordination efforts have also highlighted the important role New Jersey's population plays in the Atlantic coast's breeding population since this state supports a relatively large number of birds when compared to surrounding areas. Therefore, this one site is critical on both the state and regional levels.

- The impact of sea-level rise in the marsh islands may be a occupied nesting areas. The largest colonies are located either on the beach strand or on large, relatively stable marsh islands with a sandy substrate. Whether or not this represents a true move away from wrack nesting marsh colonies or is just an anecdotal observation is yet to be determined but something ENSP will be closely tracking in future years.
- The banding of black skimmer chicks at the Belmar colony was a successful venture and served as an excellent starting point from which to expand the NJ banding program.
- Similar to black skimmer, the statewide **least tern** breeding population returned to longer term trend numbers. Without individual marking of birds, it is unclear if this upturn was related to regional movements or an increase in the number of sexually mature birds entering the breeding population (first age of breeding 2-3 years old).
- The number of active least tern colonies (26) was the highest recorded since 2004 and considered a step in a positive direction. The colony size was distributed fairly equally among smaller and larger colonies. Of note were "micro" colonies, consisting of just 1-3 pairs, which made up 35% (9 colonies) of the total. Some of colonies may represent the bird's attempts to colonize new areas.
- The state recorded its third consecutive year of strong productivity for **piping plover**, well above the long term average in New Jersey and above the levels believed necessary to maintain a range-wide stationary population. While these are encouraging results, any chance for long-term recovery still rests with sustained higher than average productivity, which has proved difficult to achieve in New Jersey. Of special note was the excellent pair-nest success rate (90%), extremely high for New Jersey.
- For the first time in a decade, there was an increase in pairs on state and municipal sites, breaking a somewhat disquieting trend of a concentration of pairs on federal sites. Although Piping Plovers are extremely well protected on federal sites, additional pairs at non-federal locations is the only way to meet regional recovery goals as the major sites reach capacity. It was especially promising that the state and municipal sites posted such high productivity, at record and near record highs.
- The fruits of increased predator control efforts and Hurricane Sandy's habitat improvements continued to be reaped in terms of strong statewide reproductive success. Very few sites did not perform well, but those lower on the spectrum were impacted by predation as flooding continued to have negligible impact on nesting birds (it is unclear why this is, but some speculate that Sandy increased the elevation of the berm just enough to prevent flooding of nests). Documented predators included fish crows, laughing gulls, peregrine falcons, red fox, and cat as well as unidentified species.
- Hurricane Sandy was detrimental to many human landscapes around the state but for beach nesting birds, the overall net impact to their habitat continued to be extremely positive, producing excellent nesting and foraging conditions. This fourth field season post-Sandy was the first where a noticeable addition of vegetation heralded the very beginning of end of optimal conditions. However, the habitat was so extraordinary that it should still produce exceptional conditions for at least a few more seasons.
- Although the statewide productivity (1.35 fledges/pair) was still below the 1.50 fledglings per pair recovery goal, it was above the 1.245 fledglings per pair range-wide threshold for population maintenance established in the USFWS Recovery Plan for the Atlantic Coast population of piping plovers (USFWS, 1996) and higher than the average for New Jersey for the period since federal listing (0.99 fledges/pair).
- This chick mortality project for which transmitters were deployed on plover adults and chicks is on-going and no results are available at this time.
- Seaview Harbor Marina's importance to beach nesting species continued unabated this year. In addition to housing the vast majority of the black skimmer adult and fledges, it also hosted a least tern colony, a common tern colony and American oystercatchers.

Recommendations:
- Continue to annually monitor population and productivity at least tern and black skimmer nesting sites along the Atlantic Coast (as well as black skimmer colonies on marsh islands) about once every two weeks during the breeding season in order to make a statewide assessment of population trends. Consider increasing the number of visits to marsh island locations as staff and resources allow.

- Periodically monitor other back bay island complexes within the coastal region of the state to ensure that large numbers of skimmers are not nesting in these areas. When sites are identified through this or other means, such as the long-legged wader aerial survey, include them in the once every two weeks survey rotation.
- 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 control plan as it is the primary way forward to recovery for 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 predator control on municipal lands.
- Lead and/or coordinate restoration efforts to improve beach nesting bird habitat. Targeted sites include Barnegat Light, Malibu Beach WMA and Cape May Point State Park.
- Continue to make every effort to allow Seaview Harbor Marina's beach nesting birds to flourish. This includes continuing intense predator control but also considering undertaking vegetation thinning to ensure the habitat stays suitable for as long as possible.
- 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.
- 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. What was once an important management tool may no longer so as NJ continues to evaluate their use and determine future paths to reproductive success for piping plovers.
- Continue to follow the piping plovers that were banded in 2012-13 and 2015-16 (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.
- 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.
- Continue to coordinate management with municipalities, as well as county, state and federal landowners.
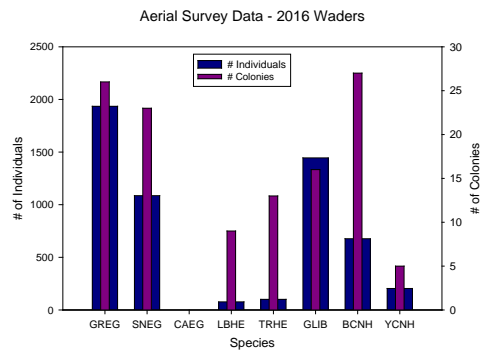- Continue to incorporate breeding data into the Landscape Project and NJ DEP's Biotics database.

Colonial Waterbirds

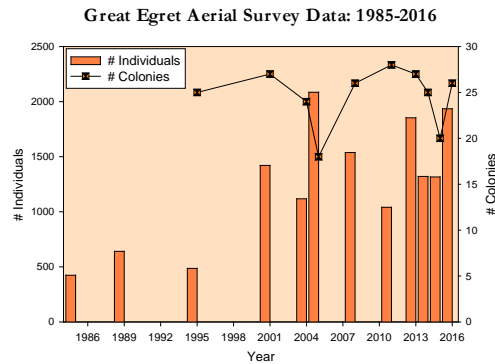**Prepared by**: Christina Davis, Environmental Specialist II

Job Objective: Census long-legged wading birds nesting on Atlantic coastal marsh islands, via aerial survey.
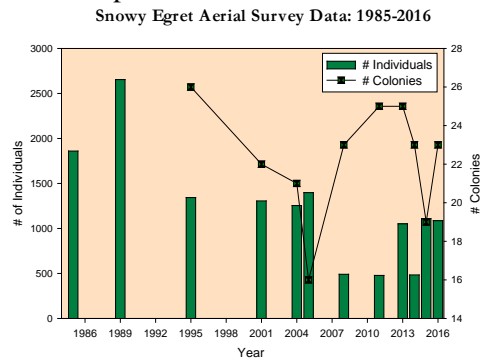
Key Findings:
- 5,525 individual wading birds were counted on the aerial survey in 35 colonies. Of the 5,525, 1,935 (35%) were great egrets, 1,086 (19%) were snowy egrets, 1,445 (27%) were glossy ibis, 677 (12%) were black-crowned night-herons, 204 (4%) yellow-crowned night-herons, 77 (1%) little blue herons, 101 (2%) tricolored herons and 0 (0%) cattle egrets.
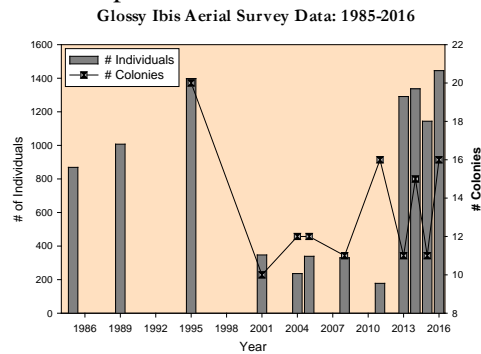
Aerial Survey Data - 2016 Waders

- There were 1,935 individual great egrets observed in 26 colonies. Due to changes in methodology, please note that colony data is not available prior to 1995.

Great Egret Aerial Survey Data: 1985-2016

- There were 1,086 individual snowy egrets observed in 23 colonies. Due to changes in methodology, please note that colony data is not available prior to 1995.

