Summary Report of the Butterfish and Shortfin Squid Research Track Stock Assessments Peer Review

March 7-11, 2022

Report prepared by Panel members:
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Introduction

We report here on the peer review of the 2022 research track stock assessments for butterfish (*Peprilus triacanthus*) and shortfin squid (*Illex illecebrosus*). The Terms of Reference (ToRs) for butterfish are provided in Appendix 1 and shortfin squid in Appendix 2. The final agenda for the meeting is provided in Appendix 3.

The Research Track Stock Assessment Peer Review Panel met via WebEx on March 7-11, 2022 (see agenda in Appendix 3). The Panel was composed of three scientists selected by the Center for Independent Experts (CIE): Yong Chen (SUNY Stonybrook), Robin Cook (University of Strathclyde) and Robin Thomson (CSIRO). The Panel was chaired by Mike Wilberg (University of Maryland Center for Environmental Science), as a member of the Mid-Atlantic Fishery Management Council's Scientific and Statistical Committee. The instructions for research track peer reviewers are provided in Appendix 4 and the Performance Work Statement for CIE reviewers is provided in Appendix 5.

The Panel was assisted by Michele Traver (Chair, NEFSC's Stock Assessment Workshop) and Russ Brown (Chief, NEFSC Population Dynamics Branch). Documentation was prepared by the Butterfish and *Illex* Working Groups, and presentations were made by Charles Adams, Andrew Jones, Jason Didden, Tori Kentner, Eric Robillard, Laurel Smith, and Rob Vincent for butterfish and Lisa Hendrickson, Brooke Lowman, Jessica Jones, Sarah Salois, Paul Rago, John Manderson, and Anna Mercer for *Illex*. Members of the Working Groups and public also provided valuable discussion. Jason Boucher, Tony Wood, Russ Brown, Ben Levy, Brian Linton, Toni Chute, Laurel Smith, and Abigail Tyrell (all from the NEFSC) acted as rapporteurs throughout the meeting (see Appendix 6 for meeting attendees).

Prior to the meeting, assessment documents were made available to the Panel through the NEFSC website (https://apps-nefsc.fisheries.noaa.gov/saw/sasi/sasi_report_options.php). Panel members met with Michele Traver and Russell Brown before the meeting to review and discuss the meeting agenda, reporting requirements, meeting logistics and the overall process.

The meeting opened on 12:00 EST, Monday March 7, with welcoming remarks and comments on the agenda by Russ Brown, Michelle Traver, and Panel Chair Mike Wilberg. The first two

days of the meeting focused on presentations and discussion of the 10 ToRs for the butterfish 2022 research track assessment, and the second two days focused on the 11 ToRs for *Illex*. All Panel members contributed to this Summary Report, which was compiled and edited by the Panel Chair with assistance from the CIE Panelists, before submission of the report to the NEFSC. Additionally, each of the CIE Panelists will submit their separate reviewer's reports to the Center for Independent Experts.

The scientific and statistical analyses conducted by the WG were thorough and of high quality. Their very clear and well-organized reports, background information and presentations made the Panel's job much easier.

The Panel thanks all the members of the Working Groups and participants in the research track stock assessment peer review for the large amount of work that went into each of these assessments and the collegial discussions with the Panel. The specific comments on each ToR are provided below.

Butterfish (*Peprilus triacanthus*)

1. **Estimate catch from all sources including landings and discards. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data.**

   The Panel concluded that this ToR has been adequately addressed.

   The Working Group (WG) conducted a thorough study to characterize landings and discards, evaluate the quality of the data, and develop the protocol (or use the existing acceptable protocols) for estimating landings and discards. The uncertainties were provided for the estimated landings and discards. In general, the more recent data are of good quality and adequate for the use in stock assessment. The WG also adequately described the spatio-temporal distributions of landings, discards and fishing effort.

   Discard quantification is always challenging, but discard estimates are fairly precise in recent years. The Panel encourages the WG to continue exploring alternative approaches (e.g., model-based approaches) to identify factors influencing the discard rates and improve the estimation of discards and associated uncertainties.

   The landings are observed to shift from SA 537 off the RI coast to SA 526 off MA. Given that most landings occurred in Rhode Island ports, the causes for the change (e.g., shifts in stock distributions) could be examined to better understand the fleet dynamics.

   The Panel evaluated the gap filling procedure used to develop the age-length key and landings length composition and concluded that the current practice likely leads to blending of cohorts. This might introduce biases in developing age composition data. The Panel recommends a careful evaluation of the current gap filling procedure to better quantify the landing age composition data. Alternatively, the gaps could simply be treated as missing data in the assessment model.

The Panel also recommends that catch-at-age data be separately characterized for landings and discards.

2. **Present the survey data available (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.), and describe the basis for inclusion or exclusion of those data in the assessment. Characterize the uncertainty in these sources of data.**

   The Panel concluded that this ToR has been adequately addressed.

   The WG evaluated various federal and state survey programs and recommended that the abundance indices from the following programs be used in the stock assessment: Albatross Fall, Bigelow Spring and Fall, NEAMAP Spring and Fall, and coastal YOY which is developed based on six coastal state surveys. The proportion of positive tows is one of the key factors determining if a survey program is included in the assessment. The uncertainties associated with the survey abundance indices are well quantified.

   The Panel suggests that the Albatross spring surveys be included only for a sensitivity analysis as it appears that the availability of butterfish at this season has changed over time. The positive tow criterion is mainly for tracking availability (the spatial distribution on the shelf in spring has changed), but does not necessarily index population abundance.

   The Panel also recommends that the life history data derived from different survey programs be compared to identify possible spatial variability, which may improve our understanding of stock structure of this species over its large distribution area.

