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# The Maine e-DNA EPSCoR Program and its Ties to Maine Salmon Ecosystems

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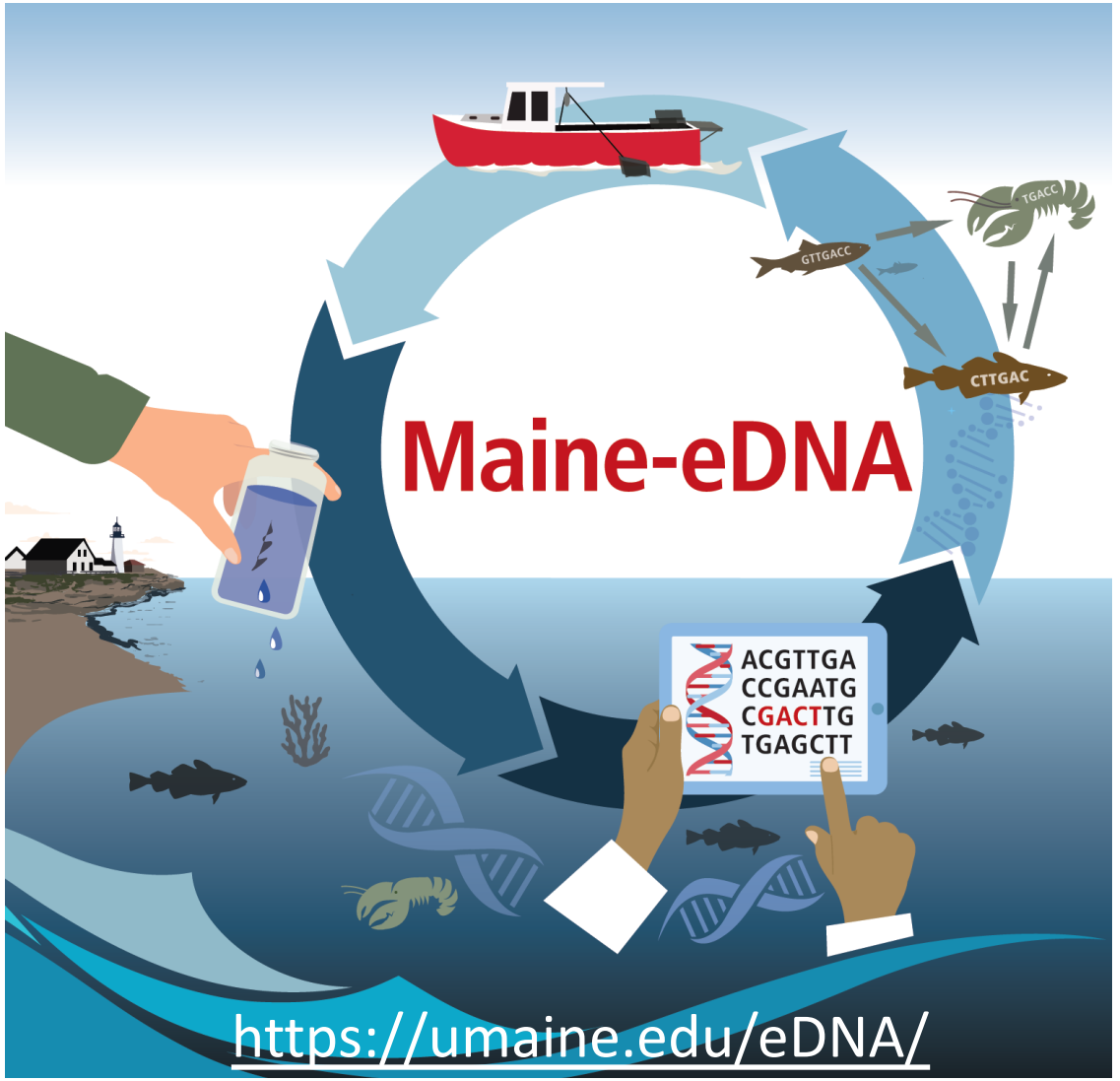



THE UNIVERSITY OF MAINE

MAINE EPSCoR

Bigelow | Laboratory for Ocean Sciences

# Environmental DNA (eDNA)

**Environmental DNA (eDNA) – genetic material obtained directly from environmental samples (sediment, water, etc.) without any obvious signs of biological source material**

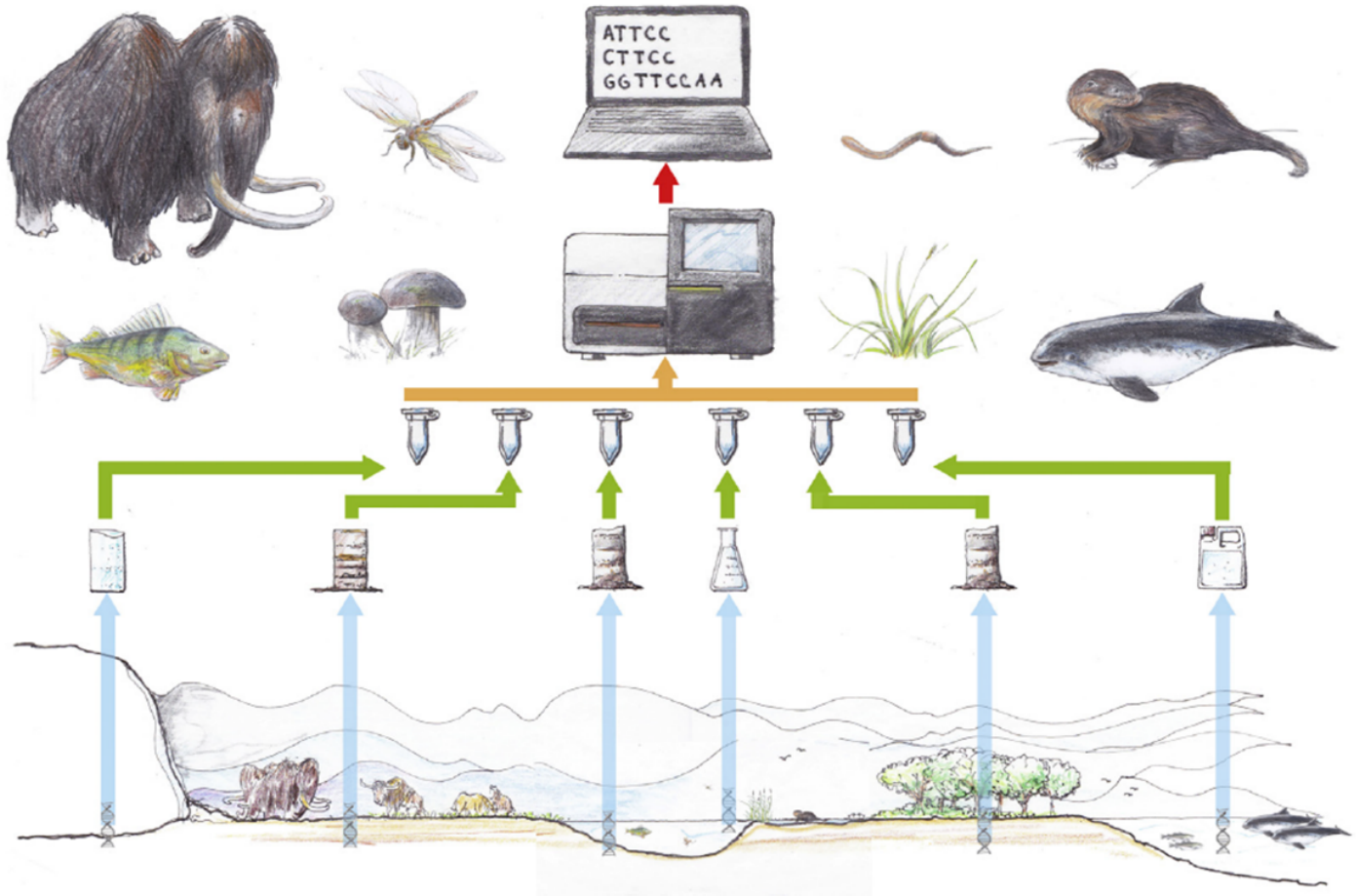
Thomsen and Wilerslev (2015), Biological Conservation 183, pp 4-18

