Browning impacts on fish communities and the nutritional value of fish for human consumption

Sami J. Taipale
Lecturer in Environmental Science
Research Group Leader of AquaOmics

Finnish Envinromental Centre: Marko Järvinen, Kristiina Vuorio

Natural Research Institute Finland: Mikko Olin, Martti Rask, Jukka Ruuhijärvi

University of Eastern Finland: Paula Kankaala, Ursula Strandberg, Tomi-Pekka Tuomainen, Tarja Nurmi

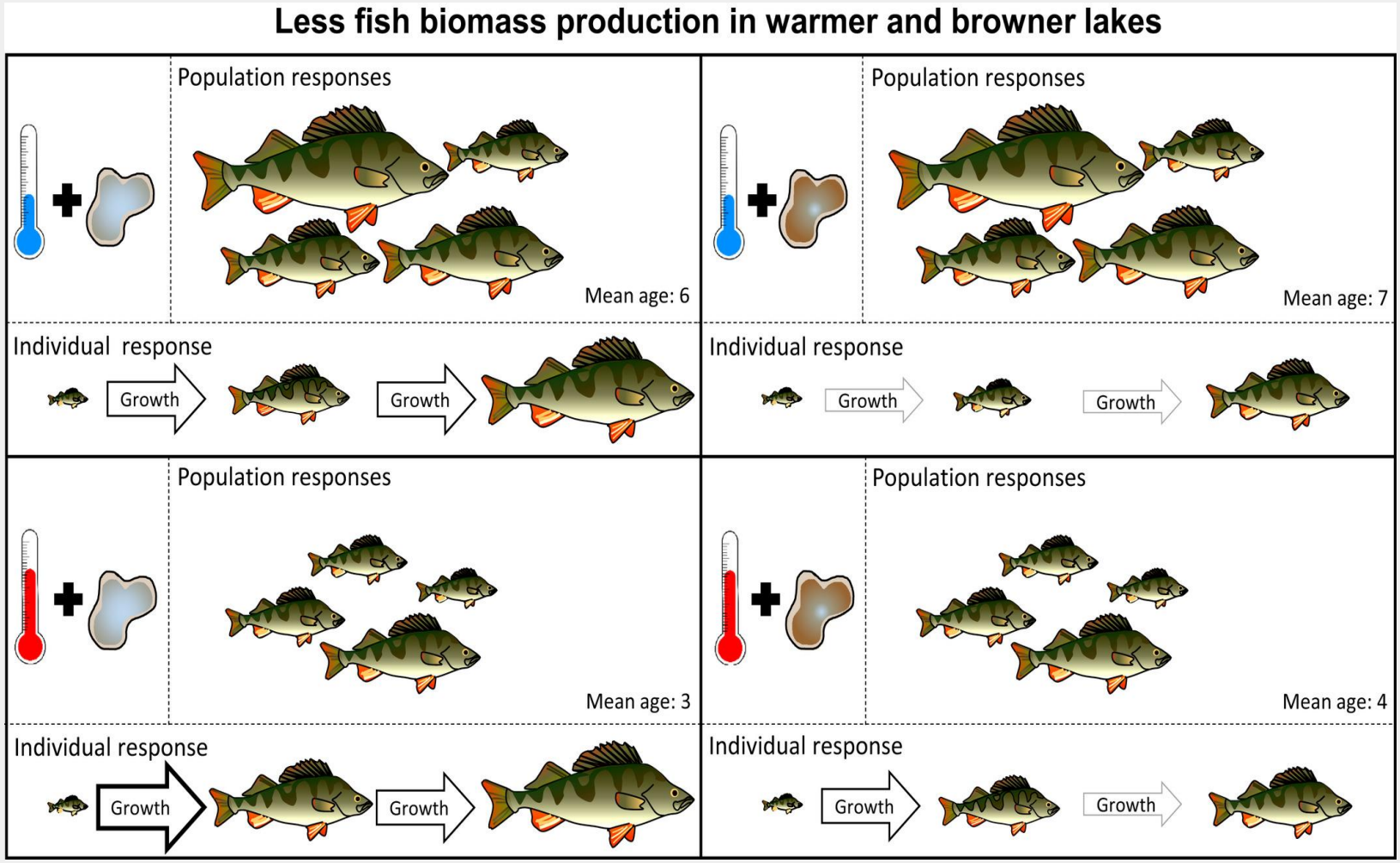
University of Helsinki: Kimmo Kahilainen, Elina Peltomaa

University of Jyväskylä: Ossi Keva, Mikko Kiljunen, Heikki Hämäläinen, Roger I. Jones

BROWNING AND FISH COMMUNITY

- Browning influence light attenuation, temperature, pH and stratification that influence structure of phytoplankton, zooplankton and fish communities
- Intensified browning decreases the abundance of salmonids (vendace, whitefish, trout)
- Low pH have negative effect on cyprinids (e.g roach)
- Percids (perch) and pike is known to tolerate best these harsh conditions

