



Potential management procedures to determine the total constant exploitation yield (TCEY) by IPHC Regulatory Area for Pacific halibut fisheries

PREPARED BY: IPHC SECRETARIAT (P. CARPI, A. HICKS, & I. STEWART; 19 SEPTEMBER 2020)

PURPOSE

To provide an update on management procedures related to distributing the TCEY for use in the MSE process.

1. INTRODUCTION

The Management Strategy Evaluation (MSE) at the International Pacific Halibut Commission (IPHC) completed an initial phase of evaluating management procedures relative to the coastwide scale of the Pacific halibut stock and fishery. Results of the MSE simulations were presented at the 96th Session of the IPHC Annual Meeting (AM096) and endorsed by the Commission at the Intersessional Meeting held on 3 March, 2020 (IPHC-2020-CR-007). The next phase is to investigate management procedures related to the distribution of the Total Constant Exploitation Yield (TCEY). The TCEY is the mortality limit composed of mortality from all sources except under 26 inch (66.0 cm, U26) non-directed discard mortality, and is determined by the Commission at each Annual Meeting for each IPHC Regulatory Area.

Preliminary results were presented during a two-day intersessional meeting held online in August 2020. During this meeting MSAB members had the opportunity to review the proposed Management Procedures (MPs), to familiarize themselves with the MSE Explorer tool for results evaluation, and to identify useful performance metrics.

A management procedure consists of three elements: the monitoring (data generation), the Estimation Model (EM) and the Harvest Rule (HR) (Figure 1). Data are generated from the Operating Model (OM) to simulate the data collection and sampling process. Variability and bias are introduced in the data in this phase. The EM is analogous to the stock assessment and simulates estimation error in the process. Using the data generated, it produces an annual estimate of stock size and status and provides the inputs for applying the HR. The HR is the application of the estimation model output using various specifications to determine mortality limits for the upcoming year or years.

This document presents and discusses the Management Procedures (MPs) for determining the TCEY for each IPHC Regulatory Area. First, a summary of recent developments in the Management Procedures for Pacific Halibut that arised from the last most recent MSAB meeting and the Commission recent meetings is provided (Section 2). Next, the general framework under which both the current and the recently proposed MPs operate is described (Section 3). It will then review the current interim management procedure, including the recent short-term agreements for 2021 and 2022 (Section 4). Finally, an overview is provided of the MPs that will

be tested during this second phase of the MSE process, highlighting limits and benefits of the tools used (Section 5).

