

Aquaculture Research at NEFSC



**NOAA
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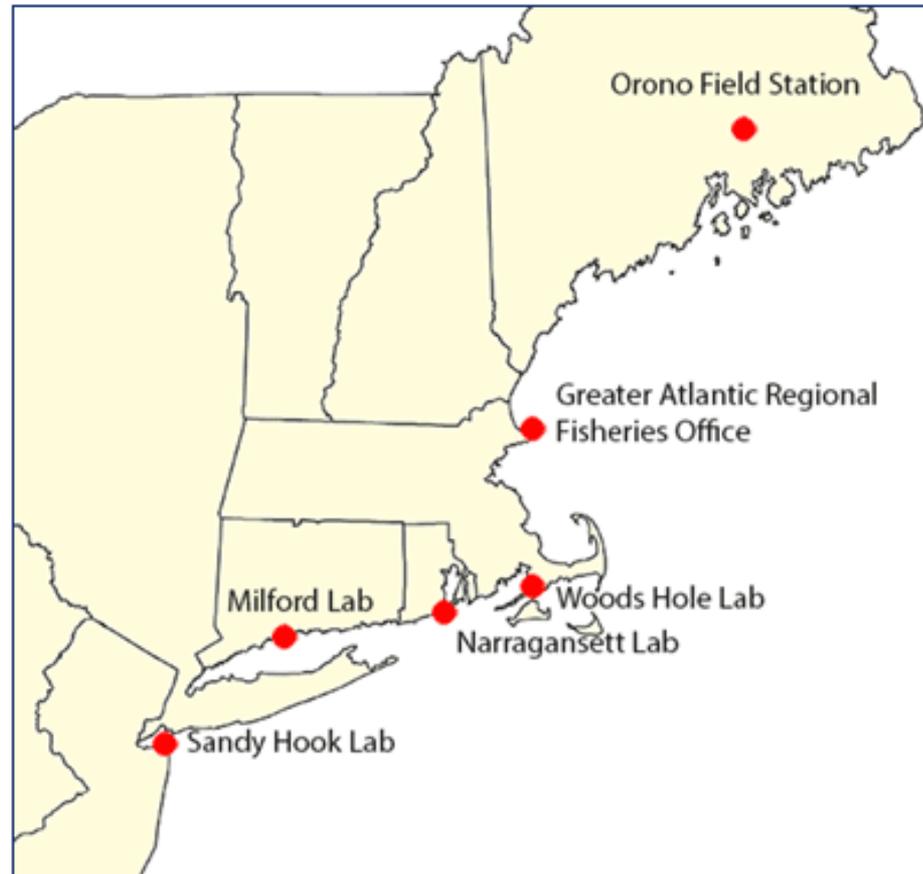


Lisa Milke

Northeast Fisheries Science Center

5 research labs from NJ to Maine

NEFSC headquarters in Woods Hole, MA



Milford Lab established in 1931



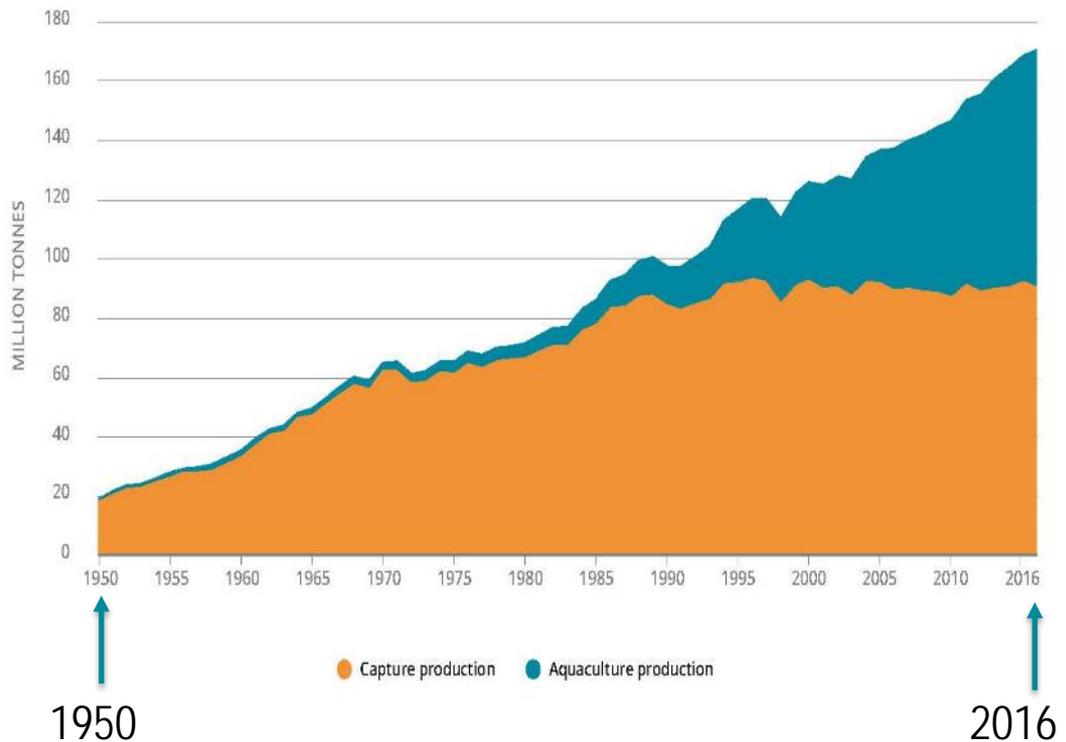
Our facilities



Aquaculture in the US

- Human population is rising, abundance of wild fish is not
- Aquaculture is the fastest growing form of food production, 6% per year globally
- US imports ~90% of the seafood consumed domestically by value
- Seafood deficit of more than \$14 billion
- Support research to advance marine aquaculture in DOC Strategic Plan

World capture fisheries and aquaculture production



Aquaculture in our region

- In 2013, aquaculture product in the northeast U.S. was worth approx. \$219 million.
