INTERNATIONAL PACIFIC HALIBUT COMMISSION

IPHC–2024–MSAB020–00
Last Update: 29 October 2024

20th Session of the IPHC Management Strategy Advisory Board (MSAB020) – *Compendium of meeting documents*

29-30 October 2024 Seattle, WA, USA

Commissioners

Canada	United States of America
Paul Ryall	Jon Kurland
Neil Davis	Robert Alverson
Peter DeGreef	Richard Yamada

Executive Director

David T. Wilson, Ph.D.

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INTERNATIONAL PACIFIC HALIBUT COMMISSION

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PROVISIONAL: AGENDA & SCHEDULE FOR THE 20th SESSION OF THE IPHC MANAGEMENT STRATEGY ADVISORY BOARD (MSAB020)

Date: 29-30 October 2024
Location: Electronic
Link: Please Register here
Time (PDT): 09:00-17:00 (daily)
Co-Chairpersons: Ms Gwyn Mason (Canada); Dr Pete Hulson (USA)

Notes:
- ***Document deadline****: 29 September 2024 (30 days prior to the opening of the Session)*
- *All sessions are open to observers and the general public, unless the Commission specifically decides otherwise.*

1. OPENING OF THE SESSION

2. ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION
- ➢ *IPHC-2024-MSAB020-01: Agenda & Schedule for the 20th Session of the IPHC Management Strategy Advisory Board (MSAB020)*
- ➢ *IPHC-2024-MSAB020-02: List of Documents for the 20th Session of the IPHC Management Strategy Advisory Board (MSAB020)*

3. IPHC PROCESS
3.1. MSAB Membership (D. Wilson)
- ➢ *IPHC-2024-MSAB020-03: MSAB Membership (D. Wilson)*

3.2. Update on the actions arising from the 19th Session of the MSAB (MSAB019) (A. Hicks)
- ➢ *IPHC-2024-MSAB020-04: Update on the actions arising from the 19th Session of the MSAB (MSAB019) (A. Hicks)*

3.3. Outcomes of the 100th Session of the IPHC Annual Meeting (AM100) (A. Hicks)
- ➢ *IPHC-2024-MSAB020-05: Outcomes of the 100th Session of the IPHC Annual Meeting (AM100) (A. Hicks)*

4. MANAGEMENT STRATEGY EVALUATION PROGRAM OF WORK (2024-2025)
4.1. Primary MSE objectives and associated performance metrics (A. Hicks)

4.2. Evaluation of management procedures (A. Hicks)
- ➢ *IPHC-2024-MSAB020-06: Update to the Management Strategy Evaluation Program of Work for 2024-2025 (A. Hicks & I. Stewart)*

5. DRAFT HARVEST STRATEGY POLICY

5.1. Consideration of the draft Harvest Strategy Policy (A. Hicks)

- *IPHC-2024-MSAB020-07: Interim: IPHC Harvest Strategy Policy (IPHC Secretariat)*

6. OTHER BUSINESS

7. REVIEW OF THE DRAFT AND ADOPTION OF THE REPORT OF THE 20TH SESSION OF THE IPHC MANAGEMENT STRATEGY ADVISORY BOARD (MSAB020)

Tuesday 29 October 2024		
Time	**Agenda item**	**Lead (support)**
08:30-09:00	Connect electronically and troubleshoot connections	IPHC Secretariat
09:00-09:10	**1. Opening of the Session**	Co-Chairperson & Secretariat
09:10-09:30	**2. Adoption of the agenda and arrangements for the Session**	Co-Chairpersons
09:30-10:00	**3. IPHC Process** 3.1. MSAB Membership 3.2. Update on the actions arising from the 19th Session of the MSAB (MSAB019) 3.3. Outcomes of the 100th Session of the IPHC Annual Meeting (AM100)	 D. Wilson A. Hicks A. Hicks
10:00-10:45	**4. Management Strategy Evaluation Program of Work** 4.1. Primary MSE objectives and associated performance metrics	A. Hicks
10:45-11:00	Break	
11:00-12:30	**4. Management Strategy Evaluation Program of Work (cont.)** 4.1. Primary MSE objectives and associated performance metrics (discussion)	A. Hicks
12:30-13:30	Lunch	
13:30-15:00	**4. Management Strategy Evaluation Program of Work (cont.)** 4.2. Evaluation of management procedures	A. Hicks
15:00-15:15	Break	
15:15-15:45	**4. Management Strategy Evaluation Program of Work (cont.)** 4.2. Evaluation of management procedures	A. Hicks
15:45-16:00	Review of Day 1	Co-chairpersons
16:00-17:00	MSAB Drafting Session	MSAB drafting group

Wednesday 30 October 2024		
Time	**Agenda item**	**Lead (support)**
08:30-09:00	Connect electronically and troubleshoot connections	IPHC Secretariat
09:00-10:00	Review of Day 1 and discussion of draft report	Co-Chairpersons
10:00-10:45	**5. Draft Harvest Strategy Policy** 5.1. Consideration of the draft Harvest Strategy Policy	A. Hicks
10:45-11:00	Break	
11:00-11:45	**5. Draft Harvest Strategy Policy (cont.)** 5.1. Consideration of the draft Harvest Strategy Policy	A. Hicks
11:45-12:00	**6. Other Business**	A. Hicks
12:00-13:00	Lunch	
13:00-14:30	MSAB Drafting Session	MSAB Drafting Group
14:30-15:00	Break	
15:00-17:00	**7. Review of the Draft and Adoption of the Report of the 20th Session of the IPHC Management Strategy Advisory Board (MSAB020)**	Co-Chairpersons & A. Hicks

DRAFT: LIST OF DOCUMENTS FOR THE 20th SESSION OF THE IPHC MANAGEMENT STRATEGY ADVISORY BOARD (MSAB020)

Meeting documents	Title	Availability
IPHC-2024-MSAB020-01	Agenda & Schedule for the 20th Session of the IPHC Management Strategy Advisory Board (MSAB020)	✓ 29 Jul 2024 ✓ 27 Sept 2024
IPHC-2024-MSAB020-02	List of Documents for the 20th Session of the IPHC Management Strategy Advisory Board (MSAB020)	✓ 29 Jul 2024 ✓ 28 Oct 2024
IPHC-2024-MSAB020-03 Rev_1	MSAB membership (IPHC Secretariat)	✓ 20 Sept 2024 ✓ 29 Sept 2024
IPHC-2024-MSAB020-04	Update on actions arising from the 19th Session of the MSAB (MSAB019) (A. Hicks)	✓ 20 Sept 2024
IPHC-2024-MSAB020-05	Outcomes of the 100th Session of the IPHC Annual Meeting (AM100) and 2024 Intersessional Decisions (A. Hicks)	✓ 24 Sept 2024
IPHC-2024-MSAB020-06	MSE update on progress in 2024 and development of a revised Harvest Strategy Policy (A. Hicks, I. Stewart, & D. Wilson)	✓ 27 Sept 2024
IPHC-2024-MSAB020-07	Interim: IPHC Harvest Strategy Policy (A. Hicks, I. Stewart, & D. Wilson)	✓ 29 Sept 2024
Information Papers		
IPHC-2024-MSAB020-INF01	Informal meeting summary of the 4th MSAB Ad-Hoc Working Group (MSAB-AdHoc04)	✓ 29 Jul 2024
IPHC-2024-MSAB020-INF02	Using Management Strategy evaluation to investigate the effect of fishing and the environment on Pacific halibut (IPHC Secretariat)	✓ 28 Oct 2024

MSAB Membership 2024

PREPARED BY: IPHC SECRETARIAT (29 SEPTEMBER 2024)

PURPOSE

To provide the Management Strategy Advisory Board (MSAB) with an updated membership list as of **29 September 2024**.

BACKGROUND

Rule II of Appendix V [Management Strategy Advisory Board (MSAB) – Terms of Reference and Rules of Procedure] of the IPHC Rules of Procedure (2024), states:

> *3. The MSAB will include the following interests (in alphabetical order): harvesters (commercial, sport, and subsistence), fisheries managers, processors, science advisors and other experts as required may be represented, and be facilitated by the IPHC Secretariat. Upon request, the IPHC shall cover the travel costs, in accordance with IPHC travel policies, for non-State and non-Federal board members, to attend one (1) MSAB session each year.*
>
> *4. The term of MSAB members will be four years, and members may serve additional terms at the discretion of the IPHC.*

DISCUSSION

At the 99th Session of the IPHC Annual Meeting (AM099), the Commission made the following agreements related to MSAB membership.

> **IPHC-2023-AM099-R, para. 69**. *The Commission* ***AGREED*** *that the Management Strategy Evaluation process and the Management Strategy Advisory Board continue to support the Commission's management of the stock and fishery by providing the means to define fishery objectives and evaluate the performance of management measures against these objectives. The two Contracting Parties have reviewed MSAB membership with the intention of ensuring that the MSAB represents the diversity of interests and remains at a manageable size.*
>
> **IPHC-2023-AM099-R, para. 70**. *The Commission* ***AGREED*** *that term appointments can continue to be renewed without limit at the discretion of the Commissioners.*
>
> **IPHC-2023-AM099-R, para. 71**. *The Commission* ***AGREED*** *that current MSAB membership terms which expired on 31 December 2022 should be renewed for up to four (4) years to facilitate staggered term expiry among members.*

> **IPHC-2023-AM099-R, para. 72**. *The Commission **NOTED** that there are vacancies within the current membership, and **AGREED** that there will not be active solicitations to fill these vacancies. The MSAB process remains open to observers, including to people who may be interested in applying for an appointment to the MSAB at a later date.*

No recommendations were made at the 100th Annual Meeting of the IPHC (AM100) pertaining to MSAB meetings or membership.

Provided at Appendix A are the current MSAB membership and term expirations, taking into account the AM099 decisions detailed above and any changes in membership since MSAB018 and MSAB019.

RECOMMENDATION/S

That the MSAB **NOTE** paper IPHC-2024-MSAB020-03 Rev_1 which details the MSAB membership and term expirations, as of **29 September 2024**.

APPENDICES

Appendix A: MSAB Membership as of 29 September 2024

APPENDIX A
MANAGEMENT STRATEGY ADVISORY BOARD (MSAB) MEMBERSHIP

(AS OF 29 SEPTEMBER 2024)

Membership category	Member	Canada	U.S.A.	Current Term commencement	Current Term expiration
Commercial harvesters (6-8)					
1	Sporer, Chris	CDN Commercial		10-April-23	31-Dec-26
2	Hauknes, Robert	CDN Commercial		10-April-23	31-Dec-24
3	Grout, Angus	CDN Commercial		10-April-23	31-Dec-26
4	Vacant	CDN Commercial			Vacant
5	Behnken, Linda		USA Commercial	01-May-24	30-April-28
6	Odegaard, Per		USA Commercial	10-April-23	31-Dec-24
7	Conrad, Michele		USA Commercial	01-May-24	30-April-28
8	Johnson, James		USA Commercial	17-Apr-23	31-Dec-24
First Nations/ Tribal fisheries (2-4)					
1	Lane, Jim	CDN First Nations		10-April-23	31-Dec-26
2	Vacant	CDN First Nations			Vacant
3	Mazzone, Scott		USA Treaty Tribes	9-May-23	31-Dec-24
4	Fitting, Emily		USA Treaty Tribes	25-Sept-24	24-Sept-28

Membership category	Member	Canada	U.S.A.	Current Term commencement	Current Term expiration
Government Agencies (4-8)					
1	Mason, Gwyn	DFO		01-May-24	30-April-28
2	Huang, Ann-Marie	CDN Science Advisor		10-April-23	31-Dec-24
3	Vacant	DFO			Vacant
4	Iverson, Kurt		NOAA-Fisheries	17-Oct-22	16-Oct-26
5	Hulson, Pete		USA Science Advisor	13-Jul-22	31-Dec-24
6	Mattes, Lynn		PFMC	25-June-24	31-Dec-26
7	Bush, Karla		NPFMC	25-Oct-21	31-Dec-24
8	Vacant		ADFG		Vacant
Processors (2-4)					
1	Vacant	CDN Processing			Vacant
2	Vacant	CDN Processing			Vacant
3	Parker, Peggy		USA Processing	9-May-23	31-Dec-24
4	Drobnica, Angel		USA Processing	17-Apr-23	31-Dec-26
Recreational/ Sport fisheries (2-4)					
1	Ashcroft, Chuck	CDN Sportfishing		17-Apr-23	31-Dec-24
2	Fowler, Michael	CDN Sportfishing		01-May-24	30-April-28
3	Marking, Tom		USA Sportfishing (CA)	9-May-23	31-Dec-26
4	Braden, Forrest		USA sportfishing (AK)	17-Apr-23	31-Dec-24

Update on the Actions Arising from the 19th Session of the IPHC Management Strategy Advisory Board (MSAB019)

PREPARED BY: IPHC SECRETARIAT (20 SEPTEMBER 2024)

PURPOSE

To provide the Management Strategy Advisory Board (MSAB) with an opportunity to consider the progress made during the intersessional period, on the recommendations/requests arising from the MSAB019.

BACKGROUND

At the MSAB019, the members recommended/requested a series of actions to be taken by the IPHC Secretariat, as detailed in the MSAB019 meeting report (IPHC-2023-MSAB019-R) available from the IPHC website, and as provided in Appendix A.

DISCUSSION

During the 20th Session of the MSAB (MSAB020), efforts will be made to ensure that any recommendations/requests for action are carefully constructed so that each contains the following elements:

1) a specific action to be undertaken (deliverable);
2) clear responsibility for the action to be undertaken (such as the IPHC Staff or MSAB officers);
3) a desired time frame for delivery of the action (such as by the next session of the MSAB or by some other specified date).

RECOMMENDATION/S

That the MSAB:

1) **NOTE** paper IPHC-2024-MSAB020-04, which provided the MSAB with an opportunity to consider the progress made during the inter-sessional period, in relation to the consolidated list of recommendations/requests arising from the previous MSAB meeting (MSAB019).
2) **AGREE** to consider and revise the actions as necessary, and to combine them with any new actions arising from MSAB020.

APPENDICES

Appendix A: Update on actions arising from the 19th Session of the IPHC Management Strategy Advisory Board (MSAB019)

APPENDIX A
Update on actions arising from the 19th Session of the IPHC Management Strategy Advisory Board (MSAB019)

RECOMMENDATIONS

Action No.	Description	Update
MSAB019–Rec.1 (para 51)	**NOTING** paragraph 48, the MSAB **RECOMMENDED** developing an objective and identifying a management procedure that addresses the current circumstances and differences in perception of the stock status.	**In progress** The 4th Meeting of the Ad Hoc MSAB Working Group took place on 18 July 2024 and began this discussion.
MSAB019–Rec.2 (para 52)	The MSAB **RECOMMENDED** adopting the following exceptional circumstances: a) The coastwide all-sizes FISS WPUE or NPUE from the space-time model falls above the 97.5th percentile or below the 2.5th percentile of the simulated FISS index for two or more consecutive years. b) The observed FISS all-sizes stock distribution for any Biological Region is above the 97.5th percentile or below the 2.5th percentile of the simulated FISS index for two or more consecutive years. c) Recruitment, weight-at-age, sex ratios, other biological observations, or new research indicating parameters that are outside the 2.5th and 97.5th percentiles of the range used or calculated in the MSE simulations	**Completed** These three exceptional circumstances were presented to the SRB at SRB024 and the SRB suggested retaining only a). See paragraph 25 of IPHC-2024-SRB024-R.
MSAB019–Rec.3 (para 55)	The MSAB **RECOMMENDED** adopting the follow actions if an exceptional circumstance occurs: a) Consult with the SRB and MSAB to identify why the exceptional circumstance occurred, what can be done to resolve it, and determine a set of MPs to evaluate with a possibly updated OM. b) If a multi-year MP was implemented and an exceptional circumstance occurred in a year without a stock assessment, a stock assessment would be completed as soon as possible along with the re-examination of the MSE. c) Further consult with the SRB and MSAB after simulations are complete to identify whether a new MP is appropriate.	**Completed** These actions are currently listed in the draft Harvest Strategy Policy. See IPHC-2024-MSAB020-07.

Action No.	Description	Update
MSAB019–Rec.4 (para 57)	The MSAB **RECOMMENDED** a one- to two-day hybrid MSAB meeting in the fall of 2024, prior to the 100th Session of the IPHC Interim Meeting (IM100), to discuss results from the ad-hoc working group (para. 56) and review any simulation designs and results.	**Completed** MSAB020

REQUESTS

Action No.	Description	Update
MSAB019–Req.1 (para 32)	The MSAB **REQUESTED** that outreach materials be developed by the Secretariat that synthesize the effect of the PDO (e.g. via recruitment) on the coastwide and regional stock dynamics and the relative effect of fishing in simple terms with interpretation and consequences of the outcomes. This may be a pamphlet or a short document to be reviewed via email by MSAB members before the 100th Session of the IPHC Interim Meeting (IM100).	**In progress** This is in progress and a draft is planned to be made available before MSAB020 as an informational document.
MSAB019–Req.2 (para 39)	The MSAB **REQUESTED** that the evaluation of annual, biennial, and triennial assessments include, but is not limited to, the following concepts. a) Annual changes in the coastwide TCEY is driven by an empirical rule in nonassessment years of a multi-year MP; b) A constraint on the coastwide TCEY to reduce inter-annual variability and the potential for large changes in every year or only assessment years. This may be a 10%, 15%, or 20% constraint, a slow-up fast-down approach, or similar approach; c) SPR values ranging from 35% to 52%.	**Completed** Results of simulations are presented in document IPHC-2024-MSAB020-06.
MSAB019–Req.3 (para 40)	**RECALLING** paragraph 39 item a) the MSAB **REQUESTED** the Secretariat and SRB develop empirical rule options using the following possible sources of data: a) A static coastwide TCEY determined from the stock assessment; b) FISS O32 WPUE; c) Incorporation of commercial and FISS age data with FISS O32 WPUE	**In progress** Empirical rules continue to be developed.

Action No.	Description	Update
MSAB019–Req.4 (para 42)	The MSAB **REQUESTED** that the Commission provide guidance on whether and how to incorporate distribution in the MSE simulations. Three potential options are: a) Integrating over multiple distribution procedures; b) Use a single distribution procedure and add uncertainty; c) Use recent years to define percentage of TCEY in each IPHC Regulatory Area and add uncertainty.	**Completed** With the assistance of the SRB, distribution is included in the MSE simulations using a combination of b) and c).
MSAB019–Req.5 (para 47)	The MSAB **REQUESTED** that the Secretariat report performance metrics noted in paragraph 44 and 45 over ten (10) and fifteen (15) year periods.	**Completed** These performance metrics and time-periods are reported in document IPHC-2024-MSAB020-06.
MSAB019–Req.6 (para 54)	The MSAB **REQUESTED** that the SRB and Secretariat work together to consider different ways to incorporate fishery-dependent data into an exceptional circumstance.	**Pending** Will be discussed with the SRB as time allows.
MSAB019–Req.7 (para 56)	The MSAB **REQUESTED** that the Secretariat assist with hosting an ad-hoc working group (in accordance with the MSAB Terms of Reference and Rules of Procedure (Appendix V, Sect. V, para 10), in 2024 to discuss potential management procedures that include adjusting fishing intensity at low spawning biomass, low FISS WPUE, low commercial fishery catch-rates, or low productivity.	**Completed** An informal meeting of the 4th MSAB Ad-Hoc Working Group was held on 18 July 2024. A summary is provided in IPHC-2024-MSAB020-INF01.

Outcomes of the 100th Session Of The IPHC Annual Meeting (AM100) and 2024 Intersessional Decisions

PREPARED BY: IPHC SECRETARIAT (A. HICKS, 24 SEPTEMBER 2024)

PURPOSE

To provide the MSAB with the outcomes of the 100th Session of the IPHC Annual Meeting (AM100) and 2024 intersessional decisions relevant to the mandate of the MSAB.

BACKGROUND

The agenda of the 100th Session of the IPHC Annual Meeting (AM100) included items relevant to the MSAB.

DISCUSSION

During the course of the 100th Session of the IPHC Annual Meeting (AM100) the Commission made one agreement regarding the MSE process. Subsequently, five intersessional decisions (ID003-007) were made on 11 June 2024 that were also relevant to the MSAB (IPHC-CIRCULAR-2024-015). Relevant sections from the report of AM100 and 2024-ID003–ID007 are provided in Appendix A for the MSAB's consideration.

RECOMMENDATION

That the MSAB:

1) **NOTE** paper IPHC-2024-MSAB020-05 which details the outcomes of the 100th Session of the IPHC Annual Meeting (AM100) and 2024 intersessional decisions relevant to the mandate of the MSAB.

APPENDICES

Appendix A: Excerpts from the 100th Session of the IPHC Annual Meeting (AM100) Report (IPHC-2024-AM100-R) and 2024 intersessional decisions 2024-ID003–ID007 (IPHC-CR-2024-015).

APPENDIX A
Excerpt from the 100th Session of the IPHC Annual Meeting (AM100) Report (IPHC-2024-AM100-R) and 2024 intersessional decisions 2024-ID003–ID007

RECOMMENDATIONS

Nil

REQUESTS

Nil

AGREEMENTS

IPHC Management Strategy Evaluation: update

AM100 (para. 53) The Commission **AGREED** to undertake intersessional discussions on the recommendations contained within paper IPHC-2024-AM100-11, and provide further direction to the IPHC Secretariat.

INTERSESSIONAL DECISIONS

IPHC-2024-ID003: The Commission **RECOMMENDED** that:

a) the Secretariat work with the MSAB and SRB to explore a potential new coastwide objective that uses spawning biomass and/or fishery catch-rates to indicate the status of the resource, potentially replacing the current $B_{36\%}$ objective;

b) an ad-hoc working group of the MSAB, to be selected by each Contracting Party, meet in July or August 2024 for this purpose (ref a);

c) the MSAB020 be held virtually in October 2024.

IPHC-2024-ID004: The Commission **RECOMMENDED** that the Secretariat evaluate the following management procedures (MPs) in 2024:

a) Multi-year management procedures along with fishing intensity and multiple empirical rules for non-assessment years;

b) additional management procedures, such as constraints on the interannual change in the TCEY.

IPHC-2024-ID005: The Commission **RECOMMENDED** that the Secretariat work with the SRB to:

a) define exceptional circumstances (events) using information such as FISS observations, biological observations, and new research;

b) recommend the actions to take when an exceptional circumstance occurs;

c) incorporate these elements into the draft harvest strategy policy.

