

assessing the impact of effluents from offshore activities by their biological effects – local and regional scales

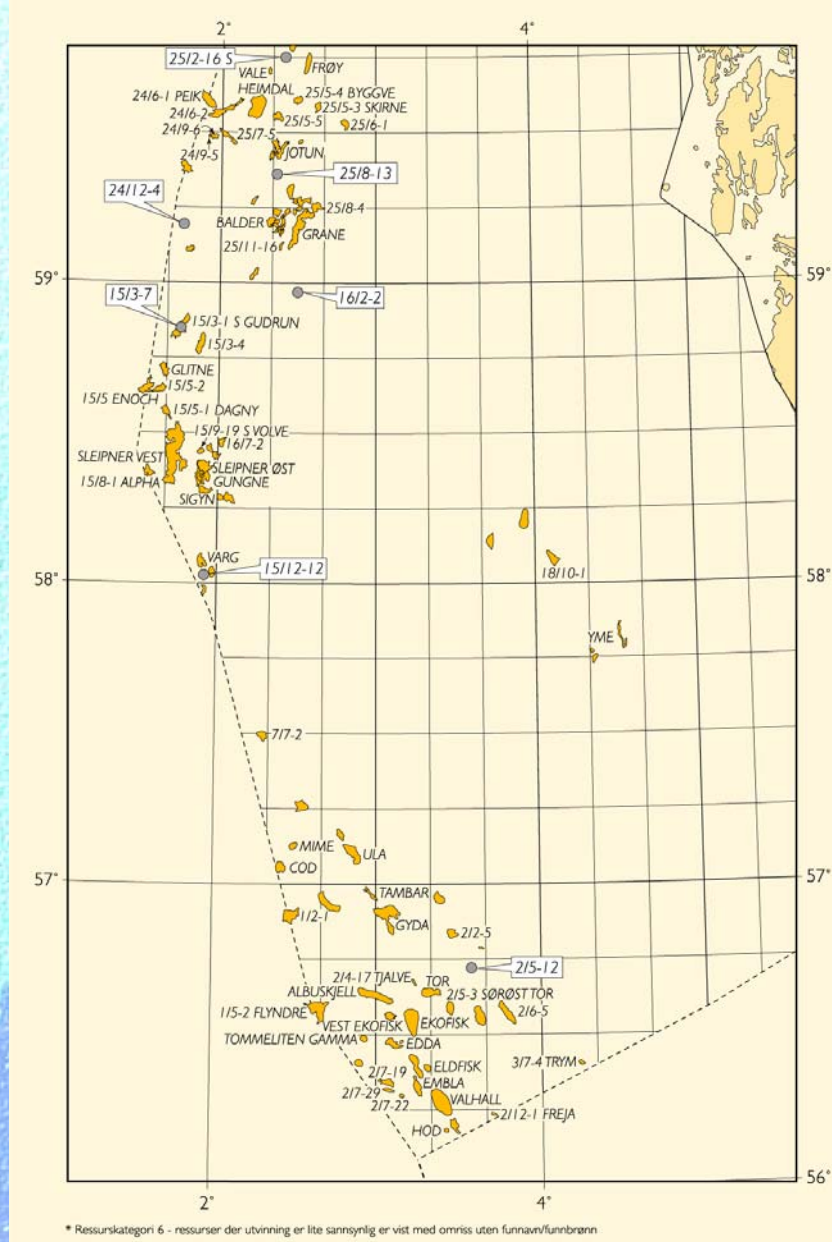
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the issue

- major inputs of chemicals from offshore activities
 - drilling
 - production
- impacts virtually the entire North Sea to some extent
- ecological impacts not really established
- laboratory data suggest effects, but at levels higher than those generally found
- how can we assess the risk of produced water effluents?



risk assessment

- inputs from many sources need to be considered
 - adjacent production areas
 - drilling in relation to production
 - chemicals change over time
- risk assessment by way of models (DREAM)
 - exposure (3-D model using real-time data)
 - effect (PNECs derived from laboratory tests)
- assessment of biological effects in the field - validation of model or contributions to risk assessment?

