Guiding principles for management of freshwaters

Recommendations for RBMPs

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Adaptive strategies to mitigate the impacts of climate change on European freshwater ecosystems

REFRESH

Technical Report - 2009 - 040

COMMON IMPLEMENTATION STRATEGY FOR THE WATER FRAMEWORK DIRECTIVE (2000/60/EC)

- Guiding principles
  - – Suggested actions
    - Examples

Guidance document No. 24

RIVER BASIN MANAGEMENT IN A CHANGING CLIMATE

Additional principles from REFRESH

- For lakes
  - On nutrient loads
  - On the importance of zooplankton
  - On regional and type specific differences
- For rivers
  - On riparian shade
  - On environmental flow

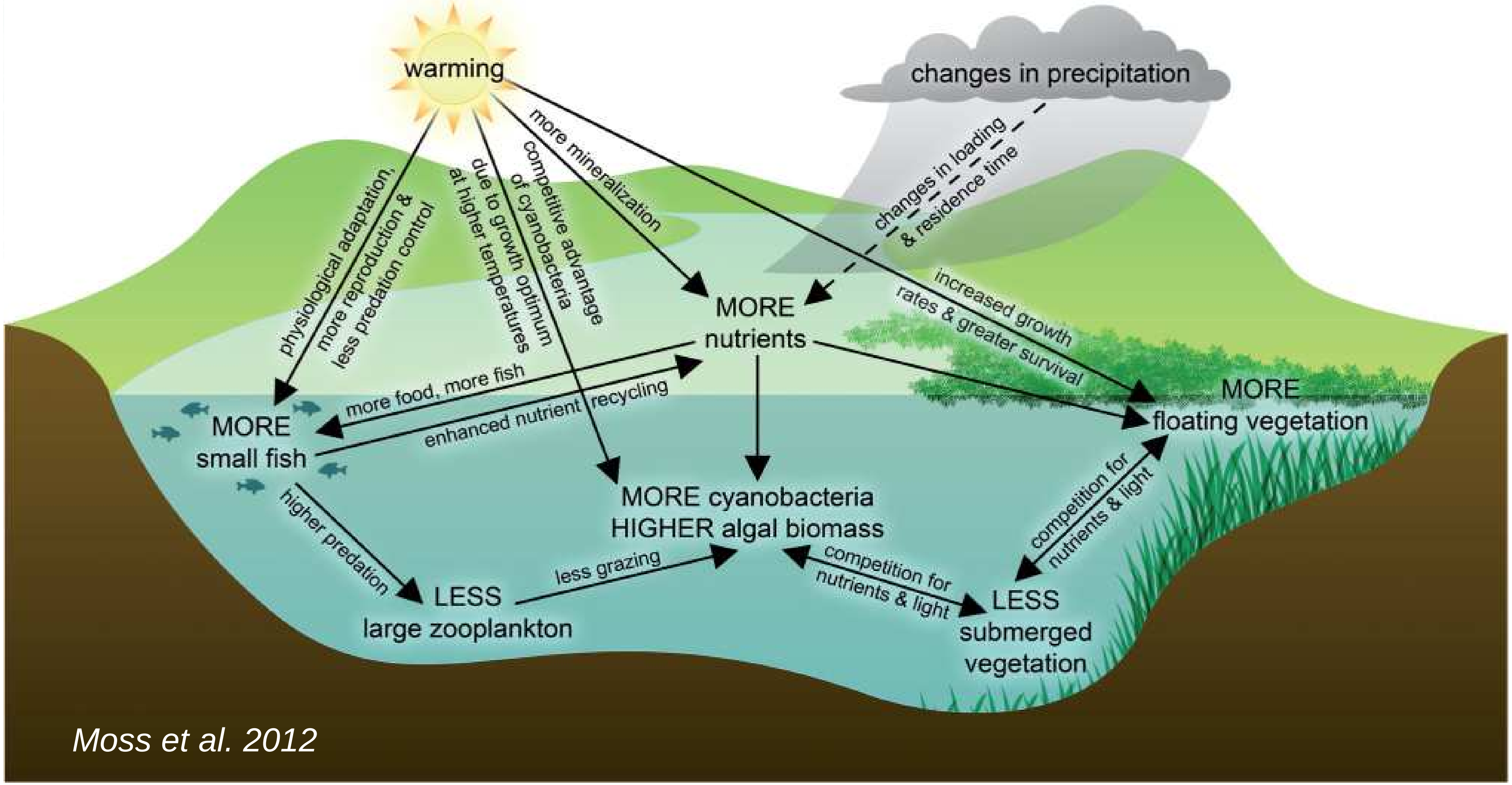
REFRESH

Statement in the present guidance

- Apart from exceptional circumstances, it is not expected that, within the timeframe of WFD implementation (i.e., up to 2027), a climate change signal will become statistically distinguishable from the effects of other human pressures.

