



Development of a framework to investigate fishing intensity and distributing the total constant exploitation yield (TCEY) for Pacific halibut fisheries

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PURPOSE

To update the Management Strategy Advisory Board (MSAB) on discussions and ideas related to science inputs and management procedures for distributing the Total Constant Exploitation Yield (TCEY) across the IPHC Convention Area, as well as the development of simulation framework to evaluate these management procedures (as of 5 April 2019).

1 INTRODUCTION

The report from the 95th Session of the IPHC Annual Meeting (AM095) contained one paragraph that noted the TCEY distribution component of the IPHC harvest strategy policy ([IPHC-2019-AM095-R](#)).

62. The Commission **RECOMMENDED** that the MSAB and IPHC Secretariat continue its program of work on the Management Procedure for the Scale portion of the harvest strategy, *NOTING* that Scale and Distribution components will be evaluated and presented no later than at AM097 in 2021, for potential adoption and subsequent implementation as a harvest strategy.

There are many notes, requests, and recommendations from past Annual Meetings and MSAB meetings that pertain to distributing the TCEY. These are reproduced in Appendix I. Some important themes from these paragraphs are

- Distributing the TCEY to IPHC Regulatory Areas may result in a change to the coastwide total mortality or to the coastwide SPR.
- There are science-based and management derived elements to distributing the TCEY. A framework has been proposed that incorporates these elements.
 - **Coastwide Target Fishing Intensity:** this defines the TCEY to be distributed. *Science-based.*
 - **Regional Stock Distribution:** this distributes the TCEY to biological Regions to satisfy the Biological Sustainability objective of preserving biocomplexity. *Science-based.*
 - **Regional Allocation Adjustment (optional):** this adjusts the distribution of the TCEY among Regions to account for additional Biological Sustainability objectives and fishery objectives. *Science-based and management-derived.*
 - **Regulatory Area Allocation:** this distributes the TCEY from Regions to Regulatory Areas to satisfy fishery objectives. *Management-derived.*
- The IPHC Secretariat has described four biological Regions (consistent with IPHC Regulatory Area boundaries) based on the best available science.
- The MSAB has identified many potentials tools for use in distribution procedures.

This document advances IPHC-2018-MSAB012-08 (and repeats important material) and reports progress on the topic of distributing the TCEY.

2 DISTRIBUTING THE TCEY

A considerable amount of discussion related to a description of the harvest strategy policy occurred at previous MSAB meetings. Figure 1 shows an updated depiction of the harvest strategy policy with terms describing the various components. These terms are defined in the IPHC glossary¹, but of note for this paper are TCEY distribution, stock distribution, and distribution procedures. The management procedure is the sequence of elements including the assessment, fishing intensity, stock distribution, and distribution procedures. The goal of the MSAB is to define a management procedure that will be used to output O26 mortality limits (TCEY) for each IPHC Regulatory Area that meet the long-term objectives of managers and stakeholders. The “decision” step on the right of Figure 1 is where a deviation from the management procedure may occur due to input from other sources and decisions of the Commissioners that may reflect current biological, environmental, social, and economic conditions.

In 2017, the Commission agreed to move to an SPR-based management procedure to account for the mortality of all sizes and from all fisheries. The procedure uses a coastwide fishing intensity based on spawning potential ratio (SPR), which defines the “scale” of the coastwide catch. The current interim management procedure for distributing the TCEY among IPHC Regulatory Areas contains two inputs: 1) the current estimated stock distribution and 2) relative target harvest rates.

