## Environmental Studies Program: Ongoing Study

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| Title | Investigating the Impacts of Oil Exposure and Changing Snow Cover on Sea Ice Microbial Communities (AK-19-02-11) |
| Administered by | Alaska Regional Office |
| BOEM Contact(s) | Rick Raymond (richard.raymond@boem.gov) |
| Procurement Type(s) | Cooperative Agreement |
| Conducting Organization(s) | University of Alaska Coastal Marine Institute |
| Total BOEM Cost | $149,831, plus joint funding ($148,281) |
| Performance Period | FY 2020–2023 |
| Final Report Due | December 2022 |
| Date Revised | September 14, 2022 |
| PICOC Summary | |
| *Problem* | Crude oil spills in the Arctic may cause impacts to primary producers such as sea-ice algae and phytoplankton contacted with oil. The sublethal impacts of low concentrations of crude oil contamination on these primary producers may also be modulated by other variables such as declining snow cover and thinning ice due to environmental change occurring in the Arctic. |
| *Intervention* | This study will investigate how oil spills may alter primary production in the changing Arctic by developing new genetic markers for sea-ice algae, using the diatom *Nitzschia fridgida* as a model species. Physiological stresses to *N. fridgida* from changing light and crude oil contamination will be examined, as well as utilizing markers previously characterized for heterotrophic bacteria. Molecular tools will be used to uncover changes in microbial interactions in natural sea ice communities exposed to snow and low-level crude oil contamination. |
| *Comparison* | Gene expression profiles will be compared with sea-ice algae communities from ice cores incubated under the same levels of crude oil contamination and light levels in the laboratory. The gene expression profiles from cultured isolates and natural sea-ice algal communities will be analyzed to develop biomarkers for rapid quantification of sublethal effects of crude oil contamination. Results can be used to assess the sublethal impacts of a spill and differentiate these from other sources of oxidative stress such as high light. |
| *Outcome* | Understanding ice algae metabolic pathways in response to increased light will provide insight into the future trajectory of algal productivity in a warming Arctic, and how microbial communities and carbon pool dynamics may change in Arctic sea ice. |
| *Context* | Beaufort Sea |

**BOEM Information Need(s):** This study will lead to improved understanding of how oil spills in the Arctic may affect primary producers such as sea-ice algae and phytoplankton compared to other physical variables including declining snow ice cover and thinning ice. A better understanding of these effects on primary production will provide insights into the existing environment for all organisms utilizing trophic transfer of particulate organic carbon, either directly or in relation many important ocean biogeochemical processes. Any changes to these processes as result of OCS activities could cause impacts to these same analyzed resources. BOEM will also benefit from this study by improved understanding on algal productivity in a warming Arctic and how an oil spill may alter primary production.

**Background:** Diatoms are a prolific group of marine algae, contributing considerably to Arctic algal biomass in ice and water (>95%; Szymanski and Gradinger 2016). Sea-ice diatoms, such as the ice-endemic *Nitzschia frigida*, are known to produce excess dissolved organic carbon (DOC) for cryoprotection and in response to stressors such as high irradiance (Parker and Armbrust 2005). DOC represents a major pool of carbon that can be remineralized by marine or ice-bound bacteria, thus feeding the microbial loop and decreasing the trophic transfer efficiency of particulate organic carbon (POC). High irradiance can cause damage to photosystem components of diatoms resulting in photoinhibition and shifts in metabolism such as increased photorespiration (Parker and Armbrust 2005). Understanding the ways in which ice algae regulate metabolic pathways in response to increased light will provide critical insight into the future trajectory of algal productivity in a warming Arctic, and how microbial communities and carbon pool dynamics may change in Arctic sea ice. Both oil contamination and changing irradiance levels in the Arctic are predicted to impact the availability of DOC and therefore may shift the interactions between heterotrophic and autotrophic microbes.

**Objectives:** The primary objective of this study is to identify changes in microbial interactions of ice microbes under changing irradiance and sub-lethal levels of crude oil contamination to investigate how an oil spill may alter primary production in a changing Arctic environment.

**Methods:** Using physiological and genetic tools, this study will characterize the response of the cultured sea-ice diatom *N. frigida* to a gradient of crude oil contaminated media and irradiance in controlled conditions in a laboratory setting. The study will use the water accommodated fraction (WAF) of Alaska North Slope (ANS) crude oil to isolate the toxicological impacts on *N. frigida*. Batch culture experiments will be used to determine the physiological and gene expression responses of the sea-ice diatom to tipping points in crude oil contamination levels and light conditions as identified from plate assays. Series of laboratory analysis will include plate experiments to determine sea ice diatom oil sensitivity over a range of light levels, batch gene expression analysis experiments to determine gene expression responses to crude oil and increased irradiance, bioinformatic analysis, and oil quantification.

**Specific Research Question(s):**

1. What are the potential impacts of an oil spill on sea-ice primary productivity?
2. What is the potential that sublethal concentrations of crude oil may cause trophic disruption for organisms at the base of the food web?

**Current Status:** Awaiting final report

**Publications Completed:** None

**Affiliated WWW Sites:**

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

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

**References:**


Parker M.S. and Armbrust E.V. 2005. Synergistic effects of light, temperature, and nitrogen source on transcription of genes for carbon and nitrogen metabolism in the centric diatom *Thalassiosira pseudonana* (Bacillariophyceae). J Phycol 41:1142–1153. https://doi.org/10.1111/j.1529-8817.2005.00139.x.

Szymanski A. and Gradinger R. 2016. The diversity, abundance and fate of ice algae and phytoplankton in the Bering Sea. Polar Biol 39:309–325. https://doi.org/10.1007/s00300-015-1783-z.