Alternatives for Setting Catch Limits when a Stock is Assessed using Multiple Independent Sub-Area Assessment Models.

The Pacific Fishery Management Council (Council) is currently undertaking the process of identifying stock definitions that will designate areas for determining stock status. A stock area represents an inter-related population based on a range of factors: genetic information, demographic information, and/or larval, juvenile, and adult movement patterns. The Stock Definitions Analytical document (Agenda Item F.7, Attachment 1, March 2023) presents alternative approaches to apply harvest control rules when a stock area consists of sub-area assessment models. This report aims to outline potential processes for assessment authors to conduct projections for Scientific and Statistical Committee (SSC) review and Council consideration.

Overview and Items for Consideration

Assessments of West Coast groundfish are required to provide a ten-year projection for consideration by fishery management. Generally, the assumed removals during the projection period are set equal to the ABC, the ACL (e.g., if the stock is below the biomass target), or removals less than the ABC (or the ACL) specified by the Council's Groundfish Management Team (GMT). These projections are evaluated during the harvest specification process for potential adoption by the Council.

Sub-Alternatives 1a and 1b lay out two alternative approaches for determining a stock-wide ACL if there are multiple sub-area models for a stock. Sub-Alternative 1a is most similar, generally, to how harvest specifications (OFL, ABC, and ACL) have been determined across assessment model sub-areas historically. Since Sub-Alternative 1a determines the sub-area OFL, ABC, and ACL at the sub-area model level, model based projections may be performed and combined to determine the stock-wide harvest specifications. In contrast, the approach specified under Sub-Alternative 1b to determine the stock-wide ACL requires additional considerations on how to reallocate portions of the stock-wide ACL to each sub-area. Additionally, since this approach would require iteratively running the projections year-by-year for each of the sub-area models in tandem, assessment authors would benefit from having clear guidance on the methodology early. It should be noted that the SSC specifies the ABCs, while the Council selects ACLs. Given the intricacies of determining a stock-wide ACL and the allocation back to sub-areas there are items that may benefit from SSC input:

1. Considerations on how to determine the stock-wide ACL particularly if one or more of the sub-areas are below the biomass target.
2. Best practices for reallocating a stock-wide ACL to each sub-area (based on, e.g., proportion of current spawning biomass, exploitable biomass, etc., or multiple factors).
3. Best practices for calculating stock-wide ABCs and ACLs across sub-area assessments with different category designations, different σ values and/or different P*s assigned.
4.

Determining harvest specifications for stocks with multiple sub-area assessment models

Overfishing Limit (OFL)

If there are multiple sub-area assessments, which together, cover the area of a stock, each sub-area model will calculate a sub-stock sub-OFL based on the proxy F_{MSY} and the estimated spawning biomass relative to the B_{MSY}. The sub-area OFLs should be summed to get the stock-wide OFL.

Acceptable Biological Catch (ABC) and Annual Catch Limit (ACL)

There are at least two potential approaches for determining ABCs and ACLs for the stock-wide (or sum of sub-stock values) presented in the Stock Definitions Analytical document (Agenda Item F.7. Attachment 1, March 2023).

Sub-Alternative 1a

When there are multiple sub-area assessment models which together cover the range of a stock, the management risk tolerance (P*) and scientific uncertainty (σ) is selected for each sub-area. The P* value is a policy determination by the Council reflecting a level of risk tolerance and σ is determined by the SSC based upon scientific uncertainty. Each sub-area assessment model will determine a sub-stock ABC value for a particular year, given the buffer fraction based upon a P* (≤0.45), σ, and the time-varying change in σ. The sub-area sub-ABCs would be summed to get the stock-level ABC. If the P* and σ values are the same for all sub-area assessment models, this is equivalent to applying the single buffer fraction to the stock-wide OFL.

Apply the corresponding harvest control rule to each sub-stock area model results to determine the maximum sub-area ACLs. The sub-stock ACLs are then summed to determine the maximum stock-wide ACL. If the stock status from each sub-area model is at or above the biomass target, the ACL may equal the ABC. If one or more of the estimated stock statuses from a sub-area model is below the biomass target, the harvest control rule will be applied to produce a sub-ACL reduced from the corresponding sub-ABC.

