SCIENTIFIC COUNCIL INTERSESSIONAL MEETING

22-23 July 2024, via Webex

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Report of the Scientific Council Intersessional Meeting. July 2024.

22-23 July 2024, via Webex

Chair: Diana González-Troncoso Rapporteur: NAFO Secretariat

1. Opening

The Scientific Council (SC) met by Webex during 22-23 July 2024, to finalize discussions on some of the items that required more time following the June Scientific Council meeting (SCS Doc. 24/16).

The meeting was opened by the Chair, Diana González-Troncoso (European Union), at 08:00, Halifax time (UTC -3).

Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), the European Union, Japan, Ukraine, the United Kingdom and the United States of America (Appendix I).

2. Appointment of rapporteur

The NAFO Secretariat (Dayna Bell MacCallum and Jana Aker) was nominated as rapporteur of the meeting.

3. Adoption of agenda

The agenda was adopted as circulated (Appendix II).

4. Update on the results of the PAF testing

a) Generic Approach

Mariano Koen-Alonso (Canada) presented the detailed results of the generic simulation testing, following the feedback received at the 2024 June Scientific Council Meeting. The feedback included two major recommendations: implementing TAC-based removals and improvements to fishery performance metrics. All feedback was addressed. The Scientific Council thanked Mariano and Andrea Perreault (Canada) for their work on the generic testing.

b) Specific Approach

Rajeev Kumar (Canada) presented the detailed results of the specific testing for 3M cod, following the feedback received at the 2024 June Scientific Council Meeting, including the management reference points. The new management reference points use equilibrium analysis, simulation approach and current F_{lim} approach. Nick Gullage (Canada) also presented the detailed results outlined in the dashboard. The Scientific Council thanked Rajeev, Nick and Divya Varkey (Canada) for their work on the specific testing.

The results of the PAF testing are described under agenda item 5.

5. Response to the Request #6 of the Commission

Commission request 6. *The Commission requests Scientific Council to continue progression on the review of the NAFO PA Framework in accordance to the PAF review work plan approved in 2020 and revised in 2023 (NAFO COM-SC RBMS-WP 23-19 (Revised)), specifically to undertake testing of the Provisional Draft PA Framework (COM-SC RBMS-WP 23-20 (Revised)).*

Scientific Council responded:

SC evaluated the proposed Precautionary Approach Framework (PAF) by implementing two simulation exercises using a common set of Performance Statistics (PSs), which effectively constitutes a Management Strategy Evaluation (MSE) focused on testing the PAF itself. These two exercises were a generic testing that evaluated performance using simulated stocks with a range of life histories and error profiles, and a specific testing that evaluated performance of the proposed PAF implementation in two concrete NAFO stocks, 3M Cod and 3NO Witch flounder.

The results from the simulation testing exercises indicate that the proposed PAF reasonably meets most of the objectives proposed, while promoting stock biomass to stabilize at higher levels and away from B_{lim}. The proposed PAF was fairly effective in rebuilding stocks to the Healthy Zone, but it fell short in terms of maintaining stocks above B_{msy} more often than not, mainly because of the intrinsic population variability. Reducing F_{target} is one way of compensating for this variability.

Recovery times are variable and dependent on the life history characteristics of the stock, and they tend to be somewhat longer than standard management planning horizons.

Due to the variability associated with process and observation error, fishing along the different trajectories within the leaf Harvest Control Rule (HCR) tends to show similar performances in the long term, but some differences exist when fishing in the Cautious Zone, which tend to be amplified as the leaf width increases

While the proposed PAF appears to be somewhat tolerant to Reference Points (RPs) misspecification, good estimates of RPs are essential for the proposed PAF to work as desired.

Defining a default leaf width within the PAF is probably adequate to formalize the framework and facilitate its operational implementation. SC suggests the middle width leaf HCR as a good starting point, since it provides a balanced performance among the three leaf width options considered.

While the simulation testing indicates that the proposed PAF can generally achieve the management objectives, a complete PAF would require agreement on some important elements like: a) definition of risk levels and their use in the provision of scientific advice, b) guidance and/or clarifications on how to implement flexibility for different life histories, c) guidance and/or clarifications on how the trajectory of the stock and position in the Cautious Zone need to be considered in the scientific advice, and d) guidance and/or clarifications on the implementation of the PAF for stocks managed with survey-based assessments.

In addition to these elements, it would also be advisable for the proposed PAF to include a timeline (e.g. every 5-7 years) for reviewing the functioning of the PAF in general, and in particular some of its elements such as the values of RPs.

