Report
State Wildlife Grants
T-1-5

Endangered, Threatened and Rare Wildlife Conservation Projects

Progress Report for Project Year
September 1, 2009 – August 31, 2010

NJ Department of Environmental Protection

DIVISION OF FISH AND WILDLIFE

ENDANGERED AND NONGAME SPECIES PROGRAM

NEW JERSEY DIVISION OF
Fish and Wildlife

Conserve Wildlife

EXECUTIVE SUMMARY

Project:	**Bird Conservation**
Federal Aid Project:	T-1-5 amended (State Wildlife Grants)
Segment dates:	September 1, 2009 to August 31, 2010
Total Project Expenditures:	$751,496 ($375,748 Federal, $375,748 State) (09-10 year only)

JOB 1: Federal and State Listed Bird Species

OBJECTIVE: To halt or reverse the decline of endangered and threatened species populations through a coordinated approach of population and habitat monitoring, threat assessment, habitat protection and acquisition, management, research, education and environmental review.

JOB 1A: Bald Eagle Monitoring and Management Planning

Project leader: Kathleen Clark, Supervising Zoologist

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:

- ENSP biologists monitored all nesting pairs known and tracked in list format. Sixty-five 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 2010, 90 territorial eagle pairs were monitored during some or all of the season, of which 82 were active (exhibiting incubation) and eight were territorial (maintained a nest area). While we monitored ten pairs that moved to new nest trees in 2010, four pairs that nested in recent years were not relocated after they moved (Figure 1).
    - During the 2010 nesting season, 43 nests were successful in producing 69 young, for a productivity rate of 0.84 young per active nest. The productivity rate of 0.84 young per active nest is lower than the minimum rate required for a stable population in the long term, and lower than the ten-year average in New Jersey of 1.30 young per active nest by one-third. Overall nest success rate was 52%, lower than the ten-year average of 77%.
    - The high nest failure rate seemed to be related to weather, primarily. Most of the 33 nest failures occurred during the egg incubation period, when there was higher than average snowfall in the state. At least three other nests failed between the time of hatching and three weeks, generally in association with wind or rain storms. Due to the poor weather conditions, many nest observers could not make observations as often as they usually do, and so were less able to document exact dates of failures.
    - Thirteen new eagle nests were discovered: one in north Jersey in Sussex County, one in central Jersey (Ocean County) and 11 in Salem, Gloucester, Cumberland and Cape May counties. Eagle nests have been documented from 20 of the state's 21 counties in recent years, although they are currently active in 18 counties.
- ENSP biologists visited a sample of nests to band young with federal and color leg bands and to take blood samples. In 2010 we banded 17 eaglets at ten nests. We took blood from all 17 banded eaglets and stored it for future analyses.
    - One unhatched and addled egg was collected during a nest visit at Oradell Reservoir in Bergen County. The egg was found in the nest, hidden by nest material; the adults had abandoned the nest during incubation for unknown reasons.
- 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 (52 of 90 total, 58%) were located on private land, with the balance on state, federal, county, municipal and conservation-organization lands.
- ENSP biologists coordinated the Midwinter Eagle Survey that took place January 9-10, 2010. A total of 333 bald eagles was counted by volunteers and staff, up 15% from 2009 and a new high count in New Jersey since the survey began in 1978 (Figure 2). Most eagles (258) were observed in southern New Jersey, primarily in the Delaware Bay region; northern New Jersey had 75 bald eagles on the Delaware River and on inland reservoirs. The cold temperatures likely contributed to the increase in wintering eagles in the state. Surveyors recorded detailed data on eagle locations, and those data were compiled to help document critical eagle wintering habitat. Total figures also were reported to the USDOI Bureau of Land Management's Raptor Research and Technical Assistance Center, which compiles national winter eagle counts.
- Staff used Midwinter Survey point-location data to identify important wintering habitats. Data from past surveys (2008) were digitized, and polygons were digitized from those points. Continued surveys of these sites during annual Midwinter Surveys will help track their use over time. The condition of wintering habitats can be tracked as land use/land cover mapping is updated.
- All new nests were GPS'd using a Trimble unit in the non-nesting season and were added to the database. Revised Landscape Project mapping that included new nests was provided to DEP offices for use in environmental review.
- New nests in Pennsylvania within 2 km of the Delaware River (NJ border) were provided by PA Game Commission biologists, and were included in NJ mapping. NJ eagle habitat mapping can therefore represent important eagle habitat that spans the Delaware River but crosses the state line. This cooperation in 2010 important to map additional nests on the Delaware River, and to facilitate nest protection guidelines for environmental review in border habitats.
- Staff participated in meetings and correspondence on the topics of the USFWS management guidelines and the post-delisting monitoring plan. In 2010, NJ continued our monitoring using the "list" method.
- ENSP staff worked with Bureau of Law Enforcement to address specific problems at nest sites, and included Law Enforcement officers in the pre-season eagle project orientation meeting.
- No action was taken on comparing management practices for efficacy. Currently, management is designed for specific nest sites to address on-site issues in the context of site conditions (habitat and other).

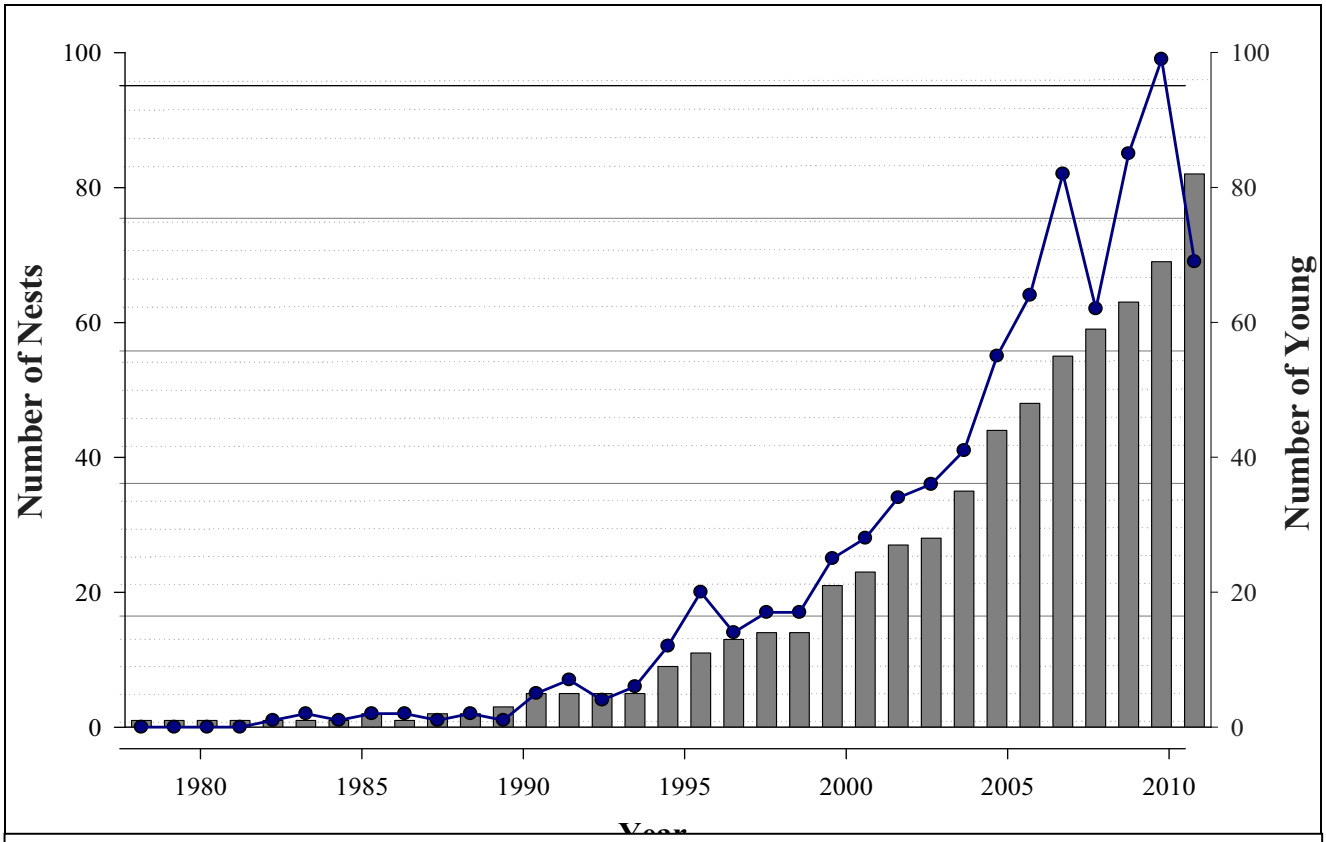


Figure 1. Number of bald eagle nests (bars) and young produced (line) in NJ, 1978-2010.

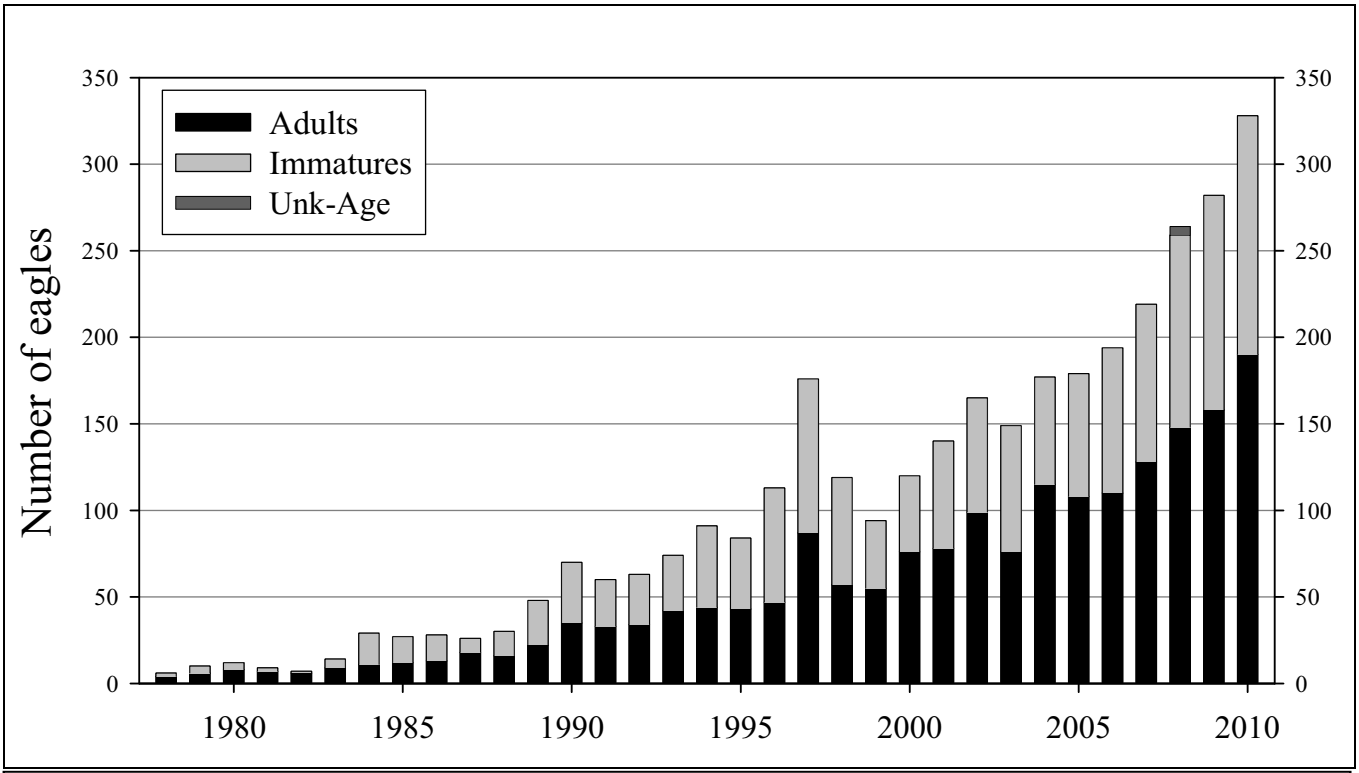


Figure 2. Number of bald eagles counted during the annual Midwinter Eagle Survey in NJ, 1978-2010.

Conclusions:

- The New Jersey bald eagle population has increased an average of 14% per year since 2000, a momentum that results from average productivity of 1.30 young per active nest. The state's eagle population has been increasing since the late 1980's, when one nesting pair existed in the state, but population growth has been substantial only since 2002. Management by biologists that includes nest-site protection in cooperation with landowners has been essential to success in NJ. In 2010, 13 new eagle nests were discovered, and expansion into unoccupied habitat is likely to continue in the next few years.
- In 2010 eagles suffered some setbacks, when 52% of nests failed and productivity dropped by one-third, mostly due to wind storms and higher precipitation (snow and rain) during January and February.
- While the strength of the current recovery is encouraging, most of the population growth is very recent and must be viewed with caution. Regulatory protection levels, nest site protection, and efforts by nest observers and landowners have been essential ingredients in the current recovery, and will be necessary to sustain it. With federal delisting and strengthening of the federal Bald and Golden Eagle Act, we will seek more coordination with the USFWS to minimize disturbance and habitat loss to development and other activities.
- As evidenced this year, harsh weather conditions during sensitive incubation and early hatching periods can have a significant effect on nest success. It remains important to continue standardized monitoring for the foreseeable future to measure nest occupancy and success to assess eagle recovery in the state.
- Disturbance is a major management issue at many nests, and posting and regular surveillance by staff and nest observers are essential to protecting nests and ensuring the chance of success.
- Contaminants may be affecting nest success at several nests in the lower Delaware River region at a localized level. Regular nest failures often cause eagles to relocate to an alternate nest, making site management and habitat protection more complex, especially in the face of development pressure. Planning is necessary to manage for long term recovery as well as development needs.
- The majority of nests are located on privately owned land, making landowners key partners in the maintenance of the eagle population. While many landowners have become staunch advocates for the eagles and work closely with the ENSP biologists, others may have other goals for their land that may threaten long-term habitat viability.

Recommendations:

- Continue to monitor population size, activity and productivity through weekly or bi-weekly observations of nests. 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.
- Continue to monitor the New Jersey wintering population through the annual Midwinter Eagle Survey in January, in coordination with regional and national efforts.
- 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.
- Monitor for environmental contaminants in the population by 1) annually taking blood samples from nestlings and 2) regularly testing eagle prey animals for contaminant exposure.
- 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.

JOB 1B: Piping Plover Conservation

Project Co-leaders: Christina Kisiel, Senior Environmental Specialist, and Dave Jenkins, Chief

This job is jointly supported by State Wildlife Grants and ESA Section Six funding.

OBJECTIVE 1: To determine statewide and site specific piping plover populations, including nesting success and productivity; and determine the nature and level of threats to populations and reproductive success. Reduce threats through implementation of various management strategies in order to advance species recovery both within the state and as part of the coordinated Atlantic coast recovery effort.
OBJECTIVE 2: To evaluate techniques for creating and maintaining supplemental foraging opportunities (foraging stations near the toe of the dune) for piping plover (*Charadrius melodus*) chicks in areas sheltered from human disturbance. This project is a continuation of work that was initiated in 2006.
OBJECTIVE 3: To evaluate techniques to identify mammalian predators of piping plovers and other beach nesting and colonial waterbird nests, including testing DNA residue left on egg remains.

Objective 1: Piping plover abundance and productivity
Key Findings:

- One hundred eight (108) pairs of piping plovers nested in New Jersey in 2010, a 3% increase over 2009 (105 pairs). Despite the slight increase this year, the population has essentially been the same the past three years (111, 105, and 108 from 2008-2010, respectively). The 2010 population remained below the 120-pair average in the years since federal listing.

- The total number of adults recorded for the entire nesting season (226) was nearly the same as the count during the date-restricted survey conducted June 1-9 (223). However, the number of pairs tallied during the entire nesting season (108) was somewhat higher than those counted during the date-restricted survey (101), which is a typical pattern in New Jersey. Slight variations in the methodologies used by the USFWS–Edwin B. Forsythe NWR in tabulating breeding pairs during the date-restricted survey account for most of the difference between the final season and the census pair counts.

- The northern Monmouth County region recorded an 18% increase in pairs (52 pairs vs. 44 in 2009), and accounted for nearly half (48%) the pairs in the state. Furthermore, most of those pairs nested at Sandy Hook (45 pairs or 42% of the statewide total). The next highest concentration of piping plovers in the state was the region comprised of Holgate, Little Beach, and North Brigantine Natural Area with 26 pairs (24% of the statewide total). The southernmost region of the state from Stone Harbor Point to Cape May Point saw the biggest decline in nesting pairs (20 pairs compared to 29 in 2009, a 31% drop).

- Pairs nested at 22 sites, the same as in 2009, but well below the peak count of 30 sites recorded in 2004 and 2005. NJDFW monitored 11 (50%) of the active nesting sites, which accounted for 34 nesting pairs (31%).

- Pair-nest success (the percentage of pairs that successfully hatch at least one nest) for the state was up in 2010 compared to 2009, 84% vs. 66%, and above the 65% average for the period since federal listing. Likewise, looking at just NJDFW-monitored sites, pair-nest success was up sharply in 2010 compared to 2009 (79% vs. 52% respectively).

- The statewide fledgling rate, which incorporates data collected by all state cooperators, was 1.39 fledges per pair, notably higher than in 2009 (1.05 fledges/pair) and one of the highest ever recorded on a statewide basis. Productivity at NJDFW-monitored sites (0.94 fledges/pair for 34 pairs) was well below the 2010 statewide average, but was nearly twice the NJDFW-monitored rate in 2009 (0.48 fledges/pair). This was the first year since 2001 and one of the few years overall since federal listing that New Jersey's statewide productivity was above the 1.24 fledges/pair range wide threshold for population maintenance established in the USFWS Recovery Plan for the Atlantic Coast population of piping plovers (USFWS, 1996).

- Productivity varied by individual site and region, which is a typical pattern. The northern Monmouth County region fledged 1.62 chicks per pair (52 pairs), which was above the USFWS recovery goal (1.50 fledges/pair). Over half (56% or 84 out of 150) of the fledges produced statewide came from the northern Monmouth County region alone. The high productivity in that region, especially Sandy Hook (1.76 fledges/pair for 45 pairs), drove productivity for the entire state, although there were some other areas where robust productivity was recorded as well. The region comprised of Holgate, Little Beach, and North Brigantine Natural Area recorded productivity of 1.42 fledges per pair (26 pairs), also approaching the USFWS recovery goal. Likewise, productivity at Stone Harbor Point (1.44 fledges/pair for 9 pairs) nearly attained the USFWS recovery goal, which is particularly notable for that site because it has typically had very low productivity. Cape May Meadows, a site with strong productivity since 2003 (although it has been reduced somewhat the past two years) also fared fairly well in 2010 with 1.25 chicks per pairs (8 pairs). The southern region of the state (Stone Harbor Point to Cape May Point) pooled together produced 1.20 fledge/pair (20 pairs), somewhat below the rest of the state, but a substantial increase over 2009 when just 0.48 chicks fledged per pair in that region.

CONCLUSIONS

- The state's population of nesting piping plovers increased slightly in 2010 to 108 pairs, but remains below the average of 120 pairs since 1986. Northern Monmouth County area supported nearly half the state's nesting population, and showed the largest regional increase within NJ, led by Sandy Hook in particular. A decline in nesting pairs was found in south Jersey's Cape May County.
- The fledging rate, at 1.39 young/pair, was one of the highest ever recorded statewide. Similarly, pair-nest success was also higher than last year. This was the first year since 2001 and one of the few years overall since federal listing that New Jersey's statewide productivity was above the 1.24 fledges/pair range wide threshold for population maintenance established in the USFWS Recovery Plan for the Atlantic Coast population of piping plovers.
- Because New Jersey's piping plover population trend is closely correlated to productivity in the prior year (or two), we could expect a population increase in 2011. However, there are some factors that may moderate such an increase.
  - The existence of suitable breeding habitat is a baseline requirement for nesting, and habitat quality is severely diminished at a number of current nesting areas due to erosion, wash-over tendencies, and vegetation encroachment. Also, although productivity was generally good across the state in 2010, the Sandy Hook area has been the primary location of strong success. As a result, Sandy Hook has more than doubled its nesting population between 2006 and 2010 (from 22 to 45 pairs) and the Monmouth County region hosted nearly half (48%) of the entire state population this year.
  - Historic development of the coast, as well as heavy recreational use and intensive management of its beaches already limits the number of suitable nesting habitats in the state. Increasing productivity and sustaining populations in the remaining areas with suitable nesting habitat (not just Sandy Hook) is critical if the piping plover population is to recover in New Jersey.
  - The BP oil spill in the Gulf of Mexico may have an impact on piping plover survival rates. A sizeable portion of the U.S. population winters along the Gulf, and may include a portion of New Jersey's breeding population, so there is potential for adverse impacts on our local breeding population in 2011.

RECOMMENDATIONS

Improvements in the nesting population and nesting success were recorded in 2010, but mainly in areas where beach management and disturbance controls were effectively enacted. Such management must continue to maintain the state's piping plover population.

Objective 2: Supplemental Foraging Opportunities

Key Findings:

- Experimental foraging plots (10' x 25') were lined with a thick plastic liner and then covered with approximately 6" of sand which proved effective for:
  - Preventing water from percolating through the sand and instead allowing it to pool.

- Allowing a wet microhabitat to flourish and wetland consistent plants to grow at the perimeter.
- Easy installation and removal.

- "Jetting" continued to be the best technique for installing the wells. The wellpoints were made of PVC pipe and had a 4" diameter. The wells were jetted into the substrate in October, as per a recommendation from last year. This was so that the foraging area would be functioning before the birds' arrival and could act as an attractive habitat feature for the site. The wells went in with no problems but severe winter storms caused so much sand to shift that the wells, though 2-3' above the ground initially, were completely buried. Staff had to hand dig them out from >2' of sand.
- As predicted, Ocean City – Center hosted no pairs this year, so a new site had to be selected and, as recommended last year, that site was Corson's Inlet State Park. Instead of two smaller foraging areas, one large area was created that was fed with two wells. This was in response to a recommendation from last year and was proposed because this site has consistently had birds every one of the 23 consecutive years it has been surveyed. The idea of a larger foraging area was recommended because it seemed more likely to attract and be more valuable to birds than the smaller foraging areas of years past.
- The third unit (unmonitored in this study) remained at Two-Mile Beach at the request of the US Fish and Wildlife Service as they continue testing for the petroleum-like smell associated with the water to determine if there is a contamination issue.
- Corson's Inlet State Park
  - Corson's Inlet State Park is a relatively active beach, but there are no lifeguards. Thus, the majority of the user group consists of fishermen and walkers. Over the course of the five months that the equipment was visible (although inside the same light fencing that protects the plover nests and nesting areas) there were never any incidents of tampering or vandalization of the equipment.
  - The 4" diameter pipes were jet in using high-pressure water. Installation was moderately difficult for one well, and surprisingly easy for the other, though they were located only 30' apart. Both wells were eventually installed in late October by ENSP staff.
  - The 20'x50' plot was dug in early spring with help from the Ocean City High School Ecology Club. It was lined with plastic and filled with a thin layer of sand and wrack (to help retain moisture) and coated with fish fertilizer (to help attract invertebrates). The location of the plot proved to be in an area that was quite susceptible to sand transfer (due to wind) and the plot had to be continually re-dug over the course of the season. ENSP staff did not expect this outcome, since it was purposefully sited in an area that appeared to be protected from wind by surrounding dunes, but this turned out not to be the case.
  - The battery/solar panel combination allowed the pumps to run continuously 24 hr/day. The resulting consistent flow, coupled with the plot being lined, allowed water to puddle, creating the desired effect of artificial foraging areas that mimicked ephemeral pools. The addition of wrack and fish fertilizer allowed the invertebrate habitat to flourish.
  - No birds nested at Corson's Inlet State Park this year, so it was impossible to test how piping plovers would use the foraging area. The foraging area was functional during early piping plover migration, so there was an opportunity for piping plovers to be attracted to the site because of the plot, but that did not appear to occur. The lack of nesting pairs was completely unexpected since there have been breeding piping plovers in each of the previous 23 field seasons surveyed, and probably further back than that.
  - Formal invertebrate sampling was not conducted this year. Testing in 2008 confirmed that the plots attract piping plover food items, so it was deemed unnecessary to re-test.
  - The New Jersey Division of Parks and Forestry and school system of Ocean City were supportive and helpful with this project.

Conclusions:

- Lining the plots with plastic continued to play an integral role in water retention. The combination of the liner and a timer on the pump assured that plots stayed wet virtually all the time, even in the hottest weather.
- Deploying the wellpoints in the fall was a good tactic that allowed the project to begin earlier in the spring than in past years. However, the unanticipated havoc that the winter storms wreaked on the beach, resulting in 2 weeks of intense work by a staff member to hand dig a large area in an attempt to locate the buried wellpoints, suggested that waiting until spring to deploy them is a more efficient strategy. Alternately, if

wells are jetted in prior to winter, GPS points of the well could be taken to assist in relocation efforts should the wells be buried.

- The solar power configuration continued to be a great success. The straightforward operation and the success of the panel throughout the season validated their continued use. They sustained no damage or obvious wear. The addition of the battery to the system continued to work well, and help meet the goal of a constantly moist or wet foraging area.
- This was the first time a foraging plot was sited on state park property. As with other sites in prior years, the public had relatively easy access to the equipment, but no interference or vandalism was detected.
- A strong working relationship with the landowner where the artificial foraging area is located is paramount to the success of the project.
- The lack of nesting birds at this site for the first time in at least 23 years was not deemed related to the presence of the foraging area and the associated equipments that goes along with it (solar panels, linear current booster, etc.). The population numbers have been on a downward trend for a number years and poor productivity made it likely that fewer adults would be returning to the site. This trend has been going on for some time, but there has always been at least one breeding pair at this site and biologists anticipated that this would be the case this year. In addition, Corson's Inlet State Park is a rather large site – nearly a mile in length- and it is likely that a nesting pair or pairs would have just moved to a spot far enough from the foraging area not to be disturbed by it. Furthermore, piping plovers have nested quite closely to the units in years past with no trouble. Therefore, this was deemed an unfortunate coincidence.

Recommendations:

- We recommend not continuing this project. It has been conducted for the past 5 field seasons, and although we gained an incredible amount of information about the best configuration and equipment to create artificial foraging ponds near nesting areas, it has not improved foraging opportunities enough to the staff time necessary to continue it. Although the plots were able to sustain an invertebrate prey base that would suit piping plovers, there is simply too much unpredictability in determining where a plover will nest (and thus whether the foraging area will be in a territory) and whether that pair will be successful (one year a pair nested near the plot, but abandoned their nest and left the area).
- For those who may attempt this work elsewhere:
  - Continue to use the Lorentz pump and the size 6-gauge, 4" diameter wellpoint.
  - Continue to line foraging plots with plastic, add wrack and fish fertilizer, and use the battery/timer to ensure continued success of the system.
  - Choose either a smaller or larger foraging area depending on the attributes of the site (a smaller foraging area worked well for a site like Ocean City – Center from 2009 where birds were split into partitions created by street blocks, but a larger foraging area would be better suited to a site with a wide open nesting area, such as Corson's Inlet State Park).

Objective 3: Identify Mammalian Predators

Key Findings:

- Staff members were instructed on how to gather eggshell remains while reducing the chance of contamination by human DNA. Kits were created for each staff member to carry with them in the field. The contents of each kit included disposable latex gloves, Ziploc baggies and a marker to write the details of the collected eggs (species, date, evidence at scene) on the bags.
- Staff members gathered the remains of predated eggs on an opportunistic basis. Predated eggs were differentiated from hatched eggs by the way the eggs were cracked and by the way the membrane was connected to the egg.
- In 2009, two piping plover eggs were collected and two American oystercatcher eggs were collected. In 2010, one American oystercatcher egg was collected. No other species' eggs were located.
- The purchasing and logistical problems from 2009 continued and no DNA analysis was conducted this year.

Conclusions:

- Individual kits are an excellent way to ensure each staff member always has the necessary tools needed to securely collect any predated eggs that are found.
- The relatively small numbers of samples retrieved highlights the difficulty of detecting predated eggs despite the high numbers of eggs attributed as lost to predation.

Recommendations:
- Continue to collect predated eggs as they are encountered in the field.
- Remind staff members throughout the season to be on the lookout for predated eggs. Detection of predated eggs is difficult, but there may also be an issue of observer fatigue as the season wears on and technicians forget to search for and collect eggs.
- Consider re-formatting this project as a contract. Since issues regarding procurement and analysis are not being resolved in a timely fashion, it may make more sense to outsource this project completely.
- Since eggs are difficult to detect, consider making this a long-term collection process in order to amass a large enough sample to assess predator concerns at different sites around the state. Alternately, or in addition, consider collecting eggs from other species, such as long-legged wading birds, which have similar predators as piping plovers and nest in large numbers, increasing the likelihood of finding predated eggs. These eggs could be a proxy for piping plover eggs and would allow for a greater sample size, which would be especially helpful when classifying the molecular based identities of predators.

JOB 1C: Beach nesting Birds (Black Skimmer and Least Tern)

Project Co-leaders: Christina Kisiel, Senior Environmental Specialist, and Dave Jenkins, Chief

OBJECTIVE 1: To assess population and productivity trends of nesting black skimmers (*Rynchops niger)* and least terns (*Sternula antillarum*) through continued monitoring of nesting sites on the beach strand. Monitoring for black skimmers will also be extended into the Barnegat Bay marsh islands.

OBJECTIVE 2: To determine whether black skimmers are more sensitive to human disturbance when they first arrive at their potential breeding sites than during the incubation and chick-rearing period.

Population and Productivity Trends

Key Findings:
- Black skimmer breeding surveys were conducted approximately every 2 weeks from mid-May until the end of August at barrier island beaches along the entire Atlantic coast and back bay islands in Barnegat Bay. Observations were made at eight nesting sites. A total of 2,227 adults were present at these sites (based on a cumulative total of peak counts that occurred in the August 16-31 survey period). The vast majority (95%) of the known state's population was present at just one site during the peak count survey period, which was located at Seaview Harbor Marina (2,112).
- A peak count of 663 adult black skimmers was observed incubating, but that number is likely an underestimate because vegetation can obstruct the observer's view of the nesting colony and some individuals may not be detected.
- Black skimmer productivity was quite high, relatively speaking, with at least 876 fledglings produced statewide, or 1.32 chicks per pair. The productivity rate may have been lower, closer to 1.00, if the peak incubating adult count was indeed an underestimate. Only three sites fledged young, with the vast majority of young (88%) produced at one site, Seaview Harbor Marina. Tidal flooding at two sites was the primary factor limiting success, even though there were fewer flood events than previous years. However, the lack of flood events combined with the southwestern orientation of the Seaview Harbor Marina beach (generally less susceptible to flooding) allowed this site to flourish.
- 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. Active nesting occurred at 19 sites. A total of 1,274 adults were present at these sites (based on a cumulative total of peak counts that occurred in the 1-15 June survey

period). Significant colonies, with the highest peak counts of adults, were Sandy Hook–Critical Zone (281), Belmar–Shark River Inlet (289), Seaview Harbor Marina (184) and Cape May Meadows (120).

- A peak total of 557 adult least terns were observed incubating. The number of incubating adults varied widely at individual sites across the survey periods due to a combination of predation and disturbance problems. As with black skimmers, flooding played a very small role in reproductive success this year, which was a welcome reprieve from the past few seasons where it has been a larger issue.
- Productivity was low to moderate for least terns with 210 fledglings produced statewide (0.41 chicks per pair, based on the peak number of incubating adults). Unlike prior seasons, and the situation with black skimmers this year, chick production was distributed rather evenly throughout the state. The primary limiting factor was predation, with predator identity ranging from crows to cats to peregrine falcons. Interestingly, Sandy Hook's predator removal program is still paying dividends in the form of productivity for many beach nesting birds, and the appearance of a black skimmer colony after a 20-year absence in this area may be related to this reduction of predators.
- Two particularly interesting nesting colonies this year were the black skimmer colony at Cape May Meadows and the least tern colony at Newark Airport. Black skimmer colony surveys have been conducted since 1976 and this was the first time active nesting was confirmed at the Cape May Meadows site. A few individuals prospected the site in 2009, but no egg laying occurred. This year, 34 individuals were tallied at the site, and while only 3 nests were confirmed, this bodes well for this site in the future. The least tern colony at Newark Airport has existed on and off through the years, but is notable in its dramatic difference from the rest of the colonies in the state. The airport is located further inland than most other sites, the nesting substrate is grass and they roost on the pavement. Their primary issues are related to airstrikes. Despite this unusual scenario, the colony was able to fledge young at a fairly respectable rate (0.50 chicks per pair).
- In both 2009 and 2010, black skimmers were observed nesting on salt marsh cord grass (*Spartina patens)*. This is a higher growing marsh species than the other vegetation that skimmers nest on. Although it is not known if this is in response to rising sea levels, it appears to be a positive development and it may prevent some loss of eggs and chicks during future flood events.

Conclusions:

- The statewide black skimmer breeding population remained very similar in 2010 from 2009 (2,112 vs. 2,219 total adults, respectively), although both years were rather lower than 2008's total of 2,787 adults. However, over the past 10 years, the skimmer population appears to have remained relatively stable.
- Black skimmer productivity was above average this year (1.32 chicks per pair), which should help reduce the impact of 2009's lower rate (0.36 chicks per pair). Black skimmers are a relatively long-lived species and this year's productivity, combined with that which was observed in 2008 (0.51 chicks per pair) and 2007 (0.76 chicks per pair), bodes well for the future of the state's population.
- The number of known black skimmer colonies in the state continues to be of some concern. The 8 occupied colonies is an increase from 2009's 5 sites, but still lower than historical highs of 14-16 colonies, although not all potential colony sites (especially in marshes) are being surveyed annually. Including those small colonies (in 2010, there were 5 observed on the colonial waterbird aerial count, see Job 1E for details) would increase the number of nesting sites known in the state to 13, a figure more in line with historical averages.
- The statewide least tern breeding population was nearly the same in 2010 as in 2009 (1,274 vs. 1,166 total adults, respectively), and on par with levels since 2004. Despite the stability of the statewide population over the past five years, the population remains relatively low with respect to the long-term trend. A slight increase in total adult count in 2010 may signify the beginning of an anticipated increase in the least tern's population, since the previous 3 seasons have resulted in moderate productivity. Productivity in 2010 (0.41 chicks per pair) was higher than 2009 (0.27 chicks per pair), and combined with the productivity of 2008 (0.54 chicks per pair) suggests the near-term prospects for the state's population are good.
- The number of active least tern colonies increased 17% in 2010 compared to 2009 (21 vs. 18, respectively). This also represented a realignment in a range of total number of colonies that is more average for the state.

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 within Barnegat Bay) about once every two weeks during the breeding season in order to make a statewide assessment of population trends.
- Periodically monitor (no less than once every three years) other back bay island complexes within the coastal region of the state to insure that large numbers of skimmers are not nesting in these areas. When sites are identified through this or other means, such as the aerial survey, include them in the once every two weeks survey rotation.
- Continue to incorporate management strategies for black skimmers and least terns into comprehensive beach management plans being developed for municipalities in the coastal zone. Develop similar plans for state managed parks and natural areas.
- Continue to incorporate breeding data into the Landscape Project and NJ DEP's Biotics database.

Watercraft Impacts to Black Skimmers

Key Findings based on the 2009 study:

- Observations were made on Mordecai Island, located in the Barnegat Bay and an important nesting site for black skimmers over the past few nesting seasons.
- Observations were made during the pre-incubation period. In 97 observations, the mean number of skimmers present was 125 $\pm$ 4.1, and the number of boats within 500 m was 1.9 $\pm$ 0.2, although most did not come within 150 m. Further, most boats passed by and did not stop. Because the main channel was more than 150 m from the nesting colony site, boats tended to remain in the channel as they passed by. When five boats came within 100 m and remained there, all skimmers flew up and remained flying about; the boats moved away, remaining about 120 m from the colony, and skimmers were alert for almost an hour, although they eventually settled down. Other boats moved quickly by, and the skimmers stood up when boats were within 120 m, but did not fly.
- During the pre-egg phase, the skimmers flew about more, partly selecting and defending nest sites from one another; the average number of birds flying about was 28 $\pm$ 5.5 skimmers. When disturbed (by boat, helicopter, plane), the average number of birds to fly (124 $\pm$ 4.6) was not significantly different from the average number present. In other words, when disturbed, all skimmers present in the colony flew up. This number represents the mean number in the three subcolonies (there are three sub-colonies on Mordecai Island).
- The mean distance to boats when birds flushed was 97.5 $\pm$ 22.5 m. The mean number of boats (based on over 100 boat-samples) was greater on weekends (mean = 6 $\pm$ 0.6) than on weekdays (1.3 $\pm$ 0.2). There was no difference, however, between weekends and weekdays with respect to the number of birds present, the number of fly ups, or the skimmers responses. In other words, the skimmers responded similarly to disturbances; the more disturbances, the more fly-ups.

Conclusions:

- Most boats during the pre-incubation period stayed in the main boat channel and did not come close to the skimmer colony.
- The boats that did come close elicited a response at a mean distance of 97 meters. Boats that remained within 120 m continued to elicit an adverse response of flying up and remaining alert (very close to the numbers obtained for the rest of the season in the Burger et al. publication).
- Any disturbance that caused any birds to flush caused all to flush early in the breeding season.
- There were nearly five times as many boats present on weekends as on weekdays.
- As noted previously, more skimmers nested in salt marsh cord grass (*Spartina patens*) in 2010. *Patens* grows in less-flooded high marsh than the normal wrack generally used for nesting, thus putting the skimmers farther away from boater traffic than they normally would be.

Recommendations:

- This study should be repeated at least one more year if funds are available, because the skimmer colonies under study all failed in 2009 due to flooding. Further work could also be done at a sand-nesting colony

(perhaps further south), where numbers are higher. Observations could be made by scope from a suitable distance.

JOB 1D: Osprey Monitoring and Management Planning

Project leader: Kathleen Clark, Supervising Zoologist

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

Key Findings:

- NJ Division of Fish and Wildlife biologists conduct the statewide census every three to four years, and the 2009 census documented 485 nesting pairs. No statewide aerial survey was done in 2010 but 21 new nests were located during the course of nest checks by volunteers (Table 1), which raised the known nesting population to 506 pairs.
- In 2010 approximately 71% of the population was checked by ground surveys, which allowed for productivity estimates for the major colonies and the state as a whole (Table 1). During ground surveys nestlings were banded with USGS aluminum bands by licensed bird banders.
- Biologists and volunteers conducted ground surveys in June and July to document nest success and productivity at 355 nests (Table 1). We grouped nests by watershed or water-body areas to which they were closest. Nest success averaged 1.97 young per active nest, one of the highest rates recorded by ENSP biologists and well above the rate necessary for a stable population. Nest productivity was similar between Delaware Bay and Atlantic coast colonies (2.18 vs. 1.92 young/active nest).
- Previous surveys documented that most nests (approximately 80%) were along the Atlantic coast, where many new platforms have been erected over the past four years to increase nesting opportunities. In recent years, more than 50 nest platforms have been installed with funding by private donations.
- Eight osprey eggs were collected during nest visits during the nestling-banding period. Eggs were collected only if they remained when nestlings were at least two weeks of age. Eggs were wrapped in aluminum foil and refrigerated, and were later opened and contents placed in chemically-clean jars and frozen. Eggshells were rinsed and left to dry for $\geq$2 months.
- ENSP staff provided technical assistance and advice to the US Coast Guard, the US Army at Fort Monmouth, and communications companies, to deal with osprey nests in hazardous or unsafe locations.
- All nest locations were maintained in Excel and GIS databases, tracking all occupied nests. Those databases were used to update the state's Biotics database, which is the basis for the Landscape Project critical habitat mapping. The osprey habitat model for use in Landscape Project was also updated with new information. Although we have identified the need for a more streamlined data-handling system, we did not make any progress on that this segment.
- No information was gathered on fisheries' (menhaden and flounder species') trends to identify a potential correlation with osprey population parameters.
- No new volunteers were recruited for banding, but partner Conserve Wildlife Foundation of NJ organized volunteers to install fourteen new nest platforms along the Atlantic Coast.

Conclusions:

- This year's ground surveys by volunteers and cooperators documented one of the highest nest success rates recorded in a coast wide survey, for a population estimated at 500 pairs. Weather conditions during the nesting season were relatively mild, with no major storms to damage nests during incubation or young chick-rearing. The high productivity suggests that fish resources were more than adequate as well.
- ENSP's coordination of volunteers and licensed banders 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 three to four years (next survey in 2012 or 2013) 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 measure annual productivity of ospreys to monitor regional conditions and changes (e.g., Atlantic vs. Delaware Bay regions, and Atlantic subregional comparisons). Continue to recruit and train additional volunteers to conduct nest checks. Investigate a data-reporting system to ease 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 2010 in all NJ nesting areas. Productivity determined by aerial and ground surveys in May-July. Productivity rates in 2006-2009 provided for comparison.