- Compared to single species landings, aquaculture comes in third, behind the 2013 value of scallop landings (\$466 million) and lobster landings (\$461 million).

Our mission is to conduct science that serves

- 1) Industry -- Services to the aquaculture industry
- 2) Managers -- Evaluations of aquaculture practices for sustainability to inform management
- 3) Science community -- Collaborative research supporting sustainable aquaculture and environmental change and responses of living marine resources

1. Provide services to the aquaculture industry

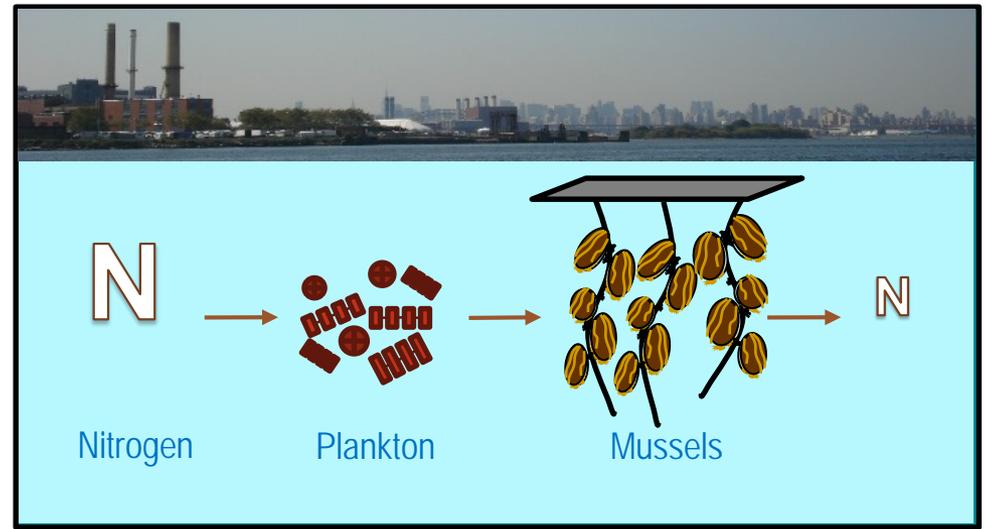


1. Perpetuate Milford Microalgal Culture Collection
2. Provide microalgal starter cultures to constituents
3. Operate the shellfish hatchery and Microalgal Mass Culture Room
4. Provide advice and troubleshooting
5. Convene the Milford Aquaculture Seminar
6. Microalgal culture workshop



