State of the Ecosystem Planning

Joe Caracappa, NEFSC

CESM, September 2, 2025

SOE team

Editors

Mid Atlantic: Abby Tyrell

New England: Joe Caracappa

Responsible for coordinating the synthesis of indicators and producing the final report

SOE Coordination

Brandon Beltz

Responsible for coordinating contributions and managing ecodata, catalog, and technical documentation

SOE Leads

Geret DePiper

Kim Hyde

Scott Large

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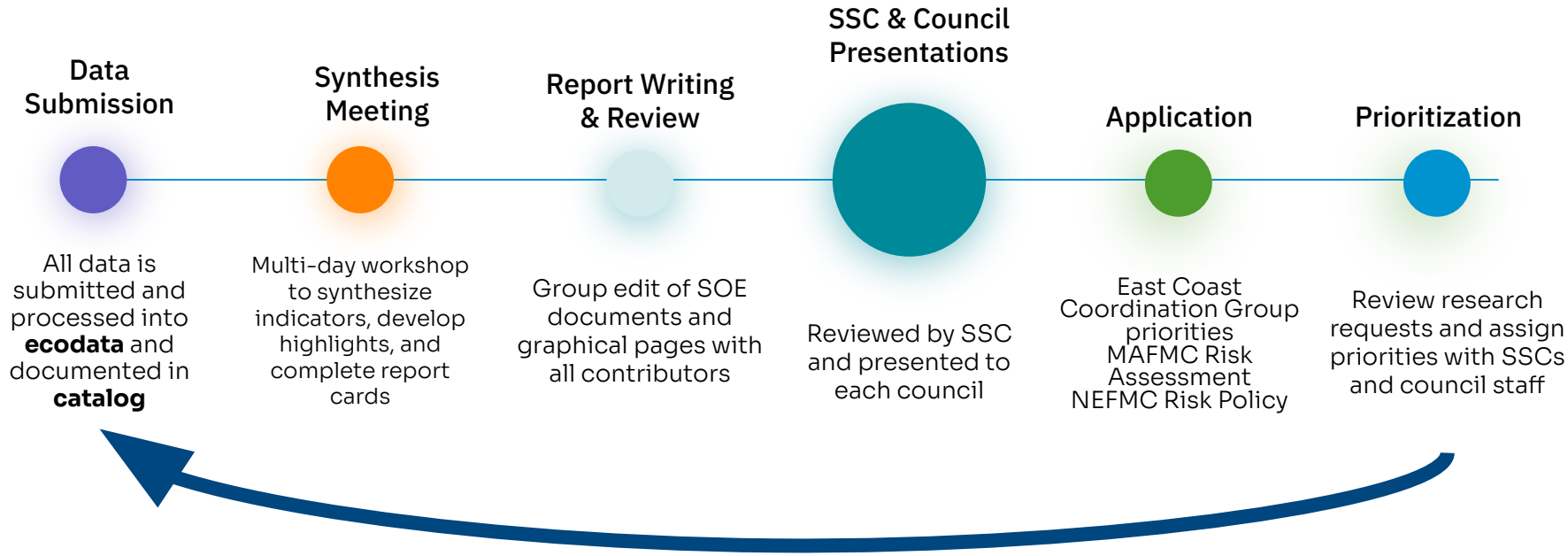
Responsible for planning report progress and POCs for report sections

SOE Cycle


Data Submission
All data is submitted and processed into **ecodata** and documented in **catalog**
Synthesis Meeting
Multi-day workshop to synthesize indicators, develop highlights, and complete report cards
Report Writing & Review
Group edit of SOE documents and graphical pages with all contributors
SSC & Council Presentations
Reviewed by SSC and presented to each council
Application
East Coast Coordination Group priorities
MAFMC Risk Assessment
NEFMC Risk Policy
Prioritization
Review research requests and assign priorities with SSCs and council staff

Expected Changes for 2025

Inclusion of Ocean Forecasts

Reproduce existing indicators with MOM6 12 month forecasts

Revised Community Indicators

Will reflect the national discussion about community vulnerability

Profitability Indicators

Inclusion of net-revenue from last year's discussions

Improved language for "fishery stability"

Incorporating feedback from SSC SS subcommittee & others

SOE Highlights

Who?	Anyone with a working relationship with the ocean (industry, coastal communities, academia, etc.)
What?	Any “unusual” or “anomalous” events. Things that haven’t been seen ever or in a long time. Events that counter the norm.
Why?	Things happen faster than we can write reports. We want to start investigating current events, but we need to know where to look.

northeast.ecosystem.highlights@noaa.gov

SOE 2026 Objectives for NEFMC

Risk Policy

How do we improve the applicability of SOE data for use in scoring?

SSC Decisions

What ecosystem context will be helpful for the SSC's to have during the next year?

Communicating Forecasts

Forecasted indicators are new to the SOE. How should their uncertainty be addressed?

NOAA FISHERIES

Snapshot Ecosystem & Socioeconomic Profile (ESP)
Herring Case Study

Joe Caracappa, NEFSC EDAB
September 2, 2025

joseph.caracappa@noaa.gov

NOAA FISHERIES

Examples of Council/management requests

- “Single-stock SOEs” have been requested since ≤2019
- Linking ecosystems indicators to risk policy
- Incorporate more social indicators into management decision-making
- Short-form, easily readable and digestible documents similar to summary pages of the SOE

ESP Objectives

- Leverage existing information and knowledge pathways
  - Incorporate a broad range of information
  - Identify cumulative and comprehensive patterns
- Facilitate interpretation and use in management
  - Standardized framework & visuals
  - Improve transparency, reproducibility, and efficiency
- Identify on-ramps to fill knowledge gaps and work toward operational Ecosystem Based Fisheries Management
  - Provide relevant ecosystem and socioeconomic information for fisheries management
- Track changes in the system over time

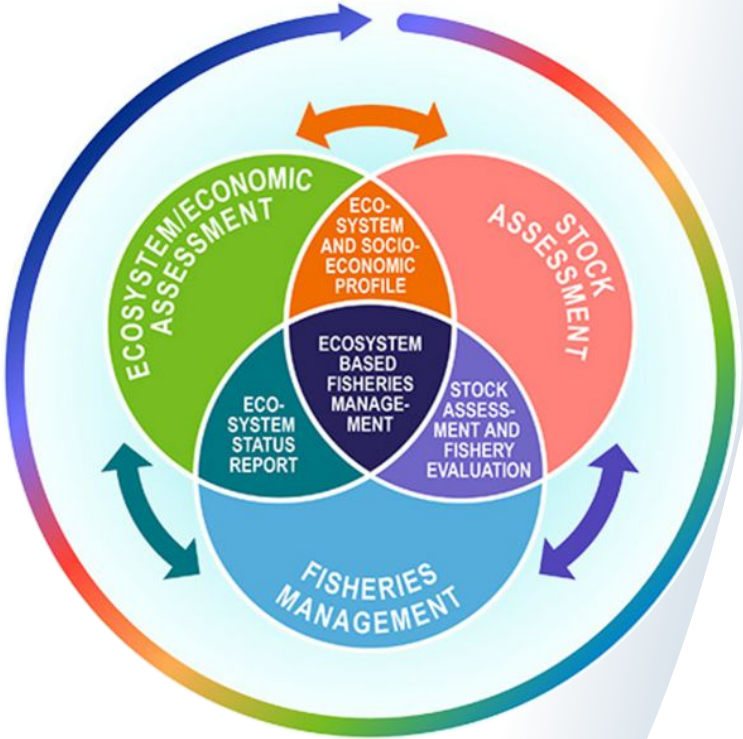
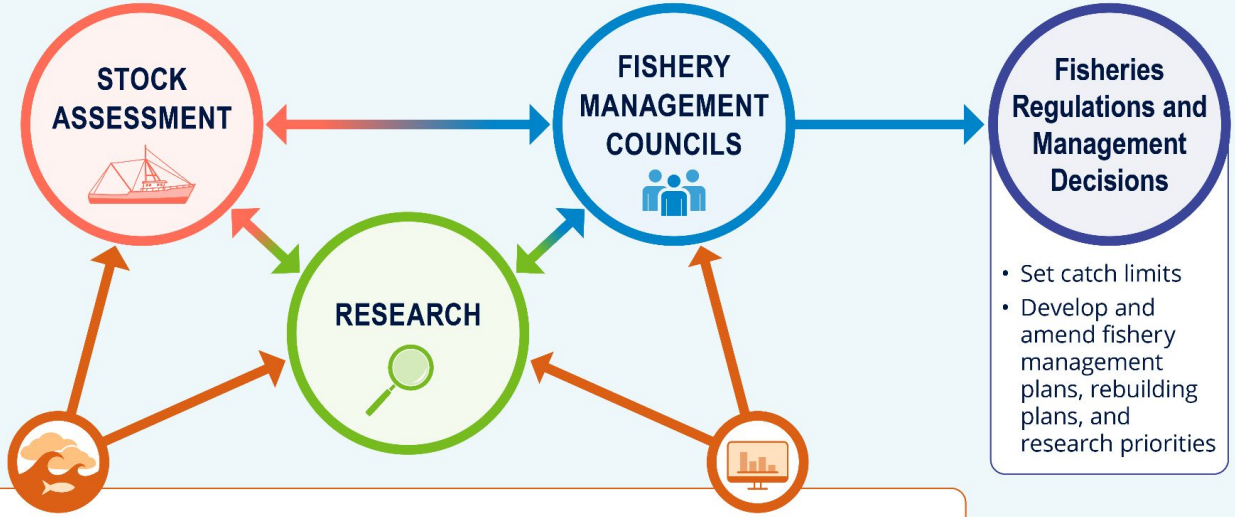