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

   The Panel concluded that this ToR has been adequately addressed.

   The Panel recommends the development of a model that uses a shorter time step than one year. Butterfish are relatively short-lived, the main cohorts seen in the surveys and fishery are the 0, 1 and 2 year olds. A shorter time step could more accurately reflect the biology of this species. It should also rectify the current mismatch that results from the model year starting in January whereas spawning occurs mid-year so that zero year old fish are modeled as belonging to the population 6 months before they hatch and this raises questions about the way natural mortality is modeled for this age group.

   The WHAM model estimates selectivity-at-age by fleet (and survey) and the estimated weight of discarded fish is added to the landings to give total observed catch. The Panel suggests separating the catch into retained and discarded components and attempting to

model a retention function. Observations of the age structure of the retained and discarded catches clearly show a greater tendency to discard smaller fish than those retained.

The dynamics of the assessment model can usefully be explored through the use of sensitivity analyses. While many of these are likely to have been conducted, only a smaller set of candidate models were presented to the panel, with just the preferred / chosen model discussed in detail. It would have been useful to see a general set of sensitivity tests, at least of the final model, to better understand the model's robustness to key assumptions and choices. These should include:

- a plausible range of alternative values for the fixed value of catchability (q) for the Albatross surveys,
- exclusion of the Albatross survey,
- alternative (and age dependent) values for natural mortality (M),
- earlier start years for the model,
- the use of functional forms for selectivity-at-age (esp logistic).

The reason for trialing models that use a functional form for selectivity-at-age is that the free form used in the chosen model could hide or compensate for an incorrect value of natural mortality.

The absolute size of the butterfish stock (i.e ., the scale) cannot be estimated by the model with certainty because there has been little signal of fishing affecting abundance. Choosing the value for at least one of the catchabilities (q's) effectively dictates the estimate of scale / abundance.

4. Update or redefine status determination criteria (SDC point estimates or proxies for BMSY, BTHRESHOLD, FMSY and MSY) and provide estimates of their uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

The Panel concluded that this ToR has been partially addressed. The WG considered several potential candidate reference points and recommended $F_{50\%}$ and $B_{50\%}$, for fishing mortality and biomass, respectively. The Panel had concerns about the high value (>6 per yr, ~ 99.9% mortality for fully selected ages) for the estimated $F_{50\%}$ reference point.

The recent range of years for calculation of $B_{50\%}$ seems appropriate given the analyses shown and that effects of fishing seem low (i.e., it seems like a good candidate for dynamic reference points). However, the Panel's endorsement of this approach is specific to butterfish. It may not be appropriate for other stocks, particularly those that are at low biomass compared to historical levels. The stock assessment did not provide the percentage for the biomass reference point that would follow from the previously used reference point of F=2/3M. This latter reference point may be more appropriate given the extremely high value calculated for $F_{50\%}$.

The uncertainty in the reference points (estimation and choice of appropriate BRPs) was not fully considered. In particular, the uncertainty in the scale of the population was not fully considered because the assumed catchability of NEFSC fall trawl survey heavily affects the $B_{50\%}$ reference point.

The justification of a "Schaefer production function" for B50% is not warranted because a production function is not used to estimate the reference point (i.e., a Schaefer model is not being used).

The Panel also considered whether the percentage used for the biomass reference point ($B_{50\%}$) should be higher (e.g., $B_{75\%}$ - approximately the lowest biomass on record) given butterfish is a forage species. Additionally, the Panel raised the question of whether total biomass should be used for the biomass reference point instead of spawning stock biomass if the justification for the reference point is about leaving enough food for predators.

5. **Make a recommended stock status determination (overfishing and overfished) based on new modeling approaches developed for this peer review.**

   The Panel concluded that this ToR has been adequately addressed.

   The consensus of the evidence suggests that the stock is not overfished or experiencing overfishing. This conclusion is likely to be robust to the major sources of uncertainty including those expressed above about reference point estimation.

6. **Define the methodology for performing short-term projections of catch and biomass under alternative harvest scenarios, including the assumptions of fishery selectivity, weights at age, and maturity.**

   The Panel concluded that this ToR was adequately addressed. Short term projections were based on the 17-NAA5 WHAM model fit which assumes an AR(1) process for recruitment. The recruitment assumption should therefore capture information on the level of recent recruitment and its variability, and project this forward. In the absence of any identifiable stock recruitment relationship this is appropriate. Other biological parameters such as weights and maturities are based on a recent 5-yr average. This is standard practice in the region and widely used in many jurisdictions.

7. **Review, evaluate and report on the status of the Stock Assessment Review Committee (SARC) and Working Group research recommendations listed in most recent SARC reviewed assessment and review panel reports, as well as the most recent management track assessment report. Identify new research recommendations.**

   The Panel concluded that this ToR was adequately addressed.

   The Panel supports the previous research recommendations but suggests expanding the research recommendation (2) "Explore the possibility of spawning south of Cape Hatteras, NC and potential contribution to the northern stock" to include a general study of stock

structure and distribution that includes the different life history stages (e.g., revisit larval survey data and how well they match the older life stages).

New research recommendations suggested by the Panel include:

1. Conduct a new evaluation of survey catchability. The current value of q is based on an analysis of habitat distribution to estimate availability to the survey. A q~0.2 implies that 80% of the stock is not within the survey area, which seems potentially problematic given that butterfish are widely caught throughout the survey that covers most of their range.

2. Consider alternative ways of calculating total discards. Current estimates raise samples based on a ratio estimator that uses total fish catch as the denominator. Raising using number of trips or shots (or other effort measures) are possible alternatives. Applying a time series smoother to the ratio estimator may be able to exploit information across years to improve estimates.