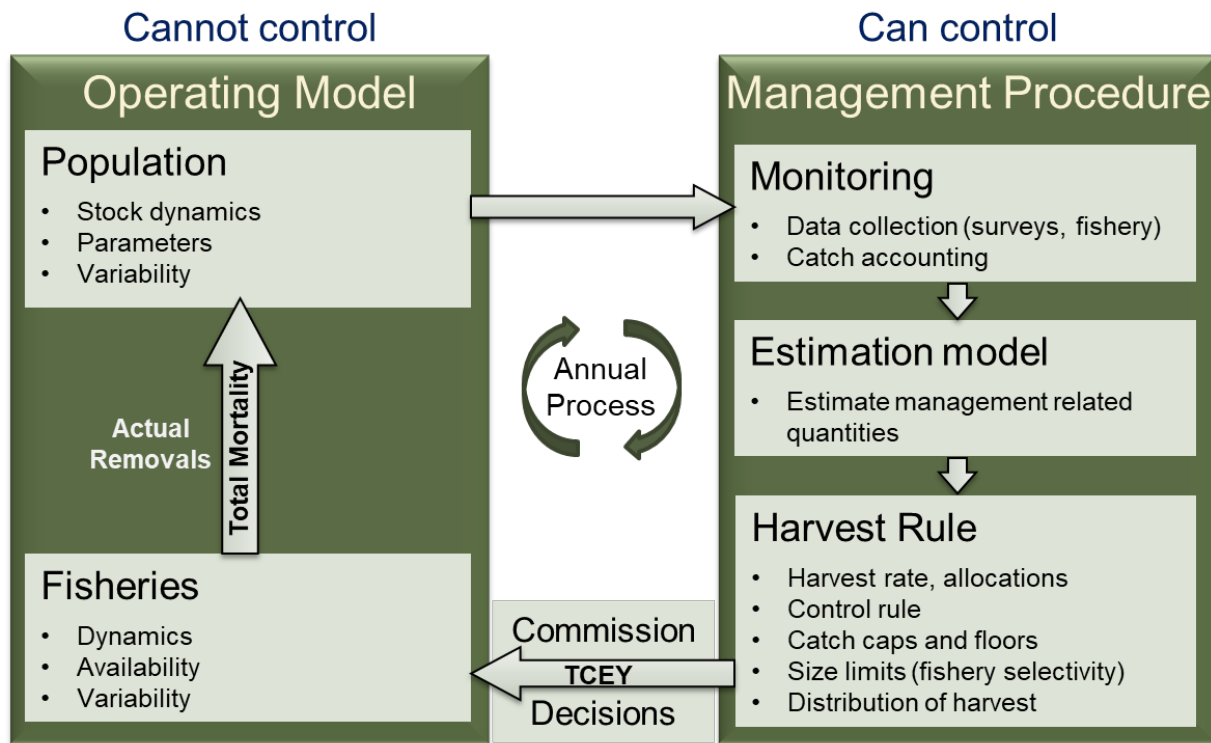


Figure 1: Illustration of the closed-loop simulation framework with the operating model (OM) and the Management Procedure (MP). The annual process represents a single loop of this framework.

2. MANAGEMENT PROCEDURES FOR COASTWIDE SCALE AND DISTRIBUTION OF THE TCEY

The 96th Session of the IPHC Annual Meeting (AM096) discussed the recommendations from the MSAB and the IPHC Secretariat on the coastwide results of the MSE and agreed to hold an inter-sessional meeting soon after AM096 to provide further direction. During this inter-sessional meeting, the Commission endorsed the coastwide and area-specific objectives defined at MSAB014, and the revision of the reference Spawning Potential Ratio (SPR, or fishing intensity) from 46% to 43% based on the analysis presented to SRB015 and MSAB014 to be used in the interim harvest policy.

The MSAB has defined a list of candidate management procedures for distributing the coastwide TCEY. At MSAB014, the distribution framework was formalized in 3 steps: a coastwide TCEY, an optional distribution of the TCEY to Biological Regions or Management Zones, and the final distribution to IPHC Regulatory Areas. Specific elements of MPs were considered at MSAB014 ([IPHC-2019-MSAB014-R](#), para 55, 57 and 58). At MSAB015, some of these elements were identified as important for the 2020 evaluation (paragraph 42 of [IPHC-2020-MSAB015-R](#)):

- a) constraints on the change in the TCEY can be applied annually or over multiple years at the coastwide or IPHC Regulatory Area level. Constraints on the change in TCEY currently considered include a maximum annual change in the TCEY of 15%, a slow-up fast down approach, multi-year mortality limits, and multi-year averages on abundance indices;
- b) indices of abundance in Biological Regions or IPHC Regulatory Area (e.g. O32 or All sizes from modelled survey results);
- c) a minimum TCEY for an IPHC Regulatory Area;
- d) defined shares by Biological Region, Management Zone, or IPHC Regulatory Area;
- e) maximum coastwide fishing intensity (e.g. SPR equal to 36% or 40%) not to be exceeded when distributing the TCEY;
- f) relative harvest rates between Biological Regions or IPHC Regulatory Areas.

3. THE GENERAL FRAMEWORK

The framework for distributing the TCEY begins with the coastwide TCEY determined from the stock assessment and fishing intensity defined by a reference SPR. The TCEY can be distributed to Biological Regions first and then to Regulatory Areas, or directly to Regulatory Areas; however, maintaining spawning biomass in each Biological Region is a primary objective. Relative adjustments can be applied in each step of the distribution process. Typically, the distribution procedure does not alter the overall fishing intensity (i.e., reference SPR).

