Center for Independent Experts (CIE) Independent Peer Review Report

on

Atlantic Menhaden Ecological Reference Point Stock Assessment Peer Review

August 12 - 15, 2025

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I. Executive Summary

The Atlantic Menhaden Ecological Reference Points (ERP) Stock Assessment Peer Review was held in person in Charleston, SC from August 12-15, 2025. The CIE review aimed to provide an independent external peer review evaluating whether a pre-defined set of Terms of Reference was addressed to ensure that the ecological reference point stock assessment provides the best available information to inform management decisions. The Southeast Data, Assessment and Review (SEDAR) and Atlantic States Marine Fisheries Commission (ASMFC) provided the necessary logistics support, review reports and relevant documentation, presentation slides, and background information for the review. The Ecological Reference Point Working Group (WG) was open to suggestions and provided additional information and analyses upon request during the review. The review process was transparent and constructive. I would like to commend the effort of the WG for continuing to improve models and the modeling process to estimate ecological reference points and projections; evaluating the quality and quantity of model input data for the relevant single species assessments and Ecopath with Ecosim (EwE) models; considering ecological drivers in developing model configurations and parameterizations to identify the base-case model, and identifying major sources of the uncertainty associated with input data and model configuration.

The 2025 ERP Assessment Review was a non-typical stock assessment in many ways. It was not common because it covered the stock assessments of several species and used a hybrid approach that combined an ecosystem model with a traditional single species model (BAM) to estimate ERPs. The WG proposed a modeling framework to develop and apply the ERPs for catch advice and stock status determination.

As a CIE reviewer, I evaluated the Atlantic Menhaden Ecological Reference Point Stock Assessment with respect to the pre-defined Terms of Reference. Overall, I believe the MICE-BAM models used in the Atlantic Menhaden Ecological Reference Point Stock Assessment provide robust analytic tools for assessment and projection of Atlantic Menhaden and the stock dynamics of their key predators with respect to various uncertainties in data and models. I conclude that the 2025 ERP Assessment yields robust results, especially regarding the various uncertainties in model input data and model configuration/parameterization. The modeling approach recommended by the WG is sound and the results of the base-case run appear to be scientifically sound and adequately address management needs with menhaden being considered as an important forage species in the ecosystem.

However, I believe that there is room for further improvement. I would like to make the following recommendations: (1) continue coding and fully document model input data processing, balancing, and tuning protocols along with standard measures for model diagnostics and criteria for selection of sensitivity runs to ensure fully repeatable and transparent operational assessment; (2) continue and expand seasonal, spatial, and taxonomic collection of population abundance/biomass, life history, and diet data for both managed fish species and functional groups; (3) better coordinate the relevant single species stock assessments and ERP assessment to ensure the availability of updated data from the single species assessments for the ERP assessment; (4) develop a workshop with managers and stakeholders similar to the 2015 EMO workshop to determine clear objectives for a potential spatial ERP assessment; (5) develop a

suite of sensitivity runs once the base-case model is determined; (6) evaluate NWACS_MICE model sensitivity to prey switching parameters in the absence of actual data and/or evaluate food habit data (or other existing data sets) to identify possible prey switching in the ecosystem; (7) continue evaluating NWACS-MICE behavior with different forcing functions; (8) develop clear objectives and utilities for the NWACS-FULL model and coordinate the development and fitting of the NWACS-MICE and NWACS-FULL models; and (9) develop age data from the menhaden fishery independent surveys to inform M estimates.

II. Background

Atlantic menhaden (*Brevoortia tyrannus*), a filter feeder consuming phytoplankton and zooplankton, is a key forage fish species found along the Northwest Atlantic coast from Nova Scotia to northern Florida with the majority of the population distributed between Maine and North Carolina. Atlantic Menhaden play a crucial role in linking plankton to higher trophic levels. Juveniles grow rapidly in estuarine habitats and reach sexual maturity at age 1 or 2. Atlantic menhaden have a lifespan of up to 10–12 years, but few live that long due to heavy predation and fishing pressure.

Atlantic menhaden spawns primarily between October and March, peaking from December to February in offshore waters along the U.S. East Coast, especially from the Carolinas to Florida. Females produce hundreds of thousands to millions of eggs per season with eggs hatching within 2–4 days. Larvae are then transported by currents to estuarine nursery areas. Adults return offshore and are often found in large schools near the coast. Atlantic menhaden are highly tolerant of a range of salinities and temperatures and are often found in hypoxic (low oxygen) environments that other fish avoid.

Atlantic menhaden support one of the largest volume fisheries on the U.S. East Coast. They are primarily harvested for the reduction fishery, ground into fishmeal and fish oil used in animal feed, aquaculture, and dietary supplements, and the bait fishery, used for lobster, crab, and sport fishing. They are mostly caught using purse seines by large industrial fleets, especially in Virginia, home to the largest menhaden processing plant in North America.

Atlantic menhaden are managed by the Atlantic States Marine Fisheries Commission (ASMFC) using total allowable catch (TAC). Ecosystem-based management has been implemented to account for their role as forage for predators (e.g., striped bass, Atlantic bluefish, weakfish, ospreys, and marine mammals). Management has recently moved toward ecological reference points that consider predator needs.

Atlantic menhaden have been assessed with conventional single-species stock assessment models in SEDAR 20 (2010–2012) and SEDAR 40 (2014). SEDAR 69 (2019) was the latest prior benchmark assessment, which began to incorporate ecological reference points (ERPs) followed by an update in 2022. The current SEDAR 102 is a benchmark stock assessment specifically for Atlantic Menhaden with a focus on incorporating and evaluating ERPs. It includes Data & Methods Workshops held in October 2023 and November 2024, Assessment Workshops held in March 2025, and the current Review Workshop held August 12–15, 2025.

As a CIE reviewer, I was asked to evaluate the Atlantic Menhaden Ecological Reference Point Stock Assessment with respect to the Terms of Reference provided by the CIE. This report was prepared following the required format, including an executive summary (Section I), a background introduction (Section II), a description of my role in the review activities (Section III), my comments on each item listed in the Terms of Reference (ToRs, Section IV), a summary of my comments and recommendations (Section V), and references (Section VI). The final part of this report (Section VII) includes a collection of appendices, including the Statement of Work (SoW).

III. Description of the Individual Reviewer's Role in the Review Activities

My role as a CIE independent reviewer was to conduct an impartial and independent peer review of the Atlantic Menhaden Ecological Reference Point Stock Assessment with respect to the pre-defined Terms of Reference. About two weeks prior to the in-person review workshop in Charleston, SC, the Benchmark Assessment Report and supporting working papers and background information were provided to the reviewers on the SEDAR report portal (https://sedarweb.org/assessments/sedar-102-asfmc-atlantic-menhaden/). I downloaded all the materials for the Atlantic Menhaden Ecological Reference Point Stock Assessment, and read all the relevant documents provided (see the list in Appendix I). I also collected and read references relevant to the topics covered in the reports and the SoW prior to my trip for the review.

The in-person CIE review workshop was held from August 12 to 15, 2025 in Charleston, SC (see Appendix II for the schedule). The review was chaired by Dr. Sarah Gaichas and attended by scientists, managers, and other stakeholders in person or online from various institutions (see the List of Participants in Appendix III).

Presentations were given during the four days of review to provide the CIE reviewers with the relevant information. I was actively involved in the discussions during the presentations by questioning and making comments and suggestions. I also discussed relevant issues with fellow reviewers.

IV. Summary of Findings

My detailed comments on each item of the TORs are provided under their respective subtitles from the TORs (see below).

ToR 1. Evaluate the justification for the inclusion, elimination, or modification of data from the Atlantic menhaden single-species assessment and the single-species assessments of the other major predator and prey species included in the ERP models.

I concluded that this TOR was adequately addressed.

The WG compiled and conducted a comprehensive review of the data from the Atlantic menhaden single species assessment and the single species assessment of the other major predator and prey species included in the ERP models.

