Atlantic States Marine Fisheries Commission

Atlantic Herring Management Board

August 4, 2026
10:00 – 11:00 a.m.

Draft Agenda

The times listed are approximate; the order in which these items will be taken is subject to change; other items may be added as necessary.

1.	Welcome/Call to Order *(D. Grout)*	10:00 a.m.
2.	Board Consent • Approval of Agenda • Approval of Proceedings from October 2025	10:00 a.m.
3.	Public Comment	10:05 a.m.
4.	Consider 2025 Research Track and 2026 Management Track Stock Assessments **Action** • Presentation of Stock Assessment Reports (*J. Deroba)* • Presentation of Peer Review Panel Reports (*J. Deroba)* • Consider Acceptance of Northeast Fisheries Science Research Track Stock Assessment and Peer Review Report for Management Use	10:15 a.m.
5.	Update from New England Fishery Management Council on Atlantic Herring Activity *(NEFMC Staff)*	10:55 a.m.
6.	Other Business/Adjourn	11:00 a.m.

The meeting will be held at The Westin Crystal City (1800 Richmond Highway, Arlington, VA; 703.486.1111) and via webinar; click here for details.

MEETING OVERVIEW

Atlantic Herring Management Board
August 4, 2026
10:00 – 11:00 a.m.

Chair: Doug Grout Assumed Chairmanship: 09/24	Technical Committee Chair: Vacant	Law Enforcement Committee Representative: Delayne Brown (NH)
Vice Chair: Eric Reid	Advisory Panel Chair: Vacant	Previous Board Meeting: October 27, 2025
Voting Members: ME, NH, MA, RI, CT, NY, NJ, NMFS, NEFMC (9 votes)		

2. Board Consent
- Approval of Agenda
- Approval of Proceedings from October 2025

3. Public Comment – At the beginning of the meeting public comment will be taken on items not on the agenda. Individuals that wish to speak at this time must sign-in at the beginning of the meeting. For agenda items that have already gone out for public hearing and/or have had a public comment period that has closed, the Board Chair may determine that additional public comment will not provide additional information. In this circumstance the Chair will not allow additional public comment on an issue. For agenda items that the public has not had a chance to provide input, the Board Chair may allow limited opportunity for comment. The Board Chair has the discretion to limit the number of speakers and/or the length of each comment.

4. 2025 Research Track and 2026 Management Track Stock Assessments (10:15-10:55 a.m.) Action
Background • The 2025 Research Track Stock Assessment was conducted by the Northeast Fisheries Science Center (NEFSC) and completed in February 2025 **(Briefing Materials)**. • A peer review of the 2025 assessment was held in March 2025 **(Briefing Materials)**. • The 2026 Management Track Stock Assessment was conducted by the NEFSC and completed in June 2026 **(Briefing Materials)**. • A peer review of the 2026 assessment was held in June 2026 **(Briefing Materials)**.
Presentations • Assessment overviews by J. Deroba • Peer review summaries by J. Deroba
Board action for consideration at this meeting • Accept the 2025 Research Track Stock Assessment Report and Peer Review Report for management use.

5. New England Fishery Management Council Update (10:55-11:00 a.m.)
Background • In June 2026, the New England Fishery Management Council (NEFMC) voted to separate Atlantic herring specifications for fishing years 2027-2031 into a standalone action distinct from ongoing work to modify river herring and shad management measures **(Briefing Materials)**. • The NEFMC plans to take final action on 2027-2031 specifications at its September 2026 meeting. • In a separate action, the NEFMC directed its Atlantic Herring Plan Development Team to continue working on time-area closures for river herring and shad, an updated specifications process, and carryover provision modifications, with final action targeted for April 2027.
Presentations • NEFMC update by NEFMC staff

6. Other Business/Adjourn

DRAFT PROCEEDINGS OF THE

ATLANTIC STATES MARINE FISHERIES COMMISSION

ATLANTIC HERRING MANAGEMENT BOARD

Hyatt Place Dewey Beach
Dewey Beach, Delaware
Hybrid Meeting

October 27, 2025

These minutes are draft and subject to approval by the Atlantic Herring Management Board.
The Board will review the minutes during its next meeting.

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INDEX OF MOTIONS

1. **Approval of agenda** by consent (Page 1).

2. **Approval of Proceedings of May 2025** by consent (Page 1).

3. **Move to implement seasonal distribution of quota for the 2026 Area 1A sub-ACL with 72.8% available from June through September and 27.2% allocated from October through December, with no landings prior to June 1. Underages will be rolled over into the next quota period. The fishery will close when 92% of the seasonal period's quota is projected to be caught** (Page 2). Motion by Megan Ward; second by Renee Zobel. Motion approved by unanimous consent (Page 3).

4. **Move to approve the Atlantic Herring FMP Review for the 2024 fishing year, state compliance reports, and *de minimis* request for New York** (Page 6). Motion by Jeff Kaelin; second by Matt Gates. Motion approved by unanimous consent (Page 6).

5. **Move to elect Eric Reid as Vice-Chair** (Page 6). Motion by Megan Ware; second by Ray Kane. Motion passes by unanimous consent (Page 6).

6. **Move to adjourn** by consent (Page 6).

ATTENDANCE

Board Members

Megan Ware, ME, proxy for C. Wilson (AA)
Steve Train, ME (GA)
Rep. Allison Hepler, ME (LA)
Renee Zobel, NH (AA)
Doug Grout, NH (GA)
Melanie Griffin, MA, proxy for D. McKiernan (AA)
Raymond Kane, MA (GA)
Rep. Sarah Peake, MA, proxy for Rep. Armini (LA)
Nicole Lengyel Costa, RI, proxy for J. McNamee (AA)
Eric Reid, RI, proxy for Sen. Sosnowski (LA)
Matt Gates, CT (AA)
Bill Hyatt, CT (GA)
Robert LaFrance, CT, proxy for Rep. Gresko (LA)
John Maniscalco, NY, proxy for M. Gary (AA)
Scott Curatolo-Wagemann, NY, proxy for E. Hasbrouck (GA)
Heather Corbett, NJ, proxy for J. Cimino (AA)
Jeff Kaelin, NJ (GA)

(AA = Administrative Appointee; GA = Governor Appointee; LA = Legislative Appointee)

Ex-Officio Members

Delayne Brown, Law Enforcement Committee Rep.

Staff

Bob Beal
Toni Kerns
Tina Berger
Madeline Musante
Caitlin Starks
Tracey Bauer
Chelsea Tuohy
James Boyle
Emilie Franke
Katie Drew
Jeff Kipp
Samara Nehemiah

The Atlantic Herring Management Board of the Atlantic States Marine Fisheries Commission convened in the Ballroom East/West via hybrid meeting, in-person and webinar; Monday, October 27, 2025, and was called to order at 11:15 a.m. by Chair Douglas E. Grout.

CALL TO ORDER

CHAIR DOUGLAS E. GROUT: Okay, folks, welcome to Delaware and welcome to a meeting of the Atlantic Herring Management Board. We have three tasks at hand today, one, set the quota period for the 2026 Area 1A Fishery. We are also going to Consider Approval of the FMP Review and State Compliance for the 2024 Fishing Year, and we're going to elect a Vice-Chair. My name is Doug Grout; I'm Chair for the moment, and before we go on Toni needs to make an announcement.

MS. TONI KERNS: Just to let everybody know that Scott Curatolo-Wagemann is online, John Maniscalco and Melanie Griffin for Commissioners.

APPROVAL OF AGENDA

CHAIR GROUT: We have in our documents an agenda. Are there any changes that people would like to make to the agenda? Seeing none; is there any objection to the agenda? Seeing none; it is approved by unanimous consent.

APPROVAL OF PROCEEDINGS

CHAIR GROUT: We also have the proceedings from the May 2025 meeting. Are there any comments, edits? Are there any objections to approving the minutes? Seeing none; that is approved by unanimous consent too. We're now down to setting our quota period for, oh one more thing I forgot.

PUBLIC COMMENT

CHAIR GROUT: This is an opportunity we have right now for public comment on Atlantic herring for items that are not on the agenda? Is there anybody in the audience that would like to speak to something that is not on the Atlantic herring agenda? Is there anybody online? Okay.

SET QUOTA PERIOD FOR THE 2026 AREA 1A FISHERY

CHAIR GROUT: Now we'll move on to Setting the Quota Period for 2026 Area 1A Fishery. Emilie is going to give a brief presentation on this.

MS. EMILIE FRANKE: Great, thank you, Mr. Chair. Just on the next slide I'll just go over first the potential quota for Area 1A for 2026. There are two different possibilities for next year. Then I will review the FMP details on the quota periods for Area 1A, and the Board action for consideration today is to set the quota periods for the 2026 Area 1A Fishery.

As far as the quota for next year, just as little bit of background. This Board did approve a set of revised specifications for Atlantic herring for all of the areas back in May, and these were substitutions as recommended by the New England Fishery Management Council.

The Board approved those specifications contingent on a Final Rule being published by NOAA Fisheries. In June, NOAA did issue a proposed rule for those specifications. However, the Final Rule has not yet been implemented and the timeline is TBD. We do not know when those specifications will be implemented, so far these specifications for 2026 are not in place. If NOAA Fisheries does publish that Final Rule in time for next year's season, then the sub-ACL for Area 1A would be 2,640 metric tons.

However, if the Final Rule is not implemented in time for next year's fishery, then the current year's specification, so it would be 2025 specifications would roll over to be the 2026 specifications, that is per the Federal FMP. In that case, the sub-ACL would be 783 metric tons. There are two quota scenarios. Again, we don't have any details on the timeline for implementation of those specifications.

Then as far as how the quota period worked for Area 1A, just as a reminder, per Amendment 3 to the Interstate FMP, these quota periods shall be determined annually by the Board for Area 1A. The Board can distribute the Area 1A sub-ACL to meet the needs of a fishery across the year using, there are a couple options for different types of quota periods.

There is the bi-monthly, the trimester or the seasonal quota periods. The Board can also decide whether any quota from January 1st to May 31st should instead be allocated to June 1st or later. The Board would also specify whether any underages from one period would be rolled into the next period.

Up on the screen, I know it's a lot of tables, but Amendment 3 outlines all of the options for these quota periods. It's important to note that these percentages are fixed. The only way we can change these percentages would be through an Addendum. At the top of the screen that is the bi-monthly option, where the quota is allocated to two-month periods throughout the year.

There are also separate options if you would like no landings prior to June 1st. The first option if you want to include the first part of the year, and then the second two options are no landings before June 1st. Then at the bottom on the left is the trimester option, where you have three quota periods throughout the year.

Then at the bottom on the right are the seasonal quota periods. Again, you have an option for landings before June and then options for no landings before June. What is happening in the last few years. Back in 2019 the Board decided to go with bi-monthly quota periods for Area 1A with no landings prior to June 1st. The underages were rolled into the next period.

Then for the last six years the Board has opted to go with the seasonal quota period approach, with no landings prior to June 1st, and underages rolled into the next period. That is all I have in terms of background. Happy to answer any questions.

CHAIR GROUT: Questions for Emilie. Seeing no questions; we do need to set a season. Megan Ware:

MS. MEGAN WARE: Yes, I have sent staff a motion to set the season. Obviously a really frustrating situation on the herring specs. I hope that resolves itself soon. I think regardless, I would support continuing to use the same season split we've used recently. **Move to implement seasonal distribution of quota for the 2026 Area 1A sub-ACL with 72.8% available from Jue through September and 27.2% allocated from October through December, with no landings prior to June 1. Underages will be rolled over into the next quota period. The fishery will close when 92% of the seasonal period's quota is projected to be caught.**

CHAIR GROUT: Renee Zobel seconding it. Megan, would you like to provide rationale?

MS. WARE: Just obviously still working under very low quotas. There is not a lot of room to move here, so I think keeping what we've been doing works as best as we can.

CHAIR GROUT: Renee as seconder do you have? Ray Kane.

MR. RAYMOND W. KANE: Megan, do you think we should include in this motion something about the rollover from Canada, with the weir fishery up there? It doesn't happen until what, the middle of October, but should something be in this motion? Should it be mentioned?

CHAIR GROUT: Megan.

MS. WARE: My understanding is that that is a Federal Process, unfortunately. For us right now with the Federal Government shut down, so I don't think that is something the Commission has control of or going through that now.

CHAIR GROUT: Rob LaFrance.

MR. ROB LaFRANCE: Just a quick question, Megan. Is the 92%, is that current practice? Thank you.

CHAIR GROUT: Any other questions? Jeff Kaelin.

MR. JEFF KAELIN: I just wanted to speak in support of the motion, Mr. Chairman. No questions.

CHAIR GROUT: Okay, thank you, is there any other comments from the Board? Seeing none; I'm going to try this the easy way first. **Is there any objection to this motion? Seeing no objection it is approved by unanimous consent**. Thank you very much.

This will also give us time, since there is not going to be any landings before June, that if we come up with a situation where we have to adjust what we approved back in May for a quota, that we can make that adjustment at the spring meeting, or even the winter meeting if we find that out.

CONSIDER APPROVAL OF FMP REVIEW AND STATE COMPLIANCE FOR THE 2024 FISHING YEAR

CHAIR GROUT: Next item is Approval of the FMP Review and state Compliance.

MS. FRANKE: On the next slide I'll just briefly go over the main points of our FMP Review, including a couple of recommendations from the Plan Review Team. Again, the Board is considering approving the FMP Review, Compliance Reports and one de minimis request for 2024. Just a reminder, as far as the FMP. We have complementary management plans between the Commission and the New England Fishery Management Council. As far as the Interstate FMP we are operating under Amendment 3, as well as its addenda. Addendum I, which further specifies the Days Out Program for Area 1A and Addendum II, which further specifies the Gulf of Maine spawning closures. On the next slide, as far as the status of the stock, we are currently under a rebuilding plan that's at the Federal level.

As far as stock assessments, the last stock assessment to provide an update on stock status, that was the 2024 management track assessment, conducted by the Northeast Fishery Science Center. They found the stock was overfished but not experiencing overfishing. One of the things it noted, as well as previous assessments has noted is the poor recruitment for the stock for the past several years, and the difficulty of identifying a particular mechanism that is really driving that low recruitment.

There was a research track assessment earlier this year, it was peer reviewed in March 2025. Notably that transitioned the stock to the WAM model. I think we'll have a presentation to the Board on that benchmark at one of the upcoming meetings. Then as you may recall, the research track assessments through NOAA do not provide stock status, so the next assessment that will provide stock status relative to the reference points will be a management track assessment that is scheduled for this coming year in 2026.

On the next slide this is Atlantic herring landings, U.S. landings are in orange and Canadian landings are in that kind of darker red. Over time you can see as was mentioned during the last agenda item, you know we are really in a low quota situation here for the past several years. Landings have really dropped off as those quotas have decreased quite a bit in the recent years.

On the next slide, these are preliminary 2024 landings from NOAA Fisheries quota monitoring. You can see the landings are listed by area. That first column you see the sub-ACL for each area, the landings and then the last column is the approximate percent of that sub-ACL that has been caught. At the bottom you can see overall last year across all areas, about 51% of the sub-ACL was harvested, primarily from Areas 1A and Area 3. That is about 22 million "Ish" pounds.

As far as sort of comparing to recent year's landings in 2023 and 2024 were more than double '21 and '22. We're now at about 22 million pounds as compared to about 10 or 11 million pounds in '21 and '22. We're still in this very low quota situation. Maine and Massachusetts do typically account for more than 90% of landings, and it is important to note that some vessels do land herring outside of their home port state.

On the next slide the PRT typically discusses every year, we also get updates from the fixed gear fishery. Obviously, most of the landings are coming from the mobile gear. But we do get updates from Maine, where there is a small portion of landings from fixed gear and fixed gear does get a 30 metric ton set aside in Area 1A.

Maine noted that last year in 2024 there was low fixed-gear harvest. But this was due to some overlap with other species on the shores, particularly menhaden arrived a little bit early last year and that sort of impeded the transit of Atlantic herring into those fixed gears, those stop seines. However, despite those low landings the past few years, these fixed gear harvesters in Maine waters have consistently reported adult herring returning to Maine waters in early spring. As far as comments, the PRT finds that all states have regulations in place that meet the requirements of the FMP. New York is requesting de minimis and they do meet that requirement. The average of the last three years of commercial landings is less than 1% of the coastwide total for that period. New York has had de minimis status for quite a while.

Then on the next slide the PRT had a couple of recommendations for the Board to consider. First, a short-term recommendation is for the Board to discuss long term funding solutions for the Maine DMR portside sampling program. I'll let Maine speak to this after the presentation in detail. But essentially, funding is needed to collect biological samples out of state.

These are really important to inform the spawning closures to Area 1A and overall, for the entire coast for the stock assessment. A medium-term recommendation from the PRT is for the TC to at some point review the Area 1A spawning closure protocol to determine if there are any concerns with the prolonged period we've had of insufficient samples and using the default closure date.

Essentially, in recent years there haven't been enough samples to forecast a closure date, so we've been using the default closure dates in the FMP. The PRT recommends the TC discuss this. The Board has noted this should not be a short-term priority, because we're working with such low quotas. But at some point, the PRT recommends the TC discuss this.

Finally, the last recommendation is, the next time the Board does a management action, for the Board to also look at the definition of fixed gear in the FMP. Right now, fixed gear is only defined as stop seines and fish weirs only. But there are other gears being used like pound nets and gill nets.

Just sort of for context I mentioned there was the low fixed gear harvest in Maine last year. However, this year the Maine fixed gear harvest was quite a bit higher, and they actually used the entire fixed-gear set aside by summertime, so just something we'll need to continue to monitor closely so we'll take a look at this definition in the future. But that's it, happy to take any question.

CHAIR GROUT: Questions for Megan, I mean Emilie, sorry. Yes, Ray.

MR. KANE: Emilie, you spoke about the Maine DMR. What about an observer program in Massachusetts, because those vessels fish in Area 4 would be Georges Bank, and they fish it in the spring primarily and they catch their quota. What is the coverage there? I would like to know that we've got coverage defining Atlantic Sea herring and river herring.

MS. FRANKE: As far as observer coverage I can't really speak to the specifics. I know NOAA Fisheries has noted in the past, especially during COVID there were some challenges with observer coverage. But that would be a question for Federal Staff once they return, on sort of what the specifics are for Area 3 observer coverage.

CHAIR GROUT: Follow up, Ray.

MR. KANE: Yes, please, thank you. We're looking for funding for Maine DMR for a dockside program, how about Massachusetts?

MS. FRANKE: I think, and I'll let Megan speak to this, but I think typically Maine DMR has been able to collect and process the samples from multiple states. Massachusetts DMF staff definitely assist with that sample collection in coordination, but I think a lot of the program for samples is run by Maine DMR.

MR. KANE: Thank you.

CHAIR GROUT: Megan.

MS. WARE: Yes, maybe just a little bit about that. Yes, Maine has been doing the herring samples basically coastwide for all the states. It was originally an ACCSP Grant, we graduated from that and have been trying to hang on with some funds. But at this point the funds are out.

We in November of 2024, amended our Herring Disaster Spend Plan to include some funds for this. That was almost two years ago and we still have not gotten approval of that Herring Spend Plan. A really frustrating situation there. In the absence of that we don't have any funds, so we can carry on for just the Maine portion of the herring sampling, but we don't have funds to send staff up and down the coast right now.

I think what would be a good step is maybe I can ask Emilie to coordinate a call of the administrative commissioners or if any other commissioners that want to join, to start talking about other options. I know at one point we talked about states collecting their own samples, sending them to Maine for processing. I think that is an option. Otherwise, it's states kind of taking that on themselves. But definitely something we need to figure out, because we are out of ACCSP funds at this point.

CHAIR GROUT: Emilie.

MS. FRANKE: I believe the amount is about $25,000.00 per year.

MS. WARE: Yes, it's a really low amount. I think in our herring amended spend plan we have tried to ask for two or three years of funding. That's obviously not that much. Just a little background on that. We had a provision in our original Herring Disaster Spend Plan that said if someone is undergoing litigation regarding that herring harvest, we would basically hold their portion of the disaster funds until that litigation was complete.

We had that happen. The result of the litigation basically said that person was no longer eligible based on our criteria for their portion of the funds, so we have an individual's funds that we are trying to reallocate, and we were going to use some of that for herring port sampling and then distribute the rest to the herring harvesters, but we have not been able to get that approved.

CHAIR GROUT: Nicole.

MS. NICOLE LENGYEL COSTA: Megan, is the majority of the portion for that funding just due to stopped traveling to the other states? If the other states were able to continue the sampling and send the samples to Maine, would you still be able to do the processing and aging without funding?

MS. WARE: Yes, that is correct, it's mostly travel cost at this point. We can do the processing if folks are sending us stuff.

CHAIR GROUT: Further questions about this? Okay, we need a motion to approve the FMP Review and a de minimis request from New York. Go ahead, Jeff Kaelin.

MR. KAELIN: I **move to improve the Atlantic Herring FMP Review for the 2024 fishing year, state compliance reports and de minimis request for New York.**

CHAIR GROUT: The second is Matt Gates. Would you like to provide any rationale for this?

MR. KAELIN: The end of the meeting and let's get it over with, no it speaks for itself, Mr. Chairman, I think.

CHAIR GROUT: Does anybody have any comments on this? **Is there any objection to this motion? Okay, motion is approved by unanimous consent.** Thank you very much.

ELECT VICE-CHAIR

CHAIR GROUT: Next agenda item is to elect a Vice-Chair. Megan Ware.

MS. WARE: **I would like to nominate Eric Reid as Vice-Chair**.

CHAIR GROUT: Ray Kane will second that nomination. Do you have any objection to that, Eric Reid? **Are there any objections to having Eric Reid as your next Vice-Chair? Seeing none; it is approved by unanimous consent**. Thank you very much, Eric. We'll start calling you Mr. Chairman again soon.

ADJOURNMENT

CHAIR GROUT: Okay, only other thing is Other Business. Any other business that people would like to bring up? Seeing none; I'll take a motion to adjourn. So, moved. Thank you very much for an efficient meeting.

(Whereupon the meeting adjourned at 11:37 a.m. on Monday, October 27, 2025)

Northeast Fisheries Science Center Technical Memorandum 335

Atlantic Herring Research Track Assessment Report

March 2025

Northeast Fisheries Science Center Technical Memorandum 335

Atlantic Herring Research Track Assessment Report

by the Northeast Fisheries Science Center

NOAA Fisheries, Northeast Fisheries Science Center, 166 Water Street, Woods Hole, MA 02543

US DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts

March 2025

Northeast Fisheries Science Center (NEFSC) Reference Documents

This series is a secondary scientific series designed to assure the long-term documentation of and to enable the timely transmission of research results by Center and/or non-Center researchers, where such results bear upon the research mission of the Center (see the outside back cover for the mission statement). These documents receive internal scientific review, and most receive copy editing. The National Marine Fisheries Service does not endorse any proprietary material, process, or product mentioned in these documents.

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Information Quality Act Compliance: In accordance with section 515 of Public Law 106-554, the NEFSC completed both technical and policy reviews for this report. These pre-dissemination reviews are on file at the NEFSC Editorial Office.

This document may be cited as:

Northeast Fisheries Science Center. Atlantic Herring Research Track Assessment Report. US Dept Commer, Northeast Fish Sci Tech Memo. 335; 91p.

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PEER REVIEW PANEL SUMMARY REPORT

Report prepared by Peer Review Panel members:

- Dr. Conor McManus (Chair), New England Fisheries Management Council Science and Statistical Committee
- Dr. Henrik Sparholt, independent contractor with the Center for Independent Experts
- Dr. Florian Berg, independent contractor with the Center for Independent Experts
- Dr. Gary Melvin, independent contractor with the Center for Independent Experts

The Northeast Region Coordinating Council (NRCC)[1] has developed an enhanced stock assessment process to improve the quality of assessments. The process involves two tracks of assessment work: 1) a Management Track (MT) that includes routine updates of previously approved assessment methods to support regular management actions (e.g., annual catch limits), and 2) a Research Track (RT) that allows comprehensive research and development of improved assessments on a stock-by-stock or topical basis. The RT assessment process allows for a more thorough review of information available and for the evaluation of different assessment approaches than would be possible in a standard stock assessment process where the results are immediately needed for management advice. RT assessments are followed by MT assessments; occasionally, scientists can improve an RT assessment before or during a subsequent MT assessment. This Peer Review Panel (hereafter Panel) reviewed the RT Assessment for the Atlantic herring stock in United States waters.

Scientists first assessed Atlantic herring using Virtual Population Analysis (VPA) in the 1960s-70s. Since 2009, the Northeast Fisheries Science Center has assessed the stock using the Age Structured Assessment Program (ASAP), which it developed. Scientists conducted the last benchmark stock assessment in 2018, have provided updates every other year since, and most recently completed an MT assessment in 2024 using ASAP. The RT assessment for Atlantic herring aimed to develop an age-structured state space assessment model to estimate process and observation error and to consider environmental covariates within the model.

The Atlantic Herring RT Working Group (WG) used the Woods Hole Assessment Model (WHAM) platform to develop a state space model to be used in future MT assessments of the stock. Matt Cieri (MEDMR) chaired the WG that included staff from NEFMC, GARFO, Massachusetts Division of Marine Fisheries (MADMF), University of Massachusetts – Dartmouth School for Marine Science and Technology (SMAST), and Rutgers University. Terms of Reference (TORs) for the WG are provided in Appendix 1.

The Atlantic Herring RT assessment peer review took place in Woods Hole, MA, during March 10-14, 2025 using a hybrid meeting platform. The Panel included three independent scientists selected by the Center for Independent Experts (CIE): Henrik Sparholt, Florian Berg, and Gary

[1]Atlantic States Marine Fisheries Commission (ASFMC), Greater Atlantic Regional Fisheries Office (GARFO), Mid-Atlantic Fishery Management Council (MAFMC), New England Fishery Management Council (NEFMC), and Northeast Fisheries Science Center (NEFSC).

Melvin. Conor McManus (Member of the NEFMC Scientific and Statistical Committee) chaired the Panel. The agenda is located in Appendix 2 and attendees in Appendix 3.

The RT WG submitted the Assessment Report and supporting working papers to the Panel via the NEFSC data portal (https://apps-nefsc.fisheries.noaa.gov/saw/sasi.php) on February 21, 2025. The RT WG provided additional information requested by panelists during the peer review and uploaded it to the data portal. Listed items are in Appendix 4. Before the meeting, on March 6, 2025, members of the Panel met with Brian Hooper (NEFSC's Stock Assessment Process Lead) and Kristan Blackhart (Chief, NEFSC Population Dynamics Branch) to review and discuss the meeting agenda, reporting requirements, meeting logistics, and the overall process.

In addition to the report and working papers, WG members and Chair-invited participants made presentations available on the data portal during the RT Review. WG members attended the meeting to answer questions from the Panel, and NEFSC staff acted as rapporteurs to capture conversations between the Panel and WG, Panel consensus on various topics, and Panel recommendations. Panelists led drafting individual portions of this report, but the entire Panel edited and reviewed the report to ensure it represents the consensus views of the Panel. The Panel Chair compiled and edited this Summary Report with assistance from all panelists before submission of a draft report to the WG Chair and WG Lead Analyst. CIE Panelists will submit separate individual reviewer reports to the CIE.

The Panel agreed that all eight TORs were adequately addressed. With specific regard to the transition from ASAP to WHAM, the WG presented a series of WHAM runs testing the sensitivity of the model to various configurations and life history assumptions. The final candidate model recommended by the WG included many of the same data inputs as the previous 2024 MT ASAP configuration except for select elements outlined in the main WG report; however, the model now includes random effects being applied in the model, most notably on the numbers-at-age (NAA) transitions. After reviewing the various model variants the WG provided, and further investigation of the diagnostics and outputs from the models, the Panel agrees that WHAM is an appropriate tool for the Atlantic herring assessment and offers a scientific improvement over ASAP. Before the next MT assessment for Atlantic herring, the Panel provided several recommendations for consideration that strive for model diagnostic improvements, improved biological plausibility, and a deeper understanding of WHAM given its relatively nascent nature. In its recommendations, the Panel emphasized the importance of better understanding the impacts of the NAA random effects, including the stability of NAA estimates with additional years of data added through peel analyses, and their influence or utility in projections. While WHAM reduces retrospective patterns compared with the ASAP for this stock, the uncertainties around the projection methods need further investigation, particularly as they relate to projections beyond the bridge year and subsequent year. The Panel commended the WG for the substantial amount of work made in moving to the state space WHAM platform for the Atlantic herring stock and for the collegial nature of the review.

The Panel's evaluation of the WG's responses to the eight TORs is provided below.

> ***Term of Reference (TOR) #1:*** *Identify relevant ecosystem and climate influences on the stock. Characterize the uncertainty in the relevant sources of data and their link to stock dynamics. Consider findings, as appropriate, in addressing other TORs. Report how the findings were considered under impacted TORs.*

The Panel concluded that this TOR was adequately addressed.

Significant progress has been made in the identification of ecosystem drivers that can influence Atlantic herring abundance and distribution. The findings in TOR 1 were addressed and further considered in TOR 4 and TOR 7. Uncertainty was documented through the analyses, both within TOR 1 via analyses and a literature review, and through evaluation of TOR 1 elements in TOR 4 (i.e., WHAM sensitivity runs).

The WG provided a thorough review of Atlantic herring life history and ecosystem drivers on the species (as documented in the literature) through an updated Ecosystem and Socioeconomic Profile (ESP). The ESP leveraged essential fish habitat and life history information previously collated and gathered new, more contemporary research. The processes that influence population dynamics and could be evaluated as environmentally explicit relationships in WHAM were better understood through the use of ESP. These endeavors led to a conceptual life history model that outlined the various ecosystem influences on the species in this region, with hypotheses for the impact of specific conditions on each life stage (Figure 1). This conceptual model was then used to identify possible environmental datasets for further exploration.

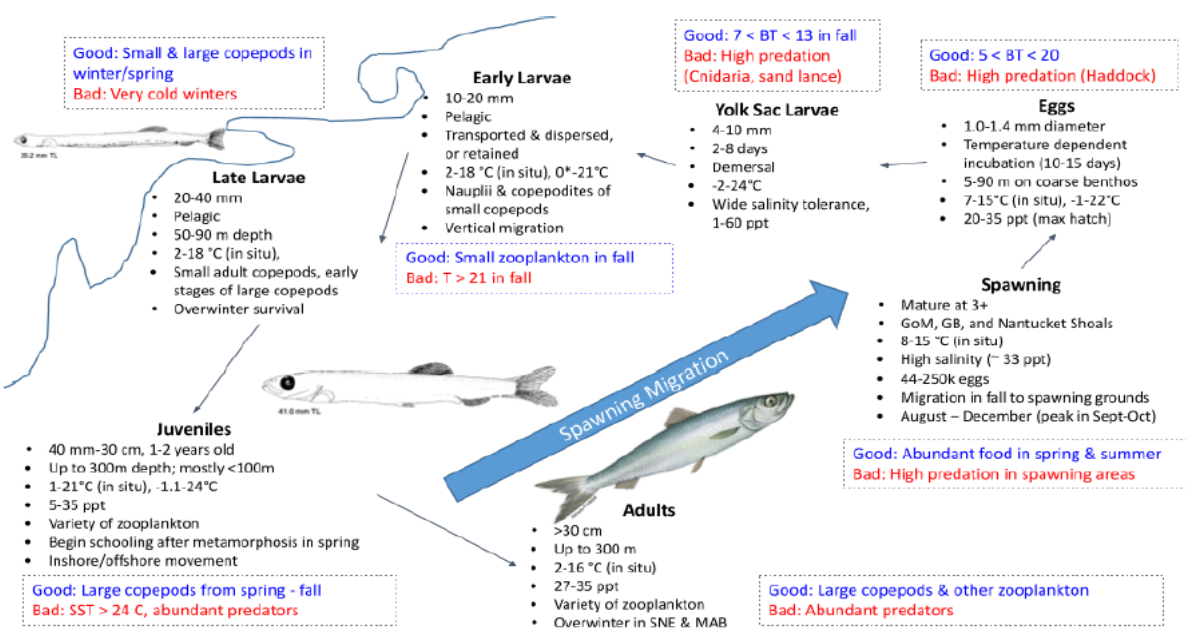

Figure 1. Life history diagram and ecosystem influence hypotheses for Atlantic herring as presented by the WG and in the assessment report.

The WG used boosted regression trees (BRTs) to understand which environmental factors influence Atlantic herring, and their relative importance compared with each other. Several covariates were explored (e.g., copepods, haddock, temperature indices) to understand influences on Atlantic herring (e.g., starvation/food availability, predation pressure, thermal mortality). The response variable for the BRTs was Atlantic herring recruitment estimated from the previous ASAP run to help guide how these covariates could be used in conjunction with recruitment estimates in WHAM.

The Panel commended the WG for its efforts within the ESP, as well as using both hypotheses for impacts on herring recruitment to guide model prioritization runs and ensure biological plausibility. In addition, the use of a tool (e.g., BRTs) was appreciated to determine which variables were most sensible for testing within WHAM.

The Panel recommended several future advancements for this work, including modifications to copepod and haddock predation indices to refine the indices and better capture the interactions between these factors and herring. In addition, the Panel suggested considering competition metrics (e.g., other forage fish abundance) in the future given the abundance and spatiotemporal changes in certain species that have been captured in the literature and reflected in the stakeholders' comments collected via this assessment. The environmental covariates constructed might also be used to understand other processes within the assessment model (e.g., catchability and selectivity, natural mortality, growth) as deemed appropriate in the future.

The Panel provided two substantive comments of caution for the BRTs going forward. The first concern was with regard to the BRT method. The Panel was unclear on whether the BRT was the best tool for this prioritization exercise compared with other methods (e.g., principal component analysis, dynamic factor analysis, other regression approaches). Testing WHAM and ASAP recruitment data for the BRTs suggested that variable importance conclusions may be subject to input data with the BRTs (Figure 2), and testing its robustness against other methods would be beneficial in the future. The second concern involved using assessment model output (i.e., Age-1 Atlantic herring estimates) for these analyses. Caution is raised when conducting post-hoc analyses using data output as the uncertainty in the assessment products themselves is often overlooked (Brooks and Deroba, 2015; Dickey-Collas et al., 2015). The differences in BRT results from using WHAM and ASAP-predicted recruitment also suggest this concern, in addition to the rather circular nature of these analyses (i.e., use WHAM-estimated recruitment to pick an environmental

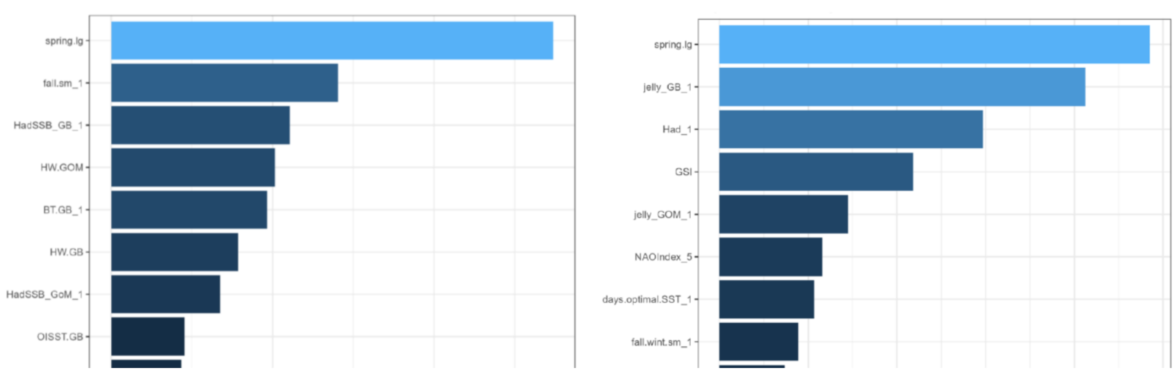

Figure 2. Boosted regression tree results for environmental variables explaining Atlantic herring recruitment estimates produced from ASAP (left) and WHAM (right). Figures were presented during the peer review.

covariate to include in modeling for revised WHAM-predicted recruitment). Efforts should be made to analyze Age-1 abundance indices from other sources (e.g., state surveys, seabird diet data) to avoid this circularity.

TOR #2: *Estimate catch from all sources, including landings and discards. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data.*

The Panel concluded that this TOR was adequately addressed.

The information presented by the WG provided a good and general summary of the landings over time, by region, and gear type given the historical extent of the fishery and the magnitude of catches. They identified potential uncertainty associated with the different reporting mechanisms and how estimates of discards were integrated into the estimates of landings over time. Over the years, the authorities responsible for the data collection used several approaches to account for fishing mortality (catch and discards) from all sources. The implementation of CAMS in 2020 represents an improved methodology in this process and reflects the sequential approach in the enhancement of the catch monitoring/reporting system. While the WG met the TOR regarding fishing effort in the macro-sense, limited information was provided on the spatial and temporal changes or variability of the fishery (fleet activity), which occurred within a broad geographical area. Showing how and where fishing effort has spatially decoupled over time in relation to the available surveys and their coverage would have been informative. The Panel agreed with the decision to use CAMS to estimate catches and discards given its reasonable comparability with past approaches; however, a few inconsistencies were identified in the reporting with slight differences for the CAMS between the report and the presentation. These differences need resolution and correction in the reporting. The Panel strongly recommends comparative analyses presented from 2020 onward be conducted as far back as possible (e.g., 1996). This will allow for determining whether differences between previous methods and CAMS align with smaller differences observed from 2021 to 2023 or larger differences as observed in 2020 (i.e., up to a 25% difference).

The number of biological samples (50 fish/sample) from commercial catches has dramatically declined and the temporal coverage has contracted since 2019 due to the reduction in allowed catch and management restrictions. Although the total number of samples is the lowest in the time series (1964-present), the WG concluded that the level of sampling was adequate to describe the characteristics of the mobile fleet. Information on the fixed gear fishery (i.e., weir/shutoff) was provided by the Canadian Department of Fisheries and Oceans and resulted in some slight modifications, but inconsequential relative to the assessment. The weight at age for the commercial fishery, which showed a steep decline between 1980 and 1990 for most adult ages (i.e., representing a potential loss in productivity), appears to have leveled off and may even be increasing slightly for some age groups in recent years. This is consistent with observations for adjacent and ocean-wide herring stocks as well as many other fish species.

Spring spawning fish were mentioned on several occasions during the meeting. While traditionally, the stock has been dominated by fall spawners and remains so, the continued presence of spring spawners in catches and survey sampling may be a forerunner of things to come. Unfortunately, their presence appears more anecdotal with no quantification of their presence. The proportion of spring spawners in the resource and the fishery is not expected to be large or have an impact on the assessment at the current time but is worth considering in the future.

TOR #3: *Present the survey data used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, application of catchability and calibration studies, etc.) and provide a rationale for which data are used. Describe the spatial and temporal distribution of the data. Characterize the uncertainty in these sources of data.*

The Panel concluded that this TOR was adequately addressed.

The WG provided an overview of the fishery-independent surveys available and used in the Atlantic herring stock assessment. The four surveys currently used in the assessment model included the NEFSC Spring (1968-present) and Fall (1963-present) Bottom Trawl (BT) surveys, the Summer (Shrimp) survey (1980s-2023) and the Acoustic survey (1998-present) conducted as part of the Fall BT survey. The former three surveys focus on the near-bottom distribution and abundance of herring (Figure 3), while the latter quantifies fish throughout the water column. The Panel suggested that additional explorations of the Acoustic/BT survey data be undertaken to evaluate the catchability of the gear and potentially combining the Fall BT and Acoustic survey data into an age-based acoustic index given they are from the same ship and time.

All surveys have broad geographical coverage and incorporate the general extent of herring distribution at the time of the surveys. The NEFSC BT surveys time series have been split multiple times to account for gear and vessel changes. These surveys have been the subject of several evaluations in past assessments and the current configuration has been consistently applied since the 2018 framework review. The WG concluded that no new information warranted reevaluating the previously accepted characteristics of these surveys and calibration between the vessels or door changes.

One noted omission in the assessment was the larval survey series that extends back to the 1970s (Richardson et al. 2010). This extensive survey, which has a broad coverage, should be explored further as it may provide additional information on the early life history of herring. In addition, the survey has the potential to be used as an index of abundance to complement the limited data in the assessment surrounding recruitment (Age-1 herring) or herring in their first year of life. The Summer (Shrimp) survey was paused in 2024 and uncertainty about its future was expressed. The Panel suggested that the WG evaluate the impact of permanently losing a survey on the assessment beyond the traditional leave-one-out approach and hope for an ability to prioritize its continuation.

For many fish stocks, limited data exists to quantify recruitment and juvenile fish distribution/abundance (i.e., lack of an index of abundance). The WG explored five additional long-term surveys not included in the model: The MENH Spring and Fall BTS, the MADMF Spring and Fall surveys, and the seabird diet composition survey. Particular emphasis was placed on the seabird diet as a potential index of abundance for Age-1 fish. Combined, these surveys cover most nearshore (potentially broader) juvenile habitat and contain quantitative information on the abundance and distribution of juvenile fish. Although these surveys were dismissed from inclusion in the current assessment for various reasons, most of these surveys followed trends in abundance consistent with this assessment. The Panel highly recommended exploration of these surveys as indices of abundance and better leveraging the Age-1 composition data from the state surveys and the seabird diet. In addition, comparing the state surveys and the seabird diet might allow for confirming the accuracy of the diet data tracking inshore recruitment dynamics. Further, the Panel suggested that a more quantitative model-based approach (e.g., VAST, sdmTMB) might be useful to integrate surveys with spatial footprints smaller than the stock area into a single index for the assessment.

A limiting factor in the abundance indices currently used in the herring assessment is absence or poor representation of small fish (Age-1), although the sampling gear, in theory, is capable of capturing size fish of this size, when present. Selectivity for each survey clearly shows how the various ages are treated in the model and the limits imposed on the younger ages. Notably, acoustic technology will detect and quantify all age groups of herring if they are present. A knife-edge full selection for ages 3-8 may not be appropriate. Better understanding and quantification of the recruitment dynamics for this species is needed. Enhanced age composition data collection in recent years (i.e., 25 years) have improved the reliability of all indices.

