State of the Ecosystem: #11a

New England 2019

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Today's Talk

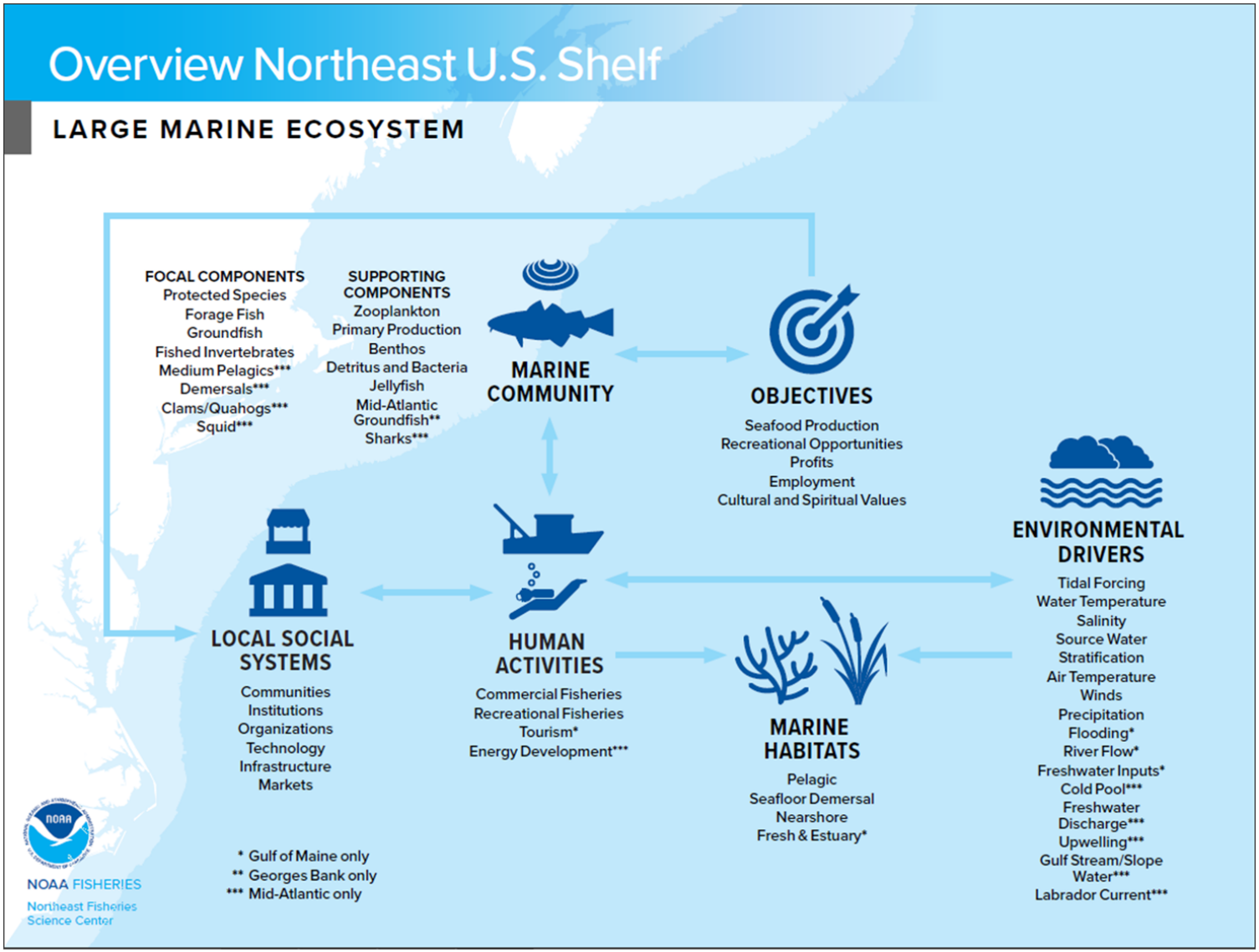
- Report Structure/ Orientation
- Overview of 2019 New England State of the Ecosystem
- Notable Improvements
  - Open-source Data
  - Technical Documentation
- New Avenues for Ecosystem Information

The IEA Loop[1]

[1] https://www.integratedecosystemassessment.noaa.gov/national/IEA-approach

Overview Northeast U.S. Shelf

LARGE MARINE ECOSYSTEM



State of the Ecosystem 2019: Structure

Report Structure

1. Human dimensions
2. Protected species
3. Fish and invertebrates (managed and otherwise)
4. Habitat quality and ecosystem productivity

Ecosystem-scale objectives and indicators on the Northeast US shelf

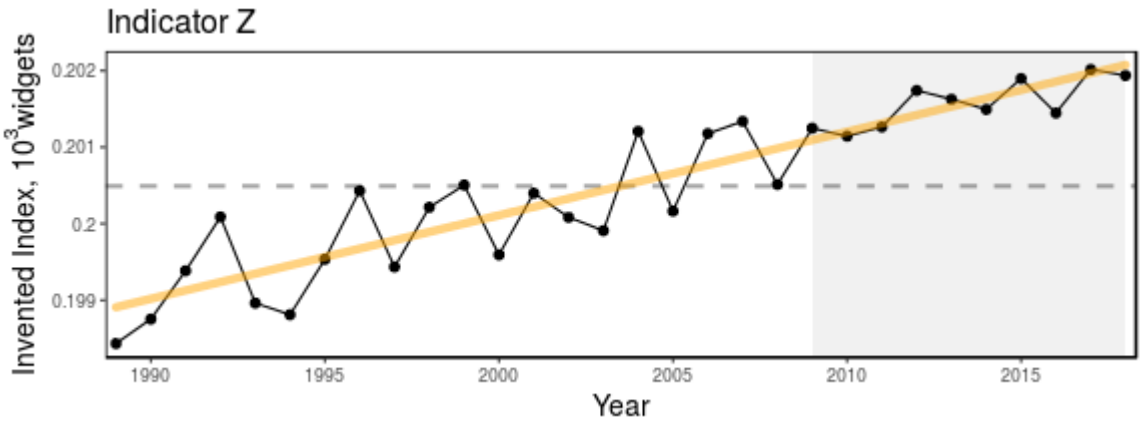
Objective Categories	Indicators
Seafood Production	Landings by feeding guild
Profits	Revenue by feeding guild
Recreation	Number of anglers and trips; recreational catch
Stability	Diversity indices (fishery and species)
Social & Cultural	Commercial and recreational reliance
Biomass	Biomass or abundance by feeding guild from surveys
Productivity	Condition and recruitment of managed species
Trophic structure	Relative biomass of feeding guilds, primary productivity
Habitat	Estuarine and offshore habitat conditions

SOE Orientation: Indicator visualization

Status (short-term) and trend (long-term) of components are measured as **indicators** and plotted in a standardized way

Indicators are selected to

1. Be broadly informative about a component in a management context[1-3]
2. Minimize redundancy of information
3. Be responsive to ecosystem change

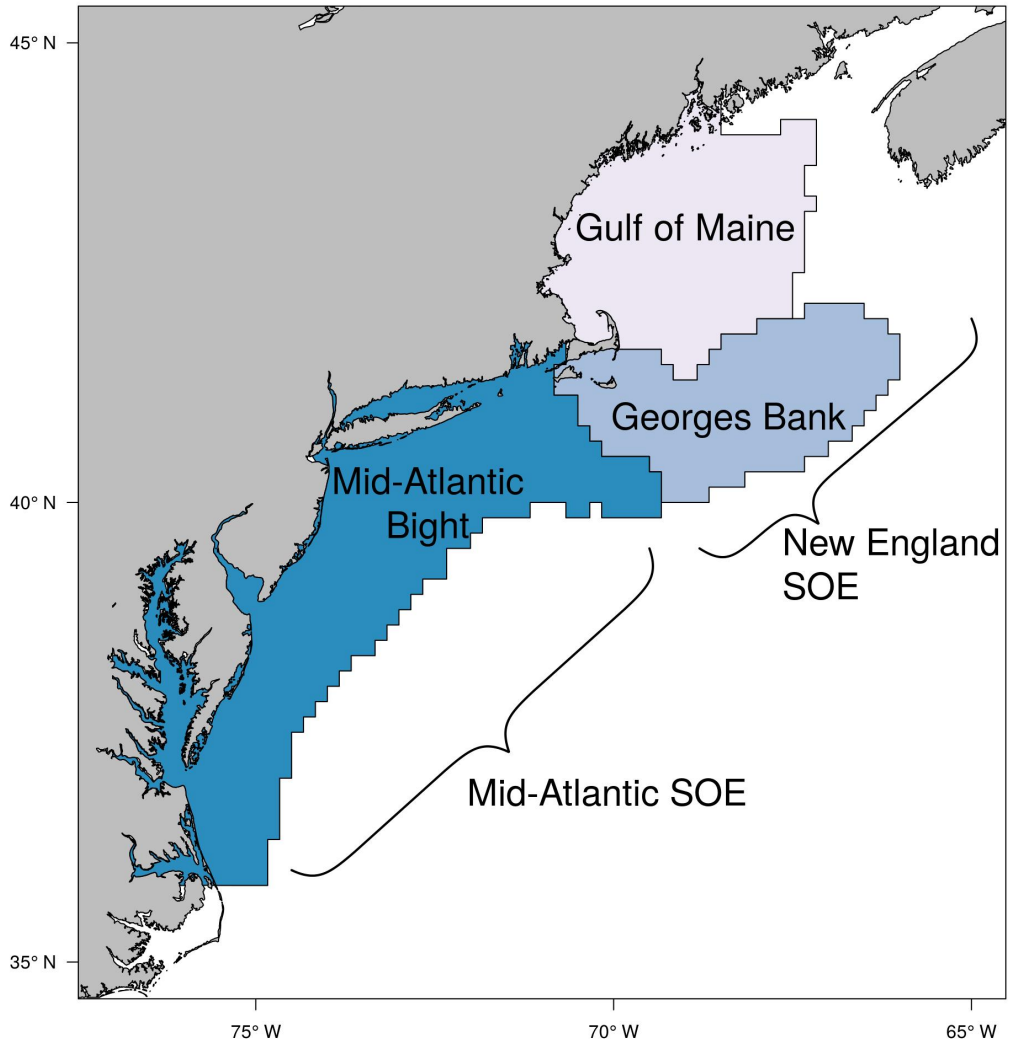


[1] Rice J. C.Rochet M. J. "A framework for selecting a suite of indicators for fisheries management." ICES Journal of Marine Science 62 (2005): 516–527.

[2] Link J. 2010. Ecosystem-Based Fisheries Management: Confronting Tradeoffs . Cambridge University Press, New York.

[3] Zador, Stephani G., et al. "Ecosystem considerations in Alaska: the value of qualitative assessments." ICES Journal of Marine Science 74.1 (2017): 421-430.

