Why is Lake Superior so susceptible to methylmercury accumulation?

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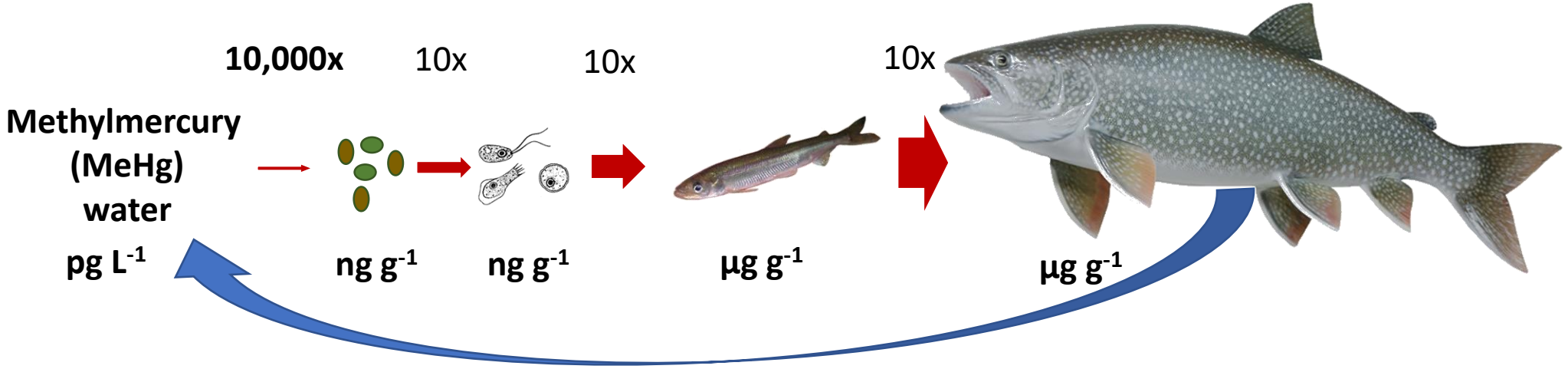
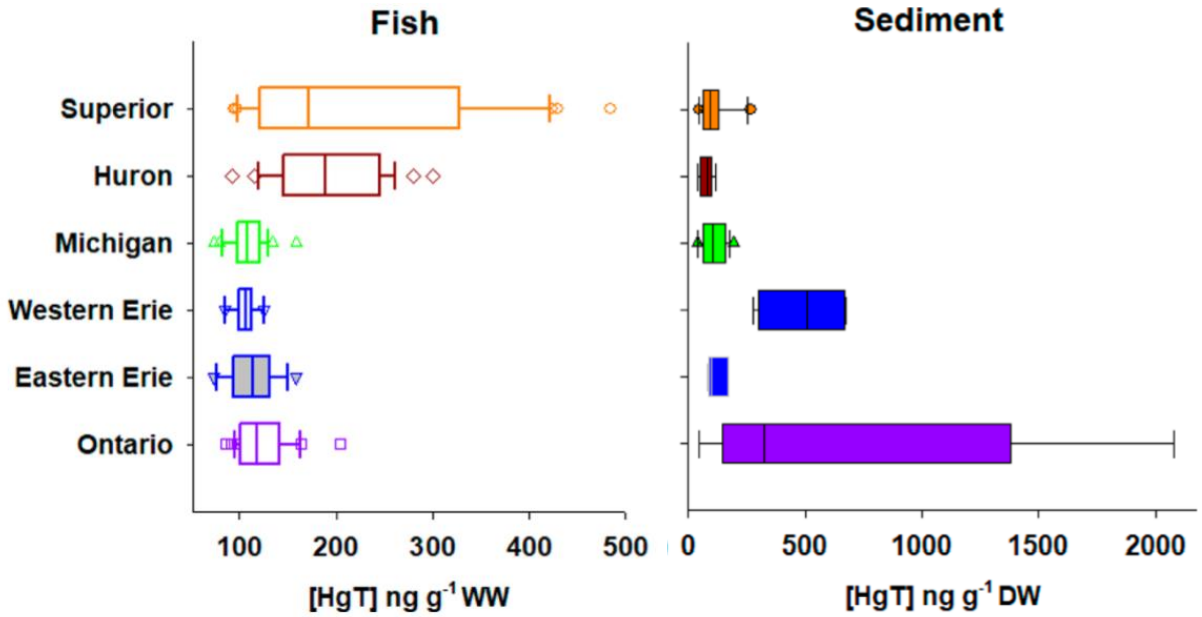
Hg bioaccumulation and magnification

