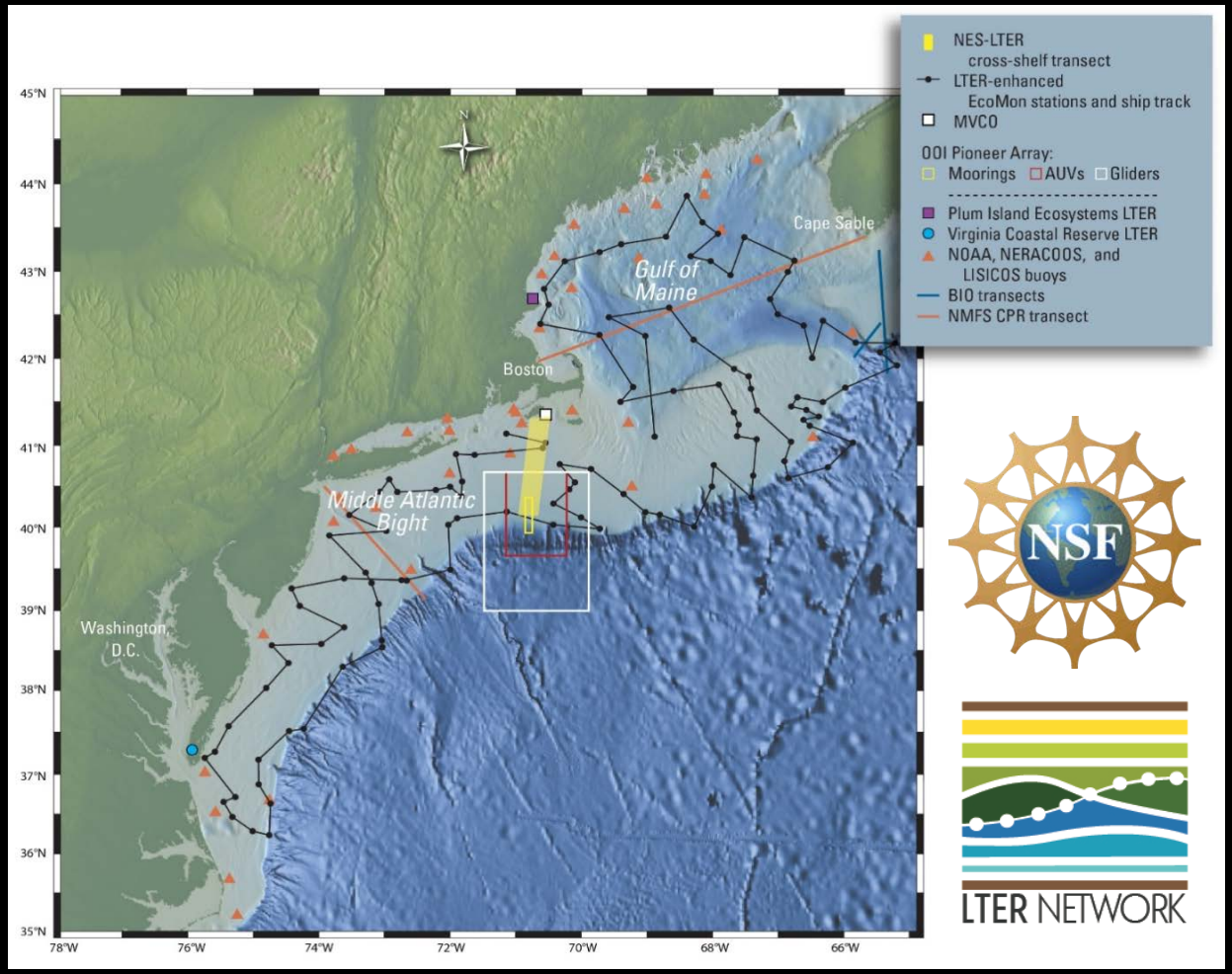
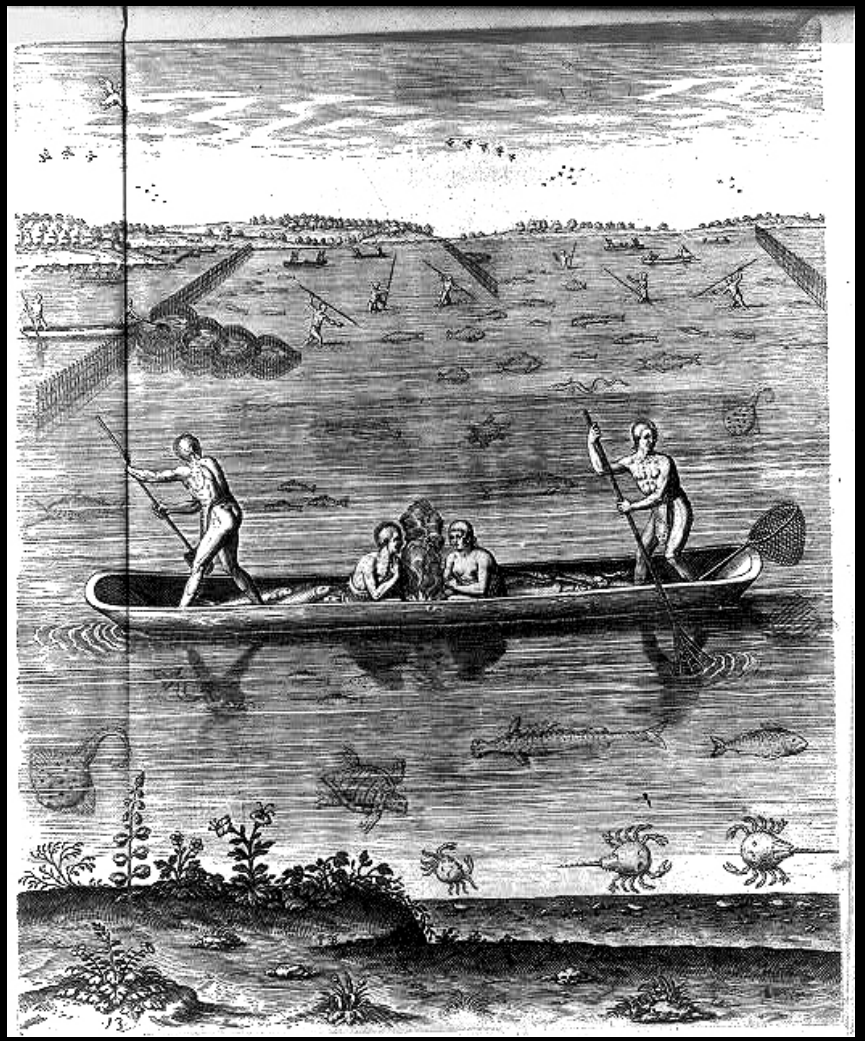
Northeast Shelf LTER – a new Long-Term Ecological Research Site on the Eastern Seaboard



Susanne Menden-Deuer
Graduate School of Oceanography
University of Rhode Island
smenden@uri.edu

A Historic Seashore

Marine resources and transportation have long sustained coastal communities



Images: John Margulis New England Fishing Village
Thomas De Bryn Algonquin Fishing

Humans increasing dependence on the sea

First Offshore Wind farm in the US operational in Block Island Sound

Image: Rhode Island SeaGrant

Building on Knowledge

Region has wealth of long-term and historic records, from light house observations in the 1800s to satellite altimetry

- Ocean Physics
- Nutrient concentrations
- Plankton Abundance and Taxonomy - > 50 years continuous
- Fish Trawl Surveys - > 50 years continuous
- Sea surface height and Temperature

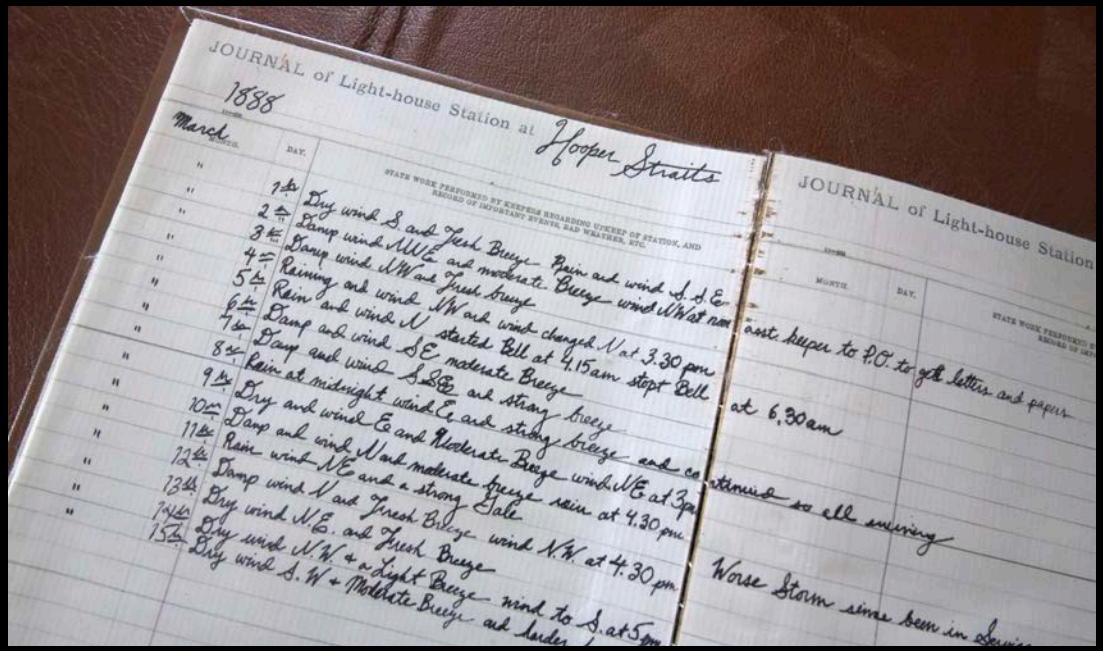
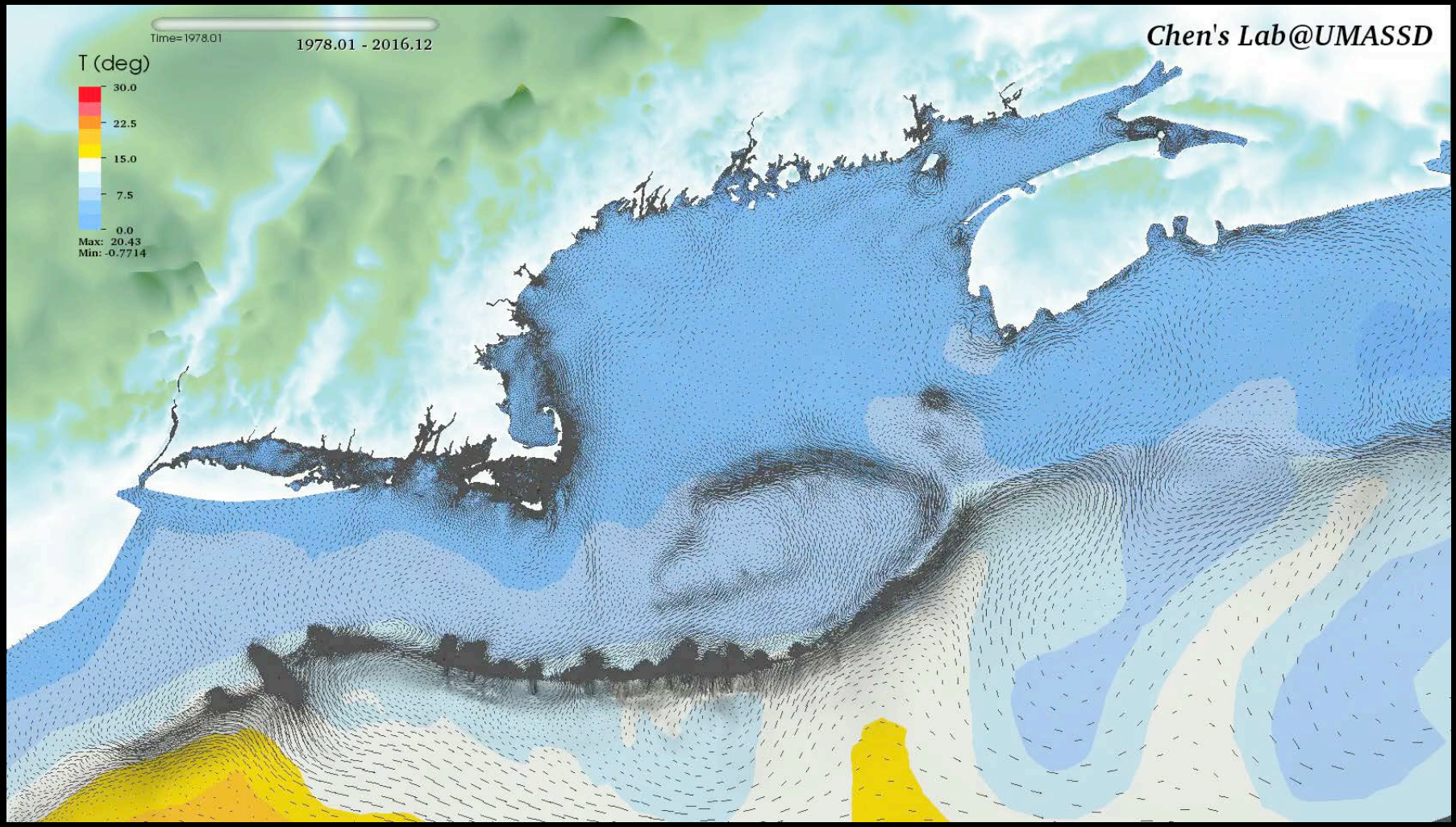