Image courtesy of Rebecca White, AFSC Communications Branch

NOAA FISHERIES

FISHERIES SCIENCE AND MANAGEMENT SYSTEM



Addresses Term of Reference to identify ecosystem and climate influences

- Improves fisheries stock assessments
- Informs decisions that determine the health and abundance of fish stocks

Ecosystem and Socioeconomic Profile Information

Provides scientific information to fisheries managers

- Improves estimates of risk and uncertainty
- Can be used in setting sustainable harvest policies
- Highlights research needs and data gaps

Integrating ESPs into the existing stock assessment and management schedule

- **Full ESPs** have historically been presented with Research Track Stock Assessments
  - Peer reviewed as a research product
  - Opportunity to test ecosystem covariates in the stock assessment model
- **Snapshot ESPs** will be presented following operational model peer review
  - Communicate recent indicator status and recent events/ observations that could be contextually important for the stock
  - Would not necessarily update every indicator, depending on the underlying hypotheses and methods
  - Possibility of doing a snapshot without a full ESP

Full ESP steps

Literature Review

Identify problem statement & key questions

Comprehensive literature review

Develop life history and socioeconomic conceptual models

Indicator Identification

Brainstorm indicators from possible mechanistic linkages

Narrow down indicators based on data availability and feasibility of use

Indicator Selection

Score indicators on data quality, effort, theoretical basis, and interpretability

Finalize ~3 umbrella topics with 2-3 indicators each

Analyses

Compile indicator time series and assess trends

Assess relationships between indicators and the stock

Additional analyses as capacity allows

Conclusions & Future Work

Suggest how findings could be used in the assessment and management

Provide research recommendations

Snapshot ESP steps

Indicator Prioritization

Update the indicators identified for continued maintenance in the full ESP

-OR- (if no full ESP)

Non-comprehensive literature review. Brainstorm and choose indicators with established methods with evidence from lit review

Analyses

Indicator time series with recent year data

Analysis of risk elements in most recent year Risk Assessment

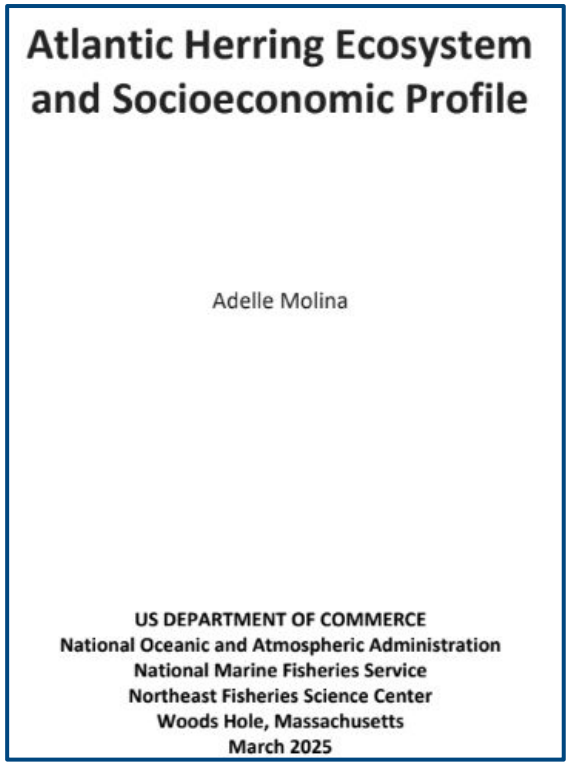
Automated indicator toolbox with code for figures and tables

Conclusions

Implications on the stock with most recent year data update

Summarize information from the fishery, industry, and ecosystem important to management and model considerations

Herring Full ESP (2024-2025)



- 60 page report completed for Atlantic herring Research Track Stock Assessment (2025)
- Comprehensive literature review, synthesize information (life history table and conceptual model), highlight processes influencing each life stage
- Identified critical recruitment drivers:
  - Food availability, egg predation, and larval temperature stress
- Supported decisions about ecosystem covariates on recruitment in the stock assessment model

Herring Snapshot ESP (2025)

- Short-form example based on the 2025 Full ESP, focusing on indicator status updates for 2024
  - Implications on the herring fishery and habitat suitability for most recent year
  - Added socioeconomic indicators
- Connections to management applications
  - Risk Policy criteria or others?
- Reproducible in the future with few changes to incorporate new data updates

Black Sea Bass (*Centropristis striata*) Snapshot Ecosystem & Socioeconomic Profile

Spring 2025

This is a short-form update to the full Ecosystem and Socioeconomic Profile [1] highlighting the recent status of environmental, ecological, and socioeconomic factors. Black sea bass is an important Mid-Atlantic stock with high commercial value and recreational engagement. Overfishing is not occurring and the stock is not overfished. Winter bottom temperature is used in the stock assessment model as a factor that influences recruitment to incorporate the observed link between cold temperature and smaller year classes [2].

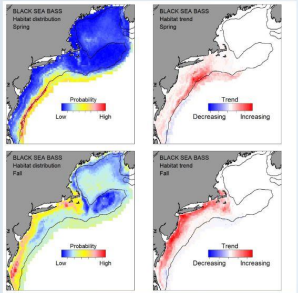


Figure source: https://www.fisheries.noaa.gov/new-england-mid-atlantic/ecosystems/fisheries-habitat-northeast-us-shelf-ecosystem

2024 in Review

Fishing Community Observations
- Steady or increasing availability
- Concerns about high discards
- Restrictive and complex regulations limit fishing opportunities
- For additional information, see [3], [4], and [5]

Commercial Fishery
- Number of active vessels declined in 2024, but total landed pounds increased from 2023
- Total revenue decreased slightly along with average prices ($/lb)
- Average revenue per vessel increased

Recreational Fishery
- Targeted trips, catch, and landings all down from 2023 [3]
- However, number of trips is still above the historic average
- Recreational catch-per-angler index not yet updated for 2024

Ecosystem
- The stock assessment models the stock as two subunits, divided at the Hudson Canyon
- Cold winter in the north but near average in the south
- Poor or below average fish condition (i.e., weight at a given length; see below)

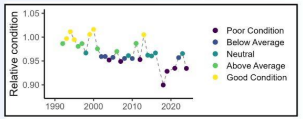
Key Points from the Mid-Atlantic Risk Assessment

