Overall approach of Ilves consortium: do you agree that this is important?

Sakari Kuikka **& Inari Helle, Annukka Lehikoinen, Mika Rahikainen, Jarno Vanhatalo, Samu Mäntyniemi and Maria Hänninen**

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)

Focal point of International Ocean Institute in Finland

Interests for the visit

- To create interest to establish an international project on the cost effective management of oil spill risks in the Malacca Straits and nearby areas
- Visits in Chulalonkgorn University, Thailand, and University of Malyesia Sabah, **and now** Nanyang Technological University
- Interest for joined research, and linked education?
- Suggested course: **Operational use of biodiversity and economic values in operational maritime management: 1) identification and classification of values, 2) risk assessment and 3) risk management : UH, UMS and NTU ?**

FEM group at the University of Helsinki

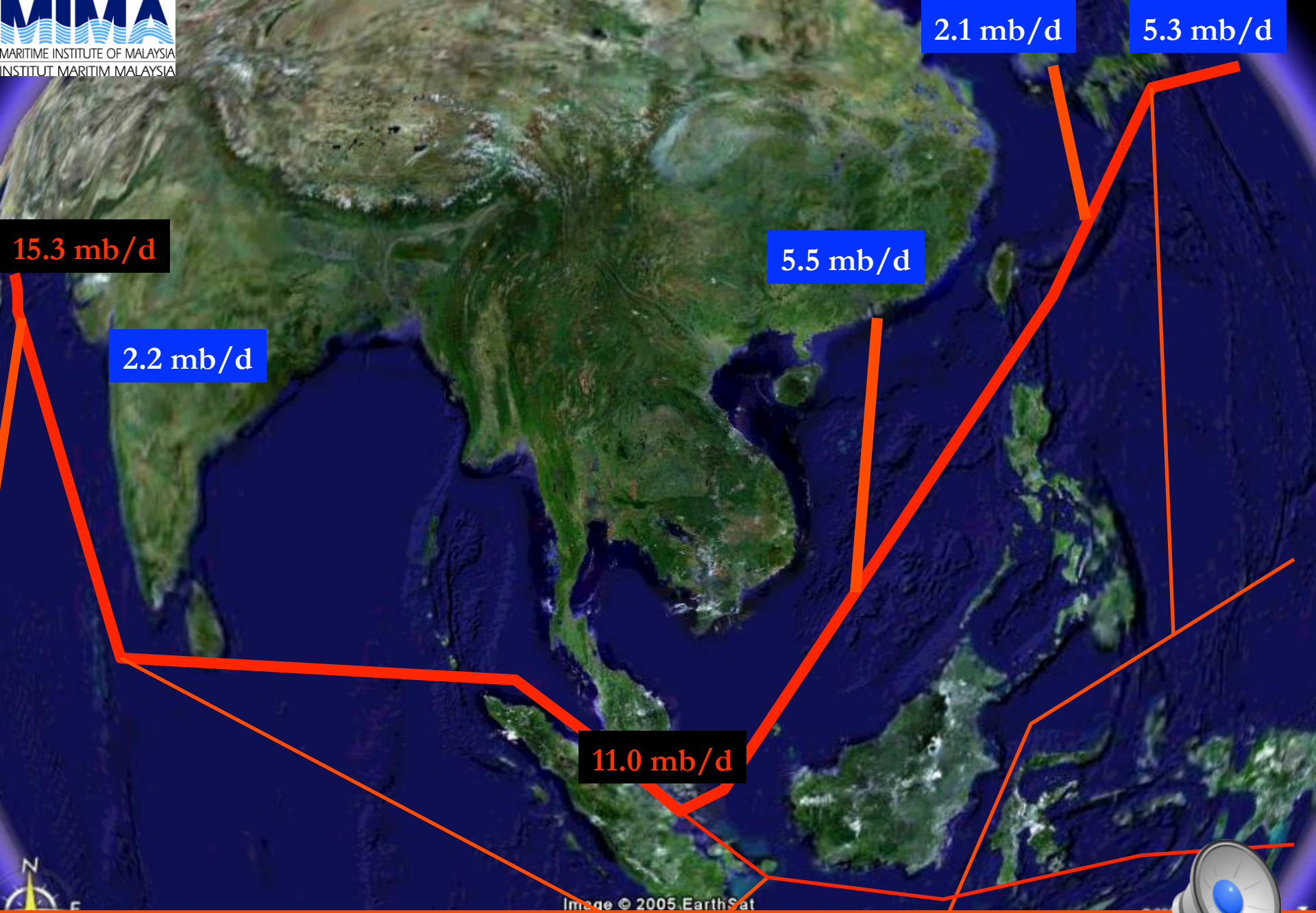
- 2 professors, 4 senior scientists, 2 postdoctoral researchers, 7 postgraduate researchers
- Research interests:
  - Applications in fisheries and oil spill risk analysis
  - Decision analysis of renewable resources
  - Integrating different sources of data and knowledge: Bayesian analysis
  - Identification 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

Decision making and poor knowledge

☺



Energy Shipping Lane and Strategic Passages in Asia Pacific

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) Published papers by FEM group

2) Oil spills: basic models

3) Why Bayesian inference?

4) Concluding slides, including learning systems

Published papers on oil spills

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]

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.** *Environmental Science and Technology*

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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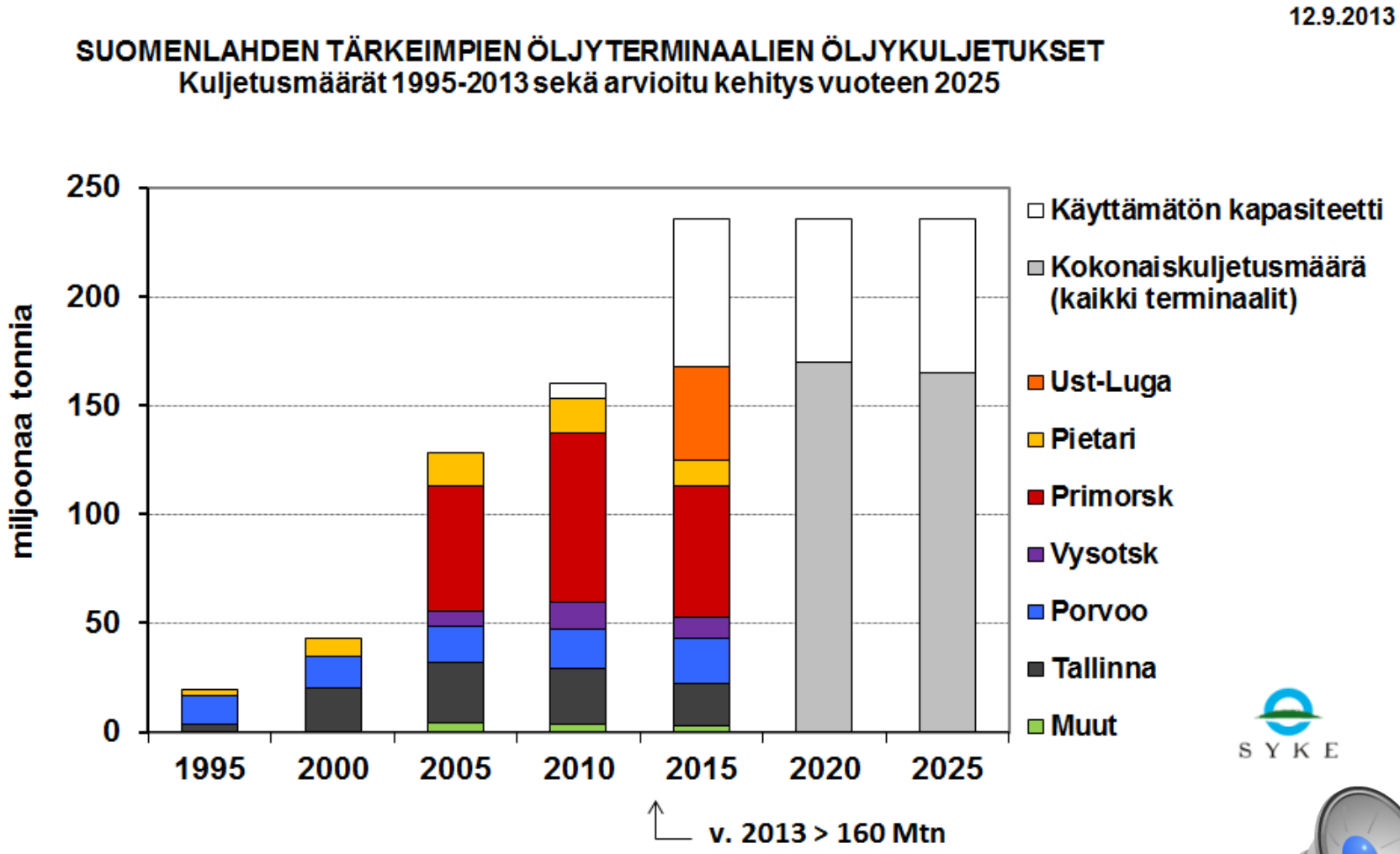
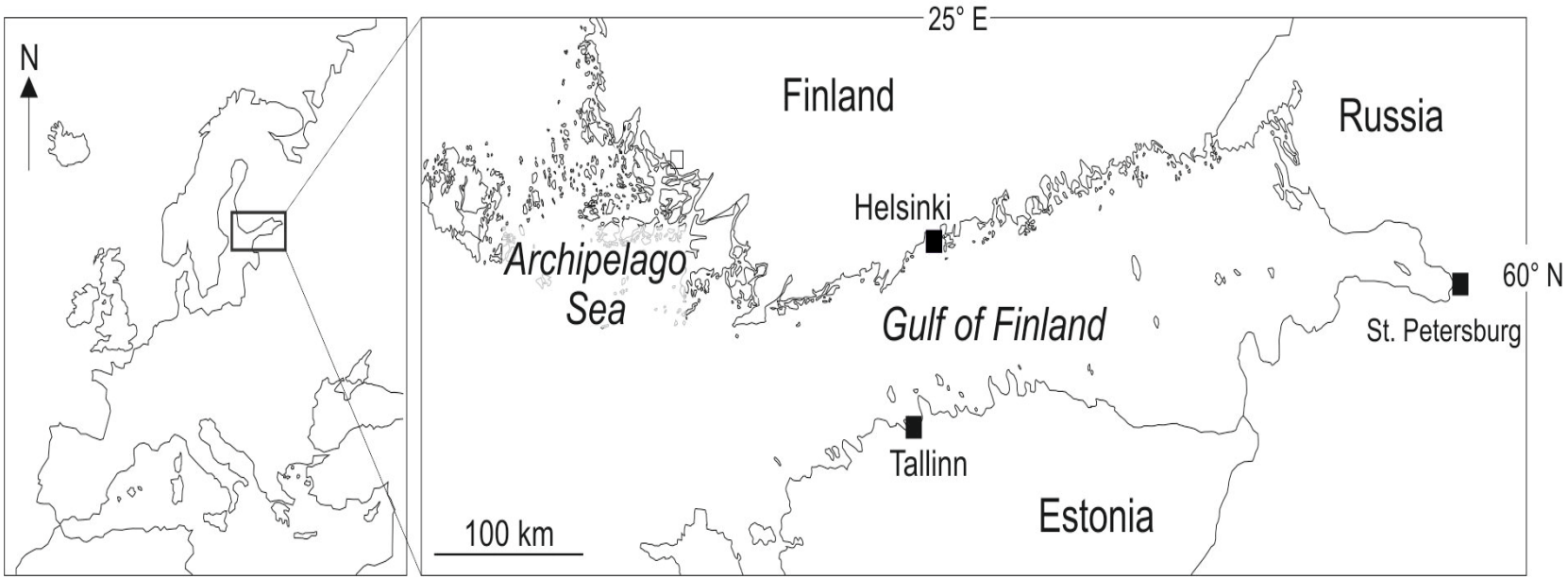
2) Oil spill and basic models: scientific description of learning

