Serial No. N6768 NAFO/COM-SC Doc. 17-11

Northwest Atlantic Fisheries Organization

Report of the NAFO Joint Commission-Scientific Council Working Group on Risk-Based Management Strategies (WG-RBMS) Meeting

15-17 September 2017
Montreal, Quebec, Canada

NAFO
Dartmouth, Nova Scotia, Canada
2017

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1. Opening of the meeting

The meeting was opened at 09:45 hours on 15 September 2017 in the Marriott Château Champlain, Montreal, Canada. The co-Chairs, Jacqueline Perry (Canada) and Carsten Hvingel (Norway) welcomed representatives from Canada, the European Union (Spain, Portugal, Estonia and the European Commission), Japan, the Russian Federation and the United States of America (Annex 2).

2. Appointment of Rapporteur

The NAFO Scientific Council Coordinator (NAFO Secretariat) was appointed as rapporteur.

3. Adoption of Agenda

The provisional agenda (Annex 3) previously circulated was adopted without any changes.

4. Selection of the Management Procedure and associated Harvest Control Rule

The results of the trials of six candidate management procedures (CMPs) specified at the July 2017 Dartmouth RBMS meeting (COM-SC doc 17-06) were reported for base case and robustness trials developed under SCAA and SSM based operating models (COM-SC RBMS-WP 17-17 and COM-SC RBMS-WP 17-18 respectively).

An important advance from the previous meetings was the addition under the SCAA model of a new CMP that combined slope and target based HCRs in the form:

$$\mathrm{TAC}_{(y+1)} = \frac{\mathrm{TAC}_{(y+1)}^{target} + \mathrm{TAC}_{(y+1)}^{slope}}{2}$$

Given the similarity of the results amongst the alternative slope based CMPs variants under consideration, it was agreed that only one slope based variant (S2) should be taken forward. Thus, only three CMPs were included in subsequent trials: one slope, one target and one combination, with two alternative starting TACs (15 000 and 17 500 tonnes).

It was noted that the SSM trials resulted in a very high number of failures relative to the SCAA trials. Japan considered that this could be attributed to the different way that tuning had been applied for the SCAA and SSM models. Tuning parameters for proposed management procedures are chosen to ensure the resource meets pre-specified targets in a pre-specified year for a specified OM (e.g. the median spawning biomass projected equals B_{MSY} in the specified year). For the SSM, different tuning parameters were used for each OM, while for SCAA the tuning parameters for the base operating model (OM1) were used in all other robustness trials. To investigate this, Canada re-ran the SSM trials using the SSM OM1 tuning parameters for all runs.

It was also observed that in the SSM trials, the alpha parameters for the target-based CMPs were around 0.6, in contrast to being close to 1 for the corresponding SCAA based CMPs. This results in these SSM based CMPs being much more “aggressive”, i.e. tending to result in much higher TAC values. Given this large difference, it is important that each CMP associated with SCAA or SSM OMs be tested against the base OM for the other assessment method for a proper comparison to allow an assessment of the robustness of each CMP.

To apply this cross-check, the CMP settings and survey weightings used for each of the base OMs were run under the alternative base OM. The results of applying the SSM CMP settings to the SCAA base OM trial gave very low B values and very high values for F etc. Likewise, applying the SCAA settings to the base SSM trial gave high B values. Clearly changing the alpha parameter in the CMP originally tuned using SSM base OM gave much better outcomes (the results shown earlier gave a very high number of failures). The consensus was that the CMP settings (tunings) used under the SCAA model should be applied for both base case and robustness trials for both the SCAA and SSM based OMs.

The relative benefit of the three types of CMPs were summarized as follows:

Target superior to Slope

- Lower F values over most of the projection period
- Higher final spawning biomass
- Smoother time trends in TACs
- Lower average annual variation (AAV)

Slope superior to Target:

- Lower F values towards the end of the projection period
- Higher annual average catches
- Lesser ranges for average annual catch and for final exploitable biomass

Combination superior to both Slope and Target?

