Independent Peer Review Report on the Gulf of Maine Haddock Research Track

Prepared for:
The Center for Independent Experts

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EXECUTIVE SUMMARY

The report must be prefaced with an Executive Summary providing a concise summary of the findings and recommendations and specify whether the science reviewed is the best scientific information available.

The GoM Haddock (*Melanogrammus aeglefinus*) Research Track Stock Assessment Peer Review Panel met virtually using WebEx from 25-27 January 2022. The review was very well organised and the Panel was assisted in advance and throughout by Northeast Fisheries Science Center (NEFSC) staff. The Haddock Working Group prepared all documentation and clear and concise presentations were made. All materials and presentations were of a high standard. The Peer Review Panel meeting was well chaired and provided excellent opportunities for public comment. A Summary report was finalised within a week of the meeting ending.

The Gulf of Maine haddock stock assessment was last updated in 2019 based on the previous benchmark assessment conducted in 2014. The 2022 Research Track assessment which is the subject of this review is exploratory but the WG-preferred model is essentially an update of the 2019 assessment with just one year of additional data. At the Management Track assessment to be considered later in 2022, an additional two years of data will be added. It is possible that conclusions drawn by the Research Track WG and this review could be affected.

The GoM haddock Research Track WG attended to all ten of its Terms of reference (ToR). The processing of catch data and surveys are well described and the WG has responded to specific needs for improvement where necessary. The assessment model bridging and preferred model development are clear, and the preferred model appears to have converged and have reasonable goodness-of-fit. It has persistent retrospective patterns which are a concern and the WG has not been able to enumerate the underlying causes. This remains an important need and should be explored prior either to simply retro-adjusting model outputs as has been done in the past or adopting a Plan B for advising on future catches.

Limited alternative model configurations have been explored. There is room for possible model development as new bottom longline survey data accrue and a need for development to account for disparate fleets which are currently combined in the model. Selectivity is estimated for the combined fleet but is likely different for the commercial and recreational components. Given the (appropriate) use of dynamic reference points, it is important to have a reliable estimate of recent selectivity. It is suggested that there should be further exploration of a split fleet model, starting in 1989 and with selectivity estimated for more recent time blocks than is currently done.

The WG considered how weight-at-age has varied long-term and due to density-dependence and used this work to justify clear choices of weight-at-age in both proxy biological reference point (BRP) calculations and short-term projections. The WG suggested how BRPs should be calculated, and short-term projections run.

In addition to data preparation and assessment model development, the WG also considered information and research related to recruitment processes for and habitat use by GoM haddock. The work on both issues was inconclusive and did not feed into the stock assessment or any future stock assessment plans.

BACKGROUND

*The main body of the reviewer report shall consist of a **Background**, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each TOR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the TORs*

The Gulf of Maine haddock (*Melanogrammus aeglefinus*) stock assessment was last updated in 2019 (Northeast Fisheries Science Center, 2019) based on the previous benchmark assessment conducted in 2014. The 2014 assessment is available at the NOAA Institutional Repository website and three individual CIE reports are available at the NOAA OST website listing of CIE reports for 2014. The CIE reports are generally favourable and support conclusions from the 2014 assessment. One CIE reviewer (Needle) for the 2014 stock assessment is also a member of this 2022 Review Panel.

Based on the 2019 updated assessment, the stock status for the GoM haddock stock was not overfished and overfishing not occurring. Retrospective adjustments were, however, made to the model results due to strong retrospective patterns, a common issue for stock assessments in the region and one which persists in the assessment under review. Spawning stock biomass (SSB) in 2018 was estimated to be significantly greater than the biomass target (SSBMSY proxy) and the 2018 fully selected fishing mortality was estimated to be 22% of the overfishing threshold proxy (FMSY proxy = F40%).

The stock assessment in 2022 which is now subject to review is a Research Track assessment and is a single year update of the 2019 assessment. The Northeast Region Coordinating Council (NRCC) assessment process, including Research and Management Track variations is described at https://www.fisheries.noaa.gov/new-england-mid-atlantic/population-assessments/fishery-stock-assessments-new-england-and-mid-atlantic. A good summary is provided at https://apps-nefsc.fisheries.noaa.gov/saw/sasi/uploads/Background_Stock-assessment-process-June2020.pdf. It is sufficient here to note that Research Track assessments do not directly inform management decision-making but are rather developmental with an aim to providing the basis for Management Track assessments which feed directly into decision-making processes. Importantly, Research Track assessments do not update status determinations.

Later in 2022 there will be a Management Track stock assessment for GoM haddock which will update the assessment considered at this review with data from 2020 and 2021, though 2020 data are compromised due to the Covi-19 pandemic. That Management Track assessment can in principle also build on considerations and recommendations from this review. At the Management Track assessment, status determination will be updated and final catch projections run.

REVIEWER'S ROLE IN THE REVIEW ACTIVITIES

*The main body of the reviewer report shall consist of a Background, **Description of the Individual Reviewer's Role in the Review Activities**, Summary of Findings for each TOR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the TORs*

The role of the reviewer is set out in the CIE Statement of Work (SoW), Attachment A, attached here in Appendix 2.

The GoM Haddock Research Track Stock Assessment Peer Review Panel (the Panel) met virtually using WebEx from 25-27 January 2022 and followed the final agenda as shown Appendix 3. A full participants list is included at Appendix 4. The Panel was chaired by Richard Merrick (NEFMC SSC) and included three CIE appointees: Coby Needle, Anders Nielsen and Kevin Stokes.

The review was very well organised and the Panel was assisted in advance and throughout by Michele Traver (NEFSC Stock Assessment Process Lead) and Russell Brown (Chief, NEFSC Population Dynamics Branch). The Panel met remotely in advance with Michele Traver and Russell Brown to discuss the agenda, reporting requirements, and logistics. I am grateful to the Panel and organisers for delaying the daily start of the meeting by one hour to 4am New Zealand time; this may seem a small thing, but it made a big difference.

The Haddock Working Group prepared all documentation and clear and concise presentations following a consistent format were made by Charles Perretti and Brian Linton. All documentation and presentations were made available one week in advance using a NEFSC repository website (see Appendix 1). The NEFSC supplied rapporteurs for the meeting with notes appearing in near real time using Google Docs. This is an excellent system, and the rapporteurs should be congratulated for a job well done.

In advance of the review, in addition to meeting virtually with the Panel and NEFSC staff, I reviewed the background documents provided (Appendix 1). During the review, I participated fully in the discussions during and after the presentations provided. Additionally, along with other CIE panelists, I suggested edits and commented on the draft Summary report prepared by the Panel Chair to reflect Panel discussion and recommendations. I am grateful to the Chair for leading on the Summary Report; this was efficient and effective and is a good model for future reviews. As ever, I took continuous notes for my own use in developing this report though if future real time rapporteuring is of the same standard as for this meeting, that need might be obviated!

SUMMARY OF FINDINGS BY ToR

The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, ***Summary of Findings for each TOR in which the weaknesses and strengths are described****, and Conclusions and Recommendations in accordance with the TORs*

NB. ToR for the Review are highlighted in *purple italics* to distinguish them from the CIE ToR highlighted in *blue italics*.

ToR 1 *Review existing research efforts, data, and habitat information in the Gulf of Maine and Georges Bank, identify any findings relevant to influences of ecosystem conditions on haddock, and consider those findings, as appropriate, in addressing other TORs. For processes that the working group deems important and promising that are not currently feasible to consider quantitatively, describe next steps for development, testing, and review of quantitative relationships and how they could best inform assessments.*

The Panel agreed that this TOR has been met. I agree with that finding.

The WG described in detail how it approached the ToR and provided a good discussion on its reservations. The report states that it considered species distribution models based on machine learning methodologies and cites Friedland *et al* (2020). Friedland *et al* applies machine learning (random forest classification and regression trees) to a dataset for the US northeast shelf for a range of species and concludes species ranges and overlaps have expanded over time with potential for increased between-species interactions. It is unclear if the WG is using the haddock-related outputs from the Friedland *et al* analysis or has applied the same methods with the same covariates but just to haddock with no other species included. I think the latter. It is also unclear if the WG analysis is for the whole or a subset of the region included in the Friedland *et al* analysis. I think the former.

