Atlantic States Marine Fisheries Commission

1050 N. Highland Street • Suite 200A-N • Arlington, VA 22201
703.842.0740 • 703.842.0741 (fax) • www.asmfc.org

MEMORANDUM

TO: Atlantic Menhaden Management Board

FROM: Atlantic Menhaden Technical Committee

DATE: October 20, 2022

SUBJECT: Stock Projection Memo

The Atlantic Menhaden Management Board (Board) will discuss the 2023-2025 total allowable catch (TAC) for Atlantic menhaden at its November 2022 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 2023 by the Annual Meeting, next year's TAC will automatically be set at the level of the 2022 TAC (194,400 mt). Since the implementation of coastwide quota management the TAC has been set at the following levels: 170,800 metric tons (2013–2014); 187, 880 metric tons (2015–2016); 200,000 metric tons (2017); 216,000 metric tons (2018–2020); and 194,400 metric tons (2021-2022).

At the August 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 2023-2025 combined and as separate years.
- The percent risk of exceeding the ERP target and threshold if the current TAC was changed by -10% to +10% in 5% increments, including 0% (the current TAC).

This memo outlines the methods for the projections and the results of the analysis 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
- **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.

Monte Carlo Bootstrap (MCB) runs of the base model run from the BAM are used as the basis for the projection analysis (see stock assessment update report for details on BAM base run and MCB runs; ASMFC 2022).

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).

An additional source of uncertainty that is not fully captured by the MCB approach is the retrospective pattern in the update (ASMFC 2022), as well as the potential impacts of the 2020 and 2021 data issues on the terminal year estimates of abundance. The TC noted that the retrospective analysis in the update showed a more consistent pattern of underestimating *F* and overestimating fecundity in the terminal year of the assessment compared to the benchmark assessment. The NEFSC (Legault 2020) and ICES (2020) provide recommendations about when to adjust for a retrospective pattern in projections for management use. The NEFSC uses adjusted estimates of abundance-at-age in projections when the retrospectively adjusted terminal year estimates of spawning stock biomass and *F* are outside the 90% confidence intervals of the unadjusted estimates (Legault 2020). ICES recommends adjusting projections for short-lived species, like menhaden, if the Mohn's rho value for spawning stock biomass is greater than 0.3 or the Mohn's rho value for *F* is less than -0.22, or if two of three or three of five peels fall outside the confidence intervals of the terminal year run (ICES 2020). For menhaden, the NEFSC guidelines indicated an adjustment was appropriate and the ICES guidelines indicated it was not necessary. The TC elected not to adjust the projections for the retrospective pattern, due to the conflicting advice given by the NEFSC and ICES guidelines and the lack of formal ASMFC guidance, as well as the uncertainty as to whether the retrospective pattern would persist in the future to the same degree or direction. However, the TC does note this as a source of uncertainty that is not well quantified in the projections, and the Board may wish to adjust their risk tolerance accordingly. In addition, the TC recommended that the issue of retrospective adjustments be looked at more thoroughly by the Commission's Assessment Science Committee so that consistent guidelines can be established for all of the Commission's assessments.

Results

One of the Board requests was to provide TACs that have a 40%-60% probability of exceeding the ERP target, in 5% increments, using 2023-2025 combined and as separate years. For the

projections using 2023-2025 as separate years, a TAC has been calculated to provide a TAC that does not exceed the level of risk for any year, or the lower of the three TACs provided in Table 1. The second request from the Board was to calculate the percent risk of exceeding the ERP target and threshold if the current TAC was changed by -10% to +10% in 5% increments. The results are presented in Table 2. Additionally, the TC notes that a TAC in 2023 does affect the TAC in 2024 and 2025 and therefore a value may not have the same associated risk in Tables 1 and 2.

Instead of providing figures for all the of scenarios the Board requested, the TC provided figures of the fecundity, recruits, full fishing mortality rate (*F*), and landings for the current TAC, a TAC of 174,960 mt (10% decrease to TAC), and the scenario where the risk of exceeding the ERP target in 2023- 2025 was 60% (Figures 1-3). These three plots provide the bounds of the highest and lowest risk scenarios in addition to the current TAC (194,400 mt).

References

Atlantic States Marine Fisheries Commission (ASMFC). 2022. Atlantic Menhaden Stock Assessment Update. Arlington, VA. 135 pp.

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.