Image: Baltimore Sun

Dynamic environment

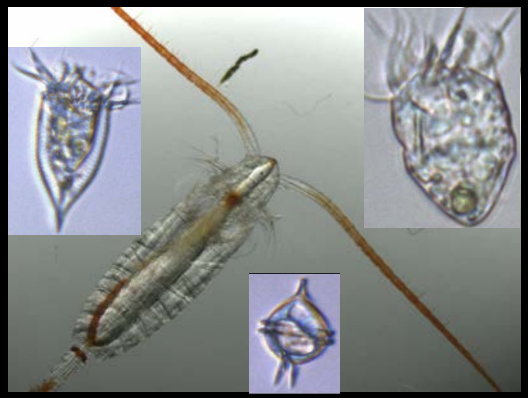


Chen et al.

Microscopic Engines

Diverse microscopic organisms (plankton) generate the energy and organic matter that fuels the ecosystem.

Microscopic primary producers



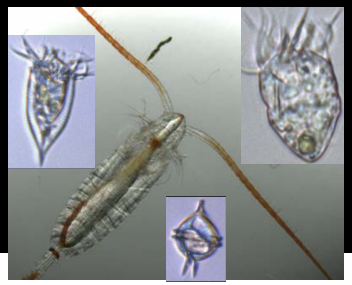
Herbivorous consumers Zooplankton

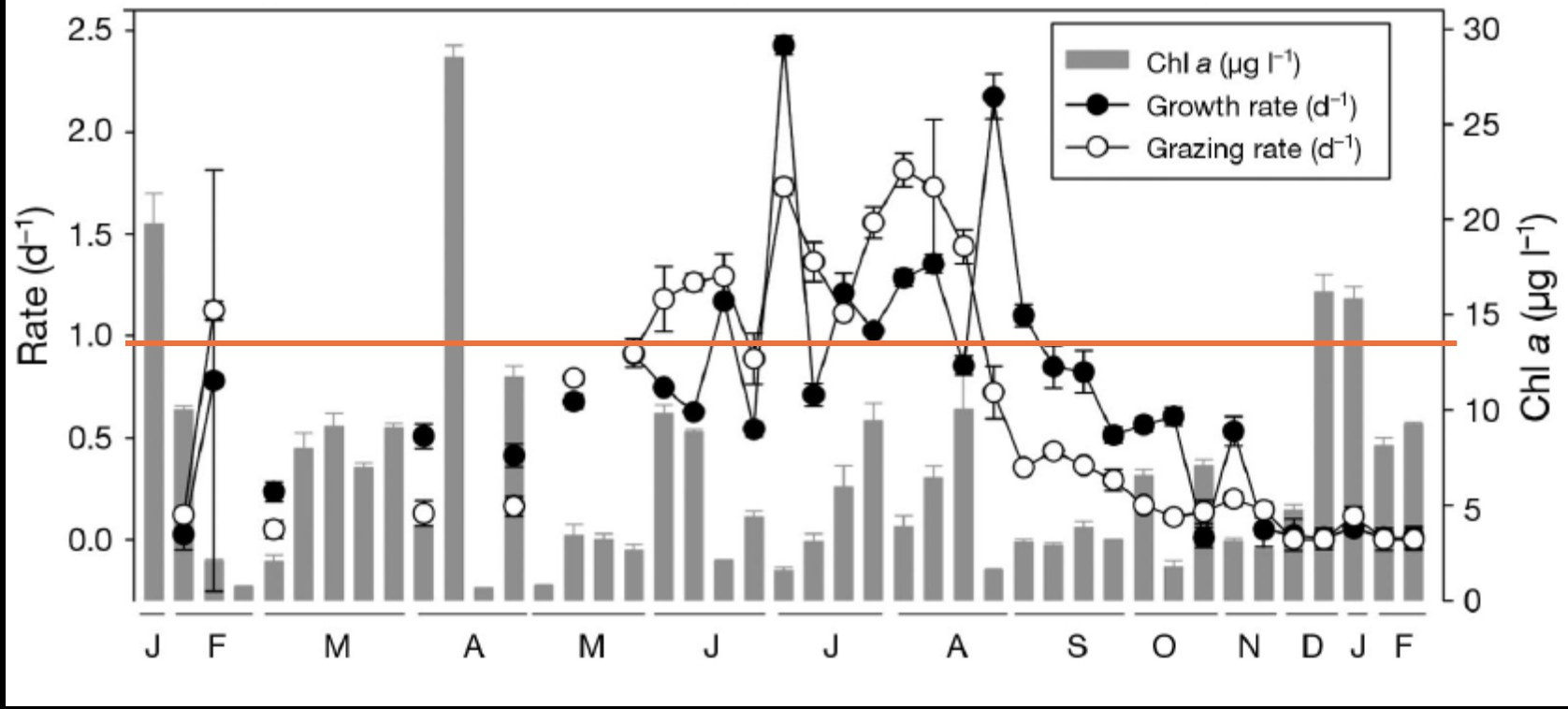
Alewife (river herring)

