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Five decades of declining methylmercury concentrations in boreal foodwebs suggest pivotal role for sulphate deposition

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Long-term decline in Hg in fish

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Improved Environmental Status: 50 Years of Declining Fish Mercury Levels in Boreal and Subarctic Fennoscandia

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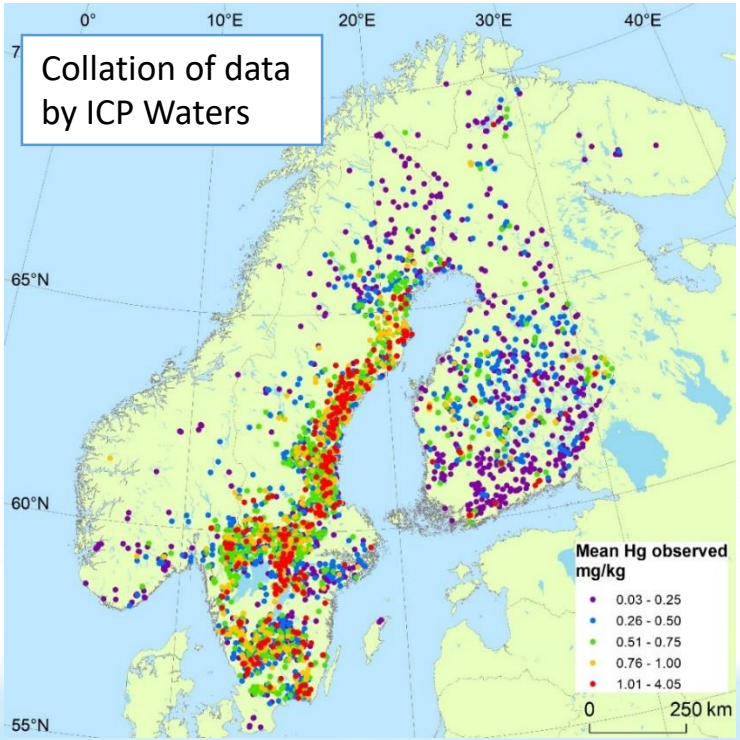
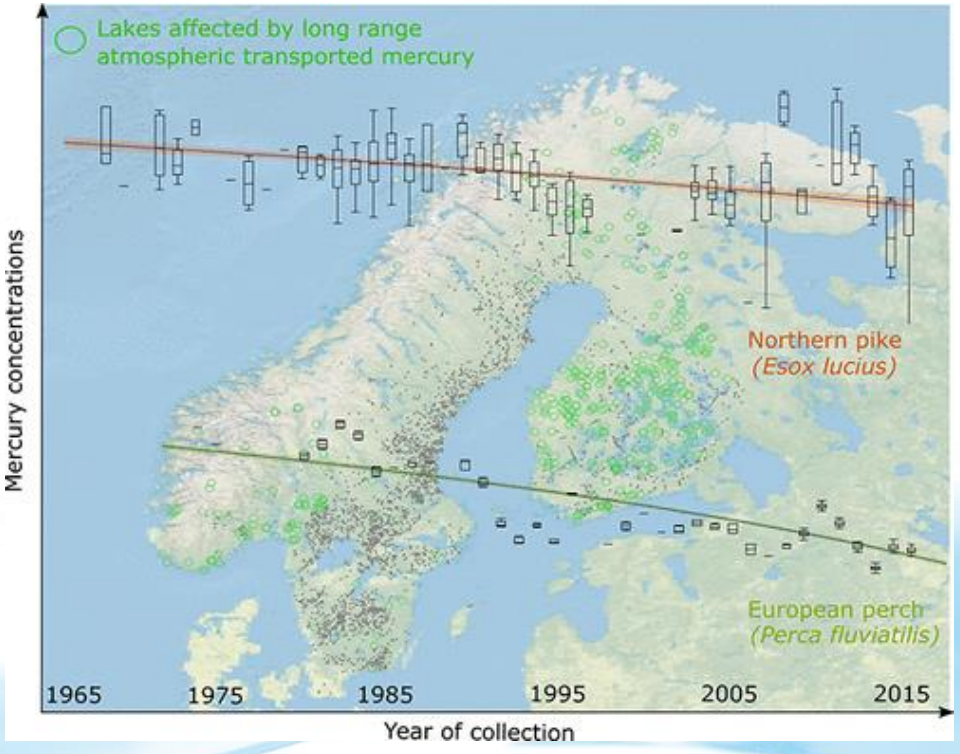
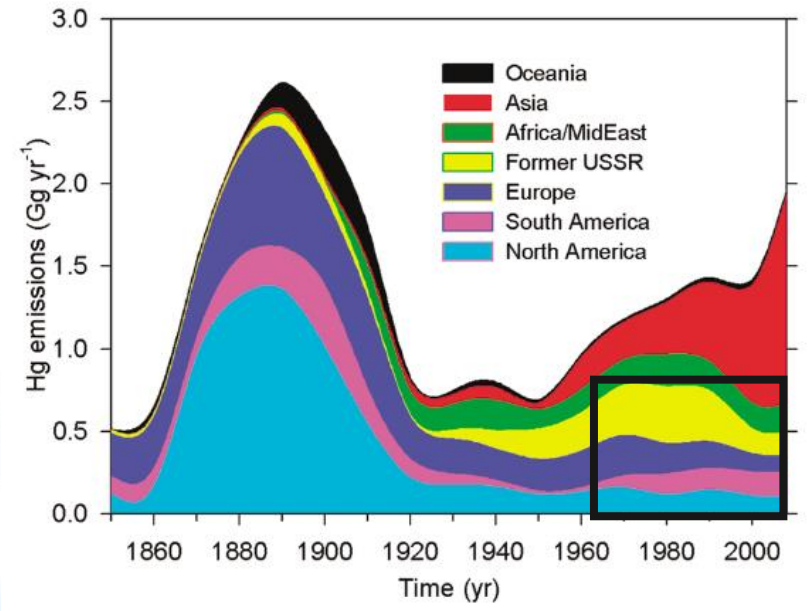




