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Proceedings of the Regional Peer Review of the Continuation of Southwest Nova Scotia/Bay of Fundy Herring Framework: Part 2 – Management Strategy Evaluation Conditioning Operating Model Review

Meeting dates: May 26–27, 2020
Location: Virtual meeting

Chairperson: Tara McIntyre
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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

A regional peer review of the Continuation of the Southwest Nova Scotia/Bay of Fundy Herring Framework Part II: Operating Model Development was held on May 26–27, 2020, virtually using Microsoft Teams and was a continuation of the meeting held on January 21–22, 2020. As set out in the Terms of References (ToR) the focus was to review the structure and fitting of a reference case operating model (OM) that will be used as the basis for all of the operating models in the management strategy evaluation (MSE). A reference set of OMs was defined based on the uncertainties in Herring fishery dynamics identified during a workshop held in January 2020 (DFO 2023). Participation in this meeting included DFO Science, DFO Resource Management, Aboriginal Communities/Organizations, Non-Government Organizations, Fishing Industry, University of British Columbia modelling team, and external experts.

This proceedings document includes a summary of the presentations and is a record of the meeting discussions and conclusions. A Research Document resulting from this meeting will be published on the Fisheries and Oceans Canada (DFO) Canadian Science Advisory Secretariat's (CSAS) Website once it becomes available.

INTRODUCTION

Atlantic Herring is a pelagic species found on both sides of the North Atlantic. Herring spawn in discrete locations, to which they are presumed to home. Herring first mature and spawn at three or four years of age (23–28 cm), then begin a predictable annual pattern of spawning, overwintering, and summer feeding, which often involves considerable migration and mixing with members of other spawning groups. The Northwest Atlantic Fisheries Organization (NAFO) areas 4VWX management unit contains a number of spawning areas. Spawning areas in close proximity with similar spawning times, and which share a larval distribution area, are considered part of the same complex. For evaluation and management, the 4VWX Herring fisheries are divided into four components:

1. Southwest Nova Scotia/Bay of Fundy (SWNS/BoF) spawning component;
2. Offshore Scotian Shelf banks spawning component;
3. Coastal (South Shore, Eastern Shore and Cape Breton) Nova Scotia spawning component;
4. Southwest New Brunswick migrant juveniles.

Recommendations from the last assessment framework conducted in 2011 included a focus on model improvement and exploration for the next framework (DFO 2011). This assessment framework will focus on the SWNS/BoF spawning component. The last stock assessment for this component was conducted in 2018 (DFO 2018), and a stock status update was provided in 2019 (DFO 2020). The 2018 assessment identified the framework assessment as a priority and in 2019 the SWNS/BoF spawning component was identified to be in the critical zone.

Fisheries and Oceans Canada (DFO), Maritimes Region is proceeding with a management strategy evaluation (MSE) process as the framework for SWNS/BoF Herring. This meeting is the third of four Science Advisory Process meetings to develop this MSE and will involve the final peer-review of the MSE operating model (OM) conditioning and the definition of a reference set of OMs based on uncertainties identified in the last meeting. The first meeting was in February 2019 and addressed the data inputs. The second meeting was in January 2020 and was a review of the structure and fitting of an example set of OMs. The fourth meeting, to be scheduled later in the year, will involve the review of the entire MSE process.

The objective of this meeting was to continue to review the structure and fitting of a reference case OM to be used as the basis for all of the OMs in the MSE. A reference set of OMs was defined based on the uncertainties in Herring fishery dynamics identified during a workshop held in January 2020 (see Appendix 4 in DFO 2023). This meeting involved a review of:

- updates to the data inputs since the last meeting;
- goodness of fit of the reference case OM and the suitability of this model to be used to model a range of uncertainties in Herring fishery dynamics;
- prior assumptions and error structure in the OM;
- uncertainty scenarios and parameter estimates used to capture sources of uncertainty in Herring fishery dynamics; and
- the definition of an interim reference set of OMs (see below, next paragraph).

The reference set of OMs will be the central focus of candidate management procedure (CMP) testing. A working set of reference OMs has been defined. This reference set of OMs will be the interim set of OMs for CMP testing and may change as CMP testing progresses (e.g., removal of OMs, or additions from the robustness set of OMs). The code (R/Template Model Builder)

was made available to the reviewers so anything documented in the working paper Carruthers et al. 2023) can be replicated.

