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M E M O R A N D U M

Date: August 4, 2022

To: Michael P. Luisi, Chairman, MAFMC

From: Paul J. Rago, Ph.D., Chair, MAFMC Scientific and Statistical Committee (SSC)

Subject: Report of the July 2022 SSC Meeting

Executive Summary

Surfclam Genetics

Recently completed genetic studies of Surfclams suggest two significantly different haplotypes for *Spisula solidissima solidissima* and a difference between *S.s. solidissima* and *S.similis*. Gene flows among populations support high levels of genetic diversity. Report authors recommended management as separate species. The implications of these differences for management are unknown because differences in life-history traits are unknown. The ability to assess and manage these units as separate stocks will require major changes in monitoring procedures, as well as possible spatial management regulations.

Interim *Illex* Squid Specifications for 2023

The SSC received an update on the key findings of the Research Track Assessment (RTA) review panel. Attempts to develop a new stock assessment model were not successful and no biological reference points could be specified. Research conducted, particularly on aging and maturation, could lead to better models in the future, but in the meantime the SSC will continue to base its ABC recommendations on a risk analysis of escapement estimates based on the Councils Risk Policy and candidate reference points used in other squid fisheries. **The SSC recommended continuation of the 2022 ABC of 40,000 mt (approved in March 2022) for 2023. In March 2023 the SSC will receive an update of this analysis using data through 2022 and potentially revise this recommendation.**

Butterfish ABC Specifications for 2023-2024

The SSC reviewed the results of the RTA and received a Level 1 MTA (direct delivery) of the updated assessment through 2021. Despite considerable efforts to include new ecological information in the assessment, estimates of consumption of Butterfish by a wide range of fish, avian, and mammalian predators, data were insufficient to revise natural mortality rates. The stock was assessed with the recently developed state space model known as the Woods Hole Assessment Model (WHAM). **The SSC recommended the use of a F=2/3M biological reference point and catch limits of 17,267 mt for 2023 and 15,764 mt for 2024.**

Update on Recreational Reform Initiative and Harvest Control Rule

The SSC received an update on the decisions of the Council on the Harvest Control Rule and noted its sunset provision in 2025. The SSC expressed interest in continued involvement with the HCR process when a new FMAT is convened in 2023 to update the HCR.

Summer Flounder Catch Recommendation

Recreational catches declined in 2021. Catches continued to be below existing quotas. **The SSC recommended continuation of previously approved quota of 15,021 mt for 2023.**

Scup Catch Recommendation

Catches of Scup for 2021 were updated. The 2021 MTA concluded that the stock was not overfished and overfishing is not occurring. SSB remains above target values, but recruitment has been below average with 2019 being the lowest in the time series. **The SSC recommended continuation of previously approved quota of 13,460 mt for 2023.**

Black Sea Bass Catch Recommendation

Commercial catches of Black Sea Bass were under the quota in 2020 and 2021; recreational landings exceeded the RHL by 56% and 89% in 2020 and 2021, respectively. Black Sea Bass will be reviewed in a RTA in February 2023. **The SSC recommended continuation of previously approved quota of 7,557 mt for 2023.**

Bluefish Catch Recommendation

Bluefish are currently in a rebuilding plan and a RTA will be reviewed in December 2022. The state-space model known as the Woods Hole Assessment Model (WHAM) will be used. No new information was provided to suggest that a change from the current ABC is warranted**. The SSC recommended continuation of the current ABC of 13,890 mt for 2023.**

Northeast Regional Climate Action Plan

The SSC received an overview of the draft Northeast Regional Climate Action Plan. The presentation sparked much praise and debate within the Committee. Suggestions by the SSC included improving linkages with existing monitoring stations, considering improved survey sampling designs, developing a basis for support of spatial models, improving near-term forecasts of environmental drivers to reduce uncertainty in population forecasts, and

examining a broader range of species life histories when developing environmental forecast models (i.e., contrast *Illex* squid with Ocean Quahog).

Background

The SSC met in person and via webinar from 25th -26th of July 2022, addressing the following topics:

- Surfclam genetics
- Interim *Illex* squid specifications for 2023 fishing year
- Butterfish ABC specifications for 2023-2024
- Receive update on Recreational Reform Initiative and HCR decision from Council
- Summer Flounder catch recommendations for 2023
- Scup catch recommendations for 2023
- Black Sea Bass catch recommendations for 2023
- Bluefish catch recommendations for 2023
- Draft Northeast Regional Climate Strategy Action Plan

See Attachment 1 for the meeting's agenda. An Executive Summary provides a quick summary of the primary conclusions of the SSC.

Most SSC members were able to participate for all or part of the meeting (Attachment 2), but only five SSC members attended in person in Baltimore. Other participants included Council members, Council staff, NEFSC and GARFO staff, and representatives of industry, stakeholder groups, and the general public. Most participants were online rather than onsite. Council staff provided outstanding technical support to implement the hybrid meeting. The hard work of Brandon Muffley to plan the meeting and run the hybrid meeting is especially appreciated.

Within the SSC, Thomas Miller's leadership on the *Illex* squid TOR and Rob Latour's leadership on Butterfish TORs were exceptionally noteworthy. I thank Sarah Gaichas and Geret DePiper for contributing their meeting notes – they were a major help for crafting this report.

I also thank SSC members and Council staff for their comments on an earlier draft of this report.

All documents referenced in this report can be accessed via the SSC's meeting website https://www.mafmc.org/ssc-meetings/2022/july 25-26. A comprehensive guide to the acronyms in this report may be found in Attachment 5.

Atlantic Surfclam Genetics

In 2019 the Council supported a study to investigate potential genetic differences between *Spisula solidissima solidissima* and *Spisula solidissima similis* in the management area that extends from the Mid-Atlantic region to Georges Bank. Matt Hare, Cornell University, provided a detailed overview of recently completed genetic analyses of Surfclam samples. The purpose of his presentation was to begin discussions on the implications of these findings for assessments, surveys, and management, and identify further research.

Compared to earlier approaches, advances in genetic methods now allow for much higher capabilities to distinguish genetic differences among areas and potential gene flows. Differences in phenotypes are less well described, but the results may have important implications for future management of the mixture of haplotypes and subspecies that comprise the Surfclam resource.

Following these presentations and general discussion, the SSC addressed the Terms of Reference (italics) for the Surfclam genetics research. Responses by the SSC (standard font) to the Terms of Reference provided by the MAFMC are as follows:

Terms of Reference

For the Surfclam genetics research, the SSC will provide a written report that identifies the following:

1) *Evaluate and consider the results of the final report on Surfclam population structure and population connectivity (genetics) and the additional aging work completed;*

   The presentation stimulated considerable discussion within the SSC. The SSC appreciated the comprehensive and thorough summary of a complex topic. It also noted that the genetic methods and analyses reflected state-of-the-art approaches. The report was lucid and detailed. The SSC questions included the presence of hybrids, the ability to identify underlying ecological or climatic factors, and technical questions on the statistical analyses. The additional work on ageing is intriguing but, as noted below, further work will be necessary to determine the phenotypic importance of the genotypic differences detected.