3. Investigate whether environmental variables or time varying catchability can be applied to the spring Albatross/Bigelow survey so that it can be included in the assessment. Time varying catchability should be estimable within an assessment.

4. Consider an age- and length-structured model that allows increased use of the state survey data (by including all the length data). This may help to avoid the need for gap-filling. The derived data that are used to fill gaps will give a false sense of precision and is likely to over-smooth estimates of recruitment.

5. Consider alternative (area, or habitat, weighted) averaging for the aggregated state survey YOY index. The Conn model used by the assessment team assumes a common signal across multiple areas and cannot, therefore, take into account spatial effects that might be important.

6. Consider implementing a wider range of assessments/data processing to understand effects of decisions and provide a basis for ensemble modeling. Recent work at the SEDAR68 assessment of Atlantic scamp grouper implemented methods for ensemble modeling while diagnostics developed by Carvalho et al (2021) have been used to weight models from an ensemble in order to obtain estimates of uncertainty for quantities of interest.

7. Develop a wider range of diagnostics for state-space models (e.g., plots of the random effects predictions). Include MCMC methods to estimate posterior distributions of critical parameters and quantities of interest, e.g. $F_{50\%}$ and $B_{50\%}$.

8. Consider alternative model selection criteria that are more appropriate for mixed-effects models. AIC was used to inform model selection, but this may not be appropriate where random walk models reduce the number of effective parameters. DIC and WAIC may prove more appropriate in these circumstances.

9. Consider developing an age- or size-dependent M. The current value used is a mean value over all ages/sizes but it is highly likely that M is greatest on the youngest fish. Mis-specification of M by size may lead to biased estimates of selectivity and hence BRPs. One common approach is to scale the Lorenzen weight based Ms to the overall mean derived from meta-analyses.

10. Consider using stomach contents data to inform time-varying M. Data were presented at the review meeting on consumption of butterfish by marine mammals, birds and some fish. These data may offer an insight into temporal effects on M.

8. Develop a "Plan B" for use if the accepted assessment model fails in the future.

The Panel concluded that this ToR has been adequately addressed.

The Panel does not believe a "Plan B" will be needed.

Additional Terms of Reference

1. Describe life history characteristics and the stock's spatial distribution, including any changes over time. Describe ecosystem and other factors that may influence the stock's productivity and recruitment. Consider any strong influences and, if possible, integrate the results into the stock assessment.

The Panel concluded that this ToR has been adequately addressed.

Integrating the results of these analyses into the stock assessment will require future work.

2. Evaluate consumptive removals of butterfish by its predators, including (if possible) marine mammals, seabirds, tunas, swordfish and sharks. If possible, integrate results into the stock assessment.

The Panel concluded that this ToR has been adequately addressed.

The assessment included consideration of stomach contents data from the NEFSC trawl surveys and studies on marine mammals and birds. The estimated consumption amounted to a small amount of the estimated losses due to natural mortality. It is conspicuous that for a forage fish relatively few species seem to eat butterfish. No new analyses were provided for tunas (little to no evidence of butterfish in bluefin tuna diets), swordfish, and sharks. Given the results, integrating predation into the model was not a high priority. The WG may want to consider alternative approaches to estimate butterfish consumption such as DNA and isotopes. These consumption study results are a possible indication that the estimated scale of the butterfish stock is too high.

Shortfin squid (*Illex illecebrosus*)

1. **Estimate catches from all sources, including landings and discards, and characterize their uncertainty.**

   The Panel concluded that this ToR has been adequately addressed.

   Landings from the U.S. domestic fishery are thought to be accurate (1997 and onwards). Discards are adequately estimated and relatively low compared to the retained catch. Newfoundland recreational catches are unknown but are likely small relative to the US fisheries.

2. **Evaluate indices used in the assessment, including annual abundance and biomass indices based on research survey data and standardized industry CPUE data. Characterize the uncertainty of the abundance and biomass index estimates. Explore the relationship between fishing effort and economic factors (e.g., global market price) in order to determine whether the addition of an economic factor will improve the fit of the CPUE standardization model.**

   The Panel concluded that this ToR has been adequately addressed.

   The WG explored a range of state, regional and federal surveys. Extensive analyses (GAMs and GLMs) of the fishery dependent landings per unit effort (LPUE) data were conducted. Annual standardized indices from the GLM largely agreed with the NEFSC fall trawl survey biomass indices since 2008. Economic factors were considered in the GAM and average weekly price was identified as an important variable. Environmental factors were also considered in an LPUE model of the study fleet and observer data, and influential factors were identified.

3. **Utilize the age, size and maturity dataset, collected from the 2019 landings, to identify the dominant intra-annual cohorts in the fishery and to estimate growth rates and maturity ogives for each cohort. Also use these data to identify fishery recruitment pulses.**

   The Panel concluded that this ToR has been adequately addressed.

   Data were collected in 2019 and 2020. Sample sizes of mature females were too small to estimate cohort-specific maturity ogives. The Panel recognized the utility of estimating cohort-specific vital rates, however cautioned that relatively few cohorts have been observed and cohorts in future years may differ. The observations confirmed dominant winter (Nov.-April) and summer (May-July) cohorts recruiting to the fishery.

4. **Characterize annual and weekly, in-season spatio-temporal trends in body size based on length and weight samples collected from the landings by port samplers and provided by Illex processors. Consider the environmental factors that may influence**

trends in body size and recruitment. If possible, integrate these results into the stock assessment.

The Panel concluded that this ToR has been adequately addressed.

Data from processors and port samples were considered. There appear to be substantial changes in body weight over time in the fishery (increase), which do not correspond with changes in the NEFSC fall survey (decrease). Recruitment, body size, and LPUE indices could not be teased apart.

