Atlantic States Marine Fisheries Commission

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MEMORANDUM

TO: Atlantic Menhaden Management Board

FROM: Atlantic Menhaden Technical Committee and Ecological Reference Point Workgroup

DATE: October 9, 2025

SUBJECT: Stock Projections to Inform 2026-2028 Total Allowable Catch Levels

The Atlantic Menhaden Management Board (Board) will discuss the 2026-2028 total allowable catch (TAC) for Atlantic menhaden at its October 2025 meeting. Per Amendment 3, the TAC is set through Board action, either on an annual basis or for multiple years, based on the best available science. If the Board does not set a TAC for 2026 by December 31, 2025, next year's TAC will automatically be set at the level of the 2025 TAC (233,550 mt).

Since the implementation of coastwide quota management the TAC has varied but has overall increased from 170,800 metric tons for 2013–2014 to 233,550 mt for 2023-2025 (Table 1). Table 2 provides each jurisdiction's Addendum I allocations.

At the May meeting, the Board tasked the Atlantic Menhaden Technical Committee (TC) with developing projections using the ecological reference points (ERPs) and the single-species assessment model (Beaufort Assessment Model, or BAM). Specifically, the Board requested the following projections:

- The TACs that have a 40%-60% probability of exceeding the ERP target, in 5% increments, using 2026-2028 combined and as separate years.
- The percent risk of exceeding the ERP target and threshold if the current TAC was changed by -20% to +20% in 5% increments, including 0% (the current TAC).

This memo outlines the methods for the projections and the results of the analysis that the Board requested to support the specifications process.

TAC Setting Process

As in recent years, the TAC has been informed by the results of projection analysis, which explores a range of TAC alternatives to determine the percent risk of exceeding the ERP reference points adopted in 2020:

- **ERP target**: the maximum fishing mortality rate (*F*) on Atlantic menhaden that sustains Atlantic striped bass at their biomass target when striped bass are fished at their *F*

target and the other ERP species in the model (bluefish, spiny dogfish, weakfish, and Atlantic herring) are fished at their current levels

- **ERP threshold**: the maximum *F* on Atlantic menhaden that keeps Atlantic striped bass at their biomass threshold when striped bass are fished at their *F* target and the other ERP species in the model (bluefish, spiny dogfish, weakfish, and Atlantic herring) are fished at their current levels

Monte Carlo Bootstrap (MCB) runs of the base model run from the BAM are used as the basis for the projection analysis (see main stock assessment update report for details on BAM base run and MCB runs).

Sources of Uncertainty

Single-Species Model

The projections have the same methods and assumptions as those run for the benchmark assessment. It is important to note that key uncertainties about natural mortality and fecundity are accounted for in the projections. Additionally, during the benchmark assessment (SEDAR 2020), the SAS used a new procedure for projecting recruitment. Instead of assuming a static median value for recruitment, as is done for many assessment projection methodologies and as was done in the past, recruitment was projected using nonlinear time series analysis methods (Deyle et al 2018). Nonlinear time series analysis methods project recruitment based on how recruitment has changed in the past under similar conditions. This is done for each MCB run to account for uncertainty. Thus, uncertainty is recognized in the recruitment time series and the methods used for projections adequately accounted for that uncertainty using the best scientific methods available. As usual, projections are highly uncertain and subject to model assumptions (i.e., no changes in fishing effort, seasonality of the fishery is not modeled, there is no structural model uncertainty in projections).

The assumption that the full 2023-2025 TAC would be utilized in 2024 and 2025 is also a source of uncertainty, as compliance report data indicated that only 80% of the TAC was landed in 2024. After the initial presentation of results to the TC and SAS, sensitivity runs were conducted using the 2024 bait and reduction landings from the compliance reports and assuming either (1) full utilization of the TAC in 2025, or (2) 80% utilization of the TAC in 2025.

