Peer Review Committee Report for the 2021 Management Track Assessment of Black Sea Bass, Golden Tilefish, Scup and Atlantic Mackerel

Thomas J. Miller[1,2] and Alexei S. Sharov[1,3]

[1]Mid-Atlantic Fishery Management Council Scientific and Statistical Committee

[2]University of Maryland Center for Environment Science, Chesapeake Biological Laboratory

[3]Maryland Department of Natural Resource, Fishing and Boating Service

Executive Summary

The 2021 Management Track Assessments (MTA) for Black Sea Bass, Golden Tilefish, Scup and Atlantic Mackerel were reviewed by members of the Mid-Atlantic Fishery Management Council's Scientific and Statistical Committee. For all species, other than Golden Tilefish, the disruption to survey sampling resulting from COVID restrictions limited the updates to 2019 as a terminal year. Since the assessment for Golden Tilefish does not rely on survey data, and the commercial fishery was substantially completed before the onset of the COVID pandemic, the assessment for this species could be updated through 2020. The Peer Review Committee (PRC) found that MTAs for all four species were acceptable, used procedures appropriate for an MTA, not deviating substantially from previously approved assessment, and represent the best scientific information available for management of these four species.

The 2021 MTA for Black Sea Bass involved the addition of a single year of fishery-dependent and fishery-independent data. There were no structural changes to the assessment, and any parameter changes fell well within the scope of an MTA update of an approved assessment. The PRC concluded that the 2021 MTA for Black Sea Bass represents the best scientific information available and can serve as the basis for management for 2022 and 2023. Based on the calculated reference points, the stock was not overfished (SSB_{2019} =29,688 mt > ½ SSB_{MSY}=7,046) and overfishing was not occurring (F_{2019}=0.41 < F_{MSY}=0.46). Lack of reliable commercial and recreational data for 2020 and 2021 meant that the assessment team had to make assumptions for these data gaps to produce projections for 2022-2020. The assessment team assumed an exceedance in the catch in the recreational fishery for 2020, but not for 2021. The PRC found these adjustments reasonable, though somewhat arbitrary. Projections suggest a catch in 2022 of 9,383 mt and a decline in 2023 to 8,014 mt. In response to these removals, the spawning stock biomass is projected to decline steadily by almost 25% from its 2020 estimate of 26,385 mt to 20,166 mt by 2023. This decline reflects an SSB_{MSY} = 14,441 mt.

The PRC concluded that the 2021 Management Track Assessment for Golden Tilefish represents the best scientific information available and can serve as the basis for management for 2022 and 2023. There were no structural changes to the assessment and any parameter changes fell well within the scope of an operational update of approved assessment. The PRC concluded that the 2021 MTA for Golden Tilefish represents the best scientific information available and can serve as the basis for management for 2022 and 2023. This assessment is somewhat unusual in that it does not rely on survey data, instead

relying exclusively on catch-dependent data. Assessment results indicate the fishing mortality rate was F= 0.16 in 2020, below the updated reference point F_{MSY} proxy = 0.26. There is a 90% probability that the fishing mortality rate in 2020 was between 0.11 and 0.22. SSB was estimated to be 10,562 mt in 2020, which is equal to 96% of the updated biomass target reference point SSB_{MSY} proxy = 10,995 mt. There is a 90% chance that SSB in 2020 was between 6,238 and 16,438 mt. As a result, Golden Tilefish is not overfished and overfishing is not occurring. The PRC noted the critical importance of continuing the sampling age in the catch to support the switch from the use of pooled age-length-key to year specific age-length-keys for more appropriate characterization of age structure and better tracking of year classes. The PRC also noted significant concern with reductions in the biological port sampling that may negatively affect future assessments, including the next RT assessment model in 2024.

The PRC concluded that the 2021 Management Track Assessment for Scup represents the best scientific information available and can serve as the basis for management for 2022 and 2023. The 2021 MTA involved the addition of a single year of fishery -dependent and fishery-independent data. There were no structural changes to the assessment, and any parameter changes fell well within the scope of an operational update of approved assessment. Based on model results, the stock was not overfished and overfishing was not occurring in 2019 relative to the updated biological reference points. The 2021 MTA indicated the spawning stock biomass (SSB) in 2019 to be 176,404 mt. There is a 90% chance that SSB_{2019} was between 154,000 and 210,000 mt. Fishing mortality on the fully selected age 4 fish F_{2019}= 0.136. There is a 90% probability that the fishing mortality rate in 2019 was between 0.106 and 0.166. The PRC noted particularly the benefits in terms of model fit that have come from the addition of a new selectivity block in the 2021 MTA for Scup.

The PRC concluded that the 2021 Management Track Assessment for Atlantic Mackerel represents the best scientific information available and can serve as the basis for management for 2022 and 2023. The 2021 MTA involved the addition of three years of fishery-dependent and fishery-independent data. There were no structural changes to the assessment. The most substantial change to the assessment was the incorporation of revised MRIP estimates, which indicated increased removals by the recreational fishery in the most recent years. Other changes to parameter values fell well within the scope of a management track update of an approved assessment. This species is currently under an approved rebuilding plan. Fishery-independent indices of SSB are derived from egg collections in Canada and the US. The Canadian survey for the northern contingent occurs at a time coincident with the fishery and targets mackerel spawning in the Gulf of St. Lawrence. The egg survey for the southern contingent is a broad ecosystem survey, not specifically targeting mackerel. Results of the two surveys are combined to yield a total SSB index. In most years the southern contingent represents <15% of the SSB, although in occasional years (1983, 2018), the southern contingent can represent >40% of the SSB. These patterns are indicative of substantial changes in recruitment in this species. The 2021 management track assessment indicates that the 2015 year class was only 15% weaker than estimated in the 64th SAW, yet this reduction, followed by a time series low 2017 recruitment have meant that SSB has not recovered appreciably. Revised reference points were produced in the 2021 MTA that are lower than they were in the earlier assessment ($F_{MSY2021}$=0.22 vs $F_{MSY2017}$=0.26, and $SSB_{MSY2021}$=181,090 vs $SSB_{MSY2017}$=196,894). The PRC note that the F_{MSY} estimate is lower than the $F_{rebuild}$ estimated in the 2017 rebuilding plan. The revised BRPs translate to a stock status that is overfished (24% of SSB_{MSY}) and overfishing is occurring (108% greater than F_{MSY}). The 90% confidence intervals of the terminal year are lower than the overfished threshold and above the overfishing threshold. Under these new BRPs, the stock has been overfished for the last 12 years and has been experiencing overfishing for the last 30 years.

Furthermore, projections indicate that rebuilding of the stock by 2023 is highly unlikely given recruitment levels currently observed in the stock. The RPC support the continued exploration of recruitment dynamics in this species, and particularly of its impact on the reliability of short term projections. The RPC recommend consideration of the impacts of overall system productivity and stock characteristics on the reliability of projections.

Peer Review Committee Report

The Peer Review Committee (PRC) for the Management Track Assessment (MTA) met via webinar on June 28-30, 2021. The PRC provided technical reviews for Level 2 expedited review of MTAs for Black Sea Bass (*Centropristis striata*), Golden Tilefish (*Lopholatilus chamaeleonticeps*), Scup (*Stenotumus chrysops*) and Atlantic Mackerel (*Scomber scombrus*). The assessment for each species were prepared by an assessment lead and a workgroup. Results of initial model explorations were reviewed by the Assessment Oversight Panel (AOP) that determined the level of peer review required.

