

# BioSea JIP - Development of a Global Biomonitoring Tool for the Offshore Petroleum Industry

## Phase I - completed

*The biomarker approach, analogous to human health diagnostics, has been adopted to monitor biological effects in marine organisms. A major objective of the BioSea programme has been the continued development of biomarker knowledge and its transfer from temperate to cold/arctic areas.*

In this three-year project a number of selected biomarkers were evaluated following long term exposures at Akvamiljø. Exposures mimicking produced water were carried out using dispersed crude oils from the Statfjord and Goliat fields. Field validations of most of these biomarkers were performed within Arctic and temperate areas and background levels were established for these regions.

### And for fish:

- Biliary PAH metabolites
- DNA adducts
- Micronuclei assay
- VTG/ZRP

Methods suggested for further evaluation (in fish) are: Cyp 1a and GST

Two promising new biomarkers (under development) are: Biliary Alkyl Phenol metabolites and Gill EROD assay

The above biomarkers will serve as early warning signals for a range of potentially harmful effects in the environment. In many of the BioSea laboratory studies reproduction and survival effects were measured in the test species in addition to the biomarkers, enhancing the basis for a more thorough interpretation of the different biomarker signals in

relation to produced water exposures. Handbooks supporting the methods used, including descriptions of both sampling and analytical techniques, have been produced. Thus the biomarker approach can be considered as operative and globally applicable, provided

that the methods described above are calibrated with local species.

The BioSea JIP phase I was financed by Eni Norge AS and Total E&P Norge AS. Our aim is to follow-up this activity in 2006 with a second phase with greater emphasis on the Arctic environment.

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### Arctic species



Photo by: Endre Aas



Photo by: Thierry Baussant

### Main test species

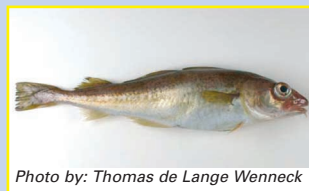


Photo by: Thomas de Lange Wenneck



Photo by: Thomas de Lange Wenneck



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Based on the results obtained, a common set of biomarker methods, using both invertebrates and fish, relevant for biomonitoring produced water in the North Sea and the Barents Sea has been produced.

### The suite of biomarkers recommended for use in invertebrates includes:

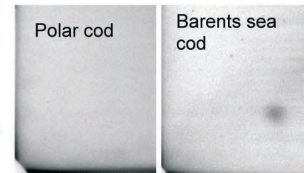
- Lysosomal membrane stability
- Comet assay or the Alkaline Unwinding assay (in shrimp)
- Catalase (in scallop)

# Field Measurements of Biomarkers

(Data & Figs.: R. Sundt, J. F. Børseth et.al.)

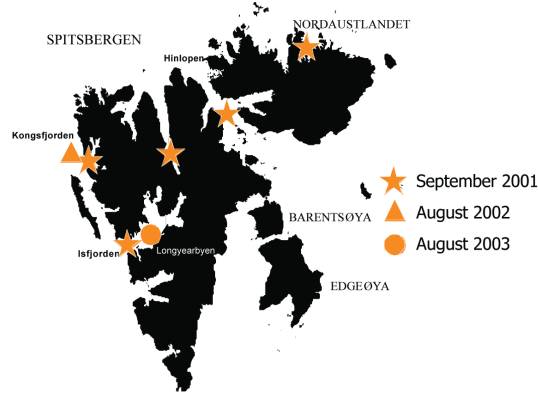
## Background biomarker field levels

Example:  
DNA adducts in fish

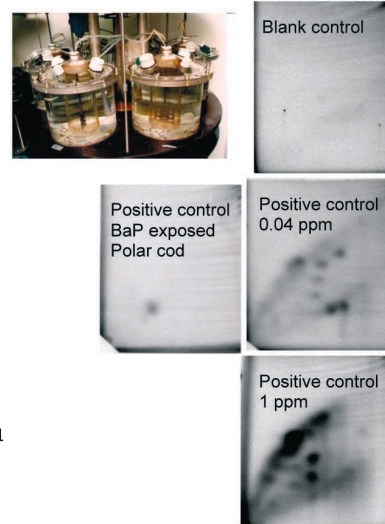


### Emphasis on Arctic

- at present less influenced by oil and gas industry.
- strong seasonal variations.
- cod, polar cod, haddock, Icelandic scallop, northern shrimp, ice shrimp, crab and sea urchin sampled from Arctic areas (Spitsbergen and Barents Sea).



Above: Field measured levels  
Below: Control exposures in laboratory

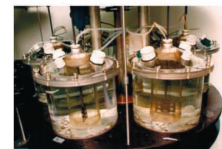


DNA analysis by L. Balk (ITM, Stockholm)

# Laboratory Measurements of Biomarkers

(Data & Figs.: A. Skadsheim et.al., 2005)

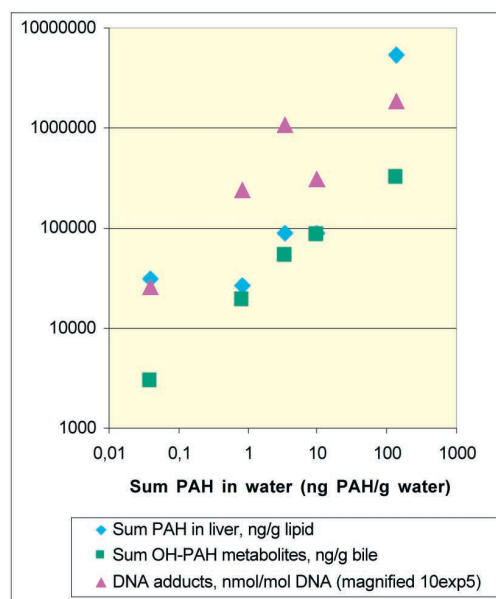
## Dose : response



Example:

PAH uptake, biotransformation and DNA adducts formation in fish

- Cod exposed to a mimicked produced water (dispersed crude oil).
  - Uptake of PAH shown as liver tissue concentration.
  - Biotransformation shown as hydroxylated PAH metabolites in bile.
  - Biological effect signal shown as DNA adducts in cod liver
  - Fish sampled after 24 days of exposure.
  - In this case, clear dose-response relationships between exposure, dose and biomarker signals.



DNA analysis by L. Balk (ITM, Stockholm)