2. Research to Inform Industry and Management

Because shellfish can remove nitrogen from the environment, states and municipalities would like to include shellfish in their plans to improve water quality



Potential pathways of nutrient reduction:

- Assimilation into tissue & shell
- Enhanced sediment denitrification
- Burial in seafloor sediments

2. Research to Inform Industry and Management *BMP Panel in Chesapeake Bay*

Oyster Best Management Practice expert panel for aquaculture convened in Chesapeake Bay region

Panel recommended nutrients in oyster tissue harvested by growers count towards required reductions

Shell height: Dry Weight relationship for Chesapeake oysters; tissue N&P content

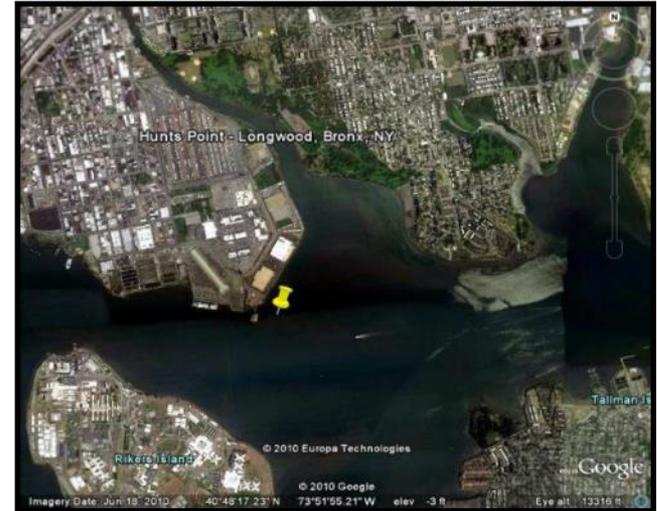
Shell, denitrification, public fishery, restoration, are scheduled to be released by the panel 2018



2. Research to Inform Industry and Management

Pilot scale ribbed mussel installation in NYC

- Native ribbed mussel displaced by urbanization; non-commercial species with poor taste
- NYS funded mussel farmer to install commercial raft, youth development org to maintain
- Milford Lab documented raft-environment interactions and nitrogen removal



- Mussels grew on longlines
- Local mussel populations were healthy
- Fully stocked mussel raft would clear 12 million liters daily, remove 63 kg N annually
- Findings used actively by local and state governments



2. Research to Inform Industry and Management

Ecosystem services of oyster gear

Document habitat services provided by aquaculture gear

Use video to compare fish interactions with oyster cages to fish activity in natural habitats

