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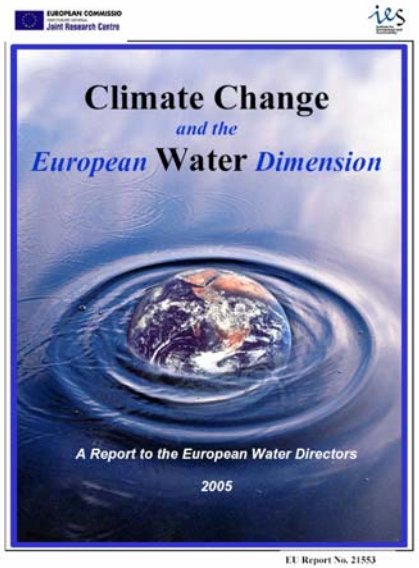
Climate change impacts on water quality / freshwater ecology

Implications for the WFD implementation

Outline

- Important relevant and recent documents
- Physical steering factors for water quality and freshwater ecology
- Main impacts on water quality
- Main impacts on freshwater ecology
- Implications for WFD implementation
- Research challenges

Important relevant and recent documents

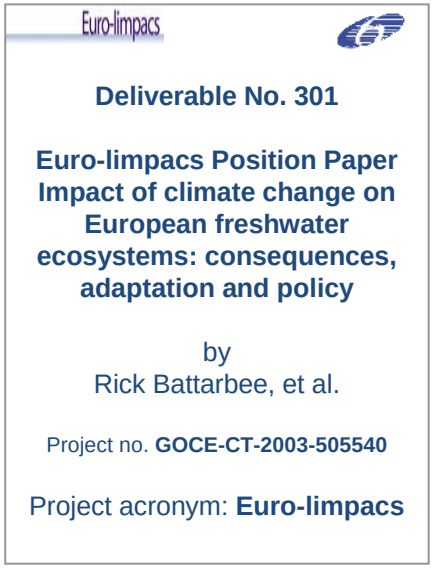


JRC report to Water Directors 2005

JRC/DGEnv/DG Research:

CC and WFD workshop report 2006

EEA/JRC/WHO CC report 2008

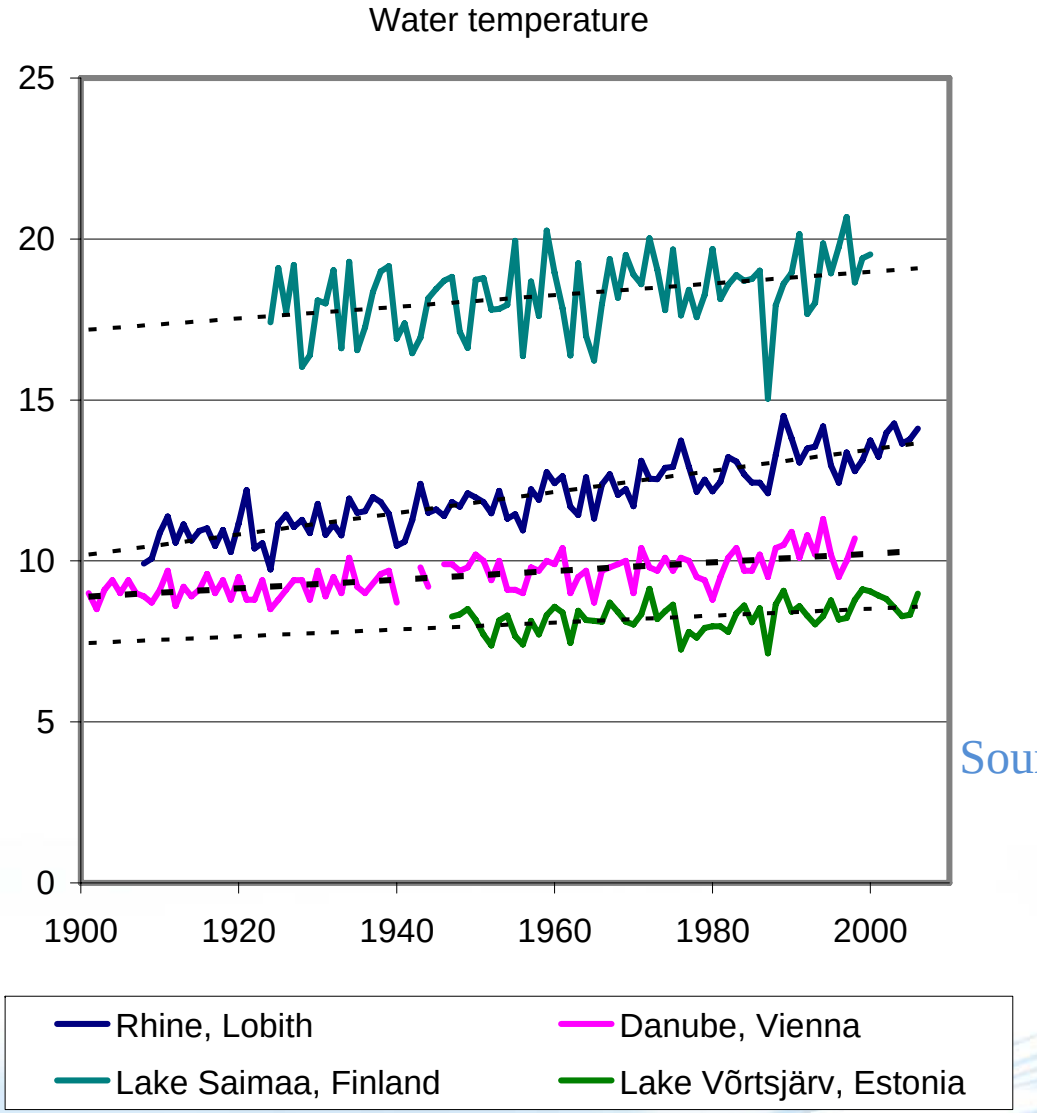


EuroLimpacs summary, 2008 Battarbee et al.

Physical steering factors for water quality and freshwater ecology

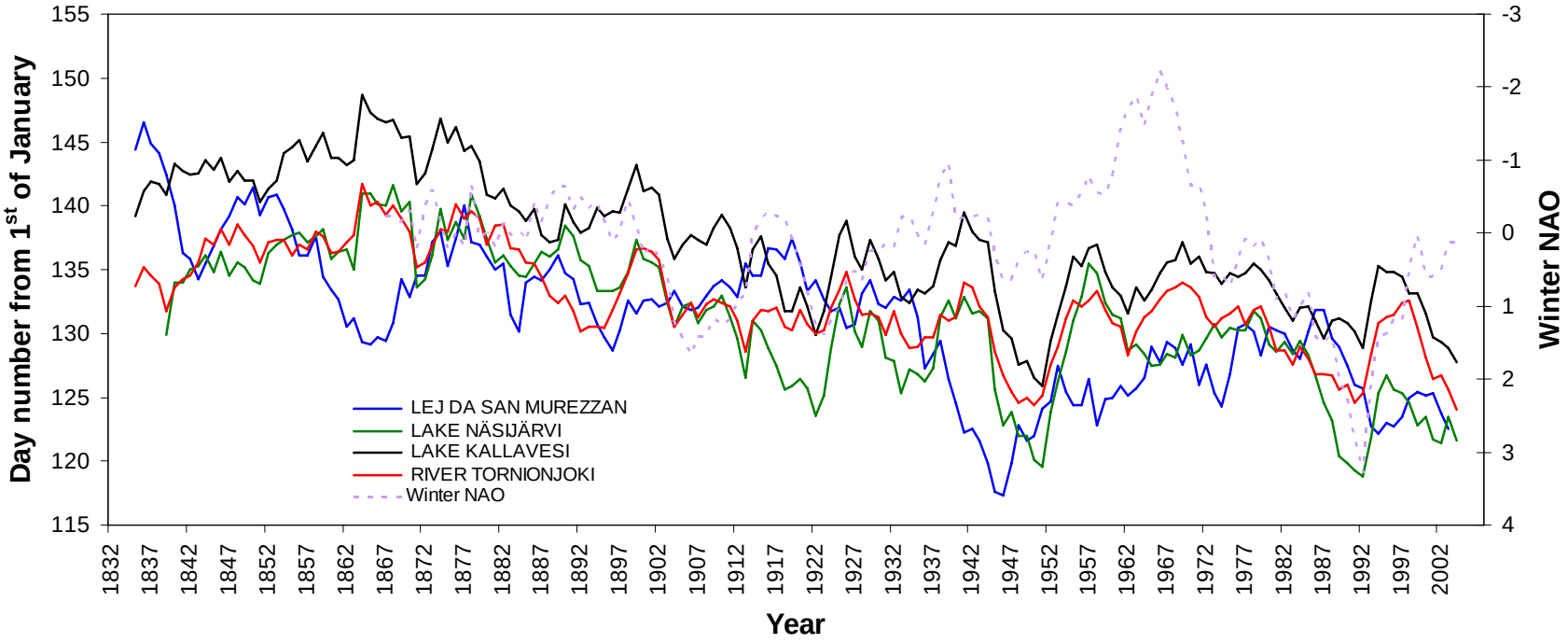
- Higher water temperature
- Less ice cover, and longer growing seasons
- Increased water flows (North-Central)
- Increased water level/flow fluctuations
- More erosion
- Increased droughts and lower water levels/flows (South)
- Less underwater light (North-Central)
- More/less turbulence in lakes (North/South)
- Physical modifications of river channel

