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Proceedings of the Maritimes Regional Peer Review of the Southwest Nova Scotia/Bay of Fundy Herring Framework: Part 3 – Management Strategy Evaluation

Meeting dates: February 16–17, 2022
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Foreword

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SUMMARY

The Southwest Nova Scotia/Bay of Fundy (SWNS/BoF) management component of the 4VWX Atlantic Herring (*Clupea harengus*) stock has been without a modeling framework for about two decades and management decisions have been based on trends in an acoustic index of spawning stock biomass. At the time of this meeting, the status of the SWNS/BoF Herring management component was determined to be in the critical zone of the Fisheries and Oceans Canada (DFO) Precautionary Approach (PA). DFO Maritimes Region began a Management Strategy Evaluation (MSE) process as the modelling framework for SWNS/BoF Herring in 2019. This meeting was the final meeting of four Science Advisory Process meetings to develop this MSE framework. The first meeting was in February 2019 and addressed the data inputs. The second set of meetings were in January 2020 and May 2020 and were a review of the conditioning of the operating models to be used in the MSE. The objectives of this final meeting were to summarize the progress that had been made since the last meeting and a review of the framework used to evaluate candidate Management Procedures (MPs) against objectives in DFO's PA Policy and objectives defined by stakeholders. This meeting also included a review of the situations under which the advice from an MP may be over-ridden (exceptional circumstances). Participants at this meeting included DFO Science, DFO Ecosystem Management, Province of Nova Scotia, Province of New Brunswick, Indigenous communities / organizations, Fishing Industry, non-government organizations, and external experts.

INTRODUCTION

The Southwest Nova Scotia/Bay of Fundy (SWNS/BoF) management component of the 4VWX Atlantic Herring (*Clupea harengus*) stock has been without a modeling framework for about two decades and management decisions have been based on trends in an acoustic index of spawning stock biomass. The SWNS/BoF Herring management component was last assessed in 2018 (DFO 2018) as part of the assessment of 4VWX Herring. Stock status updates for SWNS/BoF Herring were provided in 2019, 2020, and 2021 (DFO 2020a; 2020b; 2021) and the status was determined to be in the critical zone of the Fisheries and Oceans Canada (DFO) Precautionary Approach (PA) Policy ("A Fisheries Decision-Making Framework Incorporating the Precautionary Approach"; DFO 2009) in 2018, 2019, and 2020. DFO Maritimes Region began a Management Strategy Evaluation (MSE) process as the modelling framework for SWNS/BoF Herring in 2019. This meeting is the final meeting of four Science Advisory Process meetings to develop this MSE framework. The first meeting was in February 2019 and addressed the data inputs. The second set of meetings were in January 2020 and May 2020 and were a review of the conditioning of the operating models (OMs) to be used in the MSE. This final meeting summarized the progress that has been made since the last meeting and involved a review of the framework to be used to evaluate candidate Management Procedures (MPs) against objectives in DFO's PA Policy and objectives defined by stakeholders. This meeting also included a review of the situations under which the advice from an MP may be over-ridden (exceptional circumstances).

The general framework for conditioning operating models for this MSE was already peer-reviewed in a Canadian Science Advisory Secretariat (CSAS) Regional peer review process in May 2020 and forms the basis for the MSE framework (Carruthers et al. 2023). An MP was not selected for the fishery during this meeting. The product arising from this CSAS peer review process, is an MP testing framework that can be used to identify MPs that meet the objectives of DFO's PA Policy and that can be used to evaluate trade-offs in performance among MPs relative to other stakeholder defined objectives.

The specific objectives of this meeting were to review the Science components of the MSE framework:

- The MSE objectives, and corresponding performance metrics used to evaluate the performance of MPs, including:
    - use of the limit reference point (based on the acoustic index) as a minimum performance standard for evaluating the performance of MPs.
- The reference set of operating models that represent potential plausible alternative hypotheses for the structure and dynamics of the SWNS/BoF stock.
- The closed-loop simulation approach used to evaluate the performance of candidate MPs, including:
    - the assumptions for projecting the acoustic index of spawning stock biomass;
    - the assumptions for evaluating trade-offs in the future selectivity for juvenile versus adult Herring for the purse seine fleet.
- The "exceptional circumstances" criteria for determining when the advice from the MP may be over-ridden.
- The proposed frequency and timing of interim-year updates to be provided between full peer-reviewed frameworks, and the recommended timing of the next framework.

- Future research recommendations.

