The Norwegian Grenland fjord dioxin story
-sediment remedial options and consequences

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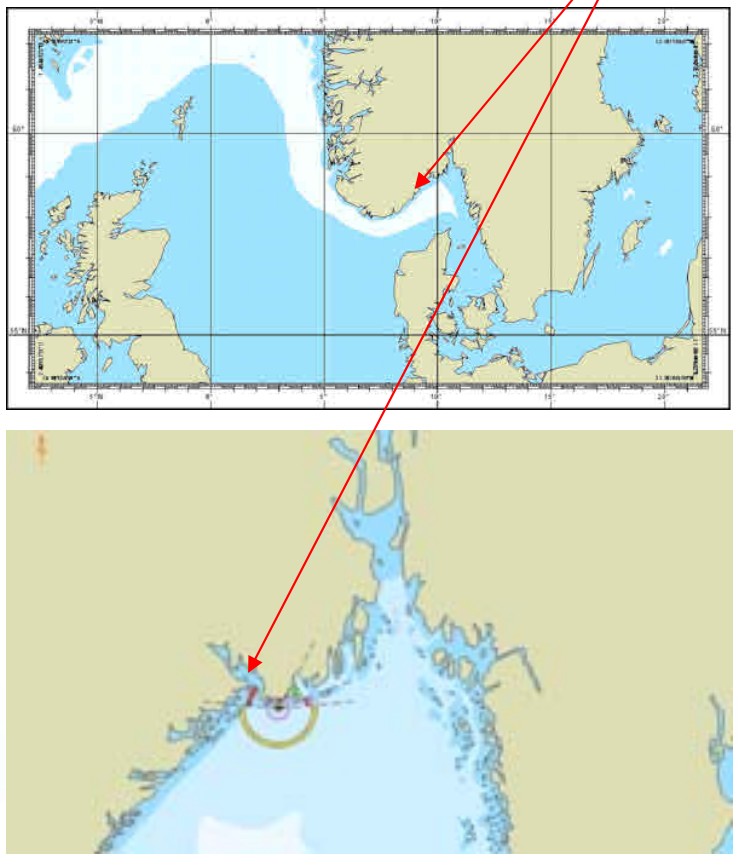
Problem

In 1951 Norsk Hydro started production of magnesium at Herøya in the inner part of the Grenlands fjords. In the production process dioxins/furans and other chlorinated compounds were formed as biproducts during chlorination of magnesium oxide to give water free magnesium chloride

Presentation outline

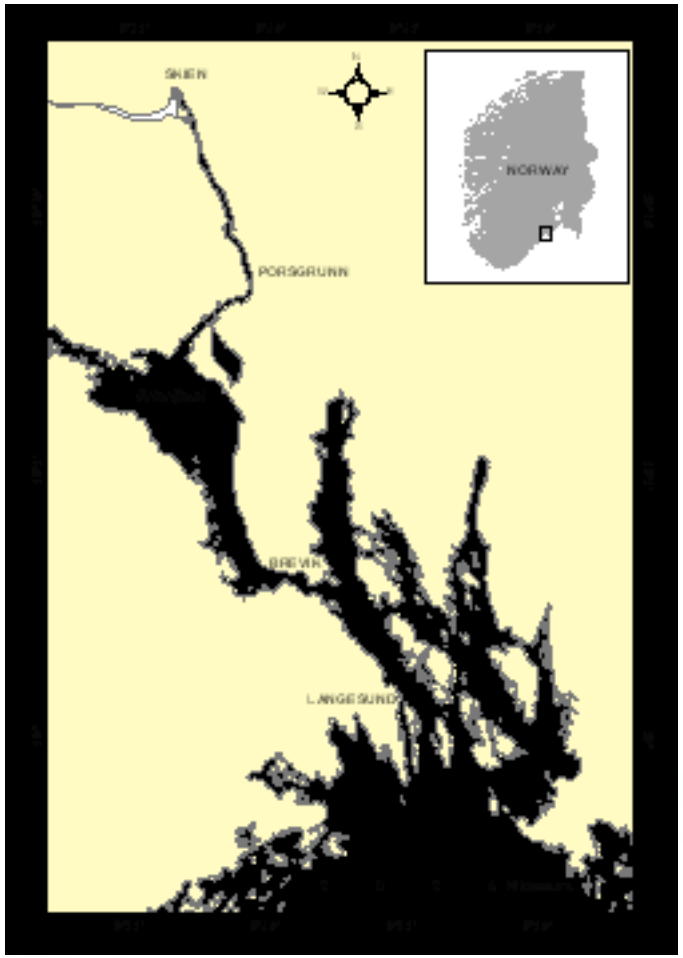
- Problem overview
- Scientific approach
- Problem owner/stake-holder communication
- Reaching the final decision on remedial options