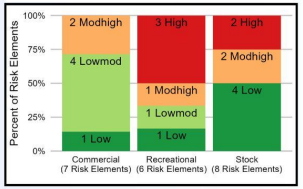
Moderate-high to high risk of the stock not achieving optimal biomass due to:
- Very high exposure to changes in climate
- Observed and potential changes in distribution; northward shift into the Gulf of Maine
- Dependence on threatened estuarine habitat
- Decline in the biomass of benthic invertebrate prey
- Decline in black sea bass body condition (see right)

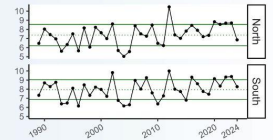
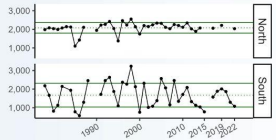
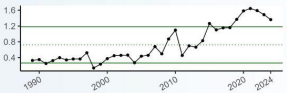
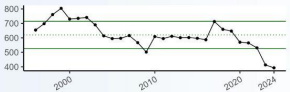
High risk of the recreational fishery not achieving optimal yield due to:
- Catch exceeding harvest limits in several years
- High regulatory complexity; frequent changes and varying interstate regulations; regulatory changes in allocations

Moderate-high risk of the commercial fishery not achieving optimal yield due to:
- Commercial revenue in wind development areas
- High discards & discard mortality

Please see the Mid-Atlantic 2024 EAFM risk assessment update for more details and explanation of the low and low-moderate risks to black sea bass and its associated fisheries.





Indicator	Status In 2024	Implications	Time Series*
Mean winter (Feb-Mar) bottom temperature (°C)	North: Below threshold South: Near long-term average	Cold winter temperatures may increase the mortality of young-of-the-year fish, resulting in smaller year classes. 2024 temperature in the northern subunit (north of Hudson Canyon) was colder than black sea bass's lower threshold of 8°C. Bottom temperature data comes from GLORYS, a modeled product [7].	
Shelf water volume (km^3)	No data for 2024	Shelf water volume [8] is a proxy for suitable winter habitat; higher shelf water volume indicates less suitable habitat, potentially leading to northern fish migrating into the southern subunit. The shelf water volume dataset is created from in situ data, and there has been no winter sampling since 2022, highlighting the need for additional indicators to inform stock subunit mixing.	
Black sea bass MRIP recreational trips (millions of annual trips)	Above long-term average	Recent trip numbers are near an all-time high, but have decreased from 2023. Catch (not shown) generally reflects trip patterns, while landings (not shown) have remained steady. High regulatory complexity may contribute to recreational fishing trends.	
Number of active black sea bass commercial vessels (#)	Below long-term average	Active vessels were defined as the number of vessels with federal permits that landed at least one pound of black sea bass in a year. The number of active vessels has been decreasing since 2017, which could impact revenue distributions and fleet composition.	
Commercial revenue per active black sea bass vessel (2024 USD)	Above long-term average	Commercial revenue per active black sea bass vessel follows an overall increasing trend most likely driven by the continued decline of active vessels and an overall increase in total commercial landed pounds over the past decade.	

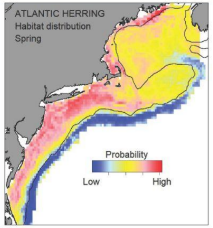
* The y-axis units are included in the "Indicator" column of the table. In all figures, the dashed line represents the time series mean, and the solid green lines indicate ± 1 standard deviation. Commercial data were derived from the commercial dealer database hosted at the Greater Atlantic Regional Office. All dollar values have been adjusted to 2024 real dollars using the Gross Domestic Implicit Price Deflator. The code used to create this report can be viewed online: github.com/NEFSC/READ-EDAB-bsbESP

We welcome your observations! Please contact northeast.ecosystem.highlights@noaa.gov with any on-the-water insights or changes observed in the black sea bass fishery and nefsc.esp.leads@noaa.gov with questions or comments on the information presented in this report.

Atlantic herring (*Clupea harengus*) Snapshot Ecosystem & Socioeconomic Profile

Summer 2024

This is a short-form update to the full Ecosystem and Socioeconomic Profile [1] highlighting the recent status of environmental and ecological factors. Atlantic herring is an important and valuable New England stock fished primarily by commercial vessels for use as bait (for lobster). The stock is currently overfished but not subject to overfishing.



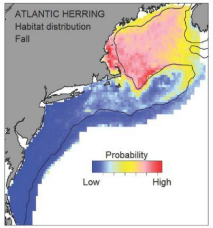


Figure source: https://www.fisheries.noaa.gov/new-england-mid-atlantic/ecosystems/fisheries-habitat-northeast-us-shelf-ecosystem

Recent highlights

2025 Research Track Stock Assessment
- Explored a recruitment index from seabird diet data [2]
- Developed indicators of predation by haddock [3], food availability [4], and temperatures experienced by larvae [5] to test as ecosystem covariates for recruitment but none significantly improved the model [6]

Fishing community observations [7]
- Market processes: increased reliance on menhaden due to declining and inconsistent herring catch, reduced quotas, higher fuel prices, river herring bycatch
- Ecological concerns: warming, changing zooplankton and forage base, haddock predation, altered predator-prey interactions

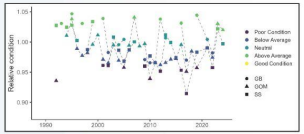
Commercial Fishery
- Reduced participation, particularly of larger vessels
- Broader market impacts include switch to alternative sources like frozen herring and menhaden

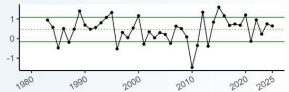
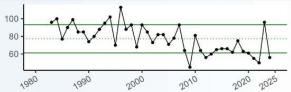
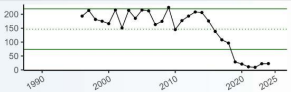
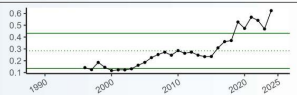
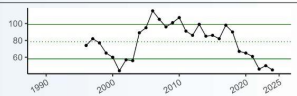
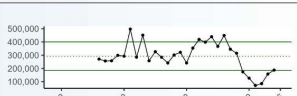
Management
- Still in a period of substantially reduced catch limits
- Frequently changing ABC and sub-ACLs across the 4 management areas
- Several extensions and revisions to the target rebuilding date, currently 2031

Ecosystem
- Age 3+ adults migrate to the Gulf of Maine for summer/fall spawning.
- Haddock predation on eggs is decreasing
- Development depends on appropriately sized zooplankton prey at the right time in lifecycle; zooplankton communities are changing
- Warming increases herring larval encounters with stressful or lethal surface temperature

NEW ENGLAND RISK POLICY SUMMARY (PLACEHOLDER)

- What type of information is useful to summarize here?
  - –Risks to meeting management objectives
  - –Compile existing risk indicators relevant to the stock
  - –Sources of management and model uncertainty
- Some capacity to develop our own risk indicators and/or provide additional context based on other ecosystem risk indicators
- Is there other information related to stock-level risk that should go here?



Indicator Units	Status In 2024	Implications	Time Series
Winter NAO (Index)	WinterNAO anomalies have been positive in 2024 and 2025	NAO phases impact oceanographic properties of water entering the Gulf of Maine. Easily updatable, data publicly available [8]. Could be replaced by other indices of climate variability or SOE indicators (such as Gulf Stream Index)	
Haddock Predation (Index)	Declining predation on herring eggs	Lower egg predation favors strong year classes. Tailored indicator developed by Micah Dean at MADMF for the RTSA. Alternative indicator:haddock SSB from the stock assessment model	
Optimal larval temperature duration (# of days)	Short duration of optimal larval temperature in fall 2024	Unsuitable conditions for larvae. Easily updatable, data publicly available. Based on larval thermal limits and OISST data, using herring spatial footprint.	
Commercial Landings (millions of lbs)	Well below average	Commercial landings remained relatively static compared to 2023 and are slightly higher than 2020-2022 quantities; however, landings are still well below the historical average as well as the standard deviation from the mean.	
Average Price per lb. (2024 $/lb)	Well above average	Ex-vessel price was well above the historical average in 2024. Given no notable uptick in landings, this increase may be driven in part by supply constraints, particularly for Area A1 which had a 92.1% of its quota landed by December of 2024 [9].	
Active Vessels (# of vessels)	Well below average	The number of active vessels in the herring fishery declined from 2023 to 2024, following an overall decreasing trend since 2017, suggesting overall negative implications for fishing fleet diversity and resilience.	
Average Vessel Revenue (2024 $)	Below average	The average revenue per vessel from herring landings increased slightly from 2023 and has continued a positive trend since 2021. This is most likely due to a lower number of vessels in the fleet and potential increases in effort from those remaining in the fishery to maintain relatively consistent landings relative to previous years.	