Overall, the use of the data is consistent with those estimated in the single-species stock assessment for Atlantic Menhaden and their predator species and is well justified in the ERP models. However, a large source of uncertainty is recreational data – MRIP will adjust catch data in 2026-2027, which may introduce large changes in total removal for some species (e.g., striped bass and Atlantic bluefish), resulting in changes of unknown magnitudes in the estimation of key stock dynamics such as stock biomass, recruitment and fishing mortality.

Menhaden natural mortality M in this assessment was estimated using tagging data in the late 1960s. A comparative study evaluated M estimates from different models (Liljestrand et al. 2019a, b; Ault et al. 2023). The WG evaluated all the available information and identified factors (e.g., spatial coverage, potential missing data, use of confidential data, different methods to estimate magnet tag efficiency) that may influence the analysis. Although the estimated M from this exercise was for the late 1960s and the current M may differ due to ecosystem changes, it still represents the best available information for the estimation of the menhaden M. Aging data are currently unavailable for the survey, but if collected they would provide information to validate and potentially revise M.

The use of fishery-dependent and fishery-independent (e.g., adult and YOY abundance indices) data in the stock assessment of menhaden and other ERP species is also well justified. One possible source of uncertainty for these data sets is changes in stock availability to the surveys. However, some of these uncertainties may have been accounted for by the data standardization in the stock assessment.

Maturity and fecundity were assumed to vary by age and time for menhaden and some ERP species, which is well justified, given the evident changes in the life history for these species.

Menhaden selectivity differs between reduction (large sizes) and bait (medium sizes) fisheries, as determined by an analysis of size composition data, reflecting the best available information. However, changing distributions and fishing grounds because of changing processing facility, regulations, and stock distributions may affect fishery selectivity, which may be a source of uncertainty in the menhaden stock assessment.

The three regional abundance indices derived in the menhaden stock assessment tend to have different temporal trends, showing a lack of regional coherence in stock dynamics. This may indicate large spatial variability in menhaden population dynamics and the importance of considering finer spatial scales data. The ratio of R/SSB is low prior to the 1970s, high between 1970 and 1990s, followed by low levels after 2000 (Fig. 1). This may result from relatively constant SSB and large fluctuations in recruitment, indicating large change in menhaden productivity (i.e., survival rates in early life history stages varied greatly, likely affected by biotic and abiotic environmental drivers). These spatio-temporal non-stationary changes have not been explicitly considered in the menhaden stock assessment, which may be a key source of uncertainty in the menhaden stock assessment.

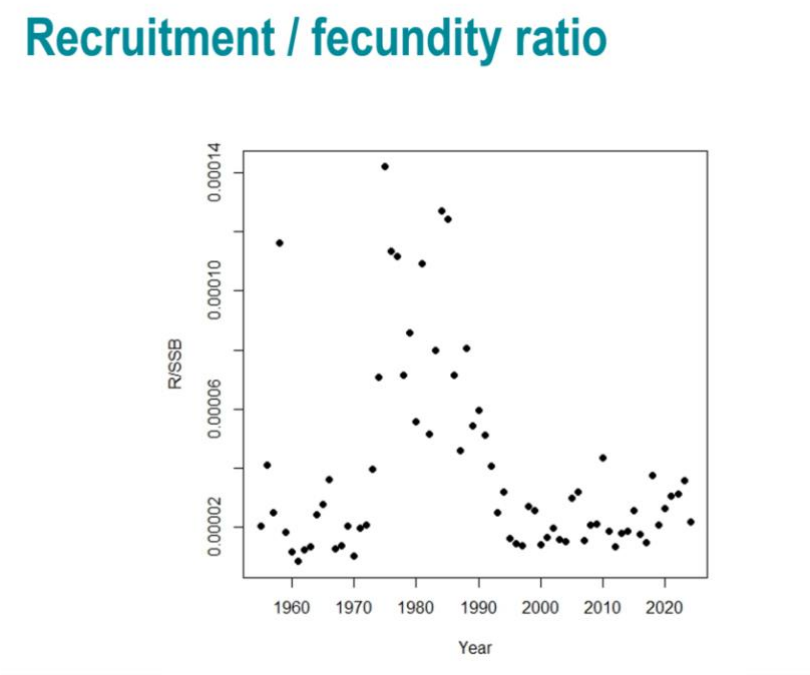

Figure 1. Changes in the Recruitment/Fecundity ratios over time. Fecundity is a measure of egg production.

The data used in the EwE for other ERP species were from relevant peer-reviewed single-species stock assessment except for weakfish. Weakfish data used in the ERP assessment departed from its single-species stock assessment, with M scaled to higher mortality, based on a tagging study and EwE performance, which is well justified.

Overall, for all ERP species, data used for the EwE models, although having uncertainty of various sources and nature, reflect the best available information.

ToR 2. Evaluate the thoroughness of data collection and the presentation and treatment of additional fishery-dependent and fishery-independent data sets in the assessment, including but not limited to:
a. Presentation of data source variance (e.g., standard errors).
b. Justification for inclusion or elimination of available data sources,
c. Consideration of data strengths and weaknesses (e.g., temporal and spatial scale, gear selectivities, aging accuracy, sample size),
d. Calculation and/or standardization of abundance indices.

Overall, I concluded that this TOR was adequately addressed.

This review focuses on the ERP stock assessment that is developed based on the assessment for the ERP species and other functional groups in the EwE model. The fishery-dependent and

fishery-independent data used in the ERP assessment have been previously reviewed and justified, and reflect the best available information for this ERP assessment. The WG consulted with each ERP species stock assessment team for the use of these data in the EPR models.

The WG identified and evaluated the major sources of uncertainty for all the data used in the ERP assessment. For both fishery-dependent and fishery-independent data sets, uncertainty within the monitoring programs was well evaluated and described. The uncertainty quantification is also well justified. However, I believe the limitation of spatial coverage, possible impacts of climate induced change in fish movement phenology and subsequent impacts on survey consistency and data comparability need to be more carefully evaluated and quantified. Possible hyperstability in recreational CPUE data was not considered in the assessment. The WG presented additional available information on potential changes in the center of gravity for bluefish and spiny dogfish, with spatial distribution of other species not fully analyzed. I recommend that the WG explore joint species distribution models (JSDM) to evaluate relative changes in fish species distributions over time, in particular the key species included in the EwE models, which can have significant impacts on their trophic interactions. The JSDM can be informative in evaluating possible spatio-temporal overlapping of key functional groups in the NWACS-MICE and NWACS-FULL models.

In addition to the ERP species and their relevant functional groups, the WG also presented the approaches used to derive the input data for the two EwE models (i.e., NWACS-MICE and NWACS-FULL Models) for other functional groups including benthic invertebrates, updated time series of anchovy biomass, zooplankton, phytoplankton, marine mammal, blue catfish, bluefin tuna, and osprey. I conclude that the relevant approaches the WG took are scientifically sound and the resulting input data for the two EwE models reflect the best available information. However, most of these functional groups are data-poor or data-limited, and the biomass/abundance data were derived with some assumptions that may not be realistic, resulting in these data for the ERP models being relatively poor. For example, annual biomass of anchovies, an important unassessed forage functional group, was estimated by integrating survey datasets and habitat information using a species distribution model. This, however, implicitly assumes the survey catchability/selectivity is stationary over time and space, which may not be realistic given the survey is a bottom trawl survey and anchovies are pelagic species and likely have large inter-annual variations in their distributions. Zooplankton and phytoplankton time series were developed from existing surveys and global ocean model reanalysis data, respectively. Historical benthic datasets were analyzed to produce updated input biomass for benthic invertebrates, which may have issues of data quality.

