



**NOAA  
FISHERIES**

# Using Ecosystem Information in the Stock Assessment and Advice Processes

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# What do you think EBFM means?

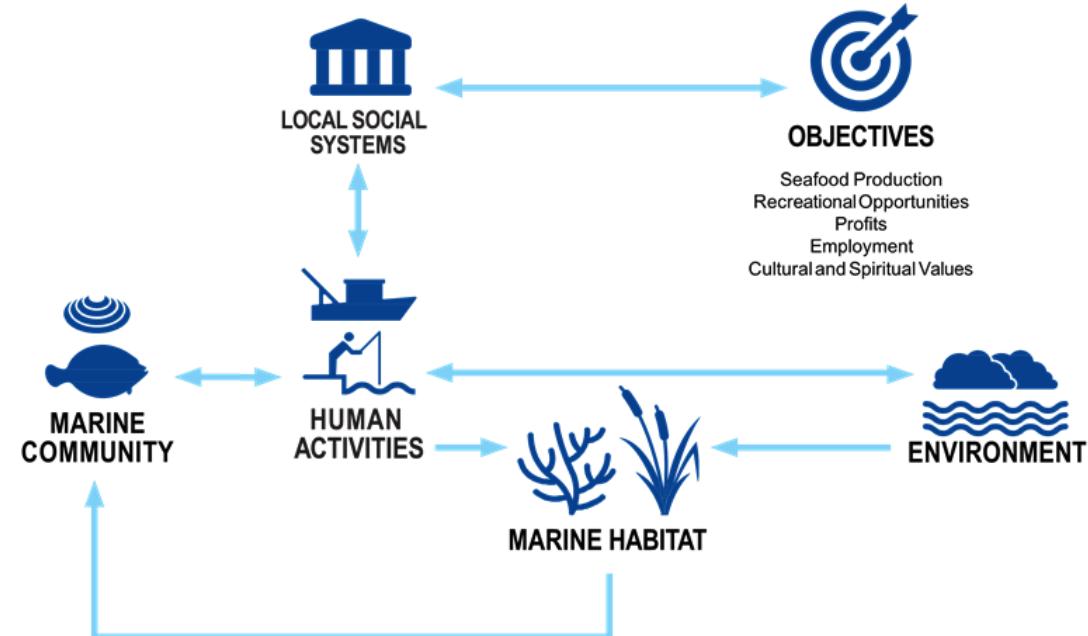
*"Bad for me because I fish for forage fish"*

*"Increased uncertainty and lower quotas"*

*"It's really complex and difficult to implement"*

*"The ocean is changing and we need to account for that"*

*"It could be really effective if done right"*



How can we effectively communicate and use ecosystem information?

## Goal: more effective resource management making best use of available science

## *Outline*

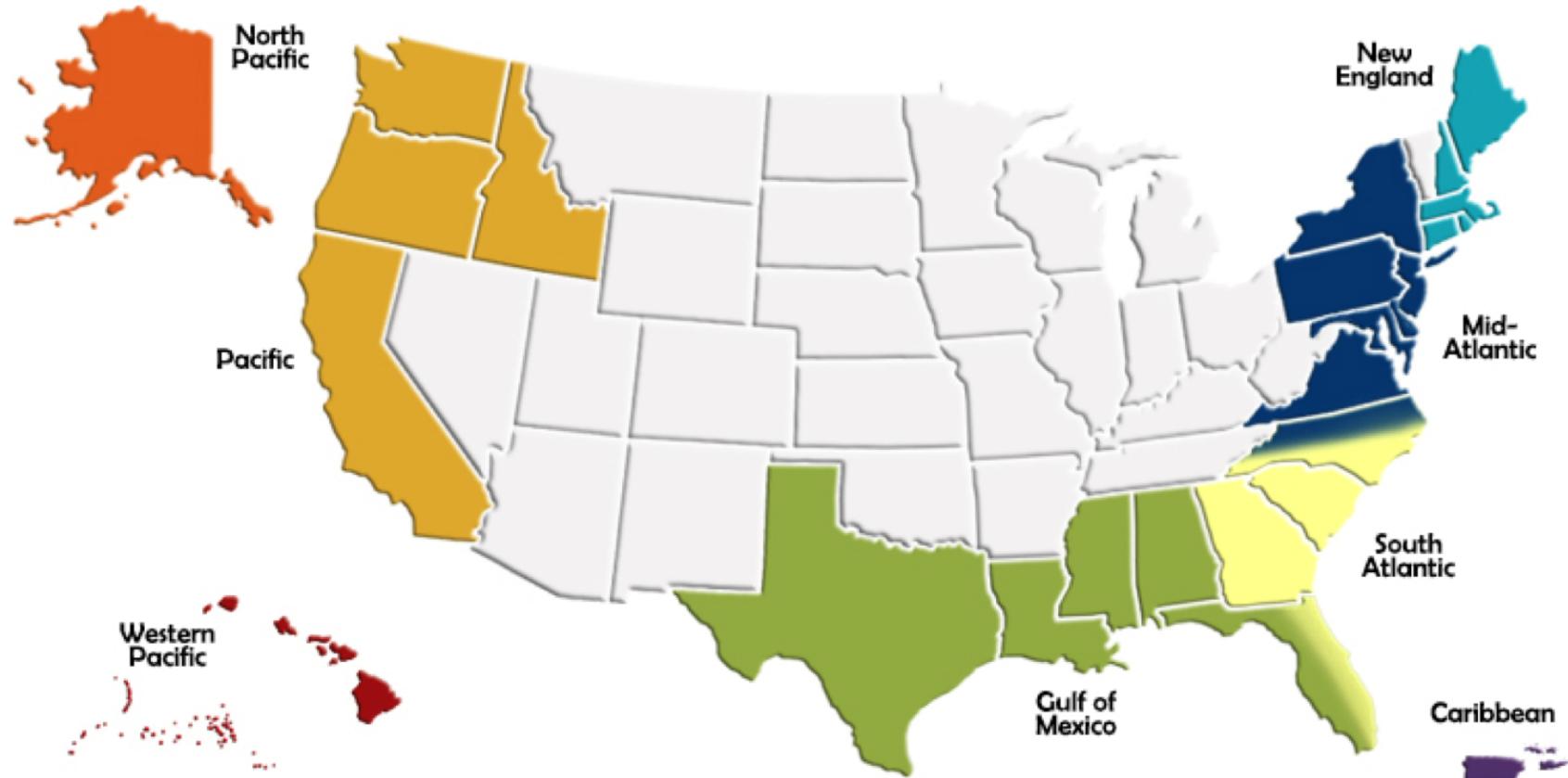
- Using ecosystem information at multiple levels
    - Stock assessment
    - Ecosystem reporting
    - Ecosystem approach (EAFM) for interactions
    - Multispecies and ecosystem level tradeoffs
  - How to support management decisions?
    - Management-science collaboration!
    - Key tools: ecosystem indicators, conceptual modeling, risk assessment, management strategy evaluation
    - Iteratively developing decision processes along with science products



## Word cloud based on Mid-Atlantic Fishery Management Council EAFM Guidance Document

## Background: Federal fishery management in the US

Eight regional Fishery Management Councils establish plans for sustainable management of stocks within their jurisdictions. All are governed by the same law, but tailor management to their regional stakeholder needs.



