

Risk Analysis of Direct and Indirect Climate effects on deep Austrian Lake Ecosystems (RADICAL)



Wanzenböck, Josef

Kurmayer, Rainer

Ficker, Harald

Research Institute for Limnology, Mondsee

University of Innsbruck

Mondseestraße 9, 5310 Mondsee

josef.wanzenboeck@uibk.ac.at

rainer.kurmayer@uibk.ac.at



Grillitsch, Britta

Aquatic Ecotoxicology Section

Department for Biomedical Sciences

University of Veterinary Medicine Vienna

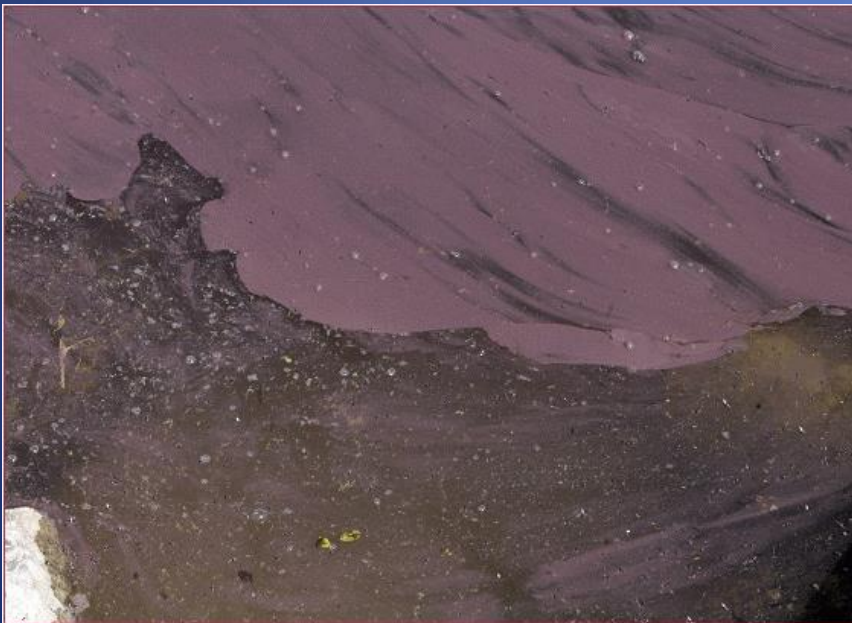
britta.grillitsch@vetmeduni.ac.at



<http://www.uibk.ac.at/limno/research/projects/radical/>

Deep lakes in the Alps

- Eutrophication (1950 – 1970ties)
- Re-oligotrophication (since 1980ties)



- Nutrient input – especially Phosphorus
-leads to Algal blooms and low water transparency
-causes low oxygen concentrations in deep water layers

