Aquatic Habitat

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Concept Paper: Aquatic Habitats
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Background: National and Regional Significance

Aquatic habitats in the northeastern coastal zone can be broadly classified into three general subsystems. Riverine habitats of coastal watersheds include the tidal reaches of rivers and creeks, often with associated freshwater and brackish tidal wetlands and submerged vascular plant beds. Intertidal and near shore habitats include rocky, cobble, gravel, and sandy shores, salt marshes, mudflats, seagrass beds, macroalgal beds, shellfish reefs, and the water column. Deep estuarine and marine environments include pelagic and benthic habitats.

Several centuries of development pressure throughout the northeast has resulted in extensive degradation and loss of natural coastal habitats. For example, more than half of the original tidal wetlands in the Gulf of Maine region have been filled or converted to agricultural lands (GOMC 2002), and a large proportion of the remaining wetlands have been degraded (Dionne et al. 1998, Roman et al. 2000). Although the historical distribution of seagrass habitat is unknown, early reports, navigational charts, and anecdotal information indicate that considerable seagrass loss has also occurred in the region. About 20% of the eelgrass distribution North of Cape Cod, Massachusetts, is estimated to have been lost since the time of European settlement; south of Cape Cod, this number is closer to 65% (Short and Short 2003). The northeastern United States (from Maine to Maryland) currently accounts for about one third of the nation's coastal population, and 16% of the entire national population (Culliton et al. 1990). The population density of this narrow coastal fringe is more than double that of any other region of the country, and it continues to grow. The consequence will be a continued assault on northeastern coastal habitats from human activities.

There are a multitude of human impacts to northeastern coastal habitats, with both acute and chronic effects (Wilk and Barr 1994, Wilbur and Pentony 1999, Roman et al. 2000, NPS 2003; Fig. 1). Disturbances from human activities include direct impacts of various physical alterations, indirect impacts of land management practices, and long-term impacts of a changing global climate. Effects of human activities can be exacerbated by natural disturbances, including severe weather events and biotic, geomorphic, and climatic processes. Collectively, these anthropogenic and natural disturbances produce a host of stresses on coastal ecosystems, from hydrologic, geologic, physical, and chemical alterations to introductions of new species and modifications to linkages within and among habitats. The ecological consequences are far reaching, ranging from changes in physical and biotic habitat structure to major shifts in ecosystem function. In many cases, the long-term and cumulative effects of multiple stresses on the structure, function, and sustainability of coastal habitats are unknown.

Key Assessment and Management Questions

A recent survey of New England coastal managers identified habitat degradation, loss, and restoration as the most important coastal management issue (CICEET 1999). The broad goals of habitat assessment and monitoring are to detect changes in attributes of coastal habitats, determine the relationship of observed changes to human and natural disturbances, and

understand the effects of these changes on overall ecosystem structure, function, and sustainability (Roman and Barrett 1999). Fundamental management questions include the following:

- Is the extent and distribution of certain aquatic habitats (e.g. tidal wetlands, seagrasses) changing over time?
- What are the causes of change in distribution, extent, or abundance of certain habitat types?
- Is the ecological condition of certain aquatic habitats changing over time?

Inherent in these basic questions are many topics focused on specific management issues. For example:

- How is sea level rise affecting tidal wetlands?
- What is the effect of nutrient enrichment on seagrass habitat?
- What are the cumulative impacts of dock construction on intertidal and shallow subtidal habitats?
- How are harvesting practices affecting rockweed habitat?
- What are the effects of commercial dragging activities on seagrass beds and offshore benthic habitats?
- Are efforts to restore coastal habitats effectively recreating the functions and values of natural systems?

Potential Indicators

The relationships among major disturbances to aquatic habitats, ecosystem stresses, and ecological responses (Fig. 1) suggest indicators at a variety of scales (see also Neckles et al. 2002, NPS 2003). The following matrix of potential indicators spans levels of ecological organization (landscapes to organisms), relationships (causes of and responses to stress), and complexity (ecosystem structure and function). Some of these indicators are relevant to all habitat types and management issues, whereas others would be most useful when applied to specific habitats or issues. Shaded cells in the matrix represent likely areas of applicability for potential indicators.

	HABITAT TYPE												MANAGEMENT ISSUES			
	Riverine		Intertidal/Nearshore subtidal								Off-shore					
Potential Indicators	River/creek	Tidal freshwater wetlands	Ledge (rocky shore)	Cobble/gravel beach	Sand/mud flat	Salt marsh	Seagrass	Macroalgal bed	Shellfish reef	Water column	Pelagic	Benthic	Natural Disturbance	Indirect Human Impacts	Direct Human Impacts	Global climate change
Disturbance Indicators																
Sea level		■	■	■	■	■	■	■	■							■
Percent of shoreline armored		■			■	■	■	■	■					■	■	
Land use/land cover	■	■	■	■	■	■	■	■	■	■				■		
Housing density	■	■	■	■	■	■	■	■	■	■				■		
Point-source discharge permits	■	■	■	■	■	■	■	■	■	■				■		
Livestock abundance	■	■	■	■	■	■	■	■	■	■				■		
Tidal restrictions (number, distribution)		■				■								■	■	
Atmospheric N deposition	■	■	■	■	■	■	■	■	■	■	■	■		■		
Marinas/docks (number, distribution)		■			■	■	■	■	■						■	
Response Indicators																
Landscape structure																
Distribution, abundance, extent of habitat types	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Location/depth of edge of vegetation		■				■	■	■					■	■	■	■
Shoreline position	■			■	■				■	■			■		■	■
Landscape pattern – habitat interspersion/ fragmentation	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Ocean color										■	■		■			■
Sea surface temperature										■	■		■			■
Habitat biotic structure																
Autotrophic community composition	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Vascular plant density, percent cover, canopy height	■	■				■	■						■	■	■	■
Suspended chlorophyll conc.	■						■	■	■	■	■		■	■		■

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Macroalgae distribution, abundance	■		■	■	■		■	■	■	■			■	■	■	■
Faunal community composition	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Faunal abundance	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Indicator species	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Habitat physical environment																
Tidal signal		■				■									■	
Sediment elevation/bottom topography	■	■			■	■	■	■	■			■	■	■	■	■
Water table level		■				■							■		■	■
Sediment organic carbon	■	■			■	■	■	■	■			■		■		■
Sediment grain size	■	■			■	■	■	■				■	■		■	■
Water column salinity	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■
Porewater salinity		■				■							■	■	■	■
Water temperature	■	■	■	■	■	■	■	■	■	■	■	■	■			■
pH	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■
Dissolved oxygen	■	■				■	■	■	■	■	■			■		
Turbidity/light attenuation	■						■	■	■	■	■	■	■	■	■	
Current speed, direction	■						■	■	■	■	■	■	■		■	■
Ecosystem function																
Plant biomass by species	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■
Plant growth rate	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■
Animal biomass by species	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Animal growth rate	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Animal diet	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Sediment accretion rate		■			■	■	■	■	■				■		■	■
Sediment redox potential	■	■			■	■	■	■	■			■	■	■		
Sediment sulfide	■	■			■	■	■	■	■			■	■	■		
Plant nutrient content		■	■	■	■	■	■	■	■			■		■		
Consumer stable isotope composition	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

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Figure 1. Northeastern coastal aquatic habitats: relationships among major disturbances (rectangles), stresses arising from those disturbances (ovals), and ecological responses (parallelograms). Adapted from National Park Service Inventory and Monitoring Program, Northeast Coastal and Barrier Network (NPS 2003).