

# PREVIOUS RESEARCH ON OIL SPILL DECISION ANALYSIS

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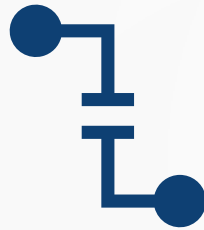


# ABOUT US

- Sakari Kuikka
  - Professor in fisheries biology
  - Special fields are probabilistic interdisciplinary analysis and Bayesian inference
- Jaana Haavisto
  - Part of Sakari's research group of Fisheries and Environmental management (FEM)
    - Interaction between human society and ecosystems
  - Analysing different sources of uncertainty using Bayesian influence diagrams



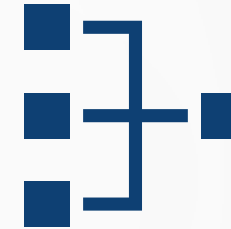
# BAYESIAN NETWORKS AND INFLUENCE DIAGRAMS



## Bayesian Networks

Causal probabilistic networks, uncertainty nodes and arcs describing the causal relationships between them

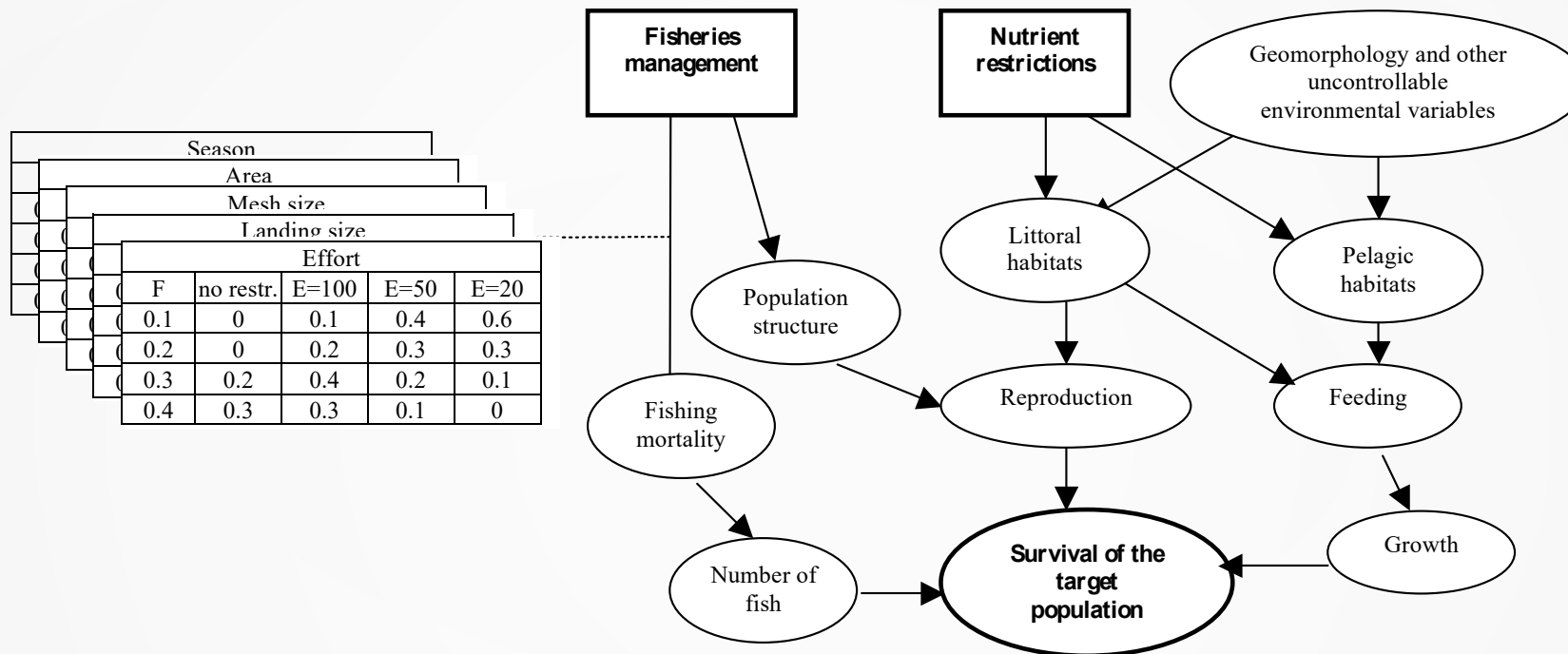
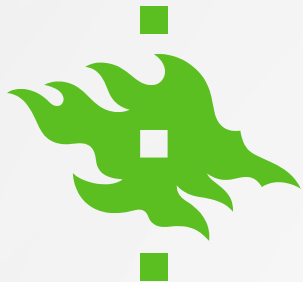
Information about the variables and their relationships from different sources: data, experts, simulations...