Oil transportation in the Gulf of Finland

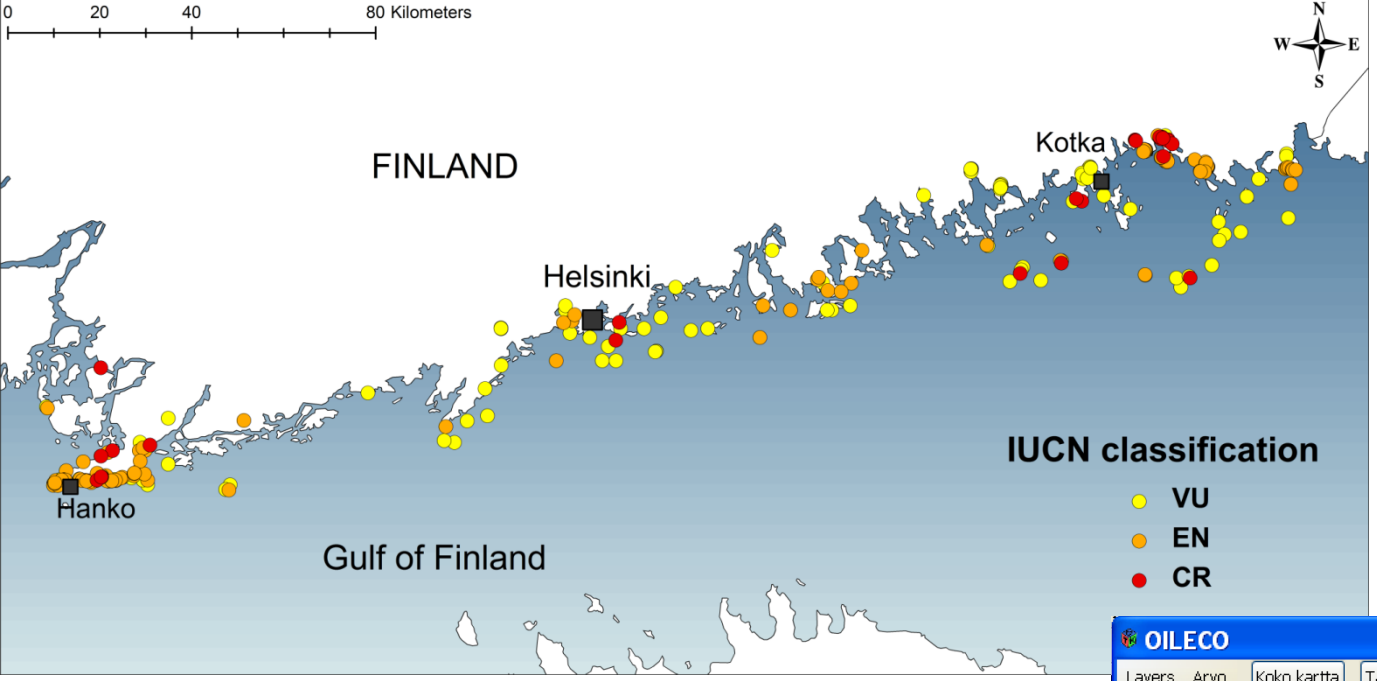


Gulf of Finland

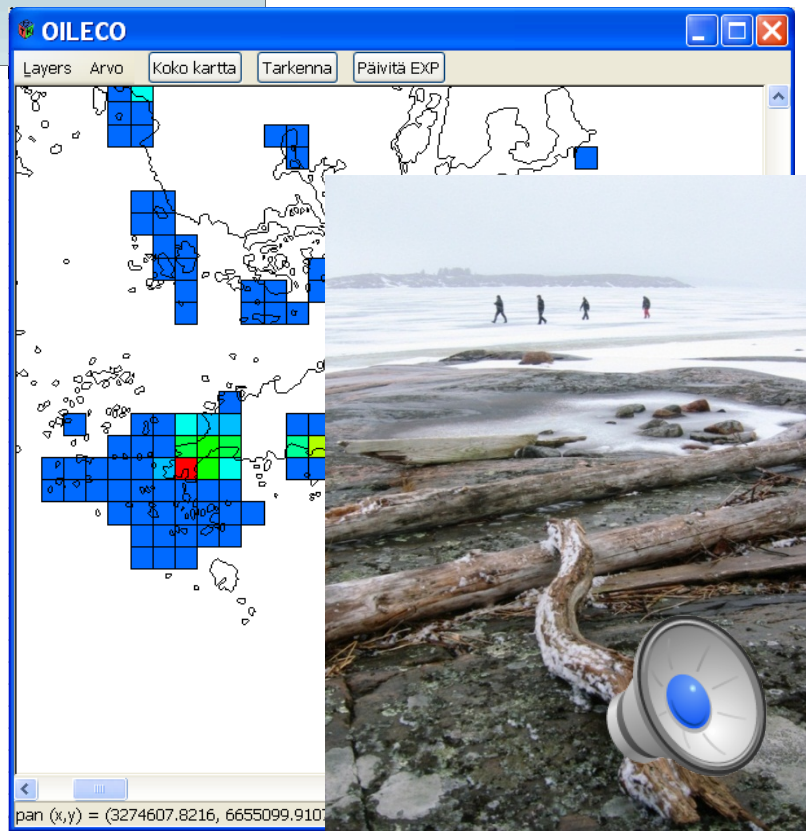
Difficult to navigate, in winter ice covered



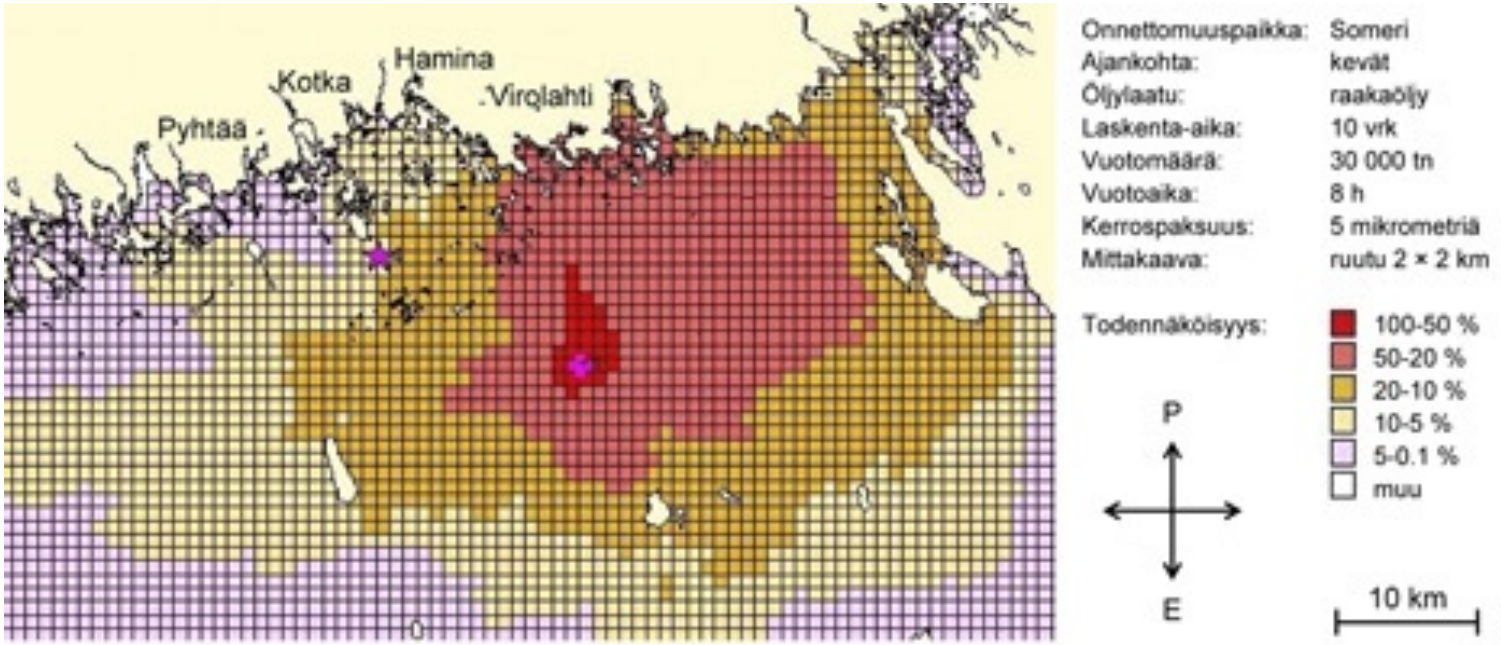
Surroundings countries are in different positi