Higher water temperatures



Source: EEA/JRC/WHO report

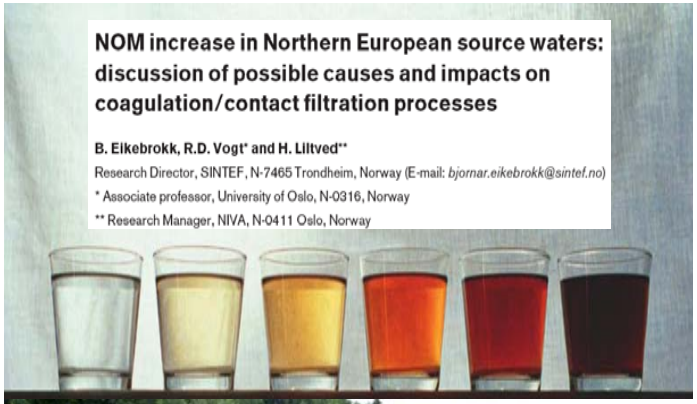
Reduced ice cover



Source: EEA/JRC/WHO report

Main impacts on water quality 1:
more coloured/turbid water with more bacteria

- Browner water, due to more DOC coming from catchment (due to less acid rains and not CC alone)
- More turbid water, due to more erosion
- More bacteria due to sewage overflow and other organic material



River Hobøl, Norway, E. Skarbøvik, Bioforsk

Main impacts on water quality 2:
more eutrophic water with less oxygen

- less oxygen due to higher temperatures and longer summer stratification periods
- more nutrients due to:
  - increased external loading from more erosion and sewage overflows
  - internal loading caused by longer summer stratification
  - lower water levels in summer (South)

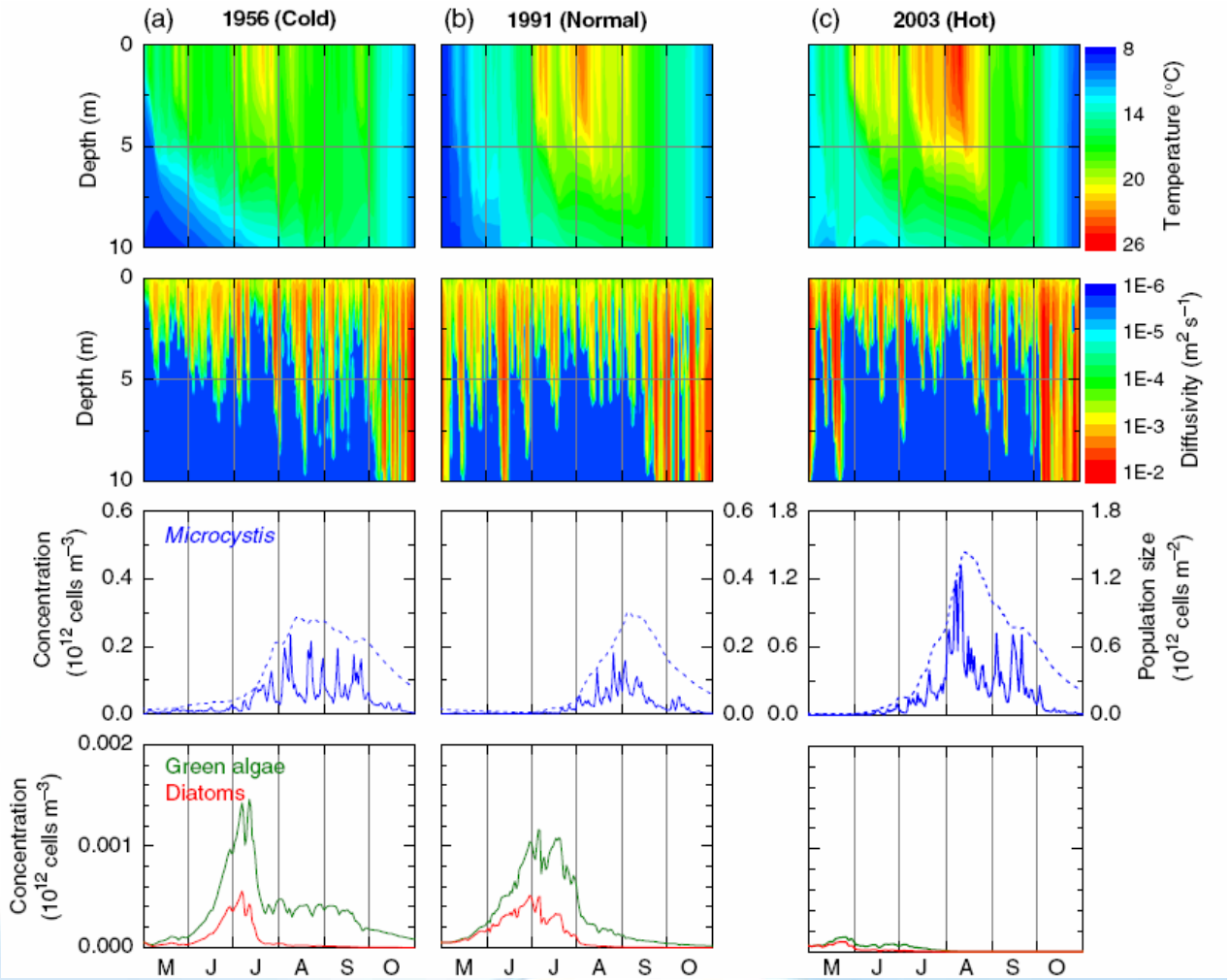
Photo: *© Jeroen van Wichelen, Ghent University*