The TC used the Commission's Retrospective Pattern Advice flowchart (ASMFC 2024) to determine whether a retrospective adjustment was warranted. The estimates of Mohn's rho for *F* (ρ=-0.09) and fecundity (ρ=0.12) were within the acceptable limits for a short-lived species. The rho values for both values were closer to zero than in the 2022 assessment update, indicating a smaller retrospective pattern in the 2025 update. The retrospectively adjusted value of fecundity was within the 90% confidence intervals of the unadjusted estimate, and all of the retrospective peels for fecundity were inside the confidence intervals of the base run. However, the adjusted value of *F* and 2 of the 3 most recent peels were outside the confidence intervals. Because *F* is not used in the projections, and because adjusting *F* would not change stock status, the TC elected not to apply a retrospective adjustment for the projections. The TC noted that the confidence intervals on *F* were extremely narrow in the 2025 update, which

likely affected the outcome of the flowchart for that metric. The TC also recommended that the Assessment Science Committee review the flowchart performance in this case and consider revising the guidance document to provide explicit guidance on situations where the recommendations for *F* and spawning stock biomass or fecundity are different.

Ecological Reference Point Model

The projections do not incorporate any uncertainty around the ERP target and threshold values, because there is not a comprehensive, quantitative way to estimate that uncertainty in the current model framework. Better quantification of uncertainty around the reference points themselves was a recommendation from the 2025 peer review panel (SEDAR 2025), but some of the uncertainty can be captured through sensitivity runs. Uncertainty in the ecological reference points includes both model uncertainty and ecosystem uncertainty. The ecosystem model was sensitive to the relationship between spiny dogfish and striped bass, and small changes in the parameters of that relationship affected striped bass's ability to rebuild to their biomass target under different combinations of striped bass and menhaden *F* rates. A sensitivity run where spiny dogfish diet composition data was adjusted to reflect the assumption that not all of the biomass estimated by the new spiny dogfish assessment was present within the ERP model domain resulted in a lower *F* target for Atlantic menhaden compared to the base run.

Uncertainty about future ecosystem conditions also contributes to uncertainty in the ERP target and threshold. For example, in the base run, it was assumed that the current low recruitment regime that Atlantic herring were experiencing at the end of the time-series would persist into the future. A sensitivity run was done where it was assumed that Atlantic herring recruitment would return to the long-term average, which resulted in a slightly higher ERP target, indicating Atlantic menhaden could experience a higher *F* rate and striped bass would remain at their biomass target when Atlantic herring were more abundant.

Results

The TACs with a 40%-60% probability of exceeding the *F* target are presented in Table 3. The probabilities of exceeding the *F* target and threshold for a range of TACs representing a 20% decrease to a 20% increase from the current TAC are presented in Table 4, and the probability of falling below the ERP fecundity target and threshold for those TACs is shown in Table 5.

Instead of providing figures for all the scenarios the Board requested, the TC provided figures of the fecundity, recruits, *F*, and landings for the current TAC (233,550 mt), a TAC of 106,100 mt (associated with a 40% probability of exceeding the *F* target in 2026), and a TAC of 280,260 mt (an increase of 20% from the status quo TAC). These three plots provide the bounds of the highest and lowest risk scenarios requested by the Board, in comparison to the status quo scenario (Figure 1 - Figure 3).

The assumption about levels of removals in 2024 and 2025 had a minimal effect on the results. The estimates of the combined year TACs that would have a 40%-60% probability of achieving the ERP *F* target for 2026-2028 were approximately 1,000-4,000 mt greater under the lower

2024-2025 removals assumptions (Table 6 - Table 7). The risk of exceeding the ERP *F* target and threshold under the status quo TAC showed at most a 1% difference in risk (Table 8).

The TACs with the 40%-60% probability of achieving the *F* target are significantly lower than the current TAC and the TACs with the same risk levels presented in 2022. This is driven largely by the change in natural mortality (*M*) in the single-species model: the lower *M* used in 2025 resulted in a lower biomass compared to the 2022 update (Figure 4)(ASMFC 2025). The time-series average of age-1+ biomass for the 2025 update with the lower M was 37% lower than the time-series average of the 2022 update. In addition, the 2022 update showed a large increase in biomass at the end of the time-series that was not present at the end of the 2025 update. As a result, the 2021 biomass that was projected forward to inform the 2023-2025 TAC options was approximately 60% higher than the 2023 biomass, which is informing the 2026-2028 TAC.