IPHC-2024-ID006: The Commission **RECOMMENDED** that the Secretariat draft a revised harvest strategy policy document that will be reviewed at the IPHC Work Meeting in September 2024 (WM2024):

a) incorporating the outcomes of ID003, ID004 and ID005 for Commission review;

b) clearly identifying the distribution of the TCEY as a component of the decision-making process and not an output of the management procedure.

IPHC-2024-ID007: NOTING that the investigation of FISS design scenarios:

a) is an additional activity of the MSE work;
b) is independent of the harvest strategy policy development;
c) will extend into 2025;
d) will be useful to inform the Commission on management outcomes if implementing reduced FISS designs in the future.

the Commission **RECOMMENDED** that the Secretariat evaluate FISS design scenarios using the MSE framework, as recommended by the SRB.

MSE update on progress in 2024 and development of a revised Harvest Strategy Policy

PREPARED BY: IPHC SECRETARIAT (A. HICKS, I. STEWART, & D. WILSON; 27 SEPTEMBER 2024)

PURPOSE

To provide the Management Strategy Advisory Board (MSAB) with an update on Management Strategy Evaluation (MSE) progress in 2024 and work supporting the development of the harvest strategy policy (HSP).

1 INTRODUCTION

A 2024 MSE workplan was provided by the Commission through intersession decisions ID003 to ID007 (IPHC Circular 2024-015). This included investigating a new objective, evaluating management procedures (MPs), defining exceptional circumstances, drafting a harvest strategy policy, and investigating different FISS design scenarios. Many of these tasks were developed from past MSAB and Scientific Review Board (SRB) recommendations, including recommendations related to MSE work made at the 19th session of the MSAB and the 24th session of the SRB (IPHC-2024-SRB024-R).

This document reports progress on MSE topics and simulations, and how they support the development of a harvest strategy policy.

2 HARVEST STRATEGY POLICY

A Harvest Strategy Policy (HSP) provides a framework for applying a science-based approach to setting harvest levels. At the IPHC, this could be specific to the TCEY for each IPHC Regulatory Area throughout the Convention Area, or it could apply to coastwide decisions, leaving specific allocation among areas and sectors to the decision-making process. Currently, the IPHC has not formally adopted a harvest strategy policy but has set harvest levels under an SPR-based framework with elements adopted at multiple Annual Meetings of the IPHC since 2017.

The MSE work and guidance from the MSAB and SRB have been a very important part of developing the HSP. To move towards formally adopting a HSP at the IPHC in the near term, the SRB recommended separating the coastwide TCEY management procedure (MP) from the distribution procedure.

> **IPHC-2023-SRB023-R, para. 30:** *The SRB **RECOMMENDED** that the Commission consider revising the harvest policy to (i) determine coastwide TCEY via a formal management procedure and (ii) negotiate distribution independently (e.g. during annual meetings). Such separated processes are used in other jurisdictions (e.g. most tuna RFMOs, Mid Atlantic Fishery Management Council, AK Sablefish, etc.).*

The coastwide TCEY determined from the MP in the harvest strategy would be an input into the allocation decision-making process.

Therefore, the IPHC HSP can be divided into two components: management procedure and decision-making (Figure 1). The management procedure is an agreed upon method to determine the coastwide TCEY that best meets all conservation and fishery objectives. The MP must be reproducible and include elements such as how to collect data, how often to conduct a stock assessment, and the fishing intensity (i.e. SPR). A harvest strategy extends the MP to encompass objectives and other procedures such as exceptional circumstances. The harvest strategy policy further includes decision-making, where management may deviate from the outputs of the MP to account for other objectives not considered in the harvest strategy. This may be to modify the coastwide TCEY and/or the distribution of the TCEY to account for economic factors or other current conditions. At the IPHC, the policy component mostly occurs at the Annual Meeting of the IPHC where stakeholder input is considered along with scientific information to determine the coastwide mortality limit and allocations to each IPHC Regulatory Area. Decision-making variability is included in the MSE simulations to ensure that the HSP is robust to all sources of variability and uncertainty.

The MSE work presented here supports the continued development of the harvest strategy policy.

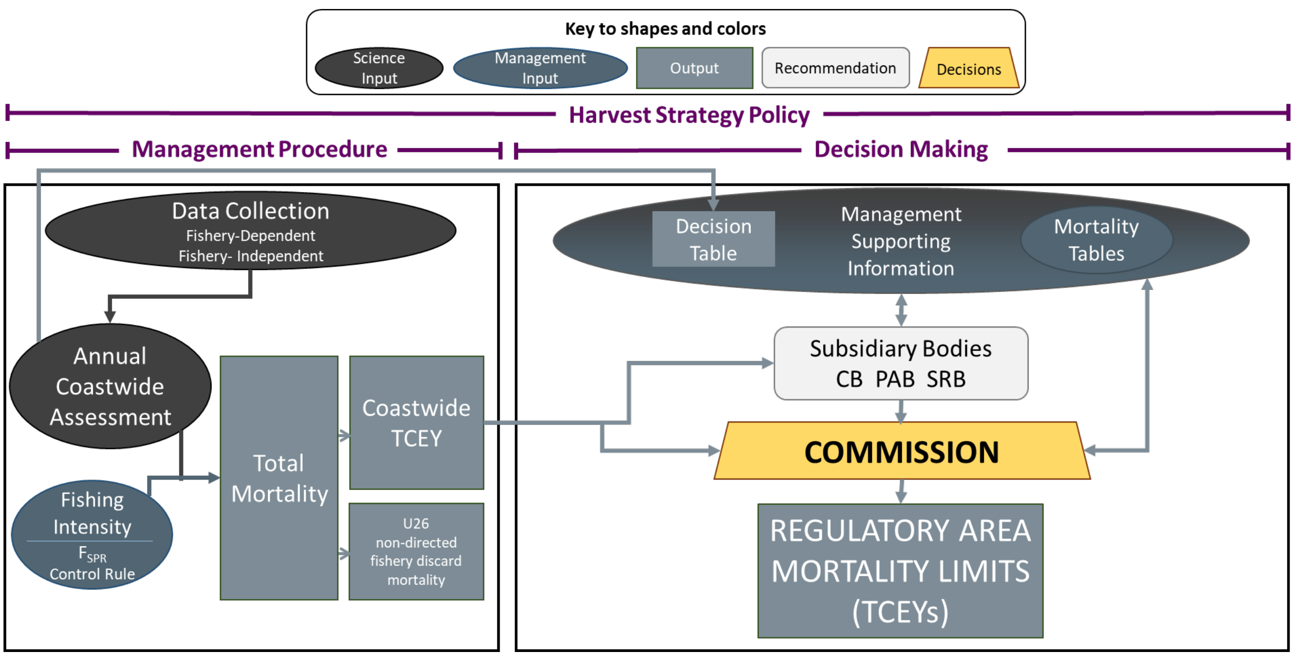

Figure 1. Illustration of the interim harvest strategy policy for the IPHC showing the determination of the coastwide TCEY (the management procedure at the coastwide scale) and the decision-making component that mainly occurs at the Annual Meeting.

2.1 Exceptional Circumstances

An exceptional circumstance is an event that is beyond the expected range of the MSE. Exceptional circumstances, which trigger specific actions to be taken if one is met, define a process for deviating from an adopted harvest strategy (de Moor, Butterworth, and Johnston 2022). It is important to ensure that the adopted harvest strategy is retained unless there are clear indications that the MSE may not be accurate. The IPHC interim harvest strategy policy

(Figure 1) has a decision-making step after the MP, thus the Commission may deviate from an adopted MP as part of the harvest strategy policy. This decision-making variability is included in the MSE simulations.

The Secretariat, with the assistance of the SRB and MSAB, has defined exceptional circumstances and the response that would be initiated, as well as potential triggers in a management procedure that would result in a stock assessment being done (if time allows) in a year that would normally not have one scheduled (e.g. in multi-year MPs). Triggers for an exceptional circumstance have been updated following further discussions with the SRB.

> **IPHC-2024-SRB024-R, para 25**. ***RECALLING*** *paper IPHC-2024-SRB024-03, Appendix A, SRB023-Rec.08 (para. 27), the SRB* ***RECOMMENDED****:*
>
> *a) removing "exceptional circumstance" item c because the expected timeline of stock assessments and OM updates will automatically revise biological parameters and processes;*
>
> *b) removing "exceptional circumstance" item b because:*
>
> - *even though the operating model is an adequate representation of the coastwide dynamics and is useful for development of a coastwide MP, additional work on the regional stock dynamics needs to be done to improve correspondence with regional observations;*
> - *improving estimation of regional stock dynamics is a longer-term project that the Secretariat will continue to work on with input from the SRB;*
> - *as per paragraph 21, the SRB suggests that the annual TCEY distribution should not be included in a MP.*

Therefore, one trigger, using coastwide WPUE or NPUE, for an exceptional circumstance has been defined.

> *The coastwide all-sizes FISS WPUE or NPUE from the space-time model falls above the 97.5th percentile or below the 2.5th percentile of the simulated FISS index for two or more consecutive years.*

The following actions may take place if an exceptional circumstance is declared.

> *a) A review of the MSE simulations to determine if the OM can be improved and MPs should be reevaluated.*
>
> *b) If a multi-year MP was implemented and an exceptional circumstance occurred in a year without a stock assessment, a stock assessment would be completed as soon as possible along with the re-examination of the MSE.*
>
> *c) Consult with the SRB and MSAB to identify why the exceptional circumstance occurred, what can be done to resolve it, and determine a set of MPs to evaluate with an updated OM.*
>
> *d) Further consult with the SRB and MSAB after simulations are complete to identify whether a new MP is appropriate.*

The MSAB was also interested in developing exceptional circumstances using fishery-dependent data.

> **IPHC-2024-MSAB019-R, para. 53:** *The MSAB* ***NOTED*** *that the FISS is conducted to measure the population and that it may not be an accurate depiction of the fishery, and that fishery-dependent data may provide insights into fishery concerns that the FISS may not capture.*

> **IPHC-2024-MSAB019-R, para. 54:** *The MSAB* ***REQUESTED*** *that the SRB and Secretariat work together to consider different ways to incorporate fishery-dependent data into an exceptional circumstance.*

The MSE simulations predict many types of fishery-dependent data (e.g. WPUE, age-compositions) which may be used to develop additional exceptional circumstances. It will be important to delineate between changes in fishery dependant data that should fall within the scope of the MSE predictions and those that may be caused by management actions not reflective of Pacific halibut stock dynamics (e.g. change in catch rates due to avoidance/targeting of other species). The response in these two cases may be different. Further consideration of exceptional circumstances incorporating fishery-dependent data will continue.

Potentially useful fishery-dependent metrics to base an exceptional circumstance on relate to the adopted TCEY or realized fishing mortality. These are important sources of uncertainty to simulate, and using them to define an exceptional circumstance would ensure that the simulations are appropriately capturing future realizations. The SRB made

IPHC-2024-SRB025-R, para. 26: The SRB strongly **RECOMMENDED** against using MSE (a strategic tool) in the annual TCEY setting process. Exceptional circumstances checks (on WPUE and CATCH) are used to judge whether management procedures are generating appropriate recommendations in a given year.

IPHC-2024-SRB025-R, para. 30: The SRB **RECOMMENDED** adopting realised coastwide catch as a fishery-dependent indicator for testing exceptional circumstances. Realised coastwide catch each year can be compared to the projected distribution of future TCEY for that year to determine whether biological or management processes (e.g. decision variability) are leading to unexpected TCEY.

Therefore, a second exceptional circumstance could be:

> *The realized coastwide fishing mortality is above the 97.5th percentile or below the 2.5th percentile of the simulated realized coastwide fishing mortality for two or more consecutive years.*

This exceptional circumstance would capture both the decision-making process and the implementation variability of the fisheries not realizing the exact adopted TCEY.

3 GOALS AND OBJECTIVES

The Commission defined four priority coastwide objectives and associated performance metrics for evaluating MSE simulations.

> **IPHC-2023-AM099-R, para. 76.** *The Commission **RECOMMENDED** that for the purpose of a comprehensive and intelligible Harvest Strategy Policy (HSP), four coastwide objectives should be documented within the HSP, in priority order:*
>
> *a) Maintain the long-term coastwide female spawning stock biomass above a biomass limit reference point (B20%) at least 95% of the time.*
>
> *b) Maintain the long-term coastwide female spawning stock biomass at or above a biomass reference point (B36%) 50% or more of the time.*
>
> *c) Optimise average coastwide TCEY.*
>
> *d) Limit annual changes in the coastwide TCEY*.
>
> **IPHC-2023-AM099-R, para. 77**. *The Commission **AGREED** that the performance metrics associated with the objectives in Paragraph 76 are:*
>
> *a) P(RSB): Probability that the long-term Relative Spawning Biomass (RSB) is less than the Relative Spawning Biomass Limit, failing if the value is greater than 0.05.*
>
> *b) P(RSB<36%): Probability that the long-term RSB is less than the Relative Spawning Biomass Reference Point, failing if the value is greater than 0.50.*
>
> *c) Median TCEY: the median of the short-term average TCEY over a ten-year period, where the short-term is 4-14 years in the future.*
>
> *d) Median AAV TCEY: the average annual variability of the short-term TCEY determined as the average difference in the TCEY over a ten-year period*.

These priority objectives and performance metrics come from a larger list of objectives which includes objectives specific to Biological Regions and IPHC Regulatory Areas (Appendix A).

The SRB recommended reconsidering two of these objectives.

> **IPHC-2024-SRB024-R, para 22**. *The SRB **RECOMMENDED** that the Commission develop a more specific and quantifiable catch objective to replace Objective c) (from AM099–Rec.02) "Optimize average coastwide TCEY".*
>
> **IPHC-2024-SRB024-R, para 23**. *The SRB **RECOMMENDED** that the Commission consider revising Objective b) (from AM099–Rec.02) "Maintain the long-term coastwide female spawning stock biomass at or above a biomass reference point (B36%) 50% or more of the time" to utilise a lower percentile than the 50th (median) to reflect concerns associated with the implications of low CPUE for the fishery at the 36% target for relative spawning biomass. A lower percentile better captures the role of uncertainty in this performance measure.*

The 4th ad hoc meeting of the MSAB met in July to discuss objectives, which is summarized in an informational document for MSAB020 (IPHC-2024-MSAB020-INF01). Some highlights include the following, which will be discussed at MSAB020.

> *10. A management procedure defined as a reference fishing intensity or more conservative would provide flexibility to the Commission to reduce fishing intensity when short-terms trends are of concern.*
>
> *12. The objective "optimize yield" may include reducing interannual variability in yield.*
>
> *13. A new objective may be defined using absolute biomass, commercial catch-rates, or TCEY. However, commercial catch-rates may not be the best option because they are dependent on other factors. TCEY and/or a reference absolute spawning biomass based on what has been observed may be more meaningful, but all have downsides in being a holistic metric. The MSAB should explore these metrics (and possibly FISS WPUE) for use in updating the objectives.*
>
> *14. Evaluating MPs based on performance of the worst conditions (e.g. low productivity regime) may result in avoiding low stock sizes under any conditions.*
>
> *15. Objectives, such as avoiding low stock sizes or low catch-rates, may be met by adding elements to the MP, such as reducing fishing intensity when the SB is below a threshold.*
>
> *17. There is likely a desire to remain above the absolute spawning biomass in 2023 and the tolerance could be 80 or 90%*

The 4th ad hoc meeting of the MSAB discussed the objective "*optimize yield*" and realized that optimizing yield may include multiple factors such as high yields and low interannual variability. Both of these concepts are important objectives and will be discussed at MSAB020.

Much of the discussion at the 4th ad hoc meeting of the MSAB centered around understanding the underlying objectives based on recent decisions to reduce the TCEY from the reference TCEY. This is due to a contrast between the stock status being above 36% (a healthy zone) and a continually declining absolute spawning biomass. The MSAB made a recommendation at MSAB019 to discuss a new objective.

> **IPHC-2024-MSAB019-R, para 51.** ***NOTING*** *paragraph 48, the MSAB* ***RECOMMENDED*** *developing an objective and identifying a management procedure that addresses the current circumstances and differences in perception of the stock status.*

Pacific halibut have seen large changes in average weight-at-age and high variability in recruitment, which have changed the stock dynamics considerably. Figure 2 shows the dynamic unfished spawning biomass, the current spawning biomass, and the RSB since 1993. Dynamic unfished spawning biomass is lower than the late 1990's because weight-at-age has decreased considerably, and dynamic unfished spawning biomass has decreased in recent years because of a recent period of low recruitment. The current spawning biomass trajectory (with fishing) has been stable in recent years, resulting in an increasing RSB. Therefore, the Pacific halibut stock is likely to be above the B_{lim} (20%), B_{trigger} (30%), and B_{thresh} (36%) reference points.

However, the coastwide FISS O32 WPUE and coastwide commercial WPUE has been declining in recent years (Figure 3), causing concern about the absolute stock size and fishery catch-rates. The coastwide FISS index of O32 WPUE was at its lowest value observed in the time-series, declining by 3% from the previous year and coastwide commercial WPUE is also at its lowest value in the recent time-series, declining by 10% from the previous year (and likely more as additional logbook information is obtained). In contrast, the stock assessment for 2023 estimates current stock status (42%, Figure 2) above reference levels and a high probability of further decline in spawning biomass at the reference fishing intensity (SPR=43%). The reference coastwide TCEY of 48.9 Mlbs was projected to result in a greater than 70% chance that the spawning biomass in any of the next three years would be less than the spawning biomass in 2023. The long-term average RSB when fishing consistently at an SPR of 43% is estimated to be near 38%.

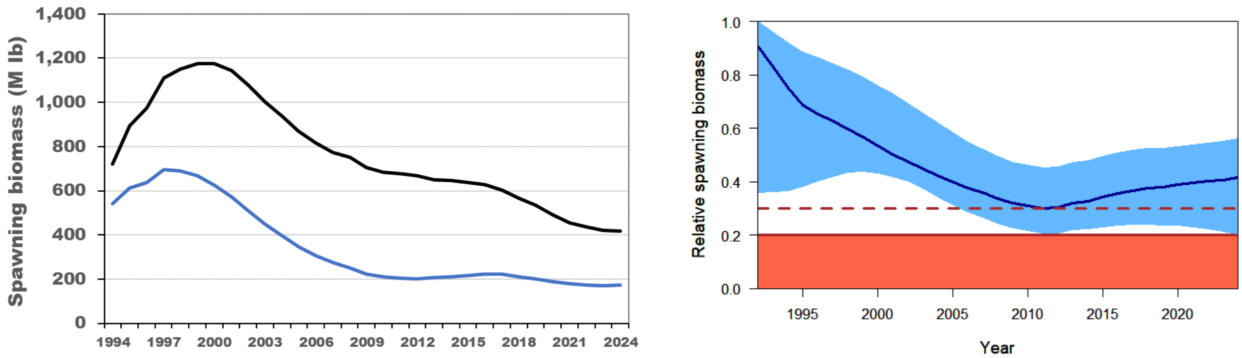

Figure 2. Dynamic unfished spawning biomass (black line) and current spawning biomass (blue line) from the 2023 stock assessment (left) and dynamic relative spawning biomass (right) with an approximate 95% credible interval in light blue and the control rule limit ($B_{20\%}$) and trigger ($B_{30\%}$) in red. Figures from IPHC-2024-SA-01.

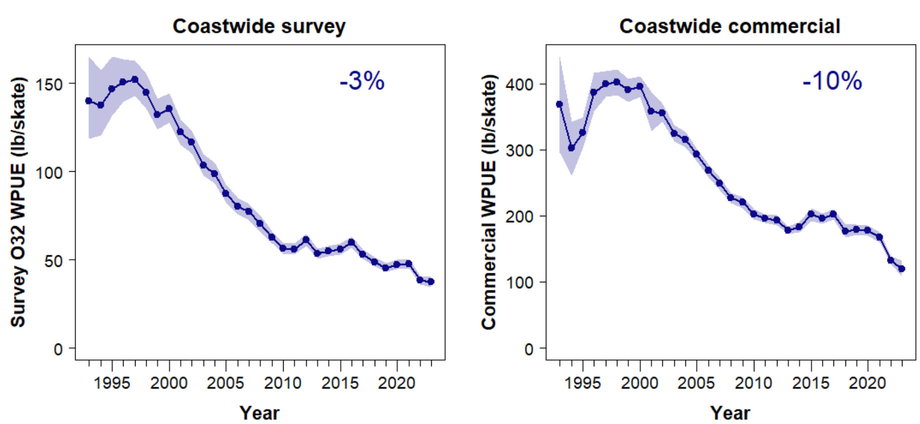

Figure 3. The coastwide FISS O32 WPUE index (left) and coastwide commercial WPUE (right) showing the percent change in the last year (from IPHC-2024-SA-02). Based on past calculations, additional logbooks collected in 2024 will likely further reduce the decline in commercial WPUE to -12%.

Recent Commission decisions (2023 and 2024) have set coastwide TCEYs less than the reference TCEY estimated by the stock assessment and current interim management strategy. Main concerns noted by the Commission include 1) low absolute spawning biomass, 2) low catch-rates in the commercial fishery, 3) high probability of decline in absolute spawning biomass at a fishing mortality above 39 Mlbs, and 4) a large amount of uncertainty in the projections.

The continued departure from the current interim MP and reduction in coastwide TCEY suggests that there may be an additional objective. Related to these concerns, the SRB initially made a recommendation to re-evaluate what they called the target objective (IPHC-2023-SRB023-R, para. 25), followed by the recommendation at SRB024 to further modify this objective (IPHC-2024-SRB024-R, para 23). Most recently, the SRB made the following recommendation.

> **IPHC-2024-SRB025-R, para. 31.** The SRB **RECOMMENDED** adding a measurable objective related to absolute spawning biomass under the general objective 2.1 "maintain spawning biomass at or above a level that optimises fishing activities" to be included in the priority Commission objectives after, or in place of, the current relative biomass threshold objective

Clark and Hare (2006) noted that "[t]he Commission's paramount management objective is to maintain a healthy level of spawning biomass, meaning a level above the historical minimum that last occurred in the mid-1970s." Thompson (1937) stated the following:

> *In actual practice, capital is accumulated in order that interest may be secured from it, and an accumulated stock of fish may also be profitable. The most obvious gain is the greater economy of effort in obtaining a catch from a larger accumulated stock. […] It not only means less effort, but also less time at sea before the catch is landed. (William F. Thompson, International Fisheries Commission, 1937)*

An objective to maintain the absolute spawning biomass above a threshold may be a useful objective for several reasons. First, the level of spawning biomass likely correlates with catch-rates in the fishery, and a higher spawning biomass would likely result in a more efficient and economically viable fishery. Second, current priority conservation objectives use dynamic relative spawning biomass which may result in a low absolute spawning biomass with a satisfactory stock status. Third, a minimum absolute coastwide spawning biomass may be necessary to ensure successful reproduction (such a level is currently unknown for Pacific halibut). Lastly, an observed reference stock level may have concrete meaning to stakeholders. For example, the recent estimated spawning biomass may be near or below the lowest spawning biomass estimated since the mid-1970's and observed fishery catch rates were historically low in 2022 and 2023.

