INTERNATIONAL PACIFIC HALIBUT COMMISSION

Goals, Objectives, and Performance Metrics for the IPHC MSE

Agenda Item 4

IPHC-2019-MSAB013-07

13th Meeting of the Management Strategy Advisory Board (MSAB013)

A. Hicks

Outline

- Goals
- Definitions
- Primary objectives related to coastwide scale
- All objectives related to coastwide scale
- Objectives related to distribution

We will revisit these throughout this meeting after seeing some results

Why do we need objectives?

Why not show stakeholders/managers the results and they can tell us why they don't like it, just like art?

(*paraphrased from Ray Hilborn*)

Goals and Objectives

- Objectives make clear the desired outcomes for conservation and the fishery
- Identifies important aspects for various user groups
- Identifies important objectives
- Identifies objectives that may have trade-offs
- Provides a transparent process to evaluate management procedures by ranking them and examining trade-offs

How to specify objectives?

"Progress [setting objectives] may be facilitated [at workshops] by providing draft specifications that can be criticized, expanded upon, or rejected outright."

(*Punt et. al. 2016; Best practices MSE*)

How to specify objectives?

"Just tell us what objectives we want and we'll tell you where you are wrong"

(*paraphrased from Dan Falvey; MSAB012*)

Definitions

Goal: overarching concept

General objective: an aspirational objective

Measurable objective: a specific objective that can be turned into a performance metric

Measurable outcome: a threshold to measure against

Time-frame: a period of time in the simulations (2 components)

Tolerance: acceptable risk

Performance metric: a quantity developed from a measurable objective that is used to evaluate management procedures

Statistic of interest: a performance metric without a tolerance

From Goals to Performance Metrics

Goal
Biological Sustainability

General Objective
Avoid critical stock sizes

Means objective to Ends objective

Measurable Objective
Maintain a minimum spawning stock biomass

Threshold
Now or later
Metric type

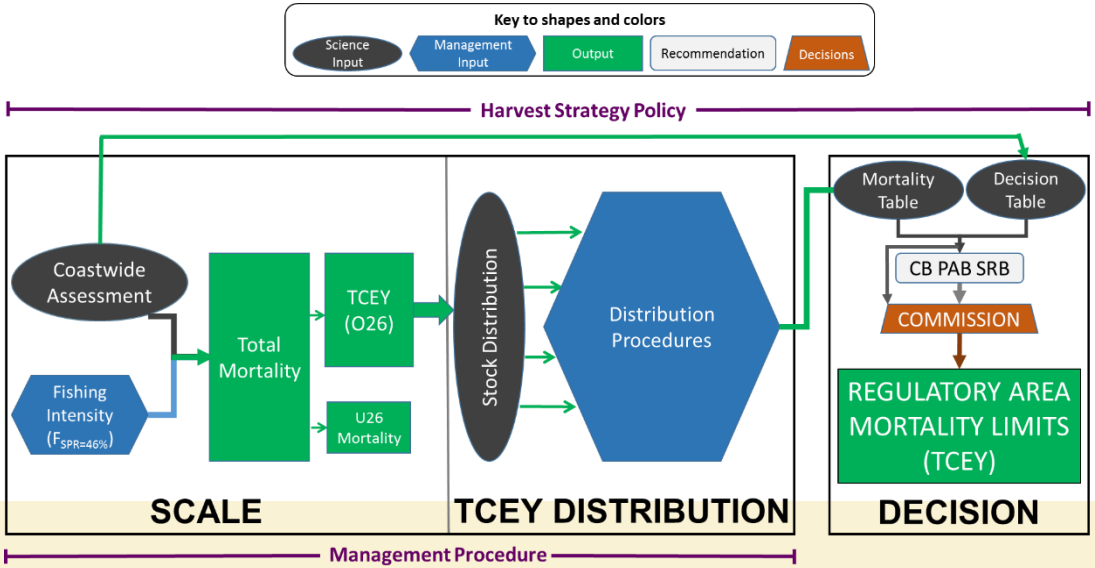
1. *Outcome*: Spawning stock is less than $0.20B_0$ ← Phrased as risk
2. *Time-frame:* Long-term, evaluate over 20 years
3. *Tolerance:* A 10% chance ← Risk tolerance

