Research Priorities and Recommendations to Support Interjurisdictional Fisheries Management

BLACK SEA BASS

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Status of previous research recommendations

The 2023 Research Track working group reviewed research recommendations from the 2017 benchmark stock assessment (SAW/SARC 62; NEFSC 2017), the 2019 and 2021 management track assessments (NEFSC 2020; NEFSC 2022), and all relevant SSC meetings from January 2017 through the present. The following sections summarize the status of relevant recommendations and the working group's rankings as high, medium, or low priorities for further work. These topics were not ranked through the previous assessments or by the SSC. The rankings below reflect the opinions of the working group. Topics are not ranked within each category of high, medium, and low (e.g., the first topic listed under "high" is not a higher priority than the other high priority topics).

High priority previous research recommendations

The working group agreed that the following previous research recommendations remain high priorities for future work to improve the assessment.

Movement rates and cues within the population

An increased understanding of movement rates and cues within the population, including implications for the two region model structure, were previously identified as research priorities. The working group supports maintaining these topics as high priorities for continued work to improve the assessment. Specifically, the working group recommends additional research to quantify movement between the northern and southern regions and research on environmental drivers of this movement.

As previously described, the proposed base model includes movement of the northern stock component between the two regions. The previous model assumed no movement. The assumptions about movement in the proposed base model would benefit from further evaluation. For example, the model assumes all fish return to their region of origin to spawn. However, few studies are available to inform this assumption. Further evaluation could also be carried out on the time scales for mixing (e.g., mixing between regions assumed on short vs. longer time scales). Additional information on movement could also help evaluate the drivers of the large survival random effects in the proposed base model. Future developments of the multi-WHAM model could also move to directly estimate movement by including the tagging data in the assessment model instead of setting the movement prior based on the results of another assessment model (SS) that uses the same input data. However, we note that very limited movement of the northern component is estimated which to some extent makes this a lower priority for this stock.

Research into movement could also contribute to a better understanding of the environmental drivers of stock dynamics. For example, there may be less movement from the northern to the southern region as temperatures increase. Stakeholder conversations also highlighted that black sea bass seasonal movement patterns have changed over time (Mercer et al. 2023 working paper). As described in TOR 1, the working group considered using winter shelf water volume as an indicator of winter mixing between the two modeled regions. We ultimately decided not to pursue this as an indicator in the proposed base model given uncertainty in the relationship between these two variables and the driving mechanisms.

Varying recruitment and strong year classes

The SSC and the 2019 Management Track Assessment Review Committee identified research recommendations related to the role of varying recruitment and strong year classes in stock dynamics, including drivers of recruitment. The working group agreed that understanding recruitment is fundamentally important for the assessment model and therefore remains a high priority for further work to improve the assessment.

The working group noted that the proposed base model and alternative modeling approaches considered (i.e., SS, see Fay et al. 2023 working paper) account for spatial differences in recruitment and changes over time. Spatially variable recruitment was a driver for moving to the current two region model structure through the 2017 benchmark assessment. As noted above, the proposed base model incorporates a relationship between bottom temperature and recruitment. As described in more detail below, the working group agreed that environmental drivers of recruitment are a medium priority for future work.

Development of a reliable index beyond existing surveys

Development of a reliable index beyond existing surveys was previously identified as a research recommendation. The working group agreed this remains a high priority for future work.

As described under TOR 3, the working group noted that ventless trap surveys are starting to provide longer time series of data and may be worth considering in future assessment updates. We also noted that alternative surveys will be needed as the NEFSC bottom trawl surveys will be impacted by offshore wind energy development. A variety of methods could be considered for new survey efforts, including acoustic telemetry, eDNA, hook and line surveys, and standardized fishery catch rates.

Medium priority previous research recommendations

The working group agreed that the following previous research recommendations should be maintained as medium priorities for future work to improve the assessment.

Impacts of climate shifts on production

The SSC recommended evaluation of evidence for increased production due to climate shifts. As described in more detail below, the working group agreed that a more specific topic of the environmental drivers of recruitment is a medium priority for future research to improve the assessment. This more specific topic has the greatest application to the assessment and is preferable over the broader topic of increased production due to climate shifts.

As previously described, the proposed base model incorporates an effect of winter bottom temperature on recruitment. This is an improvement over the previous assessment; however, more work could be done to further consider how to best incorporate this relationship into the model.