5. **Develop a model that can be used for estimation of fishing mortality and stock biomass, for each dominant cohort that supports the fishery, and estimate the uncertainty of these estimates. Compare the results from model runs for years with low, medium and high biomass estimates.**

   The Panel concluded that this ToR was partially addressed.

   The WG did not recommend an approach to estimate fishing mortality, stock biomass or uncertainty of the estimates. Rather, a wide range of models that used alternative data and assumptions were implemented. All of the models were strongly constrained by assumptions. No individual model was able to provide reliable estimates of fishing mortality and biomass. Nevertheless, bounds on plausible fishing mortality rates and biomass were estimated. While the range of results was broad enough to include overfishing scenarios, the set of plausible scenarios was dominated by those in which fishing mortality was low relative to natural mortality. This result was consistent across years with low, medium, and high fishery performance.

   The general depletion model (GDM) was attempted. Application of any depletion model to an open population with large amounts of immigration and emigration that are not necessarily pulsed has considerable challenges. The evidence in the data presented indicates that the pulses are not obvious. The approach had several issues including problematic convergence diagnostics and issues estimating the parameter standard errors. The issues associated with the GDM approach are not likely to be solved by moving to a daily time step. The Panel recommends conducting a well-designed simulation study to understand model performance specifically for this stock and to assess the costs and benefits of moving to daily data collection to support the GDM .

6. **Describe the data that would be needed to conduct in-season stock assessments for adaptive management and identify whether the data already exist or if new data would need to be collected and at what frequency.**

   The Panel concluded that this ToR has been adequately addressed.

   A detailed review of the requirements was undertaken for implementing the GDM model and identified data needs, procedures and management systems required. This showed that some

data were already available while further data were likely to be forthcoming. However, more data would still be required. There remain issues over the analytic methods to be used (e.g., GDMs) and the management framework that would need to be implemented to operate adaptive management.

The Panel did not endorse the current version of the GDM for use in real-time management. The Panel did not reach a consensus on whether the GDM model has potential for use in real time management. In particular, the GDM would require subjective decisions during a season, and it seems to have poor statistical properties. The data needs may be different if an alternative in-season management model is considered.

7. **Update or redefine Biological Reference Points (BRP point estimates for BMSY, BTHRESHOLD and FMSY) or BRP proxies, for each dominant cohort that supports the fishery, and provide estimates of their uncertainty. If analytical model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing and recommended BRPs or their proxies.**

   The WG attempted to address this ToR. Too few data were available to use the Hendrickson and Hart model. In the absence of a reliable analytical stock assessment, it was not possible to identify meaningful BRPs.

8. **Recommend a stock status determination (i.e., overfishing and overfished), for each dominant cohort supporting the fishery, based on new modeling approaches developed for this peer review.**

   The Panel concluded that this ToR was addressed adequately given the limitations of the analyses available.

   In the absence of BRPs and a definitive stock assessment, a formal stock status determination was not possible. However, the working group concluded that the indications from the various assessment approaches were that the stock was lightly fished in 2019. The Panel agreed that this was likely to be the case, but that the term “lightly fished” needs to be interpreted with caution since it has no specific definition relating to sustainable exploitation.

9. **Define the methodology for performing short-term projections of catch and biomass under alternative harvest scenarios, including the assumptions of fishery selectivity, weights at age, and maturity.**

   The Panel concluded that this ToR has been adequately addressed.

   Given the biology of the species and current models, short term projections are problematic. The status of current stock assessment models for this stock does not provide a basis for such projections. The WG suggested using Plan B smooth as an alternative and provided examples of the catch multiplier for 2019 that would be estimated from a range of abundance indices.

These multipliers (from different indices) were all close to one and imply that the best estimate of next year's catch is the last observed catch.

The application of the Plan B smooth method is only useful with the most up-to-date abundance indices. Thus, the use of the previous year's indices to set limits for the projection year (i.e., 2 years (4 generations) beyond the last abundance index) is probably not appropriate for such a short-lived species. A more responsive approach to make best use of current data is required.

10. Review, evaluate and report on the status of the Stock Assessment Review Committee (SARC) and Working Group research recommendations listed in the most recent SARC- reviewed assessment and review panel reports. Identify new research recommendations.

The Panel concluded that this ToR has been adequately addressed.

The WG considered the recommendations and ranked these in priority based on a poll of members. The Panel supports these recommendations. In view of the extensive research that has been done on the biology of the stock and the limitations of conventional stock assessment models, the Panel suggests the following additional research recommendations:

- (Highest priority) An operating model for the stock and fishery should be developed to allow the testing of potential assessment models and of simple harvest control rules based on abundance indices that would promote sustainable exploitation. The Panel recommends developing the model around a set of hypotheses of *Illex* and fishery dynamics.

- Consider methods for developing projections using environmental correlates and test their potential performance using an operating model.

- Conduct a study to improve understanding of stock structure (e.g., statolith microchemistry, genetics).

- A cost-benefit analysis of real-time management should be considered.

11. Develop a "Plan B" alternate assessment approach to providing scientific advice to managers if the analytical assessment does not pass review.

The Panel concluded that this ToR was addressed adequately given the limitations of the analyses available. The WG notes that the SSC has used the Rago indirect approach to provide annual ABC and OFL advice. Details for setting catch limits using the Rago indirect approach were not provided as part of the research track stock assessment.

Appendix 1. Terms of reference for the 2022 butterfish research track stock assessment.

1. Estimate catch from all sources including landings and discards. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data.

2. Present the survey data available (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.), and describe the basis for inclusion or exclusion of those data in the assessment. Characterize the uncertainty in these sources of data.