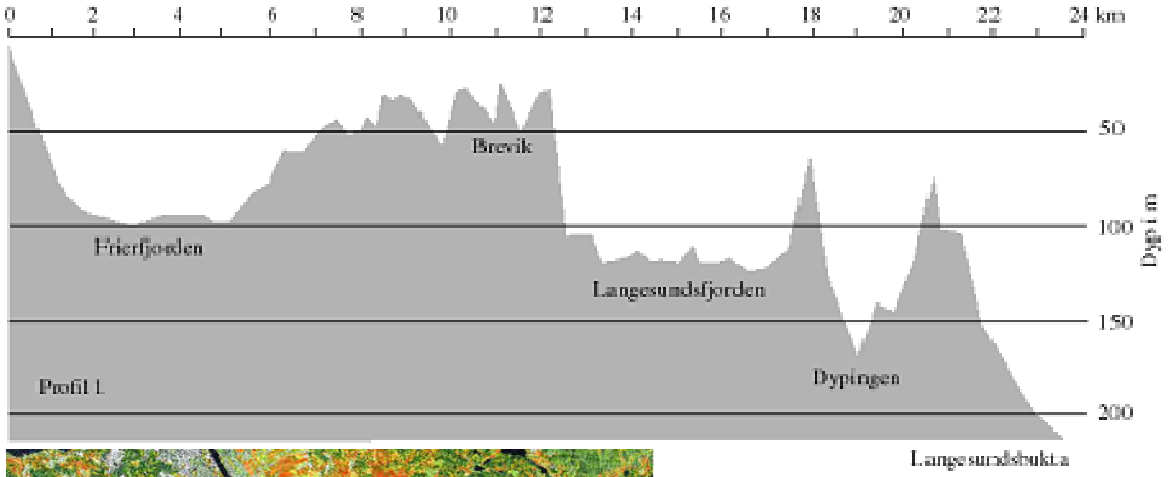
The Grenland fjords and the dioxin problem