In addition, the ERP *F* target changed as a result of the benchmark assessment (SEDAR 2025): the ERP target from the 2020 benchmark was 0.19 and the ERP target from the 2025 benchmark is 0.15. Although the change in the ERP *F* target appears relatively small, it did have an impact on the scale of the projections. The probability of exceeding the ERP target for a specific TAC in Table 4 were higher for the new, lower ERP target, and the TACs required to have a 40%-60% probability of exceeding the ERP target were lower for the new ERP target. This change in the ERP target was due to both the lower estimate of menhaden biomass going into the ERP models as a result of the lower *M* in the single-species model, and also to other factors including an increase in spiny dogfish biomass estimates, refinements to other inputs like diet data, and changes to the model structure (SEDAR 2025).

In addition, it is important to note that the values for the ERP target and threshold were based on the definitions currently used in management. The Board can use the ecosystem model developed through the ERP benchmark assessment (SEDAR 2020, SEDAR 2025) to evaluate the trade-offs between predator biomass and menhaden fishing mortality under different ecosystem assumptions and consider choosing a different ERP target and threshold definition to best meet their management objectives for Atlantic menhaden. If the Board redefined the ERP target and threshold – for example, using different assumptions about the biomass levels of other species in the ecosystem in the future or about striped bass fishing mortality – the values of the reference points and the associated TACs would change.

References

Atlantic States Marine Fisheries Commission (ASMFC). 2025. Atlantic Menhaden Stock Assessment Update. Arlington, VA. 129 pp.

ASMFC. 2024. Retrospective Pattern Advice Document. Arlington, VA. 11p. Available online: https://asmfc.org/wp-content/uploads/2025/01/ASMFC_RetrospectivePatternAdviceDocument_Jan2024.pdf

Deyle, E., A.M. Schueller, H. Ye, G.M Pao, and G. Sugihara. 2018. Ecosystem-based forecasts of recruitment in two menhaden species. Fish and Fisheries 19: 769-781.

Southeast Data, Assessment, and Review (SEDAR). 2025. SEDAR 102 Stock Assessment Report – ASMFC Atlantic Menhaden and Ecological Reference Points. SEDAR, North Charleston, SC. 424 pp. Available online: https://sedarweb.org/assessments/sedar-102-asmfc-atlantic-menhaden/

Tables

Table 1. History of Atlantic menhaden TAC levels.

TAC Period	TAC (mt)
2013-2014	170,800
2015-2016	187,880
2017	200,000
2018-2020	216,000
2021-2022	194,400
2023-2025	233,550

Table 2. Allocation of the coastwide Atlantic menhaden TAC by state, as set by Addendum I to Amendment 3.

State	Allocation (%)
ME	4.80%
NH	1.19%
MA	2.12%
RI	0.81%
CT	0.33%
NY	0.84%
NJ	11.00%
PA	0.01%
DE	0.27%
MD	1.17%
PRFC	1.09%
VA	75.21%
NC	0.37%
SC	0.25%
GA	0.25%
FL	0.29%

Table 3. The TACs associated with a 40-60% probability of exceeding the ERP F target for 2026-2028 combined and as separate years. For the combined years, the TAC is chosen such that the probability of exceeding the F target for 2026-2028 is no greater than the specified percent in any one year.

Probability of exceeding the ERP F Target	TAC for 2026-2028	2026 TAC	2027 TAC	2028 TAC
40%	106,100	106,100	111,800	120,900
45%	107,400	107,400	113,500	123,000
50%	108,450	108,450	115,300	124,800
55%	109,700	109,700	117,000	127,200
60%	111,000	111,000	119,200	129,700

Table 4. Percent risk of exceeding the ERP *F* target and ERP *F* threshold for different TAC projections.