More information: <http://www.fisherycouncils.org/>

<https://www.fisheries.noaa.gov/topic/laws-policies#magnuson-stevens-act>

# The Mid-Atlantic Fishery Management Council (MAFMC)



Summer Flounder, Scup, Black Sea Bass



Spiny Dogfish



Mackerel, Squid, Butterfish



Bluefish



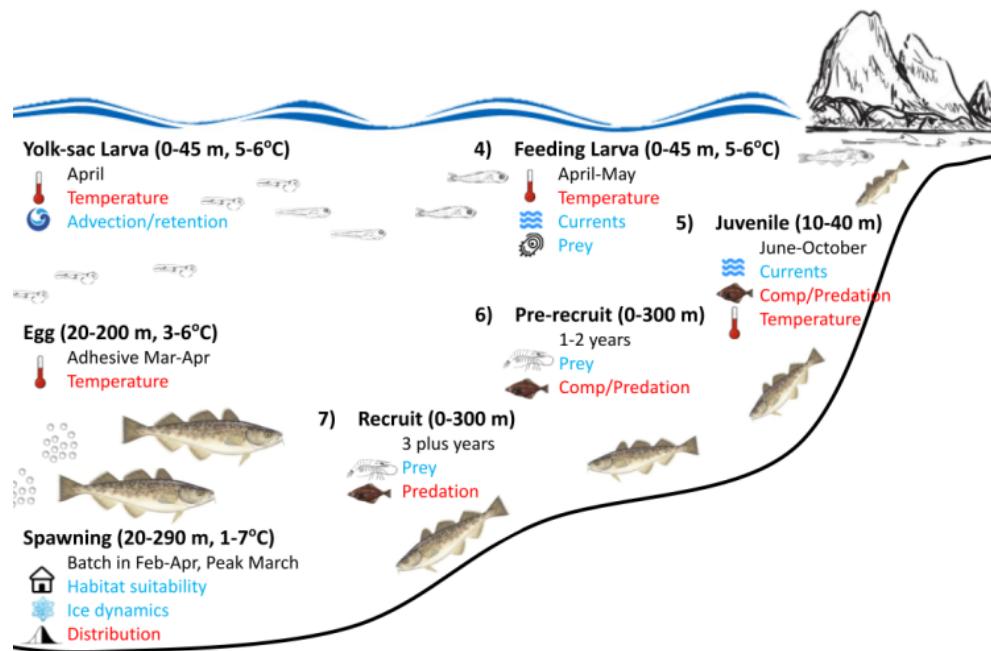
Surfclam and Ocean Quahog



Tilefish



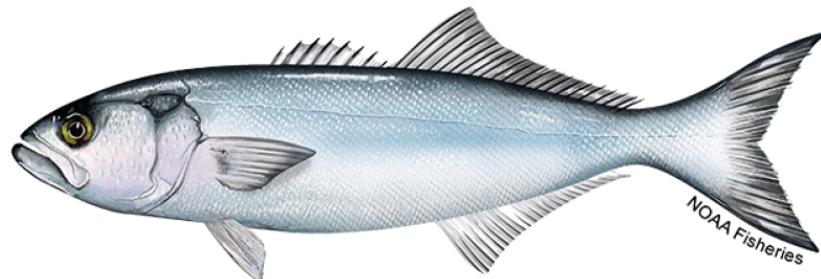
# Ecosystem information for fish stocks: Alaska Ecosystem and Socioeconomic Profiles



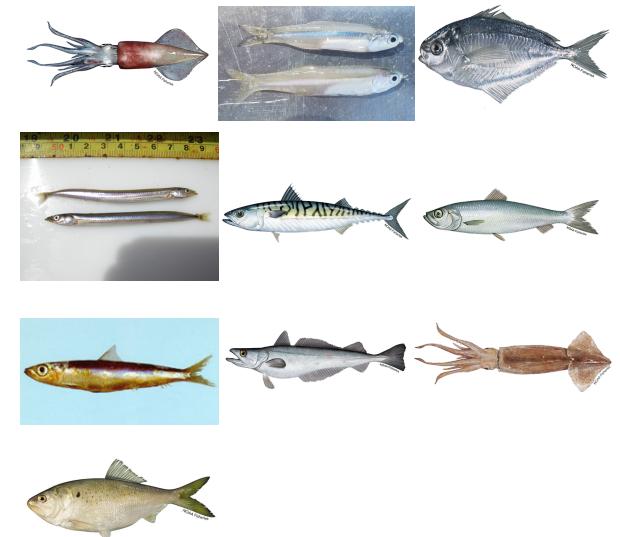
Ecosystem and Socioeconomic Profiles (ESPs)  
 (Shotwell, et al., 2023; Shotwell, et al., 2022; Haltuch, et al., 2020; Tolimieri, et al., 2018; Dorn, et al., 2020)

Indicator category	Indicator	2017 Status	2018 Status	2019 Status	2020 Status	2021 Status
Physical	Spawning Heatwave GOA Model	neutral	neutral	high	neutral	neutral
	Winter Spring Pacific Cod Spawning Habitat Suitability GAK1 Model	neutral	neutral	low	neutral	neutral
	Summer Temperature Bottom GOA Model	neutral	neutral	high	neutral	neutral
	Annual Eddy Kinetic Energy Kodiak Satellite	neutral	neutral	neutral	high	neutral
Lower Trophic	Spring Chlorophyll a Peak WCGOA Satellite	low	low	high	low	neutral
	Summer Large Copepod Abundance Shelikof Survey	low	NA	neutral	NA	NA
	Summer Euphausiid Abundance Kodiak Survey	low	NA	neutral	NA	NA
	Spring Pacific Cod CPUE Larvae Shelikof Survey	neutral	NA	neutral	NA	neutral
Upper Trophic	Annual Common Murre Reproductive Success Chowiet Survey	neutral	neutral	high	NA	neutral
	Summer Pacific Cod Condition Juvenile GOA Survey	neutral	NA	neutral	NA	neutral
	Summer Pacific Cod Condition Adult GOA Survey	neutral	NA	neutral	NA	neutral
	Summer Pacific Cod Center Gravity Northeast WCGOA Model	low	NA	high	NA	neutral

## Assessment question: Does prey drive availability of bluefish?



*Bluefish diet, Northeast US*



"... it is perhaps the most ferocious and bloodthirsty fish in the sea, leaving in its wake a trail of dead and mangled mackerel, menhaden, herring, alewives, and other species on which it preys." (Collette, et al., 2002)

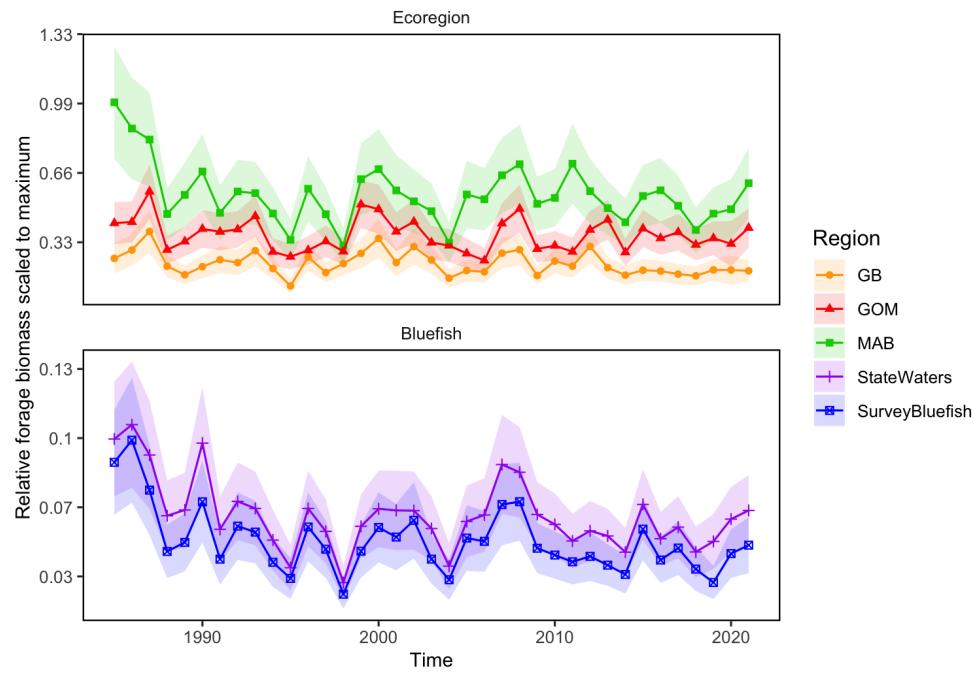
"From Raritan Bay to Rockaway Inlet, we have had a phenomenal bluefish year with lots of bunker and other bait, ultimately leading to an abundance of bluefish." Mid-Atlantic Bluefish Fishery Performance Report, 2021

