

**ANNUAL ADMINISTRATIVE REPORT (FY2003) AND WORK
PLAN (FY2004) 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**

FY2003-FY2004

Northeast Region Approval Signature:

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

Cape Cod National Seashore Approval Signatures:

Maria Burks, Superintendent Date

Nancy Finley, Natural Resources Chief Date

Prepared By:

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AARWP Checklist

Budget program (MS Access, aarwp_budget.mdb)	
97	Which version of Access did you use? [Enter 97 or XP for Access 97 or Access XP at the beginning of this line.]
√	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?).
√	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.)
√	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?)
√	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 the budget program for FY 2000-2003 (data should be included for previous years since this is our first year of building this database). Be sure to list each park that was involved in the particular inventory.
√	Each year's budget has been exported as an .rtf file (one for FY 2003 and one for FY 2004), and both files have been inserted into MS Word at the end of the AARWP document.
√	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_FY0304_aarwp.mdb
Annual Report and Work Plan (MS Word)	
√	I have carefully read the guidance for the AARWP and followed it.
√	A header or footer with the date that the aarwp was last revised has been included.
√	I gave special attention to the 'Public Interest Highlights' and 'Major Accomplishments' sections of the report. (We need good examples of the successes, applications, and highlights of the program to help us obtain funding for all 32 networks! Your 'Major Accomplishments' section is what we'll use for the I&M Program's annual Report to Congress to justify the funding spent by your network.)
√	In the 'Status of Park Vital Signs Monitoring' table, all entries are equal to or greater than the entries in last year's report.
	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 guidelines for submitting photographs.)
√	The aarwp file has been renamed using the network's 4-character alpha code and the years (FY0304) as in the example NCCN_FY0304_aarwp.doc
√	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 8.)
√	I have followed my region's procedures for submitting the two files (e.g., NCCN_FY0304_aarwp.doc and NCCN_FY0304_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 2004 Work Plan by WASO	
	[Enter Yes or No]: Has the FY 2004 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'.

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 nonpoint 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 ecological 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 could be of utility to other Atlantic and Gulf Coast parks, in addition to supporting management of Cape Cod's natural resources. 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. 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 Network 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 Northeast Coastal and Barrier Network and networks in the broader biogeographic region specifically.

Development of the CACO long-term ecological monitoring program has been a collaborative effort primarily between USGS and 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 six years, this funding has been used to support continued collaboration with USGS 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

Network and other parks in the broader biogeographic region, and to build the personnel and logistical capabilities needed for long-term monitoring.

Objectives

Our program objectives are listed below. The ecosystem approach for organizing our monitoring objectives (objectives 1-6 below) 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 nine address outreach and reporting, technical support to other monitoring programs, and program management.

Cape Cod Long-Term Ecosystem 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 Northeast Coastal and Barrier Network, to other networks and parks, and to other entities with common monitoring objectives.
9. Develop and sustain appropriate resources and infrastructure to ensure program objectives can be met now and into the future.

II. Accomplishments (FY2003) and Scheduled Activities (FY2004)

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

The accomplishments and planned activities in Tasks 1.1, 1.2, 1.4, and 1.5 contribute to the estuarine restoration goals in CACO's General Management Plan (GMP) (National Park Service 1998).

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

FY2003 Accomplishments:

- Salt marsh accretion, erosion, and relative elevation were measured at established sediment elevation table (SET) sites in three estuaries (Hatches Harbor, Nauset Marsh, Herring River/Wellfleet Bay)

Scheduled FY2004 Activities:

- Collect accretion, erosion, and relative elevation measurements at established SET sites in three estuaries (Hatches Harbor, Nauset Marsh, Herring River/Wellfleet Bay).
- Collaborate with USGS to evaluate the utility and feasibility of adding SET sites at three additional estuaries (Pleasant Bay, East Harbor, West End Marsh) and adding or converting to "deep SET" configurations. Recommendations and priorities for expanding our existing SET network will be included in the formal protocol USGS is developing for this project.

Task 1.2 - Map intertidal habitats with an emphasis on estuarine systems

FY2003 Accomplishments:

- Provided logistical support and technical assistance to the principal investigator developing the intertidal habitat map (Mike Bradley, Environmental Data Center, University of Rhode

Island). Funding for this project was obligated and planning initiated at the close of FY2002. In this first full year of the project, activities focused on assembling photography, conducting site assessments, and developing a classification system based largely on vegetation and grain size characteristics.

Scheduled FY2004 Activities:

- Continue to provide technical assistance and logistical support as needed to complete mapping and field verification; provide review and comment on a draft map and report. We expect to receive a final product in FY2004.

Task 1.3 - Monitor estuarine nutrient enrichment

FY2003 Accomplishments

- Provided technical assistance and logistical support to the investigators developing the seagrass component of the estuarine nutrient enrichment monitoring protocol (Hilary Neckles, USGS; Blaine Kopp, USGS; Fred Short, University of New Hampshire). Two monitoring sites were established (Duck Harbor Beach and Pleasant Bay), the first year of data was collected, and the program's plant ecologist and coordinator received training in seagrass monitoring procedures. This work also established Duck Harbor Beach and Pleasant Bay the newest sites in the SeagrassNet global network.

Scheduled FY2004 Activities:

- Assist Dr. Neckles and Dr. Kopp with the second year of seagrass monitoring data collection.
- A draft of the estuarine nutrient enrichment monitoring protocol may be available for review during the fourth quarter of FY2004 - we will provide review and comment when that document is distributed.

Task 1.4 - Monitor salt marsh vegetation

FY2003 Accomplishments:

- Initiated park-wide salt marsh vegetation monitoring. This involved establishing transects and plots in five estuarine systems (Pleasant Bay, Nauset Marsh, Middle Meadow/Wellfleet Bay, and West End Marsh), initiating data collection at those sites, and continuing data collection at previously established sites in Hatches Harbor and East Harbor. Salt marsh monitoring methods are described in Roman *et al.* 2001.
- Continued monitoring the response of the plant community in the Moon Pond portion of East Harbor to restoration of marine influence.

Scheduled FY2004 Activities:

- Finish site characterization (elevation and depth to water at low tide for all plots) and lab analysis (plant tissue, pore water chemistry) to complete the 2003 salt marsh vegetation monitoring data collection.
- Prepare an annual report describing the 2003 salt marsh vegetation monitoring work.
- Draft, obtain appropriate review, and finalize an addendum to the salt marsh monitoring protocol (Roman *et al.* 2001) describing the refinements and additional measures developed this year.
- Continue monitoring vegetation response to restoration activities at Hatches Harbor and East Harbor/Moon Pond.

Task 1.5 - Monitor estuarine benthos and nekton.

FY2003 Accomplishments:

- Provided technical assistance and logistical support to the investigator (Sheldon Pratt, University of Rhode Island) developing the estuarine benthos monitoring protocol. Funding for this project was obligated and planning initiated at the close of FY2002. In this first full year of the project, activities focused on field sampling to inventory benthic fauna and to estimate the statistical parameters necessary to for design of a long-term sampling strategy.
- Sponsored an undergraduate student initiating focused benthic monitoring in East Harbor. The student was a participant in the University of Rhode Island's (URI) Coastal Fellow program. URI provided a faculty advisor (Dr. Pratt) and helped select the student; we

provided training, supervision, technical support, lab space, housing, and a modest stipend. The funds were obligated through the North Atlantic Coast Cooperative Ecosystems Studies Unit (NAC CESU) agreement with URI.

- Initiated implementation of the estuarine nekton monitoring protocol (Raposa and Roman 2001) in at Hatches Harbor and East Harbor/Moon Pond.

Scheduled FY2004 Activities:

- Continue to provide technical assistance and logistical support for development of the estuarine benthos monitoring protocol. Planned activities for Year 2 focus on sample and data analysis but additional field sampling may also be necessary. We expect a draft final report and protocol in Year 3 (FY2005).
- Continue nekton monitoring at East Harbor/Moon Pond.

Task 1.6 - Develop a protocol for monitoring waterbird use of estuarine systems

FY2003 Accomplishments:

- Provided review and comment on the migrating waterbirds section of the waterbird monitoring protocol prepared by Mike Erwin, USGS (Erwin *et al* 2003).

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.

FY2003 Accomplishments:

- Provided technical assistance and logistical support to the Northeast Coastal and Barrier Network in their effort to develop a shoreline change monitoring protocol. The Network's activities at CACO in FY2003 included coordinating flights to obtain light distance and ranging (LIDAR) data and collecting the ground-based GPS element of that data set.

Scheduled FY2004 Activities:

- Continue to support the Network's efforts and increase CACO involvement in protocol development.

