There is no I in EAFM:

Adapting Integrated Ecosystem Assessment for Mid-Atlantic Fisheries Management

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An integrated ecosystem assessment success story (in progress)

Diverse stakeholders agreed that an ecosystem approach was necessary. Developing and implementing an ecosystem approach to fishery management was done in collaboration between managers, stakeholders, and scientists.

Outline

- Mid-Atlantic Fishery Management Council Ecosystem Approach (EAFM)
- Tailoring ecosystem reporting for fishery managers
- Mid-Atlantic EAFM risk assessment
- Mid-Atlantic EAFM conceptual modeling (towards MSE)
- Improvements: open-source data and technical documentation

Integrated Ecosystem Assessment

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

The Mid-Atlantic Fishery Management Council

Summer Flounder, Scup, Black Sea Bass

Spiny Dogfish

Atlantic Mackerel, Squid, Butterfish

Bluefish

Surfclam and Ocean Quahog

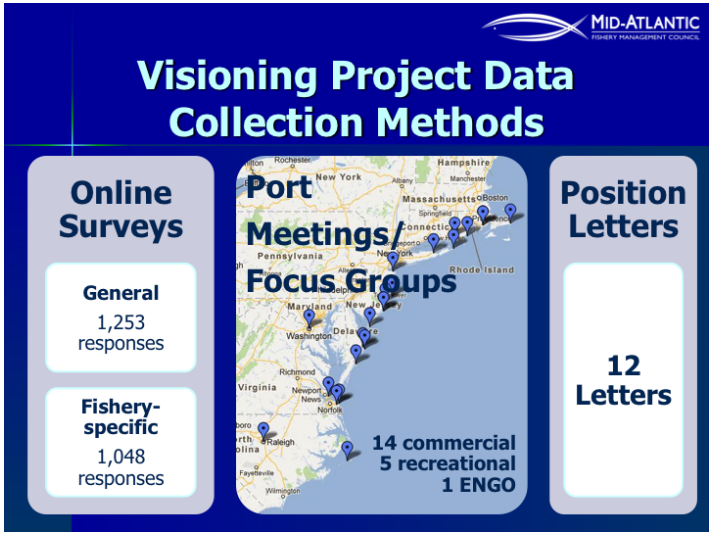
Tilefish

Source:
http://www.mafmc.org/fishery-management-plans

Why an ecosystem approach?

"We rebuilt all the stocks, so why is everyone still pissed off?" --Rich Seagraves

in 2011, the Council asked:



And many people answered, from commercial fishery, recreational fishery, environmental organization, and interested public perspectives.

Visioning report:

http://www.mafmc.org/s/MAFMC-stakeholder-input-report-p7b9.pdf

Common themes among all stakeholder groups:

> • There is a lack of confidence in the data that drive fishery management decisions.
>
> • Stakeholders are not as involved in the Council process as they can and should be.
>
> • Different jurisdictions and regulations among the many fishery management organizations result in complexity and inconsistency.
>
> • There is a need for increased transparency and communications in fisheries management.
>
> • The dynamics of the ecosystem and food web should be considered to a greater extent in fisheries management decisions.
>
> • Stakeholders are not adequately represented on the Council.
>
> • Pollution is negatively affecting the health of fish stocks.

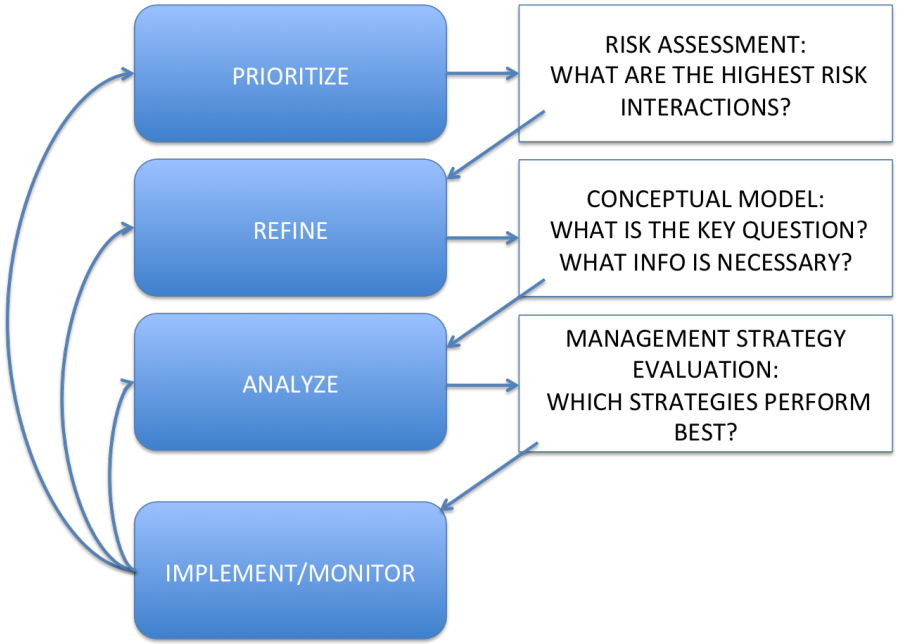
Visioning report, p. 3:

