IN SITU BURNING AND EFFECTS FROM OIL SPILL ON ARCTIC SHORELINES

Kim Gustavson, Susse Wegeberg and Janne Fritt-Rasmussen

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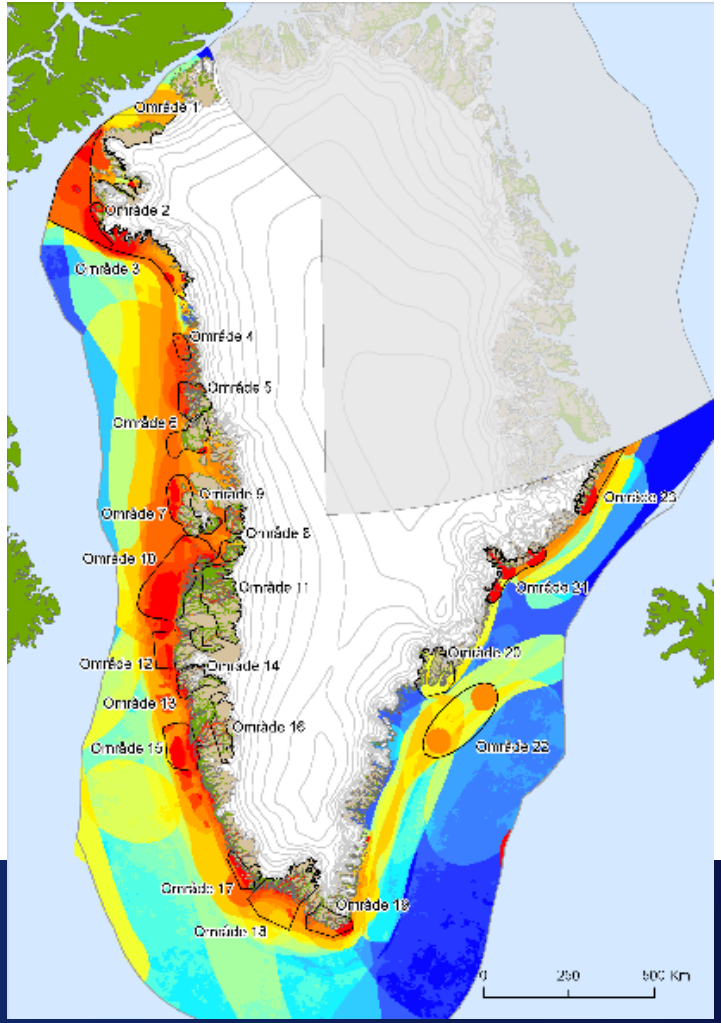
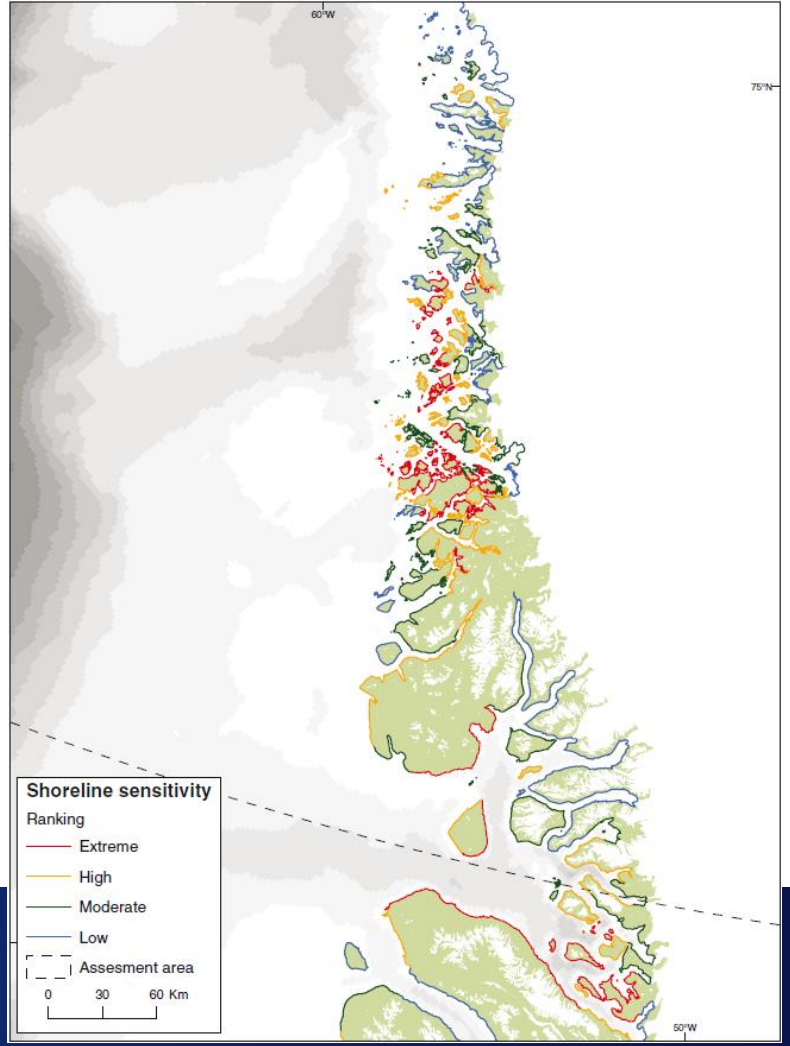
GRACE

OIL SPILL SENSITIVITY MAP FOR GREENLAND



SENSITIVITY OF SHORELINE

A large proportion of the shoreline in Greenland is classified as highly or extremely sensitive to oil spills