Braaten et al. 2019, ES&T

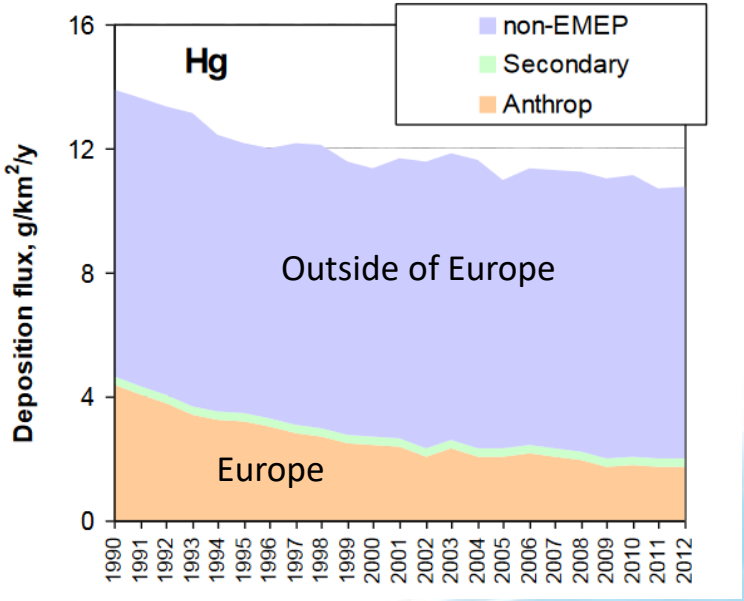
Long-term Hg emissions & deposition

Global Hg emissions
1850-2010



Streets et al. 2011, ES&T 45, 10485-10491

Mercury deposition Europe
(modeled, based on emissions) 1990-2012



EMEP, 2016

Is the decline of Hg in fish related to lower Hg deposition?

