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.

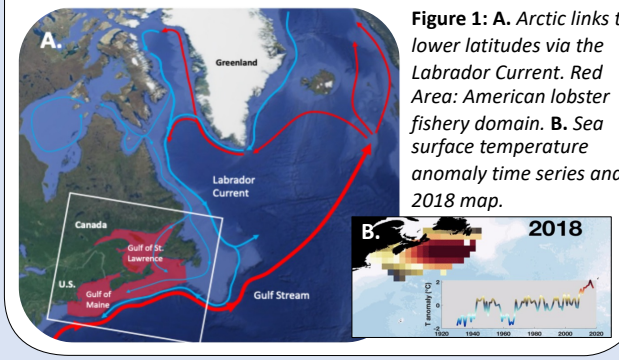


Figure 1: A. *Arctic links to lower latitudes via the Labrador Current. Red Area: American lobster fishery domain.* **B.** *Sea surface temperature anomaly time series and 2018 map.*

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

Figure 2: *Convergence research of the **Navigating the New Arctic** (NNA) program.*

- 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

- **Industry Partners:**
  Maine Lobstermen's Assn., Maine Lobster Marketing Collaborative, Atlantic Offshore Lobstermen's Assn, Ready Seafood Co., PEI Fishermen's Assn, Fundy North Fishermen's Assn.
- **Government Agency Partners:**
  NMFS-Northeast Fisheries Science Center, Maine Dept. Marine Resources, NH Fish & Game Dept., Rhode Is. Div. Mar. Fisheries, Fisheries & Oceans Canada.
- **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:*** Arnault Le Bris. **Grad students:** TBA

Integrated Projects

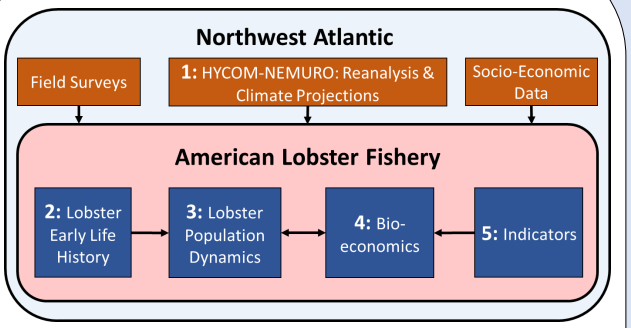
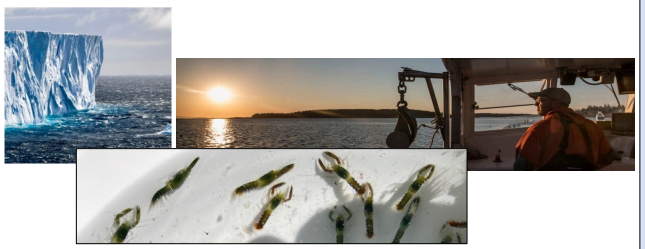


Figure 3: *Framework for data and model integration of the Northwest Atlantic and American lobster fishery. Numbers correspond to individual projects (below).*

The Natural Environment

1. **Generate** a Northwest Atlantic **Hy**brid **C**oordinate **O**cean **M**odel (**HYCOM**) with an integrated **N**orth Pacific **E**cosystem **M**odel for **U**nderstanding **R**egional **O**ceanography (**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.



Social Systems

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.