INTERNATIONAL PACIFIC HALIBUT COMMISSION

IPHC–2022–MSAB017–00
Last Update: 16 September 2022

17th Session of the IPHC Management Strategy Advisory Board (MSAB017) – *Compendium of meeting documents*

18-20 October 2022, Seattle, WA, USA

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INTERNATIONAL PACIFIC HALIBUT COMMISSION

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PROVISIONAL: AGENDA FOR THE 17th SESSION OF THE IPHC MANAGEMENT STRATEGY ADVISORY BOARD (MSAB017)

Date: 18-20 October 2022
Location: Electronic
Venue: Adobe Connect
Time: 12:30-17:00 (18th), 09:00-17:00 (19-20th) PDT
Chairperson: Vacant
Vice-Chairperson: Vacant

1. OPENING OF THE SESSION

2. ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION

- *IPHC-2022-MSAB017-01: Agenda & Schedule for the 17th Session of the Management Strategy Advisory Board (MSAB017)*
- *IPHC-2022-MSAB017-02: List of Documents for the 17th Session of the Management Strategy Advisory Board (MSAB017)*

3. IPHC PROCESS

3.1. MSAB Membership
- *IPHC-2022-MSAB017-03: MSAB Membership (D. Wilson)*

3.2. Update on the actions arising from the 16th Session of the MSAB (MSAB016)
- *IPHC-2022-MSAB017-04: Update on the actions arising from the 16th Session of the MSAB (MSAB016) (A. Hicks)*

3.3. Outcomes of Sessions of the IPHC Scientific Review Board
- *IPHC-2022-MSAB017-05: Outcomes of the 19th and 20th Sessions of the IPHC Scientific Review Board (SRB019; SRB020) (D. Wilson)*

3.4. Outcomes of the 98th Session of the IPHC Annual Meeting (AM098), and Special Sessions of the Commission (A. Hicks, D. Wilson)
- *IPHC-2022-MSAB017-06: Outcomes of the 98th Session of the IPHC Annual Meeting (AM098), and Special Sessions (A. Hicks, D. Wilson)*

4. MANAGEMENT STRATEGY EVALUATION

4.1. MSE framework to investigate management procedures for Pacific halibut fisheries (A. Hicks)
- *IPHC-2022-MSAB017-07: MSE framework to investigate management procedures for Pacific halibut fisheries (A. Hicks & I. Stewart)*

4.2. Primary MSE goals and objectives, performance metrics, and MSE Explorer (A. Hicks)
- *IPHC-2022-MSAB017-08: Primary MSE goals, objectives, and performance metrics (A. Hicks)*

4.3. Results investigating size limits and multi-year stock assessments for Pacific halibut fisheries (A. Hicks)

- *IPHC-2022-MSAB017-09: Results investigating size limits and multi-year stock assessments for Pacific halibut fisheries (A. Hicks & I. Stewart)*

5. REVIEW OF THE DRAFT AND ADOPTION OF THE REPORT OF THE 17TH SESSION OF THE IPHC MANAGEMENT STRATEGY ADVISORY BOARD (MSAB017)

PROVISIONAL: LIST OF DOCUMENTS FOR THE 17th SESSION OF THE IPHC MANAGEMENT STRATEGY ADVISORY BOARD (MSAB017)

Document	Title	Availability
IPHC-2022-MSAB017-01	Agenda & Schedule for the 17th Session of the IPHC Management Strategy Advisory Board (MSAB017)	✓ 6 Jul 2022
IPHC-2022-MSAB017-02	List of Documents for the 17th Session of the IPHC Management Strategy Advisory Board (MSAB017)	✓ 16 Sept 2022
IPHC-2022-MSAB017-03	MSAB Membership 2022- (D. Wilson)	✓ 16 Sept 2022
IPHC-2022-MSAB017-04	Update on the actions arising from the 16th Session of the MSAB (MSAB016) (A. Hicks)	✓ 16 Sept 2022
IPHC-2022-MSAB017-05	Outcomes of Session of the IPHC Scientific Review Board (SRB020; SRB021) (IPHC Secretariat)	✓ 16 Sept 2022
IPHC-2022-MSAB017-06	Outcomes of the 98th Session of the IPHC Annual Meeting (AM098), and Special Sessions (IPHC Secretariat)	✓ 16 Sept 2022
IPHC-2022-MSAB017-07	MSE Framework to investigate management procedures for Pacific halibut (A. Hicks & I. Stewart)	✓ 16 Sept 2022
IPHC-2022-MSAB017-08	Primary MSE goals, objectives, and performance metrics. (A. Hicks)	✓ 16 Sept 2022
IPHC-2022-MSAB017-09	Results investigating size limits and multi-year stock assessments for Pacific halibut fisheries (A. Hicks & I. Stewart)	✓ 16 Sept 2022
Information papers		
Nil to-date	Nil to-date	-

MSAB MEMBERSHIP 2022-

PREPARED BY: IPHC SECRETARIAT (D, WILSON; 16 SEPTEMBER 2022)

PURPOSE

To provide the MSAB with an updated membership list.

BACKGROUND

Rule II.4 of Appendix V [Management Strategy Advisory Board (MSAB) – Terms of Reference and Rules of Procedure] of the IPHC Rules of Procedure (2022), states:

> *4. The term of MSAB members will be four years, and members may serve additional terms at the discretion of the IPHC. Member terms have a staggered expiry such that no more than half of the member terms expire at a given time. Member continuity on the MSAB is key to the success of the MSE process. However, MSAB members serve at the discretion of the IPHC.*"

DISCUSSION

Subsequent to the 98th Session of the IPHC Annual Meeting (AM098), the Commission met intersessionally to consider both the MSE Program of Work, as well as the Commission's annual budget which includes the activities of the MSAB. In doing so, the Commission decided via intersessional decision IPHC-2022-ID001 (IPHC-2022-CR-007) as follows:

> *"IPHC-2022-ID001: The Commission:*
>
> *d) AGREED that it would like at least one in-person/hybrid MSAB meeting in 2023. This could occur in mid-2023 or in the standard October time slot (October 2023). In doing so, the MSAB membership may need to be reviewed and travel expenses for non-government members capped."*

As part of the intersessional decision process the Commission also advised of its intention to revisit the MSAB membership/representation as specified in the IPHC Rules of Procedure, and that the two Contracting Parties would be discussing internally with their delegations ways to 'rationalise' the membership and representation. The Commission's stated goal is to reduce meeting costs (travel) for non-government members, noting that government employees are required to pay for their own meeting attendance. The Commission will provide feedback on the internal discussions described above and provide direction to the Secretariat on how it would like to procced.

Provided at Appendix A are the current MSAB membership and term expirations. These will need ot be addressed prior to the MSAB017 meeting.

At present, the cost of an in-person MSAB meeting is budgeted at ~**US$40,000**. However, the precise cost for the 1st in-person MSAB meeting post-COVID-19 is likely to be higher due to airline costs. The costs are estimated as follows for 28 Board members for a 4-day MSAB meeting:

- Travel (flights, car) for non-Government members: $15,000
- Catering (lunches and function): US$2,500
- Per diem: Lodging (US$232/day) for non-Government members x 20: $18,560
- Per diem: Meals and Incidentals: (US$79/day – lunches and 1 x dinner provided) for non-Government members x 20: $4,000

The Commission has also directed the IPHC Secretariat to '*provide the Commission with potential governance reforms for the MSAB, via a working paper for the WM2022 which details the current membership, Terms of Reference and Rules of Procedure for the MSAB.*'

Provided at Appendix B are the current Terms of Reference and Rules of Procedure for the MSAB. Potential governance reforms are suggested in tracked-changes.

RECOMMENDATION/S

That the MSAB **NOTE** paper IPHC-2022-MSAB017-03 which details the MSAB membership as of 16 September 2022.

APPENDICES

Appendix A: MSAB Membership as of 16 September 2022
Appendix B: Management Strategy Advisory Board (MSAB) – Terms of Reference and Rules of Procedure (2022): Draft revisions as requested by the Commission.

APPENDIX A
MANAGEMENT STRATEGY ADVISORY BOARD (MSAB) MEMBERSHIP
(*AS OF 16 SEPTEMBER 2022*)

Membership: There are currently 28 seats on the Board, including 8 government seats. Expired terms are to be considered for renewal prior to the MSAB in October 2022, and after the WM2022. Vacant listings below are those who have departed the MSAB during the two-years of the COVID-19 pandemic, although all have expressed interest for re-appointment.