Notwithstanding some lack of clarity, the WG discussion is good and expansive, and the results are well presented and explained. As discussed during the Review and suggested by the WG, the results are hard to

interpret, and it is unclear if the analysis is simply reflecting a change in haddock spatial abundance in the surveys rather than finding habitat drivers for abundance changes. The WG considered this carefully and the paragraph on page 21/331 of the WG Report identifying the most important variables and how the spatial distribution of haddock is derived is clear. The WG is honest about the lack of a mechanistic explanation and the need for further work.

During the Review, it was noted that if the stock assessment in future is done using the Woods Hole Assessment Model (WHAM; Stock and Miller, 2021) then environmental indices could be included directly. This is true, but it is potentially more illuminating to explore important environmental correlates externally, as started by the WG and as seen in such work as by Friedland *et al*. External exploration can not only aid understanding of causality but in principle would make future stock assessment including ecosystem variables more efficient.

ToR 1 ends by saying " …*and how they could best inform assessments*". The WG Report on ToR 1 starts by saying "*Ecosystem variables are important drivers of the spatial distribution of fish, therefore the working group developed and reviewed habitat models which might explain changes in the spatial distribution of haddock over time*." It is unclear how the WG envisages any habitat models will actually be used to inform the assessment directly as required by the ToR (e.g., using WHAM with relevant covariates) or more qualitatively. It would be useful for the WG to be clearer on this.

The WG Report refers to but does not describe in any detail a "*minimum swept area*" approach and notes this could be useful in survey design if coverage changes in the future. I am reminded of a review of Pacific halibut (Stokes, 2019) and a discussion on application of state-space modelling of survey and environmental data. The purpose of that modelling is to improve the index used in stock assessment but as I commented in that review: *…I have what might be a related comment motivated by use of the space-time modelling to understand fundamentally how the distribution of fish is more or less stable through time and how complex, and the factors that influence variation. Fixed station design will generally reduce variance but at the possible expense of bias, especially if the complex distribution of fish changes through time. The space-time modelling approach used for [the] analysis can account for variations in distribution, but bias will still depend on survey coverage compared to stock distribution…*

The machine learning approach being used by the WG may eventually lead to better mechanistic understanding and perhaps could lead to informed inclusion of ecosystem variables using WHAM. However, would a more direct state-space analysis of the survey data (NEFSC and MADMF and MENH) and ecosystem variables be more useful in guiding survey coverage to reduce bias in future abundance indices to be used in the stock assessment?

ToR 2 *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 agreed that this TOR has been met. I agree with that finding.

The WG described in detail how the four catch components (commercial landing and discards, and recreational landings and discards) were compiled, with clear and extensive explanations building on historical and more recent analyses and processing. I note only two obvious omissions. First, and minor, while statistical areas are referred to in the WG report, none are indicated. They are, however, readily available from the NOAA Fisheries website at https://www.fisheries.noaa.gov/resource/map/greater-atlantic-region-statistical-areas. Second, and more important, while the compilation of recreational fisheries statistics is described, I can find no description in the WG report of the recreational fishery gears in use. This is important in interpreting selectivity

estimates and in any discussion of fitting to a single or split fleet. In the Northeast Multispecies Fishery Management Plan (FMP): Framework Adjustment 61 (2021) it is stated that: *The recreational multispecies fishery is primarily prosecuted with rod and reel and handline (i.e., hook and line gear).* I presume this includes the recreational fishery for GoM haddock. This is very different to the commercial fishery in which the large majority of catch has been taken in varying proportions by trawl, gillnet and longline with trawl predominating strongly in recent years, during which time the recreational fishery has also grown. I would therefore expect *a priori* very different commercial and recreational selectivity patterns over the past decade.

As noted during the review and in the Summary Report, the commercial landings and discards estimates are consistent with the presented survey data. The detailed breakdown by gear type (trawl, gillnet and longline) appears to be changing through time with trawl now dominant and having larger discard rates. Discard monitoring by observers is relatively low with, as I understand from discussion, only 3-4% of trips observed. However, as also discussed in the meeting, a limited exploratory electronic monitoring program is in place which will provide information on market retention. It will be good to see where this leads and if discard estimates of very young fish become available. However, commercial discarding appears to be very low in comparison to commercial landings and recreational discards (see Fig A.12 of the WG Report copied below).

The WG continued the use of a hindcasting method to estimate commercial discards between 1982 and 1988. As previously applied during the 2014 benchmark assessment, the discard estimates for that period are very low compared to the estimated landings (as they are in all years). I see no alternative to using such a method though for a highly variable stock for which dynamic biological reference points are appropriate (see ToR 6), and with a plus group set at 9 plus, it is appropriate to ask if it would not be simpler to start the stock assessment in 1989 from which time more direct estimates of removals are available.

The commercial fisheries for GoM haddock have varied through time and the WG has done an excellent job of describing and displaying these changes using a measure of dispersion (the GINI index), centroids, and concentration maps (Figs. A.25-A.29 of the WG Report). Other descriptive work on sampling by port, month, statistical area, and market category is comprehensive and informative.

Recreational catch estimation is handled externally to the WG through the Marine Recreational Information Program (MRIP). Since the 2014 benchmark assessment, at which simple 50% and 100% recreational discard mortality rates were explored (and the 100% assumption used), recreational discard mortality rates by size and season have been estimated and these have been applied to the assessment since 2017. In 2022, they were again applied with the note that it makes little difference to using the 50% mortality rate assumption. Given the mortality rates shown in Table A.24 of the WG Report, this is unsurprising.

With commercial and recreational fleets combined in the stock assessment, the impact of recreational discard mortality would be expected to be attenuated, but if fleets were separated, then for years with high discarding (e.g., of young fish in 2014, 2015; see Fig A.12 copied below and Table A.19) the details of recreational discard mortality might matter more.

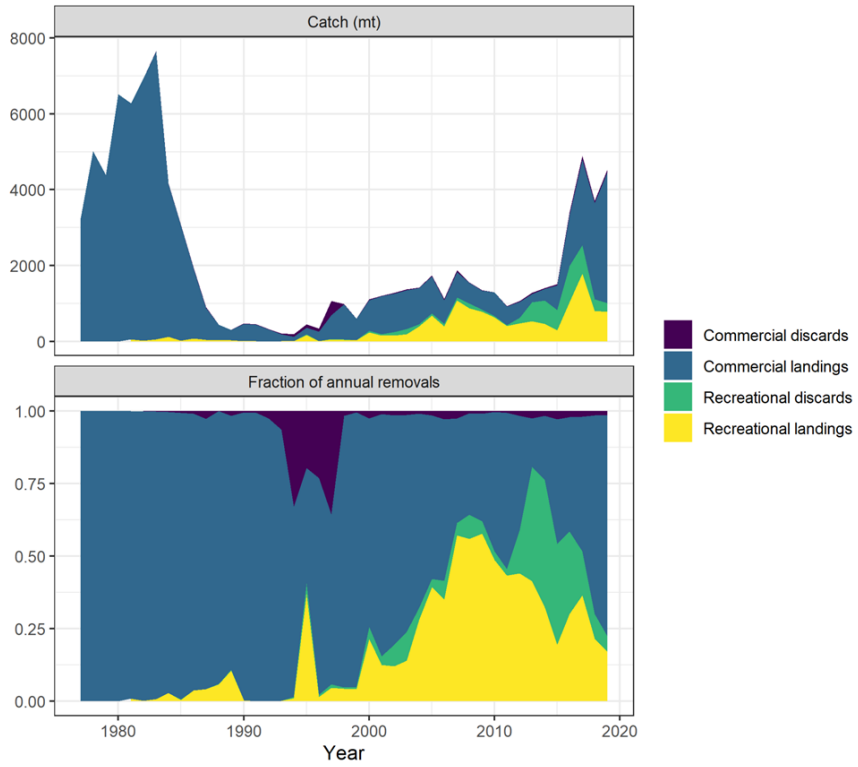


Fig A.12 from GoM Haddock WG Report (2022)

The WG Report contains a section on commercial CPUE. This was not much discussed during the meeting and is not included in the Summary Report but is worth a brief comment. It is clear that attempts have been made to develop fishery-dependent indices for GoM haddock and the WG has done a good job of describing and commenting on that work. Various suggestions for improved modelling are made. However, from the highly variable nature of the fishery through time as shown in the general descriptions, and with multiple management interventions as outlined in the FMP and included in the WG Report at the section on *Fisheries Management* and in Table A.3, it does seem a very difficult technical task. While the WG has done a good job on this issue, I do not understand the WG's final point made on page 30/331 of its report, related to the stock assessment using a single fleet structure and the difficulties of model fitting with commercial and recreational fleets split. Because the stock assessment combines fleets, which is a separate issue considered at ToR 4, that does not mean a commercial-only CPUE or LPUE could not be fit and used as an abundance index in the stock assessment.