One way to implement this new objective is to continue the use of a limit reference point for relative spawning biomass ($SB_{20\%}$) and add a fishery biomass limit reference point for which dropping below would result in serious hardships to the fishery. The fishery biomass limit reference point could be defined using an absolute metric in units of spawning biomass, fishery CPUE, FISS WPUE, or some other estimable quantity. A fishery limit reference point differs importantly from a fishing intensity limit, where the former is a threshold used to maintain catch-rates and the latter is a threshold used to indicate the potential for overfishing. A fishery absolute spawning biomass limit may also add extra protection for the stock by further reducing the probability of breaching existing limit and threshold reference points. A new objective related to fishery performance could be phrased as:

> Maintain the coastwide female spawning stock biomass (or FISS WPUE or fishery catch-rates) above a threshold.

The metric, the threshold value, and the tolerance for being below that threshold are not obvious choices. Clark and Hare (2006) used the estimated spawning biomass in 1974, which subsequently produced recruitment resulting in an increase in the stock biomass. However, there is a high uncertainty in the estimates of historical absolute spawning biomass before the 1990's. Recent estimates of spawning biomass may be reasonable as they are relevant to concerns of low catch-rates, but it is unknown how and if the stock will quickly recover from this current state.

If an efficient fishery is the objective, then fishery catch-rates may be a reasonable choice for the same reasons listed above for an absolute level of spawning biomass. A subtle difference between catch-rates and spawning biomass are that catch-rates may increase or decrease due to many factors (e.g. improvements in technology, avoidance of non-target species) without a change in spawning biomass.

The Secretariat will summarize all recommendations from the MSAB and SRB related to these objectives and present them to the Commission at the 100th Interim Meeting of the IPHC and the 101st Annual Meeting of the IPHC.

4 MANAGEMENT PROCEDURES

The MSAB made two requests at MSAB020, which coincides with SRB and Commission recommendations, providing guidance on management procedures (MPs) to evaluate. The investigation of these MPs will support the development of the harvest strategy policy.

> **IPHC-2024-MSAB019-R, para. 39**. *The MSAB **REQUESTED** that the evaluation of annual, biennial, and triennial assessments include, but is not limited to, the following concepts.*
>
> - *Annual changes in the coastwide TCEY is driven by an empirical rule in non-assessment years of a multi-year MP;*
> - *A constraint on the coastwide TCEY to reduce inter-annual variability and the potential for large changes in every year or only assessment years. This may be a 10%, 15%, or 20% constraint, a slow-up fast-down approach, or similar approach;*
> - *SPR values ranging from 35% to 52%.*
>
> **IPHC-2024-MSAB019-R, para. 40**. ***RECALLING** paragraph 39 item a) the MSAB **REQUESTED** the Secretariat and SRB develop empirical rule options using the following possible sources of data:*
>
> - *A static coastwide TCEY determined from the stock assessment;*
> - *FISS O32 WPUE;*
> - *Incorporation of commercial and FISS age data with FISS O32 WPUE.*

Elements of MPs that were evaluated included assessment frequency, the empirical rule for non-assessment years, fishing intensity, and constraints on the interannual change in the TCEY. Additionally, different FISS designs were simulated to evaluate the impacts of reduced sampling including eliminating non-core areas. Distribution of the TCEY to IPHC Regulatory Areas is not under evaluation and is implemented as a source of variability, as described below.

4.1 Distribution of the TCEY

The distribution of the TCEY to IPHC Regulatory Areas is a necessary part of the harvest strategy but is not a part of the management procedure currently being evaluated. Therefore, the distribution of the TCEY is a source of uncertainty in the MSE simulations. In the past, five distribution procedures spanning a range including recent Commission decisions were integrated into the simulations.

For these simulations, we implemented the approach recommended by the SRB.

> **IPHC-2024-SRB024-R, para 24**. ***NOTING*** *that the Operating Model (OM) requires a distribution of harvest across the IPHC Regulatory Areas even though distribution of the TCEY is not a recommended part of the MP, the SRB* ***RECOMMENDED*** *capturing uncertainty in future TCEY distribution via the approach described in IPHC-2024-SRB024-07, where the TCEY is distributed similar to what is done annually as part of the decision table construction process in the stock assessment.*

We used the observed distribution of the TCEY in recent years to define the simulated percentage of TCEY in each IPHC Regulatory Area. For the last six years, the TCEY in IPHC Regulatory Area 2A has been 1.65 M lbs (Table 1). Over the last twelve years, the adopted TCEY in IPHC Regulatory Area 2B has ranged from 17.1% to 20.8% of the coastwide TCEY with the three most recent years equal to 18.3% and no relationship with the coastwide TCEY (Table 2 and Figure 4).

Table 1. Adopted TCEYs (millions of pounds) for each IPHC Regulatory Area from 2013 to 2024.

Year	2A	2B	2C	3A	3B	4A	4B	4CDE	Total
2013	1.11	7.78	5.02	17.07	5.87	2.43	1.93	4.28	45.48
2014	1.11	7.64	5.47	12.05	3.73	1.56	1.49	3.58	36.65
2015	1.06	7.91	6.2	13.00	3.72	1.96	1.53	4.27	39.63
2016	1.26	8.24	6.54	12.75	3.41	1.95	1.37	4.07	39.59
2017	1.47	8.32	7.04	12.96	3.98	1.80	1.34	3.84	40.74
2018	1.32	7.10	6.34	12.54	3.27	1.74	1.28	3.62	37.21
2019	1.65	6.83	6.34	13.5	2.90	1.94	1.45	4.00	38.61
2020	1.65	6.83	5.85	12.2	3.12	1.75	1.31	3.9	36.60
2021	1.65	7.00	5.80	14.00	3.12	2.05	1.40	3.98	39.00
2022	1.65	7.56	5.91	14.55	3.90	2.10	1.45	4.10	41.22
2023	1.65	6.78	5.85	12.08	3.67	1.73	1.36	3.85	36.97
2024	1.65	6.47	5.79	11.36	3.45	1.61	1.25	3.7	35.28

Table 2. Adopted percentage of the coastwide TCEY (millions of pounds) for each IPHC Regulatory Area from 2013 to 2024.

Year	2A	2B	2C	3A	3B	4A	4B	4CDE
2013	2.4%	17.1%	11.0%	37.5%	12.9%	5.3%	4.2%	9.4%
2014	3.0%	20.8%	14.9%	32.9%	10.2%	4.3%	4.1%	9.8%
2015	2.7%	20.0%	15.6%	32.8%	9.4%	4.9%	3.9%	10.8%
2016	3.2%	20.8%	16.5%	32.2%	8.6%	4.9%	3.5%	10.3%
2017	3.6%	20.4%	17.3%	31.8%	9.8%	4.4%	3.3%	9.4%
2018	3.5%	19.1%	17.0%	33.7%	8.8%	4.7%	3.4%	9.7%
2019	4.3%	17.7%	16.4%	35.0%	7.5%	5.0%	3.8%	10.4%
2020	4.5%	18.7%	16.0%	33.3%	8.5%	4.8%	3.6%	10.7%
2021	4.2%	17.9%	14.9%	35.9%	8.0%	5.3%	3.6%	10.2%
2022	4.0%	18.3%	14.3%	35.3%	9.5%	5.1%	3.5%	9.9%
2023	4.5%	18.3%	15.8%	32.7%	9.9%	4.7%	3.7%	10.4%
2024	4.7%	18.3%	16.4%	32.2%	9.8%	4.6%	3.5%	10.5%

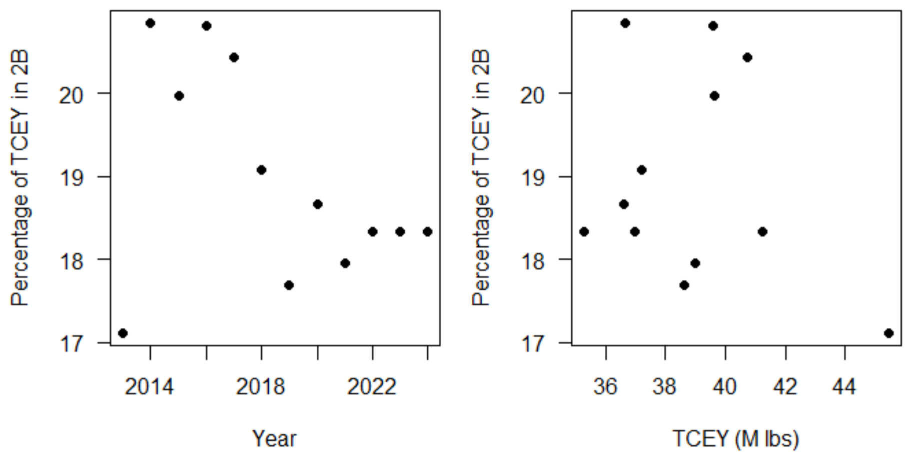

Figure 4. The percentage of the coastwide TCEY in IPHC Regulatory Area 2B plotted against year (left) and the coastwide TCEY (right).

The simulated distribution of the TCEY to IPHC Regulatory Areas 2A and 2B was therefore simply 1.65 Mlbs for 2A and a randomly drawn percentage from a triangle distribution with percentages ranging from 17% to 21% for 2B with the mode of the distribution at 18.3%. The simulated TCEY in IPHC Regulatory Areas in Alaska was distributed after the TCEY had been distributed to IPHC Regulatory Areas 2A and 2B. A year was randomly sampled, and the observed percentages in only Alaskan areas were used (Table 3).

Table 3. Percentage of the adopted TCEY for Alaskan IPHC Regulatory Areas only in each Alaskan IPHC Regulatory Area. IPHC Regulatory Areas 2A and 2B are omitted.

Year	2C	3A	3B	4A	4B	4CDE
2013	13.7%	46.6%	16.0%	6.6%	5.3%	11.7%
2014	19.6%	43.2%	13.4%	5.6%	5.3%	12.8%
2015	20.2%	42.4%	12.1%	6.4%	5.0%	13.9%
2016	21.7%	42.4%	11.3%	6.5%	4.6%	13.5%
2017	22.7%	41.9%	12.9%	5.8%	4.3%	12.4%
2018	22.0%	43.6%	11.4%	6.0%	4.4%	12.6%
2019	21.0%	44.8%	9.6%	6.4%	4.8%	13.3%
2020	20.8%	43.4%	11.1%	6.2%	4.7%	13.9%
2021	19.1%	46.1%	10.3%	6.8%	4.6%	13.1%
2022	18.5%	45.5%	12.2%	6.6%	4.5%	12.8%
2023	20.5%	42.3%	12.9%	6.1%	4.8%	13.5%
2024	21.3%	41.8%	12.7%	5.9%	4.6%	13.6%

4.2 Assessment frequency and an empirical management procedure

The frequency of conducting the stock assessment is a priority element of the MP to be investigated. This includes conducting assessments annually (every year), biennially (every second year), or triennially (every third year) to determine the status of the Pacific halibut stock and the coastwide TCEY for that year. In years with no assessment, the coastwide TCEY would be determined using a simpler approach and the estimated status of the stock would not be updated.

The mortality limits in a year with a stock assessment can be determined as specified by previous defined MPs (i.e. SPR-based approach), and in years without a stock assessment, the mortality limits would need an alternative approach. There are many different empirical rules that could be applied to determine the coastwide TCEY in non-assessment years and two have been previously identified for evaluation.

a. A multi-year TCEY set constant until a stock assessment is available.
b. Update the coastwide TCEY proportionally to the change in the coastwide FISS O32 WPUE.

Other potential methods to set the TCEY in years without an assessment include, but are not limited to, the following.

a. Update the coastwide TCEY proportionally to the change in the coastwide FISS all-sizes WPUE.
b. Use projected TCEY’s from the stock assessment with the reference SPR and control rule. This method is common among other fisheries management organizations.
c. Incorporate commercial fishery catch-rates into the empirical rule.

Further collaboration between the Secretariat and the SRB to develop empirical rule options will occur in the future.

Another option, currently not being considered, is to use a simple statistical model, tuned to meet the objectives, that would determine the coastwide TCEY. Stock assessments would be completed periodically to update the status of the stock and verify that the management procedure is working appropriately.

4.3 Fishing intensity

The fishing intensity is determined by finding the fishing rate (F) that would result in a defined spawning potential ratio (F_{SPR}). Because the fishing rate changes depending on the stock demographics and distribution of yield across fisheries, SPR is a better indicator of fishing intensity and its effect on the stock than a single F. A range of SPR values between 35% and 52% (the interim reference SPR is currently 43%) were investigated.

4.4 Constraints

One of the priority objectives (Appendix A) is to limit annual changes in the coastwide TCEY. Due to variability in many different processes (e.g. population, estimation, and decision making) the interannual variability of the TCEY from MSE simulations is typically higher than 15%. Over the past ten years (2015–2024), the interannual variability (average annual variability or AAV) in the adopted coastwide TCEY was 5.4% and the AAV of the reference coastwide TCEY was 14.5%. Across those years, the percent change in the adopted coastwide TCEY ranged from -10% to 8% and the coastwide reference TCEY ranged from -21% to 29% (Table 4). This was a period of relatively stable spawning biomass and higher variability is expected when the stock is increasing or decreasing.

Decision-making since 2015 has reduced the interannual variability in the coastwide TCEY, compared to the reference. The adopted TCEYs have a smaller range than the reference TCEYs and tend to cluster around 39 million pounds (Figure 5). The adopted TCEYs also tend to be closer to the status quo (i.e. the TCEY from the previous year) than the reference TCEYs when the reference TCEY difference from status quo was not near zero (Table 4 & Figure 5). This is akin to saying the change from one year to the next is less for the adopted TCEYs than the reference TCEYs. The spawning biomass has been relatively stable during the last ten years, and it is not known how the recent decision-making process would react to a rapidly increasing or decreasing spawning biomass. Therefore, decision-making variability was modelled as a normal random process in the OM with a fixed standard deviation of 7Mlbs. This is more variability than recently observed but ensures that the evaluations are robust to potential variability in the future.

This interannual variability in the coastwide reference TCEY can be reduced by adding a constraint in the MP, mimicking recent decision patterns. The MSAB has suggested many different constraints including a 15% constraint on the change in the coastwide TCEY from one year to the next, and a slow-up/fast-down approach (TCEY increases by one-third of the increase suggested by the unconstrained MP or decreases by one-half of the decrease suggested by the unconstrained MP). The MSAB has requested further investigating constraints on the coastwide TCEY.

Table 4. Percent change in the adopted TCEY from the previous year (2015–2024) for each IPHC Regulatory Area and coastwide, and for the coastwide reference TCEY determined from the interim management procedure in place for that year.

Year	2A	2B	2C	3A	3B	4A	4B	4CDE	Coastwide Adopted	Coastwide Reference
2015	-4.5%	3.5%	13.3%	7.9%	-0.3%	25.6%	2.7%	19.3%	8.1%	6.0%
2016	18.9%	4.2%	5.5%	-1.9%	-8.3%	-0.5%	-10.5%	-4.7%	-0.1%	2.3%
2017	16.7%	1.0%	7.6%	1.6%	16.7%	-7.7%	-2.2%	-5.7%	2.9%	7.7%
2018	-10.2%	-14.7%	-9.9%	-3.2%	-17.8%	-3.3%	-4.5%	-5.7%	-8.7%	-20.7%
2019	25.0%	-3.8%	0.0%	7.7%	-11.3%	11.5%	13.3%	10.5%	3.8%	29.0%
2020	0.0%	0.0%	-7.7%	-9.6%	7.6%	-9.8%	-9.7%	-2.5%	-5.2%	-20.3%
2021	0.0%	2.5%	-0.9%	14.8%	0.0%	17.1%	6.9%	2.1%	6.6%	22.3%
2022	0.0%	8.0%	1.9%	3.9%	25.0%	2.4%	3.6%	3.0%	5.7%	5.7%
2023	0.0%	-10.3%	-1.0%	-17.0%	-5.9%	-17.6%	-6.2%	-6.1%	-10.3%	26.0%
2024	0.0%	-4.6%	-1.0%	-6.0%	-6.0%	-6.9%	-8.1%	-3.9%	-4.6%	-5.9%

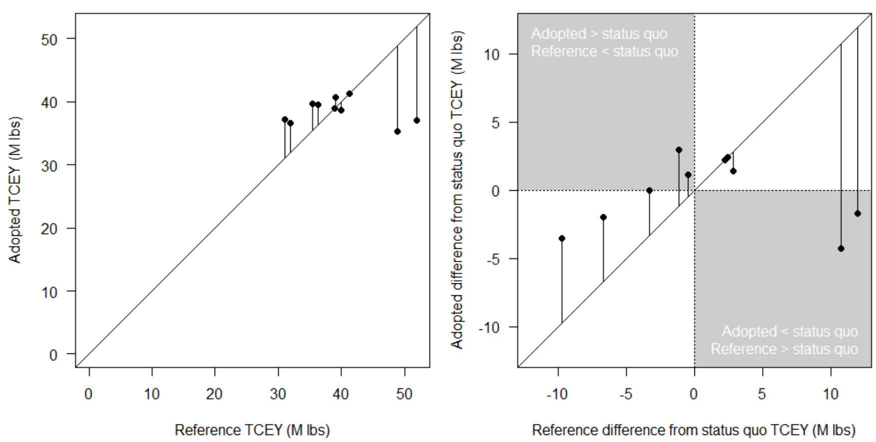

Figure 5. The adopted TCEY vs the reference TCEY (left) and the adopted difference from the status quo TCEY vs the reference difference from the status quo TCEY (right) for the last ten years (2015–2024). The 1:1 line shows when the two are equal. The grey quadrants in the right plot show when the adopted and reference TCEY differences from the status quo are opposite.

Constraints simulated in this round of MSE analyses included the following:

- A maximum 15% change in the coastwide TCEY in either direction from one year to the next.

Additional constraints will be evaluated in the future.

- A maximum 15% change in the coastwide TCEY only when the TCEY is increasing. There is no constraint when the TCEY is decreasing.
- A maximum 20% change in the coastwide TCEY in either direction from one year to the next.
- A weighted average of last year's and the MP's TCEYs.

4.5 FISS designs

An element of the management procedure that can be evaluated is the collection of data from the FISS. The recently implemented FISS design was reduced from the proposed scientific designs in 2022, 2023, and 2024 to maintain revenue neutrality and future reductions may be necessary. The SRB made two recommendations to evaluate FISS designs using the MSE framework:

> **IPHC-2024-SRB024-R, para** 35. *The SRB **REQUESTED** that the Secretariat present preliminary (at SRB025) and final (at SRB026) results of MSE runs with different FISS designs to better understand the actual net cost of the survey after accounting for potential reductions in TCEY associated with the increased uncertainty from reduced FISS designs.*

> **IPHC-2024-SRB024-R, para** 43. *The SRB **REQUESTED** that the Secretariat integrate FISS design considerations into the annual MSE workplan and 5-Year Program of Integrated Research and Monitoring to better quantify the value provided by the FISS.*

There are three sources of variability and uncertainty in the simulations, all of which may be affected by the FISS design.

- **FISS uncertainty** affects the estimates of FISS WPUE and NPUE directly. This is used in the empirical rule and affects the stock assessment estimates. It may have some feedback into decision-making variability.
- **Estimation error** is from the stock assessment and is influenced by FISS uncertainty. Estimation error is also influenced by the variability in the population and fishery-dependent data.
- **Decision-making variability** is the variability resulting from decisions made by the Commission to depart from the MP. This could be affected by bias in the FISS and assessment estimates because the Commission may respond similarly based on the trends they perceive (e.g. autocorrelation in the deviations from the MP). It is possible to correlate decision-making with the FISS estimate, but this may mimic a control rule (i.e. element of the MP) and would conflate the estimation error with the decision-making variability, possibly making performance metrics, such as the probability that the spawning biomass is less than the 2023 spawning biomass, less meaningful. FISS uncertainty is not currently modelled with an effect on decision-making variability.

The MSE framework is capable of examining FISS designs, given the necessary inputs. Projections of estimated uncertainty of FISS O32 WPUE (see document IPHC-2024-SRB024-06) and simulations investigating the outcomes of the stock assessment given different FISS design assumptions (see IPHC-2024-SRB025-06) informed the inputs to the MSE simulations. Unlike the stock assessment simulations, where specific trends in the population are investigated, the MSE simulations have emergent trends influencing uncertainty and bias.

Four FISS designs were simulated, representing increasing observation and assessment error (Table 5). A few simulations assuming no observation error were also included for comparison. The Base FISS design represents an ideal sampling approach with a random selection of stations occurring in all areas. The Base Block FISS design includes sampling in all Biological Regions and IPHC Regulatory Areas each year. It relies on a rotating selection of entire charter regions where individual charter regions are sampled every 1-5 years. The Core FISS design samples charter regions in IPHC Regulatory Areas 2B, 2C, 3A, and 3B every year and other areas are not surveyed. The Reduced Core FISS design samples a subset of higher catch-rate charter regions in areas 2B, 2C, 3A, and 3B. Bias is expected in the Core and Reduced Core FISS designs because some areas are not surveyed. It would not be expected that either of these core designs would be implemented in perpetuity without occasionally surveying other areas.

Table 5. Assumptions of observation and estimation error for four FISS designs.

FISS Design	Frequency	Coastwide WPUE CV	Coastwide WPUE Bias	Assessment Uncertainty	Assessment Bias
Base	Every year	3%	None	15%	None
Base Block	Every year	4%	None	18%	None
Core	2-4 years	6%	Increases annually up to 3%	19%	Increases annually up to 2%
Reduced Core	2-4 years	8%	Increases annually up to 4%	20%	Increases annually up to 2.5%

The Core FISS and Reduced Core FISS designs have additional details in how bias is modelled. Bias is additive depending on the trend in spawning biomass and is halved when a survey is done in non-core areas. When the spawning biomass is large, the survey is more likely to be revenue neutral increasing the ability to survey non-core areas.

