

**ANNUAL ADMINISTRATIVE REPORT (FY2005) AND WORK
PLAN (FY2006) FOR THE CAPE COD NATIONAL SEASHORE
PROTOTYPE MONITORING PROGRAM**

**PART OF THE NORTHEAST COASTAL AND BARRIER NETWORK AND THE
ATLANTIC AND GULF COAST BIOGEOGRAPHIC REGION**

FY2005-FY2006



Wood frog (*Rana sylvatica*). Amphibian monitoring at CACO has shown that the range of this species extends further out onto lower Cape Cod than previously reported. Yet monitoring has also shown that this species is not as abundant in the park as it is in other parts of its range. Lack of forested wetlands, an important summer habitat for wood frogs, is relatively rare at CACO and appears to be a limiting factor. NPS Photo.

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Northeast Region Approval Signature:

Elizabeth Johnson, Regional Inventory and Monitoring Coordinator, Date
Northeast Region

Cape Cod National Seashore Approval Signatures:

George Price, Superintendent Date

Nancy Finley, Natural Resources Chief Date

Prepared By:

Carrie Phillips, Inventory and Monitoring Coordinator Date

AARWP Checklist

Budget program (MS Access, aarwp_budget.mdb)	
X	The income amounts entered for Biological Inventories, Vital Signs Monitoring, Prototype \$\$ - Annual Transfer, Water Quality Monitoring and other sources matches the dollar amounts from the memos sent to the regions/networks by WASO (have you used the correct income amounts?).
X	In the Add/Edit Budget Records form, the amount shown for Total Expenses matches that for Total Income. (If it doesn't, enter a record under Expenses in the 7_Other category to make it balance; use an entry such as 'Unexpended funds' or 'Overspent Funds' in the Description column to explain the amount.)
X	For all Expense records, the Description field includes the name of the university, agency, company, or other vendor to help us document our outsourcing efforts. (If this expense involved a contract, cooperative agreement, interagency agreement, or other partnership, is it clear where the money went?)
X	For all Expense records, the correct item from the picklist for 'Where \$\$ Went' has been entered. [Think about who the check was written to; e.g., enter 'Other Non-Federal' for funding that went directly to the private sector, such as for purchases (computers, supplies, etc.), travel (airlines, rental cars, hotels).]
NA	On the Status of Biological Inventories form, there is one record for each inventory that is described in the text section of the AARWP or in the budget program. Be sure to list each park that was involved in the particular inventory.
X	Each year's budget has been exported as an .rtf file (one for FY 2005 and one for FY 2006), and both files have been inserted into MS Word at the end of the AARWP document.
X	The file aarwp_budget.mdb has been renamed to include the 4-character network alpha code and the years, as shown in this example: NCCN_FY0506_aarwp.mdb
Annual Report and Work Plan (MS Word)	
X	I have carefully read the guidance for the AARWP and followed it.
X	A header or footer with the date that the aarwp was last revised has been included.
X	I gave special attention to the 'Summary of Major Accomplishments' and 'Public Interest Highlights' sections of the report, following this years' guidance and example. (We need good examples of the successes, applications, and highlights of the program to help us obtain funding for all 32 networks! Your 'Summary of Major Accomplishments' section at the beginning of your annual report is what we'll use for the I&M Program's annual Report to Congress to justify the funding spent by your network.)
X	In the 'Status of Park Vital Signs Monitoring' table, all entries are equal to or greater than the entries in last year's report.
X	Photographs that might be included in one of the reports to Congress, brochures, websites, or other materials that help the program have been submitted by the network. (See the photo database and guidelines for submitting photographs.)
X	The aarwp file has been renamed using the network's 4-character alpha code and the years (FY0506) as in the example NCCN_FY0506_aarwp.doc
X	The annual report has been approved by the appropriate individuals, per my region's procedures. (If you cannot get electronic signatures, it is okay to submit a hard copy with signatures after November 4.)
X	I have followed my region's procedures for submitting the two files (e.g., NCCN_FY0506_aarwp.doc and NCCN_FY0506_aarwp.mdb). (Most regions require you to submit the files through the regional office. The files may be zipped into a zip file if desired, and then submitted to Steven Fancy via either email or ftp).
Review of FY 2006 Work Plan by WASO	
NA	[Enter Yes or No]: Has the FY 2006 workplan been approved by the network Board of Directors, and therefore ready for the full WASO review? (If you enter No, the WASO I&M and WRD offices will only briefly review the work plan for 'red flags'.

Summary of Major Accomplishments and Findings of Interest

The Prototype Monitoring Program at Cape Cod National Seashore focuses on monitoring issues relevant to management of park resources, and uses an ecosystem approach to define monitoring questions and develop appropriate monitoring methods. We also pursue discrete studies, often in partnership with other entities, that help interpret monitoring results, refine monitoring methods, and expand on questions posed by monitoring data. Our inventory and monitoring objectives reflect the ecosystem approach, and also reflect the Prototype Program's single funding source (as compared to three distinct funding sources that support inventory, vital signs monitoring, and water quality monitoring at the Network level.) These integrated objectives are:

1. Assess and monitor the integrity of estuarine and salt marsh ecosystems.
2. Assess and monitor the integrity of beach, spit, and barrier island ecosystems.
3. Assess and monitor the integrity of pond and freshwater wetland ecosystems.
4. Assess and monitor the integrity of coastal upland ecosystems.
5. Assess and monitor park-wide and multiple-system indicators of ecosystem integrity.
6. Integrate monitoring efforts and results within and across ecosystems.
7. Share information, report findings, and document program activities.
8. Provide technical assistance to the NCBN, to other networks and parks, and to other entities with common monitoring objectives.
9. Develop and sustain a comprehensive data management program, appropriate staff resources, laboratory infrastructure, and programmatic procedures to ensure program objectives can be met now and into the future.

As our transition from a developmental phase to an operational phase continues, we are implementing several monitoring protocols while advancing the development of others. Of our twenty one high- and mid-priority monitoring projects, seven are operational, one protocol has completed peer review and is being finalized, one protocol is awaiting peer review, five protocols are being drafted, and seven protocols are still in development. USGS was our principal partner during the early developmental phase of the program and continues to provide technical leadership for several projects. The Northeast Coastal and Barrier Network (NCBN) has taken the lead on development of two protocols and review of two operational protocols. We are also continuing to partner with researchers from several universities and non-governmental organizations. The North Atlantic Coast Cooperative Ecosystems Studies Unit (CESU) has played an important role in securing several of these partnerships. Many of our projects and partnerships have also been facilitated by collaboration and integration with the Atlantic Research Center (ARC) - another Natural Resource Challenge program located at Cape Cod National Seashore.

Inventories:

Vegetation Map Nears Completion

In FY2005, the field work, data entry, and analyses were completed for the thematic accuracy assessment of the CACO vegetation map. This is the last step in completing the vegetation mapping project based on aerial photography from 2000. The University of Massachusetts digitized the vegetation polygons, and NatureServe developed the

classification, collected the field data, and are conducting the accuracy assessment. The final report is expected by the end of the first quarter of FY2006. This project was initiated in FY2001 and has been supported by CACO Prototype Monitoring Program funds, and funds from the National Vegetation Mapping Program.

Field Work on Northern Harrier Study Completed

The Manomet Center for Conservation Sciences completed field work on a study to assess the abundance, distribution, habitat preferences, and nesting success of northern harriers (*Circus cyaneus*) breeding at CACO. This was the last year of a two-year project initiated in FY2003 and supported by CACO Prototype Monitoring Program funds. Preliminary results indicate that harriers nesting within CACO differ significantly from other harriers in the region by having a lower rate of nest success (38%), a high rate of re-nesting (60% of failed attempts re-nested), and a higher proportion of nests in wetlands. The presence of coyotes is suspected to play a role in the unique harrier distribution and nesting success observed at CACO thus far. One of the areas with the highest density of harrier nests is the East Harbor system. The results of this study will be of immediate utility as plans for tidal restoration of East Harbor develop.

Small Mammal Inventory and Monitoring Assessment Report Completed

A study was initiated in FY2000 to provide CACO with its first quantitative inventory of small mammals and analysis of their habitat relationships, and to assess the feasibility and utility of monitoring small mammals as indicators of upland ecosystem health. After completion of peer review, a report was finalized and posted on the CACO I&M website in FY2005. This report provides in-depth information regarding CACO's small mammal communities and habitat associations. It also includes detailed descriptions of the field methods used, analytical models and software tested, assessments of their utility, and recommendations for small mammal monitoring. Though the report is specific to CACO, other entities contemplating a small mammal monitoring program are also likely to benefit from the conclusions and recommendations.

Aquatic Turtle Inventory and Monitoring Assessment Report Ready for Peer Review

From 1999 through 2003, CACO implemented an intensive field study of the abundance, distribution, population structure, and monitoring feasibility of fresh water aquatic turtles. The results of this project are documented in a report completed in FY2005, and slated for peer review and posting on the CACO Prototype Monitoring Program website in FY2006. This report provides in-depth information on CACO's freshwater turtle species and communities, as well as a thorough assessment of a variety of survey, modeling, and analysis techniques. As with the small mammal report, the results and analyses are likely to be of utility to others considering an aquatic turtle monitoring program.

Monitoring and Related Studies:

Causes of Salt Marsh Dieback Remain Illusive

In 2003, while conducting salt marsh monitoring, large areas of sudden vegetation loss were observed in the marshes around Great Island (Wellfleet, MA). In 2004 and 2005, several more salt marsh dieback sites were discovered along the Cape Cod Bay-side of

outer Cape Cod (both within and outside CACO's boundary). Monitoring data does not indicate any obvious connection between vegetation losses and environmental gradients (i.e., hydroperiod, sediment chemistry, elevation, etc.). Tissue samples from dying *Spartina alterniflora* plants were sent to Dr. Ray Schneider at Louisiana State University to investigate the hypothesis that a new type of fungus (possibly arriving here on African dust particles) is contributing to the demise of some vegetation.

Salt Marsh Seeding Shows Initial Success

Previous vegetation monitoring in East Harbor, a system undergoing gradual tidal restoration, had documented the absence of salt marsh vegetation either as plants or as seed. In FY2005 we explored ways in which to introduce desirable species as “inoculums”. Seed was collected from the wrack lines of a nearby salt marsh and distributed in East Harbor during the fall of 2004; significant germination of native halophytes was observed in 2005. Continued monitoring will determine whether or not these new plants will accelerate the development of a salt marsh community in this restoring system.

Atlantic Research Center Attracts Citizen Science Benthic Monitoring Study

CACO's Atlantic Research Center, one of the Research Learning Centers funded by the Natural Resource Challenge, attracted and provided in-kind support for a study evaluating the utility of citizen science as a tool for monitoring select benthic taxa. The study, conducted by Brett Thelan of the Antioch New England Graduate School, will examine issues such as volunteer recruitment and retention, intensity of supervision needed, quality control and assurance, and comparability to monitoring data collected by scientists. The results will be useful in assessing the costs and benefits of using volunteers to conduct monitoring projects. In addition, the field component of the study produced a thorough inventory, density estimates, and size class distributions for bivalves in the restoring East Harbor system.

