



New England Fishermen's Stewardship Association
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July 29, 2025

Atlantic States Marine Fisheries Commission
Robert Beal, Executive Director
1050 N Highland St, Suite 200 A-N
Arlington, VA 22201

Dear Commissioner,

Thank you for the opportunity to provide comments on the Gear Marking Framework that the New England Fishery Management Council (NEFMC) is scheduled to consider this September.

As Chief Operating Officer of the New England Fishermen's Stewardship Association (NEFSA), I represent a broad and unified voice of thousands of commercial fishermen, seafood dealers, and coastal stakeholders across New England. Our membership spans both fixed gear and mobile gear sectors—placing NEFSA in a unique position to speak on behalf of the full spectrum of affected fishing communities.

On behalf of these constituents, I urge the Atlantic States Marine Fisheries Commission (ASMFC) to recommend that the Council not move forward with this framework at all. However, if the Council proceeds despite widespread opposition, NEFSA can only support Alternative 1A, which reflects the need for further evaluation and caution.

The Framework Is Unwarranted Given the Regulatory Pause

The proposed Gear Marking Framework is unnecessary at this time. Congress, through the Consolidated Appropriations Act of 2023, has paused further Atlantic Large Whale Take Reduction Plan (ALWTRP) regulations until at least December 31, 2028. This pause affirms that the 2021 ALWTRP rule is sufficient for legal compliance under both the Endangered Species Act and the Marine Mammal Protection Act during this period.

The Atlantic Large Whale Take Reduction Team (ALWTRT) has recognized this pause by delaying its own process until 2026, with final rule making not expected before 2028. The Council should align with that timeline—not override it—especially when the gear technologies under discussion are still in developmental stages, untested in real-world commercial use, and riddled with unresolved questions around safety, cost, and feasibility.

Industry-Led Caution on Ropeless Gear Is Justified

The rush to mandate on-demand or ropeless gear is misplaced. These technologies lack reliable testing, have uncertain safety profiles, and would impose severe economic burdens on fishing operations. Concerns include:

- Crew safety risks in entanglement scenarios where rapid gear removal is critical.
- Significantly lower gear recovery rates compared to standard rope-based gear.
- Excessive replacement costs, particularly for small-boat operators.
- Increased risk of lost gear and ocean pollution.

Fishermen, who are already struggling with narrow margins and growing regulatory burdens, should not be treated as test subjects for experimental solutions that have not undergone adequate industry validation.

NEFSA's Unique Role: Representing Both Fixed and Mobile Gear Sectors

NEFSA is uniquely positioned in that it represents both fixed gear and mobile gear fishermen, giving us a full-spectrum understanding of the impacts of these proposals. It is vital that policymakers recognize the important distinction between these two sectors.

The mobile gear fleet—including trawl and scallop vessels—has become an innocent bystander in the ropeless conversation. These vessels do not use vertical lines and pose no entanglement risk to North Atlantic Right Whales. Yet under the current Framework, they may be forced to adopt costly gear-marking or detection technologies meant to address a problem that does not apply to their operations.

Imposing additional requirements on mobile gear fishermen is unjustified, illogical, and deeply unfair. They should not be penalized or burdened by rules designed for a completely different fishery. NEFSA urges the Commission and Council to recognize this and remove mobile gear vessels from the scope of any gear-marking mandates tied to ropeless detection.

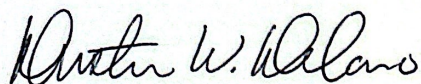
Recommendation: Reject the Framework; If Not, Support Only Option 1A

For all these reasons, NEFSA urges the Commission to strongly recommend that the Council not advance this framework. Moving forward now disregards the federal regulatory pause, places unnecessary burdens on both fixed and mobile gear fisheries, and risks undermining the livelihoods of thousands of working families across the region.

If the Council insists on action, Alternative 1A is the only approach that NEFSA and the broader fishing community can support at this time. This alternative provides the minimum level of regulatory imposition and acknowledges that more time and research are needed before advancing further.

We respectfully request that the Atlantic States Marine Fisheries Commission stand with the fishing industry in advocating for common-sense decision-making, rooted in science, safety, and the lived realities of those who work on the water every day.

Respectfully,

A handwritten signature in black ink, appearing to read "Dustin W. Delano". The signature is fluid and cursive, with the first name "Dustin" being more prominent.

Dustin W. Delano
Chief Operating Officer
New England Fishermen's Stewardship Association



Atlantic States Marine Fisheries Commission

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MEMORANDUM

TO: American Eel Management Board
FROM: American Eel Technical Committee
DATE: July 28, 2025
SUBJECT: Review of Maine Aquaculture Plan and TC Recommendations

The American Eel Technical Committee (TC) reviewed the Maine Aquaculture Plan for the 2026 fishing year. The TC recommends approval of the plan as presented. Additionally, the TC discussed the criteria for aquaculture harvest site selection established in Addendum V to the American Eel Fishery Management Plan (FMP) and developed recommendations for TC review of these criteria.

Addendum V includes the following language to guide the evaluation of proposed aquaculture plans, which was based on TC recommendations:

“Site selection for harvest will be an important consideration for applicants and reviewers. Suitable harvest locations will be evaluated with a preference to locations that have:

1. Established or proposed glass eel monitoring;
2. Are favorable to law enforcement; and
3. Watershed characteristics that are prone to relatively high mortality rates.”

In evaluating the Maine aquaculture plan, the TC noted that only some of these criteria were considered, and some may not be appropriate for Maine. For example, in consideration of the larger commercial glass eel fishery that is already occurring, monitoring efforts specific to the smaller aquaculture provision may not provide useful information. The TC noted that the proposal intentionally avoids Criterion 1 in order to avoid the commercial catch skewing the young-of-year survey data. For the newest harvest site, the Machias River, Criterion 2 is addressed as the site is routinely monitored by Marine Patrol. However, it is also an unencumbered waterway, which conflicts with Criterion 3.

The TC does not feel these issues warrant denial of the Maine aquaculture plan but would like to further discuss the site selection criteria for aquaculture plans. The TC recommends the Board task the Committee with reviewing the criteria in Addendum V to determine if changes to the language or interpretation of these criteria should be considered.



Atlantic States Marine Fisheries Commission

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MEMORANDUM

TO: Sciaenids Management Board

FROM: Red Drum Technical Committee and Stock Assessment Subcommittee

DATE: July 28, 2025

SUBJECT: Considerations for New Fishing Mortality Methods Pathway Proposed in Addendum II to Amendment 2 of the Red Drum Interstate Fishery Management Plan

The Red Drum Technical Committee (TC) met on July 8, 2025 to discuss development of Draft Addendum II to Amendment 2 of the Red Drum Interstate Fishery Management Plan. Staff provided an overview of Plan Development Team progress towards development of the addendum and the remaining timeline. The primary purpose of the call was for the TC to provide guidance to the Sciaenids Management Board (Board) on the addendum component of establishing a pathway to allow states to propose new methods to estimate fishing mortality for the evaluation of future regulation changes states may propose. This call was a continuation of the discussion from an earlier TC call on June 2, 2025, when this component was introduced.

Language provided by Board members following the 2025 Spring Commission Meeting and discussion during the June 2 TC call identified four topics for consideration behind the request for this component of the addendum:

- (1) a method used for the latest stockwide assessment becoming obsolete/outdated,
- (2) concern that delays to future stockwide assessments with updated information on stock status, could, in turn, delay the re-evaluation of red drum management by the states,
- (3) allowing the assessment of sub-stock/localized red drum condition as opposed to stockwide condition, and
- (4) using an alternative management quantity (e.g., escapement) for assessing sub-stock/localized condition and informing potential management changes (either more restrictive or liberalized from status quo).

Initial recommendations from the June 2 TC call were reviewed and included:

- **Implement a safeguard like a formal review process to ensure sub-stock/localized fishing mortality information is consistent with the stockwide information**
- **Clearly define the quantity being used as the basis of fishing mortality information (e.g., spawning potential ratio, escapement) and how it is calculated**

Staff noted the Commission does currently have processes in place that can be used as a pathway to propose new methods to estimate fishing mortality as well as to address the topics above that led to

this request. These processes are outlined in the Commission's [Technical Support Group Guidance and Benchmark Stock Assessment Process](#) document. The process for proposing new methods to estimate fishing mortality outlined in the document is as follows:

"An alternative stock assessment for a Commission-managed species developed by external groups must be brought to the attention of the Board/Section Chair during a benchmark stock assessment process if the group would like their assessment to be considered for management use. Alternative assessments are subject to the same standards, documentation, and process as assessments developed by the Commission, including SAS, TC, and independent peer review. External groups must notify the Commission one month in advance of an assessment workshop regarding their interest in presenting an alternative assessment at the workshop. Any analyses submitted outside the benchmark process may not be considered for management until the next Commission benchmark assessment."

An existing process also allows for requests for expedited assessments to prevent delays in updated stock status information:

"Requests for additional benchmark assessments and associated peer reviews may be made by the Board/Section to the Policy Board and are granted based on prioritization of the existing stock assessment and peer review schedule, relative workloads of assessment scientists, and available funding."

As the proposed process to provide new methods for estimating red drum fishing mortality deviates from that outlined in the guidance document, the TC discussed the following questions during the call to provide considerations to the Board on this component of the addendum:

- What impact(s), if any, would different assessments (e.g., state-specific vs. stockwide) used through time for evaluating management changes and making additional management changes have on future assessments and/or resource stock status?
- What does the Board need to consider if:
 - using assessments with different spatial structures/assessing sub-stocks independent of the full stock?
 - using model/analyses with different configurations/assumptions/data when assessing the same stock/sub-stock?
 - using different management quantities (e.g., $F_{30\%}$ and escapement) through time for evaluating management changes and making additional management changes?
- What is an appropriate timeframe for a red drum regulatory regime before evaluating its impact on stock status?

The TC noted estimates from a stockwide assessment and assessment at a different spatial scale (e.g., state-specific) would not be directly comparable. For example, fishing mortality estimates from these two analyses would differ due to different spatial scales. Complications from comparing estimates from various analyses are exacerbated by different data treatments and choices made by the different groups conducting the analyses. Two concrete examples were provided on the call. First, dealt with the treatment of catch per unit effort (CPUE) derived from MRIP data in the 2024 ASMFC stock assessment and 2020 Florida state-specific assessments. The ASMFC assessment excluded this CPUE data because it showed trends different than fishery-independent indices and there were concerns with hyperstability

in the catch rates, while the Florida assessment included these data as indices of abundance. Second, was the difference in treatment of selectivity patterns between the same regional and Florida assessment for the recreational fishery. In the regional assessment, it was assumed there was a dome-shaped selectivity pattern with declining selectivity on larger red drum. In the Florida assessment, logistic selectivity was assumed, such that all fish above approximately 50 cm were fully selected by the gear, though not retained above the slot maximum. These, and other, differences are likely to lead to differences between assessment estimates. It was also noted that spatial distribution of data can impact analysis estimates. More data rich areas may have a stronger influence on overall analysis estimates than more data-limited areas.

The primary concern identified by the TC with management actions informed by analysis at a spatial scale smaller than the stock unit is the potential for localized depletion. Localized depletion would have an adverse impact on the stock unit as a whole and impact other areas within the stock not considered in the analysis. This is particularly relevant if different methods to estimate fishing mortality at the sub-stock level are used to liberalize regulations at the sub-stock level as opposed to restricting regulations beyond a stock wide minimum, which is typically how different methods have been used previously in red drum management. It was also noted more research is needed to better understand the mechanisms behind the mixing of sub-stocks of red drum.

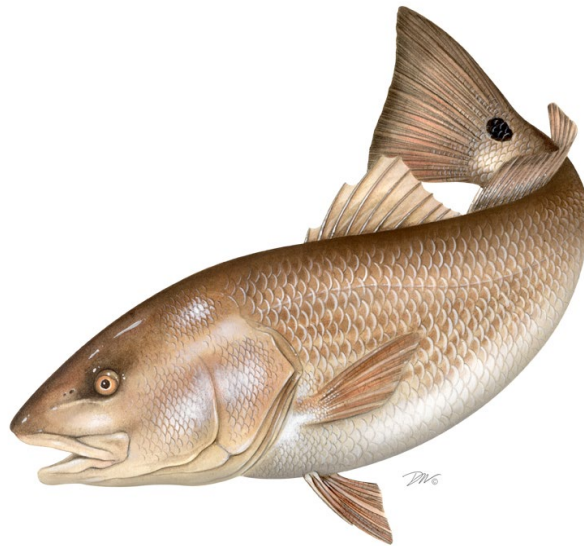
In addition to challenges comparing estimates of the same quantity from various analyses, there may also be differences in quantities being proposed for assessing stock status and informing regulatory changes. Management quantities considered in past assessments include spawning potential ratio (SPR) and escapement. Both have advantages and disadvantages. Spawning potential ratios include fishing mortality information on adults, but there are data limitations, particularly spatially across the stock unit, to inform these adult fishing mortality estimates. Escapement includes fishing mortality information on the more data-rich sub-adult components of the stock but does not include information on adult mortality and assumes there have been no changes to adult mortality. Adult discard mortality in trophy red drum fisheries was identified as a concern during the 2024 stock assessment. Evaluating the same population according to different quantities through time may lead to conflicting management advice.

During the 2024 stock assessment, the TC recommended the next benchmark assessment be completed in 2029. This timeline was revised through Board motion at the 2025 Spring Commission meeting to conduct the next benchmark assessment with a terminal year of 2031 (completion in 2033). Upon evaluating the management change impact on stock status, the TC believes the timeframe necessary with improvement in the stock is dependent on the intent of the regulatory change and how informative data are for reflecting the change. Different quantities are likely to show responses on different timeframes. Regulation changes targeting harvest of sub-adult fish may show immediate impacts to fishing mortality levels through assessments while impacts to reproductive potential and realized recruitment may take considerably longer ($\approx 20+$ years) to detect through assessments. Although changes in recruitment may be observed in the short term, it is difficult to decouple environmental impacts from underlying stock status during these short time frames given high variability observed in past red drum recruitment. A year or two years of improvement in one or more areas of the stock are likely not true indications of long-term stock recovery and several years of improvement are necessary to gauge management effectiveness. Generally, the TC believes at least a sub-adult generation time, similar to the five-year period recommended by the TC for the next benchmark assessment, is an appropriate minimum for assessing the impact of regulatory changes to stock status and considering new regulations.

ATLANTIC STATES MARINE FISHERIES COMMISSION
REVIEW OF THE INTERSTATE FISHERY MANAGEMENT PLAN

FOR
RED DRUM
(*Sciaenops ocellatus*)

2024 FISHING YEAR



Prepared by the Plan Review Team
Drafted July 2025



Sustainable and Cooperative Management of Atlantic Coastal Fisheries

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I. Status of the Fishery Management Plan

<u>Date of FMP Approval:</u>	Original FMP – October 1984
<u>Amendments & Addenda:</u>	Amendment 1 – October 1991 Amendment 2 – June 2002 Addendum 1 – August 2013
<u>Management Areas:</u>	The Atlantic coast distribution of the resource from New Jersey through Florida Northern: New Jersey through North Carolina Southern: South Carolina through the east coast of Florida
<u>Active Boards/Committees:</u>	Sciaenids Management Board, Red Drum Technical Committee, Stock Assessment Subcommittee, Plan Development Team, Plan Review Team, South Atlantic Species Advisory Panel

The Atlantic States Marine Fisheries Commission (ASMFC) adopted an [Interstate Fishery Management Plan \(FMP\) for Red Drum](#) in 1984. The original management unit included the states from Maryland to Florida. In 1988, the Interstate Fisheries Management Program (ISFMP) Policy Board requested all Atlantic coastal states from Maine to Florida implement the plan's recommended management regulations to prevent development of northern markets for southern fish. The states of New Jersey through Florida are now required to follow the FMP, while Maine through New York (including Pennsylvania) are encouraged to implement consistent provisions to protect the red drum spawning stock.

In 1990, the South Atlantic Fishery Management Council (Council) adopted an FMP for red drum that defined overfishing and optimum yield (OY) consistent with the Magnuson Fishery Conservation and Management Act of 1976. Adoption of this plan prohibited the harvest of red drum in the exclusive economic zone (EEZ), a moratorium that remains in effect today. Recognizing all harvest would take place in state waters, the Council FMP recommended states implement measures necessary to achieve the target level of at least 30% escapement.

Consequently, ASMFC initiated [Amendment 1](#) in 1991, which included the goal to attain optimum yield from the fishery over time. Optimum yield was defined as the amount of harvest that could be taken while maintaining the level of spawning stock biomass per recruit (SSBR) at or above 30% of the level which would result if fishing mortality was zero. However, a lack of information on adult stock status resulted in the use of a 30% escapement rate of sub-adult red drum to the off-shore adult spawning stock.

Substantial reductions in fishing mortality were necessary to achieve the escapement rate; however, the lack of data on the status of adult red drum along the Atlantic coast led to the adoption of a phase-in approach with a 10% SSBR goal. In 1991, states implemented or maintained harvest controls necessary to attain the goal.

As hoped, these management measures led to increased escapement rates of juvenile red drum. Escapement estimates for the northern region of New Jersey through North Carolina

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(18%) and the southern region of South Carolina through Florida (17%) were estimated to be above the 10% phase-in goal, yet still below the ultimate goal of 30% (Vaughan and Carmichael 2000). North Carolina, South Carolina, and Georgia implemented substantive changes to their regulations from 1998-2001 that further restricted harvest.

The Council adopted new definitions of OY and overfishing for red drum in 1998. Optimum yield was redefined as the harvest associated with a 40% static spawning potential ratio (sSPR), overfishing as an sSPR less than 30%, and an overfishing threshold as 10% sSPR. In 1999, the Council recommended management authority for red drum be transferred to the states through the Commission's Interstate Fishery Management Program (ISFMP) process. This was recommended, in part, due to the inability to accurately determine an overfished status, and therefore stock rebuilding targets and schedules, as required under the revised Sustainable Fisheries Act of 1996. The transfer necessitated the development of an amendment to the interstate FMP in order to include the provisions of the Atlantic Coastal Fisheries Cooperative Management Act.

ASMFC adopted [Amendment 2](#) to the Red Drum FMP in June 2002 (ASMFC 2002), which serves as the current management plan. The goal of Amendment 2 is to achieve and maintain the OY for the Atlantic coast red drum fishery as the amount of harvest that can be taken by U.S. fishermen while maintaining the sSPR at or above 40%. There are four plan objectives:

- Achieve and maintain an escapement rate sufficient to prevent recruitment failure and achieve an sSPR at or above 40%.
- Provide a flexible management system to address incompatibility and inconsistency among state and federal regulations which minimizes regulatory delay while retaining substantial ASMFC, Council, and public input into management decisions; and which can adapt to changes in resource abundance, new scientific information, and changes in fishing patterns among user groups or by area.
- Promote cooperative collection of biological, economic, and sociological data required to effectively monitor and assess the status of the red drum resource and evaluate management efforts.
- Restore the age and size structure of the Atlantic coast red drum population.

The management area extends from New Jersey through the east coast of Florida, and is separated into a northern and southern region at the North Carolina/South Carolina border. The sSPR of 40% is considered a target; an sSPR below 30% (threshold level) results in an overfishing determination for red drum. Amendment 2 required all states within the management unit to implement appropriate recreational bag and size limit combinations needed to attain the target sSPR, and to maintain current, or implement more restrictive, commercial fishery regulations. All states were in compliance by January 1, 2003. See Table 1 for state commercial and recreational regulations in 2022.

Following the approval of Amendment 2 in 2002, the process to transfer management authority to ASMFC began, including an Environmental Assessment and public comment period. The final

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rule became effective November 5, 2008. It repeals the federal Atlantic Coast Red Drum Fishery Management Plan and transfers management authority of Atlantic red drum in the exclusive economic zone from the South Atlantic Fishery Management Council to the Atlantic States Marine Fisheries Commission.

The Board approved [Addendum I](#) to Amendment 2 in August 2013. The Addendum revised the habitat section of Amendment 2 to include current information on red drum spawning habitat and life-stages (egg, larval, juvenile, sub-adult, and adult). It also identified and described the distribution of key habitats and habitats of concern.

II. Status of the Stocks

The [2024 Red Drum Benchmark Stock Assessment and Peer Review Report](#) indicates the southern stock (South Carolina through the east coast of Florida) is overfished and experiencing overfishing (Figures 1 & 2). The three-year average spawning stock biomass (SSB) at the end of the assessment was below the threshold and the spawning potential ratio (SPR) average of the last three years was less than SPR_{30%} (20.7%).

The northern stock of red drum (New Jersey through North Carolina) is not overfished and not experiencing overfishing (Figure 3). Despite the positive stock status determination for the northern stock in the last year of the assessment, fishing mortality rates have been on the rise and are approaching the fishing mortality threshold. Updates of the traffic light analysis (TLA), used to assess the northern stock, are recommended to monitor these trends closely in coming years.

III. Status of the Fishery

Red drum landings from New Jersey through the east coast of Florida in 2024 are estimated at 8.1 million pounds (Tables 3 & 4; Figure 4). In 2024, 65% of the total landings came from the southern region where the fishery is exclusively recreational, and 35% from the northern region (Figure 5).

Northern Region (NJ-NC)

Red drum landings in the northern region totaled 2.8 million pounds in 2024, an increase of approximately 44% from the previous year (Tables 3 & 4). Both commercial and recreational landings increased in 2024. Commercial landings totaled 237,034 pounds or 8% of the combined commercial and recreational harvest in the northern region, with 78% of commercial landings coming from North Carolina (Figure 6). Virginia commercial landings in 2024 increased to the highest value in the state's time series since 1965. In North Carolina, a daily commercial trip limit and an annual cap of 250,000 pounds with payback of any overage constrained the commercial harvest. Unique to this state, the red drum fishing year extends from September 1 to August 31. In 2008, the Board approved use of this fishing year to monitor the cap. During the 2023/2024 fishing year, North Carolina landed 185,259 pounds of the 250,000-pound annual landings cap.

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Recreational landings in the northern region in 2024 were estimated to be 2.6 million pounds, an increase from the previous year's estimates of recreational harvest at 1.8 million pounds (Table 4). North Carolina is estimated to have 1.3 million pounds of recreational landings, followed by Virginia with 1.1 million pounds. Virginia and North Carolina red drum recreational landings increased by 87% and 21% from the previous year, respectively. The number of fish harvested in the recreational fishery in 2024 was 607,080 fish, an increase of 57% from 2023 (Table 5). The number of fish released in the northern region, 3.2 million fish, in 2024 increased by 19% from 2023 (Figure 7). It is estimated that 8% of released fish die as a result of being caught, resulting in an estimated 256,795 dead discarded fish in 2024 (Table 6). Recreational removals from the fishery are thus estimated to be 863,875 fish in 2024 (Figure 7 and 8).

Southern Region (SC-FL)

The southern region had no commercial landings; Florida commercial harvest has been prohibited since January 1988. South Carolina and Georgia designated red drum as a gamefish, banning commercial harvest and sale since 1987 and 2013, respectively.

Recreational landings in the southern region in 2024 were estimated to be 5.3 million pounds, a 75% increase from 2023 (Table 4). An increase in recreational landings was observed in all three states in 2024. Florida is estimated to have approximately 2.6 million pounds of recreational landings, followed by Georgia with 1.4 million pounds, and South Carolina with 1.3 million pounds. Recreational landings in Florida, Georgia, and South Carolina increased by 74%, 66%, and 87%, respectively. The number of fish harvested in the recreational fishery in 2024 was 1.7 million fish, which was a 64% increase from recreational harvest in 2023 (Table 4). The number of fish released in the southern region in 2024 was 11.0 million fish, which was an increase of 29% from 2023 when 8.5 million fish were released and a time series high (1981-2024; Figure 7). It is estimated that 8% of released fish die as a result of being caught, resulting in an estimated 881,075 dead discarded fish in 2024 (Table 6). Recreational removals from the fishery are thus estimated to be 2.6 million fish in 2024, also a time series high (Figures 7 & 8).

IV. Status of Assessment Advice

Current stock status information comes from the 2024 stock assessment (ASMFC 2024) completed by the ASMFC Red Drum Stock Assessment Subcommittee (SAS) and Technical Committee (TC), peer reviewed by an independent panel of experts through the SEDAR process, and approved by the Sciaenids Management Board in October 2024 for use in management decisions. The two stocks were assessed separately, using different methods. The southern stock was assessed using the Stock Synthesis (SS) assessment model. The SS model estimates annual SPR as well as SSB. SSB reference points have not previously been defined for red drum, but were recommended during these assessments as the SSB produced when fishing at the overfishing threshold (i.e., $SSB_{30\%}$, SSB threshold) and the fishing mortality target ($SSB_{40\%}$, SSB target). Stock status is determined from three-year averages of SPR and SSB at the end of the assessment time series (2019-2021 fishing years).

A robust, technically-sound SS model could not be developed for the northern stock, so the stock was assessed using a traffic light analysis (TLA). The TLA assigns a color (red, yellow, or

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green) to categorize relative levels of metrics that reflect the condition of red drum adult abundance and fishery performance (i.e., fishing mortality). The reference period used for the TLA was the previous stock assessment period that had available data and was determined to not be in an overfishing state (1996-2013 for the northern stock). The red drum adult abundance and fishery performance metrics were used to determine overfished and overfishing stock status, respectively. To relate the TLA stock status determinations to the SS stock status determinations, which consider estimates during the last three years of the assessment, the TLA identified an overfished or overfishing status if determinations for any of the last three years were red.

Several states have also conducted state-specific assessments. In 2025, a state-specific stock assessment was completed by South Carolina, which indicated the South Carolina population of red drum was overfished, not experiencing overfishing but headed in a trajectory that would indicate overfishing would occur in 1 to 2 years with current fishing effort (Ballenger and Schlick 2025).

In 2020, Florida completed a stock assessment for red drum in Florida state waters, and found the Atlantic Coast red drum stock was not overfished and overfishing was not occurring (Addis 2020). The northeast region (Flagler through Nassau counties) exceeded the Commission's target escapement rate of 40%. The formally defined southeast region (Miami-Dade-Volusia counties) exceeded the escapement rate in the terminal year (2019), but does not meet the current escapement rate target. Overall, the state of Florida has an escapement rate higher than the Commission's goal in Amendment 2 of 40%.

V. Status of Research and Monitoring

No monitoring or research programs are annually required of the states except for the submission of a compliance report. Fishery-dependent (other than catch and effort data) monitoring programs are conducted from Maryland to Florida, with biological and sportfish carcass recovery programs collecting age, length, and sex data. Virginia, North Carolina, and South Carolina also conduct sportfish tagging programs. Fishery-independent monitoring programs that directly target or may encounter red drum are conducted in New Jersey, Delaware, North Carolina, South Carolina, Georgia, and Florida. Data collected includes CPUE, biological data, YOY indices, and mark-recapture data. See Table 2 for details on the fishery independent indices and ongoing surveys.

VI. Status of Management Measures and Issues

Fishery Management Plan

Amendment 2 was fully implemented by January 1, 2003, providing the management requirements for 2024. Requirements include: recreational regulations designed to achieve at least 40% sSPR, a maximum size limit of 27 inches or less, and current or more stringent commercial regulations. States are also required to have in place law enforcement capabilities adequate to successfully implement their red drum regulations. In August 2013, the Board approved Addendum I to Amendment 2 of the Red Drum FMP. The Addendum revises the habitat section of Amendment 2 to include the most current information on red drum spawning

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habitat for each life stage (egg, larval, juvenile, sub-adult, and adult). It also identifies the distribution of key habitats and habitats of concern, including potential threats and bottlenecks.

In May 2025, the Board initiated Draft Addendum II to Amendment 2, with the following objectives:

1. Establish a process for states to propose changes to their regulations to meet the required fishing mortality level;
2. Establish a pathway outside of the Commission's assessment process which allows for states to propose new methods to estimate fishing mortality (F) for the evaluation of future regulation changes;
3. Modify the FMP to require states to set regulations that would be expected to not exceed the threshold $F_{30\%}$ for fishing mortality in their state;
4. Consider changes to the recreational bag limits and slot limits for the northern region of red drum to address increasing fishing mortality; and
5. Update *de minimis* provisions of the FMP.

The Board will meet at the Commission's Summer Meeting (August 2025) to consider approval of Addendum II for public comment.

De Minimis Requests

New Jersey and Delaware requested *de minimis* status through the annual reporting process. While Amendment 2 does not include a specific method to determine whether a state qualifies for *de minimis*, the PRT chose to evaluate an individual state's contribution to the fishery by comparing the two-year average of total landings of the state to that of the management unit. New Jersey and Delaware each harvested zero percent of the two-year average of total landings. *De minimis* status does not exempt either state from any requirement; it may exempt them from future management measures implemented through addenda to Amendment 2, as determined by the Board.

VII. Implementation of FMP Compliance Requirements for 2024

The PRT found no inconsistencies between state compliance reports and the requirements of Amendment 2.

VIII. Recommendations of the Plan Review Team

Management and Regulatory Recommendations

Consider approval of the *de minimis* requests by New Jersey and Delaware.

Research Recommendations

Research recommendations can be found in the [2024 Red Drum Benchmark Stock Assessment and Peer Review Report](#) and the [2022 Simulation Assessment and Peer Review Report](#). The PRT also stressed the importance following additional research recommendations:

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- Implement surveys (e.g., logbooks, electronic methods, etc.) to determine the length composition (and age data, if possible) of recreational discards (B2) of red drum. This information has been highlighted as the single largest data gap in previous assessments.
- Continue sampling of adult red drum surveys to determine abundance, size, age, sex composition, and maturity of the adults. Additionally, investigate the possibility of senescence in female red drum. Investigate how targeting of adult red drum spawning and post-spawning aggregations via catch-and-release hook-and-line fisheries by anglers is affecting the reproductive potential of the stock due to both direct lethal and sub-lethal effects.
- Assess the effects of environmental factors and habitat loss on stock density/year class strength. Determine whether natural environmental perturbations and habitat loss affect recruitment and modify relationships with spawning stock size.
- Support and conduct applied research to evaluate the social and economic value of this important, primarily recreational fishery. Accomplishing this includes continued support of the Marine Recreational Fishing Expenditures Survey that is conducted every three to five years by NOAA Fisheries as well as conducting applied research on projecting social and/or economic estimated impacts associated with this fishery.

IX. References

- Addis, D. 2020. The 2020 stock assessment of Red Drum, *Sciaenops ocellatus*, in Florida. Florida Fish and Wildlife Conservation Commission Fish and Wildlife Research Institute In-House Report IHR2020-002: 129 p.
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X. Figures

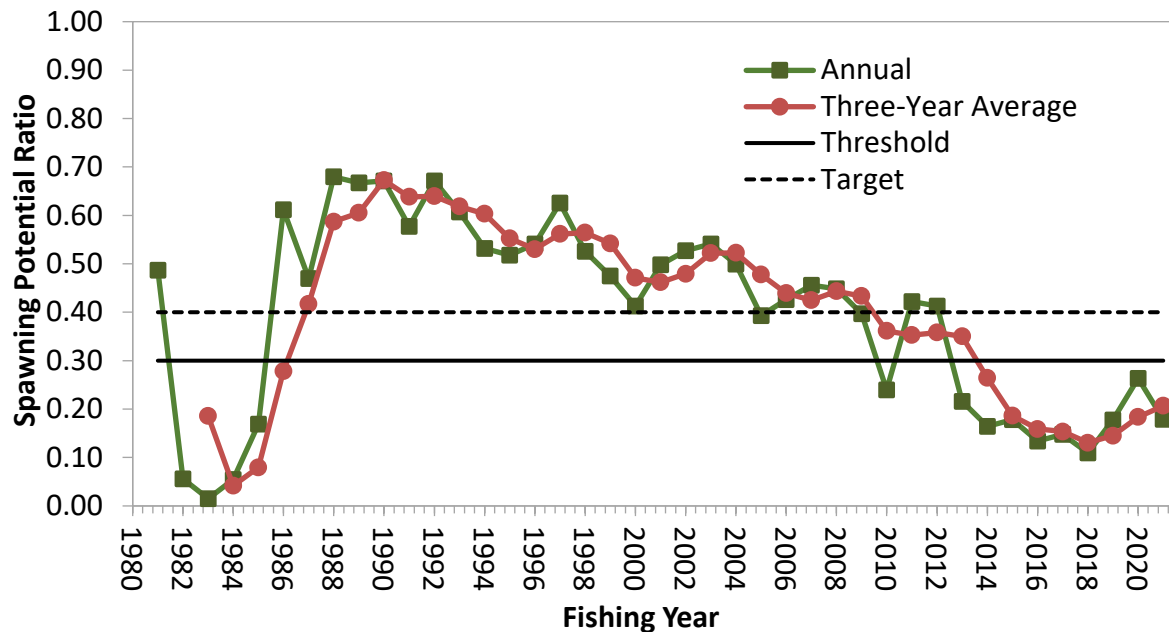


Figure 1. Annual values (green squares) and the three-year average (orange circles) spawning potential ratio (SPR) from the southern stock Stock Synthesis model. The threshold SPR is 30% (solid line) and the target SPR is 40% (dashed line) (Source: ASMFC 2024).

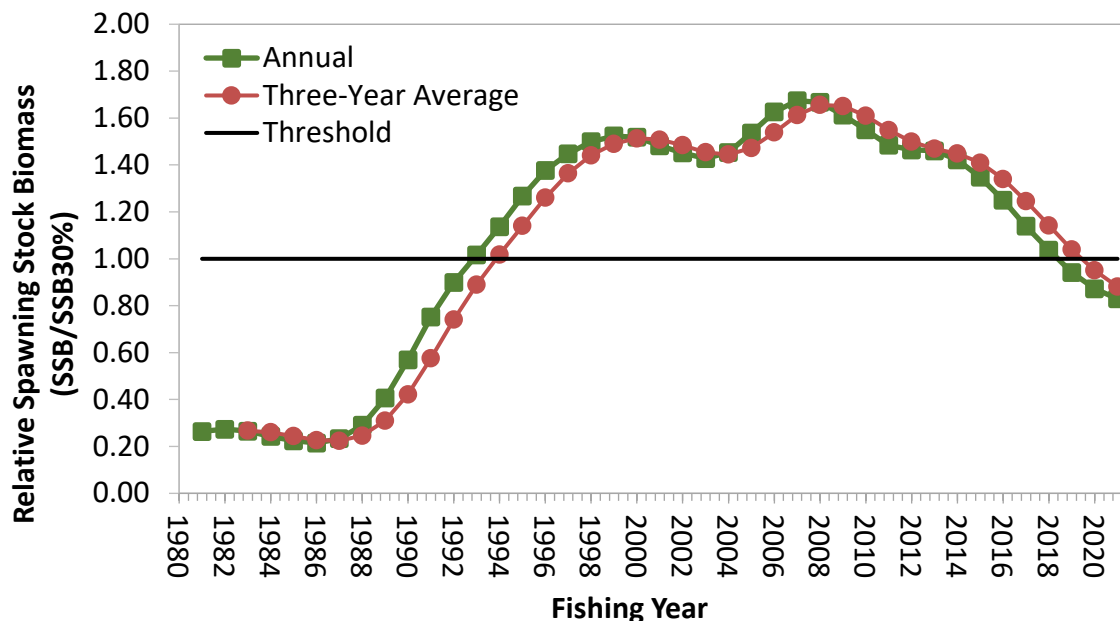


Figure 2. The annual (green squares) and three-year average (red circles) relative spawning stock biomass ($SSB/SSB_{30\%}$) for the southern stock, with the threshold (black line) (Source: ASMFC 2024).

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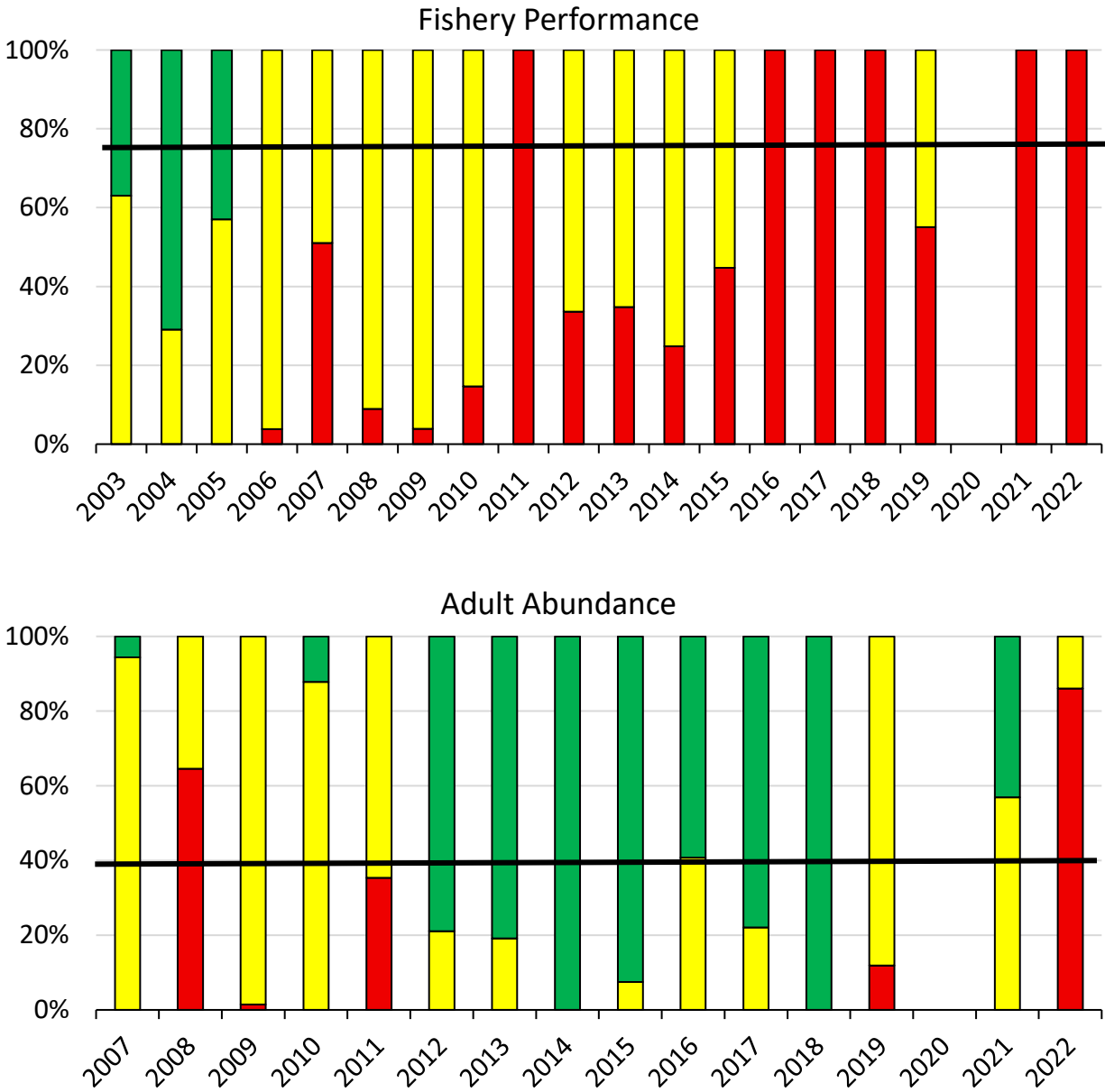


Figure 3. Annual Traffic Light Analysis (TLA) results for the Fishery Performance and Adult Abundance characteristics in the northern stock. Threshold values are represented by the solid horizontal line. The color at the threshold is the color determination for that year. TLA identifies an overfishing (Fishery Performance) or overfished (Adult Abundance) status if determinations for any of the last three years were red (Source: ASMFC 2024).

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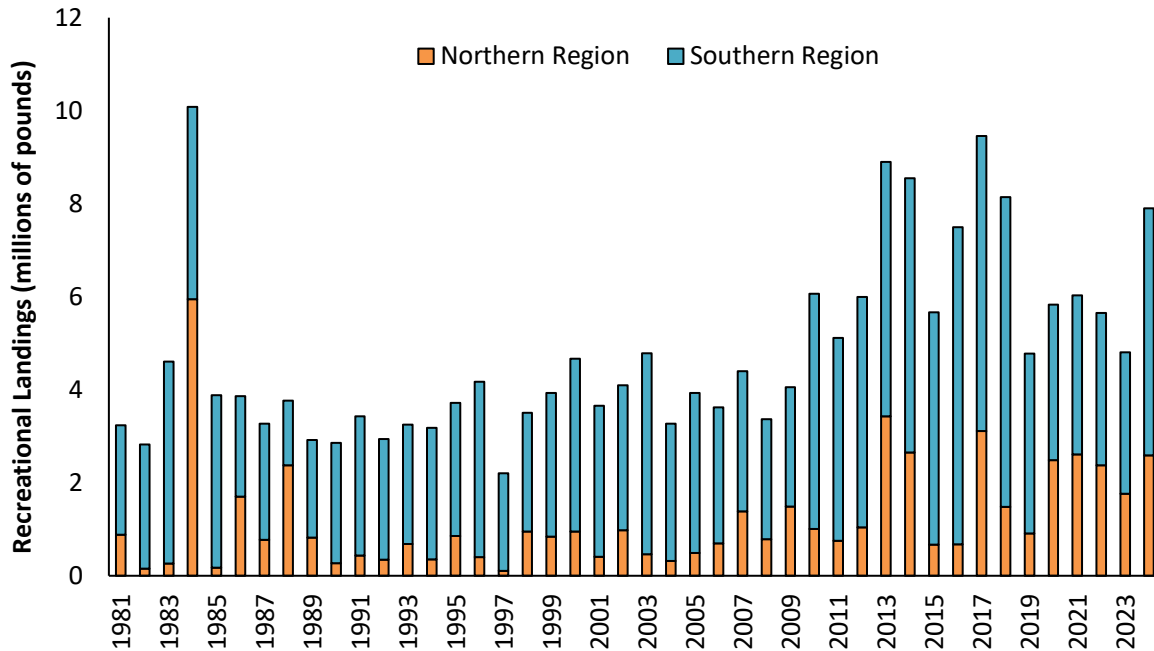


Figure 4. Recreational landings of red drum by region (1981-2024). See Table 4 for values and data sources.

*Recreational weight data for NC-FL in 1988 is unavailable. Recreational harvests in pounds were estimated for these states in this year by multiplying each state's 1988 harvest in numbers of fish by its time series average weight.

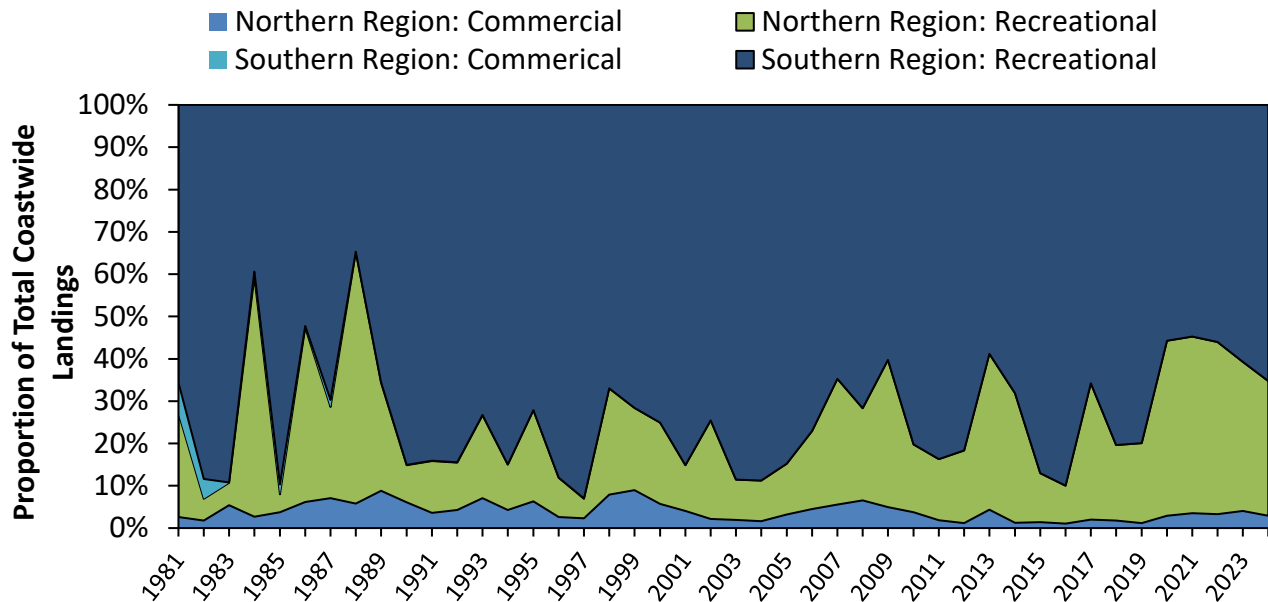


Figure 5. Proportion of regional, sector-specific landings to total coastwide landings (pounds) from 1981-2024. See Tables 3 and 4 for data sources.

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Figure 6. Commercial landings of red drum from the Northern Region (1981-2024). See Table 3 for values and data sources.

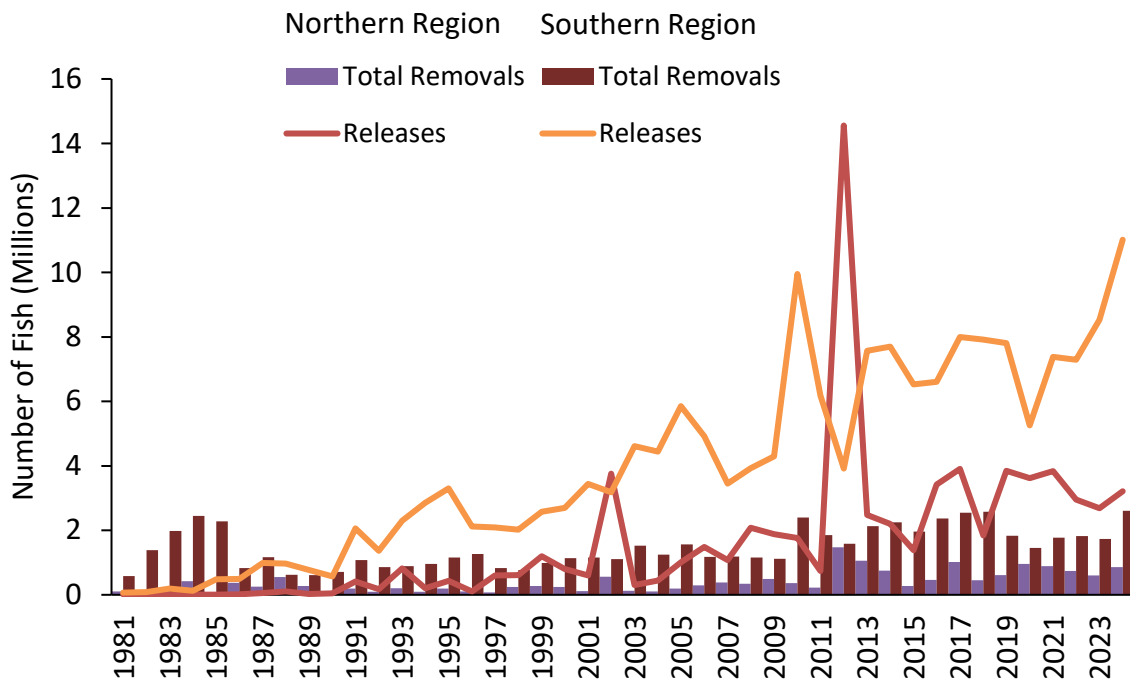
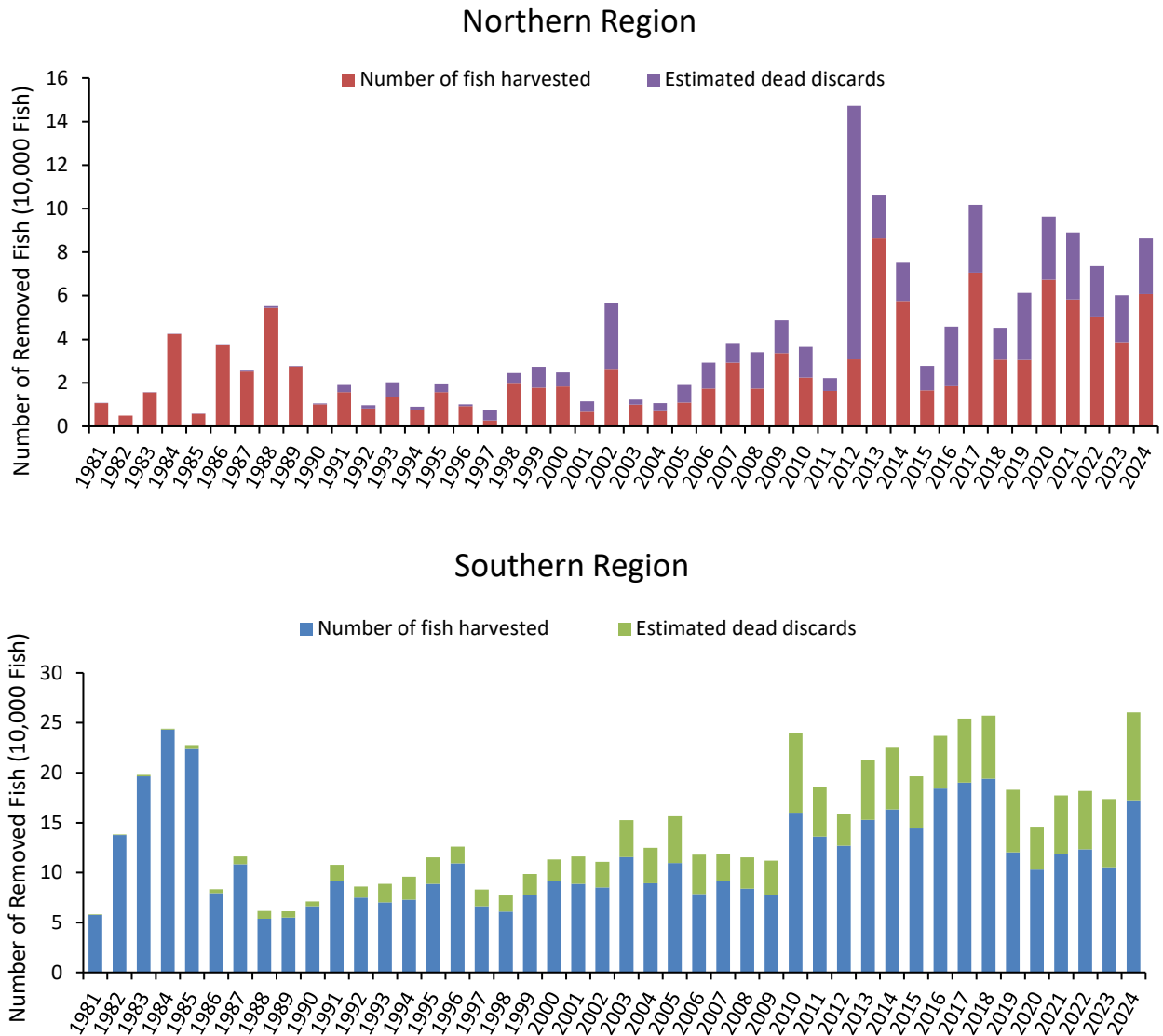


Figure 7. Total recreational removals (numbers) compared to recreational releases of red drum (numbers) for 1981-2024. See Tables 5 and 6 for values and data sources.

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XI. Tables

Table 1. Red drum regulations for 2024. The states of New Jersey through Florida are required to meet the requirements in the FMP; states north of New Jersey are encouraged to follow the regulations. All size limits are total length.

State	Recreational	Commercial
NJ	18" - 27", 1 fish	18" - 27", 1 fish
DE	20" - 27", 5 fish	20" - 27", 5 fish
MD	18" - 27", 1 fish	18" - 25", 5 fish
PRFC	18" - 25", 5 fish	18" - 25", 5 fish
VA	18" - 26", 3 fish	18" - 25", 5 fish
NC	18" - 27", 1 fish	18" - 27"; 250,000 lbs harvest cap with overage payback (150,000 lbs Sept 1- April 30; 100,000 lbs May 1-Aug 31); harvest of red drum allowed with 7 fish daily trip limit; daily landed catch of flounder, bluefish, black drum or striped mullet must exceed daily catch of drum; small mesh (<5" stretched mesh) gill nets attendance requirement May 1 - November 30. Fishing year: September 1 – August 31.
SC	15" - 23", 2 fish per person per day bag limit and 6 fish per boat per day boat limit	Gamefish Only
GA	14" - 23", 5 fish	Gamefish Only
FL	18" - 27"; Northeast Region – 1 fish per person per day, 4 fish vessel limit; Indian River Lagoon Region – 0 fish per person per day, 0 vessel limit; Southeast Region – 1 fish per person per day, 2 fish vessel limit (effective September 1, 2022).	Sale of native fish prohibited

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Table 2. Overview of each state's fishery independent surveys.

State	Fishery Independent Monitoring Details
New Jersey	Five annual nearshore trawl surveys conducted since 1988, in January/February, April, June, August, and October. Length and weight data, and catch per unit effort (CPUE) in number of fish per tow and biomass per tow recorded for all species.
Delaware	30-ft bottom trawl survey and 16-ft bottom trawl survey. Neither survey has ever captured red drum.
North Carolina	Seine survey since 1991 produces age-0 abundance index. Gill net survey in Pamlico Sound since 2001 characterizes size and age distribution, produces abundance index, improves bycatch estimates, and studies habitat usage. Longline survey since 2007 produces adult index of abundance and tags fish.
South Carolina	Estuarine trammel net survey for subadults. Electrofishing survey in low salinity estuarine areas for juveniles/subadults. Inshore and coastal bottom longline survey for biological data and adult abundance index. Genetic sub-sampling and tagging conducted during these three surveys.
Georgia	Estuarine trammel net survey for subadult biological data and abundance index. Estuarine gill net survey for young-of-year (YOY) biological data and abundance index. Bottom longline survey for adult biological data and abundance index.
Florida	Seine surveys characterizing young-of-year (YOY) (<40 mm standard length) and sub-adult (>299 mm) abundance along the northeast (NE) and southeast (SE) Florida coasts.

Table 3. Commercial landings (pounds) of red drum by state, 2015-2024. (Source: personal communication with ACCSP, for years prior to 2024 and state compliance reports for 2024, except as noted below.) Note that SC, GA, and FL do not have commercial red drum fisheries, and years with incidental landings are included in the total.

Year	NJ to PRFC	VA	NC	Total
2015	421	814	80,282	81,516
2016	197	1,898	77,833	79,927
2017	644	6,971	186,411	194,032
2018	C	885	144,464	145,500
2019	32	1,650	56,393	58,107
2020	104	7,989	165,670	173,867
2021	217	19,584	200,825	220,843
2022	57	17,411	175,029	192,554
2023	C	16,899	186,414	204,500
2024	C	51,339	184,564	237,034

*C indicates confidential landings, and totals have been rounded to protect confidentiality.

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Table 4. Recreational landings (pounds) of red drum by state, 2015-2024. (Source: personal communication with MRIP for data prior to 2024; state compliance reports for 2024)

Year	NJ	DE	MD	VA	NC	Northern Region Total
2015				98,329	567,730	666,059
2016				45,451	633,496	678,947
2017			6,782	1,628,692	1,475,852	3,111,326
2018				31,566	1,452,358	1,483,924
2019	4,107		2,113	470,940	436,219	913,379
2020		1,544	115,181	610,001	1,758,789	2,485,515
2021			5,441	1,123,953	1,479,550	2,608,944
2022				762,729	1,615,108	2,377,837
2023			53,253	588,763	1,120,661	1,762,677
2024			136,387	1,100,036	1,354,244	2,590,667

Year		SC	GA	FL	Southern Region Total
2015		656,747	394,787	3,949,000	5,000,534
2016		536,550	586,235	5,694,370	6,817,155
2017		1,048,249	826,857	4,470,905	6,346,011
2018		643,213	1,186,306	4,829,344	6,658,863
2019		862,124	630,294	2,372,773	3,865,191
2020		671,004	535,674	2,135,395	3,342,073
2021		441,191	506,962	2,473,995	3,422,148
2022		584,289	1,081,410	1,605,556	3,271,255
2023		688,722	826,719	1,527,754	3,043,195
2024		1,286,743	1,373,804	2,652,616	5,313,163

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Table 5. Recreational landings (numbers) of red drum by state, 2015-2024. (Source: personal communication with MRIP for data prior to 2024; state compliance reports for 2024)

Year	NJ	DE	MD	VA	NC	Northern Total
2015				22,102	143,876	165,978
2016				15,866	169,195	185,061
2017			4,943	347,145	353,716	705,804
2018				6,334	299,577	305,911
2019	1,331		1,258	205,824	97,186	305,599
2020		493	44,975	214,069	413,419	672,956
2021			1,415	256,281	325,662	583,358
2022				163,962	336,280	500,242
2023			17,896	137,063	232,133	387,092
2024			42,527	242,246	322,307	607,080
Year		SC	GA	FL	Southern Total	
2015		258,493	201,049	981,685	1,441,227	
2016		241,224	289,928	1,309,505	1,840,657	
2017		455,887	467,522	978,520	1,901,929	
2018		262,725	606,836	1,069,604	1,939,165	
2019		333,315	271,970	599,348	1,204,633	
2020		239,874	230,026	560,382	1,030,282	
2021		210,454	261,488	710,091	1,182,033	
2022		219,659	607,512	406,391	1,233,562	
2023		280,527	366,498	407,618	1,054,643	
2024		513,931	649,659	561,731	1,725,321	

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Table 6. Recreational alive releases (numbers) of red drum by state, 2015-2024. (Source: personal communication with MRIP for data prior to 2024; state compliance reports for 2024)

Year	NJ	DE	MD	VA	NC	Northern Region Total	Northern Region Dead Discards
2015			1,456	78,590	1,308,072	1,388,118	111,049
2016		2,598	47,908	164,575	3,203,452	3,418,533	273,483
2017			14,148	1,722,618	2,165,656	3,902,422	312,194
2018	4,715		21,384	85,338	1,729,260	1,840,697	147,256
2019		474	5,740	865,957	2,976,601	3,848,772	307,902
2020			217,710	716,277	2,686,150	3,620,137	289,611
2021		1,147	22,218	1,272,609	2,545,371	3,841,345	307,308
2022		2,116	18,010	770,731	2,160,742	2,951,599	236,128
2023	881	595	98,500	1,145,885	1,439,370	2,684,350	214,748
2024			358,323	1,041,993	1,809,302	3,209,618	256,769
Year		SC	GA	FL	Southern Region Total		Southern Region Dead Discards
2015		1,432,754	961,277	4,132,461	6,526,492		522,119
2016		1,266,931	601,153	4,734,303	6,602,387		528,191
2017		2,094,199	1,176,524	4,727,411	7,998,134		639,851
2018		1,493,803	1,045,570	5,375,011	7,914,384		633,151
2019		2,911,653	1,206,707	3,688,884	7,807,244		624,580
2020		1,705,054	393,368	3,154,500	5,252,922		420,234
2021		1,894,088	794,030	4,689,059	7,377,177		590,174
2022		1,289,714	1,814,251	4,188,940	7,292,905		583,432
2023		2,320,184	1,450,988	4,760,870	8,532,042		682,563
2024		2,764,695	1,832,338	6,416,407	11,013,440		881,075

Atlantic States Marine Fisheries Commission

July 28, 2025

Discussion Paper on Establishing and Reviewing Declared Interests

Background

The Commission's Executive Committee has discussed a series of procedures and practices at the past few quarterly meetings. The discussions have focused on: 1) declared interests, 2) voting privileges, and 3) virtual and hybrid meeting participation. These discussions were prompted by several circumstances. Most notable is the changing distribution and residency of many species managed by the Commission, which in turn has resulted in (and is anticipated to result in additional) interest by states to alter their participation on one or more species boards.

This paper focuses on the issue of state and jurisdiction declared interest in the management of a species. At the end of this paper there is also a brief discussion on the process that may be used to address the voting privileges issue.

Declared Interests

States have an opportunity to declare an interest in a fishery to participate as a voting member of a management board (see Table 1. Declared Interests by Species). The ISFMP Policy Board reviews declared interest requests to determine the membership of each board. The Commission's [Rules and Regulations](#) include the criteria used to determine interest in a species, the criteria are:

- (a) Such fish are found customarily in its territorial waters (*potentially change to "waters under state jurisdiction"*);
- (b) Such fish are customarily or periodically in the territorial waters of such state for the purpose of spawning or in transit to and from spawning grounds; or
- (c) The citizens of the state are recorded as having taken 5 percent or more of the total Atlantic coast catch of the species of fish in any of the five preceding years.

Note: a state must only meet one of these criteria to have a declared interest in a fishery.

The Policy Board has generally accepted requests for declared interest if the requesting state provides basic evidence to support their request.

The Policy Board provides primary oversight of the Commission's fisheries management process and species management boards. Some decisions made by a species board are

recommendations to the Policy Board, such as approvals of Amendments or letters. The same votes that are made at the species board level are then made at the Policy Board level.

Discussion Questions

1. Should the declared interest criteria be modified or further defined?
2. Are changes needed for the Policy Boards' review process for declared interest requests?
3. Should Policy Board voting privileges change as an oversight body of species boards?
4. Should criteria (c) be modified or removed from the list?
5. Should declared interests be reviewed and reaffirmed on regular intervals?

Possible alternative criteria or additional criteria

Such species is documented by landings and/or scientific surveys to occur annually in the territorial waters of a jurisdiction for three consecutive years.

Alternate language to replace "customarily"

Alternatives to "customarily" might be "typically", "commonly", or "regularly",

Here are the suggested substitutions:

1. "Such fish are found *commonly* in its territorial waters" – "commonly" suggests frequency and widespread occurrence.
2. "Such fish are *typically* or *periodically* in the territorial waters..." – "typically" captures a usual pattern, "periodically" suggests less frequent occurrence.

Frequency of declared interest review

1. Status quo – Policy Board only reviews when a request to add or remove a declared interest is made.
2. Regular interval – 3 years, 5 years, etc.
3. Trigger based – New assessment, significant change in distribution or landings, etc.

Voting Privileges

Voting privileges have proven to be a complex issue during the recent Executive Committee discussions. There are two options being considered to address this issue:

1. Conduct a survey to assess the Commissioner perspective on voting privileges.
2. Form a Commissioner workgroup to develop recommendations for consideration by the Executive Committee

The ISFMP Charter states: "Each state with an interest in the fishery covered by the management board shall be a voting member". The Charter does not provide further guidance

on voting privileges for states with a declared interest. Four topics for further discussion were raised at the Executive Committee meeting in October 2024.

A survey or Commissioner workgroup will address the following topics:

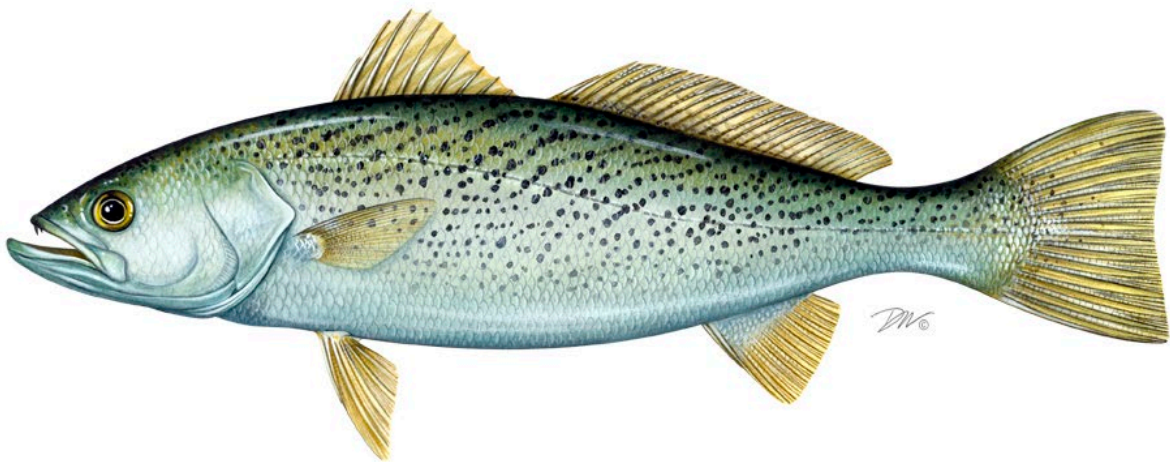
1. Voting privileges for *de minimis* states
2. Voting privileges by stock unit of a species
3. Voting privileges for states outside the management unit defined in the FMP
4. Voting privileges for states on boards that manage multiple species

Table 1. Declared Interest by Species as of February 2024

	ME	NH	MA	RI	CT	NY	NJ	PA	DE	MD	DC	PRFC	VA	NC	SC	GA	FL	NMFS	USFWS	Councils
Managed Species																				
American Eel	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
American Lobster	*	*	*	*	*	*	*		*	*			*					*		
Atlantic Herring	*	*	*	*	*	*	*											*		NEFMC
Atlantic Menhaden	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	
Atlantic Striped Bass	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			*	*	
Atlantic Sturgeon	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Bluefish	*	*	*	*	*	*	*		*	*		*	*	*	*	*	*	*		
Coastal Sharks			*	*	*	*	*		*	*			*	*	*	*	*	*		
Horseshoe Crab			*	*	*	*	*		*	*		*	*	*	*	*	*	*	*	
Jonah Crab	*	*	*	*	*	*	*		*	*			*					*		NEFMC
Northern Shrimp	*	*	*																	
Shad & River Herring	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Spiny Dogfish	*	*	*	*	*	*	*		*	*			*	*				*		
Tautog			*	*	*	*	*		*	*			*					*		
Weakfish				*	*	*	*		*	*		*	*	*	*	*	*	*		
Winter Flounder	*	*	*	*	*	*	*											*		
Summer Flounder, Scup and Black Sea Bass Board																				
Summer Flounder			*	*	*	*	*		*	*		*	*	*				*		
Scup			*	*	*	*	*		*	*			*	*				*		
Black Sea Bass		*	*	*	*	*	*		*	*		*	*	*				*		
Coastal Pelagics																				
Cobia				*		*	*		*	*		*	*	*	*	*	*	*		SAFMC
Spanish Mackerel				*		*	*		*	*		*	*	*	*	*	*	*		SAFMC
Sciaenids Board																				
Atlantic Croaker							*		*	*		*	*	*	*	*	*	*		
Black Drum							*		*	*		*	*	*	*	*	*	*		
Red Drum							*		*	*		*	*	*	*	*	*	*		
Spot							*		*	*		*	*	*	*	*	*	*		
Spotted Seatrout							*		*	*		*	*	*	*	*	*	*		
Total # of Species	12	13	18	20	18	19	25	5	23	23	4	17	23	20	15	15	15	23	7	

Atlantic States Marine Fisheries Commission

2025 Weakfish Stock Assessment Update



Sustainably and Cooperatively Managing Atlantic Coastal Fisheries

Executive Summary

The Bayesian statistical catch-at-age assessment model for weakfish was updated with data through 2023. This included updated commercial and recreational removals as well as updated fishery-independent and fishery-dependent indices of abundance. The last assessment update of weakfish was conducted in 2019 with a terminal year of 2017. During the current update, the Weakfish Technical Committee became concerned about some prior assumptions in the Bayesian model potentially leading to underestimating natural mortality in recent years, and due to this issue with model performance, does not recommend using this update for management.

Total removals for 2018-2023 averaged 478 mt, less than 10% of the time-series average of 4,912 mt, but have shown a small increasing trend since the last assessment update. Commercial landings reached a time-series low of 42.4 mt in 2015, but have been increasing somewhat in recent years; commercial landings averaged 51.3 mt from 2015-2017 and 86.6 mt from 2018-2023. Commercial discards also increased over this time period, averaging 199 mt from 2015-2017 and 238 mt from 2018-2023. A new time-block was added to the species guilds used to estimate commercial discards for this update which resulted in higher estimates of discards from 2015-2017 compared to the previous assessment update. However, a similar pattern of increasing estimates of discards in recent years is also detected when applying the species guilds from the 2019 assessment update. Recreational removals (harvest + release mortality) reached a time-series low of 45.1 mt in 2018 but have been increasing since then, averaging 153 mt from 2018-2023.

The catch-at-age in both commercial and recreational fisheries remains truncated compared to the late-1990s and early 2000s, with a very small proportion of fish older than age-4 observed. Although most states have met their sampling requirements in recent years, there were still gaps in the age-length keys that required borrowing across regions and years.

The indices showed mixed signals, with the MRIP HPUE, NC PSIGNS, and SEAMAP indices showing a somewhat increasing trend since 2017, while ChesMMA, NEAMAP, the DE 30ft Trawl, and the NJ Ocean Trawl were variable and low over those years, with the exception of an extremely high value in the standardized NJ Ocean Trawl index in 2023. The young-of-year indices have generally varied without trend over the entire time-series, but the overall composite young-of-year index showed an uptick in 2022 and 2023 after several years of declining values, and indices from the northern end of the weakfish range (New York, Rhode Island, and Connecticut) have shown some increases in recent years.

The Bayesian model developed for the 2016 benchmark assessment estimates a time-varying natural mortality for weakfish, which was low and stable during the 1980s, increased rapidly during the late 1990s and early 2000s, and stabilized at a high level from 2007 onwards (ASMFC 2016). An upper bound of 1.0 on M was used in this model during the benchmark and 2019 assessment update; however, estimates of M came very close to that bound from 2008-2013. Additionally, the 2019 assessment update estimated an average M of 0.89 for 2014-2017 while

Krause et al. (2020) estimated an M of 2.33 for weakfish during that time period using an integrated tagging model. A model with an increased upper bound of M was tested in this update and resulted in higher estimates of M from 2008 to 2017. Estimates of SSB and recruitment were also higher from the early 2000s onward than the estimates from the 2019 assessment, and estimates of F were lower in model runs using higher bounds on M . Estimates of total Z were similar across models. Based on the empirical estimate of M from Krause et al. (2020) and the performance of the model, the TC is concerned that the model when constrained by an assumed upper bound on M set at the same low bound as in the benchmark and 2019 update is underestimating M in recent years, which has implications for both the scale of the population and the reference points. The extent of the work needed to resolve this issue is beyond the scope of an assessment update. Therefore, the TC recommends that this update not be used for management and that a benchmark should be conducted as soon as possible. Although there are some positive signs in the fishery-independent and fishery-dependent data, the status of weakfish has likely not changed significantly since the last assessment update, and the TC does not believe management changes are warranted at this time.

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Introduction

This Terms of Reference (TOR) report describes the update to the benchmark stock assessment for weakfish (ASMFC 2016). The benchmark was updated in 2019 (ASMFC 2019) to extend the fishery-independent and -dependent data for weakfish through 2017, and this update further extends the data, model, and assessment through 2023. Based on model performance issues when constrained by prior assumptions (see TOR 4 below), the TC does not recommend this assessment for management use and instead recommends that a benchmark assessment be completed as soon as possible.

TOR 1. Fishery-Dependent Data

Update fishery-dependent data (landings, discards, catch-at-age, etc.) that were used in the previous peer-reviewed and accepted benchmark stock assessment.

Total removals for 2018-2023 averaged 478 mt, less than 10% of the time-series average of 4,912 mt, but have shown a small increasing trend since the last assessment update (Table 1, Figure 1). Part of this was driven by an increasing trend in commercial discards, which were not well-estimated and accounted for 50% of total removals over this time period, but the more reliable estimates of removals from other sectors (commercial landings, recreational harvest, and recreational release mortality) have increased somewhat in recent years as well.

Commercial landings reached a time-series low of 42.4 mt in 2015 and averaged 51.3 mt from 2015-2017, but averaged 86.6 mt from 2018-2023.

Commercial discards were estimated from the Northeast Fisheries Observer Program data. The benchmark assessment used a species guild approach to identify other species commonly caught on trips that discarded weakfish. The observed ratio of weakfish discards to the landings of those guild species was then used to estimate weakfish discards from the total landings of guild species by region and gear (ASMFC 2016). For the benchmark, a single time-block (1982-2014) was used to determine the species guilds; however, a new time-block was added to determine the species guilds for this update (2015-2023; i.e., years since the benchmark). The new guild was implemented to capture recent changes in other fisheries and stocks that could influence what species were commonly caught when weakfish were discarded, while incorporating enough years of data to develop reliable associations. In general, the species guilds were similar between the benchmark and the 2025 update, but one notable change was Atlantic croaker in the northern region no longer being significantly associated with weakfish discards. Additional changes included kingfish, menhaden, and black drum becoming significant for some gears/regions.

The change in guild species resulted in higher estimates of commercial discards for 2015-2017 compared to the 2019 assessment update. Commercial discards averaged 199 mt from 2015-2017 and 238 mt from 2018-2023. A sensitivity run was conducted using the same species guilds used in the 2019 assessment update, which showed a similar increasing trend for 2017 onwards and a similar magnitude of peak discards for each method, although the estimates

using the 2019 guilds peaked in 2021, slightly later than the base run time-series which peaked in 2019 (Figure 2). This indicated that while the change in guild species had some effect on estimates of total discards, the overall increasing trend was not solely caused by the new time-block for the species guilds.

Recreational removals (harvest + release mortality) reached a time-series low of 45.1 mt in 2018 but have been increasing since then, averaging 153 mt from 2018-2023. Recreational release mortality accounted for 27% of recreational removals and 9% of total removals over that time period.

As in the benchmark assessment, Florida commercial and recreational removals were adjusted to account for hybridization of weakfish with sand seatrout. Only data from Nassau and Duval counties were used, and the estimates were adjusted by the county-specific proportion of “pure” weakfish from Tringali et al. (2011).

The catch-at-age in both commercial and recreational fisheries remains truncated compared to the late-1990s and early 2000s, with a very small proportion of fish older than age-4 observed. Although most states have met their sampling requirements in recent years, there were still gaps in the age-length keys that required borrowing across regions and years.

The index of relative abundance derived from the MRIP intercept data from NY-GA was updated. The MRIP harvest-per-unit effort (HPUE) index has been increasing since the last assessment update, although it is still not at the levels seen during the mid-1990s to early 2000s (Figure 3).

TOR 2. Fishery-Independent Data

Update fishery-independent data (abundance indices, age-length data, etc.) that were used in the previous peer-reviewed and accepted benchmark stock assessment.

The six ongoing fishery-independent indices of age-1+ abundance and seven young-of-year indices were updated through 2023; the NEFSC Albatross index was also included in the model although its time-series ends in 2008. The composite recruitment index developed from the young-of-year indices was also updated. Several indices (SEAMAP, NC PSIGNS, NC P195, NJ Ocean Trawl, CT LISTS) had missing data points in 2020 and/or 2021 due to sampling issues resulting from COVID-19 and other factors. ChesMMAP changed vessels between assessment updates but provided calibrated data so the time-series was complete and consistent.

The indices showed mixed signals, with the MRIP HPUE, NC PSIGNS, and SEAMAP indices showing an increasing trend since 2017, while ChesMMAP, NEAMAP, the DE 30ft Trawl, and the NJ Ocean Trawl have generally been variable and low over those years (Figure 3). The young-of-year indices have generally varied without trend over the entire time-series, but the overall composite young-of-year index showed an uptick in 2022 and 2023 after several years of

declining values, and indices from the northern end of the weakfish range (New York, Rhode Island and Connecticut) showed some increases in recent years. (Figure 4).

TOR 3. Life History Information and Model Parameterization

Tabulate or list the life history information used in the assessment and/or model parameterization (M, age plus group, start year, maturity, sex ratio, etc.) and note any differences (e.g., new selectivity block, revised M value) from benchmark.

Model parameterization is summarized in Table 3. The preferred model from the benchmark assessment was used, a Bayesian framework that estimates an age-constant, time-varying M and allows for spatial heterogeneity in the indices (that is, the proportion of the population available to each index can vary over time). No new selectivity blocks were added for the recreational or commercial fleets.

The benchmark assessment and 2019 assessment update used an upper bound of 1.0 on M, which was deemed reasonable for a species with a maximum observed age of 17 years. However, Krause et al. (2020) estimated a value of 2.33 for M for weakfish ages 2-3 from tagging data, which suggested that the upper bound of 1.0 might not be appropriate for recent years. Furthermore, the change in age structure seen in fishery independent surveys and the truncated catch-at-age seen in both the commercial and recreational fisheries indicated a higher M than the bound set in the benchmark. Therefore, the TC explored testing an increase in the upper bound of M during this assessment update.

TOR 4. Updated Assessment Model

Update accepted model(s) or trend analyses and estimate uncertainty. Include sensitivity runs and retrospective analysis if possible and compare with the benchmark assessment results. Include bridge runs to sequentially document each change from the previously accepted model to the updated model.

The trend and scale of the estimates from the model run with the original upper bound on M (1.0) was very similar to the results of the 2016 benchmark and the 2019 update, although adding additional years of data resulted in a lower estimate of M from late-1990s to early 2000 (Figure 5). This caused lower estimates of recruitment and SSB (Figure 6) and higher estimates of F for this period (Figure 5). These patterns were also seen in the 2019 update, as new years of data were added to the 2016 assessment. All models estimated high values of M from the late 2000s onward, all close to the upper bound of 1.0, suggesting that the bound is too low.

Runs were conducted with an upper bound of 1.5 and an upper bound of 3.0. Increasing the bound on M resulted in estimates that started diverging more significantly from the early 2000s onwards. The models with these higher bounds on M estimated higher M from the mid-2000s forward (Figure 7). As a result, estimates of F were lower (Figure 7) and estimates of recruitment and SSB (Figure 8) were higher from the early 2000s onwards, compared to both

the 2025 model with the bound of 1.0 and the 2016 and 2019 assessments. However, estimates of total mortality were similar across all runs (Figure 7).

This exploration of model sensitivity and the empirical estimate of M from Krause et al. (2020) suggest that the current configuration of the Bayesian model with M bounded at 1 is underestimating M in recent years, and the TC does not recommend using the results for management. The ASMFC Benchmark Assessment Process framework specifies that changes to M require a benchmark assessment, due to how influential this parameter is on population scale and reference point estimates. The initial exploratory runs conducted during this update indicate that changing the bound on M is effectively changing the scale of M within the assessment, making it a change that is more appropriate for a benchmark. In addition, this change would likely affect model performance in other areas, particularly related to the assumption of spatial heterogeneity in the indices. The amount of work needed to fully explore this issue and understand the impacts of increasing the bound on M on model performance is beyond the scope of an update.

Additionally, a sensitivity run was conducted to evaluate the effect of the change in the commercial discards estimation method, which was minimal and did not cause the differences in between the 2019 and 2025 estimates (Figure 9).

TOR 5. Stock Status

*Update the biological reference points or trend-based indicators/metrics for the stock.
Determine stock status.*

The SSB threshold is defined as $SSB_{30\%}$, equivalent to 30% of the projected SSB under the time-series average natural mortality and no fishing. When SSB is below that threshold, the stock is considered depleted.

Currently, total mortality (Z) benchmarks are used to prevent an increase in fishing pressure when F is low but M is high. When Z is below the Z target, F reference points can be used to assess overfishing status. The Z and F targets and thresholds were calculated based on the time-series average natural mortality estimate. The Z target is $Z_{30\%SPR}$ and the Z threshold is $Z_{20\%SPR}$. $F_{30\%SPR}$ and $F_{20\%SPR}$ are the F target and threshold, respectively.

Given the results of the Bayesian model and the reliance of the reference point definitions on average M , the TC did not update the reference points or provide a quantitative evaluation of stock status.

There have been some positive signs in the fishery-independent and fishery-dependent data, with slight increases in commercial and recreational catch in recent years, albeit from very low values, and increases in some indices. However, other indices have varied without trend, and the age structure of the catch and adult indices has not expanded. The data suggest the status of weakfish has likely not changed significantly since the last assessment update, and the TC does not believe management changes are warranted at this time.

TOR 6. Projections

Conduct short term projections when appropriate. Discuss assumptions if different from the benchmark and describe alternate runs.

Projections were not conducted for this update.

TOR 7. Research Recommendations

Comment on research recommendations from the benchmark stock assessment and note which have been addressed or initiated. Indicate which improvements should be made before the stock undergoes a benchmark assessment.

The TC recommends that a benchmark assessment for weakfish be initiated in 2026 and peer-reviewed in 2028, or as soon as possible thereafter.

A high priority for this benchmark will be evaluating the ability of the model to estimate M in the current low removals scenario, as well as exploring potential other parameterizations or frameworks including an age-varying as well as time-varying M.

The TC continued to support the research recommendations from the benchmark assessment; the highest priority recommendations are listed here.

- Increase observer coverage to identify the magnitude of discards for all commercial gear types from both directed and non-directed fisheries.
- Evaluate predation of weakfish with a more advanced multispecies model (e.g., the ASMFC MSVPA or Ecopath with Ecosim).
- Develop a bioenergetics model that encompasses a broader range of ages than Hartman and Brandt (1995) and use it to evaluate diet and growth data.
- Analyze the spawner-recruit relationship and examine the effects of the relationship between adult stock size and environmental factors on year class strength.
- Develop a coastwide tagging program to identify stocks and determine migration, stock mixing, and characteristics of stocks in over wintering grounds. Determine the relationship between migratory aspects and the observed trend in weight at age.
- Monitor weakfish diets over a broad regional and spatial scale.
- Continue to investigate the geographical extent of weakfish hybridization.

Of these, only one, *Evaluate predation of weakfish with a more advanced multispecies model*, has had any significant progress, with weakfish included as part of the NWCAS-MICE Ecopath with Ecosim model that the Commission used to develop ecological reference points for Atlantic menhaden (SEDAR 2020). However, that model has not been very informative about weakfish dynamics, as weakfish is not well-fit within the model and predators on weakfish like bottlenose dolphin are not explicitly included. More work, both model-based and empirical, is needed to identify the causes of increased M on weakfish.

The TC recognizes the difficulties in achieving the current biological sampling targets for weakfish, but notes that these are important data for the assessment and recommends maintaining current sampling targets and efforts.

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Tables

Table 1. Weakfish removals by sector in metric tons.

Year	Commercial Landings	Commercial Discards	Recreational Landings	Recreational Release Mortalities
1982	8,835.3	310.4	7,163.9	20.5
1983	7,926.6	385.6	7,694.7	12.3
1984	8,969.3	340.3	3,391.6	9.5
1985	7,690.0	395.9	4,234.2	13.0
1986	9,610.7	316.9	8,365.8	73.9
1987	7,744.0	301.0	9,232.2	32.7
1988	9,310.7	259.6	3,278.1	29.7
1989	6,424.0	211.6	1,807.1	12.4
1990	4,281.0	592.5	965.0	20.8
1991	3,943.1	495.8	1,958.2	76.6
1992	3,381.0	464.2	1,653.1	63.1
1993	3,108.8	512.2	938.0	54.0
1994	2,808.0	356.1	1,198.4	176.7
1995	3,219.9	404.8	1,711.2	205.1
1996	3,147.8	498.5	2,455.7	400.4
1997	3,310.1	270.0	3,201.2	286.7
1998	3,820.9	280.4	3,238.2	293.3
1999	3,132.1	231.7	3,208.6	396.4
2000	2,449.6	156.2	3,806.2	143.1
2001	2,267.7	128.6	2,125.4	187.2
2002	2,165.0	126.1	1,957.1	117.1
2003	907.7	105.4	882.8	85.1
2004	691.2	37.9	1,008.2	77.8
2005	520.4	48.1	1,170.0	94.6
2006	481.6	38.6	822.4	147.8
2007	413.1	42.1	541.7	97.0
2008	212.7	44.1	486.8	135.5
2009	173.8	55.9	194.0	27.9
2010	93.4	40.2	78.4	44.2
2011	66.0	51.9	46.4	29.5
2012	139.4	44.1	304.3	62.3
2013	161.8	28.4	211.4	18.2
2014	92.9	44.7	98.8	34.9
2015	42.4	226.0	204.6	46.5
2016	50.9	137.4	103.5	58.7
2017	60.6	233.9	197.5	28.6
2018	46.1	276.1	31.0	14.1
2019	87.8	356.7	70.2	29.8
2020	95.7	180.2	118.1	21.3
2021	87.8	353.6	121.6	42.5
2022	89.1	118.3	173.0	68.1
2023	113.0	141.8	157.5	71.6

Table 2. Summary of indices used in the assessment.

Index Name	Index Metric	Design	Time of Year	Years	Ages
MRIP HPUE	Harvest per trip	Stratified Random	Mar-Dec	1982-2023	1+
SEAMAP	Mean number per tow	Stratified Random	April-June	1990-2023	1+
NC PSIGNS	Mean number per set	Stratified Random	Feb-Dec	2001-2023	1+
ChesMMAP	Mean number per tow	Stratified Random	Sep & Nov	2002-2023	1+
DE Bay 30' Trawl Survey	Mean number per tow	Fixed station	May-Sep	1990-2023	1+
NJ Ocean Trawl	Mean number per tow	Stratified Random	Aug & Oct	1990-2023	1+
NEFSC Bottom Trawl (Albatross)	Mean number per tow	Stratified Random	Sep-Nov	1982-2008	1+
NEAMAP	Mean number per tow	Stratified Random	Sep-Oct	2007-2023	1+
Composite Young-of-Year Index	Mean number per tow	Combined surveys		1982-2023	YOY
NC P195 Trawl Survey	Mean number per tow	Stratified Random	Sep	1987-2023	YOY
VIMS Chesapeake Bay Juvenile Trawl Survey	Mean number per tow	Stratified Random	Aug-Oct	1982-2023	YOY
MD Coastal Bays Juvenile Trawl Survey	Mean number per tow	Fixed station	Apr-Oct	1989-2023	YOY
DE Bay Juvenile Trawl Survey	Mean number per tow	Fixed station	May-Sep	1990-2023	YOY
NY Peconic Bay Juvenile Trawl Survey	Mean number per tow	Random	Jul-Aug	1985-2023	YOY
CT LISTS	Mean number per tow	Stratified Random	Sep-Oct	1984-2023	YOY
RI Seasonal Trawl Survey	Mean number per tow	Stratified Random + Fixed Stations	Sep-Nov	1982-2023	YOY

Table 3. Model structure and life history information used in the stock assessment.

	Value(s)
Years in Model	1982-2023
Age Plus Group	6+
Fleets	2 (Rec, Commercial)
Selectivity blocks	Rec: 1982-1996, 1997-2023 Comm: 1982-2023
Recreational Release Mortality Rate	10%

	Age Group					
	1	2	3	4	5	6+
Proportion mature-at-age	0.9	1	1	1	1	1
Natural mortality	Age-constant, time-varying					

Figures

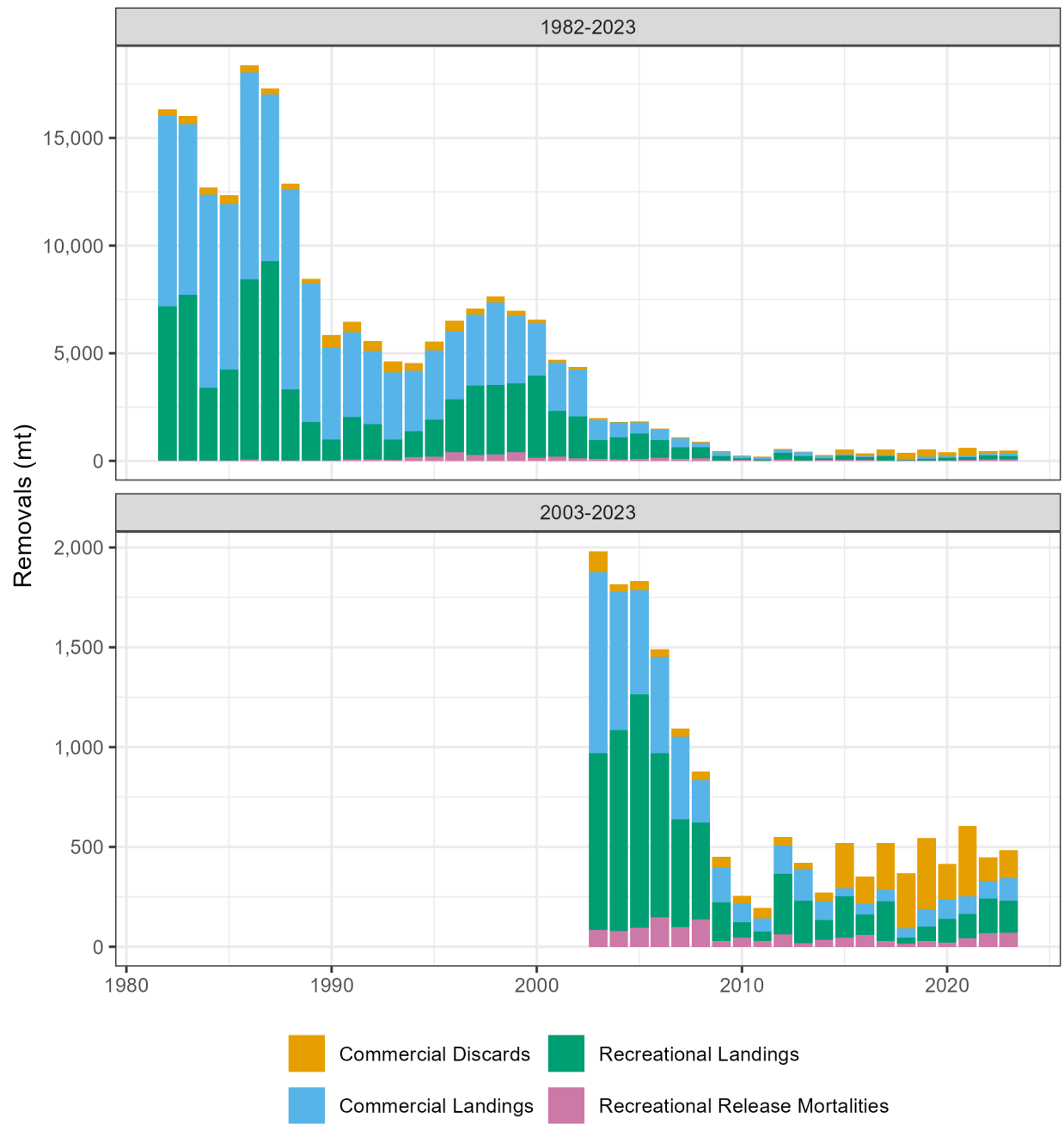


Figure 1. Weakfish removals by sector for 1982-2023 (top) and 2003-2023 (bottom) to show detail in recent years (note difference in scale of y-axis).

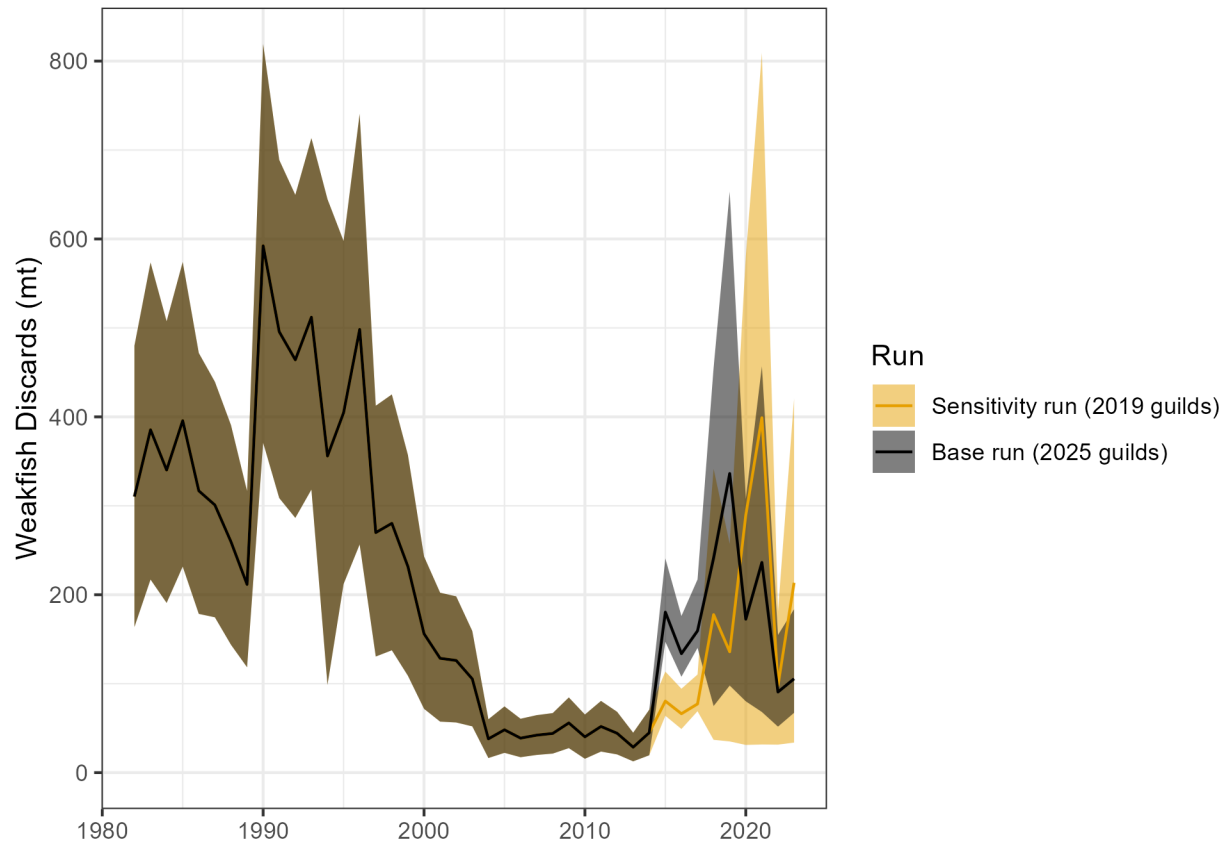


Figure 2. Commercial discard estimates for the base run using the new species guilds for 2015-2023 and the sensitivity run using the 2019 species guilds for that time period.

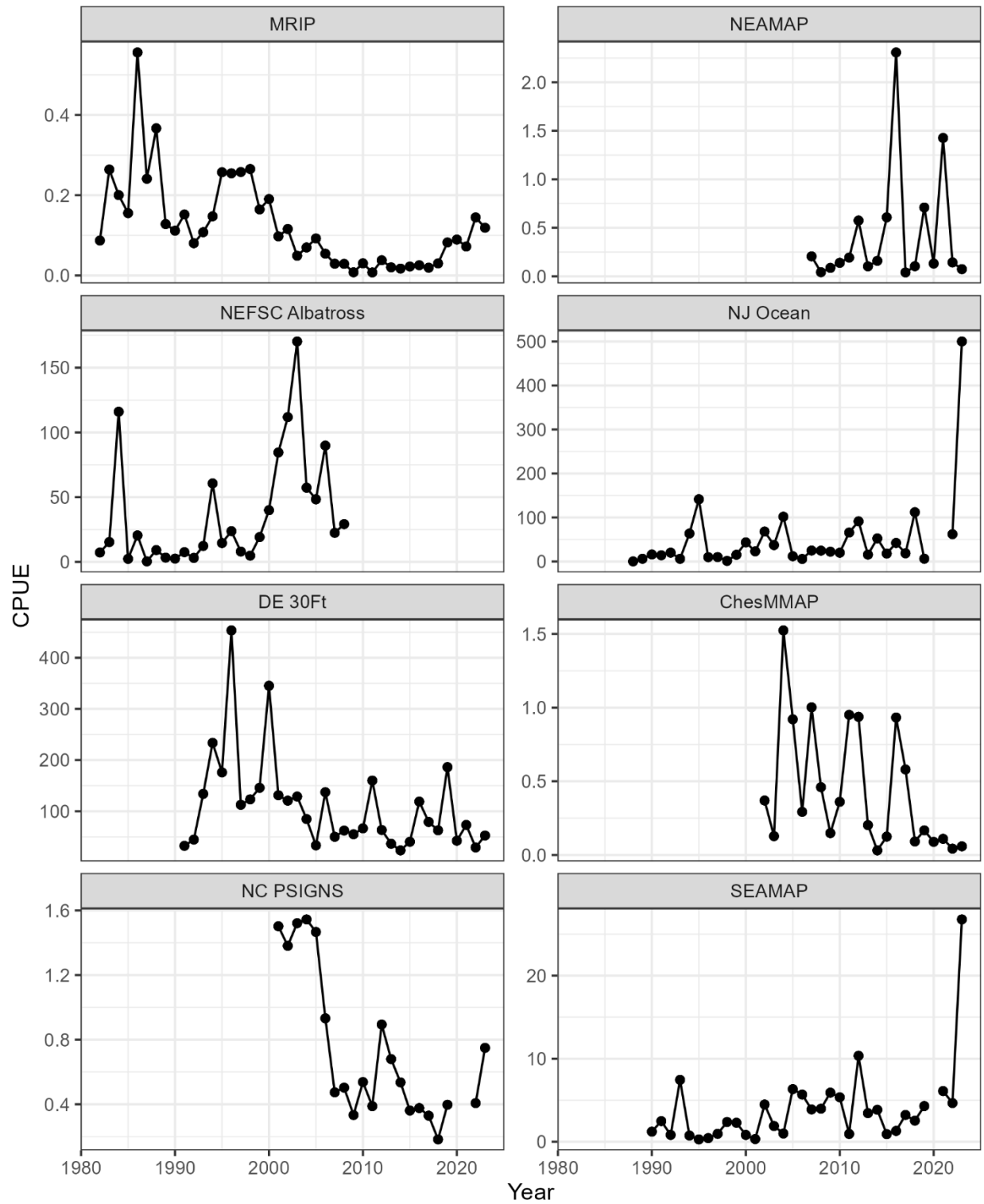


Figure 3. Age-1+ indices of abundance for weakfish.

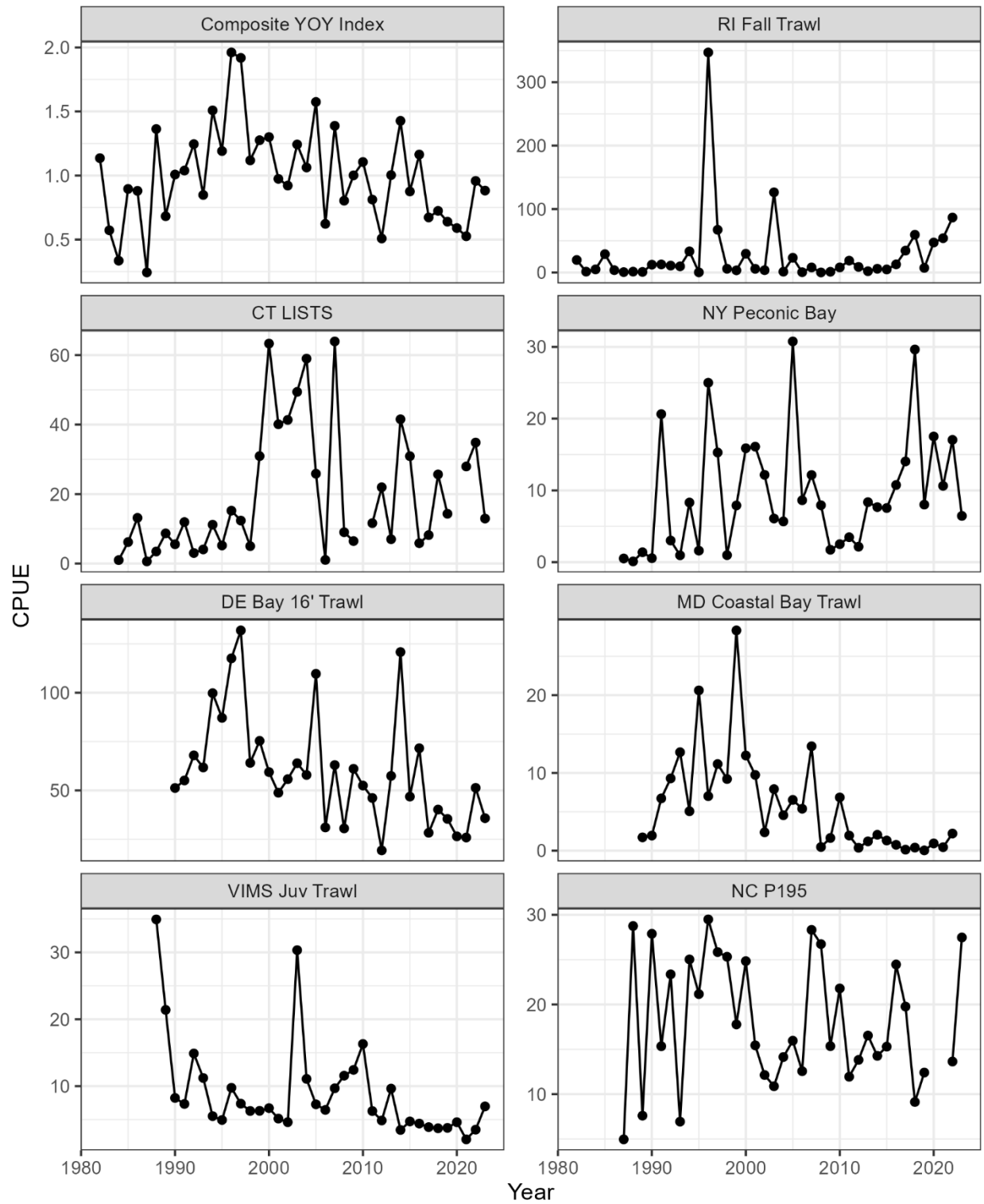


Figure 4. Young-of-year indices for weakfish.

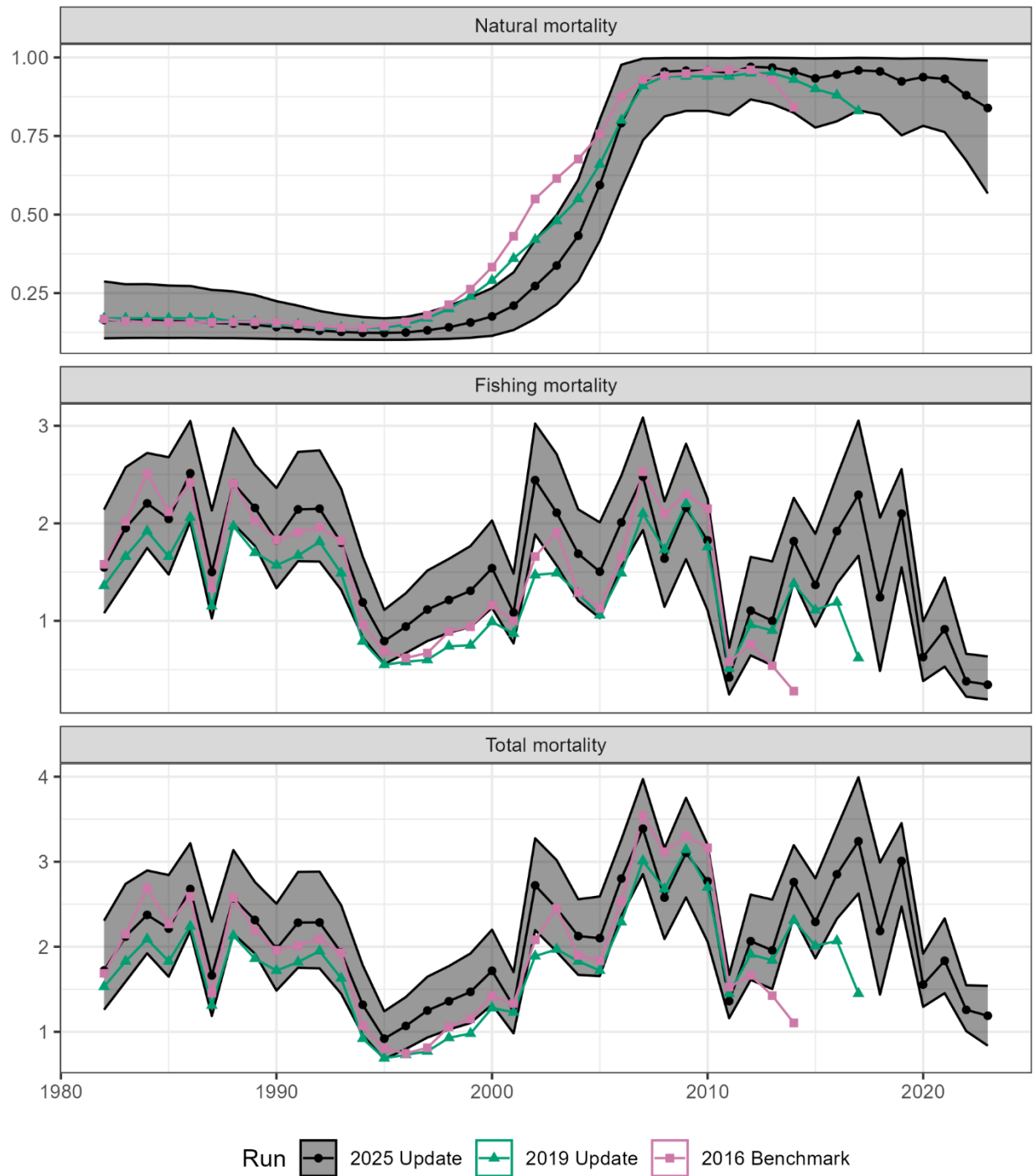


Figure 5. Historical retrospective plot of M , F , and Z estimates from the 2025 update, the 2019 update, and the 2016 benchmark assessment. All models used an upper bound of 1.0 on M . The shaded area indicates the 95% credible intervals of this assessment update.

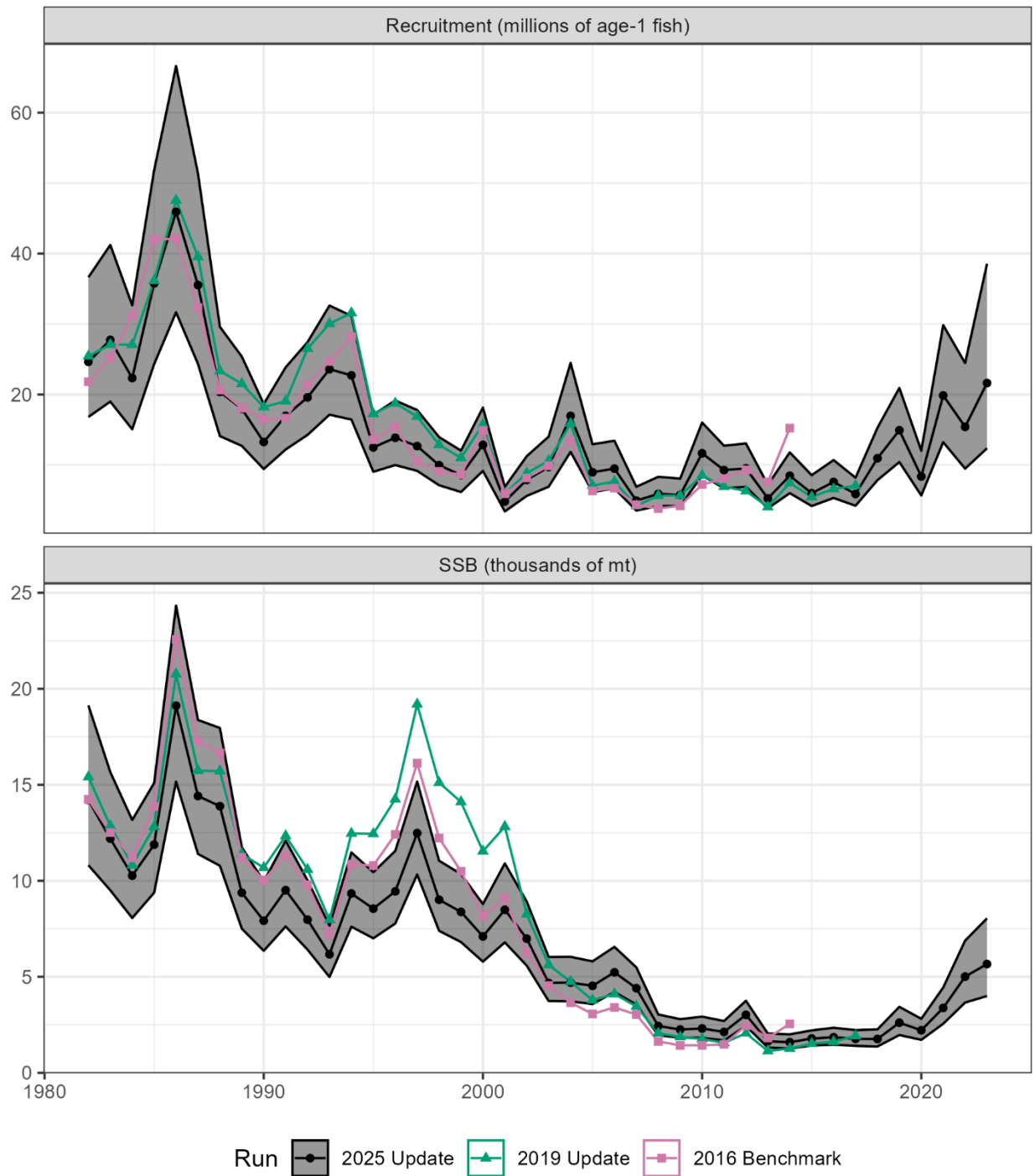


Figure 6. Historical retrospective plot of recruitment (top) and SSB (bottom) from the 2025 update, the 2019 update, and the 2016 benchmark assessment. All models used an upper bound of 1.0 on M . The shaded area indicates the 95% credible intervals of this assessment update.