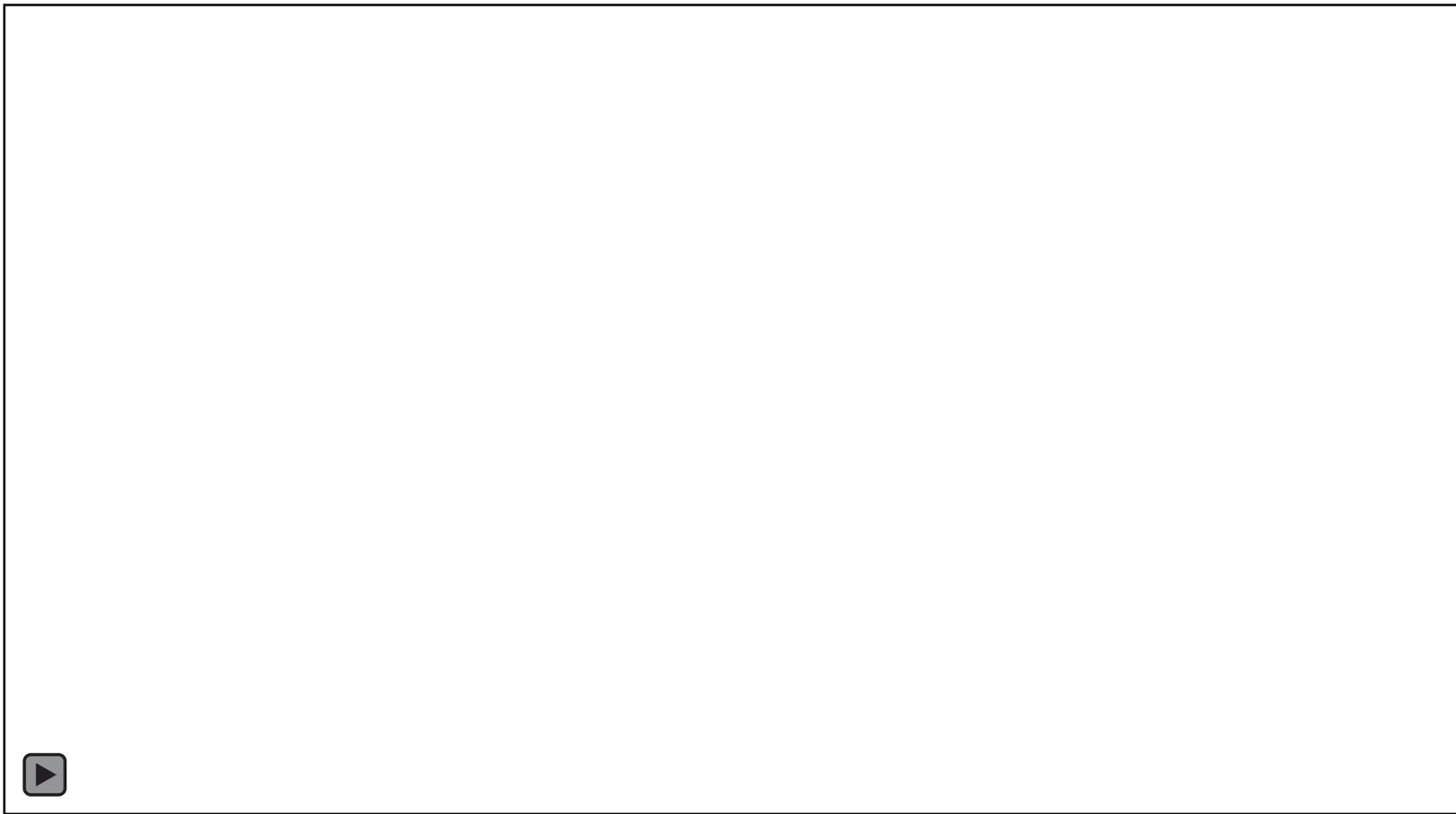
Provide data to regulators & fishery managers who make decisions about aquaculture practices

Partnering with academic and eNGO to expand geographic scope to region

Document fish assemblages by eDNA



Video!! (fingers crossed)



2. Research to Inform Industry and Management

Physiological Responses to OA

Ocean Acidification-Oysters, Surf Clams, and Sea Scallops

- Shellfish physiological responses
 - Filtration rate?
 - Growth?
 - Survival?
 - Energetic costs to shellfish

NOAA OAR and NOAA Fisheries Office of Aquaculture partnership to study cultivated and managed shellfish species

