Goals, Objectives, and Performance Metrics for the IPHC Management Strategy Evaluation (MSE)

PREPARED BY: IPHC SECRETARIAT (A. HICKS AND I. STEWART), 09 APRIL 2018

PURPOSE

To review the Management Strategy Advisory Board (MSAB) goals and objectives; add new, remove outdated, or update goals and objectives as necessary. Consider the directives from the Commission, including the consideration of additional objectives related to distributing the TCEY. Link goals and objectives with performance metrics, and define a set of performance metrics to use for evaluation.

BACKGROUND

Defining goals and objectives is a necessary part of a management strategy evaluation (MSE) which should be revisited often to make sure that they are inclusive and relevant. The MSAB has developed five goals with multiple objectives for each (Table 1 and Tables A1–A5 in Appendix A). Performance metrics have also been developed from the goals and objectives by defining a measurable outcome, a probability (i.e., level of risk), and time-frame over which it is desired to achieve that outcome.

GOALS AND OBJECTIVES

The five goals defined by the MSAB are:

- biological sustainability,
- fishery sustainability, access, and stability,
- minimize discard mortality,
- minimize bycatch and bycatch mortality, and
- serve consumer needs.

PRESERVING BIOCOMPLEXITY

An additional goal, preserve biocomplexity, was considered at MSAB009, but no measurable objectives were associated with it. Measurable objectives may need to be based on abundances in specific areas, which would require a multi-area model. However, it is unclear whether preserve biocomplexity should be listed as a goal on its own, or as an objective under biological sustainability. It may help to understand what is meant by preserve biocomplexity before making this decision.

The term biocomplexity does not have a simple definition, as it spans across many scientific disciplines. The National Science Foundation describes biocomplexity as referring "to phenomena that arise from the dynamic interactions that take place between biological systems, including the influence of humans and the physical environment."[1] The Oxford dictionary defines biocomplexity as "complexity as exhibited by living organisms in their structure, composition, function, and interactions; complexity of a kind considered distinctive of biological systems." It also mentions that the term biocomplexity first appeared in the 1980's. It is important to note that biodiversity has a slightly different definition that typically refers to different species. The Oxford dictionary defines

[1] https://www.nsf.gov/news/news_summ.jsp?cntn_id=100687&org=NSF&from=news

biodiversity as “the variety of plant and animal life in the world or in a particular habitat, a high level of which is usually considered to be important and desirable.”

In the context of Pacific halibut, preserving biocomplexity would be a useful objective to buffer against potential changes in environmental conditions. The current understanding of biocomplexity across the geographic range of the Pacific halibut stock indicates that IPHC Regulatory Areas do not represent relevant segments of the population (Seitz et al. 2017). Even with migration along the entire coast (Valero and Webster 2012; Webster et al 2013), there are hydrographic and bathymetric obstacles that appear to delineate spawning components in the Gulf of Alaska (GOA), Bering Sea (BS), and Aleutian Islands (AI) (Seitz et al. 2017). Genetic evidence further suggests weak population structure (Drinan et al. 2016).

Population structure and spawning components are likely to buffer a population against changes in the environment. Hilborn et al. (2003) concluded that biocomplexity in stock structure plays a critical role in stability and sustainability of a fish stock. Furthermore, preserving biocomplexity in a fish stock may buffer against population declines in a variable or changing environment. Schindler et al (2010) presented evidence that population diversity within sockeye salmon has reduced the variability in the population and reduced the frequency of fishery closures. This concept can be extended to multiple species in an ecosystem (biodiversity) providing ecosystem stability, just as a diversity of assets adds stability to a financial portfolio. Schindler et al (2010) referred to the diversity in a population or in an ecosystem as a portfolio effect.

There is evidence of population structure in the population of Pacific halibut, but it is not completely understood. Recruitment to the Pacific halibut population is variable, and it is not clear what the major driving force to recruitment success is. It could be that subcomponents of the population have varying success rates in different environmental instances. Balancing the removals against the current stock distribution, to preserve biocomplexity, is likely 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. This approach is likely to provide an additional precautionary buffer against spatial recruitment overfishing and may maintain sub-population structure that is not completely understood, but important to the long-term health of the coastwide population.