						Previous Years			
Nesting Area	**# Nests**	**Known-Outcome Nests**	**# Young**	**# Banded**	**Productivity 2010**	**2009**	**2008**	**2007**	**2006**
Delaware River & North Jersey	3	1	1	0		n/a	n/a	n/a	1.00
Raritan Bay area (w/Cheesequake)	34	26	43	7	1.65	1.54	1.67	1.38	1.35
Monmouth County	10	7	13	9	1.86	1.25	n/a	n/a	n/a
Barnegat Bay	44	34	65	24	1.91	1.78	2.25	2.06	n/a
Sedge Islands WMA	28	24	31	27	1.29	1.57	1.75	1.15	1.57
Great Bay to Atlantic City	44	39	80	37	2.05	1.53	2.09	1.95	1.56
Great Egg Harbor/Ocean City	50	47	112	88	2.38	1.71	1.72	1.52	1.65
Sea Isle City	15	15	31	17	2.07	1.06	1.55	1.75	2.10
Avalon/Stone Harbor Bays	46	43	81	76	1.88	1.45	1.76	1.93	1.64
Wildwood Bays & Cape May	12	10	15	14	1.50	1.39	1.88	1.89	1.89
Maurice River & Estuary Marshes	56	50	105	79	2.10	1.78	2.11	2.07	1.84
Salem Co./ Artificial Island / Delaware	13	12	30	14	2.50	1.81	1.80	1.70	2.00
TOTAL of Study Areas	**355**	**308**	**607**	**392**	**1.97**	**1.59**	1.88	1.78	1.66
Atlantic Coast only	286	246	472	299	1.92	1.53	1.82	1.72	1.74
Delaware Bay only	69	62	135	93	2.18	1.78	2.05	2.00	2.06
Total Statewide	No state survey	**308**	**607**	**392**	**1.97**	**485**	---	---	**400**

JOB 1E: Colonial Waterbirds

Project Co-leaders: Christina Kisiel, Senior Environmental Specialist, and Dave Jenkins, Chief

OBJECTIVE 1: To determine statewide distribution, nesting populations and productivity of the great blue heron (*Ardea herodias*) through ground surveys. Increase the scope of this survey to include inland colonies of other long legged wading birds, especially black-crowned (*Nycticorax nycticorax*) and yellow-crowned (*Nyctanassa violacea*) night herons, in the northeastern portion of the state by developing and implementing a protocol to complete ground surveys for these species.

OBJECTIVE 2: To determine distribution and population of tern species nesting in the Atlantic coastal marshes. Focal species include common tern (*Sterna hirundo*), Foster's tern (*Sterna forsteri*), gull-billed tern (*Gelochelidon nilotica)* royal tern (*Sterna maxima*), Caspian tern (*Hydroprogne caspia*) and black skimmer (*Rynchops niger*). (*Note: this objective was not originally included in the SWG T-1-5 grant because of lack of funding; funds became available, and this project became possible to complete*).

Objective 1: Great Blue Heron and Inland Heron Surveys

Key Findings:

- The birding community was extremely responsive to requests of locations of great blue heron and night-heron nesting areas. Requests for information were made on the "JerseyBirds" listserv (a listserv that focuses on New Jersey birding and is open to the public) and through New Jersey Audubon's Cape May Bird Observatory website. Many locations submitted by the public were previously known to the state, but this method did uncover 19 new great blue heron sites and nine new night-heron sites. The new colonies represented 28% and 43%, respectively, of the great blue heron (n=66) and night-heron (n=21) sites to be surveyed. Information that was sent in from the public about known colonies was still useful as it filled in data gaps for the years where surveys had not taken place (the great blue heron survey is conducted once every five years and this was the first year of the inland night-heron survey).
- The nature of this survey makes it ideal for volunteers. The species involved are easy to identify and the survey protocol does not require a large commitment of time. Surveyors were asked to visit the colony three times over the course of eight months. Due to these factors, and the inherent charisma of the focal species, recruiting volunteers was not a difficult task. Requests for volunteers were posted on the Division of Fish and Wildlife's website and Cape May Bird Observatory website and through the Division's volunteer listserv as well as the JerseyBirds listserv. However, the length of the survey did make it difficult to ensure that the commitment will be kept by volunteers and there were 15 participants that never returned data about their site(s).
- In addition to volunteers, staff of the NJ Division of Fish and Wildlife's Endangered and Nongame Species Program (ENSP) also participated in this survey. In total, 23 volunteers and eight staff signed up to participate in the state-wide great blue heron survey and nine volunteers and two staff signed up to participate in the NJ-northeastern region inland night-heron survey.
- The online submittal form (which is part of a larger Endangered and Nongame Species Program-wide data submittal project) is still in development by the GIS staff and their contractor. It was not completed by the end of the SWG project year (August 2010) but perhaps it will be available for the next survey, slated for 2014 for great blue herons and 2011 for inland night-herons.
- The survey protocol was developed using techniques described in Steinkamp et al. (2003). These were visual surveys in which observers were asked to visit each colony three times over the course of eight months. The first visit was timed early in the season to determine if the site was active and how many adults and nests were present. The second survey was timed to coincide with late incubation/early brooding and observers counted the number of adults, nests and young/fledges that were visible (views are generally obscured during this survey by the leaves on trees). The final survey took place in late fall after the trees lost their leaves and the birds migrated. Observers were asked to get a post-season nest count during this period. The stick nests that these species built are persistent and still present at this point, but the timing allowed for easier observation and no disturbance to the birds.

- The protocol for the great blue heron and inland night-heron surveys were the same, except that the timing of the first and second survey periods. Great blue herons begin nesting in mid-late March while night-herons do not begin until May. The third survey period remained the same for both groups. The great blue heron survey was conducted state-wide while the inland night-heron survey focused on the northeastern region of the state.
- Data was collected on 50 of the 66 great blue heron colonies (75%) identified for observation and 22 of the 31 surveyors (70%) returned data after surveying. Of the 50 surveyed colonies, 29 were active (58%). To put this in context, in 2005, 30 colonies were active, in 2001 34 colonies were active and in 1996, 18 colonies were active.
- There were a total of 459 adults counted during the course of the great blue heron survey and 279 adults were observed on nests. There were a total of 520 nests counted and 185 juveniles were observed. Since this is only the second time this survey method has been employed (counting birds during the season rather than just tallying a post season nest count) the only comparable data comes from 2004. During that survey, 253 adults, 266 adults on nests, 915 nests and 135 juveniles were counted.
- Data was collected on 16 of the 30 inland night-heron colonies (53%) identified for observation and 8 of the 14 surveyors (43%) returned data after surveying. Of the 16 surveyed colonies, 9 were active (56%). Some of the survey locations were outside the northeast boundary of the study area, but staff resources were such that surveys were conducted. These additional colonies were primarily in the southeast portion of the state. This was the first time this survey was undertaken, so there are no past years to compare with.
- There were a total of 27 adults counted during the course of the inland night-heron survey and 12 adults were observed on nests. There were a total of 17 nests counted and 25 juveniles were observed. This was the first time this survey was undertaken, so there are no past years to compare with.
- A staff biologist attended the Waterbird Society meeting in November 2009. Sessions relating to waterbirds revealed that other states and regions are experiencing similar declines to the ones that are being observed in NJ relating to many species waterbirds. However, it did appear that other states are also seeing their great blue heron populations remain stable or increase. Night-heron populations appear to have more fluctuation, depending on the area of study. An idea of creating a colonial waterbird working group-like endeavor was proposed. Instead of a traditional working group, it was decided by the members that it would be more efficient and would likely have more participation if present technologies (such as social networking sites and online meeting software) were utilized.
- There was no New England regional meeting to report on as it was cancelled due to financial constraints.

Conclusions:

- The birding community in New Jersey is an excellent resource for both information about where various species are distributed and also for recruiting volunteers. The Cape May Bird Observatory staff was helpful in posting the volunteer request, as was the NJ Division of Fish and Wildlife's staff. All colonies were covered thanks to the support of staff and volunteers.
- The survey protocol worked well, allowing biologists to compile enough data to monitor the population without requiring an overly intensive survey schedule that volunteers may struggle to maintain. However, there were a number of colonies that were not surveyed/data was not reported and these were not covered because of volunteers that did not follow through with their commitment to provide data. This is certainly the risk taken when utilizing volunteers and should be considered in the future, even when undertaking a survey that seems to require a small degree of effort. The percent of colonies where survey data was not sent in was higher on the inland night-heron survey than the great blue heron survey and it appears this is because the volunteers who did not turn in data had signed up to do multiple colonies, so their lack of input was intensified.
- It is difficult to make any inferences about great blue hersons from the data in terms of population levels across the state. The numbers reflect that there may be a long term increase in the number of colonies, but this may also just be related to an increased survey effort. The same is true for the metrics reported – on one hand the total number of adults tallied during the 2009 survey was great than that observed in 2004, but the number of nests in 2004 greatly outnumbers the total nest count in 2009. This may be related to an actual

decrease, or may just reflect the colonies that were surveyed, the ease at which nests could be counted, the number of adults present during the survey or anyone of a number of variables.

- The inland night-heron survey was intended as a pilot year survey, with intentions of expanding its reach in future years. This population of night-herons has never before been formally surveyed, so this represented the first step into integrating their nesting information into the overall state statistics. Therefore, there is not a lot to compare it with in terms of prior years. However, it was a successful effort, despite the number of colonies not surveyed, and it was a good first step to building a strong survey effort in future years.
- The online submittal form will be a great asset to these surveys (in the future) since it will eliminate the need for a staff member to complete the data entry for each site. There were 87 total potential sites with three visits for each site, plus notes on directions and observations for each. This required a time-consuming process of data entry by staff, whereas online submittal will allow each observer to enter their own data, a much more efficient method.
- Regional, national and international meetings allow biologists to interact and share ideas on data collection and analysis as well as large-scale population trends. Interaction at this level accomplishes a Program goal of collaboration with regional biologists and understanding how they are working to recover species of conservation concern.

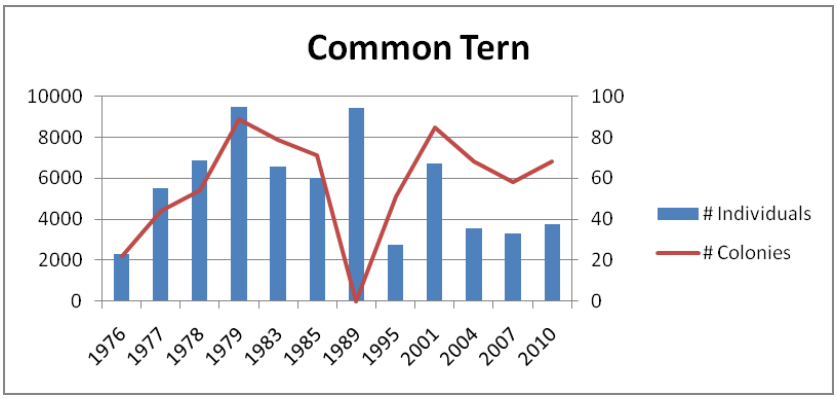
Recommendations:

- Continue to use the protocol that was developed for these surveys in future years. It marks a vast improvement over just counting nests post-season and as more data is accumulated, more will be understood about these populations.
- Consider decreasing the time between inland night-heron surveys from five years to three years to match the survey frequency of the aerial coastal marsh surveys (no aerial survey was conducted this year since one was not scheduled). There also appears to be an increase in the number of night-herons nesting at inland sites compared to areas within the Atlantic coast marsh islands and increasing the frequency of the surveys will help determine if this is an actual trend. The next aerial survey for wading birds is scheduled for 2011, so the next inland-heron survey should begin then as well.
- Despite travel and budgetary constraints, every effort should be made to continue to attend regional and international waterbird meetings.
- All of the colonies slated for surveys were not covered since some volunteers did not submit data and this is an area that needs improvement. Volunteers are an absolutely critical component of these surveys since very few colonies would be covered if only staff were making observations. However, it is equally important that those recruited can be depended upon to complete the task. In the future, consider only using volunteers that participated successfully in the past, or requiring a recommendation form a trusted source in the environmental community.
- Restoration of habitat and investigations into limiting factors of wading bird populations were not included in the approach this year due to time constraints, but they still remain important venues that should be investigated in the future.

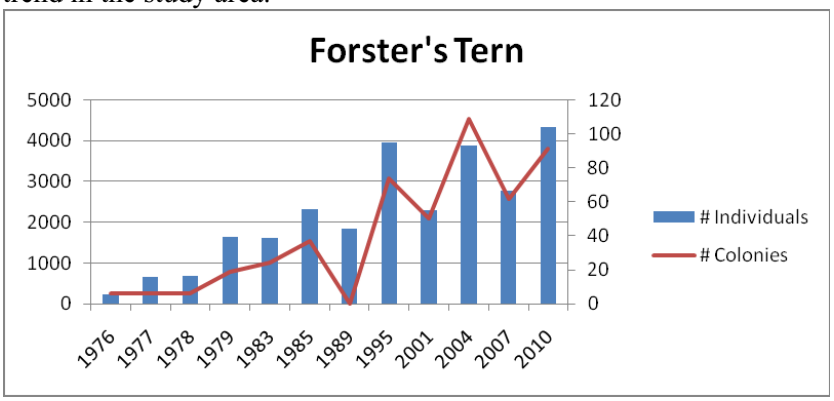
Objective 2: Aerial Tern Survey

Key Findings:

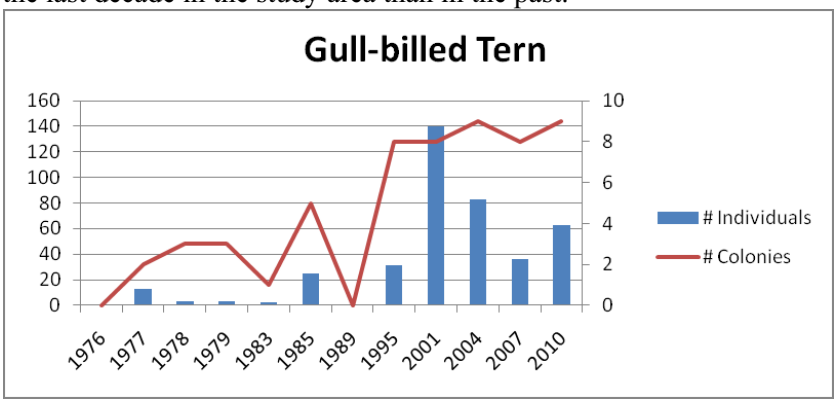
- This objective was not originally included in the SWG T-1-5 grant, but when it became clear that there were funds not used in other bird projects, this project became possible to complete in 2010. It was originally proposed but was cut during the selection process due to financial constraints, so the opportunity to complete this objective was fortunate and allowed the aerial survey for this group of species to stay on its once every three year schedule. However, due to procurement constraints, only the tern portion of the gull/tern survey was able to be completed.
- Tern surveys have been completed since 1976. The trends for each species are slightly different over the 30-plus years that surveys have been complete and individual species results are presented below.
- In 2010, there were 3,757 individual common terns observed in 68 colonies. Common terns appear to be on a downward trend in the study area.



- In 2010, there were 4,319 Forster's terns observed in 91 colonies. Forster's terns appear to be on an upward trend in the study area.



- In 2010, there were 63 gull-billed terns observed in 9 colonies. There appear to be more gull-billed terns in the last decade in the study area than in the past.



- In 2010, there were only three Caspian terns observed in one colony. This species is a rare breeder in New Jersey, so it is not surprising that there were very few detected. A trend chart is not very useful for this species, since there have always been either no or <5 individuals reported.
- In 2010, there were no royal terns detected on this survey. Royal terns nest very rarely in New Jersey and no colonies were reported this year. As with Caspian terns, a trend chart is not useful for this species.
- Although black skimmers were not a primary focal species of this survey, they were still counted as they were observed. In 2010, there were 410 adults counted in 13 colonies. Prior years' data are not presented

here because the majority of the skimmer population is not captured on this survey; the skimmers are on the beach strands, which are not surveyed here). Many of the skimmer colonies occurred in Barnegat Bay, which is also ground surveyed in Job 1C. However, some of these colonies were not counted on those ground surveys since they were not located in either the Barnegat Bay or beach strand. Therefore, these data are useful in supplementing ground counts and future aerial counts can act as an identifying mechanism to trigger ground surveys, ensuring the most comprehensive statewide data collection possible.

Conclusions:

- The aerial survey remains the best method to survey these species, which are located on marsh islands throughout the Atlantic coast. Unlike wading birds, where concerns exist about underestimating the number of individuals present due to the nesting substrate obstructing the view and dark plumages blending in with the background, terns are an excellent fit for an aerial count. They nest in the open so are easy to see and their white color contrasts extremely well with the green background of marsh grass.
- Although some of the species are increasing and others declining, the overall outlook for these species remains fairly positive. The habitat they nest in, marsh coastal islands, is protected from development and quite a bit of human disturbance. One of their biggest threats probably will come from the affects of climate change. As sea levels continue to rise, the ground nesting habits of this species make them very susceptible to flooding, which could lead to low reproductive rates.

Recommendations:

- The long terms trends of common and Forster's terns should be investigated to determine the role that observer misidentification may play in species trends. The two species are extremely similar looking, and the survey has had multiple observers over the course of 20+ years. There is a chance that the increase of Forster's terns and a decrease in common terns over time could be related to observers confusing one species for the other. However, it may very well reflect actual trends.
- Continue the tern/gull aerial survey in the future. This survey has been conducted for over thirty years, representing one of the longest datasets in ENSP. Although gulls were not surveyed during this cycle, they should be included in the future as time and funds allow. The gull species of New Jersey are not of conservation concern but they do impact many species that are. For example, laughing gulls are predators of piping plover and least tern eggs and chicks. They also compete with red knots for food items such as horseshoe crab eggs during the shorebird migration. Understanding their populations and distributions across the state is useful in making management decisions that can lead to recovery efforts for endangered species. In addition, the long term gull/tern data will also help managers measure the impact of climate change and inform policies to mitigate its impacts.

Job 1F: Migratory Shorebirds - Conservation of Red Knot in Delaware Bay

Project leader: Amanda Dey, Principal Zoologist

OBJECTIVES:

- Protect critical habitats and resources on the Delaware Bay stopover for migratory shorebirds: continue regional collaboration with state and federal agencies to recover horseshoe crab and shorebird populations, reduce anthropogenic disturbance to shorebirds, enhance/create coastal habitat and impoundments for crab spawning/shorebird foraging and roosting.
- Assess recovery of red knot and other shorebird species: monitor mass gain and adult survival through resightings of marked individuals; monitor stopover population size through baywide aerial survey and mark-and-resighting methods.
- Assess recovery of the horseshoe crab egg resource: monitor horseshoe crab egg densities on Delaware Bay beaches.

Key Findings:

DELAWARE BAY STOPOVER

- Adaptive Resource Management (ARM) Model – In 2010, federal and state fisheries and shorebird biologists completed work on a red knot and horseshoe crab population model. This collaborative two-year effort was carried out under the auspices of the Atlantic States Marine Fisheries Commission (ASMFC) to develop a model to guide harvest quotas for horseshoe crab that are protective of the migratory shorebird stopover on Delaware Bay. The model underwent external peer review in November, 2009 and was accepted by the ASMFC in February, 2010. The external peer review made several recommendations to the ARM modeling committee (see p. 8–13 in: *Stock Assessment Report No. 09-02 of the Atlantic States Marine Fisheries Commission, Terms of Reference and Advisory Report to the Horseshoe Crab Stock Assessment Peer Review*, http://www.asmfc.org/).

The ASMFC's Shorebird Technical Committee concurred with peer review recommendations and provided comments in April 2010 regarding threshold values affected by horseshoe crab survival rates and sex ratios, and shorebird survival and productivity.

In May, 2010, just after the above findings were reported, the ASMFC disbanded the Shorebird Technical Committee. In its place, a new Delaware Bay Ecosystem Committee will be formed via state nominations to advise ASMFC on the status of Delaware Bay shorebirds and horseshoe crabs. This committee will be comprised of two biologists from each state (NJ, DE, NY, MD, VA) with expertise in fisheries, the Delaware Bay ecosystem or shorebirds. The ARM modeling group will remain intact; a new Shorebird Advisory Committee will also be formed by state nomination and comprised of members from the ecotourism and education sectors. Nominations will be reviewed by the ASMFC Horseshoe Crab Management Board in November 2010.

- New Jersey Moratorium on Horseshoe Crab Harvest – The New Jersey moratorium continued in 2010. The reinstatement of horseshoe crab harvest in New Jersey is tied to numeric recovery targets for the red knot population on Delaware Bay identified in the *USFWS Red Knot Status Assessment* (Niles et al. 2007) and recovery targets identified in Niles et al. (2009). Primary recovery targets listed below can be monitored by existing surveys. Secondary recovery targets, which can identify potential problems outside the Delaware Bay, should be monitored as methods and funding becomes available.

Primary Recovery Targets for Red Knot		
Target Name	Description	Target Numeric
Restored *rufa* population † ‡	100K-150K population estimate (Morrison and Harrington 1992).	100,000 – 150,000
As measured by count of winter populations † ‡	Number of birds in winter. Accurate counts exist for Tierra del Fuego, Patagonia, Brazil from the 1982-86 Atlas: Tierra del Fuego – 53,232 Patagonia – 14,314 Brazil – 8,324 Florida – 7,500 - 10,000 (est.) Other (unk. winter sites) – 10,000 (est.)	≥ 80,000 (winter populations consistently ≥ 80K; no known threats likely to reduce population below 80K)
Stopover population †	Number of birds on Delaware Bay migratory stopover (peak count in 1980's)	80,000
Survival rate † ‡	Annual adult survival (Delaware Bay) (stable *rufa* 85%, Baker et al. 2004; stable *Icelandica* 85.8%, Boyd and Piersma 2001)	80% (initial target)*
Adult weight † ‡	Body weight at departure from Delaware Bay	≥ 180 grams (60% of birds)
Horseshoe crab eggs † ‡	Density of eggs in top 5 centimeters of sand	50,000 eggs/m^2 (50% of suitable habitat) (initial target)*
Horseshoe crabs † ‡	Number per trawl (catch per unit effort, CPUE) in Delaware Bay (DE 30-foot trawl survey, historic benchmark)	15 or equivalent from other surveys
Horseshoe crab harvest ‡	Harvest within 80 kilometers of Delaware Bay	To be determined by industry

† Niles et al. 2007
‡ Niles et al. 2009
* Initial targets may need to be adjusted in light of continuing studies

- In May 2010, the Western Hemisphere Shorebird Reserve Network (WHSRN) site assessment tool was applied to Delaware Bay during a one-day workshop.
- Beach closures for migratory shorebirds – 2010 marks the eighth year of beach closures during the shorebird migratory stopover on Delaware Bay (May 7-June 7). Thirteen sites on Delaware Bay and portions of two sites on the Atlantic coast were temporarily closed to allow shorebirds to forage and roost undisturbed by human recreation; maps were available at http://www.njfishandwildlife.com/ensp/beachclozmap.htm. Closed beaches were staffed by Shorebird Steward volunteers who educated the public about shorebirds, horseshoe crabs and the reason for closures. NJ Division of Fish and Wildlife conservation officers patroled beaches and assisted Shorebird Stewards as needed.

- Mass Gain – One of the most important recovery measures of the migrant shorebird stopover on Delaware Bay is the proportion of red knots that gain sufficient departure mass. Red knots leaving the bay ≥180 grams (g) have higher annual adult survival than birds departing at lower weight (Baker et al. 2004). In 2010, 43% of red knots that came to Delaware Bay reached the 180 g threshold weight (Figure 1). This is an improvement over the previous two years, but the trend in mass gain is still significant and negative ($P<0.001$); the number of red knots on the Delaware Bay stopover is still low and has not improved. Updated analyses of trend in the proportion of ruddy turnstones and sanderlings reaching threshold departure mass was not available for this report.

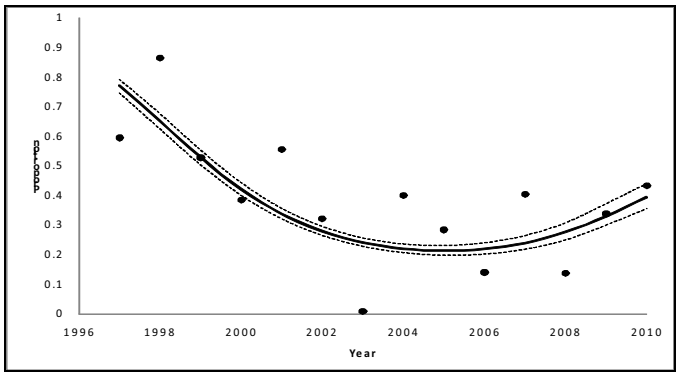


Figure 1. Proportion of red knots in the ≥180 g mass category in Delaware Bay near departure time each year (26-28 May), 1997–2010. The line shows a significant trend over 1997-2010; the trend line (±95% C.I. in respect of the line, not the variation in the data) was fitted using binary logistic regression of body mass ≥180g on year (negative, $p<0.001$) and year^2 (positive, $p<0.001$)). The strength of the quadratic trend owes much to the very low proportion recorded in 2003, but it remains significant if 2003 data are omitted.

- Annual Survival – Since Baker et al. (2004), two other survival estimates have been produced (Atkinson et al. in prep. and McGowan et al. in review). Stable isotope signatures of knots captured in Delaware Bay during 2004-2008 allowed Atkinson *et al.* (in prep) to separate knots between southern winterers (Tierra del Fuego) and northern winterers (SE United States, N Brazil, Caribbean, northern South America). The analysis showed that during the period 2004-2008 there was no significant difference between the annual survival rates of birds from the two wintering areas, with average survival rates of 93-94%. Similarly, McGowan et al. (in review) estimated red knot survival using a model linking (1) red knot stopover mass gain to horseshoe crab spawning abundance and (2) subsequent annual survival to mass state (heavy or light) at the time of departure from Delaware Bay. Survival estimates averaged ~0.90. As with the Atkinson analysis, these survival rates seem high considering recent population trends. A third survival analysis is underway that accounts for wintering site (from resightings) and sex ratio of the red knot population. Differences in survival of the largest wintering groups (Tierra del Fuego, Brazil, Florida) may provide a better understanding of annual survival of wintering groups (rather than the Delaware Bay stopover population as a whole) and how departure condition may contribute to annual survival.

- Stopover Population Size on Delaware Bay – From 1986 to 2008, shorebirds in Delaware Bay were monitored by a weekly aerial count (May–early June) organized by K.E. Clark who retired from this task in 2008, which afforded an opportunity to reconsider the methodology (see "Aerial survey calibrated by ground counts" below). The new survey methods devised for 2009 provided better coverage of Mispillion Harbor (DE) and Atlantic marshes (NJ). Ground counts were carried out on selected Delaware Bay beaches to experimentally calibrate aerial counts.

In 2010, aerial surveys were flown on four dates surrounding peak of migratory activity on Delaware Bay (Table 2); ground counts were also performed on these survey dates. As in 2009, two species (red knot and ruddy turnstone) were counted baywide, one by each of two observers. Sanderlings, semipalmated sandpiper, dunlin and short-billed dowitcher went unsurveyed from the air for a second year. Mispillion Harbor continued to be included in the aerial count and ground counts were also conducted, however DE ground counts were not available at the time of this report. Stone Harbor (on the Atlantic coast) was dropped from the survey because it increased the survey period beyond the optimal time/tide window to complete the aerial survey of Delaware Bay.

In 2010, the peak aerial count of red knots occurred on May 25 and ruddy turnstone on May 28, 2010 (Table 1). Red knot numbers appear stable but are still low and have not shown signs of recovery. The 2010 peak for red knot (14,475) was lower than the 2009 peak recorded in Mispillion Harbor (ground count of 24,000 individuals). We do not believe this represents a true decline as the 2010 peak is commensurate with 2009 calibrated aerial survey (16,229) and with peak aerial counts from the prior six years (2002-2008) (Figure 2).

The 2010 peak count of ruddy turnstones was among the lowest recorded, and is among four of the five lowest counts recorded since 2006. It is uncertain whether this indicates a true population decrease or a lower proportion of birds coming to the Delaware Bay. The highly dispersed winter range, and low number of individuals in turnstone wintering groups, makes population status of this species difficult to assess.

Table 1. 2010 aerial counts (not calibrated by ground counts) - red knot and ruddy turnstone

	May 14	May 19	May 25	May 28
Red Knot	3,788	8,090	*14,475	8,397
Ruddy Turnstone	7,530	14,939	13,974	*18,231

* Peak counts

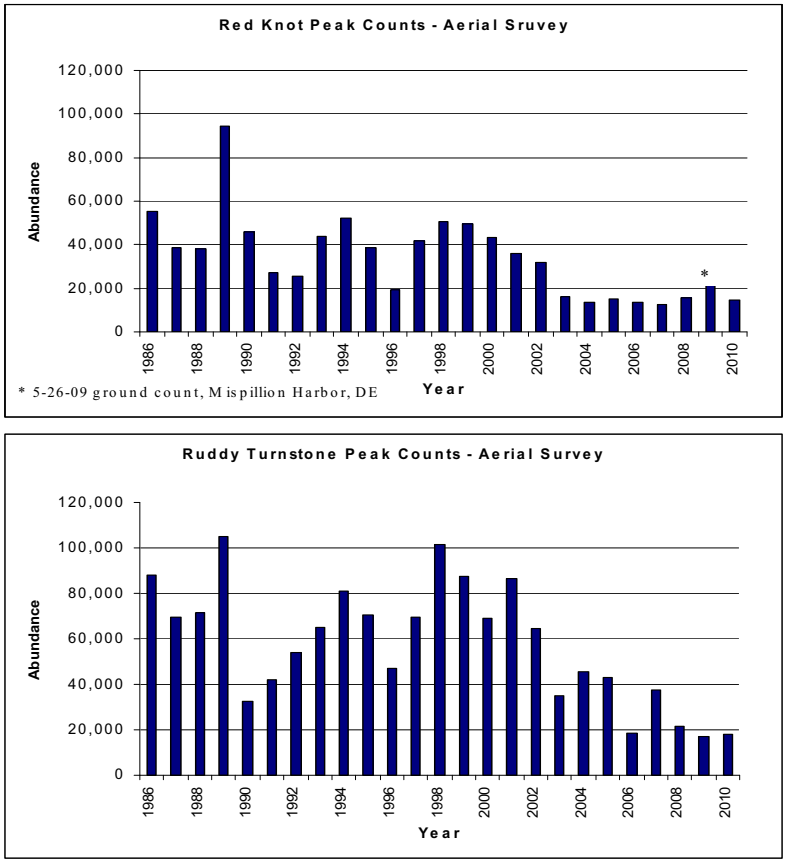


Figure 2. Peak aerial counts 1986-2010, red knot and ruddy turnstone

- Aerial survey calibrated by ground counts – In 2009, we implemented an experimental method to calibrate aerial surveys with ground counts. This method was developed to 1) include high-use areas like Mispillion Harbor that are difficult to count from the air, 2) help validate the accuracy of aerial counts by comparison with ground counts and 3) improve accuracy of aerial counts through calibration with repeated ground counts of high accuracy (see attached method).
  - The best comparison of aerial surveys and ground counts was carried out on May 18 and 21, 2009, on Kimble's Beach NJ where ground and air observers were confident that all birds in the delineated beach segment were visible and counted. The calibration factor for aerial counts of red knots ranged from 1.11 and 1.57 (aerial counts underestimated by 10%–57% respectively); calibration factor for ruddy turnstone aerial counts ranged between 0.73 and 1.25 (aerial counts overestimated by 27% and underestimated by 25%) (Table 1, Figure 3).
  - Calibrations for other sites varied more widely, and the site conditions and logistics of quasi-simultaneous ground-air surveys were onerous. The largest disparities in ground and aerial counts happened when: a) birds were not detected by aerial counters (farther up in tidal creeks and did not flush for the plane), b) birds were not detected by ground counters (as above) but were detected by aerial counters when the plane flushed birds, c) birds on the beach -- visible to both ground and air observers -- did not flush for the plane making aerial counts of individual species more difficult.
  - Ground count effort was variable across aerial survey dates in 2009 and 2010. Scheduling problems caused by cancelled/rescheduled flights and conflicting demands of ground counts, trapping, and resightings efforts, made simultaneous ground and aerial counts very difficult. In 2010, calibration was not attempted because flight delays and conflicts with other necessary surveys precluded ground counts from starting on time thus precluding enough repeated counts to develop a highly accurate flock estimate.

- Comprehensive ground counts performed before the aerial survey (same day) can provide a reasonable comparison for specific sites where large numbers of birds are present (e.g., Mispillion Harbor DE), and may be used in place of an aerial count if deemed more accurate. Ground counts are useful as a check against the overall baywide abundance relative to aerial counts.
- Aerial survey is critical for detecting large numbers of birds that are inaccessible by ground (e.g., Egg Island Point, NJ).

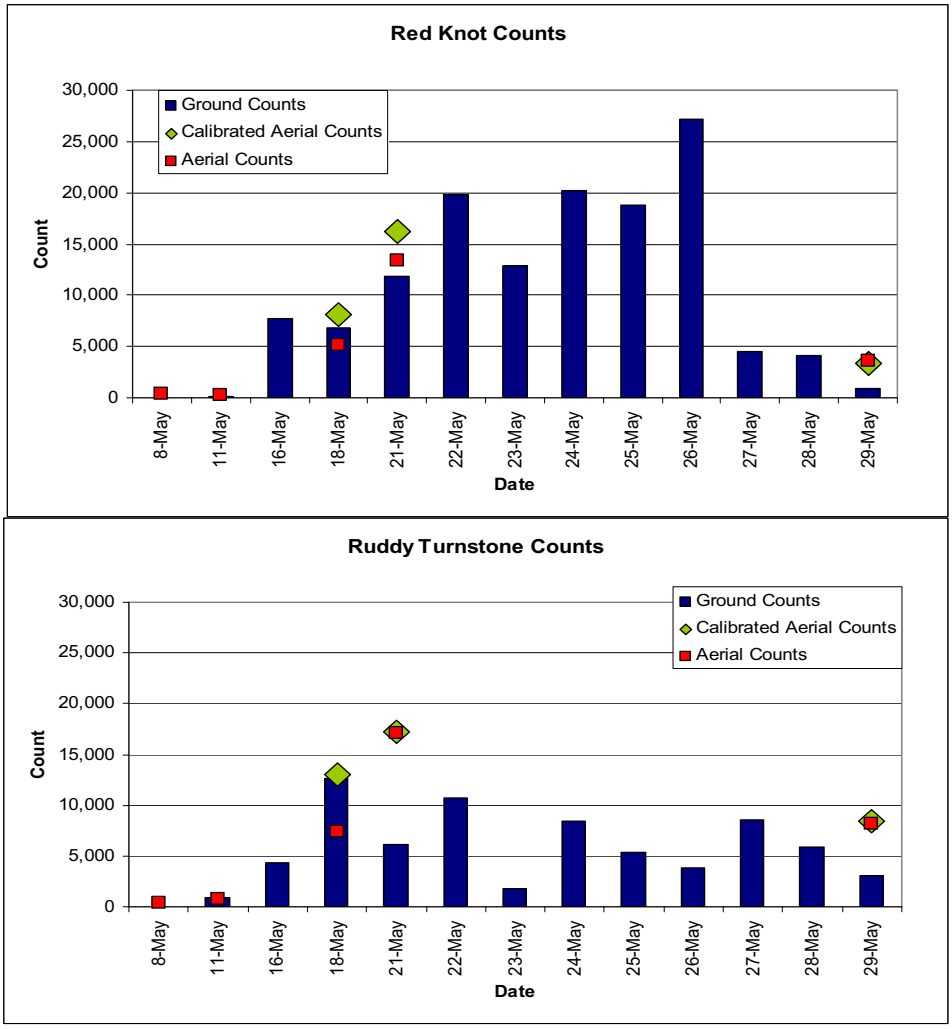


Figure 3. 2009 Red knot and ruddy turnstone counts New Jersey & Delaware: aerial, ground, and aerial-calibrated by ground.

- East Coast Aerial Survey– This survey was funded by the NJ Natural Lands Trust but reported here and elsewhere.

Red knots stopping over along the US Atlantic coast during peak migration (May 20–24) were surveyed again in 2010 (Table 2). Peak numbers in 2010 were similar to 2008. Adverse weather in 2009 precluded survey in GA and SC and likely contributed to the lower abundance recorded.

Making allowance for those parts of the coast that were not covered in 2009 (SC and GA), incomplete air coverage especially near military installations, and the likelihood that most or all juveniles of the South American wintering populations do not migrate north in spring, the 2008 and 2010 counts suggest a flyway population of approximately 30,000. This is at least 8,000 more than the sum of currently known wintering populations and indicates that there may be significant undiscovered wintering sites.

Table 2. Counts of Red Knots along the US east coast from Florida to Delaware Bay conducted over two consecutive days during 20-24 May in each year from 2006 to 2010.

	2006	2007	2008	2009		2010
New Jersey	7,860	4,445	10,045	7,631	(16,229)‡	8,945
Delaware	820	2,950	5,350	5,730		5,530
Maryland	NS	NS	663	78		5
Virginia	5,783	5,939	7,802	3,261		8,214
North Carolina	235	304	1,137	1,466		1,113
South Carolina	NS	125	180	10		1,220 †
Georgia	796	2,155	1,487	NS		260
Florida	NS	NS	868	800		41 †
TOTAL	**15,494**	**15,918**	**27,532**	18,976	**(21,844) ‡**	**25,328**

† Ground count
NS – no survey
‡ Corrected 2009 NJ & DE aerial counts (calibrated by ground counts) and corrected 2009 east coast total; (Note: 2009 SWG report contained un-calibrated aerial counts for NJ & DE and differed from calibrated count reported in Niles et al. 2010).

- Horseshoe crab egg densities – The viability of Delaware Bay migratory stopover remains impaired because of continued low densities of horseshoe crab eggs in New Jersey. Horseshoe crab egg density showed a significant recovery in 2009 after the all-time low in 2008. The 2010 mean egg density (5,005 eggs/m^2) remained near the 2009 mean (5,536 eggs/m^2) (Figure 4). In 2010, good spawning occurred in the first weeks of May and eggs were available to migrant shorebirds upon their arrival. In 2010, the majority of red knots remained on New Jersey beaches for the duration of the May stopover period.

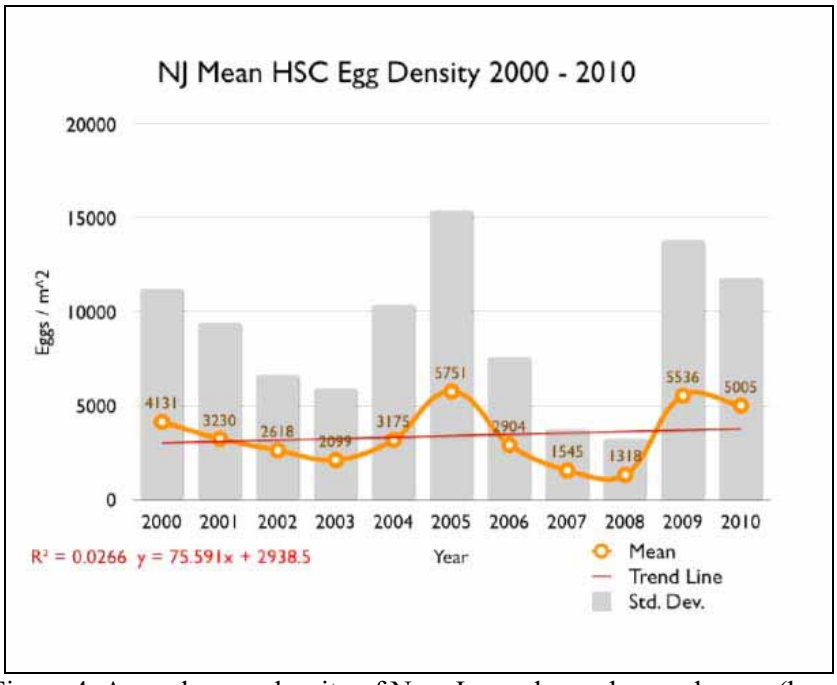


Figure 4. Annual mean density of New Jersey horseshoe crab eggs (beaches pooled by year).