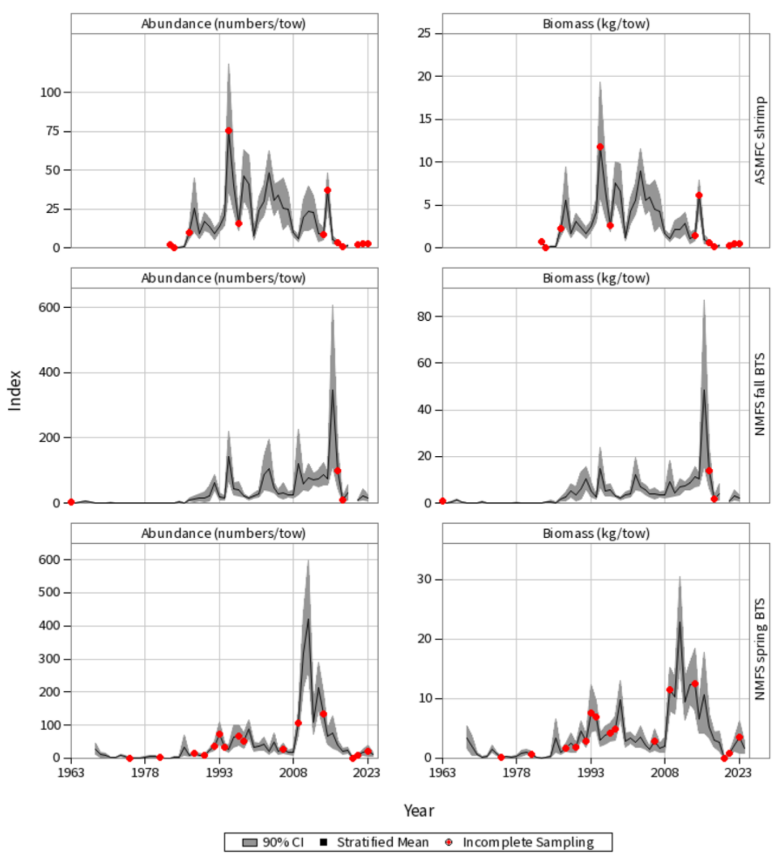

Figure 3. Stratified mean indices from NMFS trawl surveys (number per tow) as provided in the assessment report.

TOR #4: *Use appropriate assessment approach to estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Compare the time series of these estimates with those from the previously accepted assessment(s). Evaluate a suite of model fit diagnostics (e.g., residual patterns, sensitivity analyses, retrospective patterns), and (a) comment on likely causes of problematic issues, and (b), if possible and appropriate, account for those issues when providing scientific advice and evaluate the consequences of any correction(s) applied.*

The Panel concluded that this TOR was adequately addressed.

An underlying goal of the Atlantic herring RT assessment involved moving from ASAP used in previous Atlantic herring assessments to the WHAM platform. Although the WHAM platform was designed to utilize state space model formulations, the model offers many options for simplification, allowing the use of fixed effects similar to those in ASAP.

The basic data used in the assessment have gone unchanged since the 2018 benchmark stock assessment (NEFSC 2018), containing two fishing fleets: a mobile fleet and fixed fleet. The mobile fleet selectivity is age-based with selectivity fixed at 1.0 for ages 7 and 8 but estimated for all other ages. The fixed fleet selectivity is age-based with selectivity fixed at 1.0 for Age-2 but estimated for all other ages (see TOR 2 for more details). The surveys included in the assessment model are the NEFSC surveys: Spring Bottom Trawl, Fall Bottom Trawl, Summer, and Acoustic (see TOR 3 for more details).

A bridging analysis was constructed to define a WHAM model that mimics the most recent ASAP-based assessment (Figure 4). Run0 is "WHAM as ASAP" (i.e., no random effects, annual recruitments are fixed effects), and although the model did not converge, it replicated ASAP well.

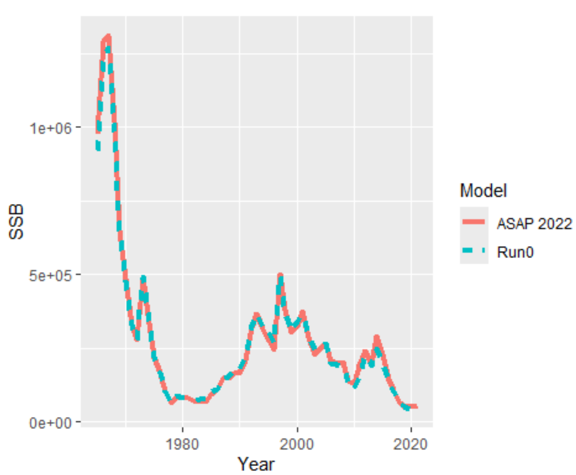

Figure 4. Spawning stock biomass (left) and recruitment (right) using ASAP (ASAP 2022) and WHAM with no random effects used (Run0). Figures are from the assessment report.

After bridging to WHAM, the WG explored several model configurations using eight model evaluation criteria, including convergence, residuals, retrospective patterns, AIC, and self-test. Firstly, the WG tried to solve the convergence issue, which was achieved by making recruitment an ar1_y random effect process, but the model still had some selectivity parameters on bounds and patterned one-step-ahead (OSA) residuals. None of the proposed model configurations resulted in a model without convergence issues or patterned OSA residuals. Next, the WG tried beginning the model in 1987 when age composition observations first became available from the bottom trawl survey (only age composition data from the fishery is available before 1987). This truncation resolved most issues of unidentifiable parameters, convergence, and residual patterns. However, this truncation raised concern about the model's ability to possibly estimate a stock-recruit curve, although the WG further highlights those previous attempts to estimate a stock-recruit curve failed. Consequently, the WG agreed to begin the model in 1987. The Panel agrees with the conclusion of the WG but recommends the WG investigate any possibilities to include data before 1987 in the future, especially when estimating reference points.

The WG continued with the WHAM model development using the truncated time series. First, the likelihood used to fit the age composition data was reevaluated using dirchlet-multinomial, dirichlet-pool0, logistic-normal-miss0, logistic-normal-ar1-miss0, or logistic-normal-pool0. The WG agreed that the logistic-normal-ar1-miss0 option provided the best residual diagnostics, and used this in all subsequent model configurations. The Panel supported this conclusion. Next, a more thorough evaluation of including various combinations of process uncertainty and correlation structures was conducted, e.g., testing iid, ar1_a, ar1_y, 2dar1 structures of abundance transitions (i.e., NAA), fishery selectivity, natural mortality (M), or recruitment. More than 200 model configurations were tested by the WG, and it used a suite of diagnostics to evaluate the different configurations. The WG investigated potential causes for model configurations that failed the diagnostics and provided solutions to account for those issues. The final model configurations used (1) the time- and age-invariant M=0.35, (2) decoupled NAA and recruitment processes, (3) iid distribution for the recruitment process, (4) ar1_a NAA random effects, and (5) estimated initial numbers-at-age (results compared to previous MT ASAP run in Figure 5). The Panel supported the final selected model configuration. However, the Panel suggested the WG evaluate the possibility to estimate recruitment at Age-2, as the current recruitment estimates are solely based on computational estimations (Age-1) without any observations. Further, the effects of the NAA random effects need exploration, especially during the projections. In addition, the Panel recommends investigating more biologically plausible configurations (e.g., implementing an age-based natural mortality). The WG presented one model configuration with scaled age-dependent mortality rates, but from a modeling point of view, the estimates did not change and the less complex model was selected at this time. The Panel suggests the MT allow for some flexibility for age-dependent natural mortality investigations.

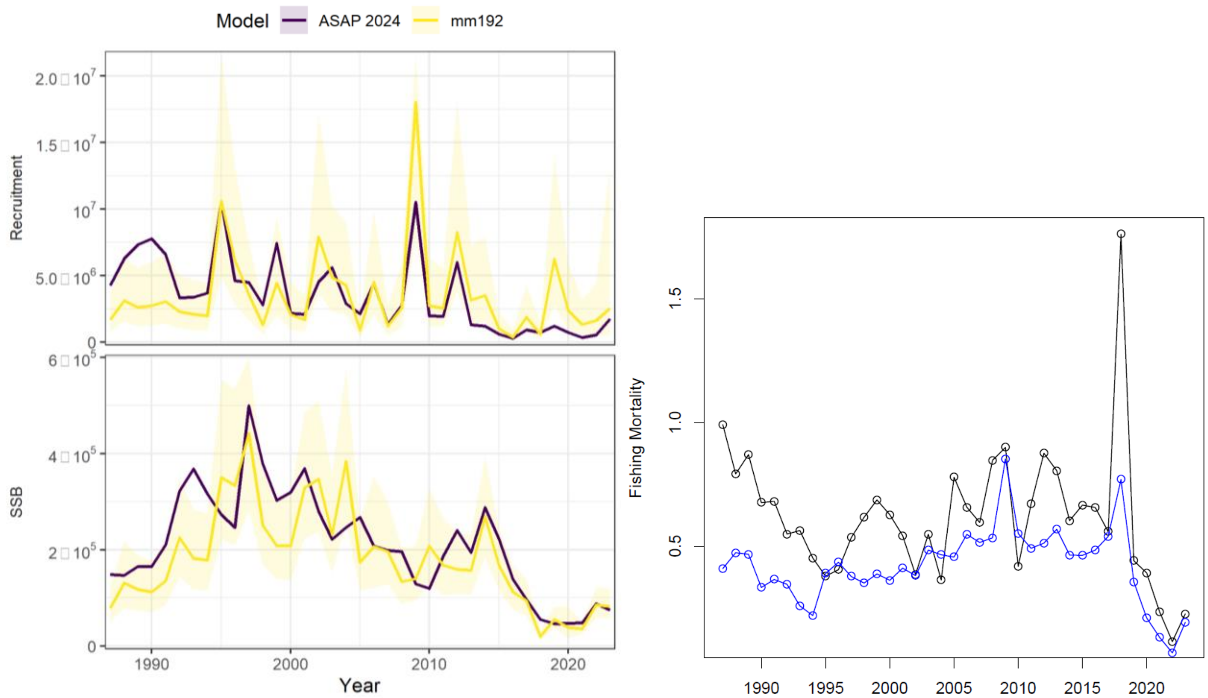

Figure 5: Results compared for the 2024 MT assessment (ASAP) and 2025 RT assessment (WHAM, mm192). Comparisons are provided for spawning stock biomass (SSB) and recruitment (left) and fishing mortality (right). For fishing mortality, the WHAM estimates are provided in black, and the ASAP results are presented in blue.

The Panel seeks to emphasize the effort of the WG to implement an Age-1 recruitment index based on seabird diet or the utilization of other environmental indices as covariates in the final WHAM model. In all cases, the data showed a positive signal, but the model did not improve enough to justify the inclusion of these extra parameters. In addition, some variables used produced counterintuitive relationships and thus need further exploration. The Panel recommends to continue work on this topic.

> ***TOR #5:*** *Update or redefine status determination criteria (SDC; point estimates or proxies for BMSY, BTHRESHOLD, FMSY, and MSY reference points) and provide estimates of those criteria and their uncertainty, along with a description of the sources of uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for reference points. Compare estimates of current stock size and fishing mortality to existing, and any redefined, SDCs.*

The Panel concluded that this TOR was adequately addressed.

The principles of previous assessments have been maintained or slightly improved since previous assessments, and the parameter setting and updates of input data were deemed appropriate. As in previous assessments, a stock-recruit relationship was not established because even very low stock sizes are as likely to produce average recruitment as large stock sizes. In addition, the WG believed that stock-recruit data from WHAM did not suggest an identifiable relationship (Figure 6). Therefore, the WG used a proxy, F40% (based on SPR calculations) for Fmsy. Assuming continued average recruitment might be problematic at low stock sizes, but given the current management strategy of reducing F when SSB is below half B40% for the major fishing fleet (the mobile-fleet), this assumption results in a low fishing pressure at low stock size.

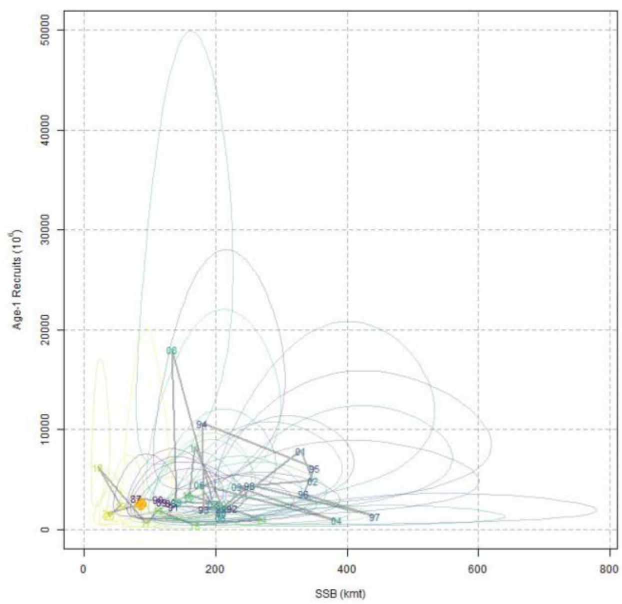

Figure 6. Stock-recruit plot from WHAM, as provided in the TOR 4-6 working paper.

Despite the difficulties in establishing a suitable stock-recruit relationship in most fish stocks, international efforts have trended toward this approach over the past decades. The International Council for the Exploration of the Sea (ICES) outlines various types of stock-recruit patterns and suggestions on models and software to apply and estimate stock-recruit model parameters (ICES 2003). One advantage of forcing a stock-recruit curve on the often very unclear stock-recruit pattern is forcing recruitment to zero when spawning stock is zero in the assessment. This will also allow for analytical reference points. As such, the Panel encourages a deeper investigation into prospective stock-recruit relationships for Atlantic herring in the future.

F40% is calculated differently in ASAP versus WHAM. In ASAP, the mobile-fleet selectivity is considered to find F40%, while the fixed-fleet is entirely ignored (so F40% will be higher in ASAP because the fixed-fleet is ignored). In contrast, WHAM estimates a global F40% that when distributed among the two fleets produces SPR40%, implicitly accounting of both fleets. WHAM estimates a global F40%, and then the fleet-specific F40%s are derived based on relative selectivity. B40% only slightly considers the fixed fleet in ASAP, but it is more accurate in the WHAM approach.

The very large difference in selectivity between the two fleets (Figure 7), makes interpretation of the F40% complicated when F is defined as F on Age-7, as done in the current assessment. Normally, F is expected to reflect fishing pressure on the dominating age groups in the fishery. For these two fleets, the dominating age groups are very different. To improve the situation, the Panel suggests to investigate new F metrics, such as the use of average F for Ages 2-6.

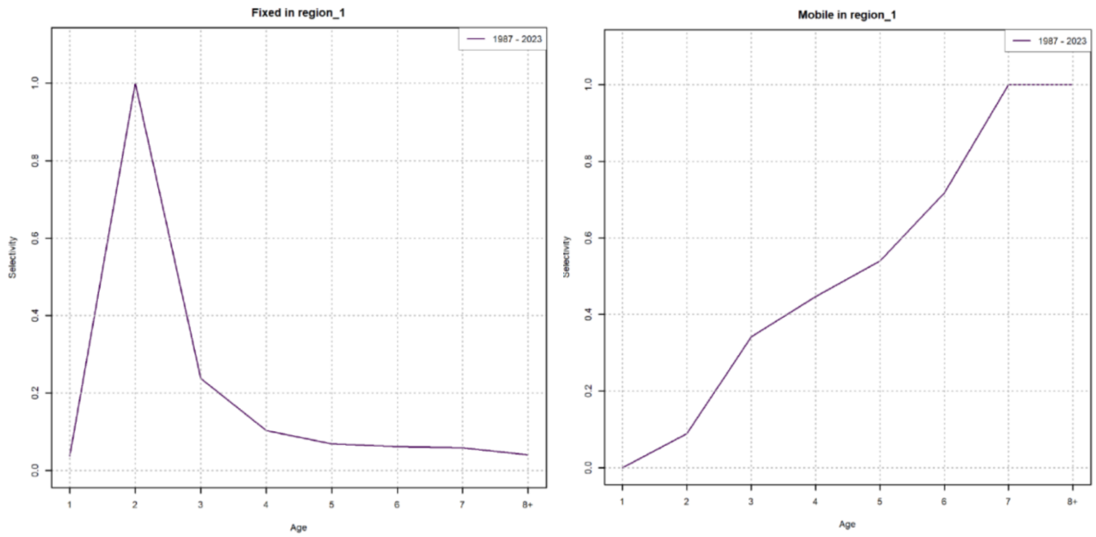

Figure 7. Selectivity patterns by age for the fixed (left) and mobile (right) fleets, as provided in the TOR 4-6 working paper.

In recent years internationally, focus increased on density-dependence (DD) in growth, maturity, and natural mortality in long-term projects, including in reference point calculations. DD in recruitment—to be more precise in survival from egg to recruitment—is appropriately addressed by using stock-recruit model or, as in this assessment, by assuming recruitment to be constant and independent of spawning stock. Density-dependence on recruitment is the main compensation mechanism for fishing in fish stocks generally, but recent science has shown that DD in growth, maturity, and natural mortality can also contribute substantially in fish stock dynamics, and missing it could result in an overestimation of stock size in reference points. This might be explored in future assessments of this stock as well.

While using F40% and B40% may be considered antiquated, they have worked reasonably well for many years when managing fish stocks. Newer science involving multispecies interactions, cannibalism, DD, and meta-analysis are available and may be worth considering. For instance, proxy Fmsy estimates based on life history parameters (e.g., age at 50% maturity and von Bertalanffy growth parameters K and Linf) are now available. Some of these new approaches could be considered. Or at minimum, comparing the results of these to F40% or B40% may be insightful. Alternative reference points (e.g., at 30% or 50%) were not presented, thus determining how sensitive results are to the reference point specification is difficult. Although intuitive regarding the directionality of reference point change impacts when considering alternative percentages, the magnitude of the impact could not be assessed by the Panel. While the Panel understands and ultimately supports the continued use of 40% based on life history information, further comparisons to other reference points would offer valuable insights.

TOR #6: *Define appropriate methods for producing projections; provide justification for assumptions of fishery selectivity, weights at age, maturity, and recruitment; and comment on the reliability of resulting projections considering the effects of uncertainty and sensitivity to projection assumptions.*

The Panel concluded that this TOR was adequately addressed.

The assumptions and input data to the projections were considered adequate by the Panel. However, the projection results seemed highly uncertain (e.g., Figure 8). As such, the Panel was uncertain on how useful projection estimates beyond the bridge year + 1 are for providing management advice. The Panel was of the opinion the median value projected showing a quite steep increase was a balanced result of the data and analysis available.

The Panel believed the SSB estimates are likely overestimated, given the projections suggest that SSB can be rebuilt to historic (or time-series high) levels within the next three to four years (Figure 8). Density-dependent effects on growth, maturity, and natural mortality would also likely be realized in this case and prevent these levels. Conversely, the lower confidence limit is probably an underestimate as the weight-at-age input data for the projections ignores a slight upward trend in weight-at-age in the most recent couple of years.

The rapid increase in the stock under the projections did not appear driven by recruitment assumptions, given these recruitment levels are small when compared with SSB in 2025 and 2026 and would not enter SSB before 2027 in significant numbers. However, the Panel did recommend further development in the WHAM code to allow for better sensitivity exercises on the recruitment projections (comparison in recruitment average values versus the recruitment parameter are provided in Figure 9). The random effects were discussed in length. They are ignored in the projections, but despite an ar_y process, the NAA random effects would quickly trend to 0. The negative random effects in recent years in the assessment was a concern of the Panel, but the model did not support a correlation between years.

A recommendation was proposed to conduct the projections in a retrospective manner. The increasing trend of SSB from 2018 to 2023 was theorized to influence projections. Changing to an earlier terminal year and re-running the projections would allow for understanding how optimistic projections are and whether the large uncertainties are linked to the method or recent years' data.

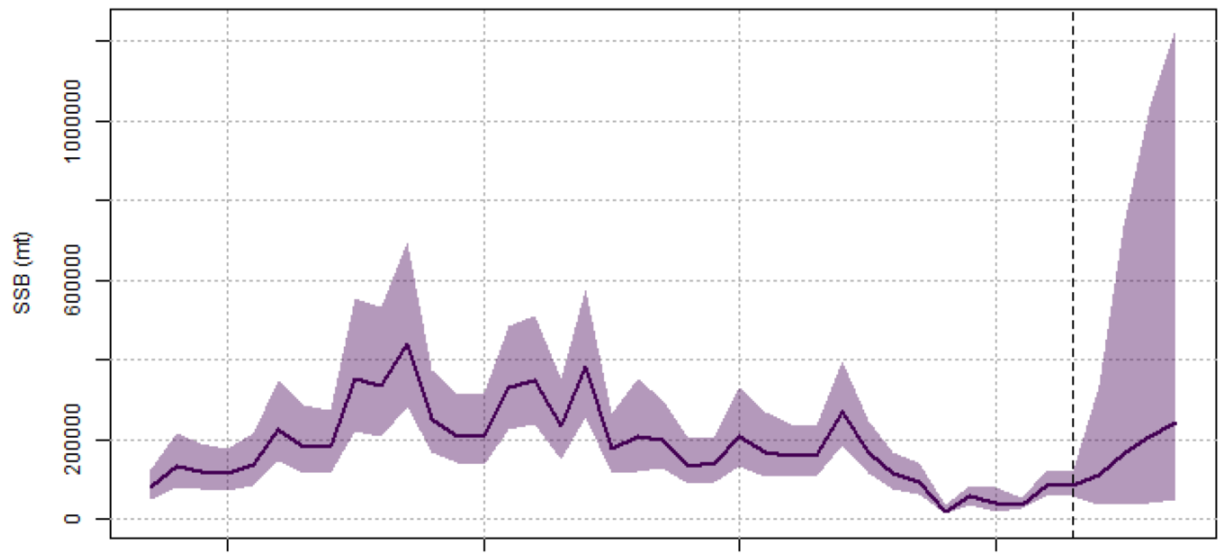

Figure 8. Estimated spawning stock biomass (SSB) from WHAM and projections. The vertical dashed line represents the demarcation between model estimates and projection estimates after 2023. Figure was provided in the TOR 4-6 working paper.

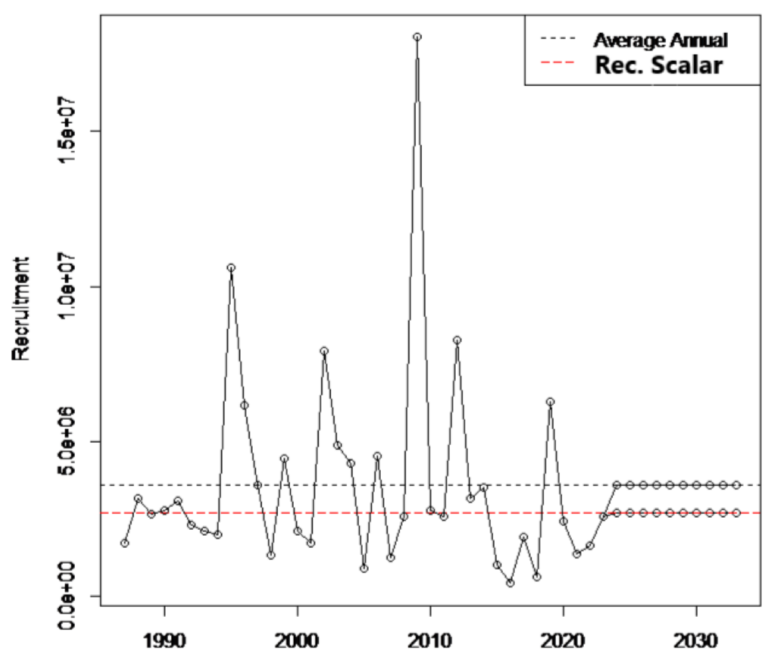

Figure 9. Recruitment time series from WHAM and recruitment projection values between recent time series averages (black) and recruitment estimates from the scalar parameter (red). Figure was provided during the review.

During the review, the Panel noted a forthcoming Projections RT WG that will evaluate how to improve short-term projection methods. The Panel strongly encouraged Atlantic herring being a case study within this RT.

TOR #7: *Review, evaluate, and report on the status of research recommendations from the last assessment peer review, including recommendations provided by the prior assessment working group, peer review panel, and SSC. Identify new recommendations for future research, data collection, and assessment methodology. If any ecosystem influences from TOR 2 could not be considered quantitatively under that or other TORs, describe next steps for development, testing, and review of quantitative relationships and how they could best inform assessments. Prioritize research recommendations.*

The Panel concluded that this TOR was adequately addressed.

The WG reviewed proposed recommendations from previous assessments, review panels, and SSC discussions. Some elements previously listed and noted from this exercise were not fully discussed or addressed by the WG (e.g., utility of the study fleet data, further expansion of acoustic surveys and research). The Panel asked for the WG to respond to these verbally during the Review. The Panel noted the research recommendations posed by the WG were not prioritized, resulting in challenges for the Panel to respond to recommendations on priorities with WG feedback. As such, during the Review, the Panel asked the WG to note the highest priority research fields from its list in the reports. These recommendations included three themes with sub-elements:

Survey Data

- Continue enhancing survey methodologies, such as incorporating age-length data, to improve reliability and consistency.
- Apply VAST methodologies to combined State and Federal Surveys.
- Evaluate the inclusion of innovative recruitment indices, like seabird diet data, for stock assessments.

Assessment Methods

- Explore alternative age-specific selectivity models and the use of random effects selectivity parameters.
- Investigate the use of larval indices as a potential index of recruitment.
- Refine projection models by integrating ecosystem indicators, such as zooplankton abundance and thermal habitat suitability.

Projection Methods

- Integrate environmental datasets, including temperature and prey availability indices, to refine projection assumptions.
- Address overly optimistic projections by exploring methods that better account for recruitment variability and environmental drivers.
- Evaluate how and if NAA random effects should be treated during the projection period.
- Consider refining how weight- and maturity-at-age are specified in the projection period (i.e., perhaps a recent 5-year average is not best, especially with trending traits).

The Panel supported this list, as well as its recommendations put forth in the other TORs. The Panel did iterate multiple research recommendations again to ensure they were pursued in the future. The first involved continuing investigating recruitment either as an index of abundance or redefining it in WHAM. Using the inshore surveys or the seabird diet data show promise in constructing a recruitment index for Atlantic herring. In addition, the WHAM could start at Age-2 as opposed to Age-1 given whether the consensus continues that no informative data for Age-1 abundance exists. The Panel reemphasized the need to better understand the impacts of NAA random effects on the WHAM model, particularly their influence on projections. Further development of the environmental covariates for future WHAM testing could be fruitful, as well as additional evaluation of natural mortality for a species that can have high natural mortality rates at younger age classes.

TOR #8: *Develop a backup assessment approach to providing scientific advice to managers if the proposed assessment approach does not pass peer review or the approved approach is rejected in a future management track assessment.*

The Panel concluded that this TOR was adequately addressed.

The WG concluded that if WHAM is rejected (WHAM configurations with random effects or those with fixed effects and thus replicating ASAP), the issues causing this rejection would not be resolvable within an alternative age-based assessment platform. Thus, the WG concluded that an index or survey trend-based backup would be appropriate. The WG chose the existing Ismooth approach (Legault et al. 2022) as an appropriate backup plan method, which has been used for several stocks in the northeast US region. The approach integrated all fisheries-independent survey indices used in the proposed WHAM model into the Ismooth approach. The WG noted that weighting the indices used in Ismooth based on some confidence criteria (e.g., by survey area coverage, likelihood values from previous ASAP or WHAM MT/RT assessments) could be evaluated as needed. However, the Panel noted that this was not a priority. The Panel concluded that the proposed backup approach would be appropriate if the WHAM model was rejected.

Appendix 1: Terms of Reference for the Atlantic Herring Research Track Stock Assessment

1. Identify relevant ecosystem and climate influences on the stock. Characterize the uncertainty in the relevant sources of data and their link to stock dynamics. Consider findings, as appropriate, in addressing other TORs. Report how the findings were considered under impacted TORs.

2. Estimate catch from all sources, including landings and discards. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data.

3. Present the survey data used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, application of catchability and calibration studies, etc.) and provide a rationale for which data are used. Describe the spatial and temporal distribution of the data. Characterize the uncertainty in these sources of data.

4. Use the appropriate assessment approach to estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Compare the time series of these estimates with those from the previously accepted assessment(s). Evaluate a suite of model fit diagnostics (e.g., residual patterns, sensitivity analyses, retrospective patterns), and (a) comment on likely causes of problematic issues, and (b), if possible and appropriate, account for those issues when providing scientific advice and evaluate the consequences of any correction(s) applied.

5. Update or redefine Status Determination Criteria (SDC; point estimates or proxies for BMSY, BTHRESHOLD, FMSY, and MSY reference points) and provide estimates of those criteria and their uncertainty, along with a description of the sources of uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for reference points. Compare estimates of current stock size and fishing mortality to existing, and any redefined, SDCs.

6. Define appropriate methods for producing projections; provide justification for assumptions of fishery selectivity, weights at age, maturity, and recruitment; and comment on the reliability of resulting projections considering the effects of uncertainty and sensitivity to projection assumptions.

7. Review, evaluate, and report on the status of research recommendations from the last assessment peer review, including recommendations provided by the prior assessment working group, peer review panel, and SSC. Identify new recommendations for future research, data collection, and assessment methodology. If any ecosystem influences from TOR 1 could not be considered quantitatively under that or other TORs, describe next steps for development, testing, and review of quantitative relationships and how they could best inform assessments. Prioritize research recommendations.

8. Develop a backup assessment approach to providing scientific advice to managers if the proposed assessment approach does not pass peer review or the approved approach is rejected in a future management track assessment.

Appendix 2: Atlantic Herring Research Track Assessment Peer Review Meeting Draft Agenda (March 10-14, 2025)

Clark Conference Room, NEFSC Aquarium Building, Woods Hole, MA

Google Meet joining info: https://meet.google.com/her-pcjt-aog
or dial: (US) +1 316-536-0378 PIN: 521 394 633#

DRAFT AGENDA* (v. 2/12/2025)

**All times are approximate at the discretion of the Review Panel Chair. The meeting is open to the public; however, during the Report Writing sessions we ask that the public refrain from engaging in discussion with the Peer Review Panel.*

Monday, March 10, 2025

Time	Topic	Presenter(s)	Notes
9:00am - 9:15am	Welcome, Introductions, & Agenda Logistics	Conor McManus Brian Hooper	
9:15am - 9:30am	Research Track Process Overview	Kristan Blackhart	
9:30am - 10:00am	Overview of Herring RT	Matthew Cieri	
10:00am - 10:30am	Management History and Current Practices	Jamie Cournane	
10:30am - 10:45am	BREAK		
10:45am - 12:00pm	TOR 1 - Ecosystem and Socioeconomic Profile & Supporting Analyses	Adelle Molina	Ecosystem
12:00pm - 1:00pm	LUNCH		
1:00pm - 2:00pm	TOR 1 - Copepods & VAST	Sarah Gaichas	Ecosystem
2:00pm - 3:00pm	TOR 1 - Haddock Predation	Micah Dean	Ecosystem
3:00pm - 3:15pm	BREAK		
3:15pm - 4:00pm	TOR 1 - Stakeholder Observations	Jamie Cournane	Ecosystem
4:00pm - 4:15pm	Public Comment	Public	
4:15pm - 5:00pm	Discussion/Summary	Review Panel	Conclusions, Recommendations, & Final Wrap-up for TOR 1
5:00pm	ADJOURN		

Tuesday, March 11, 2025

Time	Topic	Presenter(s)	Notes
9:00am - 9:05am	Welcome/Logistics/Agenda	Conor McManus Brian Hooper	
9:05am - 10:30am	TOR 2	Ashley Asci Matthew Cieri	Catch
10:30am - 10:45am	BREAK		
10:45am - 12:00am	TOR 3	Matthew Cieri	Surveys
12:00pm - 1:00pm	LUNCH		
1:00pm - 3:00pm	TOR 4	Jonathan Deroba	Model
3:00pm - 3:15pm	BREAK		
3:15pm - 3:45pm	TOR 4, continued	Jonathan Deroba	Model
3:45pm - 4:00pm	Public Comment	Public	
4:00pm - 5:00pm	Discussion/Summary	Review Panel	Conclusions, Recommendations, & Final Wrap-up for TORs 2, 3, & 4
5:00pm	ADJOURN		

Wednesday, March 12, 2025

Time	Topic	Presenter(s)	Notes
9:00am - 9:05am	Welcome/Logistics/Agenda	Conor McManus Brian Hooper	
9:05am - 10:00am	Review Homework	Conor McManus	If needed
10:00am - 10:30am	TOR 5	Jonathan Deroba	BRPs
10:30am - 10:45am	BREAK		
10:45am - 12:00pm	TOR 5, continued	Jonathan Deroba	BRPs
12:00pm - 1:00pm	LUNCH		
1:00pm - 3:00pm	TOR 6	Jonathan Deroba	Projections
3:00pm - 3:15pm	BREAK		
3:15pm - 3:45 pm	TOR 8	Jonathan Deroba	Backup Approach
3:45pm - 4:00pm	Public Comment	Public	

Time	Topic	Presenter(s)	Notes
4:00pm - 5:00pm	Discussion/Summary	Review Panel	Conclusions, Recommendations, & Final Wrap-up for TORs 4, 5, 6, & 8
5:00pm	ADJOURN		

Thursday, March 13, 2025

Time	Topic	Presenter(s)	Notes
9:00am - 9:05am	Welcome/Logistics/Agenda	Conor McManus Brian Hooper	
9:05am - 10:00am	Review Homework	Conor McManus	If needed
10:00am - 10:30am	TOR 7	Jamie Cournane	Research Recommendations
10:30am - 10:45am	BREAK		
10:45am - 12:00pm	TOR 7, continued	Jamie Cournane	Research Recommendations
12:00pm - 1:00pm	LUNCH		
1:00pm - 3:00pm	Revisit any remaining issues	Conor McManus	If needed
3:00pm - 3:15pm	BREAK		
3:15pm - 3:30pm	Public Comment	Public	
3:30pm - 5:00pm	Discussion/Summary	Review Panel	Conclusions, Recommendations, & Final Wrap-up for TOR 7, any remaining issues
5:00pm	ADJOURN		

Friday, March 14, 2025

Time	Topic	Presenter(s)	Notes
9:00am - 5:00pm	Closed panel writing session	Review Panel	*If necessary, open session may be reconvened to revisit any remaining issues
5:00pm	ADJOURN		

Appendix 3: Atlantic Herring Research Track Assessment Peer Review Attendees (March 10-13, 2025)

CIE - Center for Independent Experts
GARFO - Greater Atlantic Regional Fisheries Office
MAFMC - Mid-Atlantic Fisheries Management Council
NEFMC - New England Fishery Management Council
NEFSC - Northeast Fisheries Science Center
SSC - Science and Statistical Committee
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Peer Review Panel

First	Last	Affiliation
Conor	McManus	NEFMC SSC (Chair)
Henrik	Sparholt	CIE
Lorian	Berg	CIE
Gary	Melvin	CIE

Working Group

First	Last	Affiliation
Ashley	Asci	GARFO
Matt	Cieri	Maine DMR (Chair)
Jamie	Cournane	NEFMC
Kiersten	Curti	NEFSC
Micah	Dean	MA DMF
Jonathan	Deroba	NEFSC (Assessment Lead)
Sarah	Gaichas	NEFSC
Gavin	Fay	SMAST
John	Wiedenmann	Rutgers

