

**FY2013**  
**ANNUAL ACCOMPLISHMENTS REPORT**  
**FOR INVENTORIES AND VITAL SIGNS MONITORING**  
**NORTHEAST COASTAL AND BARRIER NETWORK (NCBN)**

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## **Northeast Coastal and Barrier Network FY 2013 Accomplishments Report**

The Northeast Coastal and Barrier Network (NCBN) includes eight parks located along the Atlantic coast from Massachusetts to Virginia: Cape Cod National Seashore (CACO), Fire Island National Seashore (FIIS), Sagamore Hill National Historic Site (SAHI), Gateway National Recreation Area (GATE), Assateague Island National Seashore (ASIS), George Washington Birthplace National Monument (GEWA), Thomas Stone National Historic Site (THST), Colonial National Historical Park (COLO). These parks represent some of the most ecologically similar collections of lands within the National Park Service. They consist of critical coastal habitat for many rare and endangered species, as well as migratory corridors for birds, sea turtles, and marine mammals. They also protect vital coastal wetlands, essential to water quality, fisheries, and the biological diversity of coastal, near shore, and terrestrial environments. All NCBN parks continue to be pressured by encroaching development, intense recreational activity, and now the effects of rapid climate change. Sea level rise, increased storm intensity, amplified variability in surface and groundwater levels, and ocean acidification are expected to be among the most pressing natural resource management challenges in the near future. In addition to the effects of climate change, being within the urban sprawl of the Northeast creates additional management pressure to monitor the condition of these sensitive and often last remaining pristine ecosystems.

The NCBN Inventory and Monitoring Program was developed to provide parks with credible, defensible scientific information that will help managers and scientists track the changes that occur in condition of a park's natural resources. As part of the National Park Service's original effort to "improve park management through greater reliance on scientific knowledge," the Cape Cod Ecosystem Monitoring (CCEM) program, an NCBN park, was established to develop and implement a long-term monitoring program that would serve to aid park managers in making sound stewardship decisions. The program at CACO was established in the early 1990's as one of the few "Prototype" parks tasked with developing a monitoring program for coastal parks. As part of this process, the CCEM program adopted an ecosystem-based, issue-oriented approach for monitoring ecosystem integrity, working closely in partnership with the USGS-Biological Resources Division. CCEM developed monitoring protocols based on the issues identified in Roman and Barrett's 1999 report *Conceptual Framework for the Development of Long-term Monitoring Protocols at*

*Cape Cod National Seashore*. Not long after, in 2000-2001, the NCBN Monitoring Program was established as part of the newly formed and funded NPS Inventory and Monitoring Program (NPS I&M). The NCBN program extended the Cape Cod CCEM program by building the Network monitoring plan on the same approach developed by Roman and Barrett for the additional seven network parks. Cape Cod National Seashore is one of the NCBN Program parks and shares the monitoring along with the seven other parks.

The following report provides a summary of accomplishments for FY13 on inventory and monitoring projects being developed and implemented by the NCBN program. Because the CACO CCEM program is a Network park and some monitoring is shared by CACO CCEM staff and Network staff, the CCEM annual accomplishments report is attached as an addendum to this report. In FY13, the network received a total of \$831,440, down \$42,760 from \$874,200; this includes \$750,500 reduced from \$790,000 in Vital Signs Monitoring funding, and \$80,940 down from \$84,200 from the NPS Water Resources Division. Cape Cod National Seashore received \$702,375 for the park's CCEM program.

### **FY13 Summary**

Vital Signs Monitoring continued in FY13 with salt marsh vegetation and nekton monitoring occurring at FIIS, including the WIFL unit, and SAHI. Three seasonal employees were hired to conduct the monitoring under the supervision of Network Biologist, Erika Nicosia. Sediment Elevation (SET) data was collected at 120 SET sampling locations, two times at each location during the year by NCBN biologist, Jim Lynch, with the assistance of other NCBN and park staff. SET data was collected in nine parks, including 2 parks (ACAD, BOHA) in the Northeast Temperate Network and 2 parks (NACE, GWMP) National Capital Region Network. Collaboration continued with NOAA and USGS scientist on the development of an SET monitoring protocol expected to be completed in 2014. The three agencies are working together to develop a protocol that can be adopted widely by other agencies, non-profits and institutions interested in monitoring surface marsh sediment elevation. Our new citizen science Marsh Bird monitoring program was implemented this year at COLO and CACO, and our partnership continued with the Saltmarsh Habitat & Avian Research Program (SHARP) that collected marsh bird data at CACO, FIIS, GATE and ASIS. The SHARP program was founded by a group of academic, governmental, and non-profit collaborators to provide critical information for the conservation of tidal-marsh birds. The NCBN continues to work closely with these partners to share data and develop a monitoring program with comparable goals, objectives and data collection methods.

The network also developed cooperative agreements with the University of Rhode Island (URI) for

herpetological inventories, the Virginia Institute of Marine Science (VIMS) and the Seagrass Ecology Lab at SUNY Stony Brook in New York for estuarine water quality and seagrass monitoring following the NCBN Estuarine Nutrient Enrichment protocol. Because NCBN parks were severely affected by Super Storm Sandy, funding was provided from Superstorm Sandy Recovery/Construction funds, to assure implementation of estuarine nutrient enrichment and seagrass monitoring for FIIS both 2013 and 2014 field seasons. SeagrassNet and bay-wide monitoring occurred at FIIS and ASIS to help evaluate the impacts of Super Storm Sandy on water quality in the bays. Ocean shoreline position monitoring continued during both fall 2012 and spring 2013 at FIIS, GATE, ASIS, GEWA, SAHI and CACO, following the network's published protocol. Additional SET data was collected for each of our sites on FIIS, GATE and ASIS immediately following Super Storm Sandy to help to evaluate any changes that may have occurred as part of the storm. This year we also partnered with Rhode Island Coastal Management program and the Salem Coast Watch in MA, to learn about marine invasive species and how to monitor them. A number of resource briefs were developed to provide parks and the public information on existing and new species.

## **I. NCBN Accomplishments**

### **Inventories**

- NatureServe continues to work on the vegetation mapping report for ASIS. All other products for ASIS are complete; NCBN staff are working closely to assist the cooperator in completing the report. A conference call was held in September 2013 with the cooperators to discuss finalizing the project.
- NCBN helped support the continued box turtle inventory/monitoring being conducted at FIIS (WIFL estate) by University of Rhode Island scientist, Nancy Karraker. Over 139 turtles were captured and marked during a 3-week period during the summer of 2013. Almost half of them were new individuals.

### **Inventory products**

- The GATE Breeding Bird Surveys report was formatted for publication into the NPS Natural Resource Technical Report (NRTR) series. The report and data products were posted to the IRMA Data Store. (Products are posted as NPS-only due to sensitivity; general project description at <https://irma.nps.gov/App/Reference/Profile/2195480>)
- A final NRDT Access database for the Synthesis of Existing Bird Data for ASIS was formatted and posted to the IRMA Data Store. (NPS-only due to sensitivity <https://irma.nps.gov/App/Reference/Profile/2194405>.)

## **NCBN Vital Signs Monitoring**

### **Forest health monitoring** (GEWA, THST, SAHI, COLO)

- A four-person field crew shared with MIDN and NETN conducted forest health monitoring at four NCBN parks (GEWA, THST, COLO, SAHI).
- Twelve new plots were established in COLO and eight plots established in 2009 were resampled in the remaining parks.
- Natural Resource Data Series Report for the 2012 field season and two resource briefs for COLO, GEWA and THST. Spatial and biological data finalized and posted to IRMA.

### **Ocean shoreline position monitoring** (FIIS, ASIS, CACO, GATE, GEWA, SAHI)

- Shoreline monitoring (1D) continued to be collected by NCBN and Park Staff for fall and spring shorelines at ASIS, CACO, GATE, SAHI, GEWA, and FIIS, following the NCBN Geomorphological Monitoring Protocol-Phase I Shoreline Position.
- CACO and the NCBN data manager compiled multi-year CACO shoreline position protocol data.
- Rutgers cooperators completed 1D, 2D, and 3D surveys at GATE in Fall 2012 and Spring 2013.
- NCBN staff and cooperators continued to interact with refuges in Region 5 USFWS to apply the Shoreline Position and Coastal Geomorphological Protocols. Andrea Spahn, in partnership with refuge staff, completed the 1D shoreline position and 2D Profile surveys for the Fall 2012, Spring 2013 and Fall 2013 seasons at Back Bay Wildlife Refuge, Edwin B Forsythe Wildlife Refuge, and Fisherman Island Wildlife Refuge. In total, 11 refuges in the northeast are using Part I: Shoreline Position protocol at the refuge and submitting the data to a designated data manager. In 2013, NCBN, Rutgers cooperators conducted a workshop on the application of the 1D Shoreline Position protocol at the Stewart B McKinney Wildlife Refuge in Connecticut.
- Conducted 1D, 2D, and 3D surveys at GATE in Fall 2012, Spring 2013, and Fall 2013. In addition, post Sandy surveys were conducted as soon as possible in Gateway. Sandy hit the area toward the end our Fall 2012 survey season, so much of, but not all pre-storm data had already been collected.
- Maintained survey monuments throughout GATE. As a result of Sandy, monuments are in the process of being replaced and moved to more secure infrastructure.
- The Northeast Coastal and Barrier Network Geomorphological Monitoring Protocol: Part III - Coastal Digital Elevation Models in Areas of Special Interest is moving forward. Eight of the nine Standard Operating Procedures have been written and are under review in-house.
- Data for the Sandy Hook Unit 2012 Annual Report on the Critical Zone and Gunnison

Beach were synthesized for the parks and included in the 2012 Sandy Hook Annual Report.

- As a component of the coastal topography monitoring program for summer 2013, two GeoCorps interns were selected from a national pool of applicants and stationed at Sandy Hook, GATE, to work on NCBN coastal geomorphology monitoring projects.
- The NCBN coastal geomorphological monitoring team was very busy this year because of responses to calls for assistance and information relating to Superstorm Sandy.

