GOHERR: Integrated governance of Baltic herring and salmon stocks involving stakeholders

Sakari Kuikka

Head of Fisheries and Environmental Management group (FEM), Department of Environmental Sciences, University of Helsinki, Finland, Email: sakari.kuikka@helsinki.fi

STECF member (EU main advisory body)

ICES WGMABS: oil disaster management in Baltic Sea

Focal point of International Ocean Institute in Finland

FEM group at the University of Helsinki

- 2 professors, 4 senior scientists, 2 postdoctoral researchers, 7 postgraduate researchers
- Research interests:
  - Applications in fisheries and oil spill risk analysis
  - Decision analysis of renewable resources
  - Integrating different sources of data and knowledge: Bayesian analysis
  - Identification and quantification of risks in the use of natural resources
  - Management of natural resources in the face of risks and uncertainty in the information

=> User of information in an essential role

www.helsinki.fi/science/fem/index.html

There are multiple uses for sea and archipelago areas:

1) Transportation
2) Fisheries (mosaic of islands provides good reproduction areas)
3) Recreationa use
4) Environment of 70 IUCN classified threatened species

Outline of the talk

1) FEM group research on environmental risks: oil disasters

2) Why Bayesian inference?

3) Aims of BONUS and GOHERR: to learn and communicate risks

4) Concluding slides

Published papers on oil spills I

Klemola, E., Kuronen, J., Kalli, J., Arola, T., Hänninen, M., Lehikoinen, A., Kuikka, S., Kujala, P. and Tapaninen, U. 2009. A cross-disciplinary approach to minimising the risks of maritime transport in the Gulf of Finland. World Review of Intermodal Transportation Research 2(4): 343–363.

Kokkonen, T., Ihaksi, T., Jolma, A. and Kuikka, S. 2010. Dynamic mapping of nature values to support prioritization of coastal oil combating. Environmental Modelling & Software, 25 (2010) 248–257.

Helle, I., Lecklin, T., Jolma, A. & Kuikka S. 2011. Modeling the effectiveness of oil combating from an ecological perspective - A Bayesian network for the Gulf of Finland; the Baltic Sea. Journal of Hazardous Materials 185(1):182-192.

Lecklin, T., Ryömä, R. and Kuikka, S. 2011. A Bayesian network for analyzing biological acute and long-term impacts of an oil spill in the Gulf of Finland. Marine Pollution Bulletin 62 (2011) 2822-2835.

Ihaksi,T., Kokkonen, T., Helle, I., Jolma, A.,Lecklin, T. and Kuikka, S. 2011. Combining conservation value, vulnerability, and effectiveness of mitigation actions in spatial conservation decisions: an application to coastal oil spill combating. Environmental Management. 47: 802–813.

Published papers on oil spills II

Lehikoinen, A., Luoma, E., Mäntyniemi, S. and Kuikka, S. (2013) **Optimizing the Recovery Efficiency of Finnish Oil Combating Vessels in the Gulf of Finland Using Bayesian Networks**. *Environmental Science and Technology*, 47(4):1792-1799.[Link]

Jolma, A., Lehikoinen, A., Helle, I. and Venesjärvi, R. (2014). **A software system for assessing the spatially distributed ecological risk posed by oil shipping**. *Environmental Modelling & Software*, 61:1-11. [Link]

Jolma, A., Lehikoinen, A., Helle, I. and Venesjärvi, R. (2014). **A software system for assessing the spatially distributed ecological risk posed by oil shipping**. *Environmental Modelling & Software*, 61:1-11. [Link]

Lehikoinen,A., Hänninen, M. Jenni Storgård, Emilia Luoma, Samu Mäntyniemi & Sakari Kuikka. (n print) **A Bayesian network for assessing the collision induced risk of an oil accident in the Gulf of Finland**

Helle, I., Ahtiainen, H., Luoma, E., Hänninen, M., Kuikka, S. Where should we invest in oil spill management? A probabilistic approach for a cost-benefit analysis under uncertainty. *Accepted with minor revisions* .

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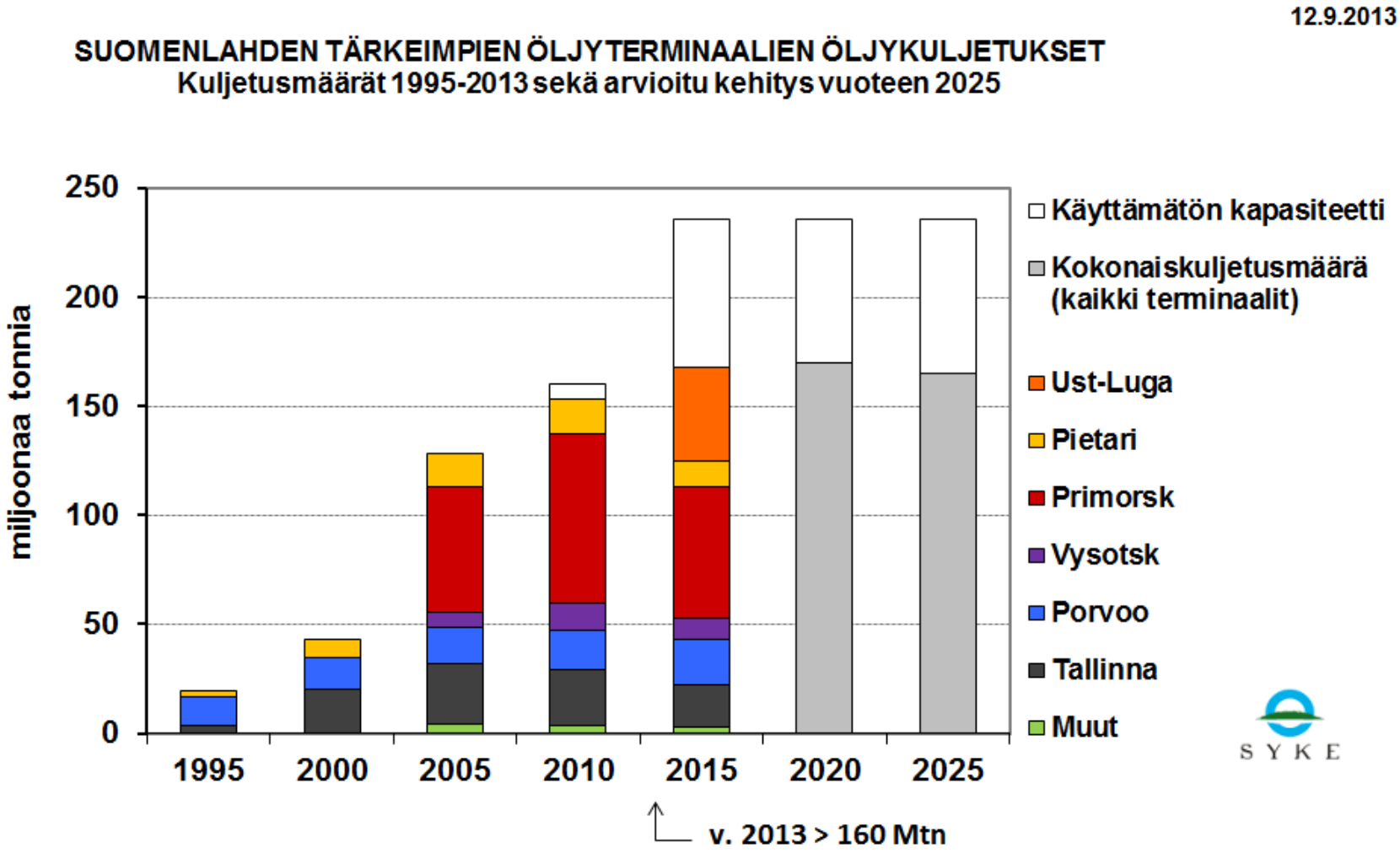
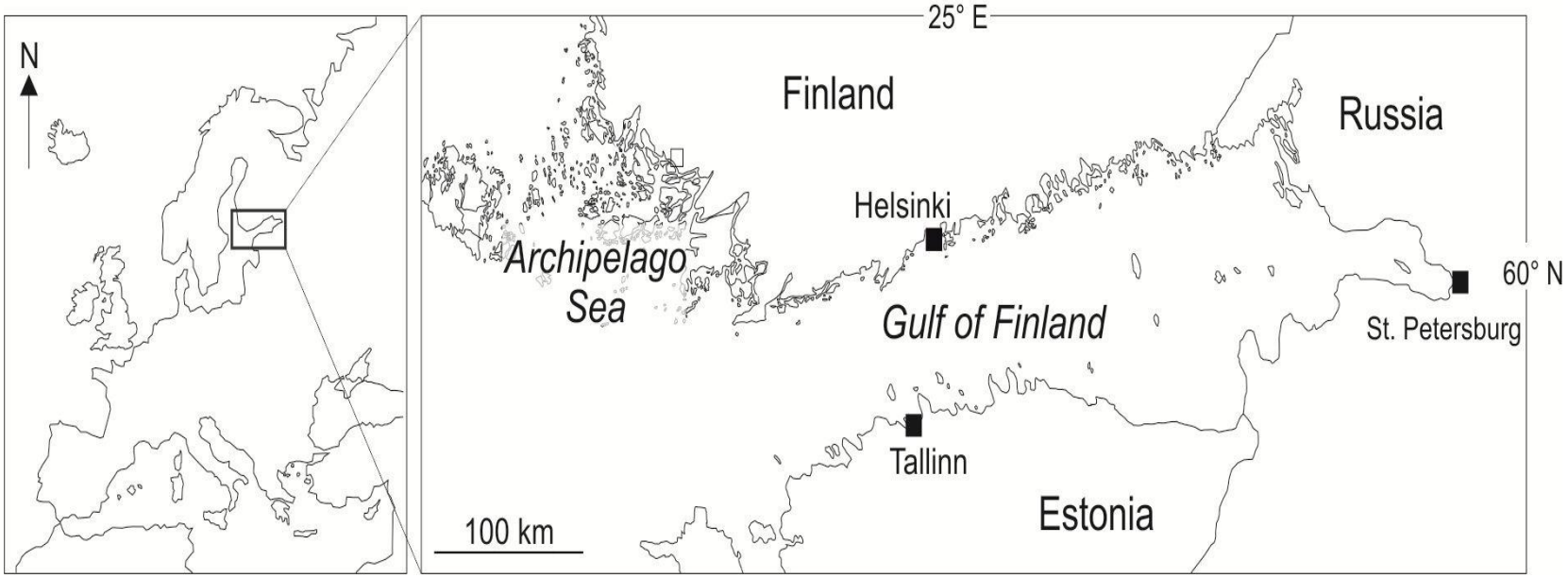
2) Oil spill and basic models:

Oil transportation in the Gulf of Finland



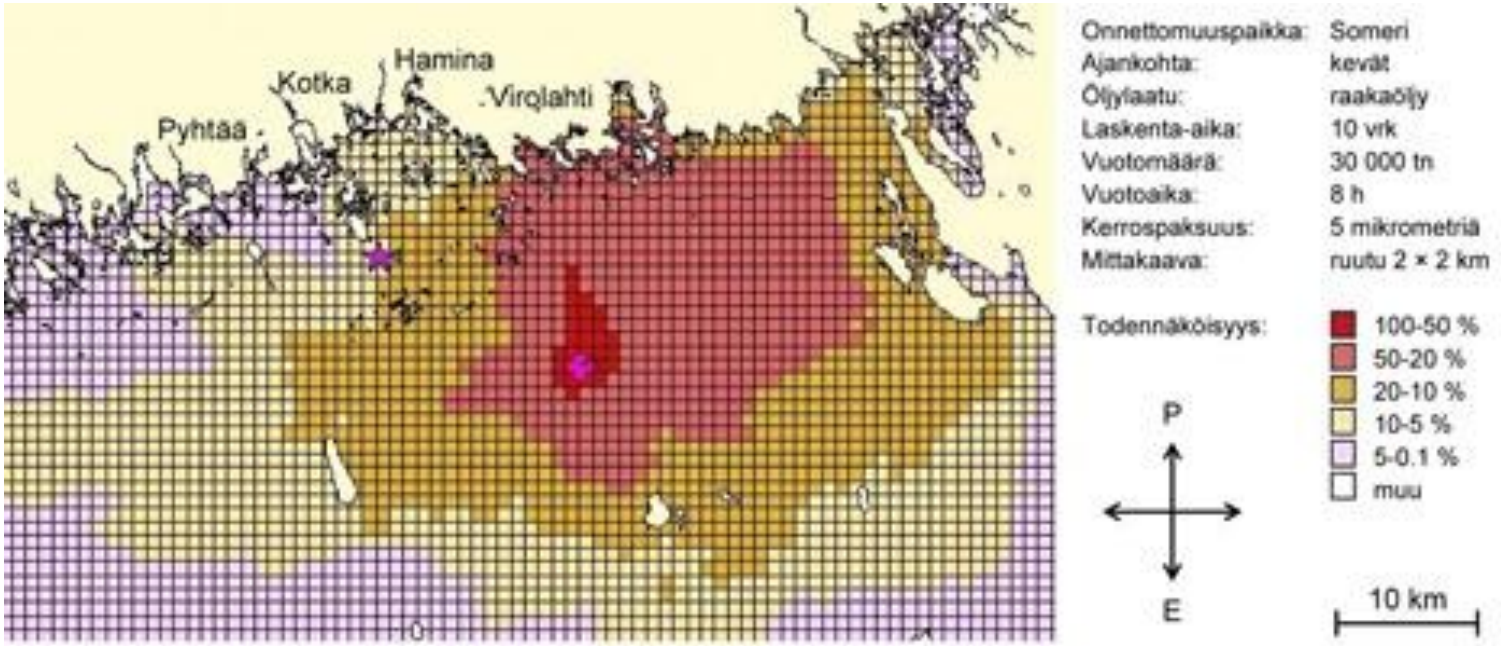
Gulf of Finland

Difficult to navigate, in winter ice covered



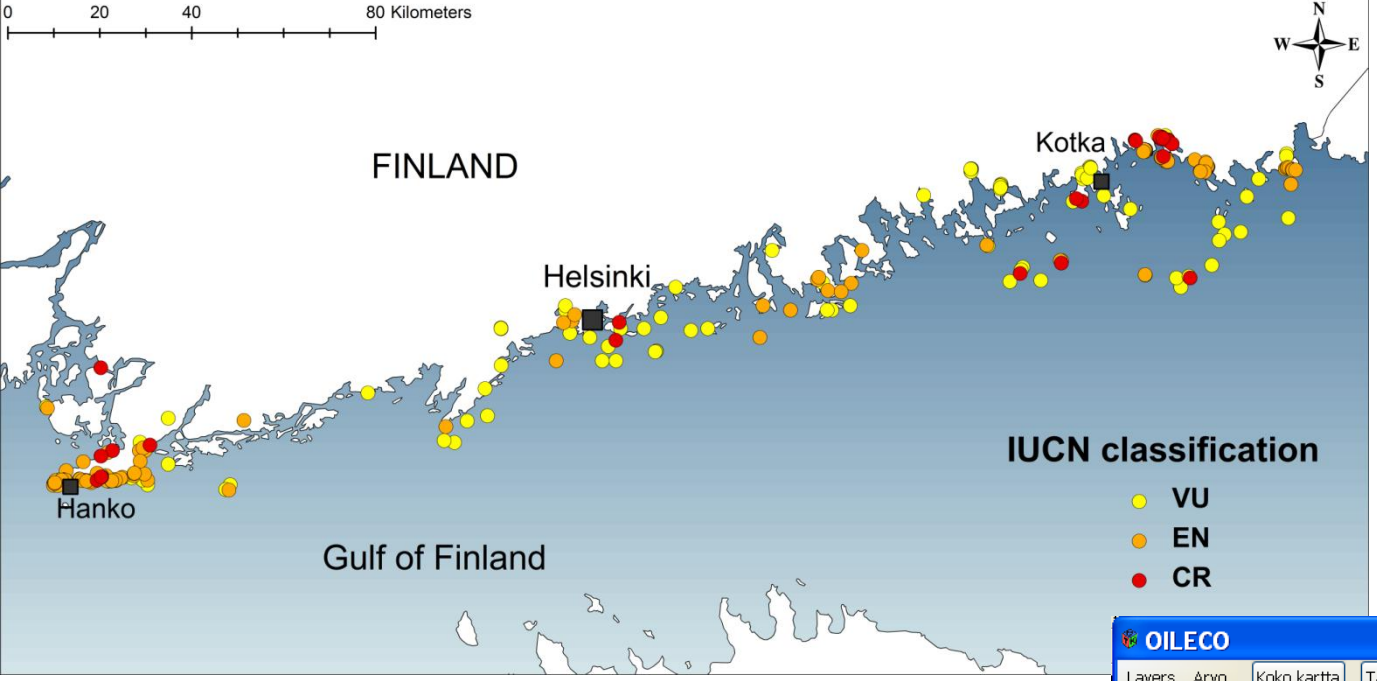
Surroundings countries are in different positions

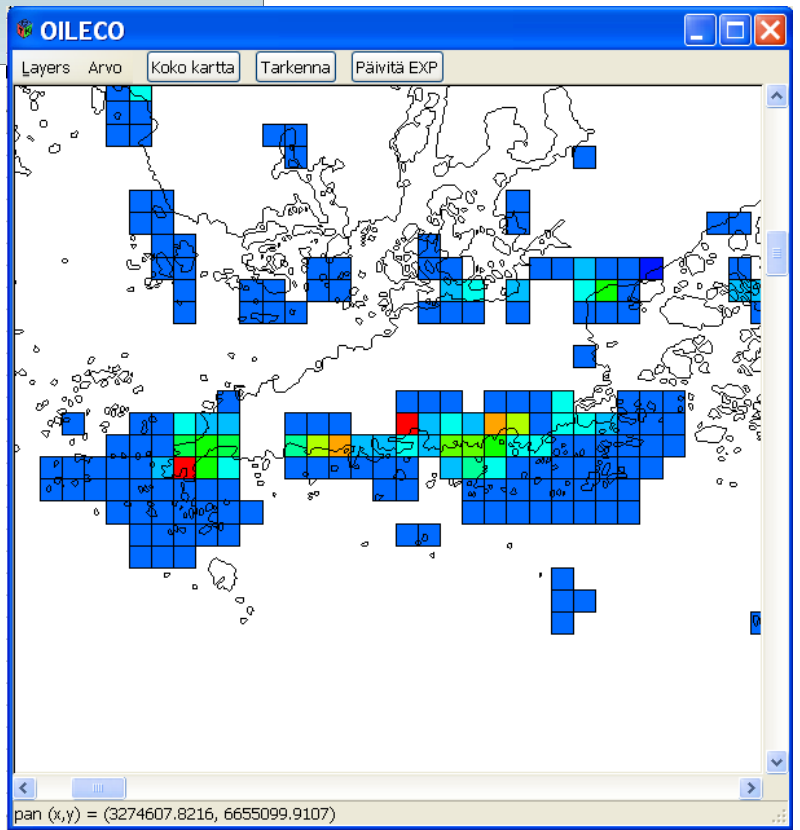
SpillMod results



