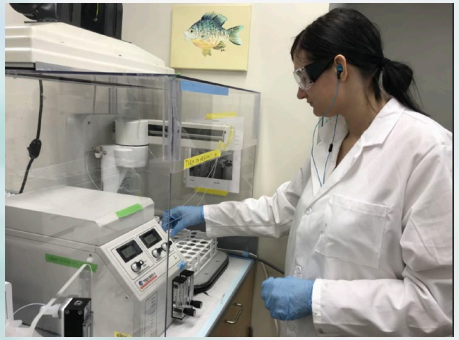
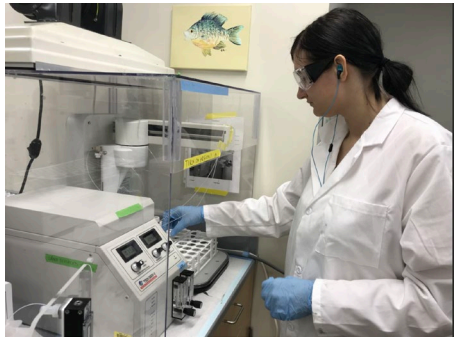


ICMGP 2024
CAPE TOWN • SOUTH AFRICA • 21 - 26 JULY

“Novel data on methylmercury bioaccumulation in natural marine plankton from coastal North Atlantic Ocean”

Zofia Baumann, Patricia Myer, Robert Mason, Colleen B. Mouw, Heidi M. Sosik, Virginie Sonnet, Audrey Ciochetto, Emily E. Peacock



ICMGP 2024
CAPE TOWN • SOUTH AFRICA • 21 - 26 JULY

“Novel data on methylmercury bioaccumulation in natural marine plankton from coastal North Atlantic Ocean”

Goal: To gain better understanding of MeHg in marine phytoplankton

What is knows about MeHg at the base of planktonic foodweb?

Experimentation with phytoplankton cultures showed that MeHg uptake is influenced by:

Cell size: Passive uptake is favored by higher surface area to volume ratio of the smaller cells

Salinity: Uptake proportional to salinity

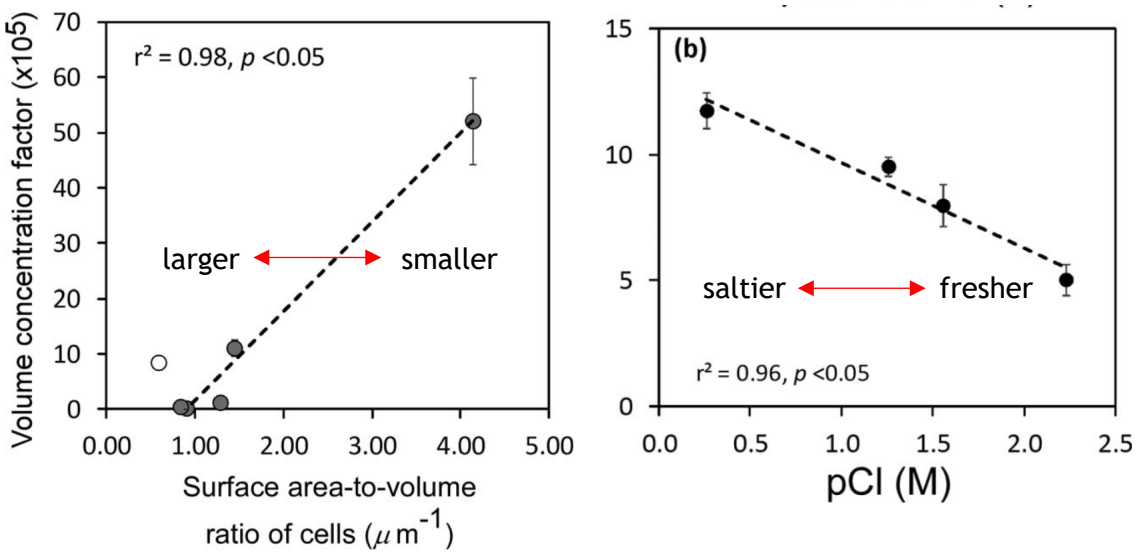
Dissolved Organic Carbon (DOC):