## Sources of eDNA:

- Cellular decomposition
- Whole shed cells
- Whole microrganisms (e.g., larvae)

## Uses of eDNA:

- Targeted detection
- Targeted quantification
- Community characterization



# eDNA Uses to Date

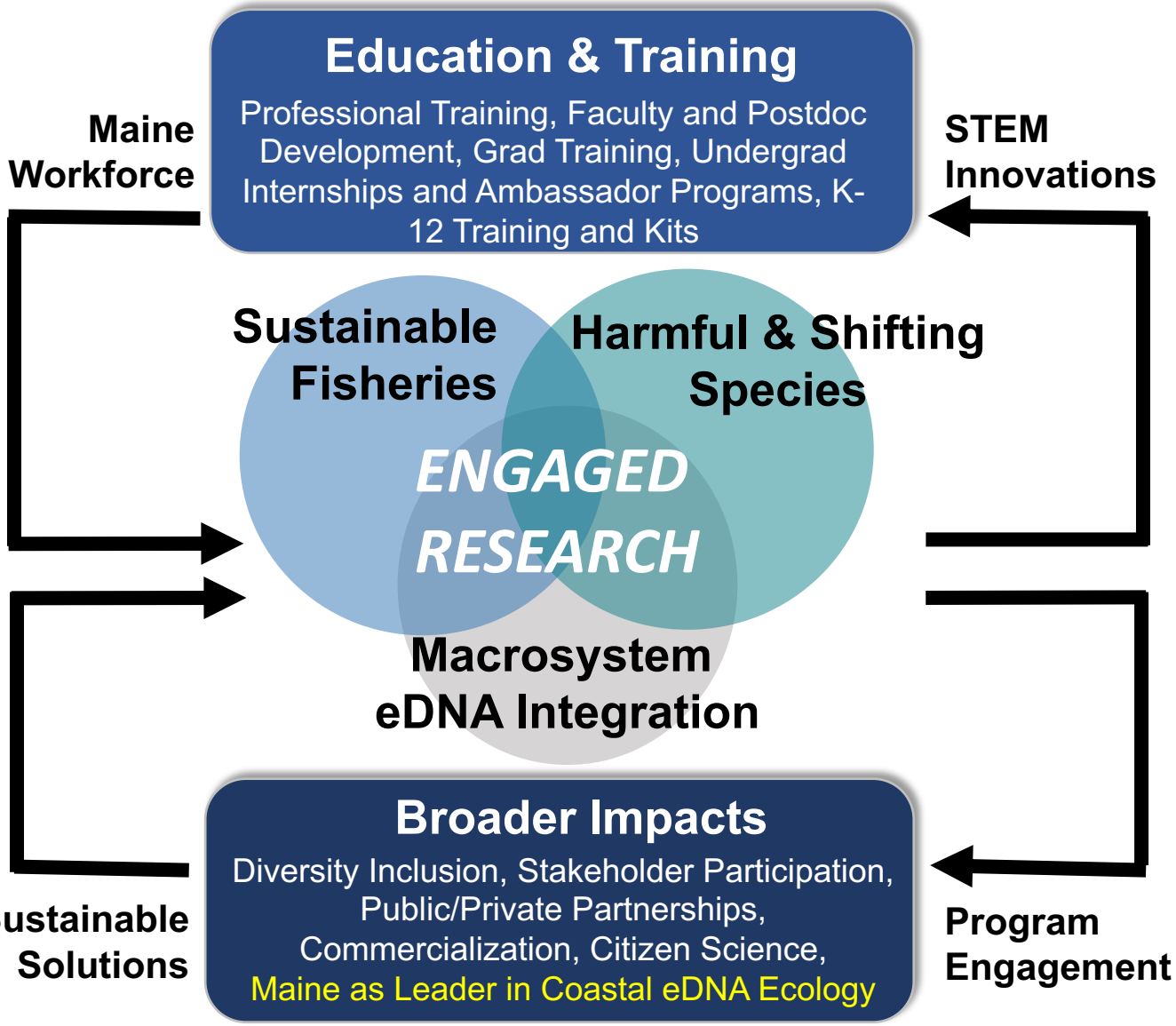
- ID species presence/absence, overall diversity
- Reveal distribution patterns over broad scales of time and space
- Detect rare, invasive, or unseen species
- Reconstruct past communities (via ancient/preserved DNA – it's very stable)
- Estimate biodiversity – for ecosystem management etc…

Bourlat et al., 2013 (Table 3) & Thomsen & Willerslev, 2015 (Table 1)

# What is the Maine-eDNA EPSCoR Program?

**A $20 million NSF EPSCoR Research Infrastructure Improvement Track-1 Award**

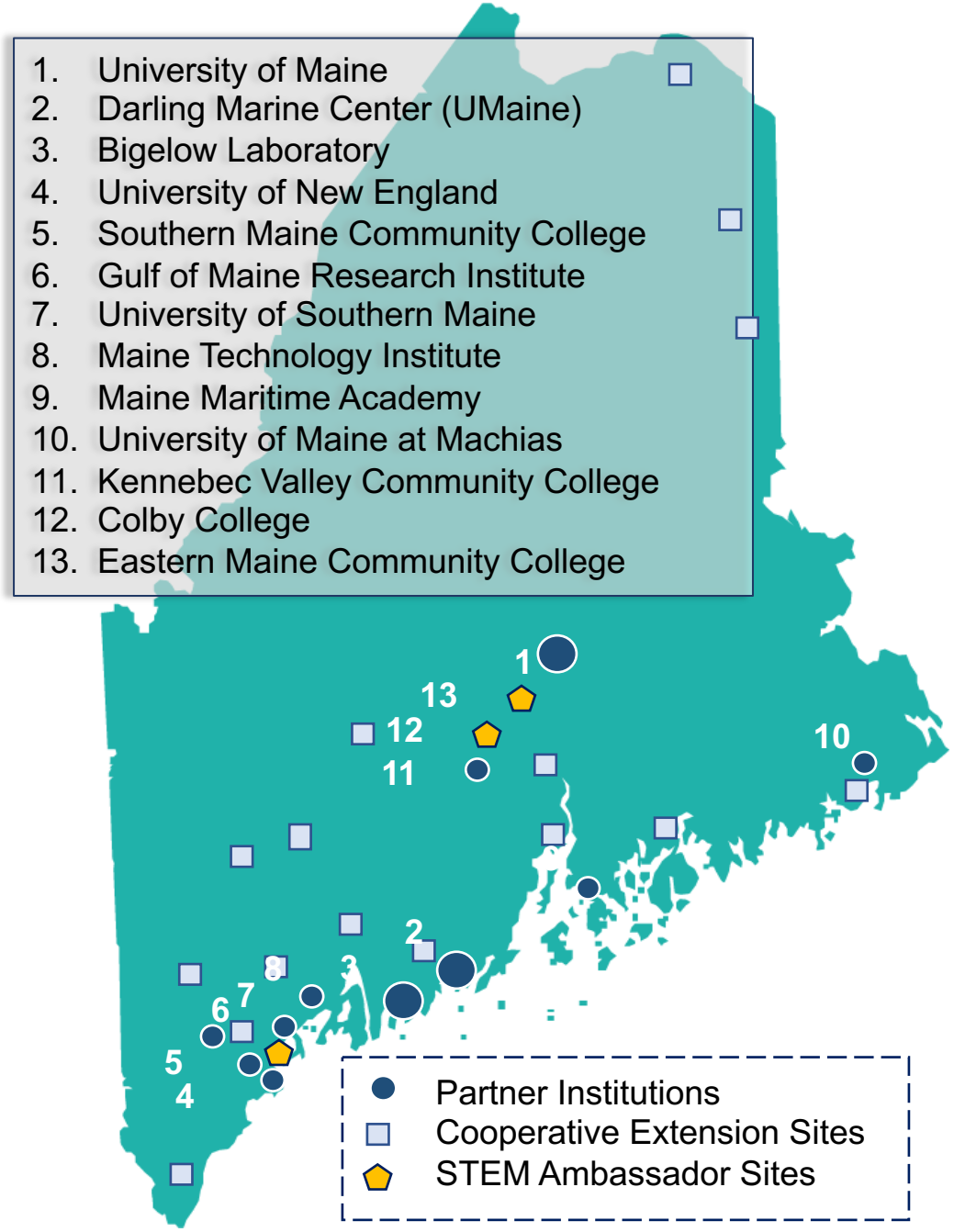
*"Molecule to Ecosystem: Environmental DNA as a Nexus of Coastal Ecosystem Sustainability for Maine (Maine-eDNA)"*




