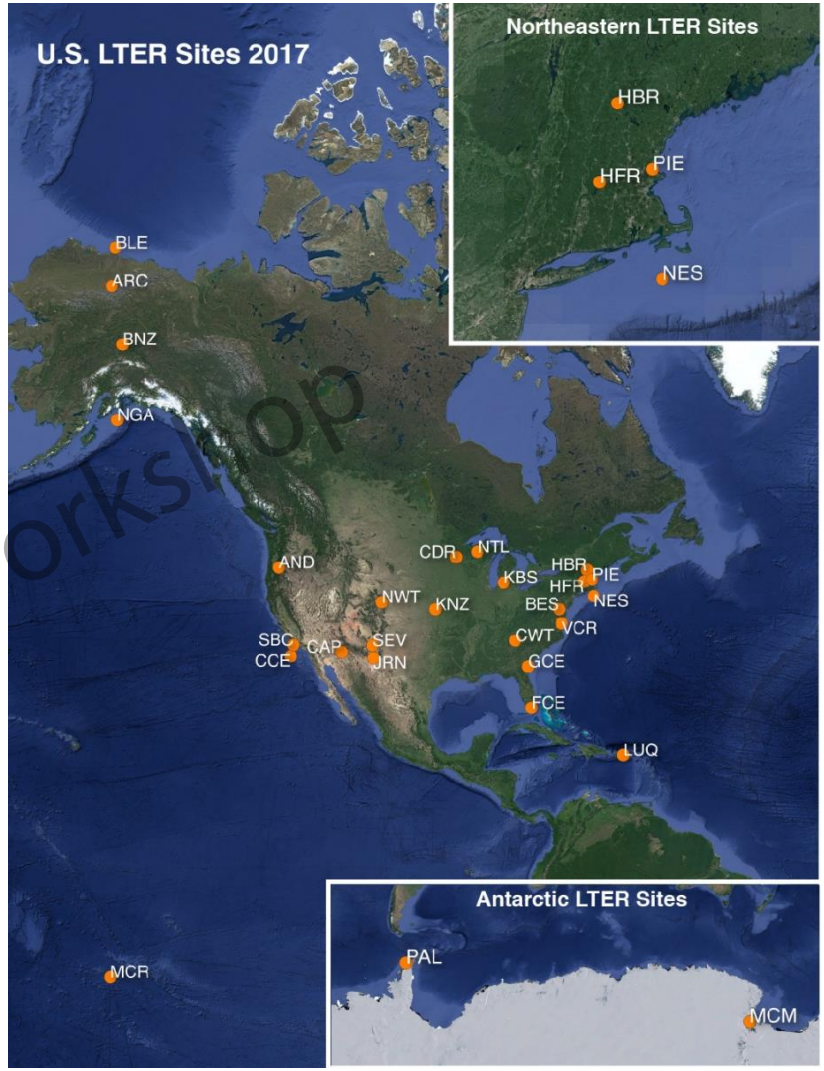
NORTHEAST U.S. SHELF
Long-Term Ecological Research

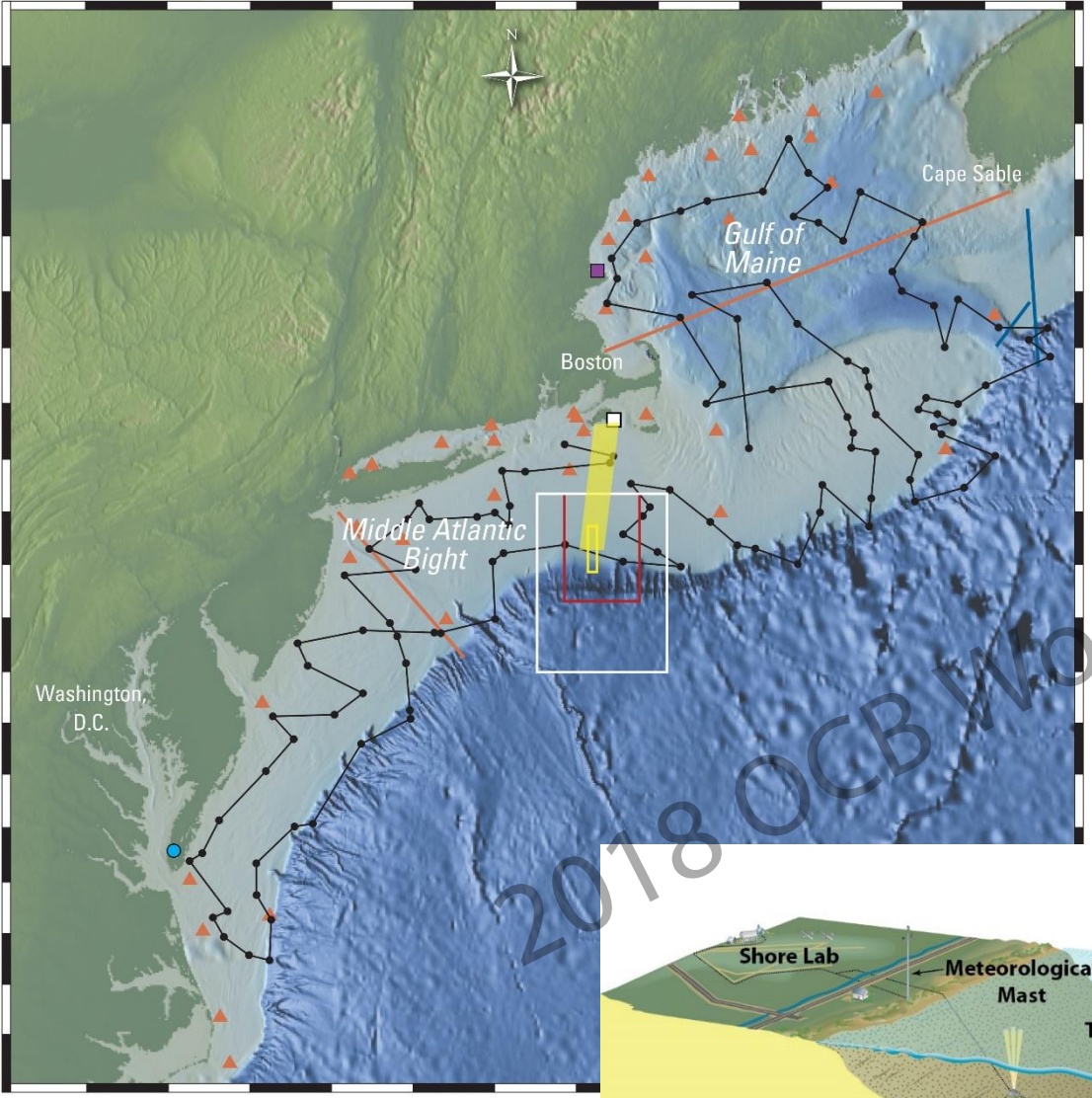
Linking pelagic community structure with ecosystem dynamics and production regimes on the changing Northeast U.S. Shelf

Heidi M. Sosik
Woods Hole Oceanographic Institution

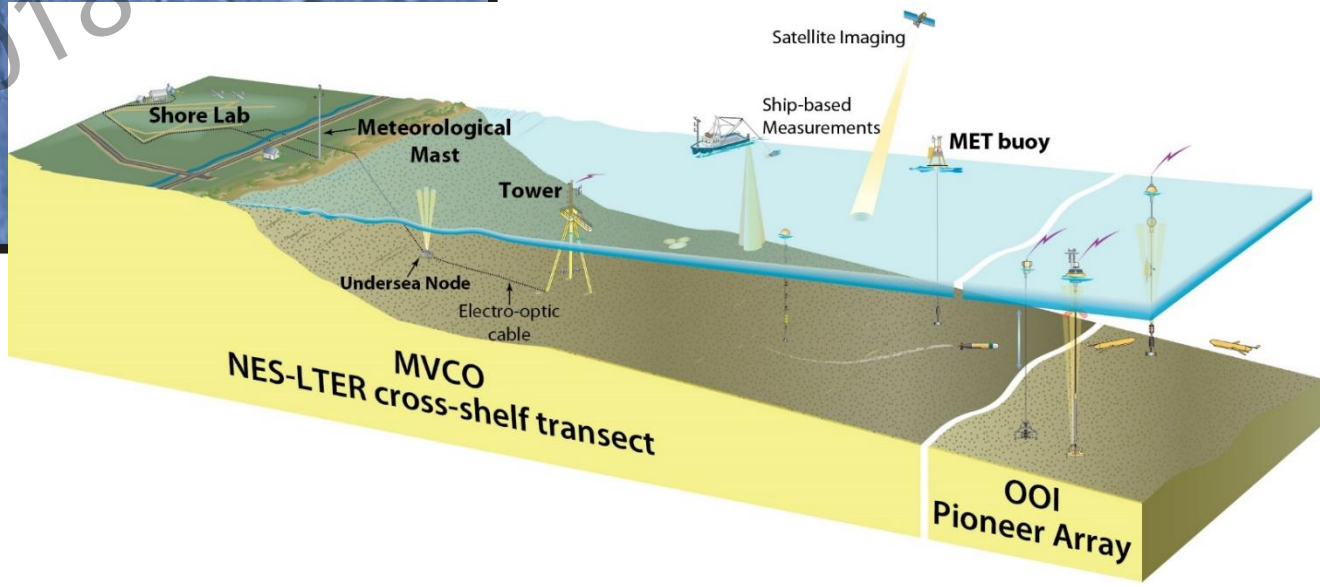
& The NES-LTER Team



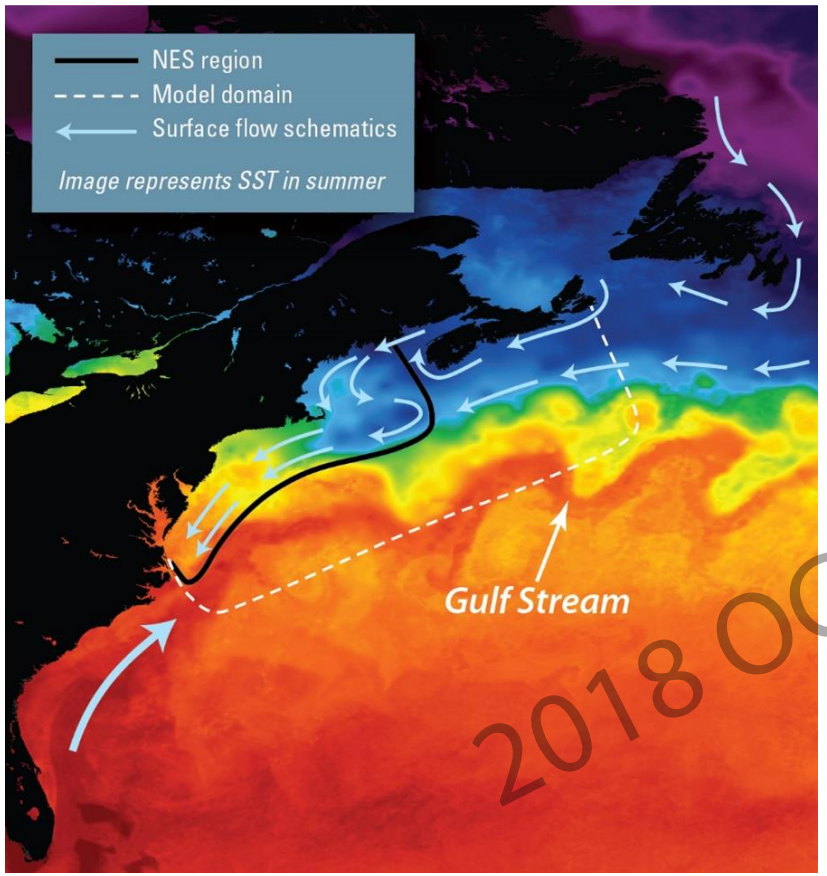
NATIONAL SCIENCE FOUNDATION
LTER NETWORK
LONG TERM ECOLOGICAL RESEARCH

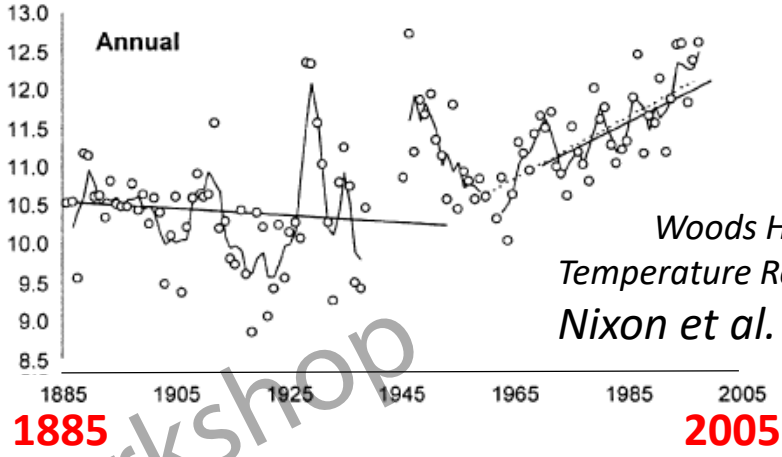


- Observations – ships & observatories
- Experiments – processes & rates
- Models – ocean & ecosystem