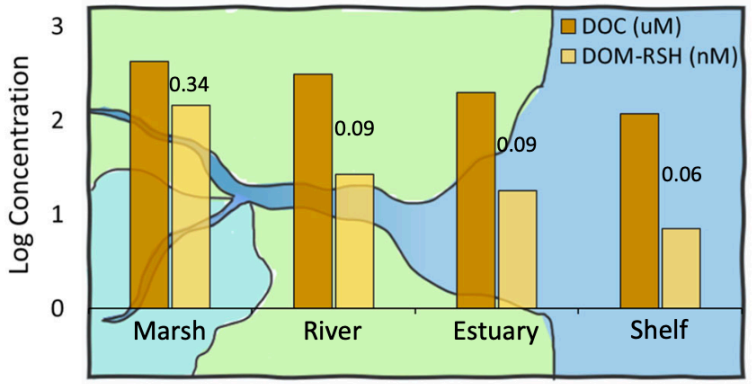
a). DOC binds MeHg and this lowers MeHg bioavailability to phytoplankton, this MeHg uptake and [DOC] are inversely related

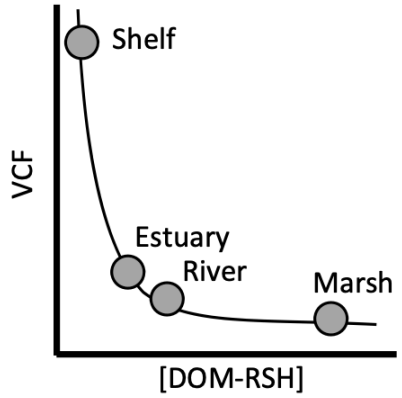
Especially,

b). The thiol content in DOC – large thiol rich compounds bind MeHg and this lowers MeHg bioavailability, and thus uptake

Lee and Fisher, 2016







Seelen et al. 2023

What is not known?...and can we seek answers? How?

1). How much MeHg accumulates in natural phytoplankton cells? Does auto v. heterotrophy matters?

Approach: Seawater sampling and sequential filtration of particles for different size classes (i.e. pico, nano, micro) to determine MeHg + particle counts, sizes, biovolumes; Experimentation in the laboratory

2). How variable is MeHg accumulation with cell size, location, time, tide etc.?

Approach: As above using existing sampling platforms such as ongoing research cruises, coastal monitoring programs to undertake adequate sampling scheme

3). Is MeHg uptake comparable between lab cultures and natural phytoplankton?

Approach: Combine MeHg measurements with the biovolumes derived from IFCB, FCM data to determine volume concentration factors (VCFs)

3). Can we determine mass-based MeHg concentrations in phytoplankton?

Approach: Biomass for common phytoplankton can be converted from biovolumes or one can assume a standard density value – e.g. equal to seawater

