State of the Ecosystem:

Mid-Atlantic 2019

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Today's Talk

- Role of Ecosystem reporting in MAFMC EAFM
- Report structure
- Overview results for Mid-Atlantic 2019
- EAFM risk assessment update (*after lunch*)
- Notable improvements: open-source data and technical documentation

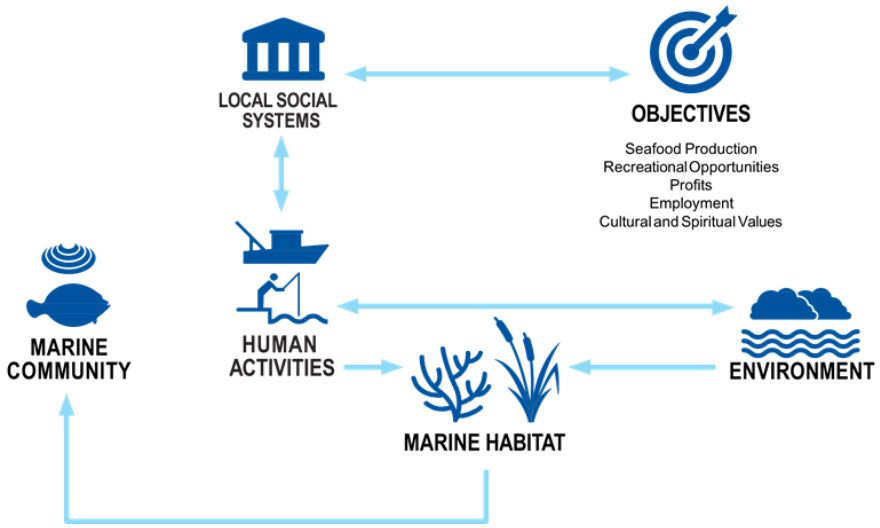
The IEA Loop[1]

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

State of the Ecosystem (SOE) Reporting: Context for busy people

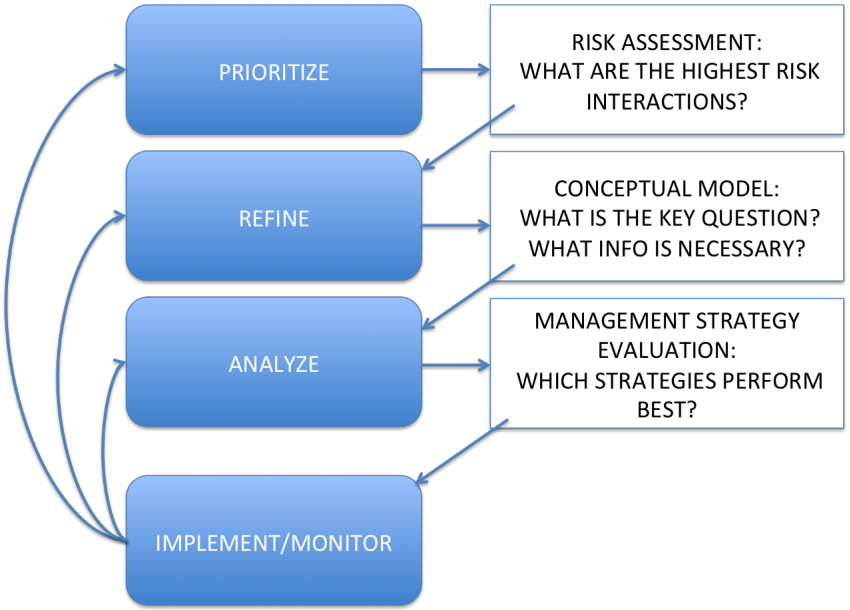
"So what?" --John Boreman, September 2016

1. Clear linkage of ecosystem indicators with management objectives
2. Synthesis across indicators for big picture
3. Objectives related to human-well being placed first in report
4. Short (< 30 pages), non-technical (but rigorous) text
5. Emphasis on reproducibility



Mid-Atlantic Council Ecosystem Approach

- 2016 EAFM Policy Guidance document; revised 2019[1]
- MAFMC EAFM framework[2]



- 2017 Inital EAFM risk assessment completed; revised and published 2018[3]
- SOE indicators to be used for annual risk assessment updates

[1] http://www.mafmc.org/s/EAFM-Doc-Revised-2019-02-08.pdf

[2] https://www.frontiersin.org/articles/10.3389/fmars.2016.00105/full

[3] https://www.frontiersin.org/articles/10.3389/fmars.2018.00442/full

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

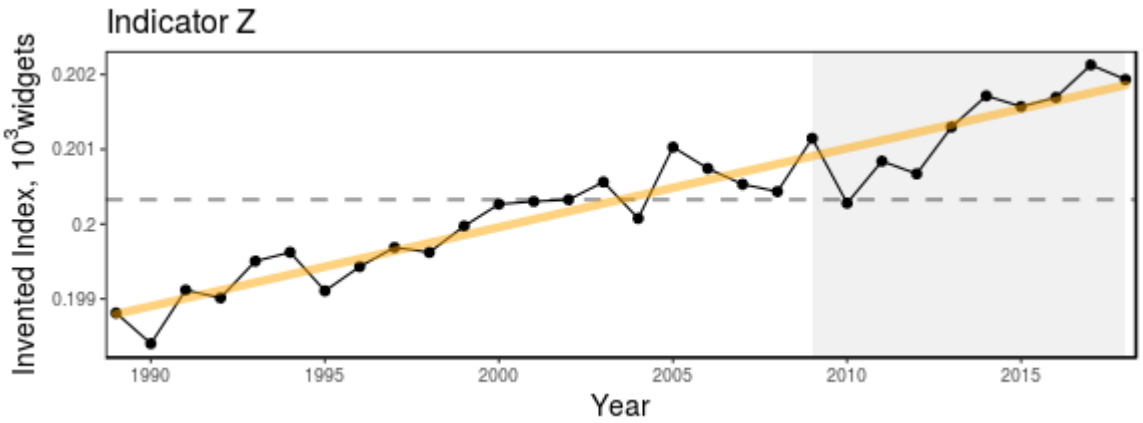
Objective Categories	Indicators
Seafood Production	Landings by feeding guild
Profits	Revenue by feeding guild
Recreation	Number of anglers and trips; recreational catch
Stability	Diversity indices (fishery and species)
Social & Cultural	Commercial and recreational reliance
Biomass	Biomass or abundance 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

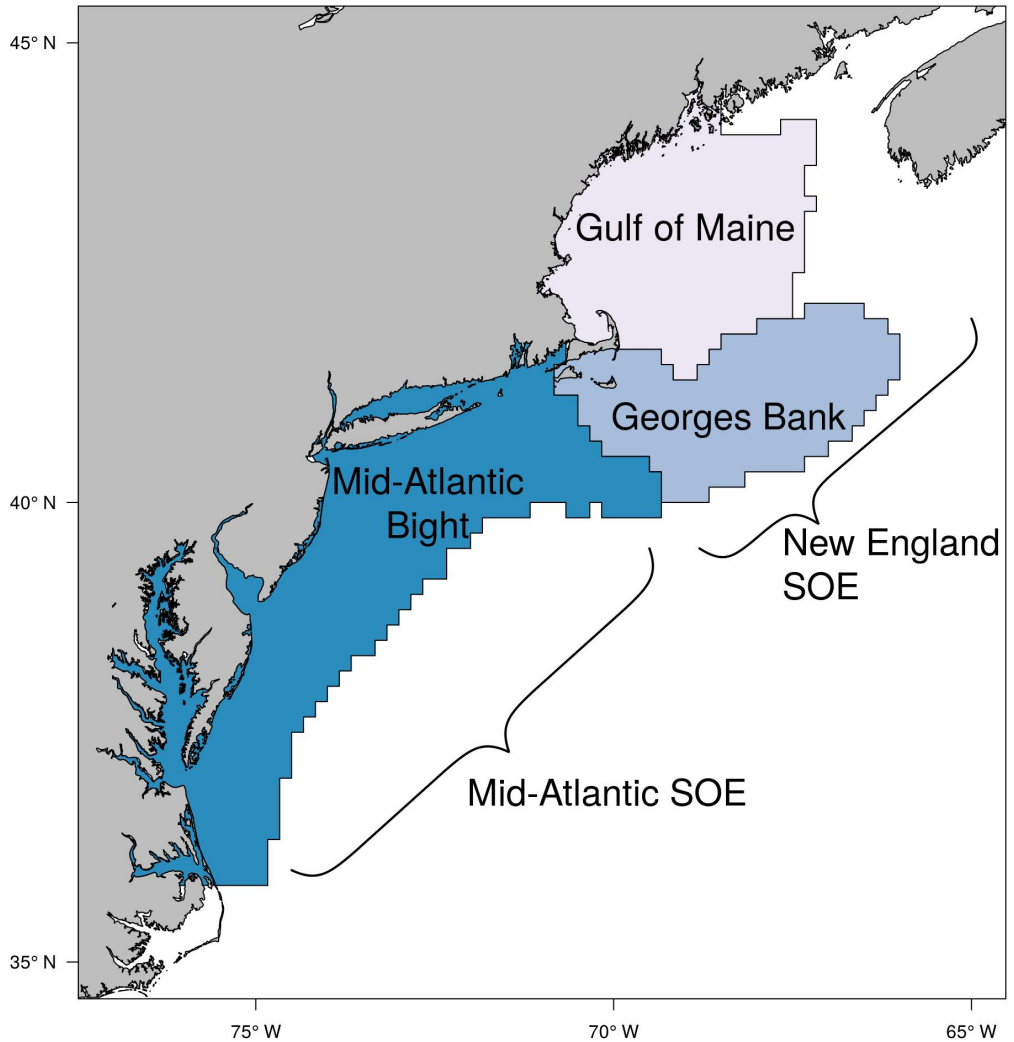


[1] Rice J. C.Rochet M. J. "A framework for selecting a suite of indicators for fisheries management." ICES Journal of Marine Science 62 (2005): 516–527.