Warmer and browner waters decrease fish biomass production

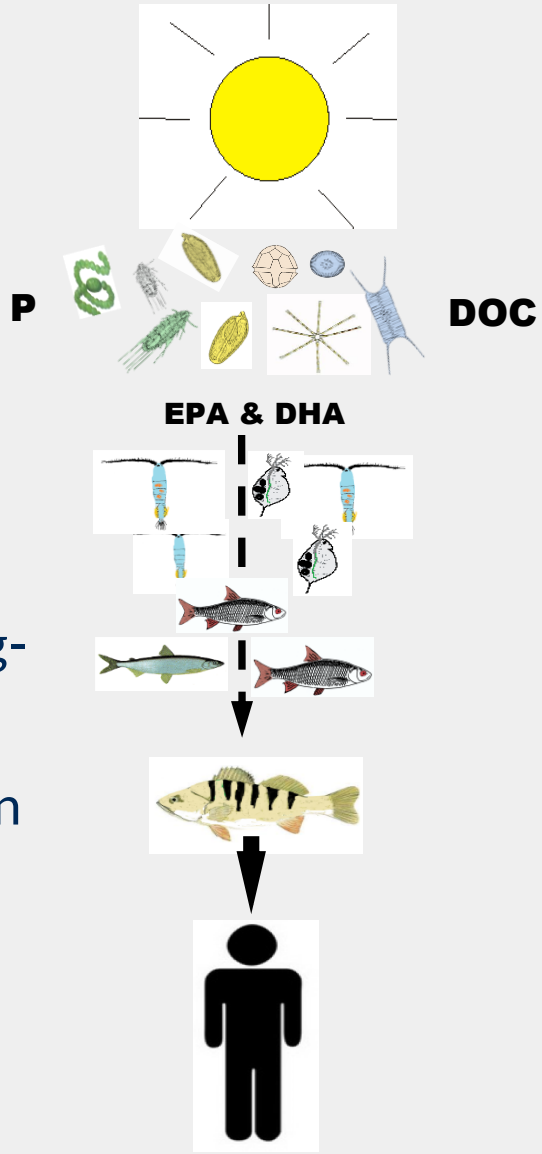


Many other factors also influence on this result, e.g. eutrophication and latitude

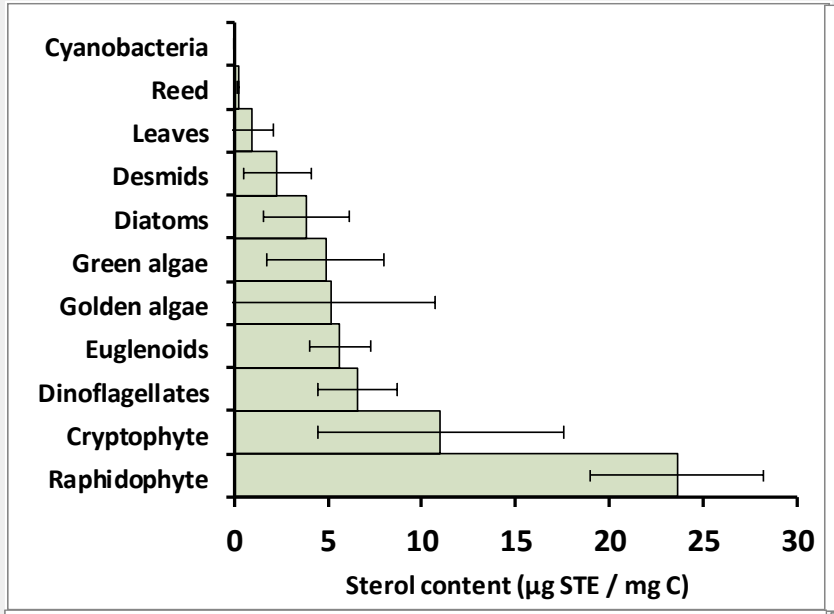
Van Dorst et al. 2018 Global Change Biology DOI: (10.1111/gcb.14551)

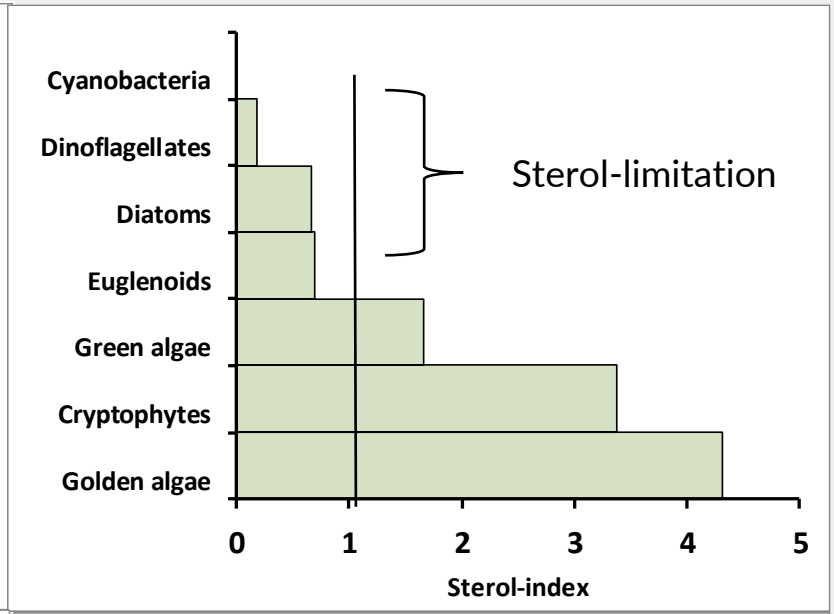
Lake ecosystem responses to organic matter load and eutrophication

