Assessing accessibility and adaptive capacity in Maine's coastal fisheries



Carly S. Lovas[1], Kanae Tokunaga[1], Katherine E. Mills[1], Joshua E. Stoll[2], Theresa L. Burnham[2], Ben Martens[3], and Emily Coffin[3].

[1]*Gulf of Maine Research Institute, Portland, Maine, US.* [2]*University of Maine, Orono, Maine, US.* [3]*Maine Coast Fishermen's Association, Brunswick, Maine, US.*

Introduction

The United States Northeast Shelf is warming faster than the global ocean (GMRI 2024).

Many species, including black sea bass (Centropristis striata), are responding to warming waters by shifting distributions.

Harvesters may need to adapt to these changes and can do so by diversifying portfolios to take advantage of increasingly abundant or "emerging" species.

Methods

Conducted a network analysis to assess connectivity of commercial harvest licenses in Maine coastal waters; metrics include degree centrality, betweeness, edge density and modularity.

Assessed latitundinal gradient and state-level distribution of federal license types.

Compared license patterns with species distribution metrics for black sea bass based on Northeast Fisheries Science Center bottom trawl survey.

State coastal fisheries

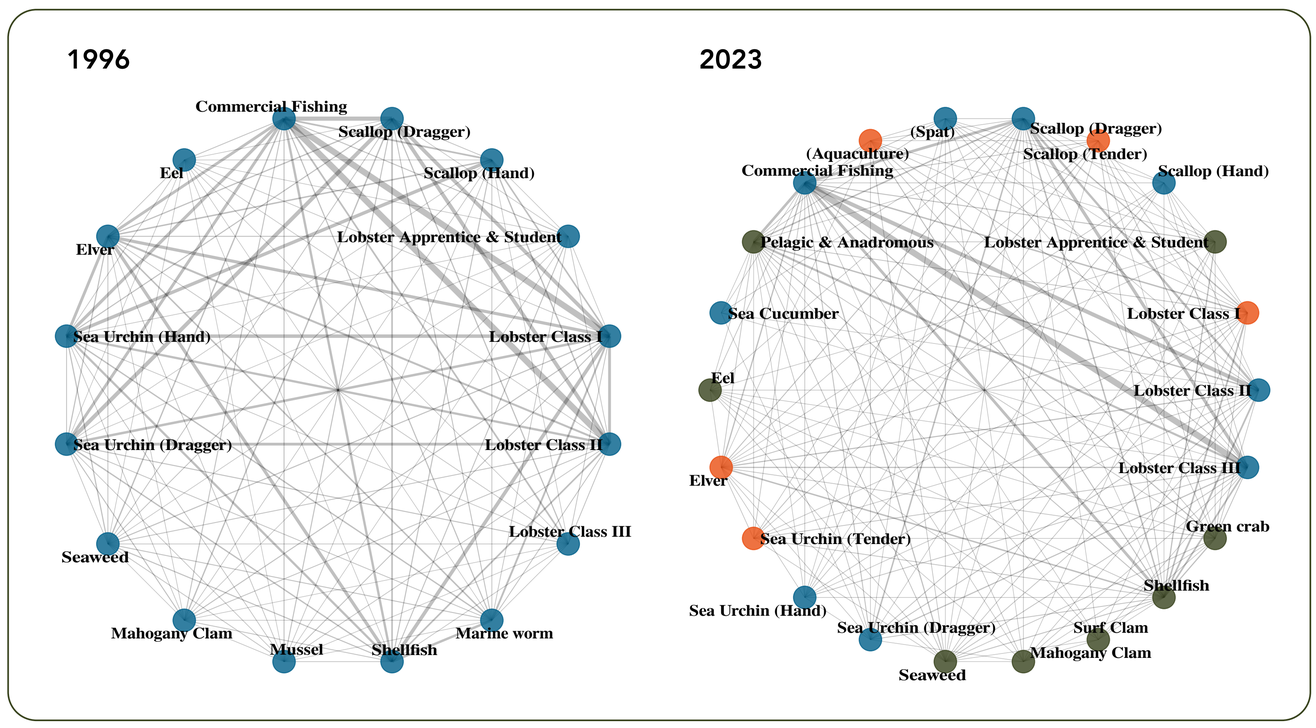
- The diversity of license types available and species managed in Maine has increased over time.
- Modularity has fluctuated with a slight increasing trend, suggesting new asynchronous groupings of licenses emerging.
- The edge density has generally decreased from the late 1990s to present, suggesting that as new nodes are added, the strongest connections between nodes remain.
- The connection between commercial fishing and pelagic/anadromous licenses (which allow catch of black sea bass in state waters) have strengthened in recent years.

Federal fisheries

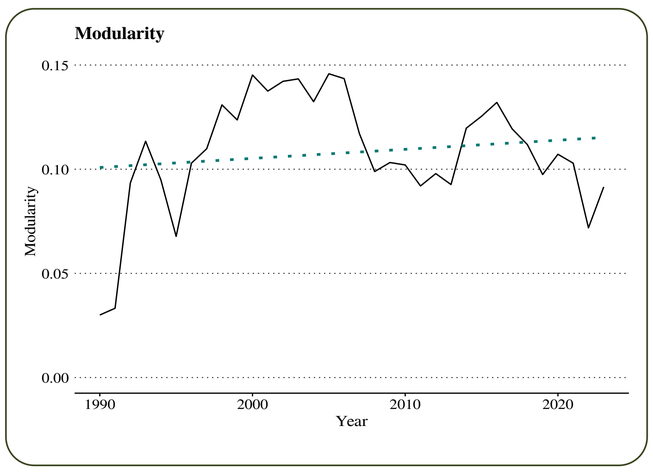
- Based on the Northeast Fisheries Science Center bottom trawl survey, the center of biomass of black sea bass has been shifting northward trend since the 1990s.
- Permits for commercial harvest of black sea bass have been steadily declining while the relative proportion of holdings by state has remained stable.