Membership category	Member	Canada	U.S.A.	Current Term commence-ment	Current Term expiration
Commercial harvesters (6-8)					
1	Sporer, Chris	CDN Commercial		9-May-17	8-May-21
2	Hauknes, Robert	CDN Commercial		9-May-17	8-May-21
3	Grout, Angus	CDN Commercial		3-Dec-19	3-Dec-21
4	Vacant	CDN Commercial			Vacant
5	Kauffman, Jeff		USA Commercial	9-May-19	8-May-23
6	Odegaard, Per		USA Commercial	9-May-17	8-May-21
7	Falvey, Dan		USA Commercial	9-May-17	8-May-21
8	Johnson, James		USA Commercial	17-Apr-19	16-Apr-23
First Nations/ Tribal fisheries (2-4)					
1	Lane, Jim	CDN First Nations		9-May-17	8-May-21
2	Vacant	CDN First Nations			Vacant
3	Mazzone, Scott		USA Treaty Tribes	9-May-19	8-May-23
4	Peterson, Joseph		USA Treaty Tribes	7-May-20	6-May-22
Government Agencies (4-8)					
1	Keizer, Adam	DFO		9-May-19	8-May-23
2	Huang, Ann-Marie	CDN Science Advisor		10-May-18	09-May-22
3	Vacant	DFO			Vacant
4	Vacant		NOAA-Fisheries		Vacant
5	Hulson, Pete		USA Science Advisor	13-Jul-22	12-Jul-26
6	Vacant		PFMC		Vacant
7	Bush, Karla		NPFMC	25-Oct-21	24-Oct-23
8	Webster, Sarah		ADFG	24-Sep-19	23-Sep-21
Processors (2-4)					
1	Parker, Peggy	US/CDN Processing	US/CDN Processing	9-May-19	8-May-23
2	Mirau, Brad	CDN Processing		9-May-19	8-May-23
3	Vacant	CDN Processing			Vacant
4	Vacant		USA Processing		Vacant
5	Drobnica, Angel		USA Processing	17-Apr-19	16-Apr-23

Membership category	Member	Canada	U.S.A.	Current Term commence-ment	Current Term expiration
Recreational/ Sport fisheries (2-4)					
1	Ashcroft, Chuck	CDN Sportfishing		17-Apr-19	16-Apr-23
2	Vacant	CDN Sportfishing			Vacant
3	Marking, Tom		USA Sportfishing (CA)	9-May-19	8-May-23
4	Braden, Forrest		USA sportfishing (AK)	17-Apr-19	16-Apr-23

Membership category	Member	Canada	U.S.A.	Current Term commence-ment	Current Term expiration
Commercial harvesters (6-8)					
1	Sporer, Chris	CDN Commercial		09-May-17	08-May-21
2	Hauknes, Robert	CDN Commercial		09-May-17	08-May-21
3	Grout, Angus	CDN Commercial		03-Dec-19	02-Dec-21
4	Vacant	CDN Commercial			
5	Johnson, James		USA Commercial	17-Apr-19	16-Apr-23
6	Kauffman, Jeff		USA Commercial	09-May-19	08-May-23
7	Odegaard, Per		USA Commercial	09-May-17	08-May-21
8	Falvey, Dan		USA Commercial	09-May-17	08-May-21
First Nations/ Tribal fisheries (2-4)					
1	Lane, Jim	CDN First Nations		09-May-17	08-May-21
2	Vacant	CDN First Nations			
3	Mazzone, Scott		USA Treaty Tribes	09-May-19	08-May-23
4	Vacant		USA Treaty Tribes		
Government Agencies (4-8)					
1	Keizer, Adam	DFO		09-May-19	08-May-23

Membership category	Member	Canada	U.S.A.	Current Term commence-ment	Current Term expiration
2	Huang, Ann-Marie	CDN Science Advisor		10-May-18	09-May-22
3	Vacant	DFO			
4	Merrill, Glenn		NOAA-Fisheries	07-May-18	06-May-22
5	McGilliard, Carey		USA Science Advisor	09-May-17	08-May-21
6	Baker, Rachel		FMC rep.	23-Oct-19	22-Oct-21
7	Webster, Sarah		ADFG	24-Sep-19	23-Sep-23
8	Sommer, Maggie		FMC rep.	14-Apr-20	13-Apr-22
Processors (2-4)					
1	Parker, Peggy	US/CDN Processing	USA/CDN Processing	09-May-19	08-May-23
2	Mirau, Brad	CDN Processing		09-May-19	08-May-23
3	Morelli, Joseph		USA Processing	29-Aug-18	28-Aug-22
4	Vacant		CDN Processing		
Recreational/ Sport fisheries (2-4)					
1	Chuck Ashcroft	CDN Sport Fishing Advisory Board		17-Apr-19	16-Apr-23
2	Marking, Tom		USA Sportfishing (CA)	09-May-19	08-May-23
3	Braden, Forrest		USA sportfishing (AK)	17-Apr-19	16-Apr-23
4	Vacant		Open		

Appendix B
Management Strategy Advisory Board (MSAB) – Terms of Reference and Rules of Procedure

(The MSAB shall operate under the Rules of Procedure of the Commission *mutatis mutandis*, except where specific provisions are laid down in the Convention or in these Rules of Procedure.)

I. Terms of reference

1. The Management Strategy Advisory Board (MSAB), on which individuals representing harvesters (commercial, sport, and subsistence), fisheries managers, processors, IPHC Secretariat, science advisors and other experts as required may be represented. The primary role of the MSAB is to advise the Commission on objectives, performance metrics, management procedures, and results arising from the Management Strategy Evaluation (MSE) process.

2. The MSAB will:

a) ~~define~~recommend clear measurable objectives and performance me~~asures~~trics for the fisher~~y~~ies;

b) ~~define~~propose candidate management strategies, which include aspects of the fishery that can be managed (e.g. regulatory requirements);~~ and~~

c) advise the IPHC Secretariat about plausible fishery-related scenarios for investigation, which include aspects of the fishery that cannot be managed by the IPHC (e.g. ~~environmental conditions and~~ removals under the management authority of a domestic management agency or changes in fishery dynamics);~~.~~

~~d) Gather and clearly articulate the interests and concerns of constituents and incorporate them into the MSAB's discussions;~~

d) ~~E~~encourage and allow members to ~~test~~propose tentative or exploratory ideas ~~and exploratory suggestions~~ without prejudice to future discussions;

e) assist with interpreting results and identifying important trade-offs between management procedures;

f) ~~R~~represent information, views, and outcomes of the MSAB discussions to constituents ~~external parties~~ accurately and appropriately;

g) gather and clearly articulate the interests and concerns of constituents and incorporate them into the MSAB's discussions;

~~g)~~h) ~~Encourage the understanding and support of their constituencies for the MSAB process and for consensus positions developed by MSAB.~~

II. Representation

3. The MSAB will include the following interests (in alphabetical order): harvesters (commercial, sport, and subsistence), fisheries managers, processors, IPHC Secretariat, 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 employees, to attend one (1) MSAB meeting each year.

a) Harvesters: Commercial fisheries (maximum of 6-8, 3 from each Contracting Party)

b) First Nations/Tribal fisheries (2-4)

c) Government agencies (incl. domestic management representatives and science advisors to each Contracting Party) (4-68; 2-3 from each Contracting Party)

d) Processors (2-4; maximum of 21 from each Contracting Party)

e) Recreational/Sport fisheries (2-4; maximum of 21 from each Contracting Party)

Efforts will be made to ensure rRepresentation may not beis distributed from throughout IPHC Regulatory Areas, but may be a consideration when determining membership.

4. The term of MSAB members will be four two (2) years, and members may serve one (1) additional terms at the discretion of the IPHC. Member terms have a staggered expiry such that no more than half of the member terms expire at a given time. Member continuity on the MSAB is key to the success of the MSE process. However, MSAB members serve at the discretion of the IPHC.

III. Officers

5. The MSAB will be co-chaired, one from Canada and one from the United States of America. Co-Chairpersons will be appointed by the MSAB from its membership described in para. 3.

6. The Co-Chairpersons will:

a) convene and adjourn meetings and preside over them, ensuring that meetings are conducted in an orderly, efficient, transparent, and respectful manner;

a)b) assist in drafting the report during the meeting;

b)c) present the MSAB's decisions, recommendations, and advice to the Commission;

c)d) Ppromote interactive dialogue, and enable all perspectives to be heard within the constraints of the time available;

~~d)~~e) ~~S~~support bringing issues to closure by ensuring that there is clarity on the topics being discussed, a summation of the collective advice of MSAB, and acknowledgement of any outstanding issues or concerns; and

~~e)~~f) ~~I~~identify areas where there are conflicts and support processes through which those conflicts can be addressed.

7. The term of the Co-Chairpersons will be two (2) years, and they may serve one (1) additional term~~s~~ at the discretion of the MSAB.

IV. Sessions of the MSAB

8. **Time and Place**: The MSAB ~~normally~~ meets~~meets~~ at least once each year ~~twice per year. The MSAB may meet more or less frequently as business requires.~~ The MSAB may also meet at other times and places, or via electronic means, facilitated by the IPHC Secretariat to consider specific issues, ~~or~~ to produce specific documents or other products, or for an update on progress from the IPHC Secretariat (e.g. an informational session).

9. **Agenda**: As per the Commission's Rules of Procedure.

V. Intersessional process and ad-hoc working groups

10. ~~**Ad-Hoc Working Groups**: If t~~The MSAB may set up ad-hoc working groups to consider particular issues and report back to the MSAB.~~determines it is necessary, the MSAB may convene ad-hoc working groups comprised of MSAB members and experts. Ad-hoc working groups will report only to the MSAB and serve at the discretion of the MSAB.~~

VI. Reports and Records

11. A report shall be adopted at ~~the end of~~ each Session of the MSAB.

12. The report shall embody the MSAB's recommendations, including, when requested, a statement of minority views.

13. A copy of the final report from each MSAB meeting shall be forwarded by the IPHC Executive Director to the Contracting Parties and to the Commissioners no later than **15 days** after the close of the Session.