NB. I note one small error at page 25/331 (of the pdf) under *Commercial landings at age estimates*. The final reference should not be to Table 3.8 but to Table A.12.

ToR 3 *Present the survey data being used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.). Characterize the uncertainty in these sources of data.*

The Panel agreed that this TOR has been met. I agree with that finding.

This ToR is concise, asking only that survey data used in the assessment are presented and associated uncertainty is characterized. The WG has exceeded the ToR by describing in depth all potentially relevant surveys: i) NEFSC bottom trawl (NEFSC BTS) in both spring and fall; ii) Massachusetts Department of Marine

Fisheries (MADMF) bottom trawl survey in both spring and fall; iii) Maine-New Hampshire (MENH) inshore groundfish survey in both spring and fall; and iv) the NEFSC bottom longline survey (NEFSC BLS) in summer. Of these, only the NEFSC BTS fall and spring surveys are used in the preferred model (base_newcalib), though the WG also explored potential use of the NEFSC BLS in various model refinements.

All survey operational matters are described in detail, together with data and associated uncertainties. Calibration of the BTS series from the RV Bigelow and RV Albatross is fully explained and use of the calibrated series rather than separate series, as used previously in the 2014 benchmark assessment, is well justified.

The NMFS BTS provide broad spatial and temporal coverage of the GoM haddock and provide important indices and biological data for the assessment. They are excellent research tools. Although the MENH and MADMF surveys are not used in the assessment, there was discussion during the Review meeting of using, e.g., geostatistical models to integrate information from these finer-scale surveys with potential information on young fish in areas not covered by the NEFSC BTS. The WG did not make any recommendation along these at ToR 7 and it is unclear to me that there would be value in prioritising such work.

In contrast, the WG explored at some length (at ToR 4) the use of BLS data which may provide information on fish in rough grounds not accessible to the BTS. The WG noted that the BLS started in 2014, has tracked the large 2013 YC, and it remains unclear if it will usefully track cohorts after the effect of the 2013 YC has passed. Considering Figure A.101, it appears that in 2014 and spring of 2015 the BLS is catching proportionately more larger fish than the BTS but by fall 2015 both surveys are swamped by the 2013 YC. Even so, the BLS does appear to be catching larger fish on average which is likely a gear-habitat interaction effect. The WG has made a good job of presenting the BLS and of attempting to use it in the stock assessment and has made pragmatic decisions as to its use at this time. This could be returned to during the Management Track assessment when 2021 data (but presumably not 2020) BLS data will be available but as the WG could only get acceptable model fits by forcing flat-topped BLS selectivity from age 5 (as is estimated for the fall BTS) and effectively forcing the BLS data to conform to the preferred model fit it does not seem there would be much advantage.

ToR 4 *Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Compare the time series of these estimates with those from the previously accepted assessment model, and evaluate the strength and direction of any retrospective pattern(s) in both the current and the previously accepted model. Enumerate possible sources of the retrospective patterns and characterize plausibility, if possible.*

The Panel agreed that this TOR has been met. I agree with that finding with the possible exception of the final sentence.

The WG has summarised the stock assessment approach, a continuation from the 2019 update of a statistical catch-at-age assessment model implemented using ASAP, has shown bridging results and compared model outputs with those from previous models, and provided a high-level summary of model "*refinements*" considered. It has shown some diagnostics for the preferred model but none for refinement models, nor for any of the retrospective peels. While it is possible, therefore, to say the ToR 4 elements have in general been met by the WG, it is not possible to say that the WG has enumerated possible sources of retrospective patterns, nor that it has tried to characterize plausibility. The issues of retrospective patterns and robustness (plausibility?) are discussed further in ToR 8.

Bridging results suggest a strong tendency, even at the Research Track, to update rather than start afresh with the stock assessment. Given the ToR, the WG has worked accordingly, and it is notable that the wider ToR do allow more research considerations. The bridging exercise is successful, as would be expected given a single year data update and no software updates. I do not understand how the change in commercial data processing

to accommodate the snapper category led to needing to fix selectivity at age 7 post 2005 as used in the updated base model (*base_covfix model*). I understand the fix and why it was made in response to the ASAP warning message, just not how the processed data change which would have a presumably small effect on the young age composition resulted in this need to fix selectivity at age 7. The issue is a small one compared to the many tasks the WG had to deal with. In general, however, it would be good to explore how and why this happened, not just how to fix it at the model fitting stage.

The WG-preferred model is *base_newcalib model*, which includes the fix for selectivity and calibration of BTS numbers-at-length. This seems *a priori* a sensible choice and a good base for further exploration. Diagnostics and results are presented. I have commented on the refinement models for BLS at ToR 3 and for split fleets at ToR 8.

For the preferred model, convergence has been tested and goodness-of-fit has been examined using residual plots and RMSE. Fits are comprehensively presented and fairly summarised by the WG. It is normal to see further model consistency checking using likelihood profiling as well as retrospective analyses but only the latter was carried out though possible sources for the persistent, unidirectional retrospective pattern were not enumerated. The retrospective analyses seem to be more aimed at potential retro-adjustment rather than being used diagnostically. The issue of retrospective analysis is considered at ToR 8.

The model refinements explored are sensible and the use of BLS data may in future be useful (though see ToR 3). Given the change in fishery composition over time and the use of different gears, splitting by at least commercial and recreational categories is worthy of further exploration though the multiple reasons for not progressing the model at this time are noted in the WG Report. I do not find it convincing that the rationale for splitting fleets should be to accommodate an LPUE index. With good quality fishery-independent indices, it is not clear what value that would add, and it would presumably receive less weighting in any analysis. In any case, if an LPUE index were representative of stock size, it is not essential to split fleets. The rationale for splitting fleets is surely that the commercial and recreational fleets have very different selectivities.

Overall, the preferred the stock assessment using data to 2019 appears sufficient to estimate annual fishing mortality, recruitment and stock biomass (total and spawning) and estimate their uncertainty. The model fits are consistent with the data and assumptions and with previous assessments. There are issues already considered that might be further explored but it is not clear if these would be best considered using the current model framework or a more flexible modelling package which might also accommodate multi-stock considerations.

More generally, while the assessment fit is acceptable as a continuation assessment, I find the selectivity blocking and lack of fleet separation unconvincing. The three selectivity blocks are predicated on management changes but there is little variation in estimated selectivity by block as seen in Figure A.128 of the WG Report. In any case, given the use of dynamic biological reference points (BRP), getting a better characterisation of recent selectivity is most important. I would like to have seen an exploration of a split fleets model starting in 1989 and with variations in selectivity explored for recent years when fleet composition has been changing.

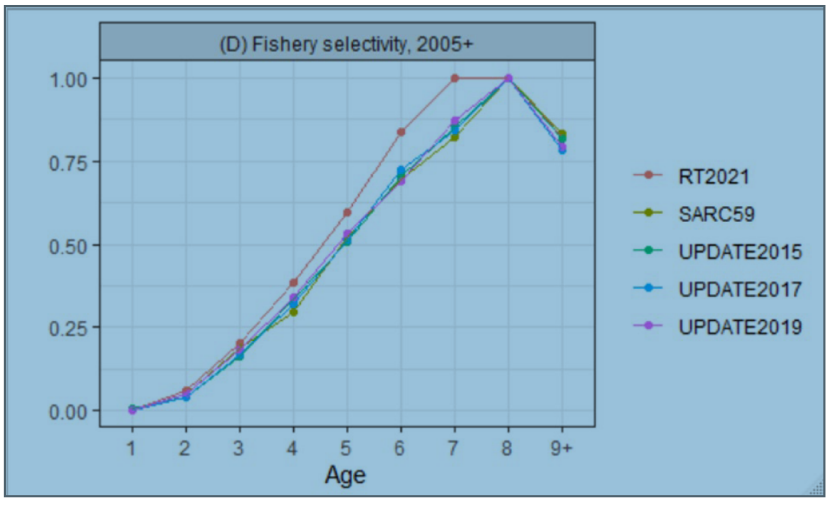
ToR 5 *Update or redefine status determination criteria (SDC point estimates or proxies for BMSY, BTHRESHOLD, FMSY and MSY) and provide estimates of their uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs.*

The Panel agreed that this TOR has been met. I agree with that finding.