It is important to note that the MSE framework was presented at this meeting using some candidate MPs. Additional candidate MPs can be evaluated before the Scotia Fundy Herring Advisory Committee meeting during which trade-offs among objectives will be discussed. A robustness set of OMs was presented at this meeting and additional scenarios can be added to the robustness set following review of the framework. The risk tolerance for the conservation objective (i.e., probability of being above the Limit Reference Point in 1.5 to 2.0 generations) is not determined by DFO Science Sector and was not part of this peer review process.

See Appendix A for the Terms of Reference. Participants in this meeting included, DFO Science, DFO Ecosystem Management, Province of Nova Scotia, Province of New Brunswick, Indigenous communities / organizations, Fishing Industry, non-government organizations, and external experts (see Appendix B for list of participants). This virtual meeting was held from February 16–17, 2022, using Microsoft Teams (MS Teams) (see Appendix C for the Agenda).

DAY 1: FEBRUARY 16, 2022

Rapporteur: R. Singh

The Chair, Kent Smedbol, started the meeting by introducing himself and then asking the two reviewers, Drs. Matthew Cieri and Elisabeth Van Beveren, to introduce themselves. Since there were many participants, rather than undertaking a full roundtable of introductions, other participants were asked to introduce themselves and provide their affiliation when they first spoke during the meeting. The Chair then briefly described the Canadian Science Advisory Secretariat (CSAS) peer review process and the use of the Scientific Advice for Government Effectiveness (SAGE) Principles and Guidelines. Since the meeting was using Microsoft Teams (MS Teams) as the platform, tips on the effective use of MS Teams were provided. The Terms of Reference with the specific meeting objectives and the Agenda for the two days were reviewed.

Before the meeting continued the Chair asked if there were any questions and a participant expressed concern about the lack of a third reviewer. Unfortunately, the third reviewer was unable to attend but the Chair expressed confidence in the abilities of the two reviewers in attendance to provide a thorough review of what was to be presented at the meeting.

The meeting continued with the start of the presentation by Tim Barrett. At appropriate breaks during the presentation, the Chair turned to the reviewers first for questions and comments and then to the other participants. A participant raised a concern with the use of the Limit Reference Point (LRP) in a performance metric in the MSE and did not agree with the statement that there was no agreement on what the LRP should be from the January 2021 Meeting “Science Advice on a Performance Threshold for the Management Strategy Evaluation for SWNS/BoF Atlantic Herring”. At that meeting, the discussion was focused on what would be an appropriate performance threshold inside the MSE to test/select an MP. A consensus was reached for a performance threshold that was clearly defined as being appropriate and adhering to the precautionary approach framework.

A reviewer sought clarification on which of the MSE objectives used were considered more important. When the MSE tool is used in the future trade-off plots will be presented and the plan is to have a series of performance metrics presented and discussed with the Herring Advisory Committee so that stakeholders can identify preferred Management Procedures (MPs) based on trade-offs. A formal ranking of objectives for selecting an MP was not done in this MSE process. A reviewer asked whether time to rebuild under a no fishing scenario (i.e., t_{min}) was considered for the primary conservation objective. The t_{min} approach was not used; the 10–25

years projection time span was selected based on the 1.5–2.0 generation time for Herring (PA Policy; DFO 2009) with 10 being the upper end of the generation time.

PERFORMANCE METRICS

After the presentation on performance metrics, a concern was raised about the lack of an Upper Stock Reference (USR) point and possible incorrect conclusions about Operating Models (OM) not being PA compliant. The USR was indeed not peer-reviewed during the meeting but there are two candidate target biomass values used in the MSE to evaluate the objectives related to the USR. A minimum probability for meeting those objectives is not defined and the relative ranking of MP performance is the same using both target biomass values (425 kt and 500 kt).

A suggestion was made by a participant that instead of using the three-year moving average index to compare to the LRP (2005–2010 average acoustic index) in the projection period, the annual index value should be used. Guidance on this issue will be sought from the Integrated Fisheries Management Plan (IFMP).

Clarification was sought on the use of the LRP based on the acoustic index as it relates to the dynamic SSB_{MSY} in determining MP performance. It was stated that MPs that meet the conservation objective (i.e., P[> LRP] > 0.75 in each year in years 10–25 of the projection period for each OM in the reference set) would also “pass” using the performance metric based on the dynamic SSB_{MSY} (which is not being used in the MSE). It was shown that there are situations where the two metrics will give different results in terms of MP performance. A plot with projections of an MP for OMs with decreasing growth was tabled as an example. Under a decreasing growth scenario, “status” (defined as SSB/SSB_{MSY}) was more optimistic than status quo growth using a dynamic SSB_{MSY} because SSB_{MSY} is decreasing over time. There are scientific arguments for not using a performance metrics based on dynamic SSB_{MSY} which will be included in the Working Paper.

