Environmental Studies Program: Studies Development Plan | FY 2022–2023

Title	Understanding Impacts of Habitat Modifications on Commercial Fisheries and Apex Predator Distribution (NT-22-03)
Administered by	Headquarters
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PICOC Summary	
Problem	BOEM needs to understand the effects of wind turbines and mineral extraction on large predator movement to manage OCS resources in an environmentally responsible manner. As an indicator species, the behavior and abundance of gray seals (*Halichoerus grypus atlantica*) are not well understood due to their rapidly changing distribution as their populations recover, particularly in the southern portion of the range. We also know very little about the predator-prey relationships between sand-dependent forage species, such as the sand lance, and their legally protected predators. such as seals and whales. The current approach to avoiding environmental and direct human impacts of energy development and mining on the continental shelf is sophisticated but still static. BOEM needs to take into account how ecosystems change over time, particularly predator-prey relationships, to better manage the resources while permitting renewable energy infrastructure and mineral extraction. The most important changes arise from the interactions among the things of concern: peoples' varied marine-dependent livelihoods and life requirements, endangered species, threatened habitats. Current approaches fail to adequately consider these interactions, or overall system dynamics, and this can lead to incorrect impressions, bad decisions, and failure to anticipate system behaviors that can have a big effect on outcomes.
Intervention	Integrate predator movements into ecosystem-based models. Gather distribution and behavioral data to integrate opportunistic observational, fisheries independent and dependent data featuring these species movements to a) create improved distribution maps of target species now and in the future under climate change scenarios and b) incorporate protected species and pelagic fishery sectors into model outputs.
Comparison	This study will compare data on species movement, fishery interactions, and ecological models which incorporate dynamics of climate change against currently used single species assessments which do not account for the chaos within natural systems.

Outcome	An improved model for use in environmental impact assessments to better understand how mineral mining and offshore wind development could affect species behavior and distribution, as well as predator-prey relationships
Context	Southern Cape Cod to Delaware OCS

BOEM Information Need(s): Understanding of the impacts of habitat modifications resulting from BOEM permitted activities on protected species in the Northeast and Mid-Atlantic are lacking across both the marine mineral and renewable energy programs. Information regarding the distribution, behavior and ecological impacts of a rebounding gray seal population will allow BOEM to effectively evaluate the potential for impacts from offshore wind farms and mineral extraction. Additionally, BOEM's FY17 study investigating the productivity and ecology of sand shoals has developed an ecosystem level model that reveals tradeoffs between various management scenarios for sand mining based on disruption to foraging species benthic habitat. During the model scoping process, it was noted that there are information needs which, if addressed, can dramatically impact the model utility. This could benefit ecosystem modeling for marine mineral and distribution modeling for renewable energy programs. Notably missing and valuable to these assessments is information on the changing movements of protected species, such as seals, and high-value migratory species (HMS) that depend upon the same forage species, as well as precipitating economic and social impacts across diverse stakeholder groups. This profile seeks to leverage investments being made into related research by the National Marine Fisheries Service (NMFS), the U.S. Navy, and the Northwest Atlantic Seal Research Consortium and other non-government organization who share the common goal with BOEM of understanding the changing distribution and abundance of these species from a whole-system perspective. Matching funding and in-kind vessel support has been committed by several partners, pending final approval of this profile.

Background: The number of gray seals in the Northeast has risen dramatically in recent decades. Few were observed in the early 1990s, and this has increased to at least 24,000 counted in Southeast MA in 2015 (Pace et al., 2019). With a range from New Jersey north to Labrador; tagging studies and NMFS bycatch estimates indicate they breed, pup, and forage in areas that overlap with BOEM sand borrow areas and wind energy areas (WEAs)(Puryear et al., 2016; Hayes et al. 2019). This study focuses on gathering and incorporating spatial movement data into decision scenario modeling to answer questions on the distribution and the role of productivity fluctuations, and on potential consequences for target fishery species within Northeast and Mid-Atlantic WEAs and sand borrow areas to inform environmental impact assessment.

