

# Ecological vulnerability analysis: from protecting species to ecosystems

Marieke De Lange



# Acknowledgements

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# *Session 1: Aspects théoriques*

- Ecological Risk Assessment (ERA):
  - estimate **likelihood** of **adverse** effects of **stressors** on **populations** and **ecosystems**



# Challenges in ERA

- Individual level toxicological sensitivity in lab  $\neq$  population level field effect
- Lab vertebrate species not relevant to field situation (conservation management)
- Protecting species or ecosystems?



lab to field ???



# Dichotomy in knowledge for wildlife species

- Wildlife species → abundant ecological data to predict vulnerability, no/limited toxicological data
- Laboratory species → abundant sensitivity data, limited info on field population effects



lab to field ???



# New conceptual method

ecological vulnerability = function of  
exposure, effect, recovery

- ecological knowledge to improve current methods of ERA
- conceptual approach based on ecological vulnerability
- more ecological relevance in Risk Assessment

De Lange et al., 2009, Environmental Toxicology & Chemistry, 28, 2233-2240

De Lange et al., 2010, Environmental Toxicology & Chemistry, 29, 2875-2880



# Ecological vulnerability

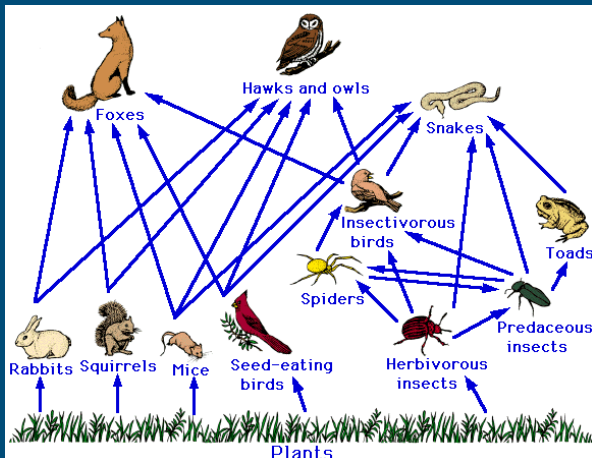
## Exposure



## Effect



## Recovery



# Toxicological sensitivity < Ecological vulnerability

## Sensitivity

- after exposure and uptake
- expressed as toxicity threshold
- organism level
- opposite of tolerance