See Appendix 1 for the Terms of Reference and Appendix 2 for the list of participants. This meeting was held virtually from May 26 to May 27, 2020 (see Appendix 3 for the agenda).

PRESENTATIONS AND DISCUSSION

DAY 1: MAY 26, 2020

Rapporteurs: Claire Mussells and Rabindra Singh

The meeting Chairperson, Tara McIntyre, introduced herself, followed by an introduction of meeting participants. The Chair thanked meeting participants for attending this DFO Regional Peer-Review Process and then reviewed the Canadian Science Advisory Secretariat (CSAS) guidelines for peer-review meetings. Participants were invited to review the meeting Terms of Reference and Agenda. The meeting took place on Microsoft Teams, and it was acknowledged that this might be challenging, but every effort would be made to ensure that there is the same opportunity for discussion as in-person meetings.

History of Meetings and Meeting Objectives - T. Barrett

A history of meetings and the present meeting objectives were presented by T. Barrett. This meeting was to review the structure and fitting of a reference case OM that will be used as the basis for all of the OMs in the MSE. An overview of the previous meetings and the updates agreed upon at the last meeting were described. Arising out of the last meeting, different methods of calculating the acoustic index (current index, sum over all spawning grounds, and sum of maximum annual surveys on Scots Bay and German Bank) were assessed. It does not seem to matter which index was used (based on implied depletion) so the decision was to continue to use the current index. One reviewer sought confirmation that the spawning stock biomass (SSB) index was calculated using target strength (TS). A participant made the point that biomass on other spawning grounds is increasing (e.g., Seal Island) and this may be important to consider in the future. There were no changes required in the age composition data.

A question was raised about the use of TS in the biomass calculations. T. Barrett clarified by email (and discussed on Day 2, May 27, 2020) that the biomass index used in the MSE was the same as reported in previous CSAS documents. The TS for the closest (temporal) survey was used when no detailed samples were available within the +/- 5 days of the survey on the respective spawning grounds for calculating the acoustic catch-at-age (CAA). On the topic of the uncertainty graph, clarification was sought about the fact that a purse seine does not have a selectivity. It was clarified that the selectivity is not a gear selectivity but vulnerability based on fish available on a fishing ground (selectivity for the purse seine fleet targeting juveniles was assume dome-shaped instead of logistic). Clarity was also sought about the definition of weir and whether Nova Scotia (NS) weirs were considered another fleet. T. Barrett clarified that for the New Brunswick (NB) weirs there is uncertainty around the percentage of United States (US)/Canada origin of Herring and that this excludes the NS weir catches which are captured in the “OTHER” fleet.

A participant sought clarification under what category in the uncertainty bar chart (Carruthers et al. 2023) presented were the larval surveys and unreported catch captured. Larval surveys are in data inputs and un-reported catch is captured under catch uncertainties. A review of natural mortality (M) was done to see what difference M values has on the sensitivity analyses.

The growth scenarios for projections include the mean of last the three years and extrapolation on regression of weight on year (separate by age). The growth scenario dealing with correlation with temperature was dropped because it did not lead to a continued decline in weight. One participant pointed out that mean temperature may not be that representative as the high and low thresholds. It was agreed that this could be captured using upper confidence limits. It is also assumed that the weight-at-age decline is going to continue even though the mechanism is unknown. Temperature is being used as a proxy for other variables such as food availability, etc.

A reviewer questioned why the extrapolations were so far ahead. T. Carruthers clarified that the plot shows projections to 50 years but only projections to 30 years may be used. It cannot be expected that the decline in the weight-at-age (WAA) will continue, as seen, indefinitely into the future. The scenarios looked at different catch uncertainties and use of the larval index. A reviewer questioned the source of the variability around the larval index. There is variability among stations in the estimate of mean larval density. Another reviewer asked about using the larval index and virtual population analysis (VPA) outputs to run against the acoustic survey data. The timing of the acoustic surveys and larval data collection only overlap for one year in 2009. The concern was about using data from a model as input into another model. There was a lack of overlap between the timing of the acoustic surveys and larval surveys to do this successfully.