Main impacts on water quality 3:
salter and more toxic water?

- increased conductivity or salinity (esp. groundwater) due to sea water rise, salt water intrusion and evaporation (in South)
- more toxic?
  - increased transport of POPs to colder areas and increased uptake in fish and other biota,
  - increased use and loads of pesticides
- more or less acidic?
  - Alkalinity generation will increase,
  - but so will sea salt episodes

Main impacts on freshwater ecology:
Structural changes 1: More algae

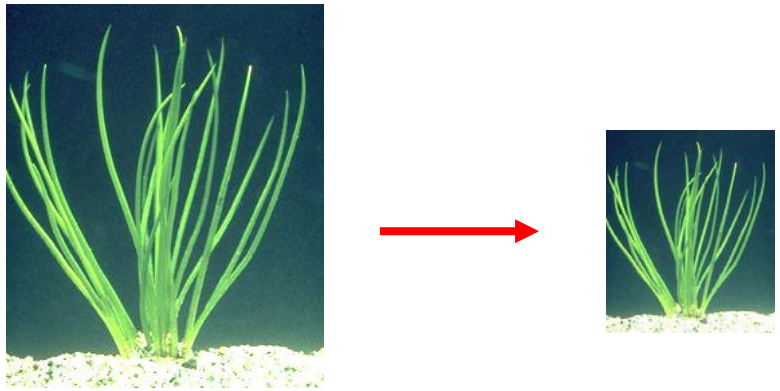
- More harmful algal blooms in lakes:
  - warmer water
  - longer growing season
  - more nutrients
  - less zooplankton
- More filamentous benthic algae in rivers and lakes:
  - warmer water
  - longer growing season more nutrients



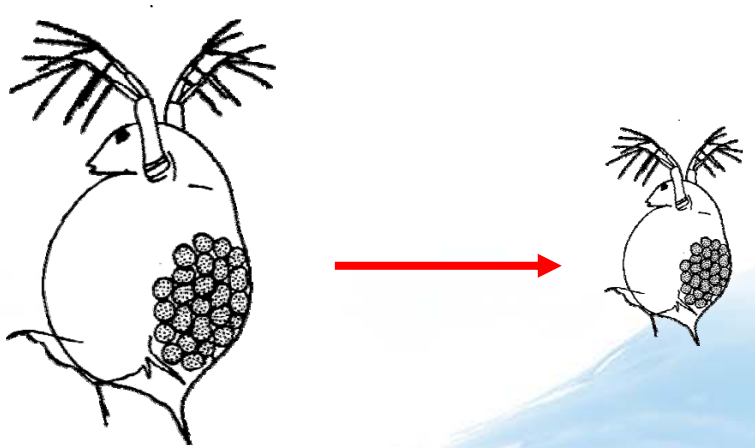
Source: Jöhnk et al. 2008.