http://www.mafmc.org/s/MAFMC-stakeholder-input-report-p7b9.pdf

Mid-Atlantic Council Ecosystem Approach

- 2016 Ecosystem Approach to Fishery Management (EAFM) Policy Guidance document: http://www.mafmc.org/s/EAFM-Doc-Revised-2019-02-08.pdf

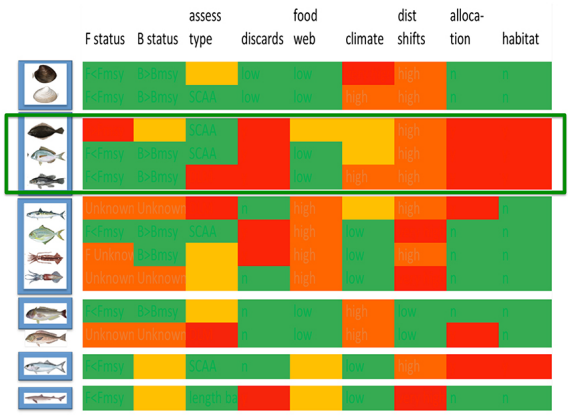
- Mid-Atlantic EAFM framework[1]:



Details on development, including workshop presentations and white papers: http://www.mafmc.org/eafm

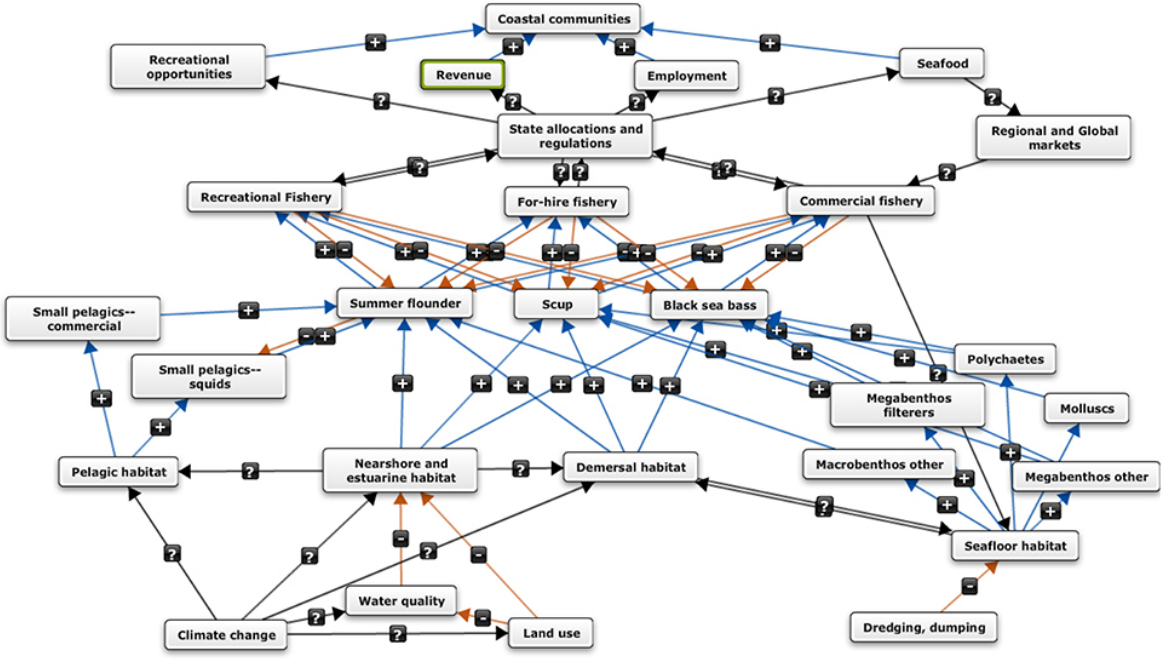
[1] Gaichas, S., Seagraves, R., Coakley, J., DePiper, G., Guida, V., Hare, J., Rago, P., et al. 2016. A Framework for Incorporating Species, Fleet, Habitat, and Climate Interactions into Fishery Management. Frontiers in Marine Science, 3.

