The North Atlantic Coast Cooperative Ecosystem Studies Unit

A Strategic Vision for the Future

Agency Partners

University Partners

Revised – October 2003

INTRODUCTION

The North Atlantic Coast Cooperative Ecosystem Studies Unit (NAC-CESU) was established in June 1999 by cooperative agreement between the Department of Interior (National Park Service and U.S. Geological Survey (USGS)) and the host institution, University of Rhode Island, with its partner institution, University of Maryland-Eastern Shore. In subsequent years the NAC-CESU has expanded to include Rutgers University, the University of Massachusetts - Amherst and Stony Brook University as academic partners. Maryland Coastal Bays Program has also joined the NAC-CESU as an Agency partner. Additionally, the mission of the NAC-CESU now includes a strong focus on the study and management of cultural resources, as well as the initial natural resource interests.

The NAC-CESU is part of a nationwide network of biogeographically focused programs established to provide research, technical assistance, and education to federal land management, environmental, and research agencies. The NAC-CESU will focus on coastal ecosystems of the North Atlantic coastal zone (coastal plain and coastal ocean) from Maine to the Chesapeake Bay in Virginia. Collaboration with the adjacent Chesapeake Watershed CESU and Great Lakes-Northern Forest CESU, as well as others within the national network, will be encouraged. A map of the CESU Network and list of all university, non-profit and federal partners can be found at the following website: http://www.cesu.org/cesu/currentcesus/currentcesus.html

NAC-CESU activities will encompass all ecosystems of coastal watersheds, including barrier islands, estuaries, nearshore oceanic environments, salt and freshwater wetlands, coastal ponds, plus terrestrial watersheds and processes that affect the coastal environments as well as cultural resources within these environments.

The NAC-CESU is a unique collaboration, bringing together a wealth of technical and scientific knowledge and expertise that will allow for the development of innovative and creative solutions to many of the social and environmental issues that confront our nation's coastal ecosystems. This five-year strategic vision for the NAC-CESU will guide the general direction and fundamental focus of the NAC-CESU program. Annual work plans will outline specific research projects, technical assistance activities, training opportunities, and cooperative education endeavors.

A discussion of research directions and needs for the NAC-CESU came about through a workshop held in January 2000 at the University of Rhode Island. Present at the workshop were representatives from the National Park Service, USGS, Environmental Protection Agency, NOAA-National Estuarine Reserve Research System, University of Rhode Island, and University of Maryland-Eastern Shore (Appendix I).

Discussions from the workshop were used to develop a strategic vision for the North Atlantic Coast Cooperative Ecosystem Studies Unit. The document was revised in May 2003 to include a cultural resources focus within the vision. This document identifies the

components of a CESU research project or activity, identifies priority directions for research and technical assistance activities, and discusses specific activities and programs to be sponsored by the CESU.

COMPONENTS OF A CESU RESEARCH PROJECT OR ACTIVITY

The philosophy of the NAC-CESU is to provide information that has important management implications, is based on good science and scholarship, provides training to federal scientists, provides special educational opportunities for students, and supports research that is complementary to existing information. Research projects that address these elements and are relevant to the coastal ecosystems and cultural resources found within the geographical scope of the NAC-CESU are considered priority CESU endeavors.

More specifically, NAC-CESU activities should:

- Address natural and cultural resource management issues that are relevant to the protection, conservation, and management of coastal ecosystems. It is expected that most CESU projects will be specifically conducted on federal lands; however, there may be situations when a CESU project will have multiple sites (i.e., many non-federal) or encompass, contiguously, federal and non-federal lands; it could also be justified that an entire CESU project be conducted on non-federal lands. The key is that the project results in specific findings that are directly relevant to addressing coastal management problems.
- Take full advantage of the research expertise of the host institution (University of Rhode Island), partner institutions (University of Maryland-Eastern Shore, Rutgers University, University of Massachusetts-Amherst, Stony Brook University), and include the participation of federal research partners (National Park Service, USGS, USEPA, NOAA-NMFS), and other participating partners.
- Take place within the geographic range of the NAC-CESU.
- Be interdisciplinary in nature.
- Provide opportunities for undergraduate and graduate students from diverse backgrounds.
- Include close collaboration with CESU partners and provide technical assistance to natural and cultural resource management agency personnel.

