Experimental methods of quantifying and monitoring ecological response to no-take marine reserves in Northeastern National Parks

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Executive Summary

The objective of this project was to review methods which can be used by National Park Service (NPS) managers to design a program of study which monitors ecological response associated with the establishment of Marine Protected Areas (MPA's) in its Northeast Region (NER). MPA's have played an increasing role in the management of coastal marine resources in the last several decades, prompting the NPS to begin considering MPA's within the Northeast Region, which currently has no permanent year round no-take reserves. There are nine coastal parks in the NER, which extends from Maine to Virginia. While many of the recommended methods are usable across the region, where applicable, methods are demonstrated using Fire Island National Seashore as a case study. While the primary goal of the project is to review techniques for monitoring ecosystem response and determining if reserves will meet the natural resource conservation goals of the NPS, the project also considers methods of quantifying fisheries response, as well as the increasing role of scientific methods in reserve design.

A diverse array of tools is available to aid decision makers in reserve selection. Effective site selection is essential for the preservation of critical or endangered habitat, which is a primary conservation goal for NPS. Traditional survey methods of identifying critical habitats can now be augmented with newer analysis tools such as MapCoast or by compilation of anecdotal data from fishermen into GIS databases such as OceanMap which help identify areas requiring conservation. It is also necessary to understand current and thermohaline circulation patterns in potential MPA's, as these factors are critical for dispersal of fish and shellfish larvae.

Ecosystem response is traditionally monitored using generalized indicators such as water quality, sediment chemistry, diversity, and species richness. Stand alone indicators can be combined with a multi-metric Index of Biotic Integrity (IBI), which provides a single index which can be used to track spatial and temporal changes in ecosystem status. Parameterization of an IBI must depend on goals of the specific reserve, For Fire Island, factors like dissolved oxygen, chlorophyll, sediment chemistry, nutrient levels, hard clam abundance, eelgrass presence, and pelagic and benthic species richness might be considered as potential parameters. IBI's should be used cautiously however, as their effectiveness in temperate ecosystems is questionable. Benthic infauna such as polychaetes can also be used as a proxy for changes in ecosystem status. Specific indicator polychaete species have been identified for both soft and hard bottom areas, and polychaete density and diversity have been used to monitor reserve response extensively. In reserves which target a few key species, or where strong fisheries implications exist, the use of numerical models should be considered. Models range from simple numerical single species approaches, to complex spatially explicit multi-species capable models. The modeling needs of a reserve are dependent on the specific goals of the reserve in question, and thus, modeling should be reviewed on a reserve by reserve basis. In Fire Island, where hard clam abundance is a critical concern, a simple numerical model like Hastings & Botford (1999), might be coupled with a more complex spatially explicit system like Ecospace to predict clam abundance and growth.

Conclusively demonstrating the effectiveness of reserves from a fisheries perspective can be extremely challenging. Quantifying growth rate changes and biomass export of fish can be done through mark-recapture studies of adults or larvae (using otolith marking). For migratory pelagic finfish stocks, it may be possible to identify a unique marker, either genetic or geochemical (again using otolith microanalysis), to identify the natal orgin of a fish, and thus track changes in the portion of the migratory population spawned from a newly protected area.