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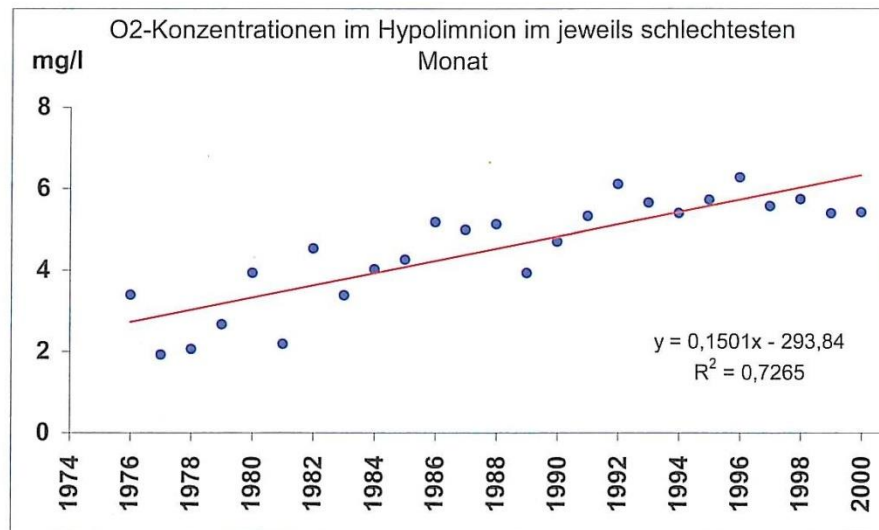
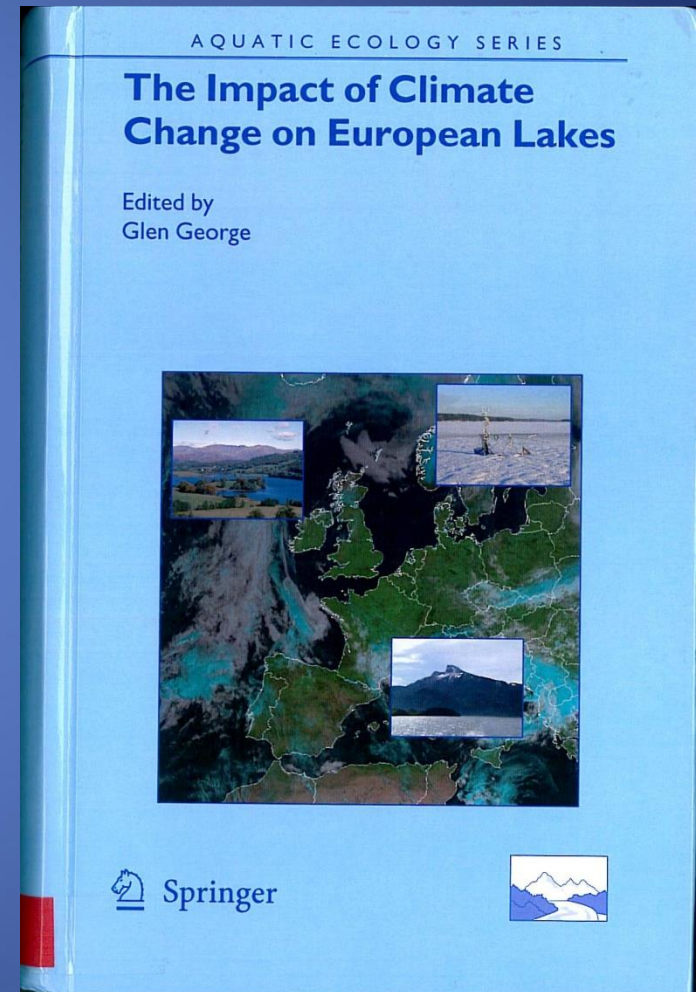


Abbildung 65: Verlauf der Sauerstoff-Konzentrationen im Hypolimnion des Mondsees im jeweils schlechtesten Monat

Deep lakes in the Alps

The effects of global change are likely to run counter to the reductions in nutrient loading rather than reinforcing re-oligotrophication, i.e. increasing phytoplankton and toxic cyanobacteria.



Whitefish occurring in deep lakes in the Alps



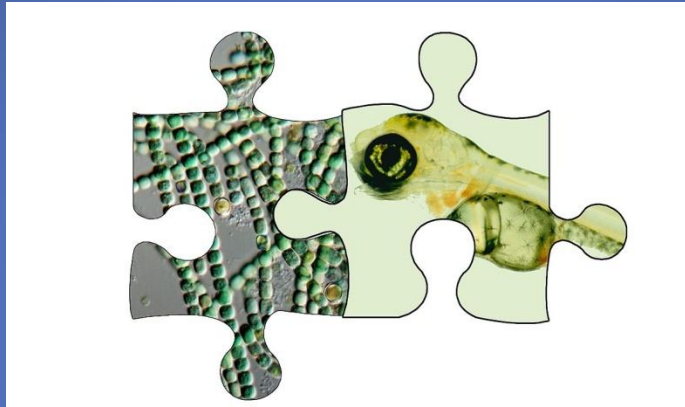
Whitefish (*Coregonus* sp.) are one of the most temperature sensitive fish species as they depend on low egg developmental temperatures and high oxygen concentrations, which is only found in the cold, deep water zone of Alpine lakes.

Whitefish occurring in deep lakes in the Alps



Whitefish are of high fishing value and due to their endemic nature these populations are of concern in conserving our biodiversity.