RESEARCH AND TECHNICAL ASSISTANCE DIRECTIONS

The northeast coast is highly developed, with “islands” of protected lands within the urban sprawl. The coastal counties of the northeast United States are the most densely populated coastal regions in the country. Sixteen percent of the entire United States population resides in the coastal zone, and the density of human populations within this narrow fringe is increasing (Culliton et al. 1990). Recent censuses estimate that population densities in coastal counties are growing at three times the rate of the total United States population (Culliton et al. 1989). This increasing urban pressure has a

significant and growing impact on the natural coastal environment and the conservation and preservation of significance cultural resources. Research and technical assistance activities of the NAC-CESU should be designed to address natural and cultural resource management issues within the northeast coastal zone, given intense urban pressures.

Several research areas and needs were identified during the NAC-CESU workshop; however, a few were of particular importance because they addressed broad overarching concerns confronting the coastal ecosystems of the northeast. Among the top research priorities and needs were nutrient enrichment and contaminants, landscape ecology and maintenance of habitat diversity, restoration ecology, coastal geomorphic processes, monitoring and modeling long-term changes, and data and information exchange. Specific research topics, garnered from the CESU workshop as well as other sources (USGS Patuxent Wildlife Research Center 1999; Orson et al. 1997; Nordstrom & Roman 1996; Roman et al. 1987), are detailed at the end of each section. Issues and priorities related to the management of the wide range of cultural resources within the NAC are now included in this revised vision statement. Activities of the NAC-CESU will strive to address these broad topics.

Nutrient Enrichment and Contaminants

As populations grow, increases in anthropogenic loading from many sources (fertilizers, agricultural waste, sewage, ground water, fossil fuel emissions) contribute to the eutrophication of coastal waters (Portnoy et al. 1998; Jaworski et al. 1997; Nixon 1995; Valiela et al. 1992). Small shallow systems are often the first to be affected by nutrient enrichment. Nutrient enrichment can cause a cascade of events at several trophic levels. Impacts include increases in phytoplankton production and macroalgal biomass, which have been linked to the decline of seagrass habitat (Kinney & Roman 1998; Short et al. 1996; Harlin 1995; Valiela et al. 1992). Other ecosystem perturbations, such as anoxic and harmful algal blooms, have also been linked to eutrophication (Paerl 1997; Cosper et al. 1989). These events, in turn, may lead to deleterious effects on fish and benthic communities (Valiela et al. 1992).

In addition to nutrient enrichment, urbanization has caused a rise in the concentration of heavy metal and toxic contaminants in coastal ecosystems. Regional patterns in the concentrations of heavy metals (copper, lead, mercury and zinc) and toxins (PAHs, DDT, PCBs) have all been positively correlated with the degree of urbanization within coastal watersheds (Cochran et al. 1998; Breault & Harris 1997; Golomb et al. 1997a, 1997b; Mason et al. 1997).

Some specific research areas related to nutrient enrichment and contaminants are:

- Evaluate and identify coastal ecosystem responses to changes in the magnitudes of nutrient enrichment and/or contaminant inputs.
- Determine the thresholds for nutrient enrichment and contaminant inputs and their effects on ecosystem function and structure.

- Identify, quantify, and monitor sources and fates of nutrient and contaminant inputs to coastal ecosystems.
- Develop and test the best management practices to minimize the impact of nutrient and contaminant effects on natural resources.
- Identify and develop biotic indicators of ecosystem stress related to nutrient enrichment and contaminants.
- Conduct functional assessments for coastal ecosystems and habitats.
- Develop predictive models for nutrient and contaminant inputs and processes, and their related biotic effects.

Landscape Ecology and Maintenance of Habitat Diversity

Economic development and associated activities within the recreationally oriented coastal zone is increasing at a significant rate (Culliton et al. 1990). Coastal ecosystems depend upon high quality resources to sustain the biotic complexity inherent in barrier island, estuarine, and nearshore oceanic environments. Changes in land use and land cover patterns and urbanization of coastal watersheds threatens the quality of these resources (Roman et al. 2000; Jaworski et al. 1997). Threats to natural resources and habitats as well as cultural resources may originate from the cumulative effects of residential, commercial, industrial, and agricultural activities adjacent to or within the watersheds of coastal lands, or may be associated with more widespread activities, such as aquaculture, fisheries harvest, maintenance of navigational waterways, increase in boat traffic, oil spills, and ocean dumping. More localized land use impacts may occur from construction of shoreline structures, which alter natural sediment dynamics, or the effects of inholdings, residential communities, visitor services and infrastructure (e.g., roads) that may also significantly impact cultural and natural resources.