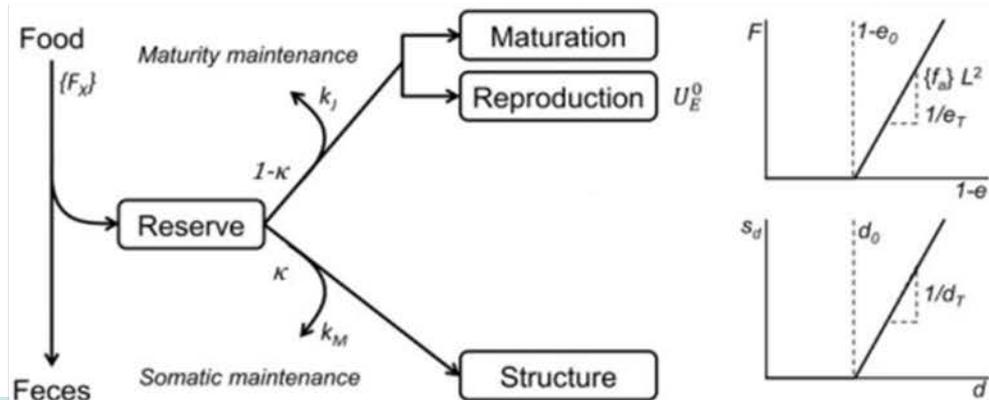


2. Research to Inform Industry and Management

Physiological Responses to OA

Current Research

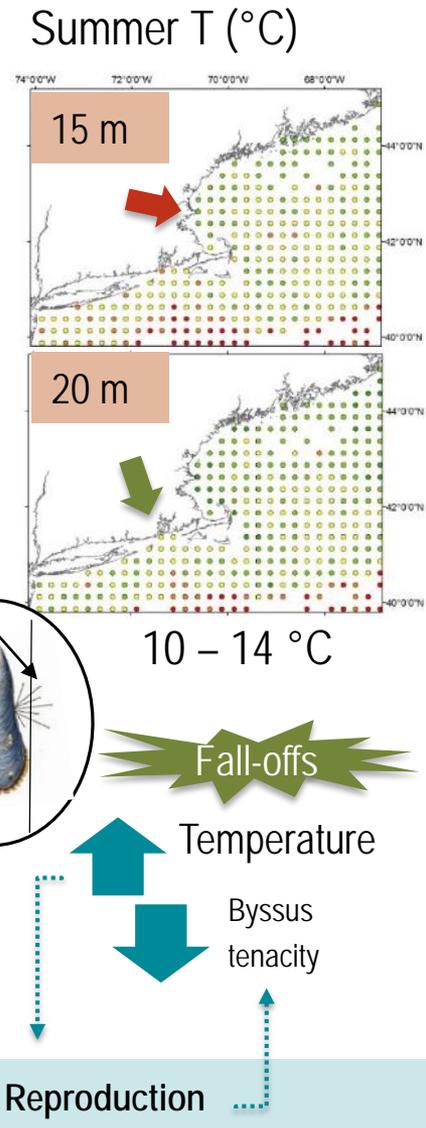
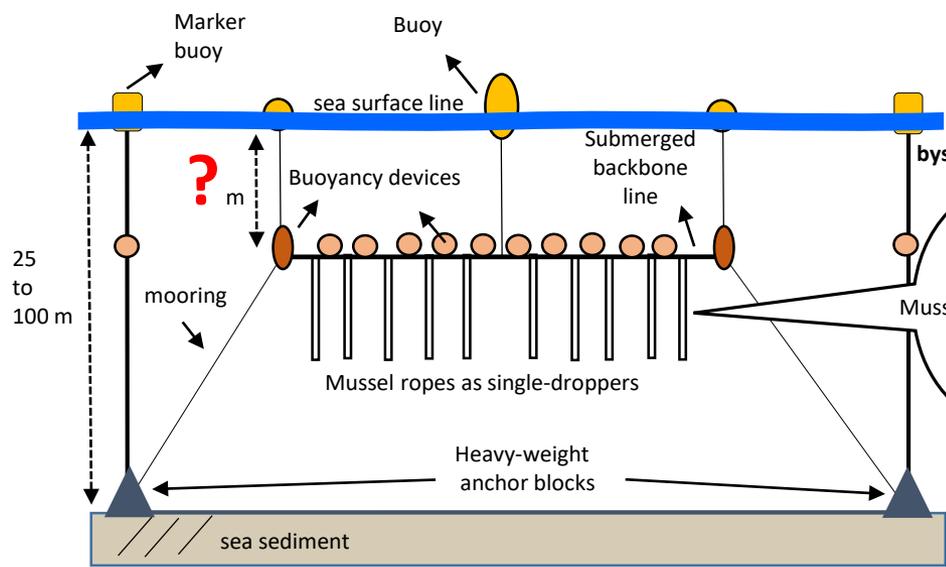
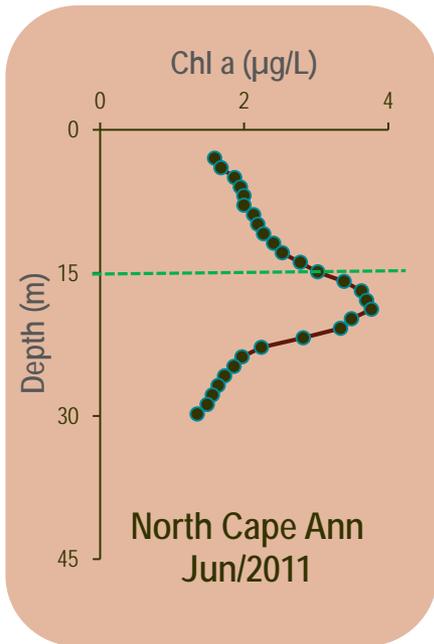
- Filtration and respiration rates of oysters, surf clams, and sea scallops
- Scope for growth of oysters, surf clams, and sea scallops
- Dynamic Energy Budget (DEB) modelling with ocean acidification under natural environmental conditions for adults.
- DEB model modified to hatchery conditions where food, temperature, carbon dioxide, and stocking densities are controlled.