The PRC makes the following observations and recommendations

1) The agenda for the MTA Review was completed slightly ahead of schedule. The PRC believes this is likely because there were only two members of the PRC. We recommend that the possible meeting efficiencies gained by a smaller review team are offset by structural concerns with occurring from having only two reviewers, particularly should opinions diverge between the reviewers. We recognize this was a unique circumstance and do not feel the resulting review was any less rigorous, but we do recommend that the custom of using three reviewers be maintained.
2) All background documents, information, and presentations should be available two weeks prior to the beginning of a stock's review. Materials provided to the PRC should include the full AOP report and summary that led to the specific designation of level of review required, the current MTA documentation, the preceding assessment document (including peer review reports and relevant SSC reports); the most recent benchmark/ research track assessment (if different from the preceding), a table of the stock's status and reference points, and at least a draft version of the PowerPoint presentations.
3) Document naming conventions should be standardized. There is continuing inconsistency over names of assessments – benchmarks, SAW/SARC, operational, research track and management track. Some assessment results are referred to by a CRD (notably SAWs), others by the principal author (often updates delivered to SSCs). This confusion makes understanding the assessment history difficult.
4) The PRC is responsible for determining whether the MTA meets specific Terms of Reference. The structure of the Assessment Report, and indeed the presentation, should specifically address each ToR.
5) The addition of ToR 6 – Response to Research Recommendation represents a substantial enhancement. This ToR indicates where progress is being made, even when such work does not result in a change to the assessment

The PRC recognizes Gary Shepherd who led the Black Sea Bass assessment particularly, prior to his forthcoming retirement from federal service. On behalf of the legion of biologists, analysts and managers who have had the pleasure of working with Gary over the years, we wish to recognize his long-standing contributions to our understanding of the biology and management of the regions fish stocks, and to thank him for his open and collaborative approach to his work.

The PRC thanks Russ Brown (Population Dynamics Branch Chief) and Michele Traver (Assessment Process Lead) for their support during and after the meeting. We thank the MTA Leads for each species for the open and collaborative spirit with which they engaged the PRC. Our thanks are extended also to

the researchers and stakeholders who asked thoughtful questions that deepened our understanding of each assessment. We thank the rapporteurs who took extensive notes during the meeting.

For each of four species covered in the MTA Review, we provide below a brief statement on the validity of the MTA for use in management, and details of progress against each ToR. We note that data from 2020 were not consistently available because of COVID impacts, and so unless noted otherwise, only data from 2019 were added to the assessment for each species. Assumptions regarding catches in 2020 and 2021 were necessary to permit projections for 2022 and 2023. The species are discussed in the order in which they were presented during the meeting.

Black Sea Bass

The 2021 MTA for Black Sea Bass involved the addition of a single year of fishery-dependent and fishery-independent data. There were no structural changes to the assessment, and any parameter changes fell well within the scope of an MTA update of an approved assessment. The PRC concluded that the 2021 MTA for Black Sea Bass represents the best scientific information available and can serve as the basis for management for 2022 and 2023.

Black Sea Bass is a temperate fish in the Serranidae family distributed from the central Gulf of Mexico eastward to Florida and then along the Atlantic coast as far north as Nova Scotia, Canada. Genetic evidence suggests partitioning of the distribution into three stocks: the Gulf of Mexico, the South Atlantic (Cape Hatteras, NC to Florida) and the Mid-Atlantic (Cape Hatteras northward) (Roy et al. 2012, McCartney et al. 2013). The Mid-Atlantic Fishery Management Council and the Atlantic States Marine Fisheries Commission jointly manage the Mid-Atlantic stock of Black Sea Bass.

Since the 62nd SAW (Northeast Fisheries Science Center 2017), Black Sea Bass in the Mid-Atlantic region has been assessed using an forward-projecting age structured model (ASAP, Legault & Retrepo 1998) that delineates two spatial regions within the Mid-Atlantic Black Sea Bass population. The model should not be taken to imply distinct populations within the Mid-Atlantic region. Rather the model structure was adopted to account for substantial differences in recruitment north and south of the Hudson River Canyon. This recruitment pattern was evident particularly in 2011 when the recruitment in the northern region was strong. A 2019 age-structured assessment utilizing the two region spatial structure incorporated data up to 2018 (Northeast Fisheries Science Center 2019). The most recent assessment indicated that Black Sea Bass was not overfished and overfishing was not occurring. Below we assess the extent to which each Term of Reference (ToR) for the 2021 MTA was met by the assessment team.

ToR 1: Estimate catch from all sources including landings and discards.

The PRC concluded that the assessment team fully met this term of reference. The assessment added commercial and recreational data for 2019 to the 2018 assessment. Data on commercial removals indicated the pattern of the increasing importance of trawling and related declines in the traditional pot and trap fisheries continued in 2019. Evidence suggests the precision and accuracy of commercial data remains high. Total commercial landings in 2019 were 1,579 metric tonnes (mt). Commercial discards in 2019, estimated to be 1,207 mt, represent almost 40% of commercial landings. The increase in discards reflects increased availability of fish from the strong 2011-year class that now dominate the large/jumbo size category. This has led to discarding of small market category fish. Recreational data are associated with less certainty. Revised estimates from the Marine Recreational Information Program (MRIP) were introduced in the 2019 Assessment (Northeast Fisheries Science Center 2019) and updated for 2019 for the 2021 MTA. Recreational landings in 2019 were 3,194 mt with an associated 1,468 mt of dead discards. These data continue the trend of the increasing importance of recreational removals, driven largely by an increase in recreational catches in the northern region. The overall allocation over the 1989-2019 times series has been 66% recreational: 34 commercial, but shifted to 74% recreational, 26% commercial.

ToR 2: Evaluate the survey indices used in the assessment.

The PRC concluded that the assessment team fully met this term of reference. Treatment of all survey data followed methods used in the prior approved assessments (Northeast Fisheries Science Center 2017, 2019). The 2021 MTA added data from 12 fishery-independent surveys and recreational catch per unit effort data for 2019. Data from seven independent surveys and from a recreational CPUE for the northern region were examined. These surveys continue to track the dominant 2011-year class. There was also evidence of a strong 2015-year class in the northern region. Eight fishery-independent surveys and a recreational CPUE for the southern region were also examined. The majority of these indices were for limited ages (Age-0 and Age-1). Two indices, the New Jersey trawl and the Recreational CPUE provide some age-structure information. These two surveys continue to indicate the weak presence of the 2011-year class in the south, and suggest some strength of the 2015-year class in the south.

ToR 3: Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) as possible (depending on the assessment method) for the time series using the approved assessment method and estimate their uncertainty. Include retrospective analyses if possible (both historical and within model) to allow a comparison with previous assessment results and projections, and to examine model fit.

a. *Include bridge runs to document sequentially each change from the previously accepted model to the updated model proposed for this peer review.*

b. *Prepare a "Plan B" assessment that would serve as an alternate approach to providing scientific advice to management if the analytical assessment were to not pass review*

The PRC concluded that the assessment team fully met this term of reference. The model structure approved in the 62nd SAW was continued in the 2021 MTA, with changes only in parameterization related to reductions in effective sample sizes in the calculations involving both fleets in the north to improve model fit and in the 2019 Bigelow index necessitated by an extremely high catch at one survey station in the northern region. In addition, a temporal selectivity block was defined for the years 2009-2019. The spatial structure of the assessment model was reviewed at the 62nd SAW. The PRC discussed the uncertainties associated with the allocation of removals and survey data to the appropriate region. Uncertainties in the locations of catch, timing of surveys, and timing of movement of black sea bass seasonally mean commercial or survey catches may be miss-assigned to region. There was no clear approach identified to overcome these challenges. The PRC recognized this as almost an inevitability of a spatially structured model. However, the PRC recognized that there is no reason to think the impacts of these uncertainties are any higher in the 2021 MTA than in earlier assessments.

Prior assessments reported retrospective bias in both northern and southern regions, with those in the northern region being larger and of opposite direction to those in the south. In the north, fishing mortality rates were overestimated and spawning stock biomasses underestimated; the opposite pattern was evident in the south. This retrospective pattern was continued in the 2021 MTA but was larger in magnitude. The retrospective biases were 2-3x larger in the north than in the south. Retrospectively adjusted estimates for both spawning stock biomass and fishing mortality rates were outside the 90% confidence intervals for the final year estimates for the northern region, but not for the southern region. However, retrospective adjustments were applied to both regions before they were combined to yield the overall stock status. The retrospectively adjusted F_{2019}=0.41, and SSB_{2019} = 29,668 mt.

A Plan B assessment was unnecessary because the ASAP assessment was accepted.

