Effects of oil spill responses on key Arctic zooplankton species

The copepod Calanus glacialis is a key species in the Arctic ecosystem. Increased shipping and oil and gas activities in the Arctic increase the risk of an oil spill. It is therefore important to study the potential consequences of an oil spill on this key species in the Arctic marine ecosystems. As a part of a large joint industry initiative (www.arcticresponsetechnology.org) a first of its kind mesocosm experiment was executed in an Arctic fjord of the Island of Svalbard. Effects of natural attenuation of the oil, in-situ burning and chemical dispersion were studied on grazing, egg production and hatching of the Arctic copepod Calanus glacialis. Eight mesocosms with open top and bottom were deployed in the sea ice in Van Mijenfjorden, Svalbard, in February 2015. Two replicates were used for all treatments. After application, surface ice was allowed to re-establish. Water was collected from the top 2 cm water column in March and just before sea ice break up in May, and was used in two 14-day incubation experiments with C. glacialis collected in Isfjorden. Copepods were fed during the experiment and eggs and pellets were quantified daily. Egg hatching was determined in the beginning and end of the experiment. There was no significant effect of the oil spill treatments on average cumulated specific pellet production or egg hatching success. However in May, the average cumulated specific egg production was significantly higher in the dispersed oil treatment compared to the control from day 2 (+169 %) until the end of the experiment (+41 %)

Preliminary results: Deep sea oil spill in the Arctic – effects of pyrene on overwintering Calanus copepods

Polar Oceans are some of the least impacted by human activities due to seasonal or permanent sea ice that limits human access. Projections of future polar ice loss suggest that the impact will increase substantially because of changing environmental conditions and pollution. Arctic Oceans hold a substantial amount of the world’s remaining oil and gas reserves, but exploration is extremely technically challenging. To enable proper risk assessment, it is crucial to understand how oil spills can impact Arctic marine ecosystems. During polar night, biological processes in Arctic marine ecosystems are conventionally believed to slow down or cease. Indeed, several marine species have overwintering strategies, such as the Calanus copepods that overwinters for 8-10 months at depths of 200-2000 m and migrate to the productive surface layers to feed on the short Arctic bloom. We conducted a winter experiment with two species of Artic copepod to study the impact of long term exposure to oil during polar night. We used the ecological important Calanus hyperboreus (winter breeder) and C. glacialis (spring breeder) as tests species, and quantified effects on the fitness-related traits mortality, egg production, grazing and
egg hatching. Females were incubated in bottles with seawater and the oil compound pyrene (in concentrations of 0.1, 1, 10, 100 and 100+ nM) from December to March. They were transferred to clean seawater and fed in excess for 2-3 weeks until termination of the experiment. Mortality was checked daily, and egg and fecal pellets were collected within 24 h of production. Egg hatching success was determined at the beginning, middle and end of the experiment. Preliminary results indicate that C. hyperboreus exhibit a delayed response to pyrene through reduced feeding after transfer to clean seawater. Effects diminish over time, and feeding rate is recovered after 14 days without exposure to oil. Both egg production and feeding rate of C. glacialis is impacted by exposure in a concentration dependent manner after transfer to clean seawater. These findings suggest, that long term oil exposure during overwintering does indeed impact both Calanus species, and that C. hyperboreus seem to be more robust than the smaller C. glacialis. While effects on C. glacialis may have implications for stock recruitment within the season, potential effects on C. hyperboreus are likely delayed until next season. Negative effects on copepods may potentially affect the entire food chain and have severe ecosystem effects.

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The copepod Calanus glacialis is a key species in the Arctic ecosystem. Increased shipping and oil and gas activities in the Arctic increase the risk of an oil spill. It is therefore important to study the potential consequences of an oil spill on this key species in the Arctic marine ecosystems. As a part of a large joint industry initiative (www.arcticresponsetechnology.org) a first of its kind mesocosm experiment was executed in an Arctic fjord of the Island of Svalbard. Effects of natural attenuation of the oil, in-situ burning and chemical dispersion were studied on grazing, egg production and hatching of the Arctic copepod Calanus glacialis. Eight mesocosms with open top and bottom were deployed in the sea ice in Van Mijenfjorden, Svalbard, in February 2015. Two replicates were used for all treatments. After application, surface ice was allowed to re-establish. Water was collected from the top 2 cm water column in March and just before sea ice break up in May, and was used in two 14-day incubation experiments with C. glacialis collected in Isfjorden. Copepods were fed during the experiment and eggs and pellets were quantified daily. Egg hatching was determined in the beginning and end of the experiment. There was no significant effect of the oil spill treatments on average cumulated specific pellet production or egg hatching success. However in May, the average cumulated specific egg production was significantly higher in the dispersed oil treatment compared to the control from day 2 (+ 169 %) until the end of the experiment (+ 41 %)