Task 2.2 - Monitor beach and barrier island nesting birds

FY2003 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.
- Contributed \$26,000 toward a study that will evaluate the effects of disturbance on nesting piping plovers, develop methods for monitoring the effects of disturbance, and assist interpretation of long-term piping plover monitoring data. Other funding for this project (\$25,000) has been provided by CACO's Over-Sand Vehicle Permit program. The principal investigator is Scott McWilliams at URI; funds were obligated through an existing agreement between URI and the NAC CESU. These funds will support the first two years of this three-year project. Work in Year 1 (FY2003) focused on refining the study plan, testing methods for monitoring the effects of disturbance on incubating plovers, and collecting initial disturbance/response data.

Scheduled FY2004 Activities:

- NRM will continue to monitor piping plover and beach-nesting colonial waterbird productivity.
- Provide technical assistance and logistical support for Year 2 of the piping plover disturbance monitoring study. In partnership with the NAC CESU, the Over Sand Vehicle Permit program, NRM, and URI, identify and secure funding for the third year of the piping plover disturbance effects monitoring project.

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.

Task 3.1 - Characterize dune slack wetlands and evaluate long-term monitoring needs

FY2003 Accomplishments:

- Implemented the first year of the dune slack characterization study as described in the comprehensive work plan for this project (Smith and Portnoy 2002). This year's work included mapping dune slacks, hydrologic monitoring, and collecting pore water, sediment, and vegetation data. This is a joint project with NRM and is supported by competitive funds from NPS-Water Resource Management Division (WRD).

Scheduled FY2004 Activities:

- Implement the second year of the study. Year 2 activities include refinement of landscape parameters, continued hydrologic monitoring, and repeated physical, chemical, and biological sampling. Data analysis and report writing is scheduled to occur in Year 3 (FY2005).

Task 3.2 - Monitor kettle pond water quality and limnology

FY2003 Accomplishments:

- Completed revision of the 2001 version of the kettle pond monitoring protocol to incorporate minor corrections and update selected field and laboratory methods.
- Collected water quality monitoring data from all 20 CACO kettle ponds according to the revised protocol (Portnoy *et al* 2003).

Scheduled FY2004 Activities:

- Prepare an annual report describing this year's kettle pond monitoring work.
- Continue annual monitoring at all ponds according to the revised protocol.
- Collaborate with USGS on a trend analysis of the long-term kettle pond data set and begin drafting a report on the results.

Task 3.3 - Monitor pond vegetation.

FY2003 Accomplishments:

- Evaluated the design, field and analytical methods, and results from previous kettle pond vegetation studies for their utility and applicability to long-term monitoring of these plant communities.
- Documented pre-project conditions and monitored the results of invasive plant (purple loosestrife (*Lythrum salicaria*) and common reed (*Phragmites australis*)) removal projects at several CACO kettle ponds.

Scheduled FY2004 Activities:

- Conduct preliminary field studies to develop and refine potential long-term pond vegetation monitoring methods.
- Continue to monitor the results of invasive plant removal projects.

Task 3.4 - Inventory and develop a monitoring protocol for fresh water aquatic invertebrates.

FY2003 Accomplishments:

- Provided technical assistance and logistical support to the principal investigator developing the fresh water aquatic invertebrate monitoring protocol (Elizabeth Colburn, Harvard University). Funding for this project was obligated and planning initiated during FY2002. In this first full year of the project, activities focused on characterizing ponds based on environmental variables most likely to influence aquatic invertebrates, and on initial field collections.

Scheduled FY2004 Activities:

- Continue to provide technical assistance and logistical support to Dr. Colburn. Year 3 activities will focus on field sampling, data analysis, and drafting the final report and long-term monitoring protocol.

Task 3.5 - Inventory and develop a monitoring protocol for freshwater fish.

FY2003 Accomplishments:

- Provided review and comment on the final inventory report (Mather *et al* 2003a) and research report (Mather *et al* 2003 b) prepared by the principal investigator (Martha Mather, USGS).

Scheduled FY2004 Activities:

- If time, we will draft a long-term freshwater fish monitoring protocol based on the inventory and research reports; however, we may defer this activity to FY2005 or FY2006.

Task 3.6 - Inventory and monitor amphibians.

FY2003 Accomplishments:

- Worked with the principal investigator (Peter Paton, URI) and the NAC CESU (Mary-Jane James-Pirri) to finalize the pond-breeding amphibian monitoring protocol (Paton *et al* 2003).
- Conducted the first year of monitoring according to the recently completed protocol. This included implementing the egg mass count component at 20 sites, and the anuran call count component at 30 sites.
- In addition to performing the egg mass counts as prescribed by the protocol (locus method), we also tested a potentially more efficient approach to quantifying egg masses (maximum daily count method).
- Collaborated with Peter Paton (URI) to write a successful funding request to study the distribution and habitat parameters of spadefoot toad (*Scaphiopus holbrookii*) breeding ponds.
- Surveyed spadefoot toad presence and mortality along park roads; coordinated with Resource and Visitor Protection staff to develop a traffic detour plan to reduce road mortality.
- Provided technical assistance and logistical support to a graduate student studying habitat parameters influencing the distribution and abundance of Fowler's toads (*Bufo fowleri*) at CACO.

Scheduled FY2004 Activities:

- Prepare an annual report describing the 2003 amphibian monitoring work and comparing the two egg mass count methods used. If the maximum daily count method is determined to be as effective as the loci method, we will also prepare an addendum to the protocol documenting the shift to the maximum daily count method.
- Implement the second year of amphibian monitoring according to the protocol.
- Develop a work plan for the spadefoot toad study and continue to support management efforts to reduce road mortality.
- Continue to provide technical assistance and logistical support for the graduate research project on Fowler's toads.
- Complete a report on the terrestrial salamander inventory work conducted in FY2001 and 2002. This report will also evaluate the efficacy of using cover boards for long-term monitoring.

Task 3.7 - Inventory and monitor aquatic turtles

FY2003 Accomplishments:

- Completed an inventory of spotted turtles (*Clemmys guttata*), a Massachusetts species of special concern.

Scheduled FY2004 Activities:

- Complete a report on the turtle inventory including recommendations regarding further monitoring.

Task 3.8 - Develop a protocol for monitoring marsh birds

FY2003 Accomplishments:

- Provided review and comment on the marsh birds section of the waterbird monitoring protocol prepared by Mike Erwin, USGS (Erwin *et al* 2003).

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 begin development of a dune grassland vegetation monitoring protocol.

FY2003 Accomplishments:

- In collaboration with Raeid Abed from the Max Planck Institute for Marine Microbiology in Bremen, Germany, and Ferran Garcia-Pichel from Arizona State University, completed a characterization of the microbiotic crusts of CACO's dunes and began drafting a manuscript describing the results.

Scheduled FY2004 Activities:

- Complete the microbiotic crust manuscript and submit it to an appropriate journal for publication.
- Conduct preliminary field studies to develop long-term dune grassland vegetation monitoring methods.

Task 4.2 - Develop a monitoring protocol for coastal heathlands.

FY2003 Accomplishments:

- Completed analysis and began writing the coastal heathland monitoring protocol.

Scheduled FY2004 Activities:

- Complete draft, obtain peer review, and finalize the heathland monitoring protocol.
- Begin drafting a heathland management plan.

Task 4.3 - Monitor coastal forest vegetation

FY2003 Accomplishments:

- Completed a report documenting the status of protocol development for monitoring coastal forest vegetation (Smith 2003).
- Completed the third and final year of data collection comprising the first complete data set for the long-term forest vegetation monitoring project. Additional data collection is planned to occur at ten-year intervals. This also completes the data collection required to finalize the forest vegetation monitoring protocol. The work completed this year includes establishing sites in four additional forest types (red maple (*Acer rubrum*), black locust (*Rubinia pseudoacacia*), Atlantic white cedar (*Chamaecyparis thyoides*), and oak (*Quercus* sp.) dominated forests), developing leaf litter quality and decomposition rate measures, and incorporating plant tissue analysis into the protocol.
- Initiated a collaborative project with the University of Massachusetts (UMass) to analyze change in forest structure and composition based on data collected in 1981, 1992/3, and 2001/2. William Patterson, the collaborator at UMass, collected the 1981 and 1992/3 data, and is supervising a graduate student who will do most of the analyses. We collected the 2001/2 data, and are contributing \$4847 toward the analyses.

Scheduled FY2004 Activities:

- Draft, obtain peer review, and finalize the forest vegetation monitoring protocol.
- Continue the collaboration with UMass on the analyses of change in forest structure and composition.

Task 4.4 - Inventory terrestrial reptiles

FY2003 Accomplishments:

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

Scheduled FY2004 Activities:

- Complete a report on the snake inventory work conducted in FY2001 and 2002. This report will also evaluate the efficacy of using cover boards for long-term monitoring.

