

Environmental Studies Program: Ongoing Study

Title	Microbial Biodegradation of Alaska North Slope Crude Oil in Arctic Marine Sediments (AK-13-03-24)
Administered by	Alaska Regional Office
BOEM Contact(s)	Rick Raymond, richard.raymond@boem.gov
Conducting Organizations(s)	CMI, UAF
Total BOEM Cost	\$174,931 plus Joint Funding (\$174,931)
Performance Period	FY 2017-2020
Final Report Due	May 2020
Date Revised	June 5, 2020
PICOC Summary	
<i>Problem</i>	Little is known about the oil biodegradation potential in the Arctic marine environment. Following an oil spill, microbial biodegradation is the main mechanism for removing petroleum from the marine environment. Understanding the oil biodegradation potential for ecosystems is important to assessing the fate and effects of oil contamination and for developing bioremediation strategies.
<i>Intervention</i>	This study will conduct laboratory incubation studies to investigate the biodegradation of fresh and weathered crude oil in sediments under both aerobic and anaerobic conditions in order to assess biodegradation rates.
<i>Comparison</i>	The results will provide an in-depth analysis of the crude oil biodegradation potential of Arctic marine sediments.
<i>Outcome</i>	The analysis will document biodegradation rates and identify oil-degrading microbes.
<i>Context</i>	Beaufort Sea

BOEM Information Need(s): BOEM needs additional information to facilitate evaluation of the fate of oil spilled in the Arctic marine environment. To better assess the fate of oil spilled in the Arctic marine environment, there is a need to understand the oil biodegradation potential in Arctic sediments. BOEM analysts and decision-makers can use this information in NEPA analysis and documentation for potential EPs and DPPs in the Beaufort Sea.

Background: Ice-covered waters are becoming more accessible to human activities, increasing the likelihood of anthropogenic disturbance and contaminant exposure through oil and gas development as well as increased commercial shipping and other activities. Because microbial biodegradation is the primary means through which petroleum is removed from the marine environment following a spill, knowing the oil biodegradation potential for each ecosystem compartment (i.e. shoreline, sea ice, sea surface, water column, and benthos) is important to evaluating the fate and effects of oil contamination and to developing cleanup strategies such as bioremediation. To date,

relatively little is known about the oil biodegradation potential of the Arctic marine environment, particularly in the benthos (sediment).

Oil in the benthos, although less visible than that on the surface or shoreline, can greatly impact the health of the marine system immediately following an oil spill for up to a decade or more, and can result in adverse effects on both benthic and pelagic food webs. Oil can be toxic or fatal to a multitude of demersal fishes and invertebrates and is persistent in the environment and the tissues of exposed organisms years after a spill event. Ten years following the Exxon-Valdez oil spill (EVOS), researchers discovered oil compounds both within marine sediments and at toxic levels within the tissues of organisms such as Pacific Halibut, mussels, and clams. In Arctic marine sediments, benthic fishes and invertebrates compose all or some of the diets of marine mammals including walruses, seals, and bowhead whales, which are also important for Alaska Native subsistence hunting. Thus, understanding the fate of oil in Arctic marine sediments is important to assessing the potential environmental and human health impacts of an oil spill in this ecosystem.

This study proposes to perform laboratory incubation studies to investigate the biodegradation of fresh and weathered crude oil in sediments under both aerobic and anaerobic conditions in order to assess biodegradation rates and to identify oil-degrading microbes, which can help to formulate projections regarding the fate of spilled oil in sediments.

Objectives:

- Assess the capacity for biodegradation of Alaska North Slope crude oil by indigenous microorganisms in subtidal Arctic marine sediments under aerobic and anaerobic conditions.
- Compare the biodegradation of fresh oil versus moderately weathered oil in Arctic sediments.
- Identify microorganisms involved in biodegradation of oil in Arctic marine sediments.
- Utilize taxonomic information from incubation studies to assess the distribution of putative oil-degrading microbes

Methods: Marine sediment samples will be collected approximately one km offshore on the Chukchi Sea, directly north and west of Point Barrow, AK in late summer (August-October) 2017. Laboratory incubation studies will be performed to investigate the biodegradation of fresh and weathered crude oil in sediments under both aerobic and anaerobic conditions to assess biodegradation rates and to identify oil-degrading microbes, which can facilitate evaluation of the fate of spilled oil in sediments. Following the identification of putative oil-degrading bacteria in incubation tests, queries will be conducted to existing microbial community datasets from sediments across the Beaufort Sea to assess the biodegradation potential present in indigenous sediment microbial communities across the region. Together, the findings will provide an in-depth analysis

of the crude oil biodegradation potential of Arctic marine sediments at growing risk of contamination.

Specific Research Question(s): How many microorganisms species are involved in biodegradation of oil in Arctic marine sediments?

Current Status: Completed

Affiliated WWW Sites: <http://www.boem.gov/akstudies/>

<https://marinecadastre.gov/epis/#/search/study/100198>

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