Dynamic temperate ecosystem

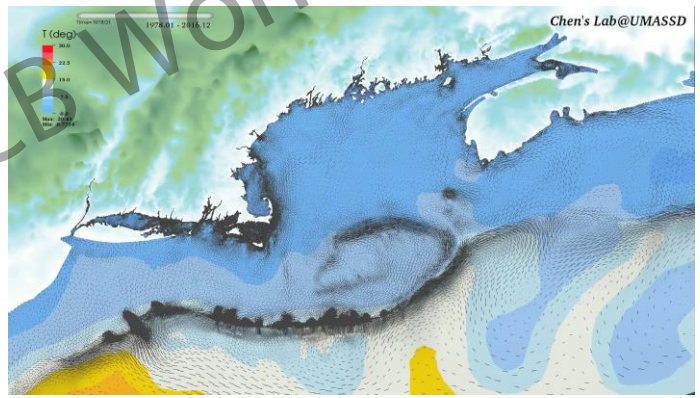


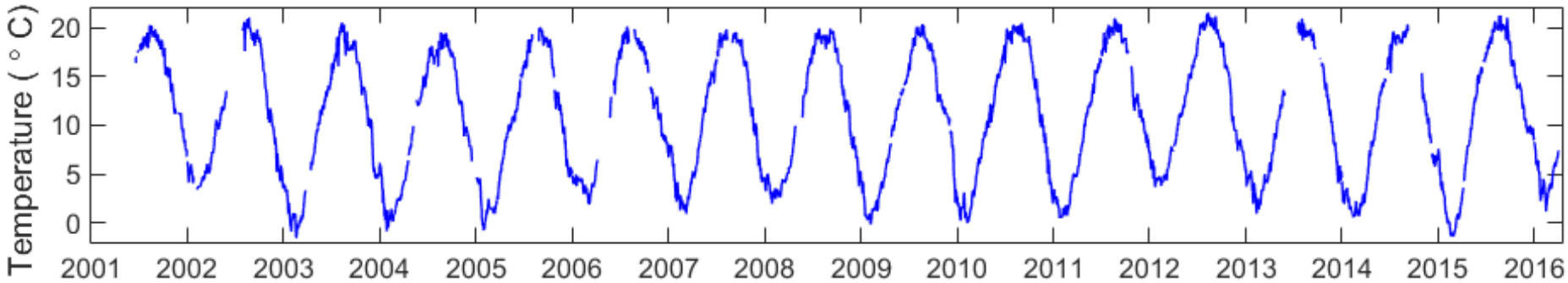


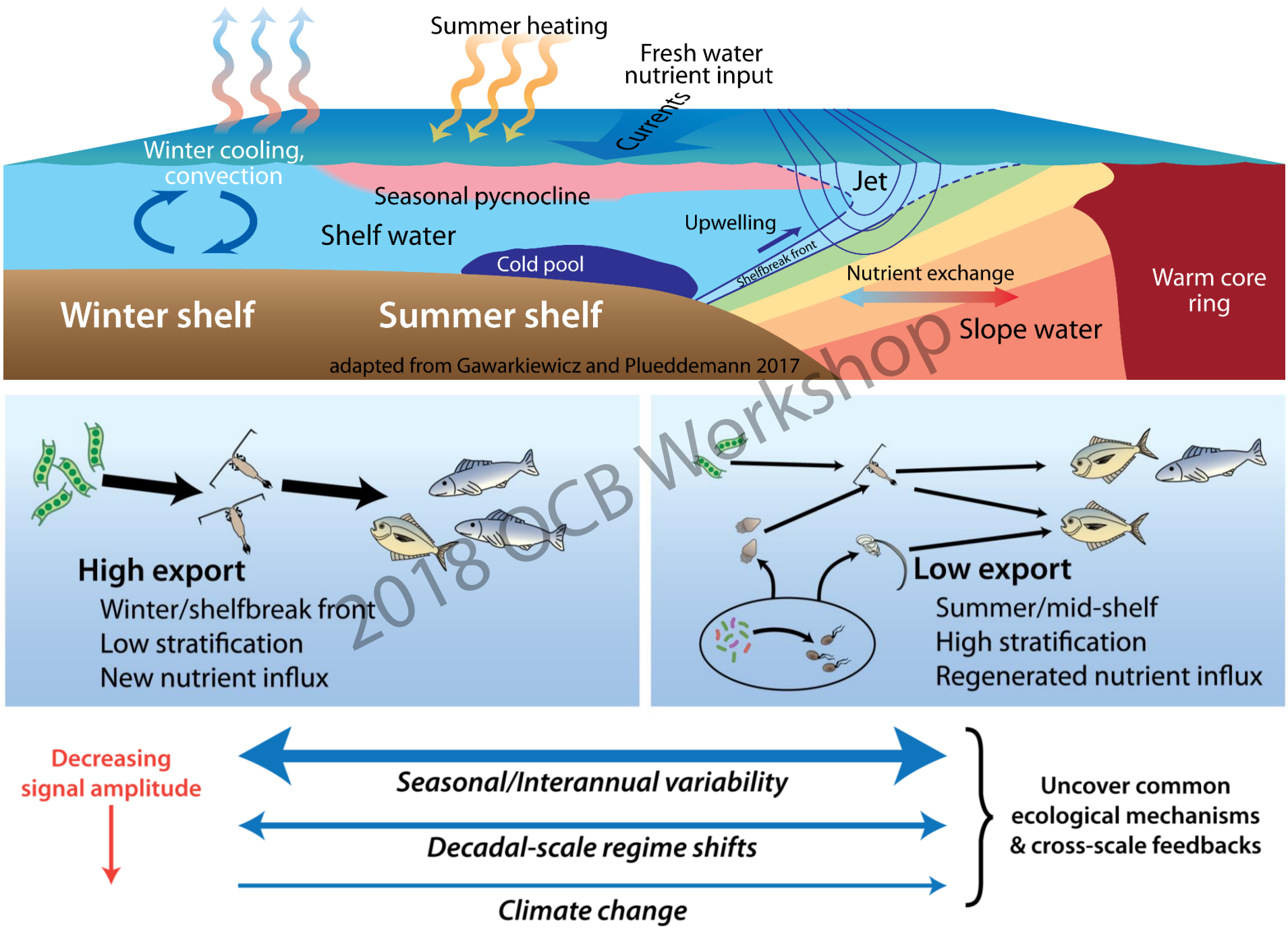
Woods Hole Temperature Record

Nixon et al. 2004

1885 **2005**



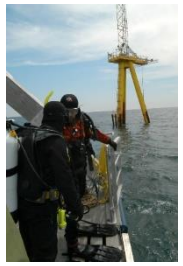




How did the stage get set?

A personal perspective…

MVCO
Martha's Vineyard Coastal Observatory

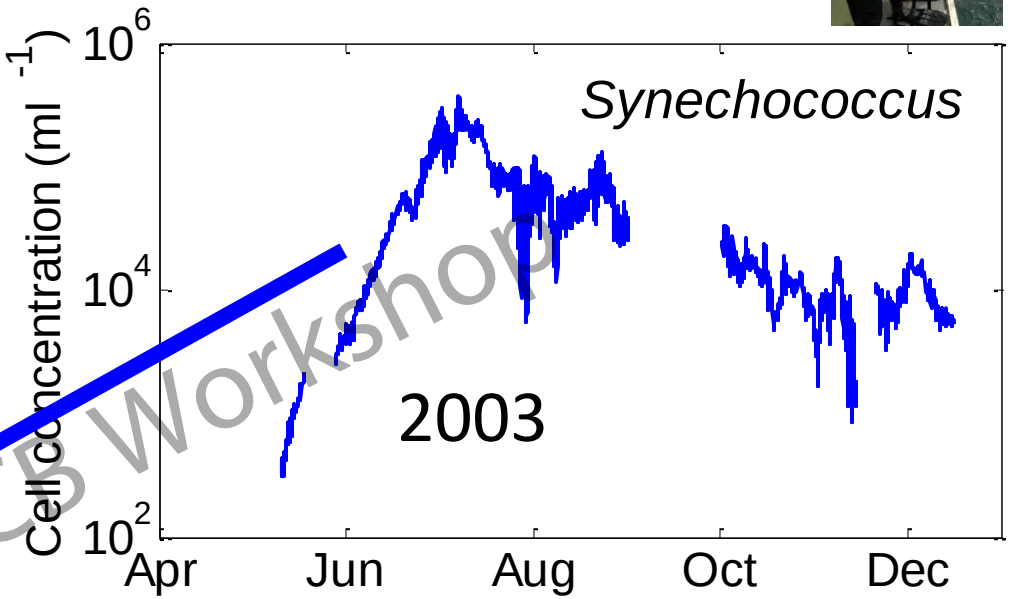


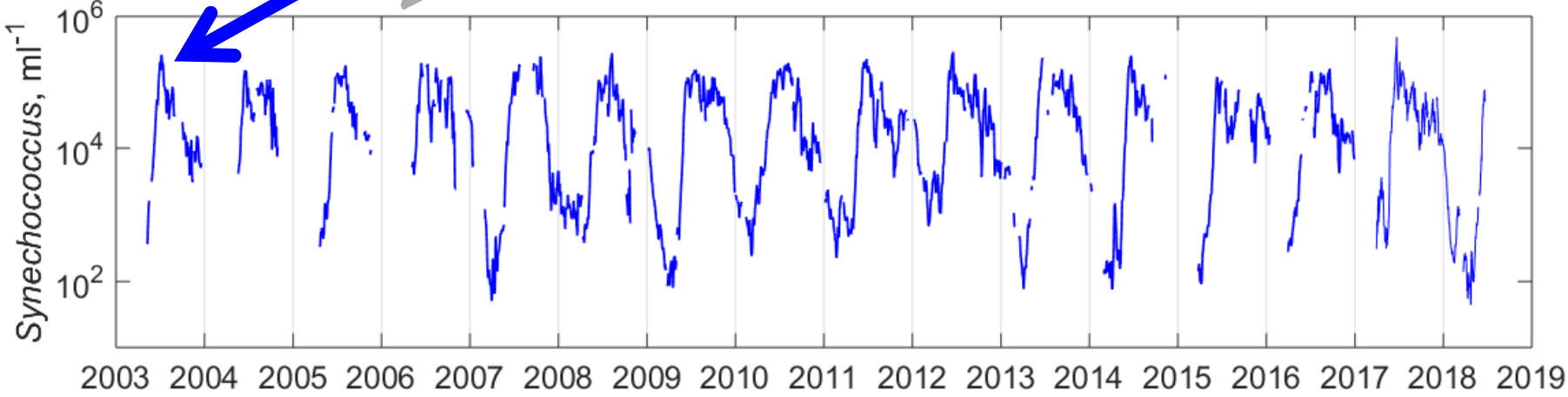
Circa 2001

An underwater flow cytometer

FlowCytobot

Optimized for picoplankton





How did the stage get set?