14. All reports shall be available on the Commission's website.

UPDATE ON THE ACTIONS ARISING FROM THE 16TH SESSION OF THE IPHC MANAGEMENT STRATEGY ADVISORY BOARD (MSAB020)

PREPARED BY: IPHC SECRETARIAT (A. HICKS, 16 SEPTEMBER 2022)

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 MSAB017.

BACKGROUND

At the MSAB016, the members recommended/requested a series of actions to be taken by the IPHC Secretariat, as detailed in the MSAB016 meeting report (IPHC-2022-MSAB016-R) available from the IPHC website, and as provided in Appendix A.

DISCUSSION

During the 17th Session of the MSAB (MSAB016), 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-2022-MSAB017-04, 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 (MSAB016).
2) **AGREE** to consider and revise the actions as necessary, and to combine them with any new actions arising from MSAB017.

APPENDICES

Appendix A: Update on actions arising from the 16th Session of the IPHC Management Strategy Advisory Board (MSAB016)

APPENDIX A
Update on actions arising from the 16th Session of the IPHC Management Strategy Advisory Board (MSAB016)

RECOMMENDATIONS

Action No.	Description	Update
MSAB016–Rec.1 (para 35)	The MSAB **RECOMMENDED** that the performance metrics related to the current primary objectives (Appendix VI) be considered when evaluating MPs.	**Completed** These objectives were used in past evaluations and the current evaluation.
MSAB016–Rec.2 (para. 53)	The MSAB **RECOMMENDED** the following MPs for analysis and consideration in 2021: a) MP-J in combination with a fixed TCEY of 1.65 Mlbs in Regulatory Area 2A, as in paragraph 97 b) of IPHC-2020-AM096-R, with total mortality rebalanced among remaining U.S.A. IPHC Regulatory Areas to maintain a constant SPR; b) MP-J in combination with a minimum TCEY of 1.65 Mlbs in Regulatory Area 2A which allows the TCEY to exceed 1.65 in IPHC Regulatory Area 2A with total mortality rebalanced among remaining U.S.A. IPHC Regulatory Areas to maintain a constant SPR.	**Completed** The Commission has directed the MSE program of work to not consider new procedures related to distribution. However, concepts from this recommendation are considered where appropriate.

REQUESTS

Action No.	Description	Update
MSAB016–Req.1 (para 38)	***MSAB Program of work*** The MSAB **REQUESTED** that an MSAB meeting be scheduled to discuss a Program of Work for 2021 and beyond.	**Completed** Note that the Commission paused the MSAB process while they worked through a range of objectives and determined a Program of Work. MSAB017 is the first MSAB meeting since 2020.

OUTCOMES OF SESSIONS OF THE IPHC SCIENTIFIC REVIEW BOARD (SRB020; SRB021)

PREPARED BY: IPHC SECRETARIAT (16 SEPTEMBER 2022)

PURPOSE

To provide the Management Strategy Advisory Board (MSAB) with outcomes of the 20th Session of the IPHC Scientific Review Board (SRB020), noting that the outcomes of the 21st Session will be communicated once the report of the meeting closes on the 22 September 2022.

BACKGROUND

The agenda of the 20th Session of the IPHC Scientific Review Board included an item related to Management Strategy Evaluation (MSE) that is relevant to the mandate of the MSAB.

DISCUSSION

At the SRB020, the members recommended/requested a series of requests related to (MSE), as detailed in the SRB020 meeting report (IPHC-2022-SRB020-R) available from the IPHC website, and as provided in Appendix A.

RECOMMENDATION/S

That the MSAB:

1) **NOTE** paper IPHC-2022-MSAB017-05, which details the outcomes of the 20th Session of the IPHC Scientific Review Board relevant to the mandate of the MSAB.

APPENDICES

Appendix A: Excerpts from the 20th Session of the IPHC Scientific Review Board (SRB020)

APPENDIX A
Excerpt from the 20th Session of the IPHC Scientific Review Board (SRB020) Report (IPHC-2022-SRB020-R)

REQUESTS

Management Strategy Evaluation: update

SRB020–Rec.02 (para. 18) The SRB **NOTED** the Secretariat's plan to further explore migration scenarios in the MSE and therefore **REQUESTED** that the set of migrations scenarios remain within bounds of plausible values identified via the OM development/fitting and previous tagging studies.

SRB020–Rec.03 (para. 19) The SRB **REQUESTED** that the ramped implementation bias scenario (Fig. 17 in paper IPHC-2022-SRB020-06 Rev_1) be run under the most aggressive fishing intensity targets to determine the scale of performance sensitivity to that source of implementation variability.

SRB020–Rec.04 (para. 20) The SRB **REQUESTED** that the MSE not attempt to implement a Stock Synthesis estimation procedure as part of the management procedure and, instead, to integrate a simpler assessment modelling approach into the management procedure via tuning

SRB020-Rec.05 (para. 21) The SRB **REQUESTED** evaluating whether the relative ranking of MPs – defined only by multi-year assessment cycle and size limits - remains similar across the set of proposed distribution scenarios using objectives identified as priorities by the Commission

OUTCOMES OF THE 98TH SESSION OF THE IPHC ANNUAL MEETING (AM098), AND THE 12TH SPECIAL SESSION OF THE IPHC (SS012)

PREPARED BY: IPHC SECRETARIAT (16 SEPTEMBER 2022)

PURPOSE

To provide the MSAB with the outcomes of the 98th Session of the IPHC Annual Meeting (AM098), and the 12th Special Session of the IPHC (SS012), relevant to the mandate of the MSAB.

BACKGROUND

The agendas of the 98th Session of the IPHC Annual Meeting (AM098) and the 12th Special Session of the IPHC (SS012) both included agenda items relevant to the MSAB.

DISCUSSION

During the course of the 98th Session of the IPHC Annual Meeting (AM098) the Commission made a number of specific recommendations and requests for action regarding the MSE process. Relevant sections from the report of the meeting are provided in Appendix A for the MSAB's consideration. In addition, the Commission made a decision related to MSE during a Special Session in 2022 (SS012).

RECOMMENDATION

That the MSAB:

1) **NOTE** paper IPHC-2022-MSAB0017-06 which details the outcomes of the 98th Session of the IPHC Annual Meeting (AM098), and the 12th Special Session of the IPHC (SS012), relevant to the mandate of the MSAB.

APPENDICES

Appendix A: Excerpts from the 98th Session of the IPHC Annual Meeting (AM098) Report (IPHC-2022-AM098-R), and the 12th Special Session of the IPHC (SS012) (IPHC-2022-SS012-R).

APPENDIX A
Excerpt from the 98th Session of the IPHC Annual Meeting (AM098) Report (IPHC-2022-AM098-R)

RECOMMENDATIONS

Management Strategy Evaluation

AM098–Rec.01 (para. 69) The Commission **RECOMMENDED** that an MSE agenda item be added to the upcoming special session to discuss and provide direction on elements of the MSE workplan, including distribution procedures to incorporate in the management procedures being simulated in 2022 and evaluated at the 99th Session of the IPHC Annual Meeting (AM099).

12th Special Session of the Commission (SS012)

AM098–Rec.02 (para. 116) The Commission **RECOMMENDED** that the 12th Special Session of the Commission be held electronically in late February or early March 2022 and include the following agenda items: 1) FY2023 budget review and adoption; 2) Management Strategy Evaluation; 3) IPHC Fishery Regulations: Daily bag limit in IPHC Regulatory Area 2B (Sect. 28) (IPHC-2022-AM098-PropB4).

REQUESTS

Management Strategy Evaluation

AM098–Req.02 (para. 61) The Commission **RECALLED** SS011-Rec.01 and **REQUESTED** that the current size limit (32 inches), a 26 inch size limit, and no size limit be investigated. to understand the long-term effects of a change in the size limit.

AM098–Req.03 (para. 63) The Commission **REQUESTED** that the IPHC Secretariat work with the SRB and others as necessary to identify potential costs and benefits of not conducting an annual stock assessment. This will include a prioritized list of work items that could be accomplished in its place.

AM098–Req.04 (para. 64) The Commission **REQUESTED** that multi-year management procedures include the following concepts:

a) The stock assessment occurs biennially (and possibly triennial if time in 2022 allows) and no changes would occur to the FISS (i.e. remains annual);
b) The TCEY within IPHC Regulatory Areas for non-assessment years:
   i. remains the same as defined in the previous assessment year, or
   ii. changes within IPHC Regulatory Areas using simple empirical rules, to be developed by the IPHC Secretariat, that incorporate FISS data.

AM098–Req.05 (para. 66) The Commission **NOTED** that a distribution procedure is necessary to evaluate the size limit and multi-year assessment management procedures, and **REQUESTED** that a range of distribution procedures be used to highlight potential differences in the performance of size limits and multi-year assessments.

AM098–Req.06 (para. 68) The Commission **REQUESTED** that work continue on methods to evaluate MSE outcomes, including providing new alternative methods to quickly evaluate large sets of management procedures, which may involve ranking them in various ways.