SOE Orientation: Indicator spatial scales



https://noaa-edab.github.io/tech-doc/epu.html

SOE Orientation: Feeding guilds

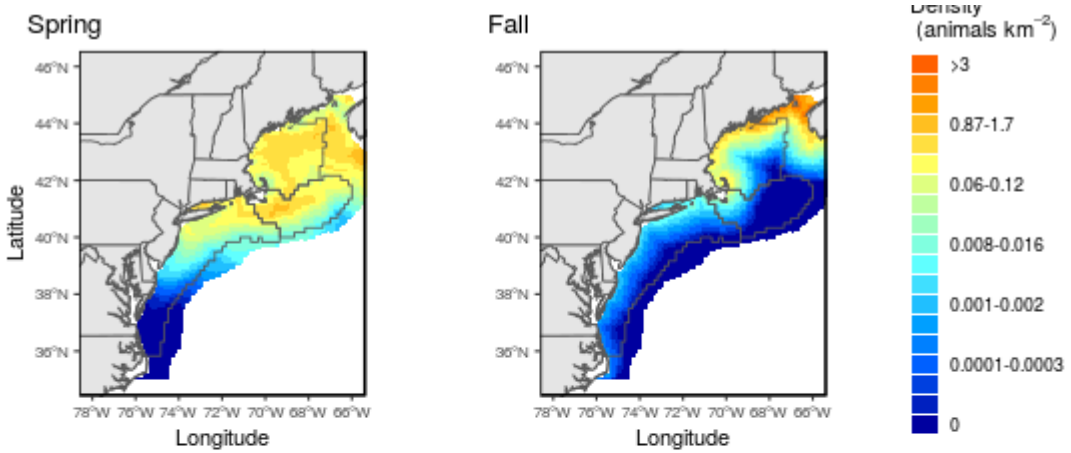
Feeding guilds and management bodies.

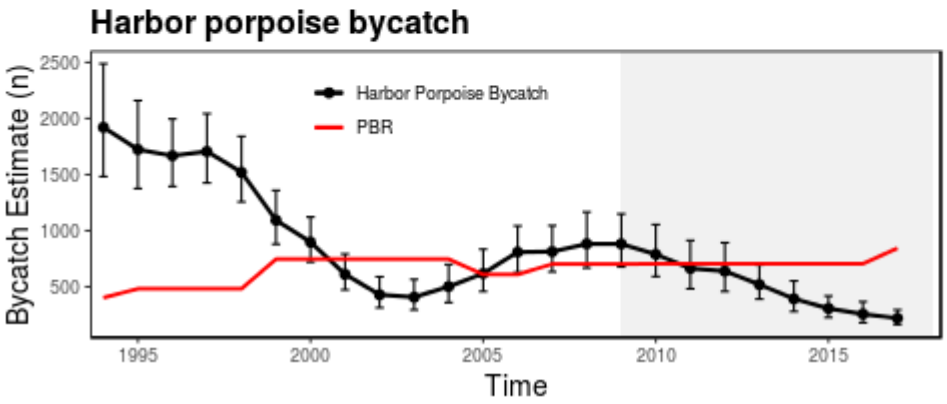
Guild	MAFMC	Joint	NEFMC	State or Other
Apex Predator	NA	NA	NA	bluefin tuna, shark uncl, swordfish, yellowfin tuna
Piscivore	bluefish, summer flounder	goosefish, spiny dogfish	acadian redfish, atlantic cod, atlantic halibut, clearnose skate, little skate, offshore hake, pollock, red hake, silver hake, smooth skate, thorny skate, white hake, winter skate	fourspot flounder, john dory, sea raven, striped bass, weakfish, windowpane
Planktivore	atlantic mackerel, butterfish, longfin squid, northern shortfin squid	NA	atlantic herring	alewife, american shad, blackbelly rosefish, blueback herring, cusk, longhorn sculpin, lumpfish, menhaden, northern sand lance, northern searobin, sculpin uncl
Benthivore	black sea bass, scup, tilefish	NA	american plaice, barndoor skate, crab,red deepsea, haddock, ocean pout, rosette skate, winter flounder, witch flounder, yellowtail flounder	american lobster, atlantic wolffish, blue crab, cancer crab uncl, chain dogfish, cunner, jonah crab, lady crab, smooth dogfish, spider crab uncl, squid cuttlefish and octopod uncl, striped searobin, tautog
Benthos	atlantic surfclam, ocean quahog	NA	sea scallop	blue mussel, channeled whelk, sea cucumber, sea urchin and sand dollar uncl, sea urchins, snails(conchs)

2019 New England Report

Good news: Management works

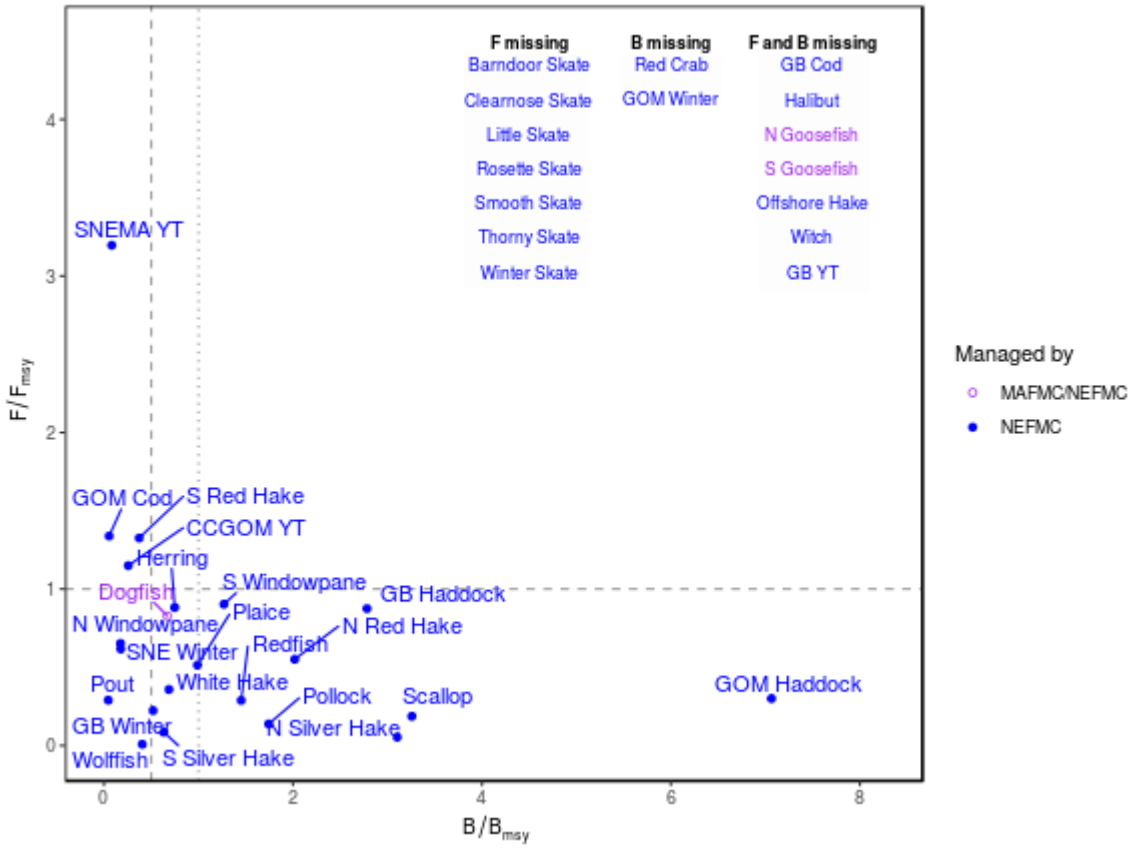
Current bycatch levels suggest that management actions have been effective in reducing harbor porpoise bycatch





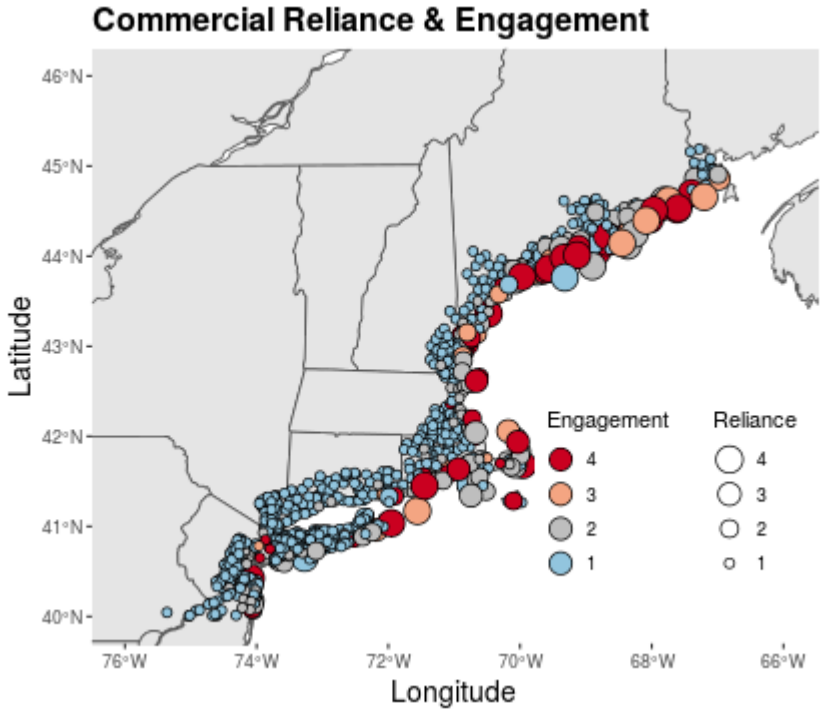
Challenges: F and B objectives

- Objectives being met for 20 stocks
- 4 stocks below B and above F thresholds
- Herring dropped to B/Bmsy < 1