Northeast Fisheries Science Center Diet Data Online:  
<https://fwdp.shinyapps.io/tm2020/>

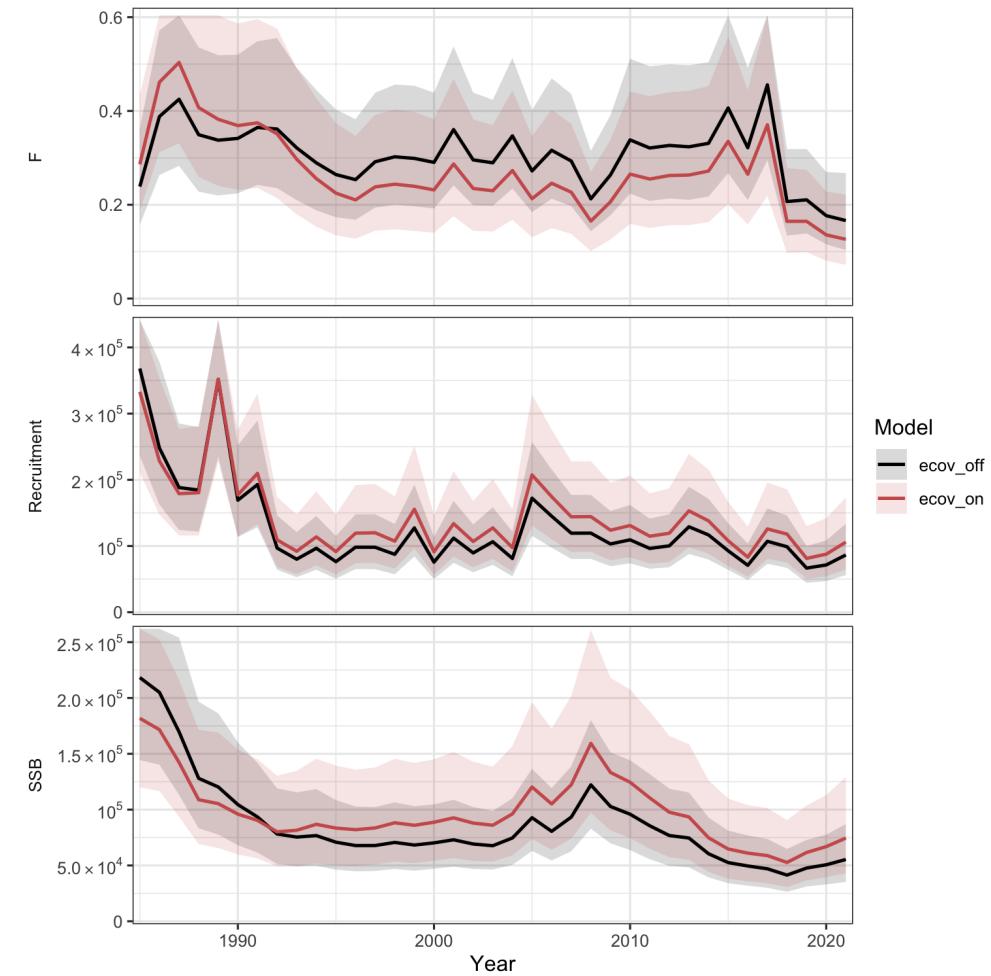
New spatial "forage index" of 20 prey groups from stomach contents of 22 predators (Gaichas, et al., 2023)

## Quotas won't always go down

The bluefish assessment was implemented using the Woods Hole Assessment Model (WHAM) (Stock, et al., 2021) with the forage index as a catchability covariate.



*Inclusion of the forage fish index improved model fit.*

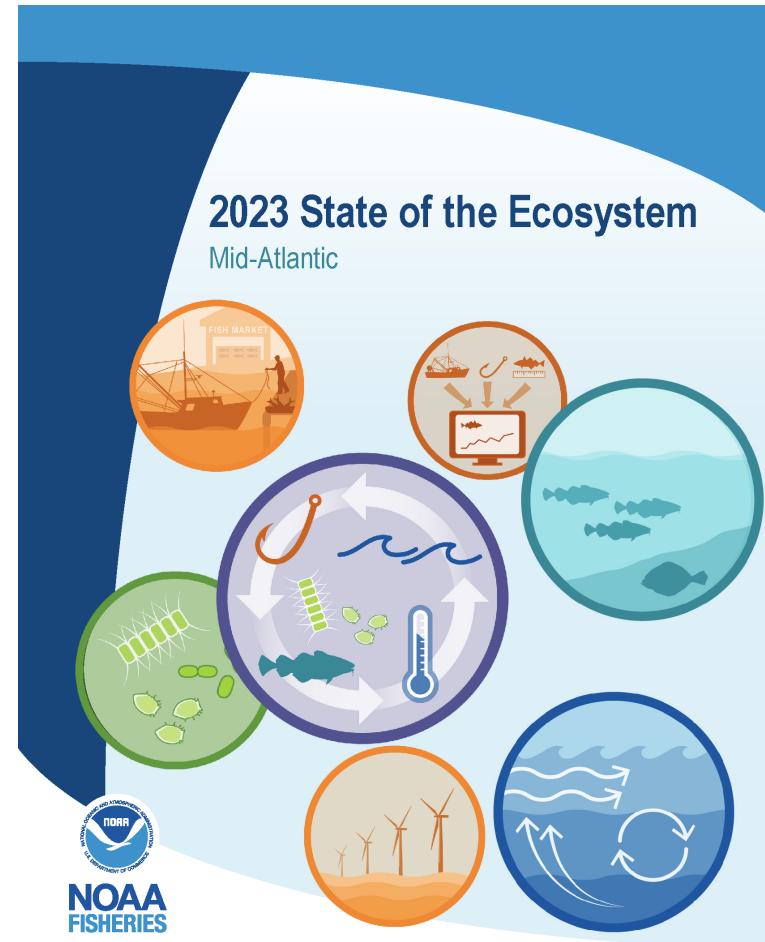


The recreational index is important in scaling the biomass results, and the lower availability at the end of the time-series led to **higher biomass estimates from the assessment including forage fish.**