Images: Menden-Deuer Lab, University of Rhode Island, Joel Lopiz, WHOI

Efficient trophic transfer

Nearly all (70-100%) primary production is eaten by zooplankton

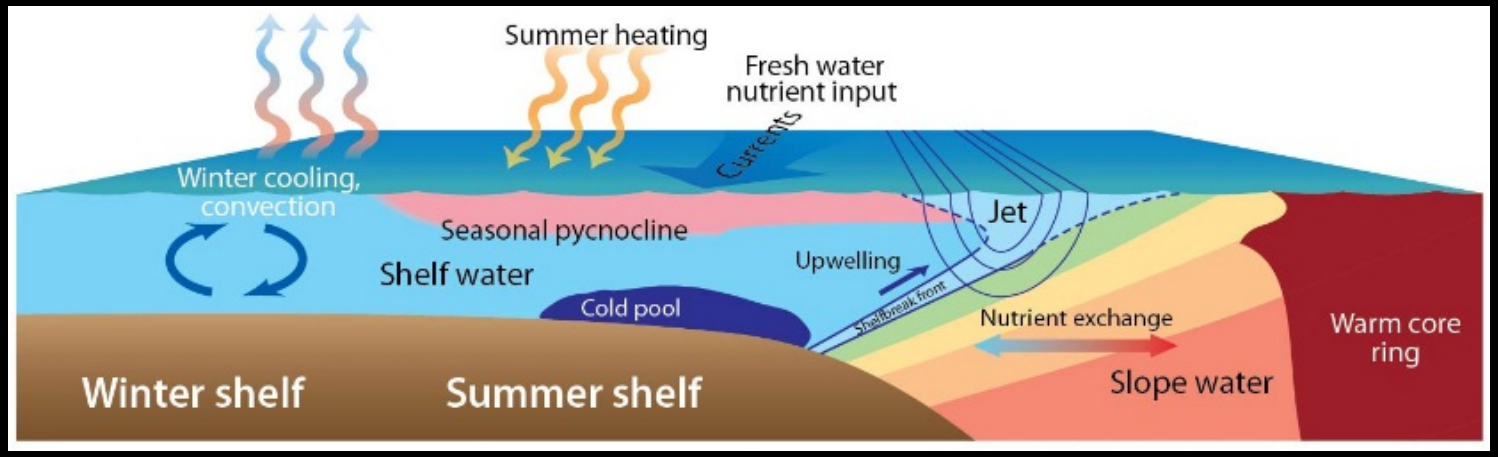




Lawrence & Menden-Deuer 2012

A Changing Ecosystem

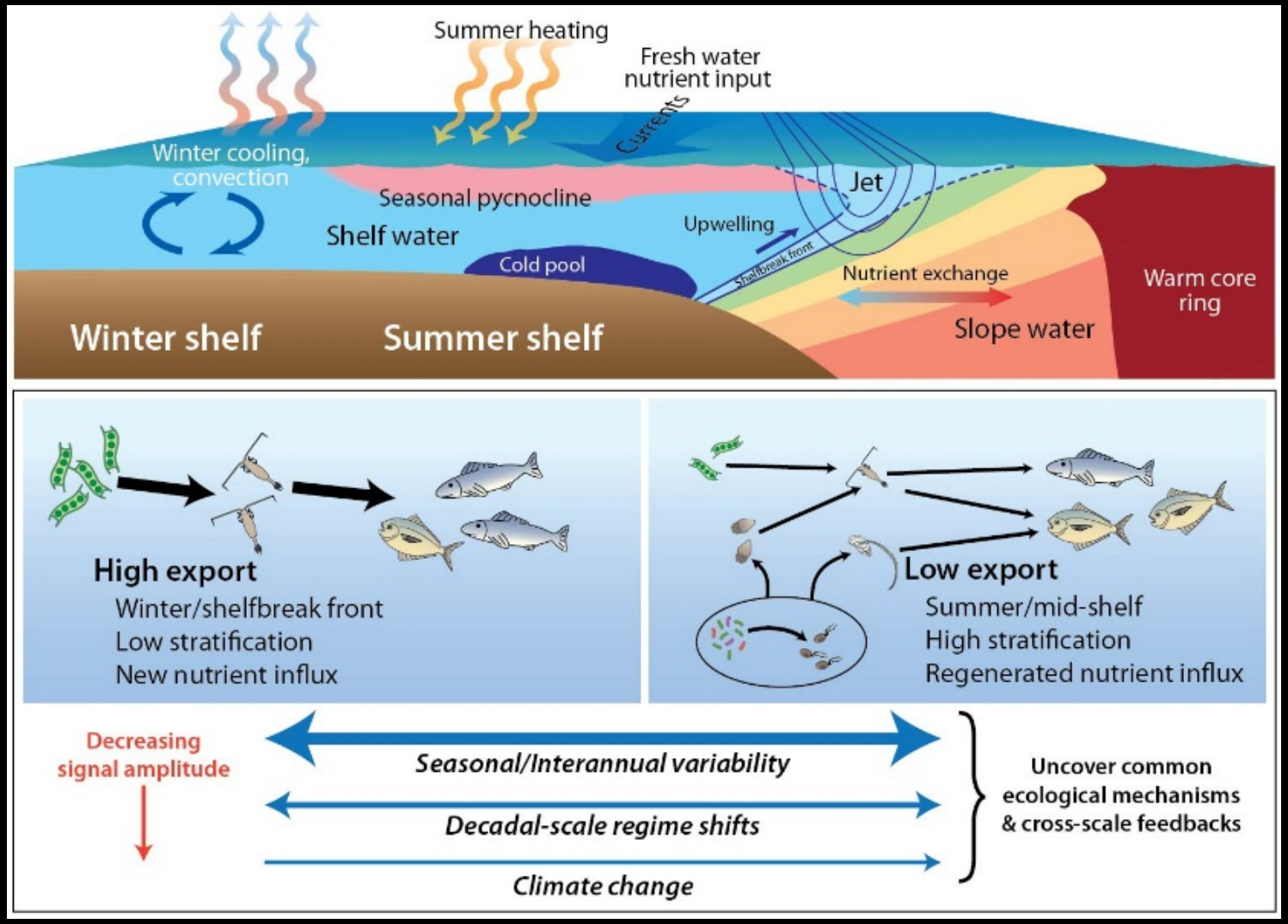
Ecosystem change is driven both by humans and environment



- Heat flux → Mixing
- Freshwater input → Water Column Stability
- Nutrient Input → Production

A Changing Ecosystem

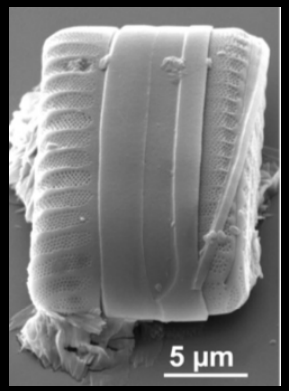
Physical and chemical changes affect food webs

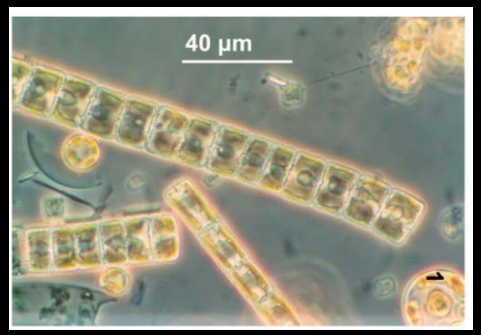


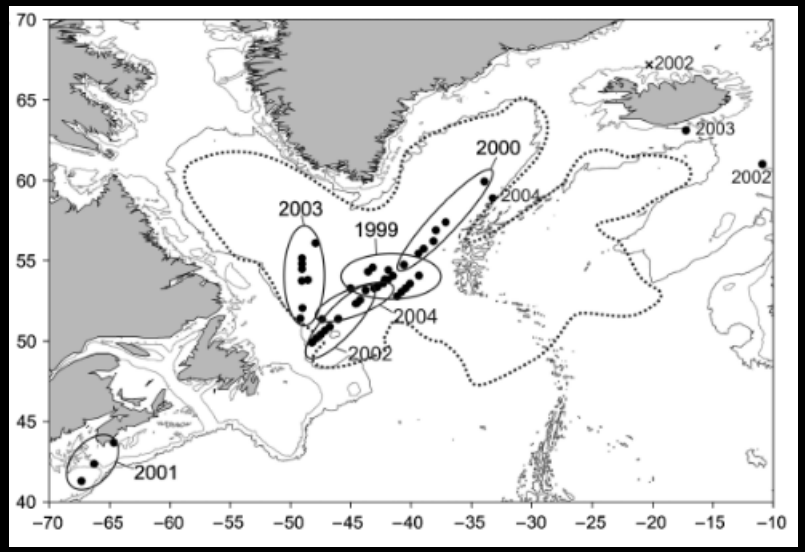
Base of the food web is changing

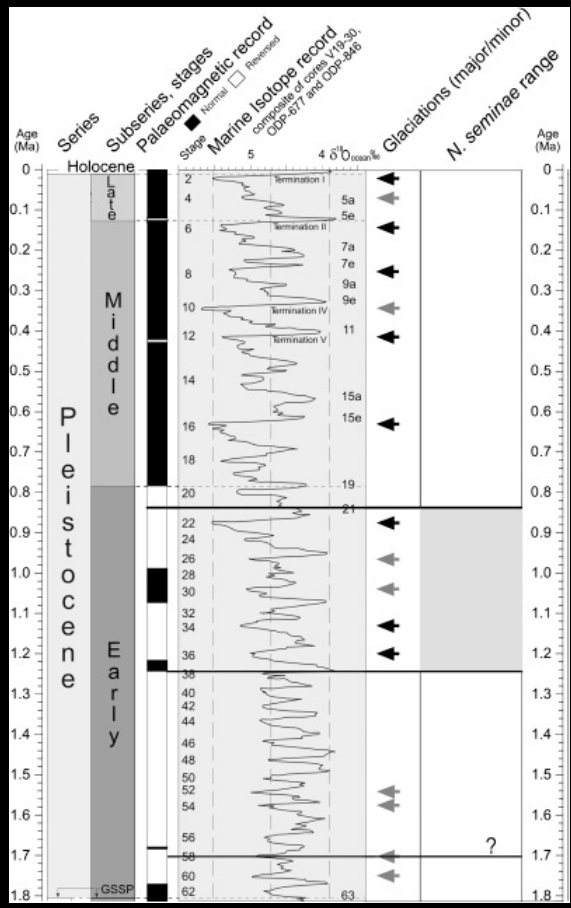
Species distributions change in a warming ocean

- 1999: reappearance of the diatom *Neodenticula seminae* after 800,000 year absence,
- Reduced Sea Ice cover allowed trans-arctic advection from North Pacific









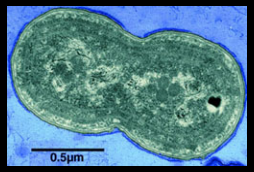
Reid et al. 2007

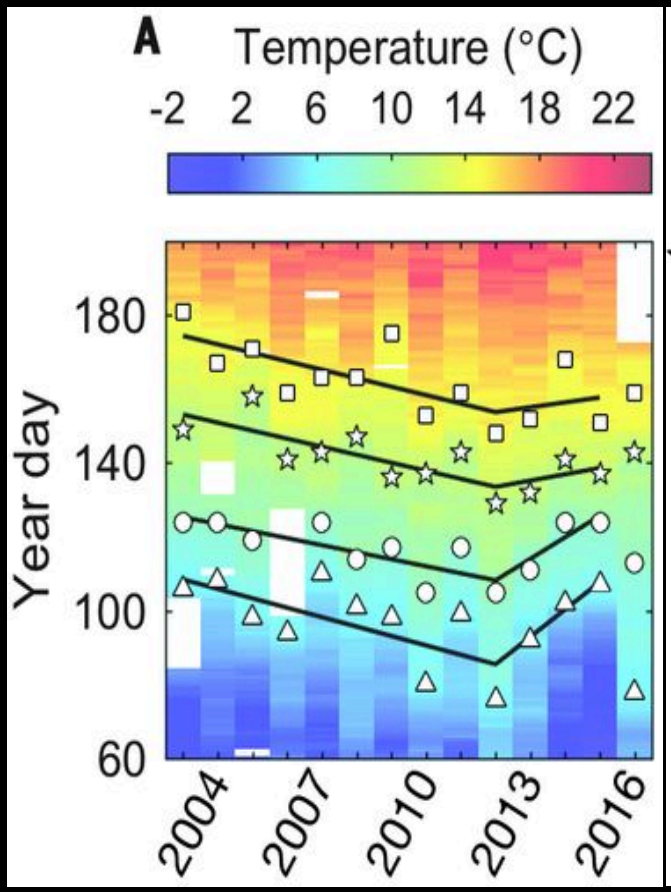
Base of the food web is changing

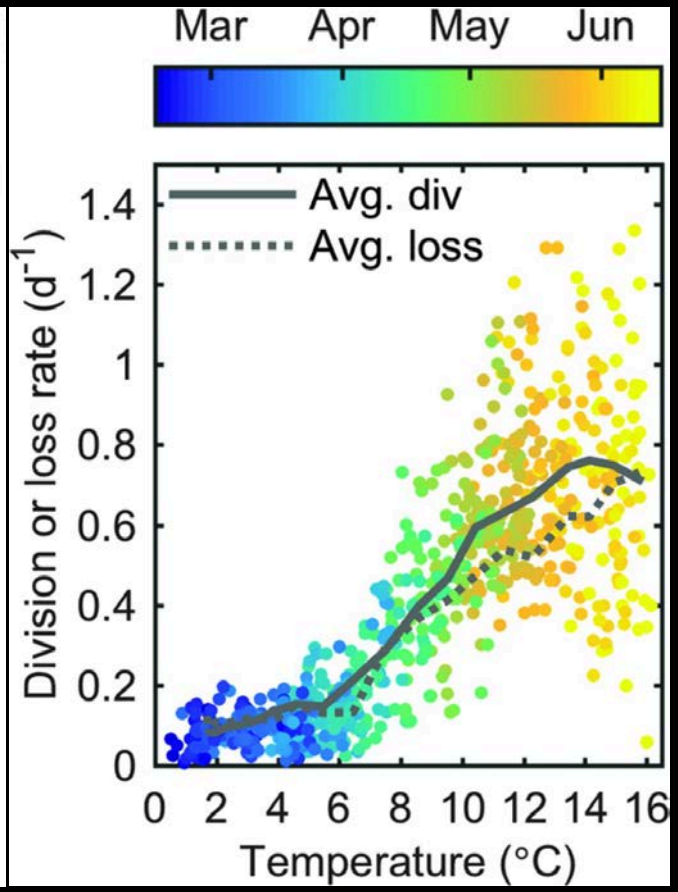
Timing of phenomena change in a warming ocean