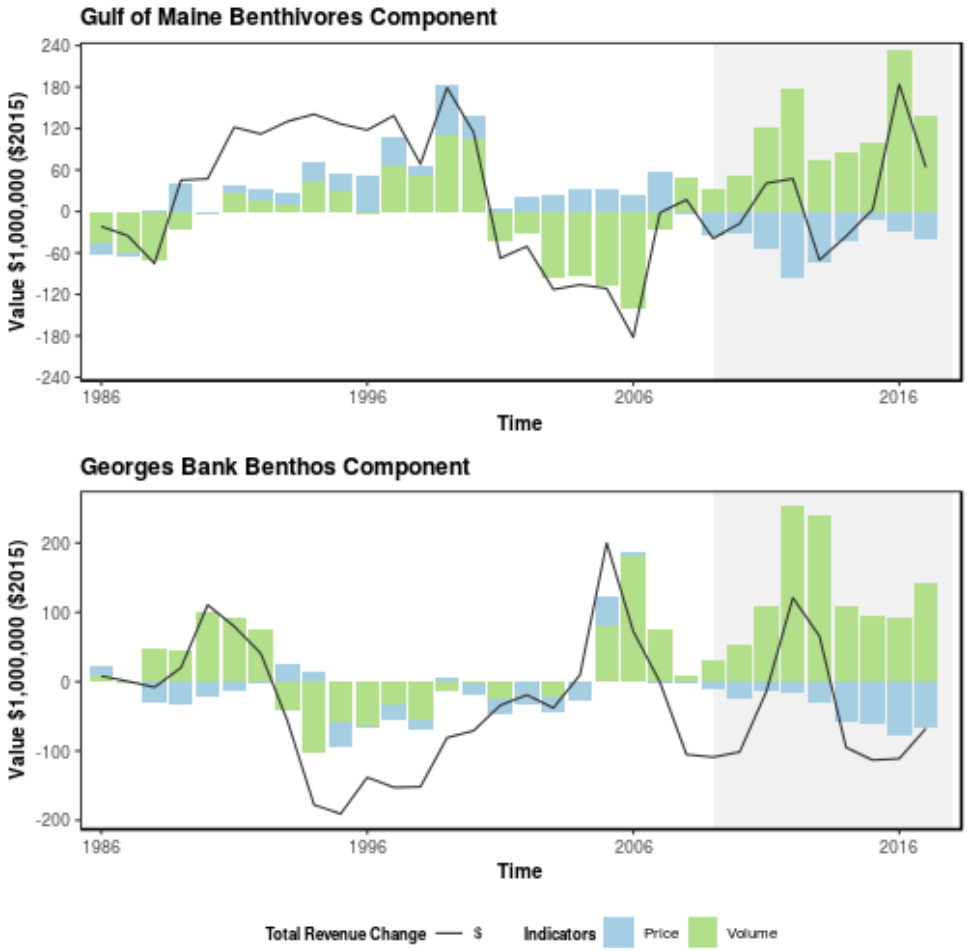


Challenges: Community reliance and vulnerability

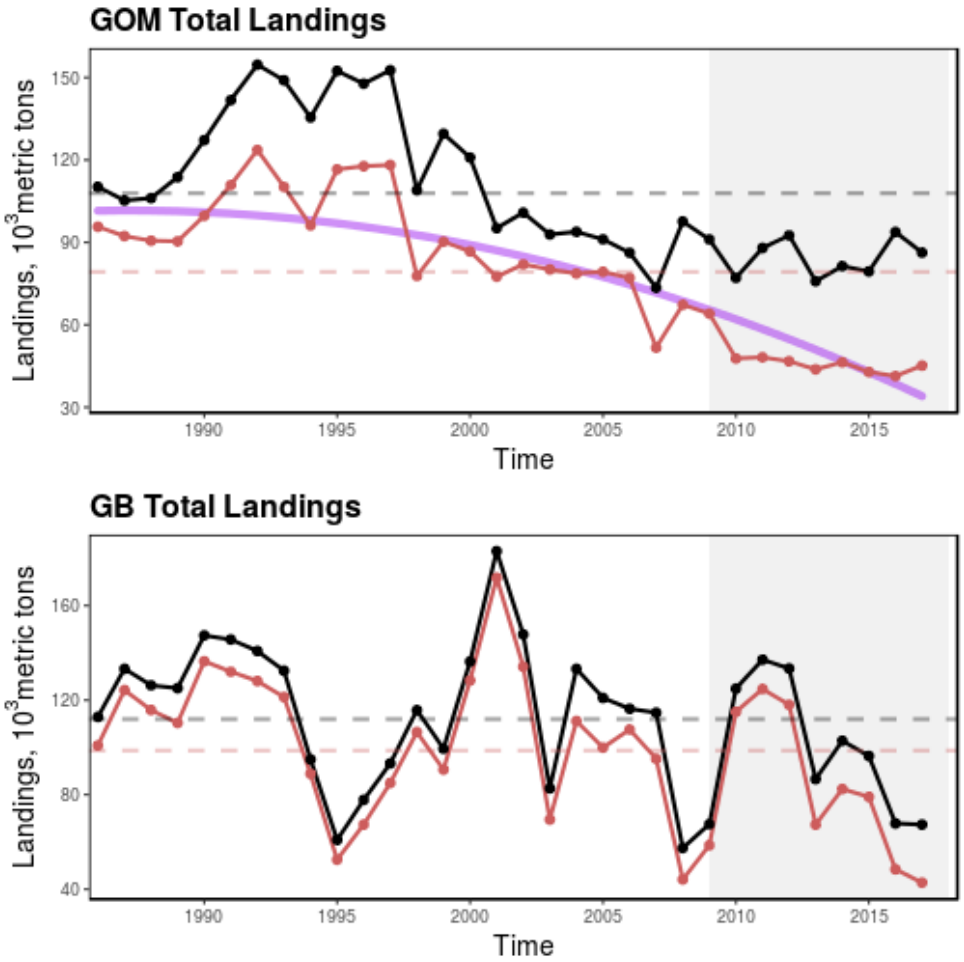
- High social-ecological reliance on scallop and lobster
- Species considered moderately to highly at risk due to climate change (OA, temp)



Commercial drivers



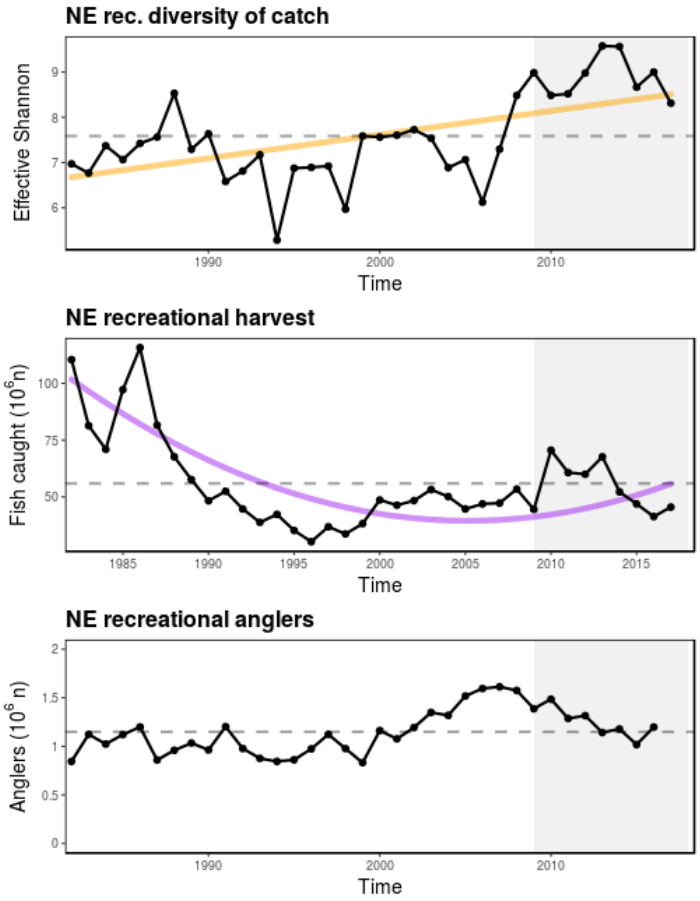
Challenges: Long-term decline in seafood production



Recreational fishing

NE:

- Positive long-term trend for diversity of catch in New England recreational fisheries
- Overall decline in rec seafood harvest since 1980s
    - Trending upwards since mid-90s
- Increase in recreational effort (n anglers) since the mid 90s



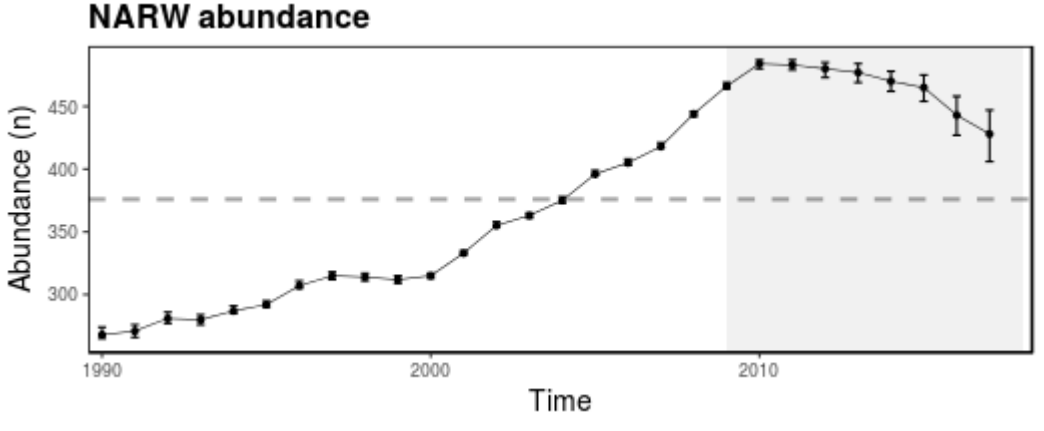
Challenges: Protected species interactions (I)

- 2018: 4 unusual mortality events for three large whale species and two seal species

North Atlantic right whales (NARW)

- Strong consensus of population decline
- Diverging abundance trends between sexes, with higher female mortality rates

- Evidence suggests that the level of interaction between NARWs, fixed gear (US and CAN) is contributing to the decline of the species
    - 20 NARW deaths in 2017 and 2018, >50% due to human interactions (5 vessel strike, 6 entanglement)



Challenges: Proctected species interactions (II)

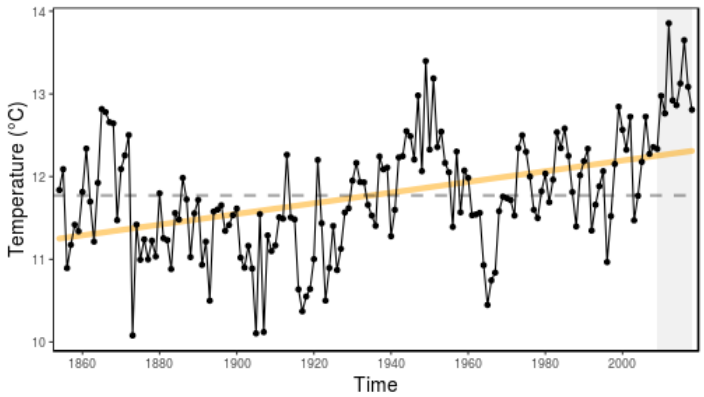
- MA gray seal population between 30-40,000 individuals
- Annual gray seal bycatch mortality ~900
- Unusual Mortality Event declared for seals (gray and harbor)
- Seal diet studies underway to understand role in fisheries

Image credit: NOAA Fisheries

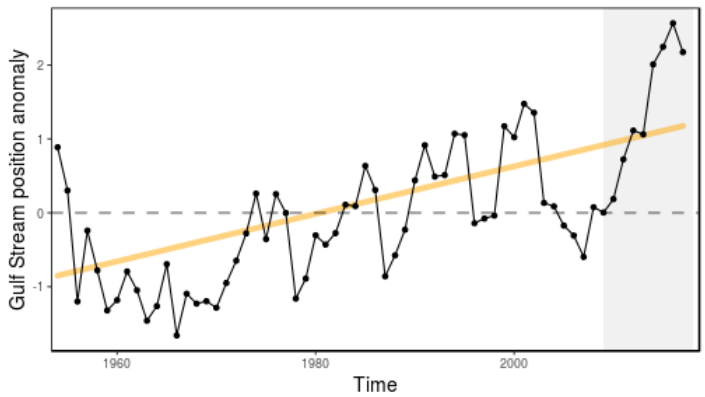
Challenge: Unprecedented ecosystem observations

- Northeast US shelf is still among the fastest warming waters globally
  - 7/10 warmest years observed in the past decade
- Most northerly Gulf Stream north wall positions ever recorded 2014-2017
  - associated with warmer ocean temperature in the Northeast US shelf

Advice for managing in the face of rapid, unprecedented ecosystem changes?