Dune Grassland Protocol Development Project and Dune Slack Wetland Study Generate Collaborative Study of Province Lands Dune Dynamics

The Province Lands are a large post-glacial dune complex that comprises the northern third of the park, and dominates the landscape of "outer Outer Cape Cod". The dune slack wetland study, completed last year, and dune grassland protocol development project, currently underway, have greatly expanded our understanding of the grasslands and dune slack wetlands within this extensive dune complex. But like many studies, as many questions have been generated as have answers. In particular, the hydrologic and vegetation characteristics of the dune slack wetlands have raised questions about the age of the dune slacks, and the dynamics of the Province Lands overall. Using data from these two studies, CACO's aerial photo archive, and the technical expertise of CACO scientists, Dr. Steve Forman from the University of Illinois, is heading up a study of dune movement and wetland development in the Province Lands since 1938. Preliminary analyses show some very interesting trends. Total dune movement in the past 65 years is between 140 to 314 meters (12 parabolic dunes) and the average dune migration rate is approximately 4 meters per year. The majority of dune movement occurred between 1938 and 1977, with noticeable stability and fluvial dissection of dunes in the 1980s and

90s. The 20th century is characterized by rejuvenation of dune forms and incipient movements. In terms of wetland propagation patterns, the first assessments indicate that wetlands develop contemporaneous with maximum dune migration, reflecting the development of more pronounced topographic lows, but also with catchment "capture" as the blowout enlarges and extends down and up wind. Dr. Forman and collaborators from Western Michigan University were able to trace a number of current wetlands from inception to "full" development with the time series of images. Particularly considering the recent mobilization of the Province Lands dunes, this study will be of key interest and importance to CACO's managers and adjacent communities.

Exotic Plant Inventory Detects Purple Loosestrife; Monitoring Will Track the Success of Control Efforts

In 2000, an exotic species inventory was conducted which described a large population of *Lythrum salicaria* (purple loosestrife) existing in a freshwater pond (Great Pond) of the Province Lands. In an effort to thwart the spread of this species to other nearby ponds and wetlands, approximately 10,000 *Galerucella* spp. beetles were released at the site in August of 2005. Two days after release the beetles had already defoliated a number of loosestrife plants. It is our hope that these beetles will substantially reduce or eradicate purple loosestrife at this site and, subsequently, migrate to other infestations in nearby wetlands. Quantitative monitoring of beetle effects on the pondshore vegetation will continue for the next several years.

Amphibian Monitoring Documents In-Park Range Expansion of Green Treefrogs

Amphibian monitoring in FY2005 refined our knowledge of the distribution of gray treefrogs (*Hyla versicolor*) within CACO. Prior to 2005, this species had been reported to occur in Provincetown (the far north tip of the park), but these reports had not been confirmed or well documented. Since gray treefrogs had only been confirmed in Eastham (the southern end of the park), and had never been reported in either of the two towns in between Eastham and Provincetown despite the presence of suitable habitat, the unconfirmed Provincetown reports were viewed with a degree of uncertainty. This year, the biologists conducting the amphibian monitoring program confirmed gray treefrog occurrence in Provincetown, solidifying our knowledge of their distribution, but leaving intact the puzzle of their geographic discontinuity.

Spadefoot Toad Monitoring Data Leads to Enhanced Protection and Additional Research

In 2001, data collected during development of the amphibian monitoring protocol indicated that CACO's Province Lands support perhaps the largest concentration of Eastern spadefoot toads (*Scaphiopus h. holbrooki*) in the Northeast. Unfortunately much of this data involved counting the number of toads killed on park roads on rainy nights. Additional monitoring in subsequent years indicated that the majority of spadefoots were found on Province Lands Road, which bisects an area of the temporary wetlands preferred by spadefoots. The additional monitoring also provided better data on the weather conditions associated with spadefoot movements. With better ecological data in hand, the park refined road closure plans to better protect spadefoots while maintaining essential access to key areas of the park. Monitoring data were also combined with other information about spadefoot ecology to develop interpretive materials and a community

communication strategy as part of the closure plan. Monitoring data were also used to develop a successful competitive proposal to study spadefoot habitat preferences and movements. In FY2005, the competitive funds were obligated to Dr. Kevin McGarigal and Brad Timm, University of Massachusetts, and field work was initiated in the spring. The study will involve extensive surveys, habitat characterization and mapping, and radio-telemetry.

Piping Plover Disturbance Monitoring Study Tests Two Methods of Quantifying Nest Attendance

In FY2003, Scott McWilliams and Eric Schneider, University of Rhode Island, initiated a study investigating how anthropogenic disturbance affects incubation patterns of piping plovers (*Charadrius melodus*), and comparing the effectiveness of iButton data loggers and custom made thermocouples for measuring nest attendance. This project was supported by the Prototype Monitoring Program and CACO's Over-Sand Vehicle Permit Program. The study found that iButtons were effective for determining when nests were abandoned or predated, but were too insensitive to provide reliable measures of nest attendance. However, use of thermocouples allowed nest attendance to be measured with 93 to 99% accuracy. The study also found that plovers nest attendance patterns were influenced by temperature and levels of human activity. Further, the patterns observed were consistent with the hypothesis that plovers reduce nest activity in response to perceived increased predation risk. The report for this project was finalized in FY2005.

Water Quality Monitoring and Related Studies:

Refining Kettle Pond Monitoring Methods Leads to New Understanding of Pond Nutrient Dynamics

In FY2004 a pilot project was initiated to test the utility of measuring periphyton growth as an indicator of kettle pond water quality. Follow-up work in FY2005 included nutrient diffusions bioassays. Periphyton response to nitrogen and nitrogen/phosphorous diffusion indicates that ponds can become nitrogen limited during summer stratification. This is a fundamental change in our understanding of pond dynamics, and indicates that these ponds may be more susceptible to anthropogenic nitrogen input than previously thought.

I. Overview and Objectives

Ecological Context

Cape Cod is a large glacial peninsula that extends 60 miles into the Atlantic Ocean from the coast of Massachusetts. Cape Cod National Seashore (CACO) encompasses 44,600 acres of marine, estuarine, fresh water, and terrestrial ecosystems. Marine and estuarine ecosystems include barrier islands, beaches, spits, tidal flats, salt marshes, salt ponds, and soft-bottom benthos. Freshwater ecosystems include kettle ponds, vernal pools, sphagnum bogs, forested swamps, and dune slack wetlands. Terrestrial systems include pitch pine and scrub oak barrens, pitch pine forests, oak forests, heathlands, dunes, and

grasslands. Many of these habitats are globally uncommon and the species that occupy them are correspondingly rare.

During the past three centuries Cape Cod ecosystems have been altered profoundly by human occupation. For example, construction of dikes and ditches in estuaries has changed natural tidal regimes resulting in water quality degradation and loss of native plant and animal species. Beach and dune stabilization efforts have interfered with natural processes shaping shorelines. Discharges from non-point sources of pollution such as landfills, septic systems, and golf courses have adversely affected surface and ground-water quality. Fire suppression has altered the distribution and volume of the heathland and pitch pine communities that predominated before European settlement. Some of the highest ozone levels in the northeast have been recorded at CACO. The park includes many municipal and private in-holdings and is surrounded by varying densities of residential and commercial development. Add the over 5 million visitors that come to CACO each year, and the significance of the challenges facing CACO managers becomes apparent.

Program Overview

In 1996, CACO was identified as a prototype park for long-term ecosystem monitoring within the Atlantic and Gulf Coast biogeographic region. As a prototype park and in partnership with U.S. Geological Survey (USGS), CACO was charged with developing and refining long-term monitoring protocols that would support management of Cape Cod's natural resources and that could be of utility to other Atlantic and Gulf Coast parks. With the advent of the network approach to inventory and monitoring, our mission expanded to include focused technical support to the Northeast and Coastal Barrier Network (NCBN). Specifically, our role as a prototype park is to:

- develop and implement a long-term ecological monitoring program that is scientifically sound and relevant to management of park resources;
- test inventory and monitoring methods;
- develop long-term monitoring protocols relevant to CACO and to systems common among parks in the NCBN and the broader biogeographic region;
- conduct studies to refine monitoring questions and help interpret monitoring results; and
- share our experience and technical expertise with parks and networks nation-wide, and with the NCBN and networks in the broader biogeographic region specifically.

Development of the CACO Prototype Monitoring Program was a collaborative effort primarily between USGS and the National Park Service (NPS). USGS provided the bulk of the funding for development of a conceptual framework for the program and for protocol development. CACO began receiving funding specifically for the long-term monitoring program in 1997. Over the past eight years, this funding has been used to support continued collaboration with USGS and other cooperators on protocol development, to implement completed monitoring protocols, to initiate specific studies needed to develop monitoring approaches, to provide information and technical assistance to the NCBN and other parks in the broader biogeographic region, and to build the personnel and logistical capabilities needed for long-term monitoring.

We are still in transition from a developmental phase to an operational phase: of our twenty one high- and mid-priority monitoring projects, seven are operational, one protocol has completed peer review and is being finalized, one protocol is awaiting peer review, five protocols are being drafted, and seven protocols are still in development. We have developed a prioritized approach for phasing in monitoring projects as program capacity allows, filled our key permanent and term positions, made substantial investments in durable lab and field equipment, and have made significant progress on a comprehensive data management system. Over the next few years, our attention will be focused on implementing our highest priority projects, phasing in our mid-priority projects as program capacity allows, and completing and maintaining the data management system.

The CACO Prototype Monitoring Program also emphasizes partnership and integration with the Atlantic Research Center (ARC), another element of the Natural Resource Challenge located at Cape Cod National Seashore. We have already seen substantial benefits from an integrated approach to management of these two highly related programs. For example, in FY2005:

- the ARC provided housing to several cooperators working on protocol development allowing monitoring program dollars to stretch further;
- information generated through protocol development and monitoring has attracted externally funded research that is facilitated by ARC housing and analytical services;
- ARC resources supported a graduate student monitoring bivalve response to restoration of tidal influence in East Harbor; and
- integration of research and prototype monitoring coordination roles have improved efficiency and integration, and have made a larger portion of each funding source available to support monitoring and research projects.

As the monitoring program matures, and as ARC facilities and partnerships develop, we anticipate that the synergy between the two programs will grow, particularly with respect to attracting and supporting research that expands on the results of long-term monitoring.