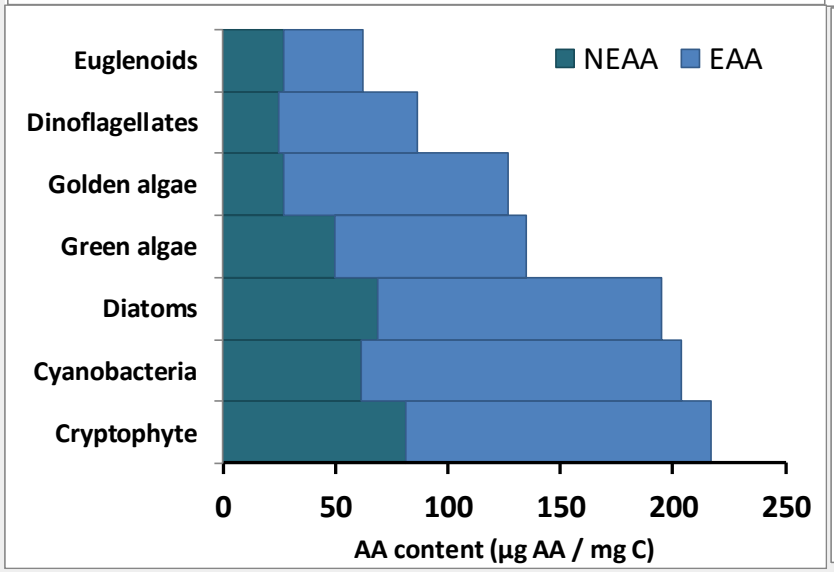
- Phytoplankton productivity and community composition are crucial for lake food webs
- Phytoplankton produce essential polyunsaturated fatty acids (PUFA) → The whole food web is dependent on these, the most important are EPA and DHA
- All phytoplankton taxa are not able to produce long-chained EPA and DHA
- EPA and DHA are beneficial for human health (brain and nerve function, cardiovascular health)
- Fish are the principal sources of EPA and DHA for humans

