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## Ideas on estimating stock distribution and distributing catch for Pacific halibut fisheries

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### PURPOSE

To update the MSAB on discussions and ideas related to science inputs and management procedures for distributing the TCEY across the IPHC Convention Area.

### BACKGROUND

The report from the 9<sup>th</sup> Meeting of the Management Strategy Advisory Board (MSAB09)<sup>1</sup> included the following related to distributing TCEY among the Regulatory Areas (IPHC 2017).

41. The MSAB **NOTED** paper IPHC-2017-MSAB09-09, which aimed to stimulate discussion about alternatives to distribute the TCEY in the current harvest strategy policy, noting that the Commission has directed the IPHC Secretariat to initiate a process as follows:  
*AM093–Req.02 (para. 40) “The Commission REQUESTED that the IPHC Secretariat initiate a process to develop alternative, biologically based stock distribution strategies for consideration by the Commission and its subsidiary bodies. This should also be incorporated into the MSE Program of Work.”*
42. The MSAB **NOTED** a Harvest Strategy and terms to describe the Harvest Strategy Policy, specifically the distribution component, and **AGREED** to continue development of this Harvest Strategy and the terms to describe the components for further consideration at the MSAB10.
43. The MSAB **AGREED** that there are separate components, science (e.g. stock distribution) and management-focused, associated with distributing the TCEY when describing the harvest strategy policy. Management components may include different harvest rates in each Regulatory Area (or region), trends in fishery WPUE, age/size compositions, national shares, or simple allocations.
44. The MSAB **NOTED** the proposed alternatives for distributing the TCEY (pseudo-status quo and regional distribution) to evaluate in the future using the MSE framework.
45. The MSAB **CONSIDERED** the proposal for stock distribution to operate on the regions defined in paper IPHC-2017-MSAB09-09.
46. The MSAB **AGREED** to further consider a goal related to preserving biocomplexity at MSAB10.
47. The MSAB **REQUESTED** that the following items be delivered by the IPHC Secretariat staff to the MSAB10 for further consideration, prior to their delivery to the Commission at AM094:
  - a) Simulation results of Management Procedure evaluation including sensitivity analysis.
  - b) Terms and Definitions for a refined Harvest Strategy Policy.
  - c) Updates on the Scientific Review Board discussions/recommendations on stock distribution, biocomplexity, and performance metric timeframes.
  - d) Updated MSE Program of Work (2016-20).
  - e) Updates on other pertinent work.

The report from the 10<sup>th</sup> meeting of the Scientific Review Board (SRB10)<sup>2</sup> in June 2017 included the following related to distributing the TCEY.

44. The SRB **AGREED** that a more informative description of the survey results would involve reporting both total survey catch and O32 catch (biomass by Regulatory Area).
45. The SRB **CONSIDERED** that focusing on four biologically relevant regions, with the possibility of distributing stock to IPHC Regulatory Areas within these biogeographic regions is a potentially useful approach that should be evaluated further.

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<sup>1</sup> [IPHC-2017-MSAB09-R](http://www.iphc.info/MSAB), <http://www.iphc.info/MSAB>

<sup>2</sup> [IPHC-2017-SRB10-R](http://www.iphc.info/SRB), <http://www.iphc.info/SRB>

The SRB noted (paragraph 2) that “the core purpose of the SRB10 is to review progress on the IPHC scientific program, and to provide guidance for the delivery of products to the SRB11 in September 2017,” and they agreed “that formal recommendations to the Commission would not be developed at the present meeting, but rather, these would be developed at the SRB11.” Given that SRB11 will take place after the submission of this document, the formal recommendations of the SRB will be presented at MSAB10, and are not included in this document.

This document expands on [IPHC-2017-MSAB09-09](#) (MSAB 2017) to report progress on the topic of distributing the TCEY and provide a response to the MSAB and SRB comments noted above. This information will hopefully spur additional discussion on the topic of TCEY distribution with MSAB members.