The DFO Gulf Region Herring biologist stated that when the Mackerel egg survey was compared with the Herring larval density in Quebec, there was good correlation with Age 2 Herring and not with the SSB. The present larval survey database contains very detailed information so it is possible to determine the age of the fish and apply some mortality functions. Mortality rate for Herring larvae can be as high as 35% per day. The previous round of model fitting showed that larval survey data did not have impacts on current stock status and projections.

Operating model fits and assumption: reference case presentation – T. Carruthers

Before the presentation started a few questions were raised. A participant wanted to know where in the MSE process are objectives set. T. Carruthers responded that performance metrics could come first but, in reality, when presented with a new framework it is difficult to sign off on performance metrics before understanding what is possible. Another participant wanted to know, with the steps that are being followed, if the objectives were weighted before the performance metrics are defined and if they are thrown out, as it could be valuable for the metrics decisions later on. The need is to focus on plausibility which could be unnecessary until the performance metrics are determined. The focus is on what matters and everyone has to become comfortable with the approach. It is best to get a demonstration model to work before expecting to be 100% sure on the performance metrics. It is better to see it and to understand what is possible before settling on it.

Another question raised was whether there are specific OMs that are being considered. The model should bring it together cumulatively and thus be acceptable. If the group wants to see the robustness of each OM then they need to be looked at individually. A decision has not been made on how to combine the results of individual OMs (e.g., weighting).

A reference case OM was presented by T. Carruthers. A reviewer wanted to know if the OM was projecting recruitment and SSB. This is about OM conditioning and use of the weighting of the CAA data. T. Carruthers responded that to get a good fit, the composition data must almost always have to down-weighted. Another reviewer commented that the implication of the reference case is that the stock has a good SSB. This is because the stock needs to rebound

quite quickly from the high F in the early years. A participant wanted to know what was driving the optimism seen in the outputs. T. Carruthers responded that this is one of 24 models and the purpose of the reference OM is to test sensitivity and is not representative of status. This is not the reference set that is thought to be the most representative.

Another participant saw no “red flags” in the way model is working. It requires some bold moves to get it working and does not necessarily think that this is optimistic. If this was an assessment, the validity of SSB/SSB_{MSY} as a reference point would have been questioned when compared to different reference points. Compared to B_0 (equilibrium unfished biomass) the stock is not in an optimistic position for the reference case example.

Sensitivity OMs were presented using an OM with two purse seine fleets – small juvenile fleet and spawning fish fleet. Overall, none of the first 11 sensitivities can be discounted. A participant wondered what happens if the run with M was not constant. T. Carruthers responded that no time-varying M scenarios were proposed (i.e., linked to ecosystem components). Removing the constraint of larval survey made no difference to current stock status but did change historical composition. The problem with –its removal is that it created patterns that were not easily reconciled with perceptions or knowledge by the group. It was not thought to be plausible. Removal of larval survey was not included here as a sensitivity but can be included in a robustness set. While it is not known what it is, or what to replace it with, the idea of a non-constant M should be considered in the future.

Grey seal abundance was investigated and increased since 2006 (68%), based on predation rates from Guenette and Stephenson (2012). This would result in a 10% increase in M. Grey seals were a small fraction of the total M so a lot more information is needed for a reasonable scenario of time-varying M including contributions from all the other predators.

A participant stated that when dealing with reference set OM under the growth scenario it is not inconceivable that growth rate starts to increase. This was not covered in the presentation and it might be worthwhile to include a scenario that includes increasing growth in projections. Also, for landings it would be worthwhile to investigate including and excluding weir catches with two separate ‘virgin’ populations.

On the topic of the acoustic index, a participant stated that there are assumptions on converting acoustic energy to biomass and that changing the TS equation to that used for North Sea Herring can have a substantial impact on the biomass estimate. The suggestion was to move q (catchability) closer to 1 without making modeling assumptions. Another participant liked the idea of including stochasticity of M like a random walk. A reviewer asked about how age composition weighting changes and wondered if this means that the acoustic index is no good because of negative correlation with composition data (if we do not adjust the weight of the composition data). T. Carruthers will follow up on this on Day 2. Another reviewer stated that candidate management procedures (CMP) would not affect this future data collected but only if composition data are used to inform them. A participant asked why catch-per-unit-effort (CPUE) analyses are not used as an indicator. CPUE is not a useful indicator for mobile pelagic gear.