The structure of two of the four current stock assessment models is developed around identifying portions of the data (both FISS and fishery) that correspond to differing biological and population processes within the larger Pacific halibut stock. This approach, referred to as ‘Areas-As-Fleets’ is commonly used in stock assessments (Waterhouse et al. 2014), and recommended by the SRB during review of models developed in 2014 (Cox et al. 2016, Stewart and Martell 2015, 2016).

Regions were defined with boundaries that matched IPHC Regulatory Areas to correspond to these biological differences. The boundaries of IPHC Regulatory Areas were used for many reasons. First, data (particularly historical data) for stock assessment and other analyses are most often reported at the IPHC Regulatory Area scale and are largely unavailable for sub-Regulatory Area evaluation. Particularly for historical sources, there is little information to partition data to a portion of a Regulatory Area. The use of these data is mainly a stock assessment issue. Second, it is necessary to distribute TCEY to IPHC Regulatory Area for quota management, and the final outcome of a distribution procedure will reflect this. If a Region is not defined by boundaries of IPHC Regulatory Areas (i.e. a single IPHC Regulatory Area is in multiple Regions) it will be difficult to create a distribution procedure that accounts for biological stock distribution and distribution of the TCEY to Regulatory Areas for management purposes. Overall, it is highly unlikely that there is a set of Regions that perfectly delineates the stock biologically since different aspects of the stock differ over varying scales, and movement occurs between Regions.

However, if the goal is to preserve biocomplexity across the entire range of the Pacific halibut stock, Regions are considered by the IPHC Secretariat to be the best option for biologically-based areas to meet management needs.

Each Region had some qualities that identified it as differing biologically from adjacent Regions, despite clear evidence from tagging studies of movement among all areas at some point in the life-cycle of Pacific halibut (Valero and Webster 2012; Webster et al 2013). These qualities include sex ratios, age composition, size-at-age, historical trends, and others that could be indicative of important diversity within the greater Pacific halibut population. The four Regions are labeled as follows and composed of the listed IPHC Regulatory Areas (Figure 1):

Region 2: 2A, 2B, and 2C
Region 3: 3A and 3B
Region 4: 4A and 4CDE
Region 4B: 4B

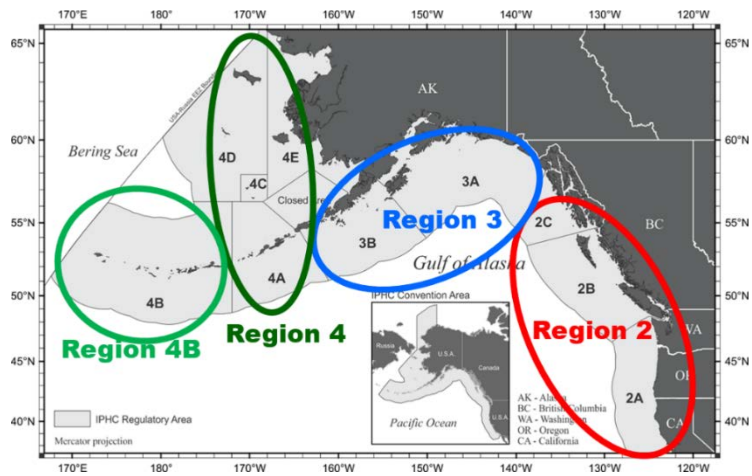

FIGURE 1. Four biological Regions. They are overlayed on IPHC Regulatory Areas with Region 2 comprised of 2A, 2B, and 2C, Region 3 comprised of 3A and 3B, Region 4 comprised of 4A and 4CDE, and Region 4B comprised solely of 4B.

PERFORMANCE METRICS

IPHC-2017-MSAB09-08 Rev 2 presented thirteen performance metrics associated with the goals and objectives in Appendix A. Table 1 presents a summary of the measurable objectives and associated performance metrics. All of the performance metrics will be easy to calculate, but the performance metrics associated with discard mortality (formerly called wastage) may have little meaning. This is because discard mortality in the current simulation model is an assumed function of the commercial+discard mortality and the size at age for an age 8 male halibut. When the commercial+discard mortality goes up, the discard mortality also increases, and when age 8 males are small, the discard mortality increases. A more meaningful calculation of discard mortality would occur if length-at-age and length-specific discards could be modeled. Unfortunately, that would require a significant amount of work given the variability in growth.