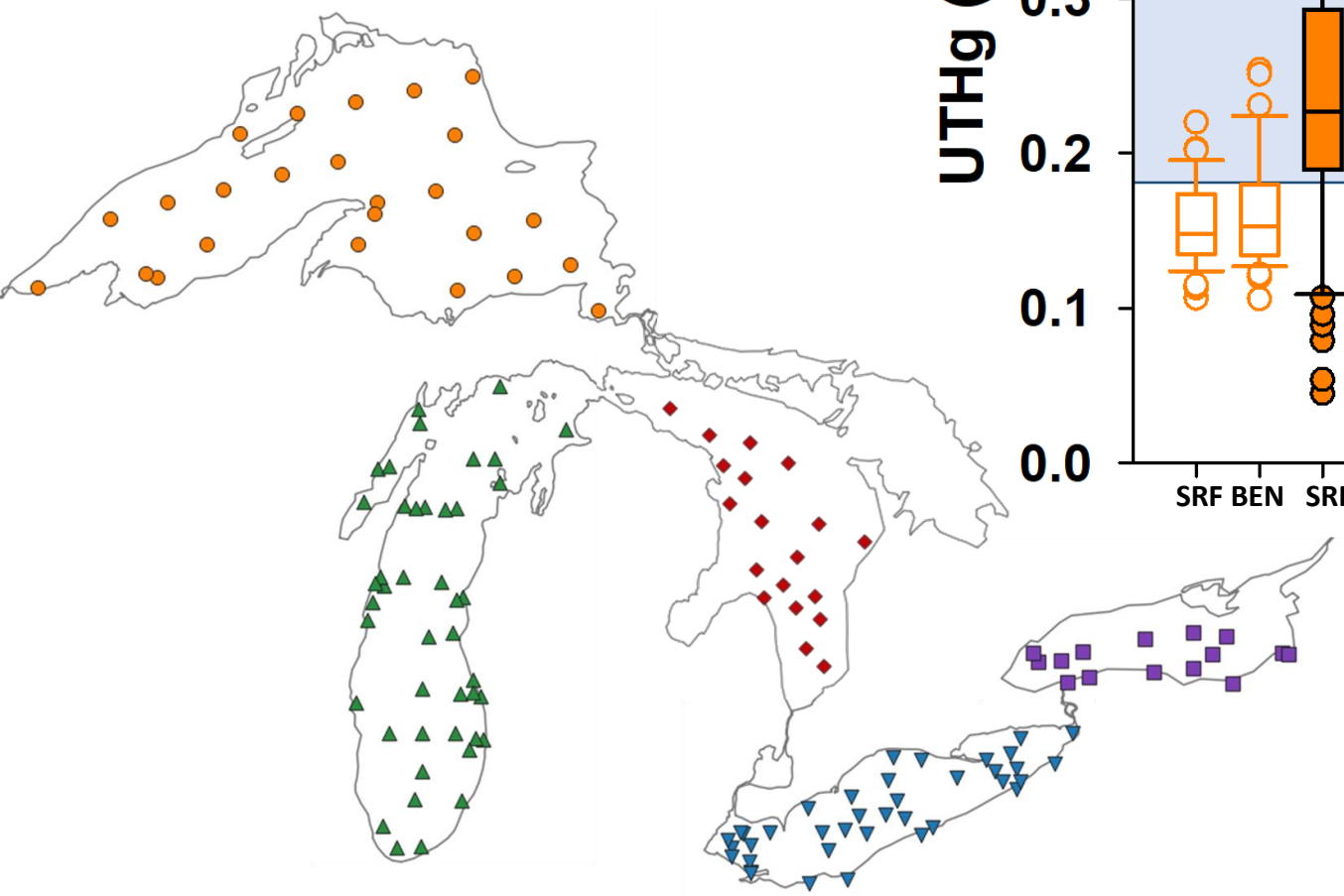


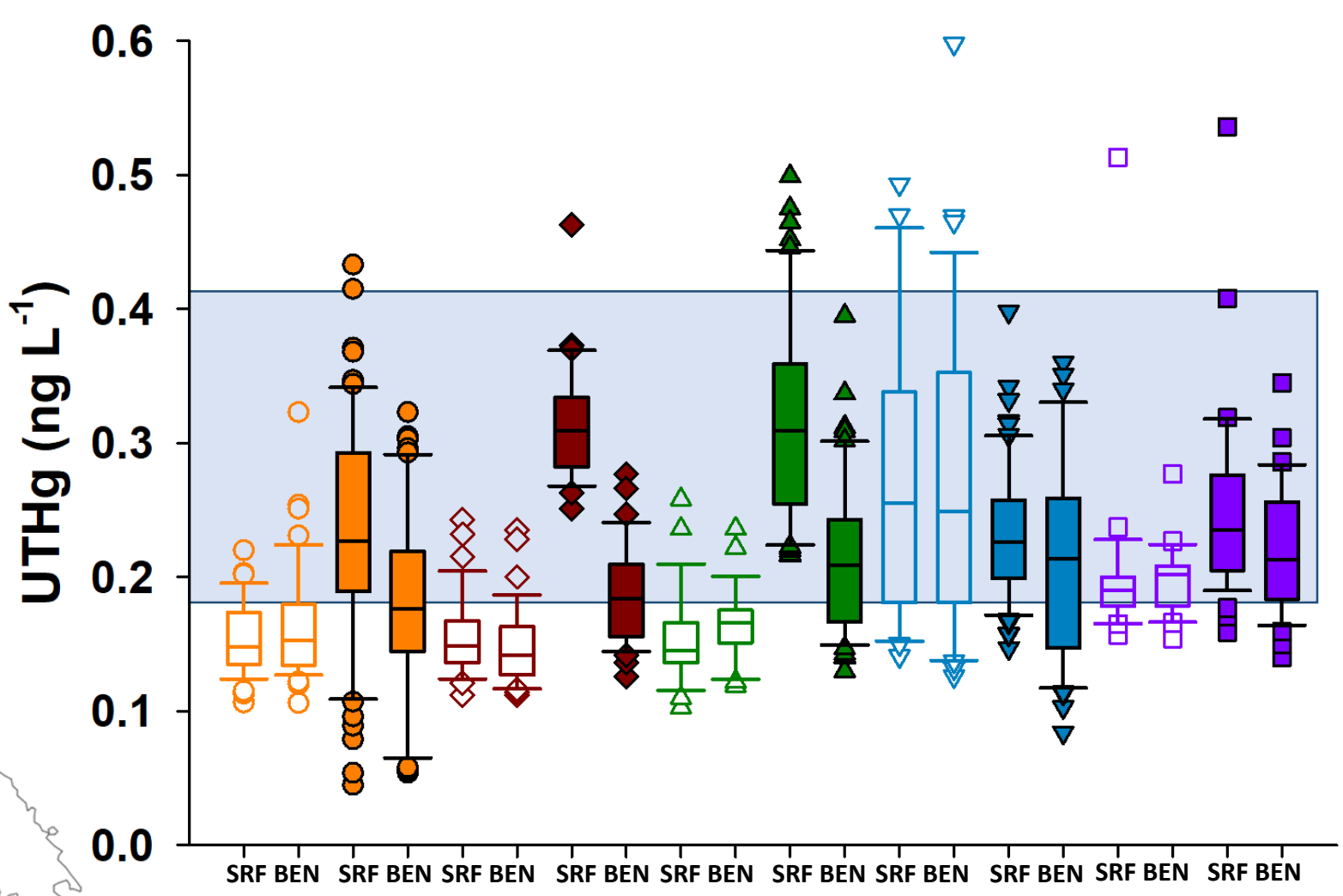
25,000,000 fold higher than water



Total Hg in water

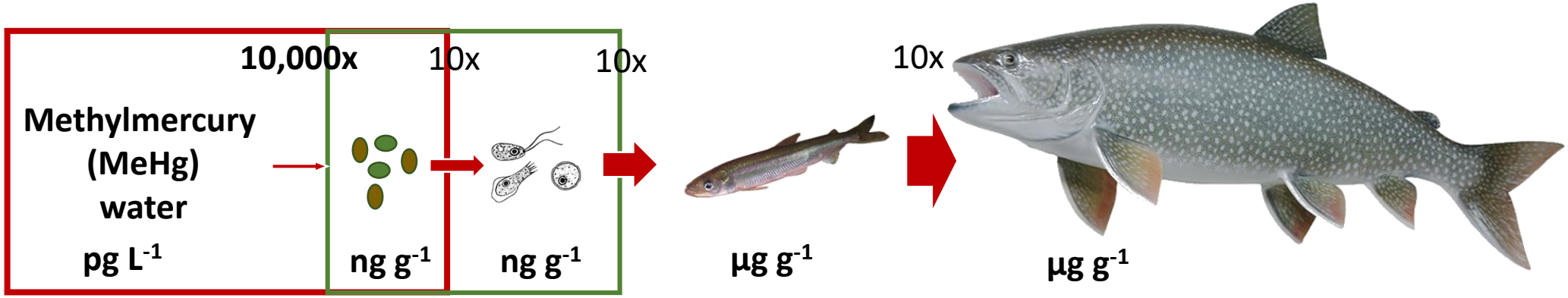
- 143 sample locations
- 511 profiles





- Lack of UTHg buildup in benthos of Upper GLs
  - Sediments are NOT Hg source (Erie maybe)