- Biological rates proceed faster at higher temperature
- Warming ocean promotes earlier phytoplankton bloom

Synecococcus, one of the smallest phytoplankton in the ocean



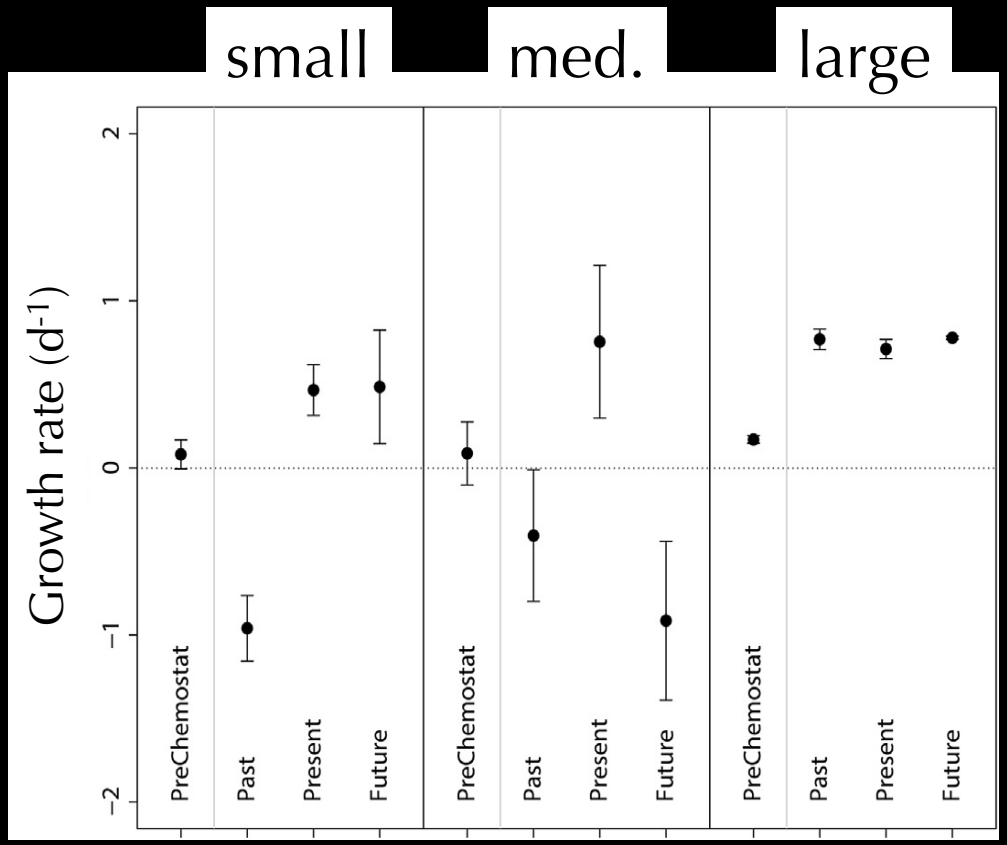


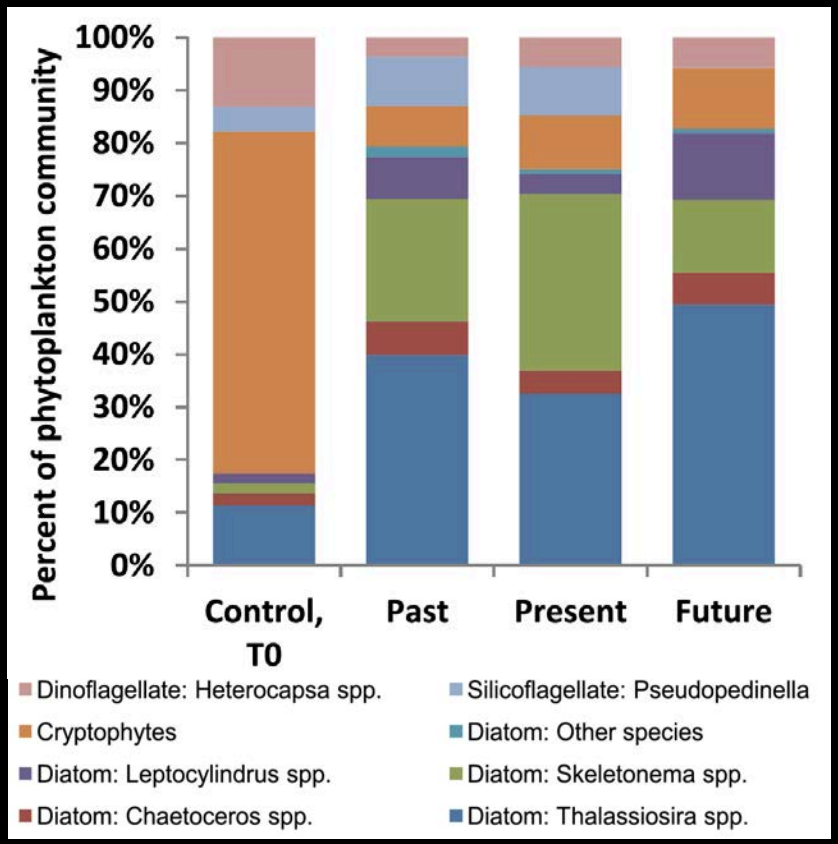


Hunter-Cevera et al 2016

Base of the food web is changing

Large diatoms thrive in changing conditions
Large diatoms associate with efficient trophic transfer

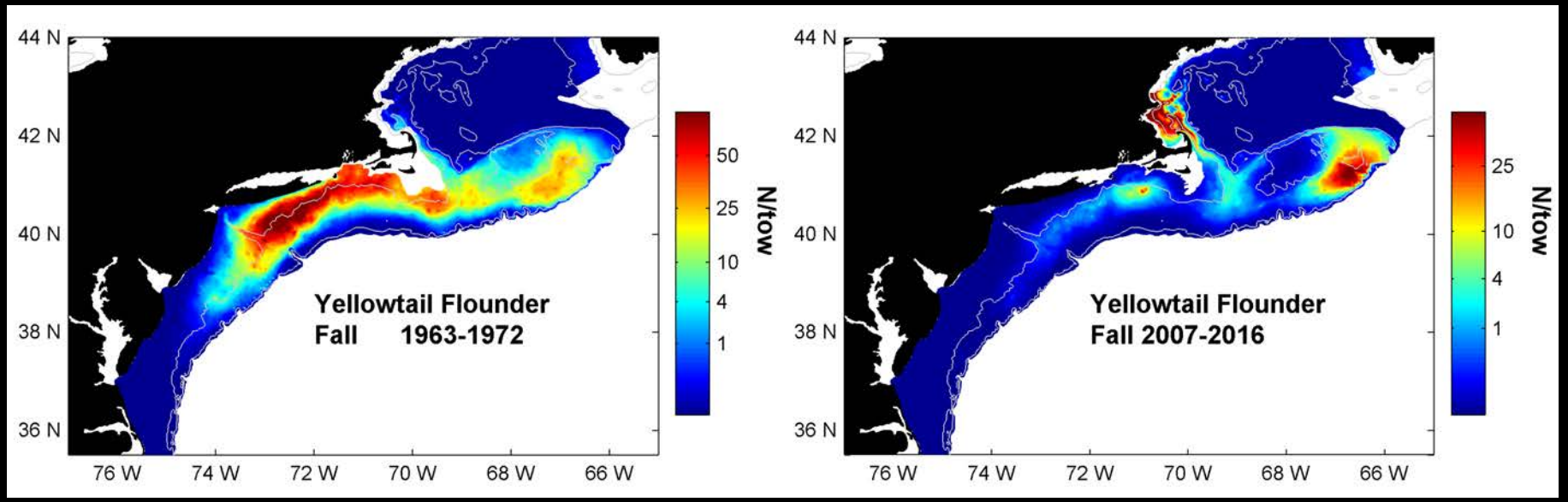




Grear et al. 2007

Fish distributions are changing

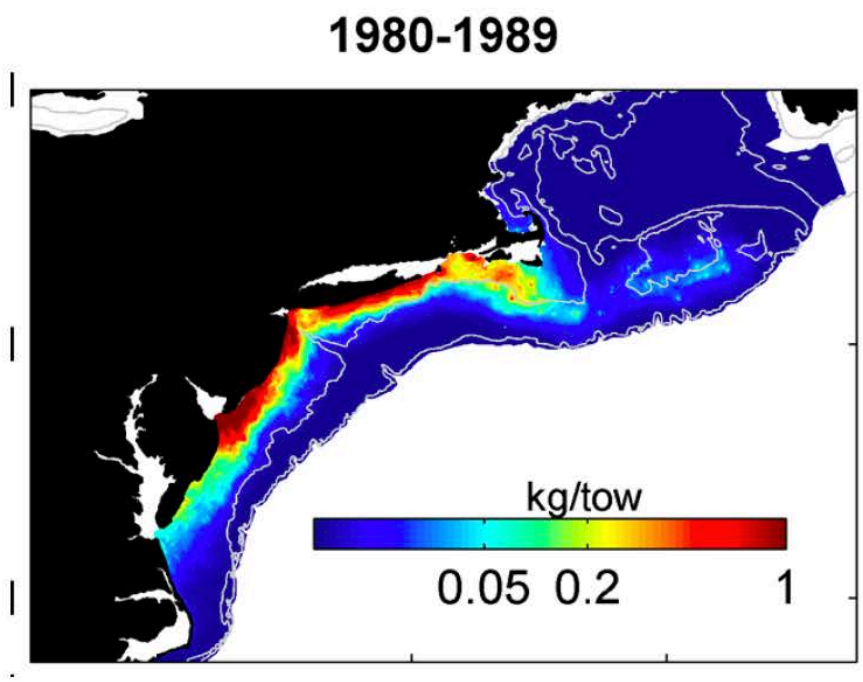
Yellowtail Flounder: Northward shift in commercially valuable species with increasing temperature