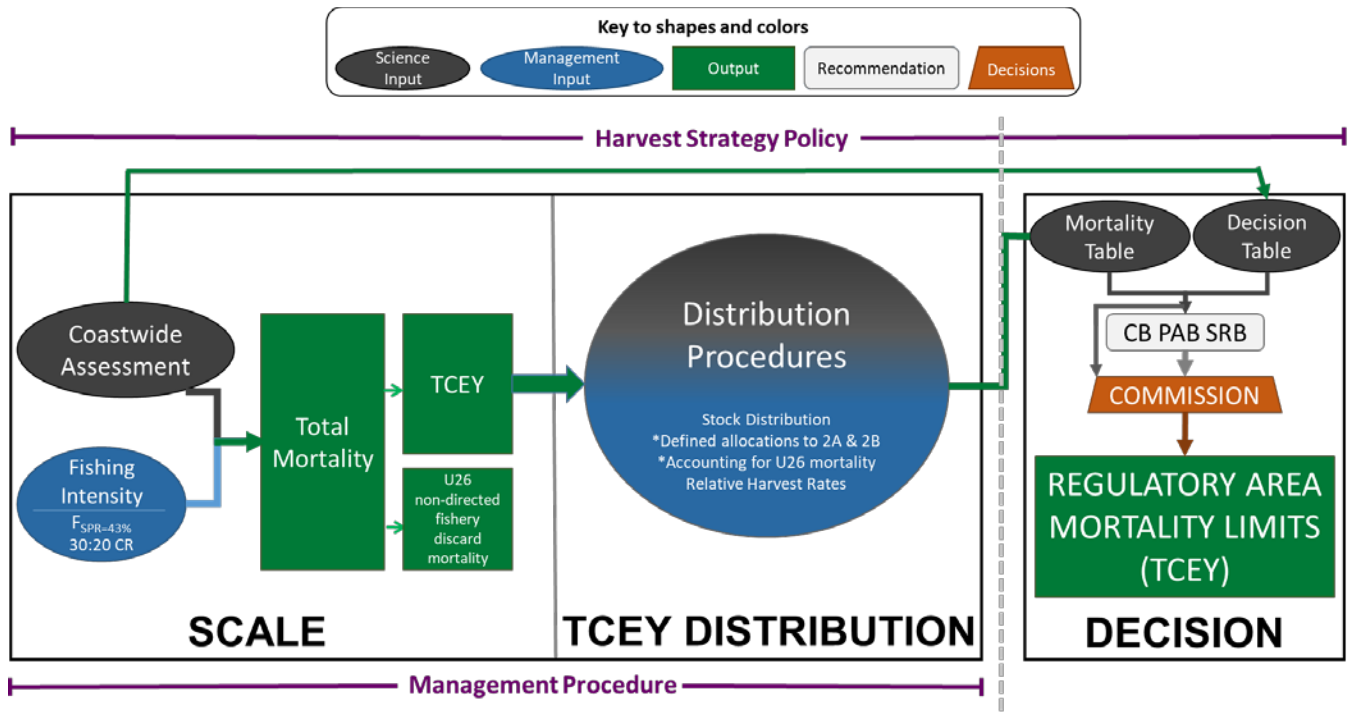


Figure 2: Illustration of the Commission interim IPHC harvest strategy policy (reflecting paragraph ID002 in [IPHC CIRCULAR 2020-007](#)) showing the coastwide scale and TCEY distribution components that comprise the management procedure. Items with an asterisk are three-year interim agreements to 2022. The decision component is the Commission decision-making procedure, which considers inputs from many sources.

The framework is described below. Only steps 1 and 3 are required and steps 2 and 4 are optional.