Whitefish occurring in deep lakes in the Alps



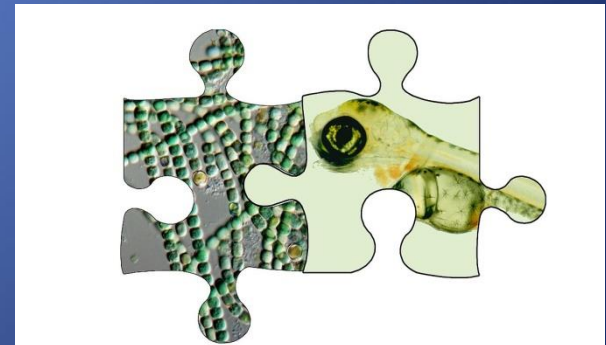
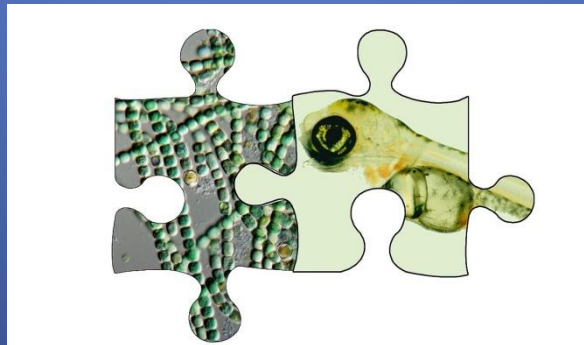
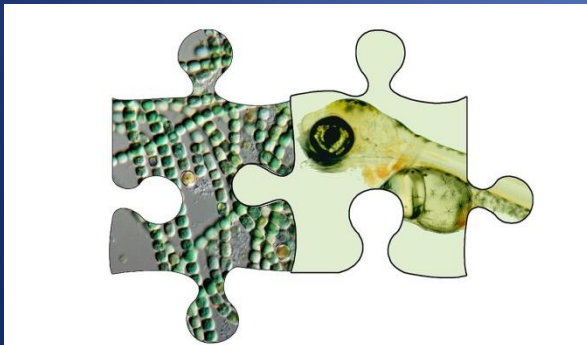
In this project, we follow the hypothesis that deep Alpine lakes are at risk to lose a major part of their ecological and socio-economic value in the course of climate change, because

- coregonid fish stocks will slump, due to direct demographic effects of increased temperature and indirect effects, since
- filamentous, toxic cyanobacteria will (re-) increase, thus counteracting re-oligotrophication efforts and adversely affecting other biota including coregonid fish.

Project aim:

to estimate the direct and indirect consequences of climate effects on autochthonous whitefish populations by analysing:

- the effects of regional climate changes on phytoplankton growth,
- the exposure of early life stages of whitefish to toxic cyanobacteria at chronic/subchronic levels,
- the demographic consequences for autochthonous whitefish populations in the next few decades under a changing plankton community composition subject to various climate scenarios.

