Northwest Atlantic Fisheries Organization

Serial No. N7497 **NAFO SCR Doc. 24/003**

SCIENTIFIC COUNCIL– APRIL 2024

Comparing Results for the proposed revised Greenland Halibut Candidate Management Procedure for the final SCAA and SSM Robustness trials

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Summary

The performances of a revised Candidate Management Procedure, named CMPts, is compared for the final SCAA and corresponding SSM Reference Set of trials. For virtually all these trials, the SSM OMs give more optimistic results than the corresponding SCAA OMs, with higher final depletion (though slightly lower average catches). This is expected, as (with one exception) the SSM trials do not have recruitment reducing as spawning biomass drops to low levels.

Key words: Catch; Depletion; Greenland halibut; Management procedure; Performance; Reference set trials; SCAA; SSM

Introduction

A Management Procedure (MP) needs to offer satisfactory performance in terms of meeting management objectives not only if the underlying model being used for testing (the Operating Model – OM) reflects what is considered to be the best representation of stock and fishery dynamics (the base case OM), but also for variations of that OM which might also describe those dynamics reasonably.

These alternative "variations" provide the "robustness tests" against which a Candidate Management Procedure (CMP) is tested. A simple example is provided by an OM with an alternative value of natural mortality (M – a parameter whose value is usually not particularly well known) to that used for the base case OM. Typically a CMP will be tested against a fairly large number of these robustness tests, chosen on the basis that they cover the major uncertainties considered to apply for the stock under consideration.

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Types of robustness tests

Robustness tests come in different "types", where "type" relates to the primary aim which applying the test is trying to achieve.

At the one end of this spectrum are tests for situations almost as plausible as the base case OM. For those, performance by a CMP would be expected to show results almost as good as that CMP does for the base case OM (a type "High" test). At the other end are tests whose plausibility is much lower, but whose "difficulty" has deliberately been increased to provide insight regarding how far the MP can be pushed before it "breaks"; for such cases, one would not expect attainment of all the thresholds which have been specified for the CMP to reach for the base case OM (type "Low" tests). Tests falling somewhere between these two extremes are termed type B tests. Across this range, a key requirement is an indication that if the stock is at or initially drops to some low abundance during the management period considered, the MP (through its feedback control abilities) is able to achieve some recovery over that period.

The robustness tests and type categorisation (High, Intermediate or Low) are listed below.

The history

The process of choice of robustness tests for the 2017 GHL MSE was not fully documented, given the speed at which a series of RBMS-like meetings were conducted to move towards an MP choice by the Commission that year.

Basically, a fairly lengthy set of tests was put forward in meetings of the Scientific Council (SC), this was culled at the 2017 annual SC meeting on the basis of omitting those having relatively little impact on MP performance. Further adjustments, as well as further culling of these robustness tests, took place at the subsequent RBMS-type meetings. Eventually only four tests remained, within which the one involving a series of years of poor recruitment had the most deleterious impact on performance.

Moving forward, it is important that any MP for Greenland Halibut perform adequately across the robustness tests (with their corresponding OMs) for both the SCAA and SSM models of the resource's dynamics.

Robustness Tests

OM1: Base Case. The projection model follows the same structure as the SCAA or SSM. (High).

OM2: Hockey-stick stock-recruit relationship. For the future, include a hockey-stick S/R relationship, where the recruitment drops linearly to the origin from the lowest value of Bsp (SSB) in the assessment and mean recruitment (which applies at still higher Bsp values too). This is an SSM only robustness scenario, as recruitment is assumed to be random and independent from spawning stock biomass for the base case SSM OM (note that the SCAA includes a stock-recruitment relationship). In the case of the SCAA, a smooth HS S/R is going to be used to avoid convergence problems with the Beverton and Holt S/R used in this model. (High).

OM3: Assume allometric natural mortality. Assume that M follows an allometric shape (i.e., Lorenzen M), where Ma = 0.12 * WAA ^ -0.305. (Note that this requires reconditioning – of the base case OM only; unless this model resolves the unusual survey selectivity patterns in the Canadian Autumn 2J3K index, it may be redundant given other OMs). (High).

OM4: Include future random error in natural mortality. Include future random error in M(y,a) with variance of the error as indicated by the SSM, which has a process error variance estimate of 0.16. (Note: This is an SCAA specific OM, as variation in M is already part of the process errors carried forward in the SSM projections). (High).