ICES. 2020. Workshop on Catch Forecast from Biased Assessments (WKFORBIAS; Outputs from 2019 Meeting). ICES Scientific Reports. 2:28. 38 pp. Available online at: https://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/Fisheries%20Resources%20Steering%20Group/2020/WKFORBIAS_2019.pdf

Legault, C.M. 2020. Rose vs. Rho: a comparison of two approaches to address retrospective patterns in stock assessments. ICES Journal of Marine Science 77: 3016–3030. Available online at: https://academic.oup.com/icesjms/article/77/7-8/3016/5986648

Southeast Data, Assessment, and Review (SEDAR). 2020. SEDAR 69 - Atlantic Menhaden Single-Species Benchmark Stock Assessment and Peer Review Report. SEDAR, North Charleston, SC. 691 pp.

Table 1. The TACs associated with a 40-60% probability of exceeding the ERP target (0.19) for 2023-2025 combined and as separate years.

Probability of Exceeding the ERP Target	TAC for 2023-2025	TAC for 2023	TAC for 2024	TAC for 2025
40%	259,500	290,900	271,100	259,500
45%	270,500	303,800	281,800	270,500
50%	284,600	318,600	294,100	284,600
55%	301,000	335,100	308,200	301,000
60%	326,500	350,200	326,500	329,700

Table 2. Percent risk of exceeding the ERP target (0.19) and ERP threshold (0.57) for five different total allowable catch (TAC) projections.

TAC	Probability of Exceeding ERP Target			Probability of Exceeding ERP Threshold		
	2023	2024	2025	2023	2024	2025
174,960 mt (-10%)	0%	0%	2%	0%	0%	0%
184,680 mt (-5%)	0%	1%	3%	0%	0%	0%
194,400 mt (current TAC)	0%	1%	6%	0%	0%	0%
204,120 mt (+5%)	0%	4%	10%	0%	0%	0%
213,840 mt (+10%)	0%	8%	14%	0%	0%	0%

