Environmental Studies Program: Ongoing Studies

Study Area(s):	Beaufort Sea, Chukchi Sea
Administered By:	Alaska OCS Region
Title:	Using Trace Elements in Pacific Walrus Teeth to Track the Impacts of Petroleum Production in the Alaskan Arctic (AK-13-03-26)

BOEM Information Need(s) to be Addressed: BOEM NEPA analysts evaluate the potential environmental effects of OCS oil and gas exploration, development, and production activities. Trace element concentrations have been found to be an effective measure of the degree and spatial extent of environmental contaminants related to oil and gas activities. This study will provide information about variations of trace metal concentrations in relation to oil and gas activities and will improve understanding of the potential impacts of these contaminants to biota at multiple trophic levels. Results from this study will inform NEPA analyses for EPs or DPPs that may be submitted in the Beaufort Sea and for potential future lease sales.

Total BOEM Cost: $25,000 plus Joint Funding ($25,000)

Period of Performance: FY 2017-2018

Conducting Organization: CMI, UAF

Principal Investigator(s): Casey Clark

BOEM Contact: Carol Fairfield

Description:

Background: During the extraction of petroleum resources, there is the potential for the discharge of contaminants from drilling muds to the environment. Typical contaminants associated with sediments include concentrations of As, Ba, Cd, Cr, Cu, Fe, Mn, Pb, Ni, V, and Zn), which may impact the benthic ecosystem. Pacific walruses (*Odobenus rosmarus divergens*) are an ideal species for monitoring the impact of petroleum exploration and extraction on benthic environments in this region due to their geographic overlap with historic oil and gas exploration areas, and their broad diet of benthic invertebrates. Walrus teeth act as biological archives of trace element exposure, from which one can measure the concentrations of trace elements in the teeth of walruses from historic museum collections and present-day Alaska Native subsistence harvests. As a result, these animals may serve as a valuable means of monitoring the impacts of oil and gas activities on benthic communities as well as other predators foraging in this area (e.g., bearded seals, *Erignathus barbatus,* and gray whales, *Eschrichtius robustus*).

Walrus teeth contain an unusually large cementum layer, which is laid down seasonally in dark and light bands. Trace elements are included in the matrix of the tooth cementum in concentrations that reflect those of the environment in which the animal lives and feeds. By measuring these trace element concentrations, the lifetime history of

an animal's exposure to specific trace elements may be reconstructed. This method has the potential to capture seasonal or annual exposure events, as well as increases in element exposure within an individual's lifetime. Walrus teeth are relatively abundant in museum collections, allowing a time series of element concentrations to be generated that spans many decades, and are available through the Alaska Native subsistence harvests. Natural variation in trace element concentrations can be established by measuring element concentrations in walrus teeth from historic and modern walruses. This baseline will allow for examination of walrus contact with trace elements associated with petroleum exploration, as well as potential changes since the discovery of oil reserves in the Alaskan Arctic.

Objectives: The objectives of this study are to:

- Quantify natural variability of trace elements commonly associated with oil and gas activities (As, Ba, Cd, Cr, Cu, Fe, Mn, Pb, Ni, V, and Zn) in teeth of female walruses killed prior to the era of petroleum exploration and extraction in the Alaskan Arctic (pre-1970s)
- Assess differences/similarities in trace element concentrations before and after the beginning of petroleum extraction in the Alaskan Arctic
- Analyze lifetime changes in trace element concentrations in the teeth of individual female walruses to identify seasonal or annual exposure events as well as lifetime trends in trace element exposure.

Methods: Female walrus teeth from museum collections (n = 65) and recent Alaska Native subsistence harvests (n = 25) have been compiled and are awaiting processing. This study will focus on female walruses because their summer habitat overlaps with past oil and gas exploration areas, whereas most male walruses remain in the Bering Sea all year. Each tooth will be cut longitudinally to create a 3 mm thick cross-section of each tooth. Concentrations of As, Ba, Cd, Cr, Cu, Fe, Mn, Pb, Ni, V, and Zn will be measured and compared to the USGS microanalytical phosphate standard (MAPS-4), as well as the National Institute of Standards and Technology Standard Reference Material (NIST 610) to obtain trace element concentrations in parts per million (ppm). Changes in trace element exposure throughout the life of individual walruses will be investigated by examining increases and/or decreases of element concentrations in a given transect of the tooth. Variability of element concentrations among walruses will be quantified by comparing mean values for the entire transect, allowing comparisons to be made across time periods. In this way, natural variability in trace element concentrations will be established for the era before oil and gas exploration activities occurred in the U.S. Arctic (pre-1968), providing a baseline for comparison with values in teeth of modern walruses.

Current Status: Completed

Final Report Due: September 30, 2018

Publications Completed:

Clark, C. 2018. Using Trace Elements in Pacific Walrus Teeth to Track the Impacts of Petroleum Production in the Alaskan Arctic, *in* CMI Graduate Student Projects: Volume 2, B. Konar (Ed.). Final Reports, OCS Study BOEM 2018-058, University of Alaska Coastal Marine Institute and USDOI, BOEM Alaska OCS Region.

Affiliated WWW Sites: http://www.boem.gov/akstudies/
http://www.cfos.uaf.edu/cmi/

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