   Modern genetic methods now allow for greater resolution of differences among sample sites. Latitudinal differences among samples from Georgia to Massachusetts were initially posited as important for distinguishing between *S.s.solidissima* and *S.s.similis*. However, the current study suggests important differences between inshore and offshore populations. In the parlance of modern genetics these are known as Operational Taxonomic Units (OTU).

   Metrics of genetic diversity appear to be similar for all OTUs, but clear distinctions among sample sites were detected. Two OTUs for *S.s.solidissima* were identified and their proportions varied by sample site. Investigators used Principal Components Analyses (PCA) and two measures of gene flow to describe spatial patterns. Initial ageing analyses of samples suggest differences in growth rates, but further studies are required to distinguish between genetic and environmental influences.

2) Identify potential implications to our understanding of Surfclam life history (i.e., recruitment, distribution, growth, maturity, etc.), to the stock assessment, NEFSC clam survey, and fisheries management;

   Current sampling is insufficient to determine the influence of genetic differences on recruitment, growth, maturity, or other life history traits. For example, initial investigations into differences in growth rates among haplotypes or subspecies need to include consideration of possible environmental differences, such as depth or productivity. It is currently unknown how the sample information scales to the total population. Many of the samples were taken inshore such

that the inshore strata may be oversampled relative to the population as a whole. Simply put, the samples may need to be properly weighted before estimating the total population fractions.

3) Identify new research needs to address data and science gaps with respect to the new information identified with the existing research.

Most of the recommendations for new research follow from the premise that genetic differences alone are not sufficient to change harvest levels or management.

The SSC noted that additional biological analyses are needed to determine whether different life history characteristics, including age and growth, can be associated with genetic differences. Further work is needed to evaluate how oceanographic processes (especially advective transport) affect patterns of gene flow and differences in OTUs. The implications of the genetic studies for management are indeterminate at this time. In particular, it is not clear how such differences will affect sampling regimes for the surveys, how biomass and F for spatial sub stocks will be estimated in the model, and how spatial management might be implemented. Alternative survey sampling allocations may be required, as well as increased spatial resolution of harvesting, particularly in state waters. As with other recent genetic analyses in the Northeast Region (e.g., cod), the questions of stock structure will ultimately be resolved by considering what differences are important and whether existing or future sampling programs can provide an adequate basis for more refined management. Continued monitoring of the distribution of the different species and haplotypes is essential, particularly if climatic changes are responsible. If spatially distinct exploitation patterns are evident then patterns of genetic diversity may change. It is not clear if historical exploitation would be sufficient to reduce genetic variation; available data do not suggest any significant differences in genetic diversity among species.

Hybrids were detected between the A and B OTUs but only two to three individuals were identified. No work on the role of ecological factors or climatic factors have been attempted (yet). While the PCAs generally explain a small fraction of the total variance, it was noted that such values are common when the number of potential genetic types are very high. In this study there were nearly 12,700 possible SNPs. The spatial and temporal patterns for genetic sampling were affected by Covid, and samples from smaller vessels operating in state waters may be overrepresented in the sampling relative to the total harvest patterns. Future sampling by the Joint Industry-NEFSC survey will be helpful for acquiring samples. Archiving of samples is considered valuable, particularly since samples may be analyzed several years after collection.

Illex Squid

This session opened with a formal recusal by Paul Rago on *Illex* decisions owing to his support from the Council for analyses. Michael Wilberg kindly served as chair of the SSC during these discussions.

Lisa Hendrickson, NEFSC, provided an overview of the updated catch data for 2021 and the 2022 NEEFC bottom trawl survey indices. Multiple state and regional surveys, along with

various DFO Canada surveys, were presented. The NEFSC spring survey has a much lower frequency (14%) of positive tows vs the fall survey, which averages about 57% positive tows. Surveys that cover only a small fraction of the stock area, particularly when inshore only, are difficult to interpret since abundance cannot be readily distinguished from availability. Landings in Canada increased significantly in 2022 with a sharp increase in the Newfoundland jig fishery. Total catches in 2021 for NAFO areas 3-6 were the highest since 1981. Discards constitute a small fraction (6.4%) of US catch. Various GLM model approaches have been used to summarize commercial vessel catch rates. Key predictors include vessel type, days absent, and port landed. These analyses may be useful for future stock assessments.

Key results from the March 2022 Research Track Assessment include:

- Estimates of stock biomass and fishing mortality rates could not be provided because none of the proposed approaches were considered sufficient.
- A generalized depletion model (GDM) was attempted, but its reliance on strong assumptions and weekly data led to its rejection for assessment advice. Increased frequency of data (daily rather than weekly), and alternative model parameterizations may be helpful in future applications. Importantly, simulation testing using realistic assumptions about migration of *Illex* into and out of the survey area should be investigated. The CIE reviewers, however, were not unanimous in their recommendations for future work on the GDM.
- The Plan B smooth approach was not recommended given the limited support for autocorrelation in indices and the multiple generations of *Illex* that occur between annual survey estimates.
- No revised biological reference points were developed and a previously used method could not be applied due to lack of contemporary data.
- Valuable information on *Illex* ageing was obtained via seasonal biological sampling supported by industry and the Council. These and other scientific advances, notably in understanding of oceanographic influences, were summarized in the SSC report from its May 9-19, 2022 meeting,
- An ensemble approach of multiple models, which examine the range of abundance estimates over likely ranges of catchability, availability, and natural mortality, was recommended as an interim approach for providing catch advice. These methods have been considered by the SSC in its derivation of ABCs for 2020 to 2022.
- Reviewers recommended a Management Strategy Evaluation (MSE) approach for future assessments.
- Difficulties with the timing of the RTA and subsequent MTA were noted. In particular, the 2022 ABCs were set in March only a few days after the RTA was completed. The joint comments of the reviewers were not received until May and the CIE reviews were not available until just before this SSC meeting.

I (Paul Rago) summarized the methodology used by the SSC in March 2022 for its determination of ABC for the 2022 fishery. The methodology used by the SSC is largely based on the approaches presented to the RTA but differs in several important ways:

- Numerical methods are improved and the joint effects of the range of model parameters are considered. These changes allow for estimation of the distribution of possible outcomes for key decision variables, such as escapement.
- Alternative quotas are examined with respect to their consequences for risk of exceeding biological reference points (BRP). There are no accepted BRPs for *Illex* squid, but the escapement targets ranging from 40 to 50% have been used for other squid fisheries. In addition, harvest rates where F=2/3 M have been used for forage species in various assessments around the world. The methodology allowed the SSC to examine the probability of violating the reference point for various levels of catch limits ranging from 24,000 to 60,000 mt.
- The Council's Risk Policy was recognized by considering the current stock status ranging from 0.5 to 1.5 B_{msy}. Earlier assessments and previous SSC deliberations have concluded that *Illex* appears to be lightly exploited.
- Further work could include consideration of uncertainty in the survey indices. This would be expected to increase the range of likely outcomes for key decision variables, such as escapement.