The WG conducted a comprehensive analysis and compilation of diet data in the ERP assessment. I found the analysis to be thorough, adequate, and justified. Building on the 2020 ERP assessment, the WG expanded diet data sources by evaluating and analyzing existing data sources and a comprehensive literature review. These diet data were used to identify key predator species of menhaden and generate diet composition matrix for the two NWACS EwE models. The WG quantified the diet data uncertainty by resampling diets and fitting the sampled data to a Dirichlet multinomial function. I believe the approach used to derive the diet data, which are one of the most important input data for the NWACS-MICE and NWACS-FULL EwE models, is robust and reflects the best available information. The exclusion of bluefin tuna,

marine mammal and osprey from the NWACS-MICE model is well justified with an evaluation of their menhaden consumption, data quality and quantity and management relevance to ASMFC. The exclusion of the blue catfish functional group from both models is also well justified because of low spatial overlapping with menhaden and low menhaden consumption.

ToR 3. Evaluate the methods and models used to estimate Atlantic menhaden population parameters (e.g., F, biomass, abundance) that take into account Atlantic menhaden's role as a forage fish, including but not limited to:

a. Evaluate the choice and justification of the recommended model(s). Was the most appropriate model (or model averaging approach) chosen given available data and life history of the species?

b. If multiple models were considered, evaluate the analysts' explanation of any differences in results.

c. Evaluate model parameterization and specification as appropriate for each model (e.g., choice of CVs, effective sample sizes, likelihood weighting schemes, calculation/specification of M, stock-recruitment relationship, choice of time-varying parameters, choice of ecological factors).

I concluded that this TOR was adequately addressed.

I understood this TOR as evaluating the development and selection of ERP models for evaluating Atlantic menhaden's role as a forage fish in this review.

The WG developed three models considering possible trophic interactions of Atlantic menhaden and its key predators. They include two EwE models with moderate data requirement and ecosystem complexity (NWACS-MICE) and high data requirement and ecosystem complexity (NWACS-FULL), and one multispecies statistical catch at age assessment model, VADER. The WG recommends the NWACS-MICE model to provide ERP estimates considering the balance of data quality and quantity, ecological realisms and model complexity. I support the WG's recommendation and believe the NWACS-MICE model is the most appropriate ERP model, which considers both top-down effects of predator on menhaden and bottom-up effects of menhaden on predators, have adequate and balanced biological realisms and model complexity (and input data requirements), is adequate to meet the ASMFC management objectives for menhaden, and is suitable for operationalizing the ERP models to inform fisheries management.

The NWACS-MICE model used peer-reviewed stock assessment results for model configurations and tuning (see TORs 1 and 2) and includes all key managed menhaden predators with striped bass being identified as the most sensitive managed predator. Multistanza groups were included for key ERP species in the NWACS-MICE model to reflect their ontogeny in feeding, life history, habitat, and fishery selectivity, which is well justified. The current NWACS-MICE model is modified from the 2020 EPR model. I conclude that the current NWACS-MICE model performs adequately to quantify the dynamics of trophic interactions among menhaden, their key predators and other functional groups included in the model. This is especially true for the menhaden and striped bass multistanza groups. However, there remain potential spatio-temporal overlapping issues related to some of the functional groups such as spiny dogfish and striped bass that may need to be further evaluated.

The vulnerability parameters were the most important set of parameters in the EwE model with the modeling results tending to be sensitive to the assumed values. The default value is 2. The WG optimizes vulnerability parameters in the NWACS-MICE modeling using a phased approach for calibration. The 13 model types were considered with 30 possible configurations of each model. A preliminary analysis removes some model types and configurations, leading to around 150 plausible model runs. I support the approach the WG took and believe the model selection process is well structured, defined and transparent. However, I would like to suggest that the WG explore the selection of weight factors and evaluate the sensitivity of modeling results with respect to possible changes in the weights. In addition, the robustness of the final base model configuration to possible fitting protocol should be evaluated to have a better understanding of the robustness of the final model with respect to various choices the modelers have to make in the development of the final base model.

Before finalizing the base model run, the WG used the identified plausible model runs for the project to identify how the key ERP species respond to changes in the menhaden fishing mortality and evaluate if they have a chance to reach target biomass under a range of menhaden fishing mortalities. For those model runs/configurations that lack responses to changing menhaden fishing mortality and cannot achieve target biomass at any level of menhaden fishing mortality, they were not considered as the final model run. The projection performance of the NWACS-MICE model is essential to inform fisheries management, and I support the WG decision to include the performance of model projection in finalizing the base model run and believe the two criteria (i.e., adequate responses of the key ERP species to changing menhaden fishing mortality, and being able to achieve target stock biomass of the key ERP species at certain level of menhaden fishing mortality) used by the WG are appropriate and well justified.

Based on all the analyses, two model runs/configurations (Runs 150 and 153) were presented and discussed in the review. These two model runs differ in their treatment of spiny dogfish predation on striped bass. The WG suggests Run150 as the base-case to inform management with Run 153 as a sensitivity run. I support the WG decision.

The current status quo low recruitment was used for Atlantic herring in the ERP models, which realistically reflects current herring stock conditions. This setting may influence the model performance and base model selection. Possible improved herring recruitment in future may call for an evaluation of the ERP model performance.

Although some sensitivity analyses have been done (e.g., spiny dogfish predation on striped bass), the uncertainty identified in the sensitivity analysis was not explicitly incorporated in the ERP assessment. Future work can consider a suite of biologically and statistically plausible ERP model configurations, which can outline possible uncertainty for the ERP assessment. One possible way to quantify such an uncertainty is to consider ensemble model averaging for management advice. However, the suite of model runs included should be carefully selected and the selection process should be transparent and well documented to address the key aspects of ERP assessment and management.

Although the model selection process is documented in the ERP report, I would suggest that the WG put together a detailed protocol including the criteria and performance measures used for the

selection process that leads to the finalization of the base model run. Such a protocol also needs to include possible sensitivity runs the modelers need to explore to ensure the same final model run and sensitivity model runs are identified by different modelers.

Both NWACS EwE models estimated biomass time series and estimated menhaden biomass time series are relatively consistent with the single species stock assessment (but noting that EwE model does not estimate annual recruitment like in a single species model). Both NWACS EwE models, although different in their complexity, assumptions and model tuning protocols, identified striped bass as the most sensitive managed fish predator of menhaden. This justifies the use of striped bass as the indicator species accounting for menhaden's role as forage species in the ecosystem.

ToR 4. Evaluate the methods used to estimate reference points and total allowable catch.

I concluded that this TOR was adequately addressed.

A hybrid modeling approach was developed with the NWACS-MICE model providing estimates of ecosystem-level reference points and with the menhaden stock assessment BAM model projecting alternative short-term TACs and associated risks of exceeding the defined target and threshold ERPs. The NWACS-MICE model was also used to project the dynamics of menhaden and ERP species forward under different combinations of fishing mortality for menhaden and striped bass, which is considered an 'indicator species" because it is the most sensitive predator species to the change in the menhaden fishing mortality. This was then used to identify menhaden fishing levels required to reach target and threshold biomass levels for the striped bass when striped bass were fished at their F reference points. The total allowable catch was then derived from the single species assessment, which avoids relying directly on the more uncertain EwE model for absolute abundance estimates. Overall, I conclude that this hybrid modeling approach to estimate reference points and total allowable catch was scientifically sound and robust.

The single species BAM model projections incorporate uncertainty in menhaden M and fecundity by running 5000 Monte Carlo simulation runs with M and fecundity in each run randomly drawn from their distributions defined by an analysis of uncertainty associated with M and fecundity. The recruitment in the projection was derived from a nonlinear time series analysis. The Monte Carlo simulation runs allow for the estimation of probabilities of being below or higher than ERP target and thresholds for F and fecundity. I found the probabilistic approach considers major sources of uncertainty and is adequate and appropriate in determining the probability of exceeding target and thresholds ERPs. However, additional uncertainty may be explored (see TOR 6).

I believe the proposed approach is appropriate for managers to conduct "tradeoff" analysis and to answer "what if" management questions and alternative management options. For ASMFC-managed species, quota setting is conducted at the Management Board level based on the tradeoff analysis and projection results, management goals and objectives, and risk tolerance.