lab measurements

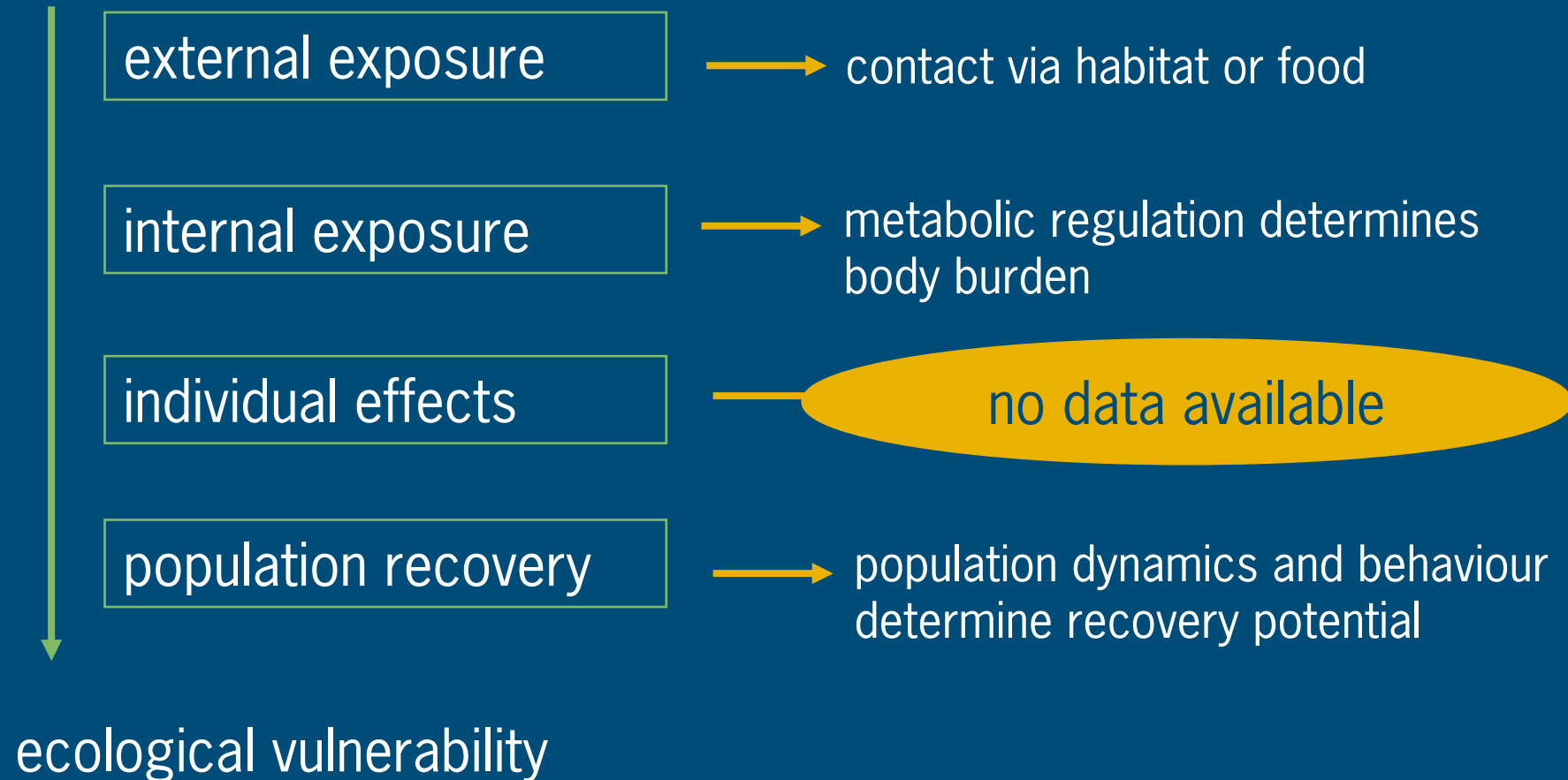
## Vulnerability

- exposure
- uptake, metabolism, protection mechanisms, excretion
- toxicological sensitivity
- recovery
- population level

