Environmental Studies Program: Ongoing Study

Title	Hydrocarbon Oxidation Products in Cook Inlet: Formation and Bioaccumulation in Mussels (AK-19-02-12)
Administered by	Alaska Regional Office
BOEM Contact(s)	Caryn Smith (caryn.smith@boem.gov)
Procurement Type(s)	Cooperative Agreement
Conducting Organization(s)	University of Alaska Coastal Marine Institute
Total BOEM Cost	$175,000 plus Joint Funding ($175,000)
Performance Period	FY 2020–2023
Final Report Due	April 2023
Date Revised	September 20, 2022
PICOC Summary	
Problem	Research on hydrocarbon oxidation products (HOPs) has been conducted in warmer climates, where sunlight exposure is less than southcentral Alaska in the summer, and on different types of oils.
Intervention	This study will identify HOPs formed by crude or diesel oil in simulated laboratory-scale spills, perform correlations to broad molecular characterization, identify potential uptake in marine organisms, and assess the presence/absence of these compounds in Cook Inlet.
Comparison	This study will reveal an oil weathering pathway, HOP formation and bioaccumulation, to provide a framework to assess impacts from accidental oil spills.
Outcome	Study products will assist BOEM in conducting NEPA impact analyses and document baseline criteria to monitor HOPs in Cook Inlet.
Context	Cook Inlet Planning Area

BOEM Information Need(s): The Bureau of Ocean Energy Management (BOEM) needs information about the weathering of oil spills, including their weathering products, for NEPA analyses as well as baseline status of weathered oil components for monitoring.

Background: Once oil is spilled into the marine environment, oxygenation by microbial and photochemical processes results in the formation of HOPs (Aeppli et al. 2012). HOPs are dissolved oxidized petroleum products that have not fully degraded. Because HOPs dissolve into seawater they can be distributed throughout aquatic environments. Measuring HOPs, which are more bioavailable in the marine environment than their parent petroleum molecules, is important to aid understanding of how marine ecosystems will respond to accidental oil spills. Existing research on HOPs is difficult to apply to Cook Inlet because it was often conducted in regions of warmer temperatures, differing sunlight exposure, and/or different oil types.

Objectives:

- Examine how particular environmental conditions of Cook Inlet (lower temperature, increased sunlight) affect weathering of crude and diesel oil.
- Identify production of HOPs in laboratory spill simulations.
- Identify bioaccumulation of HOPs in Cook Inlet mussels in laboratory spill simulations.

Methods: This project will simulate spills of Cook Inlet crude and diesel oil mimicking diurnal temperature and sunlight exposure in Cook Inlet and then sample their resulting oxidation products. Bioaccumulation trials will use Cook Inlet mussels and then sample their tissue. Chemical profiling of water or tissue samples will include a suite of analyses including dissolved organic carbon (DOC), targeted oxy-polyaromatic hydrocarbons (PAHs), and targeted PAHs.

Specific Research Question(s):

1. Can HOPs be detected in Cook Inlet seawater when incubated with Cook Inlet crude or diesel oil and exposed to sunlight?
2. Can HOPs bioaccumulate in mussel tissues when exposed to sunlight-exposed oiled seawater?

Current Status: Ongoing, lab work underway.

Publications Completed:

Whisenhant EA, Zito P, Podgorski DC, McKenna AM, Redman ZC, Tomco PL. 2022. Unique molecular features of water-soluble photo-oxidation products among refined fuels, crude oil, and herded burnt residue under high latitude conditions. ACS ES&T Water. 2(6): 994-1002. https://doi.org/10.1021/acsestwater.1c00494

Affiliated WWW Sites:

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

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

References:

Aeppli, C., Carmichael, C.A., Nelson, R.K., Lemkau, K.L., Graham, W.M., Redmond, M.C., Valentine, D.L., Reddy, C.M. 2012. Oil weathering after the Deepwater Horizon disaster led to the formation of oxygenated residues. Environmental Science & Technology, 46(16): 8799-8807.