Introduction

The review process of the NAFO Precautionary Approach Framework (PAF) has agreed on several structural elements that would be expected to be at the core of a revised NAFO PAF (NAFO/COM-SC Doc. 22-07; NAFO/COM-SC Doc. 23-03; NAFO/COM-SC Doc. 24- 01). These elements include the establishment of three risk zones for stock status (Critical, Cautious and Healthy Zones) defined by two stock biomass levels (B_{lim} and $B_{trigger}$), as well as prescribed fishing levels within each zone. Fishing mortality (F) is set at the lowest possible level within the Critical Zone (conceptually $F=0$), and as F_{target} in the Healthy Zone, with F_{target} defined as 85% of the limit fishing mortality ($F_{lim}=F_{msy}$). Within the Cautious Zone, fishing level is defined as a range of fishing mortalities based on the implementation of a leaf-shaped Harvest Control Rule (leaf HCR). The leaf HCR is intended to provide managers with alternative options for decisions, all of which should be consistent with meeting management objectives based on the principles established in the NAFO Convention.

A critical step in the review process is to evaluate the performance of the currently agreed structure to determine if the PAF as proposed does indeed meet the suite of defined management objectives (NAFO/COM-SC Doc. 24-01) and what the emergent trade-offs among objectives are. This evaluation was carried out by implementing closed-loop simulation testing of the proposed PAF in two complementary ways. One was the generic testing, which relied on simulating stocks with different life histories, included process, observation and implementation - misspecification of Reference Points (RPs) - errors to cover a broad range of potential circumstances, and tested three alternative widths for the leaf HCR (narrow, middle and wide). The other one was the specific testing, which involved simulation testing of the proposed PAF in two real NAFO examples (3M cod and 3NO witch flounder), where models as close as possible to the current assessment models were used in the simulation testing, and focused on testing a single leaf HCR width (middle) in very concrete and tangible implementation scenarios.

These two closed-loop simulation testing exercises used a common set of Performance Statistics (PSs) (NAFO SCS Doc. 24/13), and effectively represent an Management Strategy Evaluation (MSE) focused on testing the management framework itself. The results from these exercises are expected to inform the path forward for firming-up the structure of a revised NAFO PAF (e.g. is the current proposed structure adequate? which kind of modifications may be required, if any?), including generic HCRs that should be generally applied automatically by the SC to produce the advice unless bespoke approaches are available (e.g. stock-specific MSEs).

Generic Testing Results

The generic testing considered a range of parameterizations for the stocks that represented a suite of life histories, and even explored some variations within them to consider lower productivity cases as seen in recent years in many NAFO stocks.

The results show that the proposed PAF is generally effective in achieving the objectives related to preventing the stock from systematically falling into undesirable stock status states due to fishing in most cases and scenarios (e.g. preventing stocks from falling below $B_{trigger}$), but regularly fails to achieve the objective of maintaining biomass above B_{msy} more often than not with a high probability (≥0.75). When more realistic scenarios are considered (e.g. misspecification of the true values for the reference points), performance is generally eroded. For example, when errors are assumed in the F reference points, the PAF fails to achieve the objective of keeping F below F_{msy}, as might be expected.

In terms of recovery-related objectives, the proposed PAF performs generally well in terms of promoting growth, but typically fails to achieve the objective of rebuilding biomass above $B_{trigger}$ for stocks with pelagic and redfish life history characteristics. Recovery times are variable and dependent on the life history characteristics of the stock, and they tend to be somewhat longer compared to standard management planning horizons (between 1-3 years). As expected, mis-specification of reference points erodes performance, with stocks with redfish and small pelagic life histories being the most affected.

On fishery performance, the proposed PAF does not meet the criteria for maintaining the long-term catch around MSY, but this result is a consequence of F_{target} being set below F_{msy} within the PAF. When this is evaluated considering the catch level associated with F_{target}, the performance metric improves, but this does not fully resolve the issue. Meeting the objective of keeping TAC interannual variation within 20% tends to fail for species with pelagic and redfish life history characteristics, and as expected, the failure is more pronounced when fishing follows the lower edge of the leaf.

In general, while the leaf width and fishing trajectory within a leaf can impact performance, the variability due to process and observation error often obscures differences among leaf options. Nevertheless, some patterns were robust to this variability. Interannual TACs variability was higher when fishing along the lower edge of the leaf in all leaf width scenarios, and it was the most variable in the wide leaf option. The forgone yield from fishing along the lower edge of the leaf vs the upper edge was variable and dependent on the life history of the stock and scenario, but in all cases increased with the leaf width. Time to recovery was longer when fishing along the upper edge of the leaf in all width scenarios, and it was the longest for the wide leaf option.