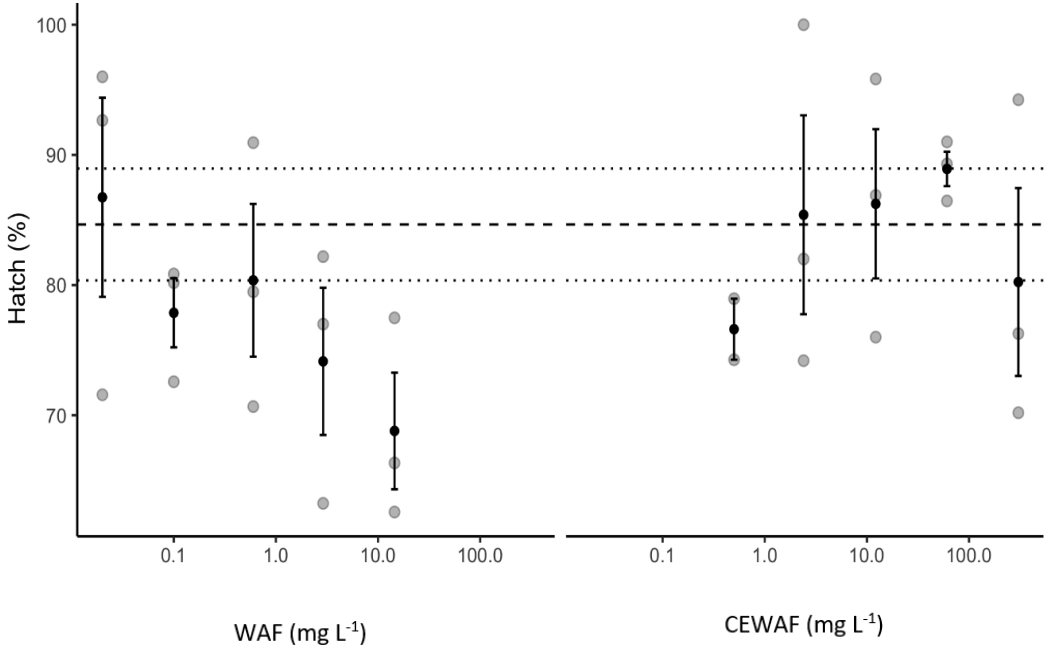


EFFECT OF OIL, DISPERSED OIL AND DISPERSANT HAS BEEN STUDIED ON ORGANISMS IN THE ARCTIC SHORELINE

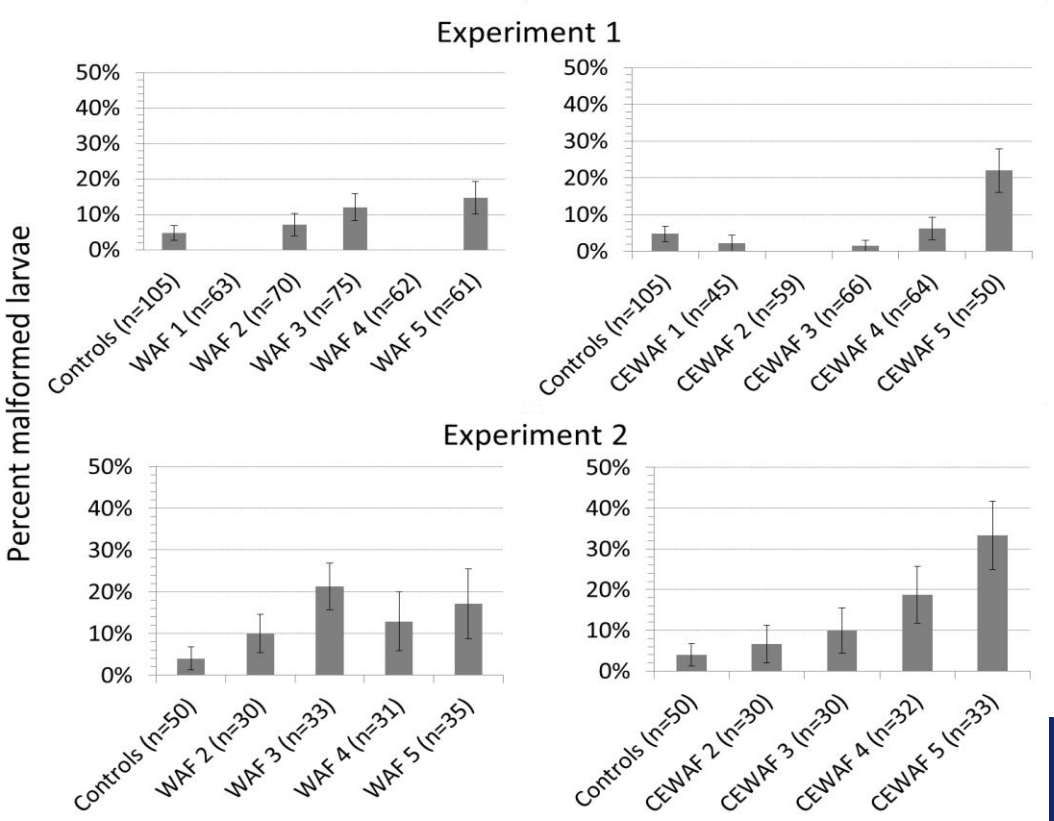
Studies has includes:

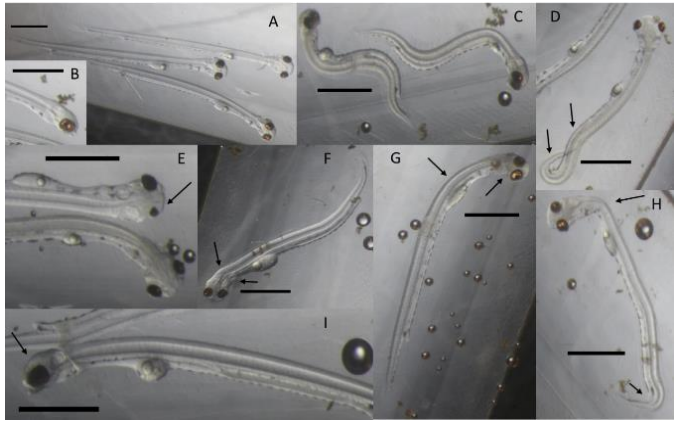
Capelin *(Mallotus villosus)*
Seaweed *(Fucus distichus)*
Blue Mussel *(Mytilus edulis)*
Winkles *(Littorina saxatilis)*
Amphipod *(Gammarus oceanicus)*