The ERP assessment, rather than BRP approach, advances ecosystem-based fishery management considering both bottom-up and top-down feedback and multiple species impacts.

During the review, the precision of the previous iteration of the scheme of an overly coarse search grid of F values for striped bass and menhaden was found to be different from the ERP values estimated directly from the model. This issue was not addressed during the review and needs to be addressed after the review.

The NWACS-FULL model provides more realistic and complex trophic interactions in the study ecosystem, but requires a much larger quantity of data that may not be available or is of poor quality. The complex model's needs for a large quantity of data and possible low quality (or nonexistence) of data make the model unsuitable for the use in an actual tactical management. The NWACS-MICE model misses many functional groups that feed on menhaden or on menhaden's predators such as striped bass. The simplification of ecosystem dynamics by excluding these functional groups may introduce some uncertainty in the ERP estimates. When the NWACS-FULL model is more fully developed and configured with the same protocol as the NWACS-MICE, comparing the results of these two models may provide some insights on the possible uncertainty incurred by the model simplification. A clearly defined objective for the further development of the NWACS-FULL model may be needed to guide its further development.

ToR 5. Evaluate the diagnostic analyses performed as appropriate to each model, including but not limited to:
a. Sensitivity analyses to determine model stability and potential consequences of major model assumptions
b. Retrospective analysis

I concluded that this TOR was adequately addressed.

Overall, I conclude that the diagnostics are adequate and appropriate for all the models.

Diagnostic analyses conducted in single species models are well developed. The menhaden stock assessment is the only single-species model with detailed presentation of its diagnostics in this assessment. The diagnostics for other ERP species assessments have been peer-reviewed and found to be the best available information for providing catch advice. Thus, the diagnostics for these species were not fully discussed.

For the menhaden single species stock assessment, a sensitivity analysis was conducted to evaluate possible impacts of alternative M on the menhaden stock assessment. As expected, alternative M values have large impacts on the menhaden stock assessment, suggesting that the estimation of stock biomass and fishing mortality tend to be sensitive to the assumed M values used in the menhaden stock assessment. The M is assumed time-invariant, a common practice in a single-species stock assessment. However, the M used in this assessment was based on an extensive analysis of the late 1960s tagging data, and may not reflect the current M levels. Given the sensitivity of the menhaden stock assessment with respect to M, it can be expected that

the temporal stationarity assumed for the menhaden's M may result in some uncertainty for the menhaden stock assessment. A retrospective analysis was also done in the menhaden stock assessment. Moderate retrospective patterns were identified in the estimation of stock biomass, recruitment and fishing mortality. However, their Mohn's rho values were generally within acceptable limits. The need to adjust for the retrospective pattern may be considered by managers using the ASMFC framework currently available. The retrospective error adjustment was not done for the projection in this assessment.

The ecosystem model diagnostics are more diverse and complicated because of complexity of the model structure, diverse input data and biological simplifications/ assumptions made, both implicitly and explicitly, in the ecosystem modeling. I found that the NWACS-MICE diagnostics to be adequate and appropriate, and the WG is transparent in developing structured approaches to develop and conduct sensitivity analyses with respect to the uncertainty of the key sources in input data, model parameters and assumptions. Unlike a regular stock assessment in which sensitivity analysis runs are often developed after the identification of the base-case model run, the ERP modeling work done in this assessment had the most sensitivity analyses done with various model configurations and parameterization during the development of the base-case model (rather than after the base model was determined). This approach is necessary because complex model parameterization, phased model fitting and potential forcing function options need to be carefully and comprehensively evaluated. Sensitivity analysis was limited to the runs created during the tuning focusing on predator-prey vulnerability (Vij) exchange rate multipliers Kij and different forcing functions, but time between the assessment data becoming available and this review was too short to conduct sensitivity analysis on the selected base run, 150, or the alternative run 153.

Several approaches are built-in the EwE modeling framework to quantify the parameter sensitivities. The WG focuses on predator-prey vulnerability (Vij) exchange rate multipliers Kij because EwE models tend to be sensitive to predator-prey vulnerability. The WG identified the Kij estimates at bounds for the NWACS runs, which was used as one diagnostic in evaluating the model performance. Future sensitivity model runs can be identified from a careful evaluation of the results and model performance from these 150+ model runs. The future sensitivity runs may also focus on changes in the prey switching parameter, initial biomasses, and alternative vulnerability parameters for some pair predator-prey species (e.g., spiny dogfish vs striped bass and striped bass on menhaden). There is also a need to include alternative lower menhaden M suggested by life history estimates in a sensitivity analysis.

No retrospective analysis can be done for the ERP model because of its short history, however, a "historically retrospective" analysis (i.e., comparing the historical model outputs from a series of assessments) can be done for the hybrid NWACS-MICE model and BAM model (including comparison of ERP estimates and model projections) in the future.

ToR 6. Evaluate the methods used to characterize uncertainty in estimated parameters. Ensure that the implications of uncertainty in technical conclusions are clearly stated.

I concluded that this TOR was adequately addressed.

Overall, I conclude that the methods used by the WG to characterize uncertainty in estimated parameters are adequate.

The methods used to quantify the uncertainty in the single species stock assessments are well developed, and they were not extensively presented and discussed in this review. However, they had been peer-reviewed and represent the best information available. The menhaden stock assessment was presented and discussed for its uncertainty. The uncertainty in M and fecundity was identified as most significant based on an analysis in the 2020 menhaden benchmark assessment and was quantified using 5000 Monte Carlo simulation runs with M and fecundity randomly drawn from a well-defined range of values. The M range was derived from the posterior distribution of M estimated from the tagging model, and the fecundity range was derived from the bounds around batch frequency and number of spawns per year (Latour et al. 2023). Out of the 5000 simulation runs, 4734 runs converged and were used to characterize uncertainty in projection. These values were compared with ERP target and threshold values derived from the NWACS-MICE model tradeoff analysis to quantify the probability of exceeding the ERPs. Because only M and fecundity were considered as sources of uncertainty, with future recruitment projected using a nonlinear time series analysis, this approach may underestimate the uncertainty in projection. The nonlinear time series recruitment projection is likely to reduce uncertainty compared with most commonly used approach of randomly drawing recruitment from historic recruitment values. Projections were made only for a selected total allowable catch and include no changes in fishing effort, no seasonality, and no structural model uncertainty. The small uncertainty associated with F may result from relatively small uncertainty associated with M from the tagging data analysis. I believe the uncertainty associated with M should be expanded by considering alternative values detailed in the report and life history theory. Although there is uncertainty associated with F, stock biomass and projections for menhaden, I conclude the methods are appropriate and adequate in capturing the most important sources of uncertainty. I appreciate the transparent process, structured approach to identify the most important uncertainty sources, and good documentation to justify the choices made in the modeling process.

For the NWACS-MICE model, limited time was available for an in-depth analysis of parameter uncertainty impacts on modeling results after the base-case model was identified. Uncertainties associated with different model configurations were presented, but these were not for the base-case model parameters. Because of its complexity and large quantity of input data (and associated uncertainty), it seems unlikely to establish 95% confidence intervals comparable to those for the traditional single species stock assessment models. Developing a suite of biologically plausible base-case models with similar good model performance would provide some information to evaluate possible uncertainty ranges associated with model structure, model configuration and model parameters in the hind-, now-, and fore-casting of the dynamics of functional groups. This can help identify key parameters and model components that may have the most influence on the model performance and results, helping inform the uncertainty associated with the modeling results. More studies may be needed to develop an approach/protocol to evaluate and quantify the uncertainty resulting from the model parameter uncertainty for an ecosystem model such as NWACS-MICE.

