Indicators of Habitat Change Affecting Three Key Commercial Species of the U.S. Northeast Shelf: A Design to Facilitate Proactive Management in the Face of Climate Change

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Statement of the Problem and Rationale: The productivity and/or distributions of many living marine resources (LMRs) within the U.S. Northeast Shelf (U.S. NES) have been changing in concert with warming ocean temperatures. However, most operational models used for the assessment of LMRs to inform fisheries management assume that the effects of the environment on distribution, population productivity, and natural mortality are implicit or fixed in space and time. As a result, assessment projections of stock size used for developing fisheries management regulations assume past ecosystem conditions will be sustained in the future. The few studies that have incorporated climate change into LMR models have used empirical relationships between the environment, distribution, and abundance derived from field studies. These studies are in essence "environmental correlations" but are limited in their description of ecological relationships because: 1) Abundance and distribution patterns in the field can be poor proxies for habitat suitability because there can be time lags between changes in habitat and an organism's response; 2) Broad-scale distribution models do not do a good job at local scales nor at locations where habitat gradients are steep; and 3) Species-environmental relationships derived from statistical analyses of existing survey data are of unknown quality in terms of an organism's responses to novel environmental conditions that might arise with climate change. Laboratory- based studies of physiological responses that can be used to calibrate species niche models with a basis in fundamental eco-physiological mechanisms are likely to produce more accurate projections that can include future environmental states. Three commercial species will be the focus of this proposal: black sea bass (*Centropristis striata*), longfin squid (*Doryteuthis pealeii*), and spiny dogfish (*Squalus acanthias*). The Mid-Atlantic Fishery Management Council currently has substantial interest in these species due to existing and potential changes in habitat. Achieving improved habitat metrics based on laboratory studies of these three species can produce hindcast simulations and climate change projections of habitat quantity and quality and ultimately guide existing and future management decisions.

Summary of Work: The research will be organized into the following four tasks: **1)** *Laboratory studies of thermal optima*: We will use temperature-controlled, sealed metabolic chambers with intermittent-flow respirometry to determine the metabolic functional response of our target species to temperatures. **2)** *Simulate contemporary habitat using an existing ROMS hindcast*: With the data generated from the laboratory studies, we will produce thermal response curves combined with fine-scale bottom topography (for black sea bass) and apply them to an existing 50-year, three- dimensional hindcast of the U.S. NES (ROMS). **3)** *Habitat metric assessment:* We will use the hindcast simulations to develop and assess habitat metrics with respect to changes in population distribution, size, and variability. **4)** *Habitat projections under climate change:* We will project habitat quality and quantity and calculate relevant habitat metrics over various climate change scenarios. This will involve the use of high-resolution global climate models at NOAA GFDL.

Relevance to Option 1: Habitat hindcasts and projections of black sea bass, spiny dogfish, and longfin squid will advance our understanding of climate (variability and change) on three economically important LMRs that may already be changing. These hindcasts will be based on metabolic theory, thus building upon the population-climate modeling done in the region previously.

Relevance to NOAA's NGSP: This proposal directly addresses the goal "Improved scientific understanding of the changing climate system and its impacts" because: 1) our improved habitat metrics will result in climate change projections (and hindcasts) of suitable thermal habitat for three commercial species; 2) these improved metrics can produce climate-ready management that will consider variable and changing thermal habitat in population biomass assessments.