EFFECTS OF PHYSICALLY (WAF) AND CHEMICALLY DISPERSED (CEWAF) HEAVY FUEL OIL ON BEACH SPAWNING CAPELIN

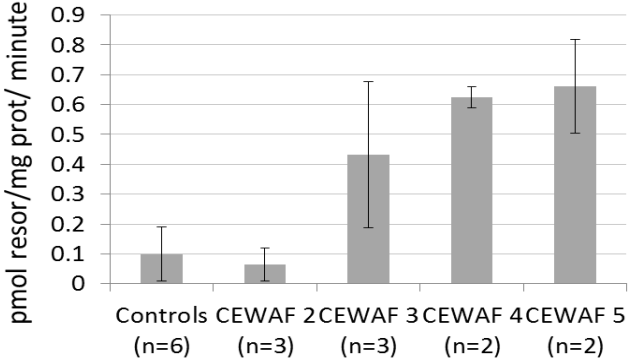


MALFORMATION – CAPELIN LARVAE





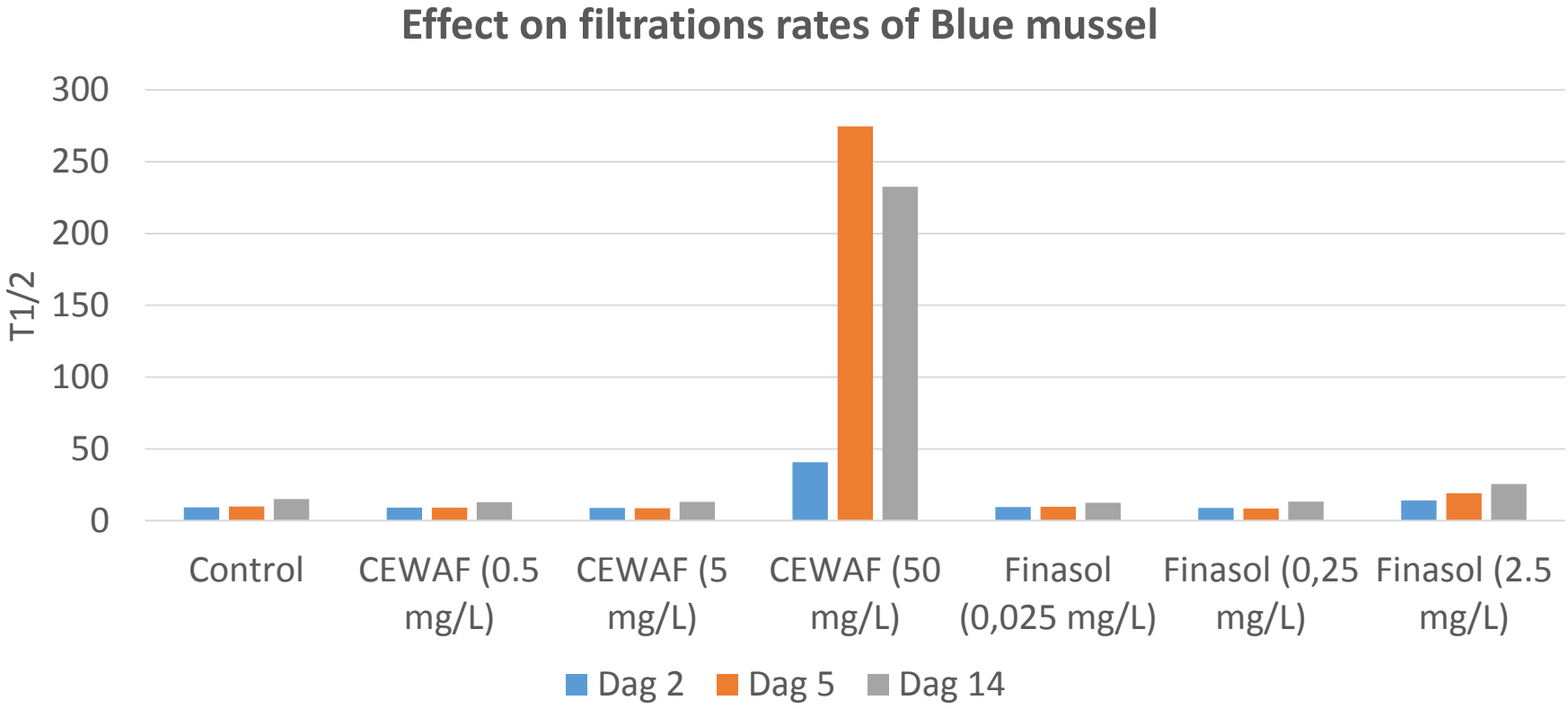
Enhance EROD activity



MESOCOSMS STUDIES

Toxic effect of chemical dispersed oil and dispersants on tidal organisms:

- Seaweed *(Fucus distichus)*
- Blue Mussel *(Mytilus edulis)*
- Winkles *(Littorina saxatilis)*
- Amphipod *(Gammarus oceanicus)*


Effect on filtrations rates of Blue mussel
300
250
200
150
100
50
0
T1/2
Control
CEWAF (0.5 mg/L)
CEWAF (5 mg/L)
CEWAF (50 mg/L)
Finasol (0,025 mg/L)
Finasol (0,25 mg/L)
Finasol (2.5 mg/L)
Dag 2
Dag 5
Dag 14

