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Northwest Atlantic Fisheries Organization

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

25-27 April 2017
Falmouth, MA, USA

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1. Opening by the co-Chairs, Carsten Hvingel (Norway) and Jacqueline Perry (Canada)

The meeting was opened at 10:00 hours on 25 April 2017 at the Holiday Inn in Falmouth, Massachusetts, USA. Carsten Hvingel (Norway) and Jacqueline Perry (Canada), co-Chairs of the Working Group were unable to attend. Katherine Sosebee (USA) was elected as acting Chair. Representatives from the following Contracting Parties were in attendance: Canada, European Union, Japan and the United States of America (Annex 1).

2. Appointment of Rapporteur

The Senior Fisheries Commission and Scientific Council Coordinators (NAFO Secretariat) were appointed co-Rapporteurs.

3. Adoption of Agenda

The revised provisional agenda previously circulated was adopted (Annex 2).

4. Review of the recommendations from the WG-RBMS Meeting, 07-09 February 2017

The meeting recommendations are documented in FC-SC Doc. 17-02. They include:

- **Fisheries Commission to consider and endorse the updated plan for the 3M cod benchmark.**

  The Working Group took note of the updated plan which was presented as Annex 3 of the FC-SC Doc. 17-02. It will endeavour to work on the 3M cod benchmark in accordance with the updated plan.

- **Scientific Council to take into account the guidance Management Objectives and the formulation of the HCRs developed by this WG, and to reflect on potential updates to the Exceptional Circumstances protocol.**

  The Working Group discussed this recommendation under agenda items 5 - 8.

- **WG-RBMS to reflect on potential updates to the Exceptional Circumstances protocol.**

  The Working Group discussed this recommendation under agenda item 9.

5. Matters arising from the SC Meeting, 03-07 April 2017 in Vigo, Spain

The SC NAFO Greenland Halibut Management Strategy Evaluation meeting, 03-07 April in Vigo, Spain was held in accordance with the MSE workplan adopted in September 2016 during the NAFO Annual Meeting. The final report of this meeting was not available in time to be considered by the present meeting due to the very large number of model runs that were done. A decision was taken to focus on the technical details of these results from the Vigo meeting, which resulted in lack of time to complete the report during the meeting as per normal practice. Parties recognized that the compressed timeline between the two meetings provided limited opportunity to prepare and finalize the report. To allow this Working Group the opportunity to discuss the report, a "working draft" was made available, although some sections (e.g. on State-Space Assessment Model) were not yet available. Candidate assessment models considered by the Vigo meeting included: Statistical-Catch-At-Age (SCAA), a variation of the State-Space Assessment Model developed by Nielsen and Berg (2014) (hereafter referred to as SAM-style), Extended Survivor Analysis (XSA) and a Bayesian implementation of a series of Surplus Production Models. The SC also provided some preliminary evaluation of the performance of the 2010 MSE.

The EU expressed concern that the XSA model, which was agreed to be taken forward by this Working Group last year, appears to have been dropped from consideration in favour of the SAM-style model and that some runs of the SAM-style model included a spatial element that differentiates between the Newfoundland Shelf and Flemish Cap areas. The EU believed that this spatial model is likely to be unacceptable to the EU and possibly to other Commission members and its addition to the number of models already discussed could lead to delays in completing the MSE. There were conflicting views among scientists present about whether the spatial elements had been discarded in Vigo purely on scientific grounds. One of the Vigo meeting co-Chairs clarified that the spatial model development process was based upon patterns in the residuals of initial model runs, which had no spatial component, and was wholly independent of any other considerations. The SC Chair stated that, given the different interpretations on the work done on SAM-style models, all the models discussed at the Vigo meeting remained under consideration and a decision on which to take forward will be made by the SC at its June meeting.

6. Update on Progress to Develop Candidate Management Strategies and/or Harvest Control Rules (HCRs)

SCR 17-05 presents an example of the development of a suite of candidate Harvest Control Rules with the general form:

$$TAC_{y+1} = \omega TAC_y \left(1 + \gamma_{up/down}(J_y - 1)\right)$$

where:

TAC_y is the TAC for year y,

ω, γ_{up} and γ_{down} are tuning parameters (γ_{down} if $J_y < 1$ and γ_{up} if $J_y \geq 1$),

J_y is a measure of the immediate past level in the biomass indices that are available to use for calculations for year y,

and a is a further tuning parameter which is part of the definition of J_y.