- AAV lower
- Less trend in catches over earlier years
- In other respects, at least the equal of both other CMP types
- Exceptions to previous bullet: less annual average catch and higher F towards the end of the projection period than for slope-based

It was observed that the target based CMPs gave greater inter-annual variability TAC than either the slope or combination, and lower average TACs in the long term. It was therefore agreed to remove the target based CMPs from further consideration.

Between the two remaining options, the combination CMP gives the greatest stability while the slope CMP gives the greater TAC increase in the early years and so better yields over the first 20 years. The combination CMP gives a marginally faster increase in biomass, but the difference is very small. Looking at the lower 10th percentile, there is a greater risk of catch going down in the short term with the slope based rules.

Looking at the superimposed plots, it was agreed that there was little difference between the combination and slope CMPs for almost all of the criteria. The only real exception was the yield, where it was noted that the slope based rule resulted in greater inter annual variability and a possible dip to low values in the earliest years. It was finally agreed that only the combination rules should go forward.

Regarding starting values, it was observed that the 17 500 tonnes starting TAC value led in many runs to median F going well above F_{msy} in the early years. This was not the case for the 15 000 tonnes starting TAC. Consensus was that 17 500 tonnes was too high and therefore further runs were conducted with a starting TAC of 16 500 tonnes.

With a starting TAC of 16 500 tonnes, for the base case (OM1) run, median F/F_{msy} was very close to 1 at its highest point. For some robustness tests, F goes above F_{msy}; however these are relatively extreme scenarios so could be considered to have low plausibility. For some criteria, even a TAC of zero could result in failure for some of the robustness tests (e.g. those with low recruitment). The zero removals comparison proved useful for management decision making as it enabled a comparison of the 'cost of fishing' under specific rules, compared to a most-optimistic population growth scenario possible.

Based on this reasoning, the WG agreed a starting TAC of 16 500 tonnes.

The group considered a number of options for the implementation period to be covered by the management strategy and a potential schedule for update assessments. Suggested options for the length of the implementation period ranged from three to eight years; however most participants considered that a period between six and eight years would be more appropriate. It was noted that an Exceptional Circumstances protocol would be required to determine under what circumstances the TAC recommendation output by the management procedure should be over-ruled or perhaps the management procedure reviewed earlier than planned. There was consensus that indicators of Exceptional Circumstances should be monitored annually with periodic assessments to allow recruitment to be monitored.

It was agreed that the management procedure should be implemented for an initial period of six years with an "update" assessment after three years. The assessment could be done any year if the circumstances included in the exceptional circumstances protocol occur. (Note that an "update" assessment involves only rerunning the previously agreed base case assessment unchanged except for the addition of data becoming available in subsequent years, whereas a full assessment would include consideration of alternative assessment assumptions and methods as well.)

5. Review of Recommendations from this meeting and from previous 2017 meetings to the Commission and Scientific Council.

Recommendations were forwarded to the Commission for consideration and adoption at its Annual Meeting in September (COM-SC Doc. 17-10). The recommendations below are substantially the same with minor editorial clarifications.

i) Management procedure

WG-RBMS recommends that the Commission should implement a model-free management procedure (MP), i.e. the MP does not include any assessment model, but instead calculates TACs to be implemented in the future directly from the biomass indices provided each year by five different surveys.

WG-RBMS further recommends that the harvest control rule (HCR) component of this MP should be a combination of a "target based" and a "slope based" rule. The "target-based" rule increases or decreases the TAC depending on whether an biomass index averaged over the 5 available surveys is above or below a target level, taken here to be a specified multiple (α) of its immediate past (in this case 5 years average) level. A "slope-based" rule considers the recent trend in this averaged biomass index, and increases or decreases the TAC depending on whether the overall trend is up or down.