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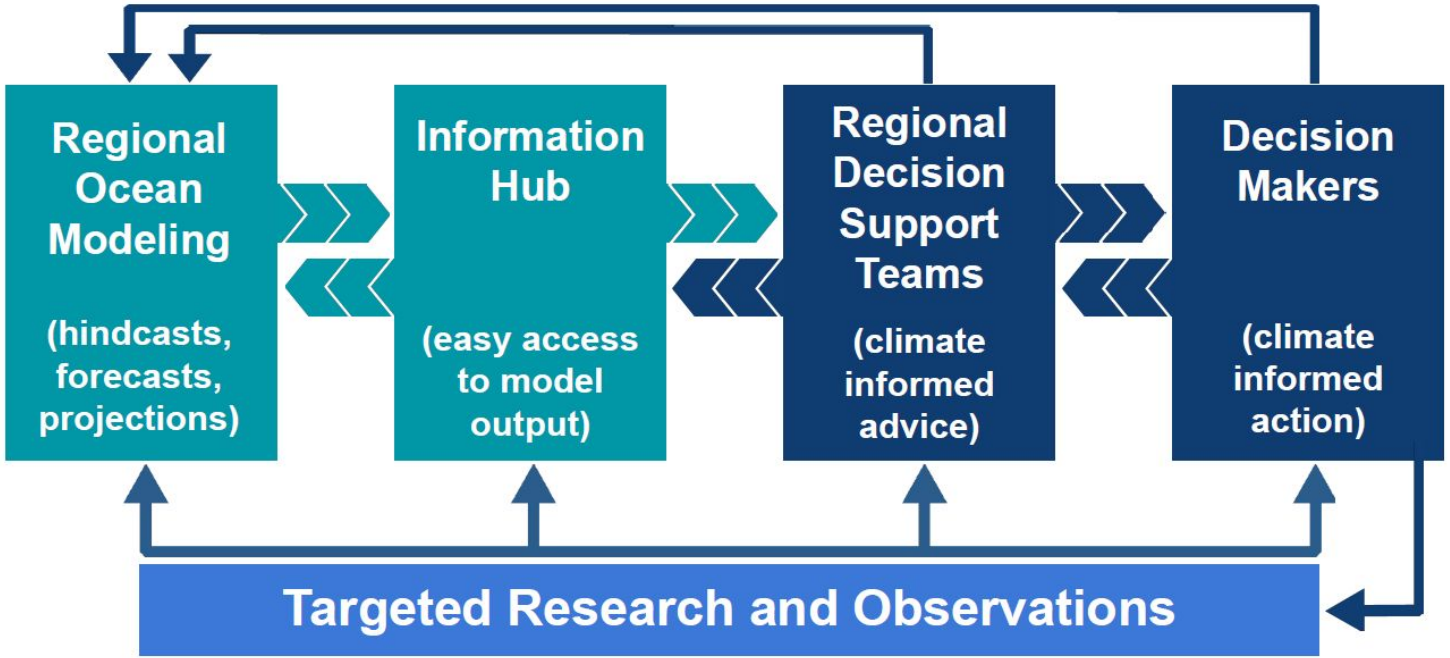
We welcome your observations! Please contact northeast.ecosystem.highlights@noaa.gov with any on-the-water insights or changes observed in the Atlantic herring fishery and nefsc.esp.leads@noaa.gov with questions or comments on the information presented in this report.

Discussion Questions

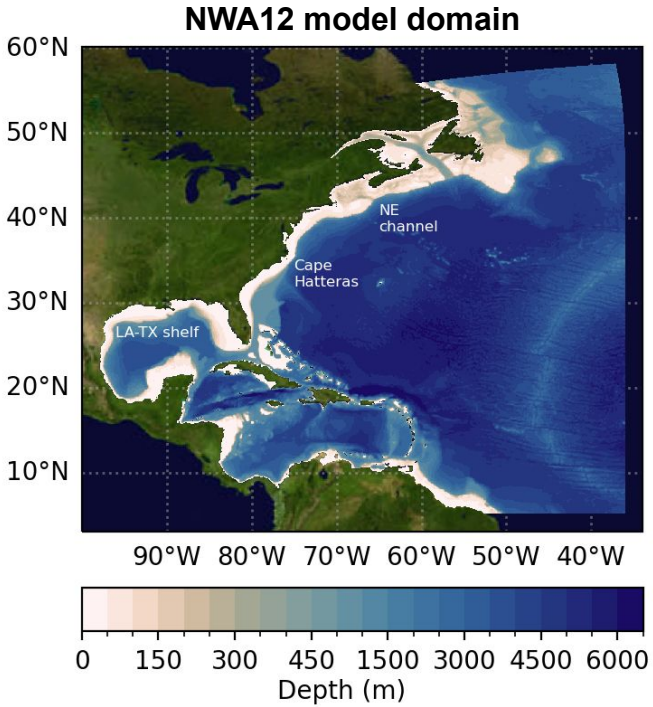
- How could Snapshot ESP information be used to inform SSC deliberations and/or management decisions?
  - Present indicators with respect to NEFMC Risk Policy categories
  - Species-level decisions such as allocations, size limits, etc
  - What additional information could be used? When has ecosystem/socioeconomic information been requested but not available?
- How should we prioritize data-limited stocks for Snapshot ESPs?
  - Value of fishery
  - Recent stock trends
  - Vulnerability to climate
- How should we balance ecosystem and socioeconomic indicators?

The Changing Ecosystems & Fisheries Initiative (CEFI)



NWA12 regional 1/12° resolution Northwest Atlantic model

- Coupled MOM6 ocean, COBALT ocean biogeochemistry, and SIS2 sea ice models, with forcing from atmosphere and land.
- 1/12° resolution to balance representation of shelf scale processes with computational efficiency for running thousands of simulations.
- Model evaluated in several recent papers:
  - Ross et al., GMD, 2023 (doi.org/10.5194/gmd-16-6943-2023)
  - Koul et al., GRL, 2024 (doi.org/10.1029/2024GL110946)
  - Ross et al., Ocean Science, 2024 (doi.org/10.5194/os-20-1631-2024)