The Working Group discussed the implications of this format for the generation of Harvest Control Rules. The preliminary nature of the testing of this candidate HCR and the need for closer examination of the parameters was noted and it was agreed that further study was required. Insights gained through preliminary runs of the MSE will allow the range of candidate Harvest Control Rules under consideration to be reduced to a manageable number. The effects of varying the starting TAC and of including the assumption of unreported catches of up to 30% were examined through exploratory runs of the SCAA model under the baseline scenario. It was agreed that at least one run including future 30% unreported catches should be included for each trial. Participants also noted the concern expressed by SC that the agreed annual catch estimates (recently available) were appreciably higher than the TAC for 2011-14. Further, they recognized that recent estimates developed by the Catch Data Advisory group were more in line with TAC for 2015 and discrepancies between TAC and catch estimates would need to be considered in the development and implementation of the HCR.

A study of the Harvest Control Rule parameterization applied in SCR 17-05 indicated that further consideration should be given to additional parameter choices that place greater emphasis on responsiveness to changes in stock size (i.e. changes to J_y). The values used in the initial MSE work in SCR 17-05 result in limited TAC change even under very large changes in stock size – for example, a one year halving or doubling in stock size. It was agreed that parameter choices which make this HCR more responsive to stock size change would be considered in future work.

There was agreement that the existing slope-based HCR (as outlined in Annex I.F of the NAFO Conservation and Enforcement Measures), as well as possible variants of the same, would also be tested as an alternative to the target-based formulation put forward in SCR 17-05.

7. Finalization of management objectives and their corresponding Performance Targets and associated Performance Statistics

The finalization of the management objectives, performance targets and associated performance statistics continued. Table 1 below captures the progress made by the Working Group. Table 2 summarizes the performance targets that were considered to be either "required" or "desirable but secondary" performance targets.

The Working Group noted that risk thresholds associated with "required" as distinct from "desirable but secondary" performance target would likely differ to ensure that essential objectives under the management procedure would be met with high probability. It was difficult to reach agreement on other targets/thresholds in the absence of an assessment with projections that would inform the feasibility and/or trade-offs associated with reaching such targets. However, there was agreement on what performance statistics would be generated. A discussion on potential trade-offs will be required at a future meeting of the WG-RBMS.

8. Provision of advice concerning the direction for further Candidate Management Strategies and/or Harvest Control Rules (HCRs) development

Paring down exercise to limit the number of candidate management strategies and/or HCRs will be undertaken as preliminary results of the MSE simulations become available.

The work on the revised management strategies and/or HCRs is planned to proceed as follows:

1. The existing central Candidate Harvest Control Rules (HCRs) (SCR 17-05) will be used to identify those OMs which have the greatest impact on performance – this is called the Reference Set
2. A set of Candidate Management Strategies will be developed which are:
    a. Tuned to the $P(B_Y < 0.3\,B_{MSY}) \leq 0.10$ criterion for the 2018-2037 period, with $P(B_{2037} < B_{MSY}) \leq 0.5$ as a desirable secondary criterion
    b. Show good performance over the Reference Set
    c. Have investigated alternative form, i.e. aspects such as the value of the gamma parameter in the current central Candidate Harvest Control Rules (HCRs)
3. Since it is time-consuming and less-user-friendly for decision-makers to list values of performance statistics and provide plots for every combination of Candidate Management Strategy and Operating Model (OM), discretion may be used by the Scientific Council to provide:
    a. Full output for the preferred 2 or 3 Candidate Management Strategies and the baseline plus a few members of the Reference Set of OMs
    b. Reduced output for the remainder of the OMs of the Reference Set, plus any other HCRs for all the Reference Set of OMs
    c. Tabular and summary comparative plot statistics for the remaining OMs
4. If possible, results will be circulated to SC members a few days before the start of the SC meeting for possible requests for a few additional runs

9. Exceptional Circumstances Protocol

It was agreed to defer the discussions on Protocol until the HCR is selected.

10. Recommendations to forward to SC and FC

This item was deferred to the next meeting.

11. Other Matters

The next meeting of WG-RBMS will be held shortly after the June SC meeting to allow time for the completion of the SC report. Candidate dates for this meeting, based on the availability of Working Group members, were identified as the second week (10 – 14) of July or the second (14 – 18) or third (21 – 25) full weeks of August, with a preference for the July dates. These dates and the location of the meeting will be agreed after consultation with the WG-RBMS co-Chairs.