## Influence Diagrams

Additional nodes for decisions and utilities

How decisions influence the system by changing probability distributions of outcomes and overall benefit defined by utility function

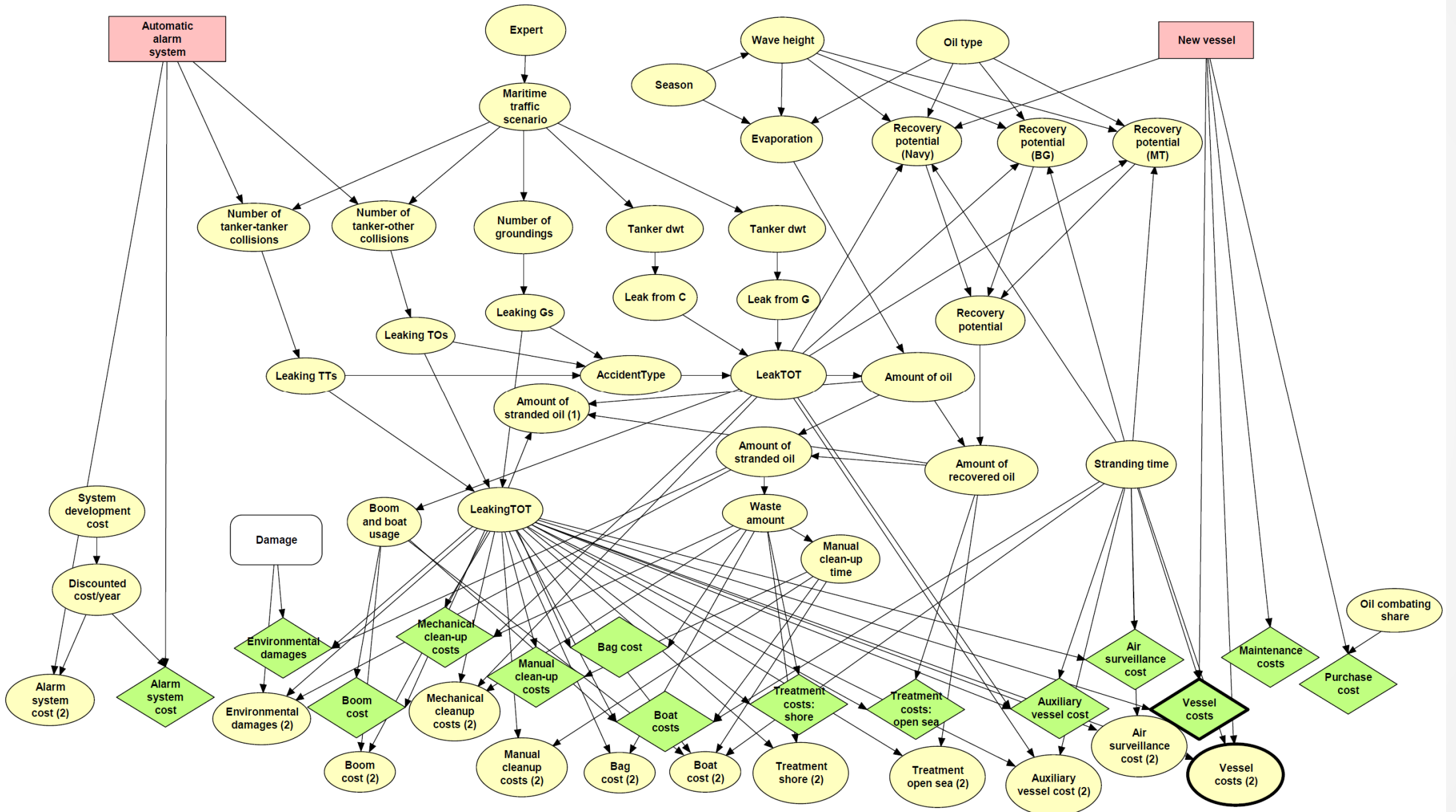


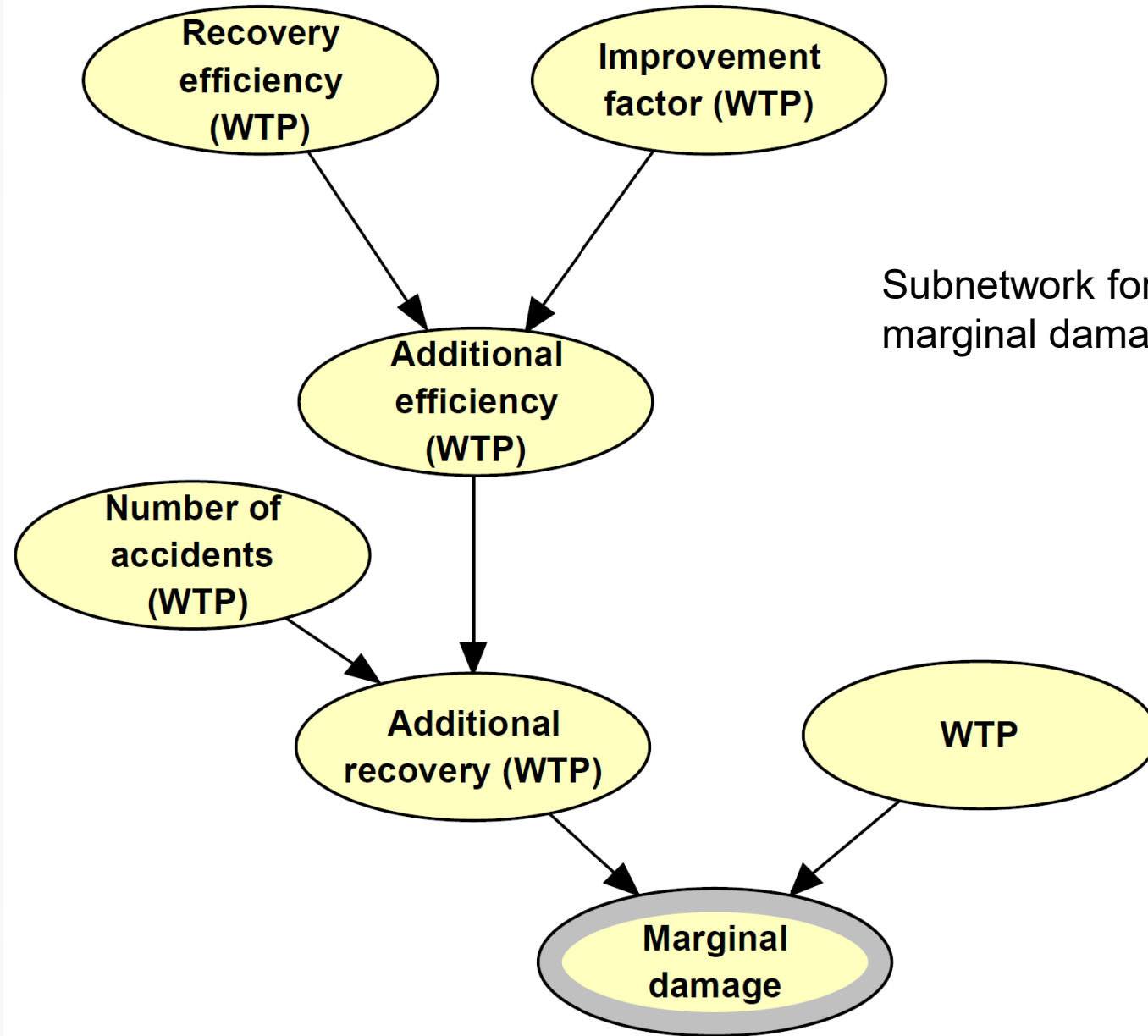
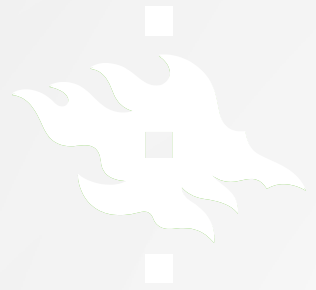
Probabilistic approach – decisions under uncertainty