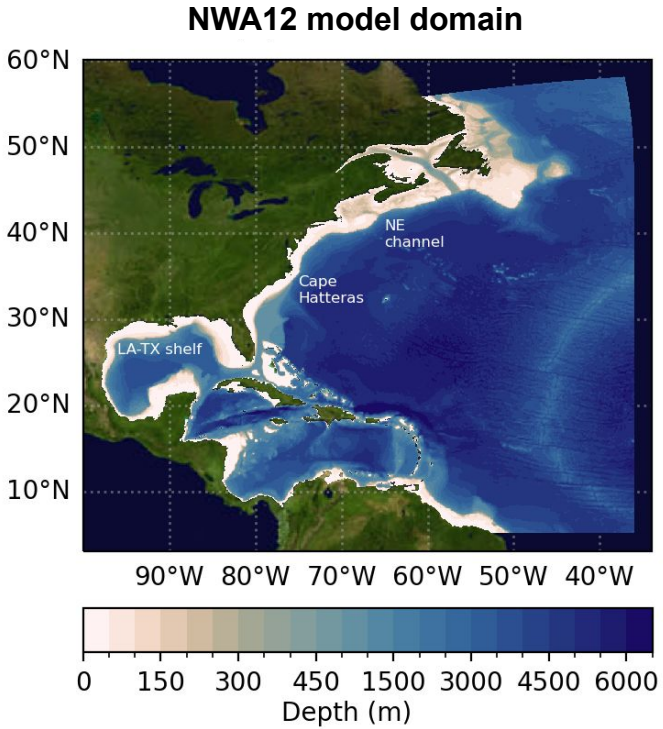


Northwest Atlantic CEFI modeling status

	Status
Baseline Config	github.com/NOAA-GFDL/CEFI-regional-MOM6/tree/main/xmls/NWA12
Hindcast (1993 to near present)	Published in 2023 doi.org/10.5194/gmd-16-6943-2023
Retrospective Seasonal (1 month to 1 year ahead)	Physics only published in 2024: doi.org/10.5194/egusphere-2024-394 BGC in progress
Retrospective Decadal (1 year to 1 decade ahead)	Physics only published in 2024: doi.org/10.1029/2024GL110946 BGC in progress
Projections (middle to end of century)	In progress
Seasonal Outlook (delivered every 3 months)	April and July 2025 delivered psl.noaa.gov/cefi_portal/
Decadal Outlook (delivered every year)	2025–2034 outlook should be on portal soon
Updated hindcast (every year)	Updated July 2025 (extends through end of 2023)

Seasonal and decadal forecasts

- Downscaling GFDL's SPEAR global seasonal and decadal predictions NWA12
- 10 ensemble members and long retrospective forecast evaluations to understand model skill and uncertainty
- Focusing on along-shelf bottom temperature, oxygen, acidification, other metrics most relevant for marine resources
- Now running as operational prototypes with latest results regularly posted to CEFI data portal (https://psl.noaa.gov/cefi_portal/)



Seasonal and decadal forecasts

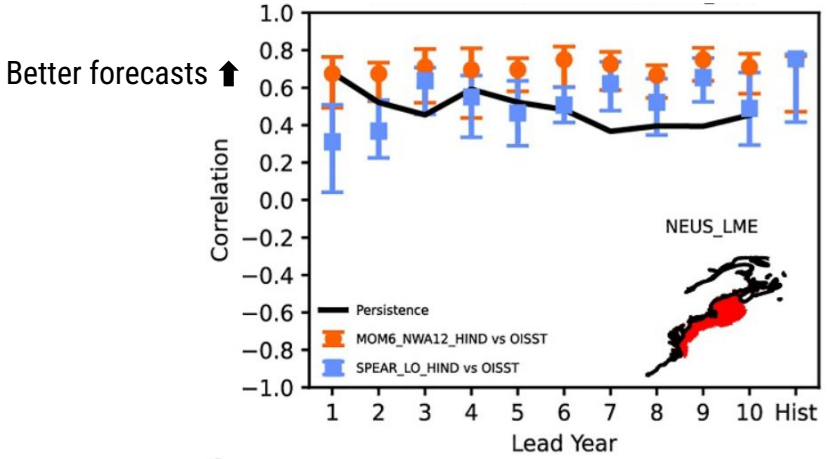
- Seasonal: out to 1 year, run every 3 months
  - Skill varies, most predictions in Northeast US region skillful at least 3 months out, some much longer.
  - Small spatial scales reasonable except extremely close to coast
  - Typically look at monthly averages
- Decadal: out to 10 years, run every year
  - Most predictions skillful at least 2 years out, temperature skillful full period
  - Typically look at spatial scales the size of the EPUs or the full NEUS LME
  - Typically annual or multi-year averages
- Like weather forecasts, uncertainty is primarily driven by chaotic evolution from the imperfectly known initial state

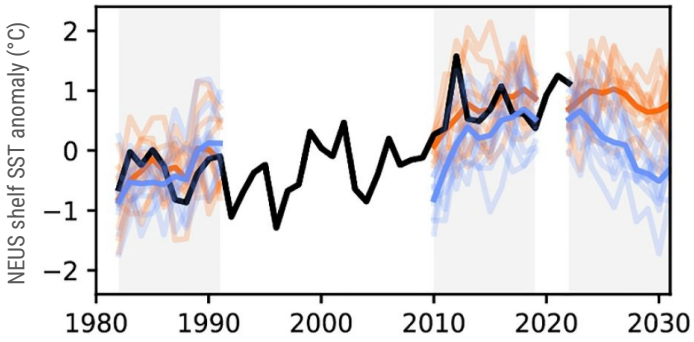
Decadal forecasts: First-of-its-kind downscaled decadal ocean prediction system

- 10-year long forecasts initialized January 1
- NWA12 has higher SST prediction skill than SPEAR and persistence
- 2022 forecast: predicted transient AMOC strengthening and southward Gulf Stream shift.
- Global model (SPEAR) predicted a shelf SST cooling, but downscaled solution with improved shelf resolution and skill predicted only a warming pause.

Koul et al., GRL, 2024
(doi.org/10.1029/2024GL110946)

SST retrospective forecast anomaly correlation



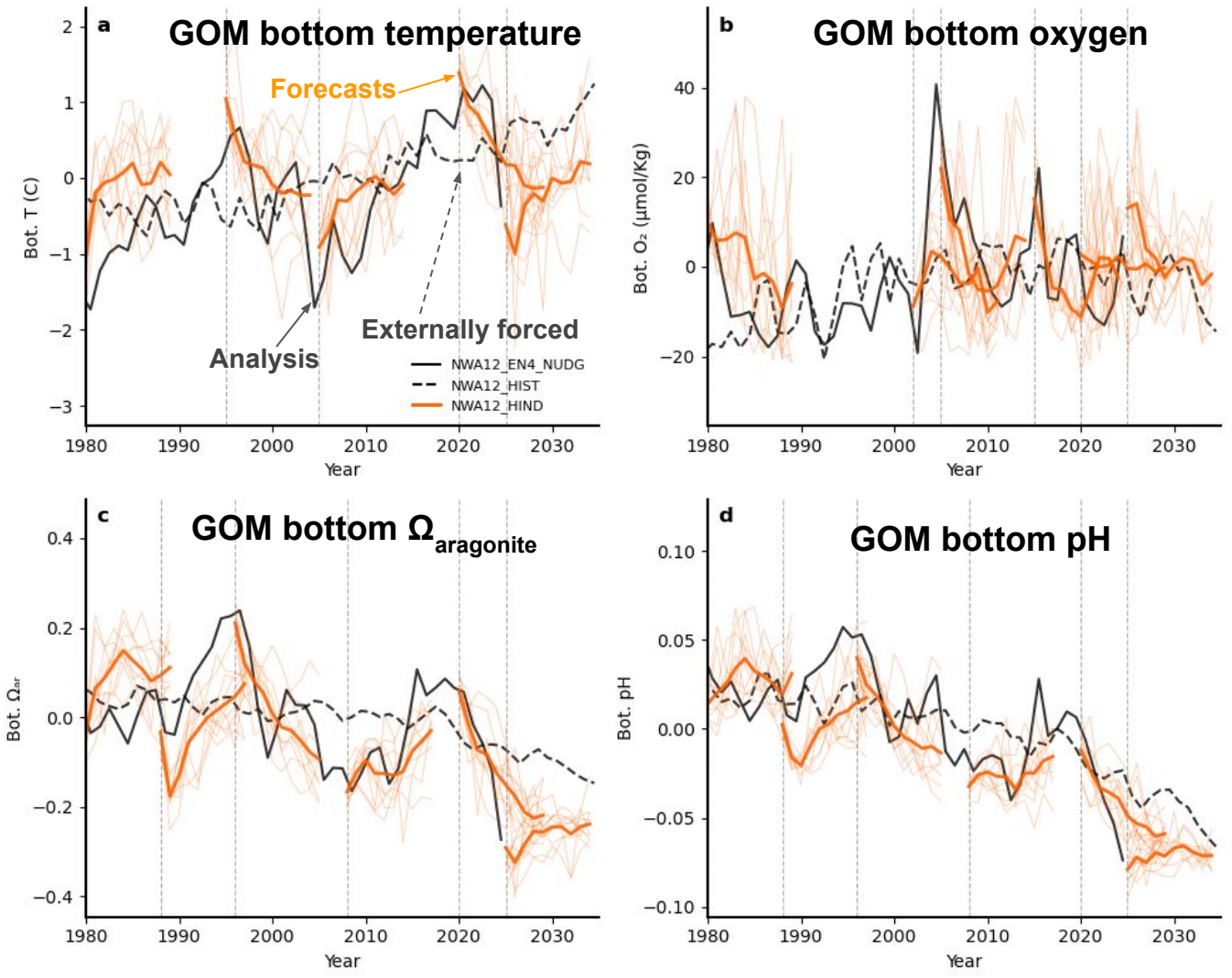


Selected SPEAR and downscaled NWA12 temperature anomaly predictions for the Northeast U.S. Shelf compared with **observations**

