ANNUAL REPORT FY12
Habitat Assessment Funded Research

Project Title:

Defining eco-regions and applying spatial analyses of species abundance, community dynamics and stock substructure to incorporate habitat in assessment models

Principal Investigator(s):

Anne B. Hollowed, Senior Scientist, Leader Status of Stocks & Multispecies Assessment Program, National Marine Fisheries Service, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115

Trevor A Branch, Assistant Professor, School of Aquatic and Fisheries Sciences, University of Washington, Box 355020, Seattle, WA 98195-5020

Postdoctoral Researcher:
Matthew R Baker**,** Research Associate, Joint Institute for the Study of the Atmosphere and Ocean, University of Washignton; Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NOAA 7600 Sand Point Way NE, Seattle, WA 98115

Goals:
Research under this project is conducted to improve our understanding of the role of habitat in the status and sustainability of fish and invertebrate populations. Further research is needed to characterize the ecological value of various habitats and integrate spatially discrete environmental effects and species interactions into stock assessments. Scientists at the Alaska Fisheries Science Center and University of Washington are developing and applying statistical tools to define boundaries of fish habitats in space and time, determine the strength of species interactions in varying regional habitats, and integrate knowledge of habitat associations as a means to measure multispecies interactions in multi-species assessments (MSMs) of Gulf of Alaska and Bering Sea stocks. Understanding how volume, area, and quality of habitat govern species interactions, and how these interactions govern spawning, feeding, or growth of managed species is a key element of Essential Fish Habitat (EFH).

Approach:
Biological data (NOAA Resource Assessment and Conservation Engineering bottom trawl data, BASIS surveys) and physical habitat data (physical oceanographic conditions, sediment data) have been integrated to determine how community composition varies along environmental gradients within the eastern Bering Sea and to define distinct regional habitats within this system. This is intended to map important habitat distinctions within this system, as well as to develop and illustrate methodology useful in efforts to define core ecoregions within large marine ecosystems.

Brief Summary of How Funds Were Used:
Funds have been transferred to the University of Washington to support the salary of a postdoctoral researcher responsible for developing and these analyses. Due to remaining funds under an existing grant that are currently supporting this researcher, Habitat Assessment funds have not yet been applied towards this research. It is anticipated drawdown of funds will begin in early 2013.

Work Completed:
We have integrated multiple data sets into analyses that determine the range of habitat used by individual species (commercially exploited as well as ecologically important vertebrate and invertebrate species) within the eastern Bering Sea. We have used time series data on abundance to map and delineate core habitats for key species in this system and to examine variability of abundance over time. This has led to the discovery of key distinctions in how certain species assemblages respond to shifts in abundance (e.g. forage fishes densities fluctuate but remain within the same core habitat, whereas benthic flatfishes expand and contract their range from core to marginal habitats as abundances fluctuate). Similarly we have noted key distinctions in how certain species assemblages differ in response to shifts in environmental conditions (e.g.)

We have also analyzed individual species responses to physical drivers in the eastern Bering Sea, using random forest approaches to determine variable importance measures and the relative influence of physical drivers (i.e. temperature, depth, stratification, frontal boundaries, substrate) on the presence and abundance of species, as a means to identify core habitat and identify important physical thresholds.

We have aggregated individual species responses to physical drivers in the eastern Bering Sea to illustrate delineating distinct areas of shifts in community composition across the shelf system and have used this as a means to distinguish unique ecoregions in the eastern Bering Sea. We have also illustrated how dynamic physical drivers such as climate shift habitat gradients and alter ecoregion boundaries under different temperature regimes.

Applications:
We are working with ecosystem modelers and stock assessment modelers to integrate our findings of species into single species and multispecies models to improve estimation of fishing mortality targets, given multispecies interactions, vulnerability to predation, and stock substructure. Multispecies interactions complicate our ability to understand and interpret fishery impacts on species abundance and related compensatory or depensatory effects. Uncertainty in species abundance estimates may be reduced by explicitly analyzing how habitat impacts species interactions.

We are developing means to identify and parameterize key physical variables within multispecies models of the eastern Bering Sea system to determine how habitat influences species overlap and therefore both vulnerability to predation and constraints to competition. Both the inclusion of physical variables and the attention to species interactions are key components to strengthening our ability to further ecosystem approaches to fisheries management.

Publications/Presentations/Webpages:

- International Council for the Exploration of the Sea (ICES) Annual Conference, Norway
  Title: Habitat & Climate: Species distribution and interaction in Arctic and Subarctic systems: Delineating ecological regions and identifying biophysical drivers of community composition
  Authors: Matthew Baker, Anne Hollowed