OM5a: Assume provisional conversion factors are biased. Assume that a biased conversion factor is applied to the future Canadian 2J3K and 3LNO indices. Specifically, increase the true conversion factor by 10%. The intent here is to test the potential consequence of getting the conversion factor wrong before being final. (High).

OM5b: Assume the 3LNO Fall survey conversion factor is biased. Assume the 3LNO Fall survey conversion factor is biased (10%): The conversion factor for the 3LNO Fall survey is mainly based on data from the 2J3K Fall survey Comparative Fishing program, as the one for 3LNO Fall survey was incomplete and there is no chance to finish it. This bias is for taking into account the differences that could be between the conversion factors of 3LNO and 2J3K. (High).

OM6: Increase the variance in natural mortality for younger ages. Increase the variance of M(y,a) for age groups 1 to 10 by multiplicative amounts that decrease linearly with age from 2 for age 1 to 1 for age 10. Keep the variance at 0.16 for still higher ages. This is intended to account for the possibility that variability in M may be greater at younger ages. This is a SCAA only test as this variation is partially covered by the process error variance carried forward in the SSM projections. (Intermediate).

OM7: Zero selectivity on plus-group. The plus group for the stock (age 10+), which also acts as the mature/spawning portion of the stock, is not fished, and selectivity for age-10+ fish for all years is fixed at 0. This tests the ability of the CMP to pass fisheries-related performance statistics assuming the 10+ group is inaccessible. (Intermediate).

OM8: Decrease the doming in the commercial selectivities. Decrease the doming in the commercial selectivities, by fixing the parameter values for the right side (higher age) half-normal to double their values for the base case OM, so that commercial selectivity decreases at higher ages at half its previous rate. For the SSM, this would involve coupling the F process estimates across ages 9+; alternatively, consider fixing selectivity at age 10+ half way between its terminal estimate and 1. (Note that this change also requires reconditioning). This OM is going to be tested only with SCAA as reducing doming is technically difficult, and perhaps not possible, in the SSM given its non-parametric approach to estimating F. (Intermediate).

OM9: Decrease starting values N(2022, a) by 10% for all ages. To allow for a possible decrease in abundance while some surveys could not take place. (Intermediate).

OM10: 8 years with recruitment halved. Recruitment for the first eight years of the projection are half of the mean log-recruitment estimate from the SSM; afterwards, recruitment returns to its base value. This tests the ability of the CMP to recover the stock following a series of years of poor recruitment. (Low).

OM11: Assume senescence. M increases from 0.12 for age 9 to 0.5 for ages 10+. (Note that this requires reconditioning – of the base case OM only.) Though the values chosen are biologically extreme, this scenario aims primarily to partially address concerns over cryptic biomass. (Low).

OM12: 8 years with increased natural mortality. Assume that M increases from 0.12 to 0.2 in the first 8 years of the projections (similar structure to the low recruitment OM). This scenario is intended to assess the ability of the CMP to recover the stock following a sequence of years with heightened values of M. (Low).

OM13: Catch = 110% TAC. TAC for each year of the projection is increased by 10% from the value returned by the CMP to account for implementation error. This simulates behavior assuming TAC overruns are be a chronic issue in the future. (Low).

OM14: 8 years with limited survey data from 3LNO. Repeat baseline OM but, at the start of the projections, exclude the EU-Spain 3L series and Canada Autumn 3LNO surveys for 8 years from 2022 to 2029. (Low).

Results and Discussion

Figure 1 below compares the projected medians and 80% probability intervals for a series of performance statistics for each OM under the Candidate Management Procedure named CMPts (described in Rademeyer and Butterworth, 2024) for SCAA (Rademeyer and Butterworth, 2024) and SSM (Regular et al., 2024). Note that CMPts has been tuned to prove the target performance of median exploitable biomass at the MSY level in 2044 for the base case SCAA OM, viz. OM1.

For virtually all the trials, the SSM OMs give more optimistic results than the corresponding SCAA OMs, with higher final depletions (though lower average catches). The one (very marginal) exception is for OM2 (hockey-stick stock-recruitment) that sees the final depletion slightly lower for SSM. Thus, if the performance of CMPts is acceptable for the SCAA OMs, it would seem also to be acceptable for the SSM-based OMs.