Core FISS design

- Frequency
  - When the spawning biomass is less than the spawning biomass in 2020 other areas are surveyed every 5th year and bias is reduced by one-half.
  - When the spawning biomass is greater than the spawning biomass in 2020 other areas are surveyed every 3rd year and bias is reduced by one-half.
- FISS bias
  - Bias depends on recent 3-year coastwide trend and the number of years without a block design surveying non-core areas
    - 0-5%: ±0.5% bias added to current bias. Sign chosen randomly.
    - 5-15%: annual increase of 1% bias opposite direction of trend
    - 15-30%: annual increase of 2% bias opposite direction of trend
    - >30%: annual increase of 3% bias opposite direction of trend
- Assessment bias
  - Bias depends on recent 3-year coastwide trend and the number of years without a block design surveying non-core areas
    - 0-5%: ±0.25% bias added to current bias. Sign chosen randomly.
    - 5-15%: annual increase of 0.5% bias opposite direction of trend
    - 15-30%: annual increase of 1% bias opposite direction of trend
    - >30%: annual increase of 2% bias opposite direction of trend

Reduced Core FISS design

- Frequency
  - When the spawning biomass is less than the spawning biomass in 2020 other areas are surveyed every 5th year and bias is reduced by one-half.
  - When the spawning biomass is greater than the spawning biomass in 2020 other areas are surveyed every 3rd year and bias is reduced by one-half.
- FISS bias
  - Bias depends on recent 3-year coastwide trend and the number of years without a block design surveying non-core areas:
    - 0-5%: ±0.5% bias added to current bias. Sign chosen randomly.
    - 5-15%: annual increase of 2% bias opposite direction of trend
    - 15-30%: annual increase of 3% bias opposite direction of trend
    - >30%: annual increase of 4% bias opposite direction of trend
- Assessment bias
  - Bias depends on recent 3-year coastwide trend and the number of years without a block design surveying non-core areas:
    - 0-5%: ±0.25% bias added to current bias. Sign chosen randomly.
    - 5-15%: annual increase of 0.75% bias opposite direction of trend
    - 15-30%: annual increase of 1.5% bias opposite direction of trend
    - >30%: annual increase of 2.5% bias opposite direction of trend

The MSE analysis of FISS designs will not capture the stakeholder perception and possible lack of confidence in the FISS as a tool for management. FISS observations have been important for the stock assessment, distribution of the TCEY, general understanding of the trends in each IPHC Regulatory Area, and in negotiations of the coastwide and area-specific TCEYs.

4.6 Summary of MSE simulations

The Base Block FISS design was used to compare other elements of the MPs such as assessment frequency, constraints, and depensation (Table 6). Annual, biennial, and triennial assessment frequencies were simulated with an empirical rule proportional to FISS O32 WPUE and for some cases as fixed in non-assessment years. No constraint was contrasted with a constraint on the coastwide TCEY of 15% in both directions (15% u/d) and a 15% constraint only when increasing.

Simulations with the Core and Reduced Core FISS designs were done with only the annual assessment frequency and four levels of fishing intensity from 43% to 52%. Simulations using the Base FISS design and simulations without estimation, observation, and decision-making variability were done only with a fishing intensity of 43%.

Table 6. MSE simulations using the Base Block FISS design and decision-making variability.

Empirical Rule		Proportional to FISS O32			NA	NA	NA
Depensation		None			None	None	δ=2
Constraint		None			15% u/d	15% u	None
Assessment		Annual	Biennial	Triennial	Annual	Annual	Annual
SPR	35						
	40						
	43						
	46						
	49						
	52						

Performance metrics associated with Commission priority objectives are presented and any additional performance metrics of interest are provided. The average annual variability (AAV) performance metric is calculated over 10- and 15-year periods, each starting in year 4 of the projection. All performance metrics and MPs are available on the MSE Explorer.

5 RESULTS

5.1 Assessment frequency, fishing intensity, and constraints

Assessment frequency, different fishing intensities (SPR), and a constraint were simulated assuming a Base Block FISS design with estimation error and decision-making variability. Performance metrics associated with the four priority objectives are shown in Table 7. The probability of being below a relative spawning biomass (RSB) of 36% was similar for each assessment frequency at the same fishing intensity, and an SPR of 40% resulted in an RSB near 36%. The short-term median TCEY increased and the AAV decreased as the assessment frequency increased; this is opposite of the expected pattern that a greater TCEY results in a higher AAV. The AAV was lowest with the triennial assessment frequency but was greater than 15% (a past benchmark defined by the MSAB) for all fishing intensities and assessment frequencies. For the annual and biennial assessment frequencies, the AAV was lowest (but above 22%) for a fishing intensity of 46% and increased with lower and higher fishing intensities. This may be a consequence of how decision-making variability was modelled (i.e. constant standard deviation).

Additional performance metrics provide insight into the variability in the TCEY from the biennial and triennial assessment frequencies (Table 8). The AAV calculated over a 15-year period was similar to the AAV calculated over a 10-year period. The probability that the annual change (AC) was greater than 15% for 3 year or more years increase for a 15-year period because there were more chances for the AC to be greater than 15%. The maximum change in a 10-year period was reported as the absolute change in the TCEY (in millions of pounds) and increased from Annual to Triennial assessment frequencies and higher fishing intensities. The mean maximum duration of the AC less than 15% (i.e. the run of years where the TCEY changed by less than 15%) was near 3 years and increased with less frequent assessments. A less frequent assessment resulted in lower average variability and more often the changes in the TCEY was less than a 15% change from the previous year. However, occasionally, a less frequent assessment had a larger change than an annual assessment, suggesting that the biennial and triennial MPs may have to make a correction when an assessment is done. The choice of assessment frequency depends on the trade-off between a lower average variability over a range of years vs. the chance of a slightly larger absolute change in the TCEY. Lastly, there is a greater than 25% chance that the spawning biomass is less than the spawning biomass in 2023 when fishing at an SPR=40% and a near 20% chance when fishing at an SPR=49% in the long-term. These probabilities increase to 51% and 34% in the short-term.

Table 7. Performance metrics associated with priority objectives for various fishing intensities (SPR) and an annual, biennial, or triennial assessment with an empirical rule proportional to FISS O32 WPUE used to determine the TCEY in non-assessment years. All simulations assumed the Base Block FISS design, estimation error, and decision-making variability. No constraints are applied to the interannual change in the TCEY. Relative spawning biomass (RSB) performance metrics are long-term and yield based performance metrics (TCEY and AAV) are short-term metrics.

Assessment Frequency	**Annual**				
SPR	**40**	**43**	**46**	**49**	**52**
P(RSB<20%)	<0.001	<0.001	<0.001	<0.001	<0.001
P(RSB<36%)	0.4534	0.2466	0.0896	0.0144	0.0012
Median TCEY	64.26	60.11	56.08	52.03	47.87
AAV	25.3%	24.2%	23.5%	23.5%	23.7%
Assessment Frequency	**Biennial**				
SPR	**40**	**43**	**46**	**49**	**52**
P(RSB<20%)	<0.001	<0.001	<0.001	<0.001	<0.001
P(RSB<36%)	0.4638	0.2912	0.1294	0.0400	0.0066
Median TCEY	64.96	60.38	56.28	52.27	48.17
AAV	23.3%	22.6%	22.5%	22.8%	23.5%
Assessment Frequency	**Triennial**				
SPR	**40**	**43**	**46**	**49**	**52**
P(RSB<20%)	<0.001	<0.001	<0.001	<0.001	<0.001
P(RSB<36%)	0.4734	0.2870	0.1338	0.0526	0.0094
Median TCEY	65.50	60.46	56.96	53.57	49.11
AAV	20.7%	20.2%	20.0%	20.5%	21.0%

Table 8. Additional performance metrics for various fishing intensities (SPR) and an annual, biennial, or triennial assessment with an empirical rule proportional to FISS O32 WPUE used to determine the TCEY in non-assessment years. All simulations assumed the Base Block FISS design, estimation error, and decision-making variability. No constraints are applied to the interannual change in the TCEY. All performance metrics are short-term with 10-year being 4-13 years and 15-years being 4-18 years into the projection period.

Assessment Frequency	**Annual**				
SPR	**40**	**43**	**46**	**49**	**52**
Long-term P(SB < SB_{2023})	0.308	0.272	0.230	0.196	0.164
Short-term P(SB < SB_{2023})	0.490	0.428	0.362	0.316	0.282
AAV 10-year	25.3%	24.2%	23.5%	23.5%	23.7%
AAV 15-year	26.4%	24.5%	23.9%	24.0%	24.6%
P(AC3>15%) 10-year	0.992	0.988	0.986	0.988	0.986
P(AC3>15%) 15-year	1.000	1.000	1.000	1.000	1.000
Max Change (10-yr, absolute Mlbs)	47.7	40.3	36.1	32.7	30.2
Mean Max Duration < 15% AC (10-yr)	2.53	2.55	2.52	2.48	2.45
Assessment Frequency	**Biennial**				
SPR	**40**	**43**	**46**	**49**	**52**
Long-term P(SB < SB_{2023})	0.322	0.278	0.248	0.212	0.168
Short-term P(SB < SB_{2023})	0.488	0.442	0.372	0.322	0.288
AAV 10-year	23.3%	22.6%	22.5%	22.8%	23.5%
AAV 15-year	23.0%	22.9%	22.4%	22.6%	22.7%
P(AC3>15%) 10-year	0.972	0.980	0.978	0.974	0.976
P(AC3>15%) 15-year	0.998	1.000	1.000	0.996	0.996
Max Change (10-yr, absolute Mlbs)	48.2	42.6	38.5	34.9	32.5
Mean Max Duration < 15% AC (10-yr)	3.00	3.02	2.95	2.84	2.79
Assessment Frequency	**Triennial**				
SPR	**40**	**43**	**46**	**49**	**52**
Long-term P(SB < SB_{2023})	0.316	0.282	0.232	0.202	0.172
Short-term P(SB < SB_{2023})	0.510	0.484	0.394	0.340	0.292
AAV 10-year	20.7%	20.2%	20.0%	20.5%	21.0%
AAV 15-year	23.0%	21.6%	21.6%	21.7%	22.0%
P(AC3>15%) 10-year	0.914	0.906	0.926	0.932	0.940
P(AC3>15%) 15-year	0.988	0.986	0.986	0.992	0.992
Max Change (10-yr, absolute Mlbs)	49.5	43.8	40.4	37.8	34.6
Mean Max Duration < 15% AC (10-yr)	3.26	3.29	3.31	3.22	3.12

Results with no observation error, no estimation error, and no decision-making variability show a slightly higher median TCEY and a much lower AAV (Table 9). Some variability remains in the interannual change in the TCEY due to the annual assessment tracking changes in the population. However, the AAV was near 12% for the biennial and triennial assessment frequencies because the TCEY is proportional to the FISS O32 WPUE which is a different demographic of the population than is tracked using SPR, and when the assessment occurred it resulted in a large correction to maintain the SPR. Using all sizes FISS WPUE may result in a reduced AAV for biennial and triennial assessment frequencies.

Table 9. Performance metrics for an SPR of 43% and an annual, biennial, or triennial assessment with an empirical rule proportional to FISS O32 WPUE used to determine the TCEY in non-assessment years. All simulations assumed **no observation error**, **no estimation error**, and **no decision-making variability**. No constraints are applied to the interannual change in the TCEY. Relative spawning biomass (RSB) performance metrics are long-term and yield based performance metrics (TCEY and AAV) are short-term metrics.

Empirical Rule	**Fixed**		**FISS O32 WPUE**
Assessment Frequency	**Annual**	**Triennial**	**Triennial**
P(RSB<20%)	<0.001	<0.001	<0.001
P(RSB<36%)	0.2438	0.2728	0.2652
Median TCEY	60.34	60.23	61.69
AAV 10-year	6.2%	4.7%	12.0%
AAV 15-year	6.1%	5.1%	11.4%
P(AC3>15%) 10-year	0.176	0.108	0.606
P(AC3>15%) 15-year	0.216	0.360	0.790
Max Change (10-yr, absolute Mlbs)	10.7	17.8	22.2
Mean Max Duration < 15% AC (10-yr)	11.62	8.50	6.50

Including a constraint of 15% when the TCEY goes up or down in the MP reduced the AAV, but the AAV remained above 15% with decision-making variability (Table 10). With a constraint, the median TCEY was less, resulting in a smaller probability of the RSB being less than 36%. The 15% constraint resulted in a lower potential range of TCEYs with the 5th percentile of the TCEY as low as 14.7 M lbs (Figure 6).

Without decision-making variability, the AAVs were less for the annual and triennial assessment frequencies and the median TCEY was slightly larger (Table 10). However, the AAVs remained above 15% due to observation and assessment error.

Table 10. Performance metrics associated with priority objectives for an SPR of 43%, a triennial assessment without a constraint, an annual assessment with and without a 15% constraint on the change in the TCEY, and with and without decision-making variability. All simulations assumed the Base Block FISS design. Relative spawning biomass (RSB) performance metrics are long-term and yield based performance metrics (TCEY and AAV) are short-term metrics.

	Annual	**Triennial**	**Annual**	**Annual**	**Triennial**	**Annual**	**Annual**
Decision-making variability	**No**	**No**	**No**	**Yes**	**Yes**	**Yes**	**Yes**
Constraint	**None**	**None**	**15% up/down**	**None**	**None**	**15% up/down**	**15% up**
P(RSB<20%)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
P(RSB<36%)	0.2420	0.2634	0.0564	0.2466	0.2870	0.0506	0.0528
Median TCEY	59.92	61.00	52.30	60.11	60.46	49.51	51.55
AAV	20.8%	17.2%	14.5%	24.2%	20.2%	16.6%	16.7%

Overall, the range of SPR values investigated and the three assessment frequencies met the conservation objective and the objective to remain above an RSB of 36% at least 50% of the time. The TCEY increased with higher fishing intensity and was slightly higher with a longer interval between assessments. The interannual variability in the TCEY was greater than 15% but lowest with a triennial assessment frequency. The triennial assessment frequency showed potential increases in the TCEY but larger potential change in an assessment year. AAV was lowest with an SPR between 43% and 46%, and unexpectedly increased at lower fishing intensities, which is likely due to decision-making variability.

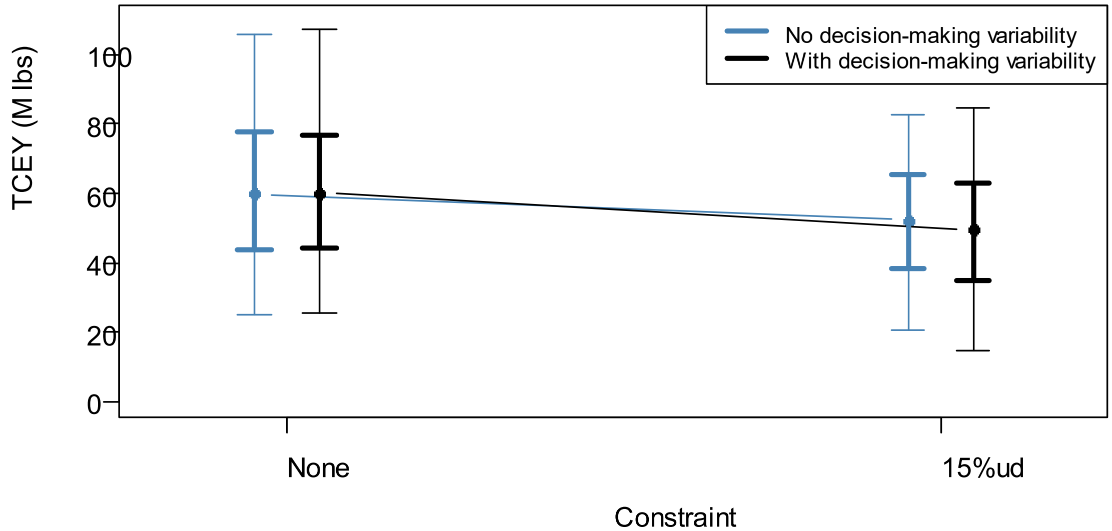

Figure 6. The TCEY (M lbs) for simulations with and without a constraint (15% maximum change up or down) and with and without decision-making variability. All simulations assumed the Base Block FISS design, an annual assessment, and an SPR of 43%. Light whiskers show the 5-95% interval, dark whiskers the 25-75% interval and the dot the median.

5.2 FISS Designs

The three FISS designs were compared across multiple fishing intensities, but with the annual assessment frequency only. Decision-making variability was present in all simulations.

The conservation objective of remaining above an RSB of 20% was met for all fishing intensities and FISS designs (Table 11). The probability that the RSB was less than 36% decreased with the reduced FISS designs, indicating that the population size was slightly larger when the non-core areas were not sampled. This occurred because the median TCEY was less when using the Core FISS design compared to the Base Block FISS design and was less again when using the Reduced Core FISS design compared to the Core FISS design. The AAV increased with the Core and Reduced Core FISS designs (Figure 7).

With an SPR of 43%, the median TCEY declined by 450,000 lbs moving to the Core FISS design from the Base Block FISS design, and another 450,000 lbs moving to the Reduced Core FISS design. At $6.00/lb, a 450,000 lb drop in the TCEY would equate to a $2.7 million reduction in economic value. A similar drop occurred for an SPR of 52%. This metric includes the long-term, multi-year result where a reduction in the TCEY may provide fish for future years to spawn or be caught at a larger size. This may be why this value is less than the value determined from the stock assessment simulation results reported in document IPHC-2024-SRB025-06. As also discussed in document IPHC-2024-SRB025-06, there is a non-economic value to the FISS in that it is used for decision-making, comparisons, and to have a better understanding of the population trends.

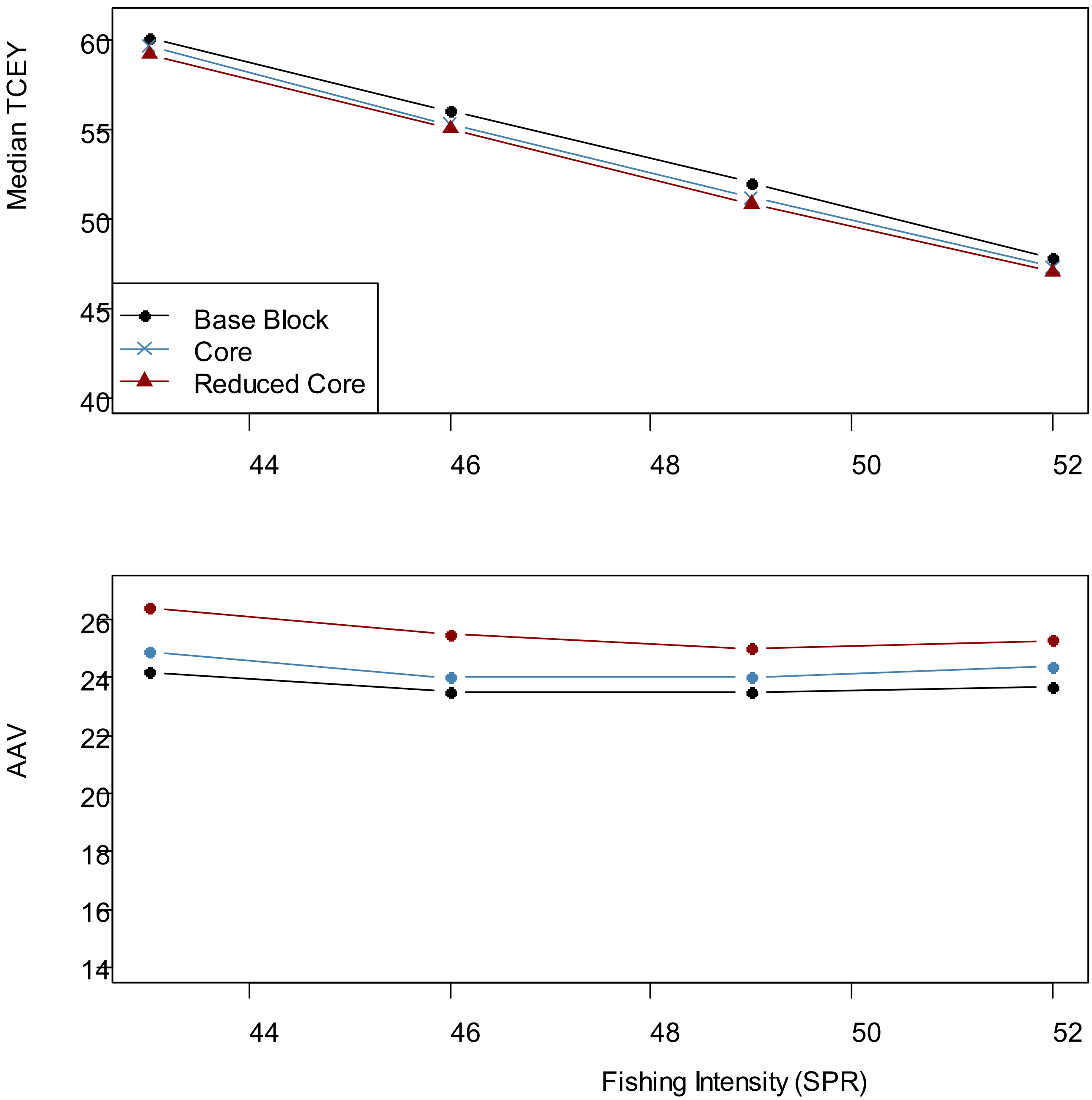

Figure 7. Median TCEY (top) and AAV (bottom) for different fishing intensities (SPR) and FISS designs.

Table 11. Performance metrics associated with priority objectives for various fishing intensities (SPR) and different FISS designs. All simulations assumed an annual assessment and decision-making variability. No constraints were applied to the interannual change in the TCEY. Relative spawning biomass (RSB) performance metrics are long-term and yield based performance metrics (TCEY and AAV) are short-term metrics.