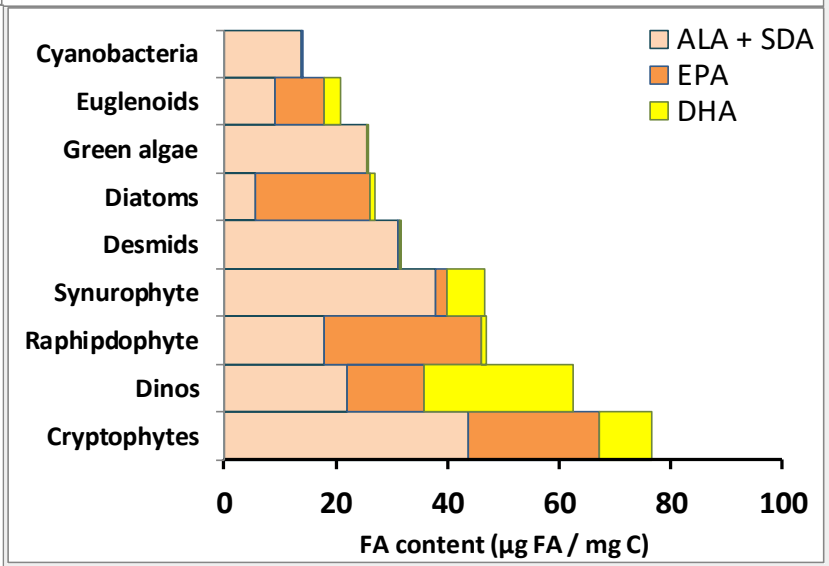


FRESHWATER PHYTOPLANKTON DIRRER IN QUALITY AND QUANTITY





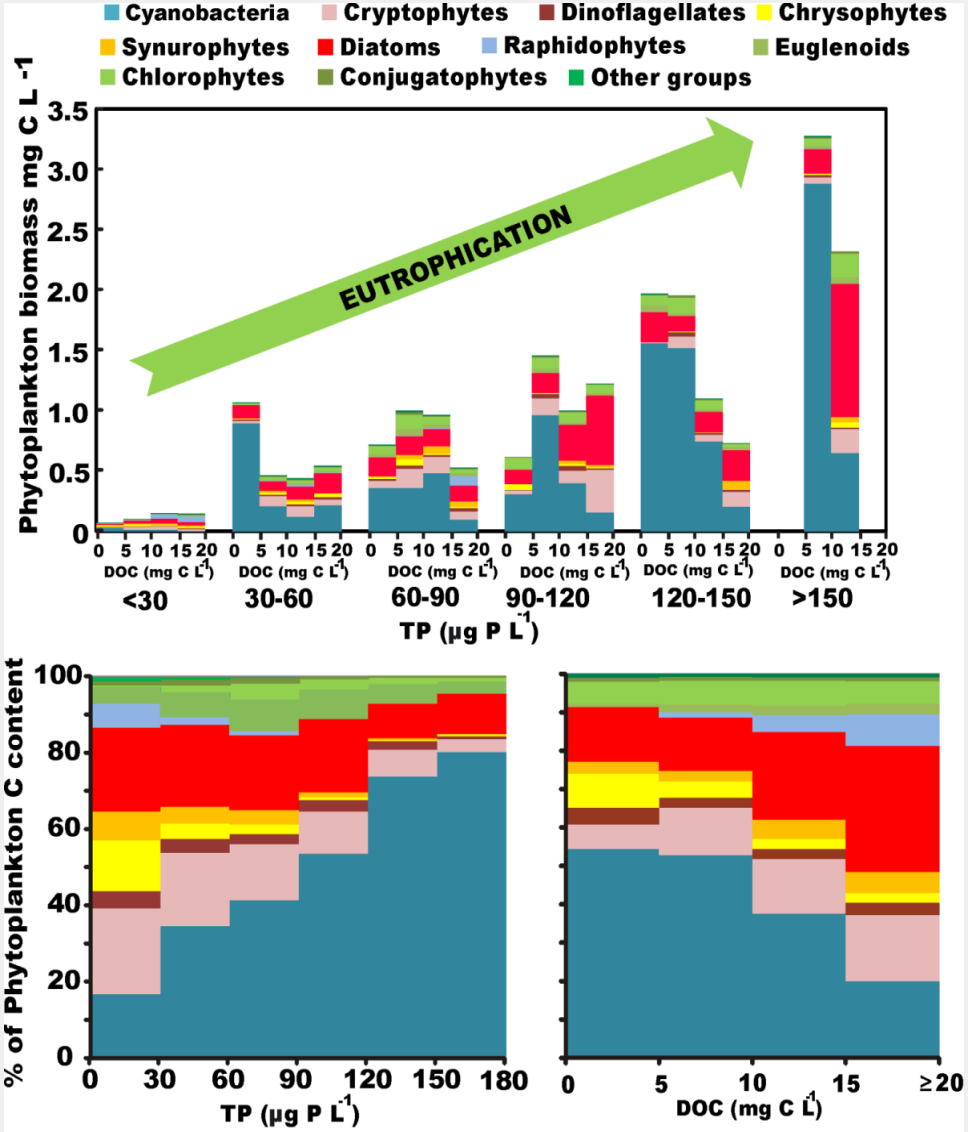




Taipale et al. AME 2013, Frontiers 2016; Peltomaa et al. 2017 Frontiers

Fatty acid content of lake phytoplankton and impacts on fish

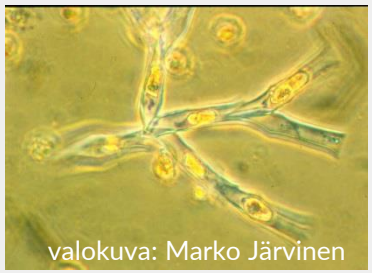
- 39 phytoplankton strains belonging to 10 classes were cultured in laboratory and their fatty acid (FA) content was analyzed
- Phytoplankton data collected by Finnish Environment Institute from 713 lakes in Finland during the years 2000-2015 (2547 samples)
- FA content of phytoplankton was estimated for the lakes classified according to their **phoshorus** and **dissolved organic carbon** (**DOC**) content
- In 14 lakes the FA content of predatory perch was analyzed



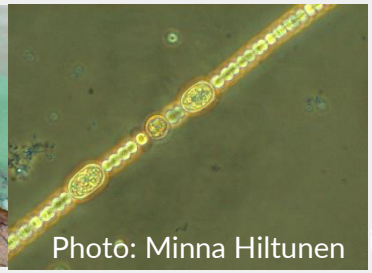
Changes in phytoplankton biomass and community composition along with eutrophication (total phoshorus (TP) and increasing dissolved organic carbon (DOC)) concentration of the lakes

Eutrophication

Chrysophytes decline↓



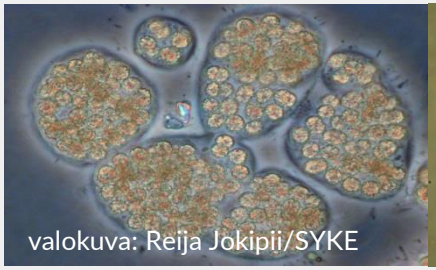
Blue-green algae (Cyanobacteria) benefit↑



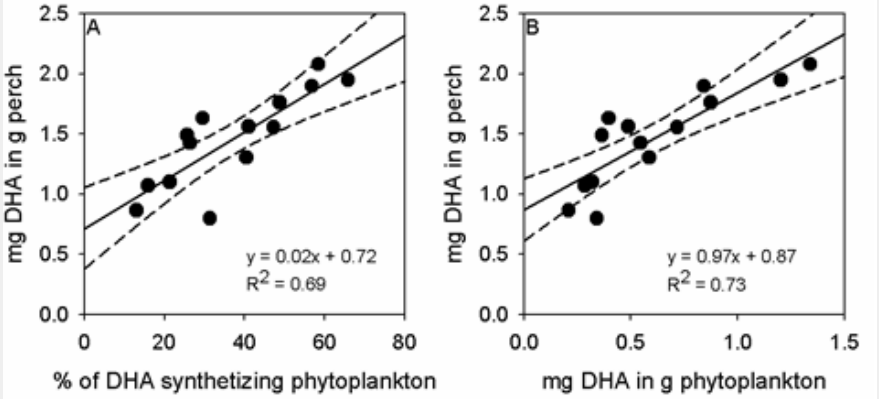
i/SYKE

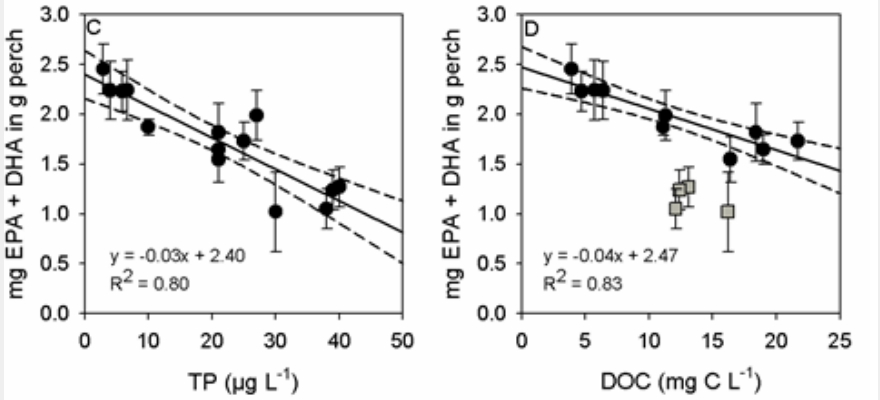
Browning (increasing DOC concentration)

Blue-green algae decline ↓



Rhapidophyte *Gonyostomum semen* benefits ↑





- DHA content of phytoplankton could be traced up to predatory perch muscle
- EPA + DHA content of perch muscle decreased along with increasing phophorus (TP) and dissolved organic carbon concentration (DOC) of the lakes

