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Proceedings of the Regional Peer Review on the Review of Candidate Stock Assessment Frameworks for the Northwest Atlantic Fisheries Organization Subarea 0+1 (Offshore) Greenland Halibut Stock

December 12-15, 2022
Virtual and Winnipeg, Manitoba

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Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

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SUMMARY

Assessment of the North Atlantic Fisheries Organization (NAFO) Subarea (SA) 0+1 (offshore) Greenland Halibut (GH-0+1) stock uses time series data produced from bottom trawl surveys conducted by Fisheries and Oceans Canada (DFO) Science and the Greenland Institute of Natural Resources. The vessel (RV *Paamiut*) used for the surveys from 1999-2017 was retired in 2018 before paired trawling experiments with a replacement vessel could be conducted. In 2019, an interim vessel (FV *Helga Maria*) used the same gear (Alfredo trawl), and from 2022 and onwards a new vessel (RV *Tarajoq*) and gear (Bacalao) will be used. Assessing time series data often relies on an assumption that consistent methods and effort are used across years to ensure data are comparable. When changes in data collection methods occur, trawl survey time series are commonly standardized by conducting paired trawling experiments. Given the absence of such paired experiments, DFO is exploring analytical approaches that could be used to provide science-based advice on the status of the GH-0+1 stock in the short-term, while in the long-term exploring the potential of a contemporary, model-based assessment framework.

A DFO Canadian Science Advisory Secretariat (CSAS) Regional Science Advisory peer-review meeting was held between December 12-15, 2022 in Winnipeg, Manitoba that included virtual attendance via Microsoft Teams/Teleconference. The purpose of the meeting was to explore analytical approaches that could incorporate data collected by multiple vessels and gears for GH-0+1 stock assessment. These approaches would be used to provide advice so DFO Science could make further advances on these, or other, frameworks in the future. Scientifically defensible approaches will then be presented for review by the NAFO Scientific Council (SC). Three working papers were presented. All participants were required to complete a review of the working papers prior to the meeting. Participants included staff from DFO Science and Fisheries Management programs, representatives from the Greenland Institute of Natural Resources, the Marine and Freshwater Research Institute of Iceland, the Atlantic Groundfish Council, the Northern Coalition, the Institute of Marine Research in Norway, Qikiqtaaluk Corporation, the University of Windsor, and contracted experts from Blue Matter Science and Landmark Fisheries Research.

This Proceedings report summarizes the relevant discussions from the meeting and presents recommended revisions to be made to the associated research documents. The Proceedings, Science Advisory Report, and Research Documents resulting from this science advisory meeting are published on the DFO Canadian Science Advisory Secretariat (CSAS) website.

INTRODUCTION

Stock assessments often rely on data standardization when collection methods change, in order to account for differences that may arise by this change and enable the continuation of the time series. Stock assessments of Northwest Atlantic Fisheries Organization (NAFO) Subarea (SA) 0+1 (offshore) Greenland Halibut (GH-0+1) have relied on biomass and abundance indexes derived from bottom trawl surveys conducted using the RV *Paamiut* and Alfredo III trawl (hereafter called Alfredo Trawl) from 1999 to 2017. The vessel was retired before paired surveys with the new vessel RV *Tarajoq*, required for method standardization, could be conducted. In 2019, the FV *Helga Maria,* with the same Alfredo trawl that was used by the RV *Paamiut,* was used to conduct the survey. In 2022, the RV *Tarajoq* with a Bacalao 476 trawl began a new survey series.

To identify available data sources and analytical frameworks that could be used to provide interim advice while the new time series is developed, three draft research documents (working papers) were prepared. The first by Hedges and Raffoul (2023) outlined current data sources available to inform the assessment, a preliminary analytical approach, and literature review of approaches used in similar situations. The second by Huynh and Carruthers (2023) proposed a framework for evaluating different survey designs to improve precision in estimating stock abundance. The third by Johnson and Cox (2023) presented an assessment modeling framework that was then used to provide an assessment of stock status and a simulation framework for evaluating harvest strategies for this fishery. Major topics of discussion included ensuring mutual understanding of the data sources and their differences, assumptions and uncertainty associated with the modelling approaches demonstrated in the working papers, and most appropriate short-term and long-term assessment approaches to present to the NAFO Scientific Council (SC).

The Chair opened the meeting by reviewing the Terms of Reference (ToR; Appendix 1), introducing the participants (Appendix 2), and reviewing the meeting agenda (Appendix 3). An overview of the CSAS peer-review process was provided by the regional CSAS program. Before launching into detailed presentations, the ToR objectives were clarified to note that the goal of this process was to provide advice to DFO Science on development of potential assessment frameworks for this stock from which scientifically defensible approaches will then be presented for review by the NAFO SC. Following this, short high-level introductory presentations were given for each working paper, to provide context on the sources of data available, analytical methods used in existing literature for similar situations, and an overview of the analytical frameworks with example models and outcomes that were described in the working papers. Later in the meeting, participants discussed revisions to the working papers that were required before they could be accepted as research documents, which included additional presentations on data visualizations to best demonstrate the nature of the data sources and model outputs and sensitivity to changes in model inputs where there is a great deal of uncertainty. The meeting closed with a discussion of the draft Science Advisory Report (SAR), including development of summary bullets and key sections. All meeting participants were encouraged to contribute to the discussion and provide input on the working papers and SAR.

PRESENTATIONS

Context for this Peer Review

Presenter: Mary Thiess

The context and Terms of Reference objectives (Appendix 1) for the meeting were explained. The ability to assess time series data relies on an assumption that consistent methods and effort are used in surveys that produce abundance and biomass indexes. Stakeholders raised concerns at the Eastern Arctic Groundfish Stakeholder Advisory Committee (EAGSAC) meeting in January 2021 about the impacts of changing the research vessel used in the DFO and Greenland surveys. DFO sought science advice through a CSAS process and contracted companies with expertise to provide candidate methods for consideration and peer review. A Steering Committee was created in May 2021 with DFO Science, Fisheries Management and key stakeholders to discuss the development of the CSAS process and the ToR.