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

4. Update or redefine status determination criteria (SDC point estimates or proxies for BMSY, BTHRESHOLD, FMSY and MSY) and provide estimates of their uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

5. Make a recommended stock status determination (overfishing and overfished) based on new modeling approaches developed for this peer review.

6. Define the methodology for performing short-term projections of catch and biomass under alternative harvest scenarios, including the assumptions of fishery selectivity, weights at age, and maturity.

7. Review, evaluate and report on the status of the Stock Assessment Review Committee (SARC) and Working Group research recommendations listed in most recent SARC reviewed assessment and review panel reports, as well as the most recent management track assessment report. Identify new research recommendations.

8. Develop a "Plan B" for use if the accepted assessment model fails in the future.

Additional Terms of Reference

1. Describe life history characteristics and the stock's spatial distribution, including any changes over time. Describe ecosystem and other factors that may influence the stock's productivity and recruitment. Consider any strong influences and, if possible, integrate the results into the stock assessment.
2. Evaluate consumptive removals of butterfish by its predators, including (if possible) marine mammals, seabirds, tunas, swordfish and sharks. If possible, integrate results into the stock assessment.

Appendix 2. Terms of reference for the 2022 shortfin squid (*Illex illecebrosus*) research track stock assessment.

1. Estimate catches from all sources, including landings and discards, and characterize their uncertainty.

2. Evaluate indices used in the assessment, including annual abundance and biomass indices based on research survey data and standardized industry CPUE data. Characterize the uncertainty of the abundance and biomass index estimates. Explore the relationship between fishing effort and economic factors (e.g., global market price) in order to determine whether the addition of an economic factor will improve the fit of the CPUE standardization model.

3. Utilize the age, size and maturity dataset, collected from the 2019 landings, to identify the dominant intra-annual cohorts in the fishery and to estimate growth rates and maturity ogives for each cohort. Also use these data to identify fishery recruitment pulses.

4. Characterize annual and weekly, in-season spatio-temporal trends in body size based on length and weight samples collected from the landings by port samplers and provided by Illex processors. Consider the environmental factors that may influence trends in body size and recruitment. If possible, integrate these results into the stock assessment.

5. Develop a model that can be used for estimation of fishing mortality and stock biomass, for each dominant cohort that supports the fishery, and estimate the uncertainty of these estimates. Compare the results from model runs for years with low, medium and high biomass estimates.

6. Describe the data that would be needed to conduct in-season stock assessments for adaptive management and identify whether the data already exist or if new data would need to be collected and at what frequency.

7. Update or redefine Biological Reference Points (BRP point estimates for BMSY, BTHRESHOLD and FMSY) or BRP proxies, for each dominant cohort that supports the fishery, and provide estimates of their uncertainty. If analytical model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing and recommended BRPs or their proxies.

8. Recommend a stock status determination (i.e., overfishing and overfished), for each dominant cohort supporting the fishery, based on new modeling approaches developed for this peer review.

9. Define the methodology for performing short-term projections of catch and biomass under alternative harvest scenarios, including the assumptions of fishery selectivity, weights at age, and maturity.

10. Review, evaluate and report on the status of the Stock Assessment Review Committee (SARC) and Working Group research recommendations listed in the most recent SARC-reviewed assessment and review panel reports. Identify new research recommendations.

11. Develop a “Plan B” alternate assessment approach to providing scientific advice to managers if the analytical assessment does not pass review.

Appendix 3. Final agenda for the research track stock assessment peer review meeting.

Illex and Butterfish
Research Track Assessment Peer Review Meeting

March 7 - 11, 2022

WebEx link: https://www.google.com/url?q=https://noaanmfs-meets.webex.com/noaanmfs-meets/j.php?MTID%3Dm8a1062743b689f38d340622b4c9367ff&sa=D&source=calendar&ust=1646591056258287&usg=AOvVaw3rFDmh4DLEfDF0VFfJvy57
Meeting number (access code): 2761 523 2146
Meeting password: vNhr8Y75tBu

Phone: +1-415-527-5035 US Toll

AGENDA* (v. 3/7/2022)

**All times are approximate, and may be changed at the discretion of the Peer Review Panel chair. The meeting is open to the public; however, during the Report Writing sessions we ask that the public refrain from engaging in discussion with the Peer Review Panel.*

Monday, March 7, 2022

Time	Topic	Presenter(s)	Notes
12 p.m. - 12:15 p.m.	Welcome/Logistics Introductions/Agenda/ Conduct of Meeting Butterfish	Michele Traver, Assessment Process Lead Russ Brown, PopDy Branch Chief Mike Wilberg, Panel Chair	
12:15 p.m. - 1:45 p.m.	TORs #1 and A1	Charles Adams, Andrew Jones, Jason Didden, Tori Kentner, Eric Robillard	Life history Catch Spatial Distribution Industry Perspective and Outreach Aging
1:45 p.m. - 2 p.m.	Break		
2 p.m. - 3:15 p.m.	TORs #2 and A2	Charles Adams, Laurel Smith, Rob Vincent	Survey Data Consumptive Removals
3:15 p.m. - 3:45 p.m.	Break		
3:45 p.m. - 5:15 p.m.	TOR #3	Charles Adams	F, R, SSB Productivity

Time	Topic	Presenter(s)	Notes
5:15 p.m. - 5:35 p.m.	Discussion/Summary	Review Panel	
5:35 p.m. - 5:45 p.m.	Public Comment	Public	
5:45 p.m.	Adjourn		