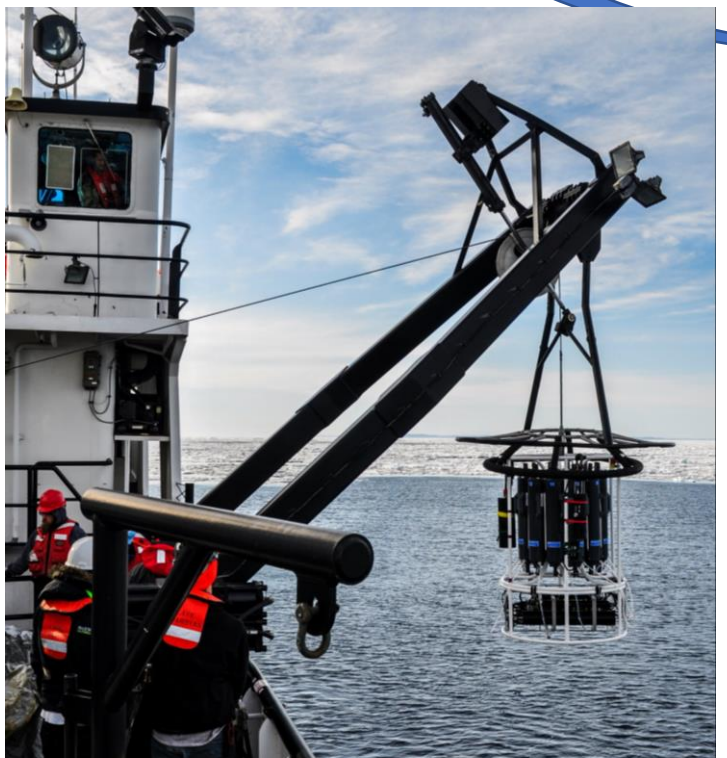
Hg bioaccumulation and magnification



1) Are bioaccumulation dynamics enhanced at the critical step?
   a. Hg concentrations

2) Does the lower food web play a substantial role?
   a. stable isotope ratios - CN