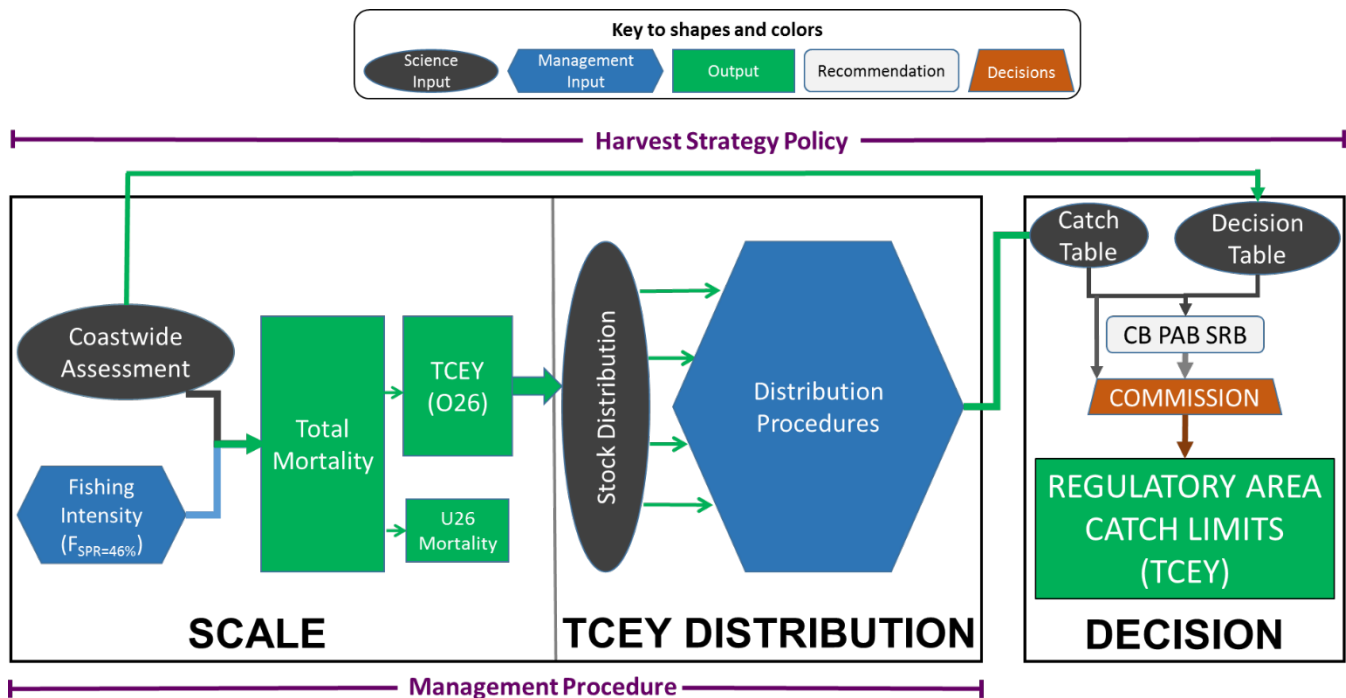


Figure 1. A pictorial description of the interim IPHC harvest strategy policy showing the separation of scale and distribution of fishing mortality. The “decision step” is when policy and decision-making (not a procedure) influences the final mortality limits.

2.1 STOCK DISTRIBUTION

The IPHC uses a space-time model to estimate annual Weight-Per-Unit-Effort (WPUE) for use in estimating the annual stock distribution of Pacific halibut (IPHC-2019-AM095-07). Briefly, observed WPUE is fitted with a model that accounts for correlation between setline survey stations over time (years) and space (within Regulatory Areas). Competition for hooks by Pacific halibut and other species, the timing of the setline survey relative to annual fishery

¹ <https://iphc.int/the-commission/glossary-of-terms-and-abbreviations>

mortality, and observations from other fishery-independent surveys are also accounted for in the approach. This fitted model is then used to predict WPUE (a measure of relative density) of Pacific halibut for every setline survey station in the design, including all setline survey expansion stations, regardless of whether it was fished in a particular year. These predictions are then averaged within each IPHC Regulatory Area, and combined among IPHC Regulatory Areas, weighting by the “geographic extent” (calculated area within the survey design depth range) of each IPHC Regulatory Area. It is important to note that this produces relative indices of abundance and biomass, but does not produce an absolute measure of abundance or biomass because it is weight-per-unit-effort scaled by the geographic extent of each IPHC Regulatory Area. These indices are useful for determining trends in stock numbers and biomass and are also useful to estimate the geographic distribution of the stock.

2.2 RELATIVE HARVEST RATES

The distribution of the TCEY for 2019 was shifted from the estimated stock distribution to account for additional factors related to productivity and paucity of data in each IPHC Regulatory Area. Previously, this was accomplished by applying different harvest rates in western areas (16.125% in IPHC Regulatory Areas 3B, 4A, 4B, and 4CDE) and eastern areas (21.5% in IPHC Regulatory Areas 2A, 2B, 2C, and 3A). However, with the use of an SPR-based fishing intensity to determine the coastwide scale, the TCEY, rather than the esoteric concept of exploitable biomass, is now distributed.

Therefore, an absolute measure of harvest rate is not necessary, but it may still be desired to shift the distribution of the TCEY away from the estimated stock distribution to account for other factors. Consistent with the previous approach, relative harvest rates were used with a ratio of 1.00:0.75, being equal to the ratio between 21.5% and 16.125%. This application shifted the target TCEY distribution away from the stock distribution by moving TCEY into IPHC Regulatory Areas 2A, 2B, 2C, and 3A and removing TCEY from IPHC Regulatory Areas 3B, 4A, 4B, and 4CDE (Table 1), thus harvesting at a higher rate in eastern IPHC Regulatory Areas.

Table 1. IPHC Regulatory Area stock distribution estimated from the 2018 space-time model O32 WPUE, IPHC Regulatory Area-specific relative target harvest rates, and resulting 2019 target TCEY distribution based on the IPHC’s 2019 interim management procedure (reproduced from the mortality projection tool <https://iphc.int/data/projection-tool>).

	2A	2B	2C	3A	3B	4A	4B	4CDE	Total
O32 stock distribution	1.8%	11.2%	14.3%	37.2%	9.0%	6.7%	5.9%	13.9%	100%
Relative harvest rates	1.00	1.00	1.00	1.00	0.75	0.75	0.75	0.75	--
Target TCEY Distribution	1.9%	12.3%	15.6%	40.9%	7.4%	5.5%	4.9%	11.5%	100%

2.3 REDEFINING THE DISTRIBUTION OF THE TCEY

TCEY distribution is the part of the management procedure for distributing the TCEY among IPHC Regulatory Areas and is composed of a purely scientific component to distribute the TCEY in proportion to its estimated biomass in each area (stock distribution) and steps to further modify the distribution of the TCEY based on additional considerations (distribution procedures). These two components are described below.