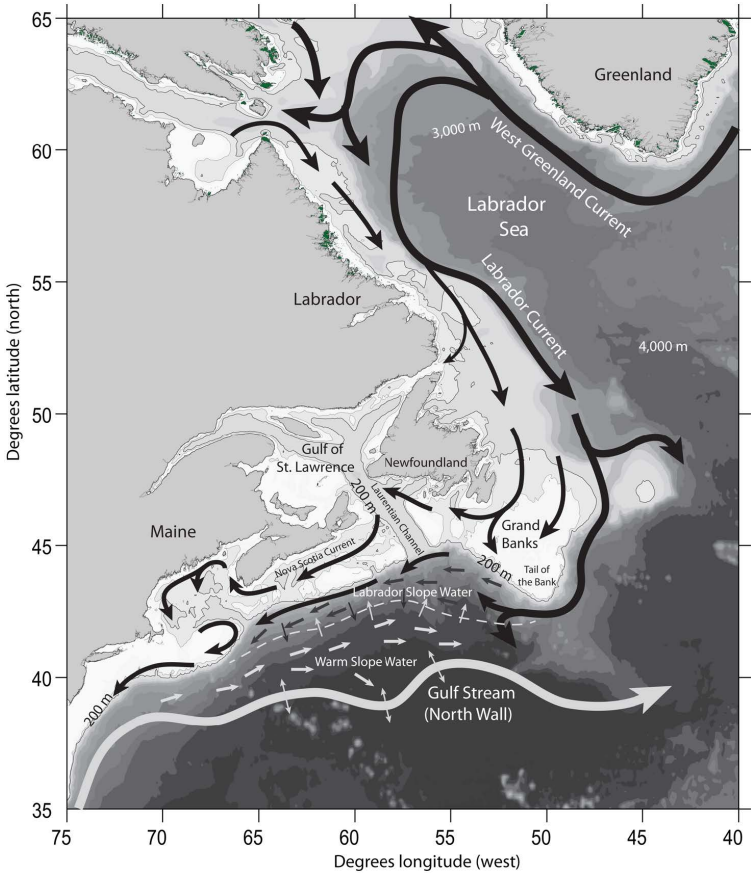


NE Shelf Long-term SST



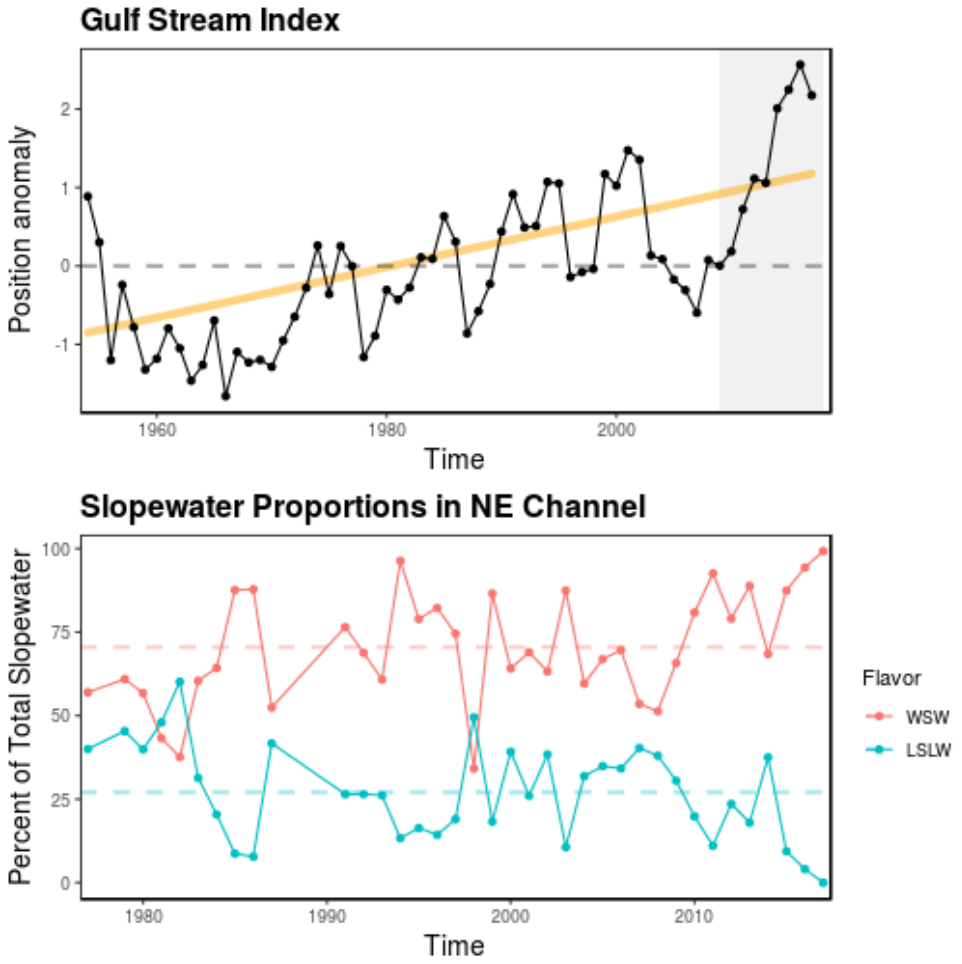
Gulf Stream Index

Ocean circulation in NW Atlantic



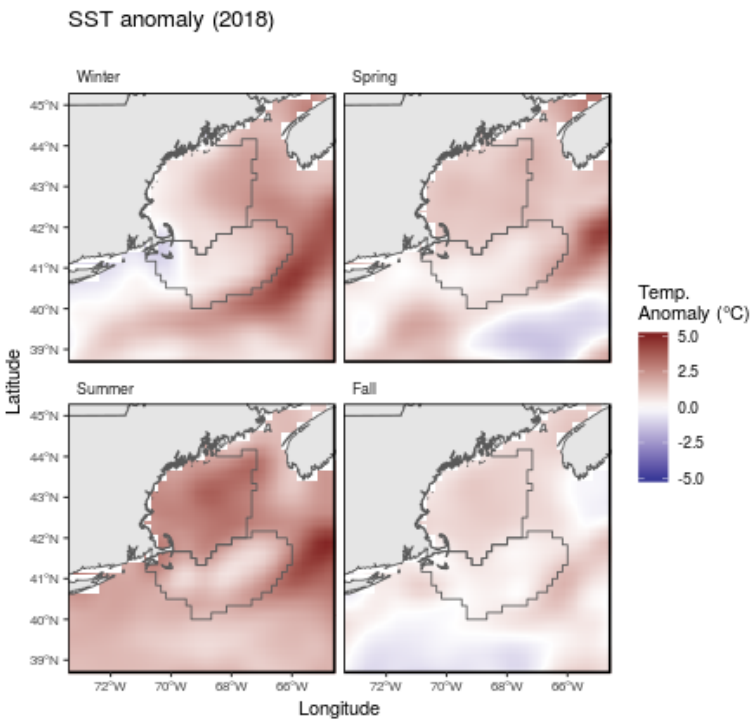
Townsend, D. W., Pettigrew, N. R., Thomas, M. A., Neary, M. G., McGillidcuddy, D. J., O'Donnell, J (2015), Water masses and nutrient sources to the Gulf of Maine, Journal of Marine Research, 73: 93-122.

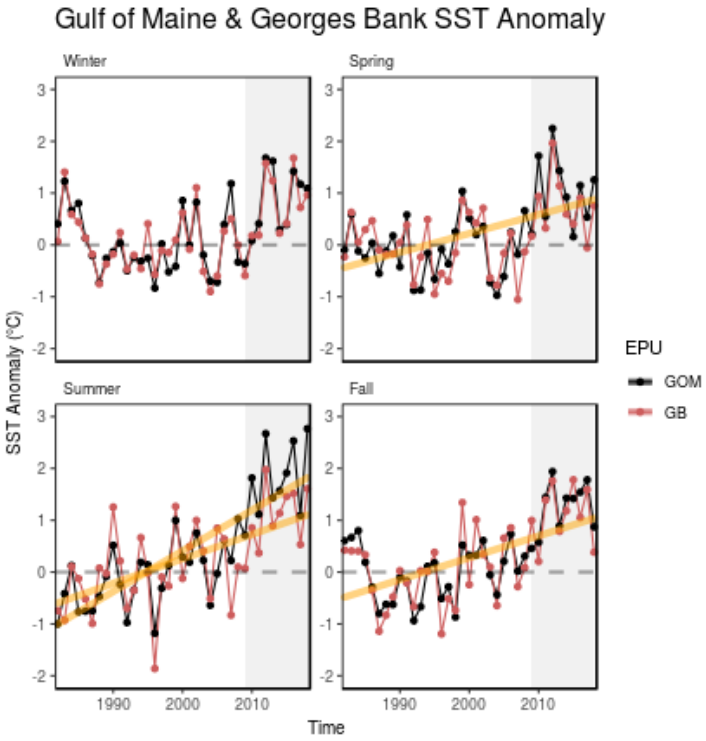
Challenges: Ocean circulation



Challenges: A warming Shelf

Warming oceans have implications for suitable fish habitat, which is predicted to decline for many NE species[1]