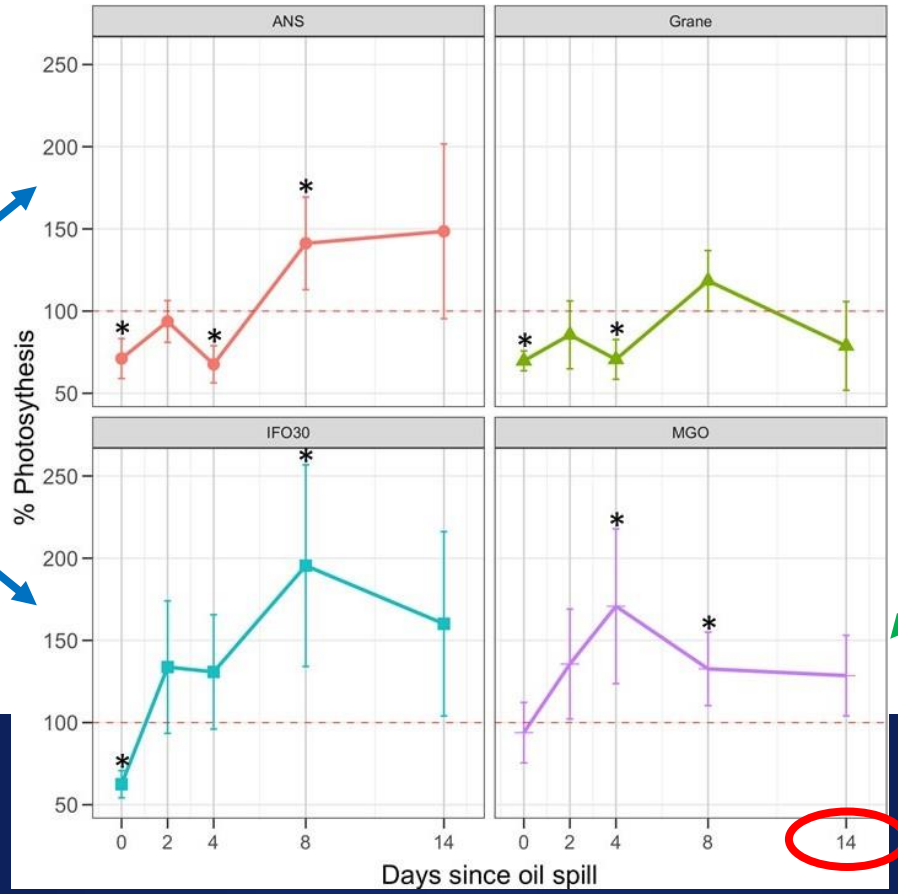
EFFECTS OF OIL SPILL ON MACROALGAE IN THE TIDAL ZONE

Oil	Type
ANS	Crude
Grane	Crude
IFO30	Heavy Fuel Oil
Marine Gas Oil (MGO)	Dielsel

Effect of different oil on photosynthetic activity

Inhibition +

Stimulation



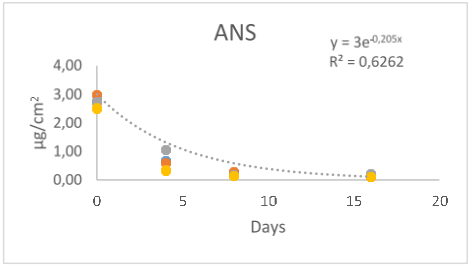
Inhibition

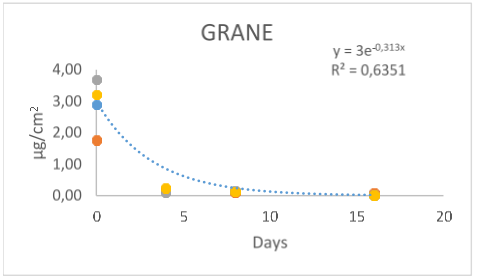
Stimulation

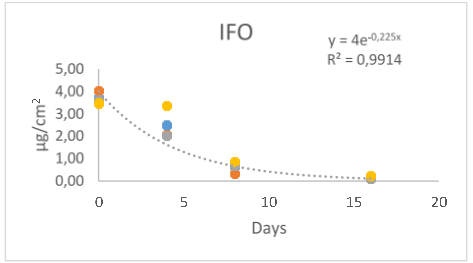
?

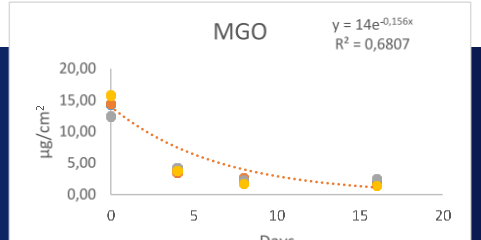
SELF-CLEANING POTENTIAL OF OILED SEAWEED (FUCUS SP.)