## Ecosystem reporting in the Northeast US:

### Focus on the fishery management audience

- Ecosystem indicators linked to management objectives (DePiper, et al., 2017)
  - Contextual information
  - Annual reporting since 2016
  - Fishery-relevant subset of full Ecosystem Status Reports
- Open science emphasis (Bastille, et al., 2021)
- Used within Mid-Atlantic Fishery Management Council's Ecosystem Process (Muffley, et al., 2021)
  - Risk assessment (Gaichas, et al., 2018)
  - Conceptual modeling (DePiper, et al., 2021)
  - Management strategy evaluation (MSE)



# Reporting ecosystem level performance first

## Performance relative to management objectives

Seafood production  

Profits  

Recreational opportunities: Effort  ; Effort diversity  

Stability: Fishery  ; Ecological  

Social and cultural, trend not evaluated, status of:

- Fishing engagement and reliance by community
- Environmental Justice (EJ) Vulnerability by community

Protected species:

- Maintain bycatch below thresholds  
- Recover endangered populations (NARW)  

## Performance Relative to Fishery Management Objectives

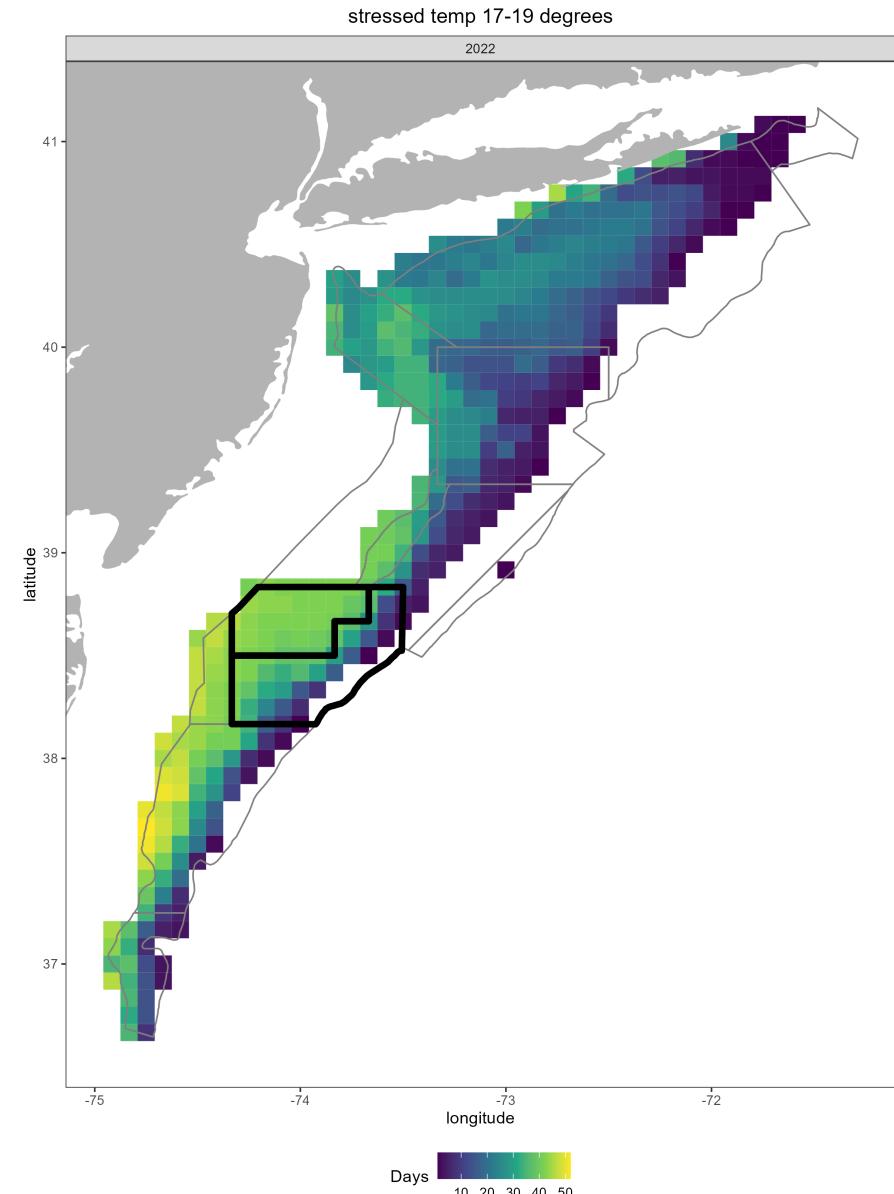
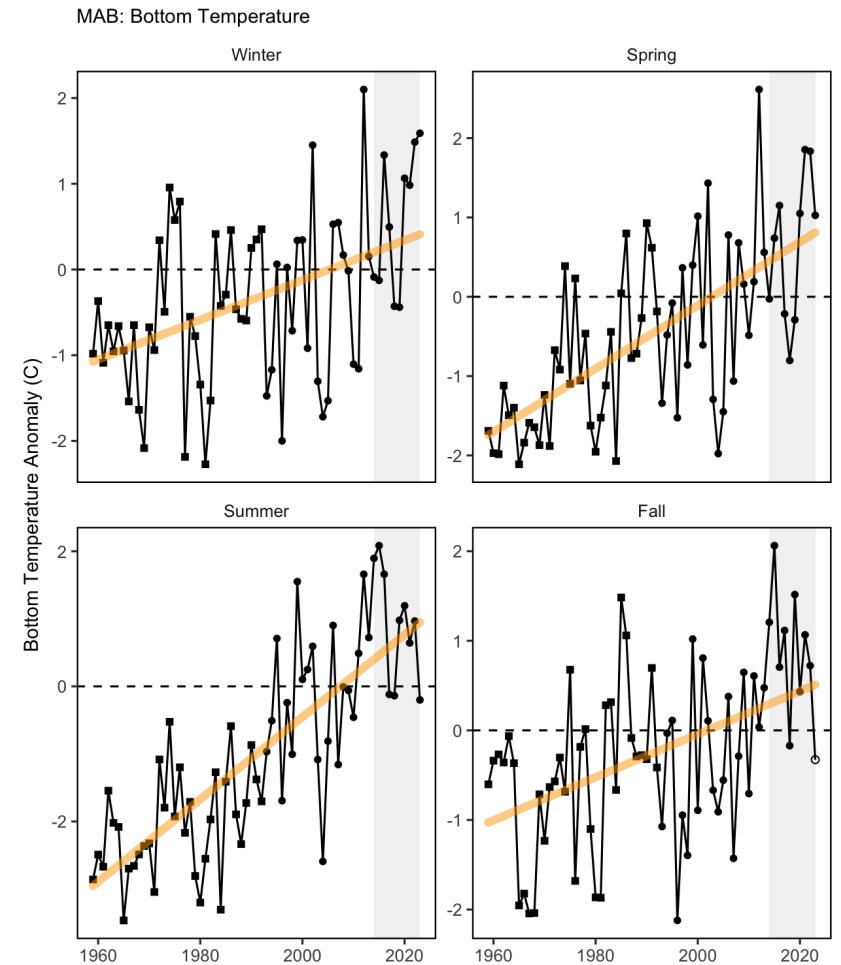
Trends and status of indicators related to broad ecosystem-level fishery management objectives, with implications for the Mid-Atlantic Fishery Management Council (MAFMC)