Examples illustrating the use of the framework



Risk assessment highlights prority species/issues for more detailed evaluation

A conceptual model maps out key interactions for high risk fisheries, specifies quantitative management strategy evaluation

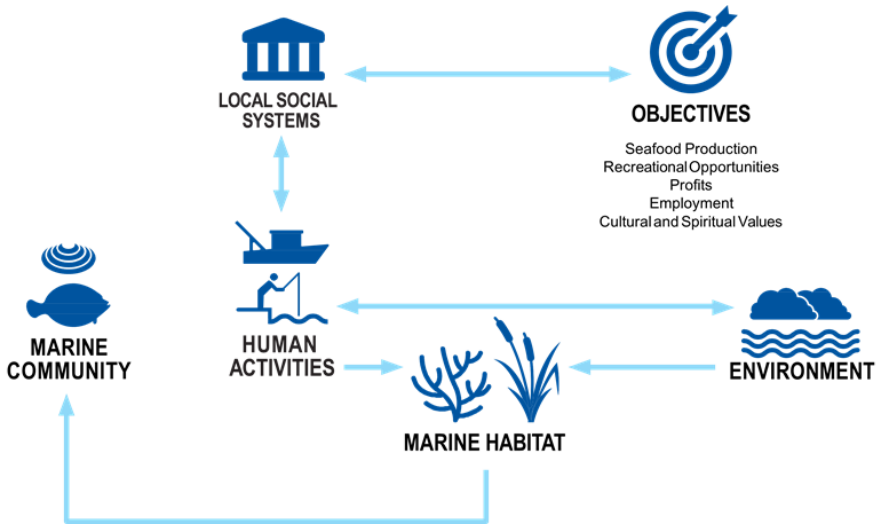


But where will the risk assessment indicators come from?

Meanwhile, scientists were improving ecosystem reports:

"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



Revised ecosystem status reporting

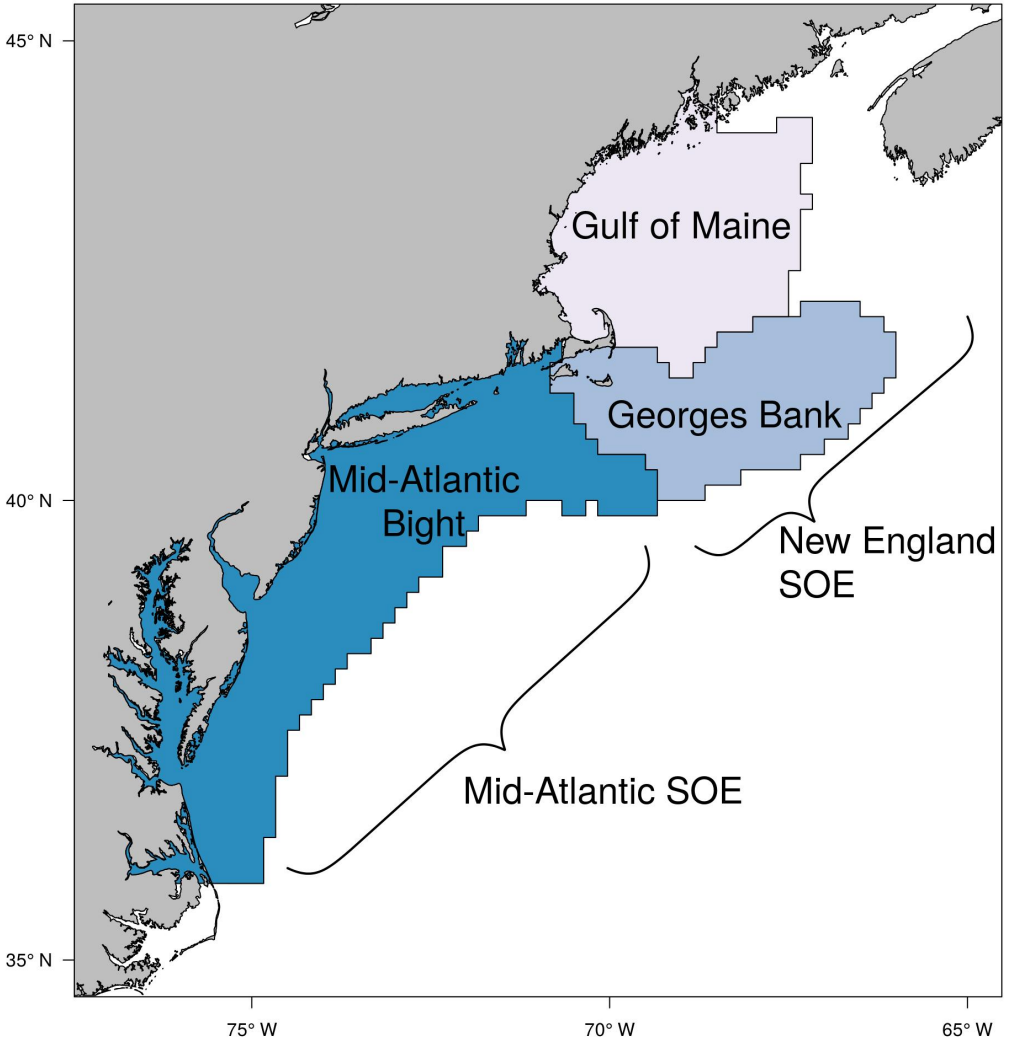
Report structure

1. Synthetic overview
2. Human dimensions
3. Protected species
4. Fish and invertebrates (managed and otherwise)
5. 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