TAC (Status quo -/+)	Probability of Exceeding the ERP *F* Target			Probability of Exceeding the ERP *F* Threshold		
	2026	**2027**	**2028**	**2026**	**2027**	**2028**
186,840 (-20%)	100%	100%	100%	0%	0%	0%
198,518 (-15%)	100%	100%	100%	0%	0%	0%
210,195 (-10%)	100%	100%	100%	0%	1%	1%
221,872 (-5%)	100%	100%	100%	0%	1%	1%
233,550 (0%)	100%	100%	100%	1%	4%	4%
245,228 (+5%)	100%	100%	100%	1%	10%	8%
256,905 (+10%)	100%	100%	100%	4%	18%	14%
268,583 (+15%)	100%	100%	100%	11%	29%	23%
280,260 (+20%)	100%	100%	100%	22%	41%	32%

Table 5. Percent risk of falling below the ERP fecundity target and ERP fecundity threshold for different TAC projections.

TAC (Status quo -/+)	Probability of Falling Below the ERP Fecundity Target			Probability of Falling Below the ERP Fecundity Threshold		
	2026	2027	2028	2026	2027	2028
186,840 (-20%)	52%	52%	46%	2%	4%	4%
198,518 (-15%)	52%	54%	49%	2%	4%	5%
210,195 (-10%)	52%	56%	51%	2%	5%	5%
221,872 (-5%)	52%	58%	54%	2%	6%	7%
233,550 (0%)	52%	59%	57%	2%	6%	8%
245,228 (+5%)	52%	61%	59%	2%	7%	9%
256,905 (+10%)	52%	62%	61%	2%	8%	10%
268,583 (+15%)	52%	64%	64%	2%	8%	12%
280,260 (+20%)	52%	66%	66%	2%	9%	13%

Table 6. Sensitivity run results showing the TACs associated with a 40-60% probability of exceeding the ERP *F* target for 2026-2028 for the scenario using 2024 landings from compliance reports and assuming full utilization of the TAC in 2025.

Probability of exceeding the ERP F Target	TAC for 2026-2028	2026 TAC	2027 TAC	2028 TAC
40%	107,100	107,100	111,900	120,900
50%	109,500	109,500	115,500	124,800
60%	112,200	112,200	119,600	129,700

Table 7. Sensitivity run results showing the TACs associated with a 40%-60% probability of exceeding the ERP *F* target for 2026-2028 for the scenario using 2024 landings from compliance reports and assuming 80% utilization of the TAC in 2025.

Probability of exceeding the ERP F Target	TAC for 2026-2028	2026 TAC	2027 TAC	2028 TAC
40%	110,200	110,200	112,900	120,900
50%	112,600	112,600	116,600	124,900
60%	115,100	115,100	120,300	129,700

Table 8. Sensitivity run results showing the percent risk of exceeding the ERP *F* target and ERP *F* threshold for status quo TAC projections under different assumptions about 2024 and 2025 removals.

Assumption for 2024 and 2025 Removals	Probability of Exceeding the ERP Target			Probability of Exceeding the ERP Threshold		
	2026	2027	2028	2026	2027	2028
2024 & 2025 = full TAC utilization	100%	100%	100%	1%	4%	4%
2024 = compliance report data 2025 = full TAC utilization TAC	100%	100%	100%	1%	4%	4%
2024 = compliance report data 2025 = 80% TAC utilization	100%	100%	100%	0%	3%	3%