Fishery-independent abundance indices

The 2019 Management Track Assessment Review Committee recommended re-examination of the fishery-independent indices included in the model, noting that only those indices that are a priori considered to capture trends in the stock should be included. The working group agreed this remains a medium priority for future work.

As described in more detail under TOR 3, the working group did a considerable amount of work on fishery-independent indices. We thoroughly considered indices based on many fisheries-independent surveys, including consideration of survey standardization and development of a VAST approach for both abundance and age compositions. However, more work could be done, including further consideration of fall indices using a VAST approach and further work to standardize individual state surveys (if not aggregated through an approach like VAST). It would be beneficial to develop guidelines for integrating both fishery-dependent and fishery-independent indices in assessments generally, not just for black sea bass, including methods to efficiently create and update standardized indices and tools to integrate indices and their length/age composition.

Use of industry study fleet data

Consideration of use of samples collected by industry study fleets was previously identified as a research recommendation. The working group considered several sources of fisheries-dependent data and agreed this remains a medium priority for future work to improve the assessment.

The working group was not able to incorporate some sources of fisheries-dependent data into the proposed base model due to differences in the sampling methodologies across datasets. For example, the working group considered data from the Commercial Fisheries Research Foundation's black sea bass research fleet (Verkamp et al. 2023 working paper). Under the modeling framework used for the proposed base model (i.e., Multi-WHAM), however, CFRF's size composition data from kept fish could not be combined with federal portside sampling data for estimating expanded landings-at-length because these data did not include market category. However, size composition data from discarded fish sampled through the black sea bass research fleet were combined with federal observer data to estimate expanded disards-at-length because market category is not needed to complete expansions for discards. Additionally, age-length data from the CFRF research fleet were incorporated into the development of age-length keys.

Fisheries observer data and NEFSC commercial study fleet data were considered through the commercial CPUE index (Jones et al. 2023 working paper); however, this index was ultimately not included in any model runs. Continuing to develop and apply CPUE indices could be beneficial to the assessment moving forward.

The working group noted that in order for fisheries-dependent data to be most useful for the stock assessment, they should contain a representative distribution of samples and should include length measurements, including market category. As noted above, it would be beneficial to develop guidelines for integrating both fishery-dependent and fishery-independent indices in assessments generally, not

just for black sea bass, including methods to efficiently create and update standardized indices and tools to integrate indices.

Discard mortality rates

In July 2020, the SSC recommended consideration of revisions to the discard mortality rates used in the assessment based on new research (i.e., Zemeckis et al. 2020 and Rudershausen et al. 2020), to the extent that these depth-specific mortality estimates can be appropriately matched to recreational catch from similar depths. The working group addressed this topic (Beaty et al. 2023 working paper) and agreed that further research on discard mortality rates is a medium priority for future work, particularly for gear types for which there has been limited or no new research.

As described in more detail in the Beaty et al. 2023 working paper, the working group reviewed multiple new studies on discard mortality rates. We ultimately agreed to leave all discard mortality rates unchanged based on the limited spatial precision of the recreational fishery data, limitations in the applicability of some research to the fishery at a larger scale, and a lack of new research for some gear types (e.g., trawl and gillnet). The working group emphasized that the spatial precision of the recreational fishery data poses challenges for applying new research on hook and line discard mortality rates in the assessment and in management. A better understanding of the depths of recreational fishing effort, including variation across states, in state vs. federal waters, and at different times of year, would be useful for the purposes of applying new research on hook and line discard mortality rates in the assessment.

Low priority previous research recommendations

The working group agreed that the following previous research recommendations are low priorities for future work.

Further evaluation of the two region structure of the model

The 2019 Management Track Assessment Review Committee and the SSC recommended further evaluation of the two region structure of the model, including further evaluation of the stock structure north of Cape Hatteras based on genetic analysis, otolith microchemistry, traditional and acoustic tagging, or other types of analysis. They also recommended re-evaluation of the ability to track year classes in a single model, as opposed to a model with multiple regions. The inability to do so was part of the rationale for use of the current two region structure.

The working group agreed that the rationale for modeling the stock as two regions, split approximately at Hudson Canyon, remains appropriate. Recent research on otolith microchemistry (Koob et al. 2023) generally confirmed that the current model spatial structure, split at approximately Hudson Canyon, remains appropriate. Recent research on the genomic population structure of black sea bass suggests there is no distinct genomic clustering north of North Carolina. However, fish collected around Cape Hatteras showed a distinct genomic cluster, suggesting that the southern stock boundary may be farther north than Cape Hatteras, as currently understood (Lotterhos et al. unpublished data).