2.3.1 Stock Distribution

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 pertinent portions of the stock. One method for addressing this objective, without knowing what pertinent portions of the stock are, is to distribute the fishing mortality relative to the distribution of observed stock biomass. This requires defining appropriate areas for which the distribution is to be conserved, hence balancing the removals to protect against localized depletion of spatial and demographic components of the stock that may produce differential recruitment success under changing environmental and ecological conditions. Splitting the coast into many small areas for conservation objectives can result in

complications, including i) making it cumbersome to determine if conservation objectives are met, ii) making it difficult to accurately determine the proportion of the stock in that area resulting in inter-annual variability in estimates of the proportion, iii) forcing arbitrary delineation among areas despite evidence of strong stock mixing, and iv) not representing biological importance. Emerging understanding of Pacific halibut diversity across the geographic range of the Pacific halibut stock indicates that IPHC Regulatory Areas should only be considered as management units and do not represent relevant sub-populations (Seitz et al. 2017). Biological Regions, defined earlier and shown in Figure 2, are considered by the IPHC Secretariat, and supported by the SRB (paragraph 31 IPHC-2018-SRB012-R), to be the best current option for biologically-based areas to meet management needs, such as protect against localized depletion. Biological Regions are also the most logical scale over which to consider conservation objectives related to distribution of the fishing mortality.

In addition to using Biological Regions for stock distribution, the “all sizes” WPUE from the space-time model (Figure 3), which is largely composed of O26 Pacific halibut, due to selectivity of the setline gear, is more congruent with the TCEY (O26 catch levels) than O32 WPUE. Therefore, when distributing the TCEY to Biological Regions, the estimated proportion of “all sizes” WPUE from the space-time model should be used for consistency.

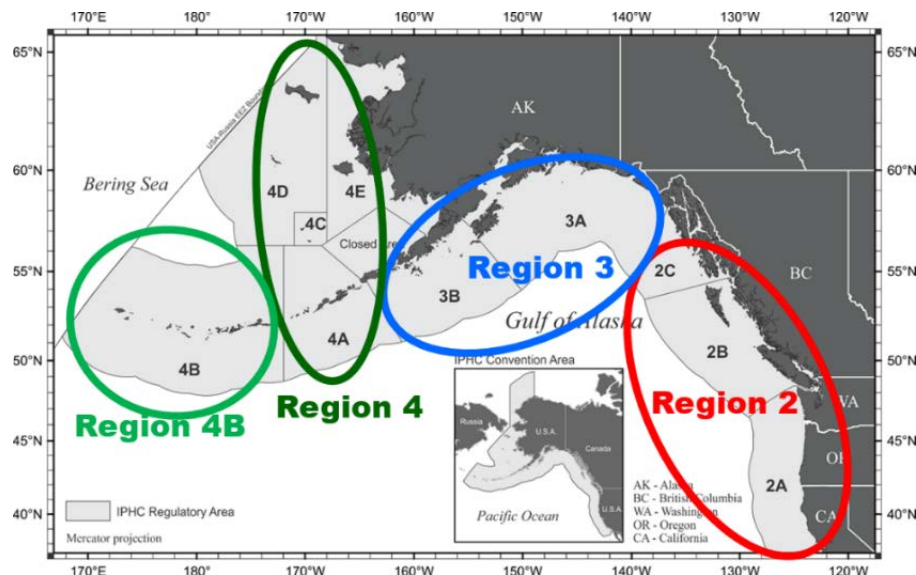


Figure 2. Biological Regions overlaid on IPHC Regulatory Areas with Region 2 comprised of 2A, 2B, and 2C, Region 3 comprised of 3A and 3B, Region 4 comprised of 4A and 4CDE, and Region 4B comprised solely of 4B.