Goals and general objectives for IPHC MSE

- Biological sustainability
  - Avoid critical stock sizes
- Optimize directed fishing opportunities
  - Limit catch variability
  - Maximize directed fishing yield
- Minimize discard mortality
- Minimize bycatch and bycatch mortality

Harvest Strategy Policy

- a framework for applying a rigorous science-based approach to setting harvest levels for Pacific halibut (*Hippoglossus stenolepis*) within the Convention Area
- https://www.iphc.int/the-commission/harvest-strategy-policy



Harvest Strategy Policy Document

Sustainable and profitable use (optimum yield) of Pacific halibut

- “Maintain Pacific halibut, on average, at a target (fixed or dynamic) female spawning biomass equal to the stock size required to produce maximum net economic returns on a spatial and temporal scale relevant to the fishery”
- “Maintain Pacific halibut, above a female spawning biomass limit where the risk to the stock is regarded as unacceptable (SB_{LIM}), at least 90% of the time”

Harvest Strategy Policy Document

Reference Points and Proxies

Reference point	Definition	Proxy
Target reference point	The female spawning biomass level at maximum economic yield (SB_{MEY})	0.45 of unfished female spawning biomass; or 1.2 of female spawning biomass at maximum sustainable yield.
Limit reference point	The female spawning biomass level where the ecological risk to the population is regarded as unacceptable (i.e. at least 90 percent of the time) (SB_{LIM})	0.5 of the female spawning biomass at maximum sustainable yield or 0.2 of the unfished female spawning biomass

- Probability of achieving target or better is at least 50%
- Probability of breaching the limit does not exceed 10%

Other HSP-like documents

- **NPFMC**: EBS and GOA fishery management plans

  https://www.npfmc.org/bering-seaaleutian-islands-groundfish/

- **DFO**: A fishery decision-making framework incorporating the precautionary approach

  http://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/precaution-eng.htm

- **PFMC**: Groundfish fishery management plan

  https://www.pcouncil.org/groundfish/fishery-management-plan/

Primary objectives (coastwide scale)

General Objective	Measurable Objective	Measurable Outcome	Time-frame	Tolerance	Performance Metric
1.1. Keep biomass above a limit to avoid critical stock sizes Biomass Limit	Maintain a minimum female spawning stock biomass above a biomass limit reference point at least 90% of the time	*SB* < Spawning Biomass Limit (SB_{Lim}) SB_{Lim}=20% spawning biomass	Long-term	0.10	$P(SB < SB_{Lim})$
2.1. Limit Catch Variability	Limit annual changes in the coastwide TCEY	Average Annual Variability (*AAV*) > 15%	Short-term	0.25	$P(AAV > 15\%)$
2.2. Maximize Directed Fishing Yield	*Maximize average TCEY coastwide*	*Median coastwide TCEY*	*Short-term*	*STATISTIC OF INTEREST*	*Median* $\overline{TCEY}$

AM095

AM095-R, para 58. The Commission **NOTED** that the biological objective of the stock status not being below 20% of spawning biomass with a tolerance of 10% can be interpreted as accepting the stock status being below 20% in 1 out of 10 years. This is a common biological objective in fisheries, and addressing concerns of fishery performance can be stated as fishery objectives, such as defining a low tolerance for fishery closures.

AM095-R, para 59a. The Commission **ENDORSED** the primary objectives and associated performance metrics used to evaluate management procedures in the MSE process (as detailed in paper IPHC-2019-AM095-12)

AM095-R, para 59c. The Commission **RECOMMENDED** the MSAB develop the following additional objective, as well as prioritize this objective in the evaluation of management procedures, for the Commission's consideration.

i. A conservation objective that meets a spawning biomass target.