Why?

Global warming reinforces eutrophication



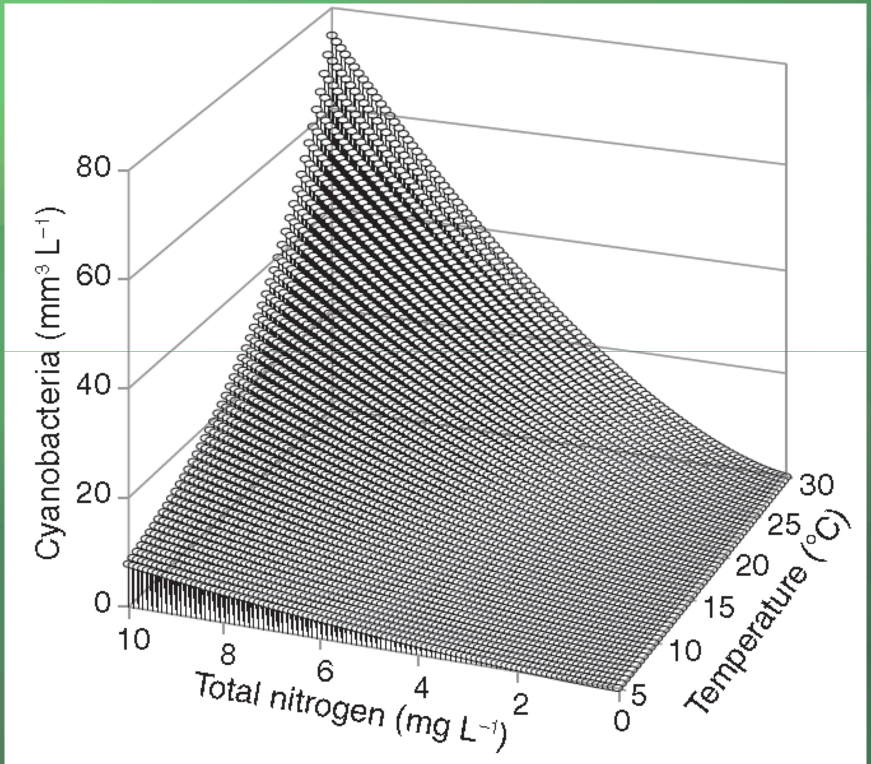
Moss et al. 2012

Guiding principle on nutrient loading:

- Critical nutrient loading limits for lakes have to be lowered in a future warmer climate because natural mechanisms that control phytoplankton development weaken

Stronger stimulating effect of nitrogen

- Synergistic effect of N and temperature
- Increased N loss from soils in northern Europe
- Increased concentrations due to higher evaporation in southern Europe
- Denitrification becomes limited by organic matter scarcity.