NSF Grant No. 11A-1849227

# What is the Maine-eDNA EPSCoR Program?

- 32 Senior Personnel
- 3 ½ New Faculty Hires
- 21 Graduate Students
- 5 Postdocs
- >300 of Undergrad Interns
- 4 Primarily Undergrad Institutions
- 2 Research Nonprofits
- 3 Community Colleges
- 1 Land & Sea Grant University



# What is the Maine-eDNA EPSCoR Program?

## VISION

**Make Maine '*the DNA Coast*' - a world leader in eDNA-based partnerships, understanding, and sustainability of coastal marine and freshwater ecosystems.**

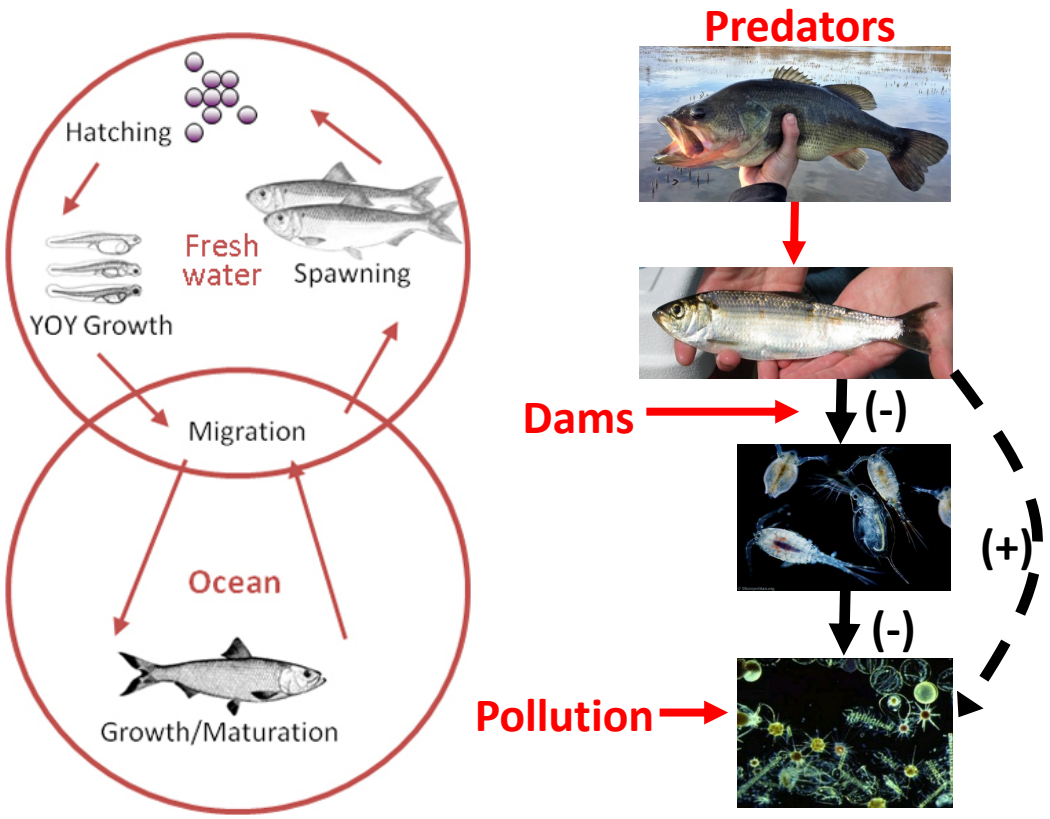
## MISSION

**Harness the power of eDNA science to:**

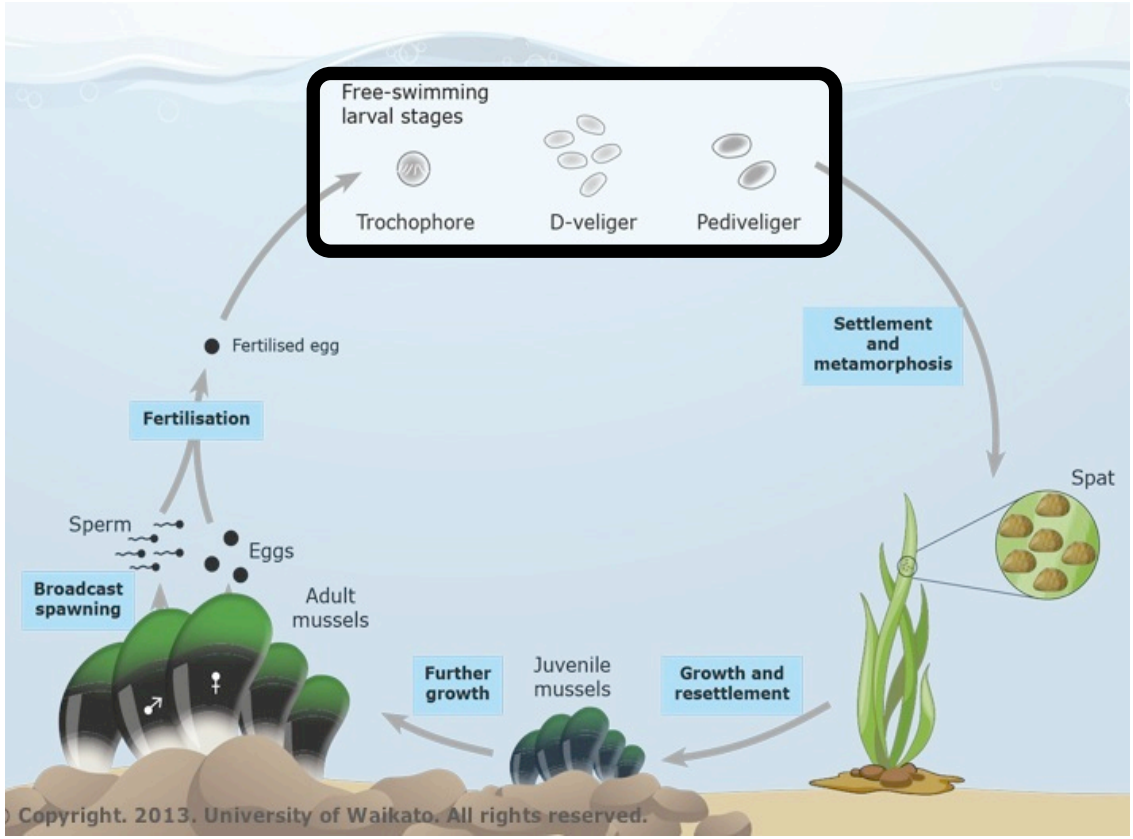
1) **Advance ecological understanding crucial to the current needs of Maine's marine and freshwater resources.**
2) **Build the Big Data and IP innovations, technical workforce, and partnership capacities to address increasingly large-scale and complex sustainability challenges of changing coastal ecosystems.**