FISS design	**Base Block**			
SPR	**43%**	**46%**	**49%**	**52%**
P(RSB<20%)	<0.002	<0.002	<0.002	<0.002
P(RSB<36%)	0.2466	0.0896	0.0144	0.0012
Median TCEY	60.11	56.08	52.03	47.87
AAV	24.2%	23.5%	23.5%	23.7%
FISS design	**Core**			
SPR	**43%**	**46%**	**49%**	**52%**
P(RSB<20%)	<0.002	<0.002	<0.002	<0.002
P(RSB<36%)	0.2308	0.0856	0.0164	0.0010
Median TCEY	59.66	55.30	51.23	47.32
AAV	24.9%	24.0%	24.0%	24.4%
FISS design	**Reduced Core**			
SPR	**43%**	**46%**	**49%**	**52%**
P(RSB<20%)	<0.002	<0.002	<0.002	<0.002
P(RSB<36%)	0.2256	0.0860	0.0180	0.0012
Median TCEY	59.21	55.10	50.88	47.07
AAV	26.4%	25.5%	25.0%	25.3%

6 DEPENSATION STRESS TEST

6.1 A background on depensation

The Pacific halibut population has shown a high amount of variability in spawning biomass over 100 years of commercial fishing, sometimes increasing to high levels quickly after a low period. However, if a population experiences a very low number of spawners, it may have reduced reproductive success. Depensation occurs if the per-capita rate of growth decreases as the density or abundance decreases to low levels (Liermann and Hilborn 2001). In other words, it is inverse density dependence at low population sizes (reduced spawning potential) and is also referred to as the Allee effect (Dennis 2002).

There are many mechanisms that may result in depensation (Liermann and Hilborn 2001), such as increased adult mortality observed in Northwest Atlantic cod (*Gadus morhua*) stocks (Kuparinen and Hutchings 2014). It is not known if Pacific halibut may experience depensation, but MSE is a useful tool to examine the effects on the population and management outcomes if depensation was present. The SRB recommended examining the effects of possible depensation in the Pacific halibut stock using the MSE framework.

> **IPHC-2024-SRB024-R, para** 29. *The SRB* ***NOTED*** *the analysis of depensation presented in paper IPHC-2024-SRB024-07, and* ***RECOMMENDED****:*
>
> *a) fitting a depensatory stock-recruitment model to estimate the depensation parameter value;*

b) operating model stress tests in the MSE with and without depensation across a range of plausible fishing intensities.

The stock-recruitment elements of the operating model were updated to allow for a depensation parameter following Liermann and Hilborn (1997).

$$R_t = \frac{\alpha S^\delta}{\beta^\delta + S_t^\delta}$$

where R_t is the number of recruits at time t, S_t is the spawning biomass at time t, α is the maximum number of predicted recruits (asymptote), β is the level of spawners that produces $\alpha/2$ recruits, and δ is the depensation parameter. A value greater than 1 for δ indicates depensation. The Pacific halibut stock assessment (and many other stock assessments from around the world) use the steepness parameterization (Mace and Doonan 1998) and use steepness (h), R_0, and B_0 to calculate the α and β parameters. Steepness is defined as the proportion of unfished recruitment that occurs when the spawning biomass is at 20% of its unfished level. An example Beverton-Holt stock-recruit curve is shown in Figure 8 with these various parameters and concepts labeled.

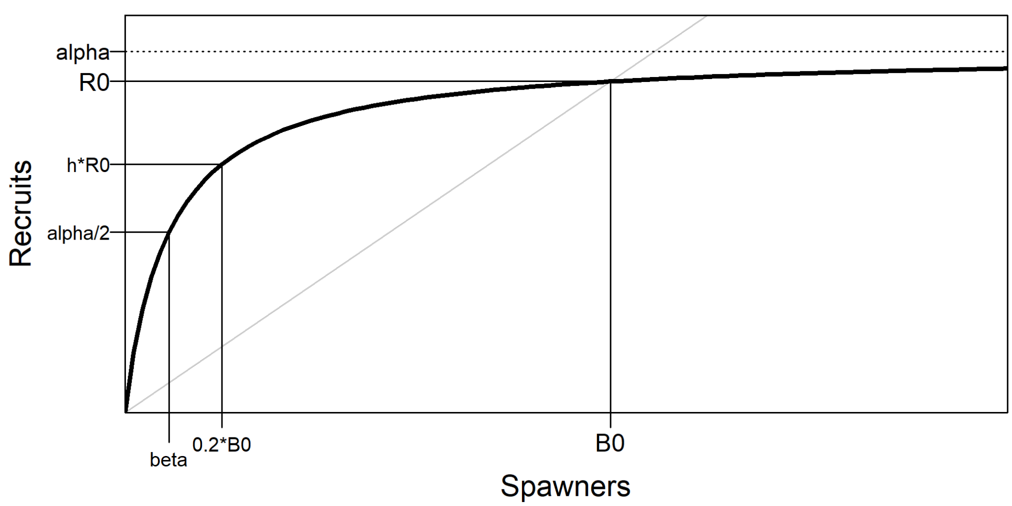

Figure 8. An example Beverton-Holt stock-recruit curve with various parameters and concepts labeled.

Environmental effects may change R_0, which changes the stock-recruit curve. For example, the Pacific halibut stock assessment assumes a steepness of 0.75 and estimates R_0 (and thus B_0) for two different environmental regimes related to periods of low or high Pacific Decadal Oscillation (PDO). Figure 9 shows the estimated Beverton-Holt stock-recruit curves for the two regimes within the two 'long' models of the Pacific halibut stock assessment ensemble.

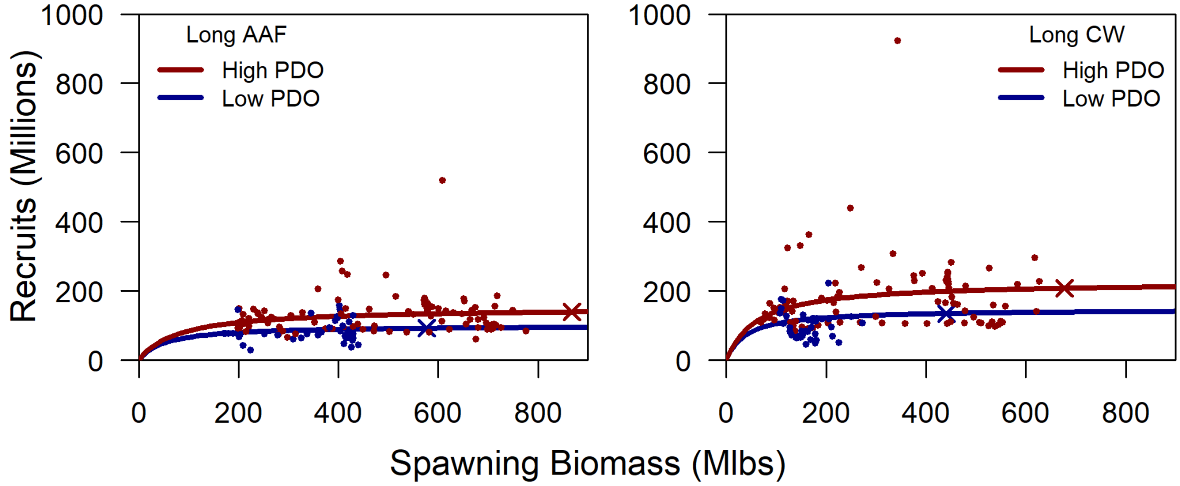

Figure 9. Beverton-Holt stock-recruit curves for two regimes as estimated in the two long models of the stock assessment ensemble. Points are estimated recruits at spawning biomass and the Xs mark the unfished equilibrium R_0 and B_0.

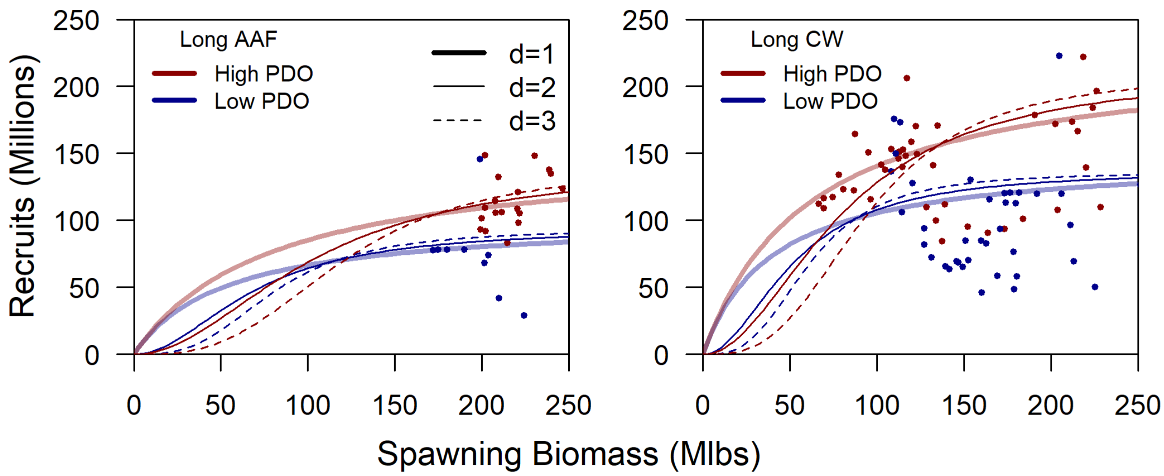

Figure 10. Beverton-Holt stock-recruit curves for the two regimes as estimated in the two long models of the stock assessment ensemble with three different values for depensation. Points are estimated recruits at spawning biomass. Axes have been truncated to focus on the change in the curve at low spawning biomass.

Using the above formulation, depensation with δ at values greater than 1 shows a steepening of the curve at low spawning biomass with a resulting increase in recruits above the curve to meet the consistent R_0.

6.1.1 Estimates of depensation in the Pacific halibut population

Estimates of recruitment and estimates of spawning biomass from the two 'long' models in the 2023 stock assessment ensemble were treated as data in a Beverton-Holt stock-recruit model to estimate three parameters, including depensation.

For each long model (LongAAF and LongCW) three analyses were done: 1) all data were combined into a single analysis to estimate the stock-recruit parameters, 2) only recruits and spawning biomass from years with a positive PDO were used, and 3) only recruits and spawning biomass from years with a negative PDO were used.

From these results, there is not a clear indication of depensation over the observed range of spawning biomass and the value of δ is highly uncertain (Table 12). Analyzing only recruits from high PDO years showed potential depensation, but was uncertain. Low PDO years had fewer observations, especially at low spawning biomass. The uncertainty in the estimate of depensation is due to variable recruitment and the lack of observations at low spawning biomass.

The purpose of this analysis was to determine a reasonable level of depensation for a stress test using the MSE framework. Given no clear indication of depensation, a value of $\delta = 2$ was chosen. Other values may be reasonable but were not tested at this time. Applying depensation only in a specific environmental regime is also possible but was not attempted here because the OM does not change the stock-recruit function in separate environmental regimes, but simply multiplies recruitment by a factor for the high PDO regime. Future improvements to the OM are expected where tested management outcomes with depensation on specific environmental regimes would be appropriate.

Table 12. Estimated depensation parameter for the LongAAF and LongCW model observations combined or separated by PDO regime. The lower and upper 95% confidence interval determined from the likelihood profile is also shown (An NA indicates that the confidence limit could not be determined over the range tested).

Model	Data	Depensation (δ)	Lower	Upper
Long AAF	All	0.35	0.22	1.75
	Positive PDO	4.49	1.35	20.85
	Negative PDO	0.92	NA	NA
Long CW	All	0.36	0.24	0.81
	Positive PDO	2.9	0.70	9.43
	Negative PDO	13	5	29

6.1.2 MSE simulations with depensation

From the investigation of depensation (results reported below) MSE simulations were done using two levels of depensation, three fishing intensities (with a 30:20 control rule), and the base block FISS design (Table 13). Additionally, the highest fishing intensity was simulated without a control rule to increase the realized fishing intensity. Models were not reconditioned by incorporating depensation.

Table 13. Specifications of MSE simulations investigating depensation.

Parameter	Values
Depensation (δ)	$\delta = 1$ or 2
SPR	35%, 43%, 52%
FISS design	Base block

The spawning biomass of Pacific halibut is currently at low values and may be at the lowest values observed historically. However, stock status remains above 30% and the spawning biomass of Pacific halibut has likely remained above levels where depensation can be detected, if present. Therefore, parameterizing depensation in the MSE simulations is largely a theoretical exercise to conduct a “stress-test” and show the potential effects if present.

Including depensation in the OM (δ = 2) resulted in an undetectable difference in long-term performance metrics (Table 14) for all fishing intensities investigated (SPR = 35%, 43%, and 52%). There are two explanations for no effect due to depensation. First, a control rule reduces the fishing intensity when RSB is less than 30%, and sets directed fishery mortality to zero when below 20%. This results in a realized fishing intensity that may be lower than implied by the input SPR, especially at an SPR of 35% (the long-term median realized SPR was 36% with an input SPR of 35%). Second, this control rule reduces the chance that the spawning biomass falls to a low enough level where depensation becomes a concern. However, simulations removing the control rule were still similar for the two levels of depensation (Figure 11).

Table 14. Performance metrics for two different levels of depensation and three fishing intensities.

Depensation	**δ=1**			**δ=2**		
SPR	**35%**	**43%**	**52%**	**35%**	**43%**	**52%**
P(RSB<20%)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
P(RSB<36%)	0.7106	0.2466	0.0012	0.7102	0.2462	0.0012
Median TCEY	71.78	66.55	57.81	71.78	66.55	57.81

This does not conclude that depensation does not occur for Pacific halibut. Depensation may exist, especially below spawning biomass levels lower than have been observed. However, if it does exist, the use of a 30:20 control rule and recent levels of fishing intensity seem to avoid these low spawning biomass levels where depensation would have an effect.

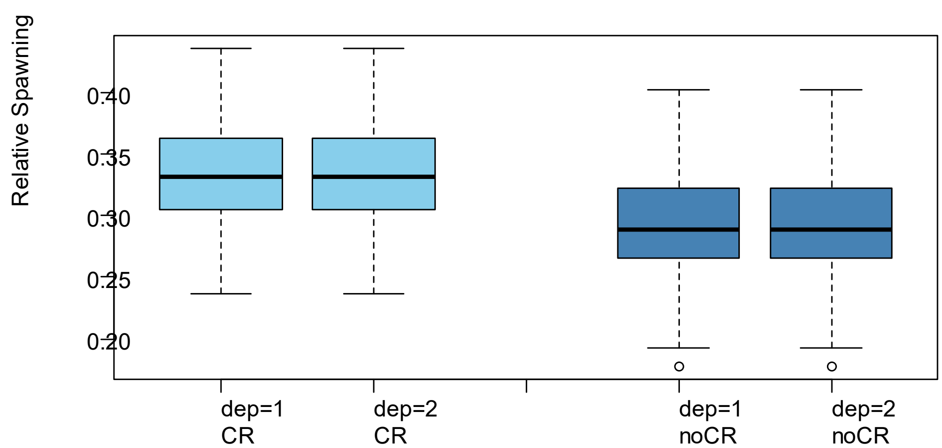

Figure 11. Boxplots of relative spawning biomass using a fishing intensity of SPR=35%, with and without a control rule, and with and without depensation.

7 Conclusions

Three concepts were evaluated using the MSE: assessment frequency along with harvest control rule elements, FISS designs, and depensation. These simulations show that reducing the fishing intensity (i.e. higher SPR) would achieve a higher spawning biomass, slightly lower interannual variability in the TCEY, and move towards a potential new objective of avoiding low absolute spawning biomass. However, yield would be reduced, on average. Biennial and triennial assessments may improve yield and would lower the interannual variability in the TCEY. This would also allow more time to improve assessment and MSE methods, but at the cost of not providing detailed annual information such as stock status. Reducing the FISS to the core areas, and occasionally surveying non-core areas would reduce yield and increase uncertainty and interannual variability in the TCEY. Finally, depensation is likely not a concern for the Pacific halibut stock, given the expected range of fishing intensities.

This work supports the development of the harvest strategy policy (IPHC-2024-MSAB020-07). Next steps include working with the MSAB to recommend updated objectives and endorse the MSE simulation results, and then presenting this work to the Commission along with an updated harvest strategy policy for their endorsement.

Recommendation/s

That the MSAB

1) **NOTE** paper IPHC-2024-MSAB020-06 presenting recent MSE work including exceptional circumstances; goals and objectives; evaluating assessment frequency, a constraint and fishing intensity; investigating the effects of reduced FISS designs; and simulating a scenario with depensation.
2) **RECOMMEND** adding a measurable objective related to absolute spawning biomass under the general objective 2.1 “maintain spawning biomass at or above a level that optimizes fishing activities” to be included in the priority Commission objectives after, or in place of, the current biomass threshold objective.
3) **RECOMMEND** further analyses to support the development of the harvest strategy policy.
4) **REQUEST** any further analyses to be provided to the Commission or at MSAB021.

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APPENDICES

Appendix A: Primary objectives used by the Commission for the MSE

APPENDIX A
PRIMARY OBJECTIVES USED BY THE COMMISSION FOR THE MSE

Table A1. Primary objectives, evaluated over a simulated ten-year period, accepted by the Commission at the 7th Special Session of the Commission (SS07). Objective 1.1 is a biological sustainability (conservation) objective and objectives 2.1, 2.2, and 2.3 are fishery objectives. Priority objectives are shown in green text.

GENERAL OBJECTIVE	MEASURABLE OBJECTIVE	MEASURABLE OUTCOME	TIME-FRAME	TOLERANCE	PERFORMANCE METRIC
1.1. KEEP FEMALE SPAWNING BIOMASS ABOVE A LIMIT TO AVOID CRITICAL STOCK SIZES AND CONSERVE SPATIAL POPULATION STRUCTURE	Maintain the long-term coastwide female spawning stock biomass above a biomass limit reference point ($B_{20\%}$) at least 95% of the time	*B* < Spawning Biomass Limit (B_{Lim}) B_{Lim}=20% unfished spawning biomass	Long-term	0.05	$P(B < B_{Lim})$ PASS/FAIL Fail if greater than 0.05
	Maintain a defined minimum proportion of female spawning biomass in each Biological Region	$p_{SB,2} > 5\%$ $p_{SB,3} > 33\%$ $p_{SB,4} > 10\%$ $p_{SB,4B} > 2\%$	Long-term	0.05	$P\left(p_{SB,R} < p_{SB,R,min}\right)$
2.1 MAINTAIN SPAWNING BIOMASS AT OR ABOVE A LEVEL THAT OPTIMIZES FISHING ACTIVITIES	Maintain the long-term coastwide female spawning stock biomass at or above a biomass reference point ($B_{36\%}$) 50% or more of the time	*B*<Spawning Biomass Reference (B_{Thresh}) B_{Thresh}=$B_{36\%}$ unfished spawning biomass	Long-term	0.50	$P(B < B_{Thresh})$ Fail if greater than 0.5
2.2. PROVIDE DIRECTED FISHING YIELD	Optimize average coastwide TCEY	Median coastwide TCEY	Short-term		*Median* $\overline{TCEY}$
	Optimize TCEY among Regulatory Areas	Median $TCEY_A$	Short-term		*Median* $\overline{TCEY_A}$
	Optimize the percentage of the coastwide TCEY among Regulatory Areas	Median $\%TCEY_A$	Short-term		*Median* $\overline{\left(\frac{TCEY_A}{TCEY}\right)}$
	Maintain a minimum TCEY for each Regulatory Area	Minimum $TCEY_A$	Short-term		*Median Min(TCEY)*
	Maintain a percentage of the coastwide TCEY for each Regulatory Area	Minimum $\%TCEY_A$	Short-term		*Median Min(%TCEY)*
2.3. LIMIT VARIABILITY IN MORTALITY LIMITS	Limit annual changes in the coastwide TCEY	Annual Change (*AC*) > 15% in any 3 years	Short-term		$P(AC_3 > 15\%)$
		Median coastwide Average Annual Variability (AAV)	Short-term		*Median AAV*
	Limit annual changes in the Regulatory Area TCEY	Annual Change (*AC*) > 15% in any 3 years	Short-term		$P(AC_3 > 15\%)$
		Average AAV by Regulatory Area (AAV_A)	Short-term		*Median* AAV_A

$$AAV_t = \frac{\sum_{t+1}^{t+9} |TCEY_t - TCEY_{t-1}|}{\sum_t^{t+9} TCEY_t}$$

$$AC_t = \frac{|TCEY_t - TCEY_{t-1}|}{TCEY_{t-1}}$$

Interim: IPHC Harvest Strategy Policy

PREPARED BY: IPHC SECRETARIAT (A. HICKS, I. STEWART, & D. WILSON; 29 SEPTEMBER 2024)

PURPOSE

To provide the Management Strategy Advisory Board (MSAB) with a draft of the interim Harvest Strategy Policy (HSP).

INTRODUCTION

A draft Harvest Strategy Policy (HSP) has been developed for consideration by the Commission. The HSP provides a framework for applying a consistent and transparent science-based approach to setting mortality limits for Pacific halibut (*Hippoglossus stenolepis*) fisheries throughout the Convention Area while ensuring sustainability of the Pacific halibut population. This draft contains principles developed during the MSE process at IPHC and identifies areas that are incomplete. The Commission will review the HSP at the 100th Session of the Interim Meeting (IM100) and it will be updated as needed.

RECOMMENDATION/S

That the MSAB

1) **NOTE** paper IPHC-2024-MSAB020-07 presenting a draft interim Harvest Strategy Policy.
2) **RECOMMEND** edits to the draft interim Harvest Strategy Policy.

APPENDICES

Appendix A: International Pacific Halibut Commission Interim: Harvest Strategy Policy (2024)

APPENDIX A

INTERNATIONAL PACIFIC HALIBUT COMMISSION

INTERIM: HARVEST STRATEGY POLICY

(2024)

INTERNATIONAL PACIFIC HALIBUT COMMISSION

Commissioners

Canada	United States of America
Paul Ryall	Jon Kurland
Neil Davis	Robert Alverson
Peter DeGreef	Richard Yamada

Executive Director

David T. Wilson, Ph.D.

DISTRIBUTION:
Members of the Commission
IPHC Secretariat

BIBLIOGRAPHIC ENTRY
IPHC 2024. Interim: IPHC Harvest Strategy Policy
IPHC–2024–HSP, 19 pp.

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NOTE: The following is an interim document based on an amalgamation of current IPHC practices and best practices in harvest strategy policy. It is expected that this policy document will then be updated accordingly.