Picture is from SÖKÖ project

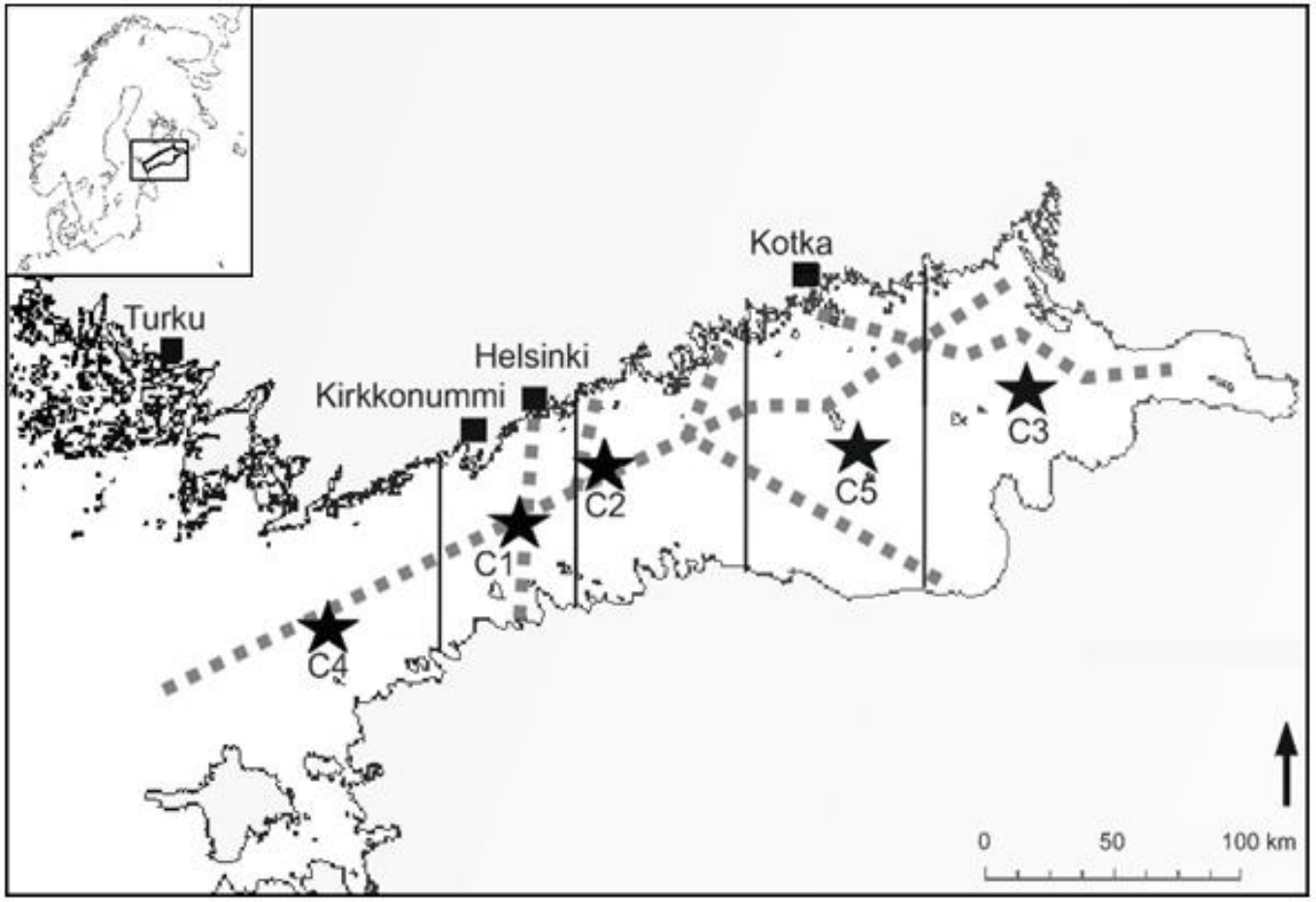
- Probabilistic maps with grids of 2*2 km
- Probability to become oiled for each cell is calculated given the place of accident, type of oil, season (weather stats during last 10 years), spill size, duration of the spill and the drifting time