1. Coastwide scale (*required*)

- 1.1. **Estimation model (science-based, *required*)**: A statistical analysis or summary of data to inform the current status of the stock and possibly projections given various mortality limits. This may be as complex as a stock assessment or as straightforward as the estimate of relative coastwide abundance/biomass from the modelled survey index.
- 1.2. **Reference Fishing Intensity (management-derived, *required for an assessment-based approach*)**: Determine the coastwide total mortality using a reference SPR that is most consistent with IPHC coastwide objectives defined by the Commission, removing the U26 non-directed fishing discard mortality from the Total Mortality to determine the coastwide TCEY.

2. Regional distribution (*optional*)

- 2.1. **Regional Stock Distribution (science-based, *required when using the Regional step*)**: Distribute the coastwide TCEY to four (4) biologically-based Regions (Figure 3) using the proportion of the stock estimated in each Biological Region for all sizes of Pacific halibut using information from the IPHC space-time model. “All sizes” WPUE is the most congruent metric to distribute the TCEY at this scale.
- 2.2. **Regional Relative Fishing Intensity (science-based, *optional*)**: Adjust the distribution of the TCEY among Biological Regions to account for migration, productivity, and other biological characteristics of the Pacific halibut observed in each Biological Region.
- 2.3. **Regional Allocation Adjustment (management derived, *optional*)**: Adjust the distribution of the TCEY among Biological Regions to account for other factors. This may include evaluation of recent trends in estimated quantities (such as fishery-independent WPUE), inspection of historical trends in fishing intensity, recent or historical fishery performance, and uncertainty. Regional relative harvest rates may also be determined through negotiation, leading to an allocation agreement for further regional adjustment of the TCEY.

3. Regulatory Area Allocation (*required with at least one sub-option*)

- 3.1. **Regulatory Area Stock Distribution (science-based)**: Distribute the coastwide (if step 2 is omitted) or regional TCEY to IPHC Regulatory Areas using the proportion of the stock estimated in each IPHC Regulatory Area for all sizes or O32 Pacific halibut using information from the IPHC space-time model.
- 3.2. **Regulatory Area Allocation (management derived)**: Apply IPHC Regulatory Area allocation to the coastwide TCEY (if step 2 is omitted) or within each Biological Region to distribute the TCEY to Regulatory Areas. This management or policy decision may be informed by data or defined by an allocation agreement and may include different relative harvest rates by Regulatory Area. For example, recent trends in estimated all sizes WPUE from the modelled survey or fishery data, age composition, or size composition may be used to distribute the TCEY to IPHC Regulatory Areas. Inspection of historical trends in fishing intensity or catches by IPHC Regulatory Area may also be used. Finally, predetermined fixed percentages are also an option. This allocation to IPHC Regulatory Areas may be a procedure with multiple adjustments using different information or agreements.

The steps described above would be contained within the IPHC Harvest Strategy Policy as part of the Management Procedure and are predetermined steps with a predictable outcome. The decision-making process would then occur (Figure 2).

4. **Annual Regulatory Area Adjustment (policy, *optional*):** Adjust individual Regulatory Area TCEY limits to account for other factors as needed. This is the policy component of the harvest strategy policy and occurs as a final step where other objectives are considered (e.g., economic, social, etc.). A departure from the reference SPR may be a desired outcome for a particular year (short-term, tactical decision making based on current trends estimated in the stock assessment) but would deviate from the management procedure and the long-term management objectives. Departures from the management procedure could take advantage of current situations but may result in unpredictable longer-term outcomes.

3.1. Coastwide TCEY

The stock assessment along with a target fishing intensity determine the coastwide Total Mortality (TM). The stock assessment model estimates the status of the stock (i.e, relative spawning biomass, RSB) and uses a target fishing intensity (i.e, SPR) to determine the TM for the next year. If the stock status is below a trigger reference level, the fishing intensity for the upcoming year is reduced accordingly based on a harvest control rule (i.e., 30:20 control rule). Additional elements, such as constraints on how much the TM can change from year to year, may also occur at the coastwide level. The coastwide TM is split into the TCEY and under 26" non-directed fishery discard mortality.