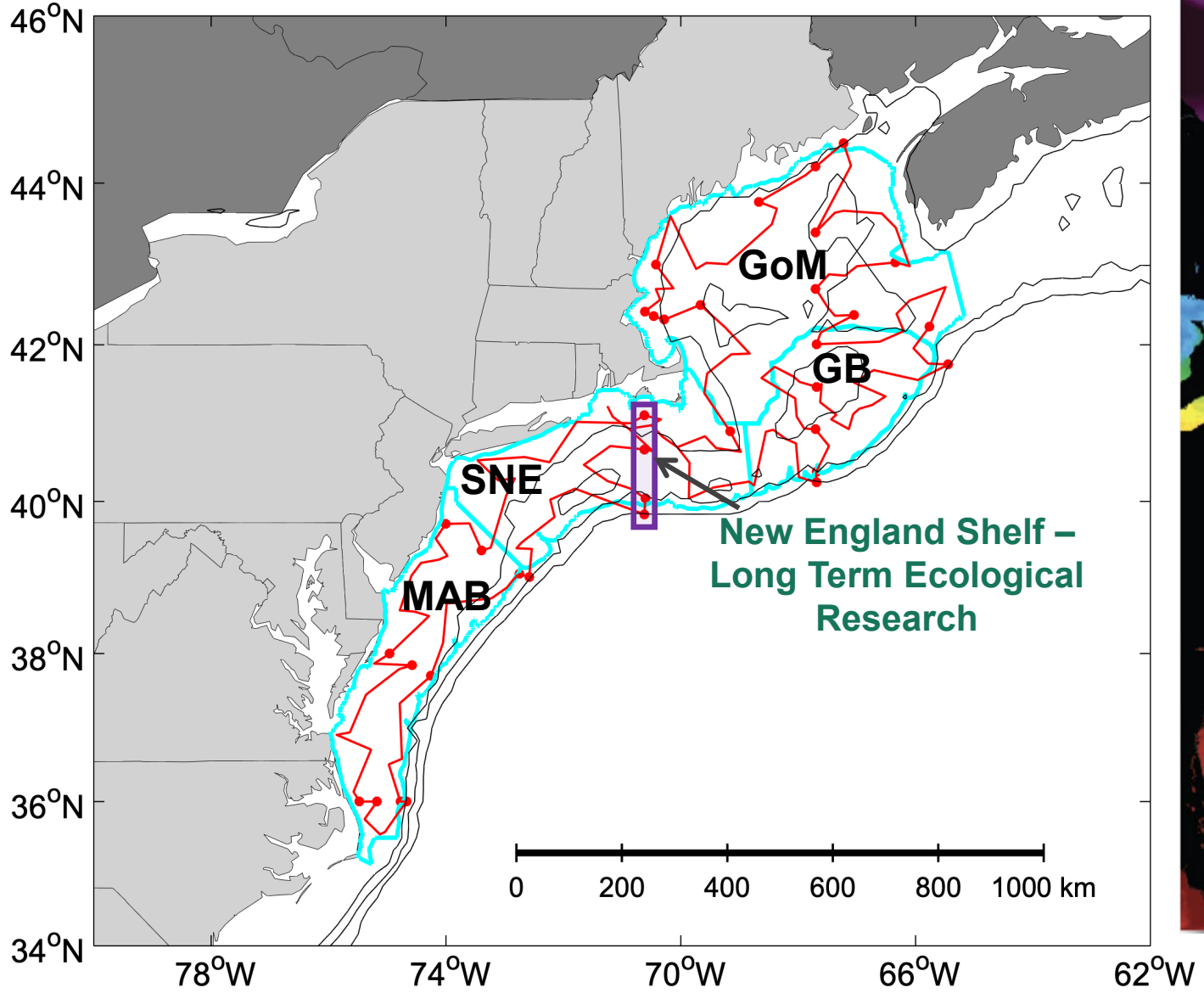
A Novel Approach: characterization of suspended particles combined with trace metal clean sampling and MeHg analysis