Biological sustainability objectives

- Should be consistent with standard practices and satisfy international standards
- Meets certification agencies that are important to the Pacific halibut fishery
- Commission recommended that the MSAB develop an objective related to target biomass

Examples of SB_{Lim}

- **NPFMC**: MSST
  - 50% B_{MSY}
- **DFO**: Limit Reference Point, Critical Zone
  - 40% B_{MSY}
- **PFMC**: Minimum Stock Size Threshold (MSST)
  - 25% B_0 for rockfish, 12.5% B_0 for flatfish

Examples outside of U.S. and Canada (B_{Lim})

- North Pacific Albacore
  - 20%B0; 14%B0=(1-M)*20%B0; $SSB_{0.5R0,h=0.75}$
- IOTC
  - 40-50% B_{MSY}
  - Tolerance = 5%
- ICES
  - Below B_{Lim} has a high risk of reduced recruitment
  - Maintain above B_{lim} with 95% probability

MSC Fisheries Standard V2.01

SA2.2 Stock status PI (PI 1.1.1)

Table SA1: PI 1.1.1 Stock status PISGs

Component	PI	Scoring issues	SG60	SG80	SG100
Outcome	Stock status **1.1.1** The stock is at a level which maintains high productivity and has a low probability of recruitment overfishing.	(a) Stock status relative to recruitment impairment.	It is **likely** that the stock is above the point where recruitment would be impaired (PRI).	It is **highly likely** that the stock is above the PRI.	There is a **high degree of certainty** that the stock is above the PRI
		(b) Stock status in relation to achievement of Maximum Sustainable Yield (MSY).		The stock is at or fluctuating around a level consistent with MSY.	There is a **high degree of certainty** that the stock has been fluctuating around a level consistent with MSY or has been above this level over recent years.

MSC Fisheries Standard V2.01

Scoring stock status !!

SA2.2.1 In P1 the terms “likely”, “highly likely” and “high degree of certainty” are used to allow for either qualitative or quantitative evaluation. In a probabilistic context and in relation to scoring issue (a):

SA2.2.1.1 Likely means greater than or equal to the 70th percentile of a distribution (i.e., there shall be at least a 70% probability that the true status of the stock is higher than the point at which there is an appreciable risk of recruitment being impaired).

SA2.2.1.2 Highly likely means greater than or equal to the 80th percentile.

SA2.2.1.3 High degree of certainty means greater than or equal to the 95th percentile.

SA2.2.2 The team shall consider the biology of the species and the scale and intensity of both the UoA and management system and other relevant issues in determining time periods over which to judge fluctuations. !!

SA2.2.3 Where information is not available on the stock status relative to the Point of Recruitment Impairment (PRI) or MSY levels, proxy indicators and reference points may be used to score PI 1.1.1. !!

SA2.2.3.1 Where proxy indicators and reference points are used to score PI 1.1.1, the team shall justify their use as reasonable proxies of stock biomass for the PRI and/or MSY. !!

MSC Fisheries Standard V2.01

GSA2.2.3.1 Use of proxy indicators and reference points for PRI and B_{MSY} ▲

In this section the term "reference point" is used in relation to determination of status, not in relation to harvest control rules (see additional guidance on this distinction in GSA2.6).

The default PRI values given above (½B_{MSY} or 20%B_0) apply to stocks with average productivity. Such points are generally consistent with being above the point at which there is an appreciable risk that recruitment is impaired, though for some short-lived stocks the actual point at which there is an appreciable risk that recruitment is impaired may be lower than 20%B_0 and for some long-lived species it may be higher than this.