- Population parameters of horseshoe crabs in Delaware Bay – After a peak harvest in 1998, management actions by the Atlantic States Marine Fisheries Commission and some states led to a reduction in the annual harvest of horseshoe crabs to a mean of 752,429 crabs coastwide, 2004-2009 (Figure 5). An average of 52% were landed in NJ, DE, MD and VA during this period and are considered to be from the Delaware Bay breeding population. However, although a 15-year low harvest of 681,323 crabs occurred in 2004, harvest has since been higher despite the full moratorium in New Jersey since 2006. Harvests have periodically increased in NY, MA, DE, MD, VA and NC during this period.

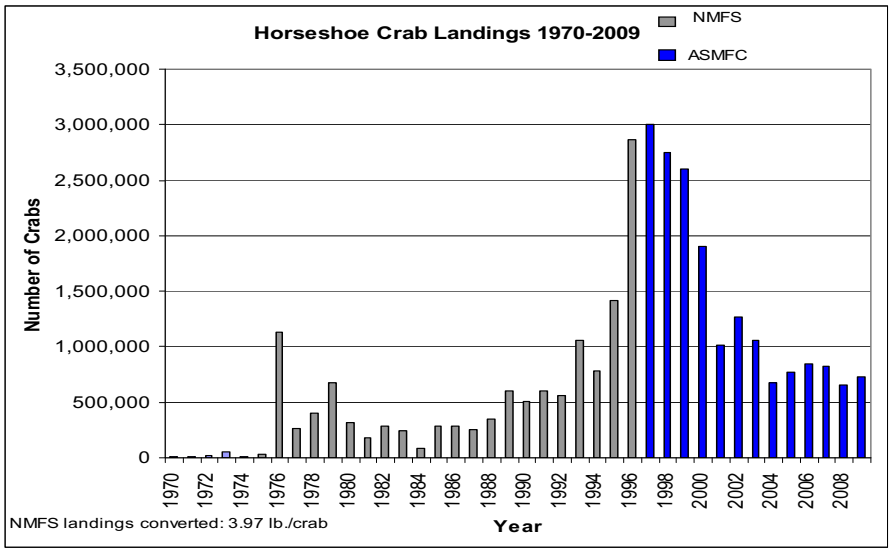


Figure 5. Annual landings of horseshoe crabs coastwide. NMFS landings 1970-1996 were used prior to mandatory reporting (converted from pounds to number of individuals: 3.97 lb/crab).

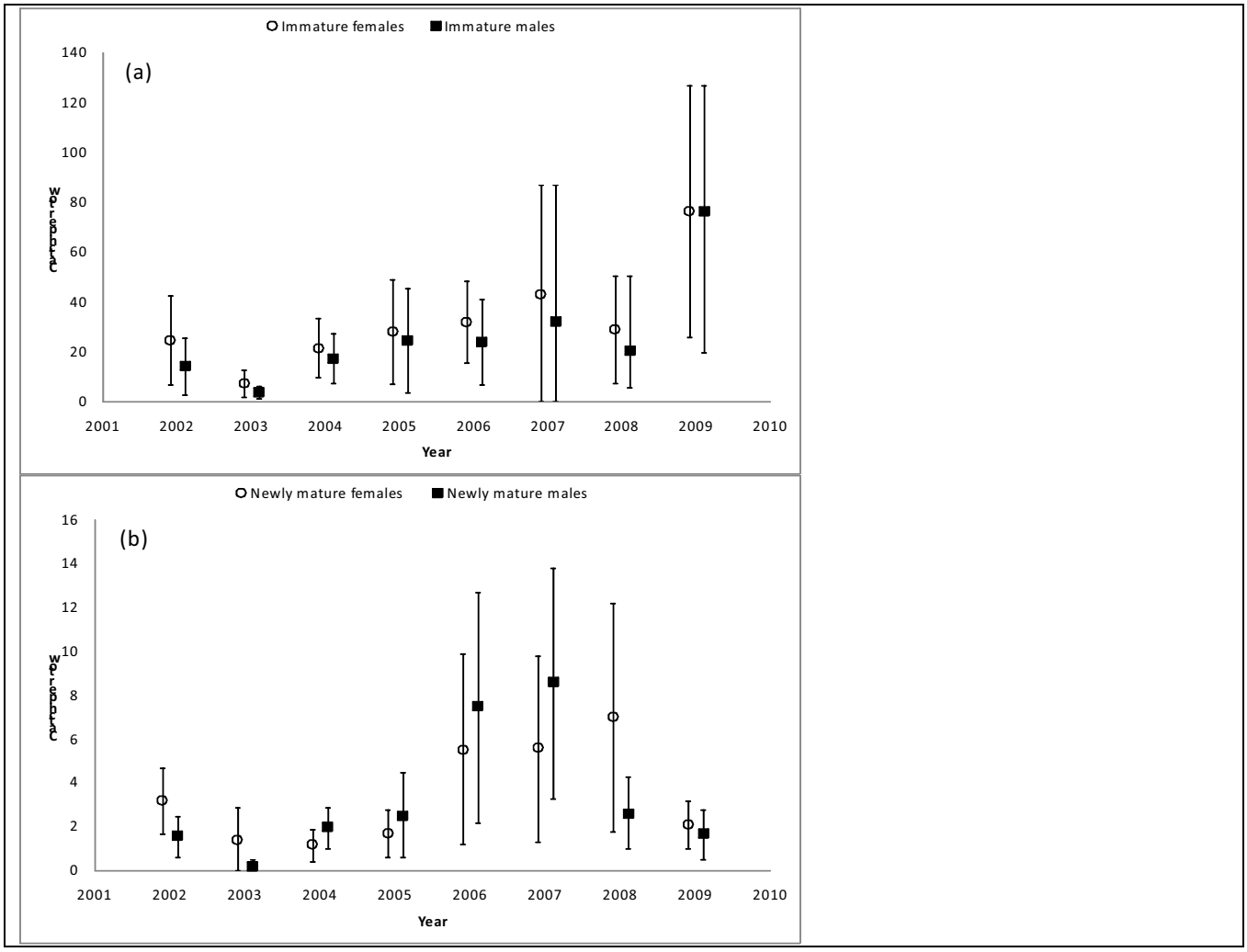
Table 3. Population parameters of horseshoe crabs in Delaware Bay for 2004-2009.

	2004	2005	2006	2007	2008	2009	Trend	Source
Spawning females (index)	0.77	0.82	0.99	0.89	0.68	1.00	None [3]	Michels *et al.* 2010
Spawning males (index)	2.93	3.23	3.99	4.22	2.30	4.67	Increase [3]	Michels *et al.* 2010
Egg density New Jersey (index) [1]	61	100	50	27	23	96	None	NJDFW per D. Hernandez
Egg density Delaware (index) [1]	No survey	100	73	123	52	85	None	DEDFW per K. Kalasz
Egg density Delaware exc Mispillion (index) [1]	No survey	100	49	62	35	30	Decline	DEDFW per K. Kalasz
Delaware Trawl Survey (geo-mean) [2]	0.06	0.20	1.37	1.72	0.77	1.06	None [3]	S.F. Michels pers. comm.

[1] In top 5 cm of sand, 2005 = 100
[2] Data relate to trawls during April-July
[3] Trend relates to 1999-2009

Despite management to reduce the horseshoe crab harvest, there is still no clear evidence that this has led to a recovery of the population. The Delaware Trawl Survey shows no significant trend over 2004-2009 (Table 3). The male spawning crab index showed a significant increasing trend in 2009 but the female spawning crab index did not improve. Egg densities in NJ and DE to 2009 show no improvement and decline, respectively; (2010 DE egg data were not available for this report). It must be noted that Mispillion Harbor, DE, has in excess of 170,000 eggs/m^2 on an annual basis, but this is anomalous relative to the rest of the Bay, it dominates trend, and was excluded from this analysis.

The Virginia Tech Offshore Trawl Survey area shows no significant trend in any demographic group over 2002-2009 (Figure 3; Hata & Hallerman 2010). The survey shows some patterns that are consistent between the sexes (Figure 6); these should be treated with caution because the confidence limits are large. Mature and newly mature crabs, especially females, are the most important demographic groups in terms of producing eggs for shorebirds; the relative abundance of both peaked during 2006-2008 but show a decline in 2009 (Figure 6). Immatures showed a three-fold increase in the mean catch per tow in 2009 (Figure 6), and this may be the first evidence of recovery resulting from the major decrease in the harvest in 2004. However, the change between 2008 and 2009 is not statistically significant and it not a change that is reflected in the whole of the area surveyed -- there was about a 4-fold increase in the peripheral survey area, but little change in the core survey area (see Figure 1 in Hata & Hallerman 2010).



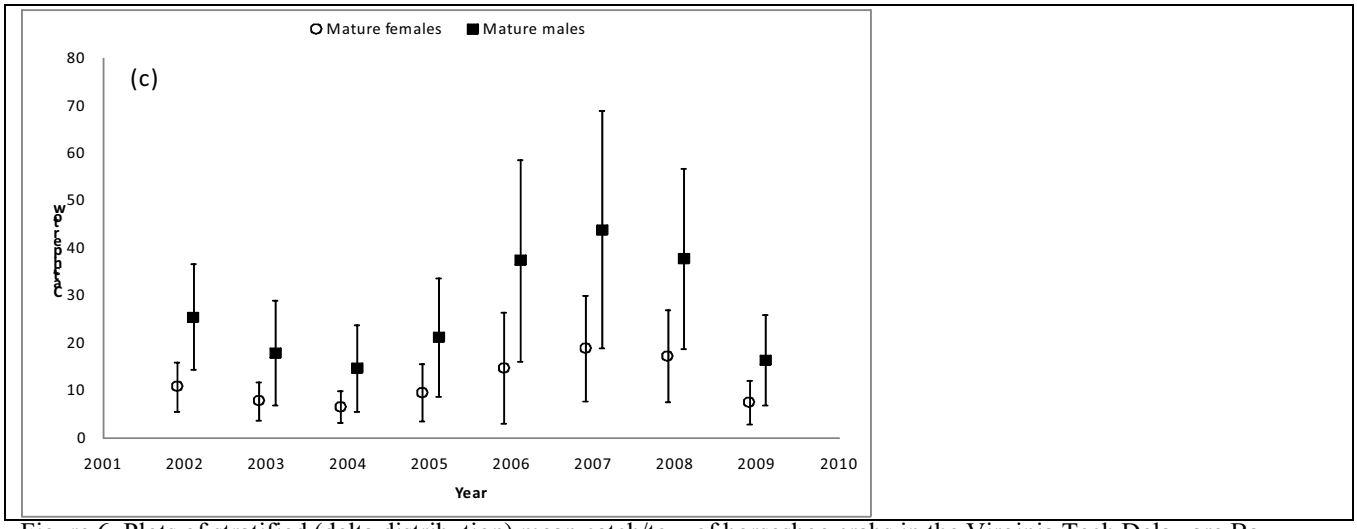


Figure 6. Plots of stratified (delta distribution) mean catch/tow of horseshoe crabs in the Virginia Tech Delaware Bay Offshore Trawl Survey (Hata & Hallerman 2010) by sex and demographic group: (a) immatures, (b) newly mature adults and (c) mature adults by demographic group (± 95% C.I.). The survey area is within 12 nautical miles of the coast and from 37°40'N to 39°20'N, but excludes Delaware Bay itself. Note different y-axis scales.

SOUTH AMERICAN AND US WINTERING/STOPOVER AREAS

- The number of red knots in Tierra del Fuego declined slightly in 2010 (Figure 7). This indicates the wintering population is apparently stable at a low number but has not yet shown signs of improvement.

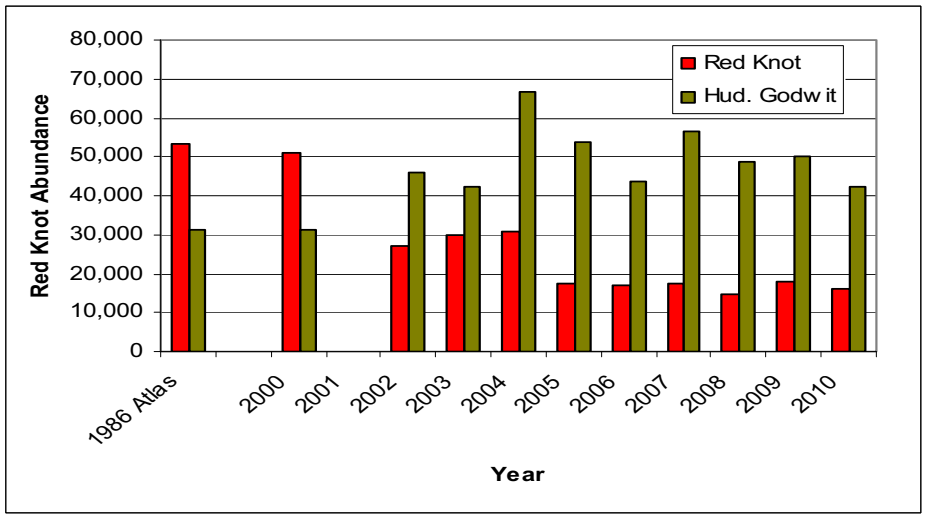


Figure 7. Red knot and Hudsonian godwit abundance on Tierra del Fuego (Chile and Argentina).

CONCLUSIONS:

DELAWARE BAY STOPOVER

- In 2010, the red knot population on Delaware Bay remained stable and abundance was commensurate with aerial counts during 2003 to 2008. The higher count in 2009 was attributed to a single-day count in Mispillion Harbor, DE. Ground and aerial surveys will continue to establish best methods to validiate aerial surveys.
- The improved conditions in crab spawning this year (good weather and apparent increase in spawning activity) led to a greater proportion of red knots and other species gaining adequate departure weight.
- Current egg densities (5,005eggs/m^2) are not sufficient to support even a greatly-reduced migrant shorebird population and must be increased to a minimum of 50,000 eggs/m^2 on 50% of suitable spawning beaches to

begin recovery of the stopover. There is little indication that the Delaware Bay horseshoe crab breeding population is increasing although an increased number of juveniles in the Virgina Tech Trawl is promising. Closure of crab harvest and/or significant coast-wide harvest reductions, particularly for Delaware Bay breeding population, may be necessary to realize substantive and sustained increases in eggs on the beach.

- The ruddy turnstone and sanderling have suffered declining trends in mass gain and abundance on Delaware Bay similar to red knot. It is likely that reduced mass gains on the last stopover before breeding impacts most shorebirds in a similar manner (reduced adult survival, reduced productivity) and may account for declines in abundance on the Delaware Bay.
- Analogous to red knot, semipalmated sandpipers have declined in the rate of mass gain while on Delaware Bay (Peters et al. 2007).

SOUTH AMERICAN AND US WINTERING/STOPOVER AREAS

- Bahia Lomas remains the most important wintering site for red knots in the Western Hemisphere.
- The greatest threat to the Tierra del Fuego population is declining horseshoe crab egg resources on Delaware Bay. Bahia Lomas was recently designated a RAMSAR site, and the Chilean government is developing a management plan for the area.

RECOMMENDATIONS:

DELAWARE BAY STOPOVER

- Recover and maintain Delaware Bay horseshoe crab egg densities at levels sufficient to sustain stopover populations of all shorebirds including 50,000 horseshoe crab eggs/m^2 on 50% of suitable beaches and 100,000 red knots. In part this will be supported by:
  - Continuation of all current yearly studies on Delaware Bay of shorebird numbers, rate of mass gain, and horseshoe crab egg densities, as continuing inputs for models.
- Continue efforts to develop a system for annual determination of population status based on survey results, capture data and resightings of banded individuals in Delaware Bay and throughout the Atlantic Flyway.
- Develop annual estimates of productivity and juvenile survival as inputs for population models. Determine key southbound and northbound stopovers that account for at least 80% of stopover areas supporting at least 100 red knots, and develop coast wide surveillance of birds as they migrate.
- Control disturbance at all stopovers and wintering areas.

SOUTH AMERICAN AND US WINTERING/STOPOVER AREAS

- Create a hemisphere-wide system of protected areas for each significant wintering, stopover and breeding area.
- Complete site assessment, using Western Hemisphere Shorebird Reserve Network (WHSRN) site assessment tools, for Bahia Lomas, Rio Grande, San Antonio Oeste, Lagoa do Piexe, Maranhao, the west coast of Florida, the Altamaha Region of Georgia, the Virginia Barrier Islands, Delaware Bay, Stone Harbor Point, James Bay, Southampton Island and King William Island.
- Delineate and propose protection measures for key habitats within the main wintering areas of Maranhao, Tierra del Fuego and Florida, and develop management plans to guide protection.

JOB 1G: Peregrine Falcon

Project leader: 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:

- In 2010 the New Jersey peregrine falcon population remained nearly steady at 25 known pairs (Figure 1). One new pair was reported in 2010; other pairs recently discovered on bridges could not be monitored but

were assumed to be territorial, especially two bridge pairs found in 2009 (Rt. 3/Hackensack and the Newark Bay Bridge). There were five occupied territories in cliff habitats, but none was successful.

- Twenty-five occupied sites were known or suspected to be active (laid eggs) (Table 1).
  - ⊕ Fourteen pairs on towers and buildings continued to be the core of the nesting population, producing 34 young, for a productivity rate of 2.42 young per active nest. This is above New Jersey's average of 1.78 recorded since 1986 when the population stabilized. Relatively good weather conditions during incubation and chick-rearing probably helped to increase survival to banding age. In addition, biologists treated <2 week old hatchlings with bird lice spray where needed to reduce infestations of parasitic flies (*Carnus hemapterus*); such infestations have caused mortality of young hatchlings in recent years.
  - ⊕ Five pairs occupied territories in natural cliff habitat in northeastern NJ, up from four and the most cliff sites in simultaneous occupation since their reestablishment there (see Clark and Pierson 2009). However, none of the pairs produced young. The cause(s) of the failures is unknown; two pairs lost eggs in mid- to late-incubation, and one of those pairs laid a second clutch, also lost during incubation. A third pair may have hatched their first clutch, but any chicks were lost within one week; that pair also laid a second clutch, but failed after approximately three weeks. Unlike previous years, there were no major easterly or northeasterly storms that would account for the complete nest failure at the cliffs. The nest ledges appear to be impervious to ground predators that would take eggs.
  - ⊕ Of six pairs on bridges, four were known to have produced eight young, for a rate of 2.00 young/active nest. Some previously occupied bridges (e.g., Trenton, Hackensack and Newark Bay) were not tracked due to insufficient staff or volunteers. New Jersey monitored four pairs on bridges spanning the NJ-PA border. Pairs on the Betsy Ross and Walt Whitman bridges raised zero and three young, respectively; pairs at Burlington-Bristol and Tacony-Palmyra bridges produced four and one young, respectively. Other bridges may have been occupied, but the program lacked monitors in northern NJ to document all possible sites.

- For a fifth year, NJ donated peregrine nestlings to the New River Gorge hack site in West Virginia. A total of nine young (one from a building, four from bridges and four from coastal towers) were delivered to and hacked at the New River Gorge hack site near Beckley, with oversight and direction from West Virginia DNR, the National Park Service and Three Rivers Avian Center. These young peregrines would face high competition if they remained in the coastal population (where production is well above the minimum needed for population stability), and their transfer to the southern Appalachians supports the recovery of the peregrine in that part of the range.
- We banded all but one of the 42 young produced at 18 nests, using both a federal band and a bicolor band with an alpha-numeric code. One young fledged before banding. Ownership of the bands of nine peregrines translocated to West Virginia was transferred to WV for band reporting and future tracking.
- Staff collected five addled eggs from three sites for future analysis. The study of contaminants in mid-Atlantic eggs was published in the journal *Environmental Contamination and Toxicology* (Clark et al. 2009). Coastal-NJ eggs were of special concern with regard to elevated levels of PCBs and DDT compounds, and warrant continued study. One adult carcass recovered in Atlantic City was necropsied, and brain and liver tissues were archived for future contaminant analysis.
- In 2010 we continued to use remote, motion-activated cameras to photograph peregrines at nests. Using this method we read the legbands on 19 breeding adults at ten nest sites. An additional ten birds were identified using optics. The information that these identifications provide is immensely valuable for relating peregrine origin and age to nest success, site fidelity and turnover rate in the population.
- All nest sites were maintained during the non-nesting season. New predator guards were installed on one tower and repairs were made to guards on others. Gravel in coastal nests was cleaned or replaced at all coastal nests to reduce the over-winter survival of parasitic fly eggs (*Carnus hemapterus*).
- All new sites were added to the Biotics database, along with an updated record of existing sites.

Conclusions:

- The peregrine population remained steady between 2009 and 2010, but nest success and productivity increased in 2010 (Figure 1). Across all sites – towers, building, bridges and cliffs – nest success was 64% and produced 1.68 young/active site. 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 situations for the birds, continues to be the predominant factor in a stable and productive population.
- The lack of nest success at the cliff territories continues to be a problem if we are to consider the historic habitat important for long term stability; targeted investigation of the cause of those losses is necessary to 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.

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.
- 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. New research suggests the high levels of brominated fire-retardant chemicals (polybrominated diphenyl ethers) found in peregrines may affect adult peregrine nesting behavior and nest success, which certainly bears watching in NJ.
- Continue 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.

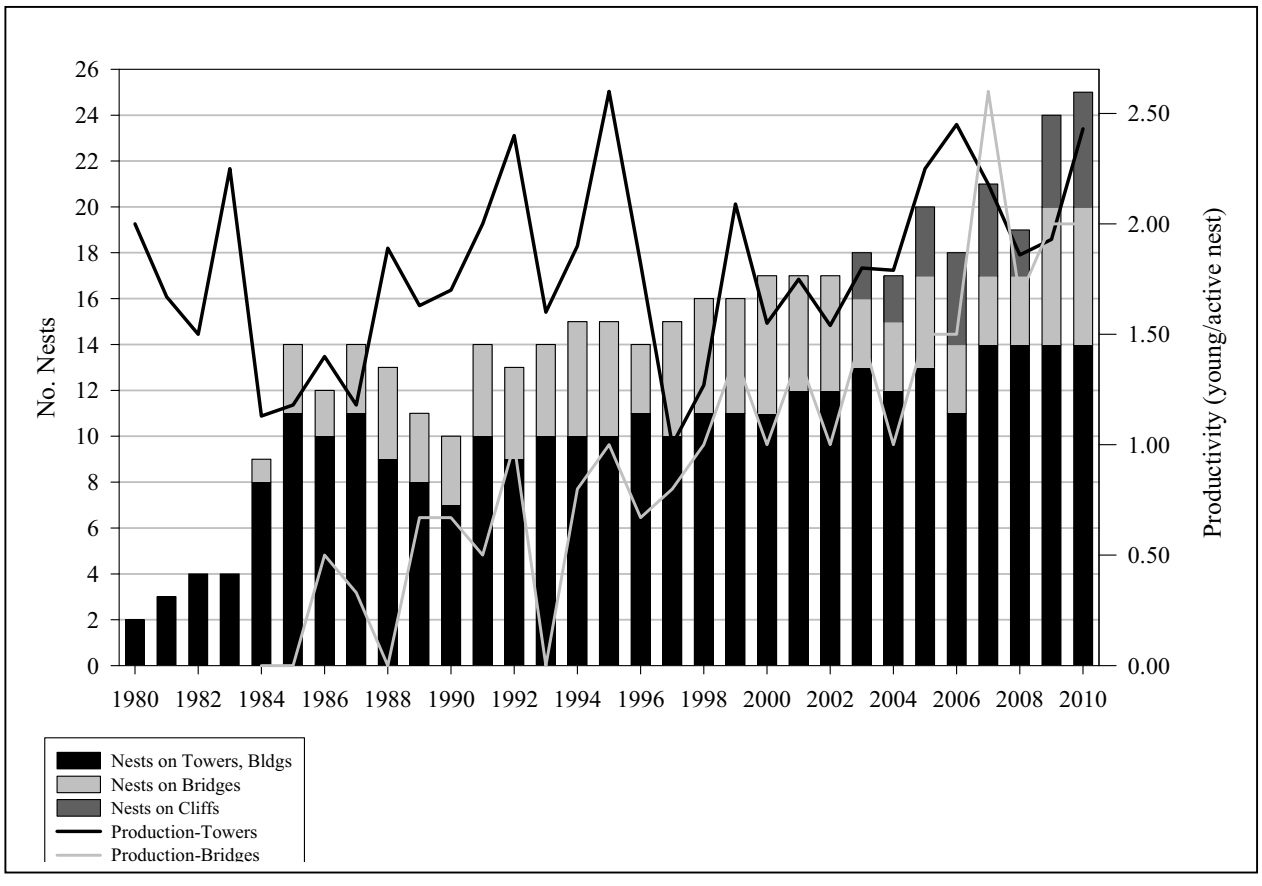


Figure 1. Nesting and productivity of peregrine falcons in New Jersey, with comparisons between towers/buildings, cliffs, and bridges.

Table 1. Site-specific results of peregrine falcon nesting in New Jersey, 2010.

Name	Occupied	Active	Eggs	Yng Hatched	Yng@ BandAge	Yng Fledged	Comments
Sedge Island WMA Tower	Y	Y	3	2	2	2	Treated for flies ~3 days old
Forsythe NWR/Brigantine Tower	Y	Y	4	3	3	3	Coll 1 egg
Forsythe NWR/Barnegat Tower	Y	Y	3	0	0	0	
Marmora WMA / Sea Isle Tower	Y	Y	4	3	3	3	Coll 1 egg; 2 yng to WV
Great Bay WMA/ water tower	single	N					One ad obs. in May
Heislerville WMA Tower	Y	Y	4	4	4	4	2 yng to WV
Egg Island WMA Tower	Y	Y	4	4	4	4	Treated for flies ~3 days old
Swan Bay WMA Tower	Y	Y	4	3	3	3	Coll 1 egg/broken on collection
Tuckahoe WMA Tower	Y	Y	3	2	2	2	
Ocean Gate (AT&T) Tower	Y	Y	2	1	1	1	Not banded
Stone Harbor marsh	Y	Y	Unk	2	2	2	
Margate marsh	N	N					
Hilton/The Grand Casino	Y	Y	5	2	2	2	1 to WV; Coll 3 egg
101 Hudson, Jersey City	Y	Y	4	4	4	4	1 rehabbed >fledging; released 11/10
Newark -Broad St bldg.	U	U					
Elizabeth-Union Co. Court House	Y	Y	4	4	4	3	1 died at fledging
Sewaren building	U	U					
Refinery (Greenwich-Paulsboro)	Y	Y	unk	≥1	1	1	Nestling/nest found in July
SUBTOTAL TOWERS & BUILDINGS	***14***	***14***		***35***	***35***	***34***	
Natural Site C-1 (Alpine)	Y	Y	4	0	0	0	
Natural Site C-2 (South)	Y	Y	?	?	0	0	2 attempts
Natural Site C-3 (South)	N	N					
Natural Site C-4 (North)	Y	Y	? & 4	0	0	0	2 attempts
Natural Site C-5 (Tenafly)	Y	Y	?	?	0	0	
SUBTOTAL NATURAL SITES	***5***	***5***			***0***	***0***	
G. Washington Br. (Hudson River)	Y	Y	?	?	2	2	NY side/NY monitored
Betsy Ross Br. (Delaware River)	Y	Y	4	0	0	0	Wind destroyed nest
Walt Whitman Br. (Delaware R.)	Y	Y	4	3	3	3	2 to WV
Ben Franklin Br. (Delaware River)	Y	Y	?	≥2	2	2	PA
NJ-PA Turnpike (Delaware River)	Y	Y	?	3	3	3	PA
Tacony-Palmyra (Delaware River)	Y	Y	?	1	1	1	
Burlington-Bristol (Delaware R.)	Y	Y	4	4	4	4	2 to WV
Rt 78-Scudders Falls Bridge	Y	Y	?	?	3	3	PA
Brigantine Bridge (A.C.)	N	N					
Vince Lombardi - NJTP Bridge	U	U					
Secaucus-Kearny NJTP Bridge	U	U					
Newark Bay Br. (NJTP or Conrail)	Y	Y	?	?	?	?	Conrail bridge
Trenton RR Bridge	U	U					
Route 3 Br./Hackensack (NJDOT)	Y	Y	?	?	?	?	
SUBTOTAL BRIDGES	***6 (NJ)***	***6***		***8***	***≥8***	***≥8***	
TOTALS (NJ only)	**25**	**25**		**43**	**≥43**	**42**	**(incl. 9 yng to WV)**

JOB1H: Grassland Birds

Project leader: Kim Korth, Senior Zoologist

OBJECTIVE 1: To develop long-term population monitoring and distribution approaches, particularly on grasslands enrolled in incentive programs, for endangered, threatened, and special concern grassland-nesting birds: grasshopper sparrow (*Ammodramus savannarum*), vesper sparrow (*Pooecetes gramineus*), bobolink (*Dolichonyx oryzivorus*), Henslow's sparrow (Ammodramus henslowii), Savannah sparrow (*Passerculus sandwichensis*), upland sandpiper (*Bartramia longicauda*), horned lark (*Eremophila alpestris*), eastern meadowlark (*Sturnella magna*) and northern harrier (*Circus cyaneus*).
OBJECTIVE 2: To continue to expand properties managed for grassland birds via incentive programs and create, evaluate and modify management techniques for grassland bird species (see above for list of species).
OBJECTIVE 3: Create predictive models using landscape variables related to grassland bird species presence to identify areas to target management for specific grassland bird species (see above list of species).

Key Findings:

- New Jersey Audubon Society (NJAS) was contracted to use trained Citizen Scientist volunteers to conduct bird surveys on managed grassland habitats across New Jersey as part of ENSP's effort to evaluate management techniques on grassland bird populations.
  - ENSP biologists, NJAS staff and volunteers performed two point count bird surveys per survey location to record the number of breeding target grassland birds. Volunteers were provided training to assure adherence to methodology and were instructed to record and map the location of individual target species.
    - Bird Survey I (15 May to 31 May, 2010)
    - Bird Survey II (1 June to 15 June, 2010)
  - During each of the two grassland bird surveys, staff and volunteers also conducted a general habitat assessment at each point location which included overall habitat category (upland or wetland), habitat class (e.g. fallow field, row crop, meadow, sod) and average vegetation height.
  - A total of 394 grassland bird survey points were assigned in the 2010 breeding season, including unmanaged roadside control points and managed Landowner Incentive Program (LIP), Wildlife Habitat Incentive Program (WHIP), Wildlife Management Areas (WMA), and landfill.
    - Assigned sites and points included:
      - Roadside control – 28 routes/199 points
      - LIP managed – 59 sites/152 points (16 points were conducted on LIP sites that had expired but the landowner allowed us to continue surveying the points)
      - WHIP managed – 7 sites/16 points
      - WMA managed – 4 sites/15 points
      - Landfill managed – 4 sites/10 points
      - Additional control points – 1 site/2 points
- The final evaluation of the effectiveness of management techniques was not completed because problems with the dataset (standardization between years) continue to be addressed.
  - Grassland bird survey data from the 2005–2009 field seasons were standardized and all but the 2009 and 2010 data have been entered into the NJ DEP's Biotics (Biotics) database. Staff continue to enter the 2009 and 2010 data into the Biotics database.
  - Approximately 50% of the 2010 grassland bird data have been submitted to ENSP; we expect all the data by year's end and will subsequently be entered in the Biotics database.
  - Habitat and management data on all Landowner Incentive Program (LIP) sites were standardized using ARC GIS; management treatments were digitized and standardized for each grassland site.
    - The standardization will allow us to use these data in our predictive modeling and evaluation analysis as well as to assess the threat of habitat loss/conversion, agricultural practices, prescribed burns, and fragmentation (area sensitivity) using habitat information gathered and changes in Land Use/Land Cover over time.

- ENSP staff and volunteers collected microhabitat data on 136 points between 25 May and 15 July, which captured all currently enrolled LIP sites. Bird point count locations were used as the habitat survey location. The 2009 protocol was modified to focus on key vegetation structure rather than dominant grass species while decreasing the sample size at each point. We reduced our percent cover quadrant (grass type (warm season grass, cool season grass), forbs, woody, litter, open space, standing dead, bare ground, or moss) from $1m^2$ to $0.5m^2$ and reduced the number of quadrants measured at each bird point from 5 to 4. Weins Pole data (estimate stand height and density) and the Robel Pole data (estimate total biomass) were also reduced from 4 in each cardinal direction to one at each $0.5m^2$ quadrat.
    - Microhabitat data will help inform a predictive model by describing stand age and structure at a microhabitat level.
- The predictive habitat model was not completed because we wanted to include the microhabitat data collected in the 2010 field season. The habitat data have been entered and will be included with the landscape variable and other covariates for the model; the model will be completed once the database is reformatted.
- Because the model was not completed, we were unable to use the model to identify areas of suitable habitat, create species-specific management plans or evaluate the model.
- The best management practices (BMPs) for target grassland species were not completed; however, a statistician is currently analyzing the microhabitat data. The results of the analyses will be the basis of the BMPs.
- Threat assessment was not addressed because the NJDEP Land Use Land Cover (2007) was only recently released for the state of New Jersey.
- Staff met with NJAS and New York Audubon to discuss the data needed to coordinate evaluation of Landowner Incentive Programs region-wide. The grassland bird working group did not convene this year. However, staff will attend the grassland bird working group roundtable discussion as part of the Northeast Bird Conservation Conference 19-21 October, 2010 in Plymouth, MA.

Conclusions:

- The use of Citizen Scientists for grassland bird surveys continues to be a necessary and efficient method to collect data. Of the 49 volunteers that were assigned sites for the 2010 grassland survey, 34 (69%) entered data online and returned their datasheets to NJAS; 4 (8%) entered data but have not yet returned their datasheets; 5 (10%) have not returned data yet. Six volunteers (12%) did not complete their assigned surveys in 2010, however, the points assigned to 3 of these volunteers were surveyed by another participant.
- Since 2005, ENSP staff have QA/QC'd bird data collected by staff and volunteers. While the error rates fluctuate from year to year, we estimate a low average error rate (<5%) with the majority of errors result from volunteers filling out the datasheet incorrectly and not following all of the instructions. The most common error was volunteers failing to map individual species locations.
- The 2009 microhabitat pilot study allowed us to determine that the most time-consuming element was grass species identification, which is especially difficult before flowering and seed head development. Based upon recommendations by grassland vegetation experts, including NRCS staff, we decided that this species-specific identification was unnecessary as vegetation structure was probably the driving factor in bird use. By simplifying the protocol and narrowing the scope of the survey we were able to sample all current LIP sites during the same timeframe that the sites were surveyed for bird density. We believe that this modified protocol was successful as we sampled 136 points in 2010 versus the 10 points sampled in the previous year by eliminating superfluous data without sacrificing important structural information.

Recommendations:

- Continue to use Citizen Scientist volunteers to conduct two replicates of point count surveys for target grassland bird species at each site where management techniques are to be evaluated and its paired control.

- Explore shifting bird survey effort from all sites to increasing bird survey effort at sites where adaptive management practices will be implemented in 2011. Work with a statistician to determine number of sites (including control) necessary to compare treatments.
- Work with a statistician to develop microhabitat variables that we can effectively and efficiently collect at target sites. Determine the minimum sample size required to collect the proper microhabitat data and ensure all management practices are adequately represented.
- Evaluate potential temporal and spatial differences in grass growth rates. Grassland points were clustered by location and clusters were sampled between 25 May and 15 July. Warm season grasses reach their peak growing season from June to September, while cool season grasses' peak growing season is late March to June. By sampling the most southern sites first and moving northward, we may be able to counteract the differences in growing season within the state.
- Continue simplified microhabitat methodology annually but only at a sample of randomly selected sites with complete baseline data collected every 3 years.
- Continue working on BMPs based on survey and habitat data (see above) for each endangered, threatened and special concern grassland bird species
- Evaluate the effectiveness of management techniques (delayed mowing, burning, WSG, CSG, etc.) on LIP and other sites actively managed for grassland birds using control and pre- and post- treatment surveys.
- Continue to create and validate a predictive habitat model using landscape variables (# total acres, core area, proximity to other open habitat, etc.) for one endangered or threatened grassland bird species and establish a protocol for developing habitat models for the remaining endangered, threatened and special concern grassland bird species.
    - Use the predictive GIS model to identify areas of suitable and potentially suitable habitat where preserved farmlands and incentive programs for private landowners could improve quality and quantity of habitat for grassland bird species.
    - Create species-specific management plans for each property actively managed for endangered, threatened and special concern grassland birds (LIP, WHIP, state lands, etc.) based upon the results of a predictive model.
    - Evaluate and modify the predictive model as new data become available.
- Continue participating in NE CBM Grassland Working Group meetings.

JOB 1J: Raptors

Project co-leaders: Kathleen Clark, Supervising Zoologist and Kris Schantz, Principal Zoologist

OBJECTIVE 1: To inventory and monitor state-listed woodland raptor populations and their habitat, and determine population trends in relation to available habitat. To develop forest management practice guidelines and informational vehicles that help reverse the declines of the state-endangered northern goshawk (*Accipiter gentiles*) and red-shouldered hawk (*Buteo lineatus*), and the state-threatened Cooper's hawk (*Accipiter cooperii*) and barred owl (*Strix varia*).
OBJECTIVE 2: To determine the distribution of owls throughout NJ including the listed short-eared owl (*Asio flammeus*), long-eared owl (*Asio otus*), and barred owl (*Strix varia*), special concern status common barn owl (*Tyto alba*), and other inhabitants including the great horned owl (*Bubo virginianus*), eastern screech owl (*Megascops asio*), and the northern saw-whet owl (*Aegolius acadicus*); and develop baseline data for long-term monitoring of owl populations, distribution, and habitat selection. **This portion of the job was not proposed for the 2009-2010 funding cycle.**
OBJECTIVE 3: To determine home range and broader habitat usage by barred owls within NJ, specifically targeting the differences between northern and southern residents.

Job 1J, Part 1: Woodland Raptors:
Key Findings:

- During the 2008-2009 segment, staff worked to compile survey data from 1986–2006 into a single, standardized database (see details in *State Wildlife Grants Progress Report, T-1-5, Endangered, Threatened and Rare Wildlife Conservation Projects: September 1, 2008-August 31, 2009*).
    - In December, 2009, ENSP staff met with Dr. E. Green, Rutgers University statistician, to discuss the database, the objectives of the analysis (population trend in surveys in relation to changing land use cover, evaluating forest types), and how the database should be revised to a more workable format for statistical analysis.
        - Raptor survey data were associated with the Land Use/Land Cover (LU/LC) data that best represented the survey period. Thus, raptor data collected in 1986-1989 were associated with 1986 LU/LC, raptor data collected in 2001-2002 with the 2002 LU/LC, and 2006 raptor data with the 2007 LU/LC. During the initial consultation with the statistician, the State's 2007 LU/LC was not finalized; therefore 2006 raptor data were initially excluded from the database submitted for analysis. When the 2007 LU/LC data were made available (in spring, 2010) the raptor database was revised to include the 2006 raptor data and associated habitats and resubmitted to the statistician.
        - At the time of this report, the data have not yet been analyzed and therefore, management strategies were not developed.
- Without a final analysis of the data and the subsequent ability to determine if the survey effort is providing the needed information, ENSP staff refrained from conducting the originally scheduled 2010 woodland raptor surveys. Staff held three meetings and conference calls to discuss our next steps:
    - ENSP staff began planning the 2010-2011 segment work. The focus will be on evaluating the different ways that "core forest" can be defined, and to use species data to identify the most accurate method to represent important barred owl and red-shouldered hawk habitats. Once this is determined, random survey locations within both suitable and unsuitable sites will be selected to test our findings.
- ENSP staff worked with NJ Bureau of Forestry to set goals and objectives for forest management at Belleplain State Forest (Cape May and Cumberland counties). Belleplain supports one of the densest barred owl populations in southern NJ. Forest management prescriptions were written for each forest stand type to promote a multi-aged, more mature forest on state lands.
- We solicited sightings of forest raptors to augment the ENSP database. Solicitation effort was limited to focus on consultants and citizens who had made other sightings reports. We could not determine how many woodland raptor observations reported were due to our request. The on-line E&T sightings reporting system, under development by ENSP and Rutgers University, has not been completed, but is expected to facilitate submission of E&T sightings.
- There were no sightings that required staff or volunteers to visit and confirm a reported observation.

Conclusions:
- Conclusions regarding trends in population data and land use cover could not be completed due to delays in availability of habitat data, and the analyst's time.
- Any effort to refine and improve how rare species' habitats are represented will assist biologists to properly manage and protect these species.
- ENSP has developed a good partnership with the Bureau of Forestry, which may result in a standard protocol for interior-forest bird conservation on state lands.
- Conservation groups conducting bird surveys claim to report rare bird observations; continued solicitation of these groups may be unnecessary.

Recommendations:
- ENSP staff must evaluate population data relative to habitats, and design or re-design methods for future surveys to track population trends
- Complete the evaluation of methods to define core forest (using GIS) to better represent the habitat requirements of barred owls and red-shouldered hawks.

- Continue to work with state land managers to promote forest health and reduce fragmentation, to support forest bird populations on state lands.