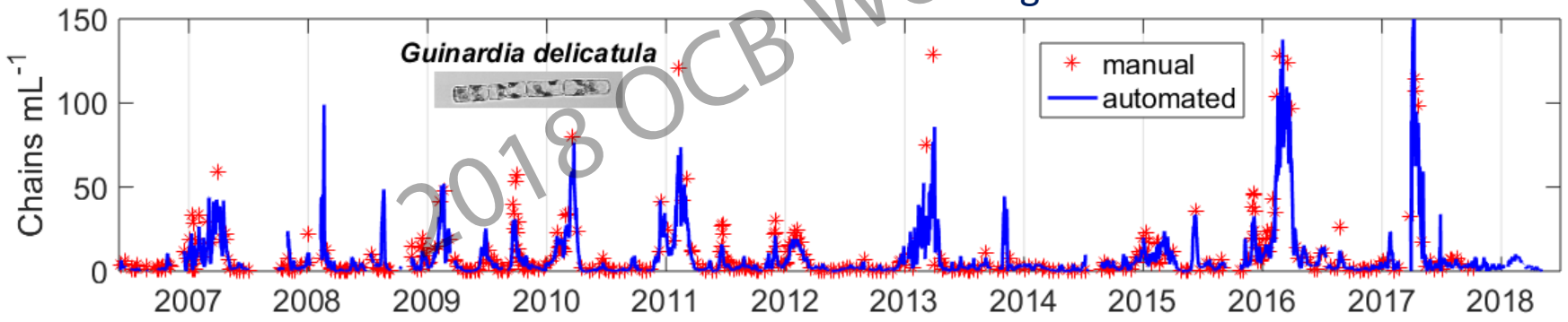
Another flow cytometer…

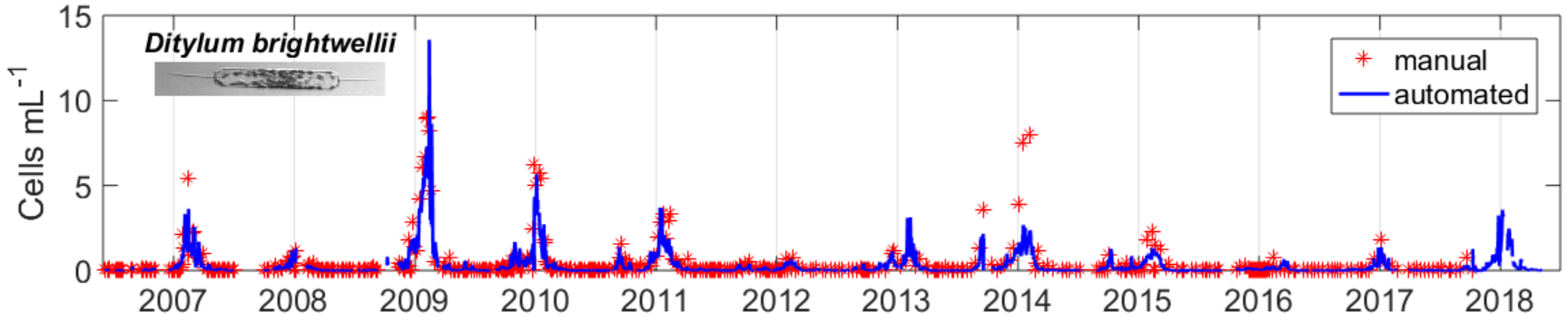
Imaging FlowCytobot

Optimized for microoplankton

Example diatoms

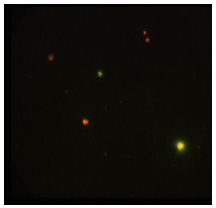
~800 million images at MVCO since 2006



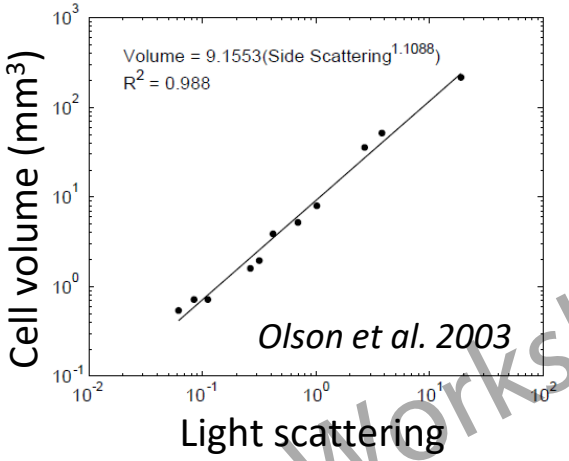


Plankton size and biomass budgets

Pico/nanoplankton



FlowCytobot



Cell volume from laser scattering

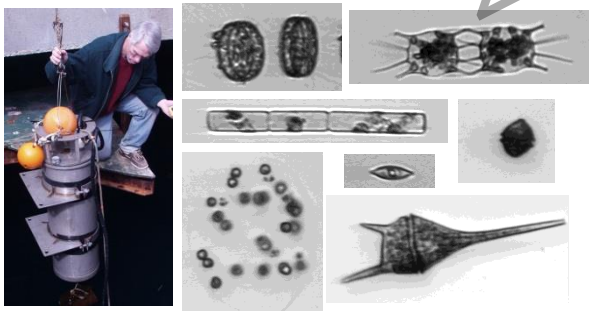
Cell carbon from cell volume

$$\text{Carbon} = \sum_i C_i$$

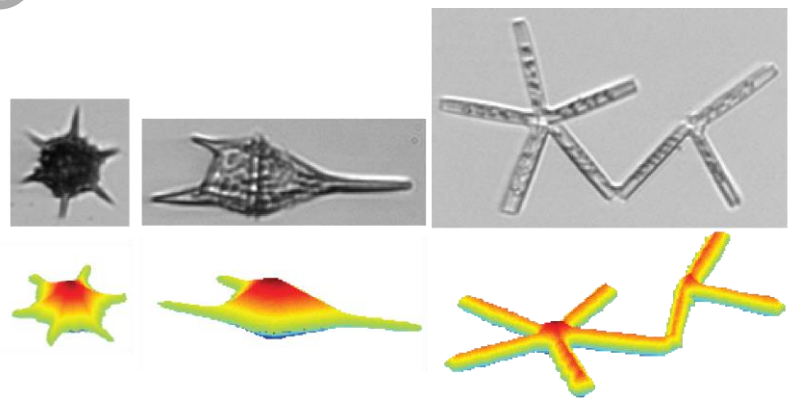
$$C_i = f(V_i)$$

e.g., Menden-Deuer & Lessard 2000

Nano/microplankton



Imaging FlowCytobot

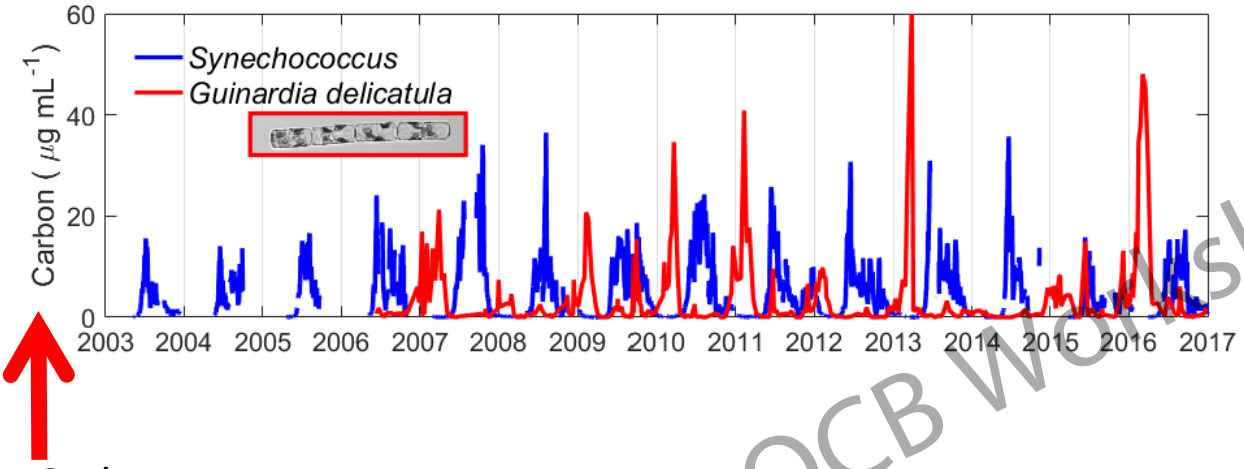


Cell volume from image analysis
"distance map" approach

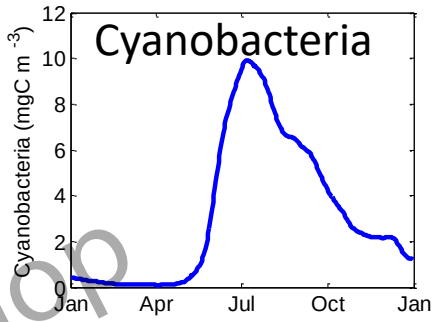
Sosik and Olson 2007
Moberg & Sosik 2012

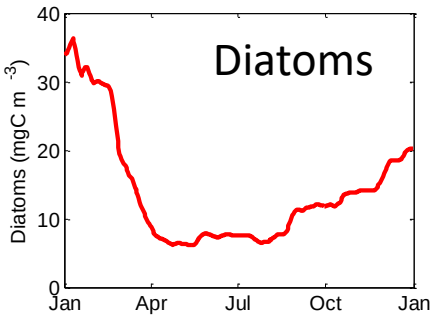
Plankton size and biomass budgets

Individual cells → Taxa → Communities

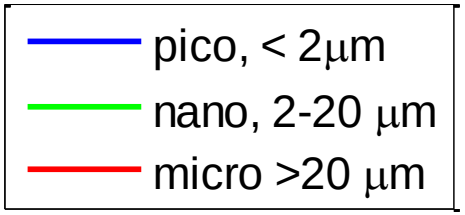


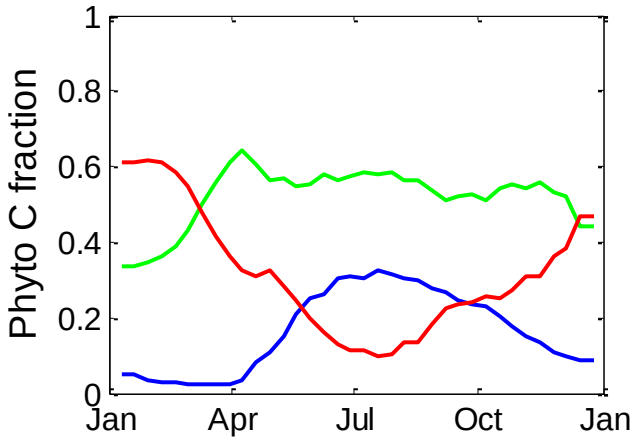
Carbon





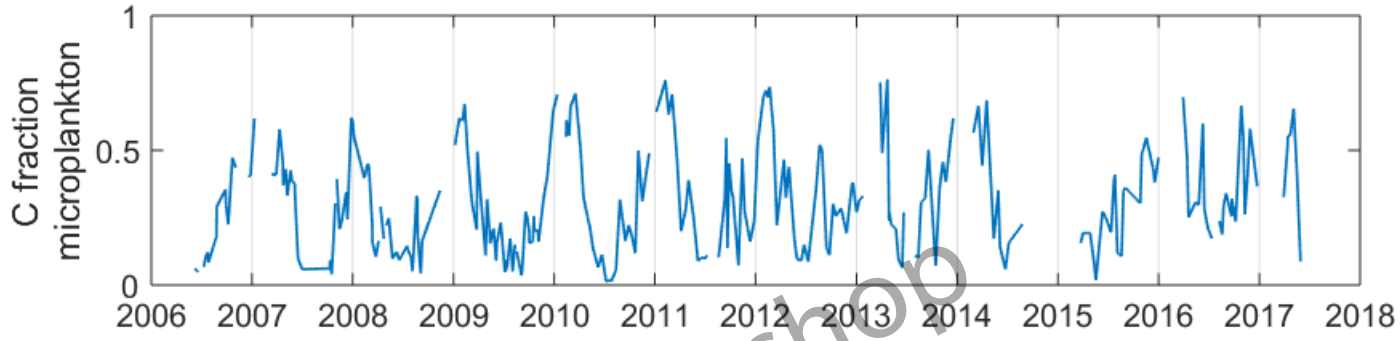
Individual cells → Size classes → Communities