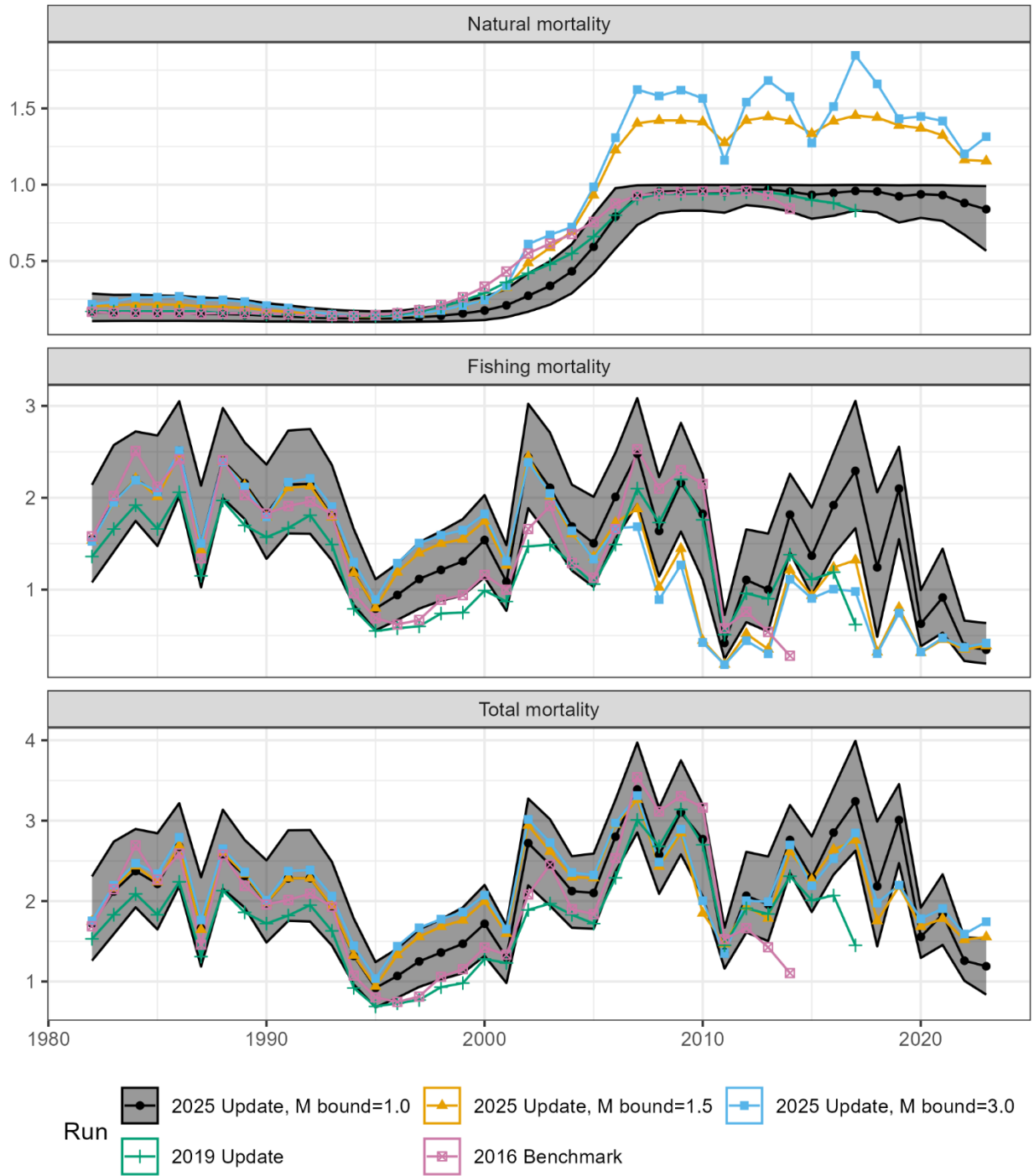


Figure 7. Comparison of M, F, and Z estimates from the 2025 update with different bounds on M and the 2016 and 2019 assessments. Shaded areas indicated the 95% credible interval of the 2025 update with the bound of 1.0.

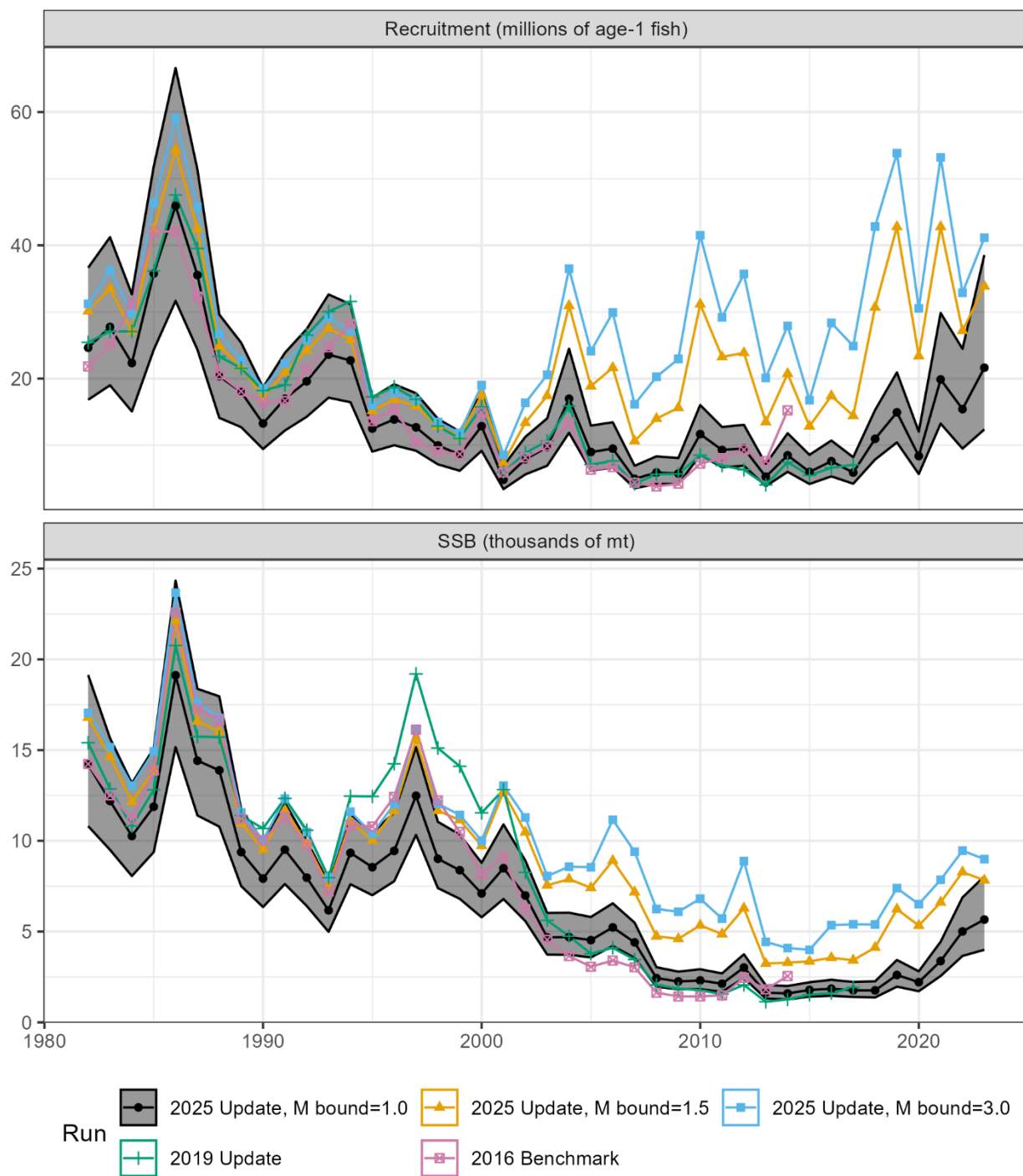


Figure 8. Estimate of recruitment and SSB from the 2025 update with different bounds on M and the 2016 and 2019 assessments. Shaded areas indicated the 95% credible interval of the 2025 update with the bound of 1.0.

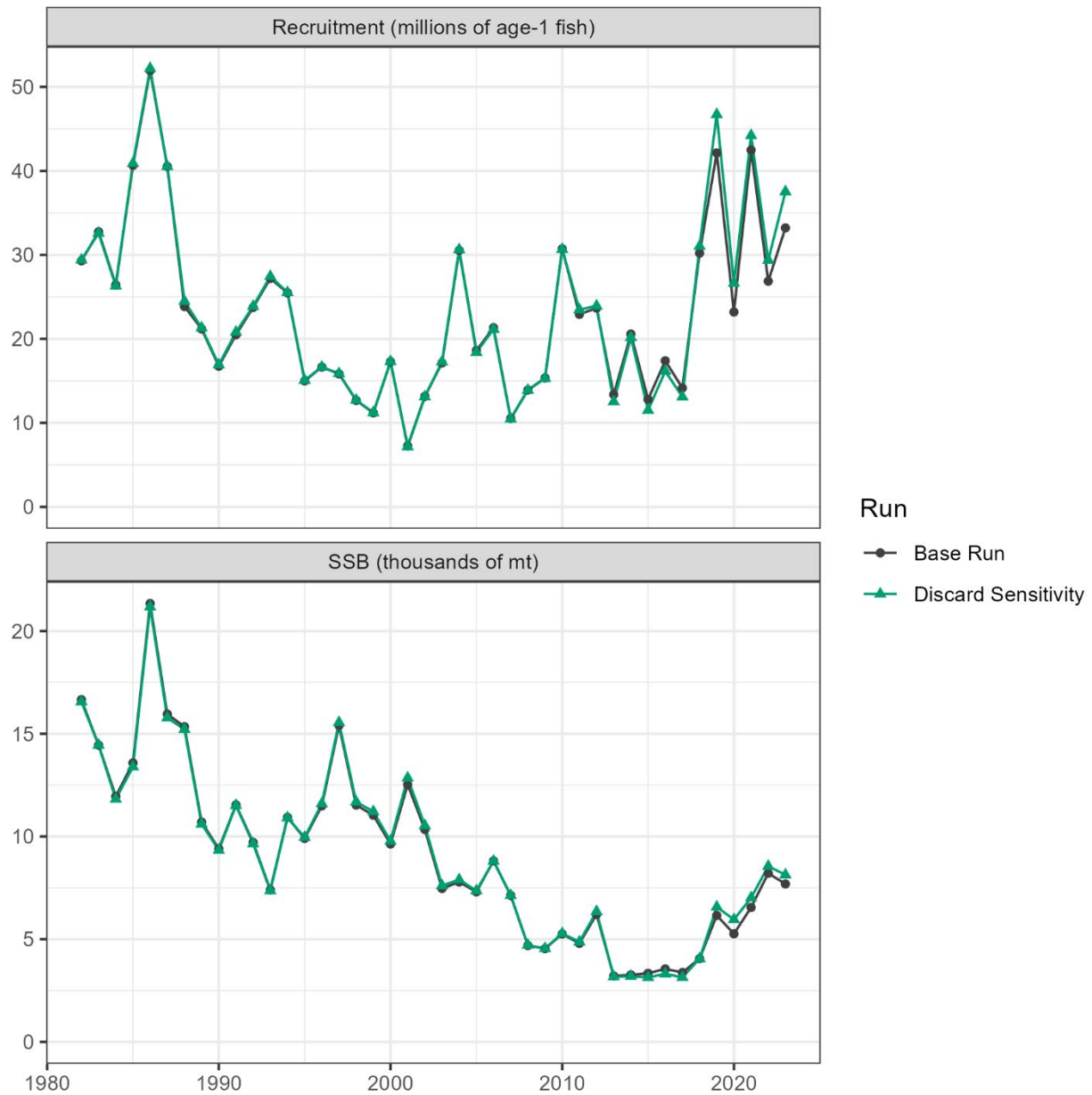
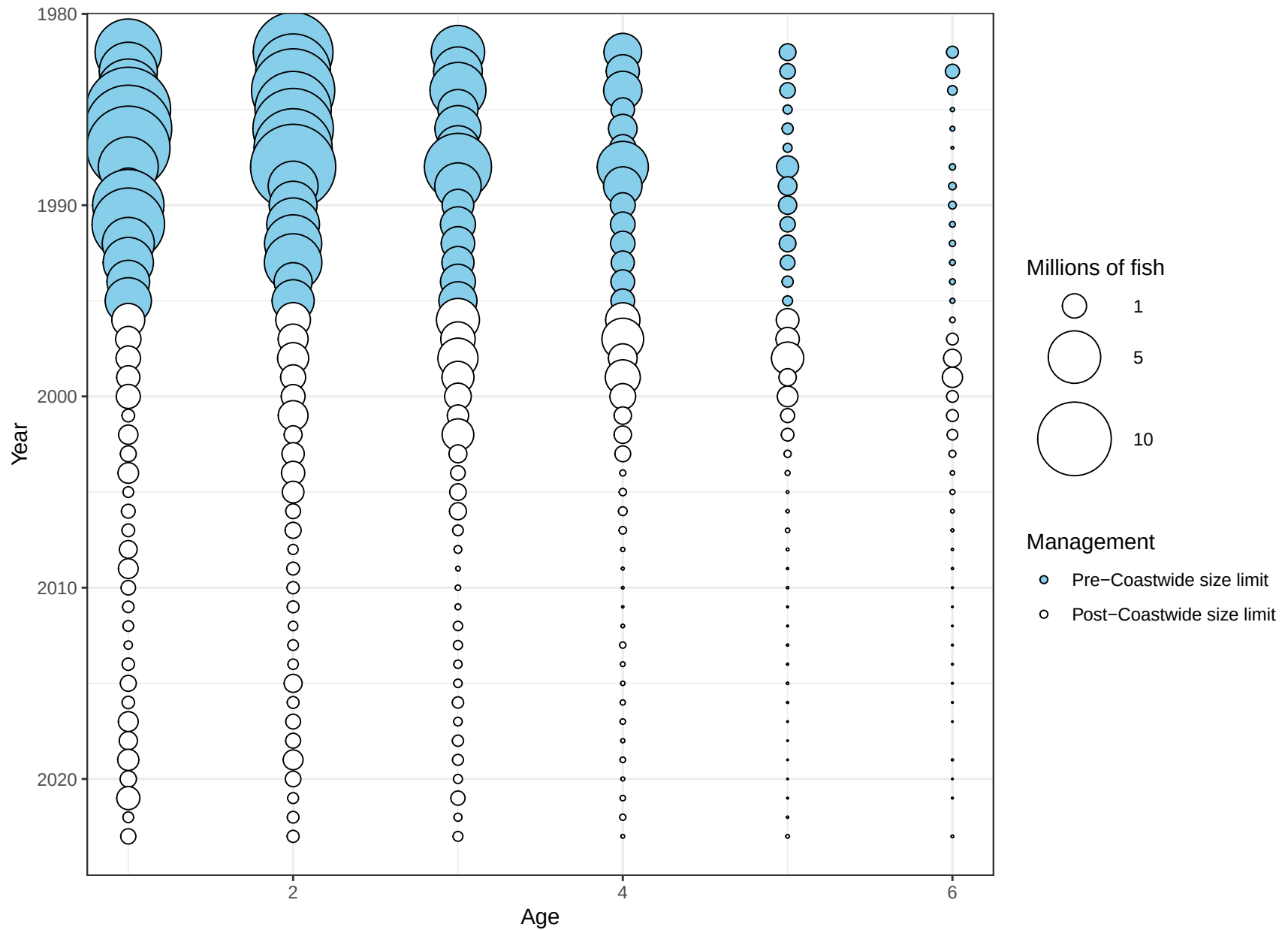


Figure 9. Recruitment (top) and SSB (bottom) for the 2025 assessment run with the updated species guilds and the sensitivity run with commercial discards calculated using the 2019 species guilds.

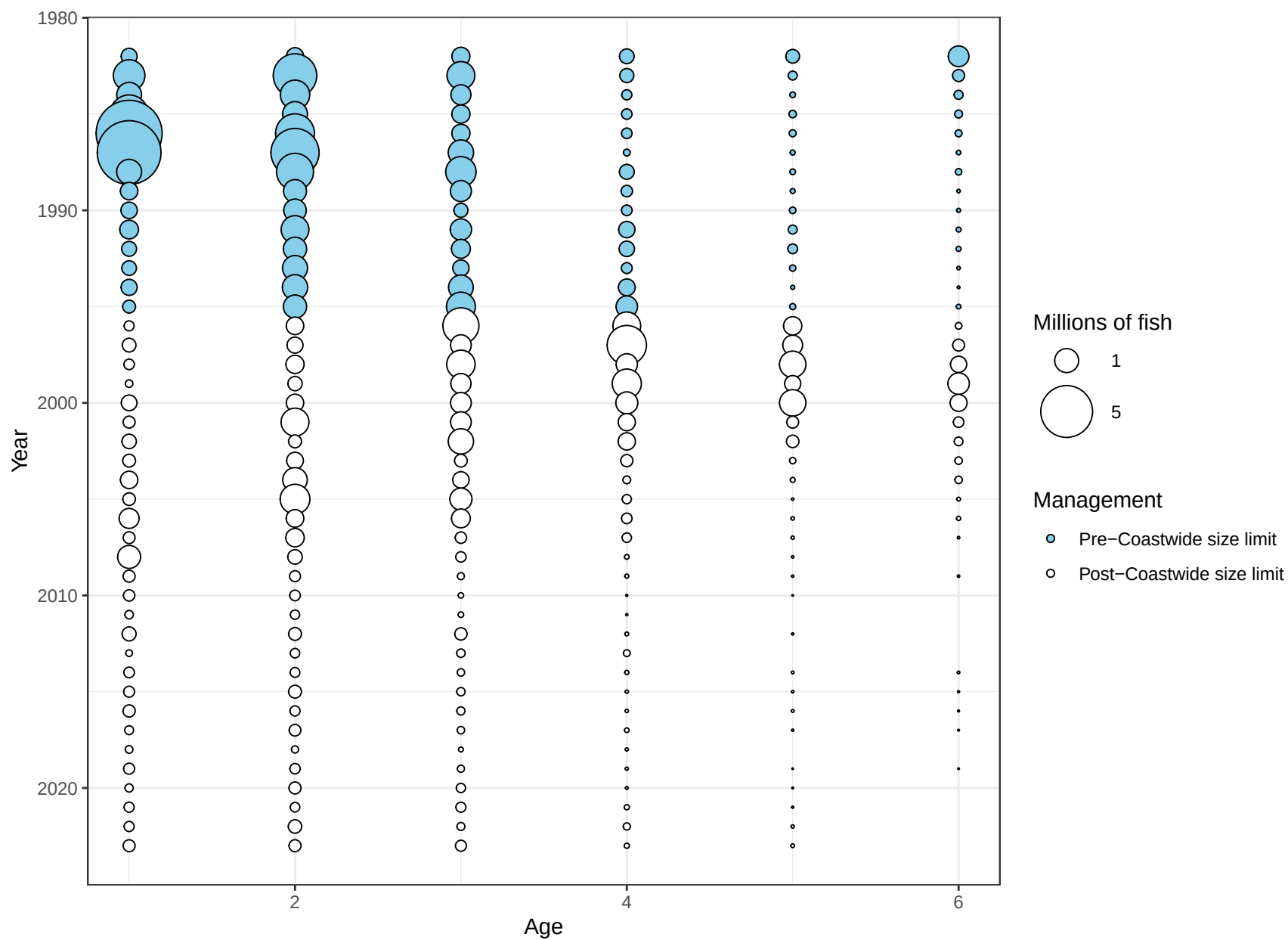
Appendix I: Input and Diagnostic Plots

- Input Data Plots
 - Catch-at-Age
 - Index-at-Age
- Diagnostic Plots
 - Observed vs. Predicted
 - * Indices
 - * Total catch
 - * Catch-at-age

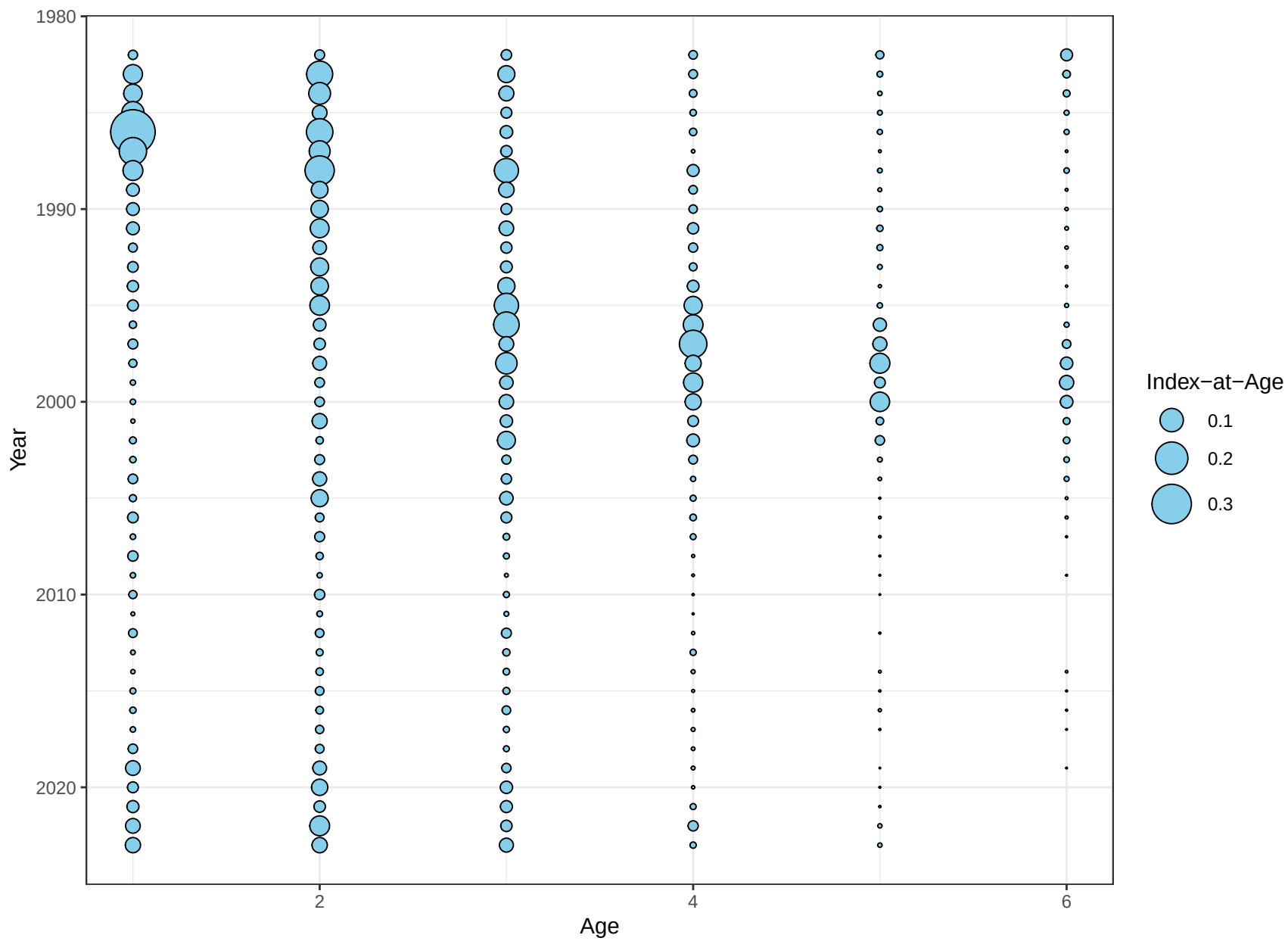
Commerical Age Composition (Harvest + Discards)



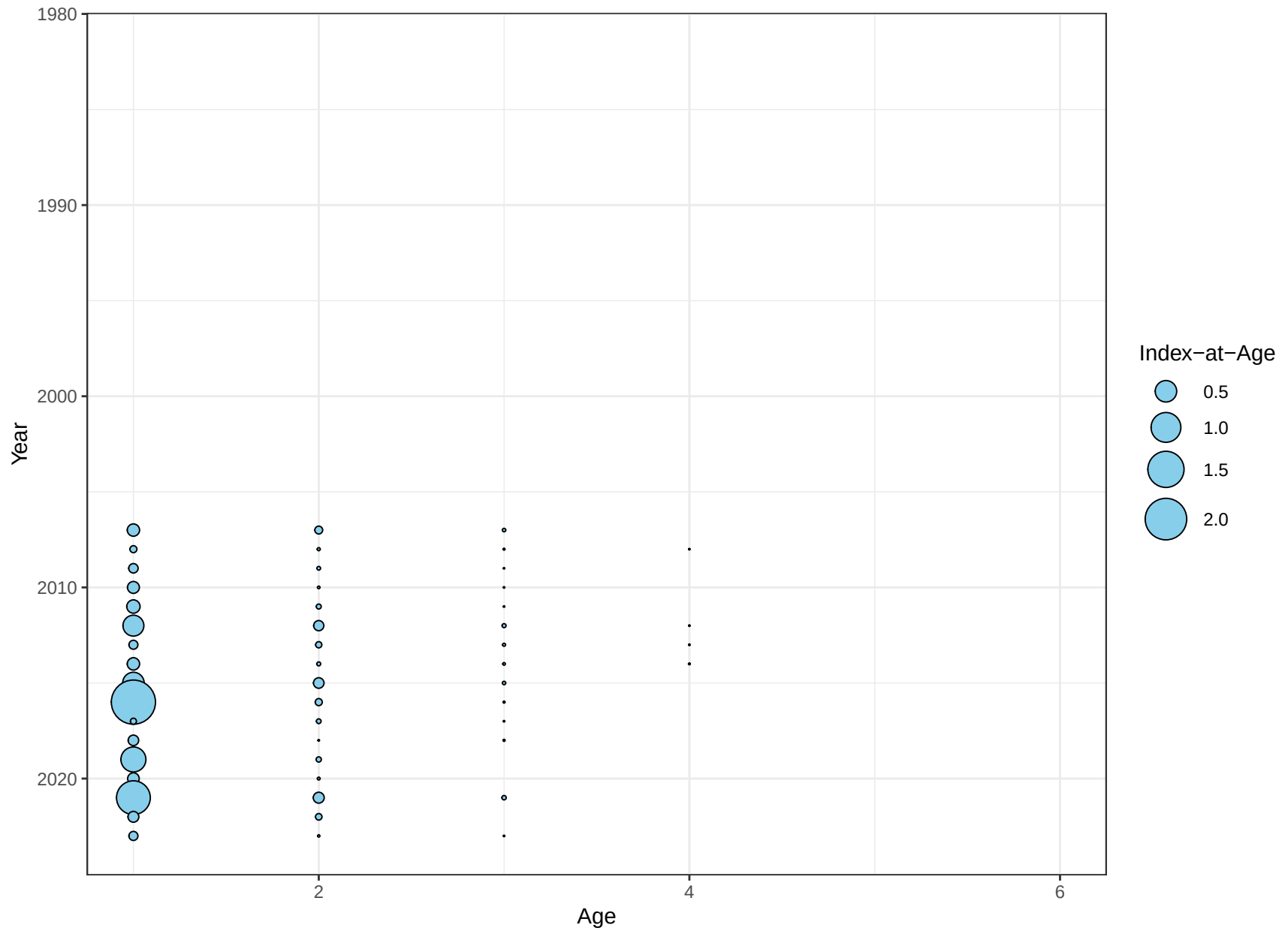
Recreational Catch-at-Age (Harvest + Release Mortality)



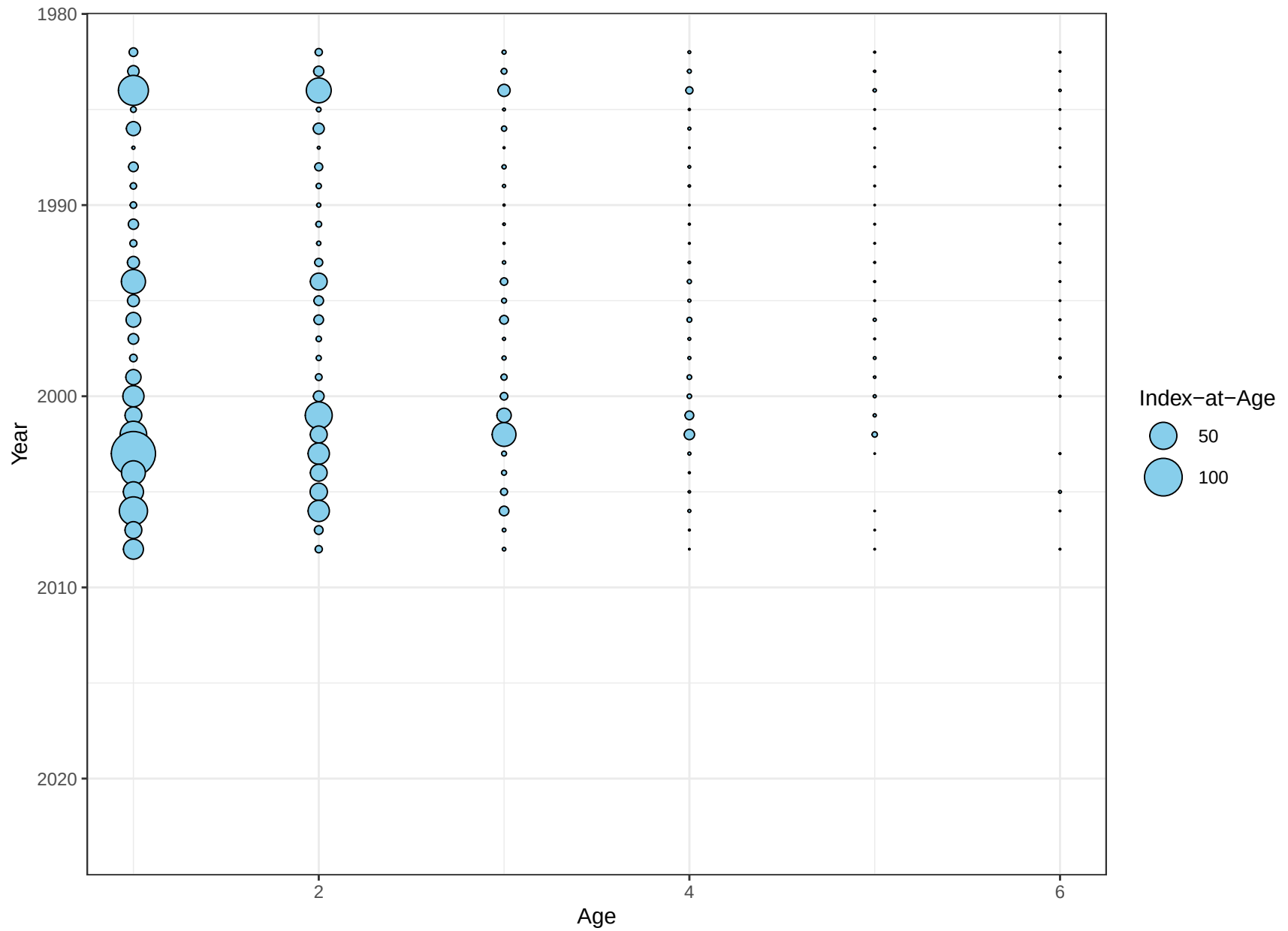
MRIP



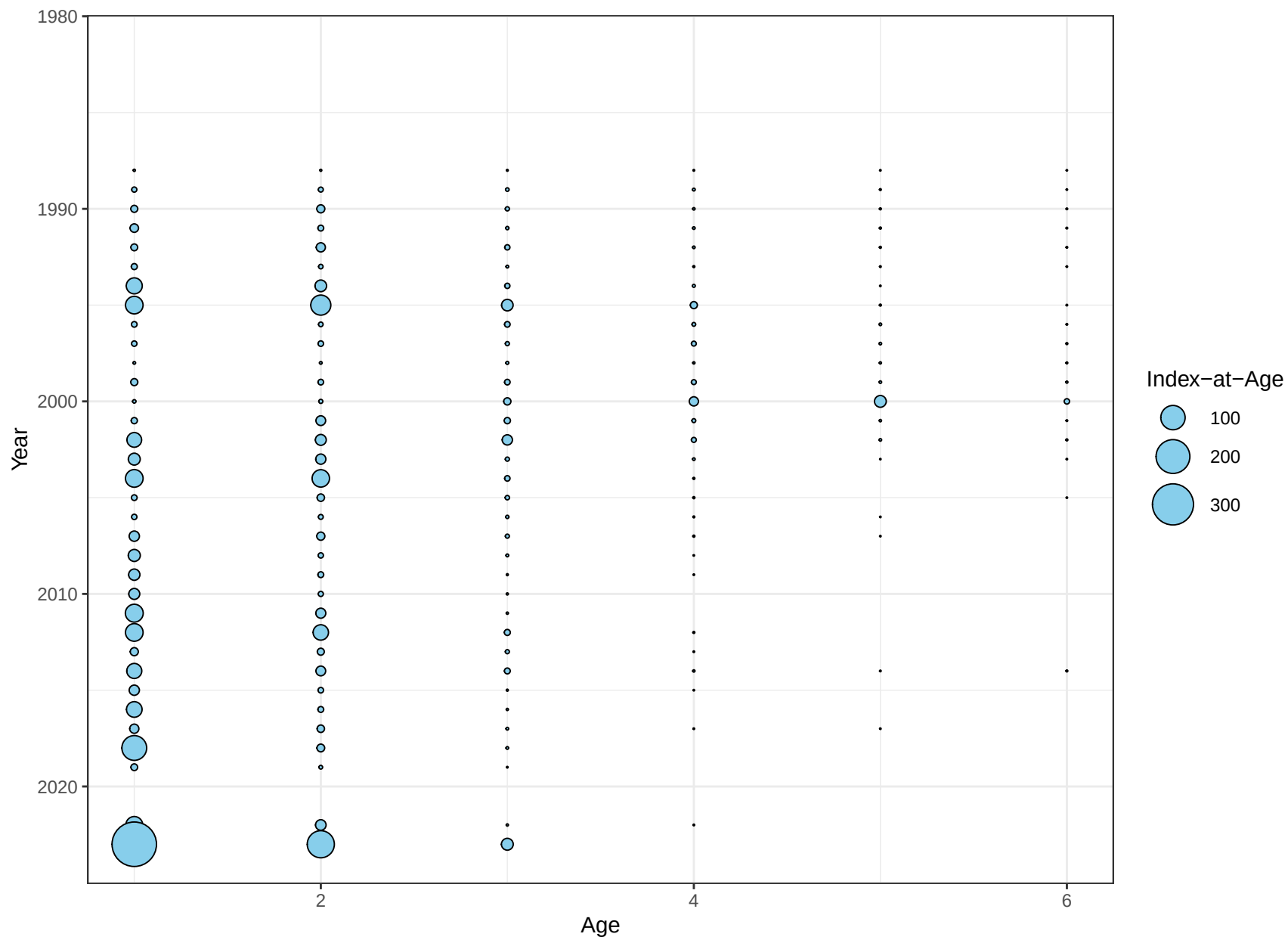
NEAMAP



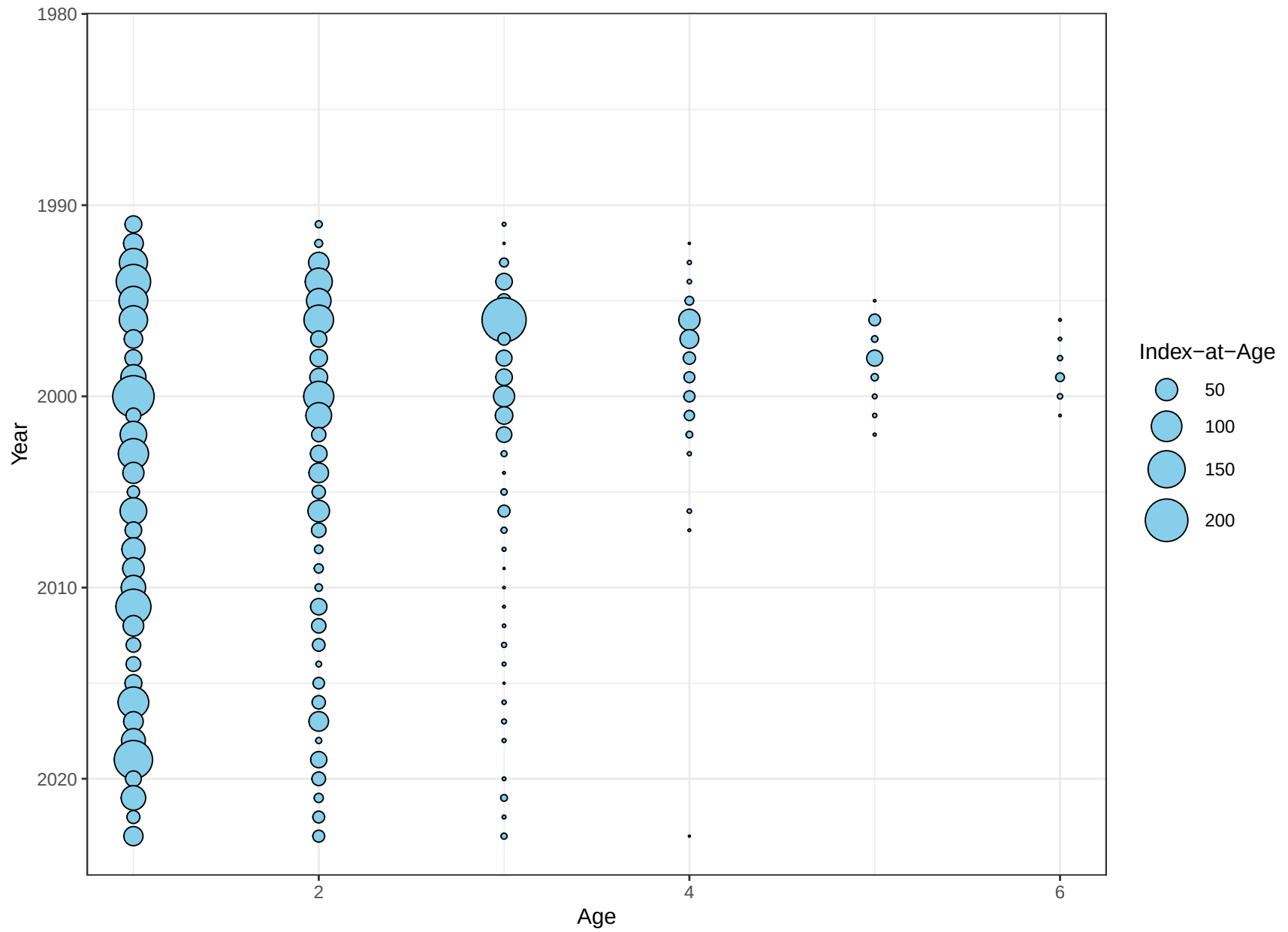
NEFSC Albatross



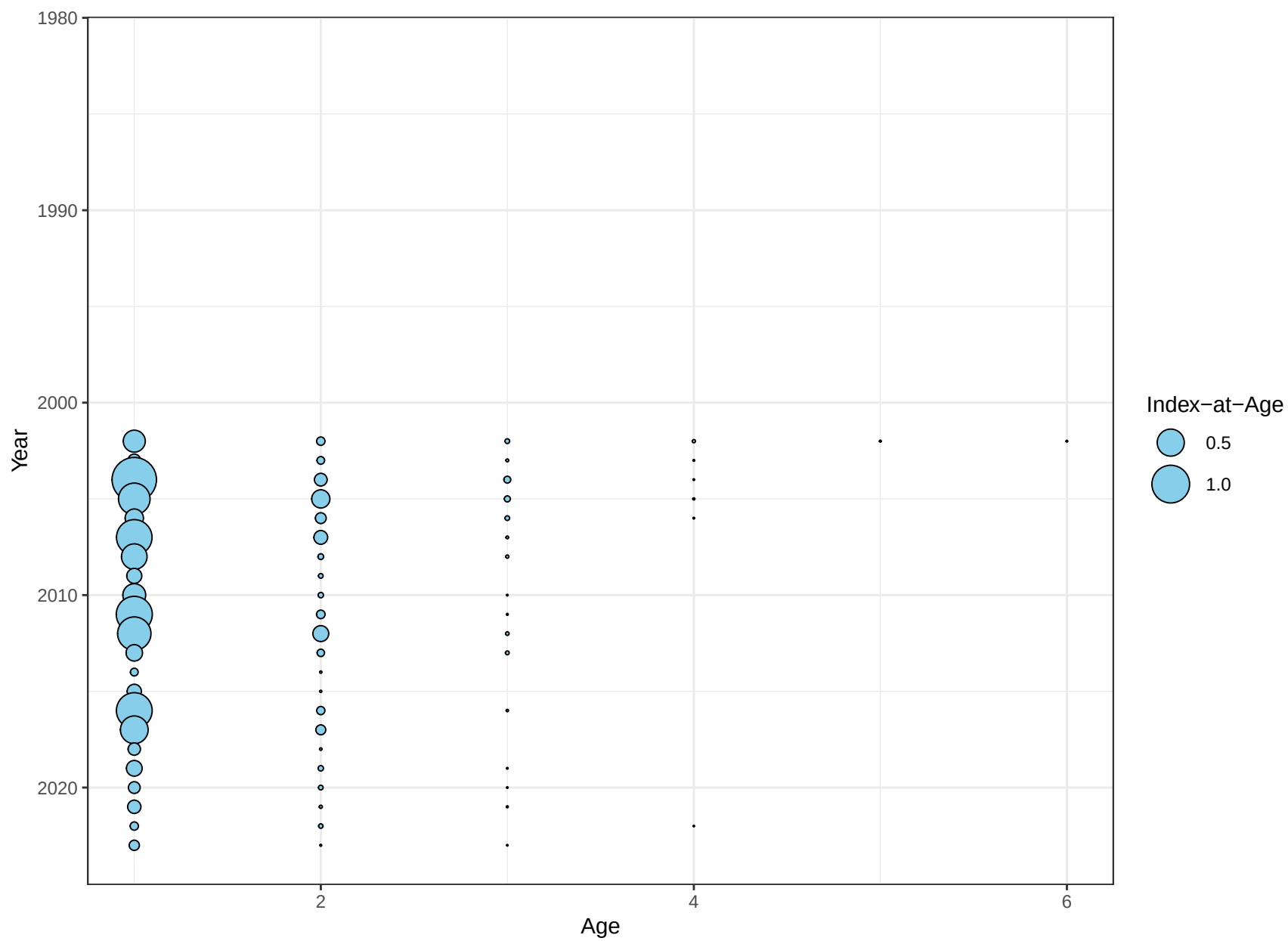
NJ Ocean



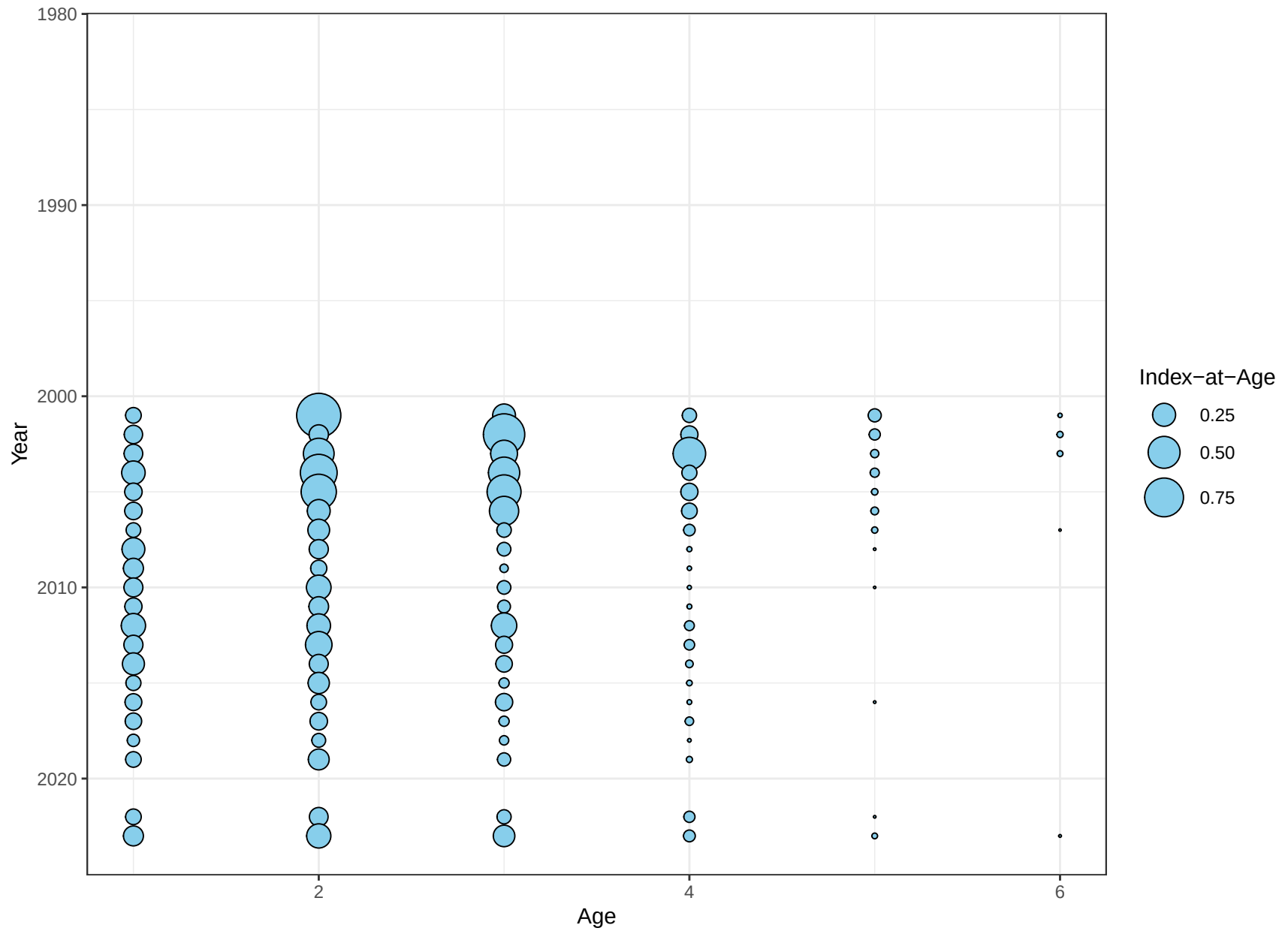
DE 30Ft



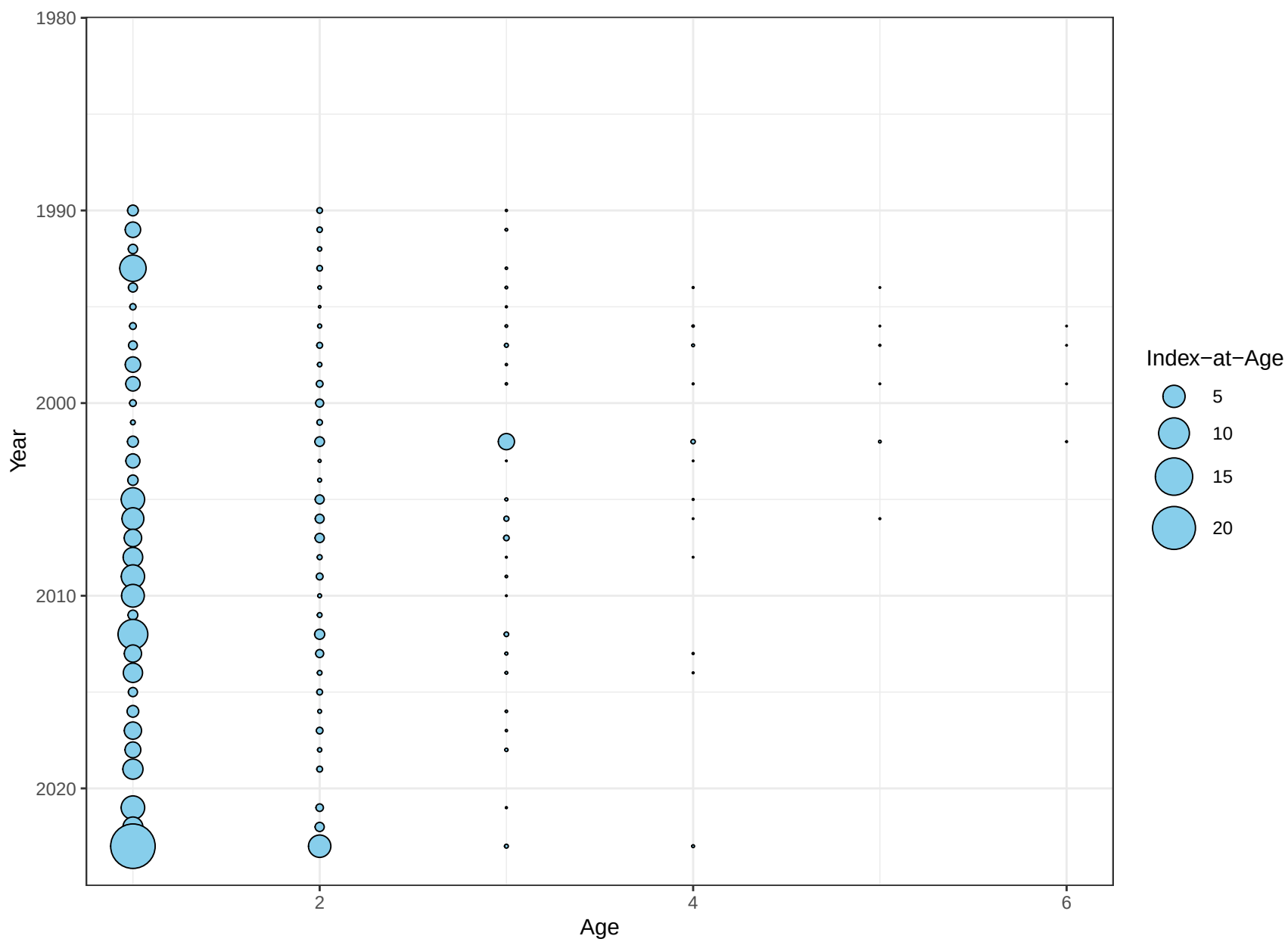
ChesMMAP



NC PSIGNS



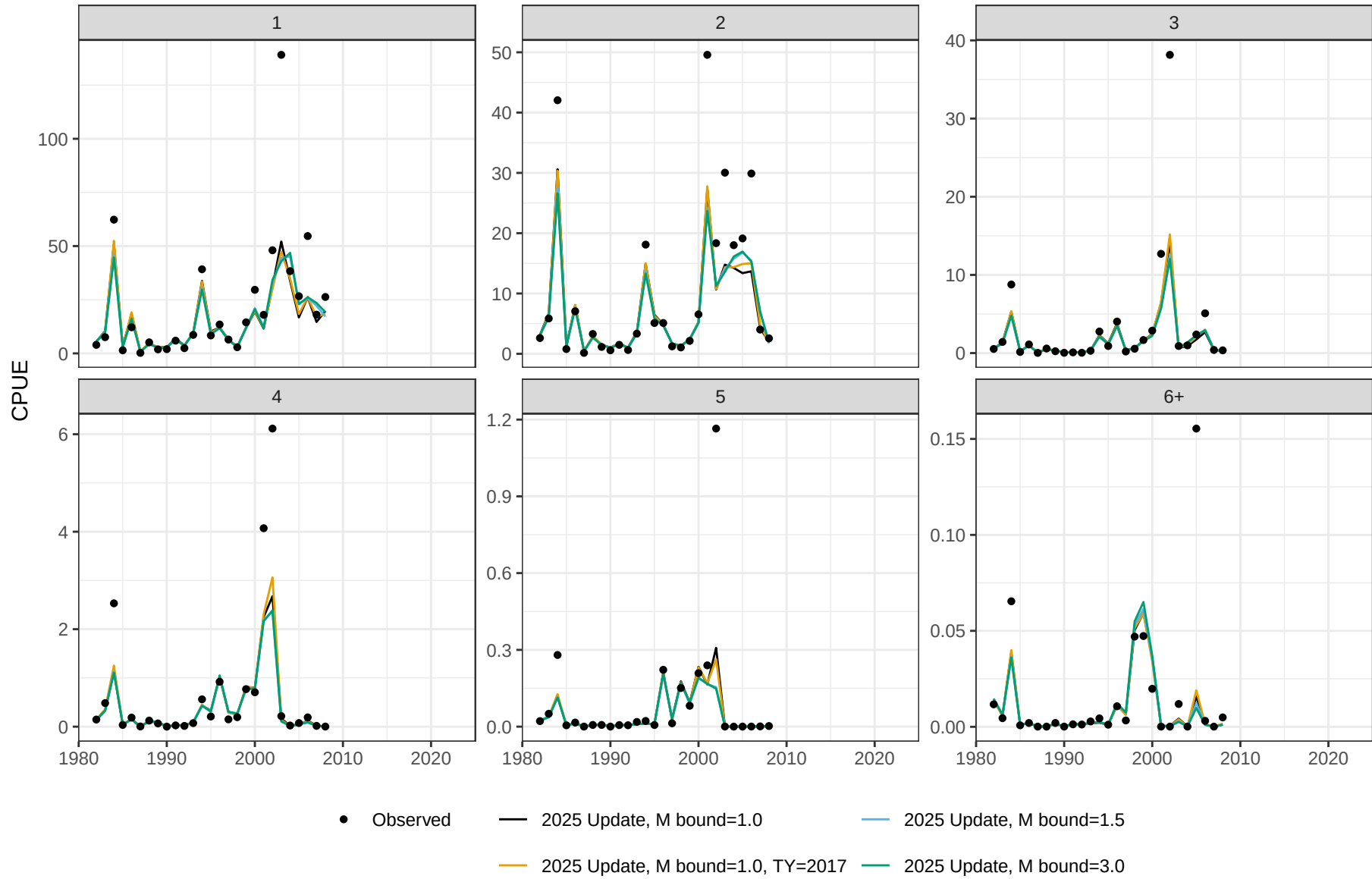
SEAMAP



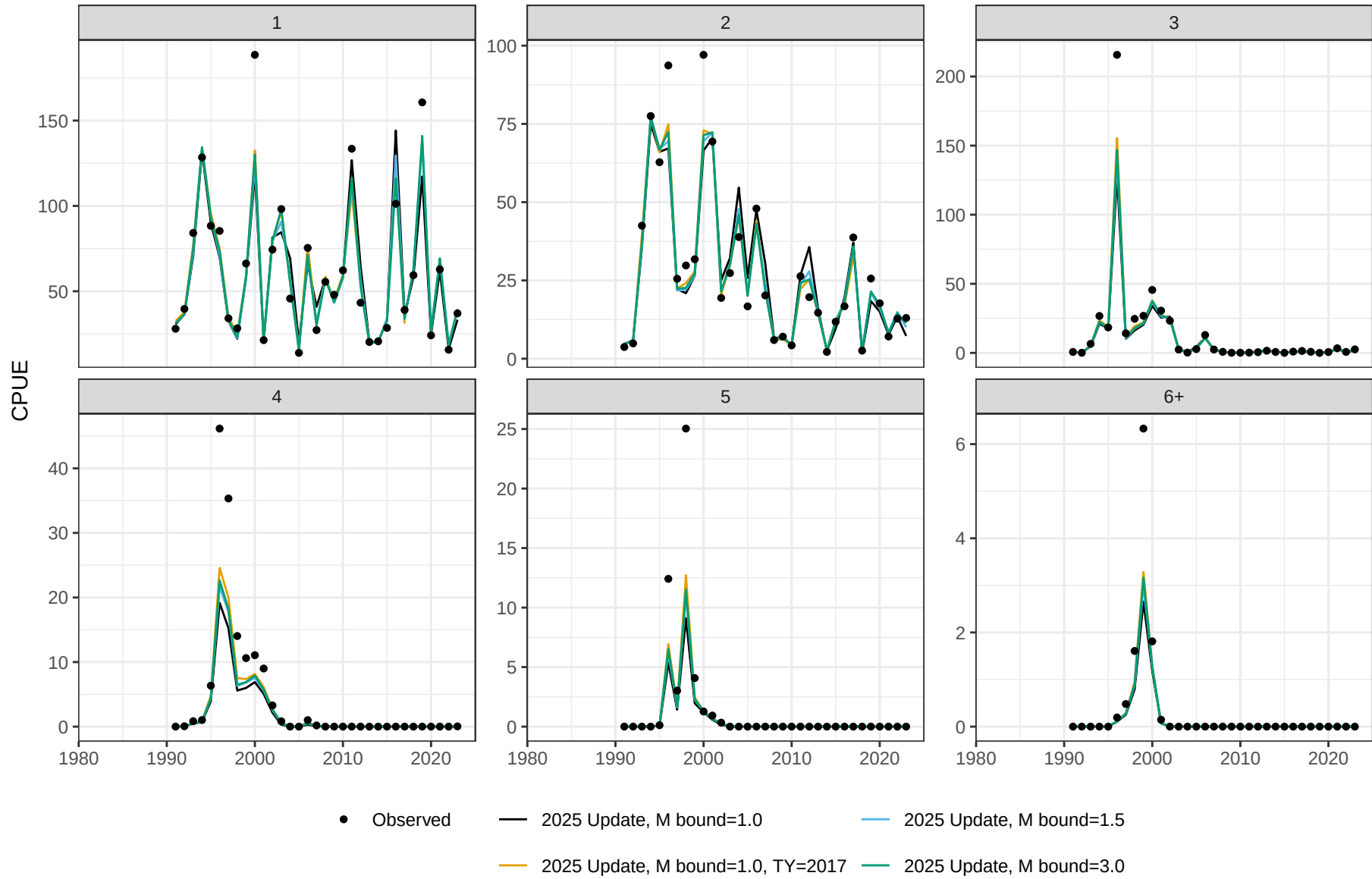
Diagnostic Plots: Observed vs. Predicted

Indices

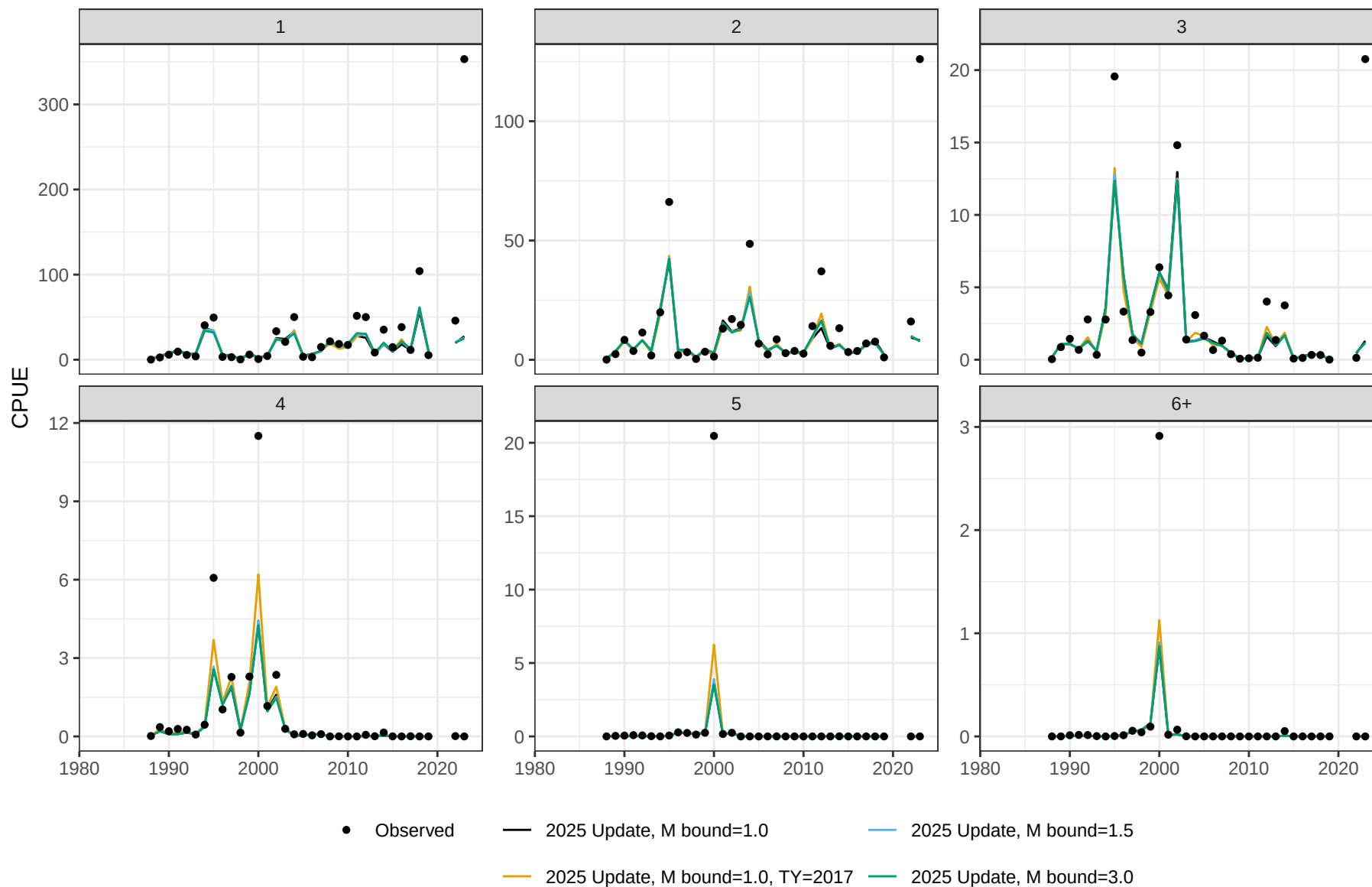
NEFSC Albatross



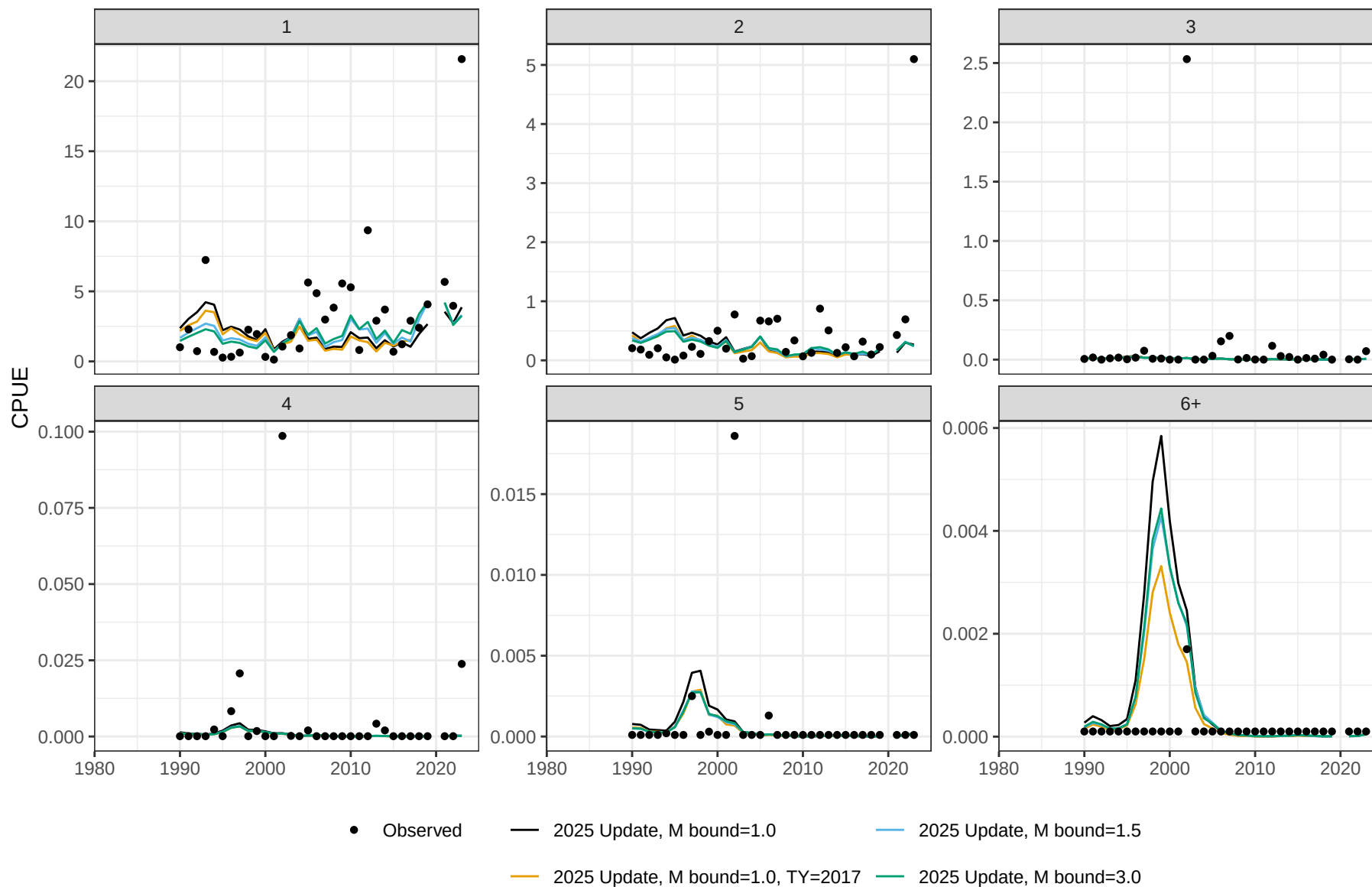
DE 30ft Trawl



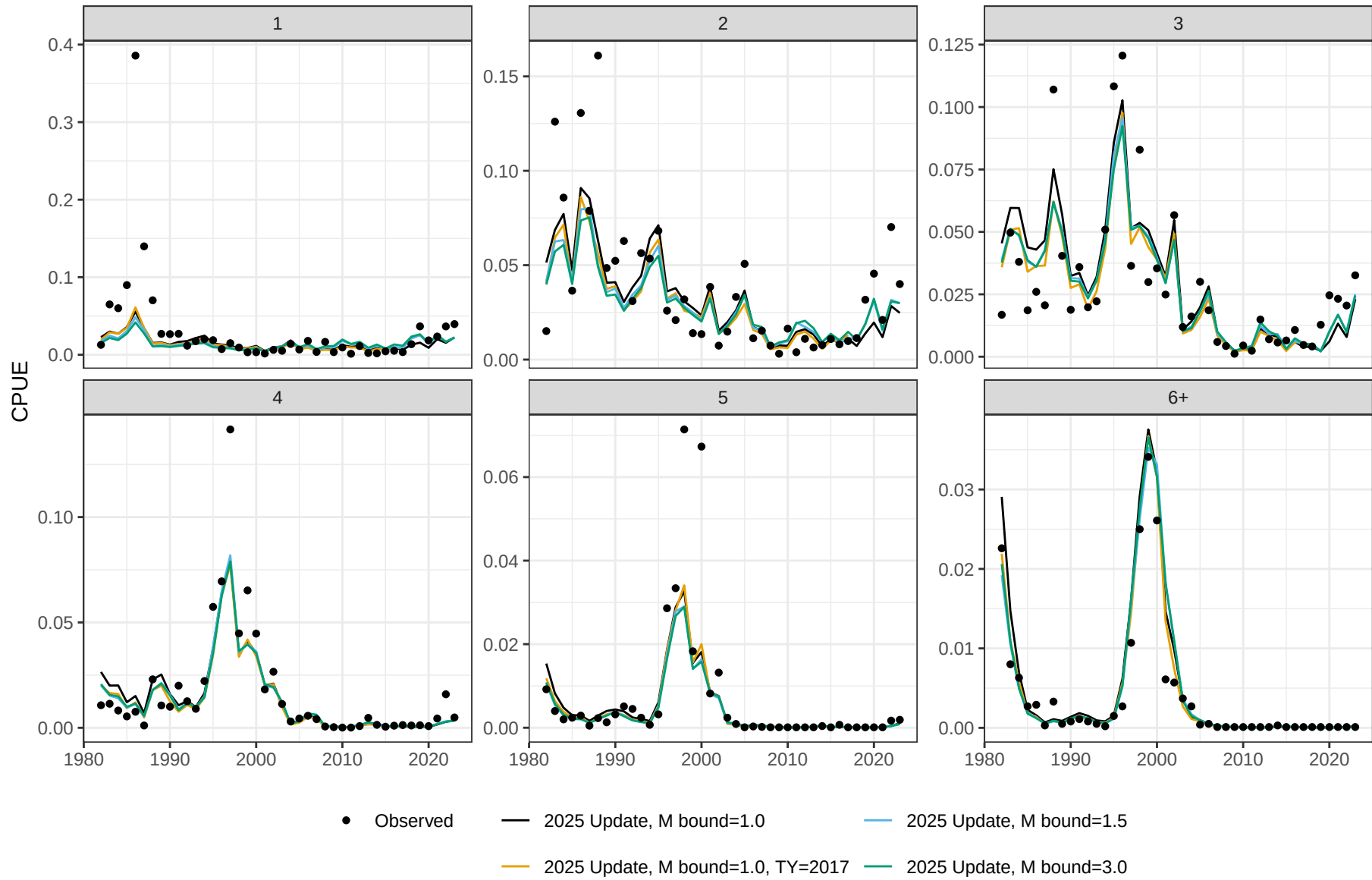
NJ Ocean Trawl



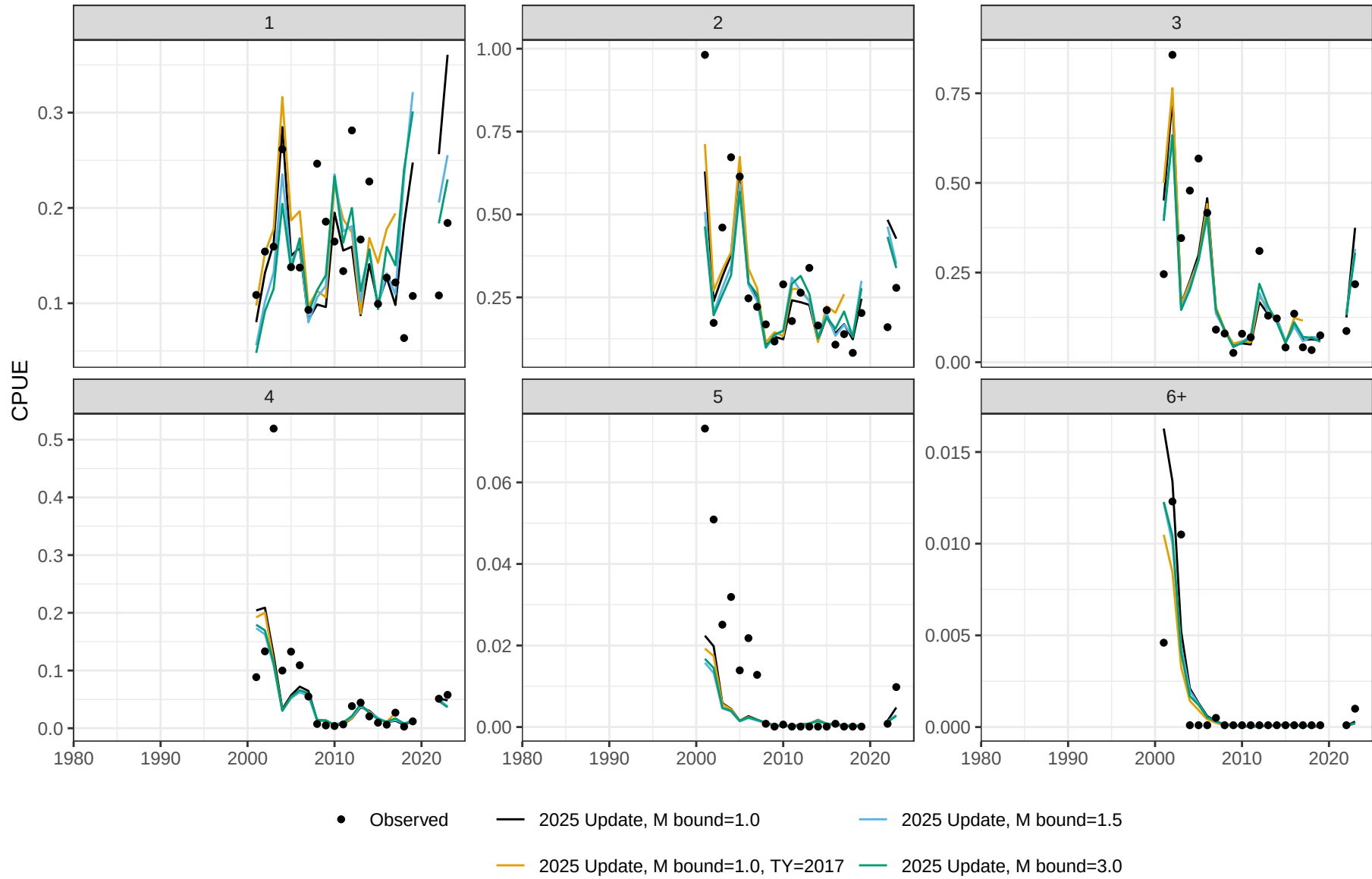
SEAMAP



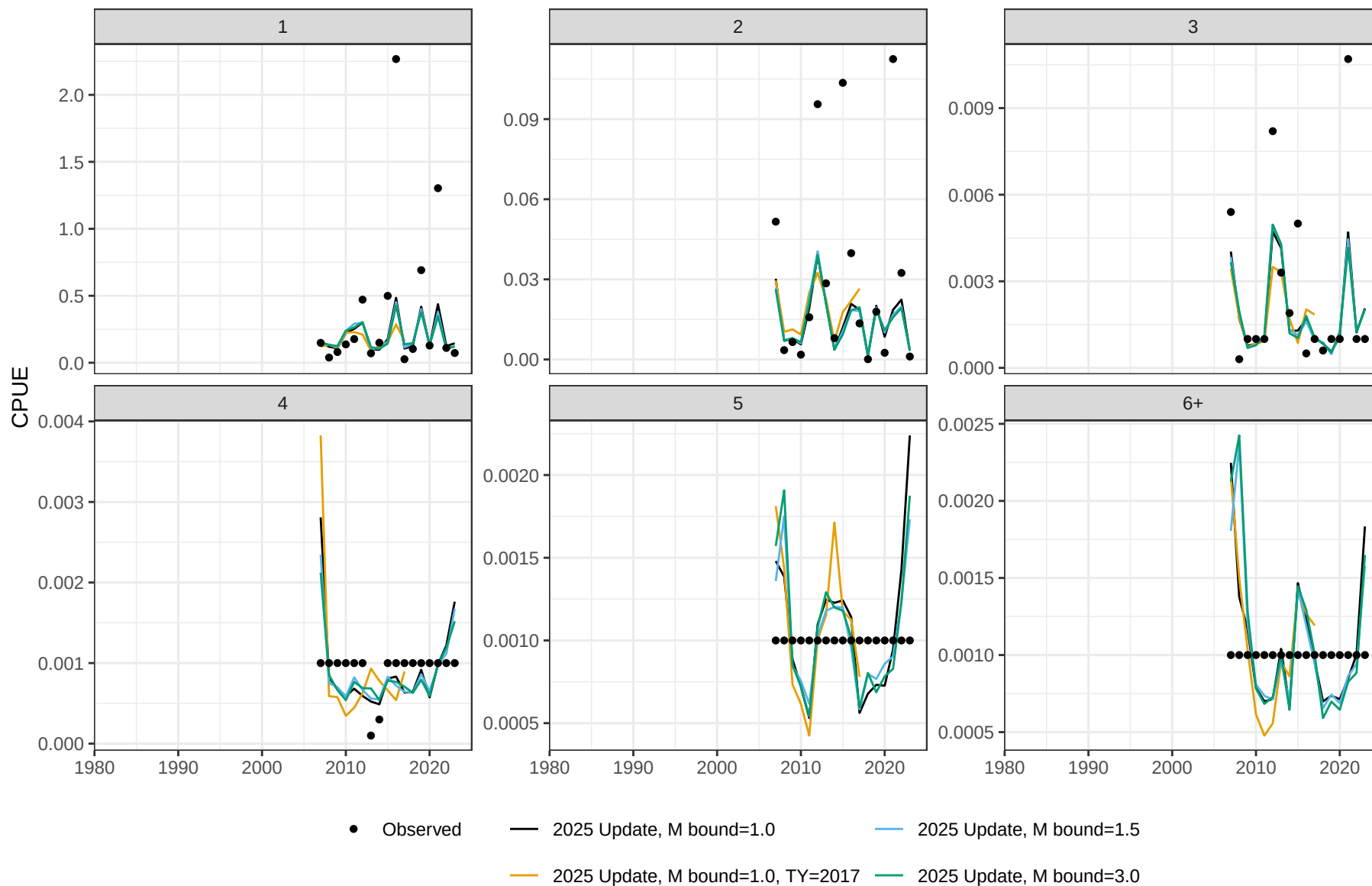
MRIP HPUE



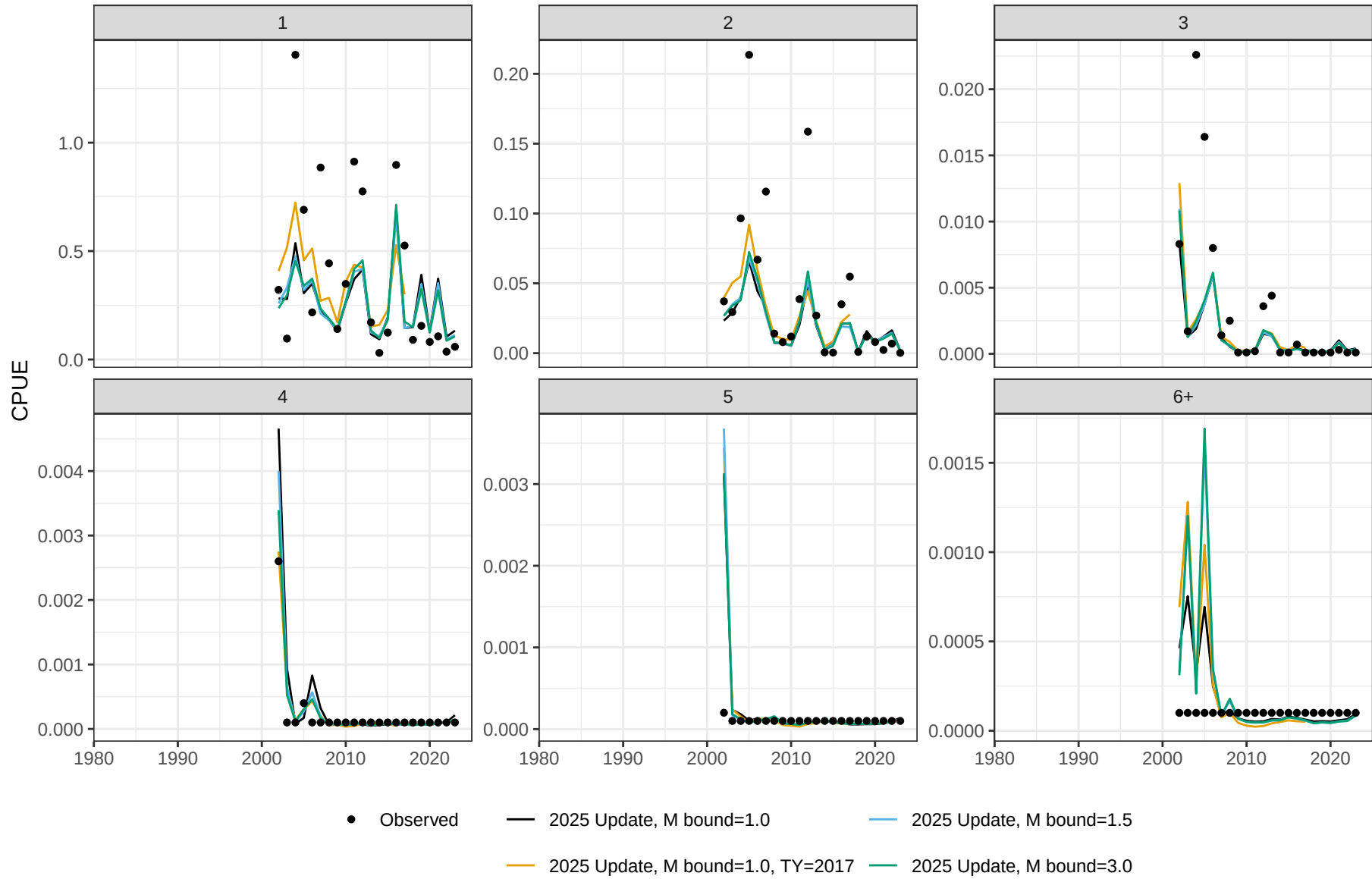
NC PSIGNS



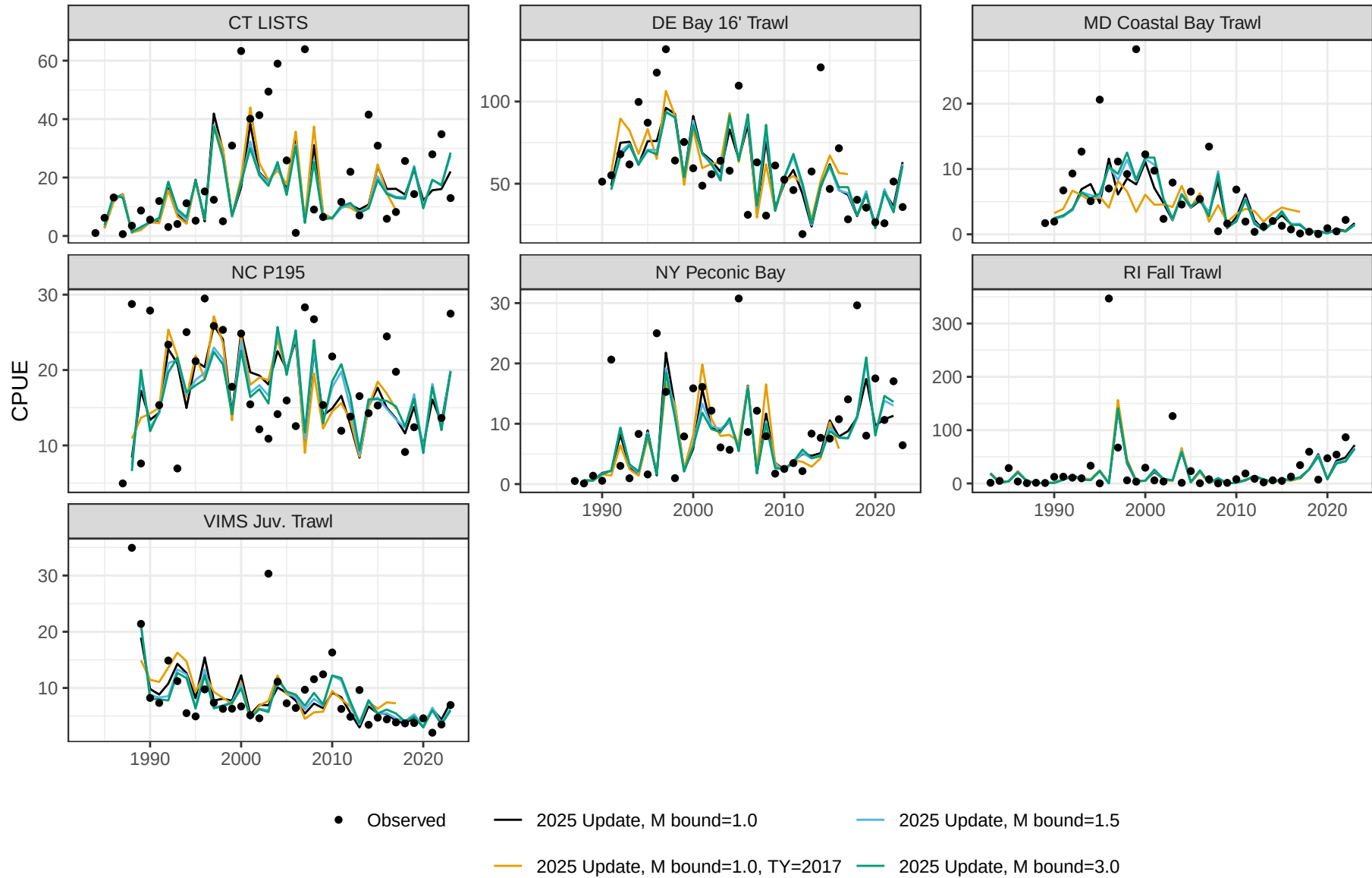
NEAMAP



ChesMMAp

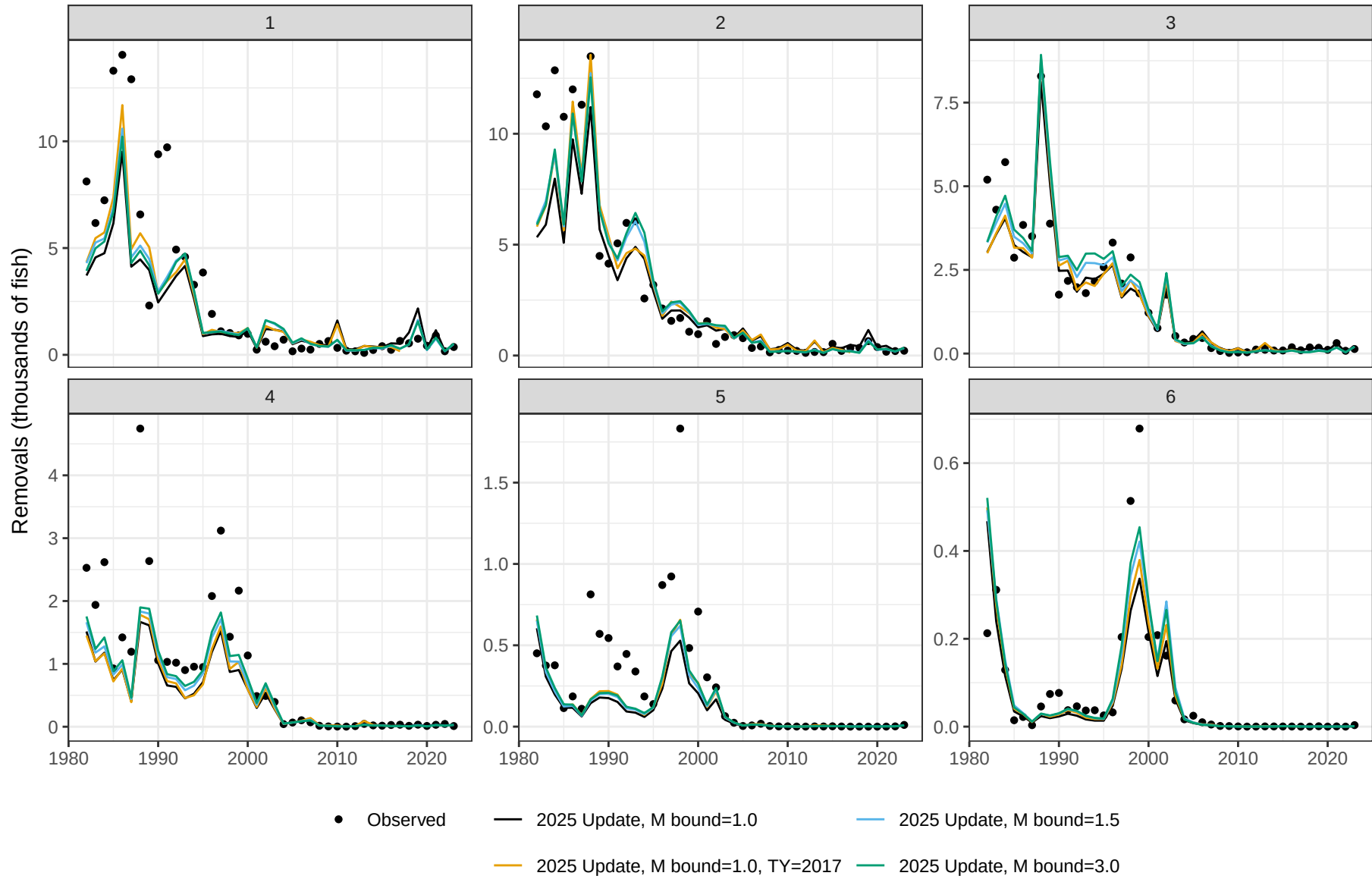


YOY Indices

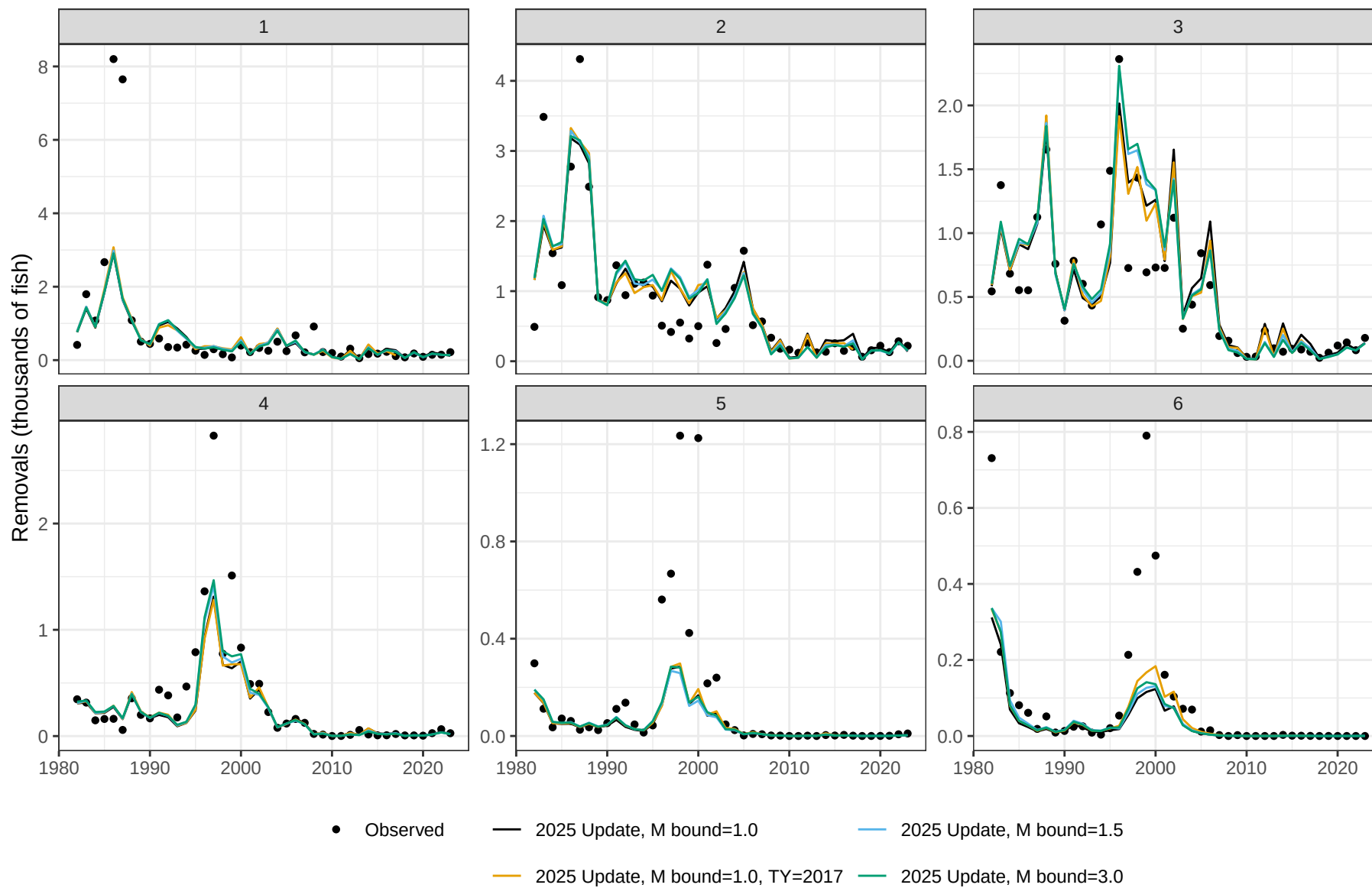


Total Catch

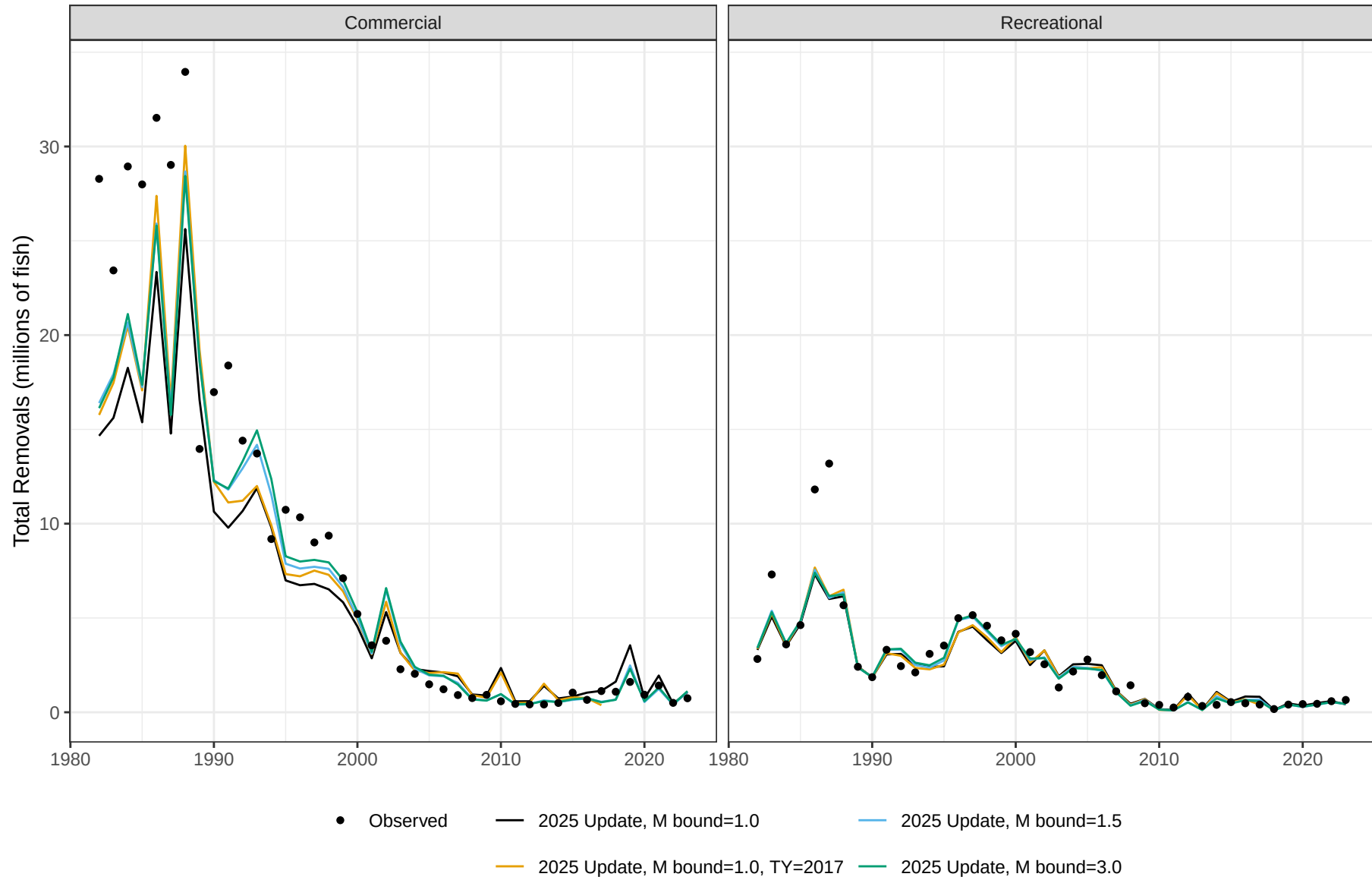
Commercial



Recreational



Total Removals

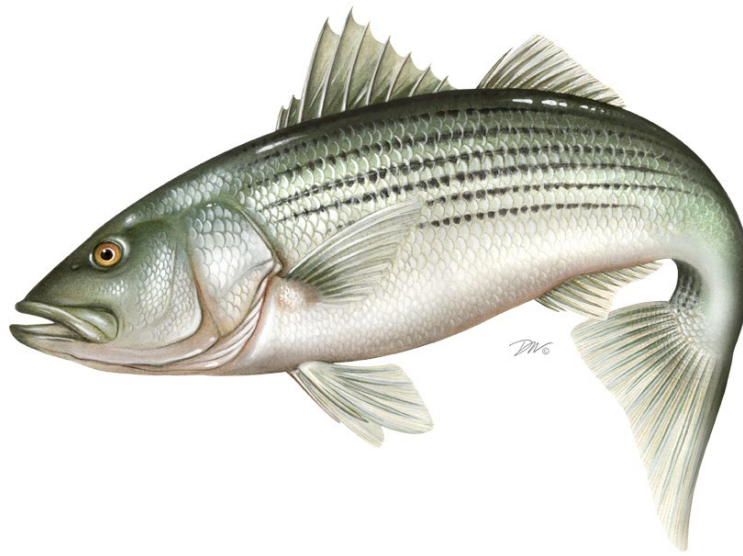


ATLANTIC STATES MARINE FISHERIES COMMISSION

REVIEW OF THE INTERSTATE FISHERY MANAGEMENT PLAN

FOR ATLANTIC STRIPED BASS
(Morone saxatilis)

2024 FISHING YEAR



For Board Review
July 2025



Sustainable and Cooperative Management of Atlantic Coastal Fisheries

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I. Status of the Fishery Management Plan

<u>Date of FMP Approval:</u>	Original FMP – 1981
<u>Amendments:</u>	Amendment 1 – 1984 Amendment 2 – 1984 Amendment 3 – 1985 Amendment 4 – 1989; Addendum I – 1991, Addendum II – 1992, Addendum III – 1993, Addendum IV – 1994 Amendment 5 – 1995; Addendum I – 1997, Addendum II – 1997, Addendum III – 1998, Addendum IV – 1999, Addendum V – 2000 Amendment 6 – 2003; Addendum I – 2007, Addendum II – 2010, Addendum III – 2012, Addendum IV – 2014, Addendum VI -2019 Amendment 7 – 2022; Addendum I – 2023
<u>Management Unit:</u>	Migratory stocks of Atlantic striped bass from Maine through North Carolina
<u>States With Declared Interest:</u>	Maine - North Carolina, including Pennsylvania
<u>Additional Jurisdictions:</u>	District of Columbia, Potomac River Fisheries Commission, National Marine Fisheries Service, United States Fish and Wildlife Service
<u>Active Boards/Committees:</u>	Atlantic Striped Bass Management Board, Advisory Panel, Technical Committee, Stock Assessment Subcommittee, Tagging Subcommittee, Plan Review Team, and Plan Development Team

Original FMP and Amendments 1-5

The Atlantic States Marine Fisheries Commission (Commission) developed a Fisheries Management Plan (FMP) for Atlantic Striped Bass in 1981 in response to poor juvenile recruitment and declining landings. The FMP recommended increased restrictions on commercial and recreational fisheries, such as minimum size limits and harvest closures on spawning grounds. Two amendments were passed in 1984 recommending additional management measures to reduce fishing mortality. To strengthen the management response and improve compliance and enforcement, the Atlantic Striped Bass Conservation Act (P.L. 98-613) was passed in late 1984. The Striped Bass Act¹ mandated the implementation of striped bass regulations passed by the Commission and gave the Commission authority to recommend to the Secretaries of Commerce and Interior that states be found out of compliance when they failed to implement management measures consistent with the FMP.

¹ The 1997 reauthorization of the Striped Bass Act also required the Secretaries of Commerce and Interior provide a biennial report to Congress highlighting the progress and findings of studies of migratory and estuarine Striped Bass. The ninth such report was recently provided to Congress (Shepherd et al. 2017).

The first enforceable plan under the Striped Bass Act, Amendment 3, was approved in 1985, and required size regulations to protect the 1982 year-class – the first modest size cohort since the previous decade. The objective was to increase size limits to allow at least 95% of the females in the 1982 year-class to spawn at least once. Smaller size limits were permitted in producer areas than along the coast. Several states, beginning with Maryland in 1985, opted for a more conservative approach and imposed a total moratorium on striped bass landings for several years. The amendment contained a trigger mechanism to relax regulations when the 3-year moving average of the Maryland juvenile abundance index (JAI) exceeded an arithmetic mean of 8.0 – which was attained with the recruitment of the 1989 year-class. Also, in 1985, the Commission determined the Albemarle Sound-Roanoke River (A-R) stock in North Carolina contributed minimally to the coastal migratory population, and was therefore allowed to operate under an alternative management program.

Amendment 4, implemented in 1989, aimed to rebuild the resource rather than maximize yield. The amendment allowed state fisheries to reopen under a target fishing mortality (F) of 0.25, which was half the estimated F needed to achieve maximum sustainable yield (MSY). The amendment allowed an increase in the target F once spawning stock biomass (SSB) was restored to levels estimated during the late 1960s and early 1970s. The dual size limit concept was maintained (coastal versus producer areas), and a recreational trip limit and commercial season was implemented to reduce the harvest to 20% of that in the historic period of 1972-1979. A series of four addenda were implemented from 1990-1994 to maintain protection of the 1982 year-class.

In 1990, to provide additional protection to striped bass and ensure the effectiveness of state regulations, NOAA Fisheries passed a final rule (55 Federal Register 40181-02) prohibiting possession, fishing (catch and release fishing), harvest, and retention of Atlantic striped bass in the Exclusive Economic Zone (EEZ), with the exception of a defined transit zone within Block Island Sound. Atlantic striped bass may be transported through this defined area provided that the vessel is not used to fish while in the EEZ and the vessel remains in continuous transit, and that the fish were legally caught in adjoining state waters.

In 1995, the Atlantic striped bass migratory stock was declared recovered by the Commission (the A-R stock was declared recovered in 1997) and Amendment 5 was adopted to increase the target F to 0.33, midway between the existing F target (0.25) and F_{MSY} . Target F was allowed to increase again to 0.40 after two years of implementation. Regulations were developed to achieve the target F (which included measures to restore commercial harvest to 70% of the average landings during the 1972-1979 historical period) and states were allowed to submit proposals to implement alternative regulations that were deemed conservationally equivalent to the Amendment 5 measures. From 1997-2000, a series of five addenda were implemented to respond to the latest stock status information and adjust the regulatory program to achieve each change in target F .

Amendment 6

In 2003, Amendment 6 was adopted to address five limitations within the existing management program: 1) potential inability to prevent the Amendment 5 exploitation target from being exceeded; 2) perceived decrease in availability or abundance of large striped bass in the coastal migratory population; 3) a lack of management direction with respect to target and threshold biomass levels; 4)

inequitable effects of regulations on the recreational and commercial fisheries, and coastal and producer area sectors; and 5) excessively frequent changes to the management program. Accordingly, Amendment 6 completely replaced the existing FMP for Atlantic striped bass.²

The goal of Amendment 6 is “to perpetuate, through cooperative interstate management, migratory stocks of striped bass; to allow commercial and recreational fisheries consistent with the long-term maintenance of a broad age structure, a self-sustaining spawning stock; and also to provide for the restoration and maintenance of their essential habitat.” In support of this goal, the following objectives are included:

1. Manage striped bass fisheries under a control rule designed to maintain stock size at or above the target female spawning stock biomass level and a level of fishing mortality at or below the target exploitation rate.
2. Manage fishing mortality to maintain an age structure that provides adequate spawning potential to sustain long-term abundance of striped bass populations.
3. Provide a management plan that strives, to the extent practical, to maintain coastwide consistency of implemented measures, while allowing the States defined flexibility to implement alternative strategies that accomplish the objectives of the FMP.
4. Foster quality and economically viable recreational, for-hire, and commercial fisheries.
5. Maximize cost effectiveness of current information gathering and prioritize state obligations in order to minimize costs of monitoring and management.
6. Adopt a long-term management regime that minimizes or eliminates the need to make annual changes or modifications to management measures.
7. Establish a fishing mortality target that will result in a net increase in the abundance (pounds) of age 15 and older striped bass in the population, relative to the 2000 estimate.

Amendment 6 modified the F target and threshold, and introduced a new set of biological reference points (BRPs) based on female SSB, as well as a list of management triggers based on the BRPs. The coastal commercial quotas were restored to 100% of the states’ average landings during the 1972-1979 historical period, except for Delaware’s coastal commercial quota which remained at the level allocated in 2002³. In the recreational fisheries, all states were required to implement a two-fish bag limit with a minimum size limit of 28 inches, except for the Chesapeake Bay fisheries, North Carolina fisheries that operate in the A-R, and states with approved alternative regulations. The Chesapeake Bay and A-R regulatory programs were predicated on a more conservative F target than the coastal

² While NOAA Fisheries continues to implement a complete ban on the fishing and harvest of striped bass in the EEZ, Amendment 6 includes a recommendation to consider reopening the EEZ to striped bass fisheries. In September 2006, NOAA Fisheries concluded that it would be imprudent to open the EEZ to striped bass fishing because it could not be certain that opening the EEZ would not lead to increased effort and an overfishing scenario.

³ The decision to hold Delaware’s commercial quota at the 2002 level is based on tagging information that indicated F on the Delaware River/Bay stock is too high, and uncertainty regarding the status of the spawning stock for the Delaware River/Bay.

migratory stock, which allowed these states/jurisdictions (hereafter states) to implement separate seasons, harvest caps, and size and bag limits as long as they remain under that F target. No minimum size limit can be less than 18 inches under Amendment 6. The same minimum size standards regulate the commercial fisheries as the recreational fisheries, except for a minimum 20 inch size limit in the Delaware Bay spring American shad gillnet fishery.

States are permitted the flexibility to deviate from these regulations by submitting conservation equivalency proposals to the Plan Review Team (PRT). All proposals are subject to technical review and approval by the Atlantic Striped Bass Management (Board). It is the responsibility of the state to demonstrate through quantitative analysis that the proposed management program is equivalent to the standards in the FMP, or will not contribute to the overfishing of the resource.

Five addenda to Amendment 6 have been implemented. Addendum I, approved in 2007, established a bycatch monitoring and research program to increase the accuracy of data on striped bass discards and recommended development of a web-based angler education program. Also in 2007, President George W. Bush issued an Executive Order (E.O. 13449) prohibiting the sale of striped bass (and red drum) caught within the EEZ. Addendum II was approved in 2010 and established a new definition of recruitment failure such that each index would have a fixed threshold rather than a threshold that changes annually with the addition of each year's data. Addendum III was approved in 2012 and requires all states with a commercial fishery for striped bass to implement a uniform commercial harvest tagging program. The Addendum was initiated in response to significant poaching events in the Chesapeake Bay and aims to limit illegal harvest of striped bass.

Addendum IV was triggered in response to the 2013 benchmark assessment, which indicated a steady decline in SSB since the mid-2000s. The Addendum established new F reference points, and changed commercial and recreational measures to reduce F to a level at or below the new target. Chesapeake Bay fisheries were required to implement lower reductions than coastal states (20.5% compared to 25%) since their fisheries were reduced by 14% in 2013 based on their management program. The addendum maintained the flexibility to implement alternative regulations through the conservation equivalency process. This practice has resulted in a variety of regulations among states. All states promulgated regulations prior to the start of their 2015 seasons.

Addendum VI was initiated in response to the 2018 benchmark assessment which indicated the stock is overfished and experiencing overfishing⁴. Approved in October 2019, the Addendum aimed to reduce total removals by 18% relative to 2017 levels in order to achieve F target in 2020. Specifically, the

⁴ In February 2017, the Board initiated development of Draft Addendum V to consider liberalizing coastwide commercial and recreational regulations. The Board's action responded to concerns raised by Chesapeake Bay jurisdictions regarding continued economic hardship endured by its stakeholders since the implementation of Addendum IV and information from the 2016 stock assessment update indicating that F was below target in 2015, and that total removals could increase by 10% to achieve the target F. However, the Board chose to not advance the draft addendum for public comment largely due to harvest estimates having increased in 2016 without changing regulations. Instead, the Board decided to wait until it reviews the results of the 2018 benchmark stock assessment before considering making changes to the management program.

Addendum reduced all state commercial quotas by 18%, and implemented a 1 fish bag limit and a 28” to less than 35” slot limit for ocean fisheries and a 1 fish bag limit and an 18” minimum size limit in Chesapeake Bay to reduce total recreational removals by 18% in both regions. The Addendum’s measures were designed to apply the needed reductions proportionally to both the commercial and recreational sectors, although states were permitted to submit alternative regulations through conservation equivalency that achieve an 18% reduction in total removals statewide. The Board reviewed and approved management options for 2020 on a state-by-state basis in February, and all states promulgated regulations by April 1.

Addendum VI also required the mandatory use of circle hooks when fishing with bait to reduce release mortality in recreational striped bass fisheries. States are encouraged to promote the use of circle hooks through various public outreach and education platforms to garner support and compliance with this important conservation measure. In October 2020, the Board approved state implementation plans for circle hook requirements, with the caveat that no exemptions to Addendum VI mandatory circle hook requirements will be permitted. Circle hook regulations were required to be implemented no later than January 1, 2021. In March 2021, the Board approved a clarification on the definition of bait and methods of fishing⁵ that require circle hooks, which must be implemented by states as part of Addendum VI compliance. Per Commission standards, states could implement more restrictive measures. The Board also approved guidance on how to address incidental catch of striped bass when targeting other species with non-circle hooks with bait attached. This guidance was not a compliance criterion since incidental catch was not originally part of Addendum VI.