Job 1J, Part 2: Barred Owl, Home Range Study

Key Findings:

- This part of the job was not initiated or completed. Staff evaluated the approach, specifically whether the job would be best accomplished by employing a graduate student at Rutgers or another state university, of assigning it to staff biologists. We discussed the project with researchers at Rutgers University but were not able to reach agreement nor find a suitable (prospective) student. The funding needed to support a graduate student was more than the amount budgeted in this grant, so we needed more time to find additional funding or obtain more university support for a student. For that reason, NJ DFW applied for additional funding from the Pittman-Robertson fund for the 2010-2011 period.

Conclusions:

- This project remains one that is needed for ENSP to develop informed conservation plans for the state's barred owl populations in northern and southern NJ.

Recommendations:

- Develop the necessary support for a graduate assistantship or an advanced internship to carry out this project.

JOB 1L: American Kestrel

Project co-leaders: Peter Winkler, GIS Specialist and Kim Korth, Senior Zoologist

OBJECTIVE: To halt and reverse the decline of the newly listed American kestrel through a coordinated approach of population and habitat monitoring, threat assessment, habitat protection, management, research, education and environmental review.

Key findings:

- Suitable sites for American kestrels were identified using a GIS predictive model based on the NJ Department of Environmental Protection's 2002 Level III Land Use/Land Cover data layer (LU/LC) and kestrel occupancy data from Dr. Smallwood of Montclair State University. Areas of contiguous kestrel habitat were divided into three patch sizes: 0-250 ha, 250-1000 ha, and >1000 ha.
- Nest boxes placed in the top two patch categories, 250-1000 ha and >1000 ha, accounted for the majority of active nest boxes throughout the 5-year study (Table 1).

Table 1. Percentage of active nest boxes in patches >250 ha in size for all study years (2006-2010)

Study year	Percentage of active nest boxes in patches >250 ha
2006	84%
2007	82%
2008	78%
2009	86%
2010	90%

- For the 2010 season, ENSP targeted a subset (139) of the existing 275 boxes for monitoring, while maintaining some representation within all study areas (Clinton, Amwell Valley, Assunpink), to focus our monitoring efforts on the most productive areas. We determined the subset by selecting boxes that had been used by kestrels at least once in the previous three seasons. Boxes not identified for monitoring included those that were in suboptimal locations, where volunteer help was lacking, where

landowner support was lacking, or where nest boxes failed (box broke or the supporting structure fell down).
  - A total of 139 nest boxes was monitored every 12-15 days from April through August 2010. Of those 139 nest boxes, 38 (27%) were occupied by American kestrels. Eighteen (47%) boxes were successful, defined by the nest attempt resulting in nestlings that reached bandable age of 14-22 days. Twenty nest attempts (53%) resulted in failures.
  - One new nest box volunteer monitor was recruited and trained.
- The 2010 nestbox field season resulted in the following:
  - 68 kestrels were banded: 62 nestlings (35 female, 24 male) and 6 adults (all females) at 38 nest boxes.
  - Six failed/addled eggs were collected at three different nest boxes.
  - Three volunteers monitored 18 nest boxes while staff monitored 121 boxes.
- All data collected continued to be entered online through a Google documents online interface. All banding data will be supplied to the Bird Banding Lab via BandIt.

- In 2010, ENSP created a pilot call-playback survey protocol for American kestrels. The survey was used to compare the accuracy of standard point count surveys and call-playback surveys to detect kestrels.
  - For the call-playback/standard point count comparison, the study area was the same as the nestbox survey area, monitored since 2006. Four survey routes were created with 10 survey locations on each route. Survey locations along routes were divided into two categories. The categories were "high likelihood of kestrels using the area (HL)" and "suitable habitat with no known nesting (SH)." High likelihood is defined as kestrels attempting nesting within 500 meters of a location at least twice in the past four years; the survey location was between 100 m and 500 m from previously-occupied nest boxes. Suitable habitat is defined as areas of kestrel habitat with no known nesting attempts within 500 m in the past four years. At each survey location, a standard observation point count (5 min) was conducted, immediately followed by a call-playback survey (5 min of kestrel call and intermittent listening periods). Each route was surveyed between dawn and 10:00 AM twice during each of the three breeding phases (courtship, incubation, and nestling). Surveys were discontinued at locations once kestrels were detected.
  - A total of 191 point count/call-playback surveys were conducted at 40 locations, with kestrels observed at 9 (22.5%) locations (Table 1). Seven were observed during the courtship phase and two during the nestling phase; no kestrels were observed during the incubation phase. In total, 11 individuals were observed at the 9 locations.
  - Call-playback increased the number of positive survey locations from 6 to 8 and increased the number of kestrels observed from 6 to 10. At one survey location a kestrel was observed during the call-playback but since it was a flyover and the bird did not react to the call we did not include this individual in our analysis.
- Of the 20 HL survey locations within the study, only 8 had active nests in ENSP-monitored nest boxes within 500 meters of the survey locations. Of the 8 HL survey locations where kestrels were observed, 4 had kestrels nesting within 500 meters of the survey location. Of the 13 HL survey locations where kestrels were not observed, 4 had kestrels nesting within 500 meters of the survey location (Table 2).

Table 1. Kestrels detected by two survey techniques.

Survey method	No. locations with "hits"
Point count only	3
Call-playback only	3[a]
Both (pt count and call-playback)	3
No responses	31
Total	40

[a] Includes one kestrel observed during the call-playback period that was a flyover (did not respond or call).

Table 2. Kestrels observed in surveys conducted in locations with High Likelihood of kestrels using the area (HL) and Suitable Habitat with no known nesting (SH)

	Number of Locations	
Location Type	Kestrels Observed (#nests known w/in 500m)	No Kestrels Observed (#nests known w/in 500m)
HL	8 (4)	13 (4)
SH	2 (0)	18 (0)

Conclusions:

- Nest box placement has been successful; we have determined that open habitat patches >250 ha are 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 nest area fidelity in the NJ population. These data may help identify problems related to population declines.
- ENSP monitored fewer nest boxes but maintained the same success rate and almost the same total number of breeding pairs by concentrating on the most productive areas identified in previous years. This change allowed us to maximize staff and volunteer time and the number of pairs monitored.
- The call-playback survey technique increased the percentage of positive locations by one-third (from 6 to 8). However, both the call-playback and point count surveys failed to detect kestrels nesting at four (50%) of 8 known-occupied nesting locations containing monitored nest boxes. The lack of responses by kestrels during the incubation period, and highest response during courtship, suggest that call-playback surveys are best conducted during the courtship phase.

Recommendations:

- Identify a sample of nest boxes in the most productive areas in ENSP study sites to determine occupancy (by kestrels and competitors), kestrel productivity, and causes of mortality and nest failures.
- Remove unoccupied nest boxes in unsuitable habitat and relocate to locations in the largest patch size categories and on properties that are permanently protected from development to maximize use by kestrels.
- Continue to evaluate effectiveness of nest box program to improve kestrel reproductive success.
- Recruit and train a group of dedicated 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.
- Conduct call-playback at different times of the day to determine if time of day affects detectability of kestrels.
- Develop framework and funding to investigate use of and potential loss of kestrel migration habitat in NJ.
- Develop survey protocols to determine habitat use by kestrels that may be recommended for use in environmental review process.
- Develop kestrel patch model using updated NJDEP Land Use Land Cover (2007) and compare kestrel patch statistics to previous years (1986, 1995 & 2002) to evaluate habitat trends.

JOB 1M: Secretive Marsh Birds

Project co-leaders: Christina Kisiel, Senior Environmental Specialist and Robert Somes, Assistant Zoologist

OBJECTIVE: Develop and implement a monitoring program for secretive marsh birds.

Key Findings:

- The Landscape Project (Landscape) habitat mapping was used as a starting point to determine where survey routes should be located within the Highlands Region and the Atlantic Coastal Region. The paucity of secretive marsh bird occurrences in Landscape meant that there was insufficient information to inform an approach based solely on prior sightings. A habitat model was created and updated with 2009 data from Landscape and used in conjunction with extensive advice from local birders that were highly experienced with secretive marsh bird species.
- Although the Highlands are defined by political boundaries, covering the entire range of this area was not a realistic goal with ENSP's limited staffing resources. Due to this limitation, this survey focused on areas that were deemed to represent suitable habitat for secretive marsh birds based on an examination of NJ Department of Environmental Protection 2002 Level III Land Use/ Land Cover data (LU/LC) overlaid on aerial photographs and soliciting information from local birders.
- Nine routes were created throughout the Highlands Region and six trial routes were created along the Atlantic Coast region of the state. Each route had 9-12 survey points, located a minimum of 0.25 miles apart. Most of these routes and survey points were determined through a combination of GIS mapping and contacts with local birders who had knowledge of where secretive marsh birds were likely to occur.
- These routes were a combination of nine repeated survey routes in the Highlands (from 2009) and six new routes in the Atlantic Coast region. The new routes were chosen to survey areas that had been left out during previous surveys, had poor access, or lacked secretive marsh bird data. The new routes were also trial surveys in the Atlantic Coast region of the State.
    - Volunteers surveyed seven of the fifteen routes.
        - Volunteers were recruited through a number of sources, including list serves and e-mail solicitations to the Division of Fish and Wildlife's Wildlife Conservation Corps.
        - The same small, core group of five volunteers and one new volunteer were utilized from the previous year's survey to improve replication of sites that were to be repeated during the 2010 season and to assist with the Atlantic Coast surveys.
    - Two ENSP biologists surveyed eight of the 15 routes.
- A one-day training session was conducted to review the protocol with volunteers, carry out distance estimation exercises, and to distribute datasheets and equipment to the volunteers.
- Surveyors followed the Conway protocol, the standard recommended in the Coordinated Bird Monitoring protocols, which requires passive listening as well as call-back portions of the survey. Conway supplied digital files of the focal species' calls. The equipment that was available for this survey included compact disc players and MP3 players. The files were downloaded to the appropriate media with no problems, although the MP3 players performed slightly better than the compact disc players. Calls were amplified using speaker boxes at a decibel level of 90 decibels at 1 meter in front of the speaker.
- This year's survey yielded extensive results. For the 15 routes/135 points surveyed there were a total of 144 responses from Virginia Rails (55 individuals), Sora Rails (2), Clapper Rails (47), American Bitterns (1), Least Bitterns (4), Common Moorhens (6), and Pied-billed Grebes (6). There were no responses from King Rails or Black Rails.
- Expansion of the project in Central and Southern New Jersey was accomplished through the surveying of 6 Atlantic Coast routes.
- All data from the previous 3 years of surveys have been compiled and entered into New Jersey's Biotics and Landscape databases. This data has been incorporated into species-specific habitat models to be utilized for habitat mapping and conservation planning and management decisions.

Conclusions:

- A large area of previously unsurveyed habitat was surveyed during this season and led to high numbers of responses from target species.
- The Coastal Marsh sites surveyed yielded large numbers of Clapper Rails calling during the survey. Several locations had 10 or more individuals calling at any given time sometimes making it difficult to get an accurate count of how many individuals were present.
- Surveys along the Atlantic Coast will be limited greatly by access but if watercraft are available for staff use, efficiency will be increased greatly. Several locations were easily surveyed via the use of a kayak.
- Weather once again was a major issue with record rainfall in March, a heat wave in April, and then cool weather again at the end of the survey period. Due to the record early rainfall many early nesting birds probably experienced nest failures due to flooding at the start of the survey period.
- The past 3 years of intensive secretive marsh bird surveys in New Jersey have been highly successful, and we were able to develop an effective survey program that yielded large amounts of useful data and greatly enhanced our understanding of the habitat needs for these species.

Recommendations:

- This year completes three years of intensive Secretive Marsh Bird surveying in the Highlands region of NJ. Owing to the success of the project in the Highlands Region, the project should be expanded at a larger scale in the Atlantic Coast and Delaware Bayshore Landscape regions of New Jersey where there is significant data lacking and extensive threats from sea-level rise and exotic species invasions.
- Due to site access issues often encountered during the survey, and the small window of time during the course of any survey day that is spent at a specific site, remote monitoring technologies should be investigated for their potential application in Secretive Marsh Bird surveying efforts. Remote acoustic monitoring/recording equipment could be used to monitor for bird calls at a given site for several hours on any given day and could also be utilized in a call-playback survey. They are also useful for inaccessible sites in that they would cut down on the number of site visits. This technology could also be used to monitor for other rare bird species of interest (i.e., saltmarsh and seaside sparrows and sedge wrens) other than just secretive marsh birds.

JOB 2: Species of Special Concern

OBJECTIVE: To conserve populations of birds having Special Concern status in New Jersey, and prevent declines that would necessitate listing through a coordinated approach of population and habitat monitoring, threat assessment, habitat protection and acquisition, management, research, education and environmental review.

JOB 2B: Scrub-shrub/Open Field Passerines

Project leader: Sharon Petzinger, Senior Zoologist

OBJECTIVE: To stabilize and reverse the decline in scrub-shrub/open-field nesting birds of special concern and regional priority, both those that migrate through New Jersey and, in particular, those that breed in NJ. Goals include: inventorying and monitoring species populations (specifically those not covered by the Breeding Bird Survey), the identification and preservation of critical habitat, the identification of specific threats at these sites, and the provision of guidance/recommendations to land managers and landowners. In 2009-2010: To determine the characteristics of source habitat for golden-winged warblers occupying utility ROWs in New Jersey as well as golden-winged warbler response to certain management techniques used by the utility companies and create, implement, and evaluate habitat management guidelines for the creation of source golden-winged warbler habitat in NJ.

Key Findings:

- The golden-winged warbler management guidelines are not yet completed but are being analyzed by a statistician.
  - Errors are being worked out of the code for Bayesian analyses.
  - Foresters were not contacted because the management guidelines are still in progress.
  - All utility companies were contacted to review revised no-harm guidelines. One utility company (PSEG) was willing to discuss the management of select spans. As a result, management for golden-winged warblers on those spans was to be included in their mitigation plan.
  - Management for golden-winged warblers and other species was proposed to be done on Sparta Mountain Wildlife Management Area this winter. This area has had breeding golden-winged warblers near the proposed area for at least a decade up to the year 2006, but none were documented in surveys since then.
- Post-management surveys were not conducted because habitat management had not been implemented.
- The predictive GIS model was not completed because the statistical analyses are still in progress.
- Data on golden-winged warbler occupancy and habitat were collected in 2010 as part of the 2010 Golden-winged Warbler Atlas run by Cornell Lab of Ornithology. Biologists surveyed 117 points for golden-winged warblers in potential habitats (utility ROW, shrub swamp, successional forest, old field) in northwestern NJ to aid in the identification of priority areas for golden-winged warbler management. Thirty-five points were repeated from 2008 and 2009, and a total of 631 different locations were surveyed from 2008 to 2010.
  - Habitat data were collected at all survey points in 2010**.** Approximately 47% of the points were in predominately wetland habitat, and 53% of the points were in predominately upland habitat.
    - The majority of the survey points were in wetland successional forest (21%), upland successional forest (18%), upland shrubby field (17%) and upland utility ROW (15%). The remainder of the points were in wetland utility ROWs (9%), fens (7%), beaver wetlands (6%), alder swamp (3%), and other (4%) (Figure 2B-1).
    - Most (80%) of the survey points contained <50% tree cover, with the majority of those (54%) containing 25-50% tree cover (Figure 2B-2).
    - All of the survey points contained 0-50% herbaceous cover with the majority of those (52%) containing 1-25% herbaceous cover (Figure 2B-2).
    - Most (90%) of the survey points contained <25% shrub cover with the majority of those 661%) containing 0-25% shrub cover (Figure 2B-2).
    - All of the survey points contained <25% dead vegetative cover with the majority of those (94%) containing no dead vegetative cover (Figure 2B-2).
    - The height of the vegetation at survey points was <2 m tall at most (62%) points, but 23% of the points had vegetation >3m tall (Figure 2B-3).
    - The majority of points (61%) had swamp or wet ground present; 27% had no water visible (Figure 2B-4).
  - Seventeen golden-winged warblers, six hybrids, and 64 blue-winged warblers were observed during the 2010 survey (Figure 2B-5).
    - All golden-winged warblers were observed on or adjacent to protected lands (state parks, state wildlife management areas, county parks, city watersheds, NGO properties).
    - Of the 17 golden-winged warblers observed, six (37.5%) were in upland utility ROWs, three (20%) in shrubby fields, three (20%) in wetland utility ROWs, two (13%) in successional forest uplands, one (6%) in a beaver wetland and one (6%) in successional forest wetlands (Figure 2B-1).
    - Most (75%) of the golden-winged warblers were observed in areas with <25% herbaceous cover. All golden-winged warblers were observed in areas with <50% tree cover and shrub cover and <25% dead vegetation cover (Figure 2B-2).
    - Almost half of the GWWAs occurred in areas where the average vegetation height was 0-1 m (Figure 2B-3).

        - Most (59%) of the GWWAs occurred in areas where a swamp or wet ground was observed (Figure 2B-4).
    - Eleven percent of new (non-repeated) 2010 survey locations were occupied by golden-winged warblers, 45% by blue-winged warblers, 2% by Brewster's warblers, and 2% by Lawrence's warblers (Figure 2B-6).
    - Almost half of the 2009 survey locations occupied by golden-winged warblers were not occupied in 2010 where 6% of 2009 unoccupied survey locations repeated in 2010 were occupied by golden-winged warblers (Figure 2B-7).
- Staff attended the Golden-winged Warbler Working Group meeting in Ithaca, NY from August 3-5, 2010.
    - Staff identified focal areas in New Jersey to target for management of golden-winged warblers and identified partners to contact to implement management
- The status assessment (employing the Delphi technique) has been completed for the golden-winged warbler. Consensus was reached to list breeding golden-winged warblers as endangered in NJ, but no consensus was reached for the non-breeding population. The Endangered and Nongame Advisory Committee voted to keep the non-breeding golden-winged warbler listed as special concern.
- The data will be submitted for entry into the NJ DEP's Biotics database by mid-November.

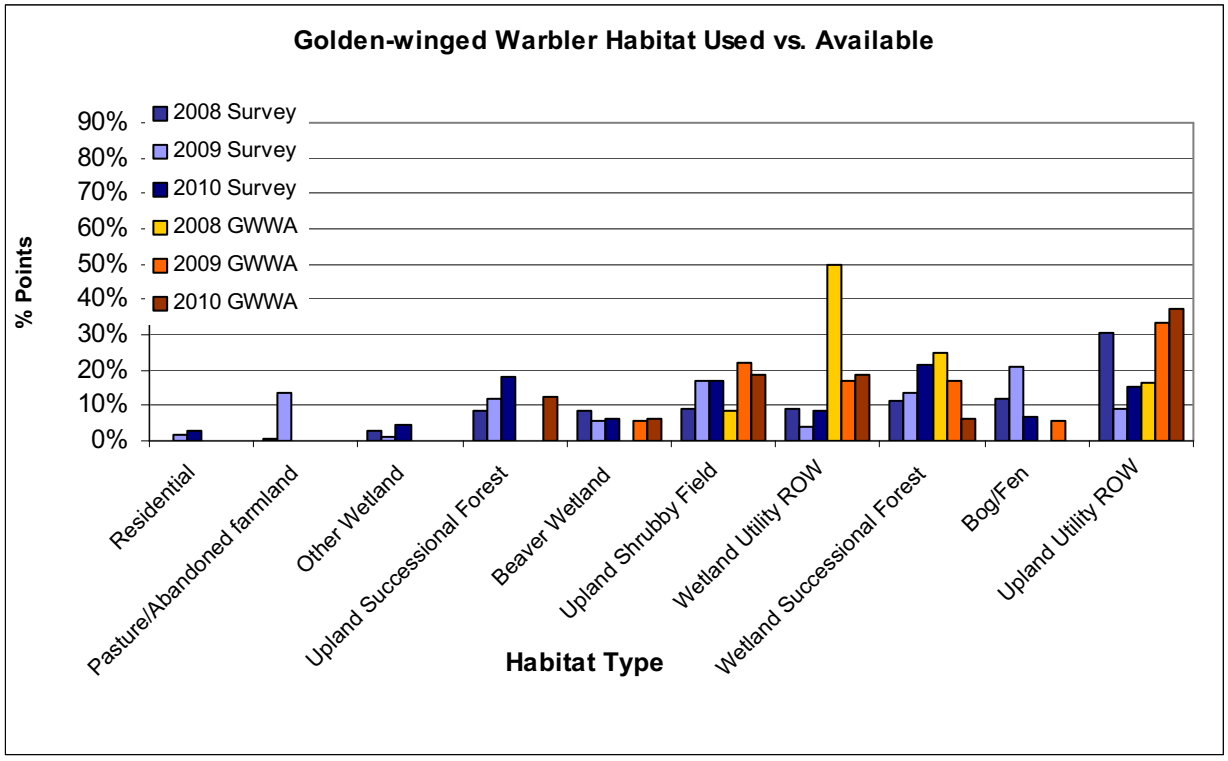


Figure 2B-1. Habitats used by golden-winged warblers (GWWA) vs. available habitat surveyed (Survey) during the 2008, 2009, and 2010 survey.

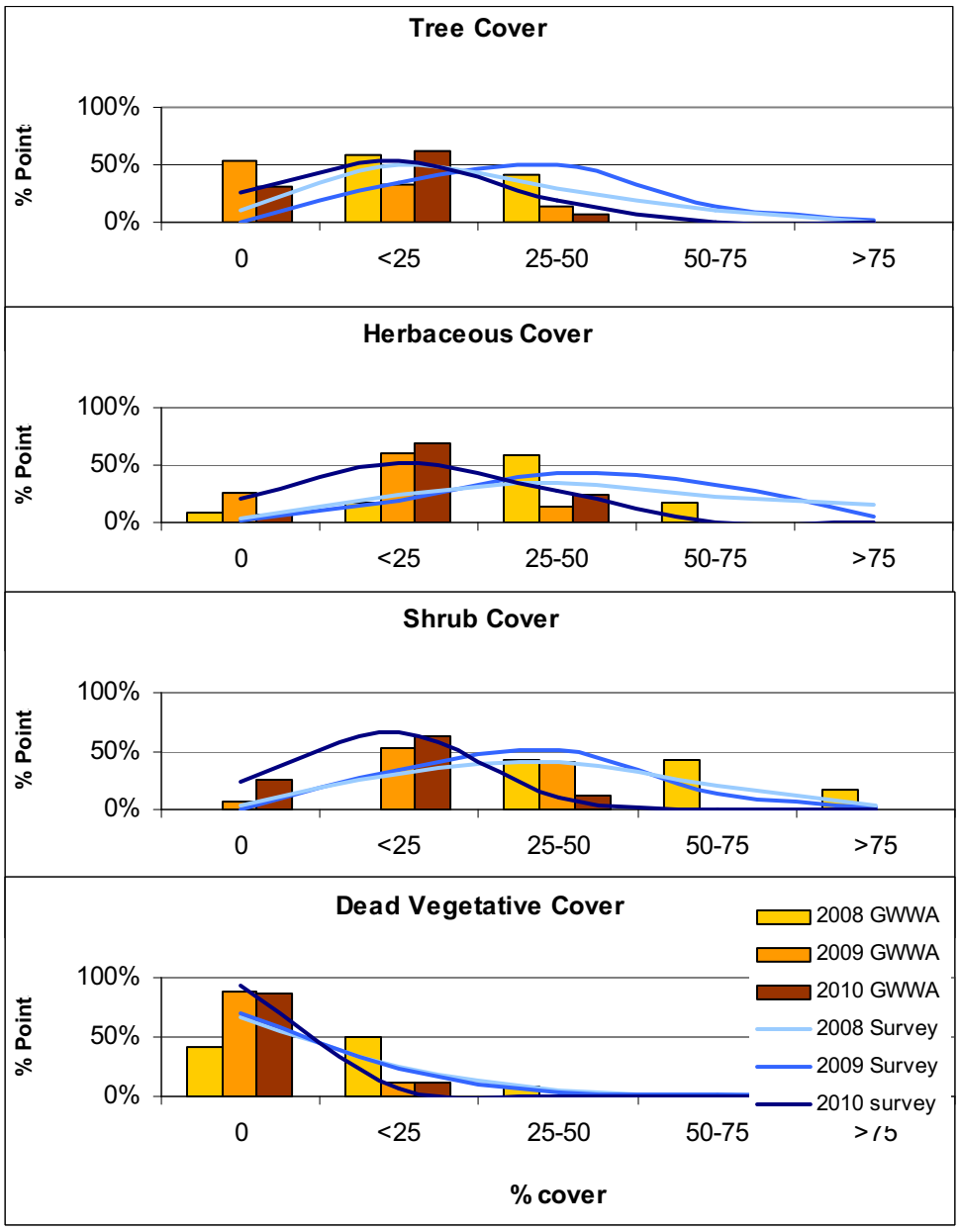


Figure 2B-2. Percent cover type used by golden-winged warblers (GWWA) vs what was available (Survey) during the 2008, 2009, and 2010 surveys.

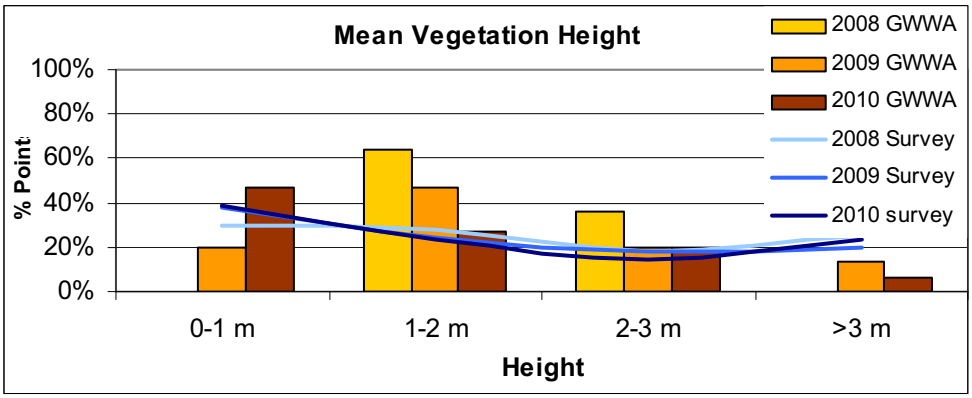


Figure 2B-3. Mean vegetation height in the area used by golden-winged warblers (GWWA) vs what was available (Survey) during the 2008, 2009, and 2010 surveys.

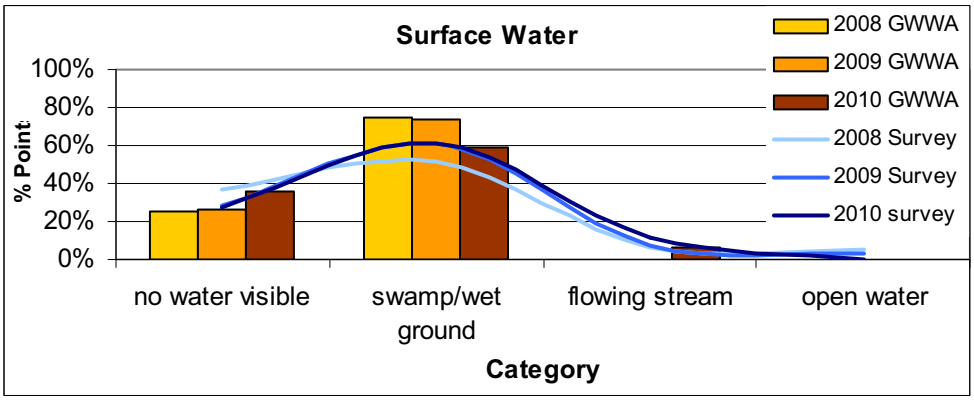


Figure 2B-4. Surface water observed in the area used by golden-winged warblers (GWWA) vs what was available (Survey) during the 2008, 2009, and 2010 surveys.

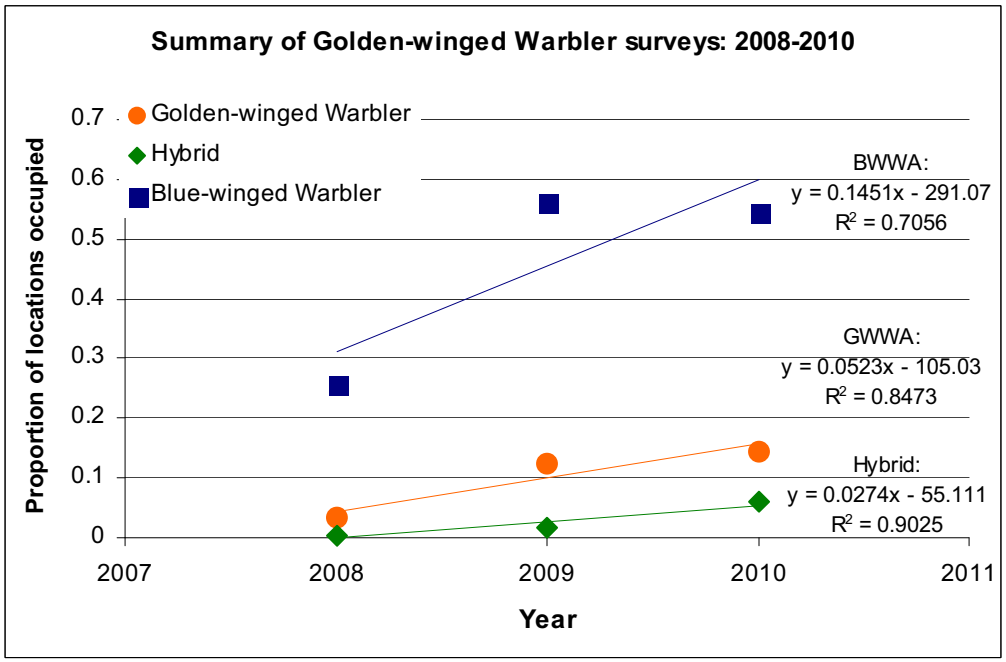


Figure 2B-5. Proportion of golden-winged warblers, blue-winged warblers, and hybrids observed per survey location during the 2008 (n=405), 2009 (n=179), and 2010 (n=117) surveys.

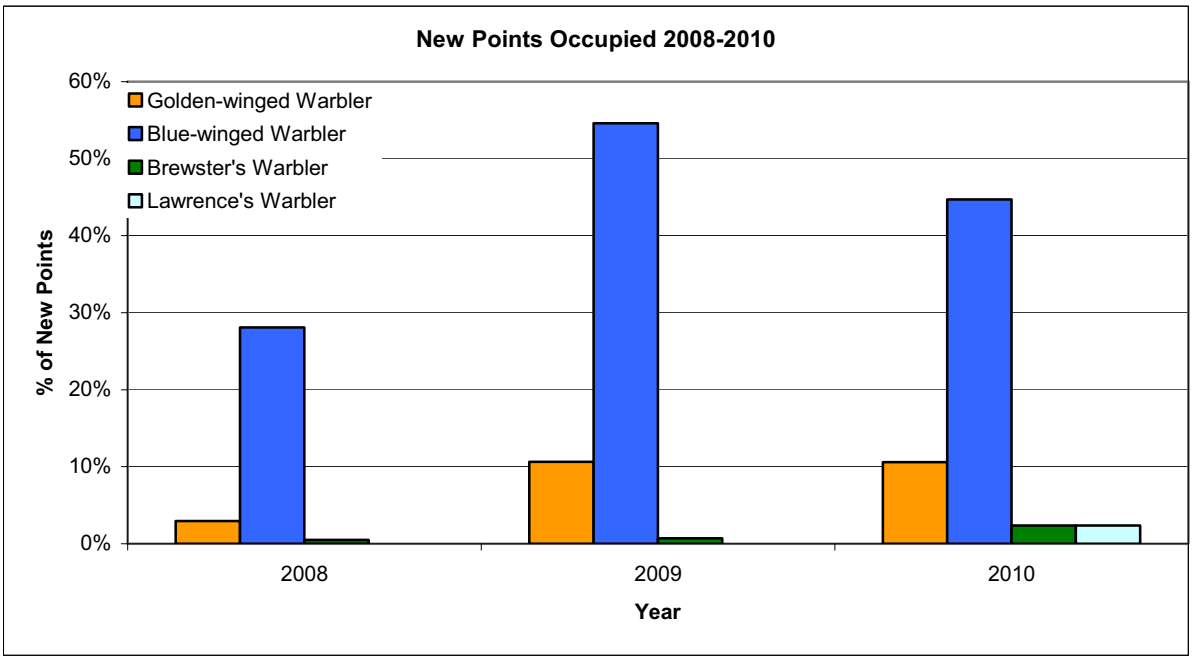


Figure 2B-6. Percentage of new (non-repeated) survey locations occupied by golden-winged warblers, blue-winged warblers, or hybrids during 2008 (n=405), 2009 (n=141) and 2010 (n=85) surveys.

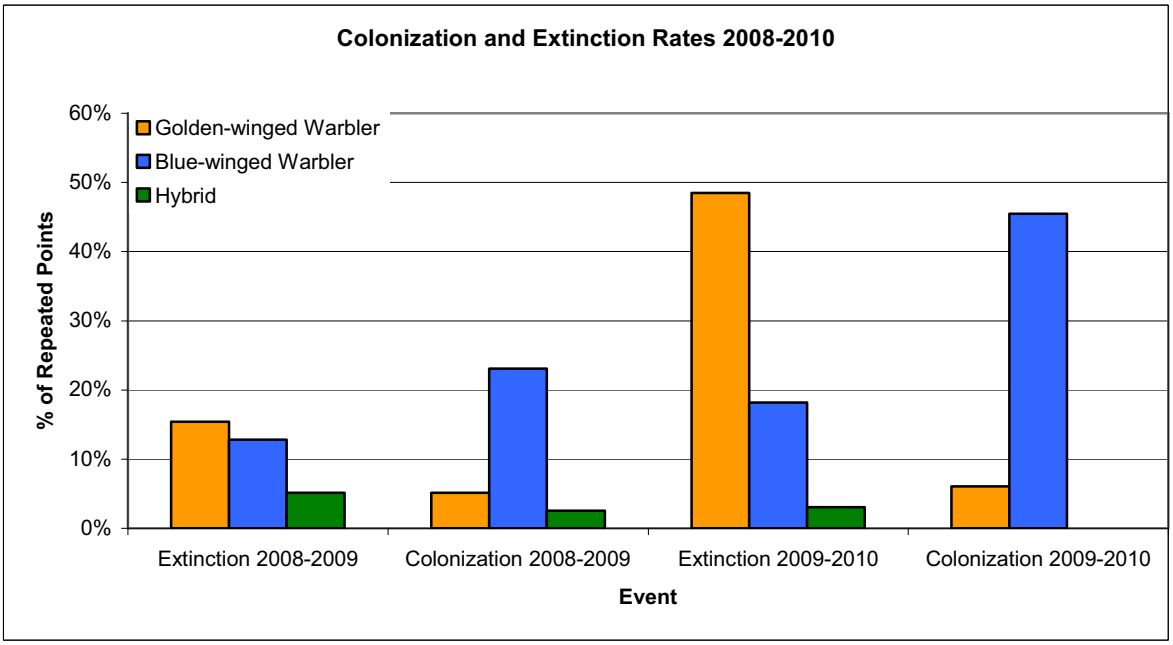


Figure 2B-7. Percentage of golden-winged warblers, blue-winged warblers, and hybrids undergoing colonization or extinction events at each repeated survey location during 2008-2009 (n=39) and 2009-2010 (n=33) surveys.

Conclusions:

- Although habitat exists in NJ for golden-winged warblers and the population appears to not have changed over the years, the extinction rate of a point occupied in the previous year is greater than the colonization rate of a point not occupied in the previous year, where the inverse is true for blue-winged warblers. Furthermore, the extinction rate for golden-winged warblers and colonization rate for blue-winged warblers have both nearly doubled in the period of 2009-2010.

- The number of hybrids, particularly Lawrence's warbler, has increased since 2008.
- The results of the 2010 survey demonstrate an affinity by golden-winged warblers for both upland and wetland utility ROWs with <25% tree cover, <25% herbaceous cover, <25% shrub cover, no dead vegetation, and areas with overall vegetation height of 0-1 meters with a swamp or wet ground present.

Recommendations:
- Perform occupancy modeling on data to identify habitat covariates that could influence colonization and extinction events
- Create management recommendations for source golden-winged warbler habitat based on the analyses of 2003-2007 data and in coordination with the Golden-winged Warbler Working Group.
- Work with utility companies, NJ Division of Parks and Forestry, NJ Division of Fish and Wildlife's Bureau of Land Management, Morris County Park Commission, and The Nature Conservancy-New Jersey Chapter to manage the last remaining active golden-winged warbler breeding areas.
- Work with land managers to use the best methods for maintaining optimal golden-winged warbler habitat in areas where individuals have already nested without displacing those individuals by severely altering the habitat.

JOB 2C: Monitoring Avian Productivity and Survivorship (MAPS)

Project leader: Sharon Petzinger, Senior Zoologist

OBJECTIVE: To provide data to the Institute for Bird Populations that will help describe temporal and spatial patterns in the vital rates of target species. Identify causes of population declines, formulate strategies to reverse declines and maintain healthy populations, and evaluate effectiveness of strategies.

Key Findings:
- In 2010, three trained volunteers, with assistance from one untrained volunteer, mist-netted in Bear Swamp, Cumberland County for approximately 421 net hours on eight different days from May through August. This is the 17th consecutive year of operation at this station.
  - Seventy-two individual birds of 16 different species were mist-netted, 63 of these were new captures (60 banded) and14 were recaptures from previous years.
  - The majority of the birds netted were ovenbirds (18), followed by tufted titmice (12), common grackles (10), and worm-eating warblers (9).
  - The mean species abundance in Bear Swamp, 1995–2010, was 72.6 (± 6.8); mean species richness was 17.9 (± 1.0)
  - While the species abundance and richness still have an overall increasing trend in 1995–2010, both figures are lower than 2009 (Figure 2C-1).
  - Productivity was the third highest with 35 (49%) of the 72 aged individuals being young fledged from this year (Figure 2C-2).
- Data have been submitted to the Institute of Bird Populations and the Bird Banding Lab and will be submitted for entry into NJ DEP's Biotics database by mid-November.

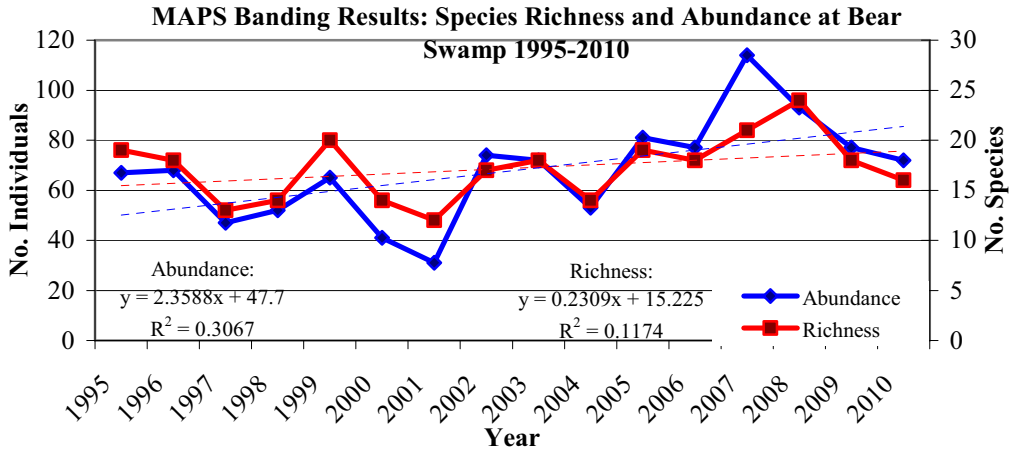


Figure 2C-1. Species richness and abundance at the Bear Swamp banding station 1995–2010 (1994 banding results were omitted due to inconsistencies/bias of the first year).

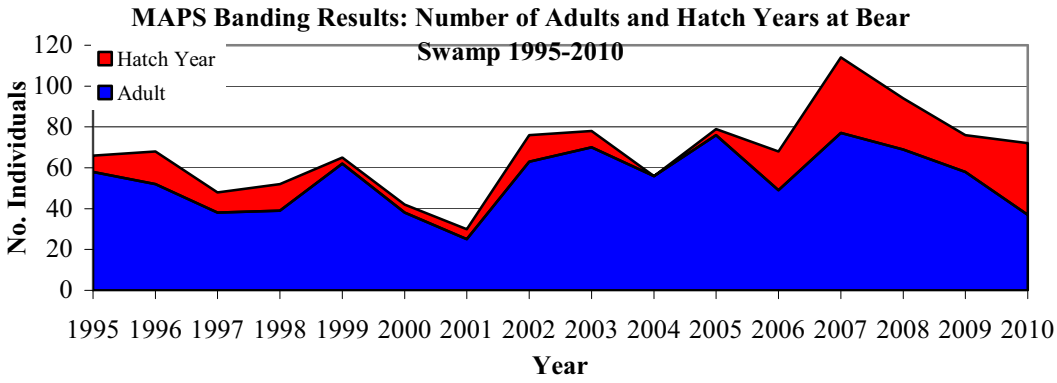


Figure 2C-2. Number of adults and hatch-year birds at the Bear Swamp banding station 1995–2010 (1994 banding results were omitted due to inconsistencies/bias of the first year).