For this ERP assessment, uncertainty associated with the spiny dogfish-striped bass vulnerability was identified as critical in the development of the NWACS-MICE base model. For the base

model run 150, the vulnerability multiplier for spiny dogfish (as predator) and striped bass (as prey) required manual adjustment away from the lower bound to ensure that striped bass were at their biomass target when fished at their target F rate. In alternative run 153, spiny dogfish input parameters for biomass and diet composition were reduced relative to run 150 to represent the possibility that the spiny dogfish stock spends less time within the model domain. Higher vulnerability of striped bass to dogfish was estimated in this alternative run, resulting in lower but still feasible striped bass productivity relative to the base-case run 150. Comparing ERP tradeoffs for these two model runs illustrates the implications of uncertainty in a vulnerability parameter. Other feasible runs are likely to exist, but have not yet been explored in this assessment. This highlights the implication of uncertainty associated with model parameters in the NWACS-MICE and BAM models. The management implications of the parameter uncertainty in NWACS-MICE need to be tracked through to the uncertainty in the ERPs, stock status and catch advice.

Uncertainties in input EwE model parameters can be assessed by using a data pedigree built into the EwE software, which can create a distribution for each input parameter with high quality data having tight distributions around base parameters and vice versa. These distributions can be used to resample base model parameters and generate a plausible range of base models. The complexity is that each of these models accounting for initial parameter uncertainty also needs to be fitted to the time series data to estimate vulnerabilities and then project under different Fs to produce a range of ERPs. This can only be done manually with Ecosim. Future research may focus on the development of a customized workflow/protocol and relevant computer code to link the EwE model and BAM model for the ERP tradeoff analysis.

ToR 7. If a minority report has been filed, review minority opinion and any associated analyses. If possible, make recommendation on current or future use of alternative assessment approach presented in minority report.

No minority report was presented for this assessment. However, during the public comment period, an alternative M estimate documented in a working paper (Ault and Luo 2025) was repeatedly raised. This estimated M is much lower than the M estimate used in the menhaden stock assessment. This alternative M value was used in a sensitivity analysis, which has large impacts on the estimation of menhaden stock dynamics. This sensitivity analysis run was not considered further in the ERP assessment. This M value needs to be further evaluated, and if plausible may be considered as a lower bound in future assessment.

ToR 8. Recommend best estimates of stock biomass, abundance, exploitation, and stock status of Atlantic menhaden from the assessment for use in management, if possible, or specify alternative estimation methods.

I concluded that this TOR was adequately addressed.

This review did not review the single species menhaden assessment. I support the use of the stock biomass/abundance, fishing mortality and recruitment derived from the peer-reviewed benchmark single species assessments. It would be interesting to compare possible differences in stock status determination using the Biological Reference Points (BRPs) developed in the

menhaden stock assessment and the ERPs derived from the hybrid NWACS-MICE and BAM models reviewed in this assessment (see ToR 4).

A recommendation of a specific catch level is not the purpose of this review. This review focuses on the evaluation of the proposed framework for the managers to use for tradeoff analysis of alternative catch levels relative to their goals for the striped bass and menhaden fisheries. The final ERP estimates may need to be re-examined following any adjustments to the ERP models.

ToR 9. Review the research, data collection, and assessment methodology recommendations provided by the TC and make any additional recommendations warranted. Clearly prioritize the activities needed to inform and maintain the current assessment, and provide recommendations to improve the reliability of future assessments.

I concluded that this TOR was adequately addressed.

I found the research recommendations, including those from the 2020 ERP benchmark assessment, proposed by the WG to be well thought out and appropriate. The separation of short-term and long-term recommendations on the model development and data needs is insightful and very helpful. Given the list of recommendations and the WG time constraints, it is important to prioritize the research recommendations. I list the following priorities:

- Continue and expand seasonal, spatial, and taxonomic collection of population abundance/biomass, life history, and diet data for both managed fish species and functional groups including primary producers through zooplankton and benthos to apex fish, bird and marine mammal predators in the ecosystem. Improved data on prey size or age from diet collections are recommended to apportion diet across age stanzas of prey. Exploring other existing datasets such as the Hudson River Biological Monitoring Program (HRBMP) data (1974 to 2018 for menhaden and striped bass) is also recommended.
- Better coordinate the relevant single species stock assessments and ERP assessment to ensure the availability of updated data from the single species assessment for the ERP assessment.
- Develop a workshop with managers and stakeholders similar to the 2015 EMO workshop to determine clear objectives for a potential spatial ERP assessment and any spatial scale issues related to data collection needs and possible regional ERP models prior to any spatially explicit ERP model development.
- Develop a suite of sensitivity runs once the base-case model is determined. These sensitivity model runs should explore different model parametrizations, which can be generated by making changes to the base model and yield plausible model outputs. Such models can be used to characterize the key uncertainty in the ERP model including possible ensemble model averaging for future management advice.
- Continue to code and fully document model input data processing, balancing, and tuning protocols along with standard measures for model diagnostics and criteria for selection of sensitivity runs for fully repeatable and transparent protocols for operational assessment.

- Evaluate NWACS-MICE model sensitivity to prey switching parameters in the absence of actual data and/or evaluate food habit data (or other existing datasets) to identify possible prey switching in the ecosystem.
- Continue evaluating NWACS-MICE behavior with different forcing functions (e.g., use recruitment deviations as egg forcing to determine if this allows estimation of predator prey parameters away from bounds).
- Develop clear objectives and utilities for the NWACS-FULL model and coordinate the development and fitting of the NWACS-MICE and NWACS-FULL models.
- Develop age data from the menhaden fishery-independent surveys to inform M estimates.
- Develop an MSE to identify harvest strategies maximizing the likelihood of achieving the defined ecosystem management objectives.

ToR 10. Recommend timing of the next benchmark assessment and updates, if necessary, relative to the life history and current management of the species.

I concluded that this TOR was adequately addressed.

I support the asynchronous benchmarks for the menhaden stock assessment and ERP assessment recommended by the WG. Coordination with relevant ERP species assessment timelines is also required to ensure most updated and peer-reviewed inputs to ERP models.

An upcoming recreational data (MRIP) recalibration scheduled for 2026 and a striped bass benchmark assessment scheduled for 2027 need to be considered for deciding the next benchmark ERP assessment. The MRIP recalibration is likely to affect several ERP species assessments, including striped bass, bluefish and weakfish. The benchmark ERP assessment should not be done before these assessments for these species with recalibrated recreational catch data are completed.

It is also important to allow sufficient time between the single species assessment data and results becoming available and the ERP benchmark assessment to allow for the development of both NWACS models. The current ERP assessment does not provide enough time to allow full exploration of the developed NWACS models and full development and testing of bottom up species interactions in the VADER model. I suggest that the ERP benchmark assessment be scheduled a minimum of 12 months after the ERP species stock assessments are finalized and the results are available.

ToR 11. Prepare a peer review panel terms of reference and advisory report summarizing the panel's evaluation of the stock assessment and addressing each peer review term of reference. Develop a list of tasks to be completed following the workshop. Complete and submit the report within 4 weeks of workshop conclusion.

I concluded that this TOR was adequately addressed.

The current terms of reference are more tailored to a single-species stock assessment. There is a need to develop a new set of ToRs specifically for ecosystem and ERP modeling. I recommend

that a new set of ToRs that explicitly address the needs of ERP assessments and hybrid modeling approaches be developed for future ERP stock assessment review.

A few tasks were identified during the review for the WG to complete after the review. The tasks are relatively minor and are unlikely to result in large change to the base-case model results. These tasks include (1) implementing seasonal egg production forcing in NWACS-MICE with better documentation for the seasonal egg forcing function in Ecosim; and (2) clarifying interpolation method used for the ERPs from the tradeoff projections in the documentation.

The Review Panel has completed all other tasks as outlined in the schedule provided, including submitting a summary panel report which is drafted by the review panel Chair (Dr. Sarah Gaichas) assisted by the two CIE reviewers.