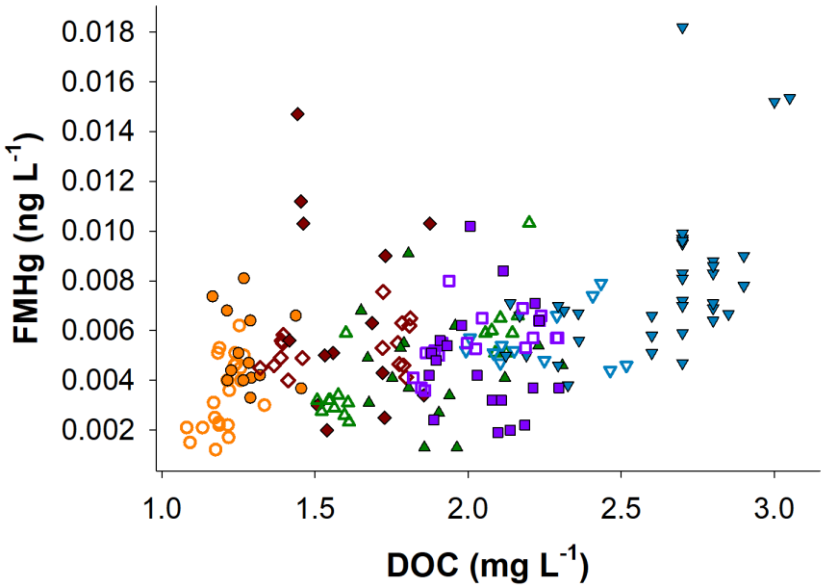
Hg bioaccumulation and magnification

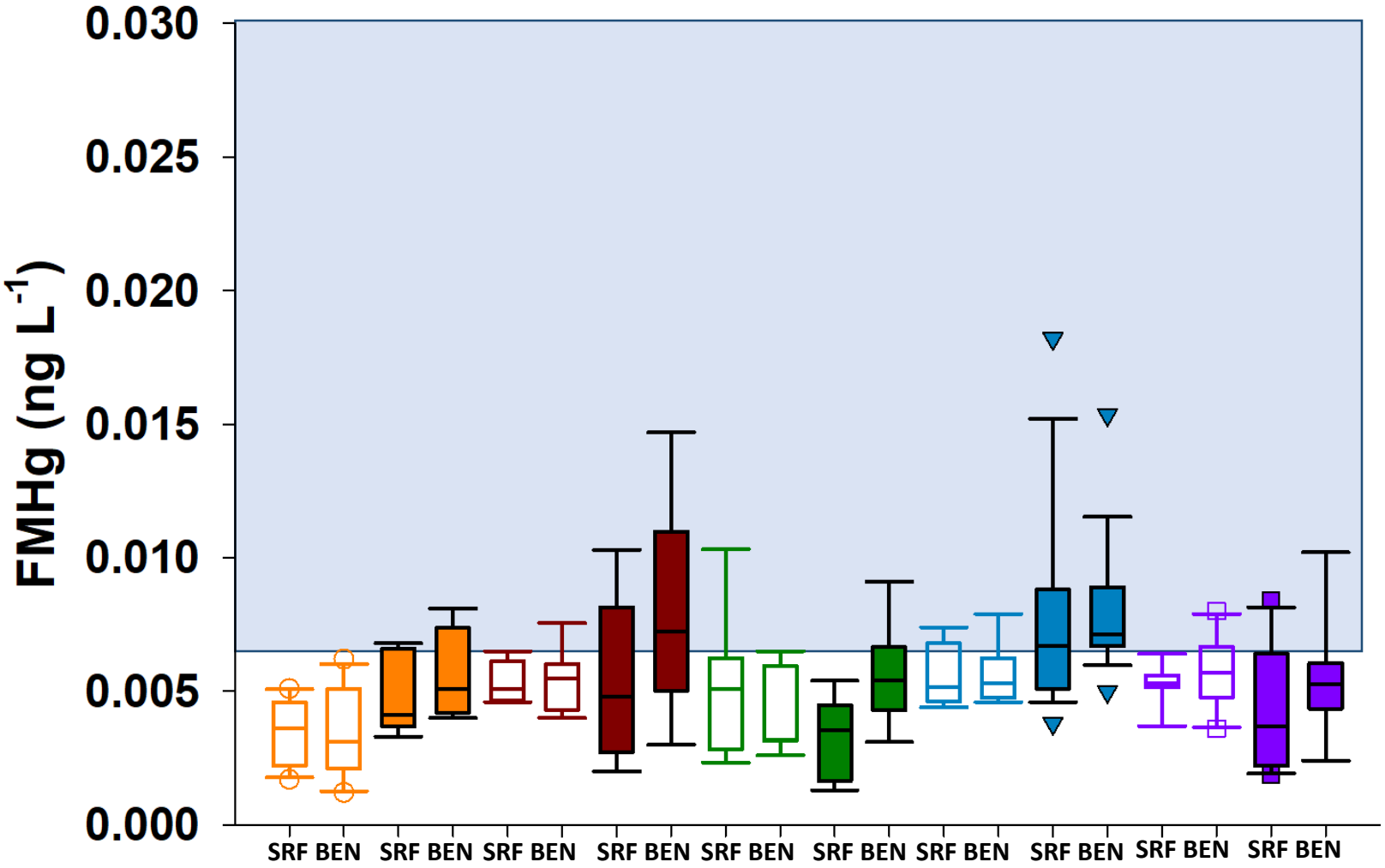


Dissolved MeHg in water

- 20-30% of MeHg is on particles

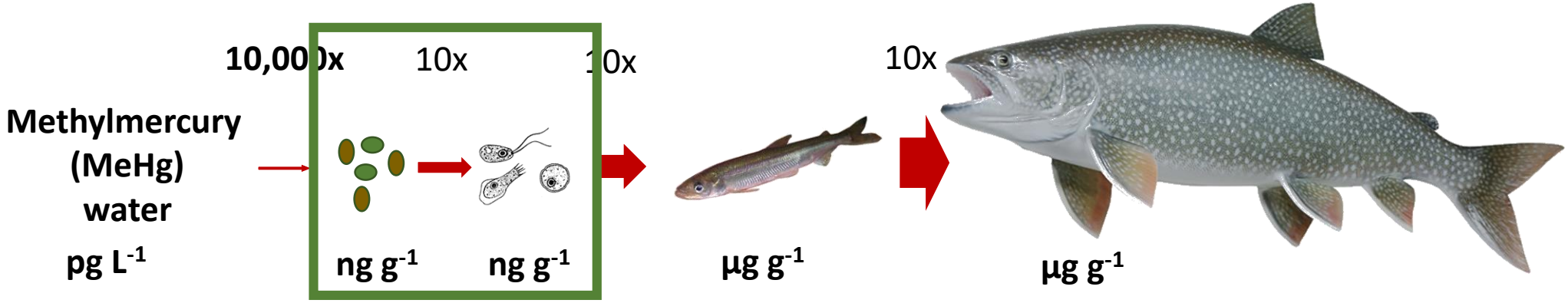
- Unlike the ocean, DOC does not modulate FMHg concentrations

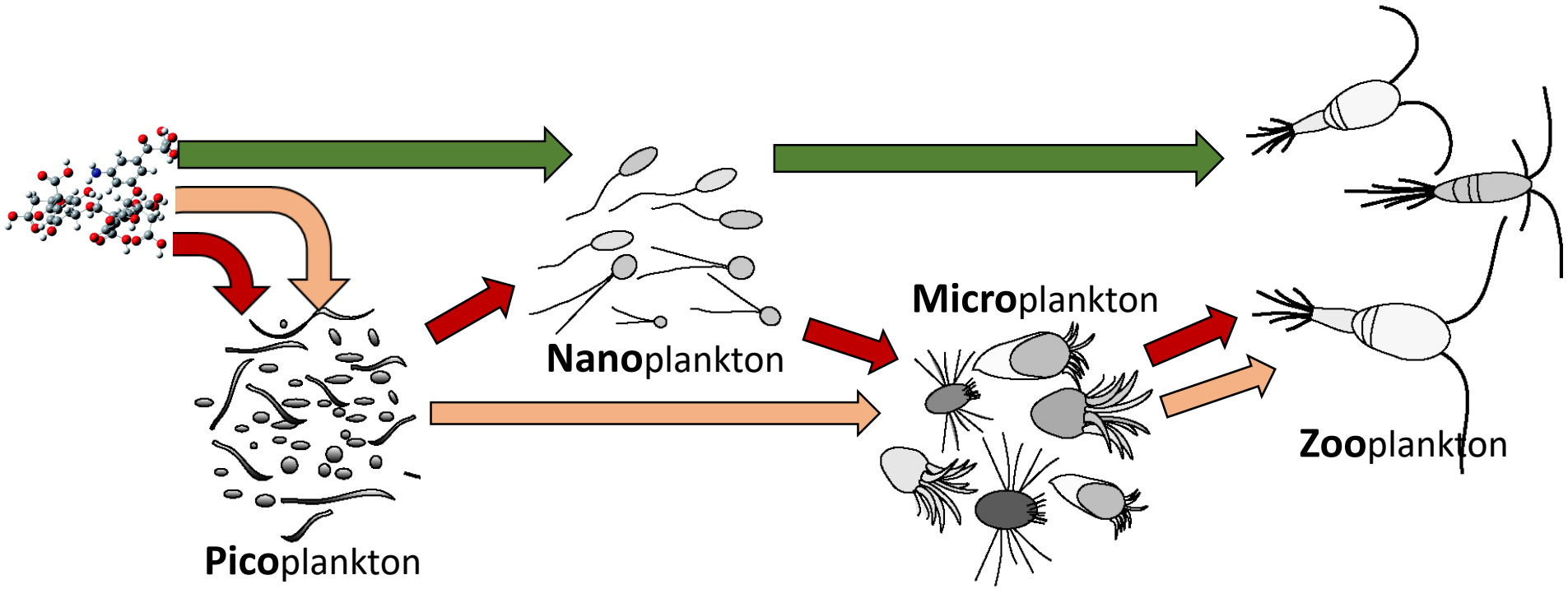




- FMHg buildup in benthos of Upper GLs
  - But 30 – 70% of FMHg is photochemically destroyed in epilimnion