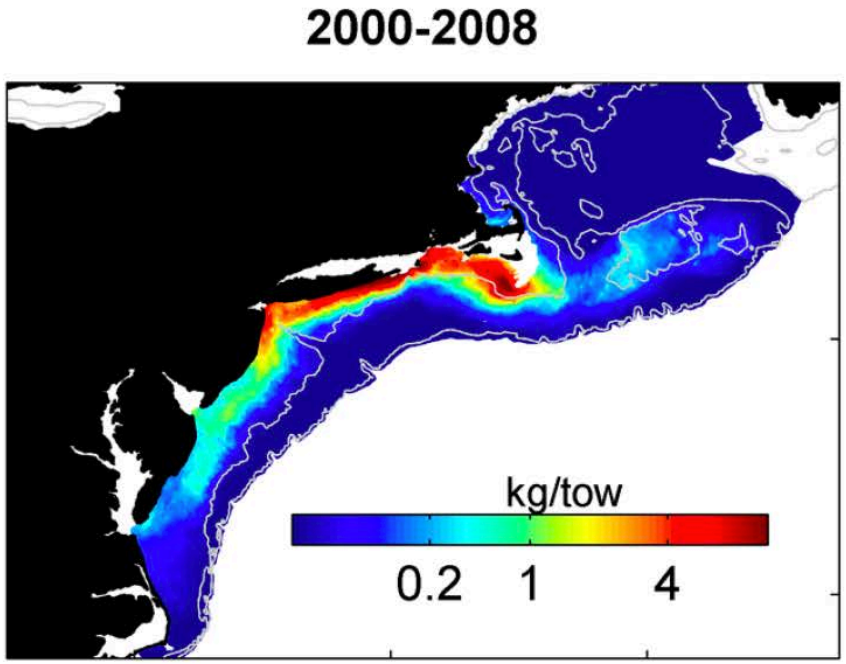


David Richardson, NOAA

Fish distributions are changing

Summer Flounder: Northward shift of formerly valuable species due to decreased fishing pressure

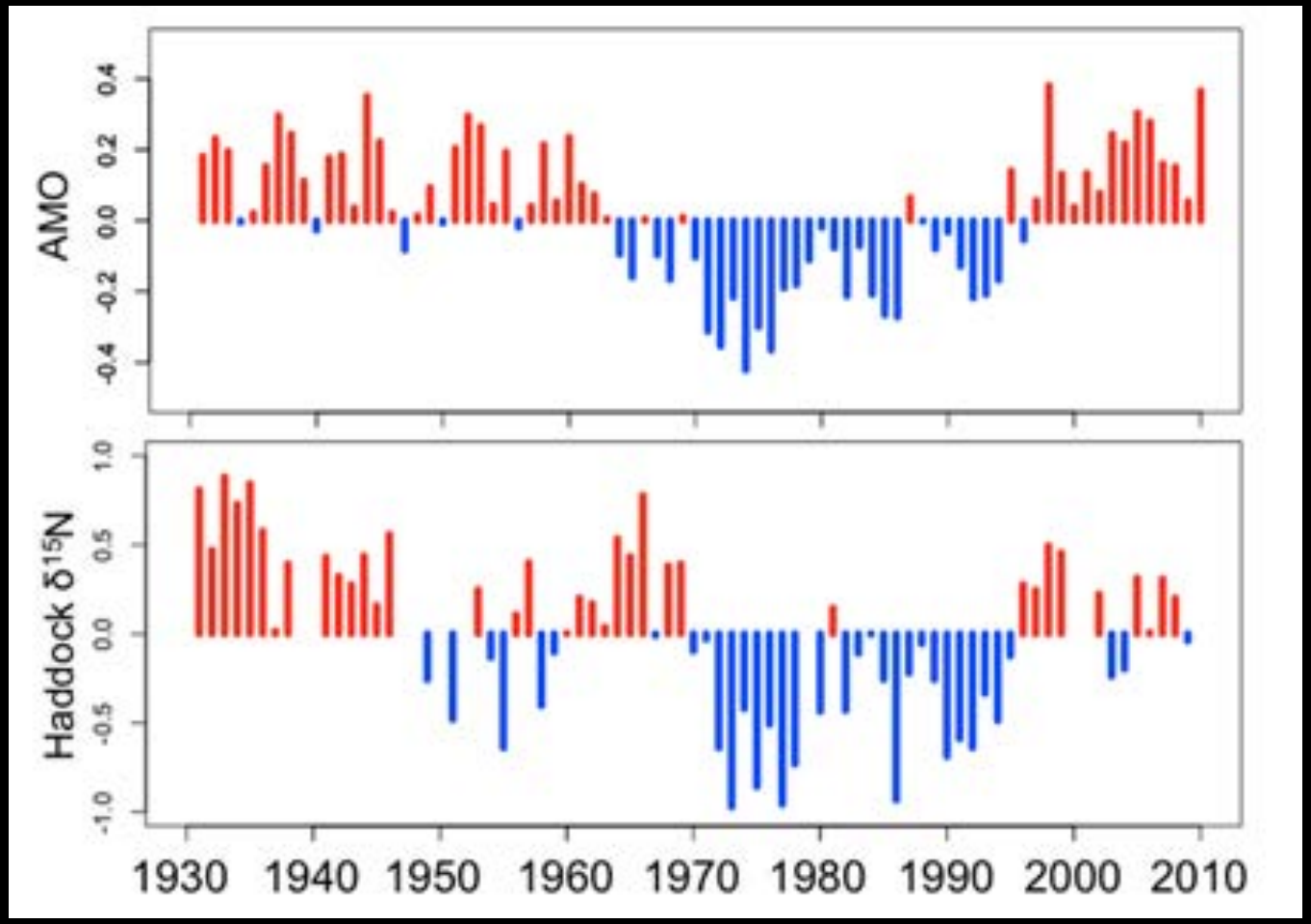




Bell et al. 2014,
Map D. Richardson

A connected system

- Environmental fluctuations reflected in Haddock
- Mechanism of connection is unknown



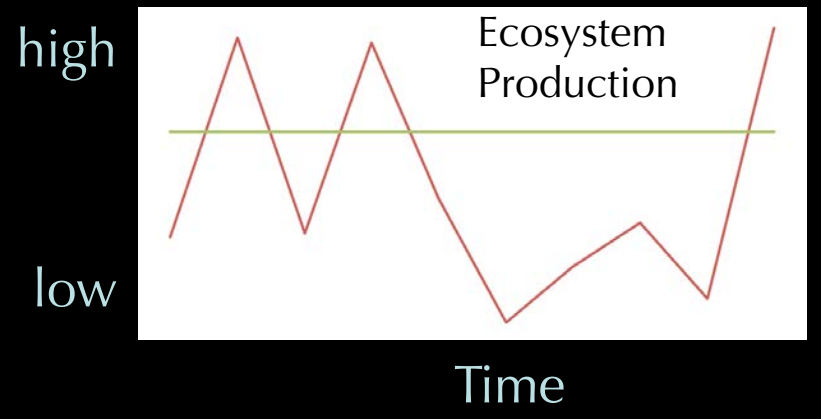
Joel Lopiz, WHOI

NES – LTER Phase 1 Questions:

1. Base of food web:
What are the main factors controlling patterns of plankton species composition and biological production?

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

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



Hypothesis: diversity imparts resilience

1. Base of food web:

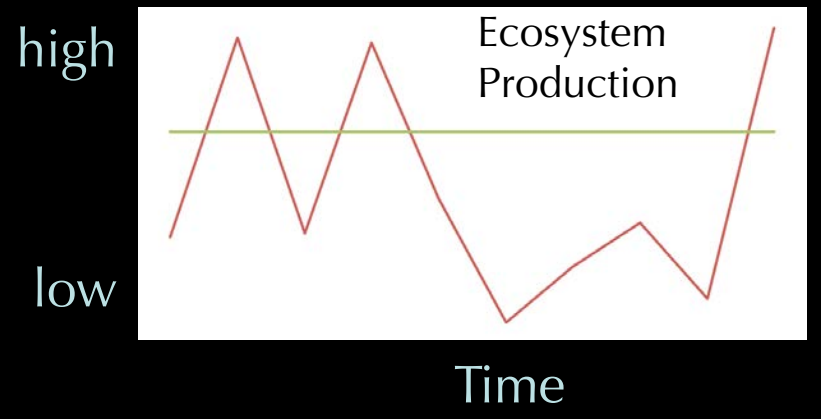
Hypothesis: warming induces reduction in phytoplankton size, increased energy demand by zooplankton and a low production food web

2. Fish:

Hypothesis: shifts in zooplankton assemblage will cascade up to forage fish favoring fish species with feeding preferences for small zooplankton