OBJECTIVE (Indicator)	TREND	CURRENT STATUS	IMPLICATIONS
<b>Seafood production</b> (total and MAFMC managed landings)	 Decline	 Below long term average	Commercial landings are at the lowest point observed, driven by recent declines in species not managed by the Mid-Atlantic Council. Recreational harvest is declining due to multiple drivers. COVID-19 likely exacerbated existing trends, but impacts are not uniform across fisheries.
<b>Commercial profits</b>	 Decline	 Below long term average	Biomass trends within the ecosystem continue to be stable. Climate indicators continue to exceed historical bounds, which affects stock distributions and will generate other ecosystem changes.
<b>Recreational opportunities</b> (effort and fleet diversity)	 No trend  Decline	 Near long term average  Below long term average	Regional commercial revenue is the lowest that has been observed, driven in part by managed clam species. Falling prices are almost universal and due to market dynamics including COVID-19 impacts. Monitor climate risks to surfclams and ocean quahogs.
<b>Stability</b> (fishery and ecosystem diversity maintained over time)	 No trend  Mixed trends	 Near long term average  Near long term average	Recreational effort shows no long term trend and is near average, but fleet diversity is decreasing because of a shift away from party/charter to shore-based fishing. This shift results in a decreased range of recreational fishing opportunities. Shore-based anglers will have access to different species/sizes of fish than vessel-based anglers.
<b>Social and cultural</b> (community fishery engagement, reliance, and environmental justice vulnerability)	 Status only indicator	 Environmental justice status for top commercial and recreational communities	Commercial: Fleet diversity metrics suggest stable capacity to respond to the current range of fishing opportunities. Recreational: Species catch diversity has been maintained by a different set of species over time and continues to be above the long-term mean. Ecosystem: Adult fish diversity indices are stable, but several climate and oceanography metrics are changing and should be monitored as warning signs for potential regime shift or ecosystem restructuring.
<b>Protected species</b> (coastwide bycatch, population numbers, mortalities)	 Mixed trends  Decline	 Meeting objectives  Below long term average	These indicators are used to identify top fishing communities and those with environmental justice concerns based on 2020 data. Highlighted communities may be vulnerable to changes in fishing patterns due to regulations and/or climate change. When any of these communities also experience environmental justice issues, they may have lower ability to successfully respond/adapt to change. The top Mid Atlantic recreational communities changed between 2019 and 2020.
			Mixed bycatch trends through 2021 are related to fishery management, shifts in population distribution combined with fishery shifts, and population increase for seals. Recent bycatch data is uncertain.
			Population drivers for North Atlantic Right Whales (NARW) include combined fishery interactions/vessel strikes, distribution shifts, and copepod availability.
			Unusual mortality events continue for 3 large whale species.

# Reporting ecosystem risks for managers

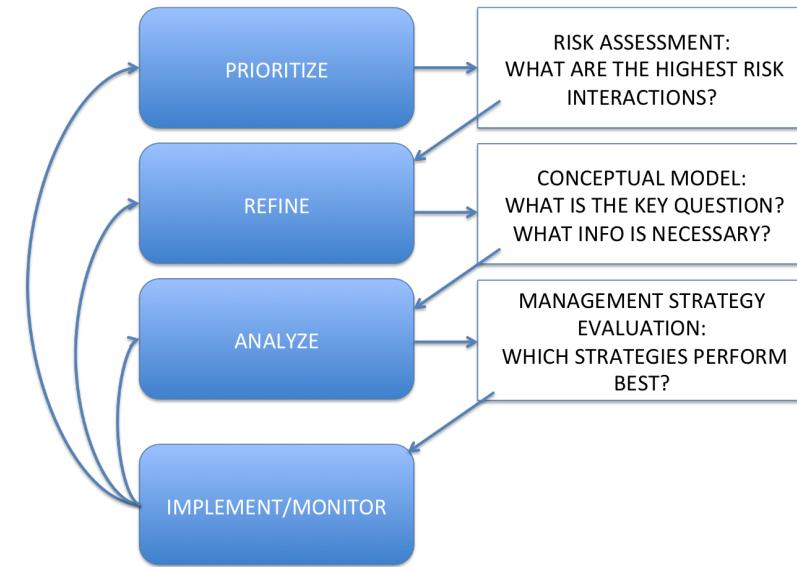
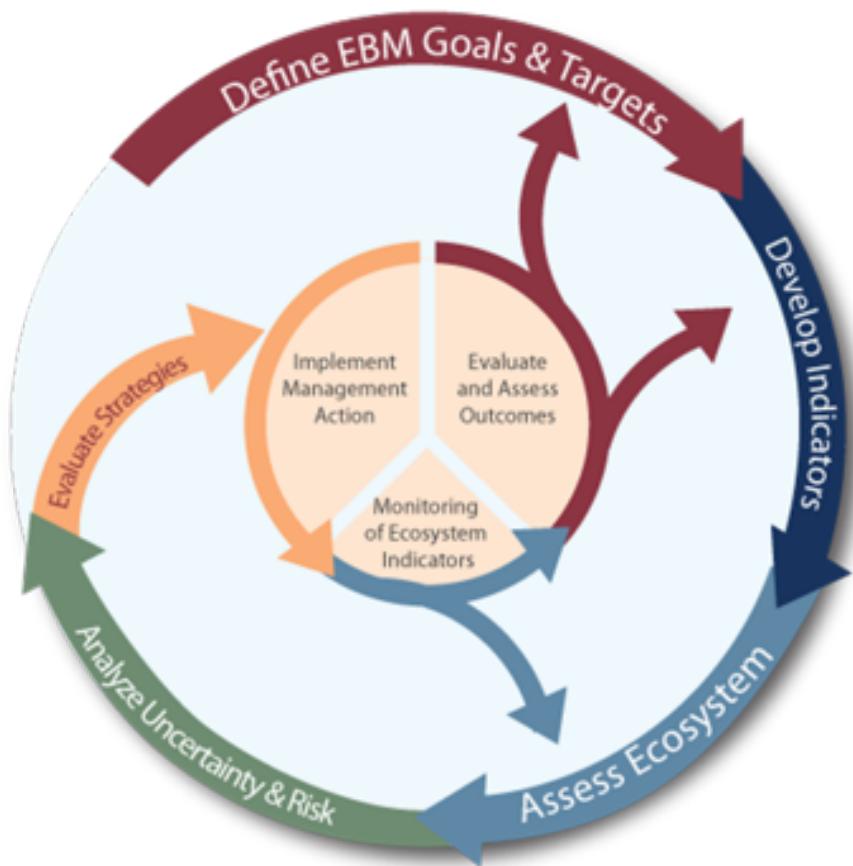
2024 Report

2016-2023 Reports



## Adapting Integrated Ecosystem Assessment to managers' needs

Diverse stakeholders agreed that an ecosystem approach was necessary. Developing and implementing EAFM is done in collaboration between managers, stakeholders, and scientists. <https://www.mafmc.org/eafm>

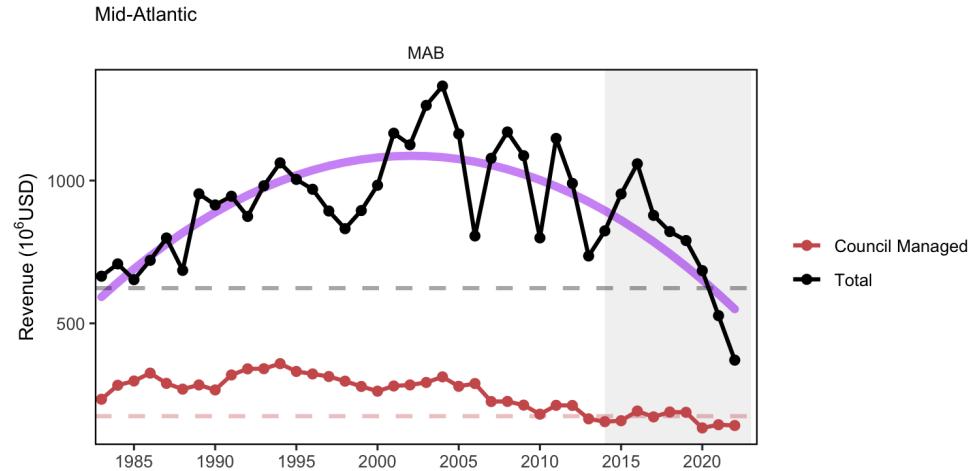


- Direct link between ecosystem reporting and risk assessment
- Conceptual model links across risk elements for fisheries, species
- Management strategy evaluation includes key risks

## State of the Ecosystem → MAFMC Risk assessment example: Commercial revenue

This element is applied at the ecosystem level. Revenue serves as a proxy for commercial profits.