REFERENCE SET OF OPERATING MODELS

After the presentation, a reviewer suggested that the number of simulations be increased and that it be set to a consistent number for all the OMs. The number of 200 was chosen based on convergence of performance metrics. A review of the use of 200 simulations was assigned as an item to evaluate and report on for the next day.

The next part of the presentation addressed the steps to determining a final reference set of OMs from an initial set of 36 to be used as a testbed for MP evaluation. OMs with low steepness (h), low natural mortality rate (M), and weir catches included did not converge and were removed. Kobe plots were tabled and OMs with low h/low M and high h/high M had historical trajectories that suggested that overfishing or underfishing was occurring over most of the historical time period and this was not consistent with the expected trajectory. These OMs (low h/low M and high h/high M) were removed from the reference set.

Plots were displayed showing performance of a no fishing scenario (24 OMs, 8 with unique historical trajectories). It was suggested that the boxplots be replaced with individual values and that the performance metrics might be more stable from year to year if the number of simulations is increased. Under the no fishing scenario, there were extreme low productivity and high productivity scenarios evident. It was proposed that the reference set be defined using only the baseline M = 0.35 scenario and that the high and low age-varying M scenarios be moved to the robustness set of OMs. It was also asked why M and not h was selected to be fixed when the two are related. M is more likely to be age variant than a fixed value. This left 12 OMs in the final reference set.

A participant asked to see the full output from the Reference and Robustness sets and that the document be updated to show other reference points (B_0 and B_{MSY}). The outputs from the OMs are available in documentation provided prior to the meeting. Alternative reference points are not being used in the MSE framework but can be found in a Working Paper from the November 2020 meeting on reference points. Following the lunch break, the Chair reported that after consultation with the assessment team, alternative reference points will not be calculated as part of the framework as this activity is not part of the Terms of Reference for the meeting.

A reviewer expressed surprise at the use of the acoustic index in the performance metric for the conservation objective and not the estimated SSB from the model. It was requested that a comparison between the two metrics be shown on the next day of the meeting.

Concern was expressed about decreasing the number of OMs from 36 to 12 and not capturing uncertainty. It was also suggested by a participant that time varying uncertainties included in the reference set of operating models such a growth would be more appropriately evaluated by a dynamic performance threshold rather than a static point which is being proposed. It was explained that the dynamic reference points make different assumptions (e.g., MPs will fail first using the dynamic SSB_{MSY} for the positive growth scenario)and decreasing growth can be interpreted as serious harm to the productivity of the stock.

A participant asked whether an MP needed to achieve a 75% probability for each OM in each year. It was pointed out that the risk tolerance was set by DFO Resource Management.

CLOSED LOOP SIMULATIONS

After the presentation on Closed Loop Simulations, a reviewer sought clarification on the number of simulations (to be set to 200 runs). Simulations will be run and translated from the model estimated SSB to the units of the index. The assumption is that SSB will be proportional to the acoustic index (i.e., hyperstability parameter $\beta = 1$) in all the OMs, however, the observed historical β (estimated from 1999–2020) is less than one. There is no expectation of a perfect 1:1 relationship between the index and model estimated SSB since additional data are used in the OM conditioning. It was suggested that these details and the rationale for the assumption of $\beta = 1$ be included in the Working Paper. It was requested that a comparison between the projections of the index be shown for two OMs under the different β assumptions for the meeting on the following day.

A participant asked about the appropriateness of a fixed LRP in the performance metric. It was pointed out that each OM represents a different productivity scenario and that the stock trajectories will be specific to each OM. The use of the LRP based on the mean index value from 2005–2010 is consistent with the $B_{recover}$ approach to defining reference points (stay above the lowest point in the trend in the historical data).

A reviewer queried the values of q (catchability) for all the OMs. If the performance metric for the conservation objective is defined based on model estimated SSB instead of the index would we get the same results? It will not be exactly the same but the theory behind the calculation of the performance metric is the same. The suggestion was to explain this better in the Working Paper and to check this out for one OM to see what the results would be. This was evaluated and presented at the meeting the following day. There is high variability in the acoustic index and the 3-year moving average is used to address this high variability.