# Theme 1: Sustainable Fisheries

## Goal 1.1: Ecosystem-Based Restoration: eDNA Past, Present, and Future



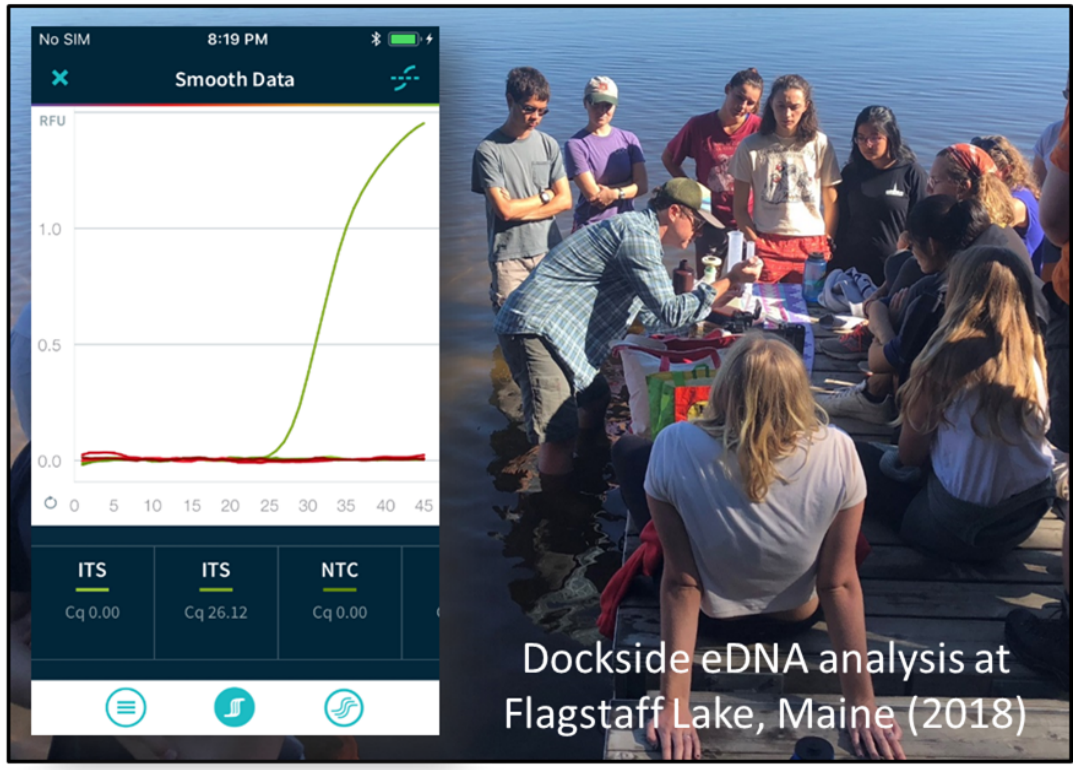

## Goal 1.2: Larval Black Box: Revealing Early Life Ecology with eDNA



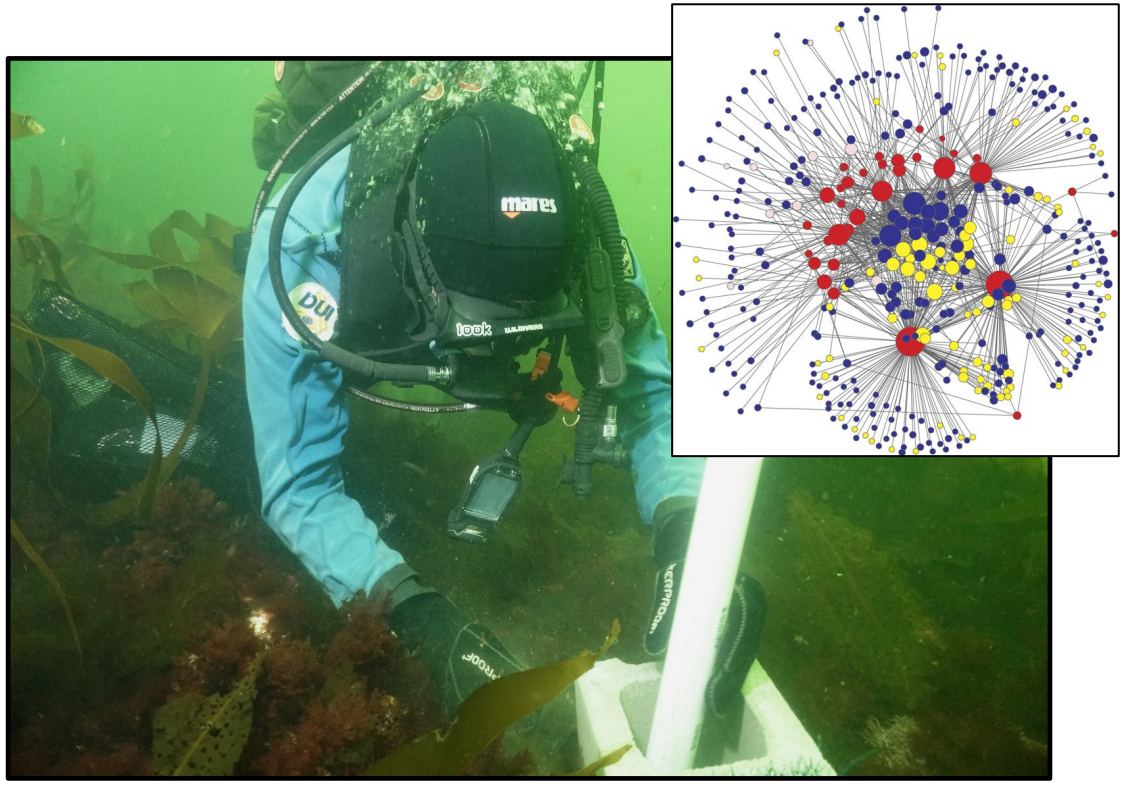

**Integration Objective:** eDNA framework for ecosystem-based fisheries and aquaculture.

# Theme 2: Harmful & Shifting Species

## Goal 2.1: Harmful Blooms: Population and Community Ecology of Toxic Threats



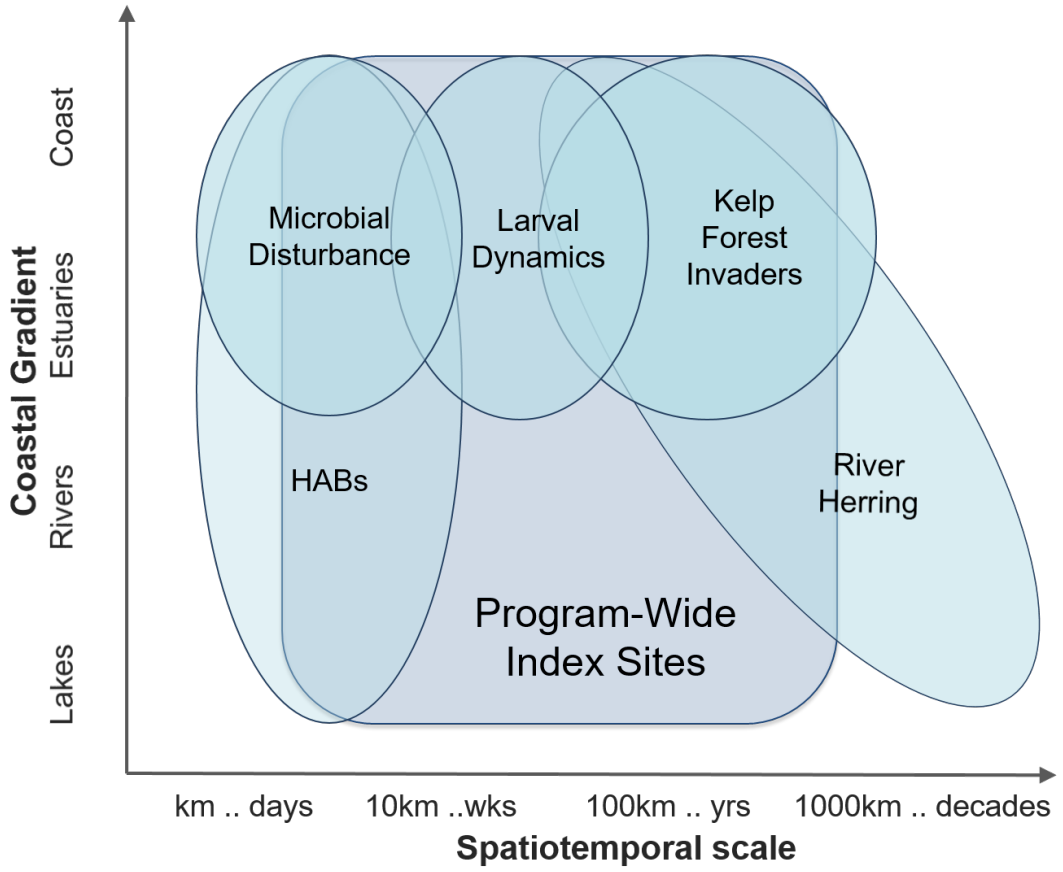

## Goal 2.2: Species on the Move: Patterns and Determinants of Range Shifts



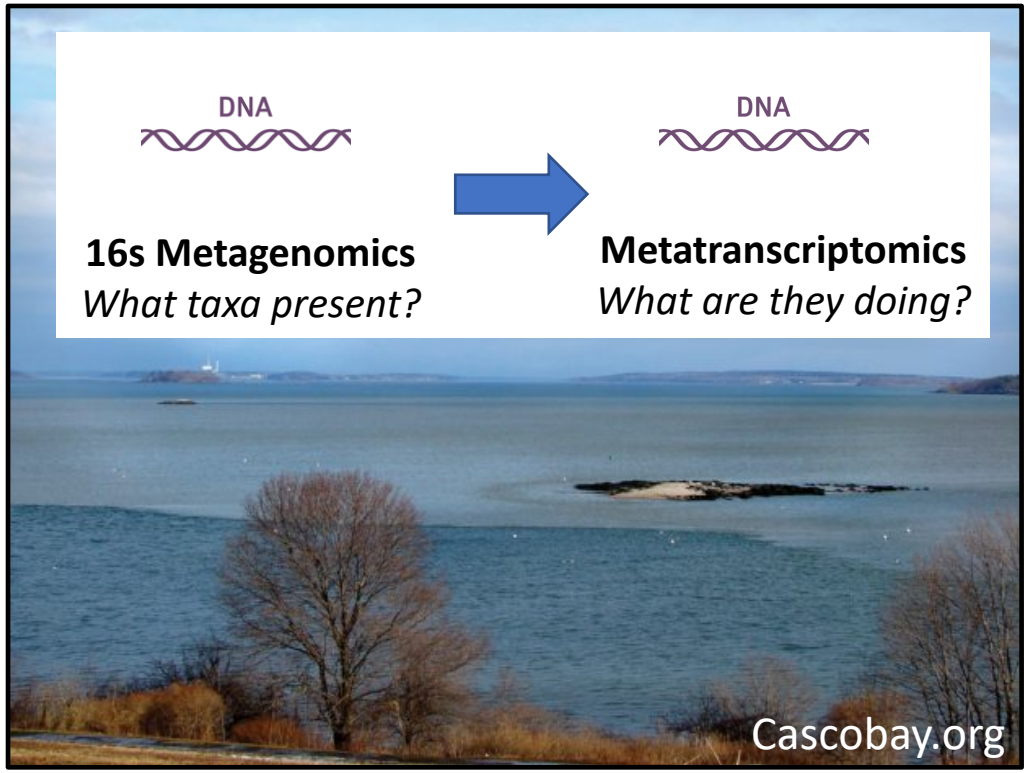

**Integration Objective:** eDNA early warning and forecasting tools to mitigate harmful effects

# Theme 3: Macrosystem eDNA Integration