### **TERMS FOR AND A DESCRIPTION OF THE PROPOSED IPHC HARVEST STRATEGY POLICY**

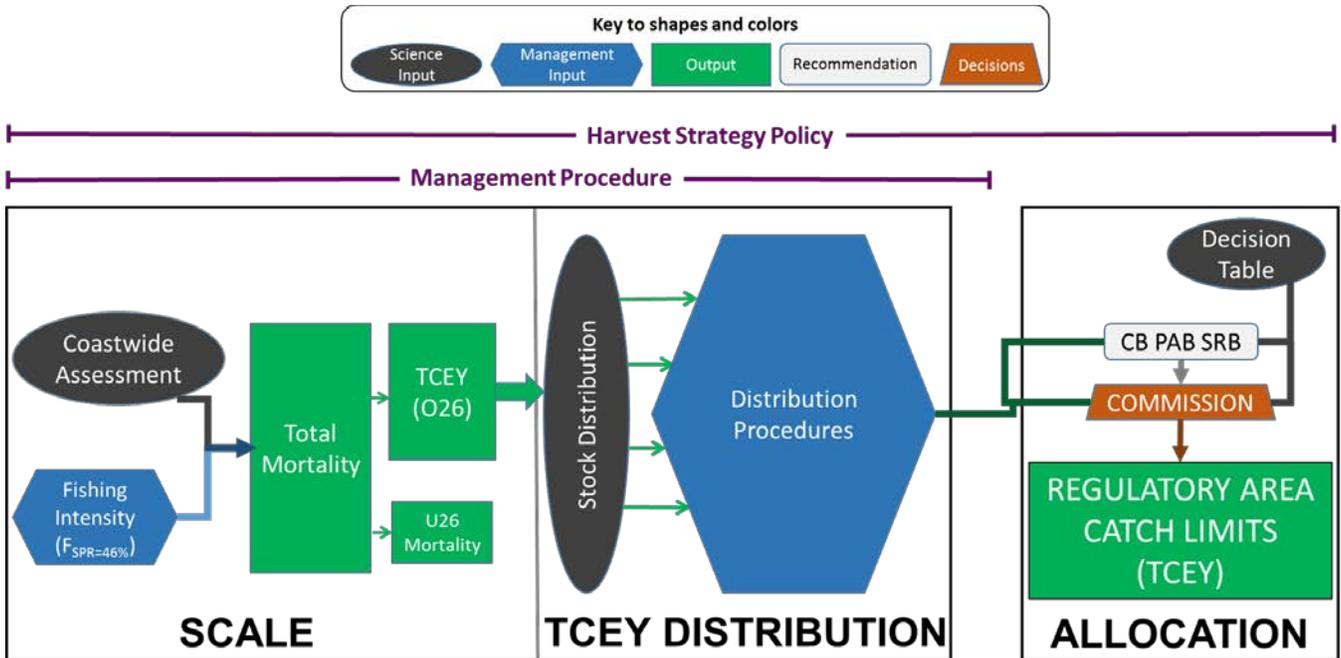
A considerable amount of discussion related to a description of the harvest strategy policy occurred at MSAB09. Figure 1 shows an updated depiction of the harvest strategy policy with terms describing the various components. These terms are defined in Appendix A, but of note are TCEY distribution, stock distribution, and distribution procedures (formerly called management distribution). 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 for each Regulatory Area that meet the long-term objectives of managers and stakeholders. The allocation 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.