Movement in permits and licenses

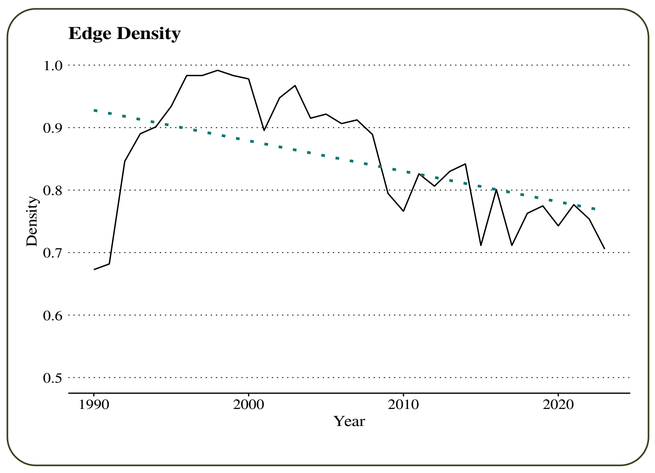
- High diversity, high modularity, and low edge density have the strongest potential for adaptive capacity (Nomura 2022)[2]. The network of Maine commercial harvest licenses would suggest an increase in adaptive capacity, yet this adaptive capacity is not realized.
- We would expect to see movement of permits across state lines following the movement of commercially viable species, like black sea bass. However, category 1 black sea bass licenses have not been shifting north.



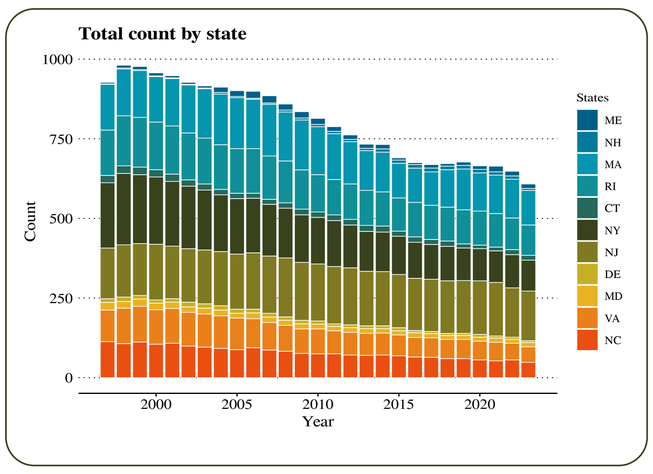
Holding patterns of commercial harvest licenses in Maine in 1996 and 2023. Nodes represent specific license types as defined by Stoll et al (2016)[1]. Color of nodes represent modules. Weight of lines represent number of jointly held licenses. License types in parentheses (aquaculture, spat) were created after Stoll et al (2016).



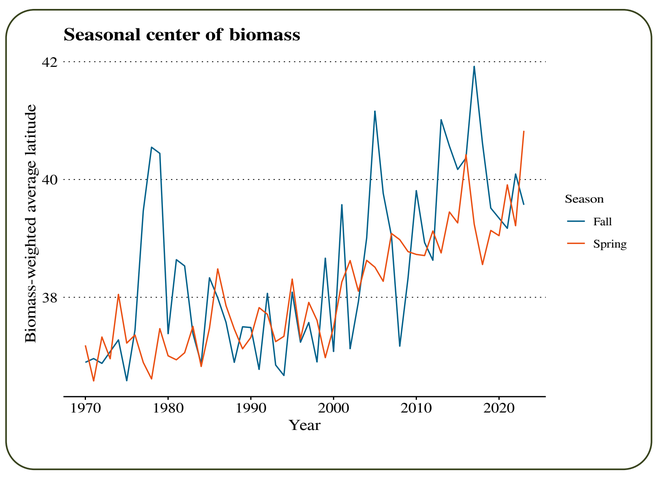
Modularity measures the strength of divisions within a network into clusters or modules. Here, the Louvain method of community detection was applied to each year to determine modules.



The density of a graph is the ratio of the actual number of edges and the largest possible number of edges in the graph.



The total number of federal category 1 black sea bass permits by state from 1996-2023 (GARFO 2023).



The seasonal center of biomass for black sea bass from 1970-2023 (NEFSC 2023).

Accessibility of adaptation options

Commonly used fishery management measures such as limited entry, individually allocated quotas, vessel and engine size restrictions, limit harvesters' ability to adaptive to climate impacts on fisheries.

Bolstering resilience and adaptive capacity in marine fisheries requires addressing the rigidity and complexity of licensing in the United States.

[1]*How access to Maine's fisheries has changed over a quarter century: The cumulative effects of licensing on resilience.* Stoll et al. 2016. [2]*Fisheries connectivity measures of adaptive capacity in small-scale fisheries.* Nomura et al. 2022.