field effects



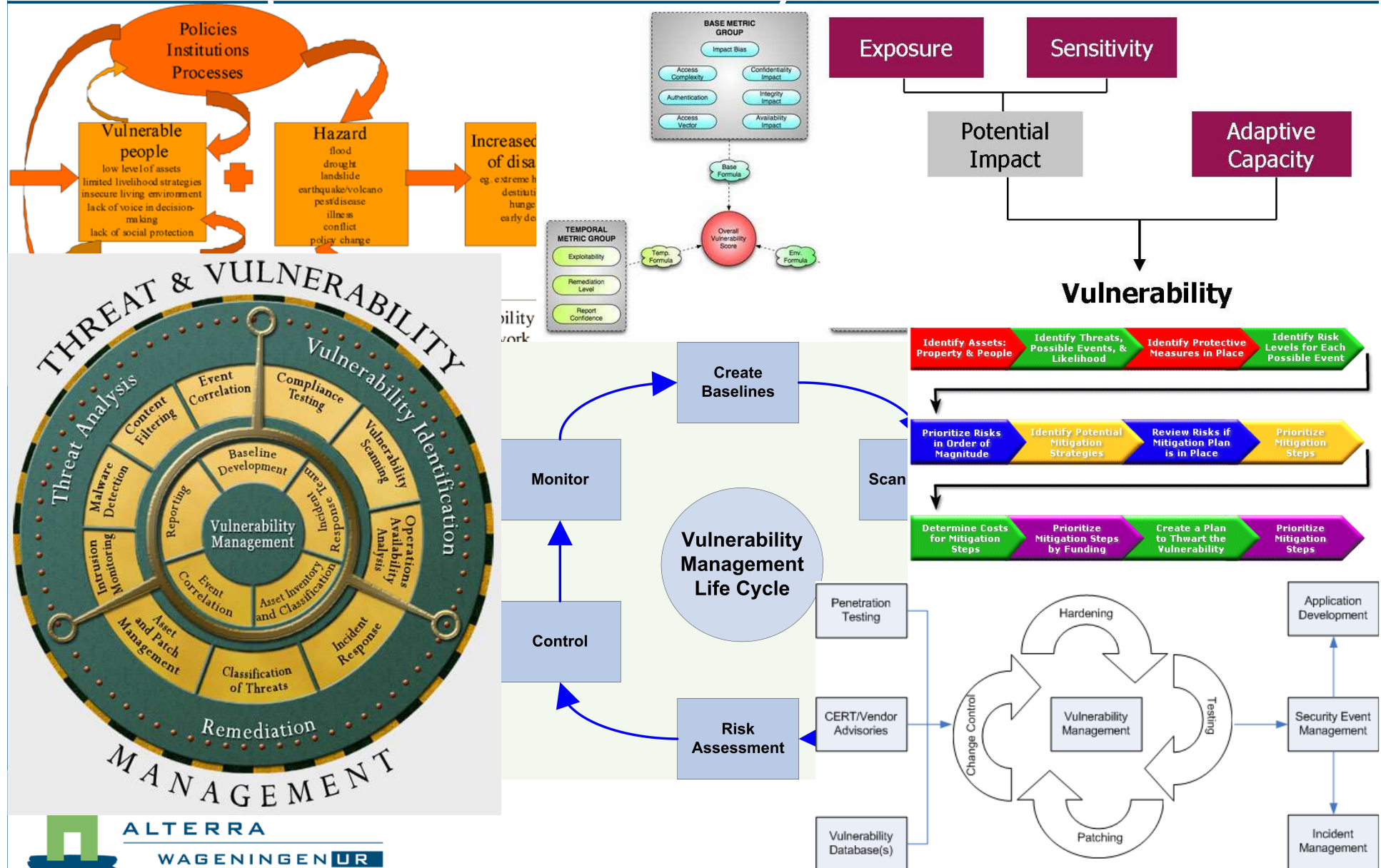
# Ecological traits



# Ecological vulnerability assessment in ERA

- ordinal ranking of species
- no large inconsistencies with field data
- ecological traits of relevant wildlife species
- toxicological experiments less needed
- useful and sound innovation to ERA

# Concept of vulnerability: Is it all new ?



# Resilience versus vulnerability

- Trade of terms between disciplines
- Resilience = originally from ecology
  - retrospective approach
  - community and ecosystem level
- Vulnerability = originally from social sciences
  - prospective approach
  - population level

# Two sides of the same coin?

- Convergence in socio-ecological systems
  - adaptive capacity = resilience
  - increasing adaptive capacity reduces vulnerability





# From species to ecosystems

- Risk = Hazard X Vulnerability
- Vulnerability
  - exposure
  - effects
  - recovery
- Easy concept, yet difficult to grasp in a simple measure
- Prognosis and diagnosis

# Synergy between resilience and vulnerability

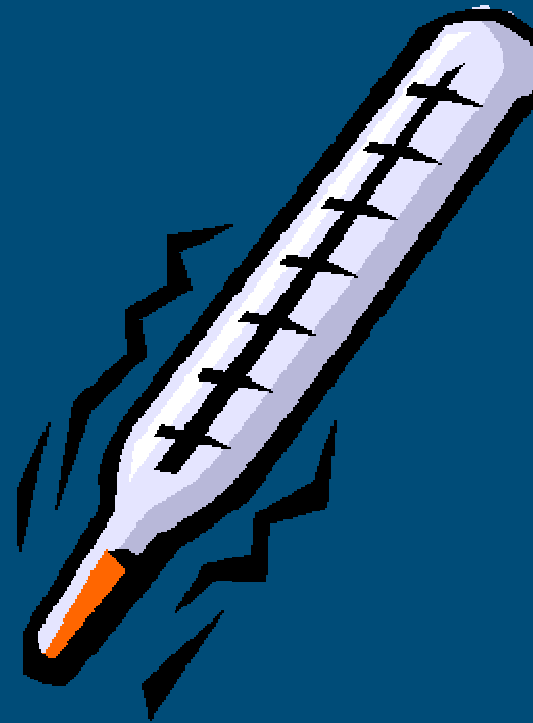
- Vulnerability of what to what ?
  - similar to Carpenter (2001) resilience of what to what?
- Biological integration level
  - population, community, ecosystem
- Ecological traits
  - link between structure and function

# Vulnerability = inability to respond

- Inability to respond determines vulnerability
  - plasticity at species level
  - persistence, resistance and resilience at community level
- What species/systems cannot do !