Oil	$T_{1/2}$ (days)
ANS	3,4
Grane	2,2
IFO30	3,1
Marine Gas Oil (MGO)	4,4







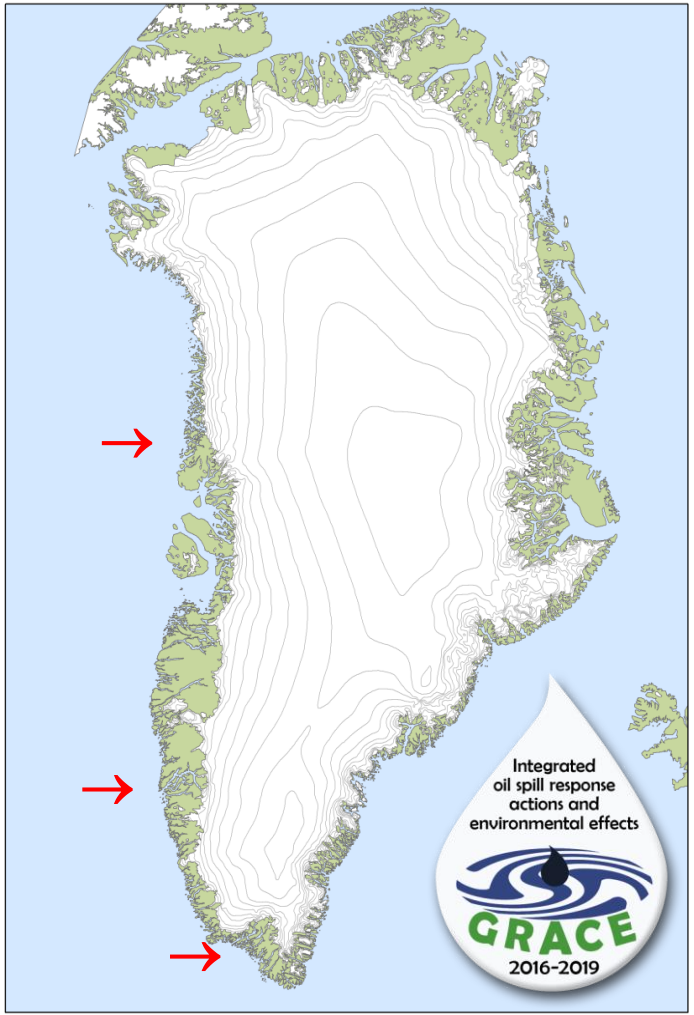


SELF-CLEANING POTENTIAL OF OIL ON ROCKY SHOLRELINE

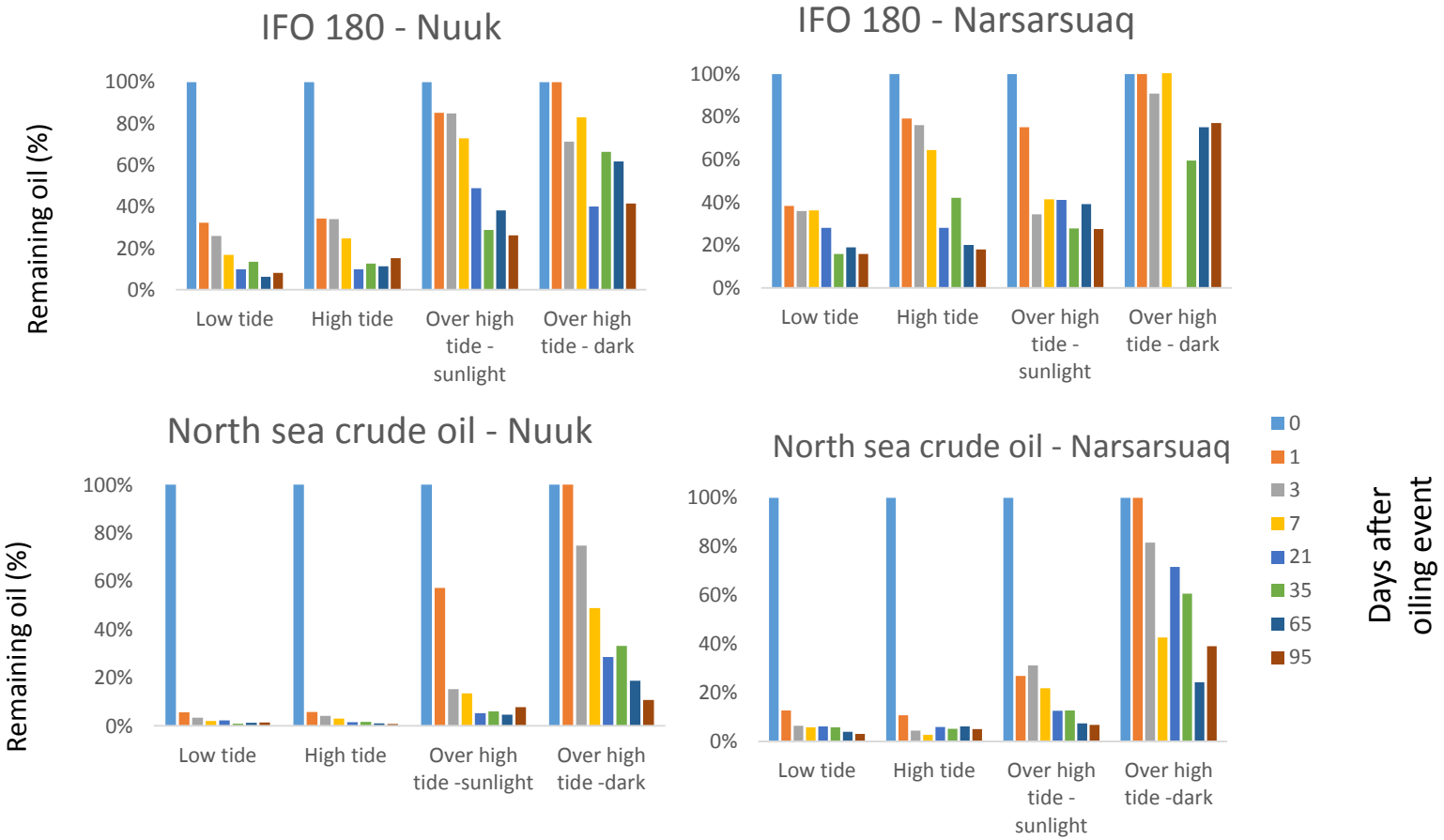
MIMICKED BY SLATE TILES TREATED WITH A CRUDE OIL OR A HEAVY FUEL OIL

Removal of oil by:

- Seawater and rain
- Evaporation
- Degradation (bacteria and light)



Remaining Oil (Crude oil and IFO180) on Tiles in Different Heights of the Tidal Zone