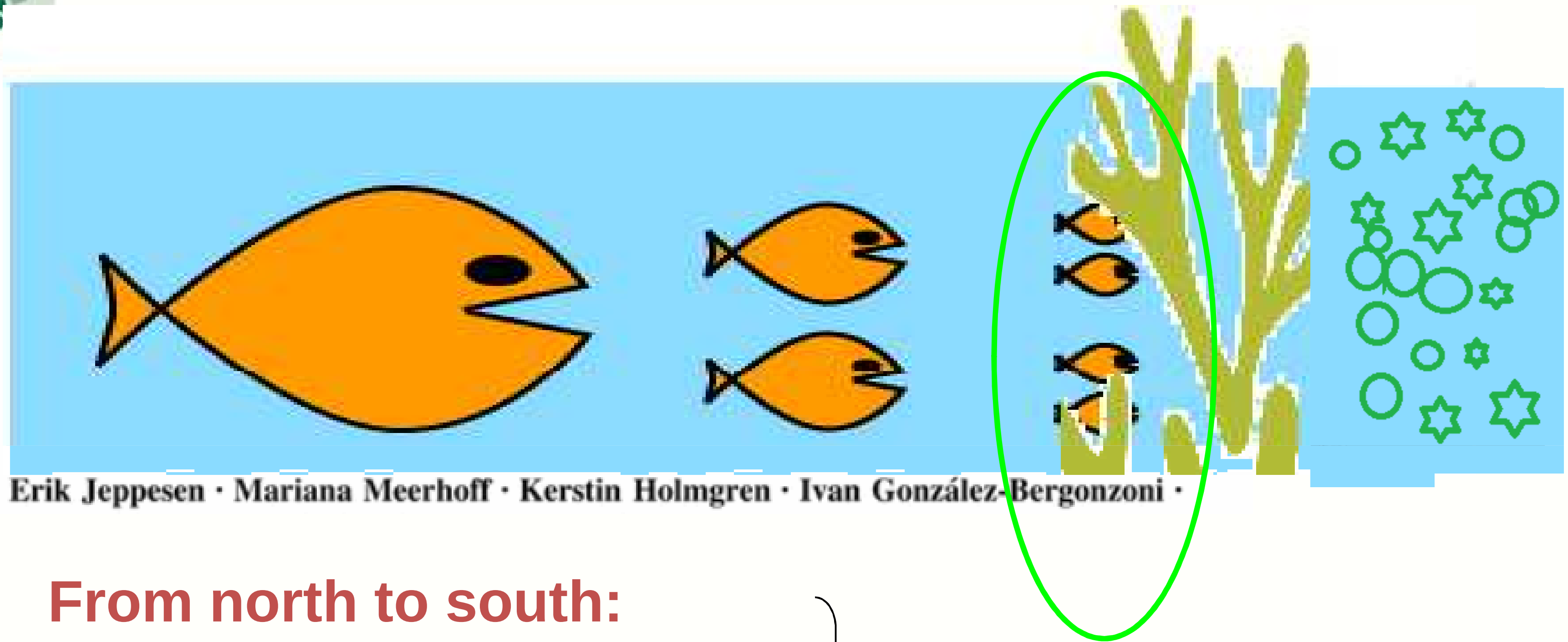


Jeppesen et al. 2011
Kosten et al. 2012

CC, phosphorus & cyanobacteria

- Longer periods of thermal stratification lead to oxygen depletion, which enhances phosphorus release from lake sediments
- Warmer climates boost cyanobacterial dominance in shallow lakes (Kosten et al., 2012)
- Stronger fish pressure on zooplankton weakens its control over phytoplankton