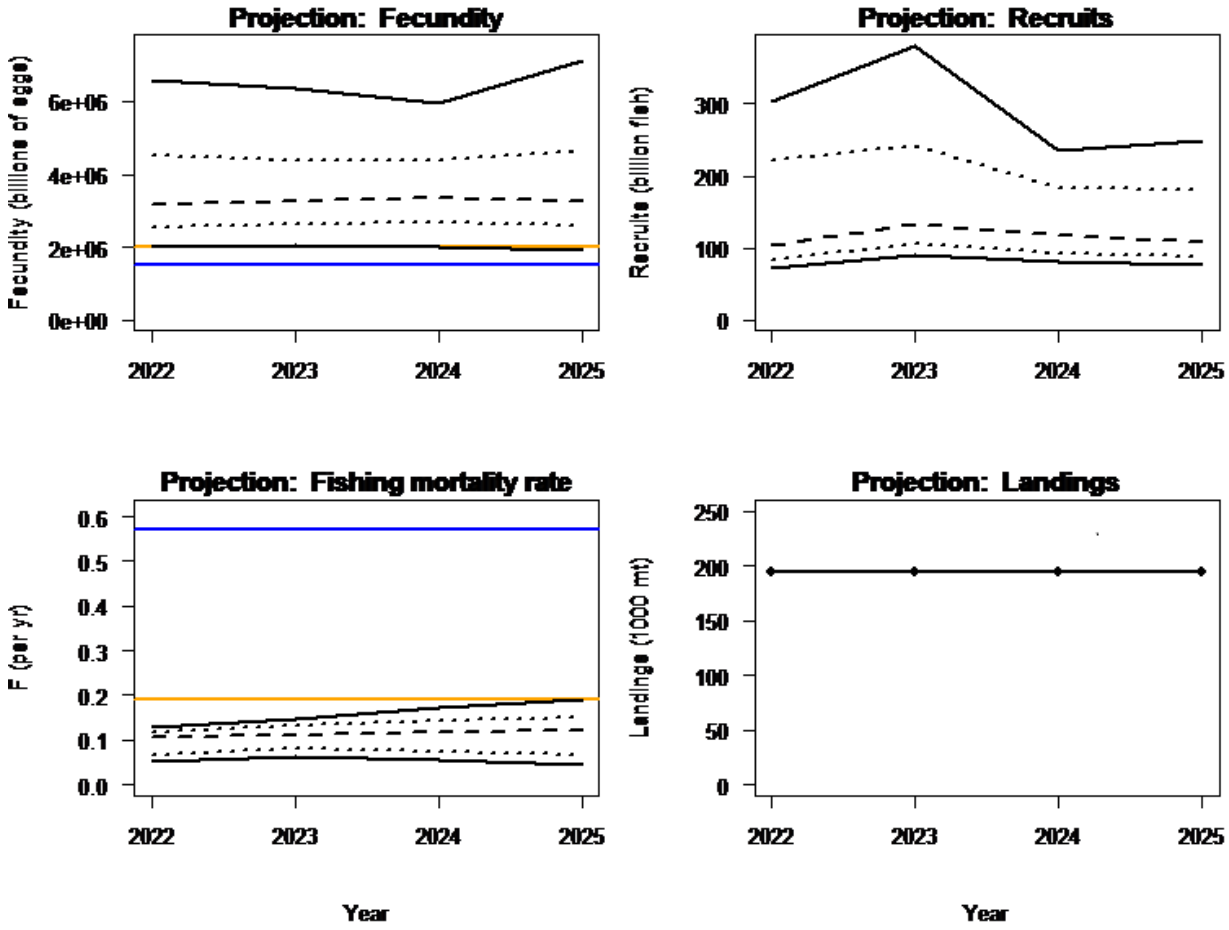

Figure 1. Fecundity, recruits, full fishing mortality rate, and landings for projections done with the current TAC of 194,400 mt. The blue lines indicate the ERP thresholds and the orange lines indicate the ERP targets. The dashed black line is the 50th percentile (median), the dotted black lines are the 25th and 75th percentiles, and the solid black lines are the 5th and 95th percentiles.

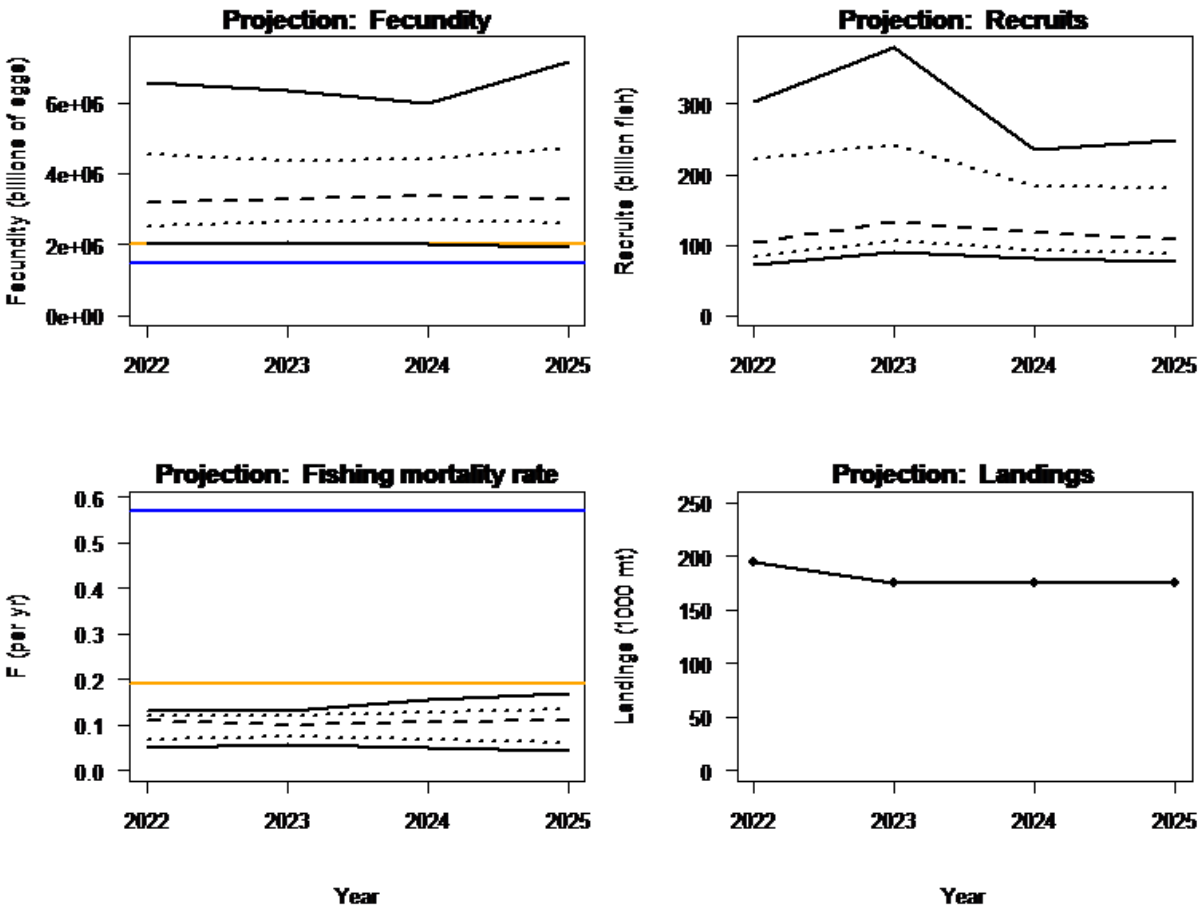

Figure 2. Fecundity, recruits, full fishing mortality rate, and landings for projections done with a TAC of 174,960 mt, representing a 10% decrease to the current TAC. The blue lines indicate the ERP thresholds and the orange lines indicate the ERP targets. The dashed black line is the 50th percentile (median), the dotted black lines are the 25th and 75th percentiles, and the solid black lines are the 5th and 95th percentiles.