#### **Coastal topography monitoring (FIIS, ASIS, CACO, GATE, GEWA)**

- In FY13, three GeoCorps interns were sited at Sandy Hook to work on aspects of the coastal geomorphological monitoring program conducted throughout the NCBN, one of the interns was on a continuation appointment from the previous year, one of the interns was on a 'diversity appointment'. The interns assisted in conducting 1D, 2D, and 3D field surveys with GPS equipment according to established protocols, and they also assisted in data processing and data analysis in the production of annual and trend reports for Gateway NRA, Fire Island National Seashore, and Assateague Island National Seashore.
- The 2010-2011 & 2011-2012 2D Profile Coastal Topography Annual Technical Report and synthesis for Gateway was completed.
- The data synthesis for the 2012-2013 Gateway Annual Report for 1D Shoreline Monitoring & 2D Profiles is currently underway. This report will include effects of Superstorm Sandy on Gateway.
- ASIS GIS staff continued coastal topography monitoring, conducting both spring and fall surveys, and submitted the data to the NCBN for archiving.
- The NCBN data manager continued database development in support of the NCBN Coastal Topography Monitoring program.
- CACO staff worked with Provincetown Center for Coastal Studies including short term monitoring to document variations in geomorphology due to tidal cycles. Collected field data for coastal elevation profiles in support of 3D coastal monitoring protocol.

#### **Marsh Bird monitoring (NCBN, NETN, NCRN coastal parks)**

- NCBN Data Manager and Marsh Bird Project Lead began development of the NCBN Marsh Bird Monitoring Database, following NRDT guidelines and utilizing the I&M Front-end Application Builder (FAB).
- NCBN continued collaboration with the University of Rhode Island to adapt the USGS marshbird monitoring protocol to the NCBN monitoring program. A completed protocol is due to be published in FY14.
- Marsh bird monitoring was conducted by a combination of volunteers, park staff, and partners at ASIS, GATE, FIIS, ACAD, and CACO sampling sites in conjunction with a regional partnership effort investigating marsh bird populations throughout the northeast

(SHARP, <http://www.tidalmarshbirds.org/>). A preliminary recon was conducted at some of the sites at GATE and FIIS, but will need to be re-visited because of the damage sustained from hurricane Sandy.

- The NCBN Marsh Bird Monitoring Program was implemented at COLO this year. The NCBN Marsh Bird Monitoring Lead trained 3 volunteers from the Williamsburg area and staff from COLO on how to collect marsh bird and vegetation data (classroom & field work). Data was collected at COLO April-July, 2013.
- The NCBN Marsh Bird Monitoring Program was also implemented at CACO this year, pilot testing the new sampling design. The marsh bird monitoring lead conducted the survey from May-July, 2013 along with volunteers.
- NCBN staff also assisted the SHARP program technician in conducting surveys at CACO (Nauset Marsh).
- All data sheets were scanned and archived following the field season.

**Salt marsh vegetation and nekton monitoring** (*FIIS (WIFL included), SAHI*)

- 2013 was the third year that salt marsh monitoring was conducted at FIIS and SAHI (initiated in 2009).
- One Pathways Intern (East Carolina University graduate student), and 2 Biological Science Technicians were stationed at FIIS and completed the sampling under the supervision of NCBN staff. Data entry for the 2013 field season has been completed. Data are currently undergoing quality control procedures prior to analysis for the annual data summary reports.
- All data from the 2012 sampling season at ASIS, COLO, GEWA, and GATE-SHU have been summarized in the annual data summary reports for each park.
- CACO nekton sampling was accomplished by the park's CCEM program. CACO estuaries sampled in 2013 included: East Harbor, Moon Pond, Hatches Harbor, Nauset Marsh, and West End Marsh. QA/QC of 2013 data is being finalized.
- Salt marsh vegetation and various environmental parameters were sampled in 8 CACO marshes, including both tidally-restricted and unrestricted sites. The surveys were conducted as part of CACO's ongoing I&M protocol for salt marsh vegetation, which calls for monitoring every 5 years. The data will be compared with previous surveys conducted in 2003 and 2008 and the results summarized in a technical report to be completed in 2014.
- NCBN staff and USGS scientists received funding from USGS NPMP for a project entitled "Development of a Multimetric Index for Integrated Assessment of Salt Marsh Condition in the Northeast Coastal and Barrier Network." This is a three year project.

**Salt marsh elevation monitoring** (*NCBN Parks CACO, GATE, FIIS, ASIS, COLO; NETN Parks ACAD, BOHA; NCRN Parks NACE, GWMP*)

- The NCBN SET monitoring lead continued the bi-annual salt marsh elevation monitoring (accretion and elevation change) and other related activities at salt marsh surface sediment elevation table (SET) stations at NCBN, NETN, and NCRN sites.
- The 86 SET monitoring stations at five NCBN parks (GATE, FIIS, CACO, ASIS, COLO) were sampled in the fall and spring in FY13.
- At CACO, 6 new SET's were installed in July of 2013. This is the first round of upgrades to the SETs at CACO.
- The 19 SET stations at two NCRN parks (NACE, GWMP) were sampled in the fall and spring of FY13 in collaboration with NCRN colleagues.
- The 21 SET stations at two NETN parks (BOHA, ACAD) were sampled in the fall and spring of FY13 with the support of NETN colleagues.
- CACO staff Assisted James Lynch with QA/QC of all CACO salt marsh elevation data from 1998 through present. All data sets from all years were evaluated in a systematic way in order to ensure confidence in the long-term data trends.
- CACO staff analyzed all data from all years to calculate an annual rate of change in marsh surface elevations of three systems (Hatches Harbor, Herring River and Nauset Marsh).
- Water level recorders were deployed at GWMP, COLO, ASIS, GATE, FIIS, CACO, BOHA and ACAD during FY13. These are being used to characterize the tidal patterns and differences in marsh flooding at the various SET sampling stations within each park.
- In response to the impacts of hurricane Sandy in the fall of 2012: NCBN re-measured all SETs at ASIS, FIIS and GATE in November and December of 2012 to quantify any impacts from the hurricane on marsh elevation and accretion. Staff participated in a GPS survey of the first floor elevations of all critical buildings and structures managed by Gateway National Recreation Area in June 2013. This project obtained first floor elevations for most of the 600 buildings and structures in Gateway. This project was expanded to also include the Statue of Liberty and Ellis Island. Data from this survey is being used for updating flood maps for the parks?.
- Work on the SET monitoring protocol continued in FY13. NCBN staff collaborated with colleagues and co-authors Dr. Don Cahoon (USGS) and Dr. Philippe Hensel (NOAA) via conference call, email, and face-to-face meetings to develop the main text and standard operating procedures for the protocol.
- NCBN, NCRN, and NETN data managers worked on the design and implementation of the SET database.
- Conducted an RTK GPS survey of five SET sites around New York City for the Forestry, Horticulture and Natural Resources Group of the New York City Parks and Recreation Department. The NYC parks department has SETs at five locations throughout New

York City. The NPS provided equipment and personnel to obtain accurate elevations of the marshes where SET measurements are being taken.

- NCBN staff assisted NPS colleagues with the establishment of a NOAA water level gauge located at Assateague Island National Seashore. The gauge is being installed for one year to characterize the flooding patterns on the backside of Assateague Island. Data will be used to update the tidal datums in the park.

### **NCBN Water Quality Monitoring**

Funds transferred to the NCBN from the Water Resources Division paid for approximately one third of the NCBN water quality monitoring effort in FY13. CCEM staff continue to collect water quality data at CACO following the NCBN Estuarine Nutrient Enrichment (ENE) monitoring protocol. NCBN provides equipment support as needed to CACO, and, in return, the park continues to handle the analysis of all NCBN chlorophyll *a* samples.

### **Estuarine nutrient enrichment (ENE) monitoring** (*FIIS, CACO, GEWA, COLO, ASIS*)

- NCBN staff continued to work with USGS scientists on the NCBN estuarine water quality analysis and synthesis project funded through the USGS NPMP. The project working group made significant gains toward certifying all NCBN water quality data to standards specified in the network protocol and completing the development of new water quality data analysis and summary tools. Products for this project will be delivered to the NCBN in 2014.
- NCBN collaborators from the Virginia Institute of Marine Sciences (VIMS) continued to collect water quality data for the NCBN based on the network's Estuarine Nutrient Enrichment (ENE) protocol.
- The monitoring index period at GEWA occurred during the four week period of July 10-August 2, 2013. A continuous water quality monitoring station was deployed from July 10, 2013 to August 8, 2013. The logging station was removed and returned to the lab once during the index period for recalibration and maintenance (July 23- July 24). Cleanings occurred in the field during the Week 2 and Week 4 samplings. Chlorophyll samples were sent to Cape Cod National Seashore North Atlantic Coast Laboratory for analyses. Results were returned to VIMS and NCBN. Digital copies of all data were created. All data collected at GEWA will be submitted to the NCBN Estuarine Nutrient Enrichment Database in early 2014.
- All data collected from the ASIS 2012 and the COLO 2012 sampling events were entered and submitted into the NPS database in April, 2013.
- Stony Brook University (SBU) collaborators completed the four week monitoring index period from July 2, 2013 to July 22, 2013 at GATE. A continuous water quality monitoring station was deployed and maintained by SBU staff during this index period.

Chlorophyll samples were processed and sent to Cape Cod National Seashore North Atlantic Coast Laboratory for analyses. Results have been returned to SBU.

- CACO staff conducted the ENE monitoring during four-week index periods for each of three strata within CACO (Pleasant Bay, Nauset Marsh, and salt ponds). All 2012 data were entered into the NCBN database.
- CACO Physical Scientist completed chlorophyll analyses for CACO, as well as NCBN parks ASIS, COLO, and GATE for the ENE protocol in 2013. CCEM & NCBN chlorophyll analyses, equipment calibrations, and data analysis/management were conducted according to the provisions of the protocol. All data and controls were submitted to the respective cooperators as well as the NCBN Program and Data Managers.
- In 2012, additional surface water samples were collected during each sampling event and were analyzed by CACO Physical Scientist at the Atlantic Research Center's analytical lab for dissolved and total nutrients (NO<sub>3</sub>, NH<sub>4</sub>, PO<sub>4</sub>, total P, and total N). These nutrients analyses were completed for all FY12 water samples in FY13 (110 samples).