Review of methods used to standardize survey time series across vessels and gear, and spatial delta-GLMM analysis of Greenland Halibut catches from surveys conducted in NAFO Subarea 0+1

Presenter: Kevin Hedges

The presentation focused on the first ToR objective of identifying factors contributing to differences in catchability of Greenland Halibut. The presenter gave an overview of the current data sources available, along with methods used in other fisheries to provide advice across vessel changes and combine data from multiple surveys into stock assessments. One of the objectives was to find potential methods to bridge the gap between the RV *Paamiut* data and indices, and future RV *Tarajoq* data. The presenter discussed methods used within other fisheries through a systematic literature review and explored the suitability of using a spatial delta-GLMM (generalized linear mixed model) to analyze data from multiple sources to assess stock status during the transition between survey vessels.

One participant inquired about the spatial and temporal overlap between the data sources, since this would be essential for spatial models to calibrate between two surveys. The presenter clarified the overlaps between areas and gaps in the data sources and agreed to clarify data sources, gaps, overlaps and covariates used in the modelling, within the working paper. Another participant questioned if the surveys on the Greenland side, 1CD and 1AF, were offshore or if some of them were inshore as well. The presenter and a participant stated that surveys in Greenland begin on the shelf at a depth of 50 meters, but do not go into the fjords. There was a question about including data from DFOs survey in Cumberland Sound, however, due to the different gear used (i.e., long lines), it was concluded that there would be limited added value to try and include it in the models.

Participants requested clarification about the FV *Helga Maria* data. The presenter explained that the FV *Helga Maria* conducted deep water surveys in NAFO Divisions 0A-South and 1CD and a shallow water survey in 1A-F in 2019, but only Divisions 1A-F in 2020. Comparisons of the data collected via the FV *Helga Maria* and the RV *Paamiut* (Wheeland et al. 2020, Treble and Nogueira 2020) revealed different gear performance between the two vessels and this could have an effect on differences in catchability below 700 meters and consequently the NAFO SC determined the 2019 data were not suitable for assessing Greenland Halibut stock status. Hence this vessel was not used again for Greenland Halibut surveys. Data from the FV *Helga Maria* are still available and were used in the “All Surveys” model configurations but not in the initial comparison between published 0A-South indices and the 0A-*Paamiut*-Alfredo model.

There was uncertainty amongst participants on how the model handled incidences of little or no data between years, especially since the model results showed error estimates of similar magnitude when comparing years. The presenter confirmed that the catches were variable and was unsure what could be driving this issue and mentioned it would be reviewed. A participant questioned what the error bars showed, and the presenter confirmed it was standard error. Another participant asked about what the model was doing in the years that lacked data and what information was used to inform the current values between years. The presenter answered that the model should be taking data from adjacent years, but it would be reviewed for confirmation. Another participant recommended more model validation figures should be produced and the presenter agreed.

There was a discussion among participants and the presenter on whether to add commercial data to the analysis in the future. However, after significant consideration, several participants shared the view that including commercial data could be challenging due to lack of data on swept area, and biased nature of commercial sampling. However, it was recommended that there was value in using these data to develop a commercial index to separately compare to the survey data.

One participant recommended that the author should add information about vessel and gear used in each survey to the table summarizing available survey data (e.g., vessel, gear, areas surveyed, dates, depth ranges sampled, etc.). Another participant recommended that survey depths and seasons should be made available. The presenter explained that there are no seasonal variations in surveys. Other recommendations were that the spatial delta-GLMM results section required more figures to better understand the data. Box-plots, figures, and maps should be inserted to get a better picture of the data and see how much the surveys differed over time. In addition, a proper model description should be added.

A modelling framework for stock assessment and harvest strategy evaluation for the NAFO 0+1 Greenland Halibut (*Reinhardtius hippoglossoides*) fishery

Presenter: Sam Johnson

The presentation described how a Spatially Implicit Statistical Catch-At-Length (SISCAL) operating model was fit to the GH-0+1 data, to provide an assessment of stock status and productivity. In addition, the presenter explained how a closed-loop simulation framework was used to evaluate a hypothetical GH-0+1 harvest strategy. Although sensitivities and data issues (e.g., limitations) were present, the model fit the data well.

The presenter focused on the second ToR objective of examining analytical methods and/or frameworks that could allow integration and/or comparison of data collected by different vessels and gear configurations. A two-part analysis was developed. Firstly, a GH-0+1 specific stock assessment framework was defined for estimating annual stock biomass, recruitment, fishing mortality, and biological reference points to the extent possible. Secondly, using this framework, authors evaluated a hypothetical harvest strategy aimed at meeting objectives derived from conservation and yield requirements of the NAFO Precautionary Approach policy, given combinations of historical and future data.

A participant mentioned that it would be important to note that this was a single operating model with a single management procedure that was set up around the fit of that one model, so performance could degrade substantially if scale differences were present in the simulation models. The participant recommended testing across a wider grid of operating models. The presenter responded that if there was a different operating model with a different scale, the control points would be tuned, however, the presented version was simplified to show how the framework would function.

A participant noted that the assumption of deterministic recruitment in the early years of the model is not true, and thus may be biasing early dynamics and the results of the simulation self-tests. The participant understood that this assumption reconciled the different indices, but the concern was that in trying to reconcile the data, authors created enough flexibility to lose information about scale, and any changes/decisions made in the model to reduce the flexibility would result in an assessment that was substantially smaller in scale. However, sensitivity tests could be used to assess the impact of these changes/decisions. The participant would have liked to see sensitivities without the sex structure, and sensitivity analysis of using a larger prior, since it may lead to different results. The participant recommended avoiding time-varying assessments since it can be hard to have these types of models accepted by peer review. The presenter agreed.

On the topic of female spawning stock biomass (SSB), one of the participants sought clarification on the reasoning for the female SSB being low, whether it was a sex ratio difference or catchability, or a combination of both. The presenter acknowledged that information was missing to determine an asymptotic length for females. Maturity models fit to current data indicate only 80% of females are mature by 35 years of age, which is an issue possibly driving the resulting low SSB (and it is likely not correct). Another participant asked if low female SSB was based on asymptotic selectivity and the presenter confirmed, since it was the best fit. A recommendation was to plot selectivity over maturity to further address this point.

Another concern was mentioned by a participant about the presence of more uncertainty than what was being conveyed. The presenter agreed that uncertainty was high, and it had been communicated in the working paper. The participant recommended setting a different prior and having a constant M (natural mortality) to determine if this substantially alters the outputs. The participant expressed concern that interpretation of the data was more erratic than implied and that structural sensitivities are important. The participant recommended sequentially adjusting the fit to one or two of the elements making up the larger model to portray that there are limits to what is known. Another participant highlighted the importance of treating natural mortality with high sensitivity given its potential to drastically alter model outputs. The presenter noted the comments and that there would be further investigation of the model sensitivity to mortality.