ToR 4. Update the BRPs as defined by the management track level and recommend stock status.

The PRC concluded that the assessment team fully met this term of reference. Biological reference points were derived for each spatial region and then combined to produce a framework for the overall stock status. Biological Reference Points were based on an F40% proxy for F_{MSY}, and an $SSB_{40\%}$ proxy for the SSB_{MSY} reference point. The north F_{MSY} (=0.465) and the south F_{MSY} (=0.451) were averaged to yield an overall F_{MSY}=0.46. The combined SSB_{MSY} threshold proxy was the sum of the SSB_{MSY} proxies for the north (8,306 mt) and south (6,135 mt) was calculated as 14,092 mt. Similarly, the limit biomass reference point was 7,046 mt

Based on the calculated reference points, the stock was not overfished (SSB_{2019} =29,688 mt > ½ SSB_{MSY}=7,046) and overfishing was not occurring (F_{2019}=0.41 < F_{MSY}=0.46). The PRC notes that the status with respect to the overfished threshold is robust to retrospective adjustment; the not overfishing status relies on the retrospective adjustment. Qualitatively, stock status continues to be dominated by the large 2011 years class that predominated in the northern region. This age class joined the plus group in this assessment, and uncertainties in model outputs increased. The 2021 MTA indicates that biomass is declining in the northern region, but increasing in the southern region due to the distribution of the 2011 and 2015 year classes. Whether the two region model will be required as the impact of the 2011 year class declines is unclear.

The PRC probed explanations for the increasing retrospective patterns. The assessment team lead questioned the assumption of M=0.4 in both regions, suggesting mortality rates in the north may be lower than in the south. However, no definitive explanation of the retrospective patterns was reached. The PRC also discussed errors that inevitably arise by categorizing survey catches and landings to spatial regions given that survey and harvest strata were not designed to reflect the division at the Hudson Canyon. Similarly, uncertainty is introduced because of variability in the timing of surveys, and in the movements of fish that may introduce specific biases. However, analyses have been insufficient to determine the direction and impact of such sources of uncertainty, and these errors are not likely to have changed since the last assessment.

ToR 5. Conduct short-term stock projections when appropriate.

The PRC concluded that the assessment team met this term of reference. To permit projections to be made for 2022 and 2023, the assessment team had to first make assumptions regarding removals for

2020 and 2021 in both regions. Commercial catches were assumed equal to the 2020 region-specific commercial ABC because of the monitoring and tight control over catches. However, there is a history of recent overages in the recreational sector. To account for this, the assessment team increased the 2020 recreational ABC by an amount equal to the recreational landings for 2019. This resulted in estimated catches of 6,591mt in the northern area and 1,680mt in the southern region to give a total catch of 8,271 mt. Removals for 2021 were set to the existing ABCs. The PRC found these adjustments reasonable, though somewhat arbitrary, as no adjustments to ABC were used to project 2021 catches, leading to a projected 17% decline in total catch from 8,271 mt in 2020 to 6,835 mt in 2021, which seems unlikely given recent catch histories.

Standard approaches to projecting for 2022 and 2023 were then applied. Projections suggest catch should increase in 2022 to 9,383 mt and decline in 2023 to 8,014 mt. In response to these removals, the spawning stock biomass is projected to decline steadily by almost 25% from its 2020 estimate of 26,385 mt to 20,166 mt by 2023. This decline reflects an SSB_{MSY} = 14,441 mt.

ToR 6. Response to research recommendations.

The PRC accepted the explanation for the limited response to research recommendations in the 2021 Black Sea Bass assessment. This assessment was intended to be a Level 1 – direct delivery assessment prior to the finding of the increased retrospective pattern. Under this approach, all model development and exploration was postponed to an upcoming 2022 Research Track Assessment.

Golden Tilefish

The PRC concluded that the 2021 Management Track Assessment for Golden Tilefish represents the best scientific information available and can serve as the basis for management for 2022 and 2023. There were no structural changes to the assessment and any parameter changes fell well within the scope of an operational update of approved assessment. The 2021 MTA for Golden Tilefish is an expedited review (Level 2 assessment). This was recommended because the last assessment was completed in 2017 with a terminal year of 2016 (Nitschke 2017), hence four years of additional data were accumulated prompting an update. The 2017 MTA employed an ASAP model updated with landings, catch at length distributions, catch at age and mean weights at age using updated pooled and year specific age-length keys, and commercial CPUE data through 2020. Increases in available age data with this MTA allowed for the use of additional age data within the pooled age-length-key and the use of year specific age keys for more recent years.

Golden Tilefish, *Lopholatilus chamaeleonticeps,* inhabit the outer continental shelf from Nova Scotia to South America and are relatively abundant in the Southern New England - Mid-Atlantic region at depths of 80 to 440 m. Tilefish have a relatively narrow temperature preference of 9 to 14 °C. The Virginia-North Carolina border defines the boundary between the northern and southern Golden Tilefish management units. The golden tilefish fishery in the U.S. is managed from Maine through Virginia, with the majority of the fishery concentrated between Nantucket Island, Massachusetts, south to Cape May, New Jersey; more specifically between Hudson and Veatch Canyons. The commercial fishery predominantly uses longline gear, although handline, rod and reel, and trawl gear are also authorized.

The Golden Tilefish stock in the Mid-Atlantic was assessed with ASAP forward projecting age-structured model (Legault & Retrepo 1998) at the 58th SAW (Northeast Fisheries Science Center 2014). This framework was used in an assessment update in 2017 (Nitschke 2017). The 2021 MTA used the same model structure. A significant addition to the 2021 assessment was the addition of year-specific age-length keys for 2007, 2009-2012, and 2014-2020 in addition to the pooled age-length key that was used in the 2017 model update (Nitschke 2017).

The fishing mortality rate was estimated to be 0.16 in 2020, below the updated reference point F_{MSY} proxy = 0.26. There is a 90% probability that the fishing mortality rate in 2020 was between 0.11 and 0.22. SSB was estimated to be 10,562 mt in 2020, which is equal to 96% of the updated biomass target reference point SSB_{MSY} proxy = 10,995 mt. There is a 90% chance that SSB in 2020 was between 6,238 and 16,438 mt. Average recruitment from 1971 to 2020 was 1.48 million fish at age-1. A most recent large year class is estimated at 2.5 million in 2014. This year class has started to recruit to the large-medium market category in 2020. The updated 2020 final run had a minor retrospective pattern in fishing mortality (Mohn's ρ = -0.09), spawning stock biomass (Mohn's ρ = +0.02) and age-1 recruitment (Mohn's ρ = +0.03), therefore, no retrospective adjustments were made to the model results.

ToR 1. Estimate catch from all sources including landings and discards.

The PRC concluded that the assessment team fully met this term of reference. The time series of commercial landings used in 2017 operational assessment was updated with landings data from 2017-2020. Historic commercial landings data are available from 1915; the assessment uses commercial landings since 1970. Commercial landings are taken by the directed longline fishery primarily. According to the "Discard Estimation, Precision, and Sample Size Analysis" conducted by the NEFSC, discard estimations for commercial fisheries (mostly large/small mesh trawls and gillnets) appears to be low (several metric tons per gear type). For the last five years (2016-2020), on average 7.9 mt of tilefish were discarded, which is about 1.2 % of average commercial landings for the same period. Recreational catches in Mid Atlantic area estimated to be very low. According to VTR data, party/charter vessel landed 5,424 fish in 2019 and 3,466 golden tilefish in 2020. Private recreational vessels landed 50 golden tilefish in 2020 (August 2020 to December 2020). Hence, neither commercial discards nor the recreational harvest was included as a component of the removals in the assessment model.

Total commercial landings (live weight) increased from less than 125 mt during 1967-1972 to more than 3,900 mt in 1979 during the development of the directed longline fishery. Annual landings ranged between 454 and 1,838 mt from 1988 to 1998. Landings from 1999 to 2002 were below 900 mt (ranging from 506 to 874 mt). An annual quota of 905 mt was implemented in November of 2001. Landings in 2003 and 2004 were slightly above the quota at 1,130 mt and 1,215 mt, respectively. Landings from 2005 to 2009 were at or below the quota, while landings in 2010 at 922 mt were slightly above the quota. Since 2010, landings have been below the quota and decreased to an estimated 494 mt in 2016. The landings have increase slightly to an average of 698 mt from 2017 to 2020.