→ poorer quality for human diets

Environment International 96 (2016) 156–166

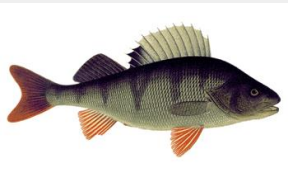
Contents lists available at ScienceDirect

Environment International

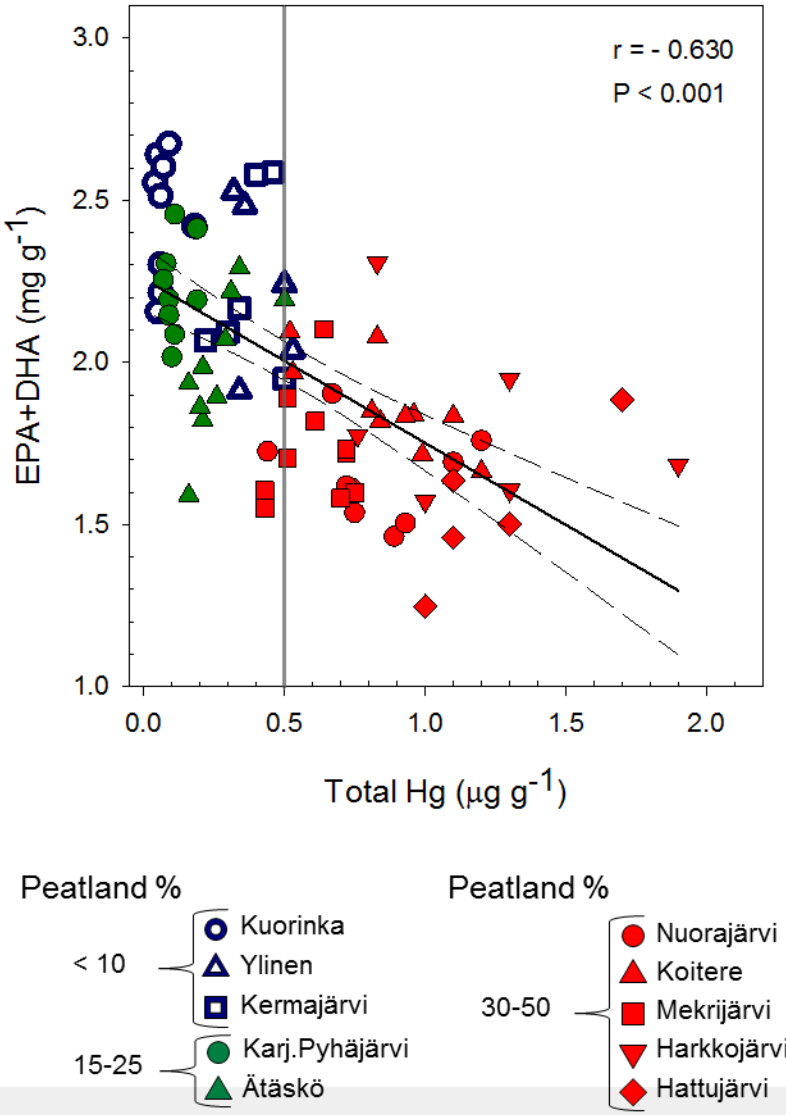
journal homepage: www.elsevier.com/locate/envint

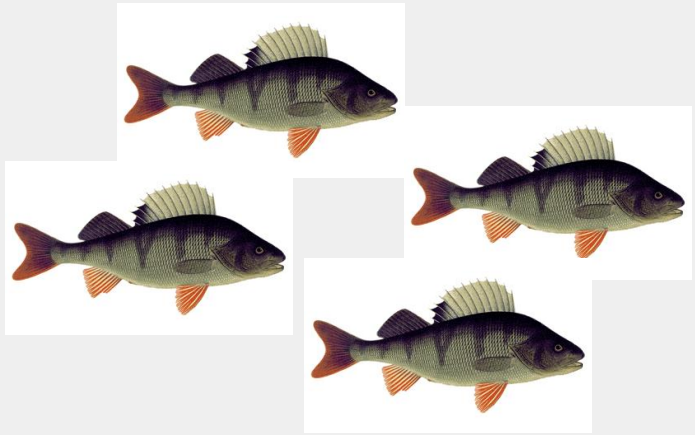
Lake eutrophication and brownification downgrade availability and transfer of essential fatty acids for human consumption

S.J. Taipale [a,b,c,*], K. Vuorio [c,d], U. Strandberg [a,1], K.K. Kahilainen [e,f], M. Järvinen [g], M. Hiltunen [a], E. Peltomaa [b,f], P. Kankaala [a]



EPA + DHA and total mercury content of perch muscle





- In humic lakes perch contain more mercury and less beneficial ω3-fatty acids (EPA+DHA) compared with perch grown in clear-water lakes
- Hg and EPA+DHA content was best explained by peatland area in the catchment

Strandberg et al. 2016. Env. Poll. 219: 305-314.