Making biodiversity data as an operational tool for firemen



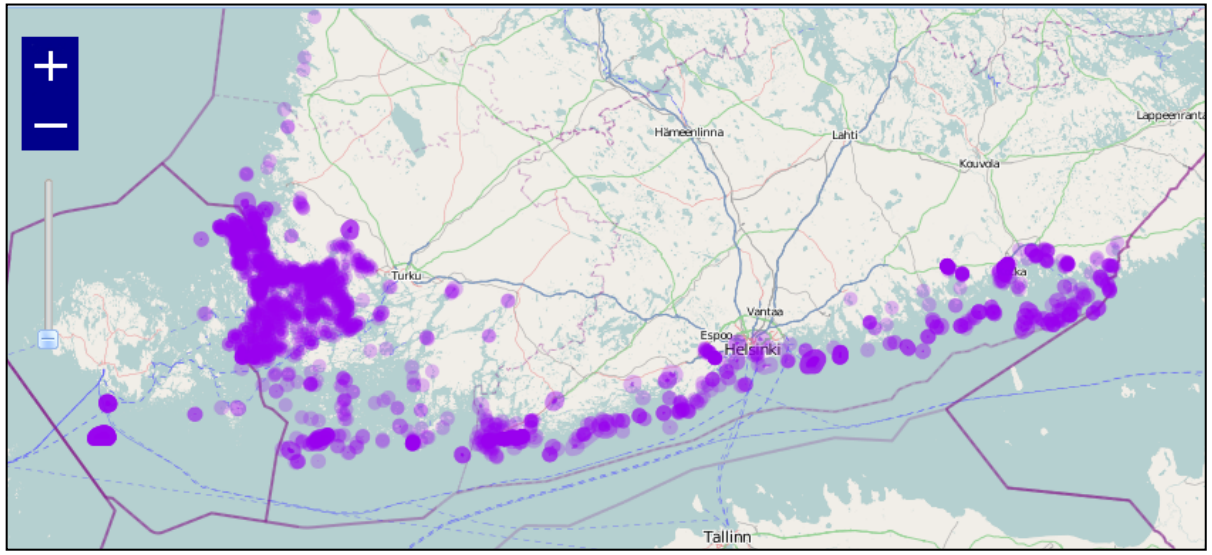
SpillMod results

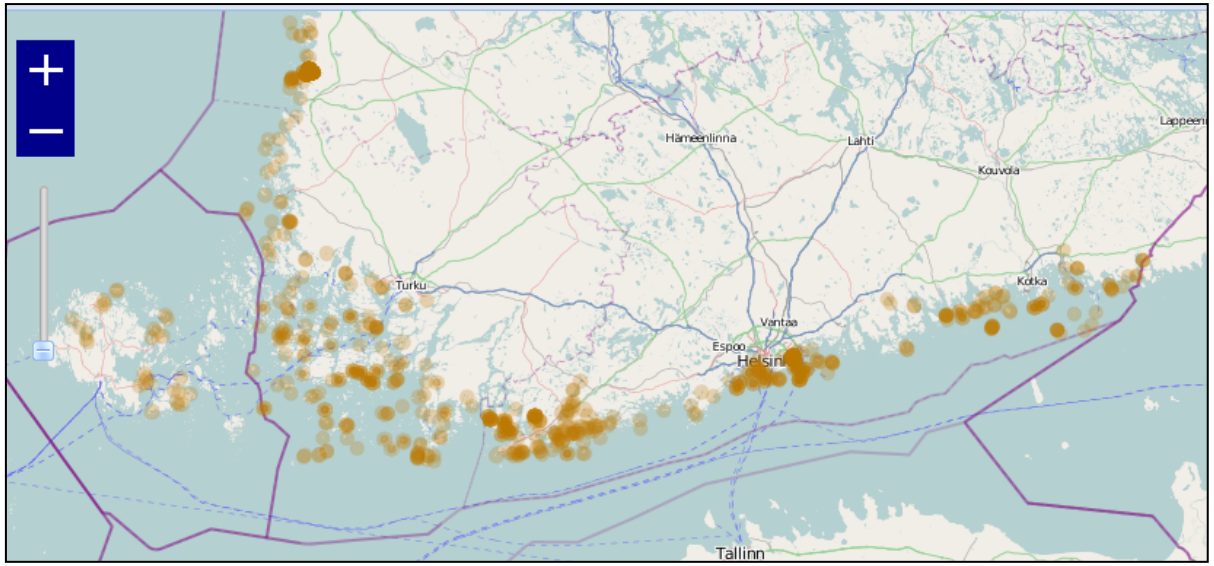


Picture is from SÖKÖ project

- 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

Species and habitat data





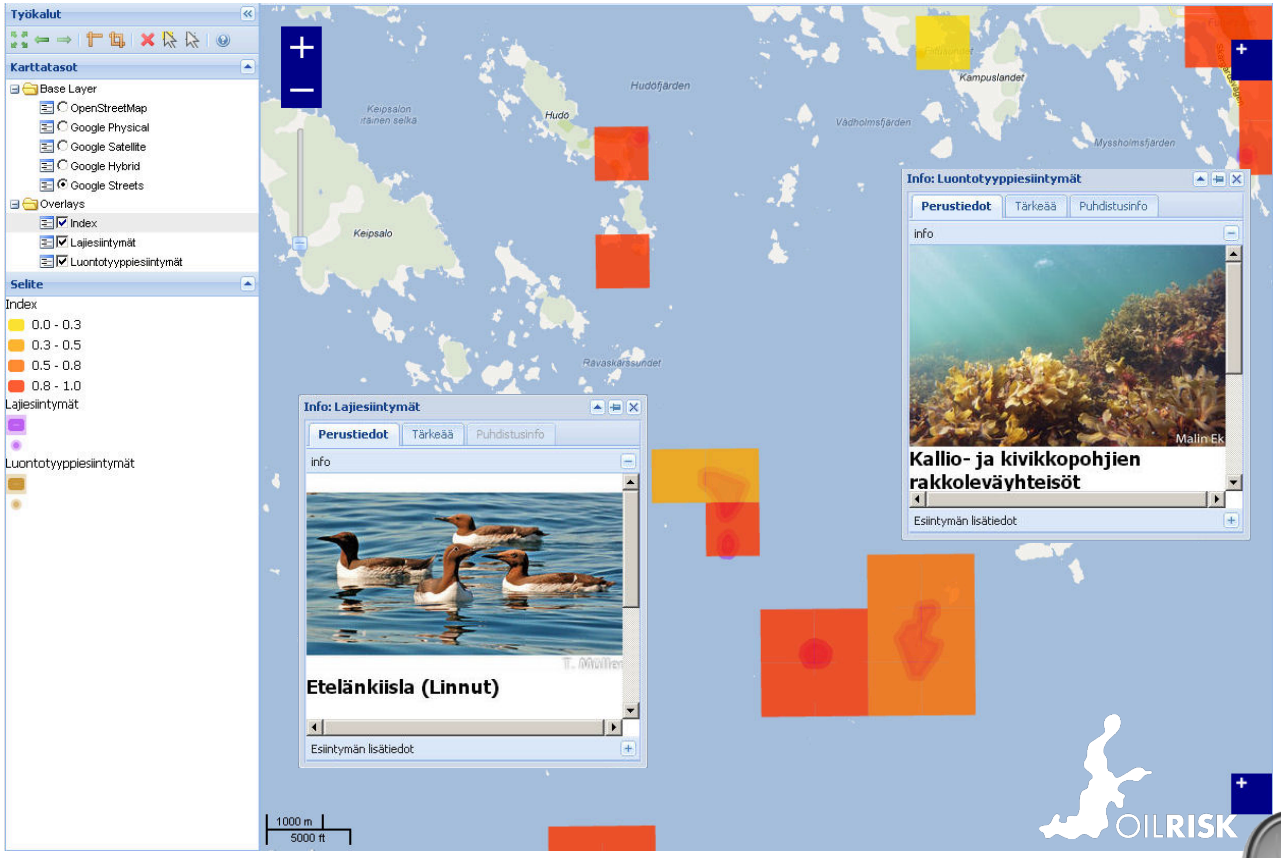
Species and habitats

- **Locations**
- **Conservation value index (VAL)**

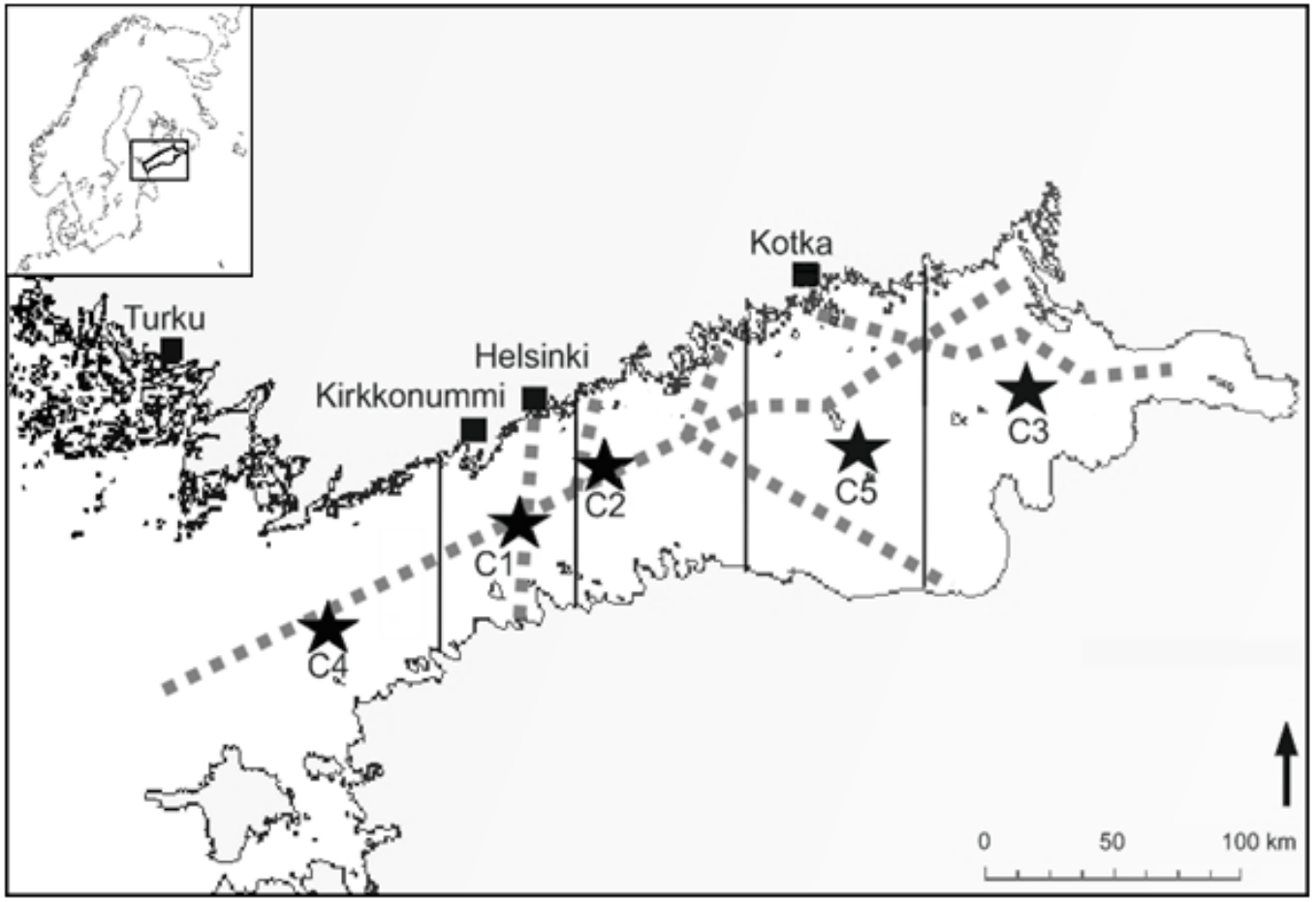
IUCN ”Red List”classes:
CR – Critically Endangered
EN – Endangered
VU – Vulnerable

+ status as Directive species/habitat

Map application



Gulf of Finland and oil



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

3) Bayesian analysis

Impact of randomness on impacts

M/T Amoco Cadiz

- March 1978
- Bretagne
- 230 000 t
- 20 000 dead birds

VS.