Objectives

Our program objectives are listed below. The ecosystem approach for organizing our monitoring objectives (objectives 1-6) is based on the *Conceptual Framework for the Development of Long-term Monitoring Protocols at Cape Cod National Seashore* (Roman and Barrett 1999) and its 2002 Update (Boland *et al.* 2002). These documents also describe the conceptual models used to select specific monitoring components, provide justification for each monitoring project, enumerate the specific monitoring questions being addressed, and identify the parameters being measured. Selection of the specific activities planned under these objectives has been guided by the project prioritization and implementation scheme described in *2003 Cape Cod National Seashore LTEM Project Prioritization Report* (Phillips 2003). Objectives seven through eight address information sharing, reporting, and technical support to other monitoring programs. Objective nine focuses on program management and infrastructure.

Cape Cod Prototype Monitoring Program Objectives:

1. Assess and monitor the integrity of estuarine and salt marsh ecosystems.

2. Assess and monitor the integrity of beach, spit, and barrier island ecosystems.
3. Assess and monitor the integrity of pond and freshwater wetland ecosystems.
4. Assess and monitor the integrity of coastal upland ecosystems.
5. Assess and monitor park-wide and multiple-system indicators of ecosystem integrity.
6. Integrate monitoring efforts and results within and across ecosystems.
7. Share information, report findings, and document program activities.
8. Provide technical assistance to the NCBN, to other networks and parks, and to other entities with common monitoring objectives.
9. Develop and sustain a comprehensive data management program, appropriate staff resources, laboratory infrastructure, and programmatic procedures to ensure program objectives can be met now and into the future.

Objectives 1 and 3 include water quality monitoring; specifically Tasks 1.2 (estuarine nutrient enrichment), and 3.1 (kettle pond water quality monitoring). Further, Tasks 1.1, 1.3, 1.4, and 3.1 directly pertain to 303d-listed water bodies (Herring River and Ryder Pond).

II. Accomplishments (FY2005) and Scheduled Activities (FY2006)

Objective 1 - Assess and monitor the integrity of estuarine and salt marsh ecosystems: The accomplishments and planned activities in Tasks 1.1, 1.3, and 1.4 contribute to the estuarine restoration goals in CACO's General Management Plan (GMP) (NPS 1998). Also, these tasks are being used in restoration planning for the Herring River system - a formerly tidal creek that does not meet water quality standards for metals and acidity. Consequently, this objective also contributes to NPS Strategic Plan Goal 1a4.

Task 1.1 - Monitor salt marsh sediment elevation response to sea level rise

FY2005 Accomplishments:

- Salt marsh accretion, erosion, and relative elevation were measured at established salt marsh surface sediment elevation table (SET) sites in two estuaries (Hatches Harbor and Nauset Marsh). SET measurements were not collected from the salt marsh pool sites in Nauset Marsh due to severe ice damage to the SET mounts.
- Sediment elevation monitoring methods are well established and documented by USGS; however, application of these methods at CACO had not been documented in a formal protocol. In FY2005, Dr. Don Cahoon (USGS) drafted a formal protocol specific to CACO that also provides guidance for developing sediment elevation monitoring programs at other parks in the NCBN and larger biogeographic region (Cahoon *et al.* 2005). We provided formal review and comment on the draft protocol and expect that it will be finalized in early FY2006. USGS funds supported Dr. Cahoon's and his co-authors' work on the protocol.

Scheduled FY2006 Activities:

- In FY2006, we will continue to collect accretion, erosion, and relative elevation measurements at established marsh-surface SET sites in three estuaries (Hatches Harbor, Nauset Marsh, Herring River/Wellfleet Bay).
- In FY2005, USGS recommended switching from brass to fiberglass rods in the SET apparatus. We will implement this change at our second round of FY2006

monitoring by collecting duplicate measurements, one set with the brass rods and one with the fiberglass, at marsh-surface SET sites.

- We will also work with Dr. Cahoon to determine whether or not continued monitoring of the salt marsh pool sites in Nauset Marsh is feasible and worthwhile, and if so, to determine what additional site design and quality control measures should be incorporated into current methods to account for ice damage.
- In FY2006 we also plan to develop an Access database for the SET project and import the existing data which is currently in Excel.
- SET data collected in 2006 will be incorporated in a system-specific report for Hatches Harbor.

Task 1.2 - Monitor estuarine nutrient enrichment

FY2005 Accomplishments:

- In FY2005 we provided detailed review and comment on the draft protocol for monitoring estuarine nutrient enrichment. This protocol was developed by Drs. Hilary Neckles and Blaine Kopp, USGS, and was supported by the NCBN (Kopp and Neckles 2005). We expect the protocol will be finalized during the first or second quarter of FY2006.
- In FY2005 we also assisted Drs. Neckles and Kopp with implementation of the submerged aquatic vegetation (SAV) portion of the project.

Scheduled FY2006 Activities:

- In FY2006 we will continue planning and purchasing instrumentation as needed to establish sampling sites and begin collecting field measurements for the water quality portion of the project. This protocol will involve intensive field and lab operations that we expect to be logistically challenging. While we would like to plan for full implementation in 2006, it is likely this will be a pilot year for testing and refining field operations, leading to full implementation in FY2007.
- We will also continue to work with the NCBN and USGS to formulate a strategy for efficient and reliable long-term implementation of the SAV portion of the protocol.

Task 1.3 - Monitor salt marsh vegetation

FY2005 Accomplishments:

- Completed a report on the salt marsh vegetation work completed in FY2004 (Smith 2005a).
- Continued to monitor salt marsh vegetation response to restoration of marine influence at East Harbor and Hatches Harbor.
- Continued to monitor SAV response [widgeon grass (*Ruppia maritima*) and eelgrass (*Zostera marina*)] in the recovering East Harbor system.
- Established and collected baseline data from the remaining planned vegetation transects in the Herring River in anticipation of future restoration of marine influence. Herring River will be integrated into the overall salt marsh vegetation monitoring program as the restoration proceeds.
- Continued to monitor the salt marsh die-back at Middle Meadow and The Gut (first detected during salt marsh monitoring in 2003), and established informal collaboration into the occurrence and causes of die-back with the State of Connecticut, the Department of Plant Pathology and Crop Physiology at Louisiana State University, and Rachel Carson National Wildlife Refuge.

- In collaboration with Dr. Scott Warren, Connecticut College, submitted a manuscript to the Journal of Coastal Research on an inexpensive and time-efficient water mark method for determining elevations in tidal marshes (Smith and Warren 2005).

Scheduled FY2006 Activities:

- Prepare a monitoring report on the salt marsh vegetation monitoring work completed in FY2005.
- Incorporate 2005 vegetation monitoring data into system-specific reports for Hatches Harbor, East Harbor, and Herring River.
- Continue to monitor vegetation response to restoration of marine influence at East Harbor and Hatches Harbor.
- Continue monitoring SAV response [widgeon grass (*Ruppia maritima*) and eelgrass (*Zostera marina*)] in the recovering East Harbor system.
- Continue to monitor salt marsh die-back at Middle Meadow and The Gut, and continue existing informal collaboration into die-back occurrence and possible causes. In addition, and in partnership with the ARC, we hope to interest other researchers in developing a more in-depth collaborative study on the extent and causes of salt marsh die-back on the Cape.
- Salt marsh vegetation monitoring at CACO is guided by the protocol completed by USGS in 2001 (Roman *et al* 2001). This protocol was also adopted by the NCBN, and in 2005, they completed substantial work on converting the protocol to the National I&M format. However, in applying this approach to other network parks, several questions have arisen regarding spatial elements of the design. In FY2006, the NCBN is planning to obtain external review and recommendations for a revised spatial sampling design if needed. We plan to assist the NCBN with assessment of the review results, and revision of the protocol if necessary. If protocol revision is not necessary, we will work with the NCBN to include the CACO-specific elements of this project in the conversion to the I&M protocol format.
- We also plan to revise the salt marsh vegetation database in concert with revisions or refinements to the protocol and in collaboration with NCBN.

Task 1.4 - Monitor estuarine benthos and nekton

FY2005 Accomplishments:

- Provided technical assistance and logistical support to Dr. Sheldon Pratt, University of Rhode Island (URI), who is developing the estuarine benthos monitoring protocol. In this third year of the project, efforts focused on sample processing and statistical analysis. We expect a draft final report and protocol in FY2006. This project is supported by CACO Prototype Monitoring Program and USGS Prototype Development funds through a cooperative agreement between USGS and URI executed in FY2002 .
- Continued monitoring nekton response to the restoration of marine influence in East Harbor and Hatches Harbor, and continued pre-restoration monitoring in the Herring River system. Monitoring methods are described in the nekton monitoring protocol (Raposa and Roman 2001).
- Collaborated with the NCBN to continue nekton monitoring at Nauset Marsh. This was the second year of a five year effort to improve estimates of annual variability in order to refine the sampling frequency recommended in the protocol.

Scheduled FY2006 Activities:

- Provide technical support, review, and comment as necessary to assist Dr. Pratt in producing a draft final report and protocol for monitoring estuarine benthos.
- Collaborate with the ARC to bring a URI Coastal Fellow or other intern to the park to monitor the response of the benthic community to restoration in East Harbor.
- Prepare a report on the nekton monitoring work completed during 2003, 2004, and 2005.
- Incorporate nekton data collected in 2005 into system-specific reports for Hatches Harbor, East Harbor, and Herring River.
- Continue to monitor nekton response to the restoration of marine influence in East Harbor and Hatches Harbor.
- Continue monitoring nekton at Nauset Marsh in collaboration with the NCBN.
- Nekton monitoring at CACO is guided by the protocol completed by USGS in 2001 (Raposa and Roman 2001). This protocol was also adopted by the NCBN, and in 2005, they completed substantial work on converting the protocol to the National I&M format. However, in applying this protocol to other network parks and to the restoring systems at CACO, several questions have arisen regarding the sampling design. In FY2006, the NCBN is planning to obtain external review and recommendations for a revised sampling design if needed. We plan to assist the NCBN with assessment of the review results, and revision of the protocol if necessary. If protocol revision is not necessary, we will work with the NCBN to include the CACO-specific elements of this project in the conversion to the I&M protocol format.
- We also plan to revise the nekton database in concert with revisions or refinements to the protocol and in collaboration with NCBN.
- We have found that the sampling gear and methods in the nekton protocol are impractical to use or of limited utility in some of CACO's altered salt marsh habitats. If time allows in FY2006, we plan to develop and test alternate sampling gear for use in these difficult habitats. If necessary, depending on the gear developed, we may also need to develop a study plan for determining the reliability of density estimates provided by the new gear.

Objective 2 - Assess and monitor the integrity of beach, spit, and barrier island ecosystems.

The accomplishments and planned activities in Task 2.1 implement the long-term monitoring strategy under the Coastal Processes Goal in CACO's GMP.

Task 2.1 - Develop geomorphic shoreline change monitoring protocol

FY2005 Accomplishments:

- The NCBN has taken the lead on developing geomorphic shoreline change monitoring protocols that will apply to network parks. We anticipate adopting those portions of the NCBN protocols applicable to CACO's shorelines, and developing additional approaches for those shoreline features and processes unique to CACO. In FY2005, we provided review and comment on the ocean shoreline position protocol being prepared by the NCBN (Duffy *et al.* 2005).
- Coordinated with the NCBN on flight lines and ground-based operations for acquisition of light distance and ranging (LIDAR) data.