ACRONYMS

CB	Conference Board
HCR	Harvest Control Rule
HSP	Harvest Strategy Policy
IPHC	International Pacific Halibut Commission
LIM	Limit
MEY	Maximum Economic Yield
MP	Management Procedure
MSAB	Management Strategy Advisory Board
MSE	Management Strategy Evaluation
NER	Net Economic Returns
OM	Operating Model
PAB	Processor Advisory Board
RAB	Research Advisory Board
RSB	Relative Spawning Biomass
SB	Spawning Biomass (female)
SPR	Spawning Potential Ratio
SRB	Scientific Review Board
TCEY	Total Constant Exploitable Yield
THRESH	Threshold
U.S.A.	United States of America

DEFINITIONS

A set of working definitions are provided in the IPHC Glossary of Terms and abbreviations: https://www.iphc.int/the-commission/glossary-of-terms-and-abbreviations

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The *IPHC Harvest Strategy Policy* (HSP) provides a framework for applying a consistent and transparent science-based approach to setting mortality limits for Pacific halibut (*Hippoglossus stenolepis*) fisheries throughout the Convention Area while ensuring sustainability of the Pacific halibut population. It defines biological and economic objectives that apply to the development of a harvest strategy for Pacific halibut. It also identifies a management procedure and reference points for use in the harvest strategy to achieve the Commission's stated objectives. This policy, together with the *Protocol amending the Convention between Canada and the United States of America for the preservation of the [Pacific] halibut fishery of the northern Pacific Ocean and Bering Sea (1979)*[1], provides the basis to manage the risk to Pacific halibut fisheries and the Pacific halibut population.

The IPHC is responsible for determining the coastwide mortality limit and the allocation of this limit among eight (8) IPHC Regulatory Areas. The mortality limit in each IPHC Regulatory Area consists of all fishing mortality of all sizes and from all sources, except for discard mortality of under 26-inch (U26) Pacific halibut from non-directed commercial (e.g. trawl) fisheries, which is accounted for at the coastwide level. The distribution of the mortality limit to each sector within an IPHC Regulatory Area is determined by Contracting Party domestic agencies. Therefore, this Harvest Strategy Policy is specific to the mortality limit in each IPHC Regulatory Area, across all sectors (i.e. TCEY).

Being a framework, the harvest strategy policy encompasses the entire process of the management procedure and decision-making process to determine mortality limits as well as other important considerations such as objectives, key principles, and responses to specific events. A harvest strategy, which may also be referred to as a management strategy, is the decision framework necessary to achieve defined biological and economic objectives for Pacific halibut.

> **Management Procedure (MP)**: A formulaic procedure to determine a management outcome (e.g. mortality limit) that has been simulation tested and produces a repeatable outcome.
>
> **Harvest Strategy**: The framework for managing a fish stock, including the MP and objectives.
>
> **Harvest Strategy Policy (HSP)**: The harvest strategy and decision-making process that results in endpoint management outcomes.

A goal of the IPHC Harvest Strategy Policy is the long-term sustainable and profitable use (optimum yield) of Pacific halibut through the implementation of a harvest strategy that maintains the stock at sustainable levels while maximising economic returns. The Commission's current priority objectives to achieve this goal, which may be updated, are to:

- maintain Pacific halibut female spawning biomass, above a female spawning biomass limit where the risk to the stock is regarded as unacceptable (SB_{LIM}), at least 95% of the time;
- maintain Pacific halibut female spawning biomass, at least 50% of the time, at or above a threshold reference (fixed or dynamic) female spawning biomass that optimises fishing activities on a spatial and temporal scale relevant to the fishery;

[1] https://www.iphc.int/uploads/pdf/basic-texts/iphc-1979-pacific-halibut-convention.pdf

- optimise average coastwide yield given the constraints above;
- limit annual changes in the coastwide mortality limit (TCEY) given the constraints above.

The harvest strategy will ensure fishing is conducted in a manner that does not lead to *overfishing*. Overfishing is defined as where the stock is subject to a level of fishing that would move it to an *overfished* state or prevent it from rebuilding to a 'not overfished' state, within a specific time-frame and probability.

Overfished: when the estimated probability that female spawning stock biomass is below the limit reference point (SB_{LIM}) is greater than 50%.

Overfishing: where the stock is subject to a level of fishing that would move it to an overfished state, or prevent it from rebuilding to a 'not overfished' state, within a specific time-frame and probability, to be determined.

A transparent and systematic approach to meet the objectives of the Harvest Strategy Policy is supported by a number of requirements. These include accounting for all mortality of all sizes and from all sources; accounting for multiple sources of uncertainty including environmental and biological; balancing risk, cost, and catch; developing threshold and limit reference points as indicators for managing Pacific halibut; robust simulation testing of management procedures; and identifying circumstances when the harvest strategy may be reconsidered and possibly updated. One threshold reference point and one biological limit reference point are currently defined.

Reference point	Definition	Proxy
Threshold reference point SB_{THRESH}	The female dynamic spawning biomass level at maximum economic yield (SB_{MEY}).	36% of the unfished spawning biomass ($SB_{36\%}$).
Biological limit reference point SB_{LIM}	The female dynamic spawning biomass level where the ecological risk to the population is regarded as unacceptable.	20% of the unfished female spawning biomass ($SB_{20\%}$).

The coastwide reference mortality limit from the management procedure is currently determined using the stock assessment and a fishing intensity ($F_{SPR=43\%}$). The reference SPR is linearly reduced when the stock status is estimated below 30% and is set to 100% (no fishing for directed fisheries) when the stock status is estimated at or below 20% (SB_{LIM}). A rebuilding strategy must be developed if the stock is estimated to be below SB_{LIM}.

The management of Pacific halibut is an annual process with a coastwide mortality limit and allocation to each IPHC Regulatory Area decided upon by the Commission at each Session of the IPHC Annual Meeting with the input of management supporting information including mortality tables, the harvest decision table, stakeholder input, and any other requests by the Commission. A mortality table shows the resulting allocation of mortality limits to each sector within each IPHC Regulatory Area. The harvest decision table is a stock assessment output that provides an estimate of risk relative to stock trend, stock status, fishery trends, and fishery status for a range of short-term (3-year) coastwide mortality levels includingi the coastwide reference fishing mortality.

Chapter 1 INTRODUCTION

The *IPHC Harvest Strategy Policy* (HSP) provides a framework for applying a consistent and transparent science-based approach to setting mortality limits for Pacific halibut (*Hippoglossus stenolepis*) fisheries throughout the Convention Area while ensuring sustainability of the Pacific halibut population.

It defines biological and economic objectives that apply to the development of a harvest strategy for Pacific halibut. It also identifies a management procedure and reference points for use in the harvest strategy to achieve the Commission's stated objectives. This policy, together with the *Protocol amending the Convention between Canada and the United States of America for the preservation of the [Pacific] halibut fishery of the northern Pacific Ocean and Bering Sea (1979)*[2], provides the basis to manage the risk to Pacific halibut fisheries and the Pacific halibut population.

A harvest strategy developed under this policy will take available information about the Pacific halibut resource and apply a consistent and transparent science-based approach to setting mortality limits. A harvest strategy consistent with this policy will provide all interested sectors with confidence that the Pacific halibut fisheries are being managed for long-term economic viability while ensuring long-term ecological sustainability of the Pacific halibut population. The implementation of a clearly specified harvest strategy will also provide the fishing industry with a more certain operating environment.

1.1 SCOPE

The IPHC Harvest Strategy Policy applies to the Pacific halibut population managed by the IPHC, and where overlap with domestic jurisdictional management exists (e.g. coordinated management between the IPHC and Contracting Party domestic agencies) the IPHC will seek to apply and encourage the adoption of this policy in negotiating and implementing cooperative management arrangements.

The IPHC is responsible for determining the coastwide mortality limit and the allocation of this limit among eight (8) IPHC Regulatory Areas (Figure 1). The mortality limit in each IPHC Regulatory Area consists of all fishing mortality of all sizes and from all sources, except for discard mortality of under 26-inch (U26) Pacific halibut from non-directed commercial (e.g. trawl) fisheries, which is accounted for at the coastwide level. This mortality limit without U26 non-directed commercial discard mortality has been termed the Total Constant Exploitation Yield, or the TCEY, but mortality limit is used here.

The distribution of the mortality limit to each sector within an IPHC Regulatory Area is determined by Contracting Party domestic agencies. Therefore, this Harvest Strategy Policy is specific to the mortality limit in each IPHC Regulatory Area, across all sectors (i.e. TCEY).

[2] https://www.iphc.int/uploads/pdf/basic-texts/iphc-1979-pacific-halibut-convention.pdf

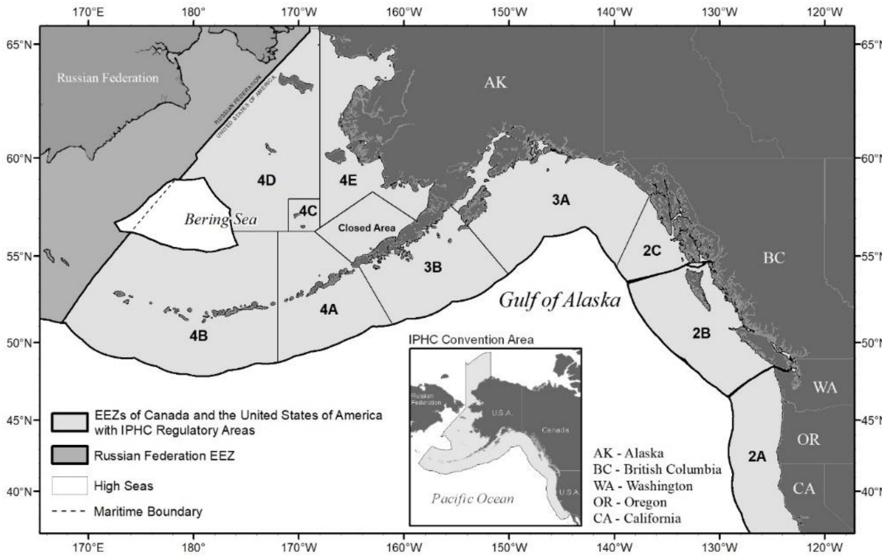


Figure 1. IPHC Regulatory Areas, where 4C, 4D, 4E, and the closed area are considered one IPHC Regulatory Area (4CDE). The IPHC Convention Area is shown in the inset.

1.2 WHAT IS A HARVEST STRATEGY POLICY (HSP)?

Being a framework, the harvest strategy policy encompasses the entire process of the management procedure and decision-making process to determine mortality limits (Figure 2) as well as other important considerations such as objectives, key principles, and responses to specific events. To determine mortality limits, the process begins with determining the coastwide scale of fishing mortality (the Management Procedure or MP). The decision-making process then occurs at the Annual Meeting of the IPHC where various forms of supporting information are used by subsidiary bodies to provide a recommendation to the Commission of the coastwide mortality limit and allocation to each IPHC Regulatory Area. The Commission uses all this information to arrive at a final decision defining mortality limits for that year. Due to many considerations in this decision-making process, the final coastwide mortality limit may deviate from the coastwide reference mortality limit determined from the management procedure.

1.3 WHAT IS A HARVEST STRATEGY?

A harvest strategy, which may also be referred to as a management strategy, is the decision framework necessary to achieve defined biological and economic objectives for Pacific halibut. A harvest strategy will outline:

- Objectives and key principles for the sustainable and profitable use of Pacific halibut.
- Reference points and other quantities used when applying the harvest strategy.
- Processes for monitoring and assessing the biological conditions of the Pacific halibut population and economic conditions of Pacific halibut fisheries in relation to biological and fishery reference levels (reference points).
- Pre-determined rules that adjust fishing mortality according to the biological status of the Pacific halibut stock and economic conditions of the Pacific halibut fishery (as defined by monitoring and/or assessment). These rules are referred to as harvest control rules or decision rules.

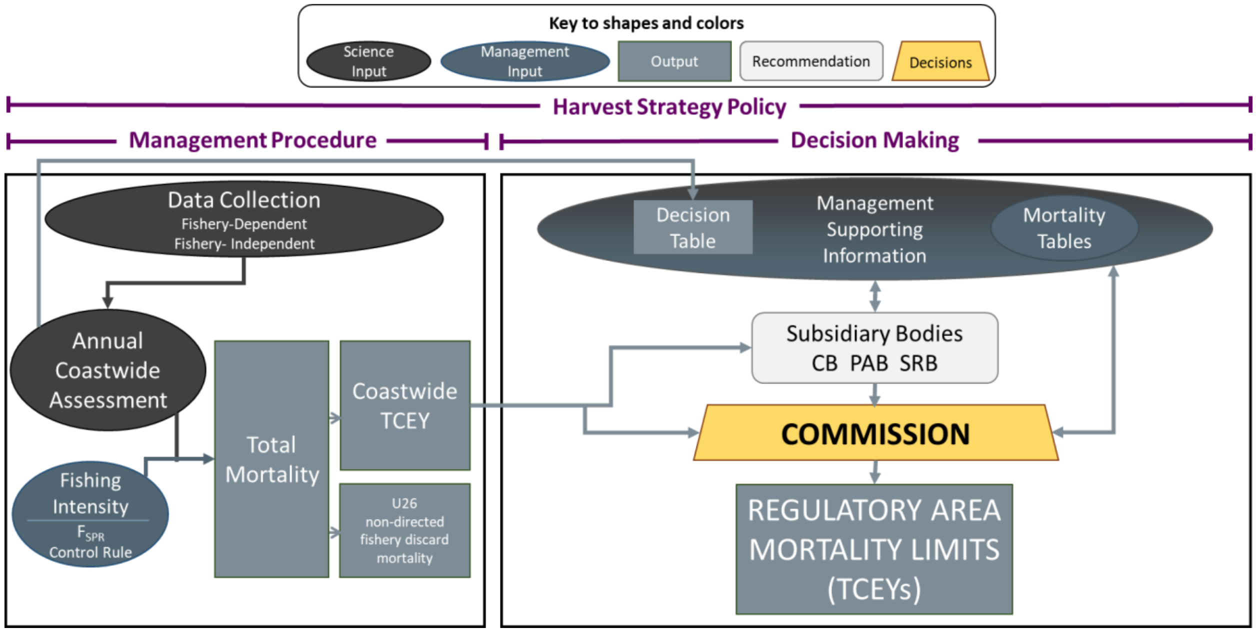


Figure 2. Illustration of the interim IPHC harvest strategy policy process to determine mortality limits showing the management procedure affecting the coastwide scale and the decision-making component, that considers inputs from many sources to distribute the coastwide TCEY to IPHC Regulatory Areas and may result in the coastwide TCEY deviating from the reference coastwide scale management procedure.

A management procedure (MP) contains many of the components of a harvest strategy and is sometimes synonymous with harvest strategy. Here, we define an MP as the formulaic procedure that defines data collection, assessment, and harvest rules to determine the coastwide reference mortality limit. The MP has been shown to meet the objectives through simulation testing while also being robust to uncertainty and variability. Harvest strategy is a more general concept containing the MP as well as objectives. Simulation testing of MPs is done using Management Strategy Evaluation (MSE) models with decision-making variability to ensure that a harvest strategy policy is robust to this uncertainty as well as other sources of uncertainty.

Management Procedure (MP): A formulaic procedure to determine a management outcome (e.g. mortality limit) that has been simulation tested and produces a repeatable outcome.

Harvest Strategy: The framework for managing a fish stock, including the MP and objectives.

Harvest Strategy Policy (HSP): The harvest strategy and decision-making process that results in endpoint management outcomes.

Chapter 2 OBJECTIVES AND KEY PRINCIPLES

A goal of the IPHC Harvest Strategy Policy is the long-term sustainable and profitable use (optimum yield) of Pacific halibut through the implementation of a harvest strategy that maintains the stock at sustainable levels while maximising economic returns.

To achieve this goal the IPHC will implement a harvest strategy that minimises risk to the stock and pursues maximum economic yield (MEY) for the directed Pacific halibut fisheries. Maximising the net economic returns (NER) from the fishery may not always equate with maximising the profitability of the fishery. Net economic returns may consider inter-annual stability to maintain markets, and economic activity may also arise from recreational and Indigenous fishing. The need to share the resources appropriately will also be considered where necessary. The Commission's current priority objectives to achieve this goal, which may be updated, are:

- maintain Pacific halibut female spawning biomass, above a female spawning biomass limit where the risk to the stock is regarded as unacceptable (SB_{LIM}), at least 95% of the time;
- maintain Pacific halibut female spawning biomass, at least 50% of the time, at or above a threshold reference (fixed or dynamic) female spawning biomass that optimises fishing activities on a spatial and temporal scale relevant to the fishery;
- optimise average coastwide yield given the constraints above;
- limit annual changes in the coastwide mortality limit (TCEY) given the constraints above.

The harvest strategy will ensure fishing is conducted in a manner that does not lead to *overfishing*. Overfishing is defined as where the stock is subject to a level of fishing that would move it to an *overfished* state or prevent it from rebuilding to a '*not overfished*' state, within a specific time-frame and probability. Where it is identified that overfishing of the stock is occurring, action will be taken immediately to cease that overfishing to ensure long-term sustainability and productivity to maximise NER.

The harvest strategy will also ensure that if the stock is overfished, the fishery must be managed such that, with regard to fishing impacts, there is a high degree of probability the stock will recover. In this case, a stock rebuilding strategy will be developed to rebuild the stock, with high certainty, to the limit female spawning biomass level, whereby the harvest control rules would then take effect to build the stock further to the threshold reference female spawning biomass level.

Overfished: when the estimated probability that female spawning stock biomass is below the limit reference point (SB_{LIM}) is greater than 50%.

Overfishing: where the stock is subject to a level of fishing that would move it to an overfished state, or prevent it from rebuilding to a '*not overfished*' state, within a specific time-frame and probability, to be determined.

Chapter 3 DEVELOPMENT OF THE HARVEST STRATEGY

The following requirements provide the basis for a transparent and systematic approach used when developing the harvest strategy to assist in meeting the objectives of the Harvest Strategy Policy.

3.1 ACCOUNTING FOR FISHING MORTALITY ON ALL SIZES AND FROM ALL SOURCES

The harvest strategy accounts for all known sources of fishing mortality on the stock and all sizes of Pacific halibut mortality, including directed commercial, recreational, subsistence, and fishing mortality from fisheries targeting species other than Pacific halibut and may be under the management of another jurisdiction, such as non-directed fishing mortality. Discard mortality of released fish is accounted for using best available knowledge.

3.2 VARIABILITY IN THE ENVIRONMENT AND BIOLOGICAL CHARACTERISTICS

The productivity of Pacific halibut is affected by variability in the environment and by changes in biological characteristics. The environment fluctuates naturally and is altered due to climate change and other factors, which may affect biological characteristics such as size-at-age and recruitment of age-0 fish. The following types of variability were considered when developing the harvest strategy for Pacific halibut:

- Variability in recruitment of age-0 Pacific halibut due to unknown causes
- Variability in average recruitment of age-0 Pacific halibut due to the environment (e.g. indexed by the Pacific Decadal Oscillation, PDO).
- Variability in the geographical distribution of age-0 recruits linked to the PDO.
- Changes in weight-at-age due to unknown causes
- Variability in movement throughout the Convention Area due to the environment (e.g. linked to the PDO).

Some potential impacts of climate change were taken into account when developing the harvest strategy policy and future research on additional effects of climate change on Pacific halibut fisheries and stocks will be incorporated as knowledge improves.

3.3 MONITORING

The harvest strategy includes best practices for monitoring the stock and fisheries and the collection of fishery-dependent and fishery-independent data on the distribution, abundance, and demographics of Pacific halibut, as well as other key biological data. These observations are used in the stock assessment and inform other management supporting information. Fisheries-dependent data include observations from the fisheries and should be collected across the entire geographical range and across all sectors, including landed catch and discards. Fishery-independent data include observations collected from scientifically designed surveys providing standardised biological and ecological data that are independent of the fishing fleet.

3.4 ESTABLISHING AND APPLYING DECISION RULES

The harvest strategy developed under this policy specifies all required management actions or considerations for Pacific halibut, at the stock or IPHC Regulatory Area level, necessary to achieve the ecological and economic management objectives for the fishery. Specifics are provided in Chapter 4.

3.5 BALANCING RISK, COST AND CATCH

This policy establishes a risk-based management approach, which provides for an increased level of caution when establishing control rules in association with increasing levels of uncertainty about stock status.

In the context of this policy, the risk, cost, and catch trade-off, refers to a trade-off between the amount of resources invested in data collection, analysis and management of Pacific halibut, and the level of catch (or fishing mortality) applied. Fishing mortality should always be constrained to levels at which scientific assessment indicates Pacific halibut is not exposed to an 'unacceptable ecological risk' (that is the risk that stocks will fall below the limit reference point).

The management decision to be taken in this context is whether investment of more resources in data collection and analyses and/or additional management will increase the understanding of the risk to the stock from fishing and provide confidence in the sustainability of a higher level of fishing pressure or catch. In the absence of this additional information–and associated improved understanding of a stock, it may be necessary to reduce the fishing effort in order to manage the risk. Decisions about investment in managing risk versus the economic return of the catch taken will be transparently made, clearly documented and publicly available.

3.6 REFERENCE POINTS AND PROXIES

A reference point is a specified level of an indicator used as a basis for managing Pacific halibut. A reference point will often be based on indicators of the female spawning stock size (relative or absolute spawning biomass), the amount of harvest (fishing mortality), or on other factors such as economic return from the fishery.

A harvest strategy for Pacific halibut shall be based on 'threshold' reference points and 'limit' reference points. A threshold reference point is a level that achieves the policy objectives (e.g. acceptable levels of biological impact on the stock and desired economic outcomes from the fishery) if the indicator is at or above that level. When the stock is at or above a threshold reference point, optimal yield is possible. A limit reference point indicates a point beyond which the long-term biological health of the stock or the performance of the commercial fishery is considered unacceptable and should be avoided. Fishing when the Pacific halibut population is below the biological limit reference point places the Pacific halibut stock at a range of biological risks, including an unacceptable risk to recruitment and productivity, and an increased risk that the stock will fail to maintain its ecological function, although risk of extinction is not a major concern. A fishery limit reference point indicates a stock level below which the fishery is unlikely to remain profitable. Proxy reference points are described in Table 1.

Spawning biomass reference points may be dynamic or absolute calculations. A dynamic calculation pertains to relative spawning biomass (RSB) being the estimated value relative to the estimated spawning biomass that would have occurred without any fishing given natural variability (e.g. recruitment deviations, changes in size-at-age, etc). This measures the effect of only fishing, rather than the effect of fishing and the environment. Absolute spawning biomass is not relative to another value and is typically presented as a number or a value estimated in a particular year. Absolute spawning biomass may be useful as a threshold reference point where being below would result in low catch rates and possibly other concerns. Currently there are no absolute spawning biomass reference points, but they may be a useful addition to dynamic reference points.