Attendees

First	Last	Affiliation
Emilie	Franke	ASMFC
Richard	Klyver	Blue Green Future
Gerry	O Neill	Cape Seafoods Inc
Gareth	Lawson	Conservation Law Foundation
Kurt	Gottschall	CT DEEP
Kevin	Job	CT DEEP
M	Smith	Public
Tim	Barrett	Fisheries and Oceans Canada
~~~~~~

First	Last	Affiliation
Nathan	Hebert	Fisheries and Oceans Canada
Kaleigh	Hill	GARFO
Carrie	Nordeen	GARFO
Ashley	Trudeau	GARFO
Jonathan	Watson	GARFO
Raffaela	Terzo	Gloucester Fishermen’s Wives Association
Jeff	Kaelin	Lunds Fisheries
Sefatia	Romeo Theken	MA Department of Fish and Game (FWE)
Melanie	Griffin	MA DMF
Kelly	Whitmore	MA DMF
Jason	Didden	MAFMC
Brandon	Muffley	MAFMC
Megan	Ware	Maine Department of Marine Resources
Addie	Binstock	ME DMR
Andrew	Applegate	NEFMC
Emily	Bodell	NEFMC
Rachel	Feeney	NEFMC
Cate	OKeefe	NEFMC
Charles	Adams	NEFSC
Larry	Alade	NEFSC
Christina	Asante	NEFSC
Brandon	Beltz	NEFSC
Kristan	Blackhart	NEFSC
Jason	Boucher	NEFSC
Russell	Brown	NEFSC
Maxwell	Grezlik	NEFSC
Amanda	Hart	NEFSC
Daniel	Hennen	NEFSC
Cameron	Hodgdon	NEFSC
Brian	Hooper	NEFSC
Christopher	Legault	NEFSC
Chengxue	li	NEFSC
Emily	Liljestrand	NEFSC
Brian	Linton	NEFSC
Tim	Miller	NEFSC
Adelle	Molina	NEFSC
Paul	Nitschke	NEFSC
Stephanie	Owen	NEFSC

First	Last	Affiliation
Charles	Peretti	NEFSC
Burton	Shank	NEFSC
Laura	Solinger	NEFSC
Katherine	Sosebee	NEFSC
Michele	Traver	NEFSC
Samuel	Truesdell	NEFSC
Abigail	Tyrell	NEFSC
Sara	Weeks	NEFSC
Anthony	Wood	NEFSC
Renee	Zobel	NH Fish & Game
Cheri	Patterson	NH Fish & Game
Joseph	Warren	NOAA Affiliate
Mary Beth	Tooely	O'Hara Corporation
Justin	Didden	Public
Bill	Lucey	Save the Sound
Alexander	Jensen	SEFSC
Maria Cristina	Perez	SMAST
Jaclyn	Higgins	Theodore Roosevelt Conservation Partnership
Andrew	Jacobs	WTGHA

Appendix 4: Materials Provided or Referenced During the Atlantic Herring Research Track Stock Assessment Peer Review Meeting

Working papers and presentations are available on a NEFSC website https://apps-nefsc.fisheries.noaa.gov/saw/sasi.php by selecting the species and year of assessment.

Working Papers and Background Documentation

Information Type	File Name
All Files	2025_HER_UNIT_1.zip
All Files	2025_HER_UNIT_2.zip
Assessment Report	2025_Herring_RT_assessment report_final_508.pdf
Figures	Figures_Homework and other_Deroba_revised.pdf
Background	Acoustic-WP.pdf
Background	Boosted Regression Tree-WP.pdf

Information Type	File Name
Background	CAMS-WP.pdf
Background	Copepod Indices-WP.pdf
Background	ESP-WP.pdf
Background	Fecundity-WP.pdf
Background	Haddock_predation-WP.pdf
Background	Management-WP.pdf
Background	RecCovariates-WP.pdf
Background	Seabird_Diet-derived_Recruitment_Index-WP.pdf
Background	Spawn_timing-WP.pdf
Background	Stakeholder-WP.pdf
Background	TOR_2-WP.pdf
Background	TOR_3-WP.pdf
Background	TOR_4-5-6-WP.pdf
Background	TOR_7- WP.pdf
Background	TOR_8-WP.pdf
Background	Threshold-WP.pdf
Background	ToR_1-WP.pdf
Background	_Working_paper_list.pdf
Presentations	Presentation_Management History and Current Practices_Cournane.pdf
Presentations	Presentation_Overview_TORs_2-3_Cieri.pdf
Presentations	Presentation_TOR 1_Copepods and VAST_Gaichas.pdf
Presentations	Presentation_TOR 1_Ecosystem and Socioeconomic Profile_Molina.pdf
Presentations	Presentation_TOR 1_Stakeholder Engagement_Cournane.pdf
Presentations	Presentation_TOR 1_haddock predation_Dean.pdf
Presentations	Presentation_TOR 2_Asci.pdf
Presentations	Presentation_TOR 4-6_Deroba.pdf
Presentations	Presentation_TOR 4_Zooplankton indices as covariates in WHAM_Gaichas.pdf
Presentations	Presentation_TOR 7_Cournane.pdf
Presentations	Presentation_TOR 8_Deroba.pdf

RESEARCH TRACK WORKING GROUP REPORT

Report prepared by members of the Atlantic Herring Research Track Working Group:

- Matt Cieri, MEDMR
- Jon Deroba, NEFSC
- Kiersten Curti, NEFSC
- Sarah Gaichas, NEFSC
- Jamie Cournane, NEFMC
- Ashley Asci, GARFO
- Micah Dean, MADMF
- John Wiedenmann, Rutgers University
- Gavin Fay, University of Massachusetts / SMAST

The Atlantic herring stock assessment working group met multiple times online, as well as conducting two in-person meetings in Woods Hole, MA at the NEFSC.

PARTICIPANTS

Working Group (WG)

Name	Affiliation
Matt Cieri	MEDMR, chair
Jon Deroba	NEFSC, assessment lead
Kiersten Curti	NEFSC
Sarah Gaichas	NEFSC
Jamie Cournane	NEFMC
Ashley Asci	GARFO
Micah Dean	MADMF
John Wiedenmann	Rutgers University
Gavin Fay	University of Massachusetts / SMAST

GARFO - Greater Atlantic Regional Fisheries Office
NEFSC - Northeast Fisheries Science Center
NEFMC - New England Fishery Management Council
MEDMR - Maine Dept. of Marine Resources
MADMF - MA Div. of Marine Fisheries
SMAST - School for Marines Science and Technology

In addition to the Working Group members, the following individuals participated heavily in either the analysis or the stakeholder engagement session:

Chair-invited participants	
Adelle Molina	NOAA Affiliate
Addie Binstock	MEDMR
Emily Bodell	NEFMC
Mark Wuenschel	NEFSC
Mike Jech	NEFSC
James Gartland	VIMS
Sean Hardison	University of Alaska

ACKNOWLEDGEMENTS

The WG would like to acknowledge the many people responsible for data collection that are too numerous to list. In addition, the WG appreciated input from Atlantic herring stakeholders throughout the process. Lastly, the WG thanks Chris Legault for regularly attending WG meetings and providing helpful guidance.

EXECUTIVE SUMMARY

Term of Reference (TOR) #1: *Identify relevant ecosystem and climate influences on the stock. Characterize the uncertainty in the relevant sources of data and their link to stock dynamics. Consider findings, as appropriate, in addressing other TORs. Report how the findings were considered under impacted TORs.*

Atlantic herring (*Clupea harengus*) are schooling planktonic feeding fish inhabiting the Western Atlantic. While ranging from Newfoundland, Canada to the Mid-Atlantic, United States, this stock assessment focused on the Gulf of Maine/Georges Bank stock complex found in US waters. Atlantic herring exhibits a complex life cycle, transitioning from planktonic larvae to forming coastal schools as juveniles. In this region, spawning occurs primarily in autumn across inshore and offshore banks, with egg deposition occurring in dense mats that hatch within 14 to 21 days. Critical recruitment drivers include food availability, larval temperature stress, and egg predation, particularly from haddock (*Melanogrammus aeglefinus*). Analysis using dynamic linear models linked predator consumption to herring abundance, supporting a constant predation mortality rate.

Temperature bottlenecks were identified, with bottom temperatures suitable for embryos but sea surface temperatures increasingly stressful for larval stages, especially during prolonged summer conditions. These temperature challenges reduce the optimal thermal window for larval survival, potentially increasing density-independent mortality. Prolonged periods of unsuitable thermal conditions may delay the onset of fall cooling, further constraining larval survival rates. In addition, fecundity assessments revealed stable-to-increasing reproductive output, highlighting significant maternal effects, particularly in larger, older females, which contribute disproportionately to egg production. Research suggests that maternal effects, such as enhanced fecundity and larval viability, could be further explored to refine stock assessment models and improve projections. Integration of these maternal factors may also provide insights into recruitment variability and stock resilience under changing environmental conditions.

The results of this TOR suggested two additional model runs as sensitivities: a run to examine these recruitment covariates, and another to examine the effects of haddock predation on herring eggs. Efforts to model time-varying natural mortality were abandoned because of diagnostic issues and lack of support (e.g., fit statistics, external support).

TOR #2: *Estimate catch from all sources, including landings and discards. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data.*

Atlantic herring catch data reflects significant historical variability, influenced by changes in management, fleet composition, availability, utilization, and ecosystem influences. During the 1960s and 70s, catches peaked at more than 450,000 metric tons (mt) because of intense fishing by domestic, Canadian, and distant-water fleets. This was followed by a sharp decline in catches with the implementation of the Magnuson-Stevens Fishery Conservation and Management Act in 1978 and reduced fishing effort. After the early 1980s, the catch increased as the stock rebounded from depletion to above 100,000 mt by the early 2000s. In recent decades, the catch has since declined and currently ranges from 4,000 to 9,000 mt due to low abundance and correspondingly low quotas. The current fishery primarily targets herring as bait for American lobster (*Homarus americanus*) operations by using midwater trawl, purse seine, and bottom trawl gear, although alternative bait sources have reduced dependency on herring.

The transition to NOAA's Catch Accounting and Monitoring System (CAMS) for this stock assessment has improved the consistency and accuracy of catch data. Historical comparisons between CAMS and previous systems have shown minor differences, confirming the reliability of the updated methodology. CAMS integrates multiple data sources, including vessel trip reports (VTRs), dealer reports, and observer data, providing a unified approach to catch for quota monitoring and stock assessments. Use of CAMS is recommended going forward.

The fishery biological sampling programs continue to monitor biological data, such as size, age, and reproductive stage, ensuring robust data collection and aiding assessment for this stock. These improvements in data collection and integration support more accurate assessments of fishing impacts and enhance the understanding of temporal and spatial catch patterns, particularly for assessing regional differences in herring utilization and management compliance.

TOR #3: *Present the survey data used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, application of catchability and calibration studies, etc.) and provide a rationale for which data are used. Describe the spatial and temporal distribution of the data. Characterize the uncertainty in these sources of data.*

Survey data for Atlantic herring include the National Marine Fisheries Service (NMFS) spring and fall bottom trawl surveys, NMFS acoustic surveys, and the NMFS summer (shrimp) survey. Key surveys, such as the NMFS spring and fall bottom trawl and summer shrimp surveys, have shown consistent cohort tracking but declining indices since 2009, reflecting broader declines in abundance. These surveys provide critical data on age composition, abundance, and spatial distribution, which are essential for modeling stock dynamics.

Methodological updates, including improved age composition data collection, have enhanced the reliability of these indices. The spring and fall Maine/New Hampshire and Massachusetts state bottom trawl surveys provide valuable insights into inshore recruitment dynamics, particularly for younger age classes. However, they were excluded from the final models because of restricted spatial coverage and potential bias favoring inshore components.

To address data gaps, a novel approach to integrate seabird diet data was explored, providing an innovative recruitment index for stock assessments. Despite this, the seabird diet index was not used in any of the final model runs. These innovative methodologies contribute to a more comprehensive understanding of herring recruitment patterns and help identify critical habitat areas for management and conservation efforts.

TOR #4: *Use appropriate assessment approach to estimate annual fishing mortality, recruitment, and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Compare the time series of these estimates with those from the previously accepted assessment(s). Evaluate a suite of model fit diagnostics (e.g., residual patterns, sensitivity analyses, retrospective patterns), and (a) comment on likely causes of problematic issues, and (b), if possible and appropriate, account for those issues when providing scientific advice and evaluate the consequences of any correction(s) applied.*

This assessment transitioned Atlantic herring from the Age-Structured Assessment Program (ASAP) to the Woods Hole Assessment Model (WHAM), which offers improved flexibility for incorporating environmental covariates and improved estimation of process and observation uncertainty. Diagnostic evaluations indicated acceptable performance, with improvements in retrospective patterns achieved through the integration of random effects on numbers-at-age transitions. This approach reduced biases and improved the reliability of stock status determinations.

The WHAM model provided a robust platform for evaluating stock dynamics, revealing critical insights into herring population trends. Natural mortality was maintained at a fixed constant rate (M=0.35), aligning with historical assumptions and predator-prey relationships observed in the ecosystem. Time-invariant selectivity patterns were applied to ensure consistency across age classes and gear types. Recruitment, modeled as independent and identically distributed (iid) random effects, highlighted variability linked to environmental factors and fishery-independent indices. The integration of random effects on numbers-at-age transitions enhanced the model's accuracy, particularly in accounting for strong and weak year classes. While haddock biomass and the effects of temperature, as well as food availability, were tested as potential recruitment covariates, no significant correlation was observed, indicating other drivers or multiple drivers may play a more prominent role in recruitment variability.

In addition, the WHAM model underscored the importance of environmental conditions, such as temperature and prey availability, in shaping recruitment and stock resilience. These findings suggest that incorporating additional ecosystem indicators, such as zooplankton abundance and thermal habitat suitability, could further refine future assessments. Sensitivity analyses highlighted the model's robustness to parameter adjustments, reinforcing confidence in its application for stock evaluation and management.

TOR #5: *Update or redefine status determination criteria (SDC; point estimates or proxies for BMSY, BTHRESHOLD, FMSY, and MSY reference points) and provide estimates of those criteria and their uncertainty, along with a description of the sources of uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for reference points. Compare estimates of current stock size and fishing mortality to existing, and any redefined, SDCs.*

The WG continued using F40% as the F_{MSY} proxy, applying life history traits based on a recent five-year average. The recruitment scalar parameter from the WHAM model was selected to determine B40%, minimizing subjective decision-making and ensuring internal consistency with model parameters. This approach provides a stable foundation for estimating biological reference points and evaluating stock status.

Current reference points include B40% = 233,176 mt and global F40% = 0.358. Terminal year (2023) estimates showed spawning stock biomass (SSB) at 82,402 mt (90% CI: 60,582–112,082), with fishing mortality at 0.225.

The objective of this research track is to develop the assessment and projection methodology that will be used in subsequent management track assessments. As such, stock status recommendations are not part of the research track Terms of Reference, and the results from this research track assessment will not be used directly in management. Instead, this research track assessment will inform a management track assessment scheduled for June 2026. The 2026 management track assessment will provide updated estimates of stock status using data through 2025 and will be used to inform management measures for 2027-28.

TOR #6: *Define appropriate methods for producing projections; provide justification for assumptions of fishery selectivity, weights at age, maturity, and recruitment; and comment on the reliability of resulting projections considering the effects of uncertainty and sensitivity to projection assumptions.*

Projections were developed using processes consistent with the preferred WHAM model. Results indicated rapid increases in SSB and catch under current fishing mortality rates below F40%. This optimistic outlook is attributed to assumptions of iid recruitment and the absence of negative random effects in the projection period. Without temporal correlation, recent poor recruitment events are not projected to persist, allowing for more favorable projections. The WG suggests these overly optimistic results may not be accurate given past stock recruitment.

Further exploration of uncertainty revealed that the use of iid recruitment could overestimate stock recovery rates if environmental drivers or density-dependent effects are not accounted for. While the projections demonstrate potential for rapid rebuilding, the WG noted that the absence of negative random effects in the projection period may not fully capture real-world dynamics.

In addition, the group identified the importance of integrating environmental datasets, including temperature and prey availability indices, to refine projection assumptions. Sensitivity analyses showed that projections were sensitive to fishing mortality rates, highlighting the need for continuous refinement and evaluation of projection models. These enhancements will improve the reliability of projections and support more robust decision-making processes, ensuring that management strategies remain adaptive to evolving stock conditions and environmental factors.

TOR #7: *Review, evaluate, and report on the status of research recommendations from the last assessment peer review, including recommendations provided by the prior assessment working group, peer review panel, and SSC. Identify new recommendations for future research, data collection, and assessment methodology. If any ecosystem influences from TOR 1 could not be considered quantitatively under that or other TORs, describe next steps for development, testing, and review of quantitative relationships and how they could best inform assessments. Prioritize research recommendations.*

The WG addressed prior recommendations and identified new research priorities to enhance future Atlantic herring assessments as outlined below.

Review of Past Research Recommendations

Low Recruitment Mechanisms:

- The WG examined recruitment variability (TOR 4), finding no significant decline but noted retention variability and explored covariates (e.g., haddock predation, temperature, plankton). No single driver was identified.

Projections and Reference Points:

- Change Point Analysis Consistency: No longer relevant.
- F40% in Lower Productivity: No evidence for revising F40% as an FMSY proxy (TOR 5).
- Direct FMSY Estimation: MSY-based reference points remain incalculable; proxies B40% and F40% are retained.

Fleet Selectivity:

- The WG retained the two-fleet structure, finding no support for increased selectivity of younger fish by the mobile fleet.

Recruitment Index via Seabird Diet:

- Addressed in TOR 3.

Natural Mortality (M):

- Little support for time- or age-varying mortality models (TOR 1, TOR 4).

Stock Structure and Movement:

- Deferred to genetics studies planned for 2025-26.

Survey Data and Age Observations:

- Uncertainty persists regarding summer surveys, with no data collected in 2024 and future surveys unlikely. Related impacts remain unresolved.

Recruitment Penalties and Missing Data:

- Recruitment penalties are not used in WHAM. Missing 2020 survey data were addressed, resolving retrospective issues.

Condition, Growth, and Fecundity:

- Examined under TOR 1 and related working papers.

New Research Recommendations

Maternal Effects and Fecundity:

- Refine reference points using maternal effects, including fecundity and body condition metrics.

Spawning Timing:

- Prioritize spring body condition indices to avoid fall spawning weight confounding.

Egg Predation:

- Study haddock predation impacts on recruitment.

Larval Temperature Stress:

- Investigate warming impacts on larval survival and mortality.

Food Availability:

- Develop zooplankton indices for critical herring life stages.

Natural Mortality:

- Enhance predator-prey models for mortality estimates.

Survey Data:

- Improve methodologies and sampling (e.g., age-length data, seabird diet indices), including additional biological sampling and standardized collections of seabird diet, and formal data-sharing agreements to make data access easier.

Assessment Methods:

- Explore new selectivity models, larval indices, and ecosystem indicators for projections.

Projection Methods:

- Refine environmental data integration, recruitment variability, and NAA random effects in projections.

After careful consideration, the WG concluded that the aforementioned Research Recommendations should improve the Atlantic herring assessment going forward.

TOR #8: *Develop a backup assessment approach to providing scientific advice to managers if the proposed assessment approach does not pass peer review or the approved approach is rejected in a future management track assessment.*

In the event of diagnostics failure in the primary WHAM model, the Ismooth approach was identified as the preferred backup. The Ismooth approach would use all indices of abundance included in the age-based assessment. This trend-based method uses standardized abundance indices to provide catch advice, ensuring robustness in rebuilding scenarios. The Ismooth approach integrates recent survey observations, including those from the spring following the terminal year, to enhance its responsiveness to changing stock conditions.

Adjustments to the indices used in Ismooth may be necessary, depending on survey availability and spatial coverage. For example, the suspension of the NMFS summer shrimp survey in 2024 may require reconsideration of its inclusion in the backup methodology. The Ismooth approach offers a practical contingency plan, balancing simplicity with reliability in data-limited scenarios. This flexibility ensures that management decisions remain data-informed, including cases where primary assessment methodologies encounter challenges.

INTRODUCTION

Atlantic herring (*Clupea harengus*) is a small schooling Clupeid that ranges in the Western Atlantic from Newfoundland, Canada through the Mid-Atlantic, US Atlantic herring are obligate planktonic feeders, forming large dense schools. Spawning generally occurs in the autumn, across a number of both inshore and offshore banks (Figure 10) when fish are mature: generally, age 3 or older. Eggs are sticky and demersal, with hatching occurring from dense mats approximately 14 to 21 days after spawning. The resulting larvae are planktonic, feeding on smaller plankton in the water column until spring, when they become more coastal and start forming schools. These juvenile herring, called “brit” in some locations, feed and grow until adulthood. Generally, Atlantic herring live until at least age 10-14. Throughout its life cycle, herring are an important consumer, of zooplankton, as well as important forage for commercially and recreationally important species such as bluefin tuna, striped bass, dogfish, and cod. Further, herring can be an important food item for seabirds, whales, dolphins, and seals. A full examination of the life history of Atlantic herring can be found in TOR 1 as well as TOR 1-WP.

The subject of this stock assessment is the Georges Bank/Gulf of Maine stock complex. This stock is composed of at least two subcomponents, the inshore Gulf of Maine (GOM) and the offshore Georges Bank (GB). Both components mix during non-spawning seasons, resulting in distinguishing these two components in the catch being difficult to nearly impossible using current methods. Given this uncertainty in substructure, the US Atlantic herring stock is assessed as a single unit, incorporating both inshore and offshore components.

While some degree of mixing between the GB/GOM US stock and the Canadian 4WX unit occurs, the degree of this mixing is uncertain and is the subject of ongoing research. Nonetheless, a portion of the Canadian catches are assumed to be from the US GB/GOM stock complex. The New Brunswick weir and stop seine fishery, which operates in the southwest region of New Brunswick, is generally believed to catch mostly juveniles from the US GB/GOM stock.

Exploited well before European colonization, herring has been an important source of sustenance, fertilizer, and bait for other commercial fisheries for centuries. Before the 1970s and the institution of the 200-mile exclusive economic zone, herring was the subject of substantial removals via foreign fleets. Currently, the fishery is mostly prosecuted for bait to supply the economically important American lobster fishery. As a low-value, high-volume fishery, the principal gear types used in the fishery are mobile gear (midwater trawl, purse seine, and bottom trawl) and fixed gear (stop seine and weir).

Atlantic herring has a long history of assessment. The resource was first assessed using Virtual Population Analysis (VPA) in the 1960s and 70s as part of the International Commission for the Northwest Atlantic Fisheries (ICNAF), and later as part of the Transboundary Resource Assessment Committee (TRAC) with the Canadian Fisheries and Oceans (DFO) through the 1990s and early 2000s. The last TRAC assessment for this stock occurred in 2009. Since 2009 the stock has been assessed using the Age Structured Assessment Program (ASAP) by the Northeast Fisheries Science Center (NEFSC). The last benchmark stock assessment was conducted in 2018, with updates occurring every other year in 2020, 2022, and most recently in 2024.

The Atlantic herring population has fluctuated relatively dramatically since the 1960s, according to the most recent Management Track Stock Assessment (Figure 11) conducted in 2024 (NEFSC 2024). Since the late 1960s, the herring population declined precipitously from near-historic highs to very low levels by the late 1970s and early 1980s. Rebuilding occurred in the late 1980s through the late 1990s, with a peak in abundance observed in 1997. Since then, the stock has declined, although this decline was variable, often offset by strong year classes for periods of time. Since 2012 recruitment has been at or near historic lows, leading to a steep decline in stock abundance to well below B_{MSY}. Currently, the stock is below ½ B_{MSY} and is both overfished and in a rebuilding plan. However, the harvest is below proxy FMSY and is not considered to be experiencing overfishing.

Current management of Atlantic herring is by the New England Fishery Management Council (NEFMC), the Atlantic States Marine Fisheries Commission (ASMFC), and NOAA Fisheries. Atlantic herring is a quota-managed fishery, with catches being monitored in-season with limits in four management areas (Figure 12) linked to accountability measures, with the goal of preventing overharvest of the smaller subcomponents. Other management measures include permit/license conditions, specifications on vessel size, closed areas, and seasons, as well as catch caps for non-target species of river herring and shad, as well as haddock. Further, Atlantic herring has a harvest control rule (HCR), which sets the level of catch and exploitation based on stock conditions. This HCR was selected after extensive stakeholder engagement through a Management Strategy Evaluation (Feeney et al. 2018, NEFMC 2019). Further exploration of the history of herring management can be found in the Management-WP.