When discussing the closed-loop simulation exercise, a participant asked if the authors assumed that the new index will be equivalent to the old index that was used, and how it affected the projections going forward. The presenter answered by stating that it was assumed that the new survey (RV *Tarajoq*) would have more information on smaller fish, and noted differences in catchability estimates used between different surveys within the model. In addition, the simulation can estimate “q” (catchability) and test different ranges. The participant requested the presenter add an explanation to the working paper to clarify this, and the presenter agreed.

One of the participants sought clarification on model fitting and requested insights on the length data, with particular interest in the selectivity data. The participant wanted to know if the length data were truncated due to either larger fish being deceased or not being captured by the survey. Another participant inquired about how the variation in age versus size was accounted for within the model. In response, the presenter noted variation in length at age is incorporated in the model and indicated that it is challenging to provide insight given the information available. If there is a lack of fish sampled at the smallest sizes/age, then age class or cohort signals cannot be obtained. Generally, the variance and modes in this data were similar year to year, however, the vulnerable biomass for the index was very different.

A participant commented on the selectivity plots, noting they were surprised some of the trawl data from commercial fleets did not show dome-shaped selectivity, given trawls are known to

have limited catchability for large Greenland Halibut (i.e., large fish are able to avoid the trawl). The participant wondered how this compared to similar species and fisheries. The presenter answered that in other iterations of the model, dome-shaped selectivity was assumed, but at most a shallow dome was observed. The presenter postulated that this may be explained by truncation in the available length data, but that the data could not identify if it was dome-shaped or not, which then increased uncertainty.

A participant questioned if when calculating the selectivity by age, it was based on a definitive length at age relationship or if it accounted for the variability in that relationship. The presenter confirmed that it incorporated the variability.

The presenter and participants agreed that an increase in sampling effort for older fish is required to better define length at maturity, and decrease the uncertainty in growth and maturity, which affects estimates of SSB, and fishing mortality on each age and sex.

Demonstration of Spatial Operating Models and Survey Simulation for NAFO Subarea 0 + 1 (Offshore) Greenland Halibut (*Reinhardtius hippoglossoides*)

Presenters: Tom Carruthers and Quang Huynh

The presenters gave an overview of the working paper (focused on the second objective in the ToR) which describes a framework for developing a spatial operating model to test survey design, which first required estimating abundance and spatial distribution using an age-structured population model and a spatiotemporal model, respectively. Three software packages, SimSurvey (Regular et al. 2020), sdmTMB (Anderson et al. 2022), and openMSE (Hordyk et al. 2022), were used to simulate survey design for the GH-0+1 stock. sdmTMB was used to estimate spatial distribution, although the presenter noted that VAST (Thorson and Barnett 2017) can also be used for this purpose. Using both the age-structured and spatiotemporal models, a survey operation model (SOM) can be created allowing two different survey designs to be tested. The presenter mentioned that the 2022 survey data was not included in the analysis, however, the working paper will show how the 2019 FV *Helga Maria* survey data, vessel and trawl calibration, could be used to bridge to the new RV *Tarajoq* index. The example outlined in the paper compares two indices of abundance from surveys which differ in spatial coverage. The presentation also included a comparison to the model developed by Johnson and Cox (SISCAL-GH) to explore if the two approaches could give similar results (when based on common assumptions and data). Participants agreed that based on the information and data available, differing assumptions made while developing the operating models can vastly change the model output.

A participant requested an explanation of why there was a negative parabolic depth effect in the predicted data that could not be seen in the observed data for large fish in Division 0A, as presented in lattice graphs showing the predicted and observed numbers of individuals per square kilometer of swept area by size class (small, medium, and large fish). The presenters responded that it may be an issue of scale, and that future visualizations will adjust the scale to reflect trends in both the observed and predicted data. The participant suggested modifying the visual to overlay the predicted data on the observed data. Another participant suggested plotting the marginal depth effect and then overlaying the data points to see which model estimate best fits the data.

Several participants had questions regarding the spatiotemporal model. The first question was if depth effects were included in the model. The presenter confirmed that depth was included as a fixed effect. The second was about a possible over-interpretation in the spatial random field based on the heat maps presented. The participant recommended interpreting the depth effect from the data itself, producing a couple of scenarios based on a hypothetical depth effect in the

future for Division 0B and testing it. One of the presenters agreed, saying that it would be a good adjustment point, there may have been extrapolations that should be avoided. Another participant mentioned that the software provided estimates of uncertainties that were involved with the random fields and would expect them to be easily visible, which was not the case. The presenter agreed that it would be something to note and review.

A participant asked how the vessel effect was estimated, as there has been significant past investment by DFO to calibrate vessels when vessel or gear changes occur and understanding if/how this approach could be used may be helpful in these circumstances. The presenter explained that the spatiotemporal field that controls time-area effects is modelled as a random walk in the next time step and the random walk constrains how much the time-area effects change year-to-year due to the biology of the species, where estimates for short-lived species could be expected to change more over shorter intervals than long-lived species. The presenter explained that the random walk structure, in theory, allows projections to be made based on the physical characteristics of that random walk. The historical time series provides information on the stock distribution in the year 2019, and if survey data exist in addition to that, the model will try and tease out catchability versus stock abundance as informed by that random walk. To follow up, the participant asked how well the effects of time (year) versus change in sampling vessel could be de-confounded and requested clarification on whether the size classes (small, medium, and large fish) were included together as part of a multivariate analysis, or if each size class was tested separately in univariate models. The presenter confirmed that the species distribution model (SDM) is a univariate analysis so models for each size class were independent but did note that multivariate options could be accommodated in VAST to account for correlations between different size classes. The participant noted that cohort dynamics may suggest that the prediction of intermediate size may be more related to the previous year's distribution of smaller-sized fish than the distribution of the intermediate size from the previous year. The participant also recommended following up on how well the vessel and year effects can be estimated or de-confounded. The presenter agreed that this was a point to note and review. An additional reminder was made by another participant, that in this case the vessel effect was also confounded with a seasonal effect for the 2019 FV *Helga* survey of Division 0A-South, given the survey occurred earlier that year.