Amendment 7

Amendment 7 was approved in May 2022, and consolidates Amendment 6 and its associated addenda into a single document. The purpose of Amendment 7 is to update the management program to align with current fishery needs and priorities given the status and understanding of the resource and fishery has changed considerably since implementation of Amendment 6 in 2003. Amendment 7 builds upon the Addendum VI to Amendment 6 action to address overfishing and initiate rebuilding in response to the overfished finding from the 2018 stock assessment, requiring the Board to rebuild the stock by 2029. Amendment 7 established new requirements for the following components of the FMP: management triggers, conservation equivalency, additional measures to address recreational release mortality, and the stock rebuilding plan.

For management triggers, Amendment 7 established an updated recruitment management trigger that is more sensitive to low recruitment than the previous trigger, and it required a specific management response to low year-class strength. The response requires re-evaluation of the fishing mortality management triggers to account for low recruitment. If one of those triggers trips after reevaluation, the Board is required to take action to reduce fishing mortality. Amendment 7 also updated the spawning stock biomass triggers by establishing a deadline for implementing a rebuilding plan. The

⁵ Definition of Bait and Methods of Fishing: Circle hooks are required when fishing for striped bass with bait, which is defined as any marine or aquatic organism live or dead, whole or parts thereof. This shall not apply to any artificial lure with bait attached.

Board must implement a rebuilding plan within two years of when a spawning stock biomass trigger is tripped.

For conservation equivalency (CE), Amendment 7 does not allow CE to be used for most recreational striped bass fisheries when the stock is overfished. Amendment 7 also provided constraints around the use of Marine Recreational Information Program data for CE proposals and defines the overall percent reduction/liberalization a proposal must achieve, including required uncertainty buffers. These restrictions are intended to minimize the risks due to uncertainty when CE is used for non-quota managed striped bass fisheries.

For recreational release mortality, Amendment 7 established a new gear restriction which prohibits gaffing striped bass when fishing recreationally. This is in addition to the existing circle hook requirement when fishing recreationally with bait. Additionally, Amendment 7 required striped bass caught on any unapproved method of take (e.g., caught on a J-hook with bait) must be returned to the water immediately without unnecessary injury. This provision, which is related to incidental catch, was previously a recommendation in Addendum VI to Amendment 6.

For stock rebuilding, Amendment 7 addressed the 2022 stock assessment and how it would inform efforts to meet the 2029 stock rebuilding deadline. Given concerns about recent low recruitment and the possibility of continued low recruitment, Amendment 7 required the 2022 stock assessment's rebuilding projections to use a low recruitment assumption to conservatively account for that future possibility. Amendment 7 also established a mechanism for the Board to respond more quickly to the 2022 assessment results if action was needed to achieve stock rebuilding by 2029.

All provisions of Amendment 7 were effective May 5, 2022 except for gear restrictions. States had to implement new gear restrictions by January 1, 2023. Amendment 7 also maintained the same recreational and commercial measures specified in Addendum VI to Amendment 6, which were implemented in 2020. As such, all approved Addendum VI conservation equivalency programs and state implementation plans are maintained until such measures are changed in the future.

Addendum I to Amendment 7

Addendum I to Amendment 7 was approved in May 2023 to allow for voluntary ocean commercial quota transfers contingent on stock status. The addendum was developed to provide some, more immediate relief to states seeking a change to their commercial quota after the Board decided that changes to the commercial quota system would not be considered in the then ongoing development of Draft Amendment 7. When the stock is overfished, no quota transfers will be allowed. When the stock is not overfished, the Board can decide every one to two years whether it will allow voluntary transfers of ocean commercial quota. The Board can also set criteria for allowable transfers, including a limit on how much and when quota can be transferred in a given year, and the eligibility of a state to request a transfer based on its landings.

2023 Emergency Action

In May 2023, the Board approved an emergency action to change the recreational size limit, effective initially for 180 days from May 2, 2023 through October 28, 2023. This action responds to the extreme

magnitude of 2022 recreational harvest, which was nearly double that of 2021, and new stock rebuilding projections, which estimate the probability of the spawning stock rebuilding to its biomass target by 2029 drops from 97% under the lower 2021 fishing mortality rate to less than 15% if the higher 2022 fishing mortality rate continues each year.

The Board implemented the emergency 31-inch maximum size limit to reduce harvest of the strong 2015 year-class. The 31-inch maximum size limit applies to all existing recreational fishery regulations where a higher (or no) maximum size applies, excluding the May Chesapeake Bay trophy fisheries which already prohibit harvest of fish less than 35 inches. All bag limits, seasons, and gear restrictions will remain the same. As of July 2, 2023, all jurisdictions implemented regulations consistent with the required 31-inch maximum size limit.

In August 2023, the Board extended the emergency action through October 28, 2024 or until the implementation of Addendum II to Amendment 7 of the Interstate Fishery Management Plan, whichever comes first. The extension of the emergency action provided the Board time to develop and finalize Addendum II, which was approved in January 2024 with an implementation date of May 1, 2024. Therefore, Addendum II replaced the emergency action upon its implementation by the states by May 1, 2024.

Addendum II to Amendment 7

Addendum II to Amendment 7 was approved in January 2024 to reduce fishing mortality in 2024 and support stock rebuilding. For the ocean recreational fishery, the Addendum implements a 28" to 31" slot limit, 1-fish bag limit, and maintains 2022 season dates for all fishery participants; this maintains the same ocean recreational measures adopted under the 2023 emergency action. For the Chesapeake Bay recreational fishery, the Addendum implements a 19" to 24" slot limit, 1-fish bag limit, and maintains 2022 season dates for all fishery participants. For the commercial fishery, the Addendum reduces commercial quotas by 7% in both the ocean and Chesapeake Bay.

To address concerns about recreational filleting allowances and compliance with recreational size limits, the Addendum establishes two requirements for states that authorize filleting of striped bass: racks must be retained and possession limited to no more than two fillets per legal fish. Finally, to enable an expedited response process to upcoming stock assessments, the Addendum establishes a mechanism allowing the Board to respond to a stock assessment via Board action if the stock is not projected to rebuild by 2029 with a probability greater than or equal to 50%. All Addendum II measures were required to be implemented by the states no later than May 1, 2024.

II. Status of the Stocks

The biological reference points (BRPs) currently used for management are based on the 1995 estimate of female spawning stock biomass (SSB). The 1995 estimate of female SSB is used as the SSB threshold because many stock characteristics (such as an expanded age structure) were reached by this year and the stock was declared recovered. The SSB target is equal to 125% of SSB threshold.

The accepted model is a forward projecting statistical catch-at-age (SCA) model which uses catch-at-age data and fishery-dependent and -independent survey indices to estimate annual population size, fishing mortality, and recruitment (NEFSC 2019). Indices of abundance track relative changes in the population over time while catch data provide information on the scale of the population size. Age structure data (numbers of fish by age) provide additional information on recruitment (number of age-1 fish entering the population) and trends in mortality.

In November 2024, the Board reviewed the results of the 2024 Atlantic Striped Bass Stock Assessment Update, which uses the same peer-reviewed SCA model from the last benchmark assessment. The 2024 assessment indicated the resource is still overfished but not experiencing overfishing relative to the updated reference points. Female SSB in the terminal year (2023) was estimated at 191 million pounds, which is below the SSB threshold of 197 million pounds and below the SSB target of 247 million pounds (Figure 1). F in 2023 was estimated at 0.18, which is below the F threshold of 0.21 and above the F target of 0.17 (Figure 2). The updated fishing mortality reference points take into account the period of low recruitment the stock has experienced in recent years.

The assessment also indicated a period of strong recruitment (numbers of age-1 fish entering the population) from 1994-2004, followed by a period of lower recruitment from 2005-2011 (although not as low as the early 1980s, which likely contributed to the decline in SSB in recent years) (Figure 1). Recruitment of age-1 fish was above-average in 2012, 2015, 2016, and 2019 (corresponding to strong 2011, 2014, 2015, and 2018 year-classes), but estimates of age-1 striped bass were below the long-term average for 7 of the last 10 years. Recruitment in 2023 was estimated at 95 million age-1 fish, below the time series average of 137 million fish.

Stock projections were updated in 2025 for use in Draft Addendum III. The updated stock projections estimate 2024 fishing mortality based on final 2024 recreational catch estimates from MRIP and initial 2024 commercial harvest estimates from the states.

The Technical Committee (TC) reviewed assumptions about fishing mortality levels from 2025 through 2029 for the projections. Under status quo management, 2025 fishing mortality is predicted to increase as the above average 2018 year-class enters the current recreational Ocean slot limit, followed by a predicted decrease in fishing mortality in 2026 as the 2018 year-class starts to grow out of that Ocean slot limit with a lack of strong year-classes following. For the 2025 increase, the TC determined the best assumption is a 17% increase from the 2024 level based on the observed 17% increase from 2021 to 2023 when part of the 2015 year-class was still in the newly reduced Ocean slot limit. The TC noted the magnitude of increase may be overestimated since the 2018 year-class is not as strong as the 2015 year-class was. For 2026 through 2029, the TC determined the best assumption is a decrease back to the 2024 fishing mortality level in 2026 and maintain that level through 2029. This is a reasonable assumption under the same narrow slot limit with an above-average year-class growing out of the slot.

With the estimate of 2024 fishing mortality, the above assumptions about 2025-2029 fishing mortality under status quo management, and the same low recruitment assumption as the assessment, the projections estimate a 30% probability of being at or above the SSB target in 2029. The TC continues to

highlight several major sources of uncertainty in the projections and the difficulty of predicting future fishing mortality rates.

The next stock assessment for striped bass is a benchmark stock assessment—in which the assessment input data and methods are fully re-evaluated—scheduled for peer review in Spring 2027. The 2027 Benchmark Stock Assessment will include data through 2025.

III. Status of the Fishery in the Ocean and Chesapeake Bay

Total Removals

In 2024, total Atlantic striped bass removals (including commercial harvest, commercial dead discards, recreational harvest, and recreational release mortality) were estimated at 4.1 million fish, which is a 27% decrease from 2023 total removals and 40% decrease from the recent peak removals in 2022 (Table 3; Figure 5). This 2024 decrease was primarily driven by a decrease in recreational removals, with commercial removals at a similar level as in 2023. In 2024, the commercial sector accounted for about 15% of total removals in numbers of fish (15% harvest and <1% dead discards), and the recreational sector accounted for about 85% of removals in numbers of fish (42% harvest and 42% release mortality) (Table 4, Figure 5).

Commercial Fishery

The commercial fishery (ocean and Chesapeake Bay) harvested an estimated 4.3 million pounds (about 604,000 fish) in 2024, which is about the same level of harvest as 2023 (approximately 2% increase by weight and <1% increase in number of fish) (Table 6, Table 7, Figure 7).

Since 1990, commercial landings from the Ocean fishery have accounted for an average 40% of total coastwide commercial landings by weight, with the other 60% coming from Chesapeake Bay. The proportion of commercial harvest coming from Chesapeake Bay is much higher in numbers of fish (roughly 80%) because fish harvested in Chesapeake Bay have a lower average weight than fish harvested in Ocean fisheries.

Of total commercial harvest (combined Ocean and Chesapeake Bay) by weight in 2024, Maryland landed 33%, Virginia landed 22%, Massachusetts landed 15%, and New York landed 14% (Figure 6). Additional harvest came from the Potomac River (10%), Delaware (3%), and Rhode Island (confidential).

In 2024, the Ocean commercial striped bass quota was 2.2 million pounds with 1.7 million pounds harvested in the Ocean region. In Chesapeake Bay region, the 2024 commercial striped bass quota was 2.8 million pounds, and 2.6 million pounds were harvested (Table 14).

The Ocean region regularly underutilizes its cumulative commercial quota due to the lack of striped bass availability in some state waters (particularly North Carolina, which holds 13% of the Ocean quota, yet has had zero Ocean harvest since 2013) coupled with prohibitions on commercial striped bass fishing in Maine, New Hampshire, Connecticut, and New Jersey (which collectively share about 10% of the Ocean commercial quota). The Ocean commercial quota utilization was 76% in 2024, which was

about the same as Ocean quota utilization in 2021-2023. In the Ocean, most states that allow commercial harvest utilized >96% of their Ocean quota in 2024 with the exception of North Carolina which had zero Ocean harvest.

In Chesapeake Bay, quota utilization in 2024 was about 94%, which was an increase from 2021-2023 quota utilization of 84%.

Quota utilization is important to consider when calculating reductions in commercial removals. The projections for Addendum II's 2024 measures assumed the same quota utilization rate as 2022 (i.e., a 7% quota reduction in 2024 would result in a 7% reduction in harvest). While ocean quota utilization was about the same in 2024 as it was in 2022, Chesapeake Bay quota utilization increased in 2024 as compared to 2022. As quota utilization changes from year to year, the realized reduction in commercial removals will change.

The PRT notes there are several factors that contribute to changes in commercial harvest levels from year-to-year aside from changes to the quota level. Year-class availability could be a factor, particularly in the ocean, with the relatively strong 2015 year-class becoming less available to ocean fisheries in 2024 after the relatively high availability in 2022-2023. If stock abundance is increasing overall, that could also contribute to more fish being available. Availability also depends on when and how long striped bass stay within state waters (vs. offshore in the EEZ) during the season.

Looking across several years, commercial landings have generally decreased as quota has decreased, with the exception of 2024. From 2004-2014, coastwide commercial landings averaged 6.8 million pounds per year. From 2015-2019, commercial landings decreased to an average of 4.7 million pounds due to implementation of reduced quotas through Addendum IV. From 2020-2023, coastwide commercial landings decreased again to an average 4.1 million pounds due to further reduced quotas through Addendum VI to Amendment 6 and Amendment 7. In 2024, commercial landings were 4.3 million pounds, a slight increase despite the Addendum II quota reduction.

Recreational Fishery

Total Recreational Removals

Total recreational removals (harvest and release mortality) coastwide were estimated at 3.4 million fish in 2024, which is a 31% decrease from recreational removals in 2023 (Table 8). This coastwide decrease in total recreational removals was a combination of a decrease in both harvest and live releases (Figure 8). Combined private vessel/shore modes accounted for 97% of Ocean recreational striped bass removals in 2024, while for-hire components (charter and head boats) accounted for about 3% of Ocean removals. In Chesapeake Bay, private vessels/shore modes accounted for 77% of Bay recreational removals in 2024, while for-hire modes accounted for 23%.

Live Releases

The vast majority of recreational striped bass catch (over 90%) is released alive either due to angler preference or regulation (i.e., closed season, undersized, oversized, or already caught the bag limit) (Figure 9). The stock assessment assumes, based on previous studies, that 9% of fish that are released alive die as a result of being caught. In 2024, recreational anglers caught and released an estimated

19.1 million fish, of which 1.7 million are assumed to have died. This represents a 26% decrease in live releases coastwide from the 2023 level. By region in 2024, a reduction in live releases was observed in both the Ocean and Chesapeake Bay, 26% and 29%, respectively.

Recreational Harvest

Recreational harvest in 2024 decreased to 1.7 million fish (15.3 million pounds) from the 2023 level of 2.6 million fish (23.9 million pounds), which is a 34% decrease by number (Figure 8, Table 9, Table 10). Relative to 2022 when recreational harvest spiked, 2024 harvest is 50% lower. By region, both the Ocean and Chesapeake Bay saw a decrease in recreational harvest in 2024 relative to 2023, with the Bay seeing a larger reduction of 54% and the Ocean seeing a 28% reduction. The larger reduction in recreational harvest in Chesapeake Bay could be attributed, at least partly, to the implementation of a Bay-wide 19"-24" slot limit in 2024 under Addendum II, and to the lack of strong year-classes available in the Bay in 2024. In the Ocean, the size limit did not change between 2023 and 2024, but most of the remaining fish from the strong 2015 year-class (age-9 in 2024) had likely grown out of the narrow 28"-31" Ocean slot limit by 2024, potentially contributing to the decrease. However, it is important to note that changes in effort can also impact harvest.

In 2024, New Jersey landed the largest proportion of recreational harvest in number of fish (36%), followed by New York (25%), Massachusetts (15%), and Maryland (13%). The proportion of coastwide recreational harvest in numbers from Chesapeake Bay has been the lowest since the stock recovered in the 1990s (20% in 2022, 22% in 2023, and 16% in 2024). This decrease in the proportion of recreational harvest from Chesapeake Bay in recent years, and therefore increased proportion of Ocean recreational harvest, aligns with the availability of the strong 2015 year-class in the Ocean fishery in 2022-2023, implementation of a Chesapeake Bay-wide slot limit in 2024, and a decrease in Maryland's for-hire bag limit from 2-fish to 1-fish in 2024. Additionally, as the last above average year-class (2018) move out of Chesapeake Bay after 2023, there are no strong year-classes following.

For recreational harvest by mode, the magnitude of change from 2023 to 2024 differs between the for-hire modes and the private-shore modes by region (Table 11). Private-shore harvest in 2024 decreased by 29% in the Ocean and 60% in Chesapeake Bay. For-hire harvest in the Ocean remained about the same as in 2023, while for-hire harvest in Chesapeake Bay decreased by 40% in 2024. The Ocean saw larger decreases in these modes from 2022-2023, when recreational harvest decreased by 50% in the for-hire modes and 25% for the private-shore modes.

Recreational Effort

Similar to the change in recreational harvest, the number of trips directed at striped bass (primary and secondary target) also shows a larger reduction in the Bay as compared to the Ocean (Table 12). In 2024, the number of striped bass directed trips in Chesapeake Bay region decreased by about 40% relative to 2023, while the number of striped bass directed trips in the Ocean decreased by about 10%. Overall, the total number of coastwide striped bass directed trips in 2024 decreased by 14% from 2023 and is the lowest number of directed trips in the past decade.

For directed trips by mode, private-shore directed trips in 2024 decreased by about 10% in the Ocean and decreased by 42% in Chesapeake Bay (Table 13). For-hire directed trips in the Ocean in 2024 decreased by about 16%, while for-hire directed trips in Chesapeake Bay decreased by 13%.

Factors Contributing to Catch and Effort Trends

Overall, there are several factors that contribute to trends in recreational catch and effort, including management measures, year-class availability, overall stock abundance, nearshore availability of bait and striped bass, and angler behavior. The relatively strong 2015 year-class moving into the Ocean and becoming available to the Ocean slot (i.e., surpassing 28-inches), was likely the primary driver of increased Ocean recreational catch in 2022. The subsequent emergency action in 2023 intended to reduce harvest of the 2015 year-class likely contributed to the harvest reduction observed in 2023. The 2015 year-class grew out of the Ocean slot by 2024 (i.e., surpassing 31-inches) likely contributing to the decreases in Ocean recreational harvest in 2024. In Chesapeake Bay, a combination of the five-inch recreational slot limit implemented in 2024 and the lack of strong year-classes available after the 2018 year-class moved into the Ocean likely played a role. Angler effort and behavior are also important to consider. When more fish are available in the fishery, effort can often increase in response. When narrower size limits are in place or less fish are available in the fishery, anglers may change their behavior and level of effort.

IV. Albemarle Sound and Roanoke River Management Area

While striped bass in North Carolina's ocean waters are managed under the Interstate FMP, the Interstate FMP formally defers management of the Albemarle Sound-Roanoke River (A-R) stock to the state of North Carolina using A-R stock-specific BRPs approved by the Board (NCDMF 2013, 2014). North Carolina is required to inform the Commission of changes to striped bass management in the A-R System.

Status of the Albemarle Sound-Roanoke River Striped Bass Stock

The most recent A-R stock assessment, the 2022 Stock Assessment Update, uses a forward-projecting fully-integrated, age-structured statistical model estimating population parameters and reference points for the A-R striped bass stock for 1991-2021 (Lee et al. 2022). The 2022 stock assessment is an update of the 2020 Benchmark Stock Assessment (Lee et al. 2020). The 2020 benchmark stock assessment model was peer reviewed by an outside panel of experts and approved for management use by the Board in May 2021. The 2022 assessment update was also peer reviewed in January 2023.

The A-R stock is managed using reference points for female spawning stock biomass (SSB) and fishing mortality (F) with threshold values based on 35% spawning potential ratio and target values based on 45% spawning potential ratio. The 2022 assessment estimated female SSB in 2021 (terminal year) was 16.1 metric tons, which is below the SSB threshold of 125 metric tons. The assessment estimated F in 2021 was 0.77, which is above the F threshold of 0.22. These results indicate the stock is overfished and overfishing is occurring (Figure 3, Figure 4). Abundance indices indicate continued stock decline, and juvenile recruitment, in particular, has been very low for several consecutive years.

	<i>Target</i>	<i>Threshold</i>	<i>Terminal Year (2021) Estimate</i>
<i>Female SSB</i>	164 metric tons	125 metric tons	16 metric tons
<i>Fishing Mortality (F)</i>	0.14	0.20	0.77

NC Estuarine Striped Bass Fishery Management Plan

Estuarine striped bass in North Carolina are currently managed under Amendment 2 to the North Carolina Estuarine Striped Bass Fishery Management Plan (FMP) and its subsequent revision and recent supplement (NCDMF 2022, 2024). The plan is jointly developed between the North Carolina Marine Fisheries Commission (NCMFC) and the North Carolina Wildlife Resources Commission (NCWRC). Amendment 2, adopted in 2022, lays out separate management strategies for the A-R stock and the estuarine (non-migratory) Central and Southern striped bass stocks in the Tar-Pamlico, Neuse, and Cape Fear rivers. Management programs in Amendment 2 for the A-R stock utilize annual total allowable landings (TAL), daily possession limits, open and closed harvest seasons, gill net mesh size and yardage restrictions, seasonal small mesh gill net attendance requirements, single barbless hook requirements in some areas, minimum size limits, and a no-harvest slot limit in the Roanoke River to maintain a sustainable harvest and reduce regulatory discard mortality in all sectors.

Based on the results of the 2022 stock assessment, the resulting total allowable landings (TAL) level needed to reduce fishing mortality to its target is effectively too low to manage. For this reason and due to continued concern about stock decline and low recruitment, North Carolina implemented a harvest moratorium in the Albemarle Sound and Roanoke River Management Areas (ASMA and RRMA) effective January 2024 via the adaptive management framework under Amendment 2 of the NC Estuarine Striped Bass FMP (NCDMF 2024). In addition, the 2023 fall recreational and commercial seasons in the Albemarle Sound did not open because there is little quota remaining and because of stock status concerns.

V. Status of Research and Monitoring

Amendment 7 (approved May 2022) and its addenda, as well as the 2023 emergency action effective through April 2024, set the regulatory and monitoring measures for the coastwide striped bass fishery for 2024. Amendment 7 requires certain states to implement fishery-dependent monitoring programs for striped bass. All states with commercial fisheries or substantial recreational fisheries are required to define the catch and effort composition of these fisheries. Additionally, all states with a commercial fishery must implement a commercial harvest tagging program.

Amendment 7 also requires certain states to monitor the striped bass population independent of the fisheries. Juvenile abundance surveys are required from Maine (Kennebec River), New York (Hudson River), New Jersey (Delaware River), Maryland (Chesapeake Bay tributaries), Virginia (Chesapeake Bay tributaries), and North Carolina (Albemarle Sound). Spawning stock sampling is mandatory for New York (Hudson River), Pennsylvania (Delaware River), Delaware (Delaware River), Maryland (Upper Chesapeake Bay and Potomac River), Virginia (Rappahannock River and James River), and North Carolina (Albemarle Sound-Roanoke River). NOAA Fisheries, USFWS, Massachusetts, New York, New

Jersey, Maryland, Virginia, and North Carolina are also required to continue their tagging programs, which provide data used to determine survivorship and migration patterns.

VI. Status of Management Measures and Issues

Ocean Commercial Quota

In 2024, the ocean cumulative commercial quota was 2.2 million pounds (sum of all state quotas). New York and Maryland Ocean exceeded their state quotas in 2024 by about 3% and 7%, respectively. Table 14 outlines 2024 quotas and harvest.

Chesapeake Bay Commercial Quota

In 2024, the Chesapeake Bay-wide quota was 2.8 million pounds and was allocated to Maryland, the PRFC, and Virginia based on historical harvest per their mutual agreement. In 2024, the Bay-wide quota was not exceeded but Maryland exceeded their portion of the Bay quota by less than 1%. Table 14 outlines 2024 quotas and harvest.

Conservation Equivalency Programs

There is one approved conservation equivalency (CE) program under Addendum II: the New Jersey Striped Bass Bonus Program (SBBP). New Jersey's approved CE plan allows the state to allocate its commercial quota to its recreational bonus program that has been in place since 1990. The SBBP currently allows participants to harvest 1 fish at 24" to less than 28" per permit. NJ calculates the total number of issuable permit/tags by converting the quota to number of fish based on mean weight; in addition, as an added conservation measure, NJ will apply a buffer by using the rounded-up mean weight of the largest fish possible under the slot. This results in a lower maximum than using the average weight alone.

In 2024, a total of 24,717 SBBP permits were issued and 8,010 were used, which is an 18% decrease from 2023. The percent used (32%) is similar to the percent used in 2023 of 37%. Usage in 2023-2024 increased compared to 26-28% of permits used in 2021-2022. New Jersey noted the increase in number of permits issued and percent of total permits used in 2023 and 2024 is likely due to the availability of the above-average 2018 year-class to the SBBP fishery (targeting smaller fish than the ocean fishery) and the opportunity to harvest a bonus fish given the narrow slot limit restriction in the ocean recreational fishery since 2023. Another factor contributing to increased participation in recent years was the COVID-19 pandemic, which transitioned the SBBP application process online leading to higher participation since then. However, although the number of SBBP permits used (i.e., number of SBBP fish harvested) has increased in recent years, the number of permits used is still less than half of the maximum number of permits allowed to be used per New Jersey's quota allocation.

Chesapeake Bay Spring Harvest of Migrant Striped Bass

Historically, recreational fishermen in Chesapeake Bay are permitted to take adult migrant fish during a limited seasonal fishery, commonly referred to as the Spring Trophy Fishery. From 1993 to 2007 the fishery operated under a quota. Beginning in 2008, the Board approved non-quota management until stock assessment indicates that corrective action is necessary to reduce *F* on the coastal stock. Through 2023, the Spring Trophy Fishery was managed via bag limits and minimum sizes in Maryland and the

Potomac River. The Commonwealth of Virginia closed the spring trophy season beginning in 2019, and Maryland and the Potomac River Fisheries Commission closed the spring trophy season beginning in 2024.

Due to the 2024 season closure, the 2024 estimate of migrant fish harvested during the Maryland trophy season from May 1-May 15 was 0 fish.

For the entire time period of May 1 through June 15, 2024 when migrant fish were available to the Chesapeake Bay fisheries, a total of 146 migrant fish were harvested in Maryland (50 fish by charter vessels; 96 fish by private vessels), which is an 85% decrease compared to 2023 and well below the 2006-2024 average of 29,652.

In the 2024 Migrant Striped Bass Harvest Report, Maryland noted that if the current trophy season closure and 24-inch maximum size limit regulations remain in future years, the harvest of migrant striped bass will remain at biologically insignificantly low levels.

Wave-1 Recreational Harvest Estimates

Evidence suggests that North Carolina, Virginia, and possibly other states have had sizeable wave-1 (January/February) recreational striped bass fisheries beginning in 1996 (NEFSC 2018b). MRIP, formerly the Marine Recreational Fisheries Statistics Survey (MRFSS), has sampled for striped bass in North Carolina during wave-1 since 2004 (other states are not currently covered during wave-1). Virginia harvest in wave-1 is estimated for stock assessment via the ratio of landings and tag returns in wave-6 and regression analysis (refer to the methods described in NEFSC 2018a for more detail).

However, based on fishery-independent data collected by NCDMF, ASMFC and USFWS, striped bass distributions on their overwintering grounds during December through February have changed significantly since the mid-2000s. The migratory portion of the stock has been well offshore and shifted north in the EEZ (>3 miles) affecting both Virginia's and North Carolina's striped bass winter ocean fisheries in recent years. Furthermore, North Carolina has reported zero recreational striped bass harvest during wave 1 and wave 6 in the ocean for 2012-2024, and Virginia has reported zero recreational ocean harvest for nine of the last ten years (note MRIP sampling does not occur in Virginia during wave 1). Similarly, North Carolina's commercial fishery has reported zero striped bass landings from the ocean since 2013.

Amendment 7 Commercial Fish Tagging Program

Section 3.1.1 of Amendment 7 includes compliance requirements for monitoring commercial fishery harvest tagging programs, which have been required through the FMP since 2013. In 2024, all states implemented commercial tagging programs consistent with the tagging program requirements. Table 15 describes commercial tagging programs by state.

The PRT continues to emphasize the importance of tag accounting to account for unused tags at the end of each fishing year in all states. Due to the early deadlines for commercial tagging reports (60 days before the commercial fishery opens), tag accounting for the previous year is often preliminary or not yet available at that time. To address this, the PRT reiterates the importance of states reporting all

tag accounting results in their annual state compliance reports (i.e., tags issued, tags used, tags returned, tags missing/broken/reported lost, tags not accounted for).

The PRT and state commercial tagging contacts met in July 2025 to conduct a ten-year review of the commercial tagging program as previously recommended by the PRT and as tasked by the Board in August 2024.

Addendum II Recreational Filleting Requirements

Addendum II established two requirements for states that authorize filleting of striped bass: racks must be retained and possession limited to no more than two fillets per legal fish. All states except PRFC have implemented regulations per the approved Addendum II state implementation plans. The PRT notes that the approved implementation plans included approval of states with existing language that does not explicitly specify two fillets per fish. During Board discussion in March 2024, it was noted that current rules requiring racks to be maintained and that the racks must be measurable preclude anyone from landing more than two fillets per fish.

Juvenile Abundance Index Analysis

The following states are required to conduct striped bass young-of-year juvenile abundance index (JAI) surveys on an annual basis: Maine for the Kennebec River; New York for the Hudson River; New Jersey for the Delaware River; Maryland for the Maryland Chesapeake Bay tributaries; Virginia for the Virginia Chesapeake Bay tributaries; and North Carolina for the A-R stock.

The PRT and the Striped Bass Technical Committee (TC) annually review the JAIs per the recruitment trigger specified in the FMP. As of May 2022, the new Amendment 7 recruitment trigger is effective and reads as follows:

If any of the four JAIs used in the stock assessment model to estimate recruitment (NY, NJ, MD, VA) shows an index value that is below 75% of all values (i.e., below the 25th percentile) in the respective JAI from 1992-2006* (which represents a period of high recruitment) for three consecutive years, then an interim F target and interim F threshold calculated using the low recruitment assumption will be implemented, and the F-based management triggers will be reevaluated using those interim reference points. If an F-based trigger is tripped upon reevaluation, the striped bass management program must be adjusted to reduce F to the interim F target within one year.

The 2025 review of JAIs evaluates the 2022, 2023, and 2024 JAI values per the Amendment 7 recruitment trigger. Three states (New Jersey, Maryland, and Virginia) met the criteria of the Amendment 7 recruitment trigger (Figure 10). New Jersey's (Delaware River) JAI values for 2022 (0.77), 2023 (0.26), and 2024 (0.53) were below its trigger level of 1.07. Maryland's JAI values for 2022 (1.78), 2023 (0.57), and 2024 (1.06) were below the Maryland JAI trigger level of 4.16. Virginia's JAI values in 2022 (7.95), 2023 (4.26), and 2024 (3.43) were below its trigger level of 8.22. These states trip the recruitment trigger, requiring F reference points using the low recruitment assumption to be calculated, which was already done for the 2024 stock assessment update and current reference points. The reference points from the 2022 stock assessment update also used the low recruitment assumption.

While New York's JAI (Hudson River) was above its trigger level of 11.70 in 2022 (21.68), the JAI dropped to 4.04 in 2023 and 7.85 in 2024. 2023 was the lowest value in the time series since 1985.

Maine's JAI (Kennebec River) and North Carolina's JAI (Albemarle-Roanoke) are not part of the recruitment trigger, but are still required monitoring for those states (Figure 11). Maine's JAI has been below its recruitment failure since 2019, and North Carolina's JAI was below its recruitment failure level from 2018-2023 but increased in 2024. In 2024, North Carolina stocked 2.4 million striped bass at the fry stage, and 427,176 striped bass at the Phase-I stage into the western Albemarle Sound nursery area. All fish are marked in the hatchery using Parentage Based Tagging (PBT) techniques that allows for future genetic analysis of fin clips to determine the percentage of wild versus hatchery reared fish collected during the 2024 sampling season. When genetic analysis of fin clips collected in 2024 is complete, North Carolina will update the 2024 JAI to determine the JAI of hatchery fish and the JAI of wild fish.

Law Enforcement Reporting

States are asked to report any law enforcement issues that occurred the previous season in annual compliance reports. The most common issue noted in state compliance reports is striped bass above or below the slot limit.

VII. Plan Review Team Comments and Recommendations

A summary of 2024 fishery regulations by state is provided in Table 1 and Table 2. Each state's commercial tag monitoring program is described in Table 15 and state compliance with fishery-independent and fishery-dependent monitoring requirements are summarized in Table 16.

Based on annual state compliance reports (ASMFC 2025), the PRT determined that all states in 2024 implemented a management and monitoring program consistent with the provisions of the FMP except for the following inconsistencies:

- PRFC has not yet implemented the Addendum II requirements for recreational filleting. PRFC noted that due to an error in its regulations, the PRFC does not have any regulatory language that authorizes or prohibits filleting striped bass at-sea/shore-side at the current time. The PRFC is in the process of amending the existing language at their upcoming September 2025 Commission meeting with the intention of prohibiting any at-sea/shore-side filleting for recreationally caught striped bass. If passed, the language would become effective September 22, 2025.
- New York and Maryland are addressing their 2024 quota overages with most of the quota payback in 2025 based on preliminary harvest estimates available when planning for the 2025 commercial fishery. The remaining small portion of the quota payback will be taken in 2026 based on final harvest estimates that were not available until after 2025 commercial tags had been distributed. Maryland's approved Addendum II implementation did note this process of using the preliminary estimate for 2025 payback and using the final estimate for any remaining

payback in 2026. This approach for reconciling a quota overage over two calendar years was not in New York's approved Addendum II implementation plan.

The PRT developed the following **recommendations**:

- The PRT recommends the Board discuss the issue of determining quota overages based on preliminary harvest estimates. Per the FMP, quota overages must be paid back the following year, but final commercial harvest estimates may not be available to determine the full amount of a quota overage before planning for the next year's fishery, as with New York and Maryland for 2024 quota overages. The Board should discuss this process and consider whether states could try to account for any expected increase in final harvest estimates when determining the overage amount using preliminary estimates.

The PRT notes the following **additional comments**:

- Maryland has proposed to discontinue its annual Striped Bass Spring Migrant Harvest Report, which details harvest of trophy fish in the spring, since the Maryland trophy fishery is now closed and the Bay slot limit is designed to avoid larger fish. The spring migrant report has been accompanying the annual state compliance report since 2004 when the FMP at the time managed the spring trophy fishery using a quota that changed every year. It has been several years since the spring trophy fishery was managed under a specific quota.
- While the New York spawning stock monitoring program in the Hudson River does meet the FMP's fishery-independent monitoring requirements, it does not provide an index of relative abundance to characterize the Hudson River stock which was identified as a high priority research recommendation at SAW 66. This will be considered during the 2027 Benchmark Stock Assessment.

VIII. Research Recommendations

Research recommendations were developed by the 2018 Benchmark Stock Assessment Subcommittee and the 66th SARC and are listed in the final [stock assessment report](#) starting on report page 569 (NEFSC 2019).

IX. References

- ASMFC. 2021. Review of the Interstate Fishery Management Plan for Atlantic Striped Bass (*Morone saxatilis*): 2020 Fishing Year.
- ASMFC. 2022. Review of the Interstate Fishery Management Plan for Atlantic Striped Bass (*Morone saxatilis*): 2021 Fishing Year.
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- Shepherd, G.R., R.W. Laney, M. Appelman, D. Honabarger and C.L. Wright. 2017. Biennial Report to Congress on the Progress and Findings of Studies of Striped Bass Populations --2017. National Marine Fisheries Service, Silver Spring, MD. 11 p.

X. Tables

Table 1. Summary of 2024 Atlantic striped bass commercial measures under Addendum II to Amendment 7 as of May 1, 2024. Please refer to each state's regulations for additional details. Source: 2025 State Compliance Reports. Minimum sizes and slot size limits are in total length (TL). *NJ commercial quota reallocated to recreational bonus fish program.

STATE	SIZE LIMITS (TL) and TRIP LIMITS	ADDENDUM II QUOTA	OPEN SEASON
ME	Commercial fishing prohibited		
NH	Commercial fishing prohibited		
MA	35" minimum size; no gaffing undersized fish. 15 fish/day with commercial boat permit; 2 fish/day with rod and reel permit.	683,773 lbs. Hook & Line only.	6.18-9.30 (or when quota reached); open fishing days of Tuesday and Wednesday, with Thursday added on August 1 if >30% quota remains. Cape Cod Canal closed to commercial striped bass fishing.
RI	Floating fish trap: 26" minimum size unlimited possession limit until 80% of quota reached, then 500 lbs. per licensee per day	Total: 138,467 lbs., split 39:61 between the trap and general category. Gill netting prohibited.	4.1 – 12.31
	General category (mostly rod & reel): 34" min. Five (5) fish per person per calendar day, or if fishing from a vessel, five (5) fish per vessel per calendar day.		6.11-6.20; 7.9-12.31, or until quota reached. Closed Thursdays, Fridays, Saturdays, and Sundays throughout.
CT	Commercial fishing prohibited; bonus program in CT suspended indefinitely in 2020.		
NY	26"-38" size; (Hudson River closed to commercial harvest)	595,868 lbs. Pound Nets, Gill Nets (6-8"stretched mesh), Hook & Line.	5.15 – 12.15, or until quota reached. Limited entry permit only.
NJ	Commercial fishing prohibited; bonus program*: 1 fish/permit at 24" to <28"	200,798 lbs.*	5.15 – 12.31 (permit required)

STATE	SIZE LIMITS (TL) and TRIP LIMITS	ADDENDUM II QUOTA	OPEN SEASON
PA	Commercial fishing prohibited		
DE	Gill Net: 20" min in DE Bay/River during spring season. 28" in all other waters/seasons.	Gill net: 132,501 lbs. Split between gill net and hook and line.	Gill net: 2.15-5.31 (2.15-3.30 for Nanticoke River) & 11.15-12.31; drift nets only 2.15-28 & 5.1-31; no trip limit.
	Hook and Line: 28" min	No fixed nets in DE River.	Hook and Line: 4.1-12.31, 200 lbs./day trip limit
MD	Chesapeake Bay and Rivers: 18-36" Common pool trip limits: Hook and Line - 250 lbs./license/week Gill Net - 300 lbs./license/week	1,344,216 lbs. (part of Bay-wide quota)	Bay Pound Net: 6.1-12.31 Bay Haul Seine: 1.1-2.28; 6.1-12.31 Bay Hook & Line: 6.1-12.31 Bay Drift Gill Net: 1.1-2.28, 12.1-12.31
	Ocean: 24" minimum	Ocean: 82,857 lbs.	1.1-5.31, 10.1-12.31
PRFC	18" min all year; 36" max 2.15-3.25	532,761 lbs. (split between gear types; part of Bay-wide quota)	Hook & Line: 1.1-3.25, 6.1-12.31 Pound Net & Other: 2.15-3.25, 6.1-12.15 Gill Net: 11.9.2021-3.25.2022 Misc. Gear: 2.15-3.25, 6.1-12.15
VA	Chesapeake Bay and Rivers: 18" min; 28" max size limit 3.15-6.15	914,555 lbs. (part of Bay-wide quota)	1.16-12.31
	Ocean: 28" min	116,282 lbs.	
NC	Ocean: 28" min	274,810 lbs. (split between gear types)	Seine fishery was not opened Gill net fishery was not opened Trawl fishery was not opened

Table 2. Summary of 2024 Atlantic striped bass recreational size limits, bag limits, and seasons under Addendum II to Amendment 7 as of May 1, 2024. Please refer to each state’s regulations for gear/fishing restrictions in that state. Source: 2025 Compliance Reports. Minimum size and slot size limits are in total length (TL).

STATE	SIZE LIMITS (TL)/REGION	BAG LIMIT	OPEN SEASON
ME	28" to 31"	1 fish/day	All year, except spawning areas are closed 12.1-4.30 and C&R only 5.1-6.30
NH	28" to <31"	1 fish/day	All year
MA	28" to <31"	1 fish/day	All year
RI	28" to <31"	1 fish/day	All year
CT	28" to 31"	1 fish/day	All year
NY	Ocean and Delaware River: 28" to 31"	1 fish/day	Ocean: 4.15-12.15 Delaware River: All year
	Hudson River: 23" to 28"	1 fish/day	Hudson River: 4.1-11.30
NJ	28" to 31"	1 fish/day	Closed 1.1 – end of Feb in all waters except in the Atlantic Ocean, and closed 4.1-5.31 in the lower DE River and tribs
PA	Upstream from Calhoun St Bridge: 28" to <31", 1 fish/day		All year
	Downstream from Calhoun St Bridge: 28" to <31", 1 fish/day* *except from 4.1-5.31: 22" to <26", 1 fish/day		All year. 1 fish/day at 22" to <26" slot from 4.1-5.31

STATE	SIZE LIMITS (TL)/REGION	BAG LIMIT	OPEN SEASON
DE	28" to 31"	1 fish/day	All year. C&R only 4.1-5.31 in spawning grounds. 20" to 24" slot from 7.1-8.31 in DE River, Bay & tributaries
MD	Ocean: 28" to 31"	1 fish/day	All year
	Chesapeake Bay and tribs^	C&R only	1.1-2.28, 3.1-3.31, 12.11-12.31
	Chesapeake Bay and tribs^	No targeting	4.1-5.31, 7.16-7.31
	Chesapeake Bay: 19" to 24" 1 fish/day^		5.16-5.31
	Chesapeake Bay and tribs: 19" to 24", 1 fish/day^		6.1-7.15, 8.1-12.10
PRFC	Summer/Fall: 19" to 24"		1 fish/day
DC	19" to 24"		1 fish/day
VA	Ocean: 28" to 31"		1 fish/day
	Bay Spring/Summer/Fall: 19" to 24"		1 fish/day
NC	Ocean: 28" to 31"		1 fish/day

^ MD Susquehanna Flats: C&R only 1.1-3.31 and 12.11-12.31; No targeting 4.1-5.31; 1 fish at 19"-24" slot 6.1-7.15 and 8.1-12.10; No targeting 7.16-7.31

Table 3. Total removals (harvest plus discards/release mortality) of Atlantic striped bass by sector in numbers of fish, 1998-2024 calendar years. Note: Harvest is from state compliance reports/MRIP (June 2025), discards/release mortality is from ASMFC. Estimates exclude inshore harvest from NC.

Year	Commercial		Recreational		Total Removals
	Harvest	Dead Discards*	Harvest	Release Mortality	
1998	1,215,219	359,876	2,915,390	3,259,133	7,749,618
1999	1,223,572	348,807	3,123,496	3,140,905	7,836,779
2000	1,216,812	213,504	3,802,477	3,044,203	8,276,995
2001	931,412	182,703	4,052,474	2,449,599	7,616,188
2002	928,085	198,124	4,005,084	2,792,200	7,923,493
2003	854,326	129,223	4,781,402	2,848,445	8,613,396
2004	879,768	154,995	4,553,027	3,665,234	9,253,023
2005	970,403	147,004	4,480,802	3,441,928	9,040,137
2006	1,047,648	159,914	4,883,961	4,812,332	10,903,855
2007	1,015,114	158,718	3,944,679	2,944,253	8,062,765
2008	1,027,824	105,275	4,381,186	2,391,200	7,905,484
2009	1,050,055	131,583	4,700,222	1,942,061	7,823,921
2010	1,031,448	133,375	5,388,440	1,760,759	8,314,022
2011	944,777	82,175	5,006,358	1,482,029	7,515,339
2012	870,684	199,927	4,046,299	1,847,880	6,964,790
2013	784,379	116,919	5,157,760	2,393,425	8,452,483
2014	750,263	114,049	4,033,746	2,172,342	7,070,400
2015	621,952	84,840	3,085,725	2,307,133	6,099,651
2016	609,028	92,260	3,500,434	2,981,430	7,183,151
2017	592,670	100,349	2,937,911	3,421,110	7,052,041
2018	615,649	100,491	2,244,765	2,826,667	5,787,571
2019	652,777	84,827	2,150,936	2,589,045	5,477,585
2020	581,832	60,363	1,709,973	2,760,231	5,112,399
2021	644,204	89,484	1,841,902	2,583,788	5,159,378
2022	622,335	44,624	3,454,021	2,667,846	6,788,826
2023	600,631	16,965	2,624,429	2,343,556	5,585,581
2024	604,170 ⁺	17,102	1,728,744	1,718,439	4,068,455

* Commercial discards for 2024 were estimated by applying the 2023 discard-to-landings ratios for each region. The entire time series for commercial dead discards will be re-estimated as part of the 2027 stock assessment.

+ Maryland and Virginia commercial landings for 2024 are considered preliminary.

Table 4 Proportion of total removals (harvest plus discards/release mortality) of Atlantic striped bass by sector in numbers of fish, 1998-2024. Note: Harvest is from state compliance reports/MRIP (June 2025), discards/release mortality is from ASMFC. Estimates exclude inshore harvest from NC.

Year	Commercial		Recreational	
	Harvest	Dead Discards*	Harvest	Release Mortality
1998	16%	5%	38%	42%
1999	16%	4%	40%	40%
2000	15%	3%	46%	37%
2001	12%	2%	53%	32%
2002	12%	3%	51%	35%
2003	10%	2%	56%	33%
2004	10%	2%	49%	40%
2005	11%	2%	50%	38%
2006	10%	1%	45%	44%
2007	13%	2%	49%	37%
2008	13%	1%	55%	30%
2009	13%	2%	60%	25%
2010	12%	2%	65%	21%
2011	13%	1%	67%	20%
2012	13%	3%	58%	27%
2013	9%	1%	61%	28%
2014	11%	2%	57%	31%
2015	10%	1%	51%	38%
2016	8%	1%	49%	42%
2017	8%	1%	42%	49%
2018	11%	2%	39%	49%
2019	12%	2%	39%	47%
2020	11%	1%	33%	54%
2021	12%	2%	36%	50%
2022	9%	1%	51%	39%
2023	11%	0.3%	47%	42%
2024	15%	0.4%	42%	42%

* Commercial discards for 2024 were estimated by applying the 2023 discard-to-landings ratios for each region. The entire time series for commercial dead discards will be re-estimated as part of the 2027 stock assessment.

Note: Percent may not sum to 100 due to rounding.

Table 5. Total harvest of Atlantic striped bass by sector, 1998-2024 calendar years. Note: Harvest is from state compliance reports/MRIP (Query June 2024). Estimates exclude inshore harvest from NC.

Year	Numbers of Fish			Pounds		
	Commercial	Recreational	Total	Commercial	Recreational	Total
1998	1,215,219	2,915,390	4,130,609	6,551,623	29,603,199	36,154,822
1999	1,223,572	3,123,496	4,347,068	6,485,079	33,564,988	40,050,067
2000	1,216,812	3,802,477	5,019,289	6,715,044	34,050,817	40,765,861
2001	931,412	4,052,474	4,983,886	6,266,953	39,263,154	45,530,107
2002	928,085	4,005,084	4,933,169	6,152,583	41,840,025	47,992,608
2003	854,326	4,781,402	5,635,728	6,750,799	54,091,836	60,842,635
2004	879,768	4,553,027	5,432,795	7,340,822	53,031,074	60,371,896
2005	970,403	4,480,802	5,451,205	7,120,647	57,421,174	64,541,821
2006	1,047,648	4,883,961	5,931,609	6,780,541	50,674,431	57,454,972
2007	1,015,114	3,944,679	4,959,793	7,047,179	42,823,614	49,870,793
2008	1,027,824	4,381,186	5,409,010	7,190,800	56,665,318	63,856,118
2009	1,050,055	4,700,222	5,750,277	7,217,484	54,411,389	61,628,873
2010	1,031,448	5,388,440	6,419,888	6,996,713	61,431,360	68,428,073
2011	944,777	5,006,358	5,951,135	6,789,792	59,592,092	66,381,884
2012	870,684	4,046,299	4,916,983	6,516,761	53,256,619	59,773,380
2013	784,379	5,157,760	5,942,139	5,819,678	65,057,289	70,876,967
2014	750,263	4,033,746	4,784,009	5,937,949	47,948,610	53,886,559
2015	621,952	3,085,725	3,707,677	4,829,997	39,898,799	44,728,796
2016	609,028	3,500,434	4,109,462	4,848,772	43,671,532	48,520,304
2017	592,670	2,937,911	3,530,581	4,816,423	37,952,581	42,769,004
2018	615,649	2,244,765	2,860,414	4,795,679	23,069,028	27,864,707
2019	652,777	2,150,936	2,803,713	4,254,547	23,556,287	27,810,834
2020	581,832	1,709,973	2,291,805	3,607,681	14,858,984	18,466,665
2021	644,204	1,841,902	2,486,106	4,306,781	15,781,510	20,088,291
2022	622,335	3,454,021	4,076,356	4,323,762	35,800,246	40,124,008
2023	600,631	2,624,429	3,225,060	4,218,988	23,937,530	28,156,518
2024	604,170 ⁺	1,728,744	2,332,914	4,319,384 ⁺	15,322,884	19,642,268

+ Maryland and Virginia commercial landings for 2024 are considered preliminary.

Table 6. Commercial harvest by region in pounds (x1000), 1998-2024 calendar years. Source: State compliance reports. ^Estimates exclude inshore harvest from NC.

Year	Ocean								Chesapeake Bay				Grand Total
	MA	RI	NY	DE	MD	VA	NC^	Total	MD	PRFC	VA	Total	
1998	810.1	94.7	485.9	163.2	84.6	375.0	273.0	2,286.6	2,426.7	726.2	1,112.2	4,265.1	6,551.6
1999	766.2	119.7	491.8	187.1	62.6	614.8	391.5	2,633.7	2,274.8	653.3	923.4	3,851.4	6,485.1
2000	796.2	111.8	542.7	140.6	149.7	932.7	162.4	2,836.0	2,261.8	666.0	951.2	3,879.0	6,715.0
2001	815.4	129.7	633.1	198.8	113.9	782.4	381.1	3,054.3	1,660.9	658.7	893.1	3,212.6	6,267.0
2002	924.9	129.2	518.6	160.6	93.2	710.2	441.0	2,977.6	1,759.4	521.0	894.4	3,174.9	6,152.6
2003	1,055.5	190.2	753.3	191.5	103.9	166.4	201.2	2,662.1	1,721.8	676.6	1,690.4	4,088.7	6,750.8
2004	1,214.2	232.3	741.7	182.2	134.2	161.3	605.4	3,271.2	1,790.3	772.3	1,507.0	4,069.6	7,340.8
2005	1,102.2	215.6	689.8	173.1	46.9	185.2	604.5	3,017.4	2,008.7	533.6	1,561.0	4,103.3	7,120.6
2006	1,322.3	221.4	688.4	179.5	91.1	195.0	74.2	2,771.8	2,116.3	673.5	1,219.0	4,008.7	6,780.5
2007	1,039.3	240.6	731.5	188.7	96.3	162.3	379.5	2,838.1	2,240.6	599.3	1,369.2	4,209.1	7,047.2
2008	1,160.3	245.9	653.1	188.8	118.0	163.1	288.4	2,817.7	2,208.0	613.8	1,551.3	4,373.1	7,190.8
2009	1,134.3	234.8	789.9	192.4	127.3	140.4	190.0	2,809.1	2,267.3	727.8	1,413.3	4,408.4	7,217.5
2010	1,224.5	248.9	786.8	185.4	44.8	127.8	276.4	2,894.7	2,105.8	683.2	1,313.0	4,102.0	6,996.7
2011	1,163.9	228.2	855.3	188.6	21.4	158.8	246.4	2,862.5	1,955.1	694.2	1,278.1	3,927.3	6,789.8
2012	1,218.5	239.9	683.8	194.3	77.6	170.8	7.3	2,592.0	1,851.4	733.7	1,339.6	3,924.7	6,516.8
2013	1,004.5	231.3	823.8	191.4	93.5	182.4	0.0	2,526.9	1,662.2	623.8	1,006.8	3,292.8	5,819.7
2014	1,138.5	216.9	531.5	167.9	120.9	183.7	0.0	2,359.4	1,805.7	603.4	1,169.4	3,578.5	5,937.9
2015	866.0	188.3	516.3	144.1	34.6	138.1	0.0	1,887.5	1,436.9	538.0	967.6	2,942.5	4,830.0
2016	938.7	174.7	575.0	136.5	19.7	139.2	0.0	1,983.9	1,425.5	537.1	902.3	2,864.9	4,848.8
2017	823.4	175.3	701.2	141.8	80.5	133.9	0.0	2,056.1	1,439.8	492.7	827.8	2,760.3	4,816.4
2018	753.7	116.8	731.4	155.0	79.8	134.2	0.0	1,970.9	1,424.3	449.4	951.0	2,824.7	4,795.7
2019	586.1	144.2	327.3	132.6	82.8	138.0	0.0	1,410.9	1,475.2	417.3	951.1	2,843.6	4,254.5
2020	386.9	115.9	518.2	138.0	83.6	77.2	0.0	1,319.8	1,273.8	400.3	613.8	2,287.9	3,607.7
2021	732.1	130.3	600.9	140.3	88.7	119.9	0.0	1,812.1	1,351.5	411.3	731.9	2,494.7	4,306.8
2022	770.4	100.0	588.6	139.2	88.9	121.7	0.0	1,808.8	1,363.7	428.5	722.8	2,515.0	4,323.8
2023	677.3	80.6	616.6	140.0	84.6	122.7	0.0	1,721.9	1,319.0	363.6	814.5	2,497.1	4,219.0
2024	662.8	86.6	612.0	130.0	88.9 ⁺	115.0	0.0	1,695.3	1,350.2 ⁺	448.0	825.9	2,624.1	4,319.4

*Rhode Island general category harvest (mostly rod and reel) shown only; floating fish trap landings confidential in 2018 and 2022-2024.

+ Maryland and Virginia commercial landings for 2024 are considered preliminary.

Table 7. Commercial harvest and discards by region in numbers of fish (x1000), 1998-2024 calendar years. Source: harvest is from state compliance reports, discards is from ASMFC. ^Estimates exclude inshore harvest from NC.

Year	Ocean								Chesapeake Bay				Discards**			Grand Total Removals
	MA	RI	NY	DE	MD	VA	NC^	Total	MD	PRFC	VA	Total	Ocean	Bay	Total	
1998	44.3	8.8	45.1	31.4	10.3	41.1	14.2	195.2	729.6	93.3	197.1	1,020.1	326.7	33.2	359.9	1,575.1
1999	40.9	11.6	49.9	34.8	10.2	48.7	21.1	217.2	776.0	90.6	139.8	1,006.3	316.3	32.5	348.8	1,572.4
2000	42.1	9.4	54.9	25.2	13.3	54.5	6.5	205.8	787.6	91.5	132.0	1,011.0	180.7	32.8	213.5	1,430.3
2001	45.8	10.9	58.3	34.4	11.1	42.3	25.0	227.7	538.8	87.8	77.1	703.7	139.7	43.0	182.7	1,114.1
2002	49.8	11.7	47.1	30.4	10.2	38.8	23.2	211.3	571.7	80.3	64.7	716.8	146.7	51.4	198.1	1,126.2
2003	56.4	15.5	68.4	31.5	11.6	10.5	5.8	199.6	427.9	83.1	143.7	654.7	95.6	33.6	129.2	983.5
2004	63.6	16.0	70.4	28.4	14.1	10.4	31.0	233.9	447.0	92.6	106.3	645.9	108.4	46.6	155.0	1,034.8
2005	60.5	14.9	70.6	26.3	6.1	11.3	27.3	217.1	563.9	80.6	108.9	753.3	84.6	62.4	147.0	1,117.4
2006	70.5	15.4	73.6	30.2	10.9	11.5	2.7	214.9	645.1	92.3	95.4	832.7	96.2	63.7	159.9	1,207.6
2007	54.2	13.9	78.5	31.1	11.6	10.6	16.8	216.7	587.6	86.5	124.3	798.4	93.3	65.4	158.7	1,173.8
2008	61.1	16.6	73.3	31.9	14.0	10.8	13.4	221.0	580.7	82.0	144.1	806.8	62.7	42.6	105.3	1,133.1
2009	59.4	16.8	82.6	21.8	12.5	8.9	9.0	211.1	605.6	89.6	143.8	839.0	58.8	72.8	131.6	1,181.6
2010	60.4	15.7	82.4	19.8	5.4	9.4	13.7	206.8	579.2	90.6	154.9	824.7	39.6	93.7	133.4	1,164.8
2011	58.7	14.3	87.4	20.5	2.1	12.2	10.9	206.0	488.9	96.1	153.7	738.7	34.8	47.4	82.2	1,027.0
2012	61.5	15.0	67.1	15.7	6.9	10.8	0.3	177.3	465.6	90.7	137.0	693.4	26.9	173.0	199.9	1,070.6
2013	58.6	13.8	76.2	17.7	7.6	10.0	0.0	183.8	391.5	78.0	131.0	600.5	37.3	79.6	116.9	901.3
2014	58.0	10.5	52.9	14.9	8.5	10.0	0.0	154.8	362.2	81.5	151.8	595.5	50.4	63.7	114.0	864.3
2015	42.3	11.3	45.6	11.0	2.6	7.7	0.0	120.4	298.3	71.0	132.2	501.5	34.9	49.9	84.8	706.8
2016	48.0	11.7	51.0	8.8	1.2	7.6	0.0	128.3	284.9	73.7	122.2	480.8	42.4	49.9	92.3	701.3
2017	41.2	10.1	61.6	9.5	3.5	7.6	0.0	133.5	263.6	67.5	128.0	459.2	78.1	22.3	100.3	693.0
2018	37.8	4.6*	52.2	11.4	3.5	6.9	0.0	116.4	286.4	64.4	148.4	499.3	56.6	43.9	100.5	716.1
2019	29.6	7.3	28.5	8.2	3.3	6.9	0.0	83.9	356.7	62.6	149.6	568.9	15.9	68.9	84.8	737.6
2020	19.6	5.0	48.1	8.4	3.4	4.42	0.0	89.0	299.9	66.6	126.4	492.9	19.2	41.2	60.4	642.2
2021	36.9	4.6	58.8	9.2	3.6	6.6	0.0	119.6	310.4	68.0	146.2	524.6	11.6	77.8	89.5	733.7
2022	33.0	3.9*	53.9	8.2	3.4	6.3	0.0	108.6	295.3	71.7	146.7	513.7	3.1	41.5	44.6	667.0
2023	29.9	2.6*	55.5	7.4	3.6	5.9	0.0	104.9	284.3	60.7	150.7	495.7	3.7	13.3	17.0	617.6
2024	30.1	3.5*	56.0	8.3	4.1 ⁺	6.0	0.0	108.0	292.2 ⁺	67.4	136.5	496.1	3.8	13.3	17.1	621.3

** Commercial discards for 2024 estimated applying the 2023 discard-to-landings ratios for each region. The entire time series for commercial dead discards will be re-estimated as part of the 2027 stock assessment. *RI general category harvest only; floating fish trap confidential some years. + MD and VA landings preliminary.

Table 8. Total recreational catch, releases, and release mortality in numbers of fish by region (x1000), 1998-2024. Source: MRIP (Query June 2025). Estimates exclude inshore harvest from NC.

Year	Harvest (A+B1)			Releases (B2)			Total Catch (A+B1+B2)			Release Mortality (9% of B2)		
	Ocean	Bay	Total	Ocean	Bay	Total	Ocean	Bay	Total	Ocean	Bay	Total
1998	1,647	1,268	2,915	29,294	6,918	36,213	30,941	8,187	39,128	2,637	623	3,259
1999	1,758	1,366	3,123	26,139	8,760	34,899	27,897	10,125	38,022	2,353	788	3,141
2000	2,198	1,604	3,802	25,090	8,734	33,824	27,289	10,338	37,627	2,258	786	3,044
2001	2,758	1,294	4,052	21,073	6,145	27,218	23,831	7,440	31,270	1,897	553	2,450
2002	2,756	1,249	4,005	23,653	7,371	31,024	26,409	8,620	35,030	2,129	663	2,792
2003	3,124	1,658	4,781	20,678	10,971	31,649	23,802	12,628	36,431	1,861	987	2,848
2004	3,078	1,475	4,553	27,868	12,857	40,725	30,946	14,332	45,278	2,508	1,157	3,665
2005	3,182	1,299	4,481	28,663	9,580	38,244	31,845	10,879	42,724	2,580	862	3,442
2006	2,789	2,095	4,884	41,239	12,232	53,470	44,028	14,327	58,354	3,711	1,101	4,812
2007	2,327	1,618	3,945	25,135	7,579	32,714	27,462	9,196	36,659	2,262	682	2,944
2008	3,025	1,356	4,381	21,878	4,691	26,569	24,904	6,046	30,950	1,969	422	2,391
2009	2,898	1,803	4,700	16,740	4,838	21,578	19,638	6,641	26,279	1,507	435	1,942
2010	3,906	1,483	5,388	13,606	5,957	19,564	17,512	7,440	24,952	1,225	536	1,761
2011	3,617	1,389	5,006	12,644	3,823	16,467	16,261	5,212	21,473	1,138	344	1,482
2012	3,071	975	4,046	11,242	9,290	20,532	14,314	10,265	24,578	1,012	836	1,848
2013	3,723	1,435	5,158	19,463	7,131	26,594	23,186	8,565	31,751	1,752	642	2,393
2014	2,276	1,758	4,034	15,107	9,031	24,137	17,382	10,789	28,171	1,360	813	2,172
2015	1,770	1,316	3,086	15,419	10,216	25,635	17,189	11,532	28,721	1,388	919	2,307
2016	1,817	1,683	3,500	17,794	15,333	33,127	19,611	17,016	36,627	1,601	1,380	2,981
2017	1,738	1,200	2,938	28,963	9,050	38,012	30,701	10,249	40,950	2,607	814	3,421
2018	1,195	1,050	2,245	22,739	8,669	31,407	23,933	9,719	33,652	2,046	780	2,827
2019	1,342	809	2,151	21,131	7,636	28,767	22,473	8,445	30,918	1,902	687	2,589
2020	923	787	1,710	22,710	7,959	30,669	23,633	8,746	32,379	2,044	716	2,760
2021	1,189	653	1,842	24,281	4,427	28,709	25,470	5,081	30,551	2,185	398	2,584
2022	2,756	697	3,454	26,031	3,611	29,643	28,788	4,309	33,097	2,343	325	2,668
2023	2,036	588	2,624	22,363	3,676	26,040	24,400	4,264	28,664	2,013	331	2,344
2024	1,459	270	1,729	16,486	2,608	19,094	17,945	2,878	20,823	1,484	235	1,718

Table 9. Recreational harvest by region in pounds (x1000), 1998-2024. Source: MRIP (Query June 2025). ^Estimates exclude NC inshore harvest.

Year	Ocean												Chesapeake Bay			Grand Total
	ME	NH	MA	RI	CT	NY	NJ	DE	MD	VA	NC^	Total	MD	VA	Total	
1998	305	262	7,359	1,544	1,807	4,889	4,182	645	579	545	636	22,754	3,023	3,826	6,849	29,603
1999	196	181	4,995	1,904	1,327	7,414	9,473	312	3.8	110	339	26,256	2,323	4,986	7,309	33,565
2000	347	109	4,863	2,008	890	7,053	9,768	925	0.0	416	277	26,656	3,503	3,892	7,395	34,051
2001	446	334	7,188	2,044	1,101	5,058	12,314	695	314	382	1,082	30,959	2,928	5,376	8,304	39,263
2002	775	322	10,261	2,708	1,251	5,975	9,621	589	0.0	1,135	998	33,634	2,643	5,563	8,206	41,840
2003	458	466	10,252	4,052	2,666	10,788	12,066	763	14	392	966	42,882	5,246	5,964	11,210	54,092
2004	554	268	9,329	2,460	2,229	6,437	13,303	870	57	1,067	6,656	43,230	4,860	4,941	9,801	53,031
2005	546	384	7,541	3,155	3,133	11,637	14,289	680	7.7	487	3,947	45,808	7,753	3,860	11,614	57,421
2006	610	244	6,787	1,569	2,854	9,845	12,716	586	2.8	921	2,975	39,109	6,494	5,071	11,565	50,674
2007	422	93	7,010	2,077	2,786	10,081	8,390	207	0.0	516	1,965	33,547	5,249	4,027	9,277	42,824
2008	607	182	8,424	970	2,273	18,000	12,407	847	0.0	1,690	750	46,150	5,639	4,877	10,515	56,665
2009	781	222	9,410	2,185	1,458	7,991	17,040	940	138	48	187	40,399	8,672	5,340	14,012	54,411
2010	218	238	9,959	2,102	2,323	18,190	17,454	895	107	206	1,198	52,891	6,482	2,059	8,541	61,431
2011	245	659	11,953	3,066	981	13,151	15,715	605	8.6	308	4,467	51,157	6,220	2,214	8,435	59,592
2012	152	432	14,941	2,096	1,835	13,096	11,551	644	21	1.7	0.0	44,768	3,819	4,670	8,488	53,257
2013	331	831	9,025	4,428	4,236	16,819	19,451	1,073	1,051	67	0.0	57,313	5,137	2,607	7,744	65,057
2014	423	203	7,965	3,402	2,665	13,998	8,886	381	159	0.0	0.0	38,083	8,877	989	9,866	47,949
2015	132	202	7,799	1,394	2,585	8,695	9,982	340	28	0.0	0.0	31,156	7,786	957	8,743	39,899
2016	189	191	3,731	1,776	912	12,053	12,790	86	7.2	0.0	0.0	31,735	10,912	1,024	11,936	43,672
2017	318	394	5,664	1,655	1,560	8,885	10,886	666	0.0	1.8	0.0	30,030	7,309	613	7,922	37,953
2018	142	130	4,925	1,121	1,165	3,453	7,012	33	0.0	0.0	0.0	17,982	4,683	404	5,087	23,069
2019	415	291	2,698	2,300	685	7,072	6,674	44	7.3	0.0	0.0	20,187	3,145	224	3,370	23,556
2020	180	29	776	483	830	2,202	6,584	16	0.0	0.0	0.0	11,100	3,480	280	3,759	14,859
2021	89	36	1,826	597	201	1,492	8,313	132	0	0	0	12,686	2,682	414	3,095	15,782
2022	590	240	5,288	779	1,294	10,695	13,508	39	0	0	0	32,434	3,083	288	3,371	35,805
2023	510	287	3,212	575	769	5,171	10,730	0	31	0	0	21,285	2,195	458	2,653	23,938
2024	318	234	2,414	360	526	4,395	6,070	12	0	0	0	14,328	833	161	995	15,323

Table 10. Recreational harvest by region in numbers of fish (x1000), 1998-2024. Source: MRIP (Query June 2025). ^Estimates exclude NC inshore harvest.

Year	Ocean												Chesapeake Bay			Grand Total
	ME	NH	MA	RI	CT	NY	NJ	DE	MD	VA	NC^	Total	MD	VA	Total	
1998	65.3	14.8	500.9	91.1	114.1	383.8	289.2	51.0	24.3	71.3	41.2	1,647.0	596.2	672.2	1,268.4	2,915.4
1999	37.5	9.9	327.1	116.6	88.2	450.9	657.1	28.3	1.6	14.1	26.4	1,757.8	530.9	834.8	1,365.7	3,123.5
2000	77.3	6.0	306.2	156.8	84.0	494.6	939.8	88.3	0.0	27.2	18.1	2,198.3	810.9	793.3	1,604.2	3,802.5
2001	91.9	23.5	551.0	149.8	78.2	364.2	1,267.5	70.6	64.1	36.7	60.7	2,758.1	513.3	781.1	1,294.4	4,052.5
2002	135.2	28.1	723.5	181.5	92.5	439.3	957.6	65.7	0.0	76.4	56.3	2,756.1	464.4	784.6	1,249.0	4,005.1
2003	99.7	41.3	797.2	226.4	181.7	678.4	942.8	75.7	0.9	29.3	50.4	3,123.8	816.0	841.6	1,657.6	4,781.4
2004	118.3	22.1	666.7	159.6	134.5	458.1	1,042.1	66.6	11.0	75.9	323.2	3,078.1	657.5	817.4	1,474.9	4,553.0
2005	118.3	35.5	536.1	195.6	202.6	854.6	958.1	48.8	3.6	34.2	194.9	3,182.2	815.5	483.1	1,298.6	4,480.8
2006	140.9	20.9	483.2	129.3	168.3	614.8	972.2	44.5	0.4	80.6	134.2	2,789.0	1,342.0	753.0	2,094.9	4,884.0
2007	95.5	8.1	471.9	135.8	163.9	602.8	722.2	17.2	0.0	28.0	81.8	2,327.1	1,127.3	490.3	1,617.6	3,944.7
2008	133.4	11.9	514.1	73.4	132.8	1,169.9	791.0	67.7	0.0	94.4	36.9	3,025.4	779.7	576.1	1,355.8	4,381.2
2009	146.5	17.3	695.0	138.4	100.3	574.2	1,141.5	64.8	10.2	3.0	6.5	2,897.7	1,094.4	708.1	1,802.5	4,700.2
2010	37.3	21.4	808.2	162.0	170.2	1,449.0	1,091.4	61.4	12.5	25.3	67.1	3,905.9	1,139.3	343.2	1,482.6	5,388.4
2011	48.5	54.2	873.5	202.2	91.1	1,005.3	1,038.9	43.7	0.8	51.2	207.6	3,617.1	1,112.1	277.2	1,389.3	5,006.4
2012	31.4	37.3	1,010.6	130.7	137.1	927.5	742.4	51.3	2.9	0.3	0.0	3,071.5	716.7	258.1	974.8	4,046.3
2013	73.3	63.2	658.7	308.3	269.6	902.5	1,324.2	70.6	48.4	4.4	0.0	3,723.2	1,136.7	297.9	1,434.5	5,157.8
2014	86.4	16.5	523.5	172.0	131.8	804.5	501.9	26.2	12.6	0.0	0.0	2,275.5	1,627.0	131.2	1,758.2	4,033.7
2015	14.4	10.0	485.3	67.0	140.8	406.8	600.3	41.9	3.5	0.0	0.0	1,770.1	1,108.0	207.7	1,315.7	3,085.7
2016	14.2	17.6	230.1	128.4	63.3	697.7	659.6	5.9	0.5	0.0	0.0	1,817.2	1,545.1	138.1	1,683.2	3,500.4
2017	22.0	37.7	392.3	59.8	94.9	477.3	626.4	27.8	0.0	0.1	0.0	1,738.3	1,091.6	108.0	1,199.6	2,937.9
2018	16.0	13.4	389.5	39.2	85.5	181.7	465.3	4.2	0.0	0.0	0.0	1,194.6	993.3	56.8	1,050.1	2,244.8
2019	38.0	14.7	195.6	104.1	67.1	498.0	412.9	10.9	1.0	0.0	0.0	1,342.2	764.1	44.6	808.7	2,150.9
2020	19.0	3.2	67.2	36.9	71.2	203.7	520.1	1.6	0.0	0.0	0.0	922.9	734.8	52.2	787.0	1,710.0
2021	12.7	4.4	179.1	57.7	21.2	137.8	766.2	9.496	0.0	0.0	0.0	1,188.6	583.7	69.6	653.3	1,842.9
2022	57.6	23.4	479.9	66.4	116.2	882.9	1,126.5	4.0	0.0	0.0	0.0	2,756.8	642.2	55.0	697.2	3,454.0
2023	62.8	36.1	343.8	51.9	78.9	500.4	959.3	0.0	3.1	0.0	0.0	2,036.1	502.3	86.0	588.3	2,624.4
2024	34.4	25.2	257.8	33.6	51.6	433.0	622.3	1.2	0.0	0.0	0.0	1,459.2	232.6	36.9	269.5	1,728.7

Table 11. Recreational harvest and recreational release mortality by mode for 2022-2024.
Source: MRIP (Query July 2025).

Year	Private-Shore Harvest	For-Hire Harvest	Private-Shore Release Mortality	For-Hire Release Mortality
OCEAN				
2022	2,619,253	137,595	2,305,198	37,608
2023	1,967,001	69,135	1,984,532	28,172
2024	1,283,223	62,868	1,348,630	30,030
CHESAPEAKE BAY				
2022	553,480	143,694	310,919	14,121
2023	416,900	171,393	319,434	11,417
2024	173,120	73,483	236,677	9,029
COASTWIDE				
2022	3,172,733	281,289	2,616,117	51,729
2023	2,383,901	240,528	2,303,966	39,589
2024	1,456,343	136,351	1,585,307	39,059

Table 12. Number of directed trips for Atlantic striped bass (primary and secondary target) from Maine through North Carolina (excluding inshore NC) for 2020-2024. Source: MRIP (Query July 2025).

Year	Ocean	Chesapeake Bay	Coastwide Total
2020	15,859,277	2,678,922	18,538,199
2021	16,017,420	2,183,568	18,200,988
2022	21,044,439	2,132,346	23,176,785
2023	18,358,961	2,133,807	20,492,768
2024	16,434,248	1,276,206	17,710,454

Table 13. Number of directed trips for Atlantic striped bass (primary and secondary target) by mode from Maine through North Carolina (excluding inshore NC) for 2022-2024. Source: MRIP (Query July 2025).

Year	Private-Shore Directed Trips	For-Hire Directed Trips
OCEAN		
2022	20,814,563	229,876
2023	18,191,509	167,453
2024	16,293,296	140,952
CHESAPEAKE BAY		
2022	2,023,852	108,494
2023	2,016,729	117,078
2024	1,174,869	101,338

Table 14. . Results of 2024 commercial quota accounting in pounds. Source: 2025 state compliance reports. 2024 quotas set by Addendum II to Amendment 7.

State	2024 Quota	2024 Harvest	2024 Overage
Ocean			
Maine*	143	-	-
New Hampshire*	3,289	-	-
Massachusetts	683,773	662,810	0
Rhode Island	138,467	General Category: 86,610 Floating Fish Trap: Confidential	0
Connecticut*	13,585	-	-
New York	595,868	612,033	16,165
New Jersey**	200,798	-	-
Delaware	132,501	130,000	0
Maryland	82,857	88,857 ⁺	6,000
Virginia	116,282	115,004 ⁺	0
North Carolina	274,810	0	0
Ocean Total	2,242,373	1,695,314	0
Chesapeake Bay			
Maryland	1,344,216	1,350,247 ⁺	6,031
Virginia	914,555	825,871 ⁺	0
PRFC	532,761	443,300	0
Bay Total	2,791,532	2,619,418	0

Note: North Carolina's fishing year is December-November; PRFC's fishing year for gill nets is November-March.

* Commercial harvest/sale prohibited, with no re-allocation of quota.

** Commercial harvest/sale prohibited, with re-allocation of quota to the recreational fishery.

+ Maryland and Virginia commercial landings for 2024 are considered preliminary.

Table 15. Status of Commercial Tagging Programs by state for 2024.

State	Total Participants	Tags Issued	Tags Used	Tags Returned/ Broken/ Lost	Tags Not Accounted For ¹	Point of Tag (sale/ harvest)	Biological Metric ² (Y/N)	Year, State and Unique ID on Tag (Y/N)	Size Limit on Tag (Y/N)	Tag Colors	Annual Tag Color Change (Y/N)
MA	129	51,240	30,109	20,606	525	Sale	Y	Y	Y	one tag color	Y
RI GC only ³	18	5,030	3,527	1,409	94	Sale	Y	Y	N	two tag colors by gear	Y
NY	378	60,193	56,008	3,574	611	Harvest	Y	Y	N	one tag color	Y
DE*	241	17,300	8,321	8,906	3	Both	Y	Y	N	Harvest: two tag colors by gear Sale: one color	Y
MD	805	441,000 ±	310,711 ±	104,369 ±	25,920 ±	Harvest	Y	Y	N	three tag colors by fishery and area	Y
PRFC	264	88,051	66,804	20,441	403	Harvest	Y	Y	N	five tag colors by gear	N
VA	362	188,700	142,525	18,720	4,334	Harvest	Y	Y	Y	two tag colors by area	Y
NC	0	0	0	NA	NA	Sale	Y	Y	Y	three tag colors by area	N

¹ Tags not accounted for refers to unused tags that are not returned/not reported as lost.

² States are required to allocate commercial tags to permit holders based on a biological metric. Most states use the average weight per fish from the previous year, or some variation thereof. Actual biological metric used is reported in Annual Commercial Tag Monitoring Reports.

³ Rhode Island tag information only listed for the general category (GC) fishery, which is mostly rod/reel. Floating fish trap harvest for 2024 are confidential.

*The number of tags noted in the table for Delaware are the tags issued to and used by harvesters. Tags are also issued to weigh stations where a second tag is attached to each striped bass, such that each fish has two tags.

± Maryland's tag accounting is preliminary.

Note: North Carolina's fishing year is December-November; PRFC's fishing year for gill nets is November-March.

Table 16. Status of compliance with monitoring and reporting requirements in 2024. JAI = juvenile abundance index survey, SSB = spawning stock biomass survey, TAG = participation in coastwide tagging program, Y = compliance standards met, N = compliance standards not met, NA = not applicable, R = recreational, C = commercial.

Jurisdiction	Fishery-independent Monitoring		Fishery-dependent Monitoring		Annual reporting Status
	Requirement(s)	Status	Requirement(s)	Status	
ME	JAI	Y	-	NA	Y
NH	-	NA	-	NA	Y
MA	TAG	Y	composition, catch & effort (C&R), tag program	Y	Y
RI	-	NA	composition (C&R), catch & effort (R), tag program	Y	Y
CT	-	NA	composition, catch & effort (R)	Y	Y
NY	JAI, SSB, TAG	Y	composition, catch & effort (C&R), tag program	Y	Y
NJ	JAI, TAG	Y	composition, catch & effort (R)	Y	Y
PA	SSB	Y	-	NA	Y
DE	SSB, TAG	Y	composition, catch & effort (C), tag program	Y	Y
MD	JAI, SSB, TAG	Y	composition, catch & effort (C&R), tag program	Y	Y
PRFC	-	NA	composition, catch & effort (C&R), tag program	Y	Y
DC	-	NA	-	NA	Y
VA	JAI, SSB, TAG	Y	composition, catch & effort (C&R), tag program	Y	Y
NC	JAI, SSB, TAG	Y	composition, catch & effort (C&R), tag program	Y	Y

XI. Figures

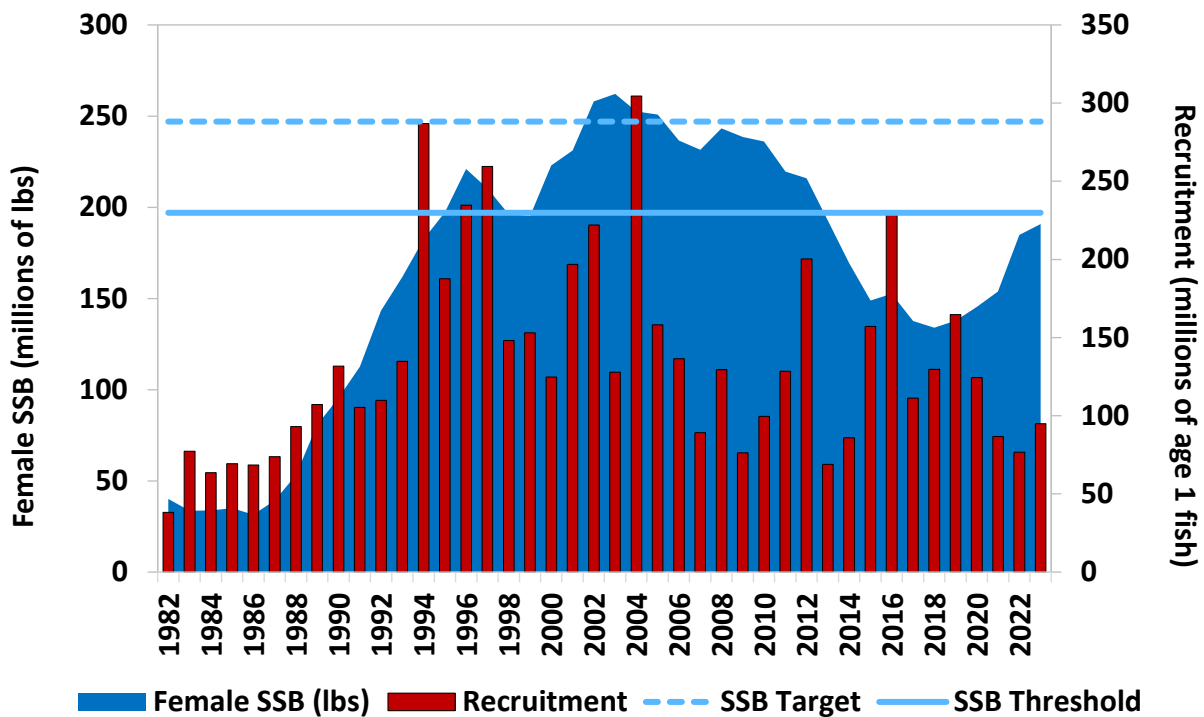


Figure 1. Atlantic striped bass female spawning stock biomass and recruitment, 1982-2023. Source: 2024 Stock Assessment Update.

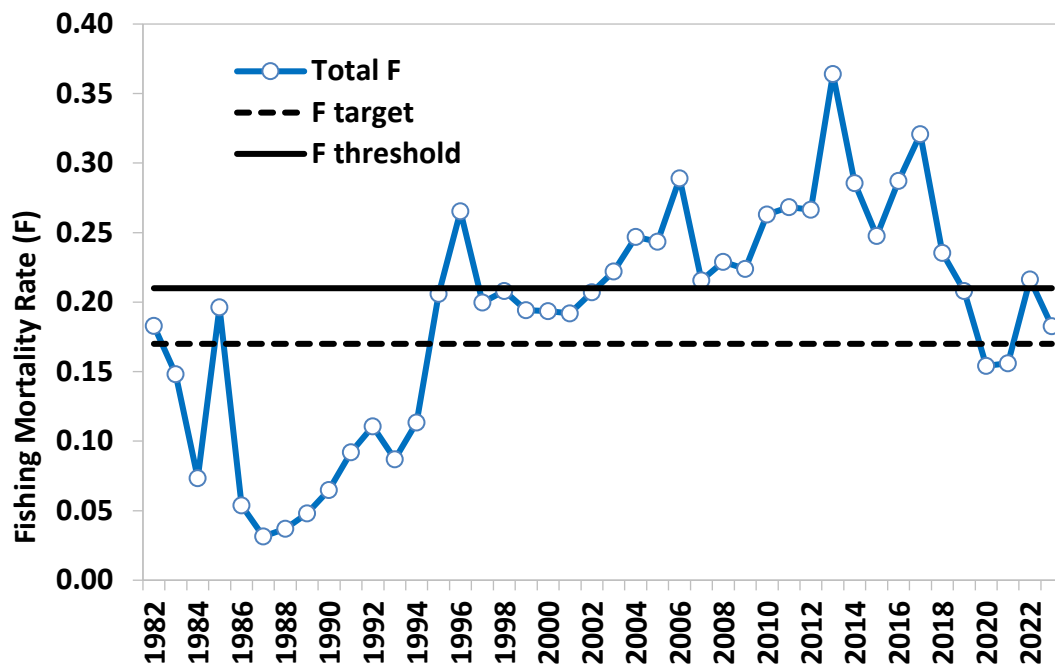


Figure 2. Atlantic striped bass fishing mortality, 1982-2023. Source: 2024 Stock Assessment Update.

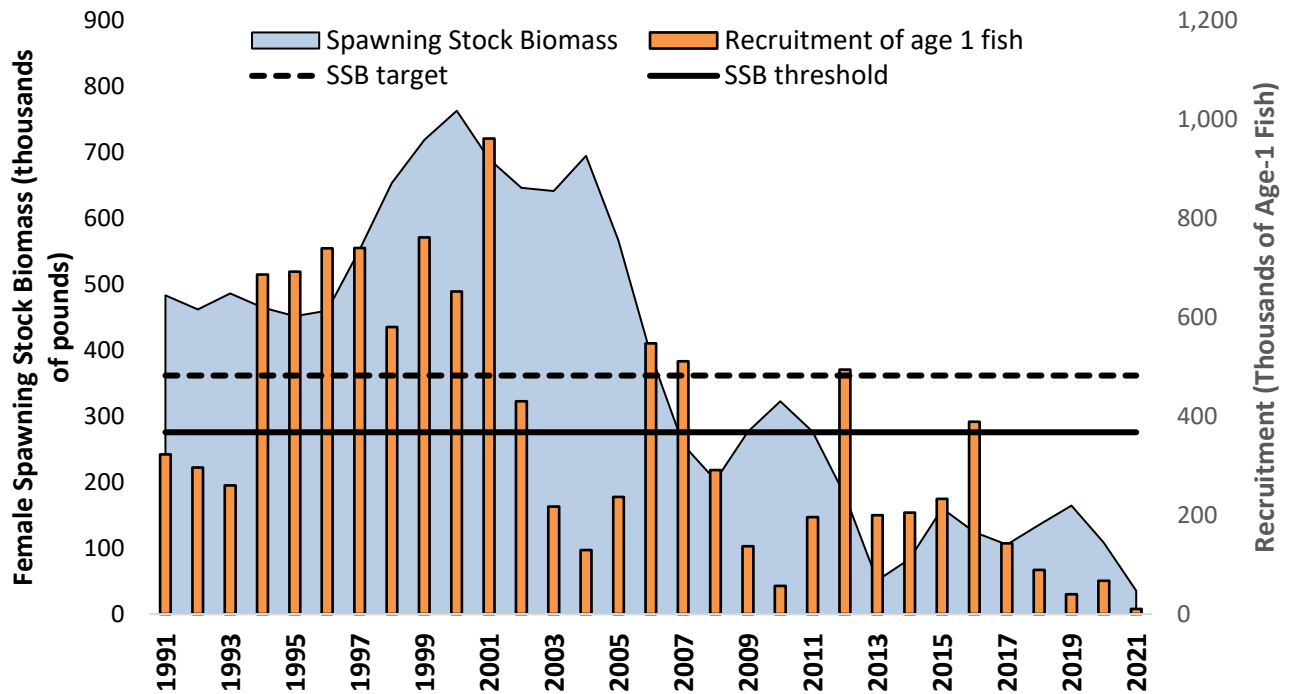


Figure 3. Albemarle Sound-Roanoke River striped bass female spawning stock biomass and recruitment (abundance of age-1), and biological reference points, 1991-2021. Source: 2022 A-R Stock Assessment (Lee et al. 2022).

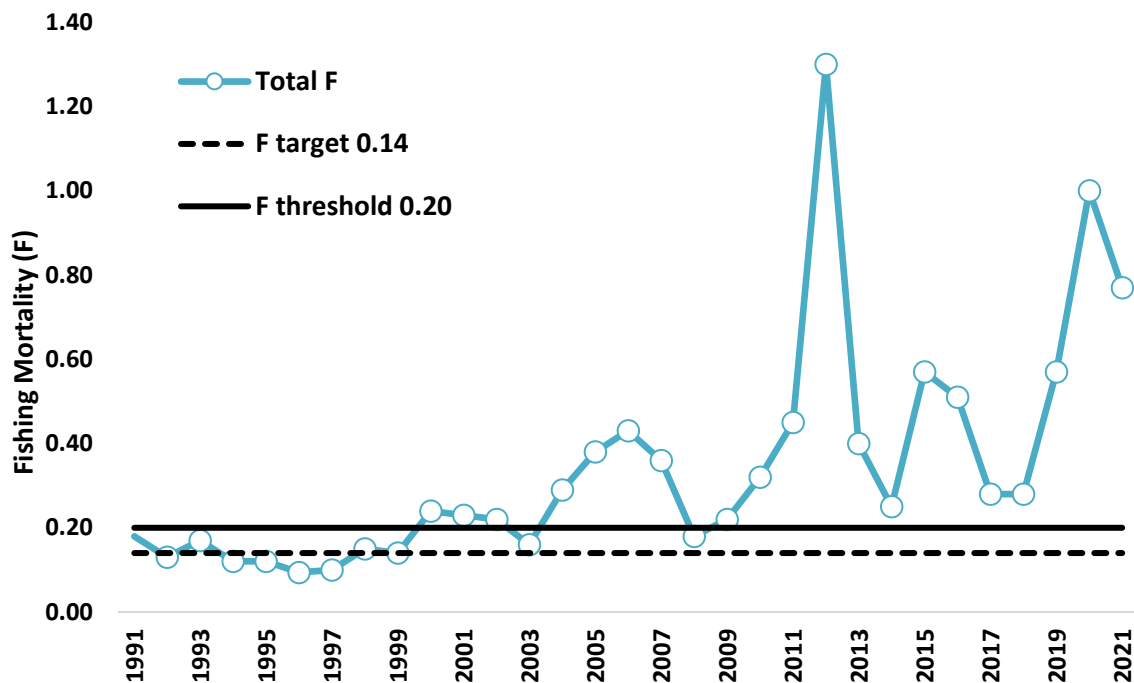


Figure 4. Albemarle Sounds-Roanoke River striped bass fishing mortality (F) estimates, and biological reference points, 1991-2021. Source: 2022 A-R Stock Assessment (Lee et al. 2022).

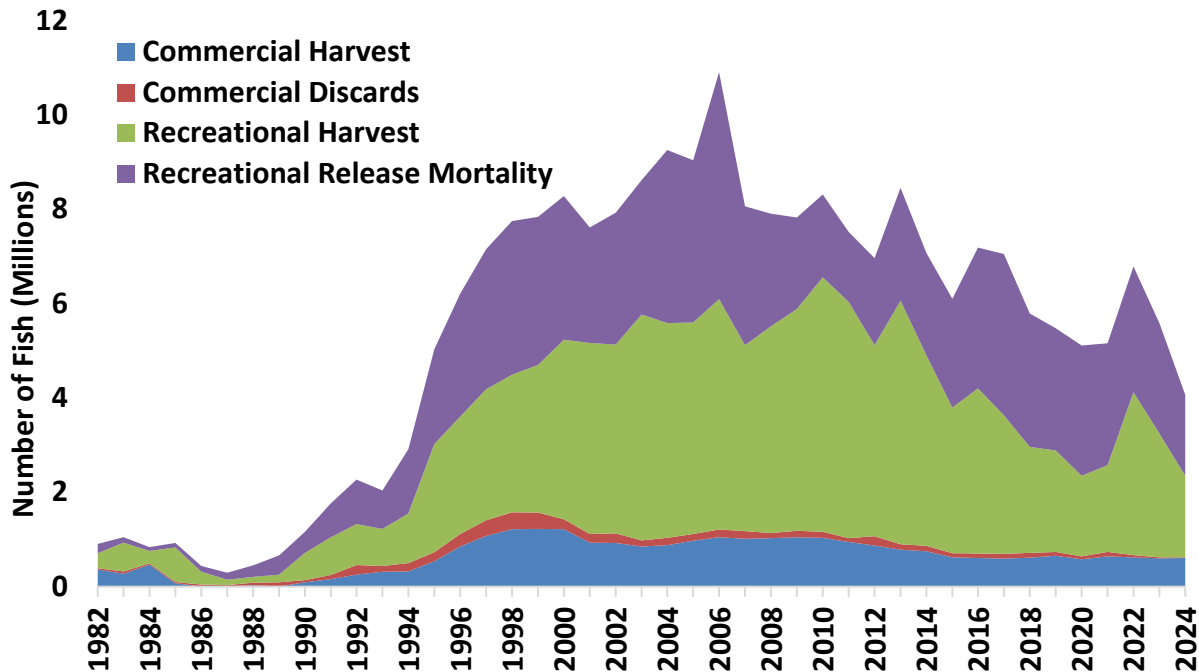


Figure 5. Total Atlantic striped bass removals by sector in numbers of fish, 1982-2024. Note: Harvest is from state compliance reports/MRIP, discards/release mortality is from ASMFC. Estimates exclude inshore harvest from A-R.

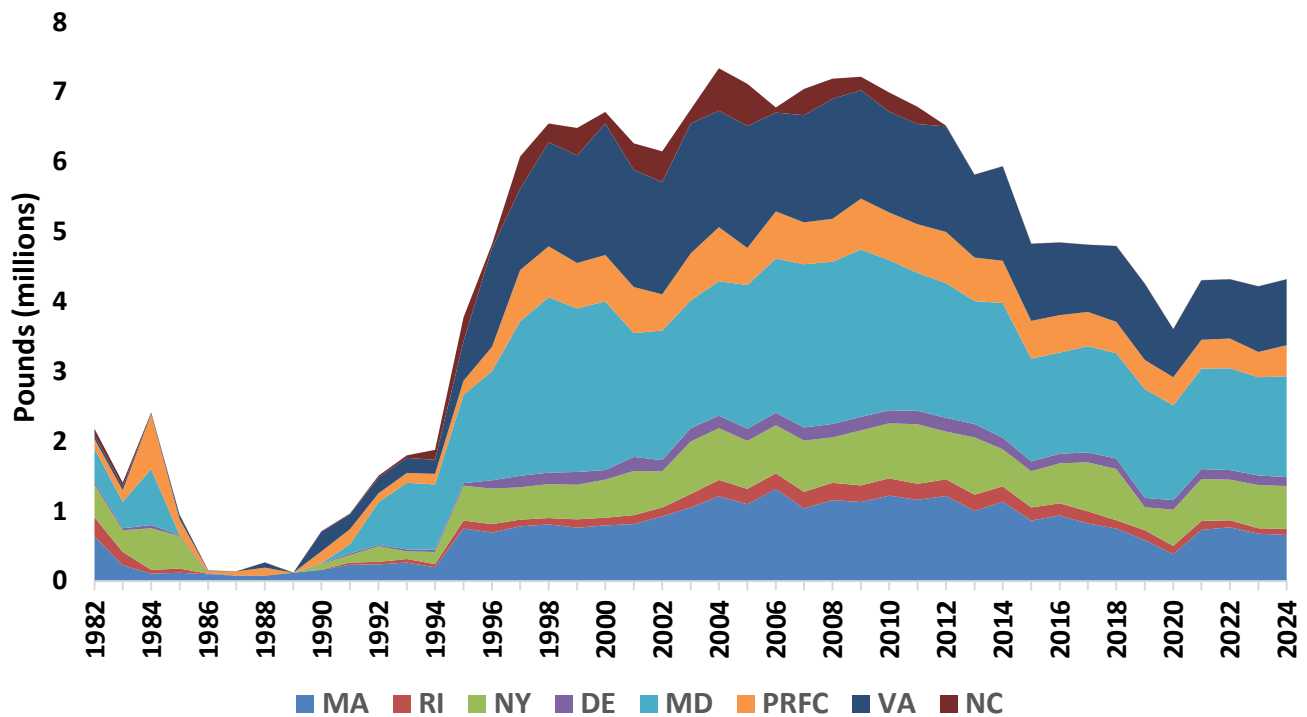


Figure 6. Commercial Atlantic striped bass landings by state in pounds, 1982-2024. Source: State compliance reports. Commercial harvest and sale prohibited in ME, NH, CT, and NJ. NC is ocean only.

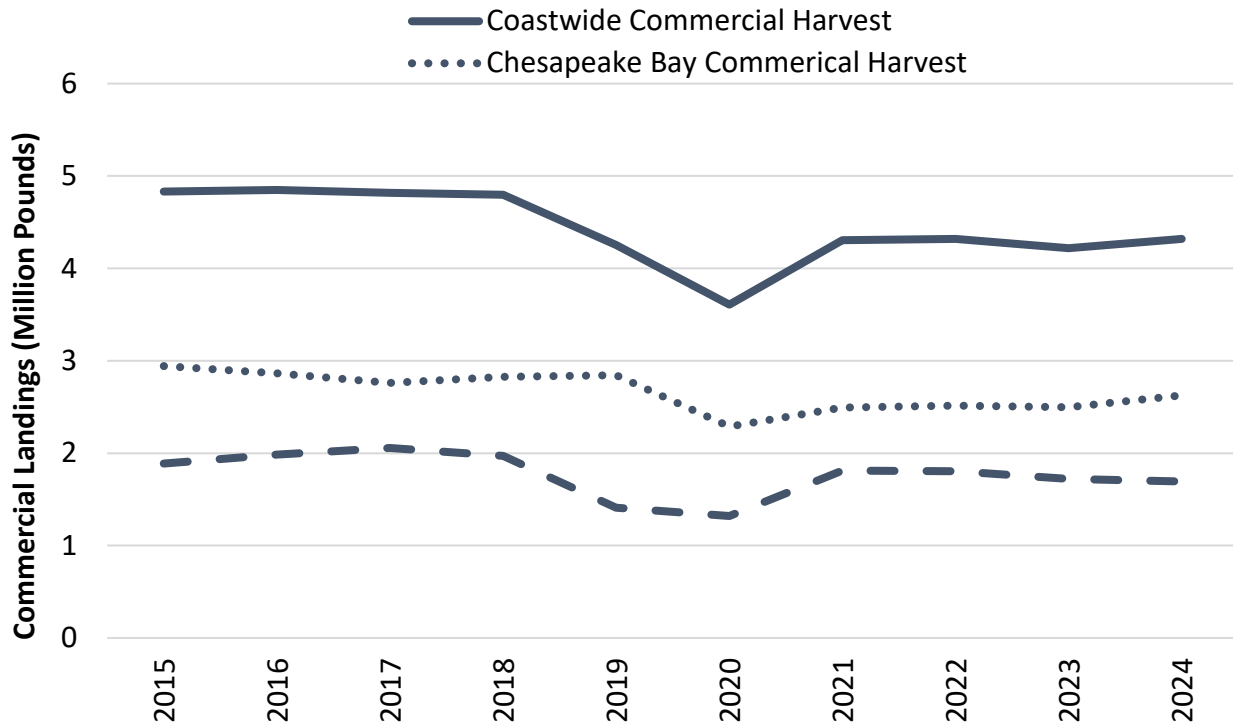


Figure 7. Commercial harvest by region for 2015-2024. Source: 2025 State Compliance Reports.

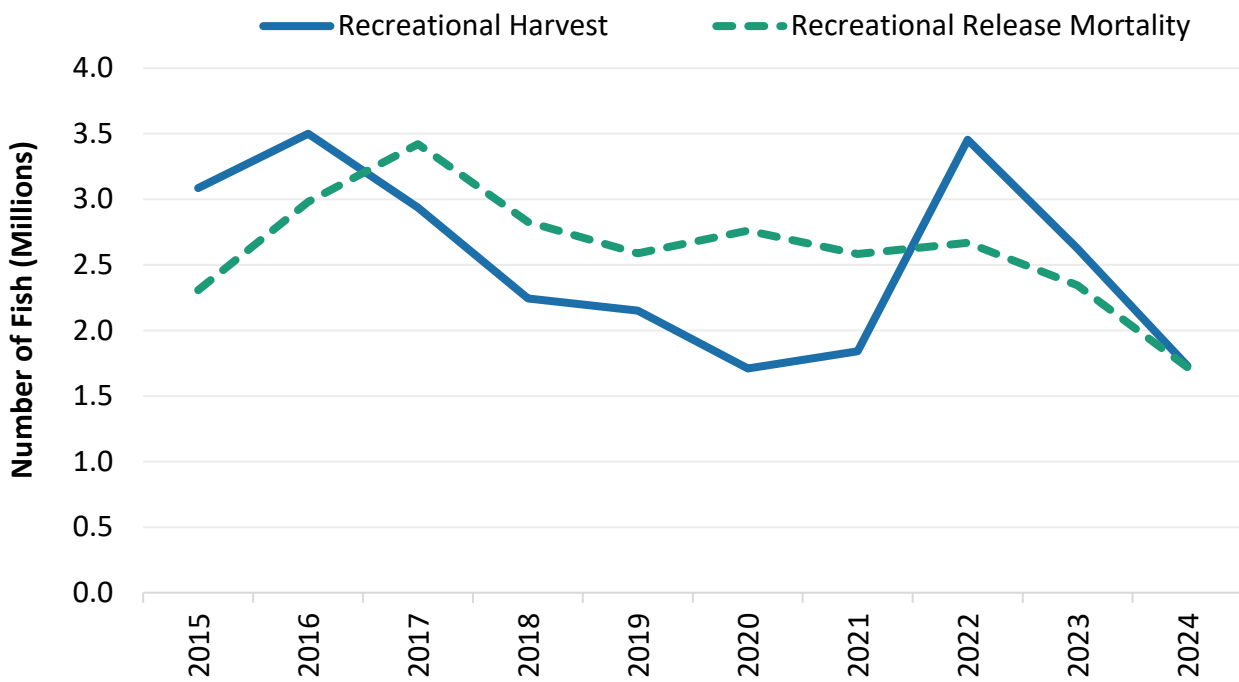


Figure 8. Coastwide recreational harvest and recreational release mortality from 2015-2024. Source: MRIP (June 2025).

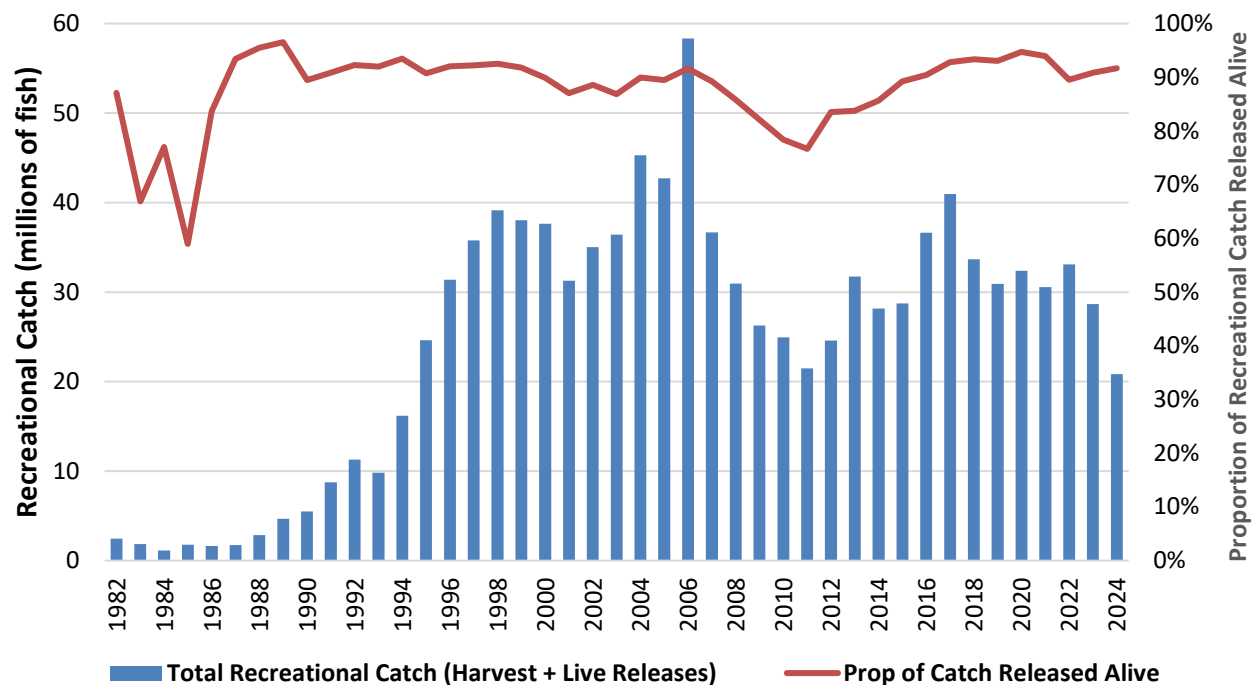


Figure 9. Total recreational catch and the proportion of fish released alive, 1982-2023. Source: MRIP (June 2025).

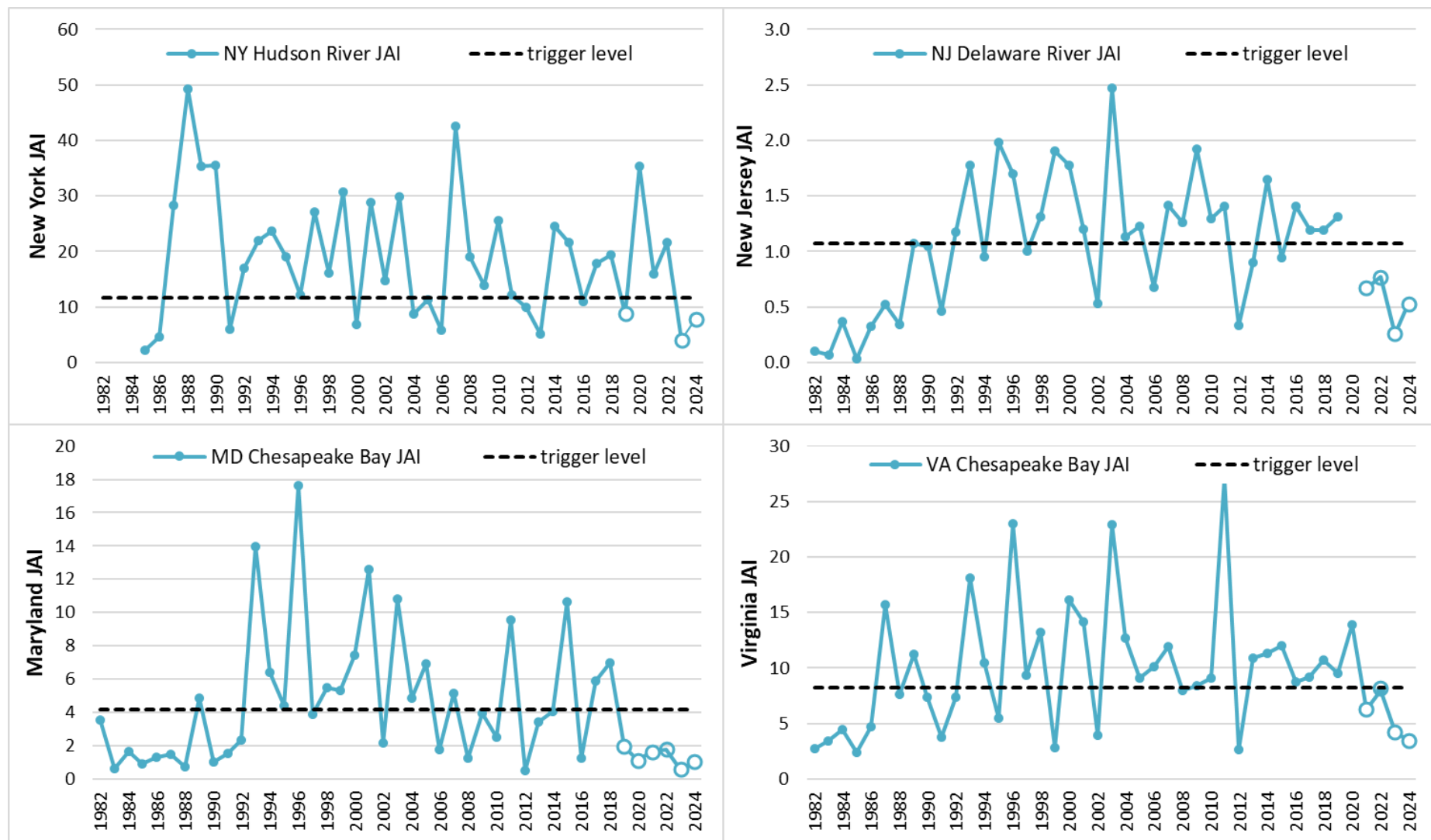


Figure 10. Juvenile abundance indices for New York, New Jersey, Maryland, and Virginia for 1982-2024 with recruitment trigger analysis for recent years. An open circle in the last three years indicates a value below the recruitment trigger level. The recruitment trigger is tripped if a JAI is below the trigger level for three consecutive years. Source: 2025 State Compliance Reports.