Contents lists available at ScienceDirect

Science of the Total Environment

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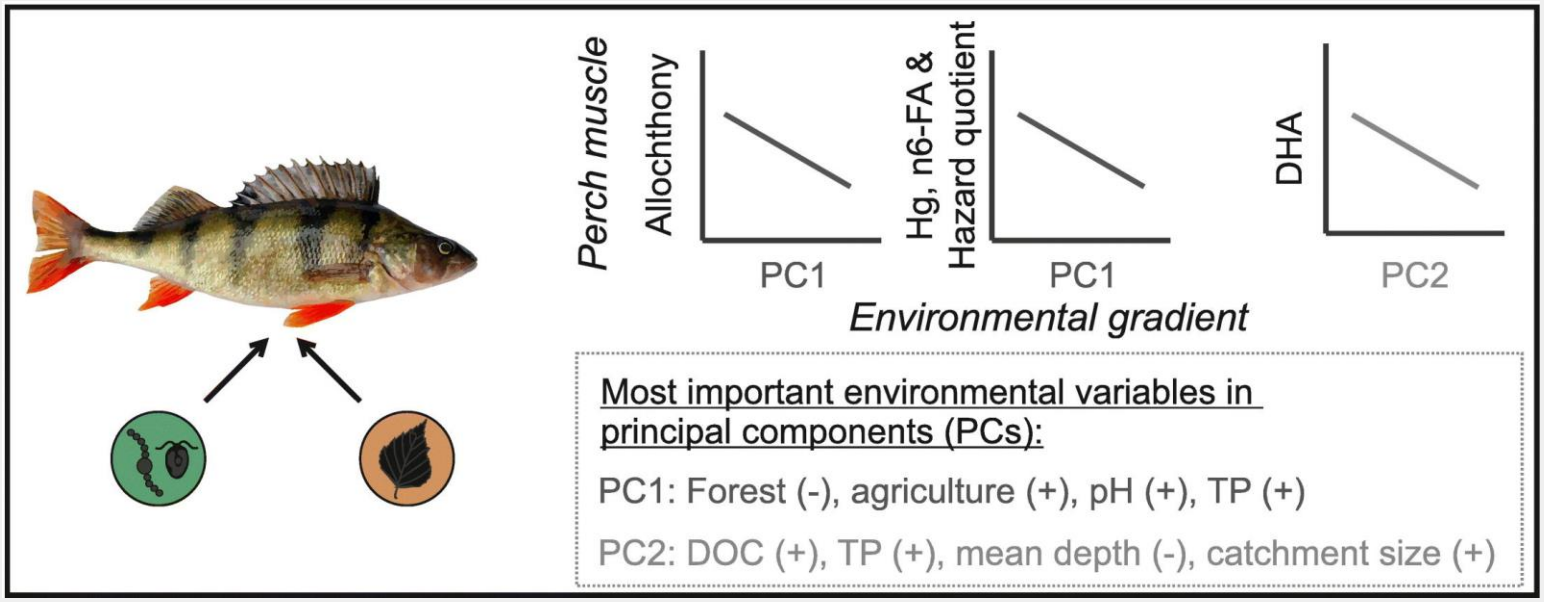
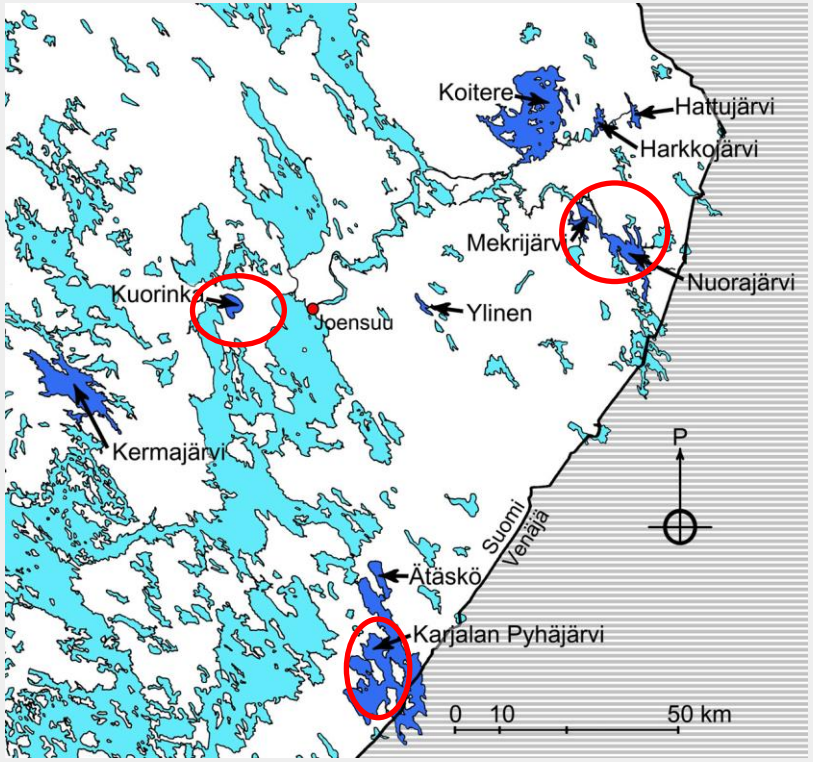
Allochthony, fatty acid and mercury trends in muscle of Eurasian perch (*Perca fluviatilis*) along boreal environmental gradients

Ossi Keva [a,*], Mikko Kiljunen [a], Heikki Hämäläinen [a], Roger I. Jones [a], Kimmo K. Kahilainen [b], Paula Kankaala [c], Miikka B. Laine [a], Jos Schilder [a], Ursula Strandberg [c], Jussi Vesterinen [c,d], Sami J. Taipale [a]



