EXTERNAL PEER REVIEW SEDAR 102 Atlantic Menhaden Single Species and Ecosystem Reference Points

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Doubletree North Charleston

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Individual Peer Review Report prepared for the Center for Independent Experts by

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Executive summary

The SEDAR 102 review was aimed at reviewing updates to the model and methodology for providing ecosystem reference points (ERPs) and advice for Atlantic menhaden, following the initial approval of the approach and models at SEDAR 69.

The Atlantic menhaden is both an important forage fish along the east coast of the USA and supports profitable large-scale fisheries. Given this joint importance, there has been a focus on how to provide advice which supports both the directed fishery and the ecosystem services generated by the menhaden. The focus is on menhaden as food supply for striped bass. This is partly because striped bass is a high-profile recreational stock currently recovering from low biomass, and partly because the striped bass is a viable indicator species for menhaden interactions – sufficient food for striped bass is likely sufficient food for a range of other species.

The overall workflow in the advice involves maintaining and running a single species stock assessment (using the BAM model) for Atlantic menhaden. In parallel, an ecosystem model (termed NWACS-MICE), formulated in Ecopath with Ecosim (EwE), is run to analyse the impact of menhaden abundance on striped bass, and suggest reference points for menhaden fishing which take into account of the needs of striped bass. The two models are thus used in conjunction to give an ecosystem-informed quota advice for the menhaden fishery. This overall system was approved at SEDAR 69, and is reviewed here as continuing to provide a "best available science" (and, in fact, world-leading science) approach to management for menhaden in an ecosystem context (and specifically to provide sufficient food for striped bass).

At the review, the recent revision of the menhaden assessment, and especially the revision in natural mortality (M), was considered. It should be noted that SEDAR 102 did not attempt to replicate the benchmark process for reviewing the menhaden assessment, rather it approved the choices already made as appropriate for feeding into the ERPs and multispecies management. The NWACS-MICE EwE model that was previously approved at SEDAR 69 has been developed. This review evaluated these changes, and approved the revised model as appropriate for use in the ERP management advice. In addition, two further models were briefly considered. Neither is currently proposed for use in direct tactical management, but both provide benefits beyond the NWACS-MICE model. The first was a larger (i.e., more species across the ecosystem) EwE model (termed NWACS-FULL). This model allows for impacts across a wider range of species to be examined, albeit with lower degrees of precision resulting from the increased complexity. Finally, a statistically-tuned multispecies model is under development. However, although this model is able to reproduce stock trends relatively well, finding the bottom-up prey to predator linkages required for the ERP management has proved challenging. This is a difficulty with all such multi-species models, and the review encourages the development of this model alongside the EwE models to provide a slightly different perspective on the ecosystem.

One focus of the review was on the uncertainty estimates associated with the NWACS-MICE model. Little work was possible on this prior to review, due to the short time available between the assessment data becoming available to the NWACS-MICE team, and the SEDAR 102 review. Configuring and optimizing the EwE models is a time-consuming process, and essentially all of the time available was spent in producing a viable "base case" model. This review therefore suggests that more time be made available in future and proposes suggestions for how to progress in examining uncertainty in the NWACS-MICE model and resulting ERPs. In general, ecosystem models are unlikely to be able to provide the "95% confidence intervals" style information associated with single species stock assessments. Rather, the review suggests creating a suite of "plausible" formulations of NWACS-MICE models, which can then be used to investigate the uncertainties arising from the range of potential model formulations.

This review would stress that, despite caveats over uncertainty estimates, the process reviewed represents state-of-the-art in providing advice to support Ecosystem Based Management of the relevant species.