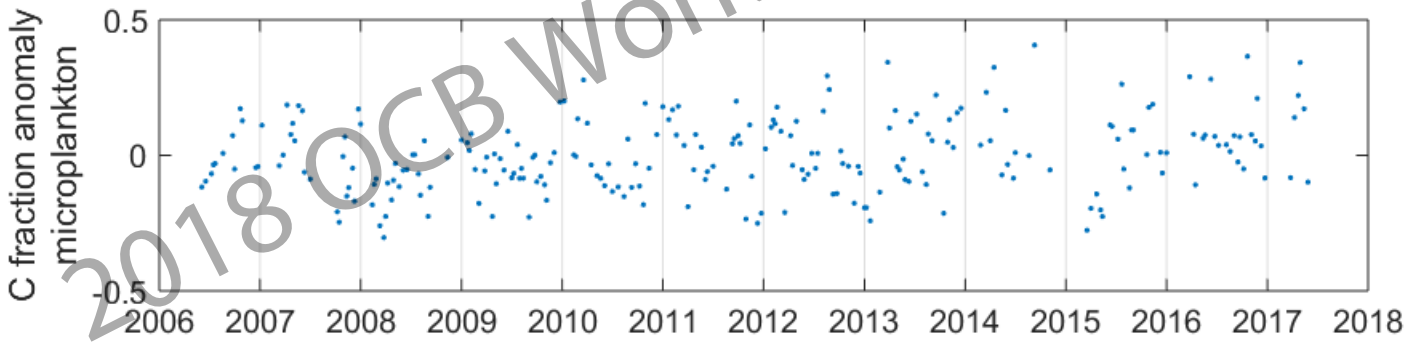


Phytoplankton communities are changing

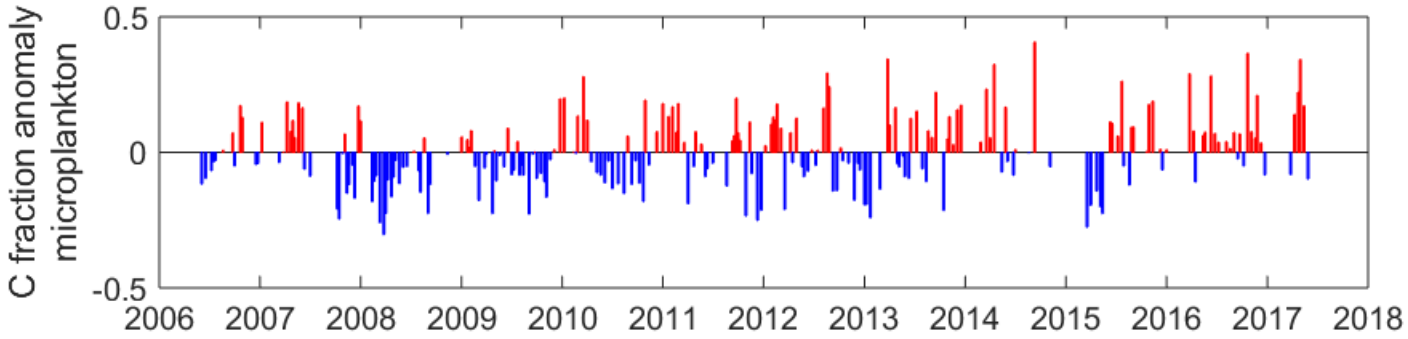
Microplankton fraction



Remove average seasonal cycle

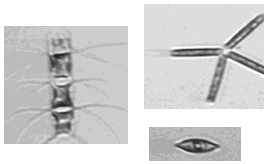


Anomaly time series



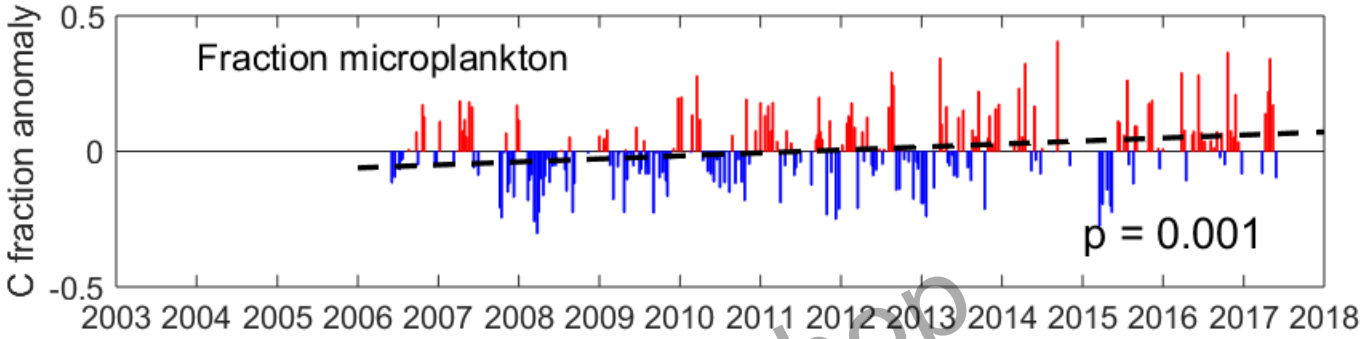
Phytoplankton communities are changing

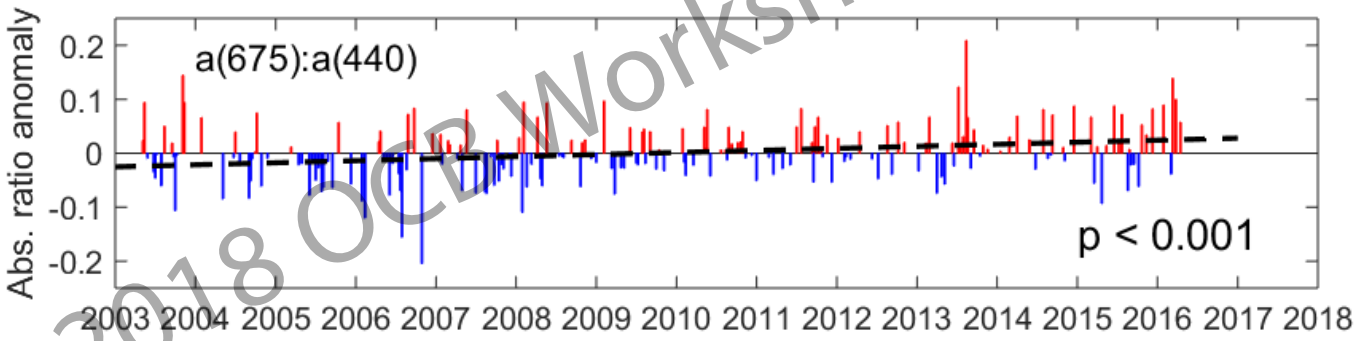
Carbon >20 μm

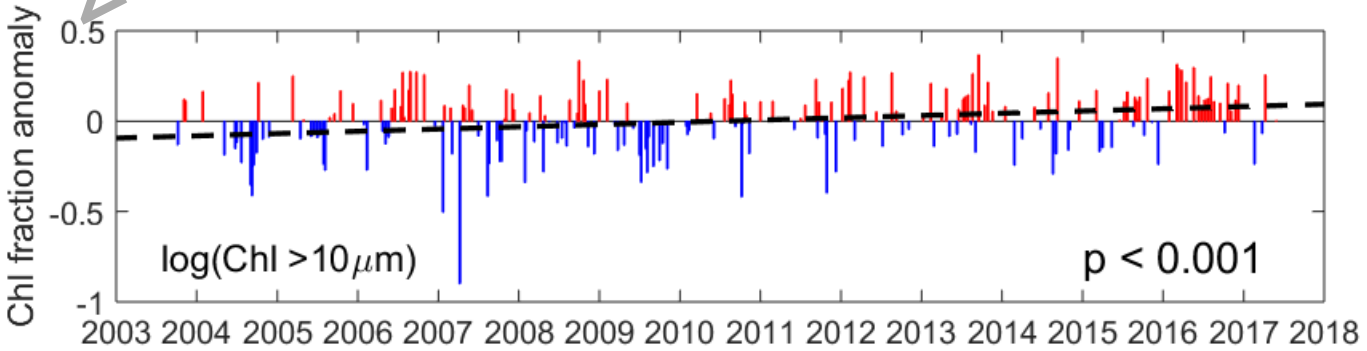


Spectral flatness

Chl > 10 μm



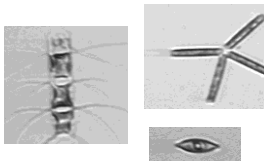


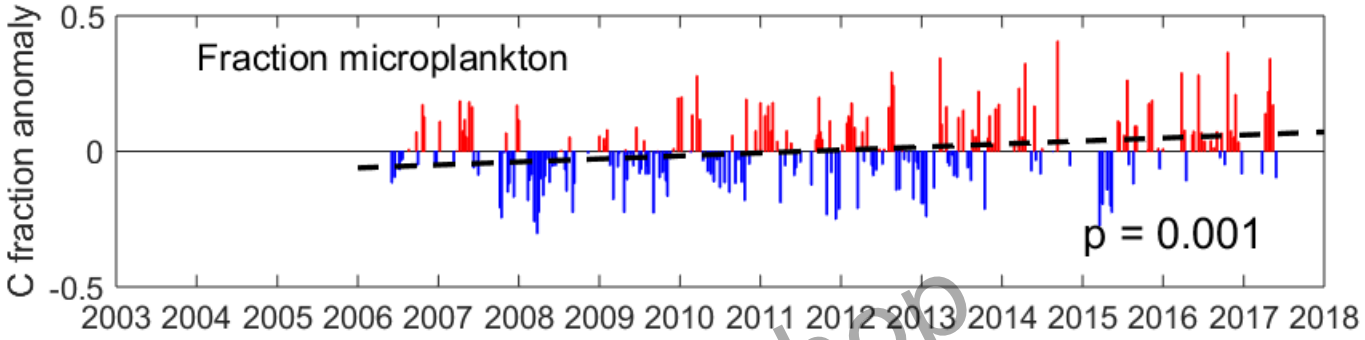


3 independent indices → increase in *relative* contribution of large-celled phytoplankton