3. Response to environmental change:

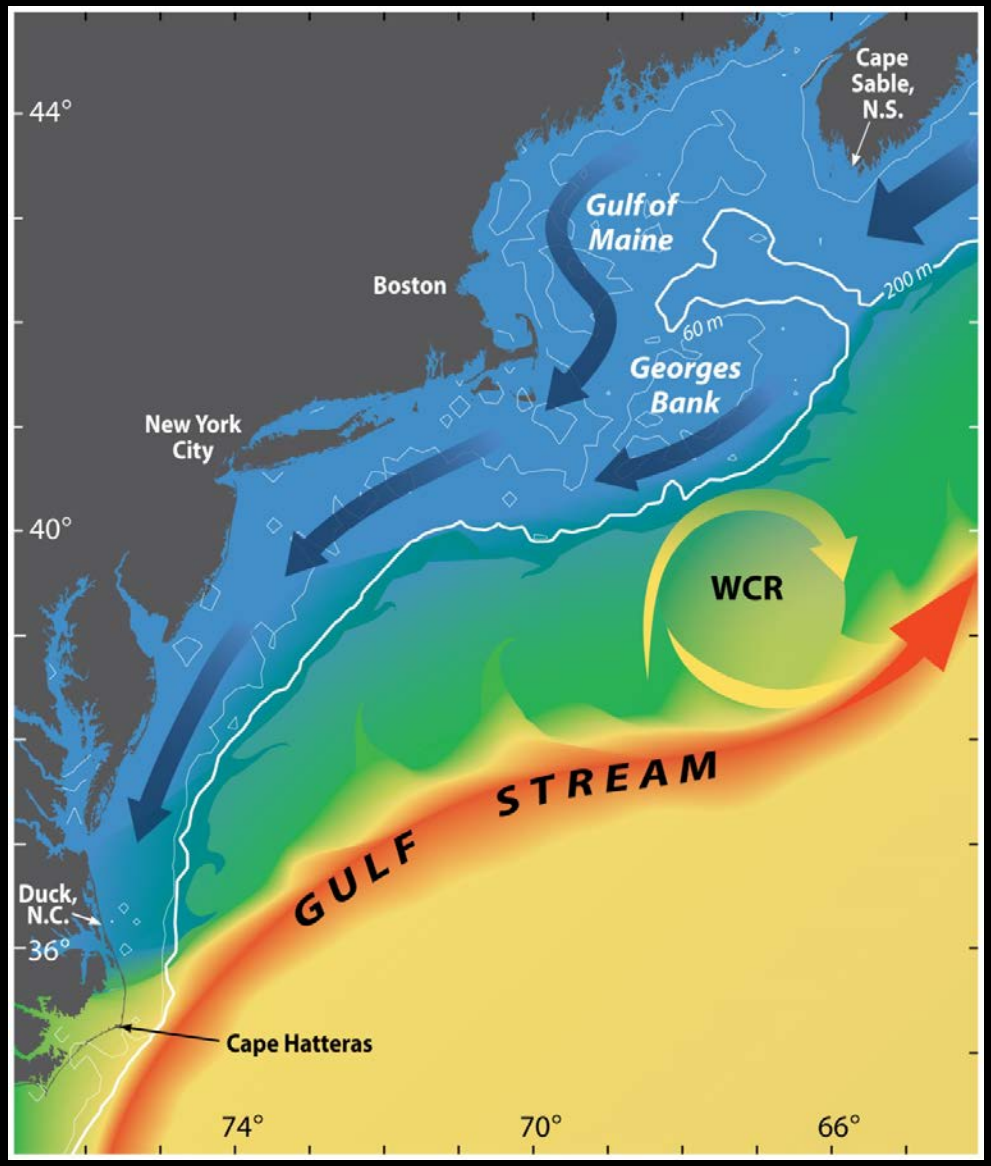
Hypothesis: Diversity in phytoplankton species and diet flexibility in fish impart resilience to the ecosystem



A multi-pronged approach - modeling

Complex hydrography requires sophisticated physical modeling

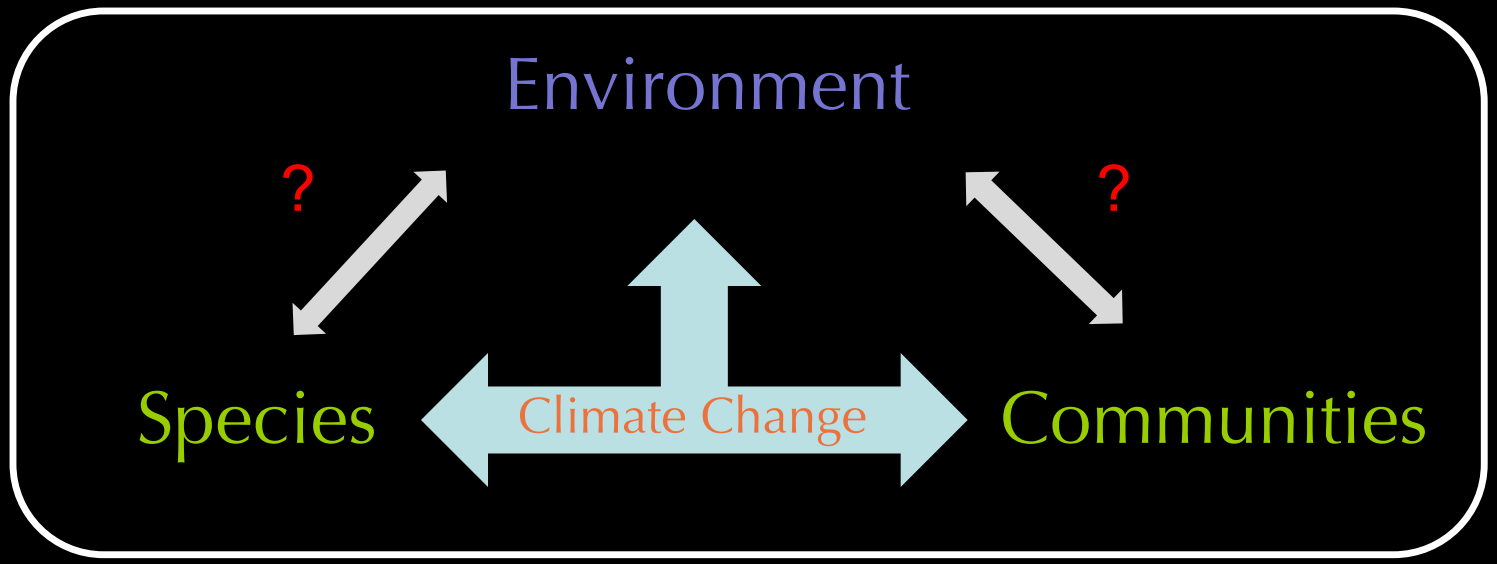
Highly productive, integrated system with shelf influenced by Arctic inflows, Gulf Stream rings and meanders, rivers and large estuaries



A multi-pronged approach - modeling

Complex biological interactions require sound, testable theory

How do climate conditions affect species composition and ecosystem production?

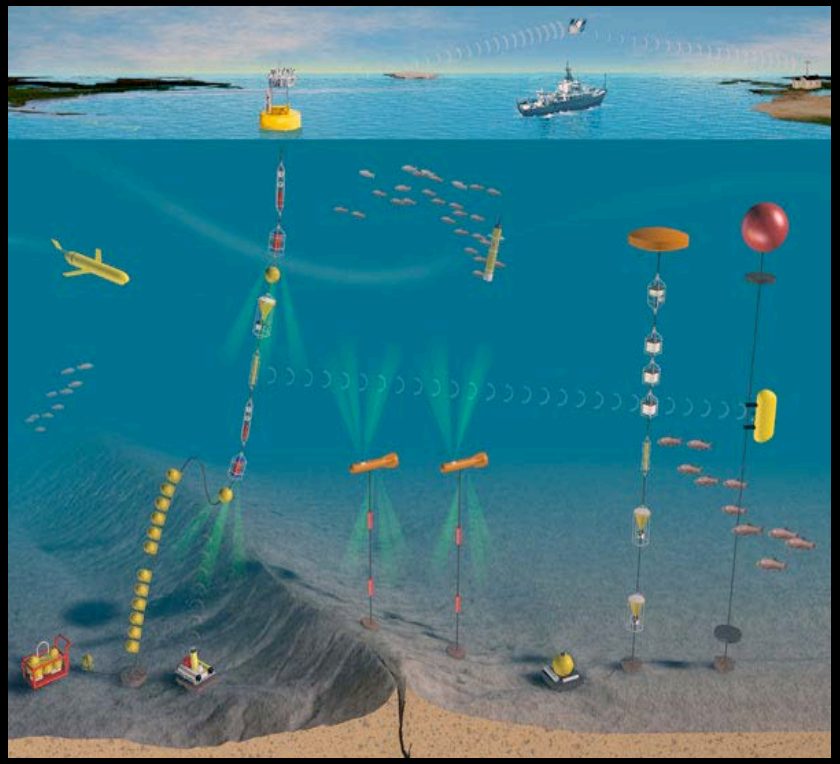


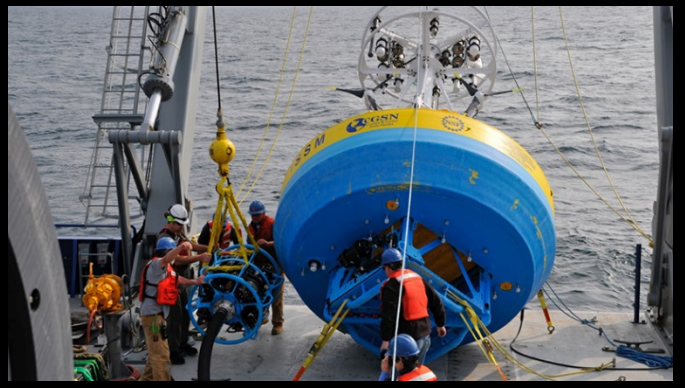
after Micheli et al. (1999); Defriez et al. (2016).

A multi-pronged approach - observations

Data hungry models require high resolution, in situ data

Continuous occupation of the
Martha's Vineyard Observatory and
Pioneer Array Ocean Observatory

