Assessment of Climate Change for the Baltic Sea Basin - The BACC Project - 22-23 May 2006, Göteborg, Sweden

Climate-related Change in Freshwater Ecosystems

Past and Potential Future Changes

Recent and Historical Changes

Impacts of reduced ice cover

- A shift towards a longer annual ice-free period and earlier ice-out has been observed for many lakes in recent decades.
- Longer annual ice-free periods and earlier ice-out greatly affect lake ecosystems and impacts such as *dominance shifts in phytoplankton assemblages, changed succession events, reduced species diversity* and *an earlier shift from clear-water to turbid state*.

Impacts of increased water temperatures

- *Increased productivity, higher phytoplankton biomass* and the *occurrence of phytoplankton blooms* in some northern European lakes
- Warm early summers may favour *spring-spawning zooplanktivorous fish at the expense of autumn-spawning species* in oligotrophic lakes.

Impacts of altered lake nutrient status and N:P ratios

- Changes in precipitation regimes have had inconsistent effects on the nutrient status of lakes in the Baltic Sea basin.
- Warm and dry years are associated with reduced influxes of nutrients (particularly nitrate) in runoff, but may also lower minimum water levels, increasing resuspension (particularly phosphate) from bottom sediments in shallow lakes.
- Changing N:P ratio may lead to *phytoplankton dominance shifts*, with lower relative N availability

Fig. 1: Cyanobacterial bloom (Gloeotrichia sp.) in Lake Erken, Sweden. Photo: Thorsten Blenckner

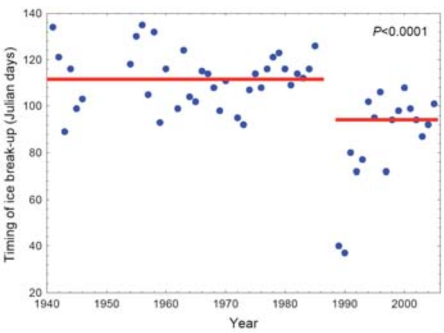

Fig. 2: Timing of spring ice break-up in Lake Erken, Sweden. A significant advancement in the onset of ice-free conditions after 1988 has been attributed to climatic warming.

Background

Lake ecosystems respond to climate change via changes in water temperature, the duration of ice cover, mixing regime, water levels and water residence times. Lake nutrient status is affected by the amount and timing of runoff inputs, and remineralisation rates from bottom sediments, exerting feedbacks on the biota.

Interactions across trophic levels may complicate responses of individual species and functional groups, and constitute the major area of uncertainty in projecting responses of freshwater ecosystems to climate change.

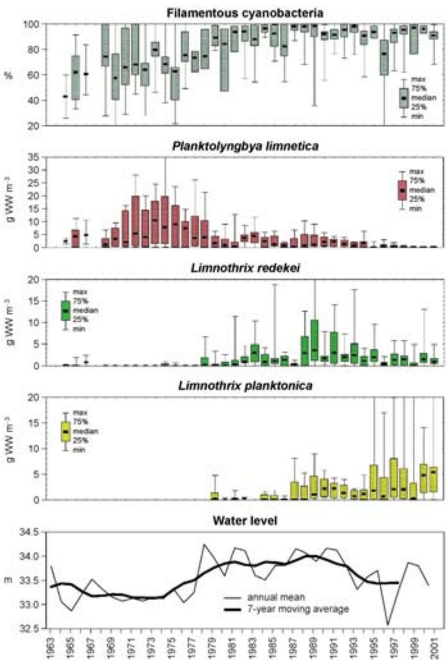

Fig. 3: Long-term changes in phytoplankton community composition in relation to water level in Lake Võrtjärv, Estonia. Adapted from Nõges et al. 2003.

Potential Future Changes

Impacts of increased water temperatures

- Warmer water temperatures combined with longer stratified and ice-free periods in lakes may accelerate *eutrophication*, particularly in the western and southern Baltic Sea Basin. *Shallow lakes and littoral zones* may be particularly vulnerable.
- *Cold-water fish species may be extirpated* from much of their current range while *cool- and warm-water species expand northwards*.

Impacts of altered lake nutrient status and N:P ratios

- Increased remineralisation and higher diffusion rates of nutrients in warmer water is expected to increase nutrient availability, especially in lakes with longer water residence times.
- Reduced N:P ratios combined with higher temperatures may *shift phytoplankton community structure towards species with higher temperature optima*, including cyanobacteria, and pose *risks for deteriorated drinking water quality*.

Impacts on lake biogeochemistry

- *Dissolved organic carbon loads in runoff from boreal and subarctic catchments may increase or decrease* in the future in conjunction with changes in soil temperature, water table depth, discharge and seasonal runoff distribution.
- Increased influxes of humic substances to lakes would steepen light attenuation, with *negative impacts on lake periphyton and benthic (deep-water) communities,* while potentially *increasing the contribution of boreal lakes to regional CO_2 emissions and climate forcing.*

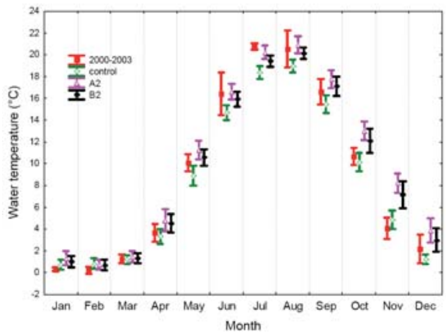

Fig. 4: Mean and range of monthly water temperatures simulated for Lake Erken, Sweden for a control period, 1960-1990, and under two alternative RCM-generated climate scenarios for 2071-2100. The simulated temperatures may be compared to observed temperatures for the warm-summer period 2000-2003.

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