#### *Seagrass monitoring (CACO, ASIS)*

- All final data from the 2012 SeaGrass Net samplings were added to the NPS database and SeagrassNet data base by January of 2013 for ASIS.
- To better evaluate the cause and effect of stressors, especially those related to climate change, two additional SeagrassNet surveys, other than yearly summer sampling, occurred during the year at ASIS.
- VIMS personnel travelled to ASIS and successfully performed a fall, spring, and summer SeagrassNet survey. The fall field survey occurred on October 7-9, 2012, the spring survey on April 14-16, 2013 and the summer survey on June 24-26, 2013. Biomass samples were collected and processed. TidbiT (Onset, Inc.) temperature loggers were retrieved and new ones deployed. Sediment and voucher specimens were also collected. An additional trip was conducted in January 24, 2013 in order to switch out the TidbiT temperature loggers. A continuous water quality monitoring station was also deployed and maintained by the Assateague Island National Park Service staff during each of the survey periods.
- Stony Brook University collaborators successfully performed the summer SeagrassNet survey on July 24, 2013 for FIIS. Biomass samples were collected and processed. HOBO temperature loggers were deployed on the day of the SeagrassNet survey and retrieved on August 12, 2013. All data was digitized, but has yet to be added to the SeagrassNet data base.
- In 2011, Stony Brook University collaborators convinced the NY Seagrass Taskforce to fund the purchase of three self-wiping PAR sensors and a Trilogy fluorometer with

modules to measure both Chl a and CDOM. It is the intention to use the fluorometers in combination with the FIIS water quality monitoring program to create a Zostera Bio-Optical model for FIIS. In addition, the self-wiping PAR sensors will provide insight into how the new inlet created by Superstorm Sandy is impacting light levels to the seagrass resources in proximity to the FIIS breach.

- Monitoring by CACO staff in cooperation with Dr. Hilary Neckles continued at CACO in Pleasant Bay and Duck Harbor for the eleventh consecutive year following the NCBN protocol. All 2013 data were entered into the NCBN database.
- CACO staff worked in collaboration with USGS researcher Hilary Neckles to complete a system-wide survey of seagrass distribution in Pleasant Bay.

#### **Marine Invasive Species Monitoring (CACO, GATE, FIIS, ASIS)**

- Five Resource Briefs were developed for identification of marine invasive species
- NCBN staff collaborated with Rhode Island CRMC and Salem Coast Watch to learn about invasive species monitoring protocols and how they might be applied to NCBN parks as a citizen science monitoring program.
- NCBN staff presented *Marine Invasive Species Monitoring in the National Parks*, to 2 local schools Rhode Island public schools.

#### **NCBN Data Management, Information Transfer, and Support to Park Management and the Public**

- The NCBN website was transitioned to a new I&M network template in FY13, bringing the site more in line with NPS-wide web standards. The NCBN data manager collaborated closely with WASO staff to complete the conversion and took advantage of the opportunity to implement an enhanced methodology for archiving/disseminating NCBN reports and data products utilizing REST services and IRMA bibliographic widgets. Saved IRMA searches and collections were created for each NCBN inventory project and monitoring program, allowing for automatic website updates when new content is posted. These enhancements were featured in subsequent I&M training webinars.
- NCBN data management / GIS staff were recognized for providing data and GIS assistance for post Hurricane Sandy recovery efforts. Staff served as part of a team of NER GIS specialists surveying first-floor elevations of 500+ historic structures and other natural and cultural resources at GATE, STLI, and Ellis Island.
- The Data Manager Performed LiDAR data mining activities in support of Sandy recovery initiatives, obtaining, evaluating, and distributing LiDAR data from USGS cooperators, parks, and other sources.
- The NCBN Data Manager co-taught a graduate-level course on the theory and application of

Global Positioning System (GPS) technology for the University of Rhode Island's Natural Resources Science Department during the spring 2013 semester. The course offers a hands-on introduction to the use of GPS for navigation and data-collection.

- NCBN Data Manager served a second year as the I&M Program representative to the NPS GIS Council (GISC), where he represents the geospatial needs of the 32 I&M Networks to the council and provided insight on the needs and direction of Network monitoring activities. The Data Manager participated in monthly conference calls, served on committees, and participated (via polycom) in the GISC annual meeting in August 2013.
- NCBN staff collaborated with USGS scientists on two NPMP funded projects. The NCBN Data Manager provided GIS expertise in support of a project examining Estuarine Water Quality in Relation to Watershed Characteristics in Northeastern National Parks, as well as aided in compiling and organizing the Network's salt marsh monitoring data in support of a project developing a multimetric index for integrated assessment of salt marsh condition.
- In collaboration with USGS and CACO partners, the Data Manager formatted and provided Virginia Department of Environmental Quality (VA DEQ) with all certified ENE water quality monitoring data for COLO and GEWA, including in-depth metadata regarding sampling processing techniques.

## **II. Public Interest Highlights**

### **After the fact: Baseline data and protocols assist Sandy recovery efforts**

Late last October, Super Storm Sandy drastically impacted coastal parks in the Northeast such as Gateway National Recreation Area (GATE) and Fire Island National Seashore (FIIS) when it rolled up the Eastern Seaboard, making landfall in New Jersey and New York. Scientists tell us that we can expect more of the same as sea-levels rise and storm frequencies and intensities increase with climate change. For a number of years now, the Northeast Coastal and Barrier Network (NCBN) has been collecting shoreline and coastal topography data in its parks, and these baseline data have proven invaluable in helping park and regional staff to evaluate the extent of change caused by Sandy. These data are being used in many ways to inform subsequent management responses and mitigation planning efforts in these parks. The value of long-term monitoring is not only proven to be essential and effective in measuring baseline information to best understand and further our knowledge of ecosystem dynamics and change, but also in its necessity in management and mitigation practices in the parks.

## **Looking SHARP: a Collaborative Marsh Bird Monitoring Program**

In 2010, a group of individuals representing academia, governmental and non-governmental agencies formed the Saltmarsh Habitat & Avian Research Program (SHARP). SHARP was created in order to gather vital information for the conservation of tidal marsh birds that utilize this rare and extremely bio-diverse habitat to breed, forage and over-winter. The U.S. Department of the Interior reported a loss of over 28,000 acres of intertidal wetlands occurring from 1998 to 2004 across the country. Current estimates indicate a 0.5%-1.5% annual loss of tidal wetlands from accelerated sea level rise alone. Flooding is one of the major threats to the reproductive success of marsh-breeding species. With predictions of rapid sea level rise, increased frequency of storm surges, and increased marsh inundation, these species have become an important indicator of tidal marsh health.

Although many species of birds utilizing these marshes will be affected by the loss and degradation of the habitat, the salt marsh sharp-tailed sparrow (*Ammordramus caudatus*) is especially vulnerable and is currently listed as a "species of conservation concern" for the U. S. Fish and Wildlife Service, as well as in the states of Georgia, Maryland, New York, South Carolina, and Virginia.

For the last three years, the NCBN has collaborated and participated with the SHARP monitoring program. This spring NCBN initiated a long-term marsh bird monitoring program in two of its eight parks, Cape Cod National Seashore and Colonial National Historical Park. The monitoring program enlists the help of park personnel, along with local volunteers who go out to the marsh once a month from May through July to conduct the point count and call-back survey. The current plan is to continue to add more NCBN parks in the spring of 2014.

## **Marine Invasive Species: Do we know what's here?**

The invasion of introduced species is well documented in the terrestrial world. Funding has been targeted towards monitoring, eradication and control of many of these plant, insect and animal species. Emerging though, as one of the leading environmental threats to coastal and marine habitats and resources, is the invasion of aquatic species from around the world. To develop an understanding of the extent and impacts of marine biological invasions, efforts need to be focused on the invasion of these species in our coastal areas. In recognition of this, the Salem Sound Coastwatch (SSCW), with the assistance of the Massachusetts Office of Coastal Zone Management (CZM), developed methods and protocols for monitoring marine invaders along the New England

coast. A Citizen's Guide to Monitoring Marine Invasive Species was developed to provide the information necessary to become a member of a volunteer monitoring team or to initiate a marine invasive species monitoring programs for citizen scientists and students.

This year, Northeast Coastal and Barrier Network staff worked with a biologist from the Rhode Island Coastal Resources Management Zone to learn about the state's marine invasive species monitoring program which utilizes the Salem Sound Coastwatch protocol, in order to evaluate how the program might be implemented in NCBN parks. As part of this collaboration, both groups worked with a local student intern to develop interpretive information on particular invasive species or groups of species that can be provided to park staff and the public. As part of the effort, NCBN staff also met with biologists from the Cape Cod Ecosystem Monitoring program and scientist specializing in marine invasive species from the Woods Hole Oceanographic Institute, to begin to identify species found in the National Seashore. Early detection of new introductions is critical to prevent further loss of biodiversity, negative impacts to coastal and marine industries, and costly control programs in the future. The NCBN will be developing ways to educate park staff and interpreters on monitoring marine aquatic invasive species in their parks, and how to engage citizens in the monitoring efforts.

### **Seagrass Monitoring Documenting Change**

The Northeast Coastal and Barrier Network has been monitoring Seagrass in the Chincoteague Bay for over 8 years in collaboration with the Dr. Ken Moore from the Virginia Institute of Science (VIMS). As part of the Network's long-term monitoring program, Seagrass was identified as a key indicator of estuarine health and water quality. VIMS scientists have recently described the current status of populations in Chincoteague Bay and other coastal Bays along the Delmarva Peninsula of Maryland and Virginia. SeagrassNet sampling conducted by the NPS/VIMS collaboration, has demonstrated significant diebacks of the dominant species, *Zostera marina*. Monitoring documented this in 2011 in Chincoteague Bay, occurring after an unusually hot summer in 2010. Some regrowth of *Z. marina* has been measured since then, along with the expansion of *Ruppia maritima*, which is a more temperature tolerant species that is also found to co-occur in these populations. Since Chincoteague Bay has more restricted tidal flushing compared to more southern lagoon systems in Virginia that are often flooded by cooler coastal waters, more frequent high

summer temperature events will continue to stress *Z. marina*, potentially resulting in a change in dominant species in the bay.

### **NCBN Estuarine Nutrient Enrichment and Seagrass Monitoring help to document changes in Water Quality in the Great South Bay due to Superstorm Sandy**

During Hurricane Sandy in October 2012, the barrier island unit of Fire Island National Seashore was breached in three areas, connecting the Atlantic Ocean to the Great South Bay of Long Island. Since the storm, two of the breaches have been mechanically closed or filled in, but the NPS has kept the breach at Old Inlet open, which has become quite a controversial topic. Debates have arisen over the effects of the breach on the Great South Bay – its marine life, water quality, and water levels, and on a politically controversial side, whether or not it will cause increased flooding in towns along Long Island’s South Shore.