3.2. Distributing the TCEY

The TCEY is then distributed to IPHC Regulatory Areas where catch sharing plans and other agreements determine the ultimate allocation to sectors within an IPHC Regulatory Area (the management procedures considered here only go as far as the TCEY in each IPHC Regulatory Area). The allocation to sectors within an IPHC Regulatory Area is not currently being evaluated and is consistent for all management procedures. For a description of these within IPHC Regulatory Area allocation procedures see IPHC-2020-MSAB016-08. The distribution of the TCEY to IPHC Regulatory Areas has several components, that range from purely scientific, to describe the stock distribution and shifts in harvest rates due to differences in productivity, to policy driven, that modify the distribution based on additional considerations.

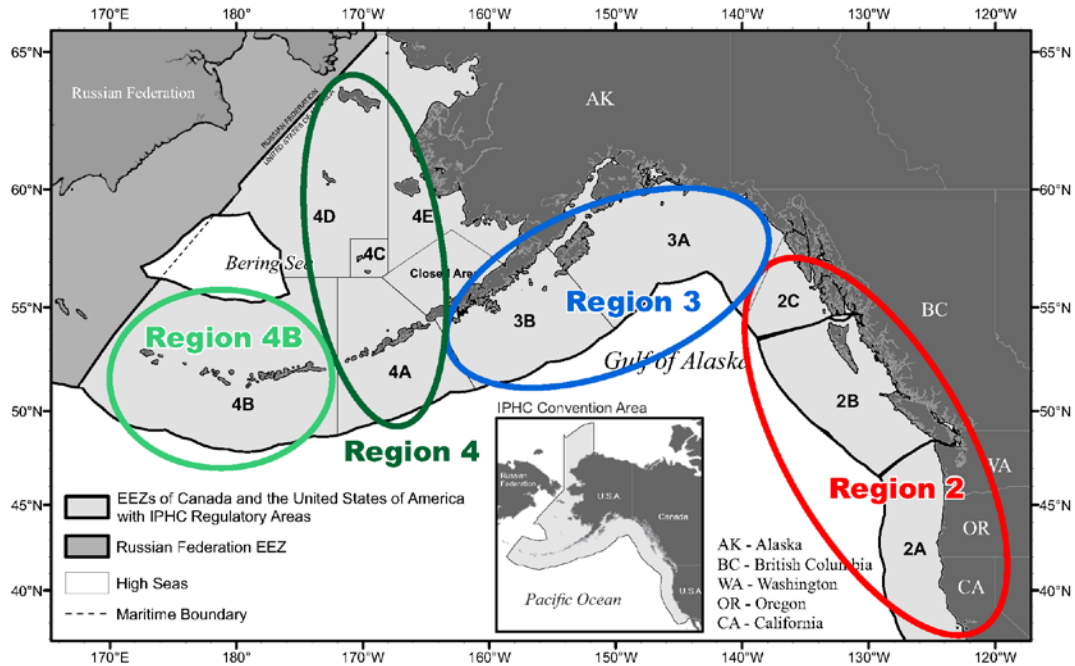


Figure 3: Biological Regions overlaid on IPHC Regulatory Areas. Region 2 comprises 2A, 2B, and 2C, Region 3 comprises 3A and 3B, Region 4 comprises 4A and 4CDE, and Region 4B comprises solely 4B.

The overarching conservation goal for Pacific halibut is to maintain a healthy coastwide stock, which implies an objective to retain viable spawning activity in all geographic components of the stock. This goal is well reflected in both the coastwide and area specific objectives defined by the MSAB (MSAB012, MSAB013, MSAB014) and recommended by the Commission at the 6th Special Session of the Commission. Pacific Halibut is a highly migratory species and years of research have contributed to an understanding of the general pattern of movement of the species and helped define Biological Regions (Figure 3). Each Biological Region encompasses multiple IPHC Regulatory Areas and shares common environmental and demographic features. In general, within a year fish move regularly across IPHC Regulatory Areas, but tend to remain within the same Biological Regions (Loher and Seitz 2006; Seitz et al. 2007; Webster et al. 2013). Hence, spawning components are defined by Biological Region. Shifts in productivity will most likely be detected at a Biological Regions level, and will affect each regional component differently. For these reasons, Biological Regions are the most logical scale over which consider conservation objectives related to distribution of the fishing mortality.

