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# Understanding MSE and its role in the management of Pacific halibut

Agenda item: 4.1 IPHC-2025-MSAB021-06 (A Hicks)



### History of MSE at IPHC

- First MSE for fisheries conducted at IPHC
  - Southward 1968 (IPHC-1968-SR047)
  - Objective: optimal yield
  - 3 management procedures
    - CPUE-based, equilibrium yield, yield-per-recruit
  - Minor differences between them
- Others since then
  - Parma, Hare, Valero
- Since 2012
  - Martell, Hicks, MSAB



#### Management Strategy Evaluation (MSE)

a process to evaluate harvest strategies and develop a management procedure that is robust to uncertainty and meets defined objectives



An important process informing the development and application of a Harvest Strategy Policy



#### Important elements/concepts of MSE

- It is a process, not a product
- Is iterative and may backtrack
- Stakeholder and resource user involvement
- Simulations have a closed-loop feedback
- A Management Procedure (MP) is defined to have a repeatable outcome
- Performance Metrics are related to objectives for evaluation
- Once an MP is applied, the process may repeat itself
- Communication is a key component





### **Development of objectives**

- Many potential objectives were developed with assistance of the MSAB
- Some objectives were revised after simulation and evaluation
- Some objectives are vague and not easily measurable
- Some objectives are specific to regions or areas
- Most objectives have a performance metric that allows for comparison of that objective across different Management Procedures

Goal	GENERAL OBJECTIVE	MEASURABLE OBJECTIVE	Measurable Outcome	TIME- FRAME	Tolera NCE	Performance Metric
Conservation/ Sustainability	1.1. KEEP FEMALE SPAWNING BIOMASS ABOVE A LIMIT TO AVOID CRITICAL STOCK SIZES AND CONSERVE SPATIAL POPULATION STRUCTURE	Maintain a female spawning stock biomass above a biomass limit reference point at least 95% of the time	SB < Spawning Biomass Limit (SB <sub>Lim</sub> ) SB <sub>Lim</sub> =20% unfished spawning biomass	Long- term	0.05	P(SB < SB <sub>Lim</sub> ) PASS/FAIL



#### **Commission Priority Objectives**

#### **Priority Order**

- a) Maintain Pacific halibut female spawning biomass, above a female spawning biomass limit where the risk to the stock is regarded as unacceptable (RSB<sub>LIM</sub>), at least 95% of the time;
- b) Maintain Pacific halibut female spawning biomass, at least 50% of the time, at or above a female spawning biomass threshold (RSB<sub>THRESH</sub>) that optimises fishing activities on a spatial and temporal scale relevant to the fishery;
- c) Optimise average coastwide yield given the constraints above;
  - d) Limit annual changes in the coastwide mortality limit (TCEY) given the constraints above.



# At or above B<sub>36%</sub> (objective b)

- RSB<sub>36%</sub> is a proxy for Maximum Economic Yield (MEY)
- Relative Spawning Biomass was above 36% in 2025
  - Measuring the effect of fishing
  - Well above the conservation objective (RSB<sub>20%</sub>)
- 2024 FISS & Commercial WPUE lowest observed since 1993
  - Affected by the weight-at-age, recruitment, and fishing
  - Concern about catch-rates and level of spawning biomass
- Adopted coastwide TCEY less than that determined from the interim reference fishing intensity (SPR=43%) in 2023, 2024, and 2025
- Catch-rates and absolute biomass seem to be important, especially when they are low, and even though stock status is above RSB<sub>36%</sub>



#### Working towards a potential new objective

- <u>IPHC-2024-MSAB020-R</u>, para 16. The MSAB **NOTED** that a new objective to maintain the coastwide TCEY above a threshold may be useful because
  - it is meaningful to stakeholders,
  - may define a minimum coastwide TCEY necessary for economic viability, and
  - may be a proxy for maintaining catch-rates and absolute spawning biomass above a threshold which may be important to stakeholders.
- <u>IPHC-2024-MSAB020-R</u>, para 17. The MSAB **NOTED** that the RSB<sub>36%</sub> objective (b in paragraph 12) is a useful objective because
  - it separates fishing effects from environmental effects on the stock,
  - scales with changes in productivity,
  - defines a desired relative spawning biomass to be at or above,
  - is based on a proxy for  $\text{RSB}_{\text{MEY}}$  and
  - is an objective that is often important to fishery certification agencies



## **Hierarchical objectives**

- 1. Maintain the long-term coastwide Pacific halibut female relative spawning biomass, above a biomass limit reference point where the risk to the stock is regarded as unacceptable (RSB<sub>20%</sub>), at least 95% of the time;
- Maintain the long-term coastwide Pacific halibut female relative spawning biomass, at least 50% of the time, at or above a threshold reference point that optimises fishing activities on a spatial and temporal scale relevant to the fishery (RSB<sub>36%</sub>);
- 3. Balance the trade-off between maximising the sustainable average coastwide yield and minimising annual changes in the coastwide mortality limit, given the constraints above .