Past decadal predictions and latest forecast

Experimental, from draft manuscript

Biogeochemistry now included and new 2025 forecast run

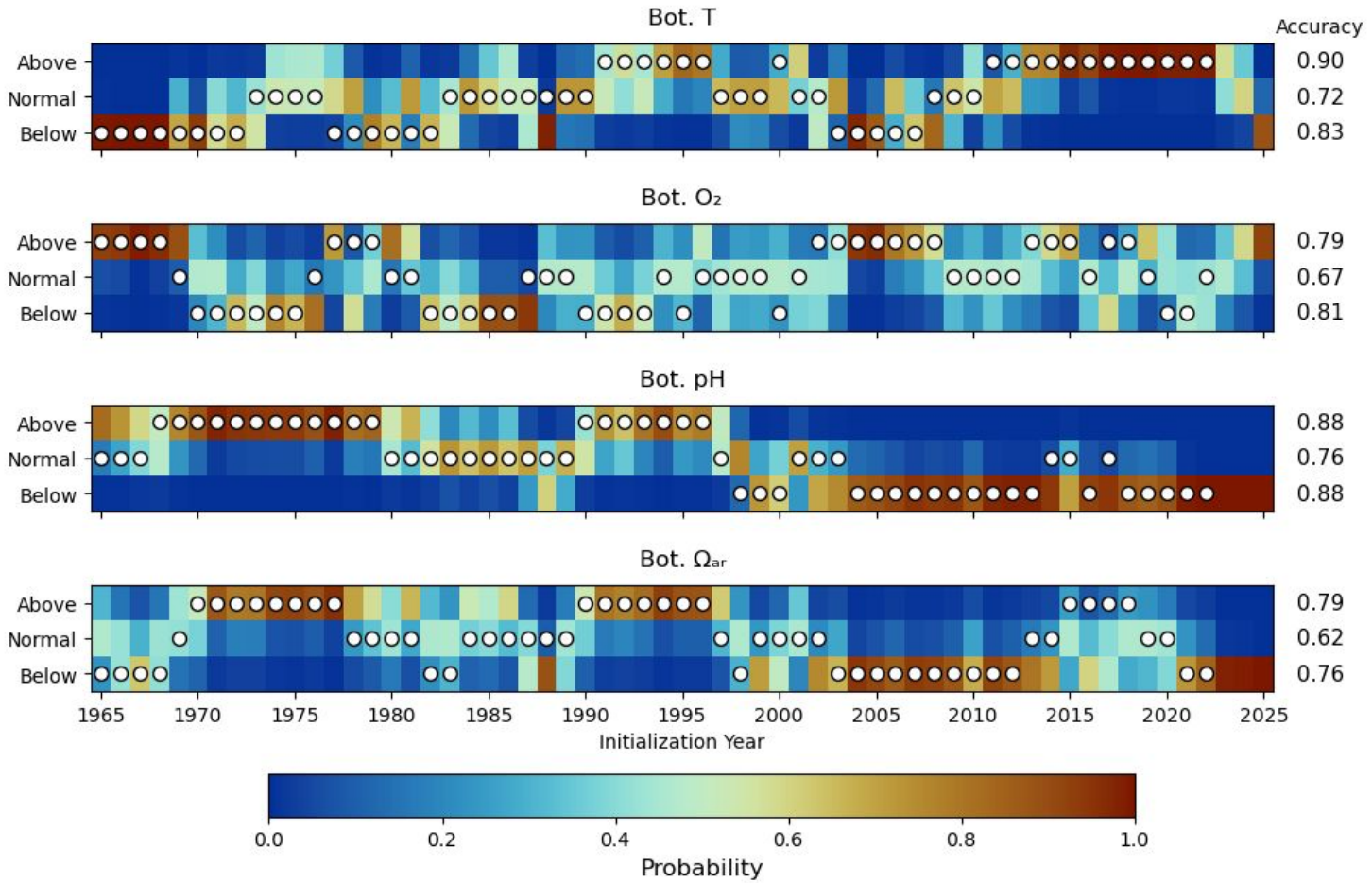


Past decadal predictions and latest forecast

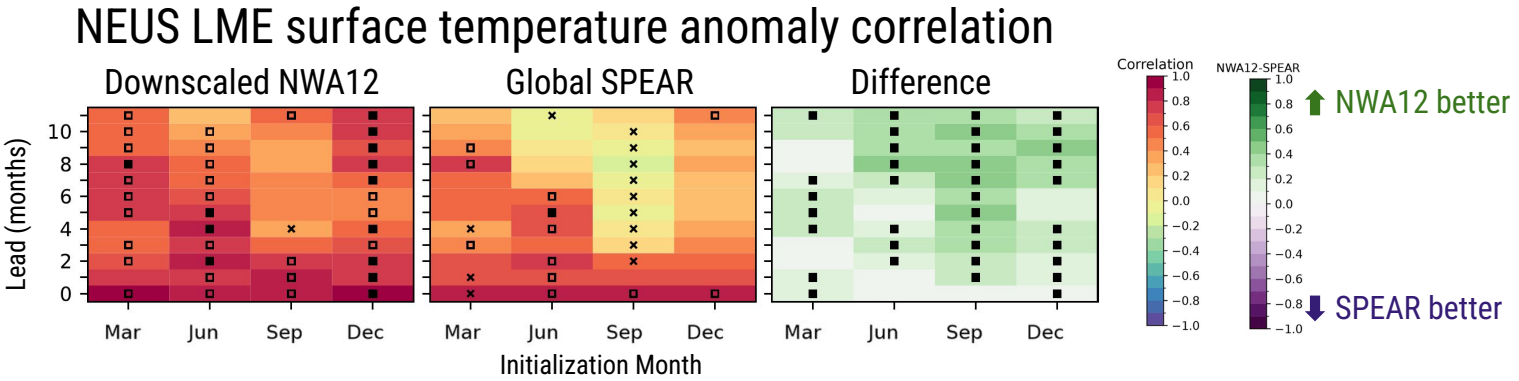
Experimental, from draft manuscript

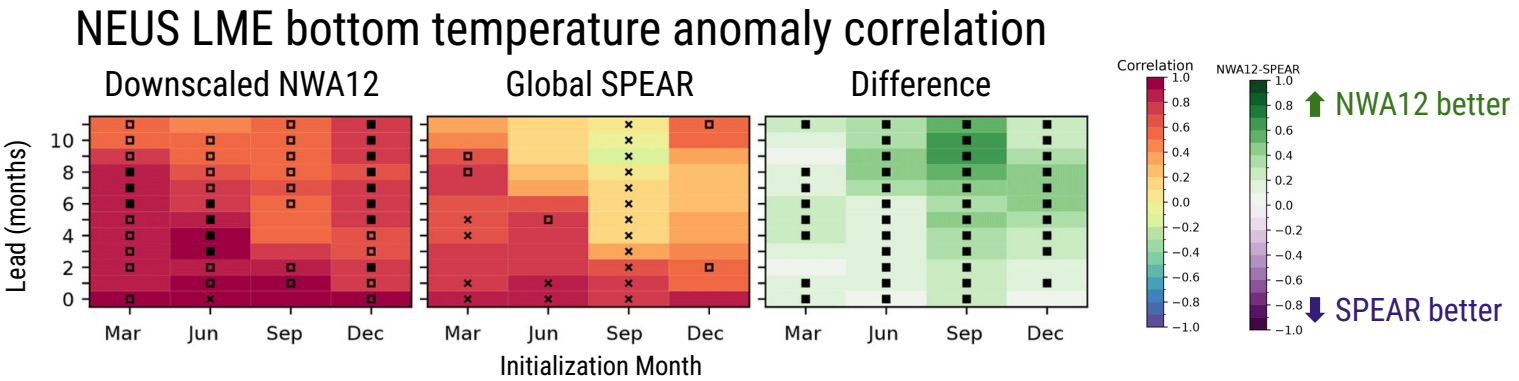
Forecast for average over next 3 years

Ensemble mean post-processed with extended logistic regression using analysis as reference