Tuesday, March 8, 2022

Time	Topic	Presenter(s)	Notes
12 p.m. - 12:10 p.m.	Welcome/Logistics	Michele Traver, Assessment Process Lead Mike Wilberg, Panel Chair	
12:10 p.m. - 1:30 p.m.	TORs #4, A1 and 5	Charles Adams, Laurel Smith	BRPs Stock Determination
1:30 p.m. - 2 p.m.	Break		
2 p.m. - 3 p.m.	TOR #6	Charles Adams	Projections
3 p.m. - 3:45 p.m.	TORs #7 and 8	Charles Adams	Research Recommendations Alternative Approach
3:45 p.m. - 4 p.m.	Break		
4 p.m. - 4:45 p.m.	TOR #7 and 8 cont.	Charles Adams	Research Recommendations Alternative Approach
4:45 p.m. - 5:05 p.m.	Discussion/Summary	Review Panel	
5:05 p.m. - 5:15 p.m.	Public Comment	Public	
5:15 p.m. - 6 p.m.	Wrap Up/Key Points on Butterfish	Review Panel	
6 p.m.	Adjourn		

Wednesday, March 9, 2022

Time	Topic	Presenter(s)	Notes
12 p.m. - 12:10 p.m.	Welcome/Logistics *Illex*	Michele Traver, Assessment Process Lead Mike Wilberg, Panel Chair	

Time	Topic	Presenter(s)	Notes
12:10 p.m. - 2 p.m.	TORs #1 and 2	Lisa Hendrickson Brooke Lowman	Landings and Discards Surveys and Fishery CPUE
2 p.m. - 2:30 p.m.	Break		
2:30 p.m. - 3:25 p.m.	TOR #3	Lisa Hendrickson Jessica Jones	2019 age, size and maturity, trace element data
3:25 p.m. - 3:40 p.m.	Break		
3:40 p.m. - 5:40 p.m.	TORs # 4 and 5	Lisa Hendrickson Sarah Salois Paul Rago	Fishery body size Environmental effects Stock size and Fishing mortality
5:40 p.m. - 6 p.m.	Discussion/Summary	Review Panel	
6 p.m. - 6:10 p.m.	Public Comment	Public	
6:10 p.m.	Adjourn		

Thursday, March 10, 2022

Time	Topic	Presenter(s)	Notes
12 p.m. - 12:10 p.m.	Welcome/Logistics	Michele Traver, Assessment Process Lead Mike Wilberg, Panel Chair	
12:10 p.m. - 1:10 p.m.	TOR #5 cont.	John Manderson	Stock size and Fishing mortality
1:10 p.m. - 2:10 p.m.	TOR #6	Anna Mercer	In-season data
2:10 p.m. - 2:40 p.m.	Break		
2:40 p.m. - 3:40 p.m.	TORs #7 - 9	Lisa Hendrickson	BRP's Stock Status Projections
3:40 p.m. - 3:55 p.m.	Break		
3:55 p.m. - 5:55 p.m.	TORs #10 and 11	Lisa Hendrickson	Research Recommendations

Time	Topic	Presenter(s)	Notes
			Alternative approach
5:55 p.m. - 6:10 p.m.	Discussion/Summary	Review Panel	
6:10 p.m. - 6:20 p.m..	Public Comment	Public	
6:20 p.m.	Adjourn		

Friday, March 11, 2022

Time	Topic	Presenter(s)	Notes
12 p.m. - 6 p.m.	Report Writing	Review Panel	

Appendix 4. Instructions to research track peer reviewers.

Instructions for the Research Track Peer Reviewers
(Based on: 2011 Generic Operational Assessment Process White Paper, 2011, Description of New England and Mid-Atlantic Region Stock Assessment Process, 2018, and NEFSC edits. v.01/24/2022)

The Peer Review is to determine whether the completed research track assessment is technically sufficient to (a) evaluate stock status determination, (b) evaluate new data streams and/or model changes and (c) successfully address the assessment Terms of Reference. The Peer Review Panel may determine that the proposed research track assessment approach has not worked; if so, the alternative backup approach to the assessment will be reviewed.

Conduct of the Meeting:

- The Meeting Chair is responsible for:
    - the conduct of the meeting
    - ensuring that meeting participants are provided with opportunities to provide input
    - ensuring that the Peer Review panel drafts a report that evaluates stock status determination, evaluates new data streams and/or model changes and whether the assessment Terms of Reference are addressed.
- The Peer Review meeting is a public meeting and opportunities are provided for input from participating scientists and interested stakeholders. The Meeting Chair is responsible for providing opportunities for public participation, while balancing the need for the reviewers to complete their work
- The Assessment Process Lead (currently Michele Traver) and the Branch Chief of the Population

Dynamics Branch (currently Russell Brown) are staff who can provide guidance relative to process or policy related questions. These staff are also responsible for meeting logistics and support.

- The Northeast Fisheries Science Center provides a rapporteur who will take meeting notes. Meeting notes are a reference for use by the Peer Review panel for their deliberations and report writing but have no official standing and are not included in the meeting reports.
- The panel has the option to meet privately (without other participants) for short periods of time to discuss issues related to their review. Private meetings should include all panel members including the Chair and may or may not include the Assessment Process Lead and/or the Population Dynamics Branch Chief at the discretion of the panel. Private meetings are announced to meeting participants in the interest of transparency.

Report Guidance:

For each stock assessment, the assessment reports:

- Should address whether each stock assessment TOR was completed successfully
- Should make clear whether the proposed assessment approach was accepted, or whether the backup assessment approach was recommended
- Should identify major sources of uncertainty in the stock assessment and comment on the qualitative descriptions of stock status based on simple indicators/metrics in the assessment report
- Can also make recommendations for improving the assessment in the future, which could be

considered in determining stocks or topics for future research track assessments. It is helpful if these research recommendations are prioritized.

● If the panel rejects the model presented, please indicate the reason why and make recommendations.

