Primary MSE goals, objectives, and performance metrics

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PURPOSE

To provide an overview of goals, scale and distribution objectives, and associated performance metrics to the Management Strategy Advisory Board (MSAB) for use in the MSE process.

1 INTRODUCTION

The Management Strategy Evaluation (MSE) at the International Pacific Halibut Commission (IPHC) has investigated elements of management strategies related to coastwide scale and distribution of the TCEY (Figure 1). Currently, the MSE is being used to investigate size limits and multi-year assessments. This document presents and describes the objectives that the MSAB and Commission have identified and may use to evaluate management procedures.

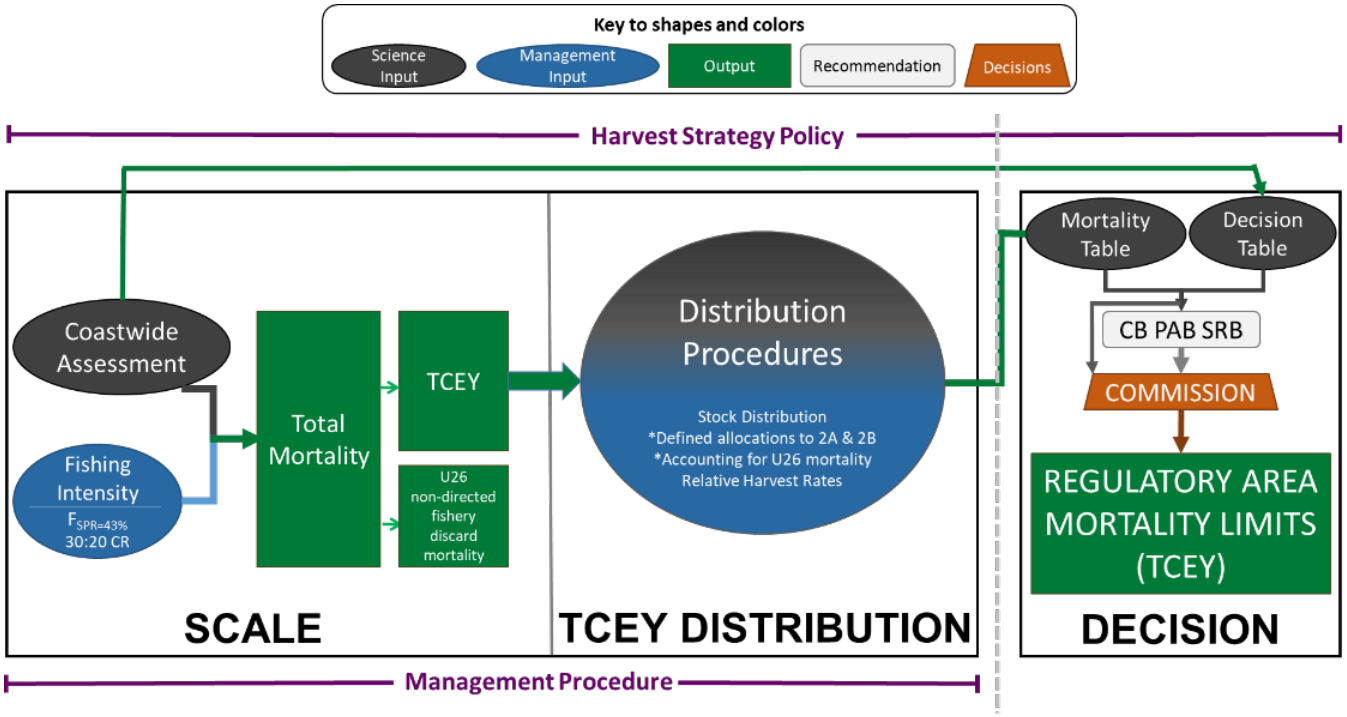

Figure 1. Illustration of the Commission interim IPHC harvest strategy policy (reflecting paragraph ID002 in IPHC-2020-CR-007) showing the coastwide scale and TCEY distribution components that comprise the management procedure. Items with an asterisk are interim agreements in place through 2022. The decision component is the Commission decision-making procedure, which considers inputs from many sources.