As a Research Track assessment, the WG has not estimated biological reference points (BRP) but has focused on explaining and justifying the continued use of proxy BRPs, specifically 40%SPR. The WG has provided a clear description of why (no estimated S-R relationship) the SPR approach has been adopted for GoM haddock, and indeed widely in the region. Discussion during the Review meeting noted that the stock is highly dynamic and that other approaches might be usable, but I see no obvious alternative proxy unless an entirely different management decision-making approach were to be adopted; the obvious choice being a simulation-tested Management Procedure (MP). Even then, and, if possible, within the constraints of the regional management arrangements, management objectives would need to be defined and some performance measures agreed. In my view it is reasonable to continue with the SPR approach given its familiarity and pedigree as well as the available standard software which has been used.

The SPR calculations involve fixed natural mortality (M), maturity-at-age, and selectivity-at-age, as well as weight-at-age (WAA) and recruitment. Fixed M is clearly a simplification and there is concern, just as with density-dependent growth, that M-at-age will vary through time due to length-dependent predation and density-dependent processes (e.g., Jørgensen and Holt, 2013). Figure A.11 suggests there may have been a decline in maturity-at-length in recent years, but there is no noticeable decline in maturity-at-age and no obvious alternative to the fixed maturity assumption in the BRP calculations.

Selectivity is a concern given the changing nature of the fishery (increasing trawl within the commercial fisheries and increasing recreational fisheries) as well as changing size-at-age. However, unless the stock assessment is restructured to accommodate more than one fleet, use of the selectivity estimated for the one assumed fleet is consistent. A concern is whether the estimated final selectivity block is appropriate for calculating BRPs given the blocking is from 2005 but size-at-age has decreased more recently (see ToR 10) and the fishery composition has changed most markedly in recent years. At ToR 6, the WG refers to Figure A.155 to claim there is no consistent trend in selectivity in the final block, based on selectivity estimates by assessment. That figure is copied below. I am not convinced that the most recent Research track assessment, labelled as RT2021, can be interpreted as showing no change in selectivity from the earlier assessments. RT2021 is essentially the same assessment at UPDATE2019 with just one year of additional data but the estimated selectivity-at-age is shifted substantially to the left. Given there will be two more years of data at the Management Track assessment, it is not possible to predict how the final selectivity estimate will look as the 2010, 2012 and 2013 YCs accumulate in the plus group and more recently recruited fish may grow faster.



Notwithstanding concerns about selectivity estimation, the main consideration for the BRP calculations in the preferred assessment is the use of WAA (weight-at-age) and recruitment. The WG has recommended continuation of the existing use of a 5-year average for both catch and weights-at-age. It is clear that weight-

at-age has declined through time and Figure A.161 clearly indicates decadal reductions in growth rate. Whether averaging over five years is appropriate is difficult to judge with annual growth variations being so large (Figure A.160). By the time the Management Track assessment is updated to use data up to 2021, the plus group will be dominated by the 2013 YC but that YC will have disappeared from all other age classes. Lack of survey data from 2020 may create data gaps. I think it is reasonable to persist with 5-year averaging for BRP calculation, but close scrutiny will be needed at the Management Track assessment to check whether the then most recent average appears reasonable. I note that weights-at-age from the surveys are not tabulated but based on the catch weights-at-age in Tables A.28-29 it appears the weight-at-age 0 in 2019 (the 2019 YC) is the highest on record; is this correct? It does not seem to be consistent with the age 0 WAA in 2019 for the NMFS BTS shown in Figure A.69.

Recruitment for the BRP calculations is based on sampling from a parametric CDF with the last two years of estimated recruitment removed, consistent with existing practice. I think this is fine and have no further comment. Similarly, the use of the MCMC simulation to estimate uncertainty is reasonable and appears to be robust from the limited diagnostics presented.

ToR 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, maturity, and recruitment.*

The Panel agreed that this TOR has been met. I agree with that finding.

At ToR 6, because of the high variation in annual growth rates, the WG explored the best balance of bias and error in short-term (i.e., two-year) projections using various time spans for averaging WAA. I find the conclusions reasonable and the justification to use a recent 2-year average for the BRP and short-term projections is convincing. Discussion in the Review meeting turned briefly to linear prediction along the cohorts to estimate more accurately WAA in coming years. I understood in the discussion that work on this has been carried out in ICES and may be considered by other reviewers but note also papers on Northern cod which may be of interest (Cadigan, 2013 and 2016).

ToR 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. Identify new research recommendations.*

The Panel agreed that this TOR has been met, though expressed some reservations. I agree with that finding.

The WG was tasked with reviewing and evaluating a large number of recommendations, some of which were general and well beyond the scope of any individual stock assessment WG. Some in the Review Panel found this a little frustrating and it was noted the WG could at least have commented on the relevance to the GoM haddock assessment. In my view, the WG commented not unreasonably on these with a repeated response though if time had permitted a little more detail would have been helpful.

Some of the recommended issues were considered in the ToR while some were general or not able to be considered at this time. The WG responded in sufficient detail where recommendations were effectively covered by ToR and made four specific recommendations itself that emerged from its work. I think the WG comments and recommendations are clear, concise, and reasonable.

It is unfortunate that the recommendations are not numbered, which would facilitate commenting here.

Six recommendations were made at SAW 59 in 2014 when the GoM haddock benchmark was conducted. The WG regarded three of those as requiring their own topical research track. On a recommendation to develop fishery-dependent indices the WG noted work on LPUE/CPUE at ToR 2 but that more work was required. I have commented on this at ToR 2. On a recommendation to conduct Northeast Region haddock assessments at the same time, this was addressed by a combined WG though reporting is being split. This raises a wider issue of whether concurrent assessments are enough or whether there is a need to consider assessments that combine areas or maintain structure but allow for movement, shared recruitment, or link parameters, etc. The work on stock structure (ToR 12 at the Georges Bank assessments) may help inform on this. On a recommendation regarding tagging studies the WG commented that there were none. There is no need to comment further.

One of the recommendations for which the WG suggested a topical research track was on the SAW 59 WG's note to the SSC on multi-model inference and risk evaluation in the Northeast Region. This is somewhat confusing and now also dated. It is unclear where any work on this is being progressed, if at all. It would be very helpful to clarify the intent and the type of multi-model inference being contemplated. Are ensemble approaches (e.g., as used by the IPHC - see Stewart and Hicks, 2022; Stokes, 2019) being contemplated or is the intention to use an alternate states-of-nature approach as is common, e.g., in the Pacific region? Without knowing the intent, it is hard to comment. I do not see a sufficient basis in the GoM haddock assessments to support a well-justified ensemble approach though there is clear potential to explore alternate treatments of natural mortality and selectivity that might be viewed in a decision table with alternate states of nature.

A single recommendation on the need to better understand recruitment processes was made at the 2019 Management Track assessment. The WG noted ToR 9 and that information available is primarily focused on Georges Bank. The Review Panel commented at ToR 9 that updating the Friedland *et al* (2015) analysis for GoM haddock would be useful but this has not found its way into any recommendations.

Four recommendations were made by the 2019 Management track review Panel. One was to split the snapper and small market categories to better characterise the age composition. This was done and the WG used the newly processed age composition data in the preferred model and explained at ToR 4 the need for a fix in the third (2005 onwards) selectivity assumptions. This is commented on at ToR 4 above. A recommendation to explore the utility of the detailed recreational discard mortality data *cf* an assumed single rate was also responded to at ToR 2. The WG used the detailed approach and found it gave very similar outcomes to an assumed rate of 50%. These data improvements are worthwhile but relatively unimportant given uncertainties in the assessment. Further recommendations made related to better understanding how and why retrospective patterns emerge in the haddock stock assessments. The WG responded that it was unable to identify mechanisms for the patterns, including the contrasting patterns between GoM and Georges Bank haddock. As noted at ToR 8, more could be done on this. The review Panel suggested that examination might be better done in the context of how multiple haddock stocks are modeled. This is a major issue and needs careful examination. Consideration from the multiple stock perspective would be interesting but I reiterate my comments at the end of ToR 4 about development of the GoM haddock assessment; I think this needs to be done first.