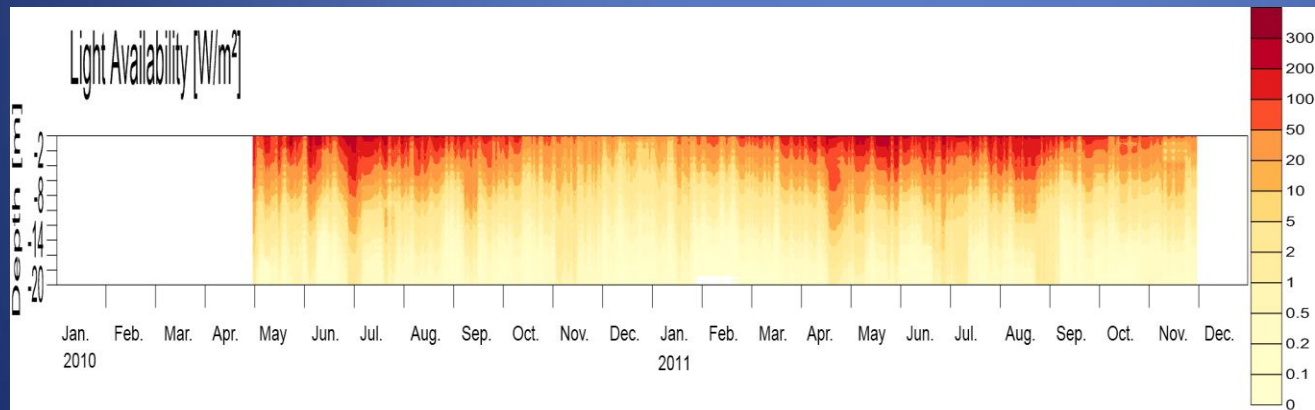
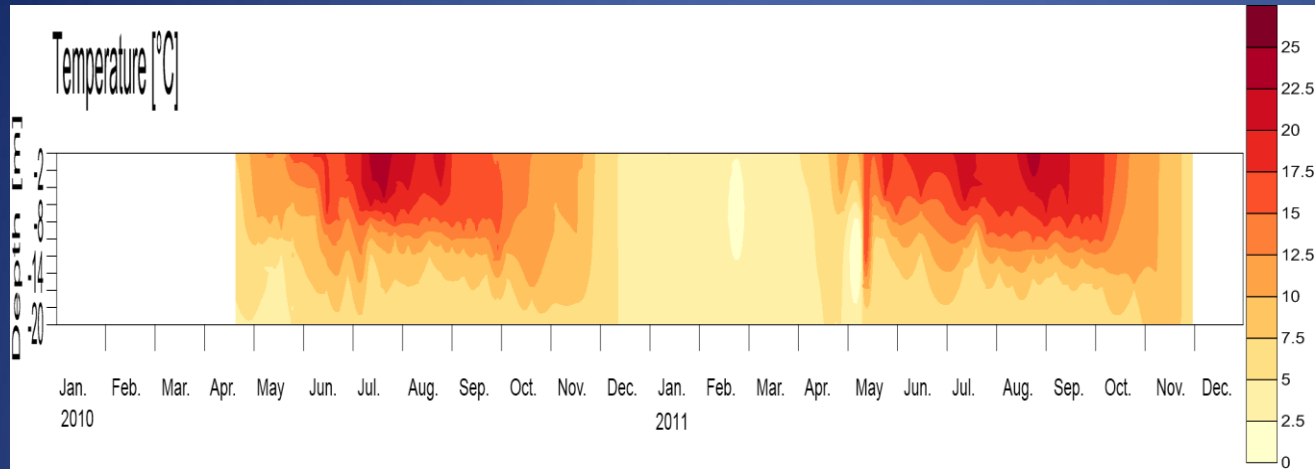