Appendix 5. Performance Work Statement for CIE reviewers for the Butterfish and Shortfin Squid (Illex) research track stock assessments.

Performance Work Statement (PWS)

National Oceanic and Atmospheric Administration (NOAA)
National Marine Fisheries Service (NMFS)
Center for Independent Experts (CIE) Program
External Independent Peer Review

Butterfish and Northern Shortfin Squid (Illex)
Research Track Peer Review

Background

The National Marine Fisheries Service (NMFS) is mandated by the Magnuson-Stevens Fishery Conservation and Management Act, Endangered Species Act, and Marine Mammal Protection Act to conserve, protect, and manage our nation's marine living resources based upon the best scientific information available (BSIA). NMFS science products, including scientific advice, are often controversial and may require timely scientific peer reviews that are strictly independent of all outside influences. A formal external process for independent expert reviews of the agency's scientific products and programs ensures their credibility. Therefore, external scientific peer reviews have been and continue to be essential to strengthening scientific quality assurance for fishery conservation and management actions.

Scientific peer review is defined as the organized review process where one or more qualified experts review scientific information to ensure quality and credibility. These expert(s) must conduct their peer review impartially, objectively, and without conflicts of interest. Each reviewer must also be independent from the development of the science, without influence from any position that the agency or constituent groups may have. Furthermore, the Office of Management and Budget (OMB), authorized by the Information Quality Act, requires all federal agencies to conduct peer reviews of highly influential and controversial science before dissemination, and that peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards[1]. Further information on the Center for Independent Experts (CIE) program may be obtained from www.ciereviews.org.

Scope

The Research Track Peer Review meeting is a formal, multiple-day meeting of stock assessment experts who serve as a panel to peer-review tabled stock assessments and models. The research track peer review is the cornerstone of the Northeast Region Coordinating Council stock assessment process, which includes assessment development, and report preparation (which is done by Working Groups or Atlantic States Marine Fisheries Commission (ASMFC) technical committees), assessment peer review (by the peer review panel), public

[1] http://www.cio.noaa.gov/services_programs/pdfs/OMB_Peer_Review_Bulletin_m05-03.pdf

presentations, and document publication. The results of this peer review will be incorporated into future management track assessments, which serve as the basis for developing fishery management recommendations.

The purpose of this meeting will be to provide an external peer review of butterfish and northern shortfin squid (*Illex*) stocks. The requirements for the peer review follow. This Performance Work Statement (PWS) also includes: **Appendix 1**: TORs for the research track, which are the responsibility of the analysts; **Appendix 2:** a draft meeting agenda; **Appendix 3:** Individual Independent Review Report Requirements; and **Appendix 4:** Peer Reviewer Summary Report Requirements.

Requirements

NMFS requires three reviewers under this contract (i.e. subject to CIE standards for reviewers) to participate in the panel review. The chair, who is in addition to the three reviewers, will be provided by either the New England or Mid-Atlantic Fishery Management Council's Science and Statistical Committee; although the chair will be participating in this review, the chair's participation (i.e. labor and travel) is not covered by this contract.

Each reviewer will write an individual review report in accordance with the PWS, OMB Guidelines, and the TORs below. All TORs must be addressed in each reviewer's report. The reviewers shall have working knowledge and recent experience in the use and application of both index-based and age-based stock assessment models, including familiarity with retrospective patterns and how catch advice is provided from stock assessment models. In addition, knowledge and experience with simulation analyses is required

Tasks for Reviewers

- Review the background materials and reports prior to the review meeting
    - Two weeks before the peer review, the Assessment Process Lead will electronically disseminate all necessary background information and reports to the CIE reviewers for the peer review.
- Attend and participate in the panel review meeting
    - The meeting will consist of presentations by NOAA and other scientists, stock assessment authors and others to facilitate the review, to provide any additional information required by the reviewers, and to answer any questions from reviewers
- Reviewers shall conduct an independent peer review in accordance with the requirements specified in this PWS and TORs, in adherence with the required formatting and content guidelines; reviewers are not required to reach a consensus.
- Each reviewer shall assist the Peer Review Panel (co)Chair with contributions to the Peer Reviewer Summary Report
- Deliver individual Independent Reviewer Reports to the Government according to the specified milestone dates

- This report should explain whether each research track Term of Reference was or was not completed successfully during the peer review meeting, using the criteria specified below in the "Tasks for Peer Review Panel."
- If any existing Biological Reference Points (BRP) or their proxies are considered inappropriate, the Independent Report should include recommendations and justification for suitable alternatives. If such alternatives cannot be identified, then the report should indicate that the existing BRPs are the best available at this time.
- During the meeting, additional questions that were not in the Terms of Reference but that are directly related to the assessments and research topics may be raised. Comments on these questions should be included in a separate section at the end of the Independent Report produced by each reviewer.
- The Independent Report can also be used to provide greater detail than the Peer Reviewer Summary Report on specific stock assessment Terms of Reference or on additional questions raised during the meeting.

Tasks for Review panel

- During the peer review meeting, the panel is to determine whether each research track Term of Reference (TOR) was or was not completed successfully. To make this determination, panelists should consider whether the work provides a scientifically credible basis for developing fishery management advice. Criteria to consider include: whether the data were adequate and used properly, the analyses and models were carried out correctly, and the conclusions are correct/reasonable. If alternative assessment models and model assumptions are presented, evaluate their strengths and weaknesses and then recommend which, if any, scientific approach should be adopted. Where possible, the Peer Review Panel chair shall identify or facilitate agreement among the reviewers for each research track TOR.
- If the panel rejects any of the current BRP or BRP proxies (for B_{MSY} and F_{MSY} and MSY), the panel should explain why those particular BRPs or proxies are not suitable, and the panel should recommend suitable alternatives. If such alternatives cannot be identified, then the panel should indicate that the existing BRPs or BRP proxies are the best available at this time.
- Each reviewer shall complete the tasks in accordance with the PWS and Schedule of Milestones and Deliverables below.