## Goal 3.1: Big Data Integration: Dynamics and Stability of Maine's Coastal Macrosystem



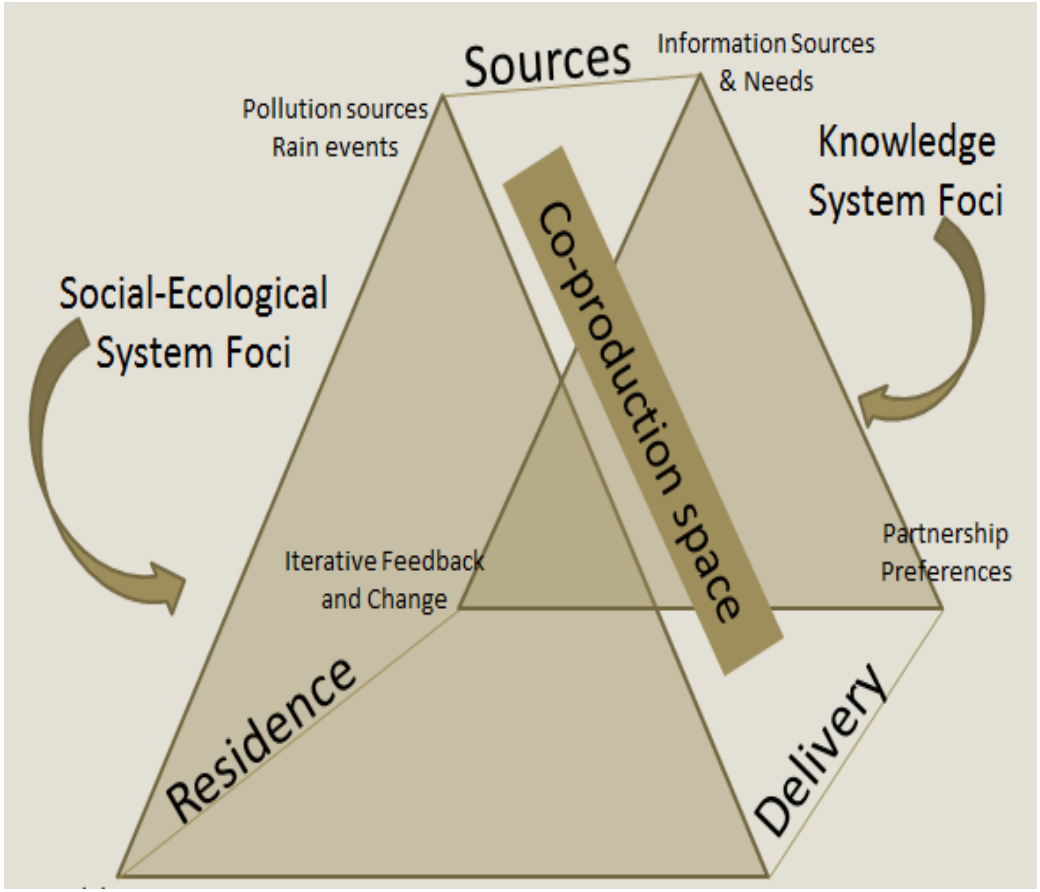

## Goal 3.2: Microbial communities as biosensors of change



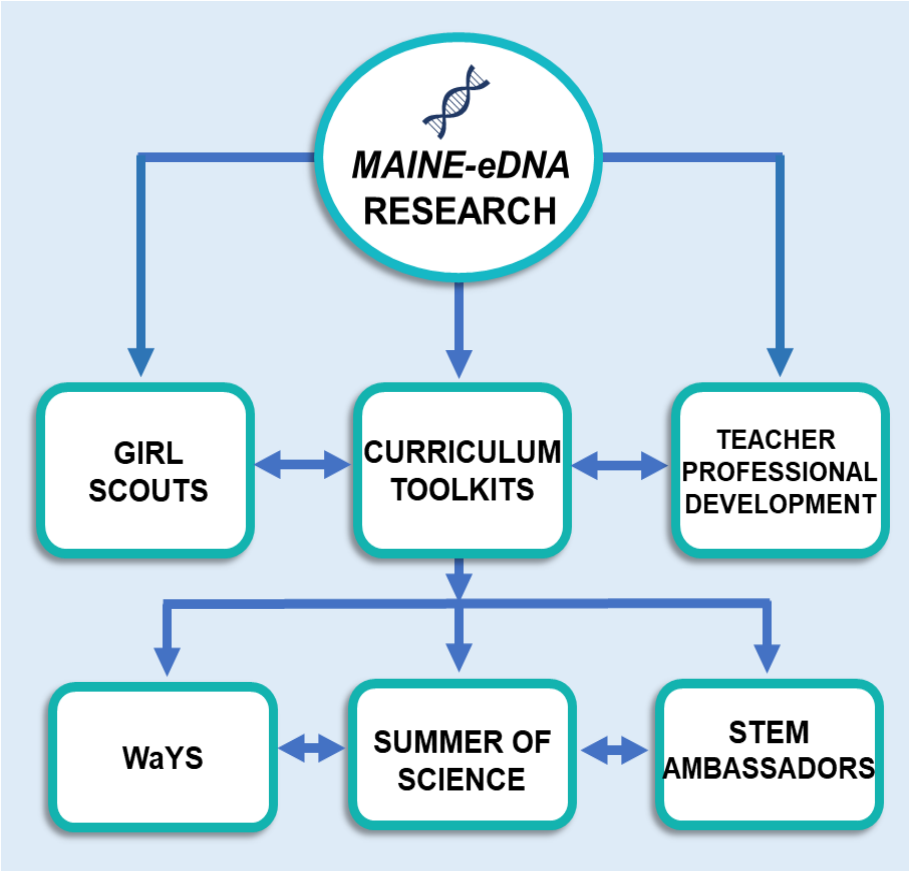

Casco Bay in 2014 after 5.6 inch rainfall

# Theme 3: Macrosystem eDNA Integration

**Goal 3.3 Communication Research: Comparative Study of eDNA Team Science**



# Education, Diversity and Workforce Development




**K-PHD STEM Training**

**Environmental Professional Training**


**Citizen Science and Community Engagement**

# Aquaculture Relevant eDNA Applications

1. Developing eDNA tools to predict when/where ‘seed’ sets for scallops and mussels are expected
2. Quick (near real-time) tool for monitoring biosecurity on aquaculture farms