Seasonal forecasts: improved seasonal temperature prediction skill

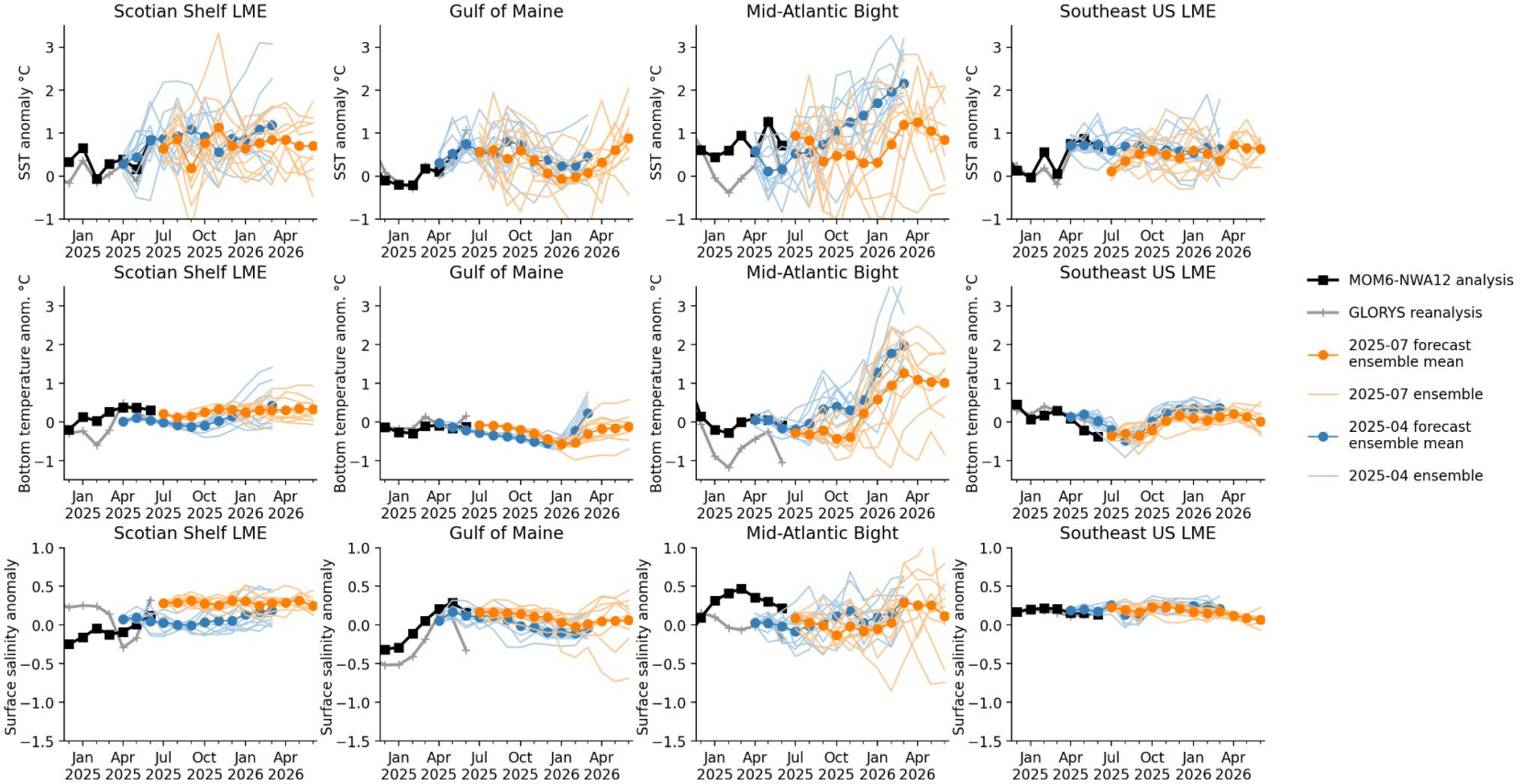




Ross et al. 2024 https://doi.org/10.5194/os-20-1631-2024

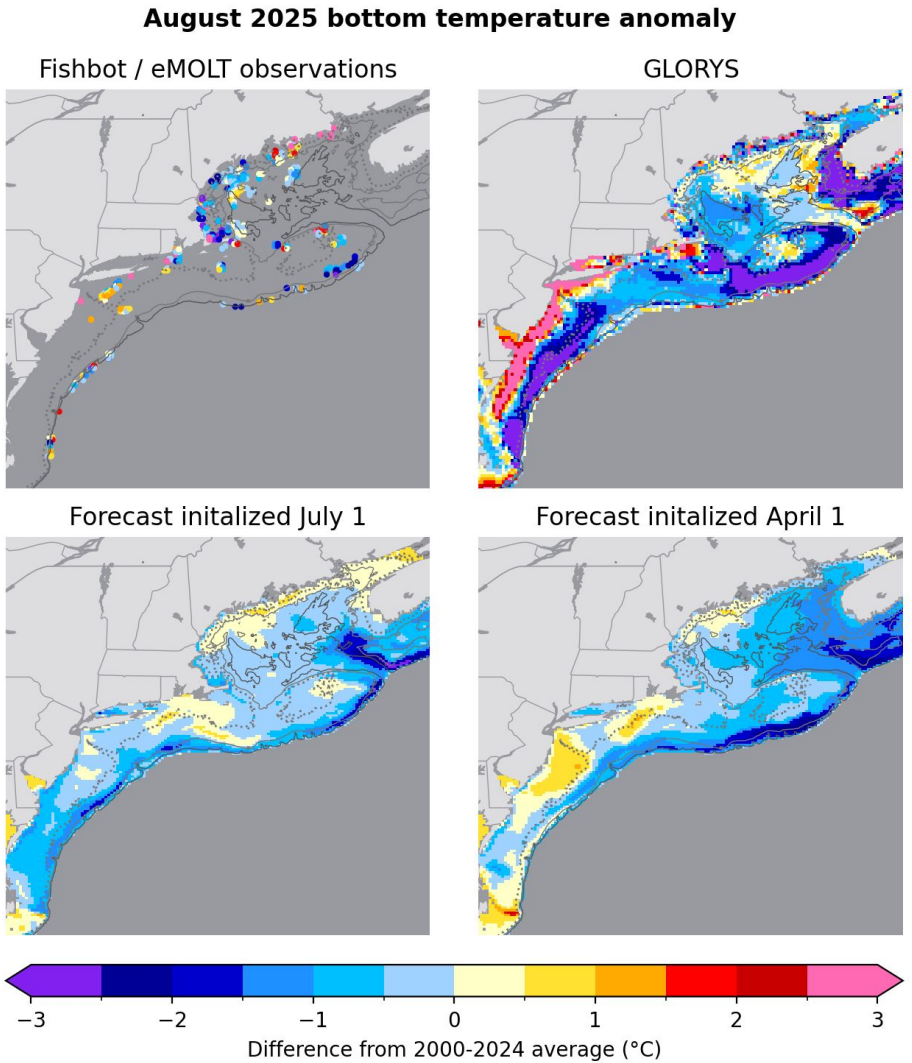
Seasonal forecasts now prototype operational

- Running every 3 months starting April 2025
- Near real time: model runs finish ~ 10 days into month