Jason Didden, MAFMC, provided a summary of input from the Advisory Panel, comparisons of current landing with last year's catch rates, and initial recommendation for catches in 2023. Catch rates in 2022 have only recently begun to increase. High catch rates and prices for longfin squid and high fuel costs may be delaying the shift towards *Illex* fishing. Various oceanographic drivers of *Illex* availability in the fishing areas are continuing to be monitored. Council staff recommend a continuation of the 40,000 mt ABC as a provisional quota for 2023 in lieu of additional analyses. The analyses considered by the SSC in March 2022 will be updated in March 2023 to include new survey data and potential enhancements described above.

SSC discussions noted the divergence of opinions by the CIE reviewers, particularly with respect to the future utility of the GDM approach. However, there was general agreement by the CIE and SSC that an MSE-like approach would be valuable. The SSC noted that Rago's work partially addressed these issues and might serve as a basis for future work.

A closed loop simulation framework with alternative Harvest Control Rules (HCR) was suggested. Fishery dependent CPUE indices should be considered more extensively.

It was noted that the TOR for the RTA did not include a specific recommendation to examine alternative catch limits. This omission explains some of the differences for methods considered in the RTA with respect to methods used by the SSC. The SSC noted that the distinction between what NOAA Fisheries uses for determination of stock status and what the SSC needs for decision making should be highlighted. The Council needs to manage the fishery based on the scientific advice from the SSC, irrespective of the validity of the formal status determination. The SSC noted that TOR in RTA should be updated to reflect the dilemma when assessments fail. The RTA and MTA process should revisit this aspect of the assessment planning and review process. With respect to *Illex*, the catch advice is being crafted apart from the formal review process. Efforts should be placed on how to manage without an assessment. Continuation of work begun by the RTA for Index Methods could be useful.

Following these presentations and general discussion, the SSC addressed the Terms of Reference (italics) for *Illex* Squid. Responses by the SSC (standard font) to the Terms of Reference provided by the MAFMC are as follows:

Terms of Reference

For *Illex* squid, the SSC will provide a written report that identifies the following for the 2023 fishing year:

1. *Utilizing the 2022 research track stock assessment and peer review results and the most recent fishery and NEFSC trawl survey information, specify a preliminary 2023 acceptable biological catch (ABC), in weight, and provide any rationale and justification for the recommended ABC (note: the SSC will review an updated "Indirect Method" analysis in March 2023 with 2022 catch and the fall 2022 NEFSC trawl survey information, which could be used to modify/finalize the 2023 ABC);*

   The Research Track Assessment (RTA) did not provide any acceptable reference points on which the SSC could base any revision of our previous March 2022 specification.

   In March 2022, the SSC established an ABC of 40,000 MT. This ABC emerged from the Council-supported escapement analysis and was associated with an approximately 5% chance of exceeding the ⅔ F:M generic guidance for data poor species. Model results suggest this provides greater than 50% escapement for *Illex* squid.

   The SSC expects to revisit this ABC in March 2023.

2. *Provide any recommendations or areas of consideration to update the "Indirect Method" analysis (see Rago 2022) for 2023;*

   The SSC recommends the following analyses be considered to improve the "indirect method analysis":

   - Consider effects of point estimates of uncertainty in estimates of abundance on overall risk profiles.
   - Undertake a "first principles" consideration of the sign and potential magnitude of covariation among q, v, and M.
   - Conduct exploratory analyses over whether the model effort results are sensitive to levels of covariation among q, v, and M. If these exploratory analyses indicate that covariation is important, additional analyses should be conducted to inform the scale of the anticipated covariation.
   - Consider development of an "indirect method" analysis package that facilitates the transfer of the approach to the Center.

   The SSC notes that the recommendations provided above are offered as short-term improvements in the indirect method. The SSC joins the external peer reviewers of the RTA in recognizing the need for a longer-term plan for improvements to the scientific advice to managers for this species. The SSC notes also a desire for improvements in the systems and procedures used to deliver that scientific advice, given the short life span of this species and the highly variable nature of its biology and ecology.

3. The most significant sources of scientific uncertainty associated with determination of the ABC;

The SSC concluded the following sources of uncertainty were important:

- The lack of a peer-reviewed OFL introduces substantial uncertainty for the foundation of ABC determination. As an alternative, the SSC is relying on data-poor approaches and reference points used to manage other squid fisheries and used to promote sustainability of exploited forage species.
- Continued uncertainty over the fraction, and the interannual variability, of the squid population that is subject to exploitation. This likely leads to estimates that are likely lower bound estimates of the impact of the fishery on the squid population.
- The lack of understanding of stock-recruitment processes in squid complicates development of biological reference points.
- The lack of understanding of the coherence of squid availability on the shelf with environmental drivers of distribution complicates understanding of whether sequences of good or bad years are likely to occur, which would bias understanding of stock status when using data poor approaches.
- Levels of escapement or other biological reference points that afford protection against overfishing are poorly understood analytically and empirically.
- Estimates of q, v, and M are uncertain and estimates are assumed to be uncorrelated, whereas there are easily conceived processes that could introduce correlations among these key parameters.

4. A conclusion that the recommendations provided by the SSC are based on scientific information the SSC believes meets the applicable National Standard guidelines for best scientific information available.

The SSC certifies this advice meets the National Standard guidelines for best scientific information available.

Butterfish

Charles Adams, NEFSC, provided an updated MTA using data through 2021. The methodology was based on the recently-completed RTA that included a new state-space modeling approach known as the Woods Hole Assessment Model (WHAM). A key difference between this model and earlier ASAP models is that the numbers at age are modeled as an autoregressive process. Many of the technical innovations and ancillary research efforts were presented to the SSC at its May 2022 meeting.

Estimated natural mortality rates are about M = 1.3/yr, which suggest a short life span. However, examination of estimated consumption of Butterfish by a broad range of piscine, avian, and mammalian predators was insufficient to explain the high natural mortality rates. Predation from other predators, perhaps squid, or another source of mortality may be important. The high rates of natural mortality, rapid growth, and early maturation lead to very high rates of fishing mortality at 50% MSP and higher still at 40% MSP (i.e., F>5.6/yr). The implied stock

biomass at $F_{40\%MSP}$ was lower than any point estimate of biomass in the 40+ year time series. This may be true if the resource has been lightly fished, but the CIE Peer Review Panel and RTA chair expressed concerns about the validity of such high rates. Underlying this concern was the consequence of being wrong for future fisheries. Much hinges on the reliability of the catchability estimate of the NEFSC bottom trawl survey, and the associated fixed estimate of availability over all years. Setting this parameter at a fixed value is the primary control on stock size estimates, which in turn allows for estimation of M. If the catchability estimate has changed in recent years, the high population biomass would be an artifact. To counteract this possibility, the Review Panel recommended consideration of a reference point for F = 2/3M, based on an approach of Patterson (1992). Using this alternative reference point basis, the stock is not overfished and overfishing is not occurring. Using a lower F for reference point implies that the %MSP is higher than 50%, but the exact value was not available for review by the SSC.