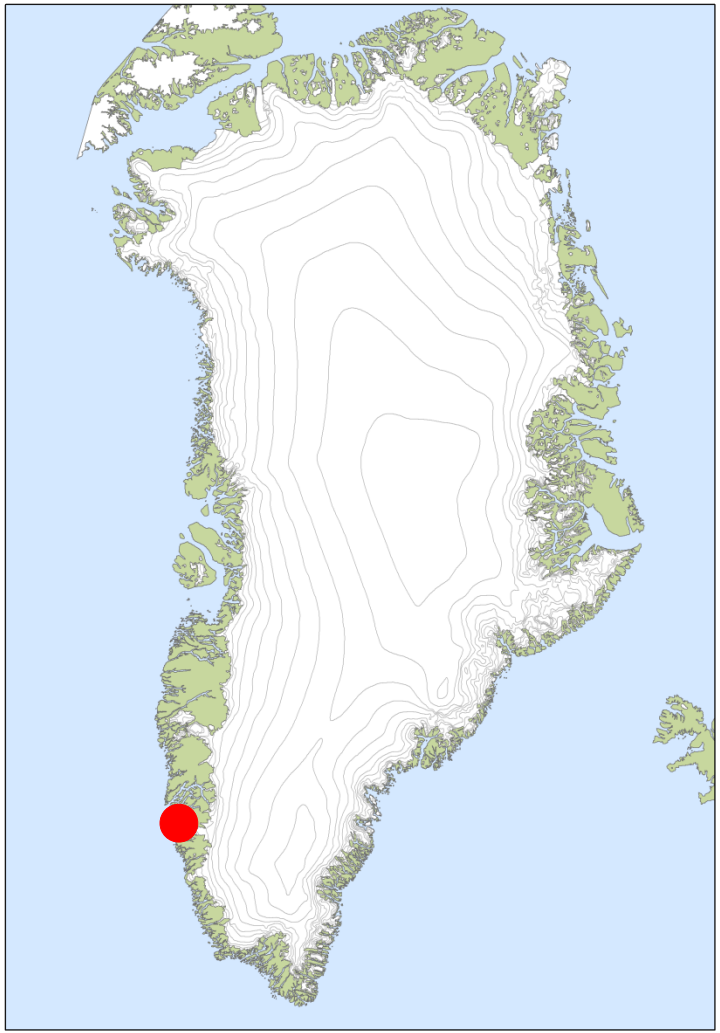
RESULTS OF STUDIES

- Oil spill as well as use of dispersants may have significant toxic effect on key species in the arctic coastal waters.
- Self-cleaning potential of rocks in the tidal zone varies between 23% - 99% depending on oil type and position in the tidal zone.
- The results also suggest that removal rate of oil that have been pushed by waves or sea ice onshore above the tidal zone may be slower for both the tested oils, although sun light and precipitation also may have a significant impact on the removal rate.
- Seaweed exposed to wave-wash shows high self-cleaning potential (85% - 95% removal within 14 days) after an oiling event. However effect on the photosynthetic activity continues to be affected up to 14 days after oil-exposure.




FIELD EXPERIMENT 2017

SHORELINE IN SITU BURNING AND EFFECTS ON TIDAL ORGANISMS



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OIL SPILL FIELD EXPERIMENT

Permission from the Greenland authorities including mitigation plans

Pinngortitamut Avatangiisinut Nukissiuuteqarnermullu Naalakkersuisoqarfik
Departementet for Natur, Miljø og Energi

NAALAKKERSUISUT
GOVERNMENT OF GREENLAND

Aarhus Universitet
Bioscience
Frederiksborgvej 399,
Postboks 358,
4000 Roskilde,

Kim
E-mail: kig@bios.au.dk

Tilladelse til gennemførsel af forsøg vedrørende forvitring af olie
bekæmpelse af oliespild ved Grønlands kyst

Postboks 1614
3900 Nuuk
Tlf. (+299) 34 50 00
Fax (+299) 34 54 10
E-mail: paian@nanoq.gl
www.naalakkersuisut.gl

Afgørelse

Departementet for Natur, Miljø og Energi giv
tilladelse til gennemførsel af praktisk fors
bekæmpelse af oliespild ved Grønland
forskningsprojekt om oliespild i k

Tilladelsen gives i henhold t
om beskyttelse af hav
Landstingsforordni
maj 20
Tilladels
besky

4 af 3. november 1994
ændret ved
Landstingsforordning nr. 2 af 21.
ningen).
eller tilbagekaldes, hvis hensynet til
et nødvendigt, jf. havmiljøforordningens § 39.

nstående vilkår.

Approved

SHORELINE IN SITU BURNING

HTTPS://WWW.GRACE-OIL-PROJECT.EU/EN-US/

OVERVIEW OF ACUTE IMPACTS ON THE SHORELINE AFTER THE IN SITU BURNING

Section no. / tidal level	I	II	III	IV	V	VI	VII
High							
Mid							
Low							

USE OF THE LAMOR BUCKET SKIMMER FOR COLLECTING BURN RESIDUE

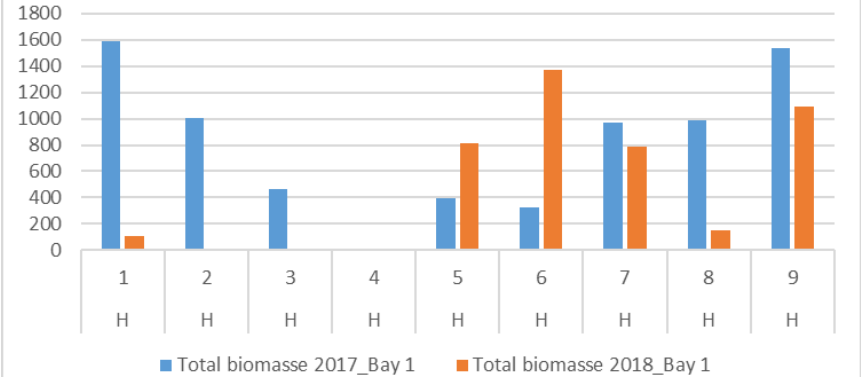
Impact of In Situ Burning on biomass of seaweed

Total biomass (g) per replicate (0.0625 m^2)