- Foodweb exposure to Hg is COMPLEX
  - Fish diet is key!
  - Sulfate-reducing bacteria produce methylmercury
- The ICP Waters fish data base does not contain enough supporting data (water chemistry, catchment characteristics, land use, sediments, lower foodweb) to test hypotheses

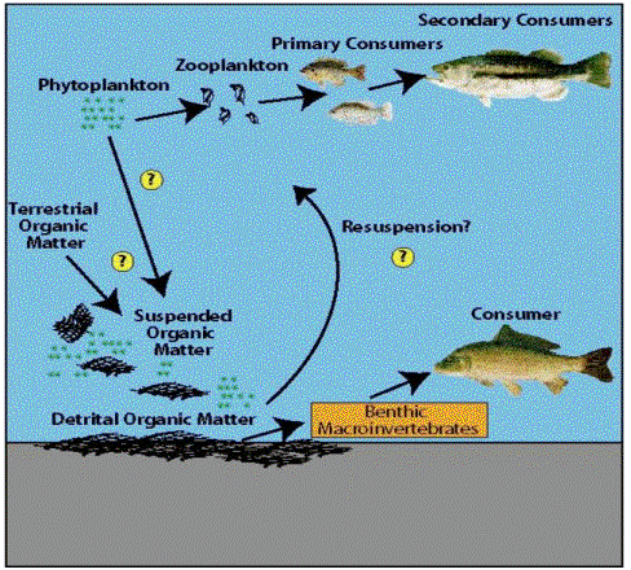


FIGURE 2: This diagram shows the relations between typical aquatic organisms. The arrows connect the prey (diet) to the predator (consumer). Several different food webs are shown.

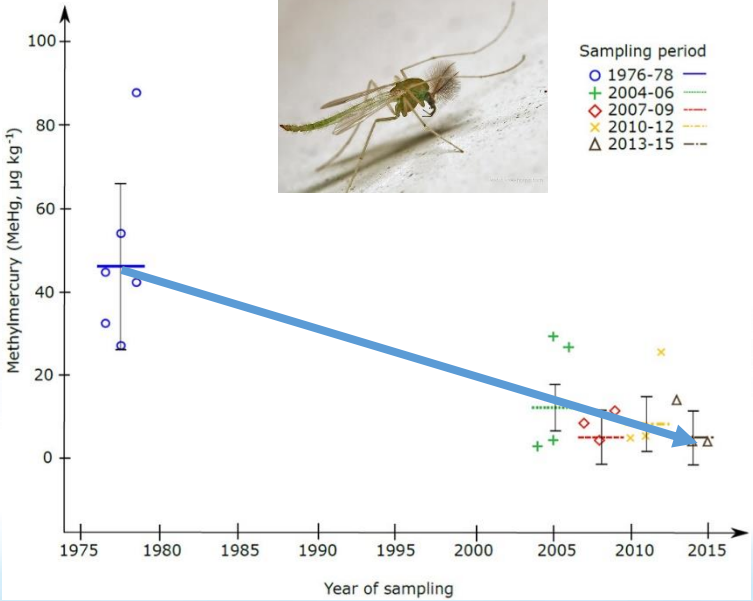
Source: USGS

Data-rich, remote catchment Langtjern

- Monitoring data
  - inorganic water chemistry since 1972
  - DOC since 1986
  - Hg+MeHg since 2004
  - Dated sediment core
  - No local sources of Hg
  - Climate and deposition
  - Small trout population
  - ARCHIVED SAMPLES!

Long-term record on Hg in midgets obtained from archived samples from Langtjern in museum in Bergen (Norway).

Museums have archived samples!



To our surprise, the insects (chironomids, sediment-dwelling non-biting midgets) showed a substantial decline in Hg (just like the Hg in fish!)

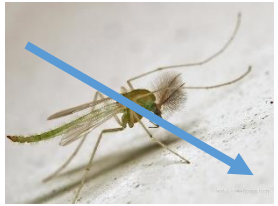
Mercury in foodweb is sensitive to DOC and SO4

- SO4-reducing bacteria produce methyl-mercury (MeHg), which is the most toxic form of mercury
  - Reduce SO4 deposition, reduce MeHg?

?