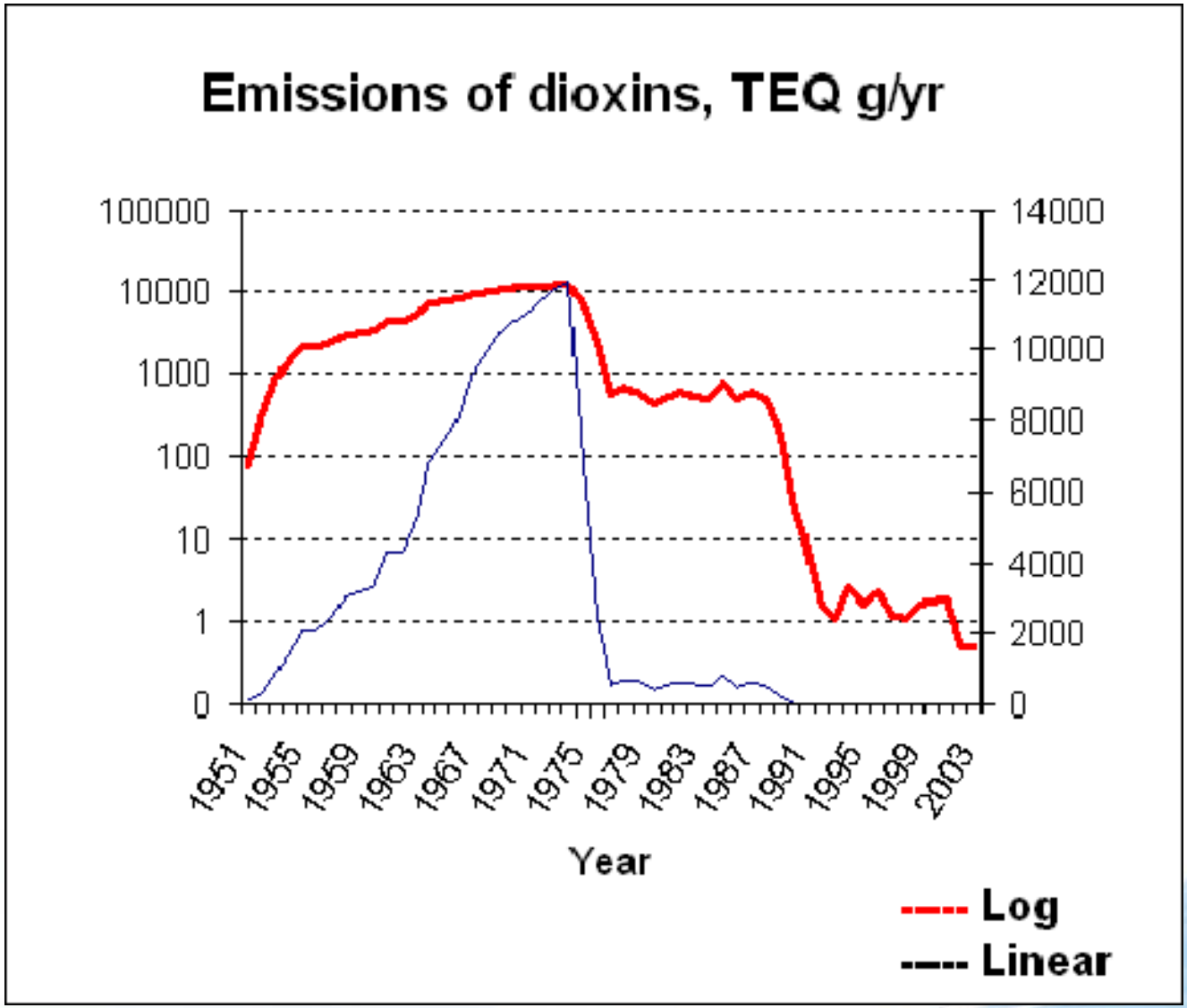


Mg plant a major dioxin point source 1951-2002

The Grenland fjords



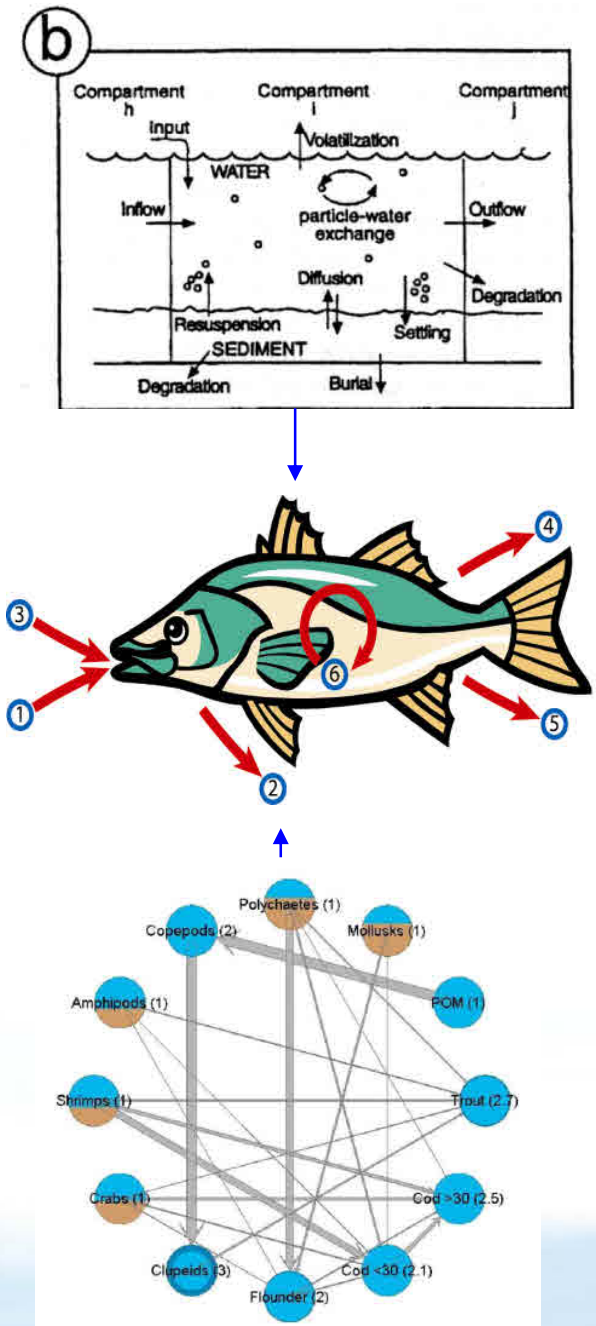



Emissions of dioxins, TEQ g/yr
100000
10000
1000
100
10
1
0
14000
12000
10000
8000
6000
4000
2000
0
1951
1955
1959
1963
1967
1971
1975
1979
1983
1987
1991
1995
1999
2003
Year
Log
Linear

The Grenland fjords dioxin vision

- Objectives in 1990 expressed by the Minister of Environment:
  - *Within year 2000 there should be no restrictions due to dioxins on consumption of sea food caught in the area*
- 2008
  - *Still restrictions*

Main questions:
•How important is the contaminated sediments?
•How will it change with time?
•What can we do and how should we do it?

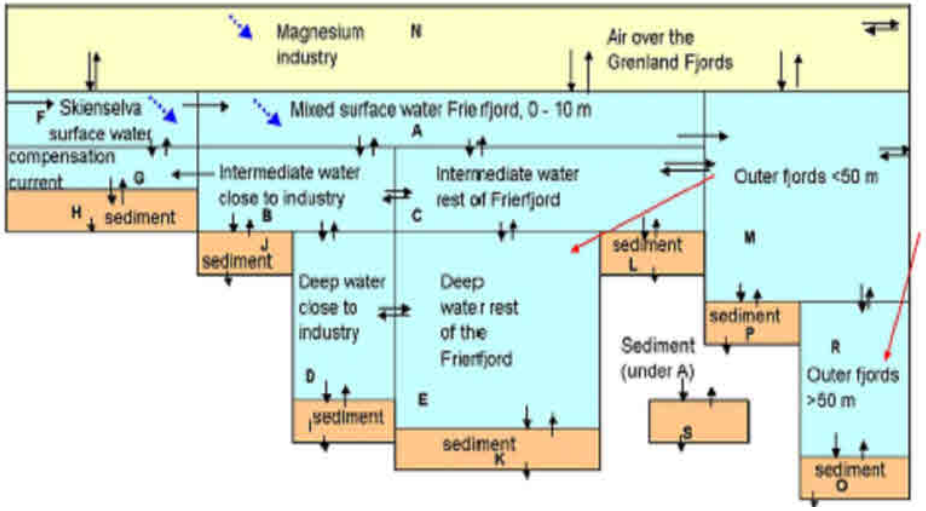


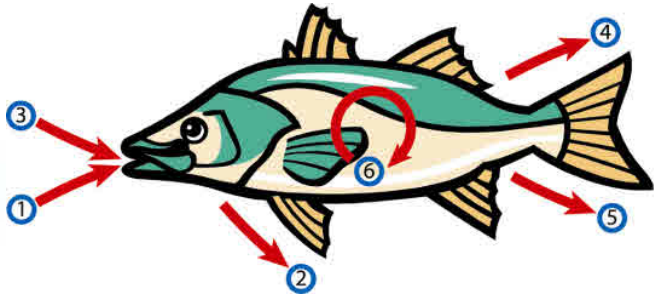
Target organisms in focus

Linking the abiotic and biotic environment:

>Render possible to assess the effect of sediment remedial actions on target organisms and thereby promote an integrated and holistic management appoach