effects in the water column

- complementary approaches
 - *in situ* extracts can be tested for mechanisms of toxicity
 - caging provides direct link to local exposure
 - field sampling provides ecological relevance
- which effect methods?
 - identifiable threshold or dose-response level(s)
 - methods should be used in combination
 - quality assurance of methods is essential
- which species/systems?
 - there are no "universal" species, even in a limited area such as the North Sea
 - unresolved problems for the use of fish (migration, exposure)
 - have to be able to separate zooplankton species during sampling

approach	pro's	con's
field sampling	ecological relevance	difficult to assess area integrated (but large); high natural variability (needs large sample numbers)
caging	reflects local exposure (history); can use organisms with desirable properties (e.g. blue mussel and fish)	"semi-natural" exposure situation; food availability unknown; limited to selected species (relevance in relation to local species); exposure at one point (does not integrate over larger area)
<i>in situ</i> extracts/bioassays (can be extended to TIE*)	identify specific mechanisms and substances; sensitive and reproducible; possible to test systems not otherwise included (e.g. early lifes stages in fish)	not possible to extrapolate directly to ecological impact

activities

- WCM 1999-2000
 - caging (passive samplers, blue mussels)
- DREAM development
- BECPELAG
 - field-collection
 - caging
 - extracts
 - modelling
- WCM 2003
 - caging (cod, blue mussels)
 - few locations
- regional monitoring 2002-2003
 - field-collection
 - haddock, saithe, cod, pelagic species
 - a range of endpoints

activities

- WCM 1999-2000
 - caging (passive samplers, blue mussels)
- DREAM development
- BECPELAG
 - field-collection, caging, extracts, modelling
 - many methods
- WCM 2003
 - caging (cod, blue mussels)
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 - histopathology and biomarkers
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indications that there may be effects - BECPELAG

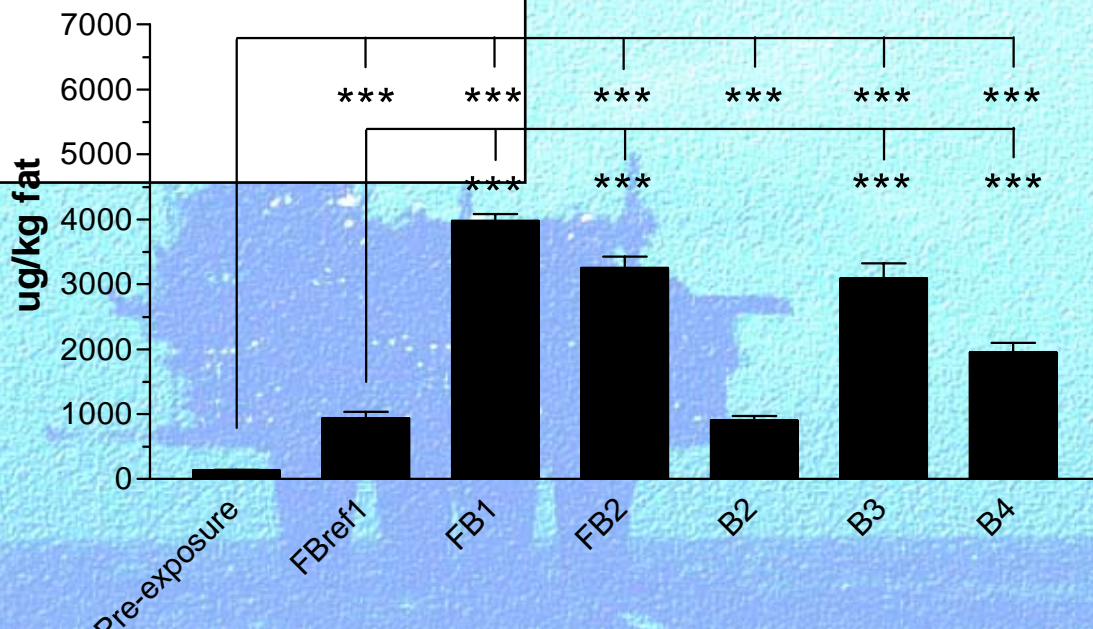
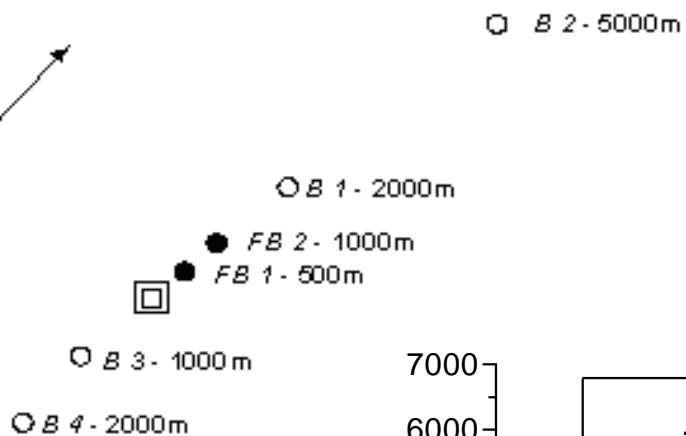
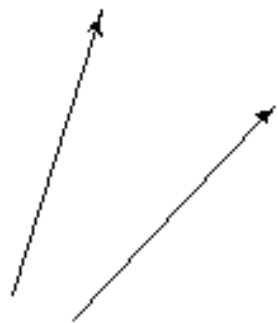
- gradient for PAH exposure away from platforms – predominantly 2-/3-ring
- clear responses in caged blue mussels
- histopathological changes in both caged and field-collected fish; no obvious effects for biomarkers
- more responses in caged organisms (cod, blue mussel) than in field-collected organisms
- limited responses in bioassays of SPMD extracts