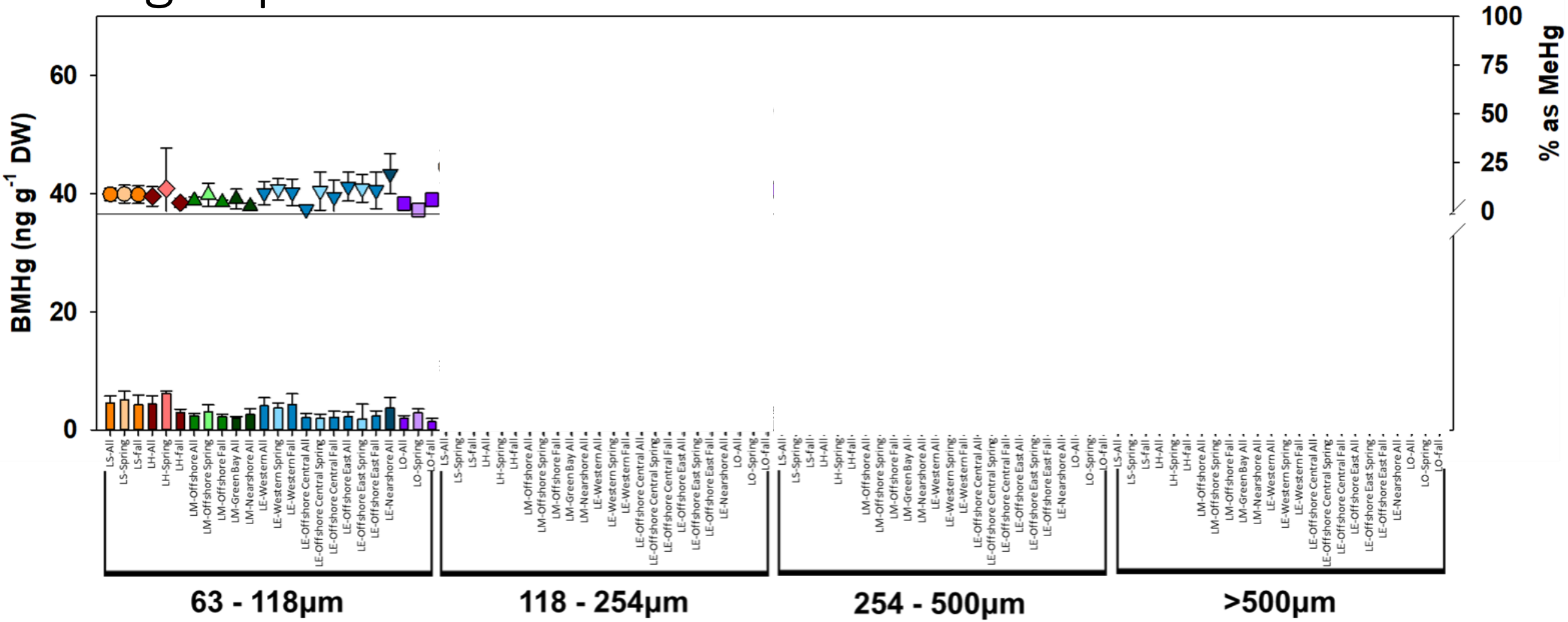
Hg bioaccumulation and magnification

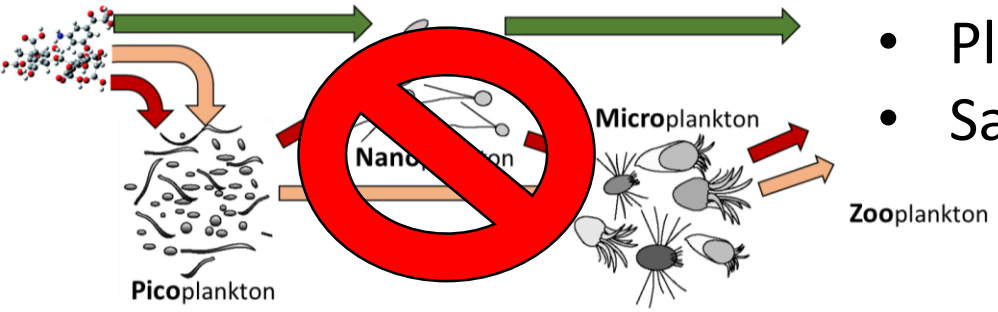




Complexity	MeHg
• Simple	+
• Moderate	++
• Complex	+++

MeHg in plankton – food web interactions

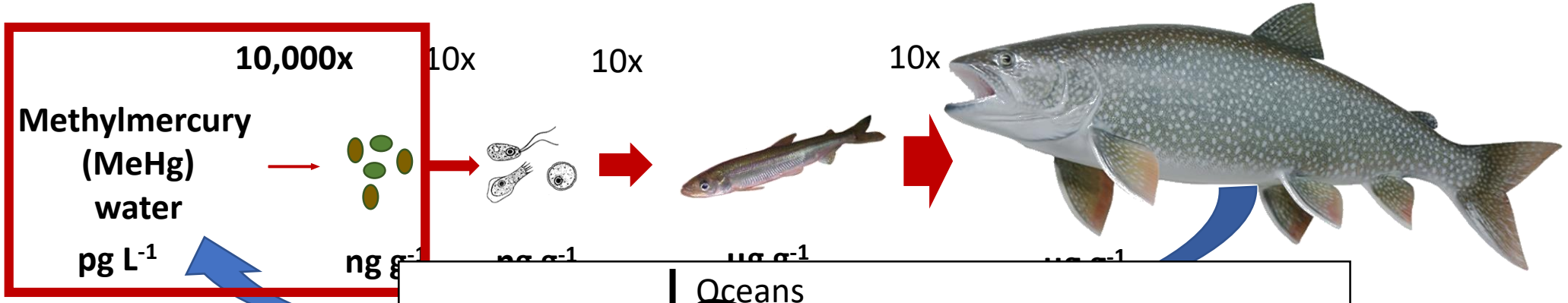


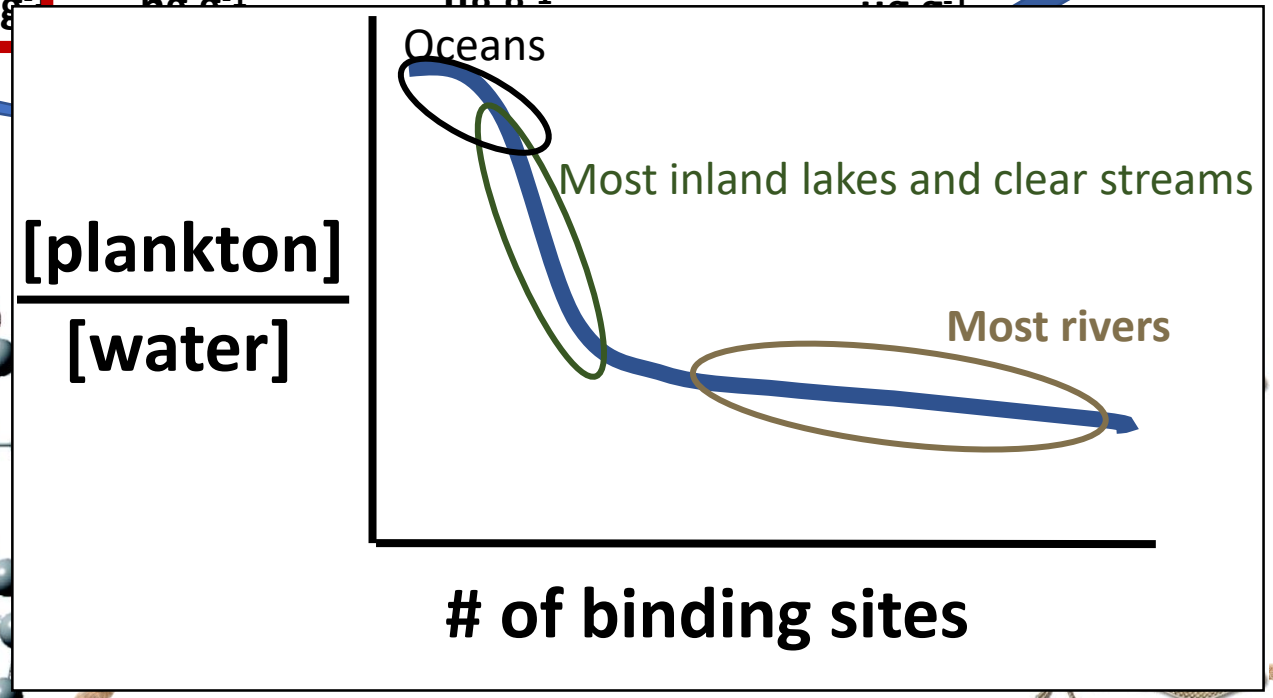


- Planktonic concentrations are 10 – 100 times lower than fish.
- Sampling design captured biomagnification.