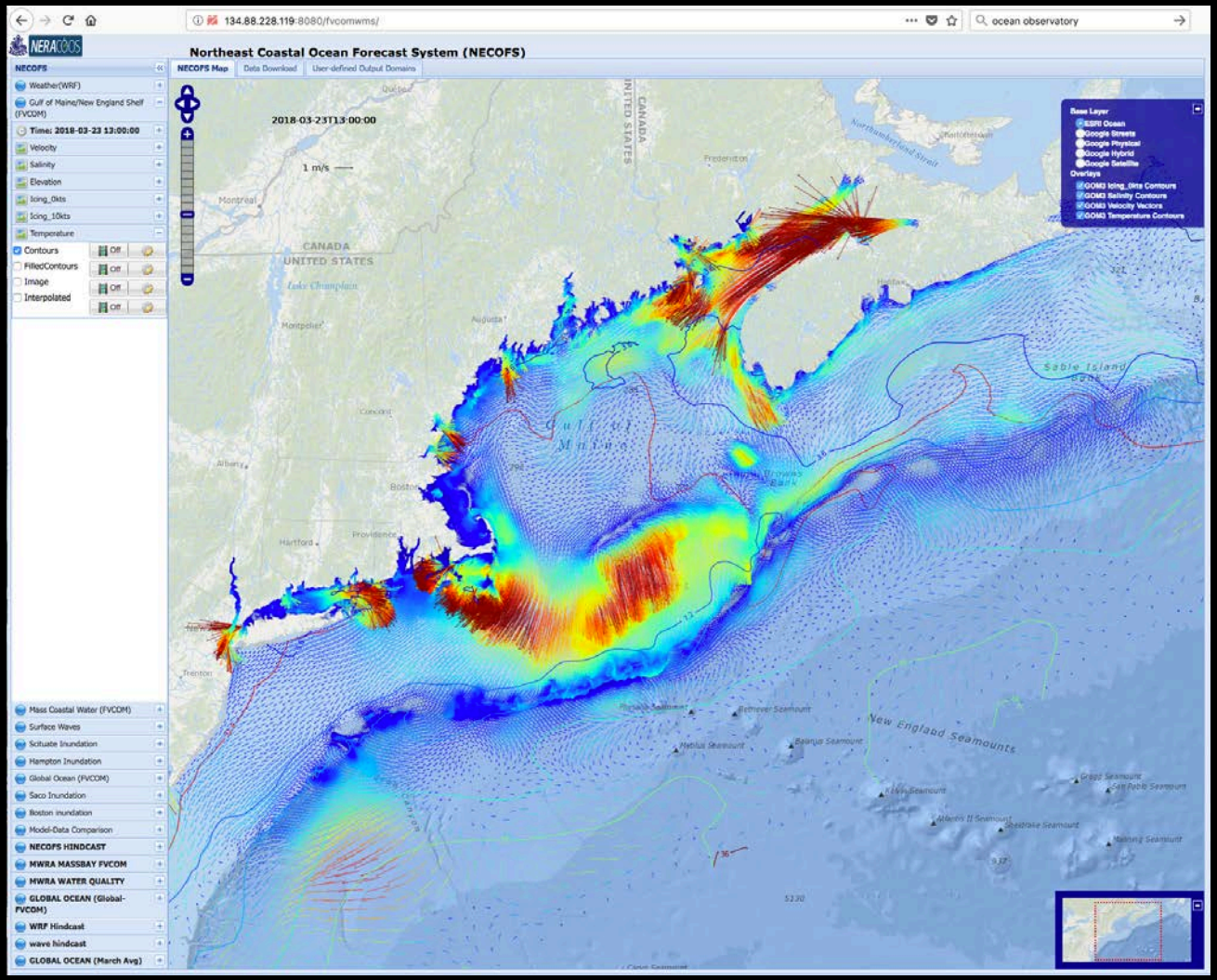




Images: WHOI

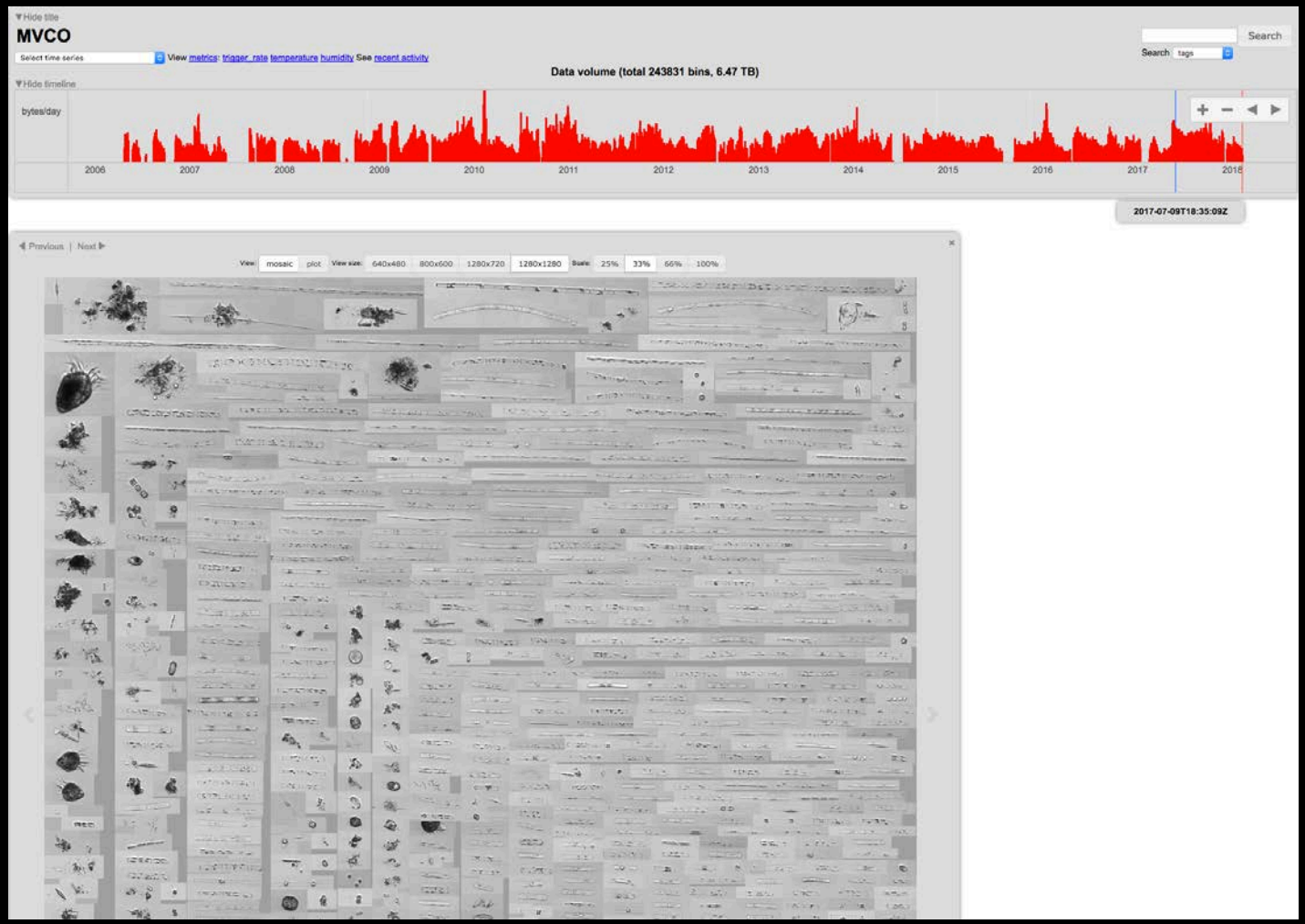
Real Time Ocean Conditions

Data collected in real time and available at:
FVCOM http://134.88.228.119:8080/fvcomwms/

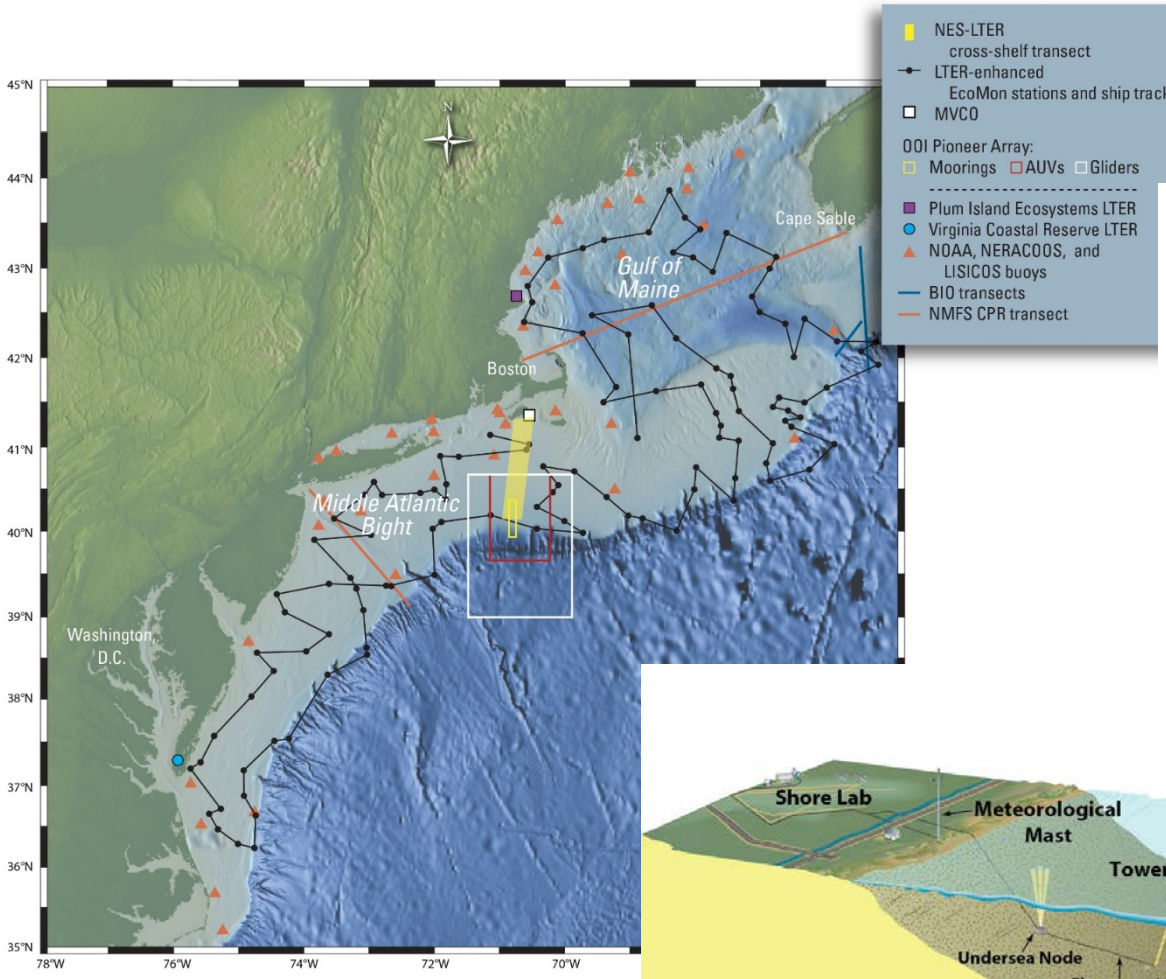


Research that is accessible

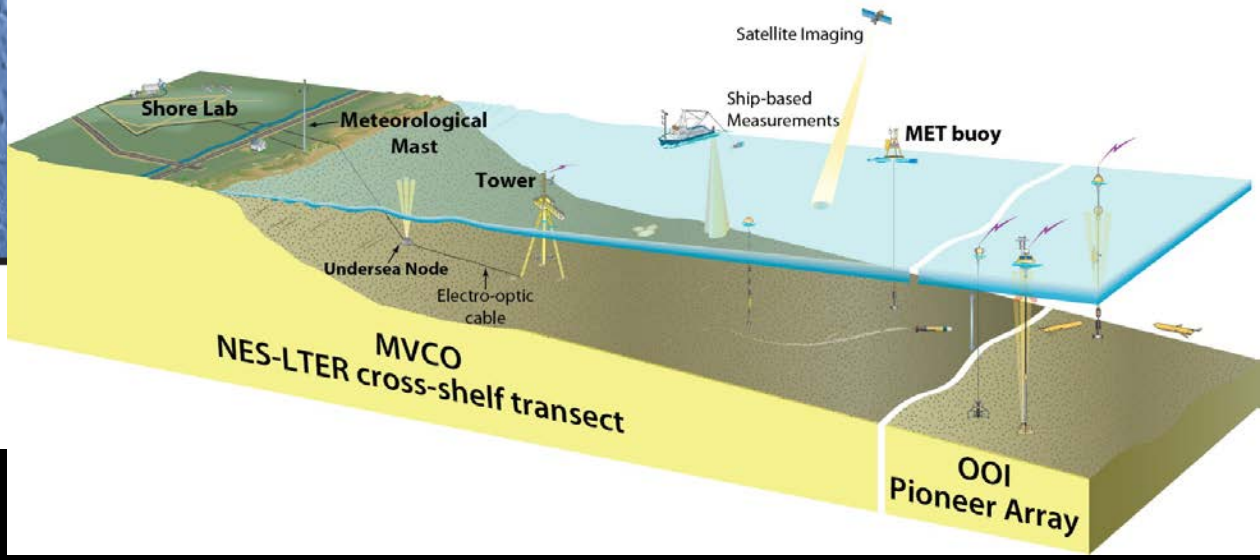
Much of the data collected is available in real time
Plankton Species composition (MVCO IFCB)
http://ifcb-data.whoi.edu/mvco