Scheduled FY2006 Activities:

- In FY2006, the NCBN is planning to obtain external review and recommendations on the sampling design for the ocean shoreline position protocol. We plan to assist the NCBN with assessment of the review results, and revision of the draft protocol if necessary. We also plan to develop the CACO-specific elements of the ocean shoreline position protocol.
- Begin collecting data for the ocean shoreline position protocol.
- Locate potential cooperators and potentially enter into a cooperative agreement for development of the data analysis procedures for the CACO-specific elements of shoreline change monitoring.

Task 2.2 - Monitor beach and barrier island nesting birds

FY2005 Accomplishments:

- CACO's Division of Natural Resource Management (NRM) monitored the breeding population and productivity of piping plovers (*Charadrius melodus*) at CACO. This monitoring project was initiated in 1985 and is funded with NRM base funds.
- NRM also monitored breeding populations and nesting effort of beach-nesting colonial waterbirds.
- Provided review and comment on the final report for the piping plover disturbance monitoring study (Schneider 2005). This project was funded by the Prototype Monitoring Program (FY2003) and the Over-Sand Vehicle Permit Program through the CESU. One of the outcomes of the project was the comparison of two different techniques for monitoring disturbance to beach nesting birds.

Scheduled FY2006 Activities:

- NRM will continue to monitor piping plover and beach-nesting colonial waterbird productivity.

Objective 3 - Assess and monitor the integrity of pond and freshwater wetland ecosystems.

All the tasks associated with this objective further the strategies described in CACO's GMP for protecting water quality, water quantity, and wetlands. Also, the water quality monitoring discussed in Task 3.1 includes Ryder Pond - a pond that does not meet water quality standards for nutrients; therefore this objective also contributes to NPS Strategic Plan Goal 1a4.

Task 3.1 - Monitor kettle pond water quality and limnology

FY2005 Accomplishments:

- Collected water quality monitoring data from all 20 CACO kettle ponds as guided by the protocol (Portnoy *et al.* 2003b).
- Developed methods for importing kettle pond data from CACO's Access-based kettle pond water quality database into NPStoret.
- Initiated a rigorous review of recent (since the inception of the CACO Prototype Monitoring Program and historic (extending back over 20 years) kettle pond monitoring data. USGS Water Resources Division (USGS-WRD) is providing assistance with data analysis. At a minimum, this review will culminate in a peer-reviewed technical report. If protocol revision is indicated, the technical report will form the basis of the narrative section of a revised protocol, and the protocol document will be converted to the National I&M Program format.

- Completed a report on the work completed in 2004 assessing periphyton as a monitoring tool for kettle pond water quality (Smith 2005b). This report, completed before the field season, also included detailed plans for the additional work performed during the 2005 field season.
- Completed the periphyton work planned for 2005 which included nutrient diffusion bioassays. Results indicate that nitrogen limitation occurs during summer stratification - this is a fundamental change in our understanding of pond dynamics and susceptibility to anthropogenic influences.

Scheduled FY2006 Activities:

- Continue annual monitoring at all ponds according to the current protocol. We will not implement any changes in the field until the review and protocol revision have been peer reviewed.
- Complete loading kettle pond water quality data into NPStoret.
- Produce a draft report on the kettle pond water quality protocol review.
- Prepare a report on the periphyton work completed in 2005 and a study plan for the work planned for FY2006. A manuscript on the nutrient diffusion bioassay portion of the project will be developed and submitted to an appropriate journal.
- Continue implementation of the periphyton monitoring and nutrient diffusion bioassay project.

Task 3.2 - Characterize and develop monitoring strategies for vernal pools and dune slack wetlands

FY2005 Accomplishments:

- Completed a report on the two-year dune slack wetland study with recommendations for future monitoring. This project was supported by competitive funds from NPS-Water Resource Management Division (NPS-WRD).
- If time allows, the dune slack wetland report will be developed into a manuscript to be submitted to an appropriate journal.

Scheduled FY2006 Activities:

- Prepare a study plan for development of a vernal pool vegetation monitoring protocol. Implement the intensive method testing and related field experimentation elements of the study plan. Completion of a draft protocol is planned for FY2007 or 2008.

Task 3.3 - Monitor pond vegetation

FY2005 Accomplishments:

- Completed intensive method testing and field experimentation for development of a pond vegetation monitoring protocol.
- Continued monitoring responses to various exotic plant control projects including manual control of common reed (*Phragmites australis*) and bio-control of purple loosestrife (*Lythrum salicaria*).
- A manuscript on manual control of *Phragmites* in freshwater ponds (submitted in 2004) was published in the Journal of Aquatic Plant Management (Smith 2005c)

Scheduled FY2006 Activities:

- Prepare a draft pond vegetation monitoring protocol for peer review.
- Develop a database and data management SOP for pond vegetation monitoring.
- Continue monitoring responses to exotic plant control projects.

Task 3.4 - Inventory and develop a monitoring protocol for freshwater aquatic invertebrates

FY2005 Accomplishments:

- Continued to provide technical assistance and logistical support to the principal investigator developing this protocol (Dr. Elizabeth Colburn, Harvard Forest). This project was initiated in FY2002 through a cooperative agreement with Harvard Forest.

Scheduled FY2006 Activities:

- Continue to provide technical assistance and logistical support as needed. Provide review and comment on a draft report and protocol if they become available in FY2006.

Task 3.5 - Inventory and monitor amphibians

FY2005 Accomplishments:

- Prepared a monitoring report on the amphibian monitoring work completed in 2004 (Cook et al 2005).
- Redesigned the previous database, designed to hold data for amphibian monitoring and turtle inventories, into a more robust stand-alone data base for the amphibian monitoring project.
- Conducted the third year of monitoring according to the protocol (Paton *et al.* 2003). This included implementing the egg mass count component at 20 sites and the anuran call count component at 30 sites.
- In addition to conducting the egg mass counts according to the long-term monitoring protocol, we also conducted egg mass counts at an additional 20 ponds as part of the USGS Amphibian Research and Monitoring Initiative (ARMI) program.
- A manuscript comparing two methods of counting spotted salamander egg masses (submitted in 2004) was published in Herpetological Review (Cook and Boland 2005).
- Provided technical, logistical, and field assistance to Dr. Kevin McGarigal, University of Massachusetts (UMass) on initiation of a study of Eastern spadefoot toad (*Scaphiopus h. holbrooki*) habitat use and movements at CACO. FY2005 is the first year of the planned two-year project. The need for this study became apparent during development of the amphibian monitoring protocol when data indicated that CACO supported a regionally-significant population of spadefoot toads, and extensive road mortality was observed. This study is supported by competitive NRPP funding. Data from the amphibian monitoring project was critical to development of the successful funding proposal.

Scheduled FY2006 Activities:

- Prepare a monitoring report for the work completed in FY2005, and a study plan for collecting additional hydrological data from study sites in FY2006.
- Implement the fourth year of monitoring according to the protocol and collect additional hydrological data.
- Implement the third year of the USGS-ARMI project at CACO.
- Continue to provide technical, logistical, and field assistance for the spadefoot toad study.
- Complete a report on the terrestrial salamander inventory work conducted in FY2000 and 2001.

Task 3.6 - Inventory and monitor aquatic turtles

FY2005 Accomplishments:

- Completed a review draft of the aquatic turtle study conducted from 1999 through 2003 (Cook *et al* 2004b).

Scheduled FY2006 Activities:

- Obtain peer review and finalize the aquatic turtle report.

Objective 4 - Assess and monitor the integrity of coastal upland ecosystems.

The accomplishments and planned activities under Task 4.2 are integral to development of the heathland management plan called for in CACO's GMP.

Task 4.1 - Characterize dune habitat parameters and develop a dune grassland vegetation monitoring protocol

FY2005 Accomplishments:

- Completed method development and preliminary field studies necessary for development of a dune grassland monitoring protocol.

Scheduled FY2006 Activities:

- Complete a report on protocol development studies. Preparation of a complete draft protocol will be deferred until FY2007.

Task 4.2 - Develop a monitoring protocol for coastal heathlands

Scheduled FY2006 Activities:

- Adapt the report on coastal heathland protocol development work (completed in FY2004) into a full monitoring protocol. Alternatively, depending on park priorities, emphasis may be transferred to development of a heathland management plan.

Task 4.3 - Monitor coastal forest vegetation

Scheduled FY2006 Activities:

- Obtain peer review of the draft coastal forest vegetation monitoring protocol completed during FY2004. Finalize the protocol based on reviewers comments.

Task 4.4 - Inventory terrestrial reptile.

FY2005 Accomplishments:

- Continued monitoring Eastern box turtles (*Terrapene carolina carolina*) through incidental encounters.

Scheduled FY2006 Activities:

- Continue incidental Eastern box turtle monitoring.
- Complete a report on the snake inventory work conducted in FY2001 and 2002.

Task 4.5 - Monitor land birds

FY2005 Accomplishments:

- Provided technical assistance and received an interim report for the northern harrier (*Circus cyaneus*) inventory initiated in F2003. This study is being conducted by Rhys Bowen through a cooperative agreement with the Manomet Center for Conservation Sciences (Manomet).

Scheduled FY2006 Activities:

- Provide review and comment on the final report for the northern harrier project.
- We expect a draft monitoring protocol based on point counts to become available from Dr. Curt Griffin, UMass; we will provide the review and assistance necessary to complete the protocol. This project was initiated through a cooperative agreement with UMass in FY2000.

Task 4.6 - Assess the feasibility of small mammal monitoring

FY2005 Accomplishments:

- In FY2004 we obtained peer review of a draft report evaluating the utility and feasibility of a small mammal monitoring protocol based on a two-year field testing phase. In FY2005, this report was finalized in light of reviewers' comments (Cook *et al.* 2004a).

Task 4.7 - Develop a protocol for long-term meso-mammal monitoring

FY2005 Accomplishments:

- Provided technical assistance and logistical support for the last season of field work for the meso-mammal protocol development study led by Dr. Allan O'Connell, USGS. This project is funded by USGS.

Scheduled FY2006 Activities:

- Provide review and comment on the report and draft protocol; we anticipate these products will become available in early FY2006.

Objective 5 - Assess and monitor park-wide and multiple-system indicators of ecosystem integrity. The accomplishments and planned activities noted in Task 5.1 implement the research, monitoring, and effects detection strategies in CACO's GMP under the Air Resources Goal; those in Task 5.2 contribute to the water quality and quantity protection strategies in CACO's GMP; and those in Task 5.3, together with the array of vegetation monitoring activities described throughout this report and work plan, are part of the native plant and wildlife habitat restoration strategy described under the biotic resource management goal in CACO's GMP.