Table 1. Proxy reference points

Reference point	Definition	Proxy
Threshold reference point SB_{THRESH}	The female dynamic spawning biomass level at maximum economic yield (SB_{MEY}).	36% of the unfished spawning biomass ($RSB_{36\%}$).
Biological limit reference point SB_{LIM}	The female dynamic spawning biomass level where the ecological risk to the population is regarded as unacceptable.	20% of the unfished female spawning biomass ($RSB_{20\%}$).

3.7 TECHNICAL EVALUATION OF THE HARVEST STRATEGY

A harvest strategy should be formally tested to demonstrate that it is highly likely to meet the objectives and key principles of this policy, and outcomes of that testing should be made publicly available. Management strategy evaluation (MSE), a procedure where alternative management strategies are tested and compared using simulations of stock and fishery dynamics, is one of the best options to test harvest strategies. MSE involves determining objectives, identifying MPs to evaluate, simulating those MPs with a closed-loop simulation framework, evaluating the MPs to determine which one best meets the objectives (Chapter 2) , and finally adopting that MP as part of the harvest strategy. This process receives input from stakeholders through meetings of the Management Strategy Advisory Board (MSAB) and is reviewed by the IPHC Scientific Review Board (SRB).

The MSE supporting this HSP incorporates variability and uncertainty, such as described in Section 3.2, structural uncertainty in an operating model (OM), and implementation variability from decision-making and realized fishing mortality. The MSE also represents all fishing sectors as necessary to appropriately remove different cohorts from the population and to determine if objectives are met for each sector. An important component to this HSP is the decision-making component (Figure 2) where the Commission considers management inputs and additional relevant factors when deciding on the coastwide TCEY and distribution of the TCEY to IPHC Regulatory Areas to balance risk, cost, and catch (Section 3.5). The MSE uses historical decisions to determine how to simulate decision-making variability, ensuring that an MP is robust to that variability as well as other sources of uncertainty.

3.8 RE-EVALUATING THE HARVEST STRATEGY AND MANAGEMENT PROCEDURE

A harvest strategy is a transparent and science-based approach to determining mortality limits and is meant to remain in place for many years. Frequent modifications or departures from the harvest strategy reduce the transparency and science-based approach. Therefore, it is important to specify, as part of the harvest strategy, time periods for re-evaluation of management procedures and to identify exceptional circumstances that would trigger a re-evaluation before that time period.

The IPHC currently operates of a schedule of three-years for full stock assessments, with update stock assessments in the intervening two years, and the MSE OM is updated following each full stock assessment to maintain consistent approaches and paradigms. Therefore, MPs are re-evaluated at a minimum of three years after implementation. An exceptional circumstance may trigger a re-evaluation before then and are defined as follows.

- The coastwide all-sizes FISS WPUE or NPUE from the space-time model is above the 97.5th percentile or below the 2.5th percentile of the simulated FISS index for two or more consecutive years.

Exceptional circumstances would be reviewed by the SRB to determine if one should be declared.

In the event that an exceptional circumstance is declared, the following actions are to be completed.

- Review the MSE simulations to determine if the OM can be improved and MPs should be re-evaluated.
- Consult with the SRB and MSAB to identify why the exceptional circumstance occurred, what can be done to resolve it, and determine a set of MPs to evaluate with an updated OM.
- Further consult with the SRB and MSAB after simulations are complete to identify whether a new MP is appropriate.

MSE work is currently ongoing to supplement this interim harvest strategy policy. Current elements of MPs being investigated include conducting a stock assessment every second or third year and using an empirical rule based on the FISS WPUE in years without a stock assessment to determine the coastwide TCEY. With the harvest strategy currently being evaluated, updates to this interim harvest strategy policy may occur before three years.

Chapter 4 APPLYING THE HARVEST STRATEGY

4.1 COORDINATED MANAGEMENT OF DOMESTIC STOCKS

Consistent with the *Protocol amending the Convention between Canada and the United States of America for the preservation of the [Pacific] halibut fishery of the northern Pacific Ocean and Bering Sea* (1979), the IPHC will pursue the sustainable use of Pacific halibut within fisheries managed by other jurisdictions.

4.2 COORDINATED MANAGEMENT OF INTERNATIONAL STOCKS

The IPHC Harvest Strategy Policy does not prescribe management arrangements in the case of fisheries that are managed by a Party external to the IPHC Convention. This includes management arrangements for commercial and traditional fishing in the US Treaty Tribes and Canadian First Nations, that are governed by provisions within relevant Treaties. However, it does articulate the IPHC preferred approach.

4.3 STOCK ASSESSMENT

A full stock assessment occurs triennially and incorporates all available data through the current year, investigates all data and modelling aspects, and potentially makes changes to any of these components as needed. In the intervening years, an update stock assessment is completed to include all available data through the most current year. The stock assessment includes a summary of the data available for analysis, estimates of current stock size, recent trends of stock size relative to reference points, and uncertainty in the estimates of stock size.

The stock assessment also produces a harvest decision table containing short-term projections of various risk metrics under different levels of future harvest (input as a specific amount of fishing mortality, e.g. TCEY). Risk metrics include the probability of a decline in spawning biomass for the next 1 to 3 years, the probability of a decline in spawning biomass that is greater than 5% for the next 1 to 3 years, the probability that the spawning biomass is less than 20% or 30% of unfished spawning biomass in the next 1 to 3 years, the probability that the TCEY is less than the selected TCEY in the next 1 to 3 years, the probability that the TCEY is at least 10% less than the selected TCEY in the next 1 to 3 years, and the probability that the fishing intensity in the upcoming year is greater than the reference fishing intensity as specified in the MP (currently $F_{SPR=43\%}$). The harvest levels including the reference fishing mortality (i.e. TCEY determined from the MP), a range less than and greater than the reference fishing mortality , no fishing mortality (to assess short-term maximum biological productivity), various levels based on status quo (the previous year's coastwide mortality), a 3-year surplus that would maintain the spawning biomass at the same level in three years with a 50% probability, fishing mortality based on the SPR proxy for MEY, and the fishing mortality based on the SPR proxy for MSY.

4.4 COASTWIDE REFERENCE MORTALITY LIMIT

The coastwide reference mortality limit is determined using the stock assessment and a fishing intensity (i.e. F_{SPR}) defined by a harvest control rule (Figure 3). The stock assessment estimates the stock status (dynamic RSB) which is used in the harvest control rule to determine if fishing intensity should be reduced from the reference SPR (currently 43%). The reference SPR is linearly reduced when the stock status is estimated below 30% and is set to 100% (no fishing for directed fisheries) when the stock status is estimated at or below 20% (SB_{LIM}).

This management procedure determining the coastwide reference mortality limit (TCEY) is brought into the decision-making step as a reference value from which the Commission uses additional management supporting information to account for other relevant factors during the annual decision-making process on the coastwide TCEY and the distribution of the coastwide TCEY to IPHC Regulatory Areas. The MP provides a reference value in the decision table (see Section 4.3). The MSE simulations account for this decision-making variability (see Section 3.7).

The decision table represents short-term projections that are useful for tactical decision-making and are an important item in the management supporting information. Longer-term strategic implications of the choices in the decision table could be determined from the MSE simulations. If available, performance metrics associated with the four priority objectives (Chapter 2) determined from the most recent MSE simulations should be presented for, at a minimum, some F_{SPR} values associated with the fishing mortality options presented in the decision table.

4.5 Rebuilding if the stock becomes overfished

If Pacific halibut is determined to be overfished (when the probability that female spawning stock biomass is below the limit reference point (SB_{LIM}) is greater than 50%), immediate action is required to constrain directed fishing and rebuild the stock to levels that will ensure long-term sustainability and productivity, i.e. at or above SB_{LIM}. A rebuilding strategy must be developed to rebuild the stock to above its limit reference point, for agreement by the Commission. A rebuilding strategy will be required until the stock is above the limit reference point with a reasonable level of certainty (at least a 70% probability that the stock has rebuilt to or above the limit reference point). It must ensure adequate monitoring and data collection is in place to assess the status of the stock and rebuilding progress.

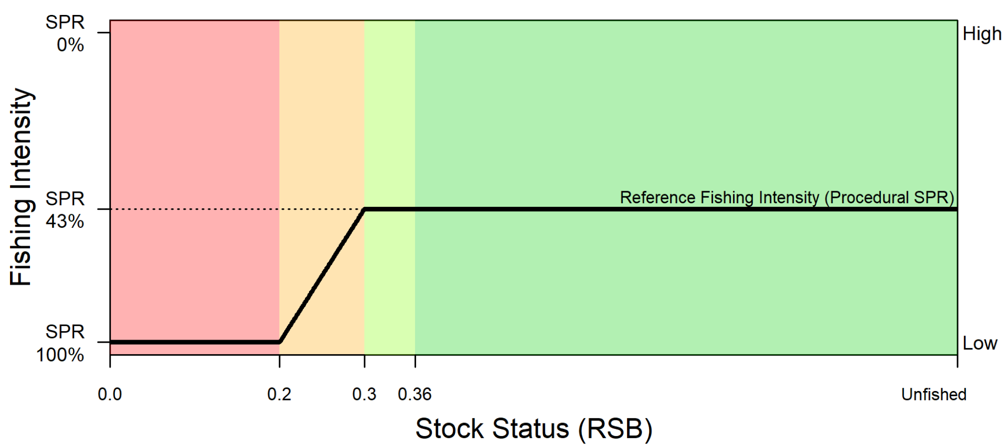


Figure 3. Harvest control rule for the fishing intensity (i.e. F_{SPR}) to determine the coastwide total mortality limit. The stock status is the dynamic relative spawning biomass (RSB) determined from the stock assessment. The reference fishing intensity is $F_{SPR=43\%}$, and is applied when stock status is above the trigger of 30%. SPR is linearly reduced between a stock status of 30% and 20%, and set to 100% when at or below

20% (no directed fishing). A stock status of 20% is also the reference point SB_{LIM}. The threshold RSB, 36%, is related to an objective to maintain the relative spawning biomass at or above $SB_{36\%}$ at least 50 percent of the time. Colours show the area below B_{LIM}, the area 'on the ramp', the area above the trigger and below SB_{THRESH}, and the area above SB_{THRESH}.

Directed fishing and incidental mortality of Pacific halibut, if determined to be overfished, should be constrained as much as possible to levels that allow rebuilding to the limit reference point (SB_{LIM}) within the specified timeframe. Once a stock has been rebuilt to above the limit reference point with a reasonable level of certainty, it may be appropriate to increase directed fishing, and increase incidental mortality in line with the harvest strategy, noting that the usual harvest strategy requirements regarding the application of the harvest control rule and risk of breaching the limit reference point will apply.

The rebuilding strategy should note where sources of mortality exist that cannot be constrained by the IPHC, and must take this mortality into account. Where practical and appropriate, the IPHC will coordinate with other jurisdictions to ensure other sources of mortality from fishing are reasonably constrained consistent with any catch sharing arrangement.

When a rebuilding strategy is being developed, it must include performance measures and details on how and when these measures will be reported. Where there is no evidence that a stock is rebuilding, or is going to rebuild in the required timeframe and probability, the IPHC will review the rebuilding strategy and make the result of the review public. If changes to the rebuilding strategy are considered necessary, such changes should be made in a timely manner.

Rebuilding timeframes

Rebuilding timeframes are explicitly related to the minimum timeframe for rebuilding in the absence of fishing. Rebuilding timeframes should take into account Pacific halibut productivity and recruitment; the relationship between spawning biomass and recruitment; and the stock's current level of depletion.

4.6 Mortality limits for each IPHC Regulatory Area

The final outputs of the harvest strategy policy before domestic management is applied are mortality limits for each IPHC Regulatory Area. These are decided upon by the Commission at the Annual Meeting with the input of management supporting information (Figure 2) requested by the Commission including mortality tables and the harvest decision table (see Section 4.3).

Mortality table: A mortality table shows the resulting allocation of mortality limits to each sector within each IPHC Regulatory Area. Domestic catch-sharing plans and Commission agreements on projecting non-directed discard mortality are used to fill out the details. This table can be produced for any projected year but is commonly presented for only the first projected year. Mortality limits for each IPHC Regulatory Area are defined by the Commission as part of the decision-making process.

4.7 Stakeholder and scientific input

Stakeholder and scientific input into the application of the harvest strategy is an important process to support the sustainable and profitable management of the Pacific halibut fishery. Input from both sources occurs at meetings throughout the year.

Stakeholder input

Stakeholder input can occur via public testimony at any public IPHC meeting or at meetings of various IPHC subsidiary bodies. In particular, the MSAB, Research Advisory Board (RAB), Conference Board (CB), and Processor Advisory Board (PAB) are populated by individuals representing various interests related to Pacific halibut. Terms of reference and rules of procedure are provided for each subsidiary body.

MSAB: The Management Strategy Advisory Board suggests topics to be considered in the MSE process, provide the IPHC Secretariat with direct input and advice on current and planned MSE activities, and represent constituent views in the MSE process. The MSAB meets at least once per year and makes recommendations to the Commission regarding the MSE analyses.

CB: The Conference Board consists of individuals representing Pacific halibut harvesters, organisations, and associations. The CB provides a forum for the discussion of management and policy matters relevant to Pacific halibut and provides advice to the Commission on these matters. This subsidiary body also reviews regulatory proposals received by the Commission and IPHC Secretariat reports and recommendations, and provides its advice concerning these items to the Commission at its Annual Meeting, or on other occasions as requested. The CB meets during the week of the Annual Meeting.

PAB: The Processor Advisory Board represents the commercial Pacific halibut processing industry from Canada and the United States of America and advises the Commission on issues related to the management of the Pacific halibut resource in the Convention Area. The PAB meets during the week of the Annual Meeting.

RAB: The Research Advisory Board, composed of members of the Pacific halibut community, provides the IPHC Secretariat staff with direct input and advice from industry on current and planned research activities contemplated for inclusion in the IPHC 5-year program of integrated research and monitoring. This subsidiary body suggests research topics to be considered and comments upon operational and implementation considerations of those research and monitoring activities. The RAB meets once per year, typically before the Interim Meeting.

Scientific input

Scientific input occurs through independent, external reviews, including, but not limited to, semi-annual meetings of the SRB. The SRB reviews science/research proposals, programs, products, strategy, progress, and overall performance, as well as the recommendations arising from the MSAB and RAB.

4.8 ANNUAL PROCESS

A series of meetings occurs throughout the year, leading up the Annual Meeting in January when mortality limit decisions are made. The MSAB meets at least once a year in spring to provide guidance on the MSE and may also meet in autumn if necessary. The SRB meets in June and September to peer review IPHC science products, including the stock assessment and MSE. The CB and the PAB meet during the week of the Annual Meeting to advise the Commission on issues related to the management of the Pacific halibut resource in the Convention Area.

An Interim Meeting, typically late November, precedes the Annual Meeting and is when the stock assessment, stock projections, and harvest decision table are first publicly presented. The final stock assessment, stock projections, and harvest decision table are presented at the Annual Meeting, typically in late January, to support mortality limit decisions.

Informal meeting summary of the 4th Ad Hoc Meeting of the Management Strategy Advisory Board (MSAB-AdHoc-04)

Meeting held electronically, 18 July 2024

ACRONYMS

FISS	Fishery-Independent Setline Survey
IPHC	International Pacific Halibut Commission
MP	Management Procedure
MSAB	Management Strategy Advisory Board
MSE	Management Strategy Evaluation
SRB	Scientific Review Board
TCEY	Total Constant Exploitation Yield
WPUE	Weight-Per-Unit-Effort

DEFINITIONS

A set of working definitions are provided in the IPHC Glossary of Terms and abbreviations: https://iphc.int/the-commission/glossary-of-terms-and-abbreviations

INFORMAL MEETING SUMMARY

1. The 4th ad hoc meeting of the International Pacific Halibut Commission (IPHC) Management Strategy Advisory Board (MSAB) was held electronically on 18 July 2024. The session was opened by Allan Hicks, welcoming the invited MSAB members.
2. There are four priority coastwide objectives currently adopted by the Commission.
   a) *Maintain the long-term coastwide female spawning stock biomass above a biomass limit reference point (B20%) at least 95% of the time.*
   b) *Maintain the long-term coastwide female spawning stock biomass at or above a biomass reference point (B36%) 50% or more of the time.*
   c) *Optimise average coastwide TCEY.*
   d) *Limit annual changes in the coastwide TCEY.*
3. The descriptions of priority objectives a) and b) could be improved to clearly indicate that they are relative spawning biomass (RSB).
4. The Scientific Review Board (SRB) has recommended modifying objectives b) and c).
5. The focus of the ad hoc working group is to explore potential new objectives to replace priority objective b) and c) that are consistent with recent decisions by the Commission to depart from the current interim harvest strategy using SPR=43%.
6. In recent years, the Fishery Independent Setline Survey (FISS) and commercial catch-rates have been low, with 2023 having the lowest values observed since 1993, but stock status has been good at 42%, which is above the $RSB_{36\%}$ threshold in objective b).
7. Dynamic reference points such as SPR and RSB may remain the same in different productivity regimes, but yield and absolute spawning biomass will change. These reference points measure the effects of fishing rather than the effects of fishing and the environment.
8. The decision-making process uses tactical short-term predictions from the stock assessment while the MSE process is focused on longer term metrics.
9. The Commission has flexibility to depart from the harvest strategy and may do so because of uncertainty and risk. The lowest spawning biomass in 35 years, short-term trends when biomass is low, and consideration of age-structure and reliance on a single year class are important to decision-making in recent years.

10. A management procedure defined as a reference fishing intensity or more conservative would provide flexibility to the Commission to reduce fishing intensity when short-terms trends are of concern.
11. A variable fishing intensity could be based on short-term predictions from the stock assessment decision table.
12. The objective “optimize yield” may include reducing interannual variability in yield.
13. A new objective may be defined using absolute biomass, commercial catch-rates, or TCEY. However, commercial catch-rates may not be the best option because they are dependent on other factors. TCEY and/or a reference absolute spawning biomass based on what has been observed may be more meaningful, but all have downsides in being a holistic metric. The MSAB should explore these metrics (and possibly FISS WPUE) for use in updating the objectives.
14. Evaluating MPs based on performance of the worst conditions (e.g. low productivity regime) may result in avoiding low stock sizes under any conditions.
15. Objectives, such as avoiding low stock sizes or low catch-rates, may be met by adding elements to the MP, such as reducing fishing intensity when the SB is below a threshold.
16. A target reference point is important to Marine Stewardship Council (MSC) certification and an appropriate target reference point for Pacific halibut may be higher than B36%.
17. There is likely a desire to remain above the absolute spawning biomass in 2023 and the tolerance could be 80 or 90%.
18. There are some potential challenges using an absolute spawning biomass in a changing ocean when the future is uncertain.
19. An item brought up, but not discussed, was the possibility of using age structure in the definition of an objective.

APPENDIX I
LIST OF PARTICIPANTS FOR THE 4TH AD HOC MEETING OF THE MANAGEMENT STRATEGY ADVISORY BOARD (MSAB-ADHOC-04)

MSAB Members

Canada	United States of America
Ms Gwyn Mason: Gwynhyfar.Mason@dfo-mpo.gc.ca	Dr Pete **Hulson**: pete.hulson@noaa.gov
Ms Ann-Marie **Huang**: Ann-Marie.Huang@dfo-mpo.gc.ca	Mr Kurt **Iverson**: kurt.iverson@noaa.gov
Mr Jim **Lane**: jim.lane@nuuchahnulth.org	Mr Scott **Mazzone**: smazzone@quinault.org
Mr Chris **Sporer**: chris.sporer@phma.ca	Ms Linda **Behnken**: alfafishak@gmail.com
Mr Michael **Fowler**: midon@protonmail.ch	

Absentees

Canada	United States of America
	Forrest **Braden**: forrest@seagoalaska.org

IPHC Secretariat

Name	Position	Email
Dr Allan **Hicks**	Quantitative Scientist (Management Strategy Evaluation)	allan.hicks@iphc.int
Dr Ian **Stewart**	Quantitative Scientist (Stock Assessment)	ian.stewart@iphc.int

Appendix II

AGENDA FOR AN AD HOC WORKING GROUP OF THE IPHC MANAGEMENT STRATEGY ADVISORY BOARD (MSAB-ADHOC04)

Date: 18 July 2024
Location: Electronic
Time (PDT): 9:30am to 3:30pm

Notes:

- ***IPHC Rules of Procedure*, Appendix V, para. 10**: *The MSAB may set up ad-hoc working groups to consider particular issues and report back to the MSAB.*

1. OPENING OF THE AD HOC WORKING GROUP

2. ADOPTION OF THE AGENDA AND GOALS FOR THE SESSION

- ➢ *IPHC-2024-MSAB0-AdHoc04-01: Agenda & Schedule for the 2024 Ad Hoc Working Group of the IPHC Management Strategy Advisory Board (MSAB-AdHoc04)*

2.1. Request from MSAB019 (A. Hicks)

- ➢ *See Report of the 19th Session of the IPHC Management Strategy Advisory Board (IPHC-2024-MSAB019-R, para 56)*

2.2. Commission recommendation (A. Hicks)

- ➢ See *IPHC-2024-ID003*

3. BRIEF OVERVIEW OF COASTWIDE OBJECTIVES

3.1. Four priority coastwide objectives (A. Hicks)

- ➢ *See Section 4 of IPHC-2024-MSAB019-07: Considerations for the Management Strategy Evaluation Program of Work for 2023-2025*