The presentation then continued on the Closed Loop Simulations, the application of the MP to the simulated data, implementation of the MP recommendations, the 25 years projections and summary of the MPs.

A reviewer commented that as the TAC is reduced, the contributions from the NB weir will be assumed to also decrease; this is an assumption because the selectivity in the two groups are different. Another participant also commented that we do not know what percent of catch is United States (US) origin. The OMs are currently defined such that the weir catches are set as a proportion of the stock TAC, so indeed an assumption is inherently made that the TAC and weir catch are correlated, specifically that the weir catch is 20% of the TAC. The influence of the choice of a 20% proportion is evaluated in the robustness set of OMs and a threshold is defined as a trigger for exceptional circumstances.

For evaluating trade-offs in the future proportion of juvenile and adult fish harvested in the purse seine fleet, assumptions had to be made for the selectivity of these "fleets". The juvenile purse seine selectivity was assumed to be weir fleet selectivity and the adult purse seine selectivity was assumed to be the maturity ogive. The performance metric to evaluate changes in future selectivity was the percent of catch (by number) < 23 cm. It was suggested that a variable annual portion of the of fish < 23 cm were spawning. The performance metric is currently defined using 23 cm but this can be changed if it will be more informative. The 23 cm length is used by industry for their own management measures, if a change is being considered, this could be included as a research recommendation.

MANAGEMENT PROCEDURE PERFORMANCE

The presentation was followed by a request for clarification on the use of the 25-year projection and the elimination of MPs. It was clarified that the risk probability and time period are part of the risk tolerance for the conservation objective. Risk tolerance is outside the scope of the meeting and is defined by Fisheries Management. The MPs need to meet the minimum 75% probability of being above the LRP for each OM on the reference set. The plots displayed the distribution of the probabilities of being above the LRP for the reference set of OMs.

A participant suggested that the change in the percent of small fish is not reflected in the change in the probability of being above the LRP in the MP testing output. It was clarified that the change in the percent of small fish was combined with a change in the harvest rate in the MP comparison in the Working Paper. MP *P3.5* was a fixed harvest rate of 3.5% and reducing the percent of small fish removed resulted in an increase in the harvest rate that would meet the conservation objective (4% - see for MP *P4_20_80*). An html report was shared that showed the trade-offs in probability of being above the LRP and trade-offs in long-term yield for MPs with a fixed harvest rate but various percentages of small fish harvested by the purse seine fleet.

A participant suggested that since adjusting the TAC is the only management measure possible, the percent of small fish can also be used to see if this additional management input could result in some MP's passing, when under only a TAC change they would fail. It was clarified that this is the intent of the MPs for which the harvest levels of juvenile fish can be changed.

A reviewer asked how the MPs were selected in the Working Paper and presentation and whether a grid search was done to find the best MPs. The general shape of the MPs were proposed by stakeholders. Control points were modified until the MP met the conservation objective and these MPs are used to demonstrate how the MSE framework would be used. MP development and testing can continue after the meeting.

WRAP UP OF DAY 1

The day ended with a list of 3 items that would be revisited on Day 2.

1. The choice of n = 200 simulations. For OMs 1 and 7 look at conversion of median and percentiles (model estimated SSB and the 3-year moving index) across the number of simulations and show in graphs.
2. A paragraph on the assumptions of hyperstability with β = 1. For OM 1 and 7 use beta estimated from historical data for projection on an MP (e.g., Fix14, NFref).
3. Calculate a performance metric based on model estimated SSB to evaluate performance for the conservation objective (based on the LRP). OM performance on the reference set using the metric of mean model estimated SSB from 2005–2010 and the LRP (acoustic index of SSB from 2005–2010).

DAY 2: FEBRUARY 17, 2022

Rapporteur: R. Singh

After introductory remarks by the Chair, T. Barrett reported on the three items from the previous day.

The choice of 200 simulations was made in 2020 based on the performance metric SSB/dynamic SSB_{MSY}. The process error is "cancelled" out in the SSB/dynamic SSB_{MSY} so fewer simulations are needed. For performance metrics based on model estimated SSB or the index, more simulations are needed. The number of simulations was increased in steps of 100 from 100 to 1000 and n = 1000 gave better convergence for medians and 25^{th} and 75^{th} percentiles.

There was general support for the proposal of using 1000 simulations. A reviewer suggested to look beyond 1000 simulations and confirm that there is no benefit of using more than 1000 and update the Working Paper with the results.