The goal of the current assessment is to transition this stock to the state space modeling approach, the Woods Hole Assessment Model (WHAM), to allow for the future consideration of environmental covariates, as well as the ability to estimate process and observation uncertainty for this variable stock. To accomplish this, nine Terms of Reference (TOR) should be examined:

1. Identify relevant ecosystem and climate influences on the stock. Characterize the uncertainty in the relevant sources of data and their link to stock dynamics. Consider findings, as appropriate, in addressing other TORs. Report how the findings were considered under impacted TORs.

2. Estimate catch from all sources, including landings and discards. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data.

3. Present the survey data used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, application of catchability and calibration studies, etc.) and provide a rationale for which data are used. Describe the spatial and temporal distribution of the data. Characterize the uncertainty in these sources of data.

4. Use the appropriate assessment approach to estimate annual fishing mortality, recruitment, and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Compare the time series of these estimates with those from the previously accepted assessment(s). Evaluate a suite of model fit diagnostics (e.g., residual patterns, sensitivity analyses, retrospective patterns), and (a) comment on likely causes of problematic issues, and (b), if possible and appropriate, account for those issues when providing scientific advice and evaluate the consequences of any correction(s) applied.

5. Update or redefine Status Determination Criteria (SDC; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY}, and MSY reference points) and provide estimates of those criteria and their uncertainty, along with a description of the sources of uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for reference points. Compare estimates of current stock size and fishing mortality to existing, and any redefined, SDCs.

6. Define appropriate methods for producing projections; provide justification for assumptions of fishery selectivity, weights at age, maturity, and recruitment; and comment on the reliability of resulting projections considering the effects of uncertainty and sensitivity to projection assumptions.

7. Review, evaluate, and report on the status of research recommendations from the last assessment peer review, including recommendations provided by the prior assessment working group, peer review panel, and SSC. Identify new recommendations for future research, data collection, and assessment methodology. If any ecosystem influences from TOR 1 could not be considered quantitatively under that or other TORs, describe the next steps for development, testing, and review of quantitative relationships and how they could best inform assessments. Prioritize research recommendations.

8. Develop a backup assessment approach to providing scientific advice to managers if the proposed assessment approach does not pass peer review or the approved approach is rejected in a future management track assessment.

9. Identify and consider any additional stock-specific analyses or investigations that are critical for this assessment and warrant peer review and develop additional TOR(s) to address as needed.

Notably, this report represents a summary report. Most, but not all, of the TORs are more fully analyzed in dedicated TOR Working Papers. These in turn draw on specific Additional Working Papers.

ECOSYSTEM, CLIMATE, AND OTHER INFLUENCES

> ***Term of Reference (TOR) #1:*** *Identify relevant ecosystem and climate influences on the stock. Characterize the uncertainty in the relevant sources of data and their link to stock dynamics. Consider findings, as appropriate, in addressing other TORs. Report how the findings were considered under impacted TORs.*

Relevant Ecosystem and Climate Influences on the Stock

Key ecosystem and climate factors impacting Atlantic herring in the Northeast US were identified across spawning, egg, larval, juvenile, and adult stages (see ESP-WP). These insights are presented in a conceptual model (Figure 13) and life history table (see TOR 1-WP). Critical recruitment drivers include food availability, egg predation, and larval temperature stress (Figure 14). Spawning timing and maternal effects were noted as secondary but significant factors.

Boosted regression tree analysis highlighted recruitment drivers: food availability for larvae and juveniles, egg predation, and larval temperature stress. These indicators guided recruitment covariate testing in the stock assessment model.

Management History

The Atlantic herring fishery in waters off the US has been managed since 1972, with international management from 1972-76, federal management from 1978-1982, interstate management from 1983-2000, and joint federal and state management under the Atlantic States Marine Fisheries Commission (ASMFC) and the New England Fishery Management Council (NEFMC) since 2001. The fishery is currently managed using a stock-wide annual catch limit (ACL) that is assigned to sub-ACLs in four spatial management units. The stock-wide ACL is derived using an acceptable biological catch (ABC) control rule designed to account for herring's role as forage in the ecosystem that was developed using stakeholder-driven management strategy evaluation and implemented in 2021.

Stock status is currently overfished (below ½ the spawning stock biomass target level) but not subject to overfishing (fishing mortality is below the fishing mortality limit).

Atlantic herring are primarily used as bait in lobster fisheries and are targeted with purse seine, midwater trawl, and bottom trawl gear. Recent herring catches range from 4,000-9,000 metric tons, down from catches in the 50,000-95,000 metric ton range 2010-17.

For more details, see the Atlantic herring management summary working paper (Management-WP).

Stakeholder Observations

A June 2024 stakeholder engagement session identified key market and ecological dynamics influencing Atlantic herring (Stakeholder-WP). Participants highlighted herring's diminished role in the regional bait market, now dominated by menhaden and frozen alternatives, attributed to declining and inconsistent herring catches, increased prices, and lower quotas. These challenges, compounded by rising fuel costs, have discouraged exploratory fishing and reduced communication among fishers.

Environmental concerns included warming waters and zooplankton shifts impacting recruitment, alongside haddock predation on herring eggs. Participants stressed the need for detailed analysis of zooplankton interactions, changing forage bases, and predator nutritional stress. Notable ecological shifts included predator dietary transitions favoring menhaden over herring. Recommendations included examining herring fecundity, fat content, and aggregation patterns through acoustic detection.

Natural Mortality

Dynamic linear modeling (DLM) linked predator consumption to herring abundance, supporting a constant predation mortality rate (Figure 15). Attempts to model time-varying mortality faced diagnostic challenges or failed to improve fit (e.g., likelihood), leading to its exclusion.

Abundant predators were identified as a key ecosystem influence on juvenile, adult, and spawning herring. Historical assessments used predator consumption data to infer time-varying natural mortality rates, but uncertainties in predator sampling, particularly for striped bass, undermined reliability. Consequently, the 2018 benchmark adopted a constant mortality rate (M) across ages and time. The 2025 research track revisited these assumptions to evaluate potential improvements (see TOR 4).

Gartland and Latour (2024) estimated herring consumption using spatiotemporal modeling of predator stomach contents and survey data (1978-2019). Consumption rates, higher in fall than in spring, fluctuated over time, with lows in the 1980s and greater variability post-2000. Analysis revealed no consistent trend in consumption relative to biomass but identified a rising trend in consumption relative to catch.

DLM examined nine potential drivers, including atmospheric and oceanographic indices (North Atlantic Oscillation, Southern Oscillation), regional oceanography (Gulf Stream extent, cold pool area, warm slope water proportions), zooplankton ratios, herring survey indices, and catch. Results indicated that predator consumption of herring closely tracked herring abundance in spring and fall (Figure 15), suggesting a constant predation mortality rate.

Despite the insights, efforts to incorporate time-varying natural mortality into stock assessments encountered challenges, including poor diagnostic performance and overfitting risks. These limitations reaffirmed the use of a constant M in the assessment model. However, the findings underscore the importance of continued monitoring and refinement of predator-prey interactions to improve mortality estimates.

Maternal Effects and Fecundity

Spawning stock biomass (SSB) as a reproductive potential indicator assumes proportional fecundity to spawner weight at age. However, fecundity tends to be higher in larger, older females, leading to potential overestimation of reproductive potential as age structure skews toward younger fish. Research on Nova Scotia, Canada herring stocks demonstrated non-proportional egg production relative to SSB (Barrett et al. 2022).

Fecundity assessments for mature female herring (2011-19) in the Gulf of Maine revealed stable-to-increasing fecundity, suggesting that reduced fecundity did not drive population declines. Lower fecundity was noted from 2011-15, followed by increases in 2016-18, potentially influenced by environmental or density-dependent factors. Significantly higher reproductive output was observed in 2018-19.

Maternal effects analysis indicated a hyper-allometric relationship between fecundity and both length and weight, with weight showing a stronger correlation. Females exceeding 200 g exhibited higher-than-expected fecundity. Preliminary findings by Joseph Warren (UMass) suggest that fall spawners may have greater fecundity than spring spawners, with larger females contributing disproportionately to egg production. These findings, derived from NEFSC and MADMF surveys (2021-23), highlight the importance of maternal effects.

Further analysis is recommended to refine reference points incorporating maternal effects. For comprehensive details, see the fecundity and maternal effects working paper (Fecundity-WP).

Spawning Timing

Macroscopic maturity data collected during NEFSC spring and fall bottom trawl surveys were analyzed to determine the proportions of developing, ripe, spent, and resting mature female Atlantic herring across seasons. Multinomial regressions evaluated the influence of sampling week, bottom temperature, and decade on observed spawning conditions, providing insights into potential temporal and environmental shifts in spawning phenology.

The Atlantic herring population is dominated by fall spawners, with spring spawning contributing a minor amount. An observed increase in developing fish during spring surveys since 2000 is partly, but not solely, attributed to a shift in survey timing closer to the spring spawning season. Before 2000, spring surveys primarily sampled fish before spawning. Fall surveys have similarly shifted later in the year since the early 2000s, coinciding with an increased proportion of resting fish, which suggests that these later surveys now capture the end of the spawning season. Despite these timing changes, fall bottom temperatures have continued to rise, indicating that warming waters are not directly altering the timing of spawning but may influence other spawning-related dynamics.

Given the declining prevalence of spring spawners, prioritizing spring body condition indices when analyzing changes in herring body condition is recommended. This approach avoids the confounding effects of significant weight fluctuations (15-20% of body weight) associated with the fall spawning season.

For a more comprehensive analysis, see the spawning phenology working paper (Spawn_timing-WP).

Egg Predation

Haddock, identified as an important predator of Atlantic herring eggs (Haddock_predation-WP), experienced a population surge between 2010 and 2020, coinciding with a decline in herring recruitment. A haddock species distribution model (SDM) was developed to explore this relationship using NEFSC offshore and Massachusetts–Maine–New Hampshire inshore bottom trawl survey data from fall (September-November), the herring spawning season. The spatiotemporal model, built using the sdmTMB package in R, employed haddock catch per unit effort as the response variable, with depth, seafloor complexity, year, time of day, and survey platform as predictors. All predictors except seafloor complexity were included in the final model. Herring egg distribution was synthesized from the literature, and from where herring eggs were observed in haddock diet data.

The haddock SDM and herring egg distribution data created an egg predation index. Annual fall haddock biomass density was predicted across the region using a 5-km grid. The index calculated the annual average haddock density within areas likely to contain herring eggs, with uncertainty estimated via the "emmeans" package.

The index revealed high haddock predation on herring eggs in the 1960s, a decline through the 1980s and 1990s, a peak from 2010 to 2020, and a subsequent decrease in recent years (Figure 16). A significant negative correlation ($R = -0.33$; $p = 0.011$) was observed between the index and herring recruits-per-spawner (R/SSB) as estimated in the 2022 stock assessment model updated through 2023 (Figure 16).

These findings suggest that haddock predation may play a substantial role in herring recruitment dynamics. See the haddock egg predation index working paper for more details (Haddock_predation-WP).

The haddock egg predation index was tested as a recruitment covariate within the Atlantic herring assessment model (see TOR 4).

Larval Temperature Stress

Two temperature bottlenecks for Atlantic herring were identified in the conceptual model. Bottom temperatures between August and December impact embryos and yolk sac larvae, while sea surface temperatures affect early and late larval stages during fall. Temperatures exceeding 16°C are considered stressful, and those above 21°C are lethal.

For embryos and yolk sac larvae, bottom temperatures in the Gulf of Maine and Georges Bank are generally suitable, with predation and other factors likely having a more significant role. However, sea surface temperatures pose a critical challenge for pelagic larval stages. Stressful conditions before winter and lethal temperatures during several days in the last decade have been documented. Prolonged summer conditions mean lethal temperatures persist later into the year, delaying the onset of fall cooling and reducing the optimal thermal window for larval survival.

The duration of the optimal thermal window has declined over time (Figure 17), although exceptions in years like 2010 and 2018 showed longer windows, comparable to earlier decades.

Extended optimal windows improve larval survival by minimizing exposure to lethal temperatures. Overall, warming fall surface temperatures near spawning grounds represent a significant source of density-independent mortality for larval herring. For more detailed information, see the Threshold-WP.

Food Availability

Existing zooplankton indices for the Northeast US were implemented for general ecosystem reporting rather than tailored to Atlantic herring life history. Therefore, new zooplankton indices were developed using VAST spatiotemporal modeling of NEFSC zooplankton survey data collected between 1982-2022. Based on the results of the Ecosystem and Socioeconomic Profile (ESP) literature review and the boosted regression tree analysis (ESP-WP), the first two indices are large copepods in spring (influencing the growth of herring post-larvae and juveniles), and small copepods in fall (influencing survival of herring larvae over the winter). The spatial scale of these indices is the Atlantic herring bottom trawl survey strata in spring and fall, respectively.

Large copepods include the taxa *Calanus finmarchicus*, *Metridia lucens*, *Calanus minor*, *Eucalanus* spp., and *Calanus* spp. Small copepods include the taxa *Centropages typicus*, *Pseudocalanus* spp., *Temora longicornis*, *Centropages hamatus*, *Paracalanus parvus*, *Acartia* spp., *Clausocalanus arcuicornis*, *Acartia longiremis*, *Clausocalanus furcatus*, *Temora stylifera*, *Temora* spp., *Tortanus discaudatus*, and *Paracalanus* spp.

The third index is more refined to focus on herring larval food and habitat, using temporal and spatial bounds defined by herring larvae observations in the zooplankton dataset. This third index focuses on small copepods from September to February in the area where more than 70% of herring larval density was identified between 1982-2022.

The indices suggest that spring large copepods increased to a relatively high level in 2015 but have been declining since, although no long-term trend appears in the time series. Fall small copepods have generally increased from a low in the mid-2000s and have remained relatively stable from 2010-present and similarly have no long-term trend in the time series (Figure 18).

For a more detailed analysis see Zooplankton and VAST Working Paper

Consideration of Findings in Other TORs

TOR 4

The results of this TOR suggested two additional model runs as sensitivities: a run to examine these recruitment covariates, and another to examine the effects of haddock predation on herring eggs. Efforts to model time-varying natural mortality were abandoned because of diagnostic issues.

TOR 7

Research recommendations include exploring maternal effects and alternative reference points beyond SSB, such as age-structured fecundity metrics and body condition indices.

CATCH & SAMPLING

TOR #2: *Estimate catch from all sources, including landings and discards. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data.*

A more comprehensive analysis of this TOR can be found in the TOR 2 working paper (TOR 2-WP).

Historic Trends in Catch

As shown in Figure 19, herring catches surged during the 1960s and 70s because of domestic, Canadian, and distant-water fleets, peaking at more than 450,000 mt before the Magnuson–Stevens Fishery Conservation and Management Act (MSA) implementation in 1978. However, catch data from this period, particularly from Russian and Polish vessels, are uncertain because of self-reporting issues. Gear used before the early 1980s included bottom trawls, purse seines, weirs, and stop seines, with industrial fleets favoring purse seines and trawls. Post-1987 records provide greater certainty, with midwater trawls dominating from the mid-1990s onward (Figure 20).

More recent management measures, such as the inshore summer prohibition on midwater trawls (implemented in 2010), shifted catches further offshore. Declining US quotas due to low herring abundance have increased the relative proportion of Canadian fixed-gear catches, which remain stable due to the absence of quota restrictions. Regional catch trends are illustrated in Figure 21.

Market and Utilization

Before ICNAF fisheries, most landed herring supported Maine's sardine industry, targeting smaller fish (ages 1-2) for canning (Anthony & Waring 1980). During ICNAF operations, catches shifted to spawning-aged fish (3+), largely for export markets. The 1980s marked the rise of the lobster bait market, which demanded larger fish unsuitable for canning. Mechanized canning in the 1990s further increased the preferred fish size, resulting in canned herring "steaks," a product still common in Canada.

By the late 2000s, nearly all herring landings supported the lobster industry, peaking at 100,000 mt annually. With the 2010 closure of the last US canning plant in Prospect Harbor, nearly all US Atlantic herring now serves as lobster bait, with minor amounts for aquariums and zoos.

Catch and Landings Data

Catch data before the MSA primarily originated from sardine facilities and ICNAF quota monitoring. Improved dealer reporting in the 1990s captured landings outside sardine operations, while the introduction of vessel trip reports (VTR) and interactive voice reporting (IVR) in 1999 standardized reporting.

Until this Research Track, VTR data served as the primary source of catch data for assessments. Maine DMR conducted QA/QC checks on VTR data, correcting errors and reconciling discrepancies before submitting data to NOAA. However, inconsistencies between VTR and quota monitoring systems prompted the WG to evaluate alternative methods.

NOAA's Catch Accounting and Monitoring System (CAMS) was developed as a unified source of catch (landings and discards) data for stock assessments, quota monitoring, and related analyses in New England and Mid-Atlantic fisheries. A working paper on the details of the transition to using CAMS for Atlantic herring can be found elsewhere (CAMS-WP). The working paper analyzes a refinement in discard estimation methods within CAMS. The transition aligns Atlantic herring discard estimation with other federally managed species using the calendar year (CY) approach. CAMS integrates multiple fishery-dependent data sources, including VTRs, dealer reports, and observer data, offering consistent estimates for both landings and discards.

Based on these results, the WG concluded that the use of the CAMS CY approach was the preferred method to estimate discards. A comparison between the previous catch accounting system performed by Maine DMR and CAMS is shown in Table 1. The differences between the two catch accounting systems are relatively minor, and the WG was comfortable going forward with the CAMS CY approach as the primary system in this and subsequent assessments. In addition, the stock assessment was insensitive to the switch to CAMS.

An additional source of catch and landings information for this assessment comes from DFO Canada. Catches in the New Brunswick (NB) fixed-gear fishery are assumed to be from the US GOM/GB stock complex (NEFSC 2018) and mainly consist of juvenile fish. Canada updated the catch time series it provided since the 2024 management track assessment. The differences in the time series were largely induced by changes to the gear types used for age-length keys and a move to standardized code used to calculate the catches. The changes were relatively minor (Figure 22) and had negligible effects on the stock assessment.

Fishery Sampling

Atlantic herring have been sampled for length, weight, and age since before the 1970s. Early sampling efforts were conducted by the offshore ICNAF fishery and inshore sardine operations. By the 1980s, sampling shifted primarily to sardine canneries, with occasional collections from bait operations.

The Maine DMR established a standardized sampling program in the late 1990s, funded by the Inter-Jurisdictional Fisheries (IJF) and Atlantic Coastal Cooperative Statistics Program (ACCSP). This program collects two 50-fish samples per gear type, per statistical area, on a bimonthly basis during the fishing season with the total number of samples per year fluctuating based on fleet activity (Figure 23). Additional fresh fish samples are collected to monitor spawning areas under ASMFC management, implemented in 1999. Sampling is conducted across all states where herring are landed, from Maine to New Jersey.

Since 1999, sampling has targeted vessels using vessel monitoring system (VMS)/VTR reports to align with the program's design. Samples are either analyzed immediately or frozen for later examination. Fish are measured for weight and length, and two fish per centimeter size bin are randomly selected for further analysis. These fish are aged using otoliths, which are extracted, dried, and embedded in epoxy resin. Gonads are also removed, weighed, sexed, and staged according to ICNAF protocols. Since 2011 fresh fish in spawning stages higher than five are included in a fecundity study (see Fecundity-WP).

Aging is performed under a microscope, with images archived for QA/QC. Calibrations between Maine DMR, NOAA's Age and Growth Lab, and DFO occur every 3-7 years to ensure consistency.

All sampling data is stored in a Maine DMR relational database, linked to NOAA's VTR records to trace individual catch events and locations. In addition, this database contains digitized historical data from ICNAF and sardine cannery sampling programs. These datasets support stock assessments, management decisions, and academic research (Becker et al. 2020).

Data on size and age from the NB fixed gear fishery is supplied directly from DFO.

SURVEY DATA

> ***TOR #3:*** *Present the survey data used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, application of catchability and calibration studies, etc.) and provide a rationale for which data are used. Describe the spatial and temporal distribution of the data. Characterize the uncertainty in these sources of data.*

Recent assessments relied on several comprehensive surveys to evaluate trends and stock dynamics. Key surveys include:

- NMFS spring bottom trawl survey (1968-present), NMFS fall bottom trawl survey (1965-present), and NMFS summer shrimp survey (1983-present).
- NMFS acoustic surveys conducted during the fall bottom trawl surveys since 1998.

The methodologies applied to these surveys remain consistent with the standards set in the 2018 benchmark stock assessment (NEFSC 2018 TORB2). Significant effort has been directed toward addressing data gaps, particularly by developing an age-1 recruitment index based on seabird diet data, as early cohort strength observations remain limited. While Massachusetts and Maine/New Hampshire state surveys were analyzed, their restricted spatial coverage led to their exclusion from assessment models. Moreover, the WG noted that because both surveys sampled more inshore component fish, a risk that including these surveys would bias the data in favor of this one component was present.

NMFS Spring Bottom Trawl Survey

The NMFS Spring bottom trawl survey has undergone no methodological changes since the 2018 benchmark assessment (NEFSC 2018). The survey's index trends have shown a steady decline since 2009 (Figure 24). Age composition data demonstrates clear cohort tracking over time, validating its utility in stock assessment. The WG's preferred model continues to split the survey into two distinct time series to account for the transition from the Albatross to the Bigelow vessel in 2008 and 2009.

NMFS Fall Bottom Trawl Survey