From a scientific point of view, many see the breach as a great opportunity to better understand the natural processes and effects island breaching has on an ecosystem. For the Northeast Coastal and Barrier Network, this is an opportunity to demonstrate the usefulness in collecting long-term datasets and their use in future management decisions. As part of Hurricane Sandy funding, the NCBN in collaboration with scientists from Stony Brook University who will collect water quality and seagrass monitoring data over three consecutive years following the hurricane (2013-2015). The NCBN typically collects these data every 2 years, but this increase in data collection frequency will allow for better analysis of how water quality and habitats within the bounds of Fire Island National Seashore have changed pre and post Hurricane Sandy as a result of the Old Inlet breach.

### **III. Staffing**

#### **NCBN Board of Directors**

Deborah Dardin, ASIS  
George Price, CACO  
P. Daniel Smith, COLO  
Chris Soller, FIIS  
Jennifer Nersesian, GATE  
Lucy Lawliss, GEWA/THST (current acting Tarona Armstrong)  
Tom Ross, SAHI (Kelly Fuhrman-new superintendent due Nov. 2013)  
Sara Stevens, NCBN Program Manager

Mary Foley, Chief Scientist Northeast Region  
John Karish, I&M Program Manager Northeast Region (current acting- Jim Comiskey)

**Northeast Coastal and Barrier Network Staff**

Sara Stevens-NCBN Program Manager  
Dennis Skidds-NCBN Data Manager  
Erika Nicosia-NCBN Biologist (Salt Marsh)  
James Lynch-NCBN Biologist (SET)  
Dana Filippini-NCBN Biological Science Technician (Marsh birds)  
Casey Nolan, Pathways student-seasonal (Marsh monitoring)  
Michael Scott-NCBN Seasonal (Marsh Monitoring)  
Erica Brown-NCBN Seasonal (Marsh Monitoring)  
Michael Towle-GeoCorp Intern  
R. Tucker Fullmer-GeoCorp Intern  
Carlos Carvajal-GeoCorp Intern

**NCBN Technical Steering Committees**

*Note:* The original NCBN Technical Steering Committee has been disbanded and new “protocol” specific technical steering committees are being developed for: shoreline monitoring, salt marsh monitoring, and water quality monitoring.

**Estuarine Water Quality Monitoring Members:**

Sophia Fox, CACO (Lead)  
Kelly Medieros, CACO  
Penelope Pooler, NCBN  
Sara Stevens, NCBN  
Dennis Skidds, NCBN  
Hilary Neckles, USGS  
Kenneth Moore, VIMS  
Brad Peterson, SUNY  
Brian Sturgis, CACO

**SET Monitoring**

James Lynch, NCBN (Lead)  
Sara Stevens, NCBN  
Geoff Sanders, NCRN  
Phillipe Hensel, NOAA  
Don Cahoon, USGS  
Charles Roman, NPS CESU  
Bill Thompson, USFWS  
Sue Adamowicz, USFWS  
Bill Crouch, USFWS  
Laura Mitchell, USFWS

**Salt Marsh Vegetation and Nekton Monitoring (initial invitees)**

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(Group has not met yet)  
Erika Patenaude, NCBN (Lead)  
Sara Stevens, NCBN  
Charles Roman, NPS CESU  
Mary-Jane James-Pirri, URI  
Megan Tyrell, CACO

#### **Key NCBN Contractors and Cooperators**

Dr. Norbert Psuty, Rutgers University, Institute of Marine and Coastal Sciences (NCBN Geomorphological monitoring protocols, data collection and reporting and analysis)  
Dr. Hilary Neckles, USGS Patuxent Wildlife Research Center, Augusta, ME (ENE and Seagrass monitoring and assistance)  
Dr. Nancy Karraker and Research Assistant Robin Baranowski, University of Rhode Island, (Herp Inventories and Box Turtle monitoring).  
Dr. Peter August (NRS faculty), Research Associates Charles LaBash, Roland Duhaime, Mike Bradley, Aimee Mandeville, and Greg Bonyng. University of Rhode Island, URI Environmental Data Center (GIS, Data Mgt Support/Elevation monitoring)  
Dr. Brad Peterson, State University of New York, Stony Brook, School of Marine and Atmospheric Science (ENE monitoring FIIS/GATE)  
Dr. Kenneth Moore and Betty Neikirk Virginia Institute of Marine Science (ENE monitoring ASIS, GEWA, COLO)  
Dr. Bill Monahan, NPS Inventory and Monitoring Division (ENE monitoring data synthesis)  
Andrew Neil (MESM Student), University of Rhode Island (tidal datum analysis)  
Dr. Dave Ullman, University of Rhode Island (tidal datum analysis)  
Dr. Phillippe Hensel, NOAA-National Geodetic Survey (SET and salt marsh elevation protocol development)  
Dr. Don Cahoon, USGS (SET and salt marsh elevation protocol development)  
Dr. Mary Jane James-Pirri, URI (Coastal Park Condition Assessments/Salt Marsh Monitoring)  
Dr. John Kiddon, U.S. Environmental Protection Agency (ENE monitoring data synthesis)  
Dr. Jim Caldwell, USGS (ENE monitoring data synthesis)  
Dr. Charles Roman, NPS CESU (Salt Marsh Monitoring)  
Dr. Greg Shriver, University of Delaware (SHARP Program-Marsh Bird Monitoring)

#### **IV. Reports, Publications, and Presentations (FY13)**

##### **NCBN**

Comiskey, J. A. 2013. Forest vegetation monitoring: Mid-Atlantic Network 2012 summary report. Natural Resource Data Series NPS/MIDN/NRDS—2013/555. National Park Service, Fort Collins, Colorado.

Hart T E and Others. 2013. Priority data on marine and estuarine resources within northeastern National Parks: Inventory and acquisition needs. Natural Resource Report. NPS/NCBN/NRR—2013/612. National Park Service. Fort Collins, Colorado. Published

Report-2192248

- James-Pirri M. 2013. Natural resource condition assessment for Sagamore Hill National Historic Site. Natural Resource Report. NPS/NCBN/NRR-2013/617. National Park Service. Fort Collins, Colorado. Published Report-2192714
- Neckles, H.A., J.M. Caldwell, J. Kiddon, M. Nixon, B. Monahan, P.S. Pooler, D. Skidds, S. Fox. 2013. Estuarine Water Quality Monitoring in Northeastern U.S. National Parks: Integration at Local and Regional Scales. Coastal and Estuarine Research Federation Conference, November 3-7, San Diego, CA. Abstract submitted for oral presentation in FY2014.
- Neckles, H.A., J.M. Caldwell, J. Kiddon, B. Monahan, P.S. Pooler, D. Skidds, S. Fox. 2013. Estuarine Water Quality in Relation to Watershed Characteristics in Northeastern National Parks. George Wright Society Conference, March 11-15, Denver, CO.
- Nicosia E. L. 2013. Monitoring salt marsh vegetation at George Washington Birthplace National Monument: 2012 summary report. Natural Resource Data Series. NPS/NCBN/NRDS—2013/442. National Park Service. Fort Collins, Colorado.
- Nicosia, E. L. 2013. Monitoring salt marsh vegetation at Colonial National Historical Park: 2012 summary report. Natural Resource Data Series NPS/NCBN/NRDS—2013/444. National Park Service, Fort Collins, Colorado.
- Nicosia, E. L. 2013. Monitoring salt marsh vegetation and nekton at Gateway National Recreation Area's Sandy Hook Unit: 2012 summary report. Natural Resource Data Series NPS/NCBN/NRDS—2013/458. National Park Service, Fort Collins, Colorado.
- Nicosia, E. L. 2013. Monitoring salt marsh vegetation and nekton at Assateague Island National Seashore: 2012 summary report. Natural Resource Data Series NPS/NCBN/NRDS—2013/655. National Park Service, Fort Collins, Colorado.
- Orth, R.J., Professor VIMS presented talk to the Virginia Marine Resources Commission on seagrass status and trends in Chincoteague Bay on Dec 10, 2012 (Use of NCBN Seagrass Monitoring Data)
- Orth, R.J. Status and recent trends of seagrass populations in the Delmarva Coastal Bays region. Public Meeting of the Virginia Marine Resources Commission, December 10, 2012. Newport News Virginia. (Use of NCBN Seagrass Monitoring Data)
- Patenaude, E. 2012. Long-term monitoring of salt marsh condition in National Parks on the Atlantic Coast. 6th National Conference on Coastal and Estuarine Habitat Restoration. Tampa Convention Center, October 20-25, 2012. (Presentation)
- Psuty N. P., T. M. Silveira, A. Love. 2013. Shoreline change along Fire Island National Seashore: annual monitoring report, 2007-2008 (revised). Natural Resource Data Series NPS/NCBN/NRDS—2013/450. National Park Service, Fort Collins, Colorado.
- Psuty, N. P., October 9, 2012. Sediment Management: A Recurring Theme and Some Potential  
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- Unique Approaches. Liverpool Hope University, University Lecture Series, Liverpool, England (Presentation)
- Psuty, N. P., Oct 22, 2012. Erosion as a Coastal Hazard. Liverpool Hope University, Dept. of Geography Lecture, Liverpool England. (Presentation)
- Psuty, N. P., July 24, 2013. Coastal Geomorphology at Aviator Road, Floyd Bennett Field, GATE. (Presentation)
- Psuty, N.P., M. Patel, J. Freeman, W. Schmelz, W. Robertson, and A. Spahn (under review). Development of the Geomorphological Map for Fire Island National Seashore: Principal Characteristics and Components. Natural Resource Report, National Park Service (unassigned),
- Psuty, N.P., W. Hudacek, J. Gagnon, J. McDermott, M. Towle, W. Robertson, A. Spahn, M. Patel, (in press) Development of the Geomorphological Map for Sagamore Hill National Historical Site: Principal Characteristics and Components. Natural Resource Report, National Park Service, (unassigned).
- Psuty, N.P., T.M Silveira, A. Spahn, and D. Skidds, 2012. Northeast Coastal and Barrier Network Geomorphological Monitoring Protocol: Part II – Coastal Topography. Natural Resource Report NPS/NCBN/NRR —2012/591. National Park Service, Fort Collins, Colorado, 162 p.
- Psuty, N. P., W. Schmelz, M. Towle, A. Spahn. February 2013. Gateway National Recreation Area: Shoreline Change Trend Report, 2007-2012 (DRAFT). Submitted to the Northeast Coastal and Barrier Network, National Park Service, 24 p.
- Psuty, N. P., W. Schmelz, A. Spahn. May 2013. Monitoring Shoreline Changes Sandy Hook Unit, Gateway National Recreation Area, Report on Survey Period 2011-12. Submitted to Division of Natural and Cultural Resources, Gateway National Recreation Area, 33 p.
- Psuty, N. P., W. Schmelz, A. Spahn, September 2012. Coastal Profile Changes, Gateway National Recreation Area: Annual Monitoring Report, 2010-2011 (DRAFT). Submitted to the Northeast Coastal and Barrier Network, National Park Service, 54 p.
- Psuty, N. P., W. Schmelz, A. Spahn, C. Carvajal. September 2013. Coastal Profile Changes, Gateway National Recreation Area: Annual Monitoring Report, 2011-2012 (DRAFT). Submitted to the Northeast Coastal and Barrier Network, National Park Service, 56 p.
- Psuty, N. P., August 8, 2013. Coastal Geomorphological Evolution, Northeastern US: A Geotemporal Perspective. Sponsored by the National Park Service. Webinar
- Silveira, T.M., A.M. Carapuco, H. Sousa, R. Taborda, N.P. Psuty, C. Andrade, and M. da Conceicao Freitas, 2013. Optimizing Beach Topographical Field Surveys: Matching the Effort with the Objectives. Journal of Coastal Research, Special Issue 65, pp. 588-593.
- Skidds, D. E. 2013. NPS Inventory & Monitoring Program: GIS Update. NER GISC Meeting
- NCBN Annual Accomplishments Report FY13