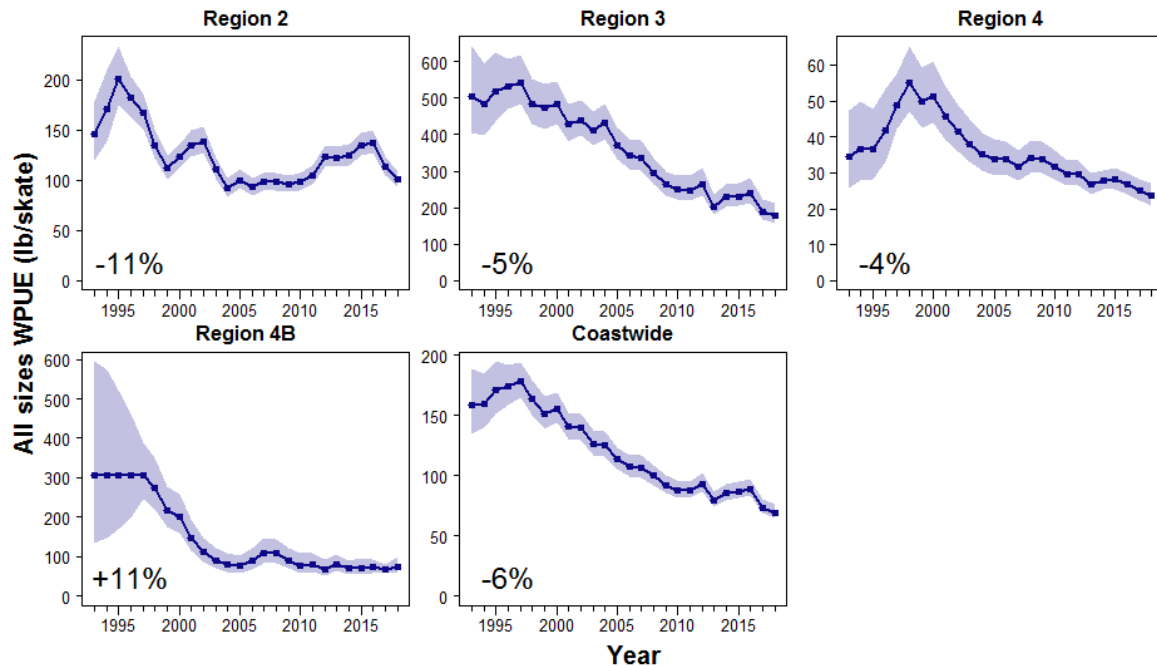


Figure 3. Estimated stock distribution (1993-2018) based on estimate “all sizes” WPUE for Pacific halibut from the space-time model. Shaded zones indicate 95% credible intervals. Reproduced from [IPHC-2019-AM095-08](#).

2.3.2 Distribution Procedures

The Distribution Procedures component contains additional steps of further modifying the distribution of the TCEY among Biological Regions and then distributing the TCEY among IPHC Regulatory Areas within Biological Regions (Figure 4). Modifications at the level of Biological Regions or IPHC Regulatory Areas may be based on differences in production between areas, observations (i.e., data) in each area relative to other areas (e.g. WPUE), uncertainty of data or mortality in each area, defined allocations, or national shares. Data may be used as indicators of stock trends in each Region or IPHC Regulatory Area and are included in the Distribution Procedures component because they may be subject to certain biases or include factors unrelated to the biomass in that Biological Region or IPHC Regulatory Area. For example, commercial WPUE is a popular source of data used to indicate trends in a population, but may not always be proportional to biomass, yet useful to understand fishery trends. Types of data that could be used may include but is not limited to

- fishery WPUE,
- survey observations (not necessarily the IPHC fishery-independent setline survey),
- age-compositions,
- size-at-age, and
- environmental observations.

The steps in the Distribution Procedures may consider conservation objectives, but they will mainly be developed with respect to fishery objectives. Yield and stability in catch levels are two important fishery objectives that often contradict each other (i.e. higher yield often results in less stability). Additionally, area-specific fishery objectives will likely be diverse and potentially in conflict across IPHC Regulatory Areas. Pacific halibut mortality levels are

defined for each IPHC Regulatory Area and quota is accounted for by those IPHC Regulatory Areas. Therefore, IPHC Regulatory Areas are the appropriate scale to consider fishery objectives.