[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



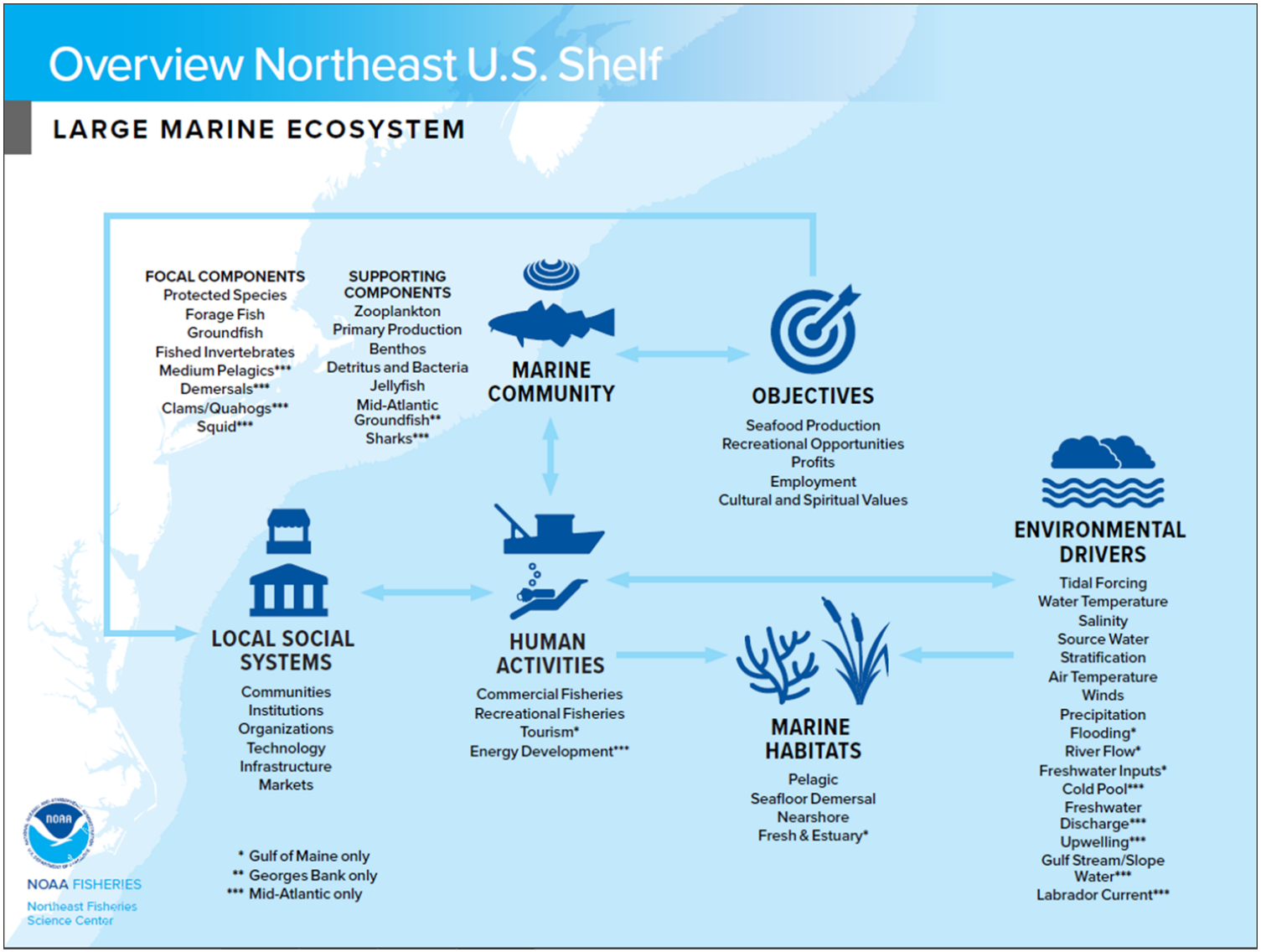
https://noaa-edab.github.io/tech-doc/epu.html

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)

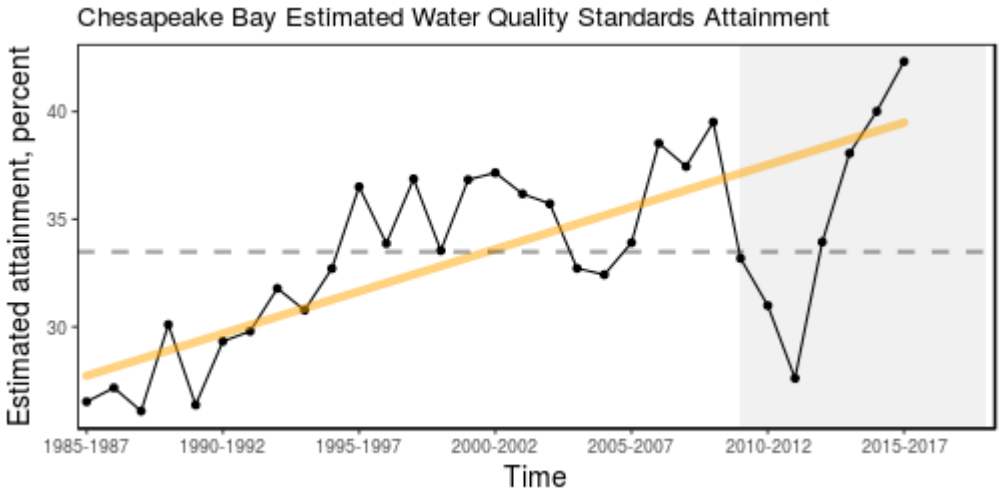
SOE 2019 Overview Results



Good news: Management works (I)

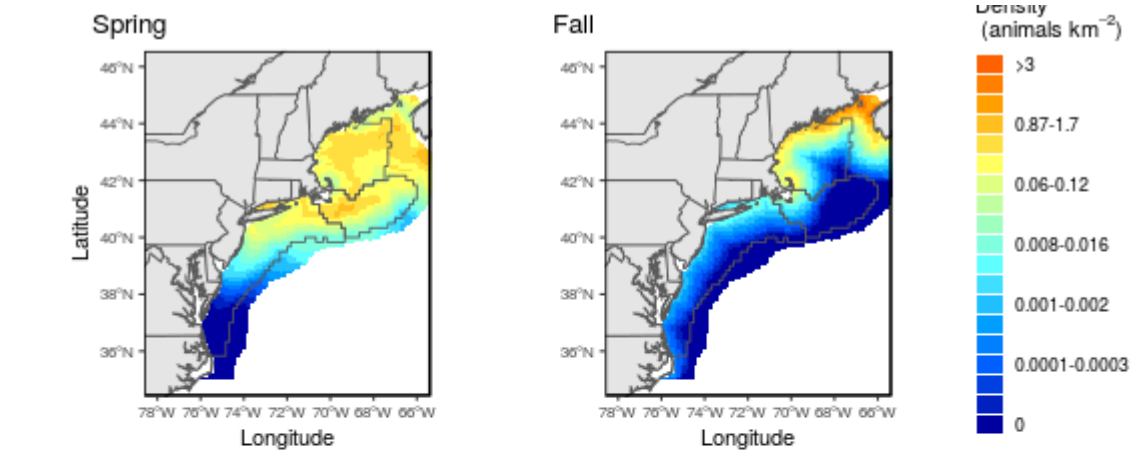
Evidence suggests that management limiting nutrient inputs has significantly improved water quality in Chesapeake Bay

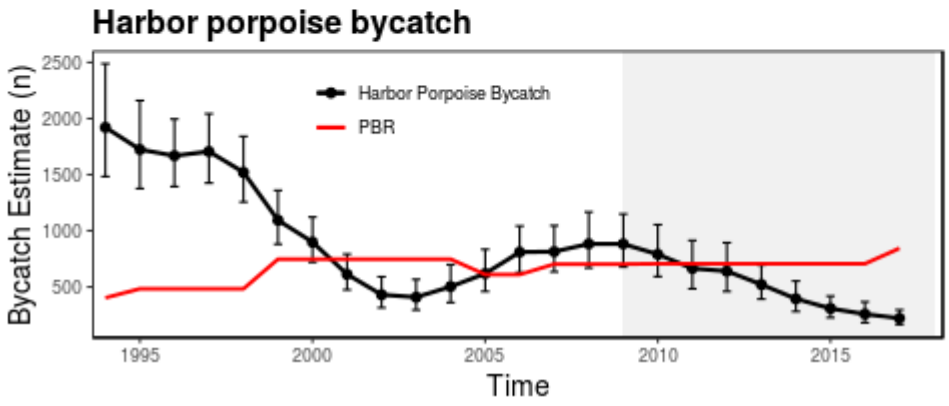
Chesapeake Bay Water Quality



Good news: Management works (II)