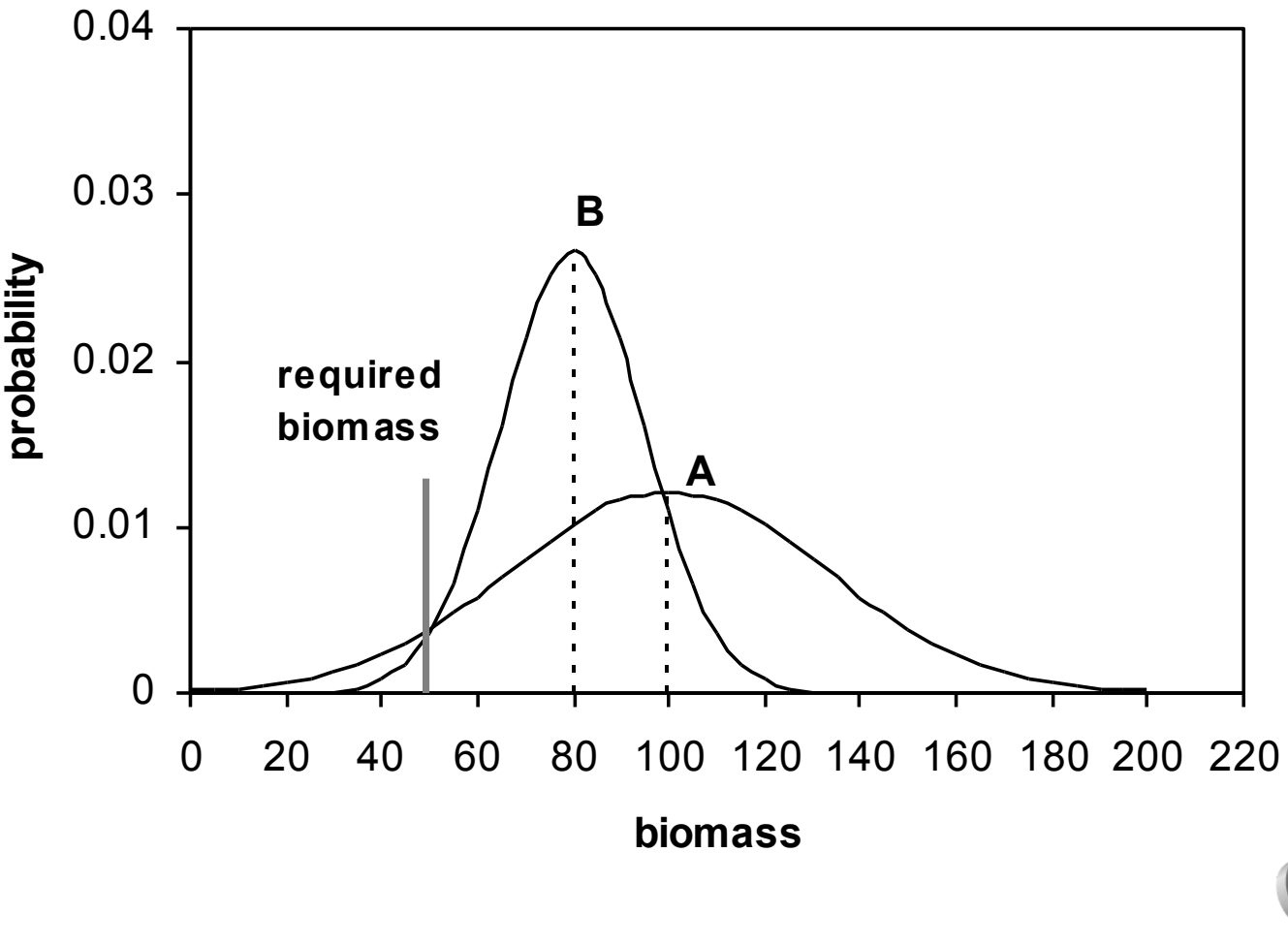
M/T Exxon Valdez

- March 1989
- Alaska
- 37 000 t
- 250 000 dead birds

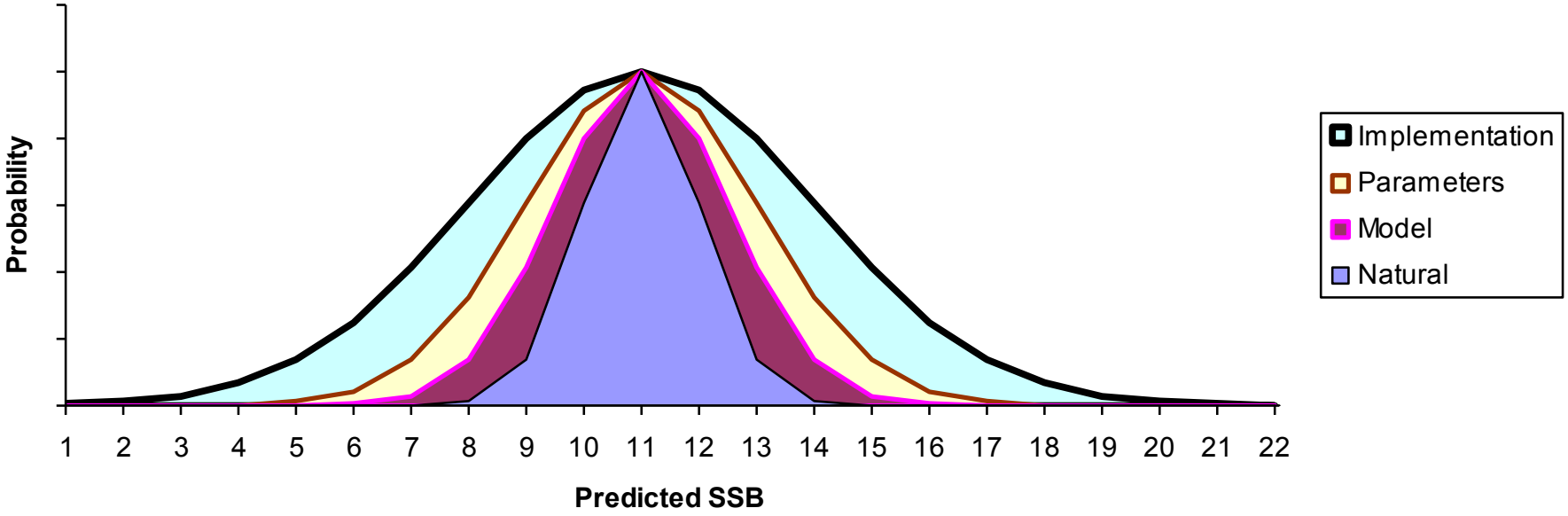
Unknown vessel

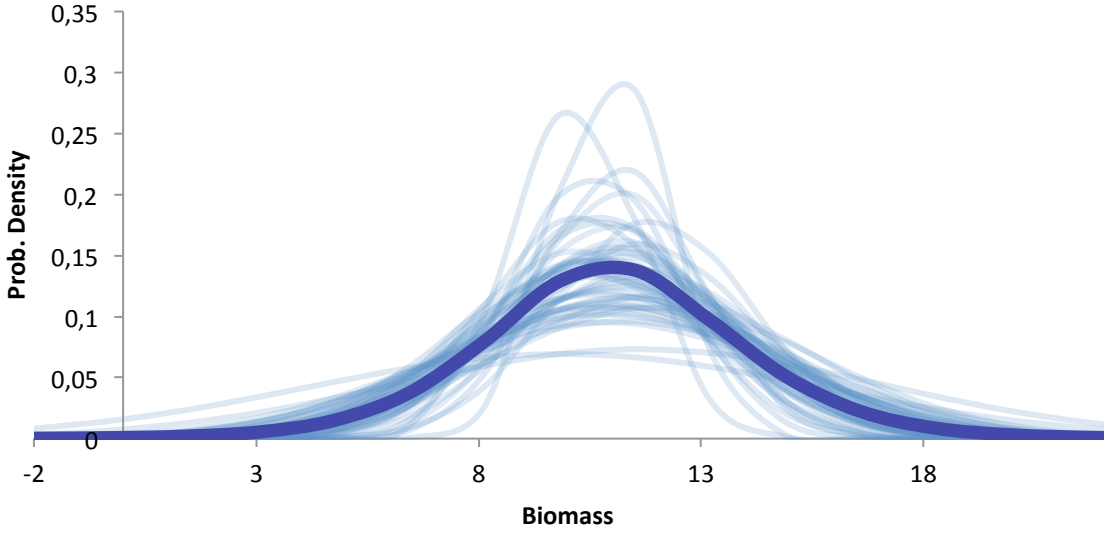
- February 1976
- Gotlanti
- 10 t
- 60 000 dead birds