Conclusions:

- Bear Swamp continues to be a stable community for forest birds. Both species abundance and richness show a positive trend and productivity is still above the mean of the last 17 years.

Recommendations:

- Continue the long-term monitoring project and supplement the Institute for Bird Populations with data. Investigate comparing this data with trends from other forest songbird surveys.

JOB 2D: Region-based Breeding Landbird Surveys

Project leader: Sharon Petzinger, Senior Zoologist

OBJECTIVE: To detect trends and monitor distribution patterns of breeding landbirds within the different regions in New Jersey.

Key Findings:

- In 2010 staff summarized data from previous years' surveys (1994-2008) and conducted power analyses for a subset of species (Table 2D-1).
    - To obtain 80% power (α=0.05) to conduct a T-test, the sample sizes ranged from a few hundred survey points for the more common and easily-detected species (Baltimore oriole, black-capped chickadee, wood thrush) to thousands of survey points for the less common and harder-to-detect species (brown creeper, blackburnian warbler).
    - The number of survey points repeated from previous years did not meet the requirements for all of species used in the above analysis (Table 2D-1).
    - Reliable trend data for NJ already exist from USGS Breeding Bird survey analyses for the common species in NJ that the region-based landbird surveys can also detect trends for.
- Based on results, staff discussed options for changing the survey protocol to gather information on rarer landbirds in NJ
    - No volunteers were recruited and no surveys were conducted in 2010 because more time and research was needed to change the survey protocol.
    - A habitat change analysis was not done because the 2007 Land Use-Land Cover was not available until a few months ago and a third year of surveys was not conducted.
- Due to a backlog with entering data into NJ DEP's Biotics database and a change in status to Special Concern or higher for many landbird species based upon the last Delphi bird review, a contractor was hired to enter the previous years' landbird data in NJ DEP's Biotics database.
    - 4,077 records from the 1994-2008 landbird surveys were entered in NJ DEP's Biotics database.
- The species occurrence area models and feature labels for the special concern landbirds in NJ were revised in preparation for the next version of NJ DEP's Landscape Project Map.
- Survey data from the Pinelands region were conformed and analyzed to determine changes in species richness and abundance (Fig. 2D-1).
    - There were fewer species and number of individuals in the Pinelands region in 2006 than in 1999.

Table 2D-1. Sample size requirements based upon 2 different analyses based upon previous year's landbird survey data. Species in red require a larger sample size than survey points available in the region(s) they occur.

power = 0.80; α=0.05	***Sample size needed***	
Species	**2-sample t-test**	**paired t-test**
Baltimore oriole	213	155
Black-capped chickadee	452	292
Brown creeper	15,612	13,428
Brown thrasher	2,304	1,238
Blackburnian warbler	9,571	8,206
Eastern wood-pewee	1,918	37
Gray catbird	486	69
Golden-winged warbler	1,989	75,732
Scarlet tanager	216	302
Swamp sparrow	1,537	436
Veery	1,198	1,237
Worm-eating warbler	n/a	n/a
Willow flycatcher	7,270	776
Wood thrush	480	47

Table 2D-2. Number of points surveyed by region each year and repeated both years

	Number of points surveyed		
Region	**First year**	**Second year**	**Repeated both years**
Highlands	2,540	1,717	1,552
Delaware Bay	1,331	346	323
Pinelands	1,411	334	296
Piedmont	590	890	0
Urban	393	68	0
TOTAL	6,265	3,355	2,171

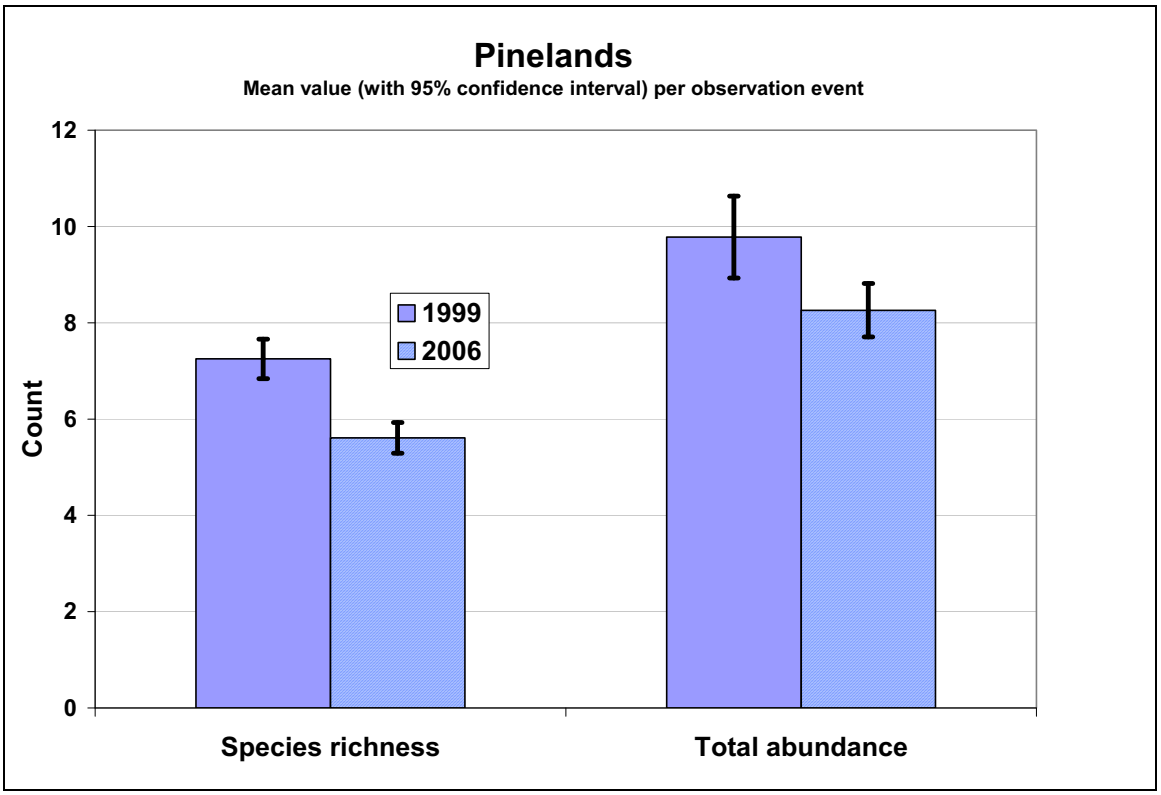


Figure 2D-1. Mean species richness and abundance (± 95% confidence limits) for 1999 and 2006 surveys in the Pinelands region of NJ (N=296).

Conclusions:

- The region-based landbird survey can obtain relative abundance and distribution for each region but would not be reliable to detect trends for all species, particularly those species that do not have reliable trends from the Breeding Bird Survey

Recommendations:

- Determine which landbird species and/or guilds are in need of trend estimates and updated distributions.
- Determine which state lands can be surveyed for forest health indicators
- Determine where forest management will occur on state lands to evaluate the impact of that management on landbirds

JOB 3: Species of Regional Priority

OBJECTIVE: To monitor and conserve populations of birds having a Regional Priority status in the northeast, and prevent declines that would necessitate listing.

JOB 3A: American Oystercatcher

Project leader: Christina Kisiel, Senior Environmental Specialist

OBJECTIVE 1: Determine statewide distribution of wintering populations of American oystercatcher (*Haematopus palliates*).
OBJECTIVE 2: Determine breeding population and reproductive success of American oystercatchers that utilize beach strand habitat (i.e. Atlantic coastal beaches, inlet beaches, inlet sand islands).
OBJECTIVE 3: Continue collaborative range-wide research and survey efforts, especially band resighting, coordinated and facilitated through the American Oystercatcher Working Group.

Key Findings:

- A survey of wintering American oystercatchers, focusing on inlet areas from Barnegat Inlet to Cape May (Canal) Inlet, was conducted 5-15 December, 2009. Additional ground surveys were also conducted later in the season (5-15 January, 2010 and 4-15 February, 2010); the fifth consecutive year late winter surveys were completed. The surveys were conducted by ground (or watercraft) within an hour of high tide to determine the total number of birds present, the ratio of adults and juveniles, and the presence of banded individuals.
  - A total of 807 birds were counted during the 2009 December winter survey. This total is similar to the December 2008 survey (755 birds), with both totals being higher than the past three years (617, 636, and 546, respectively in 2007, 2006, and 2005) and the same as 2004 (807).
  - Only four high tide roost flocks were identified during the 2009 December survey, the largest being two large flocks present within Hereford and Absecon Inlets.
    - Hereford Inlet (Stone Harbor Point) and Absecon Inlet (Brigantine Cove/Rum Point) had 410 and 280 birds present, respectively. This accounted for 86% of the state total, the same as the previous year for these two inlets. Furthermore, this is a similar trend for the six years that ground surveys have been conducted in December
    - The only other notable roost flock during the December survey was within Great Egg Harbor Inlet (North Ocean City), with 92 birds present.
  - About half as many birds (415) were present statewide during the January 2010 survey, similar to the trend for the January 2009 survey. Just 9 birds were present during the February 2010 survey.
    - Nearly all the birds present in the January 2010 survey were found in Absecon Inlet (275) and Hereford Inlet (135).
    - Although low overall numbers are typical for the February survey, in past years the Absecon Inlet flock generally maintained a consistent number of birds for the entire winter period. However in February 2010, just 2 birds were observed at this location.
- American oystercatcher breeding surveys were conducted in 2010 at all Atlantic coast barrier island beach strand sites, with the exception of Little Beach Island, an isolated barrier island that is part of the Edwin B. Forsythe NWR. Intensive surveys were completed in conjunction with piping plover and other beach nesting bird surveys and through research projects conducted by Rutgers University.
  - 61 nesting pairs were identified at 23 beach nesting sites.
    - Nearly half (49%) of the beach nesting pairs hatched young.
    - Productivity was 0.66 chicks fledged per beach nesting pair.
    - Nest failure due to flooding was relatively low this year, which accounts, in part, for the high nest hatch success (and productivity).

    - For the second year in a row, and following intensive predator control efforts directed at red fox, productivity was especially high (1.36 chicks fledged per pair for 11 pairs) at Gateway National Recreation Area (Sandy Hook).
    - For the second year in a row, no oystercatchers nests hatched (and no fledglings were produced) at Edwin B. Forsythe NWR – Holgate Unit, in part due to flooding, but also intense red fox activity and predation.
    - Productivity was also relatively high (0.63 chicks fledged per pair) in the southernmost portion of the state, from Stone Harbor Point to Cape May Meadows, which hosts the highest concentration of beach nesting pairs of oystercatchers in the state (27 pairs, 44% of total).
    - Stone Harbor Point recorded a 31% increase in pairs in 2010 (21 pairs vs. 16 pairs in 2009). However, the increase in pairs is likely just a regional shift in distribution because Champagne Island, formerly a stronghold for oystercatchers, now undergoes complete washover during high tide and no longer supports nesting birds.
- Sixty American oystercatchers, including 19 adults and 41 juveniles, were marked with orange color bands (which represent birds banded in New Jersey) during the breeding season, Banding procedures followed the protocol established by the American Oystercatcher Working Group and consistent with other states along the Atlantic coast. Adults were captured using decoys and noose-carpets (McGowan et al. 2005) placed near nest scrapes on breeding territories. Juveniles were captured with a dip net or by hand prior to fledging. The number of oystercatchers banded in 2010 represents the most in any given year, with the number of oystercatchers banded in New Jersey since 2004 (when the banding program began) now totaling 265 individuals.
- The resighting of banded American oystercatchers is ongoing and is being conducted by ENSP, the Conserve Wildlife Foundation of N.J., Rutgers University, various federal agencies in the state, and the public. Preliminary analysis of the resight data suggests strong site fidelity to both breeding sites and winter high tide roost locations.
- All breeding and wintering populations were documented using GIS for incorporation into NJ DEP's Biotics database and ENSP's Landscape Project.
- ENSP, in conjunction with the U.S. Fish and Wildlife Service–New Jersey Field Office, continued developing comprehensive beach management plans to address threats to beach nesting birds (including American oystercatchers) and implement management strategies. Fifteen plans have been completed to date, with two more in the development stage at this time. Other plans are also now going through a revision phase.
- A statewide breeding survey was not conducted during this grant period (only beaches, not back bay marsh islands/dredge sites). The funds or resources to complete a survey of the entire coastal zone are not presently available. However, it is still recommended that such a survey be initiated some time in the near future, and that once a baseline survey is completed, that it be repeated at least every five years (or at an interval established by the American Oystercatcher Working Group),
- GIS map layers were created that indicate the known distribution of American oystercatcher within the coastal zone. The mapping is intended to be included as part of proposed revisions to the portion of the state's coastal zone management rules that deal with critical wildlife designations. However, that regulatory initiative is currently stalled.

Conclusions:

- The number of breeding pairs of American oystercatcher (61) on barrier/beach strand (the beach nesting portion of the population) in 2010 was close to average (59 pairs) for the period since 2003 when comprehensive monitoring began. This follows a small spike in 2009 (67), however, because this is just a small portion of the overall breeding population and there is movement between habitat types (beaches and back bay marshes/dredge sites), any real trend is difficult to assess.
- Pair hatch success (49% of pairs hatched young) for beach nesting American oystercatchers in 2010 was the highest recorded for the period since 2003 when comprehensive monitoring began, and well above the average (29%) for the same period. Low levels of nest loss due to flooding at several sites (e.g., Stone Harbor Point) was a key factor, although lower levels of predator losses (e.g., Gateway National Recreation Area–Sandy Hook) also played a role.

- Productivity for beach nesting American oystercatchers in 2010 (0.66 chicks fledged per pair) was the highest recorded for the period since 2003 when comprehensive monitoring began, and more than double the average (0.32 chicks fledged per pair) for the same period.
- The number of active nesting sites (23) for beach nesting American oystercatchers was on the high side of the range (19-23 sites) for the period since 2003 when comprehensive monitoring began, but about average (21 sites) for the same period. As the tight range suggests, there has not been significant variability in the number of active sites from year to year.
- The state's wintering population of American oystercatcher (as determined from the December survey period) was the highest in 2009 (along with 2004 when 807 birds were also present) as compared to other years since ground surveys using consistent protocols began in 2004. Overall, there has been considerable variability with a range of between 546 and 807 birds. No trend is apparent over that period although weather is believed to be factor (i.e. temperature and related prey availability). During the entire period (2005-2009) that late winter surveys have been completed in January and February, there are significantly fewer birds present in the late winter, especially on the February surveys. Absecon and Hereford Inlets have consistently been the most important winter roost locations, in terms of number of birds present. Use of Hereford Inlet has tapered off later in the season in some years, although birds are typically present in high numbers at Absecon Inlet throughout all entire winter season (with the exception of the February 2010 survey).

Recommendations:

- Continue to monitor breeding population size and productivity of beach-nesting American oystercatchers on an annual basis. Monitor population and productivity of oystercatchers breeding in other habitat types (i.e., back bay marsh island, dredged material areas), as resources allow.
- Conduct a statewide breeding survey in all suitable habitat types (beaches, back bay marsh/dredged material areas) along the Atlantic coast and Delaware and Raritan Bays at a minimum of five-year intervals (or as determined by the American Oystercatcher Working Group).
- Continue to individually mark American oystercatchers as part of an Atlantic/Gulf coast initiative to study productivity/site fidelity, migratory movements, and generate key demographic metrics.
- Initiate weekly survey to track post-breeding/fall migration population and distribution within the state (abundance and resightings of individually-marked birds). Preliminary results from pilot surveys started in August 2010, and slated to continue through the end of November at important sites in southern NJ, show large concentrations of oystercatchers are present, often at sites not managed for human disturbance. Flocks contained high numbers of banded individuals which resulted in a significant number of band resightings.
- Continue to track American oystercatcher wintering population and distribution annually.
- Continue to include American oystercatchers as part of management strategies (i.e. fencing and signage) implemented at sites where other beach nesting birds (i.e., piping plover, least tern, black skimmers) are present. Continue to assess whether areas where concentrations of oystercatchers occur by themselves or in areas not protected because of other beach nesting birds also require protection through management actions. Implement protection where need is determined.
- Continue to include protections for American oystercatchers in beach nesting bird management plans being developed in partnership with the U.S. Fish and Wildlife Service for municipalities and other breeding sites in the state's coastal zone.
- Continue working to designate American oystercatcher breeding sites and wintering roost locations as critical wildlife habitat in the state's coastal zone. Include post-breeding and fall staging areas, as data during this period are collected.
- Continue collaborating with the American Oystercatcher Working Group, and using the American Oystercatcher Conservation Plan for the Atlantic and Gulf Coasts of the U.S. and New Jersey's Wildlife Action Plan to help establish conservation priorities for the monitoring, management, and research efforts within the state.
- Continue to incorporate breeding and wintering data into Biotics and Landscape Project databases. Include post-breeding and fall staging areas, as data during this period are collected.

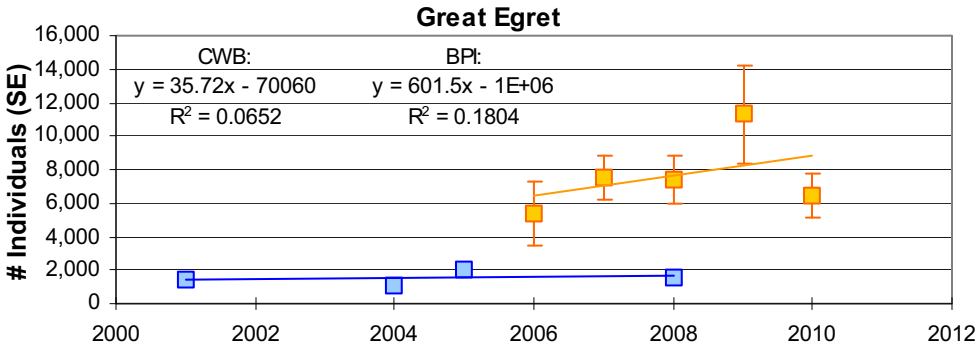
JOB 3B: Regional & National Bird Coordination

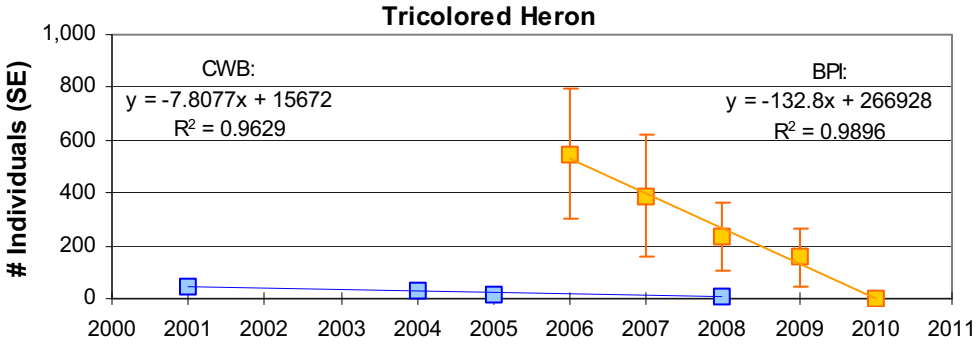
Project leader: Sharon Petzinger, Senior Zoologist

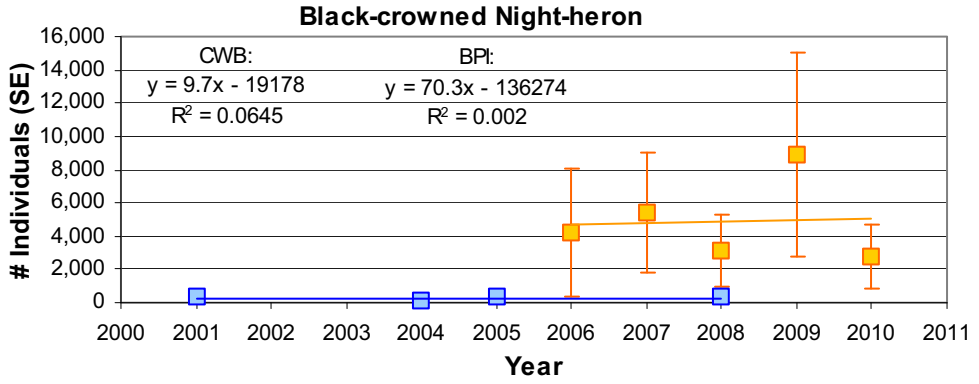
OBJECTIVE: To continue active participation in regional/national meetings, planning, and surveys including the Breeding Bird Survey, Coordinated Bird Monitoring, Partners in Flight, Atlantic Flyway Council, Nongame Technical Section and other working groups pertinent to bird research.

Key Findings:

- Staff attended the Northeast Coordinated Bird Monitoring Partnership Steering Committee on April 25, 2010 in Newton, MA to discuss data management, bird monitoring needs, and planning for the next Northeast Bird Conservation Conference to be held in Plymouth, MA in October 2010.
    - Staff participated in the steering committee for the conference to decide on the venue, prices, and agendas.
- Staff attended the Appalachian Mountain Joint Venture Technical Meeting in Roanoke, VA from September 14-15, 2010.
    - Staff participated in group discussions about conservation planning for early and late-successional focal species, population objectives, and what web-based tools would be useful for state governments
- Three volunteers from 2009 surveying the USGS Breeding Bird Survey (BBS) routes in New Jersey did not continue in 2010 and 5 routes were already vacant from 2009. Staff recruited 6 new volunteers for 2010, resulting in 25 out of 28 of the USGS Breeding Bird Survey (BBS) routes in New Jersey assigned.
    - Only one volunteer did not run their assigned route in 2010
- Three staff were assigned one route each in 2010.
- As part of the NJ Coordinated Bird Monitoring Plan, biologists from NJ DFW collaborated for the sixth year to conduct a joint waterfowl breeding population index (BPI) and endangered and threatened waterbird survey.
    - A total 86 state endangered or threatened and 79 state special concern individuals were observed in 2010.
    - Trends can be detected in the saltmarsh strata for great egrets, snowy egrets, tricolored herons, little blue herons and black-crowned night-herons (Figure 3B-1).
    - Trends from the waterfowl BPI are different from trends from the waterbird colony count.
    - A final analysis cannot be done until the next long-legged wading bird aerial count is conducted in 2011.


Great Egret
CWB:
y = 35.72x - 70060
R² = 0.0652
BPI:
y = 601.5x - 1E+06
R² = 0.1804
# Individuals (SE)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
2000
2002
2004
2006
2008
2010
2012


Tricolored Heron
CWB:
y = -7.8077x + 15672
R² = 0.9629
BPI:
y = -132.8x + 266928
R² = 0.9896
# Individuals (SE)
1,000
800
600
400
200
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011


Black-crowned Night-heron
CWB:
y = 9.7x - 19178
R² = 0.0645
BPI:
y = 70.3x - 136274
R² = 0.002
# Individuals (SE)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Year

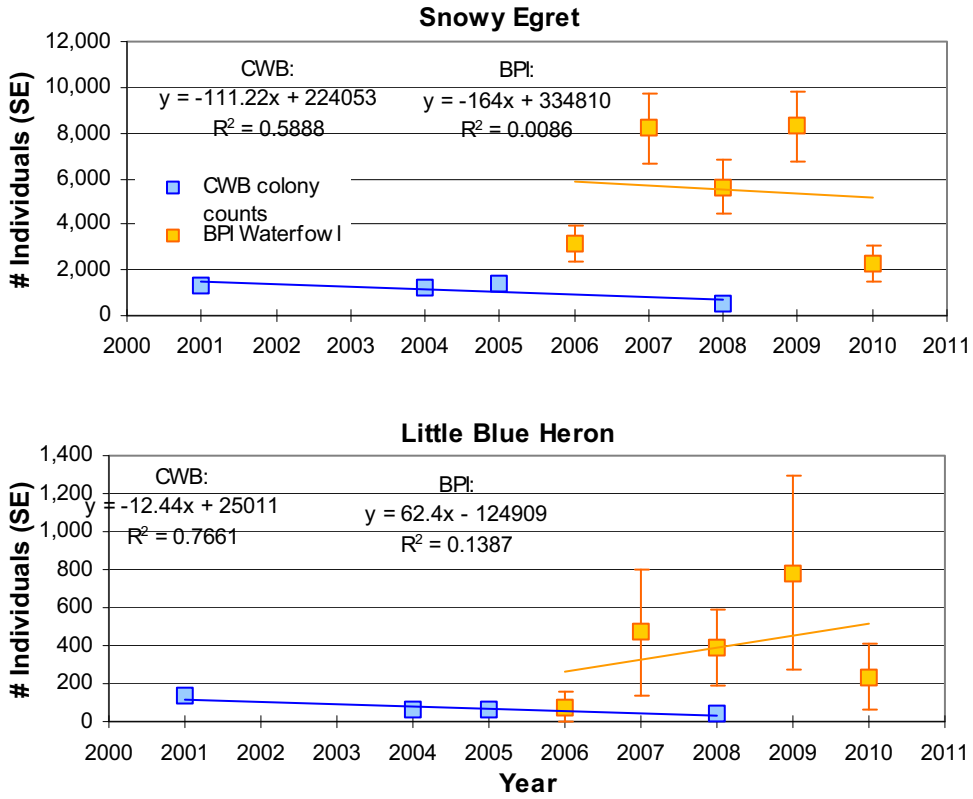


Figure 3B-1. Trends of the BPI waterfowl surveys, 2006–2010 (yellow), and the colonial waterbird aerial colony count, 2001–2008 (blue). The year 2005 was dropped from the BPI waterfowl survey due to first-year bias.

Conclusions:

- Collaboration with other states and regions is critical for large-scale bird monitoring and should be a high priority for the state of New Jersey.
- Trends from the BPI cannot be directly compared with results of the colonial waterbird surveys due to discrepancies in protocol and analyses (area ground search for population index versus systematic aerial colony count).
- Collaborating waterfowl and waterbird surveys within state provides results and should be continued at least a few more years to determine whether the waterfowl survey can adequately replace the more expensive waterbird surveys.

Recommendations:

- Continue to collaborate on waterfowl and waterbird surveys in NJ and analyze the efficiency of the survey protocol at estimating trends and population indices of waterbirds in NJ when the data become available.
- Continue to participate in the Northeast Coordinated Bird Monitoring Working Groups and other regional coordination efforts.

JOB 4: New Jersey Important Bird and Birding Areas (IBBA)
Project leader: Amanda Dey, Principal Zoologist

OBJECTIVE: The primary objective for 2008 is to continue ENSP staff participation in the final phases of the current IBBA project. Completed objectives include development of digital IBBA maps and compilation of endangered/threatened species data from the nomination process. As important bird and birding sites have now been identified and mapped, the NJ IBBA Project will seek to ensure continued viability of these sites through development of management plans, increased public awareness, and by providing public access to digital mapping of important bird areas both on the Audubon website and the NJ Department of Environmental Protection's interactive mapping website.

Key Findings:
Key Findings:

- ENSP contracted with NJ Audubon (NJAS), whose staff completed implementation of GIS methodology for delineating boundaries for IBAs using NJDEP's Landscape Project Version 2.1 and 3.0 for the Highlands Region, Metadata and a comprehensive attribute table including detailed site information accompany the GIS layer's boundary data (see Appendix A – Final IBBA Report). These data were used to produce maps of IBAs for download from the IBBA Program website. As part of ENSP's Landscape Project mapping, the IBA boundaries will be available to the public on the Department's interactive mapping application, download on the Department's GIS download page or on CD by request.
- There were no new sites nominated, including urban IBAs, during the period of 2008-2009.
- No new endangered/threatened species data were submitted to be incorporated into Landscape Project critical habitat mapping and the NJ DEP's Biotics (Biotics) database.
- A total of 123 Important Bird Areas and 28 Important Birding Areas were identified. All 2007 and 2008 data collected in the nomination process with accompanying attribute table of the GIS IBA boundary data were vetted and submitted to the ENSP's Biotics database. However not all of those data met the strict requirements for inclusion in Biotics.
- Comprehensive conservation plans were developed for Mannington Meadows IBA (MMIBA), the Cohansey River Corridor IBA (CRCIBA), Cape Island IBA (CIIBA) and the Southern Pinelands IBA. Through this process, the IBBA Program developed Conservation Templates that demonstrate techniques for protecting and improving habitat within Important Bird Areas.
- NJAS staff hosted 25 free public workshops for landowners and other stakeholders reaching over 250 landowners throughout the Cohansey River Corridor IBA, Cape Island IBA, Southern Pinelands IBA and the Mannington Meadows IBA.
- The IBBA Program provided technical support to communities interested in making informed decisions about natural resource management.
- The IBBA Program's comprehensive guide to the NJ's IBAs, "The Important Bird Areas of New Jersey" was published in late 2009.
- The IBBA Program identified additional opportunities to expand conservation efforts, implement habitat restoration plans and conduct outreach in priority IBAs. Current and proposed projects directly implement priority goals for habitat management and species recovery in the State Wildlife Action Plan

Recommendations:

- The IBBA Program should continue annual submission of avian data from IBAs to the state's database to inform the Landscape Project and avoid discrepancies between the two databases.
- ENSP should update IBA boundaries when Landscape Project Version 3.1 data or new Land Use/ Land Cover data become available. Consider the inclusion of IBA boundaries in NJ DEP's i-Map and Landscape Project, Version 3.1.

- The IBBA Program should analyze data collected during avian and vegetation monitoring at IBAs to allow for the assessment of pre- and post-management impacts;
- Identify new opportunities within priority IBAs to implement habitat restoration as well as expand ongoing conservation efforts.
- Continue community involvement in the protection and restoration of IBAs through participation in the Adopt-an-IBA Program;
- Continue outreach and education for citizens and landowners about the goals of IBBA, the importance of habitat conservation, and the various state and federal incentive programs available to landowners;
- Continue to initiate and foster partnerships with local governments, citizens groups and professional planning organizations to facilitate the identification and protection of important bird habitat within communities.

EXECUTIVE SUMMARY

Project:	**Mammal Conservation**
Federal Aid Project:	T-1-5 (State Wildlife Grants)
Segment dates:	September 1, 2009 to August 31, 2010
Total Project Expenditures:	$120,000 ($60,000 Federal, $60,000 State) ('09-'10 year only)

JOB 1: Federal and State Listed Mammals

OBJECTIVE: To conserve populations of federal and state-listed species through a coordinated approach of population and habitat monitoring, threat assessment, habitat protection and acquisition, management, research, education and environmental review.

JOB 1A: Bobcat Conservation

Project leader: Mick Valent, Principal Zoologist

Key Findings:

- Tissue samples were obtained from NJ road-killed bobcats, incidentally-trapped bobcats (by licensed fur trappers), bobcats trapped by ENSP for collaring, and from bobcats in New York and Pennsylvania (provided by those states) for the regional genetic variability study. This study is aimed at understanding the genetic structure of the New Jersey population. A total of 44 samples were collected in NJ and were sent to the U.S. Forest Service Rocky Mountain Research Station lab (Montana) for analyses. To date, bobcat tissue samples from New Jersey (n=44), New York (n=62), Pennsylvania (n=71) and Maine (n=25) (Figure 1) have been sent to the lab. The lab determined that the sample size and distribution were adequate to perform mitochondrial DNA sequencing and analysis.
- Preliminary results from the DNA analysis suggest that the NJ samples represent one group genetically. The results also suggest that the NJ and ME bobcats represent one group, in that all the NJ samples are consistent with a Maine origin thus suggesting that there was no remnant population of bobcats in NJ at the time of the NJ reintroduction of bobcats from Maine. Lastly, the NY set of samples are closer genetically to the ME/NJ group than the PA samples. Examining all samples together (NJ, PA, NY, and ME) suggests that there may be four distinct groups, but the analysis also suggests that these four groups do not correspond with states.
- Canine teeth were collected from nine road-killed or incidentally-trapped bobcats during the reporting period. In addition, reproductive tracts were collected from the four females included in this group. A total of 23 canine teeth samples and 8 reproductive tract samples have been collected to date.
- Three bobcats were collected dead on roads and six bobcats were incidentally trapped by licensed fur trappers during the reporting period. We responded to two calls from trappers who inadvertently captured bobcats in snares. One animal was dead upon our arrival. The second animal was an adult female (20 lbs.) that we removed from the snare alive on 12/1/09. The snare had cinched tightly around the animal just in front of the pelvic girdle. It was immediately transported to a licensed wildlife rehabilitator where it subsequently died from its injuries on 12/2/09.
- Eight potential road-crossing structures (culverts) along Interstate Route 80 in Warren County were monitored for bobcat use using 12 motion-sensitive cameras between 2/4/10 and 8/31/10 (Figure 2). No bobcats were documented using the culverts although several other wildlife species have been documented using the structures (Table 1). It should be noted that we experienced some equipment problems during the monitoring period that interrupted monitoring. Some of the camera cards were found to be corrupt and did not record activity for varying lengths of time during the period. In some locations vegetation grew above camera height and blocked the view of the culverts. These problems were corrected when the cameras were visited for card and battery changes.

- A total of 480 trap-days resulted in the capture of two bobcats using box traps baited with beaver carcasses. One adult female bobcat (19 lbs.) was trapped at the Weldon Brook Wildlife Management Area near Sparta on 2/1/10. The animal appeared to be in excellent condition and was chemically immobilized using a 10 mg/kg : 2 mg/kg dosage of Ketamine and Xylazine and then fitted with a GPS/VHF collar for tracking. A 4mm biopsy punch was used to collect a DNA sample from the left ear of the animal. The animal was held overnight for observation and released at the point of capture on 2/2/10. A second bobcat (undetermined sex) was captured in Allamuchy Township near Interstate Rt. 80. This was an immature animal that was determined to be too small for collaring. Therefore, the animal was not chemically immobilized and was released at the capture site.
- An adult male (31 lb) bobcat was inadvertently captured in a snare by a licensed trapper on 2/21/10. We immediately responded and were able to successfully remove the bobcat from the snare by chemically immobilizing it using a 10mg/kg : 2mg/kg dosage of Ketamine and Xylazine. The bobcat was immediately transported to a veterinarian to determine if the animal had suffered any injuries during its capture. Other than some minor abrasions to the neck, the animal was determined to be free of injuries. The animal was then transported to a licensed wildlife rehabilitator for supportive care and observation. A 4mm biopsy punch was used to collect a DNA sample from the right ear. The animal was fitted with a GPS/VHF collar and released at the point of capture on 2/24/10.
- No dog-handler team surveys were conducted during the reporting period. We are continuing to deal with issues where the dog is responding to both bobcat and coyote scats. We have arranged for the dog to be re-trained by Working Dogs for Conservation in Montana in the coming year. Surveys will commence following re-training.
- No volunteer training for bobcat track identification was conducted during the reporting period. Volunteers from past training sessions were asked to continue surveys. One volunteer reported tracks and we successfully live-trapped a female bobcat in the area.
- Bobcat observation data from the public as well as our survey efforts (n=30) have been entered into the Biotics database.

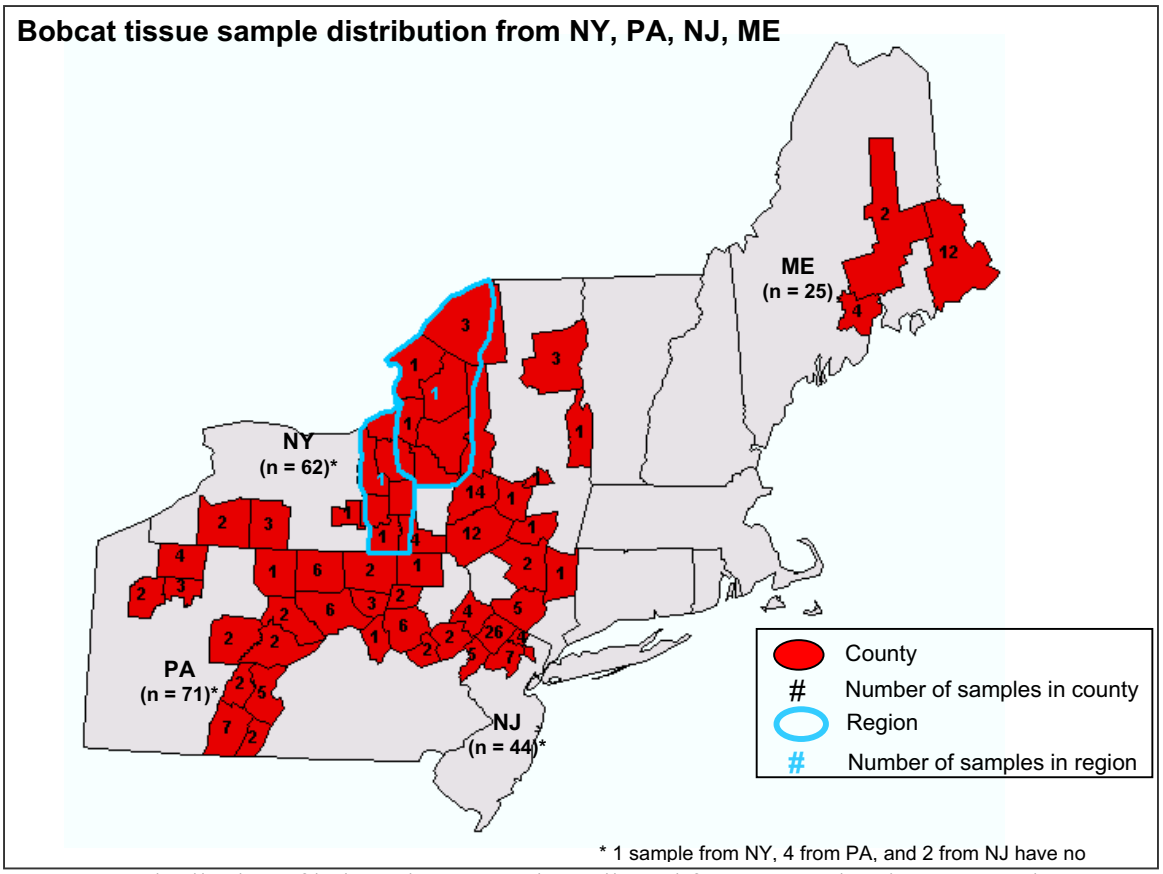


Figure 1. Distribution of bobcat tissue samples collected from Pennsylvania, New York, New Jersey, and Maine for a regional genetic analysis.

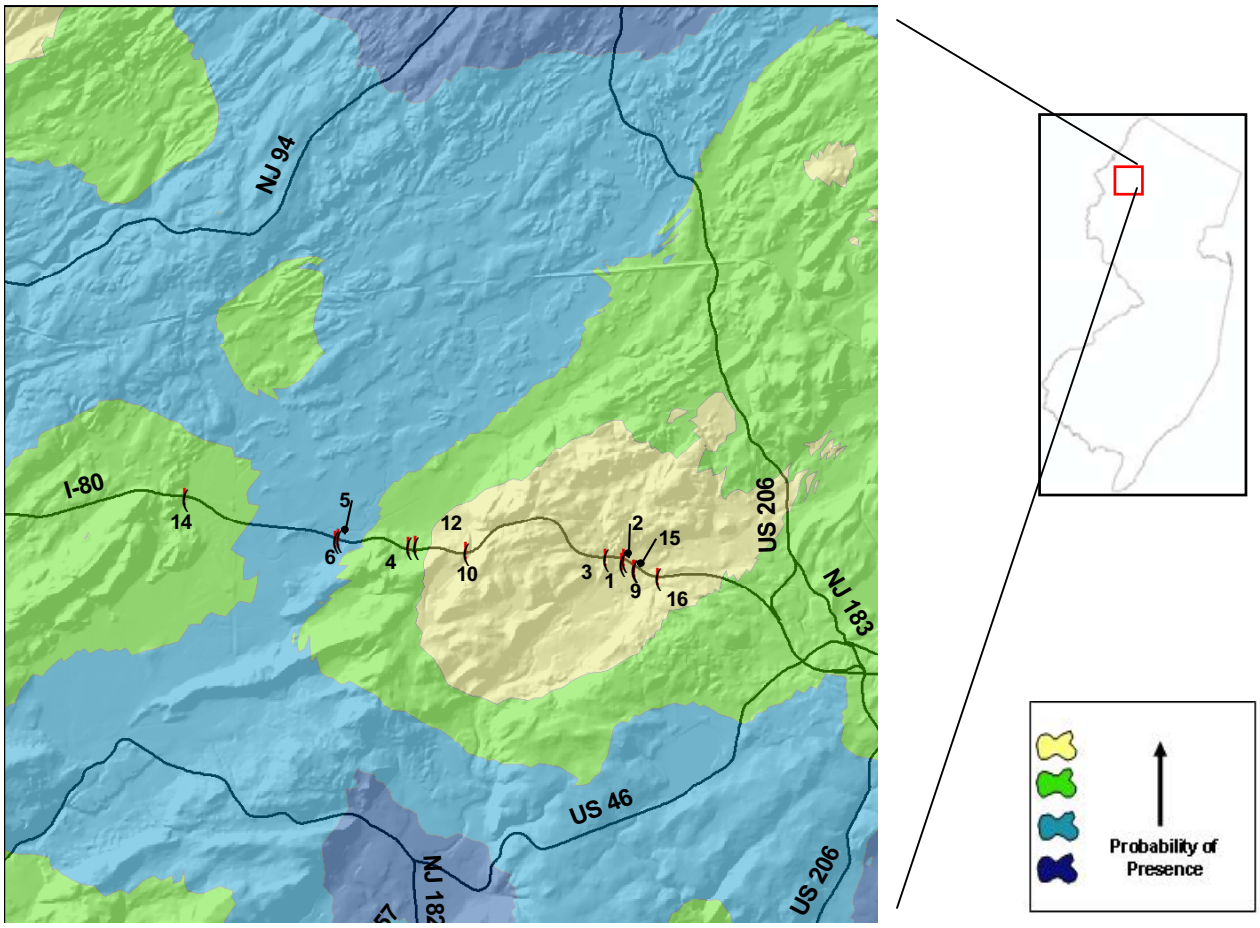


Figure 2. Locations (●) and camera ID of remotely triggered cameras used to monitor potential crossing structures for bobcats under Rte. 80 in northern New Jersey.