Interim Reference Set – T. Carruthers

A participant wanted to know that given that M has a big impact and given the analysis by T. Barrett was not able to show M coming from grey seals, what is thought to be causing the M. T. Carruthers responded that time-varying M is a primary driver in population dynamics. Understanding mortality and how it varies is important. T. Barrett stated that both scenarios were based on predator abundance and consumption rates as outlined in the data on Grey Sseals (Guenette and Stephenson 2012). A reviewer raised the issue of using high resilience, high steepness and low M. Resilience is more an ecosystem factor and not a related to M and

steepness. The present data cannot discriminate between high and low resilience. These three factors are not independent of each other and consideration should be given to this if equal weight was going to be placed on each reference OM. Another participant wondered that given what was presented, would there be any additional factors that might fit under axis of uncertainty of the reference set. T. Carruthers responded that any factor that varies with time such as time-varying M or a shift in recruitment would also fit under the axis of uncertainty. It was suggested that consideration be given to including time-varying M as a key uncertainty.

DAY 2: MAY 27, 2020

Rapporteurs: Claire Mussells and Rabindra Singh

The Chairperson, T. McIntyre, started Day 2 with introductions and then moved into the first item of the day: a review and presentation of outstanding items from Day 1.

T. Barrett clarified how samples were used in the TS calculation. There was no change from the method used in the past to calculate the biomass estimates. The cohort tracking work done by B. Berges using the acoustic CAA was presented. By looking at the cell values directly adjacent to the diagonal line, the conclusion is that overall good tracking of cohorts is not shown in the acoustic CAA data. If it did work, and there were periodic strong recruitments, then good recruitment would be reflected in the cohort tracking. Very consistent recruitment would result in low correlation among cohorts. A participant suggested that perhaps using the acoustic turnover index with German Bank and Scots Bay separated may be better since German Bank is a feeding and spawning ground and this may convolute cohort tracking. There may be better cohort tracking using only the data for Scots Bay which may have different environmental conditions when compared to German Bank.

Discussion of cohort tracking using the survey CAA followed. There was not a good relationship between one year and the next for the acoustic survey CAA. While there is no cohort tracking for this index, it does not mean this is not a useful index. The point was made that ages 3–5 are only partially recruited into the SSB and the proportion can change annually. There has not been a surprisingly good year class that overlaps with the time series (when comparing with the fishery CAA bubble plot). It was suggested that because the acoustic surveys are on the spawning stock, one would not expect the cohort tracking to be as good. If you compare this to the groundfish survey index, there are really big gaps and the groundfish survey index was not tracking year classes, resulting in gaps and negative correlations.

A participant wondered about the concerns related to the larval density and it being from SSB derived from the old VPA outputs especially when referring to goodness-of-fit. For the scenarios, goodness-of-fit is a measure of how much a dependent variable is explained by the independent variable and the R-squared (coefficient of determination) is included. A comparison of model fits is done using negative log-likelihood. A reviewer expressed concern with the acoustic survey index because there are no strong year classes reflected in the acoustic CAA. Herring populations are highly recruitment driven and this lack of strong year classes indicates that the acoustic survey index may not be informative. Another participant commented that indeed there has not been any surprisingly good year classes. Since the acoustic surveys are conducted on the spawning stock one would not expect to see high tracking of Ages 2–4 and, additionally, the groundfish survey index shows really big gaps in cohort tracking.

When the larval survey index is weighted as zero this results only in some ‘tucking’. There is good correspondence between the larval survey index and composition data. The output agrees with general pattern of larval survey so any concerns about including the larval index are not as big an issue. It was suggested that perhaps DFO can look into length bins for the larval survey data and examine only newly hatched larvae to see if it changes the trend for the larval density.

This may provide a better fit to the model by providing a way to look at mortality between different larval lengths. It may also provide a way to look at larger larvae (pre-metamorphose) as a potential index of recruitment.