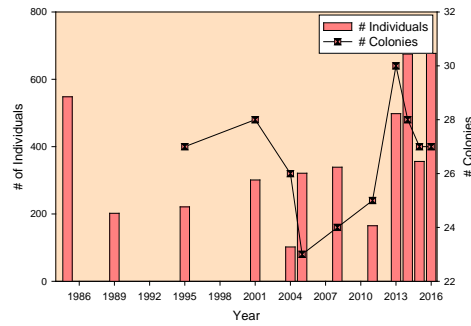
Snowy Egret Aerial Survey Data: 1985-2016

- There were 1,445 individual glossy ibis observed in 16 colonies. Due to changes in methodology, please note that colony data is not available prior to 1995.

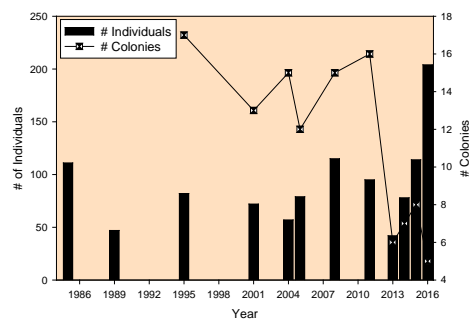Glossy Ibis Aerial Survey Data: 1985-2016

- There were 677 individual black-crowned night-herons observed in 27 colonies. Due to changes in methodology, please note that colony data is not available prior to 1995.

Black-crowned Night Heron Aerial Survey Data: 1985-2016

- There were 204 individual yellow-crowned night-herons observed in 5 colonies. Due to changes in methodology, please note that colony data is not available prior to 1995.

Yellow-crowned Night Heron Aerial Survey Data: 1985-2016

- There were 77 individual little blue herons observed in 9 colonies. Due to changes in methodology, please note that colony data is not available prior to 1995.

Little Blue Heron Aerial Survey Data: 1985-2016
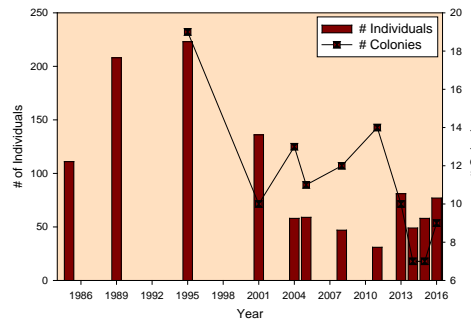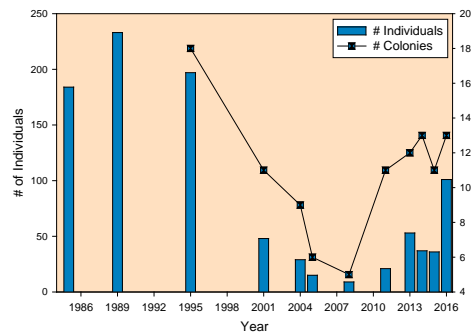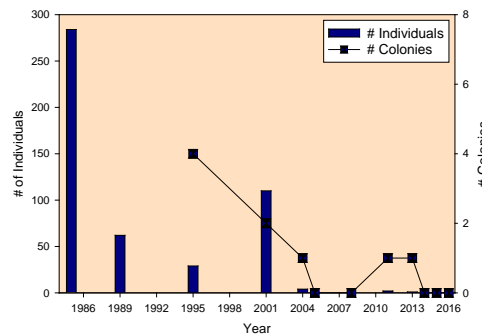

- There were 101 individual tricolored herons observed in 13 colonies. Due to changes in methodology, please note that colony data is not available prior to 1995.

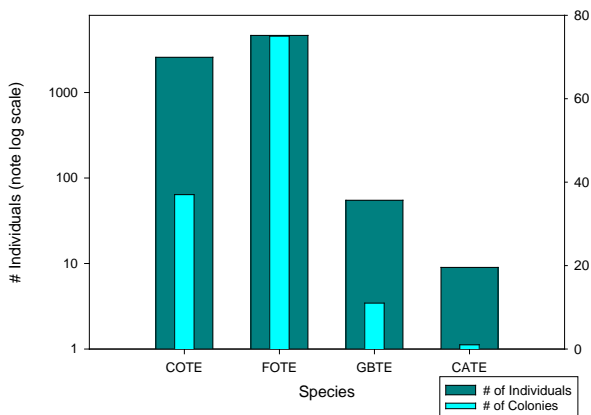**Tricolored Heron Aerial Survey Data: 1985-2016**

- 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.

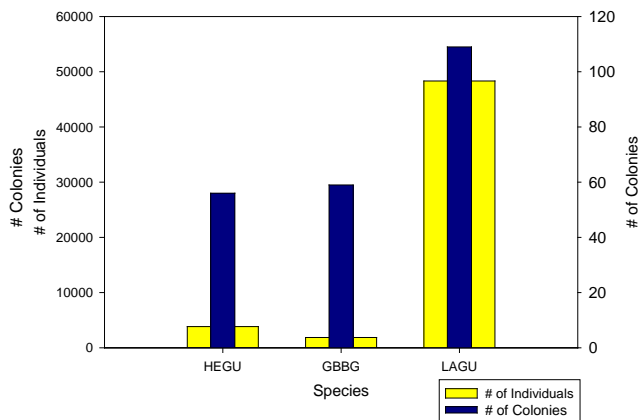**Cattle Egret Aerial Survey Data: 1985-2016**

- Although the focus of this objective is long-legged colonial waterbirds, surveyors also took the opportunity to census tern and gull species. Surveyors counted 2,585 common terns in 47 colonies, 4,654 Forster's terns in 88 colonies, 55 gull-billed terns in 9 colonies and 5 Caspian tern in 3 colonies. 48,329 laughing gulls in 109 colonies, 3,836 herring gulls in 56 colonies and 1,864 great-black backed gulls in 59 colonies were also tallied. The number of Laughing Gulls was the highest recorded since 2004. For the second year, rooftop nesting by large gulls was recorded, on a strip mall in Ventnor.

Aerial Survey Data - 2016 Terns

Aerial Survey Data - 2016 Gulls

- The continuation of the active colony of double-crested cormorants at one of the largest, and longest running, colonies in the state, Gull Island (near Stone Harbor) has been upgraded from a troubling development to an alarming one. This site has hosted hundreds of wading birds for decades and is one of the state's most critical nesting areas. In 2015, a high count of 61 was tallied. In 2016, the high count was 194. The cormorants expanded their nesting area from just the trees at the outer limit of the northwest sub-colony to the ground within that sub- colony.

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 unprecedented luxury of doing four yearly surveys in a row (2013-2016) emphasized the difficulties in getting an accurate count associated with the snapshot aerial survey technique. The "declines" and "increases" noted throughout this time period, especially the large ones, are unlikely to be due to actual population changes but rather because of the survey technique. Since the counts are not repeated within any given year, no true population estimates can be calculated. However, repeated counts, while desirable, are cost prohibitive.

- 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 2016 there were 35. 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 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). In 2016, the state and a local NGO made an effort to dissuade the birds from nesting, which failed. The state contracted with USDA-APHIS (under a non-federal funding source) to destroy nests. The APHIS permit was not large enough to accommodate the number of nests that needed to be removed and thus many cormorants were able to successfully breed at the site. Losing this colony to cormorants would have an extremely negative impact on the wading birds in the state, given the importance of Gull Island to this group.
- 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 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.

Literature Cited:
Kushlan J. A. 2011. Heron count protocols: inventory, census, and monitoring of herons. Heron Conservation. www.HeronConservation.org Accessed 20 October 2016.

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; estimate population size and survival rates; monitor stopover population size through two methods: baywide aerial and ground survey and mark-and-recapture/resighting methods; 2) monitor horseshoe crab egg densities as 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 that achieve body mass ≥180 grams by the time of normal departure from the Delaware Bay (May 26-28) is statistically related to foraging conditions (horseshoe crab egg densities in the top 5 cm of sand).   Knots that leave the bay at ≥180 g have a higher survival than birds departing at lower weights (Baker et al. 2004). In 2016, the proportion of red knots reaching ≥180 grams was 0.56, a decline from 2015 (0.77) but still promising because the proportion of birds reaching adequate mass has remained above 0.50 in four of the last five years – an improvement over the decade prior (Figure 1). This must be tempered by the fact that red knot peak abundance is, on average, 20% of historic numbers (94,460 individuals in 1989) and has remained there for the last 14 years. Peak abundance counts are taken from a combination of aerial and ground surveys, and are single-day counts that do not account for the turnover of red knots on the Delaware Bay stopover in May. The peak count in 2016 was 21,128, and the average of the last six years was 22,476 (SD=5,022) (Table 1).