Climate gradient studies

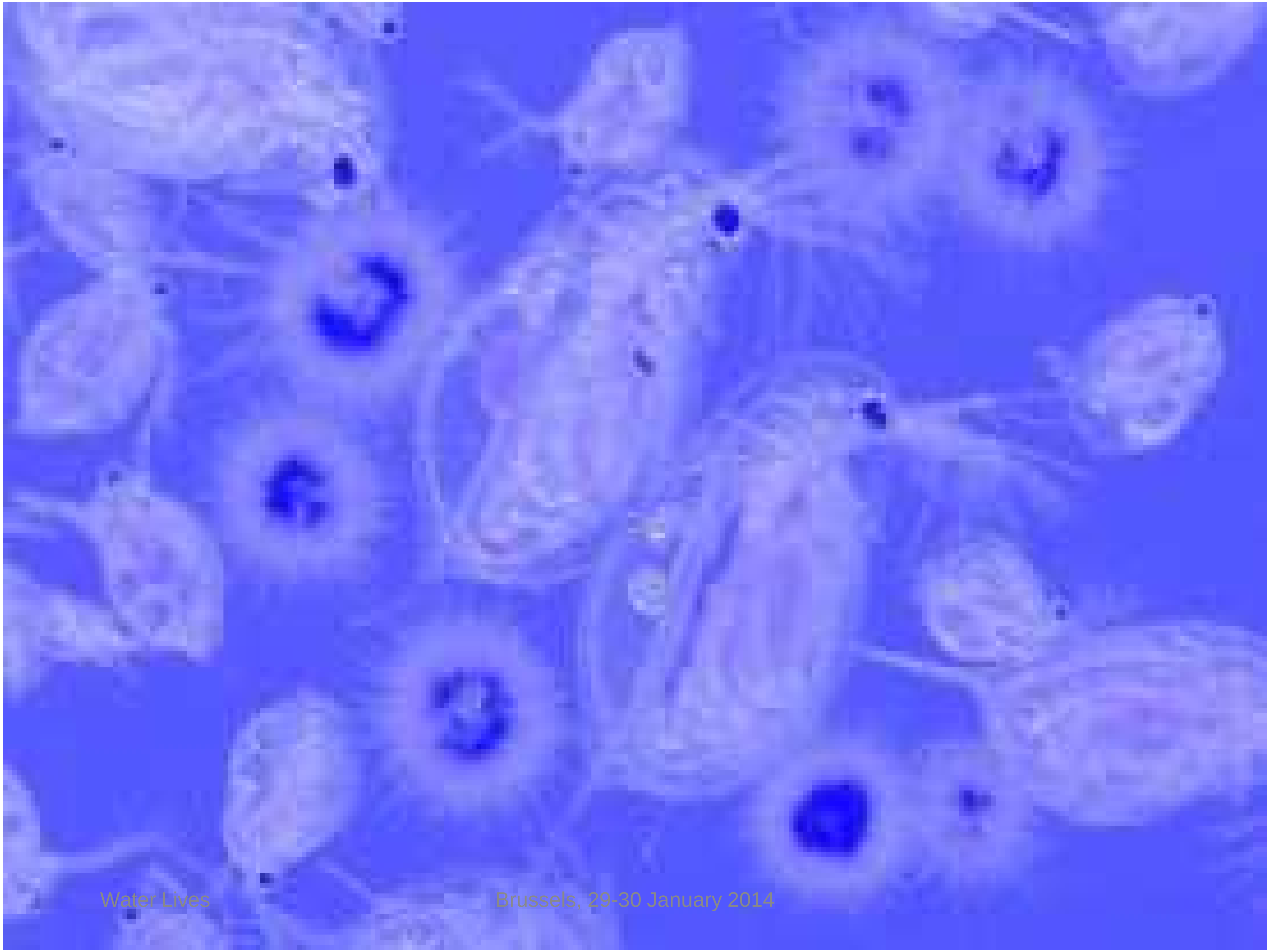


From north to south:

- Smaller body size
- Shorter life span
- Longer and less synchronized spawning period
- More omnivores
- Stronger linkage with littoral vegetation

Stronger pressure on zooplankton →

Less control over phytoplankton



Guiding principle on zooplankton:

- **Rehabilitate zooplankton in lake monitoring schemes**

Hydrobiologia (2011) 676:279–297
DOI 10.1007/s10750-011-0831-0

CLADOCERA AS INDICATORS | Review Paper

Zooplankton as indicators in lakes: a scientific-based plea for including zooplankton in the ecological quality assessment of lakes according to the European Water Framework Directive (WFD)

Erik Jeppesen · Peeter Nõges · Thomas A. Davidson · Juta Haberman · Tiina Nõges · Kätlin Blank · Torben L. Lauridsen · Martin Søndergaard · Carl Sayer · Reet Laugaste · Liselotte S. Johansson · Rikke Bjerring · Susanne L. Amsinck

Why include zooplankton?

- Zooplankton is an integrative and cost-efficient indicator of the ecological quality of lakes and of recovery after restoration.
- Changes in trophic structure of lakes due to climate change will be evidenced in the zooplankton community
- Studying zooplankton could partly compensate for the lack of fish tools in countries where gill nets are illegal or widely seen as unacceptable (e.g. UK)

Zooplankton metrics

- From water samples:
  - Zooplankton biomass,
  - Individual mean weight
  - Size and proportion of taxonomic groups
  - Zooplankton: phytoplankton biomass ratio
- From surface sediment samples
  - Size and proportion of resting eggs (i.e. Daphnia spp.) and
  - Proportion of pelagic cladoceran remains.

Guiding principle on regional and type-specific differences:

- **Consider geographic, and type-specific differences in sensitivity of lakes to pressures for selecting appropriate conservation, adaptation and restoration measures**

www.climate-and-freshwater.info

sitemap legal note

Climate Change and Freshwater

„Indicating the status of freshwater ecosystems under changing climatic conditions“

REFRESH

Home | Climate change and Freshwater ecosystems | Measures | How to use the website | Background | Contact

You are here: / lakes / warm ecoregions /

Rivers Lakes Wetlands

cold ecoregions

temperate ecoregions

warm ecoregions

case studies

Overview | Species affected by climate change | Proposed indicators for climate change impacts | Existing methodologies | Adaption and mitigation

Lakes in warm ecoregions - overview

The pristine status

In southern Europe most deep lakes are artificial (reservoirs), while shallow lakes are more common, though less frequently occurring than in the formerly glaciated areas of central and northern Europe. Mediterranean lakes are ice-free throughout the year, and are thus monomictic, with long summer stratification and a single circulation period in winter.