V. Conclusions and Recommendations

I would like to commend the WG for their efforts in conducting the ERP Benchmark Assessment and for providing all necessary information. I was impressed by the breadth and depth of expertise and experience of the team in single species stock assessments and ecosystem models, the amount of effort spent collecting, processing and compiling the data, and the constructive discussions during the review.

The 2025 ERP Assessment Review was a non-typical stock assessment in many ways. It was not common in that it covers the stock assessments of several species and uses hybrid approach of combining an ecosystem model with a traditional single species model (BAM) to estimate ERPs. The WG proposed a modeling framework to develop and apply the ERPs for catch advice and stock status determination.

I conclude that the 2025 ERP Assessment yields robust results, especially with regard to the various uncertainties in model input data and model configuration/parameterization. The modeling approach recommended by the WG is sound and the results of the base-case run presented appear to be scientifically sound and adequately address management needs with Menhaden being considered as an important forage species in the ecosystem. However, I believe that there is room for further improvement.

Although the modeling protocol is well documented in most places, there is a lack of adequate documentation on some components of this assessment including the protocol/analysis that led to the configuration of the base models and diagnostics before the base models were configured and finalized. A clearly defined protocol may be needed to make the base model selection more structured and transparent. More in-depth diagnostic analyses should be presented to the review panel for a more constructive and productive discussion during the review.

Other general recommendations are presented in ToR 9 and more specific recommendations are presented in each TOR.

VI. References

Ault, J.S., Luo, L., & Porch, C.E. 2023. Understanding Atlantic Menhaden Population Demographics: Re-evaluation of the 1960's NMFS Tagging Data (Working Paper SEDAR 102-WP-03; p109).

Aust, J.S. and Luo, J. 2025. Investigation of Atlantic 1 Menhaden mortality rates. SEDAR 102 WP-10.

Latour, R. J., Gartland, J., & Schueller, A. M. 2023. The reproductive biology and fecundity of female Atlantic Menhaden. Marine and Coastal Fisheries, 15(5).

Liljestrand, E. M., Wilberg, M. J., & Schueller, A. M. 2019a. Estimation of movement and mortality of Atlantic Menhaden during 1966–1969 using a Bayesian multi-state mark-recovery model. Fisheries Research, 210, 204–213.

Liljestrand, E. M., Wilberg, M. J., & Schueller, A. M. 2019b. Multi-state dead recovery mark-recovery model performance for estimating movement and mortality rates. Fisheries Research, 210, 214–223.

VII-1. Appendix 1: Bibliography of materials provided for review

Materials provided or referenced during the Atlantic Sea Scallop Research Track Stock Assessment Peer Review meeting

Working papers and presentations were available on a SEDAR website
https://sedarweb.org/assessments/sedar-102-asfmc-atlantic-Menhaden/

The following listed documents are made available to the review panel.

Document #	Title	Authors	Date Submitted
Documents Prepared for the Review Workshop			
SEDAR102-RW-01	Revised Estimates of Natural Mortality for Atlantic Menhaden	Sydney Alhale, Jeff Brust, Caitlyn Craig, Katie Drew, Brooke Lowman, Amy Schueller, Alexei Sharov	7/25/2025
SEDAR102-RW-02	Understanding Atlantic Menhaden Population Demographics: Re-evaluation of the 1960's NMFS Tagging Data- Revised with February 2025 Supplemental Materials	Jerald S. Ault[1], Jiangang Luo[1] & Clarence E. Porch[2]	7/25/2025
SEDAR102-RW-03	Population data for including bluefin tuna in the NWACS ecosystem model	Micah Dean	7/25/2025
SEDAR102-RW-04	Blue Catfish Candidacy for the ERP Assessment	Shanna Madsen	7/25/2025
SEDAR102-RW-05	A species distribution model (SDM) approach to representing anchovies in the NWACS ecosystem model	Micah Dean and Mike Celestino	7/25/2025
SEDAR102-RW-06	Zooplankton estimates for 2025 ERP Benchmark	M Celestino, D Chagaris, A Buchheister	7/25/2025
SEDAR102-RW-07	Osprey candidacy for inclusion in the NWACS ecosystem models: a review of population and diet	Jainita Patel	7/25/2025
SEDAR102-RW-08	Virtual Assessment for the Description of Ecosystem Responses (VADER) Multispecies Statistical Catch-at-Age Model Description and Output	J. McNamee	7/25/2025
SEDAR102-RW-09	VADER Bottom-Up Feedback Data Exploration	G. Nesslage, M. Wilberg, J. Collie, and J. McNamee	7/25/2025
SEDAR102-RW-10	Investigation of Atlantic Menhaden mortality rates- IN REVIEW	Jerald S. Ault and Jiangang Lou	7/25/2025
SEDAR102-RW-11	SEDAR 102 Public Comment	Public Comment	8/15/2025
SEDAR102-RW-12	NWACS FULL 2023_V2.1 Input Tables and Model	Andre Buchheister	8/18/2025
Reference Documents			
SEDAR102-RD-01	Estimation of movement and mortality of Atlantic Menhaden during 1966–1969 using a Bayesian multi-state mark-recovery model	Emily M. Liljestrand[a,*], Michael J. Wilberg[a], Amy M. Schueller[b]	
SEDAR102-RD-02	Multi-state dead recovery mark-recovery model performance for estimating movement and mortality rates	Emily M. Liljestrand[a,*], Michael J. Wilberg[a], Amy M. Schueller[b]	

SEDAR102-RD-03	SEDAR 69 Atlantic Menhaden Benchmark Stock Assessment	ASMFC
SEDAR102-RD-04	SEDAR 69 Ecological Reference Points Stock Assessment Report	ASMFC

VII-2. Appendix 2: Statement of Work for Dr. Yong Chen

Performance Work Statement (PWS)

National Oceanic and Atmospheric Administration (NOAA)
NOAA Fisheries
Center for Independent Experts (CIE) Program
External Independent Peer Review

SEDAR 102 Atlantic States Marine Fishery Commission Menhaden and Ecological Reference Points
August 12-15, 2025

Background

The NOAA Fisheries is mandated by the Magnuson-Stevens Fishery Conservation and Management Act, Endangered Species Act, and Marine Mammal Protection Act to conserve, protect, and manage our nation's marine living resources based upon the best scientific information available (BSIA). NOAA Fisheries science products, including scientific advice, are often controversial and may require timely scientific peer reviews that are strictly independent of all outside influences. A formal external process for independent expert reviews of the agency's scientific products and programs ensures their credibility. Therefore, external scientific peer reviews have been and continue to be essential to strengthening scientific quality assurance for fishery conservation and management actions.

Scientific peer review is defined as the organized review process where one or more qualified experts review scientific information to ensure quality and credibility. These expert(s) must conduct their peer review impartially, objectively, and without conflicts of interest. Each reviewer must also be independent from the development of the science, without influence from any position that the agency or constituent groups may have. Furthermore, the Office of Management and Budget (OMB), authorized by the Information Quality Act, requires all federal agencies to conduct peer reviews of highly influential and controversial science before dissemination, and that peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards[1].

Scope

The **SouthEast Data, Assessment, and Review (SEDAR)** is the cooperative process by which stock assessment projects are conducted in NOAA Fisheries' Southeast Region. SEDAR was initiated to improve planning and coordination of stock assessment activities and to improve the quality and reliability of assessments.