2. Research to Inform Industry and Management

Offshore mussel siting

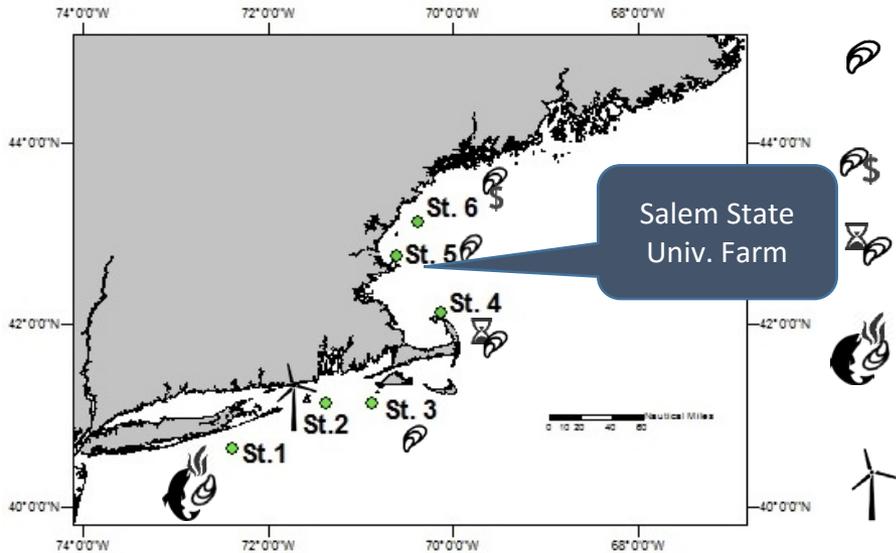
- Submerged long-lines
- Submersion depth is important
 - Environmental suitability of depth
 - Many variables
 - 2 selected: Temperature, Chlorophyll *a*



(Lachance et al., 2008;
Seguin-Heine
et al., 2014)

2. Research to Inform Industry and Management

In situ validation in Cape Ann



Experimental farm

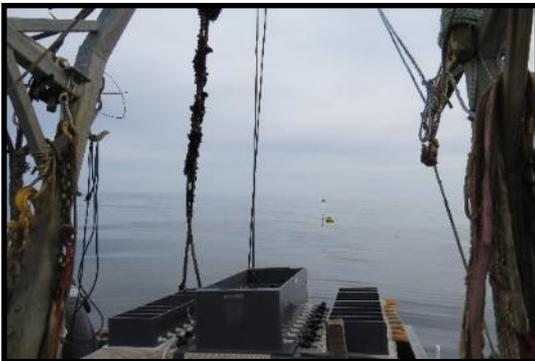
Commercial farm

Possible future farm

Multitrophic farm permit

Wind-farm co-siting

- Collaboration with NEMAC Salem State University
- Biodeposition analysis
- How do mussels perform in this environment?
 - Offshore
 - 15 m depth