Task 4.5 - Monitor land birds

FY2003 Accomplishments:

- Provided technical assistance, logistical support, and an additional \$2500 to the principal investigator (Curtice Griffin, UMass) developing a land bird monitoring protocol based on point counts. This was the third and final year of field work for this project; the additional funds were provided to help address the unforeseen demise of a UMass field vehicle. A report and draft protocol are expected in FY2004 or FY2005.
- Provided technical assistance and logistical support to the principal investigator (David DeSante, Institute for Bird Populations) testing the MAPS (Monitoring Avian Productivity and Survivorship) protocol at CACO. This was the fifth and final year of field work for this project. A final report is expected in FY2004.
- Initiated a collaborative project with Manomet Center for Conservation Sciences to inventory breeding northern harriers (*Circus cyaneus*) at CACO. The principal investigator is Rhys Bowen. In FY2003, we assisted with development of the study and project planning, and obligated \$38,789 for the project. Field work will begin in FY2004 or FY2005, and will run for two consecutive field seasons.

Scheduled FY2004 Activities:

- Provide review and comment on a draft report and protocol from the point count project, and on a draft report on the MAPS project.
- Provide technical assistance and logistical support to Manomet for the northern harrier inventory.

Task 4.6 - Assess the feasibility of small mammal monitoring

FY2003 Accomplishments:

- Completed a draft report evaluating the utility and feasibility of a small mammal monitoring protocol based on a two-year field testing phase. This report also comprises an inventory of CACO's small mammals, assesses which population parameters and community measures can be realistically estimated, and suggests optimal field and analytical methods for future monitoring.

Scheduled FY2004 Activities:

- Obtain appropriate peer review and finalize the small mammal report.

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

FY2003 Accomplishments:

- Provided technical assistance and logistical support to the principal investigator (Alan O'Connell, USGS) testing meso-mammal monitoring techniques at CACO, FIIS, GATE, and COLO.
- Collaborated with Dr. O'Connell to prepare a successful funding proposal for development of a meso-mammal monitoring protocol.

Scheduled FY2004 Activities:

- Continue to provide technical assistance and logistical support for the protocol development phase of this project.

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 contributes to the water quality and quantity protection strategies in CACO's GMP; and those in Tasks 5.3 and 5.4, 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.

FY2003 Accomplishments:

- Monitored precipitation and atmospheric deposition through NADP, aerosols through IMPROVE, and ozone in partnership with the State.
- With technical leadership from the NRM Chemist, we added a mercury atmospheric deposition element to the meteorologic and atmospheric monitoring project.

Scheduled FY2004 Activities:

- Continue to monitor precipitation, atmospheric deposition, aerosols, and ozone.
- Prepare an annual report summarizing meteorologic and atmospheric monitoring results from FY2003.
- Develop an addendum to the meteorologic and atmospheric monitoring protocol (USGS, URI, CACO 2001) that updates in-park procedures, updates links to partner data sources, specifies the frequency for downloading data, and addresses data management.

Task 5-2 - Monitor hydrology and ground water quality.

FY2003 Accomplishments:

- Continued monthly collection of ground water level and pond stage data.
- USGS-Ground Water Studies Section finalized the hydrologic monitoring protocol (McCobb and Weiskel 2003)
- Provided technical assistance and logistical support to the investigators developing a ground-water quality monitoring protocol. The investigators are John Colman and Peter Weiskel, USGS-Ground Water Studies Section; funds were committed and planning was initiated in FY2002. We expect this document to be drafted and finalized in FY2004.
- Contributed \$19,575 toward a project that includes completion of a detailed topographic survey and collection of initial surface hydrology data in the Mill Creek portion of the Herring River system. Other funding for this project (\$50,000) has been provided by NPS-WRD. The project manager is Robert Ericson with Earthtech; funds were obligated through a cooperative agreement with the Coastal America Foundation. This project will be completed in FY2004.
- Initiated a collaborative project with USGS-Ground Water Studies Section and NPS-WRD to monitor the sub-surface freshwater-saltwater interface in the vicinity of Mill Creek. The principal investigator is John Masterson, USGS. In FY2003, we collaborated on development of the study and project planning, and provided \$30,000 for well installation and initial modeling.

Scheduled FY2004 Activities:

- Initiate implementation of the hydrologic monitoring protocol.
- Provide review and comment on a draft of the ground-water quality monitoring protocol. If time, we will initiate implementation of this protocol; however, we may defer this activity until FY2005.
- Continue collaboration on the Mill Creek topography, surface hydrology, and freshwater-saltwater interface projects.

Task 5.3 - Create digital aerial photo map of historic conditions

FY2003 Accomplishments:

- Provided \$6000 to URI's Environmental Data Center for the creation of a digital aerial photo map based on photography from 1947. This will be an important tool for interpreting wetland monitoring data and cover type change. The principal investigator is Charles LaBash, URI; the funds were provided through the Northeast Region's cooperative agreement with the FTSC. This project is scheduled to be completed this year.

Task 5.4 - Complete cover-type map

FY2003 Accomplishments:

- Provide technical assistance and logistical support to the principal investigators (Leslie Sneddon, NatureServe; Donna Peterson, UMass) developing the cover-type map. This

Scheduled FY2004 Activities:

- Provide review and comment on draft products as necessary to complete the cover-type map and accompanying report.
- Provide for an appropriate accuracy assessment of the cover-type map. Our preference is to collaborate with NatureServe or other qualified cooperator; however, if potential cooperators' funding requirements or availability are prohibitive, we may pursue this element of the project in-house.

Task 5.5 - Develop a protocol for monitoring the effects of visitation

Scheduled FY2004 Activities:

- Provide review and comment on a draft protocol if it becomes available from the principal investigator (Jeff Marion, USGS). This project was initiated in FY2001; we expect the protocol to be drafted and finalized in FY2004.

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

Task 6.1 - Develop an integrated data management system.

FY2003 Accomplishments:

- Continued recruiting for a Data Manager. This process was initiated near the close of FY2002 and has continued throughout F2003. Our efforts to fill this critical position have been slowed, in part, by a lack of attractive applicants. We believe this is due largely to the unusual combination of skills required for this position, and to the deterrence posed by the high cost of living on Cape Cod.
- Updated, improved, and populated several existing data bases including those containing salt marsh vegetation data, kettle pond water quality data, meteorologic and atmospheric data, hydrologic data, sediment elevation data, amphibian data, forest vegetation data, and legacy incidental encounter data for special status species dating back to 1970.
- We purchased the hardware and software needed to upgrade the North Atlantic Coastal Laboratory's server to increase storage capacity, improve reliability, and enhance the security of program data.
- The NRM GIS Program:
 - organized the Lab's collection of digital photos including those documenting species vouchers and vegetation community types;
 - began re-organizing the Lab's GIS data and updating associated metadata; and
 - began assembling a base cartographic data set to disseminate to program collaborators and other researchers.

Scheduled FY2004 Activities:

- Complete the hiring process for the Data Manager position. We have selected a candidate and are cautiously optimistic that she will EOD before the end of the first quarter of FY2004.
- Collaborate with NRM's GIS Specialist to develop an initial work plan for the new Data Manager. We anticipate that priority tasks will include:
 - assessing the status and condition of extant data sets;
 - collaborating with program scientists to identify data management and analysis objectives for each data set;
 - designing Access data bases that meet project objectives;
 - documenting current data stewardship procedures and prioritizing the procedures that need to be developed;
 - reviewing data management plans and data bases developed by other programs; and
 - developing familiarity with the data bases, templates, and tools developed by the National I&M Program.

- NRM will complete the re-organization and metadata update for the Lab's GIS data and will finish assembling the base cartographic package to be provided to cooperators.

Task 6.2 - Develop an inter-disciplinary monitoring area approach to promote understanding of the causes of change.

FY2003 Accomplishments:

- Presented the IMA concept at the CACO LTEM Symposium and the Program Review for discussion and feedback. Comments were very positive - we will continue to develop this approach as the program matures.

Task 6.3 - Prioritize monitoring needs within and across ecosystems to ensure that our core monitoring program is sustainable for the long-term while meeting scientific objectives.

FY2003 Accomplishments:

- Developed a prioritization scheme and implementation guidance that identifies the most critical projects and guides the subsequent phase-in of other important monitoring efforts as program capacity allows. This effort involved assembling a Prioritization Group to guide the process, establishing *a priori* criteria for determining priority, evaluating each project independently using the criteria, conducting a workshop to synthesize the evaluations and develop the prioritization scheme, and documenting the process and results (Phillips 2003).
- Used the results of the prioritization scheme to adjust selected elements of our FY2003 Work Plan and to develop the work plan for FY2004.