The working group agreed that, given this recent and ongoing research, genetic stock structure is a low priority for future research to inform the assessment. If additional research on this topic is carried out, it may be beneficial to use recent techniques such as single nucleotide polymorphism markers.

Spatial patterns in growth, recruitment, and mortality

Spatial patterns in growth, recruitment and mortality were previously identified as research priorities. The two region model structure allows for spatial variation in many parameters. As described in more detail in TOR 4, the proposed base model estimates SSB, recruitment and fishing mortality separately by region. The working group agreed that although improvements can be considered in the future, this topic is a low priority for future research given that spatial patterns can be, and in many cases have been, incorporated into the proposed base model. The working group emphasized the importance of the spatial coverage of data, especially fishery-dependent data (e.g., port sampling), to support efforts to evaluate and incorporate spatial differences in the model.

Range expansion

The SAW/SARC 62 reviewers recommended further consideration of the impacts of climate change on black sea bass, particularly in the Gulf of Maine. The 2019 Management Track Assessment Review Committee recommended consideration of the impacts of range expansion on coverage of the stock in surveys and model applicability. The SSC recommended further evaluation of the implications of range expansion to the stock and fishery dynamics, including consideration of methods and modeling approaches to evaluate this topic. The working group agreed these are generally low priorities for further work to improve the model given improvements in the proposed base model which largely address these concerns. For example, Gulf of Maine strata have been added to the proposed base model. This will allow future model updates to pick up changes in the Gulf of Maine over time. As previously noted, the working group agreed that the spatial coverage of data is important for many aspects of the model, including the ability to pick up on range expansion and changes in the Gulf of Maine. As previously noted, the working group placed high priority on further research on environmental drivers of movement and recruitment. They agreed that these specific topics are a higher priority than climate change and range expansion more broadly.

Habitat use and seasonal changes

An improved understanding of habitat use and seasonal changes were identified as research recommendations through SAW/SARC 62. The working group agreed that further work on these topics could lead to improvements to the assessment. However, for the reasons described below, this is a lower priority than other topics, including related, but more specific topics such as movement between the regions, environmental drivers of movement, and environmental drivers of recruitment.

Multiple updates made through the proposed base model address habitat use and seasonal changes. For example, it includes seasonal mixing between the two regions. The previous assessment assumed no mixing. The survey standardization work done for this research track can also be viewed as a way of incorporating habitat associations into the model. The proposed base model incorporates an effect of winter bottom temperature on recruitment. The working group also considered using winter shelf water volume as an indicator of mixing between the two regions; however, we ultimately decided not to pursue this as an indicator in the model given uncertainty in the relationship between these two variables and the driving mechanisms.

Black sea bass habitat is changing, and their use of habitat is also changing. For example, stakeholder conversations indicate that as abundance has increased and the stock has expanded into New England,

they are less associated with hard structures and are now commonly encountered on open bottom (Mercer et al. 2023 working paper). Changing ocean temperatures and the planned construction of many offshore wind energy projects (i.e., addition of hard structures) are expected to further impact stock productivity. Important datasets in the assessment, especially the NEFSC bottom trawl surveys, will also be impacted by offshore wind energy development. Robust, long-term datasets are needed to assess and account for changes in habitat use.

Sex change, sex ratios, and spawning

Sex change and sex ratios, particularly comparing dynamics among communities, and investigation of social and spawning dynamics were identified as research recommendations through SAW/SARC 62. The working group agreed that further consideration of these topics may help improve future assessments; however, these are lower priorities than other topics.

The two region structure of the model accounts for differences in spawning across these two areas. The proposed base model is not sex-structured. However, the working group considered a sex-structured model through an alternative approach (i.e., SS, Fay et al. 2023 working paper).

Some uncertainties remain regarding black sea bass sex change. However, it is challenging to better understand sex change without the data to support it. For example, sex cannot be accurately determined based on the size of black sea bass.

The hermaphroditic life history of black sea bass is not accounted for in the proposed base model. However, the fact that the northern stock of black sea bass are considered to be atypical protogynous hermaphrodites and may be more resilient to exploitation than would be expected of typical protogynous hermaphrodites (e.g., not all fish transition from female to male) mitigates some concerns.

