Environmental Studies Program: Completed Study

Title	Model-based Essential Fish Habitat (EFH) Descriptions for Arctic Cod, Saffron Cod and Snow Crab in the Alaskan Arctic (AK-19-07)
Administered by	Alaska Regional Office
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Procurement Type(s)	Cooperative Agreement
Conducting Organizations(s)	UAF
Total BOEM Cost	$171,308
Performance Period	FY 2019-2021
Final Report Due	June 2021
Date Revised	March 8, 2022
PICOC Summary	
Problem	Current understanding of the Arctic Fisheries Management Plan (FMP) target species habitat distribution is inadequate to define EFH to the level required to fully identify and address potential habitat impacts from anthropogenic disturbances.
Intervention	This project will update EFH descriptions for Arctic FMP species using current, comprehensive data.
Comparison	Modeling strategies and outputs will be compared to the current EFH designations to look for areas of refinement.
Outcome	Model-based EFH designations will be produced with life stage information, where available, to update current habitat distributions.
Context	Beaufort and Chukchi Seas

BOEM Information Need(s): This project will conduct species distribution modeling to improve the descriptions of habitat use by key Arctic species. The resulting refined habitat maps and descriptions by life-stage will strengthen BOEM's impact assessments during EFH and NEPA analyses associated with Arctic resource development activities.

Background: Essential Fish Habitat (EFH) definitions for the three species (Arctic cod, saffron cod, and snow crab) covered under the Arctic Fisheries Management Plan (FMP) are qualitative and based on presence-absence data. Commercial fishing is prohibited in the Arctic Management Area, but the habitats of these three ecologically important species may be subjected to non-fishing effects, necessitating increased understanding of their current habitat distributions.

Species distribution models can be used to identify important habitat characteristics that influence spatial patterns in abundance and may provide insight into changes in species distribution. Specifically, the species distribution models can be used to link habitat characteristics to species occurrence and catch per unit effort (CPUE) data from surveys (including several BOEM-funded studies). The ultimate

goal of this project is to refine the EFH text and maps for juvenile, adult and possibly larval life stages of Arctic cod, saffron cod and snow crab for the next 5-year EFH revision (target date 2021).

Objectives:

- Identify habitat characteristics most important to distributions and habitat suitability of larval (if data is available), juvenile and adult Arctic cod, saffron cod and snow crab.
- Refine map and text descriptions of EFH for Arctic cod, saffron cod and snow crab based on species distribution models.

Methods: Researchers will use two types of species distribution models that have been used to define EFH for groundfish in the Gulf of Alaska, Bering Sea and Aleutian Islands (Laman et al. 2017, Pirtle et al., 2017, Turner et al. 2017). First, maximum entropy (MaxEnt) models will be applied, incorporating presence-only data and habitat covariates to predict habitat suitability. In cases where data from large-scale surveys are available and CPUE is recorded, generalized additive models (GAMs) will be used to predict abundance.

As most biological surveys have occurred during the ice-free season (i.e., summer) in the Arctic, the proposed models will describe EFH during the summer. Previous survey data from 1972-2015 will be compiled and supplemented with recent survey data from the nearshore Beaufort Sea and the productive Barrow Canyon as it becomes available. When available, researchers will use length data, von Bertalanffy growth curves, and maturity data to separate juveniles from adults and model the life stages separately. Length-based gear selectivity curves may be used to convert CPUE data for Arctic cod between gear-types to create a more comprehensive dataset for modeling abundance. For species distribution models, habitat covariates to be considered include productivity, bathymetry characteristics, sediment types (Jenkins 1997; dbSEABED), currents, temperature, and salinity (Curchitser et al. 2013). Other habitat covariates will be considered, such as bathymetry-derived seafloor terrain metrics, biogenic habitat features, and occurrence of prey. Model fitting procedures will be used to identify the most important habitat characteristics to be used in the best-fit models.

Specific Research Question(s): How can distribution models be used to update maps and text descriptions for Arctic cod, saffron cod, and snow crab EFH?

Current Status: Completed Study

Publications Completed: None

Affiliated WWW Sites:

http://www.boem.gov/akstudies/

https://marinecadastre.gov/espis/#/search/study/100238

References:

Curchitser, E.N., Hedstrom, K., Danielson, S., and Weingartner, T., 2013. Adaptation of an Arctic Circulation Model. U.S. Department of the Interior, Bureau of Ocean Energy Management, Environmental Studies Program, Headquarters, Herndon, VA. OCS Study BOEM 2013-202. 82 p.

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Laman, E. A., Rooper, C. N., Rooney, S. C., Turner, K. A., Cooper, D. W., and Zimmermann, M., 2017. Model-based essential fish habitat definitions for Bering Sea groundfish species. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-AFSC-357, 265 p

NPFMC (North Pacific Fisheries Management Council), 2009. Fishery management plan for fish resources of the Arctic management area. ⟨http://www.npfmc.org/ wp-content/PDFdocuments/fmp/Arctic/ArcticFMP.pdf⟩

Pirtle, J. L., Shotwell, S. K., Zimmermann, M., Reid, J. A., and Golden, N., 2019. Habitat suitability models for groundfish in the Gulf of Alaska: Deep Sea Research Part II: Topical Studies in Oceanography, Understanding Ecosystem Processes in the Gulf of Alaska: Volume 2.

Turner, K., Rooper, C. N., Laman, E. A., Rooney, S. C., Cooper, D. W., and Zimmermann, M., 2017. Model-based essential fish habitat definitions for Aleutian Island groundfish species. U.S. Department of Commerce., NOAA Tech. Memo. NMFS-AFSC-360, 239 p.