Background

The SEDAR 102 Atlantic Menhaden Single Species and ERP Review Panel (hereafter referred to as the "Panel") was convened on 12th -15th August 2025 in Charleston, SC. The review was to evaluate the ongoing use of the Statistical Catch At Age (SCAA) model (using the Beaufort Assessment Model, or "BAM") and the "NWACS-MICE" Ecopath with Ecosim (EwE) model to provide management advice for the menhaden fishery via Ecosystem Reference Points (ERPs). The key underlying motivation is that as well as supporting a profitable fishery in its own right, the menhaden are also a critical food species in the ecosystem. Management actions are therefore aimed to balance the needs of the directed fishery with maintaining a sufficiently large menhaden biomass to support predator species.

The review evaluated the results of a recent revision of the single species menhaden model for use, as well as revisions in the NWACS-MICE model. The aim was to focus on the uncertainty estimates in the NWACS-MICE model, although as explained below, insufficient development time limited this part. Finally, the review also briefly reviewed a larger EwE model termed NWACS-FULL, as well as a multispecies model, VADER, statistically tuned to the data.

Review Panel

The Panel consisted of Dr. Sarah Gaichas (Chair), and Center for Independent Experts (CIE) reviewers Dr. Yong Chen and Dr. Daniel Howell. Dr. Sarah Gaichas is an independent researcher specializing in fisheries science and management. Dr. Yong Chen is professor at Stony Brook University, and Dr. Daniel Howell is research professor at the Institute of Marine Research, Norway.

As Chair of the Panel, Dr. Gaichas facilitated the meeting and made sure that all the terms of reference were reviewed by the Panel. She also led the preparation of the Peer Review Panel Summary Report. Drs. Daniel Howell and Yong Chen served as independent and impartial CIE reviewers. The CIE reviewers each completed independent peer review reports in accordance with the requirements specified in the Statement of Work and terms of reference (Appendix A), in adherence with the required formatting and content guidelines; reviewers were not required to reach a consensus. CIE Reviewers submitted Individual Peer Review Reports and contributed to the Peer Review Panel Summary Report.

Review Activities

The focus of the review was to review the developments of the models involved in the Ecological Reference Point (ERP) management advice previously approved for management use at SEDAR 69 (2019). The review focused on developments in the single species "BAM" assessment model (principally involving a revision of natural mortality) and the NWACS-MICE Ecopath with Ecosim (EwE) model approved for tactical advice. A larger EwE model (NWACS-FULL) and a statistically-tuned multispecies model (VADER) were also reviewed, although neither of these was considered for direct use in tactical management. In addition, the procedure used to derive the ERPs was reviewed and slightly revised. Note that the review assessed the model structure and formulation, and the methodology for computing ERPs and subsequent management advice, and the choice of model formulation to serve as the basis for management advice. The review did not consider the specific advice arising from the process. Detailed terms of reference were provided for both the single species and the ERP review, and are presented in Appendix A.

Prior to the in-person meeting, the Panel was provided with written materials to review describing the single species model and the multispecies and ecosystem models considered during the review. There was a preliminary web meeting to present an

overview of the work and to allow for reviewer requests which could be addressed prior to the physical meeting commencing.

During the physical meeting the technical team provided presentations and discussions of the single species model (with focus on the change in M), the NWACS-MICE model proposed for management use, and briefly on the NWACS-FULL and VADER models. Specific review activities were mostly focused on the management-relevant parts of the overall system. Details of the presentations are in the meeting agenda (Appendix B). In addition to the scheduled presentations, there were daily sessions for public comment and for interaction via an online webinar. All working documents, written public submissions and other documents were made available at the SEDAR website (https://sedarweb.org/assessments/sedar-102-asfmc-atlantic-menhaden/).

Introduction

The underlying rationale of the work reviewed is that Atlantic menhaden, as well supporting a large commercial fishery, are also a key forage species for a number of predators along the eastern coastline of America. There is particular interest in the impact of menhaden abundance on striped bass, and in particular on what fishing levels on menhaden would be appropriate in order to allow striped bass to thrive and ideally reach their target biomass.