A review of assessments since 2009 provides additional context for the F = 2/3M reference point. A delay-difference model failed to determine scale. A later assessment, using ASAP4 allowed for incorporation of thermal habitat as a primary determinant of Butterfish availability. The product of availability and gear efficiency led to a time invariant catchability because interannual variations in thermal habitat were small. A $F_{50\%MSP}$ reference point was rejected in that assessment as well, so the choice of an F = 2/3M reference point in this assessment is consistent with previous assessment reviews. The current assessment suggests that maturation is occurring at an earlier age which also leads to a higher $F_{50\%}$ value. Given the "fast" dynamics of this species , the SSC commented on the potential value of using a subannual time-step in the model. However, no specific proposals were tabled.

Jason Didden, MAFMC, reviewed the current fishery, noting that effort is low in view of much better prices for Longfin squid.

Following these presentations and general discussion, the SSC addressed the Terms of Reference (italics) for Butterfish. Responses by the SSC (standard font) to the Terms of Reference provided by the MAFMC are as follows:

Terms of Reference

For Butterfish, the SSC will provide a written report that identifies the following for the 2023-2024 fishing years:

1. *Based on the criteria identified in the acceptable biological catch (ABC) control rule, assign the stock to one of four types of control rules (analytically derived, modified by the assessment team, modified by the SSC, or OFL cannot be specified) the SSC deems most appropriate for the information content of the most recent stock assessment;*

   Type 3 (Modified by the SSC): the SSC recommends the use of F = ⅔ M as a reference point because the F50% reference point was not accepted by the peer review panel. This reference point has been used in past Butterfish assessments.

2. *If possible, determine the level of catch (in weight) associated with the overfishing limit (OFL) for each requested fishing year based on the maximum fishing mortality rate threshold*

or, if appropriate, an OFL proxy, and the associated coefficient of variation recommended by the SSC and its basis. If necessary, please provide any rationale and justification for the maximum fishing mortality rate threshold (or proxy) used to determine the OFL;

The SSC applied a 100% OFL CV based on the table in Attachment 4. See criteria in Attachment 3.

OFL for 2023 based on F = ⅔ M = 0.85 is 17,631 mt.
OFL for 2024 based on the same F is 16,096 mt.

3. *The level of catch (in weight) and the probability of overfishing (P*) associated with the ABC for each requested fishing year, based on the traditional approach of varying ABCs in each year. If appropriate, specify interim metrics that can be examined to determine if multi-year specifications need reconsideration prior to their expiration;*

ABC for 2023 is 17,267 mt with a P* of 0.49
ABC for 2024 is 15,764 mt with a P* of 0.49

Interim metrics:
CPUE from the surveys and indices of recruitment

4. *The most significant sources of scientific uncertainty associated with determination of OFL and ABC;*

- Choice of reference points, especially $F_{50\%}$, since the value was estimated to be > 6.0 in the research track assessment, and 5.6 in the management track assessment.
- Scale of the population. A q of 0.2 for the Fall Albatross survey was needed to reasonably scale the population. However, a q of 0.2 implies that up to 80% of the stock is not within the survey area, which is potentially problematic given that Butterfish are frequently captured throughout the survey.
- Uncertainty in discard estimates, particularly early in the time-series.
- Gap-filling procedures potentially blending cohorts and potentially leading to bias in the age composition data.
- Estimated consumption removals account for only a small fraction of estimated M. Results seem inconsistent with Butterfish being considered a forage species.

5. *Ecosystem considerations accounted for in the stock assessment, as appropriate, and any additional ecosystem considerations that the SSC considered in selecting the ABC, including the basis for those additional considerations;*

Changes in Butterfish condition were related to ecosystem indices and used to determine the appropriate stanza for recruitment projection starting in 2011.

Considerable work estimating consumption of Butterfish by fishes, marine mammals, and seabird predators was completed. Unfortunately, this did not further resolve the Butterfish natural mortality estimate.

6. *Research or monitoring recommendations that would reduce the scientific uncertainty in the ABC recommendation and/or improve the assessment level;*

   In addition to the research recommendations identified by the peer review panel (see page 6 of the Summary Report of the 2022 Butterfish and Shortfin Squid Research Track Stock Assessment Peer Review), the SSC recommends the following:

   - Research into survey catchability is a high priority.
   - Examine shorter (sub-annual) model time steps.
   - Evaluate maturity methods, impact on maturity ogive, and estimated reference points.
   - Consider alternative ways to calculate discards.
   - Evaluate adequacy of port sampling to support continued assessments (is full age structure sampled?).
   - What is eating butterfish? Consider additional methods to estimate predation mortality.
   - Evaluate methods for developing age length keys to avoid pooling.

7. *The materials considered by the SSC in reaching its recommendations;*

   - SSC Terms of Reference for Butterfish
   - Staff Memo: 2023-2024 Butterfish ABC Recommendations
   - 2022 Butterfish Management Track Assessment Report
     - Management Track Report Figures
     - Management Track Report Tables
   - 2023-2024 Butterfish OFL/ABC Stock Projections
   - Draft Butterfish OFL CV Decision Criteria Summary
   - Summary Report of the 2022 Butterfish and Shortfin Squid Research Track Stock Assessment Peer Review (same report as provided under Illex above)
   - Center for Independent Experts (CIE) Reports for the 2022 Butterfish and Shortfin Squid Research Track Stock Assessment Peer Review (same reports as provided under Illex above):
     - Report #1 - Thomson
     - Report #2 - Cook
     - Report #3 - Chen
   - 2022 Butterfish Research Track Assessment Working Group Report
     - See the Stock Assessment Support Information (SASINF) Search Tool for additional information including tables, figures, and additional analyses
   - April 11, 2022 Assessment Oversight Panel (AOP) Report (same report as provided under Illex above)
   - 2022 Butterfish Advisory Panel Fishery Performance Report
     - Supplemental: Consumption of important pelagic fish and squid by predatory fish in the northeastern USA shelf ecosystem with some fishery comparisons (Overholtz 2000)
   - 2022 Research Track Industry Perspectives Working Paper
   - 2022 Butterfish Fishery Information Document

- Hare, J. A., Morrison, W. E., Nelson, M. W., Stachura, M. M., Teeters, E. J., Griffis, R. B., Alexander, M. A., et al. 2016. A Vulnerability Assessment of Fish and Invertebrates to Climate Change on the Northeast U.S. Continental Shelf. PLOS ONE, 11: e0146756. Supplemental information at https://www.st.nmfs.noaa.gov/data-and-tools/NE-CVA/pdf/Tilefish.pdf

8. A conclusion that the recommendations provided by the SSC are based on scientific information the SSC believes meets the applicable National Standard guidelines for best scientific information available.

The SSC agrees that this recommendation is based on the best available scientific information.