Interim Robustness Set – T. Carruthers

The presentation covered the use of the data and previously made suggestions but other ideas for possible robustness sets would also be welcomed. A participant suggested that mixing and migration may be useful to test and wondered if these have been captured in the uncertainty in relation to the entire stock structure. Spawning is occurring in coastal areas and Herring migrate east and west, so it is not simply just the weir in the axis of uncertainty. There may be a way to include this by reducing the overall catch by a proportion to account for Herring that are not within the fishing areas. Movement and migration are not addressed very well in the framework. With respect to mixing and migration, there is a need to capture the essence of this in relation to the overall stock structure. Catches of Canadian Herring occur in the US waters but fish are actually moving in and out of the area. The acoustic survey index is relative only to the SSB which is why the surveys are focused on the spawning areas. There is evidence of movement throughout the area and this needs to be considered. It was agreed that G. Melvin will provide catch uncertainty scenarios post-meeting by email to the MSE group.

It is possible that spawning could be occurring along the Maine coast and also in other local areas that are not documented. In terms of the transboundary migration of Herring in and out of the management area, there needs to be sensitivities to cover the extremes. For example, adding 40% of US winter landings and the weir landings is one of the extremes. What has not been attempted yet is shifting the stock structure, along with time-varying M; these could change the stock trajectory substantially. The Ricker recruitment model has a really large impact, with a lower stock level. Similar to the rebuilding model, they have very strong impacts. Using the US catch as a test of robustness did not make much of an impact on the stock trajectory.

T. Carruthers commented that stock trajectories outputs for the landings of US Herring as 20% and 40% of the stock look very similar; however, he was able to confirm that the codes were implemented correctly. The change in landings by adding the US winter catches is small. Previous discussions agreed to use time-varying M and incorporating them into the robustness sets. The Ricker and Beverton-Holt recruitment models showed only marginally different fits. T. Carruthers suggested that they can be elevated to reference models if deemed necessary, but they are not well resolved. The priority would be for use in a robustness test. The robustness tests use two different levels of recruitment and assume a currently lower recruitment regime. This could also get at attrition of spawning areas which have not really been considered as yet. This will be influential so it will matter a lot.

A reviewer suggested that recruitment be used as a robustness set to include variability. T. Carruthers responded that there actually was not a regime shift seen in recruitment. Historically recruitment was really high or low; however, and more recently it has been stable and moderate. It was suggested that we would want to see a scenario where recruitment varies. Projections might be too optimistic if using an average recruitment; however, while the robustness set is using the median, this could also be a reference set. The assumption here is that recruitment is similar for the last 20 years. The base case might use the recruitment from the last 20 years but consideration should be given to how different this would be. Sensitivity analyses might look at the difference between the assumption being made right now, and what it is in the last 20 years.

In the Gulf Region, there is research showing that recruitment is linked to environmental variables. Spring spawners show very high recruitment in certain years before 1990s, and almost constant low recruitment afterwards. The years with high recruitment were years when the sea surface temperature (SST) was low and certain zooplankton species were available. Those few variables indicated that those periods of time were favorable to certain spawners. This would support the use of recruitment from recent years because those conditions are not expected to persist in the long-term.

In this process, the deviations used to be larger but the median is still the same; however, there could certainly still be two different scenarios. When looking at the average recruitment it is possible that there has not been much change. Regardless, different robustness recruitment scenarios should probably be included because it is possible there will be lower recruitment in the future. This probably will have a big impact on the future projections. A reviewer suggested that even if the mean is not different, the variability will be quite different. In the past, there was the possibility of getting a good recruitment year. It was pointed out that the recruitment plot was on a log scale so the large recruitment values were relatively extreme. It was suggested that the first data point might be very badly estimated (this is often the case when first measured) and could greatly change the trend.

T. Carruthers wondered if he could produce a set of plots for various models by deciding where to build break point in recruitment time series. It was suggested that around 1992 there appears to be a regime shift. The SST from the Atlantic Zone Monitoring Program (DFO 2019) also indicates a break point around 1992. In terms of the Herring biomass, 1989 appears to be pivotal due to reduction in Trinity Ledge fishing area catches.