Natural mortality

The natural mortality rate used in the model was previously identified as a research recommendation, including the appropriateness of maintaining a constant natural mortality rate given the protogynous life history of black sea bass. The working group agreed that it would be beneficial to clarify the most relevant aspects of this topic for population dynamics (e.g., spatial differences in natural mortality, differences by life stage, or a different aspect). The working group agreed that although natural mortality is an important parameter in the model, it is a relatively low priority for future work to inform the assessment given the considerations outlined below. We also note that it is generally considered best practice to do sensitivity runs with different natural mortality assumptions.

The McNamee 2023 working paper describes an analysis done by the working group to re-evaluate the previously assumed natural mortality rate of 0.4. The working group considered multiple updated empirical approaches for estimating natural mortality, including methods for calculating stock-wide and region-specific natural mortality rates, as well as potential approaches for weighting the different methods. Ultimately, the working group agreed there was not sufficient evidence to change natural mortality from the previously used estimate of 0.4.

The working group also noted there has been limited new research on predation to inform the natural mortality rate used in the model. Additional data collection may be challenging as some of the key black

sea bass predators are not easily sampled. The working group also noted that diet data to inform the estimation of natural mortality should be stock-wide.

The modeling framework for the proposed base model (i.e., Multi-WHAM) can explore temporal variation in and/or covariate effects on natural mortality. This could be further considered through future assessment updates.

Precision and uncertainty in discard estimates

The SSC recommended efforts to improve the precision of discard estimates and to estimate uncertainty in discards. The working group agreed these are low priorities for future work to improve the black sea bass assessment. Discard estimates are provided through the Catch Accounting and Monitoring System (commercial) and MRIP (recreational). Both programs are designed to produce estimates for many stocks. It is anticipated that improvements to both programs will be made over time; however, this is outside the scope of the black sea bass assessment. The working group agreed that the research recommendations summarized under this TOR should focus on work that is most directly relevant to improving the black sea bass assessment.

Other previous research priorities identified by the working group

Survey catchability

Consideration of catchability in a variety of survey gear types was previously identified as a research recommendation and the working group agreed this remains an area for future work. Catchability rates can be impacted by climate change; therefore, it will be important to re-evaluate catchability over time.

Day/night differences in NEFSC trawl survey catch

The SSC recommended consideration of day/night differences in NEFSC trawl survey catch, as Secor et al. 2021 showed diurnal vertical migration for this stock, suggesting catchability differences could affect survey-based estimates.

Fishing mortality reference points

The SSC recommended consideration of alternative approaches for calculating fishing mortality and fishing mortality reference points, given the spatial nature of the assessment, for example calculated from summed numbers over the northern and southern models.

The working group agreed that, given the two region structure of the model, which has been maintained in the proposed base model, further consideration could be given to defining reference points or catch advice spatially.

Discard mortality projections

The SSC recommended further investigation of the implications of size structure, specifically the progression of strong year classes, on projected discard mortality.

New research recommendations

In addition to the previous research recommendations summarized above, the working group recommended the following additional topics for future research to improve the stock assessment. These topics were ranked as high, medium, or low priorities. Topics were not ranked within each category of high, medium, and low (e.g., the first topic listed under "high" is not a higher priority than the other high priority topics).

High priority new research recommendations

The working group identified the following topics as high priority new research recommendations.

Enhanced port sampling or similar program to bolster data that support estimation of fishery length and age compositions

The working group recommended enhanced port sampling or a similar program to bolster the data that support estimation of fishery length and age compositions as a high priority. These data are essential for the assessment. Degradation of these datasets through reduced sampling would be detrimental to the stock assessment and impede the ability to track cohorts through the fishery. The working group also emphasized that the spatial coverage of the data is important to support continued use of and improvements to the two region structure of the model.

Metrics for measuring recruitment as a response variable to environmental indicators

The working group agreed that further consideration should be given to the appropriate metric for measuring recruitment as a response variable to environmental indicators. For example, consideration could be given to survival as a ratio of the spring index to the previous year's fall index, rather than spring recruitment deviations. This was ranked as a high priority research recommendation. It was noted that the Multi-WHAM package allows for consideration of possible relationships with or effects of the environment on recruitment within the model.

Medium priority research recommendations

The working group identified the following topics as medium priority new research recommendations.

Environmental drivers of recruitment

The working group recommended additional research into environmental drivers of recruitment as a medium priority. The working group noted that black sea bass habitat is changing, and their use of habitat is also changing. For example, stakeholder conversations indicate that as black sea bass abundance has increased and the stock has expanded into New England, they are less associated with hard structures and are now commonly encountered on open bottom (Mercer et al. 2023 working paper). Changing ocean temperatures and the planned construction of many offshore wind energy projects (i.e., addition of hard structures) are expected to further influence stock productivity. These changes will affect the recruitment estimates from the stock assessment. As noted above, the working group considered the use of winter bottom temperature as an indicator of YOY survival; however, more work could be done to further consider this topic.