Table 1: Measurable objectives and associated performance metrics, as reported in the MSAB09 Report (IPHC-2017-MSAB09-R). Discard mortality is used to describe what was formerly known as wastage.

Biological Sustainability				
Measurable Objective	**Outcome**	**Time-frame**	**Probability**	**Performance Metrics**
Maintain a minimum of number of mature female halibut coast-wide	Number of mature female halibut less than a threshold	10 year period, long-term	0.01	Median average number of mature female halibut
Avoid very low stock sizes	dRSB < Limit of control rule	10 year period, long-term	0.05	$P(dRSB < Limit)$
Mostly avoid low stock sizes	dRSB < Threshold of control rule	10 year period, long-term	0.25	$P(dRSB < Threshold)$
When Limit < Estimated Biomass < Threshold, limit the probability of declines	SSB declines when 20%<RSB<30%	10 year period, long-term	0.05 – 0.5, depending on est. stock status	$P(SSB_{i+1} < SSB_i)$ given $20\% < RSB < 30\%$
Spawning Biomass	An absolute measure	10 year period, long-term	NA	Median $\overline{RSB}$

Fishery Sustainability, Stability, and Access				
Measurable Objective	**Outcome**	**Time-frame**	**Probability**	**Performance Metrics**
Maintain directed fishing opportunity	Fishery is open	Each year	0.05	$P(FCEY = 0)$
Maximize yield in each regulatory area		Each year	0.5	
Maintain median catch	Within ±10% of 1993-2012 average	Within 5 yrs, 10 yr per, long term		$P(FCEY > 110\%$ or $FCEY < 90\%$
Maintain average catch	> 70% of historical 1993-2012 average	10 year period, long-term	0.1	$P(FCEY < 70\%)$
Limit annual changes in TAC, coast-wide and/or by Regulatory Area	Change in FCEY < 15%	10 year period, long-term		$P\left(\frac{FCEY_{i+1} - FCEY_i}{FCEY_i} > 15\%\right)$
Absolute	FCEY	10 year period, long-term	NA	Median $\overline{FCEY}$
Absolute	Variability in FCEY	10 year period, long term		Average Annual Variability (AAV)

Table 1: Measurable objectives and associated performance metrics, as reported in the MSAB09 Report (IPHC-2017-MSAB09-R). Discard mortality is used to describe what was formerly known as wastage. Continued from above.

Minimize discard mortality				
Measurable Objective	**Outcome**	**Time-frame**	**Probability**	**Performance Metrics**
Discard mortality in the longline fishery	<10% of annual catch limit	10 year period, Long-term	0.25	$P(discardMortality > 10\%FCEY)$
Absolute	Discard Mortality	10 year period, Long-term		Median $\overline{discardMortality}$
Minimize bycatch and bycatch mortality				
Measurable Objective	**Outcome**	**Time-frame**	**Probability**	**Performance Metrics**
Serve consumer needs				
Measurable Objective	**Outcome**	**Time-frame**	**Probability**	**Performance Metrics**
Preserve biocomplexity				
Measurable Objective	**Outcome**	**Time-frame**	**Probability**	**Performance Metrics**

Reporting Results

The thirteen performance metrics described in Table 1 were expanded into many more performance metrics depending on the quantity used to calculate the metric (Appendix B). For example, the FCEY or Total Mortality could be used for yield objectives. Also, many of the performance metrics were calculated over a 10-year time period, and the metric may be reported as the probability that all observations were below a threshold, or the probability that any in a given year of the 10 years was below the threshold. These formulations have subtle differences and depend on the risk tolerance. The pertinent set of performance metrics (decided on by the MSAB) would be reported in a table as rows with the columns representing different management strategies (see Table 2 in IPHC-2017-MSAB10-09 Rev 1). Additionally, figures will be created as necessary to show specific performance metrics against the management procedures, as well as interesting trade-offs between performance metrics.