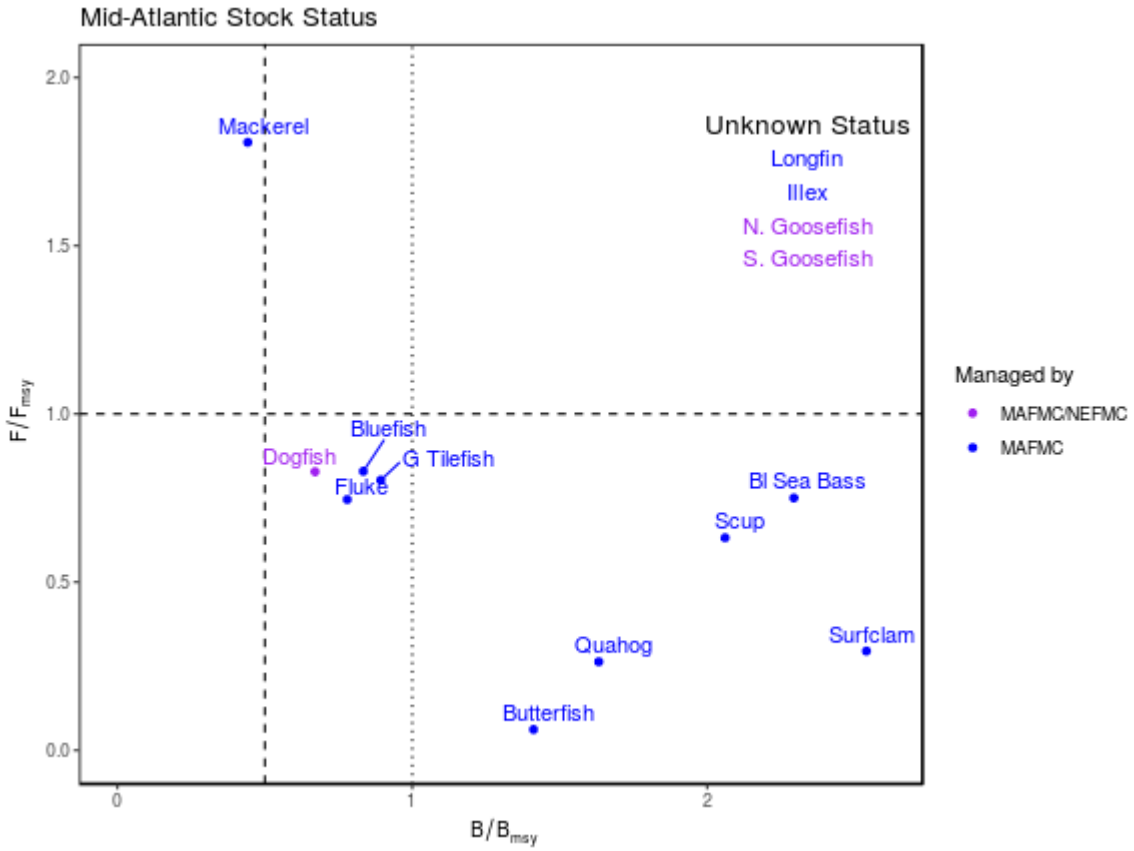
Current bycatch levels suggest that management actions have been effective in reducing harbor porpoise bycatch





Harvested species (mostly) meeting B and F objectives

- Atlantic mackerel stock above F/Fmsy and below 0.5 B/Bmsy
- Summer flounder status improved in recent benchmark

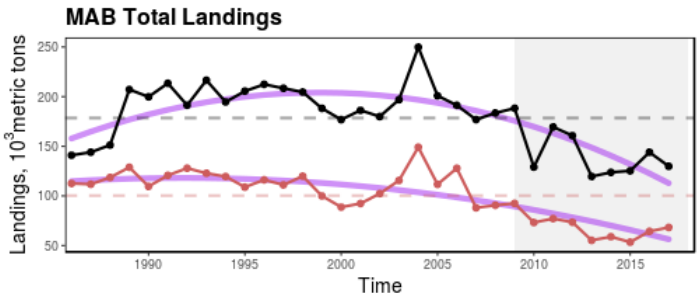


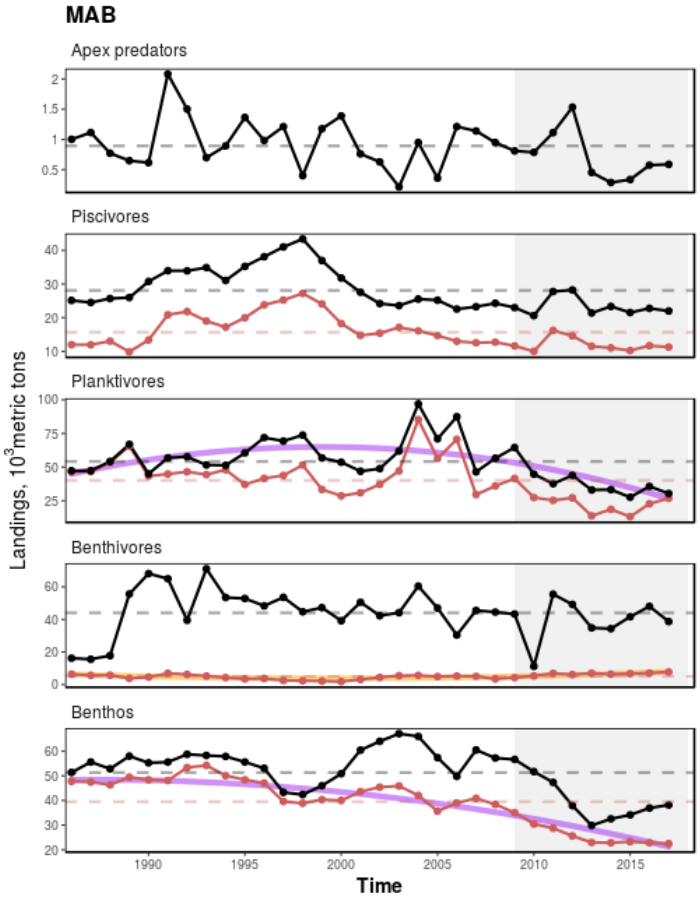
Challenges: Long term decline in seafood production

Commercial fisheries landings: total and by guild

MAB:

- Total managed and non-managed landings in MAB are declining, playing out as declines in most feeding guild landings
- Increase in benthivore landings (scup, black sea bass, tilefish)



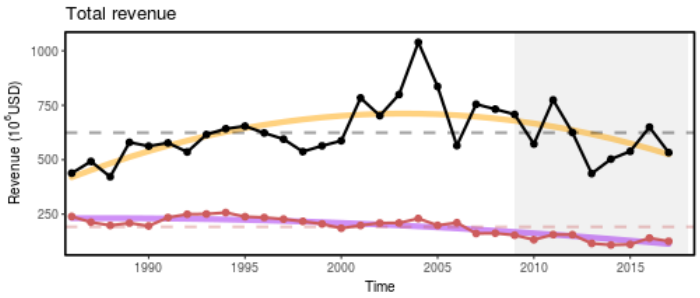


Challenges: Long term decline in commercial revenue

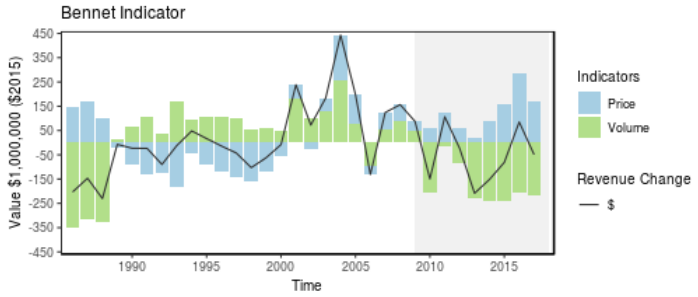
Commercial fisheries: Total revenue, with price and volume components

MAB:

- Total revenue of managed species shows negative trend



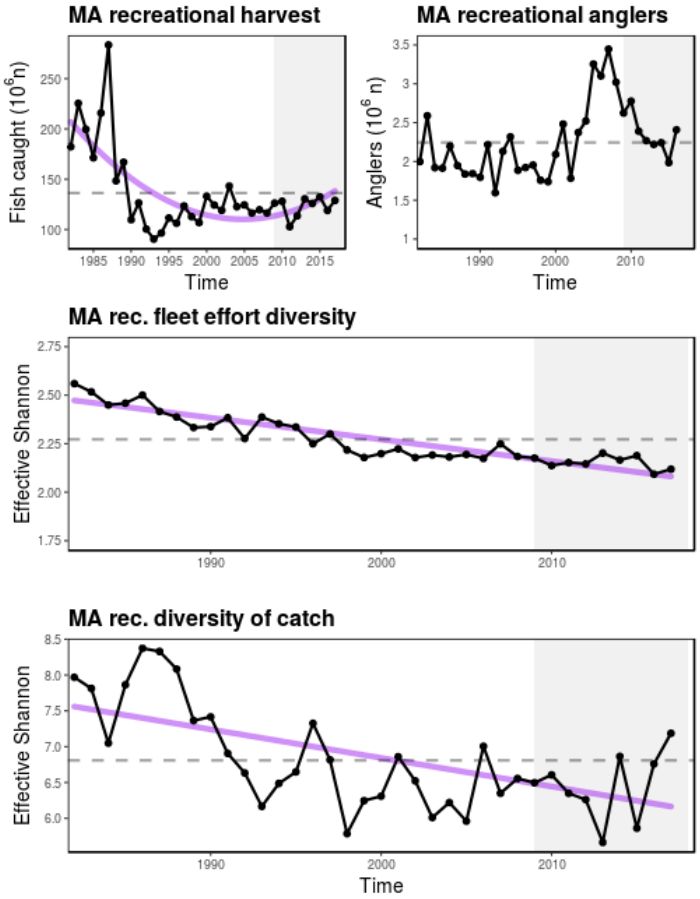
- Driven by decreased landings volume outweighing increased prices for benthos, planktivores, and other species groups



Challenges: Decreased diversity in the recreational sector

MAB:

- Overall decline in rec seafood harvest since 1980s
    - Trending upwards since mid-90s
- Increase in recreational effort (n anglers) since the mid 90s
- Decreasing diversity indicators
    - Fleet effort diversity driven by fewer party boats (24% of all trips down to 6%)
    - Species diversity does not break out the SAFMC-managed species--should it?

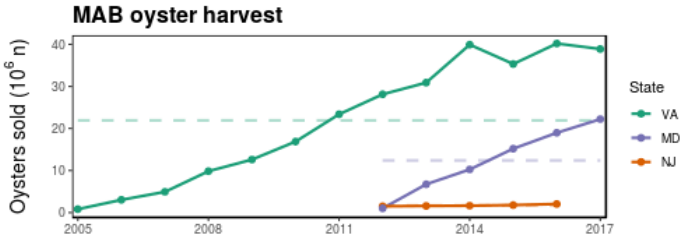


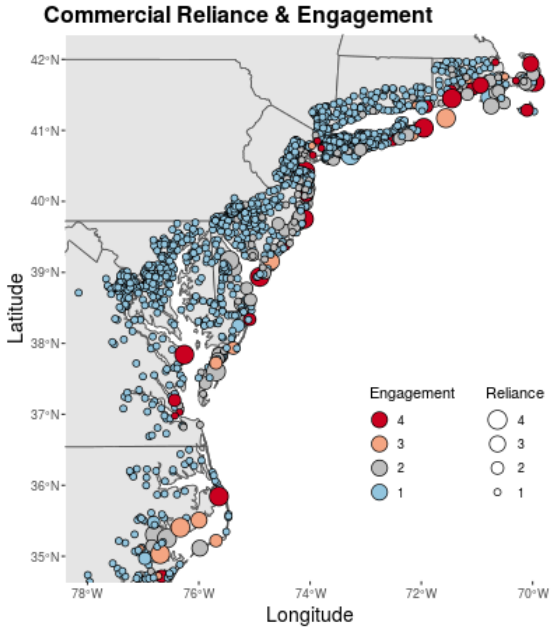
Risk of high reliance on climate-vulnerable species

Community engagement and reliance on commercial fisheries

MAB:

- High social-ecological reliance on scallop commercial fisheries
- Species considered moderately to highly at risk due to climate change (OA, temp)
- Aquaculture in the MAB is also dominated by shellfish (oysters)

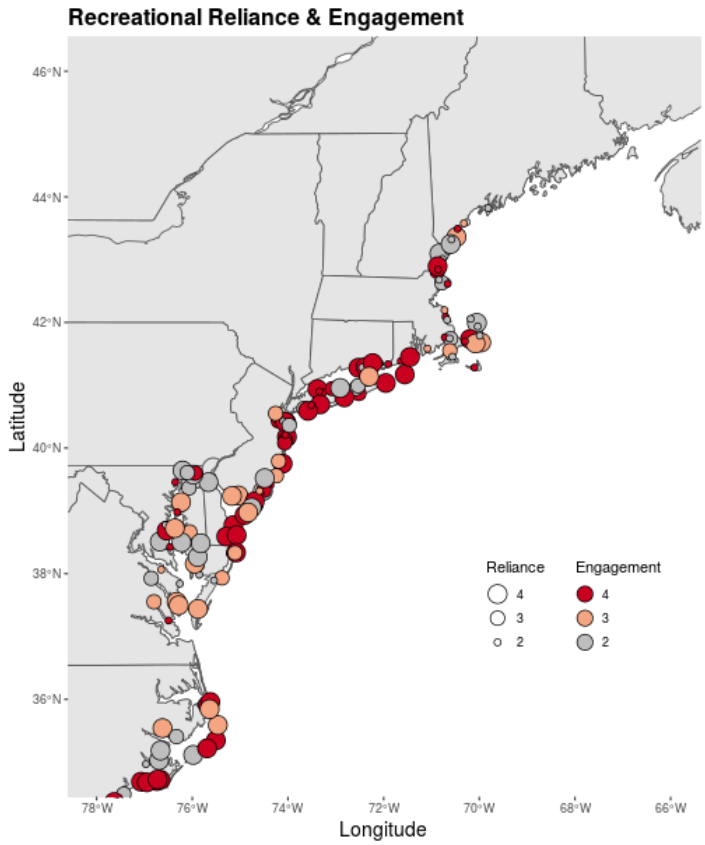




Risk of changing species diversity for recreational fishing?

Recreational engagement and reliance

- Downward trend in recreational catch diversity may threaten fishing community stability in Mid-Atlantic (caveat: should SAFMC species be separated?)
- Engaged and reliant communities in New England could benefit from higher diversity of catch observed (see New England report)



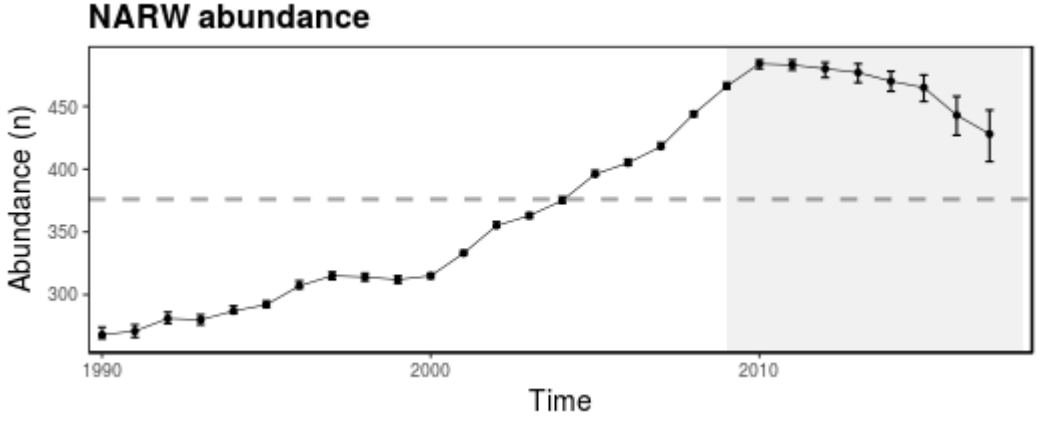
Challenges: Protected species interactions

- 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

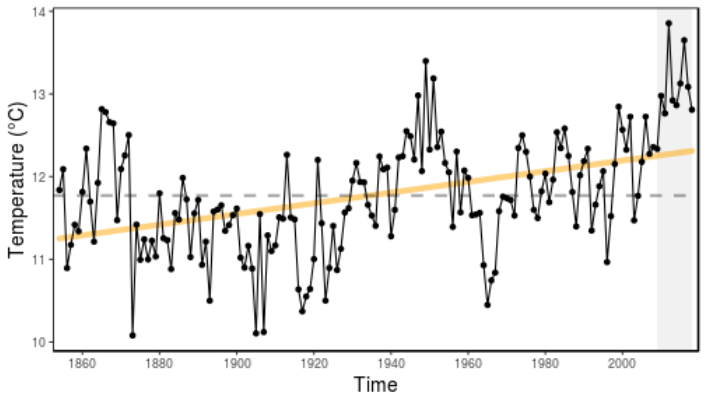
- Evidence suggests that the level of interaction between NARWs, fixed gear (US and CAN) is contributing to the decline of the species
    - 20 NARW deaths in 2017 and 2018, >50% due to human interactions (5 vessel strike, 6 entanglement)



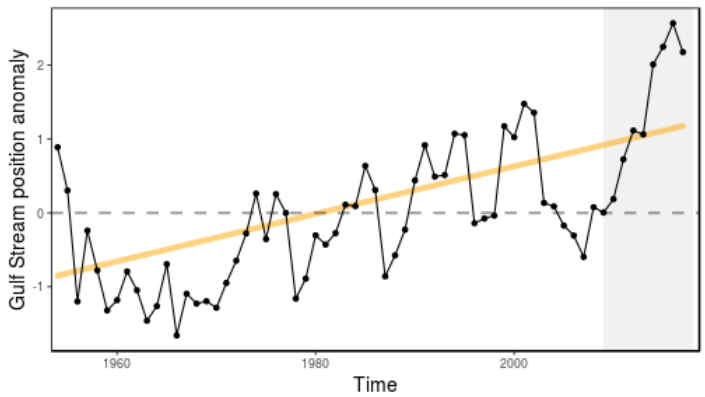
Challenge: Unprecedented ecosystem observations

- 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?