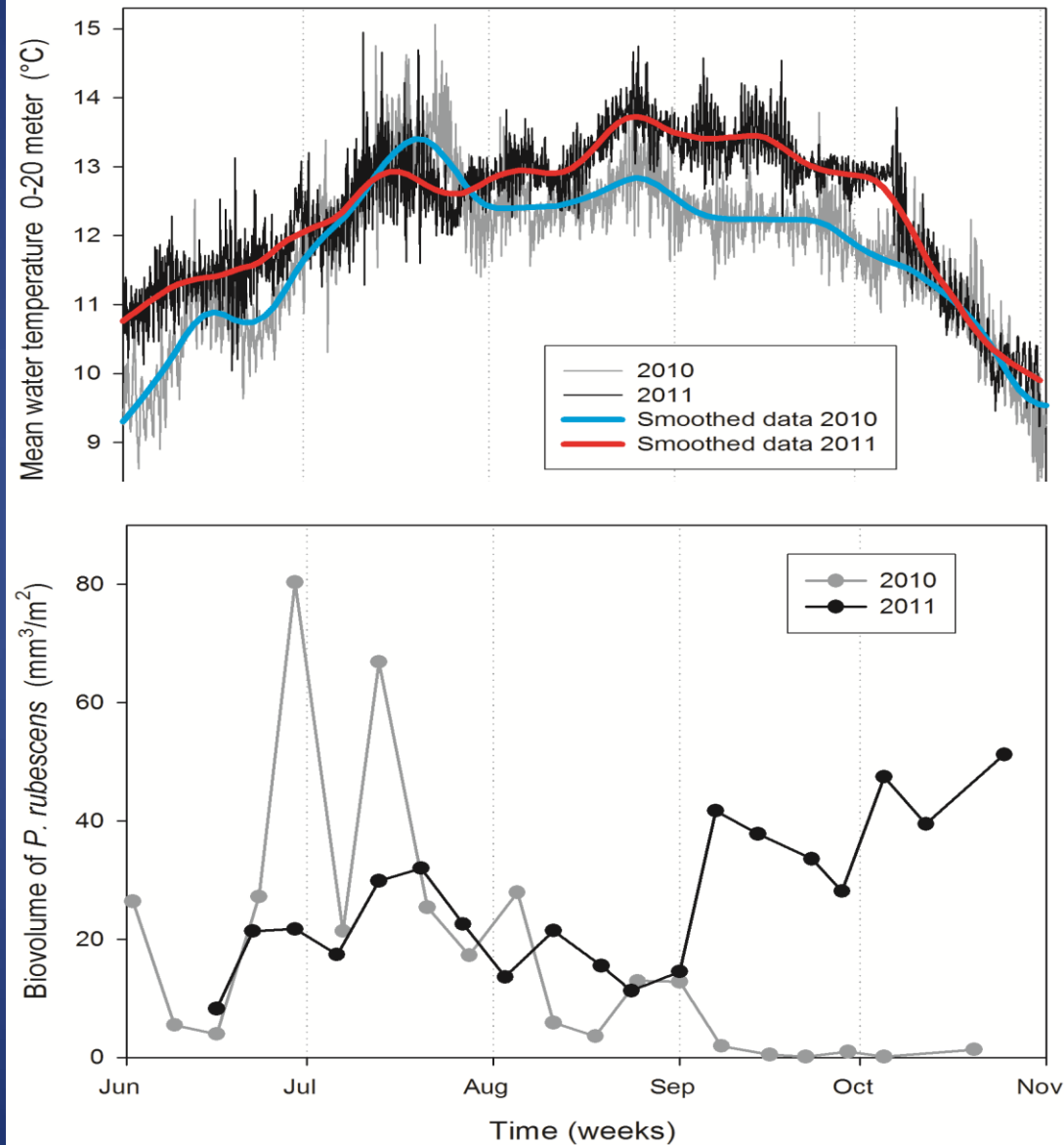
The effects of regional climate changes on phytoplankton growth

Provide quantitative data on:

- lake physics (vertical stratification, vertical mixing, light availability in the water column) as basis for modelling of cyanobacterial stratification
- the variability of occurrence of hepatotoxic cyanobacteria in relation to environmental (climatic) factors in the field both temporally and vertically through the water column (as basis for algal modelling and fish exposure assessment)
- Model cyanobacterial population/phytoplankton abundance and vertical/horizontal distribution in dependence on climate effects, physical conditions







Exposure of early life stages of whitefish to toxic cyanobacteria at chronic/subchronic levels



Assess effects of cyanobacteria on whitefish populations in Mondsee and Hallstättersee conducting a field survey on free-living fishes to check histopathological damages as observed in exposure experiments.

Aim of the laboratory experiments is to characterize the developmental and behavioural toxicity of Cyanobacteria/Microcystins on early life stages of the fish by means of conventional Effective Concentrations (EC-values).



Exposure of early life stages of whitefish to toxic cyanobacteria at chronic/subchronic levels