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

Task 7.1 - Develop a protocol integrity plan

Scheduled FY2004 Activities:

- Develop and document a formal process for finalizing, revising, and making minor adjustments to monitoring protocols in order to ensure the scientific validity, continuity, and relevance of this program over the long term. This plan will include peer review standards, documentation procedures, and controls for maintaining linkages between protocol versions and data sets

Task 7.2 - Develop reporting guidance for the program.

Scheduled FY2004 Activities:

- In preparation for the Program Review of November 2002, we developed a brief summary of key audiences and potential tools for communicating results. In FY2004, we plan to build on this outline to establish content and review standards for specific types of reporting products, to establish general goals that will help us prioritize reporting activities in future work plans, and to provide a framework for evaluating and updating reporting activities to ensure they are effective.

Task 7.3 - Share information with non-technical audiences

FY2003 Accomplishments:

- Finalized Seashore Science rack card development, production, and distribution arrangements with the Division of Interpretation and Cultural Resources. Produced one Seashore Science on the microbiotic crusts of the dunes and another on spadefoot toads in the Province Lands.
- Conducted training sessions for seasonal interpretive staff.
- Contributed two articles to the Park News 2003-2004 Activity Guide; one on commonly observed birds at the park, and one on shoreline change.
- Program staff and cooperators gave presentations about the results of program projects to a variety of public groups. Audiences included the Gull Pond Areas Conservation Association, the Cape Cod Community Leadership Council, the Cape Cod Natural History Conference, and visitors at the Province Lands Visitors' Center.

Scheduled FY2004 Activities:

- Produce at least two Seashore Science rack cards
- Continue to provide training to seasonal interpretive staff.

- Continue to provide information about program results through public presentations, articles in Park News, or other appropriate venues as opportunities arise.

Task 7.4 - Share technical information with scientists, NPS audiences, and other entities interested in monitoring and resource management.

FY2003 Accomplishments:

- Obtained expert review of CACO's wildlife portion of NPSpecies and made substantial revisions, corrections, and updates to the amphibian, reptile, and mammal sections. Expert review of the bird section is in progress and should be completed in FY2004.
- Completed the 2002 update to the 1999 Conceptual Framework (Roman and Barrett 1999). The update describes the evolution of the program's scope and the status of protocol development efforts, and includes summaries of each operational or proposed inventory and monitoring project.
- Held the conference titled: Symposium on Long-Term Ecosystem Monitoring at Cape Cod National Seashore. This event is described in Appendix I, and the presentations are listed in Section IV.
- In addition to the Symposium, program staff shared technical information through presentations to the Cape Cod Commission, CACO's managers and supervisors, and the Estuarine Research Federation.
- Program staff provided technical expertise for the Sensing Cape Cod curricula development project led by the Atlantic Learning Center. Program scientists gave presentations, worked with groups of teachers to develop monitoring questions, demonstrated monitoring techniques, and helped provide ecological continuity and scientific integrity to the curricula development process.
- With technical assistance from the Northeast Coastal and Barrier Network, we created and launched a web site. This site provides information about all aspects of the program through text and links to protocols, operational documents, reports, and partners. The address is <http://www.nature.nps.gov/im/units/caco/index.htm>.

Scheduled FY2004 Activities:

- Continue to share program results and other technical information through presentations, posters, workshops, and other appropriate venues as opportunities arise.
- Prepare and submit manuscripts to peer reviewed journals on the microbotic crust characterization study and on monitoring results from Hatches Harbor and East Harbor.
- Develop content for the data management section of the website.

Task 7.5 - Document activities and findings.

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

FY2003 Accomplishments:

- Completed the following project reports and protocols:
 - revised kettle pond water quality monitoring protocol
 - coastal forest vegetation protocol development report
 - draft small mammal protocol assessment report
- Completed the following programmatic and operational reports and plans:
 - draft five-year staffing plan
 - project prioritization report
 - 2002 update to the 1999 Conceptual Framework
 - Lab Quality Assurance Project Plan (currently awaiting State approval)
- Assisted cooperators to complete the following:
 - pond-breeding amphibian monitoring protocol
 - hydrologic monitoring protocol
 - fresh water fish inventory and research reports

Scheduled FY2004 Activities:

- Complete the following project reports and protocols:
 - salt marsh vegetation monitoring annual report
 - salt marsh vegetation protocol addendum
 - kettle pond water quality monitoring annual report
 - pond-breeding amphibian monitoring annual report
 - pond-breeding amphibian protocol addendum
 - dune microbiotic crust report
 - forest vegetation protocol
 - heathland vegetation protocol
 - terrestrial salamander, snake, and aquatic turtle inventory reports
 - finalize the small mammal protocol assessment report
 - meteorologic and atmospheric monitoring annual report
 - meteorologic and atmospheric protocol addendum
- Complete the following programmatic and operational reports and plans:
 - finalize the five-year staffing plan
 - protocol integrity plan
 - reporting guidance
 - finalize the Lab Handbook of Analytical Methods
- Assist cooperators to complete the following:
 - salt marsh sediment elevation protocol
 - intertidal map and accompanying report
 - vegetation map and accompanying report
 - freshwater aquatic invertebrate protocol
 - ground-water quality protocol
 - visitor use and resource impact protocol

Objective 8 - Provide technical assistance to the Northeast Coastal and Barrier Network, to other networks and parks, and to other entities with common monitoring objectives.

Task 8.1 - Share technical expertise with the Network and other parks.

FY2003 Accomplishments:

- Provided technical leadership on the herptofaunal inventory project covering ten NPS units in the Northeast Region. This project is funded by the Northeast Region and is being conducted in partnership with the Wildlife Conservation Society. FY2003 activities included providing peer review and comments on a report on diamond back terrapins at Sandy Hook; writing a work plan and providing field training for the GATE portion of the project, and contributing to reports on the inventories at DEWA, ACAD, MORR, WEIR, MIMA, SARA, SAIR, SAGA, WIFL, and FIIS.
- Provided detailed peer review of herptofauna inventory reports from FONE, FRHI, and VAFO.
- Reviewed the status of ASIS herptofaunal information and assisted in identifying inventory needs.

Scheduled FY2004 Activities:

- Help finalize the herptofaunal inventory reports for DEWA, ACAD, MORR, WEIR, MIMA, SARA, SAIR, SAGA, WIFL, and FIIS; assist in analysis and report preparation for the GATE inventory.
- Assist in scoping and work plan preparation for herptofaunal inventory at ASIS.

Task 8.2 - Provide technical assistance to other monitoring efforts.

FY2003 Accomplishments:

- Assisted the Cape Cod Commission, lower Cape towns, and Massachusetts Audubon's Wellfleet Bay Sanctuary with fresh and salt water quality monitoring. Assistance included

training volunteers and performing the laboratory analyses for all samples. CACO's contribution to this project is supported by NRM, the monitoring program, and a grant from the Community Foundation of Cape Cod.

Scheduled FY2004 Activities:

- Continue support of local water quality monitoring projects by providing training and laboratory analysis services.

Objective 9 - Develop and sustain appropriate staff resources and laboratory infrastructure to ensure program objectives can be met now and into the future.

Task 9.1 - Build technical expertise.

FY2003 Accomplishments:

- Began an extensive recruitment process for a Data Manager (also listed under objective 6).

Scheduled FY2004 Activities:

- Complete the hiring process for a Data Manager. We have selected a candidate and are cautiously optimistic that she will EOD before the end of the first quarter of FY2004.

Task 9.2 - Secure an adequate work force to complete scheduled field and laboratory tasks.

FY2003 Accomplishments:

- Hired a 4-year term, GS-5 Aquatic Ecology Tech.
- Hired a 4-year term, GS-6/7 Hydrology Tech. The incumbent will EOD during the first quarter of FY2004.
- Hired four seasonal BioTechs for the following projects:
 - coastal forest vegetation monitoring
 - salt marsh vegetation monitoring
 - pond-breeding amphibian monitoring
 - dune slack wetland study (paid for by study funds from NPR-WRD)
- Sponsored the undergraduate Coastal Fellow from the University of Rhode Island who worked on a benthic inventory of East Harbor.
- Recruited and supported six Student Conservation Association volunteers to assist with the projects listed above, and with the kettle pond water quality monitoring project.

Scheduled FY2004 Activities:

- Hire two seasonal BioTechs for the following projects:
 - pond-breeding amphibian monitoring; and
 - salt marsh vegetation sample processing and other vegetation projects.
- Recruit and support five Student Conservation Association or other volunteers to assist with the projects listed above, with the pond water quality monitoring project, and with the dune slack study.

Task 9.3 - Improve program efficiency and coordination.

FY2003 Accomplishments:

- Held a Program Review in conjunction with the symposium. This involved writing program documentation, preparing briefing materials, developing a presentation that provided an overview of program operations, and other miscellaneous tasks. The results were extremely helpful; many of the elements in this work plan reflect the constructive input received from the review panel.