GSA2.2.7 Consideration of environmental variability (including climate change) and human-induced impacts ▲

MSC recognises that the productivity of fisheries is affected by a range of environmental factors, as much as by the levels of fishing and the management of the fishery. The actual values of reference points may thus change over time as reflected in stock assessments, and these changes may be allowed for in scoring the status of the stock in PI 1.1.1. Section

Updated Biological Sustainability objectives

General Objective	Measurable Objective	Measurable Outcome	Time-frame	Tolerance	Performance Metric
1.1. Keep biomass above a limit to avoid critical stock sizes Biomass Limit	Maintain a minimum female spawning stock biomass above a biomass limit reference point at least 95% of the time	*SB* < Spawning Biomass Limit (SB_{Lim}) SB_{Lim}=20% unfished SB	Long-term, 10-yr period	0. 05	$P(SB < SB_{Lim})$

Consistent with MSC

Specific

Updated tolerance

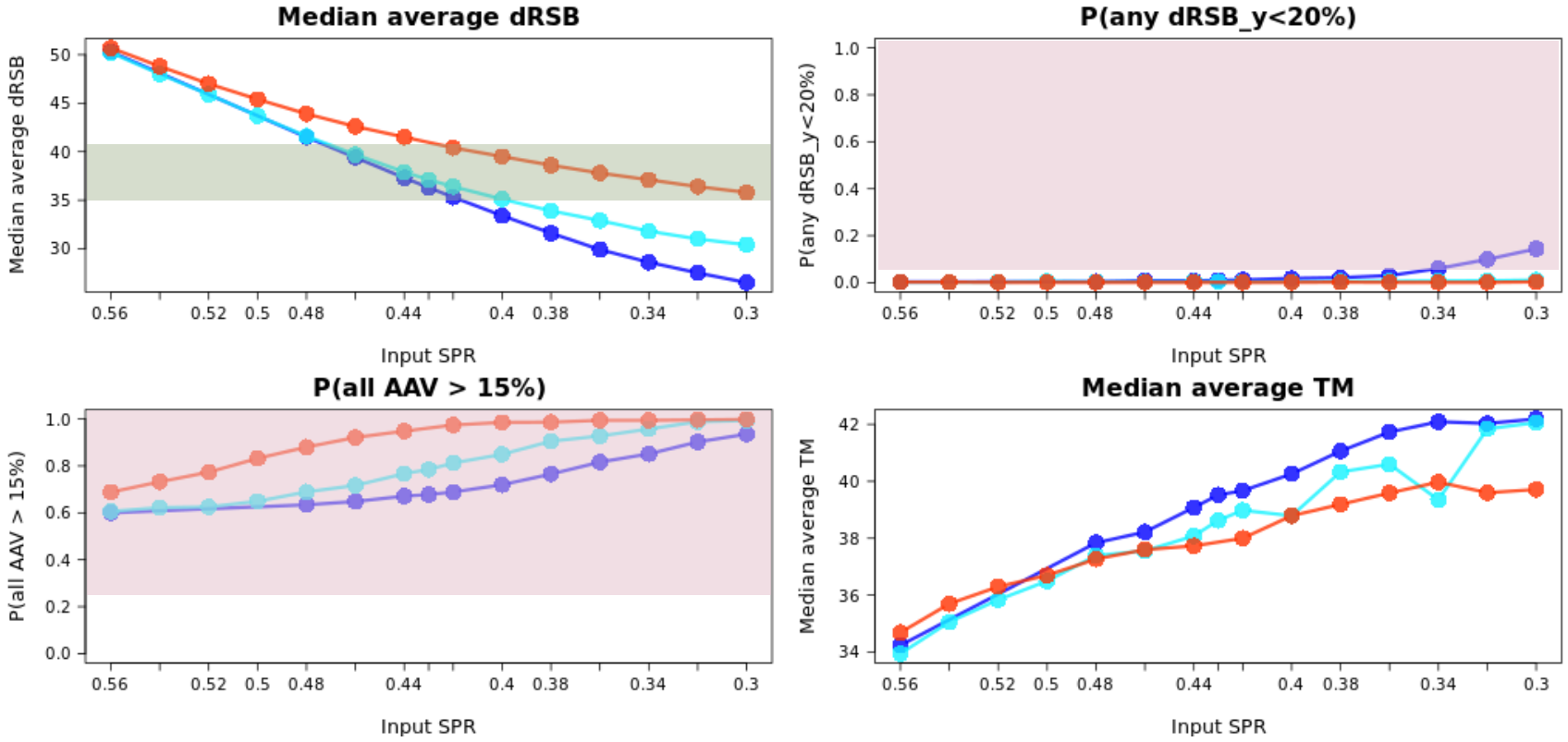
*Bmsy/B0 from past assessment models ranges from about 0.35 to 0.41