RECOMMENDATIONS FROM THE 12TH SPECIAL SESSION OF THE IPHC (SS012)

(25 February 2022)

(IPHC-2022-SS012-R)

RECOMMENDATIONS

Management Strategy Evaluation

SS012-Rec.01 (para. 10) The Commission **RECOMMENDED** the following five distribution procedures to be used in the management strategy evaluation of size limits and multi-year assessments, noting that these distribution procedures are for analytical purposes only and are not endorsed by both parties, thus would be reviewed in the future if the Commission wishes to evaluate them for implementation.

a) Baseline based on recent year O32 FISS results, relative harvest rates of 1.0 for IPHC Regulatory Areas 2-3A, relative harvest rates of 0.75 for IPHC Regulatory Areas 3B-4, and no application of the current interim agreements for 2A and 2B;

b) Baseline based on recent year O32 FISS results, relative harvest rates of 1.0 for IPHC Regulatory Areas 2-3A, relative harvest rates of 0.75 for IPHC Regulatory Areas 3B-4, and current interim agreements for 2A and 2B;

c) Baseline based on recent year O32 FISS results with 1.65 Mlbs to 2A and 20% of the coastwide TCEY to 2B;

d) Baseline based on recent year O32 FISS results, relative harvest rates of 1.0 for IPHC Regulatory Areas 2-3, 4A, and 4CDE, a relative harvest rate of 0.75 for IPHC Regulatory Area 4B, and no agreements for 2A and 2B;

e) Baseline based on recent year O32 FISS results, relative harvest rates of 1.0 for IPHC Regulatory Areas 2-3, 4A, and 4CDE, a relative harvest rate of 0.75 for IPHC Regulatory Area 4B, and current interim agreements for IPHC Regulatory Areas 2A and 2B.

MSE Framework to investigate management procedures for Pacific halibut

PREPARED BY: IPHC SECRETARIAT (A. HICKS & I. STEWART; 16 SEPTEMBER 2022)

PURPOSE

To provide the Management Strategy Advisory Board (MSAB) with an update of improvements to the Management Strategy Evaluation (MSE) framework.

1 INTRODUCTION

The most recent interim management procedure (MP) at the International Pacific Halibut Commission (IPHC) is shown in Figure 1.

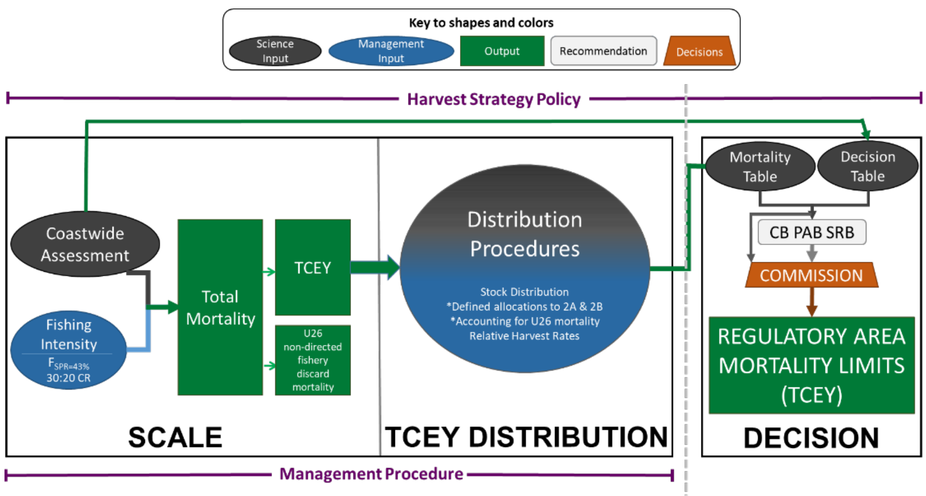

Figure 1. Illustration of the Commission interim IPHC harvest strategy policy (reflecting paragraph ID002 in IPHC-2020-CR-007) showing the coastwide scale and TCEY distribution components that comprise the management procedure. Items with an asterisk are interim agreements in place through 2022. The decision component is the Commission decision-making procedure, which considers inputs from many sources.

The Management Strategy Evaluation (MSE) at the IPHC completed an evaluation in 2021 of management procedures (MPs) relative to the coastwide scale and distribution of the Total Constant Exploitation Yield (TCEY) to IPHC Regulatory Areas for the Pacific halibut fisheries using a recently developed closed-loop simulation framework. The development of this closed-loop simulation framework supports the evaluation of the trade-offs between fisheries management procedures. Descriptions of the MPs evaluated and simulation results are presented in Hicks et al. (2021). Additional tasks were identified at the 11th Special Session of the IPHC (IPHC-2021-SS011-R) to supplement and extend this analysis for future evaluation (Table 1). Document IPHC-2021-MSE-02 contains details of the current MSE Program of Work.

Table 1. Tasks recommended by the Commission at SS011 (IPHC-2021-SS011-R para 7) for inclusion in the IPHC Secretariat MSE Program of Work for 2021–2023.

ID	Category	Task	Deliverable
F.1	Framework	Develop migration scenarios	Develop OMs with alternative migration scenarios
F.2	Framework	Implementation variability	Incorporate additional sources of implementation variability in the framework
F.3	Framework	Develop more realistic simulations of estimation error	Improve the estimation model to more adequately mimic the ensemble stock assessment
F.5	Framework	Develop alternative OMs	Code alternative OMs in addition to the one already under evaluation.
M.1	MPs	Size limits	Identification, evaluation of size limits
M.3	MPs	Multi-year assessments	Evaluation of multi-year assessments
E.3	Evaluation	Presentation of results	Develop methods and outputs that are useful for presenting outcomes to stakeholders and Commissioners

This document provides updates on the progress for the framework related tasks.

2 Closed-Loop Simulation Framework

The closed-loop framework (Figure 2) with a multi-area operating model (OM) and three options for examining estimation error was initially described in Hicks et al. (2020b). Technical details are updated as needed in IPHC-2022-MSE-01 on the IPHC MSE webpage. Improvements to the framework have been made in accordance with the MSE program of work and a new OM has been developed.

2.1 Development of a new Operating Model

The IPHC stock assessment (Stewart & Hicks 2022) consists of four stock synthesis models integrated into an ensemble to provide probabilistic management advice accounting for observation, process, and structural uncertainty. A similar approach was taken when developing the models for the closed-loop simulation framework along with some other specifications to improve the efficiency when conditioning models and running simulations.

2.1.1 General specifications of the OM

The emerging understanding of Pacific halibut diversity across the geographic range of its stock indicates that IPHC Regulatory Areas should be only considered as management units and do not represent relevant sub-populations (Seitz et al. 2017). Therefore, four Biological Regions (Figure 3) were defined with boundaries that matched some of the IPHC Regulatory Area boundaries (see Hicks et al 2020b for more description). The OM is a multi-regional model with population dynamics modelled within and among Biological Regions, and fisheries mostly operating at the IPHC Regulatory Area scale. Multiple fisheries within a Biological Region may have different selectivity and retention patterns to mimic differences similar to that of an Areas-

As-Fleets (AAF) approach. Thirty-three fisheries were defined for five general sectors consistent with the definitions in the recent IPHC stock assessment:

- **directed commercial** representing the O32 mortality from the directed commercial fisheries including O32 discard mortality (from lost gear or regulatory compliance);
- **directed commercial discard** representing the U32 discard mortality from the directed commercial fisheries, comprised of Pacific halibut discarded due to the minimum size limit;
- **non-directed commercial discard** representing the mortality from incidentally caught Pacific halibut in non-directed commercial fisheries;
- **recreational** representing recreational landings (including landings from commercial leasing) and recreational discard mortality; and
- **subsistence** representing non-commercial, customary, and traditional use of Pacific halibut for direct personal, family, or community consumption or sharing as food, or customary trade.

Additionally, there are four modelled surveys, one for each Biological Region.

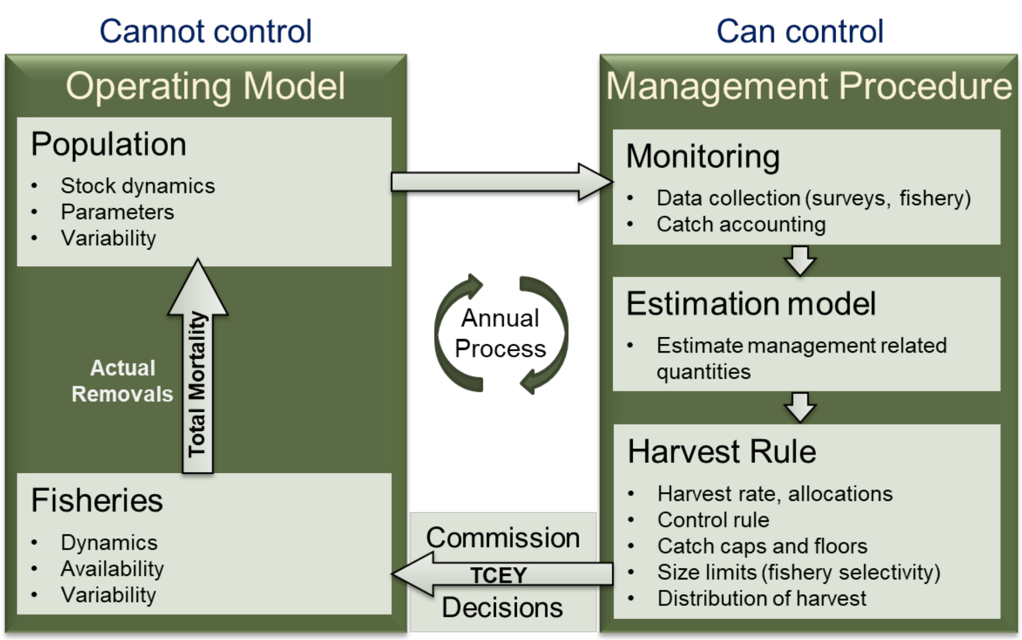

Figure 2. Illustration of the closed-loop simulation framework with the operating model (OM) and the Management Procedure (MP). This is the annual process on a yearly timescale.

