Northeast Coastal and Barrier Network
Protocol Development Summary
(May 2009)

Protocol Title: Northeast Coastal and Barrier Network Geomorphological Monitoring Protocol: Part I—Ocean Shoreline Position

This protocol has been implemented in the following parks:

- Assateague Island NS
- Cape Cod NS
- Fire Island NS
- Gateway NRA

Justification and Issues Addressed:

The problem of land loss/gain and landscape alteration at the marine edge is fundamental to many management issues facing coastal park resource stewards, and shoreline change is a prime geo-indicator of threats to coastal environmental resources within parks. Change in the width and/or volume of the beach drives the alteration and replacement of established natural habitats and may result in the destruction of cultural resources, facilities, and other infrastructure where they exist. Geomorphologic change to the beach/dune system is a basic concern because it is also directly related to – and in some cases drives – changes in other natural resource areas, such as quality of ground water and surface water in estuaries, abundance and distribution of species and habitats of concern, recreational visitor use, and even resource extraction.

Shoreline change monitoring and mapping is commonly used as a proxy for monitoring changes to a beach system. Changes in the shoreline, whether caused by erosion or accretion, vary both spatially and temporally. Understanding historical variations, along with seasonal variability, is key to early recognition of potential ecological problems in coastal parks. For managers, an understanding of the spatial and temporal patterns of geomorphologic change is basic to optimal management of any coastal park because the interface of marine and land systems, 1) is highly dynamic and driven by multiple forcing mechanisms, 2) results in alterations to resource patterns and dynamics at habitat and ecosystem levels, and 3) can eventually result in the loss of static resources. The establishment of local, long-term monitoring programs would provide data to help understand the processes that are driving coastal change within the parks.

The primary factors causing geomorphologic change in Northeastern coastal parks are sea level rise, changes in wave climate (e.g. increased storm frequency and intensity), and changes in sediment supply. Static resources in all eastern coastal parks are adversely affected by a relative rise in sea level. Although slow (roughly 0.2-0.3 m in the last century), sea level rise is a chronic driving force of shoreline retreat, which is further driven by aperiodic storms (i.e., tropical cyclones in summer and mid-latitude nor'easters in the winter). Beaches can commonly recover from such storms within a week or two, but if enough sediment is relocated or removed from the system, a decade of storm quiescence may be needed for recovery, if it occurs at all. Unfortunately, many coastal locations have a declining sediment supply that contributes to coastal erosion.

Localized conditions – including the geologic framework, offshore topography, orthogonal fetch limitations, and local sediment sources and sinks – may control change rates and trends in sediment supply. However, coastal erosion can be accelerated by human perturbations to the natural system. Engineering structures such as jetties, groins, seawalls, and nourishment and by-passing projects alter wave energy and currents, as well as disrupt sediment transport pathways. These human-induced changes may have profound morphological and ecosystem effects. Habitat and ecosystem responses to such changes are not well understood by ecologists, and how long these impacts persist is virtually unknown at the local level.

A complete understanding of these processes would require an adequate measurement of the hydrodynamic forcing of sediment transport, morphologic change, and ecosystem response at the level of the individual park unit. These are very complex tasks, however, and are beyond the capability of the National Park Service to perform alone. Acquiring this information will require concentrated, cooperative effort between the NPS and other federal, state, and local agencies with significant coastal mandates. There are however, several measurable indicators and expressions of overall coastal process that can be monitored at the individual park level. Some of these methods, such as monitoring changes in shoreline position, are well established and can be implemented quickly, while others involving rapidly emerging technologies will require additional research and testing to develop.

Specific Monitoring Questions and Objectives:

Objective 1: Quantify long and short term trends in the seasonal and annual variability in shoreline position for the ocean shoreline in network parks.

- **Question 1:** *What is the spatial and temporal variability in shoreline position?*
  - **Vital Sign:** Shoreline position
- **Question 2:** *What are the long-term trends in shoreline position change park-wide?*
  - **Vital Sign:** Shoreline position

Objective 2: Quantify variability in shoreline position for areas of special interest within NCBN parks (e.g., areas with significant infrastructure at risk or natural resource that may be subject to encroachment by a migrating shoreline).

- **Question 1:** *What is the spatial and temporal variability in shoreline position?*
  - **Vital Sign:** Shoreline position
- **Question 2:** *What are the long-term trends in shoreline position change for areas of special interest within parks?*
  - **Vital Sign:** Shoreline position

Vital Signs, measurements, justifications and basic approach:

Vital Sign: Shoreline position

- **Measurement: Shoreline position**
- **Justification:** Change in shoreline position is a well established and readily measurable proxy of a complex set of processes that drives the morphology of coastal features. Shoreline position monitoring was identified by coastal scientists and NCBN park managers as the type of observational data that can easily be assembled and quickly and effectively incorporated into park management operations. Shoreline position monitoring will also serve as a surrogate for sediment budget measurements in the parks and will provide documentation of the seasonal, annual, and long-term trends in beach displacement.

Basic Approach:

To determine park-wide trends in shoreline position change, a sampling design that includes all ocean, high water line shorelines is used. Differential GPS (DGPS) is used to survey the beach high water mark (wet/dry line) following a neap high tide under normal weather conditions. In order to capture extreme seasonal variability, a late summer and late winter survey are prescribed. A GPS capable of sub-meter data collection is used to record points continuously (i.e., including times when radio-link is lost), so that post-processing will be possible if required to correct position data. Surveys along the ocean shoreline are accomplished by driving a four-wheel ATV or similar vehicle at a relatively constant speed (between 5 and 10 mph) along the high tide line. For the purposes of this monitoring program, the actual ocean 'shoreline' is defined as the position of the most recent high tide, evidenced by the obvious wet/dry sand line or deposited wrack. The GPS receiver is configured to record positions at a very short interval (typically one position per second) for the best representation of the shoreline position. Data is downloaded from the GPS for inspection and editing, processed, and documented according to currently accepted FGDC standards for coastal data. The Digital Shoreline Analysis System (DSAS) software package is used to measure, calculate, and statistically analyze changes in shoreline position over time. The overall dimensions and rates of change are characterized statistically, and areas of significant erosion or deposition are identified.

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Protocol Development Status:
A completed draft of this protocol has been submitted to the NCBN and is awaiting peer review. Please contact the NCBN Program Manager, Sara Stevens, NCBN - National Park Service, University of Rhode Island Coastal Institute in Kingston, #105, 1 Greenhouse Road, Kingston, RI 02881.

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