The second item reported on was β. Projection plots were shown using β = 1 and using the historical estimated β for each OM. The historical estimates of β were all less than 1 and had a large influence on the estimated value of the projected index. Discussion was held over until the presentation of results on the third item.

The performance metric for the conservation objective (in units of model estimated SSB) was presented and compared relative to the performance metric based on the index. The presentation showed a comparison between:

a. The distribution of P(3-year moving average acoustic index > mean 2005–2010 acoustic index of SSB) for each OM in the reference set over the 25-year projection period
b. The distribution of P(model estimated SSB > mean 2005–2010 model estimated SSB) for each OM in the reference set over the 25-year projection period.

The distributions of performance were displayed for a) and b) for three different MPs and the performance was very similar. One difference was the probabilities were greater in the first few projection years using model estimated SSB compared to the 3-year moving average index. This is likely due to the use of the 3-year moving average in the performance of the index (slower to respond to change). The proposal was to proceed with the performance metric based on the model estimated SSB because:

- the mean model estimated SSB in OM and simulation specific
- model estimated SSB includes only process error (while the index also has addition observation error added)

- a smoother is not needed (index uses 3-year moving average)
- an assumption on β is not needed (which is highly influential on the index)

The reviewers agreed with the proposal.

A participant questioned whether the primary objective of being above the LRP with a probability greater than 0.75 is met when model estimated SSB is used as a performance metric. It was stated that the conservation objective remains the same: to increase the stock above the LRP within a timeframe. What the revised performance metric does is change the currency in which the objective is evaluated (model estimated SSB instead of the acoustic index of SSB). Since the LRP would not change, the metric to evaluate the stock status remains the same. A participant asked whether a probability of being above the LRP in each year can be calculated. This probability can be calculated in the simulation environment but a method of defining the uncertainty in the determination of stock status has not been defined for the stock.

A participant questioned using the actual indicator of the LRP as the mean of the 2005–2010 and wanted to use the model-based MSY reference points. T. Barrett responded that the model-based estimate of dynamic SSB_{MSY} that was defined as a performance threshold for MP evaluation can be used to evaluate MPs (e.g., relative performance among MPs) under a specified set of assumptions but the metric was not defined as an LRP and is not used as an indicator of stock status and, therefore, cannot be used to evaluate the conservation objective.

A participant questioned the way that the probability of being above the LRP was calculated. The performance metric for the conservation objective is calculated such that each OM in the reference set must have a probability of being above 0.75. The participant suggested that all simulations among all OMs should be combined to estimate the probability of being above the LRP. It was pointed out that the objective of this MSE process to was select an MP that is robust to the specific set of uncertainties captured by the reference set of OMs (and not to some percentage of these uncertainties). Although there are alternative ways of calculating the probability of being above the LRP, the approach as suggested by the participant requires plausibility weighting of OMs which was not done in this process. The reviewers accepted the approach that was taken in this process.

EXCEPTIONAL CIRCUMSTANCES

Two reasons for triggering exceptional circumstances (ECs) and 7 specific ECs developed by the MSE working group were presented by T. Barrett. During the discussion after the presentation, it was agreed that the “Process for Evaluation” triggered by the EC be changed to “Science Considerations” and that the specific actions be determined once the EC has been triggered since the specific action may depend on the magnitude of the exceedance of the evaluation criteria. The evaluation criteria of the ECs therefore represent the trigger for taking a closer look at the implications of the EC.

EC 1: After the presentation, a reviewer commented on the change in the acoustic index of SSB annual vs two years of change in the acoustic index. There are two components to this EC: evaluation criteria and action. The action or response will be guided by discussion with the stakeholders. This particular EC dealing with the acoustic index has a whole range of possible issues involved such as whether it is only one spawning ground involved, were there problems with surveying, technical issues that inhibit the completion of surveys, and the magnitude of the problem within the range of values that are modeled. It was agreed to keep the evaluation criteria to one year understanding that the specific action taken is not specified.

One of the reviewers cautioned against removing OMs because they do not perform. The trigger is expected to be an evaluation of the set of OMs.

EC 2: Weight at age in the SSB. Note that Age 7 number of fish in samples may be low and growth may have reach maximum. No change was suggested.

EC 3: Weir fleet landings. The 60% was chosen based on MP performance in the robustness set of OMs with higher weir catches. The weir OMs did not influence MP performance with weir catches up to 60% of the TAC. Maximum value consistent with 60% that has occurred in the past. No change was suggested.