These results are not unexpected, since the SCAA OMs are more "conservative" than the SSM ones because the former have expected recruitment decreasing as SSB drops. In contrast the SSM models do not incorporate such an effect, except for the hockey-stick stock-recruitment function (OM2) scenario.

References

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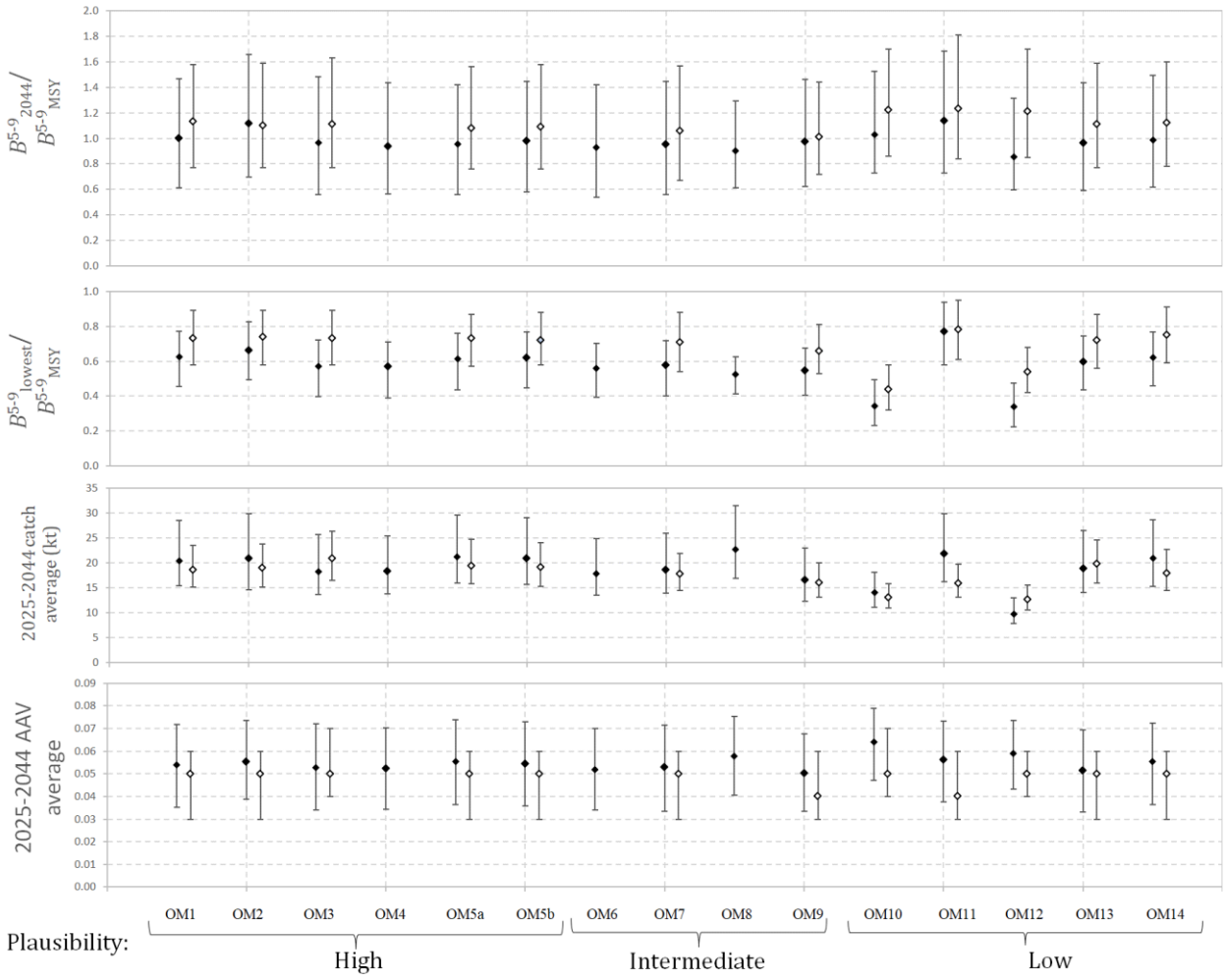

Figure 1. Projected median and 80% probability intervals for a series of performance statistics for each OM under CMPts for the SCAA (black diamonds) and SSM (white diamonds).