# PREVIOUS DECISION MODELS: HELLE ET AL. (2015)

- Bayesian cost-benefit model for evaluating pre- and post oil spill management options
  - Pre- spill option: Developing an Automatic Alarm System (AAS) for existing Vessel Traffic System (VTS)
  - Post- spill option: a New oil combatting Vessel (NV)
  - Comparison of costs and benefits for both policy option
  - Both options are almost equally beneficial: expected benefits around 0,2M €/year
  - However, costs of NV much higher
  - Expected benefit/ cost:
    - AAS +0,18M €/year
    - NV -1,68 M €/year
  - The results of the study were used for the investment decision in Finland





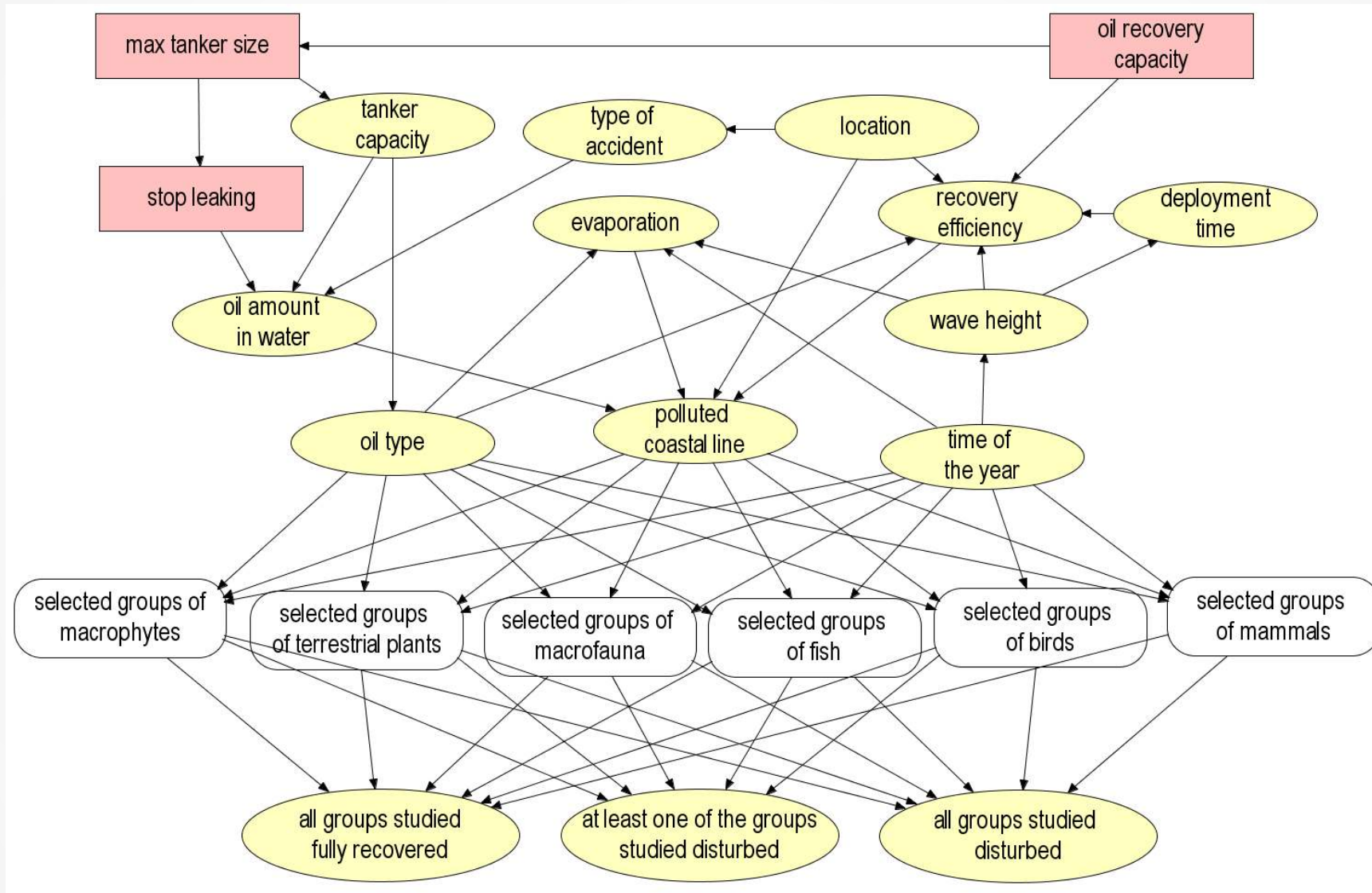
Subnetwork for deriving the marginal damage of oil in environment.