### **DISTRIBUTION OF THE TCEY**

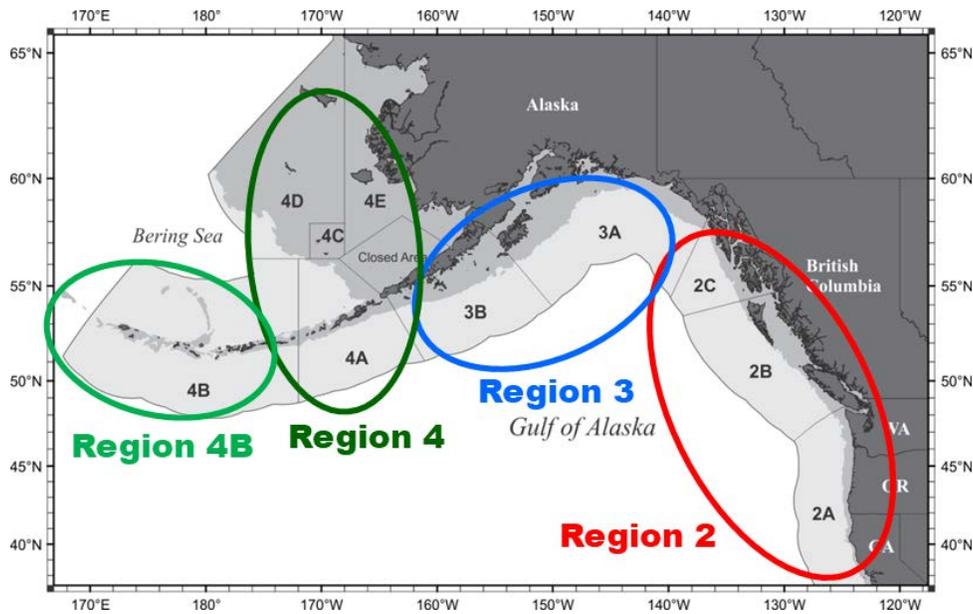
Following the Commission’s recommendation from AM093 (IPHC 2017), an option is to use the phrase **TCEY distribution** when referring to how the TCEY is distributed among IPHC Regulatory Areas, and the phrases **stock distribution** and **distribution procedures** referring to separate components determining the distribution of the TCEY (see Appendix A for definitions of these terms).

### **TCEY DISTRIBUTION**

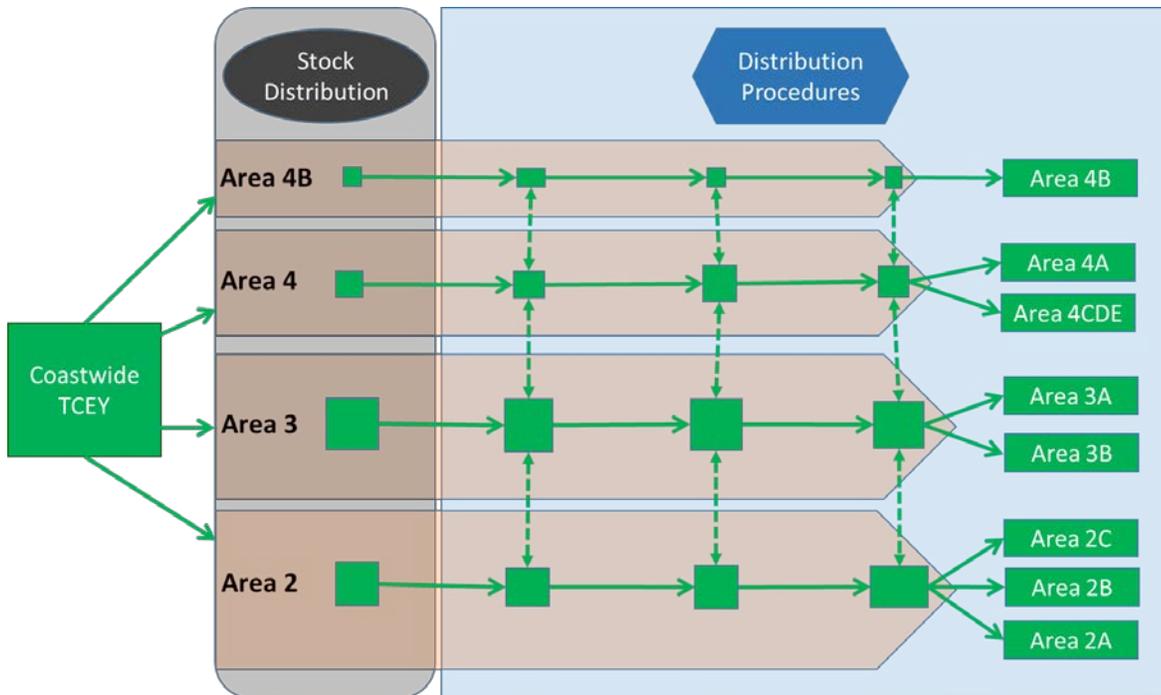
TCEY distribution is the management procedure for distributing the TCEY among Regulatory Areas and may be composed of a purely scientific component to distribute the TCEY in proportion to its estimated biomass in each area (stock distribution) and/or the management component of distributing harvest based on additional considerations (distribution procedures). Stock distribution may be focused on biological areas rather than management areas, and may distribute the TCEY to Regional Areas composed of multiple Regulatory Areas (Figure 2, also see [IPHC-2017-MSAB09-09](#)). Further distributing or allocating the TCEY to individual Regulatory Areas could be a management procedure or a management decision/negotiation (Figure 3).