Additional steps for further modification of the distribution of the TCEY among Biological Regions and subsequent distribution among IPHC Regulatory Areas within Biological Regions may be based on external factors, such as area specific observations (e.g. fishery-dependent WPUE),

higher uncertainty of data collected or observed mortality levels in each area, defined allocations, national shares, and so on.

Overall, science (e.g., analysing data and understanding the life-history of Pacific halibut) and policy (e.g, including management objectives, fishery performance and economic considerations) in each Biological Region will help inform the construction of management procedures related to distributing the TCEY among Biological Regions and IPHC Regulatory Areas. Both these aspects have been included in the MPs proposed during MSAB014.

4. CURRENT INTERIM MANAGEMENT PROCEDURE

4.1. Coastwide TCEY

The current interim management procedure uses a coastwide reference fishing intensity (SPR) which defines the scale of the coastwide Total Mortality (TM). The TM is divided into the under 26-inch (U26) non-directed fishery discard mortality and the TCEY. The stock assessment estimates the stock status as the current spawning biomass relative to unfished spawning biomass (B_0), or relative spawning biomass (RSB). The reference fishing intensity is a fishing mortality rate that would reduce the SPR in the coastwide stock to 43% ($F_{43\%}$, as recommended in IPHC-2020-ID002 of [IPHC Circular 2020-007](#)). The 30:20 harvest control rule adjusts the reference SPR if the estimated stock status falls below the 30% trigger value. Specifically, the fishing intensity is reduced linearly if the stock status falls below 30% of unfished spawning stock biomass, and is reduced to zero if the stock status falls below 20% of unfished spawning stock biomass.

4.2. Distributing the TCEY

The coastwide TCEY is then distributed among IPHC Regulatory Areas. The current interim management procedure to distribute the TCEY uses the proportion of modelled survey O32 biomass (i.e. biomass of fish over 32 inches) and 25% lower relative harvest rates in the western areas (i.e. 3B, 4A, 4CDE, and 4B) compared to the eastern areas (i.e. 2A, 2B, 2C, 3A). The lower harvest rate assigned to western areas was first implemented in 2004 (Clark & Hare 2005, Hare 2005, Hare 2006, Hare 2009) as a 'precautionary' measure based on declining trends in spawning biomass and CPUE, the presence of small fish, differences in yield-per-recruit, differences in emigration and immigration, and greater uncertainty in the data and analyses available at the time (Hare 2009). Recent changes in productivity of these areas, modelled through a simple Yield-per-Recruit (YpR) analysis, showed that the past yield-per-recruit justifications for such difference were consistent 20 to 30 years ago, but may not be as consistent in recent years ([IPHC-2019-MSAB014-07](#)).

4.3. Regulatory areas adjustment

The current interim procedure added further adjustments to the distributed TCEY in 2019, including a fixed 1.65 million pounds for IPHC Regulatory Area 2A and an allocation for IPHC Regulatory Area 2B based on both stock distribution and a fixed percentage. This is defined as a weighted average of 30% weight to the current interim management procedure's target TCEY distribution and 70% weight to a value of 20%. In 2020, the Commission decided to also account for some impacts of U26 non-directed fishery discard mortality from U.S. IPHC Regulatory Areas on available harvest in IPHC Regulatory Area 2B. The accounting increases the 2B TCEY by 50% of the estimated yield lost due to U26 non-directed discard mortality in Alaskan waters. These adjustments are intended to apply through 2022.