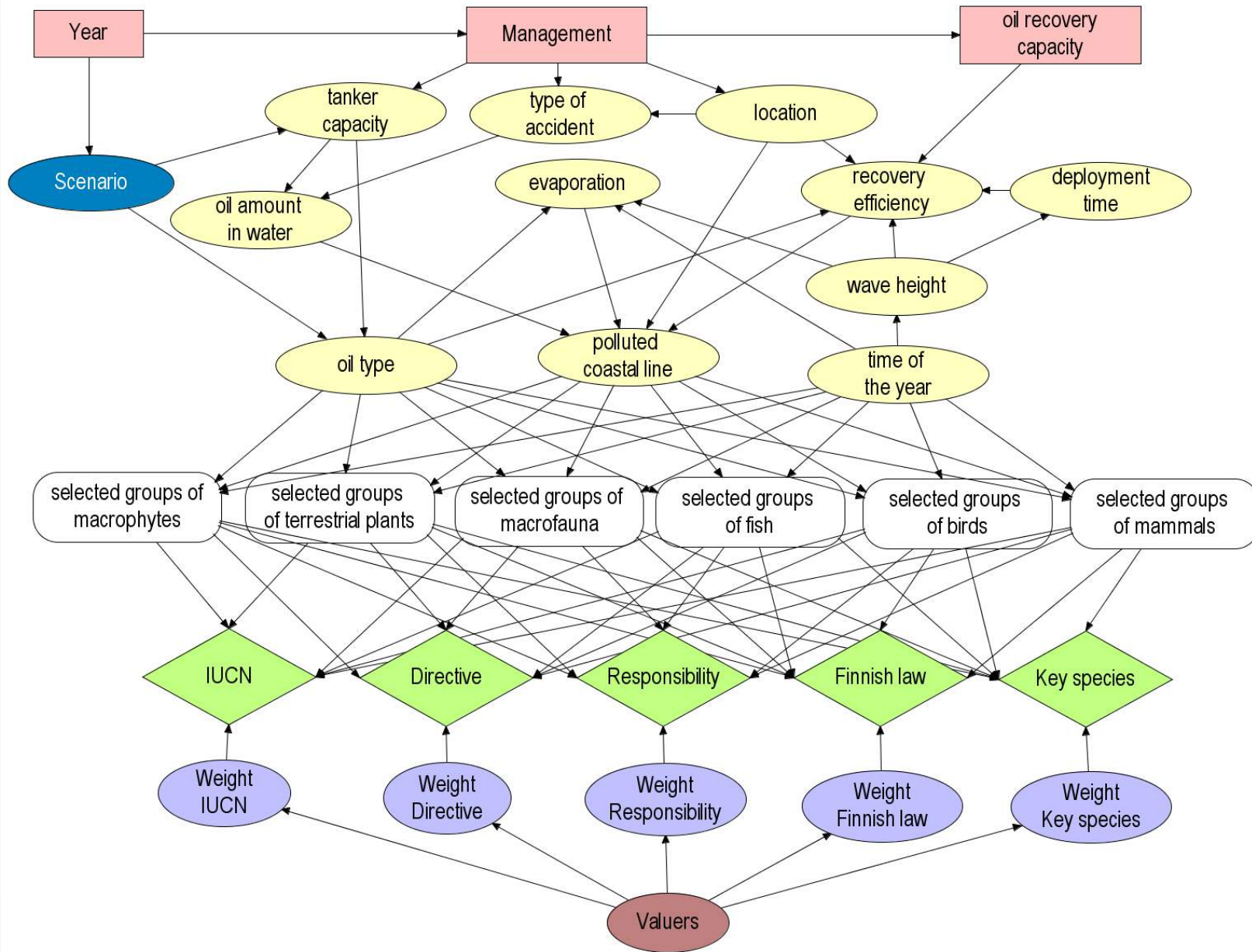


# PREVIOUS DECISION MODELS: LECKLIN ET AL. (2011)

- Helps to assess the recovery potential of different species after an oil accident
  - Considers acute- and future impacts, such as reproductivity, breeding grounds, offspring mortality
- Conditional probability distributions derived using scientific literature and expert judgement
- Analysing different decisions and their effect on long-term biological risks
- Decisions before oil accident (oil recovery capacity, maximum tanker size) and after (stop leaking)









# PREVIOUS MODELS

- Strategic approaches to environmental management
  - Can also act as operational tools
    - Observations can be used as an input to the model
  - What are the desired states in the future, and how they can be obtained?
  - Operational vs strategic, today vs tomorrow