3. Improved tracking and monitoring of harmful algal bloom dispersal for informed farm ops decisions
4. Site selection to reduce exposure to pathogens, nuisance species, and predators with one tool

# 1. Larval Black Box

*Relate scallop, kelp, lobster, and mussel gamete/spore/larval densities to eDNA counts as a function of natal source broodstock abundances, fecundity, phenology, and oceanic conditions.*

Seasonal surface and benthic eDNA analysis (qPCR & eRNA)

- Plankton counts flow cytometry & microscopy
- Gonadal indices & sporogenesis
- Settlement collectors

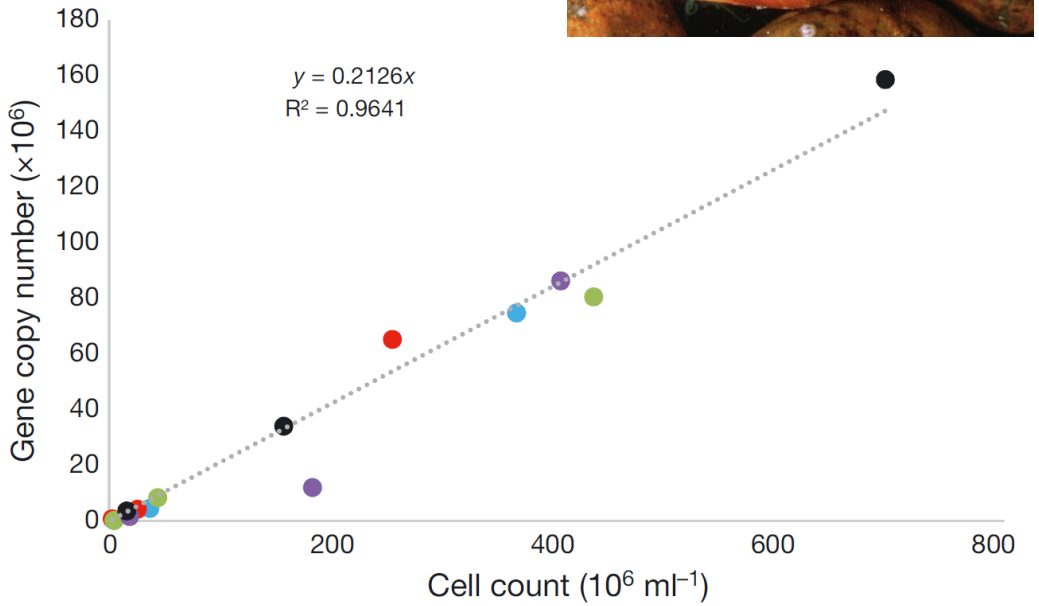



Fig. 2. Cell count of *P. magellanicus* sperm and resulting gene copy number from 5 dilution series (red, blue, green, purple and black filled circles)