Indicator spatial scales–already Mid-Atlantic specific

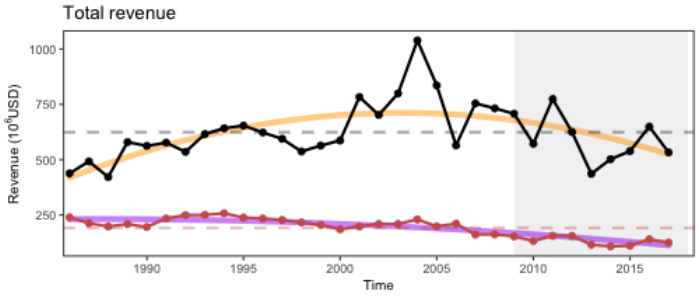


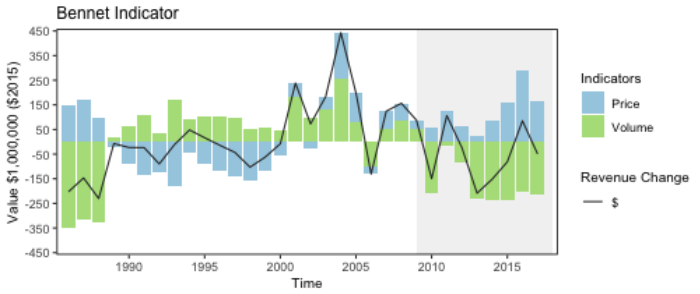
https://noaa-edab.github.io/tech-doc/epu.html

Risk assessent indicators and ranking criteria: 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	Significant long term revenue decrease
High	Significant recent decrease in revenue



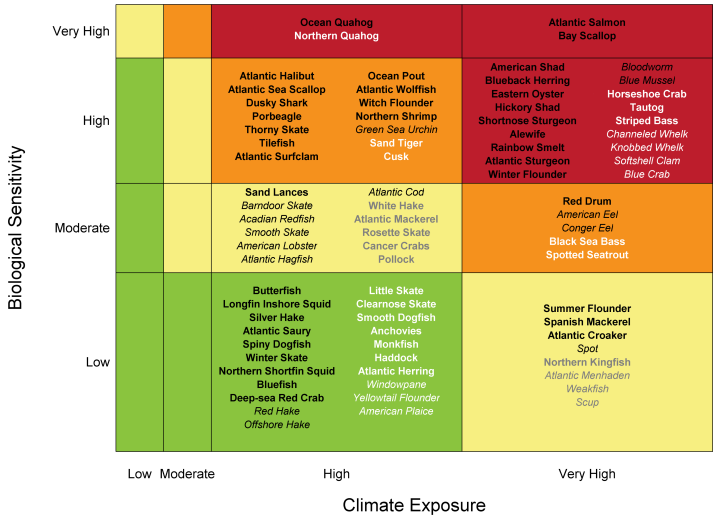


Ranked moderate-high risk due to the significant long term revenue decrease for Mid-Atlantic managed species (red points in top plot)

Risk assessent indicators and ranking criteria: Climate

This element is applied at the species level. Risks to species productivity (and therefore to achieving optimum yield) due to projected climate change in the Northeast US were evaluated in a comprehensive assessment[1].

Risk Level	Definition
Low	Low climate vulnerability ranking
Low-Moderate	Moderate climate vulnerability ranking
Moderate-High	High climate vulnerability ranking
High	Very high climate vulnerability ranking



https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0146756.

Each species ranked according to position/color in the plot on the right

[1] Hare, J. A., Morrison, W. E., Nelson, M. W., Stachura, M. M., Teeters, E. J., Griffis, R. B., Alexander, M. A., et al. 2016. A Vulnerability Assessment of Fish and Invertebrates to Climate Change on the Northeast U.S. Continental Shelf. PLOS ONE, 11: e0146756.

Risk assessment results

Species and Sector level risk elements[1]

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

[1] Gaichas, S. K., DePiper, G. S., Seagraves, R. J., Muffley, B. W., Sabo, M., Colburn, L. L., and Loftus, A. L. 2018. Implementing Ecosystem Approaches to Fishery Management: Risk Assessment in the US Mid-Atlantic. Frontiers in Marine Science, 5.

