

Environmental Studies Program: Ongoing Study

Title	Biological effects of Cook Inlet crude oil degradation products and suspect screening of oxidized polycyclic aromatic hydrocarbons (PAHs) (AK-19-02-16)
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	\$133,673 plus Joint Funding (\$133,673)
Performance Period	FY 2021–2023
Final Report Due	February 2023
Date Revised	September 20, 2022
PICOC Summary	
<i><u>Problem</u></i>	Sunlight degrades petroleum in the marine environment producing hydrocarbon oxidation products (HOPs). HOPs readily dissolve into the water column. Historically, the ability to discriminate parent hydrocarbons from the reaction products, such as HOPs, received little attention even though the reaction products can bioaccumulate in marine organisms.
<i><u>Intervention</u></i>	New analytical methods (bioassays) and instrumentation (improved mass spectrometers) can be applied to evaluate HOPs formed from sunlight-exposed Cook Inlet crude oil spilled in the marine environment and assess their potential biological effects.
<i><u>Comparison</u></i>	The study will compare photo oxidized samples to control samples. Receptor-based in-cell bioassays will be used to detect and quantify the presence of cytotoxic compounds in parallel with a contemporary mass spectrometry method to detect and screen for the specific oxidized PAHs that may correlate with bioassay response.
<i><u>Outcome</u></i>	This project will provide a substantial advancement in understanding of the fate, monitoring, and toxicological effects of oxidized PAHs specific to oils and the environmental variables of the Cook Inlet region.
<i><u>Context</u></i>	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: Dissolved hydrocarbon oxidation products (HOPs) are a class of chemical compounds that are formed as spilled petroleum weathers in the environment (Aeppli et al. 2012). Photochemical degradation processes produce HOPs in oxygenated environments by reacting with aromatic compounds that absorb light in the solar spectrum; microbes can also produce HOPs through both aerobic and anaerobic biotransformation processes.

Monitoring and toxicological impact of oxy-Polycyclic Aromatic Hydrocarbons (PAHs) in Cook Inlet are relatively under studied, and no peer-reviewed studies exist specific to Cook Inlet crude oil oxidation processes and oil-specific toxicity under realistic temperature/light regiments of the Subarctic. Cell-based bioassays (AhR activity) have recently been developed as screening tools to analyze PAHs in environmental samples (Pieterse, et al. 2013). Additionally, the rapid improvement of mass spectrometers has made suspect screening of individual environmental contaminants more attractive.

Objectives: The overall goal is to establish preliminary data to correlate the weathering patterns of Cook Inlet crude oil when spilled in the marine environment to toxicological impacts that may be indicative of potential effects to both marine aquatic life and humans. The specific objectives focus on suspect screening and toxic effects as revealed from cell bioassays:

- Define the relative Aryl hydrocarbon receptor (AhR) activation of water-solubilized Cook Inlet crude oil during progressive photo-oxidation.
- Conduct suspect screening analysis of oxy-PAH residues in HOPs from water-solubilized Cook Inlet crude oil during progressive photo-oxidation.

Methods: This project will simulate spills of Cook Inlet crude oil mimicking diurnal temperature and sunlight exposure in Cook Inlet and then sample the resulting oxidation products. Bioassay trials will use rat and human hepatoma cells to analyze AhR activity from oxidation products. Modern mass spectrometry analysis will be performed on solid phase extracted residues for suspect screening and compound identification. The presence of oxidized PAHs compounds and non-volatile dissolved organic carbon values will be evaluated for correlation to AhR activity

Specific Research Question(s):

1. Do HOPs accumulate over time when oil is exposed to the sunlight hours and temperatures of the subarctic environment?
2. Does the concentration oxy-PAHs correlate to cell bioassay activity?

Current Status: Ongoing, labwork underway

Publications Completed: N/A

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., and 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.
- Pieterse, B., Felzel, E., Winter, R., Van Der Burg, B., and Brouwer, A. 2013. PAH-CALUX, an optimized bioassay for AhR-mediated hazard identification of polycyclic aromatic hydrocarbons (PAHs) as individual compounds and in complex mixtures. *Environmental Science & Technology*. 47(20): 11651-11659.