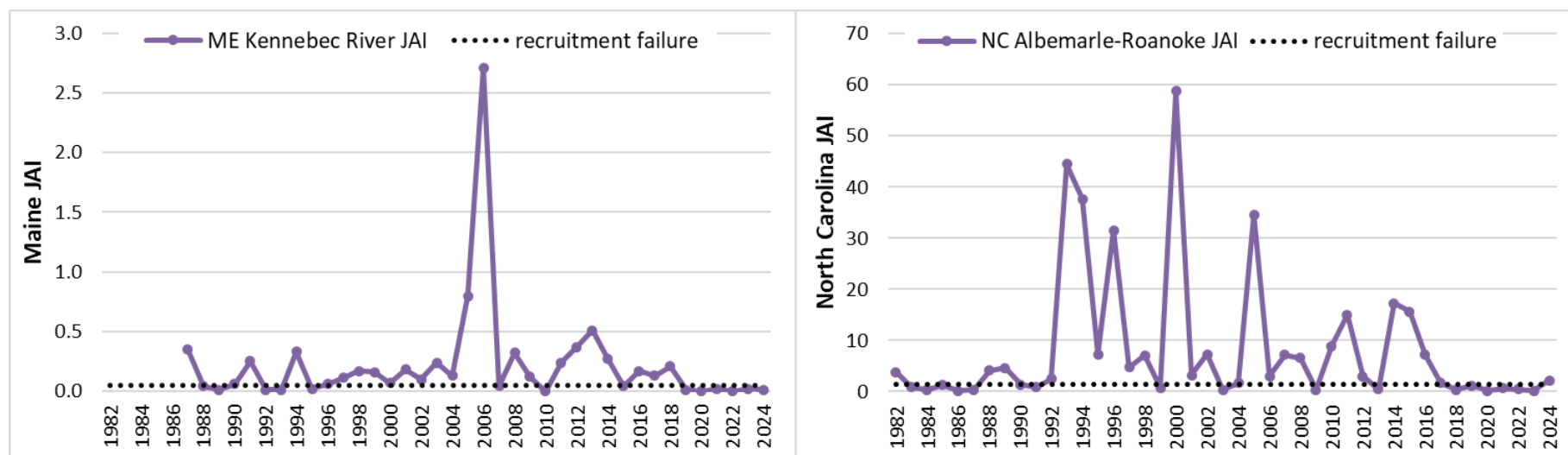


Figure 11. Juvenile abundance indices for Maine and North Carolina from 1982-2022 noting the level of recruitment failure. Source: 2023 State Compliance Reports.



Atlantic States Marine Fisheries Commission

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MEMORANDUM

TO: Atlantic Striped Bass Management Board

FROM: Emilie Franke, Plan Review Team Chair and FMP Coordinator

DATE: July 29, 2025

SUBJECT: State Overviews of Striped Bass Commercial Tagging Program

The Atlantic Striped Bass Management Board tasked the Plan Review Team with reviewing the striped bass commercial tagging program since it has been over a decade since the program was implemented. Requirements for striped bass commercial tagging programs were implemented in 2013 via [Addendum III to Amendment 6](#) to the Interstate FMP for Atlantic Striped Bass and are maintained in [Amendment 7](#) (section 3.1.1).

The PRT and state commercial tagging contacts met via webinar on July 24 and July 30, 2025, with the following meeting objectives:

1. Inform the Board: Compile a summary of each state's tagging program.
2. Look Across Programs: Report any key observations and takeaways across programs, including common challenges faced by multiple states and the various biological metrics used to determine the number of tags for each season.
3. Share Information: Opportunity for states to share best practices and information on common issues, challenges, and solutions.
4. Streamline Reporting: Minimize duplicate information submitted in annual commercial tagging reports vs. annual state compliance reports. Confirm what information is most useful to law enforcement in tagging reports (e.g., tag color) vs. what is more relevant in state compliance reports (e.g., tag accounting).

Each state provided a written overview of their tagging program (enclosed here). An overview of the PRT discussion will be provided during the August 2025 Board meeting with a written report to follow.

Atlantic Striped Bass Commercial Tagging 10-Year Review - Summer 2025
Massachusetts

Massachusetts

Overview of Striped Bass Commercial Tagging Program

A. Striped Bass Commercial Fishery Overview

1. Type of Management (e.g., ITQ, limited entry, etc.):

Open entry

2. Point of Tagging (harvest and/or sale):

Point of sale

3. Number of Participants Receiving Commercial Tags

If a state has gear-specific tags, it is optional to list participants by gear type. At a minimum, please provide some insight into the prevalence of different gears in question #4.

Maryland and Virginia please separate Ocean vs. Chesapeake Bay.

	# Participants Receiving Tags
2020	170*
2021	131
2022	124
2023	128
2024	129

*In 2020, there was a spike in harvesters purchasing the Retail Boat Seafood Dealer permit in order to act as their own dealer and sell fish straight off the boat during COVID.

4. Gears Used (please indicate which are most common):

Rod & reel (no other gears authorized)

5. 2024 Commercial Measures:

Gear	Size Limit	Trip Limit	Quota	Open Seasons*
Rod & Reel	35" minimum size	15-fish Boat-based permits, 2-fish for all other	683,773 lbs	- June 16–September 30: Tuesdays & Wednesdays, with Thursday added on August 1 if $\geq 30\%$ quota remains - October 1–November 15: Monday–Friday if quota remains

Atlantic Striped Bass Commercial Tagging 10-Year Review - Summer 2025

* In 2024, the de facto season was Tuesdays & Wednesdays, June 16 –August 13 (2024 quota filled)

6. *Optional:* Provide any additional information about the commercial fishery the state would like to explain.

The Massachusetts commercial striped bass endorsement is an open entry endorsement. 4,555 endorsements have been issued in 2025. Typically, only about a quarter of issued striped bass endorsements are active in a year. The tradition of open access participation in this fishery has been intended to foster the cultural and historical aspects of the fishery and to support those that may be interested in pursuing fishing as an occupation or as a gateway to other employment in the marine economy. This works in MA given the highly restrictive rules on gear, season/days, and possession limit. Transitioning to point-of-harvest tagging in Massachusetts would necessitate DMF to limit entry and not renew the majority of permits given current administrative resources.

B. Biological Metric, Number of Tags, and Program Operation

1. Describe the biological metric used to determine the number of tags printed and issued to participants:

An average weight of commercially harvested fish from the prior year is used to convert the current year quota in weight to number of fish. Generally, about twice as many tags are ordered as projected to be used to ensure sufficient supply under the dealer-tagging based approach. Tags are distributed to dealers who have declared their intent to act as primary purchasers of striped bass that year according to their prior year purchases, plus a buffer to minimize the need to fulfill in-season requests for additional tags. Buyers with no/limited history receive a minimum default number of tags. Requests for additional tags are fulfilled after reviewing the buyer's in-season transactions, with the amount of tags provided based on their activity level and remaining quota amount.

For example, for the 2025 season, an average weight of 22 lb/fish (based on preliminary 2024 landings/reported tag use and market sampling) was used to estimate that the Commonwealth's 2025 quota of 683,773 lb will require approximately 31,081 tags to fill. DMF ordered a total of 65,000 tags, allowing us to stage extra tags at both our Gloucester and New Bedford offices in case seafood dealers need more throughout the season. DMF reviewed the 2024 purchase history of each Primary Buyer authorized for striped bass purchases and established an initial tag issuance based on the total pounds purchased and an average weight of 22 lb/fish, plus a 20% buffer. Authorized primary buyers with no or limited purchase history received a default initial issuance of 20 tags. Subsequent tag issuances will be completed upon request based on the Primary Buyer's in-season transactions (as

Atlantic Striped Bass Commercial Tagging 10-Year Review - Summer 2025

documented by SAFIS dealer reporting records) and the remaining quota level. An average of 30 in-season requests for additional tags were fulfilled the prior two years.

2. Number of Tags Issued and Tags Not Accounted For:

	# Tags Issued	Percent of Tags Not Accounted For*
2020	46,520	2.98% (1,388)
2021	46,760	1.78% (834)
2022	58,560	1.09% (640)
2023	54,560	1.05% (574)
2024	51,240	1.02% (525)

**Tags not accounted for refers to unused tags that were not returned/not reported as lost.*

3. What is the process and timing for tag distribution? E.g., tags distributed by mail during the month of November before the fishery opens on January 1.

Tags are distributed during the month of May before the fishery opens in mid-June. Depending on dealer location, tags are delivered by DMF staff/Environmental Police, mailed, or picked up at a DMF office.

4. Are tags allowed to be transferred between individuals? If so, how are transfers monitored?

No.

5. Does the state require data about the use of each tag to be reported back to the state? This could include sale date, poundage of each fish tagged, etc.

No.

6. Describe the process for returning and auditing unused tags.

Approximately 2-3 weeks after the season closes, DMF mails an accounting report to each dealer that received tags during the season. The reports identify the number of tags issued to the dealer and the total weight of striped bass they reported purchasing, and asks for the number of tags being returned, the number of tags lost,

and the number of tags damaged. The signed accounting reports and any unused tags are required to be returned to a DMF office within 30 days. DMF staff follow up with phone calls, emails, and letters if needed. DMF then audits the number of tags returned against the calculated number of tags a dealer should have remaining based on the landings reported to the SAFIS database.

7. Describe how the state responds to non-compliance with commercial tagging or reporting requirements (e.g., failure to return unused tags, submit mandatory reports, etc.)?

Discrepancies and delinquent reports are followed up on and dealers found out of compliance may be denied tags the following year. Denial of tag issuance occurs infrequently but the threat acts as a solid deterrent to violating the tag accounting requirements. Delinquent reports have most frequently originated from dealers with no or minimal striped bass purchasing history who receive the default allotment. Dealers who are out of compliance with their SAFIS dealer reporting requirements are not allowed to renew for the following year until their reporting is completed.

C. Program Changes and Challenges

1. Identify any major changes and challenges with the commercial tagging program over the past ten years. Feel free to use the following categories to organize various issues or modify/add categories as needed.

Tag Procurement/Distribution: **During COVID, there was a significant delay in receiving our tag orders from Cambridge Security Seals. Over the past few years that delay is gone and we have received our tags in 2-3 weeks. Between 2016 and 2025 the cost of a tag rose from \$.05 to \$.0906. DMF pays for the tags.**

In terms of distribution, DMF staff now reach out to smaller dealers or dealers with no recent primary buyer history to confirm they want tags before staff drop them off. This minimizes the number of inactive dealers receiving tags and, consequently, the number of unused tags that need to be returned.

Tag Accounting/Return of Unused Tags:

We have found that it is much easier to recover tags and accounting reports if the striped bass season closes before Labor Day. After Labor Day, seasonal businesses close and we spend more time reaching out to businesses to recover tags. With our current quota, regulations, and fish availability the season has been closing prior to Labor Day for the past several years. Fishery dynamics in 2018–2020 that lead to the fishery not taking its quota and thus not closing until December 31

prompted DMF to adopt a November 15 default closure date to aid in tag accounting prior to the end of the year and the onset of the permit renewal season.

DMF's commercial harvester and dealer reporting forms collect the weight of striped bass sold, but not the number of fish, which necessitates the use of average fish weights to conduct tag accounting processes. Consideration is being given to modifying these forms to collect the number of striped bass sold. This would also aid in the enforcement of the striped bass possession limits (which are in numbers of fish).

Enforcement:

Other:

2. For states who tag at the point of sale: Since Draft Addendum III includes an option to require tagging at point or harvest, identify any major challenges the state's commercial tagging program may encounter by transitioning to point of harvest.

The biggest challenge for Massachusetts in transitioning to point of harvest tagging would be the open entry nature of our permit system. For the past three years we have issued over 4,500 commercial striped bass endorsements. At current staffing levels we could not administer a point of harvest tagging program to that many permit holders. We would likely need to limit entry and then reduce the number of permit holders to somewhere between 400 and 500. Administering a tagging program to that number of permit holders would be more feasible. Were DMF to limit entry to the fishery under a harvester tagging requirement, we do not anticipate adopting an Individual Fishing Quota management approach like every other point of harvest tagging state has (and already had when coastwide tagging was instituted). This means that DMF would likely be in a position of needing to either distribute many more tags than required to fill the quota or having to fulfill many in-season requests for additional tags (or both). Additionally, harvesters are more widespread throughout the state, including remote locations (i.e., Martha's Vineyard, Nantucket) than primary buyers, further burdening the process of tag distribution and return.

D. Program Successes

1. Identify how challenges are being addressed/resolved and any other major successes the state would like highlight from the past ten years.

In recent years, DMF received feedback from law enforcement that in some instances striped bass were being dropped off at seafood dealers after hours and in some instances the harvesters were affixing the dealer tags to the fish themselves. In response to this, DMF updated its tagging regulations in 2024 to specifically require both the commercial harvester and primary buyer dealer be present at the primary sale and the fish must be tagged immediately. Law enforcement reports this activity stopped and some dealers started having staff stay later to accept fish after the regulation change.

2. Would the state deem its current tagging program as a success in minimizing illegal harvest? Are there ongoing sources of illegal commercial harvest?

The current tagging program has been successful at increasing accountability at primary buyer dealers and throughout the supply chain. For example, untagged striped bass found at a restaurant or seafood market are easily identified as potentially illegal. This reduces the ability of harvesters to make “back door” deals and not sell to a permitted primary buyer. Law enforcement, however, still deals with illegal commercial harvest by both permitted and unpermitted harvesters at a modest level.



Rhode Island Department of Environmental Management
Division of Marine Fisheries

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TO: Emilie Franke, Fishery Management Plan Coordinator, ASMFC

FROM: Nicole Lengyel Costa, RI DEM, Striped Bass TC Member

DATE: July 18, 2025

SUBJECT: 2025 Overview of Striped Bass Commercial Tagging Program

Please find a copy of Rhode Island's 2025 overview of the striped bass commercial tagging program. Red text throughout this report indicates confidential data. All floating fish trap data, and total commercial pounds landed are confidential. If you have any questions, you may contact me directly at 401.423.1940.

Atlantic Striped Bass Commercial Tagging 10-Year Review - Summer 2025

RHODE ISLAND

Overview of Striped Bass Commercial Tagging Program

A. Striped Bass Commercial Fishery Overview

1. Type of Management (e.g., ITQ, limited entry, etc.):
RI has a limited entry fishery. New licenses are only issued based on the retirement of existing licenses. An exit:entry ratio and detailed prioritization for issuance can be found at: <https://rules.sos.ri.gov/regulations/part/250-90-00-2>
2. Point of Tagging (harvest and/or sale):
Point of sale. Several harvesters are also licensed dealers; therefore, some tagging is already occurring at point of harvest.
3. Number of Participants Receiving Commercial Tags
If a state has gear-specific tags, it is optional to list participants by gear type. At a minimum, please provide some insight into the prevalence of different gears in question #4.
Maryland and Virginia please separate Ocean vs. Chesapeake Bay.

	# Participants Receiving Tags	
	General Category	Floating Fish Trap
2020	23	3
2021	20	C
2022	18	C
2023	18	C
2024	18	C

4. Gears Used (please indicate which are most common):
General category: All gears except gillnet and floating fish trap are allowed. The most common is rod & reel.
Floating fish trap: Restricted to floating fish traps.
5. 2024 Commercial Measures:

Gear	Size Limit	Trip Limit	Quota	Open Seasons
General Category	34"	5 fish pp or 5 fish/vsl	84,465	6/11 – 6/20; 7/9 – 12/31*
Floating Fish Trap	26"	Unlimited**	54,002	4/1 – 12/31

* Closed Thursday, Friday, Saturday, Sunday throughout. Only open until quota reached.

**Once eighty percent (80%) of the seasonal allocation is projected to be harvested, the possession limit shall be five hundred (500) pounds per floating fish trap licensee per calendar day.

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6. *Optional:* Provide any additional information about the commercial fishery the state would like to explain.

The general category (GC) fishery is typically less than 14 days, it was only 8 days on 2025. The GC fishery operate in June – early July and then closes. In some years when the floating fish trap (FFT) quota is not fully harvested by September 15, the RIDEM may transfer pounds to the GC and re-open the GC fishery. There is typically a 2-3 month closure before a GC re-opening. As a result, dealers keep their unused tags after the initial closure because they may need them again in the fall for a re-opening. During this closure period, it is common for tags to be inadvertently discarded or lost.

For 2025, we will be encouraging dealers to return unused tags after the initial GC closure to avoid tag losses. We will then re-issue tags in the fall should the fishery re-open.

B. Biological Metric, Number of Tags, and Program Operation

1. Describe the biological metric used to determine the number of tags printed and issued to participants:

Number of tags printed: Based on the striped bass biological data collected in 2024, the average weights of general category and floating fish trap striped bass were used to estimate the number of tags needed. Based on our Amendment 7 quota (148,889 lbs; 90,822 lbs GC; 58,067 lbs FFT) that would equate to ~4,000 general category and 10,000 floating fish trap tags respectively. The DMF always orders extra tags for a buffer as the number of tags used each year can vary with fish size.

Number of tags issued: Dealers are given an initial allotment of tags based on how timely their reporting was the previous calendar year, e.g., 25-200 tags at a time. Dealers may receive additional tags only if they submit tag reports for each tag they have already used and are up to date with their required Standard Atlantic Fisheries Information System (SAFIS) reporting requirement. Dealers are required to report to SAFIS within 24 hours of purchase so staff can accurately track the commercial quota. If a dealer fails to report in a timely fashion, their allotment amount will be reduced.

2. Number of Tags Issued and Tags Not Accounted For:

	# Tags Issued	Percent of Tags Not Accounted For*
2020	13,760	7%
2021	13,640	12%**
2022	16,210	3%
2023	12,610	1%

Atlantic Striped Bass Commercial Tagging 10-Year Review - Summer 2025

2024	10,030	3%

**Tags not accounted for refers to unused tags that were not returned/not reported as lost.*

*** See section C(1) for further details on 2021*

3. What is the process and timing for tag distribution? E.g., tags distributed by mail during the month of November before the fishery opens on January 1.

Tag distribution begins ~ 1 month prior to the start of a commercial season and occurs throughout the season. Tags are available for pickup M-F, 8:30 – 4pm, at two RIDEM offices in Jamestown and Narragansett.

4. Are tags allowed to be transferred between individuals? If so, how are transfers monitored?

No

5. Does the state require data about the use of each tag to be reported back to the state? This could include sale date, poundage of each fish tagged, etc.

Yes, for each fish purchased, the dealer must report:

- Date landed
- Pounds
- Tag #
- Fisher name
- Fisher license #

6. Describe the process for returning and auditing unused tags.

Dealers are required to submit data reports for all tags used and any unused tags by January 1 the following calendar year. Data reports may be emailed, faxed, mailed or dropped off in person. Unused tags may be mailed back or dropped off in person.

An access database is used to track all striped bass tags distributed, returned as unused, and reported as used. RIDEM staff query the database following the January 1 deadline each year and reach out to dealers to request data reports and unused tags.

7. Describe how the state responds to non-compliance with commercial tagging or reporting requirements (e.g., failure to return unused tags, submit mandatory reports, etc.)?

Atlantic Striped Bass Commercial Tagging 10-Year Review - Summer 2025

Dealers who fail to account for all of their tags, or submit dealer reports late when the season is open, may be restricted the following calendar year. Restrictions may include receiving a reduced number of tags or no tags at all. Dealers who have had their tag allotment reduced, may have it increased again once they demonstrate improved compliance.

For 2026, Marine Fisheries staff plan to coordinate with our Division of Law Enforcement to ensure increased compliance with returning tags and data reports from 2025.

C. Program Changes and Challenges

1. Identify any major changes and challenges with the commercial tagging program over the past ten years. Feel free to use the following categories to organize various issues or modify/add categories as needed.

Tag Procurement/Distribution:

- In 2021, following the covid-19 pandemic, tag distribution changed to reduce the risk of staff becoming sick. The tagging database was queried to determine the number of striped bass typically used by a dealer in a year. The full number of tags was then given to the dealer. This method of distribution ended due to increased non-compliance of returning unused tags and dealers reporting they lost tags when given larger amounts initially.

Tag Accounting/Return of Unused Tags:

- Changes in staff responsibility for the tagging program from 2020 – 2021 led to less rigorous audits in those years and consequently, the % of tags unaccounted for in those years increased.

Enforcement:

- Tagging program staff and DLE intend to work closely in 2026 to ensure increased compliance for returning unused tags and data reports for 2025.

Other:

2. For states who tag at the point of sale: Since Draft Addendum III includes an option to require tagging at point of harvest, identify any major challenges the state's commercial tagging program may encounter by transitioning to point of harvest.

If RI is required to transition to tagging at the point of harvest, there will be several negative consequences and the administrative burden of the program will drastically increase.

- RI currently distributes tags to 18 individuals for our general category fishery. If harvester tagging is required, the number of individuals who will receive

Atlantic Striped Bass Commercial Tagging 10-Year Review - Summer 2025

tags will significantly increase. Since RI does not have an ITQ, a striped bass license, or a striped bass endorsement, RI will be forced to issue tags to any individual with a license authorized to catch and retain striped bass. In 2025, there are currently 1,017 license holders who would be authorized to receive striped bass tags with harvester-required tagging. At a possession limit of 5 fish/person/day, and a commercial general category season that typically lasts a minimum of 8 days, RIDEM may have to distribute 40,680 tags just for the general category fishery. In 2024, 5,030 tags were issued to the general category fishery. This is a potential increase of 35,650 tags that would need to be distributed and accounted for.

- Data from our tautog tagging program, which has point of harvest tagging, shows a similar pattern where the number of tags issued is significantly more than the number of tags used.
 - The tautog tagging program consistently issues ~25,000 tags each year to ~300 harvesters that end up using 12-13k tags.
 - Based on what we have seen with the tautog program, we expect we will have to purchase and distribute significantly more tags if we switch to point of harvest tagging as explained above.
- Our floating fish trap fishery is a high-volume fishery that operates under an unlimited possession limit. Having to tag at the point of harvest would significantly impact their operations by increasing the processing time of catch. The nature of this fishery makes it a very clean fishery with little discards due to their ability to quickly return regulatory discards to the water alive. Increased processing time for catch could impact this aspect of their operation and cause unnecessary dead discards. In recent years, floating fish trap harvesters have also been licensed dealers and typically tag fish at the point of landings.
- Having to purchase an additional 35-40k tags each year will increase costs to RIDEM by \$3500.
- The increased number of tags that would need to be distributed would lead to an increased burden for auditing tags. Staff spend a significant amount of time auditing the tagging data and reaching out to dealers to request that they return their tagging data and unused tags. At this point in time, RIDEM does not have the staff and resources to perform the same auditing procedures if the number of individuals receiving tags and number of tags distributed were to increase to the level described above. This would lead to an increased number of tags that are unaccounted for and could increase illegal activity.
- Switching from dealer to harvester reporting would decrease our ability to closely track our striped bass quota to prevent quota overages. Striped bass dealers are currently required to report landings to SAFIS within 24 hours of purchasing to facilitate quota monitoring and projections. Given that the general category fishery only lasts ~ 8 days, timely quota monitoring is important for preventing overages. The striped bass tagging program is used

Atlantic Striped Bass Commercial Tagging 10-Year Review - Summer 2025

to ensure compliance with the 24-hour dealer reporting rule. Dealers who are non-compliant with the 24-hour SAFIS reporting are not issued additional striped bass tags until they enter compliance. If tagging is harvester based, RIDEM staff will have to resort to taking legal administrative action against the dealer. This is a long process and would not allow for any immediate action to prevent quota overages.

- For example, Dealer A receives 200 striped bass tags. The season opens on Tuesday and Dealer A buys 75 fish on Tuesday and 100 fish on Wednesday. With only 25 tags left, Dealer A comes into the office to get more striped bass tags on Thursday. Staff check our dealer compliance file and see that Dealer A has not reported any striped bass to SAFIS for Tuesday or Wednesday. Dealer A will be refused additional tags until they submit SAFIS reports and provide documentation to prove reports have been submitted.
- If harvesters are required to tag fish, when Dealer A does not report their landings to SAFIS, there is no immediate mechanism to force them to report or even if we know that they are withholding reports. Dealer A ends up reporting their landings the following week, 7 days late, and RI exceeds their annual quota. Administrative action to suspend Dealer A's license could take 6+ months.
- RI DEM DLE is concerned that with up to 40k additional tags being distributed, including to fishers who are not currently active but have a license authorizing the harvest of striped bass, these tags could be placed on fish prior to being sold on the illegal market, making them indistinguishable from a legally sold fish through a licensed dealer. These tags could also be attached to the fish after the season has closed or by recreational fishers who obtained tags from a non-active commercial license holder. Our enforcement efforts would then be focused on the disposition of unused and unreturned tags (attached to illegal market fish, lost, broken) months after these fish were harvested and these cases would be a challenge to prosecute.

D. Program Successes

1. Identify how challenges are being addressed/resolved and any other major successes the state would like highlight from the past ten years.
 - Successes: Increased compliance with dealer reporting that prevents quota overages
 - Challenges: getting dealers to return unused tags and data reports. Staff will be working closely with DLE in 2026 to increase compliance with returning unused tags and data reports.

Atlantic Striped Bass Commercial Tagging 10-Year Review - Summer 2025

2. Would the state deem its current tagging program as a success in minimizing illegal harvest? Are there ongoing sources of illegal commercial harvest?

RI has had a commercial tagging program since 1990, 24 years prior to ASMFC requiring tagging programs. We have consistently had the same program as far as distribution and accounting with the exception of 2021 as described above.

RI views our program as a success with little evidence to support ongoing illegal activity. Additionally, there is no overlap in our commercial and recreational size limits and our GC season is extremely short only lasting 8 days in 2025.

In states that have individual quotas, there is great incentive to sell striped bass in an illegal market and have no record of your individual quota utilization. Point of harvest (POH) tagging gives enforcement the opportunity to prevent this practice and is essential for states with individual quotas. RI does not have individual quotas.

In Rhode Island, the only specific enforcement concerns that POH tagging could help to address is striped bass legally harvested by licensed commercial fishers being sold on the black-market and/or not being reported. However, the RIDEM Division of Law Enforcement believes that this is not a significant issue and very few fish are meeting this outcome.

Most fish being sold at an illegal market are from non-commercial recreational fishers and POH tagging would do little to aid in the enforcement of this issue and could exacerbate it. Recreational fishers would not be allowed to take a commercial-sized striped bass (there is no overlap in sizes like tautog) whether the fish were tagged at POH or not. The same enforcement efforts and actions are going to take place to combat illegal sales of recreational striped bass if there is POH or POS tagging.

Atlantic Striped Bass Commercial Tagging 10-Year Review - Summer 2025
New York

New York

Overview of Striped Bass Commercial Tagging Program

A. Striped Bass Commercial Fishery Overview

1. Type of Management (e.g., ITQ, limited entry, etc.):

Limited entry permit system with non-transferable individual fishing quotas (through tag allotments).

Commercial Striped Bass Harvester Permits (CSBHP) are an “endorsement” on the New York Food Fishing License (FFL). In order to have a CSBHP, you must have a FFL. Permits may only be transferred to immediate family members (as defined by NY law), or in the event of a death of a permit holder, a one-time transfer to non-family members is permitted.

Each CSBHP holder is assigned either a “full” or “part” share of tags. This is determined based on percent of income that comes from commercial fishing activity.

2. Point of Tagging (harvest and/or sale): Harvest

3. Number of Participants Receiving Commercial Tags

If a state has gear-specific tags, it is optional to list participants by gear type. At a minimum, please provide some insight into the prevalence of different gears in question #4.

Maryland and Virginia please separate Ocean vs. Chesapeake Bay.

	# Participants Receiving Tags
2020	407/*
2021	410/392
2022	394/376
2023	396/382
2024	392/379

New York does not issue tags based on gear type. Each CSBHP holder who is in good standing with the department and has renewed on time is eligible to order tags. Not all permit holders buy tags.

The table lists out the “number of participants eligible to purchase tags”/ “number of participants who actually purchased tags”.

**Don’t have the second metric easily accessible for 2020 due to a database change.*

**Atlantic Striped Bass Commercial Tagging 10-Year Review - Summer 2025
New York**

4. Gears Used (please indicate which are most common):

“Striped bass may be taken for commercial purposes by the following gear types only: hook and line, pound net, trap net, gill net with mesh size of 6.00 to 8.00 inch stretched mesh, or as by-catch in otter trawls. It is unlawful to use gill nets to take striped bass, or to possess striped bass while tending any gill net in Great South Bay, South Oyster Bay, or Hempstead Bay. Otter trawl by-catch is limited to 21 striped bass per vessel per trip and must be boxed separately. Gill nets with mesh sizes less than 6.00 inches, or greater than 8.00 inches, are limited to a by-catch of 7 striped bass per trip and must also be boxed separately. All other types of gear are prohibited for the use in taking striped bass, including, but not limited to, haul seines and spears.”

The average percentage of landing by gear from 2020-2024 is as follows:

Gillnet (64%), Hook and Line/Hand Line (24%), Trawl (6%), and Fixed Nets (5%).

5. 2024 Commercial Measures:

Gear	Size Limit	Trip Limit	Quota	Open Seasons
*	Not less than 26" TL nor greater than 38" TL	By tag allocation	595,686	May 15-December 15

** Striped bass may be taken for commercial purposes by the following gear types only: hook and line, pound net, trap net, gill net with mesh size of 6.00 to 8.00 inch stretched mesh, or as by-catch in otter trawls.*

6. *Optional:* Provide any additional information about the commercial fishery the state would like to explain.

B. Biological Metric, Number of Tags, and Program Operation

1. Describe the biological metric used to determine the number of tags printed and issued to participants:

The biological metric used for determining the number of tags is the average weight of fish which comes from NY's fisheries dependent sampling program. Commercially caught fish from markets are weighed, total length is measured, and scales are collected for ageing.

Only data from NY caught/tagged fish is collected. Length and age frequencies of these fish are also used to inform the predicted weight for the next year when calculating tag numbers.

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New York

In addition to the biological metrics, the following factors are considered when calculating the total number of tags issued: the number of permit holders who have renewed, current split between full and part share permit holders, and the amount of tags that went unused and were returned to the department.

Example of how tags are calculated yearly:

Table 3. 2025 Striped Bass Tag Distribution Calculation	
Quota (lbs)	580307
av weight (lbs) per fish market sampling	11.3
2024 comm permits issued	394
# full shares 2024*	316
# part shares 2024*	78
# tags (quota/avg lb per fish)	51354.60177
# tags+ 8% returns (based on 2024 returns)	55462.96991
# tags/394 permit holders	140.7689592
part share allocation (20% of 140)	28.15379183
part share total tags	2195.995763
full share total tags (total tags- part share tags)	53266.97415
full share allocation	168.5663739

2. Number of Tags Issued and Tags Not Accounted For:

	# Tags Issued	Percent of Tags Not Accounted For*
2020	62430	^
2021	67991	1.6%
2022	61000	1%
2023	61601	0%
2024	59502	0.5%

**Tags not accounted for refers to unused tags that were not returned/not reported as lost.*

^don't have the 2020 unaccounted for tags easily accessible due to data base change

**Atlantic Striped Bass Commercial Tagging 10-Year Review - Summer 2025
New York**

3. What is the process and timing for tag distribution? E.g., tags distributed by mail during the month of November before the fishery opens on January 1.

NYSDEC provides Cambridge Security Seals with the list of permit holders and the serial numbers they are assigned. Permit holders purchase their tags directly from Cambridge Security Seals. Cambridge Security Seals has requested an 8-10 week lead time for production, so tag numbers and permit information is sent to the company in late February in order for tags to be in hand by the May 15th start date.

Since DEC does not directly distribute tags to the fishermen, once permit holders receive their tags they must sign and return an “Acknowledgement of Receipt of Tags” form that attests to them receiving the correct number of tags and the correct serial numbers.

4. Are tags allowed to be transferred between individuals? If so, how are transfers monitored?

Tags are currently not allowed to be transferred between individuals in New York and the tag holder MUST be present if the tags are being filled. New York’s Marine Resource Advisory Council (MRAC) and DEC are considering amending regulations to allow tag transfer between commercial striped bass harvester permit holders in the future.

5. Does the state require data about the use of each tag to be reported back to the state? This could include sale date, poundage of each fish tagged, etc.

Commercial fishers must submit vessel trip reports (VTR) for each commercial fishing trip that is taken. VTRs must have the pounds of striped bass landed and the number of tags used. It is not required by regulation that the serial numbers of tags are recorded on VTRs, but it is encouraged.

Additional information collected on the VTRS include:

Harvester Reporting:

Vessel Name	Average Tow/Soak Time	Date Sold
State Reg or Vessel Doc #	NMFS Statistical Area Fished	Port and State Landed
Permit Type and Number	LAT/LONG or Loran of Area	Date/Time Landed
Date/Time Sailed	Fished	
# of Crew	Average Depth	
# of Anglers	Species Fished	
Gear Fished	Pounds of each Species	
Mesh/Ring Size	Kept/Discarded	
Quantity of Gear	Dealer Permit # or Sales	
Size of Gear	Disposition	
# of Haul	Dealer Name	

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New York

6. Describe the process for returning and auditing unused tags.

Unused tags must be returned to the department by December 20 (or 5 days after the close of the commercial season). Tags may be returned in person or by mail. Returned tags are counted by staff and serial numbers are checked. Any permit holder who has two or more tags unaccounted for are notified by mail of their discrepancy. Mailings continue until the discrepancy is resolved. If the permit holder is unable to account for the tags, a signed letter stating that tags are lost is required and held in their file.

7. Describe how the state responds to non-compliance with commercial tagging or reporting requirements (e.g., failure to return unused tags, submit mandatory reports, etc.)?

Permit holders are NOT eligible to receive tags for the current year if they have not resolved reporting and tag compliance issues from the previous year or if they have missed the Commercial Striped Bass Harvester Permit renewal deadline. According to regulation, DEC can deduct the number of tags issued to a fisher if they have not accounted for all the previous year; however, this has not been done since at least 2020, if not earlier.

C. Program Changes and Challenges

1. Identify any major changes and challenges with the commercial tagging program over the past ten years. Feel free to use the following categories to organize various issues or modify/add categories as needed.

Tag Procurement/Distribution:

- Starting in 2015 and due to staffing and logistical constraints at DEC, the department switched from distributing tags in house to having permit holders order tags directly from Cambridge Security Seals.
- The 2022 season saw delays in permit holders receiving their tags in time for NY's May 15 opening date, due to production issues with the tag vendor. This issue caused significant economic impact to fishermen who did not have their tags on opening day. For the 2023 commercial fishing season, the tag vendor increased production lead time for tags from 4 weeks in 2022 to 8-10 weeks. To avoid a delay in 2023 and to accommodate the new production lead time, New York distributed tag order material earlier than the past (late February) to give permit holders ample time to purchase tags before the start of the commercial fishing season and to ensure equitable opportunity for commercial harvesters. DEC has maintained this earlier timeline since 2023 but this has resulted in needing to estimate the number of used/unused tags for the previous fishing year, as well as the number of permit renewals for the current year.

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New York

- New York's regulations (prior to March 7, 2023) stated a \$0.25 price cap on commercial tags. This price cap had become an issue for NY's tag vendor, as they had not had a price increase in many years. To address this issue and to maintain a functioning commercial tagging program, New York filed an emergency rule making in 2023 to remove the \$0.25 price cap. This measure allows for flexibility in the future and avoid subsequent regulatory changes in order to work with tag manufacturers.
- Cambridge Security Seals has had QA/QC issues resulting in permit holders receiving the wrong number of tags or set of serial numbers. Although this has happened consistently the last several years, it appears to be a small percentage of orders based on what has been reported to the department by the permit holders.

Tag Accounting/Return of Unused Tags:

- There have not been any major issues with tag accounting or return of unused tags over the past ten years.
- Staffing and departmental changes, as well as the development of new commercial fisheries databases since 2018, have caused some minor inconsistencies when calculating final numbers year-to-year, but overall the transition has been smooth and percentage of "unaccounted for" tags remains low.
- Tag deductions are a mechanism the department can use to help with tag accounting and compliance, but since at least 2020 tags this has not been utilized. This first began because of administrative and logistical issues related to COVID and has yet to be reestablished as part of the program.

Enforcement:

- Within the last ten years, Law Enforcement requested that the permit numbers be printed on the commercial tag. Law Enforcement has found this effective.

Other:

- In 2024, NY went over commercial harvest by ~15k pounds. This is likely due to both fish availability (2015 and 2018 year class in the slot) and also heavier fish. Additionally, in 2024 DEC was less conservative with their "unused tag rate" buffer. This was driven by a requests by the Marine Resources Advisory Council and their concern with consistent underharvest of commercial quota in NY prior to 2024.

From 2024 Tagging Report:

"In previous years, including 2023, tag determinations were based on an observed trend in the fishery which showed an 8% return rate of tags. This 8% has been used as a buffer to increase finalized tag allocations. The quota utilization rate has been increasing in recent years, but still falls short of full utilization. For 2024, we are using an 11% tag

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New York**

return rate/buffer for our tag allotment calculations. This percentage was selected in consideration of the 4,000 unaccounted for 2023 tags (as of January 2024 when the allotments were calculated) and with the assumption that half of the tags will be returned, and half will be used. While this is a slightly less conservative approach, the tag utilization trends, the size and numbers of available fish projected to fall in the 26-38" slot size, and the consistent underharvest from the commercial fishery provides confidence that we will not overharvest during the 2024 season. Additionally, to safeguard against overharvest, our regulations allow us to close the fishery if the harvest is projected to be over quota, despite issuance of tags to all permit holders."

- 2. For states who tag at the point of sale: Since Draft Addendum III includes an option to require tagging at point or harvest, identify any major challenges the state's commercial tagging program may encounter by transitioning to point of harvest.**

The Addendum III option that may require point of harvest tagging will not affect New York as point of harvest tagging is already required in New York.

D. Program Successes

- 1. Identify how challenges are being addressed/resolved and any other major successes the state would like highlight from the past ten years.**

Tag Procurement/Distribution:

- To eliminate the need to estimate the number of permit renewals each year, DEC is proposing a regulatory change to amend the permit renewal deadline from April 15 to February 15. This will provide more precise metrics for calculating tag allotments.

Tag Accounting/Return of Unused Tags:

- DEC commercial data management staff continually work on ways to improve data entry methods to have more timely and precise tag accounting.
- DEC staff is developing a protocol to begin docking tags in a standardized way, including keeping detailed records of permit holders who are late on reporting or who consistently lose tags.
- DEC is exploring switching tag distribution back to in house rather than directly from the tag company. This will allow for greater oversight over the tags, reduce QA/QC concerns from the tag company, and make it easier to reinstate the tag docking protocol.

Other:

- Quota was reduced in 2025 to account for the 2024 overage

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New York

- For 2025 tag calculations, the “unused tag rate” buffer was returned to 8% (down from 11% in 2024) since quota was more fully utilized than past years. This reflected what was seen in the fishery.
- Besides 2024, NY has generally harvested under quota, indicating the yearly tag allotment calculation system has been successful.

2. Would the state deem its current tagging program as a success in minimizing illegal harvest? Are there ongoing sources of illegal commercial harvest?

According to NYSDEC and Law Enforcement staff:

“We are happy with our current tags and point of harvest tagging as a deterrent of illegal sales. I agree, the change of having the permit number on the tag to make sure the tags are being used by the actual holder has had an impact on the illegal sharing of tags. We are never going to be able to stop all illegal harvest and sales, but the system does have a significant impact.”

“It minimizes illegal harvest. There is likely poaching and illegal commercialization ... hear most often anecdotal comments about restaurant sales.”

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Delaware

DELAWARE

Overview of Striped Bass Commercial Tagging Program

A. Striped Bass Commercial Fishery Overview

1. **Type of Management (e.g., ITQ, limited entry, etc.):** ITQ, limited entry
2. **Point of Tagging (harvest and/or sale):** Point of tagging was changed by the legislature from harvest to “before landing or putting on shore” in 2015.

3. Number of Participants Receiving Commercial Tags

If a state has gear-specific tags, it is optional to list participants by gear type. At a minimum, please provide some insight into the prevalence of different gears in question #4.

Maryland and Virginia please separate Ocean vs. Chesapeake Bay.

	# Receiving Tags				# Receiving Tags		
	GN	HL	Total		GN	HL	Total
2016	111	122	233	2021	111	141	252
2017	111	131	242	2022	111	133	244
2018	111	150	261	2023	111	130	241
2019	111	138	249	2024	111	130	241
2020	111	128	239	2025	111	126	237

4. **Gears Used (please indicate which are most common):** Three types of gear are used to harvest Delaware’s commercial quota. The primary gear is anchored gill net. Three to five licensees fish only drift net annually. Lastly, hook and line harvest is responsible for less than 1% of the annual total quota.

5. 2024 Commercial Measures:

Gear	Size Limit	Trip Limit	Quota (lbs)	Open Seasons
Anchor Gill Net	≥20"	None	Per license 1134, Total 125,876	Feb 15 - April 27*
Drift Gill Net	≥20"	None	Per license 1134, Total 125,877	Feb 15 - May 31*
Hook and Line	≥28"	None	Per licence 51, Total 6,625	April 1 - Dec 31

*if <98% of quota is caught during spring season, then DE opens a fall GN season beginning November 15 with a min size of 28"

6. Optional: Provide any additional information about the commercial fishery the state would like to explain.

Although Delaware issues 111 commercial Striped Bass gill net licenses annually, only 35 to 40 are fished annually due to ITQ. Transfers must occur prior to the season start date which reduces the number of fishers whose tags Delaware has to track. Delaware also incorporates weigh stations which serve as a second point of harvest verification. Weigh stations are responsible for attaching a second tag to each fish and call in each licensed fisher's catch daily. Tag color for both fisher and weigh station tags changes on a rotating basis every year.

B. Biological Metric, Number of Tags, and Program Operation

1. Describe the biological metric used to determine the number of tags printed and issued to participants:

DDFW uses metrics such as average weight from previous years' landings and estimated year class strength of striped bass recruiting to the commercial gear to inform the decisions on the number of tags needed for the upcoming season. However, these biometrics do not describe the future year's tag needs completely. Due to the manner in which tags are administered by DDFW licensing, an overage must be built in to provide for multiple weigh stations and all 111 licensees receiving the same amount of tags initially, regardless of fishing effort, latency, or transfers. Furthermore, while the spring gill net fishery targets larger (>26") striped bass that can be sold in NY, the size limit for this fishery is 20" and the fishery will target smaller fish under certain conditions, so the number of tags ordered must also account for that situation.

2. Number of Tags Issued and Tags Not Accounted For:

	# Tags Issued GN	# Tags Issued HL	Percent of Tags Not Accounted For*
2020	16,650	896	<1
2021	16,650	846	<1
2022	16,650	931	<1
2023	16,650	650	<1
2024	16,650	650	0

**Tags not accounted for refers to unused tags that were not returned/not reported as lost.*

3. What is the process and timing for tag distribution?

Tags are ordered in November so they are available for distribution to fishers February 1st of each year for the February 15th start date.

4. Are tags allowed to be transferred between individuals? If so, how are transfers monitored?

Tags can be transferred between individuals but such transfers must be done prior to the start of the season. Each quota is allocated 150 tags with unique numbering. When a quota is transferred, tags with specific numbers assigned to that quota are given to the individual licensee in which the quota is transferred to.

5. Does the state require data about the use of each tag to be reported back to the state? This could include sale date, poundage of each fish tagged, etc.

Cumulative weight and number of fish is reported for each licensed individual via an IVR (Interactive Voice Response) system daily and again via monthly fisher reports. Catch date, license number, cumulative weight and number of fish are reporting elements.

6. Describe the process for returning and auditing unused tags.

Fishers return tags to the Division when their quota is filled. The number of tags returned is checked against IVR reports and harvest logs.

7. Describe how the state responds to non-compliance with commercial tagging or reporting requirements (e.g., failure to return unused tags, submit mandatory reports, etc.)?

Unused tags, including broken tags, are required to be turned into the Division along with a Daily Striped Bass Catch Report by June 30th of the year. Non-compliant individuals are not issued quota for the following year.

C. Program Changes and Challenges

1. Identify any major changes and challenges with the commercial tagging program over the past ten years. Feel free to use the following categories to organize various issues or modify/add categories as needed.

Tag Procurement/Distribution:

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Product quality went down and price went up using former vendor. A new vendor is now used, resulting in a more reliable product at a lower cost. Fisher tags have a tensile strength of roughly 110 lbs while weigh station tags are not nearly as strong. Price of tags will increase with quality and strength of tag type. Weigh station tags are much cheaper as they do not have the strength of fisher tags.

Tag Accounting/Return of Unused Tags:

Fishers are required to turn in any unused tags after the season. This includes the small proportion (<1%) of broken or defective tags. Over the years, the Division has had very few instances of tag loss – blown overboard, out of vehicles, etc. but these losses have been called in immediately by the fisher.

Enforcement:

Enforcement officers routinely check fishers at landing sites and weigh stations. On the water inspections have occurred but are not common.

Other:

2. **For states who tag at the point of sale: Since Draft Addendum III includes an option to require tagging at point or harvest, identify any major challenges the state's commercial tagging program may encounter by transitioning to point of harvest.**

D. Program Successes

1. **Identify how challenges are being addressed/resolved and any other major successes the state would like highlight from the past ten years.**

Weigh stations present a conflict of interest in some cases. But having a weigh station is generally viewed as a privilege and the Division, in conjunction with enforcement, heavily scrutinizes weigh station applications and the number of weigh stations is capped.

2. **Would the state deem its current tagging program as a success in minimizing illegal harvest? Are there ongoing sources of illegal commercial harvest?**

Providing independent verification and generally doing more to abate illegal harvest, DE feels that any illegal activity has been minimized. It is DE's belief that multiple means of verification minimizes illegal activity.

MARYLAND

Department of Natural Resources (MDNR)

Overview of Striped Bass Commercial Tagging Program

A. Striped Bass Commercial Fishery Overview

1. Type of Management (e.g., ITQ, limited entry, etc.):
Maryland currently manages limited entry ITQ (Individual Transferable Quota) fishery. For many years there was a small limited entry derby fishery (Common Pool) being managed in parallel with the ITQ. However, the last year for Common Pool was 2024. In 2025 and forward, ITQ is the only option.
2. Point of Tagging (harvest and/or sale):
“At harvest”. Per Maryland’s regulation, fish must be tagged (1) Immediately to a striped bass harvested by hook and line; (2) Within 200 yards of the pound net to a striped bass harvested from a pound net; or (3) Before removing a striped bass from a boat or removing a boat from the water, to a striped bass harvested by any other gear.
3. Number of Participants Receiving Commercial Tags
If a state has gear-specific tags, it is optional to list participants by gear type. At a minimum, please provide some insight into the prevalence of different gears in question #4.
Maryland and Virginia please separate Ocean vs. Chesapeake Bay.

	# Coastal Participants Receiving Tags Initially at the Beginning of the Season	# Bay Participants Receiving Tags Initially at the Beginning of the Season
2020	45	802
2021	44	786
2022	45	777
2023	44	746
2024	47	758

*Number of participants changes throughout the year based on transfers of permits/share/allocation, and tags. “# of Participants Receiving Tags” in the table above are the amount of people issued tags at the beginning of each season.

*The maximum number of permits available to the fishery is 1,231. A commercially licensed harvester must also have a permit in order to fish for striped bass.

4. Gears Used (please indicate which are most common):

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Gill Net (Drift and Anchored, anchored only allowed in Ocean)

Hook -n- Line (Bay only)

Pound Net (Bay only)

Haul Seine (Bay only)

Otter and Beam Trawl (Ocean only)

Pound net and gill net are used more commonly in the Bay Fishery. Gill net is most commonly used in the coastal fishery.

5. 2024 Commercial Measures:

Gear/Region	Size Limit	Trip Limit	2024 ASMFC Quota	Open Seasons
Chesapeake Bay: pound net	18-36" TL	none for ITQ	1,344,217 pounds*	June 1-Dec 31
Chesapeake Bay: haul seine	18-36" TL	none for ITQ		Jan1-Feb 29, June 1-Dec 31
Chesapeake Bay: hook and line	18-36" TL	none for ITQ; common pool 250 lbs/permittee/week		June 1-Dec 31; common pool- 2 days out of the month only
Chesapeake Bay: gill net	18-36" TL	none for ITQ; common pool 300 lbs/permittee/week		Jan1-Feb 29, Dec 1-31; common pool- 2-3 days out of the month only
Atlantic Ocean: gill net and trawl	24" TL min	none	82,857 pounds**	Jan 1-May 31, Oct 1-Dec 31

*The 2024 Chesapeake Bay quota of 1,445,394 pounds was already allocated to permit holders prior to when Addendum II reductions were made. Any overage will be subtracted from the 2026 quota.

**The 2024 Chesapeake Bay quota of 89,094 pounds was already allocated to permit holders prior to when Addendum II reductions were made. Any overage will be subtracted from the 2025 quota.

***Common Pool openings/limits dependant on available quota each month. Common Pool is no longer an option in 2025 and forward.

6. *Optional:* Provide any additional information about the commercial fishery the state would like to explain.

B. Biological Metric, Number of Tags, and Program Operation

- Describe the biological metric used to determine the number of tags printed and issued to participants:

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Average fish weight by fishery location and gear type. DNR's field biologists sample fish at check stations to determine this.

2. Number of Tags Issued and Tags Not Accounted For:

	# Tags Issued	Percent of Tags Not Accounted For*
2020	500,320	9.8%**
2021	525,000	17.9%**
2022	442,850	3.8%
2023	441,600	6.5%
2024	441,000	5.9% (Preliminary)

**Tags not accounted for refers to unused tags that were not returned/not reported as lost.*

***Tag return began at the start of 2020, however, when the COVID pandemic started in mid-March, the process of tag return was halted. There was a two-year tag return process in 2022 of which permittees were asked to return unused tags from both 2020 and 2021. Information from the industry to MDNR reported discarding tags thinking the tag return process would not occur given the continuing pandemic.*

3. What is the process and timing for tag distribution? E.g., tags distributed by mail during the month of November before the fishery opens on January 1.

From July 1 to July 14, staff calculate what each permittee is required to pay for tags. This is done using each permittee share percentage, a guesstimate on the upcoming years quota, and a guesstimate on the per tag cost.

DNR's license renewal and permit declaration period runs from July 15 to September 15. At this time permittees pay for their tags.

After the quota is officially set, staff then determine how many tags each permittee requires in mid October to mid November. Using DNR biologist data on weight per fish per fishery and gear, this is divided into each permittees allocation pounds to determine the number of tags required.

In late November to early December, staff provide the vendor with a list of permittee, their mailing address, and then number of tags required for each permittee. The vendor produces the tags and ships them to the permittee via certified mail. The return address

on the shipments is DNR's address so that staff are aware of undeliverable tags. The vendor supplies DNR with the unique tag numbers for each permittee.

4. Are tags allowed to be transferred between individuals? If so, how are transfers monitored?

Yes, tags are able to be transferred between permit holders. Permit holders are required to fill out this form and submit it to MDNR.

https://dnr.maryland.gov/fisheries/documents/2025_Tag_Transfer_Form.pdf

Permittees are required to fill out the tag sequence numbers being transferred and the total number of tags being transferred. Permittees also provide a total number of fish harvested at the time of requesting a transfer.

5. Does the state require data about the use of each tag to be reported back to the state?

This could include sale date, poundage of each fish tagged, etc.

No. MDNR biologists will sample striped bass at check in stations to obtain data on pound per fish, etc...

Permittees and Check Stations are only required to provide total poundage and total number of fish per day on the permit holders permit card.

Permittee are also required to send in either monthly paper harvest reports, daily electronic harvest reports, or use SAFIS to report. The fish are required to be weighed and counted at check stations. Check stations are required to either send in weekly paper reports or daily electronic reports.

6. Describe the process for returning and auditing unused tags.

Permit holders are notified of tag return bins placed around the state. These bins are placed at locations such as Natural Resource Police field offices, MDNR fisheries field offices, major landing locations, etc... The unused tags are required to be dropped off in these bins by March 31 along with a signed Tag Return Affidavit. DNR staff collect the tags multiple times at each location during the tag return period. These unused tags are then returned to MDNR's office, identified to the assigned permit holder, and counted.

If tags are lost by the permit holder, thus unable to be returned to MDNR, an incident report must be submitted to Maryland's Natural Resource Police. This report is sent to MDNR's permitting staff.

7. Describe how the state responds to non-compliance with commercial tagging or reporting requirements (e.g., failure to return unused tags, submit mandatory reports, etc.)?

Maryland Natural Resources Police would handle enforcement of non-compliance in their normal course of business. There are fines and administrative penalties (i.e., license suspension or revocation) that are tied to different types of violations. The Fine and Bond Schedule is available [here](#), which lays out the fines that would be administered by the Maryland District Court, and the commercial penalty schedule is available [here](#). Any striped bass violation that leads to at least 10 points results in the suspension of the licensee for the next practicable quota year in the striped bass fishery. Any violation or set of violations that result in an individual having 35 points or more on their license would lead to revocation from Maryland's commercial fisheries.

C. Program Changes and Challenges

1. Identify any major changes and challenges with the commercial tagging program over the past ten years. Feel free to use the following categories to organize various issues or modify/add categories as needed.

Tag Procurement/Distribution:

The time between ASMFC setting the annual quota and tag distribution can be short some years. Furthermore, the vendor producing the tags is requiring more time in order to complete orders before mid-December.

Tag Accounting/Return of Unused Tags:

This is very time consuming for staff.

Enforcement:

Maryland would expect that the Law Enforcement Committee (LEC) would have accurate input on enforcing our tag program and will defer this question to them.

Other:

Considering the vendor produces tags in bags of 100, there can be quite a lot of unused tags leftover at the end of the harvest year. This can seem wasteful to some in the industry. On average, 20% of the tags are returned unused.

MDNR's license season runs from September 1 to August 31. This is different from ASMFC striped bass harvest season (January 1 to December 31). When permit holders are renewing their licenses and permits, they are required to pay for tags at

this same time. The differences between ASMFC harvest season and MDNR's license season requires MDNR to guesstimate the upcoming quota to determine what each permit holder is required to pay for tags (based on their percent share) during the pre-season declaration window.

The license year/calendar year issue as described above also means that there are often concerns about getting tags to individuals on time. In Maryland, this is a huge concern because commercial harvest opens starting on January 1 when the market is often at its highest. In addition, because permittees are using last year's tags up until December 31 and then the present year starting on January 1, this means permittees need to be very careful to grab the tags with the right year starting on January 1.

Tags are increasing in cost.

The Tag Compliance report is due prior to when MDNR has not completed collecting and processing unused tags. If the report deadline could be extended to mid-summer this would make all the information available within the report.

2. For states who tag at the point of sale: Since Draft Addendum III includes an option to require tagging at point or harvest, identify any major challenges the state's commercial tagging program may encounter by transitioning to point of harvest.

N/A

D. Program Successes

1. Identify how challenges are being addressed/resolved and any other major successes the state would like to highlight from the past ten years.
The current challenges of the tagging program are mostly related to the timing of quota decisions made by the Board and staff resources used to collect and record all of the unused tags. In order for Maryland to address these challenges, MDNR would need changes to the 'quota year' and the requirements to collect all unused tags and account for them to the specific individual. While this would help MDNR, it is understood how this concept could be difficult for other states and it would ultimately reduce individual accountability which isn't something desired.
2. Would the state deem its current tagging program as a success in minimizing illegal harvest? Are there ongoing sources of illegal commercial harvest?

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The current tagging program is a success when compared to the program operating during the derby fishery (pre-2015). MDNR staff are not aware of any ongoing sources of illegal harvest related to the tagging program. Similar to the question above about enforcement, LEC feedback should be sought out to provide details on current/ongoing illegal harvest related to tagging.

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PRFC

Potomac River Fisheries Commission
Overview of Striped Bass Commercial Tagging Program

A. Striped Bass Commercial Fishery Overview

1. Type of Management (e.g., ITQ, limited entry, etc.):

The Potomac River Fisheries Commission (PRFC) manages the striped bass tagging program by limiting entry for various gear types. The gear types include gill net, pound net, hook and line, fyke net and haul seine.

2. Point of Tagging (harvest and/or sale):

Point of harvest – striped bass tags must be applied as soon as feasible and in no event shall any commercially caught striped bass be removed from the Potomac River or from the boat at the point of landing, whichever occurs first, without said tag being permanently affixed. The words “as soon as feasible” mean for the i) Commercial Hook & Line fishery – as soon as the fish is taken and before it is put into the cooler or storage area; ii) Pound Net fishery – as soon as the fish are taken and before the boat leaves the net site; and iii) Gill Net fishery – as soon as each separate piece of net is fished and before the boat leaves the net site.

3. Number of Participants Receiving Commercial Tags

If a state has gear-specific tags, it is optional to list participants by gear type. At a minimum, please provide some insight into the prevalence of different gears in question #4.

Maryland and Virginia please separate Ocean vs. Chesapeake Bay.

	# Participants Receiving Tags
2020	267
2021	265
2022	265
2023	258
2024	263

4. Gears Used (please indicate which are most common):

Gear types: **gill net, pound net, hook and line**, fyke net and haul seine. **Bolded are most common.**

5. 2024 Commercial Measures:

Gear	Size Limit	Trip Limit	Quota	Open Seasons
Hook & Line	Jan. 1 – Feb. 14: 18.0" min. Feb. 15 - Mar. 25: 18.0" - 36.0" slot Jun. 1 – Dec. 31: 18.0" min.	NA	76,222 lbs.	Jan. 1 – Mar. 25, 2024 Jun. 1 – Dec. 31, 2024
Pound Net	Feb. 15 - Mar. 25: 18.0" - 36.0" slot Jun. 1 – Dec. 31: 18.0" min.	NA	118,806 lbs.	Feb. 15 - Mar. 25, 2024 Jun. 1 - Dec. 15, 2024
Misc. Gear (Haul Seine & Fyke Net)	Feb. 15 - Mar. 25: 18.0" - 36.0" slot Jun. 1 – Dec. 31: 18.0" min.	NA	12,786 lbs.	Feb. 15 - Mar. 25, 2024 Jun. 1 - Dec. 15, 2024
Gill Net	Nov. 7 - Dec. 31, 18.0" min Jan. 1 - Feb. 14, 18.0" min Feb. 15 - Mar. 25, 18.0" - 36.0" slot	NA	349,405 lbs. *	Nov. 6 - Dec. 31, 2023 Jan. 1 – March 25, 2024

* Gill net quota does not reflect the 7% reduction in 2024 due to the season ending March 25, 2024. The 7% reduction is reflected in the next gill net season (2024-2025).

6. *Optional: Provide any additional information about the commercial fishery the state would like to explain.*

Since 2008, the PRFC has managed the gill net fishery on a split year season to improve the procedure for issuing tags for the gear. For example, the 2024 quota year's gill net season began on November 6, 2023 and ended March 25, 2024. Prior to the split year season, the procedure was extremely cumbersome and required significant staff time during the busiest time of the year for the PRFC office. To better serve the stakeholders and improve the efficiency of the tagging program, the PRFC shifted to a split year season which allowed for a shift of the gill net tag issuance to occur in November ahead of the license renewal period for the other gear types and for gill net tag reconciliation to occur in April once the license renewal period has ended.

B. Biological Metric, Number of Tags, and Program Operation

1. Describe the biological metric used to determine the number of tags printed and issued to participants:

The PRFC uses the average weight of a fish by gear type for the last full year of data to calculate how many tags should be issued to each license/licensee for the next season. Pound

net, hook and line, fyke net and haul seine can harvest for most of the year which requires PRFC to use the average weight of fish from the 2023 season to allocate tags for the 2025 season. Gill net is only a 5-month season thus the reporting for this gear is near-final by the time the next season begins so the 2023-2024 season's average weight of fish can be used to calculate the allocation for the 2024-2025 season.

The PRFC submits orders for next year's tag shipment in July and are typically received by the Commission in October. The tags are then organized and checked for quality control prior to issuing to harvesters. The following formula is used to calculate the number of tags ordered and allocated to each harvester by gear type.

The PRFC commercial striped bass quota for 2025 is 532,761 pounds. The gill net, pound net and hook & line fisheries are limited entry and are allocated tags per license. Note one person may hold multiple of one or more types of these licenses. Miscellaneous gears such as fyke net and haul seine are allocated per qualified licensee. To be considered a qualified licensee, the harvester must have reported landing any fish species in the gear for at least three consecutive years before being eligible to harvest striped bass from that gear.

GN quota = 324,947 lbs. H&L quota = 76,222 lbs.

PN quota = 118,806 lbs. Misc. quota = 12,786 lbs.

		<u># of Tags Ordered</u>
GN:	324,947 lbs. / 7.3 (2023-2024 avg. weight of fish) = 44,513 tags	GN: 46,000
	44,513 tags / 710 GN licenses = 63 tags/license	
PN:	118,806 lbs. / 4.8 (2023 avg. weight of fish) = 24,751 tags	PN: 26,000
	24,751 tags / 100 PN licenses = 247 tags/license	
H&L:	76,222 lbs. / 4.9 (2023 avg. weight of fish) = 15,555 tags	H&L: 19,000
	15,555 tags / 205 H&L licenses = 75 tags/license	
Misc:	12,786 lbs. / 5.4 (2023 avg. weight of fish) = 2,367 tags	Misc: 4,000
	HS (60%) = 1,420 tags / 14 (# qualified licensees) = 100 tags	
	FN (40%) = 946 tags / 12 (# qualified licensees) = 78 tags	

Note: The PRFC orders approximately 1,500 additional tags for each gear to account for replacing any lost, broken, or defective tags. For the hook and line gear, the PRFC orders a larger buffer of ~3,500 tags due to a policy that allows a gill net license to be converted into a hook and line license during the renewal season. Historically this policy only converted 3-5 licenses annually, but for the 2024 and 2025 renewal periods over 45 licenses in total have been converted. This unexpected change in behavior in 2024 required the Commission to place an additional order in January 2024 to guarantee there were enough tags for this gear given the influx of participants. Since the trend from 2024 continued into the 2025 renewal period, the Commission now orders enough tags to accommodate an additional 30 licenses in the fishery.

2. Number of Tags Issued and Tags Not Accounted For:

	# Tags Issued	Percent of Tags Not Accounted For*
2020	80,718	0.43%
2021	81,370	0.19%
2022	83,616	0.24%
2023	79,368	0.39%
2024	87,713	0.53%

**Tags not accounted for refers to unused tags that were not returned/not reported as lost.*

3. What is the process and timing for tag distribution? E.g., tags distributed by mail during the month of November before the fishery opens on January 1.

All tags must be picked up in-person at the PRFC office by the harvester or a designee and sign that they have received the correct sequences of tags. For the gill net fishery, harvesters can pick up tags and renew their licenses beginning November 1st in preparation for the season to begin the second Monday in November. For pound net and fyke net, the nets must be set and verified by law enforcement prior to any tags being issued for these gears which is first legal beginning February 15th each year. For haul seine, the net must be verified and sealed by PRFC staff prior to tags being issued. For hook and line gear, tags can be issued at the time of license renewal beginning December 1st for the season to begin January 1st. For all gears, prior to issuing tags for the next season, all tags must be accounted for from the previous season. See question #6 for more details about the accounting process.

4. Are tags allowed to be transferred between individuals? If so, how are transfers monitored?

Tags are only allowed to be transferred between participants of the Hook and Line Exchange Program where hook and line licensees may opt-in to receive tags from those licensees who do not intend to fish either their whole or partial quota allocation. The licensee receiving tags must have reported use of 100% of their personal tag allocation, be up to date on harvest reporting, and have no fishing violations or tag accounting issues for the past three years to be able to receive any additional tags. All transfers of tags must be done in person at the PRFC office so that the sequencing of tags is accounted for properly in our database.

5. Does the state require data about the use of each tag to be reported back to the state? This could include sale date, poundage of each fish tagged, etc.

Harvesters are required to report trip level data including species, market grade category, gear, quantity of tags, total poundage, area fished, port of landing, and effort on their mandatory weekly harvest reports. PRFC does not collect any additional data on a per tag/fish basis.

6. Describe the process for returning and auditing unused tags.

Harvesters are encouraged to return any unused tags to the office once the season is over and prior to the start of the next fishing season. For example, the gill net season ends March 25th each year, so many harvesters return unused tags in April and May. For the other gears, most of the unused tags are returned to the Commission at the time of renewal for the next season. All returned tags are kept in office until July 1 of the following year to allow for auditing should a harvester note a discrepancy with their count compared to the database. After July 1, the returned tags and any unissued tags are disposed of at the local landfill.

Prior to issuing tags for the next season, harvester must account for all tags that were issued to them from the previous season. If there are any discrepancies, a one-for-one penalty is applied to next season's allocation. For example, if 20 tags remain unused for a harvester from the 2025 season and they have completed all their reporting for the season, 20 tags will be audited from their 2026 season allocation to reconcile for the unaccounted tags. If the harvester can supply the missing tags at any point throughout the 2026 season, PRFC staff will release tags equivalent to what was returned, up to the current year's allocation. If the harvester believes the number of unaccounted tags is a data error in the system, they can opt in to an official audit where PRFC staff validate all physical harvest reports against the database. If the records were entered correctly into the database, a \$25 administrative fee is collected from the harvester and a one-for-one penalty is applied to the next season's allocation. If there were data entry errors on part of the PRFC staff, no fee is applied. If the submitted reports differ from what the harvester believes is accurate, they must provide proof via buyer/dealer tickets and their logbook to qualify to amend a report.

7. Describe how the state responds to non-compliance with commercial tagging or reporting requirements (e.g., failure to return unused tags, submit mandatory reports, etc.)?

Beyond the typical audit process occurring at license renewal, the PRFC may call to a hearing any harvesters who are delinquent in their harvest reporting for any species. The Commission may also call individuals who have outstanding remaining tag balances or if there is suspicious activity regarding the use of their tags. At the hearing, the Commission may revoke striped bass privileges, suspend licenses, place licensees on probationary periods, refuse to issue tags, and/or audit tags from future seasons depending on the severity of the case.

C. Program Changes and Challenges

- 1. Identify any major changes and challenges with the commercial tagging program over the past ten years. Feel free to use the following categories to organize various issues or modify/add categories as needed.**

Tag Procurement/Distribution:

Manufacturer issues: Since the beginning of the striped bass tagging requirement, the PRFC used the vendor Tyden Brooks to produce the tags. In 2023, the company unexpectedly was unable to produce the order at a reasonable price due to having a new high volume order taking priority over routine annual orders. There was a very short deadline to find a replacement vendor but by reaching out to other states, a new supplier was found in time for the season to start. Since 2023, the Commission has purchased tags from Sierra Group LLC and have been satisfied with the quality and experience. It is also important to note that striped bass tags are purchased by the PRFC with funding from a five-year NOAA grant and no cost of the product is passed on to the harvester.

Tag Accounting/Return of Unused Tags:

The majority of tags are returned at the time of renewal for the next season's license. This is one of the busiest times for PRFC staff thus returned tags are not always able to be sequenced due to the volume staff receives during a short timeframe. Most often, PRFC staff only have time to count the quantity of tags returned and verify against the remaining tag balance. This can lead to some data entry errors that are difficult to research as the sorting of the returned tags is not an easy endeavor. To address this issue, the Commission is creating a return log that requires the harvester's signature to help cut down on the confusion of tag returns in the future.

Enforcement:

There are three jurisdictions that manage waters of the Potomac River and its tributaries: PRFC, Maryland Department of Natural Resources and Virginia Marine Resources Commission. PRFC regulations are enforced jointly by the Maryland Natural Resources Police and the Virginia Marine Police. Since many of the harvesters hold licenses of the other state/jurisdictions, PRFC, MD, and VA each have regulations in place that prohibit a harvester from possessing another state/jurisdiction's striped bass tags while fishing in the respective area. This is largely one of the bigger enforcement issues in the Potomac River since the boundaries that define the territories, although physically demarcated, require more effort on the enforcement side to intercept in the right jurisdiction.

Timing of Commercial Quota Modifications:

Due to the split year gill net season, changes to commercial quota past October each year become extremely difficult for the PRFC to accommodate due to the current tag allocation procedure where the PRFC staff issues most tags in November. The gill net fishery is allocated 61% of the PRFC's total quota. Of all the gear types harvesting striped bass, the gill

net fishery utilizes the greatest proportion of their quota thereby placing the Commission in a position to potentially overharvest if commercial quotas are reduced by a significant amount. To try to combat this, when the ASMFC Striped Bass Board motioned to revise the 2025 commercial quota in October 2024, the PRFC had opted to withhold 5 tags from each gear type until after the Board's final decision in December 2024. Pre-emptively withholding tags due to the potential board action created great confusion with the stakeholders and required harvesters to return to the PRFC to retrieve the 5 withheld tags previously. If final decisions are made by the October Annual Meeting, the PRFC can act to reduce tag allocations within a few weeks.

- 2. For states who tag at the point of sale: Since Draft Addendum III includes an option to require tagging at point of harvest, identify any major challenges the state's commercial tagging program may encounter by transitioning to point of harvest.**

Not applicable.

D. Program Successes

- 1. Identify how challenges are being addressed/resolved and any other major successes the state would like highlight from the past ten years.**

Since the beginning of the program, the PRFC has worked to create a more efficient tagging program by using color-coded sequenced tags, switching to a split year gillnet season and exploring new vendors to reduce cost of materials. For other details about overcoming challenges, see the above section 'Program Challenges and Changes'.

- 2. Would the state deem its current tagging program as a success in minimizing illegal harvest? Are there ongoing sources of illegal commercial harvest?**

Yes, the current tagging program is seen as a success in minimizing illegal harvest. The use of tamper-proof sequenced tags has allowed law enforcement to trace individual fish back to the harvester. Additionally, the use of different colored tags for each gear also aids law enforcement as a visual way to inspect harvester behavior from a distance. The tag auditing process has allowed the PRFC to hold each harvester accountable from year to year. The PRFC is not aware of any sources of illegal commercial harvest as related to the tagging program.



COMMONWEALTH of VIRGINIA

Marine Resources Commission

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Building 96

Fort Monroe, VA 23651

Stefanie K. Taillon
Secretary of Natural
and Historic Resources

Jamie L. Green
Commissioner

Virginia

Overview of Striped Bass Commercial Tagging Program

A. Striped Bass Commercial Fishery Overview

1. Type of Management (e.g., ITQ, limited entry, etc.):
Limited Entry ITQ program. The only current way to enter the program is by purchasing or leasing quota (poundage) from another participant.
2. Point of Tagging (harvest and/or sale):
Harvest
3. Number of Participants Receiving Commercial Tags

of Participants Receiving Tags

	Chesapeake Bay Area	Coastal Area
2020	348	26
2021	342	26
2022	339	25
2023	339	25
2024	337	25

*These numbers are initial allocation for the season, does not include transfers. *

4. Gears Used (please indicate which are most common):

Most common gears are gill net and pound net. Virginia also has harvest from Hook & Line (rod and reel), fyke net and a small amount from fish pot. Anyone who holds Virginia Commercial striped bass quota can harvest striped bass from any gear they are licensed for.

An Agency of the Natural and Historic Resources Secretariat

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Telephone (757) 247-2200 Information and Emergency Hotline 1-800-541-4646

5. 2024 Commercial Measures:

VIRGINIA CHESAPEAKE BAY FISHERY

GEAR	SIZE LIMIT	TRIP LIMIT	QUOTA	OPEN SEASON
ALL GEAR	18" MIN	NONE	983,393	JAN 16 THROUGH DEC 31
	MAX SIZE 28" FROM MARCH 15 THROUGH JUNE 15			

VIRGINIA COASTAL
FISHERY

GEAR	SIZE LIMIT	TRIP LIMIT	QUOTA	OPEN SEASON
ALL GEAR	28" MIN	NONE	116,282	JAN 16 THROUGH DEC 31

6. *Optional:* Provide any additional information about the commercial fishery the state would like to explain.

B. Biological Metric, Number of Tags, and Program Operation

1. Describe the biological metric used to determine the number of tags printed and issued to participants:

For the purposes of assigning tags to a person for commercial harvest in the Chesapeake Bay area and the coastal area, the individual commercial harvest quota of striped bass in pounds shall be converted to an estimate in numbers of fish. Using this average weight of striped bass harvested by the permitted person during the previous fishing year, the number of striped bass tags issued to each person will equal the estimated number of fish to be landed by that individual for the following year. Staff will then add 10% of the individual allotment for each person.

For any person whose reported average coastal area harvest weight of striped bass in the previous fishing year was less than 12 pounds, a 12-pound minimum weight shall be used to convert that person's harvest quota of striped bass, in pounds of fish, to harvest quota in number of fish.

Chapter 4 VAC 20-252, "Pertaining to Atlantic Striped Bass" Section 150 C,D,E

2. Number of Tags Issued and Tags Not Accounted For:

	# OF CHESAPEAKE TAGS ISSUED*	PERCENT OF BAY TAGS NOT ACCOUNTED FOR	# OF COASTAL TAGS ISSUED*	PERCENT OF COASTAL TAGS NOT ACCOUNTED FOR
2020	176,900	6.4	8,450	5.3
2021	184,250	2.7	7,650	4
2022	190,900	2.4	7,500	6.5
2023	191,250	3.4	7,300	0.84
2024	181,600	2	7,100	1.5

*This number does not include additional tags which were issued later in the season (upon request) to commercial striped bass quota owners who have not achieved their quota.

3. What is the process and timing for tag distribution?

- Tags are ordered from the manufacture July/August of the previous year.
- Tags are delivered early October.
- Tags are bagged up for each harvester by VMRC staff approx. mid November.
- Tags are distributed in the second week of January of the fishing year. Season opens January 16.

4. Are tags allowed to be transferred between individuals? If so, how are transfers monitored?

Yes, tags are allowed to be transferred between harvesters/quota holders. When quota transfers take place, the participating individuals are required to bring any allocated tags to the office. Staff then reallocates the tags to go with the reallocation of quota. All transfers take place in front of VMRC staff, and a notarized form is required.

5. Does the state require data about the use of each tag to be reported back to the state?

Yes, the VMRC requires that each harvester reports daily harvest, in pounds, of striped bass and number of tags used.

6. Describe the process for returning and auditing unused tags.

- Each harvester/quota holder is required to turn in any unused tags within 30 days of harvesting their quota or by the second Thursday in January. Tags may be returned in person or by mail.
- Harvesters are sent a letter in October of each year stating their current tag accounting for that year. At this time, they can contact VMRC if they have any discrepancies in their records before the fall season begins.
- Harvester reports are audited using striped bass buyer reports. Any Virginia licensed buyer that wishes to purchase striped bass directly from a harvester must also get a Striped Bass Buyer Permit. One of the requirements for this permit is a monthly report that contains the ID number, date, pounds and number of tags purchased from each harvester.

7. Describe how the state responds to non-compliance with commercial tagging or reporting requirements.

- Any unused tags that cannot be turned in to the commission shall be accounted for by the harvester submitting an affidavit to the commission that explains the disposition of the unused tags that are not able to be turned into the commission. Each person shall be required to pay a processing fee of \$25, plus \$0.13 per tag, for any unused tags that are not turned in to the commission.
- Any harvester requesting a quota transfer or additional tags must be up to date on their mandatory harvest reports. If they are not, staff will deny the transfer until the reports are turned in.

C. Program Changes and Challenges

1. Identify any major changes and challenges with the commercial tagging program over the past ten years. Feel free to use the following categories to organize various issues or modify/add categories as needed.

Tag Procurement/Distribution:

- Over the past ten years the timeline for procurement has been challenging, longer processing and ship times have pushed the dates for ordering tags earlier in the past few years. Virginia has a bid process that allows companies with production overseas, transit times have been difficult. We have also seen a price increase.
- Preparation of tags has been challenging especially over the past few years due to late Board decisions on commercial reductions.

Tag Accounting/Return of Unused Tags:

- This process has historically been difficult in Virginia due to the short time between the season closure and the next season opening. (closed Dec 31 and reopens Jan 16)
- Difficulties arise due to our small staff and the number of harvesters. (Approx 400)
- Month to month tag accounting has improved due to improved computer databases and online reporting.

Enforcement:

- VMRC operates on a harvester-based reporting system. Currently the only check and balance to this is monthly striped bass buyer reporting. Unfortunately, this does not capture the fish that are sold out of state or retail sales.
- In Virginia, one challenge is the close jurisdictions of PRFC, Virginia and Maryland. Per Virginia regulation, harvesters cannot have other jurisdictions tags on board the vessel but this is an issue that Law enforcement runs into.

2. For states who tag at the point of sale: Since Draft Addendum III includes an option to require tagging at point of harvest, identify any major challenges the state's commercial tagging program may encounter by transitioning to point of harvest.

N/A

D. Program Successes

1. Identify how challenges are being addressed/resolved and any other major successes the state would like highlight from the past ten years.
 - Better communication between VMRC fisheries staff and Law Enforcement in the field.
 - VMRC law enforcement has worked with federal partners over the past ten years to prosecute Lacey Act cases involving illegal Virginia harvested striped bass being sold over state lines into Maryland.

2. Would the state deem its current tagging program as a success in minimizing illegal harvest? Are there ongoing sources of illegal commercial harvest?

Yes, Virginia's administrative tag accounting, regulations and Law enforcement work in the field all lends itself to a successful commercial striped bass program. Monthly online harvester reporting allows LE and staff a more real time view of what's occurring in the fishery.

Sources of illegal commercial harvest

- Commercial sale of untagged fish.
- Incorrect reporting of weights, especially to out-of-state buyers.

Atlantic Striped Bass Commercial Tagging 10-Year Review - Summer 2025

[NORTH CAROLINA]

Overview of Striped Bass Commercial Tagging Program

A. Striped Bass Commercial Fishery Overview

1. Type of Management (e.g., ITQ, limited entry, etc.):

Other than a cap on the maximum number of commercial licenses available in NC there are no limits to who can participate in any fishery if you have a NC Standard Commercial Fishing License (SCFL) or a Retired SCFL (RSCFL). For fiscal year 2024 there were 3,922 SCFLs and 1,354 Retired SCFLs licenses sold or issued. Of those licenses issued, 1,851 licenses were used to land seafood at a licensed seafood dealer.

2. Point of Tagging (harvest and/or sale):

At the point of sale. Licensed seafood dealers must also obtain a free Striped Bass Dealer Permit each year in order to buy striped bass from a licensed SCFL or RSCFL holder.

3. Number of Participants (i.e. dealers) Receiving Commercial Tags

If a state has gear-specific tags, it is optional to list participants by gear type. At a minimum, please provide some insight into the prevalence of different gears in question #4.

Maryland and Virginia please separate Ocean vs. Chesapeake Bay.

North Carolina issues striped bass commercial tags to the dealers to affix at the point of sale. NC does not have gear specific tags. No striped bass have been landed from the Atlantic Ocean since 2012, although dealers still get the free Striped Bass Dealer Permit just in case. NC no longer gives dealers striped bass tags for the Atlantic Ocean, although we buy them and have them on hand in the event striped bass are present in NC coastal waters 0-3 miles and we open the harvest season.

Year	Atlantic Ocean # Participants (dealers) Receiving Tags	ASMA # Participants (dealers) Receiving Tags
2000	25	43
2001	39	43
2002	38	37
2003	33	37
2004	51	27
2005	57	35
2006	34	37
2007	46	33
2008	40	34
2009	21	29

Atlantic Striped Bass Commercial Tagging 10-Year Review - Summer 2025

2010	19	32
2011	21	26
Year	Atlantic Ocean # Participants (dealers) Receiving Tags	ASMA # Participants (dealers) Receiving Tags
2012	4	22
2013	0	25
2014	0	31
2015	0	29
2016	0	30
2017	0	28
2018	0	28
2019	0	28
2020	0	27
2021	0	23
2022	0	18
2023	0	15
2024	0	0

4. Gears Used (please indicate which are most common):

Atlantic Ocean: Gill net, beach seine, and trawl. When the fishery was still active the gill net gear had the most participants due to the inexpensive nature of constructing gill nets compared to the expense of trawls and the beach seine gear.

ASMA: In 2023 gill nets accounted for 88%, pound nets 10%, and other gears 2% of the striped bass harvest.

5. 2024 Commercial Measures:

NC did not open the Atlantic Ocean to the harvest of striped bass. If NC did, the measures that would have been implemented are below.

Atlantic Ocean

Gear	Size Limit	Trip Limit	Quota	Open Seasons
Beach seine	28" min	50 fish per day	91,603 lb	Was usually December
Gill net	28" min	10-20 fish per day	91,603 lb	Was usually January
Trawl	28" min	50-100 fish per day	91,603 lb	Was usually February

6. *Optional:* Provide any additional information about the commercial fishery the state would like to explain.

None.

B. Biological Metric, Number of Tags, and Program Operation

Atlantic Striped Bass Commercial Tagging 10-Year Review - Summer 2025

1. Describe the biological metric used to determine the number of tags printed and issued to participants:

Average pounds per fish harvested based off previous year divided by the quota. We order extra tags because we never know how many tags each individual dealer is going to use.

2. Number of Tags Issued and Tags Not Accounted For:

Fishing year	Fishery	Number of participants	Number of tags printed	Number of tags issued	Number of tags used	Number of tags returned	Number of tags missing
2023	Ocean	36	25,000	0	0	0	0
	ASMA	39	15,000	6,560	4,322	2,238	0
	CSMA	26	0	0	0	0	0
2022	Ocean	40	25,000	0	0	0	0
	ASMA	41	15,000	9,000	4,824	4,256	20
	CSMA	28	0	0	0	0	0
2021	Ocean	40	25,000	0	0	0	0
	ASMA	45	12,000	10,480	6,552	3,919	9
	CSMA	27	0	0	0	0	0
2020	Ocean	42	25,000	0	0	0	0
	ASMA	46	40,000	30,000	26,900	3,073	27
	CSMA	28	0	0	0	0	0
2019	Ocean	40	25,000	7,500	0	7,500	0
	ASMA	49	40,000	40,000	33,229	6,749	22
	CSMA	36	10,000	0	0	0	0
2018	Ocean	38	25,000	8,300	0	8,300	0
	ASMA	49	40,000	33,890	27,735	6,119	36
	CSMA	38	10,000	5,850	3,788	2,014	48
2017	Ocean	40	25,000	4,140	0	4,140	0
	ASMA	50	40,000	29,085	17,659	11,408	18
	CSMA	39	10,000	7,100	4,386	2,694	20
2016	Ocean	44	18,000	4,140	0	4,140	0
	ASMA	51	33,000	36,013	31,141	4,814	58
	CSMA	41	8,000	5,942	4,166	1,769	7

The two reasons for tags not getting returned are they broke and dealer threw them away or they were lost.

**Tags not accounted for refers to unused tags that were not returned/not reported as lost.*

Atlantic Striped Bass Commercial Tagging 10-Year Review - Summer 2025

3. What is the process and timing for tag distribution? E.g., tags distributed by mail during the month of November before the fishery opens on January 1.

Tags are delivered by hand directly to dealers by either Marine Patrol or Fisheries Management staff. Dealers are brought more tags if they need them throughout the year. We do not give a dealer all the tags they may use throughout the season all at one time.

4. Are tags allowed to be transferred between individuals? If so, how are transfers monitored?

We normally order enough extra tags so we do not have to do that. When dealers receive tags, they have to sign documentation that lists the tag numbers that they were issued. Those data (tag numbers issued to each dealer) are maintained in a database.

5. Does the state require data about the use of each tag to be reported back to the state? This could include sale date, poundage of each fish tagged, etc.

NC requires each dealer to report the number of tags used and the pounds landed on a daily basis throughout the harvest season.

6. Describe the process for returning and auditing unused tags.

Once the harvest season concludes, DMF staff return to each dealer to collect any leftover tags. They then reconcile these retrieved tags with the initial delivery numbers and the number of tags used. In most years, there are minimal discrepancies.

7. Describe how the state responds to non-compliance with commercial tagging or reporting requirements (e.g., failure to return unused tags, submit mandatory reports, etc.)?

Marine Patrol will issue citations for failing to report striped bass tags used and pounds landed on a daily basis. Dealers report each day for the previous day. Each Monday they report for tags used Fri-Sun.

C. Program Changes and Challenges

1. Identify any major changes and challenges with the commercial tagging program over the past ten years. Feel free to use the following categories to organize various issues or modify/add categories as needed.

Tag Procurement/Distribution: None

Tag Accounting/Return of Unused Tags: None

Enforcement: None

Atlantic Striped Bass Commercial Tagging 10-Year Review - Summer 2025

Other: As striped bass have been absent from North Carolina's coastal ocean waters (0-3 miles) since 2012, we respectfully request that the next tag order for this species be produced without the year indicated. This would provide a cost saving measure by negating the need to purchase new tags each year when there are no landings. If landings occur, then for the following year we would either order tags with the year on it tags that were a different color from the previous year.

2. For states who tag at the point of sale: Since Draft Addendum III includes an option to require tagging at point or harvest, identify any major challenges the state's commercial tagging program may encounter by transitioning to point of harvest.

Requiring striped bass to be tagged at the point of harvest would be a major challenge for NC, especially when the A-R stock recovers and harvest is reopened. NC currently does not have a way to limit the number of participants in a fishery. That action would require legislative approval and there would likely be considerable push back from the industry. Therefore, we would have to develop a tag dispersal and accounting system for SCFL and RSCFL holders that meets the commercial tagging requirements and uses staff time and resources efficiently.

D. Program Successes

1. Identify how challenges are being addressed/resolved and any other major successes the state would like highlight from the past ten years.

None.

2. Would the state deem its current tagging program as a success in minimizing illegal harvest? Are there ongoing sources of illegal commercial harvest?

Yes, NC deems the current tagging program a success. NC does not feel there is any significant commercial harvest of striped bass that are illegally sold (i.e. sold and not reported through the tagging program) to either individuals, seafood dealers, or restaurants. There is currently no rule or statute in place that requires seafood harvested in a commercial fishing operation to be sold. A person holding a SCFL or RSCFL can legally harvest striped bass at the allowed commercial trip limit and take them home to keep for personal consumption. So there is a possibility of some unreported harvest. If it is not sold to a licensed seafood dealer that harvest will go unreported. However NC feels this situation is minimal. Starting December 2025, a new state law will require all fish that are commercially harvested to be reported to a dealer, regardless of if that fish is sold or not. <https://ncleg.gov/Sessions/2023/Bills/House/PDF/H600v8.pdf>.



Atlantic States Marine Fisheries Commission

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MEMORANDUM

TO: Atlantic Striped Bass Management Board

FROM: Atlantic Striped Bass Advisory Panel

DATE: July 29, 2025

SUBJECT: Advisory Panel Member Comments on Draft Addendum III for Board Review

The Atlantic Striped Bass Advisory Panel (AP) met via webinar on July 28, 2025 to receive an update on the revised management options in Draft Addendum III for Board review. If Draft Addendum III is approved for public comment, an AP meeting will be scheduled for October to gather AP recommendations on the specific options in the draft addendum.

Advisory Panel Members in Attendance

Eleanor Bochenek (AP Chair, NJ rec, fisheries scientist)	
Peter Whelan (AP Vice Chair, NH recreational)	
Peter Fallon (ME for-hire)	Tom Fote (NJ recreational)
Peter Whelan (NH recreational)	Charles (Eddie) Green (MD for-hire/rec)
Patrick Paquette (MA recreational)	Dennis Fleming (PRFC rec/processor/dealer)
Craig Poosikian (MA commercial)	Will Poston (DC recreational)
Andy Dangelo (RI for-hire)	Bill Hall (VA recreational)
Peter Jenkins (RI recreational)	Kelly Place (VA commercial)
Toby Lapinski (CT recreational)	Jon Worthington (NC commercial)
Julie Evans (NY for-hire, commercial)	

ASMFC Staff: Emilie Franke, Katie Drew

Board Members in Attendance: Chris Batsavage, Nichola Meserve, David Sikorski, Megan Ware

Public in Attendance: Rick Bellavance, Jesse Hornstein, Mike Waine

The following are comments from individual AP members. These are not consensus AP statements.

Option Section 3.1: Method to Measure Total Length of a Striped Bass

No AP member comments. The AP previously discussed this issue in [April 2025](#) noting general support for a standard coastwide definition of total length.

Option Section 3.2: Commercial Tagging Requirements: Point of Sale vs. Point of Harvest

One AP member noted concern and uncertainty about what the new tag allocation and distribution processes would be in states if they must switch from point-of-sale to point-of-harvest. The AP member noted it would be easier for states to manage tags at the dealers rather than the harvesters.

One AP member noted support for expanding the options to consider allowing tagging at point of landing instead of point of harvest to address safety concerns with tagging at point of harvest.

Option Section 3.3: Maryland Chesapeake Bay Recreational Season Baseline

Regarding the proposed opening of April to catch-and-release, one AP member noted concern about the impact of allowing catch-and-release fishing on pre-spawn fish.

One AP member noted concern about introducing the uncertainty associated with changing the season while a reduction is being considered.

One AP member recommends the PDT and/or TC review what portion of the Maryland season would be subject to the uncertainty buffer if there is no reduction. The draft addendum currently proposes shortening the wave 3 or wave 6 harvest period to meet the buffer, but the TC/PDT should discuss whether other parts of the season should be changed to meet the buffer.

Option Section 3.4: Reduction in Fishery Removals to Support Stock Rebuilding

Two AP members support bringing both the -12% and -18% reduction options to public comment. They noted it would be best to have a range of options in the document and that new information at the October meeting on this year's young-of-year surveys may inform which reduction to implement.

One AP member noted the uncertainty in the projections, particularly comparing projections using the preliminary MRIP data with projections using the final MRIP data. There is substantial overlap in the confidence intervals.

One AP member commented that recruitment is the real problem, not spawning stock biomass levels. Multiple reductions have been implemented over the past decade and recruitment has not improved. Research is needed to determine what is impacting recruitment and what is happening in the Chesapeake Bay.

One AP member noted concern that no-targeting closures are still being considered even though the Law Enforcement Committee has noted they are unenforceable.

Two AP members noted support for the document including options where the commercial sector takes no reduction. The commercial sector consistently underutilizes its quota and is managed by strict accountability measures (i.e., quota paybacks), while the recreational sector

does not have the same accountability and is responsible for the increases in fishery removals in recent years.

Other Topics

One AP member noted concern that the socioeconomic impact section of the draft addendum does not sufficiently convey the negative economic impact of the 2024 Addendum II measures, particularly the reduction to a 1-fish bag limit for the Maryland charter fleet in the Chesapeake Bay.

One AP member noted that when summarizing and communicating public comments, it would be helpful to separate comments by sector/mode (e.g., private recreational anglers, charter captains, commercial harvesters, etc.). It would be helpful to understand how much of each sector/mode support an option (e.g., X percent of charter captains who submitted comments support Option A).

One AP member noted concern about the estimate of commercial discards and the average reported weight of Maryland commercially harvested striped bass. On commercial discards, the concern is the number of discards relative to harvest has decreased over time which they noted does not seem logical. On Maryland's average weight, they noted concern that Maryland's reported average weight of a commercially harvested fish (just over four pounds) is much smaller than anticipated.

- ASMFC Staff Response on Commercial Discards: The very low estimates of discards in recent years are consistent with the very low recruitment over those years, since there are fewer undersize fish available to be caught and discarded compared to previous years. Declines in the reporting rate of tagged fish in recent years could also contribute to the lower estimates. However, estimates of discards from the tagging approach were similar to the estimates using observer data in the ocean during the last benchmark. The TC-SAS will be looking into this more for the next benchmark.
- ASMFC Staff Response on Maryland Average Weight: Maryland DNR consistently reports an average weight of 4-5 pounds for commercially harvested fish. This likely reflects the availability of these smaller fish in the Bay, as the average weight for recreational fish based on MRIP data has also been about 4 pounds for the past several years. MDDNR also conducts regular commercial sampling which generally corroborates the average weight from the reported pounds/number of fish tracked through Maryland checkstations/harvest reports/electronic reporting.

From: [ASMFC](#)
To: [Comments](#)
Subject: [External] [New] New public comment for 2025 Summer Meeting
Date: Monday, July 28, 2025 7:57:02 AM

2025 Summer Meeting

Action Title

2025 Summer Meeting

Action URL

<https://asmfc.org/events/2025-summer-meeting/>

Name

Rick Bellavance

Email

rickbellavance@gmail.com

State

Rhode Island

Comment

Dear Atlantic Striped Bass Board,

I apologize for the delay in commenting for the summer meeting. As you may imagine it's a challenge to find extra time during the height of my truncated season.

Regarding Striped Bass management, I am concerned that the poor recruitment that has been reported over the past several years is being influenced by management decisions that are designed to protect as much SSB as possible. I would like to board to consider the possibility that the large SSB we currently have is actually limiting spawning triggers within the stock. We have had a variety of environmental conditions over the past 6 years, yet no real change in the spawning output. Maybe something else is in play, like the stock does not feel compelled to spawn due to excessive SSB in the water. I would ask the board to consider giving a management strategy that reduces the SSB a chance. We know a low SSB can produce healthy year classes so the risk of testing this hypothesis seems limited.

I would also like to share that I believe the Chesapeake Bay is not as influencing as it was 20 years ago. In Southern New England, we routinely see smaller fish from 10-25 inches and I believe they are coming from other spawning areas. There are good numbers of fish entering the fishery each year that are not considered in the current assessment model.

It may also be the time to reconsider the productivity regime we are in for Striped Bass and set expectations accordingly.

Lastly I would like to pass along that we have seen a dramatic increase in the number of sandbar sharks in southern New England in late July thru Mid September. These sharks have found an easy meal in the large striped bass that are released this time of year. I would argue the discard mortality is highest during this period. Obviously I would prefer to harvest a fish or two for my customers instead of feeding them to sharks post release, but another choice could be no targeting of striped bass during this period. There is nothing good coming from striped bass fishing under these conditions so close it for everyone.

Thanks for the chance to offer my brief comments and observations. I've pretty much been driven out of the striped bass fishery under the current management strategy, but with Cod closed, no fluke to catch, bluefin regulations getting more restrictive, and shark prohibitions, it's really challenging to maintain a

viable business. The high abundance of striped bass seems like an opportunity to afford the public a chance to fish4dinner while preserving the historic for-hire businesses along the coast.

Thanks,

Capt Rick Bellavance

Priority Fishing Charters

Point Judith Rhode Island

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.



Maryland Charter Boat Association, Inc.

Date: July 29, 2025

To: Atlantic States Marine Fisheries Commission

Maryland's proposed new baseline must be rejected unless it is based on accurate, complete, and transparent data. The current proposal is misleading and omits critical facts that jeopardize the integrity of the ongoing ten-year striped bass rebuilding program—now in its sixth year.

In 2024, Maryland DNR deemed the spawning stock crisis so severe that it extended closures from May 1 to May 15, in addition to the long-standing April closure. Yet today, it proposes opening April to catch-and-release of pregnant females without addressing last year's emergency actions. This contradiction raises serious concerns about Maryland's commitment to science-based conservation.

April has been closed for five years to protect spawning fish. Opening it now will lead to a significant increase in fishing activity, particularly in vulnerable areas like Eastern Bay, a known staging ground for spawning females. Catch-and-release during this critical time results in repeated handling, elevated stress, and increased mortality—both immediate and delayed. Lactic acid buildup from stress renders eggs sterile, and removing females from the water can cause egg discharge. These effects are not speculative; they are supported by marine biology and peer-reviewed research.

We must protect the future of this fishery. Allowing catch-and-release in April undermines the very goals Maryland claimed to support last year. This is not a balanced proposal—it's a step backward with long-term damage.

The ecological cost is significant. A single female can carry 5–7 million eggs. Premature discharge or egg sterility could eliminate tens of thousands of juvenile fish each season. Maryland DNR's own estimate—that their plan saves 266 fish—ignores the far greater unseen loss through disrupted spawning.

This proposal does not reflect a shared stakeholder interest. It benefits a vocal minority at the expense of long-term stock health. Rebuilding requires consistent, science-driven policy—not reactive rollbacks.

We urge the Technical Committee to conduct a thorough analysis of expected mortality and reproductive loss under this plan. Conservation must take precedence over convenience. Protecting the spawning stock in April is essential to ensuring a sustainable future for striped bass.

Sincerely,

Brian L. Hardman
President
Maryland Charter Boat Association



July 28, 2025

VIA EMAIL

Mr. John Clark, Chair
Menhaden Management Board
c/o Atlantic States Marine Fisheries Commission
1050 N. Highland Street, Suite 200 A-N
Arlington, VA 22201

**RE: The Menhaden Work Group Report and Menhaden Technical Committee
Tasking at the ASMFC Summer Meeting**

Dear Chairman Clark:

In terms of the undoubted travails facing osprey in and around the Chesapeake Bay, there has been an inordinate amount of focus on menhaden generally, and the reduction fishery in particular. As the recent, record setting hypoxic zone in the upper and mainstem Chesapeake Bay,¹ coupled with the notable increase in the numbers of southern stocks like cobia, red drum, and Spanish mackerel, demonstrates,² the Bay is an ecosystem in the midst of change. While there is a tendency to look for easy answers, the likelihood is that there are a multitude of potential causes, as U.S. Geological Survey (USGS) osprey scientists recently pointed out.³

This tendency is apparent in the Menhaden Board's Atlantic Menhaden Work Group on Precautionary Management in Chesapeake Bay (Work Group) report. Rather than attempt to investigate the issue, the group charged forward with draconian management recommendations "without determining if there is or is not an adequate supply of menhaden to support predatory demand in the Bay." (Work Group Rpt., at 1.) Moving forward with such actions without investigating whether there are, in fact, fewer menhaden in the Bay or whether the fishery has

¹ Maryland Dept. of Nat. Res., "Chesapeake Bay Monitoring Shows Hypoxia Increased in June After Rainy May," (July 16, 2025), <https://news.maryland.gov/dnr/2025/07/16/chesapeake-bay-monitoring-shows-hypoxia-increased-in-june-after-rainy-may/>.

² Atl. Menhaden Work Group on Precautionary Mgmt. in Chesapeake Bay, "Precautionary Management in the Chesapeake Bay," ("Work Group Rpt."), at 17 (Apr. 23, 2025), <https://asmfc.org/resources/management-technical-committee/atlantic-menhaden-work-group-report-on-chesapeake-bay-precautionary-management-april-2025//>.

³ Menhaden Fisheries Coal., "USGS Challenges Simple Narrative Linking Menhaden to Osprey Decline," (May 5, 2025), www.accessnewswire.com/newsroom/en/food-and-beverage-products/usgs-challenges-simple-narrative-linking-menhaden-to-osprey-decline-1023783.

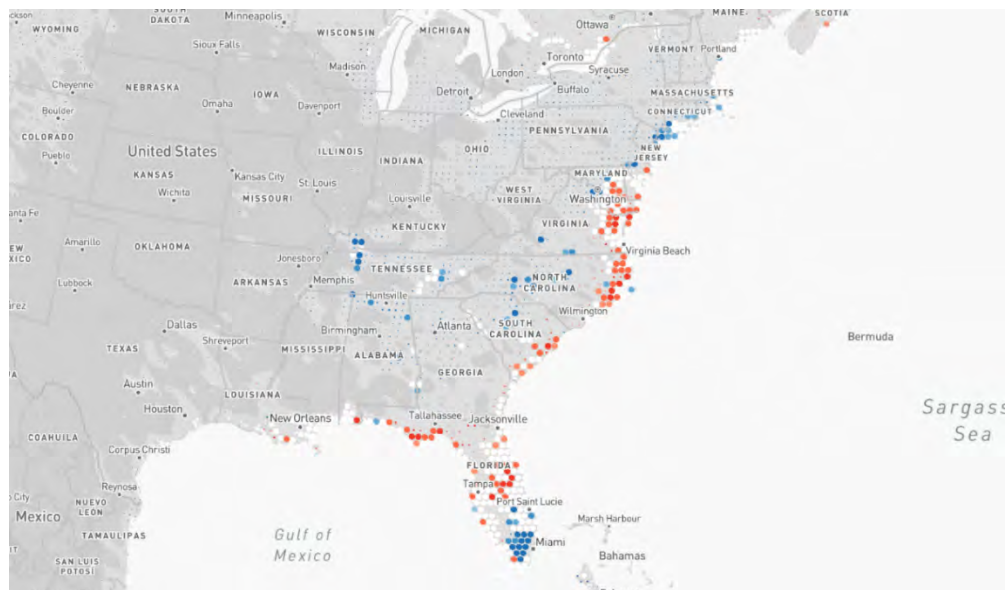
any impact on osprey, risks gravely impacting a more than a 150-year-old industry and hundreds of jobs while doing nothing to improve the osprey situation.

From the agenda for the Atlantic States Marine Fisheries Commission's (ASMFC) Summer Meeting, it appears that the Menhaden Board may be preparing to task the Technical Committee (TC) to investigate issues raised by the Work Group Report. The Board should be mindful that the TC already has a significant amount of work ahead of the Annual Meeting, such as bringing the bait catch-at-age up to date and preparing projections. That said, there are several areas of science upon which the TC can usefully provide insights which would be useful in helping the Board determine an appropriate course of action.

1. Is the phenomenon of reduced osprey production confined to the times and areas in which the menhaden reduction fishery operates?

When the USGS gave its presentation to the Menhaden Board at its 2024 Summer Meeting, Dr. Ziolkowski, Jr. and Dr. Rattner indicated recent declines in osprey populations in California, Washington, Massachusetts, Florida, and North Carolina (following, as in the Bay, significant increases). Only New Jersey showed recent increases.⁴ That presentation also contained a graphic that used data from Cornell University's eBird database that shows a net decline of osprey abundance in the Chesapeake Bay and the Maryland and Virginia coasts between 2012-2022 and increases in interior regions. USGS, at 5.

On a broader scale, more recent data from the eBird database shows a similar trend from Delaware to the mid-Florida coast⁵:



⁴ USGS, Osprey in the Chesapeake, Life History, Reproduction, Population, Diet and Stressors, at 6 (2024), https://asmfc.org/wp-content/uploads/2025/01/AtlanticMenhadenBoardPresentations_Aug2024.pdf.

⁵ Cornell Lab of Ornithology, Osprey *Pandion haliaetus*, Trends 2012-2022, <https://science.ebird.org/en/status-and-trends/species/osprey/trends-map>.

Finally, Dr. Bryan Watts of the Center for Conservation Biology at William & Mary University recently issued a news advisory indicating a 90% decline in ospreys nesting along the seaside of the Virginia portion of the Delmarva Peninsula between 1987 and 2025.⁶ According to the USGS, migrant osprey arrive in the region from late February to early March, and begin building nests from mid-March to Mid-April (USGS 2024). The menhaden reduction fishery historically has not begun fishing until the first Monday in May or later (and cannot, by law, fish in Virginia waters before then), raising a question as to how the fishery could be influencing osprey's months-earlier decisions about where they nest.

This information suggests a useful question for the TC to investigate:

- Is the most likely cause of large-scale shifts in osprey populations from parts of the Atlantic coastal region to interior riverine habitats the menhaden reduction fishery, or may climate change-induced environmental factors such as increased severe storms, excessive heat, changes in prey distribution, etc., be playing a role?

2. What other species of bird and fish in the Bay have significant dependence on menhaden and are those species showing signs of food stress in a manner similar to osprey?

Were there a decline in the number of menhaden inhabiting the Chesapeake Bay generally, or if the reduction fishery, operating at its current historically low levels, was adversely impacting osprey, it seems likely that other predators which depend on menhaden would likewise be affected. In this regard, the Work Group Report provides useful information.

While striped bass are typically referred to as “menhaden dependent,” a stomach contents study conducted from 2002 to 2020 indicate that bay anchovy make up 33% of their diet by weight, with menhaden comprising just under 16%. Nonetheless, according to both the Virginia Marine Resources Commission (VMRC) and Maryland’s Department of Natural Resources (DNR), indices “would indicate the [striped bass] are not starving and would be considered healthy.”⁷

The Report also discusses food habit data for other populations of fish that are (or appear to be, based on fishery-dependent data) increasing in the Chesapeake, including cobia, red drum,

⁶ Dr. Bryan Watts, News Advisory (June 16, 2025), <https://ccbbirds.org/2025/06/16/osprey-population-along-the-seaside-of-the-delmarva-peninsula-has-collapsed/>.

⁷ Work Group Rpt., at 23. VMRC uses “Fulton’s Condition Factor,” as explained in the report. Maryland DNR has its “traffic light index,” which makes relative judgements about various facets of the Bay’s menhaden and striped bass population, including striped bass condition. MD DNR, “Traffic light index (TLI) of forage balance of Atlantic Menhaden and resident Striped Bass in Maryland’s portion of Chesapeake Bay - update through 2024,” <https://dnr.maryland.gov/fisheries/Documents/TLI%202025%20update.pdf>. Each index supports the Work Group Report’s finding that striped bass “[c]onditions appear to be trending upward.” (Work Group Rpt., at 23.)

spotted seatrout, and Spanish mackerel. (Work Group Rpt., at 36 (Table 5).) Of these species, only cobia does not appear to heavily rely on menhaden. By contrast, menhaden have been found to make up from between 9% to as much as 40% of the diet of red drum, spotted seatrout, and Spanish mackerel, by weight, depending on the life stage and area studied.⁸ The growing population of blue catfish is not dependent on menhaden, but studies of adult catfish in the upper portions of Virginia major tributaries (James, York and Rappahannock Rivers) found menhaden comprised 0.425 to 5.00% of blue catfish diet by weight.” (Work Group Rpt., at 22.)

Populations of weakfish and bluefish – both predator species included in the Ecological Reference Point model – are in decline in the Chesapeake Bay. Both these species, however, are far less dependent on menhaden than those that appear to be taking their place in this estuary. Food habits studies show that menhaden comprise just 5% of bluefish diet by weight, while the same figure for weakfish is less than 1% (although that is “possibly due to truncation of the weakfish size range associated with high natural mortality of Age 1+ fishes.”).⁹ Nonetheless, across the full suite of fish predators in the Bay, the Report concludes: “In general, the health index measured by Fulton’s Condition Factor, seems to be slightly increasing or stable for all species, suggesting the health of these species over time has not changed substantially.” (Work Group Rpt., at 23.)

Likewise, there have been increases in avian predators of menhaden. “Double-crested cormorants and brown pelicans are two additional predators of menhaden whose numbers are increasing in Chesapeake Bay. Atlantic menhaden make up 50-55% of the diet of cormorants and 74% of the diet of brown pelicans by weight.” (Work Group Rpt., at 16.) The scale of the increases in the populations of these significant predators is detailed in the Report (pages 16-17), but the increases have been exponential.

The increases in populations of menhaden predators since at least the turn of the century suggests this line of inquiry:

- Is it more likely that ospreys are being outcompeted or that the reduction fishery uniquely impacts osprey, even though it generally does not operate in areas where brooding success has been poor during the critical time-period in the breeding season?¹⁰

⁸ Work Group Rpt., at 20-22. Few of these studies were undertaken in the Chesapeake Bay, so these results should be interpreted with caution.

⁹ Work Group Rpt., at 19-20.

¹⁰ See Work Group Rpt., at 42-45.

3. What role might the increase in the population of bald eagles throughout the Chesapeake Bay region in recent declines of osprey?

Maryland DNR just published a release announcing large increases in the state's bald eagle population.¹¹ A myriad of studies have noted the relationship between bald eagles and osprey, often referring to eagles as “kleptoparasitic” for their tendency to attack hunting osprey to steal their food and prey on osprey adults, young, and eggs.¹² A recent study goes so far as to suggest that increasing eagle populations can have a “top-down” adverse impact on competitors, including osprey.¹³

This study looked at recovering populations of bald eagles, ospreys, and great blue herons that repatriated Voyageurs National Park in northern Minnesota during the mid-20th century. The authors found that “[i]ncreased numbers of eagles were associated with a reduction in the numbers of osprey nests, their nesting success and heronry size.” The authors were unable to determine the exact top-down mechanisms resulting in this relationship, noting that osprey would nest in proximity to eagles. They surmise that ospreys “were likely impacted by eagles outside their local surroundings, including non-breeding individuals,” through kleptoparasitism and predation.

Voyageurs National Park is a different type of ecosystem (freshwater lakes) than the Bay and it is apparent that, for a long period of time, each of these species increased their repatriation of the area in tandem. This suggests a possibility that a localized abundance of bald eagles can reach a tipping point after which they may be able to exert top-down effects on osprey. Notably, the USGS also noted issues of intraspecific competition between bald eagles and osprey in its presentation. (USGS 2024). There is significant scientific and anecdotal evidence of the dominant and adverse impacts eagles have on osprey, suggesting a reasonable line of inquiry would be:

- Can issues of competition and depredation be ruled out as a cause of osprey's lack of breeding success, given that (i) bald eagles are kleptoparasitic and known to be particularly aggressive with osprey; and (ii) there are increasing populations of other piscivorous bird and fish species in the Chesapeake Bay?

¹¹ MD DNR, “A Soaring Success: Maryland's Bald Eagle Population Recovery” (July 3, 2025), <https://news.maryland.gov/dnr/2025/07/03/a-soaring-success-marylands-bald-eagle-population-recovery/>

¹² See, for example, Bierregaard, R. O., Poole, A. F., Martell, M. S., Pyle, P., & Patten, M. A. (2016). Osprey (*Pandion haliaetus*), version 2.0. In P. G. Rodewald (Ed.), *The birds of North America*. Ithaca, NY: Cornell Lab of Ornithology; Prevost, Y. A. (1977). *Feeding ecology of ospreys in Antigonish County, Nova Scotia*. Masters M.Sc., McGill University, Montreal, QC, Canada; Vennesland, R. G., & Butler, R. W. (2011). Great blue heron (*Ardea herodias*), version 2.0. In A. F. Poole (Ed.), *The birds of North America*. Ithaca, NY: Cornell Lab of Ornithology.

¹³ Cruz, Jennyffer, et al. “Top-down effects of repatriating Bald Eagles hinder jointly recovering competitors.” *Journal of Animal Ecology* 88.7 (2019): 1054-1065.

4. What role could climate change, water temperature, dissolved oxygen levels, shoreline hardening, and other environmental factors play in the local abundance of menhaden and other forage species?

Fisheries managers have grappled with the issue of climate change and its effects on fisheries and the ecosystem. Stocks are shifting—for example the noted increase in red drum and Spanish mackerel in the Chesapeake Bay. Waters are warming. Storms are becoming more frequent and more destructive. The timing of migration for many species is changing.¹⁴ All these impacts are well recognized and the subject of intense study.