Considerations of biomass target objective

- SB_{Tar} is a fishery objective
  - The biomass that produces MSY (or MEY)
    - Maximizing the yield in the long-term with minimal risk of being less than SB_{Lim} would naturally result in the stock to fluctuate around a target biomass that would sustainably produce MSY (SB_{MSY})
- Is there a more specific fishery objective for maintaining the stock at or above a specified biomass level?

Example (long-term)

25:10 30:20 40:20



Biomass target

- Classify the biomass target as a fishery objective

General Objective	Measurable Objective	Measurable Outcome	Time-frame	Tolerance	Performance Metric
2.1. Maintain biomass around a target that optimises fishing activities Biomass Target	Maintain the female spawning biomass above a biomass target reference point at least 50% of the time	*SB* < Spawning Biomass Target (SB_{Tar}) $SB_{Tar}=B_{45\%}$?B_{MEY}?B_{MSY}?$B_{40\%}$??	Long-term, 10-yr period	0.50	$P(SB < SB_{Tar})$

New objective

From HSP doc

A target

Equilibrium

Median

*Bmsy/B0 from past assessment models ranges from about 0.35 to 0.41

Primary fishery objectives

- The stability objective (formerly 2.1) was not met without introducing a constraint on the annual change in catch mortality limits

General Objective	Measurable Objective	Measurable Outcome	Time-frame	Tolerance	Performance Metric
2.2. Limit Catch Variability	Limit annual changes in the coastwide TCEY	Average Annual Variability (*AAV*) > 15%	Short-term	0.25	$P(AAV > 15\%)$

Update #

Update?

Primary fishery objectives

- Maximizing the yield was used instead of maintaining the catch above a specified level.
  - Need to define the target catch level (and a tolerance)

General Objective	Measurable Objective	Measurable Outcome	Time-frame	Tolerance	Performance Metric
2.3. Maximize Directed Fishing Yield	Maintain TCEY above a minimum level coastwide	Coastwide TCEY < $TCEY_{min}$ $TCEY_{min}$=???	Short-term	??	$P(TCEY < TCEY_{min})$

Update #

Replacement

Define

Additional objectives and performance metrics

- See Appendix I of IPHC-2019-MSAB013-07
- Many of these are *statistics of interest*, which means that they are reported as a metric without a tolerance assigned

MSAB013

- **NOTE** paper IPHC-2019-MSAB013-07
- **CONSIDER** the current MSAB goals, measurable objectives and associated performance metrics, and the identification of primary objectives (Table 1).
- **CONSIDER** the additional objectives and statistics of interest to supplement the evaluation of management procedures (Appendix I).
- **RECOMMEND** a measurable conservation objective to meet a spawning biomass target or an objective that captures the intent.
- **RECOMMEND** an objective related to maintaining catch above a specific level with definitions of a measurable objective (the catch level) and a tolerance.
- **RECOMMEND** distribution objectives for evaluation of the Scale and Distribution components of the harvest strategy policy.
- **RECOMMEND** a practical set of performance metrics, including statistics of interest, to report for the evaluation of future simulations.
- **SUGGEST** methods (e.g. tables and figures) to report the performance metrics listed here for the evaluation of future results from the simulations.