12. Adoption of Report

The report was adopted by correspondence following the meeting.

13. Adjournment

The meeting was adjourned at 15:00 hrs on 27 April 2017.

Table 1. Draft Table of Proposed Performance Statistics and Criteria

Management Objectives		Performance Measures – Vigo Draft	Performance Measures – Japan proposals – for each distribution median, 5%- and 95%ile are reported	Performance Measures and Criteria WG-RBMS, Falmouth	Example Performance Criteria (London)
1.	Restore to within a prescribed period of time or maintain at B_{msy}	a) P_{2037}/P_{MSY} where P_{MSY} is the population level when maximum sustainable yield is achieved;	$B^{5-9}{}_{2037}/B_{MSY}$ $B^{5-9}{}_{2027}/B_{MSY}$ note B_{MSY} refers to B^{5-9}, i.e. B_{exp}	$P(B_{2037} < B_{MSY}) \leq 0.5$ $P(B_{2037} < 0.8\,B_{MSY}) \leq 0.25$ [Timeframe to be determined]	To be determined
2.	The risk of failure to meet the B_{msy} target and interim biomass targets within a prescribed period of time should be kept moderately low	Need to see outputs in order to determine appropriate reference period	Covered by; $B^{5-9}{}_{2037}/B_{MSY}$ and indirectly by $B^{5-9}{}_{lowest(2018-2037)}/B_{MSY}$	$P(B_{2022} < B_{2018}) \leq \alpha$ α = 0.10 if $B_{2018} < 0.3B_{MSY}$ 0.25 if $0.3\ B_{MSY} < B_{2018}$	The probability of failure to meet a milestone within a prescribed period of time should be kept at 25% or lower
3.	Low risk of exceeding F_{MSY}	b) $F_{highest}/F_{msy}$, where $F_{highest}$ is the highest F during each evaluation period (2018-2022, 2023-2027 and 2028-2037);		$count_y[P(F_y > F_{MSY}) > 0.3]$ for y = 2018 to 2037	The probability of F exceeding F_{msy} during the evaluation period should be kept at 30% or lower.
4.	Very low risk of going below an established threshold [e.g. B_{lim} or B_{lim} proxy].	No limit threshold has been defined	Covered by; $B_{sp(2037)}/B_{sp(2018)}$ And; $B^{5-9}{}_{2037}/B^{5-9}{}_{2018}$ $Bratio_{lowest} = min_y[B_y/B_{msy}]$	$P[Bratio_{lowest} < 0.3] < = 0.1$ For y = 2018 to 2037	The probability of a total/exploitable biomass under an established threshold (e.g. B_{lim}/B_{lim} proxy) at 10% or lower

Management Objectives		Performance Measures – Vigo Draft	Performance Measures – Japan proposals – for each distribution median, 5%- and 95%ile are reported	Performance Measures and Criteria WG-RBMS, Falmouth	Example Performance Criteria (London)
			for y = 2018 to 2037 $B^{5-9}{}_{lowest(2018-2037)}/B_{\mathrm{MSY}}$	$count_y\left[P\left(B_y < 0.3B_{MSY}\right) \geq 0.1\right]$	
5.	Maximize yield in the short, medium and long term	c) (Average) annual catch over short, *medium* and long terms: , C_{2019}, C_{2020}, $\sum_{y=2018}^{2022} C_y/5$, $\sum_{y=2018}^{2027} C_y/10$, $\sum_{y=2018}^{2037} C_y/20$	Covered sufficiently by; Average annual catch (2018-2020) And' Average annual catch (2018-2037)		The magnitude of the average TAC in the short, medium and long term should be maximized. The probability that the TAC is below 10,000t in any one year for the period year x to x +5 should be 25% or lower
6.	The risk of steep decline of stock biomass should be kept moderately low	Proposal a. (considering only 5-year period) P_{2022}/P_{2018}, P_{2027}/P_{2018} and P_{2037}/P_{2018}, where P_y is the population size in year *y*;	Covered indirectly by 7) $B^{5-9}{}_{lowest(2018-2037)}/B_{MSY}$	$P(B_{2022} < 0.75\, B_{2018}) \leq \beta$ β =0.10 if $B_{2018} < 0.8\, B_{MSY}$; 0.25 if $0.8\, B_{MSY} < B_{2018}$ Further consideration to be given to monitoring change beyond the initial five-year period. [3 year/5 year?]	The probability of a decline of 25% in terms of exploitable biomass from year x to x+5 is kept at 10% or lower.