This is a medium, as opposed to a high, priority for further research to improve the assessment because although it is useful to understand the environmental drivers of recruitment, it is not necessary for these

drivers to be explicitly accounted for in the assessment in order for the model to produce unbiased recruitment estimates.

Explore ways to fill gaps in bottom temperature data for use as an environmental indicator, including consideration of new data sources and analytical products

The working group recommended further exploration of ways to fill gaps in the bottom temperature data for use as an environmental indicator, including consideration of new data sources and analytical products. This is a medium priority research recommendation. As previously noted, modeled estimates of winter bottom temperature are included in the proposed base model. Although inclusion of these estimates improved the model, the working group noted some limitations, including gaps in the data used to generate the estimates and signs of bias in the estimates. The working group noted that reliable datasets are needed to incorporate environmental considerations into stock assessments, for black sea bass and other species.

Commercial CPUE index

The working group recommended further consideration of a commercial CPUE index as a medium priority. A considerable amount of work was done to develop a commercial CPUE index for this assessment as described in the Jones & Mercer 2023 working paper. Although this index was not included in the proposed base model, the working group agreed that it warrants further consideration through future assessments. This index includes data from a broad area, can account for socioeconomic drivers of catch, and can be a useful tool for understanding changes in abundance.

Socioeconomic drivers of recreational and commercial fishing for black sea bass and associated species

The working group recommended further evaluation of the socioeconomic drivers of recreational and commercial fishing for black sea bass and associated species as a medium priority.

The working group noted that the recreational CPA index is an important index in the model. An improved understanding of the drivers of recreational fishing effort could make this index more informative.

Although not incorporated into the proposed base model, some recent work has been done to examine the drivers of fishing effort. For example, the commercial CPUE standardization included socioeconomic covariates such as fuel price and ex-vessel price (Jones & Mercer 2023 working paper). There are also ongoing efforts supported by the NEFSC, the Mid-Atlantic Fishery Management Council, and the Atlantic States Marine Fisheries Commission to model recreational fishing effort based on changes in regulations and availability of different size classes of summer flounder, scup, and black sea bass.

Impacts of expansion into the northern range of the stock on fishing behavior

The working group recommended further evaluation of how expansion into the northern range of the stock may impact fishing behavior as a medium priority. It would be useful to consider how the changing distribution of the stock impacts data collection and the utility of the indices included in the model.

Food web interactions and impacts on stock productivity

The working group recommended further research into food web interactions and impacts on the productivity of the stock. For example, consideration could be given to declines in predator species, especially in the northern edge of the range, and increases in prey species. The working group also noted that available data on predation on black sea bass are very limited. This is a medium priority research recommendation.

Incorporation of a fall VAST index

As described under TOR 3, the working group incorporated VAST indices developed from several fishery-independent spring surveys into the proposed base model. Fall VAST indices were developed for each region; however, their inclusion in the base model was not fully evaluated due to the discovery of an error in the estimated associated age compositions. This error was resolved and the fall indices were re-estimated; however, there was not sufficient time to evaluate inclusion in the base model once the error was resolved. Given that data from fall surveys were also not included in the previous assessment, this is a medium priority research recommendation.

Scaling recreational catch CVs

Additional research on scaling the recreational catch CVs would improve confidence in these data and the resulting CPA indices.

Low priority research recommendations

The working group identified the following topics as low priority new research recommendations.

Explore separating age-length keys by semester, region, and fishery/survey after 2008 when more data are available

As noted in the Truesdell & Curti 2023b working paper, the working group tried to develop separate age-length keys for survey and fishery-dependent data; however, there were generally too few paired age-length records (that too often did not cover the necessary size range) to allow for this degree of specificity. In particular, data were very limited prior to 2008 and in some years there were no paired age-length samples from fishery-dependent data sources. Therefore fishery and survey paired age-length records were combined for each year to develop region and season-specific age-length keys. Further work could be done in the future to consider separating age-length keys by semester, region, and fishery/survey after 2008 when more data are available. This is a low priority research recommendation as it is not expected to have a major impact on the assessment. However, it is still worth exploring and could be a straightforward exercise for a future management track assessment. The outcome could also inform future recommendations for sampling