A participant requested an explanation of how the underlying population model was initially used in this dataset. The presenter clarified that the SDM had to make an assumption for years with missing data, to use the most recent SDM value or remove the year effect. The authors used the spatial distribution estimated in a simulation without the year effect. Hence, the random walk constraint was the main thing used to estimate differences in catchabilities. One of the presenters followed up with a comment that it would be possible for a lot of uncertainty to be present in the stock level, trajectory, and spatial field, but still have consistency in calibration. The recommendation would be to present consistency in the calibration factor. The presenter mentioned that paired survey calibration cannot be disregarded yet. However, every time it has been done provides an empirical basis to test the random walk approach (i.e., the random walk approach could be validated by taking a subset of places where these calibration experiments have been conducted and using the data to see if similar conclusions can be drawn from both methods). Another participant questioned if the random walk was being used to constrain the number of differences allowed between the two vessels. The presenter clarified that it was constraining the spatial distribution, and putting a limit on how much the index could change from one year to the next.

Another participant inquired about how the year effect was included in the random walk model (i.e., if each year had its own intercept or if the random walk was based on a temporal mean effect). The presenter explained how the year effect was parameterized in the random walk

approach and will explain this in the added appendix to the working paper. A participant expressed interest in knowing what the confidence intervals (CIs) would be when including the 2019 survey data from the FV *Helga Maria* versus not including those data and generating simulated data using the historical RV *Paamiut* surveys, with the expectation that the CIs would be larger when including the FV *Helga Maria* data. The presenter agreed to note this comment.

Another participant suggested the use of previous comparative fishery experiments conducted by DFO on the east coast of Canada, from the 1990s and 2000s. A participant mentioned the importance of empirical validation for peer-review acceptance. It was agreed that the new 2022 data from the RV *Tarajoq*, would be compared to other comparative fishing data for a possible short-term solution. The existing dataset and historical index would be used, and the addition of a buffer in the uncertainty in the calibration would be necessary for the short-term solution until it is further developed with the new calibration data in the future.

A participant indicated they would like to know how this depth-effect model differed from classic random stratified survey design since it was mentioned that the variance can be obtained as a property of the model. The participant asked how this differed from optimizing the allocation of sample size based on variance from the observed depth effect. The presenter responded that the idea was to take catchability and known uncertainties and relate them to spatial distribution as a hypothesis. Sufficient differences in the spatial data would indicate there could be concerns about the reliability of the survey, and it is possible to test whether the results can adjust for those differences or not. The participant further inquired about environmental indices not being present. The presenter responded that it was in the ToR to consider environmental factors and that two key factors for the survey index could be depth or spatial distribution. The participant followed with another question about the simulation and the origin of the credibility intervals. The presenter replied that it was variance over the spatial field from the random walk.

The presentation of the Huynh and Carruthers working paper ended with discussion of the differences between the models presented in both this working paper and the Johnson and Cox working paper. Specifically, the two models had different parameter estimates and stock biomass trajectories despite a comparable fit to the survey index series, and there was an exploration of methods to bring the two together. Expectations concerning scale-based management with large uncertainty were not conveyed in the either demonstrated method, and would need to be clarified in future work. Presenters of both papers discussed how the uncertainty in scale was an issue, and possible options that could reduce the uncertainty or hedge against it in a management procedure. In the medium term, increasing observations of currently rarely observed portions of the GH-0+1 stock (larger fish, depths below 1500 m) would improve estimates of scale. More samples of older fish could improve estimates of unfished and current SSB, and reduce strangeness in the maturity ogive. Maturity-at-length estimates from Harris et al. (2009) were used in the Johnson and Cox paper, but the proportion of mature-at-age does not reach 100% under the age of 35. In the short-medium term, regulations such as size limits could be added to management procedures to compensate for uncertainty in stock scale. Presenters noted that introducing size limits in the fishery could introduce other issues (e.g. induce discard-based mortality of smaller fish, possibly impairing recruitment to the fishery).

DISCUSSION OF REVIEWERS COMMENTS ON THE WORKING PAPERS

The topics discussed in the reviews were based on the following subjects:

1. Advice and Terms of Reference
2. Data Sources

3. Overview of Assessment Framework
4. Operating Model Structure
5. Working Paper Revisions

ADVICE AND TERMS OF REFERENCE

The type of advice to be developed during this CSAS Science Advisory process was discussed. A clarification was made that this CSAS process was intended to: a) develop potential candidate stock assessment frameworks for consideration for the GH-0+1 stock, and b) provide Science advice so DFO Science could make further advances on these, or other, frameworks in the future, including presenting potential options to present to the NAFO Scientific Council in 2023. Hence, each working paper was meant to provide examples of approaches that could be taken, but the goal was not to choose any one single approach at this time. Instead, the objective was to combine what was learned from all three working papers and make recommendations on what could be adjusted, developed, added, or removed in the future. A participant clarified that during this meeting there was no expectation to establish an assessment framework. Participants confirmed that this goal was understood.

Early in the meeting, the ToR objectives were discussed at length based on concerns raised from a number of participants in their pre-meeting reviews. Namely, there was concern that none of the working papers fully addressed all the ToR objectives. Clarification was provided around the discussions of the Steering Committee concerning the ToR objectives and that none of the working papers were expected to address all of the ToR objectives, but rather the objectives would be addressed by the working papers collectively. Further, a participant wanted clarification on the usefulness of the first ToR objective as it had not been addressed in any of the working papers and seemed self-evident that a change in vessel and gear is likely to affect catchability. One of the presenters explained that it had been added as a ToR objective due to the apparent discrepancy in approach between the multispecies and Northern Shrimp Research Foundation (NSRF) surveys (i.e., the NSRF surveys have had several vessel changes without any comparability studies needed). NSRF data are collected, combined, and used without any concerns about differences between vessels or gear. Hence the question became, why is this possible for the NSRF survey and not for the multispecies survey? It was mentioned that the Hedges and Raffoul working paper listed reasons for standardization. Following considerable discussion, all participants agreed that there was enough context to maintain this ToR objective as stated.

DATA SOURCES

The data sources were discussed to establish what needed to be added, removed, or changed within the modelling work to aid in developing a method to integrate data collected by different vessels and gear configurations. It was discovered that modellers did not receive all the same data, since meetings were held with each company to discuss the objectives and data available but each company identified their data requirements, based on the needs of their model. Therefore, it was noted as an action item to provide the same sets of data to all modellers in the future.