Commission Review of Goals and Objectives

At the 93rd Interim Meeting, the Commission provided a directive to review the fishery goals and objectives identified by the MSAB. Four paragraphs from the IM093 Report (IPHC 2017) describe the directive.

IM093-R, para 37. **NOTING** the current fishery goals, objectives, and performance metrics identified by the MSAB for the MSE process, as detailed in the MSAB10 report (IPHC-2017-MSAB10-R), the Commission **AGREED** to provide guidance to the IPHC Secretariat and the MSAB on goals and objectives at the 94th Annual Meeting in January 2018.

IM093-R, para 38. **NOTING** the goals and objectives related to distributing the TCEY presented during the meeting by the U.S.A. (Table 3 [of IM093-R]), the Commission **RECOMMENDED** that they be considered at the 94th Annual Meeting in January 2018 after soliciting input from stakeholders.

IM093-R, para 39. The Commission **REQUESTED** the IPHC Secretariat to consolidate the objectives related to TCEY distribution (Table 3 [of IM093-R]) with the current goals, objectives and performance metrics provided as Appendix IV of the MSAB10 Report, for presentation at the 94th Annual Meeting in January 2018.

IM093-R, para 40. The Commission **NOTED** that providing guidance on the MSE process to the IPHC Secretariat and the MSAB at the Interim and Annual meetings would be an efficient and effective method to ensure the guidance is incorporated into the annual MSAB work plan.

A number of important directives come from this. First, the Commission will provide guidance on the MSAB goals and objectives. Second, the U.S.A. presented some objectives related to distributing the TCEY (Table 2). And third, the Commission would like input from stakeholders (see Circular IPHC-2017-CR022).

Table 2: Pacific halibut TCEY distribution goals and objectives presented by U.S.A. Commissioners at IM093. Table reproduced from IPHC-2017-IM093-R.

Goal	Objective
Biological sustainability: Preserving bio-complexity	1. Maintaining diversity in the population across IPHC Regulatory Areas. 2. Prevent local depletion at IPHC Regulatory Area scale.
Fisheries Sustainability: Maintain access and serve consumer needs.	1. Maintain commercial, recreational and subsistence fishing opportunities in each IPHC Regulatory Area. 2. Maintain processing opportunities in each IPHC Regulatory Area.
Fisheries Sustainability: Maximize yield by regulatory area	1. Distribution is responsive to IPHC Regulatory Area abundance trends and stock characteristics (ex. Fishery WPUE, age structure, size at age etc.). 2. Distribution is responsive to management precision in each IPHC Regulatory Area. 3. Minimize impact on downstream migration areas. 4. Minimize discard mortality and bycatch.
Fisheries Sustainability: Minimize variability,	1. Limit annual TCEY variability due to stock distribution in both time and scale. 2. Avoid zero sum distribution policy.

At AM094, a presentation was given relating the U.S.A. Commissioner objectives in Table 2 to the current MSAB objectives (agenda item 7.3). The classification of the U.S.A. Commissioner objectives is presented in Appendix C. Many of the U.S.A. Commissioner objectives complement the current MSAB objectives, and it would be worthwhile for the MSAB to consider them when reviewing goals and objectives.

Stakeholder feedback between IM093 and AM094, in response to Circular IPHC-2017-CR022, was limited to one response. The summary of that response is as follows. One, create measurable objectives and performance metrics for the objectives provided in Table 2. Define terms such as biocomplexity, depletion, and maintain. And, to not use fishery WPUE or defined allocations to distribute the TCEY as these may not be responsive to changes in the spatial distribution of biomass among IPHC Regulatory Areas.

The Commission provided the following guidance at AM094 related to goals and objectives.

AM094-R, para 32. The Commission **NOTED** the current fishery goals, objectives, and performance metrics identified by the MSAB for the MSE process, as detailed in Appendix IV of the MSAB10 report (IPHC-2017-MSAB10-R).

AM094-R, para 33. The Commission **NOTED** the summary presentation which was in response to Circular IPHC-2017-CR022 requesting stakeholder feedback on objectives proposed by a USA Commissioner related to distributing the TCEY presented at IM093. These objectives were categorized under the overarching goals defined by the MSAB for AM094.