Task 5.1 - Monitor meteorologic, atmospheric deposition, and air quality parameters

FY2005 Accomplishments:

- Monitored precipitation and atmospheric deposition through National Atmospheric Deposition Program (NADP) and the Mercury Deposition Network (MDN), aerosols through the Interagency Monitoring of Protected Visual Environments (IMPROVE) program, and ozone in partnership with the State.
- Collaborated with the ARC and National Oceanic and Atmospheric Administration (NOAA) on the installation of a new weather station at the Highlands Center. This station is part of NOAA's new Environmental Real-Time Observation Network (NERON).

Scheduled FY2006 Activities:

- Continue to implement the meteorologic and atmospheric monitoring programs identified above.
- Begin revising the meteorologic and atmospheric monitoring protocol (USGS, URI, CACO 2001) by developing SOPs for in-park procedures, updating links to partner data sources, and begin addressing data management. Our FY2006 work plan for this project may change depending on the progress made by the National I&M Program as they develop meteorologic monitoring resources.

Task 5.2 - Monitor hydrology and ground water quality

FY2005 Accomplishments:

- Continued implementation of the ground water and pond stage portion of the hydrologic monitoring protocol (McCobb and Weiskel 2003).
- Loaded hydrology monitoring data into NPStoret.

- The protocol uses siphon wells for measuring pond stage. However, over the past several years we have encountered significant maintenance and vandalism problems with the majority of the siphon wells. In FY2005 we examined the feasibility of switching to simply surveying pond stage and found this approach to be reliable and much more efficient.
- With technical assistance from USGS-WRD, began field evaluation and testing of approaches for modifying the standard stream gauging techniques called for in the protocol. Application of these techniques in tidally-influenced systems has proven infeasible with existing staffing given the timing constraints presented by tide cycles.

Scheduled FY2006 Activities:

- Continue implementation of the ground-water and pond-stage portion of the protocol.
- The ground-water portion of the hydrology monitoring protocol was developed to address questions pertaining to ground-water dynamics, salt-water intrusion, effects of sea-level rise, and effects of ground-water extraction. However, ground water data are also important ancillary data to a number of other studies and monitoring projects. In FY2006 we will complete and document a review of the monitoring well network to ensure that we are collecting data to support other studies and monitoring projects in addition to satisfying the ground water monitoring objectives of the protocol.
- Document the switch from siphon wells to surveying for monitoring pond stage.
- Continue to work with USGS to resolve the problems with the stream gauging portion of the protocol.
- Provide technical assistance and additional review and comment to Dr. John Colman, USGS-WRD, as needed to complete the ground-water quality protocol drafted in FY2004 (Colman and Masterson 2004).

Task 5.3 - Complete the cover-type map and develop a long-term approach for cover-type change monitoring

FY2005 Accomplishments:

- In FY2004, we obligated funds (from the national Vegetation Mapping Program) to NatureServe to conduct a thematic accuracy assessment of the cover type map based on aerial photography from 2000. In FY2005 all accuracy assessment points (approximately 500) collected in field season 2004 were entered into the PLOTS database by NatureServe, and CACO submitted the map attribute for each point. Map accuracy based on originally mapped units is likely to be lower than desired because some associations are not detectable on photography. A second analysis will collapse some of the units into broader map classes (pondshores are a good example), and we expect this will increase the accuracy of the map.

Scheduled FY2006 Activities:

- NatureServe will provide contingency tables and data analyses, as well as a final report to CACO by December 31, 2005.
- In collaboration with the NCBN, we will develop a study plan for development of a remote sensing based approach to monitoring cover type change. We anticipate the study plan will include tasks that can be initiated in FY2006 such as acquisition of remotely sensed data representative of conditions that correspond to the most recent CACO vegetation map, pilot data analyses, and initial algorithm development and testing.

Task 5.4 - Develop a protocol for monitoring the effects of visitation

FY2005 Accomplishments:

- This project was initiated by USGS in FY2000 with support from USGS Prototype Development funds, and field work was conducted in 2001. A final report or protocol has not been completed. Since that time, the NCBN has conducted a study assessing visitor use monitoring needs for the seven other parks in the Network. In FY2005 we participated in a workshop organized by the NCBN to review the results of both studies, review and revise initial visitor-use effects monitoring questions, and develop potential integrated approaches for monitoring.

Scheduled FY2006 Activities:

- Continue to collaborate with the NCBN to refine the monitoring questions and develop and appropriate Network-wide protocol.

Objective 6 - Integrate monitoring efforts and results within and across ecosystems

Task 6.1 - Enhance commonalities and coordination among protocols

FY2005 Accomplishments:

- Several park projects, including the developing estuarine nutrient enrichment monitoring project, involve extensive use of extended-deployment data loggers manufactured by Yellow Springs Instruments (YSI). In FY2005 we re-organized and upgraded our YSI maintenance, deployment, documentation, and data management procedures. This has improved efficiency, data quality, and our ability to integrate analysis and interpretation of data from multiple projects. This will also contribute to successful implementation of the estuarine nutrient enrichment monitoring project.
- Please see Task 5.2 above regarding review and possible expansion of the ground-water well monitoring network to provide ancillary data for other projects.

Scheduled FY2006 Activities:

- As project design and implementation are field tested and refined, we will continue to look for opportunities to enhance integration and efficiency.

Task 6.2 - Integrate analysis of monitoring results

Scheduled FY2006 Activities:

- In FY2006 we plan to integrate analyses of sediment elevation, vegetation, and nekton monitoring with data collected through other park projects on a salt-marsh system specific basis.

Objective 7 - Share information, report findings, and document program activities.

Task 7.1 - Share information with non-technical audiences

FY2005 Accomplishments:

- Staff gave presentations about the program and the results of monitoring activities to a variety of public groups such as the Gull Pond Citizens Association, and visitors to the Province Lands Visitors' Center.
- Program staff led interpretive programs in the new "In the Field With A Park Scientist" series. These programs give visitors an opportunity to learn about park science programs and projects, engage directly with park scientists, and experience data collection in the field. The projects featured included the nekton, dune grassland, and amphibian monitoring projects.

Scheduled FY2006 Activities:

- Continue to provide information through training, presentations, articles or other appropriate venues as opportunities arise.
- Continue to participate in the "In The Field With A Park Scientist" series.

Task 7.2 - Share technical information with CACO managers, other NPS audiences, scientists, and other entities interested in monitoring and resource management

FY2005 Accomplishments:

- Conducted training sessions for seasonal interpretive staff.
- Program staff helped organize and gave presentations to park managers and senior staff at a CACO Leadership Meeting focused on natural resources and science.
- In addition to the reports and articles mentioned under other objectives, staff and cooperators gave presentations on program projects at the National I&M Meeting, the Hatches Harbor Technical Advisory Committee, the Salt Marsh Die-Back Workshop, the New England Estuarine Research Society, the Wildlife Society, the Provincetown Conservation Commission, and the Cape Cod Natural History Conference.
- Added selected reports and other documents completed during the year to the CACO Prototype Monitoring Program website at <http://www.nature.nps.gov/im/units/caco/index.htm>

Scheduled FY2006 Activities:

- In partnership the ARC, we hope to complete most of the planning and preparation for a CACO Science Symposium to be held in early FY2007.
- Continue to share program results and other technical information through presentations, posters, workshops, and other appropriate venues as opportunities arise.

Task 7.3 - Document program methods, activities, and findings

The specific protocol development, reporting accomplishments and planned activities identified throughout this report and work plan are summarized below; citations are provided in Section IV.

FY2005 Accomplishments:

- Provided review for the following draft protocols:
 - draft SET Protocol (prepared by USGS)
 - draft Estuarine Nutrient Enrichment Protocol (prepared by USGS and supported by the NCBN)
 - draft Ocean Shoreline Position Protocol (prepared by the NCBN)
- Completed the following reports:
 - salt marsh vegetation monitoring report on FY2004 activities
 - manuscript on the water mark method for determining elevations in tidal marshes (in collaboration with Dr. Scott Warren, Connecticut College, submitted to the Journal of Coastal Research)
 - final report on the plover disturbance monitoring study (prepared by Eric Schneider, URI)
 - report on the periphyton work completed in 2004
 - final report on the dune slack wetland study
 - report on the amphibian monitoring work completed in 2004
 - draft report on the aquatic turtle inventory
 - interim report on the northern harrier study (prepared by Rhys Bowen, Manomet)

- final report on the small mammal inventory and protocol assessment.

Scheduled FY2006 Activities:

- The following protocols and protocol development reports, being prepared by cooperators, may be completed or become available for review in FY2006:
 - final SET protocol (being prepared by USGS)
 - final estuarine nutrient enrichment protocol (being prepared by USGS with support from NCBN)
 - draft benthic macrofauna protocol or report (being prepared by URI)
 - draft freshwater macroinvertebrate protocol or report (being prepared by Harvard Forest)
 - draft landbird protocol or report (being prepared by UMass)
 - draft meso-mammal protocol or report (being prepared by USGS)
 - draft or final ground-water quality protocol (being prepared by USGS-WRD)
- The following protocols are being developed in-house; we anticipate completing review drafts or final documents FY2006:
 - draft pond vegetation protocol for peer review
 - draft heathland protocol or management plan for peer review
 - final coastal forest vegetation monitoring protocol
- We also plan to prepare the following reports:
 - report on the salt marsh vegetation work completed in 2005
 - report on the nekton monitoring work completed in 2003, 2004, and 2005
 - integrated system-specific reports on the work completed in 2005 on Hatches Harbor, East Harbor, and Herring River
 - draft report on the kettle pond water quality protocol review
 - report on the periphyton work completed in 2005 and a study plan for the work planned for 2006
 - if time allows, a manuscript on the periphyton work for submittal to an appropriate journal
 - if time allows, a manuscript on the dune slack wetland study for submittal to an appropriate journal
 - study plan for the vernal pool vegetation monitoring work planned for 2006
 - report on the amphibian monitoring work completed in 2005 with a study plan for the additional hydrology data to be collected in 2006
 - report on the terrestrial salamander inventory
 - final aquatic turtle inventory report following peer review
 - report on the dune grassland protocol development work completed in 2005
 - report on the snake inventory
 - final report on the northern harrier study (being prepared by Manomet)
 - final report on the thematic accuracy assessment for the vegetation map (being prepared by NatureServe).

Objective 8 - Provide technical assistance to other networks, parks, and other entities with common inventory, monitoring, and research objectives.