Update on Recreational Reform Initiative and Harvest Control Rule

Julia Beaty, MAFMC staff, provided a review of the Council decision on the Harvest Control Rule made at its June 2022 Meeting. The Council selected the option known as the Percent Change Approach. This approach relies on a comparison of the joint distribution of recent average catches from the last two years with the projected RHL based on the assessment. When the projected RHL lies outside of the prescribed confidence interval, one or more management actions may be imposed to adjust the expected catch. The magnitude of these changes (liberalization or restriction of regulations) depends on the current biomass status of the resource. The Council-approved method will first be implemented in 2023 for Summer Flounder, Scup, and Black Sea Bass. Bluefish regulations will not be affected because it is currently in a rebuilding plan. To allow for continued improvement of the methodology, the amendment will sunset in 2025 and be followed by an anticipated revised methodology informed by new information and experience.

SSC members inquired about who will be leading the development of new methods. Julia responded that a new FMAT will be formed, possibly including an SSC member. Additional concerns were raised about the possible interactions between quota limits imposed on commercial fisheries and effort regulations applied to the recreational harvests. There are no interactions specifically considered in the approved HCR amendment, but it was noted that current MSE approaches used for Summer Flounder do include consideration of some aspects of interactions. Members inquired about the short anticipated life span of this amendment and ways in which the success or failure would be judged. No specific or incremental monitoring plans have been proposed, but the addition of two additional years of data, along with estimates of the realized F given the recreational harvests, would be useful as a means of evaluating the efficacy of the measures. SSC members encouraged more detailed consideration of differences between the for-hire vessels and the private boat and shore-based anglers. As noted in its previous review of the HCR, the SSC reiterated that management uncertainty may increase as a result of HCR interventions, which, in turn, could lead to changes in data quality and possibly changes in the OFL CV.

Members of the public inquired about the level of stock status necessary to require accountability measures, especially in the case of recreational overages. Accountability measures are grouped into three different biomass categories. Pound-for-pound paybacks are required when the stock is below the threshold. Above the threshold, the payback is variable and recommendations on the magnitude of payback are based on analyses of the Monitoring Committee.

Summer Flounder

Kiley Dancy, MAFMC, led the initial discussion by reviewing the results of the 2021 MTA, noting that the stock was not overfished and no overfishing was occurring in 2019. The estimated recruitment in 2018 was above average and is showing up in updated size frequency distributions from the fishery. Discard estimates for 2020-2021 are not yet available, but recreational harvests in 2021 were low. Commercial harvests have typically been below the quota. Improved methods for estimation of dead discards are desired and further work by the monitoring committee is needed. Prices for summer flounder have been low in 2022 so far and fuel prices have been very high. The potential profit squeeze may lead to catches lower than quotas in some states.

Questions were raised about the precision of recreational harvest limits and their potential utility for evaluating the interim information on stock condition by the SSC. Mark Terceiro, NEFSC, reported that typical CVs for Summer Flounder were about 10% for the stock as a whole over the entire year. Other SSC members suggested some consideration of overall recreational effort and measures of CPUE as potential signals for consideration. Recreational CPUE is not used in model development. Terceiro noted that Covid led to reductions in angler sampling efforts in 2020 and 2021; this could compromise interpretation of trends in recent years.

Members of the public inquired about the availability of commercial and recreational discards. Commercial discard estimation for 2020 and later relies on an updated CAMS data. To date, the Center and Regional Office have focused on providing timely estimates for species undergoing RTA. As a result, information for other species has lagged.

SSC found no reasons to change the ABC and recommends continuation of the previously approved ABC=15,021 mt for the 2023 fishing year.

Scup

Hannah Hart, MAFMC, provided an overview of stock status and the recent fishery information for Scup. The 2021 MTA concluded that the stock was not overfished and overfishing is not occurring. While SSB remains above target values, recruitment has been below average with 2019 being the lowest in the time series. Recreational catches were close to or exceeded RHL in the past two years (98% and 171%, respectively) and are greater than commercial catches. Because the stock size remains high, there are no provisions for payback of recreational catch overages. Scup commercial landings in 2022 are tracking patterns observed in 2021 fairly closely. The commercial fishery has been below quota levels in all years.

Model projections suggest the population will continue to decline as the strong year classes die out. However, despite the RHL overages, no evidence suggests the need to change the previously specific catch levels.

The SSC recommended continuation of previously approved quota of 13,460 mt for 2023.

Black Sea Bass

Julia Beaty, MAFMC, opened the discussion by reviewing current stock status and recent harvests of Black Sea Bass. The stock is not overfished and overfishing is not occurring. An RTA is currently underway with an expected review in February 2023. In the most recent MTA the retrospective pattern suggests significant underestimation of biomass and overestimation of F. This pattern is uncommon in Mid-Atlantic assessments. Year classes in 2011, 2015, 2016, and 2019 were above average. Recreational landings have exceeded RHLs in 2021 by 89%, while commercial landings continue to be below ACLs. Discard estimates have lagged due to impacts of Covid on sampling schedules and the ongoing efforts to reconcile catch estimation methods in the CAMS project.

Historic overages in the recreational fishery and imposition of accountability measures led to a low RHL in 2022. High fuel prices and other costs are expected to further reduce fishing effort.

The SSC questioned the basis for projections, noting that the retrospective adjustment biomass was positive. NEFSC staff advised that the forecasts were based on properly adjusted terminal year abundance estimates.

The SSC recommended continuation of previously approved quota of 7,557 mt for 2023.

Bluefish

Karson Cisneros, MAFMC, began the discussion with an overview of the current status of Bluefish and a summary of recent fisheries. The 2021 Management Track revealed that the stock remains overfished, but overfishing is not occurring. A Research Track Assessment will be reviewed in December 2022 followed by an MTA in 2023 to inform catch advice for 2024-2025. The SSC expressed interest in learning about scientific advances from the RTA at its March 2023 meeting.

Recreational CPUE declined in 2020, but increased slightly in 2021. The NEFSC and GARFO are working on improved estimation of recreational discards, particularly differences in practices between northern and southern states. The SSC highlighted the importance of compliance in the recreational fishery and implications for assessments and rebuilding plans.

The commercial fishery has been under the annual quotas, but catches above the RHL will trigger accountability measures with pound-per-pound payback of overages in 2023. An estimated 97% of Bluefish recreational landings occur in state waters. Total catch has declined. Spatial and temporal patterns of Bluefish availability vary by state, but no major anomalies were

observed in 2021 and thus far in 2022. Inshore presence of tuna, noted in several states, may be affecting Bluefish catches.

In the absence of any major signals and in consideration of the potential revisions to the stock estimates in the RTA, the **SSC recommends no change to the previously adopted 2023 ABC of 13,890 mt.**

Northeast Regional Action Plan for Climate Science

Vince Saba, NEFSC, presented an overview of the draft Northeast Regional Action Plan (NERAP) accomplishments to date and new initiatives for 2022 and beyond. The Northwest Atlantic Region is warming faster than elsewhere around the globe as the behavior of the Gulfstream continues to change and marine heat waves become more common. Surface pH has also declined with the increased uptake of atmospheric CO_2. As waters warm, many fish species have responded by moving north and into deeper waters. In response to these changes NERAP 2.0 has identified ten priority research actions for public review and comment. The initial version of NERAP 1.0 achieved a number of goals, including progress on species, habitat, and social vulnerability analyses. Formal approaches to scenario planning are underway, and laboratory studies have been used to inform process-oriented models. Some progress has also been made in the inclusion of environmental factors in stock assessment models. Physical oceanography models have improved significantly, thereby affording higher resolution temporal and spatial models that can improve linkages with resource utilization (e.g., fishing practices). However, near-term prediction skill for physical and chemical processes remains poor.