**Figure 1:** A revised harvest strategy policy showing the separation of scale and distribution of fishing mortality. Allocation is when policy (not a procedure) influences the final decision.



**Figure 2:** Proposed biological stock distribution Regions.



**Figure 3:** The process of distributing the TCEY to Regulatory Areas from the coastwide TCEY. The first step is to distribute the TCEY to regional areas 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 Regulatory Areas. The allocation to Regulatory Areas may occur at any point after stock distribution and may also be external to the procedures and instead an allocation step (see Figure 1). The dashed arrows represent balancing that is required to maintain a constant SPR, but the allocation step may deviate from the defined SPR.

### STOCK DISTRIBUTION

Stock distribution is the analytical process of estimating the proportion of biomass in defined areas of the coast relative to the coastwide biomass. This is a science product and the outcome does not need to specifically align with IPHC Regulatory Areas. Distributing the TCEY based on the stock distribution will often be the first step in the process (Figure 3).

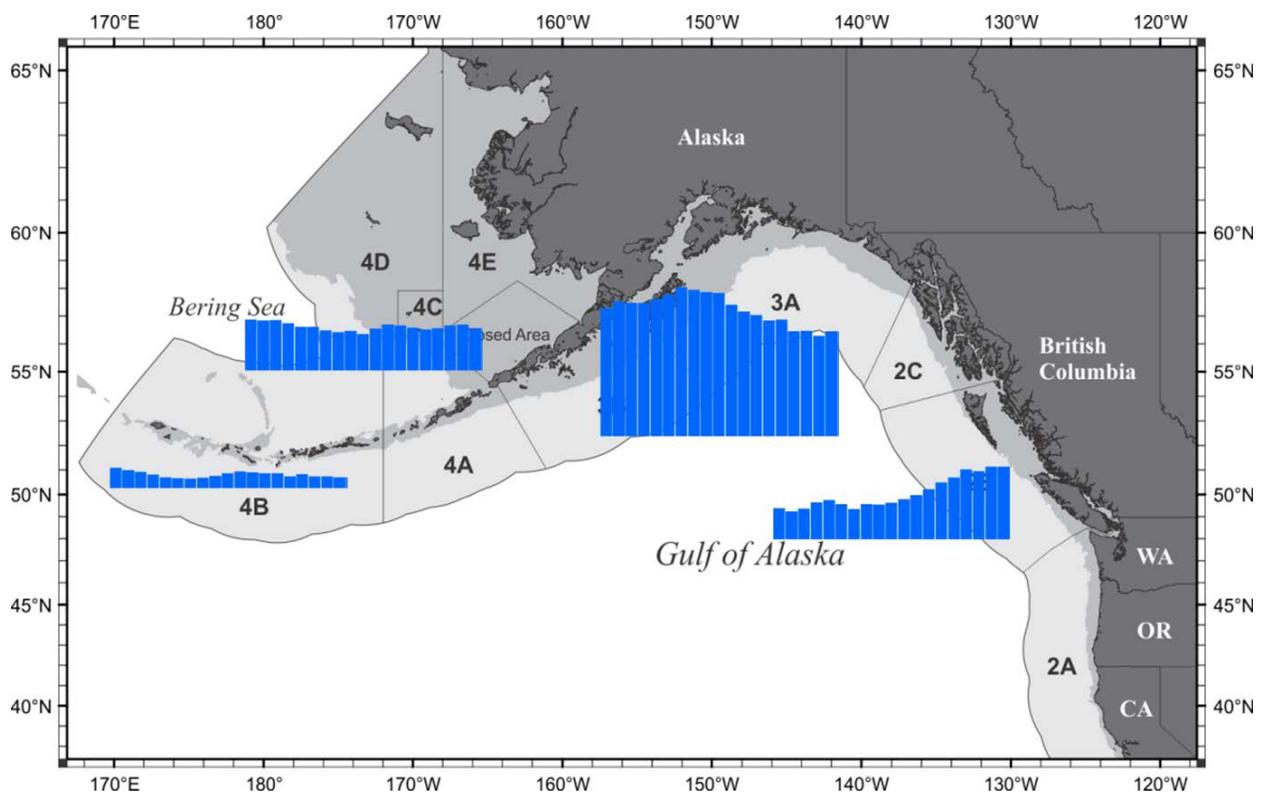
Stock distribution has been determined using the O32 space-time model estimates of the relative proportion of biomass in each Regulatory Area using data from the annual IPHC fisheries-independent setline survey. There may be some disconnect with the TCEY, which is meant to represent the O26 mortality. The SRB agreed (paragraph 44 of IPHC-2017-SRB10-R) that reporting the estimates of relative proportions using total survey catch may be useful. This may be a better representation of O26 mortality and better align the estimate of stock distribution with the O26 mortality.

Stock distribution may play a role in distributing the TCEY if there is an objective of maintaining a diversity in the population across space. It has been shown that maintaining a diverse portfolio of stocks in salmon populations (e.g., Schindler et al. 2010) has resulted in better resilience to environmental changes and regime shifts, resulting in more sustainable fisheries. Little is known about the exact interplay between geographic regions within the Pacific halibut population, but there may be subtle genetic differences

