Supplemental Information for Implementing Ecosystem Approaches to Fishery Management: Risk Assessment in the US Mid-Atlantic

Sarah K. Gaichas*, Geret S. DePiper   *NOAA NMFS Northeast Fisheries Science Center, Woods Hole, MA, USA*

Richard J. Seagraves, Brandon W. Muffley, Mary Sabo   *Mid-Atlantic Fishery Management Council, Dover, DE, USA*

Lisa L. Colburn   *NOAA NMFS Northeast Fisheries Science Center, Narragansset, RI, USA*

Andrew J. Loftus   *Fisheries Consultant, Annapolis, MD, USA*

Correspondence: Sarah K. Gaichas, Sarah.Gaichas@noaa.gov

Supplement Text

Unranked Risk Elements

Offshore habitat element-in-progress

This element is applied at the species level. The risk of achieving OY due to changes in offshore habitat quality and quantity can be assessed using trends derived from experimental species-specific habitat modeling. *In addition, the number of threats from other human uses can be enumerated; at present this is addressed under "Other Ocean Uses" in the Management section.* Low risk was defined as no change in offshore habitat quality or quantity. Low-Moderate risk was increasing variability in habitat quality or quantity. Moderate-High risk was a significant long-term decrease in habitat quality or quantity. High risk was a significant recent decrease in habitat quality or quantity.

Habitat models using both static and dynamics variables have been developed for many of the resource species on the Northeast Shelf. These models estimate spring and fall habitat for the time series 1992 to 2016 reflecting the use of the ecosystem based on the NEFSC bottom trawl survey. The variables evaluated for use in these models included station salinity, station temperature, benthic complexity, satellite derived chlorophyll concentration and sea surface temperature, the gradient magnitude (front structure) of the satellite data, and zooplankton bio-volume and taxa abundance with station depth included in all models. The random forest approach differentiates variables with strong predictive power and was used to reduce the variable set to 11 variables for each species. The models were used to estimate fall habitat scores over the entire shelf over the time series.

Overall, black sea bass, summer flounder, and scup have long term increasing trends in fall offshore habitat, and dogfish, butterfish, Atlantic mackerel and longfin squid have short term increasing trends. monkfish has no significant trend in fall offshore habitat. Therefore, these species rank low

risk for this element. However, shortfin squid has a long term and a short term decreasing trend in offshore habitat. Therefore, shortfin squid ranks high risk for this element.

Ocean quahogs, surfclams, tilefish, and bluefish are not adequately sampled by the bottom trawl survey and were not included in this analysis, similar to unmanaged forage and deepsea corals. Sessile species in particular may be highly vulnerable to habitat changes, so assessments of their habitat are particularly important to develop.

This experimental habitat index is still being studied and improved, so the habitat risk rankings based on this are considered preliminary by the EOP, and are not included in the final risk assessment.

Commercial employment

This element is applied at the state level. This element ranks the risk of not optimizing employment opportunities in the commercial sector. Risks were assessed by examining time series of employment information from Fisheries Economics of the U.S. (NMFS, 2017). A full description of the model generating employment estimates can be found here: http://www.st.nmfs.noaa.gov/documents/commercial_seafood_impacts_2007-2009.pdf Low risk criteria were no trends in employment. Low-Moderate risk criteria were increasing or high variability in employment. Moderate-High risk criteria was a significant recent decrease in employment for one state. High risk criteria were significant recent decreases in employment for multiple states.

The EOP Committee lacked confidence in the available employment indicator data, so this element remains unranked at this time.

Recreational employment

This element is applied at the state level. This element ranks the risk of not optimizing employment opportunities in the recreational sector. Risks were assessed by examining time series of employment information from Fisheries Economics of the U.S. (NMFS, 2017).

The EOP Committee agreed to the same risk ranking criteria as for commercial fishery employment, but similarly lacked confidence in the available employment indicator data, so this element remains unranked at this time.

References

NMFS (2017). *Fisheries Economics of the United States, 2015. U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-F/SPO-170.*

Supplement Table

Table 1: Risk Elements, Definitions, and Indicators put aside for future evaluation. OY=Optimum Yield; please see main text for definition.

Risk Element	Definition: Risk to what?	Indicators used
Put Aside		
Population diversity	Risk of not achieving OY due to reduced diversity	Size composition, sex ratio, genetic diversity
Ecological diveristy	Risk of not achieving OY due to reduced diversity	Fishery independent species diversity
Fishery Resilience (2)	Risk of reduced fishery business resilience due to access to capital	No current indicator avilable
Fishery Resilience (3)	Risk of reduced fishery business resilience due to insurance availabilty	No current indicator available
Fishery Resilience (5)	Risk of reduced fishery business resilience due to access to emerging markets/opportunities	Needs clarification
Commercial Employment	Risk of not optimizing employment opportunities	EOP Committee unconfident in Fisheries of US employment inicator
Recreational Employment	Risk of not optimizing employment opportunities	EOP Committee unconfident in Fisheries of US employment indicator
Seafood safety	Risk of not maintaining market access, human health	Number of public advisories by species