NERAP Priority Action research goals (abbreviated) include:

1: Maintain ecosystem survey and data collection efforts in the Northeast U.S. Continental Shelf ecosystem.
2: Coordinate with other partners to link living marine resource data, science, and management to climate science and research.
3: Continue to build industry-based fisheries and ocean observing capabilities.
4: Continue production of the NEFSC State of the Ecosystem reports.
5: Conduct laboratory and field research on the mechanistic effects of multiple climate factors on living marine resources to inform process-based models.
6: Work with partners to develop and improve regional hindcasts, forecasts, and projections of ocean and estuarine/river physics and biogeochemistry to develop and improve climate-ready management of living marine resources.
7: Improve spatial management of living marine resources.
8: Develop and use Vulnerability Analyses, Scenario Planning, and Management Strategy Evaluations to examine the effects of different management strategies under various climate change scenarios
9: Increase social, economic, and ecosystem scientist involvement in climate change research through multidisciplinary work.
10: Develop stock assessment models (e.g., WHAM) that include environmental terms with a priority for stocks in Research Track Assessments.

The SSC applauded the considerable progress achieved under NERAP 1.0 and looks forward to future accomplishments under NERAP 2.0. SSC discussions included concerns about the diminished role of historical observations as more recent trends dominate discussions and research focus. The SSC emphasized a need for high resolution temporal data (e.g., for phenology comparisons across years), especially from fixed buoys and possible collaborations with wind energy installations. It was noted that high resolution models such as those developed under Action Item 6 can help fill in data gaps. Cooperative research with fishery dependent platforms is central to this effort.

SSC members also acknowledged the importance of spatial modeling (#7). New assessment models that incorporate high resolution environmental data, as well as spatial and temporal harvesting patterns, will be essential in a changing environment. The VAST model framework provides a consistent approach to estimation at different temporal and spatial scales. Combining VAST with WHAM to take advantage of state-space methodology could be a productive endeavor. One of the key modeling limitations is poorly resolved harvest data. Several approaches are underway (e.g., study fleets) to acquire such information. Vessel Monitoring System data were suggested as an alternative approach to examining the totality of fishing behavior. In turn, such data could unlock the potential of Study Fleet data by allowing proper weighting of the subsample data to the whole fleet.

The SSC expressed some concerns about future funding of these projects. Internal reallocation of resources to address these needs is underway and collaborative studies with Canada have improved the comprehensiveness of some surveys. Attention should be given toward improving the precision of existing surveys via improved sampling strategies.

The nexus between science and management needs improvement. Inclusion of environmental data in stock assessment is valuable but the necessary next step is to generate near term forecasts of ecosystem conditions. Such forecasts, as noted above, often have low prediction capability, but recent physical modeling improvements may prove useful. Recent work on the dynamics of the Cold Pool have been illustrative.

SSC inquired about the current status of ecosystem models such as ATLANTIS. Substantial progress has been made, especially through the inclusion of higher resolution physical forcing for both historical evaluations and future projections.

Members of the public inquired about the linearity of environmental drivers (e.g., temperature) and the likelihood of interactions with other factors. Not all drivers will change at the same rate, so comprehensive approaches to modeling effects of environmental processes on biological responses are a high priority. Simulation studies are helpful in this regard. SSC further noted that effects vary across species, such that techniques applicable to, say, Summer Flounder may be less useful for *Illex* squid.

The SSC did not develop a formal list of recommendations, but discussions suggested an emphasis on the following concerns:

- Improve linkages with existing monitoring stations.

- Improve design efficiency for existing sampling programs.
- Increase temporal resolution of sampling to examine finer scale seasonal and phenological changes.
- Increase focus on spatial modeling of populations and increase spatial and temporal resolution of harvest estimates.
- Improve short-term forecasts of environmental data to avoid increases in uncertainty when incorporating environmental data in assessments.
- Consider a broader range of species when developing environmental forecast models to address the span of life histories ranging in scope from *Illex* squid to Ocean Quahogs.

The SSC looks forward to regularly receiving updates on implementation progress for the Action Plans identified under NERAP 2.0.

Other Business

The Scientific Coordination Subcommittee will be hosting a workshop of the Fishery Management Council's Scientific and Statistical Committees August 15th-17th in Sitka, Alaska. Sarah Gaichas will be presenting a keynote address. The focus of the meeting will be inclusion of ecosystem information in stock assessments. In addition to Brandon Muffley, the following SSC members will be attending: Olaf Jensen, Yan Jiao, and Alexei Sharov.

The SSC initiated discussions of potential topics for consideration at the October joint meeting of the Council and the SSC. An expected topic will be review of progress of the Ecosystem Working Group.

Brandon Muffley updated the SSC about the effects of recent delays in Research Track Assessments for SSC deliberations. None of the recent changes are expected to affect the ability of the SSC to derive ABCs, but it was noted that the interval between completion of the RTA and initiation of the MTA will be undesirably short. John Boreman will be chairing the RTA for Spiny Dogfish and Bluefish in December 2022. The Council is seeking an SSC member to chair the Black Sea Bass RTA in February 2023. The July 2023 meeting of the SSC will require derivation of ABCs for at least six species, including Atlantic Mackerel, Spiny Dogfish, Summer Flounder, Scup, Black Sea Bass, and Bluefish.

Attachment 1

Mid-Atlantic Fishery Management Council

Scientific and Statistical Committee Meeting

July 25 – 26, 2022

Hybrid Meeting:
Baltimore Marriott Waterfront (700 Aliceanna Street, Baltimore, MD 21202)
or via Webex webinar

This meeting will be conducted as a hybrid meeting. SSC members, other invited meeting participants, and members of the public will have the option to participate in person at the Baltimore Marriott Waterfront or virtually via Webex webinar. Webinar connection instructions and briefing materials will be available at Council's website: https://www.mafmc.org/council-events/2022/july-2022-ssc-meeting

AGENDA

Monday, July 25, 2022

10:00 Welcome/Overview of meeting agenda (P. Rago)

10:05 Surfclam species diagnostics and population connectivity estimates to inform management
- Presentation on research project final results (M. Hare, Cornell University)
- SSC feedback and input on document for consideration by Council

12:00 Lunch

1:00 Interim *Illex* squid specifications for 2023 fishing year
- Overview of research track assessment results, peer review findings and most recent fishery and survey information
- Review of staff memo and 2023 ABC recommendation (J. Didden)
- Interim 2023 SSC ABC recommendation (T. Miller)