Making biodiversity data as an operational tool for firemen

Gulf of Finland and oil



Lehikoinen et al 2013. Env. Sci. Techn. DOI: 10.1021/es303634f

ICES WGMABS April 2015 : Sakke chairing

- Working Group on Risks of Maritime Activities in the Baltic Sea (WGMABS) **2015 - 2017**
- **Reporting year within current cycle, once in a year, in future stakeholder involvement: round table**
- TORS: 1) Review the recent studies carried out for ecological risks of maritime activities and to plan ToRs for future group meetings 3) Plan the ToRs of future WG meetings
- 2016: either St Petersburg or Stockholm

3) Bayesian analysis:
scientific description of learning

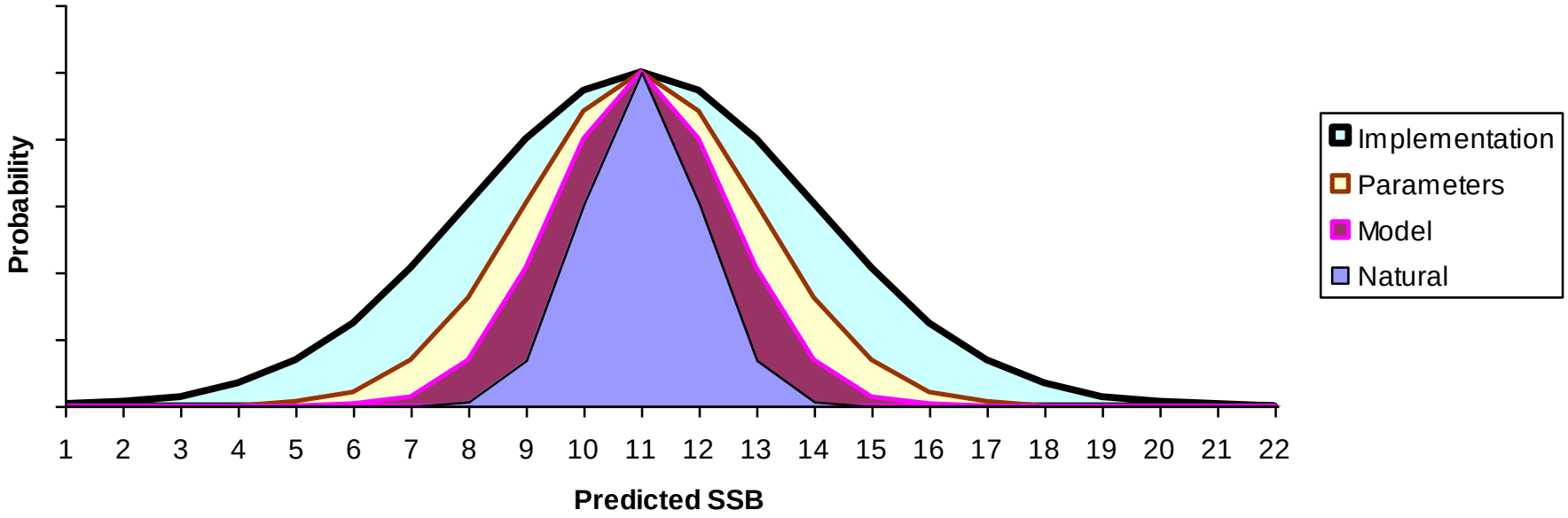
Modeling of oil spills: impacts that cannot be seen or measured

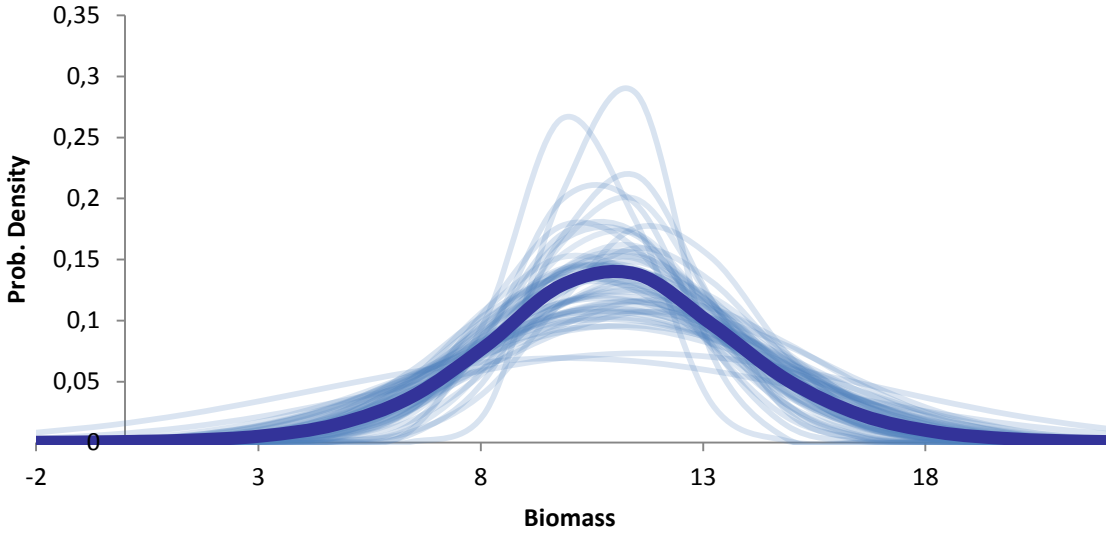
We do not want to see the data providing overall damage estimates

Even in a studied accident, we never see all impacts, even though we should be aware of them

For models we need all knowledge from field surveys, experts, publications, laboratory experiments, closeby cases