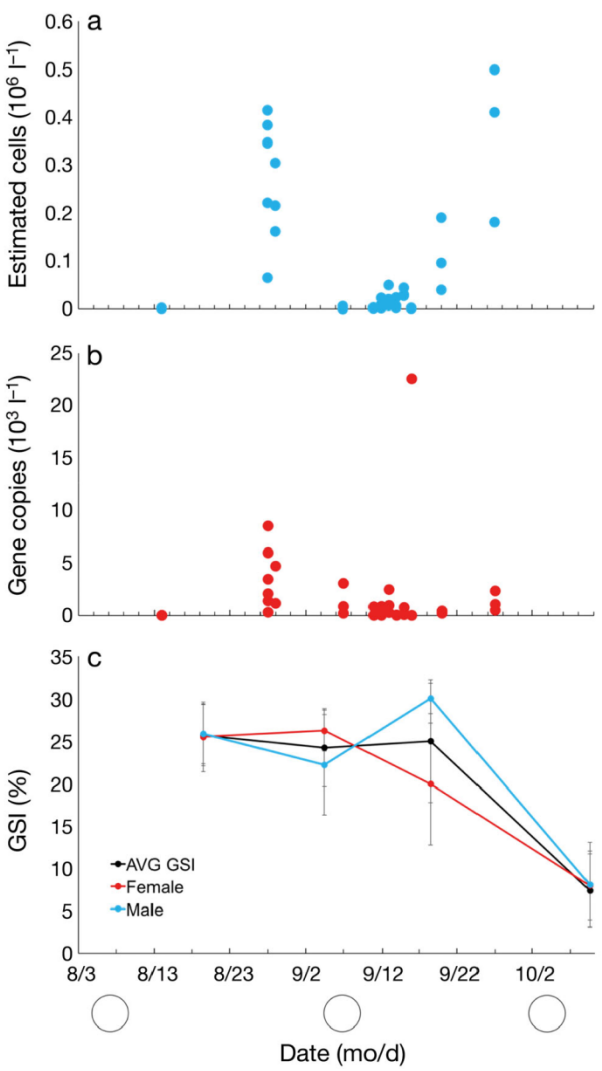
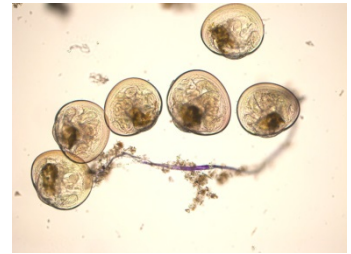
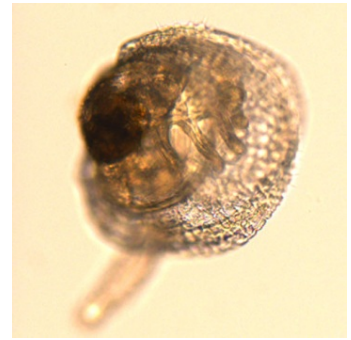
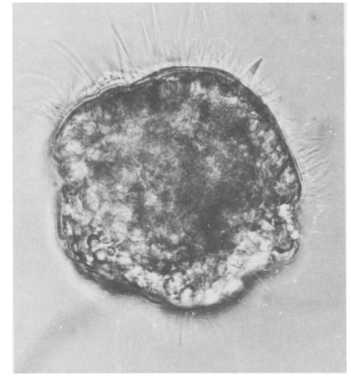
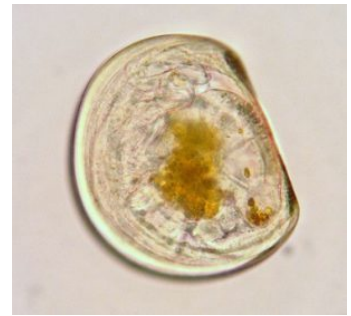



Fig. 3. Time series of (a) estimated sperm (cells < 20 µm) abundance and (b) gene copy number from cells > 20 µm from plankton pump samples collected <0.5 m from dock-hung scallops during the spawning season, and (c) gonad index (GSI, gonad weight/soft tissue weight) from a nearby population during spawning season. Error bars are ±1 SD. Full moons are indicated by open circles. Only gene copy numbers are reported in (b) due to the unknown cell concentration of the samples