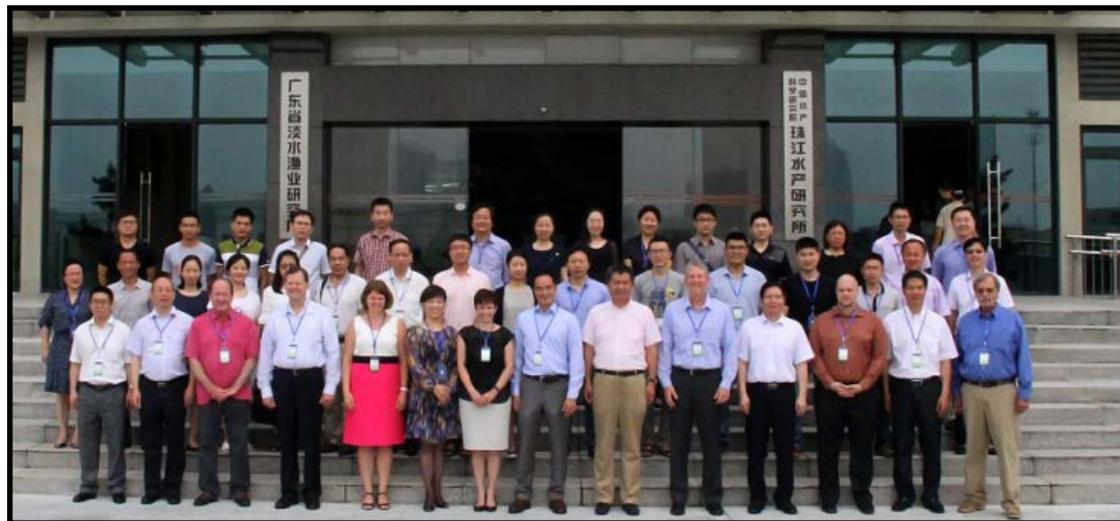


3. In partnership with the science community

International collaborations

Serve on international aquaculture work groups

- Galway Statement on Atlantic Ocean Cooperation
- China-U.S. Living Marine Resources Panel
- US-Japanese Cooperative Program in Natural Resources
- Korea-US Bilateral Program