The PRC agrees that the recreational landings and commercial discards represent very small component of total losses (approximately 2% based on limited data) and their addition would not have affected materially the assessment results. However, they are not zero and the PRC recommends their inclusion in the future assessments to the extent that such estimates are available.

ToR 2: Evaluate the survey indices used in the assessment.

No fishery-independent survey data are available for Golden Tilefish. However, there are three commercial CPUE indices developed from longline fleet records covering different but overlapping periods 1973 -1982 (catch in weight per tub trawl – "Turner index"(Turner 1986)), 1979-1993 (catch per - days absent minus on day per trip based on the port sampling interviews – "weigh-out index") and 1990-2020 (catch per - days absent minus on day per trip based on VTR reports). The VTR index was updated with data through 2020.

ToR 3. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) as possible (depending on the assessment method) for the time series using the approved assessment method and estimate their uncertainty. Include retrospective analyses if possible (both historical and within-model) to allow a comparison with previous assessment results and projections, and to examine model fit.

a. *Include bridge runs to document sequentially each change from the previously accepted model to the updated model proposed for this peer review.*

b. *Prepare a "Plan B" assessment that would serve as an alternate approach to providing scientific advice to management if the analytical assessment were to not pass review*

The PRC concluded that the assessment team fully met this term of reference. The 2021 MTA continued the application of the forward projecting age-structured model developed in the 58th SAW (Northeast Fisheries Science Center 2014). Information on the biological characteristics of the catch is available from port sampling programs. Catch information by six size categories was available since 1990, while detailed size frequency data (1cm size intervals) were available since 2002. These data permitted development of a common age-length key that was used in both the 2014 benchmark assessment (Northeast Fisheries Science Center 2014) and the 2017 model update (Nitschke 2017). However, new age data made available through 2020 provided an opportunity for the pooled age-length-key being updated to develop a more comprehensive key for use in years where age data did not exist. Actual year specific keys were used for 2007, 2009 to 2012, and 2014 to 2020. The PRC agrees that use of year specific age length keys is appropriate and important, considering that the stock and the fishery depend on appearance of occasional large year classes, whereas the use of the pooled key leads to the smearing effect.

As a result of the changes in the age-length keys used in the assessment, a bridge year run was completed which used the existing data through 2016 from the 2017 assessment and all available age data in the pooled age-length-key for years 2017 through 2020. Then the first updated run used the new updated pooled age-length-key for all years. The final run used the updated pooled age-length-key for years with age data gaps and uses the year specific information in the recent years. The PRC notes that, in general, there were very similar trends among the model runs. An additional sensitivity model run was made to determine the sensitivity of the model results to the estimated dome shaped selectivity assumption through an assumed shift of the age of full selection. This sensitivity tested the influence of a shift in fully selection from age 5 to 6 in the second selectivity block. However, the sensitivity run still estimated full selectivity at age 5.

The updated 2020 final run had a minor retrospective pattern in fishing mortality (Mohn's Rho = -0.09), spawning stock biomass (Mohn's Rho = +0.02) and age-1 recruitment (Mohn's Rho = +0.03). No retrospective adjustments were made on the assessment.

Average recruitment from 1971 to 2020 was 1.48 million fish at age-1. Large year classes occurred in 1998 (3.0 million), 1999 (2.9 million) and 2005 (2.6 million). A recent large year class is estimated at 2.5 million in 2014. This year class has started to recruit to the large-medium market category in 2020. An above average year class is estimated at 2.1 million in 2017. However, the size of the 2017-year class remains highly uncertain since it just began to enter the incidental fishery in 2020. Additionally, the PRC note that there is no information on recruitment due to a lack of young fish in commercial index and lack of fishery independent surveys that capture young fish. Hence, the estimate of recruitment to the fishery is very uncertain.

The terminal year fishing mortality rate was estimated F_{2020}=0.160, below the updated reference point F_{MSY} proxy = 0.261. The uncertainty in estimates of fishing mortality and spawning stock biomass in ASAP model was evaluated by calculating probability distribution for F and SSB with the MCMC method. There is a 90% probability that the fishing mortality rate in 2020 was between 0.110 and 0.22. SSB was estimated to be 10,562 mt in 2020, 96% of the updated biomass target reference point SSB_{MSY} proxy = 10,995 mt. There is a 90% chance that SSB in 2020 was between 6,238 and 16,438 mt.

The final run that uses the available year specific data results in slightly more optimistic stock status (F/F_{MSY} = 0.615 and SSB/SSB_{MSY} = 0.961) relative to run one which used the update pooled age key for all year (F/F_{MSY} = 0.670 and SSB/SSB_{MSY} = 0.852).

The PRC concurs that fishing mortality, spawning biomass and recruitment are estimated according to the 58th SAW approved method and uncertainty in the input data is accounted for within the assessment model appropriately. However, as before, the uncertainty related to the lack of the true fishery independent index and lack of the index for younger fish that could be used for stock projections remain unaddressed by the model due to data limitations.

A Plan B assessment was unnecessary because the ASAP assessment was accepted.

4. *Re-estimate or update the BRPs as defined by the management track level and recommend stock status. Also, provide qualitative descriptions of stock status based on simple indicators/metrics (e.g., age- and size-structure, temporal trends in population size or recruitment indices, etc.).*

The PRC concluded that the assessment team fully met this term of reference. The 58th SAW recommended using the average of the fishing mortality during 2002-2012, a period when the stock was rebuilding under constant quota = 905 mt, as the FMSY proxy for Golden Tilefish (NEFSC 2014). The 2021 MTA continued to use this approach to estimating BRPs. The 2021 MTA indicates an average F= 0.261 for 2002-2012, and by coincidence the updated yield per recruit analysis shows that this fishing rate now corresponds to $F_{40\%}$, compared to the $F_{38\%}$ estimate calculated in the 2017 operational assessment (Nitschke 2017). Therefore, the updated BRPs proxies using the same average F calculations as in SARC 58 and the 2017 operational assessment produced a F_{MSY} proxy = 0.261 (overfishing threshold), with corresponding SSB_{MSY} proxy = 10,995 mt (SSB target), one-half SSB_{MSY} = 5,498 mt (SSB threshold), and MSY = 935 mt. SSB_{MSY} was calculated from median estimates of long term (100 years) stochastic projections fishing at the F_{MSY} proxy = 0.261 which resampled from the CDF of empirical recruitment from 1971-2020.

The 2021 MTA also identified qualitative metrics of stock status. VTR based fishery dependent CPUE trend suggests improvements in stock biomass over time with the development of the FMP in 2001 and that the landings at length and age suggests a broad distribution (small/younger and large/old fish) in the fishery. There is no evidence for size or age truncation at the end of the time series.

The PRC concluded biological reference points were updated according to the methodology established by 58th SAW8 and repeated at 2017 operational assessment update. The PRC noted that while F_{MSY} proxy calculation based on empirical method was reasonably appropriate in the past, new information suggest that switching to a SPR based F40% reference point is supported by the history of stock exploitation and better theoretical background as widely accepted proxy for F_{MSY}. This is reported by the PRC as a future recommendation.

ToR 5: Conduct short-term stock projections when appropriate.

The PRC concluded that the assessment team fully met this term of reference. *The PRC concluded that short-term projections followed the previously approved methodology and account for uncertainty of stock numbers at age for the terminal year of the assessment for mid-range and older ages.* The projections are conditioned on the ABC being taken (742 mt) in 2021 and fishing at the F_{MSY} proxy = 0.261 from 2022 to 2026. Overfishing is not projected to occur in 2021 with the removals of 742 mt. If fishing is maintained at F_{MSY} in 2022 – 2024, the SSB is projected to grow from 10,061 mt to 11, 586 mt with catches in the range of 949 – 1011 mt. The probability of being overfished during this period is $0.001<p<0.015$.