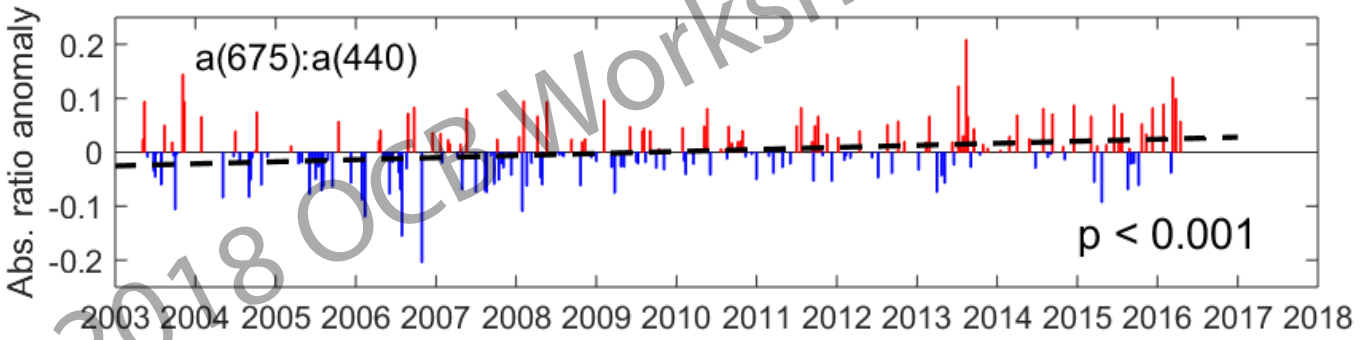
Phytoplankton communities are changing

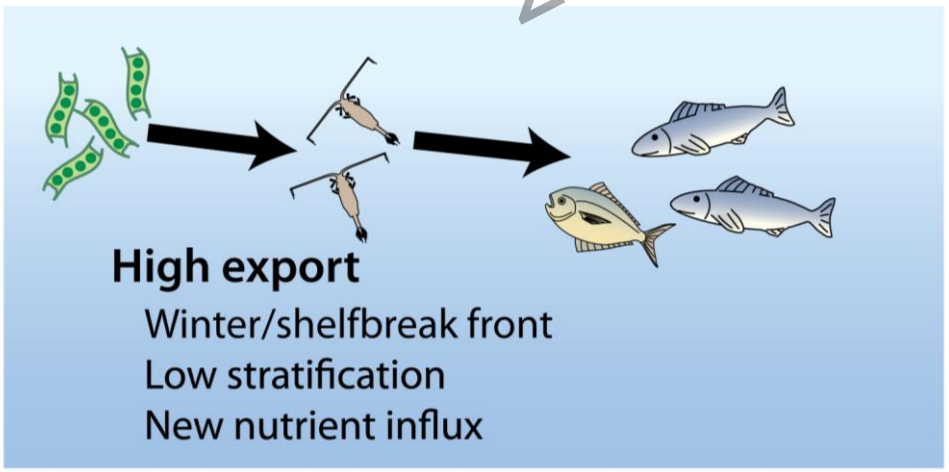
Carbon >20 µm

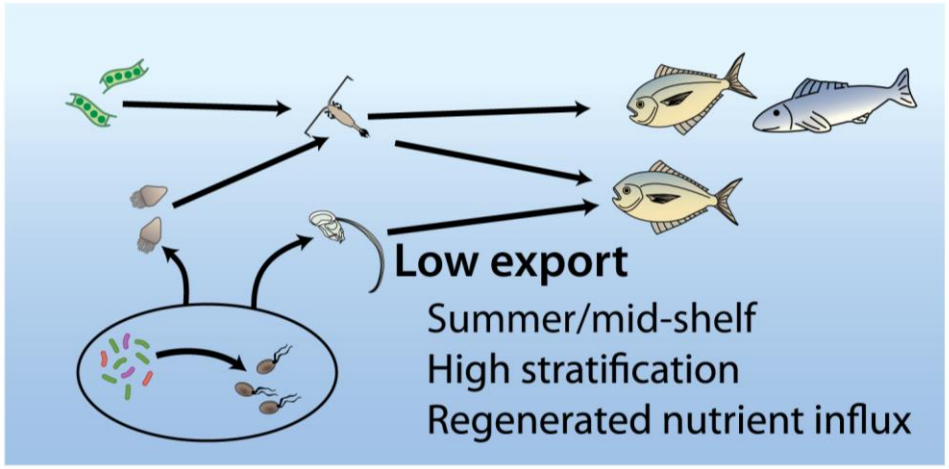




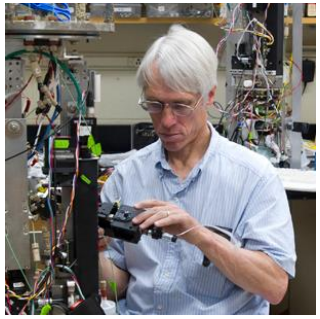
Spectral flatness





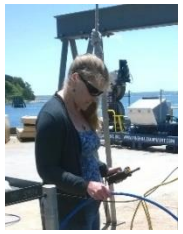


How did the stage get set?



Rob Olson

Alexi Shalapyonok



Taylor Crockford

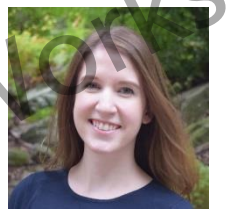
Emily Peacock

Joe Futrelle

Kristen Hunter-Cevera

Emily Brownlee

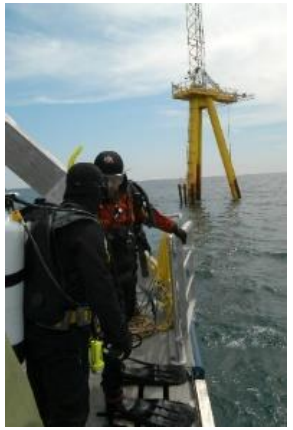
Sasha Kramer



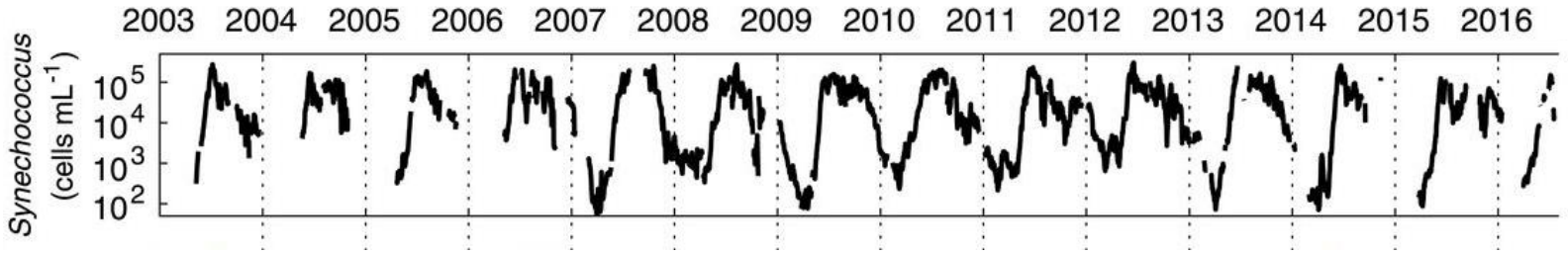
Emily Moberg

Miraflor Santos

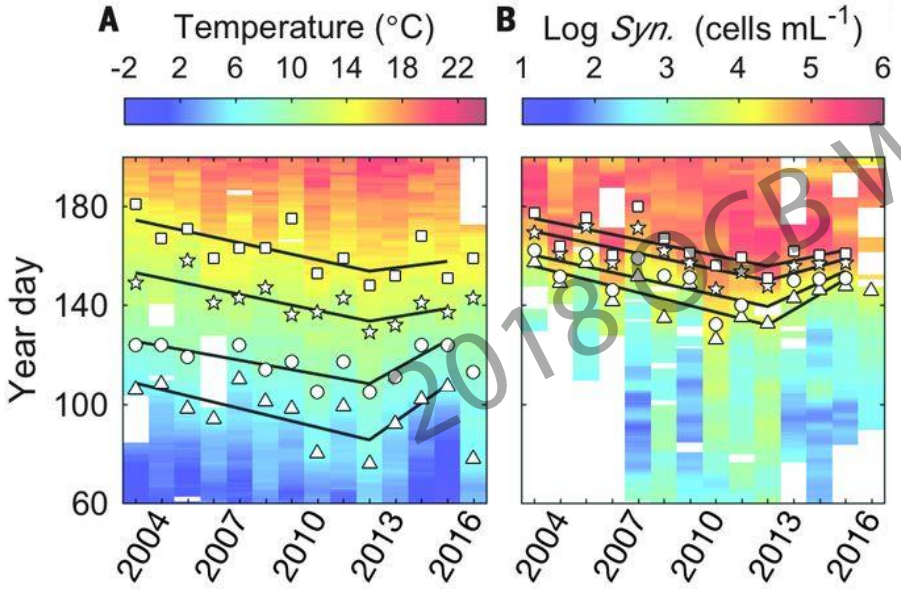
MVCO Operations Team
MVCO Divers

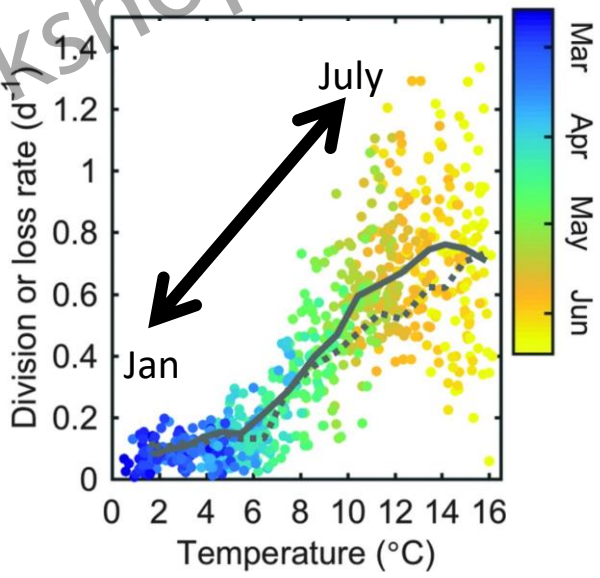


Why are phytoplankton changing?



Hunter-Cevera et al. 2016

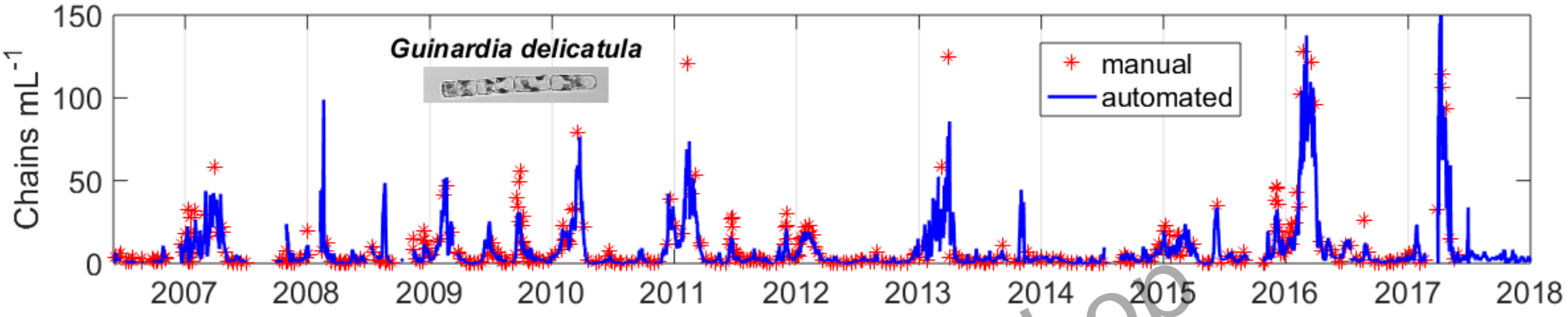




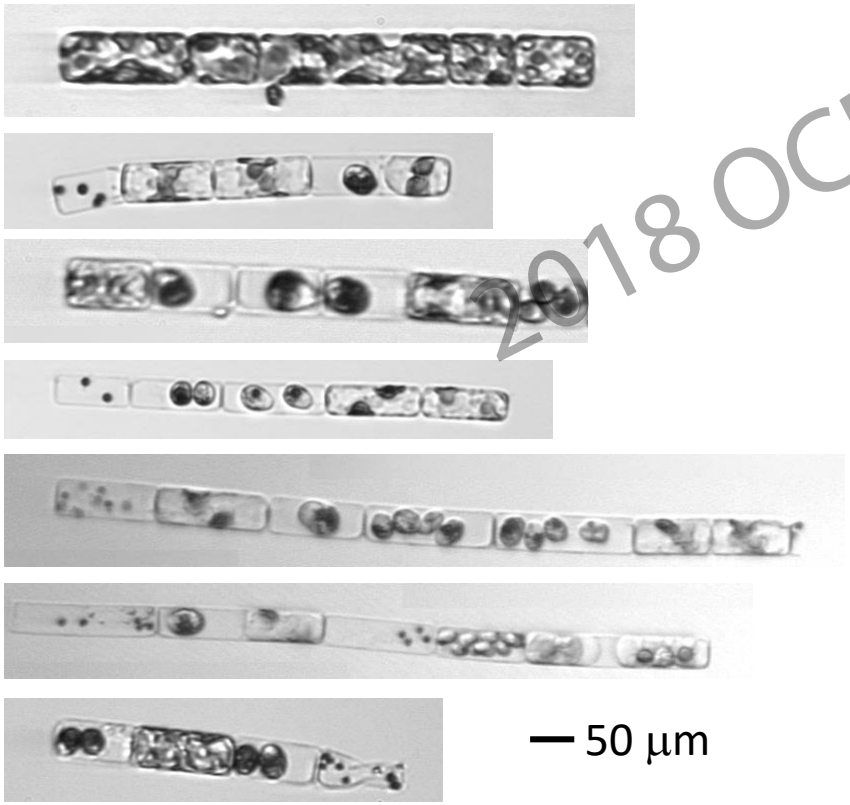
Progressively earlier spring warming

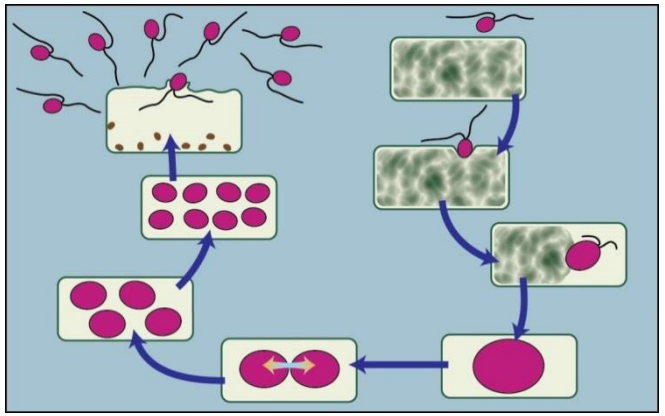
Corresponding earlier spring picoplankton bloom

Why are phytoplankton changing?