As noted above, significant portions of the Chesapeake Bay were subject to extremely low dissolved oxygen in the critical rearing season for young osprey (June and July) this year and last. In 2023, the Forage Action Team (part of the NOAA Chesapeake Bay Program) found that “that the abundance of key forage species decreases when 10 to 30% of the shoreline is hardened.”¹⁵ As it is so shallow, the Bay is particularly vulnerable to warming, and the impacts of more frequent, and intense storms (as well as sea level rise).¹⁶ Any or all of these factors can influence the local distribution of forage within the Bay, as well as foraging success.

Thus, the Technical Committee could be asked to consider the following question (while recognizing that this line of inquiry is wide-ranging, intensive, and may not lead to definitive answers):

- Noting that Watts (2024) found that deliveries of all forage species to osprey nests declined steadily from 1974 to 2021,¹⁷ is it possible, or even likely, that ospreys’ apparent lack of foraging success is tied to changes in local conditions that are impacting either local abundance of forage or osprey’s hunting success?

¹⁴ See, for example, Peer, A. C., and T. J. Miller. “Climate change, migration phenology, and fisheries management interact with unanticipated consequences.” *North American Journal of Fisheries Management* 34.1 (2014): 94-110; Crear, Daniel P., et al. “Estimating shifts in phenology and habitat use of cobia in Chesapeake Bay under climate change.” *Frontiers in Marine Science* 7 (2020): 579135; Wood, Robert J., Donald F. Boesch, and Victor S. Kennedy. “Future consequences of climate change for the Chesapeake Bay ecosystem and its fisheries.” *American Fisheries Society Symposium*. Vol. 32. 2002.

¹⁵ NOAA CBP, Forage Action Team, “Forage Status and Trends Report for the Chesapeake Bay,” at 17 (Nov. 2023), <https://www.chesapeakebay.net/what/publications/forage-status-and-trends-report>.

¹⁶ See, for example, Rezaie, Ali Mohammad, et al. “Quantifying the impacts of storm surge, sea level rise, and potential reduction and changes in wetlands in coastal areas of the Chesapeake Bay region.” *Natural Hazards Review* 22.4 (2021): 04021044; St. Laurent, Kari A., Victoria J. Coles, and Raleigh R. Hood. “Climate extremes and variability surrounding Chesapeake Bay: Past, present, and future.” *JAWRA Journal of the American Water Resources Association* 58.6 (2022): 826-854; Du, Jiabi, et al. “Worsened physical condition due to climate change contributes to the increasing hypoxia in Chesapeake Bay.” *Science of the Total Environment* 630 (2018): 707-717.

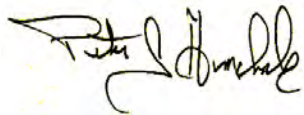
¹⁷ Watts, Bryan D., et al. “Demographic response of osprey within the lower Chesapeake Bay to fluctuations in menhaden stock.” *Frontiers in Marine Science* 10 (2024): 1284462. Notably, menhaden comprised a higher percentage of delivers in 2021 compared to 2006-07, albeit at a lower absolute rate.

###

The commission must be guided by science. Precipitous actions, taken in the name of precaution, are not always harmless. Neither Ocean Harvesters nor Omega Protein can survive without the current low level of access to the menhaden resource in the Bay. There simply are not enough “fishable days” – that is, days where the weather and sea conditions allow vessels to operate – in a year to safely conduct a profitable fishery solely in the ocean.

The menhaden fishery is managed in the most conservative manner in its 150 year or so history, and the reduction fishery is operating at its lowest sustained levels – in the Bay and overall – for as long as we have reliable records (*i.e.*, since the 1950s). Precaution is already the policy. Before taking actions that could cause irreversible economic harm to this historic fishery, the Board should ensure that all reasonable avenues of inquiry into the issues facing osprey are explored. Thank you for your time and attention.

Sincerely,

A handwritten signature in black ink, appearing to read "Peter Himchak", with a stylized flourish at the end.

Peter Himchak
Senior Scientific Advisor, Omega Protein Corp.

July 29, 2025

Robert Beal, Executive Director
John Clark, Management Board Chair
Atlantic States Marine Fisheries Commission
1050 N. Highland Street, Suite 200 A-N
Arlington, VA 22201
rbeal@asmfc.org
john.clark@delaware.gov

Re: Atlantic Menhaden Revised Natural Mortality Rate Estimate

Dear Messrs. Beal and Clark,

We are writing to follow up on our letters of October 31, 2024, and February 28, 2025, to Mr. Beal regarding the science underlying the Atlantic menhaden stock assessment.¹ In these letters, we brought to the ASMFC's attention new analysis in a draft manuscript undergoing peer review for publication by Drs. Jerry Ault and Jiangang Luo. This analysis shows that the menhaden stock assessment science is fundamentally flawed due to significant mistakes affecting the natural mortality rate (M) estimate used in the stock assessment model since 2019 (SEDAR 69). We explained that these mistakes resulted in a substantial overestimation of M, which in turn likely drove a substantial underestimation of fishing mortality rates and an overestimation of the coastwide stock size and allowable catch for the fishery. As a result, overfishing of Atlantic menhaden has likely been occurring. Our previous letters also summarized the ASMFC's legal obligations under the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA) and the ASMFC's Rules and Charter that all Interstate Fishery Management Plans be based on the best available science (BAS) and prevent overfishing.

We thank you, Mr. Beal, for your responses, as well as to the SAS M Working Group for discussing Drs. Ault & Luo's analyses. While these discussions resulted in the admission of several significant mistakes and partial correction in the M estimate, the SAS declined to correct at least one critical mistake and further declined to reduce M to the level recommended by Drs. Ault & Luo. As a result, the overestimation of M persists, even with the Atlantic Menhaden Stock Assessment Subcommittee's (SAS) newly revised M estimate (from $M=1.17$ to $M=0.92$). Further, it appears that staff leading the SAS analysis adjusted other critical model parameters, particularly the assumption for recruitment, which effectively offset the impact of the lower M estimate. Based on these adjustments, remarkably, the SAS concluded that even though M has been overestimated by at least 21 percent since 2019, the Atlantic menhaden stock is not overfished, overfishing is not occurring, and they project that continuing to fish at the current level presents little risk to the Atlantic menhaden resource. These conclusions are surprising, to say the least, and we are gravely concerned.

What is most concerning is that if Drs. Ault & Luo are correct that the M estimate should be even lower ($M=0.52$) because of a remaining uncorrected mistake in the analysis relied upon by the SAS (specifically, modeling time-area magnet efficiency as constants)—and the data and all

¹ Enclosed for reference.

other indicators suggest that Drs. Ault & Luo are correct—not only is it likely that overfishing has been occurring and that Atlantic menhaden are overfished, but the coastwide stock size could be only a fraction of the SAS estimate, perhaps as low as one quarter of the unfished biomass. The implications for Atlantic menhaden and the East Coast ecosystem are profound.² Because Atlantic menhaden is the key forage stock in the ASMFC’s ecological reference point (ERP) model, menhaden stock assessment mistakes can ripple through other ASMFC assessments such as those for striped bass, the most valuable recreational gamefish in the country.

For these reasons, we request that you take steps to ensure a thorough and independent review of the SAS’s work in view of the Ault & Luo analysis—in particular, the SAS’s extraordinary findings regarding the appropriate M estimate and the status of the Atlantic menhaden resource. First, we understand that Drs. Ault & Luo’s manuscript has been updated to reflect their significant engagement with the SAS and that publication is pending. To help ensure the August 12-15 Ecological Reference Point Peer Review fully examines these issues please include this letter and Drs. Ault & Luo’s published paper or the most recent draft manuscript in the Peer Review materials. Second, please ensure that Drs. Ault & Luo’s recommended M of 0.52 be included as a sensitivity run in the Beaufort Assessment Model (BAM)³ and that the results – including impact on biomass and stock status - be available for consideration and adoption by the Menhaden Board. Note that the SAS stated it would introduce the Ault & Luo M analysis into the Peer Review through its inclusion as a sensitivity run, however this sensitivity run was not presented or discussed at the July SAS Technical Committee (SAS TC) meeting, nor were the full impacts of a lower M discussed. Third, please ensure that all of these materials are available to the Board and the ASMFC so that these management bodies can consider them and make their final decisions consistent with their legal duties to rely on the best available science and prevent overfishing.

Finally, as noted in our prior letters, Drs. Ault & Luo have raised concerns about the adoption of the extreme statistical outlier M recommended in the paper by Liljestrand, Wilberg & Schueller (2019)⁴ since its inclusion in the 2019 SEDAR 69 benchmark stock assessment. Although the SAS M Working Group, SAS TC, and ERP Working Group discussed Drs. Ault & Luo’s analyses and acknowledged some of the critical mistakes made by Liljestrand, Wilberg & Schueller, some of these authors also actively participated in the meetings, dominating much of the analysis and discussion and resisting Drs. Ault & Luo’s findings. It is critical to prevent conflicts of interest and ensure impartiality in the Peer Review of the Atlantic menhaden M estimate and 2025 stock assessment. Thus, the authors of the Liljestrand, Wilberg & Schueller paper should be recused from participating in the Peer Review and additional related processes leading to the Board and ASMFC’s final decisions. The ASMFC and NOAA Fisheries must

² Especially given there is an East Coast “forage fish crisis” as all critical forage species (i.e., Atlantic herring, Atlantic mackerel, blueback herring, alewife, and shad) are also severely overfished (depleted).

³ BAM is the model used for the menhaden single species stock assessment, and the outputs from BAM, including the rate of natural mortality, serve as the baseline for the ERP assessment.

⁴ [Liljestrand EM, Wilberg MJ and Schueller AM \(2019\). Estimation of movement and mortality of Atlantic menhaden from 1966 to 1969 using a Bayesian multi-state mark-recovery model. *Fisheries Research* 210: 204-2013.](#) Based on the mistakes acknowledged to date, let alone the remaining impactful mistake in magnet tag recovery efficiency, in our opinion the authors should retract the paper.

ensure that the best available science is used for management of Atlantic menhaden. Additional details are provided below.

The SAS Corrections and Revised M

Drs. Ault & Luo analyzed the data, model and results contained in the Liljestrand, Wilberg and Schueller paper related to the NMFS 1966-71 mark-recapture study, including the paper's recommended M that was adopted for use in the benchmark Atlantic menhaden single species stock assessment in 2019 (SEDAR 69). The Ault & Luo analysis identified at least five significant mistakes made in the Liljestrand, Wilberg & Schueller paper affecting its recommended M including: (1) overstated tag releases; (2) underreported tag recoveries; (3) overstated primary magnet tag recovery efficiency; (4) underreported annual fishing effort⁵; and (5) modeled time-area magnet efficiency as constants. The SAS agreed with much of the Ault & Luo analysis and addressed the first four significant mistakes, concluding that the current M adopted by ASMFC from the Liljestrand, Wilberg & Schueller paper was too high and should be revised downward from $M = 1.17$ to 0.92 .

However, Drs. Ault & Luo's analysis concludes that the SAS' revised M is still almost double what it should be: $M = 0.52$. Initially, the SAS attributed the difference between the M estimate recommended by Drs. Ault & Luo to their inability to access confidential fishing effort data.⁶ However, despite the lack of access to the allegedly confidential 55 year old industry data, Drs. Ault & Luo's method for generating nominal fishing effort by month and area effectively characterized effort during the period of the mark-recapture study. The SAS M Working Group determined Drs. Ault & Luo's effort characterization to be 99 percent accurate compared to the confidential fishing effort data. Comparative analyses with SAS showed that weighting the average area efficiencies by catches in the "constant" method produced minute differences (~2.2%) in estimated M in comparison to the SAS estimate. Thus, the lack of access to the confidential fishing effort data had a minimal effect on their results. Despite this, at the July 2025 SAS TC meeting the SAS presentation continued to highlight the data access issue as though it compromised Ault & Luo's analysis, instead of objectively presenting the competing approaches to magnet tag recovery efficiency as the basis for the difference.

The Remaining Uncorrected Mistake -- Magnet Tag Recovery Efficiency

After agreeing on the first four highlighted mistakes in the Liljestrand, Wilberg & Schueller paper, the only significant remaining factor accounting for the difference between the SAS's new

⁵ Fishing effort was under-reported by Liljestrand, Willberg and Schueller by an annual average of -47.8 percent.

⁶ This data was requested by Drs. Ault & Luo but was not provided by NMFS because the fishing industry (Ocean Harvesters) refused to authorize its release, despite the fact these data are over 55 years old and unlikely to include any information that reasonably can be considered confidential business information. The Atlantic ecosystem and menhaden fishery have changed significantly in the past 55 years. Further, Ocean Harvesters is (supposedly) not even the same fishing company that originally collected the data; that was Omega Protein. Failure to provide the fishery data in support of improving fisheries science for management is inconsistent with the intent of the Magnuson-Stevens Act's confidentiality provisions, which did not even exist at the time of the mark-recapture study. 16 U.S.C. § 1801 et seq. (1976), 16 U.S.C. § 1881a(b) (1996). Refusal to provide the data is also in conflict with the Magnuson-Stevens Act's and ASMFC's mandate to ensure conservation and managements measures be based on the best available scientific information available and that management be in the public interest. 16 U.S.C. § 1801(c)(3); 16 U.S.C. § 5104(a)(2). Drs. Ault & Luo are renewing their request for this data through a formal FOIA request.

recommended $M=0.92$ and Drs. Ault & Luo's recommended $M=0.52$ results from the SAS failure to apply the most scientifically sound method to correct the Liljestrand, Wilberg & Schueller approach to magnet tag recovery efficiency at the menhaden reduction plants. As explained by Drs. Ault & Luo, the Liljestrand, Wilberg & Schueller analysis incorrectly applied simple weighted arithmetic averages of magnet efficiency by area over time.⁷

A key decision in the analysis was how to best represent plant magnet efficiencies in the estimation process. Rather than relying on simple parametric averages of random non-parametric distributions of plant- and area-specific magnet efficiencies, Drs. Ault & Luo incorporated all the empirical data to ensure a comprehensive estimation framework for natural mortality. Integrating both recapture data and the variability of trial-based magnet efficiency distributions was critical for achieving reliable model fits and scientifically robust mortality estimates. Drs. Ault & Luo's analysis shows that using a "parameters" estimation approach, which allows the magnet efficiency parameters to be estimated directly from the observed recapture data, accounted for the random nonparametric distribution of magnet efficiencies and substantially improved model fits to data. The Liljestrand, Wilberg & Schueller approach of averaging data across all plants and areas over time was, and remains, an inappropriate, non-representative and inefficient use the data, resulting in unreliable estimates of natural mortality.

The failure to appropriately address the nonparametric distribution of magnet recapture efficiency data continues to significantly inflate the M adopted by the SAS. As stated in Dr. Ault's March 14 memorandum submitted to the SAS,

"The ASMFC SAS has failed to apply standard objective statistical criteria in selecting the appropriate mark-recapture model estimates of natural mortality rate. Instead, they made a subjective, *ad hoc* choice for the value of M to be used in the upcoming stock assessment."

In contrast, Drs. Ault & Luo applied a more data-driven method for estimating magnet efficiencies, without prescribing any prior distribution or assumptions about full mixing.

Drs. Ault & Luo also applied a "Stepwise" approach to estimation of the natural mortality rate. In contrast to the characterization in the SAS TC presentation, Drs. Ault and Luo used the Stepwise method as a diagnostic tool, systematically estimating magnet efficiencies in stages to assess how sensitive model performance is to changes in M . As explained, the method was designed solely to explore the sensitivity of M estimates to increasing model complexity and spatio-temporal resolution of magnet efficiencies, not as a formal hypothesis-testing framework.

Both the "parameters" and "stepwise" methods better represent the empirical variability in magnet efficiencies observed in the plant trials, resulting in consistent and substantially lower natural mortality estimates. In the July 2025 SAS TC meeting, the SAS presentation selectively highlighted Drs. Ault & Luo's Stepwise approach, but failed to discuss the more statistically rigorous "parameters" estimation approach and its ability to improve model fits which effectively integrated both recapture data and the variability of trial-based magnet efficiency distributions, a

⁷ Magnet efficiency is a measure of the efficiency by which the magnets in the menhaden processing plants captured known ferro-magnetic tags seeded into catches in the underlying tagging study. Each plant had up to nine magnets, with the first two (primary) magnets were used in the Coston study, and all nine used in the NMFS data analysis.

modeling process that was critical for achieving reliable model fits and scientifically robust mortality estimates.

The ASMFC Must Fully Address All of the Identified Mistakes in the Analysis Leading to the Adoption of the Severely Inflated M Used in the SEDAR 69 Stock Assessment

The remaining mistake that accounts for the difference between the SAS recommended $M=0.92$ and Drs. Ault & Luo's recommended $M=0.52$ is the SAS's failure to apply the most scientifically sound method to magnet tag recovery efficiency at the menhaden reduction plants. Drs. Ault & Luo's conclusions are fully supported by every other indicator of the actual M for Atlantic menhaden, including the life history estimate of $M = 0.54$, indirect mortality estimation methods which indicate that M should fall within a reasonable range of 0.30 and 0.50 based on empirical life history principles, and the more than a dozen peer reviewed estimates of M ranging from 0.37 to 0.53. Drs. Ault & Luo also detail that the $M=1.17$ estimate adopted in the SEDAR 69 stock assessment was anomalously high compared to more than 60 recent U.S. and international fish stock assessments. The estimate represented a 2.3-fold increase over the $M=0.50$ used in SEDAR 40 (2015) assessment -- 14 standard deviations above the mean of 0.46 for the peer-reviewed publications.

Another red flag signaling problems with adopting the $M=1.17$ in SEDAR 69 stock assessment was the manipulation of other parameters that occurred, including the steeply increased recruitment assumptions needed in the model to account for the extremely high M .⁸ The parameter manipulation apparent in the Liljestrand, Wilberg & Schueller paper, ultimately adopted and approved in SEDAR 69, is inconsistent with sound science. Unfortunately, it may be occurring again. The July SAS TC presentation stated that they were "scaling" the recruitment assumption to decrease the effect of fishing and increase stock biomass. This scaling appears to be a results-driven change in recruitment by 1.5 orders of magnitude (15 times) to account for the decline in the estimated M . As a result, the SAS were able to conclude that fishing at current levels would have no impact on the status of the menhaden resource.

The SAS recommendation of $M=0.92$ remains a significant statistical outlier, still several standard deviations above all other credible estimates. The SAS agreed to introduce the Ault & Luo M analysis into the Peer Review through its inclusion as a sensitivity run, however this sensitivity run was not presented or discussed at the July SAS TC meeting, nor were the full impacts of a lower M discussed. It appears that the SAS may be reluctant to admit the full magnitude of their prior mistakes. It is understandable that there may be some professional embarrassment to the original authors, some of whom are active members or have colleagues on the SAS. Representatives from Omega Protein also apply pressure as the dominant special interest in the fishery. And states will also be affected by decreases in the allowable catch. However, Atlantic menhaden is the only major East Coast forage species that is supposedly at relatively healthy levels. It is critical to the health of striped bass, osprey, and countless other predators, and is the key forage stock in the ERP model. The ASMFC must meet its legal obligations under ACFCMA and the ASMFC's Rules and Charter to base its Interstate Fishery

⁸ SEDAR 69 continued a dramatic transition in how the health of the Atlantic menhaden population was viewed from less than 10 years prior when menhaden was considered likely overfished and overfishing occurring. SEDAR 69 not only concluded that menhaden was not overfished, but that the menhaden spawning stock was over 80 percent of the unfished population size.

Management Plans on the best available science and prevent overfishing and look to the long-term benefits of a healthy Atlantic menhaden population managed sustainably.

* * * * *

The work of the Atlantic Menhaden SAS and Drs. Ault & Luo is now consistent except for the SAS's mistaken application of the simple arithmetic average of plant- and area-specific magnet tag recovery efficiencies. The scientific evidence points to the method used by Drs. Ault & Luo as the best scientific approach for determining the M estimate. Given the magnitude of the difference between the M in use since 2019 ($M=1.17$) and Drs. Ault & Luo's estimate of $M=0.52$, there is a high risk that menhaden is overfished with overfishing occurring. Adopting their recommended $M=0.52$ in the stock assessment will help prevent overfishing and rebuild the Atlantic menhaden resource.

For these reasons, we request that you do all that is possible to ensure that the August 12-15 Ecological Reference Point Peer Review fully examines the issues raised in this letter by first including Drs. Ault & Luo's paper⁹ and our letter in the Peer Review materials. Second, please ensure that Drs. Ault & Luo's recommended ($M=0.52$) is included as a sensitivity run in the BAM and that the results – including impact on biomass and stock status - be available for consideration and adoption by the Menhaden Board. Third, please ensure that all of these materials are provided with the Peer Review results to the Board and ASMFC so that they can consider them and make their final decisions consistent with their legal duties to manage Atlantic menhaden based on the best available science and to prevent overfishing. And finally, to help ensure impartiality in the analysis and presentation of the issues raised here, please recuse the authors of the Liljestrand, Wilberg & Schueller paper from participating in the Peer Review and subsequent processes leading to the Board and ASMFC's final decisions.

Thank you for considering our concerns and recommendations.

Sincerely,



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⁹ If Drs. Ault & Luo's paper is not published before the peer review begins, please provide the most recent manuscript and response to reviewer comments available.

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Encl:

1. Dr. Jerald S. Ault Memorandum to the ASMFC Stock Assessment Subcommittee, (March 14, 2025).
2. Dr. Jerald S. Ault & Dr. and Jiangang Luo, Magnet Efficiency Parameters, (February 27, 2025).
3. Dr. Jerald S. Ault & Dr. and Jiangang Luo, Report on Estimation of Area Magnet Efficiencies and Natural Mortality, (February 25, 2025).
4. Dr. Jerald S. Ault Letter to ASMFC Menhaden Management Board, (January 31, 2020).
5. Roger Fleming, Esq. and David Reed, Esq., Letter to Mr. Robert Beal, Executive Director, (February 28, 2025).
6. Roger Fleming, Esq. and David Reed, Esq., Letter to Mr. Robert Beal, Executive Director, (October 31, 2024).

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Objective Criterion for Model Selection

The ASMFC SAS has failed to apply standard objective statistical criteria in selecting the appropriate mark-recapture model estimates of natural mortality rate. Instead, they have made a subjective, *ad hoc* choice for the value of M to be used in the upcoming stock assessment.

When using the Coston data, objective criteria for model selection should include three key metrics of model outputs for assessing the model efficacy:

- (1) Aikake Information Criteria (AIC).
- (2) Difference between observed and model-predicted recaptures.
- (3) Visual inspection of the fit between observed and model-predicted recaptures.

Method	K	neg(LL)	R	Δ	AIC	$\hat{M}$	$\hat{M}_{MCMC}$
Constant:	106	10,579	102,992	92,611	21,370	0.8992	0.9039
Stepwise:	106	9,751	102,992	-6,570	19,714	0.5149	0.5102
Parameters:	206	9,484	102,992	10,123	19,380	0.5488	0.4965

Table 1.- Summary of findings from three analytical methods applied to the Coston mark-recapture data. Symbols are: K $\equiv$ number of estimated model parameters; neg(LL) $\equiv$ model's negative log-likelihood; R $\equiv$ observed total recaptures; Δ $\equiv$ difference estimated between predicted and observed recaptures; AIC $\equiv$ Akaike Information Criterion; $\hat{M}$ $\equiv$ estimated single-run annual natural mortality rate; $\hat{M}_{MCMC}$ $\equiv$ MCMC mean estimated annual natural mortality rate.

For the Coston data, **Table 1** clearly indicates that: $AIC_{constant} \gg AIC_{stepwise} > AIC_{parameters}$.

Focusing on the “Constant” and “Stepwise” approaches, and using the objective model selection criteria outlined above:

- (1) There was a 7.7% reduction in AIC for the “Stepwise” versus “Constant” approach.
- (2) The “Constant” approach overestimated recaptures by +89.9%, whereas the “Stepwise” approach underestimated recaptures by only 6.4%—a significantly more accurate estimation.
- (3) Visualizations (**Fig. 1**) of single-run results for Coston data further support the superiority of the “Stepwise” approach.

These findings clearly indicate that the “Stepwise” approach is far superior to the “Constant” approach and should be selected as the best model choice.

Thus, the objective choice of the “base” case for Atlantic menhaden stock assessment should be the Stepwise approach with an $\hat{M} = 0.52$ (sd = 0.0234); and on the other hand, the “sensitivity” case should be $\hat{M} = 0.90$ (sd = 0.0331).

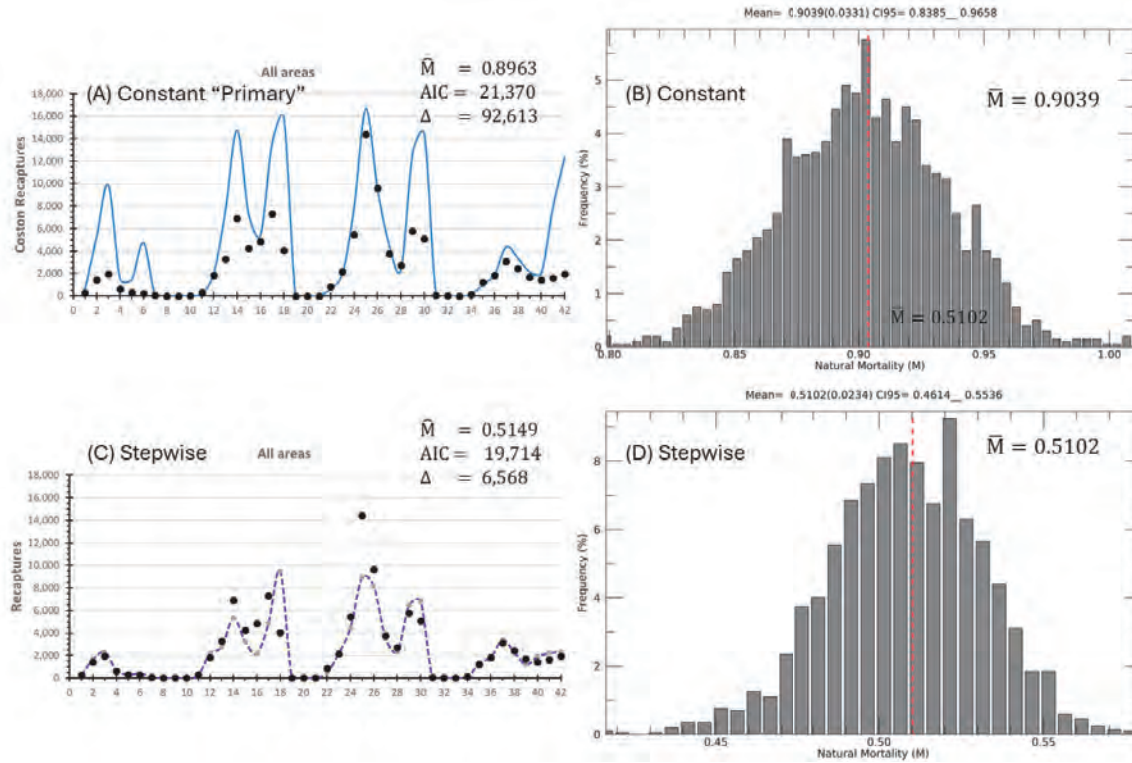


Figure 1.- Summary visualizations of single run results for Coston data: (A) “Constant” primary magnet efficiency coefficients; and (B) “Stepwise” (Step #4).

This analysis allows for a direct comparison of these estimates with other key mortality and survivorship parameters, including those generated by the single-species assessment model (BAM).

Magnet Efficiency Parameters

Some misunderstandings have been raised concerning the use and estimation of magnet efficiency parameters. Our objection to using the mean magnet efficiency from the Plant Test data is based on the fact that these frequency distribution(s) significantly deviate from a symmetrical normal distribution, instead appearing to resemble a uniform random distribution (**Figs. 1 & 2**). In fact, the true empirical distribution is neither normal nor uniform, but rather some type of a **random non-parametric distribution**.

In our model runs where magnet efficiencies were treated as parameters, we **did not** assume a uniform random distribution as a prior condition. Instead, the model estimated magnet efficiency parameters by fitting predicted recaptures to the observed recapture data using a **negative log-likelihood function** incorporated into an AIC to account for the additional estimated parameters. The resulting frequency distribution of magnet efficiency parameters emerged from the second half of a **4,000,000-step MCMC run**, saved every **1,000 steps (Fig. 1)**.

The parameter frequency distributions by the four areas are shown in **Fig. 3**, demonstrating how the model-derived estimates reflect the underlying data structure(s) without imposing any predefined probability function. When magnet efficiency parameters are averaged by month and area, they exhibit slightly different patterns (**Fig. 4**). This pattern may not exactly match the Plant Test data *per se*, but there is no expectation that it would; however, It definitely covered the range of observed magnet efficiencies. This further highlights the limitations of using simple averages to represent these relatively complex data.

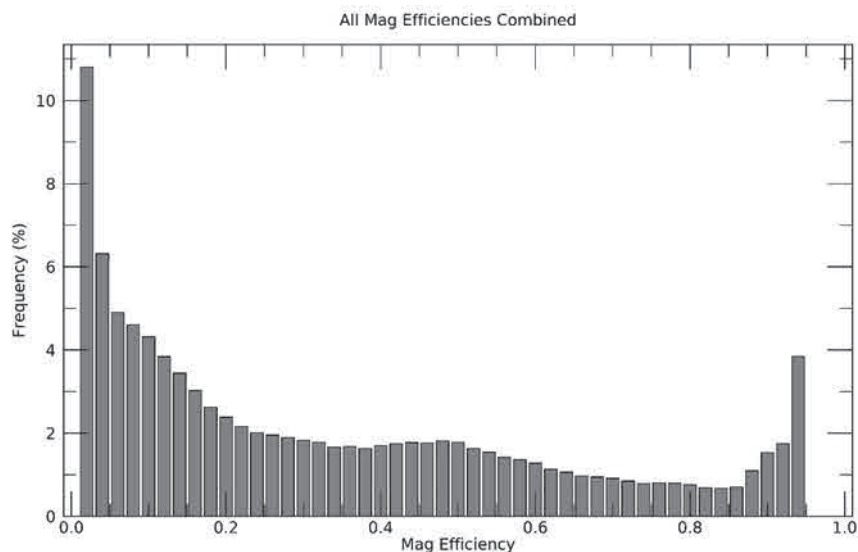


Figure 1.- Estimated primary magnet efficiency distribution corresponding to the Coston data for all months and areas combined. Data are from the second half of the 4 million step MCMC simulation, saved every 1000 steps and binned at 0.02 ($n = 2,000$).

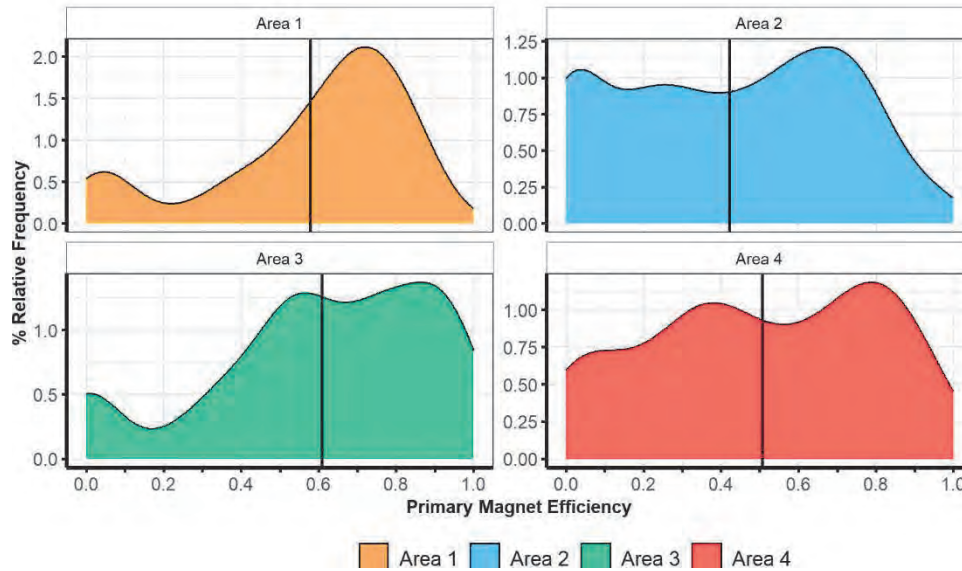


Figure 2.- Observed area-averaged primary magnet efficiency distributions from the 1966-1971 Plant Test data. Vertical black lines are the area-specific weighted means.

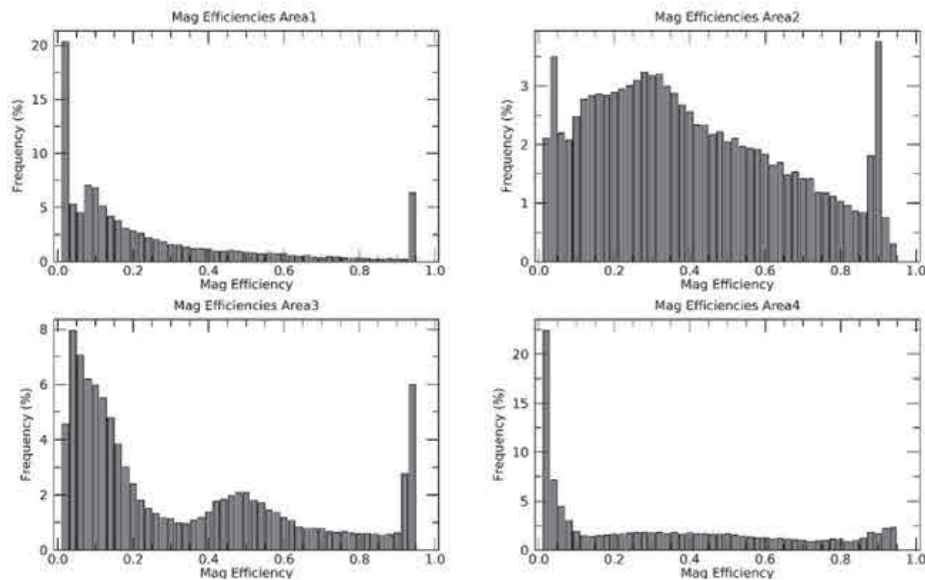


Figure 3.- Area-specific estimated primary magnet efficiency distribution for all 42 months from second half of the 4 million steps MCMC simulation saved every 1000 steps and binned at 0.02 ($n = 2,000$).

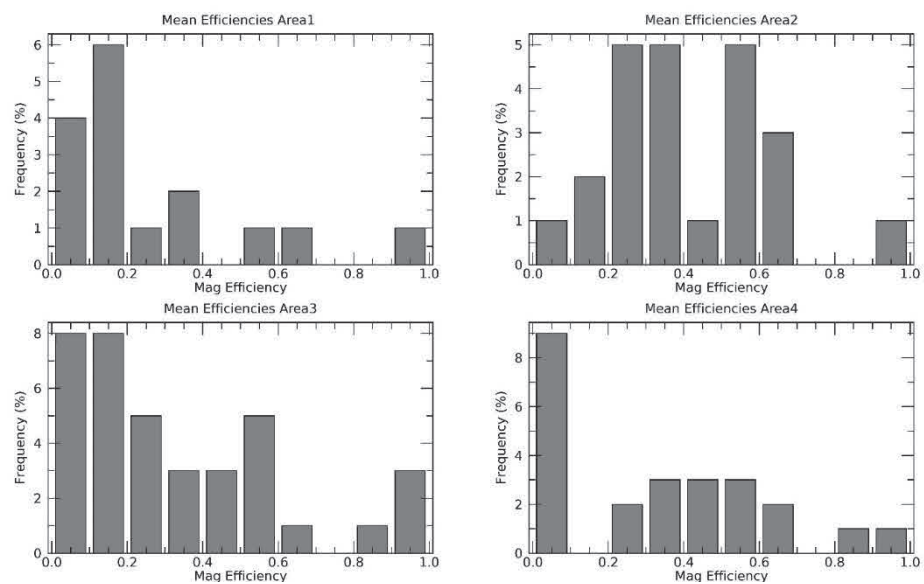


Figure 4.- Month and area averaged magnet efficiency distributions from second half of the 4 million step MCMC simulation saved every 1000 steps and binned at 0.05 ($n = 2,000$).

This report addresses the ASMFC’s SAS M workgroup’s request, dated February 12, 2025, for a detailed description of our Stepwise method used to estimate magnet efficiencies (MEs). This report also compares this method to the “Constant” and “MEs as parameters” approaches. The results from these analyses were then incorporated into a comprehensive evaluation of the two Atlantic menhaden mark-recapture databases to derive the best estimate of the natural mortality rate (M) for the species. We concluded that $M = 0.52$ is the best estimate of the annual natural mortality rate for Atlantic menhaden.

I. Constant Average Plant and Area Magnet Efficiencies ($\epsilon_{t,a}$)

Appropriate use of the Coston (1971) data required establishment of a quantitative definition of what constituted “primary” magnets. Because NMFS data for 1966 completely overlapped with the releases given in Coston, we were able to determine that recovery stations 1 and 2 should be defined as “primary magnets (p12)” in the “Plant Test” database, aligning perfectly with the reported recaptures in the Coston (1971) technical report. Determination of plant and area magnet efficiencies during 1966-1971 was accomplished through analysis of 964 batch trials conducted at 19 processing plants in 4 geographical areas (**Table S1**; note: no batch trials were conducted at plant #8), as was done by the ASMFC SAS M workgroup. Each batch trial consisted of release of approximately 100 known tagged menhaden into vessel catches received at the respective plants. The fraction of the known tags recovered was assessed for each batch according to two different magnet configurations relative to the database being analyzed: (1) Coston data required only “primary magnets (p12 -- recovery stations 1 and 2)”; while, (2) NMFS data used “all magnets” (all recovery stations). Comparisons of magnet efficiencies by plants and areas for the two databases are shown in **Fig. I.1**.

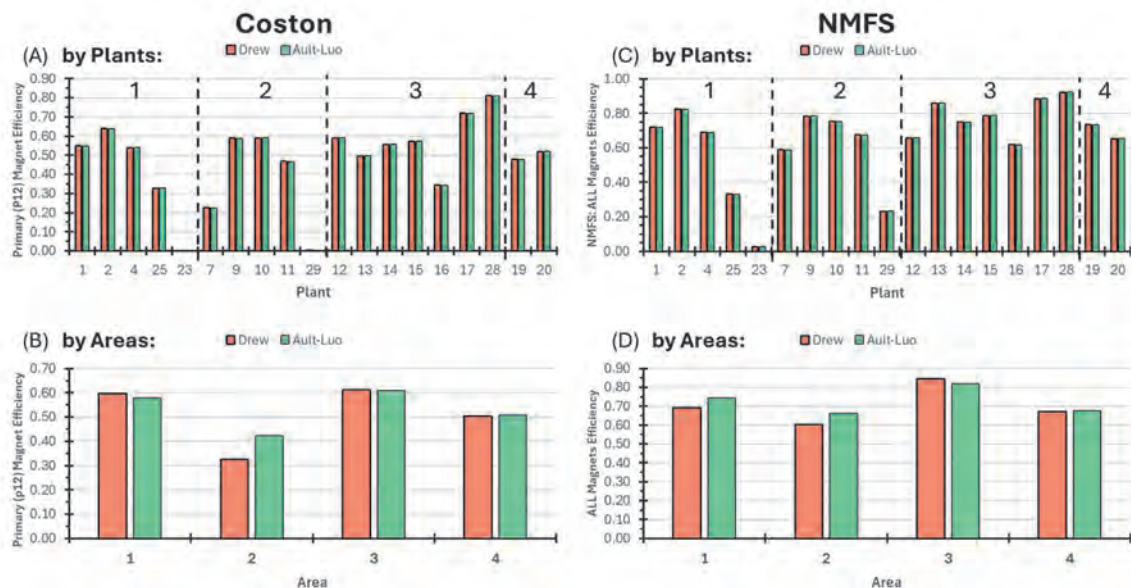


Figure I.1.- Average tag recovery magnet efficiencies over 1966-1971 at 19 reduction plants and four geographic areas for the two principal data sources: (A-B) “primary” magnets for Coston; and (C-D) “all” magnets for NMFS.

For the two data sources, average ME estimates were equivalent by plants (**Figs. I.1 A & C**); and, area averages were only marginally different due to the catch weighting of coefficients by ASMFC. However, inspection of the statistical distributions of magnet efficiencies for all plants and areas combined shows these data are not normally distributed and are not well represented by the arithmetic mean as the central value of these data; nor are they either by individual plants or areas (**Figs. I.2-I.4**).

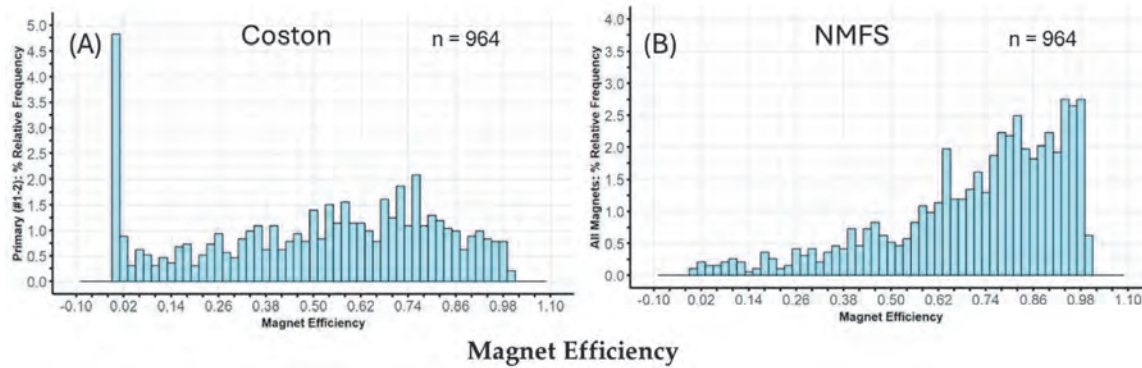


Figure I.2.- Distributions of combined magnet efficiencies for all plants and areas from 964 batch trials: (A) “primary” magnets (recovery stations 1 and 2) relevant to the Coston data; and (B) “all” magnets (all plant recovery stations) relevant to the NMFS data.

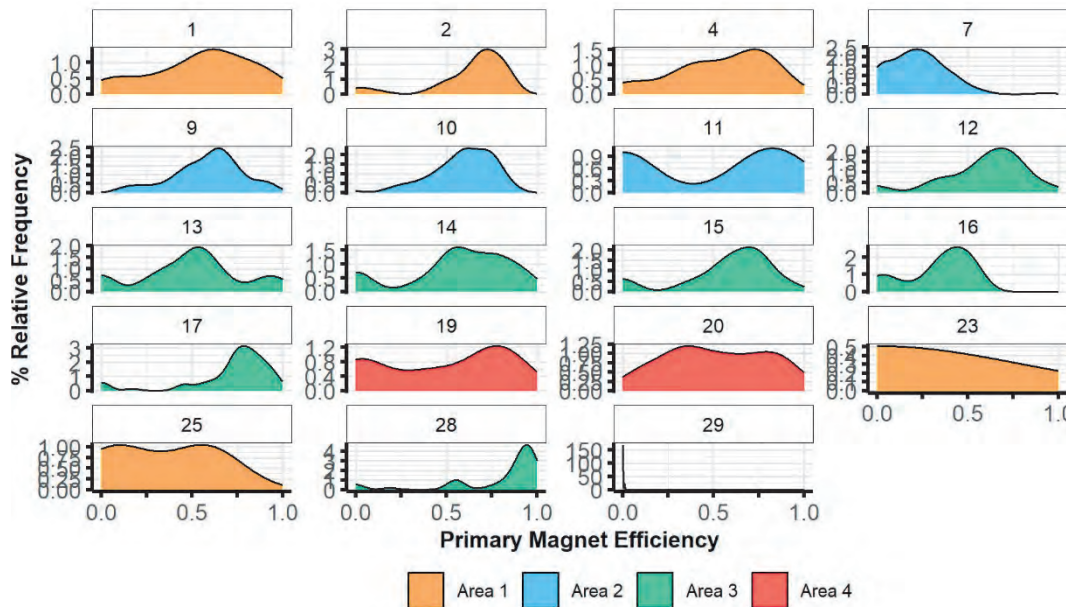


Figure I.3.- Plant-specific distributions of individual batch trial magnet efficiencies for “primary” (p12) magnets at 19 Atlantic menhaden reduction plants contained within four geographical areas (see **Table S1**) during 1966-1971.

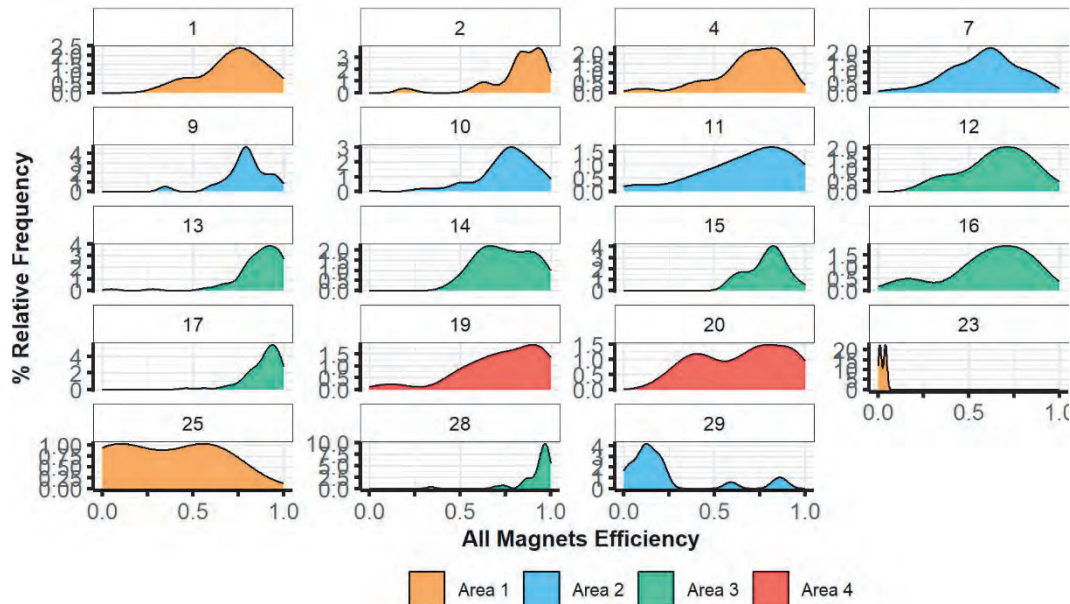


Figure I.4.- Plant-specific distributions of individual batch trials of magnet efficiencies for “ALL” magnets at 19 Atlantic menhaden reduction processing plants contained within four geographical areas (see **Table S1**) during 1966-1971.

Figs. I.2-I.4 each clearly show that the combined and individual magnet efficiency data were apparently distributed as uniform random variables ranging between 0 and 1, i.e., $U(0,1)$. A "uniform distribution" means all possible outcomes in the range have an equal probability of occurring.

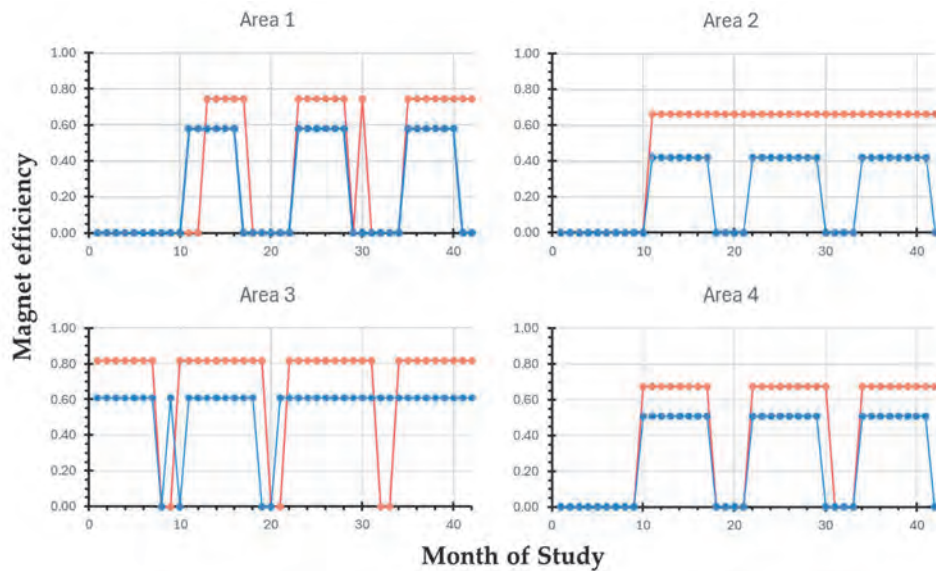


Figure I.5.- Temporal distribution of area averaged estimates of magnet efficiency within 4 geographical Areas over the 42 month (July 1966-December 1969) study. MEs are applied during months when recaptures were observed. Coston (p12) averages (blue closed dots) are from **Fig. I.1B**; while NMFS (all recovery stations) averages (red closed dots) are from **Fig. I.1D**.

In the null “Constant” modeling approach, Area averages were used by the SAS as monthly inputs by area for the estimated magnet efficiency matrix if recoveries were observed in that Area. However, given the uniform distributions of magnet efficiencies by plants, areas and all plants and areas combined, the Area mean is a poor descriptor of the underlying data.

As such, single run mean assessments were run. If the model converged, then and MCMC run of 4,000,000 trials was conducted to establish the mean and standard error of the estimated natural mortality parameter.

II. Stepwise Analysis of Magnet Efficiencies ($\varepsilon_{t,a}$)

Recoveries (theoretical catch of tagged cohorts of menhaden) for each month t and area a of tagged cohorts ($C_{T,A,t,a}$) is the product of the unknown time and area-specific tagged fish abundance, $N_{T,A,t,a}$, the proportion of mortality due to fishing $F_{t,a}$ and natural M causes, and the time and area specific plant magnet efficiency rate $\varepsilon_{t,a}$.

$$C_{T,A,t,a} = \left[N_{T,A,t,a} \frac{F_{t,a}}{(F_{t,a}+M)} (1 - e^{-(F_{t,a}+M)}) \right] \varepsilon_{t,a} \quad (1)$$

The Stepwise procedure is conducted as follows:

Step 0: Input the matrix of “Constant” average “primary” magnet efficiencies $[\hat{\varepsilon}_{0,t,a}]$ determined in the Section I analyses for each area a ($a = 1, \dots, 4$) and month t ($t = 1, \dots, 42$). Input these values and conduct a single run, letting the model estimate recaptures $C_0(t, a)$ according to Eq. (1).

Simple rearrangement of Eq. (1) produces a mean area-time estimate of magnet efficiency $\hat{\varepsilon}_{t,a}$.

$$\hat{\varepsilon}_{1,t,a} = \frac{\text{Observed } C_{t,a}}{N_{t,a} \frac{F_{t,a}}{(F_{t,a}+M)} (1 - e^{-(F_{t,a}+M)})} = \frac{\text{Observed } C_{t,a}}{\hat{C}_0(t,a)} \quad (2)$$

where,

$$\hat{C}_0(t, a) = N_{t,a} \frac{F_{t,a}}{(F_{t,a}+M)} (1 - e^{-(F_{t,a}+M)}) \quad (3)$$

The denominator of Eq. (2) is calculated internally in the model through sequencing tagged cohorts released over time in the 4 areas, resulting in an updated estimate of magnet efficiency.

Step 1: Use the theoretical numbers of tagged fish (Eq. 1) from Step 0, or “actual unknown” recaptures $(\hat{C}_0(t, a))$, without application of $\hat{\varepsilon}_{1,t,a}$, to re-estimate magnet efficiencies as: $\hat{\varepsilon}_{1,t,a} = \text{Observed } C_{t,a} / \hat{C}_0(t, a)$. Use these adjusted $\hat{\varepsilon}_{1,t,a}$ values as magnet efficiency parameters.

Additionally, minimum and maximum limits on the area-specific estimates of magnet efficiencies ($\hat{\epsilon}_{t,a}$) were set to range between 0.10 – 0.98 for “primary” magnet when using the Coston data. This constraint was reduced to 0.20 – 0.98 for “all” (all recovery stations) when using NMFS data. Upon model convergence, the new matrix of magnet efficiencies [$\hat{\epsilon}_{S_{t,a}}$] was used in the Stepwise analysis process.

Step 2: Use Step 1’s theoretical catch of tagged fish ($\hat{C}_1(t, a)$) to re-estimate magnet efficiencies [$\hat{\epsilon}_{1_{t,a}}$] and use as Step 2 model inputs.

The Akaike Information Criterion (AIC) was the estimator of prediction error and thereby relative quality of the statistical models for the given sets of data. Given a collection of models for a given set of data, AIC estimates the quality of each model, relative to each of the other models. Thus, AIC provides an objective means for model selection.

$$AIC = -2\ln(L) + 2K \quad (4)$$

Where, $K \equiv$ number of estimated parameters in the model; and, $L \equiv$ maximum value of the likelihood function for the model. A lower AIC indicates a better fit and thus better model.

Step 3+: Continue stepwise procedure outlined above until an objective stopping criterion is met.

Step	$\hat{M}$	neg(LL)	$\hat{R}$	R	Δ	AIC
0	0.8963	10,579	195,603	102,992	92,611	21,370
1	0.7289	9,795	143,697	102,992	40,705	19,802
2	0.6891	9,777	100,340	102,992	-2,652	19,766
3	0.5956	9,744	97,346	102,992	-5,646	19,700
4	0.5149	9,751	96,422	102,992	-6,570	19,714
5	0.4406	9,763	96,044	102,992	-6,948	19,738
6	0.3790	9,773	95,753	102,992	-7,239	19,758
7	0.3243	9,784	95,569	102,992	-7,423	19,780

Table II.1.- Stepwise analysis of the Coston data. Symbols are: $\hat{M} \equiv$ estimated annual natural mortality rate; neg(LL) $\equiv$ model’s negative log-likelihood; $\hat{R} \equiv$ total estimated recaptures by the model; ; R $\equiv$ observed total recaptures; $\Delta \equiv$ difference between predicted and observed recaptures; AIC $\equiv$ Akaike Information Criterion.

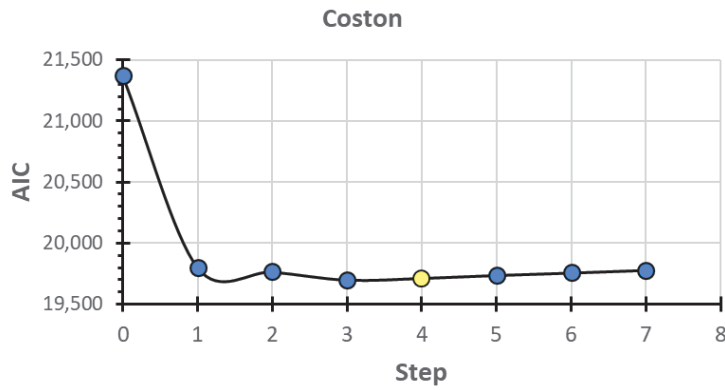


Figure II.1.- AIC reduction using the Stepwise iterative procedure for the Coston data. Minimum AIC was identified as Step 4.

Stepwise analysis for the NMFS data showed a minimum AIC in Step 7 (**Table II.2 & Fig. II.2**).

Step	$\hat{M}$	neg(LL)	$\hat{R}$	R	Δ	AIC
0	0.8909	8,044	133,279	93,335	39,944	16,300
1	0.8174	7,532	94,784	93,335	1,449	15,276
2	0.7737	7,500	88,188	93,335	-5,147	15,212
3	0.6938	7,505	95,008	93,335	1,673	15,222
4	0.6564	7,515	95,649	93,335	2,314	15,242
5	0.6294	7,519	95,962	93,336	2,626	15,250
6	0.5609	7,405	113,129	93,337	19,792	15,022
7	0.5279	7,372	107,830	93,338	14,492	14,956
8	0.4863	7,373	108,519	93,339	15,180	14,958
9	0.4498	7,377	108,746	93,340	15,406	14,966

Table II.2.- Stepwise analysis of the NMFS data. Symbols are: $\hat{M}$ $\equiv$ estimated annual natural mortality rate; neg(LL) $\equiv$ model's negative log-likelihood; $\hat{R}$ $\equiv$ total estimated recaptures by the model; R $\equiv$ observed total recaptures; Δ $\equiv$ difference between predicted and observed recaptures; AIC $\equiv$ Akaike Information Criterion.

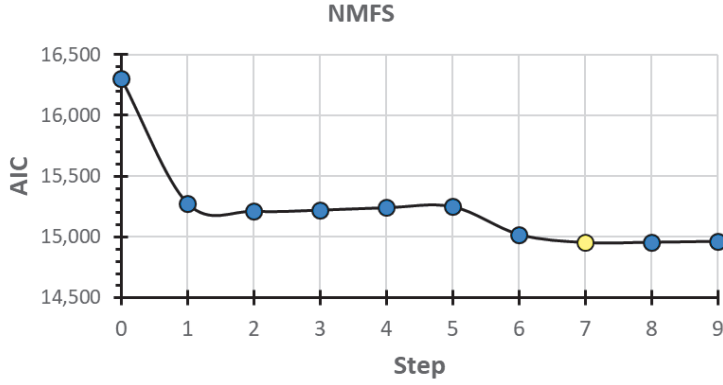


Figure II.2.- AIC reduction using the Stepwise iterative procedure for the NMFS data. Minimum AIC was identified as Step 7.

III. Magnet Efficiencies ($\epsilon_{t,a}$) as Model Parameters

The probability distribution of estimated plant time-area magnet efficiencies closely resembled a uniform random distribution $U(0, 1)$ (**Fig. III.1**), and was not well represented by the average across all plants and areas over years. Thus, another reasonable method was to estimate magnet efficiencies $\hat{\epsilon}_{t,a}$ by area and time $\hat{\epsilon}_{t,a}$ by treating them as model parameters, done in the same way that the theta parameters (catchability $\Theta_{t,a}$) are already estimated in the model. To this end, we modified the model code to allow magnet efficiencies $\hat{\epsilon}_{t,a}$ to be estimated as model parameters. The number (n) of non-zero recapture elements by area and time was used to determine the number of $\hat{\epsilon}_{1-n}$ parameters, which map to the $[\hat{\epsilon}_{0,t,a}]$ matrix. We employed a way similar to how the theta parameters were estimated as the natural log of theta, $\ln(\Theta)$, in the model, the log of magnet efficiencies, $\ln(\hat{\epsilon}_{1-n})$, that were estimated in the model. We also constrained the log-parameter boundary to range from -3.5 to -0.05 for the Coston data, and from -2.0 to -0.05 for the NMFS data. The number of non-zero recaptures elements in Coston data is 100; thus, when estimating magnet efficiencies we have additional 106 parameters that needed to be estimated by the model, that is, a total of 206 parameters for the model. The model input data of releases and recaptures creates a matrix of:

$$\text{Months tagged} \times \text{Areas} \times \text{Months recaptured} \times \text{Areas} = 42 \times 4 \times 42 \times 4 = 28,224 \text{ d. f.}$$

For a total of 28,224 data points. Thus, the degrees of freedom are not significantly affected by the increase of 106 parameters to estimate time-area magnet efficiencies

$$28,224 - 106 = 28,118 \text{ d. f.}$$

IV. Summary

Results of these analyses are summarized graphically for the three model types and two data sources as comparative single model fits of observed data for the “Constant” (Figs. IV.1A-C), “Stepwise” (Figs. IV.1B-E) and “Parameters estimated” (Figs. IV.1C-F) methods for the Coston (left panels) and NMFS (right panels) data. The observed model fits to data are superior for both Stepwise and Parameter methods as compared to the Constant method.

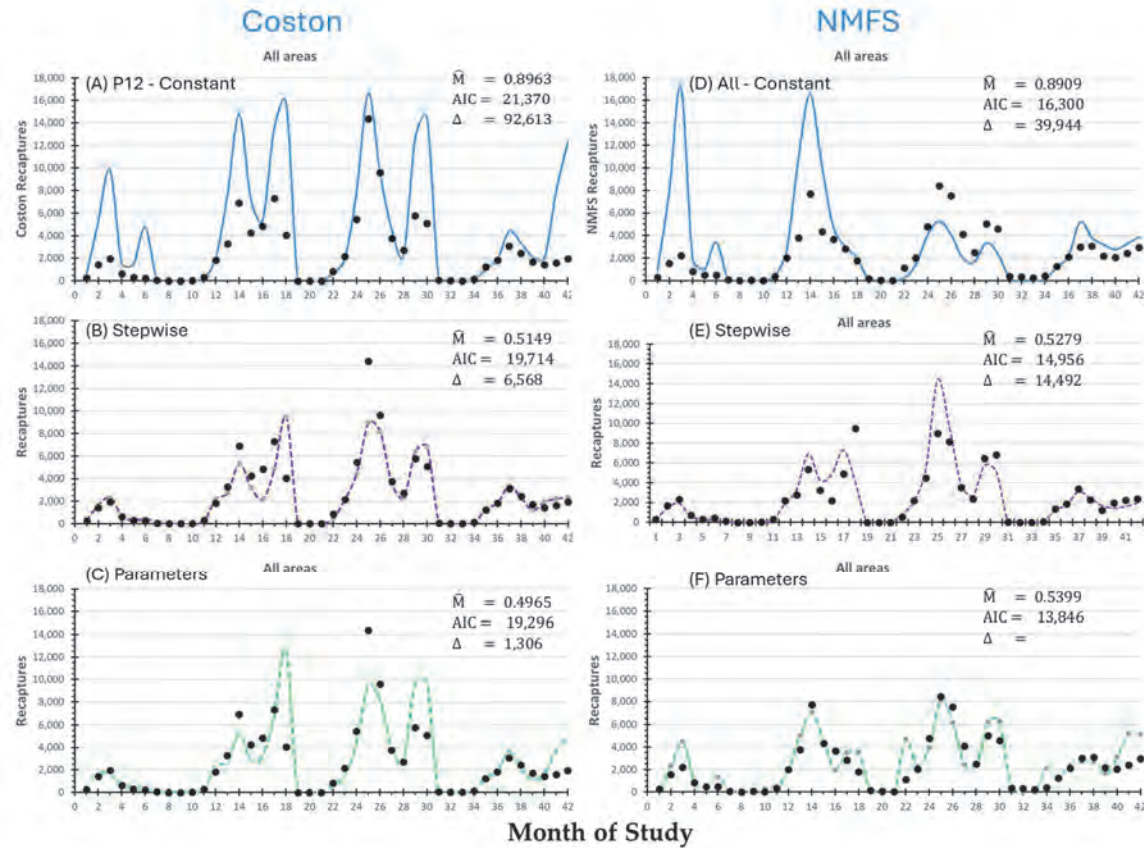


Figure IV.1.- Summary visualizations of single run results for the two data sources: **Coston:** (A) primary magnets with constant ME coefficients; (B) stepwise analysis (Step #4); (C) ME parameters estimated by model. **NMFS:** (D) all magnets with constant ME coefficients; (E) stepwise analysis (Step #7); (F) ME parameters estimated by model.

Given that all three models converged, MCMC analyses, each consisting of 4,000,000 trials, were completed (Fig. IV.2). While the unconstrained case for the ME parameter estimation was exploratory, it did produce an estimate of natural mortality lower than what we expected, and further, what we would probably consider to be unrealistic. In contrast, placing realistic constraints on the ME estimates marginally increased the AIC (Coston about +0.43%; NMFS about +1.8%), but significantly increased the value of M (Coston about +68.2%; NMFS about +83.6%) (Tables IV.1 & IV.2).

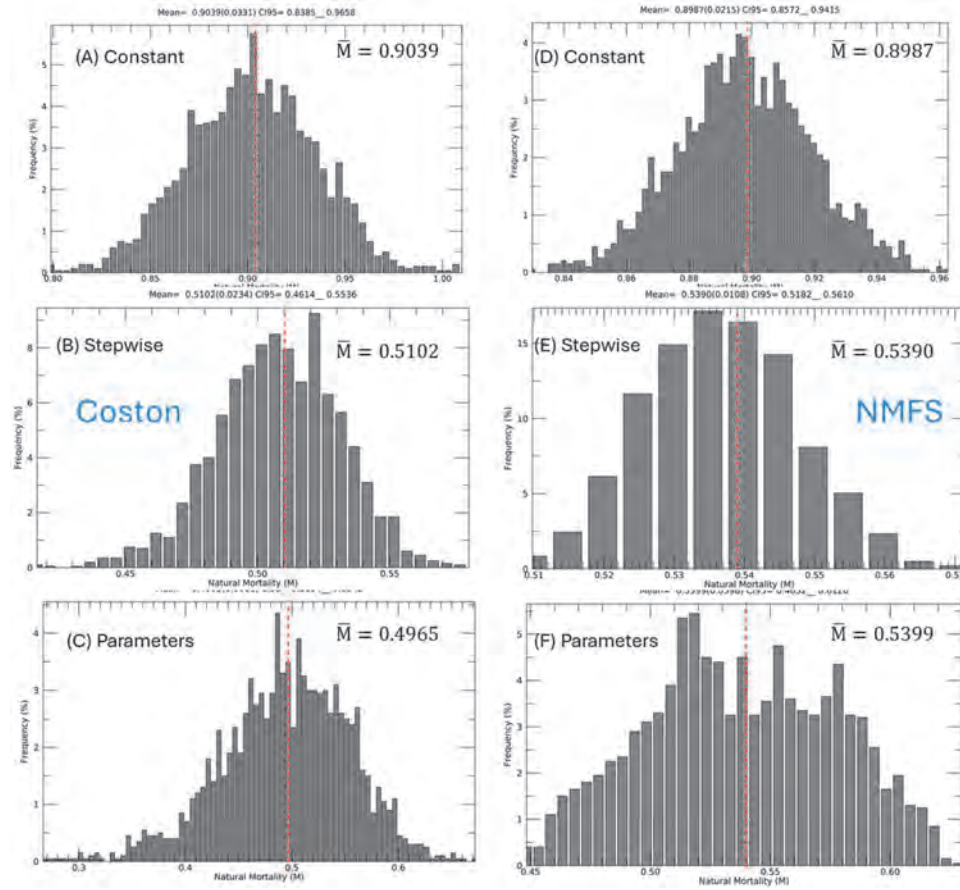


Figure IV.2.- Summary of MCMC trial results corresponding directly to the single-run results of **Fig IV.1**. **Coston**: (A) primary magnets with Constant MEs; (B) Stepwise analysis (Step #4); (C) ME Parameters estimated. **NMFS**: (D) ALL magnets with Constant MEs; (E) Stepwise analysis (Step #7); (F) ME Parameters estimated.

Method	K	neg(LL)	Δ	AIC	$\hat{M}$	$\hat{M}_{MCMC}$
Constant:	106	10,579	92,611	21,370	0.8992	0.9039
Step 4:	106	9,751	-6,570	19,714	0.5149	0.5102
As parameters:						
Unconstrained	206	9,442	8,296	19,296	0.3406	0.2939
Constrained	206	9,484	10,123	19,380	0.5488	0.4965

Table IV.1.- Summary of results from three analytical methods applied to the Coston data. Symbols are: K $\equiv$ number of estimated model parameters; neg(LL) $\equiv$ model's negative log-likelihood; Δ $\equiv$ difference between predicted and observed recaptures; AIC $\equiv$ Akaike Information Criterion; $\hat{M}$ $\equiv$ estimated annual natural mortality rate; $\hat{M}_{MCMC}$ $\equiv$ MCMC mean estimated annual natural mortality rate.

Method	K	neg(LL)	Δ	AIC	$\hat{M}$	$\hat{M}_{MCMC}$
Constant:	106	8,044	39,944	16,300	0.8909	0.8987
Step 7:	106	7,372	14,492	14,956	0.5279	0.5390
As parameters:						
Unconstrained	206	6,717	1,306	13,846	0.2935	0.2940
Constrained	206	6,839	12,669	14,090	0.5689	0.5399

Table IV.2.- Summary of results from three analytical methods applied to the NMFS data. Symbols are: K $\equiv$ number of estimated model parameters; : neg(LL) $\equiv$ is the model's negative log-likelihood; $\Delta \equiv$ difference between predicted and observed recaptures; AIC $\equiv$ Akaike Information Criterion. $\hat{M} \equiv$ estimated annual natural mortality rate; $\hat{M}_{MCMC} \equiv$ MCMC mean estimated annual natural mortality rate.

Using the all the data, the three central and most important metrics for assessing the efficacy of the model analyses are: (1) the AIC; (2) differences (Δ) between observed and predicted recaptures; and (3) visual inspection of the plot of the observed versus model-predicted recaptures. In general, for both data sets: $AIC_{\text{constant}} \gg AIC_{\text{stepwise}} > AIC_{\text{parameters}}$, which suggests that MEs estimated as parameters should be the best model choice. For the Coston data, the reduction in AIC ranged between -7.7% to -9.3% for the stepwise versus parameters, respectively. For the NMFS data, the reduction in AIC ranged between -8.2% to -13.6% for the “stepwise” versus “ $\varepsilon_{t,a}$ as estimated parameters” approaches, respectively. It is obvious that both stepwise and ME parameter estimation methods are better fits to the data than constant MEs (Fig. IV.1).

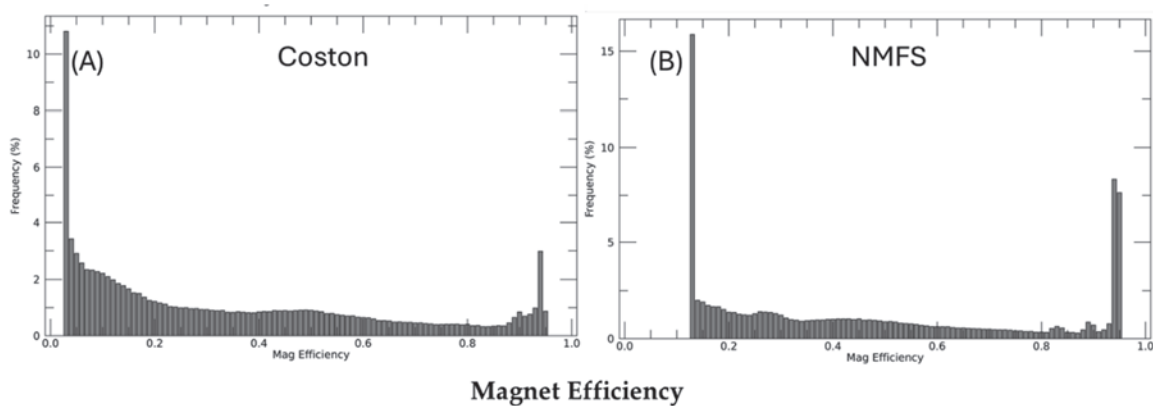


Figure IV.2.- Modeled magnet efficiency parameter estimates for: (A) Coston; and (B) NMFS data sources. Note the similarity to the observed empirical plant test magnet efficiency data shown in Fig. I.2.

V. Conclusions

As discussed by the SAS M workgroup, our analyses estimated a natural mortality rate (M) of approximately 0.54 or lower using multiple methods and two data sources. In contrast, Schueller et al. estimated an M of about 0.92 based solely on the averaged plant-area magnet efficiencies. As it turns out, the largest driver of this difference was not the confidential effort data withheld by industry, nor was it the underlying magnet efficiency data *per se*. It was simply methodological differences associated with how the tag recovery-magnet efficiency data were applied.

In our opinion, it is inappropriate to use arithmetic averages of plant- and area-specific magnet efficiencies. The Plant Test trial data show that magnet efficiencies are uniformly distributed, meaning any level of magnet recovery efficiency is equally possible (**Figs. I.2-I.4**). Consequently, averaging magnet efficiencies by area results in a poor and inefficient use of the Plant Tests data. Therefore, we employed two alternative methods: a “Stepwise” approach which was initiated with arithmetic mean efficiencies, and then in an iterative stepwise process used observed and theoretical recoveries to improve the $[\hat{\epsilon}_{S_{t,a}}]$; and a “Parameter Estimation” approach which directly estimated the MEs as model parameters. Both of these alternative methods substantially improved model fits, and also substantially lowered the natural mortality rate (M) estimates.

The preferred method(s) should be one(s) that utilize the entire data set. For both datasets, model(s) that estimated magnet efficiency parameters as a distribution produced recapture estimates closest to those observed. Similar results were obtained between the Stepwise and Parameter Estimation methods, and between the two data sources (**Tables IV.1 & IV.2**). Given the uniform random distribution of magnet efficiencies, the use of the simple weighted arithmetic averages of magnet efficiency by areas will naturally produce the highest estimates of natural mortality, and also the most unreliable.

In summary, our analyses that used appropriate statistical metrics strongly indicate that the most likely annual natural mortality rate estimate for Atlantic menhaden ranges between 0.50 to 0.54. These estimates represent a 43.3% and 40.0% reduction compared to the constant ME estimates derived from simple averaging of either the Coston and NMFS data, respectively. Therefore, we concluded that $\hat{M} = 0.52$ is the best estimate of annual natural mortality rate for Atlantic menhaden.

Supplemental

Area	Region	Code	Plant #	trials	Name	City	State
			1	29	Atlantic Processing Company	Amagansett	NY
	1	NY	23	4	Lipman Marine Products Co. (Gloucester Marine Protein)	Gloucester	ME
			25	2	Point Judith Byproducts Co.	Point Judith	RI
1							
	2	NJ	2	69	J. Howard Smith, Inc.	Port Monmouth	NJ
			4	25	New Jersey Menhaden Products Co.	Wildwood	NJ
			7	120	Standard Products Co.	Reedville	VA
			8	0	McNeal-Edwards (Standard Products Co.)	Reedville	VA
2	3	CB	9	21	Menhaden Co. (Standard Products Co.)	Reedville	VA
			10	151	Virginia Menhaden Products (Reedville Oil & Guano Co.)	Reedville	VA
			11	52	Standard Products Co.	White Stone	VA
			29	18	Cape Charles Processing Co.	Cape Charles	VA
			12	31	Fish Meal Co.	Beaufort	NC
			13	75	Beaufort Fisheries Inc.	Beaufort	NC
			14	31	Standard Products Co.	Beaufort	NC
3	4	NC	15	16	Standard Products Co.	Morehead City	NC
			16	22	North Carolina Menhaden Products	Morehead City	NC
			17	64	Standard Products Co.	Southport	NC
			28	49	Seashore Packing Co.	Beaufort	NC
4	5	FL	19	52	Quinn Menhaden Fisheries Inc.	Fernandina Beach	FL
			20	133	Nassau Oil & Fertilizer Inc.	Fernandina Beach	FL
			20	964			

Table S1.- Regional reduction processing plants distributed across four areas along the Atlantic coast that were involved in the 1966-1971 plant-area magnet efficiency trials as part of the Atlantic menhaden mark-recapture study conducted by the National Marine Fisheries Service.



January 31, 2020

Nichola Meserve, Chair
ASMFC Menhaden Management Board

Dear Ms. Meserve & Board Members,

I greatly appreciate the immense amount of effort dedicated to the production of the SEDAR 69 Atlantic menhaden Stock Assessment (SA) and Ecological Reference Point (ERP) Working Group (WG) reports. I would further like to acknowledge both the scientists and the Menhaden Management Board (MMB) for their continued efforts to pursue ecological management of Atlantic menhaden. This is ground-breaking work made successful by the outstanding leadership, professional dedication and exceptional insights of the MMB and Drs. Matt Cieri, Dave Chagaris, Jason McNamee, Amy Schuller and, Katie Drew.

I also certainly appreciate the enormous challenges associated with this unprecedented paradigm shift by the ASMFC MMB to ecological management, and I commend the ERP WG for their diligent pursuit and evaluation of multiple relatively complex ERP models. It is clear that the SA and ERP reports provide the initial roadmap for the necessary move to ecological management, thereby allowing ASMFC to begin to manage from multispecies and ecological perspectives. I encourage the Board to move forward to adopt ERPs as soon as possible and achieve this objective.

However, I have substantial concerns about the underlying data and model parameter assumptions, which if validated, mean that the SEDAR 69 benchmark stock assessment paints an overly rosy picture of Atlantic menhaden stock status.

In particular, my greatest concern relates to extremely high rates of natural mortality (M) used in the SEDAR 69 benchmark stock assessment. The new M estimate used was based on Liljestrand et al.'s (2019) re-evaluation of a 1960s tagging data set. They acknowledged that their estimated M was substantially greater than previously reported, particularly since several other published studies using the same data produced estimates that were $\frac{1}{4}$ of those of Liljestrand et al.'s (2019). Setting aside questions of whether it was appropriate to use data more than 55 years old, or whether in fact the Bayesian analysis was appropriate given the assumptions about parameter priors required, in the SEDAR 69 SA the HIGHEST rates of M-at-age were seemingly cherry-picked from the Liljestrand et al. (2019) paper, NOT the average rates. With the new rates and no fishing, only 0.6 of 1% of menhaden survive to reach their 4th birthday. In **Figure 1** below you can clearly see that those rates chosen were far greater (i.e., >2.9 times greater) than those found in any other national or international fishery stock assessments, including stocks which had similar short-lived forage fish life histories. It should also be noted that the Ms used in ASMFC menhaden assessments over the past decade have been steadily increasing, and this trend has had substantial impacts on reported estimates of stock size (both abundance & biomass), recruitment, exploitation rates, and sustainability metrics.

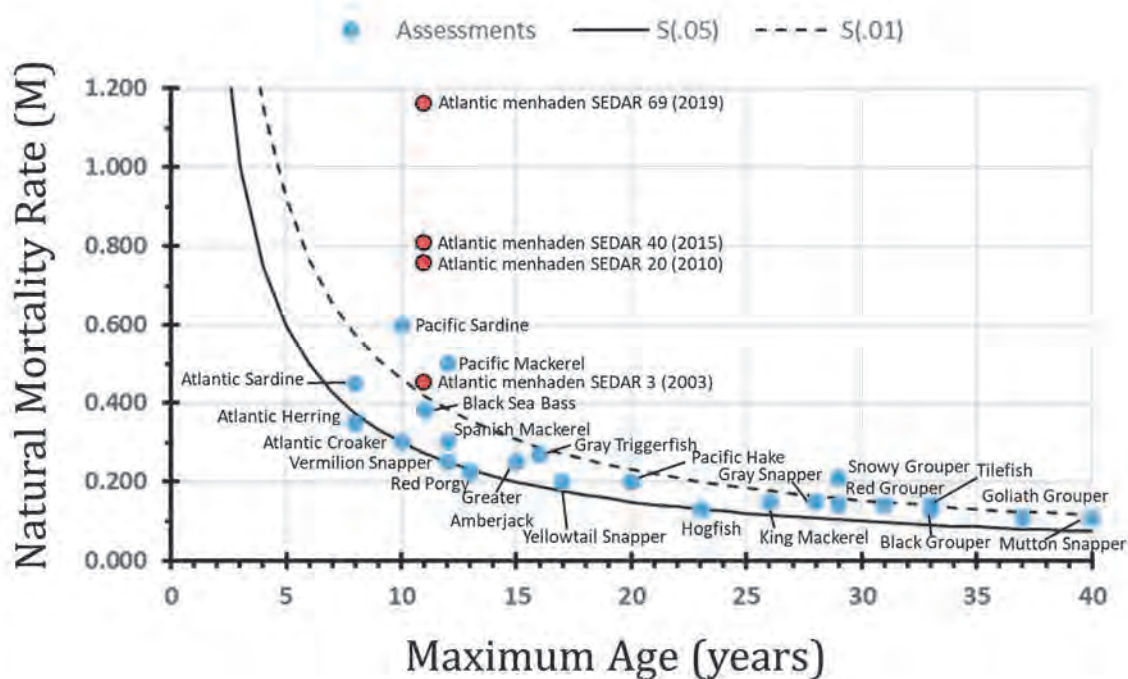


Figure 1.- Natural mortality rates $\hat{M}$ as a function of maximum age used in various national and international Commission/Council's (i.e., NOAA Southeast Data & Assessment Review, SEDAR); Pacific Fishery Management Council, PFMFC; and the International Council for Exploration of the Seas (ICES) species stock assessments during 2003-2019. Labeled red dots show the temporal progression of estimated $\hat{M}$ used in four sequential SEDAR Atlantic menhaden stock assessment reviews conducted by the Atlantic States Marine Fisheries Commission (ASMFC). Lifespan $\hat{M}$ model for 5% (solid line) and 1% (dotted line) survivorship to maximum age are also shown.

The upshot of employing such high M rates is the suggestion that mortality from fishing has had little to no impact on the Atlantic menhaden stock, leading to the most recent assertion that the Atlantic menhaden stock biomass is currently at 85% of the virgin (unfished) stock size (B_0). This is a highly unlikely conclusion. With the uncertain estimates being used for M , in a single species context, fishing effort could be cranked up to levels never seen before in the fishery. At a minimum, the stock assessment should have at least adjusted M downward to no higher than the average rates in the Liljestrand et al. (2019) paper.

In fact, the ERP WG report highlighted the issue of "unaccounted mortality" shown in **Figure 2** below. The ERP result suggests that the M is too high and cannot be reconciled, even when predators are considered in the Ecopath model.

For the single species modeling, in order to make the Beaufort Assessment Model (BAM) model work with these new extremely high rates of M , model estimates of recruitment had to be raised to levels more than ten times reported in the SEDAR 40 (2015) assessment, levels never before recorded. However, contra to this conclusion, observations from the young-of-the-year (YOY) surveys suggest that menhaden recruitment in 2017 was dangerously low. To this point, during their deliberations the SAS acknowledged there is a substantial risk that three bad years of recruitment in a row--which would not be picked up in the modeling until it is too late -- set the stock up for disaster. That is because the

reduction fishery only fully selects menhaden after all fish reach three years of age. This kind of deleterious outcome is exactly what happened in the Atlantic herring fishery and we cannot afford to do the same with Atlantic menhaden.

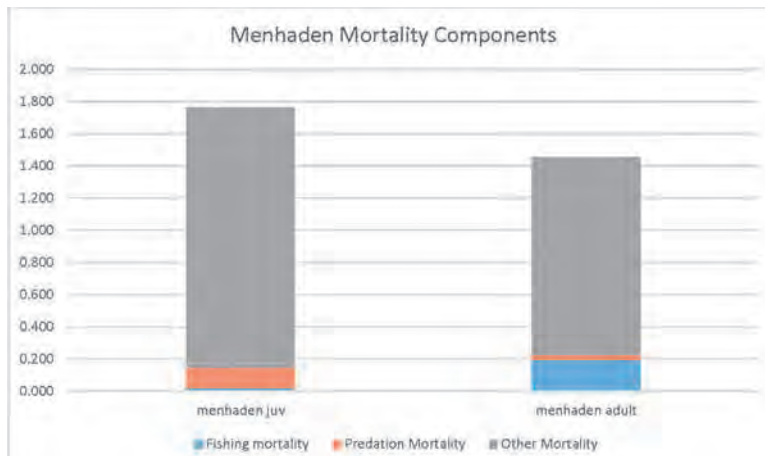


Figure 2.- Ecopath Atlantic menhaden mortality components from the NWACS-MICE model (Figure 129 from the ERP Stock Assessment Report, 2019).

Over the past year, I have shared these concerns with the SEDAR Peer Review Panel, Stock Assessment Subcommittee (SAS) and ERP Technical Committee. In addition, I have been in touch with key members of both the SAS and ERP WG to share my concerns. Now it is up the MMB to adopt a precautionary approach moving forward. The Board has a momentous opportunity and should immediately move forward with approval and implementation of ERPs; however, given the significant uncertainty and resource risks, menhaden catch should not be increased, and in fact, in my view it should be substantially reduced.

I look forward to working with the MMB and the SAS in the near future to closely evaluate the data and model parameter assumptions. I am particularly interested in assisting the ongoing analysis around M and strategies for improvement.

Sincerely,

Jerald S. Ault, Ph.D.
Professor and Chair, Department of Marine Ecosystems and Society
University of Miami

References

Liljestrand, E.M., Wilberg, M.J., Schueller, A.M. 2019. Estimation of movement and mortality of Atlantic menhaden during 1966–1969 using a Bayesian multi-state mark-recovery model. Fisheries Research 210: 204-213.

February 28, 2025

Robert Beal, Executive Director
Atlantic States Marine Fisheries Commission
1050 N. Highland Street, Suite 200 A-N
Arlington, VA 22201
rbeal@asmfc.org

Re: Atlantic Menhaden Revised Natural Mortality Rate Estimate

Dear Mr. Beal,

We are writing to follow up on our letter of October 31, 2024 regarding the science underlying the Atlantic menhaden stock assessment. In that letter, we explained that based on a recent paper currently in peer review by Drs. Jerry Ault and Jiangang Luo we are concerned that the menhaden stock assessment science may be flawed due to significant data errors affecting the natural mortality rate estimate (M) used in the stock assessment model. We explained that the scientific flaws have likely resulted in a substantial overestimation of the natural mortality rate, and in turn substantial overestimation of the coastwide stock size and allowable catch for the fishery, which could result in overfishing of the Atlantic menhaden resource. We also highlighted the ASMFC's obligation to base its conservation programs and management measures on the best scientific information available and to prevent overfishing. Our October 31 letter is enclosed for reference.

We extend our thanks to you for responding to our letter and related emails, as well as to the ASMFC Atlantic Menhaden Stock Assessment Subcommittee (SAS) and its Natural Mortality Work Group for considering the issues raised related to the M estimate used in the menhaden single species stock assessment since 2020. The SAS review confirmed that important mistakes were made in the paper that was relied on to establish the current estimated M (Liljestrand *et al.*, 2019). As a result, the SAS concluded that the current M is at least 20 percent too high -- 1.17 compared to 0.92. However, the enclosed additional analysis by Drs. Ault and Luo shows that the best available science requires an even more substantial revision.

This is largely because after uncovering critical errors made in the Liljestrand *et al.* paper, the SAS did not carefully apply the most scientifically sound methodological approach to correcting those errors. As explained in detail in the enclosed analyses, the use of simple weighted arithmetic averages of magnet efficiency by area¹ is inappropriate in this case. Instead, "Stepwise" or "Parameter Estimation" approaches account for the random distribution of magnet efficiencies and substantially improve model fits. Both methods also substantially lower the M estimates. This can be easily corrected based on the attached analysis. After applying the appropriate statistical metrics, the analysis strongly indicates that the most likely annual natural mortality rate estimate for Atlantic menhaden ranges between 0.50 to 0.54. This M estimate range is not only supported in the analysis because it results from the best model fit, an estimated

¹ Magnet efficiency is a measure of the efficiency by which the magnets in the menhaden processing plants captured tags in the underlying tagging study. Each plant had up to nine magnets, with the first two used in the Costen study, and all nine used in the NMFS data analysis.

M in this range would also be consistent with the prior 12 peer reviewed M estimates, adding credibility to its scientific soundness. In contrast, the SAS recommendation of 0.92 remains a significant statistical outlier, still several standard deviations above all prior estimates.

As you review the enclosed scientific analysis you will see that it is consistent with the work of the SAS and M Work Group leading up to the final step where the SAS inappropriately applied the simple arithmetic average of plant- and area-specific magnet efficiencies. We request that the ASMFC through its Ecological Reference Point Workgroup, which is meeting from March 3 to March 6, 2025, consider the enclosed analysis, apply one of the more statistically sound methods described, and adopt the resulting M estimate (expected to be in the range of 0.50 to 0.54) in the base run Beaufort Assessment Model (BAM)².

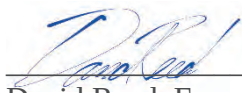
The importance of the ASMFC meeting its requirement to rely on the best scientific information available is amplified in this case because the magnitude of the substantial differences between the natural mortality rate currently being used (1.17), or alternatively currently recommended by the SAS (0.92), and that indicated by the Ault and Luo analysis (0.50 to 0.54). This suggests that there is high risk that overfishing may occur if not changed immediately, and that Atlantic menhaden could already be overfished with overfishing occurring because the incorrect natural mortality rate assumption has been used since the 2020 assessment. It is critical that the ASMFC make the scientifically and legally sound decisions at this juncture necessary to ensure the Atlantic menhaden resource and the East coast ecosystem it supports are protected.

Thank you for considering our concerns and recommendations.

Sincerely,



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Encl:

² BAM is the model used for the menhaden single species stock assessment, and the outputs from BAM, including the rate of natural mortality, serve as the baseline for the ERP assessment.

1. Dr. Jerald S. Ault Dr. and Jiangang Luo, Report on Estimation of Area Magnet Efficiencies and Natural Mortality, (February 25, 2025).
2. Dr. Jerald S. Ault Dr. and Jiangang Luo, Magnet Efficiency Parameters, (February 27, 2025).
3. Roger Fleming, Esq. and David Reed, Esq., Letter to Mr. Robert Beal, Executive Director, (October 31, 2024).

Cc:

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October 31, 2024

Robert Beal, Executive Director
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Re: Atlantic Menhaden Natural Mortality Rate Estimates

Dear Mr. Beal,

We are writing because it has come to our attention that the science that undergirds the Atlantic menhaden stock assessment may be flawed due to significant data errors affecting the natural mortality rate assumption used in the Atlantic menhaden stock assessment model. This has likely resulted in a substantial overestimation of the natural mortality rate (M), and in turn of the estimated coastwide stock size and catch limits for the fishery. Among other problems, this could result in overfishing of the Atlantic menhaden resource. We are encouraged to hear that the Atlantic Menhaden Single Species and ERP Methods Workshop from November 4th to 8th will begin a process for evaluating and potentially updating M as part of the ERP Benchmark Assessment. As this discussion and work aimed at resolving this matter are completed, we ask that the ASMFC, Atlantic Menhaden Management Board, and related committees remain cognizant of the ASMFC's legal obligations to base its decisions on the best scientific information available and to prevent overfishing. We also request that you address this matter immediately to protect the Atlantic menhaden resource and all the species that depend on it.

On September 25, 2024, Dr. Jerry Ault presented a paper he coauthored with Dr. Jiangang Luo, both from the University of Miami Rosenstiel School of Marine, Atmospheric and Earth Sciences, to the Atlantic Menhaden Stock Assessment Subcommittee (SAS) titled "Investigation of Atlantic menhaden mortality rates." This paper concludes that the extremely high M used in the menhaden assessment is based on flawed data inputs contained in the paper by Emily Liljestrand *et al.*, titled "Estimation of movement and mortality of Atlantic menhaden from 1966 to 1969 using a Bayesian multi-state mark-recovery model." In 2020, Dr. Ault submitted a letter to the Atlantic Menhaden Management Board highlighting what an extreme outlier the current M is, and his paper is a follow up investigation. See attached. Dr. Ault contacted Dr. Liljestrand and her coauthors several times when writing his paper, and again before the September 25th meeting, inviting them to review his draft and provide him with any mistakes, other concerns, or areas for improving his analysis. The SAS reviewed and discussed the paper at length. Neither Dr. Liljestrand nor members of the SAS articulated any significant flaws with the new analysis.

The authors have since submitted the paper for peer review and publication at the same respected journal, *Fisheries Research*, as the original paper.

Natural mortality is a key factor in determining stock status, so it is vital to use the most accurate M estimate during assessments. The authors noted that Dr. Liljestrand's M estimate is 2.3 times higher than the previous M estimate and more than 14 standard deviations above the average of 12 previously peer-reviewed estimates—an extraordinary outlier. This single parameter could be the deciding factor between a stock being considered as overfished or healthy. It is important to recognize that Ault and Luo attribute this result to underlying data errors, not to problems with the modeling methodologies used by Liljestrand *et al.* or the stock assessment team. Addressing these errors is critical and can be accomplished relatively quickly within the current assessment processes.

The Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA) and the ASMFC's Rules and Charter all require that all Interstate Fishery Management Plans be based on the best available science (BAS) and prevent overfishing. ACFCMA requires that the Commission establish standards and procedures ensuring that IFMPs “promote the conservation of fish stocks throughout their ranges and are based on the best scientific information available[.]” 16 U.S.C. §5104(a)(2). Consistent with ACFCMA, Article VI Section 3 of the ASMFC's Rules and Regulations require that “fishery management plans, and any actions taken according thereto, promote conservation [and] use the best scientific information available.” The ASMFC Charter, Section 1(c) establishes that it “is the policy of the Commission that its ISFMPs promote the conservation of Atlantic coastal fishery resources, be based on the best scientific information available, and provide adequate opportunity for public participation.”

This policy is directly reflected in Charter Section 6, which provides 6 Standards and Procedures for IFMPs (similar to the Magnuson-Stevens Act's 10 National Standards for Fishery Conservation and Management), including that “(2) Conservation programs and management measures shall be based on the best scientific information available.” These Standards also require that overfishing be prevented and that where necessary rebuilding plans be established providing for their long-term sustainability: “(1) Conservation programs and management measures shall be designed to prevent overfishing and maintain over time, abundant, self-sustaining stocks of coastal fishery resources. In cases where stocks have become depleted as a result of overfishing and/or other causes, such programs shall be designed to rebuild, restore, and subsequently maintain such stocks so as to assure their sustained availability in fishable abundance on a long-term basis.”

These provisions make clear that the ASMFC's conservation programs and the management measures implemented through its IFMPs be based on the best available science and prevent overfishing. The Atlantic menhaden stock assessment is integral to the ASMFC's conservation

programs and management, so it must be based on the BAS. The importance of meeting this requirement is amplified in this case because the magnitude of the difference between the natural mortality rate currently being used and that indicated by the Ault and Luo analysis suggests that there is significant risk that overfishing may occur if not changed immediately, and that Atlantic menhaden could already be overfished with overfishing occurring since the mortality rate has been used since the 2020 assessment.

As representatives of the conservation community, we want to emphasize that this is a pivotal time for the marine ecosystem on the East Coast. Most of the keystone forage species including Atlantic herring, Atlantic mackerel, river herring, shad, and American eel are at or near historic low levels of abundance. Over one-half of the coastal species managed by the ASMFC are classified as overfished, overfishing, depleted, or status unknown. It is important that the status of the most important ASMFC managed species remains healthy. The difference between an overfished menhaden stock and an abundant one may well determine how resilient marine life on the East coast are to a rapidly changing climate. The identified error in the stock assessment is coincident with dire new findings regarding the striped bass and osprey regional population health, making any corrections to the catch limit(s) all the more urgent for these menhaden-dependent species. From a management perspective, the application of the BAS and measures to prevent overfishing are cornerstones of effective fisheries management and healthy fisheries. Failure to address any data errors found in the science used to develop the Atlantic menhaden assessment's natural mortality rate risks a cascading ecosystem crisis.

Thus, in our view, it is critical that the ASMFC resolve this matter now. A corrected M estimate using a "realistic" M such as the one suggested by Ault and Luo will likely show a need to substantially reduce catches. As such, it is too risky to wait until the Assessment Update in 2028 or the next Benchmark Assessment in 2031 to address this issue. Options we have identified that are in line with the ASMFC's BAS and overfishing requirements that can be taken now, include the following: (1) adopt the recommended M from the Ault and Luo manuscript (pending confirmation of peer review) via the current "update" assessment process, as the M parameter methodologies would not change and only data errors would be corrected; (2) upgrade this cycle's assessment to a "benchmark" as was originally planned. These data concerns have been known to scientists since at least 2023, before the decision to downgrade the assessment to an "update" in February of 2024; (3) delay the single species assessment for approximately 3 months to accommodate the peer review and publication process; or (4) take emergency action to substantially increase the uncertainty buffer when setting specifications until this matter is resolved.

Thank you for considering our concerns and recommendations. We share the concern that addressing this matter now could result in a delay in the schedule for the 2025 ERP Benchmark Assessment, however we think this discussion demonstrates that it is critical that the ASMFC

make the scientifically and legally sound decisions at this juncture necessary to ensure the Atlantic menhaden resource and the East coast ecosystem it supports are protected. For these reasons, we suggest that, if necessary, you consider moving forward with both assessments using more than one M as alternates until the peer review of the Ault and Luo paper, or other work necessary to make a final decision on the appropriate M, is complete.

Sincerely,



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BALD EAGLE RECOVERY IN CHESAPEAKE BAY RAISES RED FLAGS FOR OSPREY

Saving Seafood

July 28, 2025 – The Chesapeake Bay is once again teeming with bald eagles, a testament to decades of successful conservation efforts. A recent feature by the Maryland Department of Natural Resources (DNR), “A Soaring Success: Maryland’s Bald Eagle Population Recovery” by science writer Joe Zimmermann, highlights this remarkable comeback.

In 1977, a mere **44 breeding pairs** of bald eagles were recorded in Maryland. Today, that figure has soared to **over 1,400**, according to estimates from the Maryland Bird Conservation Partnership. This dramatic rebound has established the Chesapeake Bay as a national stronghold for bald eagles, boasting the highest concentration of breeding pairs outside Alaska.

This recovery is largely attributed to sustained, science-driven policy. The **1972 federal ban on the pesticide DDT**, which caused reproductive failure and eggshell thinning, was a pivotal moment. In Maryland, the **1984 Chesapeake Bay Protection Act** further safeguarded critical habitat within 1,000 feet of tidal waters. These combined measures helped restore nesting conditions and bolster survival rates.

The scale and speed of this recovery have made bald eagles a symbol not just of national pride, but also of effective conservation action. “Bald eagles are a very good example of what happens when you find the solutions and take action, and now you can look at how they’ve come back,” said DNR conservation ecologist Dave Brinker.

Today, bald eagles nest in every Maryland county and in Baltimore City. The Bay supports not only year-round resident eagles but also seasonal visitors from both the North and South. “Through the year, we have three pretty unique populations of bald eagles,” Brinker explained. “There are local birds that are here all year long. Then southern breeding eagles disperse to the Chesapeake Bay to spend summer here because food resources are so good. And in the winter, northern populations that need a warmer place,

they come down to the Chesapeake Bay.”

Bald Eagle Recovery and Its Interspecies Consequences

While the recovery of the bald eagle in North America, particularly along the Chesapeake Bay, is a significant conservation milestone, its resurgence raises questions about its impact on other piscivorous bird species that have also been rebounding from decades of decline. Chief among these is the **osprey**, a fish-eating raptor that shares habitat and prey with bald eagles throughout coastal and inland waters. The Chesapeake Bay, now home to one of the largest bald eagle populations in the continental United States, is also crucial osprey habitat, making it an ideal region for observing interactions between the two species.

In recent years, environmental organizations like the Chesapeake Bay Foundation and sportfishing advocates such as the Theodore Roosevelt Conservation Partnership have repeatedly claimed that industrial menhaden fishing is the primary driver of osprey reproductive failures in the Bay. Their public campaigns, regulatory letters, and media statements link declining nest success to a perceived, yet scientifically undocumented, drop in Atlantic menhaden availability—a key prey species for ospreys during chick-rearing season. Much of this advocacy draws on research by Dr. Bryan Watts of the Center for Conservation Biology at William & Mary, whose studies have indicated increased nest failure in parts of the lower Chesapeake. However, even Watts has cautioned against definitive conclusions. In a 2024 Associated Press article, he stated, “We do not know why menhaden have become less available to osprey,” and suggested climate change as a possible factor.

Beyond climate shifts, other ecological dynamics may be at play, but the menhaden-focused narrative has recently overshadowed attention to other potential pressures. Given the Maryland Department of Natural Resources’ announcement that the Bay now hosts one of the nation’s largest bald eagle populations, **interspecies competition deserves closer scrutiny**—particularly food competition stemming from **kleptoparasitism**, the well-documented behavior in which eagles steal fish from ospreys. These interactions, studied for decades by field biologists and ornithologists, warrant renewed attention in light of the bald eagle’s increasing population.

While the ecological relationships between bald eagles and ospreys are not yet fully understood, evidence from multiple regions suggests that competitive pressures—especially kleptoparasitism and nest harassment by eagles—may hinder osprey nesting success in areas with high eagle densities. It is possible that the recovery of one iconic raptor is, in part, coming at the expense of another. These dynamics deserve greater consideration from scientists, wildlife managers, and policymakers.

Top-Down Pressure: A 35-Year Body of Research Shows Bald Eagle

Competition May Threaten Osprey Nesting Success

As bald eagle populations have steadily rebounded across North America, particularly in strongholds like the Chesapeake Bay, a longstanding body of scientific research suggests that their recovery may come at the expense of other raptors, especially ospreys. For more than three decades, field biologists and ornithologists have documented the effects of interspecific competition and kleptoparasitism, the act of stealing food, as a factor contributing to osprey nesting failures.

One of the most comprehensive analyses of these dynamics comes from a **2019 study published in the *Journal of Animal Ecology*** titled “Top-down effects of repatriating bald eagles hinder jointly recovering competitors.” Led by Jennyffer Cruz and co-authored by Steve K. Windels, Wayne E. Thogmartin, Shawn M. Crimmins, Leland H. Grim, James H. Larson, and Benjamin Zuckerberg, the study evaluated 26 years of nesting data in Voyageurs National Park, Minnesota. The researchers found that as bald eagle numbers increased due to intensive protections, the populations of ospreys and great blue herons declined.

“Bald eagles are top predators and a flagship species of conservation that have benefited from intensive protection,” they wrote, “but this likely hindered the recovery of ospreys and herons.” The study documented that “eagle abundance was negatively associated with nest reuse (i.e., persistence) and success of ospreys,” and concluded: “The top-down effects of returning bald eagles were the main predictors of declining nesting demographics for ospreys and herons resulting in their failed recoveries.” Importantly, the authors found “little evidence of bottom-up limitations,” such as poor weather, habitat loss, or declining fish stocks, implicating competition and interference from eagles as a primary driver.

The literature documenting these dynamics stretches back decades.

In a **1994 field note published in *The Journal of Raptor Research***, Professors J. MacDonald and N.R. Seymour of St. Francis Xavier University in Nova Scotia documented a lethal encounter in which a bald eagle pursued and killed an adult male osprey that was carrying a white perch. A second eagle joined the chase, and after a brief pursuit, one eagle seized the osprey midair, dragged it to shore, and ate it. The authors believed the attack originated as an act of kleptoparasitism—food theft—a behavior they note is well documented between eagles and ospreys and which they described as “a common occurrence.” They also referenced a second lethal attack, described by Flemming and Bancroft in 1990, in which a bald eagle attacked an osprey nestling shortly after it had received a fish.

In **2013**, four U.S. Army Corps of Engineers (USACE) staff members working at Lake Sonoma in Geyserville, California, documented what was believed to be the first officially recorded case of “**cooperative kleptoparasitism**” in which a pair of bald eagles worked together to steal a fish from an osprey. Their observations were formally published in **2014 in *The Journal of Raptor Research*** and summarized in a March 20, 2014, article on Army.mil, which likened the coordinated and calculated nature of the predation to something out of *Jurassic Park*. “Rarely have humans seen them cooperating to hunt as a pair,” USACE ecologist Wade Eakle explained. “This was the first time we witnessed them actually cooperating to steal, from another species.” The two eagles forced the osprey to drop its trout, after which

the larger female swiftly seized the fish and flew off. Rangers had been monitoring the nesting pair since 2001, but this behavior marked a milestone in understanding the extent of eagle dominance over other raptors.

Evidence for this behavior also includes a **1988 study by Dennis G. Jorde and G.R. Lingle**, published in the *Journal of Field Ornithology*, which observed repeat patterns of interspecific kleptoparasitism along the Platte River in Nebraska. Their findings indicated that bald eagles not only routinely stole food from other raptors but developed learned strategies for doing so efficiently, particularly during important foraging periods.

Even outside peer-reviewed journals, naturalists and field reporters have provided consistent anecdotal corroboration. *BirdWatching Magazine* similarly observes: “Bald Eagles are known to steal fish from other birds, particularly Ospreys. They will aggressively chase Ospreys in flight until the Osprey drops its catch, which the eagle will then snatch midair or retrieve from the water.” Another article in the same publication added, “It is common for ospreys and eagles to be in the same hunting grounds. As the more aggressive raptors, eagles will often fight the Osprey and force it to let go of the captured prey. The eagle will typically swoop in to catch the stolen prey.” The Cornell Lab of Ornithology’s *All About Birds* guide echoes these observations: “A Bald Eagle will harass a hunting Osprey until the smaller raptor drops its prey in midair, where the eagle swoops it up”, a classic example of kleptoparasitism.

Collectively, these studies and field reports spanning decades point to a clear and well-established pattern: as eagle populations recover and concentrate in resource-rich areas like the Chesapeake Bay, their aggressive behavior and dominance in the food web may have measurable negative consequences for ospreys. The repeated harassment and food theft increase energetic costs for osprey parents, reduce feeding efficiency, and may contribute to nest failures.

While the recovery of the bald eagle in the Chesapeake Bay region is unquestionably a landmark conservation success story, it does not exist in ecological isolation. As concerns continue to emerge about osprey reproductive success in key habitats like the Bay, it is increasingly important to view this predator’s return within the broader dynamics of interspecies competition. Over the past 35 years, a robust and diverse body of scientific literature—supported by peer-reviewed studies, field notes, and firsthand accounts—has documented the kleptoparasitic behavior of bald eagles, particularly their tendency to steal fish from ospreys and, at times, directly harass or even kill them. This behavior, while natural, may contribute to the energetic costs and nest failures observed in osprey populations where eagle densities are high.

Even Benjamin Franklin, in an often-cited letter, criticized the selection of the bald eagle as the national bird due in part to its scavenging habits and its theft of fish from “the fishing hawk,” known today as osprey.

For my own part I wish the bald eagle had not been chosen as the representative of our country. ... he watches the labour of the fishing hawk; and when that diligent bird has at length taken a fish, and is bearing it to his nest for the support of his mate and young ones, the bald eagle pursues him, and takes it from him.

While his concerns were framed with a satirical flourish, he anticipated a tension now supported by decades of ecological research. As wildlife managers and policymakers evaluate recent reports of declining osprey productivity, it is essential that they consider not only fishery-related factors but also the well-documented competitive interactions between these two raptor species.

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July 29, 2025

Omega Protein and Ocean Harvesters Urge Science-Based Review Before Imposing New Menhaden Restrictions

Letter from Veteran Biologist Addresses Scientific Questions Over Osprey Declines

Washington, DC – In a letter submitted to the Atlantic States Marine Fisheries Commission (ASMFC), Peter Himchak, Senior Scientific Advisor to Omega Protein, warned that “there has been an inordinate amount of focus on menhaden generally, and the reduction fishery in particular” in discussions about recent osprey declines in the Chesapeake Bay.

Omega Protein, which processes menhaden into fishmeal, fish oil, and related nutritional products, is supplied by Ocean Harvesters under a long-term harvesting agreement. Himchak submitted the letter on behalf of the company ahead of the ASMFC’s Summer Meeting.

Himchak, who served for 39 years as a fisheries biologist with the New Jersey Division of Fish and Wildlife and as a long-time advisor to both the ASMFC and the Mid-Atlantic Fishery Management Council, sat on the ASMFC’s Atlantic Menhaden Technical Committee and Stock Assessment Sub-Committee from 1988 until 2006.

In the letter, Himchak criticized the ASMFC’s Work Group on Precautionary Management in Chesapeake Bay for proposing “draconian management recommendations ‘without determining if there is or is not an adequate supply of menhaden to support predatory demand in the Bay.’” He warned that moving forward with such actions without first determining whether there are, in fact, fewer menhaden in the Bay or whether the fishery has any impact on osprey “risks gravely impacting a more than 150-year-old industry and hundreds of jobs while doing nothing to improve the osprey situation.”

Himchak wrote that the ASMFC’s Technical Committee (TC) already has a significant workload in advance of the Commission’s Annual Meeting, but raised four areas of scientific inquiry the TC could investigate that would provide the Board with more complete information. 1) He asked whether “the phenomenon of reduced osprey production [is] confined to the times and areas in

which the menhaden reduction fishery operates,” referencing USGS data showing declines in osprey abundance in coastal areas of multiple states—not just the Chesapeake—and increases in interior regions. He also noted that the fishery does not begin fishing until May or later—after migrant ospreys arrive in the region from late February to early March and begin building nests from mid-March to mid-April—raising questions about how the fishery could influence osprey’s months-earlier decisions about where to nest.

2) He wrote that there have been sizable increases in populations of multiple menhaden-dependent predators since at least the turn of the century, and that a stomach contents analysis of striped bass, which are only somewhat dependent on menhaden, indicated they “are not starving and would be considered healthy.” Therefore, he asked, “is it more likely that ospreys are being outcompeted or that the reduction fishery uniquely impacts osprey?”

3) Regarding eagle-osprey interactions, he noted a recent Maryland DNR release announcing “large increases in the state’s bald eagle population.” He referenced myriad studies finding that bald eagles are “kleptoparasitic”—a term used to describe their well-documented habit of attacking hunting osprey to steal their food or prey on adults, young, and eggs. Citing a study from Voyageurs National Park, he wrote that “increased numbers of eagles were associated with a reduction in the numbers of osprey nests, their nesting success and heronry size,” and asked whether “issues of competition and depredation [can] be ruled out as a cause of osprey’s lack of breeding success.” He further pointed to “significant scientific and anecdotal evidence of the dominant and adverse impacts eagles have on osprey.”

That concern was echoed in a newly released *Saving Seafood* special report titled “**Bald Eagle Recovery in Chesapeake Bay Raises Red Flags for Osprey.**” The report compiled over three decades of peer-reviewed research, field observations, and published accounts documenting instances in which eagles had a negative impact on osprey populations. In one study, researchers found “eagle abundance was negatively associated with nest reuse (i.e., persistence) and success of ospreys.” Significantly, the researchers found “little evidence of bottom-up limitations,” such as poor weather or declining fish stocks, and emphasized the role of eagle aggression, including harassment and food theft. While this body of research does not prove the resurgence of bald eagles in the Chesapeake to be the cause of osprey reproduction issues, it does indicate it is a possibility deserving of further investigation.