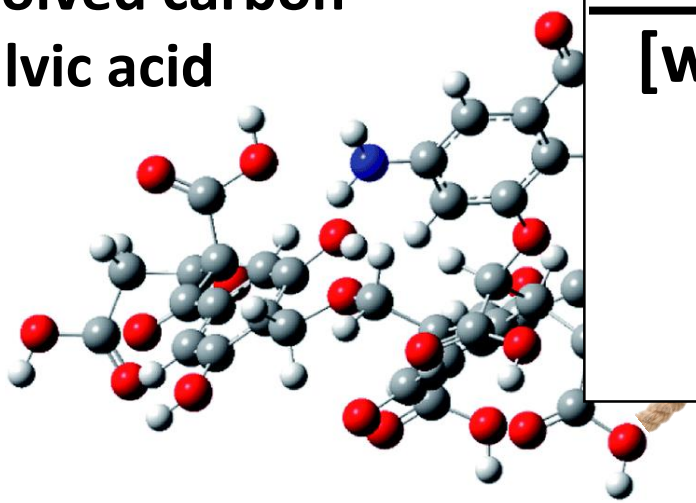
Food web tracers (C and N isotopes) support this.

Hg bioaccumulation and magnification



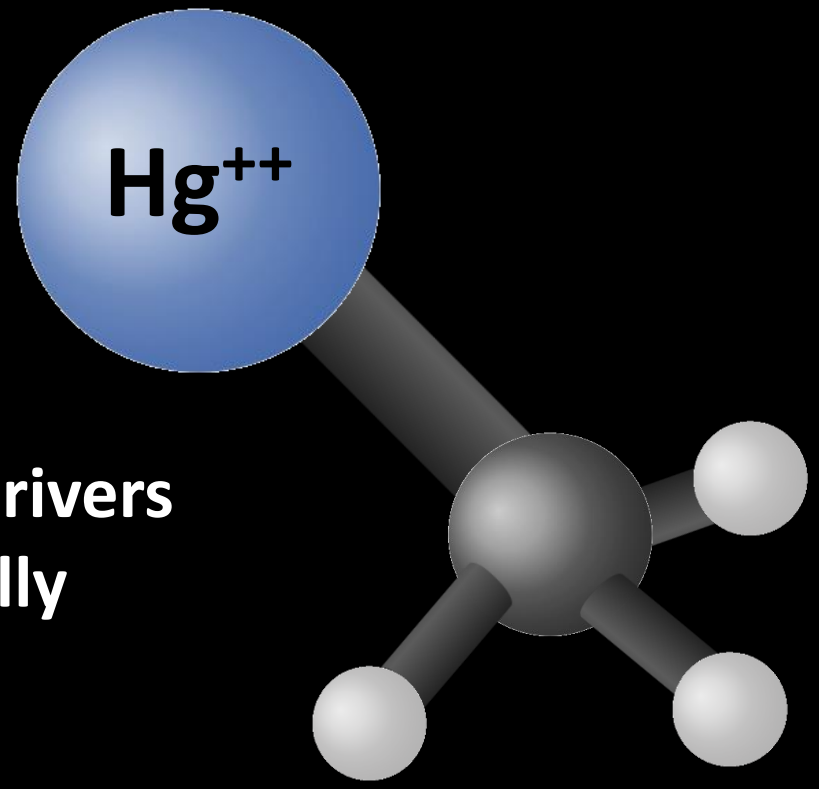


Dissolved carbon – Fulvic acid



Why ~~Lake Superior is~~ the Great Lakes are so susceptible to methylmercury accumulation?

X^-

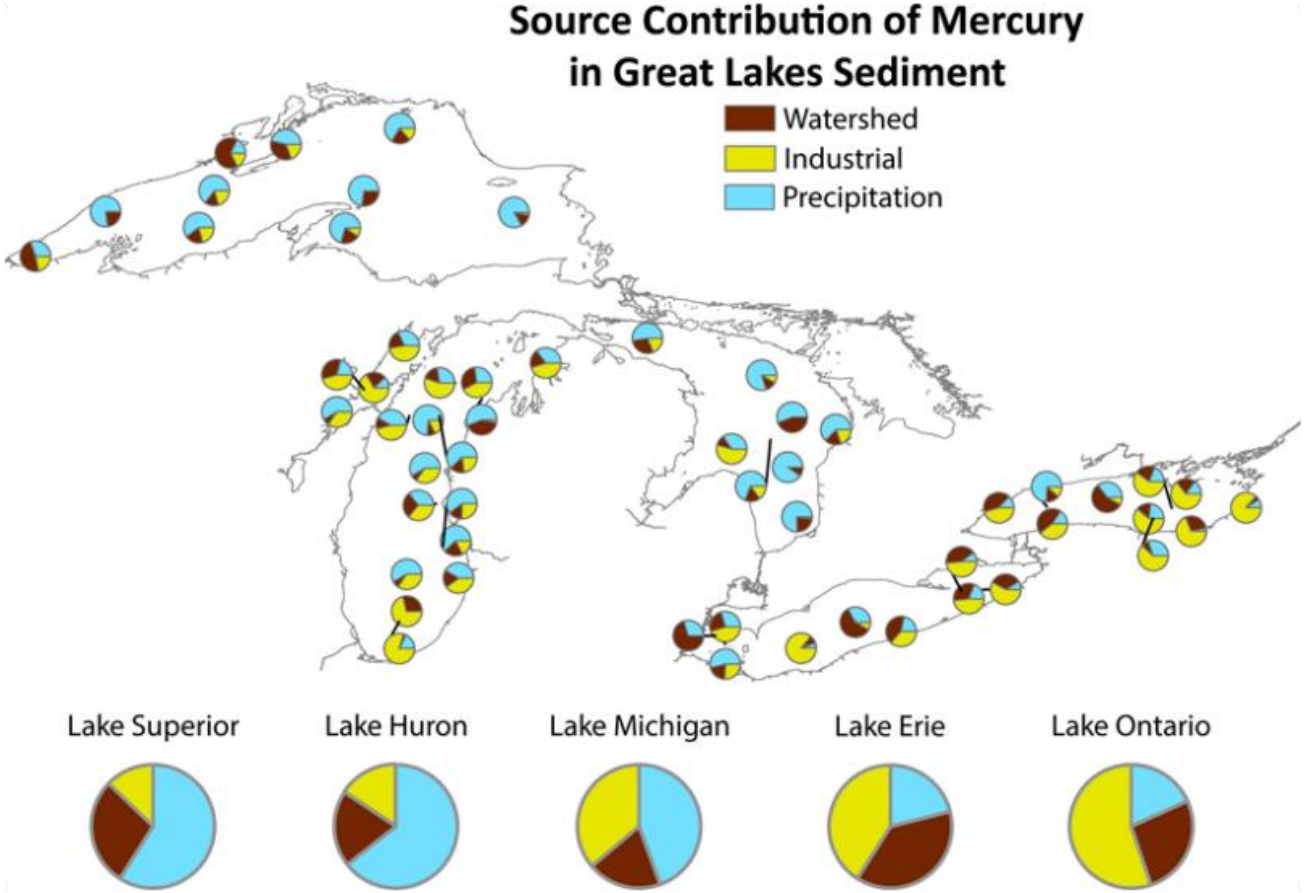


X^- could be:

1. **Chloride or Bromine – Oceans**
2. **Large complex DOC molecules – Inland lakes and rivers**
3. **Small, simple DOC molecules – Great Lakes globally**

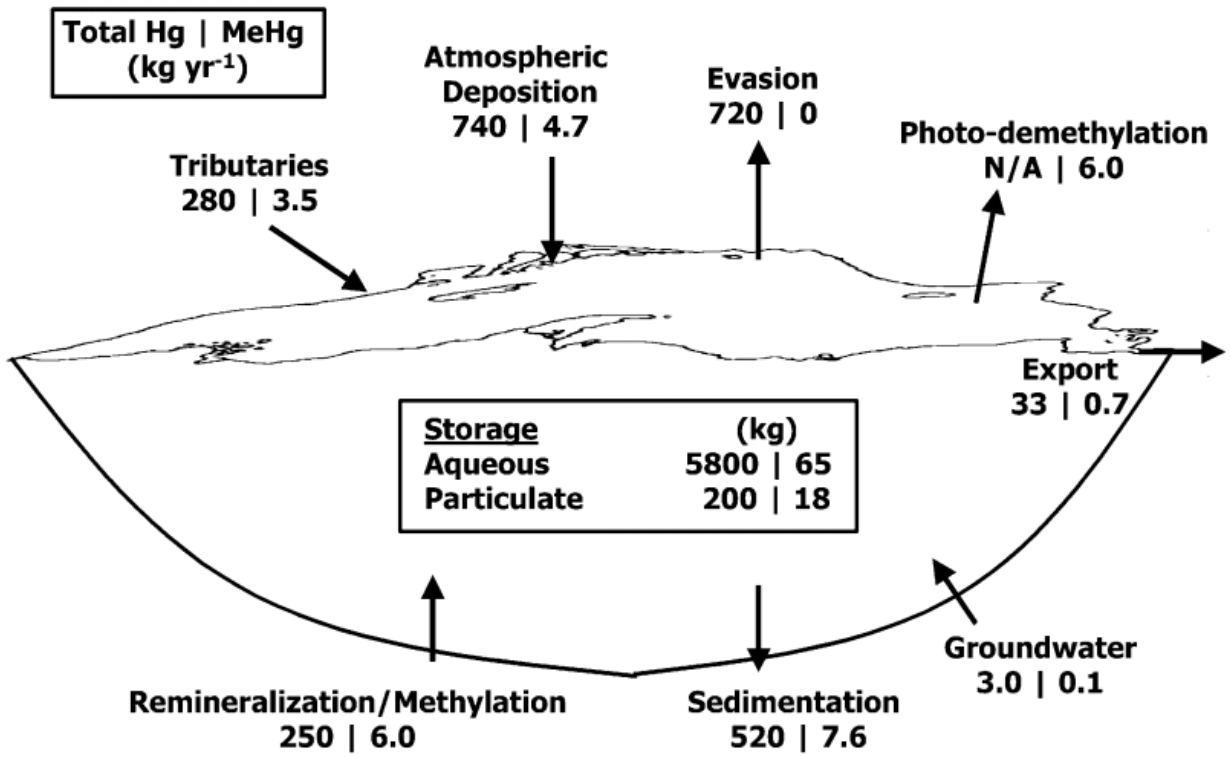
Great Lakes are susceptible to methylmercury bioaccumulation

- Proportions of atmospherically delivered Hg increase with increased Lake to Watershed ratios and/or minimal littoral zone.
  - GLs span 1.5 – 3.4 (Upper 1.5 – 2.2)[3]
  - Similar to:
    - Baikal - Russia
    - Victoria – E Africa
    - Tanganyika - E Africa
    - Malawi - E Africa
    - Great Bear – Canada
    - Great Slave – Canada
    - Winnipeg – Canada
    - Ladoga – Russia
    - Issyk - Kul – Kyrgyzstan



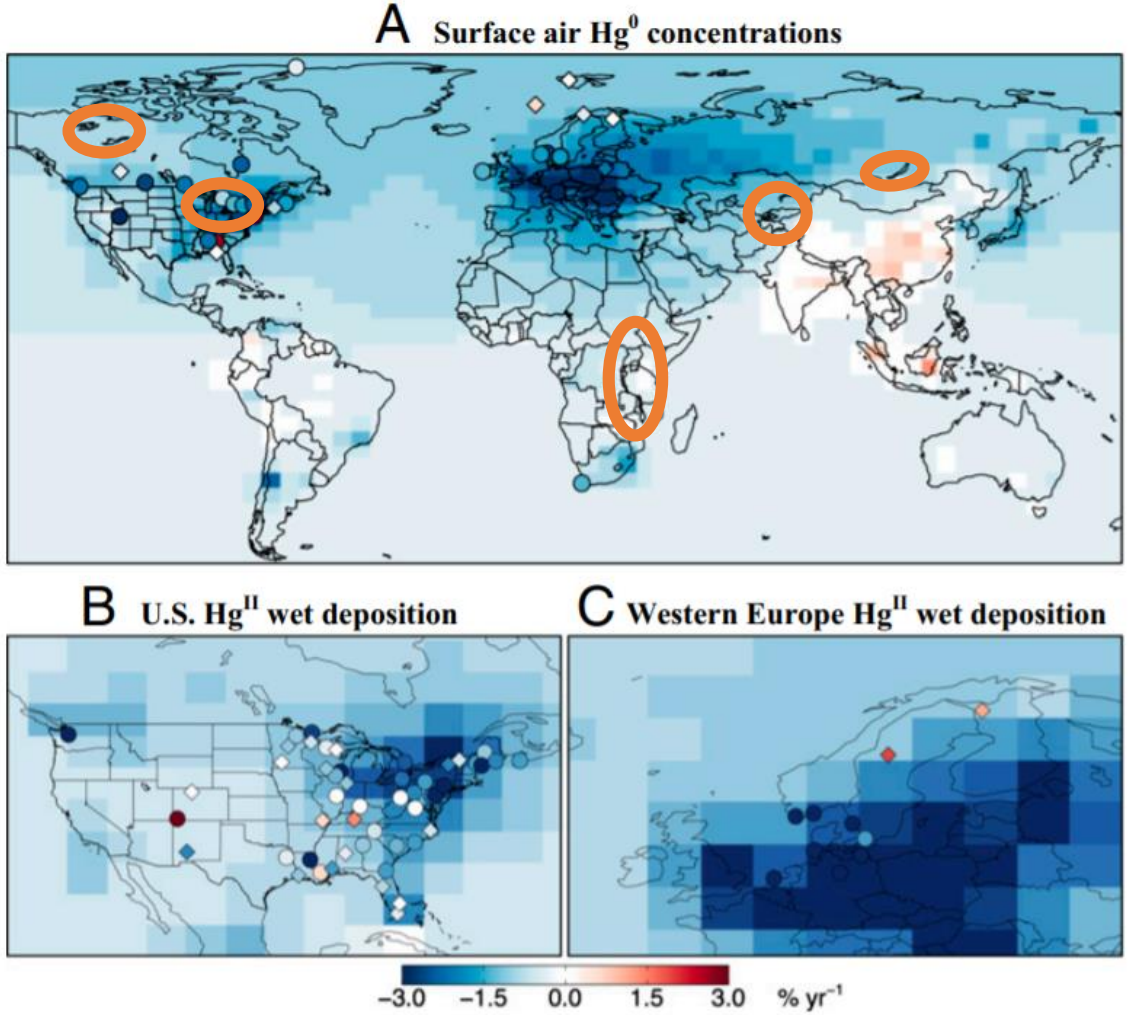
Great Lakes are susceptible to methylmercury bioaccumulation

- Proportions of atmospherically delivered Hg increase with increased Lake to Watershed ratios and/or minimal littoral zone.
- These lakes represent the world's most sensitive ecosystems to atmospherically delivered Hg[4].