(Drinan et al. 2016), and it may be beneficial to distribute harvest across all the population instead of potentially over-exploiting one component. Additionally, distributing the harvest provides opportunity for many areas. The MSAB agreed (paragraph 46 of IPHC-2017-MSAB09-R) to consider the goal of preserving biocomplexity.

Biocomplexity is related to biology and not necessarily management areas. Therefore, distributing the O26 mortality among biological regions may be more appropriate than among Regulatory Areas. The MSAB considered a proposal for stock distribution to operate on biological regions (Figure 2) at MSAB09 (IPHC-2017-MSAB09-R). Given the current understanding of Pacific halibut, four biologically relevant regions that meet management needs are: all of IPHC Regulatory Area 2 (called Region 2), all of IPHC Regulatory Area 3 (called Region 3), IPHC Regulatory Areas 4ACDE(called Region 4), and Regulatory Area 4B (called Region 4B). Figure 2 shows these four regions in relation to the Regulatory Areas.

These four biologically-based regions capture the broad spatial and productivity domains of the population. Distributing the TCEY among them would continue to protect the geographic life-history variability and possible biodiversity in the Pacific halibut population, but would not force arbitrary delineation among areas with evidence of strong stock mixing. In addition, estimates of the proportion of biomass in each region (Figure 4) would be more stable than estimates for each IPHC Regulatory Area. Further distributing the TCEY to IPHC Regulatory Areas would be done through the Distribution Procedures component (Figure 2).



**Figure 4:** Estimated percentage of the stock in each region (2, 3, 4, and 4B) from 1999–2017. The scale in each region is relative to each other and the four bars from each region in a particular year sum to one.