The full report is available at: <https://www.savingseafood.org/science/bald-eagle-recovery-in-chesapeake-bay-raises-red-flags-for-osprey>

4) Himchak also asked the Technical Committee to consider whether osprey foraging success is being affected by climate-driven environmental changes, including storm frequency, shoreline hardening, warming waters, or hypoxia. Citing a 2024 study by Bryan Watts, he noted that “deliveries of all forage species to osprey nests declined steadily from 1974 to 2021,” and asked whether “ospreys’ apparent lack of foraging success is tied to changes in local conditions that are impacting either local abundance of forage or osprey’s hunting success.”

He concluded the letter by writing, “The commission must be guided by science. Precipitous actions, taken in the name of precaution, are not always harmless. Neither Ocean Harvesters nor

Omega Protein can survive without the current low level of access to the menhaden resource in the Bay. There simply are not enough ‘fishable days’ – that is, days where the weather and sea conditions allow vessels to operate – in a year to safely conduct a profitable fishery solely in the ocean. The menhaden fishery is managed in the most conservative manner in its 150 year or so history, and the reduction fishery is operating at its lowest sustained levels – in the Bay and overall – for as long as we have reliable records (i.e., since the 1950s). Precaution is already the policy. Before taking actions that could cause irreversible economic harm to this historic fishery, the Board should ensure that all reasonable avenues of inquiry into the issues facing osprey are explored.”

James Boyle

From: Jeff Kaelin <jKaelin@lundsfish.com>
Sent: Friday, July 25, 2025 8:14 AM
To: Katie Drew
Cc: Bob Beal; john.clark@state.de.us; James Boyle; Glen Gawarkiewicz; Kim Hyde - NOAA Federal
Subject: [External] FW: Ocean Conditions Meeting slides + papers
Attachments: TaenzerEtAl2025_SeasonalSalinificationUSNortheastColdPool.pdf; JGR Oceans - 2023 - Taenzer - Categorization of High-Wind Events and Their Contribution to the Seasonal Breakdown of.pdf; Ocean Conditions Meeting July 15 2025.pdf; 4a. Final_Menhaden WG Full Report_4.18.25.pdf; Fwd: Spring 2025 Seasonal Summary

Good morning, Katie – I hope this note finds you well.

I am writing to you, as Chair of the TC, to forward a presentation by Dr. Glen Gawarkiewicz, from the Woods Hole Oceanographic Institution <https://ieeexplore.ieee.org/author/37726309400>, to a Commercial Fisheries Research Foundation / WHOI Oceans Conditions Meeting last week, which documents cold water on the Continental Shelf in recent years; likely the reason menhaden fishing in the Chesapeake Bay was delayed during the 2022-2024 fishing seasons, as documented in the CB menhaden WG full report.

From information we received from NJ DEP, as part of the Atlantic menhaden purse seine fishery's sustainability certification by the Marine Stewardship Council, the New Jersey menhaden fishery was similarly affected by this cold-water phenomenon during this same period:

Landings / catch history / % of quota caught:

2021	45,694,424	May 21 through December 14	81%
2022	46,888,789	June 29 through December 5	83%
2023	40,857,329	June 28 through December 15	72%

(NJ's quota is 11% of the coastwide TAC of 233,550; 56.6 million lbs., by my math)

I'm raising this issue in the context of our upcoming discussion at the menhaden board, on TC direction in response to the work group report, and asking that the TC evaluate the possible effects of cold water in inshore habitat during this period, relative to the lack of menhaden being available for osprey in the CB and, specifically, in the context of the report's research recommendation, 'Investigate menhaden environmental condition preferences to analyze potential shift in seasonal availability'.

The Sea Surface temperature maps in the report illustrate the occurrence of cold water in 2024. These maps are available, on a daily basis, throughout the 2022-2024 period captured in Table 3 (WG report page 34) and can be made available to the TC from Kim Hyde, who has been hosting the Squid Squad, which was created during the time of the 2022 research track assessment (RTA) for the Illex (shortfin) squid fishery, and taking place weekly since that time. The Squid Squad continues to meet, with the RTA for Loligo (longfin) squid now taking place.

Dr. Hyde is a biological oceanographer in NOAA's Ecosystem Dynamics and Assessment Branch and weekly host of the Squid Squad for most of the last 100+ Friday morning meetings. Her expertise includes

ocean color remote sensing and phytoplankton

ecology <https://www.fisheries.noaa.gov/contact/kimberly-hyde-phd>. In addition to the availability of the Clark Chart maps, Kim suggested to me that the TC might also review the seasonal summaries of water quality parameters in the Chesapeake Bay, from the NOAA Chesapeake Bay office, to track oceanographic effects on menhaden distribution there. The Spring 2025 summary is attached.

Thank you for your consideration of this information, specifically in the context of the WG's research recommendation related to seasonal distributions of Atlantic menhaden in the CB.

I look forward to seeing you in Arlington next month.

With best regards,

Jeff

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SQUID-SCALLOPS-FINFISH
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From: Jeff Kaelin <jkaelin@lundsfish.com>
Sent: Friday, July 18, 2025 9:05 AM
To: nolsen@cfrfoundation.org
Cc: Glen Gawarkiewicz <ggawarkiewicz@whoi.edu>
Subject: FW: Ocean Conditions Meeting slides + papers

Thanks Noelle and Glen...great presentation Tuesday evening, Glen.

As I mentioned, I want to make this cold water on the shelf information available to Dr. Katie Drew, the ASMFC stock assessment team lead, and TC Chair for Atlantic menhaden. As a member of the Commission's menhaden management board, I'm motivated by our upcoming August 7 agenda item, "Discuss Technical Committee direction in response to Work Group Report on precautionary management in Chesapeake Bay."

Attached is that April report to the Commission, from the menhaden workgroup tasked to consider osprey health concerns in the Chesapeake Bay.

At page 12 the report states that "The presence of menhaden schools is dependent on water temperature, as such, catch and effort varies across the season."; and ... "this is highly variable with the

past two years' catch and effort significantly below average until the end of June." See Table 3 (page 34), which records late starts for the menhaden fishery there in the years 2022-2024.

We experienced the same, here in NJ and, as we all know tracking the oceanographic and climate information coming from the Squid Squad over the last few years, while the common wisdom is that the coastal waters of the Atlantic are continuing to warm, they have actually been colder in the last 3-4 years, which has resulted in seasonal delays in menhaden fishing during that time.

These papers and your presentation, Glen, will help the TC to understand that this cold water has extended south to the Chesapeake Bay in recent years and is likely a factor in the recent, seasonal delays in catch there.

When I reach out to Katie, I will copy you, Glen, in case she would like to follow up with you, or vice versa.

If possible, I would like to make the Clark Charts depicting spring water temperatures during 2022-2024 available to Katie and the TC before our August meeting.

With best regards,
Jeff

From: Noelle Olsen <nolsen@cfrfoundation.org>
Sent: Thursday, July 17, 2025 1:51 PM
To: Jeff Kaelin <jkaelin@lundsfish.com>
Cc: Glen Gawarkiewicz <ggawarkiewicz@whoi.edu>
Subject: Ocean Conditions Meeting slides + papers

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Hey Jeff,

Thank you for tuning into our meeting on Tuesday. Here is a copy of the presentation as well as those two papers Glen mentioned.

Best,
Noelle

—

Noelle A. Olsen (she/her)
Senior Research Biologist
Commercial Fisheries Research Foundation
www.cfrfoundation.org
CFRF's [Data Access Portal](#)



The CFRF-WHOI Ocean Conditions Meeting

July 15, 2025



Research Team

Commercial Fisheries Research Foundation (CFRF)

Noelle Olsen and Linus Stoltz

Woods Hole Oceanographic Institution (WHOI)

Glen Gawarkiewicz, Frank Bahr, Svenja Ryan,
Caroline Ummenhofer, and Finn Wimberly

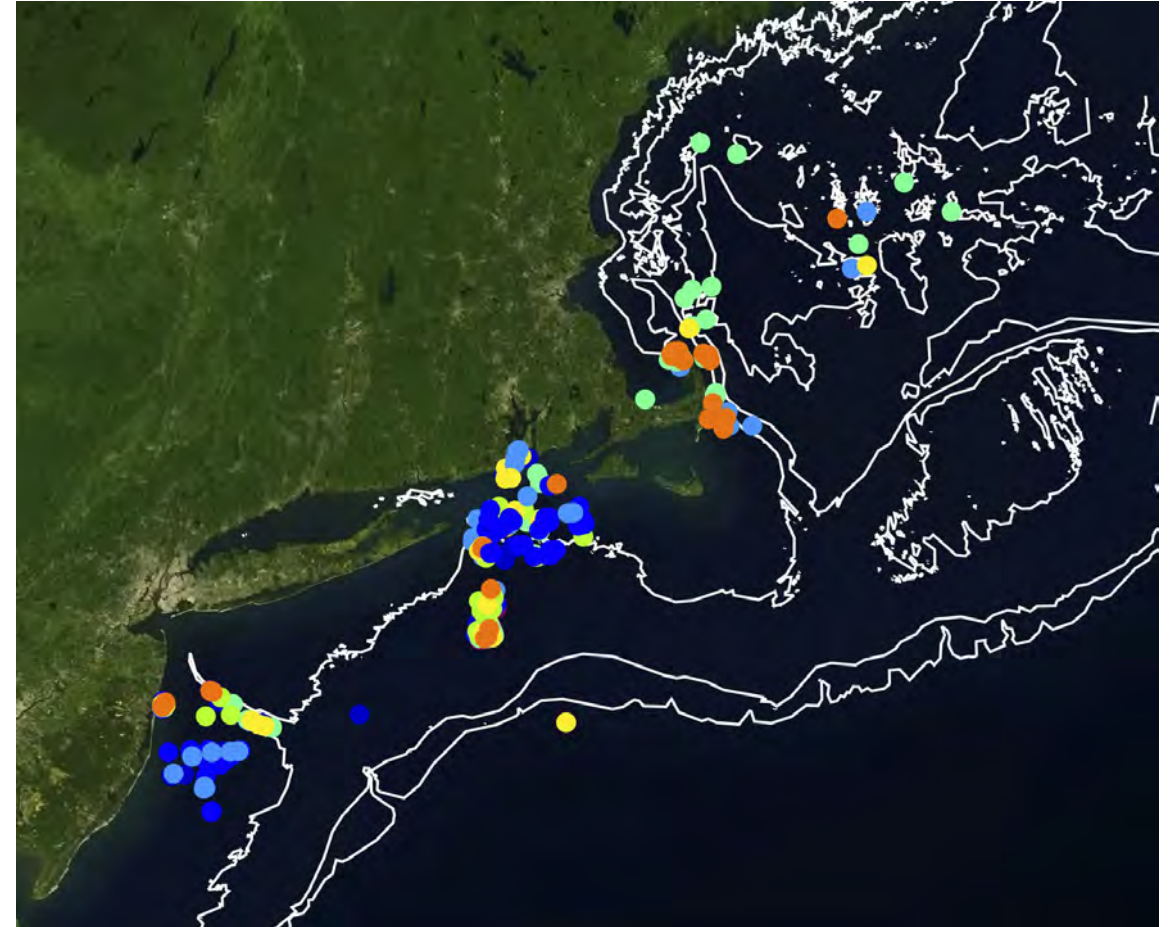
Cape Cod Commercial Fishermen's Alliance (CCCFA)

Aubrey Ellertson Church and Mel Sanderson



Shelf Research Fleet

- Started in 2014 to better monitor the ocean conditions off the shelf break in tandem with the OOI Pioneer Array
- The project has grown with >20 vessels collecting data
- We partnered with the Cape Cod Commercial Fishermen's Alliance to expand sampling



CTD profile locations since January 1, 2024.



Research Fleet Vessels

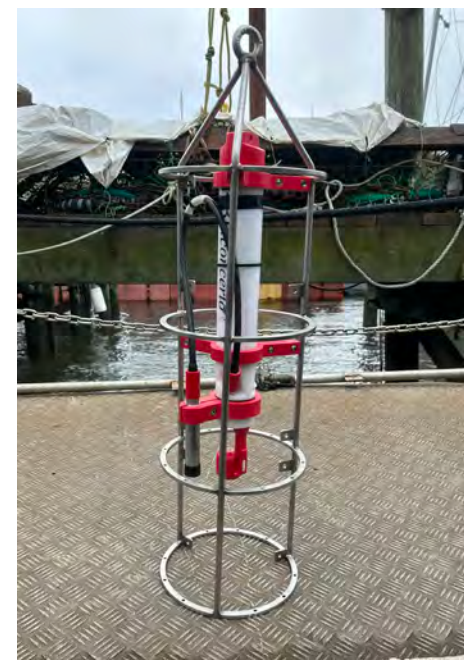
CFRF

- FV Brooke C - Point Judith, RI
- FV Finast Kind II - Tiverton, RI
- FV J-Mar - Point Pleasant, NJ
- FV Mister G - Point Judith, RI*
- FV TNT - Barnegat, NJ*

*CTD has a chlorophyll sensor

CCCFA

- FV Lisa Marie – Saquatucket, MA
- FV Miss Lilly – Provincetown, MA





Data Access Tools

CFRF's Data Access Portal – <https://ondeckdata.com/>

- Shelf Dash, Wind Dash, and ERDDAP
- Linus Stoltz (lstoltz@cfrfoundation.org)

CCCFA's Cape Cod Ocean Watch – <https://ccocean.whoi.edu/>

- Profiles with satellite and FISHBOT layers
- Finn Wimberly (finn.wimberly@whoi.edu)



Climate, Fisheries, & Cooperative Research Documentary



Zack O'Connor
Wesleyan University Student
zoconnor@wesleyan.edu



CFRF Research Opportunities

- **Lobster and Jonah crab Research Fleet** – looking for 2-3 offshore lobster and/or Jonah crab vessels
 - Contact Noelle Olsen (nolsen@cfrfoundation.org)
- **Sea Scallop Image-Based Research Fleet** – looking for 6 LAGC scallop vessels, due 7/31
 - Contact Becky Smoak (rsmoak@cfrfoundation.org)
- **eMOLT expansion** – looking for vessels to deploy temperature and dissolved oxygen sensors
 - Contact Linus Stoltz (lstoltz@cfrfoundation.org)



Fundraiser: CFRF License Plate

- Collecting pre-orders for RI passenger, commercial, and combination plates
- CFRF will get \$20 for every plate purchased
- For out-of-state folks, we are collecting donations & selling merchandise



www.cfrfoundation.org/license-plate

Questions? Contact Hannah Verkamp (hverkamp@cfrfoundation.org)

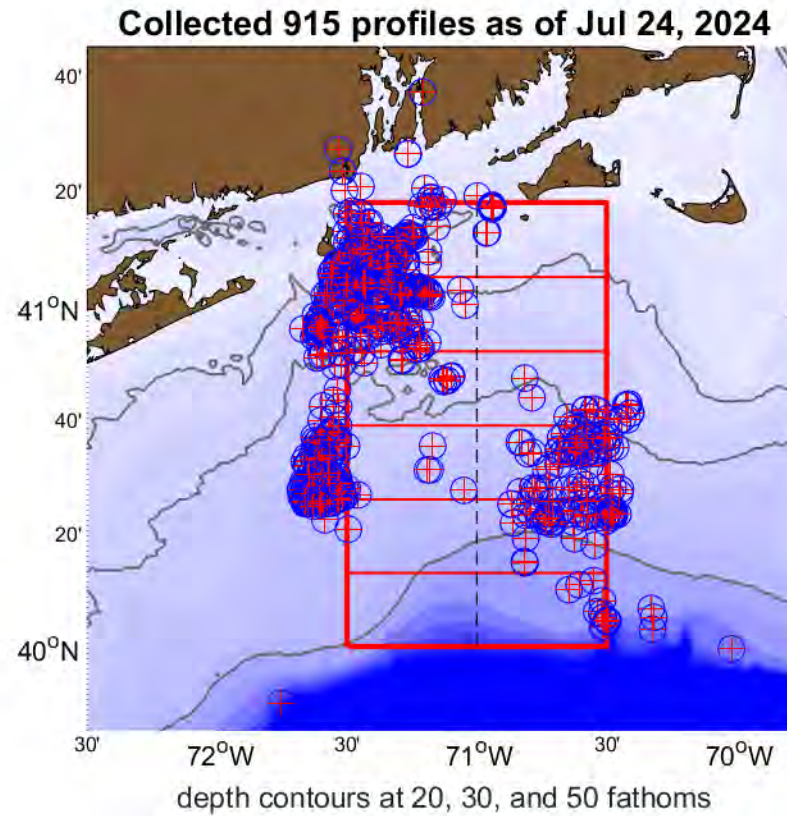
Outline

- Overview of Shelf Fleet and 2025 Statistics
- 2024 Review- The Cold Fresh Pulse and its impacts
- 2025 Shelf, Gulf Stream, and Continental Slope
- Some Squid Squad notes on shifting patterns
- Pending NSF Proposal and Potential Jaiabot Fleet

Shelf Fleet in Review

- Six Zones across the continental shelf south of Rhode Island
- Fleet expanded to New Jersey
- Sea Grant project funded a new fleet in Chatham MA with Cape Cod Commercial Fishermen's Alliance (S. Ryan, C. Ummenhofer, F. Wimberley WHOI)
- Critical Improvement- Linus automating the processing (consistent with Frank Bahr methods) to improve timeliness of data serving and appearance on website

Original Zones



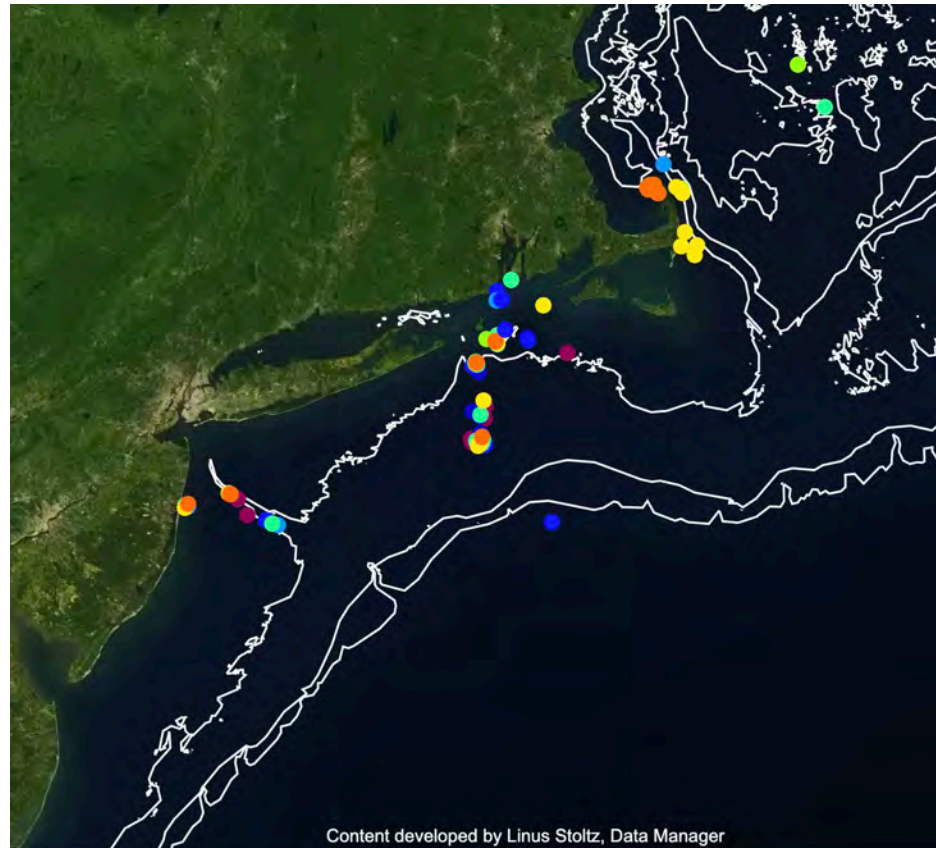
2025 to Date

- 89 Profiles, 938 casts total in the archive

Spatial pattern of
Casts from 2025

NJ casts primarily near
Hudson canyon

Chatham Fleet casts
along Outer Cape and
near Provincetown



Temperature and Salinity Profiles

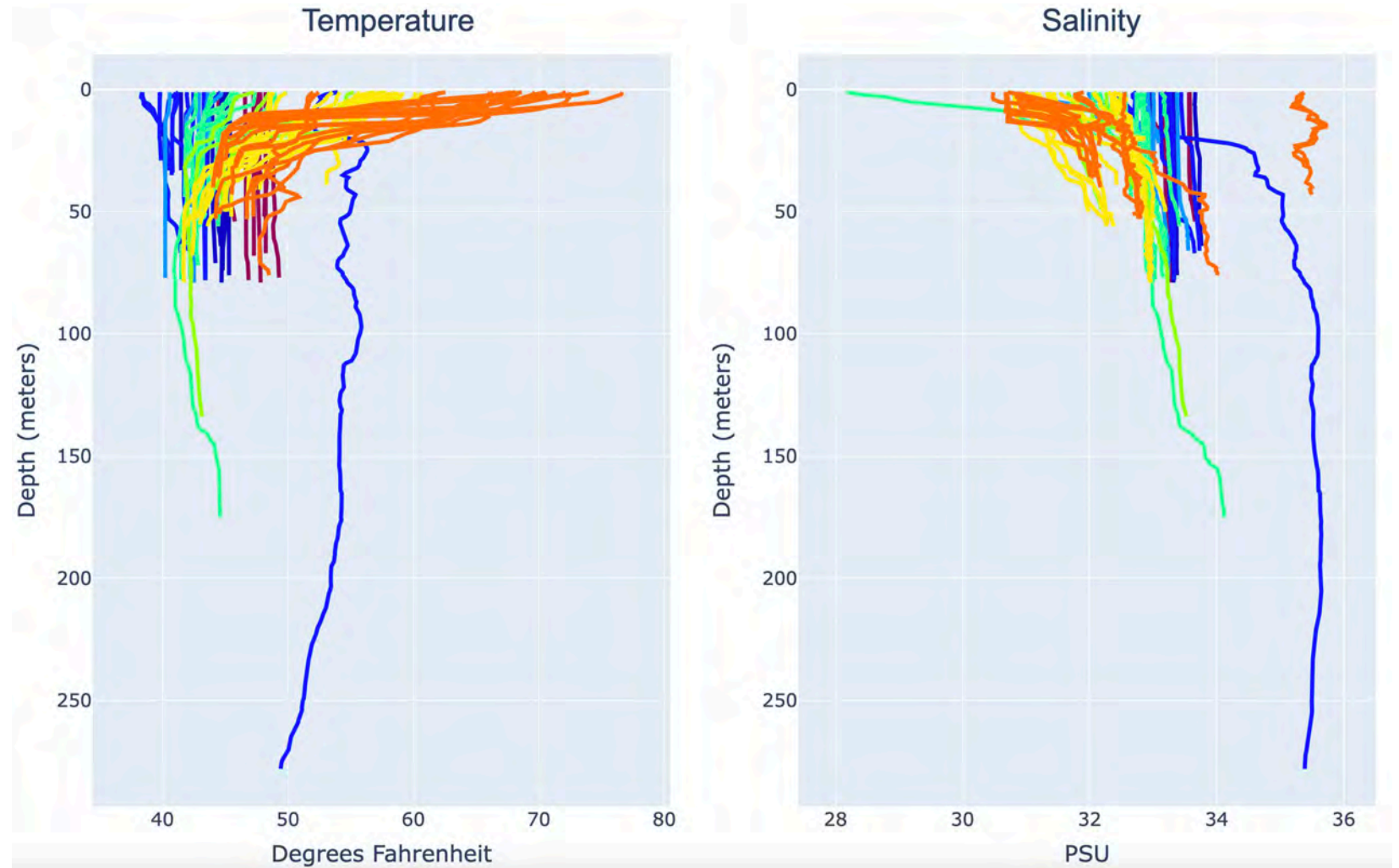
Profiles color coded with time,
Maroon-blue-green-yellow-orange

Start of the year $T \sim 47-49$ Deg F
Salinity $\sim 33.5-33.7$

Minimum Temperatures in March
40 Deg. F, Salinity 33

Steady warming through spring,
Temperatures now up to mid 70s

Freshening, as low as 30.5



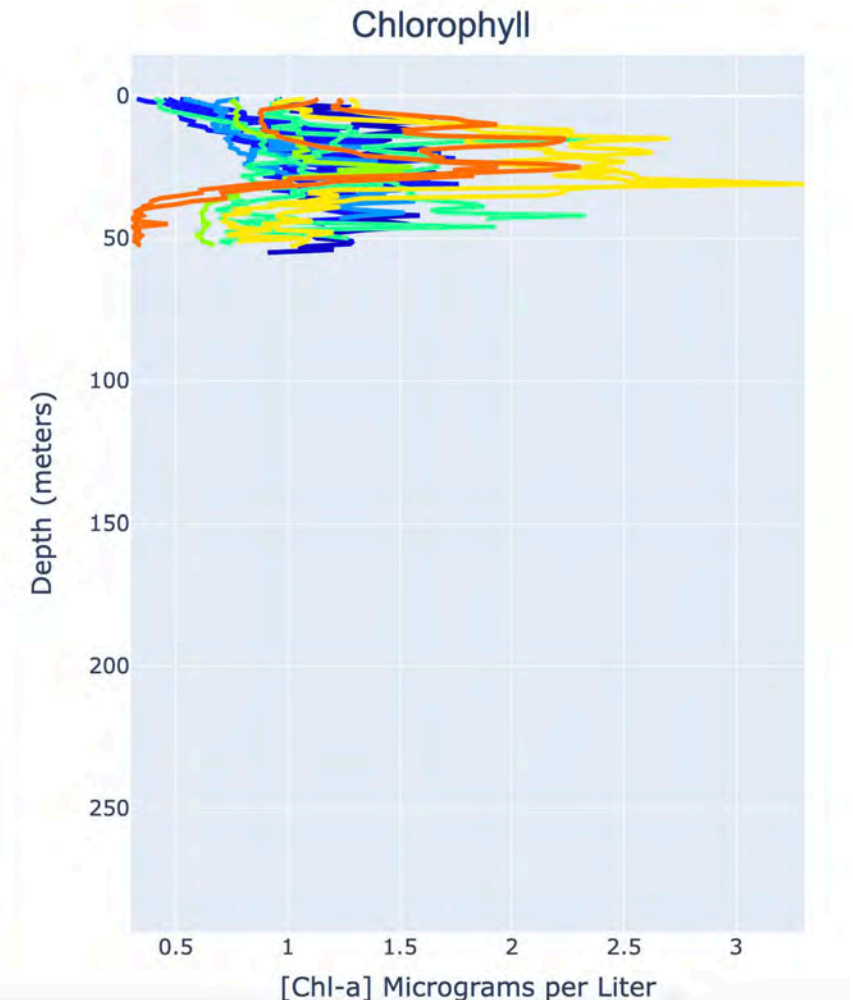
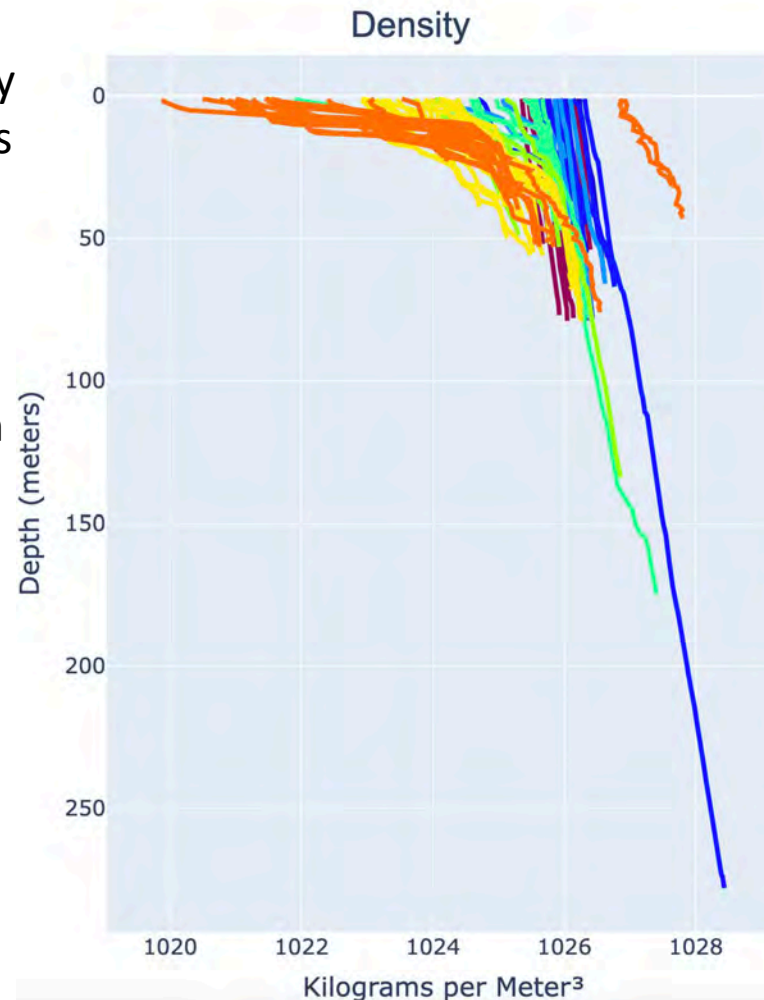
Density and Chlorophyll a Profiles

Density increases from January to March as cooling progresses

Formation of thermocline and Pycnocline in April-May

VERY buoyant surface water in July. VERY high stratification

Chlorophyll maxima at 10-15 Fathoms depth (20-30 m)

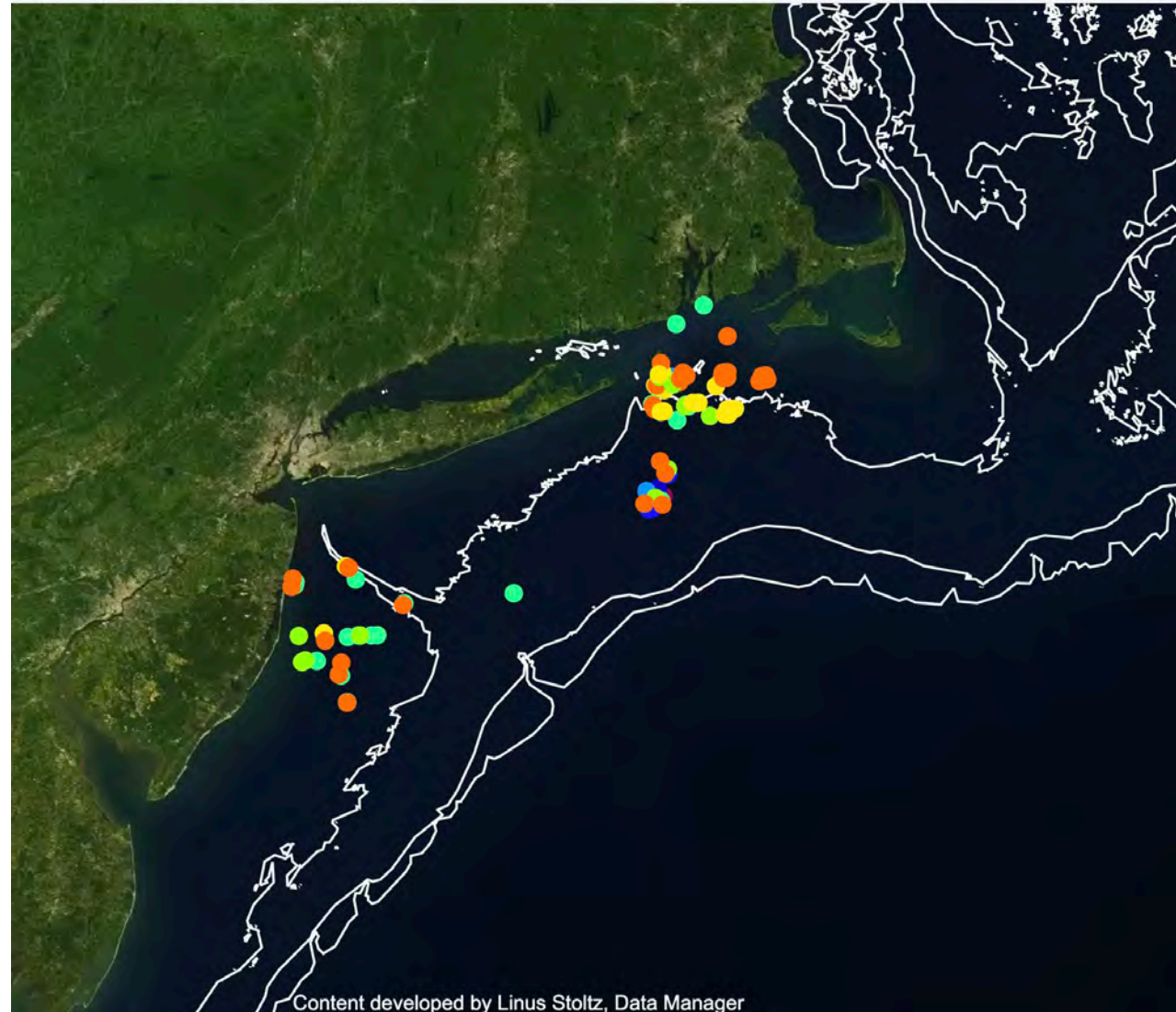


2024 Profile Locations

110 Profiles collected by July 14

No Chatham Fleet profiles

Good New Jersey coverage



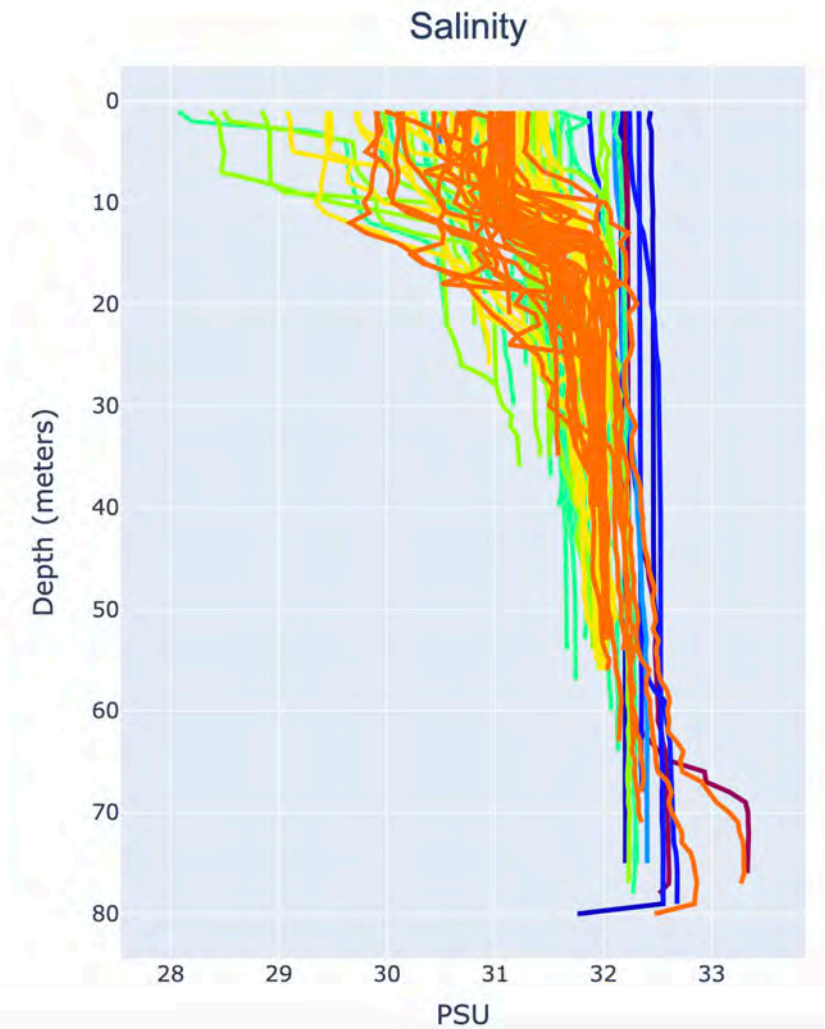
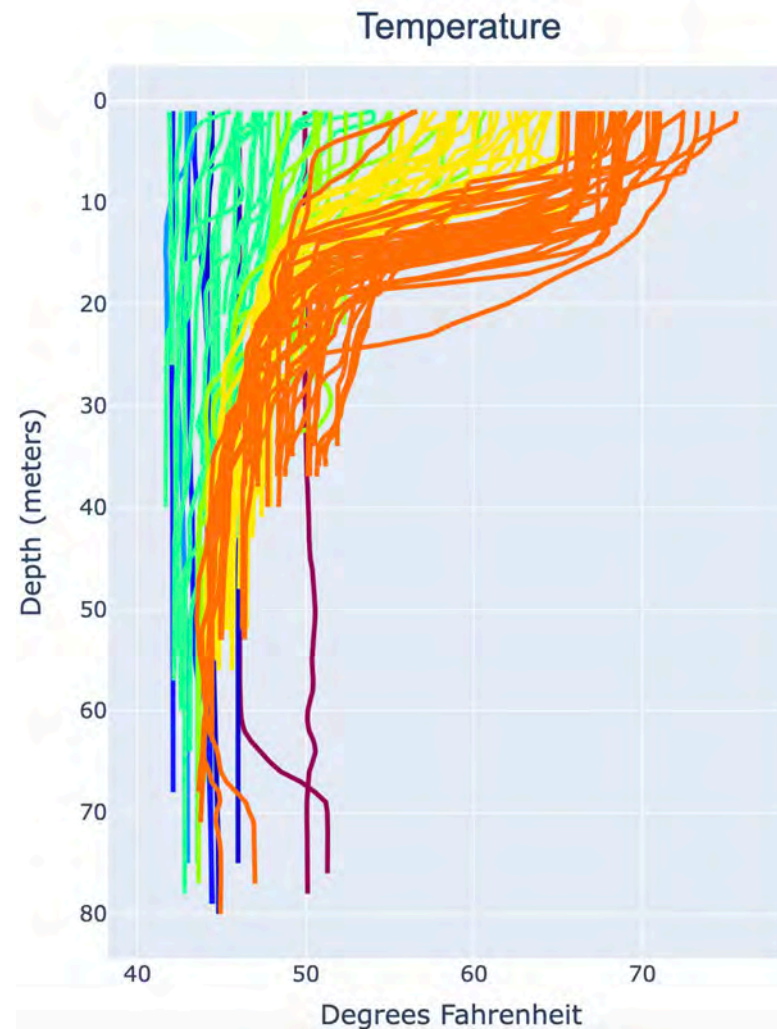
2024 Temperature and Salinity Profiles

Very cold temperatures in March,
42-43 Deg. F

Bulk of June-July temperatures
Less than 70 Deg. F

Very fresh conditions in May-June
< 30

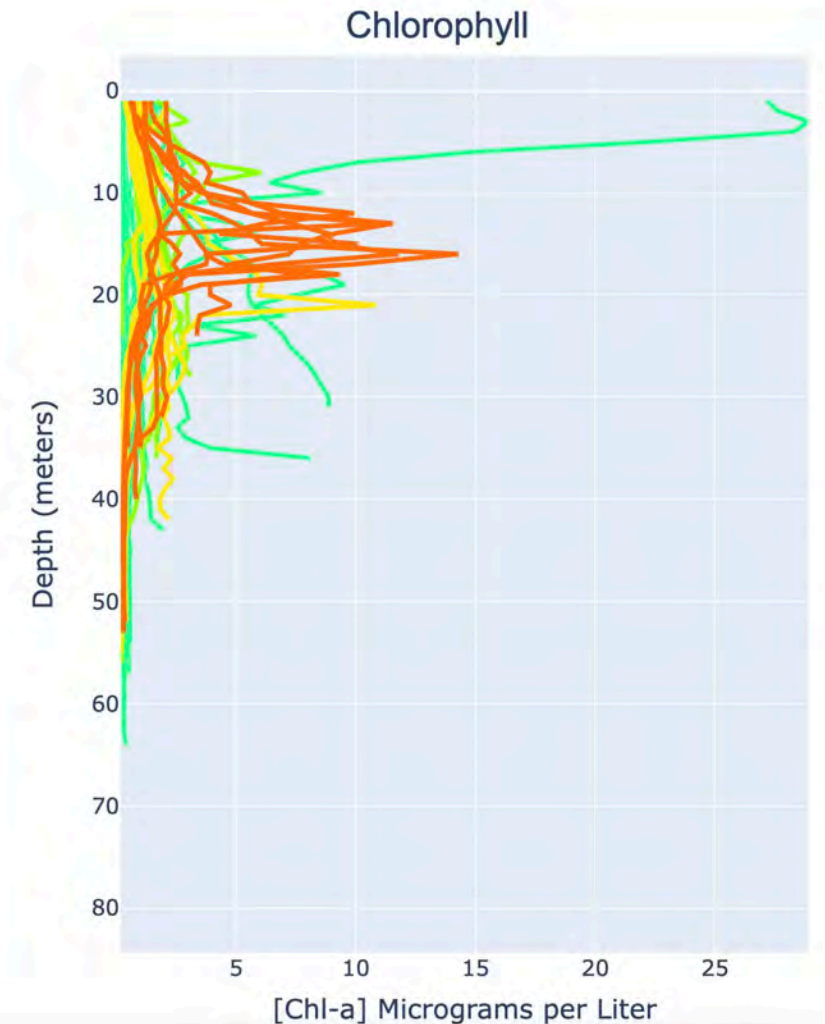
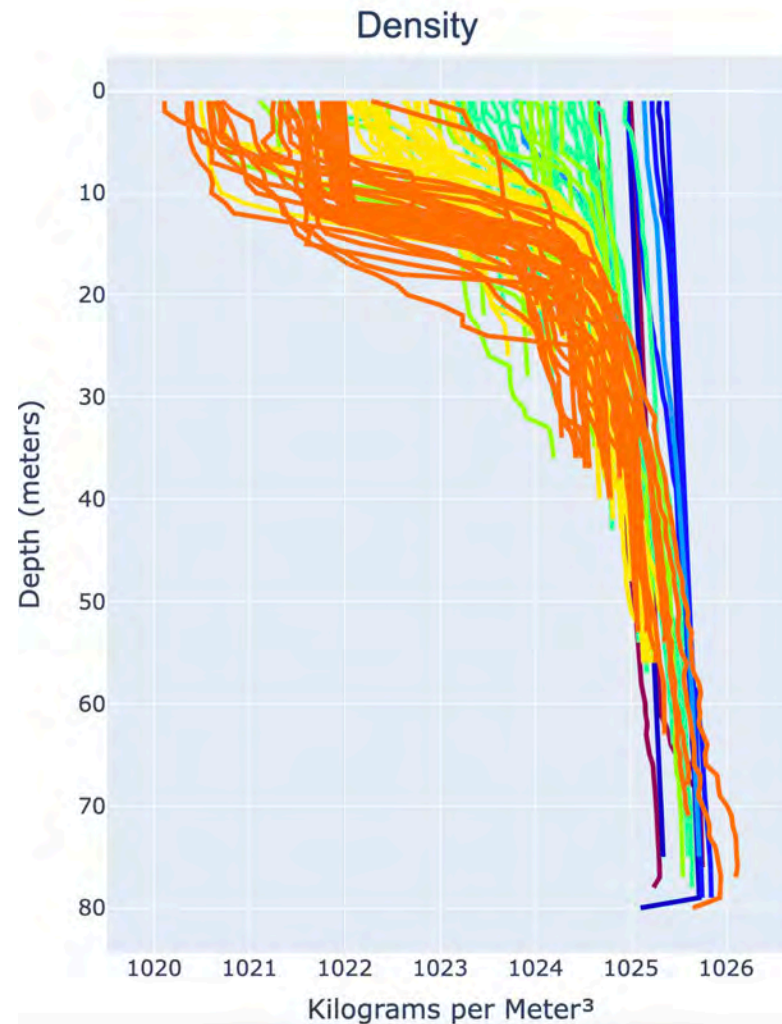
Even at the start of the year
Salinities were relatively fresh,
32.5



2024 Density and Chlorophyll a

More dense near the
Surface (cooler conditions)

Chlorophyll a maximum is
Fairly shallow (7-10 fathoms)



Salinity 2015-2024 Shelf Research Fleet

Monthly averaged
vertical profiles
from 6 Zones
fross the Shelf

Red indicates Warm
Core Ring or
Slope Water

Note the big shift
towards solid blue
in the second half of
2023

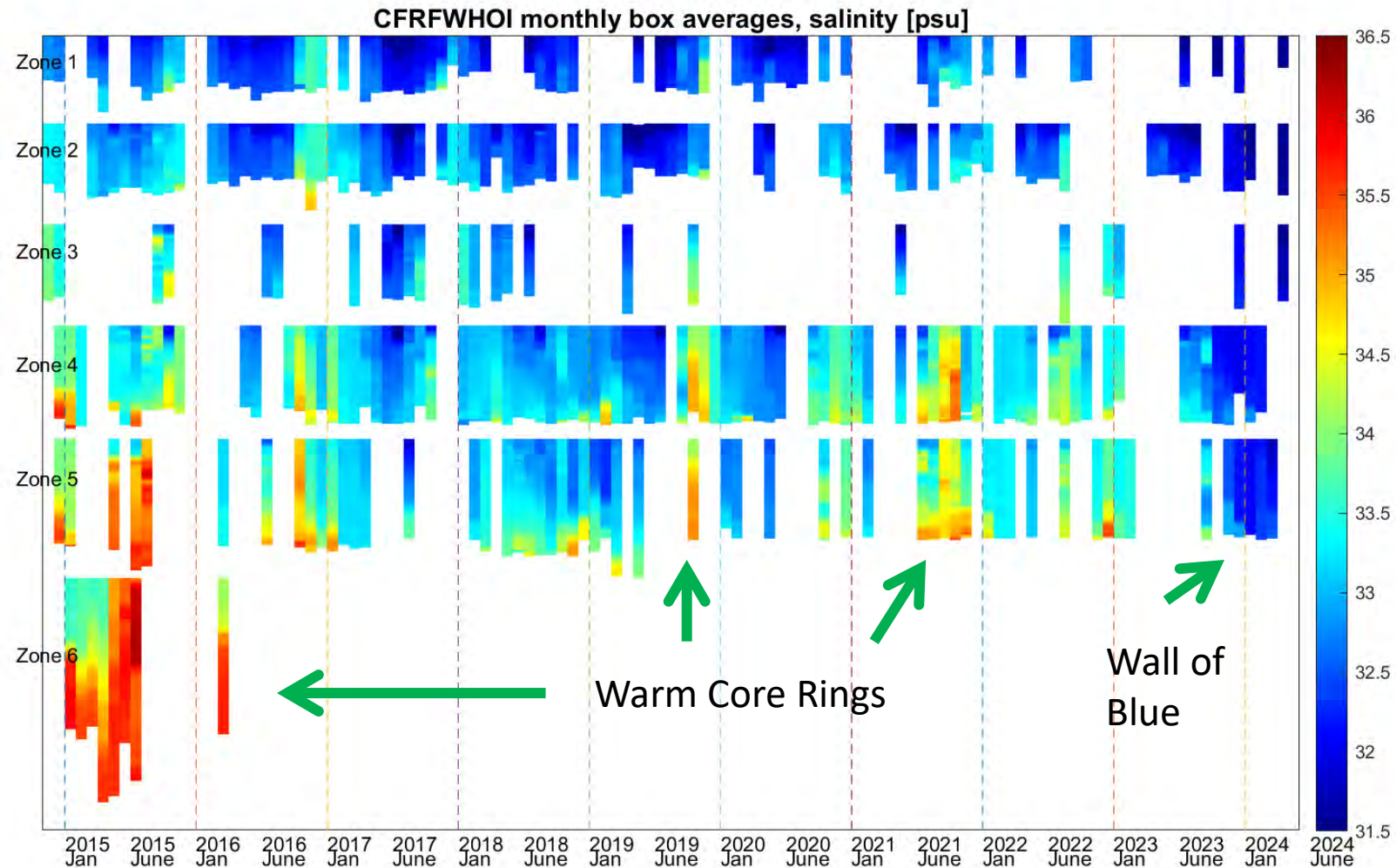


Figure from
Frank Bahr

What happened in 2024?

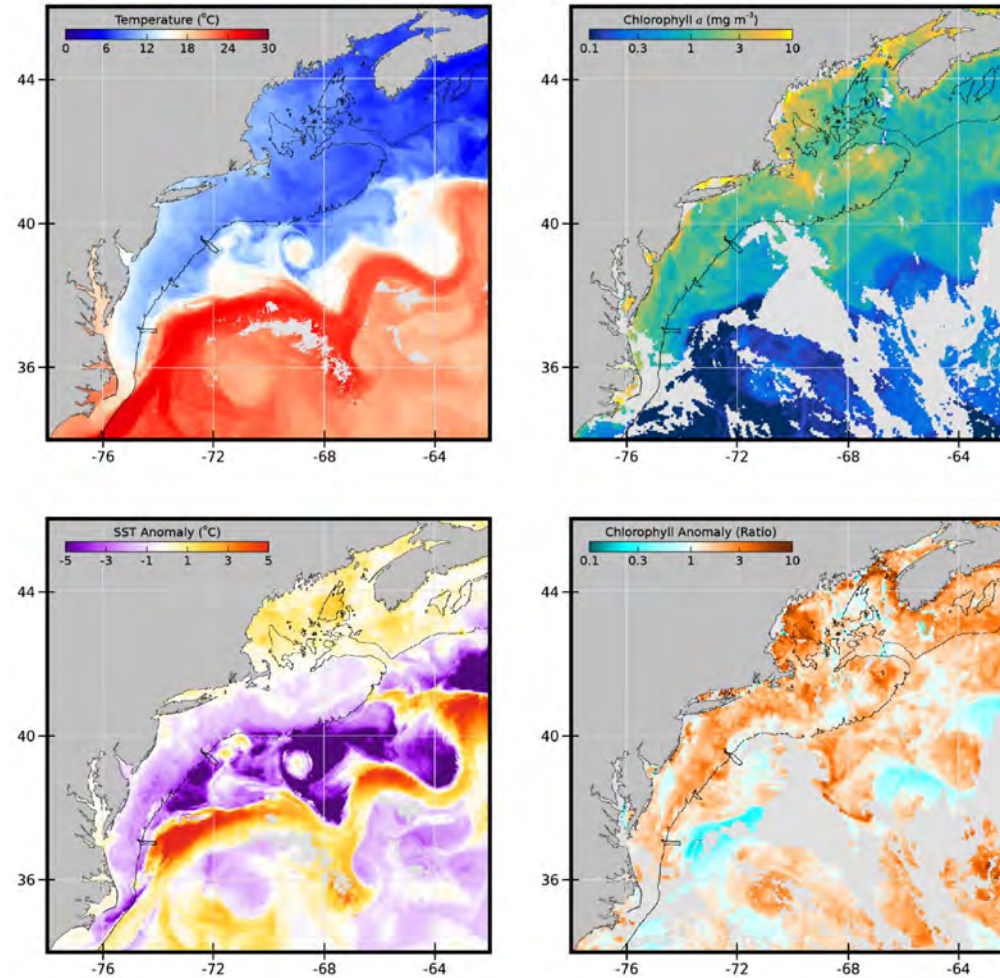
Sea Surface Temperature map
from Mid-May 2024

Temperature anomaly over
continental shelf and slope
of 5.4 to 9 Deg. F. !!!

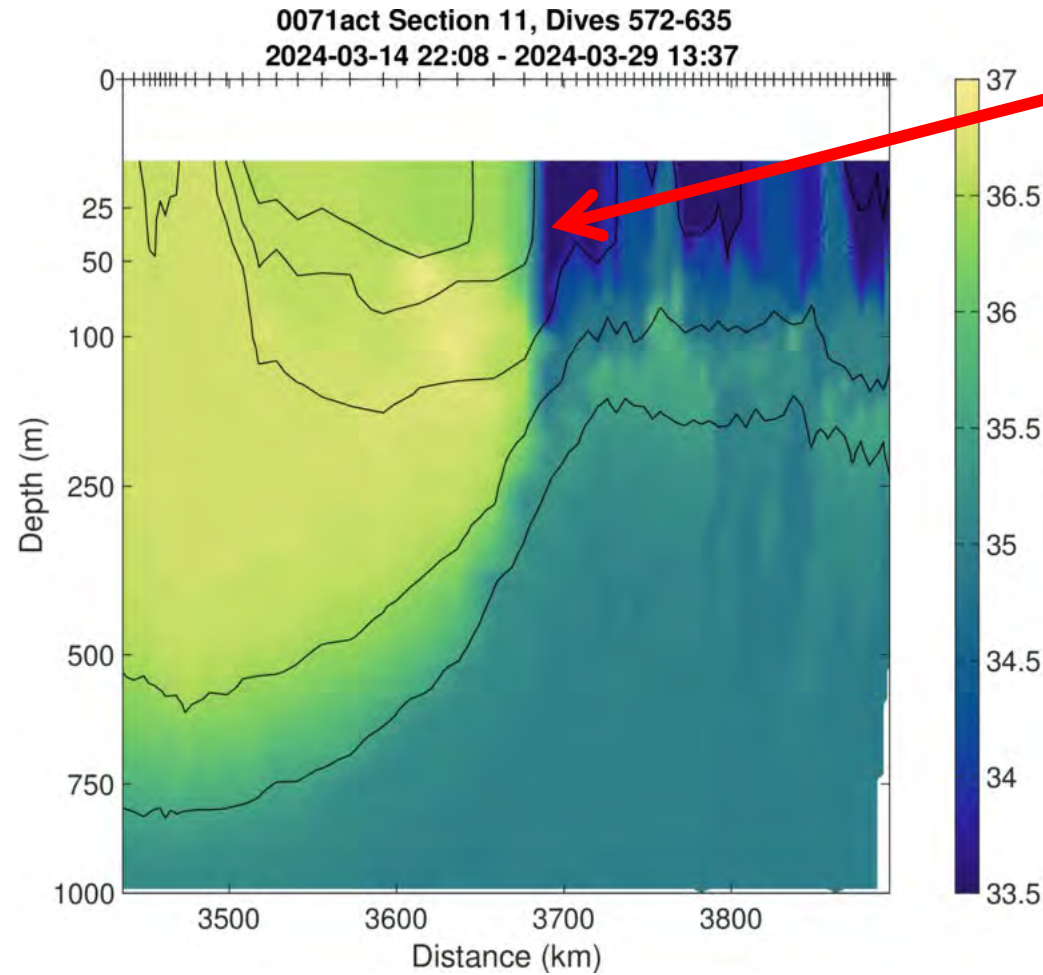
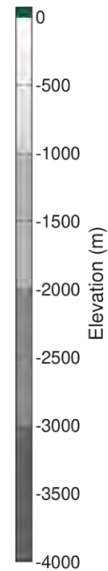
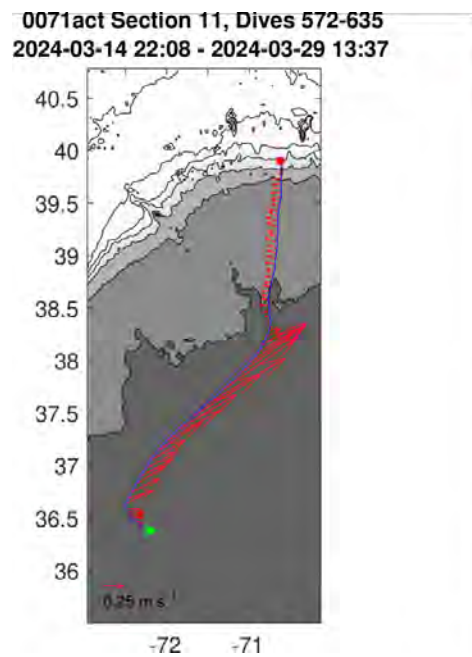
Gulf of Maine slightly warmer
than usual

Cold anomaly over the entire
continental shelf and slope

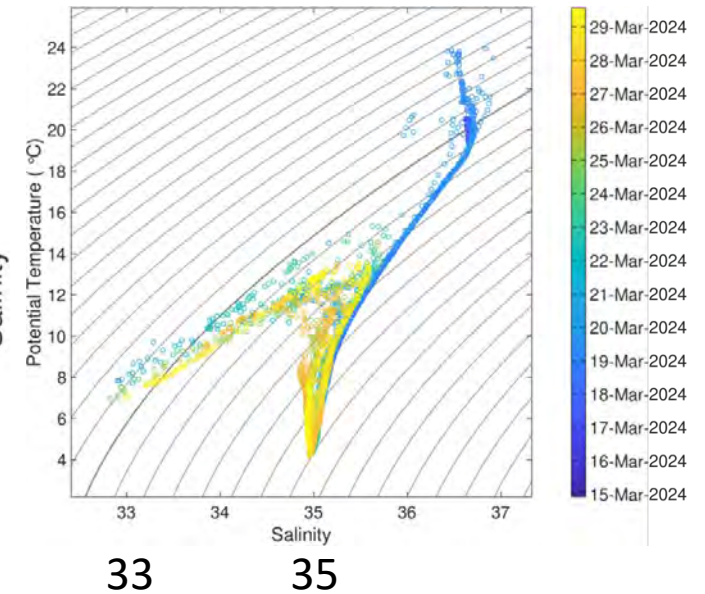
Week 20: 20240513 - 20240519



WHOI Glider Transect- March 14-29 2024



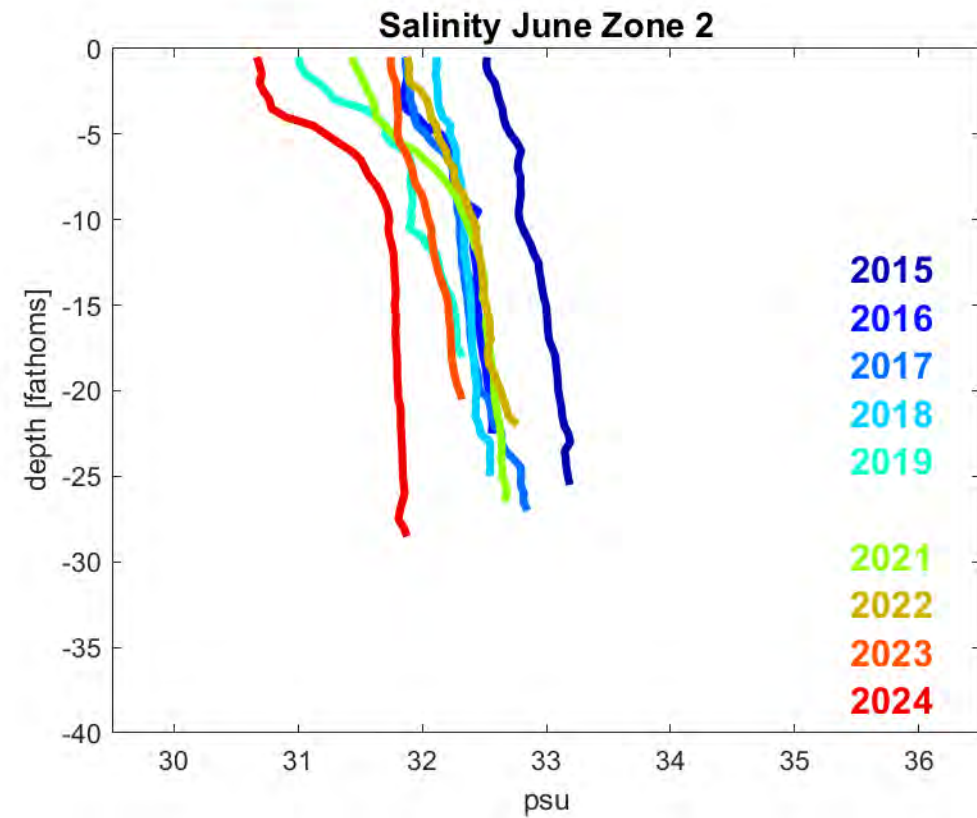
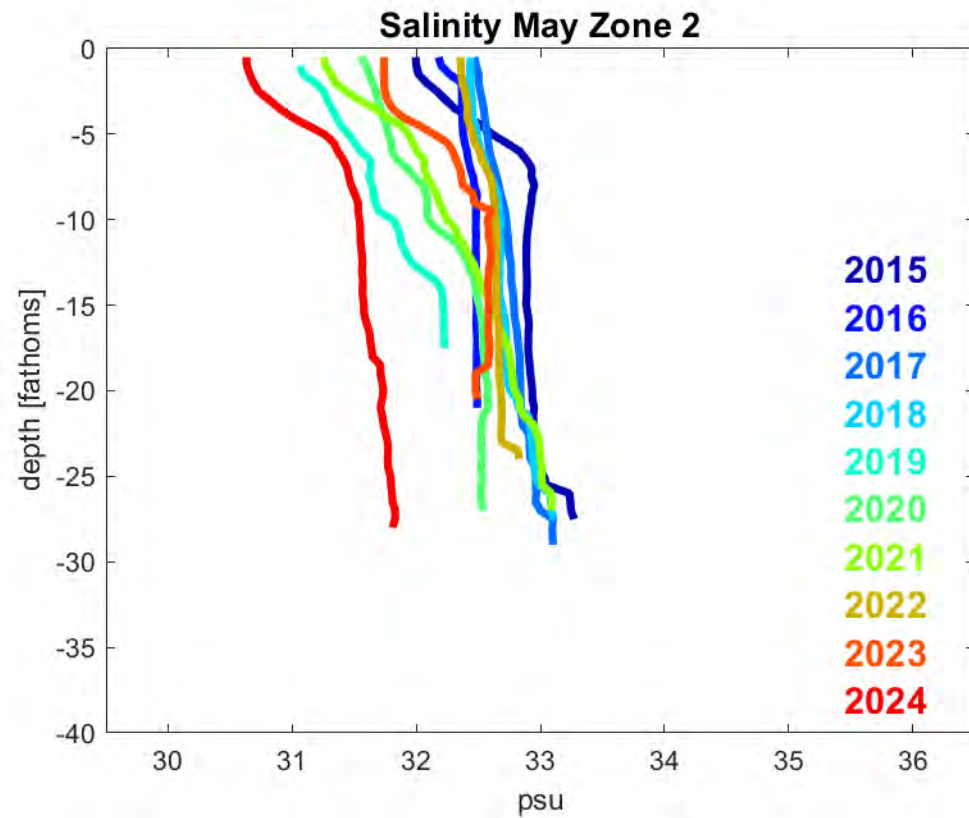
Shelf water reaching North Wall of the Gulf Stream!!!!



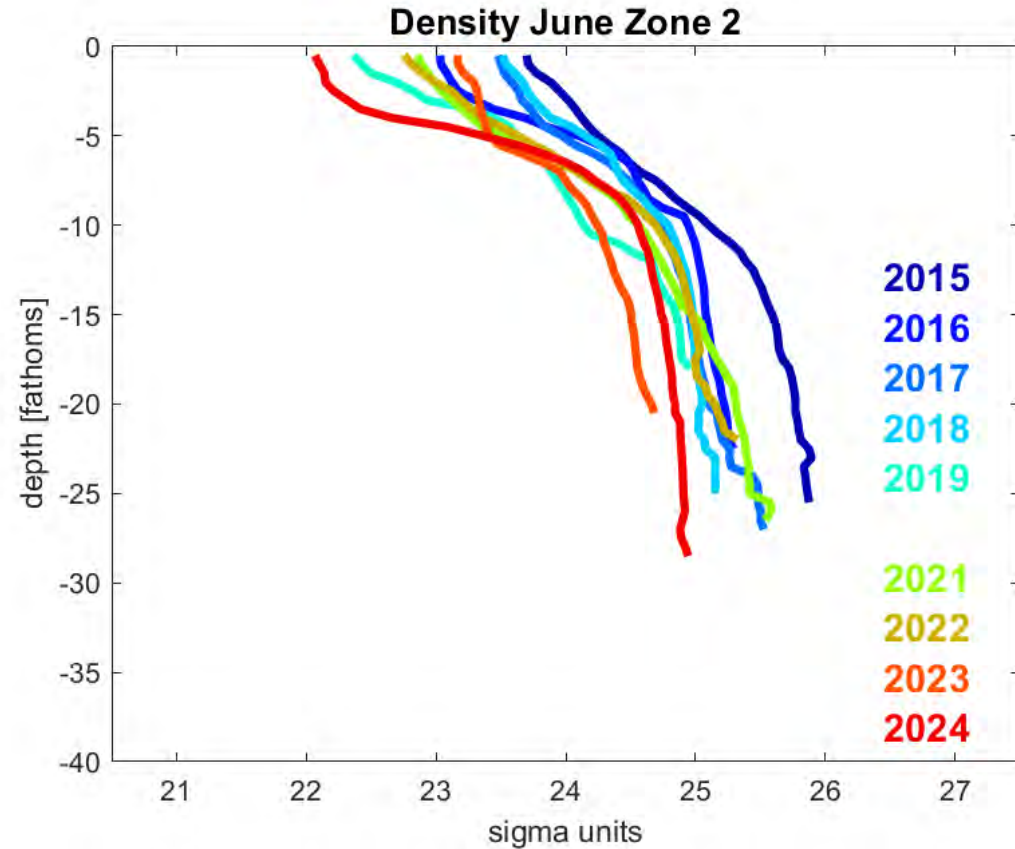
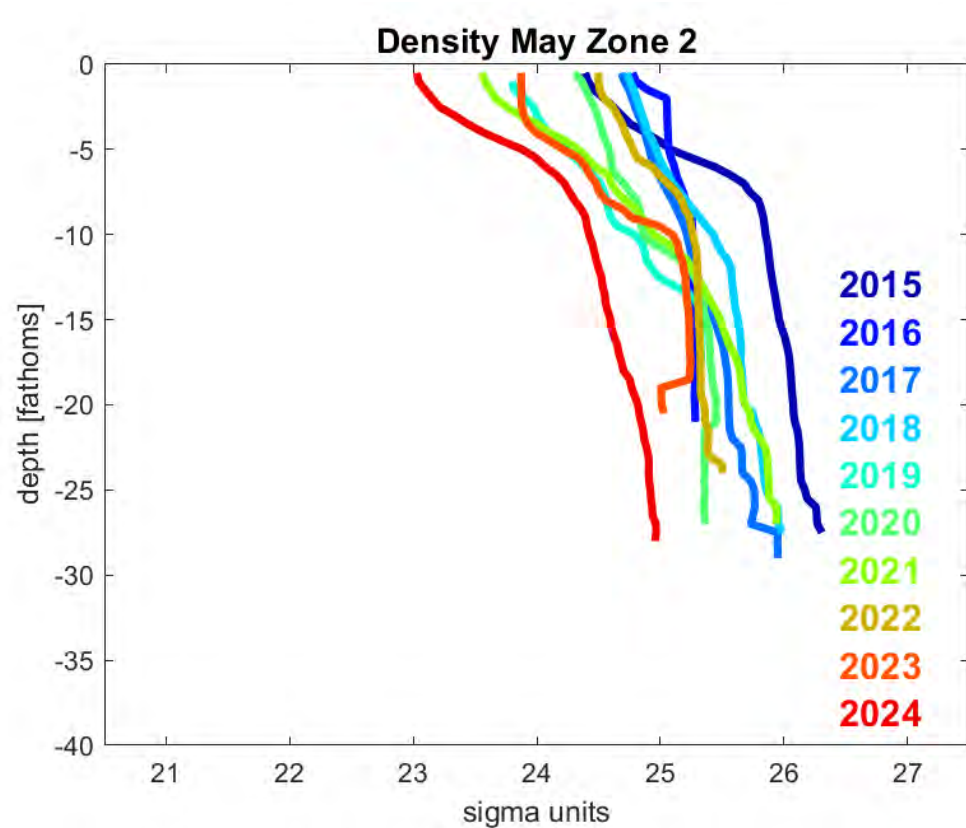
Shelf water surface layer extends to North Wall of Gulf Stream

Courtesy Robert Todd WHOI

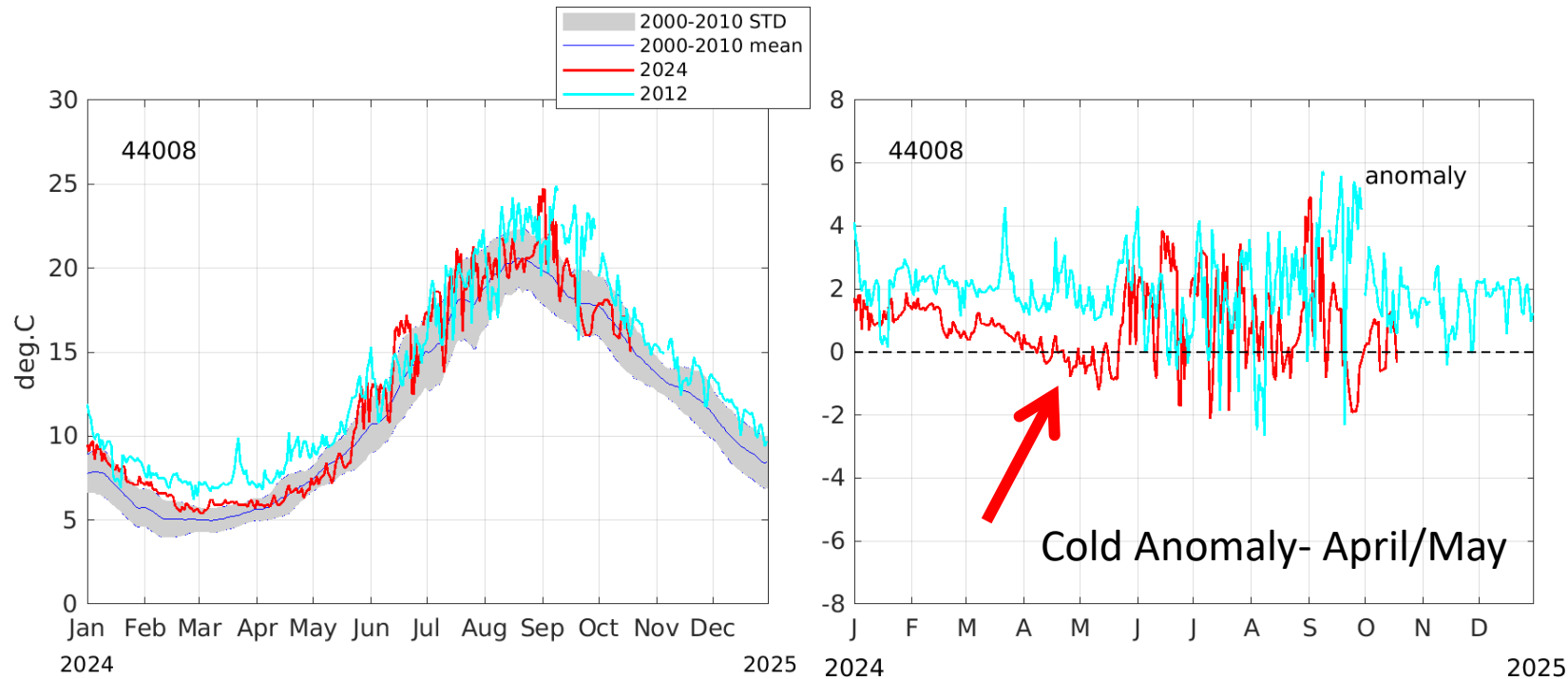
Inter-annual Variability of Salinity from Shelf Research Fleet Zone 2



Inter-Annual Variability of Density from Shelf Research Fleet Zone 2



Nantucket Shoals Temperature NDBC 44008



Red Line- 2024. Light blue line- 2012. Blue line- 2000-2010 average

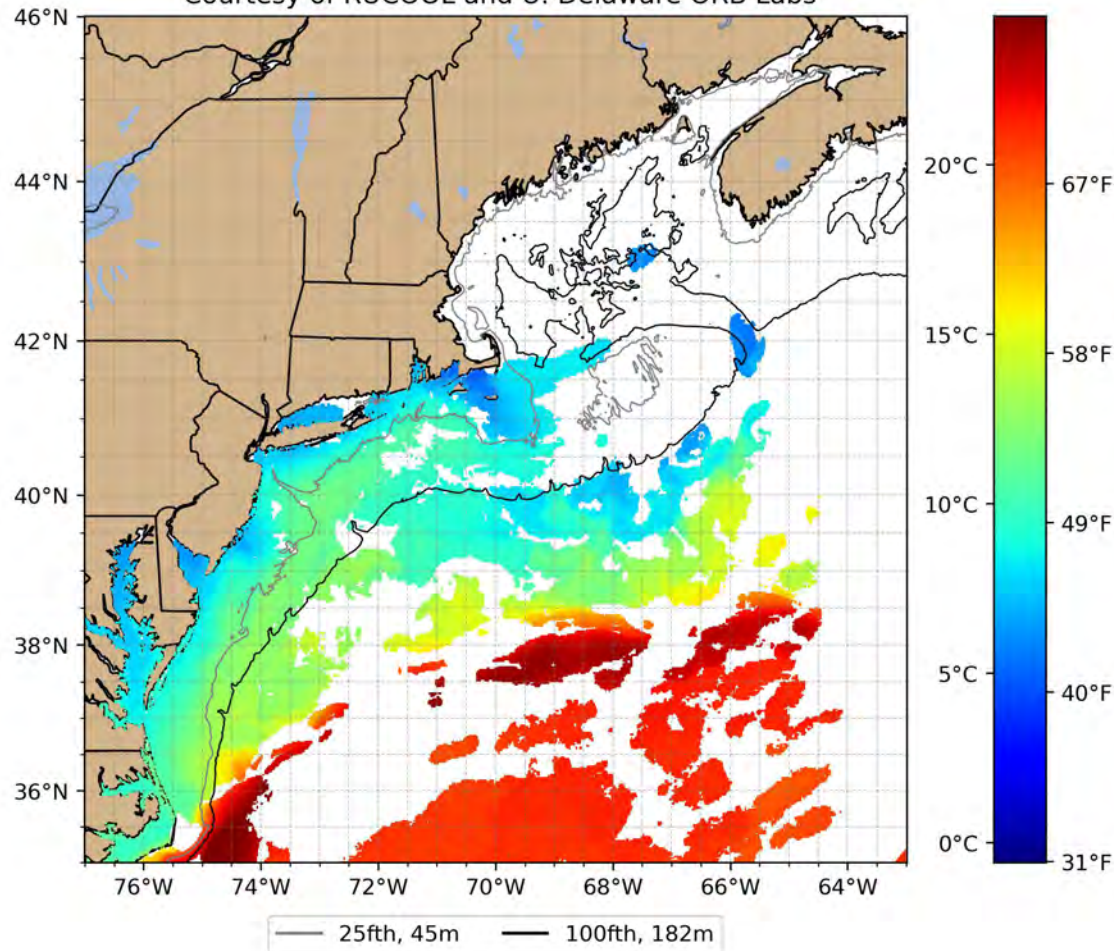
Some Fishing Impacts in 2024

- Various species showed up 4-5 weeks late off New Jersey SEASONAL MOVEMENTS DELAYED
- Illex not present for much of the season
- Loligo appeared mid-August, south of Hudson Canyon
- Unusual patterns of Marine Mammals, Sei Whales off New Jersey for the first time in over 10 years
- Abundant mackerel and herring

Sea Surface Temperature Jan-Feb 2025

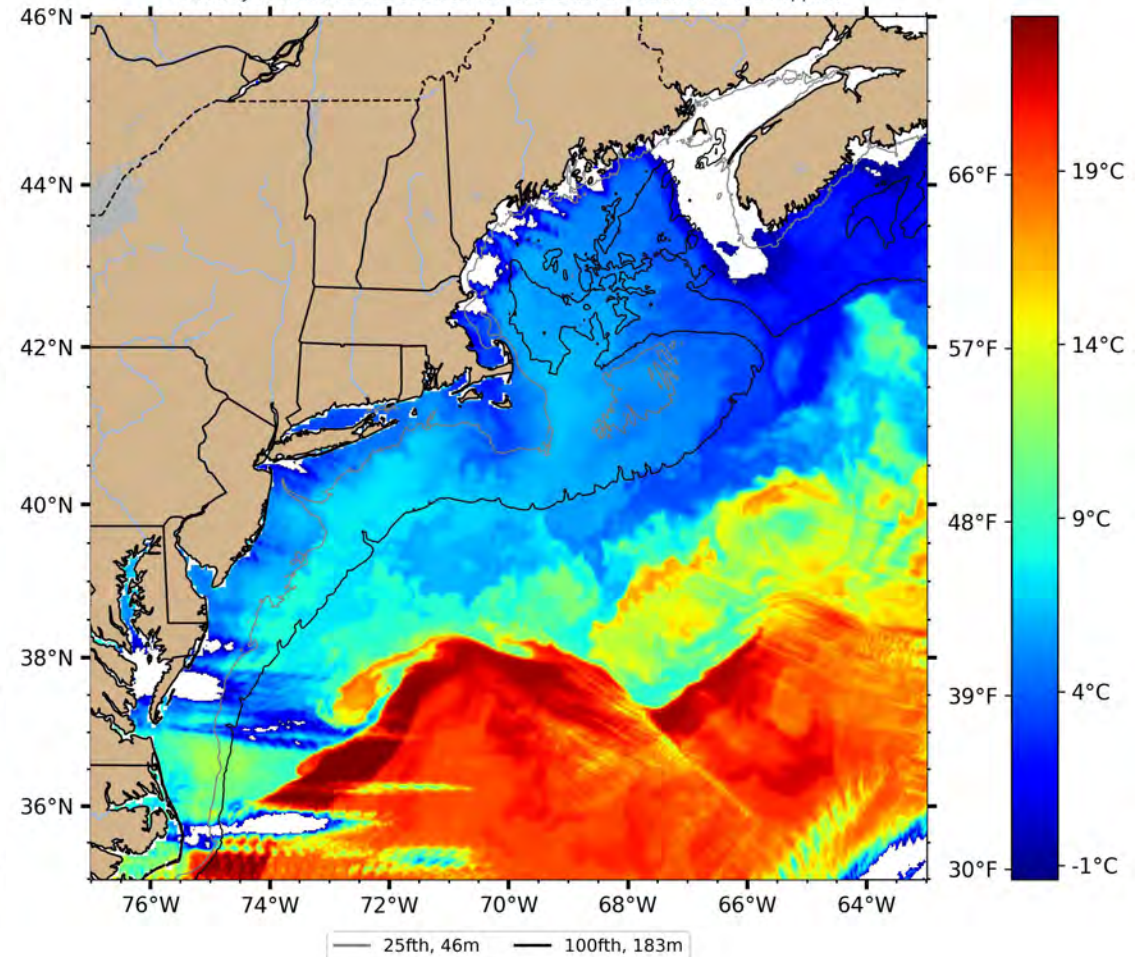
January 2, 2025

GOES Sea Surface Temperature 6-hr Composite: Jan 02 2025 0100 GMT
Courtesy of RUCOOL and U. Delaware ORB Labs



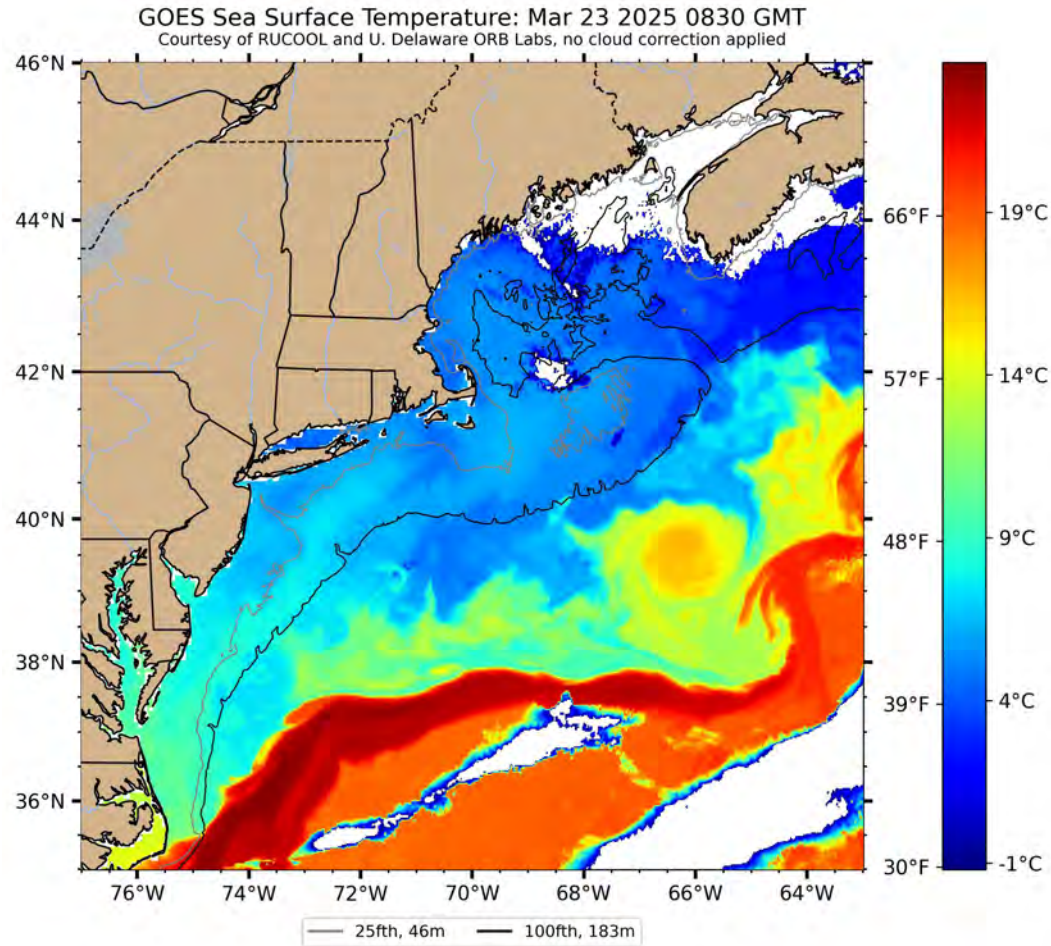
February 26, 2025

GOES Sea Surface Temperature: Feb 26 2025 1830 GMT
Courtesy of RUCOOL and U. Delaware ORB Labs, no cloud correction applied

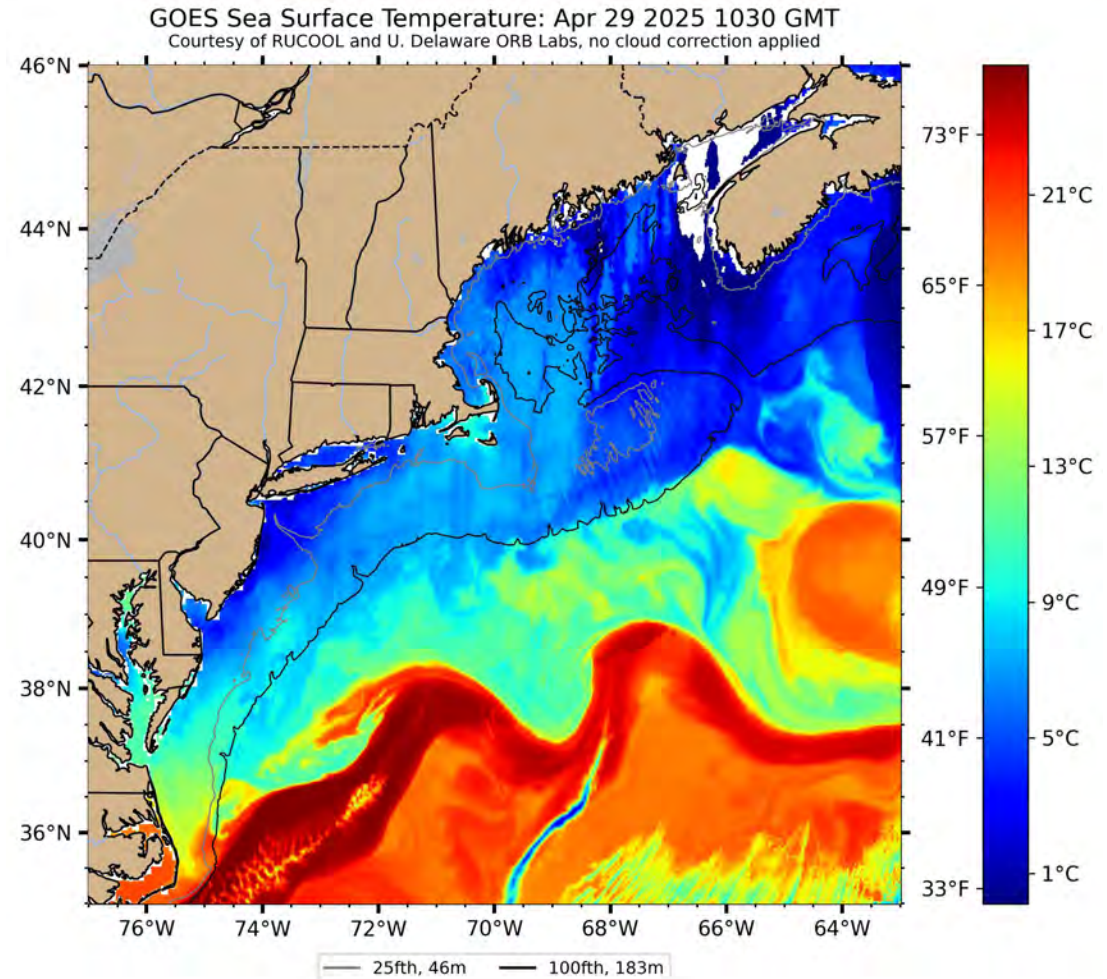


Sea Surface Temperature March-April 2025

March 23, 2025

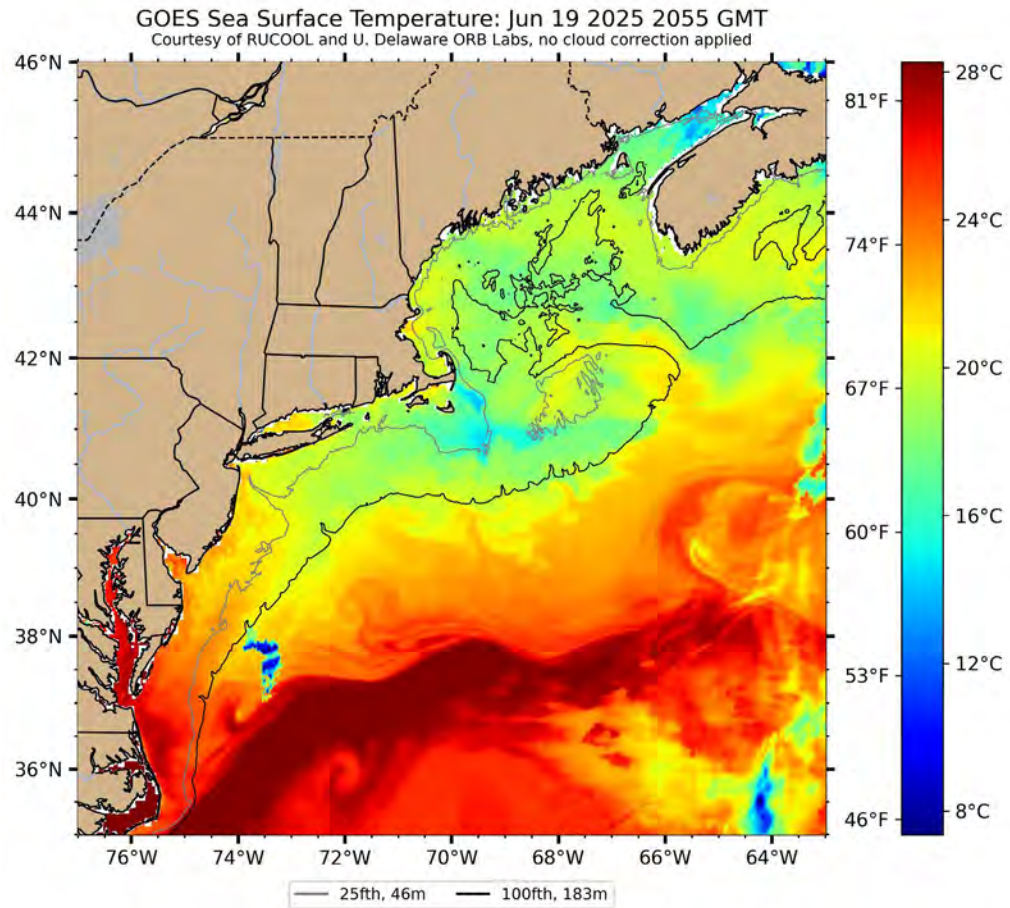


April 29, 2025

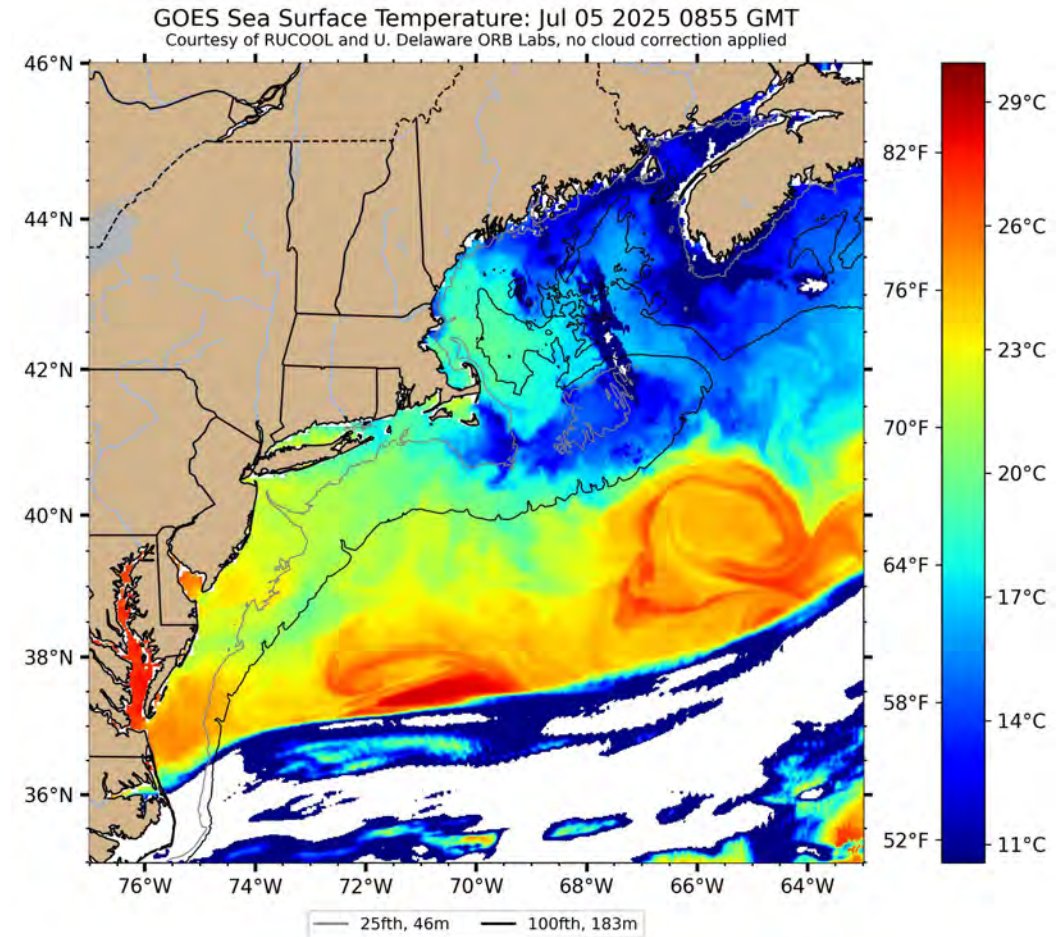


Sea Surface Temperature June-July 2025

June 19, 2025

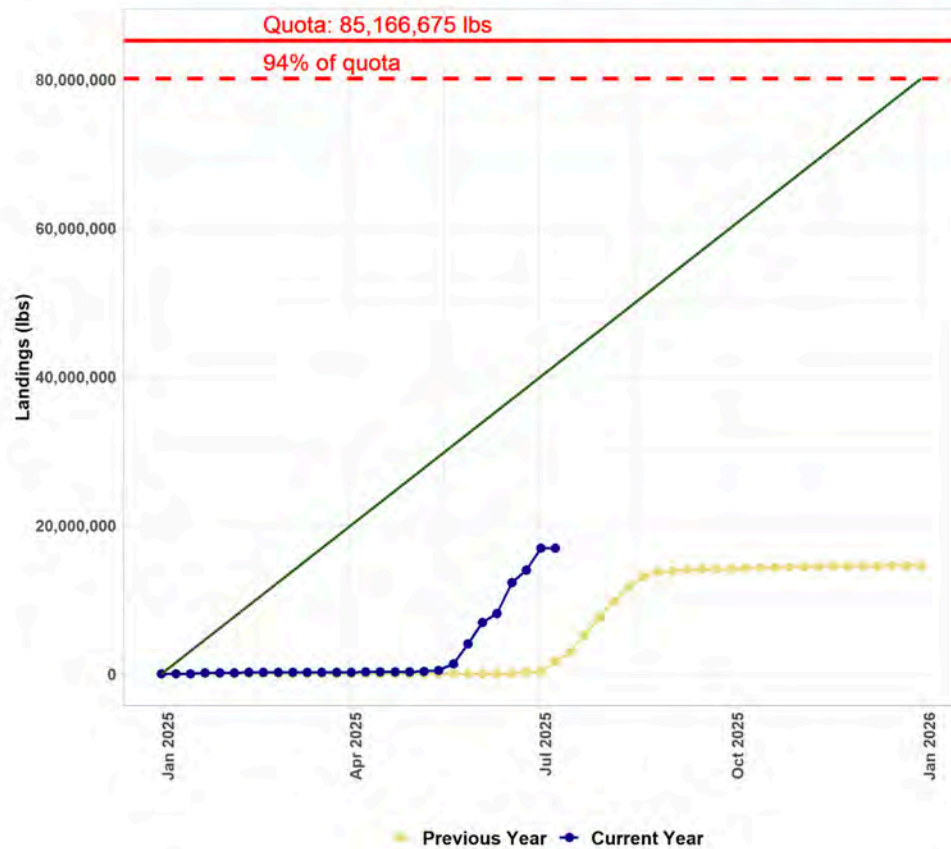


July 5, 2025

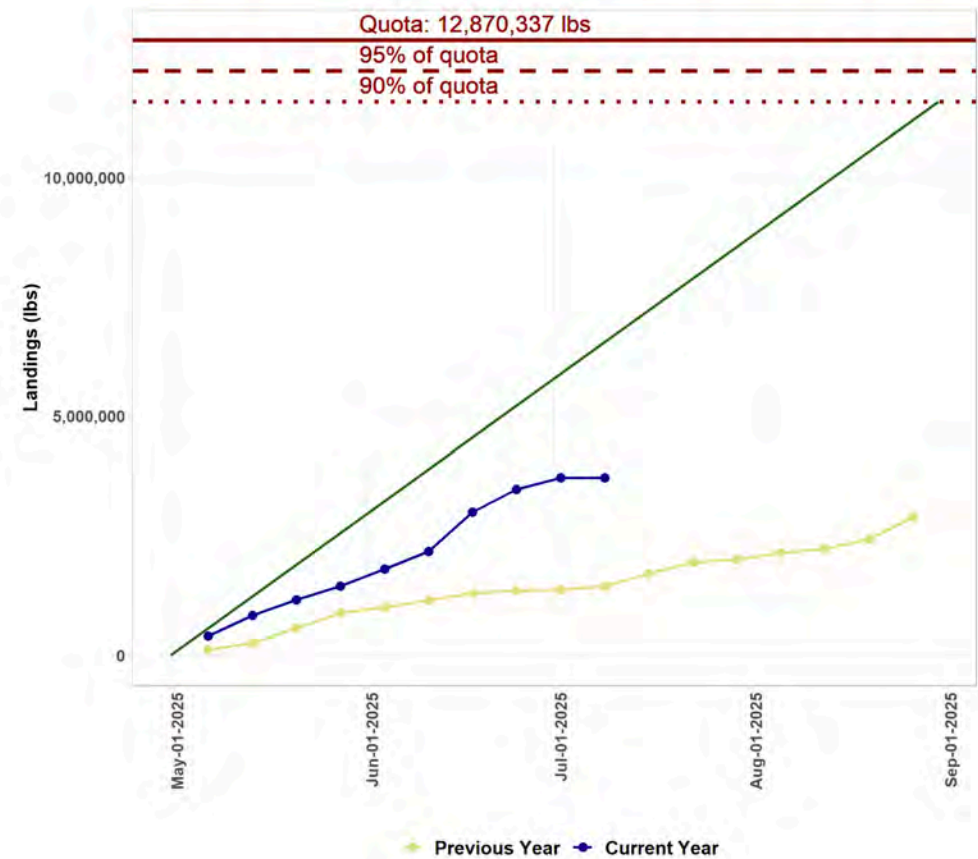


Squid Catch and Quotas

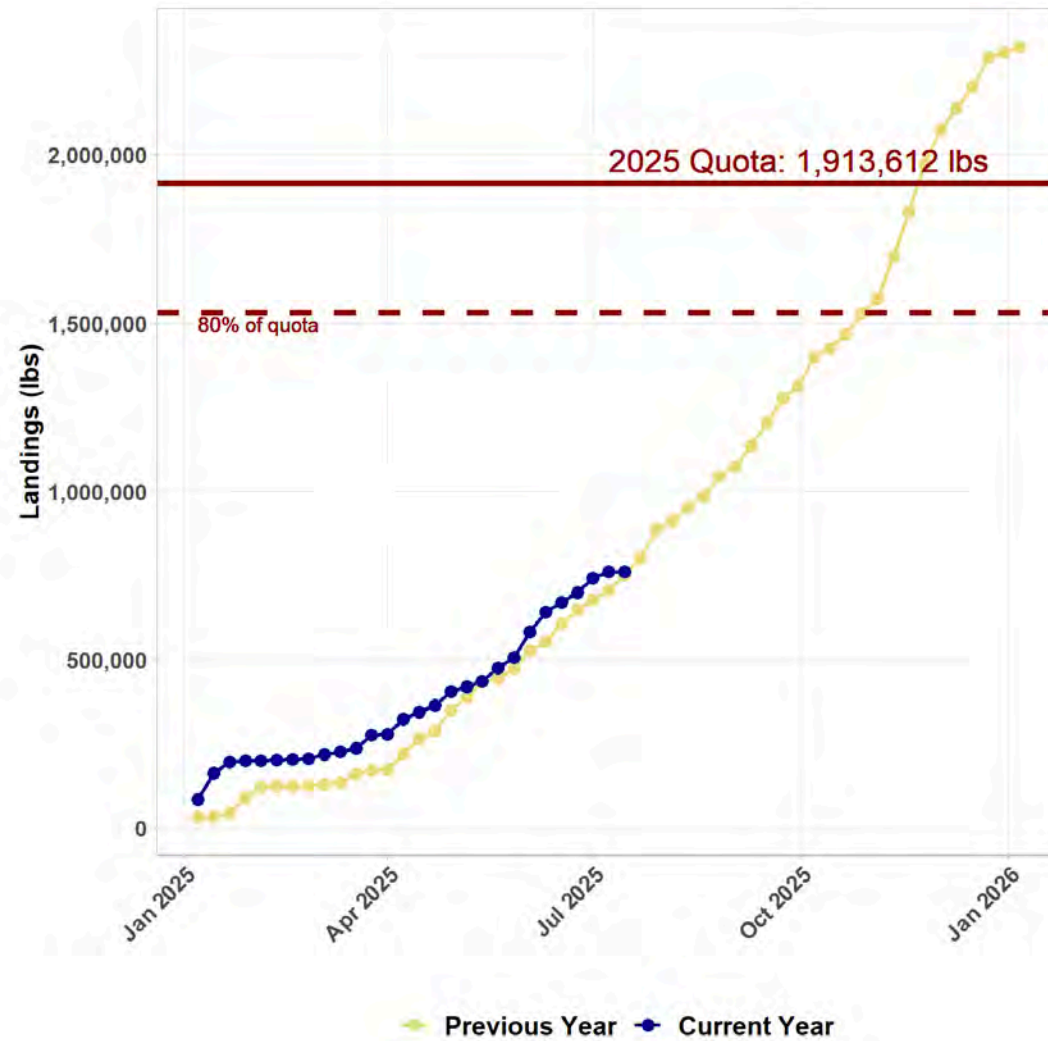
Illex



Loligo



Atlantic Mackerel

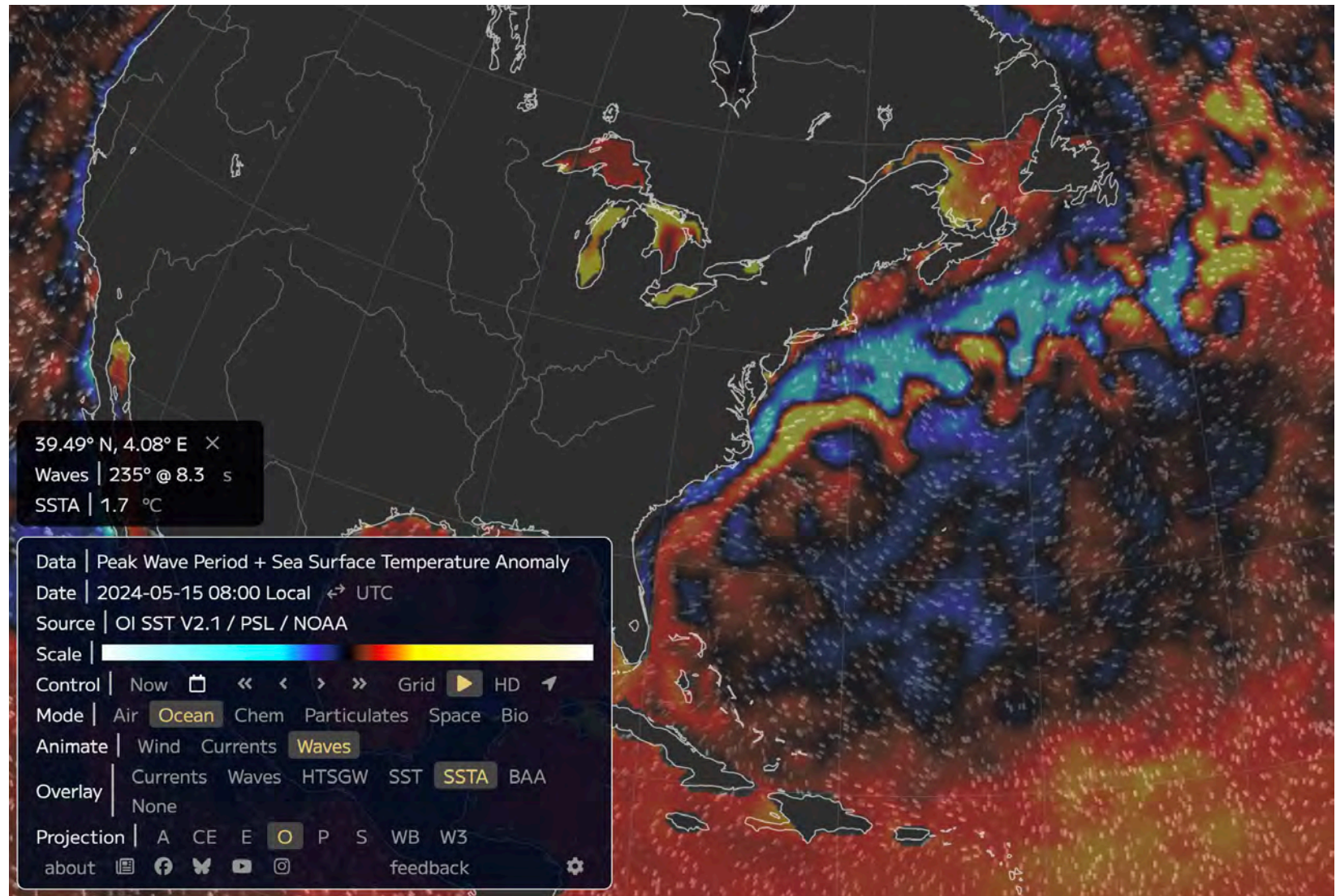


Sea Surface Temperature Anomaly May 15 2024

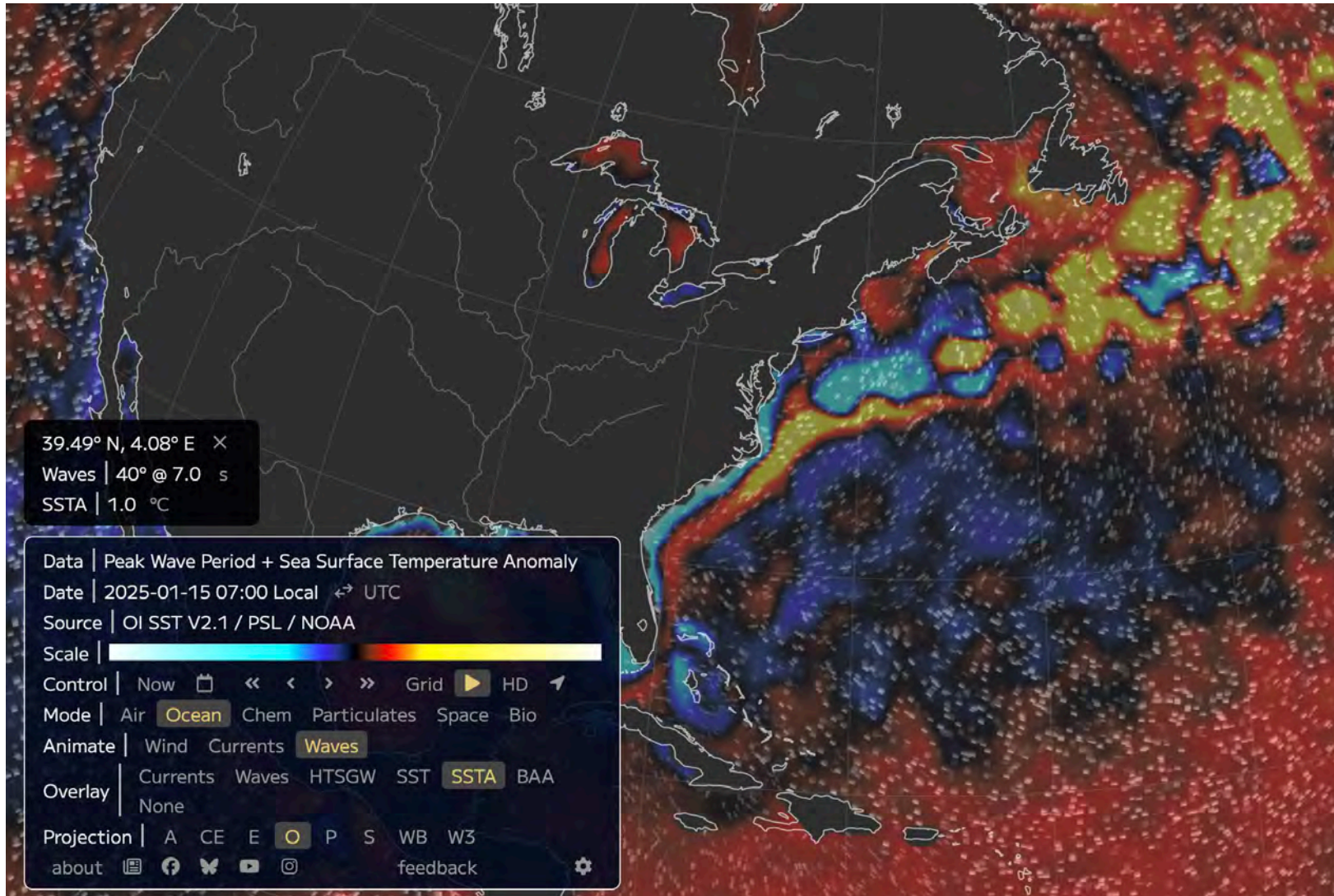
earth.nullschool.net

Maximum on colorbars are
-10.8 Deg C to 10.8 Deg C

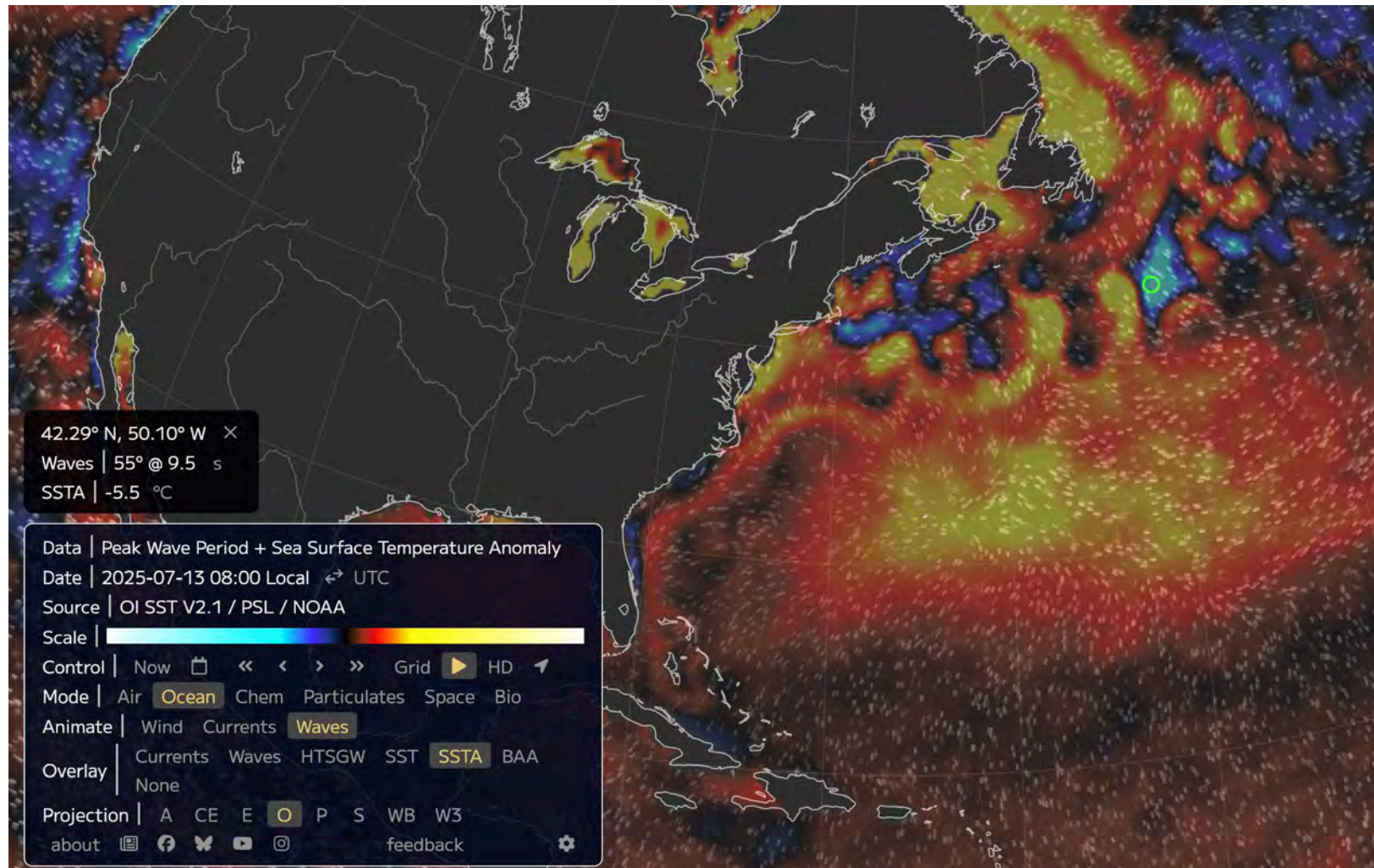
-19.44 Deg F to 19.44 Deg F



Sea Surface Temperature Anomaly January 15 2025



Sea Surface Temperature Anomaly July 13 2025



Summary

- Cold start to 2025 but anomalies mostly over the continental slope
- Very warm salty water over the continental shelf north of Cape Hatteras in April
- Gulf Stream initially straight but developed large meanders in May
- Two large Warm Core Rings currently south of Nova Scotia
- Very strong stratification, may lead to problems with low oxygen levels again off New Jersey in late August/early September

Links to Recommended Papers & Reports

- Papers from Glen's former student, Lukas Taenzer
 - Seasonal Salinification of the US Northeast Continental Shelf Cold Pool Driven by Imbalance Between Cross-Shelf Fluxes and Vertical Mixing
 - <https://doi.org/10.1029/2024JC021270>
 - Categorization of High-Wind Events and Their Contribution to the Seasonal Breakdown of Stratification on the Southern New England Shelf
 - <https://doi.org/10.1029/2022JC019625>
- Meghan Lapp – History of Soviet fishing along Atlantic coast
 - “From Cape Hatteras to Cabot Strait: the history of the Soviet fishery on the Atlantic continental shelf of the United States and Canada”
 - <https://repository.library.noaa.gov/view/noaa/23332>



Synthesis of Environmental Conditions and Potential Effects on Key Fishery Resources in the Chesapeake Bay

Spring 2025 Seasonal Summary

Spring 2025 Headlines

- Salinity remained above average through most of spring as a result of drier conditions in winter and early spring. Higher salinity supports oyster growth and reproduction.
- Hypoxia remained low compared with the early onset of hypoxia in spring 2024. This is good for crabs, oysters, and striped bass.