EC 4: Landing higher that the TAC (10% arbitrarily selected). A comment was made that landings can easily go over the TAC as it gets smaller; however, it was pointed out that with the comprehensive dockside monitoring that occurs in the fishery this would be unlikely.

EC 5: This one dealt with what to do when there is new data or change in model assumptions. No comments.

EC 6: When there is insufficient data to evaluate the stock. A participant suggested that it would be up to Science to determine whether there is enough data to evaluate the stock. Discussion on whether to keep this EC followed and it was agreed that it will be kept to guide science response.

EC 7: Dealt with the presence of high SSB (> 30.9%) outside the two main spawning grounds. Questions arose about how the 30.9% was arrived at and it was explained that it was at the 90th percentile of observation error in the index in the past. A participant suggested that the magnitude should be based on the actual observations of SSB from the other spawning grounds. The relative percentage of SSB from other spawning grounds surveyed historically was compared to the index during the meeting and the participant agreed that the 30.9% was acceptable.

The meeting Chair then reviewed the objectives as outlined in the Terms of Reference and went through each item to confirm the list of consensus items:

1. On the MSE objectives and performance metrics: the consensus was to proceed with using the performance metric based on the model estimated SSB
2. The Reference Set were approved as proposed, without any changes.
3. For the Closed Loop Simulations – juveniles versus adult herring beta = 1 was going to be used for exceptions for the projected index.
4. For the exceptional circumstances: change the 4 column heading to “Considerations from science”; and EC 1 changed so it applies to a single OM.

LOOKING FORWARD: NEXT FRAMEWORK

Michelle Greenlaw led the discussion for this final part of the meeting.

The first item dealt with the timing of the updates and next framework. A 5-year period was proposed for applying this MSE framework with annual update documents around March each year. The proposal was to continue with the status quo schedule, apply the MP using the acoustic index of SSB estimated from the previous year, and evaluate stock status using the acoustic index and the LRP while also evaluating the ECs.

A participant (supported by another) expressed concern with the length of 5 years for the framework because of the lack of use of B_{MSY} as the LRP. Reference was made to the November 2020 Working Paper which provides reasons why the B_{MSY} was not used as the LRP for this stock. Another participant supported the proposed 5-year time period for the framework as it provides a structured approach. Time is needed to see if things are working and doing a framework requires time. There is also the ECs which if triggered would force a review. This

was supported by another participant. It was pointed out that if there is a new acoustic data analysis protocol developed, peer-reviewed, and accepted, this may trigger an EC for new data and may require a new framework. The 5-year timeframe was supported by the two reviewers and there was consensus on the annual updates.

FUTURE RESEARCH RECOMENDATIONS

The discussion started off on a list of future research recommendations.

1. Factors influencing SWNS/BoF herring recruitment and growth
2. Methods to account for depensation in SRRs
3. Reference points under time varying productivity
4. Another limiting factor is trying to separate the catch into two components.

Different spawner types are represented within the 4WX mobile fleet fishery. Research from other regions have demonstrated that herring of different spawning types have different factors that lead to strong recruitment and these don't necessarily occur in the same years, i.e., typically there are different strong year classes for spring and fall spawners. This means that by combining all the data, these dynamics are not represented and the stock recruitment relationship is inaccurate. Spawner type separation of the catch can be done through sampling that includes gonad and otolith analyses; other regions have well established protocols that could be adopted in the 4WX region. In the past, separating out spawner type was likely not a priority due to the dominance of the fall spawners, but currently it appears to be more of a 50/50 split between spring/summer spawners and fall, making this change necessary in order to allow research into recruitment/climate change impacts.

1. Weir catch affinity and composition

There are some assumptions in this MSE. Would it be worthwhile to do something on stock structure of the weir catches? T. Barrett is looking into otolith microchemistry, trying to identify a tracer element to identify the two stocks (Canada/US) if that is possible.

2. Weight-at-age with fish getting smaller over the years

Long time since last evaluated and whether a juvenile fish is still 23 cm. This is a question of identifying a juvenile fish by looking at the maturity ogives, proportion at-length or age. It may be better to go with a percentage of maturity rather than a length cut off.

3. Impacts of the environment and climate change

This fits in with the first priority time listed also. MSE knowledge is evolving to being able to incorporate this sort of information also.