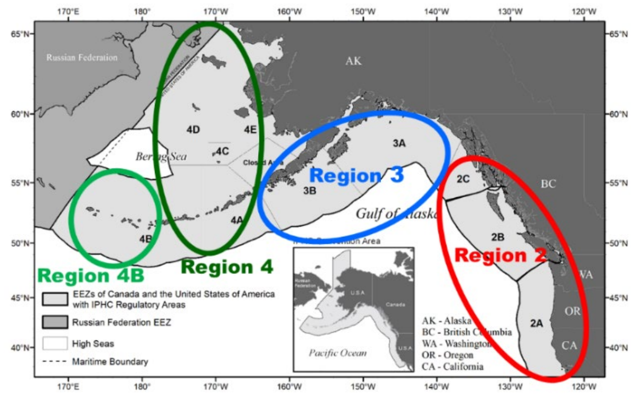

Figure 3. IPHC Regulatory Areas, Biological Regions, and the Pacific halibut geographical range within the territorial waters of Canada and the United States of America.

Two of the four models in the IPHC stock assessment (Stewart & Hicks 2022) consider a long time-series of observations beginning in 1888. One model specifies coastwide fisheries (called the coastwide (CW) long model) and the other model specifies four regions in an areas-as-fleets approach (called the AAF long model). The previous MSE OM also started in 1888 and simulated the entire time-series up to recent years before starting the forward simulations. However, the early portion of the time-series is challenging to model due to relatively little data, some significant catches in Biological Region 2, and the potential for unknown differences in population dynamics (e.g. movement between Biological Regions) compared to recent periods. To reduce the technical complexity and focus on information contained in the richer data set in the later period, the 2022 OM models were started in 1958. In order to allow for flexible starting conditions, 30 years of initial recruitment and an average fishing mortality were estimated for each fleet. This initialized the models after a bottleneck of potentially high fishing mortality in the 1930's that is confounded with the estimation of movement, while allowing for a sufficient period of time to burn-in the population such that projections began at an appropriate population size and age composition. The period from 1958 to the present includes major changes in fishery catches, weight-at-age in the population, and population size.

To account for structural uncertainty, as with the ensemble stock assessment, four individual models are integrated into a single OM. The first model was parameterised from and conditioned to results from the long AAF stock assessment model. The second model was parameterised from and conditioned using results from the long CW stock assessment model. Because these two OM models started in 1958, they are called the medium AAF (medAAF) and medium CW (medCW) models. The two remaining models also started in 1958 and were conditioned to the same observations, but parameterised with lower values of natural mortality, as in the 2021 'short' assessment models. These two models are noted as medAAF_lowM and medCW_lowM. All four models are regional models with movement between the four biological regions. The four models combined as an OM produced projections of fishing mortality that were reasonably similar to the short-term projections from the ensemble stock assessment (Figure 4).

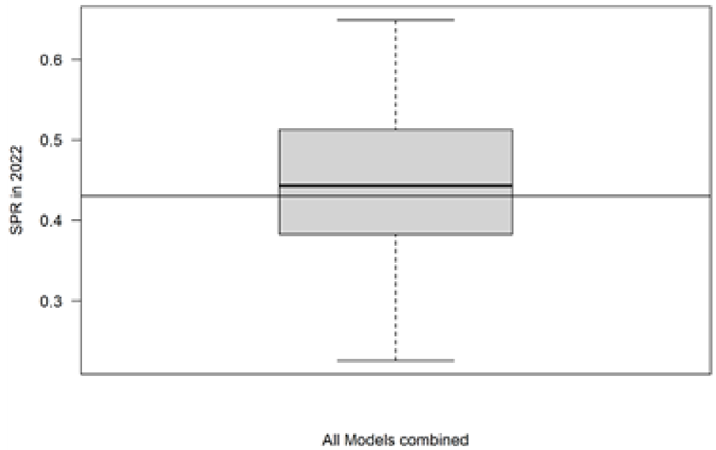

Figure 4. SPR in 2022 from the OM given fixed catches and distribution set by the Commission at the 98th IPHC Annual Meeting (IPHC-2022-AM098-R). The gray horizontal line is an SPR of 43%, corresponding to the coastwide mortality limit.

Many parameters used in the OM were drawn from the corresponding stock assessment model. Natural mortality was fixed in each model, separately for males and females. Maturity, mean weight-at-age, recruitment deviations, the relationship between R_0 and the Pacific Decadal Oscillation (PDO), selectivity, and fishing mortality were fixed at the values from the stock assessment. Parameters for initial average recruitment, recruitment distribution, initial fishing mortality, and movement were estimated during conditioning.

The models were independently conditioned to historical spawning biomass from the corresponding stock assessment model, recent ensemble spawning biomass from the stock assessment, fishery Independent Setline Survey (FISS) indices of abundance for each Biological Region, FISS estimates of proportions-at-age for each Biological Region, and proportion of all-sizes weight-per-unit-effort (WPUE) in each Biological Region from the space-time model analysis of FISS observations. The conditioning was heavily weighted to the stock distribution and spawning biomass components. The goal was to have models adequately representing stock distribution and spawning biomass in recent years, with some variability.

There is considerable confounding between the recruitment distribution and movement parameters (which was evident during the conditioning process), thus some parameters for movement between Biological Regions were fixed at values estimated from previous analyses (see Figure 3 in Hicks et al 2020b). The previous OM estimated considerably higher movement rates-at-age from Biological Region 2 back to Biological Region 3, which was unexpected. Fixing movement from Biological Region 2 to Biological Region 3 at values estimated directly from data resulted in more stable estimation with similar outputs.

Even though many parameters were fixed when conditioning the models, variability was propagated from the estimated as well as some fixed parameters, accounting for correlations between parameters. Bounds were enforced on some parameters and randomly drawn parameter sets that resulted in unrealistically low population sizes or extremely poor fits to stock distribution or spawning biomass were rejected. Multiple trajectories from 1958 through 2021 were produced for each model.

2.1.2 OM results and outputs

The four individual OM models showed important structural differences in terms of movement rates-at-age, recruitment distribution, and historical spawning biomass trends. The long AAF and long CW stock assessment models, which are the basis for conditioning each OM model, estimate significantly different historical spawning biomass trajectories before the early 2000s and subtle differences in recent trajectories (Figure 5). These differences are attributable to the very different assumptions about how the stock was distributed and connected via movement in relation to historical fishing mortality, and it is important to capture these differences in the OM.

The four OM models generally captured these trends in spawning biomass with the medCW models fitting the lower spawning biomass trend of the long CW assessment model and the medAAF model fitting the higher spawning biomass trend of the long AAF assessment model (Figure 6). The lowM models showed a higher probability that the spawning biomass is declining in recent years. The uncertainty in the OM also spanned the 2021 ensemble stock assessment uncertainty, except for the low spawning biomass in the 1970's (Figure 7).

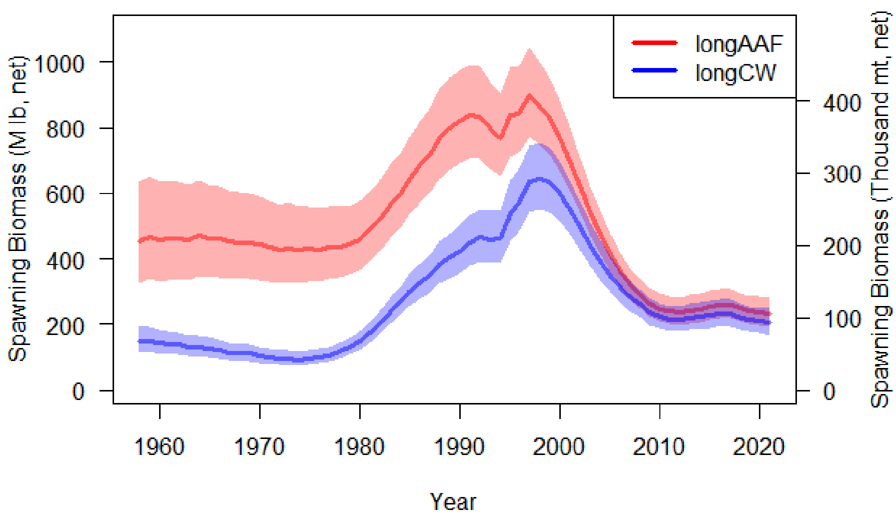

Figure 5. Estimated spawning biomass trajectories from 1958 to 2021 from the 2021 long AAF and long CW stock assessment models (Stewart & Hicks 2022).