Generic Testing Conclusions

Overall, the proposed PAF performs sensibly under the broad range of simulated stocks considered. While the framework still works reasonably well when errors in RPs are introduced, the performance of the PAF is clearly eroded. This highlights the critical importance of further research to better estimate RPs within the PAF.

The PAF did not achieve the PS of maintaining the stocks biomass around B_{msy}, but was generally capable of keeping or rebuilding stocks to levels consistent with $B_{trigger}$. The failure to meet the B_{msy} PS is a combination of the F_{target} value used (F_{target}=0.85*F_{msy}) and the success criterion for this PS (75% probability to indicate "more often than not"). Exploratory runs with F_{target}=0.75*F_{msy} performed better, allowing most stock types, except those with pelagic life histories, to meet the PS success criterion in a process+observation error scenario. This also suggests that pelagic stocks may need an even lower F_{target} because of their higher variability.

Recovery times are dependent on the life history characteristics of the stock and they tend to be somewhat longer compared to the standard planning management horizons (between 1-3 years). This suggests that the effectiveness of the management system could be improved by explicitly considering the trade-offs between the standard 1-3 years management horizons, and the potential longer-term implications of the management decisions (e.g. higher catches that produce short-term benefits can lead to a faster reduction in stock size that may take decades to rebuild).

The leaf width can impact performance, but under process and observation error this variability often dominates and can obscure differences among leaf options. However, some clear differences include higher TAC variability when fishing operates along the lower edge of the leaf, and longer recovery times when fishing operates along the upper edge of the leaf. These patterns become more pronounced as the leaf width increases.

Specific Testing Results

The specific testing, which involved MSE simulation testing of the proposed PAF for 3M cod and 3NO witch flounder with models as close as possible to the current assessment models, is focused on testing the middle width leaf HCR in very concrete and tangible implementation scenarios.

These theoretical exercises were intended to evaluate how the PAF would perform when the details of specific assessment models are considered and to determine what the emerging implementation issues might be.

3M Cod Specific Testing Results:

The simulation testing of 3M cod utilized an operating model based on the Bayesian Statistical catch-at-age model. Two stock-recruitment relationships (SRRs), Beverton-Holt and Ricker models, were evaluated. Due to the lack of confidence in any stock-recruit model fit, selecting the stock-recruitment relationships to use in the MSE simulations relied on both model fitting and expert judgment.

RPs determine the boundaries of the leaf HCR and current status of the stock. Several factors could influence these RPs, such as estimation approaches, the length of the time-series used for calculation of life-history characteristics (LHC), and the stock-recruitment curves, but the most important factor in 3M cod is the length of the time-series used in the LHC calculation. The RPs estimates for this stock are consistently higher across the approaches when using average for the full-time series compared to the average for the last 3 years.

The outcome from simulation-based RPs using a 3-year average LHC for both recruitment options showed the stock reaching the Healthy Zone. Biomass stabilizes in the Healthy Zone and does reach the prevention-related targets of maintaining biomass above B_{target}, but similar to the generic testing, biomass levels do not reach the PS of getting the biomass above B_{msy} more often than not. Consistent with the generic testing, the F_{target} implemented supports growth of the stock into the Healthy Zone, but not above B_{msy} more often than not. The fishery yields approach MSY towards the end of the simulation. F-levels at the beginning of the PAF implementation are not much different from the current F applied to the stock; and hence there is not much variability in short-term yields. Since the current stock status is at the boundary of the Healthy Zone at the beginning of the simulation and remains in that zone throughout the simulation, it was not possible to compare the different leaf trajectories. Although overall results are similar for both SRRs, the simulations using the Ricker SRR have slightly better performance metrics than the those using BH for the risk of falling below $B_{trigger}$, risk of overfishing and growth metrics.

The outcome from simulation-based RPs using the full time-series average LHC showed the stock remaining in the Cautious Zone. Only the midrib and the lower edge leaf HCR trajectories show stock growth, but the stock still remained in the Cautious Zone at the end of the projection period. This is due to the higher estimates for F_{target} and SSB at Healthy Zone boundary associated with the full time-series, and the emerging mismatch between the long-term average for stock productivity and fishing patterns used to define RPs, and the recent productivity and fishing patterns used in the projections.

The RPs estimation and simulations showed that under recent conditions (3-year LHC), the stock is less productive than indicated by historical full time-series averages. The results show the importance of robustly estimating the RPs for the functioning of the PAF. This is especially important when there are concerns about non-stationarity in stock dynamics.