Figures

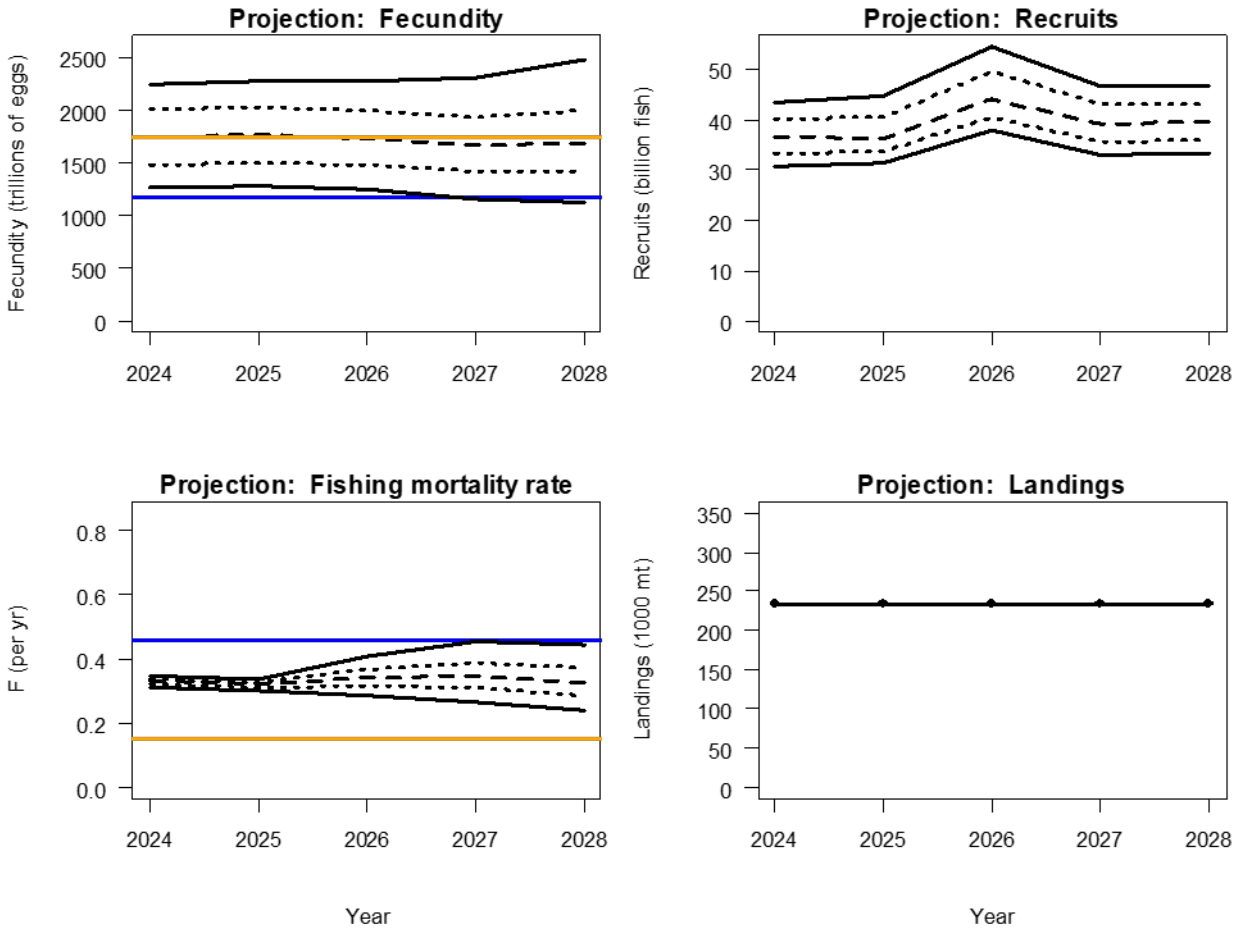

Figure 1. Fecundity, full fishing mortality rate, and recruits projected from 2024 to 2028 for a coastwide total allowable catch of 233,550 mt. The orange lines represent ERP target fishing mortality rate and fecundity, while the blue lines represent the ERP threshold fishing mortality rate and fecundity. The dashed black line is the 50th percentile (median), the dotted black lines are the 25th and 75th percentiles, and the solid black lines are the 5th and 95th percentiles.