Similarly, no methodological adjustments have been instituted to the NMFS fall bottom trawl survey. In addition, index trends from this survey have exhibited a declining trajectory since 2009 (Figure 24). Age composition patterns highlight consistent cohort tracking. As is the case with the spring survey, the fall survey is split into two time series to accommodate vessel changes, ensuring data continuity and reliability within the WG's preferred modeling framework.

NMFS Gulf of Maine Northern Shrimp (summer) Survey

Since 2018 the primary methodological update for the NMFS summer shrimp survey involves replacing borrowed age-length keys with directly collected age composition data. This adjustment, implemented during the 2022 management track assessment, enhances the accuracy of stock age data. Recent years have shown declining index trends for this survey (Figure 24). Given operational challenges, this survey was not conducted in 2024, and the timeline for its resumption remains uncertain.

NMFS Acoustic Survey

The NMFS acoustic survey, conducted during the fall bottom trawl survey, continues to provide critical data. Details regarding its methodology and findings are documented comprehensively in the working document authored by Jech (Acoustics-WP).

Age-1 Recruitment Index via Seabird Diet Data

Efforts to develop an age-1 recruitment index using seabird diet data address a key data gap in cohort strength observations. The detailed methodologies and outcomes of this work are elaborated in the document Seabird_Diet-derived_Recruitment_Index-WP.pdf.

Maine/New Hampshire Survey

The Maine/New Hampshire (ME-NH) survey has operated since 2000, utilizing a stratified random sampling design across four depth strata and five geographic regions. Sampling stations, revisited in spring and fall, involve 20-minute tows using a modified shrimp net. Species-specific measurements include length, weight, and, where applicable, maturity assessments. Catch numbers and weights have declined since its inception (Figure 25 & Figure 26), although trends exhibit variability. Despite being excluded from final modeling, the ME-NH survey aligns with trends observed in other surveys, offering insights into the inshore recruitment dynamics of Atlantic herring.

Massachusetts Survey

The Massachusetts Division of Marine Fisheries (MADMF) has conducted seasonal inshore trawl surveys since 1978, with spring and fall cruises. Spring surveys predominantly capture age-1 herring (~6 cm), while fall surveys often capture larger individuals, typically representing age-1

(~11 cm) and age-2+ (~24 cm) cohorts (Figure 27 & Figure 28). Significant interannual variability in herring indices is observed, with large shifts linked to spatial availability and bottom temperature fluctuations (Figure 29, 30, & 31). Herring are most frequently encountered in the deepest, coldest regions of Massachusetts state waters, emphasizing the influence of environmental conditions on survey results.

ASSESSMENT METHODS

> ***TOR #4:*** *Use appropriate assessment approach to estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Compare the time series of these estimates with those from the previously accepted assessment(s). Evaluate a suite of model fit diagnostics (e.g., residual patterns, sensitivity analyses, retrospective patterns), and (a) comment on likely causes of problematic issues, and (b), if possible and appropriate, account for those issues when providing scientific advice and evaluate the consequences of any correction(s) applied.*

Model Evaluation Criteria

Throughout model development, some combination of the list below was used for model selection. During stages of development that required comparison among many models, selection relied largely on convergence properties and AIC because visual comparisons of residual plots and diagnostics that require simulation (e.g., jitter, self-tests) are impractical for more than a few model alternatives. At stages when the WG was evaluating just a few models (~ <10), a fuller suite of the diagnostics below were used. More details can be found in the TOR_4-5-6-WP.

- **Convergence:** To be considered acceptable, all models were required to converge to a solution with a maximum gradient <e-10 and an invertible Hessian. Models with retrospective peels that all converged were also preferred over models that did not.

- Models with standard deviation (SD) estimates of zero for any random effects process were eliminated from consideration.

- **Residuals:** Models with fewer patterns in standard Pearson residuals and OSA residuals were preferred over models with more obvious patterning. Residuals were examined for patterns among years, ages, cohorts, and observations.

- Retrospective patterns were examined visually and summarized using Mohn's rho. Patterns in fishing mortality, spawning stock biomass (SSB), and recruitment were all examined. Retrospective patterns in recruitment are typically not used for model selection, but the WG found them to be indicative of model sensitivity to data inputs on a few occasions (see below).

- AIC was used to compare models with a preference for smaller AIC values. When two models had similar AIC, the negative log-likelihood was also examined to evaluate whether the model alternative with more parameters was having any significant effect on fit. Given similar AIC and likelihood values, the simpler model with fewer parameters was preferred.

- **Self-tests:** Pseudo-data were generated from model fits with observation uncertainty only (i.e., parameters fixed at their estimated values and no process uncertainty), and then the model refits to each pseudo-dataset. Relative error was then summarized for time series estimates of F, SSB, and R. Acceptable models would not have relative errors that were systematically different from zero or trend among years.

- Tests of normality and the standard deviation of OSA residuals were also used for model selection. OSA residuals should be approximately normal (Trijoulet et al. 2023 and Li et al. 2024), and OSA residuals for age composition data should not have a standard deviation >>1, which can be indicative of model misspecification (Li et al. 2024).

Mean absolute scaled error (MASE; Carvalho et al., 2021; Kell et al., 2021), a measure of predictive skill, was calculated but is generally not useful for model selection (Li et al., 2024).

Summary of Preferred Model

Data

More details can be found in (TOR_4-5-6-WP). All input data for the preferred model was identical to the 2024 Management Track stock assessment (NOAA 2024) with two exceptions: 1) the Canadian catch and weight-at-age time series were revised, and 2) US catch and discards used CAMS estimates from 2020 onward (See TOR 2-WP). Both of these changes had negligible effects on the assessment. Age compositions by fleet and proportion of the catch by fleets are given in Figure 32 & Figure 33, respectively. Age compositions by each index are given in Figure 34, 35, & 36, while both the nominal and the log-scaled indices are shown in Figure 36.

Age Composition Likelihoods

A broad suite of alternatives for age composition likelihoods was explored. The WG agreed that the logistic-normal-ar1-miss0 provided the best overall diagnostics, and in particular, improved the OSA residuals for the fit to age composition data from the spring and fall bottom trawl survey since 2009 (i.e., during the Bigelow years).

Initial numbers-at-age

Estimating initial numbers-at-age improved fit and was supported by AIC over assuming these values were at equilibrium. These values were estimated in the preferred model.

Selectivity

With some exceptions, the selectivity forms applied were the same as recent management track assessments as outlined below.

- **Mobile fleet:** selectivity-at-age is estimated for ages 1-6 and fixed at 1.0 for ages 7-8.

- **Fixed fleet:** selectivity-at-age is estimated for all ages except age-2, which is fixed at 1.0.

- **Summer (Shrimp) survey:** selectivity-at-age-3 is estimated while younger ages are fixed at 0.0 and older ages are fixed at 1.0.

- **Acoustic survey:** has no age composition data and selectivity is knife-edged with full selection for ages 3-8.

- **Spring bottom trawl 1987-2008:** selectivity-at-age-2 is estimated while younger ages are fixed at 0.0 and older ages are fixed at 1.0.

- **Fall bottom trawl 1987-2008:** uses logistic selectivity.

- **Spring bottom trawl 2009-2023:** estimates selectivity-at-age for ages 2-3, while younger ages are fixed at 0.0 and older ages are fixed at 1.0.

- **Fall bottom trawl 2009-2023:** uses logistic selectivity.

A broad suite of age- and time-varying selectivity random effects were evaluated for the mobile and fixed fleets. In all cases, the SD of these random effects was zero, very small, or did not improve fit based on AIC. As such, time invariant selectivity is used in the preferred model. The WG did not see any justification for considering time-varying selectivity for the indices.

Natural Mortality

A broad suite of age- and time-varying natural mortality parameterizations were evaluated. This included combinations of fixed effects estimated as age-varying or age- and time-invariant parameters and random effects with various age or time correlation structures. Estimating M as fixed effects did not improve fit based on AIC and had odd retrospective patterns. While model fit improved with M as iid random effects, the estimates appeared to be chasing observation noise and did not represent real changes in M. In addition, self-tests on models with random effects on M had low rates of convergence and bias. Random effects on M also caused volatility in reference points, and recent research suggests that time-varying M should only be included with strong, external, corroborating evidence. In this case, external evidence supported time-invariant M. Consequently, the preferred model had a constant M=0.35 (status quo).

Estimates of Atlantic herring consumption based on piscivore stomach contents data were made for the 2018 benchmark stock assessment (Figure 37). Using the same data, Gartland and Latour (2024) applied a VAST model with a range of covariates and estimated Atlantic herring consumption (Figure 37). The number of dead fish implied by an assumed M=0.35 generally matched the scale and trend of both of these estimates of consumption. Values from Gartland and Latour (2024) had to be doubled for comparison to the assessment because they only provided estimates for six months of each year (i.e., spring and fall) and warned against out-of-sample extrapolation to estimate annual consumption. While reassuring that these estimates are generally similar, the approach likely violates sound statistical practice.

Numbers-at-age Transitions

The model was started in 1987 when age data became available from the bottom trawl surveys. Including random effects on the numbers-at-age transitions greatly improved fit and reduced the retrospective pattern. Fit and AIC diagnostics supported the use of transitions correlated among ages, but not years. This correlation was not coupled with age-1 recruitment. Consequently, the preferred model has random effects on the numbers-at-age transitions with an ar1_a correlation (Figure 38).

Recruitment

Fit and AIC diagnostics supported the use of iid random effects for recruitment. The preferred model estimates a fixed effect recruitment scaling parameter and annual recruitments as iid random effects around the scaling parameter (i.e., the log scale mean of the iid random effects distribution). SSB and recruitment are shown in Figure 39; SSB and fishing mortality are given in Figure 40, how the F is portioned among the fleets in Figure 41; and the estimated numbers at age by year in Figure 42.

Covariates and Other Explorations

A variant of the preferred model used a haddock predation index as a covariate for recruitment (Haddock_predation-WP). This covariate did not improve model fit or reduce the process SD for recruitment, and the confidence interval around the covariate parameter included zero (i.e., no effect), which suggested that haddock were not a primary driver of variance in annual recruitment.

Similarly, three additional variants of the preferred model used indices of small zooplankton (larval herring food), large zooplankton (juvenile herring food), and optimal herring larval temperature duration, respectively, as covariates for recruitment. Results were similar for the haddock biomass covariate: within the preferred model structure, these covariates did not substantially improve model fit or reduce the process SD for recruitment, and confidence intervals around the covariate parameters included zero. Further, the estimated larval and juvenile food covariate parameters were negative (suggesting low zooplankton is associated with higher recruitment, and high zooplankton is associated with lower recruitment; opposite of our working hypothesis).

In two recruitment covariate sensitivity runs with NAA RE turned off, both haddock predation and optimal larval temperature duration covariates improved model fit, reduced the process SD for recruitment, and estimated covariate parameters with confidence intervals that did not include 0. However, the overall model fit was greatly reduced without NAA RE included.

Diagnostics

The WG had no major concerns about any diagnostics. Jitter analyses, self-tests, and the normality of OSA age composition residuals all had SD <1. Nearly all the OSA age composition residuals were significantly different from normality, but this was likely due to the high power of the statistical test rather than concerning deviations from normality. Given that no retrospective adjustment was necessary (TOR_4-5-6-WP), retrospective plots are not shown.

STATUS DETERMINATION CRITERIA

TOR #5: *Update or redefine status determination criteria (SDC; point estimates or proxies for BMSY, BTHRESHOLD, FMSY, and MSY reference points) and provide estimates of those criteria and their uncertainty, along with a description of the sources of uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for reference points. Compare estimates of current stock size and fishing mortality to existing, and any redefined, SDCs.*

The WG agreed to the continued use of $F_{40\%}$ as an F_{MSY} proxy. Life history traits and other necessary inputs to the per-recruit calculations will continue to use a recent 5-year average. As is also current practice (NEFSC 2022; NEFSC in press), only the $F_{40\%}$ specific to the mobile fleet should be used for official overfishing determination. This approach is taken because the fixed fleet is almost entirely Canadian, and overfishing status should not be driven by a foreign fleet without quota controls. WHAM can produce a "global" $F_{40\%}$ and an $F_{40\%}$ specific to the fixed fleet, and these values might be informative but should not be used for official status determination. More details can be found in the TOR_4-5-6-WP.

$B_{40\%}$ is found by multiplying $SPR_{40\%}$ by a recruitment scalar (e.g., mean recruitment over some years). In recent assessments, including the 2024 management track, mean recruitment was averaged over 1992-2021 (the last two years dropped due to uncertainty), and this stanza was chosen based on a change point analysis applied to the R/SSB time series that suggested a possible environmental change since 1992 that has led to reduced productivity. The R/SSB time series from the preferred WHAM model does not suggest the same changes, thus the WG agreed that a reduced time stanza is no longer needed. The differences in the R/SSB time series between the 2024 management track ASAP model and the preferred WHAM model were traced to the presence of NAA random effects in WHAM.

The WG considered two methods to define the recruitment scalar that will be used to determine $B_{40\%}$. One method involved taking the time series average of the annual estimated recruitments from the preferred WHAM model. The second method involved using the recruitment scaling parameter from which the annual recruitment random effect deviations are estimated. This recruitment scaling parameter is often mistaken for the mean or median recruitment of the natural scale recruitment estimates, but it does not necessarily equal either one. The WG agreed to use the recruitment scaling parameter because: 1) It is more stable than a time series average because it is less affected by extreme recruitment estimates; 2) It avoids subjective decision-making about whether some recruitment estimates (e.g., terminal year) are too uncertain to be included in the time series average; and 3) Using the recruitment scaling parameter creates internal consistency because it is the value from which the log scale recruitments deviate, represents the mean of the log scale recruitment process, and allows for the recruitment process to be used in short-term projections making the estimation model and projection model entirely consistent.

The reference points using this approach were:

- $B_{40\%}$ = 233,176mt (90%CI 152,540-356,439),
- Global $F_{40\%}$=0.358, $F_{40\%}$ for the mobile fleet = 0.349 (90%CI 0.305-0.440), $F_{40\%}$ for the fixed fleet = 0.008,
- Global MSY = 63,835mt, MSY for the mobile fleet = 51,001mt, and MSY for the fixed fleet = 12,835mt.

The SD of the fleet-specific $F_{40\%}$ is not reported by WHAM, and thus the SD of the global $F_{40\%}$ was used as a proxy in calculating the mobile fleet $F_{40\%}$ confidence interval.

Terminal year (2023) mobile fleet F = 0.225 (90%CI = 0.16-0.32). Terminal year (2023) SSB = 82,402mt (90%CI = 60,582-112,082). Mohn's rho for SSB = 0.27 and F = -0.16, and retrospective adjustments were unnecessary.

By comparison from the 2024 management track assessment:

- $B_{40\%}$ = 186,367mt
- mobile fleet $F_{40\%}$ = 0.45
- global MSY = 78,710mt.

Rho adjusted terminal year (2023) SSB = 47,955mt, which was 26% of $B_{40\%}$. Rho adjusted terminal year (2023) mobile fleet F = 0.263, which was 58% of $F_{40\%}$. However, direct comparisons between the results of the 2024 management track assessment and the findings of this research track are inappropriate because of the change in the modeling platform and other advances in methodology for the Atlantic herring assessment.

PROJECTION METHODS

TOR #6: *Define appropriate methods for producing projections; provide justification for assumptions of fishery selectivity, weights at age, maturity, and recruitment; and comment on the reliability of resulting projections considering the effects of uncertainty and sensitivity to projection assumptions*

As mentioned above, the WG agreed to use the recruitment scaling parameter for reference points and continue the recruitment random effect process into projections (i.e., iid lognormal recruitment), consistent with the estimation model. Using an iid lognormal distribution for recruitment differs from the current projection methodology that uses an ar1 recruitment process. In addition, as noted above, WHAM found no evidence of a significant correlation in the recruitment time series, thus autocorrelation in recruitment was not included. The other basic projection methodologies agreed to by the WG are largely consistent with existing methods. The US mobile fleet catch is specified by applying the NEFMC ABC control rule, which determines the ABC in year *y+1* in response to the ratio of B to B_{MSY} proxy in year *y* using a “hockey-stick” shaped control rule. The fixed fleet catch is held constant in projections at the most recent 10-year average, consistent with recent management practice. However, this value is considered part of management uncertainty and subject to change as recommended by the NEFMC in its specifications process. See TOR_4-5-6-WP for more details.

Projections using these methods resulted in relatively rapid increases in SSB and mobile fleet catch (Figure 43). There are several reasons for these results. The stock will trend toward $B_{40\%}$ and higher when fished below $F_{40\%}$ (the ABC control rule has a maximum fishing mortality of 80% $F_{40\%}$, and target F declines linearly to zero below half $B_{40\%}$). During the estimation model period through 2023, recent NAA random effects have been negative, which will remove fish from the population faster than the reductions caused by just fishing mortality and M. Without temporal correlation, these negative random effects do not persist into the projection period (i.e., they equal zero), and thus recent cohorts (even if relatively poor) will contribute to SSB more quickly and for a longer period than in the presence of negative NAA random effects.

Similarly, recruitment is projected as iid as opposed to the ar1y process currently used in the ASAP model. Therefore, recruitment does not remain relatively low into the projection period (Figure 44), and instead immediately reverts to the recruitment scaling parameter value. However, the WG agreed that the absence of NAA random effects in the projection period is likely more influential than the recruitment assumption. Catches for the mobile fleet also increase more quickly relative to the 2024 management track methods because WHAM estimates a slightly better stock condition (Figure 45), which permits higher fishing mortality rates for the mobile fleet. Further, the catch will increase exponentially as F increases linearly based on the ABC control rule.

The WG expressed concern that these projections were overly optimistic but did not have any immediate solutions. The issue of overly optimistic projections is not unique to this Atlantic herring Research Track and might be addressed more broadly through the upcoming Research Track stock assessment on projection methodologies scheduled for 2027.

RESEARCH RECOMMENDATIONS

***TOR #7:** Review, evaluate, and report on the status of research recommendations from the last assessment peer review, including recommendations provided by the prior assessment working group, peer review panel, and SSC. Identify new recommendations for future research, data collection, and assessment methodology. If any ecosystem influences from TOR 1 could not be considered quantitatively under that or other TORs, describe the next steps for development, testing, and review of quantitative relationships and how they could best inform assessments. Prioritize research recommendations.*

The WG examined past Research Recommendations to see whether they were still relevant and what progress had been made. In addition, the WG made recommendations on future work that would improve the Atlantic herring assessment. See TOR_7-WP for more details.

The following summarizes the WG's response to previous research recommendations.

Past Recommendations

Investigate mechanisms behind low recruitment:

The WG has examined this issue in detail (see TOR 4). The main conclusion is that while variable, recruitment has not declined as much as previously understood. Rather, NAA transitions suggest lower retention of fish as they move to older ages in some years. Several covariates on recruitment were also attempted, including haddock predation on eggs, temperature, and plankton abundance (i.e., food availability). Results suggested that these may be partial drivers of recruitment, but no single covariate was identified as largely responsible for herring recruitment patterns.

Consider informing projections with R/S for consistency with change point analysis:

This recommendation is no longer relevant.

Investigate whether $F_{40\%}$ needs to be changed/reduced in the lower productivity regime:

The issue of reference points and $F_{40\%}$ can be found in TOR 5. Briefly, no evidence indicates that the continued use of $F_{40\%}$ as a proxy of F_{MSY} is untenable. Given that the evidence for a lower productivity regime has deteriorated, this issue is less urgent.

Estimate F_{MSY} directly:

The WG has concluded that MSY-based reference points are still incalculable for Atlantic herring and have retained $B_{40\%}$ and $F_{40\%}$ as MSY proxies.

Consider younger ages as fully selected by the mobile fleet:

This assessment did not directly address the recommendation. Instead, the WG continued with the use of a two-fleet structure. The Fixed Gear fleet focuses mainly on smaller, younger fish, while the Mobile fleet targets older and larger fish. The WG attempted many assessment model runs with time—and age-varying selectivity—and no support was found to suggest that younger ages should be more fully selected.

Consider recruitment index based on seabird diet:

This recommendation is addressed in TOR 3.

Explore approaches to estimating M, especially time-varying:

As outlined in TOR 1 and TOR 4, little support for time- or age-varying natural mortality existed.

Examine stock structure and movement:

Given this Research Track's goals and time frame, a full examination of stock structure or migration patterns was not possible. Future work on herring genetics in the Gulf of Maine and Georges Bank is planned for 2025-26.

Explore model-based indices:

This recommendation was thoroughly addressed in the 2012 benchmark.

Continue collecting age data during the summer survey:

The fate of the summer survey as a whole remains uncertain. While age data has been collected, the survey was not conducted in 2024 and is unlikely to be conducted again in 2025.

Evaluate the impact of switching from borrowed ALKs to direct age observations from the summer survey:

No progress has occurred on this recommendation as of this Research track.

Explore the effect of likelihood penalties on recruitment estimation:

This is no longer relevant as recruitment penalties are not used in WHAM.

Monitor the impact of missing 2020 survey data on assessments:

This recommendation was addressed in the 2022 and 2024 Management Track assessments. Further, missing 2020 survey data combined with NAA random effects caused problems with retrospective analysis in this research track, which was monitored and resolved.

Examine reproductive status and condition over time:

This recommendation was addressed at length in TOR 1.

Improve our understanding of fleet dynamics and the relationship to herring spatial dynamics:

TORs 1 and 2 partially address this recommendation. In addition, the NEFMC is working to examine this issue in more detail.

Analyze condition, growth, and fecundity:

TOR 1 and the additional working papers referenced therein examine this issue in greater detail.

The WG recommends the following new research recommendations grouped by category:

New Recommendations include:

Maternal Effects and Fecundity:

- Further analysis is recommended to refine reference points incorporating maternal effects, such as age-structured fecundity metrics and body condition indices.

Spawning Timing:

- Prioritize spring body condition indices when analyzing changes in herring body condition to avoid confounding effects of significant weight fluctuations associated with the fall spawning season.

Egg Predation:

- Further analysis of haddock predation on herring eggs and its relationship to recruitment dynamics is recommended.

Larval Temperature Stress:

- Investigate the implications of warming sea surface temperatures and the reduced optimal thermal window on larval survival to refine models of density-independent mortality.

Food Availability:

- Develop zooplankton indices tailored to Atlantic herring life history, focusing on spring large copepods and fall small copepods to assess their influence on herring recruitment.

Natural Mortality:

- Explore and refine predator-prey interaction models to improve natural mortality estimates.