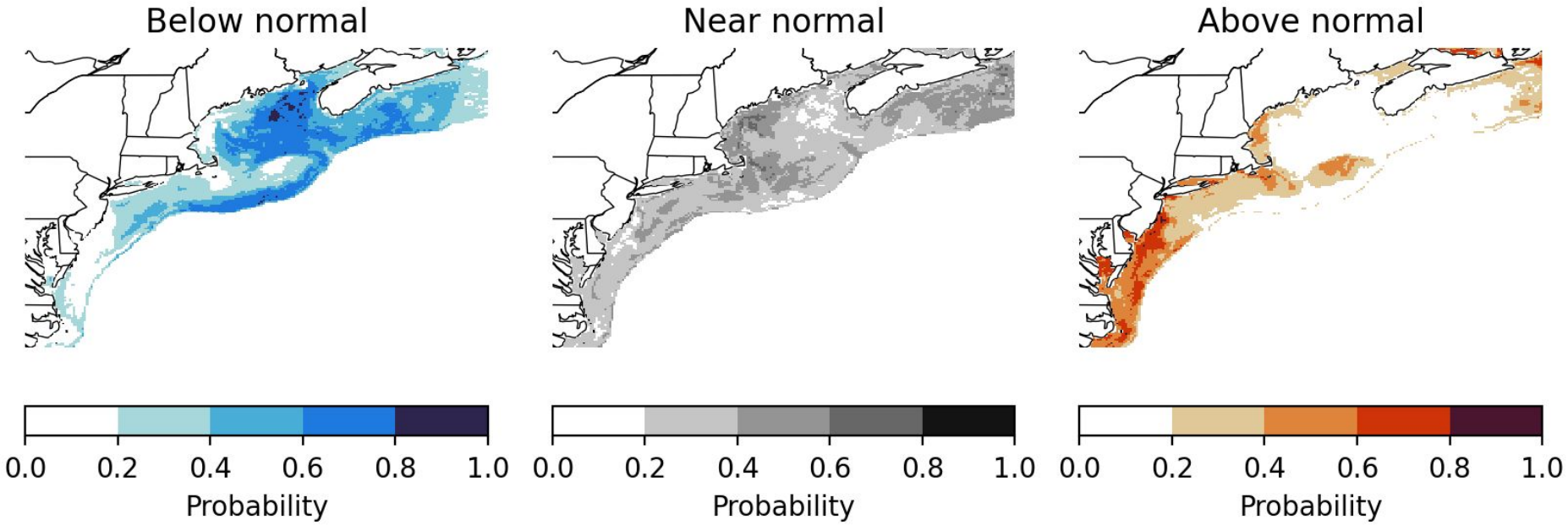
Rapid assessment of seasonal forecasts

- Fishbot database and GLORYS analysis enable near real time checks of forecast accuracy
- Figure at right is for August 1-19, created on August 21
- Looking into opportunities to provide these kinds of updates semi-regularly through blog posts or similar mechanisms



Exploring how to provide information about uncertainty

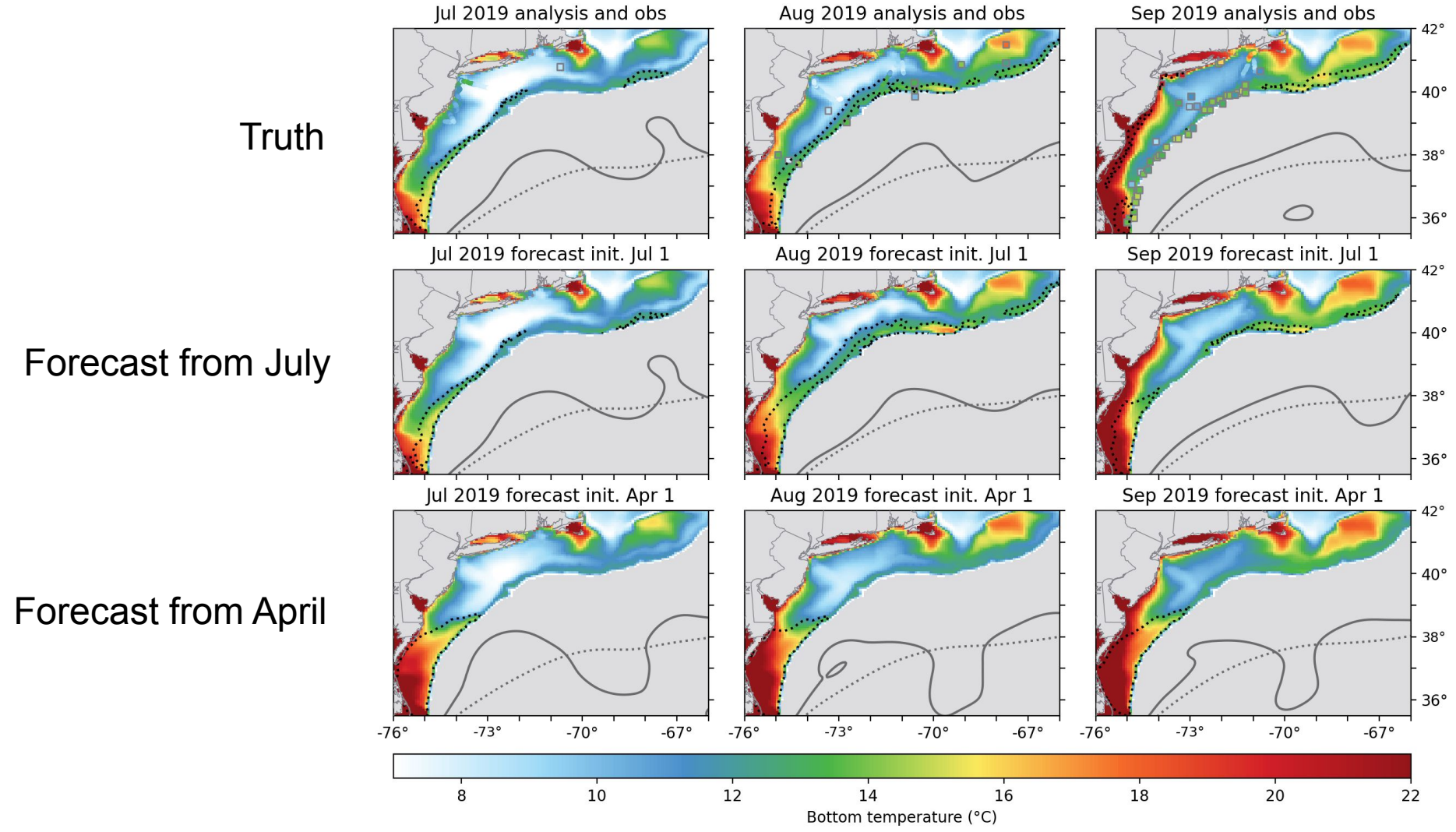
Sample forecast of the probability of below normal, near normal, or above normal bottom temperatures



Northwest Atlantic CEFI planned updates

	Status
Seasonal Outlook (delivered every 3 months)	Early October ‘25, Early January ‘26 Running with biogeochemistry now; targeting January ‘26 for public launch of BGC
Decadal Outlook (delivered every year)	Run 2026–2035 in early 2026
Updated hindcast (every year)	Update in 2026
Projections (middle to end of century)	Released in next few months

Extra slides


Truth
Forecast from July
Forecast from April
Jul 2019 analysis and obs
Aug 2019 analysis and obs
Sep 2019 analysis and obs
Jul 2019 forecast init. Jul 1
Aug 2019 forecast init. Jul 1
Sep 2019 forecast init. Jul 1
Jul 2019 forecast init. Apr 1
Aug 2019 forecast init. Apr 1
Sep 2019 forecast init. Apr 1
42°
40°
38°
36°
-76°
-73°
-70°
-67°
8
10
12
14
16
18
20
22
Bottom temperature (°C)

Seasonal forecasts now running with BGC

- Bottom oxygen, pH, and aragonite saturation state forecasts coming soon