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

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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 lighthouse 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
Dynamic environment
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
Ecosystem change is driven both by humans and environment.

- Heat flux $\rightarrow$ Mixing
- Freshwater input $\rightarrow$ Water Column Stability
- Nutrient Input $\rightarrow$ 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
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?
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

![Ecosystem Production Graph](image)
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

Temperature [°C]  Latitude north to south

Abundance [in cells/ml]
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.
A diverse research team

Academic and federal scientists join NSF-LTER network
Thank you for your attention
Dennis Hlynsky
Rhode Island School of Design