Main impacts on freshwater ecology:
Structural changes 2: macrophytes and zooplankton

- Less macrophytes in lakes and rivers:
  - less underwater light
  - more water level fluctuations



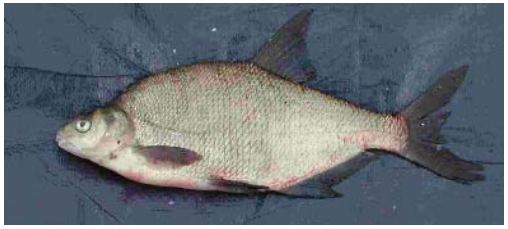
- Less zooplankton in lakes, esp. large grazers



Main impacts on freshwater ecology:
Structural changes 3: Fish

- Less salmonids and other piscivores
- More cyprinids and other planktivores/ benthivores

Photo: Frode Kroglund, NIVA



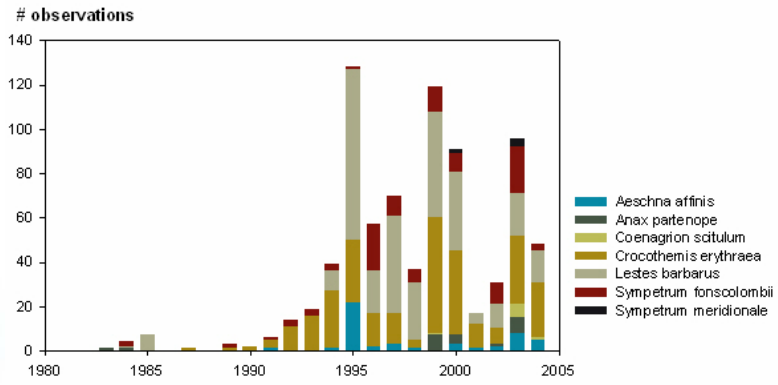
Ref: Erik Jeppesen, NERI, DK

Main impacts on freshwater ecology: Functional changes:

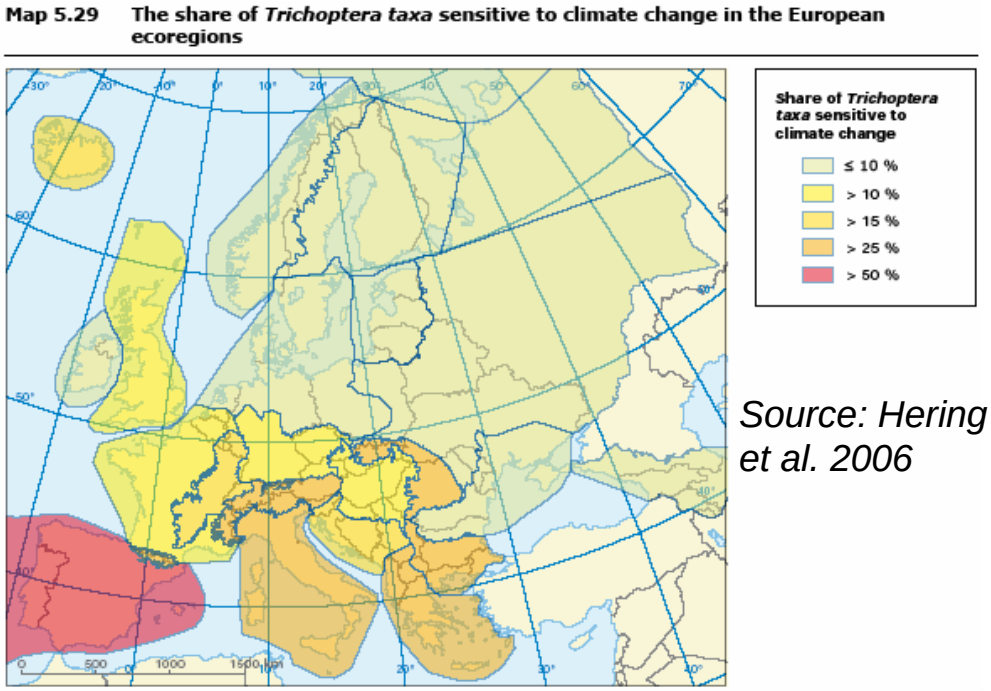
- Lower production/respiration ratio
- More heterotrophic food webs
- Greater dominance of omnivorous small organisms
- Increased risk of nuisance algae

Main impacts on freshwater ecology:
Biogeographical changes:

- Fewer northern and arctic species
- More southern and invasive /alien species



***Observed occurrence of southern dragonflies in Belgium**, 1980-2007. From Biodiversity indicators 2008*

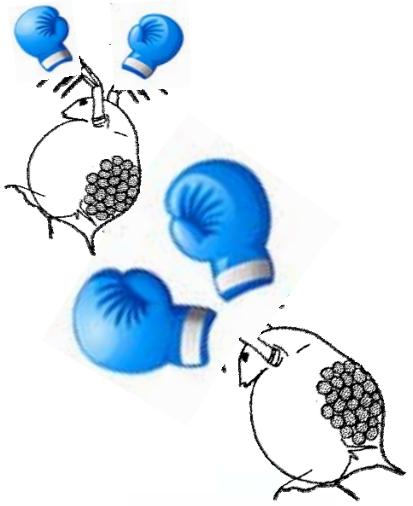


Source: Hering et al. 2006

Main impacts on freshwater ecology: Evolutionary adaptations??