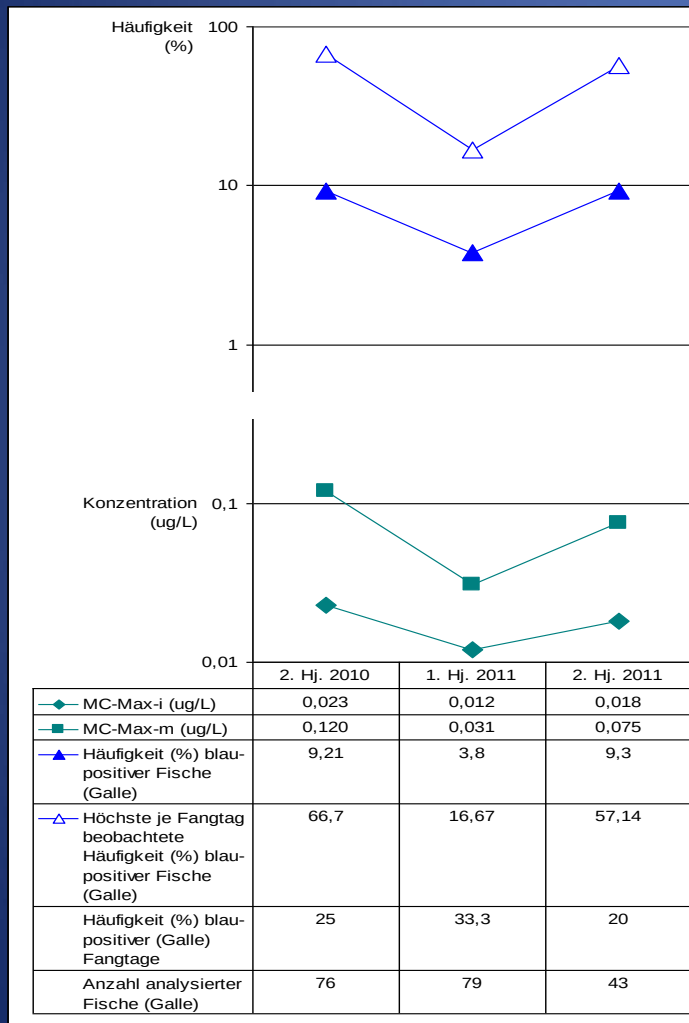


Abbildung 9: – Übereinstimmung der Beobachtungshäufigkeiten Blaufärbung der Gallenflüssigkeit der im Mondsee gefangenen adulten Fische (*Coregonus* sp.) mit den aus Algendichten (*Planktothrix* sp.) im gleichen Beobachtungszeitraum ermittelten Microcystin-konzentrationen im Mondsee

Legende: Hj.: Halbjahr; MC: Microcystin; MC-Max-i: höchste ermittelte mittlere MC-Konzentration in der Wassersäule; MC-Max-m: höchste ermittelte maximale MC Konzentration in der Wassersäule; ug: μg .