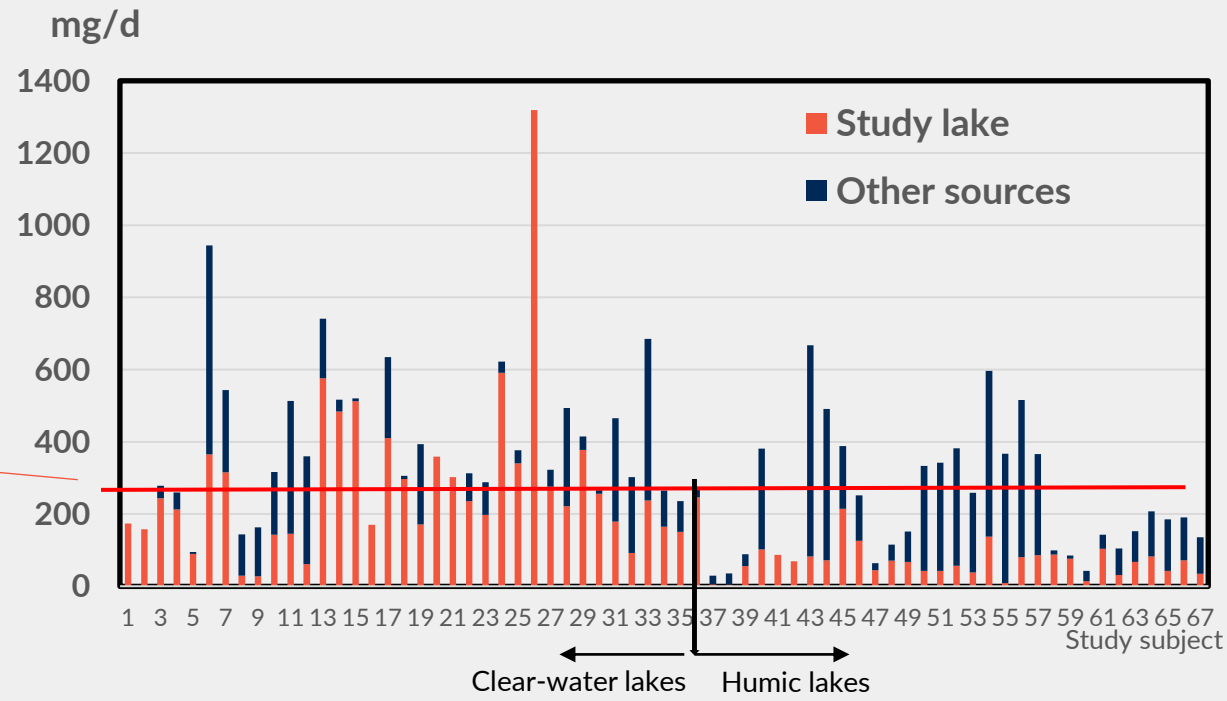
- Reduced nutritional value of perch muscle was positively related to catchment forest coverage and negatively with lake pH, potentially mediated by increasing allochthony

Health indicator studies of people fishing and eating fish from 2 clear-water and 2 humic lakes



- 67 participants
- Recorded fish consumption for two months in summer 2014
- Background information about health status and diet with questionnaires
- Blood samples in autumn: analyses of mercury, vitamin D and 'omega-3' fatty acid composition

Total intake of EPA and DHA from fish



Intake of EPA+DHA should be about 250 mg/d (Finnish Heart Association)