Model development



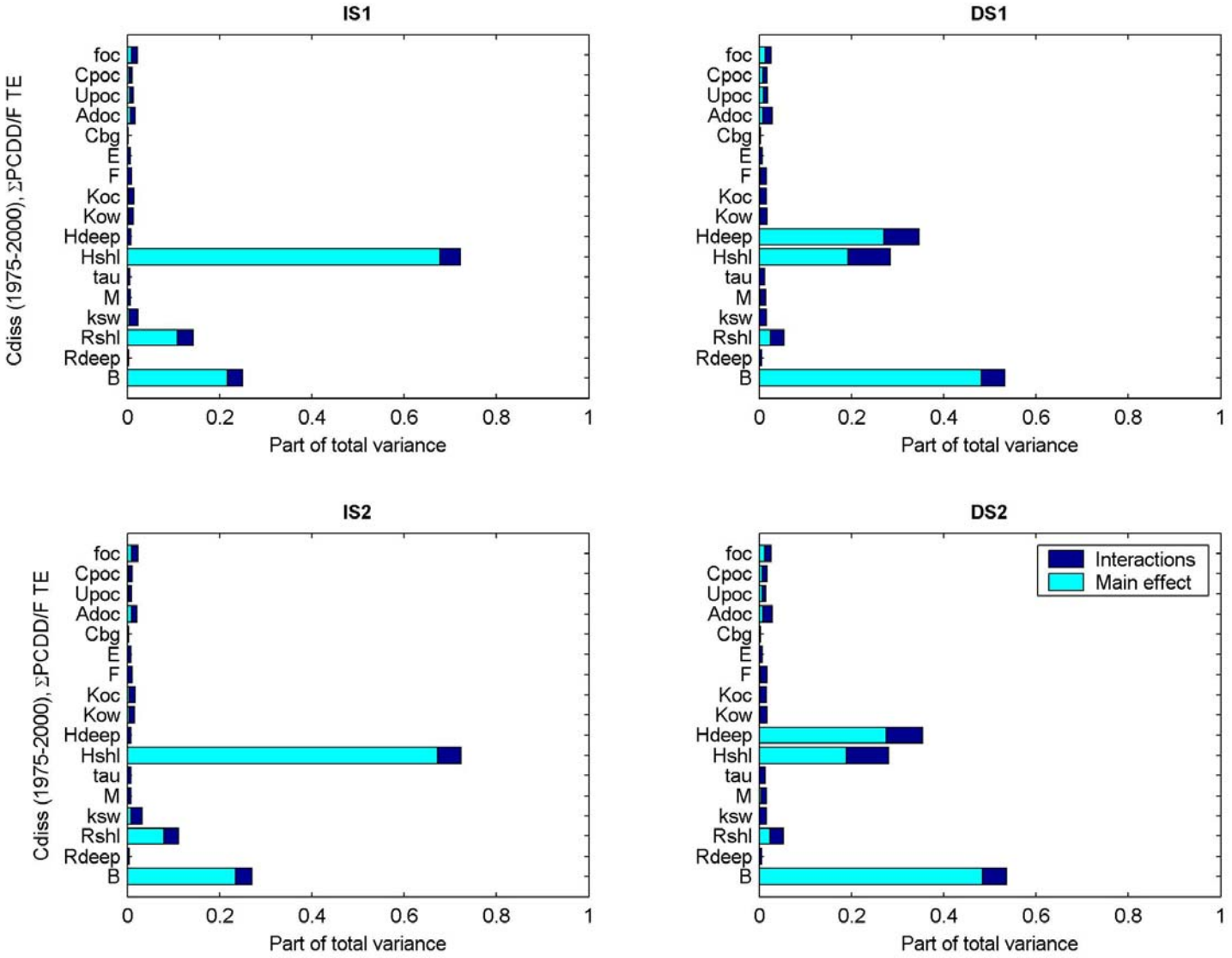


1. Uptake from water
2. Release to water
3. Uptake from food
4. Metabolic decay
5. Egestion/defecation
6. Growth dilution

Fugacity box model for simulating sources, sinks and transports (Persson et al., Sci. Total Environ., 2006)

Bioaccumulation rate constant model for simulating intake and accumulation in the food web (Saloranta et al., ETC, 2005)

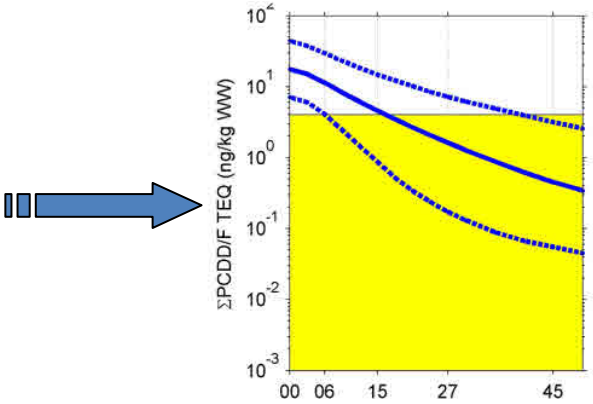
Sensitivity analysis



Uncertainty analyses

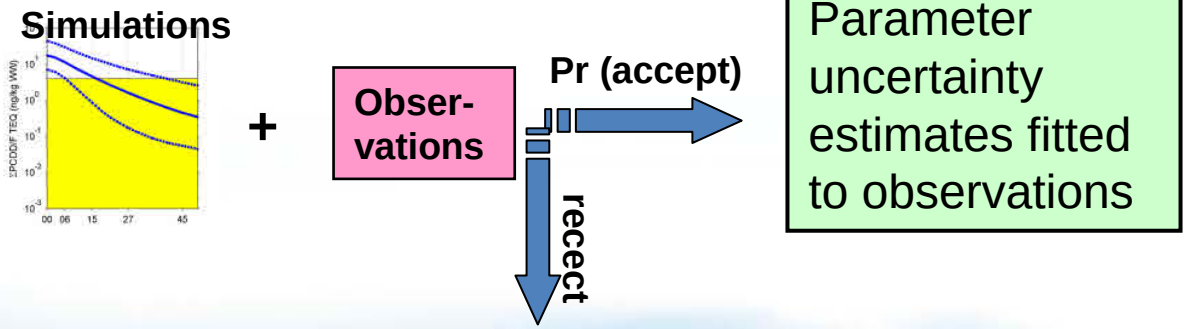
Previous uncertainty analysis (Monte Carlo):