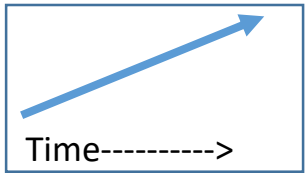
- Hg is transported from catchments to lakes by DOC
  - DOC has increased in recent years – more DOC, more Hg, more MeHg?

Hg in midgets



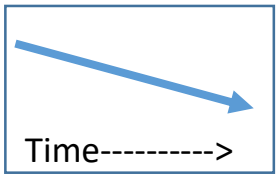
Time---------->

Hg in lake sediments

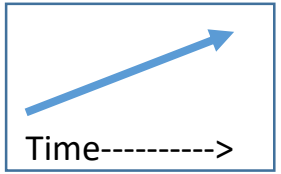


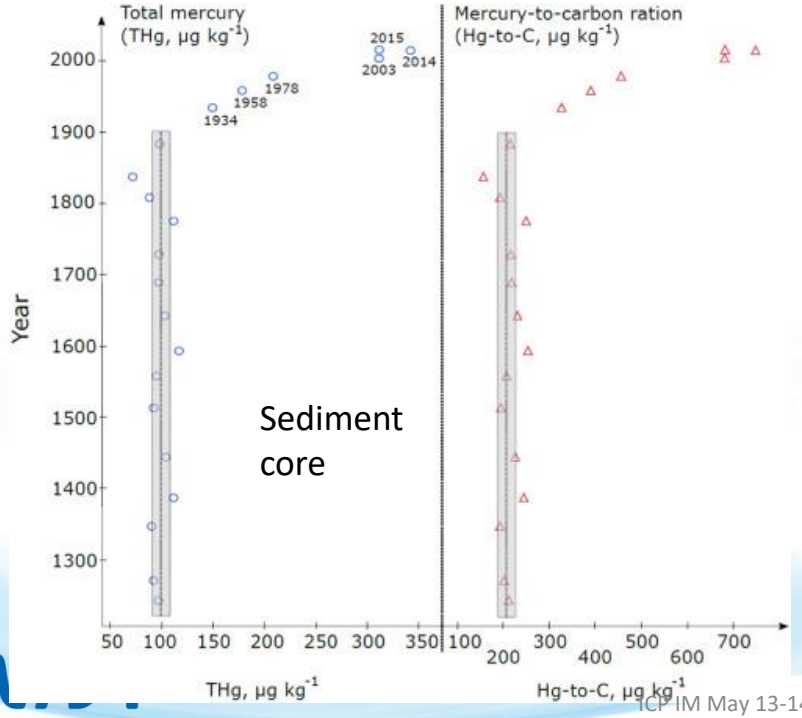
Water chemistry

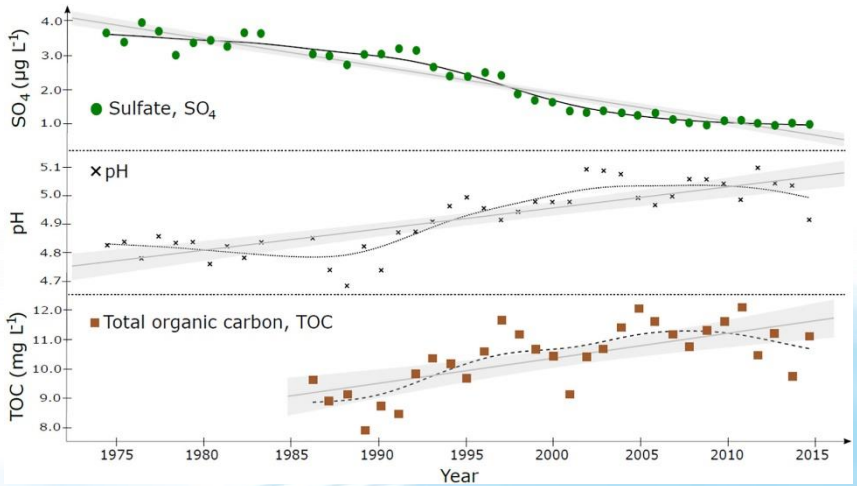