Risk management



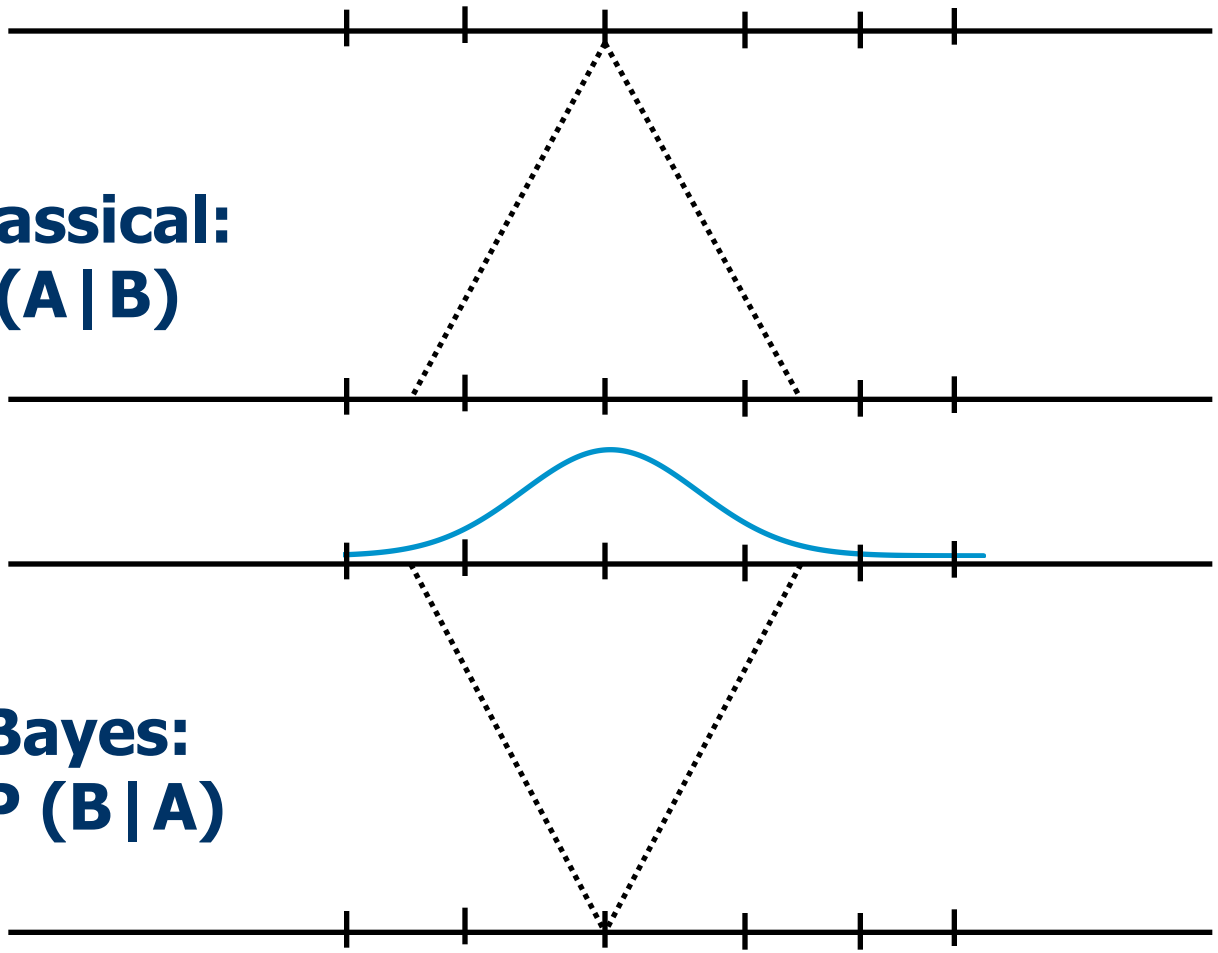
Sources of uncertainty





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

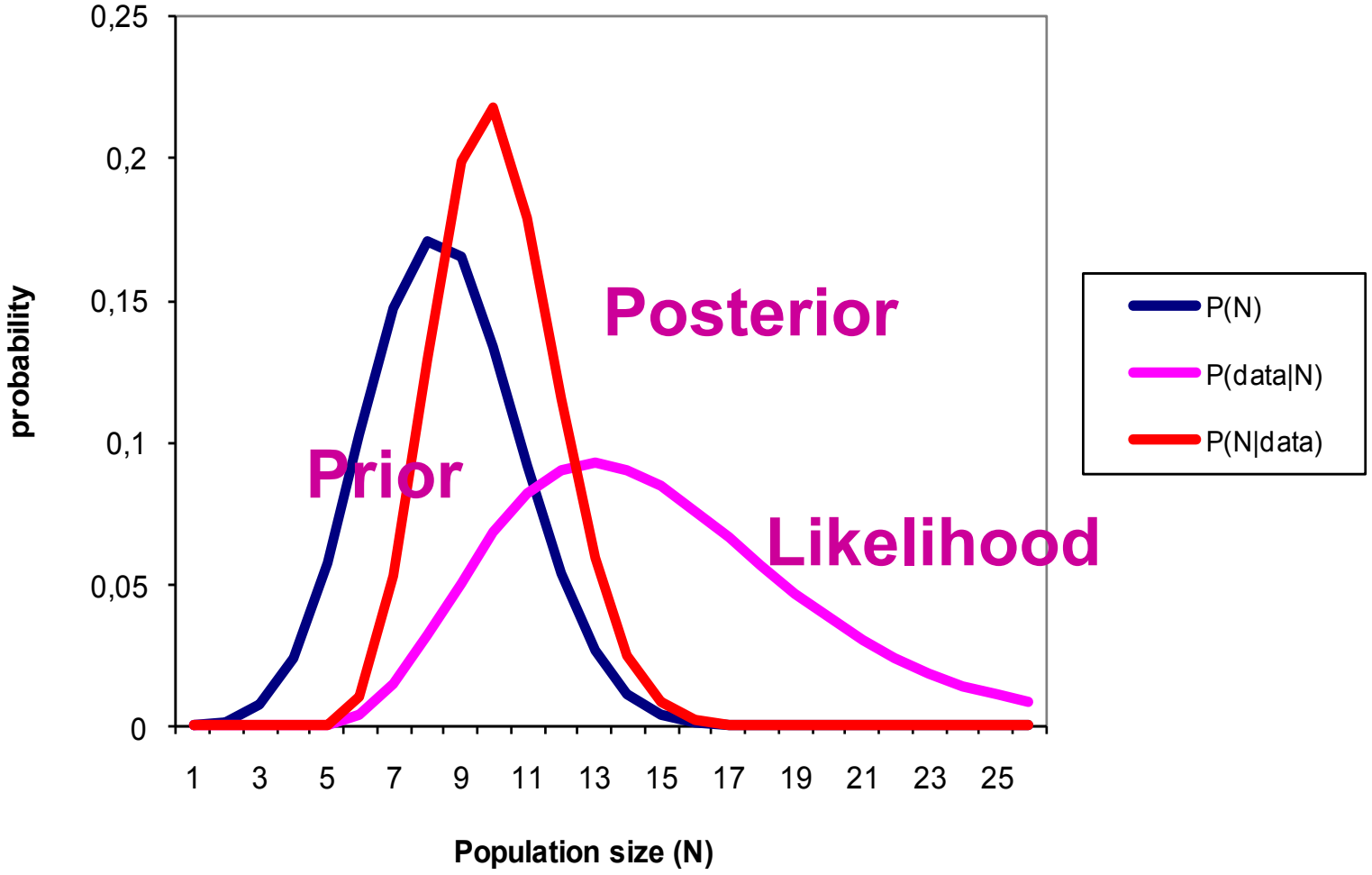
Real number of fish (B)

Bayes: P (B | A)

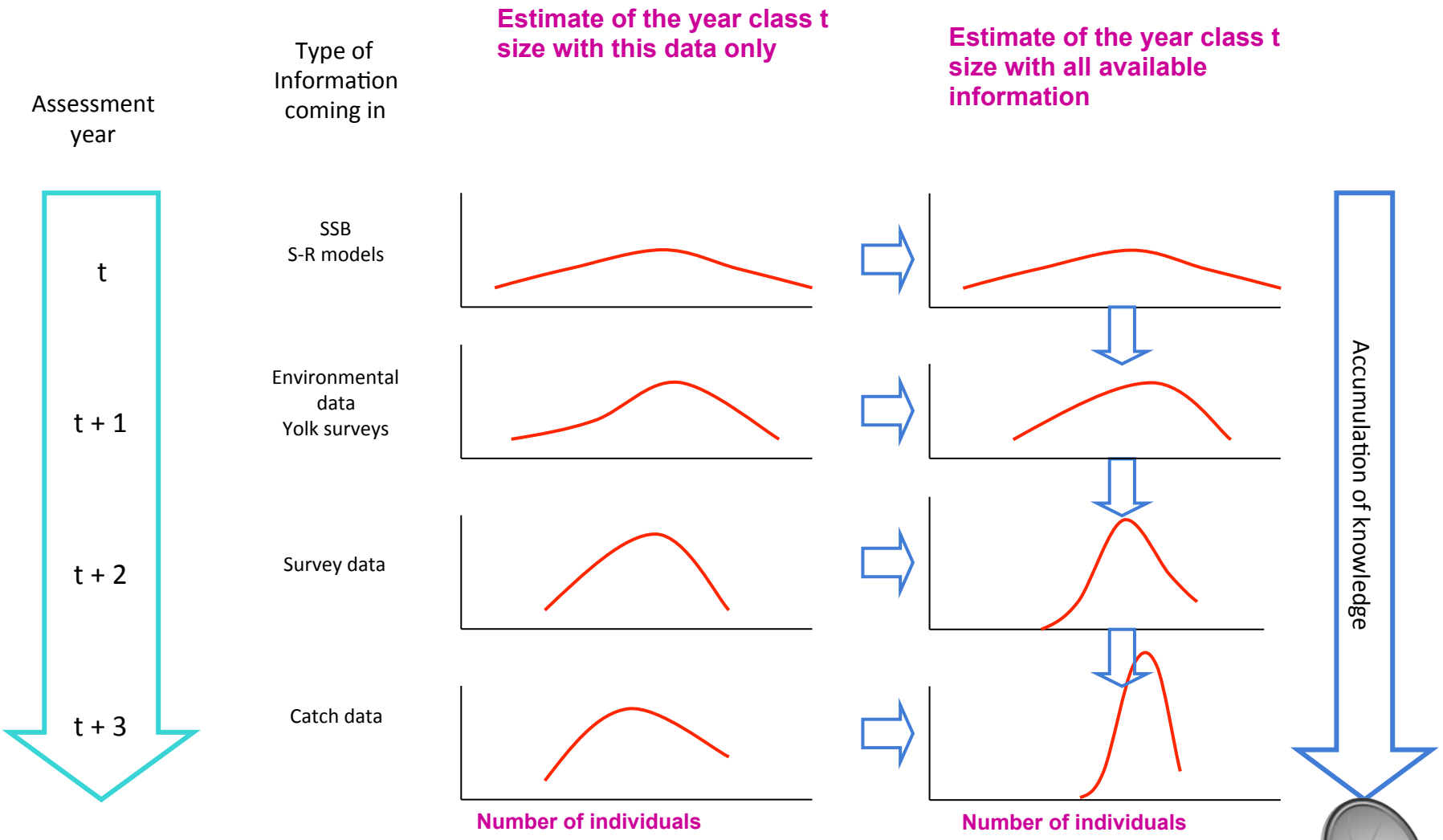
Observations

We are not interested about any possible other data sets given the data we h

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 sam
Is true if we use e.g. several models that are independent way to estimate the interest variable

5) Conclusion, with an idea of a learning system

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

Yes, but..

How to transfer the knowledge from previous accidents?

Why EU legislation packages carry the names of the oil spill disasters? Do we learn only from obsered accidents, not from model estimates?

Compare to practises in **flying businesses** and in **nuclear power management**

Flying business: all have the same interest of not having an accident

Nuclear power management: an absolute trust on models and their estimates of unseen risks

Some light in the tunnel: BAYESIAN NETWORKS: MODELLING OF UN-SEEN POTENTIAL FUTURE OIL SPILLS