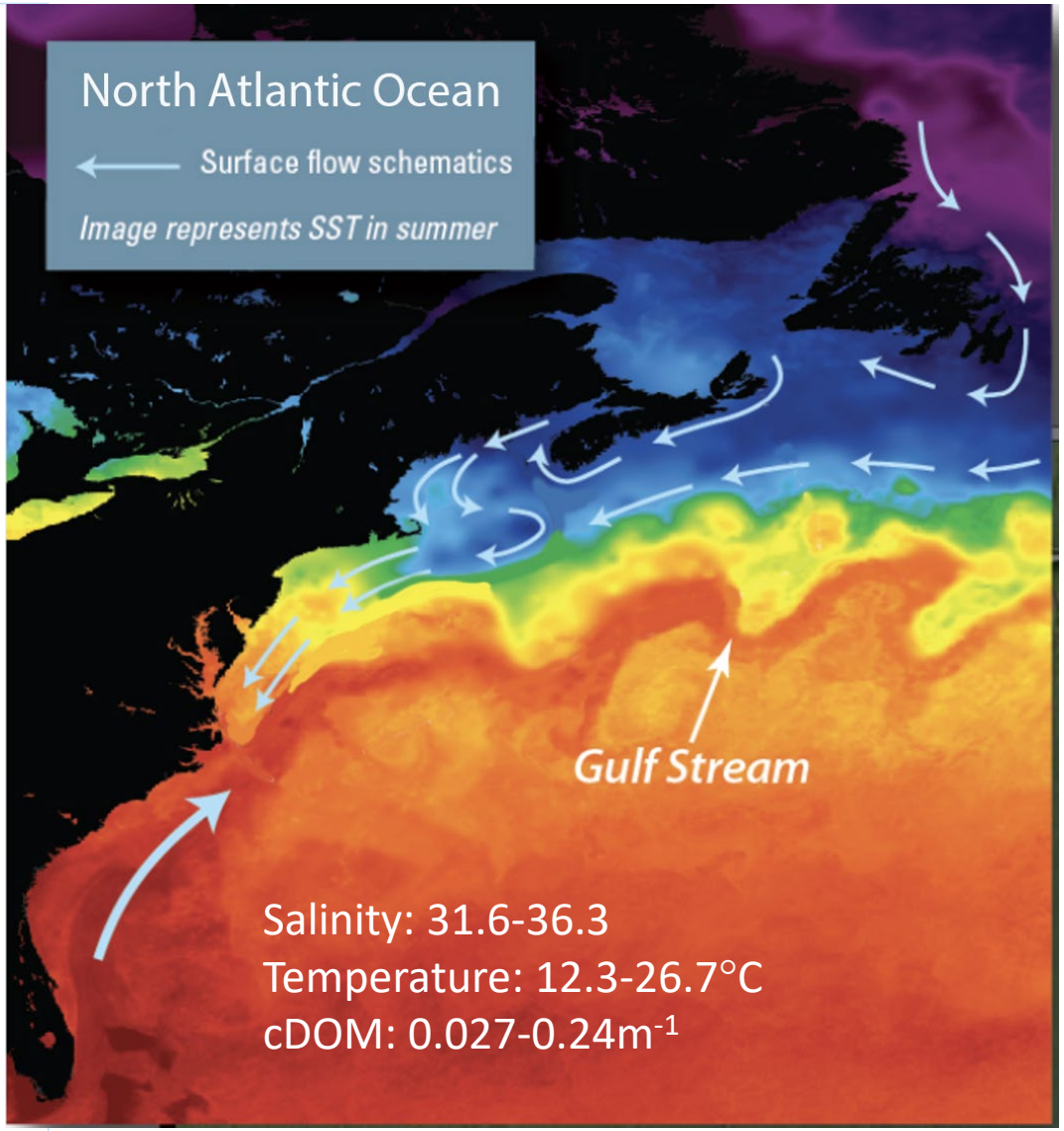
Parameters we can generate for natural phytoplankton:

- MeHg cellular quota – e.g. attomoles per cell (NEW; before available in lab studies only)
- MeHg volume concentration factors – e.g. unitless (NEW; before available in lab studies only) $\mathbf{VCF} = [MeHg/\mu m^3]_{cell} / [MeHg/\mu m^3]_{solution}$
- Wet weight-based MeHg concentrations in cells of different size classes –e.g., pmol or ng per g of cellular biomass (NEW; before available in lab studies only)
- MeHg concentrations in particles per seawater volume – e.g. pmol or ng per L of seawater

This data can be used in ecological models, and diverse hypothesis testing!