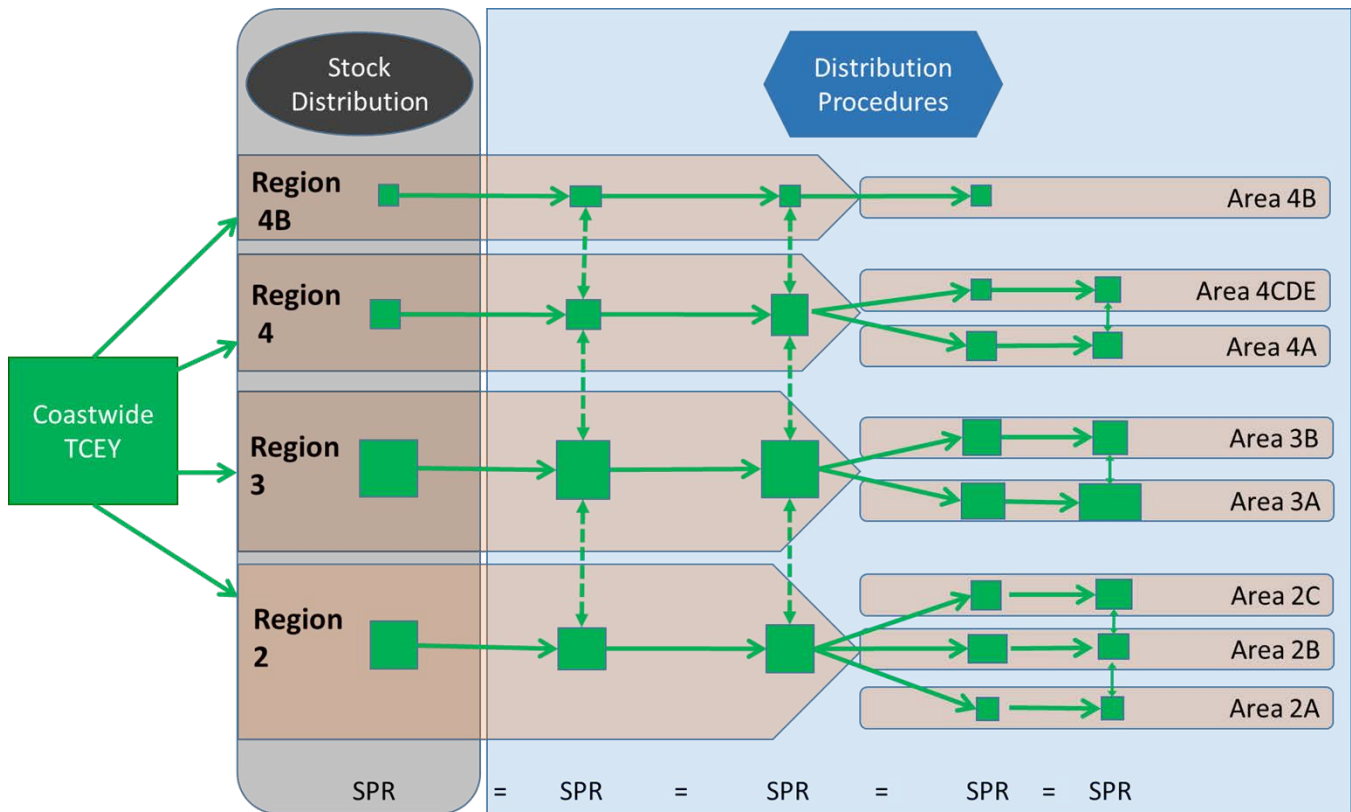


Figure 4. The process of distributing the TCEY to IPHC Regulatory Areas from the coastwide TCEY. The first step is to distribute the TCEY to Biological Regions based on the estimate of stock distribution. Following this, a series of adjustments may be made based on observations or social, economic, and other considerations. Finally, the adjusted regional TCEY's are allocated to IPHC Regulatory Areas. The allocation to IPHC Regulatory Areas may occur at any point after regional stock distribution. The dashed arrows represent the balancing required to maintain a constant coastwide SPR.

3 A FRAMEWORK FOR DISTRIBUTING THE TCEY AMONG IPHC REGULATORY AREAS

The harvest strategy policy begins with the coastwide TCEY determined from the stock assessment and fishing intensity determined from a target SPR (Figure 1). To distribute the TCEY among regions, stock distribution (Section 2.3.1) occurs first to distribute the harvest in proportion to biomass and satisfy conservation objectives. This is followed by adjustments across Biological Regions and Regulatory Areas based on distribution procedures to further encompass conservation objectives and consider fishery objectives. A constraint could be enforced such that given relative adjustments, the overall fishing intensity (i.e., target SPR) is maintained (i.e., a zero-sum game relative to fishing intensity). This is consistent with many management procedures for fisheries around the world. If a target SPR is not maintained, the management procedure must guarantee that extreme fishing intensities that could be detrimental to the stock do not occur. Without a target SPR, it may be difficult for some agencies to certify the fishery as sustainable.

A framework for a management procedure that ends with the TCEY distributed among IPHC Regulatory Areas and would encompass conservation and fishery objectives is described below.

1. **Coastwide Target Fishing Intensity (science-based):** Determine the coastwide total mortality using a target SPR that is most consistent with IPHC objectives defined by the Commission. Separate the total mortality into ≥ 26 inches (O26) and under 26 inches (U26) components. The O26 component is the coastwide TCEY.
 - 1.1. SPR is an element of the management procedure that will continue to be evaluated.
2. **Regional Stock Distribution (science-based):** Distribute the coastwide TCEY to four (4) biologically-based Regions using the proportion of the stock estimated in each Biological Region for all sizes of Pacific halibut using information from the IPHC setline survey and the IPHC space-time model. “All sizes” WPUE is the most appropriate metric to distribute the TCEY.
 - 2.1. Four Regions (2, 3, 4, and 4B) are defined above (Figure 2).
3. **Regional Allocation Adjustment (science-based and management derived):** Adjust the distribution of the TCEY among Biological Regions to account for other factors.
 - 3.1. For example, relative target harvest rates are part of a management/policy decision that may be informed by data and observations. 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 biological characteristics of the Pacific halibut observed in each Biological Region. The IPHC Secretariat may be able to provide Yield-Per-Recruit (YPR) and/or surplus production calculations as further supplementary information for this discussion. The regional relative harvest rates may also be determined through negotiation, leading to an allocation agreement for further Regional adjustment of the TCEY.
4. **Regulatory Area Allocation (management derived):** Apply IPHC Regulatory Area allocation percentages within each Biological Region to distribute the Region-specific TCEY’s to Regulatory Areas.
 - 4.1. This management or policy decision may be informed by data, based on past or current observations, or defined by an allocation agreement. For example, recent trends in estimated all sizes WPUE from the setline survey or fishery, 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 data, observations, or agreements

The four 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 1).

5. **Seasonal Regulatory Area Adjustment:** Adjust individual Regulatory Area TCEY limits to account for other factors as needed. This is the policy part of the harvest strategy policy and occurs as a final step where other objectives are considered (e.g., economic, social, etc.).
 - 5.1. A departure from the target 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 outcomes.

4 MANAGEMENT PROCEDURES RELATED TO DISTRIBUTION

The MSAB012 report (IPHC-2018-MSAB012-R) listed nine potential tools for use in developing distribution procedures (paragraph 75, noted above in Section 2). Each of these potential tools will be discussed at MSAB013.