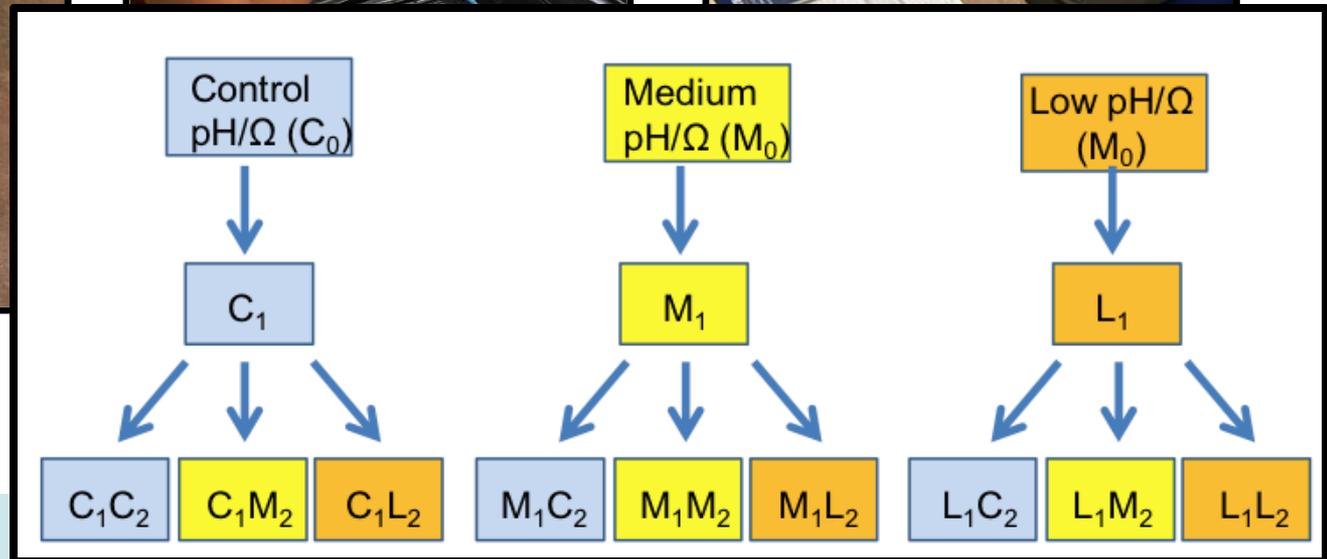
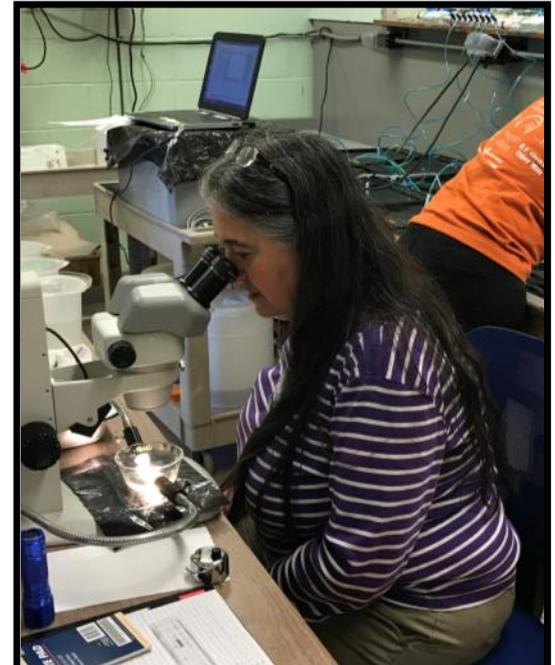
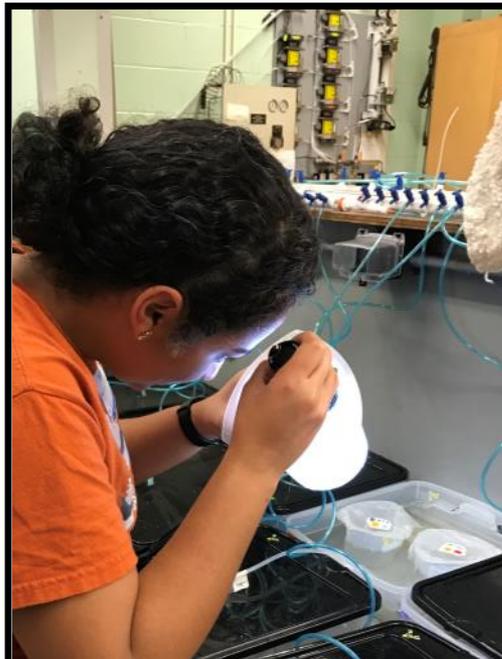


Credit: Okumura

3. In partnership with the science community *Ocean Acidification – Stony Brook*



Collected animals from populations around Long Island Sound (LIS)
Expected gradient in stressful conditions:
West (more eutrophication, industrial pollution, annual dead zones)
East (less stressful, more exposed to open ocean conditions)



3. In partnership with the science community *so many others!!!*

- Relate in vivo chlorophyll fluorescence readings from probes to true chlorophyll a concentrations (Connecticut DEEP)
- CRADA for shellfish probiotic development (ENVERA)
- Gear / fish interactions within EFH context (UCONN, GARFO)
- Studies of blue-mussel seed sourcing (WHOI, UMASS)
- CT shellfish Initiative (CT Sea Grant)
- Setting cues for cultivated bivalve species (Univ. Gothenberg)
- Oyster-HAB interactions (IUEM, FRANCE)
- Sugar kelp breeding (WHOI, UCONN)

UCONN



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Questions?