5. MANAGEMENT PROCEDURES FOR TESTING AND EVALUATION

At MSAB014, a list of ten Management procedures were defined to be tested during the next phase of the MSE process. At MSAB015, this list was reviewed and the main modification concerned the application of a constraint at the coastwide level as well as the addition of one MP. In particular, a maximum change in the TCEY from year to year of 15% was included in all MPs, with the exception of one (labeled MP-A). On the contrary, the use of Slow-up, Fast-Down constraint was removed from the updated list, but was noted to be of continued interest. In addition, some MPs have been prioritized over others, a priority of 1 meaning a focus on producing precise performance metrics (Table 1).

The tools used in the definition of these MPs can be grouped in three categories:

- a) Modelled Survey estimates (e.g. relative biomass estimates by Biological Region, IPHC Regulatory Areas or other scale, O32 WPUE, trend in O32 WPUE, etc..).
- b) Fishery Dependent Data (e.g. trend in CPUE by Biological Region, IPHC Regulatory Area or other scale).
- c) Practical Tools (e.g. relative harvest rate, percentage allocation to an IPHC Regulatory Areas, proportion of adopted TCEY, etc...).

In the definition of the different MPs, the MSAB has also highlighted the importance of testing a number of additional tools, such as i) the application or not of one or more constraints to the TCEY (i.e. 15% maximum change in TCEY, slow-up, fast-down approach, multi-year mortality limits, multi-year averages on abundance indices), ii) the application of O32 estimates of stock distribution or the use of the 'all-sizes' estimates, iii) the application of a minimum TCEY limit, ii) the definition of shares by Biological Region, Management Zone or IPHC Regulatory Area, iv) the application of a maximum coastwide fishing intensity not to be exceeded when distributing the TCEY and v) the application or not of different harvest rates across IPHC Regulatory Areas or Biological Regions. These points are reflected in the combination of different tools between MPs (Table 1).

Table 1: Recommended management procedures to be evaluated by the MSAB in 2020 and the priority of investigation. A priority of 1 denotes a focus on producing precise performance metrics. A priority of 2 denotes potentially fewer simulations are desired, if time is constrained..

MP	Coastwide	Regional	IPHC Regulatory Area	Priority
MP 15-A	SPR 30:20		<ul style="list-style-type: none"> O32 stock distribution Proportional relative harvest rates (1.0 for 2-3A, 0.75 for 3B-4) 1.65 Mlbs floor in 2A¹ Formula percentage for 2B² 	1
MP 15-B	SPR 30:20 MaxChange15%		<ul style="list-style-type: none"> O32 stock distribution Proportional relative harvest rates (1.0 for 2-3A, 0.75 for 3B-4) 1.65 Mlbs floor in 2A¹ Formula percentage for 2B² 	1
MP 15-C	SPR 30:20 MaxChange15%	Biological Regions, O32 stock distribution Rel HRs ³ : R2=1, R3=1, R4=0.75, R4B=0.75	<ul style="list-style-type: none"> O32 stock distribution Relative harvest rates not applied 1.65 Mlbs floor in 2A¹ Formula percentage for 2B² 	2
MP 15-D	SPR 30:20 MaxChange15% Max FI (36%)		First <ul style="list-style-type: none"> O32 stock distribution Relative harvest rates (1.0 for 2-3A, 0.75 for 3B-4) Second within buffer (pro-rated if exceeds buffer) <ul style="list-style-type: none"> 1.65 Mlbs floor in 2A¹ Formula percentage for 2B² 	2
MP 15-E	SPR 30:20 MaxChange15%		<ul style="list-style-type: none"> O32 stock distribution Proportional relative harvest rates (1.0 for 2-3A, 0.75 for 3B-4) 1.65 Mlbs floor in 2A¹ 	2
MP 15-F	SPR 30:20 MaxChange15%	National Shares: 20% to 2B, 80% to other	<ul style="list-style-type: none"> O32 stock distribution to areas other than 2B Relative harvest rates (1.0 for 2-3A, 0.75 for 3B-4) 	1
MP 15-G	SPR 30:20 MaxChange15%		<ul style="list-style-type: none"> O32 stock distribution Relative harvest rates (1.0 for 2-3A, 0.75 for 3B-4) 	1
MP 15-H	SPR 30:20 MaxChange15%		<ul style="list-style-type: none"> O32 stock distribution Relative harvest rates (1 for 2-3, 4A, 4CDE, 0.75 for 4B) 	1
MP 15-I	SPR 30:20 MaxChange15%		<ul style="list-style-type: none"> All sizes stock distribution Relative harvest rates (1.0 for 2-3A, 0.75 for 3B-4) 	2