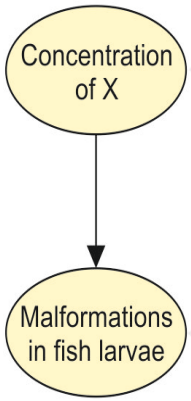
1) Need to use experts

2) Need to indenfity chains of good and cheap control

3) Need to describe the alternative views about values and risk attitudes

Bayesian networks

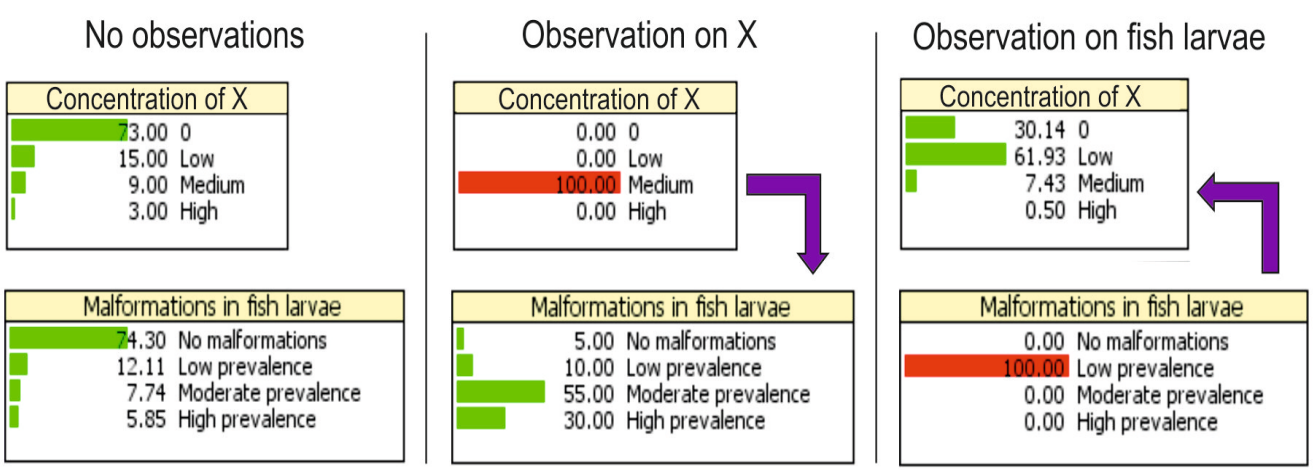
A



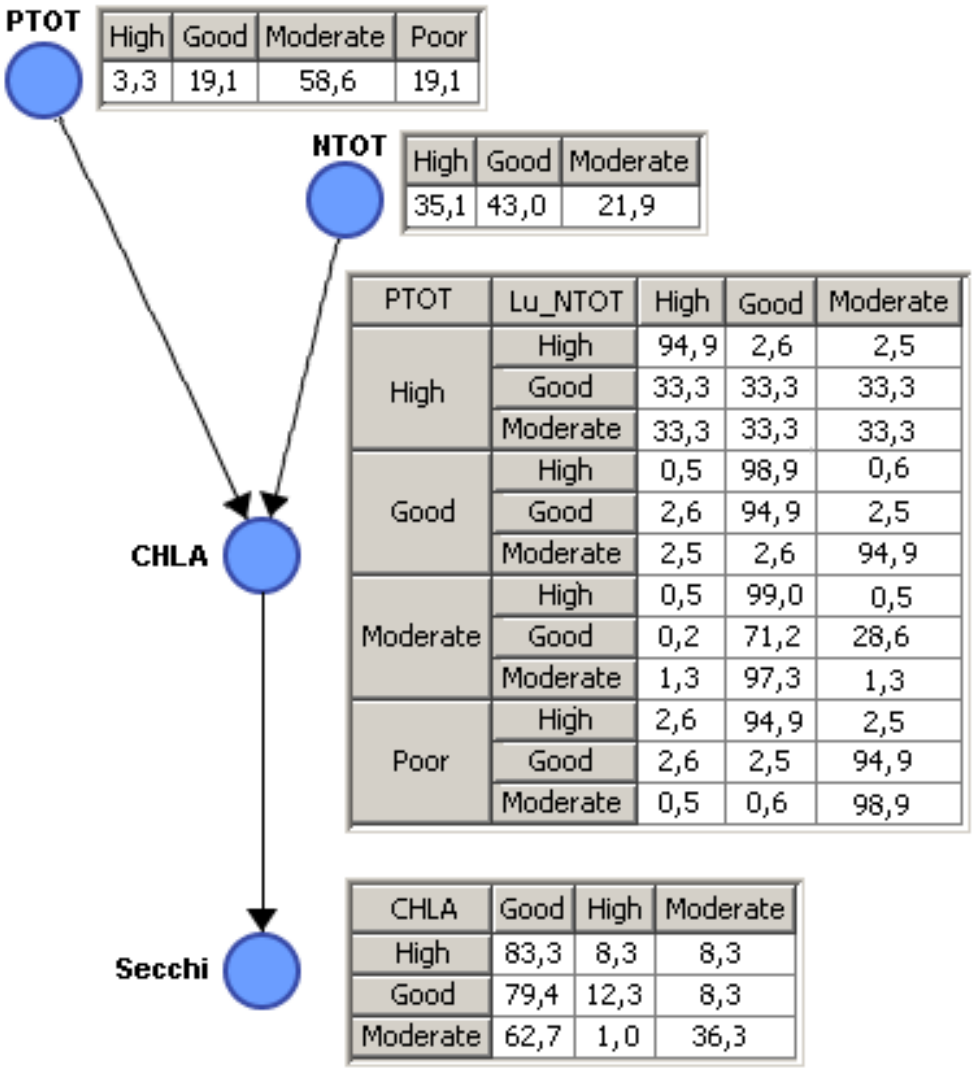
Concentration of X	Prob.
0	0.73
Low	0.15
Medium	0.09
High	0.03

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



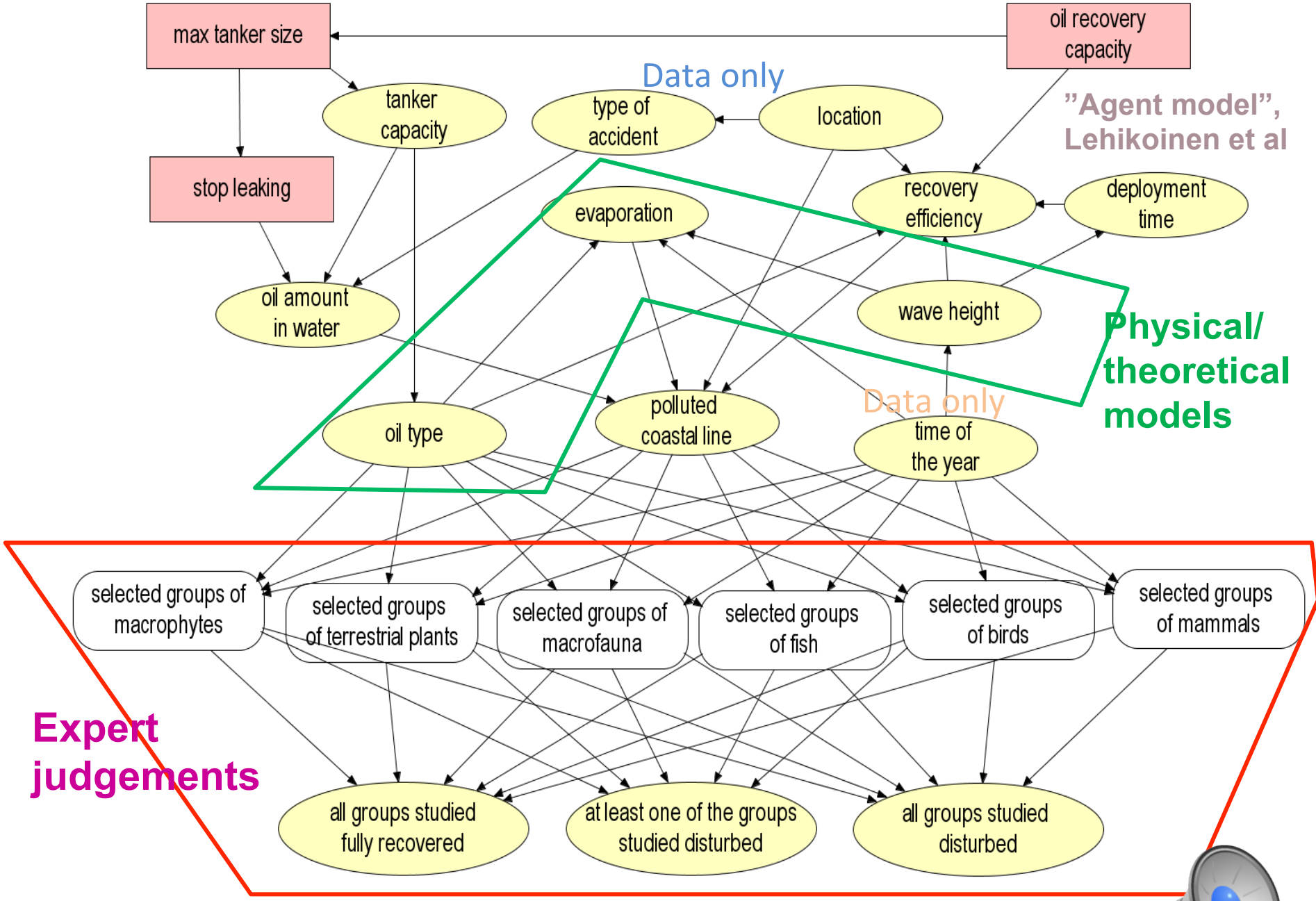
PTOT	High	Good	Moderate	Poor
	3,3	19,1	58,6	19,1

NTOT	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

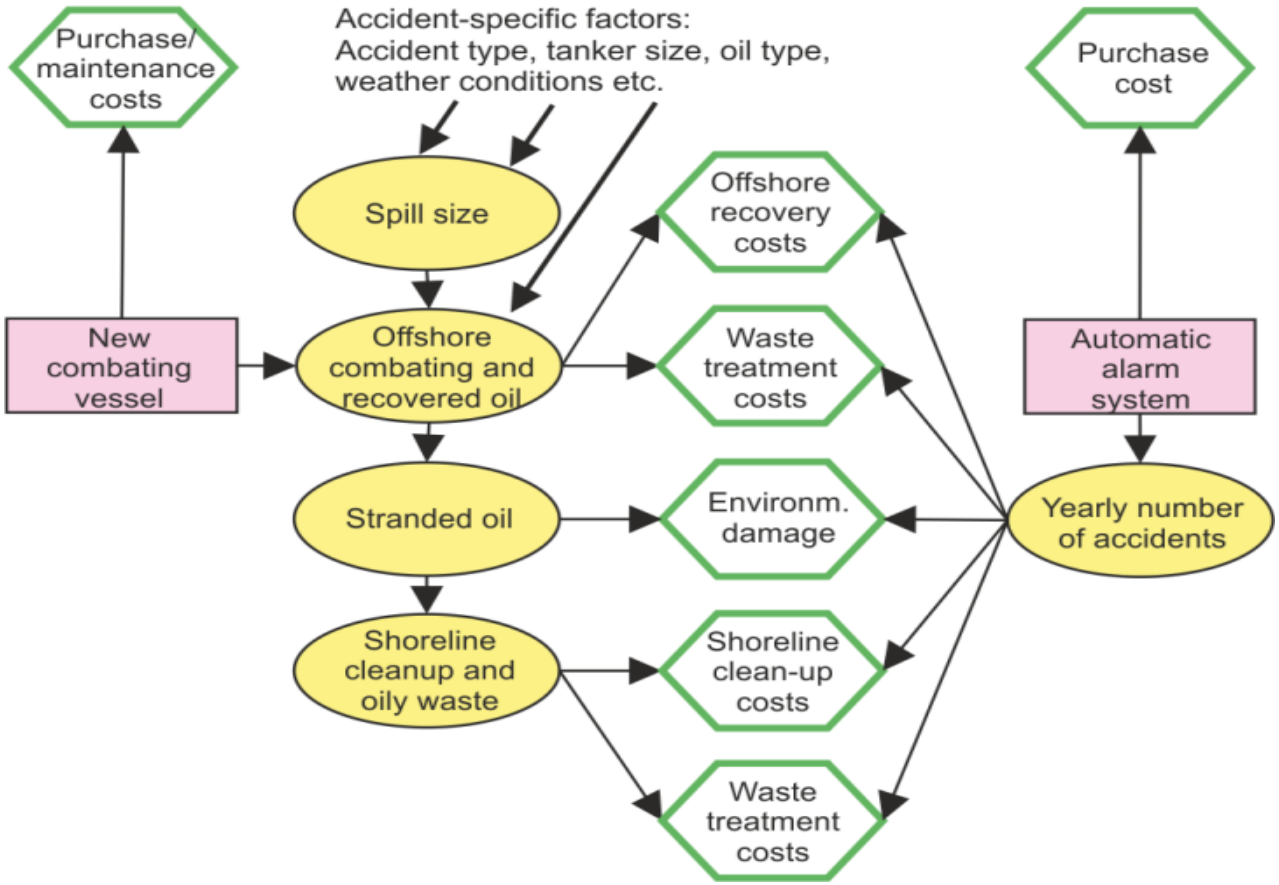
CHLA	Good	High	Moderate
High	83,3	8,3	8,3
Good	79,4	12,3	8,3
Moderate	62,7	1,0	36,3