Model Ecosystem: Western North Atlantic Ocean

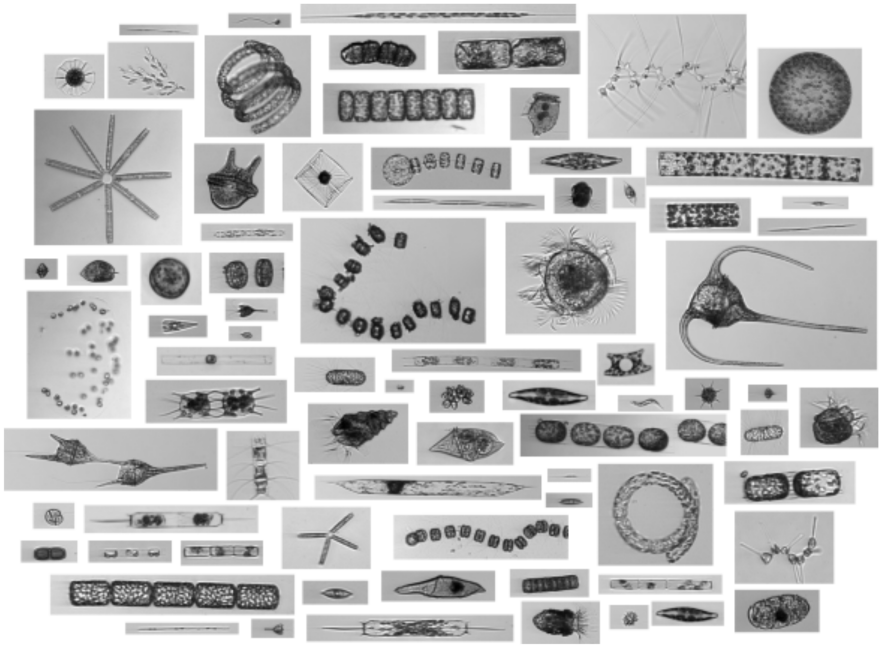




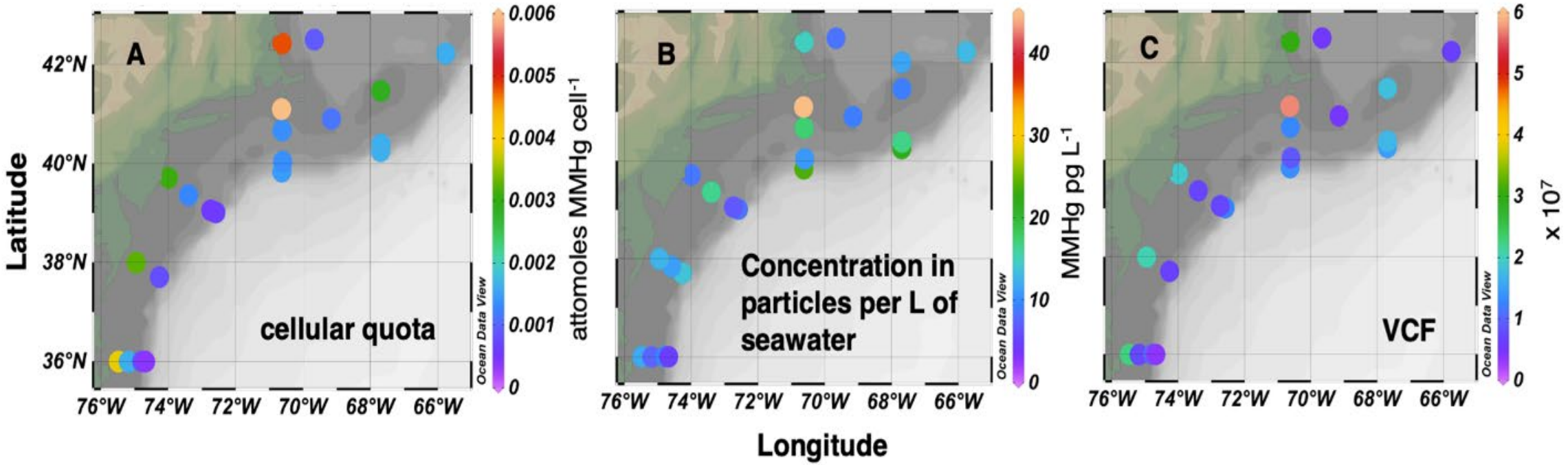
Methodology

- Water Source: flow-through systems
- Sequential filtration (20, 2.0, and 0.2 µm) to obtain micro, nano, and picoplanktonic cells, and analysis of filtrate and filters for MeHg (Tekran 2700)
- Flow CytoBot (IFCB) and flow cytometer (FCM) used to obtain data on particle characteristics
- Machine Learning algorithms fed with IFCB and FCM data to obtain cellular counts, biovolumes, binned to specific size fractions as listed above