#### LONG-TERM OVERARCHING OBJECTIVES DEFINING ACCEPTABLE MPS

1. SUSTAINABILITY						
GENERAL OBJECTIVE	Measurable Objective					
KEEP FEMALE SPAWNING BIOMASS ABOVE A LIMIT TO AVOID CRITICAL STOCK SIZES	Maintain the long-term coastwide female relative spawning biomass above a biomass limit reference point (RSB <sub>20%</sub> ) at least 95% of the time					

#### 2. OPTIMISE FISHING ACTIVITIES AND OPPORTUNITIES

GENERAL OBJECTIVE	MEASURABLE OBJECTIVE
MAINTAIN SPAWNING BIOMASS AT OR ABOVE A LEVEL THAT SUPPORTS OPTIMAL FISHING ACTIVITIES AND OPPORTUNITIES	Maintain the long-term coastwide female relative spawning biomass at or above a biomass threshold reference point (RSB <sub>36%</sub> ) 50% or more of the time.

SHORT-TERM MANAGEMENT OBJECTIVES INFORMING A REFERENCE MP

3. OPTIMISE YIELD



#### Management Procedures (MPs)

- An MP is a defined process to determine mortality limit(s)
  - Repeatable, can be coded for simulation
  - Composed of multiple elements
    - Fishing intensity
    - Assessment frequency and empirical management procedure
    - Constraints
    - FISS designs
- Current interim reference MP
  - SPR=43%, 30:20 control rule





### **Elements of MPs considered**

- Fishing Intensity or SPR (many years)
- Constraints (many years)
- Assessment Frequency (many years)
- FISS designs (2024)
- Size limits (2022)
- Distribution procedures (2020, 2021)
- Control rule (2017-2019)





## Simulation/Evaluation

- Operating Model (OM) represents the Pacific halibut population with many sources of variability
- Simulated many years into the future with closed-loop feedback





#### Simulation

- Project many years to equilibrium with a consistent MP
  - Include lots of variability
  - Repeat this many times with random variability
- Calculate performance metrics from the repeated trajectories



#### Scenarios in the OM examined

Different assumptions in the OM (sometimes unrealistic)

- Low/Curr/High Weight-at-age (2025)
- Low/High PDO (2023, 2025)
- Depensation (2024)
  - -reduced reproduction at low spawning biomass





#### **Evaluating Biomass Objectives**

- Given objectives to maintain RSB above 20% and at or above 36% there are three possibilities
  - 1. P(RSB < 20%) > 5%:

- The MP is **not** a sustainable option
- 2. P(RSB < 20%) < 5% & P(RSB < 36%) > 50%: The MP is **not** an optimal option
- 3. P(RSB < 20%) < 5% & P(RSB < 36%) < 50%: The MP is practical, continue evaluation
- The first two biomass objectives define what MPs should not be considered
- The last objective is to evaluate tradeoffs, which may not have a simple solution



#### **Evaluating Trade-offs**

- Evaluate results to identify MP that best meets the objectives
  - Can be challenging because there are trade-offs between objectives
    - One objective worsens when another is improved



**Better** 



### **Evaluating Trade-offs**

# • Evaluate results to identify MP that best meets the objectives

- Can be challenging because there are trade-offs between objectives
  - One objective worsens when another is improved

The increase in AAV at low fishing intensity (high SPR) is likely due to low TCEYs and decision-making variability





### History of Harvest Policies at IPHC

- There have been few historical objectives for managing Pacific halibut, and the current four priority objectives are the most well defined
- Historically, the Pacific halibut fisheries were managed based on CPUE, season length, and area closures
- Concepts of MSY were used in 1970s and 1980s
- Constant exploitation rate was used in 1990s along with a quota system
- Coastwide SPR-based harvest policy has been used since 2017
  - All known mortality of all sizes and from all sources
  - Coastwide SPR=43% based on previous MSE work
  - 30:20 control rule retained with some MSE investigation



#### **Coastwide SPR-based Harvest Strategy**

- Coastwide SPR=43%
  - based on previous MSE work (adopted 2020)
- 30:20 control rule based on RSB
  - Some investigation before 2020
- 32-inch size limit for directed commercial fisheries
  - Many investigations of size limits
- Distribution of TCEY to IPHC Regulatory Area decided by Commission





#### **Current Interim Harvest Strategy Policy**





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