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

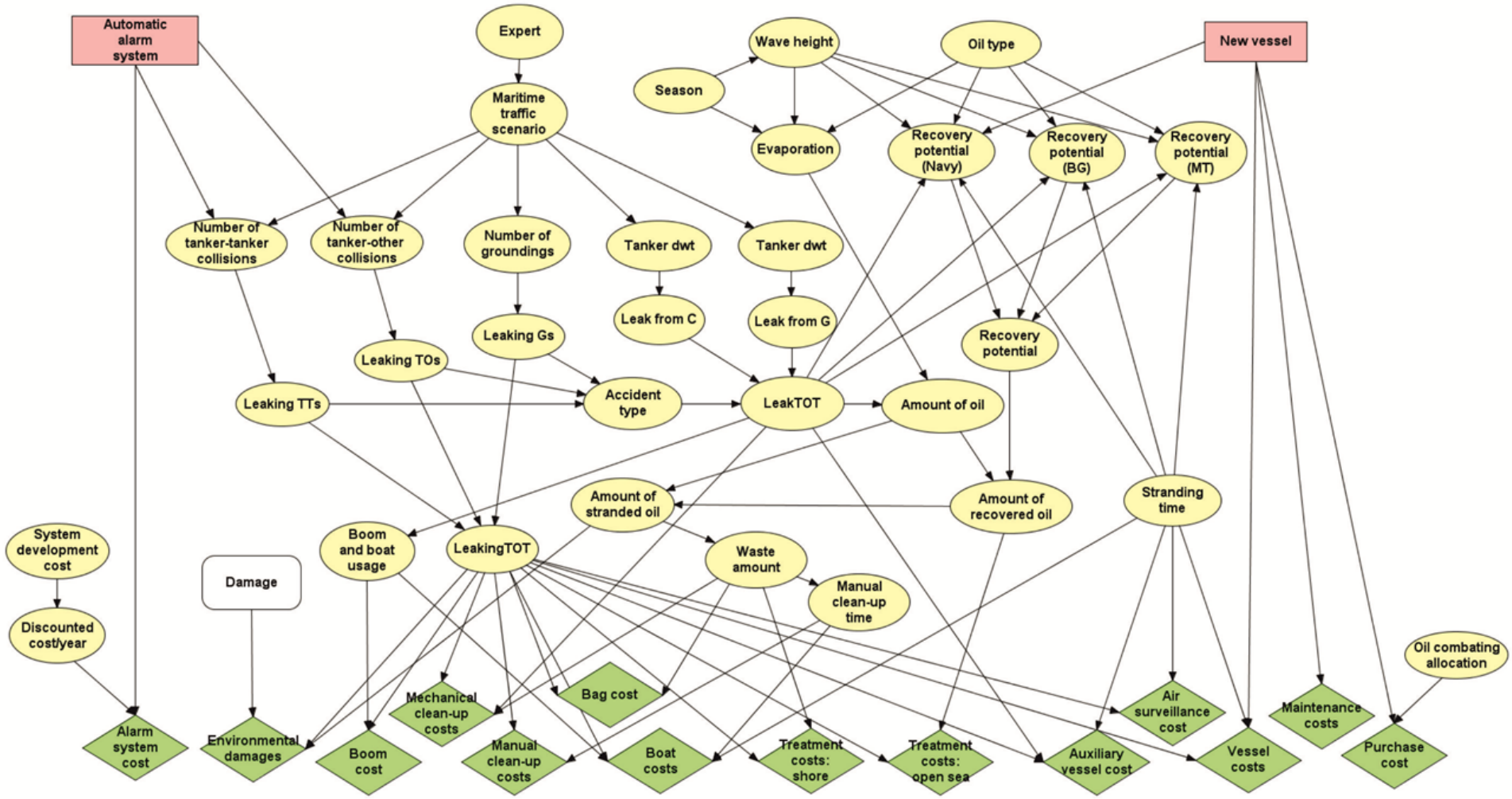


Lecklin, T., Ryömä, R. and Kuikka, S. 2011. A Bayesian network for analyzing biological and long-term impacts of an oil spill in the Gulf of Finland. Marine Pollution Bulletin 62 (2011) 2822-2835.

Cost benefit model of oil spill risk management



Helle et al subm.



Helle et al subm.

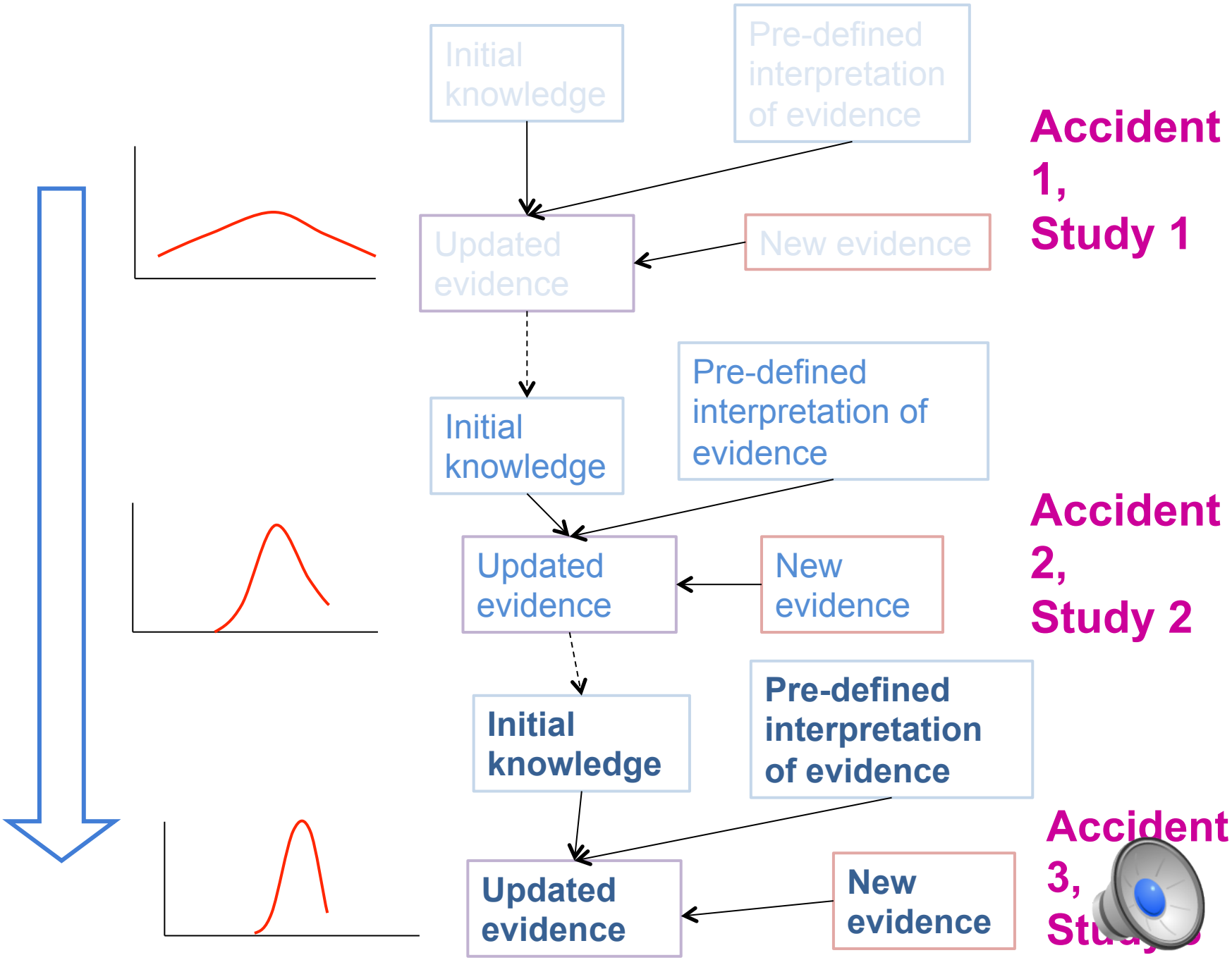
Results: expected benefits – expected costs (/year)

Decision	**Autom. Alarm syst.**		**New combatting vessel**	
State of the other option	**No**		**No**	
Costs/Benefit	***C (€)***	***B (€)***	***C (€)***	***B (€)***
Developing alarm system	-33 234			
Investment cost of vessel			-2 720 000	
Running costs of vessel			-264 226	
Open sea combatting		1 471	-28 837	
Waste treatment (open sea)		389	-1 507	
Shore line clean up		5306		11575
Waste treatment (avomeri)		6 750		35 706
Environmental damage		230 000		1 250 000
Sum	-33 234	243 916	-3 014 571	1 297
NBV (net benefit)	**210 682**		**-1 717 290**	