- Annual Meeting. Philadelphia, PA, May 28, 2013. (Presentation)
- Skidds, D.E., J. C. Lynch, and R. J. Duhaime. 2013. RTK and Rulers: Monitoring the Rise and Fall of Salt Marsh Sediment Elevations in Northeastern Coastal Parks. Annual Northeast Arc Users Group Conference, Nashua, NH. (Presentation)
- Stevens, S. M. 2013. National Park Service Student Opportunities. University of Rhode Island, Natural Resource Science Department, Kingston, RI. October 2012. (Presentation)
- Stevens, S. M. 2013. Northeast Coastal and Barrier Network Program Overview and Data. Meeting with USGS scientists, Dr. James Grace. University of Rhode Island, Kingston, RI. (Presentation)
- Tsipoura, N., D. S. Mizrahi, and M. Bisignano. 2013. Breeding bird surveys for Gateway National Recreation Area. Natural Resource Technical Report NPS/NCBN/NRTR—2013/739. National Park Service, Fort Collins, Colorado.
- Wang, Y. Q., C. M. Traber. 2013. Remote sensing of terrestrial and submerged aquatic vegetation at Fire Island National Seashore: Long-term resource management and monitoring. Natural Resource Technical Report NPS/NCBN/NRTR—2013/742. National Park Service, Fort Collins, Colorado.

**V. Status of monitoring protocols being developed by the Northeast Coastal and Barrier Network (see table following budget page)**

**VI. Budget - FY2013 Annual Report Narrative**

This year the NCBN received a total of \$831,440; this includes \$750,500 in Vital Signs Monitoring funding and \$80,940 from the NPS Water Resources Division to assist with the network's estuarine water quality monitoring program. Approximately 26% of this funding was used to develop partnerships (via cooperative agreement/contracts) with a number of CESU universities for the development and implementation of monitoring protocols. Permanent and seasonal NPS personnel expenses constituted approximately 69% of the budget in FY13. Travel (3%) and general operations, equipment purchases, and administrative/office support (2 %) rounded out NCBN expenditures for FY13.

In addition, the Cape Cod National Seashore CCEM program received their annual base of \$702,375. This funding was transferred directly to the park's base account for regular program expenses and operations.

**NCBN Budget Summary**

FY13 Admin Report

Network: 02 Northeast Coastal and Barrier

**Category: 1\_Income**

<b>Description</b>	<b>\$ Amount</b>	<b>\$\$ Source</b>	<b>Where \$ Went</b>	<b>Comments</b>
Water Resources Funds	\$80,940.00	WRD - WQ Monitoring		
Monitoring Funds	\$750,500.00	I&M - VS Monitoring \$\$		
<b>Subtotal</b>	<b>\$831,440.00</b>			

**Category: 2\_Personnel**

<b>Description</b>	<b>\$ Amount</b>	<b>\$\$ Source</b>	<b>Where \$ Went</b>	<b>Comments</b>
NCBN Staff Salary	\$571,968.00	I&M - VS Monitoring \$\$	NPS	
<b>Subtotal</b>	<b>\$571,968.00</b>			

**Category: 3\_Coop. Agreements**

<b>Description</b>	<b>\$ Amount</b>	<b>\$\$ Source</b>	<b>Where \$ Went</b>	<b>Comments</b>
URI-NCBN Data Mgt and I&M Support	\$99,950.00	I&M - VS Monitoring \$\$	University-CESU	
Rutgers University Geomorph Monitoring	\$40,059.00	I&M - VS Monitoring \$\$	University-CESU	
VIMS-ASIS/COLO/GEWA ENE Monitoring	\$49,112.00	WRD - WQ Monitoring	University-CESU	
URI-Herp Inventory/Monitoring FIIS	\$30,810.00	WRD - WQ Monitoring	University-CESU	
<b>Subtotal</b>	<b>\$219,931.00</b>			

**Category: 5\_Operations/Equipment**

<b>Description</b>	<b>\$ Amount</b>	<b>\$\$ Source</b>	<b>Where \$ Went</b>	<b>Comments</b>
Monitoring Equipment and Supplies	\$9,223.00	I&M - VS Monitoring \$\$	Other non-Federal	
Park Housing for Seasonal Staff	\$3,194.00	I&M - VS Monitoring \$\$	NPS	
<b>Subtotal</b>	<b>\$12,417.00</b>			

**Category: 6\_Travel**

<b>Description</b>	<b>\$ Amount</b>	<b>\$\$ Source</b>	<b>Where \$ Went</b>	<b>Comments</b>
NCBN Travel Costs	\$25,224.00	I&M - VS Monitoring \$\$	NPS	
<b>Subtotal</b>	<b>\$25,224.00</b>			

**Category: 7\_Other**

<b>Description</b>	<b>\$ Amount</b>	<b>\$\$ Source</b>	<b>Where \$ Went</b>	<b>Comments</b>
NERO Assessment	\$1,900.00	I&M - VS Monitoring \$\$	NPS	
<b>Subtotal</b>	<b>\$1,900.00</b>			

**NCBN Budget Analysis**

**Analysis of Expenses by Where \$ Went**

<b>Funding Source</b>	<b>Total \$\$</b>	<b>NPS</b>	<b>USGS</b>	<b>Other Federal</b>	<b>Univ.-CESU</b>	<b>Univ_Non-CESU</b>	<b>Other non-Federal</b>
I&M - VS Monitoring \$\$	\$751,518	\$602,286			\$140,009		\$9,223
WRD - WQ Monitoring	\$79,922				\$79,922		
<b>Totals</b>	<b>\$831,440</b>	<b>\$602,286</b>			<b>\$219,931</b>		<b>\$9,223</b>

**Analysis of Expenses by Category**

<b>Funding Source</b>	<b>Total \$\$</b>	<b>Personnel:</b>	<b>Coop Agree.</b>	<b>Contracts</b>	<b>Operations/Equip</b>	<b>Travel</b>	<b>Other</b>
I&M - VS Monitoring \$\$	\$751,518	\$571,968	\$140,009		\$12,417	\$25,224	\$1,900
WRD - WQ Monitoring	\$79,922		\$79,922				
<b>Totals</b>	<b>\$831,440</b>	<b>\$571,968</b>	<b>\$219,931</b>		<b>\$12,417</b>	<b>\$25,224</b>	<b>\$1,900</b>

**Expense Totals By Category**

<b>Category</b>	<b>SubTotal</b>	<b>Percent</b>
2_Personnel	\$571,968	68.79%
3_Coop. Agreements	\$219,931	26.45%
5_Operations/Equip	\$12,417	1.49%
6_Travel	\$25,224	3.03%
7_Other	\$1,900	0.23%
	<b>\$831,440</b>	

Status of monitoring protocols being developed by the Northeast Coastal and Barrier Network (as of October 2013).

Name of Protocol	Protocol Status – Dates for Actual/Expected Milestones			Comments on Protocol Status
	Draft Available	Submitted for Review	Approved by Regional Mgr.	
Coastal topography			Published/Approved 2012	Psuty, N. P., T. M. Silveira, A. J. Spahn, and D. Skidds. 2012. Northeast Coastal and Barrier Network geomorphological monitoring protocol: Part II - coastal topography. Natural Resource Report NPS/NCBN/NRR—2012/591. National Park Service, Fort Collins, Colorado.
Estuarine nutrient enrichment			Published/Approved 2009	Trend report due to be completed in FY13. Resource Briefs for each park in development as part of USGS NPMP funding .
Forest vegetation			Published/Approved 2009	(Adopted MIDN protocol <sup>1</sup> .) Final peer review complete. Annual report and resource briefs available.
Invasive species detection	May 2014 (anticipated)			Currently adapting ERMN protocol (Keefer et al., 2010 <sup>2</sup> ). Draft NCBN protocol anticipated FY14. Protocol being developed by University of Rhode Intern.
Ocean shoreline position			Published/Approved 2010	Final peer review complete. Annual reports available. ASIS 5-yr trend report 2012.
Salt marsh birds	August 2014 (anticipated)			Currently adapting Saltmarsh Habitat & Avian Research Program (SHARP) North American Marsh Bird Monitoring Protocols <sup>3</sup> . University cooperators failed to complete draft, protocol development brought in-house and is being worked on by NCBN staff.
Salt marsh sediment elevation	February 2014 (anticipated)			Protocol under development-first draft of narrative completed Sept 2012. This is a collaborative effort and dependent on other agencies. Expected completion of full draft, FY14.
Salt marsh nekton			Published/Approved 2012	Published 2012 Annual reports available.
Salt marsh vegetation		May 2011	Jan 2014 (anticipated)	Currently undergoing revisions by the authors. Completed revisions anticipated in January 2014 with anticipated final approval and publication in Feb 2013. Annual reports available.