- **Relative harvest rates.**
- **O32:O26 ratios.**
- **Trends in setline survey WPUE by IPHC Regulatory Area.**
- **Trends in modelled survey WPUE by biological region.**
- **Trends in fishery CPUE.**
- **Smoothing algorithms on area-specific catch limits.**
- **Percentage allocation with a floor (i.e. minimums of 1.65 Mlbs in 2A and 1.7 Mlbs in 4CDE).**
- **A maximum SPR with catch distribution by IPHC Regulatory Area determined from the modelled survey WPUE.**
- **Coastwide TCEY target and maximum calculated; distribution by target, but with ability to adjust TCEY up to the maximum.**

There are many other tools that could be used, and AM095 implemented two tools for IPHC Regulatory Areas 2A and 2B (IPHC-2019-AM095-R). The TCEY for IPHC Regulatory Area 2A was set at 1.65 Mlbs and will be fixed at that value for 2019–2022, “subject to any substantive conservation concerns.” The TCEY for IPHC Regulatory Area 2B was defined based on a weighted average with 30% weight to the current interim management procedure’s target TCEY distribution and 70% on 2B’s recent historical average share of 20%. The elements can easily be incorporated into a management procedure.

5 DEVELOPMENT OF THE CLOSED-LOOP SIMULATION FRAMEWORK

An MSE is a scientifically defensible, forecast-driven study of the tradeoffs between fisheries management scenarios, and requires that the software underpinning these simulations be robust, well-documented, performant, and extensible. It should return reproducible results, maximize ease-of-use, and be written with standard software development and testing processes and tools. With these guidelines in mind, the IPHC MSE development project will produce a simulation, analysis, and visualization tool set that can support Pacific halibut fisheries management in the future.

The structure of the software to be developed resembles the MSE process, highlighting the interplay between forecast models conditioned on historical data that characterize a stock, and a management procedure to be evaluated against conservation and fishery objectives. Recent experience with such codes, simulating sufficient scenarios to meet defensibility criteria, moreover indicate that performance and end-user usability testing are also key to enabling facile MSE outcomes. These facets are described above, and include

- the creation of an operating model
- an ability to condition model parameters using historical setline, catch, and survey data
- integration with stock assessment tools or data
- application of a management procedure with closed-loop feedback into the operating model

- production of performance metrics to evaluate management procedures
- support for hypothesis testing, stock performance investigation, and detailed tradeoff analysis
- a platform and data source for customizable visualizations and analytics
- standardization of the computer-based format, structure, and content of management procedures
- leveraging existing high-performance scientific computing methodologies, software, and infrastructure

In practical terms, the operating model and related high-performance scientific and statistical codes will be written in C++ and heavily leverage available libraries, such as the AD Model Builder package. Configuration files and templates will utilize YAML, a human-readable but machine-parseable text specification. Additional statistical tooling used for analysis and visualization will utilize R. A workflow management system will be used to manage and monitor the execution of computational jobs, and will support their execution both locally and on third-party (e.g., cloud or HPC center) resources.

A summary of the framework components is below.

1. Operating Model

1.1. An open-source C++ codebase developed at the IPHC, simulating the dynamics of

1.1.1. fish biology and population dynamics, including

- aging
- recruitment
- maturation
- movement between spatial regions
- mortality, both natural and fishing, and
- spawning

1.1.2. ocean regime

1.1.3. environmental and ecological effects

1.1.4. partitions for year, age, sex, and more

1.1.5. variability in various processes

1.2. Customizable spatial mapping, but at minimum per Region and IPHC Regulatory Area

1.3. Fleet mapping for consistency with stock assessment models (commercial, discards, bycatch, sport, personal use by IPHC Regulatory Area as necessary).

1.4. Uncertainty of parameters and model structure, and simulated variability in factors such as future weight-at-age and recruitment.

2. Management Procedure

2.1. Estimation Models, including

2.1.1. Perfect information, as if we knew population values exactly when applying the harvest rule.

2.1.2. Simulate error in the total mortality limit and relative spawning biomass (i.e., stock status), and their autocorrelation, from the simulated time-series to mimic an unbiased stock assessment.

- 2.1.3. Use a single existing stock assessment
- 2.1.4. Use an ensemble of stock assessment techniques
- 2.2. Data Generation
 - 2.2.1. Use the operating model to generate simulated realizations of data products (e.g., survey index) at the Region or IPHC Regulatory Area level with variability and bias
- 2.3. Harvest Rule
 - 2.3.1. Coastwide fishing intensity (FSPR) using a procedural input SPR.
 - 2.3.2. A fishing trigger to reduce the fishing intensity (increase SPR) when stock status is below a specified level.
 - 2.3.3. A fishing limit to cease directed fishing when the stock status is less than a specified value (currently, 20%).
 - 2.3.4. Constraints on the annual change in the mortality limit
 - 2.3.5. Other coastwide and area-specific elements as defined by the MSAB
- 3. Analysis, Visualization, and Reporting tools
 - 3.1. Statistical tools for data analysis and quick-look visualization, written in R and C++
 - 3.2. Web-based visualization tools, written in R and Javascript, for easy stakeholder viewing and data manipulation
 - 3.3. Reporting tools, allowing customizable summaries of MSE output for later analysis, inclusion in documents, and stakeholder review
- 4. Computing infrastructure
 - 4.1. Human- and machine-readable configuration files for operating model and management procedures (YAML)
 - 4.2. Workflow management system for the management and monitoring of computational tasks (e.g., Drake, Airflow, Dask)
 - 4.3. Ability to run locally, on cloud providers (Amazon Web Services, Microsoft Azure, Google Cloud) or on third-party supercomputing resources (Open Science Grid, XSEDE)

5.1 MULTI-AREA OPERATING MODEL

The operating model will be generalized and able to model a single-area or multiple areas such as IPHC Regulatory Areas. However, based on current knowledge, biology and inter-annual movement of Pacific halibut is best modeled with Biological Regions (Figure 2). Distribution of the TCEY will still occur to IPHC Regulatory Areas by modelling multiple sectors within a Biological Region, and sector-specific performance metrics will be calculated at the IPHC Regulatory Area level.