the follow-up: WCM 2003

- Troll field
- caged blue mussels, cod
- blue mussels
 - PAH
 - histopathology
 - BaPH
 - lysosomal stability (on board)
- cod
 - PAH-metabolites
 - histopathology
 - vtg
 - EROD
 - GST

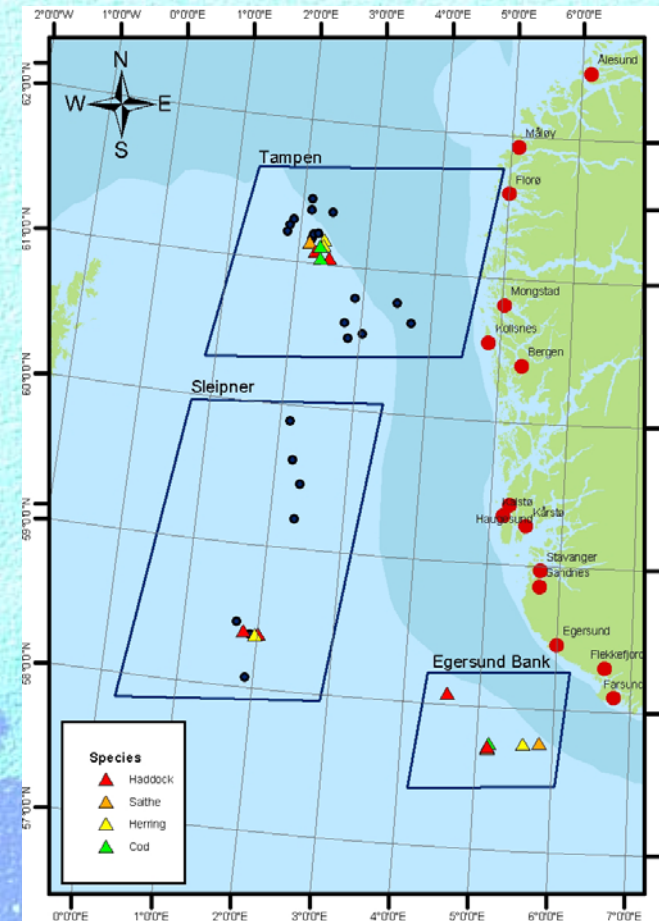
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- Troll B
- blue mussel
- cod & blue mussel



regional studies: what is this?

- different fish species sampled in three areas:
 - Tampen (high input)
 - Sleipner (low input)
 - Egersund banken (reference)
- haddock, saithe, cod, herring, ++
- endpoints included
 - alkylphenols and PAHs in muscle and liver
 - PAH metabolites in bile
 - a range of biomarkers including phase-I, phase-II enzymes, antioxidant enzymes and DNA adducts
 - lipid composition of muscle
- results indicated
 - differences between areas with regard to:
 - some PAH metabolites
 - phase-I enzymes, antioxidant responses
 - lipid composition
 - DNA adducts



risk assessment?

- risk assessment models predict effects near platforms, but not in larger areas
- have we detected all ecologically relevant impacts?
- which options are available?
 - revise model with new data
 - combined modelling and field measurements
 - rely more heavily on field measurements (needs larger resources)

summary and the future

- risk assessment models are probably not sufficiently predictive of environmental impacts from produced water inputs
- it is difficult to separate impacts from specific activities (drilling, production) or effluents from different production areas
- a link should be established between the risk assessment models and field data ("validation")
- a large-scale "inventory" of possible effects in the North Sea from offshore activities is needed (research on ecologically relevant endpoints)

acknowledgements

participants, crews and the steering group of the
BECPELAG workshop

colleagues at NIVA (Knut-Erik Tollefsen) and
Rogaland Research (Jan Fredrik Børseth)
involved in the 2003 WCM programme

project collaborators on the regional monitoring
programme: Lennart Balk, Marc Berntssen,
Jonny Beyer, Alf Melby

the Research Council of Norway, OLF and
Norwegian oil companies for funding