ToR 6: Respond to any review panel comments or SSC concerns from the most recent prior research or management track assessment.

Several research needs were identified by the SSC during 2017 Operational Assessment review:

- Explore development of a fishery independent survey to estimate abundance and distribution*. Response: Work in progress. Two tilefish longline (2017 and 2020) have been completed.
- Perform exploratory analyses of fish distributions to assess whether the dome-shaped selectivity curve used in the assessment reflects fishery selectivity or availability, or both*. Response: Work in progress. Two tilefish longline surveys provide some support for a dome shaped selectivity pattern through spatial and gear (hook) selectivity effects. However, quantifying the degree of doming may remain elusive.
- Expand observer coverage to improve index standardization of fishery-dependent data. Response: No progress.
- Leverage existing fishing activity to provide samples to improve life history and distribution information. Response: No progress. There is a reduction in port sampling due to cuts in survey funding.
- Assess the accuracy and reliability of aging techniques. Response: There are general improvements in year class tracking with year specific age data.
- Evaluate the role of sanctuaries on the Golden Tilefish stock and its fisheries. Response: No progress.

Additional Recommendations by the PRC

- Given the results of the assessment update, it seems to be reasonable to change overfishing definition to F40%.
- Continuation of adequate age sampling is critical to the switch from the use of pooled age-length-key to year specific age-length-keys for more appropriate characterization of age structure and better tracking of year classes.
- There is a significant concern with reductions in the biological port sampling that may negatively affect future assessments, including the next RT assessment model in 2024.
- Due to the lack of information on incoming recruitment at the end of the time series (no fishery independent surveys that capture young fish), alternatives to the TAL calculations based on projections that rely on uncertain indications of year class strength should be considered. Conservative approach to changes in the TAL over time appear to have resulted in overall benefits for both the tilefish stock and for the fishery.

Scup

The PRC concluded that the 2021 Management Track Assessment for Scup represents the best scientific information available and can serve as the basis for management for 2022 and 2023. The 2021 MTA involved the addition of a single year of fishery -dependent and fishery-independent data. There were no structural changes to the assessment, and any parameter changes fell well within the scope of an operational update of approved assessment.

Scup (*Stenotomus chrysops*) is a migratory, schooling species of the family *Sparidae* found on the continental shelf of the Northwest Atlantic, commonly inhabiting waters from Cape Cod, MA to Cape Hatteras, NC. Scup is highly sought after by commercial and recreational anglers throughout southern New England and the Mid-Atlantic. The Mid-Atlantic Fishery Management Council (MAFMC) and Atlantic States Marine Fisheries Commission (ASMFC) joint manage this fishery. The Fishery Management Plan defines the management unit as all Scup from Cape Hatteras, NC to the US-Canada border (MAFMC 1999).

The assessment model for scup is a statistical catch-at-age model (ASAP, Legault & Retrepo 1998) incorporating a broad range of fishery and survey data. The most recent benchmark assessment for Scup was endorsed following peer-review at the 60th SAW (Northeast Fisheries Science Center 2015). The approved model assumes an instantaneous natural mortality rate (M) = 0.2. The fishery catch is modeled as four fleets: commercial landings, recreational landings, commercial discards and recreational discards.

The 2021 MTA indicated that Scup was not overfished and overfishing was not occurring. Spawning stock biomass (SSB) was estimated to be 176,404 mt in 2019, about 2 times the updated biomass target reference point SSBMSY proxy of 90,019 mt. Fishing mortality on the fully selected age 4 fish was 0.136 in 2019, well below the updated fishing mortality threshold reference point FMSY proxy = F40% = 0.200. The model estimates of F and SSB in 2019 adjusted for internal retrospective error were within the model 90% confidence interval estimates of F and SSB in the terminal year. Therefore, no adjustment of these terminal year estimates has been made for stock status determination or projections. While the stock sustained catches above MSY during 2013-2019, stock biomass is projected to decrease toward the target unless more above average year classes recruit to the stock in the short term. Projections using the results of the 2021 MTA model assume that the 2020 and 2021 ABCs of 16,227 mt and 15,791 mt were caught. The OFL projection uses F2022-F2023 = updated FMSY proxy = F40% = 0.200. The OFL catches are 14,770 mt in 2022 (CV = 18%) and 13,626 mt in 2023 (CV = 18%).

ToR 1. Estimate catch from all sources including landings and discards.

The PRC concluded that the assessment team fully met this term of reference. The time series of commercial and recreational landings and discards were updated through 2019. No data for 2020 were used in the assessment. Reported 2019 commercial landings were 6,252 mt = 13.783 million lb. Estimated 2019 recreational landings were 6,403 mt = 14.116 million lb. Total commercial and recreational landings in 2019 were 12,655 mt = 27.899 million lb. Estimated 2019 commercial discards were 2,779 mt = 6.127 million lb. Estimated 2019 recreational discards were 560 mt = 1.235 million lb. The estimated total catch in 2019 was 15,994 mt = 35.261 million lb. MSY is estimated to be 12,054 mt = 26.575 million lb.

The PRC concurs that there is adequate characterization of landings and discards from all sources.

ToR 2. Evaluate indices used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.).

The PRC concluded that the assessment team fully met this term of reference. Indices of stock abundance from NEFSC winter, spring, and fall, Massachusetts DMF spring and fall, Rhode Island DFW spring and fall, University of Rhode Island Graduate School of Oceanography (URIGSO), RI Industry Cooperative trap, Connecticut DEEP spring and fall, New York DEC, New Jersey DFW, Virginia Institute of Marine Science (VIMS) Chesapeake Bay, VIMS juvenile fish trawl, and NEAMAP spring and fall trawl surveys were used in the 60th SAW benchmark assessment (Northeast Fisheries Science Center 2015), and both the 2017 and 2019 assessment updates. Most of the surveys provided age-specific information, several provide a total biomass index. All indices were updated through 2019 for this assessment, including age information. Treatment of all survey data followed methods used in the prior approved assessments.

ToR 3. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) as possible (depending on the assessment method) for the time series using the approved assessment method and estimate their uncertainty. Include retrospective analyses if possible (both historical and within-model) to allow a comparison with previous assessment results and projections, and to examine model fit.

a. *Include bridge runs to document sequentially each change from the previously accepted model to the updated model proposed for this peer review.*

b. *Prepare a "Plan B" assessment that would serve as an alternate approach to providing scientific advice to management if the analytical assessment were to not pass review*

The PRC concluded that the assessment team fully met this term of reference. Introduced and approved at the 60th SAW (Northeast Fisheries Science Center 2015), the assessment model for scup is a statistical catch-at-age model (ASAP, Legault & Retrepo 1998) incorporating a broad range of fishery and survey data. The model assumes an instantaneous natural mortality rate (M) = 0.2. The fishery catch is modeled as four fleets: commercial landings, recreational landings, commercial discards and recreational discards. There were no structural changes to the model or data sources; therefore, a bridge model run was not necessary.

The 2021 MTA indicated the spawning stock biomass (SSB) in 2019 to be 176,404 mt. There is a 90% chance that SSB_{2019} was between 154,000 and 210,000 mt. Fishing mortality on the fully selected age 4 fish F_{2019}= 0.136. There is a 90% probability that the fishing mortality rate in 2019 was between 0.106 and 0.166. The average recruitment from 1984 to 2019 is 136 million fish at age 0. The 2015-year class is estimated to be the largest in the time series at 415 million fish, while the 2017 - 2019 year classes are estimated to be below average, with the 2019-year class the smallest in the time series. The uncertainty in the estimates is addressed through the MCMC resampling method employed in the ASAP model.

There is a minor retrospective pattern evident in the scup assessment model. The internal model retrospective error tends to underestimate SSB by -14.4% and overestimate F by +20.2% over the last 7 terminal years. The model estimate of SSB in 2019 adjusted for internal retrospective error (201,806 mt) is within the model estimate 90% confidence interval (154,192 mt; 210,285 mt). The model estimate of F in 2019 adjusted for internal retrospective error (0.109) is within the model estimate 90% confidence interval (0.106; 0.166). Therefore, no adjustment of these terminal year estimates has been made for stock status determination or projections. The 'historical' retrospective analysis (comparison between assessments) indicates that the general trends in spawning stock biomass, recruitment, and fishing mortality have been consistent over the history of the assessment.