4. Stock affinity for not just the weir fishery but also the inshore stocks

The coastal Nova Scotia inshore stocks seem to be doing well. Is there any work that can be done? Are they doing well as a result of moving fish or the result of good stock productivity?

5. Predation, foraging, selectivity and using 0.2 for natural mortality.

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DFO. 2021. Stock Status Update of 4VWX Herring for the 2021 Fishing Season. DFO Can. Sci. Advis. Sec. Sci. Resp. 2021/040.

APPENDIX A: TERMS OF REFERENCE

Southwest Nova Scotia/Bay of Fundy Herring Framework: Part 3 –Management Strategy Evaluation

Regional Peer Review – Maritimes Region
February 16 (9:00am–5:00pm AST) and February 17 (9:00am–1:00pm AST), 2022
Virtual Meeting

Meeting Chair: Kent Smedbol

Context

The Southwest Nova Scotia/Bay of Fundy (SWNS/BoF) management component of the 4VWX Atlantic Herring (*Clupea harengus*) stock has been without a modeling framework for about two decades and management decisions have been based on trends in an acoustic index of spawning stock biomass. The SWNS/BoF Herring management component was last assessed in 2018 (DFO 2018) as part of the assessment of 4VWX Herring. Stock status updates for SWNS/BoF Herring were provided in 2019, 2020, and 2021 (DFO 2020a; 2020b; 2021) and the status was determined to be in the critical zone of the Fisheries and Oceans Canada (DFO) Precautionary Approach Policy ("*A Fisheries Decision-Making Framework Incorporating the Precautionary Approach*"; DFO 2009) in 2018, 2019, and 2020. DFO Maritimes Region began a Management Strategy Evaluation (MSE) process as the modelling framework for SWNS/BoF Herring in 2019. This meeting is the final meeting of four Science Advisory Process meetings to develop this MSE framework. The first meeting was in February 2019 and addressed the data inputs. The second set of meetings were in January 2020 and May 2020 and were a review of the conditioning of the operating models to be used in the MSE. This final meeting will summarize the progress that has been made since the last meeting and will involve a review of the framework used to evaluate candidate Management Procedures (MPs) against objectives in DFO's PA Policy and objectives defined by stakeholders. This meeting will also include review of the situations under which the advice from an MP may be over-ridden (exceptional circumstances).

The general framework for conditioning operating models for this MSE has already been peer-reviewed in a Canadian Science Advisory Secretariat (CSAS) Regional peer review process in May 2020 and forms the basis for the MSE framework. The working paper from the May 2020 meeting is:

Carruthers, T.R., Hordyk, A.R., Huynh, Q.C., Singh, R., and Barrett, T.J. 2023. A Framework for Conditioning Operating Models for the Southwest Nova Scotia/Bay of Fundy Spawning Component of 4VWX Herring. DFO Can. Sci. Advis. Sec. Res. Doc. 2023/022. v + 103 p.

An MP will not be selected for the fishery during this meeting. The advice arising from this CSAS peer review process, will be an MP testing framework that can be used to identify MPs that meet the objectives of DFO's PA Policy and that can be used to evaluate trade-offs in performance among MPs relative to other stakeholder defined objectives.

Objectives

The specific objectives of this meeting are to review the Science components of the MSE framework:

- The MSE objectives and corresponding performance metrics used to evaluate the performance of MPs, including:
  - use of the limit reference point (based on the acoustic index) as a minimum performance standard for evaluating the performance of MPs.
- The reference set of operating models that represent plausible alternative hypotheses for the structure and dynamics of the SWNS/BoF stock.
- The closed-loop simulation approach used to evaluate the performance of candidate MPs, including:
  - the assumptions for projecting the acoustic index of spawning stock biomass;
  - the assumptions for evaluating trade-offs in the future selectivity for juvenile versus adult Herring for the purse seine fleet.
- The “exceptional circumstances” criteria for determining when the advice from the MP may be over-ridden.
- The proposed frequency and timing of interim-year updates to be provided between full peer-reviewed frameworks, and the recommended timing of the next framework.
- Future research recommendations.

Note: the MSE framework will be presented at this meeting using some candidate MPs and additional candidate MPs can be evaluated before the advisory committee meeting during which trade-offs among objectives will be discussed. A robustness set of OMs will be presented at this meeting and additional scenarios can be added to the robustness set following review of the framework. The risk tolerance for the conservation objective (i.e., probability of being above the Limit Reference Point in 1.5 to 2 generations) is not determined by Science and will not be part of this peer review process.