# UNCERTAINTY OF IMPACTS – THE DIFFICULTY OF PREDICTING

## *M/T Amoco Cadiz*

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

**VS.**

## *M/T Exxon Valdez*

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



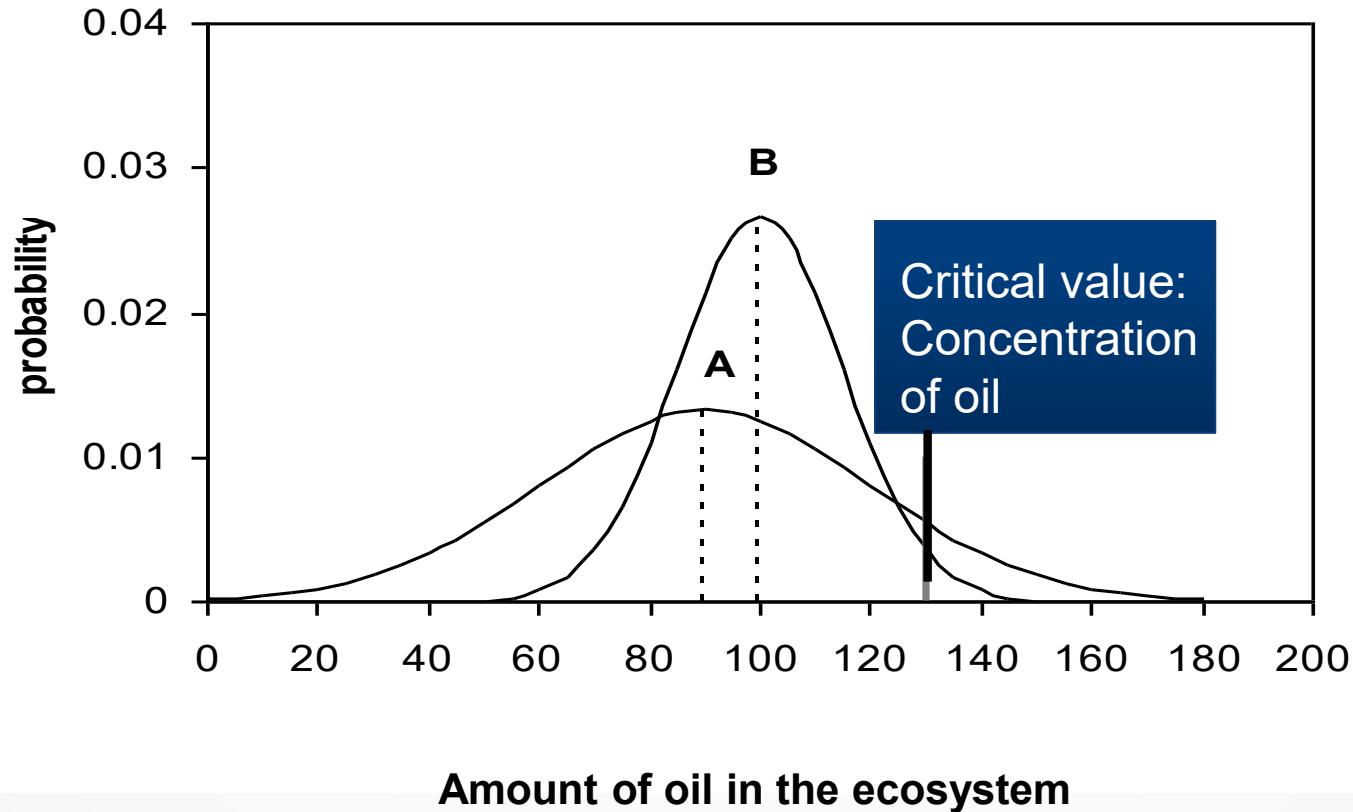
## Unknown oil tanker

- February 1976
- Öland
- 10 t
- 60 000 birds died





# Importance of uncertainty: probability to go above a critical threshold



⇒ Probabilistic calculus may be needed for a correct decision



# INFORMATION UNCERTAINTY AND VALUE OF INFORMATION (VOI)

- Uncertainty about the system affects the certainty of optimal decisions
  - Prediction uncertainty: how much the weighting and deviation of future scenarios affect the decision analysis results?
  - VOI: What variables or parts of the model are most beneficial to know better?
    - Decision making aspect



# DECISION UNCERTAINTY AND VALUE OF CONTROL (VOC)

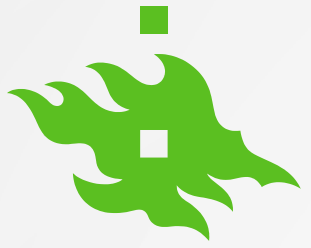
- Uncertainty in the implementation affects the outcome of the decision analysis
  - VOC: How precisely the desired outcomes can be reached?
  - Linked to VOI: knowledge and control



# QUESTIONS AND POINTS FOR DISCUSSION: UNCERTAINTY ESTIMATES IN DECISION MAKING

- From the point of view of a risk manager;
  - As a description of uncertainty, is it more beneficial to have a probability distribution or just one number? (a whole probability distribution of outcome, vs the probability to achieve the wanted outcome)
  - If management decisions are analyzed in your work, is the uncertainty of implementing the decision analyzed in your current risk management tools?
    - If not, would you find this type of analysis useful for strategic planning?





# QUESTIONS AND POINTS FOR DISCUSSION

1. What should be the objective to be achieved?
  - i Feedback to our ideas presented.
  - ii Actions at sea - what needs to be protected.
2. What the application/tool should do and how (what's already there to use)?
3. Products/tools already out there and can we add some value to those? Perhaps there are ways of combining different tools, i.e. finding additional synergies?
4. What functions and buttons should the tool have?
5. What kind of nature values should be included for sure and is it doable for all the layers that the stakeholders list down?
6. Should we make an aggregated assessment (e.g. EcoSensitivity field based on cumulative impacts on natural values)?



# SOURCES 1/2

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# Thank you for your time!