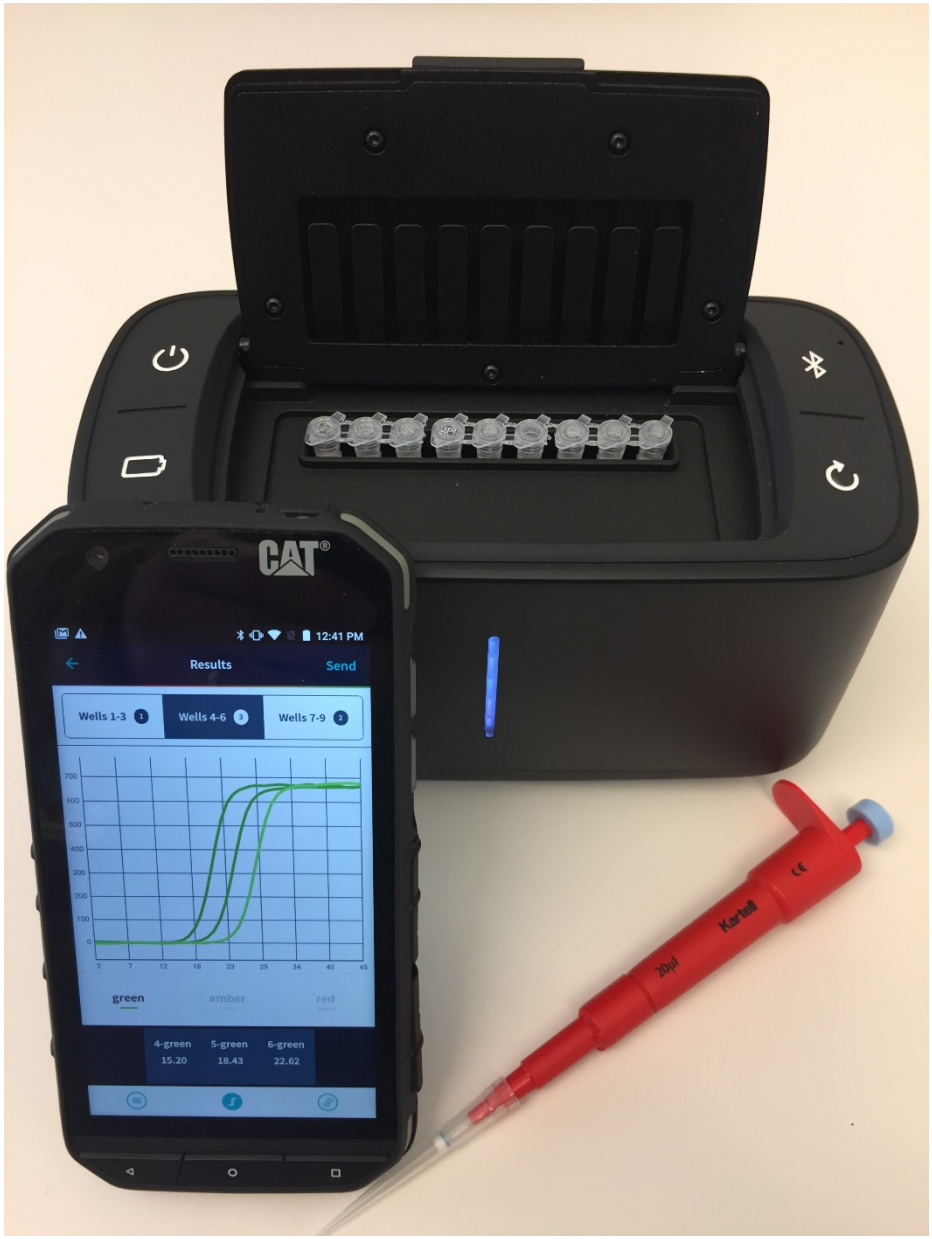




Bayer, Countway, and Wahle 2019 *MEPS*
DOI: https://doi.org/10.3354/meps12991

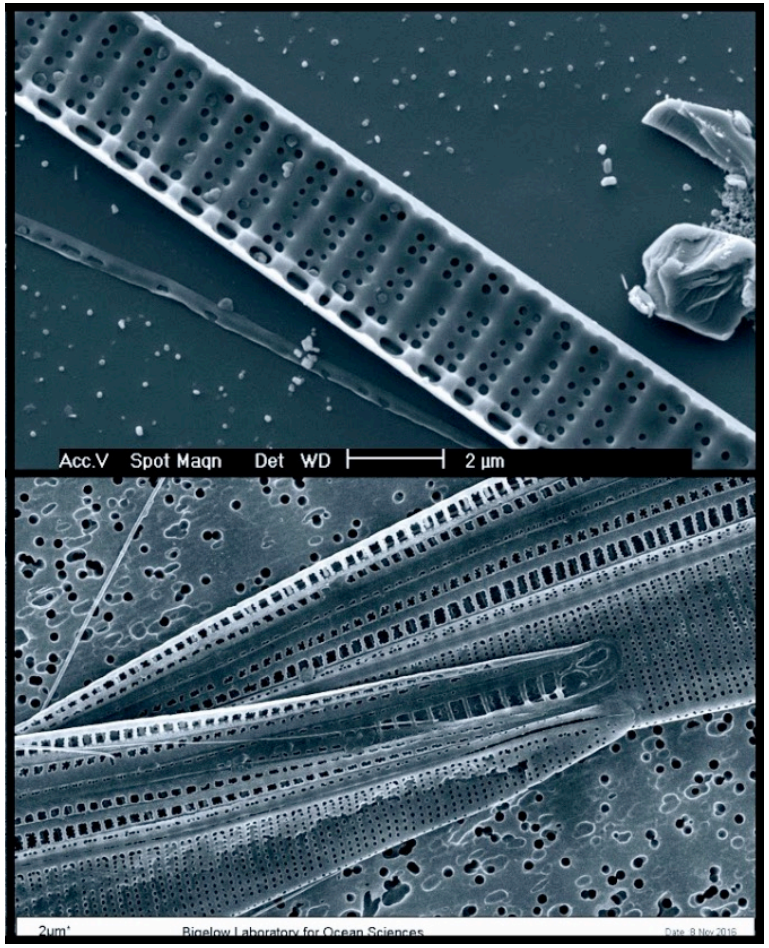
# 2. Portable, real-time eDNA

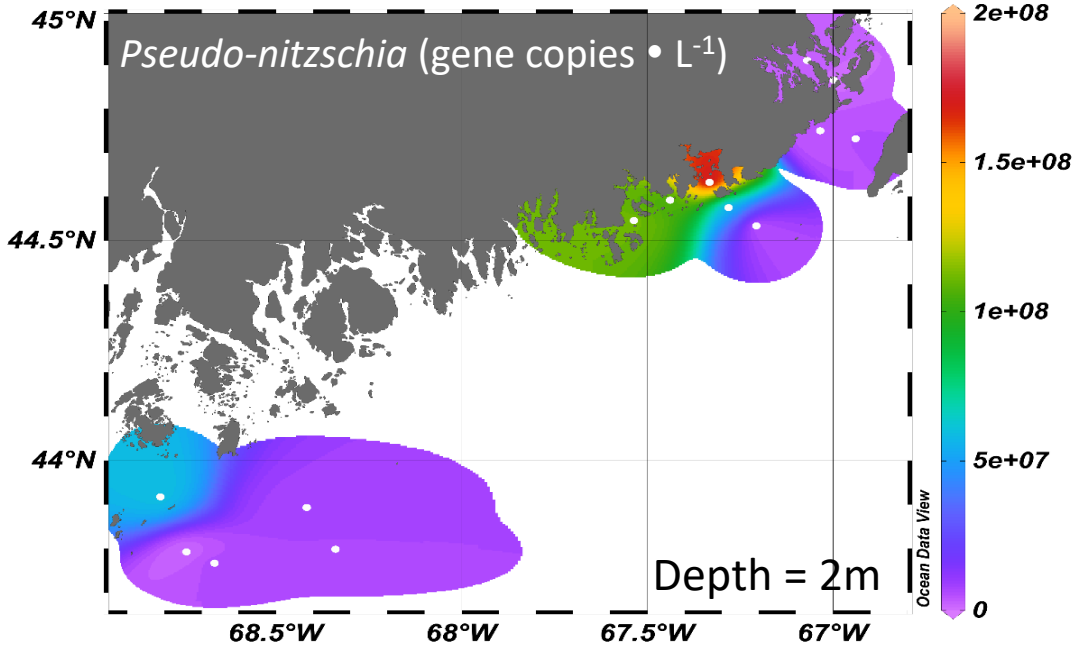
- Detects up to 3 gene targets in 9 samples
- Smart phone interface
- Uploads results to the cloud
- Can port existing assays directly
- 10 minute eDNA extraction kit (not shown here)

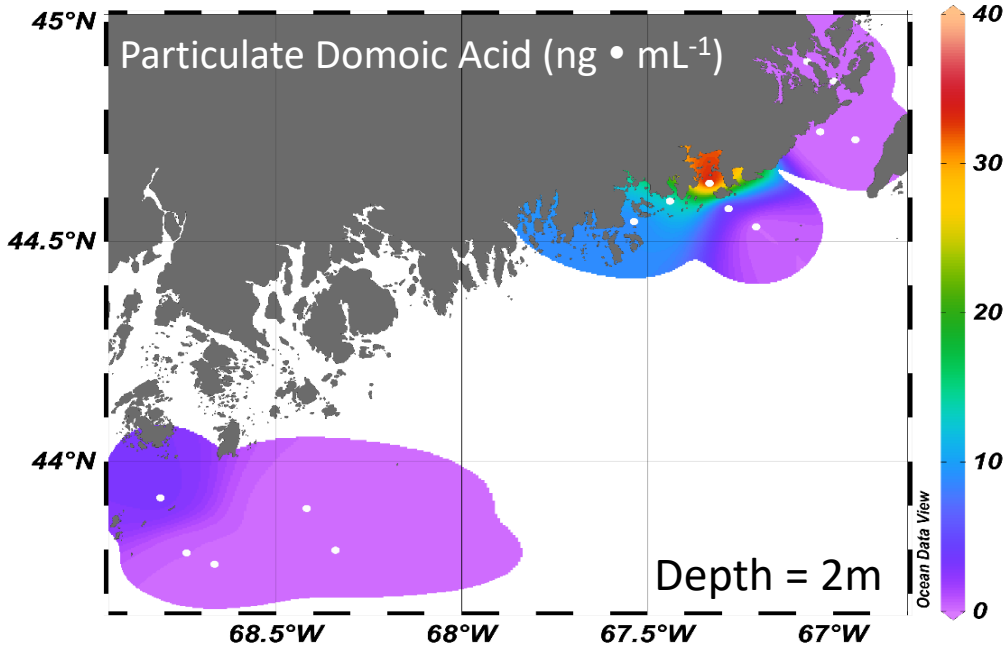


# 3. HABs and eDNA

Scanning Electron Micrographs of *Pseudo-nitzschia* cells from the 2016 Bloom Event in the Gulf of Maine




Countway, Archer, Hubbard et al.

# 4. Comprehensive Site Selection Tool

- Eventually determine likelihood of lacey bryozoan or vibrio outbreak before choosing a site, *or* taking necessary steps to avoid closures or product loss

# Thank You!

For More Information and Program Engagement:

https://umaine.edu/eDNA/

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