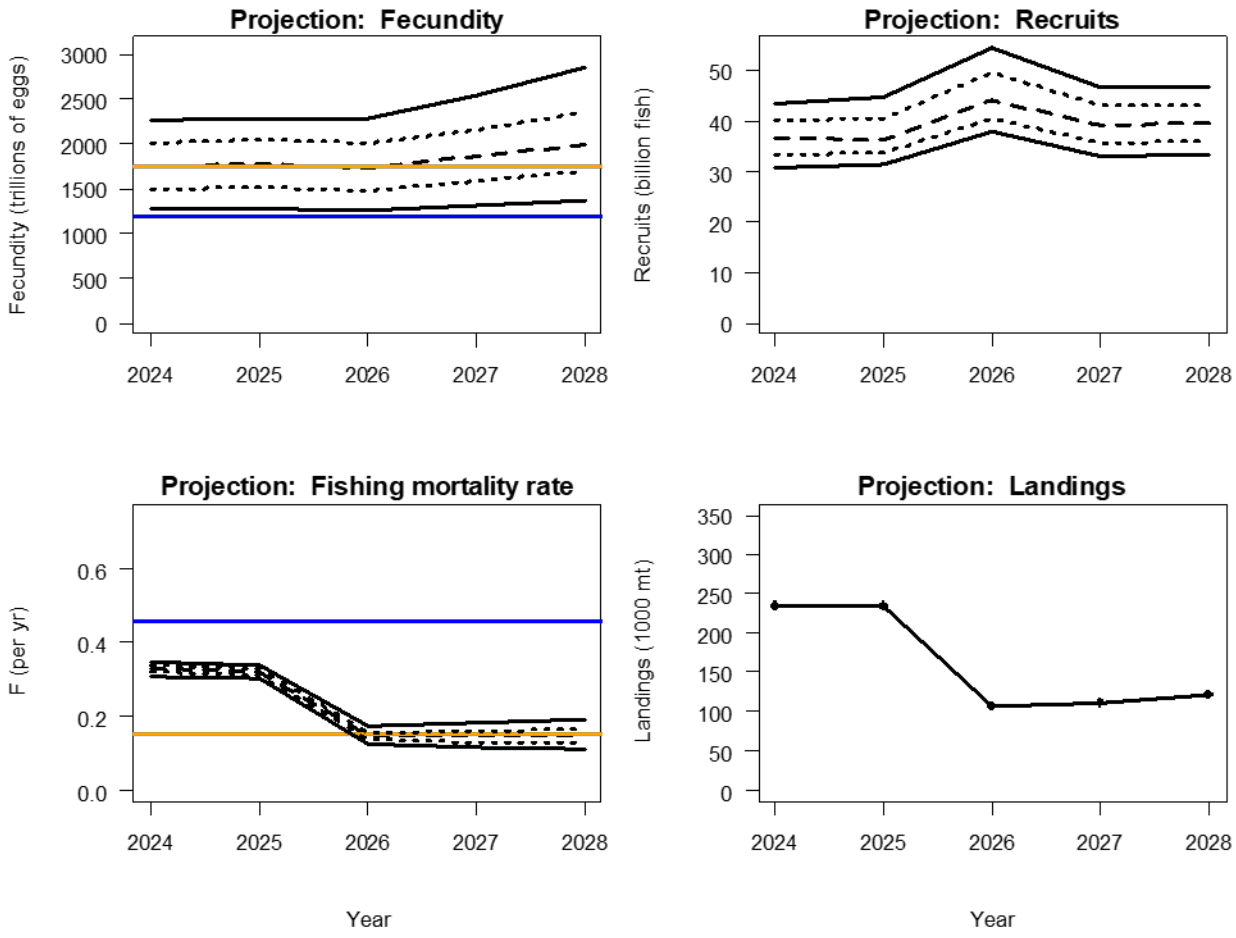

Figure 2. Fecundity, full fishing mortality rate, and recruits projected from 2024 to 2028 for a coastwide total allowable catch with a 40% probability of exceeding the ERP *F* target (106,100 mt). The orange lines represent ERP target fishing mortality rate and fecundity, while the blue lines represent the ERP threshold fishing mortality rate and fecundity. The dashed black line is the 50th percentile (median), the dotted black lines are the 25th and 75th percentiles, and the solid black lines are the 5th and 95th percentiles.