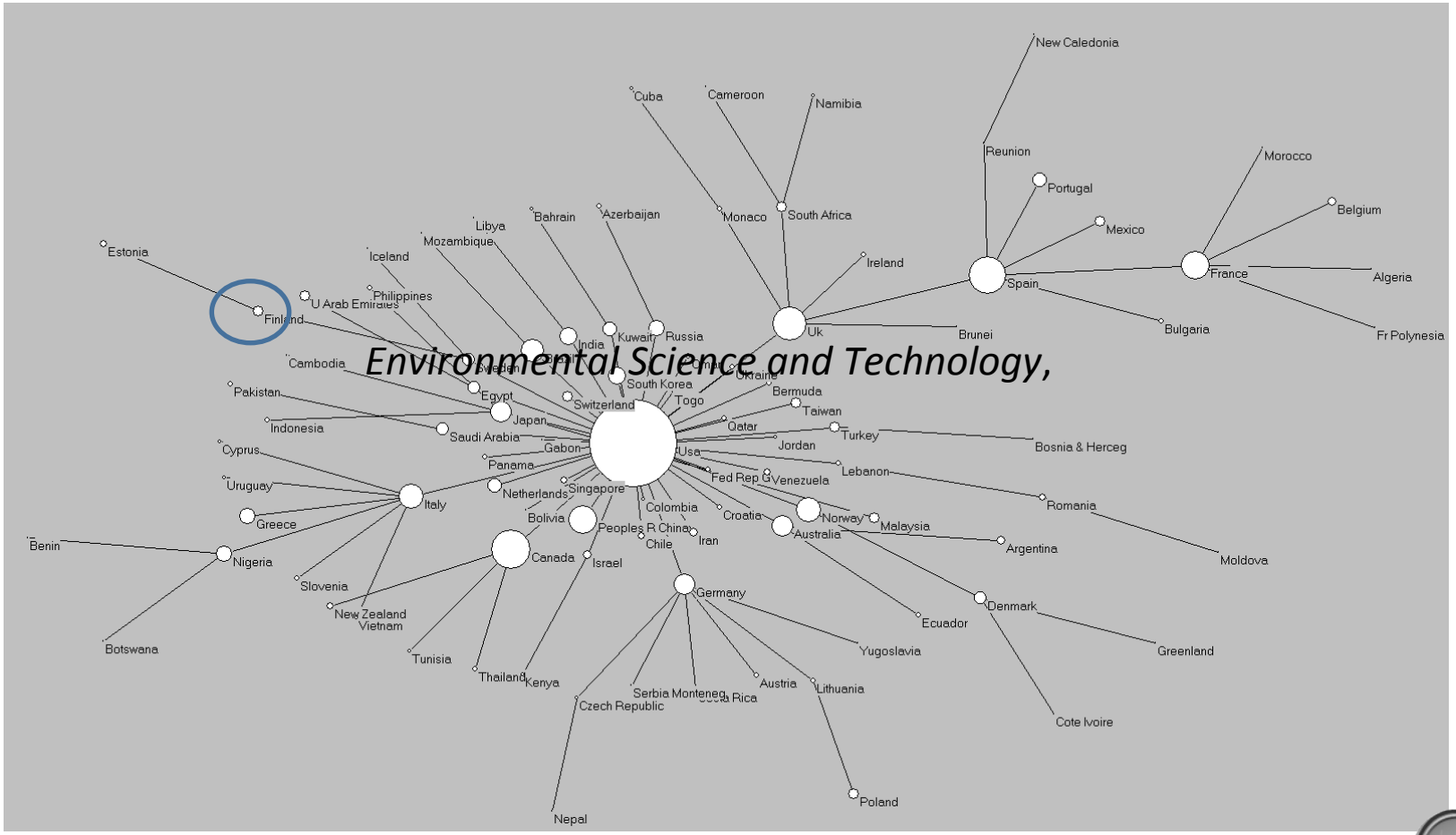
4) Concluding slides: publication and analysis practises, and suggestion for a scientific project

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


Accumulation of knowledge
Initial knowledge
Pre-defined interpretation of evidence
Updated evidence
New evidence
Accident 1, Study 1
Initial knowledge
Pre-defined interpretation of evidence
Updated evidence
New evidence
Accident 2, Study 2
Initial knowledge
Pre-defined interpretation of evidence
Updated evidence
New evidence
Accident 3,

Country collaboration map



Environmental Science and Technology,

Oil spill research by city

Click this zoomable Google map:

http://www.gpsvisualizer.com/display/data/1359360387-25398-130.239.157.157.html

Improvements of governance system

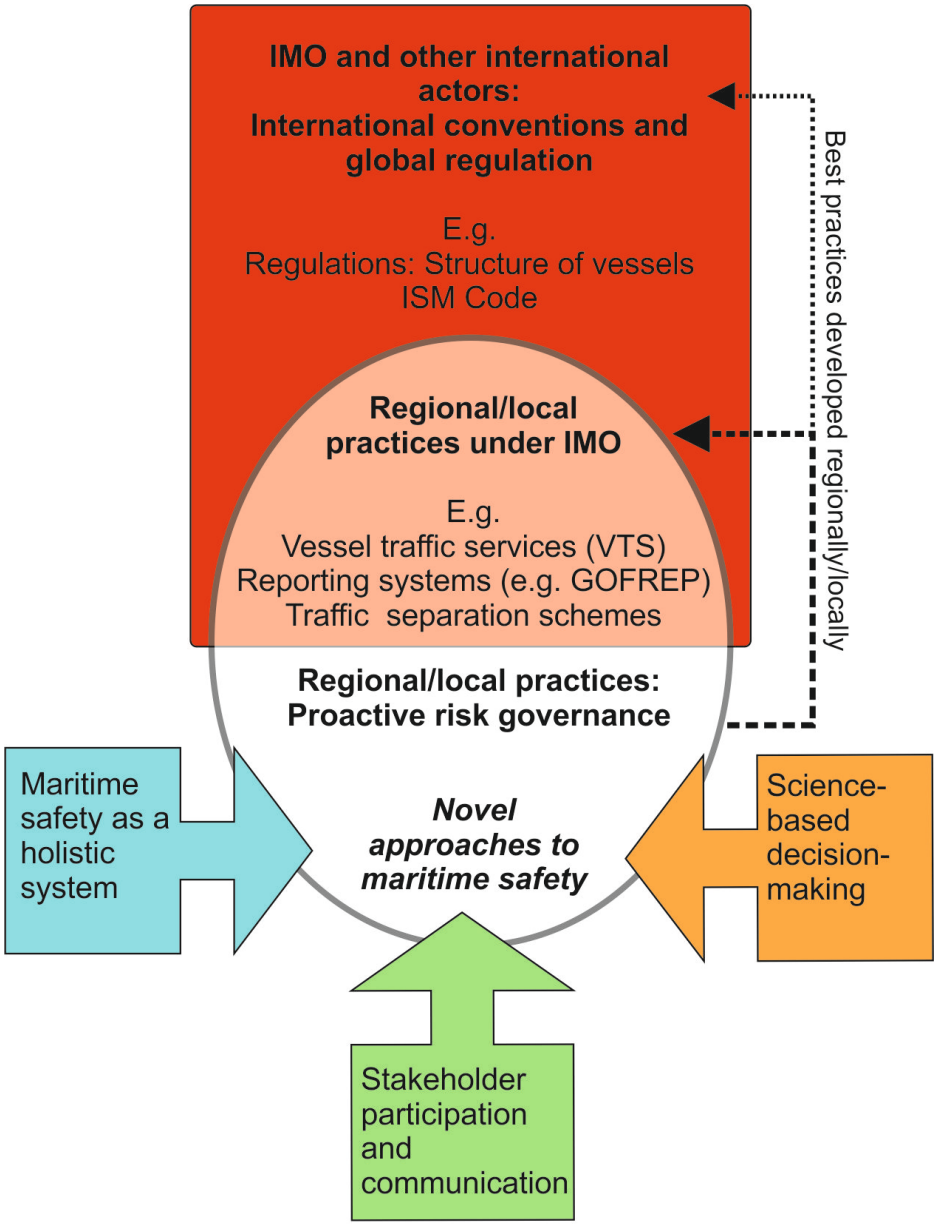
For example fisheries management has strong and active advisory systems, which have power in management and in ”green labelling of the products”

These are missing from the area of oil spill risk analysis, even though the interest of society must be even higher than in fisheries

What, then, are we lacking?

We need both national and international legistlation changes !

New suggested oil spill risk governance structure

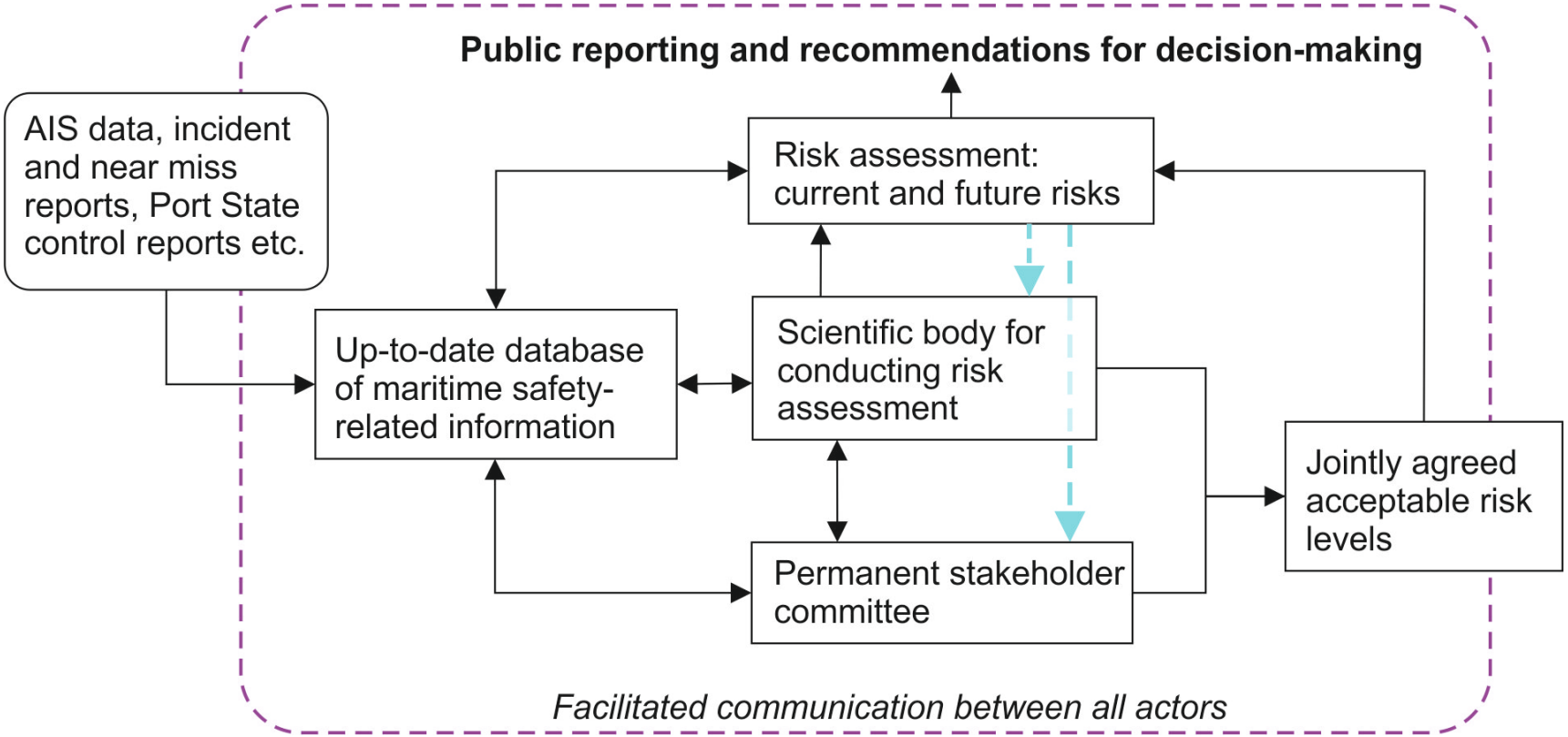


Haapasaari et al, in prep.

How to create maximal interest to prevent an accident?

- Oil companies are large, international and sell a product where are no real differences, and it is easy for customers to change the company => great interest to safeguard **brand value**
- Estimate the potential impacts IN ADVANCE and make everyone to know what they are
- Make the whole business as open as possible
- Have the capacity and legislation to link each tanker load to the final seller of the products
- Create on line systems to report about risks at the moment: reminder of responsibility for companies

New suggested oil spill risk governance structure



Haapasaari et al, in prep.

To my mind, the Strait of Malacca and surrounding waters badly need extensive risk analysis to show what we can loose. Possible funding organisation: EU research mechanisms, especially World Bank

I want to acknowledge

The Baltic Sea

And FEM group in UH

For good motivation !