Environmental Studies Program: Ongoing Study

Title	Are expanding Pink Salmon populations in the Arctic produced from regional watersheds? (AK-19-02-10)
Administered by	Alaska Regional Office
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Procurement Type(s)	Cooperative Agreement; Interagency Agreement
Conducting Organization(s)	University of Alaska Coastal Marine Institute; Pacific Northwest National Laboratory
Total BOEM Cost	$175,582 plus joint funding ($175,582)
Performance Period	FY 2020–2023
Final Report Due	September 2022
Date Revised	September 15, 2022
PICOC Summary	
Problem	A warming Arctic environment is facilitating movements by Pacific salmon into new habitats. A concern is that a radiation of Pacific salmon in the Arctic may result in displacement of native fishes and increase the reliance on salmon by subsistence communities. Currently, we lack confirmation that Arctic watersheds can sustain and produce salmon.
Intervention	This study will use otolith microchemistry coupled with geochemical water signatures, to determine the regional origin of adult Pink salmon captured in the Arctic.
Comparison	Water samples from other regions of Alaska will be collected to assess whether pink salmon captured in the Arctic are strays.
Outcome	This study will improve our understanding of the origin of Pink salmon in the Arctic and assess whether Arctic watersheds are producing sustainable pink salmon populations.
Context	Beaufort and Chukchi seas

BOEM Information Need(s): The Bureau of Ocean Energy Management (BOEM) estimated that the Chukchi and Beaufort Sea planning areas contain nearly 25 billion barrels of recoverable oil and more than 100 trillion cubic feet of recoverable natural gas. These planning areas border the documented spawning locations of pink and chum salmon throughout the region, creating potential for interactions between oil and gas development and fishery harvest by local stakeholders. If Pink salmon are establishing populations in the Arctic region, they will need to be included as a new species with an Essential Fish Habitat (EFH) designation and will need to be acknowledged in future NEPA documents, Oil Spill Risk Analysis (OSRA), and the EFH consultation process, all of which is completed by BOEM.

Background: Increases in Arctic air and ocean temperatures, and associated reductions in sea ice and regional snowpack, are expected to profoundly change Arctic coastal and marine pelagic ecosystems. Salmon are key species of interest in the context of a rapidly changing Arctic. Two long term data sets were identified that provide reliable indicators of expansion of pink salmon in the Arctic: a time series of

catches in a fyke net deployed in Prudhoe Bay (T. Sutton, University of Alaska Fairbanks [UAF], unpubl. data) and reporting from a community-based monitoring effort among subsistence harvesters in the western Canadian Arctic (K. Dunmall, Department of Fisheries and Oceans Canada, unpubl. data).

The possible establishment of breeding populations of Pacific salmon in Arctic regions of Alaska presents new and fascinating socio-ecological issues. In some areas, new salmon resources might bring novel economic and subsistence opportunities, while in other areas native fish species that hold important cultural and subsistence value might be outcompeted by the establishment of salmon populations.

While fishing survey data and interviews of regional communities provide invaluable information on possible population expansions by salmon in the Alaskan Arctic, it is important to note that the adult salmon observed in the Arctic region may be strays from distant watersheds. Straying is an important strategy that salmon adopt to colonize new habitats (Quinn 2005).

Objectives: The goal of this study is to determine whether pink salmon that are captured as adults in Arctic marine waters originated from Arctic freshwater drainages. The specific objectives are:

- Determine if pink salmon caught in marine waters along the North Slope are of regional or non-regional origin.
- Determine if otolith core $^{87}Sr/^{86}Sr$ can be used as an effective discriminatory marker to assign North Slope adult pink salmon to their region of origin.
- Determine if $\delta^{18}O$ and $\delta^{13}C$ can be used as discriminatory markers for assignment of North Slope adult pink salmon to their region of early marine residence.

Methods: The origins of pink salmon in the OCS will be determined by analysis of geochemical signatures in otoliths and water samples from the Arctic region. Salmon otoliths and water samples will be analyzed for isotopes of strontium ($^{87}Sr/^{86}Sr$), oxygen ($^{18}O/^{16}O$), carbon ($^{13}C/^{12}C$), and concentrations of strontium and barium. The isotopic ratios and concentrations for these elements are well established markers for determining stream origins from fish otoliths (Walther and Thorrold 2009, Hegg et al. 2013, Brennan et al. 2015) and have also been used to track marine migrations (Sakamoto et al. 2019).

Pink salmon otolith (up to n = 100 over two years) from the North Slope will be obtained from subsistence fisheries occurring in the Beaufort and Chukchi seas. Water samples (up to n = 15) will be collected from streams identified as having spawning activity or sampled opportunistically from other potential salmon bearing rivers. Additional water samples will be obtained from the Noatak and Kobuk rivers as representative samples of known salmon streams from the western study area, and from the Mackenzie River to the east. All otolith and water samples will be analyzed with a Thermo Fisher Gas Bench II device coupled to a Thermo Fisher Delta V Plus isotope ratio mass spectrometer.

Geochemical data from North Slope otolith samples will be analyzed to determine which combinations for geochemical markers produce relevant associations to water chemistry that can be linked to large scale geologic features in the regional landscape and coastal waters.

Specific Research Question(s): The specific research questions are:

1. Can otolith microchemistry and water geochemistry be used to determine regional origins of Pink Salmon?
2. Are Pink Salmon successfully reproducing in Arctic watersheds?

Current Status: Ongoing, data analysis underway.

Publications Completed: N/A

Affiliated WWW Sites:

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

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

References:

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Sakamoto, T., K. Komatsu, K. Shirai, T. Higuchi, T. Ishimura, T. Setou, Y. Kamimura, C. Watanabe, and A. Kawabata. 2019. Combining microvolume isotope analysis and numerical simulation to reproduce fish migration history. Methods in Ecology and Evolution 10:59-69.

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