3:00 Break

3:15 Butterfish ABC specifications for 2023-2024 fishing years

- Overview of 2022 management track assessment (C. Adams)
- Review staff memo and 2023-2024 ABC recommendations (J. Didden)
- 2023-2024 SSC ABC recommendations (R. Latour)

5:45 Adjourn

Tuesday, July 26, 2022

8:30 Update on Recreational Reform Initiative and Harvest Control Rule

- Outcomes from June 2022 Council meeting

9:00 Summer Flounder data and fishery update: review of previously recommended 2023 ABC (K. Dancy)

9:30 Scup data and fishery update: review of previously recommended 2023 ABC (H. Hart)

10:00 Black Sea Bass data and fishery update: review of previously recommended 2023 ABC (J. Beaty)

10:30 Break

10:45 Bluefish data and fishery update: review of previously recommended 2023 ABC (K. Coutre)

11:15 Draft Northeast Regional Climate Strategy Action Plan

- Overview of draft 2022—2024 plan (V. Saba, NEFSC)
- SSC input and feedback for Council consideration in comment letter

12:30 Other Business

- Joint Council/SSC meeting – initial discussion on potential topics

1:00 Adjourn

Note: agenda topic times are approximate and subject to change

Attachment 2

MAFMC Scientific and Statistical Committee

July 25 - 26, 2022

Meeting Attendance via Webinar

Name	Affiliation
SSC Members in Attendance:	
Paul Rago (SSC Chairman)	NOAA Fisheries (retired)
Tom Miller (July 25th only)	University of Maryland – CBL
Ed Houde	University of Maryland – CBL (emeritus)
Dave Secor	University of Maryland – CBL
John Boreman	NOAA Fisheries (retired)
Lee Anderson (July 25th only)	University of Delaware (emeritus)
Jorge Holzer	University of Maryland
Yan Jiao	Virginia Tech University
Rob Latour	Virginia Institute of Marine Science
Brian Rothschild	Univ. of Massachusetts-Dartmouth (emeritus)
Sarah Gaichas	NOAA Fisheries NEFSC
Wendy Gabriel	NOAA Fisheries (retired)
Mike Wilberg (Vice-Chairman)	University of Maryland – CBL
Cynthia Jones	Old Dominion University
Gavin Fay	U. Massachusetts-Dartmouth
Alexei Sharov	Maryland Dept. of Natural Resources
Geret DePiper	NOAA Fisheries NEFSC
Mark Holliday	NOAA Fisheries (retired)
Others in attendance (only includes presenters, staff, and members of public who spoke):	
Jason Didden	MAFMC staff
Brandon Muffley	MAFMC staff
Julia Beaty	MAFMC staff
Jeff Kaelin	Lund's Fisheries
José Montañez	MAFMC staff
Charles Adams (July 25th only)	NEFSC
Lisa Hendrickson (July 25th only)	NEFSC
Greg DiDomenico	Lund's Fisheries
Meghan Lapp	Seafreeze Ltd.
Michelle Duval	MAFMC
Vince Saba (July 26th only)	NEFSC
Mark Terceiro (July 26th only)	NEFSC
Tony Wood (July 26th only)	NEFSC
Matt Hare (July 25th only)	Cornell University
Hannah Hartung (July 25th only)	Cornell University
James Fletcher	United National Fisherman's Assoc.
Jessica Coakley	MAFMC
Hannah Hart	MAFMC

Karson Cisneros	MAFMC
Kiley Dancy	MAFMC
Tracy Bauer	ASMFC

Attachment 3

OFL CV Decision Table Criteria (updated June 2020)

Decision Criteria	Default OFL CV=60%	Default OFL CV=100%	Default OFL CV=150%
Data quality	One or more synoptic surveys over stock area for multiple years. High quality monitoring of landings size and age composition. Long term, precise monitoring of discards. Landings estimates highly accurate.	Low precision synoptic surveys or one or more regional surveys which lack coherency in trend. Age and/or length data available with uncertain quality. Lacking or imprecise discard estimates. Moderate accuracy of landings estimates.	No reliable abundance indices. Catch estimates are unreliable. No age and/or length data available or highly uncertain. Natural mortality rates are unknown or suspected to be highly variable. Incomplete or highly uncertain landings estimates.
Model appropriateness and identification process	Multiple differently structured models agree on outputs; many sensitivities explored. Model appropriately captures/considers species life history and spatial/stock structure.	Single model structure with many parameter sensitivities explored. Moderate agreement among different model runs indicating low sensitivities of model results to specific parameterization.	Highly divergent outputs from multiple models or no exploration of alternative model structures or sensitivities.
Retrospective analysis	Minor retrospective patterns.	Moderate retrospective patterns.	No retrospective analysis or severe retrospective patterns.
Comparison with empirical measures or simpler analyses	Assessment biomass and/or fishing mortality estimates compare favorably with empirical estimates.	Moderate agreement between assessment estimates and empirical estimates or simpler analyses.	Estimates of scale are difficult to reconcile and/or no empirical estimates.
Ecosystem factors accounted	Assessment considered habitat and ecosystem effects on stock productivity, distribution, mortality and quantitatively included appropriate factors reducing uncertainty in short term predictions. Evidence outside the assessment suggests that ecosystem productivity and habitat quality are stable. Comparable species in the region have synchronous production characteristics and stable short-term predictions. Climate vulnerability analysis suggests low risk of change in productivity due to changing climate.	Assessment considered habitat/ecosystem factors but did not demonstrate either reduced or inflated short-term prediction uncertainty based on these factors. Evidence outside the assessment suggests that ecosystem productivity and habitat quality are variable, with mixed productivity and uncertainty signals among comparable species in the region. Climate vulnerability analysis suggests moderate risk of change in productivity from changing climate.	Assessment either demonstrated that including appropriate ecosystem/habitat factors increases short-term prediction uncertainty, or did not consider habitat and ecosystem factors. Evidence outside the assessment suggests that ecosystem productivity and habitat quality are variable and degrading. Comparable species in the region have high uncertainty in short term predictions. Climate vulnerability analysis suggests high risk of changing productivity from changing climate.
Trend in recruitment	Consistent recruitment pattern with no trend.	Moderate levels of recruitment variability or modest consistency in pattern or trends. OFL estimates adjusted for recent trends in recruitment. OFL estimate appropriately accounted for recent trends in recruitment.	Recruitment pattern highly inconsistent and variable. Recruitment trend not considered or no recruitment estimate.
Prediction error	Low estimate of recent prediction error.	Moderate estimate of recent prediction error.	High or no estimate of recent prediction error.

Assessment accuracy under different fishing pressures	High degree of contrast in landings and surveys with apparent response in indices to changes in removals. Fishing mortality at levels expected to influence population dynamics in recent years.	Moderate agreement in the surveys to changes in catches. Observed moderate fishing mortality in fishery (i.e., lack of high fishing mortality in recent years).	Relatively little change in surveys or catches over time. Low precision of estimates. Low fishing mortality in recent years. "One-way" trips for production models.
Simulation analysis/MSE	Can be used to evaluate different combinations of uncertainties and indicate the most appropriate OFL CV for a particular stock assessment.		