Risk Level	Definition
Low	No trend and low variability in revenue
Low-Moderate	Increasing or high variability in revenue
Moderate-High	<b>Significant long term revenue decrease</b>
High	Significant recent decrease in revenue



Ranked moderate-high risk due to the significant long term revenue decrease

### Risk element: CommRev

SOE Implications: Recent change driven by benthos. Monitor changes in climate and landings drivers:

- Climate risk element: Surfclams and ocean quahogs are sensitive to ocean warming and acidification.
- pH in surfclam summer habitat is approaching, but not yet at, pH affecting surfclam growth

# EAFM Risk Assessment: 2023 Update (all methods in review/revision this year)

## Species level risk elements

Species	Assess	Fstatus	Bstatus	FW1Pred	FW1Prey	FW2Prey	Climate	DistShift	EstHabitat
Ocean Quahog	lowest	lowest	lowest	lowest	lowest	lowest	highest	modhigh	lowest
Surfclam	lowest	lowest	lowest	lowest	lowest	lowest	modhigh	modhigh	lowest
Summer flounder	lowest	lowest	lowmod	lowest	lowest	lowest	lowmod	modhigh	highest
Scup	lowest	lowest	lowest	lowest	lowest	lowest	lowmod	modhigh	highest
Black sea bass	lowest	lowest	lowest	lowest	lowest	lowest	modhigh	modhigh	highest
Atl. mackerel	lowest	highest	highest	lowest	lowest	lowest	lowmod	modhigh	lowest
Chub mackerel	highest	lowmod	lowmod	lowest	lowest	lowest	na	na	lowest
Butterfish	lowest	lowest	lowmod	lowest	lowest	lowest	lowest	highest	lowest
Longfin squid	lowmod	lowmod	lowmod	lowest	lowest	lowmod	modhigh	lowest	
Shortfin squid	highest	lowmod	lowmod	lowest	lowest	lowmod	lowest	highest	lowest
Golden tilefish	lowest	lowest	lowmod	lowest	lowest	lowest	modhigh	lowest	lowest
Blueline tilefish	highest	highest	modhigh	lowest	lowest	lowest	modhigh	lowest	
Bluefish	lowest	lowest	lowmod	lowest	lowest	lowest	lowest	modhigh	highest
Spiny dogfish	lowest	highest	lowmod	lowest	lowest	lowest	lowest	highest	lowest
Monkfish	highest	lowmod	lowmod	lowest	lowest	lowest	modhigh	lowest	
Unmanaged forage	na	na	na	lowest	lowmod	lowmod	na	na	na
Deepsea corals	na	na	na	lowest	lowest	lowest	na	na	na

- RT assessment decreased Spiny dogfish **Assess**, risk to low and increased **Fstatus** risk to high
- RT assessment decreased bluefish **Bstatus** risk from high to low-moderate
- RT assessment increased Illex **Assess** risk from low-moderate to high

## Ecosystem level risk elements

System	EcoProd	CommRev	RecVal	FishRes1	FishRes4	FleetDiv	Social	ComFood	RecFood
Mid-Atlantic	lowmod	modhigh	lowest	lowest	modhigh	lowest	lowmod	highest	modhigh

- Recreational value risk decreased from low-moderate to low

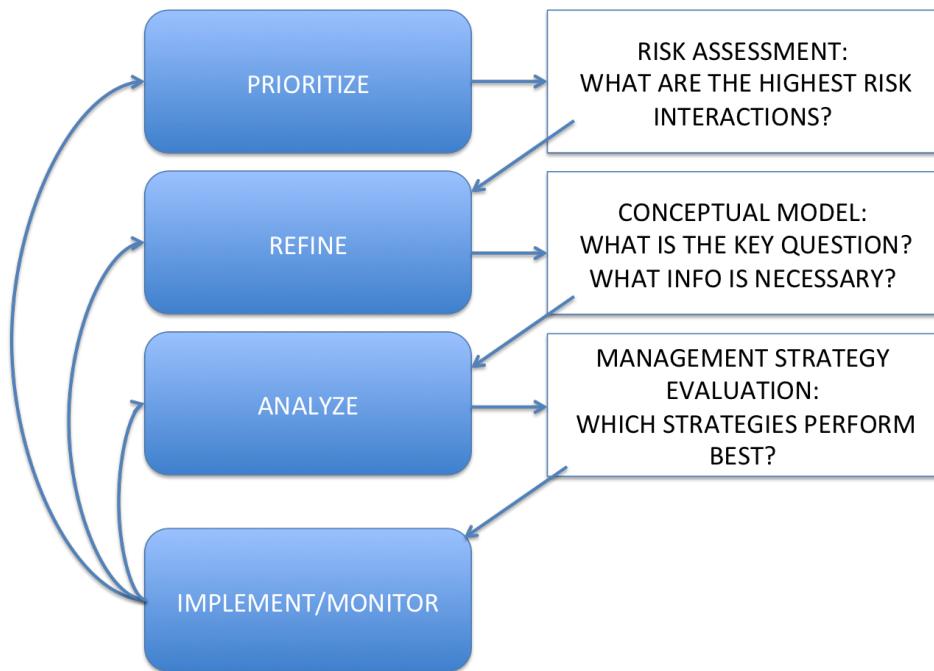
## Species and Sector level risk elements

Species	MgtControl	TecInteract	OceanUse	RegComplex	Discards	Allocation
Ocean Quahog-C	lowest	lowest	lowmod	lowest	modhigh	lowest
Surfclam-C	lowest	lowest	lowmod	lowest	modhigh	lowest
Summer flounder-R	modhigh	lowest	lowmod	modhigh	highest	highest
Summer flounder-C	lowmod	modhigh	lowmod	modhigh	modhigh	lowest
Scup-R	lowmod	lowest	lowmod	modhigh	modhigh	highest
Scup-C	lowest	lowmod	modhigh	modhigh	modhigh	lowest
Black sea bass-R	highest	lowest	modhigh	modhigh	highest	highest
Black sea bass-C	highest	lowmod	highest	modhigh	highest	lowest
Atl. mackerel-R	lowmod	lowest	lowest	lowmod	lowest	lowest
Atl. mackerel-C	lowest	lowmod	modhigh	highest	lowmod	highest
Butterfish-C	lowest	lowmod	modhigh	modhigh	modhigh	lowest
Longfin squid-C	lowest	modhigh	highest	modhigh	highest	lowest
Shortfin squid-C	lowmod	lowmod	lowmod	modhigh	lowest	highest
Golden tilefish-R	na	lowest	lowest	lowest	lowest	lowest
Golden tilefish-C	lowest	lowest	lowest	lowest	lowest	lowest
Blueline tilefish-R	lowmod	lowest	lowest	lowmod	lowest	lowest
Blueline tilefish-C	lowmod	lowest	lowest	lowmod	lowest	lowest
Bluefish-R	lowmod	lowest	lowest	lowmod	modhigh	highest
Bluefish-C	lowest	lowest	lowmod	lowmod	lowmod	lowest
Spiny dogfish-R	lowest	lowest	lowest	lowest	lowest	lowest
Spiny dogfish-C	lowest	modhigh	modhigh	modhigh	lowmod	lowest
Chub mackerel-C	lowest	lowmod	lowmod	lowmod	lowest	lowest
Unmanaged forage	lowest	lowest	modhigh	lowest	lowest	lowest
Deepsea corals	na	na	modhigh	na	na	na