IFCB setup on the USCG Healy

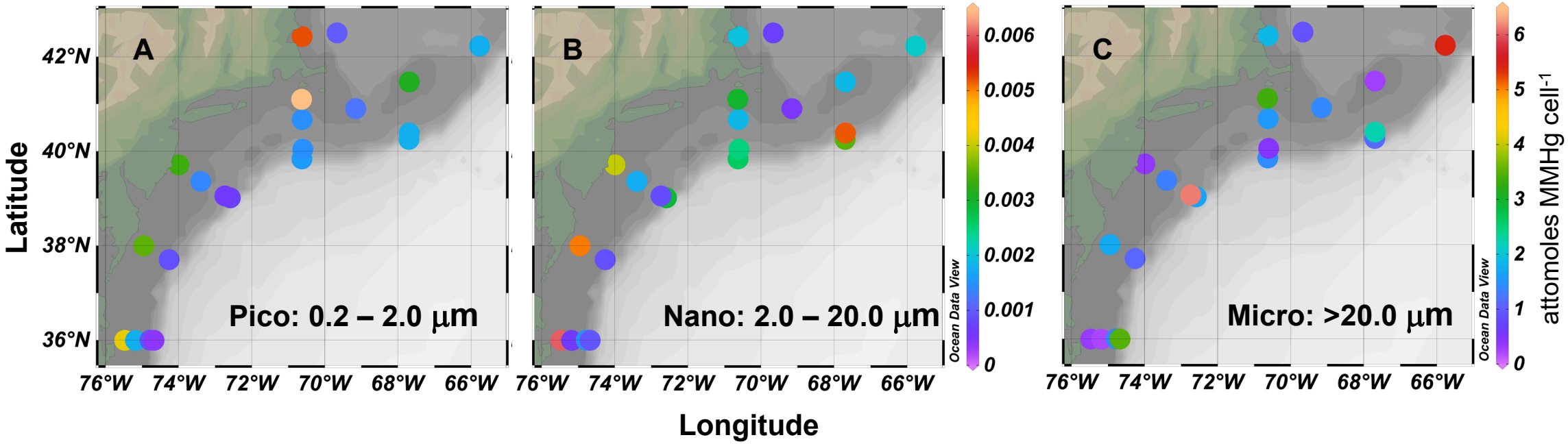


Different metrics of MeHg in picoplankton



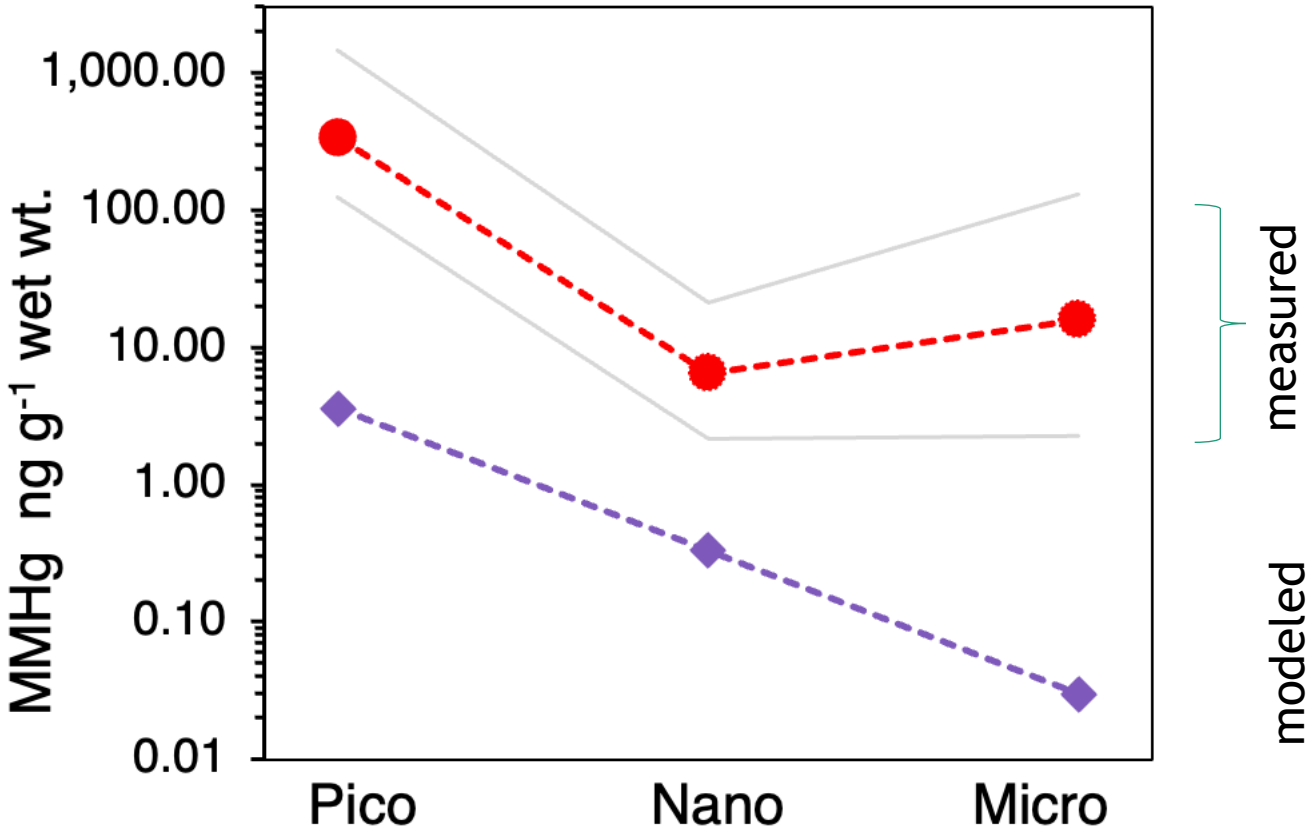
Lee and Fisher, 2016 reported VCFs for MeHg in cyanobacteria - picoplankton in the range of $2.5\times10^6 – 1.7\times10^7$, similar to what we found