The WG made four recommendations for future work. Given conversion factors were developed in the 1930s and it is not known what data were used, there is a need to update these. Also, given processing differences in commercial and growing recreational fisheries, there is a need to determine separate rates. I was surprised to read this recommendation and I support it. Having started evaluating the use of the NEFSC BLS in the assessment the WG recommends it be reevaluated when the series is longer and spans a period with greater contrast in stock abundance. This makes good sense and is in line with considerations at ToRs 3 and 4. The issue of on and off ramps for analytical assessments at the Management Track stage was raised during the Review meeting and the WG recommendation to allow exploration of new or further analytical assessments at the Management Track stage was supported. The WG also recommended further exploration of methods to

estimate WAA and selectivity for strong YCs in short-term projections given the difficulties of forecasting given density-dependent growth. This was discussed at ToR 10 and the Panel supported the recommendation.

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

The Panel agreed that this TOR has been met. I agree with that finding.

This is an interesting ToR with wider issues to consider than the adoption of a specific Plan B model to be used if the assessment model fails in the future. First, however, to the proposed Plan B model – Plan B Smooth. Plan B Smooth was one of a group of index-based methods tested during a workshop in 2020. The details of that workshop are available at the NEFSC Repository website, including a draft report. In addition, three CIE reviews are available at CIE Reports for 2021. The workshop simulation tested a number of index-based methods to determine performance in providing catch advice in the absence of an accepted analytical stock assessment. Plan B Smooth was found to perform well. Plan B Smooth has in fact been adopted previously by the haddock WG following its adoption for cod in 2015 and at the 2022 Research track assessment the WG again explored its use. The WG is clear, however, that using Plan B Smooth would not be expected to provide more accurate catch advice than using the ASAP stock assessment adjusted for retrospective patterns. Overall, while the WG explored Plan B Smooth and has provided sufficient advice for its use if the ASAP assessment is rejected, it seems intent on advising on its preference for the use of a retro-adjusted ASAP as was done in 2019. This strongly expressed preference was made without fully exploring the potential future behaviour of the ASAP model, for example with an additional two years of data at the Management Track assessment later in 2022. I think it is worth keeping an open mind until the Management Track assessment is run.

A number of issues need to be explored: i) when is it appropriate to reject a stock assessment and move to Plan B?; ii) the use of more than one model to test robustness of stock assessment conclusions; and iii) if Plan B were advised at the Research Track stage or following peer review, how would the Management Track process potentially allow for reinstatement of the analytical assessment?

Discussion in the review meeting focused on within-model retrospective patterns (seen through data peeling), seemingly as a determining diagnostic rather than a modelling outcome providing information on model consistency. I am very aware that this is a major issue for stock assessments in the region and that there are scientists at the NEFSC who have made major contributions on this subject (see, e.g., ICES, 2019, and references therein). Additionally, there are well-established regional practices regarding retrospective patterns and adjustment of estimates.

The issue of retrospective patterns as part of model diagnostics is also well-explored in Carvalho *et al* (2017, 2021). The main advice from Carvalho *et al* is that following convergence testing and goodness of fit checking (both done by the WG) consistency can be checked through likelihood profiling (not reported and presumably not done) as well as consideration of retrospective patterns. The WG has looked at retrospective patterns but has not reported on whether and how it has looked "under the hood" to try to determine why they arise and could they be mitigated by alternative assumptions on biological parameters or treatment of data sets, possibly through re-weighting. My sense is that the issue was left without further exploration because the retrospective patterns in this case are such as to lead to underestimation of potential catches and as such are "safe". Also, the measure of retrospective magnitude (Mohn's *rho*) has declined in the most recent assessment compared to the assessment in 2019.

The values of Mohn's *rho* are 0.3 for SSB and -0.24 for F in the recommended model); the WG describes these as "minor". These values are in fact high compared to the common rules of thumb in Hurtado-Ferro *et al* (2014) and, if I understand correctly, the values used for triggering Plan B in many stock assessments within the northeast region. They are also higher than in all previous assessments as reported at Table A.41 of the

WG Report. At the Management Track assessment later in 2022 there will be two additional years of data, though with missing 2020 data due to restrictions during the Covid-19 pandemic, and it is unclear at this stage how the updated model will perform retrospectively.

The strong, persistent, and unidirectional retrospective pattern for the GoM assessment, which is in the reverse direction for the Georges Bank haddock stocks, does seem worth further investigation. Obvious issues for further consideration are assumed natural mortality and selectivity by fleet, both of which may vary through time, stock structure, and model weighting. Hurtado-Ferro et al (2014) discuss how time-varying parameters may influence retrospective patterning.

Natural mortality is assumed constant at 0.2. This is consistent with the observed maximum age but given experience elsewhere it is clear that natural mortality varies with age and through time, especially for species with variable growth rates and variable predator-prey interactions (see, e.g., Jørgensen and Holt, 2013). Selectivity is blocked but is estimated for combined commercial and recreational fleets and most recently for a time block starting in 2005, well before major changes in commercial and recreational fisheries. As noted at ToR 2, this seems inappropriate and, at ToR 4, model development is possible to refine estimates of recent selectivity. The WG explored splitting the fleet data and found the two-fleet model (*split_fleets model) "failed to converge for several retrospective peels*". and was therefore not supported. However, this implies that some of the peels did converge and suggests there is potential for further exploration and model fitting, possibly involving re-weighting. With some peels converging and others not there is likely detailed diagnostic information available to assist understanding of why the retrospective behaviour occurs. No diagnostics were shown for these models, so it is hard to comment further. Stock structure and connections with Georges Bank were considered by the WG and were discussed briefly during the Review meeting. With a separate Research Track assessment Review Panel meeting of Georges Bank haddock scheduled for April, at which a ToR addresses this issue, it need not be considered further here.

The WG considered only the single ASAP model though did explore some limited variations (reported on as "*refinements of the bridge model run*"). These are all useful exploratory runs and set up future possibilities such as incorporation of the Bottom Longline Survey (BLS) once more data accrue. The alternative runs all produce similar results and act as sensitivity runs to the selected model (base_newcalib model). It would be useful to test the robustness (which may be what is termed *plausibility* at ToR 4?) of the ASAP model using alternative analytic models (e.g., an age-structured production model, ASPM). This is common practice in many assessment processes.

During the Review Meeting it was noted that it was unclear if and how a rejected analytical model, at the Research Track stage, could be re-evaluated and reinstated at the Management Track stage. This does not apply to GoM haddock given the advised and generally supported stock assessment, but it could in principle. It could, for example, have been the case that the assessment had been rejected by the Review Panel but if run with the additional two years data for 2020 and 2021 then it would have been found to be acceptable. This was discussed in the Panel Summary Report as "*off ramp*" and "*on ramp*". The Panel recommendation is simply to ensure re-evaluation can take place at the Management Track stage. I agree with this recommendation.

ToR 9 *Review and present any research related to recruitment processes (e.g., spawning and larval transport, and retention), and potential hypotheses for large recruitment events.*

The Panel agreed that this TOR has been met. I agree with that finding.

The WG considered an updated analysis of Friedland *et al* (2015) which had found support for the hypothesis that haddock recruitment on Georges Bank may be influenced by provisioning effects of the fall-bloom on pre-spawning adults. The re-analysis confirmed those conclusions for Georges Bank. In discussion at the review meeting, it was suggested that the influence is *via* detritus fall out leading to increased benthic prey being available to haddock. Friedland *et al*, however, found no such relationship for GoM haddock and the WG did not update the analysis. As discussed at the Review Meeting, given the original analysis did not include the large 2013 YC of GoM haddock, it would be useful to update the GoM analysis to check if the hypothesis may now be supported. I presume this (the data included in the analysis) is correct but cannot access the Friedland *et al* paper to confirm the data years used.

The WG also considered work on the possible drift of haddock eggs and concluded the majority of eggs spawned in the GoM stay in the GoM though may contribute insubstantially on Georges Bank given the much larger size of the Georges Bank stock. As for the Friedland *et al* studies, the drifter studies appear more focused on Georges Bank. My strong impression is that the WG has done what it can to respond to the ToR but has limited and largely circumstantial information. The Review Panel noted the synchrony of haddock recruitment events between Georges Bank and the GoM and raised questions about stock structure. Discussion was inconclusive but for the upcoming (April 2022) review of the Research Track assessments for Georges Bank and eastern Georges Bank haddock there is a ToR on this subject which may have implications for future approaches to modelling of all stocks.