Goals & Objectives related to distribution

- Some objectives have been proposed by the ad hoc working group in 2018
- General Objectives
  - Conserve spatial population structure
  - Limit catch variability
  - Maximize directed fishing yield
  - Minimize potential of no catch limit for directed fishery
- Many coastwide measurable objectives can be translated to Biological Regions and IPHC regulatory areas

Biological Sustainability

General Objective	Measurable Objective	Measurable Outcome	Time-frame	Tolerance	Performance Metric
1.1a Conserve spatial population structure	Maintain a defined minimum **proportion** of spawning biomass in each Biological Region	$p_{SB,A} < p_{SB,A,min}$	Med-term Long-term		$P(\dots)$
	Proportion of Pacific halibut spawning biomass in each Biological Region	Proportion of O26 Pacific halibut biomass in each Biological Region	Long-term	*STATISTIC OF INTEREST*	$\frac{SB_A}{SB}$

If defined as absolute spawning biomass, the sum would define the coastwide reference points

Optimize directed fishery opportunities

General Objective	Measurable Objective	Measurable Outcome	Time-frame	Tolerance	Performance Metric
2.1a Maintain biomass around a target that optimises fishing activities	Maintain a **proportion** of O26 Pacific halibut in each Biological Region within the range observed by the IPHC fishery-independent setline survey	$p_{B_{O26},A,min} < p_{B_{O26},A} < p_{B_{O26},A,max}$	Long-term Short-term		$P(\dots)$
	Proportion of O26 Pacific halibut biomass in each Biological Region	Proportion of O26 Pacific halibut biomass in each Biological Region	Long-term Short-term	*STATISTIC OF INTEREST*	$\frac{B_{O26,A}}{B_{O26}}$

It may be reasonable to define these as absolute values since there is no coastwide TCEY target

Optimize directed fishery opportunities

General Objective	Measurable Objective	Measurable Outcome	Time-frame	Tolerance	Performance Metric
2.2a Limit Catch Variability	Limit annual changes in the TCEY for each Regulatory Area	Average Annual Variability by Regulatory Area (AAV_A) > 15%	Long-term Short-term	0.25	$P(AAV > 15\%)$
		AAV_A	Long-term Short-term	*STATISTIC OF INTEREST*	*AAV and variability*
		Change in TCEY by Regulatory Area > 15% in any year	Long-term Short-term	*STATISTIC OF INTEREST*	$\frac{TCEY_{i+1} - TCEY_i}{TCEY_i}$

Optimize directed fishery opportunities

General Objective	Measurable Objective	Measurable Outcome	Time-frame	Tolerance	Performance Metric
2.3a Maximize Directed Fishing Yield	Maximize average TCEY by Regulatory Area	Median Reg Area TCEY	Long-term Short-term	*STATISTIC OF INTEREST*	$Median\ \overline{TCEY}$
	Maintain TCEY above a minimum level by Regulatory Area	$TCEY_A < TCEY_{A,min}$	Long-term Short-term	?? ??	$P(TCEY < TCEY_{A,min})$
	Maximize high yield (TCEY) opportunities by Regulatory Area	$TCEY_A >$?? Mlbs	Long-term Short-term	*STATISTIC OF INTEREST*	$P(TCEY <?\ ?\ Mlbs)$
	Present the range of TCEY by Regulatory Area that would be expected	Range of TCEY by Regulatory Area	Long-term Short-term	*STATISTIC OF INTEREST*	*5^{th} and 75^{th} percentiles of TCEY*
2.4a Minimize potential of no catch limit for directed fishery	Maintain catch limit for directed fishery in each Regulatory Area above zero	$DirectedYield_A = 0$	Long-term Short-term	?? ??	$P(DirY_A = 0)$

Other objectives related to distribution

- 2A: Minimum TCEY of 1.65 Mlbs, subject to conservation concerns (AM095-R, para 69c)
- 2B: share-based allocation, 30% weight on current interim procedure and 70% weight on 20% (AM095-R, para 69b).