Critical to illuminating the relationship between sand borrow areas and both commercially valuable HMS and protected species is understanding how modification of sand habitats impact the abundance and spatial movement patterns associated with forage base. This is composed of several key forage species in the Northeast and Mid-Atlantic, including sand lance (*Ammodytes spp*), key species that occur over potential sand shoal borrow areas from Southern Cape Cod through North Carolina. For example, sand lance can comprise over 50% of biomass of gray seal diet in seals foraging off Cape Cod (Ampela, 2009). Offshore energy structures (e.g. a wind turbine foundation) can create foraging habitat, and acoustic tagging of fish around these structures suggests they may increase foraging success (Russell et al., 2014). Changes in the available forage species, as well as increases in foraging habitat and its use, distribution, or abundance of animals around these foundations, can increase the potential for human interactions (e.g., construction) and fisheries (e.g., entanglement) in WEAs. These interactions may have population level impacts for gray seals. Gray seals have the highest bycatch mortality of all protected species. Fisheries interactions have increased, with fewer than 10 grey seal interactions in 1993, to more

than 1,000 annually in four out of the last 5 years - the highest bycatch of any US marine mammal species (NEFSC, 2020). To better understand the population, ecological, and anthropogenic effects of and to rebounding gray seals, there is a pressing need to obtain basic ecological information of this increasing seal population in Atlantic Outer Continental Shelf (OCS) waters prior to development of offshore wind facilities or sand mining activities. This study would additionally identify ecological linkages between fluctuating productivity, climate change dynamics and select HMS, which would demonstrate the utility of the trade-off tool beyond previously initial identified fishery sectors.

Movement data is needed to address increasing ocean use overlap, specifically the effects of sand mining, and understanding dynamics of the expanding population of rebounding marine mammal species. Movement data are also limited to determine differences in age class, sex and ocean basin use areas and assumptions on consumption and foraging habitat needs in U.S. waters. Studies conducted on seals tagged on Sable Island, Canada indicate that gray seals utilize different areas of nearshore and offshore areas depending on age, sex, season and life history stage (Austen et al., 2004; Beck et al., 2007).

This study aligns with several goals across the ESP Strategic Framework and OEP long term strategic goals. Gathering baseline movement and behavior data, as well as modeling various decision scenarios, allows us to understand the effect of habitat alteration resulting from BOEM regulated activities. The ability to leverage machine learning to produce dynamic ecosystem models supports both the DES strategic framework and the OEP long term goal #5. This affords the ability to look beyond the 'this happens here' black or white approach to assessment, and create dynamic models affording insight into potential impacts to stakeholders, such as different fishery sectors, which supports goal #6 of improved communications of risk and modernizing analysis. BOEM's use of emerging technology will also be present in the first ever data collection using open-source CTD tags currently in development. Open-source tags allow for a dramatic cost reduction as well as leveraging marine animals as mobile oceanographic sensors contributing to characterizing the OCS.

Objectives: a) Collect pre-construction and pre-sand mining information on the distribution, abundance, and movements of gray seals and associated apex predators; b) Leverage existing, fisheries, oceanographic data and model frameworks to project the environmental impacts by integrating apex predator movement ecology; c) Participate in partnerships to advance tag design in the area of habitat mapping.

Methods: Methods employed will consist of aggregating existing movement data, as well as deploying behavior logging tags on HMS/apex predator species which should utilize existing methodology for quantifying prey density through visual and acoustic survey. Additionally, combining data synthesized as part of BOEM's FY17 study on Productivity and Ecology of Sand Shoals with telemetry data associated with HMS species into a dynamic modeling framework to visualize potential impacts as a result of varying development scenarios.

Specific Research Question(s):

1. How does habitat modification influence apex predators in an ecosystem?
2. What are the important ecological areas for upper trophic predators such as gray seals?

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