2 PRIMARY GOALS AND OBJECTIVES

The MSAB has previously defined four potential goals for evaluating management procedures, and the Commission has identified two of these as primary goals, each one with one or more objectives.

1. Biological Sustainability (also referred to as conservation goal)
   1.1. Keep biomass above a limit to avoid critical stock sizes
2. Optimise directed fishing opportunities (also referred to as fishery goal)
   2.1. Maintain spawning biomass around a level (i.e., a target biomass reference point) that optimises fishing activities
   2.2. Limit variability in mortality limits
   2.3. Provide directed fishing yield

Details of the primary goals and objectives defined by the Commission, along with performance metrics, are shown in Appendix I.

The two remaining goals, with undefined objectives are

3. Minimize discard mortality in directed fisheries
4. Minimize discards and discard mortality in non-directed fisheries (bycatch)

These goals related to discard mortality in directed fisheries and non-directed fisheries have not yet been specifically considered in the MSE but are identified by the MSAB as important to consider in the future.

We first present the MSAB-defined coastwide objectives and performance metrics linked to those objectives. We then present objectives for IPHC Regulatory Areas and Biological Regions that have been defined by the MSAB. This is followed by a discussion of potential additional objectives.

2.1 Coastwide objectives

Primary general objectives were identified by the MSAB and the Commission for evaluating MSE results related to coastwide fishing intensity as presented at AM095. At that time, the biological sustainability objective (maintain the biomass above a limit) was prioritized to be met before evaluating the fishery stability objective (limit variability in mortality limits), which must be met before evaluating the fishery yield objective (maximize the TCEY). Performance metrics were developed from these objectives by defining a measurable outcome, a tolerance (i.e., level of risk), and a timeframe over which it is desired to achieve that outcome. Many more objectives and performance metrics were identified (IPHC-2019-MSAB013-07 Appendix I) which were used to further evaluate the MSE results. Objectives that did not have a measurable outcome, tolerance, and/or timeframe defined were labeled as "statistics of interest."

Subsequent to the presentation of coastwide objectives and MSE results at the 95th Annual Meeting (AM095), the following paragraphs from the Report of the 95th Annual Meeting (IPHC-2019-AM095-R) have guided further refinement of coastwide objectives.

> **AM095-R, para 59a.** *The Commission **ENDORSED** the primary objectives and associated performance metrics used to evaluate management procedures in the MSE process (as detailed in paper IPHC-2019-AM095-12)*
>
> **AM095-R, para 59c.** *The Commission **RECOMMENDED** the MSAB develop the following additional objective, as well as prioritize this objective in the evaluation of management procedures, for the Commission's consideration.*
>
> *i. A conservation objective that meets a spawning biomass target.*

The development of a spawning biomass target (i.e. a biomass level with a 50% probability of being above or below) was discussed extensively at MSAB013. Noting that the current IPHC harvest strategy policy (https://iphc.int/the-commission/harvest-strategy-policy) suggests using a proxy for Maximum Economic Yield (MEY), which is related to Maximum Sustainable Yield (MSY), much of the discussion focused around these quantities and what appropriate proxies may be.

The need to maximise economic benefit rather than maximising only yield has been widely recognized. However, the estimation of MEY and related quantities (SB_{MEY} and F_{MEY}) for specific fisheries remains challenging and requires a deep understanding of the economic variables relevant to the fishery. In the absence of this information and of a bio-economic model of the fishery, a proxy for MEY may be obtained from MSY. For example, the Australian government's harvest strategy policy uses the relationship: $SB_{MEY} = 1.2 \times SB_{MSY}$ (Rayns, 2007), and Pascoe *et al*. (2014) suggested that $SB_{MEY} = 1.45 \times SB_{MSY}$ may be appropriate for data-poor single-species fisheries.