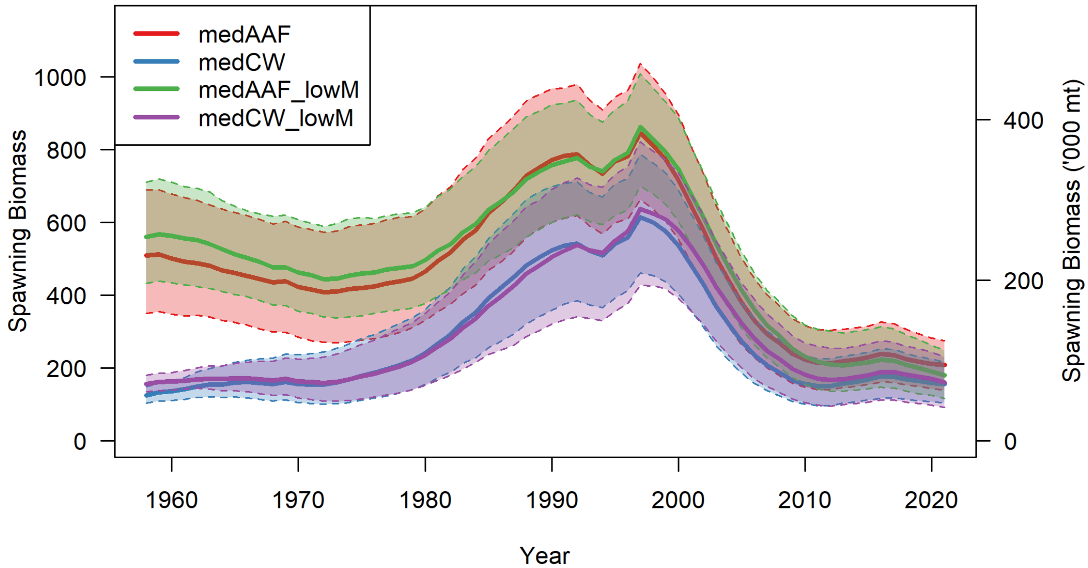

Figure 6. Median, 5th, and 95th quantiles for spawning biomass from the four OM models.

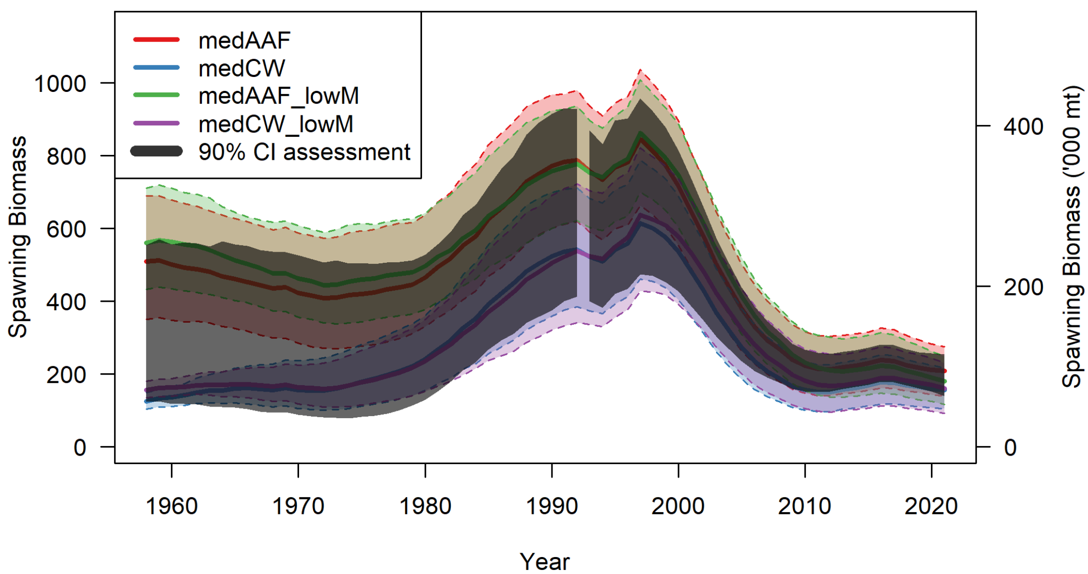

Figure 7. Median, 5th, and 95th quantiles for spawning biomass from the four OM models with the ensemble stock assessment range between the 5th and 95th quantiles shown in grey.

Stock distribution was fit well by both OM models (Figure 8) and showed similar patterns of lack of fit across all models. Specifically, the earliest years in Biological Region 4 were overfit by the OM, and recent years overfit in Biological Region 3 corresponding with a slight underfitting in region 4. All OM models matched closely with the proportion of biomass observed in 2021.

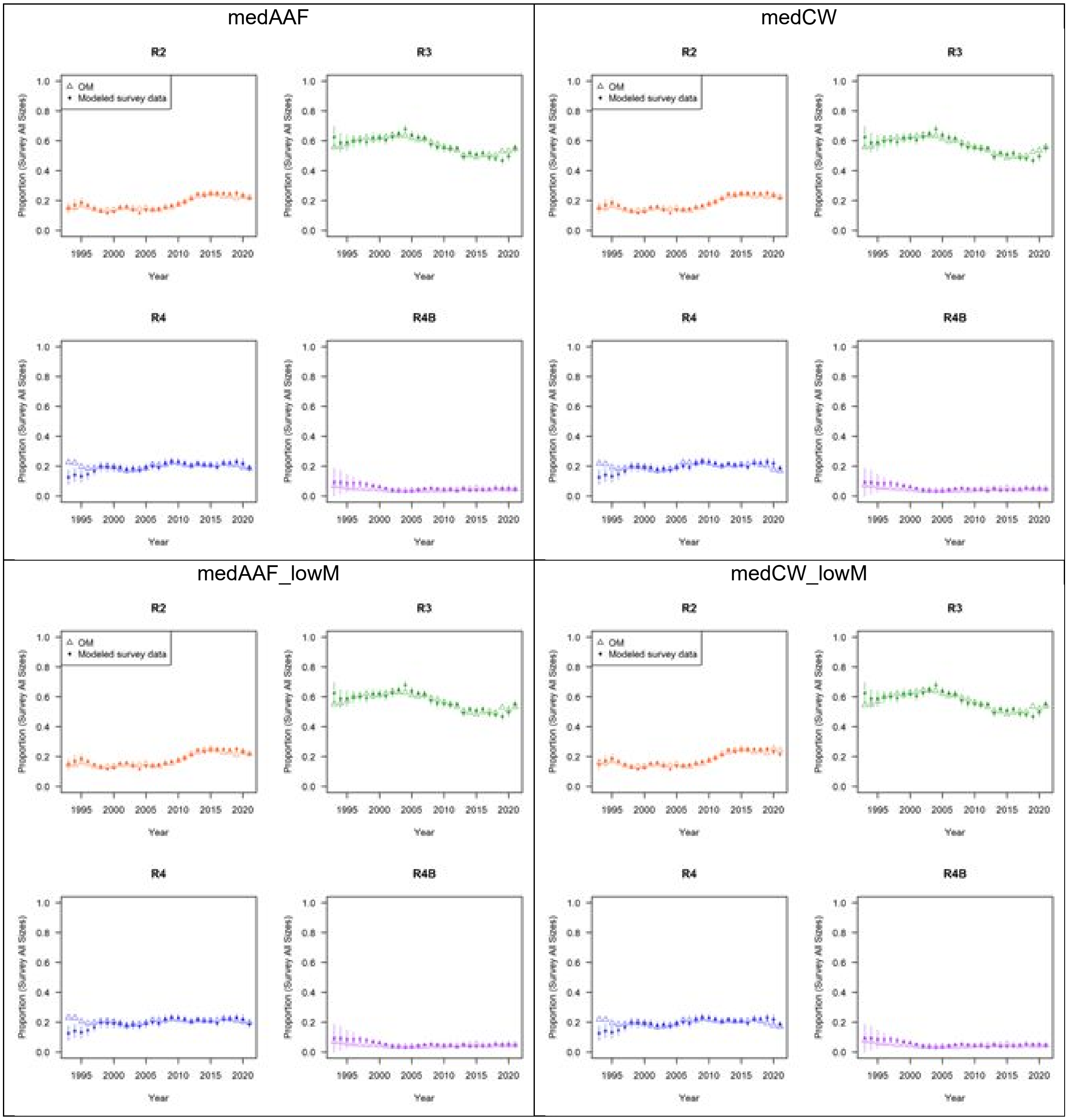

Figure 8. Fits to stock distribution across Biological Regions for each OM model.

The distribution of age-0 recruits showed a high proportion settling in Biological Region 4 in both low and high PDO regimes. The medCW showed a higher proportion of recruits settling in Biological Region 4 in high PDO years, but the medAAF model showed a slightly smaller proportion.

Movement rates between Biological Regions 3 and 2, and Biological Regions 4 and 3 were different between the four OM models (Figure 9). Both models generally showed high movement rates around ages 4 and 5 and slight differences between low and high PDO periods. Movement of fish younger than age 4 was very small from Biological Region 4 to 3 for both models and regimes, but there are few observations of fish younger than age 6 and a number of different movement rates of very young fish in combination with ages 4–6 could achieve similar results.