- Evolutionary adaptations: How fast?
- Selection for opportunistic species?
- Battle between evolution of native species versus migration of southern invaders?

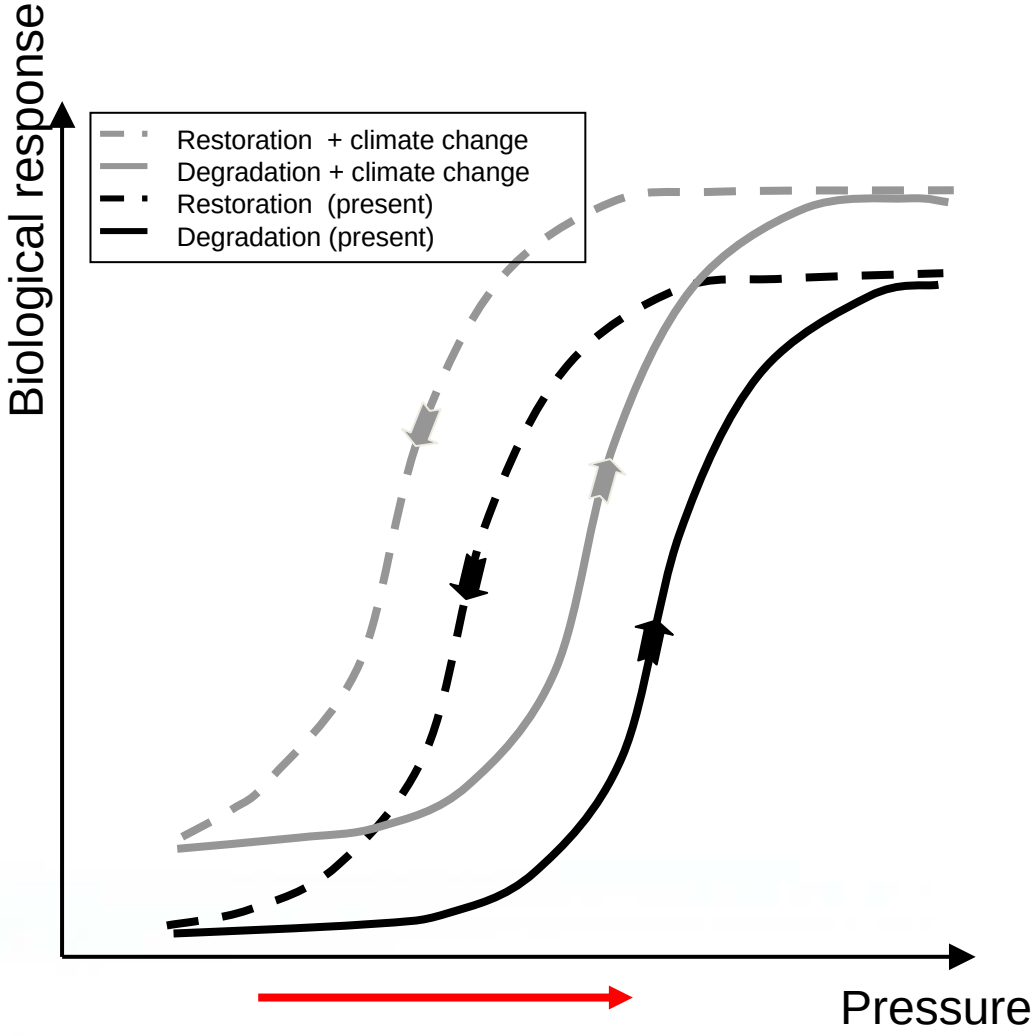
Native species



Southern invader

Ref. Luc De Meester
www.kuleuven.be/bio/dea