Sub-Alternative 1a provides both a sub-area specific sub-OFL, sub-ABC, and sub-ACL and stock-wide summed OFL/ABC/ACL.

Sub-Alternative 1b

When there are multiple sub-area assessment models which together cover the range of a stock, each assessment model will determine a sub-area ABC value for a particular year, given the buffer fraction based upon a P* (≤0.45), σ, and the time-varying change in σ. The P* is set at the stock-wide basis and the σ is set for each sub-area model. The sub-area ABCs would be summed to get the stock-level ABC. If the P* and σ values are the same for all sub-area assessment models, this is equivalent to applying the single buffer fraction to the stock-wide OFL. However, if the P* and σ values are not the same across sub-areas, applying a single buffer fraction to the entire stock is not possible.

Under Sub-Alternative 1b, a single harvest control rule is applied to the stock to determine a stock-wide ACL. The harvest control rule would be applied to the stock-wide summed spawning biomass

from each sub-area model. If the stock-wide relative spawning biomass was below the management target, the harvest control rule would reduce the stock-wide ACL from the stock-wide ABC. For a stock with multiple sub-area assessment models, decision makers may manage to the stock-wide ACL or adopt sub-ACLs for each area and implement management measures to align fishing mortality with sub-area ACLs. Regardless of the management approach, the sub-area assessment models will need to implement assumptions around the proportion of the stock-wide ACL that is removed from each model area during the projection period.

Sub-Alternative 1b would require the yearly stock-wide OFL, ABC, and ACL be iteratively determined on a stock-wide basis with proportions of the ACL being allocated back to each model year by some manner. For example, a stock-wide ACL could be split back to each sub-area based upon the proportion of spawning biomass, total biomass, or some measure of exploitable biomass in each sub-area assessment relative to the entire stock. An additional alternative approach to re-allocate a stock-wide ACL back to each area could be to use the sub-area ACL calculations to determine sub-area ACL caps. These would then sum to a value equal to or less than the value calculated for the stock-wide ACL.

Under Sub-Alternative 1b if at least one stock is below the target, it can lead to a higher stock-wide ACL compared to the stock-wide ACL determined by Sub-Alternative 1a which directly accounts for localized depletion in the application of the harvest control rule to the sub-area (Table 1). Additionally, the selection of how to reallocate the stock-wide ACL to each sub-area assessment model should be carefully considered. In the example scenario shown in Table 1, calculating a single stock-wide ACL by Sub-Alternative 1b and allocating the ACL back to each sub-area based on the proportion of spawning biomass within each modeled sub-area resulted in sub-area ACLs greater than the calculated ACL produced by the sub-area model (e.g., ACL determined based on the model area estimate of relative spawning biomass).

Table 1. Example of Sub-Alternative 1a and 1b to determine the stock-wide OFL, ABC, and ACL.

	Unfished Spawning Biomass (mt)	**Spawning Biomass (mt)**	**Depletion by Area**	**% of Spawning Biomass by Area**	**OFL (mt)**	**ABC (mt)**	**ACL (Sub-Alt. 1a, mt)**	**ACL (Sub-Alt. 1b, mt)**	**Stock ACL by Spawning Biomass % (mt)[b]**
Area 1	233.0	36.7	15.7%	18.4%	23.0	20.1	9.9		16.9
Area 2	415.8	162.2	39.0%	81.6%	93.4	81.7	81.0		74.6
Stock Total	648.9	198.9	30.7%	100.0%	116.4	101.8	91.4[a]	90.9	91.4

[a] Calculated using the 40-10 harvest control rule, the stock-wide ABC (101.8 mt), and the stock-wide depletion (30.7%).

[b] The stock-wide ACL (91.4 mt) is allocated back to each sub-area based on the proportion (%) of the spawning biomass in each sub-area.