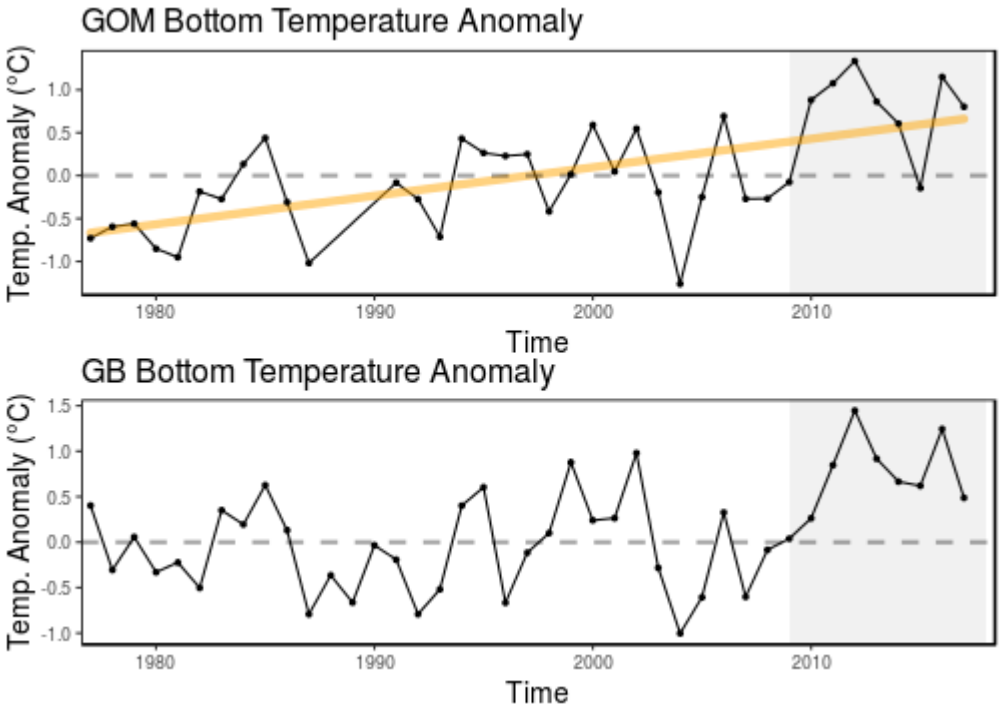




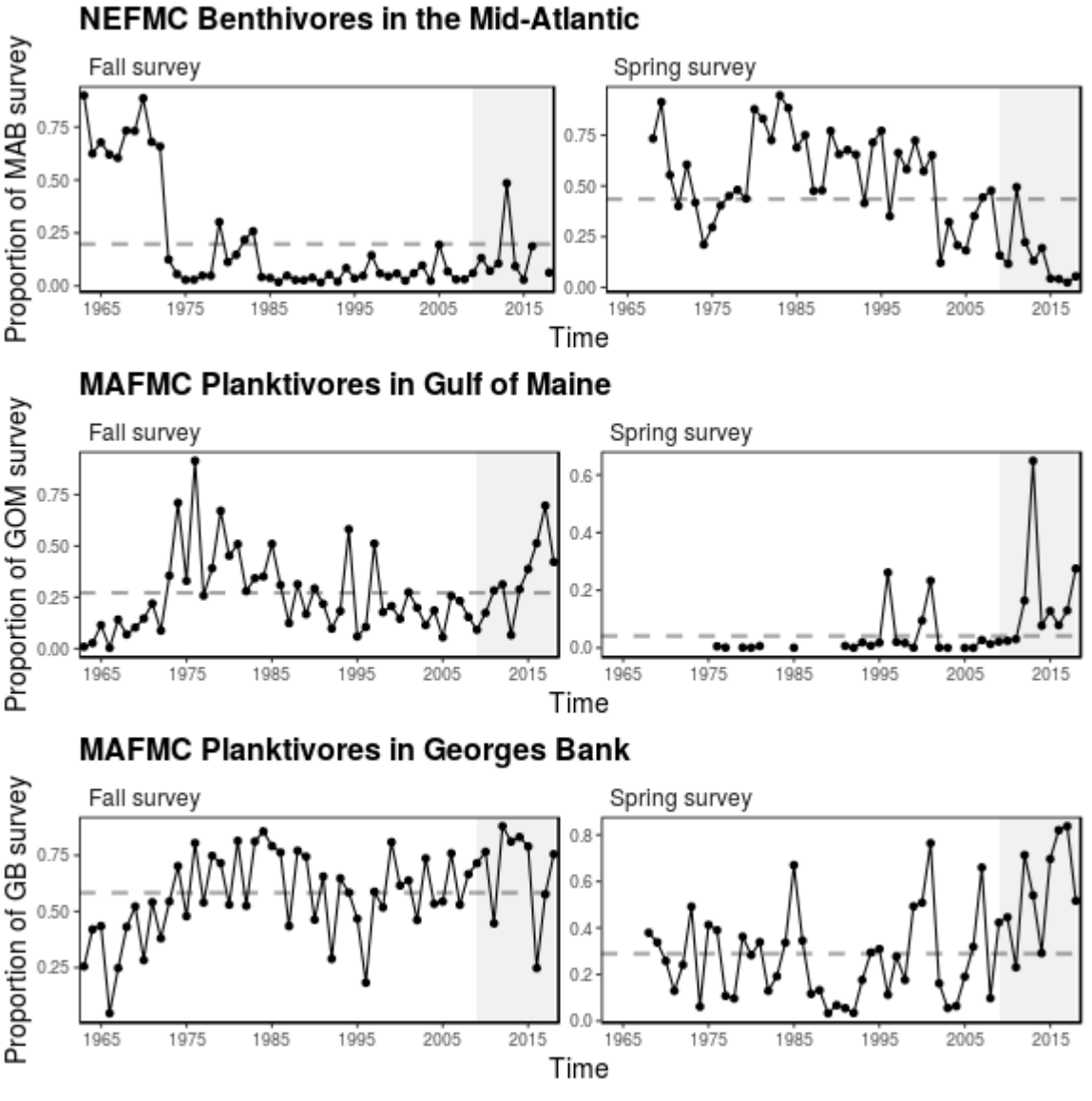
Kleisner, Kristin M., et al. "Marine species distribution shifts on the US Northeast Continental Shelf under continued ocean warming." Progress in Oceanography 153 (2017): 24-36.

Challenges: A warming Shelf

- Bottom temperatures are also increasing in the region

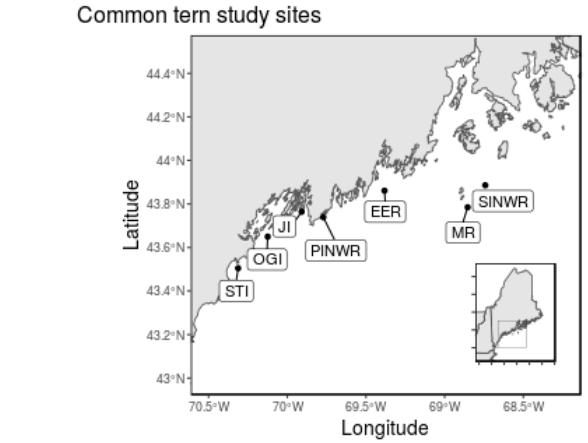


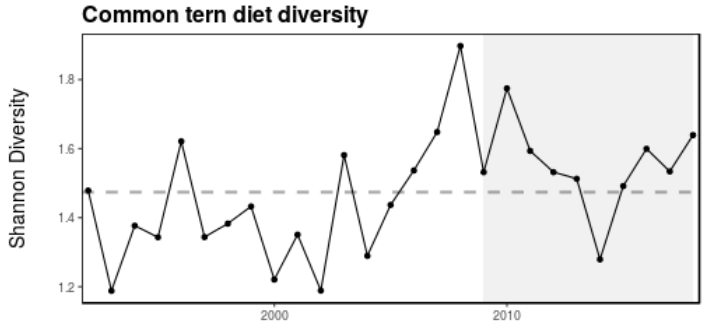
Management implications: species shifts



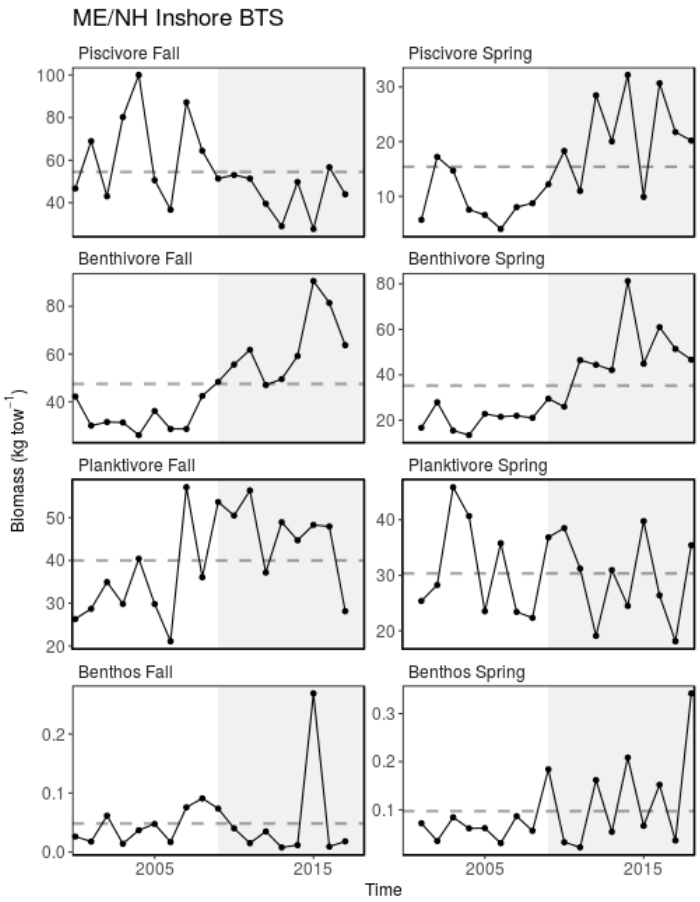
Implications for protected species: Common tern diet

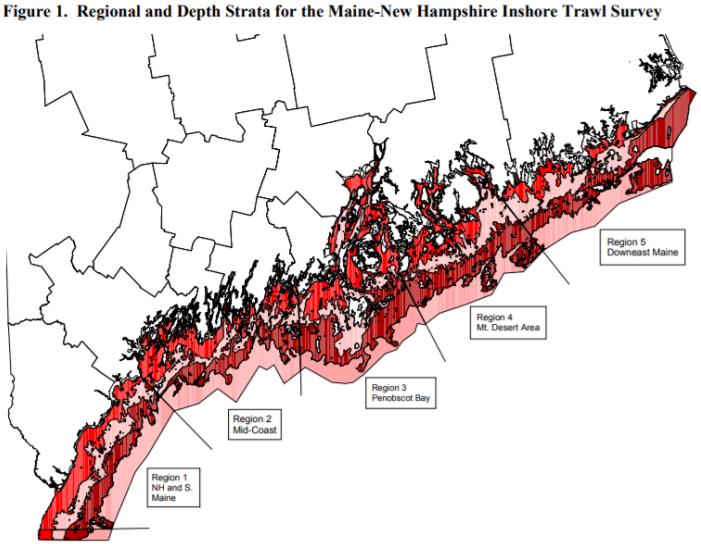
- Warmer waters affect vertical distribution of prey species
    - Results in more generalist diet choices
- High diet diversity in past decade may be the result of decreases in preferred prey type (hake, sandlance)
    - Butterfish appear in diet in warm years, are difficult to digest; may cause starvation