3NO Witch Flounder Specific Testing Results:

Simulation testing of the proposed PAF was performed using an operating model based on the Bayesian surplus production model for 3NO witch flounder. For this stock, projections were run for 50 years because the initial 25 years period was not sufficient to reach stability. Biomass for all simulations is projected to increase into the Healthy Zone; however, a few simulations (approximately 35%) reach above B_{msy}. The yields approach MSY towards the end of the simulation. As expected, the projections using the lower leaf trajectory perform better for biomass trends. In the simulations, most F values remain close to F_{target}, with around 27 to 29% exceeding

F_{lim}. In summary, the witch flounder simulations indicate that, in general, the PAF achieves most of the objectives established.

Overall, performance is consistent across all leaf HCR trajectories. All of them achieve a very low risk of stock depletion and allow rebuilding to the Healthy Zone. Consistent with the generic and the 3M cod testing, none of the leaf HCR trajectories are able to maintain the stock above B_{msy} more often than not. All options have a low risk of overfishing, but none are able to maintain yield around MSY in the long-term. All options achieve PS for short-, medium- and long-term growth objectives, and low interannual variability in catch.

Although the long-term results are similar for the three leaf HCR trajectories tested, the short-term outputs show clear differences in the recommended TACs immediately after implementation. There is an abrupt increase in F and the TAC from current levels and the ones under the proposed PAF for the midrib and upper edge leaf HCR trajectories, with the largest increase associated with fishing along the upper edge. In order to minimize abrupt changes in TAC advice upon implementation of the proposed PAF, the choice of fishing level could be informed by mapping the current position of the stock on the leaf HCR.

Specific Testing Conclusions

The specific testing exercises indicated that the proposed PAF was capable of keeping (3M cod) and rebuilding (3NO witch flounder) stocks to the Healthy Zone, but it did not achieve the objective of maintaining stock biomass above B_{msy} more often than not.

The results show that the good performance of the proposed PAF depends on robust estimation of the RPs. Overestimation of these RPs may prevent stocks from reaching the Healthy Zone. For fish stocks, RPs are never 'truly' known and are usually regularly updated during assessments. Our analyses show that choices of LHC and SRR can have large impact on RPs, and highlight a need for further research to better estimate RPs, especially when there are indications of changes in stock productivity over time. These are expected challenges with which the implementation of the proposed PAF will be faced across stocks.

Similar to the generic testing, the upper, midrib and lower leaf HCR trajectories show similar performance in the long term in all tests performed. However, the choice of leaf HCR trajectory could lead to abrupt changes in recommended F and TAC values in the period immediately after implementation of the proposed PAF. Mapping the current position of the stock onto the leaf HCR could help inform management decisions aimed at preventing such abrupt changes during the initial implementation phase.

SC conclusions

The simulation testing of the PAF was implemented by SC to evaluate the management objectives identified during the April 2024 RBMS meeting, which themselves constituted a bespoke articulation of the objectives and principles of the NAFO Convention in the context of the PAF. However, the specific risk levels used in the SC implementation of the simulation testing, which define the pass or fail boundary for the different PSs, were defined solely by SC due to the timeline limitations of the process. While in many cases the risk levels used were based on prior exercises that had managers' input, some performance statistics were new, and managers did not have the opportunity to review and provide input on these values. Since acceptable risk levels are management decisions, the SC evaluation of the performance of the PAF is conditional on these values, and can change if managers' choices of acceptable risks are different than the ones used by SC.

The results from the simulation testing exercises indicate that the proposed PAF, as implemented in these simulations, reasonably meets most of the objectives proposed, while promoting stock biomass to stabilize at higher levels and away from B_{lim}, something that has been a challenge to achieve under the current PAF.

These results also indicate that PAF performance is not homogeneous across stocks; life history characteristics can affect performance, with the proposed PAF performing generally worse for short-lived and/or sporadic recruitment stocks (e.g. redfish stocks). This is no surprise, and indicates that the PAF implementation will require flexibility to better accommodate these types of stocks (e.g. define complementary objectives and PSs focused on stocks with these life history traits, develop specific RPs/HCRs for these stocks, develop additional criteria to guide HCR application to these stocks, etc.).

While the proposed PAF appears to be somewhat tolerant to RPs mis-specification, good estimates of RPs are essential for the proposed PAF to work as desired. This becomes particularly important for stocks assessed by survey trends. Since many NAFO stocks do not have established RPs, PAF implementation will require additional dedicated SC efforts to fill this gap.