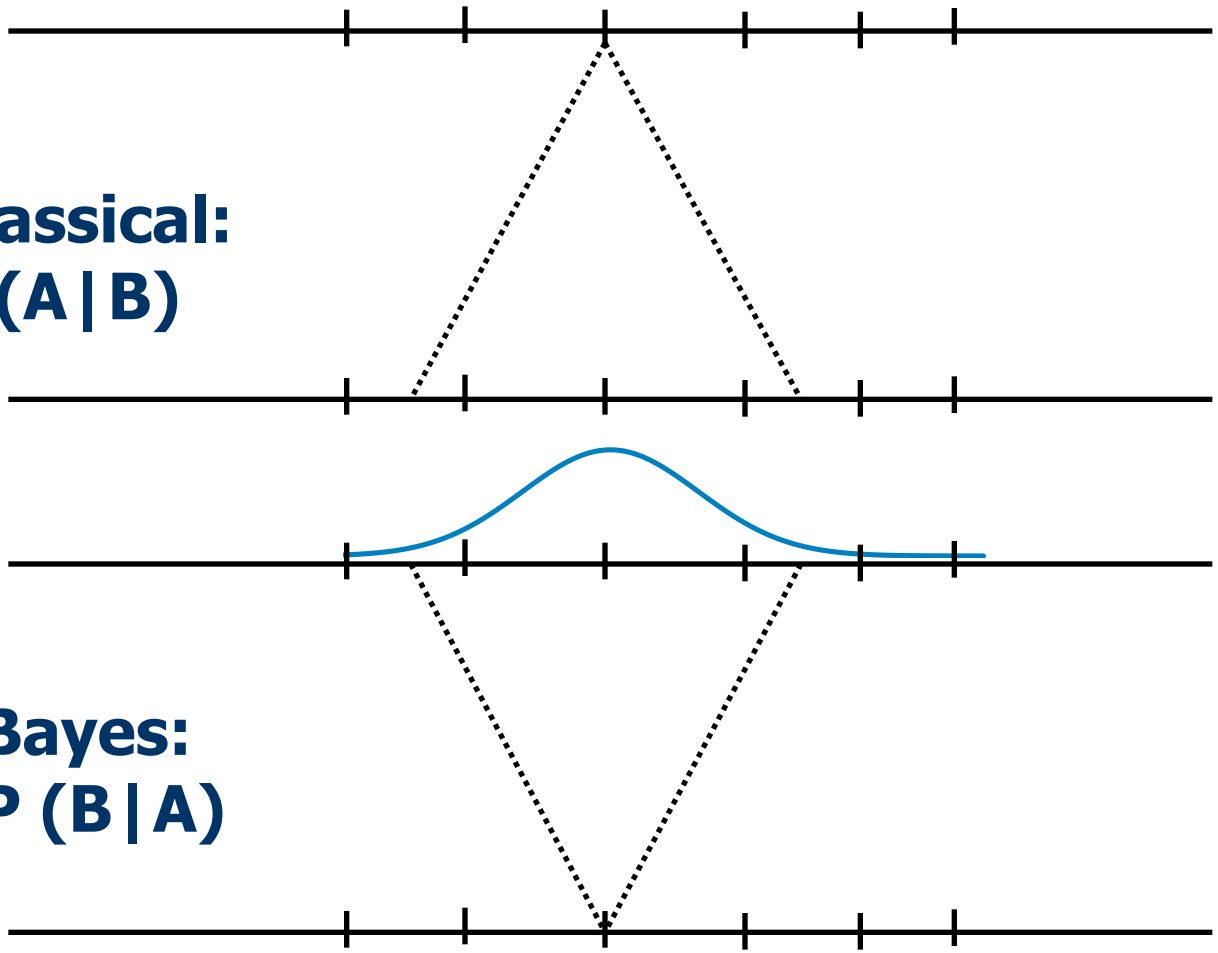
Sources of uncertainty





We need to use the unclear view of future to manage

Bayes rule: probabilistic dependencies



Real number of fish (B)

Classical: P (A|B)

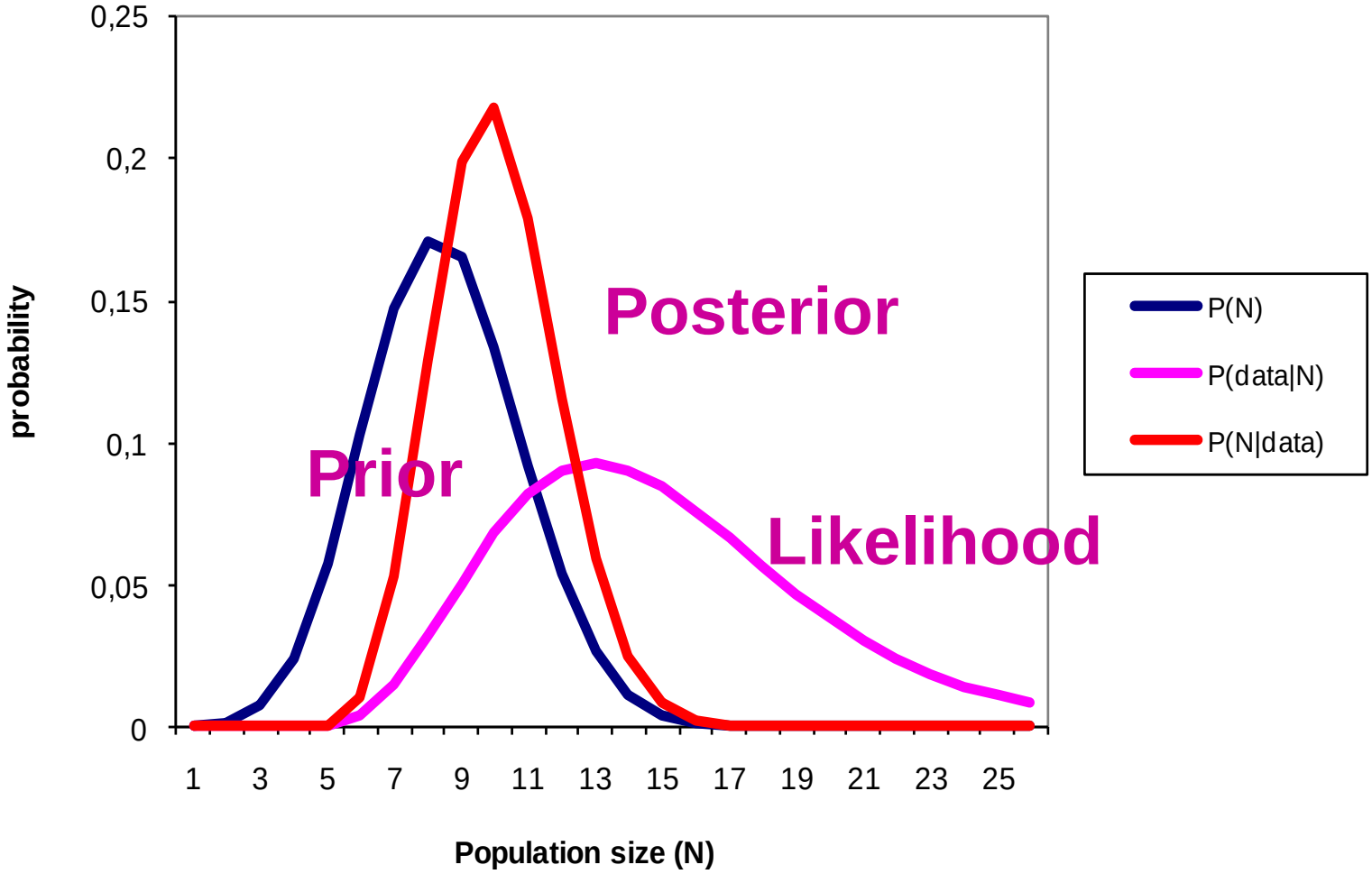
Observations (data), A

Real number of fish (B)

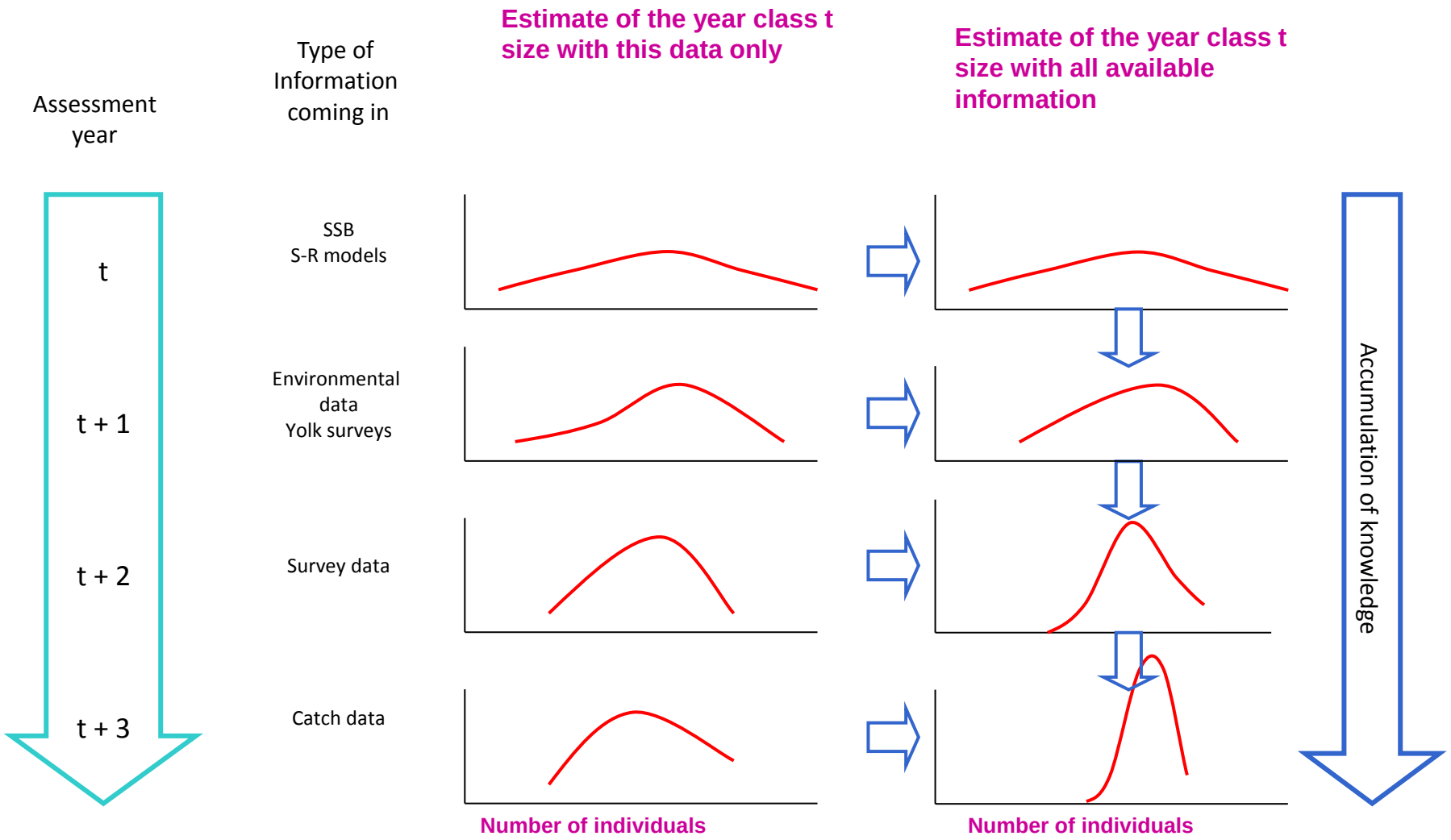
Bayes: P (B|A)