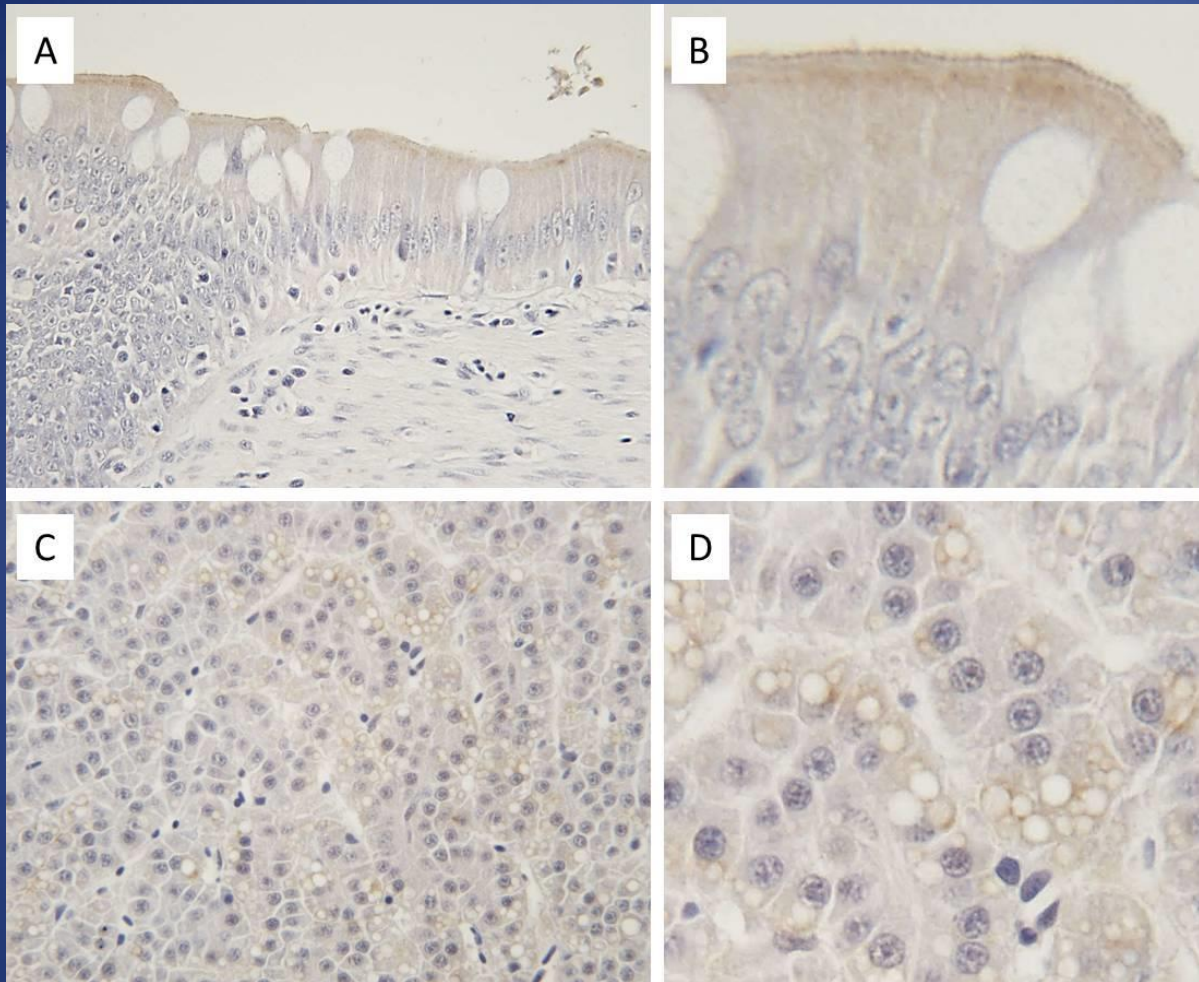


Bild 2 – Immunhistochemischer Nachweis von MC in den apikalen Regionen der Enterozyten (*Coregonus* sp.) (A), im Detail (B) erkennt man, daß nicht nur der apikale Saum sondern auch intrazelluläre Anteile positiv reagierten. In den Hepatozyten (C) wurden die Regionen um die Vakuolen (D) der einzelnen Hepatozyten als MC positiv indentifiziert.

Fish Ecology

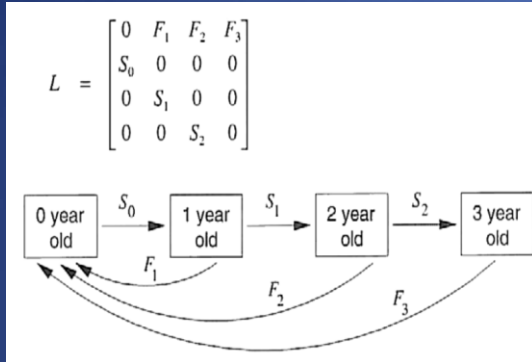
Construct an age-structured population model for whitefish in Mondsee and Hallstättersee using RAMAS (Risk Analysis and Management Alternatives Software).

Integrate the results obtained in other Modules to predict whitefish population developments under future climate scenarios (direct effects) and to assess risks of cyanobacterial blooms under future climate scenarios associated with increased production of toxins, effects on various components of the plankton community and especially on future whitefish population development considering ecotoxicological risks (indirect effects).



Fish Ecology

a)



b)