The addition of tagging and telemetry data in future modelling work was discussed as movement, more size-at-age (from larger fish) and mortality data are needed. There was a discussion around estimating fish biomass at the division levels but setting TACs at a different scale. It was agreed that data on movement and distribution of Greenland Halibut could contribute to stock assessment advice; however, TAC and allocation decisions are not Science’s responsibility. Participants discussed the option of adding a broad-scale tagging study

to better estimate selectivity, which could be started in the short-term, but results would only be analyzed in the long-term. A participant offered the options of conventional tags but also introduced the idea of genetic sampling/tagging. Genetic sampling/tagging would prevent issues faced with conventional tagging by making recapture and processing potentially more economic and decreasing mortality during the tagging process. However, it may take time to find a geneticist to process samples. It was clarified by another participant that mortality was not an issue for the Greenland Halibut during tagging since they have a high survival rate. The logistics of a potential new tagging program were discussed by participants, such as securing a budget for vessel time for a long-term program, and limitations associated with low recapture rates. One participant suggested tagging could happen on the current multispecies trawl on the RV *Tarajoq* to eliminate the costs of an additional survey. However, limitations were brought up by another participant about the well-being of the Greenland Halibut coming up from the trawl. One of the participants stated that this species was resilient and that it would be necessary to assess the individual before tagging. Other options were discussed to augment selectivity. A participant wondered if selectivity could be borrowed from a similar species, such as Atlantic Halibut to use as a prior. However, another participant mentioned that the length composition would be significantly different possibly causing a bias. A participant inquired if at-sea-observer (ASO) data could be added to the data from the future tagging program to aid with the selectivity, however, another participant mentioned that ASO data could put a lower limit on the stock. It was concluded that there are data gaps, and further data is required to better estimate selectivity.

A participant inquired about possibly including data from a German survey (Fock et al. 2021) that occurs within the same division areas. A discussion led to the conclusion that this potential data was not useful since the divisions covered by the German survey were not clear, the focus is to sample from shallower waters (up to 400 meters), very few Greenland Halibut are collected, and there is no survey data for the years of 2020 and 2021.

The lack of ageing data from large Greenland Halibut was identified as a data limitation. Participants discussed the value of having commercial fishing industry involved in the process of collecting bigger fish with longlines and/or gillnets within deeper waters. A participant stated that it would be useful to gain information on this biomass that is typically not observed in the DFO surveys as it occurs outside the surveys' depth range. Another participant mentioned that it may be possible to collect bigger fish and gain more data on the fishing effort since there are few vessels fishing for Greenland Halibut in the Arctic. A participant also suggested a deep-water longline survey, in partnership with industry, to answer the question about the existence of larger fish in the deepest areas. A participant flagged that as a passive gear, longlines tend to target only fish that are feeding and thus may exclude fish during migration while trawls avoid this bias. Another participant clarified that industry charters might not be needed consistently, if the uncertainty in growth could be addressed this information could also help clarify the depth effect and provide age-at-length information to test values and continue developing the index, which has been done before (e.g., see Cox et al. 2018).

Temperature, depth, and presence or absence of ice coverage were brought up by a participant as an important part of defining spatial distributions for Greenland Halibut and should be considered in the analysis. The pop-up archival tags deployed recently in 0A and ongoing studies can provide these types of data in the future. It was noted that a trawl mounted CTD collects Conductivity, Temperature, and Depth data for each survey haul. In addition, there are three years of data from an oceanographic survey called Knowledge and Ecosystem-Based Approach in Baffin Bay (KEBABB), started in 2019 (Pućko et al. 2022), which includes zooplankton and productivity data. However, the data do not overlap with the RV Paamiut surveys. Another participant mentioned that temperature data could be collected from fixed

depth loggers. Thus, temperature data are available to be used as a covariate in model development. However, if it is highly correlated with depth that may not be necessary. It was also noted that Greenland Halibut in other areas are known to shift the depth distribution in response to changes in temperature (Wheeland and Morgan 2020), so temperature may be an important factor to consider here. The participant mentioned the importance of this data for tracking interannual changes in temperature, or to inform climate change models to develop predictions of future changes. To be used in SDM, temperature data would need to be available at a suitable resolution (i.e., for every node in the spatial grid underlying the SDM).

Participants noted that data from previous paired tow calibration experiments could be used to test or validate one of the proposed analytical approaches. Paired tow calibration experiments are considered the "best practice" for comparing surveys that use different vessels or gear. A participant mentioned that gathering this type of data would be challenging due to the lack of comparative tows in the Arctic. However, it was noted that comparative tows have been initiated in other locations within Canada and that data could be available for use in the near future to compare and contrast with the geostatistical model approach, and serve as a proof of concept for the proposed analytical approach.

It was recommended by one of the participants to have the addition of annual maps from the different surveys, illustrating sampled areas, distribution change, and abundance trends. One of the participants mentioned that this data could be added to the Hedges and Raffoul working paper, and the presenter agreed.

OVERVIEW OF CANDIDATE ASSESSMENT FRAMEWORKS

Two of the three working papers demonstrated that the development of an operating model and its use through simulation can be beneficial to evaluate the different working hypotheses. If an index-based management procedure is going to be used to manage the fishery, the conventional approach for due diligence is to conduct robustness testing using MSE. All participants agreed on the general framework approach promoted by the working papers.

It was discussed how the development of this assessment framework should proceed. Would Greenland scientists and/or managers be involved, as GH-0+1 is a jointly managed stock? In addition, it was also discussed if the assessment framework would need to align with the existing MSE regime for 2+3KLMNO Greenland Halibut, and if the different areas may have to be analyzed as one, due to the interaction of the 0A, 0B, and the more southerly stock management areas. A participant clarified that Greenland must be involved in deciding the framework because it is a bilateral stock, which includes data from both Canada and Greenland. Another participant mentioned that it is not unusual to assess stocks that comprise a larger population in isolation, with slightly different frameworks. However, further telemetry studies should be undertaken to better understand the connectivity between these stocks. A participant brought up that there were two things to balance, (1) getting total allowable catch (TAC) advice in the short-term and (2) establishing a defensible framework for the long-term. It was put forward that the best assessment approach could be used in the interim to at least set some TACs that are scaled to some level of uncertainty in stock biomass based on harvest rates. This may facilitate receiving feedback from NAFO SC in the short-term, until a more developed framework can be put forward for consideration. For example, an operating model could be used in the short term as a "best assessment" model while longer-term work on a more robust assessment or MSE takes place.