Parameter uncertainty estimates based on data or experts



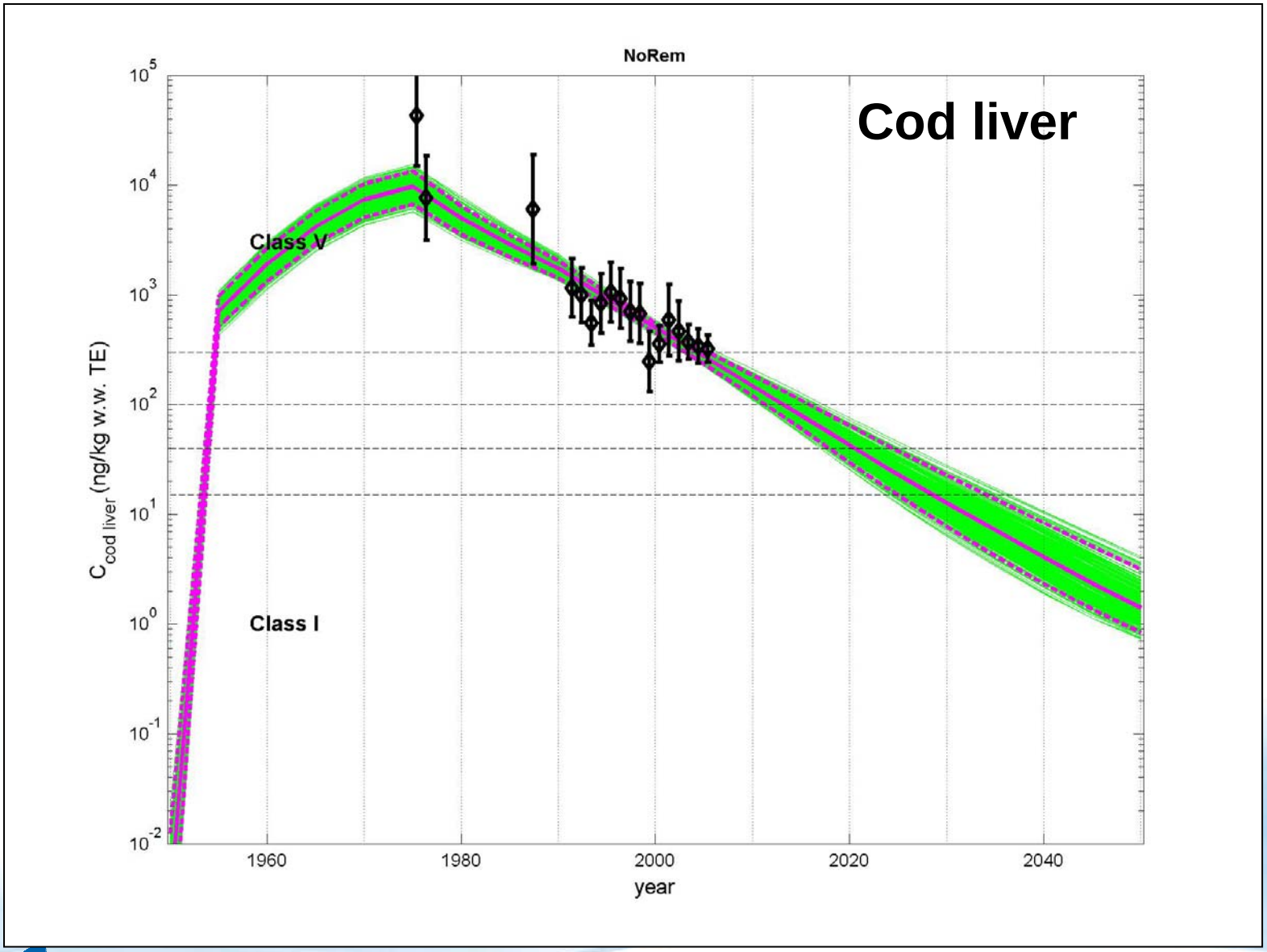
- some simulation results from the uncertainty analysis may not correspond well to observations.

Current uncertainty analysis (Markov Chain Monte Carlo):