Risk assessment results updated with 2019 indicators

Species level risk elements

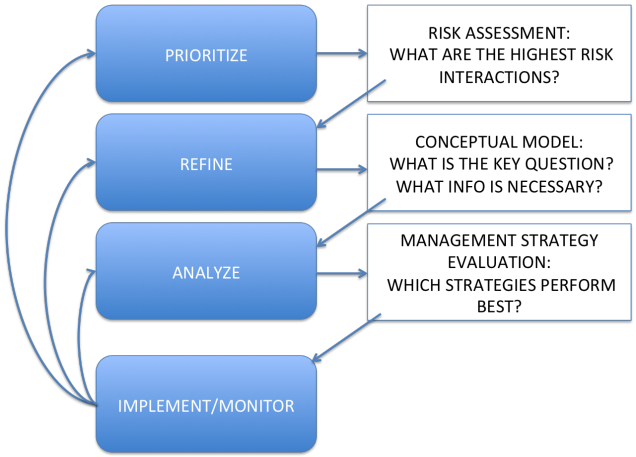
Species	Assess	Fstatus	Bstatus	FW1Pred	FW1Prey	FW2Prey	Climate	DistShift	EstHabitat
Ocean Quahog	l	l	l	l	l	l	h	mh	l
Surfclam	l	l	l	l	l	l	mh	mh	l
Summer flounder	l	l	lm	l	l	l	lm	mh	h
Scup	l	l	l	l	l	l	lm	mh	h
Black sea bass	l	l	l	l	l	l	mh	mh	h
Atl. mackerel	l	h	h	l	l	l	lm	mh	l
Butterfish	l	l	l	l	l	l	l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

Ecosystem level risk elements

System	EcoProd	CommRev	RecVal	FishRes1	FishRes4	FleetDiv	Social	ComFood	RecFood
Mid-Atlantic	lm	mh	h	l	mh	l	lm	h	mh

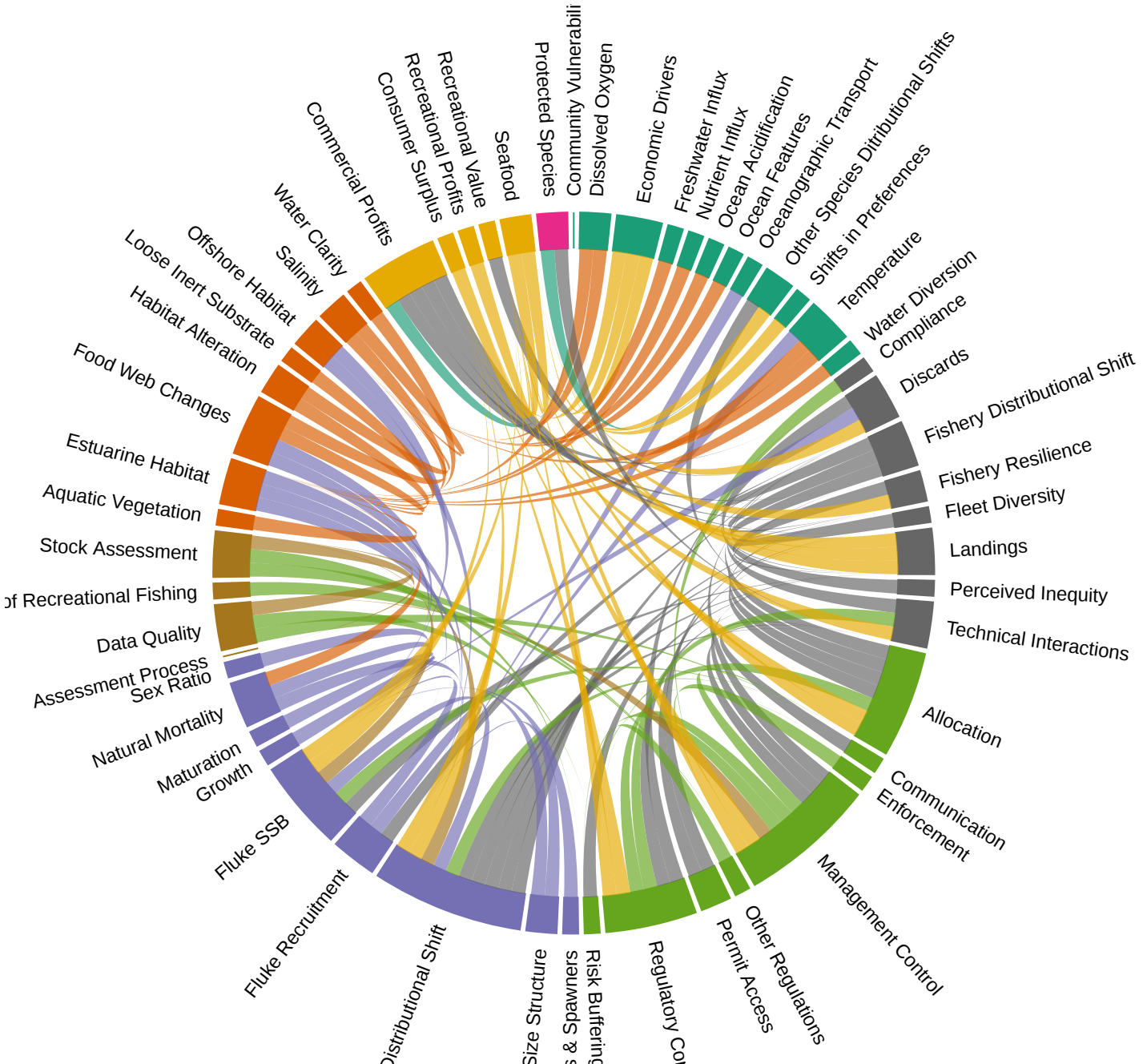
How are they using the risk assessment? What's next?