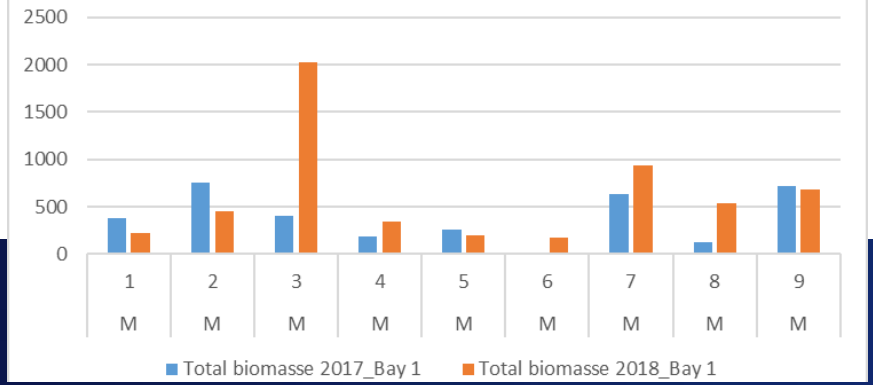
Baseline 2017 before the ISB 2017

Monitoring 2018 1 year after the ISB

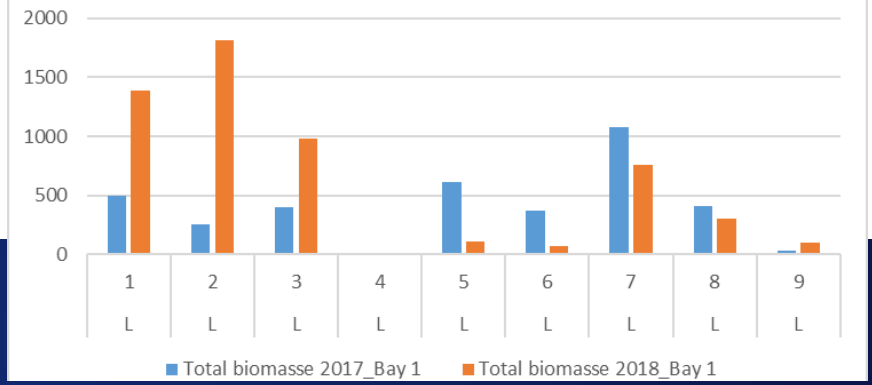
High tidal level



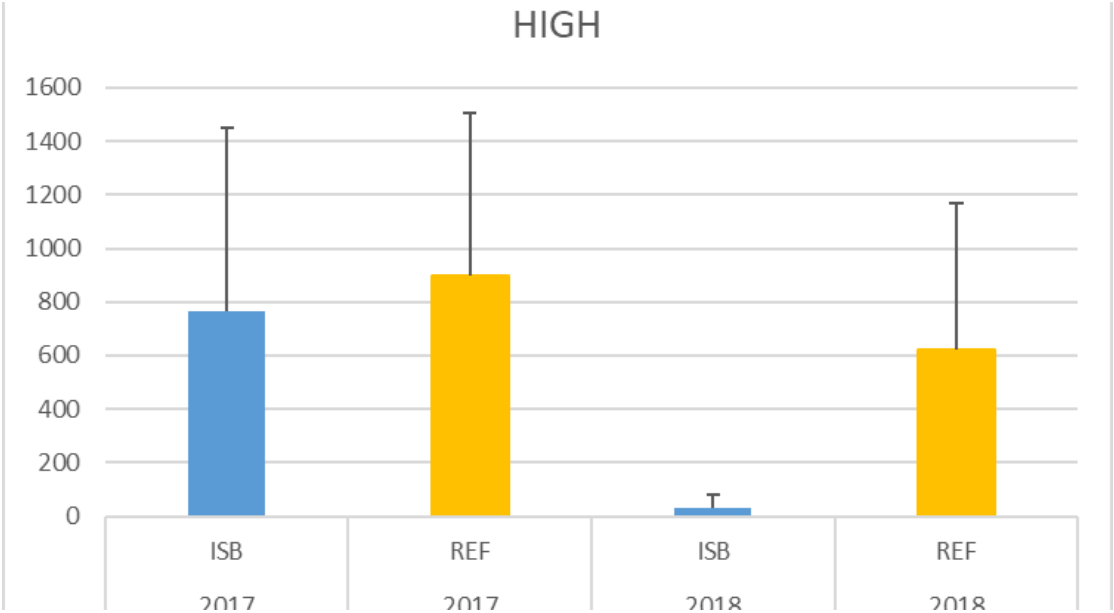
Medium tidal level



Low tidal level



IMPACT OF IN SITU BURNING ON BIOMASS OF SEAWEED



In progress:

Statistical analysis will analyze effect of ISB on abundance species, diversity of species etc.

OVERALL CONCLUSIVE REMARKS - SHORELINE IN SITU BURNING

- The studies highlighted the importance of oil type and its influence on the oil spill response capability and derived environmental impacts.
- It was seen that the shoreline in situ burn was successful (both from an operational but also environmental perspective) for a medium light crude oil, however more investigations should be completed to see if that is also the case for more viscous oil types, e.g. IFO180.
- The need for further studies on more heavy fuel oils is emphasized by the results from the natural removal of stranded oil experiments, where the heavy fuel oil proved more difficult to remediate than the medium light crude oil.
- Also, it was see that it could be possible to collect the burn residue, but that the efficiency of the collecting could be improved by upgrading and further development of the equipment.


Thank you

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THREE STUDIES

1. Self-cleaning potential of smothered *Fucus distichus* from 4 different oil types by sea wash
2. Self-cleaning potential of oil smothered rocky coast, mimicked by slate tiles, from two different oil types
3. Combat of a coastal oil spill by in situ burning and the effects on the coastal communities.

EFFECT FROM OILSPILL ON ARCTIC SHORELINE

Sensitivity maps (Tom)

Rocky coast and sandy beach are dominating shoreline in Greenland

Effects of oil and combating of oil spill on organism in the shoreline

Self cleanings potential of macroalgae

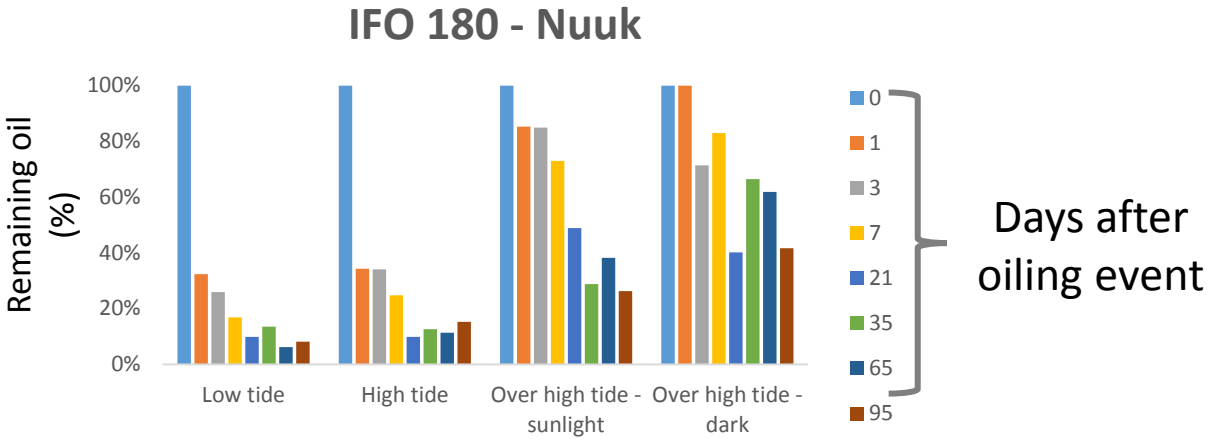
Self cleaning potential on rocky shoreline

