Atlantic States Marine Fisheries Commission
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Ecological Reference Point Work Group
Check-In Summary

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Members in Attendance: M. Cieri, M. Celestino, D. Chagaris, A. Buchheister, A. Schueller, A. Sharov, H. Townsend, M. Dean, J. Boucher, J. McNamee, G. Nesslage
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Model Updates

NWACS-MICE

To incorporate the weakfish assessment, the model was re-run with a higher M (Krause assumption). Biomass and Z from Krause were run as Ecopath inputs and all other inputs were kept the same. With these changes, the model was still slightly out of balance, so manual adjustments were made to diets to bring the ecotrophic efficiency (EE) of the model predators to be < 2. EE was set to 0.99 and the model solved for biomass accumulation. With these changes, prey Z should increase in Ecosim if predators increase.

Other changes include adjusting the last step of the diet matrix, which involved assigning prey to age stanzas. Rhode Island predator-prey size data were used to generate cumulative distribution functions of prey length data for fish prey by predator. However, this approach created situations where adult stanzas were eating disproportionately from age-0 stanzas. For example, striped bass age-6+ had a diet of 38% juvenile menhaden. The fix for this was to re-assigned prey to stanzas based on biomass proportion of prey stanzas. This didn't change the amount of diet attributed to specific species, but to species stanzas. For groups that had an EE > 1, diet adjustments were made to change the predator mortality levels to lower the EE. Biomass accumulation rates are also a result of these adjustments. Balancing the model mostly involved minor changes to the diet matrix.

For the Ecosim time series, a total of 27 biomass and 12 catch time series were used to calibrate the model. Relative catch was used for non-leading stanzas. Stock assessment biomass was included but with a weight of 0. All the time series were obtained from stock assessments except for anchovy and zooplankton. Annual observed time series were used with monthly forcing scenarios.

So far five model configurations have been run. The first three configurations (continuity, annual primary production, and monthly primary production) each have 28 calibration runs and the 4th and 5th configurations (monthly egg production and monthly vulnerability forcing) each have five calibration runs so far. The other two configurations (monthly F and full monthly) are yet to be calibrated.

To calibrate the model, only the vulnerability multipliers (k_{ij}) are estimable in Ecosim, and they are conditional on other input parameters and timeseries forcing functions. Each configuration is calibrated based on one of two calibration methods (k_j all predators and k_{ij} repeated search) and initialized by either k = 2, which is the default multiplier, or k_j Bunfo, which is scaling the vulnerability based on the relationship between unfinished biomass and the carry capacity in 1985. The prey switching power has also been calibrated but this is still being examined. 100 of 140 calibrations have been completed.

Prey switching was previously set to 1 for all interactions in the previous iteration of the model. Prey switching is defined as a predator taking disproportionately more of a prey as it becomes more abundant. To test the effect of prey switching, search rate parameters will be explored, and prey switching rates are being tested at various levels in the current calibrations.

The best fitting run was the continuity run with a k_{ij} repeated search calibration type and an initialization value of k_j Bunfo and prey switching 1. However, the sums of squares for the top ten models are not too far apart (ranging between about 1823 to about 2195).

The fits for individual predator and prey species in the best fitting model were explored with many improvements to the weakfish fits, which was a concern during the March Assessment workshop. In the most recent ~10 years, Atlantic herring fits show a much higher biomass than anticipated but this may be due to environmental drivers that are not represented in the model.

The group expressed some concern about the fits for Atlantic herring since it is an alternative prey for Atlantic menhaden. This will be examined for the other model fits to see if they demonstrate a similar trend before potentially implementing a forcing function to help herring reflect the data better. The group also recommended potentially running a sensitivity analysis for herring.

Equilibrium diagnostics were also explored for the best fitting run. With the parameters as estimated, the equilibrium becomes more unstable. This usually happens when a vulnerability is very close to 1. If this is bumped up to 1.1, it stabilizes the curve.

Next steps: D. Chagaris to continue work on the model runs and calibrations and send out model run summaries via email in an effort to help pick a base run.

NWACS-Full

The Ecopath model has been parameterized and balanced. There were 19 groups with EE > 1. Multistanza groups often had high EEs for the younger stanzas. This was fixed by adjusting the biomass accumulation rate to increase biomass (B) of lower age stanza and predator diets. A. Buchheister tried to avoid changes to B or Z for any assessed species and was more flexible with changing B or Z for non-assessed species. Menhaden EEs are better than last time (age 0: 0.84, age-1+: 0.60).

Groups with particularly high biomass included spiny dogfish, bluefish, hake, skates, and demersal piscivores. These often caused high M2 on unbalanced groups. To help with this, biomass estimates were adjusted for select groups when appropriate. Osprey biomass was also particularly low.

The Ecosim time series had 79 groups. Relative Biomass and Catch (instead of absolute) was used for non-leading stanzas. Relative B was used for non-assessed species. The time series were weighted to prioritize fit toward ERP species. Any time series coming from other stock assessment reports and other time series were weighted lower.

The fitting process followed a similar process to last time. This is similar to the MICE model's repeated search. Predator-prey vulnerabilities (v) were identified to see which impacted sums of squares the most, and a vulnerability search was conducted for 78 values. This process was repeated until sums of square or AIC didn't find a better model.

There are eight potential model fits, two of which have been fit so far. The first of these had no primary production forcing function, vulnerability caps, or manual adjustments. The second is a primary production forcing function but no vulnerability caps or manual adjustments. The latter of these had a lower SS and AIC.

For the model fits, there are several trade-offs due to the number of groups. The fits are generally comparable to the 2020 NWACS-Full model. Catch was a better fit than biomass (if F time series is present). Groups without F tend to be relatively flat. For ERP species, some fits are better than others. Strong recruitments events are not captured well (e.g., Haddock and yellowtail flounder). Oscillations are evident in some groups (e.g., yellow tail and summer flounder).