Stress on groundwater resources is just one example of the pressures facing coastal ecosystems. Groundwater supplies freshwater for domestic, industrial, and agricultural use, as well as supporting vernal pools, freshwater ponds, wetlands, and estuarine environments. Groundwater withdrawals and saltwater intrusion are of particular concern in some regions, such as Cape Cod, where groundwater is the principle source for both human usage and coastal wetlands (Godfrey et al. 1999).

The North Atlantic coast supports a wide array of biological communities including nearshore benthic and littoral communities, coastal wetlands, grasslands, shrublands, maritime forests, and freshwater wetlands. The diversity of these communities and their spatial relationships determine habitat quality for the fish, wildlife, threatened, rare, and endangered species, and other biotic resources. The size, spatial relationships, and structure of these biological communities are undergoing constant change in response to natural processes and human disturbances throughout the coastal zone.

Climate change is also influencing the structure of biological communities. Global mean temperatures are expected to rise by 1-3.5 ºC by the end of the next century (Watson et al. 1996). Increased global temperatures may shift species distributions, alter physiological

functions such as growth, metabolism and reproduction, or even result in the loss of critical estuarine habitats such as seagrass beds (Short & Neckles 1999).

Human activities have progressively altered the coastal ecosystem causing many endemic habitats and species to become increasingly rare. The introduction of non-native and invasive species has occurred in many areas, often altering the structure and function of endemic communities and resulting in significant ecosystem impacts (Bertness 1999).

Research is needed to provide a predictive framework for the management, conservation, and protection of these diverse communities, to assess problems facing natural resources, to detect changes on various temporal and spatial scales, and to minimize impacts on habitat quality and diversity. Because of the visitor-based aspect of National Parks, the balance between visitor experience and preservation of natural and cultural resources can often be a particularly challenging management issue. The ability to predict community responses to landscape changes will enable management personnel to institute prudent and scientifically based actions to protect the ecological and cultural integrity of these resources.

Some specific research areas related to landscape ecology:

- Determine and document the role of coastal parks and wildlife refuges within the highly urbanized coastal corridor in terms of maintaining regional biotic diversity, genetic diversity, preserving rare endemic species, and providing essential habitat for migratory and resident fish and wildlife.
- Determine the role of coastal parks and refuges in providing social values through open space preservation and recreational activities.
- Identifying alien invasive and non-invasive species and their distribution.
- Evaluate the incremental and cumulative effects, at all scales, of landscape use patterns and alterations on coastal ecosystems.
- Identify linkages and connectivity among habitats, trophic levels and/or organisms and evaluate the effect of land use and land cover alterations on these relationships.
- Identify immediate and long-term threats from land use, coastal ocean use activities, and alien invasive species to living resources in the coastal zone.

Restoration Ecology

Restoration has become increasingly widespread as a management tool to reclaim functionality of altered or lost ecosystems. An estimated fifty percent of the nation's coastal wetlands have been lost since the beginning of European settlement in the 16th and 17th centuries (Dahl 1990; Tiner 1984). In the northeastern United States, salt marshes and other coastal habitats have been particularly impacted. Salt marshes have been filled, drained, mosquito-ditched; tidal exchange has been altered by construction of dikes, impoundments, roads, and water-control structures. The loss of salt marsh habitat is particularly striking in New England, where in Connecticut for example, 30-50% of tidal marshes have been lost as a result of human disturbance (Rozsa 1995; Metzler &

Tiner 1992). Submerged aquatic vegetation habitats are also declining throughout all of the coastal regions of the United States. Large-scale losses of seagrass habitat from estuaries and coastal ponds have been documented throughout the northeast coastal zone (Short & Burdick 1996; Short et al. 1996; Orth & Moore 1981). Changes in water quality and clarity, fisheries related activities, and scarring from moorings, propellers, and vessel wakes have all contributed to the decline of seagrass habitat (Fonseca et al. 1998).

