Environmental Studies Program: Ongoing Study

Field	Study Information
Title	Understanding Spatial Dynamics and Movement of Pacific Halibut (Hippoglossus stenolepis) in the Northern Bering Sea (AK-19-02-15)
Administered by	Alaska Regional Office
BOEM Contact(s)	Sean Burril (sean.burril@boem.gov)
Procurement Type(s)	Cooperative Agreement
Conducting Organization(s)	University of Alaska Coastal Marine Institute
Total BOEM Cost	$ 139,946 plus Joint Funding ($139,946)
Performance Period	FY 2021–2024
Final Report Due	July 24, 2024
Date Revised	February 23, 2023
Problem	The distribution and habitat use of Pacific Halibut in the Northern Bering Sea (NBS) and Southern Chukchi Sea (SCS) are poorly understood.
Intervention	By satellite tagging Pacific halibut in the NBS this study will assess the distribution and habitat usage of this species near the northern extent of its known range.
Comparison	Results from this study will be compared to the known distribution of Pacific halibut near their northern range in Alaska.
Outcome	An improved understanding of the temporal distribution and habitat usage of Pacific halibut in the NBS and SCS.
Context	NBS and SCS Outer Continental Shelf (OCS)

BOEM Information Need(s): If the Pacific halibut is expanding its range into the SCS, BOEM will need baseline descriptions of the distribution and habitat use areas to include in future Environmental Impact Assessments, Essential Fish Habitat descriptions, as well as for developing well informed mitigation measures for any future development activities for energy or critical mineral resource developments in the NBS and SCS OCS.

Background: Climate change, particularly warming ocean temperatures, has had wide ranging impacts on the spatial dynamics of fish species across the globe. One region that has experienced notable changes in its fish assemblage is the NBS and SCS. Currently, it is recognized that Pacific cod (*Gadus macrocephalus*) and walleye pollock (*Gadus chalcogrammus*) have increased in numbers in the NBS and SCS, and it is reasonable to assume that other sub-Arctic species are either currently moving into the southern Arctic Ocean or have the potential to do so in the near future.

A changing fish assemblage in the NBS and SCS may have broad impacts to humans and their activities and the marine ecosystem. As such, it is important to examine the current status of species whose ranges are expanding to provide valuable benchmark information that will aid in understanding

potentially important food sources and their potential interactions with the human and marine ecosystems. One fish species of particular interest is the Pacific halibut (*Hippoglossus stenolepis*).

Local knowledge has suggested that the Pacific halibut is expanding its summer range northward in the NBS and even the SCS. Further, local fishers report that this species is becoming increasingly available in remote areas of Alaska, including near Nome and Savoonga, where previously these fish were sparse or absent (IPHC Secretariat, 2018). The increased abundance of Pacific halibut has drawn the attention of the Norton Sound Economic Development Corporation (NSEDC) and the International Pacific Halibut Commission (IPHC).

Pacific halibut have the potential to disrupt the current arctic ecosystem and may support important artisanal fisheries in the region; therefore, it is important to understand the spatial dynamics, behavior, and occupied thermal environment of these fish in the NBS and SCS, from which habitat usage and potential interactions with other anthropogenic activities can be inferred. This study will use satellite telemetry to track the distribution and important habitat usage areas for Pacific halibut in the NBS and SCS.