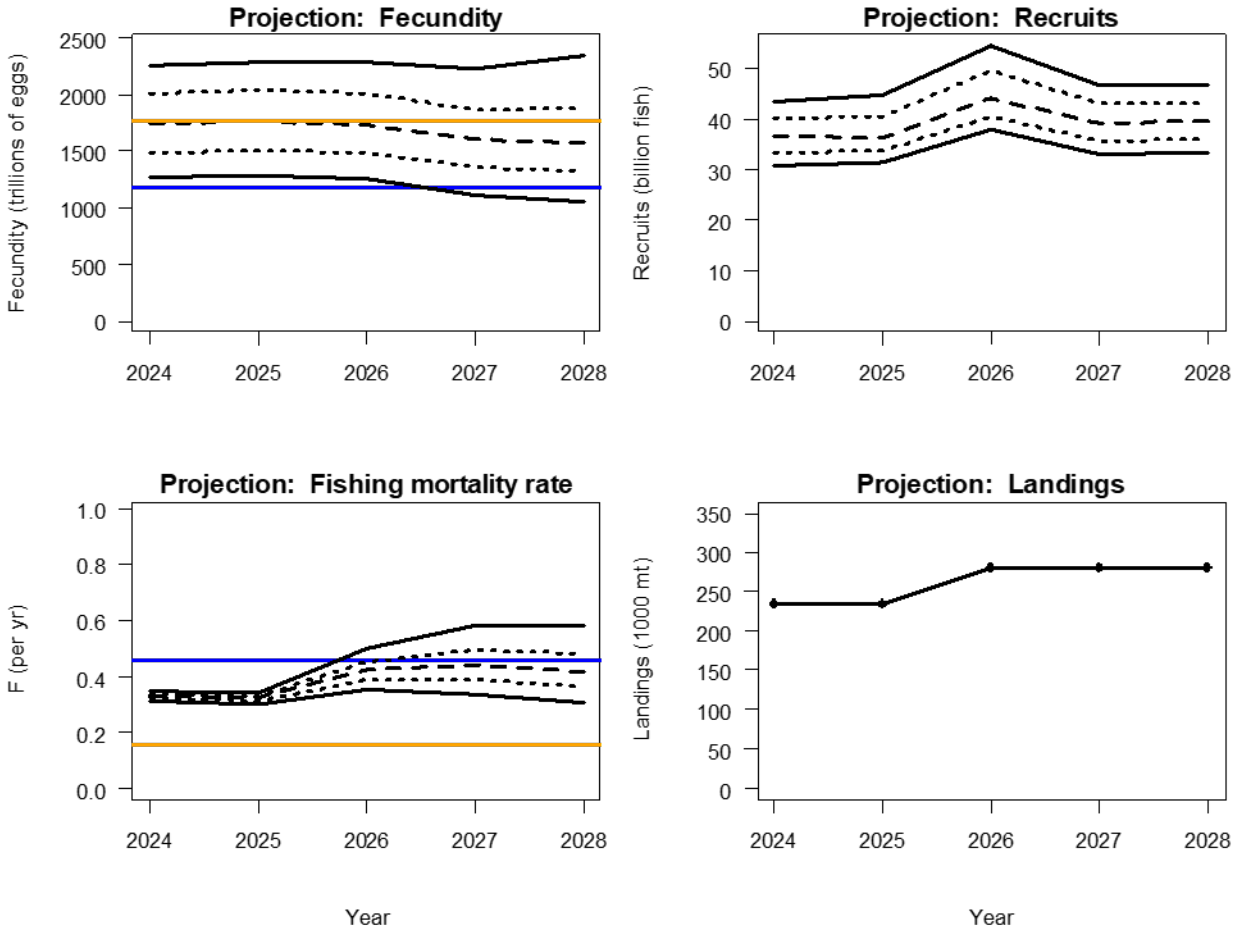

Figure 3. Fecundity, full fishing mortality rate, and recruits projected from 2024 to 2028 for a 20% increase to the coastwide total allowable catch (280,260 mt). The orange lines represent ERP target fishing mortality rate and fecundity, while the blue lines represent the ERP threshold fishing mortality rate and fecundity. The dashed black line is the 50th percentile (median), the dotted black lines are the 25th and 75th percentiles, and the solid black lines are the 5th and 95th percentiles.