Restoration of these and other habitats is occurring throughout the North Atlantic region at an increasing pace (Fonseca et al. 1998; Davis & Short 1997; Roman et al. 1995; Confer & Niering 1992; Sinicrope et al. 1990; Roman et al. 1984). Research is needed on the response of communities to restoration activities. Additionally, evaluations on the functionality of restored systems will serve as benchmarks to evaluate restoration success and the knowledge gained from such studies will be crucial to the improvement of future restoration strategies.

Some specific research areas related to restoration ecology:

- Identify critical habitat conditions and/or species to protect, restore, and manage.
- Identify the natural conditions and attributes of sensitive habitats and develop guidelines that will optimize restoration success.
- Identify the presence and area distribution of alien invasive (and non-invasive) species and formulate a management plan for removal, if feasible.
- Quantify ecosystem responses to habitat restoration and enhancement activities.
- Identify and develop ecological indicators, standards, and criteria for evaluating the success of restoration efforts.

Coastal Geomorphic Processes

The northeast coast faces a wide variety of problems associated with coastal geomorphic processes. Infrastructure (roads, facilities), significant cultural resources (lighthouses, historic structures, shipwrecks, etc.), recreational use areas (campgrounds, beaches), and interpretive areas are continually threatened by shoreline processes. Management decisions concerning the relocation of destroyed facilities and the need to protect, or not to protect, existing and threatened facilities and resources must be based on a detailed knowledge of geomorphic shoreline processes. Rates of ocean and bay shoreline change, dune migration, and other geomorphic processes must be critically assessed for effective management.

Natural coastal geomorphic processes, the temporal and spatial variability of natural processes, and the ongoing eustatic (global) sea-level rise (about 2 mm yr^{-1}) compound these issues. The coastal barrier system is a dynamic environment continually shaped by storm events, wind, wave and tidal action, sediment transport (deposition and erosion), as well as regional geology and geomorphology (Leatherman & Zaremba 1986; Cleary & Hosier 1979; Kraft et al. 1979). Shoreline erosion and overwash areas resulting from storm events can determine plant community development (Roman & Nordstrom 1988; Zaremba & Leatherman 1986) as well as the geomorphic evolution of barrier island

systems (Kochel & Donlan 1986; Leatherman & Zaremba 1986). These events can also expose previously unknown cultural resources.

Sea-level rise is an issue for many coastal landholdings. Over the next century the rise in sea level along the Atlantic coast is estimated to increase by +0.46m by 2100 but could range from +0.15m to 0.95m (Intergovernmental Panel on Climate Change 1995). Since observed rates vary throughout the region it is the relative increase in sea-level rise that is important. The environmental impacts of sea-level rise will be accelerated shoreline erosion, saltwater intrusion of coastal aquifers, surface water, and estuarine water, and flooding of low lying areas. Sea-level rise can disrupt coastal wetlands through saltwater intrusion, erosion, or inundation. Changes in vegetation or the conversion of wetlands to mudflats or open water may result (Titus 1991). Recent work suggests that marsh accretion rates are not keeping pace with sea-level rise, resulting in a shift of species dominance and a change in wetland community structure (Hartig et al. 2002; Roman et al. 1997; Warren & Niering 1993). A comprehensive assessment of short- and long-term processes influencing coastal ecosystems is needed to better understand the complex relationship between geomorphic processes, natural resource community structure, and the future of cultural resources.

In many cases shoreline change issues are the result of human disturbance. Interruption in the sediment supply because of stabilized inlets, the loss of overwash habitat resulting from dune stabilization for storm protection, the exacerbation of sea-level rise by subsurface fluid withdrawal, and the inherent incompatibility of urban and suburban development within the dynamic nature of coastal barrier features are just a few examples.

Some specific research areas related to coastal geomorphic processes are:

- Identify threats to coastal zone infrastructure and develop management protocols to address short-term and long-term processes.
- Identify and assess sensitive areas and develop protective management protocols for these areas.
- Determine the linkages between coastal geomorphic processes and habitat, ecosystem or cultural resource changes.
- Develop predictive models for coastal geomorphic change that provide guidance to natural and cultural resource managers.