Task 8.1 - Share technical expertise with other networks and parks

FY2005 Accomplishments:

- Contributed to a several national data management efforts including:

- worked with NPS-WRD and the Prairie Cluster Prototype to test NPStoret with real project data
- organized and hosted a workshop on NPStoret at the Meeting of the Networks in Austin, Texas
- served on the team that developed Version 3 of the Natural Resource Database Template (NRDT), tested and trouble shot the end product using real project data, developed and tested recommended improvements, and provided technical assistance on its use and adaptation to several data managers
- developed form templates that are potential extensions to the NRDT tables
- demonstrated the NRDT and the form templates at the Data Management meeting in Bangor, Maine
- served on the informal committee addressing the I&M data standards
- participated in the Data Management Planning meetings with the first 12 networks
- reviewed two chapters of the Phase 3 Data Management Plans.
- Provided assistance to the NCBN with database debugging and programming.
- Provided technical assistance with guidance, peer review, and debugging help to numerous data managers.
- Continued to provide technical leadership for the NPS-Wildlife Conservation Society inventory of Northeast Region amphibians and reptiles. Inventory reports were produced on a variety of taxa for ACAD, MORR, DEWA, SARA, MIMA, WEFA, SAIR, SAGA, FIIS, WIFL, SAHI, ASIS, and GATE.
- The analytical lab, which is supported by NRM, the ARC, and the Prototype Monitoring Program, provided analytical support and technical assistance to GATE for sulfide analysis of salt marsh porewater and to SAGA for nutrient analysis.
- Assisted in the evaluation of natural resource implications for SAHI GMP alternatives.
- Provided peer reviewed for wildlife research proposals at GATE.

Scheduled FY2006 Activities:

- Continue to provide technical leadership for the NPS-Wildlife Conservation Society inventory of Northeast Region amphibians and reptiles. Activities in F2006 will continue to focus on finalizing reports.
- Continue to provide technical, data management, and analytical assistance and support as opportunities arise.

Task 8.2 - Provide technical assistance to other inventory, monitoring, and research efforts

FY2005 Accomplishments:

- CACO scientific staff continued to serve on the committees of several graduate students conducting research related to protocol development or monitoring. These included:
 - Todd Tupper, George Mason University, PhD candidate studying Fowler's toad (*Bufo fowleri*) ecology
 - Brad Timm, UMass, PhD candidate studying spadefoot toad ecology
 - Mark Faherty, UMass, MS candidate studying landbird communities and monitoring methods

- Marybeth Hanley, URI, MS candidate studying dune slack wetland plant communities.
- Provided peer reviewed for proposals for the Native Plant Conservation Initiative of the National Fish and Wildlife Foundation.
- Conducted surveys for the rare plant *Orontium aquaticum* for the New England Plant Conservation Program (NEPCOP) and continued to serve on the NEPCOP Regional Advisory Commission.
- Provided specimen collection and technical assistance to researchers studying *Pityopsis falcata*, *Phragmites* genetic heterogeneity, the exotic willow *Salix cinerea*, estuarine macroalga, and fungus-infected *Spartina alterniflora*.
- Provided the Massachusetts Natural Heritage and Endangered Species program with reports of all observations during FY2005 of state-listed threatened and endangered species at CACO.
- Provided peer review of box turtle related papers for the Journal of Herpetology and other publications of the Society for the Study of Amphibians and Reptiles.
- Contemporaneously with our own monitoring efforts, collected water quality data and samples for a county-wide water quality monitoring program.
- Assisted the Orleans Pond Association with acquisition of bathymetry data for several ponds in the town of Orleans.
- Assisted a number of researchers with acquisition of tidal and hydrologic data either through sharing data already collected by CACO or through collaborative deployment and recovery of instruments in systems of common interest.
- The analytical lab provided analytical support and technical assistance to Rachel Carson National Wildlife Refuge for sulfide analysis of salt marsh porewater samples collected from Maine and Connecticut, and to the lower Cape towns of Eastham, Orleans, Brewster, and Dennis for long-term kettle pond water quality monitoring.
- Provided technical assistance and laboratory analyses in a collaborative water quality monitoring project with Massachusetts Audubon's Wellfleet Bay Wildlife Sanctuary and the Wellfleet Natural Resources Advisory Board focused on Wellfleet Harbor and Duck Creek.
- The analytical lab also completed method development for analysis of tissue nutrient content in *Ulva* for a collaborative study with USGS on estuarine nutrient enrichment.

Scheduled FY2006 Activities:

- Continue to provide technical and analytical assistance as time and resources allow.

Objective 9 - Develop and sustain a comprehensive data management program, appropriate staff resources, laboratory infrastructure, and programmatic procedures to ensure program objectives can be met now and into the future.

Task 9.1 - Build and maintain a comprehensive data management program; these accomplishments and tasks are in addition to those described under the specific projects above.

FY2005 Accomplishments:

- Began development of a comprehensive database of all inventory and monitoring project locations.
- Developed a database to better manage CACO's inventory of GIS data.
- Drafted a CACO-specific NPStoret users guide.

- Drafted a file naming conventions SOP.
- Continued to improve the organization of the server.
- Assisted the Plant Ecologist in populating NPSpecies.
- Assisted CACO's System Administrator to repair and maintain the server.
- Developed and implemented comprehensive back-up procedures to ensure the safety of program data.

Scheduled FY2006 Activities:

- Develop a strategy and corresponding SOPs for long-term file management and archiving.
- Complete the locations database, and develop an integrated map and metadata record.
- Develop an approach for managing image files.
- Develop project-specific addenda to the NPStoret users guide.
- Continue to develop program-wide data management SOPs.
- Continue to develop project-specific data management SOPs.

Task 9.2 - Build technical expertise and work force capacity that promotes consistency in monitoring project implementation

FY2005 Accomplishments:

- Hired a permanent GS-5 Aquatic Ecology Tech to refill the vacated term Aquatic Ecology Tech position.

Task 9.3 - Secure an adequate work force to complete scheduled field and laboratory tasks

FY2005 Accomplishments:

- Hired four seasonal BioTechs for the following projects:
 - amphibian monitoring
 - pond vegetation protocol development
 - estuarine monitoring projects
- Recruited and supported three Student Conservation Association (SCA) volunteers to assist with the projects listed above.

Scheduled FY2006 Activities:

- Hire three seasonal BioTechs for the vernal pool vegetation monitoring project and the amphibian monitoring project.
- Recruit and support four SCAs, VIPs, or other interns to assist with the projects listed above and with the kettle pond water quality monitoring project. In partnership with the ARC, we plan to emphasize recruitment of interns who will earn college credit for their work at CACO.
- Collaborate with the ARC to bring a URI Coastal Fellow or other intern to the park to monitor the response of the benthic community to restoration in East Harbor.

Task 9.4 - Develop and maintain the analytical laboratory's infrastructure and capabilities. The following accomplishments and activities are directed by the NRM Chemist with support from the ARC and the Prototype Monitoring Program.

FY2005 Accomplishments:

- Continued participation in the USGS Standard Reference Sample (SRS) Project for quality assurance for nutrient and trace element analyses.
- Completed updates and review of methods for the Lab Handbook of Analytical Methods in order to document the analytical procedures used in the lab in 2005.

- Increased analytical capabilities and efficiency through purchase of a Smart Chem discrete analyzer. This acquisition will increase our sample handling capacity, enable unattended sample analysis freeing up Lab Tech staff time, and will significantly reduce the volume of hazardous waste generated by sample processing.

Scheduled FY2006 Activities:

- Continue participation in the USGS SRS Project, and maintain updates and review of the Lab Handbook.
- Initiate additional method development and oversee equipment purchases and upgrades as needed to support monitoring efforts.

Task 9.5 - Develop programmatic standard operating procedures for monitoring project elements common to all or most protocols

FY2005 Accomplishments:

- Finalized Programmatic SOP guidance, and Programmatic SOPs for monitoring project safety and reporting.

Scheduled FY2006 Activities:

- Draft Programmatic SOPs for protocol review and revision, and for GPS standards and practices.

III. Staffing

CACO Prototype Staff

Carrie Phillips, Prototype Coordinator
 Velma Decker, Data Manager
 Lisa Nicholson, Budget Assistant
 Robert Cook, Wildlife Ecologist
 Stephen Smith, Plant Ecologist
 Evan Gwilliam, Aquatic Ecologist
 Michelle Galvin, Aquatic Ecology BioTech
 Kelly Morris, Hydrology Tech

CACO Natural Resource Management Staff

Many critical program functions are also carried out by the Division of Natural Resource Management. The individuals listed below provide management oversight, GIS support, laboratory management, piping plover and colonial waterbird monitoring, and expertise in chemical analysis, biogeochemistry, and ecology.

Nancy Finley, Division Chief
 John Portnoy, Senior Ecologist
 Mark Adams, GIS Specialist
 Krista Lee, Chemist
 Judith Oset, Laboratory Tech
 Mary Hake, Plover and Colonial Waterbird BioTech
 Katy Kughen, Plover and Colonial Waterbird BioTech

Primary Science Advisors:

Charles Roman, Research Coordinator, NAC CESU
 Don Cahoon, USGS-BRD, Patuxent Wildlife Research Center

Cooperators:

Rhys Bowen, independent contractor to Manomet Center for Conservation Sciences (harrier inventory)

Elizabeth Colburn, Harvard Forest (freshwater aquatic invertebrate protocol)

John Colman, USGS-WRD, MA-RI District (ground-water quality protocol)

Leslie DeSimone, USGS-WRD, MA-RI District (kettle pond protocol review)

Mark Faherty, University of Massachusetts, Amherst (landbird point-count protocol)

Steve Forman, University of Illinois, Chicago (dune slack wetland study and dune grassland protocol development)

Howard Ginsberg, USGS-BRD, Patuxent Wildlife Research Center (beach macroinvertebrate protocol)

Curtice Griffin, University of Massachusetts, Amherst (landbird point-count protocol)

Mary-Jane James-Pirri, Graduate School of Oceanography, University of Rhode Island (salt marsh vegetation and nekton protocols)

Robin Jung, USGS, Patuxent Wildlife Research Center (ARMI project)

Blaine Kopp, USGS, Patuxent Wildlife Research Center (estuarine nutrient enrichment protocol)

Jeff Marion, USGS, Patuxent Wildlife Research Center (visitor impact protocol)

John Masterson, USGS-WRD, MA-RI District (hydrology and ground-water quality protocols)

Kevin McGarigal, University of Massachusetts, Amherst (spadefoot toad study)

Scott McWilliams, University of Rhode Island (plover disturbance monitoring study)

Hilary Neckles, USGS, Patuxent Wildlife Research Center (estuarine nutrient enrichment protocol)

Barbara Nowicki, Graduate School of Oceanography, University of Rhode Island (estuarine nutrient enrichment protocol)

Allan O'Connell, USGS, Patuxent Wildlife Research Center (meso-mammal protocol)

Candace Oviat, Graduate School of Oceanography, University of Rhode Island (estuarine benthic macrofauna protocol)

Sheldon Pratt, Graduate School of Oceanography, University of Rhode Island (estuarine benthic macrofauna protocol)

Eric Schneider, University of Rhode Island (plover disturbance monitoring study)

Leslie Sneddon, NatureServe (cover-type mapping project)

Brad Timm, University of Massachusetts, Amherst (spadefoot toad study)

Todd Tupper, George Mason University (Fowler's toad study)

Scott Warren, Connecticut College (salt marsh elevation method development)

Peter Weiskel, USGS-WRD, MA-RI District (hydrology protocol)

In addition to those listed above, the efforts described in this report and work plan depend on the dedicated efforts of a dynamic cadre of seasonal technicians, research assistants, graduate students, undergraduate student interns, and volunteers.