A question was raised concerning where the amount of US fish percentages used in the scenarios came from. These came from two tagging studies that were previously discussed. The 40% proportion comes from tagging adult Herring between June and September that would be available to the US winter fishery (Stobo and Fowler 2009). R. Stephenson stated that spawning fish switching spawning grounds would be critical but there is almost no evidence of fish changing spawning grounds. It was clarified that the data on all 4VWX catch include catches from the gillnets in the coastal component.

Out of all the OMs tested, the best fit or lowest log likelihood was C_WeirEqCat, the OM that included weir catches and did not assume that 1967 was a virgin unfished population. This OM was in the robustness set.

Frequently Ask Questions – T. Carruthers

There is a section in the documentation for this MSE process on frequently asked questions.

How do we evaluate the operating models?

There are ways to compare OMs. Some of them have different parameterizations, different data in them, etc. The statistical protocols do not necessarily point to the best model. The pragmatic protocol is to ask, “Does the OM pass the red face tests?” and “Does the OM matter in terms of CMP selection?” Next, we can focus on the OM plausibility (quantitatively), if necessary.

How did we fit all the data, was there not a problem with previous assessments? Why does the model fits data when we previously could not?

We have been able to make this model work because of revised M and revised data inputs. The biomass is no longer just declining so we get outputs that show a stable level. Remember the acoustic survey index catchability *q* is fixed to a value of 1.

Should the objectives not be defined from the beginning?

While outputs show catch stability and maybe more sustainability, this does not meet all requirements of rebuilding to a more abundant state. This would depend on what MP is wanted and the need to differentiate between sustainable (i.e., not further reducing) and not sustainable within the fishery objectives. What we have seen so far is independent of performance metrics. Fishery management plans will have a huge role in informing the performing metrics. The outputs are projecting a more optimistic scenario for the biomass, and this is contrary to what is being observed currently. This is not only related to the loss of biomass but also the fact that there has been no rebuilding even with reduced TACs. There is a lack of rebuilding on spawning grounds even with the industry implementing measures to monitor length/age of landings.

Can what has happened on the Trinity Ledge spawning ground be used as a reference to predict the way changes may happen on spawning ground?

There is higher variability in recruitment and this could be because of more spawning grounds contributing the same time. Outside of the spawning grounds, we do not know where landed fish were spawned. Trinity Ledge is still being surveyed every year but it is only in the last couple of years that there has been an increase in acoustic survey biomass. An unsuccessful attempt was made to use a model to tease out a signal about 20 years ago but maybe should be retried now with 20 more years of data.

Do you expect the exercise around recruitment will bring all those trends together at all and if it does not, how do you choose a CMP?

It is expected that the less useful data will show up in the robustness tests and that the impact of recruitment is often quite influential. We could replace catches with recruitment scenarios as a dimension in the reference set. The OMs do not appear to reconcile data conflicts encountered previously. This will be addressed and the text rewritten to clarify in relation to the catchability of the acoustic survey index *q*.

In terms of the selection of CMPs for the MSE demonstration, the decision was made in December 2019 that before coming up with the CMPs and objectives/performance metrics, an example run of the MSE with some example management procedures and objectives/performance metrics would be done and presented.

In the US Herring MSE, it was found that having quite divergent reference OMs make it difficult to make management decisions. As a result, some OMs were removed because some of the outcomes were not legal. Consider what no fishing would do so that you can consider what is possible. It is possible that the reference set can change after the demonstration as long as the group decides this is the way to proceed.

B. Berges suggested that rankings with absolute performance requirements can be used but that has to be decided when setting the performance metrics, e.g., SSB_{lim} (i.e., the limit reference points). Another participant suggested that perhaps yield metrics could be used. The US Herring MSE process went through similar considerations and the process could provide good examples to look at in terms of management procedures and performance metrics. The process considered the availability of Herring for forage and making sure catches were stable over a certain period of time. Those references were shared with the everyone at the meeting via the Teams chat.

All the reference points are in the MSE demonstration and everyone in the meeting would be able to contribute to the identification of good performance metrics.