Compared to the 2020 model, the biomass trends are relatively similar with some variability based on changes to vulnerabilities. For weakfish, both iterations of the model are not fully capturing the trends in the data. Catch fits seem to be a bit more similar with still some difficulty capturing striped bass trends.

The next steps involve completing the different fits, using manual adjustments to improve diagnostics if necessary and to run future scenarios with the goal of providing a broader context for other ERP models.

The group asked if yellowtail trends may be caused by cannibalism, but this does not seem to be the cause. The group also asked about biomass fits for the new species. The model with primary production forcing is not following their trends well. For tuna, the model is predicting an increase, where the data shows a relatively flat trend and for osprey, it seems to be the opposite case. For the zooplankton, the time series tends to be relatively flat, and the model seems to be having difficulty capturing the dynamics. The model fit for microzooplankton is very strong.

Next steps: A. Buchheister to continue work on fitting the models and send results to group.

VADER

The statistical catch-at-age (SCA) model is an improvement over the traditional Virtual Population Analysis (VPA) for modeling ecosystem-related species. Unlike VPA, the SCA framework accounts for data errors by statistically estimating model parameters, and it can quantify the uncertainty in these parameters. This model is commonly used in single-species assessments but can be adapted for multi-species models. For example, the Vader model, part of the MICE model, incorporates six primary species and requires six key data series for each species. These data include commercial catch in weight, survey catch in numbers per tow, age proportions for both catch and survey data, weight-at-age information, and predator diet information by age. Additionally, the model accounts for total ecosystem biomass and the biomass of "other food" available in the ecosystem, assuming a constant total ecosystem biomass but allowing the biomass of other food to vary annually.

The model uses equations for year-class abundance, catch-at-age, and fishing mortality-at-age that are typical of age-structured assessments. M is partitioned into two components: predation and natural mortality. A dynamic M for specific species (STB) is also incorporated, based on Schiano's work. Fishery-independent survey data, such as age-specific abundance, are related to catchability assumptions. The model assumes age-invariant catchability and age-specific selectivity. Predator-prey size preferences are modeled using a lognormal function based on the predator-to-prey weight ratio, with externally calculated parameters. Though these species preferences and functional responses have not yet been updated in the current model, it is assumed that predators are not food-limited, which aligns with a Type-II functional response.

All species are explicitly modeled in this framework, and the parameters estimated include age-specific abundance for the first year, recruitment estimates, age-specific fishing mortality, and species-specific selectivity and vulnerability parameters. The model does not assume equilibrium since initial age- and species-specific abundances are estimated, and subsequent recruitment is treated as a mean parameter with deviations that sum to zero. Model parameters are estimated using maximum likelihood methods, implemented in AD Model Builder.

The model has an RTMB version, although it faced issues due to limitations in list recognition, requiring reconfiguration.

A penalized likelihood approach with priors was incorporated into the model, allowing for the estimation of parameters while assuming that data such as commercial catch, survey catch, and predator food habits contain errors. The commercial and survey catch data were assumed to follow a lognormal distribution, while the proportions of catch-at-age, survey age proportions, and predator food habits are modeled using Dirichlet multinomial distributions. Data for the model were drawn from existing single-species assessments.

The output fits for fishery independent surveys seem to have mixed results. The model fit for menhaden is not too different from the single species assessment. Striped bass has a bit of trouble fitting the MRIP time series and there are some patchy residuals but overall, the fits are adequate. Bluefish similarly fits pretty well overall. Weakfish has some noticeable residual patterns, but the model seems to be following the trends in a muted way for all except for the start of the YOY survey. The model has trouble fitting herring's NEFSC's survey using the R/V Albatross and R/V Bigelow data set. Similarly, the model has trouble accurately fitting spiny dogfish as well.

The outputs generally have a better fit for catch overall. Menhaden age-fits for catch seem to have good fits for early age classes but the model has trouble fitting age 6 and 7 accurately. For striped bass and bluefish, the fits seem to follow the data by age a bit better. For weakfish, ages 1, 6, and 7 have poor fits but the rest seem to be accurate. Herring age-1 seems to have a poor fit, but the rest have decent fits. Spiny dogfish has poor fits, especially in the later age classes.

For the selectivity plots, the model is hitting bounds which may be fixed through updating starting values or bound definitions. This may help improve model fits.

The model is showing high maximum fishing mortality for menhaden compared for the single-species assessment. For striped bass, the maximum fishing mortality matches the single species assessment fairly well at the end of the time series but not for the beginning.

M-at-age was also examined for menhaden and striped bass. The group asked if M can be attributed to various causes (prey abundance, etc.) like it can be in EwE models. The M-at-age in VADER is a deterministic calculation based on the input weight-at-age in a particular year.

There was also a proposal to use VADER as a primary model while posing the existing EwE-MICE/BAM interaction process as the primary way forward for now. Concurrently, there may be a way to transition to VADER in the future. The group expressed that they wanted a clear and transparent plan and criteria to transition to VADER to define when and how the transition would occur. The group also mentioned their desire to potentially have a spatial model, and they were uncertain whether VADER had those capacities. VADER may just be needed as a "nuts-and-bolts" model to help set quotas and answer management questions. The group also recommended refining the wording of the proposal to show that this is a potential option for moving forward. There was also a recommendation to possibly run the models together and run an ecosystem ensemble analysis. This may be worth pursuing outside of the timeline of assessments, depending on the time availability of the modelers.

Next steps: J. McNamee to finish the retrospectives and diagnostics for VADER and have VADER ready for peer review as a complimentary or supporting model with the potential of being ready for management use in the long term. The group agreed to discuss the VADER proposal between benchmarks.