The full formulation of the MP is set out in Annex I. A number control parameter values (such as α above) were selected so that the MP achieves an appropriate trade-off amongst the various objectives for the fishery and resource that were pre-specified by WG-RBMS (NAFO/FC-SC Doc. 17-03) to be desirable. The values recommended for these control parameters are set out in Tables 1 and 2 of Annex I. These selections include that the TAC for the first year (2018) of application of the MP will be 16 500 tonnes, and that TACs may change by no more than 10% (either up or down) from one year to the next.

ii) Implementation

The management procedure should be implemented initially for six years. It should be annually monitored by the Scientific Council to determine whether Exceptional Circumstances are occurring. Scientific Council should perform an "update assessment" after three years. If either the annual monitoring or the update assessment indicates that Exceptional Circumstances are occurring, the Exceptional Circumstances protocol will provide guidance on what steps should be taken.

iii) Exceptional Circumstances

The Exceptional Circumstances protocol should consist of two elements: 1) a technical description that identifies when Exceptional Circumstances have occurred, and 2) what actions should then be taken.

To support the development of an Exceptional Circumstances protocol by WG-RBMS, the Commission should request the Scientific Council at its June 2018 meeting to develop criteria for the identification of Exceptional Circumstances, taking account *inter alia* of the following issues raised by the Working Group:

- Clear determination of how missing data points required for input to the HCR should be filled and specification of the number of missing surveys that would trigger Exceptional Circumstances.

- Note elements that are based on data that are available to SC as part of its annual monitoring (survey results) as well as others that are based on less frequent update assessments, e.g. estimates recruitment, biomass or fishing mortality.
- Identify the indices that the MSE indicated to be more important to monitor in regard to the determination of Exceptional Circumstances, e.g. the factors that were indicated to have greater influence in the robustness trials. This links to the consideration of a suite of primary and secondary indicators.
- Consider an appropriate balance between specificity *vs* flexibility in defining Exceptional Circumstances.
- The robustness of the Exceptional Circumstances protocol should ensure that their application is triggered only when necessary.
- Evaluation of recruitment signals should be a key consideration, given some concern within the Working Group over poorer performance of the proposed rule under a low recruitment scenario.

WG-RBMS will meet in August 2018 to finalize the Exceptional Circumstances protocol.

6. Other Matters

The Working Group discussed timing of the 3M cod benchmark assessment and subsequent MSE. It was noted that the 3M cod MSE would be less pressurized than that for Greenland halibut as it is scheduled to take place over two years, rather than only one year. The completion of the benchmark assessment in April 2018 will be the starting point to development of the new 3M Cod this MSE.

7. Adoption of Report

The recommendations to the Commission were adopted as COM-SC WP 17-03 in order that the Commission should have the opportunity to consider WG-RBMS advice during the annual meeting.

The adoption of the full report was deferred to be completed via correspondence.

8. Adjournment

The meeting was adjourned at 17:00 on 17 September 2017, one day later than scheduled.

Annex I. A detailed technical specification of the Management Procedure (MP) recommended

As indicated in the main text of the report, the MP recommended is a combination of a target- and a slope-based approach. This Annex describes each of these approaches in turn, and then how the outputs from the two are combined to provide the final TAC recommendation.

*Target based (**t**)*

The basic harvest control rule (HCR) is:

$$TAC_{y+1} = TAC_y \left(1 + \gamma(J_y - 1)\right) \quad (1)$$

where TAC_y is the TAC recommended for year y, γ is the “response strength” tuning parameter, J_y is a composite measure of the immediate past level in the abundance indices (I_y^i) that are available to use for calculations for year *y*; for this base case CMP five series have been used, with *i* = 1, 2, 3, 4 and 5 corresponding respectively to Canada Fall 2J3K, EU 3M 0-1400m, Canada Spring 3LNO, EU 3NO and Canada Fall 3LNO:

$$J_y = \sum_{i=1}^{5} \frac{1}{(\sigma^i)^2} \frac{J_{current}^i}{J_{target}^i} \Big/ \sum_{i=1}^{5} \frac{1}{(\sigma^i)^2} \quad (2)$$

with $(\sigma^i)^2$ being the estimated variance for index *i* (estimated in the SCAA model fitting procedure, see **Table 1**)

$$J_{current}^i = \frac{1}{q} \sum_{y'=y-q}^{y-1} I_{y'}^i \quad (3)$$

$$J_{target}^i = \alpha \frac{1}{5} \sum_{y'=2011}^{2015} I_{y'}^i \quad \text{(where } \alpha \text{ is a control/tuning parameter for the MP)} \quad (4)$$

Note the assumption that when a TAC is set in year *y* for year *y*+1, indices will not at that time yet be available for the current year *y*.

*Slope based (**s**)*

The basic harvest control rule (HCR) is:

$$TAC_{y+1} = TAC_y \left[1 + \lambda_{up/down}(s_y - X)\right] \quad (5)$$

where $\lambda_{up/down}$ and X are tuning parameters, s_y is a measure of the immediate past trend in the survey-based abundance indices, computed by linearly regressing lnI_y^i vs year y' for $y' = y - 5$ to $y' = y - 1$, for each of the five surveys considered, with

$$s_y = \sum_{i=1}^{5} \frac{1}{(\sigma^i)^2} s_y \Big/ \sum_{i=1}^{5} \frac{1}{(\sigma^i)^2} \quad (6)$$

with the standard error of the residuals of the observed compared to model-predicted logarithm of survey index *i* (σ^i) estimated in the SCAA base case operating model.

*Combination Target and Slope based (**s+t**)*

For the target and slope based combination:

1) TAC_{y+1}^{target} is computed from equation (1),
2) TAC_{y+1}^{slope} is computed from equation (5), and
3) $TAC_{y+1} = \left(TAC_{y+1}^{target} + TAC_{y+1}^{slope}\right)/2$

Finally, constraints on the maximum allowable annual change in TAC are applied, viz.:

$$\text{if } TAC_{y+1} > TAC_y(1 + \Delta_{up}) \text{ then } TAC_{y+1} = TAC_y(1 + \Delta_{up}) \quad (7)$$

and

$$\text{if } TAC_{y+1} < TAC_y(1-\Delta_{down}) \text{ then } TAC_{y+1} = TAC_y(1-\Delta_{down}) \quad (8)$$

The control parameters for the recommended MP: CMP16.5_s+t are shown in Table 2.

Table 1. The weights given to each survey in obtaining composite indices of abundance are proportional to the inverse squared values of the survey error standard deviations σ^i listed below.

Survey	σ^i
Canada Fall 2J3K	0.22
EU 3M 0-1400m	0.21
Canada Spring 3LNO	0.49
EU 3NO	0.38
Canada Fall 3LNO	0.26

Table 2. Control parameter values for the MPs recommended. The parameters α and X were adjusted to achieve a median biomass equal to B_{msy} for the exploitable component of the resource biomass in 2037.

TAC_{2018}	16 500 tonnes
γ	0.15
q	3
α	0.972
λ_{up}	1.00
λ_{down}	2.00
X	-0.0056
Δ_{up}	0.10
Δ_{down}	0.10

Annex 2. List of Participants

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Annex 3. Agenda

1. Opening by the co-Chairs, Jacqueline Perry (Canada) and Carsten Hvingel (Norway)
2. Appointment of Rapporteur
3. Adoption of Agenda
4. Selection of the Management Strategy and Harvest Control Rule for MSE application to the 2+3KLMNO Greenland halibut among the candidate procedures and strategies
5. Review of Recommendations from this meeting and from previous 2017 meetings to the Commission and Scientific Council
6. Other matters
7. Adoption of report
8. Adjournment