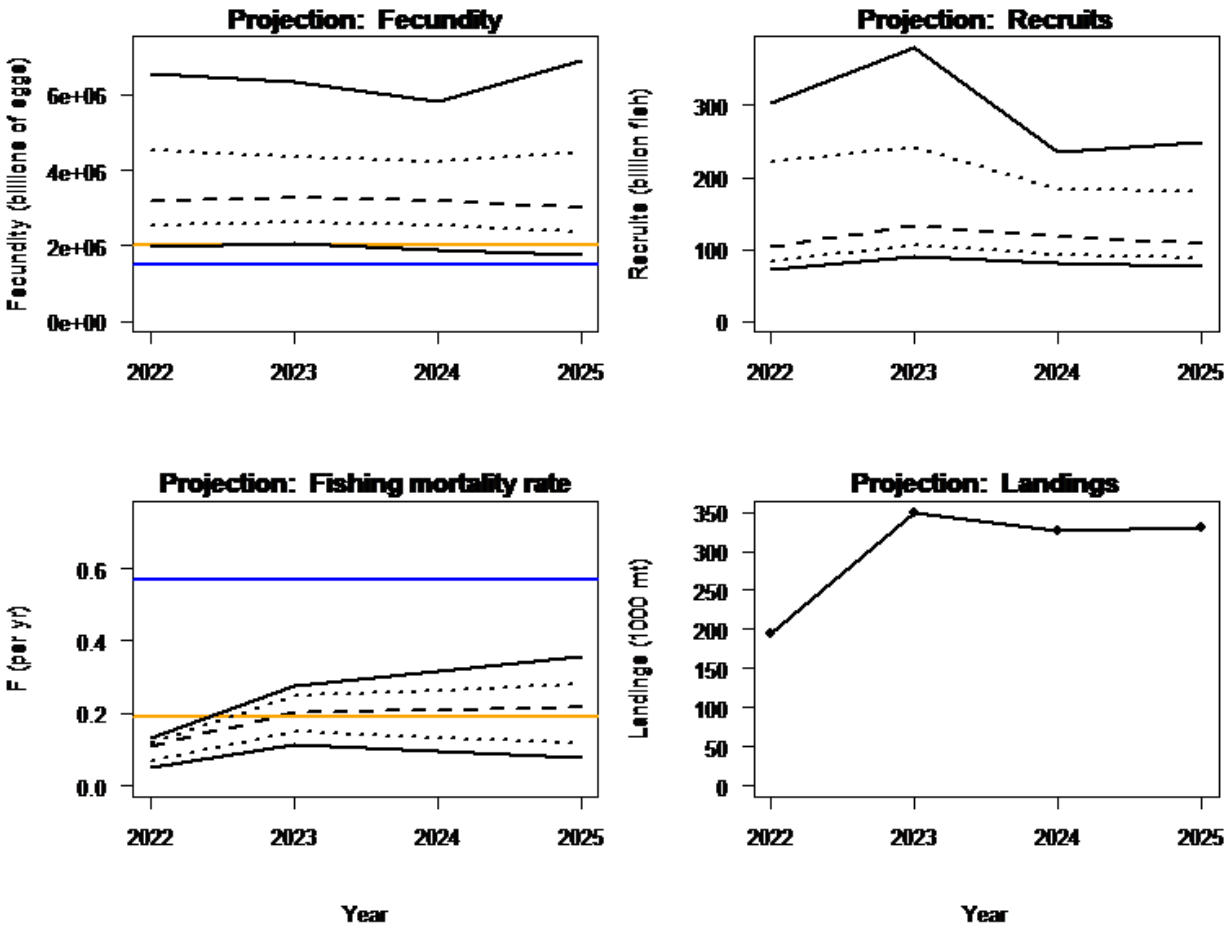

Figure 3. Fecundity, recruits, full fishing mortality rate, and landings for projections that result in a 60% risk of exceeding the ERP target in 2023-2025. The blue lines indicate the ERP thresholds and the orange lines indicate the ERP targets. The dashed black line is the 50th percentile (median), the dotted black lines are the 25th and 75th percentiles, and the solid black lines are the 5th and 95th percentiles.