Guinardia delicatula and *Cryothecomonas aestivalis*

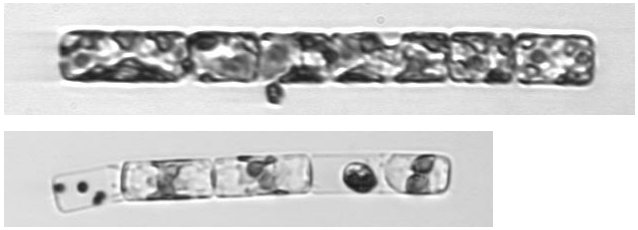




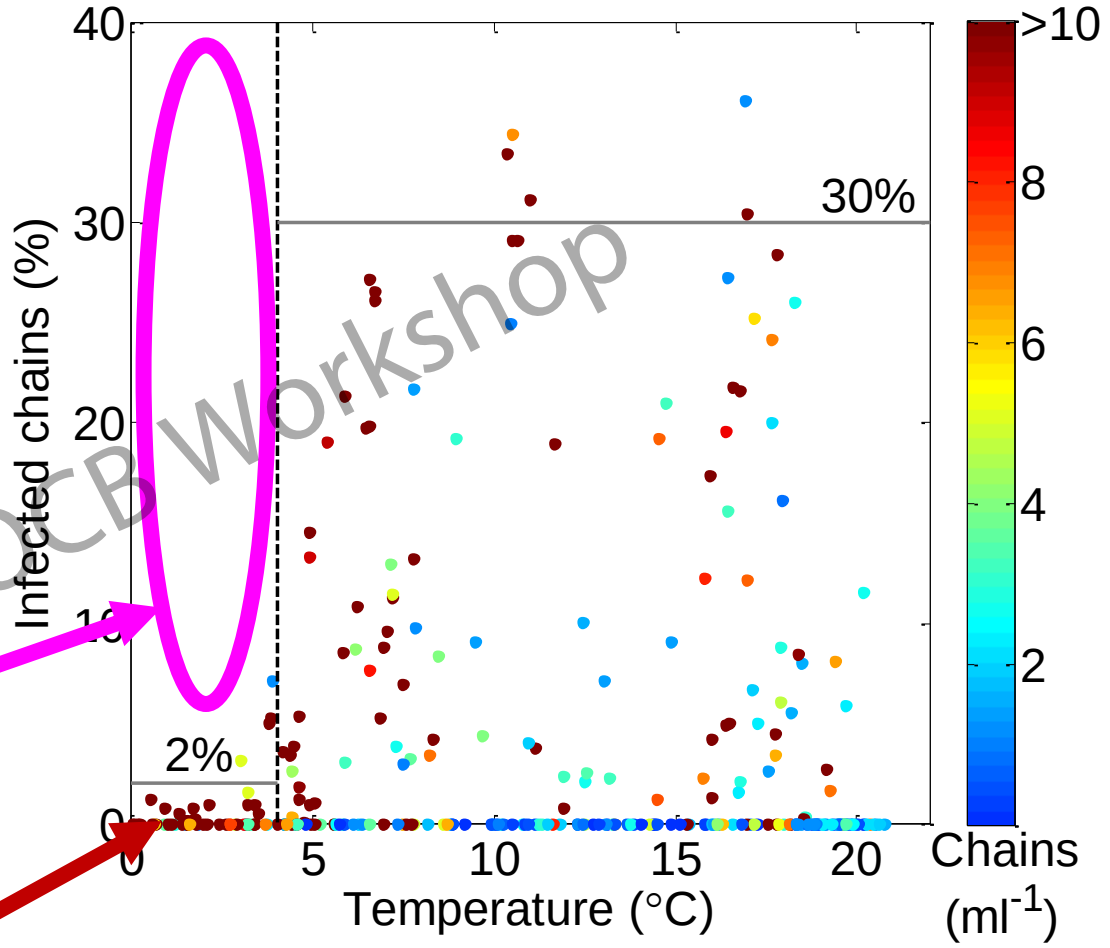
Nanoflagellate parasites consume cytoplasm and reproduce inside diatom host cells

Peacock et al. 2014

Why are phytoplankton changing?



Guinardia delicatula and *Cryothecomonas aestivalis*

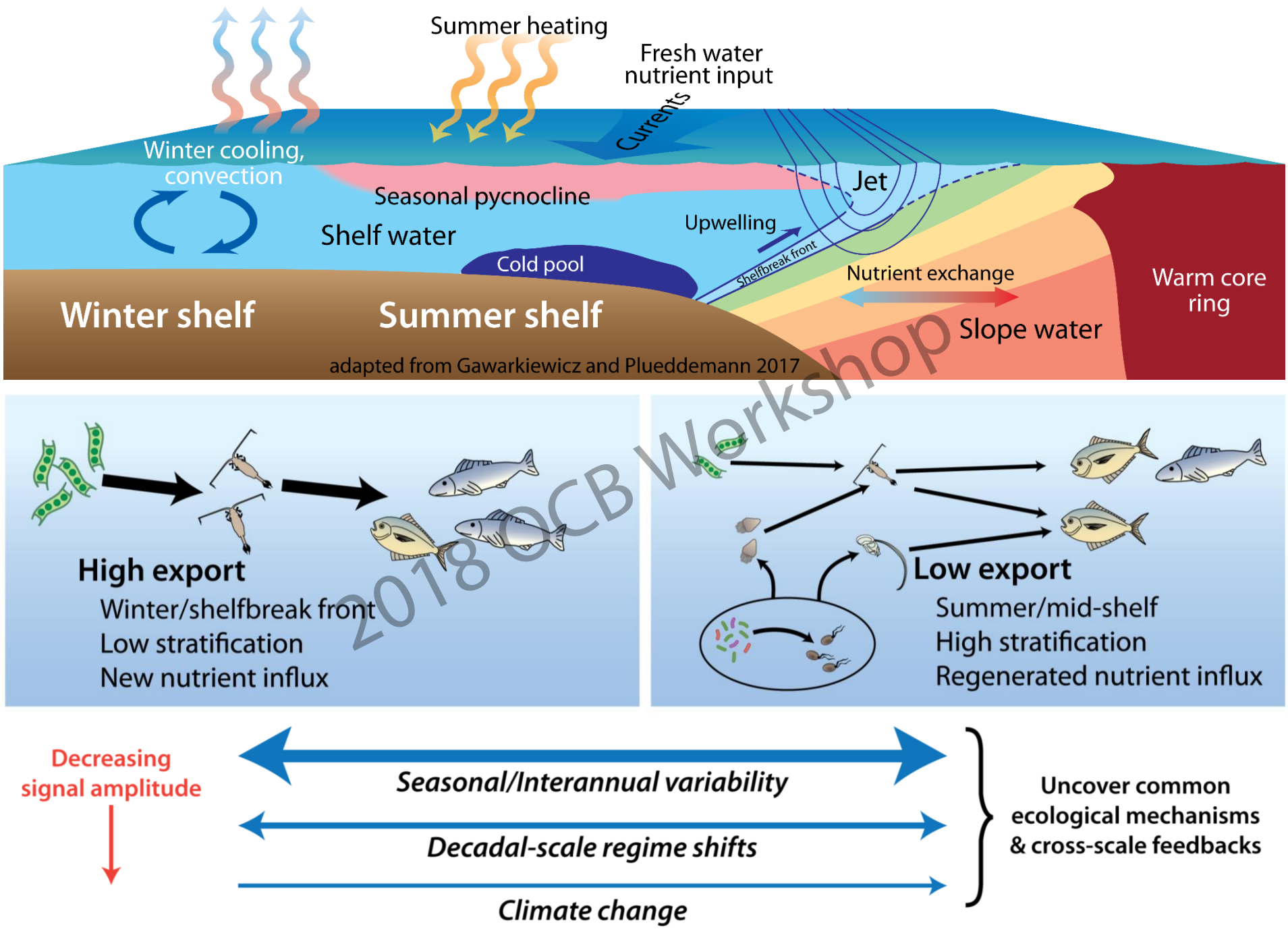


Cold waters provide refuge from parasite

Absence of infection when water temperature <4°C

Largest blooms of host diatom tend to occur during cold winter periods

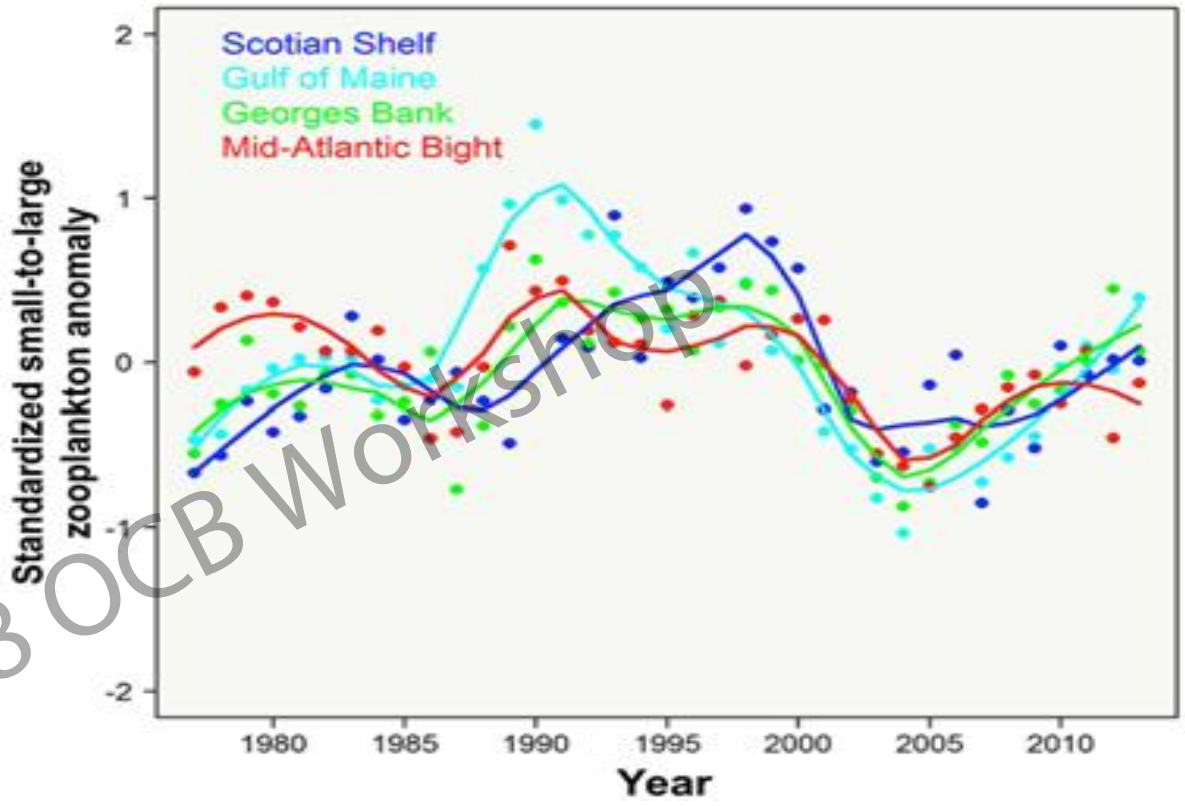
Peacock et al. 2014



Zooplankton communities are changing

Index of small-to-large bodied zooplankton

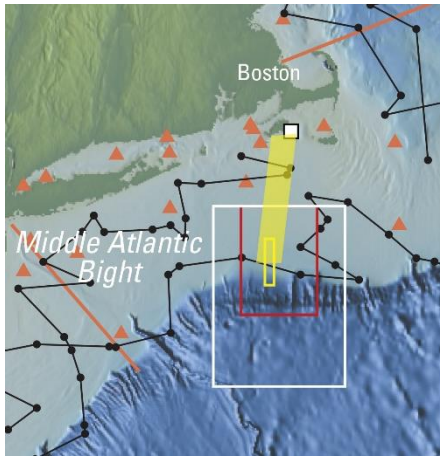
Photo: Carin Ashjian



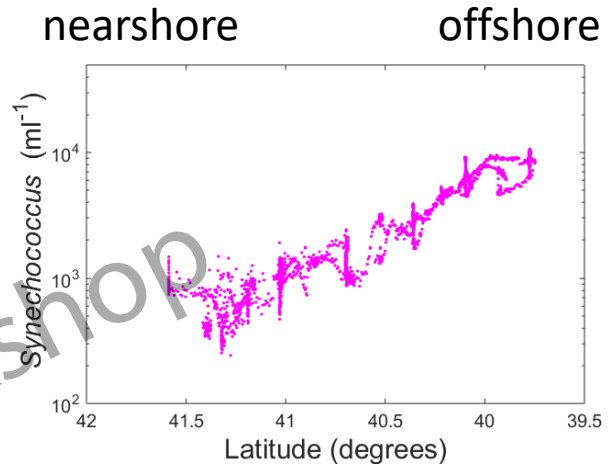
NOAA 2015

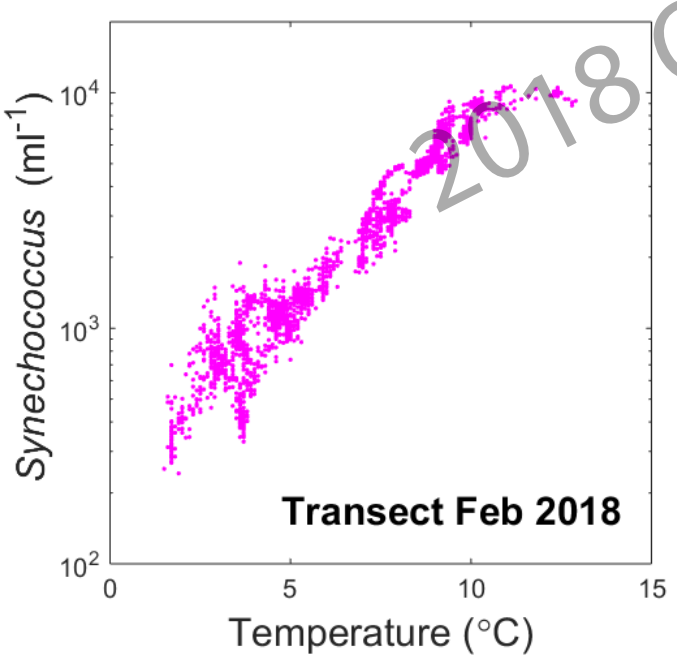
How do phytoplankton vary through space?