- Can inform Management Procedure, define an objective, or both

Specific IPHC Reg Area fishery objectives

General Objective	Measurable Objective	Measurable Outcome	Time-frame	Tolerance	Performance Metric
2.1a Maintain biomass around a target that optimises fishing activities	Maintain a proportion of O26 Pacific halibut in each Biological Region within the range observed by the IPHC fishery-independent setline survey	$p_{B_{O26},A,min} < p_{B_{O26},A} < p_{B_{O26},A,max}$	Long-term Short-term		$P(\dots)$
Maintain proportion of TCEY in Regulatory Area 2B at a target level		$??? < \frac{TCEY_{2B}}{\sum_A TCEY_A} < ???$	Long-term Short-term	?? ??	$P\left(??? < \frac{TCEY_{2B}}{\sum_A TCEY_A}\right.$

Specific IPHC Reg Area fishery objectives

General Objective	Measurable Objective	Measurable Outcome	Time-frame	Tolerance	Performance Metric
2.3A Maximize Directed Fishing Yield	Maintain TCEY above a minimum level by Regulatory Area	$TCEY_A < TCEY_{A,min}$	Long-term Short-term	?? ??	$P(TCEY < TCEY_{A,min})$
Maximize TCEY above 1.65 Mlbs in Regulatory Area 2A	$TCEY_{2A} < 1.65$ Mlbs		Long-term Short-term	*??* *??*	$P(TCEY_{2A} < 1{,}65\ Mlbs)$

Thoughts on objectives

- Need to define more area-specific objectives
- Are there sector-specific objectives to consider?

- It is important to identify a few primary objectives
  - We will report many performance metrics that are not in the primary list

MSAB013

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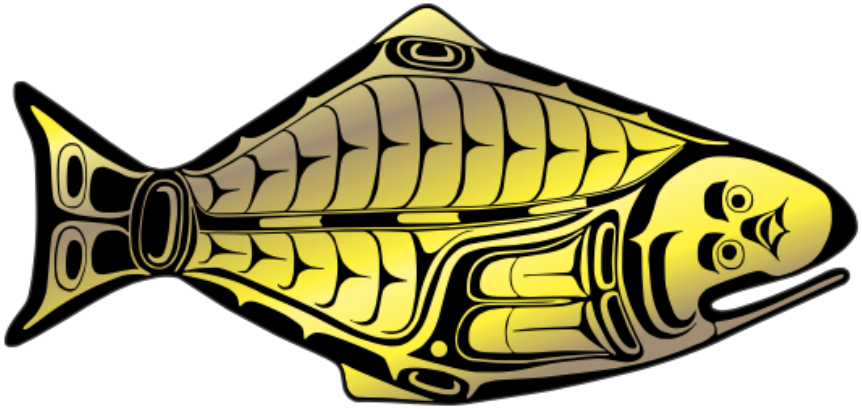

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A different look at the example

Median dynamic relative spawning biomass

	SPR													
CR	**0.56**	**0.54**	**0.52**	**0.50**	**0.48**	**0.46**	**0.44**	**0.42**	**0.40**	**0.38**	**0.36**	**0.34**	**0.32**	**0.30**
40:20	50.7	48.8	47.0	**45.4**	**43.9**	42.6	41.5	40.4	39.5	38.6	37.8	37.1	36.4	35.8
30:20	50.2	48.0	**45.9**	**43.7**	41.6	39.7	37.9	36.4	35.1	33.9	32.9	31.8	31.0	30.4
25:10	50.3		**XX**	**XX**	41.5	39.4	37.3	35.3	33.4	31.6	29.9	28.6	27.5	26.5

These objectives are important, but some will be moot

- In this case, fishery yield and SB_{Lim} are moot
  - (AAV never met)
- Should some be a statistic of interest rather than being rankable?