MP	Coastwide	Regional	IPHC Regulatory Area	Priority
MP 15-J	SPR 30:20 MaxChange15%		<ul style="list-style-type: none"> O32 stock distribution (5-year moving average) Relative harvest rates (1.0 for 2-3A, 0.75 for 3B-4) 	1
MP 15-K	SPR 30:20 MaxChange15%		<ul style="list-style-type: none"> 5-year shares determined from 5-year O32 stock distribution (vary over time but change only every 5th year) 	2

¹ paragraph 97b [IPHC-2020-AM096-R](#)

² paragraph 97c of [IPHC-2020-AM096-R](#)

³ R2 refers to Biological Region 2 (2A, 2B, 2C); R3 refers to Biological Region 3 (3A, 3B); R4 refers to Biological Region 4 (4A, 4CDE), and R4B refers to Biological Region 4B

5.1. Coastwide TCEY

All of the management procedures proposed at MSAB015 (Table 1) for testing are based on the current interim MP including a fishing intensity (SPR), and a harvest control rule (30:20). A maximum constrained in the change in the TCEY from one year to the next not higher than 15% was included for testing across all but one of the different management procedures. In addition, the inclusion of a maximum fishing intensity buffer not higher than an SPR of 36% or 40% (meaning a SPR greater than or equal to 36% or 40%) was included in one MP. The rationale behind it is in accordance with the analysis on dynamic reference points presented at MSAB014 ([IPHC-2019-MSAB014-07](#)), which identifies a potential range for SPR_{MSY} to likely be between 30 and 35%.

An additional “Slow-Up, Fast-Down” constraint, has been recommended for testing if time allows or in future MSE iterations. The SUFD enforces a TM limit increase by one-third of the increase suggested by harvest control rule and a TM limit decrease by one-half of the decrease suggested by the management procedure. It was suggested because it also met the objectives in the coastwide MSE ([IPHC-2019-MSAB013-08](#)) and has some properties that may result in less annual variability in the TCEY.

5.2. Distributing the TCEY

Most of the management procedures proposed distribute the TCEY directly to IPHC Regulatory Areas, and only one MP distributes the TCEY first to Biological Regions. In one MP, a fixed allocation is introduced at the coastwide level, assigning 20% to IPHC Regulatory Area 2B and 80% to all other areas. The modelled survey O32 stock distribution is the main tool used for distributing the TCEY both at the Biological Region and IPHC Regulatory Area levels, and it is used in ten MPs. One MP (labelled MP-I) uses the modelled all sizes stock distribution for distributing the TCEY at a IPHC Regulatory Area level. Different relative harvest rate adjustments are used across different MPs to test the effects on western and eastern areas given the potential changes in productivity that may have occurred in the last decade. This tool

is also applied to Biological Regions when distributing the TCEY to regions first. Finally, five of the MPs include at least one of the interim agreements for IPHC Regulatory Areas 2A and 2B.

6. RECOMMENDATIONS

That the MSAB:

- a) **NOTE** paper IPHC-2020-MSAB016-07 which includes a discussion of management procedures to distribute the TCEY and eleven management procedures defined for testing and evaluation.
- b) **RECOMMEND** additional elements of management procedures that would be useful to test and evaluate.

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8. APPENDICES

Nil