Survey Data:

- Continue enhancing survey methodologies, such as incorporating age-length data and calibration studies, to improve reliability and consistency.

- Evaluate the inclusion of innovative recruitment indices, like seabird diet data, for stock assessments.

- Apply VAST methodologies to combined State and Federal Surveys.

Assessment Methods:

- Explore alternative age-specific selectivity models and the use of random effects selectivity parameters.

- Investigate the use of larval indices as a potential index of recruitment.

- Refine projection models by integrating ecosystem indicators, such as zooplankton abundance and thermal habitat suitability.

Projection Methods:

- Integrate environmental datasets, including temperature and prey availability indices, to refine projection assumptions.

- Address overly optimistic projections by exploring methods that better account for recruitment variability and environmental drivers.
- Evaluate if and how NAA random effects should be treated during the projection period.
- Consider refining how weight- and maturity-at-age are specified in the projection period (i.e., investigate alternatives to a recent 5-year average, especially for trending traits).

BACKUP ASSESSMENT APPROACH

> ***TOR #8:*** *Develop a backup assessment approach to providing scientific advice to managers if the proposed assessment approach does not pass peer review or the approved approach is rejected in a future management track assessment.*

The WG concluded that if the preferred WHAM model configuration were to be rejected it would likely be due to unacceptable diagnostics (e.g., residual patterns, unresolvable data conflicts) that may not be resolvable within an age-based assessment. Consequently, the WG concluded that a trend-based backup would be appropriate, and the WG chose the existing Ismooth approach. The Ismooth approach performed relatively well when tested in a management strategy evaluation and was especially good for rebuilding depleted stocks (Legault et al. 2022). The Ismooth approach would use all indices of abundance included in the age-based assessment. Each index would be divided by its time series to standardize all time series to a similar scale. If the Ismooth approach is needed, then spring survey in the year following the terminal year of the age-based assessment will likely be available.

This spring observation would be included in the Ismooth to take advantage of the most recent survey observation. The Ismooth approach uses the mean across indices each year in the application of a LOESS-smoothed average index of abundance. The time series other than the spring survey will be lagged forward one year so that the most recent observation from each survey will be used when taking the annual means (e.g., the fall observation from year y will be averaged with the spring observation from year y+1). The multiplier produced by Ismooth would be applied to a recent average catch to provide catch advice. The multiplier using the data in this research track was 1.56.

The WG noted that the NMFS Gulf of Maine Northern Shrimp survey has been suspended and was not conducted in 2024. Future management tracks should reconsider whether this survey should remain in the Ismooth backup assessment approach. More generally, the indices considered in the Ismooth may need reconsideration depending on survey availability and temporal or spatial coverage (e.g., vessel breakdowns, incomplete strata sampling).

OTHER ADDITIONAL TORs

> ***TOR #9:*** *Identify and consider any additional stock-specific analyses or investigations that are critical for this assessment and warrant peer review, and develop additional TOR(s)* to address as needed.*

No additional TORs were necessary.

TABLES

Table 1. Comparison between current catch accounting and CAMS for fishery-wide catch by year. All catches are in mt from US vessels.

Year	Current Approach	CAMS	Difference
2020	8,069	9,866	(1,797)
2021	5,236	5,216	20
2022	3,921	4,295	(374)
2023	9,500	10,118	(618)

FIGURES

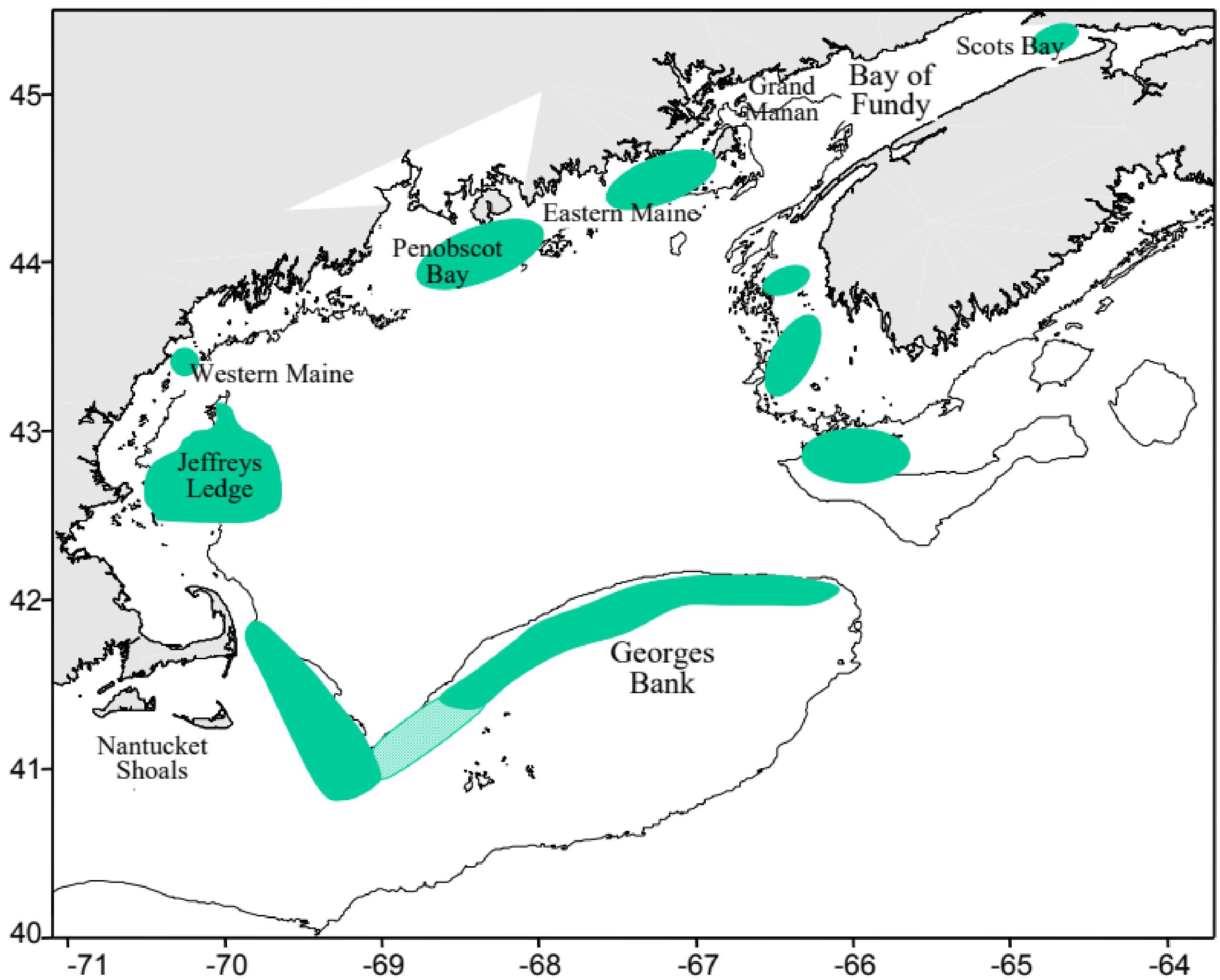


Figure 10. Generalized view of the current major herring spawning areas in the Gulf of Maine and on George Bank. From Overholtz et al. 2024

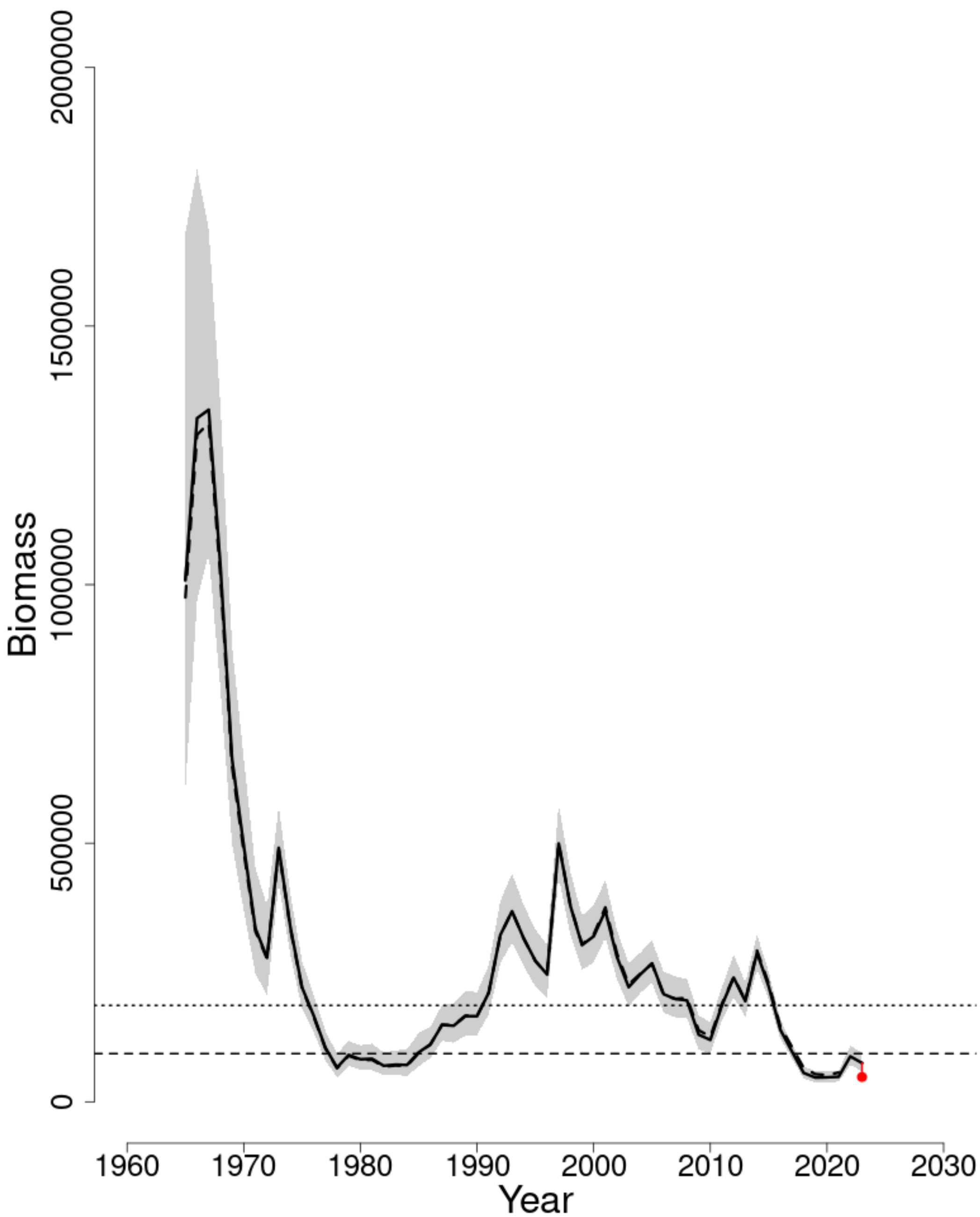


Figure 11. Trends in spawning stock biomass of Atlantic Herring between 1965 Trends in spawning stock biomass of Atlantic Herring between 1965 and 2023 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ (1/2 $SSBMSY_{proxy}$; horizontal dashed line) as well as SSB_{Target} (SSBMSY proxy; horizontal dotted line) based on the 2024 assessment. The approximate 90% confidence intervals are shown. The red line and dot show the value from the 2024 assessment adjusted for the retrospective pattern. From NEFSC 2024.

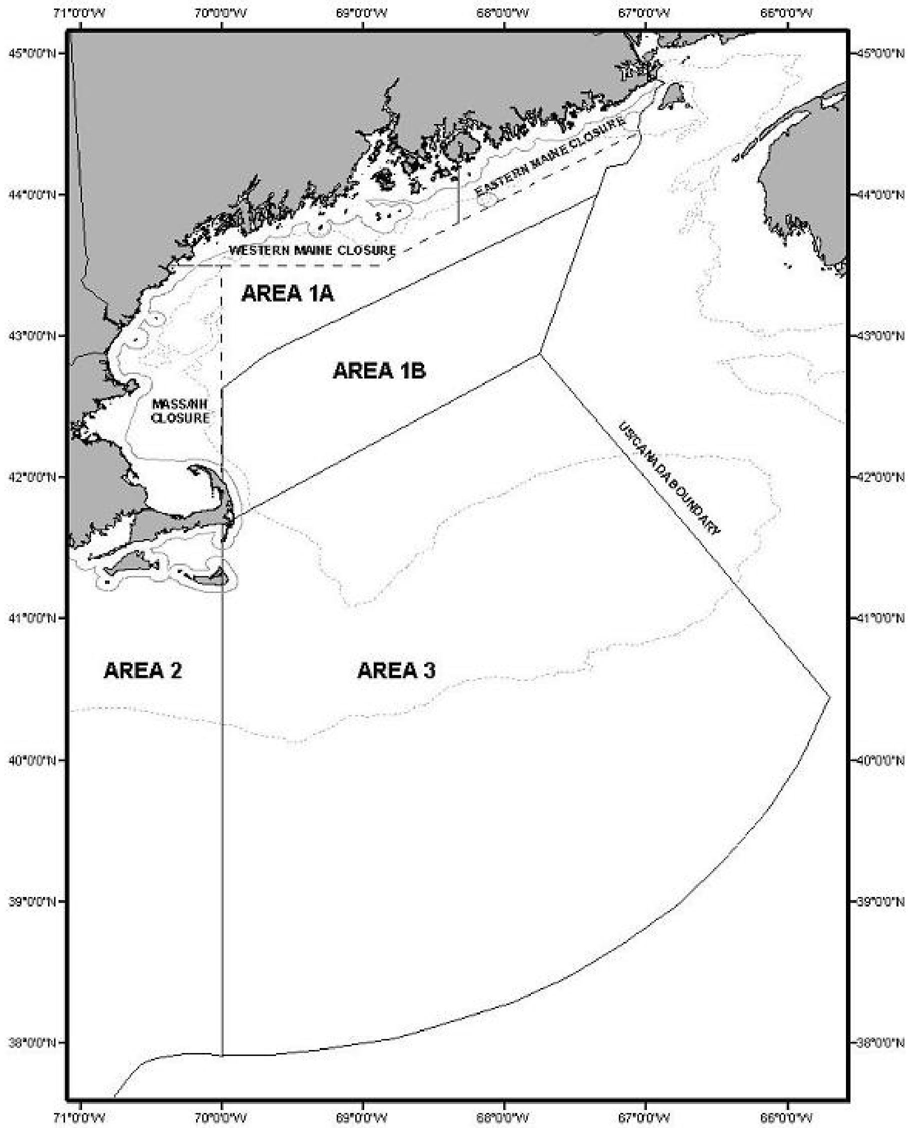


Figure 12. Atlantic herring fishery management areas including spawning closures. https://www.maine.gov/dmr/science/species-information/atlantic-herring-biology-and-research. **Note:** Area 2 extends further south to Cape Hatteras, North Carolina (not shown). See: https://www.fisheries.noaa.gov/resource/map/herring-management-areas

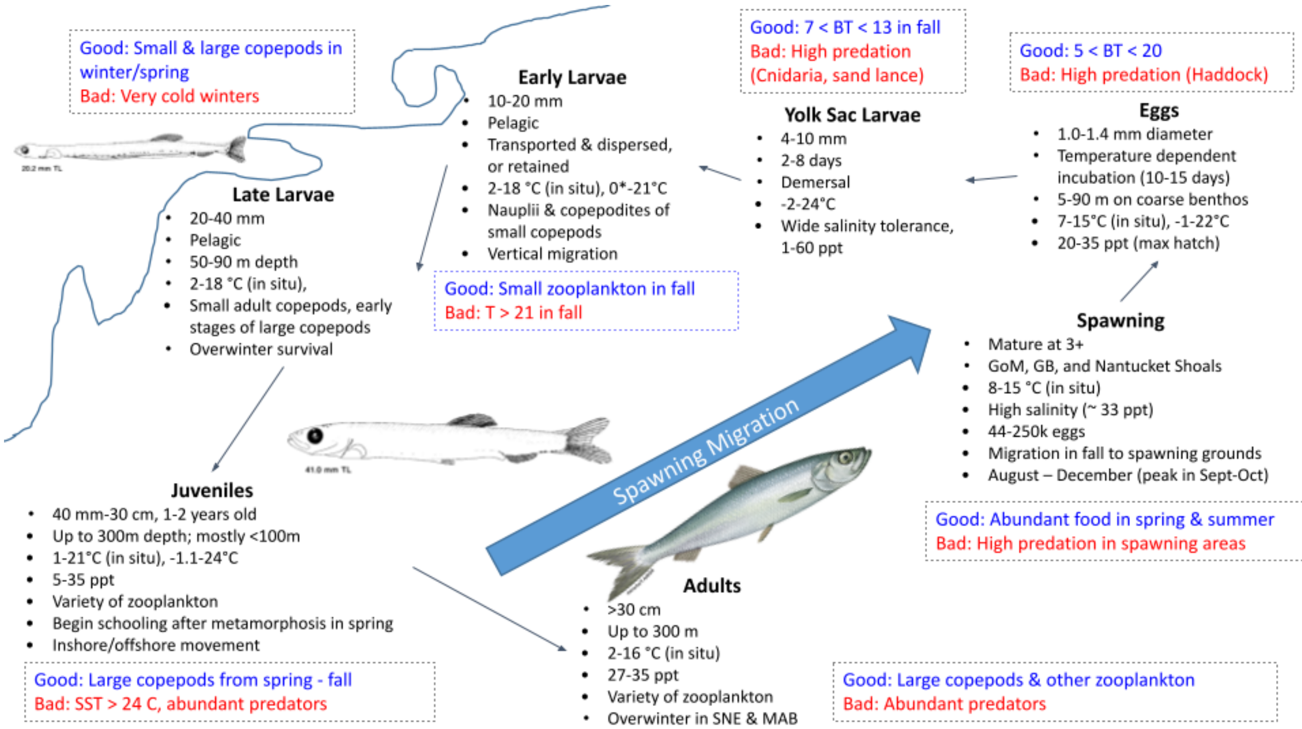


Figure 13. Atlantic herring conceptual model.

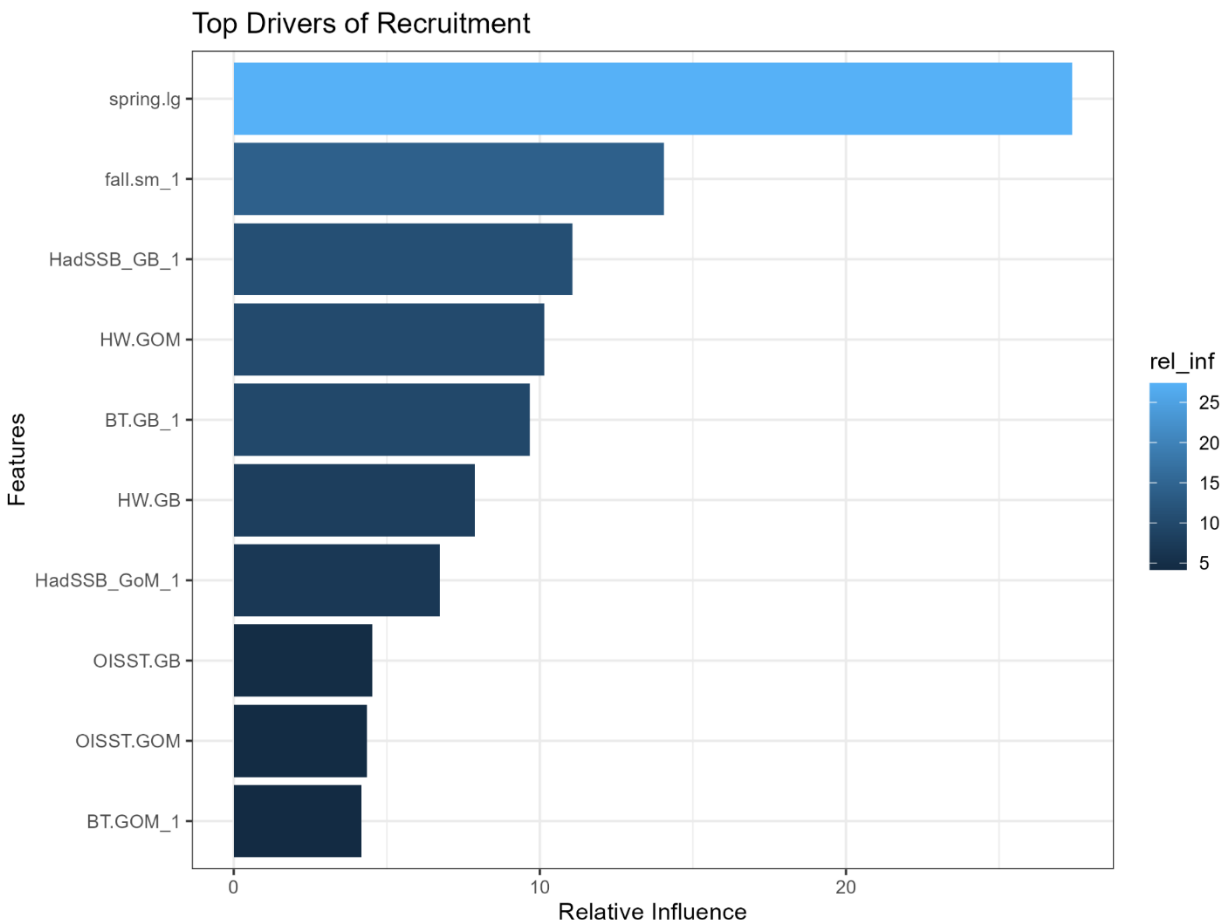


Figure 14. Relative influence of different climate and ecosystem drivers on Atlantic herring recruitment. Drivers: unlagged spring large copepods (spring_lg), lag 1 fall small copepods (fall.sm_1), lag 1 haddock spawning stock biomass on Georges Bank (HadSSB_GB_1), sea surface temperature on Georges Bank (OISST.GB), sea surface temperature Gulf of Maine (OISST.GOM), and lag 1 bottom temperature in the Gulf of Maine (BT.GOM_1).

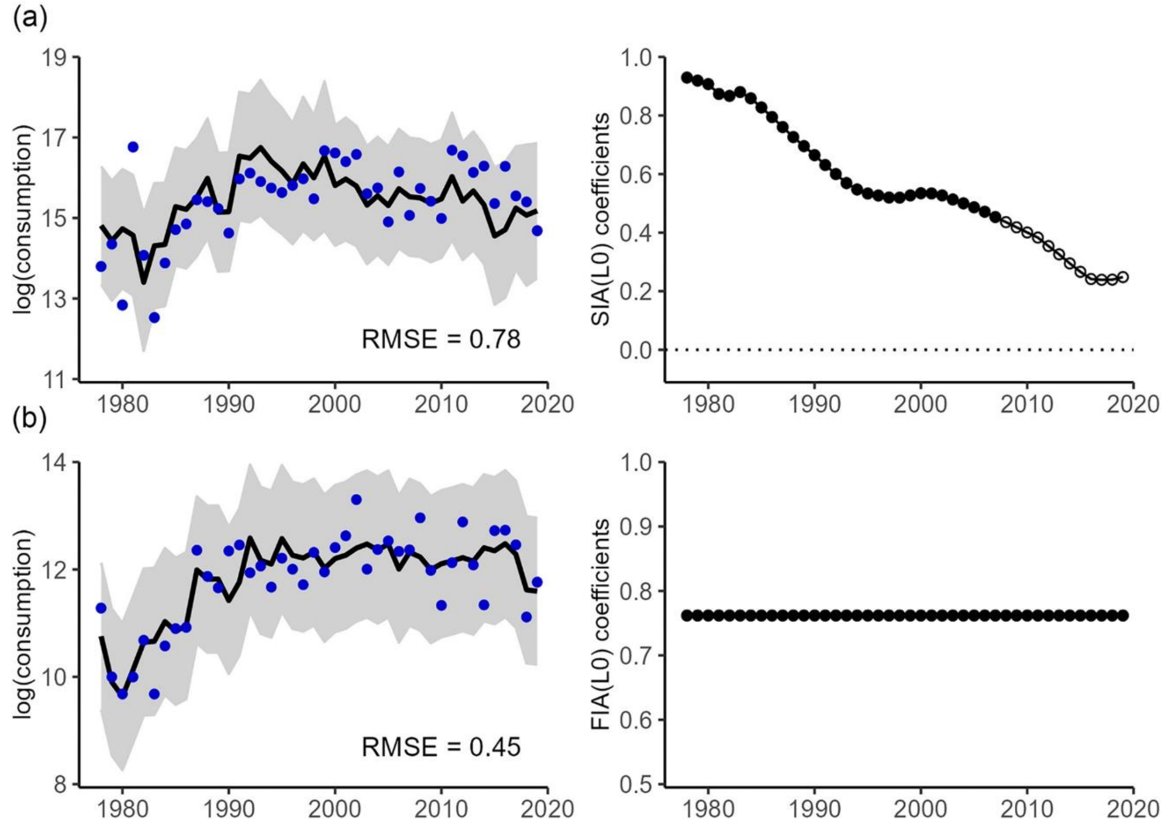


Figure 15. Figure 4 from Gartland and Latour 2024. “DLM fits (left panels, lines) and 95% prediction intervals (shading) from relating (a) the spring time-series of Atlantic herring consumption (points) to the spring index of relative abundance for this species at lag-0 (SIA, L0) and (b) the fall time-series of consumption (points) to the fall index of relative abundance at lag-0 (FIA, L0). RMSE of the model fits is given for each season. The right panels provide the associated time-series of coefficient estimates for SIA, L0 and FIA, L0 (a. spring; b. fall). Closed circles represent years in which the 95% CI of these estimates did not overlap zero. Model fits and parameter estimates are provided only for the most supported (ΔAICc = 0) DLM from each season.”

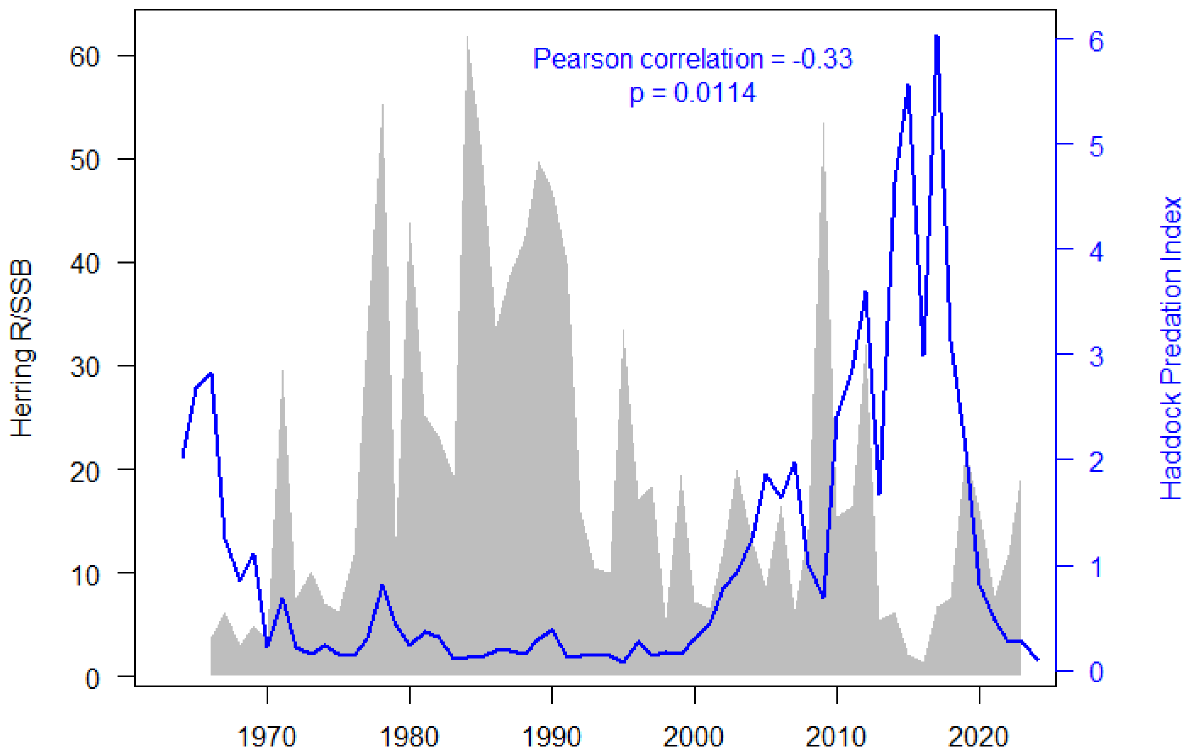


Figure 16. Correlation between the haddock predation index (blue line) and herring recruit-per-spawner (grey region) from the 2022 assessment model (updated with data through 2023).

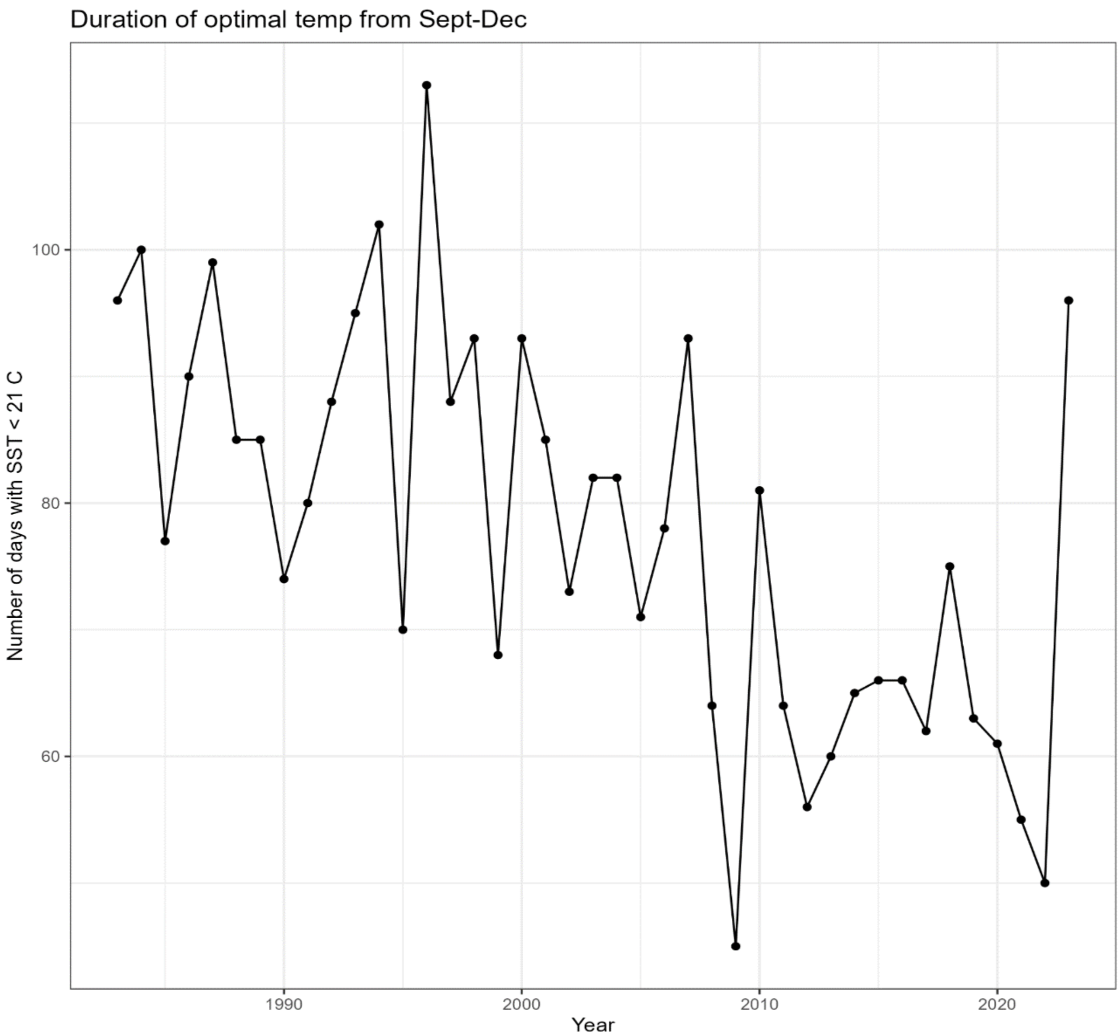


Figure 17. Duration of optimal thermal window for herring larvae in the fall (September-December). This is the number of days where none of the sea surface temperature grid cells in the fall NEFSC herring strata are greater than the lethal threshold of 21 C. Duration of optimal temperature has been decreasing over time.

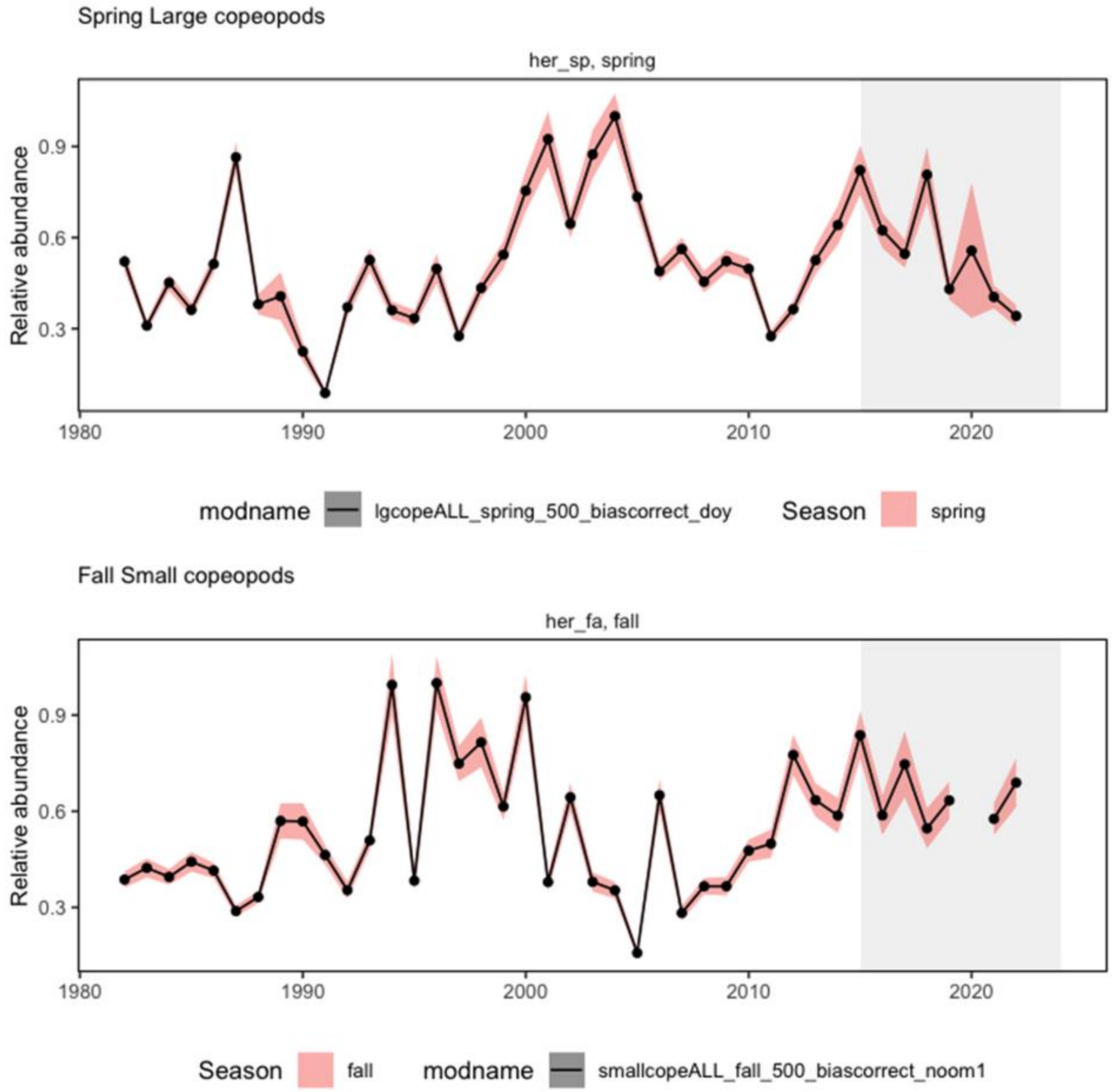


Figure 18. VAST-derived copepod indices, 1982-2022. Top panel: Spring (January-June) large copepods in spring Atlantic herring bottom trawl survey strata. Bottom panel: Fall (July-December) small copepods in fall Atlantic herring bottom trawl survey strata.

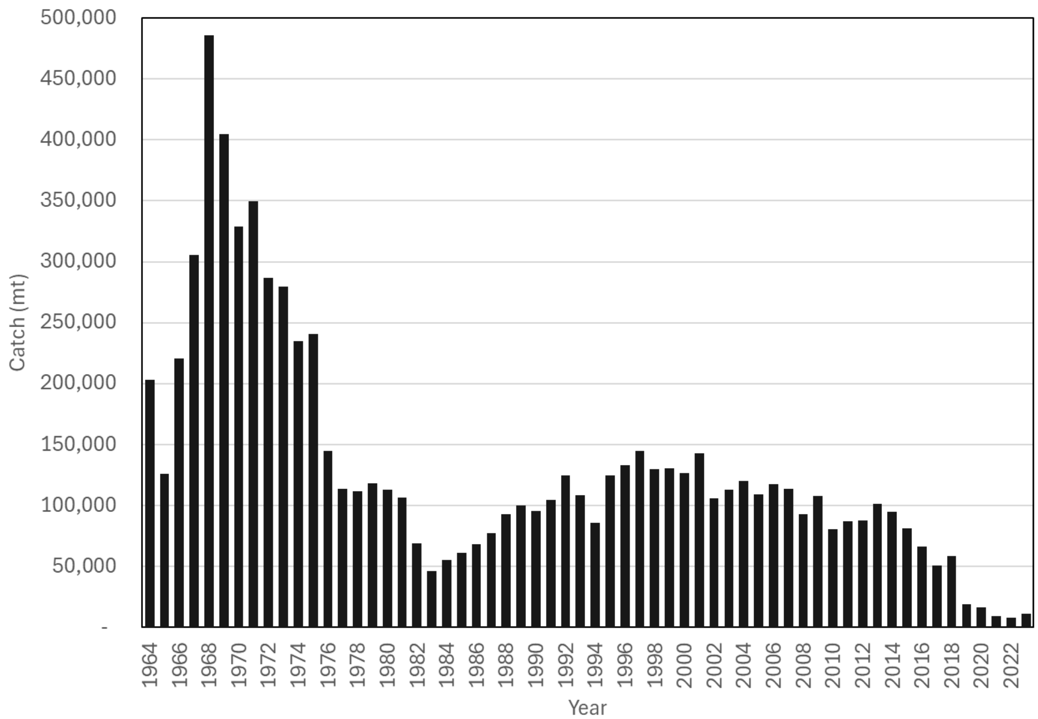


Figure 19. Atlantic herring catch by year: 1964 to 2023.

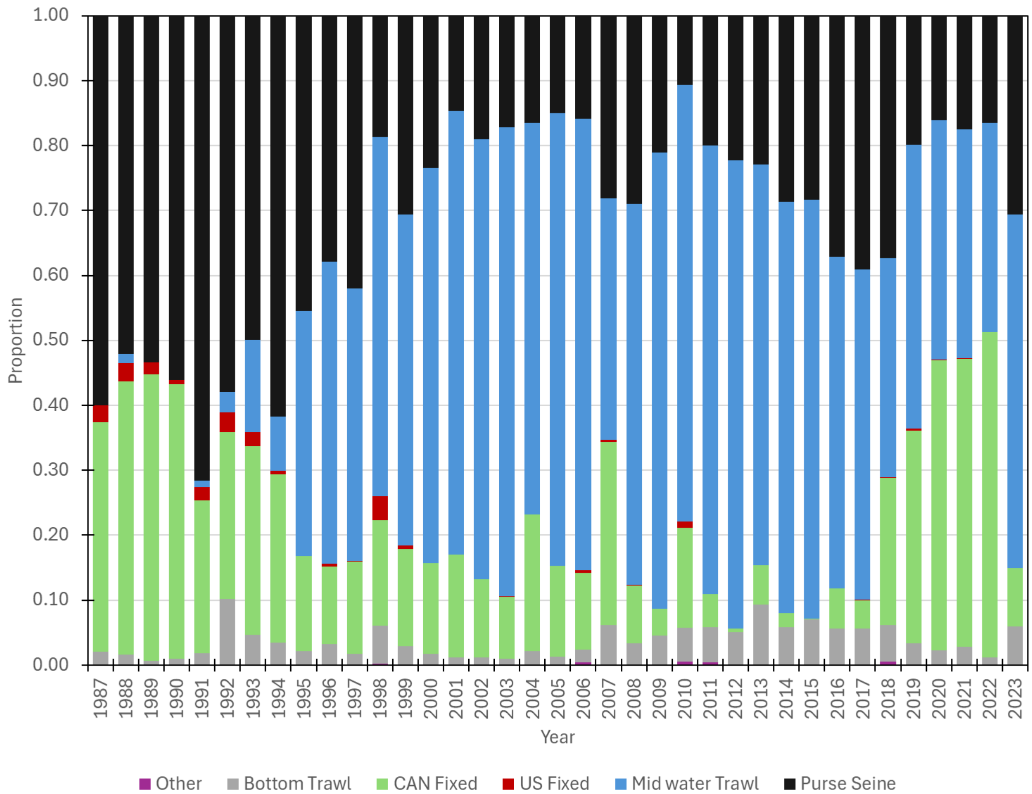


Figure 20. Atlantic herring catch by gear type as a proportion of the total catch.

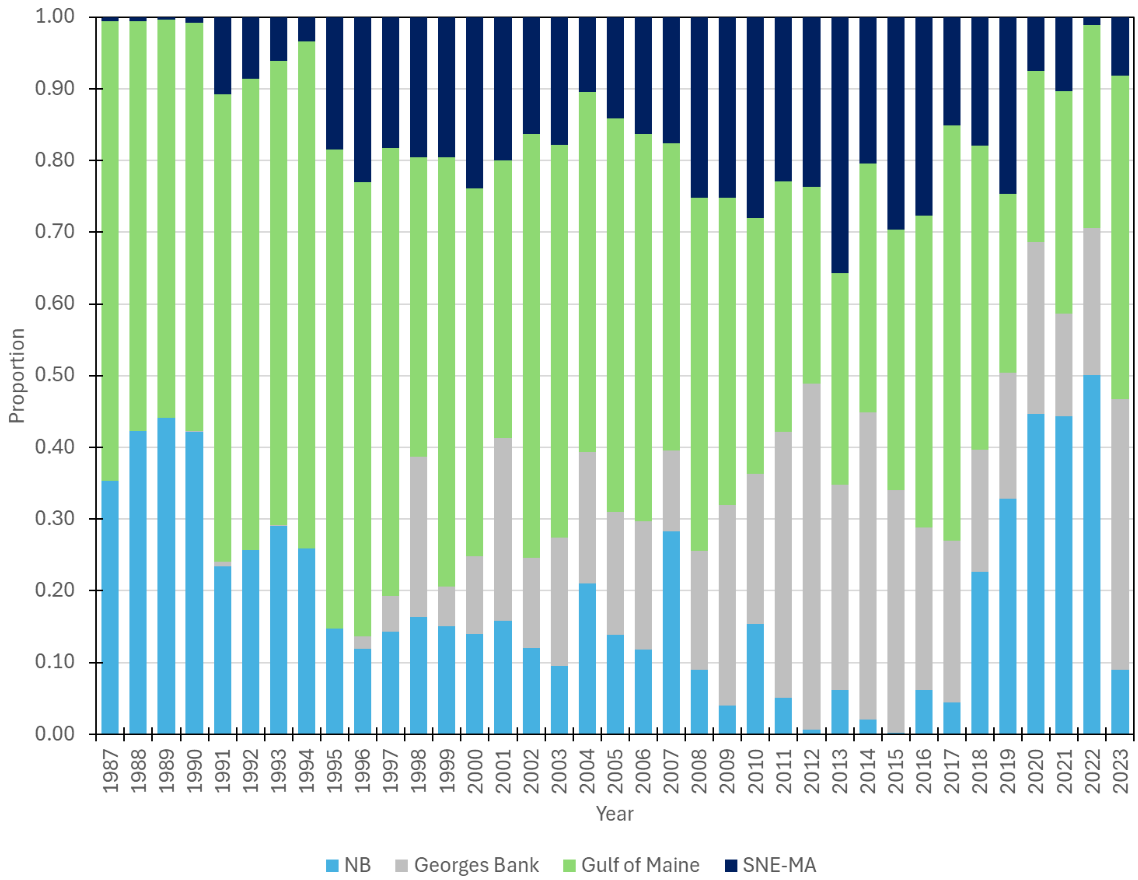


Figure 21. Atlantic herring catch by region as a proportion of the total catch.

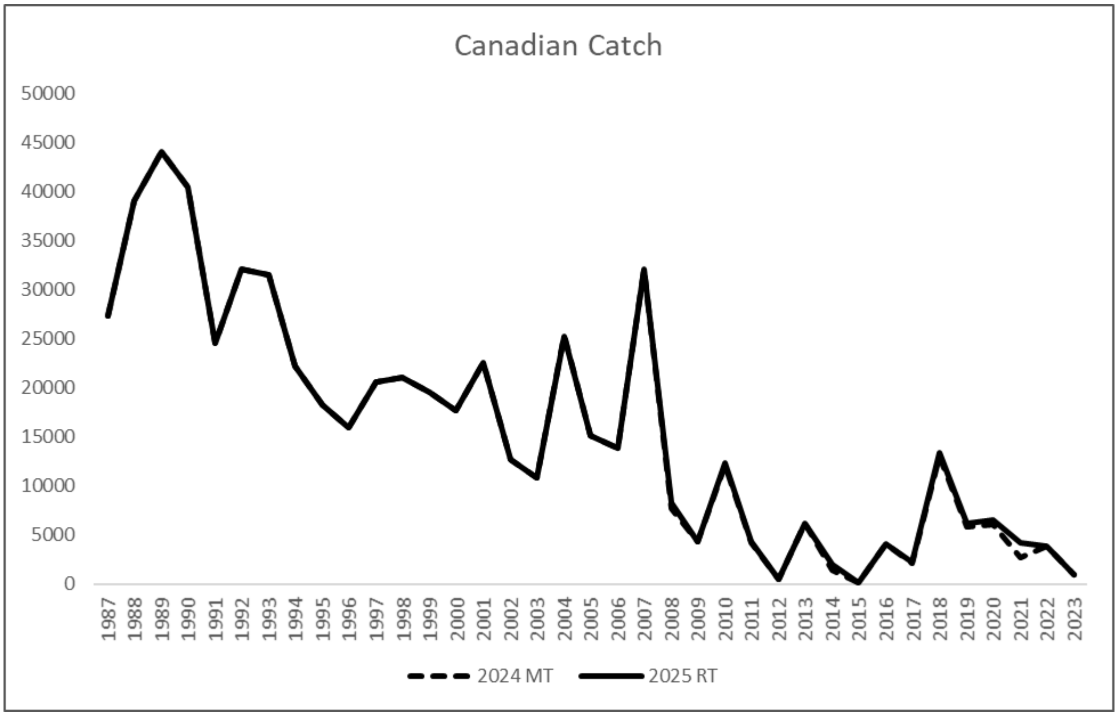


Figure 22. Canadian Catch 1987-2023.

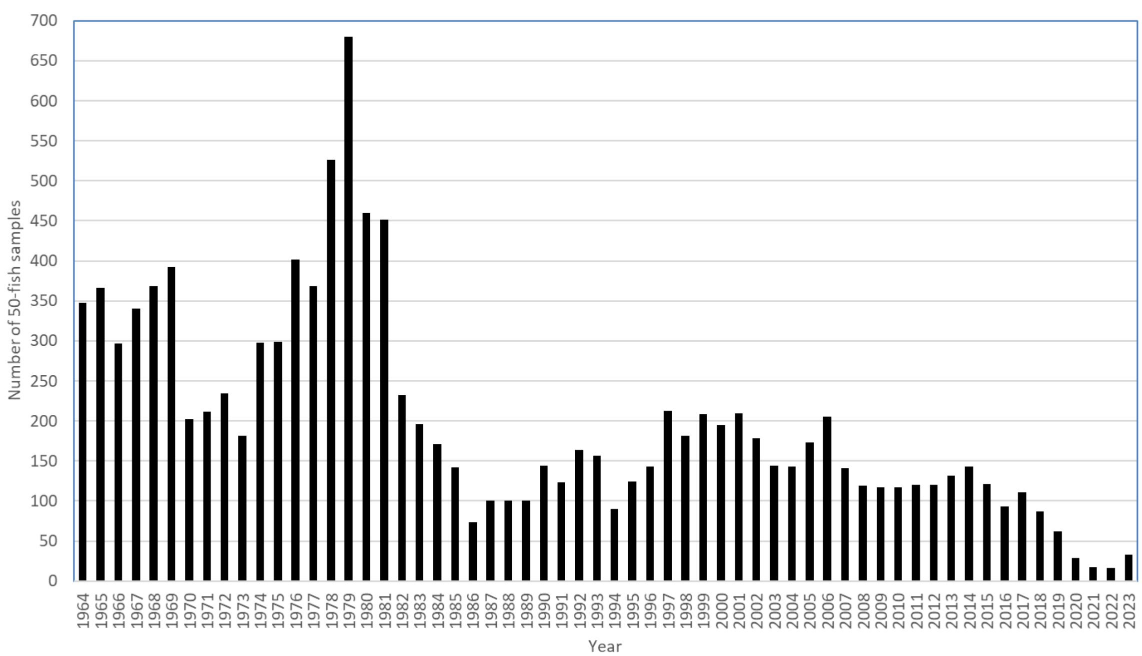


Figure 23. Number of 50-fish samples taken as part of the biological sampling program.

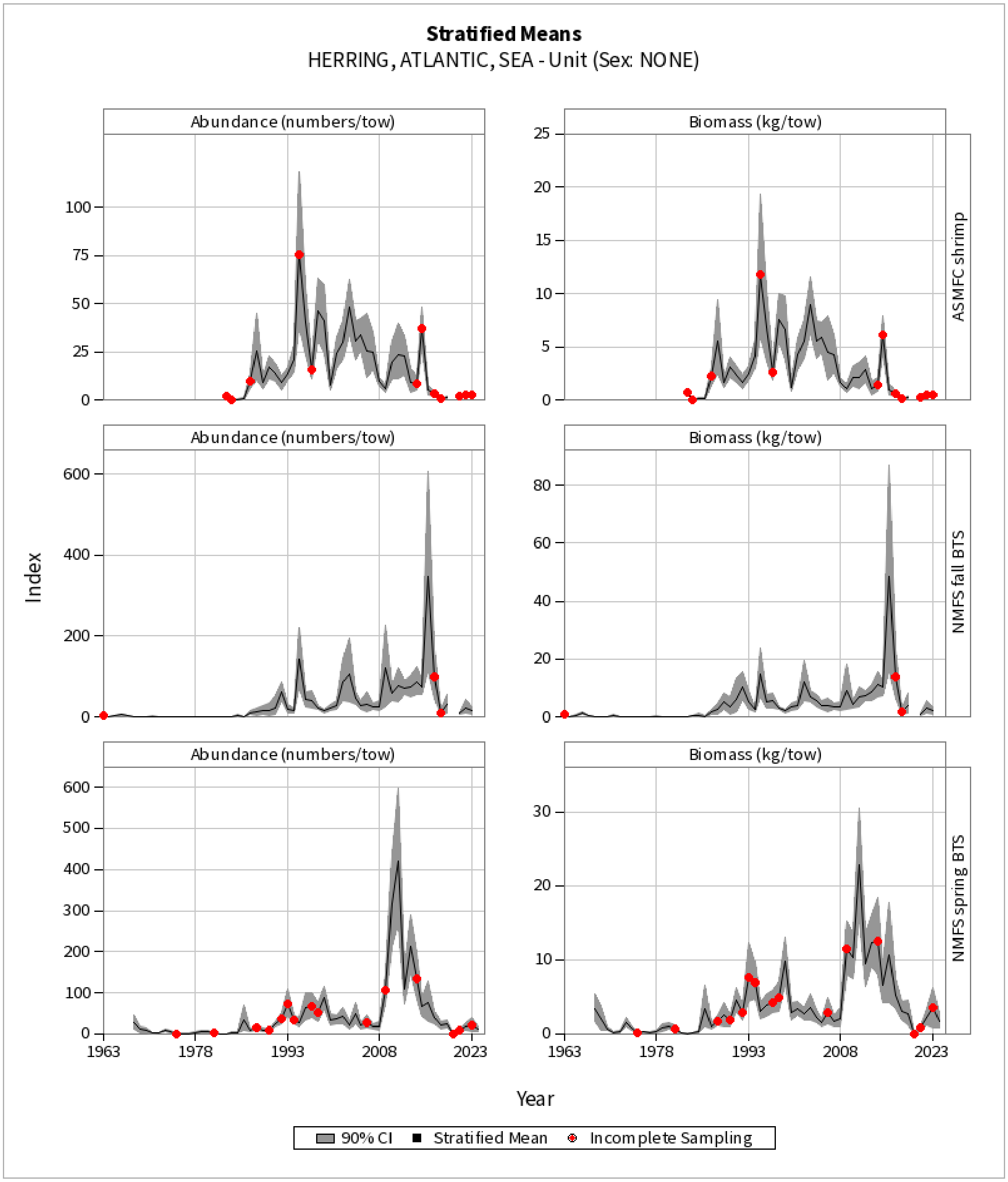


Figure 24. Stratified mean indices from NMFS bottom trawl surveys. The assessment uses numbers per tow.

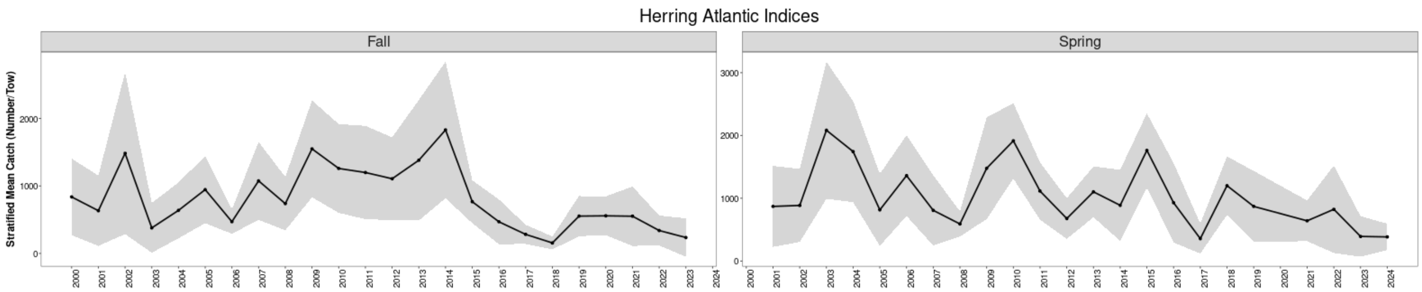


Figure 25. Spring and Fall ME-NH survey catch in Number. Shaded area 95% confidence.

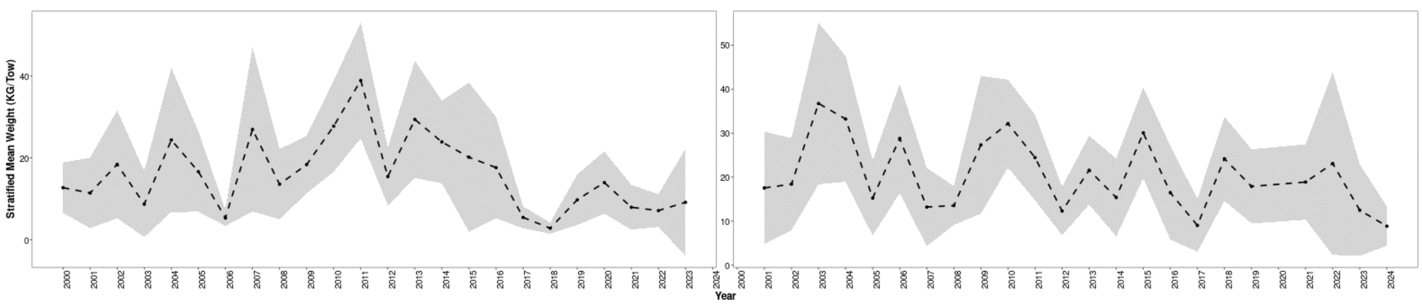


Figure 26. Spring and Fall ME-NH survey catch in weight. Shaded area 95% confidence.

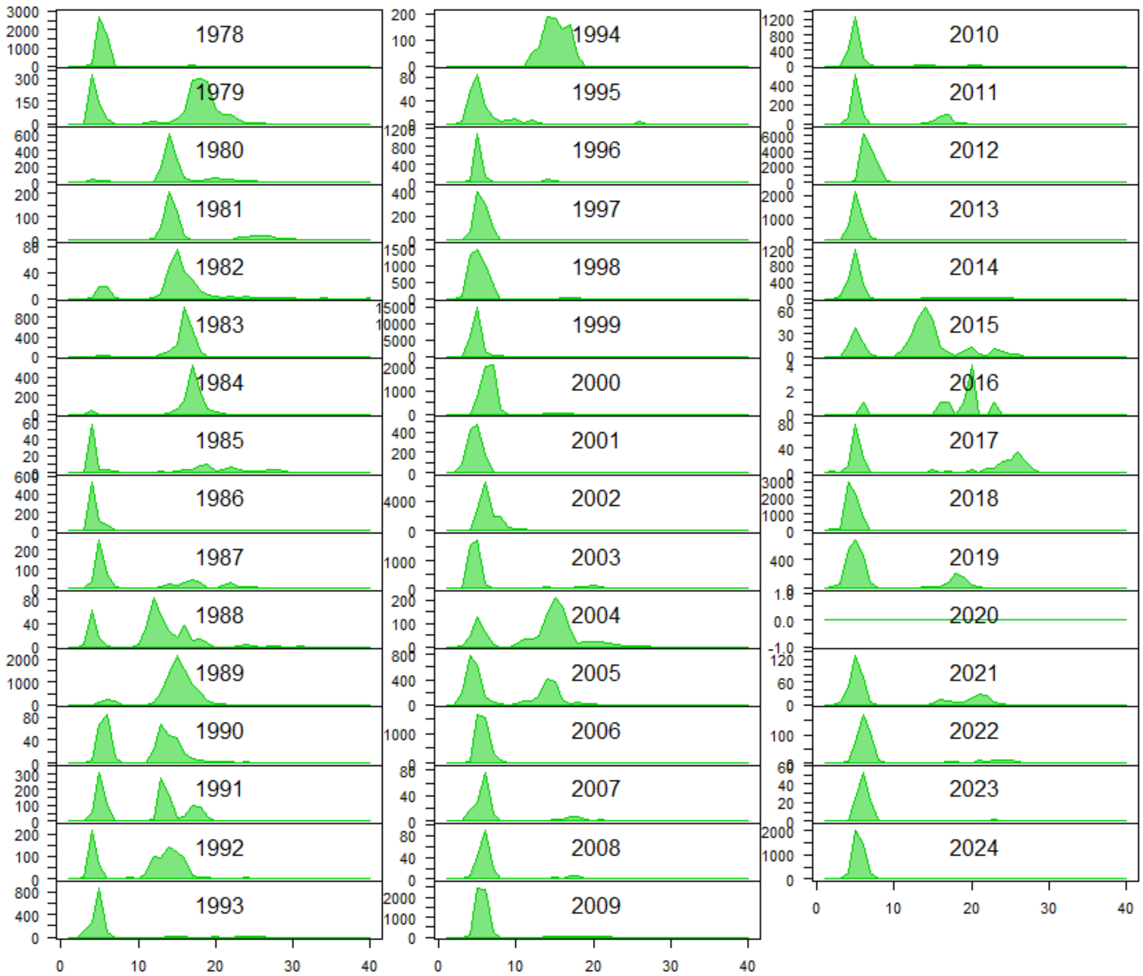


Figure 27. Length distribution of Atlantic herring catch from the Spring MADMF inshore trawl survey.

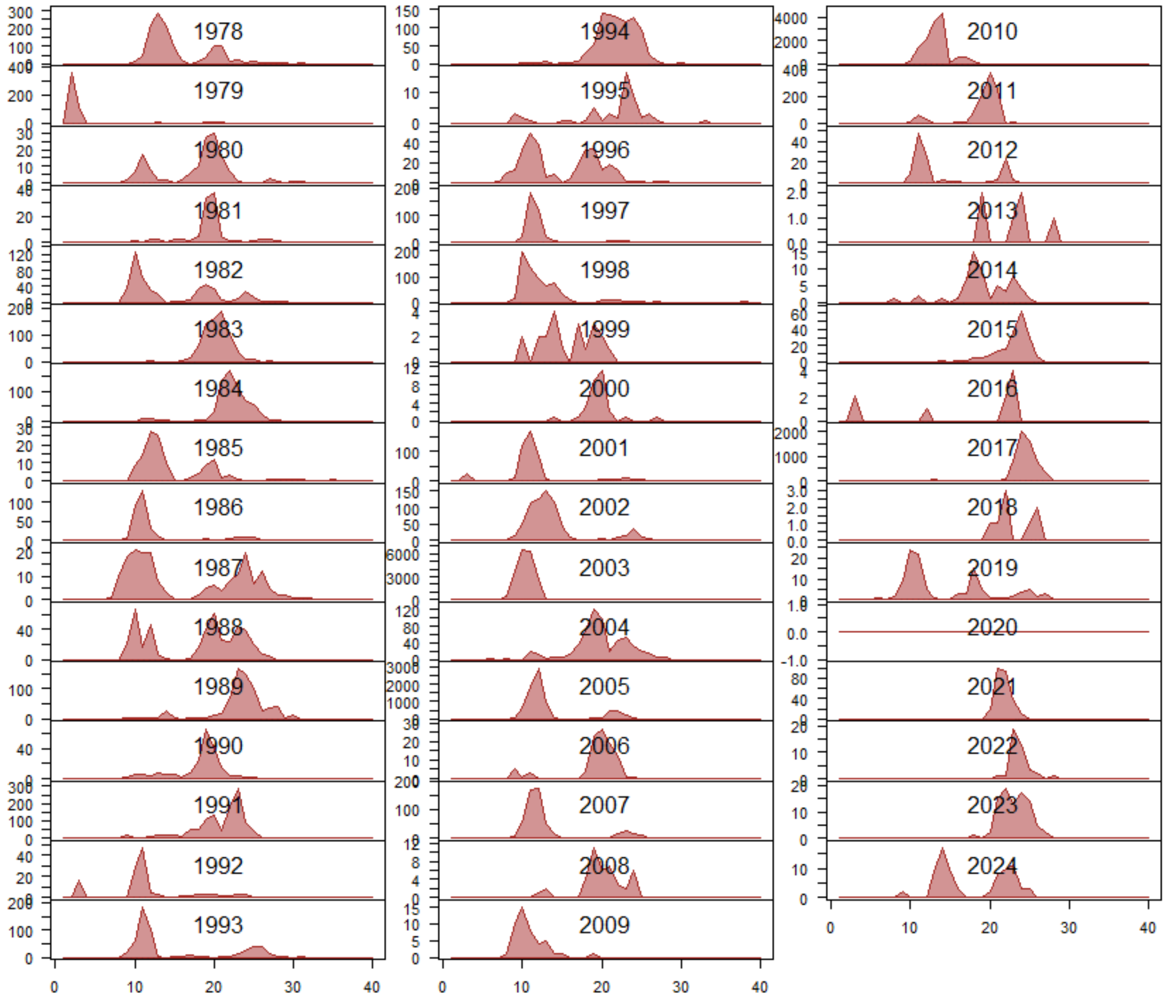


Figure 28. Length distribution of Atlantic herring catch from the Fall MADMF inshore trawl survey.

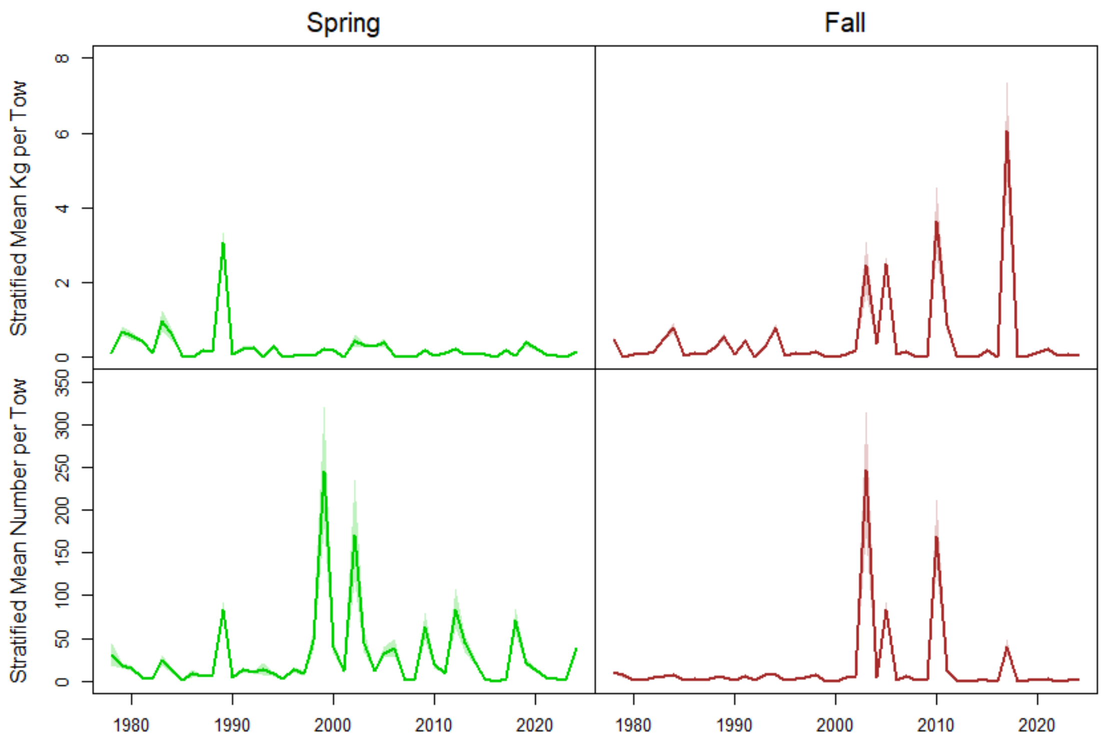


Figure 29. Stratified mean herring catch per tow in numbers (bottom) and Kg (top) for the spring (left) and fall (right) MADMF inshore trawl survey.

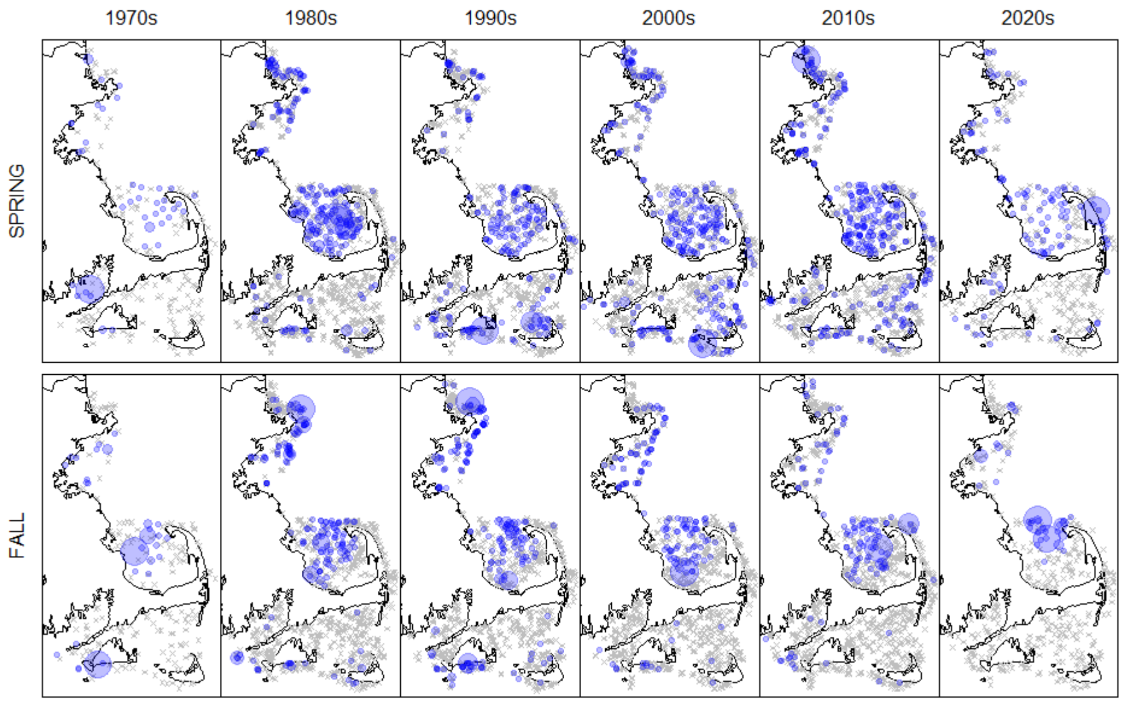


Figure 30. Spatial distribution of herring catch by decade and season from the MADMF inshore trawl survey.

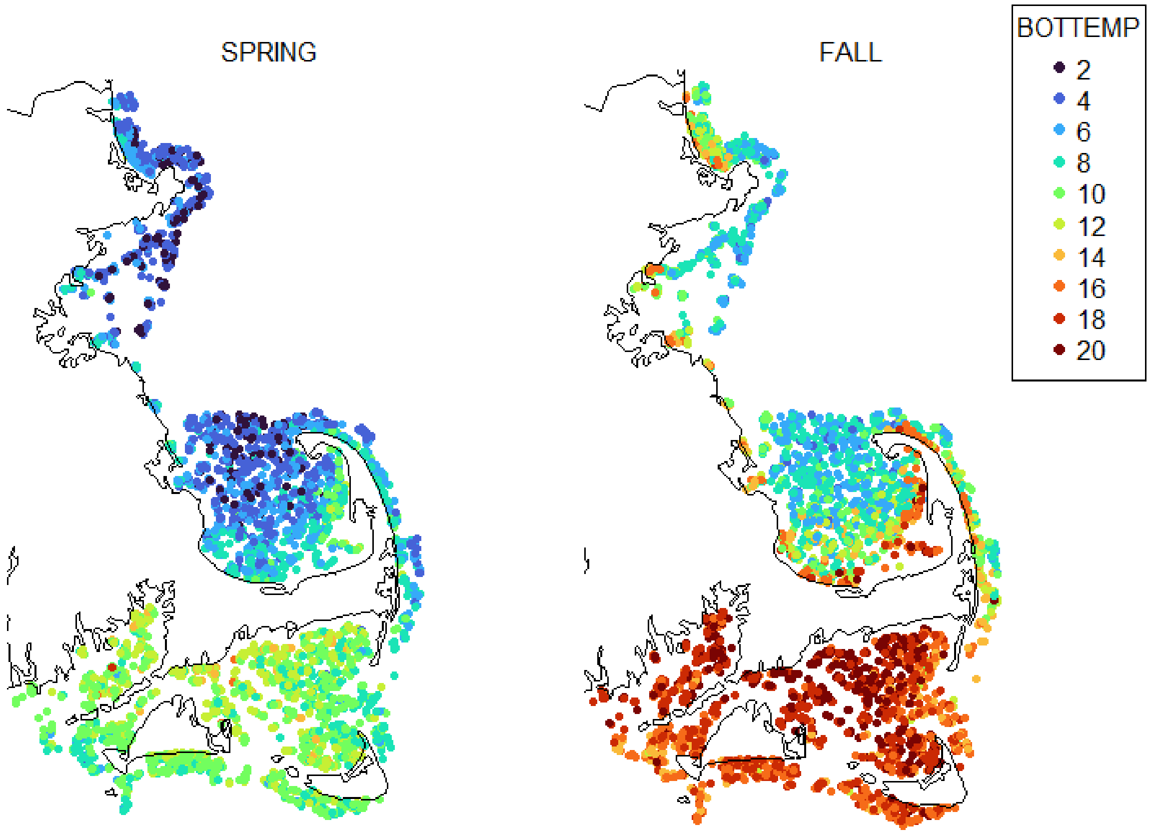


Figure 31. Spatial distribution of bottom temperature in the MADMF inshore trawl survey.

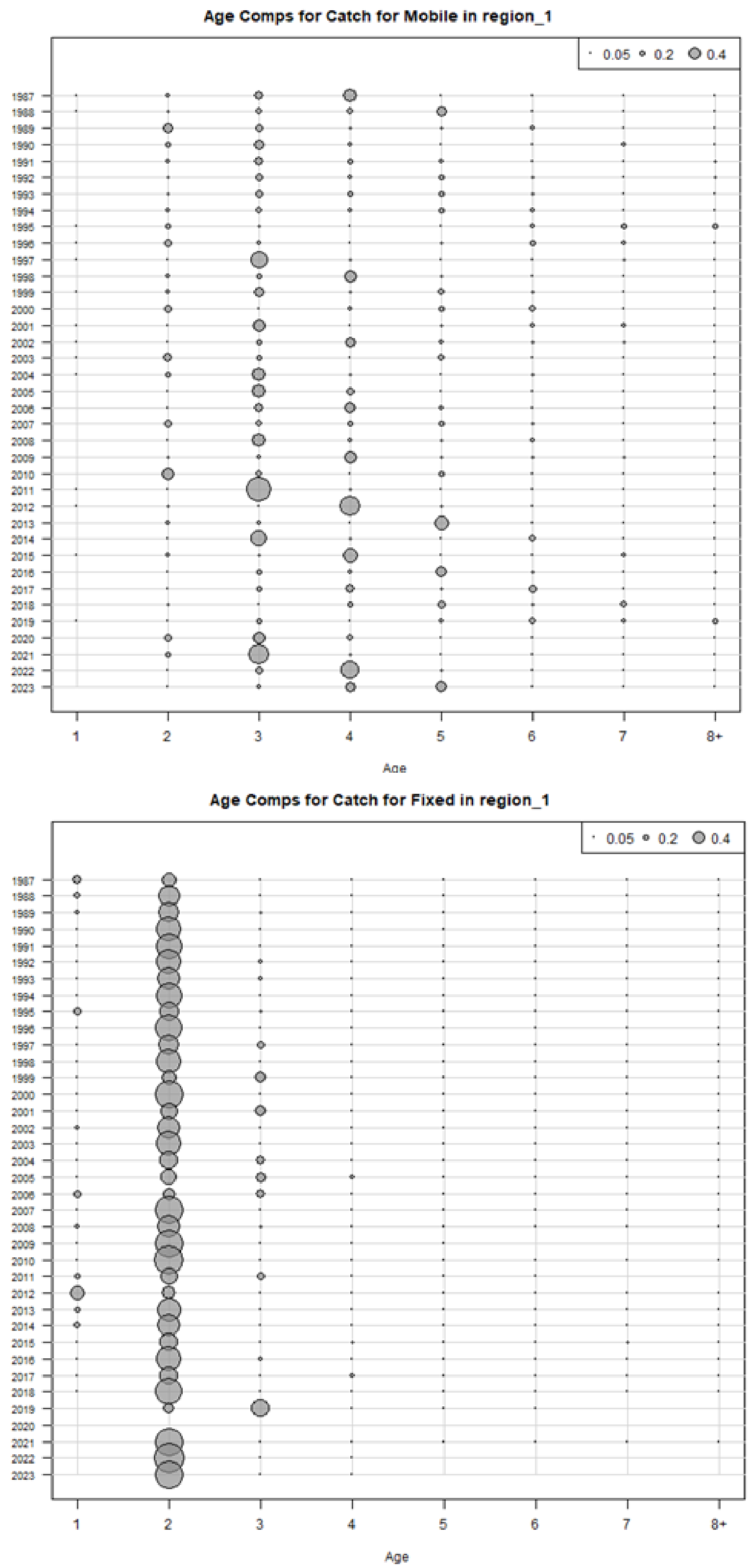


Figure 32. Age compositions by fleet. Top Mobile, Bottom Fixed.

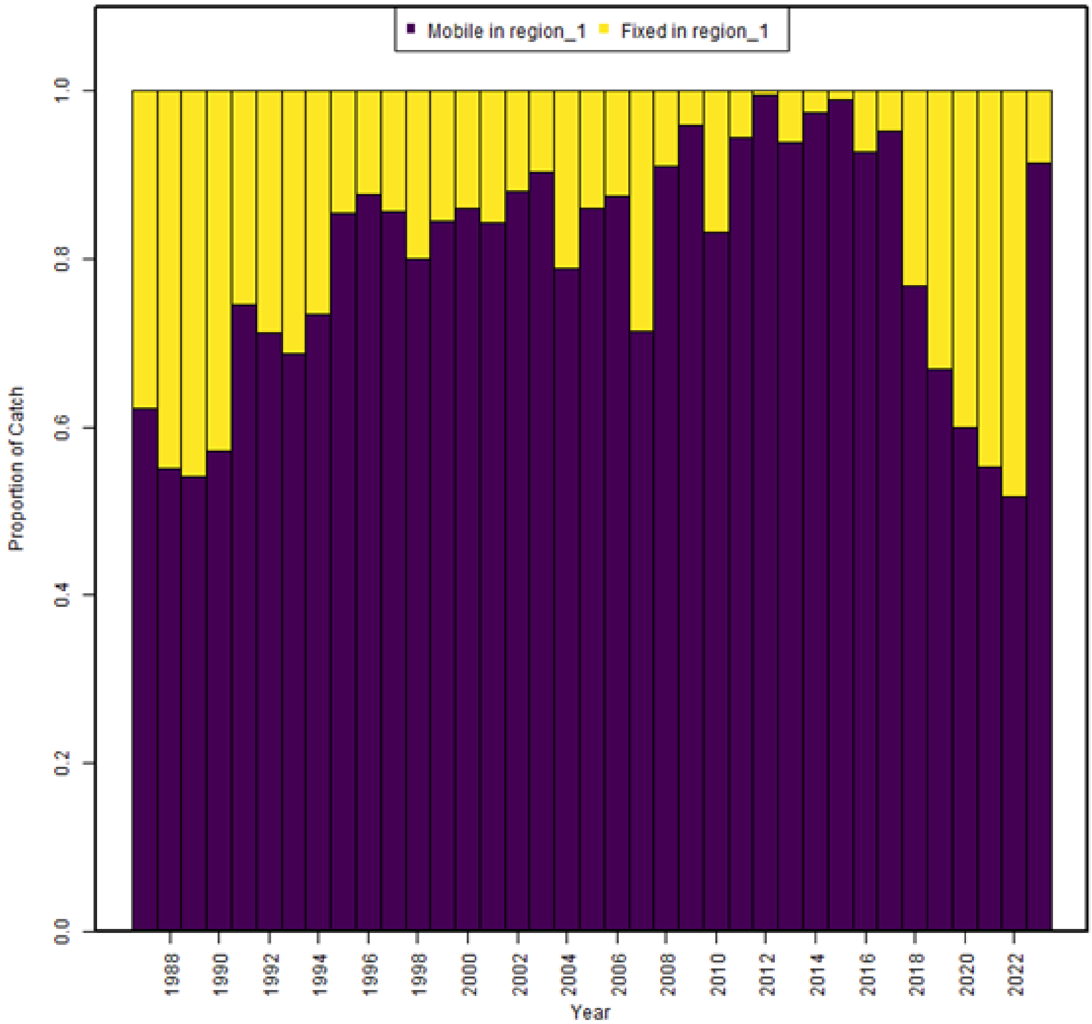
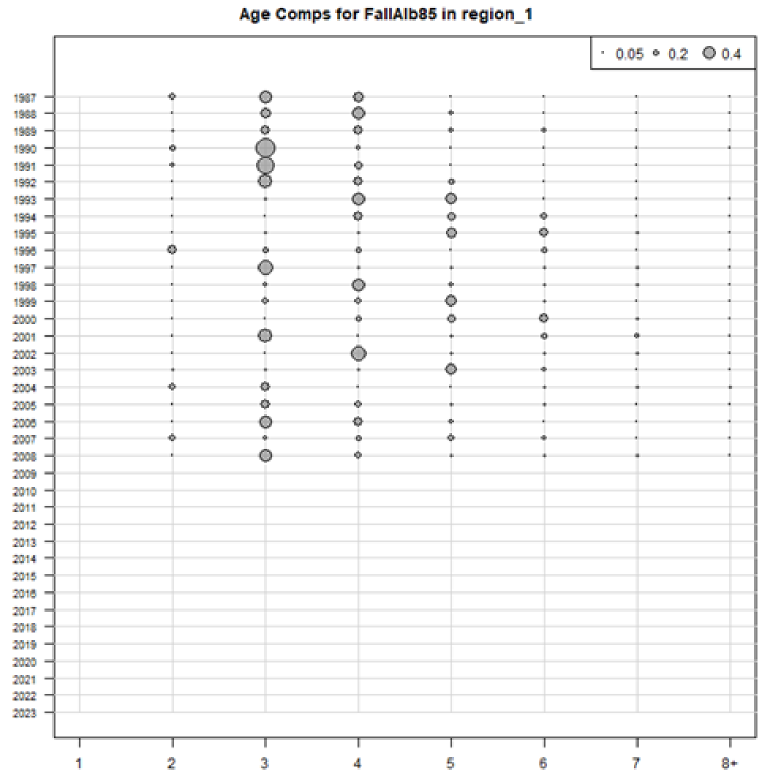


Figure 33. Proportion of catch by Mobile and Fixed Gear fleets.



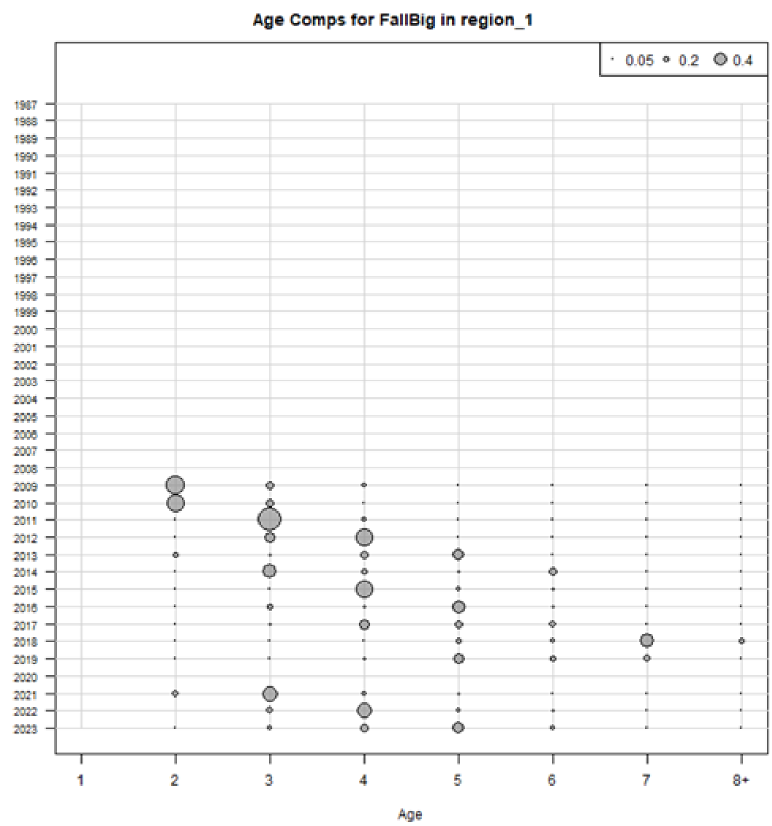


Figure 34. Age composition by survey in the Fall. Top Albatross, bottom Bigelow.

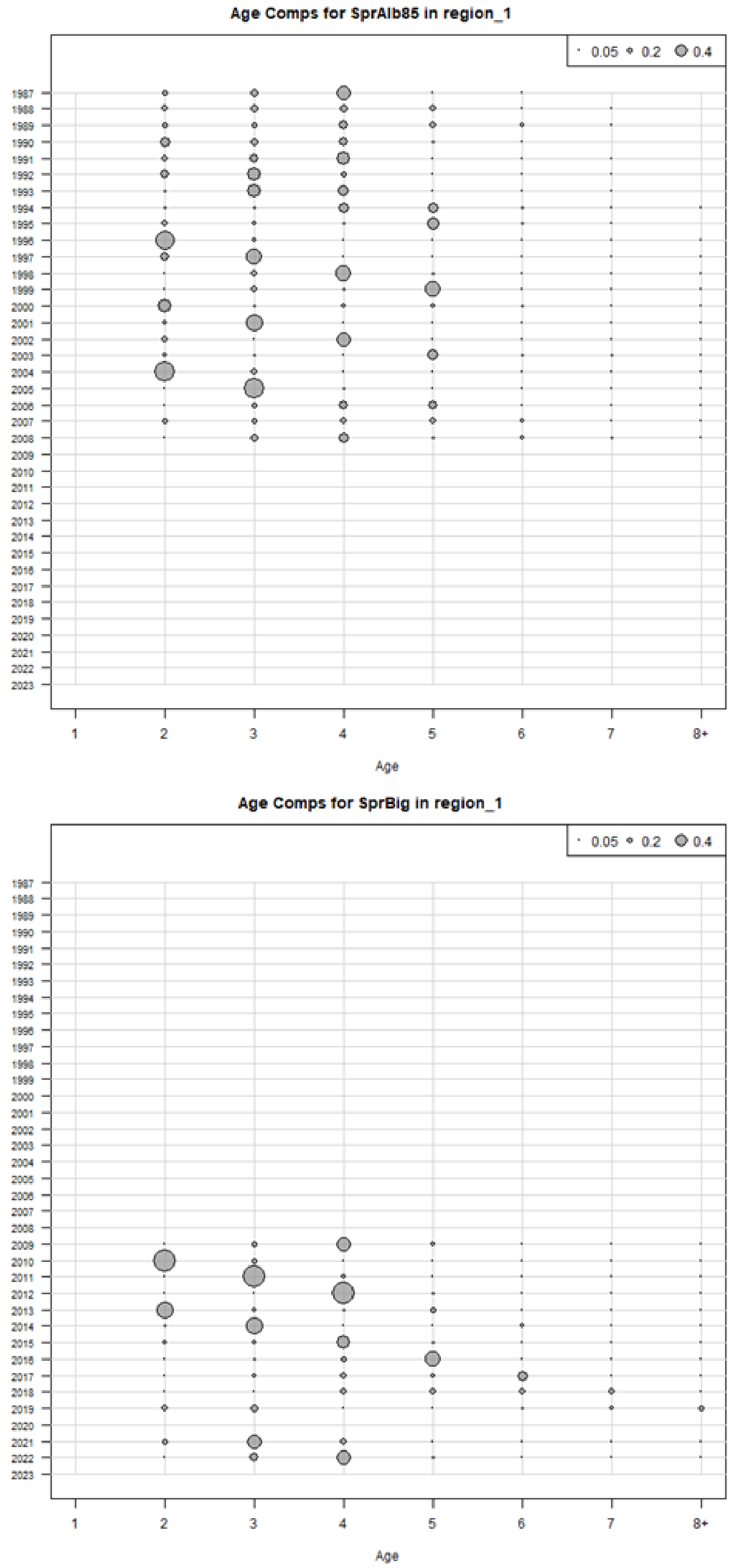


Figure 35. Age composition by survey in the Spring. Top Albatross, bottom Bigelow.

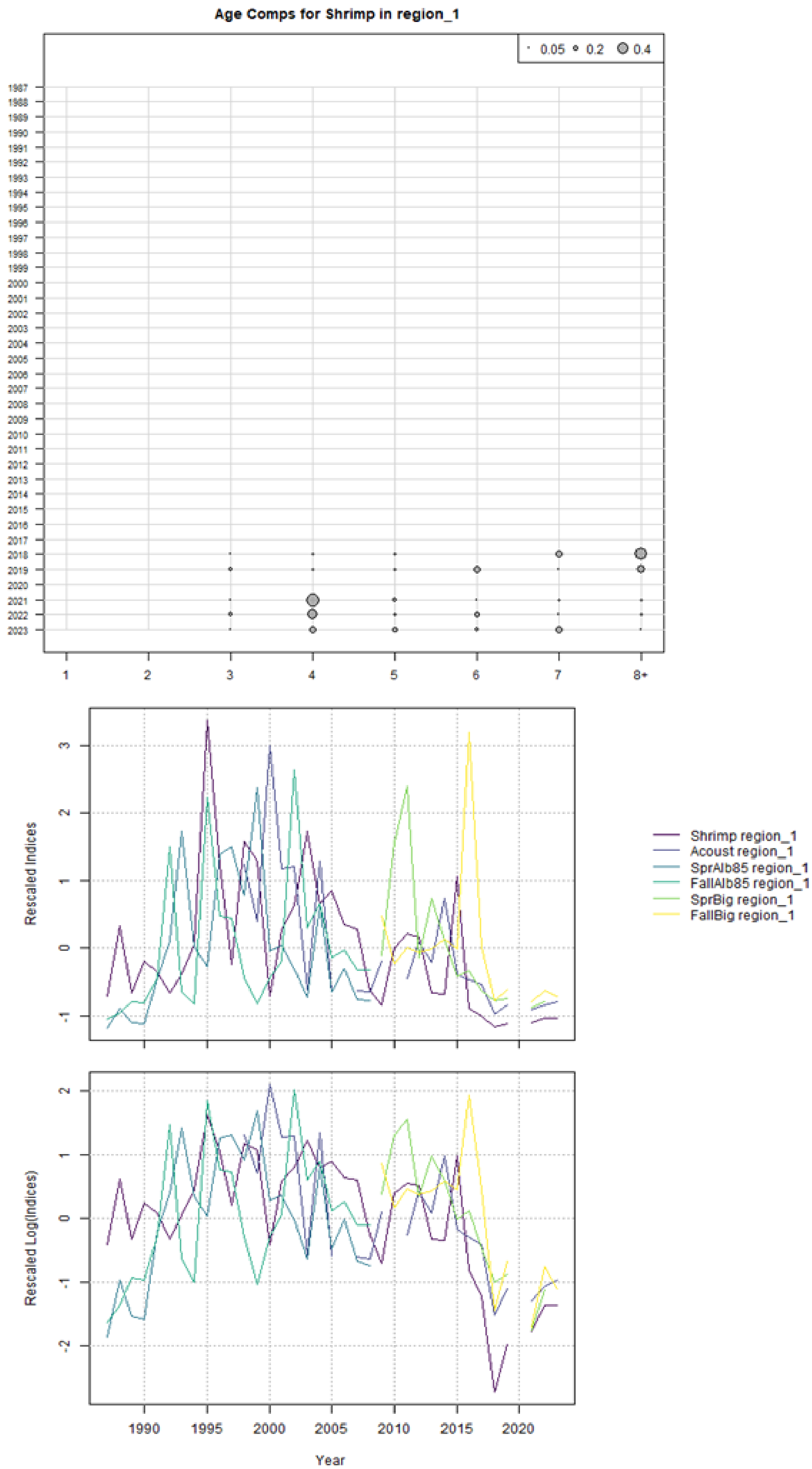


Figure 36. NMFS summer (Shrimp) survey age composition (top). Indices of abundance nominal (middle) and log scaled (bottom).

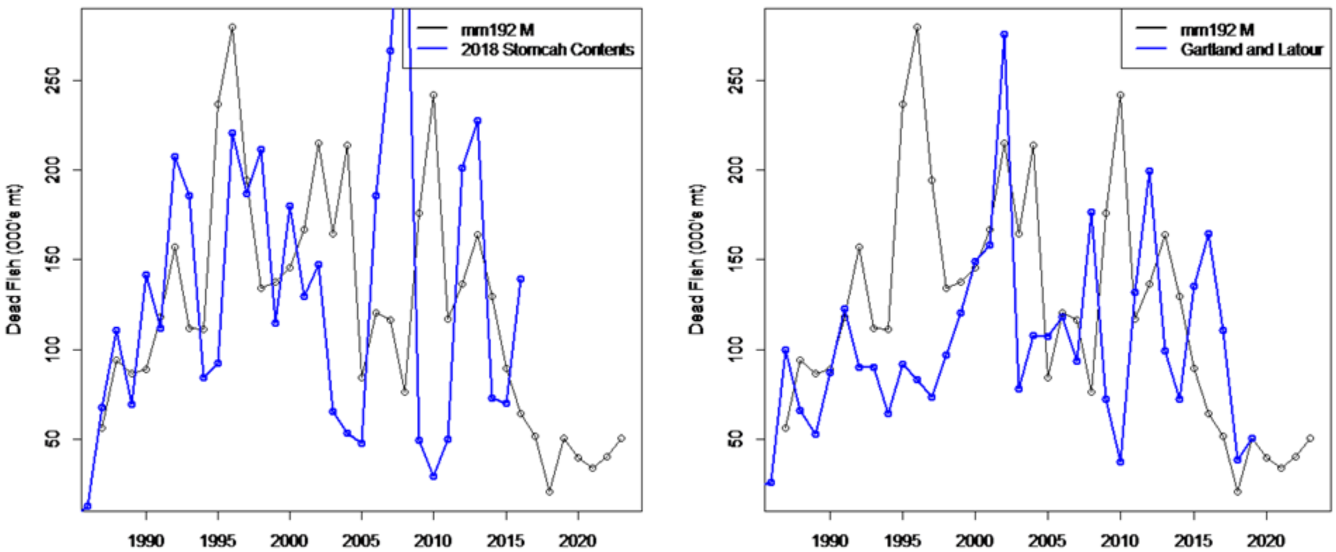


Figure 37. Number of dead herring implied by use of an M of 0.35 compared to estimates using stomach contents of predators (left) and estimates from Gartland and Latour 2024 (right).

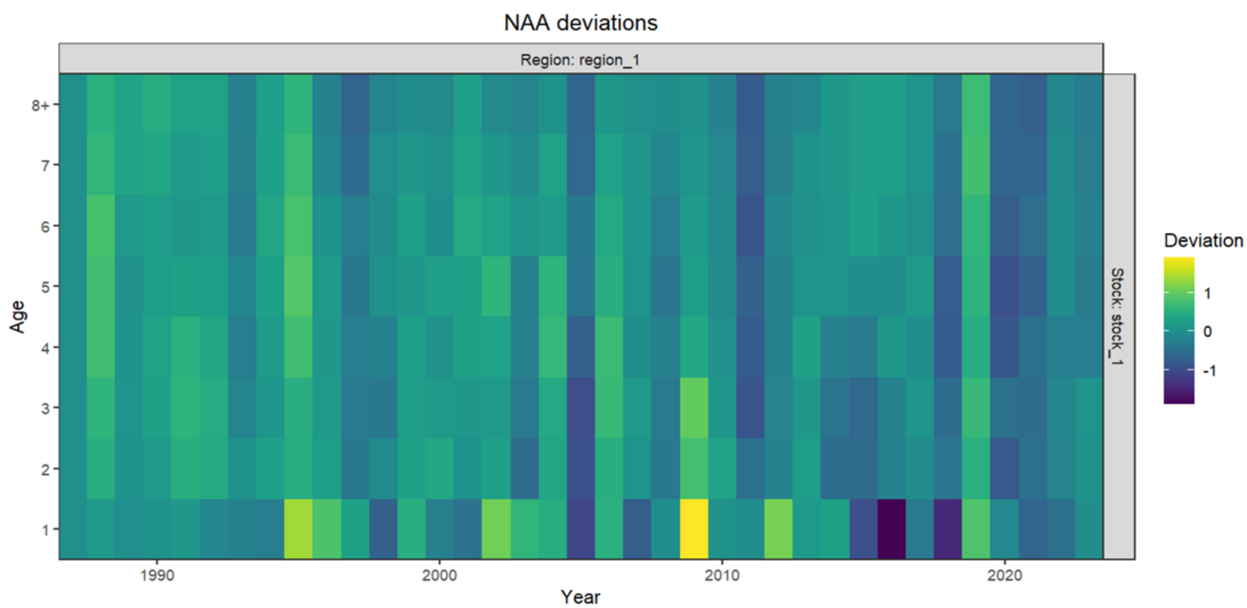


Figure 38. NAA deviations by year and age.

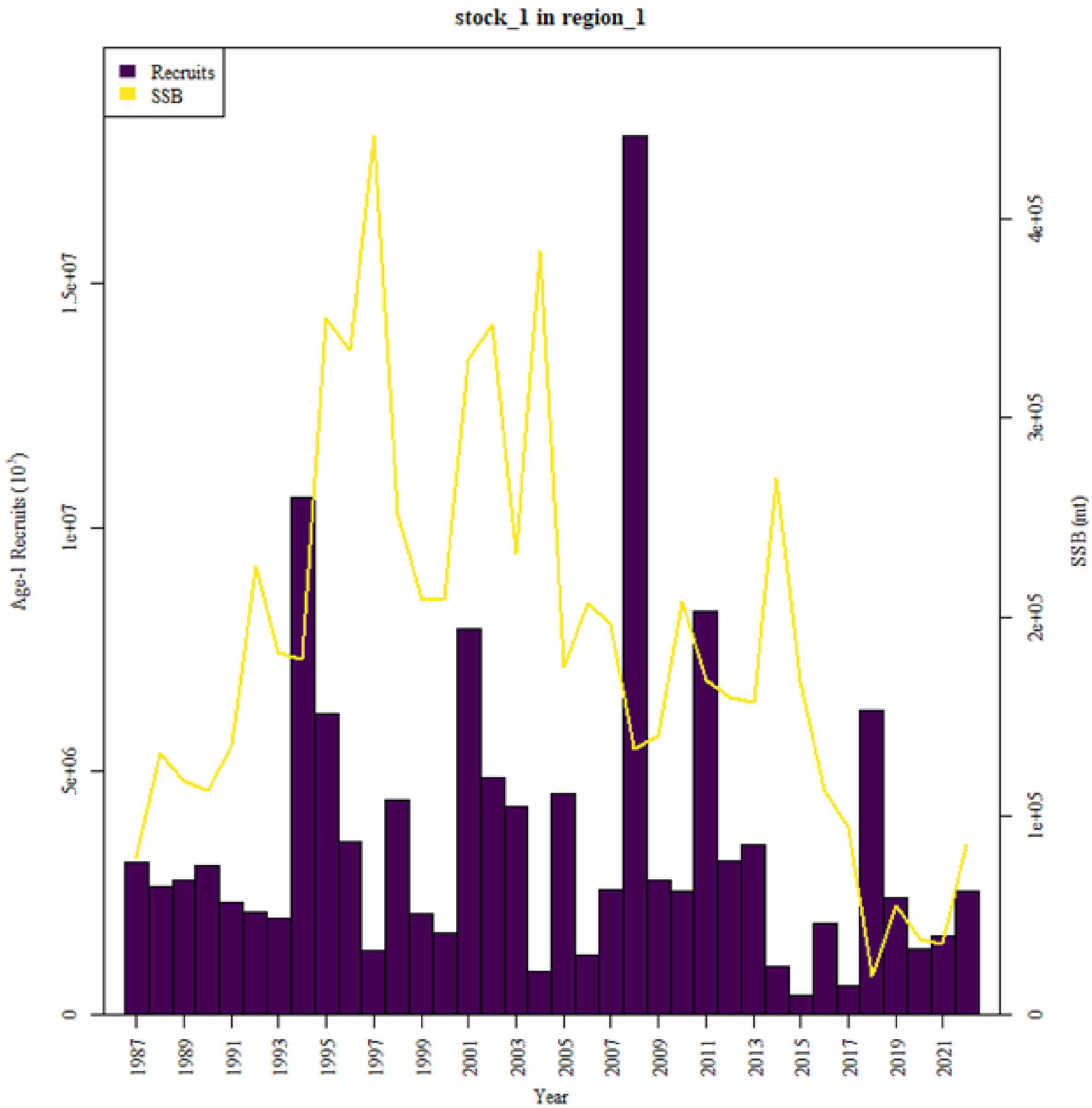


Figure 39. Recruitment (bars) and SSB (line) by year. Note scale change.

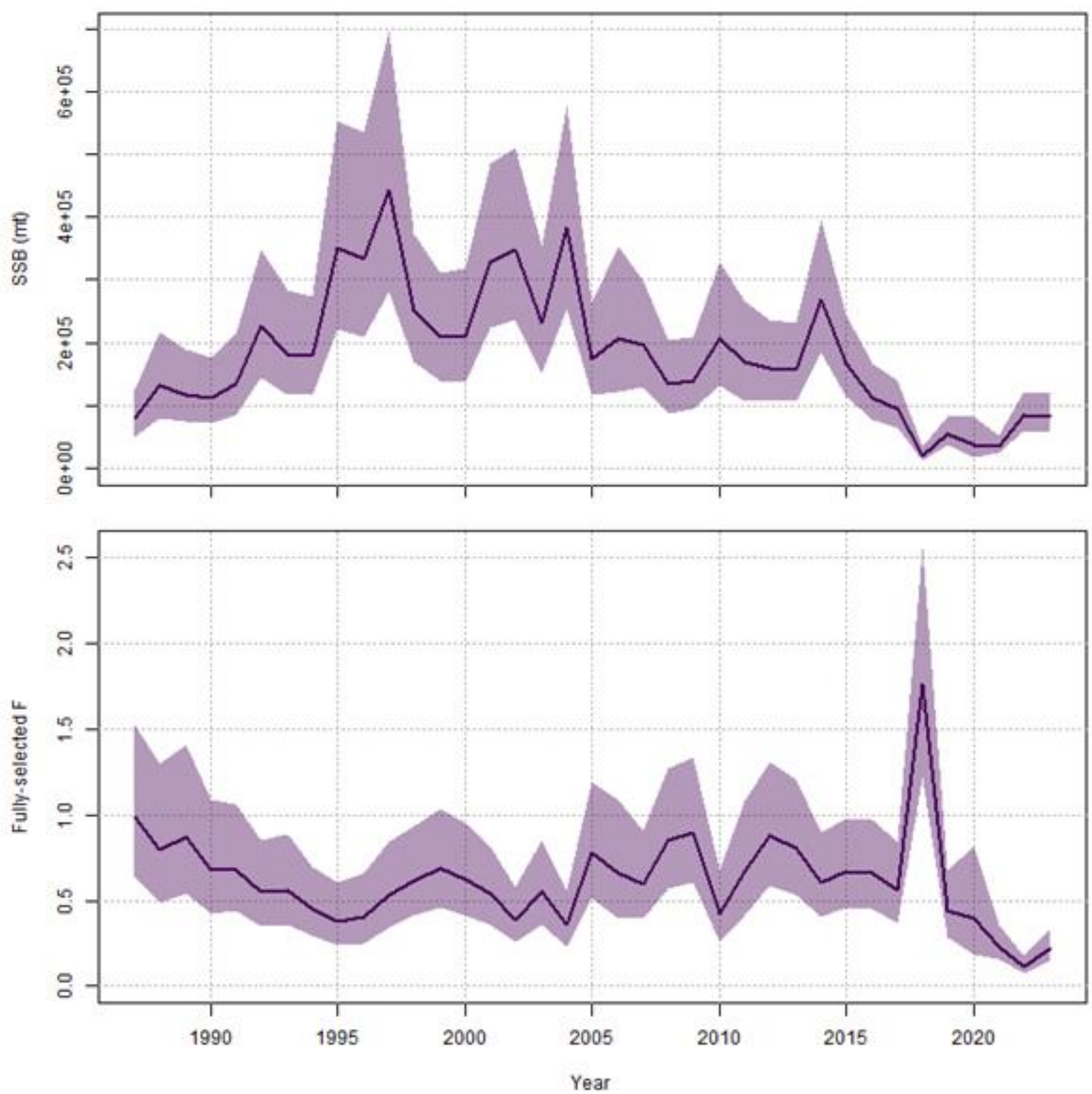


Figure 40. SSB (top) and F (bottom) by year with 95% confidence limits.

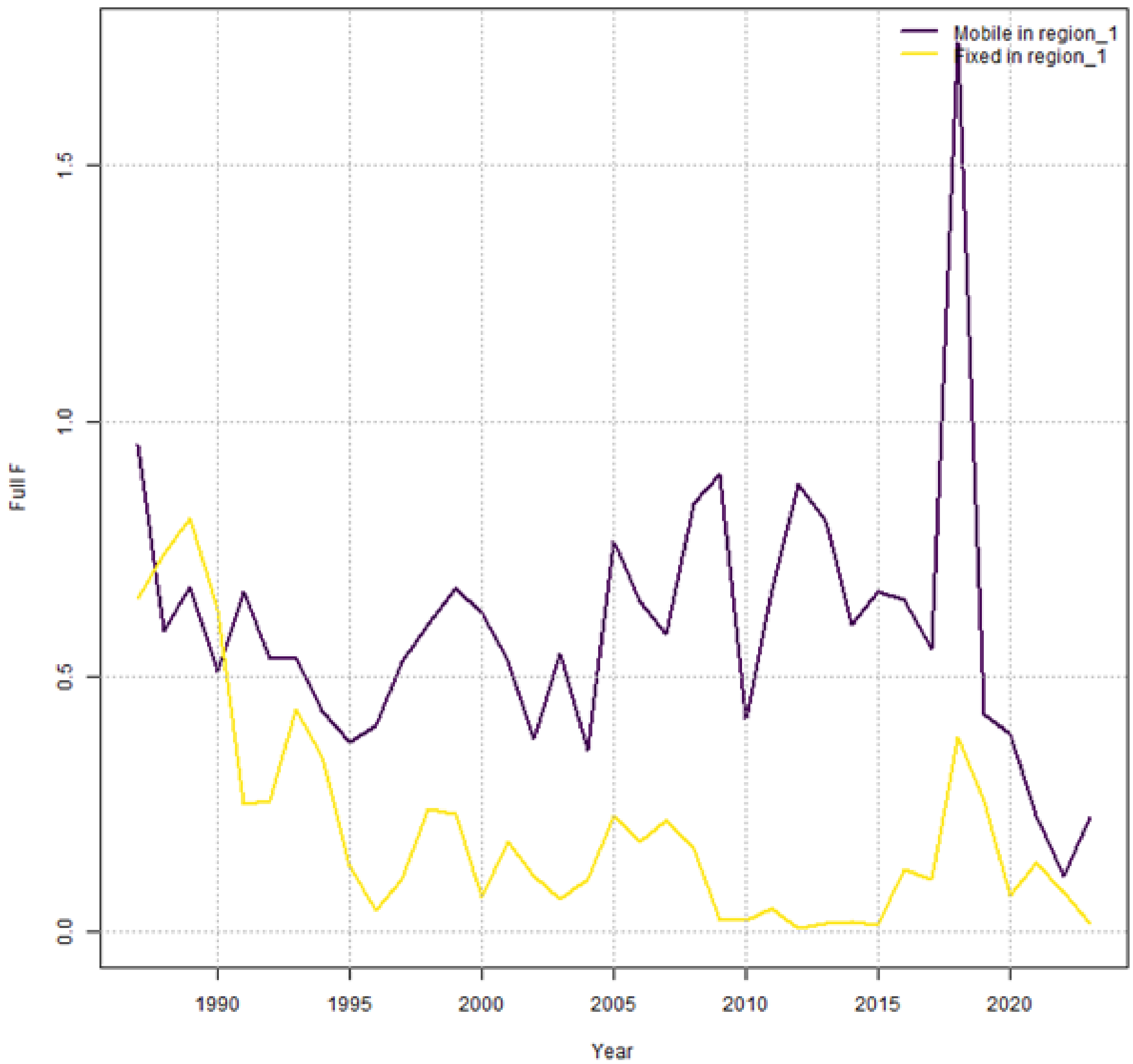


Figure 41. Fishing mortality by year by fleet. Purple Mobile, Yellow Fixed.

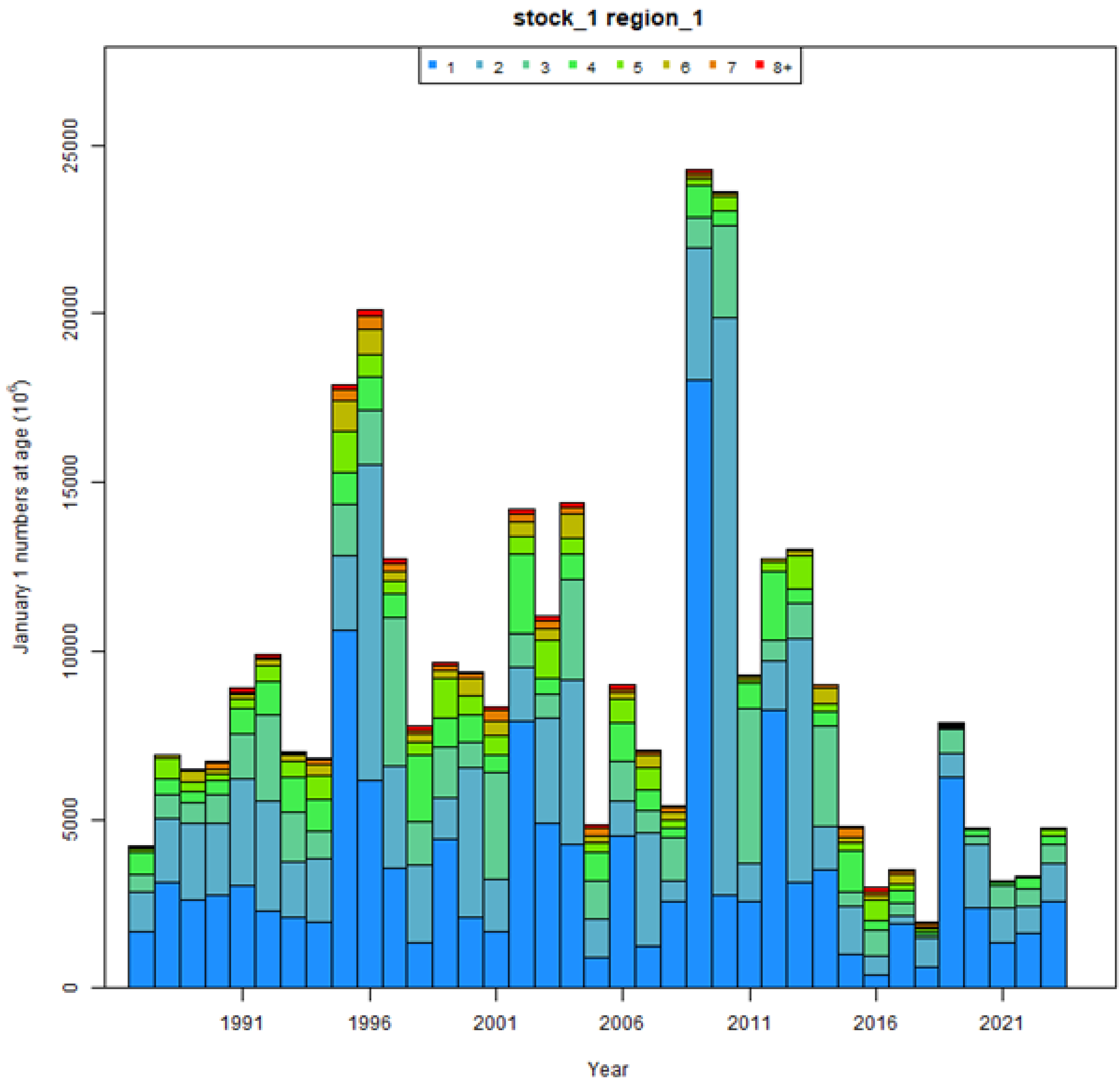


Figure 42. Estimated abundance by year and age.

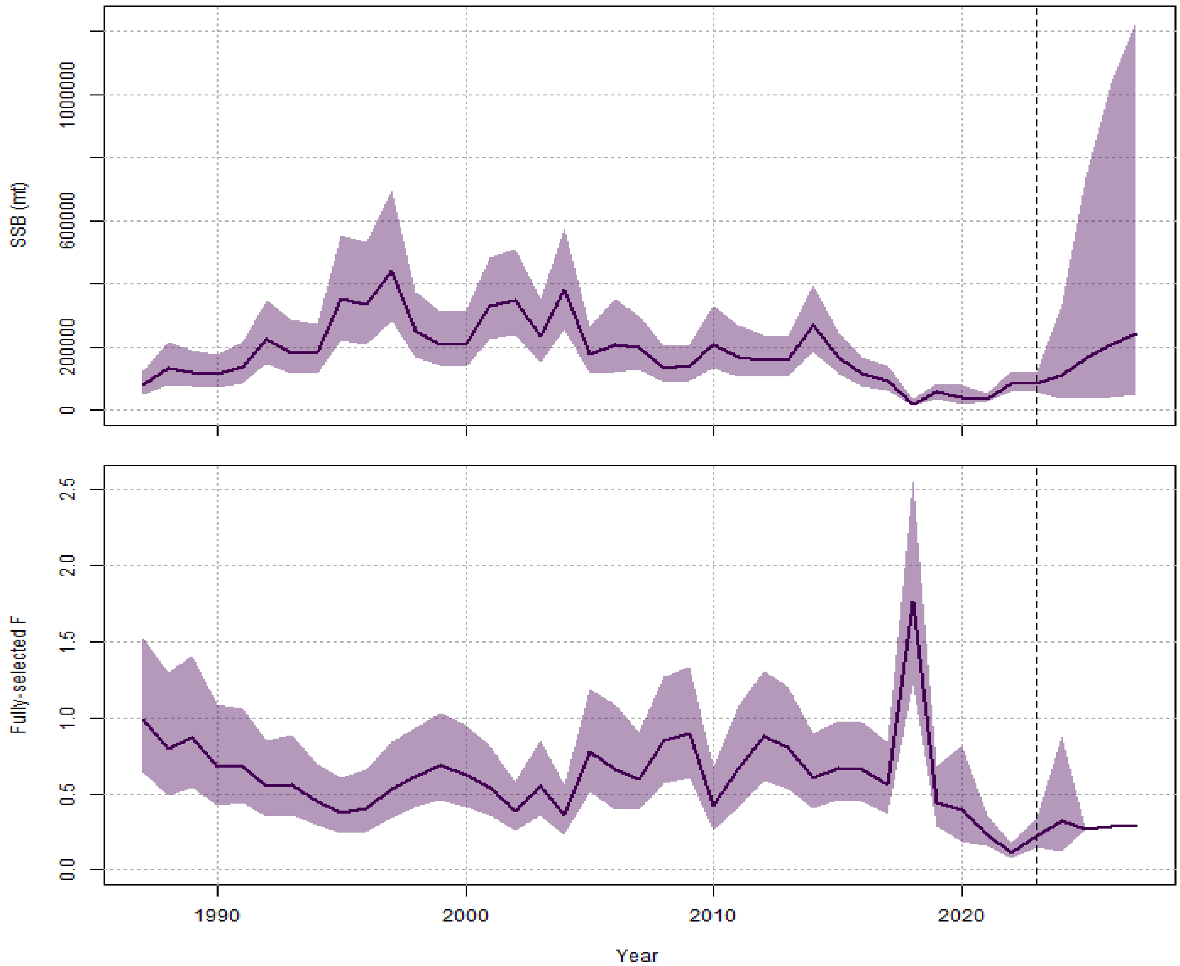


Figure 43. SSB (top) and F (bottom) across the years and in the projection. The dashed line indicates the start of the projection, while shading is the 95% confidence limit.

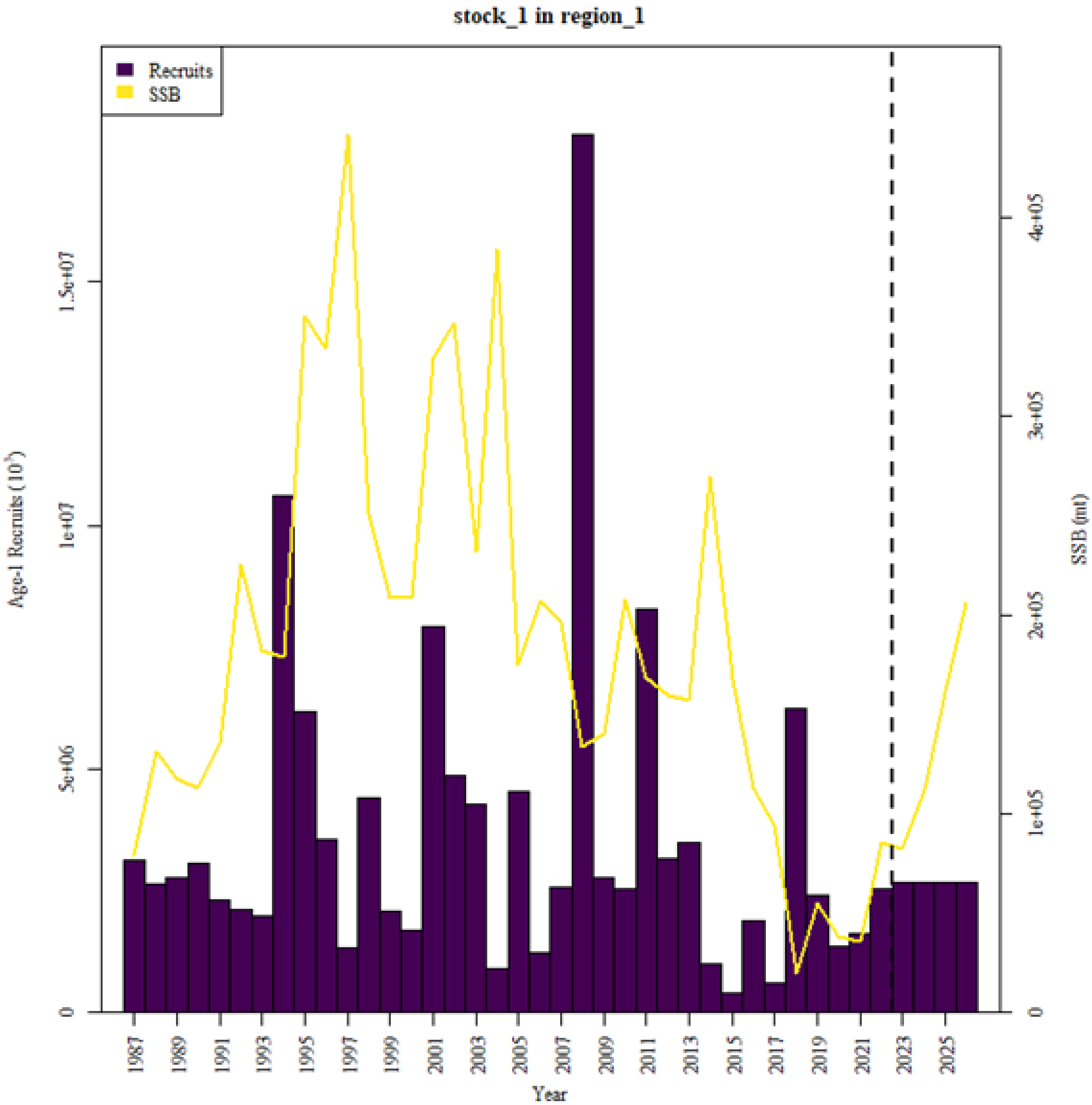


Figure 44. Recruitment (bars) and SSB (line) across years. The dash line is the start of the projection period.

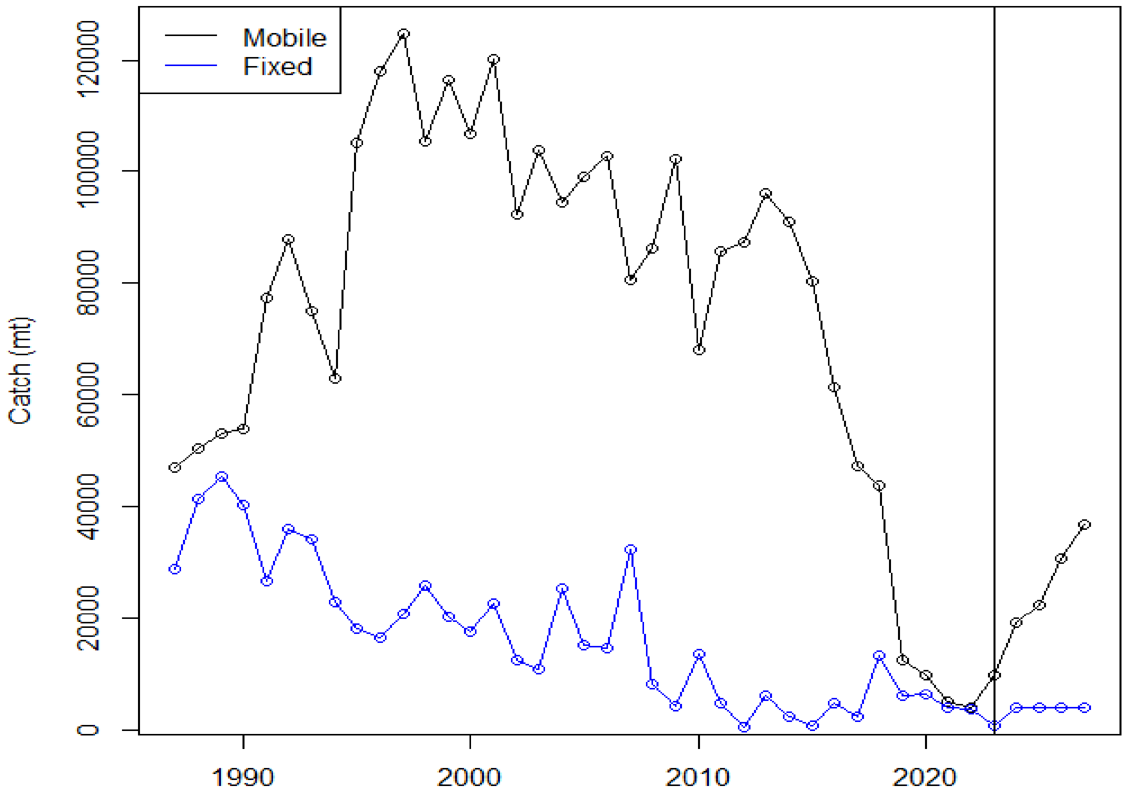


Figure 45. Historical and projected catch by fleet and year. Solid vertical line is the start of the projection period.

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draft working paper for peer review only

Atlantic Herring

2026 Management Track Assessment Report

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts

Compiled 06-05-2026

This assessment of the Atlantic Herring (Clupea harengus) stock is a management track assessment, and is the first application of the WHAM assessment platform following the 2025 research track assessment (NEFSC 2025). The last management track assessment was in 2024 and was conducted using the ASAP model. Based on that assessment, the stock was overfished but overfishing was not occurring. This assessment updated fishery catch data, survey indices, life history parameters (e.g., weights-at-age), and the WHAM assessment model and reference points (BRPs) through 2025. The change in assessment platforms from the 2024 management track makes comparisons among the assessments inappropriate. Several relatively minor changes have been made since the resarch track. Namely, a revised Canadian catch time series was used, a different approach was used for input effective sample sizes, and spawning stock biomass weight-at-age values were corrected.

State of Stock: Based on this management track assessment, the Atlantic Herring stock is overfished and overfishing is not occurring (Figures 1-2). Retrospective adjustments were not necessary (SSB Mohn's rho = 0.22 and F Mohn's rho = -0.04). Spawning stock biomass (SSB) in 2025 was estimated to be 35,258 (mt) which is 19% of the biomass target (SSB_{MSY} *proxy* = 188,214; Figure 1). The 2025 average, mobile fleet, fishing mortality for ages 7-8 (fully selected) was estimated to be 0.121 which is 44% of the overfishing threshold proxy (F_{MSY} *proxy* = 0.272; Figure 2).

Table 1: Catch and status table for Atlantic Herring. All weights are in mt, recruitment is in 000s, and $\bar{F}_{7-8}$ is the average, mobile fleet, fishing mortality on ages 7 to 8, which are fully selected. Model results are from the current WHAM assessment and no adjustment for retrospective pattern was necessary.

	2018	2019	2020	2021	2022	2023	2024	2025
				Data				
US Catch	45,527	12,792	9,864	5,210	4,239	10,165	10,447	3,265
Canadian Catch	13,426	6,496	6,965	4,877	4,347	1,960	2,965	3,884
Total Catch	58,953	19,289	16,829	10,087	8,586	12,125	13,412	7,149
				Model Results				
Spawning Stock Biomass	21,075	56,484	36,912	36,983	85,973	79,843	47,877	35,258
$\bar{F}_{7-8}$	1.656	0.4	0.445	0.199	0.109	0.222	0.315	0.121
recruits (age1)	559,391	4,457,469	2,278,256	799,145	706,515	743,734	456,155	1,966,904

Table 2: Reference points from the 2024 ASAP assessment and the current WHAM assessment are incomparable and are provided for information only. A fleet specific, mobile fleet $F_{40\%}$ proxy was used for the overfishing threshold, and the biomass proxy reference point was estimated using the mean of the recruitment process. 90% CI were reported in parentheses.

	2024	2026
F_{MSY} *proxy*	0.45	0.272
SSB_{MSY} (mt)	186,367 (95,900 - 340,000)	188,214 (123,672 - 286,439)
MSY mt	78,710 (45,000 - 128,800)	55,211 (35747 - 85273)
Median recruits (age 1)	2,493,500 (485,400 - 9,107,300)	2,324,046
Overfishing	No	No
Overfished	Yes	Yes

Projections: The projection results included here should be considered preliminary and subject to change based on future assessment and management decisions. This example projection applied the harvest control rule described in Amendment 8 of the hering Fishery Management Plan to the mobile fleet. The fixed gear catches are assumed constant during the projection period and equaled 5,283 mt. This fixed gear catch equals the sum of the ten year (2016-2025) averages of the Canadian (5,130 mt) and US (152 mt) fixed gear catches. The US fixed gear catches are those from stop seines, weirs, and pound nets. The reported $\bar{F}_{7-8}$ are those for the mobile fleet. Projected recruitment continued the independent and identically distributed process estimated by WHAM. NAA random effects did not persist into the projection period.

Table 3: Projection results.

Year	Catch mt	SSB (mt)	$\bar{F}_{7-8}$
2026	13,165	26,102	0.383

Year	Catch mt	SSB (mt)	$\bar{F}_{7-8}$
2027	6,222	77,841	0.021
2028	18,297	140,644	0.171
2029	27,637	184,357	0.218
2030	32,854	214,543	0.218
2031	38,169	235,978	0.218

Special Comments:

- What are the most important sources of uncertainty in this stock assessment? Explain, and describe qualitatively how they affect the assessment results (such as estimates of biomass, F, recruitment, and population projections).

  A definitive explanation for the continued poor recruitment has not been identified. While identifying a causal mechanism for poor recruitment would be immensely beneficial, finding explanations for patterns in recruitment have been elusive in fisheries science for decades. The research track assessment explored several hypotheses to explain poor recruitment but no definitive answer was reached. The numbers-at-age random effects in this assessment also imply that abundance of older herring is declining at rates faster than fishing and natural mortality alone would suggest. Like recruitment, no definitive explanation is available. Another uncertainty in this assessment is natural mortality. In this assessment, natural mortality was assumed constant among ages and years. The research track assessment explored several options for time- and age-varying natural mortality, but available data did not support such a change. Stock structure, particularly mixing with Nova Scotian or Bay of Funday herring, is also an uncertainty, but data to inform migration and mixing rates are unavailable.

- Does this assessment model have a retrospective pattern? If so, is the pattern minor, or major? (A major retrospective pattern occurs when the adjusted SSB or $\bar{F}_{7-8}$ lies outside of the approximate joint confidence region for SSB and $\bar{F}_{7-8}$).

  This assessment model had a retrospective pattern that could be classified as minor and no adjustments were required.

- Based on this stock assessment, are population projections well determined or uncertain? If this stock is in a rebuilding plan, how do the projections compare to the rebuilding schedule?

  The projections are uncertain, especially in regards to recruitment and the treatment of numbers-at-age random effects. The data do not currently support autocorrelated recruitment even though recent recruitment has been consistently poor. The projections effectively assume an immediate return to mean recruitment, and if this is not realized, the projections are likely to be overly optimistic. Likewise, the data do not support temporal autocorrelation in the numbers-at-age random effects either, but there seems to be a long-term, negative trend. Numbers-at-age random effects do not continue into the projection period, but if they remain negative in the future, the projections will be overly optimistic. The projections updated for this management track confirm that the projections done for the research track were overly optimistic. The stock is currently in a rebuilding schedule, but that schedule was developed using previous assessments completed in the ASAP model. The methods for reference points and projections in the WHAM model are not comparable to those from ASAP, making a comparison of these projections to the existing rebuilding plan inappropriate.

- Describe any changes that were made to the current stock assessment, beyond incorporating additional years of data and the effect these changes had on the assessment and stock status.
  Since the previous management track, this assessment transitioned from ASAP to WHAM. While WHAM differs in many ways from ASAP, the general conclusions about reduced productivity (e.g., poor recruitment) and stock status were unaffected. In addition to a switch to WHAM, a revised Canadian catch time series was used, a different approach was used for input effective sample sizes, and spawning stock biomass weight-at-age values were corrected. None of these changes had significant impacts on estimated quantities or stock status.

- If the stock status has changed a lot since the previous assessment, explain why this occurred.
  The stock status has not changed a lot since the previous assessment.

- Provide qualitative statements describing the condition of the stock that relate to stock status.
  Continued poor recruitment and negative numbers-at-age random effects (e.g., poor survival) in recent years is the main issue driving stock status. Management decisions that reduced US catches had the effect of avoiding overfishing.

- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.
  The research track assessment explored several explanations for poor recruitment, and while no definitive answer was reached, continued consideration of various hypotheses (e.g., haddock predation on herring eggs, copepod abundance, temperature) is warranted. Terminal year recruitment estimates are likely to be over estimated without an index of age-1 abundance (or under estimated should recruitment be above average). An age-1 index based on bird diet has been developed, but several challenges remain before it can be included. State (ME/NH, MA) surveys catch age-1 herring, and combining those surveys with NMFS bottom trawl data may be worthwhile. Work to improve projections and address consistently overly optimistic results would be generally beneficial. In particular, studies that quantify projection accurarcy and how to treat recruitment and NAA random effects in the projection period would be highly informative.

- Are there other important issues?
  No other important issues were identified.

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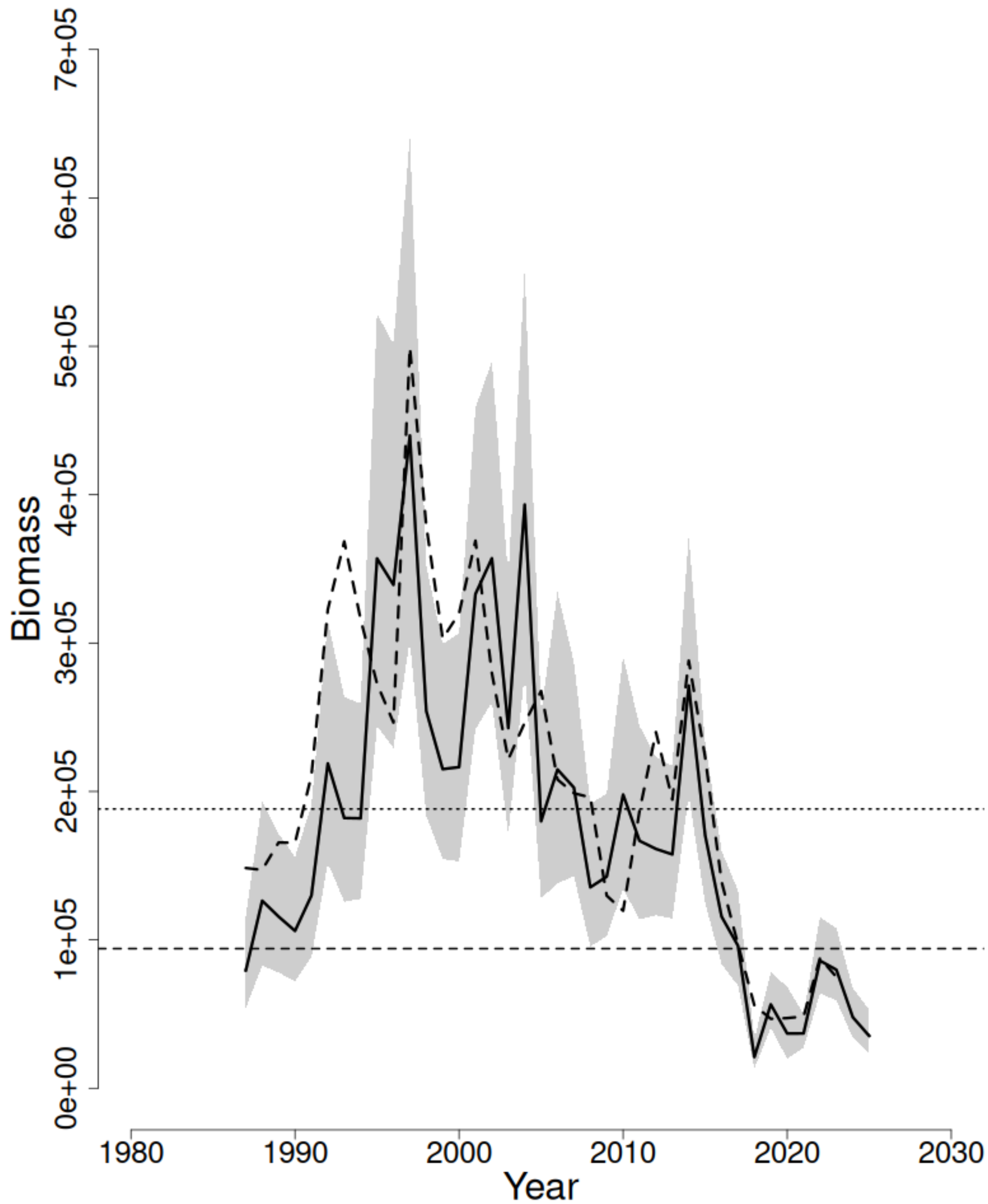

Figure 1: Trends in spawning stock biomass of Atlantic Herring between 1987 and 2025 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted line) based on the 2026 assessment. The approximate 90% confidence intervals are shown.

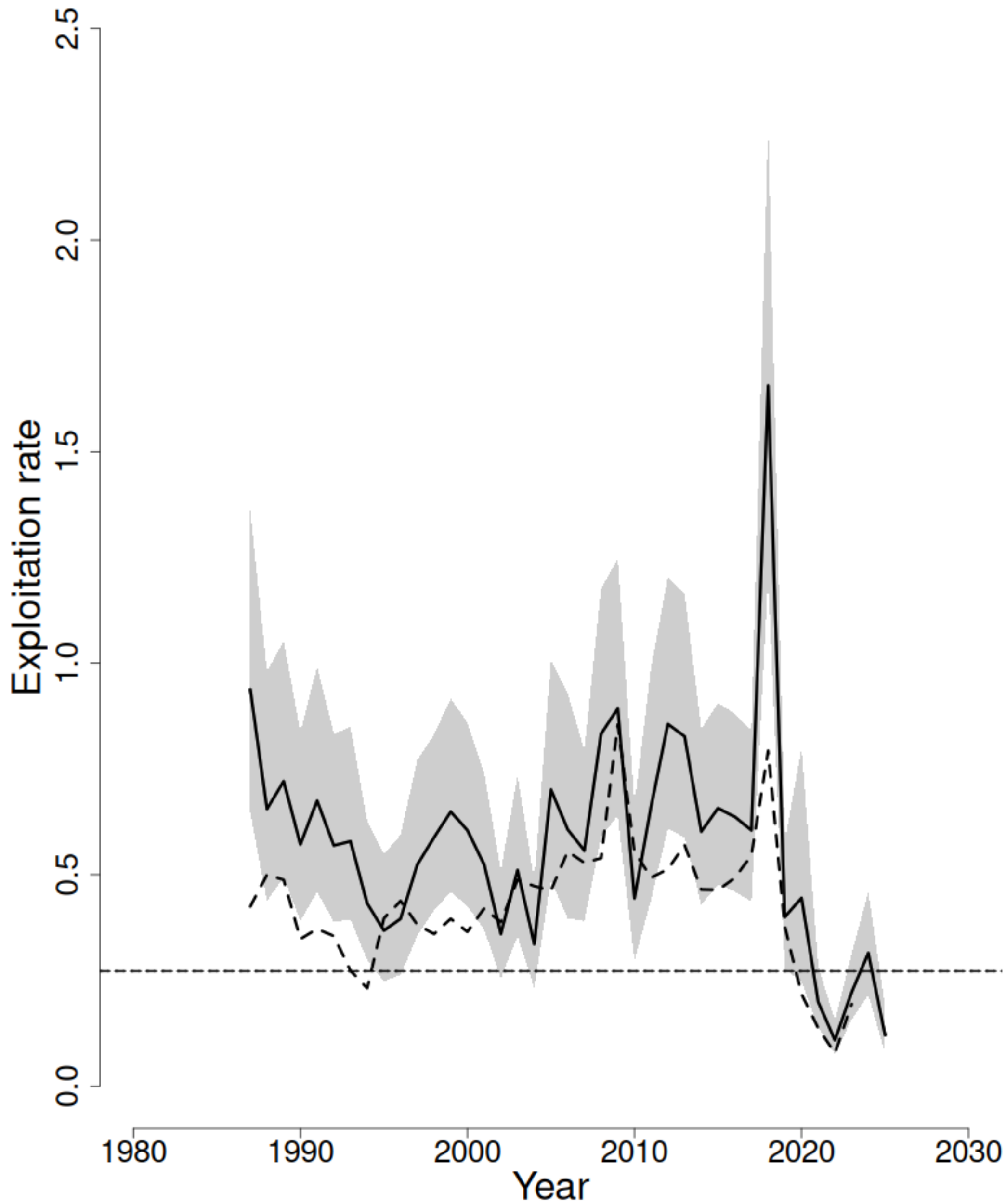

Figure 2: Trends in the average fishing mortality rate for ages 7-8, which are fully selected by the mobile fleet ($\bar{F}_{7-8}$), between 1987 and 2025 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.272; horizontal dashed line). The approximate 90% confidence intervals are shown.

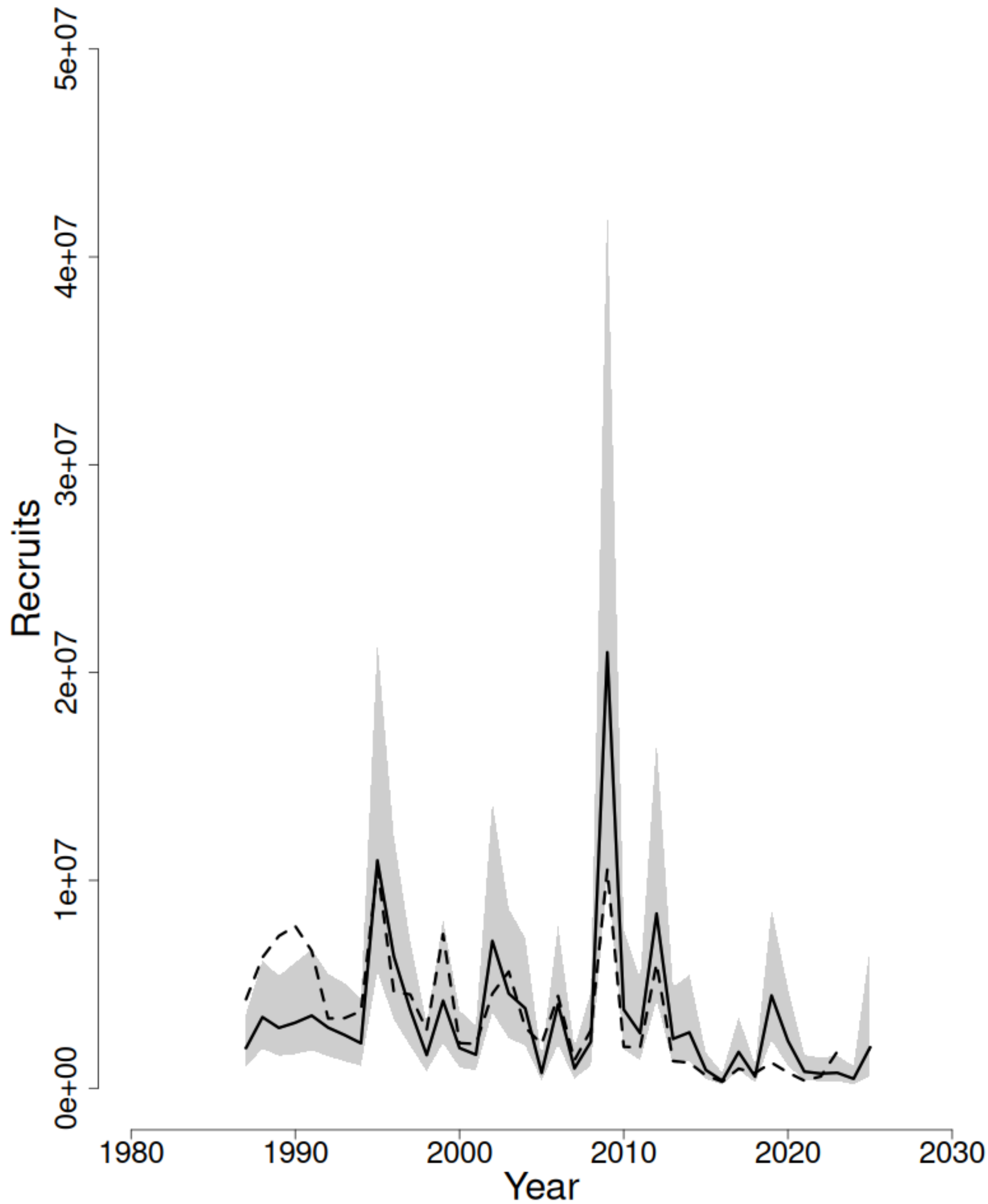

Figure 3: Trends in recruits (age-1)(000s) of Atlantic Herring between 1987 and 2025 from the current (solid line) and previous (dashed line) assessment. The approximate 90% confidence intervals are shown.

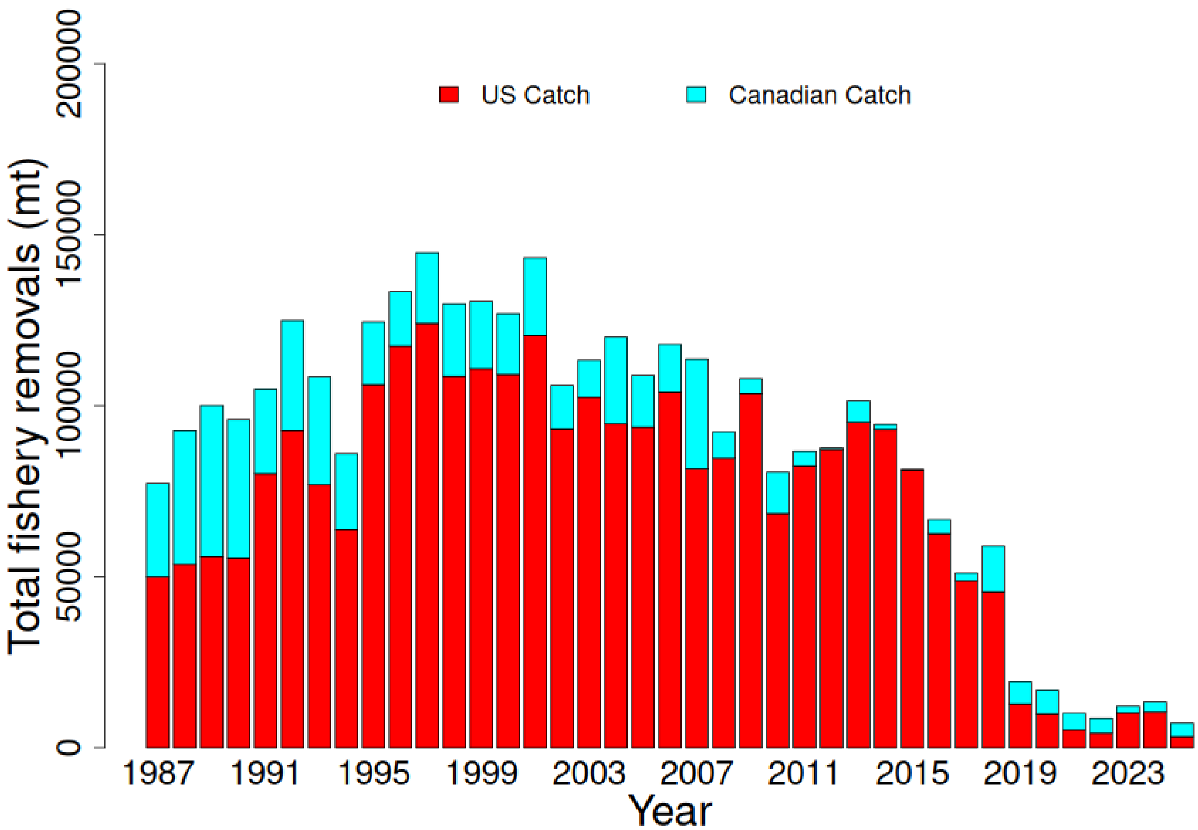

Figure 4: Total catch of Atlantic Herring between 1987 and 2025 by US and Canadian fleets.

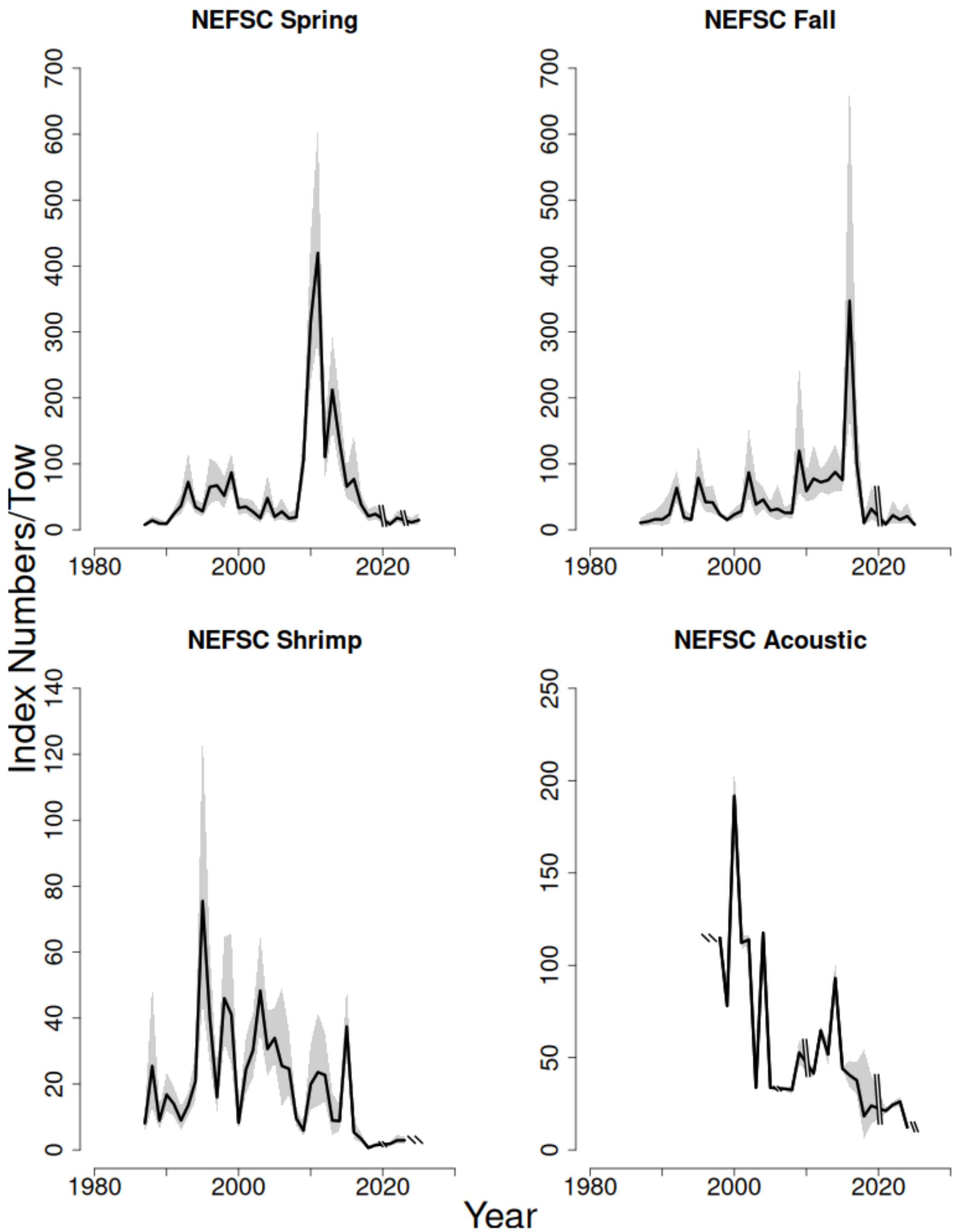

Figure 5: Indices of abundance for Atlantic Herring between 1987 and 2025 for the Northeast Fisheries Science Center (NEFSC) spring, fall, and shrimp bottom trawl surveys. The NEFSC acoustic index is collected during the fall bottom trawl survey and is in units of acoustic backscatter, not absolute numbers. The approximate 90% confidence intervals are shown.

June 2026 Management Track
Peer Review Panel Report

Richard Merrick (Chair)[1], Tim Barrett[2], Lisa Kerr[3] , Holly Kindsvater[4]

[1]NOAA Fisheries (retired), [2]Fisheries and Oceans Canada, [3]University of Maine, [4]Virginia Polytechnic Institute and State University

Executive Summary

The June 2026 Management Track (MT) peer review Panel (Panel) reviewed two stock assessments: Georges Bank haddock (*Melanogrammus aeglefinus*) and Atlantic herring (*Clupea harengus*). The Panel met in person in the USGS' Woods Hole Coastal and Marine Science Center in Falmouth, MA with hybrid capabilities on June 29-30, 2026. The Panel was to determine whether each completed MT Assessment was technically sufficient to a) evaluate stock status, b) provide scientific catch advice, and c) successfully address the assessment Terms of Reference (Appendix A).

Attendance at the meeting is provided in Appendix B, and the agenda for the peer review is available in Appendix C. An explanation of the major acronyms used in the report is provided in Appendix D.

Table 1 presents a list of the stocks, name of the assessment lead, and conclusions about stock status. Table 2 presents a summary of recommendations by stock made by the Panel.

We thank Kristan Blackhart (Population Dynamics Branch Chief) and Brian Hopper (Assessment Process Lead, Resource Evaluation and Assessment Division) for their support during the meeting and to Liz Brooks and Jon Deroba of the staff of the Population Dynamics Branch for the open and collaborative spirit with which they engaged the Panel.

Our thanks also extend to numerous NEFSC staff for taking extensive notes during the meeting, and who, along with Jamie Cournane and Robin Frede of the New England Fishery Management Council, provided context and additional background.

Georges Bank Haddock

The Panel concluded that the 2026 assessment update for Georges Bank haddock is technically sufficient to evaluate stock status and provide scientific advice and meets most of the Terms of Reference for the stock's assessment except for TORs 5 and 6 which were partially met. The assessment represents Best Scientific Information Available (BSIA) for this stock for management purposes.

The 2026 assessment of the Georges Bank haddock (*Melanogrammus aeglefinus*) stock is an update of the 2024 management track assessment, which used the Woods Hole Assessment Model (WHAM) framework. Prior to the 2022 research track, the last benchmark for this stock was in 2008 (Brooks et al., 2008).

This assessment updates commercial fishery catch data, research survey indices of abundance, weights- and maturity-at-age, and the WHAM assessment model and reference points through 2025. Based on this assessment, the stock was not overfished and overfishing was not occurring.

Stock projections have been updated through 2031. However, the Panel found that the high uncertainty in the stock's terminal year abundance estimate and the moderately strong retrospective pattern suggest projections beyond one or two years should be considered to be highly uncertain. The Panel feels it is extremely risky to set catch advice that would lead to fishing down the 2020 year class and the 2021 year class without confirming another recruitment year.

Atlantic Herring

The Panel concluded that the 2026 assessment update for Atlantic herring is technically sufficient to evaluate stock status and provide scientific advice and meets most of the Terms of Reference for the stock's assessment except for TOR 5 which was partially met. The assessment represents Best Scientific Information Available (BSIA) for this stock for management purposes.

This 2026 assessment of the Atlantic herring (*Clupea harengus*) stock is the first application of the WHAM assessment platform following the 2025 research track assessment (NEFSC 2025). The last management track assessment was in 2024 and was conducted using the ASAP model. Based on that assessment, the stock was overfished but overfishing was not occurring.

This assessment updated fishery catch data, survey indices, life history parameters (e.g., weights-at-age), and the WHAM assessment model and reference points (BRPs) through 2025. Stock projections have been updated through 2031.

The change in assessment platforms from the 2024 management track makes comparisons among the assessments inappropriate. Several relatively minor changes have been made since the research track. Namely, a revised Canadian catch time series was used, a different approach was used for input effective sample sizes, and spawning stock biomass weight-at-age values were corrected. The Panel found that the inability to account for the annual variability and downward trend in the numbers-at-age random effect deviations in the projections undermined confidence in the model projections.

Table 1. Stocks reviewed *at June 2026 Management Track Assessment Peer Review meeting.*

Stock	Assessment Lead	Peer Review Panel Conclusion on Stock Status
Georges Bank haddock	Liz Brooks	Stock is not overfished and overfishing is not occurring
Atlantic herring	Jonathan Deroba	Stock is overfished and overfishing is not occurring

Table 2. Summary of Peer Review Panel recommendations by stock from June 2026 Track Assessment Peer Review meeting.