Expected Publications

- Proceedings
- Research Document

Participation

- DFO Science
- DFO Resource Management
- DFO Policy
- Indigenous organizations
- Industry (commercial fishing industry)
- Environmental non-governmental organizations
- External experts.

References

DFO. 2009. A Fisheries Decision-Making Framework Incorporating the Precautionary Approach.

DFO. 2018. 2018 Assessment of 4VWX Herring. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2018/052.

DFO. 2020a. Stock Status Update of 4VWX Herring for the 2018/2019 Fishing Season. DFO Can. Sci. Advis. Sec. Sci. Resp. 2020/001.

DFO. 2020b. Stock Status Update of 4VWX Herring for the 2019/2020 Fishing Season. DFO Can. Sci. Advis. Sec. Sci. Resp. 2020/050.

DFO. 2021. Stock Status Update of 4VWX Herring for the 2021 Fishing Season. DFO Can. Sci. Advis. Sec. Sci. Resp. 2021/040.

APPENDIX B: LIST OF PARTICIPANTS

Participant	Affiliation
Andrushchenko, Irene	DFO Maritimes - Science
Barrett, Tim	DFO Maritimes - Science
Cawthray, Jenness	DFO National Capital Region - Fisheries Management
Chandler, Alan	Nova Scotia Department of Fisheries and Aquaculture
Cieri, Matthew	State of Maine Department of Marine Resources
Cogliati, Karen	DFO National Capital Region - Science
Corey, Peter	Comeau Seafoods
Debertin, Allan	Fisheries and Oceans Canada
d'Eon, Sherman	Cape Breeze Seafoods Ltd.
Depres, Lise	Comeau Seafoods
Deroba, Jon	National Oceanic and Atmospheric Administration - Northeast Fisheries Science
Doucette, Brandon	Turpentine Seiners Limited
Greenlaw, Michelle	DFO Maritimes - Science
Hatt, Terry	NB Department of Agriculture, Aquaculture and Fisheries
Hooper, Tony	Connors Brothers Clover Leaf
Kaiser, Tim	Scotia Garden Seafood Inc.
McIntyre, Tara	DFO Maritimes - Science
McIsaac, Ian	Seafood Producers Association of Nova Scotia
Melvin, Gary	Herring Science Council
Mitchell, Lillian	Fundy North Fishermen's Association
Mitchell, Vanessa	Maritime Indigenous Peoples Council
Munden, Jenna	Herring Science Council
Murphy, Chris	William R. Murphy Fisheries Ltd.
Murphy, Hannah	DFO Newfoundland and Labrador - Science
Pardo, Sebastián	Ecology Action Centre
Quigley, Sara	DFO Maritimes - Fisheries Management
Reader, Jeffrey	DFO Maritimes - Fisheries Management
Saulnier, Billy	Comeau's Sea Foods Limited
Schleit, Katie	Oceans North
Singh, Rabindra	DFO Maritimes - Science
Small, Tiffany	DFO Maritimes - Science
Smedbol, Kent	DFO Maritimes - Science
Sonnenberg, Melanie	Grand Manan Fishermen's Association
Stephenson, Rob	DFO Maritimes - Science
Stirling, Roger	Seafood Producers Association of Nova Scotia
Townsend, Kathryn	Maritime Indigenous Aquatic Resources Secretariate
van Beveren, Elisabeth	DFO Quebec - Science
Walsh, Matt	Connor's Bros
Wang, Yanjun	DFO Maritimes - Science

APPENDIX C: AGENDA

Day 1: February 1, 2022	
09h00 – 09h30	
Opening Remarks	Lead: Kent Smedbol
Welcome, introductions, and review of CSAS process	
09h30	
Presentation/Discussion	Lead: Tim Barrett
Introduction, MSE Objectives, Performance Metrics, Operating Models	
12h00 – 12h30	
Lunch Break	
12h30	
Presentation/Discussion	Lead: Tim Barrett
Closed Loop Simulations, Candidate Management Procedures, Management Procedure Performance	
17h00 – End of day	
Wrap Up Day 1	Lead: Kent Smedbol
Day 2: February 17, 2022	
09h00	
Recap of Day 1	Lead: Kent Smedbol
09h15	
Presentation/Discussion	Lead: Tim Barrett
Exceptional Circumstances, Proposed Frequency and Timing of Inter-year Updates and Frameworks,	
13h00 – End of Day	
Wrap Up and Conclusions	Lead: Kent Smedbol