The NNA Lobster Network: Rapid Arctic change and its implications for fishing communities of the western North Atlantic

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Background

• Melting of the Arctic and Greenland ice sheets are altering ocean circulation of the Atlantic Subpolar Gyre.
• Freshening of the North Atlantic has weakened the southward flow of cold, nutrient-rich Labrador Current just as the northward flow of the Gulf Stream's warmer, nutrient-poor waters have increased to the coast of New England and Atlantic Canada (Fig. 1).
• These changes are triggering ecosystem regime shifts that impact the biological productivity of coastal and shelf waters of the Northwest Atlantic with cascading impacts on the region's iconic fisheries.
• The American lobster, *Homarus americanus*, is the most valuable single-species fishery in the US and Canada (>US$ 2 billion in 2021), and Arctic change may impact the productivity of this species and coastal communities that depend on it.
• The NNA Lobster Network aims to do an end-to-end evaluation of the consequences of Arctic change for this lower latitude fishery.

Hypotheses

1. Ongoing and projected melt of Arctic ice will continue to alter North Atlantic currents, and in turn, these changes will alter the productivity of the Northwest Atlantic.
2. As climate change progresses, controls on lobster population productivity will increasingly be driven by large-scale basin-wide changes.
3. The business of lobstering will be shaped by climate-induced changes to the lobster populations, socio-economic factors, and regional fishery governance.
4. Socio-economic indicators can identify vulnerability of fishing communities to changes in the lobster resource.

Overarching Goal and Objectives

• This first phase of the NNA Lobster Network will build an information network focusing on the Natural Environment and Social Systems elements of the NNA program highlighted in blue in Fig. 2.
• Build on existing monitoring systems to develop forecasting tools for the ecosystem and socio-economic systems of the American lobster fishery in the Northwest Atlantic.

**The Natural Environment:**
- Evaluate, model, and forecast how changes in the Arctic cryosphere affect ocean circulation at lower latitudes in the Northwest Atlantic and the productivity of its lobster populations (Fig. 3).
- Social Systems: Model and forecast the effects of lobster population change on the fishery and well-being of the lobster industry across the region in response to impacts of climate change at different spatial scales (Fig. 3).
- The Built Environment: Contingent on phase I progress, in phase II we hope to expand existing monitoring systems and work with stakeholders to build a user-friendly decision support tool.

Partnerships and Support

• Senior Personnel, Postdocs, Professional Staff & Grad Students: UMaine: Theresa Burnham, Chris Cash, Andrew Goode, Heather Leslie, Natalie Springuel. GMRI: Riley Young Morse. FSU: Patrick Alexander, Memorial Univ: Arnauld Le Bris. Grad students: TBA

Integrated Projects

**Northwest Atlantic**

- Field Surveys
- 1: HYCOM-NEMURO: Reanalysis & Climate Projections
- Socio-Economic Data

**American Lobster Fishery**

- 2: Lobster Early Life History
- 3: Lobster Population Dynamics
- 4: Bio-economics
- 5: Impact Indicators

The Natural Environment

1. Generate a Northwest Atlantic Hybrid Coordinate Ocean Model (HYCOM) with an integrated North Pacific Ecosystem Model for Understanding Regional Oceanography (NEMURO):
   - Hindcast oceanographic conditions and primary production.
   - 2050 forecast via downscaled CESM SSP3-7.0 climate projection.
2. Generate a Larval Lobster Life History Model:
   - Simulate larval transport, trophic interactions, benthic settlement, and recruitment into the fishery.
3. Generate a Lobster Population Dynamics Model:
   - Simulate lobster growth, fecundity, mortality, and abundance.
4. Generate an Agent-Based Bio-economic Model:
   - Evaluate impacts of lobster resource changes on fleet dynamics, fishing operations, and economic outcomes for the fishery.
5. Develop Socioeconomic Indicators for lobster fishery interests:
   - Identify quantitative resilience indicators, and collaborate with industry members through interviews and surveys to validate the indicators.