Updated primary fishery objectives

General Objective	Measurable Objective	Measurable Outcome	Time-frame	Tolerance	Performance Metric
2.1. Maintain biomass around a target that optimises fishing activities Biomass Target	Maintain the female spawning biomass above a biomass target reference point at least 50% of the time	*SB* < Spawning Biomass Target (SB_{Tar}) $SB_{Tar}=B_{45\%}$?B_{MEY}?B_{MSY}?$B_{40\%}$??	Long-term, 10-yr period	0.50	$P(SB < SB_{Tar})$
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Equilibrium

From HSP doc

New objective

A target

Median

Update?

Replacement

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*Bmsy/B0 from past assessment models ranges from about 0.35 to 0.41

U.S. Commissioner objectives from IM093

Goal	Objective	MSAB011
Biological sustainability: Preserving bio-complexity	1. Maintaining diversity in the population across IPHC Regulatory Areas.	More discussion
	2. Prevent local depletion at IPHC Regulatory Area scale.	More discussion
Fisheries Sustainability: Maintain access and serve consumer needs.	1. Maintain commercial, recreational and subsistence fishing opportunities in each IPHC Regulatory Area.	Covered
	2. Maintain processing opportunities in each IPHC Regulatory Area.	Dropped
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.).	More discussion
	2. Distribution is responsive to management precision in each IPHC Regulatory Area.	More discussion
	3. Minimize impact on downstream migration areas.	More discussion
	4. Minimize discard mortality and bycatch.	Parking lot
Fisheries Sustainability: Minimize variability,	1. Limit annual TCEY variability due to stock distribution in both time and scale.	Covered
	2. Avoid zero sum distribution policy.	More discussion

ICES definitions of probabilities

3.2 Definitions (percentage, time frame)

There are alternative ways in which the statement "the probability that SSB is below B_{lim}" can be interpreted and different interpretations have actually been applied when management plans have been evaluated in the past by ICES. The issue is important because, depending on the interpretation used, the request that this probability should not exceed 5% is more or less stringent. The working document by Fernández (WD1 in Annex 2) explains this in detail and a summary is provided here (noting that instead of "risk", which is the wording employed in WD1, this report uses the wording "probability that SSB is below B_{lim}" to avoid confusion with other interpretations of risk).

A review of ICES practices (see e.g. section 2 of this report and section 6 of Annex 2) shows that three interpretations have been used in the past:

- $\boldsymbol{Prob1}$ = *average* probability that SSB is below B_{lim}, where the average (of the annual probabilities) is taken across ny years.
- $\boldsymbol{Prob2}$ = probability that SSB is below B_{lim} *at least once* during ny years.
- $\boldsymbol{Prob3}$ = *maximum* probability that SSB is below B_{lim}, where the maximum (of the annual probabilities) is taken over ny years.

Annex 2 shows that $Prob2 \geq Prob3 \geq Prob1$, so requiring that $Prob2 < 0.05$ is a more stringent condition than if this is required based on $Prob3$ or $Prob1$. It is clear from their definition that in a stationary situation (generally in the "long term", after the effect of the initial stock numbers has disappeared), $Prob3 = Prob1$, although in a non-stationary situation (generally in the "short term", corresponding to the first few years in the simulation) $Prob3$ can be considerably larger than $Prob1$. $Prob2$ can also be considerably larger than $Prob3$ and $Prob1$, particularly for stocks with low time autocorrelation in SSB (as may be expected for short-lived species). This means that, all other things being equal, $Prob2$ may be expected to be higher for short-lived than for long-lived species. On the other hand, once a stock is below B_{lim}, it will generally take longer for it to recover if it is a long-lived species, but $Prob2$ does not take this into account as it is just focused on the probability of the stock being below B_{lim} at least once in the ny years period considered.