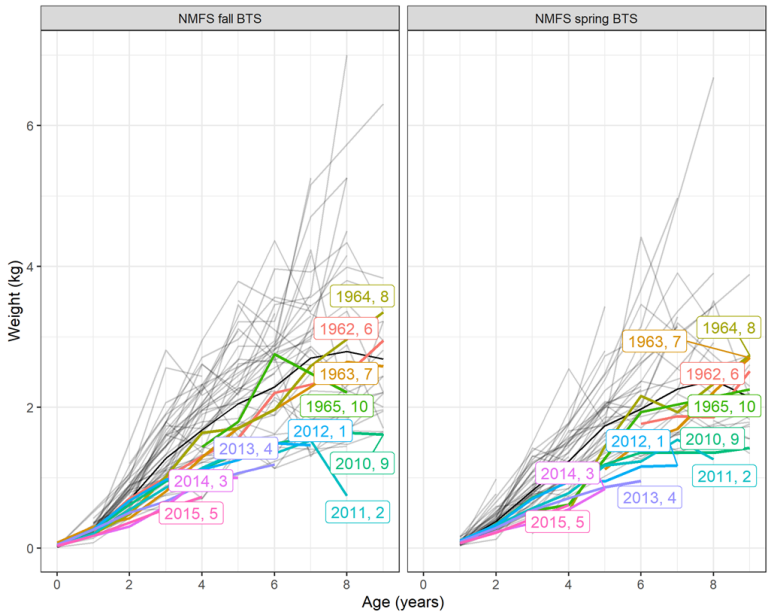
ToR 10 *Review and present any research related to density-dependent growth.*

The Panel agreed that this TOR has been met. I agree with that finding.

The WG provided a clear description of work undertaken to describe changes in GoM haddock weight-at-age (WAA) over time as well as by cohort. The presentation on ToR 10 made during the review included materials not presented in the WG report. The ToR is of relevance primarily to how WAA are used in making projections and calculating BRPs, as commented on at ToRs 5 and 6.

During the Review meeting, discussion on this ToR was wide-ranging, with questions aimed at understanding mechanisms that might explain how the changes in WAA described by the WG come about. Questions were asked about stock structure and connectivity and hypotheses on possible mechanisms that might drive density-dependent growth. Hypotheses discussed related to climate change-driven changes in predator abundance and how the timing and strength of planktonic blooms might drive haddock growth (also at ToR 9). Discussions on mechanisms were inconclusive.

The WG did a solid job of distinguishing changes in growth over the long-term and by cohort, the latter presumably being caused by density-dependent mechanisms even though detailed causality is elusive. Growth trajectories derived from survey data clearly show a gradual change by decade as illustrated in Fig. A.161 of the WG Report. When the strongest cohorts are identified (see Fig. A.163 of the WG Report) the growth trajectories of those strongest cohorts are all clearly below corresponding decadal means. When shown with growth averaged across adjacent YCs, growth for 2010-2015 YCs is at the extreme low of all growth trajectories as shown in the figure below (shown in presentation file GOM_Haddock_RT_Review_TOR1_TOR9_TOR10_v1) but not in the WG Report.



The WG concluded that it is appropriate to use a recent average of WAA for BRPs and short-term projections (TORs 5 and 6). More specifically, a 5-year average was adopted for BRP calculation and a 2-year average for short-term projections. The Review Panel explored this and what is done in other regions and for GB haddock but no specific recommendations to change the recommended averaging periods was made. In my view, given the materials presented, this is reasonable.

CONCLUSIONS AND RECOMMENDATIONS

The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each TOR in which the weaknesses and strengths are described, and ***Conclusions and Recommendations in accordance with the TORs***

These are embedded in the responses at individual ToR.

Overall, the GoM haddock Research Track WG has attended to all ten ToR. The processing of catch data and surveys are well described and the WG has responded to specific needs for improvement where necessary. The statistical catch-at-age assessment model was implemented using ASAP as in recent assessments. Model bridging and preferred model development are clear, and the preferred model appears to have converged and have reasonable goodness-of-fit. It has persistent unidirectional retrospective patterns which are a concern and the WG has not been able to enumerate the underlying causes. This remains an important need and should be explored prior either to simply retro-adjusting model outputs as has been done in the past or adopting a Plan B for advising on future catches. As a Research Track assessment, the WG has not commented on the need for retro-adjustment, but the retrospective statistic (Mohn's *rho*) is larger for both SSB and F than in previous assessments. Nevertheless, the WG has a strong preference to use the analytical model rather than the suggested Plan B which was considered and recommended.

Alternative model configurations have been explored and presented at a high level, but diagnostics were not presented. There is room for possible model development as new bottom longline survey data accrue and a need for development to account for disparate fleets which are currently combined in the model. Selectivity is estimated for the combined fleet but is likely different for the commercial and recreational components and

changes in both sectors in recent years have possibly led to more recent selectivity changes which are not modelled.

The MSY proxy biological reference points (BRPs) in use (SPR) are tried and tested within the regional management context. As haddock is highly variable and subject to fluctuations in growth and mortality, parameterisation of the BRPs and short-term projections uses recent averages of weight-at-age (WAA). For BRP calculation a recent 5-year average is well justified by the WG while for short-term projections a 2-year average is justified following careful exploration to balance bias and variance. As discussed at the review meeting, extrapolating WAA by cohort would be preferable, if possible, for short-term projections. Nevertheless, recruitment assumptions for the long-term projections used for BRP calculation and for short-term projections are consistent with past practice and are well-justified by the WG.

While the WG explored alternate model configurations, it did not examine other models to check the reasonableness or robustness of the model outputs. This would be useful and is common practice elsewhere, but it does not seem to be so in the region.

While the assessment fit is acceptable as a continuation assessment, I find the selectivity blocking and lack of fleet separation unconvincing. The three selectivity blocks are predicated on management changes but there is little variation in estimated selectivity by block. Given the use of dynamic biological reference points (BRP), getting a better characterisation of the most recent selectivity should be a priority. I would like to have seen an exploration of a split fleets model starting in 1989 and with variations in selectivity explored for more recent years when fleet composition has been changing.

In addition to data preparation and assessment model development, the WG also considered information and research related to recruitment processes for and habitat use by GoM haddock. The work on both issues was inconclusive and did not feed into the stock assessment or any future stock assessment plans. There is a clear focus on Georges Bank haddock for such work.

APPENDIX 1

The reviewer report shall include the following appendices:

a. Appendix 1: Bibliography of materials provided for review

Bibliography of materials provided for review

Prior to the Workshop, all materials were provided *via* https://appsnefsc.fisheries.noaa.gov/saw/sasi/sasi_report_options.php :

GOM_Haddock_RT_Review_TOR1_TOR9_TOR10_v1

GOM_Haddock_RT_Review_TOR2_v1

GOM_Haddock_RT_Review_TOR3_v1

GOM_Haddock_RT_Review_TOR4_v1 [Autosaved]

GOM_Haddock_RT_Review_TOR4_v1

GOM_Haddock_RT_Review_TOR5_TOR6_v1

GOM_Haddock_RT_Review_TOR8_v1

Haddock_WG_Report_DRAFT_GOM_ONLY_figures_v2

Haddock_WG_Report_DRAFT_GOM_ONLY_tables_v2

Haddock_WG_Report_DRAFT_GOM_ONLY_text_v2

Additional references are:

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- Carvalho et al (2017) Can diagnostic tests help identify model misspecification in integrated stock assessments? Fisheries Research 192:28-40 https://www.sciencedirect.com/science/article/pii/S0165783616303113
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- CIE Reports for 2014 at NOAA OST website https://www.st.nmfs.noaa.gov/science-quality-assurance/cie-peer-reviews/cie-review-2014
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- ICES J. Mar. Sci., 72 (2014), pp. 99-110
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APPENDIX 2

The reviewer report shall include the following appendices:

b. Appendix 2: A copy of the CIE Performance Work Statement

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

Gulf of Maine Haddock
Research Track Peer Review

January 25 -27, 2022

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 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.