## **DISTRIBUTION PROCEDURES**

Distribution Procedures is the process of further modifying the distribution of the TCEY among regions and then distributing the TCEY among IPHC Regulatory Areas within geographic regions based on specific elements of the overall management procedure. For example, modifications at the region or IPHC Regulatory Area level may be based on differences in production between areas, observations 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 and include factors that may be unrelated to biomass in that Region or Area. For example, commercial weight-per-unit-effort (WPUE) is a popular source of data used to indicate trends in a population, but may not always be proportional to biomass. Types of data may be used include fishery WPUE, survey observations (not necessarily the setline survey), age-compositions, size-at-age, and environmental observations.

A final step in the distribution of TCEY may be to simply make further discretionary adjustments, or to simply allocate the TCEY from regional areas to Regulatory Areas. This is entirely based on management decisions (Allocation box in Figure 1) that takes social, economic, national, and other factors into consideration. The final distribution of TCEY among Regulatory Areas would be input into the stock assessment to determine the adopted SPR and coastwide fishing intensity, which may differ from the management procedure SPR due to these final management decisions.

## **MANAGEMENT PROCEDURE FOR DISTRIBUTING TCEY ACROSS THE COAST**

The harvest strategy policy begins with the coastwide TCEY determined from the stock assessment and fishing intensity (Figure 1). When distributing the TCEY among regions, stock distribution occurs first to distribute the harvest in proportion to biomass, and then is followed by adjustments across Regions and Regulatory Area based on distribution procedures. The key to these adjustments is that they are relative adjustments such that the overall fishing intensity is maintained (i.e., a zero sum game). Departing from this 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 may result in undesirable outcomes, but could also take advantage of current situations.

There are many other management procedures that would be worth evaluating as part of the Management Strategy Evaluation and we suggest using the regional framework described above, which could be compared to distributing the TCEY to Regulatory Areas. Stock distribution is a science product and the MSAB's task is to develop distribution procedures. However, assumptions affected any of the procedures can be part of the scenarios included. Elements of the distribution procedures component may include the following.

- Use additional data, other than the fishery-independent data used to estimate stock distribution, to inform additional adjustments to the distribution of the TCEY to regions or IPHC Regulatory Areas within a Region.
- Assign a specific allocation when distributing the TCEY to IPHC Regulatory Areas within a Region.

### TIMELINE FOR EVALUATION AND DECISION POINTS

Simulating these management procedures and evaluating them against spatial objectives requires a multi-area model that is currently in development. Therefore, specific recommendations informed by MSE simulations is not possible for the 2018 Annual Meeting (AM094). However, this is a start to the conversation and there are many notes and recommendations that can be provided to the Commission at AM094. At the May and October 2017 MSAB meetings, as well as the June and September SRB meetings, the following is expected to be considered and discussed.

- The pseudo-status quo management procedure as an alternative to evaluate.
- The regional management procedure for distributing the TCEY, as explained above, as an alternative to evaluate.
- Discuss additional ideas such as incorporating fishery observations, defining static allocations, and, time periods of fixed distribution.
- Develop additional alternatives to evaluate using these ideas.

### RECOMMENDATION/S

That the MSAB:

- 1) **NOTE** paper IPHC-2017-MSAB10-10 which describes a harvest strategy policy and continues a discussion about alternatives to distribute the TCEY. This addresses the task assigned to IPHC Secretariat and the MSAB at the 2017 Annual Meeting (AM093) to “*initiate a process to develop alternative, biologically based stock distribution strategies for consideration by the Commission and its subsidiary bodies.*”
- 2) **CONSIDER** the potential definitions and terms used to describe the harvest strategy policy, and in particular the TCEY distribution and the separation of stock distribution and distribution procedures.
- 3) **CONSIDER** the proposal for stock distribution to operate on the Regions defined in this paper.
- 4) **CONSIDER** if the TCEY distribution framework could potentially meet a goal of preserving biocomplexity, if preserving biocomplexity is a goal of the MSAB.