Figure 1. Proportion of Red Knots in the >180 g body-mass category in Delaware Bay near the usual departure time (26-28 May), 1997–2016. The line shows a significant quadratic trend (the trend line ±95% CI in respect of the line, not the variation in the data). Trend line was fitted using binary logistic regression of body mass >180g (1=yes, 0=no) on year (negative, $P<0.001$) and year2 (positive, $p<0.001$). The strength of the quadratic trend owes much to the very low proportion recorded in 2003, but remains significant if 2003 data are omitted. Source: DE Division of Fish and Wildlife and NJ Division of Fish and Wildlife.

Population Estimate from Resightings of Marked Birds: As a result of a 2009 Structured Decision Making process led by the USFWS/USGS, an Adaptive Resource Management Model was developed to predict maximum horseshoe crab harvest that should not cause further red knot declines. One component of the model is the red knot stopover population estimate, derived from resightings of individually-marked birds, which accounts for the throughput of red knots during the stopover period (Lyons 2016a). Since 2011, the mark-resighting stopover population estimate has remained relatively stable except for 2015 (Table 1), and averaged 48,103 birds.

Table 1. Stopover population estimate using mark-resight methods compared to peak-count index using aerial- or ground-survey methods. The mark-resight estimate of stopover population accounts for population turnover during migration, and is therefore different from (and higher than) the peak-count index does. Source: Lyons, 2016b.

Year	Stopover population[a] (mark-resight N^*)	95% CI Stopover pop-ulation N^*	Peak-count index [aerial (A) or ground (G)]	Ratio (N^*/Peak-count index)
2011	43,570	(40,880–46,570)	12,804 (A)[b]	3.40
2012	44,100	(41,860–46,790)	25,458 (G)[c]	1.73
2013	48,955	(39,119–63,130)	25,596 (A)[d]	1.91
2014	44,010	(41,900–46,310)	24,980 (A)[c]	1.76
2015	60,727	(55,568–68,732)	24,890 (A)[c]	2.44
2016	47,254	(44,873–50,574)	21,128 (A)[b]	2.23

[a] estimate for entire season, including population turnover
[b] 23 May
[c] 24 May
[d] 28 May

The mark-resighting method of estimating red knot population relies on several assumptions that may or may not hold true in Delaware Bay. In particular, the assumption of homogeneity of resighting probability must be tested. Shorebird use of the bay is affected by 1) distribution of eggs, which changes year-to-year; 2) changes in bird behavior as they gain weight and departure period approaches (e.g., knots staging in more remote areas making them less observable); 3) and differences in how long individuals remain in the stopover. We are also beginning to understand that red knots may focus in Mispillion Harbor, Delaware, early in the stopover period, as Mispillion usually has higher egg resources, but birds may move to other beaches and stage on Egg Island later as they gain weight. These factors, and how they may affect the mark-resighting population method, will be explored over the next several years, possibly using telemetry information.

Shorebird food availability: As noted above, the proportion of red knots that achieve body mass ≥180 grams by the time of normal departure from Delaware Bay (May 26-28) is related to foraging conditions. Horseshoe crab egg densities on NJ beaches were slightly lower in 2016 (NJ mean 5.7 eggs/m^2) but were commensurate with surface densities recorded since 2005 (Figure 2). New Jersey surface egg densities remained below historic densities recorded in the early 1990's prior to large bait harvests (10,000 to 100,000 eggs/m^2; Botton et al. 1994). Niles et al. (2009) estimated a surface egg density of 50,000 eggs/m^2 on 50% of suitable habitat to be necessary for recovery of red knot and other shorebirds.

New Jersey Mean Egg densities 2005-2016

Figure 2. Mean density of horseshoe crab eggs in the top 5 cm of sand during May and early June 2005-2015 on bay beaches of New Jersey. Error bars are 90% CI. Source: New Jersey Division of Fish and Wildlife, American Littoral Society. Note: 2016 are preliminary and lack 90% CI.

Habitat Management: To improve shorebird access to limited egg resources, New Jersey restricted beach access on 13 sites on Delaware Bay during May. ENSP and staff from Conserve Wildlife Foundation of NJ (CWF) trained and fielded shorebird beach stewards with funding from NJ grant E-1-38 (Section 6). The reduction or

elimination of human disturbance provides wider availability of eggs over the full tide range, reduces interspecific and gull competition and risk from aerial predators.

In 2015 and 2016, we saw the beginning of expansion of intertidal structural aquaculture on Delaware Bay. The planned expansion in red knot foraging areas posed a new threat by covering intertidal foraging habitat with growing structures, and introducing disturbance from tending activity (on foot, with ATVs and power-washers). Other possible but undocumented risks from the expansion of structural aquaculture include impacts of structures on crab movements to spawning beaches, and impacts of structures and tending activities on crab prey resources. This expansion is unfolding: conservation measures have been put in place by the USFWS, and the Service is leading an adaptive resource management effort to test efficacy of the conservation measures.

Adaptive Resource Management (ARM) Model in use by Atlantic States Marine Fisheries Commission (ASMFC): The ARM Model uses population estimates for female crabs and red knots to establish bait harvest quotas. In 2015 a new method to estimate crab population size was developed for use in the ARM Model. The new population estimate method – a composite of two Delaware Bay trawls and one NJ Atlantic coast trawl – was developed in response to defunding of the long-term Atlantic Coast horseshoe crab trawl that sampled the entire wintering range of the Delaware Bay crabs (VA to NJ; Hata and Hallerman 2013).

Conclusions:

Red knot abundance in Delaware Bay has remained fairly steady according to ground and aerial peak counts (mean=22,476) and a mark-resight population estimate (mean=48,103) between 2011 and 2016. Red knot body condition in late May (the proportion of knots reaching ≥180g before leaving for the Arctic) improved since the mid-2000s, and has ranged between 46% and 77% in the last five years.

Habitat management, mainly seasonal beach closures and spawning beach restoration, have become important methods to quickly improve red knot foraging opportunities on Delaware Bay beaches. During the period of this project, when beach access was restricted and we worked with partners to restore beaches after Hurricane Sandy, we saw an overall improvement in the proportion of red knots reaching >180g.

Recovery of red knots and the migratory stopover will rely on increasing the capacity of the entire bayshore for both crabs (recruitment of spawning animals) and shorebirds (availability of eggs). This is important to improve resilience in the bayshore and counter other negatives in the system.

The objective of horseshoe crab harvest management has been to optimize bait harvest rather than to maximize recovery of crabs and red knots (ASMFC 2016). Years of harvest management has not resulted in a long term increase in any age class (2001-2013; Hata and Hallerman 2013) or in spawning crab densities (1999-2016; Zimmerman et al. 2016). Since 2006, under Addendum IV, the ASMFC has reduced harvest quotas of Delaware Bay origin crabs. Since 2013, it has implemented the ARM, which includes red knot recovery as a management goal. The lack of positive response in horseshoe crab numbers calls into question the adequacy of the ARM model to effect a robust recovery of migratory shorebirds.

Recent modest expansion and the potential for greater expansion of intertidal structural aquaculture has the potential to reduce shorebird foraging habitat in NJ, and deserves continued study to minimize impacts to horseshoe crab spawning and shorebird foraging.

Recommendations:
We recommend maintaining data collection on shorebird body condition and shorebird abundance in the Delaware Bay stopover, information which is informing models on shorebird populations, and habitat and forage management.

We recommend continued management of beach habitats to reduce human disturbance in important shorebird foraging areas. Increasing such management on important foraging beaches in Delaware would help provide improved foraging and increase the number of birds reaching adequate departure weight.

Funding to conduct study of impacts of oyster aquaculture structures on horseshoe crab and red knot habitat is necessary to properly focus this activity and develop methods to reduce impacts.

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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 (*In progress*) 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 in 2016 to address the habit of this species to call nocturnally. It was not well captured in the 2011 and 2012 call-playback surveys, which took place near dawn.
- ENSP biologists and GIS staff worked together to generate a map that was based on high marsh LU/LC layers and was then fine-tuned using a variety of automated and hand-digitized methods. 1,059 total points were generated. This was necessary because there is not a reliable high marsh habitat map on state, regional or federal levels (though one is expected that will include NJ in winter 2017, a product of the **S**altmarsh **H**abitat & **A**vian **R**esearch **P**rogram).
- Points were located at least 400m apart 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.