Attachment 4

SSC-Approved OFL CV Decision Table for Butterfish

Decision Criteria	Summary Points and Considerations	OFL CV bin (60/100/150)
Data quality	• Landings from 1989-2021 spanned three phases of commercial fishing activity: the historic directed fishery (1989-2001), the bycatch fishery (2002-2011), and the recent directed fishery (2013-2021). Landings during the recent directed fishery showed a variable but increasing trend through time, with magnitudes in several years comparable to those during the historic directed fishery (~3500-4000 mt). • Discard estimation was based on the standardized bycatch reporting methodology (SBRM, Wigley et al. 2007). During the historic directed and bycatch phases, the magnitude of discards often exceeded landings, however, during the recent directed fishery, discards have generally remained lower than landings (~1300-1600 mt). In the early part of the time-series, estimated precision of discards was generally poor, but since 2010, estimated precision has been good. • Landings-at-age have been stable within each of the three phases, with most harvested fish being ages 1-3 (majority age 2). Very few age 4+ fish appear in the landings. Most discards are age 0-2 with some age 3 fish and very few age 4+ fish. • The research track Peer Review Panel (herein, the Panel) concluded that the gap filling procedure applied by the WG to develop the age-length key and landings length composition likely leads to blending of cohorts which could introduce bias into the age composition data. Data gaps could be treated as missing years in the assessment model. • Indices of relative abundance recommended by the WG were based on the NEFSC Albatross Fall survey, NEFSC Spring and Fall Bigelow surveys, NEAMAP Spring and Fall surveys, and a coastal YOY composite time series based on six state surveys. The NEFSC Albatross and Bigelow surveys were treated separately in the assessment model. Uncertainties associated with the survey indices were well quantified. • The Panel suggested that the NEFSC Spring Albatross survey be included only as a sensitivity since butterfish availability during spring seems to have changed over	100

	time. The Panel also recommended that the life history data derived from different survey programs be compared to identify possible spatial variability. • Data used to characterize maturity ogive...samples at sea.	
Model appropriateness and identification process	• Initial model development done with ASAP3. The final ASAP3 model was brought into the Woods Hole Assessment Model (WHAM) for further development. • WHAM model preferred, years 1989-2019, ages 0-4+. • WHAM can implement random effects on interannual transitions in numbers-at-age, M, and selectivity. • The Panel made several comments/recommendations to the assessment modeling approach: o Develop a model with a shorter time step than one year to more accurately reflect the biology of butterfish (relatively short-lived species). o Separate catch into retained and discarded components as opposed to estimating the weight of discards and adding those quantities to landings. Age-structure of discards shows a skew toward smaller/younger fish when compared to that of the landings. o Presentation of a broader set of sensitivity model runs. o Free selectivity estimation (as opposed to estimation of a functional form) could hide or compensate for an incorrect value of M. o Butterfish scale cannot be reliably estimated because there is little indication that fishing has affected abundance. Therefore, choosing a value for one of the catchabilities (q's) essentially defines scale/abundance. • WHAM model diagnostics showed generally good model fit and performance. • The WG considered several potential candidate reference points and recommended $F_{50\%}$ and $B_{50\%}$. However, the Panel had significant concerns about the very high estimated value for $F_{50\%}$ (> 6.0 yr^{-1}, ~ 99.9% mortality for fully selected ages). The recent range of years for estimation of $B_{50\%}$ was viewed as appropriate. Fishing appears to have little impact on the butterfish stock. • The Panel noted that the previously used reference point of F = 2/3M may be more appropriate than $F_{50\%}$.	150

Retrospective analysis	• A retrospective analysis was performed and no retrospective adjustments were made to assessment model results.	60
Comparison with empirical measures or simpler analyses	• Presumably because of the sizable workload associated with first developing an ASAP3 model (reverting back from the ASAP4 model in recent assessments), migrating the final ASAP3 model to WHAM, and then further developing the WHAM model, no simpler analyses were presented. • q fixed in the model is a swept area estimate.	100
Ecosystem factors accounted	• Butterfish condition was related to copepod abundance and temperature, found breakpoints in time series, which justified the recruitment stanza starting in 2011 • The assessment included consideration of stomach contents data from NEFSC trawl surveys and studies on marine mammals and birds. The estimated consumption amounted to a small fraction of the estimated losses due to natural mortality. This result is odd given that butterfish is considered a forage species. • The Panel recommended that the WG consider alternative approaches for estimating consumptive removals of butterfish, and noted that results of the consumption study could be an indication that the estimated scale of the butterfish stock is too high. • Climate vulnerability analysis (Hare et al 2016) ranked butterfish low vulnerability to productivity impacts	100
Trend in recruitment	• Short-term projections of catch and SSB were computed by sampling from the cumulative distribution function of WHAM recruitment estimates, 2011-2021. The stanza beginning with 2011 was derived from an ecosystem analysis of butterfish condition. The most recent 5-year averages were used for the annual fishery selectivity, maturity ogive, and mean weights-at-age. The WHAM model assumes an AR(1) process for recruitment. • The recruitment pattern differs from the previous models that indicated declining recruitments in recent years. There was no substantial trend in recruitment detected in the most recent assessment. • WHAM incorporates AR(1) recruitment process into projections	100 or 60
Prediction error	• Predictive skill of the WHAM model was evaluated. Aggregate and age composition data for one index at a time were removed, the model was fitted to the reduced data, and the model was used to predict the removed data. Mean absolute scaled error (MASE) of	60

	the predictions over time horizons (1-3 years) was computed and appeared to be relatively low.	
Assessment accuracy under different fishing pressures	• Accuracy of assessment results were not characterized in relation to different fishing pressures. • F likely to be low relative to M	150
Simulation analysis/MSE	• The assessment results and subsequent management advice were not informed by simulation analysis or MSE.	NA

Attachment 5

Glossary

ABC—Acceptable Biological Catch
AIC—Akaike's Information Criterion
Bmsy—Biomass at maximum sustainable yield
CPUE–Catch per unit effort
CV—Coefficient of Variation
ESP—Ecosystem and Socio-economic Profiles
EAFM—Ecosystem Approach to Fisheries Management
F—Instantaneous rate of fishing mortality
FDA—Food and Drug Administration
GARFO—Greater Atlantic Region Fisheries Office
HCR—Harvest Control Rule
MRIP—Marine Recreational Information Program
MTA—Management Track Assessment
MSC—Marine Stewardship Council
MSE—Management Strategy Evaluation
NERAP—Northeast Regional Action Plan
OFL—Overfishing Limit
P*—Probability of overfishing
q–Catchability parameter
RHL—Recreational Harvest Limit
RSA—Research Set Aside
RSC—Research Steering Committee
RTA—Research Track Assessment
R/V—Research Vessel
SNP—Single Nucleotide Polymorphisms
SSBmsy—Spawning stock biomass at maximum sustainable yield
SSC—Scientific and Statistical Committee
v—Availability Parameter
VAST—Vector Autoregressive Spatio-Temporal package
WHAM—Woods Hole Assessment Model