Due to the variability associated with process and observation error, fishing along the different trajectories within the leaf HCR (upper edge, midrib, lower edge) tends to show similar performances in the long term, but some performance differences exist when fishing in the Cautious Zone (e.g. higher TAC variation when fishing along the lower edge, longer recovery times when fishing along the upper edge), which tend to get amplified as the leaf width increases.

Intrinsic population variability (process error) erodes the differences in stock productivity in the vicinity of MSY, and leads the PAF to underperform in terms of keeping the stocks above B_{msy} more often than not. Reducing F_{target} to 0.75*MSY is one way of compensating for this variability, and when explored, it improved PAF performance on this front for most stock types except for small pelagics. For these stocks, setting a lower F_{target} based of their life history would improve performance by better accommodating for their higher demographic variability, while also being consistent with the forage species role that characterizes most of these stocks. All these changes would also provide additional demographic resilience to rapid environmental change.

Defining a default leaf width within the PAF is probably adequate to formalize the framework and facilitate its operational implementation, but accommodations need to be made to build in flexibility around this central feature of the PAF. Ideally, the final PAF proposal should include a standard leaf width, and guidelines on how to begin implementing the PAF to avoid large and sudden shifts in TAC levels. Mapping recent stock trajectory (i.e. F and stock status) onto the leaf HCR can provide useful information to reduce TAC variability. SC suggests the middle width leaf HCR as a good starting point, since it provides a balance between the performances (good and bad) observed in the two extreme width options.

While the proposed PAF represents a step forward from the current NAFO PAF, it considers ecosystem effects only at the stock level through the impacts of process error, and makes no explicit allowances for cumulative ecosystem and/or climate change impacts. Notwithstanding these limitations, the structure of the proposed PAF could provide a platform on which to build these types of considerations. This would need the PAF to be adaptable and amenable to updates and modifications as understanding of the relevant processes develops. In this context, it would be important that the PAF to be adopted includes a regular schedule for revisions and updates (e.g. every 5-7 years). Unlike the current PAF review process, these regular revisions would typically not be expected to represent major undertakings; they are mostly intended to provide an avenue for refining the details of the PAF as experience on its use increases. It is this regular updating process, and the experience accumulated in the use of the PAF, what would dictate when the next major revision might be required, and the existence of a regular updating schedule would also provide a built-in mechanism to make it happen.

Finally, while the simulation testing undertaken by SC indicates that the proposed PAF, including the leaf concept to define harvest levels within the Cautious Zone, can generally achieve the specified management objectives, a complete PAF would also require agreement on some important elements. These include:

a) Definition of risk levels (whether qualitative or quantitative), and how to use the related probabilities of being above or below RPs (B_{lim} and $B_{trigger}$) to provide the scientific advice,
b) guidance and/or clarifications on how to implement flexibility for different life histories (e.g. Are the suggestions indicated above -e.g. changes in F_{target} - sufficient or more is needed? Different leaf width? Recommended trajectory within the leaf? Some combination of these features? Additional considerations for some life histories characteristics like redfish and pelagics?),
c) guidance and/or clarifications on how the trajectory of the stock and position in the Cautious Zone (July 2023 RBMS report – COM-SC Doc. 23-03) need to be considered in the context of the elaboration of the scientific advice (e.g. advice to be constrained to some parts of the leaf, such as between the midrib and a given edge?) and management decisions, and
d) guidance and/or clarifications on the implementation of the PAF for stocks managed with survey-based assessments (i.e. stocks for which calculating probabilities may not be straightforward or even possible).

In addition to these elements, it would also be advisable to include in the proposal a timeline (e.g. every 5- 7 years) for reviewing the functioning of the PAF in general, and in particular some of its elements such as reference point values.

6. Other matters

There were no other matters.

7. Closing

The meeting adjourned at 12:08 hours on 23 July 2024.

APPENDIX I. LIST OF PARTICIPANTS, JULY 2024

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APPENDIX II. PROVISIONAL AGENDA

Scientific Council Intersessional Meeting

22-23 July 2024, via Webex.

Provisional Agenda

Two days virtual meeting.

1. Opening
2. Appointment of rapporteur
3. Adoption of agenda
4. Update of the results of the PAF testing
    a) Generic Approach
    b) Specific Approach
5. Response to the Request #6 of the Commission: *The Commission requests Scientific Council to continue progression on the review of the NAFO PA Framework in accordance to the PAF review work plan approved in 2020 and revised in 2023 (NAFO COM-SC RBMSWP 23-19 (Revised)), specifically to undertake testing of the Provisional Draft PA Framework (COM-SC RBMS-WP 23-20 (Revised)).*
6. Other matters
7. Closing