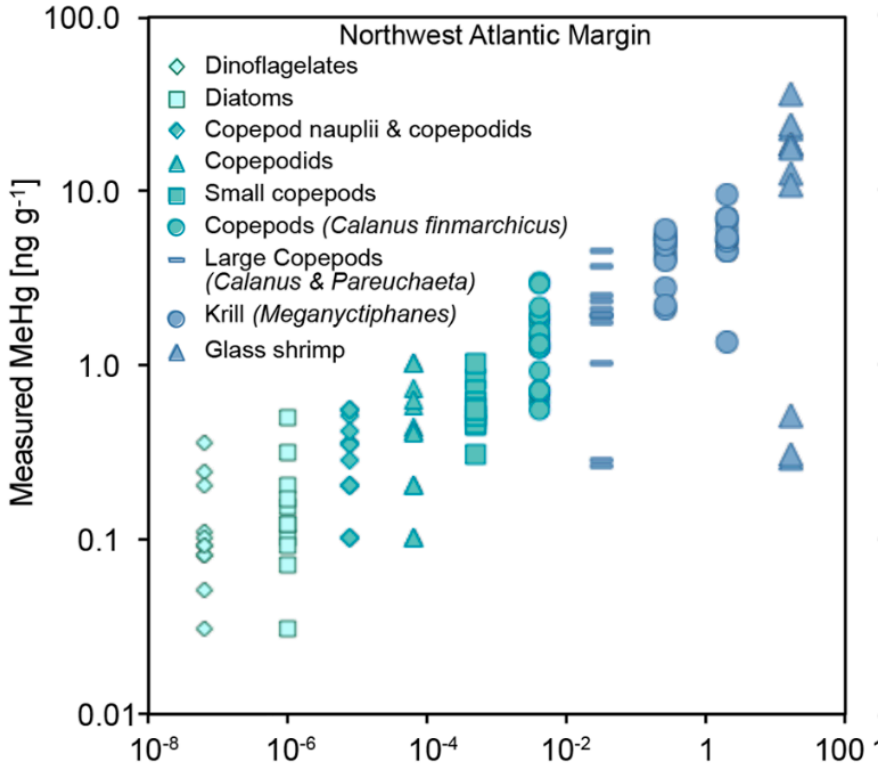
Geographic variability in MeHg cellular quota for pico, nano and microplankton - Fall 2019