### ADDITIONAL DOCUMENTATION / REFERENCES

Drinan, D. P., Galindo, H. M., Loher, T. and Hauser, L. (2016), Subtle genetic population structure in Pacific halibut *Hippoglossus stenolepis*. *J Fish Biol*, 89: 2571–2594. doi:10.1111/jfb.13148

IPHC. 2017. Report of the 93rd Session of the IPHC Annual Meeting (AM093). Victoria, British Columbia, Canada, 23-27 January 2017. IPHC-2017-AM093-R, 61 pp.

MSAB. 2017. A discussion on estimating stock distribution and distributing catch for Pacific halibut fisheries. IPHC-2017-MSAB09-09. <http://www.iphc.info/msab>

## APPENDIX A: DRAFT GLOSSARY

This appendix contains suggested definitions of some important terms and is in development. Any suggestions are appreciated. An updated glossary is currently being developed by the IPHC Secretariat.

**Adopted SPR:** The SPR calculated from the adopted catch limits for a particular year. This may differ from the default SPR due to final management decisions to increase or decrease the TCEY in certain IPHC Regulatory Areas.

**Default SPR:** The SPR used in the IPHC harvest strategy policy. This will be determined as part of the MSE process. Currently, the default SPR is a “status quo” or “interim” SPR of 46%.

**Distribution Procedures:** The process of distributing the TCEY among IPHC Regulatory Areas that is based on management decisions. This may be based on differences in production between areas or data (e.g., WPUE) in each area relative to other areas (not necessarily Regulatory Areas).

**Fishing Intensity (FI):** A measure of the total fishing mortality on all sizes and through all sources. An example is  $F_{SPR=XX\%}$  which indicates a level of fishing that would result in an SPR of XX%.

**Harvest rate:** The proportion of a specific component (exploitable) of the population that is harvested. This is commonly used for individual fisheries, but is difficult to compare among fisheries or combine across fisheries because the specific components typically differ between fisheries.

**Harvest Strategy Policy:** The harvest strategy plus the final step involving Commission decisions, which may depart from the harvest strategy evaluated with MSE.

**Management Procedure:** The science input and procedures that result in the determination of Regulatory Area TCEY's, but does not include the final Commission decision making process. The management procedure can be programmed and evaluated with MSE, and was often called harvest strategy.

**Regions:** Broad areas that encompass IPHC Regulatory Areas and are supported by current understanding of the biology and life-history of Pacific Halibut.

**Regulatory Areas:** Eight management units for which the IPHC sets annual catch limits: 2A, 2B, 2C, 3A, 3B, 4A, 4B, and 4CDE (which includes the IPHC Closed Area).

**Spawning Potential Ratio (SPR):** A commonly used metric of fishing intensity. SPR is the ratio of the equilibrium spawning biomass per recruit given some level of fishing and the equilibrium spawning biomass per recruit in the absence of fishing. An SPR equal to 100% implies no fishing, and lower SPR values indicate higher fishing intensities.

**Status Quo (Interim) SPR:** An SPR of 46%, corresponding to a Fishing Intensity of  $F_{SPR=46\%}$ , which is currently used in the interim harvest strategy.

**Stock Distribution:** the analytical process of estimating the proportion of biomass in defined areas of the coast relative to the coastwide biomass. This is a science product which may not specifically align with Regulatory Areas.

**TCEY Distribution** the management procedure for distributing the TCEY among Regulatory Areas. This may be composed of the purely scientific component (stock distribution) and the possibly science and/or management component of distributing harvest (management distribution).

**Total Constant Exploitation Yield (TCEY):** The amount of yield of halibut greater than 26 inches in length from all sources.

**Total mortality/removals:** Mortality or removals of all sizes and from all sources. This includes directed fishery, sport fisheries, bycatch, O26, U26, and everything else resulting in fishing mortality of Pacific halibut.