Four different models are considered here, providing a comprehensive picture of the ecosystem context around the striped bass and menhaden interactions and the appropriate level of menhaden fishing pressure accounting for this interaction. A single species assessment model for menhaden using the “BAM” model provides the detailed estimation of menhaden stock status and stock history. An Ecopath with Ecosim (EwE) model with a limited number of species (the “NWACS-MICE” model) provides a simulation of how the menhaden interact with a number of key species, including striped bass, and serves as the basis for the Ecosystem Reference Points (ERPs) used in providing tactical management advice. A second EwE model with a larger suite of species (the “NWACS-FULL” model) provides a wider but more uncertain analysis of impacts across the entire ecosystem. Finally, a statistically tuned multispecies model (“VADER”) considers the dynamics and interactions of key species with an eventual aim of modelling bottom up forcing through the system. All of these models have been through a previous SEDAR review process (SEDAR 69, 2019). This review therefore only considers if the existing models and procedures are still appropriate to provide management advice, and focusses in detail on the changes made since the previous review. In particular, there was not an in-depth review of the single species model structure, configuration, or performance at this review.

Specific comments on each ToR

The comments below on ecosystem models will mostly focus on the NWACS-MICE model, as this is the model being used for tactical management advice. Where comments relate to the larger NWACS-FULL model or the VADER multispecies model this will be made clear in the text.

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.

The NWACS-MICE model used the data from the stock assessments to parameterize the initial Ecopath model (and hence the overall level of the biomass) and then input data and biological parameters from the stock assessments to tune the vulnerability parameters in the Ecosim model tuning (which drive the dynamics of the species interactions). This ensures that the NWACS-MICE model is consistent with the stock assessments but avoids a pitfall of different biomass levels that could arise from fitting directly to the assessment results. However, there are a couple of issues with this. One is that any revision in the stock assessment data will obviously impact the EwE model, which can be considered appropriate in the context of using the most up to date scientific knowledge. More seriously is that the domains of the individual single species assessments are unlikely to fully overlap. This potential mismatch between assessment biomasses and spatial domains should be borne in mind by the team developing the models and is likely especially relevant for the spiny dogfish in the current model.

The biggest change from the previous menhaden assessment was the revised value for natural mortality (down from 1.17 to 0.92) based on a reanalysis of the tagging study from the late 1960s/early 1970s. The revision was largely based on fixing identified errors in the previous analysis of the tagging data, and therefore clearly represent an improvement. The existence of the tagging study is a clear advantage for this stock, however the long time since it was conducted and the limited amount of age structure information for the stock for comparison, does raise questions about its relevance for modern M estimates. The commercial catch has age samples, but with a dome shaped selectivity it does not provide the age structure information necessary for an estimate of M at age. If widespread aging data becomes available from the surveys, then this could be used to “sanity check” and, if necessary, adjust the estimate of M. In the absence of such data, then the existing methodology of relying on the old tagging data is likely the best possible approach.

There were problems with fitting the weakfish within the model using the data from the assessment. The assessment had capped the mortality at 1.0, and this arbitrary cap performed poorly within the EwE model. Therefore, a higher mortality rate (based on a tagging study) was used in the EwE model.

The data used in tuning the NWACS-MICE model were consistent with the menhaden assessment and all other assessments except as noted for weakfish.

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.

Much of this ToR is focussed on single species assessment procedures, which were not covered in this review. The ToR would have been relevant to the VADER model had that been developed to the point where it could be considered for management advice covering the bottom-up drivers in this system, but this was not the case. Therefore, this review can only comment on the additional data sources not derived from the stock assessment outputs or the data used as inputs to those assessments (which are covered above). As an aside, the choice to have the single species model reviewed separately is supported by this review. This separation both allowed for a more focused review, and also for time to develop the EwE models following the menhaden model revision but prior to the ecosystem model review.

For the NWACS-MICE model, the main change is a revision to the anchovy time series. This was well justified to the review.

For the NWACS-FULL model, this ToR also covers the new data on the osprey (which have been added as an additional species), and the bluefin tuna data (which have been modelled specifically rather than as a generic Highly Migratory Species component). Both were well presented, and the changes in model structure to follow the species-specific data were justified and appropriate. The choice not to include these explicitly in the smaller NWACS-MICE model was also considered appropriate.