- 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 broadcast recordings (of Black and Virginia Rails). The window in 2016 was moved ahead by two weeks in response to data from 2015 that suggested earlier surveys were more likely to detect black rails. The survey period in 2016 was April 29–June 30 and three surveys (7-10 days apart) were taken at each point. The survey method for boat-based surveys was ten minutes (plus a two minute settling in period prior) and calls were recorded in the minute they occurred. The road-based surveys added five minutes of passive listening at tail end as an experiment to determine of more rails were detected. Surveys took place between 10pm and 3am, in low wind conditions with little/no precipitation and, for boat-based surveys only, 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 contracted with Conserve Wildlife Foundation of NJ and six freelance biologists to carry out surveys at 49 water-based points. One surveyor had to drop out prior to the beginning of the survey so 39 points were ultimately surveyed. Nine (9) of the points were at locations near black rail "hits" from last year and 30 were in new locations around the mouth of the Mullica River, for which no previous survey data existed. There were 21 detections at 13 points (33% of 39 surveyed boat-based points). Eighteen (18) of these detections were at ten points associated with the Mullica River, confirming this area as extremely important for black rail in New Jersey.
- ENSP also contracted with New Jersey Audubon Society (NJAS) to conduct volunteer-based road surveys at locations throughout the state. This was an effort to survey more areas, as the ENSP/CWF effort was at its upper limit as in terms of the number of points that could be covered. NJAS staff and volunteers surveyed 174 points. There were 13 detections at 6 points (3.4% 174 of surveyed road points).

Figure provided by NJAS

- No acoustic recording units (ARUs) were deployed in 2016, due to lack of staff resources to place and maintain the units in the difficult-to-access areas. The 2015 data has not yet been analyzed due to lack of staff resources.

Conclusions:
- Nocturnal surveys are possible and nighttime is the appropriate time period to survey this species in New Jersey; black rails in the southeastern US appear to call diurnally as well. 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 radar during the survey. Challenges included having only one boat operator and by being limited to nights with good weather *and* the correct tides. Important components for successful road surveys were training sessions and ensuring volunteers had landowner permission for nocturnal surveys (Special Use Permits for state wildlife management areas, for example). Challenges for road-based surveys were grappling with volunteer fatigue (it was more difficult to recruit in 2016 vs 2015) and matching available volunteers with geographically desirable areas to survey.
- The southern part of the state has generated the largest number of positive hits, and the boat-based surveys are more likely to produce hits than the road-based (which is not surprising, given what is known about the

influence of roads to wildlife, and boat points being further from all types of human development). However, the boat-based surveys are limited by equipment, personnel, and tides. To ensure adequate coverage of the state, road-based surveys will need to continue to play an important role.

- The promise of acoustic recording units has yet to be fulfilled for this project. Although they represent a substantial benefit for collecting data on a scale exceeding that of traditional call-playback, the enormous time expenditure needed to analyze the data is a substantial hurdle. In addition, the NJ experience has been wrought with equipment loss. In 2011, ten units were purchased. In the five years since, half have been lost to theft or flooding. The theft issue is particularly difficult to resolve since the units are already in inaccessible and remote areas. Staff was surprised this was an issue at all, given their locations.

Recommendations:
- Since boat-based surveys appear to be critical in surveying this species' habitat, consider hiring additional boat operators so that evenings with good conditions (clear and still, high tide) could be maximized by utilizing multiple crews.
- Deploy acoustic units earlier in the season (by May 15) to ensure early callers are recorded. Conceive and employ an anti-theft deterrent system.
- Focus survey effort 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.
- Continue to use an earlier start to the survey period (late April/early May versus mid-May) as this appeared to result in more detections and is likely more synchronous with the phenology of this species.
- 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 by the USFWS.
- 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.
  o In 2016, 172 eagle nests were monitored during some or all of the season, of which 150 were active (exhibiting incubation), and 22 were territorial (maintaining a nest area). Thirty-five more territories remained on our list but were unknown (pair or nest could not be found, or we lacked observation effort).
  o During the 2016 nesting season, 130 of 150 known-outcome nests were successful in producing 216 young, for a productivity rate of 1.44 young per known-outcome, active nest (Fig.1). This is above the 10-year median in New Jersey of 1.25 young per active nest. Overall nest success rate was 87%, above the average of 75%. These results suggest a continuing growing population and indicate this was a good season for eagles in NJ.

- o Fourteen new eagle nests were discovered this season, but the overall number of known nests (150) was the same as last year. This is a result of losing track of some nests (those in the "unknown" category for location) and that some known nests with territorial pairs did not lay eggs; this was observed at some previously active nests with adult-plumage pairs. Eagles nest throughout the state.
  - o We documented 20 (13%) nest failures, lower than most years.
- ENSP biologists visited a sample of nests to band young with federal and color leg bands and to take blood samples. In 2016 we banded 23 eaglets at 11 nests. We took blood from all of the banded eaglets and stored it for future analyses. A small portion of each sample was separated 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 (about 60%) were located on private land, with the balance on state, federal, county, municipal and conservation-organization lands.
- The ENSP did not participate in the standard, national, Midwinter Eagle Survey in January, 2014 or 2015. The survey transects no longer represent the statewide wintering population, and the program did not have the funds to pay a coordinator. Instead, we directed our Eagle Project volunteers to seek out and record eagles in likely communal roosting areas. In addition, we identified night roost locations from four satellite-tracked eagles, and delineated roosts that were used multiple times. Roost data will be entered into the DEP's Biotics database.

Nest site protection:
- Nest areas were posted against trespassing in all cases where the nest is highly visible and where law enforcement officers specifically recommended.
- One nest tree located in Salem County was cut down in early February, days after eggs had been laid. The tree was in a sparse wood line on farm land, and clearly was purposefully cut. NJDFW law enforcement investigated and later brought in USFWS law enforcement; no responsible person was found. The eagles rebuilt a nest in a nearby tree and nested successfully.
- 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 6, 2016, attended by approximately 45 project volunteers.
- Staff worked regularly with USFWS-NJFO and Region 5 offices to address all issues related to USFWS Bald Eagle Management Guidelines and BGEPA permits in NJ.

Habitat protection and planning:
- New nests found in 2015 and 2016 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 during the NJDEP permit review process on a few sites due to pending development applications. ENSP also worked with the USFWS regional office to condition permits granted under BGEPA.
- The status assessment portion of the proposed Bald Eagle Recovery Plan was not conducted due to time limitations.

Conclusions:
- The population of "active" eagle nests remained the same between 2015 and 2016, even though there were 14 new pairs found. 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 to date has

been adequate for maintaining our database and meeting the eagle protection requirements in NJ regulations. We would need one additional staff to expand the volunteer program and help search for 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. Still, it is difficult to maintain all current locations, and in 2016 the number of pairs with "unknown" status increased to 35, up from 27 in 2015.
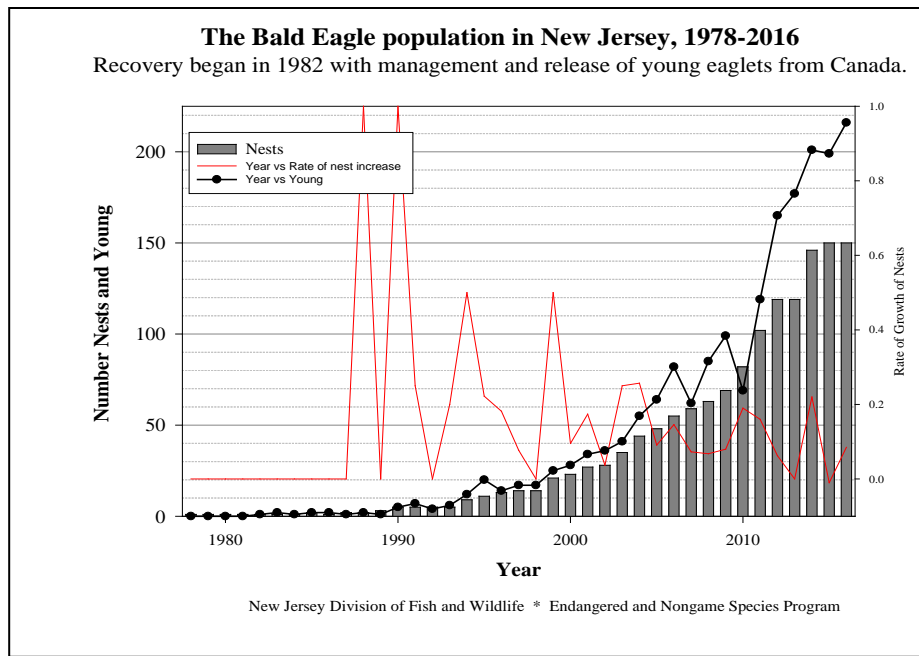
- The state's eagle population has been increasing as a result of 15 years of average productivity of 1.25 young per active nest (median=1.26 young/active nest), but population growth has been substantial only since 2002. Key to this success has been management that includes nest-site protection in cooperation with landowners.