IV. Reports, Publications, and Presentations

The reports noted with an asterisk are available from the CACO Prototype Monitoring Program web site at <http://www.nature.nps.gov/im/units/caco/index.htm>.

Reports and Publications:

Bowen, R.V. 2005. Status and Habitat Use of Breeding Northern Harriers at Cape Cod National Seashore - 2004 Progress Report. Manomet Center for Conservation Science. Duxbury, MA.

Cahoon, D.R., J.C. Lynch, and P.F. Hensel. 2005. Monitoring Salt March Elevation: A Protocol for the Long-term Coastal Ecosystem Monitoring Program at Cape Cod National Seashore. USGS, Patuxent Wildlife Research Center, Beltsville, MD. DRAFT.

Cook, R.P., K.M. Boland, and T. Dolbeare. 2004. Inventory of Small Mammals At Cape Cod National Seashore With Recommendations for Long-Term Monitoring. Cape Cod National Seashore, Wellfleet, MA.*

Cook, R.P. and K.M. Boland. 2005. A comparison of approaches to counting egg masses of the spotted salamander (*Ambystoma maculatum*). Herpetological Review 36(3): 272-274.

Cook, R.P., K.M. Boland, J. Hernandez, M. Schult, and A. Goodstine. 2005. Monitoring of pond breeding amphibians at Cape Cod National Seashore, 2004. Cape Cod National Seashore, Wellfleet, MA.*

Cook, R.P., K.M. Boland, S. Kot, J. Borgmeyer, and M. Schult. 2004. Inventory of aquatic turtles at Cape Cod National Seashore with recommendations for long-term monitoring. Cape Cod National Seashore, Wellfleet, MA. DRAFT.

Duffy, M., N.P. Psuty, and J.P. Pace. 2005. Geomorphologic Monitoring Protocol for the Northeast Coastal and Barrier Network: Part I - Ocean Shoreline Position. Northeast Coastal and Barrier Network, Kingston, RI. DRAFT.

Kopp, B.S. and H.A. Neckles. 2005. Monitoring Protocols for the National Park Service North Atlantic Coastal Parks: Estuarine Nutrient Enrichment. USGS, Patuxent Wildlife Research Center, Augusta, ME. DRAFT.

O'Connell, A.F., N.W. Talancy, L.L. Bailey, J.R. Sauer, R.P. Cook, and A.T. Gilbert. *In Press*. Estimating site occupancy and detection probability parameters for mammals in a coastal ecosystem. Journal of Wildlife Management.

Schneider, E.G. 2005. Behavioral Ecology of an Incubating Shorebird: The Effects of Ambient Temperature and Human Disturbance on Piping Plover (*Charadrius Melodus*) Incubation Patterns at Cape Cod National Seashore. M.S. Thesis, University of Rhode Island, Kingston, RI.

Smith, S.M. 2005a. 2004 Vegetation Monitoring Report for Salt Marsh Restoration Projects. Cape Cod National Seashore, Wellfleet MA.*

Smith, S.M. 2005b. Assessment of epiphytic algae (periphyton) as a component of kettle pond monitoring at Cape Cod National Seashore, 2004. Cape Cod National Seashore, Wellfleet, MA.

Smith, S.M. 2005c. Manual control of *Phragmites* on pondshores of Cape Cod National Seashore, Massachusetts, USA. *Journal of Aquatic Plant Management* 43:50-53.

Smith, S.M. and M. Hanley. 2005. Dune Slack Wetlands of Cape Cod National Seashore. Cape Cod National Seashore, Wellfleet, MA.

Smith, S.M. and S. Warren. *In Review*. Determining ground surface topography in tidal marshes using water marks. *Journal of Coastal Research*.

In addition to the CACO-focused publications noted above, the CACO Wildlife Ecologist was a co-author on 17 publications, technical reports, and draft reports stemming from the NPS-Wildlife Conservation Society inventory of Northeast Region amphibians and reptiles. These reports and publications were produced on a variety of taxa for ACAD, MORR, DEWA, SARA, MIMA, WEFA, SAIR, SAGA, FIIS, WIFL, SAHI, ASIS, and GATE.

Presentations:

Cook, R.P. 2005. Amphibians and reptiles of Cape Cod National Seashore. Wellfleet Bay Wildlife Sanctuary, Wellfleet, MA.

Decker, V. and D. Tucker. 2005. Water Quality Data and NPStoret. Annual Meeting of the Networks, Austin, TX.

Decker, V. 2005. NRDT Database Design. Data Management Conference, Bangor, ME.

Gwilliam, E. 2005. Pond Ecology and Water Quality Monitoring. Brewster Pond Association, Brewster, MA.

Gwilliam, E. 2005. Gull Pond Ecology and Water Quality. Gull Pond Citizens Association. Wellfleet, MA.

Gwilliam, E. 2005. Salt Marsh Ecology and Restoration at Cape Cod National Seashore. Wellfleet Bay Wildlife Sanctuary, Wellfleet, MA.

O'Connell, A.F., N.W. Talancy, L.L. Bailey, J.R. Sauer, R.P. Cook, and A.T. Gilbert. 2005. Estimating site occupancy and detection probability parameters for mammals in a coastal ecosystem. Annual Meeting of The Wildlife Society, Madison, WI.

Phillips, C. 2005. Protocol Development: Lessons Learned, Mistakes to Avoid. Annual Meeting of the Networks, Austin, TX.

Smith, S.M. 2005. Salt marsh dieback at Cape Cod National Seashore. Salt Marsh Dieback Workshop, Parker River National Wildlife Refuge, MA.

Smith, S.M. 2005. *Phragmites* responses to tidal restoration. New England Estuarine Research Society, Eastham, MA.

Smith, S.M. 2005. Kettle pond monitoring at Cape Cod National Seashore. Gull Pond Citizens Association, Wellfleet, MA.

V. Status of Park Vital Signs Monitoring

Cape Cod National Seashore 2005	Air Quality	Water Quality	Water Quantity	Geologic Resources	Plants	Animals	Landscape Characteristics
Planning and Design							
w/NRC funding		X		X	X	X	
w/other funding		X-c				X-c,d	X-c
Protocols Implemented							
w/NRC funding	X-a	X	X	X	X	X	X
w/other funding	X-a						
Analysis/Synthesis Available							
w/NRC funding					X	X	
w/other funding	X-b						

a-staff time supported by NRC funding; sample analysis supported by NRC funding and the Region
 b-Nationwide syntheses are available from the NADP, MDN, and IMPROVE programs
 c-development of the estuarine nutrient enrichment, estuarine benthic macrofauna, and visitor impact protocols are partially supported by USGS Prototype Development funds
 d-development of the freshwater fish and beach macroinvertebrate protocols are supported in part by NRPP funds

VI. USGS Protocol Development and Monitoring-Related Research Needs

Protocol Development:

We are interested in migrating from aerial photos to high-resolution satellite imagery as a platform for mapping and monitoring change in cover-types. We understand that several other parks and networks are interested in the same approach. USGS development of a protocol based on high-resolution satellite imagery and that cross-walks to our most recent aerial photo- and National Vegetation Classification System-based cover-type map would be valuable. If USGS pursues this project, it would be important to also investigate the utility of satellite imagery for monitoring change in inter- and sub-tidal cover-types.

Statistical Analysis Assistance:

Over the next several years, prototype parks and the first twelve networks will have collected enough data to support review of protocol design assumptions regarding inter-annual variation and power to detect trends across years. Expert assistance with these types of analyses and peer review of reports and protocol revisions based on examination of design assumptions will be critical. We recommend that USGS develop statistical analysis assistance and peer review program to meet what will be a growing need as the NPS I&M Program matures. We also request that USGS provide clear guidance to parks and networks for how to request this type of assistance.

VII. Budget Narrative

In FY2005 the Cape Cod Prototype Monitoring Program received the anticipated \$702,000 authorization for regular program expenses and operations. About 79 percent of these funds were used to support permanent, term, and temporary staff as well as modest stipends and housing for interns and volunteers. One notable change from previous years is the combining of two positions to provide integrated coordination of both the Prototype Monitoring Program and the research element of the Atlantic Research Center (ARC). This was done in FY2005 on a trial basis, and we plan on continuing this approach through FY2006. The objectives are two-fold: first, to provide for better scientific and operational integration of the two programs; and second, to increase fiscal efficiency by avoiding duplication of staff efforts, materials, and analytical infrastructure. As a result, only half of the Research and Monitoring Coordinator's salary was supported by Prototype Monitoring Program funds, the other half being supported by ARC funds. This allowed more Prototype Monitoring Program and ARC funding to be invested in non-personnel expenditures. We spent substantially less on cooperative agreements and contracts in FY2005 than in previous years. This is the result of protocol development projects being conducted in-house or being conducted by cooperators funded in previous years. The most striking difference between expenditures in 2005 from previous years was the substantial increase (19 percent) in operation and equipment expenditures. This was primary due to investments in field and lab instrumentation needed for water quality monitoring and those projects requiring nutrient, cation, anion, and metals analysis.

We anticipate an authorization of \$702,000 again in FY2006. We estimate that about 83% of this budget will be dedicated to staff salaries and support for seasonal technicians and volunteers. Step increases, potential cost of living adjustments, and plans to increase the proportion of interns and volunteers from sources without overhead costs combine to account for the expected difference between 2005 and 2006 personnel expenditures. We have planned for a small increase in the percentage (about 2.5 percent) of our budget for contracts and cooperative agreements. This would provide for additional investment in the geomorphic coastal change and cover-type change protocols, and would support external peer review of draft protocols and reports. We also plan to make additional investments in field instrumentation for water quality monitoring protocols in 2006. We expect that there will be some level of assessment from WASO or the Region in FY2006. However, since we don't know what percentage of our FY2006 budget may be redirected, we have not included it as a line item in our estimated budget. Instead, we will wait to expend funds for cooperative agreements and substantial investments in instrumentation until we know what amount, if any, our FY2006 budget will be reduced.

A summary of our FY2005 expenditures and FY2006 budget plan is provided in the Budget Summary at the end of this report.

VIII. References Cited (see also Section IV Reports, Publications, and Presentations)

The reports noted with an asterisk are available from the CACO Prototype Monitoring Program web site at <http://www.nature.nps.gov/im/units/caco/index.htm>.