It should be noted that in any ecosystem model, there will be many parts of the model with only limited and/or poor-quality data available. In general, the species without stock assessments will suffer from this lack of data to varying degrees. Therefore, there is not the same expectation (or possibility) of data rigour across the whole ecosystem as there is for the stock assessment species. This, in part, is why the NWACS-MICE model is being used in conjunction with the single species assessment to provide advice, rather than directly providing advice from the NWACS-FULL model. The NWACS-FULL model is therefore considered to provide information about wider ecosystem interactions, but at a lower level of quality than the NWACS-MICE model.

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).

The methodology presented here focusses on the ERP. Values F, biomass and abundance come directly from the single species model and assessment data and are not the subject of this review. The method used here, of projecting the NWACS-MICE model under different combinations of F for menhaden and striped bass, are described in more detail under the ToR 4.

The NWACS-MICE is an appropriate choice to provide the ERPs for advice. The VADER is not currently able to model bottom-up effects, while the NWACS-FULL is unwieldy and difficult to parameterise due to its complexity, and likely has a higher degree of uncertainty. As discussed below, the NWACS-FULL model does have a role in providing broader (and less precise) ecosystem information. The NWACS-MICE is performing adequately to produce a reasonable reconstruction of the ecosystem, especially in the menhaden and striped bass components. In general, an ecosystem model would not be expected to provide perfect fits in all species, and it is therefore only serious divergences from the assessment that raise concerns. In that context it can be noted that there are a number of issues with the models. In particular, the spiny dogfish biomass and interactions are rather uncertain but also highly important to both striped bass and menhaden. Therefore, future development work should include (and ideally focus on) refining the spiny dogfish dynamics.

The vulnerability parameters are a technical part of the EwE models, which can have a large impact on the dynamics of the modelled species and interactions. These vulnerability parameters were optimised within the model using a weighting scheme for the different datasets to allow for a single final fit to be arrived at. It is likely that the parameter values (and hence model dynamics) will be, to some extent at least, dependent on the choice of weights. A sensitivity analysis of some kind on the importance of the selection of weights would therefore be useful to highlight how sensitive the model results are to small changes in the weights (see TOR 5a).

The NWACS models estimate biomass series and can thus be compared directly to single species assessments or surveys. In general, one would not expect perfect matches between the ecosystem and single species models, but a successful ecosystem model would need to capture the main overall trends of the key species. The review notes that the menhaden time series has moderate coherence between the NWACS-MICE model and the single species assessment (stressing again that a perfect match would not be expected). Where better fits are desired, then using annual forcing on recruitment would help the model track the historical dynamics (though at the expense of reducing the importance of the within model feedback).

Note that the VADER model would be producing some of these quantities, but that model is not currently in a state for direct use in management advice for these stocks and is therefore not reviewed in detail here.

Several errors were identified and corrected. During model development an issue was identified with an overly coarse grid in the forecast procedure. This resulted in a mismatch between model results and advice, this was corrected prior to the review (see section 4). During the review, examinations of the function used to produce seasonal variation indicated that it was not performing as expected. The formulation was replaced with a different formulation, which did perform as expected (section 8).

In addition, results presented at the review identified the impact of spiny dogfish as being both an important driver and in having a high degree of uncertainty. There are uncertainties around the level of the spiny dogfish, and especially in how much this stock overlaps the other NWACS-MICE species. This results in uncertainties around the strength of the trophic interactions from this species, which have a large impact on the overall model. The current model configuration in respect to this is the best available, but further work should continue to refine this.

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

The overall methodology is sound and derives directly from the previous review. The NWACS-MICE model is projected forwards under different combinations of F for menhaden and striped bass. These results were then used to identify fishing levels required to reach target and threshold levels for the striped bass. The total allowable catch advice then comes from the single species assessment based on these reference points. This process of basing the advice on the dynamics from the single species model (but modified according to ecosystem reference points) avoids relying directly on the more uncertain EwE model for absolute abundance estimates.