Great Lakes are susceptible to methylmercury bioaccumulation

- Proportions of atmospherically delivered Hg increase with increased Lake to Watershed ratios and/or minimal littoral zone.
- These lakes represent the world's most sensitive ecosystems to atmospherically delivered Hg.
- Thus, they are sentinels to globally declining Hg emissions present in the N. hemisphere[5].



Thank you

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Citations

- 1) Tsui, M. T. K.; Finlay, J. C., Influence of dissolved organic carbon on methylmercury bioavailability across Minnesota stream ecosystems. *Environmental science & technology* **2011,** *45*, (14), 5981-5987.
- 2) Schartup, A. T.; Qureshi, A.; Dassuncao, C.; Thackray, C. P.; Harding, G.; Sunderland, E. M., A model for methylmercury uptake and trophic transfer by marine plankton. *Environmental science & technology* **2018,** *52*, (2), 654-662.
- 3) Robertson, D. M.; Saad, D. A., Nutrient inputs to the laurentian great lakes by source and watershed estimated using SPARROW watershed models1. *JAWRA Journal of the American Water Resources Association* **2011,** *47*, (5), 1011-1033.
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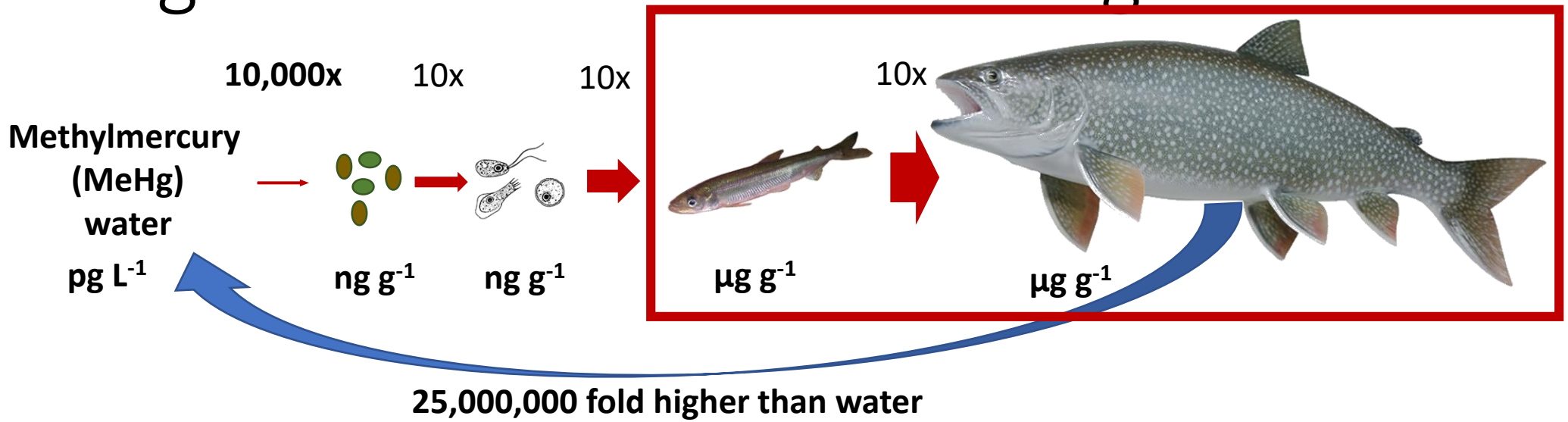
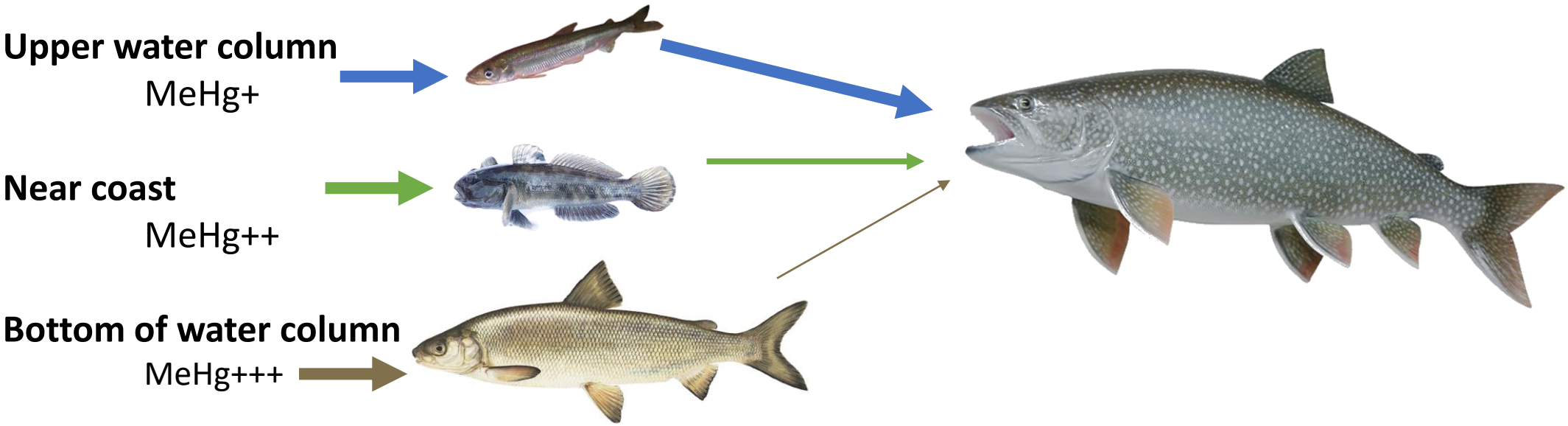
- 5) Zhang, Y.; Jacob, D. J.; Horowitz, H. M.; Chen, L.; Amos, H. M.; Krabbenhoft, D. P.; Slemr, F.; Louis, V. L. S.; Sunderland, E. M., Observed decrease in atmospheric mercury explained by global decline in anthropogenic emissions. *Proceedings of the National Academy of Sciences* **2016,** *113*, (3), 526-531.

Hg bioaccumulation and magnification





Hg bioaccumulation and magnification