Scheduled FY2004 Activities:

- Finalize the five-year staffing plan and re-assess projected personnel cost estimates within the second quarter of the arrival of the new HydroTech and Data Manager.
- Develop and test budget tracking procedures to help estimate the implementation costs of operational protocols and refine estimates of long-term operational costs.

Task 9.4 - Contribute to the development of the analytical laboratory.

The following accomplishments and activities are directed by the NRM Chemist with assistance from the monitoring program.

FY2003 Accomplishments:

- Initiated participation in the USGS Standard Reference Sample Project for quality assurance for nutrient and trace element analyses.
- Developed a Lab Quality Assurance Project Plan (QAPP) which is currently awaiting State approval.
- Began development of a Lab Handbook of Analytical Methods to establish and document the analysis procedures used in the lab.
- Increased analytical capabilities through equipment purchases and upgrades.

Scheduled FY2004 Activities:

- Complete the Lab Handbook of Analytical Methods.

III. Staffing

CACO Prototype Staff

Carrie Phillips, Prototype Coordinator

Chris Pearson, Budget Assistant

Robert Cook, Wildlife Ecologist

Stephen Smith, Plant Ecologist

Evan Gwilliam, Aquatic Ecologist

Kelly Boland, Wildlife BioTech

Data Manager - To Be Hired in FY2004

Jon Budreski - Aquatic Ecology BioTech

David Vinson - Hydrology Tech - will EOD October 6, 2003

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, 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:

Raeid Abed, Max Planck Institute for Marine Microbiology

Mike Bradley, University of Rhode Island

Rhys Bowen, independent contractor to Manomet Center for Conservation Sciences

Elizabeth Colburn, Harvard University, Harvard Forest

John Colman, USGS-WRD, MA-RI District

David DeSante, Institute for Bird Populations

Robert Ericson, Earthtech through the Coastal America Foundation

Michael Erwin, USGS-BRD, Patuxent Wildlife Research Center

Ferran Garcia-Pichel, Arizona State University

Howard Ginsberg, USGS-BRD, Patuxent Wildlife Research Center
Curtice Griffin, University of Massachusetts, Amherst
Mary-Jane James-Pirri, Graduate School of Oceanography, University of Rhode Island
Blaine Kopp, USGS, Patuxent Wildlife Research Center
Charles LaBash, University of Rhode Island
Jeff Marion, USGS, Patuxent Wildlife Research Center
Martha Mather, USGS, Patuxent Wildlife Research Center
John Masterson, USGS-WRD, MA-RI District
Scott McWilliams, University of Rhode Island
Tim McCobb, USGS-WRD, MA-RI District
Hilary Neckles, USGS, Patuxent Wildlife Research Center
Barbara Nowicki, Graduate School of Oceanography, University of Rhode Island
Allan O'Connell, USGS, Patuxent Wildlife Research Center
Candace Oviat, Graduate School of Oceanography, University of Rhode Island
Peter Paton, University of Rhode Island
William Patterson, University of Massachusetts
Donna Peterson, University of Massachusetts
Sheldon Pratt, Graduate School of Oceanography, University of Rhode Island
Kenneth Raposa, Graduate School of Oceanography, University of Rhode Island
Mark Robson, Rutgers University
Fred Short, University of New Hampshire
Leslie Sneddon, NatureServe
Peter Weiskel, USGS-WRD, MA-RI District

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

Reports and Publications:

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

Cook, R. 2003. Commonly observed birds at Cape Cod National Seashore. Park News: 2003-2004 Activity Guide. Cape Cod National Seashore, Wellfleet, MA.

Cook, R. and K. Boland. 2003. Monitoring Small Mammals: A Protocol for Long-term Coastal Ecosystem Monitoring at Cape Cod National Seashore - DRAFT. Cape Cod National Seashore, Wellfleet, MA. 75pp plus appendices.

Erwin, M.R., C.J. Conway, S.W. Hadden, J.S. Hatfield. and S.M. Melvin. 2003. Waterbird Monitoring Protocol for Cape Cod National Seashore and other Coastal Parks, Refuges, and Protected Areas. Technical Report, USGS Patuxent Wildlife Research Center, Coastal Field Station, Narragansett, RI. 87pp.

Gwilliam, E. 2003. Marindin's Legacy: Scale and Shoreline Change. Park News: 2003-2004 Activity Guide. Cape Cod National Seashore, Wellfleet, MA.

Lee, K. and J. Oset. 2003. Cape Cod National Seashore Laboratory Methods: Quality Assurance Manual - DRAFT. Cape Cod National Seashore, Wellfleet, MA.

Mather, M.E., A.J Norris, and M.P. Carey. 2003a. Freshwater Fish Inventory, Northeast National Parks, 1999-2001: 2003 Narrative, Cape Cod National Seashore. University of Massachusetts, Amherst. 36pp plus tables and figures.

Mather, M.E., A.J Norris, and M.P. Carey. 2003b. Freshwater Fish Inventory, Northeast National Parks, 1999-2001: Research Summary, CACO Kettle Ponds. University of Massachusetts, Amherst. 20pp plus tables and figures.

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, Massachusetts. 94pp.

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.

Smith, S. 2003. Coastal forest monitoring at Cape Cod National Seashore: Status of Protocol Development (January 2003). Cape Cod National Seashore, Wellfleet, MA. 40pp.

Presentations:

Budreski, J. 2003. Kettle Pond Water Quality Monitoring at Cape Cod National Seashore. Presentation to the Gull Pond Areas Conservation Association. Wellfleet, Massachusetts.

Cook, R. 2003a. Amphibians and Reptiles of Cape Cod National Seashore. Presentation at the Province Lands Visitors' Center. Provincetown, Massachusetts.

Cook, R. 2003b. Wildlife Inventory and Monitoring at Cape Cod National Seashore. Presentation to the Cape Cod Community Leadership Council.

Faherty, M. 2003. Landbird monitoring at Cape Cod National Seashore. Presentation at the Cape Cod Natural History Conference, Barnstable, Massachusetts.

Phillips, C. 2002. Natural Resource Management and Ecosystem Monitoring at Cape Cod National Seashore. Presentation to the Cape Cod Commission, Eastham, Massachusetts.

Smith, S. 2003a. Dune slack wetlands of the Province Lands, Cape Cod National Seashore. Presentation at the Cape Cod Natural History Conference, Barnstable, Massachusetts.

Smith, S. 2003b. Features of the Biosphere of Cape Cod. Presentation to the Sensing Cape Cod Teacher Workshop, Eastham, Massachusetts.

Smith, S., J. Portnoy, C. Farris, C. Roman, and M. James-Pirri. 2003. Responses of *Phragmites australis* to tidal restoration of a diked salt marsh in Cape Cod National Seashore. Presentation at the Estuarine Research Federation Conference, Seattle, Washington.

Talancy, N. 2003. Meso-mammals of Cape Cod national Seashore. Presentation at the Cape Cod Natural History Conference, Barnstable, Massachusetts.

Presentations at the 2002 Symposium:

- Overview of the Cape Cod LTEM Program. Carrie Phillips, NPS-CACO
- Conceptual Framework and Protocol Development. Charles Roman, NPS-NAC CESU.
- Marsh Sediment Elevation and Sea Level Rise. Don Cahoon, USGS-BRD.
- Estuarine Nutrient Enrichment. Charles Roman, NPS-NAC CESU.
- Salt Marsh Vegetation. Charles Roman, NPS-NAC CESU and Stephen Smith, NPS-CACO.
- Estuarine Nekton. Mary Jane James-Pirri, URI.
- Hydrologic Stresses on the Cape Cod National Seashore: Characterizing Variability and Long-Term Trends. Peter Weiskel, USGS-WRD.
- Kettle Pond Water Quality. John Portnoy, NPS-CACO.
- Kettle Pond and Vernal Wetland Vegetation. Stephen Smith, NPS-CACO.
- Pond-Breeding Amphibians. Peter Paton, URI.
- Complex Spatial and Temporal Ecological Relationships Among Aquatic Organisms in the Kettle Ponds at the Cape Cod National Seashore: Towards a More Sensitive Approach to Monitoring Fish. Martha Mather, UMass.
- Geomorphic Shoreline Change. Mark Duffy, NPS-ASIS.
- Monitoring the Effects of Off-Road Vehicle Traffic on Beach Invertebrate Fauna. Jaqui Steinback, URI.
- Heathland Vegetation. Evan Gwilliam, NPS-CACO.
- Coastal Forest Vegetation. Stephen Smith, NPS-CACO.
- Monitoring Avian Productivity and Survivorship (MAPS) and its Role in Cape Cod National Seashore's Long-Term Ecological Monitoring. Danielle O'Grady, Institute for Bird Populations.
- Landbird Point Counts. Mark Faherty, UMass.
- Small Mammal Monitoring Protocol Assessment. Robert Cook, NPS-CACO.
- Meso-Mammal/Carnivore Monitoring. Allan O'Connell and Neil Talancy, USGS-BRD.
- Contaminants. Mark Robson, Rutgers University.
- Recommendations for Long-Term Monitoring of Selected Waterbirds at Cape Cod National Seashore. Mike Erwin, USGS-BRD, Scott Melvin, Massachusetts Division of Fish and Wildlife, Courtney Conway, USGS-BRD, Steve Hadden, NPS-GRSM, and Jeff Hatfield, USGS-BRD.
- Ozone Monitoring and Potential Effects at Cape Cod. Tonnie Maniero, NPS-ARD.
- Inter-Disciplinary Study Areas. John Portnoy, NPS-CACO.
- Network and Regional Perspective. Beth Johnson, NPS-NER.

