

## Project information

### Project title

The combined effects of radionuclides, metals and organic contaminants in produced water on early life stages of *Calanus finmarchicus*

### Year

2013/2014

### Project leader

Louise K. Jensen, NRPA

### Participants

#### Project leader:

- Louise Kiel Jensen, Statens Strålevern

#### Project participants:

- Ingeborg Gammelsæter Hallanger, UiT
- Elisabeth Halvorsen, UiT
- Bjørn Henrik Hansen, Sintef
- Knut Erik Tollefsen, NIVA
- Steven Brooks, NIVA

### Flagship

Hazardous substances, Theme: Pollution from petroleum activities and shipping in the north - effects on Arctic ecosystems and communities

### Funding Source

Fram Centre

### Summary of Results

In the Barents Sea region new petroleum fields are discovered yearly and the extraction of petroleum products are expected to increase in the upcoming years. Despite enhanced technology and stricter governmental legislation, establishing the petroleum industry in the Barents Sea will introduce a new source of Naturally Occurring Radioactive Material (NORM) to the area as some discharges of produced water will be allowed. Whether the presence of produced water poses a risk to the Arctic marine life remains to be examined.

We examined effects on the copepod species *Calanus finmarchicus* after exposure to several compounds found in produced water. A mixture of polycyclic aromatic hydrocarbons and alkyl phenols commonly found in produced water was used as a proxy of the organic fraction of the produced water (hereafter termed APW (Artificial Produced Water)). In addition, exposures were done using radium-226 (proxy for NORM), barium (proxy for metals) and a scale inhibitor (SI -4470, M-I SWACO, Schlumberger Norge AS). Short-term screening tests on a range of concentrations of all compounds were run to assess the hatchability of the eggs and early survival of the nauplii. Long-term experiments were carried out with exposure concentrations at realistic levels found in the vicinity of known discharge points.

The copepod *C. finmarchicus* is considered a keystone species in the Barents Sea ecosystem as it represents the major pathway of energy transfer from lower to higher trophic levels. We have examined sub-lethal effects on early life stages and on adult females.

- The hatchability of the eggs was not affected by concentrations well above realistic environmental levels. However, the instant mortality of the hatched larvae increased with higher concentrations of barium, scale inhibitor and APW, though not with higher radium-226 concentration.
- When examining the long-term growth of the nauplii, we found that the survival was poor in the APW treatment, and in the barium treatment the stage development did not proceed to the same advanced stages as in the control (filtered sea water), the scale inhibitor and the radium treatments.
- Adult females were exposed to radium-226, APW and a mixture of radium-226 and APW at concentrations equal to those in the nauplii growth experiment. Treatments including APW caused a decrease in both feeding and cumulative egg production over the one-week experiment, while no effect was observed for the females in the radium-226 treatment.
- In-depth characterization of potential toxicological mechanisms will be characterized by monitoring the changes in the *Calanus* transcriptome after the different treatments.

### For the Management

Data from ecotoxicology experiments performed on Arctic species is essential for validating the application of the currently used Risk

Assessment Models in Arctic ecosystems, or as input to improve such models. Further, it is essential to include the NORM as a contributing factor when examining the overall risk to the biota living in a multiple stressor environment.

The data are not fully analyzed yet, but when ready they will provide valuable knowledge on the sensitivity of all life stages of *Calanus finmarchicus* to produced water chemicals and on important endpoints on the molecular and the individual level.

#### Published Results/Planned Publications

Abstract from the project is submitted to the ICRER 2014 conference ([www.icrer.org](http://www.icrer.org))

The data from the project will be published as 1-2 manuscripts during 2014

#### Communicated Results

See section above.

#### Interdisciplinary Cooperation

This project involves only natural scientist, but with complimentary fields of expertise which have been necessary for the fulfillment of the project objectives.

#### Budget in accordance to results

The main funding was provided by the Fram Centre.

It is considered highly valuable that small scale projects are funded as this allows for testing of ideas that may not be funded by agencies with requirements for large scale projects only.

#### Could results from the project be subject for any commercial utilization

No

#### Conclusions

Further research on possible effects on petroleum industry discharges in cold water areas are needed. Effects should be evaluated on multiply biological levels and links between end-points at the different levels must be revealed.

This project represents just a small stepping stone on the way to understanding possible effects of produced water discharges on one essential species in a rich ecosystem.