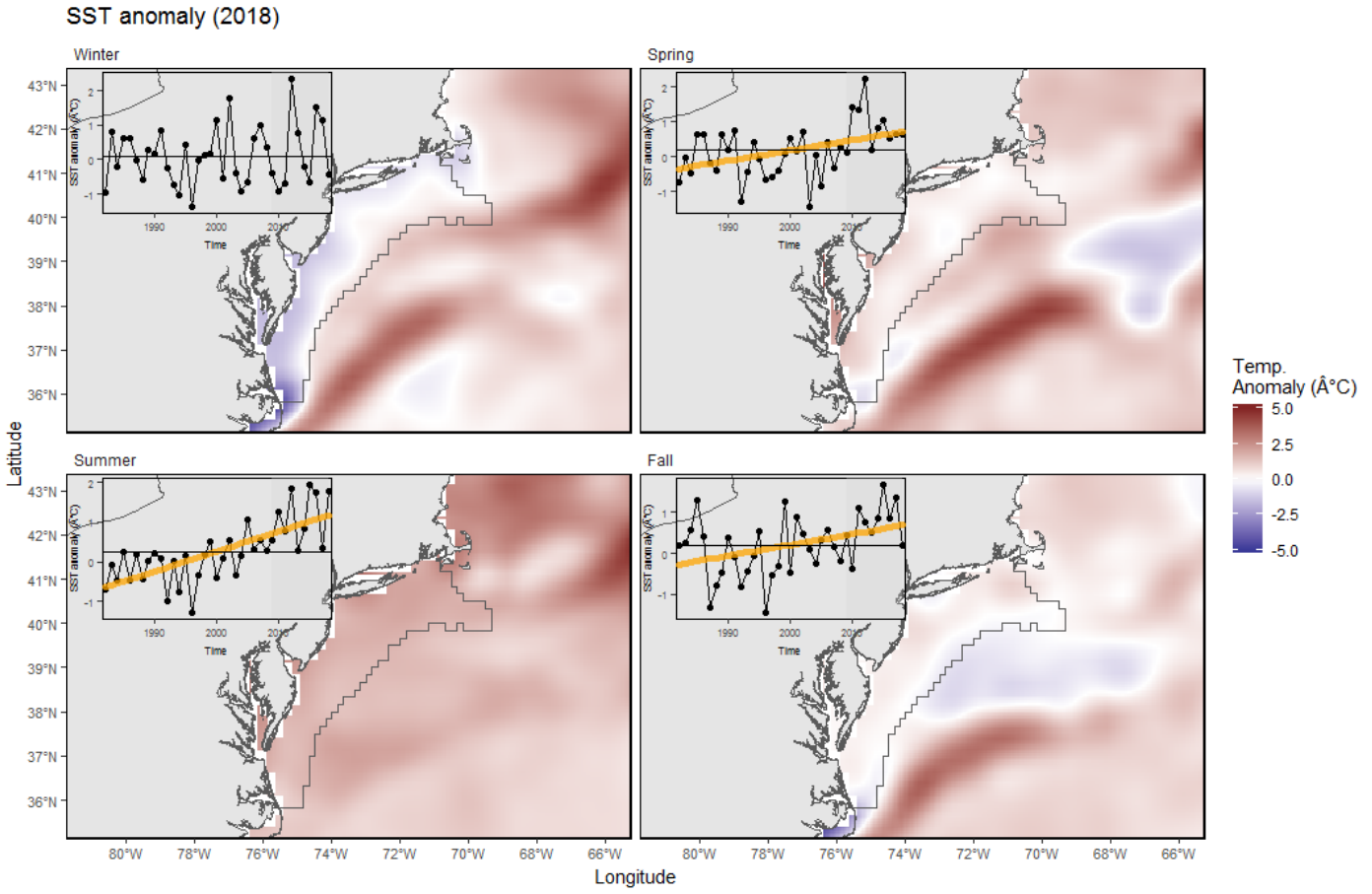
NE Shelf Long-term SST



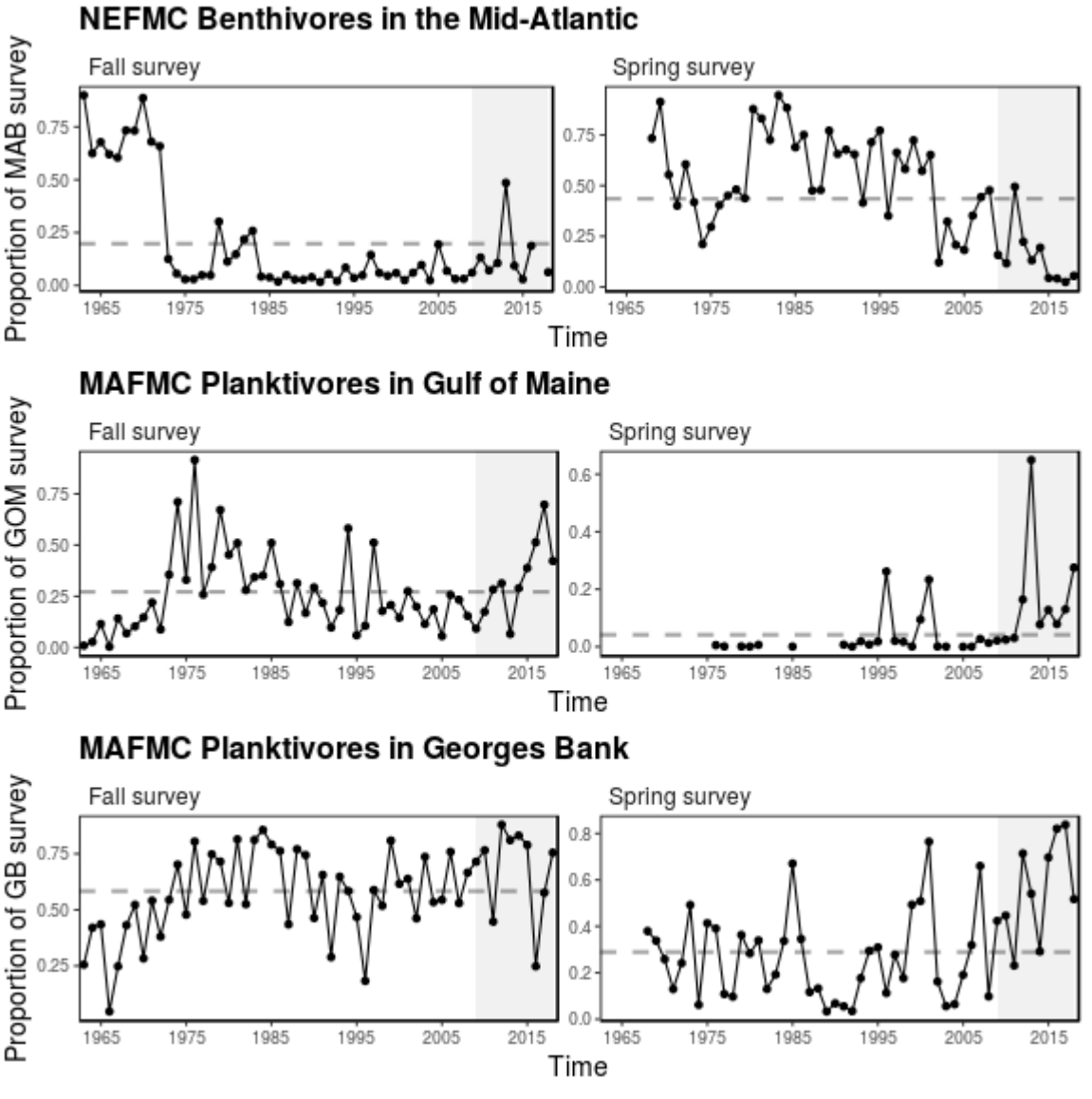
Gulf Stream Index

Challenge: Mid-Atlantic is warming

- Mid-Atlantic summer 2018 SSTs were 3rd highest on record
- Bottom temperature increasing as well, past 6 years all above average