Summary of Potential Impacts of Environmental Conditions on Species from Most Recent Four Seasons

	Summer 2024	Fall 2024	Winter 2024–25	Spring 2025
Striped Bass	WT, DO, Sal, Flow	WT, DO, Sal, Flow	WT, DO, Sal, Flow	WT, DO, Sal, Flow
Blue Crabs	WT, DO, Sal, Flow	WT, DO, Sal, Flow	WT, DO, Sal, Flow	WT, DO, Sal, Flow
Oysters	WT, DO, Sal, Flow	WT, DO, Sal, Flow	WT, DO, Sal, Flow	WT, DO, Sal, Flow
Bay Anchovy	WT, DO, Sal, Flow	WT, DO, Sal, Flow	WT, DO, Sal, Flow	WT, DO, Sal, Flow
Summer Flounder	WT, DO, Sal, Flow	WT, DO, Sal, Flow	WT, DO, Sal, Flow	WT, DO, Sal, Flow

WT = Water Temperature
Sal = Salinity
Flow = Streamflow
DO = Dissolved Oxygen

Green = Potentially positive impact
Red = Potentially negative impact
Black = Neutral or unknown impact

Purpose

The National Oceanic and Atmospheric Administration's (NOAA) Chesapeake Bay Office (NCBO) develops seasonal summaries of water-quality parameters in the Chesapeake Bay to provide fisheries managers and the public information about recent environmental conditions, how they compare with long-term averages, and how these conditions might affect key fishery resources such as striped bass (*Morone saxatilis*), blue crab (*Callinectes sapidus*), eastern oysters (*Crassostrea virginica*), and summer flounder (*Paralichthys dentatus*). The intent is to provide information linking changes in environmental conditions to potential effects on living resources that can inform ecosystem-based management at state and regional levels. The seasons are defined as winter (December–February), spring (March–May), summer (June–August), and fall (September–November).

The primary data sources for these seasonal summaries are the [NOAA Chesapeake Bay Interpretive Buoy System](#) (CBIBS) for real-time, surface water temperature and salinity information at four locations throughout the Chesapeake Bay (Figure 1); the [NOAA CoastWatch Program](#) for Bay-wide, satellite-based sea surface temperature (SST) anomalies; the [NOAA National Weather Service PREcipitation Summary and Temperature Observations](#) (PRESTO) reports for regional precipitation and air temperature information; the [National Centers for Environmental Information](#) for precipitation data; and the [U.S. Geological Survey \(USGS\) National Water Information System](#) for local streamflow information at various locations throughout the Bay. In summer, the [Chesapeake Bay Environmental Forecast System](#) (CBEFS)



Synthesis of Environmental Conditions and Potential Effects on Key Fishery Resources in the Chesapeake Bay

Spring 2025 Seasonal Summary

provides estimates of the volume and duration of seasonal hypoxia. NCBO uses these seasonal summaries to develop an annual synthesis for inclusion in the Mid-Atlantic State of the Ecosystem Report, which is developed by the Northeast Fisheries Science Center and presented to the Mid-Atlantic Fishery Management Council each year.

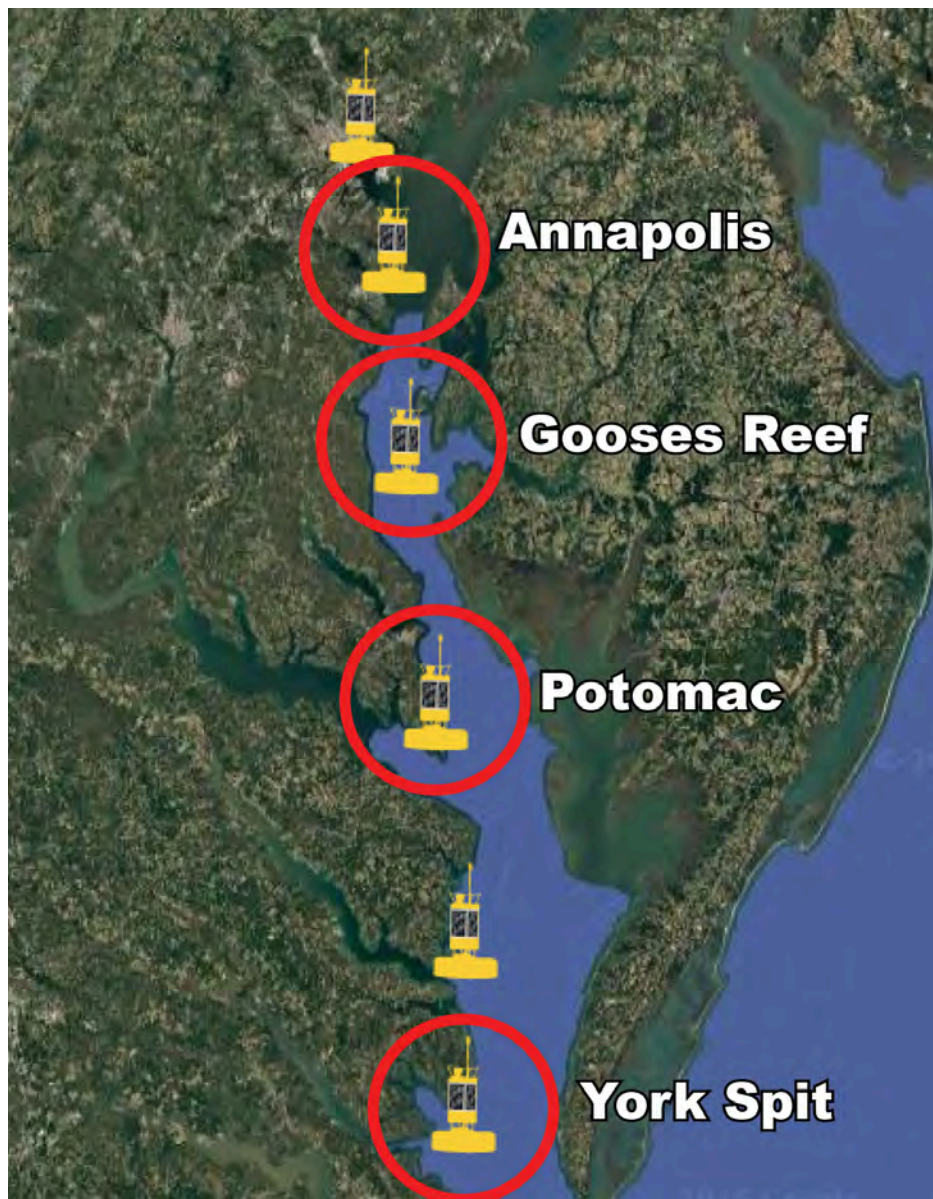


Figure 1. Map of Chesapeake Bay Interpretive Buoy System (CBIBS) observation platforms. The buoys used in these summaries are Annapolis, Gooses Reef, Potomac, and York Spit.



Synthesis of Environmental Conditions and Potential Effects on Key Fishery Resources in the Chesapeake Bay

Spring 2025 Seasonal Summary

Water Temperature

Coastal sea-surface temperatures (SST), as observed by NOAA satellites, deviated both above and below average. Anomalies in the Bay were greatest in the southern and southeastern regions (where water temperatures were slightly warmer) and in the northern Bay (where temperatures were slightly cooler) (Figure 2). However, the SST anomalies were within about 1°C of average in most places. This contrasts with [spring 2024](#), where temperatures Bay-wide were higher than average.

Observations from NOAA Chesapeake Bay Interpretive Buoy System (CBIBS) buoys show a similar and expected pattern of increasing water temperatures from March through May. At the Annapolis, Gooses Reef, Potomac, and York Spit CBIBS stations, overall, water temperatures warmed through spring (Figures 3, 4, 5, and 6). Water temperatures at all stations were below average in March, several degrees above average from the beginning of May to mid May, and then again below average at the end of May.

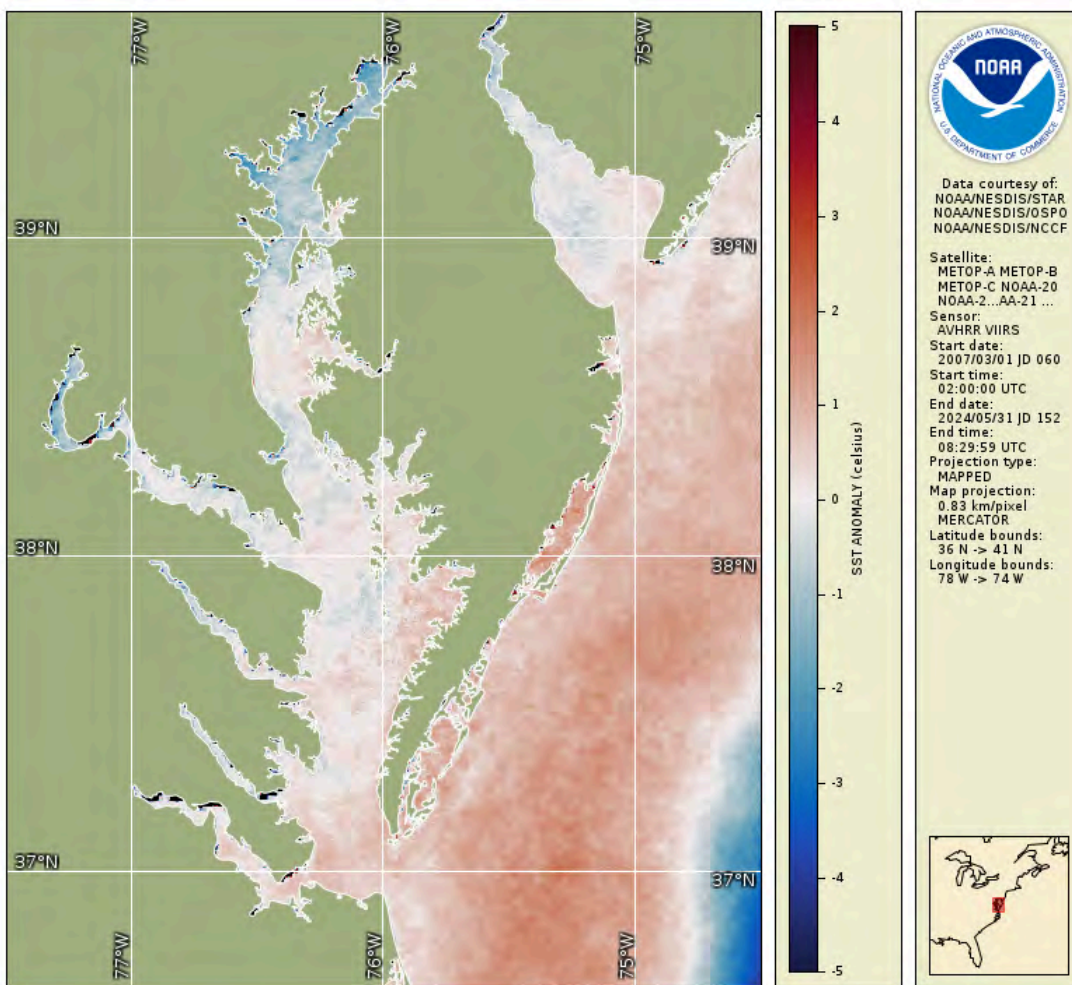


Figure 2. Sea surface temperature (SST) anomalies observed by NOAA satellites March–May 2025 relative to the average of this seasonal period 2007–2024.



Synthesis of Environmental Conditions and Potential Effects on Key Fishery Resources in the Chesapeake Bay

Spring 2025 Seasonal Summary

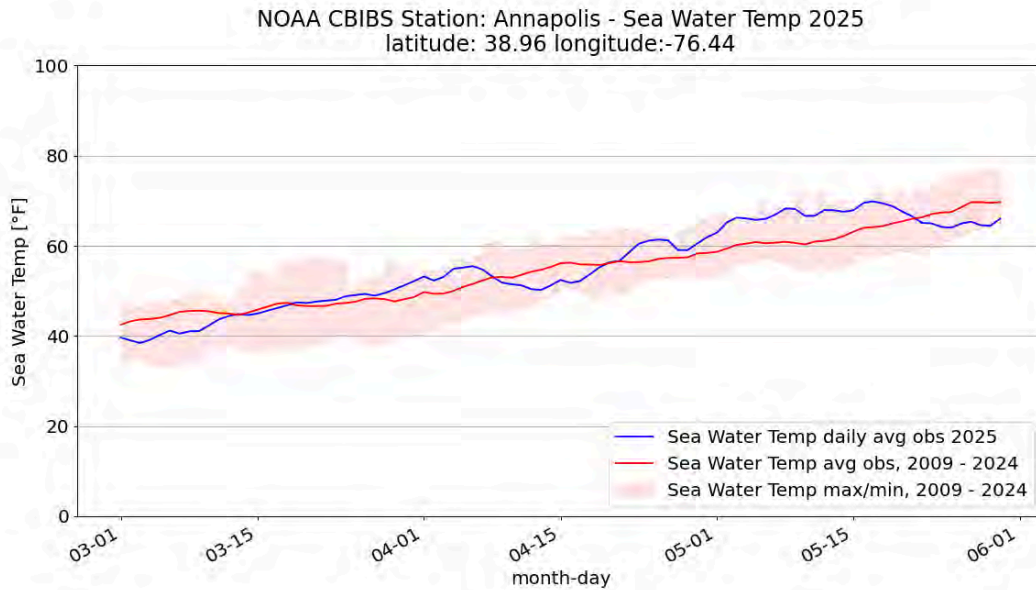


Figure 3. Surface water temperatures at the Annapolis CBIBS buoy March–May 2025 relative to the long-term average (2009–2024). The shaded area represents the full range of observations (minimum to maximum) over the time period.

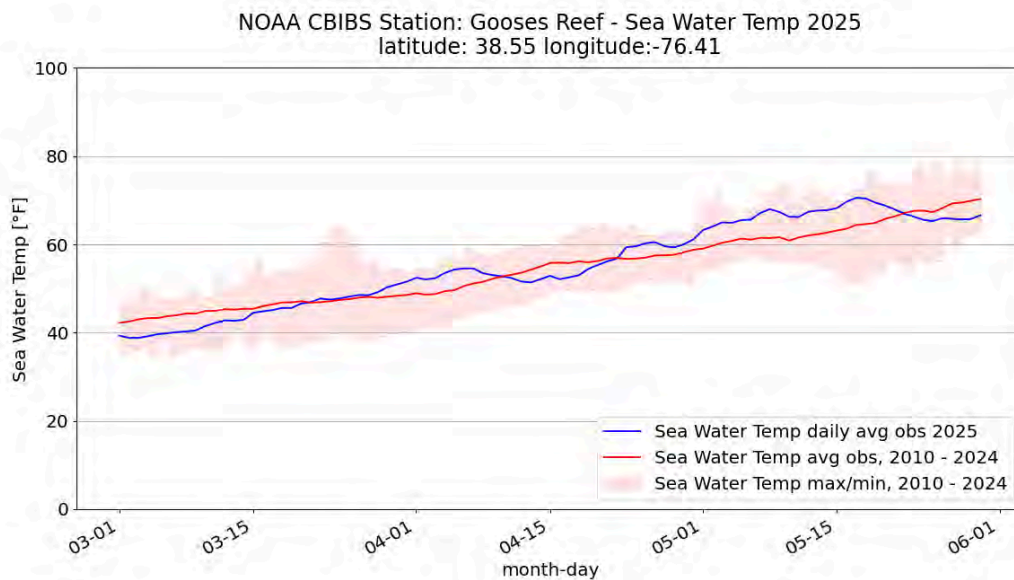


Figure 4. Surface water temperatures at the Gooses Reef CBIBS buoy March–May 2025 relative to the long-term average (2010–2024). The shaded area represents the full range of observations (minimum to maximum) over the time period.



Synthesis of Environmental Conditions and Potential Effects on Key Fishery Resources in the Chesapeake Bay

Spring 2025 Seasonal Summary

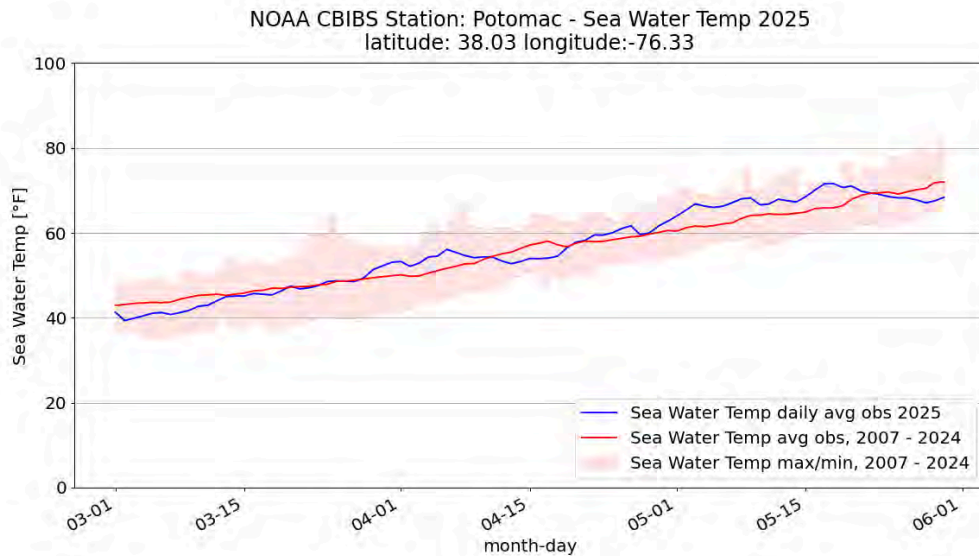


Figure 5. Surface water temperatures at the Potomac CBIBS buoy March–May 2025 relative to the long-term average (2007–2024). The shaded area represents the full range of observations (minimum to maximum) over the time period.

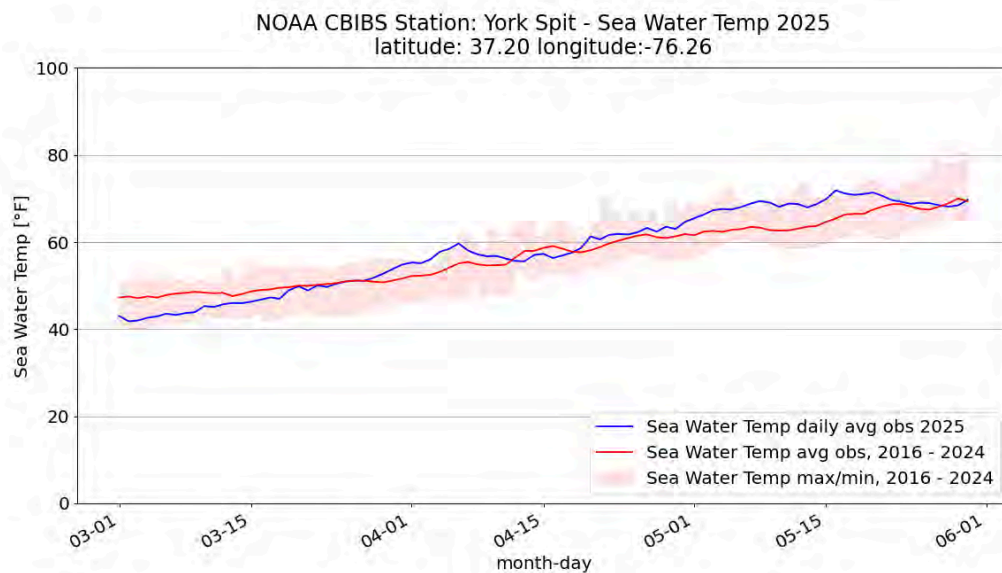


Figure 6. Surface water temperatures at the York Spit CBIBS buoy March–May 2025 relative to the long-term average (2007–2024). The shaded area represents the full range of observations (minimum to maximum) over the time period.



Synthesis of Environmental Conditions and Potential Effects on Key Fishery Resources in the Chesapeake Bay

Spring 2025 Seasonal Summary

Salinity

Salinity was above average at the Annapolis, Gooses Reef, Potomac, and York Spit CBIBS buoys from most of March into May (Figures 7, 8, 9, and 10). This continues the trend from [winter 2025](#), when salinity was above average at all buoy stations. It is in contrast to [spring 2024](#), when salinity was below average. The Annapolis CBIBS buoy showed a large drop in salinity in early March; salinity then rose and fell at that location through May (Figure 7) while staying above the long-term average. Salinity at Annapolis and Gooses Reef was about average from mid to late May (Figures 7 and 8).

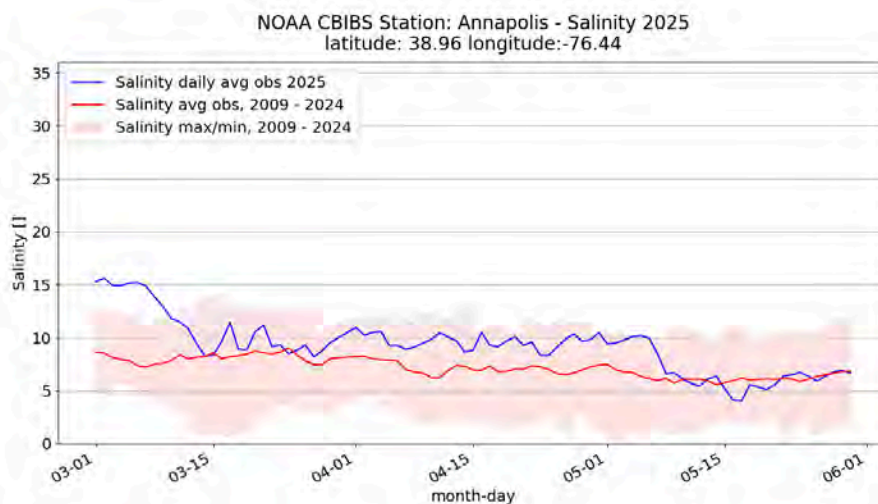


Figure 7. Salinity observations at the Annapolis CBIBS buoy March–May 2025 (blue line) relative to the average at each buoy over this seasonal period 2009–2024 (red line). The shaded area represents the full range of observations (minimum to maximum) over the time period.

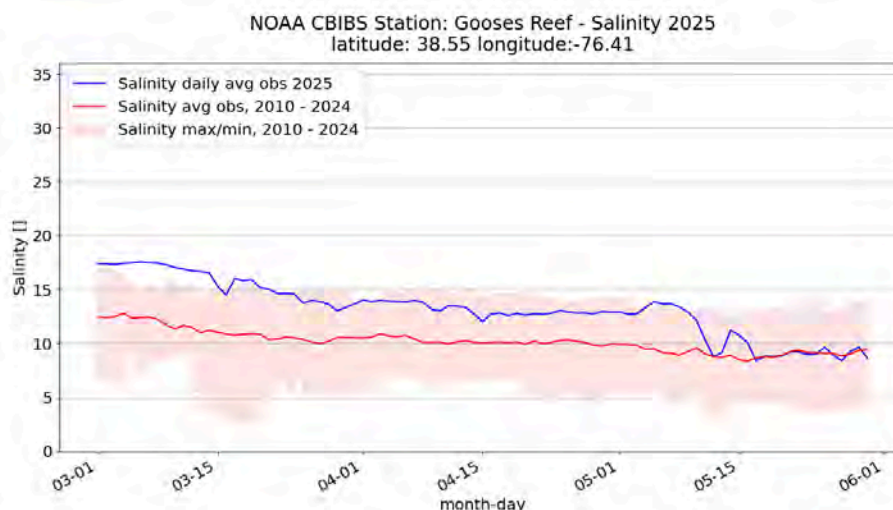


Figure 8. Salinity observations at the Gooses Reef CBIBS buoy March–May 2025 (blue line) relative to the average at each buoy over this seasonal period 2010–2024 (red line). The shaded area represents the full range of observations (minimum to maximum) over the time period.



Synthesis of Environmental Conditions and Potential Effects on Key Fishery Resources in the Chesapeake Bay

Spring 2025 Seasonal Summary

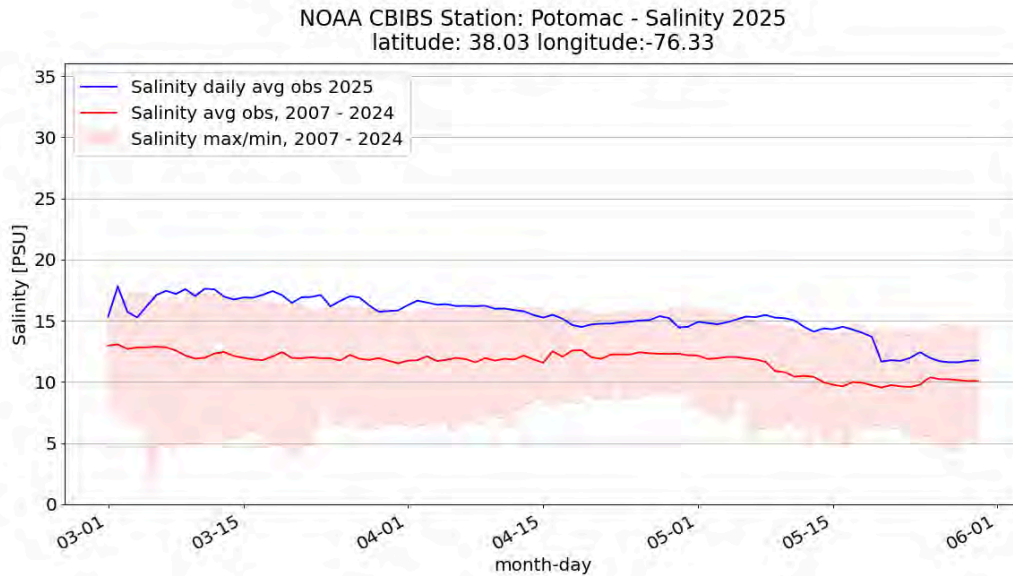


Figure 9. Salinity observations at the Potomac CBIBS buoy March–May 2025 (blue line) relative to the average at each buoy over this seasonal period 2007–2024 (red line). The shaded area represents the full range of observations (minimum to maximum) over the time period.

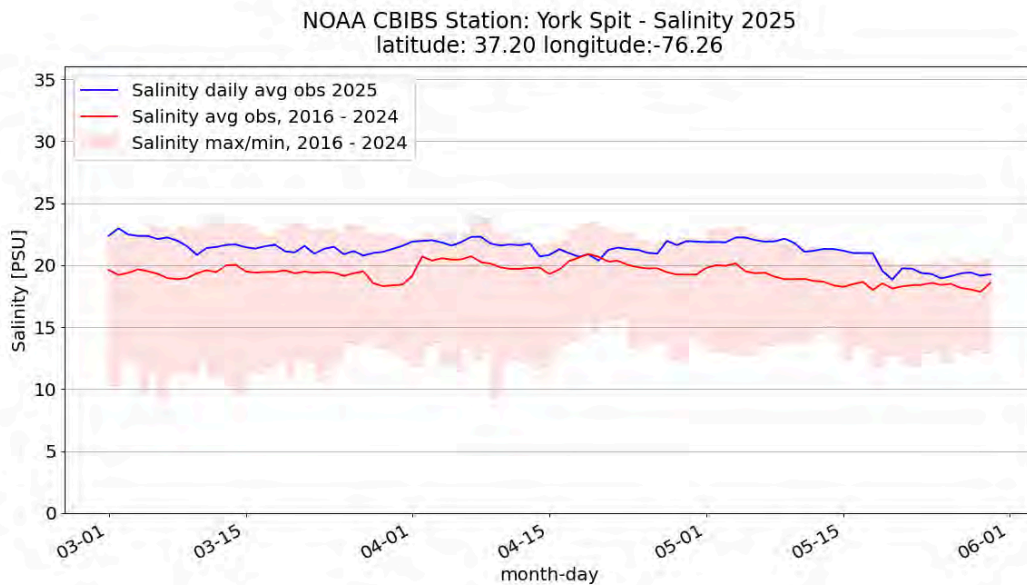


Figure 10. Salinity observations at the York Spit CBIBS buoy March–May 2025 (blue line) relative to the average at each buoy over this seasonal period 2007–2024 (red line). The shaded area represents the full range of observations (minimum to maximum) over the time period.



Synthesis of Environmental Conditions and Potential Effects on Key Fishery Resources in the Chesapeake Bay

Spring 2025 Seasonal Summary

Precipitation and Freshwater Flow

According to precipitation data from NOAA's National Centers for Environmental Information, rainfall amounts for tidewater Virginia and southern Maryland were the third and fourth highest, respectively, since 2007 (Figures 11 and 12). Higher precipitation results in higher freshwater flow to the Bay. Pulses of flow above historic flow were observed at Choptank, Pamunkey, and Zekiah Swamp (Figure 13). Higher precipitation resulted in declines in salinity toward the end of spring, as observed by the Annapolis and Gooses Reef CBIBS buoys (Figures 7 and 8). While precipitation was relatively high for spring compared to the 2007–2025 mean, it is important to note the region has experienced [drier conditions](#) since fall 2024. Some areas continued to be in moderate drought conditions at the end of spring.

Virginia, Climate Division 1 Precipitation

March-May



Figure 11. Precipitation data from 2007–2025 for March–May for Tidewater Virginia. Data from NOAA Centers for Environmental Information.

Maryland, Climate Division 3 Precipitation

March-May

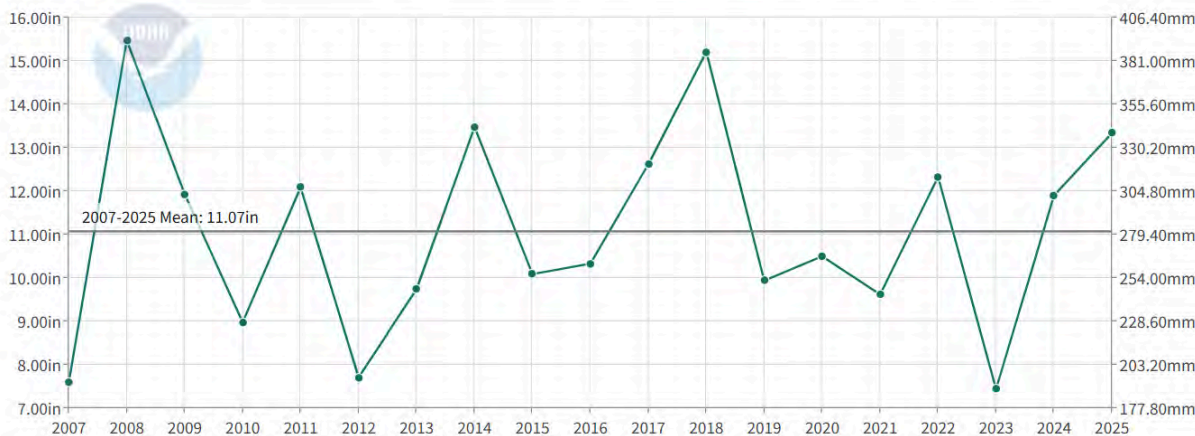


Figure 12. Precipitation data from 2007–2025 for March–May for southern Maryland. Data from NOAA Centers for Environmental Information.



Synthesis of Environmental Conditions and Potential Effects on Key Fishery Resources in the Chesapeake Bay

Spring 2025 Seasonal Summary

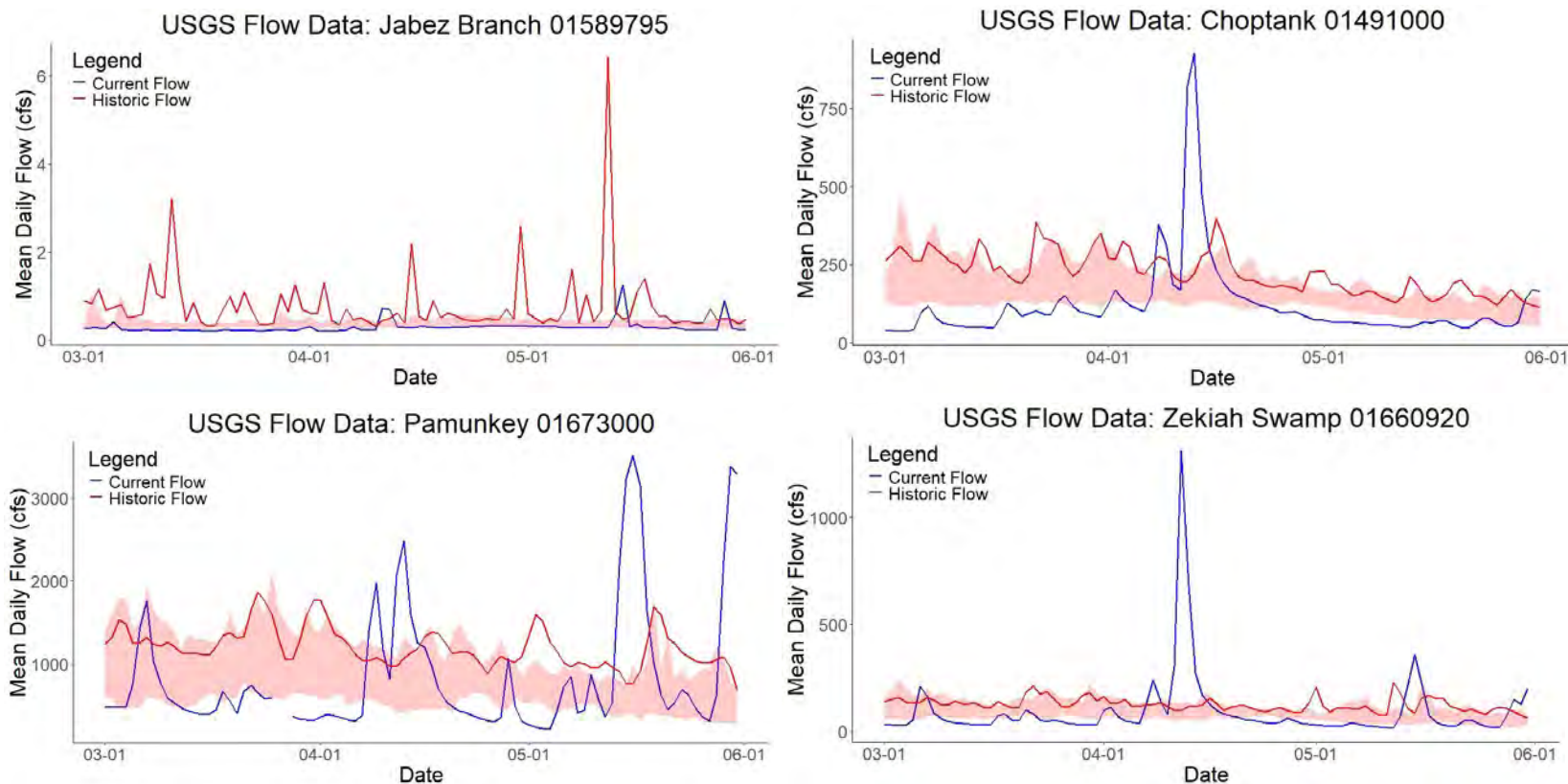


Figure 13. Daily mean streamflow observations (discharge, cubic feet/second) from the upper to lower Chesapeake Bay at U.S. Geological Survey monitoring sites at the (A) Jabez Branch, Severn River (B) Choptank River, (C) Pamunkey River, and (D) Zekiah Swamp, Potomac River throughout spring 2025 relative to the daily averages over this seasonal period from 2000–2024. The red shading indicates the interquartile range (25%–75%), where 50% of the historical values fall. These locations were chosen because they are fairly near the CBIBS Annapolis, Gooses Reef, York Spit, and Potomac locations respectively.



Synthesis of Environmental Conditions and Potential Effects on Key Fishery Resources in the Chesapeake Bay

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Dissolved Oxygen

Dissolved oxygen (DO) levels as tracked at NCBO's Lower Choptank and Sharps Island hypoxia monitoring buoys remained mostly within the historical range of values, with Lower Choptank remaining well above the [biological threshold](#) of 4 mg/L. Sharps Island daily averages hovered above or around the historical mean.

Lower Choptank Monthly Dissolved Oxygen 1984-2024 Historical Data vs 2025 Daily Average

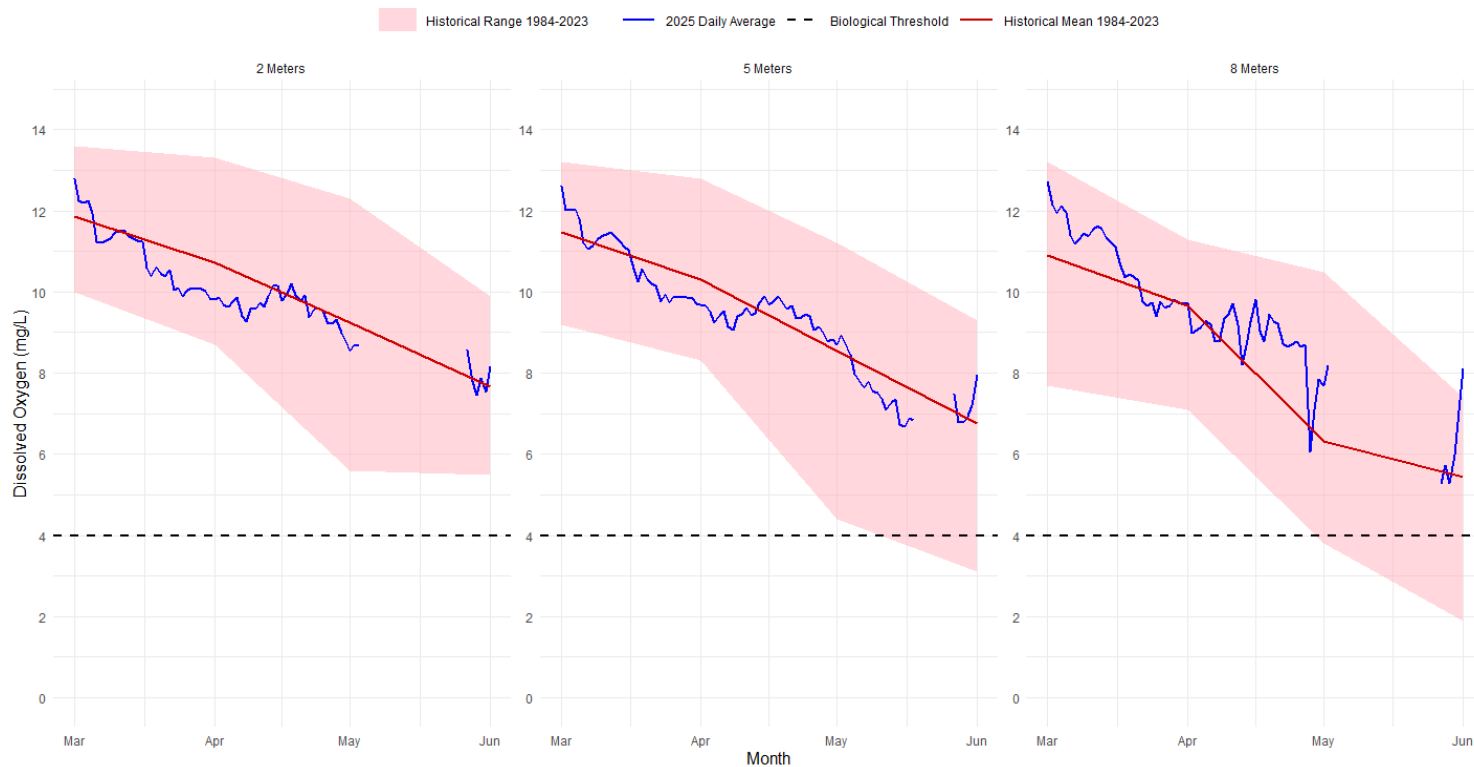


Figure 14. Dissolved oxygen (DO) daily averages at the Lower Choptank buoy for March–May 2025 compared with long-term averages (1984-2024) from the DNR EE2.1 fixed monthly monitoring station. The plots are separated by sensor depth, with the 8-meter plot using historical data from a 7-meter depth due to the absence of 8-meter historical data. The shaded area represents the historical range (minimum to maximum) of DO observations from the EE2.1 station, while the red line represents the historical mean. The 2025 daily average DO is shown by the blue line, and the black dashed line represents the biological threshold, marking the point at which aquatic life may alter its behavior to avoid low DO areas. Gaps in dissolved oxygen data are the result of station outages, sensor outages, or sensor data that does not meet QA/QC standards.



Synthesis of Environmental Conditions and Potential Effects on Key Fishery Resources in the Chesapeake Bay

Spring 2025 Seasonal Summary

Sharps Island Monthly Dissolved Oxygen 1984-2024 Historical Data vs 2025 Daily Average

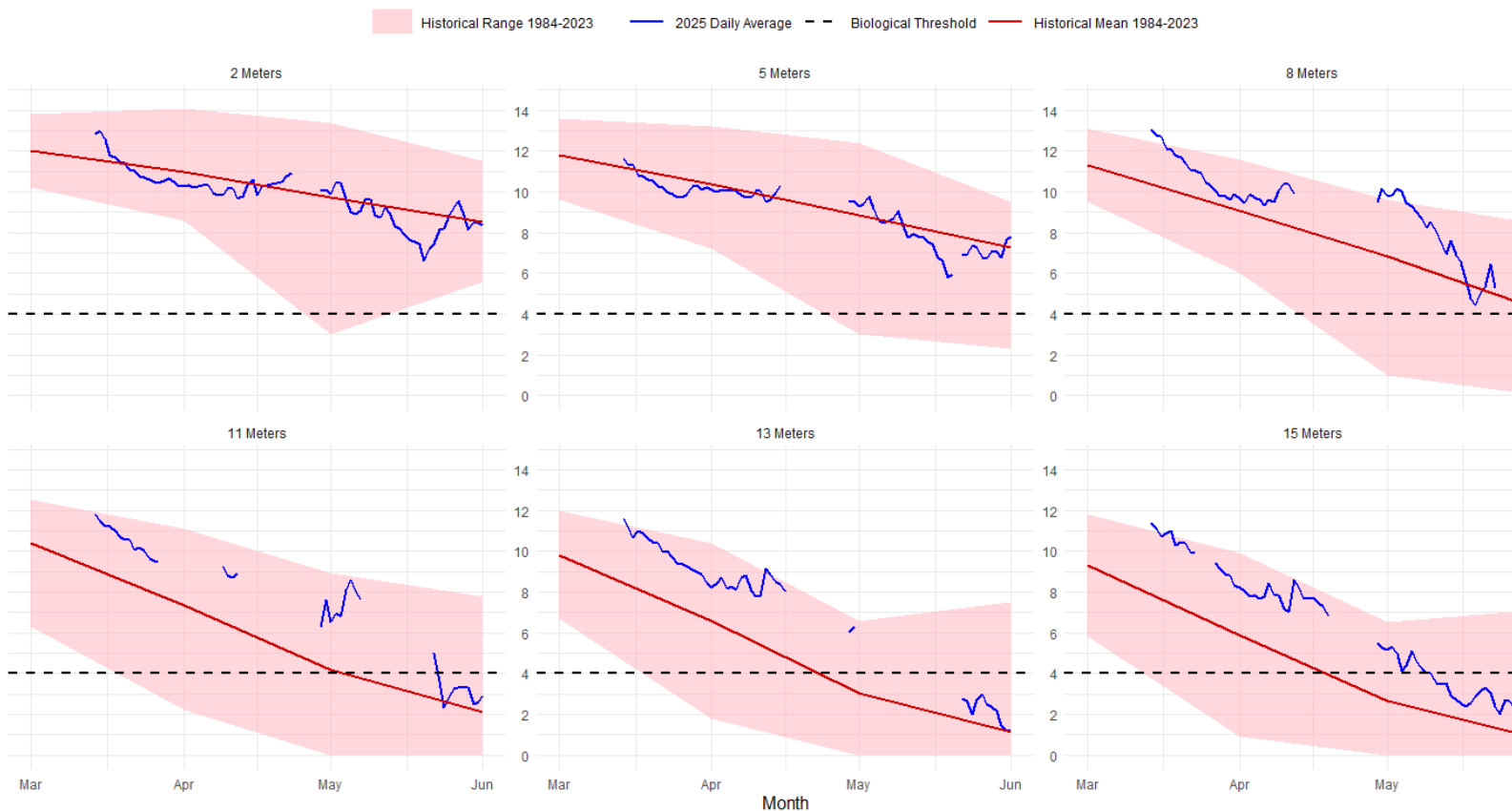


Figure 15. Dissolved oxygen (DO) daily averages at the Sharps Island buoy for March–May 2025 compared with long-term averages (1984-2024) from the DNR CB4.2C fixed monthly monitoring station. The shaded area represents the historical range (minimum to maximum) of DO observations from the CB4.2C station, while the red line represents the historical mean. The 2025 daily average DO is shown by the blue line, and the black dashed line represents the biological threshold, marking the point at which aquatic life may alter its behavior to avoid low DO areas. Gaps in dissolved oxygen data are the result of station outages, sensor outages, or sensor data that does not meet QA/QC standards.



Synthesis of Environmental Conditions and Potential Effects on Key Fishery Resources in the Chesapeake Bay

Spring 2025 Seasonal Summary

Potential Effects of Anomalous Spring Conditions on Living Resources

Striped Bass

Temperature affects the timing of striped bass spawning activity, and recruitment success appears to be related to freshwater inflow (Martino & Houde 2010). Striped bass typically begin spawning in the spring when water temperatures reach 60°F, with most spawning occurring between 61°F and 69°F. This threshold was met at all buoy locations by about mid April (a month later than in spring 2024). The spawning season usually lasts from April to mid June.

Cold winter temperatures and high freshwater flow enhance striped bass recruitment by optimizing feeding opportunities. High freshwater flows promote the retention of larvae and zooplankton near the estuarine turbidity maximum, increasing coincidence of larvae and zooplankton (Martino & Houde, 2010). Cold winter temperatures help slow copepod development, which in turn creates peaks in spring copepod abundance (Millette et al., 2020).

Although winter 2025 experienced colder-than-average sea surface temperatures (which would benefit striped bass recruitment), the sporadic and lower flow observed in winter 2025 and at the beginning of spring 2025 may diminish striped bass spawning and recruitment success by altering the spatial coincidence of striped bass larvae and their preferred zooplankton prey (Martino & Houde, 2010; Millette et al., 2020).

Blue Crab

Blue crabs emerge from overwintering burrows at 50°F. This threshold was met at all buoy locations in the later half of March. Spring's warmer water temperatures cue blue crabs to begin reproducing. The minimum temperature for reproductive activity (mating, ovarian development) is 53.6°F; 66.2°F is the minimum temperature for spawning (Schneider et al., 2024). Across all buoy locations, the minimum temperature for spawning was reached in the beginning of May. The pattern observed from the CBIBS buoys of increasing water temperatures from March through May may lead to spawning beginning earlier in the spring and thus a longer blue crab growing season (Schneider et al., 2024).

Oysters

Oyster spawning can be triggered at about 60°F; this threshold was met at all buoy locations by about mid April (a month later than in spring 2024). Higher salinity is generally better for oyster reproduction and hatchery operations. As sessile organisms, oysters are particularly susceptible to hypoxia. Spring 2025's relatively low levels of hypoxia bode well for oyster survival.

Blue Catfish

Blue catfish are limited to water with salinity below 14 PSU. Because of this, their movement may have been constrained to upstream in fresher-water areas of southern rivers like the York and Potomac, as CBIBS salinity observations at the mouths of those rivers there remained above 14 all spring. For more northern tributaries like the Severn River, salinity dropped from more than 15 PSU in early spring, enabling blue catfish to move more freely.



Synthesis of Environmental Conditions and Potential Effects on Key Fishery Resources in the Chesapeake Bay

Spring 2025 Seasonal Summary

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Key Points:

- The summer stratification on the outer shelf breaks down by the end of October ± 15 days, induced mainly by high-wind events during early fall
- Cyclones passing south of the shelf and large-scale high-pressure systems over East Canada are most impactful in removing stratification
- Differences in the dominant mixing processes likely lead to opposite T/S -contributions to destratification for the impactful wind patterns

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Categorization of High-Wind Events and Their Contribution to the Seasonal Breakdown of Stratification on the Southern New England Shelf

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Abstract High-wind events predominantly cause the rapid breakdown of seasonal stratification on the continental shelf by the end of October. In particular the timing of events leads to considerable interannual variability in the stratification breakdown with a standard deviation of 15 days. Although previous studies have shown how coastal stratification depends on local wind-forcing characteristics, the locally observed ocean forcing has not yet been linked to regional atmospheric weather patterns that determine the local wind characteristics. Establishing such a connection is a necessary first step toward examining how an altered atmospheric forcing due to climate change affects coastal ocean conditions. Here, we propose a categorization scheme for high-wind events that links atmospheric forcing patterns with changes in stratification. We apply the scheme to the Southern New England shelf utilizing observations from the Ocean Observatories Initiative Coastal Pioneer Array (2015–2022). Impactful wind forcing patterns occur predominantly during early fall, have strong downwelling-favorable winds, and are primarily of two types: (a) Cyclonic storms that propagate south of the continental shelf causing anticyclonically rotating winds, and (b) persistent large-scale high-pressure systems over East Canada causing steady north-easterly winds. These patterns are associated with opposite temperature and salinity contributions to destratification, implying differences in the dominant processes driving ocean mixing based on a high-wind pattern's overall strength and wind direction steadiness. The high-wind event categorization scheme allows a transition from solely focusing on local wind forcing to considering realistic atmospheric weather patterns when investigating their impact on stratification in the coastal ocean.

Plain Language Summary While coastal waters are strongly density-layered during the summer (called “seasonal stratification”), high-wind events during the fall mix the water column and homogenize it. While it is known which local wind conditions tend to mix coastal waters the most, these conditions have not yet been linked to regional atmospheric weather patterns. Drawing such a connection is a necessary step toward understanding how atmospheric climate change may affect the coastal ocean. Here, we propose a categorization scheme to identify which atmospheric patterns have the strongest impact on coastal ocean stratification in the fall. The scheme is applied to the coastal ocean south of New England using 7 years of mooring observations. Two weather categories are particularly impactful: Storms passing south of the coastal ocean and large-scale high-pressure systems over East Canada. Both categories occur mainly during early fall and bring northeasterly winds associated with the onshore movement of more dense open-ocean water which results in enhanced mixing. Differences in their ocean impact are likely caused by the difference in wind direction steadiness of the two categories. The categorization scheme allows a transition from solely investigating the ocean impacts from local wind forcing to incorporating more realistic atmospheric weather patterns.

1. Introduction

The annual cycle of stratification is the dominant mode of variability on the Southern New England continental shelf (Beardsley et al., 1976), abbreviated as Southern New England shelf (SNES) and shown in the inset of Figure 1. The seasonal stratification controls the phytoplankton productivity (Schofield et al., 2008) in one of the biologically most productive regions worldwide (O'Reilly & Zetlin, 1998) and regulates the timing and strength of the fall and spring phytoplankton bloom when light availability and stratification strengths change rapidly. Wind-induced mixing is particularly influential for setting the bloom variability at the shelfbreak (Xu

Writing – original draft: Lukas L. Taenzer

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et al., 2013). Lentz et al. (2003) observed that the rapid shelf stratification breakdown in the fall is clustered around storm events, suggesting that seasonal surface cooling plays a less crucial role than high-wind events.

The leading-order interactions between wind-forcing and coastal bathymetry and their effects on shelf stratification are well understood. In the region, northeasterly high-wind forcing during fall with the coast to its right is associated with rapid destratification (Lentz et al., 2003), following a simple Ekman-forcing argument for the coastal ocean (Gill, 1982): Steady downwelling-favorable (easterly) winds are associated with destratification since they advect denser surface water from the Slope Sea onshore over more buoyant shelf water and can cause enhanced mixing at the shelfbreak due to frontal steepening (shelfbreak frontal zone is shown in Figure 1). In contrast, upwelling-favorable winds are typically associated with restratification. Including such advection processes across the shelfbreak front is necessary to explain the rapidity of the stratification breakdown on the New Jersey shelf (Forsyth et al., 2018). As their model study was based significantly further inshore than observations used in this study, an even larger influence of frontal processes contributing to the observed variability can be expected on the outer shelf.

Even though the leading-order characteristics of wind-driven stratification changes along continental shelfbreaks are well understood, it remains unclear which spatio-temporal atmospheric weather patterns cause the locally detected wind signals that contribute most dominantly to the fall stratification breakdown. In addition, wind pattern characteristics beyond their along-shelf wind component have not been investigated, yet. By identifying the synoptic weather patterns that cause destratification, a more holistic view on wind-driven ocean forcing improves predictability efforts, rather than just diagnosis based on local analysis. However, demonstrating that distinct atmospheric patterns are consistently associated with different ocean impact strengths requires the investigation of a large number of events. The Ocean Observatories Initiative (OOI) Coastal Pioneer Array facilitates such an assessment by providing the first comprehensive multi-year observational (sub-)surface data set of a shelfbreak system. Matching the ocean impact on stratification with real atmospheric patterns is a necessary first step toward elucidating how the seasonal cycle of stratification on the SNES responds to changes in the atmospheric forcing.

Here, we introduce a categorization scheme based on the spatio-temporal characteristics of high-wind events to identify which atmospheric patterns contribute most to the annual breakdown of stratification. The approach of categorizing high-wind forcing patterns to identify differences in the coastal ocean response has been proven successful for the Beaufort Sea continental shelfbreak (Foukal et al., 2019). Scalar metrics, encapsulating simplified wind forcing and ocean response variables, allow for easy comparison between events across multiple years of observations. While these simplifying metrics cannot capture the full dynamics of a high-wind forcing event, they allow focusing on the first-order forcing and impact characteristics to determine which events are most important for the seasonal destratification. By focusing not only on cyclones but on all types of weather systems associated with high-wind forcing, a more comprehensive understanding of the factors contributing the most to the seasonal breakdown of ocean stratification in the fall can be gained.

Section 2 introduces the data and methods used to identify high-wind events and their ocean impact on the SNES, followed by Section 3 covering the observed interannual variability in destratifying the continental shelf during fall. The spatio-temporal high-wind event categorization scheme is described in Section 4 before Section 5 applies the scheme to distinguish between forcing and ocean impact characteristics. The manner in which the categorization scheme helps explain the variability of the seasonal impact, event timing, and mixing contributions are discussed in Section 6.

2. Data and Methods

2.1. OOI Coastal Pioneer Array

Local atmospheric and subsurface information from the SNES has been recorded by the inshore moorings of the OOI Coastal Pioneer Array (abbreviated CP Array and mooring locations marked Figure 1), a process-oriented shelfbreak observatory in operation between 2015 and 2022. The CP Array spans across the shelfbreak and is located close to the so-called “40/70 benchmark” at 40°N and 70°W, used by weather forecasters to estimate winter storm impacts for the US Northeast based on storm track positions relative to this point (Roller et al., 2016). The CP Array moorings feature surface buoys with meteorological sensors to determine bulk surface fluxes. Subsurface information is provided through wired profilers with Conductivity-Temperature-Depth (CTD)

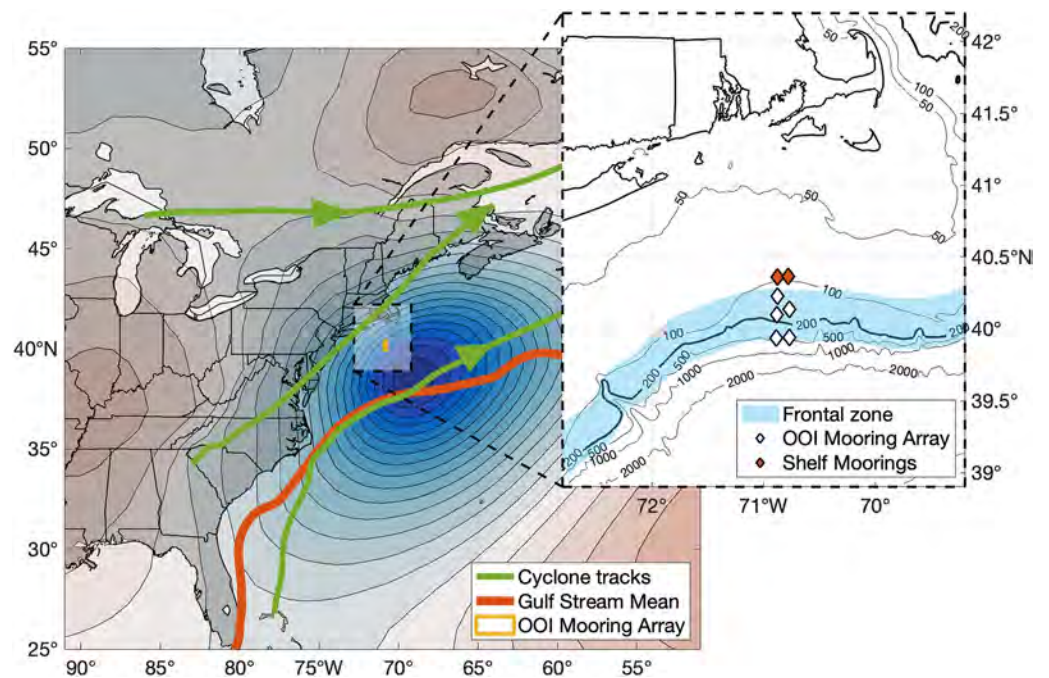


Figure 1. Map of Eastern North America and the Northwest Atlantic with a low-pressure system south of the Southern New England shelf (SNES) (contours are sea level pressure). Shown are the two dominant cyclone tracks that pass north of the shelf and one cyclone track passing south, circulation features (shelfbreak frontal zone and mean Gulf Stream position), the SNES bathymetry, and the location of the Ocean Observatories Initiative Coastal Pioneer Array moorings. Mean storm tracks are derived from manually tracked cyclones during the fall seasons 2015–2021. The mean Gulf Stream position is approximated by the 0.25 cm isoline of the absolute dynamic topography climatological mean (generated using AVISO+ products (AVISO+, 2022)).

sensors in the central water column and fixed instrument packages within the surface and bottom boundary layers. This combination of assets makes the mooring array well-suited for quantifying high-wind surface forcing impacts on subsurface temperature, salinity, and density structure.

Table 1 lists the data sources used in this study following the terminology of Gawarkiewicz and Plueddemann (2020). Technical details about instrumentation and array composition are provided in their paper. All data are mapped onto an hourly grid, either via averaging (rows 1 + 3–5) or linear interpolation (row 2). Potential ocean water density (referenced to $p = 0$) is calculated using TEOS-10 (McDougall & Barker, 2011). Hydrography measurements on the shelf are taken at different depths along the 95 m isobath: Surface, 7 m, continuously between ~30–70 m, and 2 m above the bottom. Local wind and atmospheric data are collected by the CP Array's three surface buoys, 3 m above sea level. Surface windstress was computed from bulk variables using the COARE3.5 algorithm (Edson et al., 2013) while neglecting effects from the surface wave field. Occasional data gaps in the Inshore Surface Mooring data were replaced with data from the Central and Offshore Moorings, respectively.

Table 1
Data Sources of the OOI Coastal Pioneer Array^a Time Series Analyzed in This Study

#	Variables	Mooring	Platform	Platform depth (m)	Ocean depth (m)
1	T, S	Inshore Surface M. (ISSM)	Surface buoy	2	95
2	T, S, P, ρ	Upstr. Inshore Prof. M. (PMUI)	Profiler	~30–70	95
3	U, V (wind)	Inshore Surface M. (ISSM)			95
4	SLP	Central Surface M. (CNSM)	Surface buoy	–3	135
5	T_{air}, RH	Offshore Surface M. (OSSM)			450

Note. OOI, Ocean Observatories Initiative.

^aFrom Gawarkiewicz and Plueddemann (2020).

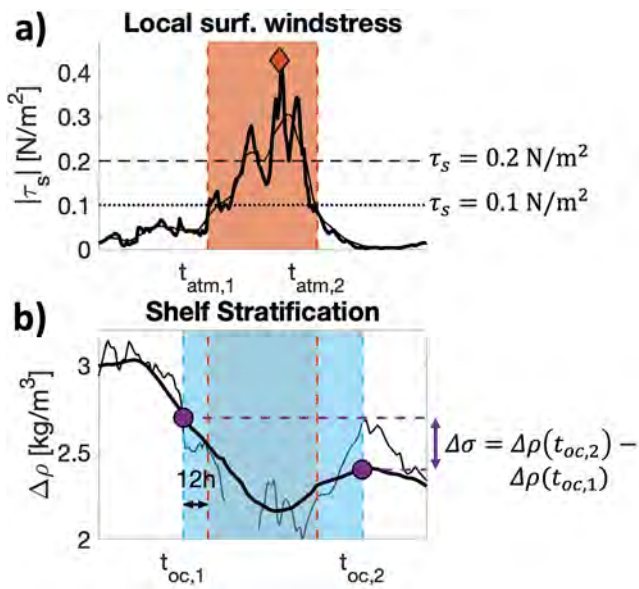


Figure 2. Illustration of how to define a high-wind forcing event, its properties, and subsurface ocean response using local CP Array time series based on an event observed around 10 September 2018. (a) surface windstress (bold line: 1 hr resolution data; thin line: 12 hr-moving mean window). (b) stratification estimate (bold line: 36 hr lowpass-filtered; thin line: 1 hr resolution data). Diamonds and circles are points of interest identified by the algorithm. The algorithm is explained in the text.

This replacement is justified since the maximum horizontal distance between the surface buoys (less than 50 km) is much smaller than the atmospheric synoptic length scale, correlations between surface mooring data are large ($>95\%$), lag-correlations peak at zero-lag, and the residual distribution peak is smaller than the noise.

Since the instrument configuration does not cover the typical depth range of the seasonal pycnocline (i.e., between 7 and 30 m), mixed-layer depths cannot be estimated. Instead, a bulk estimate of shelf stratification strength σ is defined as the density difference $\Delta\rho$ between the shelf interior and the sea surface using data from the inshore moorings:

$$\sigma|_{\text{shelf}} \equiv \Delta\rho|_{\text{shelf}} = \rho(z = 67 \text{ m})|_{\text{PMUI}} - \rho(z = 0 \text{ m})|_{\text{ISSM}}. \quad (1)$$

Similar shelf stratification estimates have been used by Forsyth et al. (2018) and Lentz et al. (2003). The deepest depth of the Upstream Inshore Profiler Mooring range with consistent data turnout is at $z = 67$ m. According to Linder and Gawarkiewicz (1998)'s climatology of the shelfbreak front, this depth should be mostly undisturbed from both variability of the mixed-layer depth and the frontal foot position, making it an appropriate location for extracting lower layer density estimates so close to the shelfbreak front. The (bulk) stratification estimate exploits data from both inshore moorings that are spatially separated by 9.2 km along the same isobath. Since the shelfbreak bathymetry shows little along-shelf variation across the CP Mooring Array area and the horizontal length scale of atmospheric weather patterns is much larger than this distance, the horizontal misalignment is not expected to affect the results.

2.2. Atmospheric Reanalysis Data

Spatial sea level pressure (SLP) and surface wind data over Northeast America and the adjacent Atlantic is taken from the ERA5 atmospheric reanalysis data set (Hersbach et al., 2018). This study utilizes ERA5 data on a $1^\circ \times 1^\circ$ -spatial and 6 hr-temporal grid. When comparing ERA5 data with observations from the CP Array's inshore surface mooring, zonal surface windstress shows a cross-correlation of $r = 0.95$, zero lag-correlation, and a narrow ($\mathcal{O}(\sigma) = 10^{-2} \text{ N m}^{-2}$) residual distribution with its peak around zero ($\mathcal{O}(\mu) = 10^{-3} \text{ N m}^{-2}$). Thus, ERA5 data seem trustworthy for the purpose of this study.

2.3. Connecting Surface Forcing With Subsurface Impact

This study aims to identify high-wind events and link them with shelf stratification changes as a metric for the events' ocean mixing impact. The following algorithm takes time series of local wind forcing and the previously defined shelf stratification index as input and outputs a list of individual events and their associated ocean impact. Event forcing and impact are characterized by a set of simple scalar metrics to allow easy comparison between events. Figure 2 applies the algorithm to an exemplary event around 10 September 2018, while a detailed description is given in the text.

Atmospheric high-wind events are defined as peaks above a 0.2 N m^{-2} surface windstress threshold. By defining high-wind events as the absence of calm conditions, the beginning and end of an event are determined in a two-step process. First, the smoothed surface windstress (thin black line in Figure 2a) is examined, and minima are identified on either side of the initial peak below a threshold of 0.1 N m^{-2} . Secondly, the beginning and end of an event are found by moving inward from the identified minima until the unsmoothed surface windstress hits the 0.1 N m^{-2} threshold. The two-step process, including smoothing, ensures that cyclones whose relatively calm center passes across the CP Array do not get split into two events. If more than one event peak is associated with the same event time period, the event gets linked with the more prominent peak.

Defining the beginning and end of a high-wind event allows for integration of atmospheric forcing variables across the event duration, leading to simplified scalar forcing estimates. This study focuses on the integrated

along-shelf windstress $\int_{t_{a,1}}^{t_{a,2}} \tau_x dt$ and the cumulative cubed wind speed $\int_{t_{a,1}}^{t_{a,2}} |U|^3 dt$ to distinguish between dominant wind-forcing regimes and their impact on ocean mixing responses. Since the x -direction aligns well with the shelf edge at the location of the CP Array, no coordinate system rotation is required. The choice of these forcing metrics will be justified in Sections 5 and 6.4. The threshold of 0.2 N m^{-2} represents the lower range of force 6 on the Beaufort scale (approx. 22 knots winds), described as a “strong breeze.” The comparatively low threshold ensures that the full bandwidth of impact variability associated with wind events is captured. While the chosen threshold affects the number and duration of identified events, the overall results of this study are robust under reasonable threshold parameter variations.

While an event's windstress peak identifies high-wind event forcing, its leading-order ocean response is the net change between the pre- and post-event ocean state, that is, a derivative variable. The impact of a high-wind event on ocean mixing is quantified by the change in shelf stratification as measured throughout the event and immediately following the event. In particular, the potential for restratification due to isopycnal slumping immediately following the high-wind event should be included when estimating the event-induced stratification change. Such restratification is an integral part of the response of an ocean frontal region to wind forcing on the meso- (Tandon & Garrett, 1994) and submesoscales (Boccaletti et al., 2007).

The ocean response signal is defined as the stratification estimate difference between two neighboring points of zero slope $\Delta\sigma = \sigma(t_{o,2}) - \sigma(t_{o,1}) = \Delta\rho(t_{o,2}) - \Delta\rho(t_{o,1})$. This simplified approach assumes that the continental shelf is in steady-state ($\partial_t \Delta\rho = 0$) before and after the event and that the high-wind forcing event dominates other potential forcing mechanisms that might be present and change the shelf stratification. We acknowledge the limitations of this assumption, in particular in the presence of other processes, for example, other high-wind events in the direct vicinity or shelfbreak frontal instability. However, the large number of observed events allows us to identify potential outliers where forcing processes could have interacted with one another.

Before identifying zero-slope points, the stratification signal needs to be lowpass-filtered to identify irreversible stratification changes on the time scale of synoptic atmospheric forcing events, rather than oscillations occurring on shorter scales. A cutoff-frequency of 2 inertial periods ($4\pi/f_0 \approx 36 \text{ hr}$) was chosen to suppress variability from inertial oscillations $\mathcal{O}(18\text{h})$, M2 and K1 tidal frequencies, daily cycle harmonics, internal waves, and other super-inertial oscillations. To the extent that these processes could lead to a net stratification change that persists beyond the oscillation period, the lowpass-filtered signal and ocean response algorithm will include their contributions.

However, since the ocean response may not exactly align with the timing of the locally observed atmospheric forcing, the ocean response time window is allowed to deviate from the timing of the high-wind event within strictly defined bounds. The start (end) of the ocean response period $t_{oc,1}$ ($t_{oc,2}$) are defined by either...

- (a) ... the local stratification extremum within the 12 hr preceding (following) the pickup $t_{atm,1}$ (decline $t_{atm,2}$) of the winds if $\partial_t \Delta\rho|_{t_{atm}}$ has the same sign than $\Delta\sigma$.
- (b) ... the start (end) of the wind speed pickup $t_{atm,1}$ (decline $t_{atm,2}$) if the local stratification gradient $\partial_t \Delta\rho|_{t_{atm}}$ has the opposite sign than the net stratification change $\Delta\sigma$ associated with the event.

While case (b) accommodates small deviations from the initial assumption that the continental shelf is in steady-state ($\partial_t \Delta\rho = 0$) before (after) the high-wind forcing event, case (a) accounts for smoothing effects from the $4\pi/f_0$ lowpass-filter if the contamination from immediately neighboring forcing events seems small. The 12 hr-threshold was chosen since the lowpass-filtered signal starts to exhibit variability on this timescale.

If the event is associated with net destratification and condition (a) has been applicable, potential post-event restratification due to isopycnal slumping in the vicinity of the shelfbreak front is incorporated as follows: The end of the ocean response time period gets extended to the next local maximum of the lowpass-filtered stratification signal. The maximum has to lie within the two inertial periods (i.e., $4\pi/f_0 \approx 36 \text{ hr}$) following the decline $t_{atm,2}$ of the high-wind forcing event, and no overlap with the beginning of the following event's ocean response period can be created. The post-forcing $4\pi/f_0$ -threshold is a compromise between accommodating (a) the time scales of mesoscale geostrophic adjustment (Tandon & Garrett, 1994) and submesoscale mixed-layer instabilities and eddies (Boccaletti et al., 2007; Mahadevan et al., 2010) and (b) restricting the post-event frontal slope relaxation period to sub-synoptic time scales to avoid contamination from other processes, for example, the next synoptic event or shelfbreak frontal meander. In the mid-latitudes, synoptic weather systems pass an area every 2–3 days.

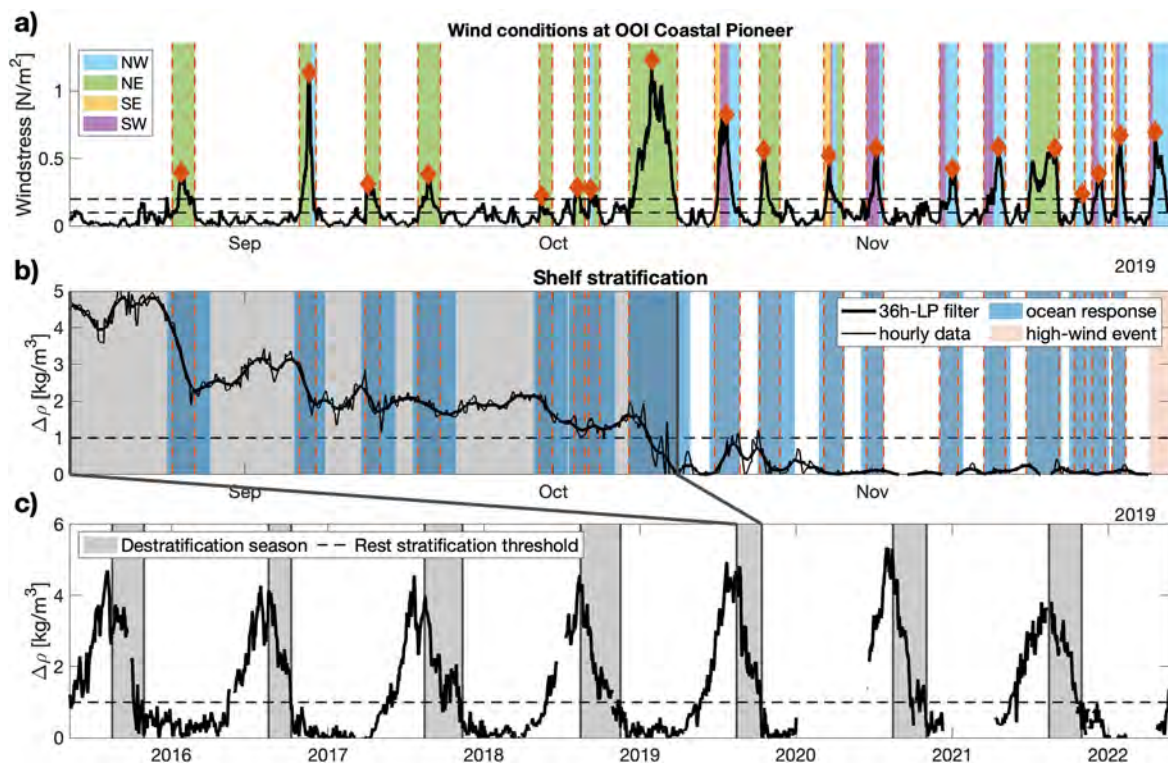


Figure 3. Locally identified high-wind events during fall 2019 and their associated ocean mixing impact by applying the algorithm outlined in Section 2.3. (a) Surface windstress; main wind directions throughout a high-wind event are color-coded. (b) Shelf stratification estimate. Ocean response periods associated with a high-wind event are colored in blue. (c) 36 hr lowpass-filtered stratification estimate $\Delta\rho$ of full time series (May 2015–2022); destratification seasons are colored in gray.

The algorithm provides a robust approach to identifying locally observed high-wind forcing events, defining their start and end, and linking the forcing with its subsurface ocean mixing impact on the outer continental shelf. Extending the time window for detecting the ocean mixing response to high-wind forcing beyond the time period of the high-wind event itself allows to capture the effects from post-event restratification. Since the stratification estimate time series has been lowpass-filtered, small variations in the start and end point of the ocean response period typically have little effect on the net stratification change associated with the high-wind event.

3. Seasonal Breakdown of Shelf Stratification

The algorithm described above has been applied to the time series recorded by the CP Array between May 2015 and 2022 (see fall destratification season 2019 in Figures 3a and 3b). The fall destratification season is defined as the time period of consistent water column homogenization (Figure 3c): The start date is set as August 15. The season's end date is the time point at which the lowpass-filtered stratification signal decreases below the rest stratification threshold $\Delta\rho < 1.0 \text{ kg m}^{-3}$ and remains there for the rest of the year. The event that pushes the stratification below the threshold is included in the destratification season. The 1.0 kg m^{-3} -threshold ensures that late season density fluctuations are not included in the analysis. Since smaller thresholds only increase the number of events with little ocean mixing impact, the overall results of this study are robust to a range of thresholds. The initial late summer stratification $\Delta\rho_0$ is defined as the maximum stratification within the fall destratification season.

The annual cycle of seasonal stratification and shelf homogenization follows the climatology outlined in Linder and Gawarkiewicz (1998) despite noticeable interannual variability (Figure 3c). Interannual variability is observed in the timing of re- and destratification, the occurrence of destratifying high-wind events within a season, and the individual destratification per event (Table 2). Stratification reaches maximum values around mid-August before it rapidly decays to leave the shelf on average homogenized on 29 ± 15 days. $\langle N \rangle = 6 \pm 2$ destratifying high-wind events are responsible for an average cumulative destratification of $\langle \sum_i^N \Delta\sigma_i \rangle = -3.5 \pm 1.4 \text{ kg m}^{-3}$

Table 2

Statistics of the Fall Destratification Breakdown on the Southern New England Shelf and Contributions From Destratifying Events

Year	Destratification season			Destratifying events		
	End	Length (days)	$\Delta\rho_0$	N	$\sum_i^N \Delta\sigma_i$	$\overline{\Delta\sigma}$
2015	October 28	74	3.7	4	−2.4	−0.6
2016	October 07	53	4.1	3	−1.6	−0.5
2017	November 11	89	4.0	7	−4.3	−0.6
2018	November 16	93	4.3	9	−2.9	−0.3
2019	October 13	59	4.8	7	−5.9	−0.8
2020	November 01	78	5.0	6	−3.9	−0.6
2021	October 30	76	3.8	8	−3.8	−0.5
Mean	October 29	75 ± 15	4.3 ± 0.5	6 ± 2	-3.5 ± 1.4	-0.6 ± 0.2

Note. The columns display the year, last day of the destratification season, season length, maximum stratification $\Delta\rho_0$ after August 15, number of destratifying high-wind events during the season N , cumulative impact from events $\sum_i^N \Delta\sigma_i$, and average impact per event $\overline{\Delta\sigma}$, respectively. The last row presents the mean and standard deviation across all years. Only events associated with destratification are considered in the right section of the table. Stratification has units kg m^{-3} .

per season. As a consequence, an individual destratifying event causes an average stratification change of $\langle \overline{\Delta\sigma} \rangle = -0.6 \pm 0.2 \text{ kg m}^{-3}$. The signal-to-variability ratios of cumulative destratification and individual events are on the same order of magnitude. This suggests that the variability in the timing of the seasonal stratification breakdown is both set by the timing and number of high-wind events throughout the season as well as the characteristics of individual events.

The cumulative destratification from high-wind events alone $\sum_i^N \Delta\sigma_i$ removes on average $83 \pm 29\%$ of the initial shelf stratification of late summer ($\langle \Delta\rho_0 \rangle = 4.3 \pm 0.5 \text{ kg m}^{-3}$). This result aligns well with Lentz et al. (2003) who inferred from just four storm events during fall 1996 that the fall destratification on the continental shelf is primarily caused by high-wind forcing and not the cumulative effects from sustained surface cooling throughout the season. Intermittent restratification, typically between high-wind events, prolongs the destratification breakdown, for example, through surface-heating. The cumulative change in shelf stratification during calm conditions has a magnitude of $-0.5 \pm 1.2 \text{ kg m}^{-3}$, that is, both weak additional destratification and net restratification during calm conditions have been observed. Restrartification associated with high-wind events occurs occasionally; though, high-wind forcing dominantly causes destratification.

The number of high-wind events per destratification season varies widely (Table 2), representing the large variability in the atmospheric forcing on synoptic time scales. As shown in Figure 3a, high-wind events during early winter shortly follow upon each other while they are more sparse during the summer and early fall with large periods of calm conditions. Hurricanes or their extratropical successors can be particularly impactful if they pass close to the shelf. Since the North-Atlantic hurricane season peaks in early September, these events typically influence the shelf when stratification is still high. While each anomaly in the 7-year long data record contains a story worth telling, this study aims to identify the atmospheric patterns that consistently impact the continental shelf every fall.

4. Connecting Local Forcing With Regional Patterns

This work aims to identify the high-wind event patterns with the largest ocean mixing impact and contribution to the fall stratification breakdown on the continental shelf. Each local forcing event is part of a large-scale atmospheric pattern with distinct forcing characteristics on the continental shelf. Thus, zooming out and categorizing spatio-temporal atmospheric patterns allows the partition of the highly variable local forcing when examining the wind-driven ocean mixing impact. The goal is to determine which patterns lead to the greatest destratification on the shelf. While Section 2.3 provides a framework to link locally observed wind forcing with its ocean mixing impact, its purely local approach does not have the ability to differentiate between different atmospheric patterns.

4.1. Categorization Scheme for High-Wind Events

To link local forcing conditions with atmospheric patterns, a categorization scheme is established that clusters spatial SLP patterns whenever a high-wind event gets detected locally by the CP Array. The scheme is motivated by Foukal et al. (2019)'s approach of investigating the origin of storms that are associated with a downwelling ocean response on the Alaskan Beaufort Sea continental shelf. Even though the scheme categorizes atmospheric forcing events, it is designed with the oceanographic application of linking the forcing with ocean mixing impacts in mind. Thus, the location of an atmospheric pattern with respect to the SNES is an integral part of the categorization since distance and wind direction largely contribute to the local forcing characteristics.

The high-wind event categorization scheme aims to identify the SLP pattern which is mainly responsible for the locally measured forcing. Pattern clustering, rather than a storm tracking algorithm was used to categorize events since high-wind forcing events on the SNES are caused by a wide variety of types and scales of synoptic weather systems. Conventional storm tracking algorithms are typically trained toward identifying closed-contour cyclone systems (Neu et al., 2013). The pattern clustering relies on human-based decision-making when categorizing high-wind events based on their spatio-temporal characteristics. To minimize human bias, a clear three-step protocol for assigning events to a particular pattern category has been established:

1. Identification: Weather systems with closed-contour SLP patterns whose isobars reach the CP Array location concurrent with a locally detected wind event (windstress at least 0.2 N m^{-2} at the CP Array) are identified as potential candidates.
2. Selection: The candidate weather systems are ranked based on the alignment between their geostrophically induced winds and the locally observed winds during the ± 24 hr period surrounding the local windstress maximum of the event. The weather system with the best alignment gets selected as the one primarily responsible for the locally observed forcing. If there is doubt about the best alignment, the system with the stronger SLP anomaly is selected.
3. Assignment: The selected pattern gets assigned to one of the pre-determined categories based on its spatio-temporal characteristics and location with respect to the CP Array. In the rare case that a clear distinction among the categories is not possible, the event remains uncategorized.

Events have been categorized by the same person in a random order to avoid establishing artificial temporal trends.

As typical for unsupervised learning frameworks, the number of categories is not inherent to the data set and needs to be determined externally. Six categories are sufficient to distinguish between the different locally observed wind forcing patterns while remaining able to unambiguously assign a particular category to an event. While increasing the number of categories would statistically reduce the variability per category, the assignment becomes more ambiguous in reality due to less distinct characteristics of individual categories. While four categories are required to differentiate between the four main wind directions associated with slowly-propagating large-scale patterns, only two categories are required to differentiate between propagating cyclones since storm tracks over New England converge and are mostly oriented in the Northeast direction toward the Icelandic Low (Zielinski & Keim, 2003). Note that there is no separation between tropical and extratropical cyclones. The chosen partitioning of large-scale SLP patterns into the presented four categories is recognizable in the spatial modes and principle component values of an Empirical Orthogonal Function (EOF) analysis (not shown).

4.2. Partitioning Weather Systems Into Six Spatio-Temporal Categories

Applying the human-centered categorization scheme described above, 98% of all locally observed high-wind events have been assigned to one of six categories. Each category is defined by its distinct SLP pattern and named after the location of their associated SLP core (Figure 4). In accordance with geostrophic theory, all high-wind event categories are associated with strong SLP gradients at the location of the CP Array at the time of maximum local windstress. The strength of these gradients is either caused by eastward propagating cyclones/storms with diameters of $\mathcal{O}(100 \text{ km})$ (Figures 4a and 4b) or typically more steady large-scale patterns of $\mathcal{O}(1000 \text{ km})$ in spatial extent (Figures 4c–4f). While the SLP patterns provide insight into the origin of the locally observed wind forcing on the continental shelf, the composite time series reveal differences between the patterns' temporal forcing development on the SNES. Abrupt changes in air temperature at an event's beginning or end suggest that the high-wind forcing pattern is associated with a frontal passage.

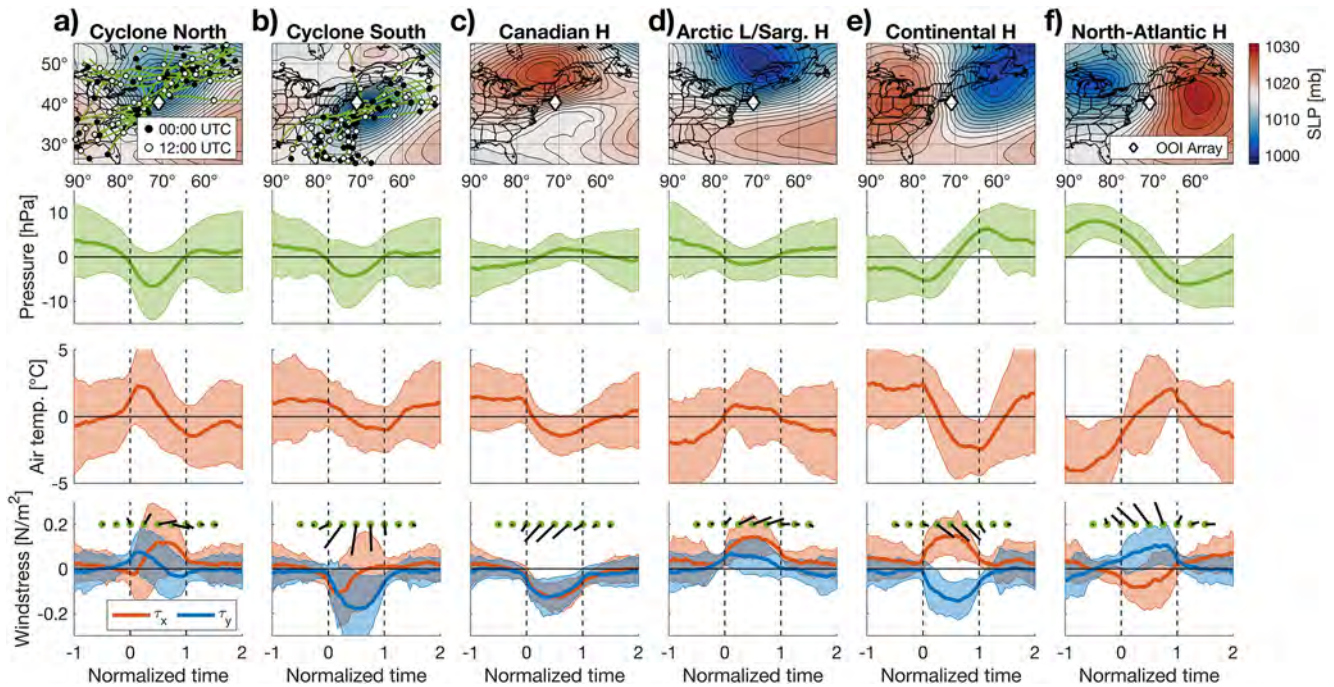


Figure 4. Composites for each high-wind event category (a–f), using categorized high-wind events between May 2015–2022. Row 1: Mean sea level pressure fields at event peaks. Storm tracks (determined manually) are included for all cyclones that occurred during the fall destratification seasons. Row 2–5: Time series composites of sea surface pressure (row 2), surface air temperature (row 3), surface windstress (row 4), as observed by the CP Array. Time axis is normalized with the event's start at $t = 0$ and end at $t = 1$. For better visualization of the wind field, surface windstress vectors (row 4) are shown in black. Time series envelopes represent one-standard deviation.

Cyclones are separated into two categories based on their storm track with respect to the CP Array and the SNES since the local forcing has opposite wind directions: *Cyclones North* and *Cyclones South*. Large-scale dipole structures of opposite SLP anomaly can lead to sufficiently strong SLP gradients between them for generating high-wind events on the shelf. Large-scale high- and low-pressure systems north and south of the SNES, called *Arctic Low/Sargasso High* and *Canadian High* (Figures 4c and 4d), respectively, lead to strong SLP gradients south of New England due to the simultaneous presence of a high-pressure ridge or low-pressure trough of opposite SLP anomaly. The low-pressure anomalies south of Canadian Highs are typically caused by weak cyclones that precede the high-wind event and are associated with a cold frontal passage initiating the high-wind event. *Continental Highs* and *North-Atlantic Highs* (Figures 4e and 4f) are characterized by East-West dipole structures with both pressure cores of similar strength. Continental Highs are associated with distinct cooling during the event, and the extent of the low-pressure system into the Arctic is similar to that of Arctic cold air outbreaks. There are differences in the seasonal occurrence frequencies between the categories as discussed in Section 6.1.

The spatio-temporal characteristics of each category lead to distinguishable surface windstress patterns on the SNES. Large-scale pressure systems cause relatively steady winds throughout the locally detected high-wind event while the cyclones' eastward propagation leads to rotating winds on the continental shelf. The spatial relationship between the cyclone and the CP Array determines the wind direction and how fast the winds rotate locally. Frictional drag in the surface boundary layer likely causes the deviation between the SLP isobar orientation at the CP Array location and the windstress vectors toward the low-pressure systems. While Canadian Highs are associated with steady down-front winds, Arctic Lows/Sargasso Highs cause steady up-front winds.

5. High-Wind Event Pattern Characteristics

Since the high-wind event categories are associated with different forcing characteristics on the SNES, their average ocean mixing impacts should differ as well. The wind forcing direction is expected to be crucial for predicting ocean mixing impacts on the continental shelf due to the existence of a bathymetric boundary (Gill, 1982). Simple scalar metrics to characterize an event's wind forcing directionality are the mean wind direction ϕ and its

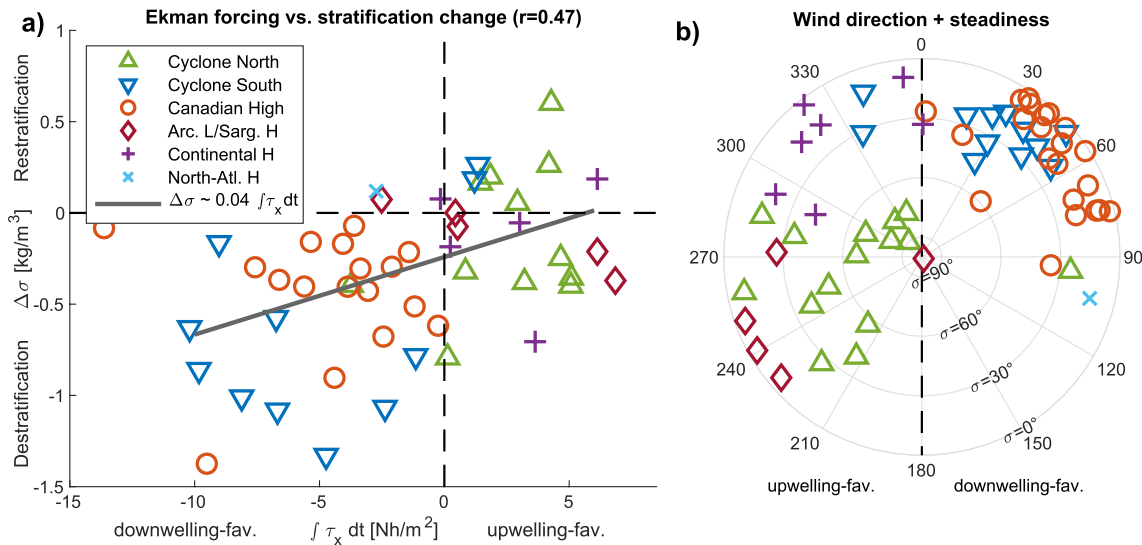


Figure 5. Clustering of high-wind event categories when comparing the local forcing indices with ocean mixing impact for individual events during the fall destratification seasons 2015–2021. (a) Cumulative cross-shelf Ekman forcing $\int_{t_{atm,1}}^{t_{atm,2}} \tau_x dt$ and stratification change $\Delta\sigma$. The linear trend is a least-squares fit applied to all data shown, while some extreme events are outside the presented axis intervals. (b) Leading-order forcing characteristics, including the mean wind direction $\bar{\phi}$ (polar angle of wind origin) and its circular standard deviation σ_ϕ (radial axis); the steadier an event's wind direction, the further it is away from the origin.

standard deviation σ_ϕ (see Equation 1 in Yamartino (1984)). A small standard deviation represents steady winds throughout the event. Following a two-dimensional Ekman theory argument for the coastal ocean, down-front winds (with the coast to the right on the Northern hemisphere) will likely cause a downwelling-favorable ocean response. The water transport across the surface Ekman layer will be onshore, causing an opposite flow in the interior to conserve mass which results in downwelling at the coastal boundary. Up-front winds will cause the opposite response. Downwelling-favorable (i.e., westward down-front winds) tend to destratify the shelf by advecting denser slope water onshore at the surface and/or steepening the shelfbreak front, potentially leading to frontal instability and additional shelfbreak exchange (Lentz et al., 2003). The onshore Ekman transport

$$V_{Ek} = -\frac{1}{\rho_0 f_0} \tau_x \quad (2)$$

solely depends on the along-shelf surface windstress component τ_x . Since the SNES shelfbreak is nearly aligned with the zonal East-West axis, no coordinate system rotation is required. From Equation 2, the cumulative (or integrated) zonal surface windstress across an event $\int_{t_{atm,1}}^{t_{atm,2}} \tau_x dt$ can act as a first-order estimate for the cross-shelf Ekman forcing strength.

Following the first-order Ekman theory argument outlined above, the cumulative zonal windstress throughout an event is correlated positively with the associated change in stratification (Figure 5a). The observations replicate the trend observed by Forsyth et al. (2018) in their realistic model study further inshore on the New Jersey shelf (at the 55 m isobath). Downwelling-favorable high-wind events ($\int \tau_x dt < 0$) are associated with destratification ($\Delta\sigma < 0$) and vice versa with a Pearson correlation coefficient of $r = 0.47$. The linear trend is statistically different from zero on a 99% confidence interval. For the statistical analysis, events have been treated as independent, which is reasonable since temporal relationships between events are not preserved. Nonetheless, the spread between Ekman forcing and ocean response remains large, particularly for positive cumulative Ekman forcing and when treating all high-wind events alike.

The results from the categorization scheme provide additional information about the individual events, and the categories tend to cluster across the forcing and ocean mixing impact indices. Thus, the categorization allows to further distinguish between distinct forcing patterns and their influence on stratification (Figure 5). Both, Canadian Highs and Cyclones South cause downwelling-favorable winds on the SNES and are consistently associated with destratification. Cyclones South are associated with the strongest destratification per event across all categories. However, their respective clusters differ considerably in their spread. Canadian Highs cluster closely and show

comparatively little variability in their forcing magnitude, wind direction, and steadiness. Similar forcing conditions coincide with relatively little spread in their associated ocean mixing impact. Arctic Lows/Sargasso Highs describe opposite local wind conditions since they are associated with fairly steady upwelling-favorable winds. However, these events are not consistently associated with restratification, potentially since local shear-driven destratification can overcome Ekman-driven restratification.

Cyclone clusters show large variability across all characteristics. Since the forcing metrics are purely based on local observations at a defined location, the distance and spatial relationship between a cyclone core and the CP Array contribute to the magnitudes of the established forcing indices. Cyclones take much less time than large-scale weather systems to pass across distances of the order of their horizontal length scale. In addition, their distance to the CP Array is more variable than for large-scale weather patterns. Combining these spatial properties likely adds to the enhanced variability in the local forcing characteristics and reduces the wind direction steadiness throughout the event. Locally rotating winds throughout the event duration strongly indicate the passage of Cyclones, and the rotation direction depicts whether the Cyclone passes north or south of the CP Array.

Since East-West dipole patterns have stronger wind components in the cross-shelf direction, only considering the along-shelf windstress component likely misses important aspects of the wind forcing. Thus, it is not surprising that East-West dipoles show the strongest deviation from the linear trend between cumulative along-shelf forcing and ocean mixing impact (Figure 5a). In accordance with first-order Ekman theory and previous studies (Forsyth et al., 2018; Lentz et al., 2003), the categories with a small along-shelf wind component are not associated with large shelf de- and restratification signals, reiterating that the along-shelf windstress is of first-order importance for predicting the wind-driven effects on coastal stratification.

6. Discussion

6.1. Intra-Seasonal Variability in Event Timing

The high-wind event categorization scheme is solely based on the event characteristics throughout the event, that is, each event is treated as an independent unit while its placement within the annual cycle and potential interaction with other events are not considered. Since the end of the destratification season fluctuates considerably between years (see Table 2), the timing of high-wind events likely affects whether they contribute to the fall stratification breakdown or not. In general, a shift from more downwelling-favorable high-wind events early in the fall to more upwelling-favorable high-wind events later in the fall can be observed in most years (see Figure 3a for 2019). Grouping the high-wind events by category reveals that this observation is indeed caused by differences in the categories' intra-seasonal timing within the fall season (Figure 6).

Most high-wind event categories cluster on sub-seasonal timescales of roughly 1–2 month length and with sharp edges toward both ends of the distribution. Due to the intermittent nature of high-wind events, 7 years of observations are not sufficient to meaningfully determine statistical occurrence distributions. Cyclones South and Canadian Highs tend to occur early in the season, adding to their likelihood to appear in the destratification season. In contrast, East-West dipole patterns and cyclones that propagate further north across New England pick up in late fall/early winter after the stratification breakdown might have already occurred.

The temporal separation between Cyclones South and North can supposedly be traced back to differences in their track and origin. The manually determined fall season cyclone tracks (Figure 4) reveal that Cyclones South tend to be of Atlantic origin while Cyclones North are separable into two distinct storm tracks: A continental track crossing the Great Lakes and an East Appalachian track originating in the Gulf of Mexico or the Southern US. The ability to distinguish between cyclone tracks based on their passage with respect to the CP Array speaks to the continued relevance of the “40/70 benchmark” for weather forecasting, introduced in Section 2. The clear divide between a more downwelling-favorable early fall and a more upwelling-favorable late fall season likely assists the rapidness of the stratification breakdown on the SNES by mid-fall. The mean position of the three cyclone tracks for the fall seasons 2015–2021 (shown in Figure 1) are aligned with the clusters of common storm tracks over New England (Zielinski & Keim, 2003).

Shelf stratification decreases consistently throughout the destratification season, leaving weaker rest stratification for events to affect if they occur late in the season. Thus, the intraseasonal differences in timing between

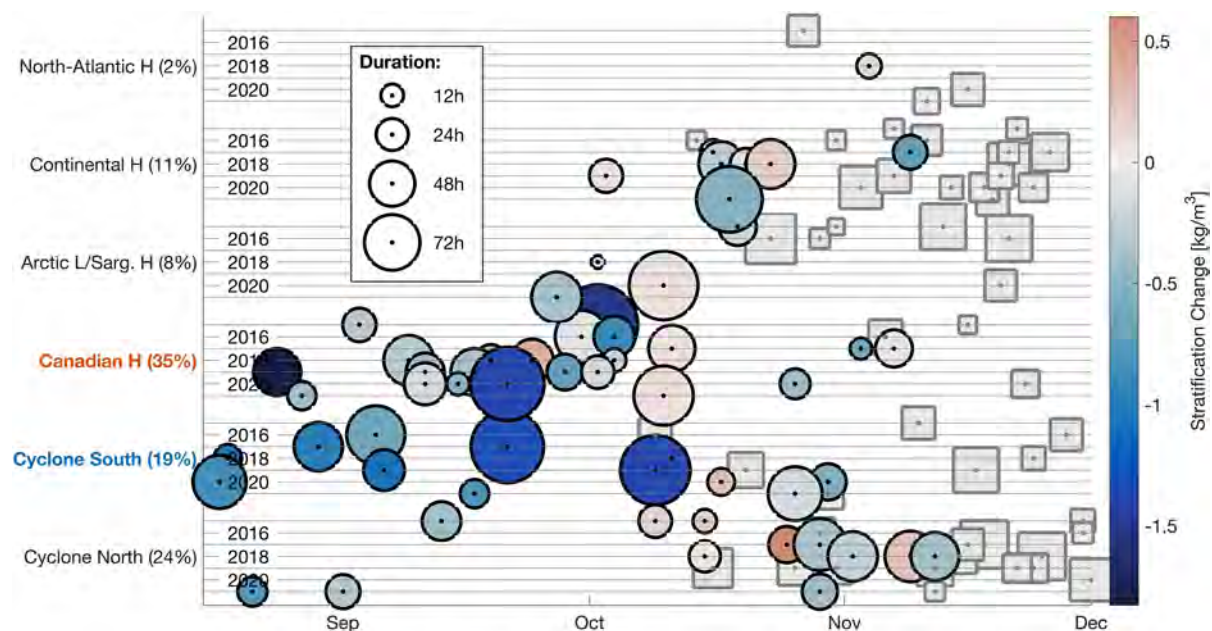


Figure 6. Timing of individual high-wind events within the fall destratification seasons 2015–2021. Events are grouped by category including their frequency of occurrence during the fall destratification season (in %). Both, the event duration (marker size) and the associated change in stratification (marker color) are shown. Events that occurred after the stratification breakdown for a given year (see Table 2) are shown as gray squares.

categories might lead to underestimating the ability of individual events late in the destratification season to impact the shelf stratification. However, this work aims to identify the most impactful high-wind weather patterns for the breakdown of seasonal stratification across the whole destratification season. Both, a high-wind event's timing and forcing are inherent characteristics of each high-wind event category, and both variables contribute to the overall seasonal impact of each category. Thus, disregarding the timing as a characteristic of interest would be unprofitable for the purpose of this work.

6.2. Seasonal Impact

So far, the characteristics of individual high-wind events and their category assignment have been the focus of analysis. A category's contribution to the fall stratification breakdown is given by combining ocean impact of individual events and the pattern's occurrence frequency and timing, that is, $\sum_{i=1}^{N_j} \Delta\sigma_{ij} = N_j \cdot \overline{\Delta\sigma_j}$ (Figure 7).

Here, N_j is the number of events per season in the j -th category and $\overline{\Delta\sigma_j}$ the average stratification change per event in the particular season and category.

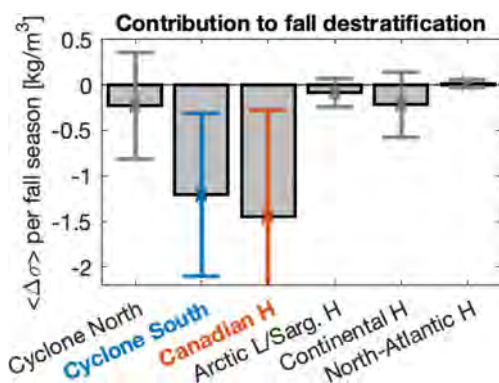


Figure 7. Cumulative contributions of individual high-wind event categories to the fall stratification breakdown. The error bars mark the 1σ -surrounding of interannual variability throughout 2015–2021.

Cyclones South and Canadian Highs are the most important for the fall stratification breakdown on the SNES. Events associated with these categories regularly occur early in the fall season (Figure 6) and individual events are consistently associated with destratification (Figure 5a). Even though Cyclones South, and in particular hurricanes, are associated with larger individual destratification signals, the continuous presence of multiple Canadian Highs every year makes this event category the number one contributor to the fall shelf destratification (Figure 7). Events from other high-wind event categories are occasionally associated with equally strong destratification signals; however, their intermittency and the variability in their impact results in less dominant contributions to the average seasonal destratification.

The interannual variability of a category's cumulative contribution to destratification is large due to the strong differences in a category's occurrence between years and the forcing and impact variability of individual events. On

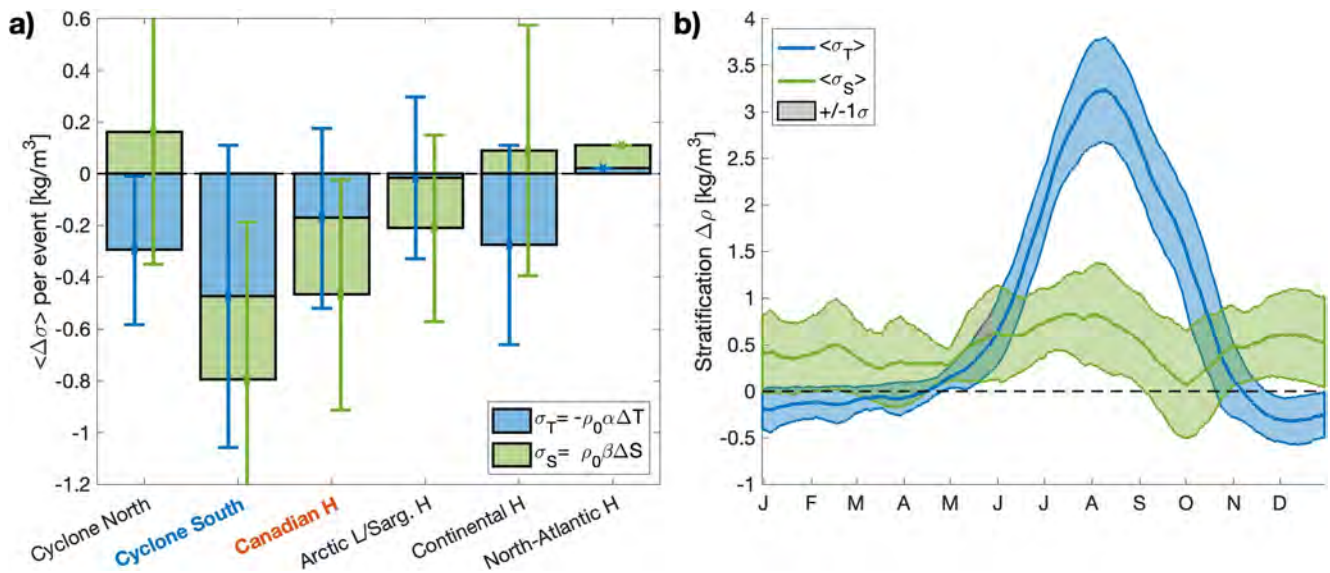


Figure 8. Temperature- (T) and salinity- (S) contributions to stratification on the Southern New England shelf by linearizing the equation of state. (a) T/S -contributions to the fall stratification breakdown from individual events, split by category. (b) T/S -contributions to the annual cycle of shelf stratification. The error bars and envelope mark the 1σ -surrounding of variability.

a year-to-year basis signals can be hidden. Thus, long multi-year time series as provided by the CP Array are vital for investigating the ocean impact from highly variable atmospheric forcing.

6.3. Temperature- and Salinity-Contributions to Stratification Change

High-wind forcing can lead to mixing and destratification on the continental shelf through a variety of processes, and the forcing characteristics determine the relative importance between such mixing processes. The events associated within each high-wind event category, identified based on their spatial SLP patterns, have similar forcing characteristics on the continental shelf (see Figures 4 and 5). Thus, similar mixing processes should be present within a category.