Observations

We are not interested about any possible other data sets given the data we have.
Why calculate p of classital hypothesis tests, then?


0,25
0,2
0,15
0,1
0,05
0
probability
1
3
5
7
9
11
13
15
17
19
21
23
25
Population size (N)
Posterior
Prior
Likelihood
P(N)
P(data|N)
P(N|data)

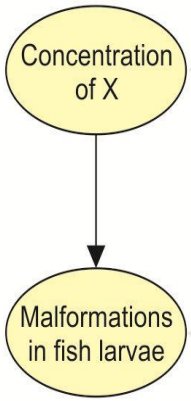
Bayes – inference: learning from several information sources



Learning over time by increasing amount of information over the time, the same Is true if we use e.g. several models that are independent way to estimate the interest variable

Bayesian networks

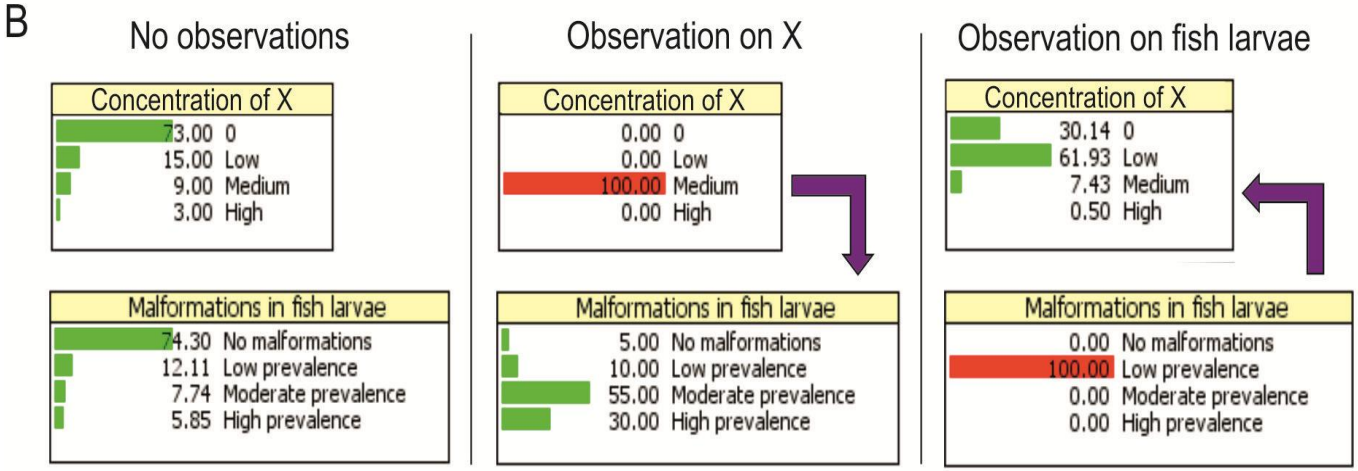
A



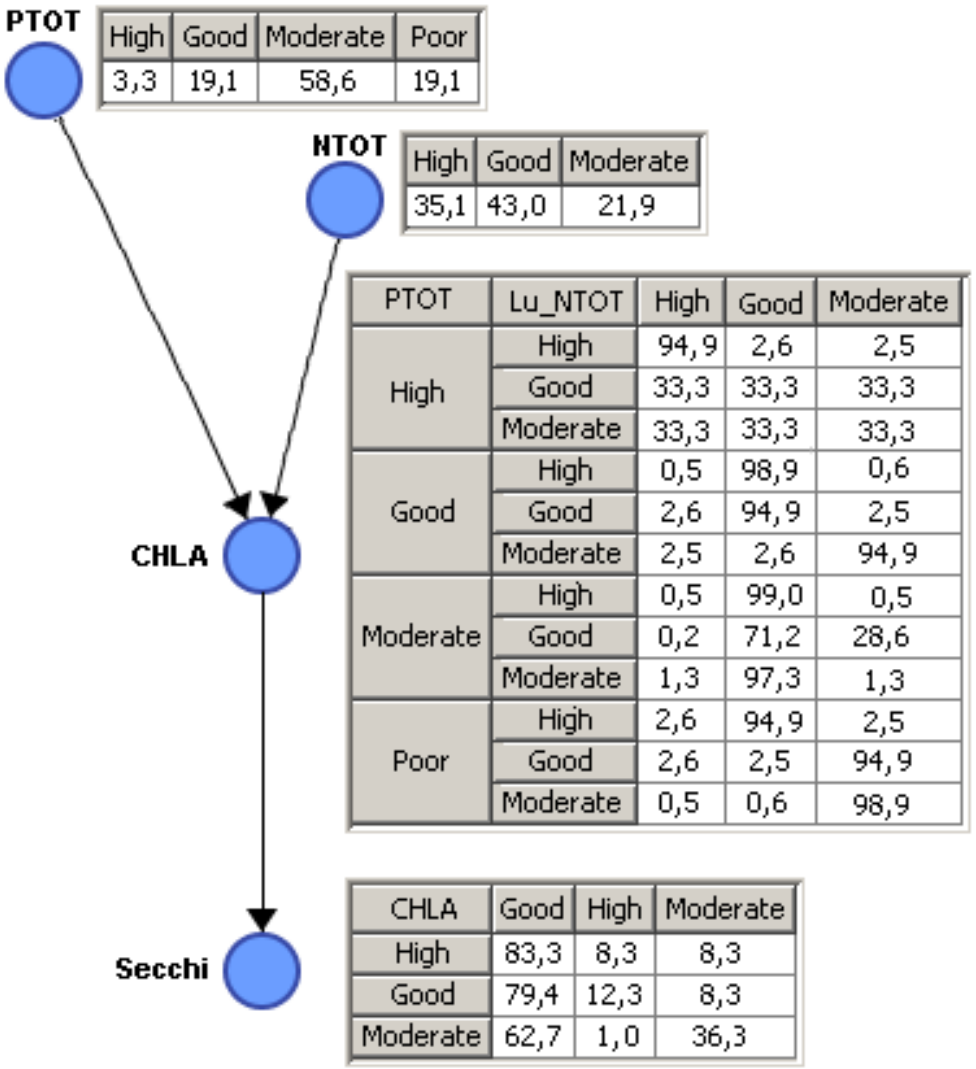
Concentration of X	Prob.
0	0.73
Low	0.15
Medium	0.09
High	0.03