A Plan B assessment was unnecessary because the ASAP assessment was accepted.

ToR 4. Re-estimate or update the BRPs as defined by the management track level and recommend stock status. Also, provide qualitative descriptions of stock status based on simple indicators/metrics (e.g., age- and size-structure, temporal trends in population size or recruitment indices, etc.).

The PRC concluded that the assessment team fully met this term of reference. Based on model results, the stock was not overfished and overfishing was not occurring in 2019 relative to the updated biological reference points.

The accepted definition of reference points for Scup are $F_{40\%}$ as the proxy for F_{MSY}, and the corresponding $SSB_{40\%}$ as the proxy for the SSB_{MSY} biomass target (Northeast Fisheries Science Center 2015). Reference points were calculated using the non-parametric yield and SSB per recruit long-term projection approach, as in the previous assessment. The recruitment time series (1984-2019) was re-sampled to provide future recruitment estimates for the projections used to estimate the biomass reference point. Estimates of the values for biological reference points for Scup were updated in the 2021 MTA. The updated fishing mortality threshold is F_{MSY}= $F_{40\%}$ proxy = 0.200. The updated biomass target proxy estimate for SSB_{MSY} = $SSB_{40\%}$ = 90,019 mt and the updated biomass threshold proxy estimate is ½ $SSB_{40\%}$ = 45,010 mt. The updated proxy estimate for MSY = $MSY_{40\%}$ = 12,671 mt. Spawning stock biomass (SSB) was estimated to be 176,404 mt in 2019, about 2 times the updated biomass target reference point SSBMSY proxy = SSB40% = 90,019 mt. There is a 90% chance that SSB_{2019} was between 154,000 and 210,000 mt. Fishing mortality on the fully selected age 4 fish F_{2019}= 0.136, 68% of the updated fishing mortality threshold reference point FMSY proxy = F40% = 0.20.

The 2021 also provided qualitative measures of stock status. The 2021 MTA indicated that the age structure in current fishery and survey catches is greatly expanded compared to the truncated distribution observed in the early 1990s. Most survey aggregate biomass indices have recently been near their time series high. Survey indices suggest the recruitment of several large year classes during 2000 - 2015. These simple metrics indicate that mortality from all sources was lower than recruitment inputs to the stock during this period, which has resulted in a spawning stock biomass that is well above the management target. The high stock biomass sustained catches above MSY during 2013-2019. However, most recent indices suggest the 2017-2019 year classes are below average. Spawning stock biomass is projected to decrease toward the target unless more above average year classes recruit to the stock in the short term.

The PRC concurs that biological reference points were updated according to approved methodology and that simple metrics agree with the assessment results.

ToR 5. Conduct short-term stock projections when appropriate.

The PRC concluded that the assessment team fully met this term of reference. Projections using the results of the 2021 MTA model (data through 2019) were made to estimate the OFL catches for 2022-2023. The projections assume that the 2020 and 2021 ABCs of 16,227 mt and 15,791 mt will be caught and sample from the estimated recruitment for 1984-2019. The preliminary estimate of 2020 catch is 15,226 mt, 94% of the 2020 ABC. The OFL projection uses F2022-F2023 = updated FMSY proxy = F40% = 0.200. The OFL catches are 14,770 mt in 2022 (CV = 18%) and 13,626 mt in 2023 (CV = 18%)

PRC concurs that short term projections were completed using previously approved methodology and provide appropriate probability distributions for the stock size given the assumed level of catch.

ToR 6. Respond to any review panel comments or SSC concerns from the most recent prior research or management track assessment.

Several research needs were identified by the MAFMC SSC in 2019 -2020 with respect to 2019 scup operational assessment. The RP noted that a number of requests were positively addressed by the assessment analysts:

- Characterize the pattern of selectivity for older ages of Scup in both surveys and fisheries. Response : this is currently ongoing estimation in assessment
- Explore the applicability of the pattern of fishery selectivity in the model to the most recent catch data to determine whether a new selectivity block in the model is warranted. Response: updated in 2021 MTA, new 2013+ selectivity block added to model.
- Mean weights-at-age have declined and age-at-maturity has increased slightly (the proportion mature at age 2 has decreased) in recent years. Continued monitoring of both is warranted. Response: ongoing monitoring in assessment.
- It was conjectured that the increase in stock biomass since 2000 resulted from increased recruitments due to the imposition of gear restriction areas (GRAs), to minimize interactions between Scup and squid fisheries, and from increases in commercial mesh sizes. Long-term climate variation is a potential alternative explanation for increased recruitments from 2000 to 2015. Research to explore the validity of both hypotheses is warranted. Response: no new research progress

- Improve estimates of discards and discard mortality for commercial and recreational fisheries. Response: no additional progress, but no concerns expected if current levels of sampling are maintained.
- Evaluate the degree of bias in the catch, particularly the commercial catch. Response: no stock-specific progress, but GARFO/NEFSC CAMS proposed for 2020+ data
- Conduct experiments to estimate catchability of Scup in NEFSC surveys. Response: no progress.
- Explore the utility of incorporating ecological relationships, predation, and oceanic events that influence Scup population size on the continental shelf and its availability to resource surveys used in the stock assessment model. Response: no new research progress.
- Explore additional sources of age-length data from historical surveys to inform the early part of the time series, providing additional context for model results. Response: no success, likely alternative is to begin model in 1984 in next RTA
- An MSE could evaluate the effectiveness of Scup management procedures. Response: no progress.
- The Scup Statistical Catch at Age assessment model uses multiple selectivity blocks. The final selectivity block (2006-2018) is the longest in the model. The applicability of the most recent selectivity block to the current fishery condition is uncertain. If the fishery selectivity implied in this block changes, estimates of stock number, spawning stock biomass, and fishing mortality become less reliable.
- Response: updated in 2021 MTA – new 2013+ selectivity block added to model
- Recruitment indices for Scup have been declining in recent years. The 2021 management track assessment should consider the implications on stock biomass projections should this trend continue. Response: evaluated in the 2021 MTA assessment model and associated projections
- Most of the fishery-independent indices used in the model provide estimates of the abundance of Scup < age 3. One consequence is that much of the information on the dynamics of Scup of older ages arises largely from the fishery catch-at-age and from assumptions of the model, and are not conditioned on fishery-independent observations. As a result, the dynamics of these older fish remain uncertain. Knowledge of the dynamics of these older age classes will become more important as the age structure continues to expand. Response: no new research progress, but assessment indicated the abundance of older fish increasing in fishery and survey catches, and there is evidence of possible density dependent effects on growth and maturity
- The projection on which the ABC was determined assumes that the quotas would be landed in 2019, 2020, and 2021; however, landings in recent years have been below the quotas and perhaps a more realistic assumption should be used in future projections: given the uncertainty of fishery dynamics and catch estimated for 2020, the 2021 MTA projections assumed the ABCs would be caught in 2020-2021. Response: preliminary 2020 catch is 94% of 2020 ABC.
- Uncertainty exists with respect to the estimate of natural mortality used in the assessment. Response: no new research progress.
- Uncertainty exists as to whether the MSY proxies (SSB40%, F40%) selected and their precisions are appropriate for this stock. Response: no new research progress

- Survey indices are particularly sensitive to Scup availability, which results in high inter-annual variability. Efforts were made to address this question in the Stock Assessment Workshop and Stock Assessment Review Committee (SAW/SARC) in 2017 that should be continued in the 2021 management track assessment. Response: no new research progress

Atlantic Mackerel

The PRC concluded that the 2021 Management Track Assessment for Atlantic Mackerel represents the best scientific information available and can serve as the basis for management for 2022 and 2023. The 2021 MTA involved the addition of three years of fishery-dependent and fishery-independent data. There were no structural changes to the assessment. The most substantial change to the assessment was the incorporation of revised MRIP estimates, which indicated increased removals by the recreational fishery in the most recent years. Other changes to parameter values fell well within the scope of a management track update of an approved assessment.