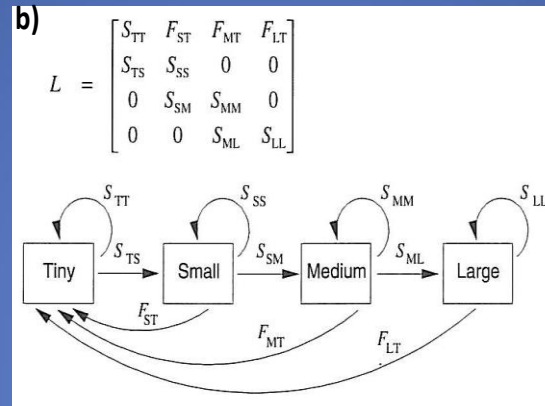
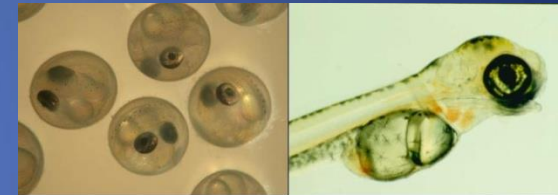
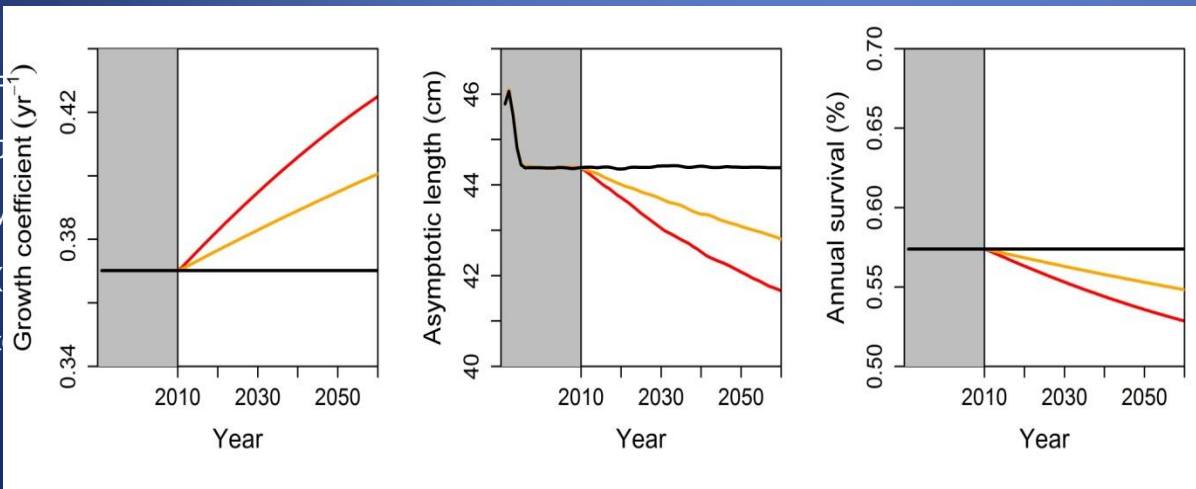
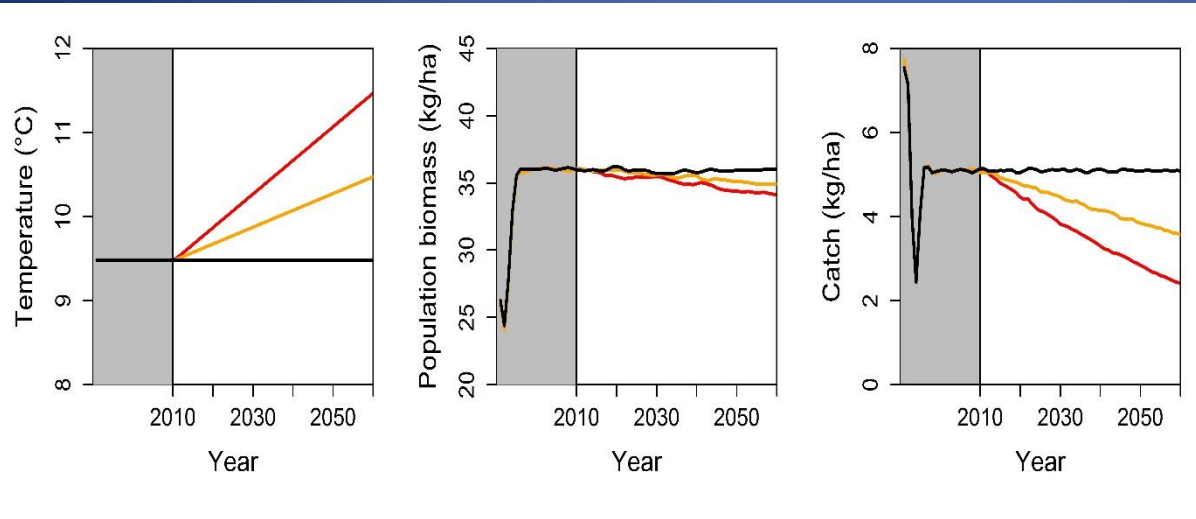


Abb.1: Struktur der altersbasierten Leslie-Matrix(a) und der längenbasierten Progressions-Matrix (b) mit den Parametern Überlebensrate (S) und Reproduktion bzw. Fertilität (F).



Fish Ecology



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