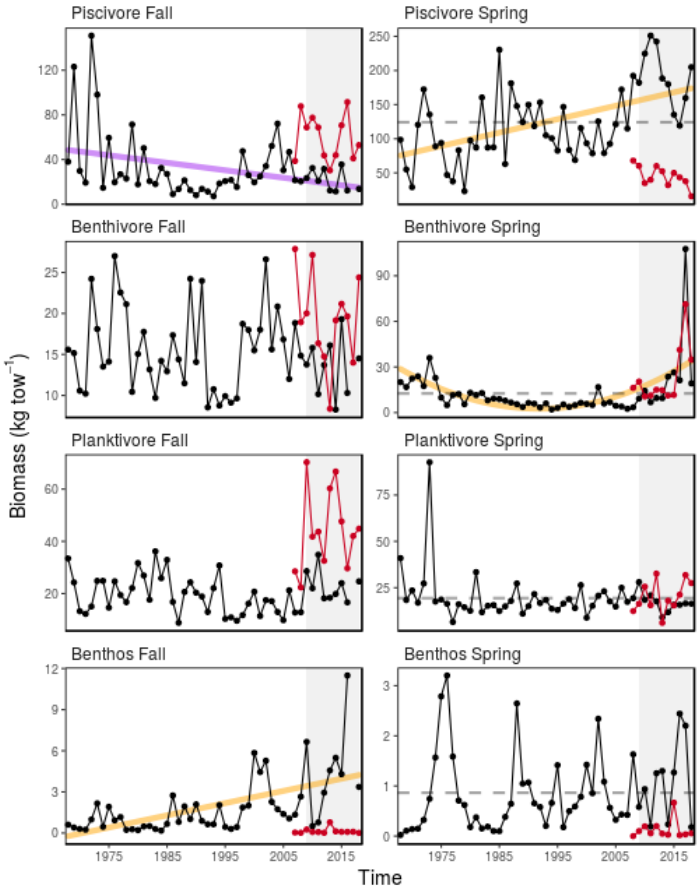
Management implications: species shifts



Comparing inshore and offshore surveys

Bottom trawl surveys: Mid-Atlantic

- NEFSC bottom trawl survey data paired with NEAMAP inshore bottom trawl data from the region
- Opposing trends in piscivore biomass during the spring and fall seasons for the offshore survey
- As temperature and ocean circulation indicators trend toward extremes, fishery management based on static stock areas will likely face continued changes in species distribution

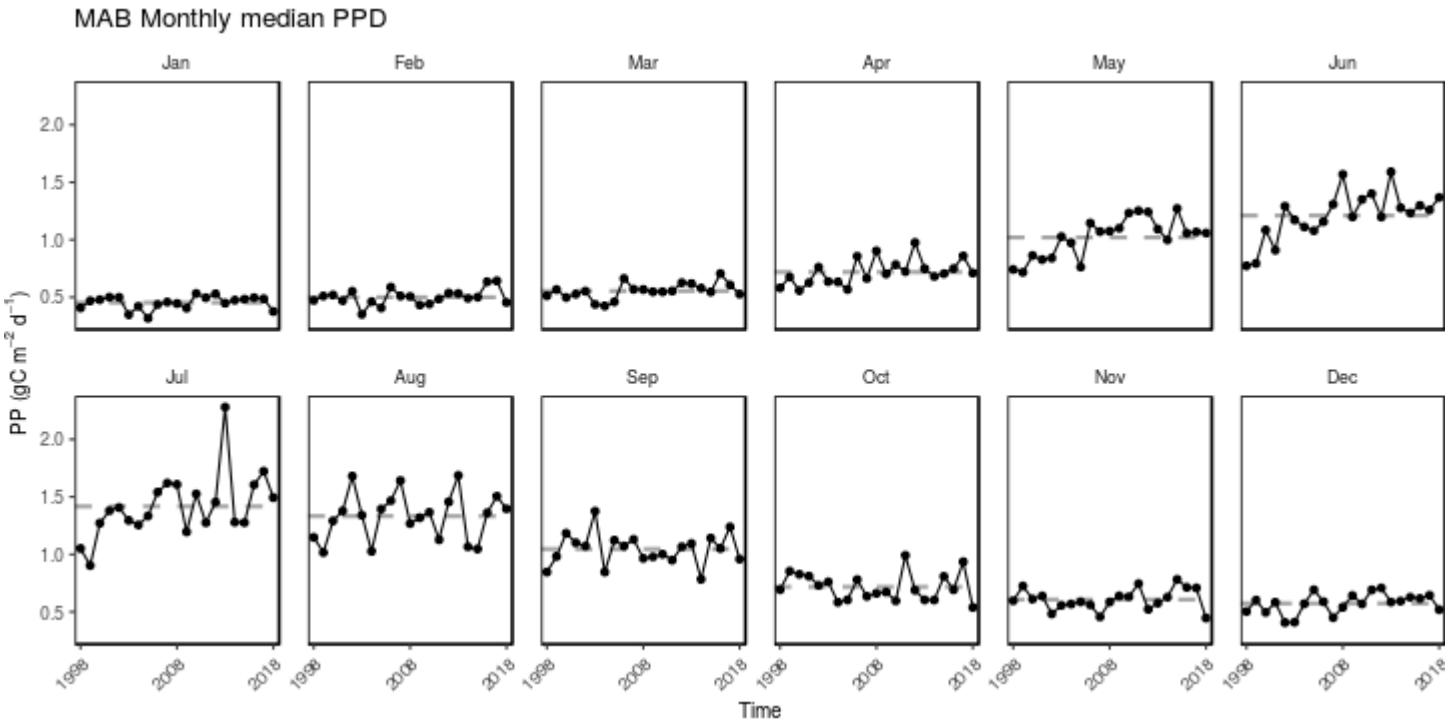


[1] View all survey data

[2] Explore survey proportions

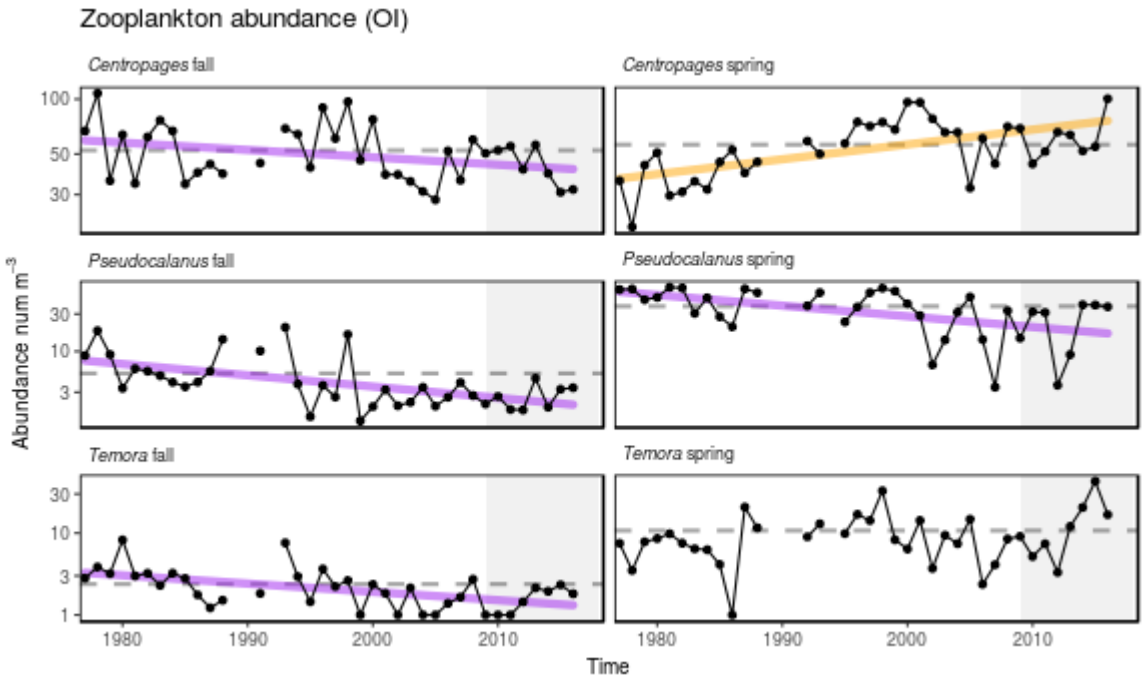
Changing base of the food web: primary production

- 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

- Seasonal abundances of key zooplankton species
  - Opposing trends in *Centropages* in spring and fall, which corresponds to a shift in timing of their peak concentration from late fall to early spring[1]