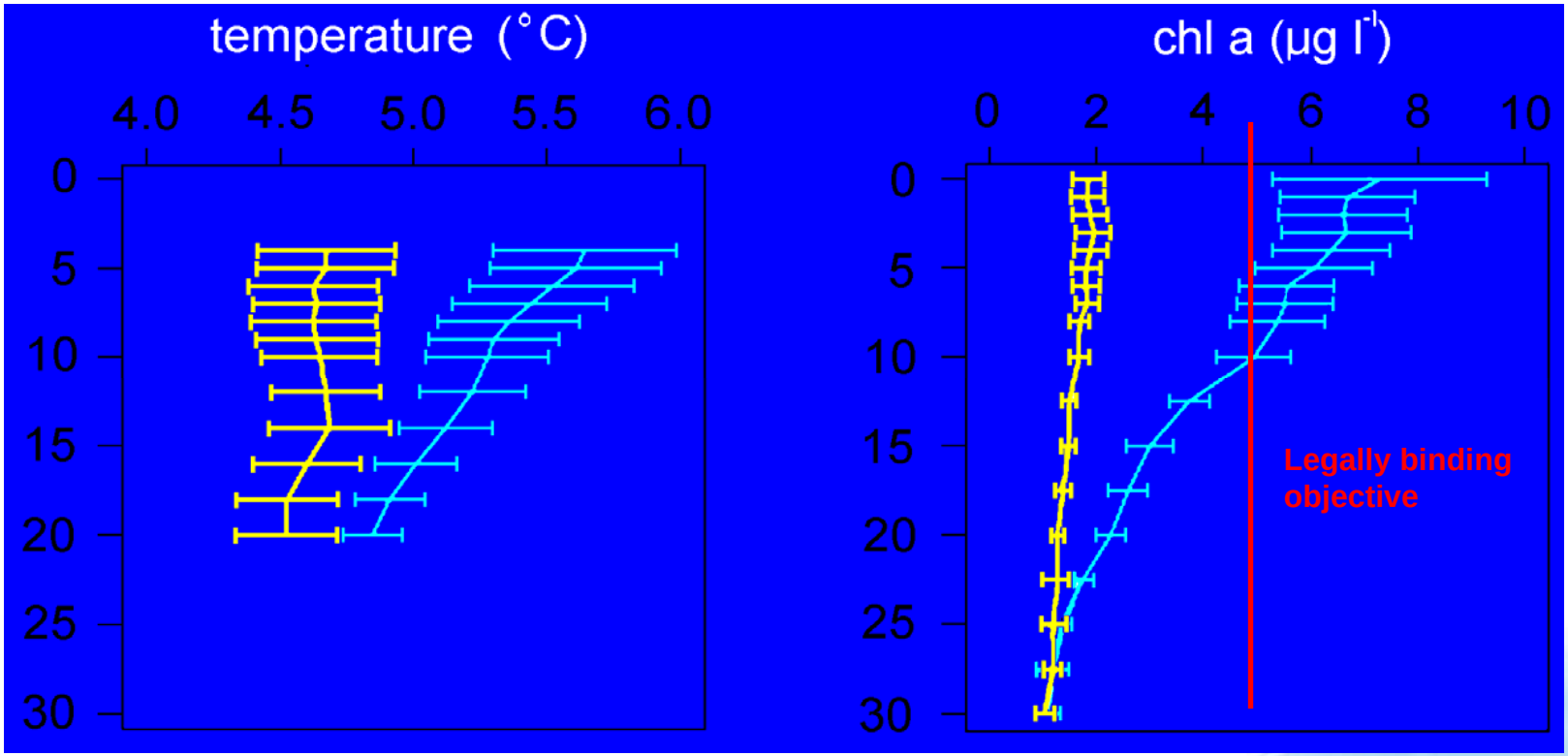
Implications for WFD implementation



- Possible shifts of thresholds used to set objective: good/mod boundary
- Possible shifts of baseline (ref.cond)
- Increased nutrient loads
- Climate change will slow down recovery