Table 1. Species documented by remotely triggered cameras at potential crossing structures for bobcats under Interstate Rt. 80 in northern New Jersey between 2/4/10 and 8/31/10. No bobcats were documented.

Camera	Species												
	Opposum	Squirrel	Ground hog	Rabbit	Domestic cat	Fox	Coyote	Black Bear	Deer	Turkey	Canada Goose	Raccoon	Human
1	x	x	x			x		x	x			x	x
2						x							
3	x	x	x					x	x			x	x
4	x	x	x	x			x	x	x	x		x	
5	x		x		x	x	x	x	x			x	x
6	x	x			x				x			x	x
9	x	x						x	x	x		x	x
10													
12	x		x		x			x				x	
14													x
15		x	x			x		x	x	x	x	x	x
16	x		x					x	x			x	

Conclusions:

- The preliminary results from the DNA analysis of bobcat tissue samples from Maine and New Jersey suggest that the reintroduction effort of 24 bobcats from Maine to New Jersey between 1978 and 1982 was a success and the current population stems from the reintroduced bobcats rather than a remnant population that was speculated to exist at the time of the reintroduction.
- There was a high incidence of bobcats incidentally caught in snares during this reporting period.
- Bobcats do not appear to be using the eight culverts under Interstate Route 80 that were monitored during 2010 even though suitable habitat exists on both sides of the highway (based on the predictive bobcat habitat model). However, several other medium to large sized mammal species were documented as having used the structures. Some gaps in monitoring occurred due to equipment problems that caused interruptions in camera coverage.
- We are continuing to track the movements of the two collared bobcats using the collar's VHF signal and telemetry receivers. The collars are scheduled to drop off on 1/15/11 (adult female) and 2/5/11 (adult male), at which point those locational data will be available for home range and habitat use analysis.

Recommendations:

- Use the updated bobcat occurrence data from the past few years to refine the existing predictive bobcat habitat model now that the 2007 land use/land cover dataset is available.
- Continue to work with the U.S. Forest Service Rocky Mountain Research Station lab as they perform the regional genetic variability analysis to determine how the four groupings of bobcats (indicated by the preliminary DNA analysis results) are divided up within New Jersey, New York, and Pennsylvania. Also, determine whether more samples will be required for a more complete analysis.
- Continue to monitor potential bobcat crossing structures under Interstate Rt. 80 and other major highways in northern New Jersey to feed into the bobcat corridor modeling effort as well as to help target structures that could be modified to increase their appeal for bobcats to use.

JOB 1C: Allegheny Woodrat Conservation

Project leader: Mick Valent, Principal Zoologist

OBJECTIVE: Annually monitor NJ's Allegheny woodrat (*Neotoma magister*) population and assess the potential exposure risk to raccoon roundworm (*Baylisascaris procyonis*). Actively manage raccoon roundworm levels in the raccoon population at New Jersey's last remaining Allegheny woodrat population through the use of medicated raccoon baits.

Key Findings:

- Standard trapping protocol was conducted at six separate talus slope sites at the base of the Palisades Interstate Park on 7-8 October, 2009. Tomahawk TM Model 201 (5"x5"x16") Collapsible and Standard Single-door Live Traps were used for sampling. The traps were baited with apple slices and peanut butter.
- Forty traps were set for two consecutive days for a total of 80 trap-nights of sampling effort.
- For the second consecutive year, a total of nine unique individuals were captured resulting in a capture index of 1.13 individuals trapped/10 trap-nights.
    - Captured animals consisted of four adult males, three sub-adult males, and two sub-adult females.
    - Two of the adult males were recaptures from previous years.
        - One male was a recapture from 2007 when it was initially captured at the same site. The second male was a recapture from 2008 when it was initially captured at a site approximately 0.5 mi. from the site of capture in 2009.

- All captured animals were held for several minutes prior to their release to determine if they exhibited any symptoms of infection by *B. procyonis*; none did. All animals were sexed and weighed at the point of capture. In addition, a 2 mm tissue punch was used to collect two tissue samples (one from each ear) from each animal for genetic testing. All animals were released at the site of capture. Tissue samples were sent to Timothy Smyser of Purdue University for genetic analysis.
- Due to the decline in capture index for the fourth consecutive year, we continued to distribute piperazine-treated fishmeal/polymer baits at a rate of 10–15 baits per acre surrounding the active woodrat sites in an effort to interrupt egg shedding by infected raccoons. Additional treated baits were distributed along the shoreline of the Hudson River below the active woodrat sites as the shoreline serves as a travel corridor for raccoons. Treated baits were distributed at the site on 15 September and 30 October, 2009. Several of the baited locations were monitored with motion-sensitive cameras in an effort to determine what species were taking the baits. Raccoons were documented at several of the bait locations consuming the baits.
- Two polyvinyl chloride (PVC) bait stations were constructed for experimental use at the Palisades. The bait dispensers were originally designed for dispensing rabies vaccine to raccoons (Boulanger et al. 2006), and needed no modification for use in our application. Two bait dispensers were attached to trees within likely raccoon travel corridors between active woodrat sites. Each dispenser was filled with piperazine-treated baits (capacity approx. 40 baits each) during April, 2010. Motion sensitive cameras were mounted on adjacent trees to monitor activity at the bait stations. Raccoons quickly discovered the bait stations and readily consumed the baits. As many as three raccoons were recorded feeding on treated baits at a single bait dispenser. The bait dispensers proved to be a better option for distributing treated baits to raccoons than broadcast baiting. Comparisons between photos taken from broadcast bait locations and bait dispensers showed that the bait dispensers were more target species-specific. Several non-target species (skunk, opossum, Norway rat and possibly gray squirrel) were observed taking baits from broadcast bait locations. Only raccoons were recorded taking baits from the bait dispensers due to their unique design that prevents other species from obtaining the baits. In addition, the bait dispensers present a less labor intensive approach to distributing baits, they are inexpensive, portable and weather-resistant.
- Supplemental feeding was conducted at several locations within the Palisades woodrat site on 10 December, 2009. A total of approximately 35 gals. of acorns of mixed species were broadcast over the talus where woodrats had been trapped in early October, 2009. Very little information exists in the literature regarding the effectiveness of supplemental feeding on Allegheny woodrat populations. However, supplemental feeding was conducted at a long-term monitoring site in Pennsylvania and it was suggested that the population may have had a positive response to this management technique (Mengak et al. 2008).
- Searches for raccoon scat and latrine locations were conducted on 8 October, 2009 and 10 December, 2009. A total of 16 person-hours of effort resulted in only four scats being collected from the area inhabited by woodrats. Due to the small number of collected scats no testing was conducted.

Conclusions:

- For the fourth consecutive year the Allegheny woodrat capture index has declined suggesting a decline in the woodrat population within the Palisades Interstate Park. In addition, increases in raccoon scats/latrines suggests a possible increase in the raccoon population compared to previous years. For the second consecutive year only two individuals were recaptures from previous years (2007 and 2008) suggesting that at least some adult animals within the population are surviving and not succumbing to *B. procyonis* infection. Additionally, none of the captured animals exhibited any symptoms of infection by *B. procyonis*.
- Preliminary results of genetic testing of the 9 individuals trapped during 2009 indicate that average heterozygosity ranged from 0% to 54% (average heterozygosity = 30%) and that the individuals had 20 alleles across the 11 loci (allelic richness = 1.81). This suggests that inbreeding depression is a serious threat to the Palisades population.

Recommendations:

- Research (LoGuidice 2000, McGowan 1993) suggests that *B. procyonis* infection in Allegheny woodrat populations is a serious mortality factor and can result in rapid population declines for the intermediate host. Therefore, woodrat and raccoon population monitoring at the Palisades Interstate Park site should continue. Periodic searches for raccoon evidence should continue and should include scat analysis for *B. procyonis* egg prevalence.
- Although low numbers of raccoon scats were found during searches, the number of raccoons documented at feeding stations by motion-sensitive cameras suggested a healthy raccoon population exists at the Palisades. In 2008 we documented a decline in the percentage of raccoon scats that tested positive for *B. procyonis* eggs after putting out treated baits. Therefore, we recommend that fishmeal/polymer baits, treated with the anthelminthic drug piperazine, be distributed at regularly scheduled time intervals throughout the year in an effort to interrupt the egg-shedding cycle. The use of polyvinyl chloride bait stations will replace broadcast baiting as they have been documented to be more effective at targeting the raccoon population. Piperazine was chosen as the treatment drug due to its high efficacy in clearing roundworms and its low toxicity (LoGuidice 2000).
- Due to the continued decline in trapping success, inferring a declining population, and the preliminary genetic testing that indicates inbreeding depression is a serious threat to the population, we will continue to conduct non-invasive genetic sampling to gain a better understanding of the genetic health of the Palisades woodrat population.
- We will consult with other experts in the field to determine the appropriate next steps to take to improve the health of the woodrat population at the Palisades.

Job 2: Bat Conservation and Management

Project leader: Mick Valent, Principal Zoologist

This job is jointly supported by State Wildlife Grants and Multi-State Competitive SWG Program funding.

OBJECTIVE 1: To identify, characterize and monitor summer bat colonies roosting within man-made structures and to provide guidance for proper management of those sites, especially where the federal endangered Indiana bats roost or maternity colonies exist.
OBJECTIVE 2: To identify, characterize, and monitor important winter habitats of New Jersey's bat species, including the federal endangered Indiana bat; and to gather Indiana bat winter population counts to contribute to USFWS database.

Key findings:

- External observations were conducted at the Asbury Mine and Jugtown Mt. Railroad Tunnel in Hunterdon Co. Two bats were observed flying outside of the Asbury Mine on 28 January 2010 suggesting that this is a WNS positive site. No dead bats were found outside of the mine. Two observers were posted at each end of the Jugtown Mt. RR tunnel in an effort to document abnormal bat behavior at the site. No bats were observed flying outside of the tunnel.
- NJ is still upholding its policy of not entering any additional known bat hibernacula in an effort to prevent human-related transmission of *Geomyces destructans* to unaffected sites.
- The final count for the January, 2009 Indiana bat survey was 148. This represents an increase of 26 individuals compared to the 2007 total. The total count (all species) in 2009 was 26,438. This represents a decrease of 1,156 individuals from the total count conducted in 2009. (USFWS requirements limit survey of Indiana bat locations to once every two years, so the next scheduled full survey is set for 2011.)

- On February 14, 2010 biologists conducted a quick visual survey of the bat population in Hibernia Mine (one year after WNS was confirmed) while conducting other related WNS research in the mine. A total (all species) of 1,756 bats were tallied.
- A bat conservation gate was constructed at a small mine (Dolan Tunnel) in Morris County during the reporting period. In 2008 the mine supported a small winter population (100-200) of *Myotis* species. Permission to construct the gate was granted by the landowner in July, 2009 and the gate was completed in December, 2009.

Figure 1. The completed bat conservation gate at Dolan Tunnel.

- A project to stabilize the subsidence existing at the Hibernia Mine was completed during the reporting period. Overburden material was cleared from the old slope and used to create a retaining wall against the existing slope. A concrete box culvert was installed to maintain access by bats to the mine shaft. The project resulted in improved safety (for humans) outside of the mine and easier access by bats to the underground workings of the mine.

Figure 2. Retaining wall and box culvert with bat conservation gate at Hibernia Mine.

- The Summer Bat Count continued in 2010 with a total of 57 volunteers collecting and submitting data. In 2010 we began using the data forms and protocols that were developed by the PA Game Commission. All volunteers were asked to perform two pre-volant counts and two post-volant counts at each site.
  - For those summer bat colonies where we have data from previous years, the average change in colony size from baseline (≤2008, i.e., pre-WNS) to 2010 was minus-45% (n=49). Of the sites where the dominant bat species is known, big brown bat colonies changed an average 38% (n=8) and little brown bat colonies changed an average of minus-80.4% (n=8).
  - Percent change since 2009: The average change in colony size from 2009 to 2010 was minus-21% (n=41). Big brown colonies changed by 57% (n=8) while little brown colonies changed by minus-50% (n=7).
  - Percent change from pre-volant to post-volant: On average, bat counts increased by 62% (n=20) after ~6 July. Big brown colonies increased by 88% (n=5) while little brown colonies increased by 8% (n=2).
  - GIS shape files (points) have been created for each summer roost site that has been counted since the project began.
  - All Summer Bat Count data were entered into the Access database created by the PA Game Commission in an effort to standardize the protocols and data collection throughout the NE.
- Data on summer roost sites and habitat use by Indiana bats was submitted by researchers at the Great Swamp and Wallkill River National Wildlife Refuges. The data were entered into the Biotics database for inclusion into the next update of the Landscape Project.
- ENSP biologists continued to provide technical assistance to state and municipal agencies and private individuals and land managers regarding the proper eviction and bat proofing of bat-occupied dwellings. In addition, technical assistance was provided for persons wishing to provide alternative roost sites where large colonies were evicted.

- Biologists participated in scheduled agency conference calls to keep appraised of WNS news and changing requirements for surveying, decontamination of gear and clothing, etc
- Staff attended the WNS meeting in Pittsburgh, PA on 25-27 May, 2010.
- No field surveys of new abandoned iron mines were conducted during the reporting period due to lack of time. Our primary focus has been on WNS-related issues.
- No new data loggers were installed in bat hibernacula to avoid unnecessary entries into mines due to WNS infection.

Conclusions:

- A rapid visual survey was conducted at Hibernia Mine on 14 February 2010 while biologists were inside the mine conducting WNS-related research. A total (all species) of 1,756 bats were counted. This represents an approximate decline of 93% compared to the count conducted in January, 2009. Based on this observation it is expected that the winter populations in the two Mt. Hope mines (WNS confirmed in January 2009) suffered similar mortality losses.
- Although the newly adopted protocols that require photographic documentation of large bat clusters is an improvement over the old method of directly counting each bat, it does not resolve the problem of having to count (estimate) bats that are located inside drill holes along the sidewalls of the tunnel. Due to difficulty in photographing these locations, biologists are required to estimate bat numbers.
- Many of the "Approaches" listed in the NJ T-1-5 SWG Proposal overlap with the jobs identified in the Regional SWG Proposal (NJ U2-1-R-1) "White Nose Syndrome: Multi-state Coordination, Investigation, and Response to an Emerging Wildlife Threat and, therefore, were contained in the interim report submitted under that project.

Recommendations:

- Due to the discovery and confirmation of WNS at the Hibernia, Mt. Hope and Copper mines during 2009, we decided that all internal mine/cave surveys should be suspended to reduce the risk of spreading *Geomyces destructans* to unaffected sites. We plan to enter the Hibernia mine only, and only for the purpose of researching WNS and bat survival.
- Continue to support the NJ DEP's ban on entering all mines and caves on state property and recommendation that the general public stay out of caves and mines on private property until further notice.
- Replace the bat conservation gate at Hibernia Mine pending funding. The replacement gate will employ an improved design with new materials that would make breaching the gate more difficult. The current gate security system would be retrofitted to the new gate increasing the security of the mine.
- Identify additional hibernacula that would benefit from the installation of bat friendly gates to prevent human disturbance and contamination with *Geomyces destructans*.
- Continue to monitor known bat hibernacula (external surveys/observations only) in an attempt to identify WNS symptoms.
- Continue the volunteer Summer Bat Count project and expand participation. Protocols developed by the PA Game Commission are being utilized in order to standardize the project throughout the region. Continue the partnership with the Conserve Wildlife Foundation of New Jersey to increase volunteer recruitment efforts.

JOB 3: Pinniped Research and Conservation

Project leader: Jeanette Bowers Altman, Principal Zoologist

OBJECTIVE: Develop a pinniped conservation plan to identify and protect overwintering colonies or haul-out areas and other transient occurrences of harbor seals and other pinnipeds.

Key Findings:

- ENSP enlisted volunteers, including Conserve Wildlife Foundation of NJ (CWF) staff to perform site visits at the three major pinniped haul out areas in the state (Monmouth and Ocean counties) to conduct population surveys and identify potential threats.
  - Up to 74 seals were observed at the Sandy Hook site in February 2010. This represents the highest count ever recorded for the site. Harbor seals (*Phoca vitulina*) were the most common species, with several observations of harp seals (*Pagophilus groenlandicus*) as well.
  - Several harbor seals were observed at the Barnegat Light site during repeated site visits. Harbor seals at this site were never observed hauled-out in groups however. Seals were either hauled-out or swimming solitarily.
  - A maximum of 146 individuals were observed at the Great Bay site. The two highest counts at the site for the season were recorded in late March 2010. Both the second and third highest counts ever documented for the site were recorded during this season (the highest count of 155 individuals was recorded in April 2008). Seals were observed regularly into mid-May 2010 and occasionally into June 2010. Harbor seals were the most common species present. Two minor haul-out sites within the Great Bay area were also occupied regularly during the 2009-2010 season by between 2-8 harbor seals.
- ENSP and CWF staff provided a guest lecture regarding NJ marine mammal conservation, seal surveys, and Geographic Information Science to the Richard Stockton College of NJ's New Jersey Seal Study class.
- Between January and June 2010, the Marine Mammal Stranding Center recorded a total of 105 seal strandings: 47 harbor seals, 32 harp seals, and 24 gray seals (*Halichoerus grypus*). Sixty-six of the total stranded seals were released for a recovery-release rate of 87%. The 2010 number of total seal strandings represents the second highest number of seal strandings recorded in the last ten years by the Marine Mammal Stranding Center, with 2005's 108 strandings being the highest.
- Shipboard marine mammal surveys related to the NJ Wind Power Initiative began in January 2008 and aerial marine mammal surveys began in February 2008. Surveys were completed by December 2009. In July 2010, Geo-Marine, Inc. (the Texas-based consulting firm which conducted the surveys) issued its final report, detailing activities and findings. Only one harbor seal was recorded in the Study Area during the study period. This seal was sighted in shallow waters east of Little Egg Inlet in June. Other unidentified pinnipeds recorded near Ocean City in April were likely also harbor seals but could not be confirmed.
- Species Occurrence Area (SOA) data for pinnipeds were provided to Lands Use Regulation, Division Office of Environmental Review, and ENSP biologists for environmental review purposes.

Conclusions:

- Repeated site visits by CWF staff and additional volunteers resulted in peak counts of 74 at Sandy Hook, 146 at Great Bay, and several seals at Barnegat Bay haul-out sites.
- The Great Bay site continues to be the largest NJ haul-out site, in fact, the largest seal haul-out on the US Atlantic coast south of eastern Long Island, NY. Harbor seals continue to be the most numerous of the seal species present.
- Boat surveys focusing on known haul out locations may be more effective in terms of counting individuals and determining species.

Recommendations:

- Incorporate pinniped sightings information from 2008-2009 GMI, Inc. surveys into Biotics (data received from GMI as of October 2010).
- Continue to solicit pinniped sightings information from whale watch groups, fishermen, and environmental organizations.

- Revisit Barnegat Light haul out sites by boat to determine numbers, species present, and areas utilized. Boat surveys may be more effective at this location due to range of habitats and familiarity of individuals with boat traffic.
- Conduct outreach programs that focus on protecting pinnipeds from human disturbance
- Identify, acquire and standardize marine data sets for future GIS analysis to better understand seal habitat in New Jersey.
- Incorporate findings from the "Threats Assessment, Baseline Abundance Data, and Habitat Characterization of the Great Bay Seal Colony," completed by Dr. Carol Slocum in March 2009 into the draft document resulting from the ENSP's Marine Mammal and Sea Turtle Conservation Workshop (2006). Update the threats and recommended conservation actions sections of the document for pinnipeds and all applicable marine species where new information is available.

EXECUTIVE SUMMARY

Project:	**Reptile and Amphibian Conservation**
Federal Aid Project:	T-1-5 (State Wildlife Grants)
Segment dates:	September 1, 2009 to August 31, 2010
Total Project Expenditures:	$265,000 ($132,500 Federal, $132,500 State) ('09-10 year only)

JOB 1: Federal and State Listed Reptiles and Amphibians

OBJECTIVE: To develop comprehensive, landscape-level conservation and management plans for all federal and state-listed reptiles to ensure long-term viability of populations.

JOB 1A: Bog Turtle

Project leader: Brian Zarate, Assistant Zoologist

This job is jointly supported by State Wildlife Grants and Section Six funding.

OBJECTIVE: To monitor and conserve populations of the federally threatened and state endangered bog turtle *(Glyptemys muhlenbergi)* on public and private lands.

- During the 2009-10 reporting period ENSP, and volunteers working on behalf of ENSP, surveyed a total of 53 sites for the presence of bog turtles. During this effort a total of 93 bog turtles were captured from 21 sites using a variety of survey methods: 1) dog-handler team; 2) volunteers; or 3) ENSP staff.
- ***Dog-handler Survey Team*:** ENSP conducted bog turtle surveys using a dog-handler team on 6 days beginning in the reporting period. Some of this work was completed using supplemental funding sources. This was the team's second year of fieldwork surveying in actual field conditions rather than as training scenarios. Twelve sites (each being a discrete wetland areas capable of supporting a colony of turtles) were visited and characterized as either known populations or low/unknown density populations. Five sites were known populations (i.e., 3 or more turtles recorded from the wetland) and 7 sites were low/unknown density populations (i.e., 2 or less turtles recorded from the wetland).
  - *Free Searching* – This technique is similar to that used by qualified surveyors during a Phase II bog turtle study. It is a combination of the dog being allowed to self-target areas to investigate and the handler presenting areas for the dog to search.
    - The dog-handler team found 5 live turtles using the free search method.
      - Three turtles were found at known populations and 2 were found at low/unknown density populations. Of note, 2 of the turtles were in a juvenile age class and 1 was found partially submerged at a known hibernaculum. One juvenile and one adult box turtle were found at 1 low/unknown density population.
      - There were no instances where the dog-handler team were the only surveyors to find turtles at a site. There was a single event where a human surveyor found a turtle at a known site and the dog-handler team did not find a turtle.
      - One low/unknown density population site was visited 3 times with no captures by either the dog-handler team or a qualified surveyor and assistant.
- ***Volunteer Surveys:*** ENSP enlisted the assistance of 21 qualified New Jersey bog turtle surveyors to opportunistically locate bog turtles at known sites (typically with number of captured turtles >15) as part of an experimental mark-recapture population estimate study. Surveyors were asked to spend 1 hour at a site once per week during the Phase II survey window beginning in May following Phase II

bog turtle survey guidelines. Not all data associated with this project has been submitted by surveyors as of this report, but 10 sites were visited with 53 turtles captured.

- Data submitted as part of this project last reporting period is insufficient to render a defensible population estimate. Additional data is needed, which will be collected in subsequent field seasons.

- ***ENSP Staff Surveys:*** ENSP conducted visual surveys following general Phase II bog turtle survey guidelines at a total of 46 sites. Fifteen sites were visited more than once. Thirty-six individuals were captured in Sussex, Warren, Hunterdon, Morris and Salem counties.
  - Turtles were captured at 14 of the 46 surveyed sites, including 8 sites that were characterized as low/unknown density populations. Two of the 8 low/unknown density sites where turtles were captured had no previous records in over 20 years. Turtles captured at 6 of the 14 sites were juveniles or hatchlings.
  - For the remaining 32 sites in which turtles were not observed, 25 were characterized as low/unknown density populations. Full Phase II survey protocols were not followed, though, and some sites were only visited once.
  - While captures were made at several low/unknown density sites, few of the recognized sites are known to support numbers of bog turtles to sustain a local population (Figure 1).

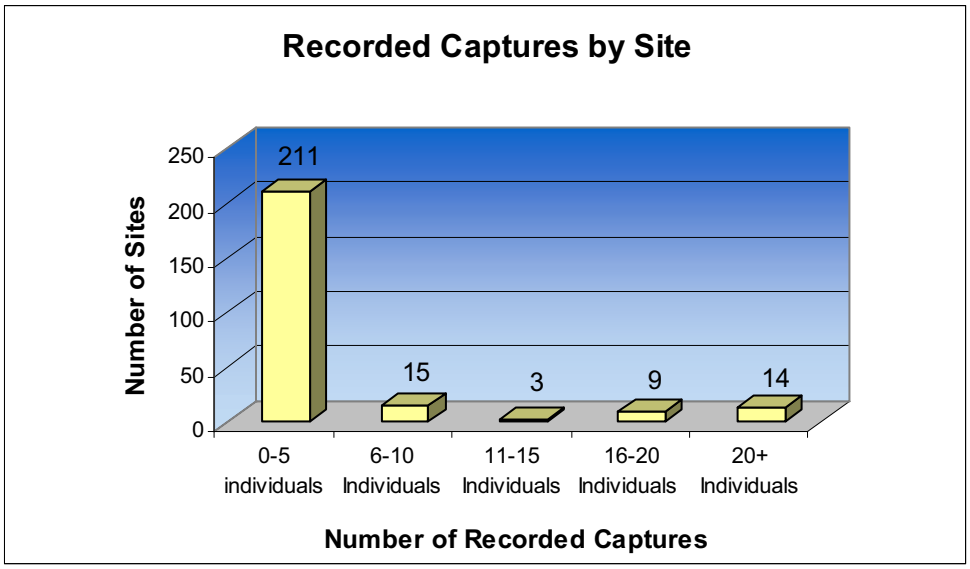


Figure 1. A large percentage of bog turtle wetlands are only known to support a small number of individual turtles. Only 33 sites have ≥6 turtles recorded. Data presented is from 1995 to 2010.

- At this time, NJDFW Bureau of Lands Management staff is not engaged in managing state-owned bog turtle wetlands. ENSP will pursue avenues to get that Bureau's assistance in the future to control woody vegetation and invasive plant removal.
- ENSP coordinated with NJ Natural Lands Trust and Wallkill River NWR staff on the vulnerability of a newly acquired property to illegal collection. Options were discussed with Law Enforcement staff involved on mechanisms to deter access, such as routine patrolling and fencing. Implementation of discussed strategies will proceed next year.
- No sites were monitored exclusively for determining use of post-restoration habitat.
- No additional volunteer surveyors were trained this year.

CONCLUSIONS:

- The human component of the dog-handler team was unable to dedicate a full season's worth of time to the surveys this year because ENSP's primary dog handler left on maternity leave halfway through

the field season. We plan on continuing with a more robust survey effort in the next segment. The limited effort this year did reveal that there was not a noticeable difference between the dog-handler team and the qualified surveyor's ability to detect bog turtles.

- The volunteer surveyors assigned to the higher density bog turtle sites have continued to produce reliable data that will be used to estimate population by site. ENSP gains from the relationship by receiving data on several of the top tier sites in the state while the volunteer surveyors gain experience with the species allowing them to apply for, or remain on, the New Jersey Recognized, Qualified Bog Turtle Surveyors list.
- Turtle captures at low/unknown density sites by ENSP staff were higher this year than in the last five seasons. The persistence of the bog turtle to remain in habitat that is, at times, marginally suitable, has yielded occurrences at a site as much as 27 years apart. For long-lived species, such as turtles, careful considerations should be made before categorizing a wetland as extirpated, and the date of last occurrence should not be the only factor in determining a habitat's ability to support a cryptic species like the bog turtle.
- The majority of known bog turtle sites in New Jersey appear to support low numbers of turtles, with 83.7% of the sites having fewer than 5 documented bog turtle captures.

RECOMMENDATIONS:

- Continue field surveys with the dog-handler team in the next reporting period. Plan comparative study between the dog-handler team to a qualified bog turtle surveyor.
- Assess volunteer surveyor dataset for use in preliminary population estimate. Possibly continue efforts to survey the same sites under the time and date constrained parameters next field season.
- Prioritize low/unknown density sites for targeted surveys based upon quality of habitat, date of most recent observation, proximity to other known observations, and access permissions.

JOB 1B: Wood Turtles

Project leader: Brian Zarate, Assistant Zoologist

OBJECTIVE: To determine wood turtle (*Glyptemys insculpta*) productivity, recruitment and mortality factors for adults, juveniles and nests, as well as home range sizes and habitat selection. Use this information to develop conservation strategies for viable populations.

Key Findings:

- ENSP staff conducted visual surveys along 7 stream transects with nearby wood turtle occurrences or in areas of suitable habitat. Survey goals were to assess activity levels of local populations at reference sites, add occurrence data to stream transects with limited observations, and to determine presence along stream transects with suitable habitat or where sightings were older than 15 years.
    - Five turtles were captured at 3 of the stream transects surveyed. This included 1 juvenile/subadult, 2 gravid females, and 3 non-gravid adults.
    - For the remaining survey transects where turtles were not found, 2 were known wood turtle populations with local populations estimated between 5-10 individuals, 1 was a transect anecdotally known to support a large number of turtles historically, and 1 was surveyed due to quality of habitat and historic record in a southern, coastal municipality.
    - All but 1 site were only surveyed once in the spring. Fall surveys are scheduled and will be included in the next reporting period.
- Four additional wood turtles were found opportunistically while surveying for bog turtles or driving. Three of these incidental observations represented possibly new local populations.

- A small population of wood turtles, including two adult females, was tracked using radio telemetry in 2006 and again in 2007 (only 1 female was radio tracked in 2007). The majority of the turtle movements recorded fell within the boundary of a public trust property in Morris County, NJ. Critical habitats, such as nesting sites, were identified during this project. Nesting movements were documented for one of the females whose nesting site in 2007 was located on a private property upstream of the trust boundary. In an effort to encourage recruitment on the trust land, two artificial wood turtle nest pits were installed on the trust property in the fall of 2008 following general recommendations from Buech and Nelson (1991). Although wood turtles were never observed incidentally or by radiotracking in the maintained, early successional field where the nest pits were installed, the location met criteria of wood turtle nesting ecology and the pits were installed close to stream in full canopy with southern exposure. No turtles, including box turtles (which were regularly encountered in the surrounding area) were documented using the pits to nest during 2009. One of the two known, gravid females from the population was relocated immediately adjacent to one of the nest pits on May 14, 2010. On May 17 the same female was observed scratching atop the nest pit. She was captured, palpated, and weighed and it was determined that she was no longer carrying eggs. Fencing to exclude nest predators was immediately placed around the nest pit. As of the end of the reporting period no eggs were known to have hatched from the enclosure.
- ENSP coordinated with NJ Natural Lands Trust and Wallkill River NWR staff on the vulnerability of a newly acquired property to illegal collection. Options on mechanisms to deter access, such as routine patrolling and fencing, were discussed with Law Enforcement. Implementation of discussed strategies will proceed next year with the outlined, draft plans. This effort was reported for bog turtle, which was the species for which this meeting was primarily held, but wood turtles also occur on the property and particular actions were discussed pertaining to their protection.
- No additional volunteer surveyors were trained this year.

CONCLUSIONS:

- Wood turtles continued to be documented in new locations, but limited data exists on the viability of both local- and meta-populations throughout their strongholds. It has been encouraging to see younger age classes and gravid females at several of the surveyed transects, but additional studies will be needed to assess the survivorship of the juveniles or nests.
- The ability of wood turtles to identify new habitat, such as nesting areas, within their dispersal areas, but outside of a known home range, was documented in 2010 when a female wood turtle used a constructed pit for nesting. Although it appears eggs were either not deposited or successfully hatched within our enclosure this season, the ability to protect known nesting areas may be an effective, non-intrusive, and low-cost alternative to other population augment efforts such as headstarting.

RECOMMENDATIONS:

- Following the bog turtle model, develop survey protocols to determine presence/absence of wood turtles.
- Identify local populations where augmentation through nest creation and/or protection may benefit wood turtle recovery or long-term stability. Areas where adult and juvenile mortality are above average are not strong candidates for augmentation at the nesting stage.
- Continue to address the vulnerability of wood turtles to illegal collection by coordinating with state and federal law enforcement, public land managers, and private citizens.

JOB 1C: Timber Rattlesnake

Project leader: Kris Schantz, Principal Zoologist

OBJECTIVE: To conserve NJ's timber rattlesnake *(Crotalus horridus)* populations through a coordinated approach of population and habitat monitoring, threat assessment, habitat protection and acquisition, management, research, education and environmental review, and to identify timber rattlesnake dens and critical habitat use in the Highlands, Pinelands, and along the Kittatinny Ridge where data gaps exist.

Key Findings:

- ENSP biologist attended a meeting held by the NY State Dept. of Environmental Conservation focused on developing a rattlesnake recovery plan for New York Timber Rattlesnakes in the fall, 2009. Participants shared information and ideas on on-going conservation efforts and helped develop a general outline for a recovery plan for consideration by the NYS DEC.
- Prior to this funding cycle, ENSP staff created a broad outline for the development of recovery plans (for various species) and topics/issues to target when conducting species' status assessments; assessments are needed before staff can adequately develop recovery plans.
    - During the spring, 2010, ENSP biologists reviewed the targeted topics for the status assessment, identified available data, potential data sources and needed information. This helped to formulate the work to be conducted during the 2010-2011 funding cycle including the return to known dens (in the northern region) to confirm continued presence and identify varied age classes and overall appearance (well-being) of present snakes.
- During this reporting period 33 rattlesnake sightings were entered into NJ DEP's Biotics database (Biotics). An additional 35 rattlesnake sightings were entered into ENSP's tracking database (preliminary database used prior to entry into the Biotics database) and will be reviewed by ENSP staff over the next year for entry into the Biotics database.
- The Biotics database continues to be updated with sighting records for timber rattlesnakes and this information will ultimately make its way into the Landscape Project mapping.

PINELANDS REGION

- In last year's report (2008-2009), we had mistakenly reported that one nongravid (female) timber rattlesnake was captured and implanted with a transmitter. This snake was in fact a sub-adult male; discovered upon transmitter removal, 2010. He was tracked by the staff of a conservation partner, the NJ Conservation Foundation. Although he eluded the staff in the fall, staff found him again this season pre-emergence at a previously known den. In anticipation of an upcoming transmitter failure, his transmitter was removed but not replaced to minimize any impact that may have resulted from multiple surgeries.
- One adult male, captured and implanted with a transmitter in late July 2009 eluded trackers in September 2009; staff from the NJ Conservation Foundation were unable to locate him on foot or by aerial telemetry searches. They found the snake this season, post-emergence, and have been consistently tracking him two-three times per week. As of early September, he had moved over five miles from where he was located six weeks prior. At this time, it appears he will provide us with a previously undocumented den location.
- A sub-adult, pre-shed male timber rattlesnake was collected August 31 (too late for transmitter implantation) from a residential area more than 10 miles from any documented den and in an area where no previous rattlesnakes observations had been reported. ENSP staff suspects the snake was captive or relocated, but decided to overwinter the snake with the State-approved venomous snake rehabilitator, Kathleen Michell, for release and radio-tracking in spring 2011.

HIGHLANDS REGION & KITTATINNY RIDGE

- K. Schantz completed the analysis of the micro- and macro-habitat data collected within the Highlands Region and along the Kittatinny Ridge during the 2008-2009 funding cycle. However, due to time constraints, staff was unable to develop a model of timber rattlesnakes' critical habitats in mountainous temperate regions or to refine the current den model which would have included testing additional landscape features as indicators for potential den presence.
- No rattlesnakes were captured during the 2010 active season that warranted implantation of a radio-transmitter because all rattlesnake bservations in 2010 could be linked to documented dens.
- ENSP research partner, Kathleen Michell, and her team (Tom Michell and George Banta) identified two previously undocumented dens.
- ENSP volunteers, staff and contractors continued to attempt to validate the 2009 den model and collect data to help refine the model by surveying for rattlesnake presence at potential dens during the gestation period (September, 2009) and emergence period (April-May, 2010). Three additional volunteers were recruited to assist in the surveys; one did not survey, two surveyed only once.
    - Using the den model and probability maps ENSP developed in the winter- spring of 2009, respectively:
        - Two areas along the same ridge totaling approximately 2.35 kilometers of ridgeline/slope (with belts widely ranging in width dependent on geomorphic structures) were surveyed. A third site, containing roughly 7 acres (2.8 ha) of modeled habitat, was also surveyed. Coordination of volunteers' work schedules with each other and with staff continues to be difficult. Three teams surveyed these three separate areas on three days during the period of snake emergence in spring 2010.
            - Even though two of the three areas surveyed by volunteers looked promising, rattlesnake presence was only documented in one of the areas surveyed. Volunteers identified three dens (potential "pockets" of a larger "den area") and one transient area during spring emergence; site determination was based on rattlesnake presence, behavior and geomorphic features.
            - One ENSP biologist surveyed a ridgeline and adjacent slopes (approximately 2 km in length with varying belt widths) six times during spring emergence. Although this work pertained to an issue unrelated to the den model regarding rattlesnakes and den presence, the ridge is valued as potential den habitat according to the 2009 den model. Additional volunteers assisted on three days. No rattlesnakes were observed.
    - ENSP contracted a research partner, Kathleen Michell (and her team), to survey historic locations that were identified as dens within the den model boundaries, but that lacked documentation of actual rattlesnake sightings. The contract also required Ms. Michell to identify and collect any snakes that were found exhibiting signs of a potential illness or harmful fungi/pathogens, as seen in populations at four dens in New England, for examination and testing.
        - ENSP contracted the research partner to survey five of 23 historic locations previously reported as dens in the 1990's. The 5 locations that were surveyed by Michell's team were chosen by ENSP because snake observation data were lacking to confirm that these locations were actually rattlesnake dens. Surveys were required to confirm or negate the presence of dens in order to determine whether to include or exclude these locations from the Biotics database and Landscape Map.
        - In addition to the 5 "historic" den sites (and surrounding suitable habitat) that the Michell team was contracted to survey, they surveyed 3 other historic den sites (and surrounding suitable habitat) on a volunteer basis, although the latter were surveyed only once as opposed to the required four surveys conducted at the contracted sites. They found no evidence of timber rattlesnake (or northern copperhead) presence at any of the 8 sites surveyed and, at some sites, no snake species or signs of snakes (sheds, scat) were observed. The contractor (and team) surveyed a minimum of four times within each of the contracted areas and once at

three voluntary sites during snake emergence, surveying a total of 255.109 acres (103.242 hectares).
    - At 5 of the 8 sites the contractor surveyed areas in addition to suitable habitat in close proximity for gestating females eligible for potential external transmitter attachment that could lead surveyors to a nearby den. The contractor (and team) surveyed a minimum of two times within each area during peak gestation encompassing 122.78 acres (49.689 hectares). No gestating females were located.
- Over the past year ENSP staff spent an unexpectedly large amount of time reviewing 2 projects related to utilities and rights-of-way proposed through the State permit process. Due to the potential impact to timber rattlesnakes, these proposals took an inordinate amount of staff time to review. Serving as technical advisors to NJDEP, ENSP staff was required prepare recommendations regarding surveys, timing and activity restrictions, and participate in meetings and conference calls with the applicants and other DEP staff. This activity is reported on in more detail under the "Technical Assistance" SWG Job, but the unexpected workload detracted from this project forcing staff to hold fewer response team trainings and no community education programs.
- ENSP staff held a limited number of trainings that included both a lecture and venomous snake safe capture and handling portions. While a number of the attendees were federal employees and could not contribute to the volunteer match, they are still considered Venomous Snake Response Team members since they will respond to venomous snake calls within their jurisdiction (i.e., on federal lands). However, the National Park Service staff informed ENSP staff that it is unlikely they will report their responses to the State.
    - Twenty-one staff members of the National Park Service working in the Delaware Water Gap National Recreation Area attended one of two trainings held during the summer, 2010. Only 13 of the participants were trained to handle the snakes.
    - Ten staff members of the US Army Armament Research Development and Engineering Center (Picatinny Arsenal) attended a training in June, 2010. Only 5 of these participants were trained to handle the snakes.
    - A training was held for the Vernon police in July, 2010. Only one Vernon police officer was trained as other officers were called out on emergencies just prior to the session.
    - A training held at Weis Ecology Center in Ringwood, August, 2010, consisted of three staff members of NJ Audubon Society, one Animal Control Officer (Ringwood), and two citizens living in close proximity to Weis Ecology Center.
- Venomous Snake Response Team:
    - As in 2009, no "local" coordinators or leaders for the Venomous Snake Response Team were established as recommended in 2008. Volunteers continue to be overwhelmed by their unrelated obligations, and their current duties and requirements as responders; no one was recruited to take on the additional responsibility of leading a team of responders.
    - Staff made no extensive effort to recruit citizens to report rattlesnake observations to help populate the Biotics database. The members of the Venomous Snake Response Team, many of whom are local animal control officers and park staff, are required and continue to educate citizens and encourage citizen involvement in rattlesnake conservation by reporting observations and sharing their knowledge of snake behavior, needs and protection with friends and neighbors.
    - Seven Venomous Snake Response Team members reported responding to 28 complaints on private lands during the 2010 field season, 21 were confirmed to be timber rattlesnakes.
    - Of the 81 active members of the northern Venomous Snake Response Team, excluding federal personnel, 52 submitted official timesheets reporting their 2010 response time; 7 new volunteers' training time was extracted from response team training sign-in sheets.
- Three citizens (two in West Milford and one in Ringwood) were charged and fined; each for killing a timber rattlesnake.