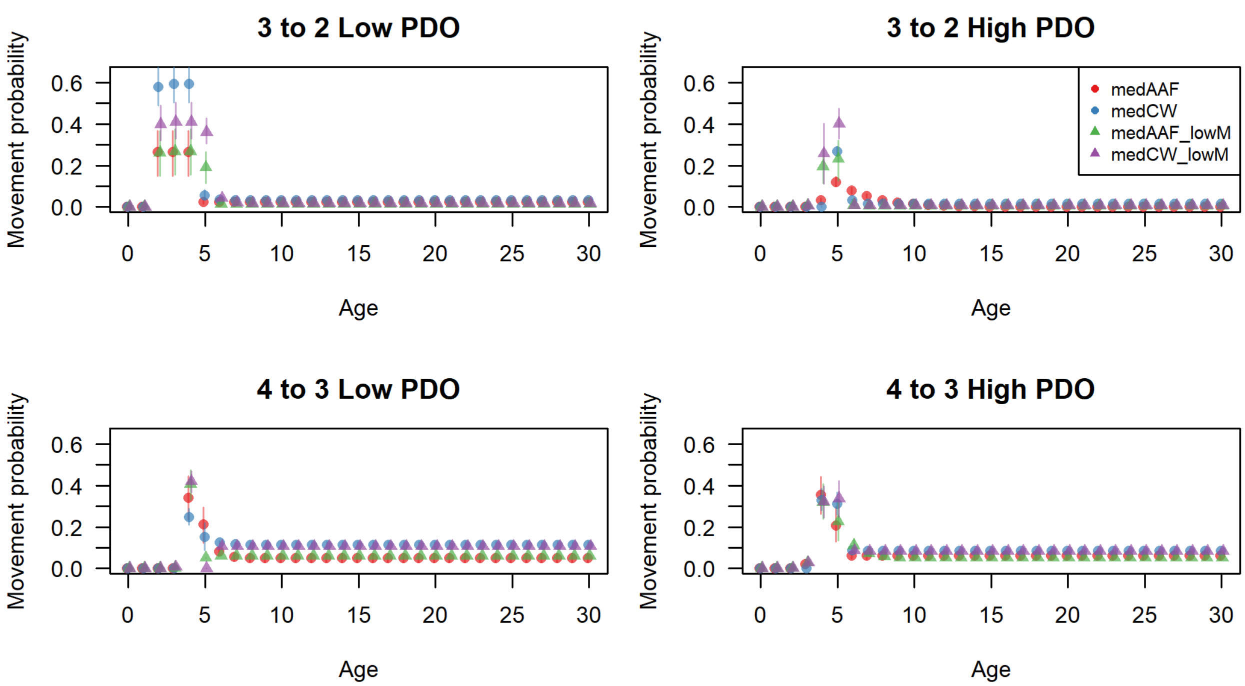

Figure 9. Probability of movement-at-age from Biological Region 3 to region 2 (top) and region 4 to region 3 (bottom) in low PDO (left) and high PDO (right) regimes for the four OM models.

2.2 Projections

The multiple trajectories from the conditioned OM provide replicate time-series of population and fishery processes. These remain fixed and the closed-loop simulation projects forward in time using various management procedures (MPs) and assumptions. The simulated projection of weight-at-age, selectivity/retention deviations, and the environmental regime do not depend on the population dynamics and can be created ahead of time to save time in the simulations, although any of these processes could be dependent on the size of the population, or a certain demographic, and included in the simulation process. Other processes, such as implementation variability, are also simulated during the closed-loop simulations.

2.2.1 Implementation variability and uncertainty

Implementation variability is defined as the deviation of the fishing mortality from the mortality limit determined from an MP. It can be thought of as what actually (or is believed to have) happened compared to the limits that were set. Decision-making variability is the difference between the MP mortality limits and the adopted mortality limits set by the Commission.

Decision-making uncertainty can be applied to the mortality limit specified by the MP ($TCEY_t$) as a multiplier.

$$\widetilde{TCEY}_t = TCEY_t \varepsilon_I$$

where $\widetilde{TCEY}_t$ is the adopted mortality and ε_I is the multiplier. Using observations from 2014 to 2021 of the MP mortality limit determined from the interim management procedure and the adopted mortality limits set by the Commission for that year and IPHC Regulatory Area, the multipliers are shown in Figure 10 (only the years 2014–2019 are plotted for 2A and 2B as those are the years without additional agreements). These years were chosen because they used a relatively consistent management procedure, although explicit use of SPR was added in 2017, additional agreements were added in 2019 and 2020, and the reference SPR changed from 46% to 43% in 2021. Decision-making uncertainty is likely different depending on the management procedure. Additionally, in 2021 and 2022, the adopted coastwide TCEY was equal to the coastwide TCEY specified by the interim management procedure, thus distribution was the only decision-making variability.

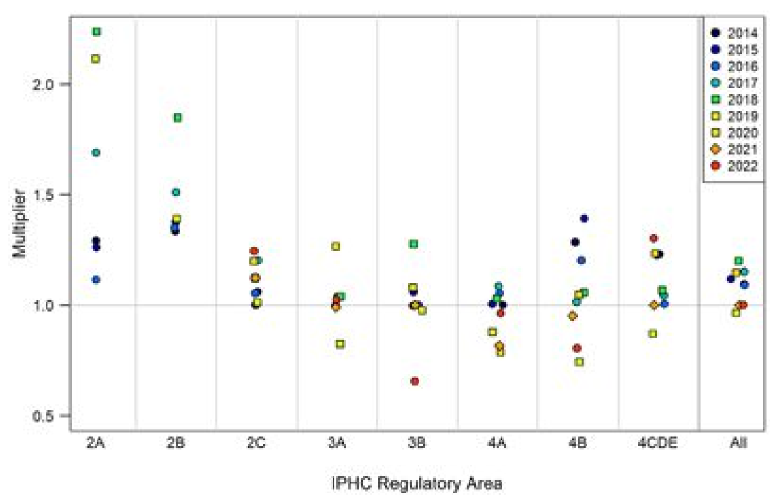

Figure 10. Multipliers for the difference between MP mortality limits and adopted mortality limits from 2014 to 2021. The years 2014-2019 only are plotted for 2A and 2B to show years when no specific agreements for those IPHC Regulatory Areas were in place.

2.2.1.1 Method to simulate decision-making uncertainty

The multiplier to simulate decision-making uncertainty is drawn from a lognormal distribution with correlation between multipliers for each IPHC Regulatory Area. The mean (center) and standard deviation (spread) of that distribution are modified such that the multiplier is closer to a value of one as the TCEY increases between low and high coastwide TCEYs. Using a coastwide low TCEY of 30 Mlbs and a coastwide high TCEY equal to 60 Mlbs (and years with no additional agreements for 2A and 2B), the distribution of simulated multipliers gets closer to 1 as the TCEY increases (Figure 11).