OPERATING MODEL STRUCTURE

Participants discussed the best options to further develop the operating model. It was mentioned that more time to explore the model would be necessary, including further work to understand key uncertainties. Participants identified some of the key uncertainties at present, such as natural mortality rate which influences the scale between total biomass and spawning stock biomass, growth which influences scale, information on unobserved “large” fish, sex-specific size information, estimates of steepness in the stock-recruit relationship, harvest rate, and selectivity.

A participant commented on the possibility of trying simpler model structures or approaches (e.g., LIME, JABBA, SPiCT, etc.), but it was not agreed by all the participants since the outputs would be more defensible with the more rigorous approaches presented and given the existing data (e.g., catch-at-age model).

The participants discussed a need to determine what could be used in the short-term and the long-term. There was a conversation about what would be more likely to be accepted by NAFO SC, if it was the index approach or the operating model. It was concluded that a model-based survey index calibration method be further explored and validated for the short-term solution. However, an age-structured stock assessment should still be developed to provide harvest advice in the long-term.

WORKING PAPER REVISIONS

The presenters addressed the comments received on their working papers on the third day of the meeting, by presenting the changes, additions, and removals that were made to their working papers and seeking consensus from participants regarding revisions.

Revision of “Review of methods used to standardize survey time series across vessels and gear, and spatial delta-GLMM analysis of Greenland Halibut catch from surveys conducted in NAFO Subarea 0+1”

Presenter: Kevin Hedges

Participants recommended that the author illustrate differences in the time (year), coverage area, gear type used, vessel used, and season of sampling using effective data visualizations to illustrate the overlap across data sources. At the meeting, the presenter showed updated maps (that were not in the working paper) of annual survey locations for each survey vessel and gear type. The presenter added the same analysis for the commercial data available and for all the different data sources combined. A participant requested that the authors also add the catch rates, length frequencies, and seasonality to the maps to further understand where Greenland Halibut is being caught. There was support for including this updated series of maps, and the presenter agreed to develop these additional data visualizations to effectively convey differences and similarities in the data availability for each data source.

There was consensus amongst participants that this working paper should be refocused, removing the preliminary literature review and delta-GLMM analysis and instead focusing on describing the available data sources in detail to provide a clear understanding of the nature of these data, how they were collected, and how they could be used to inform any modelling efforts. Participants also discussed and agreed on adding a description of the factors affecting catchability to this working paper to address the first ToR objective of identifying factors contributing to differences in catchability of GHL and other fish and invertebrate species. The working paper should acknowledge other existing data sources that were not used for the modelling exercises (e.g., Ocean Tracking Network data, oceanographic data, German surveys,

inshore surveys) and possible sources of new data or data collection that could inform gaps in the current knowledge of the stock. All participants agreed to accept the working paper as a Research Document with the noted reorganization and revisions.

Revision of "A modelling framework for stock assessment and harvest strategy evaluation for the NAFO 0+1 Greenland Halibut (*Reinhardtius hippoglossoides*) fishery"

Presenter: Sam Johnson

Following the initial presentation of the working paper at the meeting, the presenter conducted additional sensitivity analyses for SISCAL, made corrections to the working paper, and presented the updated results towards the end of the meeting. One participant noted that there are large fish in the population that contribute to total biomass but are not part of the active spawning stock biomass for that year, termed skip spawners, and asked if that was accounted for in the analyses. The presenter indicated that this may be implicit because only 80% of fish 35 years of age and older were considered sexually mature, and thus these fish are contributing to total biomass but not spawning biomass. However, they acknowledged that there would be value in formally including this adult biomass that is not contributing to spawning through adjusting the modelling to reflect that there is a smaller effective spawning population. It was also noted by a contributing presenter that the ratio of effective spawners created by skip spawning could change over time (e.g., due to environmental drivers), but this would likely be absorbed by recruitment deviation in most cases. Another participant questioned the value of using fishery catch data from the 1960s that does not inform recruitment or stock information, noting there may be data quality issues with these older data. The presenter agreed that there may not be added value in including these data in the assessments, although in other locations it is expected practice to use historical data because it typically provides information on depletion and recruitment for the stock. The presenter noted that the outputs are sensitive to the growth model because the length data provide the only information on mortality over time.

A participant indicated that there is value in summarizing in the working paper the groups of models presented at this meeting. They noted that there appeared to be more consistencies in stock status compared to the scale, and that this should be considered when determining the type of advice the best-fit models are most appropriate for. The presenter identified that it is often challenging to identify the most appropriate operating models, but that cluster analysis could be used to identify which operating models were most similar. Based on these clusters, the model options could then be reduced to four or five model 'types' that span the range of uncertainties and these could be weighted and/or combined. The presenter highlighted that this process can be challenging and takes a long time, but it can be done. The presenter indicated that if exploitable biomass clusters around a similar range, that would provide increased confidence in the estimate of exploitable biomass, given the range of optimal harvest rates appears stable and there is clustering of total biomass around a similar range. Alternatively, the low range of optimal harvest rates could be used as a conservative approach to setting allowable catch for an interim period while additional data are collected, and uncertainties addressed.

A participant inquired about whether all vessels in the trawl fleets would have the same selectivity. The presenter responded that while all vessels may exhibit the same functional form (i.e., domed-shaped selectivity), they could have different parameter estimates (e.g., due to differences in area availability).

Another participant asked a question about the 1AF biomass and abundance index. The presenter noted that just abundance was used because there was interest in seeing if it could

be used as an index of incoming small fish. However, one cannot use both biomass and abundance at the same time within one model as they are highly correlated. The presenter further explained there was hesitation in calling it a “recruitment index” since it includes fish up to age 5 or 6, rather than just age 1, and the fish growth is slow.

There was a comment that differences in length between male and female usually begin beyond the range of vulnerable biomass for the trawl fleets. But, based on the sensitivities presented, there might be value in having sexually dimorphic growth for the unobserved portion of the stock, since it was sensitive to that.