[1] https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/memoranda/2005/m05-03.pdf

The purpose of this meeting will be to provide an external peer review of the Gulf of Maine haddock stock. 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. Modifications to the PWS and ToRs cannot be made during the peer review, and any PWS or ToRs modifications prior to the peer review shall be approved by the Contracting Officer's Representative (COR) and the CIE contractor. 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 index-based, age-based, and state-space 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 Report of Haddock Research Track Working Group.

1) The Peer Review Panel (co)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. Reviewers are not required to reach a consensus.

The (co)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 (co)chair will take the lead in editing and completing this report. The (co)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.

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 April 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.

Schedule	Milestones and Deliverables
Within 2 weeks of award	Contractor selects and confirms reviewers
Approximately 2 weeks later	Contractor provides the pre-review documents to the reviewers
January 25-27, 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
166 Water Street, Woods Hole, MA 02543
Michele.Traver@noaa.gov

Appendix 1. Haddock Research Track Terms of Reference

1. Review existing research efforts, data, and habitat information in the Gulf of Maine and Georges Bank, identify any findings relevant to influences of ecosystem conditions on haddock, and consider those findings, as appropriate, in addressing other TORs. For processes that the working group deems important and promising that are not currently feasible to consider quantitatively, describe next steps for development, testing, and review of quantitative relationships and how they could best inform assessments.

2. 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.

3. Present the survey data being used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.). Characterize the uncertainty in these sources of data.

4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Compare the time series of these estimates with those from the previously accepted assessment model, and evaluate the strength and direction of any retrospective pattern(s) in both the current and the previously accepted model. Enumerate possible sources of the retrospective patterns and characterize plausibility, if possible.

5. Update or redefine status determination criteria (SDC point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} and MSY) and provide estimates of their uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs.

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, maturity, and recruitment.

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. Identify new research recommendations.

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

9. Review and present any research related to recruitment processes (e.g., spawning and larval transport, and retention), and potential hypotheses for large recruitment events.

10. Review and present any research related to density-dependent growth.

Research Track TORs:

General Clarification of Terms that may be used in the Research Track Terms of Reference

Guidance to Peer Review Panels about "Number of Models to include in the Peer Reviewer Report":

In general, for any TOR in which one or more models are explored by the Working Group, give a detailed presentation of the "best" model, including inputs, outputs, diagnostics of model adequacy, and sensitivity analyses that evaluate robustness of model results to the assumptions. In less detail, describe other models that were evaluated by the Working Group and explain their strengths, weaknesses and results in relation to the "best" model. If selection of a "best" model is not possible, present alternative models in detail, and summarize the relative utility each model, including a comparison of results. It should be highlighted whether any models represent a minority opinion.

On "Acceptable Biological Catch" (DOC Nat. Stand. Guidelines. Fed. Reg., v. 74, no. 11, 1-16-2009):

Acceptable biological catch (ABC) is a level of a stock or stock complex's annual catch that accounts for the scientific uncertainty in the estimate of Overfishing Limit (OFL) and any other scientific uncertainty…" *(p. 3208) [In other words, OFL ≥ ABC.]*

ABC for overfished stocks. For overfished stocks and stock complexes, a rebuilding ABC must be set to reflect the annual catch that is consistent with the schedule of fishing mortality rates in the rebuilding plan. *(p. 3209)*

NMFS expects that in most cases ABC will be reduced from OFL to reduce the probability that overfishing might occur in a year. (p. 3180)

ABC refers to a level of ''catch'' that is ''acceptable'' given the ''biological'' characteristics of the stock or stock complex. As such, Optimal Yield (OY) does not equate with ABC. The specification of OY is required to consider a variety of factors, including social and economic factors, and the protection of marine ecosystems, which are not part of the ABC concept. (p. 3189)

On "Vulnerability" (DOC Natl. Stand. Guidelines. Fed. Reg., v. 74, no. 11, 1-16-2009):

"Vulnerability. A stock's vulnerability is a combination of its productivity, which depends upon its life history characteristics, and its susceptibility to the fishery. Productivity refers to the capacity of the stock to produce Maximum Sustainable Yield (MSY) and to recover if the population is depleted, and susceptibility is the potential for the stock to be impacted by the fishery, which includes direct captures, as well as indirect impacts to the fishery (e.g., loss of habitat quality)." (p. 3205)

Participation among members of a Research Track Working Group:

Anyone participating in peer review meetings that will be running or presenting results from an assessment model is expected to supply the source code, a compiled executable, an input file with the proposed configuration, and a detailed model description in advance of the model meeting. Source code for NOAA Toolbox programs is available on request. These measures allow transparency and a fair evaluation of differences that emerge between models.

Appendix 2. Draft Review Meeting Agenda
{Final Meeting agenda to be provided at time of award}
Gulf of Maine Haddock
Research Track Assessment Peer Review Meeting

January 25 - 27, 2022

WebEx link: https://www.google.com/url?q=https://noaanmfs-meets.webex.com/noaanmfs-meets/j.php?MTID%3Dmac73d9098b946224d02f64d3d429d0b3&sa=D&source=calendar&ust=1633797763460762&usg=AOvVaw12N6T8o0JhfZohwPjxr3UL
Phone: +1-415-527-5035 US Toll

DRAFT AGENDA* (v. 1/5/2022)
**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.*
Tuesday, January 25, 2022

Time	Topic	Presenter(s)	Notes
9 a.m. - 9:30 a.m.	Welcome/Logistics Introductions/Agenda/Conduct of Meeting	Michele Traver, Assessment Process Lead Russ Brown, PopDy Branch Chief Richard Merrick, Panel Chair	
9:30 a.m. - 10:30 a.m.	TOR #2	Charles Perretti	Catch data
10:30 a.m. - 10:45 a.m.	Break		
10:45 a.m. - 11:15 a.m.	TOR #2 cont.	Charles Perretti	Catch data
11:15 a.m. - 11:45 a.m.	Discussion/Summary	Review Panel	
11:45 a.m. - 12 p.m.	Public Comment	Public	
12 p.m. - 1 p.m.	Lunch		

1 p.m. - 2:30 p.m.	TOR #3	Charles Perretti	Survey data
2:30 p.m. - 2:45 p.m.	Break		
2:45 p.m. - 3:45 p.m.	TORs #1, #9, and #10	Charles Perretti	Ecosystem, Recruitment Processes, and Density Dependent Growth
3:45 p.m. - 4:15 p.m.	Discussion/Summary	Review Panel	
4:15 p.m. - 4:30 p.m.	Public Comment	Public	
4:30 p.m.	Adjourn		

Wednesday, January 26, 2022

Time	**Topic**	**Presenter(s)**	**Notes**
9 a.m. - 9:15 a.m.	Welcome/Logistics	Michele Traver, Assessment Process Lead Richard Merrick, Panel Chair	
9:15 a.m. - 10:15 a.m.	TOR #4	Charles Perretti	Mortality, Recruitment and Biomass Estimates
10:15 a.m. - 10:30 a.m.	Break		
10:30 a.m. - 11:45 a.m.	TORs #5, #6, and #8	Charles Perretti	BRPs, Projections, and Alternative Assessment Approach
11:45 a.m. - 12:15 p.m.	Discussion/Summary	Review Panel	
12:15 p.m. - 12:30 p.m.	Public Comment	Public	
12:30 p.m. - 1:30 p.m.	Lunch		

1:30 p.m. - 2 p.m.	TOR #7	Brian Linton	Research Recommendations
2 p.m. - 2:30 p.m.	Discussion/Summary	Review Panel	
2:30 p.m. - 2:45 p.m.	Public Comment	Public	
2:45 p.m. - 3 p.m.	Break		
3 p.m. - 4 p.m.	Follow-ups/Key Points	Review Panel	
4 p.m.	Adjourn		

Thursday, January 27, 2022

Time	**Topic**	**Presenter(s)**	**Notes**
9 a.m. - 5 p.m.	Report Writing	Review Panel	

Appendix 3. Individual Independent Peer Reviewer Report Requirements

1. The independent Peer Reviewer report shall be prefaced with an Executive Summary providing a concise summary of whether they accept or reject the work that they reviewed, with an explanation of their decision (strengths, weaknesses of the analyses, etc.).