Candidate Management Procedure demonstration

The figure presented the output of one OM and there were four dimensions to look at: MP, OM, simulation, PM. It was pointed out that the coding can be done easily and that participants can send along ideas for possible MPs and that they can be turned into executable MPs. The time periods do not have to be how long the MPs will be in place but need to be sure that the MPs do not have long-term impacts on biomass. This is not as much of an issue with Herring because it is a short-lived species.

NEXT STEPS

One industry participant raised concern about committing more time to MSE demonstration meeting in June. He suggested that need for more time to digest and debrief on what was presented during these two days.

There will be dates when no more changes will be accepted for the data sets used in the models and when identification of possible OMs needs to finish. Any red-face tests for rejecting reference and robustness OMs also need to be identified. There will be generalized CMPs to investigate and experiment with and a demonstration MSE meeting. This will be followed by a Performance Metrics and Management Objectives meeting.

CLOSING COMMENTS

M. Greenlaw thanked everyone for participating. DFO Science is happy with how the process is moving forward and is pleased with the engagement in these meetings. DFO is committed to this process and welcome any feedback on how the process is going, particularly after this meeting. The feedback is that some participants think that the next couple workshop meetings were moving a little fast so the timing for those meetings will be looked at so everyone can fully participate. The process was originally slated to finish in October 2020, but we will have to see when we can finalize the performance metrics and see if that is still a possibility. Understandably, this is a difficult time for everyone with a global pandemic. Keep in mind we do have some restrictions, the MSE group are contracted to do this work and have a limited amount of time to work with us. We are committed to finding solutions and want the process to be successful. We would also welcome feedback about the format of the meeting as, this may be the format we use for the foreseeable future. We would like to know how people feel about this format in comparison to our regular in-person meetings. Thanks to our excellent reviewers. Positive comments have been received about the reviewers. Thanks to the MSE team who are highly experienced and we are grateful to have them working on this project.

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APPENDIX 1. TERMS OF REFERENCE

Continuation of 4VWX Herring Framework Part II: Operating Model Development

Regional Peer Review – Maritimes Region

May 26–27, 2020
Virtual meeting

Chairperson: Tara McIntyre

Context

Atlantic Herring is a pelagic species found on both sides of the North Atlantic. Herring spawn in discrete locations, to which they are presumed to home. Herring first mature and spawn at three or four years of age (23 to 28 cm), then begin a predictable annual pattern of spawning, overwintering, and summer feeding, which often involves considerable migration and mixing with members of other spawning groups. The NAFO areas 4VWX management unit contains a number of spawning areas. Spawning areas in close proximity with similar spawning times, and which share a larval distribution area, are considered part of the same complex. For evaluation and management, the 4VWX Herring fisheries are divided into four components:

1. Southwest Nova Scotia/Bay of Fundy (SWNS/BoF) spawning component
2. Offshore Scotian Shelf banks spawning component
3. Coastal (South Shore, Eastern Shore and Cape Breton) Nova Scotia spawning component
4. Southwest New Brunswick migrant juveniles.

Recommendations from the last assessment framework conducted in 2011 included a focus on model improvement and exploration for the next framework (DFO 2011). This assessment framework will focus on the SWNS/BoF spawning component. The last stock assessment for this component was conducted in 2018 (DFO 2018), and a stock status update was provided in 2019 (DFO 2020). The 2018 assessment identified the framework assessment as a priority and in 2019 the SWNS/BoF spawning component was identified to be in the critical zone.

Fisheries and Oceans Canada (DFO), Maritimes Region is proceeding with a management strategy evaluation (MSE) process as the framework for SWNS/BoF Herring. This meeting is the third of four Science Advisory Process meetings to develop this MSE, and will involve the final peer-review of the conditioning operating model to be used in the MSE. The first meeting was in February 2019 and addressed the data inputs. The second meeting was in January 2020 and was a review of the structure and fitting of an example operating model that will be used as the basis for all of the operating models in the MSE. The fourth meeting, to be scheduled later in the year, will involve the review of the entire MSE process.

Objectives

The objective of this third meeting is to review the structure and fitting of the operating models that will be used as the basis for all of the operating models in the MSE. The operating models span the range of uncertainties identified for the fishery in the workshop held in January 2020. This meeting will involve a review of:

- updates to the data inputs;
- final scenarios and parameter estimates used to capture uncertainty in the operating models;

- goodness of fit of the operating models and suitability to be used to model a range of uncertainties for the fishery;
- prior assumptions and error structure in the operating model.