An issue was identified in the precision of the previous iteration of the scheme of an overly coarse grid of F values being used for the projections of striped bass and menhaden. This resulted in the estimated ERP values being different from those coming directly from the model. This has been resolved.

The NWACS-FULL model is not suitable for development on a tactical management scale and has a lot more complexity. As a research recommendation, when the NWACS-FULL model is more fully developed and parameterised, comparing results from the two would be useful. For example, comparing the ERP values derived from the two models or the knock-on effects on the wider species in the full model would be interesting and could lead to revisions of species included in the tactical management advice NWACS-MICE model.

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

Most of the work has been focused on creating a base case model formulation. Sensitivity analysis was conducted using the runs created during the tuning, however many of these are not viable models and the utility of these sensitivity tests is therefore limited. The time between the assessment data becoming available and this review was too short to allow for extensive sensitivity analysis, rather the base case was only developed shortly before the review. It is therefore important that the sensitivity analysis should be conducted after the review as ongoing work. This further work should look at sensitivity to the prey switching, sensitivity to initial biomasses, and of small changes to a few key vulnerabilities (e.g., spiny dogfish on striped bass, striped bass on menhaden). The weighting scheme could also have a sensitivity analysis. Sensitivity on the key parameters coming from the assessments (M, F, B) is also important. One method to do this is to create a suite of plausible alternative models incorporating these variations and then using this suite to track the impacts on the NWACS-FULL model dynamics.

e. Retrospective analysis

It should be noted that the retrospective analysis is typically used within the single species modelling realm. Two different variants are possible: a historical retrospective (which compares this year's results to those obtained in previous years), and an analytical retrospective (which uses the current model but with individual years of data sequentially removed). At present, neither of these is possible for the NWACS-MICE model. However, once a time series of assessments is available then a historical retrospective of changes within the NWACS-MICE model would become possible.

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

As mentioned above, insufficient time was allocated to the EwE model development to permit an analysis of uncertainties. Some uncertainties in results were presented, but based on models used during model development (which we considered not to be realistic). Parameter uncertainty was not presented.

It should be stressed here, that there is no well-established method to characterize the uncertainties in an ecosystem model. The model is complex, and the number of possible components (and interactions between components) to examine for uncertainties is therefore large. Further, there is an overall higher degree of uncertainty and less precise model fitting

than in a single species assessment model (or a statistically-tuned multispecies model). It is unlikely that the "95% confidence intervals" style uncertainty estimation will be possible.

Rather it is likely that a qualitative or semi-qualitative analysis of what are the most sensitive and uncertain parts of the model is the best that can be achieved. In this context, it would be useful to identify how the most important uncertainties in each of the model components track through to the outputs most relevant for the ERP-based management advice. This would both give information on the uncertainty of the results and serve to identify which areas of the model to prioritise in future developments.

Producing a suite of "plausible" potential model variants would give a route to looking at uncertainty (in parameters, in structural form, in hindcast biomasses and diets, and in forecasts). These could be derived from "small" changes to a base case model and should be informed by the information on uncertainties in individual parameters (where available) and based on expert judgement where quantitative estimates do not exist. It could be worth separating out the sensitivity arising from parameters within a species and those arising from parameters governing the interaction between species.

The implications of these uncertainties need to be tracked through the likely uncertainty around the ERPs and hence their impacts on management.

The BAM single species stock assessment model does produce uncertainty estimates. These are best delt with through the single species review than at this ecosystem review.

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.

There was no 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.

The purpose of this review is not to review specific values for management advice, rather to review and approve the process for providing such advice. As such, the review does not specifically review the values for either the single species model or the ecosystem advice.

This review did not explicitly analyse the single species menhaden model, which was conducted separately at a recent single species review. The recommendation here would be to use the benchmarked single species assessment for stock biomass, abundance and exploitation rates and rely on that separate review to assure quality. The stock status should be evaluated by comparing the single species assessment to the ERP arising from the NWACS-MICE model and methodology reviewed here (TOR 4). This is a continuation of the existing procedure.