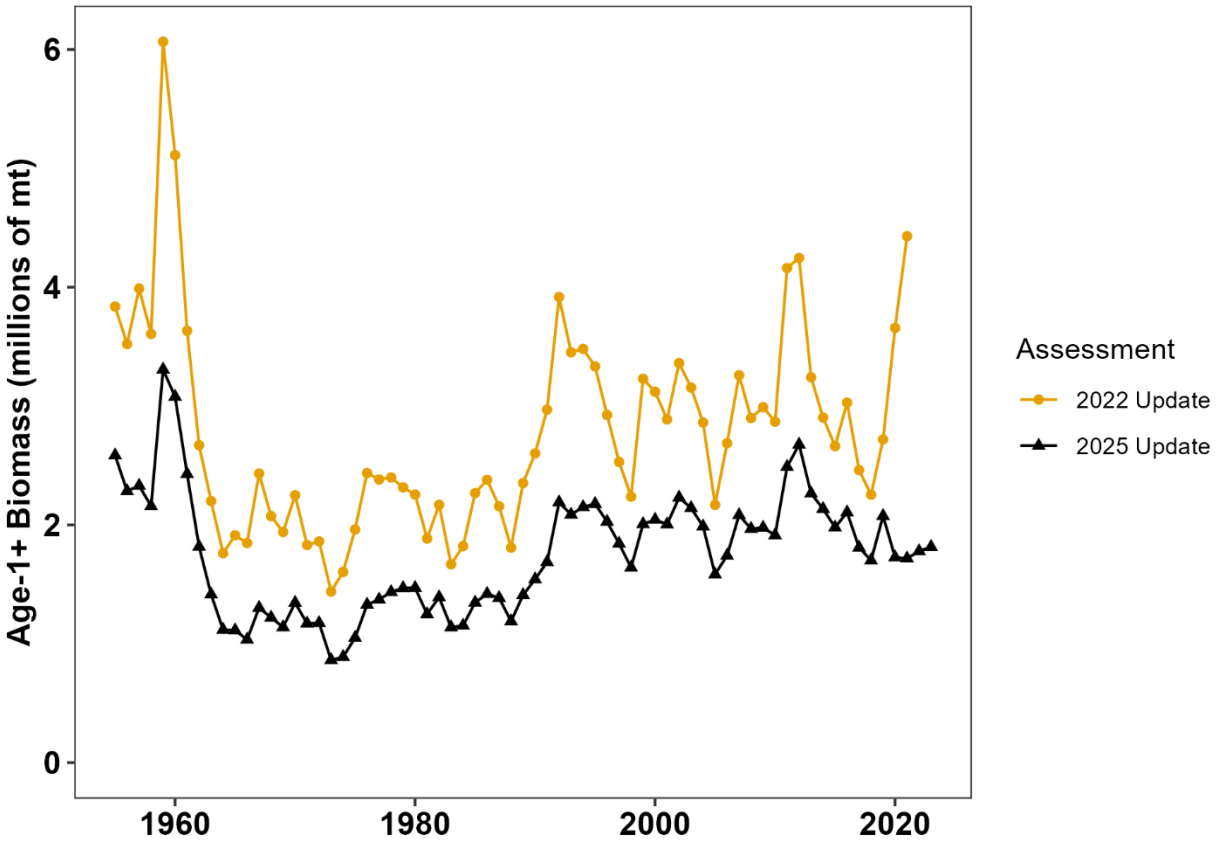

Figure 4. Age-1+ biomass estimates from the 2022 update and the 2025 update of the Atlantic menhaden single-species assessment model.