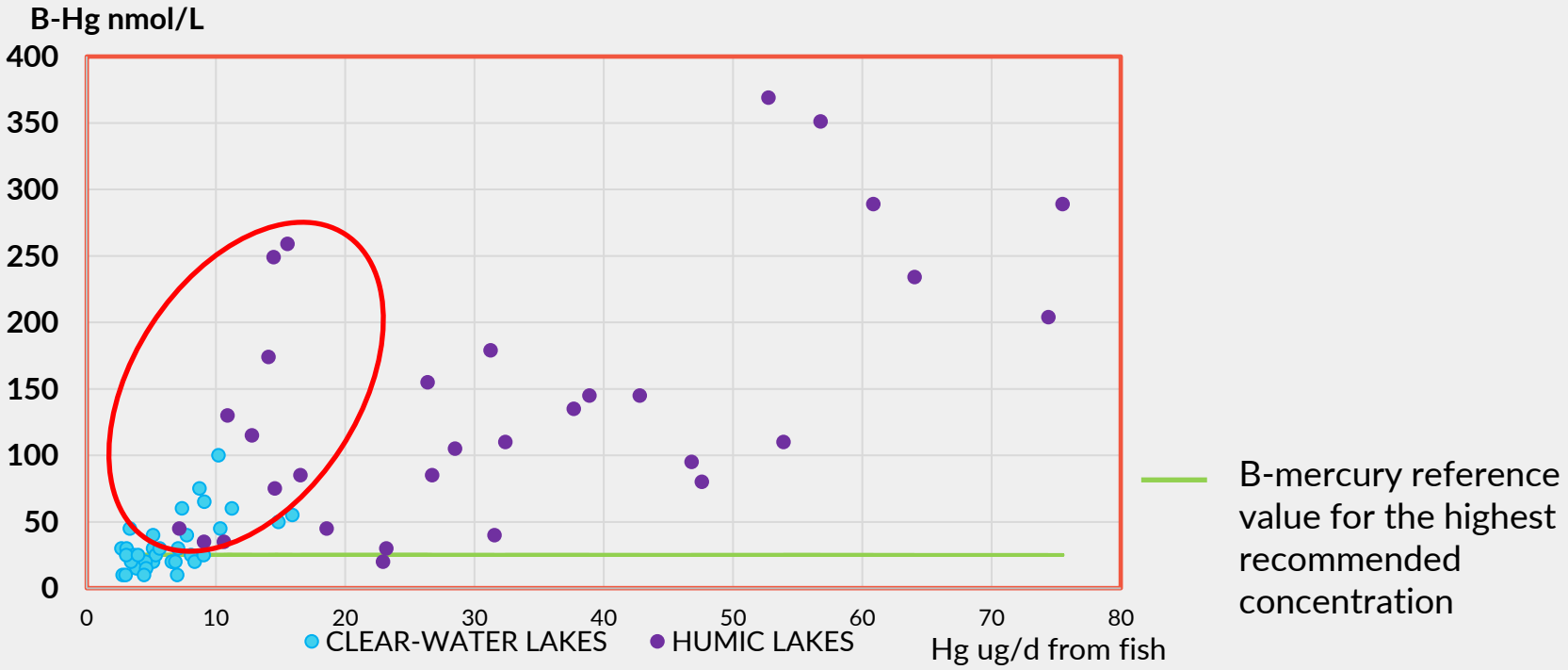
Mean intake of EPA+DHA was 326 mg/d

- People eating fish from clear-water lakes had higher EPA concentration in the body than those eating fish from humic lakes
- Fish from 'own' lake was an important determinant for EPA concentration in the body of persons eating clear-water lake fish, whereas for those eating humic lake fish, the other sources were more important
- The DHA concentration of persons eating clear-water lake fish was explained by both fish from the 'own' lake and from other sources, whereas for those using fish from humic lakes, only fish from other sources were important

Nurmi, Tuomainen et al., unpublished.

Health indicators for fish-eating people

Intake of mercury from fish and blood mercury concentrations

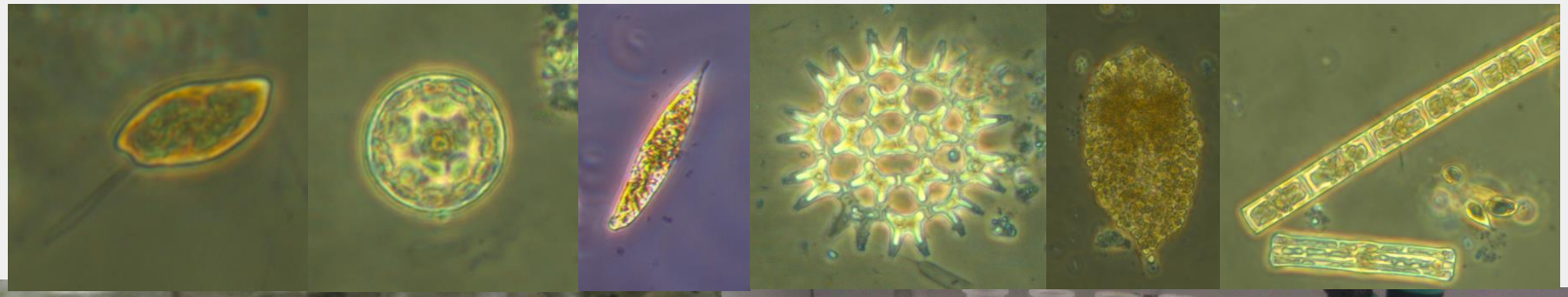


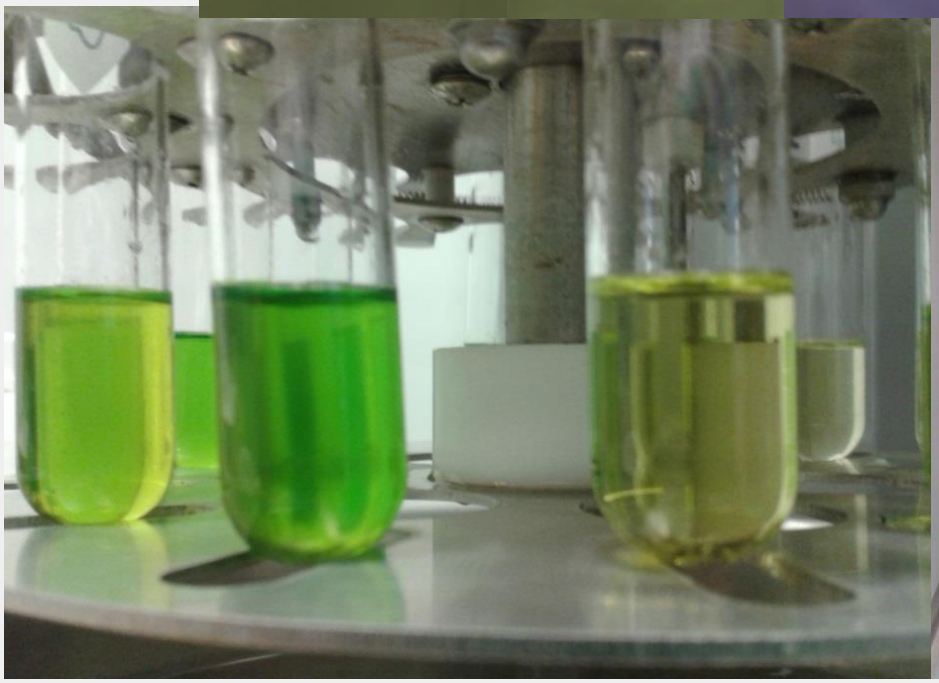
- Intake of mercury is low, but concentration in blood is high: accumulation during several years
- Correlation between mercury intake and blood concentration is 0.76

Nurmi, Tuomainen et al., unpublished.

Summary and Conclusions

- Both increase in phosphorus (eutrophication) and terrestrial organic matter (brownification) concentration affect lake phytoplankton community and production of essential ω-3 fatty acids
- Food web effects from phytoplankton can be traced up to predatory fish and fish-eating humans
- Organic matter from peatlands significantly influence lake water quality, food web structure and accumulation of mercury in fish
- Benefits of eating predatory fish from clear-water lakes are greater than the potential risks by mercury
- For predatory fish grown in highly humic lakes, the opposite conclusion can be drawn





Thank you for your attention!

Questions?

our attention!