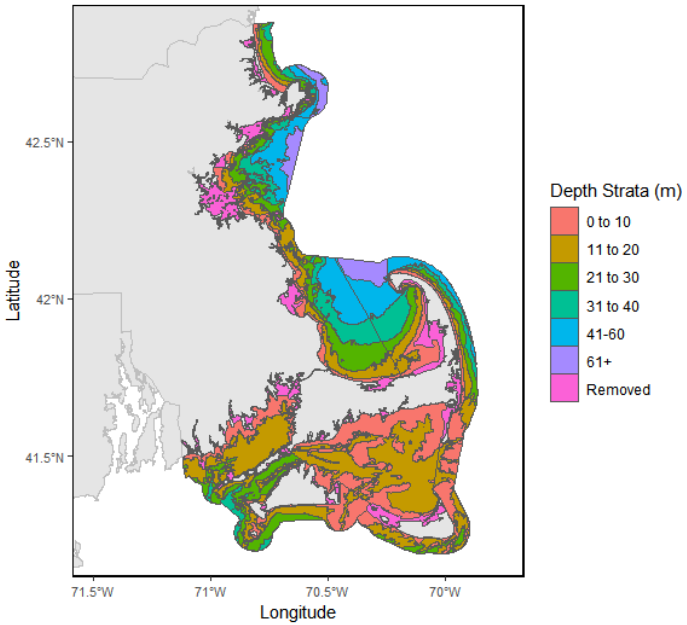


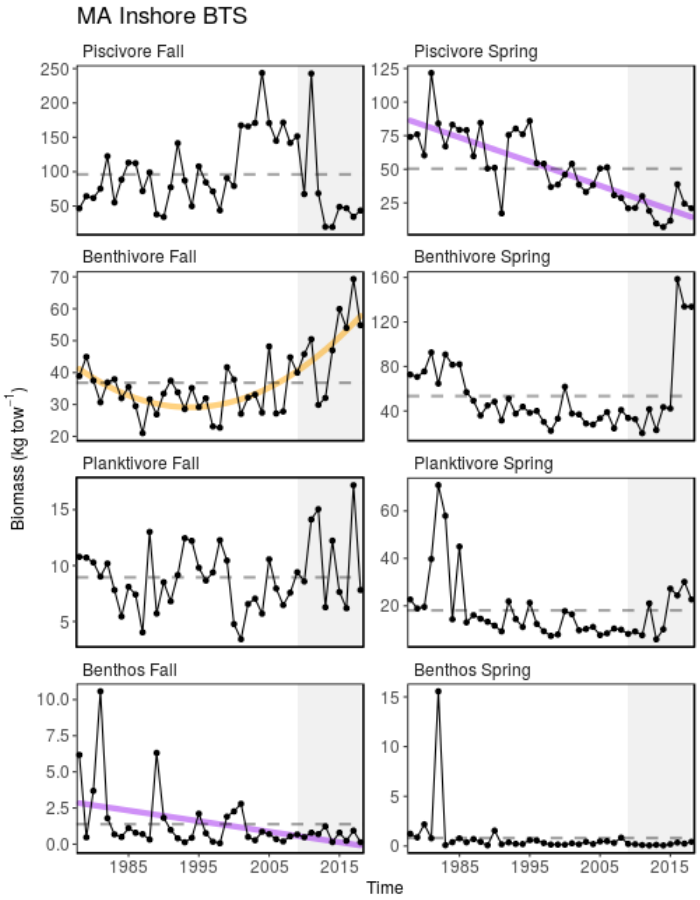
Surveys trends: Maine/New Hampshire Inshore Survey