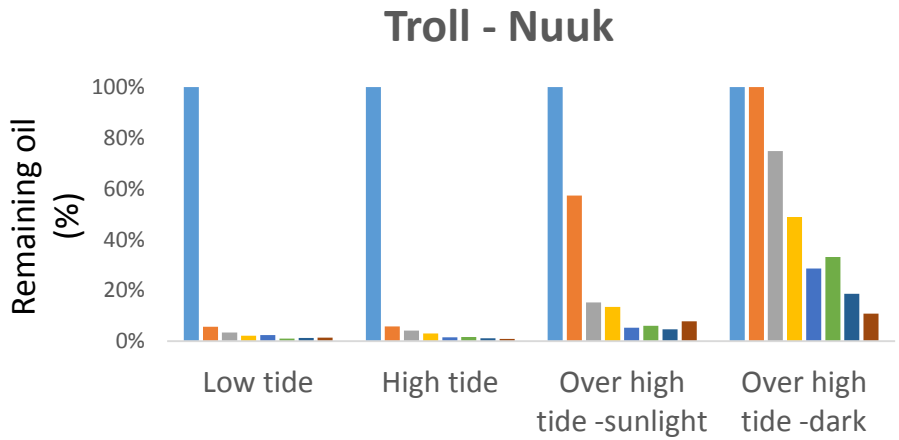
Experiment on removal of oil from shoreline by ISB

Short-term and long-term effecet by ISB

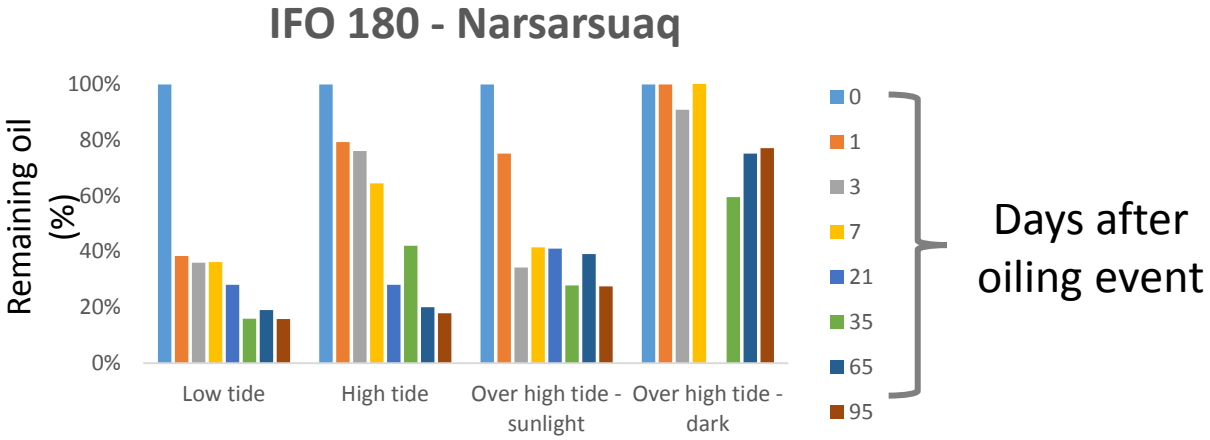
Summary

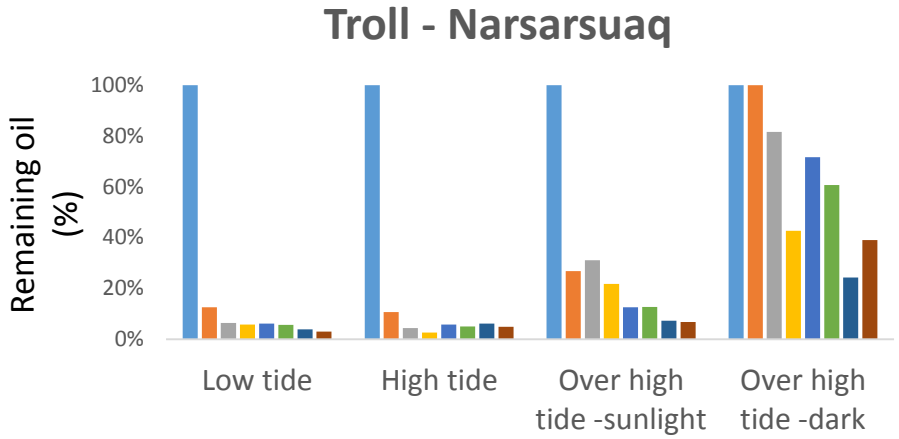
Natural wash-off & self-cleaning potential





Natural wash-off & self-cleaning potential





1. In situ burning field trials in Greenland coastal waters 2017. Two burns were completed; offshore and near the coast. Focus will be on environmental impacts from the burns and lessons learned with respect to increased usability of in situ burning.
2. Studies on natural removal of stranded oil on rocky coasts in Greenland. Focus will be on the effects of oil smothering and removal of oil from rocky coast with respects to oil types, degradation by sunlight and wave wash.

The macroalgae are found along shorelines attached to hard and stable substrate, and may occur at a depth of more than 50 m. Biomass and production of littoral and sub-littoral macroalgae can be signi cant and are important for higher trophic levels of the food web. Studies concerning macroalgal diversity in the assessment area have been carried out, documenting the importance of this group in coastal waters.

Shorelines with a rich vegetation of marcroalgae (e.g. kelp) are of high ecologically importance. The littoral- and sub-littoral canopies of macroalgae are important for higher trophic levels by providing substrate for sessile animals, shelter from predation, protection against wave action, currents and desiccation or directly as a food source (Bertness et al. 1999, Lippert et al. 2001).

The marine macroalgae are found along shorelines with hard and stable substratum, such as stones, boulders and rocky coast. The vegetation is distinctly divided in zones, which are most pronounced in areas with high tidal amplitudes. Some species grow above the high-water mark, the supra-littoral zone, where sea water reaches them as dust, spray or by wave action. In the littoral zone the vegetation is alternately immersed and emersed, and characterised by fucoid species.