- 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 have expanded our coordination with the USFWS in select cases to minimize disturbance and habitat loss to development and other activities.

- As the eagle population has increased, it has become more challenging to maintain the "list" of eagle nests and territories that is the basis for reporting the population to the USFWS under requirements of the post-delisting monitoring plan (USFWS 2009). With declining funding and an eagle population reaching recovered status, it is unlikely we will be able to continue this level of population monitoring far into the future.

- 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 coordination with the U. S. Fish and Wildlife Service in accordance with the post-delisting monitoring recommendations, via conference calls and regional/subregional meetings.

- We have ended the Mid-winter Eagle Survey in favor of deploying volunteers to identify winter roosts and concentration areas. We need to map those areas that may be significant to maintaining the local and regional population 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 Division of 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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The Bald Eagle population in New Jersey, 1978-2016
Recovery began in 1982 with management and release of young eaglets from Canada.

New Jersey Division of Fish and Wildlife * Endangered and Nongame Species Program

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 2016 New Jersey peregrine falcon population remained relatively stable with 35 known pairs (30 active) occupying suitable nesting habitat across the state. There was average success overall with 20 pairs successful in producing 47 young, for a productivity rate of 1.57 young per active nest and a success rate of 67%. (Table 1). A brief summary of data collected during the 2016 nesting season follows.
    - Sixteen pairs nesting on towers and buildings continued to be the core of the nesting population, producing 28 young, for a productivity rate of 1.75 young per active nest. This is close to the long term average. We used bird-lice spray at nests in the winter, and treated <2-week old hatchlings at two sites to reduce infestations of parasitic flies (*Carnus hemapterus*). These flies have caused mortality of young hatchlings in recent years. We did not see any total brood failure due to flies that we saw in 2014.
    - Seven pairs were known to occupy territories in natural cliff habitat in northeastern NJ. Eight young fledged for a productivity rate of 1.14 young per active nest.
    - Seven pairs of falcons were known to nest on bridges this year. Four of those bridges lie completely within the boundaries of NJ, while three span the Delaware River between NJ and PA and are monitored by NJ. All bridge pairs fledged a total of 11 young for a productivity rate of 1.57 young per active nest. Nesting can be difficult to confirm, as the nest sites are often located out of sight or on inaccessible sections of the bridge. Some previously occupied bridges (e.g., Trenton and Newark Bay) were not tracked due to insufficient staff or volunteers. Other bridges may have been occupied, but the program lacked monitors in northern NJ to document all possible sites.
- The Jersey City falcons failed to nest for a second year; the pair, new in 2015, had nesting disrupted when the tierce was apparently replaced by a new (similarly unbanded) male. One egg had been laid but not incubated and was later abandoned. The Jersey City site continued to be on webcam taken over by CWF-NJ in 2015.

- We banded 36 of the 47 young produced this year, using both a federal band and an auxiliary, bicolor band with an alpha-numeric code following USGS Bird Banding Lab protocol.
- Four addled eggs were collected from four different nest sites this season. Addled eggs from 2014 and 2015 were submitted for contaminant analysis to Dr. Da Chen at Southern Illinois University, where previous years' eggs were analyzed. Dr. Chen's research focuses on the accumulation and effects of flame retardants.
- We continued to use remote, motion-activated cameras to photograph peregrines at nests. Using this method we read the leg bands on 16 breeding adults at 10 nest sites. An additional 12 adults were identified using optics. A minimum of 6 adults (15%) were unbanded. The oldest female identified was an 18-year old Atlantic City bird that failed to lay eggs a fourth consecutive year; one nestling was successfully fostered and fledged at this site. The oldest known male was 12 years, at the Burlington-Bristol Bridge where he has little fear of people. The median age of males and females was 9.0 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 resightings we recorded at NJ nest sites, we received reports of peregrines sighted here and elsewhere:
  - 85/AN Stone Harbor 2014 female recaptured/released September 2015 at Assateague National Seashore
  - 92/AN Paulsboro 2015 female resighted October 2015 on a building in Tyson Corner, VA
  - 98/AN Drag Island 2015 female recaptured/released September 2015 at Cape May
  - 91/AM Forsythe-Brigantine 2015 male found dead December 2015 near Skidaway Island, GA
  - Adult female 1687-02937, banded as an adult in Paulsboro, died in December 2015 with an impacted crop; possibly the result of injuries sustained in a territorial battle.
  - BD/14 Atlantic City 2015 female, resighted August 2015 at Brigantine Natural Area. Captured and moved off JFK Airport in August 2016
  - 15/AM (Atlantic City 2012 male) and 15/AE (Dividing Creek 2010 male) were resighted in Stone Harbor in October 2015. 15/AM also resighted there in September 2016
  - 72/W Jersey City 2009 male had been nesting at NY Presbyterian Hospital in 2014-15, was euthanized December 2015 after being found with a serious wing injury
  - 61/Y Ocean Gate 2007 female was recaptured at Assateague October 2007; resighted nesting on Queens, NY, Marine Parkway Bridge 2012
  - 79/AN Jersey City 2014 female recaptured/released September 2015 in Toronto; resighted March 2016 Regent Park, Toronto
  - 23/AN Atlantic City 2012 female resighted nesting in Bergen County
  - 27/AW NY 2012 male resighted nesting in Secaucus
  - Y/98 NY Throgs Neck Bridge 2010 female took up nesting in Elizabeth, replacing G/*S (black/red) who had initiated nesting there in 2005 as a two-year-old
  - 13/BR banded in Reading, PA in 2015 was resighted at Holgate beach October 2015 through June 2016
  - 56/AN Sea Isle 2013 female resighted July 2016 in Avalon
  - BD/31 Atlantic City 2016 female was resighted August 2016 at Forsythe-Brig, later killed at PHL Airport 8/21/16
  - A/11 Jersey City 2009 female has been nesting at Middle River power plant in MD; recovered injured, treated and released in MD in September 2016
  - 94/AM Tacony-Palmyra 2016 male was killed at Harrisburg Airport August 6 2016
  - BD/37 Elizabeth 2016 female was recovered injured September 2016 and treated in Cutchogue, NY
  - BE/04 Elizabeth 2016 male resighted September 2016 at Sandy Hook
- New sites were added to the Biotics database.

Conclusions:
- The peregrine population remained stable in 2016 with average nest success and productivity. Across all sites – towers, buildings, bridges and cliffs – nest success was 67% and 1.57 young produced per active site, figures that are average and well below last year's results (Figure 1). The tower and building nest sites are the consistent center 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 sites declined in 2016, where just three of seven sits fledged young. We had documentation on seven occupied territories and a total of eight fledged young yielding a 1.14 productivity rate. Observations continued to be difficult in the more remote locations and where nest sites cannot be viewed after leaf-out. One adult female was injured in a territorial battle just as she initiated nesting and was replaced at the nest which did fledge young; the injured bird was successfully treated and released after fledging. The highly variable nest success at the cliff territories continues to be a problem if we consider occupancy of historic habitat important to a fully recovered population. Targeted investigation of the cause of those losses is necessary to guide future 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, and many other pairs occupy human-constructed sites. With site management and the cooperation of bridge and building staff, these sites can contribute to population viability and stability, but proper site management takes staff time and attention. 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 the age structure to nest success and contaminant levels will inform conservation decisions regarding species status and recovery planning.
- 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.
- 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, 2016