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



- Working group of habitat, biology, stock assessment, management, economic and social scientists developed:
  - draft conceptual models of high risk elements, linkages
  - dataset identification and gap analysis for each element and link
  - draft questions that the Council could persue with additional work

- Final conceptual model and supporting information at December 2019 Council meeting
- Council may then elect to proceed with management strategy evaluation (MSE) using the information from conceptual modeling as a basis


Protected Species
Community Vulnerabili
Dissolved Oxygen
Economic Drivers
Freshwater Influx
Nutrient Influx
Ocean Acidification
Ocean Features
Oceanographic Transport
Other Species Ditributional Shifts
Shifts in Preferences
Temperature
Water Diversion
Compliance
Discards
Fishery Distributional Shift
Fishery Resilience
Fleet Diversity
Landings
Perceived Inequity
Technical Interactions
Allocation
Communication
Enforcement
Management Control
Other Regulations
Permit Access
Regulatory Co
Risk Buffering
s Spawners &
Size Structure
Distributional Shift
Fluke Recruitment
Fluke SSB
Growth
Maturation
Natural Mortality
Sex Ratio
Assessment Process
Data Quality
of Recreational Fishing
Stock Assessment
Aquatic Vegetation
Estuarine Habitat
Food Web Changes
Habitat Alteration
Loose Inert Substrate
Offshore Habitat
Salinity
Water Clarity
Commercial Profits
Consumer Surplus
Recreational Profits
Recreational Value
Seafood