Click to enlarge

Human impact

As naturally dry systems, Mediterranean countries are characterized by high demand for freshwaters. Being a stable source of this scarce resource, lake systems in these regions are often heavily managed, placing considerable pressure on the Lake ecosystem. Water withdrawals from aquifers and diversion of surface waters, result in extreme water level fluctuations, and high levels nutrients inputs are also threatening water quality.

Climate change impact

Climate change in the Mediterranean might decisively accentuate fluctuations in the depth of water and favour

Photo: www.freehdw.com

Guiding principle on riparian shade:

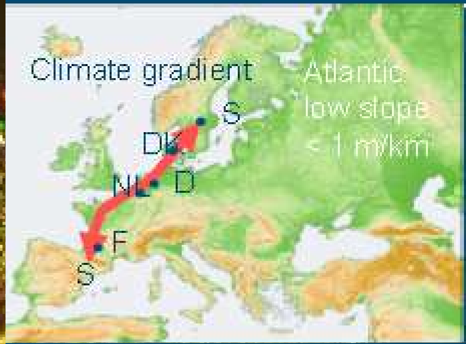
Combining open and forested reaches in riparian management allows both – habitat diversity and reduction of stream temperature

(Kristensen et al. 2013)

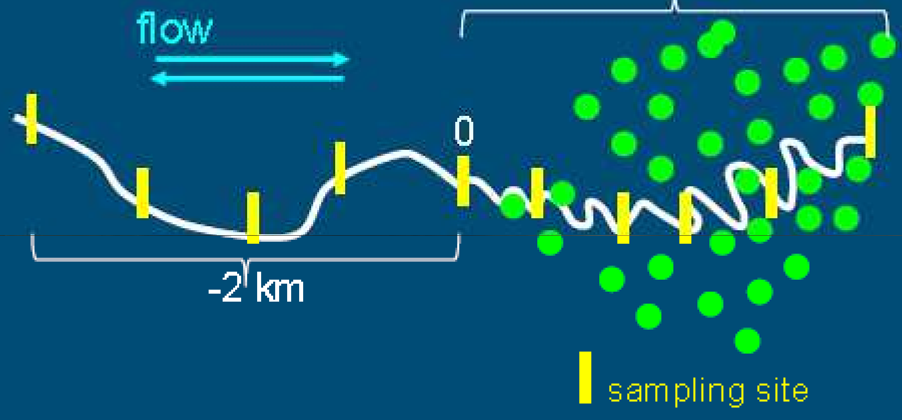
Photo: www.freehdw.com

Shading experiment

Temperature mitigation



Shading experiment



country: Sweden, Denmark, Germany, Netherlands, France, Spain

stream:

- sun → shade: 22 streams
- shade → sun: 18 streams

Photo: www.freehdw.com

Shading experiment

Planting 500 m wooded buffer strip decreases water temperature by at least 2.5 ºC, for biology 1000 m is preferable!

- Cooling down river water takes somewhat longer than warming it up.
- South-sided wooded buffer strips and mosaic landscapes of open and shaded stretches of similar lengths are equally effective in supporting ecological status of rivers.

Photo: www.freehdw.com

Guiding principle on environmental flow:

- **The need to maintain environmental flow in streams becomes stronger in a changing climate**

- **REFRESH contributed to the identification of the upper and lower boundaries of environmental flow requirements for small lowland streams.**

Upper boundary:

- **Stream ecosystems tolerate single spates with a magnitude up to 6-fold base flow. Macroinvertebrates are vulnerable for spates starting from 7-fold base flow but their vulnerability is strongly trait specific.**

Low flow and drought:

- **Rheophilic taxa are sensitive to low flow and disappear within days after onset of stagnation.**
- **In eutrophic streams, stagnation brings about oxygen depletion and an additional loss of oxyphilic taxa.**
- **Pools remaining in a stream bed during droughts are no refugia for stream biota as often believed.**

Thank you!