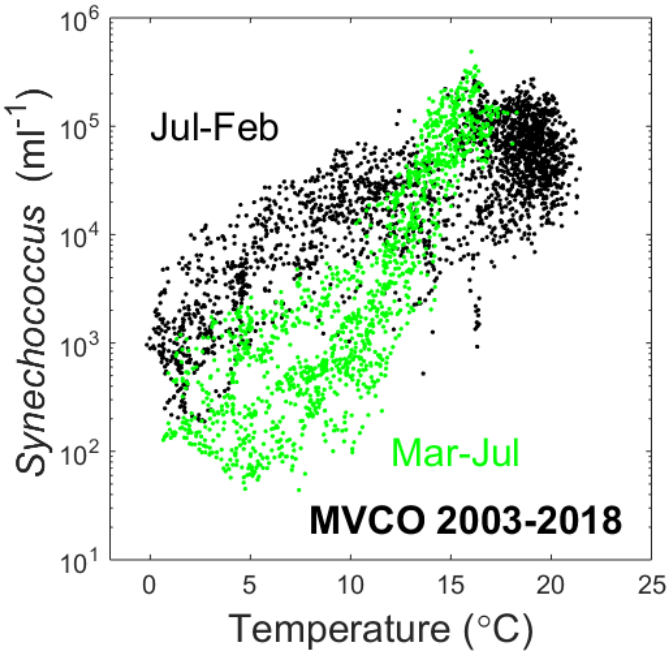
NES-LTER Transect



Underway flow cytometry and Imaging FlowCytobot







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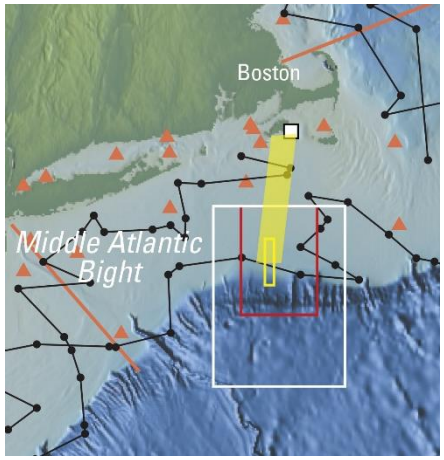
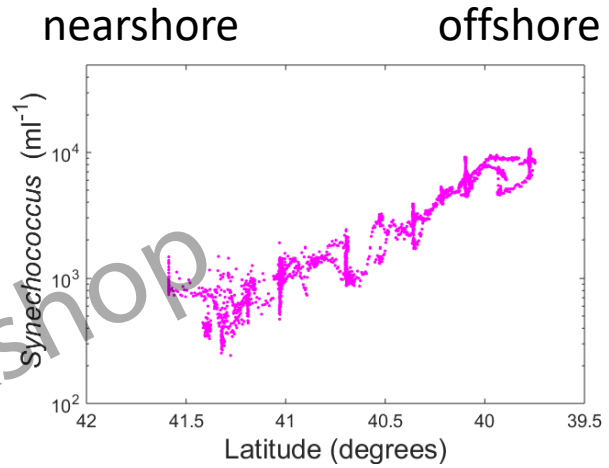
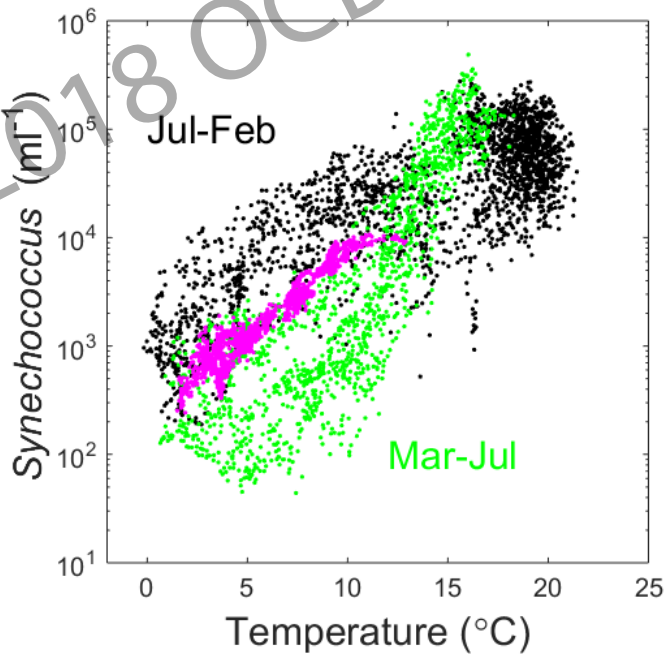