Monitoring and Modeling Long-Term Changes

To effectively preserve and maintain ecosystem and resource integrity within the northeast coast research and monitoring activities are needed to evaluate the potential impacts from environmental threats and to provide a scientific basis for resource management decisions. Predictive physical and ecological models are needed to provide a framework for the development of resource management scenarios to address all issues that confront coastal ecosystems/watersheds along the Atlantic seaboard. Standardization

of methodologies within research disciplines will strengthen the capability of assessing ecosystem and resource integrity at local and regional scales.

Natural and Cultural Resources and Heritage

The complex human history of the North Atlantic Coast has evolved in concert with a wide range of different environments and land uses. The location, type and density of original human settlements and land uses throughout the northeast coast were influenced by the diversity of natural resources encompassed within the range of terrestrial, riverine and coastal ecosystems – all connected by the flow of water from land to the ocean. Over time, humans have created an equally diverse range of cultural resources within those natural environments – e.g., archeological sites, historic structures and landscapes, rural and urban historic districts, cemeteries, battlefields and military facilities. New interdisciplinary and collaborative efforts are required to develop scientific and historic research bases for preserving and managing the diverse resources within such a complex landscape in the face of multiple stresses imposed by human activities. Specific assistance is needed in regard to:

- Understanding historic relationships between natural and cultural resources and how they were affected by the socio-economic and political factors of their times.
- Identifying and evaluating both natural and cultural resources to determine their significance – e.g., rare and endangered species and habitats, eligibility for National Register of Historic Places, condition, and threats to them in order to develop the best means of protecting, restoring, and maintaining them.
- Assisting land managers in developing work partnerships within the complex NAC landownership structure to coordinate planning and development of adjacent areas and protect internal natural and cultural resources, as well as external ones such as historic and scenic viewsheds, and greenway corridors to connect fragmented landscapes.
- Developing and implementing environmentally and economically sustainable resource management practices.
- Encouraging “Smart Growth” programs aimed at steering growth toward already developed areas to further protect existing natural and cultural resources.

Data and Information Exchange

A data repository and information system will provide a central location where information can be efficiently and rapidly disseminated. The data and information system would facilitate communication among experts from partner institutions and federal scientists and managers. This system should be designed so that information is available via the Internet and is easy to access. Information contained would include bibliographic information, geographic information system (GIS) data, results from recent investigations, and possibly a “SWAT” team of experts in various fields to provide technical assistance to federal scientists and managers in a timely fashion.

PROGRAM ACTIVITIES OF THE NORTH ATLANTIC COAST COOPERATIVE ECOSYSTEM STUDIES UNIT

To complement the research and technical assistance activities of the CESU, programs will be established to encourage education of students and federal managers and scientists, and to facilitate information exchange.

Education

- **Students**

  NAC-CESU student fellowships will be offered for undergraduate and graduate students associated with CESU projects. Students would assist in projects conducted in or at federal coastal land holdings (e.g., National Parks, National Seashores). This program could be closely integrated with the University of Rhode Island's very successful undergraduate fellowship program (Partnership for the Coastal Environment).

- **Federal Resource Managers and Scientists**

  An educational exchange program will be developed by the NAC-CESU. Federal resource managers and scientists will come to the University of Rhode Island and partner universities and interact with University scientists. University scientists could be encouraged to have sabbatical opportunities at federal land holdings (e.g., National Parks, National Seashores). This educational exchange program will enhance the interaction and communication between federal and university personnel.

Information Exchange

- **Distance Learning**

  Opportunities for distance learning will be available.
- **Workshops**

  Workshops will be held to address immediate management issues, to frame research projects, and to provide educational opportunities.
- **White Papers**

  White papers on CESU programs and activities will be published.
- **Web Presence**

  An Internet Website will be established to facilitate communication between CESU partners. Proceedings from workshops, white papers, and project proposals will be available via the Internet. Additional information exchange opportunities will develop as NAC-CESU programs and research projects are initiated.

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Appendix I
Participants in the North Atlantic Coast CESU "strategic vision" workshop; January 11, 2000; University of Rhode Island, Coastal Institute.

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