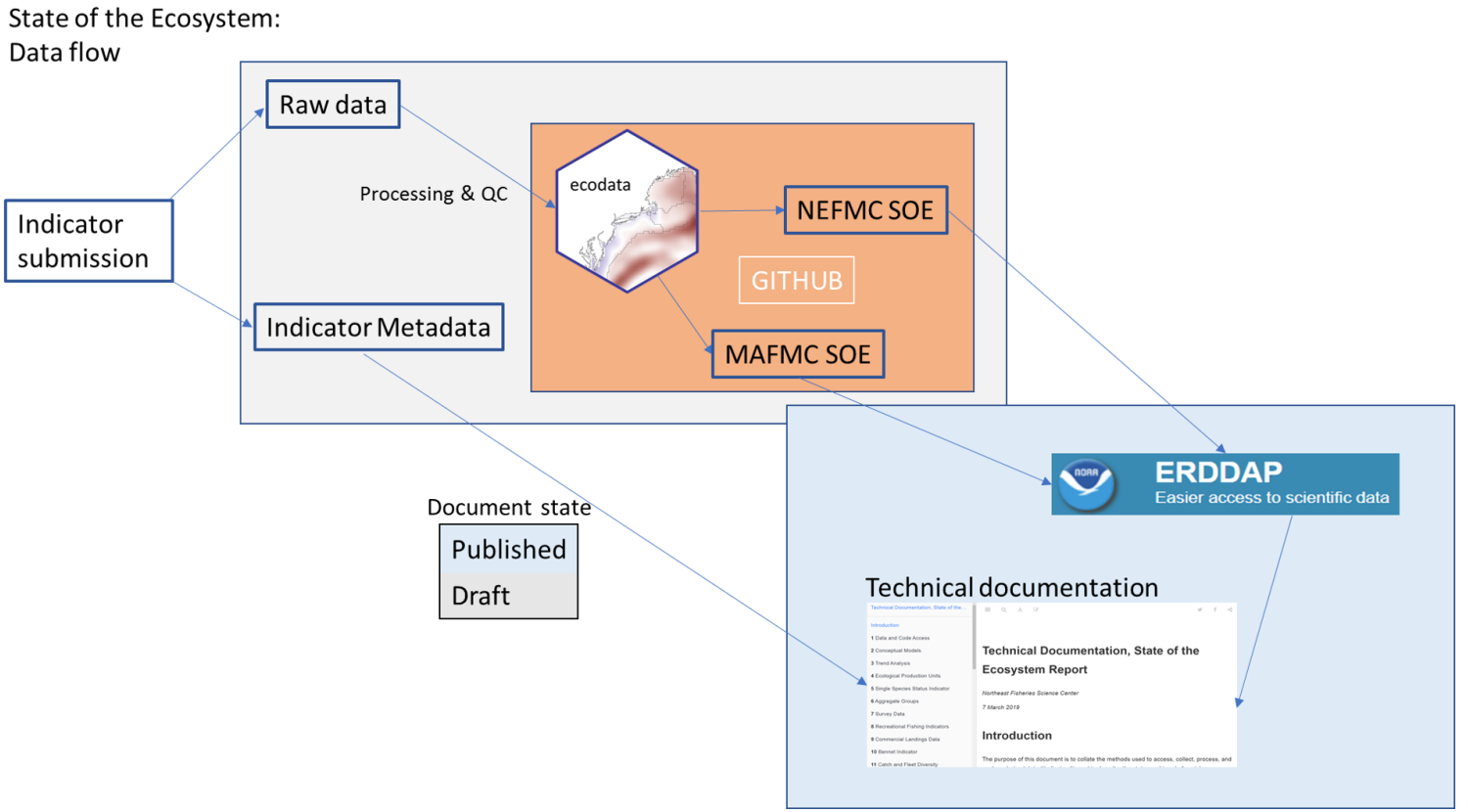
Conclusions

Integrated ecosystem assessment is a valuable framework for the general implementation of ecosystem approaches to natural resource management

- The Council's rapid progress in implementing EAFM resulted from positive collaboration between managers, stakeholders, and scientists. Collaboration is essential to IEA and to the success of EAFM.
- Ecosystem indicators and reporting can be tailored to specific regional objectives.
- Risk assessment is a rapid, familiar, scaleable, and transparent method to move forward with EAFM within a real-world operational fishery management context.
- This EAFM process highlights certain species and certain management issues as posing higher cumulative risks to meeting Council-derived management objectives when considering a broad range of ecological, social, and economic factors.
- Conceptual modeling links the key factors for high risk fisheries and scopes more detailed integrated analysis and management strategy evaluation.

Footnote: 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
- Streamlined workflow allowed scientists to meet management deadlines



If you want all the details

- Mid-Atlantic Council EAFM paper
- Mid-Atlantic Council Risk Assessment paper
- Mid-Atlantic Council Summer Flounder conceptual model and support tables
- 2019 Mid-Atlantic State of the Ecosystem report
- State of the Ecosystem Technical Documentation
- ecodata R package
    - Macrofauna indicators
    - Human Dimensions indicators
    - Lower trophic level indicators
- Slides available at https://noaa-edab.github.io/presentations

Contributors - THANK YOU!

The New England and Mid-Atlantic Ecosystem reports 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

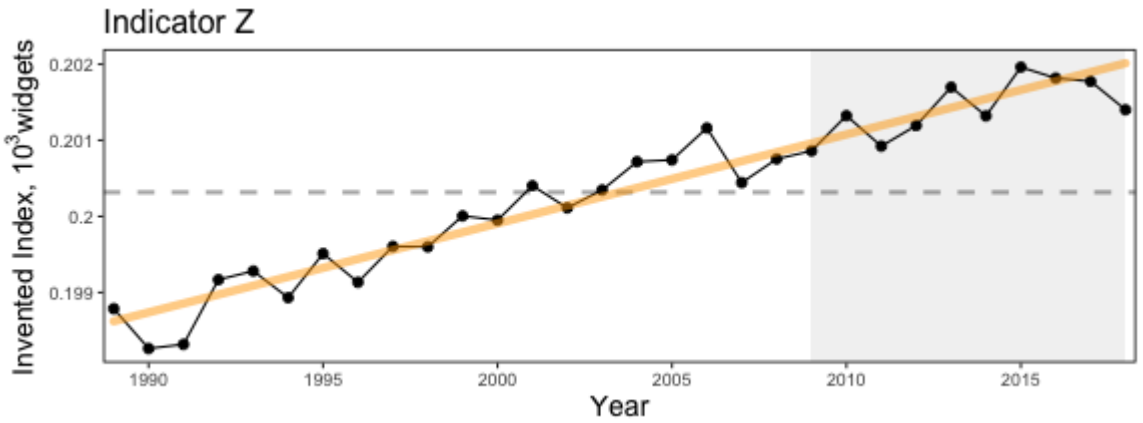
Extra Slides

Standardized indicator visualization in reports

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.