2. The report must contain a background section, description of the individual reviewers' roles in the review activities, summary of findings for each TOR in which the weaknesses and strengths are described, and conclusions and recommendations in accordance with the TORs. The independent report shall be an independent peer review, and shall not simply repeat the contents of the Peer Reviewer Summary Report.

a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including a concise summary of whether they accept or reject the work that they reviewed, and explain their decisions (strengths, weaknesses of the analyses, etc.), conclusions, and recommendations.

b. Reviewers should discuss their independent views on each TOR even if these were consistent with those of other panelists, but especially where there were divergent views.

c. Reviewers should elaborate on any points raised in the Peer Reviewer Summary Report that they believe might require further clarification.

d. The report may include recommendations on how to improve future assessments.

3. The report shall include the following appendices:

Appendix 1: Bibliography of materials provided for review
Appendix 2: A copy of this Performance Work Statement
Appendix 3: Panel membership or other pertinent information from the panel review meeting.

Appendix 4. Peer Reviewer Summary Report Requirements

1. The main body of the report shall consist of an introduction prepared by the Research Track Peer Review Panel chair that will include the background and a review of activities and comments on the appropriateness of the process in reaching the goals of the peer review meeting Following the introduction, for each assessment /research topic reviewed, the report should address whether or not each Term of Reference of the Research Track Working Group was completed successfully. For each Term of Reference, the Peer Reviewer Summary Report should state why that Term of Reference was or was not completed successfully.

To make this determination, the peer review panel chair and reviewers should consider whether or not the work provides a scientifically credible basis for developing fishery management advice. If the reviewers and peer review panel chair do not reach an agreement on a Term of Reference, the report should explain why. It is permissible to express majority as well as minority opinions.

The report may include recommendations on how to improve future assessments.

2. If any existing Biological Reference Points (BRPs) or BRP proxies are considered inappropriate, include recommendations and justification for alternatives. If such alternatives cannot be identified, then indicate that the existing BRPs or BRP proxies are the best available at this time.

3. The report shall also include the bibliography of all materials provided during the peer review meeting, and relevant papers cited in the Peer Reviewer Summary Report, along with a copy of the CIE Performance Work Statement.

The report shall also include as a separate appendix the assessment Terms of Reference used for the peer review meeting, including any changes to the Terms of Reference or specific topics/issues directly related to the assessments and requiring Panel advice.

APPENDIX 3

Agenda

Tuesday, January 25, 2022

Time	Topic	Presenter(s)	Notes
9 a.m. - 9:30 a.m.	Welcome/Logistics Introductions/Agenda/Conduct of Meeting	Michele Traver, Assessment Process Lead Russ Brown, PopDy Branch Chief Richard Merrick, Panel Chair	
9:30 a.m. - 10:30 a.m.	ToR #2	Charles Perretti	Catch data
10:30 a.m. - 10:45 a.m.	Break		
10:45 a.m. - 11:15 a.m.	ToR #2 cont.	Charles Perretti	Catch data
11:15 a.m. - 11:45 a.m.	Discussion/Summary	Review Panel	
11:45 a.m. - 12 p.m.	Public Comment	Public	
12 p.m. - 1 p.m.	Lunch		
1 p.m. - 2:30 p.m.	ToR #3	Charles Perretti	Survey data
2:30 p.m. -	Break		

2:45 p.m.			
2:45 p.m. - 3:45 p.m.	TORs #1, #9, and #10	Charles Perretti	Ecosystem, Recruitment Processes, and Density Dependent Growth
3:45 p.m. - 4:15 p.m.	Discussion/Summary	Review Panel	
4:15 p.m. - 4:30 p.m.	Public Comment	Public	
4:30 p.m.	Adjourn		

Wednesday, January 26, 2022

Time	**Topic**	**Presenter(s)**	**Notes**
9 a.m. - 9:15 a.m.	Welcome/Logistics	Michele Traver, Assessment Process Lead Richard Merrick, Panel Chair	
9:15 a.m. - 10:15 a.m.	ToR #4	Charles Perretti	Mortality, Recruitment and Biomass Estimates
10:15 a.m. - 10:30 a.m.	Break		
10:30 a.m. - 11:45 a.m.	TORs #5, #6, and #8	Charles Perretti	BRPs, Projections, and Alternative Assessment Approach

11:45 a.m. - 12:15 p.m.	Discussion/Summary	Review Panel	
12:15 p.m. - 12:30 p.m.	Public Comment	Public	
12:30 p.m. - 1:30 p.m.	Lunch		
1:30 p.m. - 2 p.m.	ToR #7	Brian Linton	Research Recommendations
2 p.m. - 2:30 p.m.	Discussion/Summary	Review Panel	
2:30 p.m. - 2:45 p.m.	Public Comment	Public	
2:45 p.m. - 3 p.m.	Break		
3 p.m. - 4 p.m.	Follow-ups/Key Points	Review Panel	
4 p.m.	Adjourn		

Thursday, January 27, 2022

Time	**Topic**	**Presenter(s)**	**Notes**
9 a.m. - 5 p.m.	Report Writing	Review Panel	

APPENDIX 4

GOM Haddock Research Track Peer Review Attendance

January 25-27, 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
DFO - Department of Fisheries and Ocean
SMAST - University of Massachusetts School of Marine Science and Technology
MADMF - Massachusetts Division of Marine Fisheries
MEDMR - Maine Department of Marine Resources
MAMFI - Massachusetts Marine Fisheries Institute

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Richard Merrick - Chair
Coby Needle - CIE Panel
Anders Nielsen - CIE Panel
Kevin Stokes - CIE Panel

Russ Brown - NEFSC
Michele Traver - NEFSC

Abby Tyrell - NEFSC
Alex Dunn - NEFSC
Alex Hansell - NEFSC
Andy Jones - NEFSC
Angela Forristall - NEFMC Staff
Ashok Deshpande - NEFSC
Brian Linton - NEFSC
Chad Demarest - NEFSC
Charles Adams - NEFSC
Charles Perretti - NEFSC
Daniel Caless - GARFO
Dave McElroy - NEFSC
Deidre Boelke - MAFMC
George Lapointe - George Lapointe Consulting LLC
Jamie Cournane - NEFMC Staff
John Couture - Unama'ki Institute of Natural Resources, Nova Scotia, Canada
Jon Deroba - NEFSC
Julie Nieland - NEFSC
Kathy Sosebee - NEFSC
Libby Etrie - NEFMC Member
Liz Brooks - NEFSC
Liz Sullivan - GARFO
Mark Grant - GARFO
Matthew Cutler - NEFSC
Melanie Griffin - MA MFI
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Michael Pierdinock - NEFMC Council member (from MA)
Mike Simpkins - NEFSC
Monica Finley - DFO
Paul Nitschke - NEFSC
Rebecca Peters - MEDMR
Robin Frede - NEFMC Staff
Ryan Morse - NEFSC
Scott Large - NEFSC
Steve Cadrin - SMAST
Tara Trinko Lake - NEFSC
Tom Nies - NEFMC Director
Xavier Mouy - NEFSC
Yanjun Wang - DFO

GOM Haddock Research Track Peer Review Attendance
January 25-27, 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
DFO - Department of Fisheries and Ocean
SMAST - University of Massachusetts School of Marine Science and Technology
MADMF - Massachusetts Division of Marine Fisheries
MEDMR - Maine Department of Marine Resources
MAMFI - Massachusetts Marine Fisheries Institute
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Richard Merrick - Chair
Coby Needle - CIE Panel
Anders Nielsen - CIE Panel
Kevin Stokes - CIE Panel

Russ Brown - NEFSC
Michele Traver - NEFSC

Abby Tyrell - NEFSC
Alex Dunn - NEFSC
Alex Hansell - NEFSC
Andy Jones - NEFSC
Angela Forristall - NEFMC Staff
Ashok Deshpande - NEFSC
Brian Linton - NEFSC
Chad Demarest - NEFSC
Charles Adams - NEFSC
Charles Perretti - NEFSC
Daniel Caless - GARFO
Dave McElroy - NEFSC
Deidre Boelke - MAFMC
George Lapointe - George Lapointe Consulting LLC
Jamie Cournane - NEFMC Staff
John Couture - Unama'ki Institute of Natural Resources, Nova Scotia, Canada
Jon Deroba - NEFSC
Julie Nieland - NEFSC
Kathy Sosebee - NEFSC
Libby Etrie - NEFMC Member
Liz Brooks - NEFSC
Liz Sullivan - GARFO
Mark Grant - GARFO
Matthew Cutler - NEFSC
Melanie Griffin - MA MFI
Michael Pierdinock - NEFMC Council member (from MA)
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