V. Status of Park Vital Signs Monitoring

Cape Cod National Seashore 2003	Air Quality	Water Quality	Water Quantity	Geologic Resources	Plants	Animals	Landscape Characteristics
Planning and Design							
w/NRC funding		3		1	4	5	
w/other funding			1			5*	1
Protocols Implemented							
w/NRC funding	1	1		1	2	2	1
w/other funding						2	
Analysis/Synthesis Available							
w/NRC funding					1	1	
w/other funding	1					2	

*One of these projects (estuarine benthos) is funded by USGS-BRD (\$70,000) and NRC (\$30,000)

VI. USGS Protocol Development and Monitoring Related Research Needs

Review of statistical analyses:

- We are currently cooperating with an investigator from UMass on analyses that will compare two methods of forest vegetation monitoring (one method used in 1981 and 1992/3, and the other used in 2001/2) and attempting to integrate the data from both methods for an analysis of change over the past 20 years. Expert review of the analyses and conclusions would be helpful.
- We have just completed an evaluation of two-years of small mammal trapping data to assess the feasibility of long-term monitoring and to refine monitoring methods. This project involved comparison of several methods for analyzing mark/re-capture data, multivariate analyses, and power analyses. We are seeking expert review from a variety of sources including USGS.
- We are concluding development of a heathland monitoring protocol and expect a draft to be completed during the second quarter of FY2004. We will be seeking expert review of this protocol from a variety of sources including USGS.

Assistance with statistical analysis:

- We are mid-way through a study characterizing various physical and vegetation parameters of dune slack wetlands. We will need assistance with multivariate analysis of this data.

VII. Budget Narrative

In FY2003, the Cape Cod Prototype Program received \$702,000 in Inventory and Monitoring Funds. Just over 60 percent of these funds were used to support permanent, term, and temporary staff as well as modest stipends and housing for volunteers. We had anticipated filling two core staff positions relatively early in the fiscal year (Data Manager and HydroTech); however, neither of those positions EODed during FY2003. As a result, a portion of the funds planned for staff support were available to meet other program needs. We directed a portion of these funds toward some large, one-time durable equipment purchases (vehicles and upgraded analytical instruments) and toward agreements for inventory and monitoring projects. We also made the hardware purchases necessary to upgrade the lab's server and replace poorly functioning desk-top computers. The remainder was used to support new and recurring field operations (from aluminum tags to Ziploc bags), laboratory analysis (reagents, test kits, and other consumable lab supplies), routine computer-related needs (software licenses, printer supplies, peripherals), and other miscellaneous expenses.

We anticipate an authorization of \$702,000 again in FY2004. We estimate that about 78 percent of our budget will be dedicated to staff salaries and support for seasonal technicians and volunteers. This increase will result from completing the hiring of core staff during the first quarter of the year. We do not plan additional large, one-time purchases of lab equipment or vehicles; therefore our planned operations and equipment budget is lower than FY2003 expenditures. We have also set aside a smaller proportion of our budget for cooperative agreements.

A summary of our FY2003 expenditures and FY2004 budget plans is provided on the following pages.

Budget Summary

FY03 Admin Report

Network: Cape Cod NS Prototype

Category: 1_Income

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
Authorization for FY2003	\$702,000.00	Prototype \$\$ - Park Base		
Subtotal	\$702,000.00			

Category: 2_Personnel

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
a) Prototype Coordinator	\$83,675.00	Prototype \$\$ - Park Base	NPS	
b) Budget Assistant	\$23,826.00	Prototype \$\$ - Park Base	NPS	
c) Wildlife Ecologist	\$81,078.00	Prototype \$\$ - Park Base	NPS	
d) Plant Ecologist	\$61,986.00	Prototype \$\$ - Park Base	NPS	
e) Aquatic Ecologist	\$50,835.00	Prototype \$\$ - Park Base	NPS	
f) Wildlife BioTech	\$37,293.00	Prototype \$\$ - Park Base	NPS	
g) Aquatic Ecology BioTech	\$19,418.00	Prototype \$\$ - Park Base	NPS	
h) Chemist	\$9,003.00	Prototype \$\$ - Park Base	NPS	for in-depth assistance with mercury monitoring and analytical methods
i) Laboratory Tech	\$13,273.00	Prototype \$\$ - Park Base	NPS	
j) Seasonal BioTech - amphibian monitoring	\$10,819.00	Prototype \$\$ - Park Base	NPS	
k) Seasonal BioTech - forest monitoring	\$5,437.00	Prototype \$\$ - Park Base	NPS	
l) Seasonal BioTech - salt marsh monitoring	\$15,153.00	Prototype \$\$ - Park Base	NPS	
m) 6 Student Conservation Association volunteers	\$17,097.00	Prototype \$\$ - Park Base	Other non-Federal	includes housing
Subtotal	\$428,893.00			

Category: 3_Coop. Agreements

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
a) USGS - salt water/fresh water interface monitoring	\$30,000.00	Prototype \$\$ - Park Base	USGS	
b) Coastal America Foundation - detailed topography and surface hydrology	\$19,575.00	Prototype \$\$ - Park Base	Other non-Federal	
c) Manomet Center for Conservation Sciences - harrier study	\$30,789.00	Prototype \$\$ - Park Base	Other non-Federal	
d) University of Rhode Island - 1947 digital aerial photo map	\$6,000.00	Prototype \$\$ - Park Base	University-CESU	
e) University of Massachusetts - forest vegetation analysis	\$4,847.00	Prototype \$\$ - Park Base	University-CESU	
f) University of Rhode Island - Coastal Fellow	\$5,750.00	Prototype \$\$ - Park Base	University-CESU	
g) University of Rhode Island - plover study	\$26,000.00	Prototype \$\$ - Park Base	University-CESU	
h) University of Massachusetts - avian point count project	\$2,500.00	Prototype \$\$ - Park Base	University-CESU	
Subtotal	\$125,461.00			

Category: 5_Operations/Equipment

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
a) Field Equipment and Supplies	\$24,097.00	Prototype \$\$ - Park Base	Other non-Federal	
b) Laboratory Equipment and Supplies	\$52,520.00	Prototype \$\$ - Park Base	Other non-Federal	
c) Computer Hardware and Software	\$20,319.00	Prototype \$\$ - Park Base	Other non-Federal	
d) Miscellaneous	\$5,938.00	Prototype \$\$ - Park Base	Other non-Federal	includes cost of Symposium
e) Office Supplies	\$4,183.00	Prototype \$\$ - Park Base	Other non-Federal	
Subtotal	\$107,057.00			

Category: 6_Travel

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
Travel and Training	\$7,278.00	Prototype \$\$ - Park Base	Other non-Federal	
Subtotal	\$7,278.00			

Category: 7_Other

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
2 vehicles	\$33,311.00	Prototype \$\$ - Park Base	Other non-Federal	
Subtotal	\$33,311.00			

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	\$411,796	\$30,000		\$45,097		\$215,107
Totals	\$702,000	\$411,796	\$30,000		\$45,097		\$215,107

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	\$428,893	\$125,461		\$107,057	\$7,278	\$33,311
Totals	\$702,000	\$428,893	\$125,461		\$107,057	\$7,278	\$33,311

Expense Totals By Category

<i>Category</i>	<i>SubTotal</i>	<i>Percent</i>
2_Personnel	\$428,893	61.10%
3_Coop. Agreements	\$125,461	17.87%
5_Operations/Equipment	\$107,057	15.25%
6_Travel	\$7,278	1.04%
7_Other	\$33,311	4.75%
	\$702,000	

Budget Summary

FY04 Work Plan

Network: Cape Cod NS Prototype

Category: 1_Income

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
Anticipated Authorization for FY2003	\$702,000.00	Prototype \$\$ - Park Base		
Subtotal	\$702,000.00			