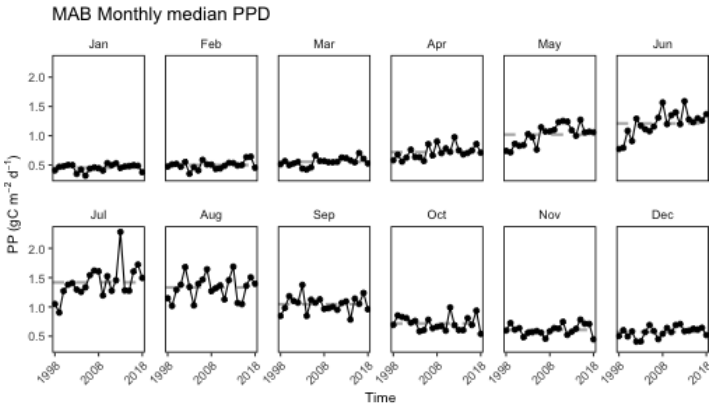
Risk assessent indicators and ranking criteria: System productivity

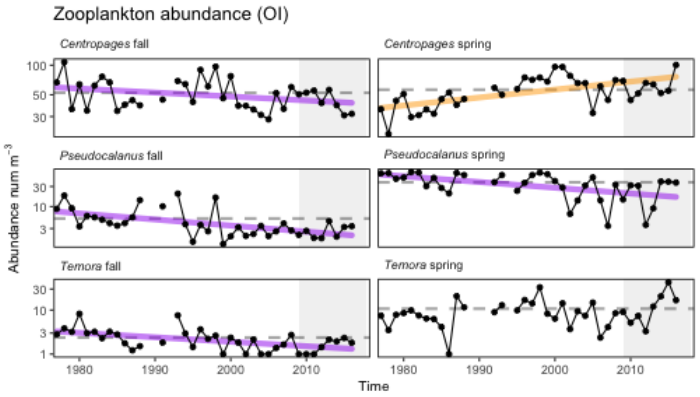
This element is applied at the ecosystem level, and ranks the risk of not achieving optimum yield due to changes in ecosystem productivity at the base of the food web.

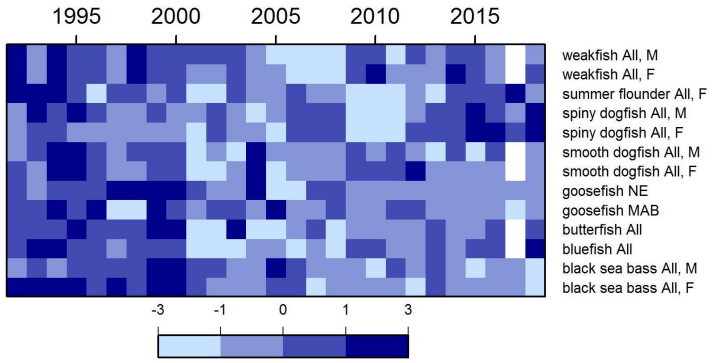
Four indicators are used together to assess risk of changing ecosystem productivity: primary production, zooplankton abundance, fish condition and fish recruitment.

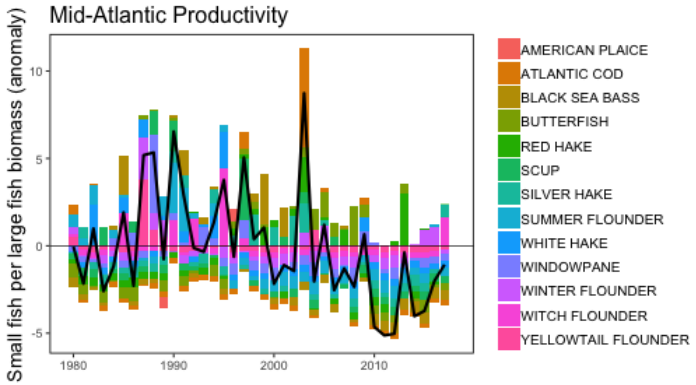
Risk Level	Definition
Low	No trends in ecosystem productivity
Low-Moderate	Trend in ecosystem productivity (1-2 measures, increase or decrease)
Moderate-High	Trend in ecosystem productivity (3+ measures, increase or decrease)
High	Decreasing trend in ecosystem productivity, all measures

Risk assessent indicators and ranking criteria: System productivity









Ranked low-moderate risk due to the significant long term trends in zooplankton abundance for major species (top right plot)