Site Name	Occupied	Active	Eggs	Young Hatched	Young @ Band Age	Young Fledged	2016 Comments
101 Hudson, Jersey City	Y	Y	1	0	0	0	Post-term egg removed 4/29
Atlantic City – ACUA water tower	N	N					Tower blocked/igloo provided.
Bayside Prison Water Tower	Y	Y	?	3	3	1	1st nest failed. Renest: 2 fledglings died 8/8.
Drag Island	Y	Y	3	3	3	3	
Egg Island WMA/Dividing Cr	Y	Y	3	2	2	2	
Elizabeth-Union County C.H.	Y	Y	4	3	3	3	
Forsythe NWR/Barnegat	Y	Y	4	4	3	3	Tx 1 chick to AC 5/16
Forsythe NWR/Brigantine	Y	Y	3	2	2	2	
Great Bay WMA/Water Twr	N	N	-	-	-	-	
Hilton/Casino/Atl Club	Y	N	0	0	1	1	Old F. Fake egg 4/29, fostered chick 5/16.
Logan Generating Plant	Y	Y	4	3	3	2	1 died @fledging
Margate Marsh	N	N					
Marmora WMA	Y	Y	5	2	2	2	
Newark: Unknown site	Y	Y	?	?	?	1	1 fledgling to TRT 6/7 from Prud Ctr
Ocean Gate	Y	Y	4	4	4	4	
Paulsboro Refinery	Y	Y	?	0	0	0	New, young F.
Sedge Island WMA	Y	Y	4	?	1	1	
Sewaren Generating Station	Y	N					
Strathmere Marsh	Y	Y	?		3	3	Found 6/20 w/3 fledglings
Stone Harbor	Y	Y	4	0?	0	0	
Swan Bay WMA	Y	Y	?	0	0	0	
Trenton-Roebling Bldg (box 2015)	N						
Tuckahoe WMA	Y	N	0	0			
Wildwood Crest-Grand Condo	Y	N	0?				
SUBTOTAL: TOWERS & BUILDINGS	**20**	**16**			**24**	**28**	***Young/Active=1.75***
Delaware Water Gap	N	N					
Natural Site C-1	Y	Y	3	2	2	2	
Natural Site C-2	Y	Y	4	4	4	4	
Natural Site C-3	N	N					
Natural Site C-4	N	N					
Natural Site C-5	Y	Y	?	?		0	
Natural Site C-6	Y	Y	?	?	?	?	
Natural Site C-7	N	N					
Natural Site C-8	Y	Y	?	?	?	?	
Natural Site C-9	Y	Y	?	?	0	0	
Natural Site C-10	Y	Y	?	?	2	2	
SUBTOTAL: NATURAL SITES	**7**	**7**			**8**	**8**	***Young/Active=1.14***
Ben Franklin Br. (Del R)	PA					1	
Betsy Ross Bridge (Del R)	Y	Y	3	2	1	0	Killed on roadway 6/22
Brigantine Bridge (A.C.)	U	U					
Burlington-Bristol (Del R)	Y	Y	4	3	3	3	In NJ tower
Commodore Barry (Del R)	PA					3	
G. Washington Br (Hudson R)	NY						
Newark Bay Br. (NJTP or Conrail)	U	U					
NJ-PA Turnpike Br. (Del R)	PA					2	
Ocean City-Longport Bridge	U	U					
Pulaski Skyway Bridge	Y	U					Pair obs mating March
Route 1/Raritan-New Brunswick	Y	Y	?	?	?	3	1 fledgling to TRT 6/7, 2 obs fledged 6/19
Route 3/Hackensack NJDOT	Y	Y	?	3	3	3	
Route 35 Bridge-Belmar	Y	Y	?	0	0	0	Failed 4/21.
Route 46 Br./Little Ferry-Ridgefield	N	N					
Route 72 Br (2015 old, 2016 new)	Y	Y	?	2	2	0	2 died @fledging
Scudders Falls Bridge	PA						
Secaucus-Kearny NJTP Bridge	U	U					
Tacony-Palmyra Br. (Del R)	Y	Y	4	3	3	2	Nest cam. 1 fledgling DOR 6/7.
Trenton RR Br	U	U					
Vince Lombardi – NJTP Bridge	U	U					
Walt Whitman Bridge	PA					3	
SUBTOTAL: NJ BRIDGES	**8**	**7**				**11**	***Young/Active=1.57***
TOTALS (NJ Only)	**35**	**31**				**47**	***Young/Active=1.57***

<mark>Osprey</mark>

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 2016, biologists and volunteers surveyed 496 nests and determined outcome at 363 nests (73%) 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 363 nests (Table 1). We grouped nests by watershed or water-body areas to which they were closest. Nest success averaged 1.79 young per active nest, which is close to the ten-year average of 1.82 young per active nest. Weather was mostly favorable with average temperatures and precipitation. There was one wind storm on June 21 causing nestling mortality in 15 of 50 nests (30%) surveyed the following day. Nest productivity varied by geographic area, with slightly higher productivity (1.93 young/active) at 60 Delaware Bay nests compared to the other regions (1.77 young/active).
- A total of 361 young were banded for future tracking. In addition, we began using an alpha-numeric color band on nestlings banded in Barnegat Bay nests. Twenty red auxiliary bands were deployed this summer to add to the 100 deployed in 2014 and 2015. A re-sighting project was implemented to help determine nest site fidelity, foraging habitat, and to engage the public in osprey conservation.
- Seven volunteer banders checked nests across ten colonies and donated 239 hours toward accomplishing this work. A pre-season orientation meeting was held in June to discuss data filing using an Excel format, in addition to 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.
- Nest locations were made public in 2013 by sharing data with the Center for Conservation Biology's "Osprey-Watch.org" website. We anticipate this website will support citizen reports that help us census and maintain data on the population.
- CWF organized volunteers to install 10 new nest platforms along the Atlantic Coast. CWF also worked to maintain many of the existing platforms throughout New Jersey. Repairs were made to more than 20 nest structures.

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 near 600 pairs. Only one watershed area, the urban Hackensack-Hudson river area showed poor success at 0.75 known young/active nest.
- Weather conditions during the nesting season were mostly mild, but one windstorm struck the Wildwood area on June 21, that resulted in nestling mortality in the Wildwood-North Wildwood area and reduced nest success.
- 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 future of the osprey population is heavily dependent on the long-term maintenance of suitable nest structures, assuming that the availability of dead trees will continue to be limited in the highly developed barrier islands of NJ.

Recommendations:

- Conduct a population census every four to five years (next survey in 2017/18) to monitor population changes statewide and regionally. Maintain integrated databases on the population and nest locations on an annual basis, so they can inform habitat mapping and land-use regulations.
- 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.
- Continue to refine the data-reporting system to improve data handling.
- Continue to collect addled and unhatched eggs to archive for monitoring contaminant levels regionally and statewide.

Table 1. Osprey nesting and productivity in 2016 in all NJ nesting areas. Productivity determined by aerial and ground surveys in May-July. Productivity rates in 2015-2012 provided for comparison.

Nesting Area	# Nests	Known-Outcome Nests	# Young	# Banded	Productivity 2016	Previous Years			
						2015	2014	2013	2012
Delaware River & N. Jersey	6	4	4	0	2.00	2.00	n/a	n/a	n/a
Hackensack River/s	5	4	3		0.75	1.00	1.20	1.50	2.33
Raritan Bay & Cheesequake	43	22	38	1	1.73	1.93	1.92	1.74	2.00
Monmouth County	20	11	20		1.82	1.27	2.00	2.00	2.20
Barnegat Bay	74	46	82	45	1.78	1.33	1.48	1.88	1.94
Sedge Islands WMA	26	17	37	18	2.18	1.65	1.05	2.00	2.10
Great Bay to Atlantic City	72	40	82	21	2.05	1.46	1.84	1.79	1.68
Great Egg Harbor/Ocean City	66	58	125	89	2.16	1.83	2.30	2.09	1.32
Sea Isle City	22	21	27	20	1.29	1.87	2.43	1.68	1.78
Avalon/Stone Harbor Bays	52	50	77	56	1.54	1.75	2.12	1.79	1.75
Wildwood Bays & Cape May	45	30	40	3	1.33	1.88	2.46	2.00	2.13
Maurice River & Estuary Marshes	65	60	116	108	1.93	2.15	2.30	2.12	2.09
Salem Co./ Artificial Island / Delaware						1.60	2.50	1.90	1.62
TOTAL of Study Areas	**496**	**363**	**651**	**361**	**1.79**	**1.74**	**2.02**	**1.92**	1.81
Del River Basin/North J	11	8	7	0					
Atlantic Coast only	420	303	535	253	1.77	1.66	1.97	1.88	1.76
Delaware Bay only	65	60	116	108	1.93	2.11	2.32	2.09	2.00
Total Statewide		**363**	**651**	**361**	**1.79**	**1.74**	**542**	**542**	