I (as well as the panel) explicitly endorse the methodology here as representing an appropriate tool for the managers to use to provide information on which to choose between a range of different potential fishing levels based on their goals for the striped bass and menhaden fisheries.

I (as well as the panel) would note that an error was identified in the use of seasonality, where the model did not behave as expected. An alternate formulation (using a function designed for long term trends) did behave as expected. The model will therefore be adjusted to use this revised formulation. This has the potential to change the exact level of advice slightly, and therefore the exact values presented in the review documents may be different from those used as the basis for advice.

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.

A significant number of recommendations for further work were presented by the technical team. This review endorses those recommendations, although the number of recommendations is likely longer than can be viably addressed. A long list of recommendations typically results in time only being available for a limited subset, and key suggestions are therefore often lost. This review will therefore focus on one key suggestion for improvement in each area of the model and advice process. This should not be taken to preclude further work in addition to that recommended, but care should be taken in prioritizing work.

Overall process

A longer time period is needed between the assessment data becoming available and the ERP models being reviewed. This would allow for a more thorough investigation of the model structure and uncertainties.

Menhaden assessment and data

A time series of age data from the combined menhaden survey would be the biggest single improvement to both the menhaden assessment and the ERP models. Even just a few years of age data would improve the modelling significantly by providing direct evidence on mortality to validate and possibly revise the estimate of M. Such a survey-based age data set would also provide a much firmer basis to estimate the dome shaped selectivity in the commercial fleet. Given the modern lack of spatial coverage in menhaden processing plants, such a dataset could be also used to better understand changes in regional distribution over time.

NWACS-MICE

Model structure

Further examination of the spiny dogfish biomass and interactions would be important for improving confidence in the model. If data is lacking to improve this

component, then different spiny dogfish configurations should be included in the uncertainty analysis (below).

Uncertainty

Creating a suite of "plausible" models (either by changing model formulation or changing key parameters slightly from existing models) would provide a test bed on which to explore the uncertainties in the NWACS-MICE model. This could focus both on how sensitive the management ERPs are and identifying which parts of the model drive the uncertainty. Further work on examining the sensitivity of the relative weighting of the different datasets would be valuable in its own right, and would be a route to creating models for such a suite.

NWACS-FULL

Reconfiguring the NWACS-FULL model to be set up as an extension of the NWACS-MICE model would be a major advantage. This would entail moving to using the same tuning data between the models (NWACS-MICE uses the tuning data from the assessments, while NWACS-FULL uses the assessment results directly which gives a greater risk of mis-match in biomass levels between the species). Once this was done it would have two key benefits. It would greatly simplify model tuning, since the existing NWACS-MICE tuning could be used as a starting point for the more difficult task of tuning the larger model. It would also make directly comparing between the models easier and more reliable. This would enable a better understanding of how the species not currently in the NWACS-MICE model interact with the core species.

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

Recommending the timing of the next review is beyond the competence of this reviewer. However, it is worth stressing that there needs to be sufficient time between the single species data and results being available and the ecosystem models being finalised for review. Developing and tuning the model is a time-consuming process, and then time will be needed to work on uncertainty and sensitivity analyses.

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.

Such a report has been prepared and submitted.

APPENDIX A: Background material

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	

APPENDIX B: Performance Work Statement

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 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

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

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.

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
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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**

APPENDIX C: Participant List

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
Jess Hornstein ..... New York State Department of Environmental Conservation
John Walter ..... NOAA
Kathryn Padgett ..... New York State Department of Environmental Conservation
Keilin Gamboa-Salazar ..... South Carolina Department of Natural Resources
Laurie Coe .....
Manuel Coffill-Rivera ..... University of South Alabama

Max Appelman ..... NOAA
Melissa Smith..... Maine Department of Marine Resources
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