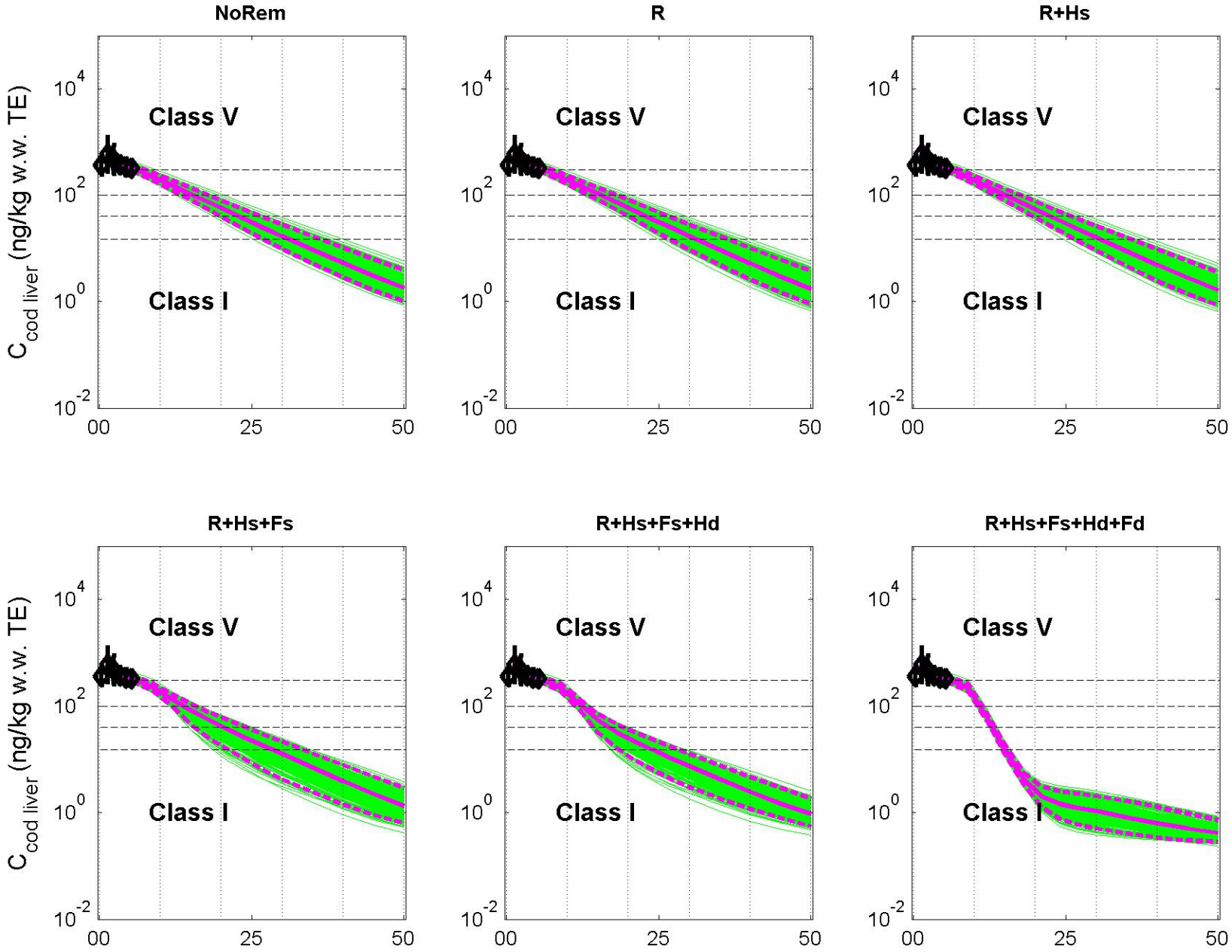


- gives both a model calibration and an uncertainty analysis consistent with observations.