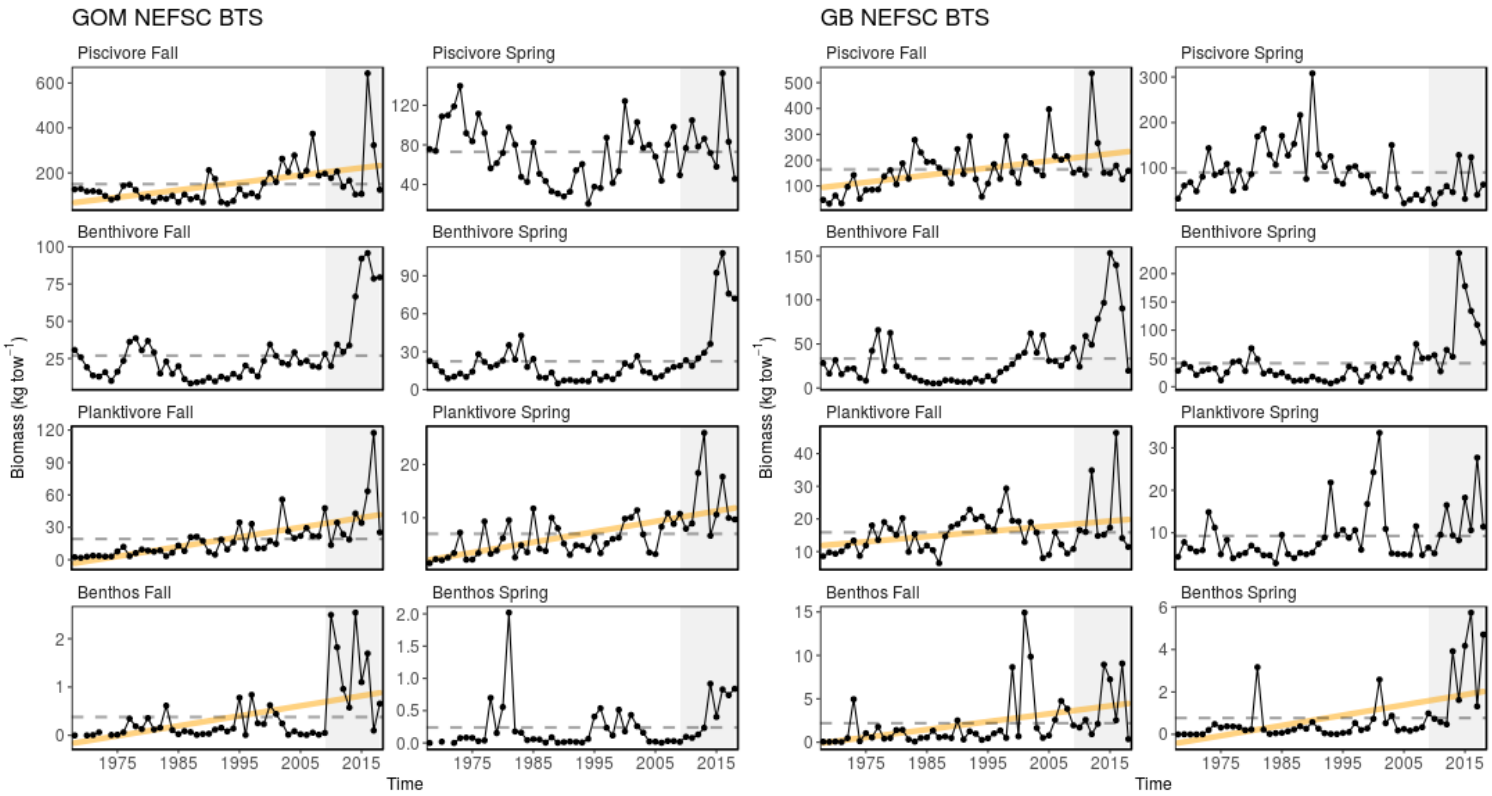


Surveys trends: Massachusetts Inshore Survey

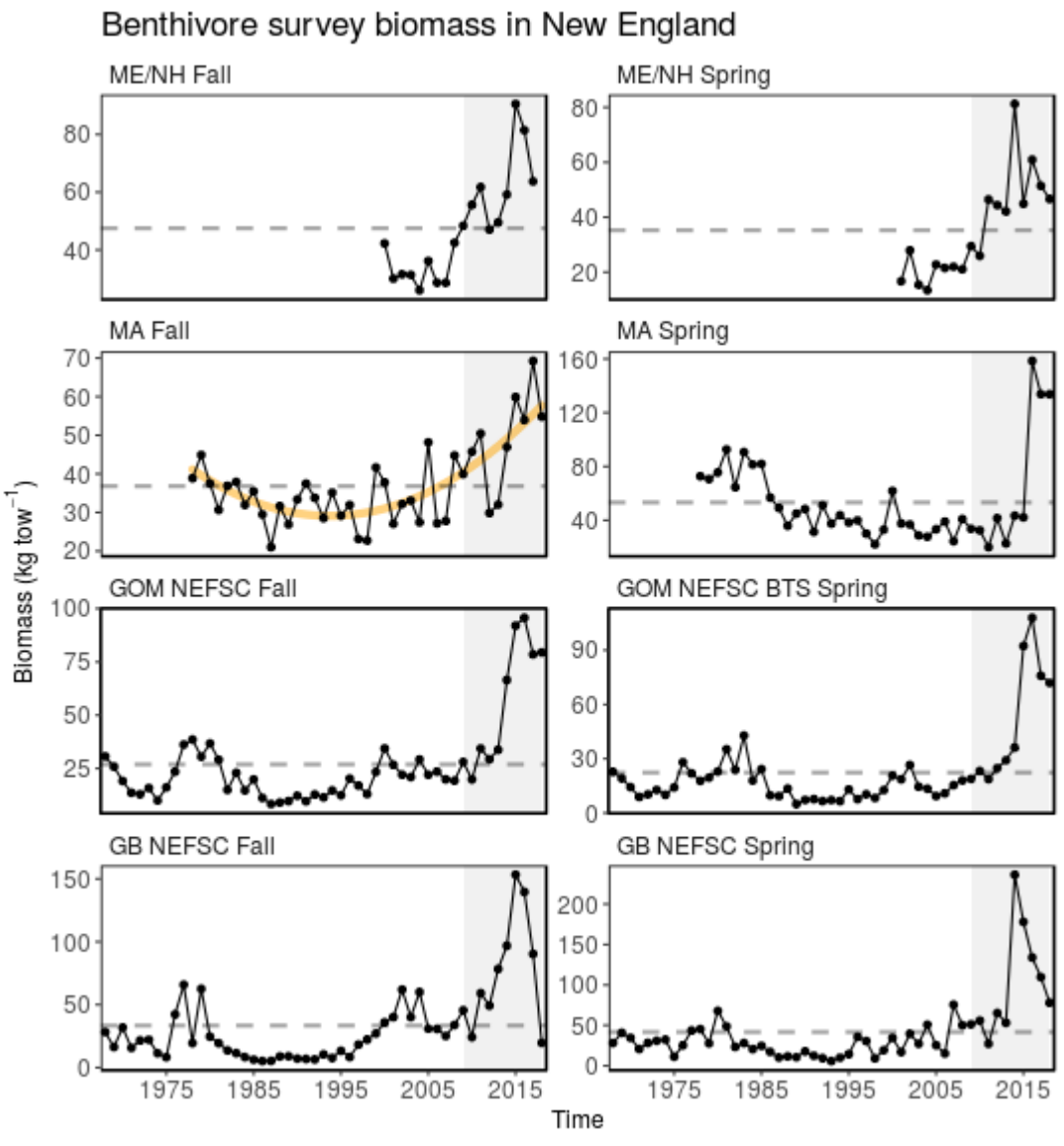




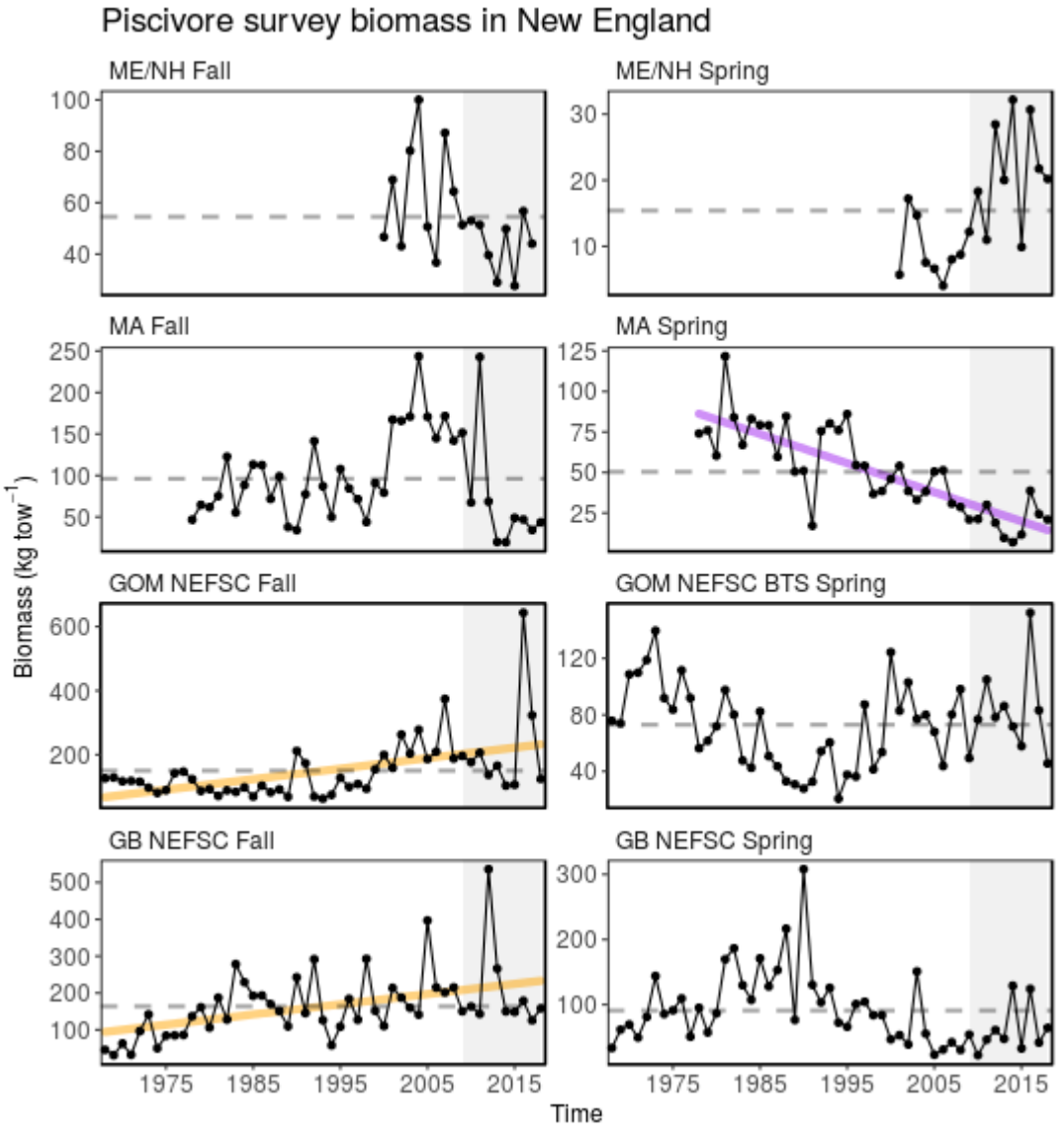
Surveys trends: Offshore



Survey trends: Inshore and offshore

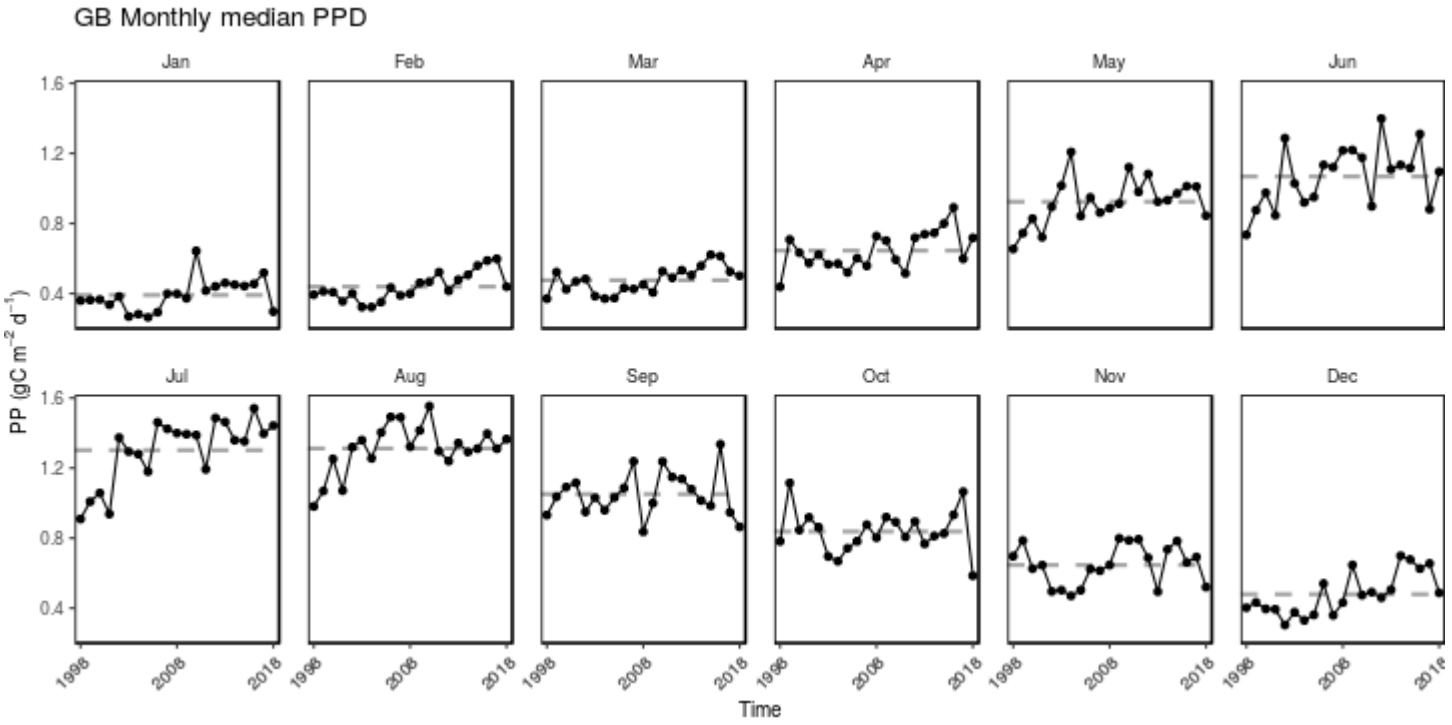


Survey trends: Inshore and offshore piscivores



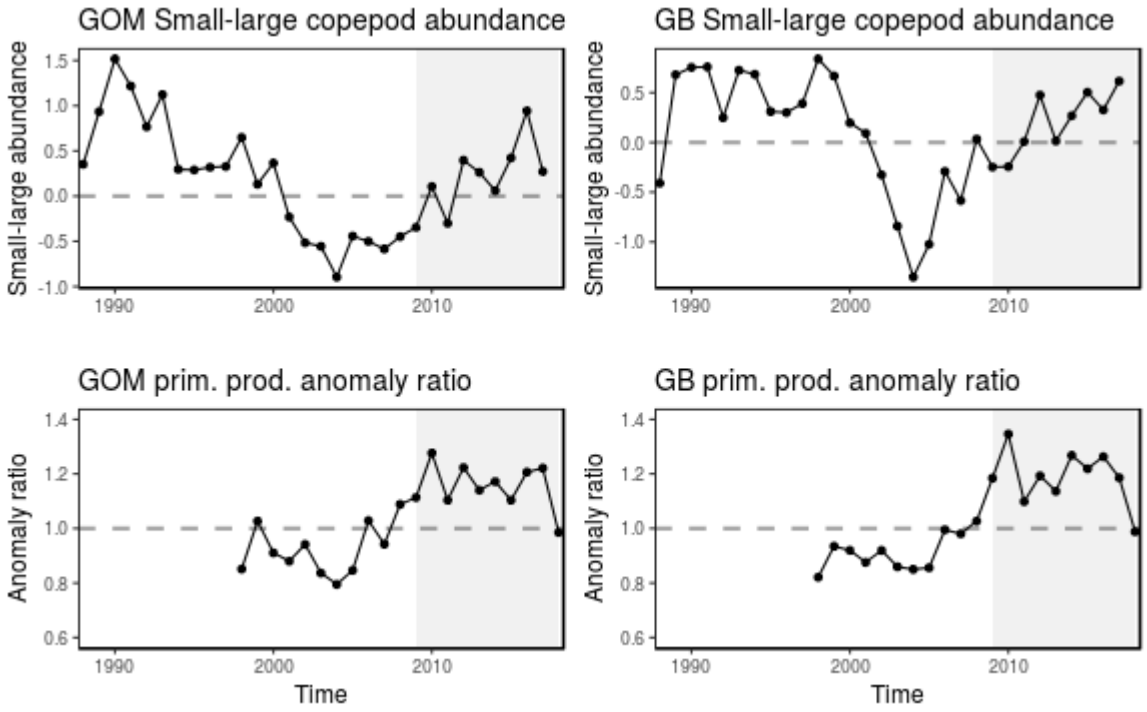
Changing base of the food web: primary production

- Summer PP is increasing in the Mid-Atlantic (and in New England)
  - Driven by warmer temperatures and increased bacterial remineralization and nutrient recycling
  - Increasing primary production likely due to higher productivity of smaller phytoplankton



Changing base of the food web: Zooplankton size structure

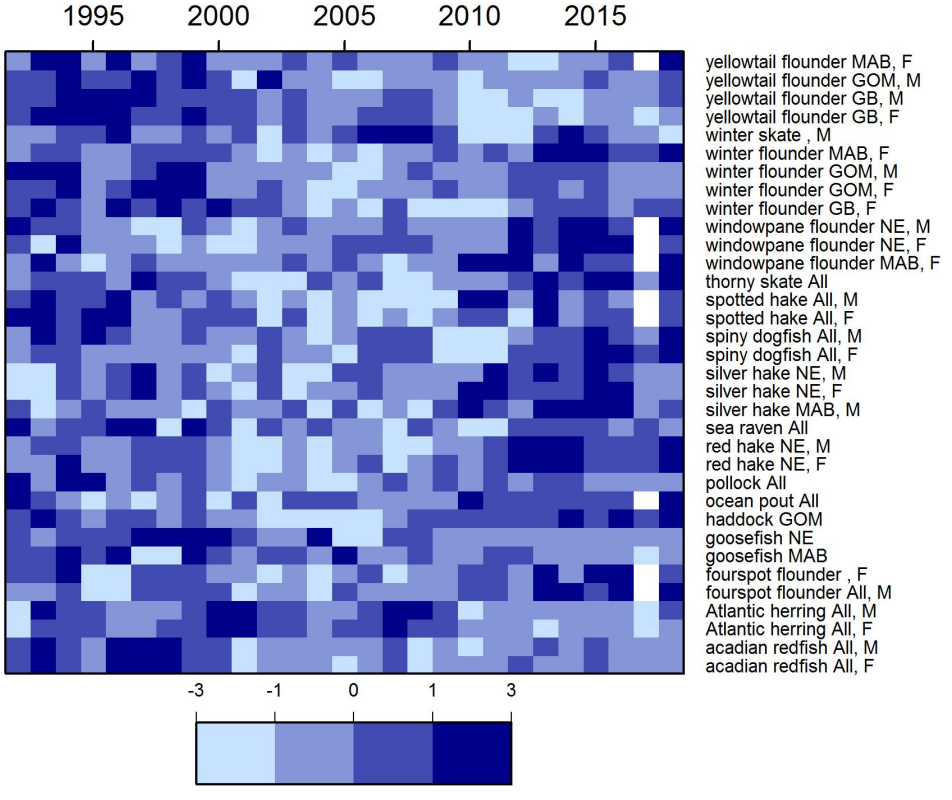
- Lower copepod size index means higher abundance of large copepods (*Calanus*)
- Primary production may play a role in zooplankton size dynamics on the shelf



