Review of Atlantic Menhaden Ecological Reference Points

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The Science Center for Marine Fisheries (SCeMFiS) requested a technical review of analyses being considered by the Atlantic States Marine Fisheries Commission (ASMFC) to estimate ecological reference points (ERPs) for Atlantic menhaden by applying a multispecies model (SEDAR 2020b). Two memoranda by the ASMFC Ecological Reference Point Work Group and Atlantic Menhaden Technical Committee were reviewed:

- Exploration of Additional ERP Scenarios with the NWACS-MICE Tool (April 29 2020)
- Recommendations for Use of the NWACS-MICE Tool to Develop Ecological Reference Points and Harvest Strategies for Atlantic Menhaden (July 15 2020)

Summary

- According to the SEDAR69 Ecological Reference Points report, the multi-species tradeoff analysis suggests that the single-species management target for menhaden performs relatively well for meeting menhaden and striped bass management objectives, and there is little apparent benefit to striped bass or other predators from fishing menhaden at a lower target fishing mortality.
- Revised scenarios of the SEDAR69 peer-reviewed model suggest that results are highly sensitive to assumed conditions of other species in the model. For example, reduced fishing on menhaden does not appear to be needed to rebuild striped bass if other stocks are managed at their targets.
- The recommendation to derive ecological reference points from a selected scenario that assumes 2017 conditions was based on an alternative model that was not peer reviewed by SEDAR69, and the information provided on alternative analyses is insufficient to determine if it is the best scientific information available to support management decisions.
- Considering apparent changes in several stocks in the multispecies model since 2017, ecological reference points should either be based on updated conditions or long-term target conditions.

Background

As part of the SEDAR69 benchmark assessment of Atlantic menhaden (SEDAR 2020a, 2020b), several multi-species models were developed to evaluate the ecological role of Atlantic menhaden in the Northeast U.S. coastal ecosystem and to derive ecological reference points for conserving forage. Two Ecopath with Ecosim (EwE) models were developed. Information for the menhaden stock and fishery were from the SEDAR69 Beaufort Assessment Model (BAM) and information for other species were from recent stock assessments. Diet data were also included in models from several sampling programs along the entire east coast.

Among the alternative models, the two EwE models were the only options that could evaluate the effect of predators on menhaden as well as the effects of menhaden on predators. The EwE model with

moderate complexity (NorthWest Atlantic Continental Shelf-Model of Intermediate Complexity, 'NWACS-MICE') was selected for tradeoff analyses because the more complex model suggested that the simpler model included the predators that are most responsive to menhaden abundance. All models provided consistent perceptions of the trend in Atlantic menhaden stock since the 1990s, and those trends were also consistent with BAM estimates.

The multi-species tradeoff analyses in SEDAR69 illustrated how the effect of menhaden fishing on predator species can be evaluated. The example tradeoff analysis suggested that the single-species management target for menhaden performed relatively well for meeting menhaden and striped bass management objectives. Model projections suggested that long-term expectations of fishing at the menhaden and striped bass fishing mortality targets maintain the striped bass stock above its threshold stock biomass and near its target stock biomass (SEDAR 2020b).

Overfishing is occurring in the striped bass fishery, and the long-term expectation of fishing at the current rate is that the striped bass stock will decrease to less than its management threshold - even with no fishing on menhaden. At the current rate of fishing mortality on striped bass, there is little change in the long-term expectation for the striped bass stock from fishing menhaden at a lower rate than the single species target. Therefore, the appears to be negligible benefit to bass from fishing menhaden lower than the single species target (SEDAR 2020b).

The SEDAR69 tradeoff analysis was entirely focused on stock biomass consequences (and stock status relative to biomass targets and thresholds), but the consequences for yield were not reported. Long-term yield expectations from multi-species simulations suggest that fishing menhaden at the ecological reference point produces 65% of the yield expected from fishing at the target reference point and only 4% or 5% of the maximum sustainable yield for menhaden (from sim1.1 and sim3.5, respectively; SEDAR 2020b). A more comprehensive tradeoff analysis would include relative costs and benefits, including economic costs of the ecological reference point.

Uncertainty in estimates from the selected multi-species model (NWACS-MICE) were evaluated through sensitivity analyses. However, the long-term projections from the selected multi-species model are deterministic and assume perfect understanding and control of predator-prey dynamics, perfect data, perfect assessments and perfect implementation of commercial and recreational menhaden and striped bass fisheries.

Results from EwE models are notoriously difficult to reproduce. The full ecosystem EwE model was refined through rigorous peer review (Buchheister et al. 2017a, 2017b) and documentation (Section 14.1.4, SEDAR 2020b), but the selected EwE model with moderate complexity had much less documentation and model development. For example, the section on balancing (13.2.2, SEDAR 2020b) only included the general criterion for ecotrophic efficiency (EE<1) and did not include the other balancing criteria applied to the full ecosystem model.