Attomole = 10^{-18} mole

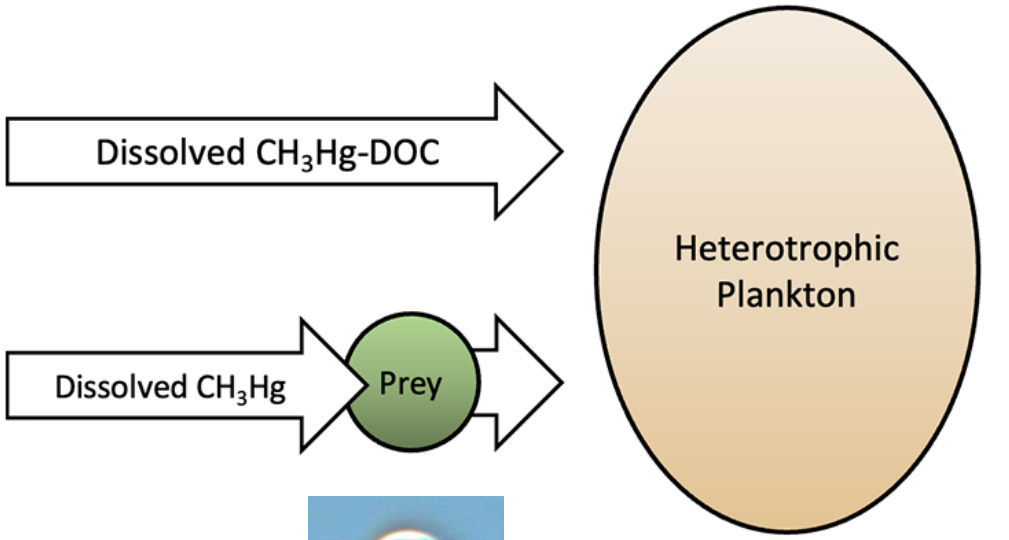
Measured vs. Modelled

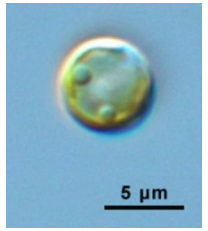




Schartup et al. 2018

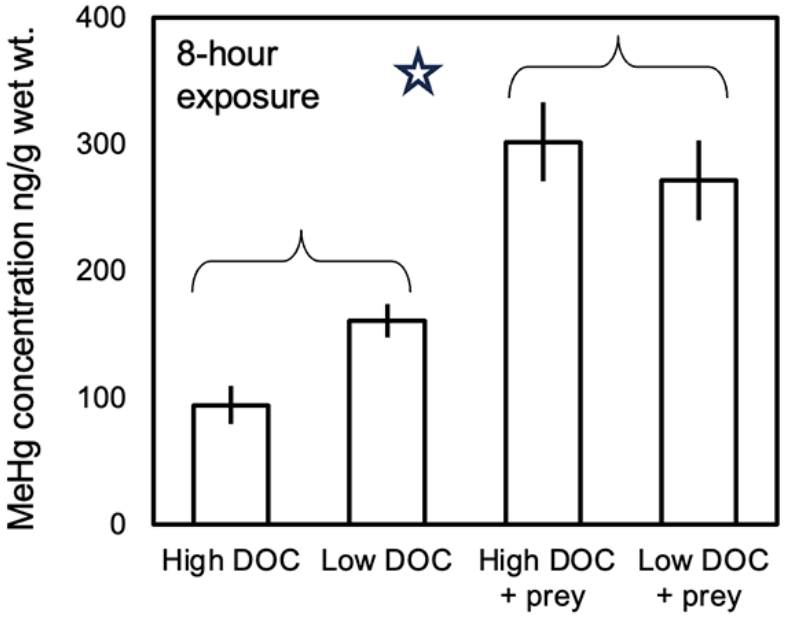
MeHg accumulation in unicellular heterotrophic organisms is influenced by both the direct uptake from water and by engulfment of prey





Isochrysis galbana

Oxyrrhis marina



Prey Engulfment as the Dominant Pathway of MeHg Uptake in a Heterotrophic Dinoflagellate: Patricia K. Myer, Robert P. Mason, Zofia A. Baumann; To be submit to ES&T shortly

Funding & near future

NEW NSF grant (July 2024 – June 2027; "Collaborative Research: A novel approach to study monomethylmercury in natural phytoplankton assemblages"

Colleen Mouw, University of Rhode Island

Heidi Sosik, Woods Hole Oceanographic Institution

Michael Lomas, Bigelow Laboratory for Ocean Sciences

M.S. student position starting in February 2025 at the University of Connecticut – Department of Marine Sciences

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