Watermasses can be characterized through temperature (T) and salinity (S), which in turn control density and ultimately stratification via the equation of state (EOS). Thus, distinguishing between T - and S -contributions to the observed stratification changes may allow further insight as to the destratification processes at play. Shelf temperature and salinity can be altered by surface heat- and freshwater-fluxes, respectively, advection, entrainment across the pycnocline, and mixing. By linearizing the EOS and proceeding analogous to Equation 1, the T - and S -contributions to stratification can be estimated as

$$\begin{aligned}\sigma_T \equiv \Delta \rho_T &= -\rho_0 \alpha_T \Delta T = -\rho_0 \alpha_T [T(z = 67 \text{ m}) - T(z = 0 \text{ m})] \\ \sigma_S \equiv \Delta \rho_S &= \rho_0 \beta_S \Delta S = \rho_0 \beta_S [S(z = 67 \text{ m}) - S(z = 0 \text{ m})]\end{aligned}$$

with the thermal expansion coefficient $\alpha_T(T, S, p) \approx 1.6 \times 10^{-4} \text{ K}^{-1}$, the haline contraction coefficient $\beta_S(T, S, p) \approx 7.6 \times 10^{-4} \text{ PSU}^{-1}$, and an average reference density $\rho_0 = 1025.8 \text{ kg m}^{-3}$. If the shelf heats up, cools, gains salt, and/or freshens non-uniformly across the water column, stratification will change. The net change in T - and S -stratification associated with an individual high-wind event $\Delta \sigma_T$ and $\Delta \sigma_S$ is defined as the difference in stratification throughout the event (analog to Section 2.3).

The different high-wind event categories are associated with different relative T - and S -contributions (Figure 8a); although the variability across events regularly exceeds the mean signal when distinguishing between temperature and salinity contributions to the observed stratification change. Though, most categories are associated with net destratification on average, seasonal restratification in T and/or S occurs in individual years. Cyclones South and Canadian Highs are the only high-wind event categories that are consistently associated with destratification within the one-sigma surrounding. Note the different y-axes between Figures 7 and 8a. While the former shows

the categories' cumulative impact on stratification per season, Figure 8a focuses on the mean and variability of individual events.

The composition of shelf stratification changes rapidly throughout the destratification season (Figure 8b). Thus, the initial stratification conditions on the shelf, preceding a high-wind event, likely affect T - and S -contributions to stratification changes. Caused by surface heating during spring and summer, the seasonal stratification is mostly driven by temperature and the seasonal pycnocline typically coincides with the seasonal thermocline (Li et al., 2015). At the end of October, the water column becomes fully temperature-homogenized, and the temperature gradient even reverses with cooler surface temperatures due to surface cooling. Thus, T -destratification becomes less likely for event categories that tend to occur late in the destratification season. In contrast, the S -stratification stays comparatively constant throughout the year since deeper shelf water stays slightly saltier than the surface layer water. However, interannual variability is higher than for temperature, potentially since salinity anomalies are more persistent than temperature anomalies.

Cyclones North, Arctic Lows/Sargasso Highs, and the East-West Dipole patterns cluster later in the destratification season, and S -driven stratification changes are present irrespective of their associated wind directions. In contrast, cyclones that pass south of the continental shelf and Canadian Highs occur early in the season. Nonetheless, they are associated with opposite T/S -signatures of stratification change. The dominance of S -destratification for Canadian Highs exceeds that of any other category. Since timing differences between the two categories are small, differences in the underlying mixing dynamics are likely responsible for the difference.

6.4. Attribution to Dynamical Processes

Opposite temperature- (T) and salinity- (S) contributions to stratification changes may act as fingerprints of different destratification processes. Since the dynamics of the ocean response depends on the high-wind forcing, the observed T/S -fingerprints in the ocean impact should coincide with differences in the forcing characteristics across categories. Even though both Cyclones South and Canadian Highs cause downwelling-favorable winds, Canadian Highs are associated with more steady winds throughout the event. In the following, we utilize two simplified scalar forcing metrics $\int_{t_{atm,1}}^{t_{atm,2}} |U|^3 dt$ and $\int_{t_{atm,1}}^{t_{atm,2}} \tau_x dt$ to distinguish between mixing contributions from local one-dimensional (1D) turbulent kinetic energy (TKE) input into the ocean and two-dimensional (2D) Ekman-driven cross-shelf advection, respectively. Here, U is the near-surface wind speed and τ_x is the along-shelf surface windstress.

The integrated $|U|^3$ throughout a high-wind event represents a simplified estimate for the one-dimensional (1D) mixing potential. In a horizontally isotropic ocean, the impact of surface forcing on stratification has been modeled by 1D mixed-layer theory. Surface windstress causes shear in the surface boundary layer, leading to instability, mixing, and entrainment of interior water into the mixed-layer (Price et al., 1986). As a result, the seasonal pycnocline deepens and weakens. As long as ocean currents are negligibly small compared to the high-wind forcing, impacts are identical irrespective of a category's wind direction. The production of TKE from windstress shear $P = -\overline{u'w'} \frac{\partial U}{\partial z} \approx \rho_0^{-1} \tau_x \cdot \frac{\partial U}{\partial z}$ with the horizontal $u = U + u'$ and vertical $w = W + w'$ wind velocity (mean and fluctuation, respectively) is to first-order proportional to $P \sim |U|^3$ (Niiler & Kraus, 1977). Assuming an Osborn-relationship between the eddy diffusivity K_v and the dissipation ϵ (Osborn, 1980) and neglecting buoyancy and transport terms in the TKE-budget, that is, $P = \epsilon$, the vertical eddy diffusion term from shear-induced mixing scales as well with $|U|^3$:

$$\mathcal{O}\left(K_v \frac{\partial^2 \rho}{\partial z^2}\right) = \mathcal{O}\left(\Gamma \frac{\epsilon}{N^2} \cdot \frac{\partial^2 \rho}{\partial z^2}\right) \stackrel{P \approx \epsilon}{\approx} \Gamma \cdot \underbrace{\frac{\rho_0^{-1} \tau_x \cdot |U|}{\frac{g}{\rho_0} \frac{\Delta \rho}{H}}}_{\mathcal{O}(N^2)} \cdot \frac{\Delta \rho}{H^2} = \frac{\Gamma C_D \rho_a}{g H^2} \cdot |U|^3 \quad (3)$$

with the mixing efficiency Γ , the drag coefficient of wind C_D , air density ρ_a , and vertical length scale H of the pycnocline width and mixed-layer depth (~ 20 m). In the last step, a bulk formula for the surface windstress $\tau_x = \rho_a C_D U^2$ with $C_D \approx const$ was applied.

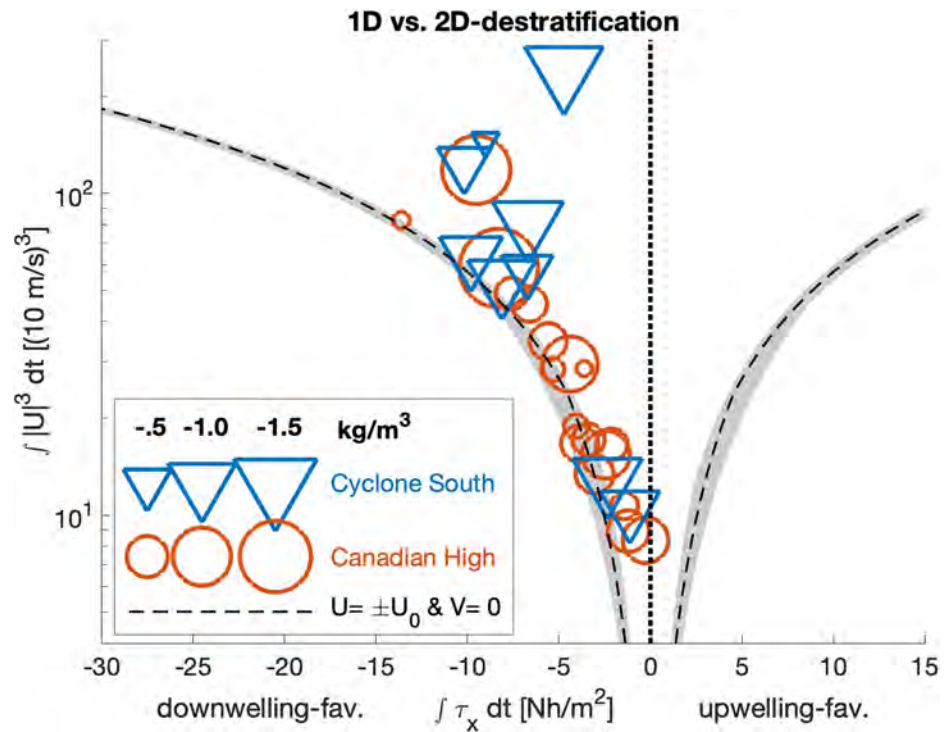


Figure 9. Clustering of Cyclones South and Canadian Highs based on their wind forcing. Y-axis: 1D mixing potential $\int_{atm,1}^{atm,2} |U|^3 dt$. X-axis: Cross-frontal Ekman forcing, that is, cumulative zonal surface windstress $\int_{atm,1}^{atm,2} \tau_x dt$. A fully zonal and steady wind event of average duration would lead to values on the two dashed branches while the gray shading covers the one-sigma envelope of the distribution of high-wind event duration. Marker size depicts the associated destratification strength.

The SNES coastline and shelfbreak challenge the 1D mixed-layer theory's isotropy assumption. Two-dimensional (2D) Ekman theory applied to the coastal ocean is consistent with observations of de- and restratification based on the wind directionality as shown in Section 5. The cross-shelf Ekman transport is proportional to the along-shelf surface windstress τ_x and given in Equation 2. Thus, $|U|^3$ and τ_x are two wind forcing variables that are representative of two different ocean response mechanisms: 1D mixing from shear and 2D advection across the shelfbreak, respectively. While τ_x is strictly restricted to the along-shelf wind component and aligned with the assumption of a 2D shelfbreak framework, $|U|^3$ does not discriminate between any wind direction and includes the full wind.

While Cyclones South and Canadian Highs are both associated with downwelling-favorable mean winds, differences in their wind direction steadiness and typical wind speeds lead to deviations between the wind forcing estimates associated with 1D- and 2D-driven destratification (Figure 9). The strongest winds on the SNES are caused by a subset of Cyclones South, leading to the largest 1D mixing potential estimates $\int_{atm,1}^{atm,2} |U|^3 dt$ from local shear production and the largest destratification signals per individual event (Figure 8a). However, since the cyclones cause comparatively unsteady rotating winds on the SNES, their cross-shelf Ekman forcing estimate $\int_{atm,1}^{atm,2} \tau_x dt$ does not exceed that of the Canadian Highs despite their elevated local wind forcing. In contrast, the Canadian Highs show little variability in their wind direction (Figure 5b); thus they tend to line up with the branch representing steady downwelling-favorable zonal wind forcing. This bathymetry-wind interaction and anticipated setup of a cross-shelf Ekman cell results in comparable destratification magnitudes between Cyclones South and strong Canadian Highs (Figure 5a) despite the Canadian Highs' smaller overall wind speeds and energy input into the ocean.

Relating the wind forcing estimates associated with 1D- and 2D-driven destratification to the shelf/slope hydrography, the two estimates should be associated with opposite *T/S*-fingerprints in the stratification changes from high-wind events. While isotropic mixed-layer theory describes how the 1D mixing potential from shear production is associated with enhanced surface cooling and entrainment of interior winter-cooled cold pool water into the summer-heated mixed-layer, the 2D Ekman forcing causes advection across the shelfbreak. Thus,

downwelling-favorable wind forcing causes a surface-intensified onshore advection of salty slope water onto the shelf while cross-shelf temperature gradients throughout the summer mixed-layer are relatively weak.

Applying the T/S -fingerprint concept to the observational record, the spatial clustering of Cyclones South and Canadian Highs in wind forcing space (Figure 9) aligns well with the differences in T/S -contributions to stratification changes (Figure 8a): The 1D mixing potential magnitudes are the strongest for Cyclones South that are associated with T -driven destratification while 2D Ekman advection is expected to lead to S -driven destratification. Canadian Highs show such a forcing and ocean response behavior. Further analysis of the velocity fields and cross-shelf gradients would be required to allow a direct comparison between contributions from the two forcing processes in a 2D cross-shelf framework. Unresolved 3D processes from along-shelf gradients and frontal oscillations/instabilities continue to add to the variability.

6.5. Frontal Pre-Conditioning

Fingerprints of different forcing processes in the shelf stratification signal have been motivated theoretically and rely on spatial gradients. For example, the simple 2D Ekman-argument to explain the shelf stratification's sensitivity to steady downwelling-favorable winds, and the influx of high-salinity offshore water relies on cross-frontal density gradients across the shelfbreak. The shelfbreak front south of New England consistently separates cooler and fresher continental shelf water from warmer and saltier Slope Sea water, leading to the strongest horizontal density gradients in the region. However, these gradients have not yet been considered despite the CP Array's proximity to the front. In the climatological mean, the frontal jet core is at the 200 m-isobath (Linder & Gawarkiewicz, 1998), while the CP Array's inshore moorings measure around the 95 m-isobath. The shelfbreak front is inherently unstable (e.g., Flagg and Beardsley, 1978; Gawarkiewicz & Chapman, 1991; Lozier et al., 2002), leading to ubiquitous meandering and frontal eddies on top of an annual cycle of varying frontal strength.

Frontal pre-conditioning describes the hypothesis that the physical state of the shelfbreak front preceding a high-wind forcing event affects the wind-driven shelf mixing and needs to be included to quantitatively assess the contribution of different forcing processes to destratification. Variability in the frontal state likely adds to the spread observed when comparing the wind forcing with an event's impact on stratification (Figure 5a). The data record reveals that large stratification changes are regularly associated with rapid changes in temperature and salinity across the water column (not shown). Since the magnitudes of typical surface buoyancy forces are insufficient to explain such observations, onshore advection of the shelfbreak front across the mooring position likely causes these anomalies. Various wind-driven cross-frontal exchange processes have been identified (Gawarkiewicz et al., 1996; Houghton et al., 1988; Mahadevan et al., 2010), and the CP Array is well designed to assess frontal pre-conditioning and shelfbreak exchange events in the future.

7. Conclusion

Atmospheric high-wind forcing events and their impact on ocean stratification on the Southern New England Shelf (SNES) have been investigated to identify which high-wind event patterns contribute most to the rapid breakdown of stratification during the fall. The multi-year data record from the OOI Coastal Pioneer Array allowed to assess the interannual variability of the fall stratification breakdown for the first time using observations. The variability in the timing of the stratification breakdown is large (± 15 days) and depends on both the number and distribution of high-wind events across the season and the individual forcing characteristics.

A high-wind categorization scheme has been developed to group weather events into six categories based on their spatio-temporal sea-level pressure signal and locally observed wind field on the SNES. Mean composites capture the distinct forcing characteristics inherent in each category. Two event categories are particularly impactful for the seasonal stratification breakdown: Cyclones that pass south of the SNES (*Cyclones South*) and high-pressure systems over East Canada (*Canadian Highs*) tend to occur during early fall and are associated with downwelling-favorable winds on the SNES. This result is in good accordance with Ekman theory for the coastal ocean (Gill, 1982) and provides an observation-based measure of interannual variability for the first time.

Cyclones are the most ubiquitous high-wind event pattern in the extratropics. However, cyclones noticeably deviate from the idealized Ekman theory case since local wind vectors tend to continuously rotate throughout a cyclone's

passage. As a result, their Ekman cross-shelf circulation cell should be less pronounced than for the steady Canadian Highs. The Canadian Highs establish a real-life representation of the idealized downwelling-favorable Ekman-forcing case on the SNES since the wind forcing is relatively steady throughout the event. Thus, while the strong wind speeds associated with Cyclones South have notable impact on local vertical mixing, Canadian Highs produce a similarly strong ocean response with weaker, steadier winds. In addition, their ocean response more likely extends the high-wind forcing duration due to enhanced horizontal advection, post-event restratification, and frontal relaxation.

Differences in mixing processes associated with Cyclones and Canadian Highs are suggested by the opposite temperature- (T) and salinity- (S) contributions to the wind-driven shelf destratification. Cyclones South are associated with larger T -destratification, likely due to their intense wind speeds leading to enhanced local mixing, cold pool water entrainment, and turbulent surface cooling. In contrast, Canadian Highs are weaker; however, their secondary Ekman circulation in the cross-shelf direction causes enhanced S -destratification. Frontal pre-conditioning by the nearby shelfbreak front likely adds to the observed variability in wind-driven ocean impact and should be included to quantify the contribution of cross-shelf exchange processes to destratification on the shelf.

The high-wind event categorization scheme has shifted the focus from solely interpreting local wind forcing on the continental shelf to studying the ocean impacts of realistic spatio-temporal atmospheric weather patterns. Since local conditions are the product of large-scale weather systems potentially affected by climate change, the categorization results are a first step toward exploring how climate change trends may affect the atmospheric ocean-forcing and contribute to the immense environmental pressure on the New England ecosystem (Pinsky et al., 2013). For example, it is well established that enhanced polar jet stream variability leads to more persistent weather patterns in the mid-latitudes (Francis & Vavrus, 2012), and Chen et al. (2014) have established the impacts of jetstream anomalies on the SNES and beyond.

Data Availability Statement

The data set of identified high-wind events, their impact on shelf stratification, and their corresponding high-wind event category, as well as the associated code to reproduce the figures is available at <https://doi.org/10.5281/zenodo.8079891>. This work heavily relies on gridded bulk meteorology and hydrography data observed by the OOI Coastal Pioneer Array which is available at <https://doi.org/10.26025/1912/66379> (Taenzer et al., 2023). Unprocessed OOI data is publicly available through multiple pathways, for example, through the OOI Data Explorer ERDDAP server erddap.dataexplorer.oceanobservatories.org (NSF Ocean Observatories Initiative, 2022). ERA5 hourly data on single levels was downloaded from the Copernicus Climate Change Service (C3S) Climate Data Store (<https://doi.org/10.24381/cds.adbb2d47>) and been used to gain spatio-temporal information on high-wind event patterns (Hersbach et al., 2018). Registration is required for download. The mean Gulf Stream position was estimated from Monthly Climatology maps of Mean Absolute Dynamic Topography (MADT-H) for 1993–2020, a global gridded ($1/4^\circ \times 1/4^\circ$) Ssalto/Duacs data product distributed in delayed time by AVISO+. Data is available through multiple gateways upon registration, for example, through the Thredds data server (AVISO+, 2022). Thermodynamic properties of seawater have been determined by using the Gibbs-SeaWater (GSW) Oceanographic Toolbox (McDougall & Barker, 2011), Version 3.06.12, available at teos-10.org/software.htm.

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Acknowledgments

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Key Points:

- The US Northeast continental shelf cold pool erodes and salinifies with a mean rate of 0.18 PSU/month throughout the stratified season
- A salinity budget shows that the seasonal erosion is caused by cross-shelf transport from offshore, unopposed by vertical mixing
- Seasonal variability in the cross-shelf position of the US Northeast shelfbreak front is too small to explain the observed salinification

Supporting Information:

Supporting Information may be found in the online version of this article.

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Seasonal Salinification of the US Northeast Continental Shelf Cold Pool Driven by Imbalance Between Cross-Shelf Fluxes and Vertical Mixing

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Abstract The US Northeast continental shelf “cold pool” comprises winter-cooled Shelf Water that is trapped below the warm surface layer during the stratified season. The regional ecosystem relies on the preservation of winter temperatures within the cold pool throughout the year. Here, we present first evidence of a significant increase in the cold pool’s salt content on the US Northeast continental shelf throughout the stratified season, suggesting that shelfbreak exchange contributes strongly to the seasonal erosion of the cold pool. Cold pool salinification rates of 0.18 PSU/month remain steady throughout the stratified season, leading to salinity differences of over 1 PSU between April and October. A cold-pool salinity budget reveals that the observed salinification is caused by an imbalance between cross-shelf salt fluxes, which deposit salt into the cold pool at all times of year, and the strong seasonal cycle of vertical mixing. During the stratified season, vertical mixing is inhibited and no longer counteracts the cross-shelf flux, leading to net salinification of the cold pool over the summer. Along-shelf freshwater advection from upstream is only present in the fall and contributes some additional freshening to shut down the salinification trend. Seasonal variability in the position of the US Northeast shelfbreak front is too small and out of phase to contribute to the salinity increase. The strong relationship between the seasonal cycle of cold pool modification and seasonal stratification points toward the importance of the timing of spring re- and fall de-stratification on near-bottom continental shelf temperature and salinity.

Plain Language Summary Near-bottom water on the US Northeast continental shelf—called the “cold pool”—preserves the cold temperatures from the previous winter and provides a sustained cold-water habitat during the warm summer season. However, ocean mooring observations from the OOI Coastal Pioneer Array show that the cold pool gets saltier by 0.18 PSU/month between April and October every year when the cold pool is trapped below a warm surface layer. We use salt as a tracer to investigate how much the influx of salty offshore water onto the continental shelf contributes to the observed erosion of the seasonal cold pool. Salt is brought from offshore and across the US Northeast shelfbreak front at all times of year, both by mean and fluctuating currents. During the summer, vertical mixing is inhibited by the warm surface layer, and the seasonal salinity increase is unopposed. In contrast, vertical mixing in the winter introduces fresher surface water to the cold pool and stops the salinity increase. Thus, the start/end of the seasonal changes in cold pool salinity coincide with the formation/breakdown of a warm summer surface layer above the cold pool, and surface conditions affect bottom conditions.

1. Introduction

The Middle Atlantic Bight (MAB) “cold pool” was first described by Bigelow (1933) as a bottom-trapped, and relatively homogeneous reservoir of winter-cooled continental shelf water that stretches across the mid-continental shelf from west of Nantucket Shoals to just north of Cape Hatteras. The cold pool forms in the spring with the development of a seasonal thermocline (Bigelow, 1933; Houghton et al., 1982), which inhibits interactions between the cold pool and the atmosphere. The breakdown of stratification in the fall fully erodes the cold pool and ventilates the bottom shelf waters (Lentz et al., 2003). At all times of year, the cold pool is bounded by the MAB shelfbreak front on its offshore side, which separates cool/fresh Shelf Water from warm/salty Slope Sea Water (Linder & Gawarkiewicz, 1998). Traditionally, all shelf waters within the 10°C-isothermal are categorized as Cold Pool Water, which is distinctly cooler than all surrounding water during the summer (Figures 1b and 1c). By preserving winter temperatures throughout the summer, the cold pool supports the

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recruitment and settlement of species (Miller et al., 2016; Sullivan et al., 2005) and acts as a nutrient reservoir for the continental shelf (Marra et al., 1990).

The cold pool warms gradually throughout the stratified season, which sparked a number of investigations of whether such warming can be more attributed to along-shelf advection from upstream (Houghton et al., 1982), local vertical mixing (Lentz, 2017), local cross-shelfbreak mixing (Ketchum & Corwin, 1964), or a combination of these processes depending on the location along the MAB (Ou & Houghton, 1982). Z. Chen et al. (2018) affirm that advection strongly contributes to seasonal cold pool warming rates in a regional model study; however, the source and direction of such advective fluxes have not been specified. Ketchum and Corwin (1964) point out that salinity can be used as a tracer to evaluate how much of the seasonal cold pool warming resulted from mixing of warm high-salinity Slope Sea Water, the only source of high-salinity water in the region, across the shelfbreak front and onto the continental shelf. Figure 2 displays the temperature-salinity characteristics across the US Northeast shelfbreak front, as observed by moorings of the Ocean Observatories Initiative (OOI) Coastal Pioneer Array during peak summer stratification. Subsurface water across the shelfbreak shows strong correlation between temperature and salinity, which suggest that cold pool variability (called “erosion” if waters below 10°C vanish) affects both quantities similarly. In addition, salinity is the more conservative tracer compared to temperature since spatial salinity gradients across the MAB shelfbreak persist throughout the year. In contrast, the strong seasonal cycle of atmospheric surface heating/cooling can easily overwhelm other contributions to the shelf heat budget. Here, we apply salinity as a tracer of cold pool properties to differentiate between the relative flux contributions to the seasonal cold pool erosion. We focus on the northeastern edge of the cold pool on the US Northeast shelf just east of Nantucket Shoals, motivated by multi-year observations of the US Northeast shelfbreak by the OOI Coastal Pioneer Array between 2015 and 2022.

To identify the largest contributors to the seasonal cold pool erosion, a finite-volume water mass budget can differentiate between different flux contributions, particularly between along-shelf advection, cross-shelfbreak fluxes, and vertical mixing. Lentz (2010) provides a climatological depth-, space-, and time-averaged MAB continental shelf budget by aggregating observations across several decades. By treating the budget's control volume like a Lagrangian parcel advected westward along the MAB, the magnitude of an “eddy” salt flux across the roughly geostrophic shelfbreak front is inferred indirectly as the budget's residual. Houghton et al. (1988) assessed cross-shelfbreak eddy temperature fluxes $\langle v'T' \rangle$ directly, but without statistically significant results for most of the year. Nonetheless, it is well established that internal frontal instability of the US Northeast shelfbreak front (Flagg & Beardsley, 1978; Garvine et al., 1988) can lead to intermittent exchange across the front when meanders grow and become non-linear (Gawarkiewicz et al., 2004). For example, Lentz (2003) estimates that salinity-maximum intrusions, which bring Slope Water onto the shelf, on average lead to a 0.3 PSU salinity increase of the MAB Shelf Water throughout the summer. Interactions between the shelfbreak front and external forcing—Warm Core Rings spun off from the Gulf Stream (e.g., Joyce et al., 1992; Silver et al., 2023; Zhang & Gawarkiewicz, 2015a) and/or strong storm systems passing over the site (Todd, 2020)—can lead to particularly large cross-shelfbreak exchange fluxes. Each of these processes occurs on timescales between days and weeks while the cold pool erodes over the timescale of months, similar to the climatological shelfbreak mean circulation. Thus, instead of focusing on the individual impact by each of the described cross-shelfbreak exchange processes, this work uses an integrative approach to estimate the net effect of cross-shelfbreak transport by all of these transient processes on the cold pool evolution in a multi-year mean sense.

This paper provides first evidence for a seasonal salinification of the cold pool on the US Northeast continental shelf, as consistently observed in the multi-year mooring record of the OOI Coastal Pioneer Array (Section 3). By applying output from the representative realistic NESS model in the same region, a cold pool salinity budget quantifies the different salinity flux contributions that annually erode the cold pool during the stratified season: Along- and cross-shelf mean-advection, eddy-advection, and vertical mixing (Section 4). In addition, we rule out seasonal onshore movements of the shelfbreak front as the main contributor to the observed salinification (Section 5). In Section 6, we discuss the importance of the seasonal cycle of stratification for seasonal cold pool trends and the relation between eddy-covariance fluxes and shelfbreak exchange.

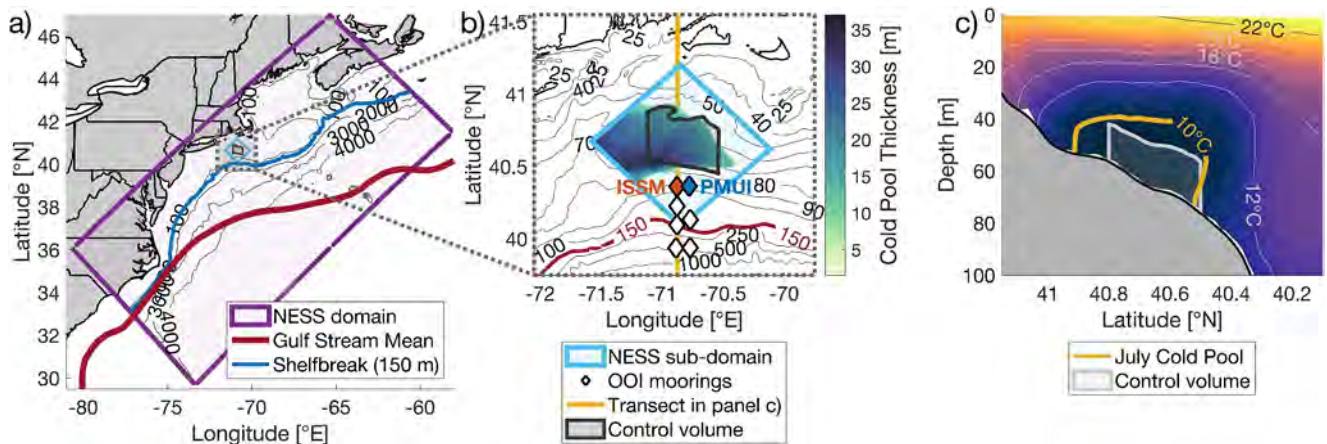


Figure 1. Map of the Middle Atlantic Bight (MAB) and Slope Sea, highlighting the data sources of this study: In situ observations come from the Ocean Observatories Initiative (OOI) Coastal Pioneer Array, supplemented with output from the realistic NorthEast Shelf and Slope (NESS) model. (a) Full NESS model domain (purple), mean Gulf Stream position (red), approximated by the 0.25 cm isoline of the absolute dynamic topography climatological mean from the “Archiving, Validation and Interpretation of Satellite Oceanographic” (AVISO, 2022) data archive, and location of the climatological MAB shelfbreak jet, which roughly follows the 150 m isobath (blue). (b) US Northeast continental shelf. The colorbar depicts the mean cold pool thickness during July within an NESS sub-domain (light-blue). Highlighted moorings are the Inshore Surface Mooring (ISSM) and Upstream Inshore Profiler Mooring (PMUI), which conjointly capture the hydrography on the outer continental shelf. The gray polygon displays the horizontal area of the cold pool control volume for the cold pool salinity budget, described in Section 2.3. (c) Meridional cross-section of the NESS cold pool edge (yellow) and control volume (gray) along 70.875°W during July.

2. Data and Methods

2.1. OOI Coastal Pioneer Data

The OOI Coastal Pioneer Array (henceforth “Pioneer Array”) spans across the shelfbreak south of the US Northeast shelf, and the two most inshore moorings, the Inshore Surface Mooring (ISSM) and the Upstream Inshore Profiler Mooring (PMUI), represent the hydrography on the outer continental shelf (Gawarkiewicz & Plueddemann, 2020). While the ISSM provides hydrographic data at 2 m, 7 m, and two meters above the ocean floor, the PMUI captures the mid-depth water column with consistent data output between 28 – 67 m depth. Both moorings are located at the 95 m-isobath, and by combining data from both moorings, a full water column profile on the outer continental shelf can be estimated. For reference, the climatological shelfbreak jet follows the 150 m-isobath, and the foot of the shelfbreak front is roughly at the 100 m-isobath (Linder & Gawarkiewicz, 1998). Data are provided on an hourly grid between May 2015 and June 2022 with few gaps in between. The processing of Pioneer Array mooring data is described in more detail in Taenzer et al. (2023a). For the purpose of this study, time series data of ocean hydrography at 67 m is used to describe conditions of the US Northeast continental shelf cold pool. Data were 36 h-lowpass filtered to remove variability from dominant tidal frequencies and inertial oscillations ($36 \text{ h} \approx 2 \cdot T_i = 2 \cdot 2\pi/f$ at 40° latitude). The Pioneer Array measures Practical Salinity, and units PSU will be used. While the Pioneer Array provides an unprecedented multi-year observational data set of the US Northeast shelfbreak, the observational data have several shortcomings with respect to the goal of this study: (a) Data coverage does not extend through the full water column, and (b) assets are restricted to the shelfbreak, which prevents closure of a subsurface continental shelf budget. Thus, while the Pioneer Array observations motivate this study, model fields will be used to investigate the underlying dynamics of the observed cold pool salinification.

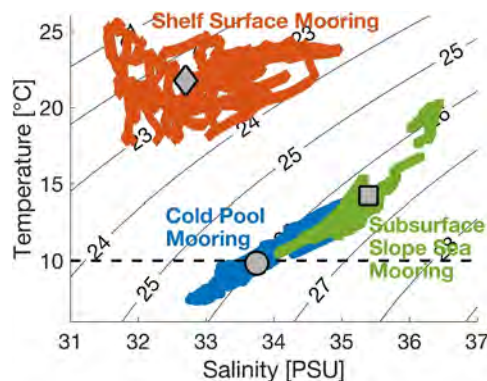


Figure 2. Water mass characteristics of the US Northeast cold pool and its surrounding water during July, observed by OOI Coastal Pioneer Moorings (2015–2022). Blue: Upstream Inshore Profiler Mooring at 67 m depth. Red: Inshore Surface Mooring. Green: Upstream Offshore Profiler at 67 m depth. Gray symbols depict the mean values in temperature and salinity for each mooring. Data were lowpass-filtered with a 1/36h lowpass frequency to avoid variability from the M2 barotropic tide. Water below 10°C is classified as Cold Pool Water.

2.2. New England Shelf and Slope (NESS) Model

Output from the high-resolution NorthEast Shelf and Slope (NESS) model is used to complement observations from the Pioneer Array and set up a cold

pool salinity budget on the US Northeast shelf south of New England. In contrast to data-assimilation efforts, the NESS model is a purely forward model and therefore reaches budget closure. The NESS model is based on the hydrostatic Regional Ocean Modeling System (ROMS) (Shchepetkin & McWilliams, 2005) and covers the MAB and Gulf of Maine on a 1 km grid (Figure 1a) in a bathymetry-following depth-coordinate system with 40 vertical layers. This study uses output from 2010 to 2017 during which the model was forced at the surface with the ECMWF ERA5 atmospheric reanalysis product (Hersbach et al., 2020) with a 3-hr temporal resolution. To capture fine-scale sea-surface temperature (SST) variations, a thermal correction was applied to adjust surface heat fluxes based on Multi-scale Ultra-high Resolution (MUR) SST data (Chin et al., 2017). Initial conditions and open ocean boundary forcing combine the mesoscale variability from an assimilative global ocean circulation model, Hybrid Coordinate Ocean Model (Chassignet et al., 2007) and Navy Coupled Ocean Data Assimilation (HYCOM/NCODA, GOF3.0), and the monthly mean temperature/salinity Northwest Atlantic regional climatology from the National Center for Environmental Information (NCEI) on a $1/10^\circ$ grid, using World Ocean Database (WOD) data (Seidov et al., 2016). This combination of data sources avoids coastal biases of the HYCOM-derived reanalysis product, while continuing to include realistic variability. Geostrophic velocities are inferred from the density-fields. In addition, the model includes freshwater runoff from nine major rivers and tidal forcing to capture coastal processes realistically. The model uses a 4th-order Akima scheme for advection and parameterizes vertical diffusion effects from sub-grid scale mixing via a GLS vertical mixing scheme (k-kl) (Warner et al., 2005). The NESS-model is the latest iteration of a realistic high-resolution regional forward model in use since 2010 (K. Chen & He, 2010). It was used to investigate interannual variability of MAB shelf conditions (K. Chen et al., 2016) and cross-shelfbreak exchange (K. Chen et al., 2022), which makes the model suitable for this study. The model's fidelity has been continuously assessed through comparison against observations, and the Supporting Information S1 provides a comparison between model output and Pioneer Array data. To minimize the potential for impact from the misalignment in data availability between the observations (2015–2022) and model (2010–2017), this study focuses on investigating the multi-year mean salinification of the US Northeast cold pool instead of its interannual variability. Since the NESS model advects Absolute Salinity, units g/kg will be used whenever describing modeled salinity output (in contrast to units PSU for in situ mooring data). More detailed information about the model setup can be found in K. Chen et al. (2022).

2.3. Cold Pool Salinity Budget

To determine the primary agent that causes the subsurface shelf salinification throughout the summer and explain the observations of seasonal cold pool erosion, we set up a cold pool salinity budget for the US Northeast shelf. Concretely, we investigate the net flux contributions to a control volume V north of the Pioneer Array on the US Northeast shelf. The cold pool control volume has been deliberately chosen to be within the conventionally defined Cold Pool Water ($T < 10^\circ\text{C}$) at the time of peak stratification (Figures 1b and 1c). This choice ensures that this study focuses on hydrography changes within the cold pool core and avoids contaminating the budget by including processes that are restricted to the cold pool's boundaries.

Specifically, the control volume is confined to the lowest 8 model layers (roughly 15 – 20 m above the ocean floor) and restricted by the 55 m and 75 m isobath in the North and South, respectively. Zonally, the control volume extends 20 km to the West and East of the Pioneer Array moorings ISSM and PMUI, respectively, resulting in a 50 km-wide sleeve. Despite the cold pool's continuity to the West, the control volume is limited zonally to ensure that the NESS model budget and observations from the Pioneer Array remain comparable. The chosen volume is 27 km^3 , includes roughly 70,000 grid cells, and strives for a balance between increasing the signal-to-noise ratio by averaging across more grid cells and the necessity to restrict the budget to a region of persistent dynamics to allow meaningful interpretation of the results. Mean salinification rates remain robust when varying the control volume's extent zonally (30 – 70 km wide sleeve) or vertically (6–10 lowest model layers). When moving the control volume closer to the shelfbreak, mean salinity and temperature values increase but salinification rates remain unchanged.

Since the bathymetry-following shelfbreak jet is approximately in geostrophic balance, cross-shelf velocities tend to be significantly smaller than along-shelf velocities on the outer continental shelf. Thus, small variations in the angle between the local coordinate system and the mean flow orientation can significantly affect the magnitude and sign of the cross-jet velocity component (Brink, 2016). For this study, the cold pool budget's coordinate

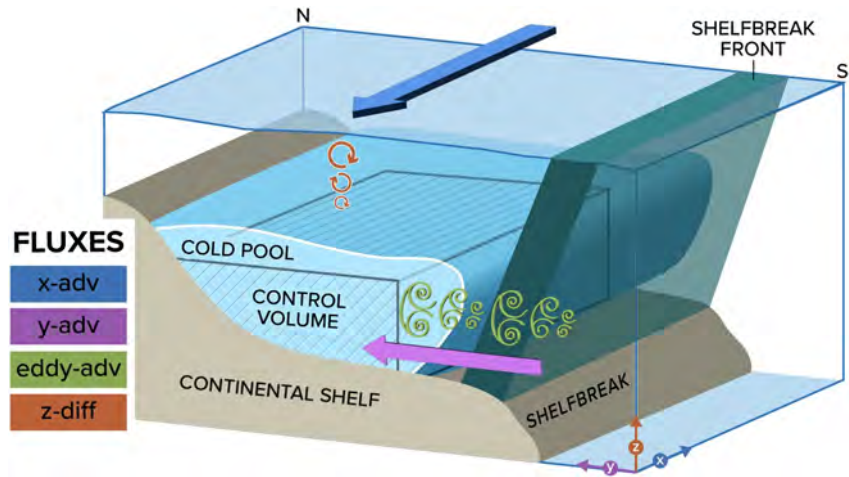


Figure 3. Sketch of the cold pool salinity budget on the US Northeast shelf with salinity fluxes in/out of the finite-volume cold pool control volume (gray streaked box). The budget distinguishes between the tendency/net term $\partial S/\partial t$ and multi-year mean fluxes of along-shelf (x) mean-advection $-\bar{u} \cdot \partial \bar{S}/\partial x$ (blue), cross-shelf (y) mean-advection $-\bar{v} \cdot \partial \bar{S}/\partial y$ (purple), eddy-advection $-(\nabla_h \cdot \langle \mathbf{u}'_h S' \rangle + w \cdot \partial S/\partial z)$ (green), and vertical (eddy) diffusion $\kappa_v \partial^2 S/\partial z^2$ (red). Horizontal diffusion is negligible (see Section 4). Illustration: Natalie Renier (WHOI).

system was rotated anti-clockwise by $\Delta\varphi = \arctan(\bar{v}/\bar{u}) = +10^\circ$ with respect to the east/north-directions to successfully distinguish between geostrophic along-shelf and ageostrophic cross-shelf advection. Here,

$$(\bar{u}, \bar{v}) = \int_{2010}^{2017} \left[\int_A \left(\int_{h(x,y)}^0 (u, v) dz \right) dx dy \right] dt \quad (1)$$

are the time- and depth-averaged zonal ($\bar{u}$) and meridional ($\bar{v}$) velocity across the cold pool control volume area A , and h is the local ocean depth. Accordingly, cross-shelf fluxes into/out of the control volume are now perpendicular to the time- and depth-averaged mean flow. The correction angle $\Delta\varphi$ remains constant throughout the analysis.

Mean salinity changes across the cold pool control volume are driven by advective and diffusive fluxes. In the following cold pool salinity budget, we partition the different salinity flux contributions as follows (Figure 3):

$$\frac{1}{V} \int_V \underbrace{\frac{\partial S}{\partial t}}_{\text{rate}} dV = \frac{1}{V} \int_V \left[\underbrace{-\bar{u} \cdot \frac{\partial \bar{S}}{\partial x} - \bar{v} \cdot \frac{\partial \bar{S}}{\partial y}}_{\text{along-shelf (x)/cross-shelf (y) mean-flux}} - \underbrace{\left(\nabla_h \cdot \langle \mathbf{u}'_h S' \rangle + w \cdot \frac{\partial S}{\partial z} \right)}_{\text{eddy-advection flux}} + \underbrace{\kappa_h \nabla_h^2 S}_{\text{horiz. diffusion}} + \underbrace{\kappa_v \frac{\partial^2 S}{\partial z^2}}_{\text{vert. diffusion}} \right] dV \quad (2)$$

The chosen budget partition distinguishes between three temporal/spatial scales to link budget terms to processes that act on these respective scales and identify the main contributors to the seasonal salinification signal: (a) Mean-advection fluxes driven by the climatological shelf- and shelfbreak velocity fields and salinity gradients (along-shelf (x)/cross-shelf (y) mean-flux). (b) Grid-resolved submesoscale advection and stirring driven by non-linear synoptic variability such as frontal meanders, continental shelf eddies, or external forcing, for example, Warm Core Rings and storm systems interacting with the shelfbreak front (eddy-advection flux). (c) Diffusion effects from sub-grid scale mixing scaled by a parameterized eddy-diffusivity, including mixing from shear-driven or convective instability on small timescales (horiz./vert. diffusion). While the NESS model inherently distinguishes between grid-resolved advective processes (a and b) and sub-grid scale parameterized diffusive processes (c), an additional mean-eddy timescale was introduced to separate mean flow advection (a) from advection driven by synoptic variability (b). A mean-eddy separation timescale of 30 d was chosen since the climatological hydrography becomes visible when averaging fields across this timescale while synoptic

variability is inherently three-dimensional and can obscure the two-dimensional cross-shelfbreak hydrography on timescales below, for example, through double-fronts, meanders, streamers, subsurface salinity-maximum intrusions, the presence of Warm-Core Rings, or wind forcing. Thus, the chosen 30 d timescale separation can be understood as the attempt to distinguish the mean-advection flux, a well-known flux from climatology (e.g., Linder & Gawarkiewicz, 1998), from a less well-known intermittent submesoscale eddy-advection flux. The former is driven by the mean gradient and velocity fields, whereas the latter is driven by fluctuating currents and gradients during synoptic events (e.g., WCRs, large frontal meanders, wind forcing) and is still captured by the submesoscale-permitting 1 km NESS model grid (in contrast to parameterized sub-grid scale processes).

Based on the above considerations, mean- and eddy-advection fluxes were separated by computing the mean-advection fluxes $-\bar{u}_i \cdot \partial \bar{S} / \partial x_i$ and eddy-covariance fluxes $-\partial / \partial x_i \langle u'_i S' \rangle$ ($i \in \{1, 2\}$) offline. First, mean-advection fluxes were calculated with the same advection scheme as used for forwarding the full NESS model (4th-order Akima); but mean-advection was driven by tracer and velocity fields which were first averaged across the chosen mean-eddy separation timescale of 30 d. In addition, the averaged advection velocity was treated as constant across the grid cell and opposing grid cell interfaces. Then, the eddy-covariance flux was defined as the residual between the complete and the offline computed mean-advection flux

$$-\frac{\partial}{\partial x_i} \langle u'_i S' \rangle \equiv \left(-u_i \frac{\partial S}{\partial x_i} \right) - \left(-\bar{u}_i \frac{\partial \bar{S}}{\partial x_i} \right) \quad (3)$$

($i \in \{1, 2\}$), preserving budget closure. While the offline computation of mean-advection fluxes was made on the native (ξ, η) -model grid, horizontal mean-advection flux components were rotated afterward such that the coordinate axes align with the along- and cross-shelfbreak jet direction from Equation 1, respectively.

The eddy-advection flux $-\left(\nabla_h \cdot \langle \mathbf{u}'_h S' \rangle + w \cdot \frac{\partial S}{\partial z} \right)$ does not distinguish between the flux directions and combines both the along-shelf and cross-shelf eddy-covariance flux and the full vertical advection component (mean + eddy). Including the full vertical advection component $-w \cdot \frac{\partial S}{\partial z}$ is justified because of the misalignment between isopycnal frontal slopes and the vertical axis as well as the inherent ageostrophic nature of all vertical motion on the continental shelf. Thus, vertical motion on all timescales contributes to eddy-driven advection. In addition, by partitioning the advection flux into directional mean components and a cumulative eddy component, we avoid reproducing the finding by Z. Chen et al. (2018) that the individual directional advection fluxes (mean + eddy component) tend to be large and of opposite sign with a small advection residual. Instead, the proposed partition absorbs the large directional flux variability into the eddy-advection flux, which allows for more meaningful comparison of the mean along- and cross-shelf advection fluxes with the tendency/net term. Considering that the chosen cold pool control volume size is on the same order of magnitude as frontal meanders, it is not surprising that eddy-covariance advection on synoptic scales has components in all three directions that tend to partly compensate each other with a small net eddy-covariance flux. The eddy-advection flux defined above combines these highly correlated large-amplitude advection terms to a net residual at the expense of losing the ability of identifying where the synoptic variability advection signal comes from.

2.4. Seasonal Cycle and Interannual Variability

To focus on the mean seasonal cycle of salinity and cold pool fluxes, and not their synoptic variability in individual years, the same smoothing was applied to the results presented in Sections 3 and 4 (Figures 4–7 and 8a): Before computing the multi-year averaged seasonal cycle, a 30-day moving mean filter was applied to the full time series to avoid focusing on extreme events within individual years. Then, the same filter was applied again to the multi-year seasonal cycle. However, when analyzing the time series of individual years instead of the multi-year seasonal cycle in Sections 4.2 and 6.1, smoothing beyond a 30-day filter was required due to the enhanced influence of synoptic variability. A lowpass-filter with a frequency of 1/90 days (instead of a 30-day moving mean filter as described above) was applied to the full time series to robustly identify the start and end date of the annual salinification period without ambivalence and assess interannual variability in Figures 8 and 11. In

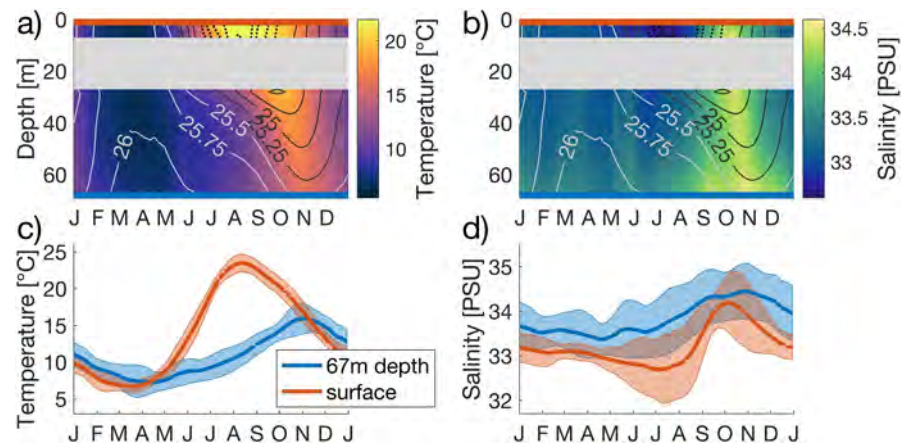


Figure 4. Annual Salinification of the outer US Northeast continental shelf and cold pool as observed by the Pioneer Array Inshore Moorings. (a and b) Observed temperature and salinity by combining data from the Inshore Surface Mooring (ISSM) (surface and 7 m depth) and the Upstream Inshore Profiler Mooring (PMUI) (28 – 67 m depth). Contours are isopycnals; solid and dotted lines have 0.25 kg/m^3 and 0.5 kg/m^3 spacing, respectively. (c and d) Seasonal cycle of temperature and salinity at two selected depths representing the surface mixed layer (orange; ISSM surface) and the continental shelf cold pool (blue; PMUI 67 m). $\pm 1\sigma$ envelopes represent interannual variability.

addition, an exception to continuous smoothing was made in Section 5 (Figure 9) for working within a non-stationary coordinate system: To compute the seasonally varying strength of the US Northeast shelfbreak jet from NESS model output, the jet core position was determined based on monthly averaged velocity fields instead of applying a 30-day moving mean filter. The monthly varying stream-following coordinate system captures meridional variability of the jet core position throughout the year.

3. Annual Salinity Increase of the Continental Shelf Cold Pool

Multi-year observations on the outer US Northeast continental shelf show that the subsurface shelf gets both warmer and saltier throughout the stratified season (Figure 4). For significant portions of the year, the Pioneer Array Inshore Moorings were within waters of below 10°C and 34.5 PSU, respectively, which are the conventional temperature and salinity signatures to separate winter-cooled Shelf Water from subtropical Slope Sea Water (Linder & Gawarkiewicz, 1998). Generally, bottom salinities are larger than surface layer salinities due to the offshore sloping of the buoyancy-controlled shelfbreak front. The mean subsurface Shelf Water, observed by the Pioneer Array PMUI at 67 m depth, gets warmer and saltier at a roughly constant rate throughout the stratified season between April and October (blue curves in Figures 4c and 4d). The lower depth range of the PMUI profiler is well suited for representing cold pool conditions on the US Northeast continental shelf since it is both well below the seasonal pycnocline and sufficiently above the ocean floor to not experience strong contamination from cross-shelf movements of the foot of the shelfbreak front (Taenzer et al., 2023a). The coherence in the timing and characteristics of the subsurface temperature and salinity trends suggest a similar origin, while trends within the surface layer (orange curves) are distinctly different, attending to the seasonal cycle of surface heating and freshwater advection from upstream. For the purpose of this study, we focus on the observed subsurface salinity trend.

We would like to assess whether the observed seasonal subsurface salinity increase on the outer continental shelf is indicative of a trend within the cold pool inshore of the Pioneer Array. Thus, we compare the Pioneer Array PMUI observations with the mean salinity trend within a conventionally defined cold pool at the same longitude, using NESS model output (Figure 5). The respective cold pool estimates contain a similar seasonal salinity trend in the multi-year mean of $0.18 \pm 0.13 \text{ PSU/month}$ and $0.19 \pm 0.04 \text{ g/kg/month}$ (1 month = 365/12 days) during the stratified season between April and October. Along the chosen transect at 70.875°W , the modeled cold pool is fully eroded by September (i.e., there are no waters below 10°C left), and Cold Pool Water properties reappear in December. The uncertainty of the linear trend depicts interannual variability only, that is, shown is the

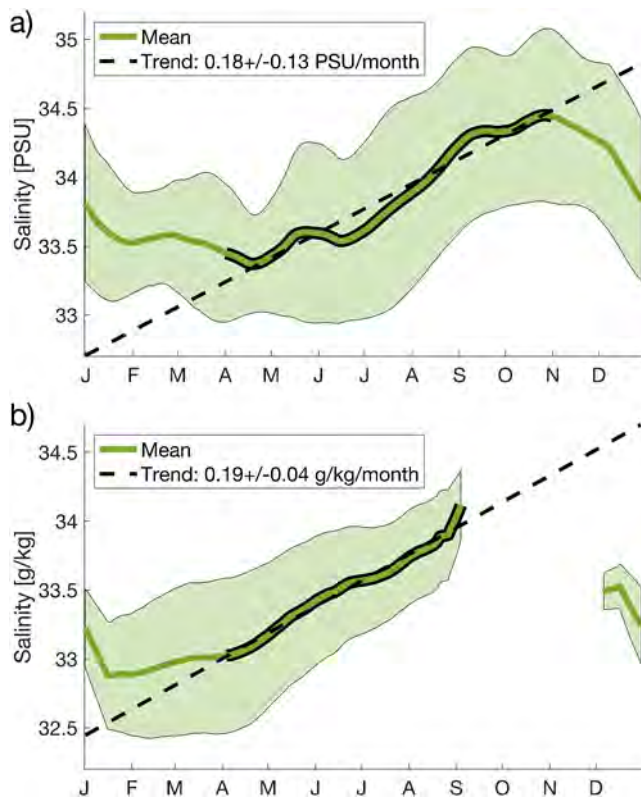


Figure 5. Annual cycle of continental shelf cold pool salinity. A linear trend has been fitted to the black-highlighted data during the stratified season (April–October) with its error depicting the trend's interannual variability from fitting constant slopes to individual years. (a) Pioneer Array PMUI salinity at 67 m depth. The $\pm 1\sigma$ envelope depicts one standard deviation of interannual variability. (b) NESS model salinity for all waters below the 10°C cold pool temperature threshold along 70.875°W, as long as the cold pool area is not below 1% of its mean maximum extent (March 15). The cold pool along 70.875°W is fully eroded by September and no mean cold pool salinity can be computed for the rest of the fall. The $\pm 1\sigma$ envelope depicts the combined variability across the cold pool volume on a given day and across all eight model years. The Pioneer Array (a) measures Practical salinity (PSU) while the NESS model (b) advects absolute salinity (g/kg).

standard deviation of the collection of linear trends fitted to individual years. The large uncertainty of the linear trend in the observations is rather driven by the strong interannual variability in the timing of the start/end of the salinification period and less by differences in the magnitude of seasonal salinification.

The Pioneer Array observations and NESS model show strong similarity in their seasonal cold pool salinification trend despite the misalignment in data availability pointed out in Section 2.2 and the two different approaches of capturing the cold pool's hydrography. While Figure 5 presents the multi-year average, seasonal salinification is unambiguously present in both the NESS model output (2010–2017) and the Pioneer Array PMUI record (2015–2022) for each individual year, with one exception. Thus, we conclude: (a) The salinification trend is a robust feature of the seasonal hydrography on the US Northeast shelf, and (b) the Pioneer Array PMUI profiler bottom range at 67 m depth is capable of capturing the mean trend of watermass transformation within the cold pool despite only measuring its outer edge. Even though the salinification trends are very similar between observations and the model, the PMUI registers overall larger salinity magnitudes and variability due to its location close to the shelfbreak front, which separates fresh Shelf Water from salty Slope Sea Water. In addition to a variety of studies that have demonstrated the NESS's and its predecessors' ability to capture the hydrography of the US Northeast continental shelf (e.g., K. Chen & He, 2010; K. Chen et al., 2016, 2022), a direct comparison between model output and Pioneer Array data shows strong correspondence in the annual cycle of temperature, salinity, and the velocity of the US Northeast shelfbreak jet (see Supporting Information S1).

4. Cold Pool Salinity Budget

4.1. Seasonal Cycle of Salinity Fluxes

Subsurface salinity on the US Northeast continental shelf increases with an approximately steady rate between spring and fall, which promotes the hypothesis that the cold pool salinity budget is seasonally unbalanced and differs considerably between the stratified and the unstratified season. The cold pool salinity budget for a cold pool control volume has a positive salinity flux residual into the control volume between April and October (Figure 6). While Figure 6a provides an overview of all fluxes constituting the salinity budget

outlined in Equation 2, panels b–d focus on individual flux contributions and their interannual variability. The average salinity trend of 0.19 g/kg/month (April–October) across the cold pool control volume (Figure 6b) coincides well with the seasonal salinification trend across the traditionally defined cold pool (Figure 5b). This agreement provides additional confidence that the chosen cold pool control volume captures the hydrography of the cold pool on the US Northeast continental shelf well.

The biggest contributors that carry salt into the cold pool control volume are the submesoscale eddy-advection flux (green) and the cross-shelfbreak mean-advection flux (purple). These two fluxes make the cold pool saltier at all times of year. In contrast, vertical diffusion/mixing (red) has a freshening effect since the continental shelf is weakly salinity-stratified at all times of year (Li et al., 2015; Taenzer et al., 2023a). The vertical diffusion/mixing flux has the strongest seasonal cycle across all flux contributions. While vertical mixing balances the cross-shelf salt flux during winter, weak vertical mixing during the summer leaves the steady salt flux seasonally unopposed. Thus, the observed seasonal cold pool salinification signal originates from combining the following two ingredients: (a) A consistent deposit of salt into the cold pool by mean- and eddy-advection fluxes at all times of year and (b) a seasonal weakening of the vertical diffusion/mixing flux that no longer opposes the net salinity flux and no longer mixes fresher surface layer water into the subsurface cold pool during the stratified season. Note that the eddy-advection flux encapsulates the flux associated with grid-resolved synoptic variability, while the vertical

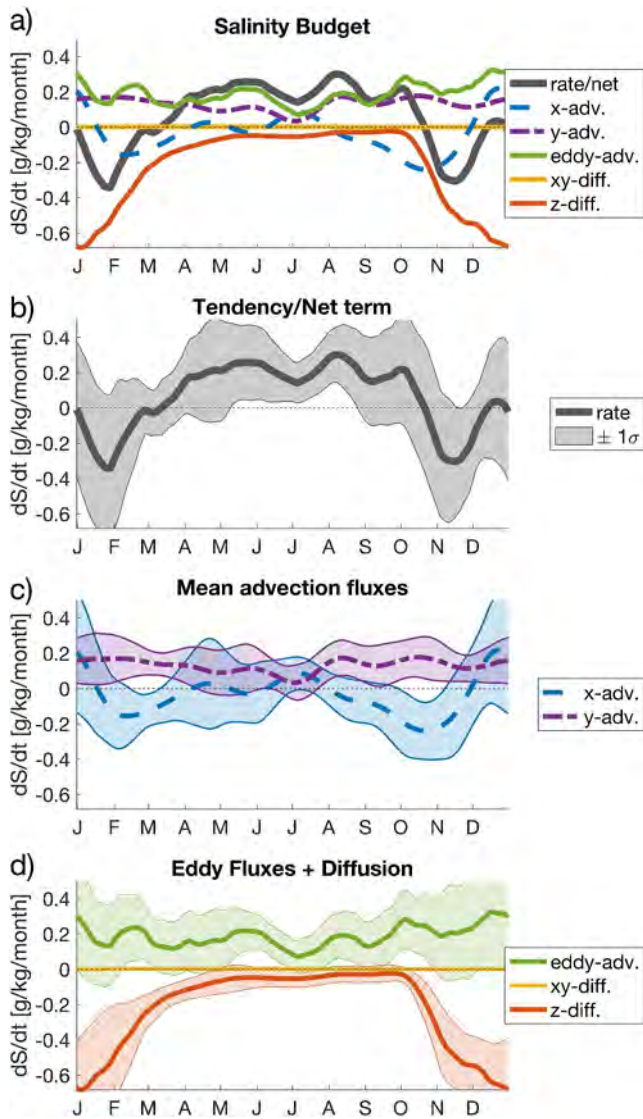


Figure 6. Seasonal cold pool salinity budget for a control volume on the US Northeast continental shelf. (a) Budget includes the tendency/net term $\partial S/\partial t$ (gray) and multi-year mean fluxes of along-shelf mean-advection $-\bar{u} \cdot \partial \bar{S}/\partial x$ (blue), cross-shelf mean-advection $-\bar{v} \cdot \partial \bar{S}/\partial y$ (purple), eddy-advection $-(\nabla_h \cdot \langle \mathbf{u}'_h S' \rangle + w \cdot \partial S/\partial z)$ (green), vertical (eddy) diffusion $\kappa_v \nabla_h^2 S$ (red), and horizontal diffusion $\kappa_h \nabla_h^2 S$ (yellow). (b)–(d) Individual budget net/flux terms and their interannual variability shown by their $\pm 1\sigma$ envelope. All budget terms are based on NESS model output. The color scheme is the same as introduced in Figure 3.

(red) and horizontal (yellow) diffusion fluxes parameterize the diffusive effects from sub-grid scale eddy-driven mixing.

The mean-advection salt flux components can be compared to climatology, that is, the climatological mean velocity field and salinity gradients averaged across the continental shelf cold pool region. As expected for an approximately geostrophically balanced shelfbreak frontal system, along-shelf velocities exceed cross-shelf velocities (Figure 7a), while cross-shelf mean salinity gradients exceed along-shelf mean gradients (Figure 7b) (Brink, 2016). The along-shelf velocities within the cold pool control volume have the same order of magnitude as the observed 3 cm/s along-shelf flow in the bottom boundary layer during the Coastal Mixing and Optics experiment in the same location (Shearman & Lentz, 2003). Scaling shows that the differences between along-/cross-shelf salinity gradients and velocity tend to compensate when computing the order of magnitude of the mean-advection flux components along and across the shelfbreak

$$\mathcal{O}(u \cdot \partial S/\partial x) = U \cdot \Delta S/L_x \approx 10^{-6} \text{ g/kg/s} \approx V \cdot \Delta S/L_y = \mathcal{O}(v \cdot \partial S/\partial y), \quad (4)$$

although, their respective seasonal cycles differ strongly (Figure 6c). Here, $U = 0.1 \text{ m/s}$, $V = 0.01 \text{ m/s}$, $\Delta S = 0.2 \text{ g/kg}$, $L_x = 100 \text{ km}$, and $L_y = 10 \text{ km}$ for the along- and cross-shelf component within the cold pool control volume, respectively. In contrast to the mean salinity gradients on the continental shelf, estimated by the mean gradients across the control volume (Figure 7b), the salinity gradient across the shelfbreak front is typically on the order of 1 g/kg/10 km (Linder & Gawarkiewicz, 1998) and thus significantly larger.

The seasonal cycle of the mean-advection fluxes into the control volume $-\bar{u}_i \cdot \partial \bar{S}/\partial x_i$ ($i \in \{1, 2\}$) (Figure 6c) qualitatively resembles the climatology of the product of their components (Figure 7). Considering that the cross-shelfbreak mean salinity gradient $\partial \bar{S}/\partial y < 0$ persists throughout the year and the cold pool cross-shelfbreak flow $\bar{v}$ is northward at all times of year, it is no surprise that the net contribution from the cross-shelfbreak mean-advection flux to the cold pool salinity budget $-\bar{v} \cdot \partial \bar{S}/\partial y$ is positive at all times of year. Neither $\bar{v}$ nor $\partial \bar{S}/\partial y$, nor their product follow a strong seasonal cycle. In contrast, the along-shelf mean-advection flux closely follows the seasonal cycle of the mean along-shelf velocity across the cold pool (Figure 7a). Along-shelf salinity gradients $\partial \bar{S}/\partial x$ are comparatively weak throughout the stratified season and become more negative in the fall when upstream conditions get fresher. Thus, the along-shelf mean salinity flux contributes little to the seasonal cold pool salinification until the fall when advection of freshwater from upstream increases.

4.2. Cumulative Flux Contributions to the Seasonal Cold Pool Salinification

To quantify the net contribution of each flux component to the seasonal salinification signal, we integrate each flux component in time across the salinification period (Figure 8). The start/end of each year's salinification period is determined by the zero-crossing of the tendency/net term $\partial S/\partial t$ within that year, resulting in a mean salinification season that is 218 days long and lasts from March $11 \pm 14 \text{ d}$ to October $15 \pm 28 \text{ d}$. Over the course of the mean salinification season, the mean control volume salinity increases by 1.3 g/kg . The timing of the mean salinification season coincides well with the seasonal cold pool warming, investigated in previous studies (e.g., Houghton et al., 1982; Lentz, 2017). Panels (a) and (b) of Figure 8 have the same y-axis, and panel (b) shows the

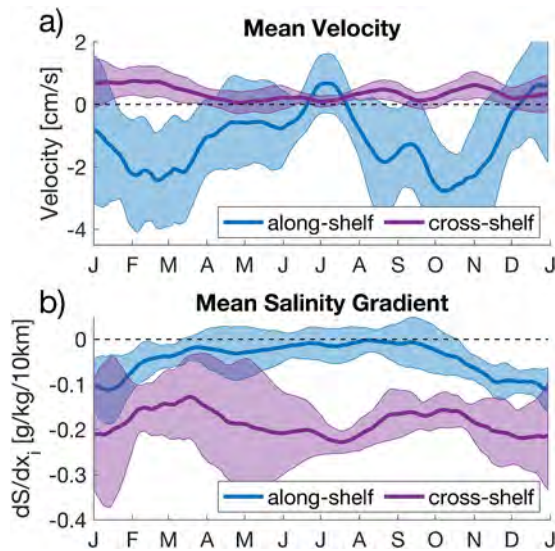


Figure 7. Seasonal cycle of horizontal mean velocity (a) and salinity gradients (b), averaged across the cold pool control volume on the US Northeast shelf. The coordinate system is aligned with the mean flow on the continental shelf. All panels show NESS model output, and the $\pm 1\sigma$ envelopes depict interannual variability.

interannual spread of the cumulative flux at the end of the salinification season between different years. Fluxes are integrated for each year individually to accommodate interannual differences in the timing of the salinification season. The required smoothing is described in Section 2.4. All cumulative flux contributions except the along-shelf advection flux have the same sign across all model years, which makes most cumulative flux signals robust across different years. In contrast, the uncertainty envelopes of the various fluxes at an individual point in time are only partly different from zero (Figure 6). Thus, seasonal salinification is a robust signal of the annual cycle while synoptic variability can obscure the seasonal trend on smaller time-scales. The provided estimates of cumulative interannual variability are applied in Section 6.2 when comparing the results of this study with the peer-reviewed literature.

The eddy-advection flux (green) and the mean cross-shelfbreak flux (purple) together contribute more than 150% of the cumulative salinification signal (Figure 8a). The eddy-advection flux has the strongest signal and shows less interannual variability than the mean cross-shelfbreak flux. In contrast, vertical mixing (red) freshens the control volume by 0.5 g/kg across the stratified season, despite being weakest during the summer (Figure 6d). The along-shelf mean-advection flux (blue) advects freshwater from upstream; though, this contribution is restricted to the fall only. During the fall, the along-shelf mean-advection flux assists the vertical diffusion flux in terminating the seasonal cold pool salinification period. However, it shall be noted that the

along-shelf advection flux is not strictly negative across all years (Figure 8b), which could contribute to interannual variability in the timing of the end of the salinification season (see Section 6.1).

5. Seasonal Cross-Shelf Movements of the Shelfbreak Front

While the cold pool salinity budget points toward the importance of salinity fluxes across the US Northeast shelfbreak front (Section 4), seasonal onshore movements of the shelfbreak front itself could also contribute to the observation of a seasonal salinity increase on the outer continental shelf (Figure 5a). Cross-shelfbreak salinity fluxes act as irreversible cross-shelfbreak exchange, salinifying the cold pool; in contrast, linear cross-shelfbreak movements of the shelfbreak front temporarily shift the cold pool boundary further inshore, leading to reversible and temporary salinification of the outer shelf without lasting net exchange. In the Pioneer Array PMUI hydrography, both processes would look similar. The shelfbreak front is a partly temperature-salinity

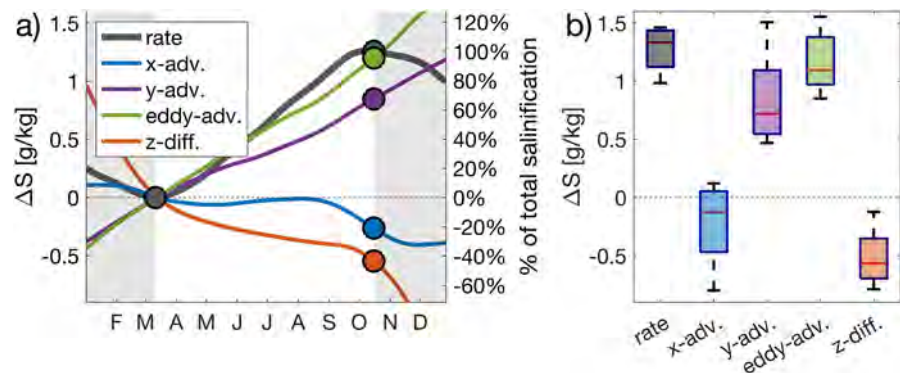


Figure 8. Cumulative contributions of individual fluxes to the seasonal salinification of the cold pool on the US Northeast shelf: Tendency/Net term $\partial S/\partial t$ (gray), along-shelf mean-advection $-\bar{u} \cdot \partial \bar{S}/\partial x$ (blue), cross-shelf mean-advection $-\bar{v} \cdot \partial \bar{S}/\partial y$ (purple), eddy-advection $-(\nabla_h \cdot \langle \mathbf{u}'_h S' \rangle + w \cdot \partial S/\partial z)$ (green), and vertical (eddy) diffusion $\kappa_v \partial^2 S/\partial z^2$ (red). (a) Time series of cumulative fluxes since the start of the mean seasonal salinification season on 11 March. The mean salinification season ends on 15 October. (b) Interannual variability of the cumulative contributions to the seasonal cold pool salinification at the end of each year's salinification season.

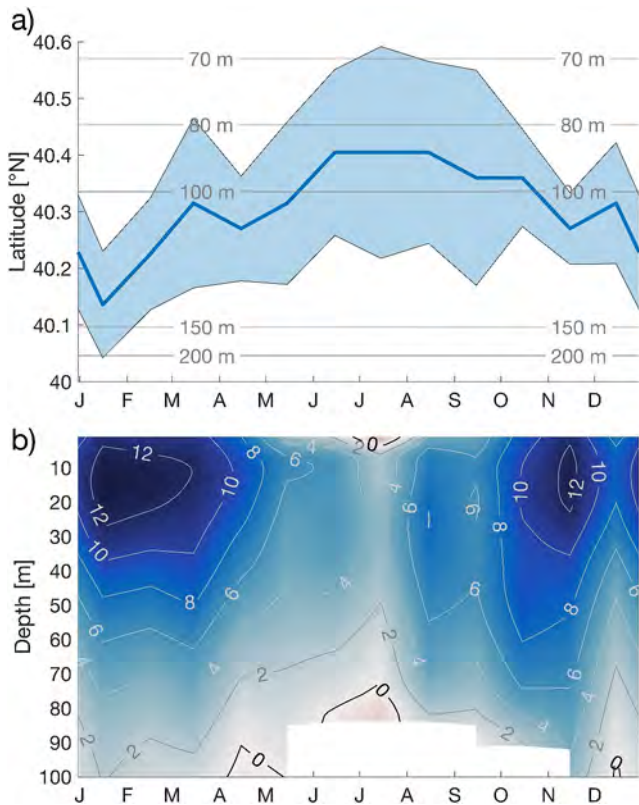


Figure 9. Seasonal cycle of the US Northeast shelfbreak jet at 70.875°W, based on multi-year monthly averages using NESS model output. (a) Latitude position of the shelfbreak jet core based on the along-shelf velocity maximum, averaged across the upper 50 m depth. The $\pm 1\sigma$ envelope depicts interannual variability, and local bathymetry is shown as overlaid contours. (b) Depth structure of the along-shelf shelfbreak jet in a jet-following coordinate system. Zonal velocities are shown in units of cm/s, and positive velocities are westward.

compensated buoyancy-driven frontal system that can be understood as the edge of a coastal freshwater plume (Chapman & Lentz, 1994), accumulating both river discharge and modified subpolar water. Traditionally, Shelf and Slope Sea Water are distinguished by the 34.5 PSU isohaline at all times of year (Linder & Gawarkiewicz, 1998) with salinity gradients of the order 1 PSU/10 km across the shelfbreak front. However, in individual synoptic transects, it can be difficult to identify the location of the shelfbreak front, that is, the location of the maximum buoyancy gradient $\partial b/\partial y$ across the front due to synoptic variability. Instead, we can take advantage of the fact that the climatological shelfbreak jet is mostly baroclinic and approximately in thermal-wind balance (Linder & Gawarkiewicz, 1998), that is, the cross-shelfbreak position of the climatological shelfbreak jet core coincides with the location of the strongest vertically integrated buoyancy gradient across the climatological shelfbreak front. Locating the cross-shelfbreak position of the shelfbreak jet core is restricted to NESS model output since the Pioneer Array Moorings are spaced too far apart to detect small differences in position.

The seasonal cycle of the shelfbreak jet position was determined based on multi-year monthly averages (Figure 9a). For each month, the jet core position across the shelfbreak was identified as the most offshore maximum of the depth-integrated (upper 50 m) westward flow across the Pioneer Array main transect at 70.875°W, north of 40°N. The approach is motivated by Fratantoni et al. (2001); and even though the NESS model captures both the shelfbreak jet and the barotropic slope jet, confusion between both currents is not expected since the slope jet is located further offshore at all times of year. When comparing the NESS jet core position and the cross-shelfbreak salinity field along 70.875°W, their seasonal cycles are distinctly different (Figure 10). A cross-shelfbreak slice through the cold pool at 67 m depth (Figures 10a and 10b) and vertical profile in a jet core-following coordinate system (Figure 10c) both confirm that the cold pool salinity is smallest during late winter and largest in the fall, aligned with the observations made by the Pioneer Array Inshore Moorings (Figure 4). In contrast, the seasonal cycle of the shelfbreak jet position is smaller and has a different timing, reaching its northernmost position in the summer (and not the fall) when jet speeds are the weakest (Figure 9b). Even though the Pioneer Array cannot be used to detect

small meridional shifts in the shelfbreak jet location, the seasonal cycle and depth structure of the modeled jet shows strong similarity compared to a multi-year ADCP average from the Pioneer Array Central Moorings, located around the climatological shelfbreak jet position (see Supporting Information S1). In contrast to the speeds within the shelfbreak jet frontal zone (Figure 9b), along-shelf velocities on the continental shelf (Figure 7a) are smaller by about a factor 2–3, setting up a horizontal velocity shear on the outer continental shelf.

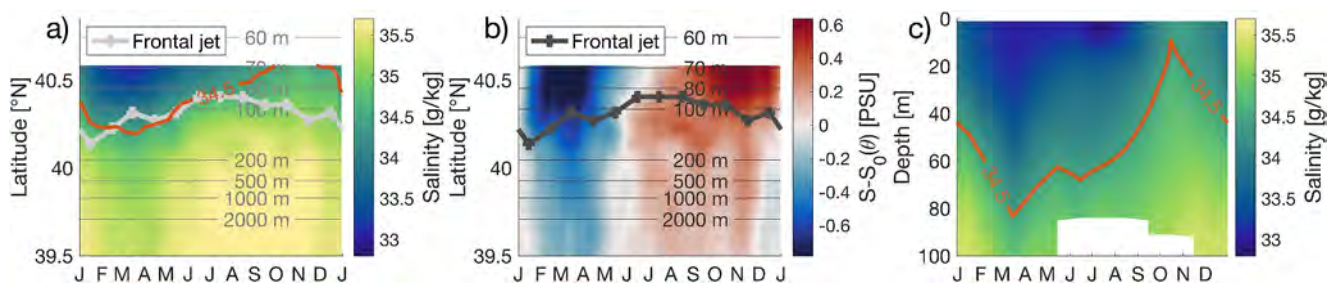


Figure 10. Comparison of interior continental shelf salinification and meridional shelfbreak frontal movements in the NESS model along 70.875°W. (a) Seasonal salinity at 67 m depth and frontal jet position. (b) Seasonal salinity anomaly per latitude at 67 m depth and frontal jet position. (c) Vertical salinity profile at the monthly jet position in a jet-following coordinate system (Figure 9). All panels show NESS model output. The annual cycle of the shelfbreak jet position is overlaid in gray, and the 34.5 g/kg isohaline is highlighted.

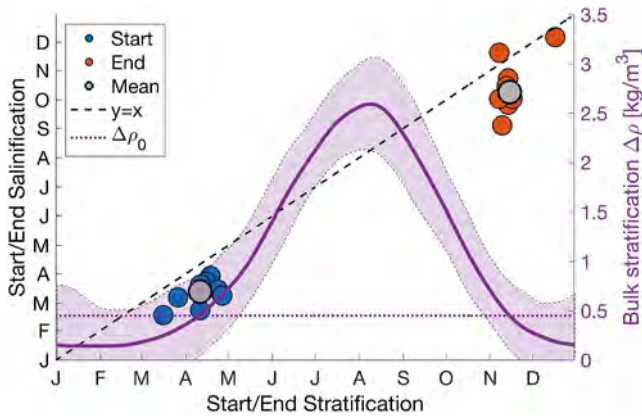


Figure 11. Interannual variability between the start/end of the seasonal cold pool salinification season (zero-crossings of the tendency term $\partial S/\partial t$) and the seasonal stratification season (bulk stratification $\Delta\rho$ above/below the stratification threshold $\Delta\rho_0 = 0.45 \text{ kg/m}^3$, i.e., $\Delta\rho \geq \Delta\rho_0$). Each dot represents the start (blue) and end (red) of the salinification/stratification season of an individual year, and the center of each cluster is shown in gray. The bulk stratification $\Delta\rho$ is defined as the potential density difference between the averaged cold pool control volume and the surface layer above it, estimated by the mean across the upper 8 NESS-layers. The $\pm 1\sigma$ envelope depicts interannual variability.

Theoretically, cross-shelfbreak movements of a geostrophic buoyancy-driven shelfbreak front would shift the watermass transition zone between cool/fresh Shelf and warm/salty Slope Sea Water, leading to a linear, that is, reversible, salinification of the outer shelf during the summer. However, seasonal salinity anomalies are not restricted to the outer shelf (Figure 10b), but extend at least beyond the 67 m isobath with weaker anomaly signals south of the shelfbreak front and in the Slope Sea. Thus, the cold pool salinification signal originates from a process that alters the hydrography across the entire continental shelf, which is not achievable by linear cross-frontal movements restricted to the cold pool's southern edge. Rather, the salinity signal's distinct minimum and maximum in spring and fall, respectively, at least qualitatively align with the onset and breakdown of the seasonal stratification signal on the US Northeast shelf with a steady mean salinification rate in between. Thus, even though the shelfbreak jet moves onshore during the stratified season, these cross-shelfbreak movements are too weak in magnitude to cause the seasonal cold pool salinification across the US Northeast shelf. Instead, the seasonal salinification is caused by a steady irreversible transport of salt across the shelfbreak as the cold pool salinity budget reveals (Section 4).

6. Discussion

6.1. Seasonal Stratification Promotes Cold Pool Salinification

The cold pool salinity budget (Section 4) and the evaluation of cross-shelfbreak frontal movements (Section 5) have demonstrated that the seasonal salinification of the near-bottom US Northeast continental shelf cold pool is driven by a seasonal flux imbalance between cross-shelfbreak exchange and vertical mixing, and not by cross-shelfbreak movements of the shelfbreak front. The start/end of the seasonal cold pool salinification period is largely set by the strong annual cycle in the vertical diffusion/mixing signal. Vertical mixing and seasonal stratification are inherently connected since vertical mixing destroys stratification while stratification has a stabilizing effect on the water column and weakens shear-driven vertical mixing. Lentz (2017) notes that interannual variability of the annual cold pool persistence is driven by the timing of the fall breakdown of stratification, caused by storms. Similarly, the timing of the seasonal cold pool salinification period aligns well with the seasonal cycle of stratification, not just in the multi-year mean, but as well in individual years (Figure 11). The start of the cold pool salinification period aligns particularly well with the start of the salinification period (blue dots) throughout the model time period, and the cluster has the same slope as the slope-1-line. The roughly 1-month offset in time is likely an artifact of the chosen $\Delta\rho_0$ -threshold. In contrast, there is more interannual scattering with respect to the end of the salinification season when compared to the timing of the stratification breakdown (red dots). The scatter along the y-axis could be caused by interannual variability in the along-shelf mean-advection of freshwater from upstream that only contributes to the cold pool budget during the fall and shows comparatively large interannual variability compared to the other cumulative fluxes (Figure 8b).

The relationship between the seasonal cold pool salinification and the seasonal cycle of stratification allows separating the year into two regimes. Panels (a) and (b) of Figure 12 summarize cold pool salinity flux conditions for the unstratified and stratified season, respectively. While the steady cross-shelfbreak salt flux and the freshwater flux from vertical mixing tend to cancel each other out during the unstratified season, the shutdown of vertical mixing during the stratified season creates an imbalance and leaves the steady cross-shelfbreak salt flux (from both cross-shelfbreak mean (purple) and eddy- (green) advection) unopposed. Thus, upper ocean conditions have a direct impact on near-bottom continental shelf hydrography. The timing of separation into the two regimes is roughly aligned with the gray/white shading presented in Figure 8a. The dominant role of the seasonal cycle of stratification in facilitating the seasonal cold pool modification also explains the robustness of summer cold pool warming and salinification every single year. While the seasonal cycle of temperature-dominated stratification is the strongest mode of annual variability across the MAB, along-shelf advection of salinity is subject to strong interannual variability (Mountain, 1991) from a combination of local freshwater input and offshore forcing (Ryan et al., 2024).

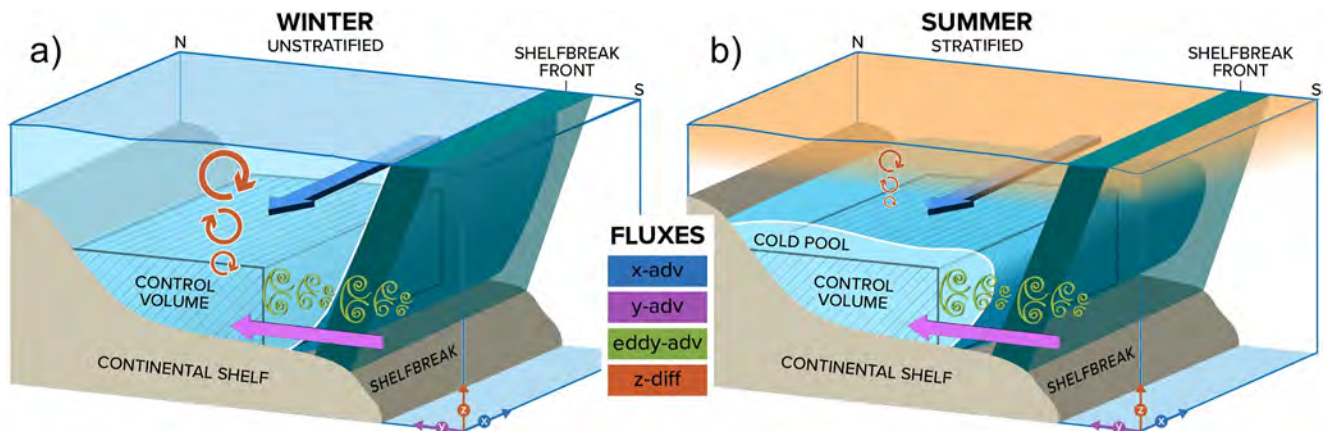


Figure 12. (a) Winter and (b) summer flux regimes explaining the seasonal cold pool salinification on the US Northeast shelf as the result of an imbalance between steady cross-shelfbreak salt advection and diminished vertical mixing during the stratified season in panel (b). The arrows qualitatively outline the magnitude of the salinity budget fluxes, introduced in Section 2.3, for the unstratified (a) and stratified (b) season: Along-shelf (x) mean-advection $-\bar{u} \cdot \partial \bar{S} / \partial x$ (blue), cross-shelf (y) mean-advection $-\bar{v} \cdot \partial \bar{S} / \partial y$ (purple), eddy-advection $-(\nabla_h \cdot \langle \mathbf{u}'_h \mathbf{S}' \rangle + w \cdot \partial S / \partial z)$ (green), and vertical (eddy) diffusion $\kappa_v \partial^2 S / \partial z^2$ (red). The cold pool is depicted in light blue and a schematic control volume is shown as a streaked gray box. Illustration: Natalie Renier (WHOI).

In contrast to this study, Lentz (2017) argues that cross-shelfbreak advection can be neglected when applying temperature instead of salinity as a tracer, and seasonal cold pool modification appears mostly driven by vertical mixing. However, the choice of tracer might influence the assessment of what type of fluxes impact the cold pool the most. The heat and salt flux due to vertical mixing have opposite signs in the cold pool heat and salt budget, adding heat and freshwater to the summer cold pool, respectively. Since Cold Pool Water has the lowest temperature of all surrounding watermasses (Figure 2) aside from the weak along-shelf temperature gradient, most budget flux terms contribute to cold pool warming; and because vertical temperature gradients in the summer are large, even diminished vertical mixing during the stratified season (Figure 6d) contributes strongly to cold pool warming. In contrast, the cold pool is surrounded by both slightly fresher water from above and saltier water from offshore. Thus, using salinity as a tracer allows for better distinction between flux contributions that can either add or remove salt from the cold pool. In addition, the strong seasonal cycle of surface heating and cooling alters the conditions of the surface tracer reservoir on the same timescale as the observed cold pool changes. In contrast, both vertical (Li et al., 2015; Taenzer et al., 2023a) and cross-shelfbreak (Linder & Gawarkiewicz, 1998) salinity gradients remain approximately constant throughout the year, that is, seasonal variability in salinity flux magnitudes is likely less driven by the seasonality of the salinity gradients and more by the seasonality of the underlying dynamical processes.

6.2. Understanding of the Eddy-Advection Flux Term

The eddy-advection flux $-(\nabla_h \cdot \langle \mathbf{u}'_h \mathbf{S}' \rangle + w \cdot \partial S / \partial z)$ is associated with intermittent synoptic events of ageostrophic shelfbreak exchange; in contrast to the cross-shelf mean-advection flux $(-\bar{v} \cdot \partial \bar{S} / \partial y)$, which is advected by the mean flow. By design, the eddy-advection flux does not include a directionality since the different eddy-advection components tend to partly compensate each other with a small net residual (see Section 2.3). However, the eddy-advection flux term adds salt to the cold pool control volume at all times of year and the only ubiquitous source of high salinity water is the contiguous Slope Sea across the continental shelfbreak (Ketchum & Corwin, 1964). Thus, we expect the eddy-advection flux term to predominantly capture synoptic processes associated with cross-shelfbreak salinity fluxes. Since the US Northeast shelfbreak front is inherently unstable (Flagg & Beardsley, 1978; Garvine et al., 1988), intermittent cross-shelfbreak exchange occurs regularly, either due to internal instability (Gawarkiewicz et al., 2004) or external forcing (Silver et al., 2023; Todd, 2020; Zhang & Gawarkiewicz, 2015a). If the eddy-advection flux is exclusively driven by cross-shelfbreak eddies, one can estimate the order of magnitude of a horizontal cross-shelfbreak bulk eddy-diffusivity K_h within the frontal region by applying a simple Fickian diffusion model:

$$-(\nabla_h \cdot \langle \mathbf{u}'_h S' \rangle + w \cdot \partial S / \partial z) \approx -\frac{\partial}{\partial y} \langle v' S' \rangle = K_h \frac{\partial \bar{S}}{\partial y^2} \sim K_h \frac{\Delta S}{(L_y)^2}. \quad (5)$$

Then, $K_h \sim 10^1 \text{ m}^2/\text{s}$ in the presence of a cross-shelfbreak salinity gradient $\Delta S/L_y = 1 \text{ PSU}/10 \text{ km}$ (Linder & Gawarkiewicz, 1998). In comparison, Sundermeyer and Ledwell (2001) observed a lateral diffusivity between 0.3–4.9 m^2/s from a dye-release experiment on the US Northeast continental shelf, which is slightly lower than this very simple estimate. However, in contrast to the continental shelf, the presence of the shelfbreak jet with its secondary circulation likely makes lateral eddy-driven diffusion highly anisotropic within the frontal zone.

In the absence of external forcing, Spall and Chapman (1998) developed the simple analytical expression $\langle v' \rho' \rangle = c_e U \Delta \rho$, which links the magnitude of an eddy-buoyancy flux across an idealized narrow front with more easily observable mesoscale frontal properties, assuming that the eddy-transport is facilitated by baroclinic eddy pairs under the presence of stratification. Here, U is a scale for the frontal jet speed difference between two layers and $\Delta \rho$ is the mesoscale density difference across the front. In an eddy-resolving idealized model, they determined the eddy-flux efficiency c_e to be between 0.02 and 0.04 across a wide range of frontal parameters. Assuming that the multi-year mean eddy-advection flux of $0.17 \pm 0.03 \text{ g/kg/month}$ (i.e., $1.3 \pm 0.2 \text{ g/kg}$ over 218 days (Figure 8)) originates solely from a Spall and Chapman (1998)-like eddy flux $\langle v' S' \rangle / \Delta W$ across the modeled shelfbreak front of width $\Delta W = 20 \text{ km}$, we estimate an eddy-flux efficiency of $c_e = 0.02 \pm 0.01$ (with $U = 5 \pm 2 \text{ cm/s}$ during peak stratification (Figure 9b) and $\Delta S = 1.5 \pm 0.5 \text{ PSU}$ as the mean salinity difference between the subsurface outer shelf and the northern Slope Sea (Figure 2)). The uncertainty estimate was propagated assuming that all variables are normally distributed and uncorrelated. The eddy-flux efficiency estimate from the cold pool salinity budget overlaps largely with the range presented in Spall and Chapman (1998), which is particularly remarkable considering the strong differences in the assumptions of each estimate. While the efficiency estimate from the cold pool eddy-advection flux includes all grid-resolved synoptic variability, it relies on the non-trivial assumption that eddy-advection fluxes are solely directed across the shelfbreak front. In contrast, Spall and Chapman (1998)'s eddy-flux efficiency only captures eddy-fluxes generated by baroclinic eddy-pairs. Furthermore, the eddy-advection flux originates from both internal instability and external forcing, while the idealized and analytical model by Spall and Chapman (1998) only captures the subsection of the net cross-shelfbreak eddy-driven advection that is caused by heton eddy pairs.

The cumulative cross-shelfbreak flux across all processes and timescales has previously been inferred indirectly as the residual to close the shelf salinity budget. Houghton et al. (1988) consider the gradient of oxygen isotope ratios along the MAB, reported by Fairbanks (1982), to indirectly infer a cross-shelfbreak salinity flux of $2.2 \cdot 10^{-3} \text{ kg/m}^2/\text{s}$ per unit width and depth. By aggregating salinity observations across multiple decades, Lentz (2010) estimates a depth-averaged multi-year mean cross-shelfbreak “eddy” salt flux of $7 \cdot 10^{-3} \text{ kg/m}^2/\text{s}$ per unit width and depth across the 100 m isobath. Here, we complement previous efforts to constrain a shelf salinity budget by investigating the seasonality of eddy-advection and focusing on the near-bottom continental cold pool, which shows less variability than the surface layer. To compare the eddy-advection flux into the cold pool control volume with the residual estimates from Houghton et al. (1988) and Lentz (2010), we approximate the sum of the cross-shelfbreak flux components into the 30 km^3 large control volume as a salt flux across the southern border only (area $A = W \cdot H = 50 \text{ km} \cdot 20 \text{ m} = 1 \text{ km}^2$), assuming advection flux contributions across other control volume boundaries to be negligible. The sum of the cross-shelfbreak mean-advection flux and the eddy-advection flux amounts to a multi-year mean of $2.0 \pm 0.3 \text{ g/kg}$ across the almost 7-month long stratification season (Figure 8), which corresponds to a salt flux of $(3.3 \pm 0.5) \cdot 10^{-3} \text{ kg/m}^2/\text{s}$ per unit width and depth across the offshore control volume boundary. This estimate is on the same order of magnitude than previous residual estimates. While Lentz (2010) describes the depth-averaged flux across the 100 m isobath, the cold pool control volume only extends southward to the 75 m isobath, which could explain the difference in the cross-shelfbreak flux magnitude due to the control volume's larger distance from the shelfbreak front. In contrast to the mean residual salinity flux estimated above, Gawarkiewicz et al. (2004) observed flux rates of nearly $20 \cdot 10^{-3} \text{ kg/m}^2/\text{s}$ for an individual synoptic non-linear large-amplitude frontal meander. However, the flux magnitude varied strongly on synoptic timescales, and even a negative flux was observed just 2 days after the strong positive cross-shelfbreak flux event. Considering that the mean eddy-advection flux magnitude of this study is in good agreement with flux estimates of various observed and modeled cross-shelfbreak eddy processes

reported on in the literature (see above), we can assume that the eddy-advection flux, that is, the largest contributor to cold pool salinification, predominantly captures eddy-driven cross-shelfbreak exchange.

While the annual cycle of seasonal stratification is essential for establishing the seasonal imbalance between the eddy-advection and vertical diffusion flux, the eddy-advection flux itself remains fairly constant throughout the year and across all years. This result is not necessarily expected considering the strong seasonal cycle of both the shelfbreak jet's velocity (Figure 9b) and stratification (Figure 11). According to a linear stability analysis by Zhang and Gawarkiewicz (2015b), the growth rate of frontal meanders along an idealized front, which resembles properties of the US Northeast shelfbreak front, depends on stratification. Houghton et al. (1988) observed a weak indication for a seasonal cycle in the cross-shelf eddy heat flux $\langle v'T' \rangle$, which was only significant during the fall. Irrespective of the eddy-advection flux's seasonal cycle, the smoothed multi-year mean curves in Figures 6 and 8 hide the strong intermittency of the eddy-advection flux on synoptic timescales. In fact, the eddy-advection flux is only positive 60% of the time (when averaged across two M2 tidal cycles), but its net positive mean is caused by intermittent strong bursts of salt fluxes into the cold pool control volume, while negative salt flux peaks tend to be smaller. Thus, the smoothed seasonal cycle primarily provides an estimate of what flux magnitude to expect in a multi-year mean, offering little information about its variability on any given day.

6.3. Moving Beyond the US Northeast Shelf

The results of this study apply to the US Northeast continental shelf where the Pioneer Array first observed the seasonal cold pool salinification trend and a direct comparison between NESS model results and multi-year observations is possible. The applicability of these results to the entire MAB is unknown; however, we can learn from observations of seasonal cold pool modification in temperature across the entire MAB (Castelao et al., 2008; Houghton et al., 1982; Ou & Houghton, 1982). The seasonal cycle of stratification is the dominant mode of seasonal variability of the MAB hydrography, which suggests that the seasonal shutdown of vertical mixing is the dominant cause for cold pool erosion everywhere across the MAB. Strong temporal coherence in the formation and breakdown of seasonal stratification across the MAB (Li et al., 2015) even suggests that the timing of the start/end of cold pool modification across the MAB could be similar. Frontal meanders (Garvine et al., 1988) and cross-shelfbreak exchange are ubiquitous across the MAB as Lozier and Gawarkiewicz (2001) observed from drifter releases. And mean cross-shelf advection points onshore in the interior water column when aggregating observations across the MAB (Lentz, 2008).

In contrast, the impact of along-shelf advection likely differs across the MAB. Houghton et al. (1982) have shown that the seasonal cold pool warming is not steady everywhere and estimated the along-shelf advection velocity of the cold pool minimum along the MAB. Hudson Bight is likely the MAB-region where along-shelf temperature advection matters the most (Brown et al., 2023; Lentz, 2017), and Hudson Bight's comparatively large continental shelf width gives it a large local "heat/salt capacity" (Ou & Houghton, 1982). The cold pool evolution in the southern MAB is likely complex due to a combination of strong local heating and varying advection from upstream (Castelao et al., 2008). Thus, it can be assumed that the along-shelf differences in the strength and timing of the along-shelf mean-advection flux modify the cold pool temperature and salinity to second order throughout the summer, resulting in a more complex cold pool development along the MAB and further downstream of the US Northeast continental shelf. Further upstream, forcing conditions are sufficiently different from the rest of the MAB (Lentz, 2017), such that the results of this study are likely not applicable. In particular, strong tidal mixing on Georges Bank (Brown, 1984) differentiates the upstream region from the rest of the MAB.

While shelfbreak exchange plays an important role for the cold pool erosion on the mid-continental shelf, the role of vertical mixing increases toward the coast (Lentz, 2017). While Lentz (2017)'s simplified cold pool heat budget without cross-shelfbreak exchange works well for shallow water depths near the coast, vertical mixing alone underestimates the cold pool warming rates on the US Northeast shelf in deeper waters closer to the shelfbreak. The strong correlation between temperature and salinity across Cold Pool Water and subsurface Slope Sea Water (Figure 2) likely resembles the mixing line between both water masses and points toward the influence of shelfbreak exchange on the mid-shelf hydrography. In contrast to Lentz (2017), this study applies a more strict definition to identify the cold pool and thus excludes the shallow inner shelf, which warms much faster and experiences different dynamics than the mid- and outer continental shelf, for example, enhanced tidal mixing and interaction between the bottom and surface boundary layer. The cold pool control volume in this study is restricted to the area between the 55- and 75 m isobaths to ensure that the control volume only captures the

homogeneous core of the cold pool on the mid-shelf (Figures 1b and 1c), which preserves winter conditions for longer than the inner and outer shelf.

7. Conclusion

The US Northeast continental shelf cold pool preserves winter conditions within the near-bottom shelf waters and serves as a habitat for the regional marine ecosystem when regional waters become too warm and/or salty elsewhere during the summer. While a seasonal warming of the cold pool has first been observed by Bigelow (1933), we provide evidence that the cold pool also gets saltier throughout the stratified season. By using salinity instead of temperature as a tracer, a cold pool salinity budget for the US Northeast continental shelf reveals that cross-frontal fluxes deposit salt into the cold pool at all times of year, and along-shelf advection contributes little to the salinification signal. The cold pool exhibits two seasonal regimes, shaped by the seasonal cycle of stratification. During the unstratified season, vertical mixing is large, and the cold pool gets replenished with fresh water from the surface layer, which inhibits salinification. During the stratified season, vertical mixing is significantly reduced, resulting in an imbalance as steady cross-shelfbreak salt fluxes salinify the cold pool without any opposing flux present. The cold pool salinifies with a mean rate of 0.18 PSU/month during the stratified season. Seasonal cross-shelfbreak movements of the shelfbreak front are shown to be too small to noticeably contribute to the seasonal cold pool salinification. In addition, cross-shelfbreak movements of the frontal jet and cold pool salinification do not align temporally, and cold pool salinification stretches across the entire shelf rather than being confined to the shelfbreak.

This study quantifies the multi-year mean contribution of the eddy-advection flux, which captures cross-shelfbreak fluxes due to synoptic variability, to the observed change of the subsurface US Northeast hydrography on seasonal timescales. The smoothed, multi-year mean eddy-advection flux is roughly constant throughout the year, despite the strong seasonal cycle of stratification and shelfbreak jet speed, and consists of intermittent eddy-flux events occurring on synoptic timescales. These events are likely associated with submesoscale shelfbreak frontal processes that cause the ageostrophic cross-shelfbreak transport. However, it remains an open question how individual eddy-flux events can be attributed to the variety of known frontal exchange processes.

Data Availability Statement

Code and model output to reproduce the figures can be found at <https://doi.org/10.5281/zenodo.14605057>. In situ observations of the US Northeast shelfbreak hydrography and velocity originate from the OOI Coastal Pioneer Array Moorings (NSF Ocean Observatory Initiative, 2022), and data are publicly available through multiple gateways, for example, through the Data Explorer ERDDAP server erddap.dataexplorer.oceanobservatories.org. A gridded version of the hydrography data set (Taenzer et al., 2023b, 10.1029/2022JC019625), described in Taenzer et al. (2023a), was used to identify seasonal watermass variability in the US Northeast cold pool. The NESS regional ocean model is described in K. Chen et al. (2022). Thermodynamic properties of seawater have been determined by using the Gibbs-SeaWater (GSW) Oceanographic Toolbox (McDougall & Barker, 2011), Version 3.06.12, available via teos-10.org/software.htm.

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Acknowledgments

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James Boyle

From: Brian Collins <brian.c1@me.com>
Sent: Tuesday, July 22, 2025 12:12 PM
To: James Boyle
Subject: Re: [External] Menhaden Technical Committee Cancellation

Thanks yes please add me to the followers list

I am concerned that there are zero schools of Menhaden making it into the Bay past industrial fishing nets in the Bay into Maryland

I hear too much extrapolation of Ocean Menhaden science as applicable to the Bay - 2 distinct and separate ecosystems.

I appreciate the response and support!

Thanks, Brian

> On Jul 22, 2025, at 12:02 PM, James Boyle <JBoyle@asmfc.org> wrote:

>

> Hi Brian,

>

> Once we have the date, we will post it to the Commission's calendar (<https://asmfc.org/events/>). If you like, I can also add you to our Followers list to be notified when menhaden meetings are scheduled.

>

> The Management Board will be meeting from 8:30-9:30am on August 7th to continue discussing next steps in response to the Work Group Report on Precautionary Management in Chesapeake Bay. More information on submitting a public comment and attending the meeting, including a webinar registration link, can be found here:

<https://asmfc.org/events/2025-summer-meeting/>.

>

> Best,

> James

>

> James Boyle (he/him) | FMP Coordinator Atlantic States Marine

> Fisheries Commission

> 1050 N. Highland Street, Suite 200 A-N Arlington, VA 22201

> Phone: 703.842.0715 | Fax: 703.842.0741 jboyle@asmfc.org |

> www.asmfc.org

>

>

>

> -----Original Message-----

> From: Brian Collins <brian.c1@me.com>

> Sent: Friday, July 18, 2025 4:43 PM

> To: James Boyle <JBoyle@ASMFC.org>

> Subject: [External] Menhaden Technical Committee Cancellation

>

> Hello James happy Friday. I just saw the meeting on Monday is canceled for Menhaden technical committee.

>

> What is the best way to find a reschedule date?

>

> What is the best way to find out what ASMFC plans to do to address the Menhaden and Osprey crisis in the Chesapeake Bay?

>

> Thanks, Brian

>

>

>

>

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From: [Tom Lilly](#)
To: [John Clark](#); [James Boyle](#); [Bob Beal](#); [Marty Gary](#); [Allison Colden](#); [Lynn Fegley](#); [Russell Dize](#); [Comments](#); [Tina Berger](#)
Cc: [Sen. Craig A. Miner](#); [Robert Lafrance](#); [William Hyatt](#); [Justin Davis](#); [Roy Miller](#); [Rep. William J Carson](#); [Jessica Mccawley](#); [Erica.Burgess@myfwc.com](#); [gjennings@asafishing.com](#); [Spud Woodward](#); [Doug Haymans](#); [Carolyn N Belcher](#); [Rep. Trey Rhodes](#); [Stephen R. Train](#); [David Sikorski](#); [nichola.meserve@state.ma.us](#); [Raymond Kane](#); [Dennis Abbott](#)
Subject: [External] Ethical treatment of Maryland aka the "Golden Rule"
Date: Friday, July 25, 2025 1:10:27 PM

Tina Please copy this to the menhaden board and policy board for the August meetings.

To John Clark chair of the menhaden board, James Boyle coordinator and all the board members

If I have this right, each of your states affected by menhaden from North Carolina up, except Virginia, have required that the factory fishing be in the US Atlantic zone to protect the ecology of your bays, rivers and coastal zone. You have seen spectacular results from the abundant menhaden now that the factory ships are gone. I think New York and New Jersey are the latest examples. But Maryland is the only state that cannot prevent the menhaden trying to migrate to it from being caught in Virginia. Only you can protect Maryland by requiring the factory fishing not be in the bay and Virginia coast but just in the US Atlantic zone. but you have not included that in your protective options for some reason.

Perhaps the oldest rule of ethics is the "Golden Rule". When I checked, I found that the origin of this is the sermon on the mount delivered by Jesus Christ more than 2500 years ago. Where he said " whatever you desire for men to do to you you shall also do to them..." Mathew 7....7-12.

So, am I out of line when I say to you that if you were to observe this "golden rule" of ethics, the first protective option that you should be considering is the same rule that you have taken advantage of to protect your fisherman and your ecology and that is moving the factory fishing out into the US Atlantic zone, which is providing you with so many benefits. Please think about this as you prepare for the meeting on August 7 and I would hope that one of you or all of you would join in a motion to protect Maryland using the same rule that you have used to protect yourselves. Sincerely Tom Lilly

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Atlantic States Marine Fisheries Commission

July 28, 2025

Discussion Paper on Establishing and Reviewing Declared Interests

Background

The Commission's Executive Committee has discussed a series of procedures and practices at the past few quarterly meetings. The discussions have focused on: 1) declared interests, 2) voting privileges, and 3) virtual and hybrid meeting participation. These discussions were prompted by several circumstances. Most notable is the changing distribution and residency of many species managed by the Commission, which in turn has resulted in (and is anticipated to result in additional) interest by states to alter their participation on one or more species boards.

This paper focuses on the issue of state and jurisdiction declared interest in the management of a species. At the end of this paper there is also a brief discussion on the process that may be used to address the voting privileges issue.

Declared Interests

States have an opportunity to declare an interest in a fishery to participate as a voting member of a management board (see Table 1. Declared Interests by Species). The ISFMP Policy Board reviews declared interest requests to determine the membership of each board. The Commission's [Rules and Regulations](#) include the criteria used to determine interest in a species, the criteria are:

- (a) Such fish are found customarily in its territorial waters (*potentially change to "waters under state jurisdiction"*);
- (b) Such fish are customarily or periodically in the territorial waters of such state for the purpose of spawning or in transit to and from spawning grounds; or
- (c) The citizens of the state are recorded as having taken 5 percent or more of the total Atlantic coast catch of the species of fish in any of the five preceding years.

Note: a state must only meet one of these criteria to have a declared interest in a fishery.

The Policy Board has generally accepted requests for declared interest if the requesting state provides basic evidence to support their request.

The Policy Board provides primary oversight of the Commission's fisheries management process and species management boards. Some decisions made by a species board are

recommendations to the Policy Board, such as approvals of Amendments or letters. The same votes that are made at the species board level are then made at the Policy Board level.

Discussion Questions

1. Should the declared interest criteria be modified or further defined?
2. Are changes needed for the Policy Boards' review process for declared interest requests?
3. Should Policy Board voting privileges change as an oversight body of species boards?
4. Should criteria (c) be modified or removed from the list?
5. Should declared interests be reviewed and reaffirmed on regular intervals?

Possible alternative criteria or additional criteria

Such species is documented by landings and/or scientific surveys to occur annually in the territorial waters of a jurisdiction for three consecutive years.

Alternate language to replace "customarily"

Alternatives to "customarily" might be "typically", "commonly", or "regularly",

Here are the suggested substitutions:

1. "Such fish are found *commonly* in its territorial waters" – "commonly" suggests frequency and widespread occurrence.
2. "Such fish are *typically* or *periodically* in the territorial waters..." – "typically" captures a usual pattern, "periodically" suggests less frequent occurrence.

Frequency of declared interest review

1. Status quo – Policy Board only reviews when a request to add or remove a declared interest is made.
2. Regular interval – 3 years, 5 years, etc.
3. Trigger based – New assessment, significant change in distribution or landings, etc.

Voting Privileges

Voting privileges have proven to be a complex issue during the recent Executive Committee discussions. There are two options being considered to address this issue:

1. Conduct a survey to assess the Commissioner perspective on voting privileges.
2. Form a Commissioner workgroup to develop recommendations for consideration by the Executive Committee

The ISFMP Charter states: "Each state with an interest in the fishery covered by the management board shall be a voting member". The Charter does not provide further guidance

on voting privileges for states with a declared interest. Four topics for further discussion were raised at the Executive Committee meeting in October 2024.

A survey or Commissioner workgroup will address the following topics:

1. Voting privileges for *de minimis* states
2. Voting privileges by stock unit of a species
3. Voting privileges for states outside the management unit defined in the FMP
4. Voting privileges for states on boards that manage multiple species

Table 1. Declared Interest by Species as of February 2024

	ME	NH	MA	RI	CT	NY	NJ	PA	DE	MD	DC	PRFC	VA	NC	SC	GA	FL	NMFS	USFWS	Councils
Managed Species																				
American Eel	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
American Lobster	*	*	*	*	*	*	*		*	*			*					*		
Atlantic Herring	*	*	*	*	*	*	*											*		NEFMC
Atlantic Menhaden	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	
Atlantic Striped Bass	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			*	*	
Atlantic Sturgeon	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Bluefish	*	*	*	*	*	*	*		*	*		*	*	*	*	*	*	*		
Coastal Sharks			*	*	*	*	*		*	*			*	*	*	*	*	*		
Horseshoe Crab			*	*	*	*	*		*	*		*	*	*	*	*	*	*	*	
Jonah Crab	*	*	*	*	*	*	*		*	*			*					*		NEFMC
Northern Shrimp	*	*	*																	
Shad & River Herring	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Spiny Dogfish	*	*	*	*	*	*	*		*	*			*	*				*		
Tautog			*	*	*	*	*		*	*			*					*		
Weakfish				*	*	*	*		*	*		*	*	*	*	*	*	*		
Winter Flounder	*	*	*	*	*	*	*											*		
Summer Flounder, Scup and Black Sea Bass Board																				
Summer Flounder			*	*	*	*	*		*	*		*	*	*				*		
Scup			*	*	*	*	*		*	*			*	*				*		
Black Sea Bass		*	*	*	*	*	*		*	*		*	*	*				*		
Coastal Pelagics																				
Cobia				*		*	*		*	*		*	*	*	*	*	*	*		SAFMC
Spanish Mackerel				*		*	*		*	*		*	*	*	*	*	*	*		SAFMC
Sciaenids Board																				
Atlantic Croaker							*		*	*		*	*	*	*	*	*	*		
Black Drum							*		*	*		*	*	*	*	*	*	*		
Red Drum							*		*	*		*	*	*	*	*	*	*		
Spot							*		*	*		*	*	*	*	*	*	*		
Spotted Seatrout							*		*	*		*	*	*	*	*	*	*		
Total # of Species	12	13	18	20	18	19	25	5	23	23	4	17	23	20	15	15	15	23	7	