AM094-R, para 34. The Commission **NOTED** the other concepts proposed by a USA Commissioner related to distributing the TCEY were not stated as measurable objectives but may be useful when developing management procedures to evaluate.

AM094-R, para 35. The Commission **NOTED** that:

a) the Commission objectives related to distributing the TCEY may be presented at MSAB11 for further stakeholder feedback.

b) the intent of the “other Commission concepts” could be further clarified and incorporated into the MSAB process, and can be converted to measurable objectives.

c) the MSAB may develop measurable outcomes and performance metrics associated with these Commission objectives.

AM094-R, para 36. The Commission **RECOMMENDED** that the draft goals, objectives, and performance metrics, as detailed in Appendix IV, IPHC-2017-MSAB10-R be used for ongoing evaluation in the MSE process, and that they may be refined in the future. The objectives should be evaluated in a hierarchal manner, with conservation as the first priority.

AM094-R, para 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.

The guidance from Commissioners had one request and one recommendation. The Commission requested that the objectives outline in IPHC-2017-CR022 be presented at MSAB11 for discussion (AM094-R, para 37). The recommendation was to endorse the current MSAB goals and objectives and to continue to refine them as necessary. An important piece of the guidance was to evaluate the objectives in a hierarchical manner with conservation as the first priority. This could mean that specified conservation objectives must be met for a management procedure to be considered any further. Or, it may mean that conservation objectives are given a higher weighting when evaluating the management procedures. This should be a topic of discussion at MSAB11.

RECOMMENDATION/S

That the Management Strategy Advisory Board:

1) **NOTE** paper IPHC-2018-MSAB011-07 which provides a review of the goals and objectives previously defined by the MSAB, associated performance metrics, and outcomes of IM093 and AM094 as they relate to objectives.
2) **CONSIDER** the current MSAB goals and objectives, and the objectives for distributing the TCEY identified by the Commission.
3) **RECOMMEND** additions or deletions to the MSAB goals and objectives. More specifically, the following topics should be addressed.
    a. How to incorporate the objectives for distributing the TCEY identified by the Commission.
    b. Defining objectives for goals that currently do not have objectives (4 & 5).
    c. Determining if the goal of preserving biocomplexity should be its own goal, or if it should be an objective under the goal of biological sustainability; and, defining associated measurable objectives.
4) **RECOMMEND** a practical set of performance metrics to report for the evaluation of future simulations.
5) **SUGGEST** method (e.g., tables and figures) to report the performance metrics listed here for the evaluation of future results from the simulations.

ADDITIONAL DOCUMENTATION / REFERENCES

Cox SP, Ianelli J, Mangel M. 2016. 6.1 Reports of the IPHC Scientific Review Board, 2015. Int. Pac Halibut Comm. Report of Assessment and Research Activities 2016: p. 616-622.

Drinan DP, Galindo HM, Loher T, Hauser L. 2016. Subtle genetic population structure in Pacific halibut. Journal of Fish Biology, 89, 2571–2594.

Hicks A. 2017. Goals, objectives, and performance metrics for the IPHC management strategy evaluation (MSE). IPHC-2017-MSAB09-08 Rev 2. https://iphc.int/venues/details/9th-session-of-the-iphc-management-strategy-advisory-board-msab09/ 7 pp.

Hicks A. 2017. Goals, objectives, and performance metrics for the IPHC management strategy evaluation (MSE). IPHC-2017-MSAB10-09 Rev 1. https://iphc.int/venues/details/10th-session-of-the-iphc-management-strategy-advisory-board-msab10 7 pp.

Hilborn R, Quinn TP, Schindler DE, Rogers DE. 2003. Biocomplexity and fisheries sustainability. Proceedings of the National Academy of Science USA. 100:6564-6568.

IPHC. 2017. Report of the 93rd Session of the IPHC Interim Meeting (IM093). Seattle, Washington, United States of America, 28-29 November 2017. IPHC-2017-IM093-R. https://iphc.int/venues/details/94th-session-of-the-iphc-annual-meeting-am094 46 pp.