Category: 2_Personnel

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
a) Prototype Coordinator	\$86,868.00	Prototype \$\$ - Park Base	NPS	
b) Budget Tech	\$24,303.00	Prototype \$\$ - Park Base	NPS	
c) Data Manager	\$68,968.00	Prototype \$\$ - Park Base	NPS	
d) Wildlife Ecologist	\$82,490.00	Prototype \$\$ - Park Base	NPS	
e) Plant Ecologist	\$64,298.00	Prototype \$\$ - Park Base	NPS	
f) Aquatic Ecologist	\$54,892.00	Prototype \$\$ - Park Base	NPS	
g) Hydrology Tech	\$38,958.00	Prototype \$\$ - Park Base	NPS	
h) Wildlife BioTech	\$37,225.00	Prototype \$\$ - Park Base	NPS	
i) Aquatic Ecology BioTech	\$36,228.00	Prototype \$\$ - Park Base	NPS	
j) Laboratory Tech	\$19,194.00	Prototype \$\$ - Park Base	NPS	
k) Seasonal BioTech - amphibian monitoring	\$11,000.00	Prototype \$\$ - Park Base	NPS	
l) Seasonal BioTech - salt marsh and vegetation	\$6,600.00	Prototype \$\$ - Park Base	NPS	
m) 5 Student Conservation Association volunteers	\$20,960.00	Prototype \$\$ - Park Base	Other non-Federal	
Subtotal	\$551,984.00			

Category: 3_Coop. Agreements

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
New Inventory or Monitoring Agreements	\$50,000.00	Prototype \$\$ - Park Base	University-CESU	
Subtotal	\$50,000.00			

Category: 5_Operations/Equipment

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
a) Field Equipment and Supplies	\$25,000.00	Prototype \$\$ - Park Base	Other non-Federal	
b) Laboratory Equipment and Supplies	\$46,256.00	Prototype \$\$ - Park Base	Other non-Federal	
c) Computer Hardware and Software	\$10,000.00	Prototype \$\$ - Park Base	Other non-Federal	
d) Miscellaneous	\$2,760.00	Prototype \$\$ - Park Base	Other non-Federal	
e) Office Supplies	\$1,000.00	Prototype \$\$ - Park Base	Other non-Federal	
Subtotal	\$85,016.00			

Category: 6_Travel

Description	\$ Amount	\$\$ Source	Where \$ Went	Comments
Travel and Training	\$15,000.00	Prototype \$\$ - Park Base	Other non-Federal	
Subtotal	\$15,000.00			

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	\$531,024			\$50,000		\$120,976
Totals	\$702,000	\$531,024			\$50,000		\$120,976

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	\$551,984	\$50,000		\$85,016	\$15,000	
Totals	\$702,000	\$551,984	\$50,000		\$85,016	\$15,000	

Expense Totals By Category

<i>Category</i>	<i>SubTotal</i>	<i>Percent</i>
2_Personnel	\$551,984	78.63%
3_Coop. Agreements	\$50,000	7.12%
5_Operations/Equipment	\$85,016	12.11%
6_Travel	\$15,000	2.14%
	\$702,000	

VII. References Cited

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.

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.

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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. 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. 47pp.

Smith, S. and J. Portnoy. 2002. Management of dune slack wetlands at Cape Cod National Seashore: Study Plan. Cape Cod National Seashore, Wellfleet, MA. 16pp.

USGS, URI, CACO. 2001. Summary of meteorological and atmospheric monitoring protocols for Cape Cod National Seashore. Technical Report, USGS Patuxent Wildlife Research Center, University of Rhode Island, Narragansett. 25pp.

Appendix I: Summary of Major Accomplishments and Public Interest Highlights

The Prototype Monitoring Program at Cape Cod National Seashore focuses on monitoring issues most relevant to management of park resources, and uses an ecosystem approach to define monitoring questions and develop appropriate monitoring methods. USGS has been our principal partner during the developmental phase of the program; over the last few years, our range of partners has expanded to include researchers from several universities and non-governmental organizations.

FY2003 Objectives for Prototype Monitoring:

- Assess and monitor the integrity of the four basic ecosystem types within Cape Cod National Seashore (estuaries and salt marsh systems; beach, spit, and barrier island systems; pond and freshwater wetland systems; and coastal upland systems).
- Assess and monitor park-wide and multiple-system indicators of ecosystem integrity.
- Integrate monitoring efforts and results across ecosystems.
- Share information, report findings, and document program activities.
- Provide technical assistance to the Northeast Coastal and Barrier Network, to other parks and vital signs monitoring networks, and to other entities with common monitoring objectives.
- Develop and sustain appropriate resources and infrastructure to ensure program objectives can be met now and into the future.

Summary of Major Accomplishments During FY2003:

In estuarine and salt marsh ecosystems, we implemented three long-term monitoring projects and assisted cooperators with four related projects. We collected data that is being used to monitor the response of salt marsh elevation to sea level rise, initiated park-wide salt marsh vegetation monitoring, and initiated estuarine nekton monitoring at two sites within the park. Program scientists assisted cooperators from USGS, the University of Rhode Island, and the University of New Hampshire with the development of three other long-term monitoring protocols; these protocols will address estuarine nutrient enrichment, estuarine benthos, and migrating waterbirds. We also continued to work with a cooperator from the University of Rhode Island on an intertidal habitat mapping project that is focusing on estuarine systems.

This year, work in beach, spit, and barrier island systems remained focused on development of monitoring methods. We continued to provide assistance to the Northeast Coastal and Barrier Network in their efforts to develop a protocol for monitoring shoreline change. We also contributed funding to study that will develop methods for monitoring the effects of disturbance on the threatened piping plover, will evaluate the effects of disturbance to this species, and will assist interpretation of long-term plover monitoring data. Other funding is being provided by the park's Over-Sand Vehicle Permit Program; the research cooperators are from the University of Rhode Island.

In ponds and fresh-water wetland systems, our monitoring efforts focused on kettle pond water quality and pond-breeding amphibians. We completed a revision of the kettle pond water quality monitoring protocol and collected monitoring data from all 20 kettle ponds in the park. The pond-breeding amphibian monitoring protocol was completed shortly before the 2003 field season. We assisted a cooperator from the University of Rhode Island to finalize the protocol, collected egg mass count data from 20 sites and anuran call count data from 30 sites, and tested a potentially more efficient method of collecting egg mass count data.

Other work in pond and fresh water systems emphasized ecological characterization and protocol development. We implemented the second year of a three-year study characterizing dune slack wetland systems; these systems are vulnerable to ground water withdrawal but their ecology remains poorly understood. This project will help assess long-term monitoring needs and inform management actions with respect to neighboring towns' municipal water plans. Supplies and seasonal staff for this project are supported by funding from the Water Resource Management Division; Prototype scientists are the principal investigators. In 2001 and 2002, the investigators developing the pond-breeding amphibian protocol found that the park supports a regionally-significant population of spadefoot toads, and that this species of special concern suffered notable mortality along specific park roads. In FY2003 we built on this knowledge by doing focused road surveys to better quantify mortality, developed a study proposal that will help us better understand the ecology and management needs of spadefoots, and worked with park management to develop traffic detours that to better protect this species. In FY2003 we also completed a multi-year inventory of spotted turtles, another species of special concern. Prototype scientists also worked with cooperators developing monitoring protocols for fresh water aquatic invertebrates and fresh water fish; these cooperators are with Harvard University and USGS respectively.

In coastal upland systems, we completed an ecological characterization of the microbiotic crusts found on the park's dunes, and worked on development of six long-term monitoring protocols. Three of these long-term monitoring protocols are being developed by Prototype scientists. In FY2003, work on the heathland protocol focused on drafting the report and monitoring methods. A draft of an analytical report and revised protocol for small mammal monitoring was also completed this year. After peer review, we expect this report will be particularly useful to vital signs monitoring networks considering small mammal monitoring. We also made significant progress on forest vegetation monitoring this year - a report documenting the status and remaining work plan for protocol development was completed, sites were established in forest types of particular management interest, we collected the third and final year of data comprising the first complete data set for the long-term monitoring project, and the data collected and site establishment also completed what was needed to finalize the forest vegetation monitoring protocol. We also contributed funding toward a collaborative effort with the University of Massachusetts to analyze the data we've collected along with the historic forest data collected by the University; this analysis will help us begin examining long-term change.

Other protocol development efforts related to upland systems included assisting cooperators from the University of Massachusetts, the Institute for Bird Populations, and USGS working on development of avian point count, avian productivity and survival, and meso-mammal monitoring protocols, respectively. In addition to protocol development, we also committed funding toward a study that will inventory and characterize the breeding ecology of northern harriers at the park. The Manomet Center for Conservation Sciences is our partner for this project.