SO4



pH
TOC

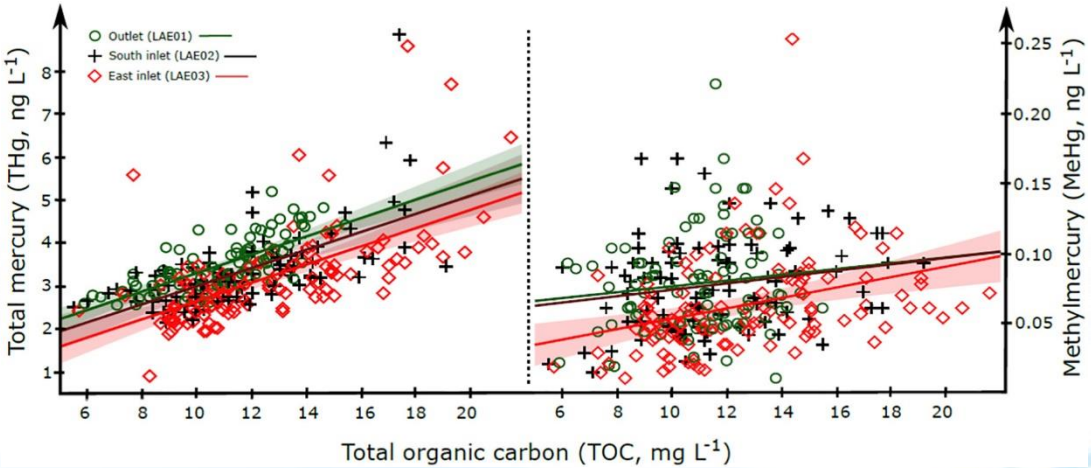




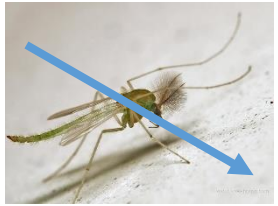


TOC and Hg are positively correlated

- More TOC = more Hg
- More TOC ≈ more MeHg



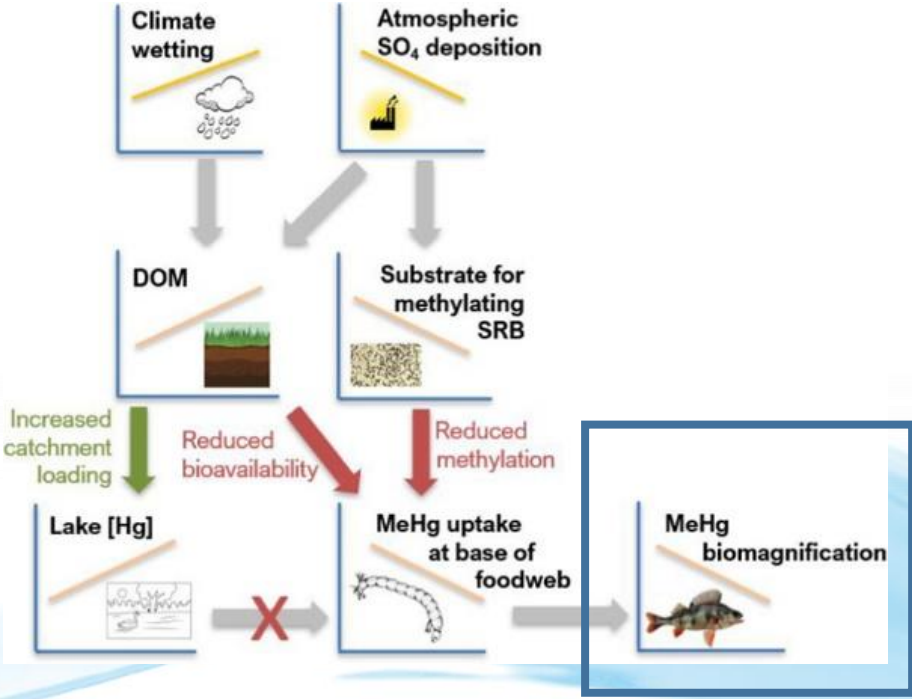
Hg in midgets



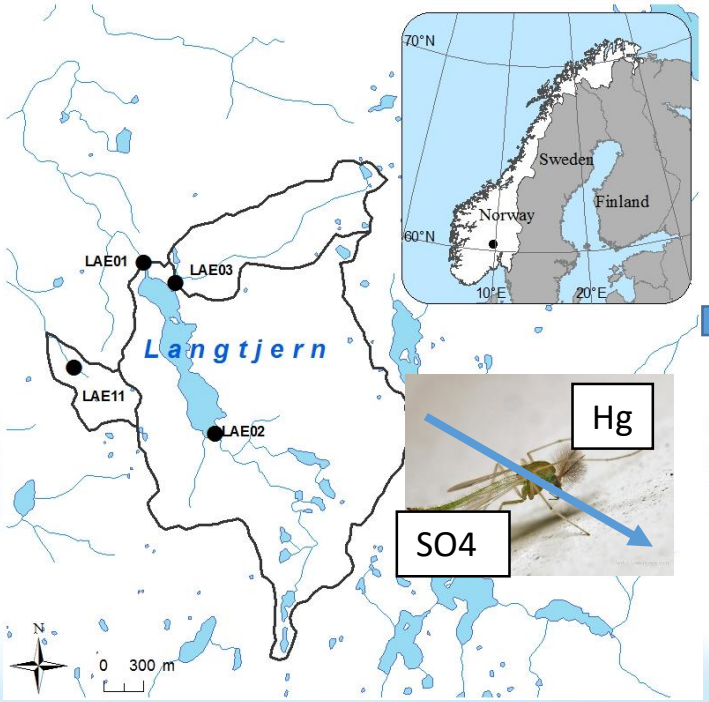
Time---------->

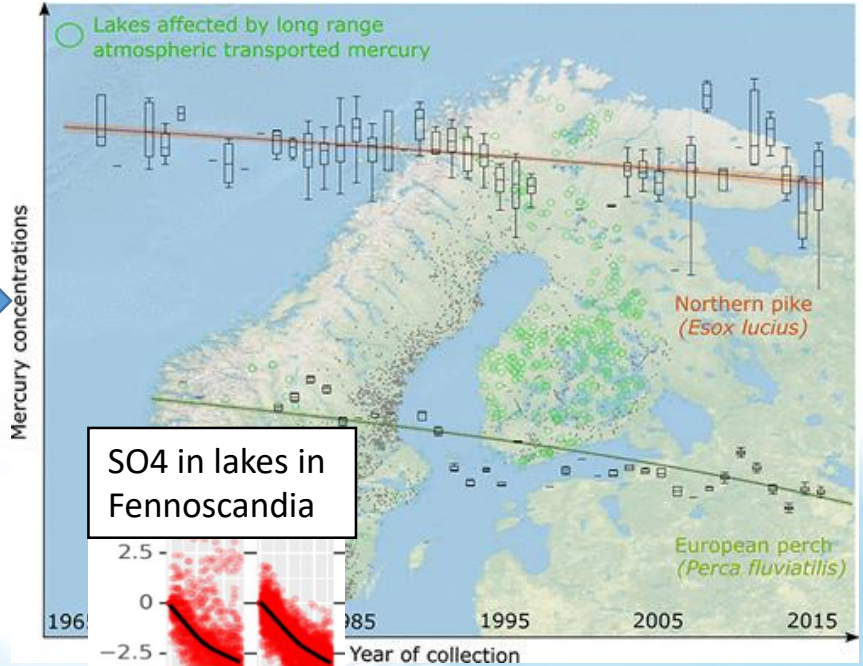
What explains the decline in Hg in midgets?

- √ climate wetting & reduced SO4 deposition increase DOM
- √ increased DOM increases lake sediment Hg (possibly)
- √ reduced SO4 deposition decrease production of MeHg and MeHg in midgets



Detailed monitoring in single catchment suggests role for S deposition to explain decline of Hg in fish





Garmo et al 2014

Thank you!

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