Boland, K., R. Cook, E. Gwilliam, C. Phillips, J. Portnoy, and S. Smith. 2002. 2002 Update of the Conceptual Framework for the Development of Long-Term Monitoring Protocols at Cape Cod National Seashore. Cape Cod National Seashore, Wellfleet, MA. 74pp.*

Colman, J.A, and J. P. Masterson. 2004. Monitoring Ground-Water Quality in Coastal Ecosystems. USGS Water Resources Discipline, Massachusetts-Rhode Island District, Northborough, MA. 102pp. DRAFT

McCobb, T.D. and P.K. Weiskel. 2003. Long-Term Hydrologic Monitoring Protocol for Coastal Ecosystems. USGS Open-File Report 02-497. USGS, Massachusetts-Rhode Island District, Northborough, MA. 94pp.*

National Park Service. 1998. Forging a Collaborative Future: General Management Plan for Cape Cod National Seashore. U.S. Department of Interior, National Park Service. 208pp.

Paton P.W.C, B. Timm, and T. Tupper. 2003. Monitoring Pond-Breeding Amphibians: A Protocol for the Long-term Coastal Ecosystem Monitoring Program at Cape Cod National Seashore. Technical Report, USGS Patuxent Wildlife Research Center, Coastal Field Station, Narragansett, RI. 113 pp.*

Phillips, C. 2003. 2003 Cape Cod National Seashore LTEM Project Prioritization Report. Cape Cod National Seashore, Wellfleet, MA. 99pp.*

Portnoy, J, K. Lee, J. Oset, E. Gwilliam, and J. Budreski. 2003. Water Quality Monitoring Protocol for Kettle Ponds of Cape Cod National Seashore. Cape Cod National Seashore, Wellfleet, MA. 52 pp.*

Raposa, K.B. and C.T. Roman. 2001. Monitoring Nekton in Shallow Estuarine Habitats. Technical Report, USGS Patuxent Wildlife Research Center, Coastal Research Field Station, Narragansett, RI. 30pp.*

Roman, C.T. and N.E. Barrett. 1999. Conceptual Framework for the Development of Long-term Monitoring Protocols at Cape Cod National Seashore. USGS Patuxent Wildlife Research Center, University of Rhode Island, Narragansett, RI. 59pp.*

Roman, C., M. James-Pirri, and J. Heltshe. 2001. Monitoring Salt Marsh Vegetation: A Protocol for the Long-term Coastal Ecosystem Monitoring Program at Cape Cod National Seashore. USGS Patuxent Wildlife Research Center, University of Rhode Island, Narragansett, RI. 47pp.*

Budget Summary

FY05 Admin Report

Network: Cape Cod NS Prototype

Category: 1_Income

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
Authorization for FY2005	\$702,000.00	Prototype \$\$ - Park Base		
Subtotal	\$702,000.00			

Category: 2_Personnel

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
a) Research & Monitoring Coordinator	\$47,285.00	Prototype \$\$ - Park Base	NPS	
b) Data Manager	\$73,135.00	Prototype \$\$ - Park Base	NPS	
c) Budget Tech	\$23,928.00	Prototype \$\$ - Park Base	NPS	
d) Wildlife Ecologist	\$91,285.00	Prototype \$\$ - Park Base	NPS	
e) Plant Ecologist	\$78,993.00	Prototype \$\$ - Park Base	NPS	
f) Aquatic Ecologist	\$64,462.00	Prototype \$\$ - Park Base	NPS	
g) Hydrology Tech	\$50,711.00	Prototype \$\$ - Park Base	NPS	
h) Aquatic Ecology Tech	\$23,224.00	Prototype \$\$ - Park Base	NPS	
i) Laboratory Tech	\$37,538.00	Prototype \$\$ - Park Base	NPS	
j) 2 Seasonal Techs - amphibians	\$31,038.00	Prototype \$\$ - Park Base	NPS	
k) Seasonal Tech - pond vegetation	\$8,808.00	Prototype \$\$ - Park Base	NPS	
l) Seasonal Tech - salt marsh	\$8,204.00	Prototype \$\$ - Park Base	NPS	
m) Seasonal Interns and VIPs	\$14,697.00	Prototype \$\$ - Park Base	Other non-Federal	includes housing
Subtotal	\$553,308.00			

Category: 4_Contracts

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
Mercury Deposition Network Contract	\$3,620.00	Prototype \$\$ - Park Base	Univ_Non-CESU	University of Illinois
Subtotal	\$3,620.00			

Category: 5_Operations/Equipment

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
a) Field Equipment and Supplies	\$49,507.00	Prototype \$\$ - Park Base	Other non-Federal	
b) Laboratory Services, Equipment, and Supplies	\$73,319.00	Prototype \$\$ - Park Base	Other non-Federal	
c) Computer Hardware, Software, and Supplies	\$8,165.00	Prototype \$\$ - Park Base	Other non-Federal	
d) Office Supplies, Equipment, and Maintenance	\$540.00	Prototype \$\$ - Park Base	Other non-Federal	
e) Miscellaneous Supplies	\$1,388.00	Prototype \$\$ - Park Base	Other non-Federal	
Subtotal	\$132,919.00			

Category: 6_Travel

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
Travel and Training	\$6,933.00	Prototype \$\$ - Park Base	Other non-Federal	
Subtotal	\$6,933.00			

Category: 7_Other

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
Miscellaneous Expenses	\$5,220.00	Prototype \$\$ - Park Base	Other non-Federal	
Subtotal	\$5,220.00			

Budget Analysis

Analysis of Expenses by Where \$ Went

<i>Funding Source</i>	<i>Total \$\$</i>	<i>NPS</i>	<i>USGS</i>	<i>Other Federal</i>	<i>Univ.-CESU</i>	<i>Univ_Non-CESU</i>	<i>Other non-Federal</i>
Prototype \$\$ - Park Base	\$702,000	\$538,611				\$3,620	\$159,769
Totals	\$702,000	\$538,611				\$3,620	\$159,769

Analysis of Expenses by Category

<i>Funding Source</i>	<i>Total \$\$</i>	<i>Personnel:</i>	<i>Coop Agree.</i>	<i>Contracts</i>	<i>Operations/Equip.</i>	<i>Travel</i>	<i>Other</i>
Prototype \$\$ - Park Base	\$702,000	\$553,308		\$3,620	\$132,919	\$6,933	\$5,220
Totals	\$702,000	\$553,308		\$3,620	\$132,919	\$6,933	\$5,220

Expense Totals By Category

<i>Category</i>	<i>SubTotal</i>	<i>Percent</i>
2_Personnel	\$553,308	78.82%
4_Contracts	\$3,620	0.52%
5_Operations/Equipment	\$132,919	18.93%
6_Travel	\$6,933	0.99%
7_Other	\$5,220	0.74%
	\$702,000	

Budget Summary

FY06 Work Plan

Network: Cape Cod NS Prototype

Category: 1_Income

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
Anticipated Authorization for FY2006	\$702,000.00	Prototype \$\$ - Park Base		
Subtotal	\$702,000.00			

Category: 2_Personnel

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
a) Research & Monitoring Coordinator	\$50,122.00	Prototype \$\$ - Park Base	NPS	
b) Data Manager	\$77,523.00	Prototype \$\$ - Park Base	NPS	
c) Budget Tech	\$26,862.00	Prototype \$\$ - Park Base	NPS	
d) Wildlife Ecologist	\$94,204.00	Prototype \$\$ - Park Base	NPS	
e) Plant Ecologist	\$83,654.00	Prototype \$\$ - Park Base	NPS	
f) Aquatic Ecologist	\$68,329.00	Prototype \$\$ - Park Base	NPS	
g) Hydrology Tech	\$53,753.00	Prototype \$\$ - Park Base	NPS	
h) Aquatic Ecology Tech	\$40,283.00	Prototype \$\$ - Park Base	NPS	
i) Laboratory Tech	\$39,790.00	Prototype \$\$ - Park Base	NPS	
j) 2 Seasonal Techs - amphibians	\$32,500.00	Prototype \$\$ - Park Base	NPS	
k) Seasonal Tech - vernal pool vegetation	\$9,336.00	Prototype \$\$ - Park Base	NPS	
l) Seasonal Interns and VIPs	\$8,000.00	Prototype \$\$ - Park Base	Other non-Federal	includes housing
Subtotal	\$584,356.00			

Category: 3_Coop. Agreements

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
Protocol Development and Related Studies	\$14,000.00	Prototype \$\$ - Park Base	University-CESU	shoreline change, cover type change, peer review
Subtotal	\$14,000.00			

Category: 4_Contracts

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
Mercury Deposition Network	\$4,000.00	Prototype \$\$ - Park Base	Univ_Non-CESU	University of Illinois
Subtotal	\$4,000.00			

Category: 5_Operations/Equipment

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
a) Field Equipment and Supplies	\$57,144.00	Prototype \$\$ - Park Base	Other non-Federal	
b) Laboratory Services, Equipment, and Supplies	\$25,000.00	Prototype \$\$ - Park Base	Other non-Federal	
c) Computer Hardware, Software, and Supplies	\$4,000.00	Prototype \$\$ - Park Base	Other non-Federal	
d) Office Supplies, Equipment, and Maintenance	\$500.00	Prototype \$\$ - Park Base	Other non-Federal	
e) Miscellaneous Supplies	\$1,000.00	Prototype \$\$ - Park Base	Other non-Federal	
Subtotal	\$87,644.00			

Category: 6_Travel

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
Travel and Training	\$6,000.00	Prototype \$\$ - Park Base	Other non-Federal	
Subtotal	\$6,000.00			

Category: 7_Other

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
Miscellaneous Expenses	\$6,000.00	Prototype \$\$ - Park Base	Other non-Federal	
Subtotal	\$6,000.00			

Budget Analysis

Analysis of Expenses by Where \$ Went

<i>Funding Source</i>	<i>Total \$\$</i>	<i>NPS</i>	<i>USGS</i>	<i>Other Federal</i>	<i>Univ.-CESU</i>	<i>Univ_Non-CESU</i>	<i>Other non-Federal</i>
Prototype \$\$ - Park Base	\$702,000	\$576,356			\$14,000	\$4,000	\$107,644
Totals	\$702,000	\$576,356			\$14,000	\$4,000	\$107,644

Analysis of Expenses by Category

<i>Funding Source</i>	<i>Total \$\$</i>	<i>Personnel:</i>	<i>Coop Agree.</i>	<i>Contracts</i>	<i>Operations/Equip.</i>	<i>Travel</i>	<i>Other</i>
Prototype \$\$ - Park Base	\$702,000	\$584,356	\$14,000	\$4,000	\$87,644	\$6,000	\$6,000
Totals	\$702,000	\$584,356	\$14,000	\$4,000	\$87,644	\$6,000	\$6,000

Expense Totals By Category

<i>Category</i>	<i>SubTotal</i>	<i>Percent</i>
2_Personnel	\$584,356	83.24%
3_Coop. Agreements	\$14,000	1.99%
4_Contracts	\$4,000	0.57%
5_Operations/Equipment	\$87,644	12.48%
6_Travel	\$6,000	0.85%
7_Other	\$6,000	0.85%
	\$702,000	