Stock	Peer Review Panel Recommendations
Georges Bank haddock	● Evaluate how density dependence, environmental change and other factors produce changes in GB haddock indices used in the assessment ● Evaluate the effect of decreasing WAA on selectivity-at-age ● Continue investigating retrospective patterns and diagnostics in state-space models ● Evaluate whether conditioning on the random effects is influencing the retro observed in self-tests ● Evaluate factors that could provide for the stability of SSB estimates in the face of declining survey indices and primarily negative NAA random effect deviations in the last 5 years ● Continue evaluation of appropriate methods for scaling recruitment in the calculation of reference points for this stock and development of dynamic BRPs ● Continue to conduct studies to evaluate gutted:whole conversion factors and length-weight for commercial landings ● Continue to characterize differences in the separate Georges Bank and eastern Georges Bank WHAM models

Stock	Peer Review Panel Recommendations
Atlantic herring	● Conduct sensitivity analysis to evaluate how different CVs (and perhaps misreporting) of the Canadian weir catch influence model estimates ● Develop estimates of the portion of catches in the fixed and mobile gears catches that come from US and Canadian stocks ● Continue work on the development of the VAST model to integrate state and federal surveys particularly with respect to use of surveys that include information on age-1 fish (ME-NH survey) ● Continue exploring use of the seabird diet data as an index of age-1 abundance ● Continue exploration of survey data to determine whether Atlantic herring distribution has changed ● Investigate the potential for autocorrelation in annual recruitment, as well as explore covariate(s) aliased in the NAA random effects and determine which is having the most effect on interannual patterns. ● Continue exploration of recruitment stanzas underlying reference points for Atlantic herring ● Reconsider the appropriateness of F40% for an F% more responsive to the changes in productivity that herring are experiencing. ● Revisit decisions on random effects as additional years of data are added as model diagnostics may support alternative configurations as new information is added. ● Review use of geometric mean recruitment of the full time series to inform projections, rather than more recent conditions.

Georges Bank Haddock

Summary

The Panel concluded that the 2026 assessment update for Georges Bank haddock is technically sufficient to evaluate stock status and provide scientific advice and meets most of the Terms of Reference for the stock's assessment except for TORs 5 and 6 which were partially met. The assessment represents Best Scientific Information Available (BSIA) for this stock for management purposes.

This 2026 assessment of the Georges Bank haddock (*Melanogrammus aeglefinus*) stock is an update of the 2024 management track assessment[1], which used the Woods Hole Assessment Model (WHAM) framework. Prior to the 2021-22 research track, the last benchmark for this stock was in 2008 (Brooks et al., 2008)[2]. Based on the previous update assessment in 2024, the stock was not overfished and overfishing was not occurring.

This assessment updates commercial fishery catch data, research survey indices of abundance, weights- and maturity-at-age, and the WHAM assessment model and reference points through 2025. Stock projections have been updated through 2031.

TOR 1. Estimate catch from all sources including landings and discards.

This TOR was Met.

US Commercial discards and landings (from CAMS), Canadian discards and landings, and the associated catch-at-age and weight-at-age (WAA) were all updated through 2025. There are striking patterns of decline in the catch WAA for this stock that warrant further examination to understand these patterns (see recommendations in TOR 2).

The Panel accepted these data as presented.

TOR 2. Evaluate indices used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.).

This TOR was Met.

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[1] NEFSC. 2024. Georges Bank haddock management track assessment report. Unpubl. rpt; 9 pp. Avail, NEFSC, 166 Water Street, Woods Hole, MA 02540

[2] Brooks, E.N, M.L. Traver, S.J. Sutherland, L. Van Eeckhaute, and L. Col. 2008. In. Northeast Fisheries Science Center. 2008. Assessment of 19 Northeast Groundfish Stocks through 2007: Report of the 3rd Groundfish Assessment Review Meeting (GARM III), Northeast Fisheries Science Center, Woods Hole, Massachusetts, August 4-8, 2008. US Dep Commer, NOAA Fisheries, Northeast Fish Sci Cent Ref Doc. 08-15; 884 p + xvii.http://www.nefsc.noaa.gov/publications/crd/crd0815/

Three surveys inform this assessment (NEFSC fall bottom trawl survey (BTS), NEFSC spring BTS, and the DFO BTS). As with the MT24 assessment for the stock, the Spring 2023 BTS was excluded because tows were only conducted in daylight and two strata were not sampled (both of which would bias the results).

Similarly, the appropriateness of including the fall 2025 BTS in the assessment was investigated. Survey sampling was considerably lower than previous years and extended much later in the year. Stratum contributions were also very different compared to recent years and the estimated CV is likely overly precise because some strata had a single tow and a variance could not be calculated for these strata. However, environmental conditions, and both the proportion and location of positive tows were similar to recent survey years, and dropping the terminal year survey could increase uncertainty and model instability. A robust array of analyses and diagnostics were examined for models that included or excluded the Fall BTS 2025 index value. Based on the model diagnostics (CVs, residuals, retrospective pattern, and self-tests) the Analyst recommended the survey be excluded from the assessment. The Panel concluded that this was a reasonable decision.

The Panel recommended additional research on density dependent growth for this stock. There are striking patterns of declining weight-at-age (WAA) for this stock in recent decades that do not appear solely explained by density, as spawning stock biomass (SSB) was high in the last decade, but the decline in WAA began well before this peak in biomass. In addition, the relative stability of growth at early periods of high abundance suggests that there is some interaction between density dependent and independent drivers (e.g., changing ocean conditions) in the recent period. Further research to understand drivers of WAA patterns, and relationship with size-at-age, maturity-at-age, and recruitment is recommended.

Time-varying selectivity patterns may interact with temporal changes in WAA. Additional research is needed to better characterize selectivity across seasons in the bottom trawl survey, as well as age-specific selectivity patterns, to improve understanding of these interactions and their implications for stock assessment.

The Panel made two Research Recommendations:

- Evaluate how density dependence, environmental change and other factors produce changes (as aliased through model parameters/inputs) in the GB haddock fishery independent data that informs the assessment (e.g., indices of relative abundance, recruitment, WAA, age-length data, etc.).
- Evaluate the effect of decreasing WAA on selectivity-at-age.

TOR 3. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) as possible (depending on the assessment method) for the time series using the approved assessment method and estimate their uncertainty. Include retrospective analyses if possible (both historical and within-model) to allow a comparison with previous assessment results and projections, and to examine model fit.

a. Include bridge runs to sequentially document each change from the previously accepted model to the updated model proposed for this peer review.

b. Prepare a backup assessment approach that would serve as an alternative for providing scientific advice to management if the analytical assessment were to not pass review

This TOR was Met.

The WHAM model used for MT26 was the same as was used for MT24: age composition likelihood was treated as logistic normal, survey years with 0 catch were treated as missing, natural mortality was set to 0.2 for all years/ages, and process error transitions in NAA were modeled as autocorrelated by age and year (2DAR1). Therefore, no bridge run was necessary. As approved in the 2022 Research Track assessment for the stock, the backup plan is an empirical, index-based approach broadly known as *Ismooth*.

This TOR was the subject of the majority of the discussion by the Panel.

The Panel was concerned that the retrospective pattern in this assessment has strengthened over time, and although the Analyst suggested no retrospective adjustment is currently required, the Mohn's rho-adjusted point estimate is approaching the limit of the model's unadjusted 90% confidence interval. This suggests a strong and persistent retrospective pattern that may warrant correction in future assessments if the trend continues. The positive Mohn's rho indicates a tendency for the model to overestimate SSB and underestimate fishing mortality (F) in terminal years.

In addition, the model incorporates random effects on numbers-at-age (NAA), which can absorb process error. These random effects are predominantly negative in recent years, suggesting systematic adjustments to the model fit at the end of the time series. Further investigation is needed to evaluate the interaction between the NAA random effects and the retrospective pattern to determine how these processes jointly influence model scaling and terminal-year estimates.

The Panel was also concerned about the biological reality of the stability of SSB over the past 5 years while the survey indices, the NAA deviations (downward trends in 2-4 year olds) in terminal years continue to decline and the reliance on “paper fish” in out years.

Additionally, the Panel was interested in whether the difficulty of sampling smaller year classes when there are bumper year classes affects the model, and how changing WAA affects fleet selectivity patterns at age in the model.

Based on this discussion the Panel had several Research Recommendations:

- Continue investigating retrospective patterns and diagnostics in state-space models (e.g., consider the utility of tests other than the 90% CI for the necessity of Mohn's rho adjustments to SSB so as to balance impacts of changes in magnitude vs. statistical precision).
- Evaluate whether conditioning on the random effects is influencing the retro observed in self-tests (e.g., if there is a misspecification in the fleet selectivity then this could be carried forward to the self-tests resulting in the observed retro in the self-tests). An alternative structure of self-tests that doesn't condition on the primary sources of process variation (recruitment deviations, age-2+ NAA deviations, and fleet selectivity) could allow for more robust testing of the hypothesis that the model is unstable due to large year classes.
- Evaluate factors that could provide for the stability of SSB estimates in the face of the last 5 years of declining survey indices and NAA deviations. The NAA deviations act as "sponges" soaking up unaccounted for observation or process error (e.g., survivorship, selectivity, migration, unaccounted for catch). Continued work to diagnose the most likely drivers of patterns in NAA deviations could inform more robust projections.

TOR 4. Re-estimate or update the BRP's as defined by the management track level and recommend stock status. Also, provide qualitative descriptions of stock status based on simple indicators/metrics (e.g., age- and size-structure, temporal trends in population size or recruitment indices, etc.).

This TOR was Met.

Retrospective adjustments were not made to the model results. Spawning stock biomass (SSB) in 2025 was estimated to be 29,037 mt which is 109% of the biomass target (SSB_{MSY} proxy = 26,615). The 2025 average fishing mortality on ages 5-7 was estimated to be 0.21 which is 78% of the overfishing threshold proxy (F_{MSY} proxy = 0.27). The F_{MSY} proxy is expressed as the average F on ages 5-7.

The Panel accepted this TOR noting that the choice of median recruitment was highly influential on the reference points. The Panel concurred with the Analyst's stock status determination. Nonetheless the Panel provides the following Research Recommendation:

- Continued evaluation of appropriate methods for scaling recruitment in the calculation of reference points for this stock and development of dynamic biological reference points.

The Panel suggests the Analyst provide the dynamic reference points from WHAM for this stock. These would be informative given the substantial changes in WAA and selectivity for this stock.

Based on this Management Track Assessment, the recommended stock status is not overfished and overfishing is not occurring.

TOR 5. Conduct short-term stock projections when appropriate.

This TOR was Partially Met because projections beyond 2028 had such high uncertainty they were not deemed to be useful for management.

Short-term projections were conducted in WHAM, which propagates uncertainty in the processes of recruitment and transitions between numbers-at-age. For projection specifications, the NEFMC's Plan Development Team supplied an estimate of total catch for 2026, and fishing mortality was set equal to $F_{40\%SPR}$ for 2027-2031. Annual fishery selectivity and maturity were fixed at a recent 2 year average (2024-2025 values), following analyses and decisions made at the 2021 research track. Weights-at-age for catch and SSB that were predicted from a Gaussian Markov Random Field (GMRF) model, rather than a recent 2 year average, were preferred by the peer reviewers at the 2022 and 2024 management track assessment and were used in the projections submitted here for peer review.

The Panel was concerned about the high uncertainty in the terminal year of the assessment, the retrospective pattern for SSB and recruitment, and that years 3 and beyond relied largely on "paper fish". **As a result, the Panel concluded that while projections for 2027-28 were reasonable, projections beyond this had such high uncertainty as to not be useful for management.**

TOR 6. Respond to any review Panel comments or SSC concerns from the most recent prior research or management track assessment.

This TOR was Met however the Panel was concerned there was no response to additional Research Recommendations from the 2024 MT and SSC

The single previous research recommendation discussed was for studies to be conducted evaluating the gutted:whole fish conversion factors and length-weight ratio for commercial landings. A collaborative project between the NEFSC and GARFO was recently funded and is ongoing. Nearly 2 years of data have been collected, but some temporal/spatial gaps remain.

The Panel was concerned that all Research Recommendations from the SSC (4 RR) and 2024 MT peer review (3 RR) were not tabled in this review, While we are grateful that the Analyst provided responses to the SSC RR, we **suggest** that all future MT peer reviews address a complete list of recent Research Recommendations during the meeting.

The Analyst proposed that research continue investigating retrospective patterns and diagnostics in state-space models. The Panel agreed with these recommendations by the Analyst and included them in their list of Research Recommendations.

Additional Discussion – US and Canadian Georges Bank haddock assessments

The Analyst provided a comparison between the NMFS Georges Bank haddock and DFO's eastern Georges Bank assessments through 2024. The table contrasting the US

Georges Bank haddock WHAM and the Canadian DFO eastern Georges Bank haddock WHAM was highly useful, and the Panel recommended this be forwarded (with current result) to the US-Canada Transboundary Management Guidance Committee (TMGC) for their consideration and understanding of the differences between the two assessment models results. Presently the two WHAMs are similar but differ in several important aspects (e.g., the US model has process error on the numbers-at-age transitions and the Canadian model estimates an age-invariant natural mortality rate in the time block beginning in 2010; the Canadian model uses the DFO survey in recent years; The US model estimates recruitment as random deviations from a mean with the log normal adjustment off and the Canadian model estimates recruitment as fixed effects and projects recruitment as random samples from the historical distribution of recruitment estimates (mean and variance) with estimated autocorrelation) suggesting there could be some scaling differences introduced by the current models.

The comparison of SSB estimates from 2002-2021 of US and Canadian was highly informative, in that it indicated that the EGB assessment typically accounted for 50% or more of the stock size the US model estimated for the entire Bank.

The Panel suggested the Analysts continue to pursue characterization of differences in the GB/EGB models, as they provide multiple realizations of stock status and provide additional advice to managers for their decision making.

Research Recommendations from the Panel

The Panel recommended that between now and the next MT assessment, the NEFSC should:

1. Evaluate how density dependence, environmental change and other factors produce changes (as aliased through model parameters/inputs) in GB haddock indices used in the assessment (e.g., indices of relative or absolute abundance, recruitment, age-length data, etc.).
2. Evaluate the effect of decreasing WAA on selectivity-at-age.
3. Continue investigating retrospective patterns and diagnostics in state-space models (e.g., consider the utility of tests other than the 90% CI for the necessity of Mohn's rho adjustments to SSB so as to balance impacts of changes in magnitude vs. statistical precision)
4. Evaluate whether conditioning on the random effects is influencing the retro observed in self-tests (e.g., if there is a misspecification in the fleet selectivity then this could be carried forward to the self-tests resulting in the observed retro in the self-tests). An alternative structure of self-tests that doesn't condition on the primary sources of process variation (recruitment deviations, age-2+ NAA deviations, and fleet selectivity) could allow for more robust testing of the hypothesis that the model is unstable due to large year classes.
5. Evaluate factors that could provide for the stability of SSB estimates in the face of the last 5 years of declining survey indices and NAA deviations. The NAA deviations act as "sponges" soaking up unaccounted for observation or process

error (e.g., survivorship, selectivity, migration, unaccounted for catch). Continued work to diagnose the most likely drivers of patterns in NAA deviations could inform more robust projections.

6. Continue evaluation of appropriate methods for scaling recruitment in the calculation of reference points for this stock and development of dynamic biological reference points.
7. Continue to conduct studies to evaluate gutted:whole conversion factors and length-weight for commercial landings.
8. Continue to characterize differences in the separate Georges Bank and eastern Georges Bank WHAM models, such that their multiple realizations of stock status may provide additional advice to managers (TMGC) for their decision making.

Atlantic Herring

Summary

The Panel concluded that the 2026 assessment update for Atlantic herring is technically sufficient to evaluate stock status and provide scientific advice and meets most of the Terms of Reference for the stock's assessment except for TORs 5 which was partially met. The assessment represents Best Scientific Information Available (BSIA) for this stock for management purposes.

This 2026 assessment of the Atlantic herring (*Clupea harengus*) stock is the first application of the WHAM assessment platform following the 2025 research track assessment (NEFSC 2025)[3]. The last management track assessment was in 2024 and was conducted using the ASAP model[4].

This assessment updated fishery catch data, survey indices, and some life history parameters (e.g., weights-at-age), and the WHAM assessment model and reference points (BRPs) through 2025. Stock projections have been updated through 2031. Based on this assessment, the stock is overfished but overfishing is not occurring.

The change in assessment platforms from the 2024 management track makes comparisons with past assessments inappropriate. Several relatively minor changes have been made since the research track. A revised Canadian catch time series was used, a different approach was used for input effective sample sizes, and spawning stock biomass weight-at-age values were corrected.

TOR 1. Estimate catch from all sources including landings and discards.

This TOR was Met.

US and Canadian commercial discards, landings, and age composition were updated through 2025. US landings data were drawn from CAMS since 2020. Discards have only been available since 1996 but generally constitute <1% of landings. Note that the time series of Canadian landings has been revised since previous assessments.

While the Panel agreed the TOR was met there was concern regarding the Canadian catch data. First, the fixed gear (weir) catch data is of unknown quality (i.e., there is no estimate of variance and there is some evidence of misreporting). Secondly, there is an assumption that the only catch of the US stock in Canadian waters is in the fixed gear fishery, when it is likely there is also catch (of unknown scale) in the larger mobile gear (purse seine) fishery. Fish from the Canadian Atlantic herring stock may also be caught

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[3] NEFSC. 2025. Atlantic herring research track assessment report. US Dept. of Commerce, NEFSC Tech Memo. 335; 91pp.

[4] NEFSC. 2024. Atlantic herring management track assessment report. Unpubl. rpt; 9 pp. Avail. NEFSC, 166 Water Street, Woods Hole, MA.

in the US fisheries. Underlying these concerns is a high uncertainty regarding mixing of US and Canadian herring fisheries and the extent to which these are mixed-stock fisheries.

Revisiting treatment of Canadian catch in this stock assessment could improve its quality. In particular, the stock identification information that underlies the assumption that these are US fish warrants an update to identify source population of these catches. Consequently, the Panel provided two Research Recommendations:

- Conduct sensitivity analysis to evaluate how different CVs (and perhaps misreporting) of the Canadian weir catch influence model estimates
- Develop estimates of the portion of catches in the fixed and mobile gear catches that come from the US and Canadian stocks.

TOR 2. Evaluate indices used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.).

This TOR was Met

The four surveys currently used in the 2026 assessment model included the NEFSC Spring (1968-2025) and Fall (1963-2025) Bottom Trawl surveys (BTS), the Summer (Shrimp) survey (1980s-2023) and the Acoustic survey (1998-2025) conducted as part of the Fall BT survey. The former three surveys focus on the near-bottom distribution and abundance of herring, while the latter quantifies fish throughout the water column.

These surveys have shown consistent cohort tracking even as they have declined since 2009, reflecting broader declines in abundance. They drive the indices necessary for the assessment - age composition, abundance, and spatial distribution.

The Panel was concerned that none of the current trawl surveys provide data on age-1 abundance, which is problematic for such a short-lived stock. Not incorporating the ME-NH survey (which samples small herring better than the NEFSC bottom trawl surveys) or the seabird diet index contributes to the loss of this information.

There was also concern that there may have been shifts in distribution. Comments from the Community Engagement session and Industry testimony in this review indicated that herring are being caught at different times, in different areas, in deeper water, and in smaller aggregations. All of this suggests the potential for time-varying catchability that could introduce sampling bias in the trawl surveys between years.

The Panel Recommended the following actions:

- Continue work on the development of the VAST model to integrate state and federal surveys particularly with respect to use of surveys that include information on age-1 fish (ME-NH survey). Development of model-based indices for this stock could also address potential for time varying catchability.

- Continue exploring use of the seabird diet data as an index of age-1 abundance (the Panel acknowledges the preceding RR is a more fruitful use of Analyst's time)
- Continue exploration of survey data to determine whether Atlantic herring distribution has changed

The Panel considered the first of these Recommendations to be a priority to address before the next Management Track assessment.

TOR 3. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) as possible (depending on the assessment method) for the time series using the approved assessment method and estimate their uncertainty. Include retrospective analyses if possible (both historical and within-model) to allow a comparison with previous assessment results and projections, and to examine model fit.

> **a. Include bridge runs to sequentially document each change from the previously accepted model to the updated model proposed for this peer review.**
>
> **b. Prepare a backup assessment approach that would serve as an alternative for providing scientific advice to management if the analytical assessment were to not pass review**

This TOR was Met but the underlying patterns in the NAA random effects require further investigation to improve attribution of process error and that the structural assumptions (e.g., no correlation across years) be revisited before the next MT assessment.

The Panel recognized that continued poor recruitment and negative numbers-at-age random effects (e.g., poor survival) in recent years is the main issue driving stock abundance. The challenge in attributing the process that is being accounted for in NAA deviations undermined confidence in the results of the model regarding current abundance and projections. The high CV on recruitment and results of self-test indicate high uncertainty in estimates.

Key concerns are the pattern observed in the numbers-at-age (NAA) random effects (i.e., strong correlation among ages) and lack of support for a correlation among years. The unusual highly correlated negative NAAs for ages 2-7 could be related to the spike in recruitment in 2019 identified by WHAM, which was not present in the 2024 MT assessment in ASAP. The Panel discussed that these NAA deviations could be artefacts that are highly influential on scaling of population estimates and may warrant re-evaluation. Specifically the underlying annual variability shown in the NAA deviations suggest there could be a covariate being aliased that has a significant effect on interannual patterns of the NAA deviations or that a signal in the input data (e.g., age-composition data or survey index data) is leading to strong annual signal that is lost in subsequent years. This uncertainty is compounded by the recent gaps in data due to missing Spring 2023 BTS data and 2024-2025 shrimp surveys, on top of recent changes in the catch reporting (switch to CAMS) and the sparse port sampling of weight-at-age. These gaps contribute to the challenge of not being able to attribute the negative NAA deviations to a process. The 2025 RT had similar concerns and the Panel hopes to see progress on the treatment of NAAs after this MT assessment.