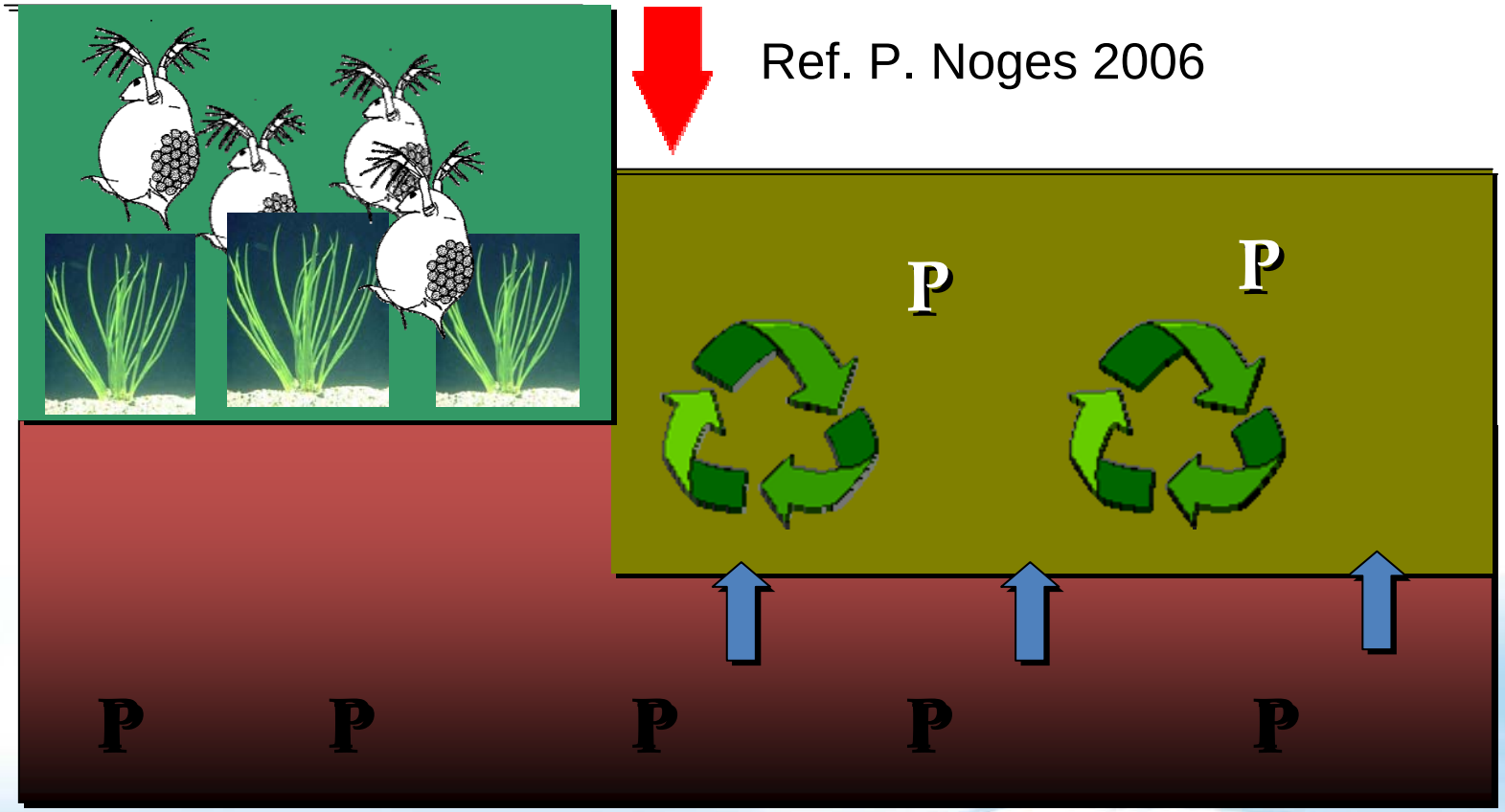
Example of CC induced exceedence of threshold

Reduced spring circulation in Lake Constance causes exceeding the agreed objective



Source: Straile et al. 2003

Impacts of reduced water level in shallow lakes: can give increased internal P-load



Implications for WFD implementation

Thus, need for:

- Revision of classification systems adjusting EQRs
- Revision of programme of measures, adding more measures in the RBMPs
  - Even more reduction of external nutrient loads
  - Making larger buffer strips and wetlands

Research challenges for WFD:
qualitative changes

- We have much knowledge on qualitative changes in major regions
- Need better spatial resolution to clarify changes for different types of water bodies within the major regions (North-Central versus South, West versus East)
- More knowledge needed on evolutionary adaptations and migration of species to improve predictions of ecological impacts

Research challenges for WFD:
quantitative changes

- Quantification of changes is more difficult, and is presently restricted to few case studies
- Quantitative predictions are needed for regional and type-specific impacts of CC on:
  - External and internal nutrient loading
  - Threshold shifts for metrics used for classification
  - Baseline / ref. cond. changes
  - Increase of harmful algal blooms
  - Reductions of salmonids and increase of cyprinids
  - Increased bacterial contamination
  - Increased salinity, etc.

Research challenges for WFD:
implications for water use and for other sectors

- How will the changes in water quality/ecology affect major water users and ecosystem services?
- What are the economic consequences?
- How to deal with conflicting interests?
  - Land use for conservation, water supply and recreation on one hand versus food and energy production on the other

Thank you for your attention

Photo: Hobøl river, Norway, Eva Skarbøvik, Bioforsk