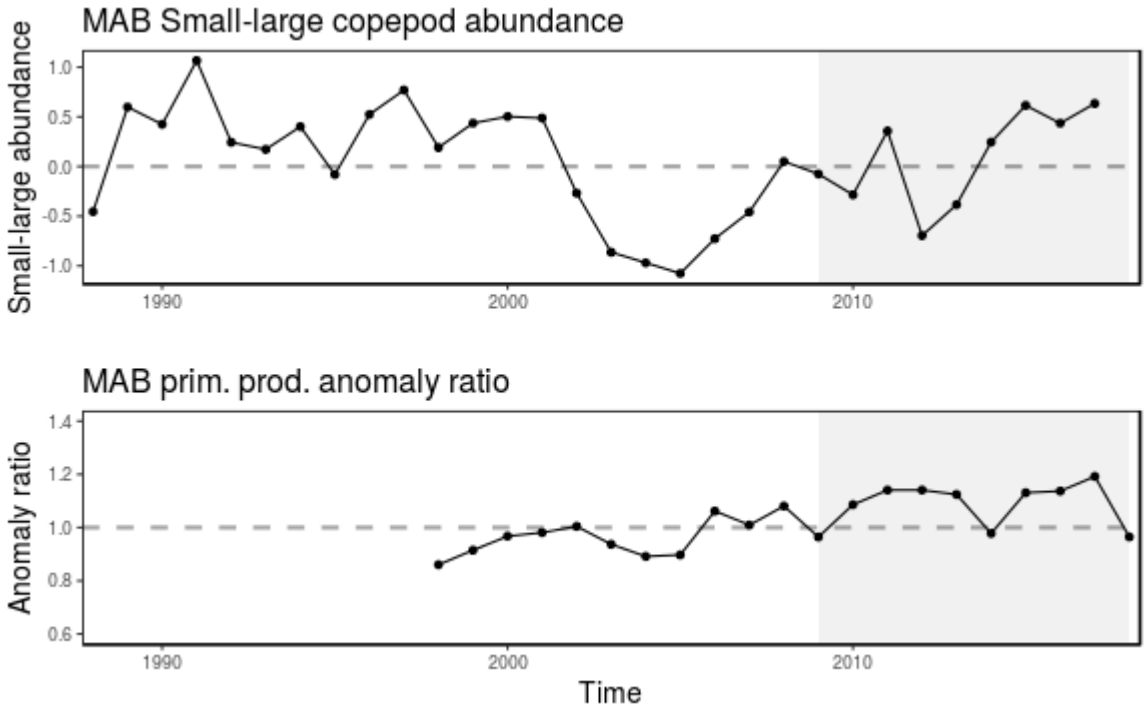


[1] Bi H, Ji R, Liu H, Jo Y-H, Hare JA. Decadal Changes in Zooplankton of the Northeast U.S. Continental Shelf. PLOS ONE. 2014;9: e87720. doi:10.1371/journal.pone.0087720

Changing base of the food web

Primary production and copepod size structure

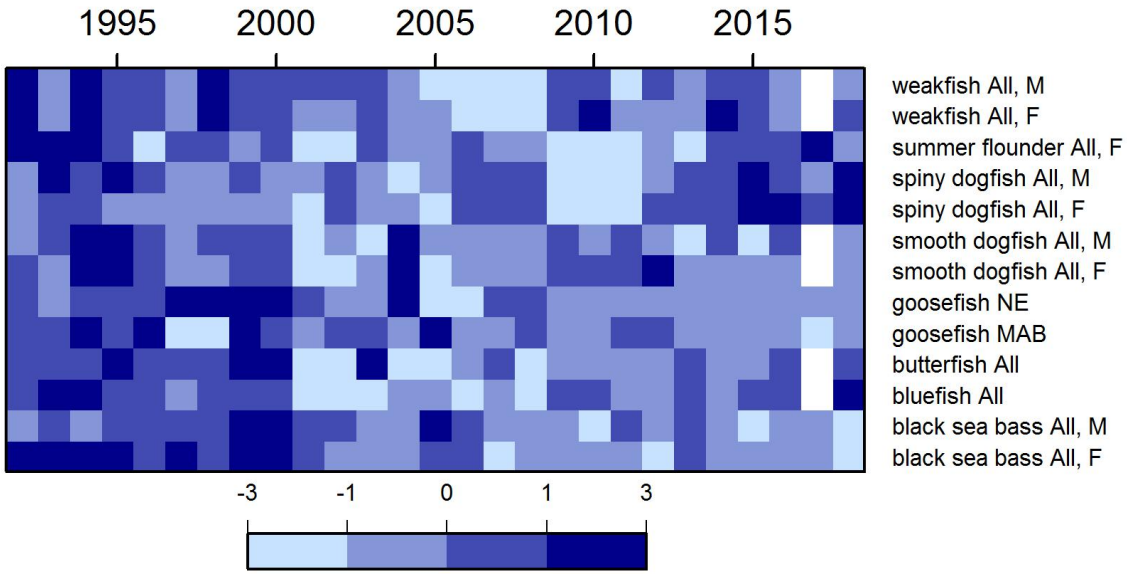
- Lower copepod size index means higher abundance of large copepods (*Calanus*)
- Primary production may play a role in zooplankton size dynamics on the shelf



Changing base of the food web and fish conditions

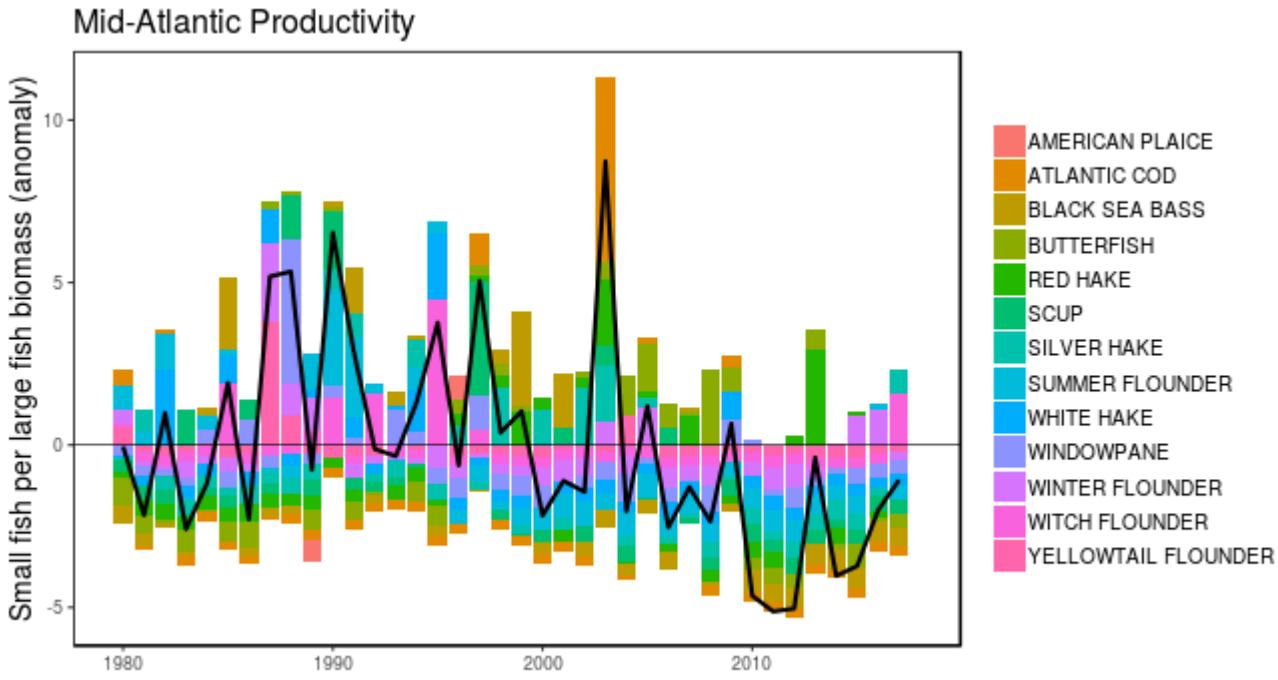
- Fish condition is measured at the weight at a given length relative to the average
  - drop-off in condition around 2000 aligns with the shift in zooplankton size-structure on the shelf

MAFMC Condition Factor



Changing base of the food web and fish productivity

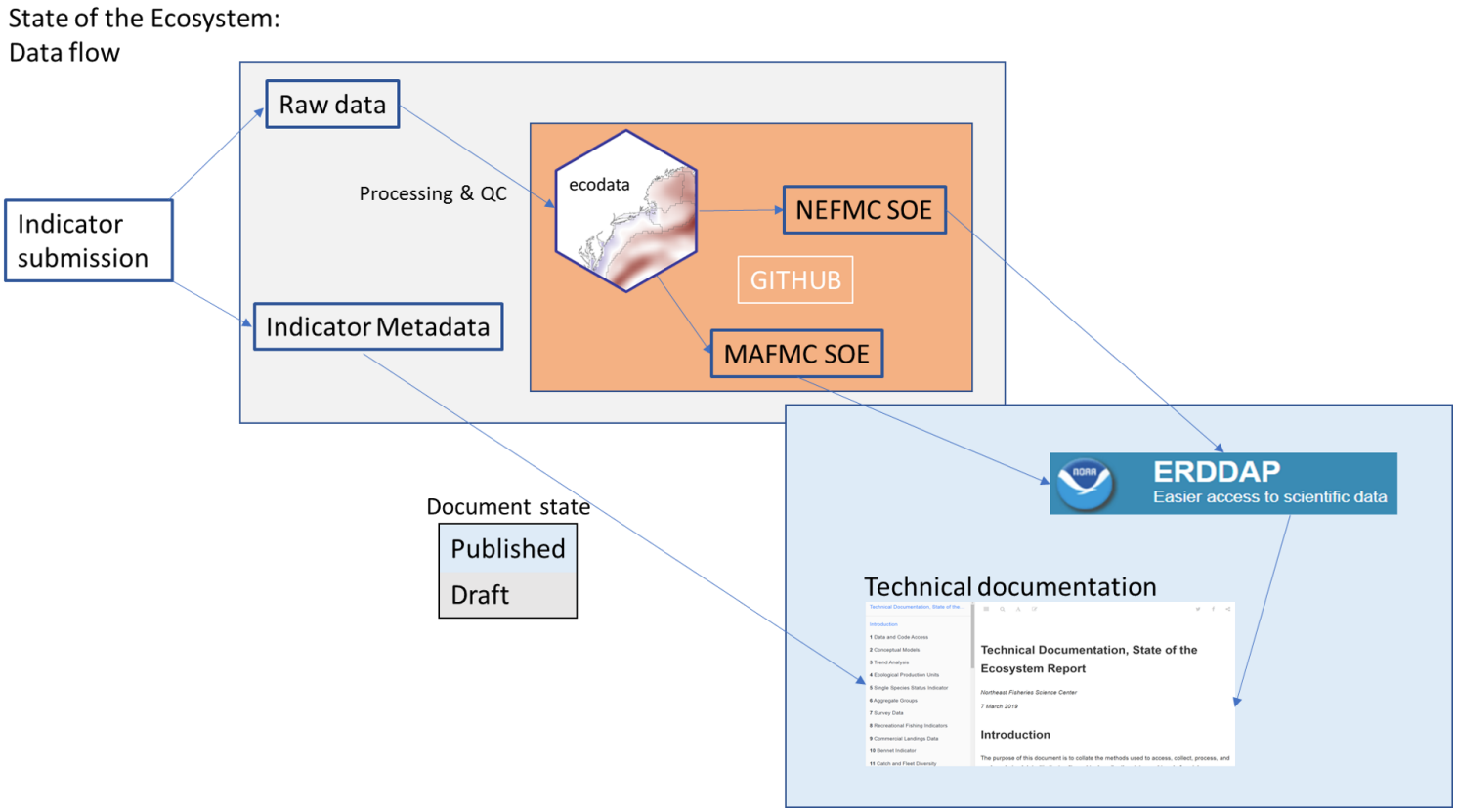
- During the 1990s and early 2000s, high relative abundance of smaller bodied copepods and a lower relative abundance of *Calanus finmarchicus* coincided with regime shifts to lower fish recruitment[1]