Four dynamic equilibrium reference points were estimated for the Pacific halibut stock: 1) unfished equilibrium dynamic spawning biomass (SB_0), 2) MSY, 3) B_{MSY} as a percentage of SB_0 (RSB_{MSY}), and 4) the equilibrium fishing intensity to achieve MSY using spawning potential ratio (SPR_{MSY}), using three different methods (IPHC-2019-SRB015-11 Rev_1). Document IPHC-2019-SRB015-11 Rev_1 describes the methods and results from this analysis, and estimates the dynamic equilibrium RSB_{MSY} for Pacific halibut to likely be in the range of 20% to 30% and SPR_{MSY} to likely be between 30% and 35%. A reasonable RSB_{MSY} proxy, including a precautionary allowance for unexplored sources of uncertainty, would be 30%, and would put a proxy for SB_{MEY} between 36% and 44% given the recommendations of Rayns (2007) and Pascoe et al. (2014).

The objective of maintaining the spawning biomass around a target or above a level that optimises fishing activities can be viewed as a fishery objective (e.g. optimise yield) as well as a biological sustainability objective (e.g., maintain a sustainable biomass). However, sustainability of the Pacific halibut stock would be satisfied by meeting the objective of avoiding low stock sizes that may result in an impairment to recruitment. Therefore, the primary biological sustainability objective should be to avoid a minimum stock size threshold (i.e. B_{Lim}) with a high probability. Defining a fishery objective related to MSY or MEY, along with other fishery objectives, would be prioritized after meeting this single conservation objective.

Fishery objectives related to stability are included in the coastwide objectives (Appendix I). An *ad hoc* working group that met in July 2019 discussed the coastwide objective to limit annual changes in the TCEY, which is measured by the average annual variability (AAV), which is an average taken over a ten-year period. Using this performance metric means that when meeting the objective (a defined threshold) some of the individual annual changes in the TCEY might exceed the defined threshold. In addition, stakeholders may be interested in the actual annual changes from year to year and to limit them to a threshold that is never exceeded in a ten-year period or allow it to be exceeded in a small number of years. A statistic called Annual Change (AC) was defined to represent actual annual change in the TCEY and has been used as a primary stability objective in addition to AAV to provide an alternative view of stability.

2.2 Area-specific objectives

2.2.1 Biological sustainability

In paragraph 31 of IPHC-2018-SRB012-R, "the SRB AGREED that the defined Bioregions (i.e. 2,3,4, and 4b described in paper IPHC-2018-SRB012-08) are presently the best option for implementing a precautionary approach given uncertainty about spatial population structure and dynamics of Pacific halibut." Therefore, primary objectives related to conserving spatial population structure have been included under the Biological Sustainability goal (Appendix I).

Conserving spatial population structure may imply several meanings, such as maintaining the current biomass distribution across regions, maintaining the proportion of spawning biomass in each Biological Region within a specified range, or maintaining a minimum spawning biomass or proportion of spawning biomass in each Biological Region. The *ad hoc* working group proposed objectives to maintain a defined minimum proportion of spawning biomass in each Biological Region (Figure 2), which complement the coastwide biological sustainability objective of maintaining the coastwide spawning biomass above a limit. These minimum proportions were determined from recent observations, but not be reflective of long-term potential shifts in distribution. Therefore, they may be updated in the future.

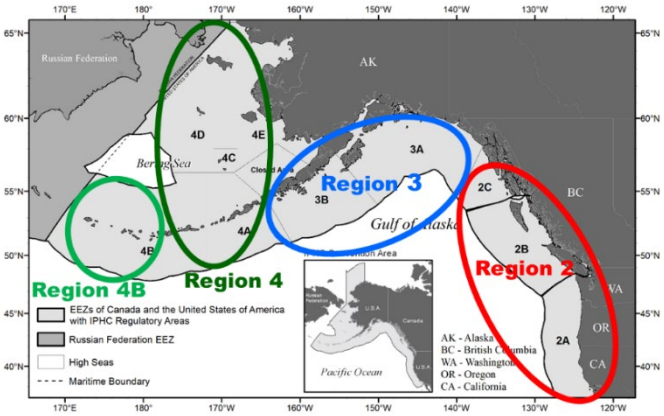

Figure 2. IPHC Regulatory Areas, Biological Regions, and the Pacific halibut geographical range within the territorial waters of Canada and the United States of America.