There are several key processes and attributes that influence all of the park's ecosystems and need to be monitored in order to inform management decisions and interpret data from system-specific protocols; these include meteorologic processes, air quality, surface- and ground-water hydrology, and cover type. In FY2003, we collected basic meteorologic data and monitored atmospheric deposition, aerosols, and ozone as we have for the last several years. Under the technical leadership of the park's Chemist, we also began monitoring atmospheric mercury deposition. We continued collection of ground-water level and pond stage data - this data comprises a subset of what will be collected through the recently completed hydrologic monitoring protocol. We continued to assist cooperators from USGS working on a ground-water quality monitoring protocol, and cooperators from NatureServe and the University of

Massachusetts developing a cover-type map. We also provided funding to a cooperator at the University of Rhode Island for development of a digital aerial photo map based on photography from 1947.

We contributed funding to two related projects that will develop detailed topography, surface hydrology, and ground-water hydrology (salt water/fresh water interface) information in the vicinity of Mill Creek in the Herring River system. Tidal influence is likely to be restored to this area within the next few years; detailed short-term and focused long-term monitoring will be critical to assessing the ecological response to restoration and informing future management actions. These projects will collect initial data and will establish the wells and other infrastructure needed to include this area in our long-term hydrologic and ground-water quality monitoring efforts. In addition, the salt water/fresh water interface monitoring will serve as a model for predicting the effects of sea level rise in this and other parks. Partners for these projects include the Water Resources Division, USGS, and the Coastal America Foundation.

As an ecosystem-based, multi-disciplinary program, it is essential that we integrate our monitoring efforts and results within and across systems. Two important components of a holistic, integrated program are a comprehensive and integrated data management system, and a clear approach for phasing in monitoring projects while preserving the program's sustainability. This year we updated and improved several existing data bases containing monitoring and legacy data. The modifications improved the functionality of the data bases and increased the security of the data, and will facilitate future integration of related data sets. We also made significant progress toward hiring a Data Manager with the high-level data base design skills needed to support integrated analysis. This has been a particular challenge, but as this report is being prepared, we are optimistic that we will have a highly qualified Data Manager on board before the end of the first quarter of FY2004.

Another important accomplishment toward integration was the development of a monitoring prioritization scheme and implementation guidance that identifies the most critical projects and guides the subsequent phase-in of other important monitoring efforts as program capacity allows. In the event that we reach the limits of the program's capacity before all protocols have been initiated, this approach will ensure that we sustain those most critical to an ecosystem-based, multi-disciplinary, and integrated program.

We completed several tasks related to communicating findings and general outreach regarding the program. Perhaps the most significant was putting on the conference entitled "Symposium on Long-Term Ecosystem Monitoring at Cape Cod National Seashore". Over the course of this two-day symposium, 20 scientists from the park, the Northeast Coastal and Barrier Network, NPS-Air Resources Division, NPS-Northeast Region, USGS, and cooperating academic institutions and non-governmental organizations presented their work related to the Cape Cod Prototype Inventory and Monitoring Program. There were 78 attendees representing the Park Service, USGS and other federal agencies, the State of Massachusetts, academic institutions, local governments, Cape Cod National Seashore's Advisory Committee, educators, and conservation groups. Park Service biologists came from as far as the Gulf Coast and Colorado. Presentations covered the genesis and scientific foundation for the program, the research conducted to support protocol development, and preliminary monitoring results. In addition to sharing information, the symposium also offered other NPS monitoring programs an opportunity to meet and discuss issues with researchers and technical experts.

In addition to the project-specific reports prepared this year, we also completed an update of the Conceptual Framework (Roman and Barrett 1999) for the program. The 2003 Update

summarizes the evolution of the program since the 1999 Framework, and provides an overview of each ongoing and proposed inventory and monitoring project.

Our ability to share information was greatly enhanced this year with the launching of the program's web site. With technical assistance from the Northeast Coastal and Barrier Network, we created a site that provides information about the program, links to program documents and partners, presentations, contacts, protocols, and links to the National Program's web site. This has already proven a useful tool for sharing information, documents, and presentations; we anticipate significant additions of content over the coming years.

Another important program objective, particularly since we are a prototype program, is to provide technical assistance to other monitoring efforts. In addition to the technical assistance provided through the symposium, reports, and the website, we contributed focused wildlife expertise to several wildlife inventory and monitoring projects in the region. We also continued our long-standing support to local towns conducting complimentary water quality monitoring programs. Staff from this program and the Division of Natural Resources provided information, training, and analytical services to these volunteer-based efforts.

From an administrative and operational perspective, we completed two tasks that will enhance the capacity and efficiency of the program. First, we added two 4-year term staff to the program: a GS-5 Biological Technician to assist with aquatic monitoring projects; and a GS-6/7 Hydrology Technician to implement the hydrology and other physical science monitoring projects. These technicians have freed program scientists to spend more time finishing developmental projects, and will be instrumental in launching those protocols scheduled to come on line over the next few years. Second, we completed a program review led by the Washington Office and conducted in conjunction with the symposium. The Review Panel was composed of several programmatic and scientific experts who attended the symposium for an overview of the scientific aspects of the program. The following day, the panel was given a presentation which reviewed the operational aspects of the program, and held focused discussions with park managers, program staff, scientific advisors, and network and regional representatives. In addition, the panel was provided with copies of important documents and a narrative overview of the program's history and operations. The panel then provided the program with specific and extremely useful comments and recommendations regarding the program's development and future operations. Several of these recommendations were implemented in FY2003, and we will continue to implement the remaining recommendations over the next one to two years.

Public Interest Highlights:

- *Cape Cod National Seashore added to a global seagrass monitoring network:* Cape Cod National Seashore and the Northeast Coastal and Barrier Network are collaborating with research partners from the University of Rhode Island and USGS to develop a protocol for monitoring nutrient enrichment of the parks' estuaries. One element of this protocol will involve monitoring the status of seagrass in both estuarine and open water locations. CACO was selected as the field test site for this component of the protocol. The seagrass monitoring methods chosen are those established by the international monitoring effort known as SeagrassNet - a global monitoring program developed to investigate and document both the status of seagrass resources world wide and the threats to this important marine ecosystem. In the spring and summer of FY2003, the CACO seagrass monitoring sites were established and the first monitoring data collected at Pleasant Bay and Duck Harbor Beach. This makes these two CACO sites the newest additions to the global SeagrassNet network.

- *Salt marsh vegetation monitoring tracks the success of estuarine restoration projects:* CACO's salt marsh vegetation monitoring program involves 350 vegetation plots in seven different salt marsh systems within the park. Two of these systems include Hatches Harbor and East Harbor, which are currently undergoing hydrologic restoration. The salt marsh vegetation monitoring program is capturing the decline of the exotic invasive *Phragmites australis* and the increase in *Spartina alterniflora*, *Spartina patens*, *Salicornia sp*, and other native salt marsh plants. In addition, the physico-chemical parameters measured as part of the monitoring protocol will enhance our understanding of the mechanisms of the change being observed, aiding future restoration planning efforts.

- *Prototype Monitoring Program partners with the Atlantic Learning Center:* Every year, the CACO Prototype monitoring program engages in numerous research and educational partnerships. This development of CACO's Atlantic Learning Center has expanded and enhanced these partnerships to the benefit of the monitoring program. For example:
 - The ALC has supported a National Park Ecological Research Fellow from Harvard University studying the influence of past land use practices on the current distribution and spread of exotic plant species. This work will help us interpret the results of vegetation monitoring projects.
 - The ALC sponsored a high school work crew organized through the Student Conservation Association. This program provided us, free of charge, with a college graduate SCA volunteer for three months and four high school students for one month. These volunteers worked on several projects in the park, including salt marsh vegetation and horseshoe crab monitoring and a seal census.
 - The ALC managed a NASA grant for the development of middle- and high-school science curricula focused on monitoring Cape Cod's natural resources in the face of global climate change. Program scientists provided extensive technical support to the project and also received helpful remote sensing data from NASA, Boston's Museum of Science, and other cooperators.
 - By providing free researcher housing, the ALC has reduced the cost of conducting research in the park. This has allowed us to focus more cooperative project dollars on research and less on lodging. It is also attracting other researchers whose work will enhance that of the monitoring program.

- *Inventory information informs management actions:* In 2001 and 2002, researchers developing the amphibian monitoring protocol found that CACO supports a regionally significant population of spadefoot toads, and that this species of special concern suffered notable mortality along specific park roads. In FY2003 we built on this knowledge by doing focused road surveys to better quantify mortality, developed a study proposal that will help us better understand the ecology and management needs of spadefoots, and worked with park management to develop traffic detours that to better protect this species.