<sup>1</sup> Comiskey, J. A., J. P. Schmit, and G. Tierney. 2009. Mid-Atlantic Network forest vegetation monitoring protocol. Natural Resource Report NPS/MIDN/NRR—2009/119. National Park Service, Fort Collins, Colorado.

<sup>2</sup> Keefer, J. S., M. R. Marshall, and B. R. Mitchell. 2010. Early detection of invasive species: surveillance, monitoring, and rapid response: Eastern Rivers and Mountains Network and Northeast Temperate Network. Natural Resource Report NPS/ERMN/NRR—2010/196. National Park Service, Fort Collins, Colorado.

<sup>3</sup> Conway, C. 2007. SHARP Avian Point-Count/Callback Survey Protocol: Summary of the Standardized North American Marsh Bird Monitoring Protocols. Modified From Wildlife Research Report #2007-04. Saltmarsh Habitat & Avian Research Program (SHARP).

# Cape Cod Ecosystem Monitoring FY13 Annual Accomplishment Report

Addendum to the Northeast Coastal Barrier Network report

Submitted by Megan Tyrrell

Nov 13 2013

## **FY13 CCEM Summary**

Vital signs monitoring on eleven protocols was accomplished at CACO by the CCEM team in FY13. Highlights for this year include: publication of the dune slack wetland monitoring protocol and completion of a full draft of forested vernal ponds vegetation monitoring protocol. In addition to the decade long kettle pond water quality monitoring program, two annually implemented protocols have also hit the decade mark. FY13 was the 11th year of seagrass monitoring at CACO (conducted by CCEM staff in collaboration with Dr. Hilary Neckles from USGS), and it was also the tenth year of pond breeding amphibian monitoring. Seven new resource briefs were created and posted on the CCEM website. A highly talented seasonal science communication technician facilitated extensive updates to the CACO website on monitoring related topics. There were approximately ten new webpages created and substantial updates to approximately 20 more pages were completed. Finally, several new videos were made including one describing the Citizen Science Phenology Monitoring Program and several new “Science Shorts” videos. These website updates and new videos were some of the most visible accomplishments of the program.

Ecosystem monitoring at CACO is mostly accomplished by Cape Cod Ecosystem Monitoring staff (wildlife ecologist, plant ecologist, aquatic ecologist, aquatic ecology technician, hydrology technician and research and monitoring coordinator) and seasonal technicians and student interns. Other members of the natural resource division act as protocol leads on air quality, shoreline position monitoring and coastal topography monitoring. NCBN staff collect the SET and marsh bird monitoring data for the park. A new division chief, Dr. Jason J Taylor, arrived halfway through the fiscal year and, in addition to allowing the wildlife ecologist to return to his regular duties, he provided program guidance and infectious energy and ideas.

## **I. CCEM Program Accomplishments**

### **Inventories**

- Continued inventory of eastern box turtles and eastern hog-nosed snake through incidental encounters. Inventory includes marking for future recognition, collecting data on size, weight, age, sex, and location, and photo-documentation. In FY 2013 there were 74 incidental box turtle

records. As a result of this work, CACO region has been designated a “core area” in MA Box Turtle Conservation Plan. A total of 4 hog-nosed snakes were recorded.

### **CCEM Vital Signs and Water Quality Monitoring**

*Note: The following monitoring protocols and information have been developed by the CCEM. Funding for this work at CACO is solely supported through the CCEM budget.*

#### **Kettle pond monitoring (Water Quality)**

- Continued to collect water quality data from 20 kettle ponds, as well as hydrologic measurements of pond stage at 10 primary ponds bi-weekly from March through November and 10 secondary ponds seasonally. Monitored chlorophyll a and nutrient concentrations of surface water grab samples as a means of detecting seasonal and inter-annual changes in trophic status.
- Processed all 2012 water samples for nutrients (NO<sub>3</sub>, NH<sub>4</sub>, PO<sub>4</sub>, total P and total N), anions (chloride and sulfate), and chlorophyll a in the Atlantic Research Center’s analytical lab (160 samples for nutrients, 40 for anions, and 360 for chlorophyll), and sent 2013 water samples for cation analysis (Na, K, Ca, Mg) to outside laboratories (20 samples).
- Conducted an in-depth analysis of water quality data from Duck Pond to identify seasonal and annual trends, and began analysis of mechanisms of change.
- Continued a comprehensive QA/QC review of kettle pond water quality monitoring data. Conducted methodology research, sample collection, and testing in support of refining the protocol. Protocol will be sent out for external peer review in FY14.

#### **Hydrology and ground water quality monitoring**

- Continued implementation of the ground water and pond stage portion of the hydrology monitoring protocol including six wetland observation wells. The wetland wells are instrumented with continuous water level loggers and are monitored on a bi-monthly basis.
- With assistance from an AmeriCorps member, CCEM staff collected streamflow data from four stream gage sites. Continuous water level loggers were deployed at 2 of these sites in Winter 2012 to collect continuous stage measurements while collecting streamflow data bi-weekly.
- Recommendations for future monitoring were reassessed by Larry Martin, NPS Water Resources Division (WRD) with the help of Gwen Gerber, of the Water Rights Branch, in Fort Collins, CO. A final report summarizing WRD recommendations was completed in FY13. Key recommendations include: 5 of the 22 existing observation wells were removed from the monthly measurements list and 1 of the 10 ponds was also removed from the monthly observation list.
- Continued coordination with NPS WRD to plan migration of CCEM hydrology data to the Aquarius database and data management system.
- NPS Water Resources Division and CCEM staff completed a report/memorandum summarizing the effects of the Town of Wellfleet Municipal Water Supply System on the surrounding aquifer. It was completed in March 2013 utilizing long-term hydrologic groundwater level and pond stage data.
- Continuous water level data from Pamet River stream flow site was presented at a public meeting in the Town of Truro after a storm breach of Ballston Beach occurred, effecting water levels downstream of two culverts. The continuous streamflow logger captured the event.

### **Amphibian monitoring**

- CCEM staff conducted the tenth year of long-term amphibian monitoring. This program consists of vernal pond egg mass counts, anuran calling surveys, and habitat monitoring activities.
- For each vernal pond where egg masses are counted, adjacent landscape habitat data from within a 1000 m buffer were extracted via GIS. Additionally, data on within-pond habitat structure was collected.
- Collected and entered hydrology data (pond stage) monthly at all 40 vernal ponds being monitored. All hydrology data going back to 2005 was reviewed to standardize with current stage gauges in place. All data are now correct and standardized.
- Water samples were collected from all 64 amphibian monitoring sites and analyzed at the Atlantic Research Center's analytical lab for pH, alkalinity, conductivity, color, chloride, and sulfate.
- Entered and proofed all 2012 data, and performed preliminary tabulation and trend analysis of all long term data on egg mass counts. Calling survey data have been tabulated and files for analysis with program PRESENCE have been created. Conducted preliminary power analysis of long term egg mass count data for spotted salamanders and determined that power of current 10 year dataset to detect trends is very limited.
- Monitored weather forecasts and ground water level to determine nights when CACO should close Province Lands Road to traffic to protect spadefoot toads. Coordinated with CACO operational staff on road closure. Implemented road closure on five nights.
- Recorded two separate spring amphibian choruses for CACO website. Wrote commentary to accompany audio recordings.

### **Aquatic turtle monitoring**

- Continued to monitor spotted turtles through incidental encounters. Two individuals were recorded, including one originally marked in 2001.

### **Meteorologic, atmospheric deposition, and air quality monitoring**

- Continued to implement the meteorologic and atmospheric monitoring program and served as site operator and/or site supervisor for participation by and communication among the following partners and cooperators: USGS, NPS Air Resources Division (ARD), the National Atmospheric Deposition Program-National Trends Network (NADP-NTN) and the University of Illinois for precipitation and wet deposition chemistry, the National Atmospheric Deposition Program-Mercury Deposition Network (NADP-MDN) and Frontier Geosciences for wet mercury deposition, the Interagency Monitoring of Protected Visual Environments Program (IMPROVE) at UC Davis for aerosols, the Commonwealth of Massachusetts (MA DEP) for ozone and primary pollutants, and UMASS-Amherst for Acid Rain Monitoring (ARM) in surface waters.

### **Heathlands Monitoring**

- The vegetation in twenty heathland monitoring sites was surveyed in 2013. This is the second survey following one completed in 1999 for 9 of the sites. The other 11 sites are new to the monitoring network and were added in 2013. The data will be summarized in a report to be completed in 2014.

### **Landbirds monitoring**

- Work on completing the landbird point count monitoring report and protocol is continuing to be led by a post-doc at University of Massachusetts, Amherst. Analysis of distance sampling data has been completed and power analysis begun. A draft is expected by end of FY 2014.
- Data from the recent MA Breeding Bird Atlas were obtained for the CACO region and organized and tabulated at different levels of geographic resolution.

### **Meso-mammal monitoring**

- The last phase of field work for the meso-mammal protocol development study, led by Dr. Allan O'Connell, USGS, was completed in FY2006. Data analysis has been completed and the report and protocol are currently being drafted.
- Field trials of camera traps were initiated. Two camera traps have been set up at sites previously used in protocol development work to develop experience and familiarity in the use of the cameras and management of data from them.
- Researched historic literature (zoological, archeological, and colonial history) to determine historic status of native meso-mammals currently or formerly present on outer Cape Cod.

### **Cover-type change monitoring**

- Conducted internal scoping of landcover change methods with project staff, acquired satellite data and assisted with classification of sample areas (with GIS technician) as baseline for future land use change analysis.

### **CCEM Monitoring products**

- The nature and science sections of the CACO websites were updated and revised. Updates and new material include: “Amphibians and Reptiles of Cape Cod National Seashore”, checklist “Mammals of Cape Cod National Seashore” [includes new records plus species documented in the literature as historically present], Mammals- Historical Importance and Abundance, and Mammals- Ecological Role and Function sections. Other new webpages include: five new pages on air quality monitoring, beaches, non-native species, ecosystem restoration, marine invertebrates, horseshoe crabs, broom crowberry, green crabs, oceans, etc. Extensive updates to photos and multimedia section of CACO website were also completed. Products include: records of amphibian calls, piping plover photo essay, and an interview with an atmospheric scientist studying aerosols at CACO.
- CCEM’s Forested Vernal Pond Monitoring Report was published in the NR Technical Report Series and a full draft of the monitoring protocol was written and is in internal review.
- CCEM’s Dune Slack Wetland Vegetation Monitoring protocol was accepted for publication in NR Technical Report Series

- Information on salt marsh dieback contained on CACO's website was created (<http://www.nps.gov/caco/naturescience/revegetation-of-salt-marsh-dieback-areas.htm>).
- Phragmites management and Nauset Marsh Salt Pools resource briefs were completed and posted on the CACO websites

### **CCEM Data Management, Information Transfer, and Support to Park Management and the Public**

- The CCEM aquatic ecology technician began a four month long data management detail to improve CACO data storage, archiving and accessibility.
- Hardcopy data sheets on salt marsh monitoring were sent to Dennis Skidds (data manager, NCBN) for scanning and archiving.