Atlantic Mackerel is a pelagic fish from the scombrid family that is widely distributed in the north Atlantic basin. In the western Atlantic, mackerel is found from North Carolina to Newfoundland and from North Africa and the Mediterranean to Norway in the eastern Atlantic. Stock structure is complex within its distribution, and large scale distributional shifts of this species are well known. For the purposes of the management track assessment, work focused on Atlantic Mackerel in the western Atlantic that is believed to comprise a single unit stock, distributed from North Carolina, northward to the Atlantic Canadian provinces. Although widespread throughout this range, spatial structure is present (Redding et al. 2020, Arai et al. 2021). Spatially separated spawning aggregations occur in Southern New England waters (termed the southern contingent) and in the Gulf of Saint Lawrence, particularly around the Isles de la Madeleine (termed the northern contingent). Management of the stock is shared between the US and Canada with biologists and analysts from both nations often working collaboratively to collect data, characterize distributions and undertake assessments.

The most recent stock assessment for Atlantic Mackerel was presented at the 64th Stock Assessment Workshop (Northeast Fisheries Science Center 2018). The primary assessment model is an age-structured model (ASAP, Legault & Retrepo 1998) that combines fishery-dependent and fishery-independent data from both contingents. The model represents fish in age classes 1-10+, experiencing a single constant rate of natural mortality (M=0.2), subject to a single fishery with a time- invariant, flat-topped selectivity profile. The assessment relies on three fishery-independent surveys, including a range wide index of SSB derived from egg surveys, and the NEFSC spring bottom trawl survey partitioned to reflect the change in vessel from the RV Albatross to the RV Henry Bigelow. An independent peer review found the assessment represented BSIA and was an appropriate foundation for management. Results from the assessment indicated that the Atlantic Mackerel stock was overfished (22% of SSB_{MSY}) and was experiencing overfishing (180% of F_{MSY}). Subsequently, a rebuilding plan was implemented that was scheduled to rebuild the stock by 2023 using a fishing mortality rate strategy of $F_{rebuild}$=0.237.

For the 2021 MTA, fishery removals and survey data were added for 2017-2019.

ToR 1: Estimate catch from all sources including landings and discards.

The PRC concluded that the assessment team fully met this term of reference.

Following the expulsion of foreign fleets in the late 1970s, catches have been dominated by US and Canadian sources, except for a short “joint-venture” fishery in the 1980s. Reported Canadian catches are only a subset of total Canadian catches, as removals resulting from commercial discards, from bait fisheries, and from recreational fisheries are not reported. The PRC notes the uncertainty this introduces in estimates of catches. It is assumed that the unreported Canadian catches are relatively small. Even were this not to be the case, provided they have varied in magnitude without trend they do not represent a significant source of uncertainty. US catches (2011-2019) have averaged 8,700 mt and are derived from three sources: commercial landings, commercial discards and recreational catch. Commercial fisheries operate largely during winter months in southern New England and the Mid-Atlantic, driven largely by patterns of availability. There is a low level of commercial discards. As noted above, the 2021 MTA for Atlantic Mackerel used the revised MRIP estimates of recreational catch for the first time. The revised MRIP estimates indicate that between 1981-2007 recreational catches were on average 62% higher than estimated previously. Estimates for 2008 – 2019 indicate an increased importance of recreational catch. Revised estimates are almost 200% higher than previous estimates for this period.

Taken overall, the revised estimate of total removals from the stock between 1981-2019 increased by only 4%.

There is a strong pattern in the age structure of the commercial catch. In the 1970s, large numbers of fish from age-1 to 7+ were harvested. Following the expulsion of foreign fleets, catches declined, but the age structure remained diverse. Strong year classes are evident, particularly in 1982, 1999, and possibly in 2015. The 1982 and 1999 year classes sustained increased harvests for short periods.

ToR 2: Evaluate the survey indices used in the assessment.

The PRC concluded that the assessment team fully met this term of reference. Data were added for 2017-2019 for the two modern fishery-independent surveys, SSB from egg surveys and the NEFSC spring survey using the RV Henry Bigelow. All three survey time series (included the NEFSC spring survey aboard the RV Albatross) were evaluated by the PRC.

The modern NEFSC spring survey is now a decade-long time series. The time series is relatively invariant over the first six years. Five of the 6 index values for 2009-2014 are below median values for the time series. The index increased rapidly reflective of the potentially large 2015 year class. The index increased again in 2018 reflecting another potential pulse of recruitment. Four of the last five index values have been at or above the median value for the survey.

Fishery-independent indices of SSB are derived from egg collections in Canada and the US. The Canadian survey for the northern contingent occurs at a time coincident with the fishery and targets mackerel spawning in the Gulf of St. Lawrence. The egg survey for the southern contingent is a broad ecosystem survey, not specifically targeting mackerel. Results of the two surveys are combined to yield a total SSB index. In most years the southern contingent represents <15% of the SSB, although in occasional years (1983, 2018), the southern contingent can represent >40% of the SSB.

ToR 3. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) as possible (depending on the assessment method) for the time series using the approved assessment *method and estimate their uncertainty. Include retrospective analyses if possible (both historical and within-model) to allow a comparison with previous assessment results and projections, and to examine model fit.*

a. Include bridge runs to sequentially document each change from the previously accepted model to the updated model proposed for this peer review.

b. Prepare a "Plan B" assessment that would serve as an alternate approach to providing scientific advice to management if the analytical assessment were to not pass review

The PRC concluded that the assessment team fully met this term of reference. The 2021 MTA for Atlantic Mackerel continued to use the structure, data sources, and parameterization approved by the 64th SAW in 2017.

Bridge runs were conducted appropriately that explored the impact of revised MRIP estimates, revised estimates of Canadian catches, and minor changes to the calculation of egg production for the southern contingent using the time window for the 64th SAW assessment (Northeast Fisheries Science Center 2018). There was a clear effect of the revised MRIP estimates on estimates of fishing mortality. Subsequently, new runs with the full 1968-2019 time series were undertaken. The new runs indicated that the magnitude "strong" 2015 year class that was evident at the end of the modeled time series in the 64th SAW assessment was not reduced in the 2021 MTA runs. Moreover, this weaker 2015-year class was followed by the lowest recruitment on record in 2017 (2016 year class). These two outcomes have meant that the increase in SSB expected in the rebuilding plan has not been realized. The 2019 SSB, SSB_{2019} =42,862 mt, is lower than expected. Lack of availability of fish and restrictions on harvest have meant that although SSB levels have not recovered, estimates of F have continued to decline, with a terminal F_{2019}=0.46.

The PRC noted that sources of uncertainty related to stock structure and the assumption of a constant, time invariant M for all ages remain features of the assessment to be evaluated in later research track assessments

Evidence for retrospective patterns in 2021 operational assessment model results was stronger than in the 64th SAW assessment (Northeast Fisheries Science Center 2018). Internal retrospective patterns were evident in SSB, R and F. In terminal five-year peels, SSB was overestimated in the more recent four years, but underestimated in the fifth year. Similarly, F was underestimated in the most recent 4 years and overestimated in the fifth. The PRC suggest that this pattern is likely related to expression of "belief" by the model in the 2015 year class. Formal retrospective adjustments were calculated for SSB and F, but the adjusted values were not outside the 90% confidence intervals of the terminal year estimates and thus no retrospective adjustment was applied.

External retrospective patterns were evaluated by comparing the 2021 operational assessment and the 64th SAW assessment. These comparisons were generally favorable, although terminal year point estimates for SSB and F from the 64th SAW model fell outside the 90% confidence band for the 2021 MTA estimates.

ToR 4. Update the BRPs as defined by the management track level and recommend stock status.