A participant asked if the presenter had corrected the steepness prior that was reported in the working paper and addressed during the presentation. The presenter confirmed that it was noted along with the correction in the omission of the scale prior in 0B. Another participant asked if the additional sensitivities presented would be added to the working paper, and the presenter mentioned that some tables and figures would be added.

All participants agreed that this working paper should include the additional sensitivities presented in a condensed fashion, along with an executive summary and highlights of key sensitivities.

All the participants agreed that the working paper would be accepted as a Research Document with the revisions noted.

Revision of “Demonstration of Spatial Operating Models and Survey Simulation for NAFO Subarea 0 + 1 (Offshore) Greenland Halibut (*Reinhardtius hippoglossoides*)”

Presenters: Tom Carruthers and Quang Huynh

Participants requested clarification on the proposed random walk calibration approach and the presenter provided some additional slides to describe what was decided would be called the “Model-Based Survey Index Calibration” method.

The presenters agreed to add an appendix to the working paper based on the additional slides presented during the revisions. The new appendix could describe how the model may be specified, including estimation of vessel effects.

A participant suggested the addition of a preamble in the introduction section on how this model, in addition to the new appendix, addresses the ToR objectives. It was also noted that the working paper authors did not receive the same data in some cases, and as such, some data was missing from some analyses. Some of these data issues were corrected prior to and during the meeting (e.g., additional year of age data provided) and in most cases these data differences did not affect the assessment of the appropriateness of the models or the ability of the meeting to draw conclusions around the feasibility of modelling approaches or general recommendations for further work. However, the participants agreed that there is value in creating a common repository so that modellers have access to the same data for future analyses. Another participant mentioned that within the introduction of the two modelling papers, the exploratory nature of this work should be stated to avoid confusion. All participants agreed that it would be beneficial to have the appendix added to the working paper given that participants have the opportunity to review it after the meeting.

There was a request for the authors to explore combining the indices developed for the different fish size classes into a single index. Presenters responded that it could be explored by adding variance, caveats, and assumptions of independence versus correlations in catch rates among size classes to see if it is comparable. The presenter was able to run a few stratified estimates

for the three different fish size classes separately which was the preferred method for having one index across the three size classes. A participant commented that the presenter could standardize and overlay the size classes to have a better visualization. Another participant mentioned, if possible, producing predicted indices using the model that complements the different groupings, to ensure that the scale of the index from the model aligns with the design-based estimator, to check for bias in the model-based approach. Ideally, it should have the same scale and show similar trends when the predictions are split. In summary it would be a prediction of the index in 0A and 1CD in the SDM model. Another participant asked if a misleading trend is present since the trend connects the survey point estimates even if years are missing surveys in between. The presenter mentioned that interpolation with a random walk is going to connect the dots through prediction and demonstrated it in a figure. A participant asked if, when discussing scale, could spatial models be used to constrain the relative catchability of fleets. The response was that it could be attempted and that there could be some brainstorming on developing relative catchability estimates.

On the topic of the estimated catchability difference for the FV *Helga Maria*, a participant inquired about a random field in 0B, where there is currently no survey data, and whether there would be an edge effect with the mesh of the spatial field. The presenter noted and mentioned it would be revised.

Another participant suggested that the value of this method to optimize the survey design should be noted. It was mentioned that analysis is not needed, but a discussion about it would be beneficial.

All the participants were in favour of accepting the working paper as a Research Document, given the additions and revisions noted.

DRAFTING OF THE SCIENCE ADVISORY REPORT

Draft Science Advisory Report (SAR) summary bullets were provided to meeting participants by the author team and were discussed and finalized at the end of the third day and start of the fourth day of the meeting. Major discussions focused on revising the bullets to (a) reflect the proposed changes to the working paper by Hedges and Raffoul, which will be refocused to provide more detailed background information on the nature of the various data sources available and/or used in the modelling working papers, and (b) clarifying terminology and precise wording to ensure the possible short-, medium-, and long-term approaches agreed upon at the meeting for informing GH-0+1 stock assessments were reflected in the bullets. Participants agreed that the summary bullets should include language clarifying what would be presented for consideration to NAFO SC, who provides the scientific advice.

Other sections to be included in the body of the SAR were also developed and agreed to as a group. This included (1) sources of uncertainty, (2) conclusions and advice, (3) other considerations, (4) background, (5) and assessment. First, major sources of uncertainty were associated with knowledge of the biology of the stock, including natural mortality, somatic growth, stock size, vulnerability to gear, and reproductive biology. There was discussion around uncertainties in survey design, and the impact of environmental variables on the stock should be included in this section. However, participants agreed that those items are better suited for other sections of the SAR.

Second, the main conclusions and advice from the meeting were that the models that were explored in the working papers by Huynh and Carruthers and Johnson and Cox are scientifically defensible assessment methods to propose to NAFO SC. Also, the model-based survey index calibration method, including steps to validate it, should be investigated for presentation to

NAFO SC in the short-term, while an age-structured stock assessment is developed concurrently, for proposal as a long-term approach for assessment of this stock.

Third, other considerations acknowledged were that this is intended to be an iterative process with a framework that can respond to new or additional information, including incorporation of environmental considerations. There was discussion on whether to include information about the migratory behaviour of Greenland Halibut (i.e., it is thought that it moves in and out of the stock assessment area), but there was consensus at the meeting to include this information in the background section as it is an underlying assumption of the stock assessment.

Fourth, background information that was discussed by the group to be incorporated in the SAR included a description of the issue driving the request for science advice (i.e. missing survey years and no paired trawling experiments to standardize data across different sampling methods), as well as a discussion of factors known to affect assessment of the target species and its catchability.

Fifth, it was recommended that the assessment information include descriptions of (a) the key features that distinguish among the various data sources that were used in the assessments including maps and diagrams that clearly illustrate sampling differences, (b) the modeling approaches from the Huynh and Carruthers and Johnson and Cox working papers in clear terminology, including a diagram that incorporated both approaches to best illustrate the framework, and (c) model testing and validation and why this was deemed necessary by the participants.

The finalized SAR and Proceedings documents would be sent to all participants for a final review before publication on the CSAS website.