Tasks for Peer Review Panel chair and reviewers combined:

Review the Reports of the Butterfish and *Illex* Research Track Working Groups.

The Peer Review Panel Chair, with the assistance from the reviewers, will write the Peer Reviewer Summary Report. Each reviewer and the (co)chair will discuss whether they hold similar views on each research track Term of Reference and whether their opinions can be summarized into a single conclusion for all or only for some of the Terms of Reference of the peer review meeting. For terms where a similar view can be reached, the Peer Reviewer Summary Report will contain a summary of such opinions.

The chair's objective during this Peer Reviewer Summary Report development process will be to identify or facilitate the finding of an agreement rather than forcing the panel to reach an agreement. The chair will take the lead in editing and completing this report. The chair may express their opinion on each research track Term of Reference, either as part of the group opinion, or as a separate minority opinion. The Peer Reviewer Summary Report will not be submitted, reviewed, or approved by the Contractor.

Foreign National Security Clearance
When reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for reviewers who are non-US citizens. For this reason, the reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, country of birth, country of citizenship, country of permanent residence, country of current residence, dual citizenship (yes, no), passport number, country of passport, travel dates.) to the NEFSC Assessment Process Lead for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/ and http://deemedexports.noaa.gov/compliance_access_control_procedures/noaa-foreign-national-registration-system.html. The contractor is required to use all appropriate methods to safeguard Personally Identifiable Information (PII).

Place of Performance
The place of performance shall be held remotely, via WebEx video conferencing.

Period of Performance
The period of performance shall be from the time of award through February 11, 2022. Each reviewer's duties shall not exceed **14** days to complete all required tasks.

Schedule of Milestones and Deliverables: The contractor shall complete the tasks and deliverables in accordance with the following schedule.

Within 2 weeks of award	Contractor selects and confirms reviewers
Approximately 2 weeks later	Contractor provides the pre-review documents to the reviewers
March 7-11, 2022	Panel review meeting
Approximately 2 weeks later	Contractor receives draft reports

Within 2 weeks of receiving draft reports	Contractor submits final reports to the Government

* The Peer Reviewer Summary Report will not be submitted to, reviewed, or approved by the Contractor.

Applicable Performance Standards

The acceptance of the contract deliverables shall be based on three performance standards: (1) The reports shall be completed in accordance with the required formatting and content (2) The reports shall address each TOR as specified (3) The reports shall be delivered as specified in the schedule of milestones and deliverables.

Travel

No travel is necessary, as this meeting is being held remotely.

- **Restricted or Limited Use of Data**

The contractors may be required to sign and adhere to a non-disclosure agreement.

NMFS Project Contact

Michele Traver, NEFSC Assessment Process Lead
Northeast Fisheries Science Center
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Michele.Traver@noaa.gov

Appendix 6. Attendees for March 7-10 research track peer review meeting.

Illex/Butterfish Research Track Peer Review Attendance

March 7-11, 2022

Attendance

NEFSC - Northeast Fisheries Science Center

GARFO - Greater Atlantic Regional Fisheries Office

NEFMC - New England Fisheries Management Council

MAFMC - Mid-Atlantic Fisheries Management Council

SMAST - University of Massachusetts School of Marine Science and Technology

MIT - Massachusetts Institute of Technology

VIMS - Virginia Institute of Marine Science

SSC - Science and Statistical Committee

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Mike Wilberg - Chair

Robin Cook - CIE Panel

Robin Thomson - CIE Panel

Yong Chen - CIE Panel

Russ Brown - NEFSC

Michele Traver - NEFSC

Abigail Tyrell - NEFSC

Alan Bianchi -North Carolina Department of Environmental Quality

Alex Hansell - NEFSC

Andrew Jones - NEFSC

Anna Mercer - NEFSC
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Ben Levy - NEFSC

Brandon Muffley - MAFMC Staff

Brian Linton - NEFSC

Brian Smith - NEFSC

Brooke Lowman - Virginia Marine Resources Commission

Carly Bari - GARFO

Charles Adams - NEFSC

Chris Legault - NEFSC

David Richardson - NEFSC

Eric Reid - Fisheries Consultant

Eric Robillard - NEFSC

Greg DiDomenico - Lunds Fisheries

Jason Boucher - NEFSC

Jason Didden - MAFMC Staff

Jeff Kaelin - Lunds Fisheries

Jessica Jones - NEFSC post doc

Jim Gartland - VIMS

Jon Deroba - NEFSC

John Manderson - Open Ocean Research

Katie Almeida - Town Dock

Kathy Sosebee - NEFSC

Kiersten Curti - NEFSC

Kim Hyde - NEFSC

Larry Alade - NEFSC

Laurel Smith - NEFSC

Lisa Hendrickson - NEFSC

Mark Terceiro - NEFSC

Meghan Lapp - Sea Freeze Ltd.

Michelle Duval - MAFMC Member/private consultant for Mellivora Consulting

Mike Simpkins - NEFSC

Noelle Olsen - Maryland Sea Grant

Paul Rago - MAFMC SSC

Rob Latour - VIMS

Rob Vincent - MIT

Sam Schiano - Maryland Sea Grant

Sarah Salois - NEFSC

Steve Cadrin - SMAST

Tim Miller - NEFSC

Thomas Swiader - NEFSC

Toni Chute - NEFSC

Tony Wood - NEFSC

Victoria Kentner - NEFSC