The PRC concluded that the assessment team fully met this term of reference. BRPS are based on $F_{40\%}$ and $SPR_{40\%}$ MSY proxies. Following the benchmark methodology, BRPs were generated from 100-year stochastic simulations drawing from the recruitment time series from 1975 onward. This is the same method as used in the previous assessment. This approach produced revised reference points that are lower in the 2021 MTA than they were in the earlier assessment ($F_{MSY2021}$=0.22 vs $F_{MSY2017}$=0.26, and $SSB_{MSY2021}$=181,090 vs $SSB_{MSY2017}$=196,894). The PRC note that the F_{MSY} estimate is lower than the $F_{rebuild}$ estimated in the 2017 rebuilding plan.

The revised BRPs translate to a stock status that is overfished (24% of SSB_{MSY}) and overfishing is occurring (108% greater than F_{MSY}). The 90% confidence intervals of the terminal year are lower than the overfished threshold and above the overfishing threshold. Under these new BRPs, the stock has been overfished for the last 12 years and has been experiencing overfishing for the last 30 years.

ToR 5. Conduct short-term stock projections when appropriate.

The PRC concluded that the assessment team fully met this term of reference.

Short term projections were undertaken based on F_{MSY}=0.22 as it is less than $F_{rebuild}$=0.237, and on interim catch information. The estimated 2020 catch of 18, 038 mt was believed to be reliable because the US catch occurs in primarily winter months, the fishery was completed prior to the impact of the pandemic, and commercial discards are comparatively minor. The Canadian fishery occurred in a manner unrestricted by COVID in 2020. Projections assumed the ABC (23,184 mt) would be fully caught in 2021. Base projections undertaken in the 2021 MTA indicated that the stock will not meet the rebuilding target by 2023. Projections suggest ½ $SSB_{MSY} < SSB_{2023} < SSB_{MSY}$.

The PRC examined the projection performance of the 64th SAW assessment model based on recent knowledge gained from the 2021 operational assessment. In the 64TH SAW, SSB_{2016} was estimated to be 43,519 mt and 30,870 in the 2021 MTA – a 29% difference. However, for 2017, projected SSB was 103,627 in the 64th SAW but was estimated to be 40,190 in the 2021 MTA – a 61% difference. The 64th SAW projections indicated that recovery of SSB to MSY levels was highly likely to occur by 2023 based on both the strength of the 2015-year class inferred in the 2017 assessment and the low age at maturity in Atlantic Mackerel. The 2021 management track assessment indicates that the 2015 year class was only 15% weaker than estimated in the 64th SAW, yet this reduction, followed by a time series low 2017 recruitment have meant that SSB has not recovered appreciably. Furthermore, projections indicate that rebuilding of the stock by 2023 is highly unlikely given recruitment levels currently observed in the stock.

ToR 6. Response to research recommendations.

Two suites of analysis were conducted in response to research recommendations: effects of recent reductions in recruitment on stock projections, and uncertainty in the rate of natural mortality.

The assessment workgroup considered three different hypotheses related to recruitment. H1: All recruitments from 1975 onward may occur in the future; H2: The industry noted substantial changes in the distribution and availability of fish from 1999 onwards, which appear still to be in operation, and thus only recruitments from 1999 onwards are likely in the near future, and H3: fishery catches changed markedly in 2011, and thus only recruitments from 2009 onwards are likely in the future. The PRC found these three alternative hypotheses to be objective defensible statements of belief of the future recruitments in this stock. Both hypotheses involving the two longer recruitment time series yield

projections that by 2023 had recovered SSB to levels between ½ $SSB_{MSY} < SSB_{2023} < SSB_{MSY}$. In contrast ,
projections based on the most recent recruitment time series indicated no substantial recovery of SSB, with SSB_{2023}=69, 562 mt, which represents only a 15% increase in SSB over the 2020 level.

Catch projections were similarly sensitive to the time window used as a basis for future recruitments. In general, the longer the window, the higher the catch in 2023.

Motivated by a question from webinar attendee Dr. Steve Cadrin, the PRC offers the following observations.

1) It is a best practice that the basis for BRP determination and projections be based on the same hypothesis regarding future recruitment. This produces BRPs and projections that are internally consistent. In response to a research question raised under ToR 6, the 2021 MTA presents supplemental projections that use different hypotheses about future recruitments in the short-term projections. This is not recognized explicitly in the assessment.
2) The PRC recognizes however, that it is not incompatible to believe that overall system productivity has not changed (i.e. BRPs could be based on the entire recruitment time series), whereas stock characteristics have changed such that recent recruitments are more likely. This is the conscious, if not explicit, statement of belief that was made in supplemental projections presented as a part of the 2021 MTA. A consequence of this combination is that stock recovery is less likely in the short term, since reference points are based on a higher level of stock productivity than currently permitted in the projections.
3) If there is a consensus that a regime change or other mechanism may have reduced the overall system productivity, it would be more appropriate to recalculate the BRPs using the lower productivity recruitment time series (2009-2019) and compare them with the short-term projections based on recent recruitments. This will likely result in even lower BRPs, which will imply the stock has been in a poorer condition than previously believed, but would, somewhat counter-intuitively, likely make rebuilding success more likely

The second recommendation was an evaluation of variation in natural mortality. The PRC was convinced that data are lacking to make changing the current time and age invariant M (=0.2) unlikely in the near future. Atlantic Mackerel are relatively rare in the NEFSC Food Habits Database, which is often used to ground patterns in time varying M. Moreover, even were Atlantic Mackerel common in the food habits database, no predation information is available for the northern contingent.

Additional Recommendations

The RPC support the continued work to define stock structure, its temporal variation and how this may relate to recruitment. The RPC recommend further exploration of mechanisms that may explain patterns in recruits per spawner, which could be interpreted as compensation

LITERATURE CITED

Arai K, Castonguay M, Secor DH (2021) Multi-decadal trends in contingent mixing of Atlantic mackerel (Scomber scombrus) in the Northwest Atlantic from otolith stable isotopes. Sci Rep-Uk 11

Legault CM, Retrepo VR (1998) A flexible forward age-structured assessment program. ICCAT Col Vol Sci Pap 49:246-253
McCartney MA, Burton ML, G. LT (2013) Mitochondrial DNA differentiation between populations of black sea bass (*Centropristis striata*) across Cape Hatteras, North Carolina (USA). Journal of Biogeography 40:1386-1309
Nitschke P (2017) Golden Tilefish, *Lopholatilus chamaeleonticeps,* stock assessment updates through 2016 in the Mid-Atlantic - Southern New England region. In: Commerce Do (ed). Northeast Fisheries Science Center, Woods Hole, MA
Northeast Fisheries Science Center (2014) 58th Northeast Regional Stock Assessment Workshop (58th SAW), Assessment Summary Report. In: Administration NOaA (ed), Book CRD. Department of Commerce, Woods Hole
Northeast Fisheries Science Center (2015) 60th Northeast Regional Stock Assessment Workshop (60th SAW) Assessment Report. In: Commerce Do (ed). National Marine Fisheries Service, Woods Hole, MA
Northeast Fisheries Science Center (2017) 62nd Northeast Regional Stock Assessment Workshop (62nd SAW) Assessment Report. In, Woods Hole, MA
Northeast Fisheries Science Center (2018) 64th Northeast Regional Stock Assessment Workshop (64th SAW) Assessment Report. In: Commerce Do (ed). National Marine Fisheries Service, Woods Hole, MA
Northeast Fisheries Science Center (2019) Operational Assessment of the Black Sea Bass, Scup, Bluefish and Monkfish Stocks, Updated Through 2018. In: Branch PD (ed). National Marine Fisheries Service, Woods Hole, MA
Redding SG, Cooper LW, Castonguay M, Wiernicki C, Secor DH (2020) Northwest Atlantic mackerel population structure evaluated using otolith delta O-18 composition. Ices Journal of Marine Science 77:2582-2589
Roy EM, Quattro JM, Greig TW (2012) Genetic Management of Black Sea Bass: Influence of Biogeographic Barriers on Population Structure. Marine and Coastal Fisheries 4:391-402
Turner SC (1986) Population dynamics of and, impact of fishing on tilefish, *Lopholatilus chamaeleonticeps,* in the Middle Atlantic-Southern New England region during the 1970's and early 1980's. Ph.D, Rutgers, New Brunswick, NJ