[1] Perretti, C., Fogarty, M., Friedland, K., Hare, J., Lucey, S., McBride, R., Miller, T., et al. 2017. Regime shifts in fish recruitment on the Northeast US Continental Shelf. Marine Ecology Progress Series, 574: 1–11.

SOE 2019: Improvements to reproducibility and provenance

- Reporting the information is not enough
- Managers appreciate the concise format, but back-end critical for describing collection, analyses, and processing



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

Contributors - THANK YOU!

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

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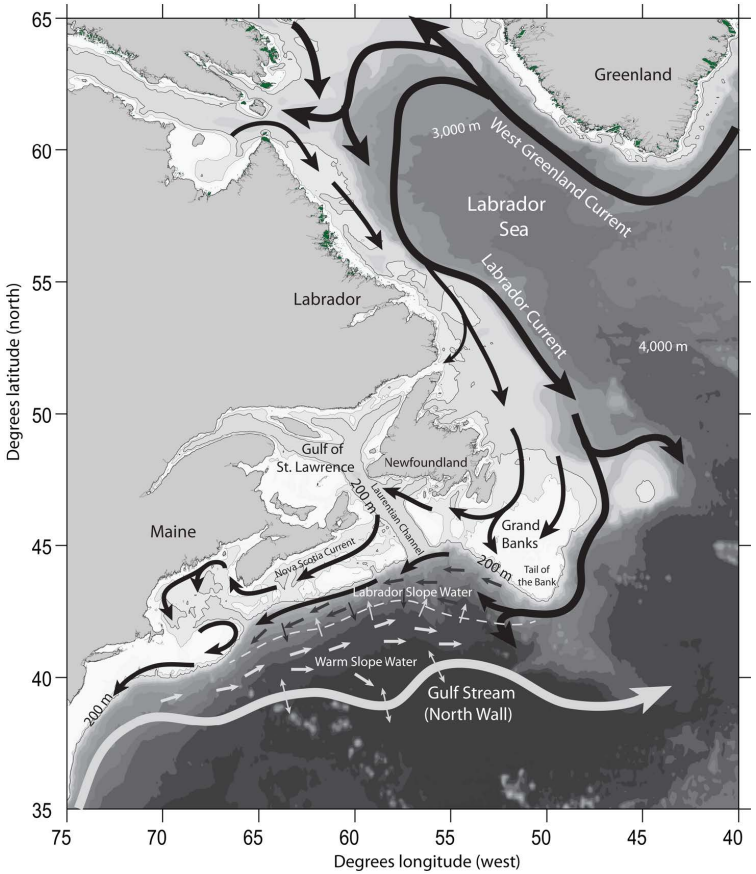
NOAA FISHERIES
National Oceanic and Atmospheric Administration

IEA
INTEGRATED ECOSYSTEM ASSESSMENT

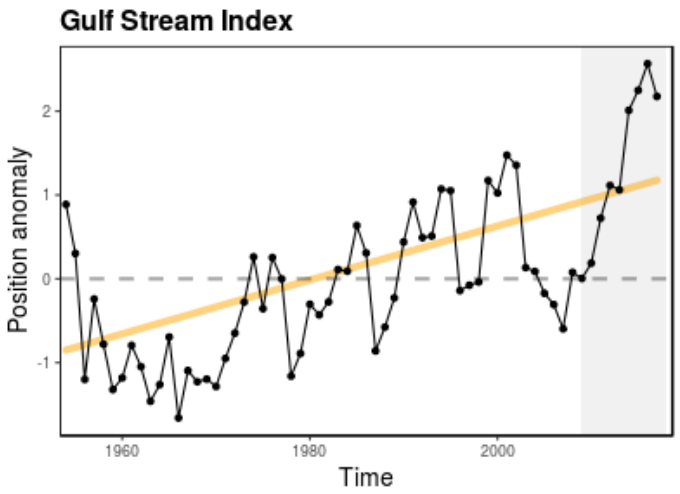
Appendix: Ocean circulation

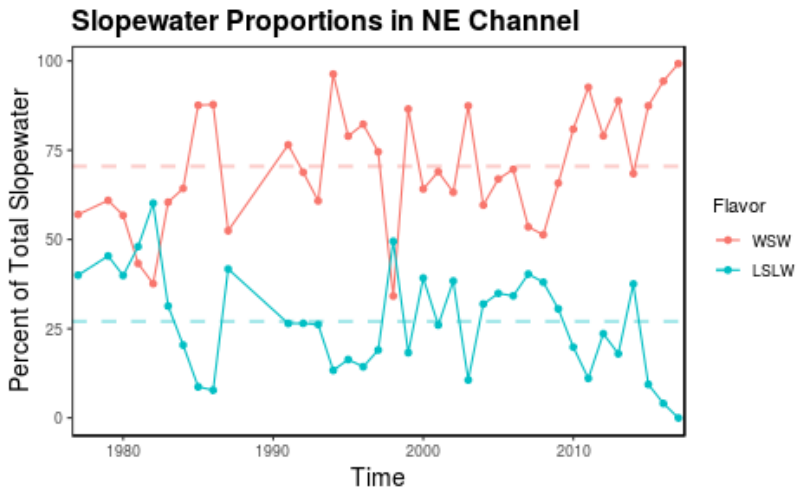


Townsend, D. W., Pettigrew, N. R., Thomas, M. A., Neary, M. G., McGillidcuddy, D. J., O'Donnell, J (2015), Water masses and nutrient sources to the Gulf of Maine, Journal of Marine Research, 73: 93-122.

Appendix: Ocean circulation changes

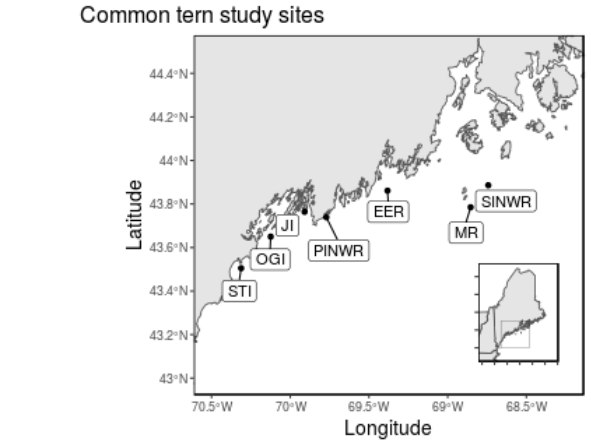
Which brings us back to...

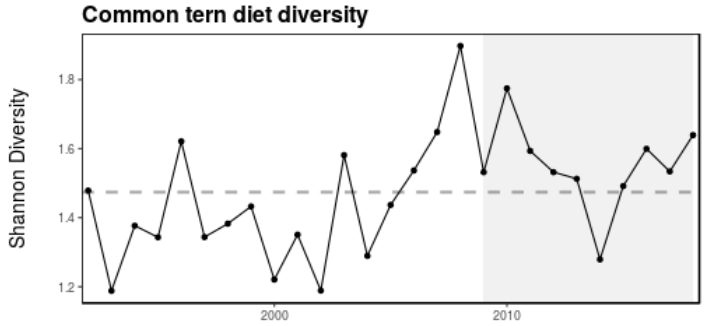




Appendix: Common tern diet diversity

- 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)





Appendix: Common tern diet

- Warmer waters result in *butterfish* appearing in common tern diet
  - May cause starvation or require parents to increase foraging effort
- High diet diversity in past decade may be the result of decreases in preferred prey type (hake, sandlance)