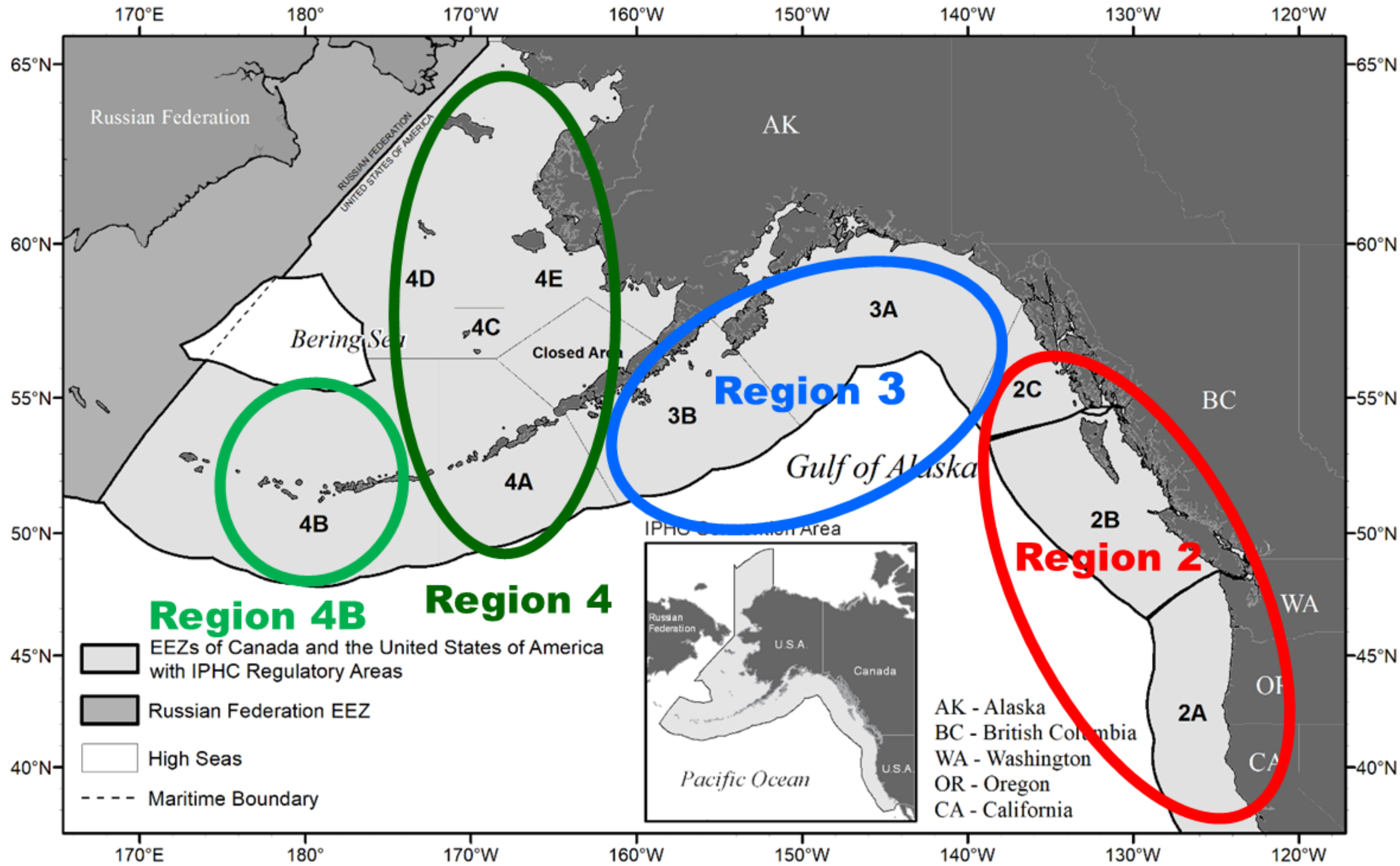
4. CONSIDERATION OF A NEW COASTWIDE OBJECTIVE

4.1. Background on development of a new coastwide objective (A. Hicks)

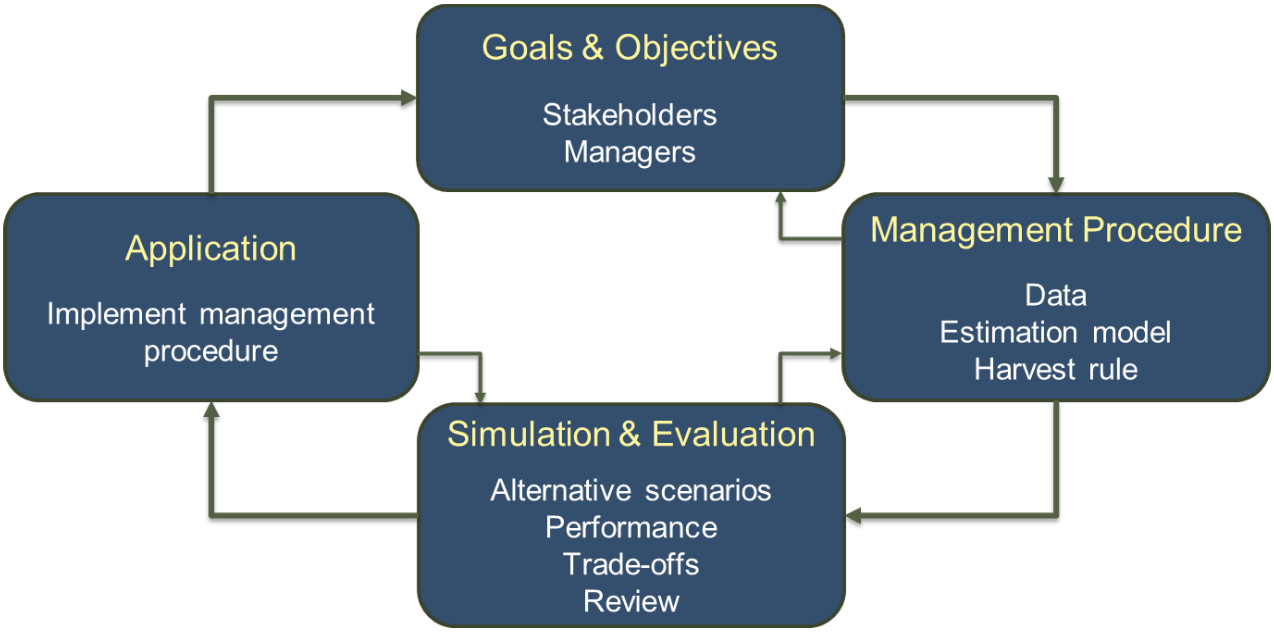
- ➢ *See Section 4 of IPHC-2024-MSAB019-07: Considerations for the Management Strategy Evaluation Program of Work for 2023-2025*

4.2. Discussion of a new coastwide objective (A. Hicks)

5. REVIEW OF THE INFORMAL MEETING SUMMARY OF THE 4th AD HOC WORKING GROUP OF THE IPHC MANAGEMENT STRATEGY ADVISORY BOARD (MSAB-ADHOC04)



Using Management Strategy Evaluation to investigate the effects of fishing and the environment on Pacific halibut



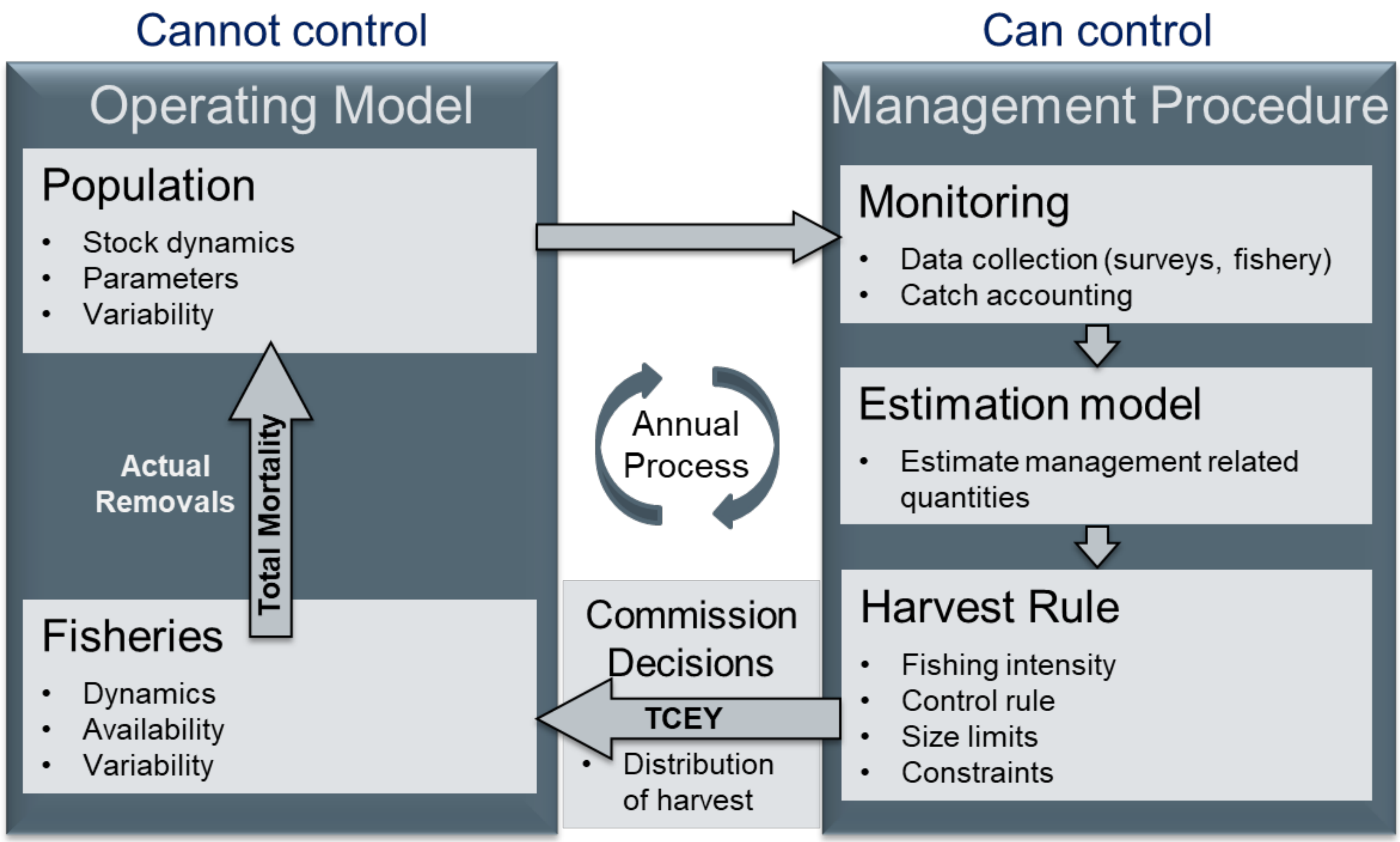
WHAT IS MSE?

Management Strategy Evaluation (MSE) is a process to evaluate the consequences of alternative management procedures. MSE uses a simulation tool to determine how alternative management procedures perform given a set of pre-defined fishery and conservation objectives, taking into account the uncertainties in the system.

MSE is a simulation technique based on modelling each part of a management cycle. The MSE uses an operating model to simulate the entire population and all fisheries, with potential environmental and/or ecosystem effects. The monitoring program, the estimation model, and management decisions (i.e. the management procedure) are factored in using closed-loop simulation. Processes that cannot be controlled, such as environmental effects, can be included as a source of variability, or by simulating specific scenarios to understand how different levels of the process affect the outcomes.

THE MSE PROCESS
DEFINE FISHERY & CONSERVATION OBJECTIVES
IDENTIFY MANAGEMENT PROCEDURES (MPs) TO EVALUATE
SIMULATE THE PACIFIC HALIBUT POPULATION USING THOSE MPs
EVALUATE RESULTS TO EXAMINE TRADE-OFFS
IMPLEMENT THE CHOSEN HARVST STRATEGY WITH THE TESTED MP

Undertaking an MSE requires scientists, managers, and stakeholders to be involved throughout the process. While the scientists do the modelling, managers must offer extensive input. Because of the many steps and the iterative process, communication among parties is critical for achieving buy-in on the results of the management strategy evaluation. The MSE is an essential part of the process of developing and agreeing to a harvest strategy policy.

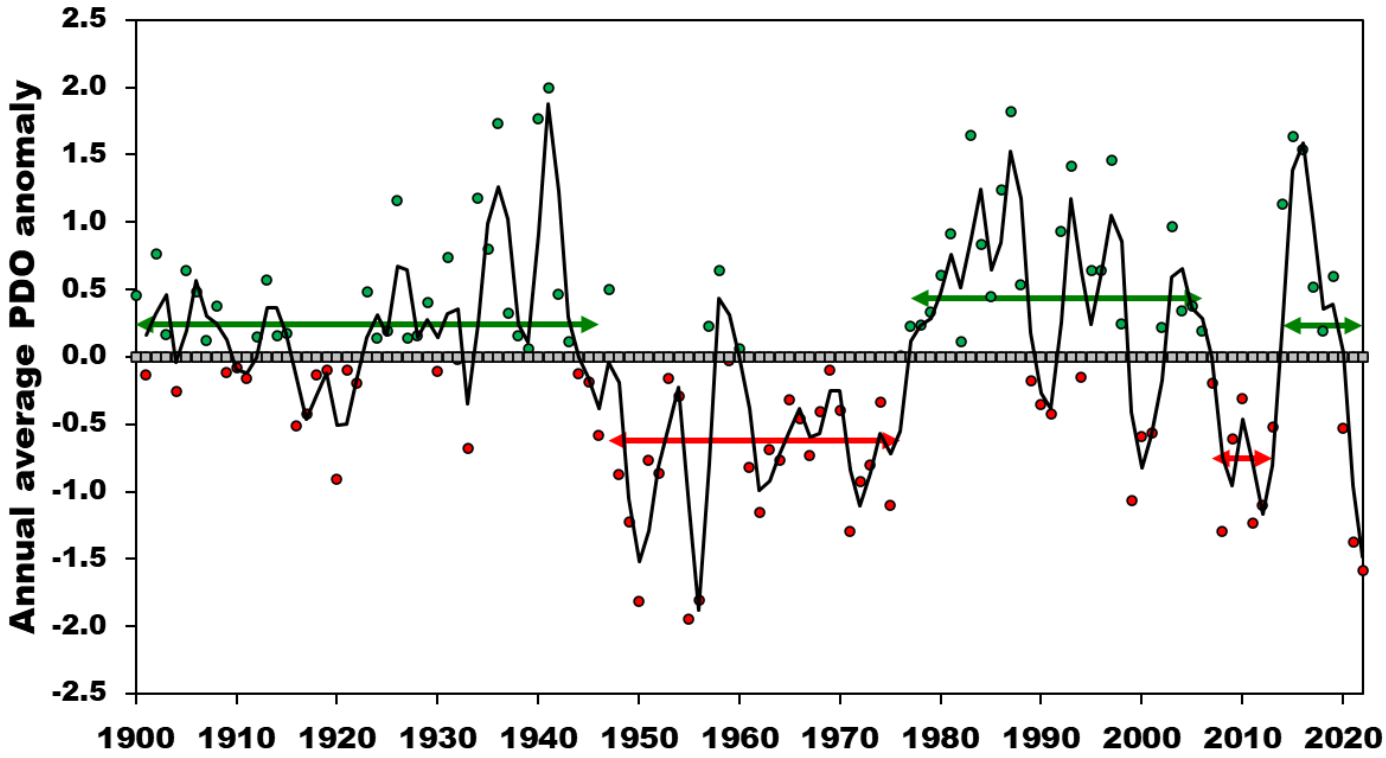


An MSE for Pacific Halibut

An operating model for Pacific halibut simulates the population dynamics within and between four regions across the Northeast Pacific Ocean. Fishing, movement, reproduction, and growth are modelled and simulation forward in time assuming a consistent harvest strategy. Variability in age-0 recruitment and growth are included. Outputs aggregated across all four regions (coastwide) include the future expected stock size, the expected fishery mortality limits (i.e. TCEY), and the interannual variability in the fishery mortality limits. These outputs are also available at the regional level. The IPHC Management Strategy Advisory Board (MSAB) provides input into the MSE process and the Commission uses the results in the development of a Harvest Strategy Policy.

CLOSED-LOOP FEEDBACK
AN OPERATING MODEL SIMULATES THE HALIBUT POPULATION INTO THE FUTURE
A MANAGEMENT PROCEDURE DETERMINES THE FISHING MORTALITY LIMITS AND FEEDS BACK INTO THE OPERATING MODEL

See https://www.iphc.int/research/management-strategy-evaluation/

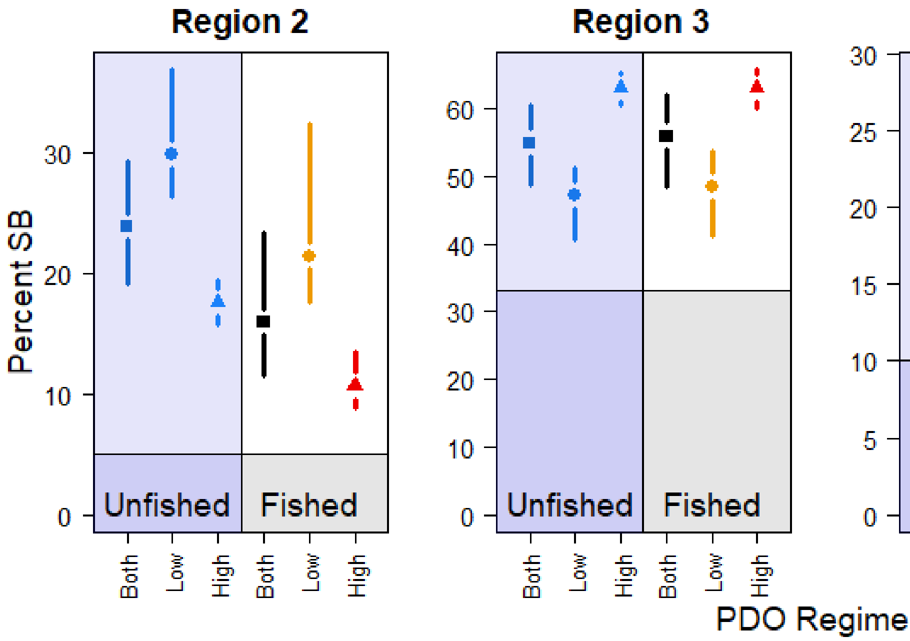


THE EFFECTS OF THE ENVIRONMENT ON PACIFIC HALIBUT

A strong correlation between the environmental conditions in the northeast Pacific Ocean, specifically the Pacific Decadal Oscillation (PDO), and recruitment of Pacific halibut to the commercial fishery during the 1900s has been identified. For Pacific halibut, the positive 'phase' of the PDO (years up to and including 1947, 1977-2006, and 2014-19) appears to have resulted in typically higher average recruitment. Additional work suggests that movement and the distribution of age-0 Pacific halibut are also different depending on the phase of the PDO.

The PDO indicates warm and cool surface waters in the Pacific Ocean and has oscillated at a decadal time scale. It has been correlated with salmon productivity as well. Since the late 1800's the PDO has oscillated between warm and cold phases at least 4 times. Recent research, however, shows many other environmental indicators were highly anomalous in recent years, and it is unclear whether these years represent comparable conditions to previous PDO observations.

Low PDO	High PDO
Low average recruitment	High average recruitment
Typically, less recruitment in Region 4	Typically, more recruitment in Region 4
Less movement from Region 4 to 3	More movement from Region 4 to 3
More movement from Region 3 to 2	Less movement from Region 3 to 2



WHAT WOULD A CHANGING ENVIRONMENT MEAN FOR THE MANAGEMENT OF PACIFIC HALIBUT

Using MSE, the Pacific halibut population was simulated forward in time, with fishing mortality similar to what has occurred recently, assuming that the PDO was either always low or always high. This allows for the separation of the effects of fishing and the effects of the environment. These results, however, would likely differ with a different harvest strategy.

The environment has a modest effect on the coastwide fishing mortality limits with the expected TCEY being 1.6 times greater in a high PDO regime when compared to a low PDO regime, although the interannual variability is the same. This is because the population size is smaller, thus fewer fish can be harvested in a persistent low PDO regime. Fishing and the environment affect the proportion of spawning biomass in each Biological Region in different ways. Region 2 (CA, OR, WA, BC, and SE AK) is affected by both the PDO and fishing. Region 3 (central Gulf of Alaska) is mostly affected by the PDO regime and fishing has little effect on the proportion of spawning biomass because fish move into this region at different rates depending on the PDO regime. Region 4 (western Gulf of Alaska and the Bering Sea) is mainly affected by fishing as fish generally move out of this region. Region 4B (Aleutian Islands) is affected by both fishing and the PDO regime because few fish move in or out of this region, but recruitment of age-0 Pacific halibut is dependent on the PDO regime.

EFFECTS OF THE ENVIRONMENT AND FISHING

THE TCEY IS 1.6 TIMES GREATER, ON AVERAGE, WITH A PERSISTENT HIGH PDO

AREAS ARE AFFECTED DIFFERENTLY BY FISHING AND BY THE ENVIRONMENT

Long-Term Performance Metrics			
PDO	Both	Low	High
Median RSB	38.8%	37.6%	39.2%
P(RSB<20%)	<0.001	<0.001	<0.001
P(RSB<36%)	0.238	0.329	0.157
Median TCEY (Mlbs)	65.6	51.4	83.0
Median AAV of TCEY	5.2%	4.5%	4.5%
Median TCEY Region 2 (Mlbs)	20.5	19.1	21.2
Median TCEY Region 3 (Mlbs)	33.7	23.0	48.7
Median TCEY Region 4 (Mlbs)	8.1	6.6	9.4
Median TCEY Region 4B (Mlbs)	2.4	2.2	2.6

IMPORTANCE TO DECISION MAKING

Even though we cannot “manage” the PDO regime, it is useful to understand the effects of the PDO regime on the Pacific halibut population and fisheries, separating the effect of fishing from the effects of the environment. In some cases, the environment may have a bigger effect on yield and the distribution of spawning biomass than fishing at a specific rate does. The environment is certainly influential on management outcomes and investigating the effects of a single regime on the management of Pacific halibut helps to understand the variability and uncertainty in the potential management outcomes.

In reality though, the environment is variable and often unpredictable. Therefore, the MSE simulations informing Commissioners, and the development of a Harvest Strategy Policy, oscillate randomly between PDO regimes and integrate the uncertainty of the environmental regime into the results. Including this variability provides the assurance that a chosen harvest strategy meets management objectives and is robust to uncertainty in the environment.

UNDERSTANDING THE EFFECTS OF THE ENVIRONEMNT

THE ENVIRONMENT IS VARIABLE AND OFTEN UNPREDICTABLE

UNDERSTANDING THE EFFECTS OF THE ENVIRONMENT IS USEFUL, BUT THE GOAL IS TO FIND A MANAGEMENT PROCEDURE THAT IS ROBUST TO THE VARIABILITY IN THE ENVIRONMENT

FOR MORE INFORMATION

QR code to https://www.iphc.int/research/management-strategy-evaluation/

References

Mantua et al. 1997

Clark and Hare 2002; Clark et al. 1999

Litzow et al. 2020