Management Objectives		Performance Measures – Vigo Draft	Performance Measures – Japan proposals – for each distribution median, 5%- and 95%ile are reported	Performance Measures and Criteria WG-RBMS, Falmouth	Example Performance Criteria (London)
7.	Keep inter annual TAC variation below "an established threshold"	d) Average annual variation in *catch* over short and long terms: $AAV_{2018-2022} = \frac{1}{5}\sum_{y=2018}^{2022}\lvert C_y - C_{y-1}\rvert / C_{y-1}$ and $AAV_{2018-2037} = \frac{1}{20}\sum_{y=2018}^{2037}\lvert C_y - C_{y-1}\rvert / C_{y-1}$ $P > 15\%$ being the proportion of years during the projection period where $\frac{\lvert C_y - C_{y-1}\rvert}{C_{y-1}} > 0.15$. Catch constraints as part of the control rule or as a performance statistic to be determined.	Covered by; 1. AAV (2018-2037)		Either this will be achieved through the constraint on the inter-annual TAC variation (at present this limit is 5%) or; a) The probability of annual TAC variations of greater than 15% be kept at 25% or lower and b) the probability of variation of more than 25% over any period of 3 years should be kept at 25% or lower.

Additional Considerations

1. Starting TAC – 0, 12.5, 15, 17.5, 20, 25
2. Performance Statistic - Percentage of catch composed of the +group weight

Table 2. Performance Statistics and Criteria agreed as required/desirable performance statistics/criteria

Required performance statistics/criteria		
Performance statistic	**Performance criterion**	**Relevant management objective**
$P(B_{2037} < B_{MSY})$	$P \leq 0.5$	Restore to within a prescribed period of time or maintain at B_{MSY}
for y = 2018 to 2037; $count_y[P(F_y > F_{MSY}) > 0.3]$	Count	Low risk of exceeding F_{MSY}
$P[B\text{ratio}_{\text{lowest}} < 0.3]$ for y = 2018 to 2037 $count_y[P(B_y < 0.3B_{MSY}) \geq 0.1]$	$P \leq 0.1$ Count	Very low risk of going below an established threshold [e.g. B_{lim} or B_{lim} proxy].
Desirable secondary performance statistics/criteria		
Performance statistic	**Performance criterion**	**Relevant management objective**
$P(B_{2037} < 0.8\ B_{MSY})$	$P \leq 0.25$	Restore to within a prescribed period of time or maintain at B_{MSY}
$P(B_{2022} < B_{2018})$	$P \leq \alpha$ Where; α = 0.10 if $B_{2018} < 0.3B_{MSY}$; 0.25 if $0.3\ B_{MSY} < B_{2018}$	The risk of failure to meet the B_{msy} target and interim biomass targets within a prescribed period of time should be kept moderately low

$P(B_{2022} < 0.75\, B_{2018})$	$P \leq \beta$ Where; β =0.10 if $B_{2018} < 0.8\, B_{MSY}$; 0.25 if $0.8\, B_{MSY} < B_{2018}$ Further consideration to be given to monitoring change beyond the initial five-year period. [3 year/5 year?]	The risk of steep decline of stock biomass should be kept moderately low
C_{2019} C_{2020} $\sum_{y=2018}^{2022} C_y$ / 5 $\sum_{y=2018}^{2027} C_y/10$ $\sum_{y=2018}^{2037} C_y/20$		Maximize yield in the short, medium and long term
For each year, y $P\left(\frac{\lvert C_y - C_{y-1}\rvert}{C_{y-1}} > 0.15\right)$ $AAV_{2018-2022} = \frac{1}{5}\sum_{y=2018}^{2022} \frac{\lvert C_y - C_{y-1}\rvert}{C_{y-1}}$ and $AAV_{2018-2037} = \frac{1}{20}\sum_{y=2018}^{2037} \frac{\lvert C_y - C_{y-1}\rvert}{C_{y-1}}$	P≤0.15	Keep inter annual TAC variation below "an established threshold"

Annex 1. Participant List

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Annex 2. Agenda

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