6 RECOMMENDATION

That the MSAB:

- 1) **NOTE** paper IPHC-2019-MSAB013-09 which provides the MSAB with discussions related to distributing the TCEY.
- 2) **NOTE** the distribution framework and the separation of scientific and management elements of distribution procedures.
- 3) **RECOMMEND** elements of management procedures for the distribution of the TCEY.

7 REFERENCES

Seitz, A. C., Farrugia, T. J., Norcross, B. L., Loher, T., & Nielsen, J. L. (2017). Basin-scale reproductive segregation of Pacific halibut (*Hippoglossus stenolepis*). *Fisheries Management and Ecology*, 24(4), 339–346. doi:10.1111/fme.12233

8 APPENDICES

Appendix I: Paragraphs from past reports that pertain to distributing the TCEY

APPENDIX I**PARAGRAPHS FROM PAST REPORTS THAT PERTAIN TO DISTRIBUTING THE TCEY****[IPHC-2018-AM094-R](#)**

The report from the 94th Session of the IPHC Annual Meeting (AM094) remains pertinent to the discussion of distributing the TCEY among the Regulatory Areas and included the following text

37. *The Commission **REQUESTED** that the objectives related to distributing the TCEY, as detailed in Circular IPHC-2017-CR022, be presented at MSAB11 for further stakeholder feedback.*
38. *The Commission **REQUESTED** that the proposed TCEY distribution methodology of the Harvest Strategy Policy reflect an understanding of both stock distribution and fishery management distribution procedures.*
39. *The Commission **RECOMMENDED** that the IPHC Secretariat consider the survey WPUE grid across the fishery as well as other biological factors (e.g. habitat configuration, size distribution in the region etc.) and provide alternatives to the current management areas (e.g. biological regions), and that the MSAB consider additional ways to incorporate biological information into TCEY distribution procedures.*
42. *The Commission **AGREED** that distributing the TCEY to regions does not necessarily need to be the first step of the TCEY distribution procedure, and other biological factors, such as habitat and size distribution, be considered.*

[IPHC-2017-MSAB010-R](#)

The report from the 10th meeting of the Management Strategy Advisory Board (MSAB) in October 2017 included the following related to distributing the TCEY:

37. ***NOTING** the order of operations in the proposed TCEY distribution procedure, the MSAB **AGREED** that the order of stock distribution and TCEY distribution procedures is a management choice that could be evaluated.*
38. *The MSAB **NOTED** that the order of operations in the proposed TCEY distribution procedure will be subject to review at future MSAB meetings and that the specific components require further definition.*

[IPHC-2018-MSAB011-R](#)

The report from the 11th meeting of the Management Strategy Advisory Board (MSAB) in May 2018 included the following related to distributing the TCEY:

69. The MSAB **NOTED** that:

- a) *if the goal of a procedure is to maintain a constant SPR through all steps of distributing the TCEY, then a change in distribution may change the total coastwide mortality to maintain that SPR.*
- b) *there are science-based and management-derived elements in the TCEY distribution procedure. Some distribution procedures may incorporate one or both elements.*
- c) *stock distribution is science-based and is linked to biological sustainability objectives. WPUE from the space-time model is used to determine stock distribution to biological regions, and using “all sizes” in the calculation of WPUE is more congruent with the TCEY, while acknowledging that the IPHC fishery-independent setline survey catches a small number of Pacific halibut below 26 inches.*
- d) *the IPHC Secretariat has described four biological Regions (consistent with IPHC Regulatory Area boundaries) based on the best available science, and will be used for stock distribution as the first step, after which distribution procedures would distribute the TCEY to meet fishery objectives.*
- e) *relative harvest rates among Regions are science-based and management-derived, and within Regions are management-derived. Science-based foundations could include productivity analyses, while management-derived elements may include quantity and quality of data in each area and other area-specific objectives.*
- f) *many more elements of the TCEY distribution procedure may be developed and include management-derived elements.*
- g) *TCEY distribution procedures are to be evaluated against objectives and reported at AM097 in 2021. Biological sustainability objectives are related to biological Regions and Fishery IPHC-2018-MSAB011-R Page 14 of 29 objectives are related to IPHC Regulatory Areas. Because IPHC Regulatory Areas are nested within Regions, distribution to Regions can affect fishery objectives.*

70. The MSAB **NOTED** that the proposed TCEY distribution procedure contains four main components, each of which may contain multiple elements. These four components are listed below and have a computational outcome:

- a) **Coastwide Target Fishing Intensity:** *this defines the TCEY to be distributed.*
- b) **Regional Stock Distribution:** *this distributes the TCEY to biological Regions to satisfy the Biological Sustainability objective of preserving biocomplexity.*
- c) **Regional Allocation Adjustment (optional):** *this adjusts the distribution of the TCEY among Regions to account for additional Biological Sustainability objectives and fishery objectives.*
- d) **Regulatory Area Allocation:** *this distributes the TCEY from Regions to Regulatory Areas to satisfy fishery objectives.*

71. The MSAB **NOTED** that the output of the TCEY distribution procedure will be a catch table describing proposed mortality (allocation) in each IPHC Regulatory Area.