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**Effects of oil spill responses on key Arctic zooplankton species**

Increased shipping and oil and gas activities in the Arctic increase the risk of an oil spill. Oil compounds can have toxic impact on Arctic marine ecosystems, but impacts from response technologies on ice associated ecology have not been studied extensively. The copepod Calanus glacialis is a key species in the Arctic marine ecosystem. It plays a central role in energy transfer between primary producers and higher trophic levels of the Arctic food chain. It is therefore relevant to study potential consequences of an oil spill on this ecological important species. As a part of a large joint industry initiative (www.arcticresponsetechnology.org) a first of its kind mesocosm experiment was executed in an Arctic fjord of the Island of Svalbard. Effects of natural attenuation of the oil, in-situ burning and chemical dispersion were studied on grazing, egg production and hatching of the Arctic copepod Calanus glacialis. Eight mesocosms with open top and bottom were
deployed in the sea ice in Van Mijenfjorden, Svalbard, in February 2015. Two replicates were used for all treatments. After
application, surface ice was allowed to re-establish. Water was collected from the top 2 cm water column in March and just
before sea ice break up in May, and was used in two 14-day incubation experiments with C. glacialis collected in Isfjorden.
Copepods were fed during the experiment and eggs and pellets were quantified daily. Egg hatching was determined in the
beginning and end of the experiment. There was no significant effect of the oil spill treatments on average cumulated
specific pellet production or egg hatching success. However in May, the average cumulated specific egg production was
significantly higher in the oil-dispersant mixture treatment compared to the control from day 2 (+ 169 %) until the end of
the experiment (+ 41 %). To correlate observed effects and toxicity, and to examine potential pollutant transfer, the
chemical content of incubation water, exposed females and produced eggs was further analysed for chemical residue.
These results will be presented on the SETAC 2016 conference

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Projects:

Effects of dispersed oil droplets and produced water components on growth, development and reproduction of Arctic
pelagic copepods (PWC-Arctic) (39297)
As the Oil & Gas industry moves north towards the Arctic, it is crucial to understand and be able to predict the potential for
detrimental effects of regular (produced water) and accidental oil spills on Arctic organisms, which often are characterized
by high lipid content. Organisms with high lipid content are susceptible to accumulation of lipophilic organic components
like produced water components (PWC) including oil droplets. Limited data exist on accumulation of oil components in
Arctic lipid-rich species which are parameterized so they can be applied as input to models predicting bioaccumulation and
body residues as a function of exposure time/concentration. Even less data exist where body residues of oil components
are explicitly linked to sub-lethal and delayed effects (e.g. on offspring). Finally, the potential contribution of oil droplets to
bioaccumulation has never been studied in Arctic species.

The present project aims at:
- providing parameterized data on uptake/elimination kinetics and internal administration (partitioning coefficients between
lipids and body fluids) for PW components in the Arctic lipid-rich copepods Calanus glacialis and C.hyperboreus:
- determine effect concentrations for PW components on early life stages of these copepods; and finally
- assess the potential for maternal transfer of PW components to eggs by exposing females prior to egg-laying and
determine potential developmental effects in early stages developing in clean sea water.

The parameterized data collected in this project will provide direct input to numerical models aimed at predicting impact of
PW on Arctic organisms. The approaches and methodologies used are based on extensive experience from previous
toxicological studies on the two Arctic species and in particular the related boreal species Calanus finmarchicus. The main
objective of the current proposal is to increase the knowledge of the potential effects of dispersed oil and other produced
water components on growth and reproduction in lipid-rich Arctic planktonic crustaceans.
This project is coordinated by SINTEF, Norway.
The project is funded by the Research Council of Norway.

National Institute of Aquatic Resources
Section for Oceans and Arctic
SINTEF
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Number of participants: 3
Research area: Oceanography
Project participant:
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Effects of oil spill and spill response technologies on ecosystems in ice-covered arctic oceans

National Institute of Aquatic Resources
Period: 01/10/2014 → 25/06/2018
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