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APPENDIX 1. TERMS OF REFERENCE

Review of candidate stock assessment frameworks for the Northwest Atlantic Fisheries Organization Subarea 0+1 (Offshore) Greenland Halibut stock

Regional Peer Review – Ontario & Prairie Region

December 12-15, 2022
Winnipeg (MB) and Virtual Meeting

Chairperson: Mary Thiess

Context

Fisheries and Oceans Canada (DFO) Science and the Greenland Institute of Natural Resources conduct multi-species bottom trawl surveys in Northwest Atlantic Fisheries Organization (NAFO) Subareas 0 and 1 to support assessment of the Subarea 0+1 (offshore) Greenland Halibut stock. The vessel and gear (*RV Paamiut*, Alfredo trawl) used for the surveys during 1999-2017 was retired in 2018 without opportunity to conduct paired trawling experiments with an interim or replacement vessel. An interim vessel and the Alfredo trawl were used in 2019 and a new long-term vessel (*RV Tarajoq*) and new gear (Bacalao trawl) will be used in 2022 and beyond. Typically, the ability to assess time series data relies on an assumption that consistent methods and effort are used over time to ensure inter-year comparability (i.e., any differences in gear or sampling effort are known or can be estimated). Survey time series are typically standardized through periods of change in data collection methods by conducting paired trawling experiments.

Given the absence of these experiments, DFO Fisheries Management has requested DFO Science to explore analytical method(s) and/or frameworks for the Subarea 0+1 (offshore) stock assessment that could incorporate data collected by multiple vessels and gears, including fishery-independent surveys and commercial fishery data. This review aims to support the NAFO Scientific Council's assessment of this stock and industry led Marine Stewardship Council certification process.

Objectives

The main objective of this Canadian Science Advisory Secretariat (CSAS) process is to identify potential analytical methods and/or frameworks that could be used to improve the Subarea 0+1 (offshore) Greenland Halibut stock assessment. Specifically, the review will include:

1. Identify factors contributing to differences in catchability of Greenland Halibut and other fish and invertebrate species; and,
2. Examine analytical methods and/or frameworks that could allow integration and/or comparison of data collected by different vessels and gear configurations.

Expected Publications

- Science Advisory Report
- Proceedings
- Research Documents

Expected Participation

- Fisheries and Oceans Canada (DFO) (Ecosystems and Oceans Science and Fisheries Management sectors)

- Academia
- Industry
- Other invited experts

APPENDIX 2. LIST OF MEETING PARTICIPANTS

Name	Organization/Affiliation
Kevin Hedges	DFO – Science, Ontario and Prairie Region
Dayanne Raffoul (Rapporteur)	DFO – Science, Ontario and Prairie Region
Chantelle Sawatzky	DFO – Science, Ontario and Prairie Region
Margaret Treble	DFO – Science, Ontario and Prairie Region
Mary Thiess (Chair)	DFO – Science, National Capital Region
Hugues Benoit	DFO – Science, Quebec Region
Paul Regular	DFO – Science, Newfoundland Region
Laura Wheeland	DFO – Science, Newfoundland Region
Jeff Adam	DFO – Fisheries Management, Arctic Region
Adrienne McLean (Rapporteur)	DFO – Fisheries Management, Arctic Region
Justin Shead	DFO – CSAS, Ontario and Prairie Region
Tom Carruthers	Blue Matter Science Ltd.
Quang Huynh	Blue Matter Science Ltd.
Sean Cox	Landmark Fisheries Research
Samuel Johnson	Landmark Fisheries Research
Bjarki Elvarsson	Marine and Freshwater Research Institute of Iceland
Nigel Hussey	University of Windsor
Adriana Nogueira	Greenland Institute of Natural Resources
Fabian Zimmermann	Institute of Marine Research in Norway
Alastair O'Rielly	Northern Coalition
Kris Vascotto	Atlantic Groundfish Council
Brian Burke	Qikiqtaaluk Corporation

APPENDIX 3. MEETING AGENDA

Review of Candidate Stock Assessment Frameworks for the Northwest Atlantic Fisheries Organization Subarea 0+1 (Offshore) Greenland Halibut stock
CSAS Regional Science Peer Review Meeting

Ontario and Prairie Region

December 12-15, 2022

Winnipeg, MB and MS Teams Virtual Meeting

Chair: Mary Thiess
Rapporteurs: Dayanne Raffoul, Adrienne McLean

Day 1 – Monday December 12 – 10:00-3:00 CST

10:00-10:15	Introductions and Roundtable	Mary Thiess
10:15-10:30	CSAS Peer Review Process	Justin Shead
10:30-10:35	Review of Terms of Reference	Mary Thiess
10:40-10:50	Presentation: Summary of Data Available	Kevin Hedges
10:50-11:10	Presentation: One slide overview of the 3 working papers	Working paper authors
11:10-11:30	Presentation: Kevin Hedge's Working Paper Overview	Kevin Hedges
11:30-12:00	Clarifications of Working Paper: Kevin Hedges Identify items for further discussion	All
12:00-13:00	Lunch Break	-
13:00-13:45	Presentation: Landmark Fisheries Working Paper Overview	Samuel Johnson
13:45-14:15	Clarifications of Working Paper: Landmark Fisheries Identify items for further discussion	All
14:15-15:00	Group Discussion	All

Day 2 – Tuesday December 13 – 10:00-3:00 CST

10:00-10:05	Recap Day 1	Mary Thiess
10:05-10:35	Presentation: Blue Matters Working Paper Overview	Quang Huynh
10:35-12:00	Clarifications on Working Paper: Blue Matters Identify items for further discussion	All
12:00-13:00	Lunch Break	-
13:00-13:15	Recap items for Group Discussion from all papers	Mary Thiess
13:00-15:00	Discussion & Resolution of Key Issues, Results and Conclusions	All

Day 3 – Wednesday December 14 – 10:00-3:00 CST

10:00-10:15	Recap Day 2	Mary Thiess
10:15-12:00	Discussion & Resolution of Key Issues, Results and Conclusions	All
12:00-13:00	Lunch Break	-
12:45-15:00	Discussion & Resolution of Key Issues, Results and Conclusions	All

Day 4 – Thursday December 15 – 10:00-3:00 CST

10:00-10:15	Recap Day 3	Mary Thiess
10:15-10:45	Finalize working papers	All
10:45-12:00	Draft Science Advisory Bullets	All
12:00-12:45	Lunch Break	-
12:45-14:30	Draft Science Advisory Report	All
14:30-15:00	Final Remarks and Next Steps	Mary Thiess