IPHC. 2018. Report of the 94th Session of the IPHC Annual Meeting (AM094). Portland, Oregon, United States of America, 22-26 January 2018. IPHC-2018-AM094-R. https://iphc.int/venues/details/94th-session-of-the-iphc-annual-meeting-am094 46 pp.

Schindler DE, Hilborn R, Chasco B, Boatright CP, Quinn TP, Rogers LA, Webster MS. 2010. Population diversity and the portfolio effect in an exploited species. Nature. 465:609-612

Seitz AC, Farrugia TJ, Norcross BL, Loher T, Nielsen JL. 2017. Basin-scale reproductive segregation of Pacific halibut (*Hippoglossus stenolepis*). Fisheries Management and Ecology. 24:339-346

Stewart IJ, Martell SJD. 2016. Development of the 2015 stock assessment. Int. Pac Halibut Comm. Report of Assessment and Research Activities 2016: A1–A146.

Valero JL, and Webster RA. 2012. Current understanding of Pacific halibut migration patterns. IPHC Report of assessment and research activities 2011. P. 341-380.

Waterhouse L, Sampson DB, Maunder M, Semmens BX. 2014. Using areas-as-fleets selectivity to model spatial fishing: Asymptotic curves are unlikely under equilibrium conditions. Fish. Res. 158: 15-25.

Webster RA, Clark WG, Leaman BM, Forsberg JE. 2013. Pacific halibut on the move: a renewed understanding of adult migration from a coastwide tagging study. Can. J. Fish. Aquat. Sci. 70(4): 642-653.

APPENDIX A: GOALS, MEASURABLE OBJECTIVES, AND INTENT

Table A1: Objectives for the biological sustainability goal along with intent and performance metric quantities (measurable outcome, probability, and time-frame). Acknowledgements to Michele Culver (WDFW) for originally putting this table together.

Goal	Objective	Measurable Outcome	Probability	Time-frame	Intent
Biological Sustainability	1.1. Keep biomass above a **limit** below which no fishing can occur	a) Maintain a minimum number ***[spawning potential ratio?]*** of mature female halibut coast-wide	0.99	Each year	• Ensure that conservation needs of the stock are met for long-term sustainability with a high degree of certainty • Regularly monitor stock biomass (i.e., continuation and improvement of survey and stock assessment efforts) to detect changes in status and abundance • **Define reference points and harvest targets (e.g., MSY)** • Take a risk-averse approach when the stock is below the threshold
		b) 2) Maintain a minimum spawning stock biomass of 20% of the unfished biomass	0.95	Each year	
	1.2. Account for all sizes in the population?	*c)*			
	1.3. Reduce harvest rate when abundance is below a threshold	d) Maintain a minimum spawning stock biomass of 30% of the unfished biomass	0.75	Each year	
	1.4. Risk tolerance and assessment uncertainty	e) When Limit < estimate biomass < Threshold, limit the probability of declines	0.05 – 0.5, depending on est. stock status	10 years	

Table A2: Objectives for the fishery sustainability goal along with intent and performance metric quantities (measurable outcome, probability, and time-frame). Acknowledgements to Michele Culver (WDFW) for originally putting this table together.

Goal	Objective	Measurable Outcome	Probability	Time-frame	Intent
Fishery Sustainability and Stability and Assurance of Access – Minimize Probability of Fishery Closures	2.1. Maintain an economically sufficient level of catch (i.e., target) across regulatory areas	a) Maintain directed fishing opportunity	0.95	Each year	• Ensure that the directed fishery has viable fishing opportunities every year • Provide directed fisheries that are economically beneficial to individual participants, local businesses, and broader communities • Support efforts to allow continued access to the halibut resource within acceptable conservation limits
		b) Maximize [Optimize?] yield in each regulatory area	0.5	Each year	
		c) Maintain median catch within ±10% of 1993-2012 average	?	Within 5 yrs	
		d) Maintain average catch at > 70% of historical 1993-2012 average	0.9	Each year	
	2.2. Limit catch variability	e) Limit annual changes in TAC, coast-wide and/or by Regulatory Area, to < 15%		Each year	

Table A3: Objectives for the minimize wastage goal along with intent and performance metric quantities (measurable outcome, probability, and time-frame). Acknowledgements to Michele Culver (WDFW) for originally putting this table together.