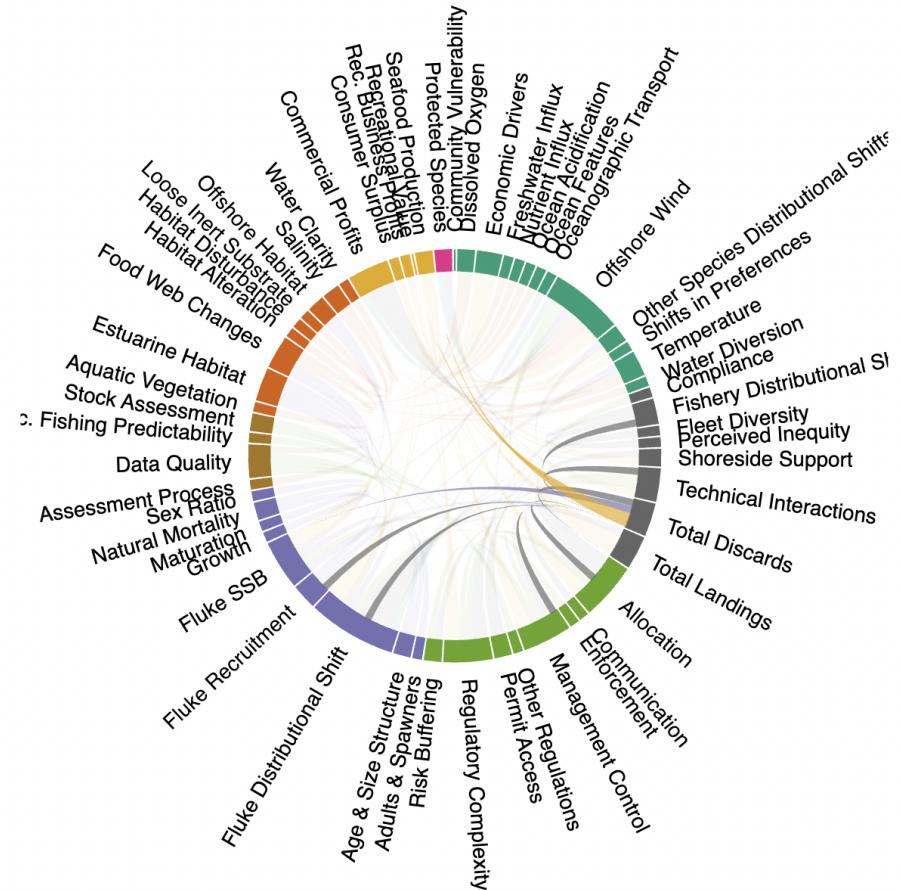
- Management section not updated--to be revised this year

## How has MAFMC used the risk assessment?

- Based on risk assessment, the Council selected summer flounder as high-risk fishery for conceptual modeling

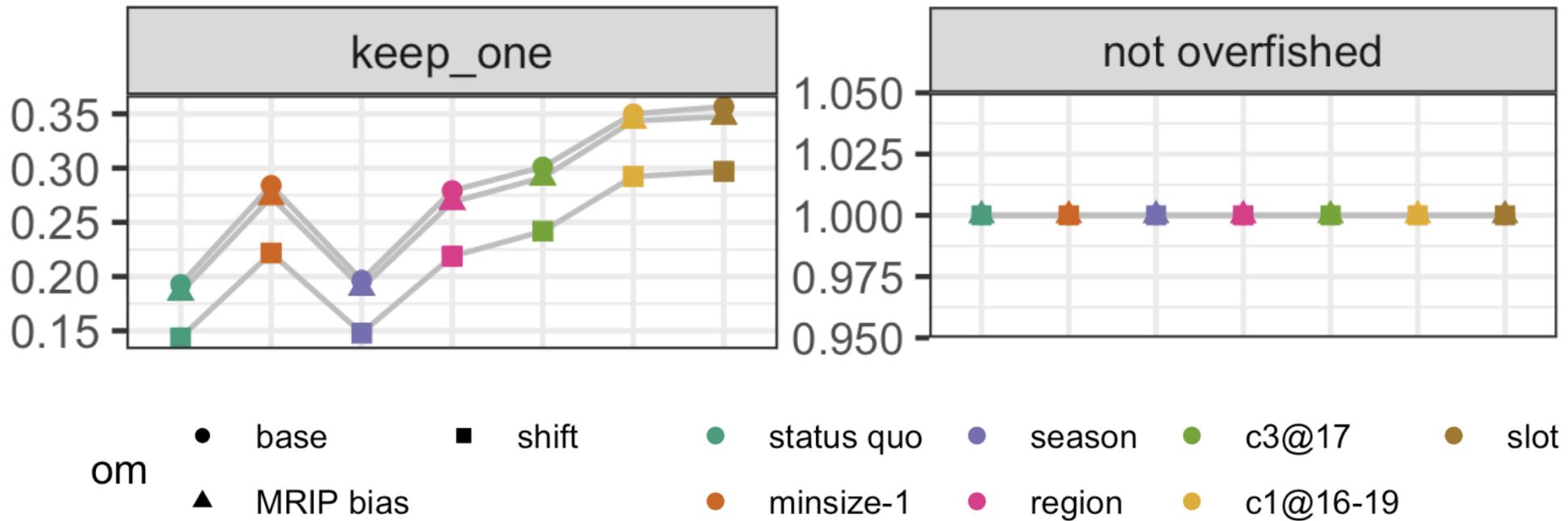


- Council proceeding with management strategy evaluation (MSE) addressing **recreational fishery discards** using information from conceptual modeling.



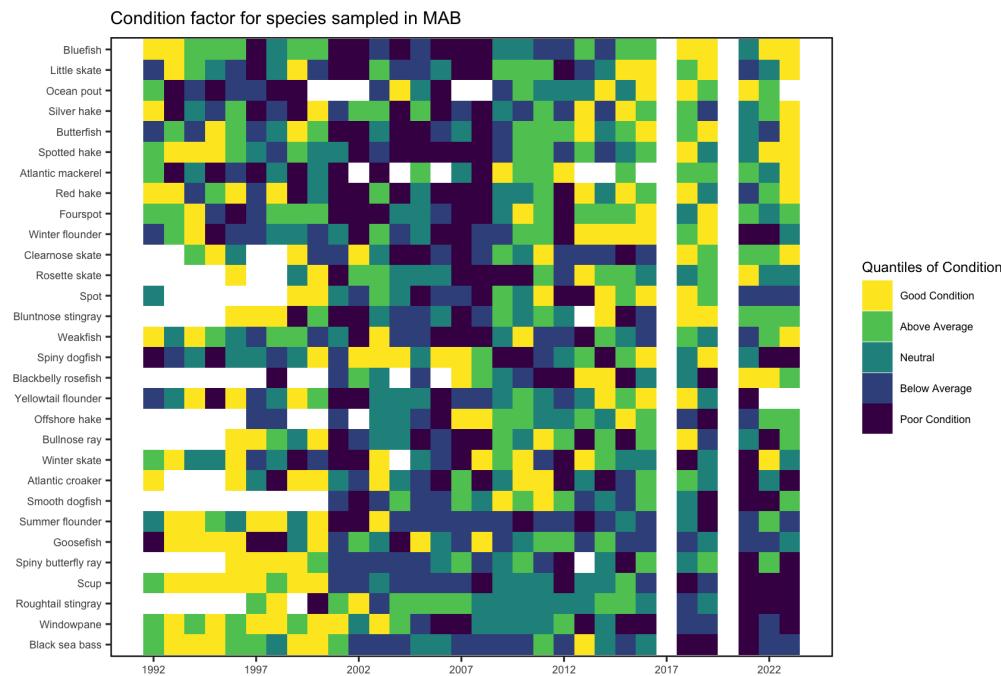
## MSE results: can improve on current management, but distribution shifts lower expectations