# How can we measure it ?

ecological health meter

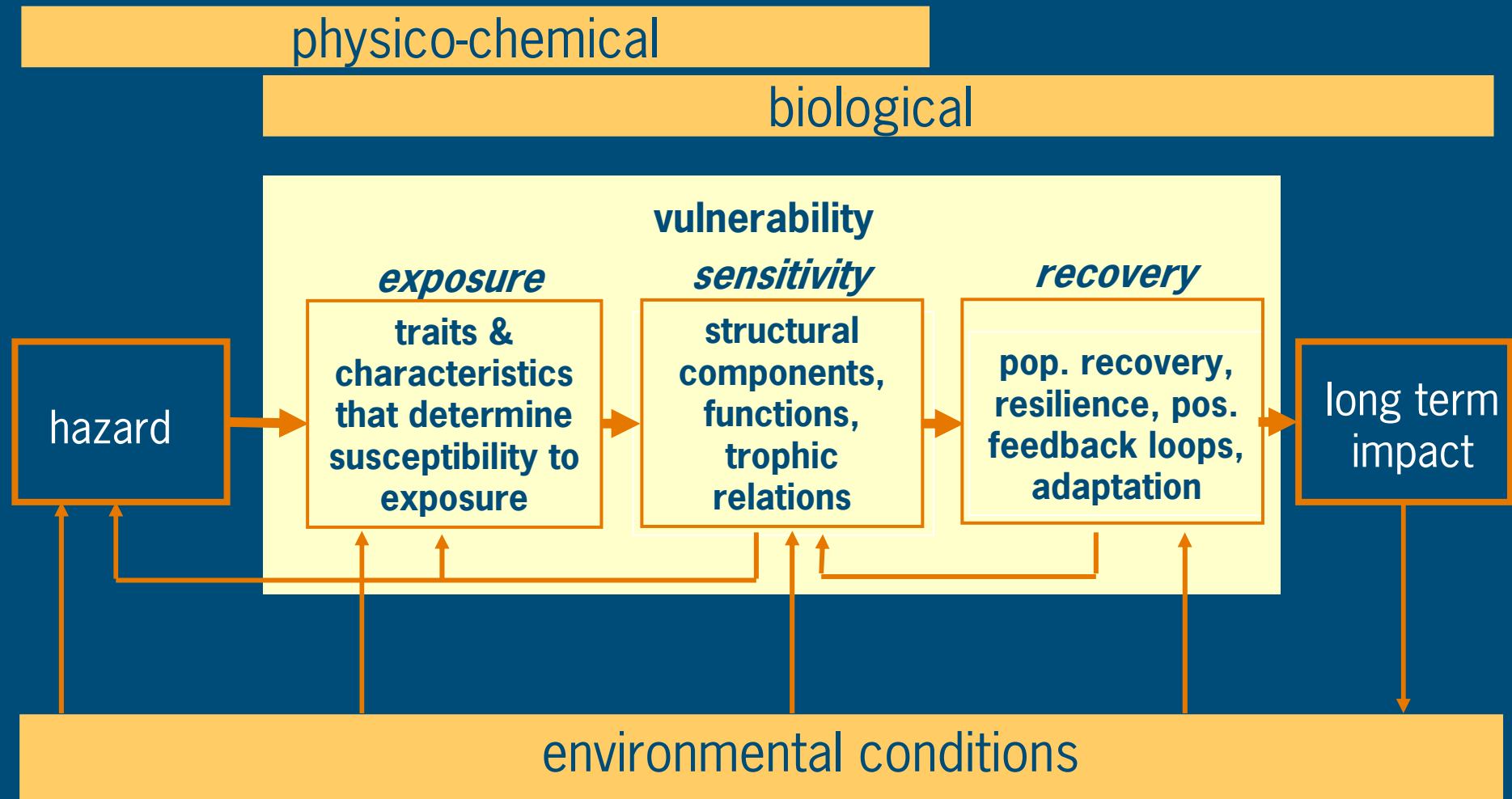


# Perspectives for further development

- Develop general framework
  - next slide
- Application in risk management
- Quantification of vulnerability
  - ecosystem services + ecotoxicology



# General framework for vulnerability analysis



De Lange et al., 2010, Science of the Total Environment, 408, 3871-3879

# Further perspectives

- Ecological vulnerability analysis useful to estimate actual risk for a specific ecosystem
- Method can be improved
  - methodology for ecosystem vulnerability
  - quantitative results
- Framework can be a guiding tool
- Implementation by a tiered approach

# To conclude

- From species to ecosystems
  - assessment of ecological vulnerability
- Simple measurement ?
  - multidisciplinary approach
- Is it feasible ?
  - combine forces in resilience and vulnerability approaches

# Questions, remarks ???

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# Published methods on ecological vulnerability

- Oil Vulnerability Index (King & Sanger, 1979)
- Environmental Sensitivity Index
- Regional Vulnerability Assessment (Boughton et al., 1999)
- Utility Index/Vulnerability Index (Golden & Rattner, 2000)
- Vulnerability maps (Offringa & Lahr, 2007)
- Vulnerable marine areas (Halpern et al., 2007)
- Ecological vulnerability analysis (De Lange et al., 2009)



## Published methods on socio-ecological vulnerability

- Landscape species (Coppolillo et al., 2004).
- Quantitative vulnerability assessment of environmental change (Metzger & Schröter, 2006).
- Vulnerability of socio-ecological systems (de Chazal et al., 2008).
- Arctic Water Resource Vulnerability Index (Alessa et al., 2008).

# Differences between methods

	Species	Habitat/Landscape
Stressor	oilspills at sea soil contaminants	human activities changes in landscape oilspills at sea
Output	ranking of species	map ranking of habitats

# Differences in scale