2.2.2 Optimise Directed Fishing Opportunities

Three primary general objectives are currently defined for this goal: 1) maintain the spawning biomass around a level that optimises fishing activities, 2) limit variability in mortality limits, and 3) provide directed fishing yield. Under each general objective, there are coastwide TCEY measurable objectives. While Biological Regions are the spatial scale for the biological sustainability goal, fishery objectives are related to IPHC Regulatory Areas because quotas are defined within these areas and are therefore of interest to a quota holder. A finer spatial scale than IPHC Regulatory Areas may be important to individual fishers and may be considered in future evaluations.

2.2.2.1 Maintain the spawning biomass around a level that optimises fishing activities

The objective to maintain the spawning biomass around a level that optimises fishing activities does not have corresponding objectives for IPHC Regulatory Areas. Defining a level of biomass that optimises fishing activity in an area of the coastwide population may be difficult without consideration of fishing activities in other areas. Therefore, only a coastwide objective has been defined.

2.2.2.2 Limit variability in mortality limits

The same objectives are defined for IPHC Regulatory Areas as for the coastwide objective to limit annual changes in the TCEY. This objective would capture the objective for stability in a stakeholder's area of interest as well as recognize that there is uncertainty in the distribution procedure that will likely add to variability in IPHC Regulatory Area mortality limits. The *ad hoc* working group from 2019 discussed the potential for redundancy when having the same objectives at a coastwide and IPHC regulatory area scale and it was noted that, even though this could be the case, the two will address two different issues: the coastwide objective will address the annual variability as a result of the population variability and assessment error, while at the regulatory area level the objective will address the uncertainty in the distribution procedure. For this reason, both have been carried forward. All objectives for variability are measured via statistics of interest and are directly evaluated rather than determining if they meet a defined tolerance.

2.2.2.3 Provide directed fishing yield

Three different types of objectives related to fishery yield in an IPHC Regulatory Area were defined.

1. An optimal yield/mortality level. This identifies an optimal TCEY, for example, that is desired within an IPHC Regulatory Area.
2. A minimum yield/mortality level. This identifies what is needed for economic viability or for directed fisheries to occur. This requires stakeholders in an area to only consider what is desired within that area.
3. A proportional share of the coastwide yield/mortality. This is a percentage of the coastwide mortality limit and would provide for sharing among areas even in times of low abundance and may maintain a sense of equity among areas. This requires within- and among-area considerations.

Given these three types of objectives, one coastwide and four IPHC Regulatory Area measurable objectives were defined (Appendix I). These objectives do not have a specific measurable outcome or tolerance, thus are statistics of interest. Performance metrics for are reported for each and evaluated directly.

3 POSSIBLE ADDITIONAL GOALS AND OBJECTIVES

Objectives in addition to the primary objectives described above may be useful when evaluating management procedures. In some cases, performance metrics are defined that are specifically associated with an objective. There are many examples in the MSE Explorer.

3.1 Goals and objectives related to discards and discard mortality

The evaluation of management procedures utilising different size limits may benefit from using objectives related to discard mortality in the directed fisheries. The MSAB has considered discard mortality objectives in the past (Table 1). It would be simple to report performance metrics related to discard mortality, but specifics of an objective should be selected by the MSAB and Commission (e.g. the 10% threshold in Table 1).

Table 1. Objectives related to discard mortality in directed fisheries as defined by the MSAB at MSAB011. See IPHC-2018-MSAB011-07.

GENERAL OBJECTIVE	MEASURABLE OBJECTIVE	MEASURABLE OUTCOME	TIME-FRAME	TOLERANCE	PERFORMANCE METRIC
MINIMISE DISCARD MORTALITY IN THE LONGLINE FISHERY	Minimize directed fishery discard mortality	Median coastwide DM_d	Short-term		$Median\ \overline{DM_d}$
	Maintain the directed-fishery discard mortality at less than 10% of the annual mortality limit	DM_d<10% of the TCEY	Short-term		$P(DM_d < 0.1 \times TCEY)$

RECOMMENDATION/S

That the MSAB:

a) **NOTE** paper IPHC-2022-MSAB017-08 which includes descriptions of coastwide and area-specific objectives for use in the MSE.

b) **RECOMMEND** additional objectives, statistics of interest, and performance metrics to report.