- No strategy has been developed to recruit law enforcement to monitor den locations for illegal collection. Due to limited staff, the Bureau of Law Enforcement (BLE) was again unable to monitor the areas ENSP biologists identified as potential collection sites. ENSP staff continued to consider the potential positive and negative effects of releasing den location data to those outside the Department of Environmental Protection.
- No road-related mortality hotspots have been identified thus far as snakes observed "dead-on-road" (DOR) are scattered and do not appear to be traveling through defined corridors. However, DORs and snakes alive-on-road (AORs) were reported over the course of the 2010 field season.

Conclusions:

PINELANDS REGION

- The first steps in identifying rattlesnake mortality hotspots along roads in the Pinelands was initiated by ENSP and DOT crews will be collecting road-kill data for this species in 2010.
- Due to the limited elevation change within the Pinelands, tracking snakes with the use of radio-telemetry requires surveyors to diligently track multiple times per week in order to minimize the risk of not being able to relocate snakes that are equipped with radio-transmitters.

HIGHLANDS REGION & KITTATINNY RIDGE

- The ENSP's northern region's Venomous Snake Response Team continued to be effective at rapidly responding to rattlesnake reports made by the general public and providing additional distribution locations for the Biotics database.
- It continues to be difficult to complete an adequate number of den and gestation surveys with volunteers due to their personal and professional obligations and time constraints.
- Although it is important to continue to search for and identify currently unknown dens and to refine the den model, with limited resources (surveyors, time), it would be prudent at this time to redirect our resources to assist in data collection regarding known den populations (i.e., continued presence and sex and age class ratios). This information can then be used to help develop a status assessment of our northern region's two metapopulations and, in the near future, to develop a recovery plan.
- Given the ENSP, through the help of volunteers and/or contractors, continue to locate previously undocumented dens, gestation areas and important basking areas, there is potential that additional undocumented critical sites (dens, gestation and basking areas) persist throughout the Highlands region and Kittatinny Ridge.
- Basking areas and foraging grounds exist on both public and private lands within the Highlands region and Kittatinny Ridge and surrounding areas. The ratio of potential basking habitat on private versus public lands has not been determined. However, due to the limitations in identifying all potential basking habitat using GIS models and the difficulties in successfully proving that snakes are using modeled habitats, it may be unrealistic to expect that we can accurately determine this ratio given our limited resources (staff, time, and volunteers' time).
- Increasing development and roads continue to impede and/or threaten travel between habitats, isolate populations, and limit habitat use.
- Obtaining completed timesheets from volunteers continues to be challenging. However, volunteers play an important role in protecting NJ's rattlesnakes and citizens, provide important rattlesnake distribution data, and are essential in educating and recruiting our citizens to assist in this endeavor

Recommendations:

PINELANDS REGION

- Surgically implant the sub-adult male timber rattlesnake collected in August, 2010, with a radio transmitter in the spring 2011. Staff and a trained volunteer will track and monitor the snake's movements to evaluate whether or not the snake is able to identify a known home range or if it appears disoriented and confused for a long period. Unusual movement or erratic behaviors will be interpreted as an indication that the snake is not within its home range, the snake will be recaptured and held in captivity.
- Surgically remove transmitter implant from adult male currently being tracked.
- Continue to maintain the Pinelands Venomous Snake Response Team.
- Continue to work with our conservation partner, the NJ Conservation Foundation, to identify critical habitats within their conserved lands and the development of management strategies.
- Identify stretches of roads where high mortality of this species occurs and develop a strategy for reducing snake mortality in these areas.

HIGHLANDS REGION & KITTATINNY RIDGE

- Continue radio-telemetric research to identify additional critical habitats in areas where data gaps exist; i.e., where rattlesnake populations are lacking potential interaction with each other due to the distances between documented dens. Focus on areas that have the potential to identify 1) links connecting populations throughout the Kitattinny Ridge and northern edge of the Highlands region, 2) populations at risk of human encroachment and increased human-rattlesnake interaction, and 3) populations using intrastate habitat (NY-NJ) for their summer ranges.
- Continue to recruit and train volunteers for the Venomous Snake Response Team in an effort to capture rattlesnakes from currently unknown populations or from areas where populations are known to exist, but critical habitats are undetermined, and to safely remove snakes from human-inhabited areas for the safety of the snakes and NJ citizens.
- Recruit dedicated volunteers and work with contracted research partners to survey documented dens and gather data that may assist the ENSP in developing a status assessment for the rattlesnake population in northern NJ, which is the first step in the development of a recovery plan for this species. Den surveys will also include a general assessment of the snakes' health and well-being; any snakes appearing to have open wounds or sores will be captured for testing of potential pathogens, fungi or bacteria that may be harmful to the population. Snakes showing sign of potential illness will not be released without proper and successful treatment.
- Review and test, when appropriate, additional landscape-scale features to refine the 2009 den model.
- Staff will continue to attempt to identify stretches of roads where high mortality of this species occurs and develop a strategy for reducing snake mortality in these areas.

JOB 1D: Northern Pine Snake

Project leader: Dave Golden, Principal Zoologist

OBJECTIVE: To identify life history traits and conserve habitat for the state-threatened Northern pine snakes *(Pituophis melanoleucus melanoleucus)*. Identifying critical habitats, monitoring trends in populations and habitat, and evaluating meta-population issues are key components of this job.

- In 2010 Endangered and Nongame Species Program worked with its research partner, Herpetological Associates, to complete the fourth year of a long-term (7-year) study designed to evaluate the movements and habitat use of Northern Pine Snakes on, and around, the Stafford Forge Wildlife

Management Area. During the past field season a total of 18 Pine Snakes were radio-tracked as part of this study. Nine of these snakes were moved from their natural den site in 2006 when a permitting decision was made to move the snakes to accommodate the capping and closure of a "leaky" landfill. The other nine snakes were captured in the area where the "moved" snakes were relocated and have been considered a "control group" (non-moved) group in this long-term study. This year we also carried out data analysis on the 2009 field season. Details of these activities are summarized below.

Data Collection During the 2010 Field Season: As in previous years (beginning in 2007), we determined the location of each study snake roughly every other day throughout the 2010 field season. Habitat characteristics such as percent cover, soil type, distance to nearest tree, and vegetative community composition were recorded in the vicinity of each snake every time it was relocated. As of October 2010, data collection for this field season was still ongoing and, therefore, data analysis has not yet been carried out on the 2010 field data.

Data Analysis Conducted During 2010: During this reporting period data analysis was carried out on the radio-tracking data originally collected during the 2009 field season. A total of 1,410 radio-telemetry relocations were made on 20 pine snakes during the 2009 field season. The activity ranges of the radio-tracked snakes are summarized in Fig A and Fig. B. Snakes that were in the control group ("non-moved" or "non-shifted") exhibited larger home ranges than those snakes that were relocated onto the site ("shifted snakes"). Fig. B illustrates the mean home range calculations for male and females snakes. Similar to previous years of this study (and consistent with NJDEP's pine snake model) the pine snakes tracked during the 2009 field season were most commonly found in the pine and pine-oak forests, with 61% of all relocations occurring in these two habitat types (Fig. C).

Fig. A

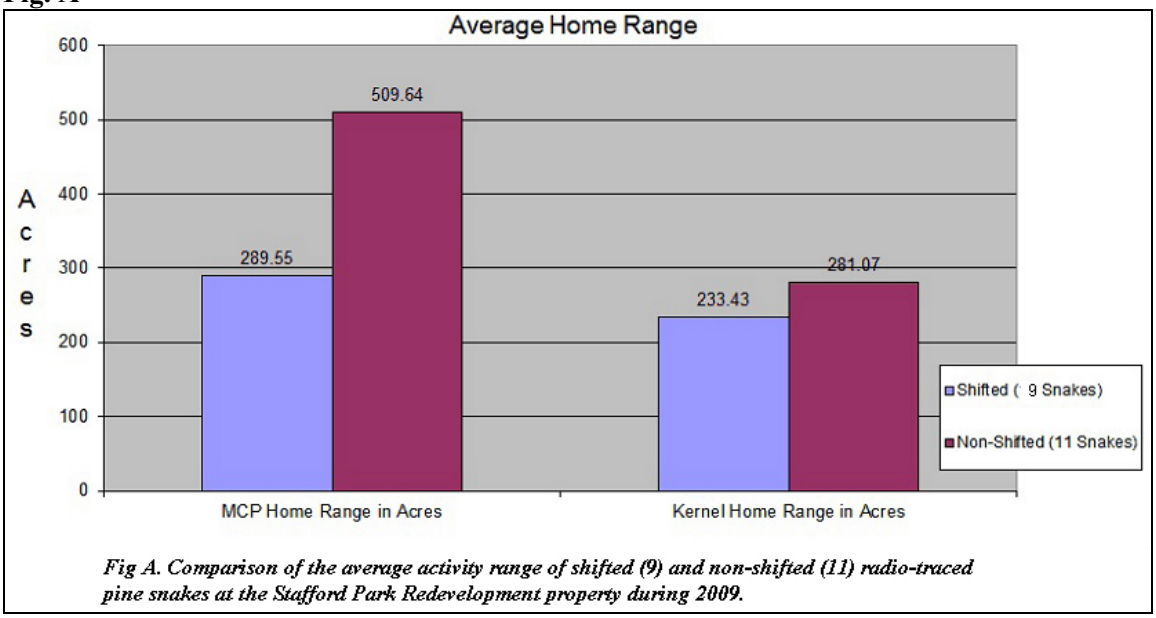


Fig A. Comparison of the average activity range of shifted (9) and non-shifted (11) radio-traced pine snakes at the Stafford Park Redevelopment property during 2009.

Fig. B

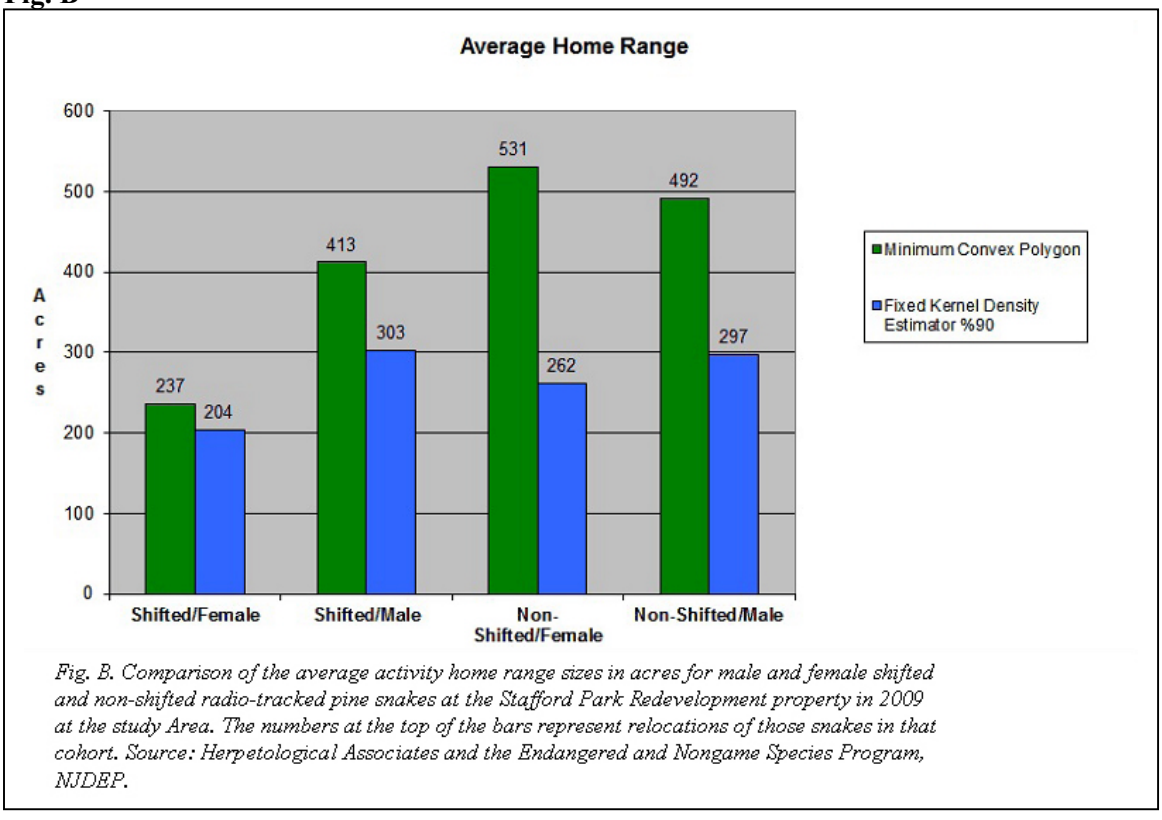


Fig. B. Comparison of the average activity home range sizes in acres for male and female shifted and non-shifted radio-tracked pine snakes at the Stafford Park Redevelopment property in 2009 at the study Area. The numbers at the top of the bars represent relocations of those snakes in that cohort. Source: Herpetological Associates and the Endangered and Nongame Species Program, NJDEP.

Fig. C.

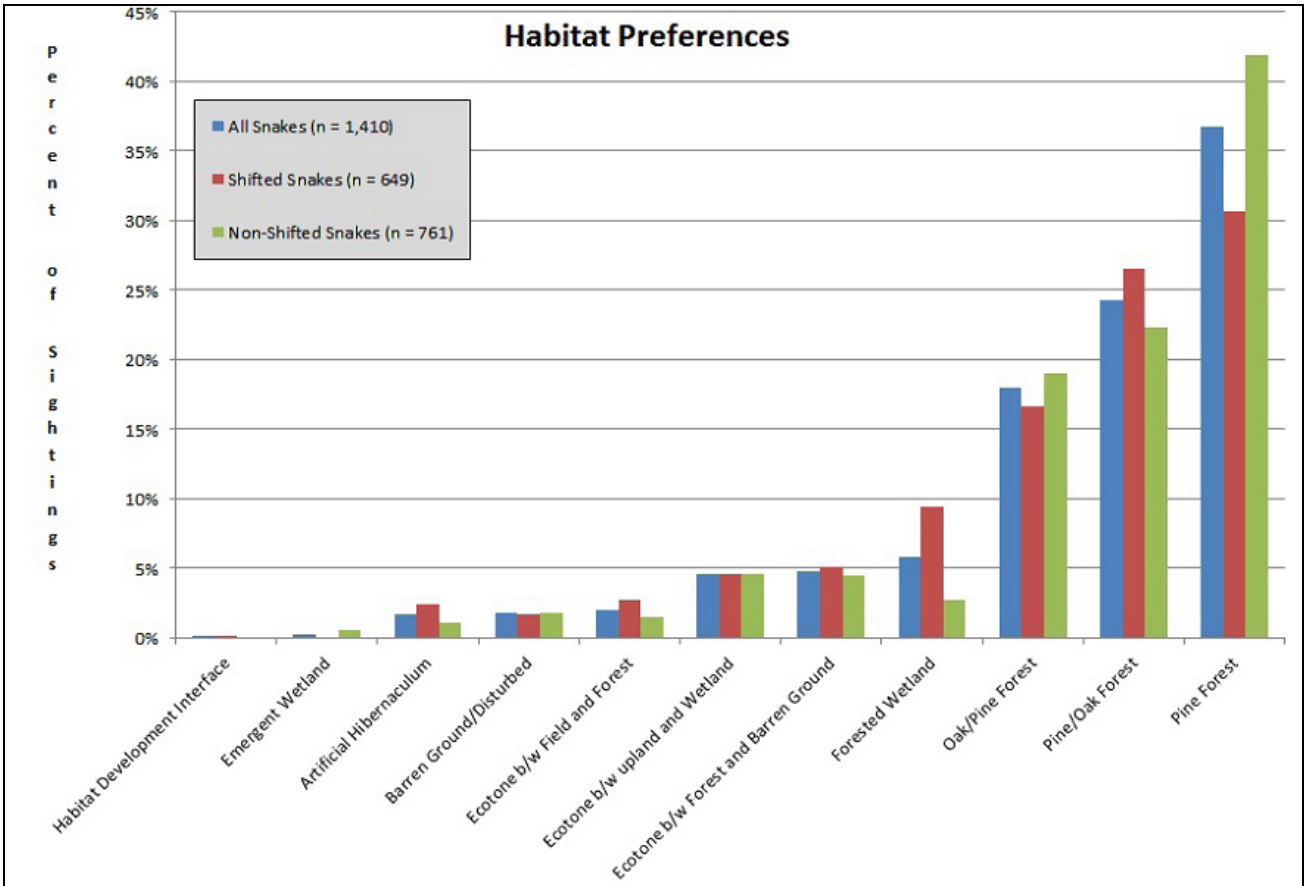


Fig. C. Twenty radio-tracked pine snakes selected different micro-habitats within the available forest. Of the 1,410 observations, pine forest was the most frequently selected habitat type, with pine-oak forest being the second most commonly chosen forest type.

- Between September 2009 and August 2010, a total of eight new pine snake records were reviewed by ENSP biologists and entered into the NJDEP's Biotics Database. An additional 20 new records were entered into ENSP's tracking database and are awaiting review by biologists before being added to Biotics.
- ENSP collected and analyzed genetic samples taken from 9 of the 14 extant tiger salamander ponds in New Jersey. Genetic results found that the NJ tiger salamander population has very low genetic heterozygosity, which is a common pattern found in small populations. A low to moderate level of genetic differentiation was detected among the 9 sites surveyed, which means that the sites are likely genetically isolated and allopatric genetic drift is taking place.
- ENSP took steps towards completed the meta analysis of habitat use by pine snakes that was proposed. Working with the Division's Permits Office, we collected 12 end of the year reports from consultants and researchers that conducted surveys (and in some cases radio-telemetry work) on northern pine snakes in 2009. As of October 31, 2010 we had not begun to analyze these data.
- In December 2009, ENSP completed a 52-page status assessment on northern pine snakes. This assessment outlined the current distribution of pine snakes in New Jersey (and throughout the US) and documented the existing threats to this species. Some significant findings from the status assessment include:

- The population of northern pine snakes in New Jersey is completely isolated from all other pine snake populations, with roughly 645 km (400 mi) separating it from the next closest population, which occurs in southern North Carolina.
- Pine snakes have experienced a major contraction of there U.S. and New Jersey range over the past 20 years.
- An analysis conducted using ENSP's pine snake habitat model ("Stat-Mod") found that pine snake habitat in New Jersey decreased a total 45,530 ha (112,459 acres) from 1986 to 2007.
- ENSP estimates that highly travel roads (road with >15,000 vehicles/day) bisecting the population of pine snakes in New Jersey create complete barriers to pine snake movements and likely divided the NJ pine snake population into at least 3 discrete populations.

A complete version of the Northern Pine Snake Status Assessment for New Jersey is available for download at:http://www.njfishandwildlife.com/ensp/pdf/pine_snake_assessment09.pdf

Conclusions:

- We continued our long-term research project to examine the typical home range size and habitat use of the northern pine snake. Preliminary home range and habitat preference results have been reported. Once this study is complete, a final analysis on these data will be a crucial component in the testing and updating of ENSP's existing pine snake models.
- The Biotics database continues to be updated with sighting records for northern pine snakes and this information will ultimately make its way into the Landscape Project mapping.
- Like other tiger salamander populations in the northeast, the NJ population of tiger salamanders exhibits low genetic heterozygosity. Evidence of low-moderate genetic differentiation was detected among the 9 tiger salamanders ponds from which genetic samples were taken.
- We completed a status assessment of northern pine snakes in New Jersey and documented that over the past 20 years there has been a decrease in the amount of suitable habitat available for pine snakes in New Jersey. The overall range size of pine snakes was also shown to have decreased over this time.

Recommendations:

- Continue to collect and summarize findings from the pine snake radio-tracking study and use the data to revise existing pine snake habitat models.
- Continue work to evaluate the isolating effects that roads have on pine snakes in NJ and work to make roads more permeable to pine snake movement.
- Work on publishing portions of the pine snake status assessment in a peer-reviewed journal.
- As recommended by the status assessment, maintain the existing "threatened" status for pine snakes in New Jersey.

1E: Northern Copperhead

Project leader: Kris Schantz, Principal Zoologist

OBJECTIVE: To determine the distribution of and conserve NJ's northern copperhead *(Agkistrodon contortrix mokeson)* populations through a coordinated approach of population and habitat monitoring, threat assessment, habitat protection and acquisition, management, research, education and environmental review, and to identify northern copperhead dens and critical habitat use.

Key Findings:

- ENSP had second thoughts on engaging the public reporting copperhead sighting and no effort to recruit the public to submit northern copperhead observations was during this reporting period due to: 1) the public's general dislike for snakes, venomous and non-venomous and 2) the difficulty in validating the public's observations as many citizens commonly misidentify eastern milk snakes and northern water snakes for copperheads.
- In 2009, ENSP staff conducted a current literature review including contacting out-of-state researchers in the northeast for unpublished data on northern copperhead movements and home range. In 2010, this information was used to revise (and finalize) an updated Species Occurrence Area (SOA) for use in NJ DEP's Biotics Database.
- The radio-telemetry study was not conducted due to restrictions in State spending; restrictions that made equipment purchases difficult and interfered with the study.
    - One northern copperhead that was not within the range of a known den was fitted with an external transmitter in late August, but the transmitter detached from the snake within two days. Surveys of the area revealed potential suitable outcrops for denning within 500 meters of the snake's capture location and a gestating female was located along the ridgetop, less than 1 km from the snake's capture location.
- Den search volunteers targeting potential timber rattlesnake dens did not observe any northern copperheads.
- ENSP staff began working with a research partner, Jason Fantuzzi of the Turtleback Zoo, West Orange, NJ, to develop and coordinate a radio-telemetry study on a northern copperhead population in Morris County, NJ, and to obtain permission to access the land. The project will focus on identifying home range and distribution, landscape-level habitat use for future model development, road permeability and/or mortalities, and include an educational component targeting the local residents. Due to our partner's difficulty to obtain enough funding for the project prior to snake emergence in spring 2010 and ENSP's difficulty in obtaining access to the proposed study site in a timely manner, no radio-telemetry was conducted in 2010. Research will begin during spring emergence 2011 when the snakes will be more easily located as they congregate on and around basking habitats.
- The Endangered and Nongame Species Program's Venomous Snake Response Team within the northern region was developed to respond to both timber rattlesnake and northern copperhead presence on private lands or human-occupied public lands. The majority of the calls warranting a responder to act are often timber rattlesnakes; in 2010, members of the Venomous Snake Response team did not report any observations of copperheads. For more details regarding the Venomous Snake Response Team and their trainings, please see Job 1C, Timber Rattlesnakes.
    - ENSP held a training for the survey team of our northern copperhead research partner. Three of the 5 team members were trained to handle a timber rattlesnake to gain the basic knowledge and understanding of handling a venomous snake. Northern copperheads are not used in trainings as they are often more mobile and ENSP staff does not want to risk losing a copperhead in unfamiliar territory.
- The injured, gravid northern copperhead released during the funding cycle 2008-2009 to the State-approved, venomous snake rehabilitator, Kathleen Michell, died in September 2009 after succumbing to internal injuries.

Conclusions:

- Northern copperhead observations are still lacking:
    - There continues to be few reported or confirmed copperhead observations on private lands.
    - Alternate sources for observations are difficult to obtain, for a number of possible reasons. Lack of awareness of copperhead presence, or a hesitation to share location data. Constraints on ENSP staff time continues to limit our ability to reach out to additional potentially knowledgeable parties.

- Copperhead observations continue to be limited, which may be in part due to their highly cryptic nature, often more difficult for the public to observe than rattlesnakes.

Recommendations:

- Continue to obtain northern copperhead location data.
  - Recruit assistance from conservation organizations.
  - Recruit assistance from the Division of Parks and Forestry.
  - Continue to work with the Venomous Snake Response Team.
- Conduct radio-telemetry study on suitably sized copperheads observed in areas that cannot be linked to a known den in an effort to identify the undocumented den location and develop/implement protective management strategies.
- Continue to provide assistance and, when possible, staff support and/or supplies to enable our research partner, Jason Fantuzzi of Turtleback Zoo, to begin researching a northern copperhead population.

JOB 2: State-Listed Amphibians

OBJECTIVE: To develop comprehensive, landscape-level conservation and management plans for all state-listed amphibians to ensure long-term viability of populations. These plans will contain concise delineations of critical breeding habitats, terrestrial habitats, and dispersal corridors, strategies and techniques for addressing threats, and long-term monitoring protocols for assessing population status over time.

JOB 2A: Longtail Salamanders

Project leader: Brian Zarate, Assistant Zoologist

OBJECTIVE: To identify viable populations of longtail salamanders *(Eurycea longicauda)*, assess threats, and implement actions to protect the riparian and lacustrine habitats they inhabit.

Key Findings:

- Based on the predictive habitat map created in 2008 and historical data, targeted surveys were conducted at 41 different locales. Nine locations were visited more than once. All sites targeted for surveying had no presence of longtail salamanders recorded during previous surveys (conducted between 2006 and 2009). However, the species was recorded in Hunterdon, Warren and Sussex counties during this recent effort.
  - Seventeen historic sites that were subjectively ranked moderate to high based on habitat suitability assessments were visited, and longtail salamander presence was documented at one of these historic sites in 2010.
  - Twelve sites visited in 2009 and assigned a high suitability ranking by the predictive habitat map were re-visited this year. We documented longtail salamander presence at two of these sites in 2010.
  - An additional 12 new sites were surveyed this year for the first time, using the predictive habitat map as a selection tool, and 3 new populations were documented.
- All new populations were precisely mapped using a Trimble GeoXM GPS unit with differential correction applied and integrated into the Biotics database.
- No reference sites were visited to gather baseline data on population dynamics. Instead, the priority of the project was to fill in data gaps between known occurrences of this species in the state.
- No additional volunteer surveyors were trained this year or used to conduct surveys.

CONCLUSIONS:

- Longtail salamanders inhabit discrete wetland areas throughout limestone bedrock regions of the state. Identifying these habitats using the predictive map as a tool has substantially increased the number of new occurrences ENSP has for this species.

RECOMMENDATIONS:

- Continue to use and refine the predictive habitat map as supplemental habitat preference data is recorded and new GIS layers become available.
- The unique habitats that longtail salamanders use in New Jersey are often unprotected by state regulations. Local population extirpations may occur if overwintering areas are destroyed or degraded as a result of development or general hydrology alterations. Consider regulations that protect seeps, headwaters, or other small wetlands.

2B: Amphibian Crossing

Project leader: Kris Schantz, Principal Zoologist

OBJECTIVE: To identify amphibian breeding migration corridors along county and rural roads in need of protection through raised roads, culverts, and/or temporary road closings.

Key Findings:

- ENSP continued to meet with the NJ Department of Transportation and the DEP's Division of Land Use Regulation (DLUR) to discuss possible resolutions and funding opportunities to implement a permanent management strategy (e.g., culverts, raised roads) at the stationary study site where there is high mortality of amphibians crossing a road segment in spring, in addition to discussing long-term solutions statewide for all wildlife crossings.
    - Staff continued to meet with Township officials representing the road/amphibian migratory corridor under consideration for wildlife passage implementation. Staff also conducted a field site visit with the town engineer and DLUR staff to discuss possible solutions to the amphibian mortality that is taking place along the local road. An informal meeting with the local landowner whose property is bisected by the road containing the amphibian migration corridor was also carried out.
        - Regardless of offers to fund the project, almost in its entirety, the town pulled back from its offer to provide in-kind services and in now presenting obstacles to the project. When the obstacles (e.g., cleaning the culverts) were addressed (e.g., volunteer fire crew willing to flush the culverts during trainings), the town continued to find fault with the project.
        - The town was unresponsive beyond May, 2010.
- The text for the draft set of guidelines for managing and protecting amphibian migration corridors is still under internal review and therefore, was not printed for distribution. The end product will be available to the public to provide guidance for anyone interested in protecting migration corridors in their local area.
- ENSP did not partner with other conservation organizations to identify and survey amphibian crossings or to pursue road closures. The Conserve Wildlife Foundation of NJ, a former ENSP partner on this project, took over this portion of the project.

Conclusions:

- The town officials representing the main study site (2002-2008) repeatedly claimed that this project could not move forward due to local economic constraints. However, when presented with the possibility that the project could be funded and maintained through volunteers, town officials continued to react negatively towards the project.

- Education at a larger scale with more towns and organizations involved in the effort of protecting migration corridors may benefit future efforts to recruit local participation and buy-in.

Recommendations:

- Complete the guidelines for managing and protecting amphibian migration corridors and work with conservation partners to distribute them throughout the state to towns, organizations and agencies that may benefit from this information.
- Continue to work with the appropriate agencies and/or organizations to develop protective measures (e.g., appropriate size, shape and structure of wildlife passages for amphibians, to identify funding sources that may help implement permanent protective measures at corridors) for amphibian migration corridors.

JOB 2C: Eastern Tiger Salamander/ Southern (Cope's) gray treefrog

Project leader: Dave Golden, Principal Zoologist

OBJECTIVE: To protect individual breeding sites, populations, and population connections, and to investigate other habitat requirements to assure long-term viability of the Eastern tiger salamander *(Ambystoma tigrinum tigrinum)* and Southern gray treefrog (*Hyla chrysoscelis*).

Key Findings:

- In 2010, ENSP completed the second year of a two-year survey of a tiger salamander breeding habitat in Lower Township, NJ (Cape May County). This survey was intended to serve as a 22-year follow-up survey on the "Bayshore Mall Study" that was originally completed at this site in 1987 and 1988. The original study (1987-88) was conducted prior to the construction of a mini mall, which is now positioned within 150 feet of the main tiger salamander breeding pond. In May 2010 we installed two drift fence and pit-fall trap arrays along the edge of two tiger salamander breeding ponds in the forested complex adjacent to the mall. These ponds were also surveyed during the original study in 1987 and 1988. One of the two ponds (the "main pond") was also surveyed by us in 2009. The 2010 results from this study (and key aspects of the study design) are summarized below.

    - In early May 2010 a 600-foot drift fence, with 22 pitfall traps, was installed along the northern edge of the large pond ("main pond") and a 250-foot drift fence, with 10 pitfall traps, was installed along the northeast edge of the small pond ("secondary pond") at this site.
    - Pitfall traps were opened on May 14, 2010 and checked daily until August 31, 2010 for a total of 3,456 trap nights (32 traps x 108 nights) during this reporting period.
    - The pitfall traps captured 0 eastern tiger salamanders, 77 marbled salamanders, 1 red-spotted newt, and 9 redback salamanders during this period. These numbers were lower than the numbers of salamanders captured last year (2009 results: 19 eastern tiger salamanders, 207 marbled salamanders, 88 red-spotted newts, and 1 redback salamander) even though the number of trap nights was nearly doubled in 2010 (3,456 in 2010 vs. 1,848 in 2009). Pitfall traps at this pond in 1987 and 1988 captured 210 and 108 eastern tiger salamanders, respectively.

- Extremely high water levels in the vernal ponds in southern New Jersey during winter 2009-2010 limited staff's ability to conduct egg mass surveys between December 2009 and April 2010. No egg-mass surveys were conducted during this time period because water levels in most vernal ponds exceeded the height of chest waders. As an alternative to egg-mass surveys, we surveyed three ponds in Mizpah, NJ (Atlantic County) for tiger salamander larvae in July 2010 using a

seine net. The presence of eastern tiger salamanders was previously undocumented in these ponds. We captured 15 tiger salamander larvae from two of the ponds and submitted this finding into the Biotics Database.

- The newly documented Mizpah ponds (described above) had clear evidence of intense ORV activity despite the fact that they are located on a Wildlife Management Area and ORVs are strictly prohibited. Working with the Division of Fish and Wildlife's Bureau of Lands Management we temporarily blocked ORV access to these ponds by cutting large trees across the trails. Unfortunately, the dedicated and energetic illegal ORV users of this area removed the trees that we had placed across some of the trails and drove in and around the dry basin of the breeding pond just a few weeks after we had blocked the trails. NJDFW Bureau of Lands Management blocked the trails with trees again in September 2010 and we are now discussing options for a more permanent solution to the illegal ORV problem at this site in and effort to reduce disturbance in and around these pond.
- One of the more productive tiger salamander sites in NJ (note: there are only 14 documented extant eastern tiger salamander sites in the state) is located on private property. We have been working with a wetland mitigation banking company (Evergreen Environmental) to purchase, permanently preserve, and manage this piece of property for eastern tiger salamanders. Evergreen Environmental now has a signed option to purchase this property. In spring 2010, at our request, Evergreen Environmental made and effort to block ORV access to this site by placing large stump piles at the points where ORVs were entering the site. Stump clusters have been effective at reducing access for ORVs and provide great habitat for many snakes and other wildlife species.
- ENSP has be working with conservation partners and planning an enhancement project for an eastern tiger salamander pond located on property owned by The Nature Conservancy (Middle Township, NJ; Cape May County). We submitted a project proposal to TNC in July 2009 and they have given approval to allow the project to move forward. Since that time we have applied for, and received, the needed DEP permits to work in this wetland complex. The project is similar to one that we completed at a tiger salamander pond in Lower Township, NJ in 2008 where we mechanically deepen the pond to lengthen its hydro-period. The same is planned for the shallow (and very ephemeral) pond on the TNC property. We were scheduled to carry out the work in September 2010, but the work was pushed back because our USFWS partners were called down to the Gulf of Mexico to work on the BP oil spill. Because the vernal pools in our area are now beginning to fill with water from fall precipitation we will likely push back this deepen project until September 2011 when the pond basins are dry.
- Many of the 14 documented (and extant) eastern tiger salamander sites in New Jersey are located on the Cape May Peninsula and many are situated in very close proximity to the coast of the Atlantic Ocean or Delaware Bayshore. In 2010, ENSP evaluated the long-term viability of New Jersey's eastern tiger salamander ponds based on climate change and sea-level rise models to provide insight on which eastern tiger salamander ponds are most vulnerable to saltwater intrusion from rising sea level. We identified 9 tiger salamander sites that have a low vulnerability to sea-level rise over the next 100-years (based on Rutgers University's Center for Remote Sensing and Spatial Analysis models). The other 5 tiger salamanders sites are very vulnerable to rises in sea level. Our current thoughts on this finding is to focus most (if not all) of our future management efforts on the 9 eastern tiger salamander sites that will not be impacted by sea-level rise.

Conclusions:

- Year 2 results of the Bayshore Mall drift fence study revealed that the relative abundance of eastern tiger salamanders at the site (Lower Township, Cape May County, NJ) has greatly declined over the past 22 years. The low numbers of salamanders at this site in 2009 and 2010

suggest that the population is no longer viable. The results of this study will be summarized and submitted for publication over the next year.

- Seine net surveys of three ponds in Mizpah, NJ (Atlantic County) resulted in the documentation of two eastern tiger salamander ponds on property owned and managed by the NJ Division of Fish and Wildlife. ENSP has initiated discussions with NJDFW's Bureau of Lands Management on potential habitat enhancement projects for these ponds (including blocking access for ORVs).
- Plans for a small, inexpensive enhancement project at a vernal pond on TNC property in Middle, NJ (Cape May County) are moving forward and a mechanical deepen of this pond will likely take place in late summer 2011.
- Using models of predicted sea-level rise, ENSP has identified 5 eastern tiger salamander sites (36% of the extant sites documented in the state) that are highly vulnerable to climate change. Given the current limitations of staff time and project funding, ENSP may decide to no longer invest in active management of these 5 sites and instead put all if its management efforts into the 9 sites that are not likely to be impacted by sea-level rise over the next 100 years.

Recommendations:

- Summarize and publish the findings from the Bayshore Mall Study, which suggest that the mitigation measures for the eastern tiger salamander that were put in place during the design and construction of the mall were insufficient to maintain this salamander population.
- Work with TNC to carry out the mechanical deepen of the pond on its Kimbles Beach Preserve.
- Work with NJDFW's Bureau of Lands Management on habitat enhancements at the two newly documented tiger salamanders ponds in Mizpah, NJ.
- Develop a longterm management plan for the eastern tiger salamander population in New Jersey that takes into account the vulnerability of ponds to climate change and focuses on management of those areas that are most likely to be unaffected by changes in sea level. Incorporate eastern tiger salamanders into any statewide climate change adaptation planning that is carried out.

JOB 3: NJ Herp Atlas Project

Project leader: Dave Golden, Principal Zoologist

OBJECTIVE: To document distribution and relative abundance of New Jersey's reptiles and amphibians through comprehensive citizen-based surveys and to integrate these atlas findings into the Landscape Project.

Key Findings:

- 2010 marked the 15th and final year of the New Jersey Herp Atlas Project. ENSP notified all active volunteers that 2010 would be the final year and that we would no longer be collecting data from volunteers as part of this project after 2010. A total of 6 volunteers submitted 2010 data prior to October 1, 2010. Volunteers reported observations of 509 turtles (representing 6 species), 348 frogs and toads (representing 6 species), 83 salamanders (representing 6 species), and 5 snakes (representing 2 species).
- In cooperation with USGS, 63 calling amphibian survey routes were established in New Jersey in 2003. In 2010, volunteers surveyed a total of 27 of these routes. Many of the routes were surveyed multiple times resulting in a total of 57 surveys as part of this project. All sixteen anuran species that occur in New Jersey were detected during the 2010 CAMP surveys. These data were incorporated into New Jersey's state database as well as into the North American Amphibian Monitoring Program's (NAAMP) national database. Northern spring peepers were the most widespread species detected in 2010, being detected on 96% (24 out of 26 of the routes

surveyed). Eastern spadefoot and Cope's gray treefrog were far less common, and were found along only one of the 26 routes (4%).

- A total of 161 volunteer hours were logged for this project over the past year. These are broken down as follows: Six Herp Atlas volunteers reported a total of 27 volunteer hours and 27 Calling Amphibian Monitoring Program volunteers reported 134 hours of volunteer time.

Conclusions:

- After 15 years of data collection, the Herp Atlas Project has been brought to a close. Volunteers submitted thousands of sightings of reptiles and amphibians over the past 15 years. In fact, so many datasheets and observations were submitted annually by volunteers that ENSP staff often struggled to keep up with the data entry and data summary for this project. Now that no additional data will be submitted for this project we plan to focus our efforts on producing a final report for the Herp Atlas Project. The comprehensive report of findings that was planned for this year was not completed.
- The Calling Amphibian Monitoring Project continues to provide valuable anuran distribution data for ENSP. The number of routes surveyed as part of the Calling Amphibian Monitoring Program (CAMP) increased from 26 (in 2009) to 27 in 2010. However, the total number of actual surveys (routes are supposed to be surveyed 3 times per year) that were conducted decreased to 57 in 2010 (down from 64 in 2009).

Recommendations:

- Begin the final summary of the data collected as part of the Herp Atlas Project and develop a strategy for reporting the results of the project to volunteers and the general public.
- Continue to recruit and train volunteers for the Calling Amphibian Monitoring Program in an effort increase the number of New Jersey frog-calling routes that are surveyed in 2011.