American Kestrel

Prepared by: William Pitts, Assistant 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:
- 2016 marked the beginning of the second decade of the American kestrel nest box project. Of the eleven years, this was the most productive season ever; a total of 62 nesting attempts produced 162 fledglings. Over the course of the project, 1,048 fledglings and 248 adult have been banded.
- Eleven boxes were removed in 2016. Many of the removed boxes were from suboptimal locations, or where volunteer help or landowner support was lacking. In all, ENSP selected 144 nest boxes for monitoring in 2016 (Figure 1), focusing on the most productive boxes from our original study areas. Partners from the Nature Conservancy (TNC) continued to monitor 40 boxes installed in 2015 in Salem, Cumberland, and Cape May counties. This new study area expanded the nest box program to other important habitat areas for kestrels in NJ 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.
  - A total of 144 nest boxes were monitored every 12-15 days from April through early August 2016: Twelve volunteers monitored 90 nest boxes and staff monitored 54 boxes.
    - Of the 144 actively monitored nest boxes, 54 (37%) were occupied by kestrels. Five of TNC's 40 boxes (12%) were active and four had nestlings that were banded by ENSP.
    - Of 62 nesting attempts, 39 (63%) were successful, as defined by nestlings that reached the bandable age of 14-22 days. Twenty-three nests or nesting attempts (37%) failed.
    - Volunteers and staff continually entered data online through a Google documents interface following each nest box route check.
  - Two new volunteer monitors were recruited and trained in 2016. One volunteer in Hunterdon County moved two boxes and installed an additional three boxes.
  - Nesting success (63%) was lower in 2016 than in the previous five years (Figure 2). However, total nesting attempts were the highest ever for this project (n=57), with the previous high coming in 2009 (n=54; Figure 3). Average productivity per successful nest was 4.24 in 2016, another best for the project, and productivity for all occupied nests was 2.60, which was on par with 2015 (Figure 2).
  - The previous project leader left ENSP in fall 2014, so we did not update the predictive American kestrel patch model (patch sizes 0-250 ha, 250-1,000 ha, and >1,000 ha) for suitable habitat in NJ. This may be revisited in the future, but currently there are no plans for this update.
  - Based on the existing patch model, 68% of the 2016 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.
  - The 2016 banding season resulted in the following:
    - 195 kestrels were newly banded: 161 young (84 female, 77 male) and 34 adults (29 female, 5 male) were banded at 43 nest boxes. All banding data was submitted to the Bird Banding Lab via Bandit.
    - Sixteen previously banded adults were recaptured (14 female, 2 male). Of those, 10 kestrels (9 female, 1 male) originated outside of our nest box program; eight were banded as fledglings in eastern PA (3 in 2014, 5 in 2015), one was banded as a fledgling in Northern NJ in 2015, and the other was banded as a fledgling in Shenandoah County, VA, in 2015. The remaining recaptured birds had been banded by ENSP prior to the 2016 season; their bands dated back as far as 2012 (one bird, banded as a fledgling).

- 2016 Marked the fourth year of geolocator study in NJ.
  - A total of 20 geolocators were deployed between 2013 (n=15) and 2015 (n=5). A total of 7 geolocators were retrieved between 2014 (n=5) and 2016 (n=2), for an overall recovery rate of 35%. Geolocator recovery rates vary among species and rely on recapturing tagged individuals; for this project, the recovery rate was slightly higher than a similar study in CT (T. Sayers, 27%), but was higher than band recovery rates of 4% overall and 14% for banded adults. Six of the seven geolocators that were recovered were from live captured birds.
  - Of the five tags recovered in 2014; four were from birds recaptured at nest boxes and the other was from a kestrel found dead in Quakertown, PA. Results indicate that three of the female kestrels remained in the same general area in winter as in the summer, while the other two migrated to south Florida for winter (Figure 5). None of the remaining ten tagged birds was recaptured in 2015 or in 2016, despite a focused effort to do so.
  - Both of the geolocators that were recovered in 2016 were from birds recaptured at nest boxes. One was recaptured in the same general area where it was banded in 2015, while the other was captured by a bander in Bucks County, PA, who encountered her during nest box checks for his own nest box project. Two additional boxes where geolocators were deployed in 2015 were active in 2016, however new adult females were nesting in those boxes suggesting that our tagged birds had either perished or been replaced at those sites.
  - Preliminary results of the two 2016 geolocators indicate that the NJ recapture remained in the general nest area over the winter, while the PA recapture had migrated to south Florida for winter.
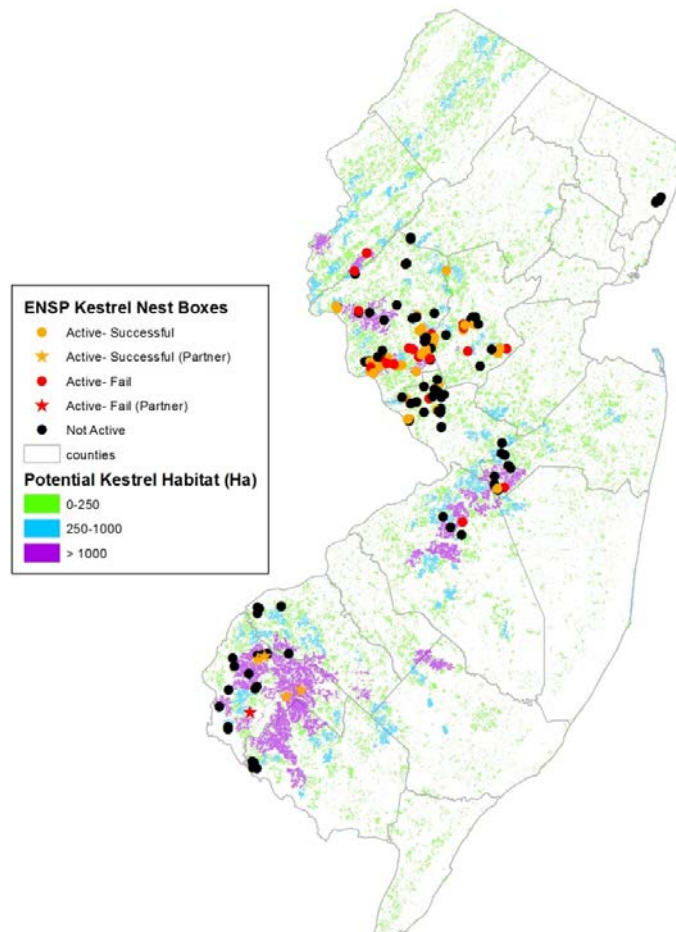

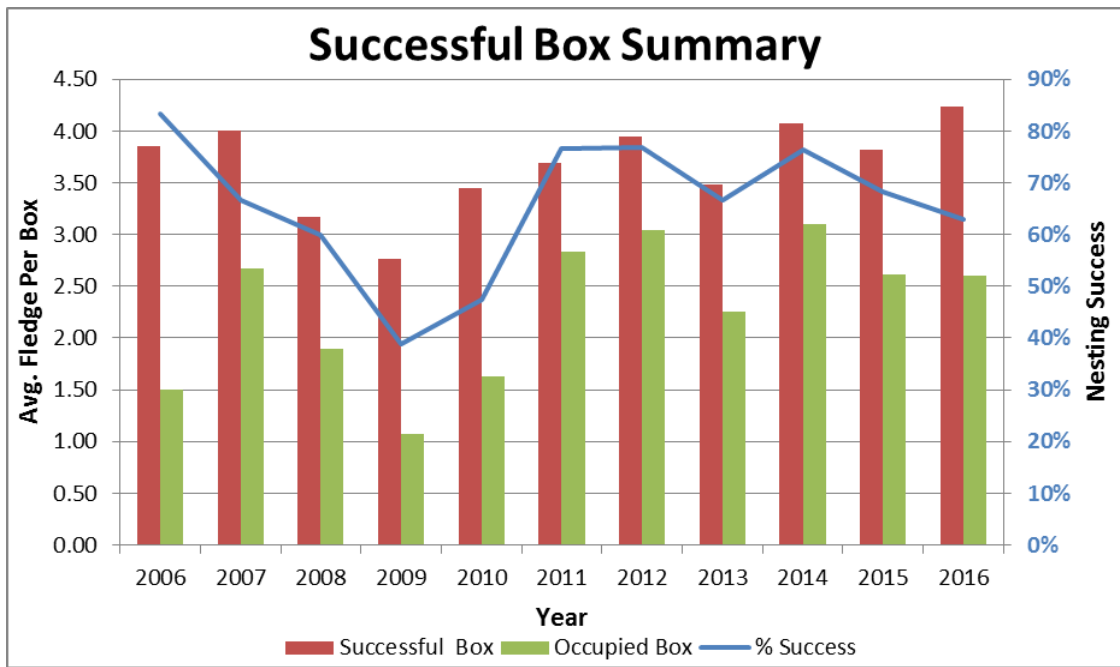Figure 1. American kestrel nest boxes monitored in 2016