The review of the conditioning operating model differs from the review of a standard assessment model. The focus of the review of a standard assessment model is on model goodness of fit, whereas the focus of this review is on the suitability of the operating model to be used to model a range of uncertainties for the fishery. The code (R/Template Model Builder) will be available for reviewers so anything documented in the working paper can be replicated.

Expected Publications

- Proceedings
- Research Document

Expected Participation

- DFO Science
- DFO Resource Management
- DFO Ecosystem Management
- DFO Policy
- Members of the Herring Advisory Committee
- University of British Columbia modelling team

References

DFO. 2011. Proceedings of the Maritimes Region Science Advisory Process on the Assessment Framework for Southwest Nova Scotia/Bay of Fundy Herring; 24–28 January 2011. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2011/031: iv + 28p.

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APPENDIX 2. LIST OF PARTICIPANTS

Name	Affiliation
Akagi, Hugh	Chief, Peskotomuhkati Nation at Skutik
Baker, Lori	Eastern Shore Fishermen Protective Association
Barrett, Tim	DFO Maritimes - Science
Berges, Benoit	Wageningen University & Research
Brushett, Rebecca	Ecology Action Centre
Bundy, Alida	DFO Maritimes - OESD
Carruthers, Tom	University of British Columbia
Chandler, Allan	NS Fisheries and Aquaculture
Cieri, Matthew	Maine Dept. of Marine Resources
Cogliati, Karen	DFO National Capital Region - Science Advisory
Debertin, Allan	DFO Maritimes - Science
d'Eon, Sherman	Cape Breeze Seafoods Ltd.
Greenlaw, Michelle	DFO Maritimes - Science
Hatt, Terry	NB Agriculture, Aquaculture and Fisheries
Hooper, Tony	Connors Bros. Clover Leaf
Hordyk, Adrian	University of British Columbia
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Landriault, Marc	Comeau Seafoods
Melvin, Gary	Herring Science Council
Mitchell, Lillian	Fundy North Fishermen Association
Mitchell, Vanessa	Maritime Aboriginal Peoples Council
Munden, Jenna	Herring Science Council
Murphy, Hannah	DFO Newfoundland Region - Science
Mussells, Claire	DFO Maritimes - Science
Nickerson, Candace	DFO Maritimes - Resource Management
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Saulnier, Brian	SeaCrest Fisheries
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Turcotte, François	DFO Gulf Region - Science
van Beveren, Elisabeth	DFO Quebec Region - Science
Walsh, Matt	Connor's Bros
Wang, Yanjun	DFO Maritimes - Science
Waters, Christa	DFO Maritimes - Resource Management

APPENDIX 3. AGENDA

AGENDA DAY 1: May 26, 2020	
12:30 - 12:45	
Introductions	Lead: Tara McIntyre
Welcome and introductions	
12:45 - 1:00	
Presentation	Lead: Tim Barrett
History of meetings and meeting objectives	
1:00 - 1:30	
Presentation	Lead: Tim Barrett
Overview of updates to data inputs from presentation in February 2020 Review of uncertainties in fishery dynamics from the workshop in January 2020	
1:30 - 3:00 (Break for 10 minutes around 2:30)	
Presentation/Discussion	Lead: Tom Carruthers
Operating model fits and assumptions 1) Reference Case	
3:00 - 4:30	
Presentation/Discussion	Lead: Tom Carruthers
Operating model fits and assumptions 2) Sensitivities	

AGENDA DAY 2: May 27, 2020	
12:30 - 12:45	
Welcome back	Lead: Tara McIntyre
12:45 - 2:00	
Presentation/Discussion	Lead: Tom Carruthers
Operating model fits and assumptions 3) Reference Set	
2:00 - 3:30 (Break for 10 minutes around 2:30)	
Presentation/Discussion	Lead: Tom Carruthers
Operating model fits and assumptions 4) Robustness Set	
3:30 - 4:00	
Presentation/Discussion	Lead: Tom Carruthers
Demonstration of a candidate management procedure	
4:00 - 4:30	
Wrap up	Lead: Tara McIntyre