EXECUTIVE SUMMARY

Project:	**Invertebrate Conservation**
Federal Aid Project:	T-1-5 (State Wildlife Grants)
Segment dates:	September 1, 2009 to August 31, 2010
Total Project Expenditures:	$113,000 ($56,500 Federal, $56,500 State) ('09-10 year only)

JOB 1: State Listed Mollusks

Project leader: Jeanette Bowers Altman, Principal Zoologist

This job is jointly supported by State Wildlife Grants and Section Six funding.

OBJECTIVE: To monitor populations and create conservation plans and strategies to aid in the recovery of listed species found throughout New Jersey, including the dwarf wedgemussel, brook floater, green floater, yellow lampmussel, eastern lampmussel, eastern pondmussel, tidewater mucket, and triangle floater.

Key Findings:

Key Findings:

- We surveyed 13 stream sites totaling 27 station segments in seven counties for listed freshwater mussels during the survey period. Timed searches for mussels were conducted at historic locations and/or previously unsurveyed suitable habitats.
- We performed habitat assessments and/or preliminary searches at 14 additional sites in six waterways to determine if larger surveys were warranted.
- EPA Habitat Assessment Field Data Sheet scores (high and low gradient combined) ranged from 73 (Wickecheoke Creek) to 157 (Pequest River, Warren County), out of a possible 200. Previous ENSP studies have shown that mussels occur in a habitat score range of 68-173. All sites surveyed scored within the preferred habitat range. Peak mussel abundance occurred at station segments with total habitat scores between 129-143. Maximum abundance was associated with the total habitat score of 143.
- We compared individual habitat characteristic scores from EPA Habitat Assessment Field Data sheets (including but not limited to epifaunal substrate/available cover, sediment deposition, bank stability, and riparian width) with freshwater mussel abundance and species richness. We found abundance to be more closely associated with channel alteration, available cover, and total bank stability, whereas species richness was closely associated with total riparian zone width and total bank stability. Prior investigations from 2000-2005 showed that total riparian zone width score was most closely associated with freshwater mussel abundance.
- Water quality values were as follows: pH ranged from 5.8 to 8.5, water temperatures ranged from 14.0 to 24.5 Celsius, dissolved oxygen ranged from 6.3 to 9.9 ppm.
- Catch per unit effort (CPUE) for all species combined during time searches was highest in the Pequest River, Warren County (Cemetery Road site), with 8.358 live + shells/minute.
- We designed and constructed a new type of freshwater mussel sampling gear. It is essentially a rake with a cross sectional opening 12 inches wide and 2 and ¼ inches deep. A steel-meshed basket was welded to the rake opening with diamond-shaped mesh openings of ¼ inch by ¾ inches. Our new gear type is designed to facilitate sampling fine to coarse sediments that are used by particular species of mussels.
- A preliminary methodology for using the "rake" was applied as follows: prior to deployment, the area to be sampled was visually inspected for observable freshwater mussels. In all tests (three sets total), the rake was drawn 18 inches through the sediment in a sawing motion. The contents were gently

shaken underwater and a visual inspection of the remainder was completed. The area was then sampled two to three more times, with the rake digging deeper to 10 centimeters. All specimens were captured in the first pass during these tests. A visual inspection was then made of the area after the sampling effort to look for missed specimens. No missed specimens were observed.

- In August 2010, 10 random samples were collected using the rake from an area in the Pequest River where dwarf wedgemussels are known to occur. Visual observation before the rake deployment showed no mussels on the surface of the sediments. Catches by the rake yielded 7 specimens (5 Eastern elliptio shells, 1 Triangle floater shell, and 1 Dwarf wedgemussel shell). Ten random .25 m quadrat samples in the same area only yielded two shells of the common species, Eastern elliptio.
- Additional testing of the rake in the Pequest and Salem rivers showed promising results, yielding several listed species, including Dwarf wedgemussels and Triangle floaters.
- We found nine species of freshwater mussels during field activities, including the Dwarf wedgemussel, Triangle floater, Eastern pondmussel, Creeper, Eastern elliptio, Eastern floater, Alewife floater, Paper pondshell and a possible Green floater. The Eastern elliptio was by far the most prevalent and widespread mussel species documented. Species richness was highest in the Cohansey River, with four species recorded.
- In addition, we documented the first North American occurrence of the highly invasive Chinese pondmussel (*Sinanodonta woodiana*) from ponds owned by the NJ Conservation Foundation. The ponds had formerly been used as part of a fish farm operation for holding bighead carp and other fish species. Genetic testing by Dr. Arthur Bogan and staff of the North Carolina Natural History Museum confirmed the species identification. We also documented Chinese pondmussel shells in Wickecheoke Creek at various segments downstream of the ponds.
- The federal/state endangered Dwarf wedgemussel was present at two locations. We found a fresh Dwarf wedgemussel valve in the Pequest River, Great Meadows, Warren County, in an area where Dwarf wedgemussel shells were previously documented. Other listed species documented at the site included Green floater (one possible shell) and one live Triangle floater. Another fresh Dwarf wedgemussel valve was located at a new location (Bear Creek, Pequest River tributary, Warren County). New occurrences for the Triangle floater (one live, one shell) and Creeper (SC, 28 shells) were also recorded.
- We documented the Eastern pondmussel (six live, 4 shells) for the first time in the Cohansey River, Salem County.
- Volunteers continued to identify and survey freshwater mussels as part of the freshwater mussel atlas effort. The volunteers are covering Salem, Cumberland and Atlantic counties, and using a draft version of the NJ Freshwater Mussel Field Guide for identification purposes.
- All new locations found to have federal and/or state listed mussels from these surveys and others (e.g. USGS surveys in the Flatbrook and Delaware River, private consultants for the Paulins Kill, etc.) have been/ are in the process of being incorporated into the Biotics database. These locations, along with sightings from previous surveys, will be used in next version of the Landscape Project mapping to identify critical areas for listed mussel populations.
- Working with the DEP's Bureau of Standards, we are participating in an internal task force to determine how to revise the Department's methods for upgrading stream classifications, including methods for selecting Category 1 areas based on listed aquatic obligate species. We have developed a draft list of species to be used in the C1 selection process which includes all listed freshwater mussels.

Conclusions:

- Based on habitat suitability assessments and preliminary searches, four out of 14 sites warrant further survey work to determine freshwater mussel species composition and abundance.
- Habitat characteristic analyses were somewhat inconsistent between the 2010 dataset and those performed in previous years.

- The rake sampler shows great promise is sampling fine and coarse sand substrates that have no embedded tree branches or cobble. Preliminary results for finding smaller species like the dwarf wedgemussel indicate that the rake is a useful sampling tool if the goal is to document rare species.
- The Chinese pond mussel may have escaped from the fish farm ponds into Wickecheoke Creek. This creek, although intermittent and fairly unsuitable to support freshwater mussel populations, contains pockets of deeper, stagnant pools, a preferred Chinese mussel habitat type. It is undetermined whether the species is living in the creek, and if so, has been washed down (or carried via hosts fishes) to the Delaware River or D & R canal. The ponds have recently undergone a rotenone treatment to eliminate the big head carp and are being drained this winter.
- Discovery of Dwarf wedgemussels and Eastern pondmussels in previously undocumented locations, underscores the need for more surveys in New Jersey. It is possible that other populations occur in the previously unsurveyed streams with suitable habitat and appropriate host fishes present.
- During the last project period, we determined that using the Landscape Project mapping may be limited in its usefulness as a tool for selecting potential C1 stream segments. For now, it appears as though using Landscape should be the initial step in alerting biologists to areas where obligate aquatic species occur.

Recommendations:

- Continue surveys for listed species in previously unsurveyed suitable habitats to document distribution.
- Continue collecting and analyzing habitat data to determine relationships with freshwater mussel abundance and diversity. Compile and analyze data from 2000-2010.
- Continue testing of the sampling rake to determine if further use in the field is appropriate. Investigate methodology to quantify results and continue to compare with .25 m quadrat sampler.
- Focus survey efforts in the Pequest River to determine Dwarf wedgemussel population boundaries and size.
- Continue searches in the Cohansey River to determine distribution and abundance of Eastern pondmussels.
- Continue searches the Lamington River to document distribution of Brook floaters.
- species.
- Work with DEP's Water Monitoring and Standards to recommend stream classification upgrades in areas with listed mussels.
- Continue work on atlas and solicit assistance from additional Wildlife Conservation Corp (WCC); train volunteers to identify and survey for mussels; assign specific areas for survey work where data are lacking. Complete maps for field guide, print and distribute to interested parties.
- Continue refining methodology for selecting potential Category 1 stream segments using listed freshwater mussels and other aquatic obligate species. Present method to Bureau of Water Monitoring and Standard's staff for input and approval.

JOB 2: Federal and State-Listed Lepidoptera

Project co-leaders: Dave Golden, Principal Zoologist and Robert Somes, Assistant Zoologist

Objective:

To identify, survey, protect, and manage for listed Lepidoptera populations and habitats in New Jersey. Listed species include Arogos Skipper, Mitchell's Satyr, Bronze Copper, Appalachian Grizzled Skipper, Checkered White, Silver-Bordered Fritillary, and Frosted Elfin. For the 2010 field season, surveys focused on surveying existing Arogos Skipper populations, surveying existing and new Silver-bordered Fritillary sites, surveying existing and potential Frosted Elfin sites, and surveying existing and potential Northern Metalmark sites.

Key Findings:

- We surveyed four known/historic Silver-bordered Fritillary sites in the state two times each between April and August 2010. One out of the three sites was positive for Silver-bordered Fritillaries with three individuals observed. Surveys were also conducted at sites possessing suitable habitat for this species. A total of eight potential sites were surveyed with no individuals observed at any location.
- We surveyed four known/historic and four potential Arogos Skipper sites in Northern New Jersey twice each during the flight period. Only one known site was positive for Arogos Skipper with four individuals observed. Three out of four potential sites had Arogos Skipper present with a total of seven individuals observed. We surveyed five known and six potential Arogos Skippers sites in southern New Jersey with no Arogos Skippers observed at any location. Each site was visited twice during the flight period. A meeting was held with the public property owner of one of the new Northern New Jersey sites to insure appropriate habitat management activities were conducted to prevent the inadvertent destruction of the site and to try and enhance the location if possible. Meetings were held with public land managers about the Southern New Jersey sites to work on prescribed fire management of several sites that are becoming overgrown and no longer suitable to the species.
- One new Georgia Satyr population was located while surveying for Arogos Skipper with a total of 10 individuals observed.
- Two new Two-spotted Skipper populations were also located while surveying for Arogos Skipper with a total of 20 individuals observed.
- All known (a total of nine locations) Northern Metalmark populations were surveyed at least once with most sites being visited twice. Northern Metalmarks were found to be present at two known/historic locations with 25 individuals and 15 individuals being observed at each location. Six potential locations were also surveyed with one new population being located with a total of three individuals observed. Many known/historic locations no longer contain suitable habitat owing to succession and the invasion of exotic species. Meetings with public property owners that have Northern Metalmark sites were held and management recommendations were made. Several sites will have some thinning and invasives removal conducted and sites where there are agricultural leases will leave uncultivated buffers for nectaring sources.
- We surveyed four potential Bronze Copper sites in northern New Jersey. All sites had food plant present and one location on the NY/NJ border was found to have 4 Bronze Coppers present. There have been no prior confirmed sightings in the northern New Jersey area in over 30 years.
- Four potential Checkered White sites were surveyed with no individuals observed. The small population discovered in southern New Jersey during 2008 was not found to be present during a late 2009 site visit and some of the fields were being cultivated at the time of the survey.
- Extensive surveys were conducted for Frosted Elfin with all known/historic (excluding Atlantic City International Airport) sites being extensively surveyed. Seventeen total historic/known sites were visited and 10 potential sites were visited. Nine historic sites and two potential sites had populations of Frosted Elfin present. Several sites had large populations present with 20 or more individuals observed. One site was heavily flooded following close to eight inches of rain during the month of March. Numerous power line ROW sites had been herbicided extensively during the fall of 2009. This would have been after the larval and adult active periods and shouldn't have caused direct mortality but extensive areas of cover and nectar plants were destroyed. Only time will tell but some overgrown sites potentially will have benefited from the herbiciding activities having removed competing vegetation. Deer herbivory and off road vehicle disturbance are a significant problem on several ROW sites. We held meetings with public property owners to discuss the continuation of beneficial management practices on public property.

Conclusions:

- Arogos Skipper continues to persist in low numbers in northern New Jersey. As illustrated with some of this year's surveys, the potential exists to find more colonies in suitable habitat adjacent to known colonies. All sites seem to have low numbers making surveying difficult and missing individuals easy. One new site was located on public property where some effort had been made to create Arogos Skipper habitat and had apparently succeeded although the habitat was not optimal. Habitat management needs to be conducted at several southern New Jersey locations to maintain the herbaceous vegetation communities at the sites.
- Northern Metalmarks are no longer present at numerous historic locations and the habitat is no longer suitable due to succession and exotic species invasions. Habitat management needs to be conducted in order to maintain some of these locations. Numerous areas of potential habitat were located and several seemingly good sites were located on private property from a distance. Also several recently abandoned farm sites are undergoing succession and will yield potential habitat in 5-10 years.
- Bronze Coppers were sited in several locations in Northern New Jersey over the last several years with this year being the first time that a site was officially documented in over 30 years.
- This year was the first year the extensive Frosted Elfin surveys were conducted in five years. Several large restoration projects were performed for this species approximately five years ago and have seen success at several locations. This species was also able to recolonize several sites that had been destroyed and then had undergone restoration activities. Better management practices have also helped to maintain several populations of this species. There are also significant areas of potential habitat that could hold undiscovered populations of this species. Power line ROW maintenance activities will continue to pose management issues for this species. If the sites are not maintained they become overgrown and no longer suitable. However, extensive herbiciding versus winter mowing may not be the most beneficial means of maintaining these sites. Also, weather was not optimal on most survey days (high temperatures and winds during peak flight period) and could have led to lower survey numbers.

Recommendations:

- Continue surveying of historical sites and conduct further surveys of other sites that contain suitable habitat.
- Survey habitat characteristics and structure to compare present sites with historical sites to determine habitat needs and potential mechanisms behind the metapopulation structure of these species.
- Work with public property owners/managers that maintain sites with rare butterfly habitat to insure that best management practices for these species are followed.
- Continue surveys for Frosted Elfins in southern New Jersey and survey the Atlantic City Airport populations if possible.
- Conduct a greater survey effort for Northern Metalmarks and work with land managers to conduct habitat improvements at several historic locations.
- Work with the New Jersey Forest Fire Service to conduct prescribed burning operations to improve habitat for Arogos Skipper in Southern New Jersey during the 2011/2012 burning season.

JOB 2B: Frosted Elfin

Project co-leaders: Dave Golden, Principal Zoologist and Robert Somes, Assistant Zoologist

OBJECTIVE: To survey suitable habitat for this species and manage habitats for the proliferation of its host plant when appropriate.

Key Findings:
- In 2009, very limited survey efforts were made due to a staff transition for invertebrate work. No management or other research activities could be conducted due to this reason and lack of personnel.
- One day of surveys was conducted under poor conditions to familiarize new personnel with current Frosted Elfin sites.
- Wildlife Conservation Corps volunteer unofficial reports found Frosted Elfins at most of the 12 historic locations, and one official report showed a new location.

Conclusions:
- Frosted elfin continue to persist at many of the historic sites in the state despite minimal habitat management.

Recommendations:
- Conduct surveys of historic sites and other potentially new sites that contain suitable habitat to determine current distribution of Frosted Elfin populations.
- Work with utility companies to determine best management practices on rights-of-way where frosted elfin habitat is present.
- Reinitiate habitat enhancement/creation activities in areas where soil characteristics are suitable for the planting of wild indigo.

JOB 3: Rare Odonata Conservation

Project leader: Jeanette Bowers Altman, Principal Zoologist

Objectives: To evaluate the status of rare Odonata species in New Jersey and proceed with the state listing process for those species that warrant the status of threatened or endangered. Routine surveys for rare Odonata species will be an important component of the long-term protection of rare Odonata in New Jersey. This project will also investigate the role of hydrological and water quality issues that may affect habitat suitability and population trends. Management will involve integrating habitat needs into forestry, farming and other land use practices, combined with habitat restoration and protection of concentration areas.

Job 3a: Gray Petaltail Conservation

Objective:
To monitor progress of an effort to reintroduce the soon-to-be listed as State Endangered Gray Petaltail (*Tachopteryx thoreyi*). This project began in 2007 with the collection of larvae out of state. An effort will be made to collect more larvae for transportation to the reintroduction site in Sussex County.

Key Findings:
- The Gray Petaltail (*Tachopteryx thoreyi*), which is soon to-be-listed as state Endangered, was once reported sporadically from the Highlands, Ridge and Valley, and Northern Piedmont areas of NJ. Surveys over the past several years have failed to located individuals of the species.
- The reintroduction of the Gray Petaltail was undertaken during May 2007, with monitoring occurring at the reintroduction site for three subsequent years. The site chosen for the reintroduction is a large woodland seepage draining into Quick Pond in Sussex County and is protected as part of Trout Brook Wildlife Management Area.

- In 2007, 31 Gray Petaltail larvae were collected at a large seepage complex in State College, PA and transplanted at the reintroduction site. Eleven adults were observed during weekly monitoring through mid-July. Individuals were marked to establish an estimate of total number present. Based on markings, seven discreet individuals were recorded.
- In 2008, five live adults (four males, one female) were observed between late May and early July, with one dead male discovered in early June. The female was observed ovipositing (egg laying), suggesting that breeding had commenced within the population.
- During the 2009 season, no adults were observed at the Quick Pond site through much of June. This lack of adults is likely due to adverse weather conditions throughout much of the month, resulting in later than normal adult emergence. This weather related impact was observed with most early season Odonata species in the region.
- Six adult males were subsequently recorded during 17 visits to the site. No evidence of adult breeding activity was observed during the 2009 flight season. The presence of adults indicated that the transplanted colony was persisting, however. An attempt was made to search for larvae in late August. Two early instar larvae were located in the main seepage, providing further evidence that the colony was persisting.
- No adults were observed during 13 visits to the site in the 2010 flight period. It is unclear whether this indicates a failure of the colony.

Conclusions:
- While it is possible that this small experimental colony may have failed it is impossible to make this judgment with one year's data.

Recommendations:
- Continue to monitor reintroduction site during May-July 2011. If no adults are found at this time, the project should be re-evaluated to determine whether or not it should be continued.
- Monitor nearby suitable habitat within a radius of one mile from the reintroduction site for the presence of stray adults.
- Continue to identify suitable habitat elsewhere and conduct surveys for the presence or absence of this species.

Job 3b: Statewide Surveys and Monitoring of Soon-To-Be Listed Odonata

Objective: To monitor populations and create conservation plans and strategies to aid in the recover of state-listed species found throughout New Jersey, including the Gray Petaltail, Superb Jewelwing, Brook Snaketail, Robust Baskettail, Banner Clubtail, Harpoon Clubtail, and Kennedy's Emerald. To locate new populations of these species in areas not yet surveyed. To periodically revisit known populations to assess status and update the element occurrence.

Key findings**:**
- Surveys for soon-to-be listed and rare Odonata were conducted throughout the state. A total of 61 sites were sampled during the project period. Of the 61 sites sampled, 24 previously surveyed sites were visited for monitoring purposes and 37 new sites were surveyed.
- Sampling was primarily conducted via the collection and identification of larvae and exuvial shells. Adult observations were also used to survey for Odonata.
- Further surveys along the upper Delaware River conducted in May and June showed that the globally imperiled Septima's Clubtail (*Gomphus septima*) and Green-faced Clubtail (*Gomphus viridifrons*) are limited to the river segment around Minisink Island in Sussex County.
- A new breeding colony of Brush-tipped Emerald (*Somatochlora walshii*) was found at the NJ Natural Lands Trust Bear Creek Preserve in Warren County. At least 25 adults were present during a one day

survey of a limestone fen. Also present were two Williamson's Emeralds (*Somatochlora williamsoni*) though no breeding activity was observed.
- Based on larval sampling conducted at Batsto Creek (Burlington County), a large but localized breeding colony of Banner Clubtail (*Gomphus apomyius*) is present here.
- Based on adult observations and exuviae collections it is now known that a small colony of Banner Clubtail (*Gomphus apomyius*) inhabits Chamberlain Brook at Bamber Lake (Ocean County). This population is most likely associated with those occurring at Cedar Creek (outflow of Bamber Lake).
- A single Brook Snaketail (*Ophiogomphus aspersus*) larva was collected from the Pequest River in Warren County. Further surveys will be conducted in 2011 in an attempt to estimate population size.
- Big Lost Pond (Mashipicong Pond Preserve) in Sussex County was re-visited and several Subarctic Darners (*Aeshna subarctica*) were observed. A female was seen ovipositing in sphagnum at the edge of this small muskeg.
- A new breeding colony of Spatterdock Darner (*Rhionaeschna mutata*) was discovered at Vernon Marsh in Sussex County.
- Follow-up surveys were conducted for Superb Jewelwing (*Calopteryx amata*) in the Flatbrook watershed of Sussex County. This conspicuous species is usually locally abundant in several parts of the watershed. This year, however, only six adults were observed. While this does not indicate a trend, the population should be closely monitored for evidence of a decline.
- A small breeding colony of Golden-winged Skimmer (*Libellula auripennis*) was discovered at Webbs Mill Bog in Greenwood Forest WMA (Ocean County).
- All locations found to have soon-to-be listed Odonata from these surveys have been/ are in the process of being incorporated into the Biotics database. These locations, along with sightings from previous surveys, will be used in next version of the Landscape Project mapping to identify critical areas for Odonata populations.

Conclusions:
- Much remains to be learned about the Odonata fauna of New Jersey. It is unclear what factors are impacting our rarest species, and whether they are natural or manmade. It is quite clear however that the value of many of the more sensitive species as environment indicators is great.
- The possibility exists that the state's one population of Superb Jewelwing may be declining. Further monitoring is needed to determine whether a trend exists and identify possible causes.
- The regionally endemic form of Septima's Clubtail is extremely localized to a small segment of the upper Delaware River. Its current conservation status of special concern may be inadequate.
- A new colony of Brook Snaketail is now known from the Pequest watershed. Based on the quality of the habitat there is the potential that it is a large colony. With other known colonies of this rare species declining it will be important to ascertain the size and geographical extent of this occurrence.

Recommendations:
- Continue to monitor known populations of rare Odonata throughout New Jersey.
- Occurrences not associated with breeding habitat or where no breeding activity was confirmed need further study.
- Continue to identify and survey new habitats in an effort to locate further populations of rare Odonata.
- In cases where known populations are declining continue monitoring and attempt to ascertain possible cause(s) of the decline.

Job 3c: Range Distances for Priority Species – Mark and Recapture Study

Objective:
Develop information to determine range distances for priority species from breeding waters.

Key Findings:

- During mid-to-late May, a total of 216 newly emerged Snaketails (111 Brook, 83 Maine, and 22 Rusty) were captured adjacent to the Big Flat Brook within Walpack Wildlife Area.
- Each Snaketail was marked on its hindwings with a large white patch created with "Whiteout" that could be obviously observed when the marked individual took flight. Individuals were released at the same location once markings were affixed on the hindwings. Subsequent re-captured adults had a second unique marking placed on the wings. These re-marked individuals were then searched for elsewhere.
- Surrounding foraging fields searched in 2010 were re-visited with a total of 14 recaptures at four sites: a) Walpack Center, approximately 2.6 miles from the capture area b) Quick Pond, approximately 3 miles from the capture area and c) Arctic Meadows TNC Preserve, approximately 2.4 miles from the capture area and d) a rocky bald area at the top of the Kittatinny Ridge, approximately 3.5 miles from the capture area (Fig. 1.). None of the re-captured and additionally marked adults were observed again.

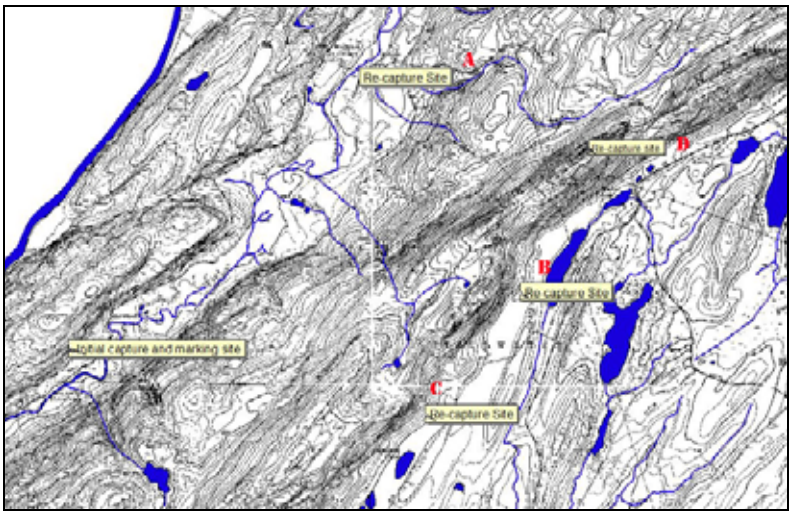


Fig. 1. Map of study area showing the initial capture site and recapture sites a) Walpack Center b) Quick Pond c) Arctic Meadows TNC Preserve and d) Ridge top site.

Conclusions:

- Anecdotal information suggests that Odonata range far from their breeding sites while foraging for prey, seeking shelter or reproducing. There have been no significant studies, however, with the intent of quantifying distances traveled or elevations surmounted.
- While this is an initial study, our data would suggest that Snaketails will fly relatively long distances to visit preferred foraging sites. It is unclear, however, whether these foraging adults ever return to their breeding streams or if this is in essence a one-way trip.
- Further study using mark recapture methods may support the need to increase the size of protective buffers around known breeding sites for the soon-to-be listed Brook snaketail (*Ophiogomphus aspersus*).

Recommendations:

- Continue mark-recapture study for one final year to determine if consistency is observed regarding disbursal patterns of Snaketails.

- Conduct similar studies on other priority Odonata species from other families. Ultimately, it may be possible to recommend scientifically based protective buffers (and Species Occurrence Areas as represented in Biotics and the Landscape Project) that take into account not only breeding habitat but crucial field and forested uplands.

Job 4. Rare Coleoptera Conservation

Project leader: Robert Somes, Assistant Zoologist

Objective:
To determine the status and distribution of New Jersey's native Coleoptera species, particularly those that may be rare or threatened on a state or global level, and take steps to stabilize and recover species as necessary.

Key findings:

- We consulted with experts and compiled available sightings data for NJ's Coleoptera species. In addition, we developed an initial list of species suspected to be rare, threatened or in decline in the state.
- We conducted surveys at the Northeastern Beach Tiger Beetle (Cicindela dorsalis dorsalis) reintroduction site located at Sandy Hook. Surveys on two different days failed to locate any individuals of this species.
- Surveys were also conducted for the rare *Cicindela marginipennis* on two different days in the Delaware Water Gap with no individuals being observed at several historic locations.
- Surveys were conducted for the rare *Cicindela limbalis* at two locations on one day with no individuals observed. Surveys targeted the historic range of this beetle in northeastern New Jersey. There have been several unconfirmed reports of this species being found near Ringwood State Park as well as across the border in NY in this vicinity.
- A *Cicindela lepida* population was found at a new location while surveying for Lepidoptera near Chatsworth in the Pine Barrens region of NJ. Several other undocumented populations have been reported near this vicinity as well as in the Cumberland County area that will need to be surveyed during 2011.
- All new occurrence data were mapped and incorporated into our State Biotics and Landscape databases.

Conclusions:

- A greater survey effort is need to determine the status and distribution of potentially rare tiger beetles in NJ. Several active State Lepidoptera volunteers are learning tiger beetle identification and will be assisting with surveying and data collection.
- Personnel shortages will continue to restrict survey efforts for these species.

Recommendations:

- Survey efforts for *C. dorsalis dorsalis* should be continued to determine if the species is still present at Sandy Hook.
- Surveys should be conducted for other rare tiger beetle species in order to determine their status within the State and assist with running a Delphi status review and establishing a Threatened and Endangered Tiger Beetle list for New Jersey.
- Efforts should be made to recruit and train volunteers to survey for these species.

EXECUTIVE SUMMARY

Project:	**Species Status Review**
Federal Aid Project:	T-1-5 (State Wildlife Grants)
Segment dates:	September 1, 2009 to August 31, 2010
Total Project Expenditures:	$12,000 ($6,000 Federal, $6,000 State) ('09-10 year only)

JOB 1: Species Status Review and Listing

Project leader: Kathleen Clark, Supervising Zoologist

OBJECTIVE: Determine the status and distribution of endangered and threatened wildlife, and wildlife species of special concern.

Key Findings:

Biologists wrote a Standard Operating Procedure manual for administering the Delphi Technique for species status reviews. The manual will guide biologists who conduct status reviews going forward. The manual was also reviewed and approved by the Endangered and Nongame Species Advisory Committee, the oversight committee of ENSP.

SELECT FRESHWATER CRUSTACEANS:

- The status of 17 crayfish and fairy shrimp species were reviewed using the Delphi process. Species were chosen based on NJ Department of Environmental Protection's Bureau of Freshwater and Biological Monitoring data, reference collection and list provided by the Philadelphia Academy of Natural Sciences, NJ Natural Heritage and Endangered and Nongame Species Program (ENSP) survey data, panelists' survey data, US Geological Survey (USGS) data, and additional literature and web sources such as NatureServe Explorer.
- 5 reviewers participated; reviewers included experts from The Philadelphia Academy of Natural Sciences, NatureServe, The College of New Jersey, Massachusetts Natural Heritage & Endangered Species Program, and one environmental consultant recognized as a global authority on fairy shrimp.
- Species reviewed included 12 crayfish and 5 fairy shrimp.
- Reviewers were provided information pertaining to the species under review, including a 2007 American Fisheries Society report on the conservation status of crayfish species, distribution maps by USGS and ENSP, and additional literature. Information was provided to each reviewer via a CD.
- Round 1 began on October 26, 2009 and Round 4, the final round, was completed on May 14, 2010.
- Consensus was achieved on 13 out of 17 species. One species was voted Special Concern (eastern fairy shrimp); three species were voted Secure/Stable (common crayfish, spinycheek crayfish, white river crawfish); nine species were voted Not Applicable.
- Four unresolved species (devil crawfish, knobbedlip fairy shrimp, springtime fairy shrimp, spinytail fairy shrimp) were referred to the Endangered and Nongame Species Advisory Committee for resolution.
- On October 20, 2010, staff presented the New Jersey Endangered and Nongame Species Advisory Committee (ENSAC) with the findings of the status review. ENSAC voted to accept the recommendations of the panel for those species for which consensus had been reached. For those species for which consensus had not been reached, ENSAC voted to recommend three species as "undetermined" and one as "not applicable."
- The results of ENSAC status recommendations will, after DEP rulemaking, add all species, other than those with a status of "Not Applicable", to the state's list of nongame species.

TERRESTRIAL NONGAME MAMMALS:
Little progress was made on the terrestrial nongame mammal status review during the project year due to staff time constraints. (The biologist administering the terrestrial mammal status review was heavily involved in dealing with White Nose Syndrome and bat issues.) Going forward, status review of terrestrial mammals remains a high priority, so it will be assigned to a different biologist.

Conclusions:
The Endangered and Nongame Species Program and its advisory Endangered and Nongame Species Advisory Committee have affirmed the Delphi technique (Clark et al. 2006) is an appropriate, objective method for determining species status, which should continue to be the method used by the Division.

Recommendations:
- Begin the administration of the status review of terrestrial nongame mammals, and a new review of select reptiles and amphibians. Complete the iterative assessment rounds as necessary to reach consensus on status of species under review.
- Compile the results of the Delphi process of review and present them to the Endangered and Nongame Species Advisory Committee for recommendations on new status assignments.
- Proceed with new status assignments through the regulatory (rulemaking) process.

LITERATURE CITED

Baker, A. J., P. M. González, T. Piersma, L. J. Niles, I. L. S. do Nascimento, P. W. Atkinson, N. A. Clark, C. D. T. Minton, M. K. Peck, and G. Aarts. 2004. Rapid population decline in red knot: fitness consequences of decreased refueling rates and late arrival in Delaware Bay. Proceedings of the Royal Society B 25:125-129.

Boulanger, J. R., L. L. Bigler, P. D. Curtis, D. H. Lein and A. J. Lembo Jr. 2006. A polyvinyl chloride bait station for dispensing rabies vaccine to raccoons in suburban landscapes. Wildlife Society Bulletin 34:1206-1211.

Bowden, Daniel. 2009. A Baiting Technique to Reduce the Prevalence of Raccoon Roundworm in Allegheny Woodrat Habitat. Unpublished report of Union College, Department of Biology. 18 pp.

Boyd, H. and T. Piersma. 2001. Changing balance between survival and recruitment explains population trends in Red Knots Calidris canutus islandica wintering in Britain, 1969-1995. Ardea 89: 301-317.

Brown, S., C. Hickey, B. Harrington, and R. Gill (eds.). 2001. *The U.S. Shorebird Conservation Plan, 2nd ed.* Manomet Center for Conservation Sciences, Manomet, MA.

Buech, R.B. and M.D. Nelson. 1991. How to create wood turtle nesting areas. US Department of Agriculture, Forest Service, North Central Forest Experiment Station, St. Paul, Minn. 12p.

Burger, J., M. Gochfeld, D. Jenkins, and F. Lesser. 2010 Effect of Approaching Boats on Nesting Black Skimmers (*Rynchops niger*) : Using Response Distances to Establish Protective Buffer Zones. J. of Wildlife Management. Pages 102-109.

Clark, K.E., J.A. Applegate, L.J. Niles, and D.S. Dobkin. 2006. An objective means of species status assessment: adapting the Delphi Technique. Wildlife Society Bulletin 34:419-425.

Clark, K.E., Y. Zhao, and C. Kane. 2009. Organochlorine pesticides, PCBs, dioxins, and metals in postterm peregrine falcon (*Falco peregrinus*) eggs from the Mid-Atlantic states, 1993–1999. Arch. Environ. Contam. Toxicol. 57:174-184.

Conway, C. J. 2005. Standardized North American Marsh Bird Monitoring Protocols. Wildlife Research Report #2005-04. U.S. Geological Survey, Arizona Cooperative Fish and Wildlife Research Unit, Tucson, AZ.

Espoz, C., Ponce, A., Matus, R., Blank, O., Rozbaczylo, N., Sitters, H.P., Rodriguez, S., Dey, A.D. & Niles, L.J. 2008. Trophic ecology of the Red Knot *Calidris canutus rufa* at Bahía Lomas, Tierra del Fuego, Chile. *Wader Study Group Bull.* 115(2): 69–76.

Hata D and E. Hallerman. 2010. 2009 horseshoe crab trawl survey: Report to the Atlantic States Marine Fisheries Commission Horseshoe Crab Technical committee. February 2010.

LoGuidice, Kathleen. 2000. *Baylisascaris procyonis* and the decline of the Allegheny woodrat (*Neotoma magister*). Ph.D. dissertation, Rutgers, The State University of New Jersey, 101pp.

LoGuidice, Kathleen. 2009. Unpublished report of Union College, Department of Biology. 1 pp.

Martin, W.H. 1992a. Phenology of the timber rattlesnake (*Crotalus horridus*) in an unglaciated section of the Appalachian Mountains. Pp. 259-277, *In* J.A. Campbell and E.D. Brodie, Jr. (eds.). Biology of the Pitvipers. Selva Press, Tyler, Texas.

McGowan, C.P., J.E. Hines, J.D. Nichols, J.E. Lyons, D.R. Smith, K.E.Kalasz, L.J. Niles, A.D. Dey, N.A. Clark, P.W. Atkinson, P.M. Gonzalez, H.P. Sitters, C.D.T. Minton, W. Kendall. In Review. Demographic consequences of migratory stopover: linking red knot survival to horseshoe crab spawning abundance.

McGowan, C.P. and T.R. Simons, 2005. A method for trapping breeding adult American Oystercatchers. Journal of Field Ornithology. 76(1): 46-49.

McGowan, E. 1993. Experimental release and fate study of the Allegheny woodrat (*Neotoma magister*). Unpublished report of New York State Department of Environmental Conservation, Endangered Species Unit. 15 pp.

Mengak, M. T., Butchkoski, C. M., Feller, D. J. and Johnson, S. A. 2008. Lessons from long-term monitoring of woodrat populations. *In* The Allegheny Woodrat: Ecology, Conservation and Management of a Declining Species, eds. J. D. Peles and J. Wright, pp. 109-125. Springer Science + Business Media, New York, NY.

Morrison, R. I. G. and B. A. Harrington. 1992. The migration system of the red knot *Calidris canutus rufa* in the New World. Wader Study Group Bulletin 64(Supplement): 71-84.

Morrison, R. I. G. and R. K. Ross. 1989. Atlas of Nearctic shorebirds on the coast of South America. 2 vols. Special Publication, Canadian Wildlife Service, Ottawa, Ontario. 325 p.

Mizrahi, David. New Jersey Audubon Society. Personal Communication. Fall 2007 summary of results from 2007 spring stopover of semipalmated sandpiper weight gains on Delaware Bay.

Niles, L. J., H. P. Sitters, A. D. Dey, A. J. Baker, R. I. G. Morrison, D. E. Hernandez, K. E. Clark, B. A. Harrington, M. K. Peck, P. M. Gonzalez, K. A. Bennett, K. S. Kalasz, P. W. Atkinson, N. A. Clark, C. D. T. Minton, C. Espoz, R. Matus N., I. L. Serrano. 2007. Status of the Red Knot (*Calidris canutus rufa*) in the Western Hemisphere. 287p. Prepared for US Fish and Wildlife Service, Ecological Services, Region 5, NJ Field Office, Pleasantville, NJ 08232.

Niles, L. J., H. P. Sitters, A. D. Dey, P. W. Atkinson, A. J. Baker, K. A. Bennett, R. Carmona, K. E. Clark, N. A. Clark, C. Espoz, P. M. González, B. A. Harrington, D. E. Hernández, K. S. Kalasz, R. G. Lathrop, R. N. Matus, C. D. T. Minton, R. I. G. Morrison, M. K. Peck, W. Pitts, R. A. Robinson & I. L. Serrano. 2008. Status of the Red Knot, *Calidris canutus rufa*, in the Western Hemisphere. *Studies Avian Biol.* 36: 1-185.

Niles, L.J., J. Bart, H. P. Sitters, A.D. Dey, K.E. Clark, P. W. Atkinson, A.J. Baker, K.A. Bennett, K. S. Kalasz, N. A. Clark, J. Clark, S. Gillings, A. S. Gates, P. M. Gonzalez, D. E. Hernandez, C. D. T. Minton, R. I. G. Morrison, R. R. Porter, R. K. Ross, and C. R. Veitch. 2009. Effects of Horseshoe Crab Harvest in Delaware Bay on Red Knots: Are Harvest Restrictions Working? Bioscience 59:153-164.

Niles, L.J., H.P. Sitters, A.D. Dey, N. Arch, P.W. Atkinson, V. Ayala-Perez, A.J. Baker, J. Buchanan, R. Carmona, N.A. Clark, C. Espoz, J.D. Fraser, P.M. Gonzalez, B.A. Harrington, D.E. Hernandez, K.S. Kalasz, R. Matus, B. McCaffery, C.D.T. Minton, R.I.G. Morrison, M.K. Peck, W. Pitts, I.L. Serrano, and B.D. Watts. Status of Red Knots *Calidris canutus* in the Western Hemisphere: February 2008–April 2010.

Niles, L.J., J. Burger, R.R. Porter, A.D. Dey, C.D.T. Minton, P.M. Gonzalez, A.J. Baker, J.W. Fox, and C. Gordon. First results using light level geolocators to track Red Knots in the Western Hemisphere show rapid and long intercontinental flights and new details of migration pathways. Wader Study Group Bulletin 117(2):123-130

Reinert, H.K. 1984b. Habitat separation between sympatric snake populations. *Ecology* 65(2): 478-486.

Smith, C. F. 2007. Sexual dimorphism, and the spatial and reproductive ecology of the copperhead snake, *Agkistrodon contortrix*. University of Connecticut, Ph.D. thesis. Pp. 201.

Smith, C. F., G. W. Schuett, R. L. Earley, and K. Schwenk. 2009. The spatial and reproductive ecology of the copperhead (Agkistrodon contortrix) at the northeastern extreme of its range. In press: 2010, Herpetologcial Monographs.

Steinkamp, M., B. Peterjohn, V. Byrd, H. Carter, and R. Lowe. 2003. Breeding Season Survey Techniques for Seabirds and Colonial Waterbirds throughout North America. February 13, 2003, Draft found at: http://www.waterbirdconservation.org/pubs/PSGManual03.PDF.