Exploration of Additional ERP Scenarios with the NWACS-MICE Tool

Ecological reference points for Atlantic menhaden were derived using the NWACS-MICE model to find the fishing mortality on Atlantic menhaden that is expected to maintain the Atlantic striped bass stock at its stock biomass target or threshold, assuming that Atlantic striped bass is fished at its fishing mortality target. The ecological target is the fishing mortality on menhaden that is expected to maintain striped bass at its biomass target, and the ecological threshold is the fishing mortality on menhaden that is expected to maintain striped bass at its biomass threshold. Candidate target and threshold reference points for menhaden were evaluated as well as the probability that the short-term catch of menhaden exceeds the candidate reference points (i.e., catching the total allowable catch of 216,000 tons in 2019-2021).

The example tradeoff analysis and example ecological reference points developed by SEDAR69 assumed 2017 stock conditions for all species in the model (SEDAR 2020b). However, management reference points are typically based on long-term expectations. Accordingly, the ASMFC Atlantic Menhaden Management Board requested several additional analyses with alternative assumptions about conditions for other stocks in the multispecies model (bluefish, weakfish, spiny dogfish, and Atlantic herring):

- Scenario 1) fished as the rates estimated for 2017 (i.e., continued overfishing for bluefish and weakfish; continued fishing at less than the target or threshold for dogfish and herring),
- Scenario 2) fished at the rate that maintains them at their biomass target,
- Scenario 3) fished the rate that maintains them at their biomass threshold, and
- Scenario 4) herring and bluefish fished at the rate that maintains them at their biomass target, but spiny dogfish and weakfish fished at the rates estimated for 2017.

Results from scenarios 1 (2017 conditions) and 3 (threshold conditions) suggest that ecological reference point estimates are considerably less than the reference points derived from the single-species BAM assessment, and probability of exceeding the ecological targets in the short term was high (60-100%), but probability of exceeding the ecological thresholds in the short term was low (0-13%). Results from scenarios 2 (target conditions) and 4 (mixed conditions) suggest that ecological reference point estimates are actually greater than the single-species reference points, the probability of exceeding targets is low (0-7%), and probability of exceeding thresholds is negligible (0%). Therefore, two of the four scenarios (including the scenario in which each species is managed according to its targets, #2), suggest that reduced fishing of menhaden is not needed to maintain striped bass at its biomass target, and the near-term expected catch of menhaden has low risk of exceeding all candidate threshold reference points. The contrasting results among scenarios demonstrates that the apparent effect of reduced fishing on menhaden for rebuilding striped bass is largely conditional on how other fisheries (primarily herring and bluefish) are managed.

Several sources of uncertainty were identified that need further exploration to understand model sensitivity, including comparability of fishing mortality rates between the NWACS-MICE model and single-species stock assessments, the trophic relationship between striped bass and herring, and natural mortality of weakfish. A work plan was recommended for the ASMFC Ecological Reference Point Work Group and Atlantic Menhaden Technical Committee to address these uncertainties.

Recommendations for Use of the NWACS-MICE Tool to Develop Ecological Reference Points and Harvest Strategies for Atlantic Menhaden

The ASMFC Ecological Reference Point Work Group and Atlantic Menhaden Technical Committee was concerned that the sensitivity of alternative scenarios explored in spring 2020 based on the NWACS-MICE model that was peer reviewed by SEDAR69 overestimated the importance of Atlantic herring. They explored sensitivity analyses with alternative assumptions about vulnerability to predators and seasonal availability of herring to striped bass. Revised assumptions of seasonal availability produced results that were similar to those from scenario 1 (i.e., 2017 stock conditions for other species). Therefore, the Work Group and Technical Committee recommended that ecological reference points should be based on scenario 1, because it approximates short-term conditions.

The recommendation to derive ecological reference points from scenario 1 (2017 conditions) was based on a model that has not been documented, tested or peer reviewed. The 6-page July 15 memo from the Work Group and Technical Committee includes less than one page of text that describes the alternative analyses, there is little information provided on how seasonal availability was derived, and only a vague description of model results are provided. The Work Group and Technical Committee concluded that the revised model with seasonal variability of herring is a '*preliminary step in incorporating seasonality in the NWACS-MICE tool*' because seasonality was only applied to striped bass-herring interactions, and the model has not been vetted or peer reviewed, and another benchmark assessment process is needed.

All stocks in the multispecies model are dynamic and should be expected to change from 2017 conditions. For examples, survey indices suggest that the spiny dogfish stock greatly increased from 2017 to 2019 (Sosebee 2019), and the updated assessment of herring estimates a substantial decrease in the stock from 2017 to 2019 (NEFSC 2020). If ecological reference points are intended to represent short-term conditions, then the NWACS-MICE model should be based on updated stock conditions. Alternatively, long-term target conditions (i.e., scenario 2) would be a reasonable long-term scenario for setting management reference points, because that scenario assumes that management targets are acheived. The other long-term conditions (scenarios 3 and 4 with threshold conditions) essentially assume that fishery management will fail to meet their targets and all stocks are at the overfished threshold.

References

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