Results for 2 of 16 performance metrics:



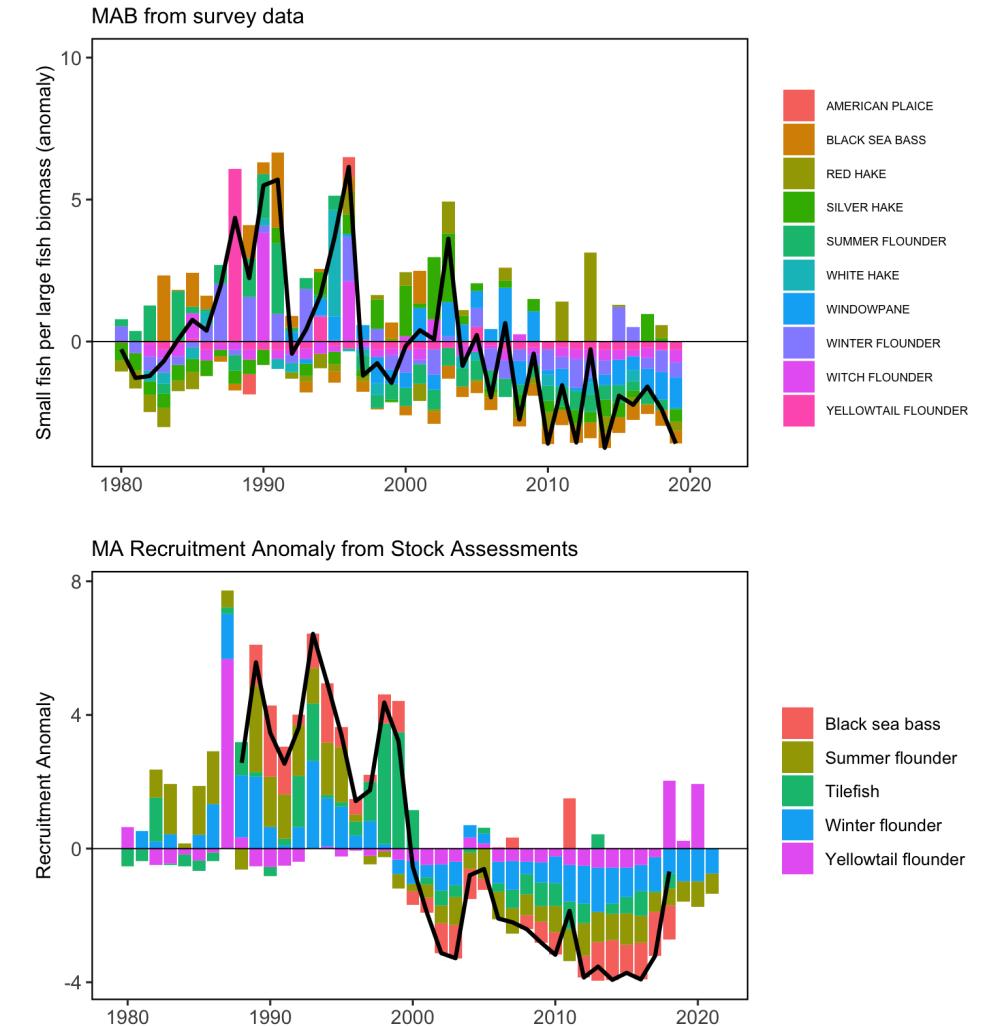
## Frontiers: multispecies and system level advice

### Fish condition



Species in the MAB had low condition 2000-2010.  
Fish productivity based on surveys and assessments  
has been below average since then.

### Fish productivity anomaly (Perretti, et al., 2017)



# Entry points for ecosystem information in management decisions: where to start?

## *Management decisions*

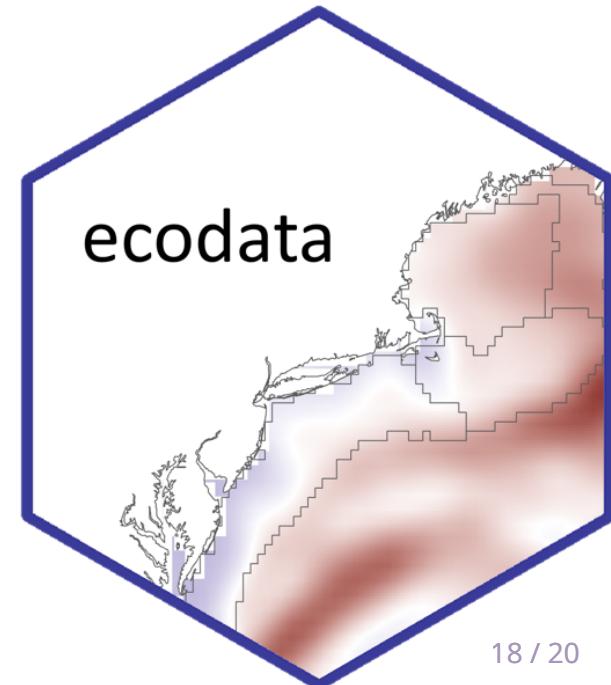
1. What are our issues and goals?
2. Current decisions
  - Stock assessments
  - Advice on catch levels
  - Harvest control rules
3. New (current) decisions
  - Habitat change or restoration
  - Changing species distribution and interactions
  - Tradeoffs between fisheries
  - Tradeoffs between ocean use sectors

Focus on developing *decision processes* that are able to use ecosystem information

- Collaborative, iterative process between scientists, managers, stakeholders
- Multispecies and system level indicators of productivity change or overexploitation

## *Methods and tools*

1. Stakeholder engagement, surveys, strategic planning
2. Add information to current process
  - Ecosystem ToRs, overviews, ESP, SOE
  - Risk or uncertainty assessments
  - Management strategy evaluation
3. Integrate across current processes
  - Risk assessment
  - Conceptual models
  - Scenario planning
  - MSE (again)



## Additional resources

- Northeast US Ecosystem Reports
- Ecosystem Report Technical Documentation
- ecodata R package
- Ecosystem Indicator Catalog (in development)
- MAFMC SSC
- MAFMC EAFM
- **MAFMC EAFM Summer Flounder MSE**
  - Slides available at <https://noaa-edab.github.io/presentations>
  - Contact: [Sarah.Gaichas@noaa.gov](mailto:Sarah.Gaichas@noaa.gov)

Questions? Thank you

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