Goal	Objective	Measurable Outcome	Probability	Time-frame	Intent
Minimize Discard Mortality	3.1. Harvest efficiency	a) Discard mortality in the longline fishery < 10% of annual catch limit	0.75	Over 5 years	• Support fishing practices that reduce discard mortality • Regulatory revisions that promote efficiency

Table A4: Objectives for the minimize bycatch goal along with intent and performance metric quantities (measurable outcome, probability, and time-frame). Acknowledgements to Michele Culver (WDFW) for originally putting this table together.

Goal	Objective	Measurable Outcome	Probability	Time-frame	Intent
Minimize Bycatch and Bycatch Mortality	4.1.	a)		Over 5 years	• Support fishing practices that reduce bycatch and bycatch mortality

Table A5: Objectives to serve consumer needs goal along with intent and performance metric quantities (measurable outcome, probability, and time-frame). Acknowledgements to Michele Culver (WDFW) for originally putting this table together.

Goal	Objective	Measurable Outcome	Probability	Time-frame	Intent
Serve Consumer Needs	5.1.	a)			• Strive to avoid or minimize regulatory changes that result in large fluctuations in product availability

APPENDIX B: PERFORMANCE METRICS CONSIDERED A

Biological Sustainability

Metric	Description
Median average dRSB	Long-term average dynamic relative spawning biomass (stock status). The average is determined over a range of years at the end of a single simulated trajectory. The median is determined from multiple random simulated trajectories.
Median average # mature females	Long-term average number of mature females. The average is determined over a range of years at the end of a single simulated trajectory. The median is determined from multiple random simulated trajectories.
P(all dRSB<Limit)	The probability of stock status declining to below a 20% limit resulting in no directed fishery over all simulated trajectories. The stock would be in an overfished state and any fishing would be overfishing.
P(any dRSB_y<Limit)	The probability of stock status declining to below a 20% limit in any of the defined years, resulting in no directed fishery. The stock would be in an overfished state and any fishing would be overfishing.
P(all dRSB<Trigger)	The probability of stock status declining to below a 30% trigger resulting in a decrease in fishing intensity over all simulated trajectories. Below this trigger and above a limit has been called "being on the ramp."
P(any dRSB_y<Trigger)	The probability of stock status declining to below a 30% trigger in any of the defined years resulting in a decrease in fishing intensity. Below this trigger and above a limit has been called "being on the ramp."
P(decrease SB|onRamp)	The probability that the spawning biomass decreases when the stock status is between the limit and trigger.

Fishery Sustainability

Metric	**Description**
Median average SPR	Long-term average SPR. The average is determined over a range of years at the end of a single simulated trajectory. The median is determined from multiple random simulated trajectories.
Median average TM	Long-term average total mortality. The average is determined over a range of years at the end of a single simulated trajectory. The median is determined from multiple random simulated trajectories.
Median average FCEY	Long-term average FCEY. The average is determined over a range of years at the end of a single simulated trajectory. The median is determined from multiple random simulated trajectories.
Median average Commercial	Long-term average commercial halibut mortality. The average is determined over a range of years at the end of a single simulated trajectory. The median is determined from multiple random simulated trajectories.
25th% average TM	The 25th percentile of the long-term average total mortality. 25% of the simulated trajectories had an average total mortality less than this value.
25th% average FCEY	The 25th percentile of the long-term average FCEY. 25% of the simulated trajectories had an average FCEY less than this value.
25th% average Commercial	The 25th percentile of the long-term average commercial mortality. 25% of the simulated trajectories had an average commercial mortality less than this value.
75th% average TM	The 75th percentile of the long-term average total mortality. 75% of the simulated trajectories had an average total mortality less than this value (25% were greater).
75th% average FCEY	The 75th percentile of the long-term average FCEY. 75% of the simulated trajectories had an average FCEY less than this value (25% were greater).
75th% average Commercial	The 75th percentile of the long-term average commercial mortality. 75% of the simulated trajectories had an average commercial mortality less than this value (25% were greater).
P(all Comm=0)	Long-term probability over all simulations that the commercial fishery is closed.
P(any Comm=0)	Long-term probability that the commercial fishery is closed in any of the defined range of years at the end of the simulated trajectories.
P(all FCEY < 50.6 Mlbs)	The long-term probability that the FCEY from all simulated trajectories is less than 70% of the historical FCEY averaged over the years 1993-2012 (50.6 Mlbs).
P(any FCEY < 50.6 Mlbs)	The long-term probability that the FCEY is less than 70% of the historical FCEY averaged over the years 1993-2012 (50.6 Mlbs) in any of the final years of a simulated trajectory.
P(all FCEY < 65.0 Mlbs)	The long-term probability that the FCEY from all simulated trajectories is less than 90% of the historical FCEY averaged over the years 1993-2012 (65.0 Mlbs).
P(any FCEY < 65.0 Mlbs)	The long-term probability that the FCEY is less than 90% of the historical FCEY averaged over the years 1993-2012 (65.0 Mlbs) in any of the final years of a simulated trajectory.