REFERENCES

Pascoe S, Thebaud O, & Vieira S. 2014. Estimating proxy economic target reference points in data-poor single-species fisheries. M*arine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science*, 6(1), 247–259. https://doi.org/10.1080/19425120.2014.966215

Rayns, N. 2007. The Australian government's harvest strategy policy. *ICES Journal of Marine Science*, 64, 596–598.

APPENDICES

Appendix A: Primary objectives defined by the Commission for the MSE

Appendix B: Supplementary material

APPENDIX A
PRIMARY OBJECTIVES DEFINED BY THE COMMISSION FOR THE MSE

Table I.1. Primary objectives, evaluated over a simulated ten-year period, accepted by the Commission at the 7th Special Session of the Commission (SS07). Objective 1.1 is a biological sustainability (conservation) objective and objectives 2.1, 2.2, and 2.3 are fishery objectives.

GENERAL OBJECTIVE	MEASURABLE OBJECTIVE	MEASURABLE OUTCOME	TIME-FRAME	TOLERANCE	PERFORMANCE METRIC
1.1. KEEP FEMALE SPAWNING BIOMASS ABOVE A LIMIT TO AVOID CRITICAL STOCK SIZES AND CONSERVE SPATIAL POPULATION STRUCTURE	Maintain a female spawning stock biomass above a biomass limit reference point at least 95% of the time	*SB* < Spawning Biomass Limit (SB_{Lim}) SB_{Lim}=20% unfished spawning biomass	Long-term	0.05	$P(SB < SB_{Lim})$
	Maintain a defined minimum proportion of female spawning biomass in each Biological Region	$p_{SB,2} > 5\%$ $p_{SB,3} > 33\%$ $p_{SB,2} > 10\%$ $p_{SB,2} > 2\%$	Long-term	0.05	$P(p_{SB,R} < p_{SB,R,min})$
2.1 MAINTAIN SPAWNING BIOMASS AROUND A LEVEL THAT OPTIMIZES FISHING ACTIVITIES	Maintain the coastwide female spawning biomass above a biomass target reference point at least 50% of the time	*SB*<Spawning Biomass Target (SB_{Targ}) SB_{Targ}=$SB_{36\%}$ unfished spawning biomass	Long-term	0.50	$P(SB < SB_{Targ})$
2.2. LIMIT VARIABILITY IN MORTALITY LIMITS	Limit annual changes in the coastwide TCEY	Annual Change (*AC*) > 15% in any 3 years	Short-term		$P(AC_3 > 15\%)$
		Median coastwide Average Annual Variability (AAV)	Short-term		*Median AAV*
	Limit annual changes in the Regulatory Area TCEY	Annual Change (*AC*) > 15% in any 3 years	Short-term		$P(AC_3 > 15\%)$
		Average AAV by Regulatory Area (AAV_A)	Short-term		*Median* AAV_A
2.3. PROVIDE DIRECTED FISHING YIELD	Optimize average coastwide TCEY	Median coastwide TCEY	Short-term		*Median* $\overline{TCEY}$
	Optimize TCEY among Regulatory Areas	Median $TCEY_A$	Short-term		*Median* $\overline{TCEY_A}$
	Optimize the percentage of the coastwide TCEY among Regulatory Areas	Median $\%TCEY_A$	Short-term		*Median* $\left(\overline{\frac{TCEY_A}{TCEY}}\right)$
	Maintain a minimum TCEY for each Regulatory Area	Minimum $TCEY_A$	Short-term		*Median Min(TCEY)*
	Maintain a percentage of the coastwide TCEY for each Regulatory Area	Minimum $\%TCEY_A$	Short-term		*Median Min(%TCEY)*

APPENDIX B
SUPPLEMENTARY MATERIAL

In addition to this document, an MSE technical document is available electronically. This is document IPHC-2022-MSE-01 and is available on the IPHC MSE page (https://www.iphc.int/management/science-and-research/management-strategy-evaluation).

The MSE Explorer will also be updated with additional results.

(http://shiny.westus.cloudapp.azure.com/shiny/sample-apps/MSE-Explorer/).