At sea measurements of food web interactions



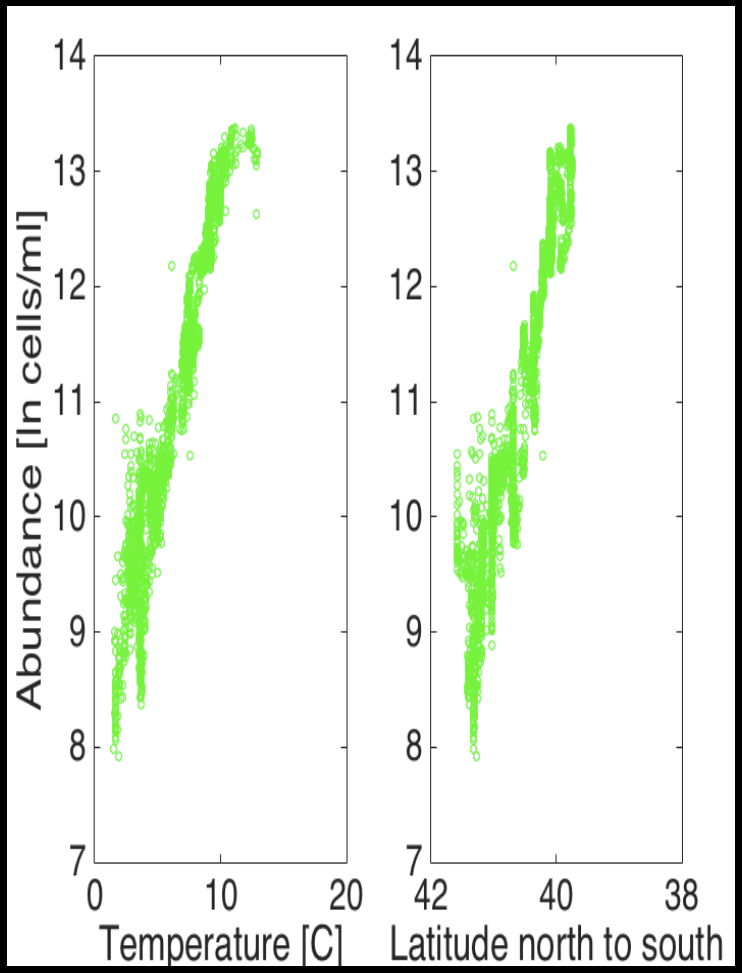
- From US/Canada border to Cape Hatteras
- Monthly Martha's Vineyard Coastal Observatory
- 4 cruises per year, regional surveys
- 4 cruises per year, cross-shelf
- 12 Tioga cruises per year, MVCO
- Continuous observations at MVCO and Pioneer Array



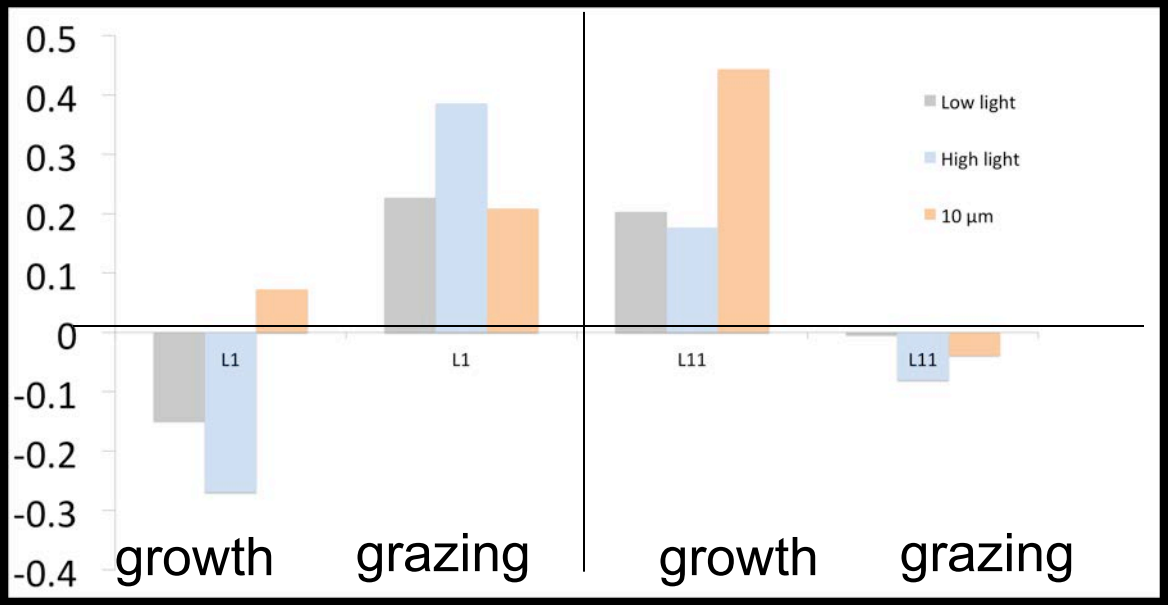
Cross shelf gradient repeats time-series

At sea measurements of food web rates

R/V Endeavor January 2018



On-shore Off-shore



Research that engages teachers and students

LTER Schoolyard reaches middle and high school curricula

- *professional development & research experiences for teachers*
- *curriculum development & field trips*

Research training and mentoring

- *REU programs*
- *Masters and Ph.D. students*
- *Post-doctoral fellows*

Research with societal benefits

NES-LTER will deliver information on how changes in environmental and biological conditions affect productivity in this highly utilized system.

Knowledge of factors driving system vulnerability and resilience benefits ecosystem management.

Images: Menden-Deuer Lab

A diverse research team

Academic and federal scientists join NSF-LTER network

Woods Hole Oceanographic Institution

University of Massachusetts Dartmouth 1895

Wellesley

The University of Rhode Island Graduate School of Oceanography

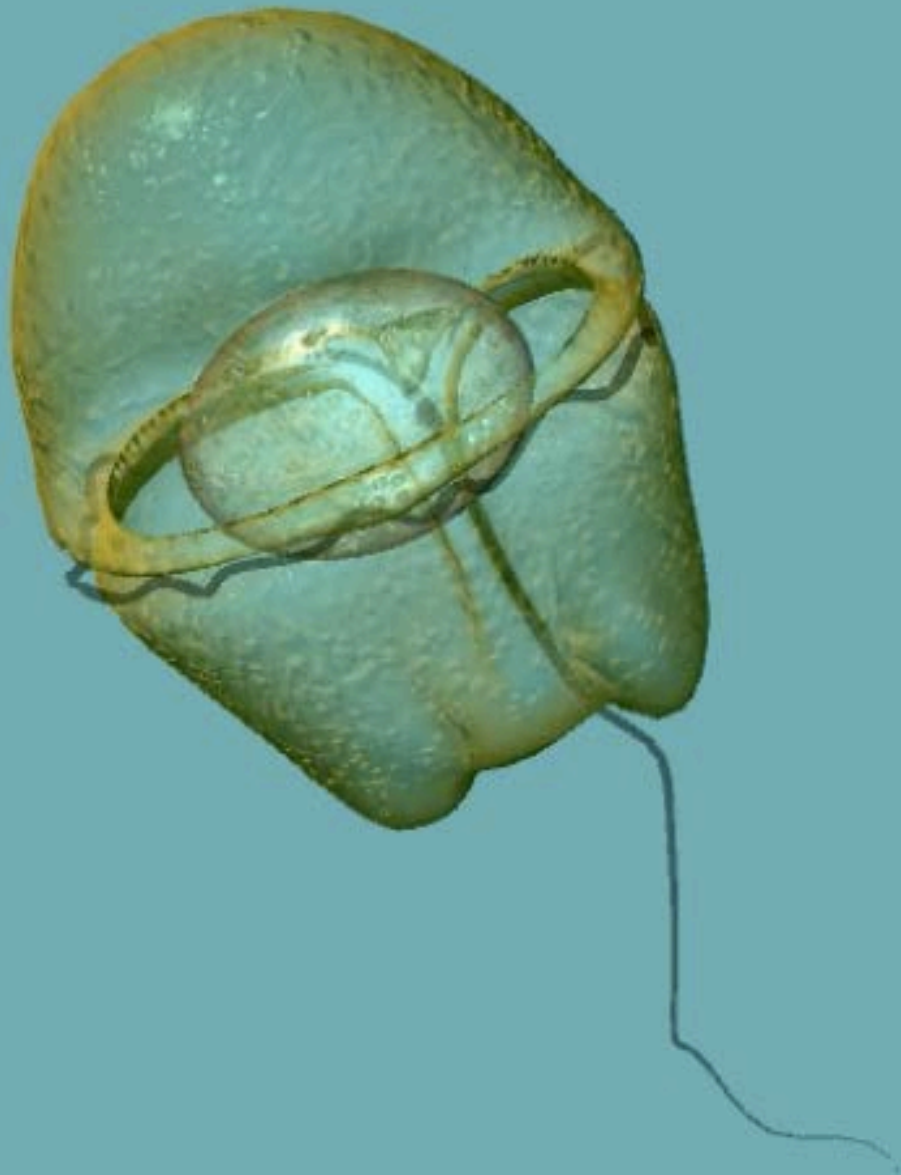
NOAA Fisheries
National Oceanic and Atmospheric Administration

National Science Foundation
LTER Network
Long Term Ecological Research

Thank you for your attention

Dennis Hlynsky

Rhode Island School of Design



Dennis Hlynsky

Rhode Island School of Design