## **II. Public Interest Highlights**

### **SNAKE FUNGAL DISEASE DETECTED IN CACO SNAKES**

In response to request for specimens from NPS BRMD and USGS Wildlife Health Lab, scale tissue samples from two eastern milk snakes was submitted to the Wildlife Health Lab. Both snakes were positive for the fungus *Ophidiomyces ophiodiicola*, which has been implicated in an emerging disease phenomenon known as "Snake Fungal Disease". Although this disease has been implicated in declines in some snake populations, the limited results at CACO so far do not indicate the fungus is having negative effects on snakes as individuals or populations.

### **LINKAGES BETWEEN ESTUARINE WATER QUALITY, GROUNDWATER AND TERRESTRIAL LAND USE**

Analysis of the 2012 study of nutrient concentrations in the nearshore areas of the Nauset Marsh system showed nutrient concentrations in waters of the Salt Pond, Mill Pond, and Town Cove embayments were associated with freshwater inputs and related to concentrations in adjacent groundwater. Preliminary results and values were presented to collaborators from USGS and Woods Hole Oceanographic Institution working on a harmful algal bloom study in the Nauset Marsh system.

### **KETTLE POND WATER QUALITY DATA USED TO SUPPORT RESTORATION/RESOURCE DAMAGE MITIGATION**

Based on an analysis of kettle pond water quality data, a set of mitigation and restoration projects were undertaken at several ponds. Educational and regulatory signs were revised and installed at all pond access points. Where necessary, shorelines were stabilized with erosion control jute netting, planting of native vegetation, and fencing to restrict foot traffic. Fencing was also installed to limit vehicle parking to number of spaces allowed by the Park. A pond stewardship guide was published on the CACO website to educate residents and visitors on best practices to avoid resource damage.

## **WATER LEVEL MONITORING DATA ALLAYED CONCERNS OVER WELLFLEET'S MUNICIPAL WATER DEMAND**

During 2011-2012, there was some public concern that the water surface elevation at Duck Pond had declined several feet. There was speculation by residents that groundwater pumping from the Wellfleet municipal water-supply well could be the cause of the observed water level decline. Groundwater pumping began on a regular basis in the Fall 2010. To determine whether there were any detectable differences in water levels that might be attributed to groundwater pumping, long-term hydrologic monitoring data from wells and ponds in the area was examined. If groundwater pumping was lowering the water table, the effect should be more noticeable near the pumped well. Data showed the expected water table elevation and pond levels fluctuating in response to weather and climate conditions, rising during wet periods and lowering during dry periods. Using the Palmer Hydrologic Drought Index it was confirmed that starting in 2008, the area was wetter than normal until late 2011. A dry period then began which lasted throughout the summer of 2012, lowering the water table and surface water elevations in ponds. It appears that the short term decline in water levels was a rebound from previously wetter than normal conditions that began in late 2008.

### **III. Staffing**

#### **Cape Cod National Seashore CCEM Staff**

Jason Taylor, Natural Resource Management Division Chief  
Megan Tyrrell, Research and Monitoring Coordinator\*  
Robert Cook, Wildlife Ecologist\*  
Stephen Smith, Plant Ecologist\*  
Sophia Fox, Aquatic Ecologist\*  
Kelly C. Medeiros, Hydrology technician\*  
Judith Oset, Budget technician  
Krista Lee, Physical Scientist  
Judith Oset, Physical Science technician  
Holly Bayley, Aquatic Ecology technician\*  
Mark Adams, GIS Specialist  
Mary Hake, Natural Resource Specialist  
Nuray Taygan, Shorebird technician  
Tim Smith, Restoration Ecologist  
Gabrielle Robinson, Shorebird technician  
Seasonal technicians for: Vegetation monitoring, Amphibian monitoring\* and Science Communication (1 each)  
Student Conservation Association interns\* for: Vegetation monitoring, Amphibian monitoring (2), Kettle Pond Water Quality and Salt Marsh Nekton monitoring (3)  
Diversity GeoCorps Intern, Catalina Mejia

*\* majority of salary funded by Cape Cod Ecosystem Monitoring funds*

#### **Key CCEM Contractors and Cooperators**

Dr. Donald Anderson, Woods Hole Oceanographic Institution (harmful algal blooms)  
 Dr. Mark Borrelli, Provincetown Center for Coastal Studies (geomorphology, sea floor mapping)  
 Dr. Barbara Brennessel, Wheaton College, (diamondback terrapin ecology and genetics)  
 Scott Buchanan, Montclair State University (hog-nosed snake ecology)  
 Jim Caldwell, USGS (ENE monitoring data synthesis)  
 Dr. Raymond Clarke, Sarah Lawrence College, (box turtles)  
 Dr. John Colman, US Geological Survey (nutrient loading to estuaries)  
 Dr. Julie Ellis, Tufts University Veterinary School (common eider die-off)  
 Lori Erb, Massachusetts Natural Heritage Program (box turtle monitoring and radio- telemetry)  
 Mark Faherty, University of Massachusetts, Amherst (landbird point-count protocol)  
 Gwen Gerber, NPS Water Rights Branch (hydrology monitoring)  
 Dr. Graham Giese, Provincetown Center for Coastal Studies (geomorphology and tides)  
 Dr. Curtice Griffin, University of Massachusetts, Amherst (landbird point-count protocol)  
 Dr. Phillippe Hensel, NOAA-National Geodetic Survey (SET and salt marsh elevation leveling)  
 Dr. Mary Jane James-Pirri, URI (horseshoe crab ecology)  
 John Kiddon, U.S. Environmental Protection Agency (ENE monitoring data synthesis)  
 Zachary Lewis, Harvard University, Four-toed Salamander Embryology  
 Larry Martin, NPS Hydrogeologist (hydrology monitoring)  
 Agnes Mittermayr, visiting PhD student, GEOMAR, Germany (seagrass food web study)  
 Randall Mickley, Wildlife Disease Biologist, USDA APHIS (common eider die-off research)  
 Dr. Bill Monahan, NPS Inventory and Monitoring Division (ENE monitoring data synthesis)  
 Dr. Hilary Neckles, USGS (seagrass monitoring, ENE monitoring data synthesis)  
 Andrew Neil, University of Rhode Island (tidal datum analysis)  
 Dr. Allan O'Connell, USGS, Patuxent WRC (meso-mammal protocol)  
 Dr. Rachel Thiet, Antioch College of New England (soft-shell clams, salt marsh vegetation. ant-Corema interactions)  
 Brad Timm, University of Massachusetts, Amherst (spadefoot toad ecology, landcover change)  
 Dr. Todd Tupper, Northern Virginia CC (chytrid fungus surveys)  
 Dr. Dave Ullman, University of Rhode Island (tidal datum analysis)  
 Dr. Betsy Von Holle, Univ. Central Florida (coastal heathland vegetation)

#### **IV. Reports, Publications, and Presentations (FY13)**

##### CCEM

Bayley, H.K. 2013. Seagrass restoration research at Cape Cod National Seashore. Cape Cod Natural History Conference.

Buchanan, S.B., B.C.Timm, R.P. Cook, and R. Couse. *Heterodon platirhinos* (Eastern Hog-nosed Snake). Reproduction – Oviposition Frequency. Herpetological Review. *In press*.

Cook, R.P. 2013. 2012 Beach Water Quality Monitoring and Results. Technical Report, Cape Cod National Seashore.

Cook, R.P. 2013. Vernal Pond Wildlife. Evening field trip for Friends of CACO, 4/10/13 & 4/11/13.

Cook, R.P. 2013. Wildlife of Cape Cod National Seashore – the rare and seldom seen. Invited presentation to Wellfleet National Seashore Homeowners Association, 7/28/13.

Cook, R.P. 2013. Herpetological Restoration in an Urban Landscape. Invited presentation to meeting of Midwest Partners in Amphibian and Reptile Conservation, Mequon, WI. 8/3/13.

Cook, R.P. 2013. Grassland/Heathland Wildlife at Cape Cod National Seashore. Presentation and walk for NPS interpreters. 6/26/13.

Cook, R.P. 2013. Turtles and Snakes of CACO. Hands-on demonstration and field trip for participants in