The Panel recommends that in the future Analysts revisit the assumption of no temporal autocorrelation in recruitment deviations across years. Because the projected population dynamics are sensitive to these assumptions, revisiting the treatment of NAA random effects and the temporal structure of recruitment as additional data are added to the assessment could have substantial implications for stock assessment results and projections. Currently, the panel discussed that this uncertainty could lead to issues with scaling of population abundance in the assessment (TOR4) and in projections (TOR5).

More work is needed to correctly attribute the uncertainty that is being captured by the NAA process error. Consequently, the Panel provided a second Major Research Recommendation for herring to address before the next Management Track assessment:

- Investigate the potential for autocorrelation in annual recruitment, as well as explore covariate(s) aliased in the NAA random effects and determine which is having the most effect on interannual patterns. Further exploration of the possible drivers of process error patterns in numbers-at-age random effects that suggest poor survival across ages.

The Panel understands from the Analyst that exploring longer lags is currently not available in WHAM; nonetheless, this remains an issue with assessment which ultimately needs to be addressed.

TOR 4. Re-estimate or update the BRP’s as defined by the management track level and recommend stock status. Also, provide qualitative descriptions of stock status based on simple indicators/metrics (e.g., age- and size-structure, temporal trends in population size or recruitment indices, etc.).

This TOR was Met

Retrospective adjustments were not necessary (SSB Mohn’s rho = 0.22 and F Mohn’s rho = -0.04). Spawning stock biomass (SSB) in 2025 was estimated to be 35,258 (mt) which is 19% of the biomass target (SSB_{MSY} proxy = 188,214). The 2025 average mobile fleet fishing mortality for ages 7-8 (fully selected) was estimated to be 0.121 which is 44% of the overfishing threshold proxy (F_{MSY} proxy = 0.272).

Reference points were calculated using the spawning potential ratio (SPR) 40% proxy approach, with $F_{40\%}$ used as a proxy for F_{MSY} and $SSB_{F40\%}$ as a proxy for SSB_{MSY}. A key concern is the scaling of these reference points for herring, particularly the recruitment assumptions underlying the estimation. It is unclear whether the resulting SSB_{MSY} proxy appropriately reflects the stock's productivity and whether $F_{40\%}$ remains a good proxy for F_{MSY} given the evidence for a regime change for many of the stocks in this region.

The Panel highlighted that decisions made in model fitting (TOR 3) have large implications for reference points. Prevailing conditions are negative in recent years for herring, as indicated by negative NAA deviations and recruitment deviations, but with no year effect selected for in the model this means these conditions do not propagate into reference point calculations. While this is consistent with decisions made at the research track, this may not be representative of prevailing conditions for this stock.

Though the Panel accepted the Analyst's results, they provided the following Research Recommendations:

- Investigate dynamic reference points for Atlantic herring, including work on fitting dynamic stock-recruit relationships, alternative specification of random effects or inclusion of covariates in the model, or short-term approaches to revise recruitment assumptions (e.g., truncation of time series).
- Reconsider the appropriateness of $F_{40\%}$ for an F% more responsive to the changes in productivity that herring are experiencing.

Note that this recommendation may apply to a number of assessed stocks using the default $F_{40\%}$ proxy.

Based on this Management Track Assessment, the recommended stock status is overfished but overfishing is not occurring.

TOR 5. Conduct short-term stock projections when appropriate.

This TOR was Partially Met as the Panel considered the OFLs (or F_{msy}) and ABC projections based on the RT methodology to be useful but likely to be overly optimistic especially in light of the sensitivity analyses

The projection results applied the harvest (ABC) control rule described in Amendment 8 of the herring Fishery Management Plan to the mobile fleet. The fixed gear catches are assumed constant during the projection period and equaled 5,283 mt/year. This fixed gear catch equals the sum of the ten year (2016-2025) averages of the Canadian (5,130 mt) and US (152 mt) fixed gear catches. The US fixed gear includes catches from stop seines, weirs, and pound nets. The reported F_{7-8} are averaged over ages 7-8, which are fully selected by the mobile fleet (trawls and purse seine) fleet. Projected recruitment continued the independent and identically distributed process estimated by WHAM. NAA random effects were not carried forward into the projection period due to lack of an autocorrelation across years in the model.

These projections indicate rapid increases in SSB and catch given the reduction in fishing with the application of the control rule. This pattern is driven by several factors, including the use of the geometric mean recruitment of the full time series and the absence of autocorrelation across years, such that recent negative NAA deviations and recruitment deviations do not inform projections. Both the RT Panel and this MT Panel believe the SSB estimates and catch projections are likely overestimated.

Estimated negative random effects on numbers-at-age (NAA), which represent additional fish losses beyond those accounted for by fishing and natural mortality, are not assumed to be autocorrelated across years and do not continue into the projection period. As a result, recent cohorts experience higher projected survival than is evident in WHAM outputs and thus contribute substantially to future SSB in the projections.

This TOR was particularly affected by the structure of the NAA random effects expressed under TOR 3. The Analyst presented a sensitivity analysis using the average of the NAA deviations estimated for the most recent 5 years that provided an alternative scenario with significant impact on projections. The Panel saw this analysis as useful and agreed both projections should be provided for management decisions. The Panel considered the OFLs (or F_{msy}) and ABC projections based on the RT methodology likely to be overly optimistic especially in light of the sensitivity analysis which better reflects prevailing conditions for the NAA deviations. The Panel also noted issues with the approach used in the sensitivity analysis (e.g., not consistent with the model, the 5-year average of the NAA deviations does not propagate the high interannual variability in the deviations). **After considerable discussion, the Panel concluded that the PDT and SSC should view the projections and sensitivity analysis as context for catch advice setting but that each has challenges that limit their utility.**

The Panel provided the following Research Recommendations:

- Revisit decisions on random effects (TOR 3) as additional years of data are added as model diagnostics may support alternative configurations as new information is added.
- Revisit use of the geometric mean recruitment of the full time series to inform projections, rather than more recent conditions.

TOR 6. Respond to any review Panel comments or SSC concerns from the most recent prior research or management track assessment.

This TOR was Met.

The Analyst reviewed the status of a dozen Research Recommendations from the 2025 Atlantic herring Research Track. Little progress had been made to date in part because of the short time since the RT was concluded but also because of the lack of resources to conduct the research. The Panel encourages the NEFSC to continue working on these items.

The Analyst also reviewed and responded to comments provided as part of the 2025 Community engagement session on Atlantic herring. Issues raised there included changes in herring migration timing, interactions between the distribution/abundance of menhaden, mackerel, and herring, herring stock structure and the treatment of

Canadian catches. Again research for many of these topics was in progress. The Panel commended the Analyst for bringing these items forward in the peer review.

Additional Discussion - Public Comments

The Panel received public comments from six representatives of the herring fishing fleet. Industry concerns about the status of the Atlantic herring stock and this assessment generally focused on changes in the distribution of herring and the impact that a further reduction in the catch advice would have on industry. With respect to the former, commenters felt that herring had moved deeper offshore (but lots of small fish inshore) and may not have been accessible to the NEFSC BT survey as in previous year's surveys. The second set of comments on the impact of the assessment suggested the reduced catch advice that would arise from the assessment's proposed 2027 OFL/ABC would severely limit fleet activities. At least two of the speakers suggested that the SSC consider averaging catch advice over the five projection years.

A full description of the comments are provided to the NEFSC via the rapporteurs' notes.

Research Recommendations from the Panel

The Panel recommended that between now and the next MT assessment, the NEFSC should:

1. Conduct sensitivity analysis to evaluate how different CVs (and perhaps misreporting) of the Canadian weir catch influence model estimates
2. Develop estimates of the portion of catches in the fixed and mobile gears catches that come from the US and Canadian stocks
3. Continue work on the development of the VAST model to integrate state and federal surveys particularly with respect to use of surveys that include information on age-1 fish (ME-NH survey). Development of model-based indices for this stock could also address potential for time varying catchability.
4. Continue exploring use of the seabird diet data as an index of age-1 abundance (the Panel acknowledges that RR3 is a more fruitful use of Analyst's time)
5. Continue exploration of survey data to determine whether Atlantic herring distribution has changed
6. Investigate the potential for autocorrelation in annual recruitment, as well as explore covariate(s) aliased in the NAA random effects and determine which is having the most effect on interannual patterns.
7. Investigate dynamic reference points for Atlantic herring, including work on fitting dynamic stock-recruit relationships, alternative specification of random effects or inclusion of covariates in model, or short-term approaches to revise recruitment assumptions (e.g., truncation of time series)
8. Reconsider the appropriateness of $F_{40\%}$ for an F% more responsive to the changes in productivity that herring are experiencing.

9. Revisit decisions on random effects (TOR 3) as additional years of data are added as model diagnostics may support alternative configurations as new information is added.
10. Revisit use of the geometric mean recruitment of the full time series to inform projections, rather than more recent conditions.

Recommendations 3, and 6 were considered by the Panel to be the most important and should be addressed prior to the next Management Track assessment for the stock.

Additionally, the Panel suggested this stock be prioritized for consideration in the upcoming Research Track on projection methodologies.

Appendix A.

Management Track Assessment Terms of Reference

1. Estimate catch from all sources including landings and discards.

2. Evaluate indices used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.).

3. Estimate annual fishing mortality, recruitment, and stock biomass (both total and spawning stock) as possible (depending on the assessment method) for the time series using the approved assessment method and estimate their uncertainty. Include retrospective analyses if possible (both historical and within-model) to allow a comparison with previous assessment results and projections, and to examine model fit.

    a. Include bridge runs to sequentially document each change from the previously accepted model to the updated model proposed for this peer review.

    b. Prepare a backup assessment approach that would serve as an alternative for providing scientific advice to management if the analytical assessment were to not pass review.

4. Re-estimate or update the BRP's as defined by the management track level and recommend stock status. Also, provide qualitative descriptions of stock status based on simple indicators/metrics (e.g., age- and size-structure, temporal trends in population size or recruitment indices, etc.).

5. Conduct short-term stock projections when appropriate.

6. Respond to any review Panel comments or SSC concerns from the most recent prior research or management track assessment.

Appendix B.

June Management Track Peer Review Meeting Attendance
June 29-30, 2026

ASMFC - Atlantic States Marine Fisheries Commission
GARFO - Greater Atlantic Regional Fisheries Office
MAFMC - Mid-Atlantic Fisheries Management Council
NEFMC - New England Fisheries Management Council
NEFSC - Northeast Fisheries Science Center

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Richard Merrick - Chair, NOAA Fisheries (retired), NEFMC Scientific and Statistical Committee
Tim Barrett - Panel, Fisheries and Oceans Canada, ASFMC appointee
Lisa Kerr - Panel, University of Maine, NEFMC Scientific and Statistical Committee
Holly Kindsvater - Panel, Virginia Polytechnic Institute and State University, MAFMC Scientific and Statistical Committee

Larry Alade, NEFSC
Melanie Barrett, Fisheries and Oceans Canada
David Benson
Kristan Blackhart, NEFSC
Jessica Blaylock, NEFSC
Jason Boucher, NEFSC
Emily Bodell, NEFMC
Bonnie Brady, New England Fishermen’s Stewardship Association
Liz Brooks, NEFSC
Carly Burns, NOAA Affiliate
Steve Cadrin, University of Massachusetts Dartmouth
Patrick Campfield, ASMFC
Jui-Han Chang, NEFSC
Ethan Chase, fisherman
Matt Cieri, Maine Department of Marine Resources
Jamie Cournane, NEFMC
Kiersten Curti, NEFSC
Jess Daniels, New England Fish Company
Micah Dean, Massachusetts Division of Marine Fisheries
Dustin Delano, fisherman
Jonathan Deroba, NEFSC
Jason Didden, MAFMC
Tara Dolan, Massachusetts Division of Marine Fisheries
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Alex Dunn, NEFMC
Corrin Flora, North Carolina Division of Marine Fisheries
Robin Frede, NEFMC
Mark Grant, NEFMC
Melanie Griffin, Massachusetts Division of Marine Fisheries
Alex Hansell, NEFSC
Amanda Hart, NEFSC
Daniel Hennen, NEFSC
Nathan Hebert, Fisheries and Oceans Canada
Daniel Hocking, GARFO
Cameron Hodgdon, NEFSC
Brian Hooper, NEFSC
Andrew Joyce, F/V Providian
Jeff Kaelin, Lund's Fisheries
Raymond Kane, Cape Cod Fishermen's Alliance
Rick Kasten
Zack Klyver, NEFMC Atlantic Herring Advisory Panel
Chris Legault, NEFSC
Brian Linton, NEFSC
Andy Lipsky, NEFSC
Bill Lucy, Long Island Soundkeeper
Declan McCormick, Maine Department of Marine Resources
Kathryn MacDonald, Fisheries and Oceans Canada
Mitch McDonald, NOAA Office of General Counsel
Tara McIntyre, Fisheries and Oceans Canada
Conor McManus, NEFSC
Timothy Miller, NEFSC
Allison Murphy, GARFO
Paul Nitschke, NEFSC
Carrie Nordeen, GARFO
Jackie O'Dell, Northeast Seafood Coalition
Cate O'Keefe, NEFMC
Danilee Palmer, GARFO
Charles Perretti, NEFSC
Michelle Raber, F/V Providian
Suzannah Raber, F/V Providian
Ryan Raber, Ocean Spray
Marianne Randell, GARFO
Kaitlin Rogers, NEFSC
Elizabeth Roros, University of Massachusetts Dartmouth
Melissa Smith, Maine Department of Marine Resources
Liz Sullivan, GARFO
Spencer Talmage, GARFO
Mary Beth Tooley, O'Hara Corporation
Samuel Truesdell, NEFSC
Kaitlynn Wade, University of North Carolina

Megan Ware, Maine Department of Marine Resources
Peter Whelan, fisherman
Kelly Whitmore, Massachusetts Division of Marine Fisheries
Antony Wood, NEFSC

Appendix C.

June 2026 Management Track Peer Review Agenda

**All times are approximate and may be changed at the discretion of the Peer Review Panel chair.*
The meeting is open to the public.

Monday, June 29, 2026

Time	**Stock**	**Subject**	**Presenter**
9:00 a.m.		Welcome/Logistics Conduct of Meeting	Brian Hooper Kristan Blackhart Panel Chair
9:15 a.m.	Georges Bank Haddock	Terms of Reference (TOR) Review & Panel Questions	Liz Brooks Panel
10:30 a.m.		***Break***	
10:45 a.m.	Georges Bank Haddock	TOR Review & Panel Questions, continued	
11:45 a.m.	Georges Bank Haddock	Public Comment	Public
12:00 p.m.		***Lunch***	
1:00 p.m.	Georges Bank Haddock	Panel Deliberations	Panel
2:15 p.m.	Georges Bank Haddock	Panel Conclusions / Recommendations and Final Stock Wrap Up	Panel
3:00 p.m.		Closed Panel Writing Session	
5:00 p.m.		***Adjourn***	

Tuesday, June 30, 2026

Time	Stock	Subject	Presenter
9:00 a.m.		Welcome/Logistics	Brian Hooper Panel Chair
9:05 a.m.	Atlantic Herring	TOR Review & Panel Questions	Jonathan Deroba Panel
10:30 a.m.	Atlantic Herring	Public Comment	Public
10:45 a.m.		***Break***	
11:00 a.m.	Atlantic Herring	Panel Deliberations	Panel
11:30 a.m.	Atlantic Herring	Panel Conclusions / Recommendations and Final Stock Wrap Up	Panel
12:00 p.m.		***Lunch***	
1:00 p.m.	All stocks	Final Meeting Wrap Up, if needed (else closed Panel writing session)	Panel
3:00 p.m.		Closed Panel Writing Session	
5:00 p.m.		***Adjourn***	

Appendix D.

Acronyms Used in This Report

ABC - acceptable biological catch
ASAP - Age Structured Assessment Program
AWG - Assessment Working Group
BLLS - Bottom Long Line Survey
BRP - biological reference point
BTS - bottom trawl survey
CAMS - Catch Accounting and Monitoring System
CI - confidence interval
CV - coefficient of variation
DFO - (Department of) Fisheries and Oceans Canada
EGB - eastern Georges Bank
F - Fishing mortality
GARFO - Greater Atlantic Regional Fisheries Office
GB - Georges Bank
GMRF - Gaussian Markov Random Field
M - natural mortality
ME - Maine
MT - Management Track
NAA - numbers-at-age
NEFSC - Northeast Fisheries Science Center
NEFMC - New England Fishery Management Council
NH - New Hampshire
NRCC - Northeast Region Coordinating Council
OFL - Overfishing Limit
PDT - Plan Development Team
RE - random effects
RR - research recommendation
RT - Research Track
RTSC - Research Track Steering Committee
SSB - spawning stock biomass
SSC - Scientific and Statistical Committee
SSRT - State Space Research Track
TMGC - Transboundary Management Guidance Committee
USGS - United States Geological Survey
VAST - Vector Autoregressive Spatio-Temporal
WAA - weight-at-age
WHAM - Woods Hole Assessment Model

FOR IMMEDIATE RELEASE
June 29, 2026

PRESS CONTACT: Alex Dunn
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Council Focuses on Timely Implementation of Fishery Specifications; Recommends Changes to Habitat Research Area

The New England Fishery Management Council met from June 23-25, 2026, in Mystic Connecticut. The following is a summary of actions taken and issues considered affecting several Fishery Management Plans (FMPs). Meeting materials, motions, and the meeting audio recordings are available on the Council's June 2026 meeting page.

HERRING INDUSTRY-FUNDED MONITORING TO BE REVISITED

The Council decided to consider rescinding the Atlantic herring Industry Funded Monitoring (IFM) program as a possible 2027 priority, to be further discussed at its December 2026 meeting. The discussion was sparked by a letter from NOAA requesting the Council rescind the Herring IFM program in response to Executive Order 14276 and ongoing litigation. Multiple Council members spoke about the importance of completing current Herring priorities as planned. The Council and NOAA partners noted that other existing IFM programs for scallops and groundfish would not be affected. The Council plans to respond to NOAA in a letter following the June meeting. More information can be found here.

HERRING SPECIFICATIONS PRIORITIZED; SEPARATED FROM OTHER MANAGEMENT MEASURES

The Council voted unanimously to separate Atlantic herring specifications for fishing years (FY) 2027-2031 into a standalone action distinct from ongoing work to modify river herring and shad (RHS) management measures. The Council plans to take final action on the specifications at its September 2026 meeting. In a separate action, the Council directed the Plan Development Team (PDT) to continue working on (1) time-area closures for RHS with and without existing catch cap methodology; (2) an updated specifications process; (3) carryover provision modifications, with final action targeted for April 2027. The full herring report can be found here.

SCALLOPS SHOW STRONG LANDINGS; COUNCIL ENSURES TIMELY IMPLEMENTATION OF SPECIFICATIONS

The 2026 scallop fishing year (FY) is seeing strong early season landings, driven by high catch rates of over 2,000 pounds per day in the Mid-Atlantic. FY2026 specifications allocated 36 Days-at-Sea to full-time Limited Access vessels and did not allocate any access area trips.

Scallop Framework 42 (FW42): The Council voted unanimously to prioritize fishery specifications for FY2027 by splitting specs from FW42. Splitting the actions reduces the risk of specifications being delayed past the start of the fishing year on April 1, 2027. Continued development of FW42 includes region-specific Limited Access Day-at-Sea management, as well as sub-management areas within the Northern Gulf of Maine management area. FW42 is scheduled for implementation in FY2028. Scallop meeting information can be found here.

Research Set Aside (RSA) NOAA staff reported a record-setting 40 applications for the 2026-2027 RSA Announcement. Over a dozen proposals have been selected with an announcement expected from NOAA Grants in the coming weeks; check NOAA's RSA webpage for updates. All 2026 RSA Set-Aside pounds and nearly all 2027 pounds will be awarded, and there is not an expected award cycle in 2027. The Council also voted unanimously on the FY2027-2028 RSA Priorities.

GROUNDFISH FRAMEWORK 74 INITIATED; UPDATES ON FRAMEWORK 68 AND AMENDMENT 23

Framework Adjustment 74 (FW74): The Council voted unanimously to initiate Framework Adjustment FW74, which would set specifications for FY2027–2031 and include targeted management measures. These proposed measures include simplifying Southern windowpane flounder Accountability Measure triggers and exploring alternative methods for setting Atlantic halibut catch limits.

Framework Adjustment 68 (FW68): The Council agreed to extend the timeline for FW68 with work continuing through the summer and potential final action in April 2027. FW68 aims to modify or replace existing groundfish Acceptable Biological Catch (ABC) Control Rules to incorporate the Council's new Risk Policy.

The revised control rules are intended to provide catch advice that minimizes large fluctuations in catch limits when appropriate. In addition to revised control rules, potential management approaches under consideration include:

- Phased-in ABCs to promote industry stability
- ABC carryover provisions to support safety and market stability
- Rules for the use of constant ABCs to improve consistency

Amendment 23 (A23): The Council received an update on ongoing evaluation work for the Groundfish Monitoring Program established under A23. The program is designed to improve catch accounting and enhance the quality of fisheries data. Initial evaluation results indicate that the program has strengthened monitoring efforts, mitigated the effects of bias, improved overall data quality, and increased the effectiveness of coverage. All groundfish report documentation can be found here.

SMALL MESH MULTISPECIES 2026 ACTION

The Council approved a 2026 Small Mesh Multispecies action that includes specifications, application of the new risk policy in the catch-setting process, and targeted possession limit adjustments. The Council deferred potential changes to exemption area boundaries and seasonal provisions to allow for broader coordination across all existing exemption areas. The Whiting Committee Report can be found here.

RECOMMENDED CHANGES TO HABITAT RESEARCH AREAS

The Council passed three motions during the habitat report. The first action approved the scope of a Clam Dredge Exemption Program Review while the other motions affected Dedicated Habitat Research Areas (DHRA). They also received an update on the 2026 Essential Fish Habitat Framework (EFH) to designate EFH for groundfish, small mesh, and Atlantic scallop management plans.

Clam Dredge Exemption: The Council agreed on the scope of a report evaluating the surfclam dredge exemption program in the Great South Channel Habitat Management Area (HMA). The report will examine the effectiveness of three exemption areas implemented in 2018 from a habitat conservation and fishery management perspective. The review will incorporate updated scientific models, fishing effects analyses, vessel monitoring and catch accounting data, fishery performance information, and Experimental Fishing Permit-based (EFP) research. It will compare pre- and post-implementation conditions. The report is scheduled for completion ahead of the September Council meeting.

DHRA decisions hinged on whether active or planned research meeting the Council's objectives existed in each area. The Council recommendations to the Regional Administrator were to sunset the Georges Bank DHRA, as they saw no qualifying planned research, and retain the Stellwagen Bank DHRA which does have active and planned research. **WHAT IS A DHRA?** Dedicated Habitat Research Areas (DHRA) are areas closed to certain bottom-tending gears to allow scientific study of seafloor habitats in a controlled environment. These year-round closures are re-examined every three years, after which time GARFO consults with the Council and the public on whether to maintain the designation.

MONKFISH AND SKATE LISTENING SESSIONS INFORM REQUEST TO NOAA

The Council received a summary of the Monkfish and Skate Listening Sessions that took place this spring. The summary highlighted industry concerns related to individual fishing quotas, area-specific management, effort controls, market conditions, latent effort, monkfish and skate interactions, protected resource regulations, and offshore wind development. The Council acknowledged these concerns and approved a motion to develop a joint letter to GARFO with the Mid-Atlantic Fishery Management Council (MAFMC) to request information on the effectiveness of current Harbor Porpoise Take Reduction Plan measures. The Councils seek an assessment of whether modifications to the plan could reduce negative socioeconomic impacts on affected fisheries, consistent with concerns raised during the Listening Sessions. The MAFMC supported this work in a motion at their June meeting and will provide an update at a future meeting.