Changing base of the food web and fish conditions

- Fish condition is measured at the weight at a given length relative to the average
  - Drop-off in condition around 2000 aligns with the shift in zooplankton size-structure on the shelf

NEFMC Condition Factor

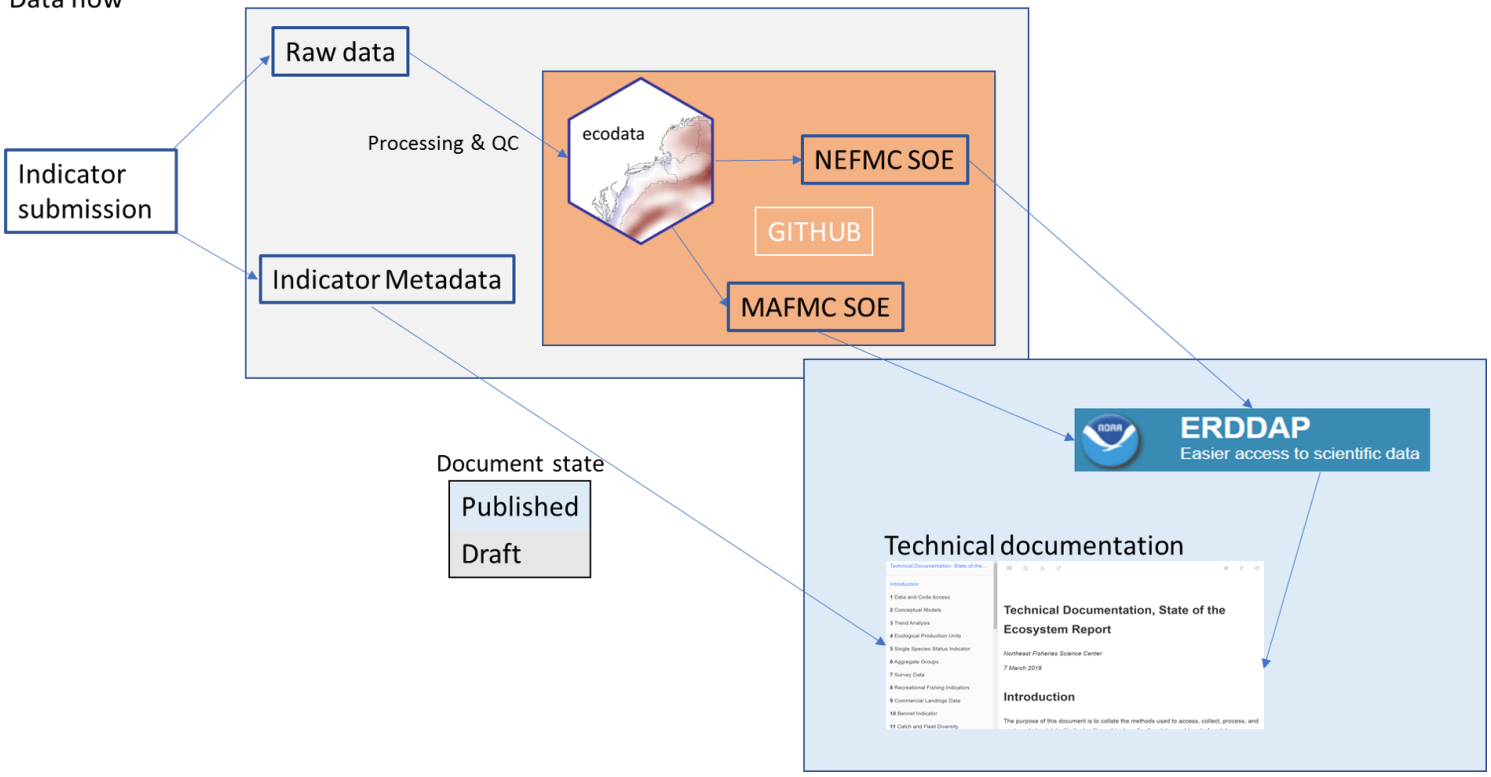


Improvements to reproducibility and provenance

SOE 2019

- Reporting the information is not enough
- Back-end critical for describing collection, analyses, and processing

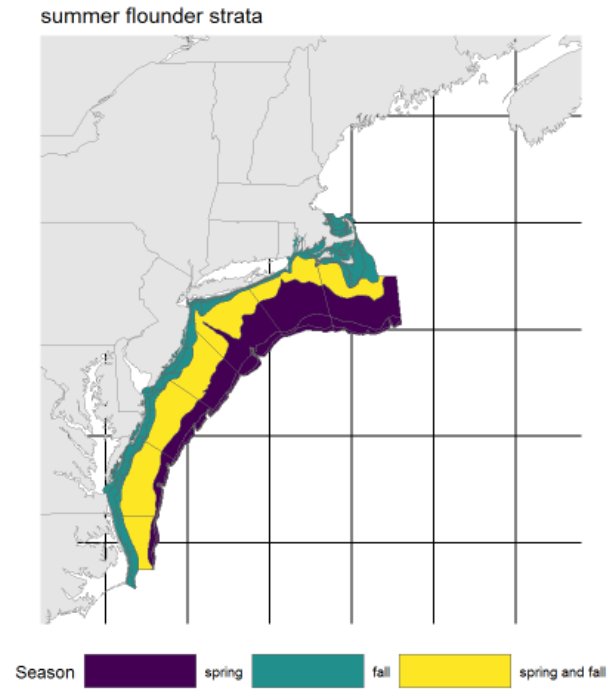
State of the Ecosystem:
Data flow



New avenues for ecosystem reporting

Ecosystem Context for Stock Assessment (ECSA)

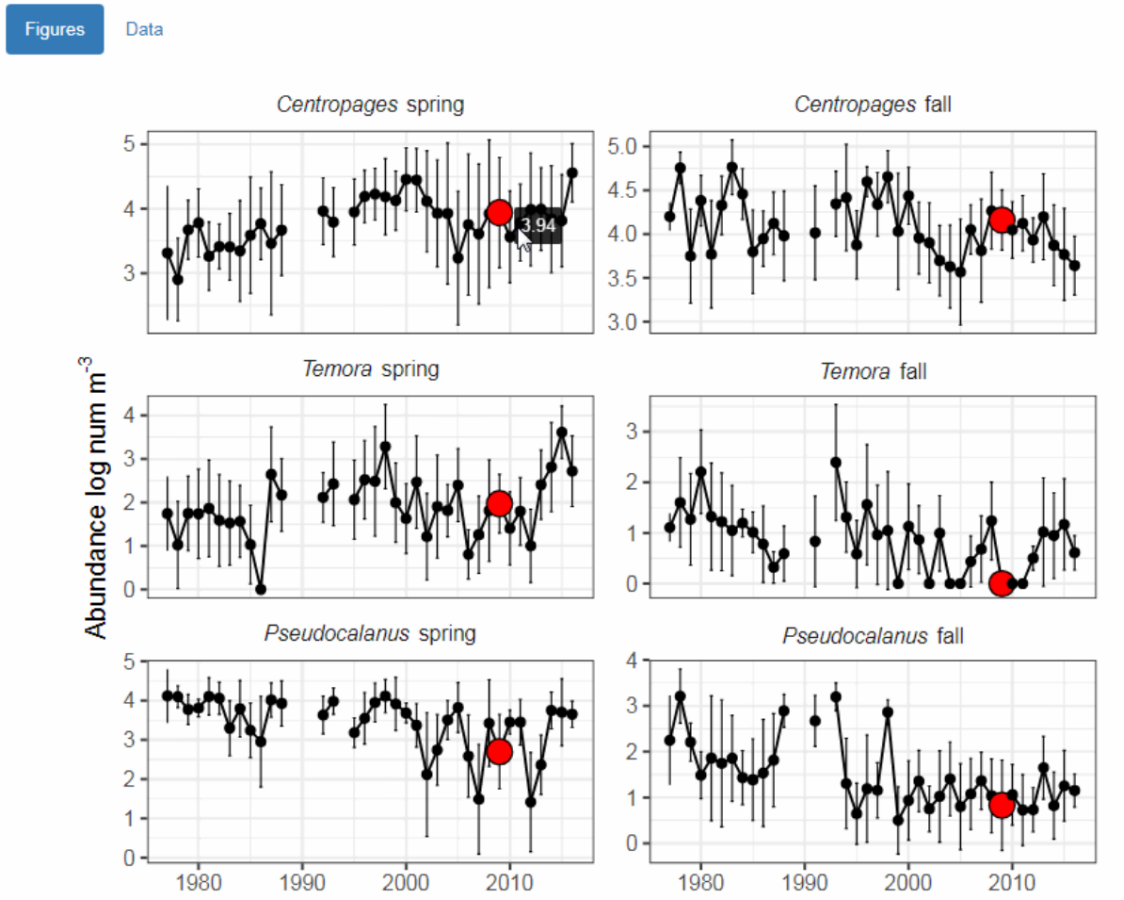
- First provided for 2018 summer flounder assessment
- Provides seasonal ecosystem information for **stock areas**
  - Ocean temperature and salinity, chlorophyll, zooplankton, estimated habitat occupancy, diet composition



Strata map for summer flounder (*Paralichthys dentatus*) on the NE shelf

Summer flounder ECSA

Ecosystem Context for Stock Assessment (ECSA)



Ecosystem Context for Stock Assessment (ECSA)

- Automated workflows for rapid generation of reports
- Transparent and reproducible methods
- Developed specifically for science audience
    - More technical language, includes methods and full references
- Positive feedback overall, will continue building out ECSA for assessments

External Resources

- SOE Technical Documentation
- ecodata R package
    - Macrofauna indicators
    - Human Dimensions indicators
    - Lower trophic level indicators
- ERDDAP server
- Slides available at https://noaa-edab.github.io/presentations/20190417_NEFMC_Lucey.html

Contributors - THANK YOU!

The New England and Mid-Atlantic SOEs made possible by (at least) 38 contributors from 8 intstitutions

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