P(all FCEY < 79.5 Mlbs)	The long-term probability that the FCEY from all simulated trajectories is less than 110% of the historical FCEY averaged over the years 1993-2012 (79.5 Mlbs).
P(any FCEY < 79.5 Mlbs)	The long-term probability that the FCEY is less than 110% of the historical FCEY averaged over the years 1993-2012 (79.5 Mlbs) in any of the final years of a simulated trajectory.
P(all decrease TM)	The long-term probability that the total mortality decreases from the previous year in a simulated trajectory.
P(any decrease TM)	The long-term probability that any of the total mortality decreases from the previous year in a defined range of years at the end of a simulated trajectory.
P(all decrease TM > 15%)	The long-term probability that the total mortality decreases by more than 15% from the previous year in a simulated trajectory.
P(any decrease TM > 15%)	The long-term probability that any of the total mortality decreases by more than 15% from the previous year in a defined range of years at the end of a simulated trajectory.
P(all increase TM > 15%)	The long-term probability that the total mortality increases by more than 15% from the previous year in a simulated trajectory.
P(any increase TM > 15%)	The long-term probability that any of the total mortality increases by more than 15% from the previous year in a defined range of years at the end of a simulated trajectory.
median AAV TM	The average annual percent change in total mortality over a defined range of years at the end of the simulated trajectory. The median is taken over all simulated trajectories.
median AAV FCEY	The average annual percent change in FCEY over a defined range of years at the end of the simulated trajectory. The median is taken over all simulated trajectories.
median AAV Commercial	The average annual percent change in commercial mortality over a defined range of years at the end of the simulated trajectory. The median is taken over all simulated trajectories.

APPENDIX C: POTENTIAL OBJECTIVES DEFINED BY COMMISSION RELATED TO DISTRIBUTION THAT CAN BE DEFINED AS A MEASURABLE OBJECTIVE

Goal	**Objective**
Biological Sustainability	Maintaining diversity in the population across IPHC Reg. Areas
	Prevent local depletion at IPHC Regulatory Area scale
	Minimize impact on downstream migration area
Fishery Sustainability and Stability	Maintain commercial, recreational, and subsistence fishing opportunities in each IPHC Regulatory Area
	Limit annual TCEY variability due to stock distribution in both time and scale
Minimize discard mortality	Minimize discard mortality by IPHC Regulatory Area
Minimize bycatch and bycatch mortality	Minimize bycatch by IPHC Regulatory Area
Serve consumer needs	Maintain processing opportunities in each IPHC Regulatory Area

OTHER COMMISSION CONCEPTS THAT ARE NOT EASILY CLASSIFIED AS A MEASURABLE OBJECTIVE

The U.S.A. Commission provided some other objectives in Table 3 of IPHC-2017-IM093-R that are not easily translated to measurable objectives. However, it would be worthwhile to further clarify these objectives, and be useful to consider them when developing management procedures. These objectives are listed below.

- Distribution is responsive to IPHC Regulatory Area abundance trends and stock characteristics (e.g., Fishery WPUE, age structure, size at age, etc.)
- Distribution is responsive to management precision in each IPHC Regulatory Area
- Avoid zero sum distribution policy