

Polar cod

A key species for environment risk assessment and monitoring of oil and gas activities in the Barents Sea

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Reliable environmental monitoring tools, adapted for the Arctic environment, are required to identify and document potential impacts associated with the expansion of oil and gas (O&G) industrial activities in the Barents Sea. As a consequence of the “zero discharge” policy for the Barents Sea, the main environmental issue of concern is accidental discharges caused by production or transport of petroleum products.

The ice-covered waters of the northern and eastern Barents Sea contain a sensitive, and perhaps vulnerable, flora and fauna due to specialised adaptations to Arctic environmental conditions. However, for many Arctic species, their life-cycles, adaptations and physiological mechanisms are poorly understood, and the knowledge of species' sensitivity to contamination and disturbance is also fragmentary. Therefore, there is a need for data to support environmental risk and impact assessments and to validate monitoring tools on a sentinel Arctic species.

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The polar cod (*Boreogadus saida*) lying between ice sheets.

The polar cod (*Boreogadus saida*) in the Barents Sea is the only fish whose life-cycle is closely associated with the ice-edge ecosystem. The polar cod stock was estimated to be as large as two million tonnes in the Barents Sea in 2001. Based on its importance as a forage species in the Arctic marine food web, the polar cod is considered an ecological key species, transferring energy from lower trophic levels to top predators such as birds, fish, seals and whales. Because of its high abundance and distribution in icy waters, this fish is potentially of great importance for monitoring the effects of pollution in the Arctic marine food web and the sea-ice environment.

Based on the importance of polar cod in the Arctic marine ecosystem and its potential for monitoring effects of pollution, ConocoPhillips funded a three-year research project (2006-2009), including a PhD student, to carry out some fundamental biology and ecotoxicological studies to identify biological responses of polar cod to oil exposure. The project is led by Akvaplan-niva in close association with the ARCTOS partners:

Norwegian Polar Institute and University of Tromsø. The Norwegian Institute for Water Research and IRIS-Akvamiljø will also contribute significantly to the project. Foreign partners include the National Oceanic and Atmospheric Administration (Auke Bay, Juneau, Alaska), the Institute of Biology at the Karelian Research Center (Russian Academy of Science), the Murmansk Marine Biological Institute (Russia), and the research group of GEMA (UMR 5805 EPOC, CNRS and Bordeaux 1 University) located in the Marine Station of Arcachon.

The project will evaluate a suite of biomarkers validated with Atlantic cod (*Gadus morhua*) for biomonitoring of O&G activities in the North Sea. Short (one-week) and long-term (minimum of one month) exposure to crude oil will be considered. These techniques would bring information on the health status of the fish following acute and chronic exposure to polluted conditions. The methods yielding the best information can subsequently be used for monitoring the impact of an oil spill on marine fauna. These include well-established methods, such as bile metabolites, EROD (ethoxy-



The live fish-box employed for catching polar cod in Kongsfjorden at 300m depth.

resorufin O-deethylation) activity, histopathology, DNA adducts, DNA micro-array, vitellogenin and a method optimisation on frozen samples, the comet assay. Uptake, depuration rates and bioaccumulation factors will also be measured. We will look at gene expression, protein quantification and enzyme activities (i.e. cytochrome P450). Furthermore, we will investigate the antifreeze biological properties and the metabolic functions of the polar cod in relation to seasonal variation. The differences in the biological responses to crude oil of adult polar cod and Atlantic cod will be investigated based on knowledge of the physiological differences between Arctic and temperate latitude species (e.g. antifreeze molecules in the blood, kidney function, higher lipid content). These differences can lead to increased time of exposure to toxic molecules. This raises the question of sensitivity of this Arctic species to oil contamination and the potential difficulty in using data produced with temperate organisms in an Arctic context.

Polar cod have been obtained by trawling in Kongsfjorden using a live fish-box (fish lift) in April and September 2006. The fish were subsequently transferred to holding facilities at the Arctic Marine laboratory in Ny-Ålesund, Svalbard, where they were maintained in good condition for acclimatisation prior to experiments. This approach will reduce the stress to the fish from handling during the exposure experiments. The first exposure study will be performed in the beginning of November 2006.

At the end of the project, we will provide an assessment of the long-term impact of oil and the sensitivity of the polar cod. A tool-box for biomonitoring purposes will also be established. These data will help support the development of appropriate risk-management systems applicable in cold-water environments, especially the Barents Sea.

• For further information, see the website <http://polarcod.akvaplan.com/>.

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