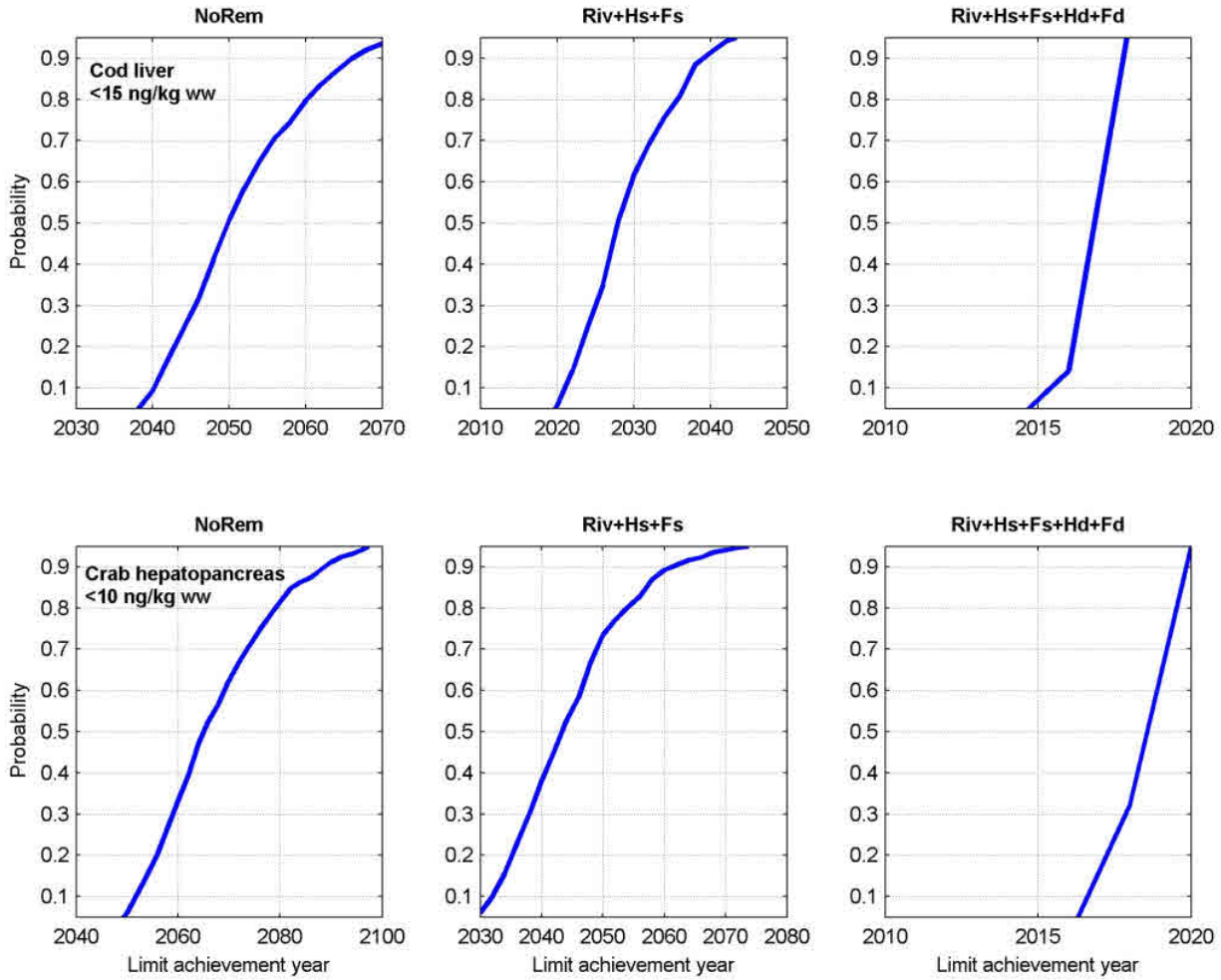
MCMC calibrated model



Simulated effects of remedial actions



Probability of achieving benchmark value



Conclusions, so far

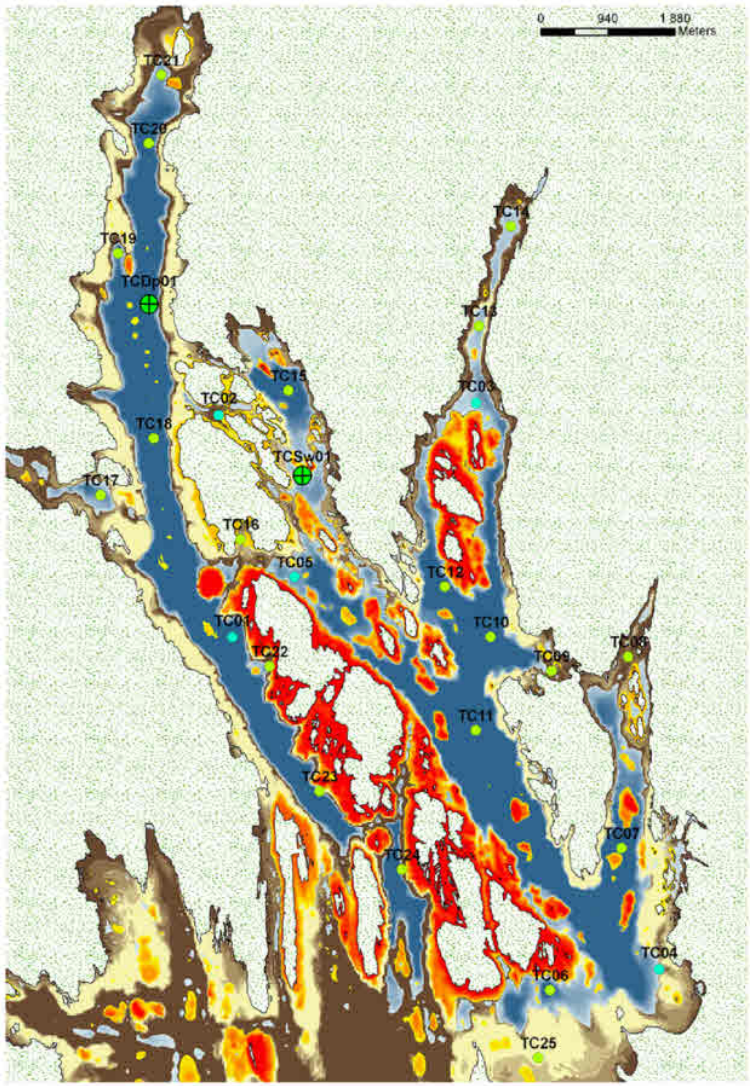
- The model is now used as a management support tool for exploring effects of remedial options against the contaminated sediments in the Grenland fjords
- The model code has been applied on similar issues in other aquatic environments
- The model is consistent with scientific theory
- Model prediction uncertainty is reported

Conclutions cont.

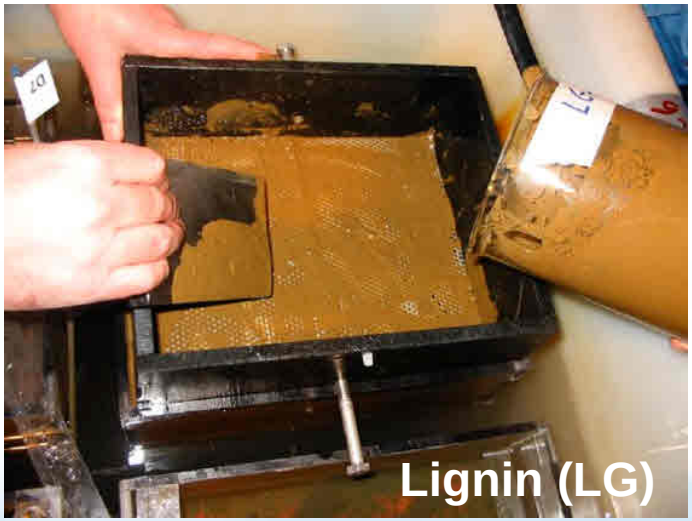
- The model is appropriate to the complexity of the situation
- The model is consistent with the amount of data available
- The model results are credible to stakeholders
- The model has given important insight in contaminant processes