SEDAR 102 will be a CIE assessment review conducted for ASMFC Atlantic Menhaden. The review workshop provides an independent peer review of SEDAR stock assessments. The term

[1] https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/memoranda/2005/m05-03.pdf

review is applied broadly, as the review panel may request additional analyses, error corrections and sensitivity runs of the assessment models provided by the assessment panel. The review panel is ultimately responsible for ensuring that the best possible assessment is provided through the SEDAR process. The stocks assessed through SEDAR 102 are within the jurisdiction of the Atlantic States Marine Fisheries Commission and the states of Florida, Georgia, South Carolina, North Carolina, Virginia, Maryland, Delaware, Pennsylvania, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, and Maine. The specified format and contents of the individual peer review reports are found in **Annex 1**. The Terms of Reference (ToR) of the peer review are listed in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3.**

Requirements

NOAA Fisheries requires two reviewers to conduct an impartial and independent peer review in accordance with the Performance Work Statement (PWS), OMB guidelines, and the ToRs below. The reviewers shall have a working knowledge in stock assessment, statistics, fisheries science, and marine biology sufficient to complete the primary task of providing peer-review advice in compliance with the workshop Terms of Reference fisheries stock assessment. It would be preferable for CIE reviewers to have expertise in forage fish population dynamics, Statistical Catch-at-Age modeling, Multispecies/Ecosystem Models with a focus on Multispecies Statistical Catch-at-Age models and Ecopath with Ecosim models, menhaden/forage fish life history and ecology, and/or management strategy evaluations/decisional frameworks.

The chair, who is in addition to the two reviewers, will not be provided by the CIE. Although the chair will be participating in this review, the chair's participation (e.g., labor and travel) is not covered by this contract.

Each reviewer will write an individual review report in accordance with the PWS, OMB Guidelines, and the TORs below. Modifications to the PWS and TORs cannot be made during the peer review, and any PWS or ToRs modifications prior to the peer review shall be approved by the Contracting Officer's Representative (COR) and the CIE contractor. All ToRs must be addressed in each reviewer's report.

Tasks for Reviewers

1) Pre-review Background Documents: Review the following background materials and reports prior to the review. Completed Data and Assessment reports, along with all working papers and reference documents, will be available on the SEDAR website no later than two weeks prior to the in-person review workshop.

2) Attend and participate in an in-person review meeting. The meeting will consist of presentations by NOAA and other scientists, stock assessment authors and others to facilitate the review, to answer any questions from the reviewers, and to provide any additional information required by the reviewers.

3) After the review meeting, reviewers shall conduct an independent peer review report in accordance with the requirements specified in this PWS, OMB guidelines, and ToRs, in adherence with the required formatting and content guidelines. Reviewers are not required to reach a consensus.

4) Each reviewer shall assist the Chair of the meeting with contributions to the summary report based on the ToRs. Each reviewer is not required to reach consensus.

5) Deliver their reports to the Government according to the specified milestones dates.

Foreign National Security Clearance
When reviewers participate during a panel review meeting at a government facility, the NOAA Fisheries Project Contact is responsible for obtaining the Foreign National Security Clearance approval for reviewers who are non-US citizens. For this reason, the reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the Project Contact for the purpose of their security clearance, and this information shall be submitted at least two weeks in advance. For additional information, please see the following link: https://www.commerce.gov/osy/programs/foreign-access-management. The contractor is required to use all appropriate methods to safeguard Personally Identifiable Information (PII).

Place of Performance
The place of performance shall be in Charleston, SC.

Period of Performance
The period of performance shall be from the time of award through September 2025. Each reviewer's duties shall not exceed **14** days to complete all required tasks.

Schedule of Milestones and Deliverables: The contractor shall complete the tasks and deliverables in accordance with the following schedule.

Schedule	**Milestones and Deliverables**
Within 2 weeks of award	Contractor selects and confirms reviewers
Approximately 2 weeks prior to the review	Contractor provides the pre-review documents to the reviewers
August 12-15, 2025	Panel review meeting

Approximately 2 weeks later	Contractor receives draft reports
Within 3 weeks of receiving draft reports	Contractor submits final reports to the Government

* The Peer Review Summary Report will not be submitted to, reviewed, or approved by the Contractor.

Applicable Performance Standards

The acceptance of the contract deliverables shall be based on three performance standards: (1) The reports shall be completed in accordance with the required formatting and content (2) The reports shall address each ToR as specified (3) The reports shall be delivered as specified in the schedule of milestones and deliverables.

Confidentiality and Data Privacy

This contract may require that services contractors have access to Privacy Information. Services contractors are responsible for maintaining the confidentiality of all subjects and materials and may be required to sign and adhere to a Non-disclosure Agreement (NDA).

Travel

All travel expenses shall be reimbursable in accordance with Federal Travel Regulations (Travel resources | GSA), and all contractor travel must be approved by the COR prior to the actual travel. Any travel conducted prior to the receipt of proper written authorization from the COR will be done at the Contractor's own risk and expense. International travel is authorized for this contract. Travel is not to exceed $10,000.

Project Contacts

Amy Schueller, Research Fish Biologist
Southeast Fisheries Science Center, Sustainable Fisheries Division, Atlantic Fisheries Branch
101 Pivers Island Road
Beaufort, NC 28516
amy.schueller@noaa.gov

Emily Ott - SEDAR Coordinator
Science and Statistics Program
South Atlantic Fishery Management Council
4055 Faber Place Drive, Suite 201 North Charleston, SC 29405
Emily.Ott@safmc.net

Annex 1: Peer Review Report Requirements

1. The independent Peer Reviewer report shall be prefaced with an Executive Summary providing a concise summary of whether they accept or reject the work that they reviewed, with an explanation of their decision (strengths, weaknesses of the analyses, etc.).

2. The report must contain a background section, description of the individual reviewers' roles in the review activities, summary of findings for each ToR in which the weaknesses and strengths are described, and conclusions and recommendations in accordance with the TORs.

   a. Reviewers must describe in their own words the review activities completed during the panel review meeting, including a brief summary of findings, of the science, conclusions, and recommendations.

   b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, but especially where there were divergent views.

   c. Reviewers should elaborate on any points raised in the summary report that they believe might require further clarification.

   d. Reviewers shall provide a critique of the agency review process, including suggestions for improvements of both process and products.

   e. The report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The report shall represent the peer review of each ToR, and shall not simply repeat the contents of the summary report.

3. The report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of this Performance Work Statement
   Appendix 3: Panel membership or other pertinent information from the panel review meeting.

Annex 2: Terms of Reference for the Peer Review

SEDAR 102 Atlantic States Marine Fishery Commission Menhaden and Ecological Reference Points
August 12-15, 2025

CIE reviewers are contracted to complete their independent peer review based on the ToRs. Therefore, the CIE-NOAA Fisheries review and approval process is based on whether the CIE independent reports addressed each ToRs.

TERMS OF REFERENCE

For the 2025 ASMFC Atlantic Menhaden Single-Species Benchmark Peer Review and the 2025 ASFMC Atlantic Menhaden Ecological Reference Points Benchmark Peer Review

Terms of Reference for Ecological Reference Point External Peer Review

1. Evaluate the justification for the inclusion, elimination, or modification of data from the Atlantic menhaden single-species assessment and the single-species assessments of the other major predator and prey species included in the ERP models.
2. Evaluate the thoroughness of data collection and the presentation and treatment of additional fishery-dependent and fishery-independent data sets in the assessment, including but not limited to:
    a. Presentation of data source variance (e.g., standard errors).
    b. Justification for inclusion or elimination of available data sources,
    c. Consideration of data strengths and weaknesses (e.g., temporal and spatial scale, gear selectivities, aging accuracy, sample size),
    d. Calculation and/or standardization of abundance indices.
3. Evaluate the methods and models used to estimate Atlantic menhaden population parameters (e.g., F, biomass, abundance) that take into account Atlantic menhaden's role as a forage fish, including but not limited to:
    a. Evaluate the choice and justification of the recommended model(s). Was the most appropriate model (or model averaging approach) chosen given available data and life history of the species?
    b. If multiple models were considered, evaluate the analysts' explanation of any differences in results.
    c. Evaluate model parameterization and specification as appropriate for each model (e.g., choice of CVs, effective sample sizes, likelihood weighting schemes, calculation/specification of M, stock-recruitment relationship, choice of time-varying parameters, choice of ecological factors).
4. Evaluate the methods used to estimate reference points and total allowable catch.
5. Evaluate the diagnostic analyses performed as appropriate to each model, including but not limited to:
    d. Sensitivity analyses to determine model stability and potential consequences of major model assumptions
    e. Retrospective analysis

6. Evaluate the methods used to characterize uncertainty in estimated parameters. Ensure that the implications of uncertainty in technical conclusions are clearly stated.