Underway flow cytometry and Imaging FlowCytobot





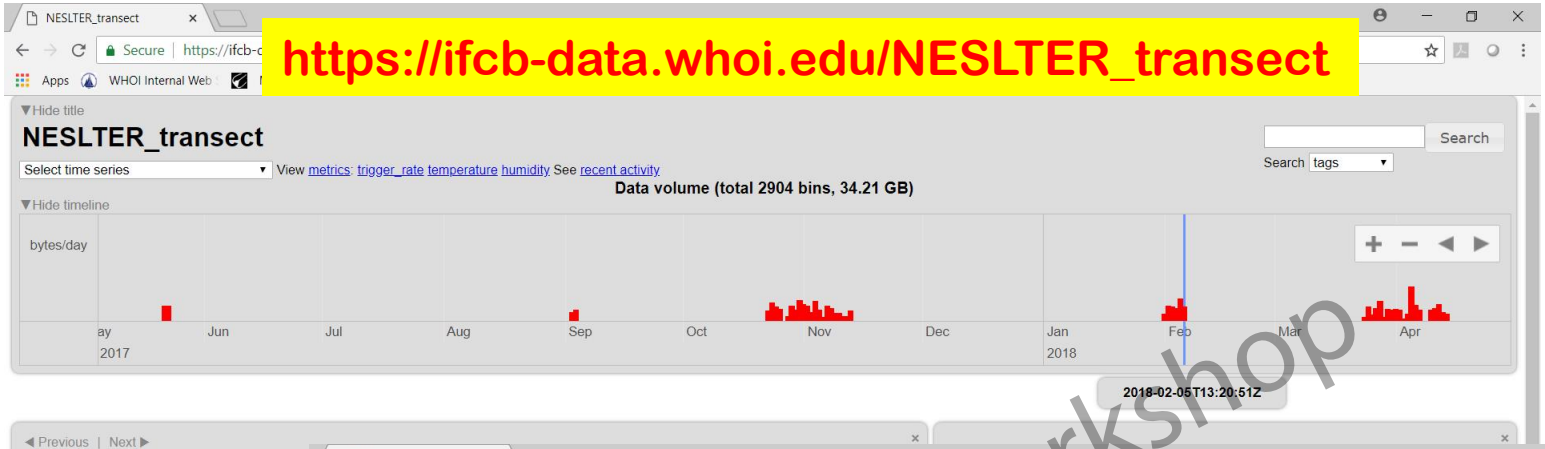
MVCO 2003-2018

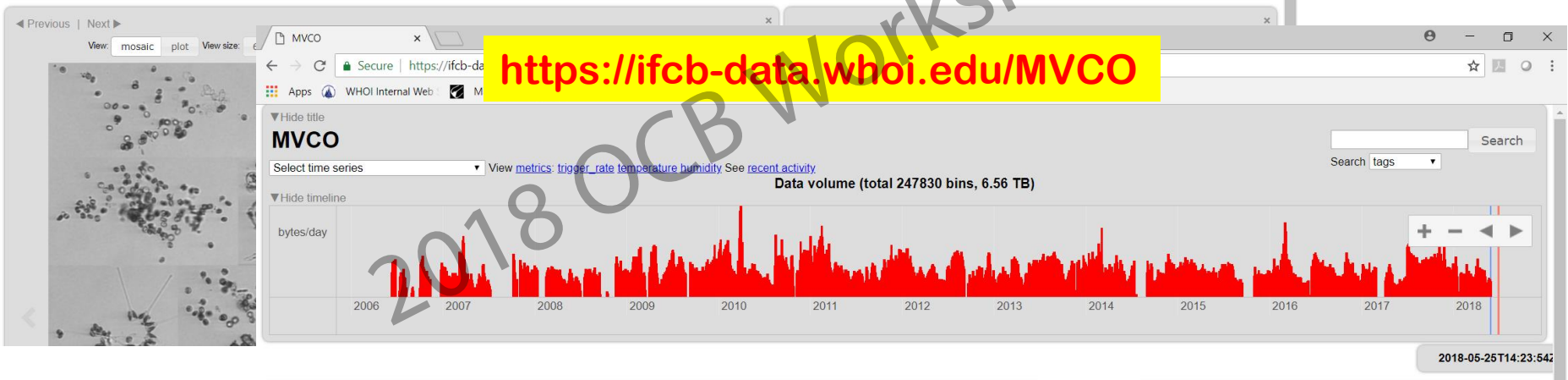
Transect

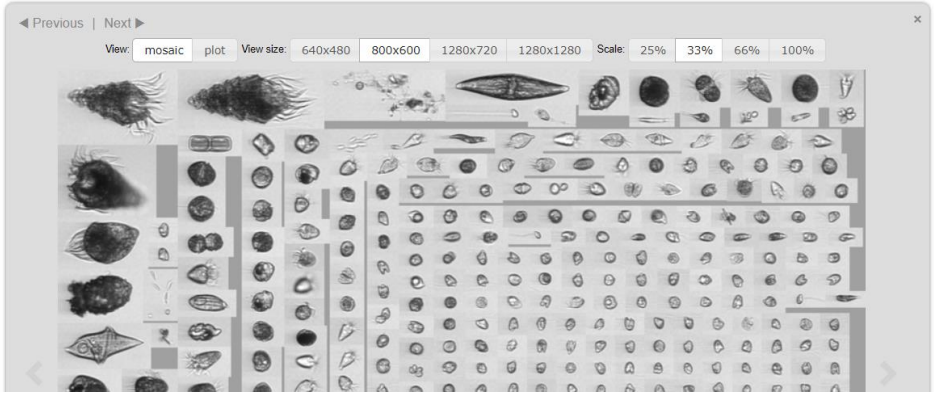
31 Jan - 5 Feb 2018

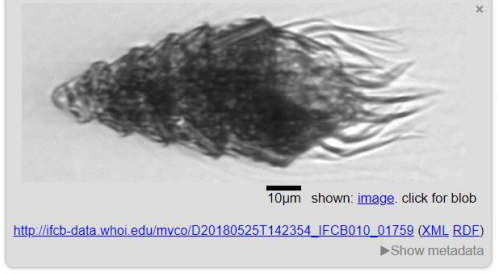
IFCB Dashboard

https://ifcb-data.whoi.edu









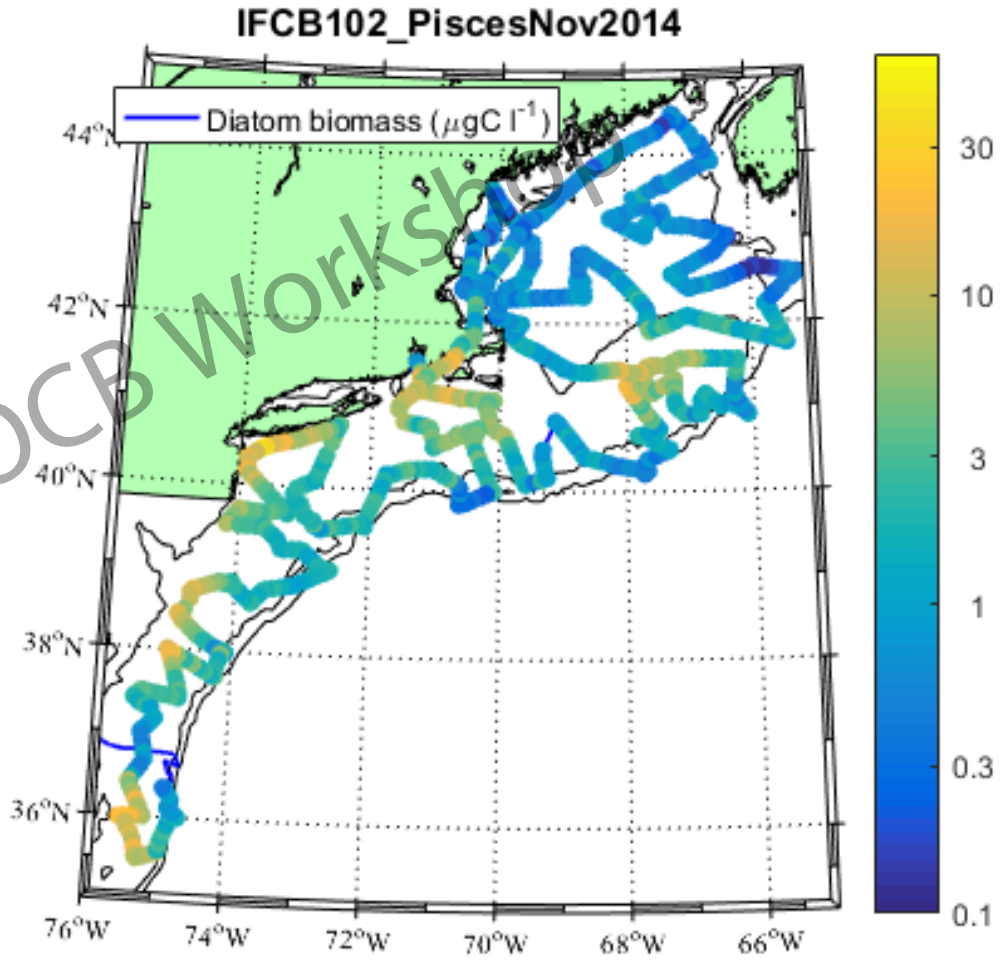
How do phytoplankton vary through space?

https://ifcb-data.whoi.edu/NESLTER_broadscale

NOAA EcoMon surveys

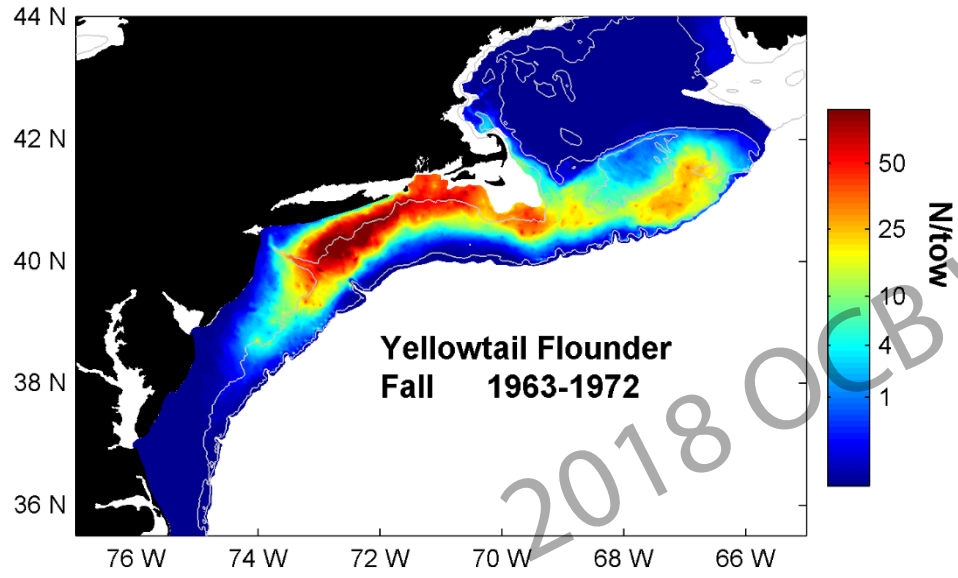
IFCB

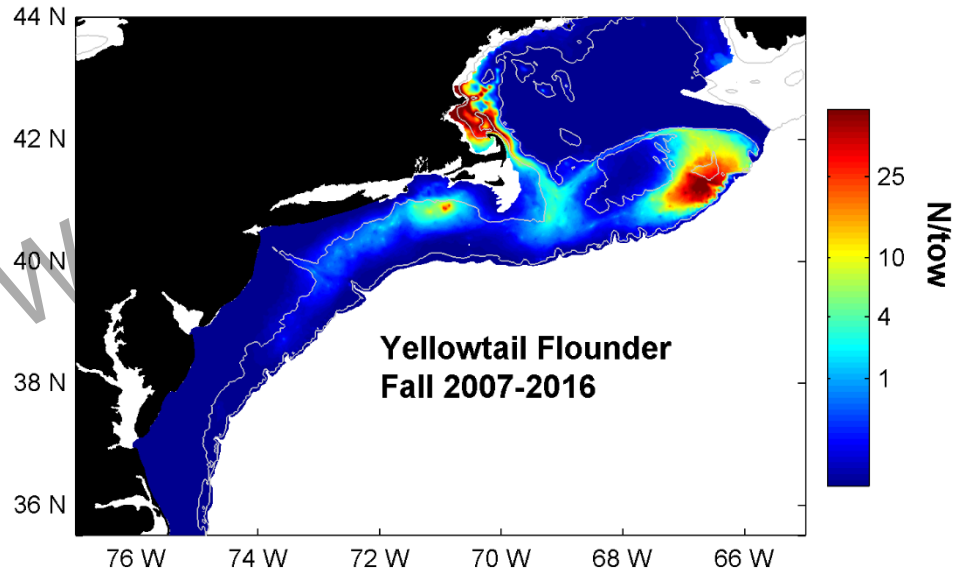
Diatom biomass from automated imaging



Fish distributions are changing

Northward shift in commercially valuable species with increasing temperature

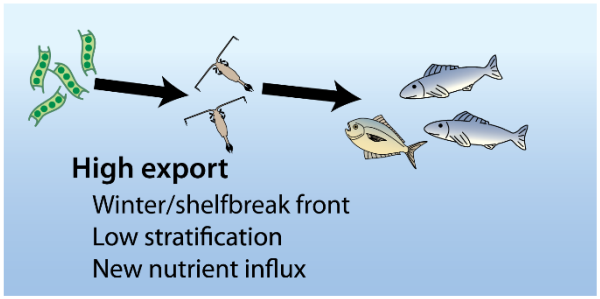


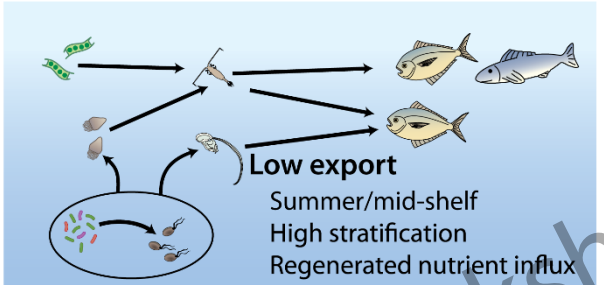


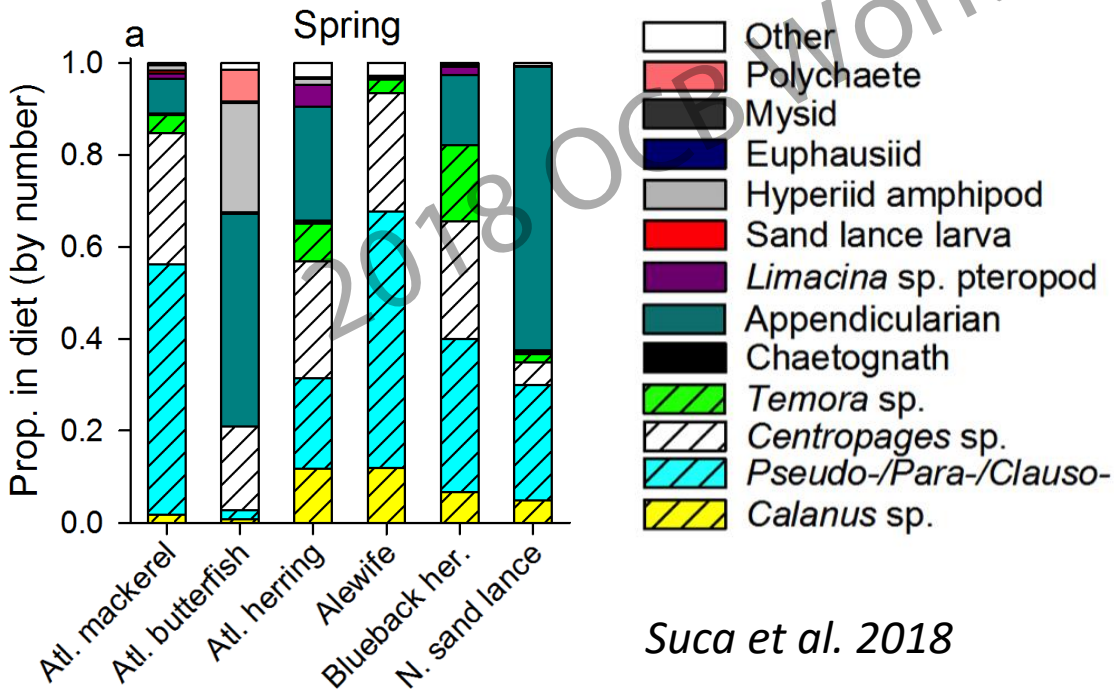
David Richardson, NOAA

Food web dynamics and linkages

Planktivorous “forage” fish are critical understudied link







Suca et al. 2018


Atlantic herring


Alewife


Blueback herring


Atlantic mackerel


Atlantic butterfish


Northern sand lance

NORTHEAST U.S. SHELF
Long-Term Ecological Research

What are the main factors controlling patterns of plankton species composition and biological production?

How is variability in the feeding and distribution of fish linked to variability in plankton species, sizes and production?

What is the vulnerability and resilience of the NES ecosystem (and the services it provides) to climate-induced environmental changes?

Regional Collaboration

Early example: Transect occupations

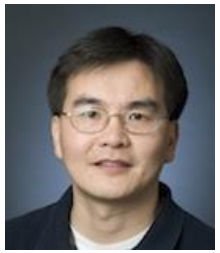
NES-LTER only

With new partnerships

NORTHEAST U.S. SHELF
Long-Term Ecological Research


Heidi Sosik

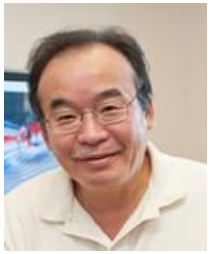

Stace Beaulieu

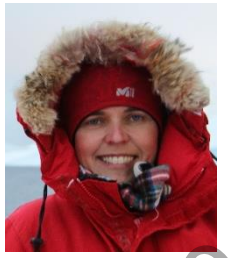

Rubao Ji


Mike Neubert


Steve Lentz


Joel Llopiz


Changsheng Chen


Susanne Menden-Deuer


Tatiana Rynearson


Rachel Stanley


David Richardson


Paula Fratantoni

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UNIVERSITY OF MASSACHUSETTS DARTMOUTH 1895

THE UNIVERSITY OF RHODE ISLAND GRADUATE SCHOOL OF OCEANOGRAPHY

WELLESLEY

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