Malformations in fish larvae	Concentration of X			
	0	Low	Medium	High
No malformations	0.95	0.30	0.05	0
Low prevalence	0.05	0.50	0.10	0.02
Moderate prevalence	0	0.15	0.55	0.18
High prevalence	0	0.05	0.30	0.80

B



Bayesian nets in AI – a simple WFD example for GoF



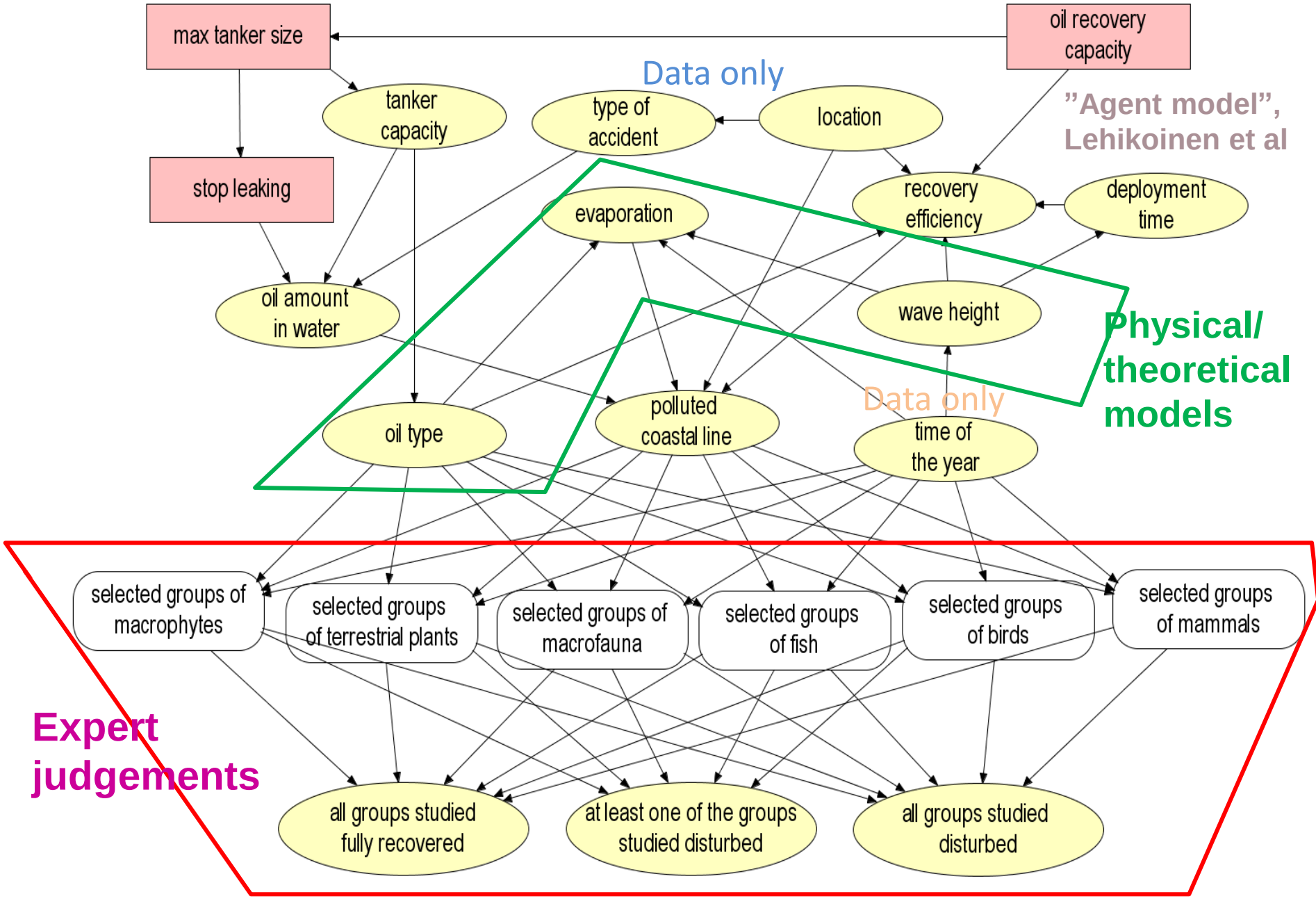
High	Good	Moderate	Poor
3,3	19,1	58,6	19,1

High	Good	Moderate
35,1	43,0	21,9

PTOT	Lu_NTOT	High	Good	Moderate
High	High	94,9	2,6	2,5
	Good	33,3	33,3	33,3
	Moderate	33,3	33,3	33,3
Good	High	0,5	98,9	0,6
	Good	2,6	94,9	2,5
	Moderate	2,5	2,6	94,9
Moderate	High	0,5	99,0	0,5
	Good	0,2	71,2	28,6
	Moderate	1,3	97,3	1,3
Poor	High	2,6	94,9	2,5
	Good	2,6	2,5	94,9
	Moderate	0,5	0,6	98,9

CHLA	Good	High	Moderate
High	83,3	8,3	8,3
Good	79,4	12,3	8,3
Moderate	62,7	1,0	36,3

Fernandez et al, 2012, Env. Sci & Tech.



Lecklin, T., Ryömä, R. and Kuikka, S. 2011. A Bayesian network for analyzing biological acute and long-term impacts of an oil spill in the Gulf of Finland. Marine Pollution Bulletin 62 (2011) 2822-2835.

5) Conclusion, with an idea of a learning system

In oil spill scientific litteraturem do not use p-values as publication criteria

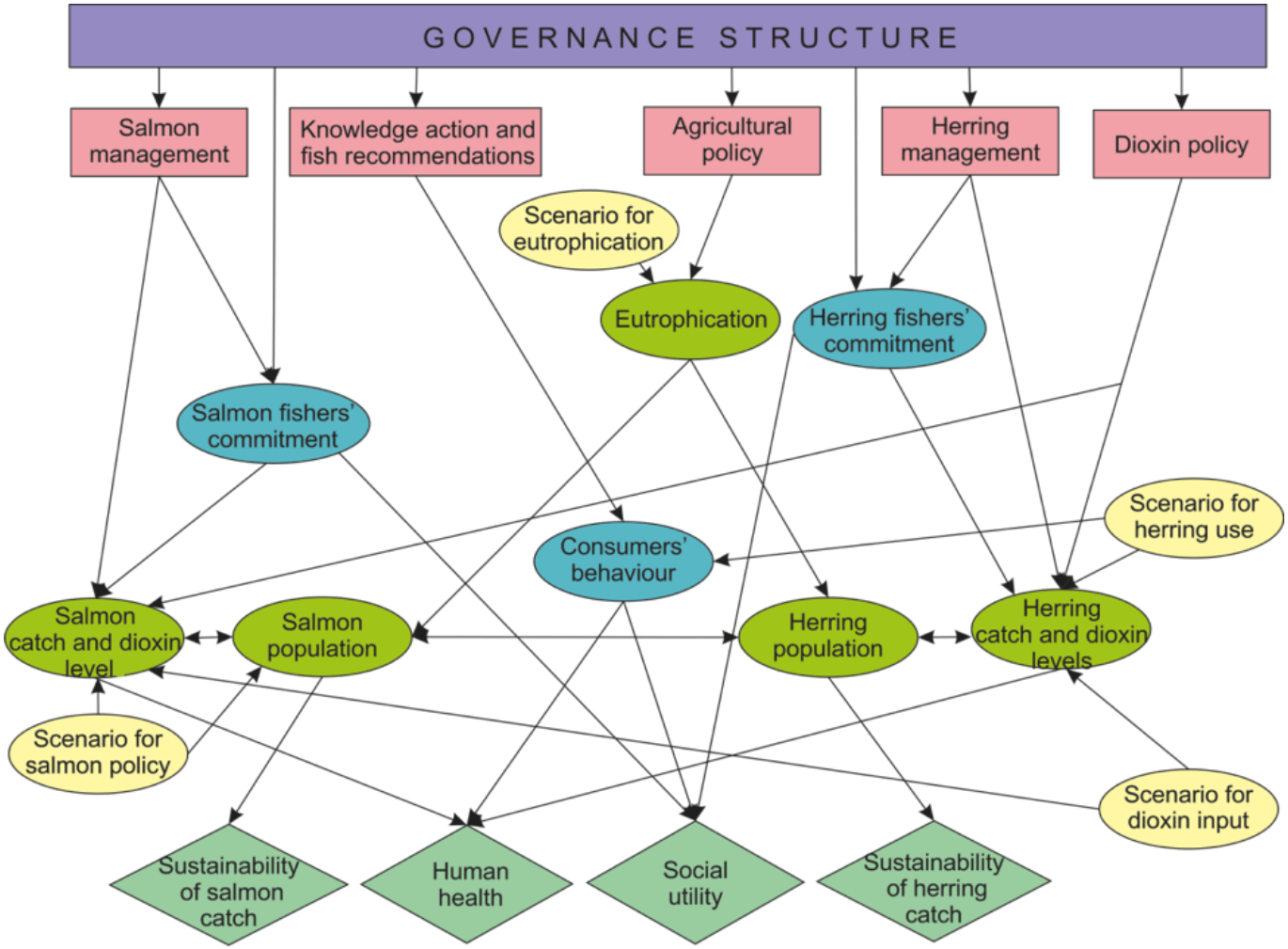
But we have some hope, if we learn between areas, species, environment, disciplines and cultures