Present activity: The ”Thinc project” – thin layer capping

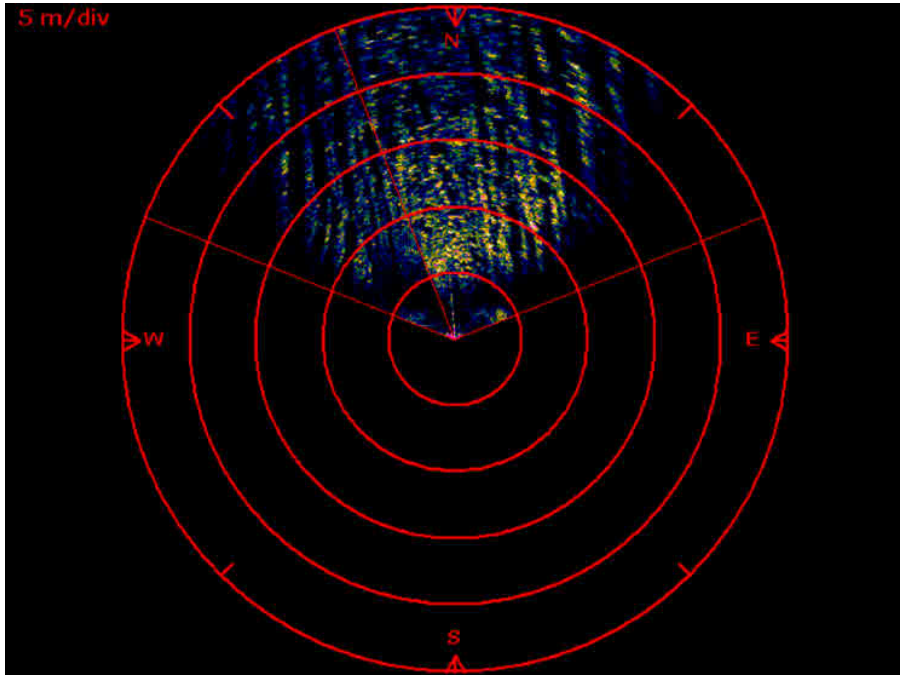
- Testing of cap materials
- Mesocosm experiments- benthic ecology concequences
- Habitat modelling
- Concequences of trawling activity
- Pilot capping study
- Uncertainty communication



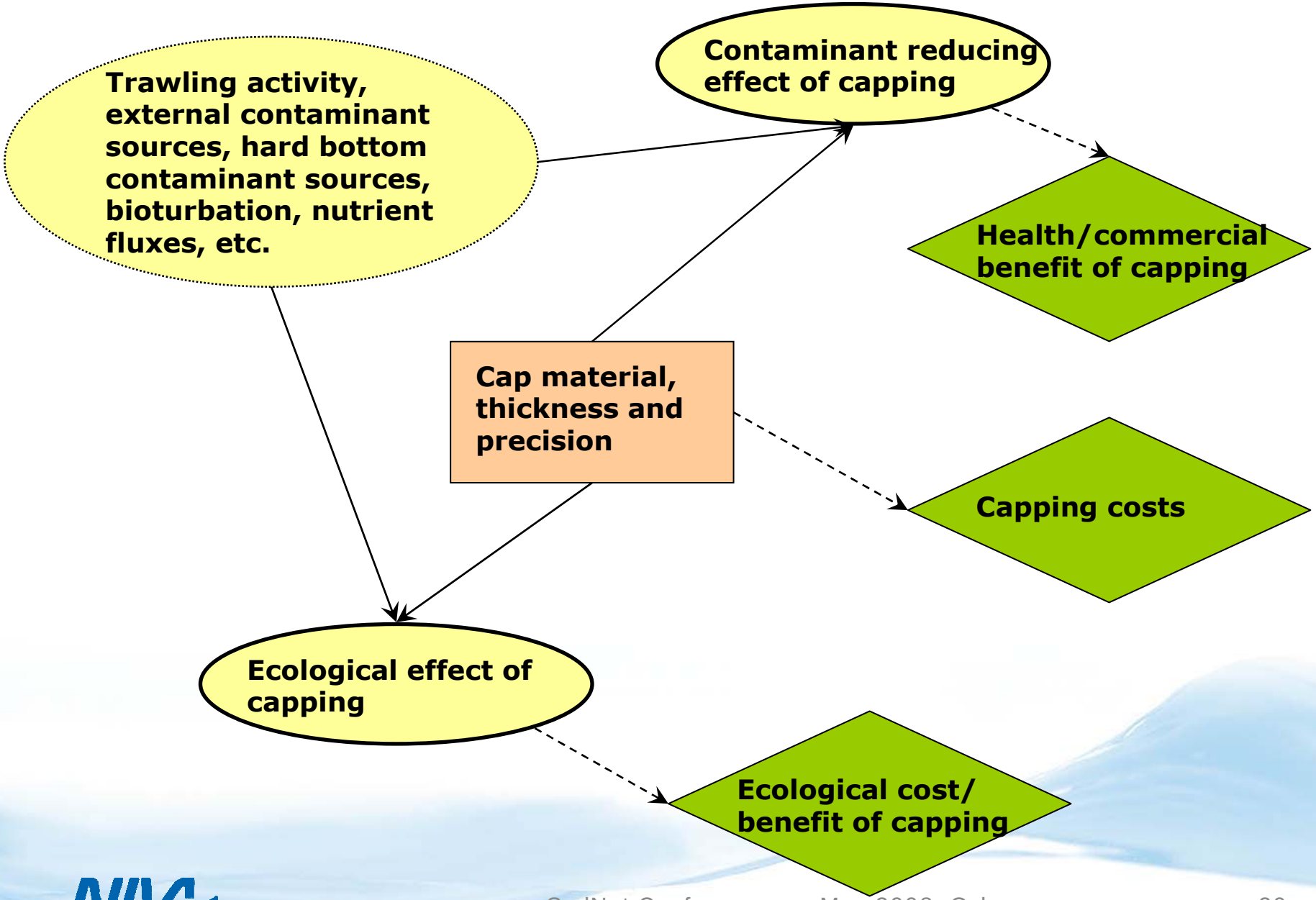
Cap testing



Sediment disturbance – trawling and bioturbation



Causal probability network (Bayesian network)



2010: Reaching the final decision. -And then at the end...

Thank you for your attention!