Objectives: The specific objectives of this study include:

- To identify areas in the Northern Bering Sea and potentially in the Southern Chukchi Sea that Pacific halibut currently occupy throughout the course of a year.
- To examine the timing and pathways of Pacific halibut movements among OCS planning areas, as well as the duration of occupation within a given planning area.
- To characterize Pacific halibut spawning events to identify spawning grounds and the OCS planning areas in which they occur.
- To characterize the depths occupied by Pacific halibut to determine the potential exposure risk to disturbance events such as an oil spill, under the pretext that Pacific halibut are not exclusively benthic.
- To characterize the thermal environment currently occupied by Pacific halibut in the Northern Bering Sea and compare it to existing bottom temperatures in the Southern Chukchi Sea to infer potential for range expansion northward

Methods: All Pacific halibut will be captured in the Northern Bering Sea, primarily from waters near Nome and Savoonga, AK. Local fisherman from each area will be chartered to capture halibut. Fishing efforts will consist of setting a longline with approximately 400-600 hooks, with each set lasting approximately 3–4 hours. Halibut that are deemed healthy will be recorded for total length and have tags affixed using a dart and tether system (Seitz et al. 2003). When possible, tagged fish will be ultra-sounded to determine sex by examining the posterior section of the halibut's abdomen for the presence of ovaries or testes.

Tags used will be Wildlife Computers' miniPAT satellite tags that have an operating life up to two years. Tags will measure and record depth, temperature, and ambient light at approximately 10-second intervals. Tags will be pre-programmed to release from the fish and pop-up to the surface of the ocean on a scheduled date, at which time the tag will transmit summarized archived data to overhead Argos satellites.

Tag deployments will be scheduled for either eight months or one year, with scheduled pop-up dates of March 15th, 2022 and July 15th, 2022. Winter release dates will identify the location of spawning individuals, with mid-March being chosen as the optimal time to determine this based on initial tagging efforts in 2019. The summer release dates will be used to examine site fidelity to summer feeding locations.

Daily locations and movement trajectories of tagged Pacific halibut will be reconstructed using a state-space geolocation model. State-space models (SSM) combine tag data with assumptions about behavior of tagged individuals and environmental characteristics in the region the fish are thought to inhabit. A Hidden Markov Model (HMM), that was developed for benthic fishes in the Atlantic Ocean (Pederson, 2008) and adapted for use in the Northern Pacific Ocean (Nielsen et al. 2019) will be used. Spawning events and spawning grounds will be characterized by a rapid ascent and subsequent descent in the water column (Loher and Seitz, 2008).

Specific Research Question(s):

1. What is the temporal distribution of Pacific Halibut that occupy the NBS and SCS?
2. What are the important spawning and habitat usage areas for Pacific halibut in the NBS and SCS?
3. How might future resource development activities affect the distribution and important habitat use areas for Pacific halibut in the NBS and SCS?

Current Status: Ongoing, fieldwork underway

Publications Completed: N/A

Affiliated WWW Sites:

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

https://www.uaf.edu/cfos/research/cmi/

References:

IPHC Secretariat, 2018. Summary of the data, stock assessment, and harvest decision table for Pacific halibut (*Hippoglossus stenolepis*) at the end of 2018. Unpublished data.

Loher, T. and Seitz, A.C., 2008. Characterization of active spawning season and depth for eastern Pacific halibut (*Hippoglossus stenolepis*), and evidence of probable skipped spawning Journal of Northwest Atlantic Fishery Science. 41: 23-36

Nielsen, J.L., Mueter, F.J., Adkinson, M.D., Loher, T., McDermott, S.F. and Seitz, A.C., 2019. Effect of study area bathymetric heterogeneity on parameterization and performance of a depth-based geolocation model for demersal fishes. Ecological Modelling. Volume 402: 18-34

Pederson, M.W., Righton, D., Thygesen, U.H., Andersen, K.H. and Madsen, H., 2008. Geolocation of North Sea cod (*Gadus morhua*) using hidden Markov models and behavioral switching. Canadian Journal of Fisheries and Aquatic Sciences. 65(11): 2367-2377

Seitz, A.C., Wilson, D., Norcross, B.L. and Nielsen, J.L., 2003. Pop-up Archival Transmitting (PAT) Tags: A Method to Investigate the Migration and Behavior of Pacific Halibut *Hippoglossus stenolepis* in the Gulf of Alaska. Alaska Fishery Research Bulletin. 10(2):124–136