GOHERR AIMS

- Involving stakeholders in building a novel integrated governance framework for Baltic salmon and herring that responds to the challenges of the ecosystem approach
- Analyse the consequences of the biological dependence between Baltic salmon and herring, and their consequences for bioaccumulation of dioxins
- Building a decision support model for an integrated risk analysis and governance of Baltic salmon and herring with the aim of reducing dioxin concentration in these fish species
- Mapping future scenarios for the use of Baltic herring and salmon
- Improving the quality of salmon and herring management through searching for synergies and coherence across sectors
- Proposing a governance structure for the integrated maritime policy in the Baltic Sea including relevant interrelated elements

Expected outcomes

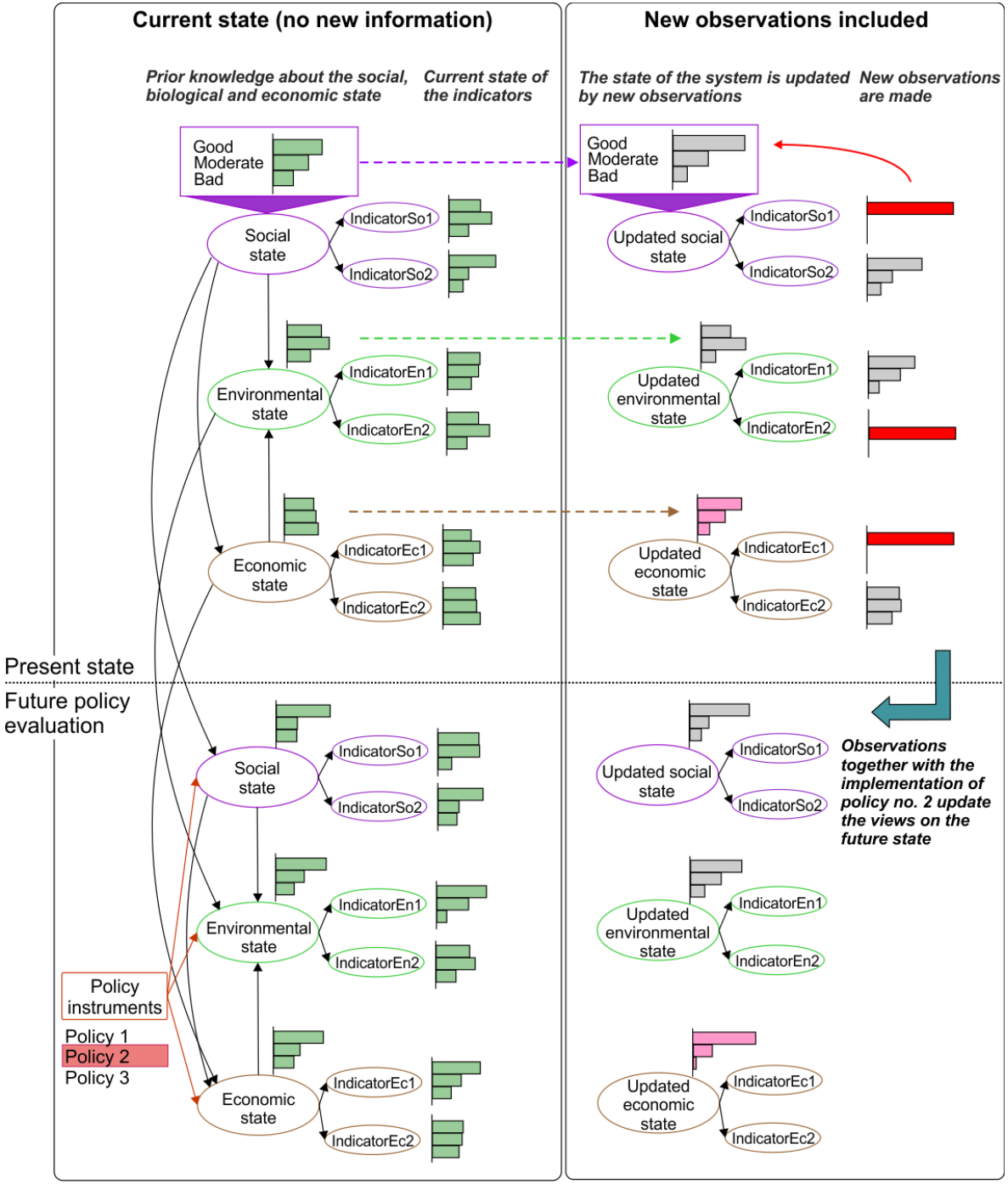
- Suggestions of new policy instruments for multi-level/nested integrated governance of Baltic salmon and herring stocks
- Increased understanding of integrated governance and suggestions of ways and tools for bridging policy sectors, governance levels, and stakeholder perspectives in ecosystem based governance
- A decision support tool to facilitate the implementation of integrated governance
- Increased understanding on the interrelationship between Baltic salmon and herring, and the impact of this on dioxin concentration


GOVERNANCE STRUCTURE
Salmon management
Knowledge action and fish recommendations
Agricultural policy
Herring management
Dioxin policy
Scenario for eutrophication
Eutrophication
Herring fishers' commitment
Salmon fishers' commitment
Scenario for herring use
Consumers' behaviour
Salmon catch and dioxin level
Salmon population
Herring population
Herring catch and dioxin levels
Scenario for salmon policy
Scenario for dioxin input
Sustainability of salmon catch
Human health
Social utility
Sustainability of herring catch

BONUS programme says:

Understanding and predicting global change in the Baltic Sea region requires integrated approaches and integrated research for the Baltic Sea System at several levels. We also need a full understanding of the Baltic Sea System in connection with relevant societal options for planning and remediation.

By some more money, FEM group can start building the integrated models of various projects?



After GOHERR?

- Atlantis model will get oil spill element and Bayesian module => all publications of use
- Risk integration requires that causes and effects are in the same model
- Inference backward fom several variable: the diagnosis of state given the observations