- the NPS Lowell SCIP program. 7/17/2013.
- Cook, R.P 2013. Dune Slack Wetland Wildlife at Cape Cod National Seashore. Walk for NPS interpreters. 8/15/13.
- Crouch, L. McKean, S. Fox. 2013. Pond Condition Progress Report and Work Plan. Cape Cod National Seashore.
- Dibble, K.L, M.Tyrrell, and P. S. Pooler. 2013. Trends in nekton community composition and water quality in restored and reference salt marshes in New England. *Estuaries and Coasts*. *In press*.
- Fox, S. 2013. Kettle Pond WQ monitoring program. CACO Citizen Science Phenology Monitoring Program. November 2012.
- Fox, S.E. Cape Cod National Seashore Kettle Ponds: A record of change. Cape Cod National Seashore Advisory Commission Meeting. March 2013.
- Martin, L. and K. Medeiros. Hydrologic monitoring in the vicinity of the Wellfleet municipal water-supply well. Memorandum to Cape Cod National Seashore Superintendent. March 2013.
- Medeiros, K.C. 2013. Water level and salinity monitoring after the Pamet river overwash. Pamet River Forum. 8/2/13
- Medeiros, K.C., C.T Roman, J. Lynch, MJ. James-Pirri. Monitoring Salt Marsh Elevation at Cape Cod National Seashore: Understanding the response to sea level rise. NE Geological Society of America Meeting. March 18-20, 2012. Bretton Woods, NH. (travel cancelled due to sequester)
- Mittermayr, A., S.E. Fox, U. Sommer. Temporal stability of food webs in temperate *Zostera marina* communities revealed by simultaneous triple ( $\delta^{13}\text{C}$ ,  $\delta^{15}\text{N}$  and  $\delta^{34}\text{S}$ ) stable isotope analysis. *Marine Ecology Progress Series*. *Submitted*.
- Neckles, H.A., J.M. Caldwell, J. Kiddon, M. Nixon, B. Monahan, P.S. Pooler, D. Skidds, S. Fox. 2013. Estuarine Water Quality Monitoring in Northeastern U.S. National Parks: Integration at Local and Regional Scales. Coastal and Estuarine Research Federation Conference, November 3-7, San Diego, CA. Abstract submitted for oral presentation in FY2014.
- Neckles, H.A., J.M. Caldwell, J. Kiddon, B. Monahan, P.S. Pooler, D. Skidds, S. Fox. 2013. Estuarine Water Quality in Relation to Watershed Characteristics in Northeastern National Parks. George Wright Society Conference, March 11-15, Denver, CO.
- Olsen, Y.S., S.E. Fox, L.C. Hofmann, and I. Valiela. 2013. Benthic community composition and faunal stable isotopic signatures differ across small spatial scales in a temperate estuary. *Marine Environmental Research* 86:12-20, DOI 10.1016/j.marenvres.2013.02.002.
- Smith, S.M. Salt marshes and wastewater. Wellfleet Wildlife Sanctuary Seminar Series. Feb 2, 2013. Wellfleet, MA.
- Smith, S.M. Salt marshes and climate change. Pleasant Bay Alliance Seminar Series. Harwich Community Center. July 10, 2013. Harwich, MA.
- Smith, S. M., 2013. Dune slack wetland vegetation monitoring protocol, Cape Cod National Seashore. Natural Resource Report NPS/NER/NRR—2013/388. National Park Service, Fort Collins, Colorado (accepted for publication)
- Smith, S.M. 2013. Substrate properties affect the recovery of *Spartina alterniflora* from drought and herbivory. In: Carlos Busso (ed), *From Seed Germination to Young Plants: Ecology, Growth and Environmental Influences*, Chapter 6. Nova Publishers.
- Smith, S.M. The potential for vegetation restoration in salt marsh dieback areas using erosion control fabric and low palatability plant species. NE Geological Society of America Meeting. March 18-20, 2012. Bretton Woods, NH. (travel cancelled due to sequester).
- Smith, S. M., M. Esposito, and M. Cox. 2013. Forested vernal pond vegetation monitoring in Cape Cod National Seashore: summary of 2011 field work and comparisons to 1997 and 2006 data. Natural Resource Technical Report NPS/CACO/NRTR—2013/786. National Park Service, Fort Collins, Colorado

- Smith, S.M. and C. Green. Sediment suspension and elevation loss triggered by Atlantic mud fiddler crab (*Uca pugnax*) bioturbation in salt marsh dieback areas of southern New England. *Journal of Coastal Research*. *In press*.
- Smith, S.M., M.C. Tyrrell, and M. Congretel. 2013. Palatability of salt marsh forbs and grasses to the purple marsh crab (*Sesarma reticulatum*) and the potential for re-vegetation of herbivory-induced salt marsh dieback areas in Cape Cod (Massachusetts, USA). *Wetlands Ecology and Management* 21:263-275.
- Thiet, R.K., SM Smith, V Rubino, R Clark, K Lee, and J Oset. Soft shell clams (*Mya arenaria*) contribute to macroalgal blooms in a partially-restored Gulf of Maine back-barrier lagoon. *Ecological Restoration*. *In press*.
- Thiet, R.K., A. Doshas, and S.M. Smith. Effects of algal crusts and moss and lichen mats on soil moisture and productivity of key successional dune plants *Deschampsia flexuosa* and *Morella pensylvanica* on Cape Cod, MA, USA. *Plant and Soil*. *In press*.
- Thiet, R.K., S.M. Smith, E. Kidd, and J. Wennemer. Molluscan community recovery in a New England back-barrier salt marsh lagoon 10 years after partial restoration. *Restoration Ecology*. *In press*.
- Timm, B.C., K. McGarigal, and R.P. Cook. Upland movement patterns and habitat selection of adult eastern spadefoots (*Scaphiopus holbrookii*) at Cape Cod National Seashore. *Journal of Herpetology*. *In press*.
- Tyrrell, M.C. Synopsis of Cape Cod Ecosystem Monitoring Program Development and Vital Signs Evolution. Submitted to IRMA, September 2013.
- Tyrrell, M.C., R. Dye, J. Barnes, S. Smith, B. Argow, K. Corwin and K. Medeiros. Cape Cod's salt marsh dieback problem- marked elevation change, shifts in plant distribution and erosion stemming from a native crabs' herbivory. NE Geological Society of America Meeting. March 18-20, 2012. Bretton Woods, NH. (travel cancelled due to sequester)
- Tyrrell, M.C., R. Dye, J. Barnes, S. Smith, B. Argow, K. Corwin, K. Medeiros, A. Dijkstra, M. Tanis, A. Thime, J. Allogio, and C. Mejia 2013. Cape Cod's salt marsh dieback - marked elevation change, shifts in plant distribution and erosion stemming from crab activity. Coastal and Estuarine Research Federation Conference, November 3-7, San Diego, CA. Abstract submitted for oral presentation in FY2014.
- Tyrrell, M.C., K. Medeiros, S. Fox and M. Adams. History of Climate Change on Cape Cod CACO's long term monitoring data in the context of climate change. Tales of Cape Cod Lecture Series. Barnstable, MA. 7/9/13.
- Valiela, I., C. Barth-Jensen, T. Stone, J. Crusius, S. Fox, and M. Bartholomew. 2013. Deforestation of watersheds of Panama: nutrient retention and export to streams. *Biogeochemistry* DOI 10.1007/s10533-013-9836-2.
- Valiela, I., M. Bartholomew, L.B. Kozma, C. Barth-Jensen, E. Kinney, S.E. Fox. Sea level rise in Great Sippewissett marsh: cascading effects on cordgrass, creek bank retreat, and fiddler crabs. *Estuaries and Coasts*. *Submitted*.
- Valiela, I., C. Harris, A. Giblin, T. Stone, S. Fox and J. Crusius. Nutrient gradients in Panamanian estuaries: Effects of watershed deforestation, rainfall, upwelling, and within-estuary transformations. *Limnology and Oceanography*. *Submitted*.
- Von Holle, B., C Neill, E Largay, K Budreski, B Ozimec, S Clark, and K Lee. Ecosystem Legacy of the Introduced N<sub>2</sub>-fixing tree, *Robinia Pseudoacacia*, in a Coastal Forest. *Oecologia*. *In press*.

**V. Status of monitoring protocols being developed by the CCEM (see table following budget page)**

Status of monitoring protocols being developed by the CCEM program (as of October 2013).

Name of Protocol	Protocol Status – Dates for Actual/Expected			Comments on Protocol Status
	Draft Available	Submitted for Review	Approved by Regional Mgr.	
Meteorologic and Atmospheric air quality			September 2001	Implementation is continuous; resource brief available on CCEM website.
Coastal Forests			2011	Implemented every 10 years, 2012 was second year of data collected under final protocol. Data pre-dating the protocol was used in development and these plots continue to be monitored as well as new plots. Monitoring report will be written in FY14. Resource brief available on CCEM website.
Hydrology			Dec 2011	Finalized in May 2012 as Medeiros, K.C. (editor) 2011. 2 resource briefs: 1) groundwater level and 2) stream gage monitoring available on CCEM website.
Kettle Pond WQ		Winter 2014 (anticipated)		Data collection ongoing with peer reviewed protocol but substantial revisions needed to update actual procedures. Expected to be submitted for review in winter 2014. Resource brief reporting on climate change trends available on CCEM website.
Kettle Pond Vegetation			Spring 2012	Finalized as Smith, S.M. 2012. Resource brief summarizing monitoring data from 1995-2010 available on CCEM website.

Dune Slack Wetland Vegetation			Summer FY13	Protocol implemented every five years. Smith, S. M., 2013. Dune slack wetland vegetation monitoring protocol, Cape Cod National Seashore. Natural Resource Report NPS/NER/NRR—2013/388. National Park Service, Fort Collins, Colorado (accepted for publication). Dune Slack Wetland Vegetation Monitoring resource brief available on CCEM website.
Forested Vernal Wetland Vegetation		Winter FY14 (anticipated)		Protocol implemented every five years. Smith, S. M., M. Esposito, and M. Cox. 2013. Forested vernal pond vegetation monitoring in Cape Cod National Seashore: summary of 2011 field work and comparisons to 1997 and 2006 data. Natural Resource Technical Report NPS/CACO/NRTR—2013/786. National Park Service, Fort Collins, Colorado. Forested vernal wetland vegetation monitoring protocol in internal review.
Pond breeding amphibians			2003	Protocol completed and implemented yearly; resource brief summarizing available on CCEM website.
Dune grassland vegetation			Fall FY14(anticipated)	Protocol being implemented every five years; resource brief available on CCEM website. Smith, S.M. 2012. Dune grassland vegetation monitoring: analysis of 2011 survey data and changes in plant communities since 2005. Natural Resources Report NPS/NER/NRR—2012/365. National Park Service. Philadelphia, PA. Final draft of protocol anticipated ready for internal review fall FY14.
Coastal Heathlands	Spring FY14 (anticipated)			Draft protocol available; Gwilliam, E. and T. Husband. 2008. Monitoring Protocol for Coastal Sandplain Heathlands and Grasslands of the Cape Cod National Seashore, Massachusetts.
Landbirds, point counts	Spring FY14 (anticipated)			Protocol is being written by Mark Faherty and Curtice Grffin, University of Massachusetts, Amherst. Draft due by end of CY13.
Meso-mammals	Winter FY13 (anticipated)			Protocol is being written by Allan O'Connell, USGS. Draft anticipated by end of CY13.

Cover type mapping	Fall 2014 (anticipated)			Report on methods and pilot results published (Timm and McGarigal 2012). In FY13, further method development and application in various ecosystems will continue along with work on full draft protocol.
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**Note:** The following NCBN protocols are being implemented at CACO either by CCEM or NCBN staff or cooperators. Estuarine Nutrient Enrichment-WQ (including seagrass), Salt marsh vegetation, Salt Marsh Nekton, Coastal Topography, Salt Marsh Sediment Elevation (SET), Ocean Shoreline Position, Marsh Birds