72. The MSAB **REQUESTED** that the proposed TCEY distribution framework described in [paragraphs 69, 70 and 71](#), be reviewed by the SRB in 2018.
73. The MSAB **NOTED** the intent expressed by the Commission that the output from the management procedure (proposed mortality – allocation – by IPHC Regulatory Area) would then be subject to an annual Regulatory Area adjustment by the Commission, which may deviate from the harvest strategy by changing the distribution and the SPR.
74. The MSAB **NOTED** that the SPR is maintained after distributing the catch. A deviation from the SPR determined in the Harvest Control Rule due to distribution procedures may be useful to investigate, but there must be a minimum SPR which is not exceeded. This ensures that a maximum fishing intensity is not exceeded.
75. The MSAB **NOTED** some potential tools for use as distribution procedures when distributing the TCEY:
- a) Relative harvest rates.
 - b) O32:O26 ratios.
 - c) trends in survey WPUE by IPHC Regulatory Area.
 - d) Trends in modelled survey WPUE by biological region.
 - e) trends in fishery CPUE.
 - f) Smoothing algorithms on area-specific catch limits.
 - g) Percentage allocation with a floor (i.e. minimums of 1.5 Mlbs in 2A and 1.7 Mlbs in 4CDE).
 - h) A maximum SPR with catch distribution by IPHC Regulatory Area determined from the modelled survey WPUE.
 - i) Coastwide TCEY target and maximum calculated; distribution by target, but with ability to adjust TCEY up to the maximum.
76. **NOTING** that these tools require further discussion, the MSAB **REQUESTED** that the IPHC Secretariat provide comments, and that further stakeholder feedback is elicited.
77. The MSAB **NOTED** that observations of stock and catch distribution during various reference periods should be considered when defining objectives for evaluation.

IPHC-2018-MSAB012-R

The report from the 12th meeting of the Management Strategy Advisory Board (MSAB) in October 2018 included the following related to distributing the TCEY:

48. The MSAB **ACKNOWLEDGED** the importance and continued support among members for the following principle: conserving spatial population structure by applying a precautionary approach and using bioregions. This would be maintained as a general objective in Appendix V. 6.2 Review the framework to investigate distributing the TCEY among IPHC Regulatory Areas and evaluate against objectives

49. The MSAB **NOTED** the distribution framework and the separation of scientific and management elements of distribution procedures.
50. The MSAB **NOTED** that catch limit decisions are based on TCEY (O26), therefore using “all-sizes” WPUE from the FISS space-time model is more congruent with regional stock distribution. 6.3 Identify preliminary MPs related to distribution.
51. The MSAB **NOTED** the MPs that are currently listed for consideration, as follows:
- a) Relative harvest rates.
 - b) O32:O26 ratios.
 - c) Trends in setline survey WPUE by IPHC Regulatory Area.
 - d) Trends in modelled setline survey WPUE by biological region.
 - e) Trends in fishery CPUE.
 - f) Smoothing algorithms on area-specific catch limits.
 - g) Percentage allocation with a floor (i.e. minimums of 1.5 Mlbs in 2A and 1.7 Mlbs in 4CDE).
 - h) A maximum SPR with catch distribution by IPHC Regulatory Area determined from the modelled setline survey WPUE.
 - i) Coastwide TCEY target and maximum calculated; distribution by target, but with ability to adjust TCEY up to the maximum.
52. The MSAB **AGREED** that an ad-hoc working group would be formed to recommend elements of management procedures for the distribution of TCEY. The working group will organize the management procedures listed in paper IPHC-2018-MSAB012-08 with respect to the framework of five steps for distributing TCEY to bioregions and regulatory areas listed in Section 3.4 of paper IPHC-2018-MSAB012-08. The members of the ad-hoc working group will be: Bruce Gabrys, Peggy Parker, Dan Falvey, Chris Sporer, Glenn Merrill, Scott Mazzone, Jim Lane, Adam Keizer, and Carey McGilliard. The working group will meet electronically between the AM095 and MSAB013 and the meeting will be facilitated by the IPHC Secretariat.
53. The MSAB **URGED** members to document candidate management procedures and share any such MPs with the ad-hoc working group prior to MSAB013, via the IPHC Secretariat. The 95th Session of the IPHC Annual Meeting (AM095) will be a key engagement point for this task.
54. The MSAB **REQUESTED** that an additional management procedure be considered to define allocations and a catch limit floor that reduces catch limits in a stair-step manner during times of large abundance changes.
55. The MSAB **REQUESTED** that the IPHC Secretariat and the MSAB continue to develop the concept of a ‘fishery footprint’, as previously considered in IPHC-2015-MSAB006-R, in part to consider how it may be incorporated into a MP