7. If a minority report has been filed, review minority opinion and any associated analyses. If possible, make recommendation on current or future use of alternative assessment approach presented in minority report.
8. Recommend best estimates of stock biomass, abundance, exploitation, and stock status of Atlantic menhaden from the assessment for use in management, if possible, or specify alternative estimation methods.
9. Review the research, data collection, and assessment methodology recommendations provided by the TC and make any additional recommendations warranted. Clearly prioritize the activities needed to inform and maintain the current assessment, and provide recommendations to improve the reliability of future assessments.
10. Recommend timing of the next benchmark assessment and updates, if necessary, relative to the life history and current management of the species.
11. Prepare a peer review panel terms of reference and advisory report summarizing the panel's evaluation of the stock assessment and addressing each peer review term of reference. Develop a list of tasks to be completed following the workshop. Complete and submit the report within 4 weeks of workshop conclusion.

Annex 3: Tentative Agenda

SEDAR 102 Atlantic States Marine Fishery Commission Menhaden and Ecological Reference Points Review
August 12-15, 2025
Charleston, SC

(Draft 02.6.25)

Location Doubletree Hotel, 5264 International Blvd, North Charleston, SC 29418
Dates August 12-15, 2025

Tuesday, August 12, 2025

8:30 a.m. **Convene**

8:30 a.m. – 9:00 a.m. **Introductions and Opening Remarks**
Coordinator/Chair
- *Agenda Review, TOR, Task Assignments*

9:00 a.m. – 10:30 a.m. **Menhaden & Ecological Reference Points Background**
- *Regulatory History* *James Boyle*
- *Modeling History* *Matt Cieri*
- *Ecological Modeling Objectives*
- *Predator & Prey Choices*

10:30 a.m. – 12:00 p.m. **Menhaden Single Species Assessment**
- *Updated Natural Mortality Estimate* *Amy Schueller*

12:00 p.m. – 1:30 p.m. **Break**

1:30 p.m. – 3:30 p.m. **Menhaden Single Species Assessment (continued)**
- *Assessment Model and Results* *Amy Schueller*

3:30 p.m. – 5:00 p.m. **Multispecies Data & Assessments** **Katie Drew**

5:00 p.m. – 5:15p.m. **Break**

5:15 p.m. – 5:45 p.m. **Day 1 Summary & assignments to analytical team** **Chair**

5:45 p.m. – 6:00 p.m. **Public Comment**

Tuesday Goals: Single-species assessment presentations completed, sensitivity and base model discussion begun, additional analyses requested

Wednesday, August 13, 2025

8:30 a.m. – 9:30 a.m. **Analytical team report on additional analyses** **Amy Schueller**

9:30 a.m. – 10:30 a.m. **Panel Discussion** **Chair**
- Choice of M for single-species model

10:30 a.m. – 12:00 p.m. **Ecosystem Modeling Presentations**
- Multispecies Statistical Catch-at-Age Model *Jason McNamee*

12:00 p.m. – 1:30 p.m. **Break**

1:30 p.m. – 2:30 p.m. **Panel Discussion** **Chair**
- Discussion on MSSCAA
-Identify additional analyses & modifications to base runs & sensitivities

2:30 p.m. – 4:00 p.m. **Ecosystem Modeling Presentations (continued)**
- Ecopath with Ecosim Models *Dave Chagaris*

4:00 p.m. – 5:00 p.m. **Panel Discussion** **Chair**
-Discussion of EwE models
-Identify additional analyses & modifications to base runs & sensitivities

5:00 p.m. – 5:15p.m. Break
5:15 p.m. – 5:45 p.m. **Day 2 Summary & assignments to analytical team** **Chair**
5:45 p.m. – 6:00 p.m. **Public Comment**

Wednesday Goals: Initial ecosystem model presentation completed, sensitivity and base model discussion begun, additional analyses requested

Thursday
8:30 a.m. – 10:30 a.m. **Ecological Reference Points Presentation**
-Review & Synthesis of Results *Matt Cieri*
-Reference Points Scenarios *Dave Chagaris*
-Projections & Quota Setting *Amy Schueller*

10:30 a.m. – 12:00 p.m. **Panel Discussion** **Chair**
-Ecological reference points & management
-Identify additional analyses to be requested

12:00 p.m. – 1:30 p.m. **Lunch Break**

1:30 p.m. – 2:30 p.m. **Review additional ecosystem modeling analyses**
-MSSCAA *Jason McNamee*
-EwE *Dave Chagaris*

2:30 p.m. –5:00 p.m. Continue Panel Discussion **Chair**

5:00 p.m. – 5:45 pm. Day 3 Summary & assignments to analytical team **Chair**
5:45 p.m. – 6:00 p.m. Public Comment

Thursday Goals: Reference point and synthesis presentations completed, additional analyses requested, initial review and discussion of reference points and management recommendations

Friday

8:30 a.m. – 12:00 p.m. **Panel Discussion** **Chair**

-Review final requested analyses
-Continue deliberations
- Recommendations and comments

12:00 p.m. – 1:30 p.m. **Lunch Break**

1:30 – 3:30 p.m. **Panel Work Session** **Chair**

3:30 p.m. **ADJOURN**

VII-3. Appendix III: List of Participants

SEDAR 102
ASMFC Atlantic Menhaden and Ecological Reference Points
Review Workshop Participants

LIST OF PARTICIPANTS

Review Panel
Daniel Howell ..... Institute for Marine Research /CIE Reviewer
Sarah Gaichas (Chair) ..... Hydra Scientific LLC
Yong Chen ..... SUNY at Stony Brook / CIE Reviewer

Analytic Team
Amy Schueller ..... Southeast Fishery Science Center
David Chagaris ..... University of Florida
Jainita Patel ..... Atlantic States Marine Fisheries Commission
James Boyle ..... Atlantic States Marine Fisheries Commission
Jason McNamee ..... Rhode Island Department of Environmental Management
Katie Drew ..... Atlantic States Marine Fisheries Commission
Matt Cieri ..... Maine Department of Marine Resources
Patrick Campfield ..... Atlantic States Marine Fisheries Commission

Staff
Emily Ott ..... SEDAR
Julie Neer ..... SEDAR

Observers
Jerry Ault ..... University of Miami
Jiangang Luo ..... University of Miami

Analytic Team via Webinar
Andre Buchheister ..... California State Polytechic

Observers via Webinar
Addie Binstock ..... Maine Department of Marine Resources
Benson Chiles .....
Brandon Muffley ..... Mid-Atlantic Fishery Management Council
Brendan Turley ..... NOAA
Brooke Lowman ..... Virginia Marine Resources Commission
Caitlyn Craig ..... New York State Department of Environmental Conservation
Catherine Wilhelm ..... Virginia Marine Resources Commission
Corrin Flora ..... Maine Department of Marine Resources
George Mapp ..... Virginia Institute of Marine Science
Jamie Cournane ..... New England Fishery Management Council
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Micah Dean.....Massachusetts Division of Marine Fisheries
Michael Celestino .....New Jersey Department of Environmental Protection
Peter Himchak..... Omega Protein Corporation, Inc.
Rachael Silvas..... South Atlantic Fishery Management Council
Rob LaFrance..... Quinnipiac University
Roger Fleming .....Blue Planet Strategy
Samara Nehemiah..... Atlantic States Marine Fisheries Commission
Shanna Madsen..... Virginia Marine Resources Commission
Sharon Glen .....
Suzanna Thomas..... South Atlantic Fishery Management Council
Tina Berger ..... Atlantic States Marine Fisheries Commission
Will Poston .....Chesapeake Bay Foundation
Zane Ruzicka ..... Wild Oceans