Figure 2. Average number of fledglings per occupied versus successful boxes, and overall success of occupied boxes 2006-2016
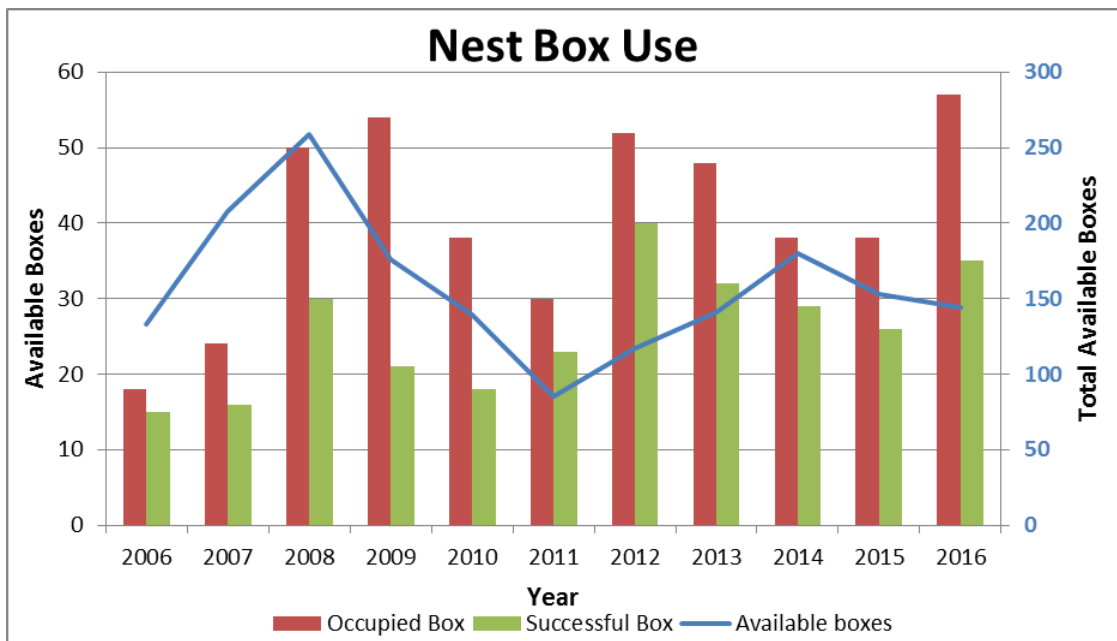

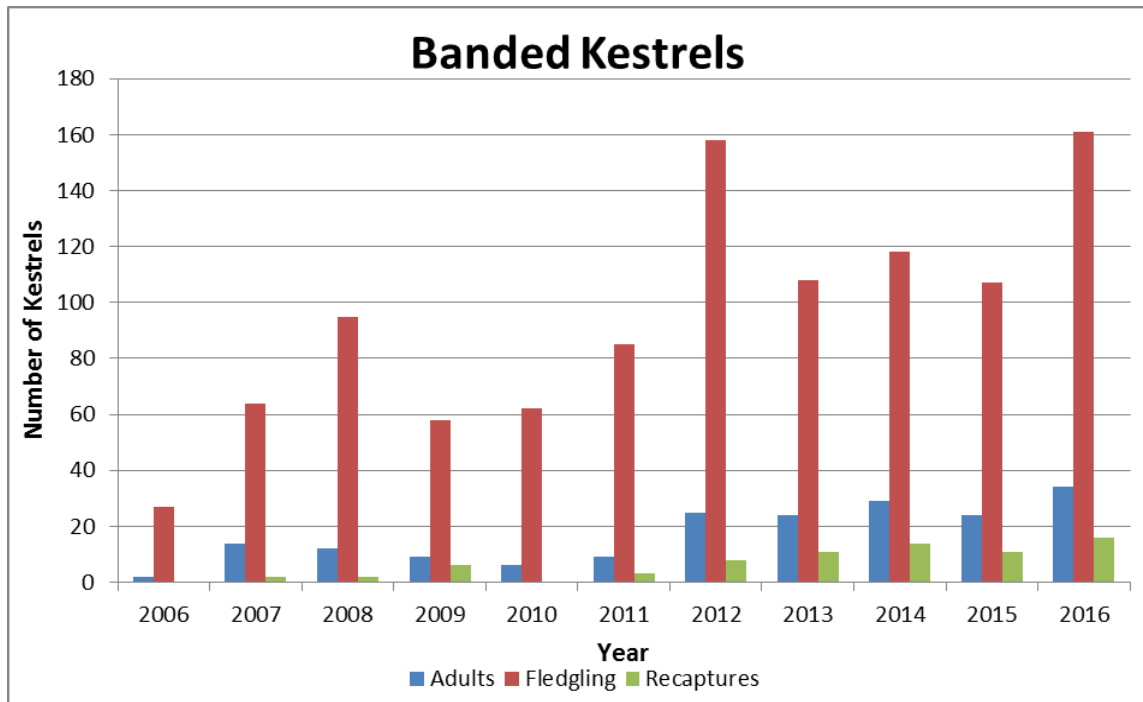Figure 3. American kestrel nest box use 2006-2016
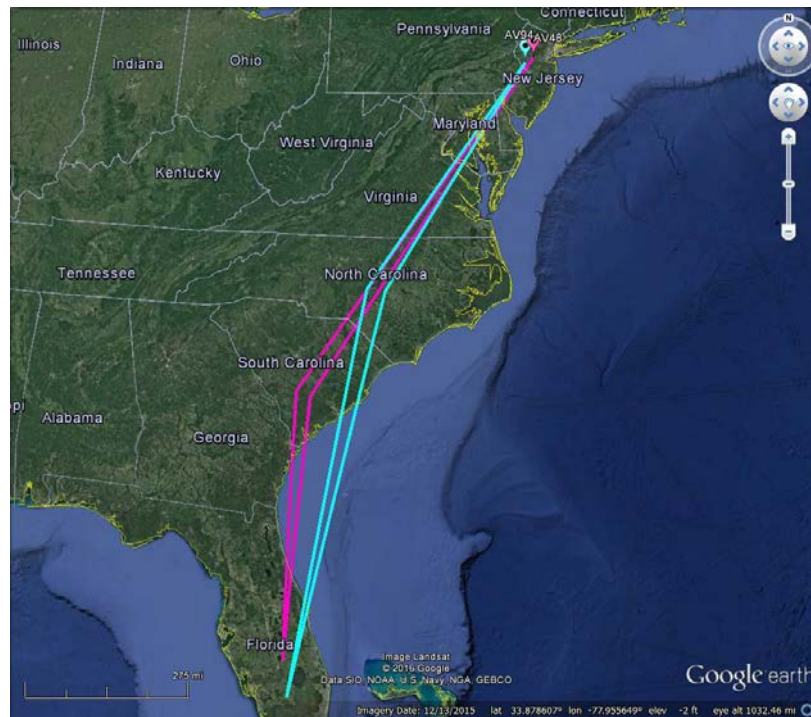
Figure 4. American kestrels banded 2006-2016

Figure 5. Migration routes for recovered 2013 geolocators. Note: Lines connect known stopover points but do not infer the bird's route of travel

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.
- Despite the continued reduction in nest boxes monitored, ENSP had its most productive kestrel nesting season in 2016. The continued refinement of box locations 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.
- TNC increased their program along with productivity, from three active boxes in 2015 to five active boxes in 2016. 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. Given this continued success, and ENSP's lack of success in South Jersey, we will likely move or remove most of our boxes in this region.

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. Attempt to quantify starling nesting competition.
- 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.

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. However, ENSP staff will be consulting with a biostatistician to help design 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 targeted forest management for SGCN species.

- ENSP staff had purchased a GPS telemetry system from Telemetry Solutions in 2013 when they were the only company offering a GPS transmitter that was small enough (<20g) for a barred owl. As reported in annual reports in 2013 and 2014, we had poor success with those tracking devices. We sent the units back after season one and asked that they be checked and tested; in season two, we had similar, poor success with the GPS units successfully recording location coordinates in about 20% of attempts. The manufacturer, Telemetry Solutions, could not explain the poor rate of recording location coordinates. A further problem was the battery life that was limited to about five weeks; that is a more common problem that tends to go along with small transmitter size and lack of solar-power recharge option.
- The data that was recorded by the GPS units 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, therefore, make and conclusions about the home range and habitat use by barred owls based on this study to date.

Conclusions:
- Technological applications are improving all the time, so in the near future it is likely that tracking devices will be available in the size range to accommodate barred owls. The project leader has discussed these issues with other researchers, and with a different manufacturer who is developing the kind of 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.