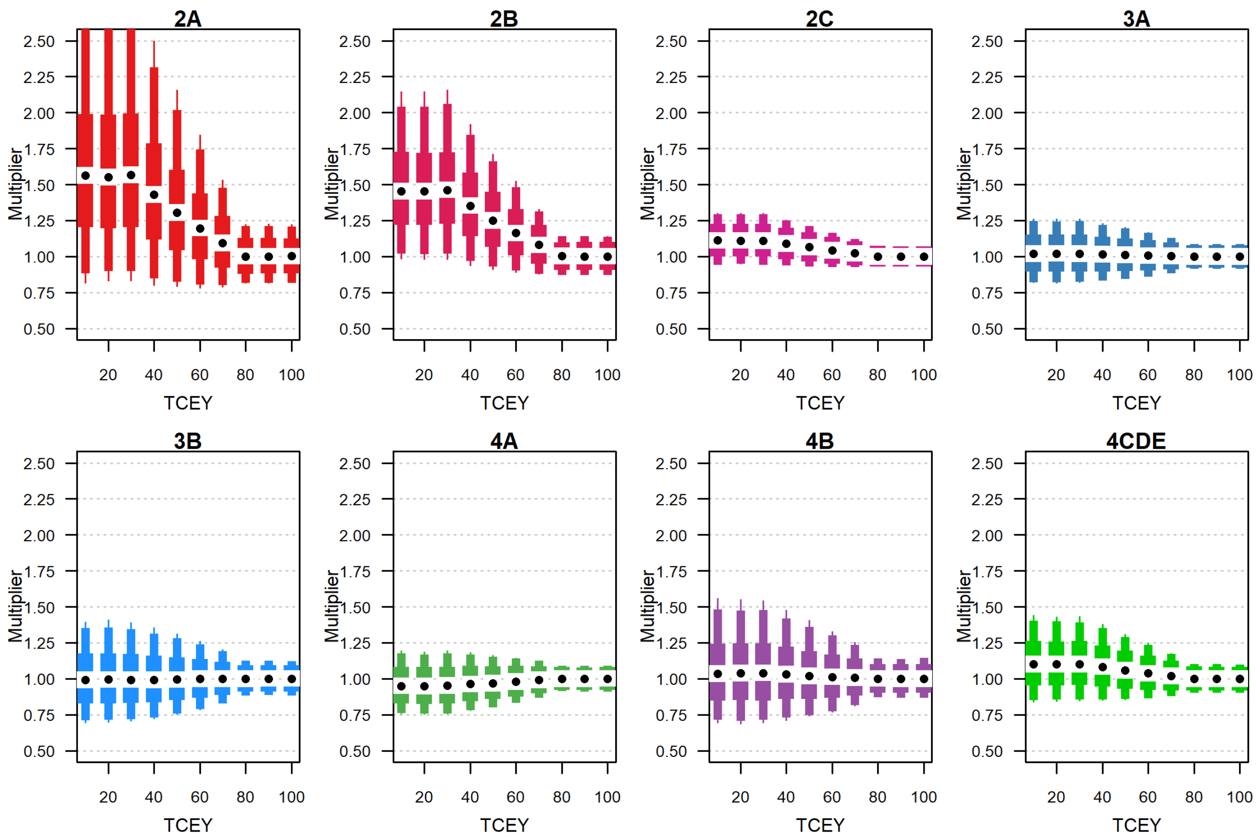

Figure 11. Simulated multipliers for IPHC Regulatory Areas at different values of the coastwide TCEY (without the recent agreements for 2A and 2B). The thickest portion of the vertical bar represents the 25th and 75th percentiles, followed by the 5th and 95th percentiles, and then the 2.5th and 97.5th percentiles.

Each IPHC Regulatory Area has a specific parameterisation to simulate decision-making variability, which is dependent on the specific management procedure. For example, an MP with a specific TCEY for an IPHC Regulatory Area will not have decision-making variability for that area, but other IPHC Regulatory Areas may have increased decision-making variability as a result. Furthermore, two options will be used for decision-making variability:

1. The coastwide TCEY is equal to the coastwide TCEY from the MP, but distribution contains decision-making variability.
2. The coastwide TCEY may deviate from the MP, along with distribution, due to decision-making variability.

Using option 1 at various TCEY values, and assuming 2021 stock distribution, the ranges of simulated TCEYs in each IPHC Regulatory Area are shown in Figure 12.

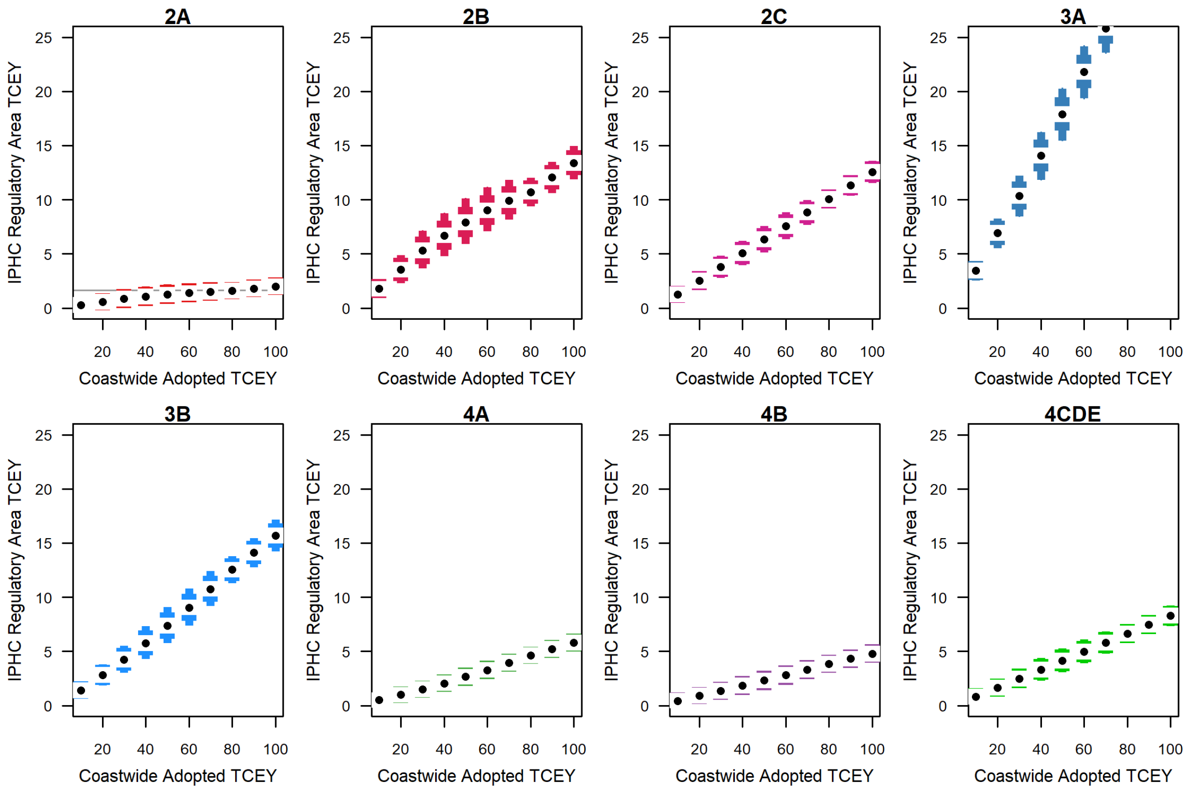

Figure 12. Simulated TCEYs in each IPHC Regulatory Area assuming there is no deviation from the coastwide TCEY (option 1), no additional agreements for 2A and 2B, and 2021 stock distribution.

Actual decision-making variability is likely more complex than these simple methods. In fact, some IPHC Regulatory Areas show a consistent adopted TCEY over a range of MP TCEYs (e.g., 4B in Figure 13). However, the goal of including decision-making uncertainty in the MSE simulations isn't to exactly simulate what the pattern may be in the future, but to identify the effect of decision-making uncertainty and identify MPs that are robust to a plausible amount of uncertainty and illustrate the costs or benefits of reducing decision-making uncertainty. Various modifications may be made to decision-making uncertainty to explore sensitivity to various hypotheses. For example, different offsets depending on the trend in the population or TCEY, as suggested by the SRB (SRB019–Rec.06, para. 35).

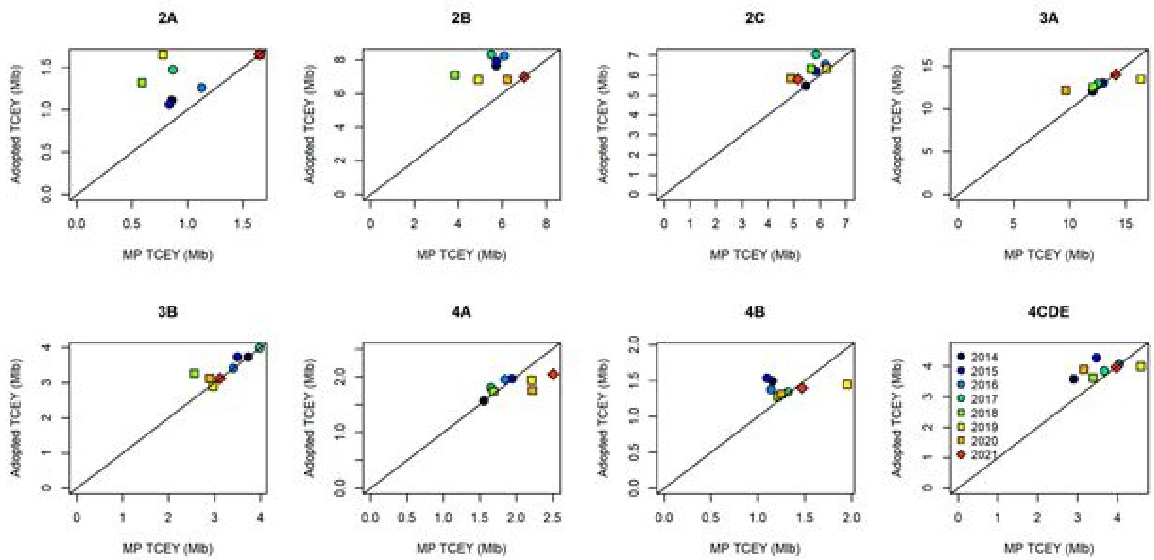

Figure 13. Adopted TCEYs plotted against MP TCEYs for each IPHC Regulatory Area and years 2014 to 2021.

2.2.1.2 Methods to simulate realized and perceived implementation uncertainty

Realized uncertainty is currently implemented in the OM by simulating a range of actual non-directed discard mortality, recreational mortality, and subsistence mortality. These are likely the largest sources of realized variability in the Pacific halibut fisheries, which is relatively small compared to many fisheries.

Perceived uncertainty is currently not simulated in the OM but will be considered as work progresses. Perceived uncertainty includes uncertainty related to sampling and estimation of landings and discards, which can include bias and variability for many reasons. Inclusion of perceived uncertainty in the MSE framework will likely not occur before the 99th Annual Meeting.

2.2.2 Estimation error

Estimation error is the uncertainty in parameters that are estimated for use in a management procedure. For example, relative spawning biomass is used in the 30:20 control rule and is an estimate from the stock assessment. The total mortality given a fixed SPR is also subject to estimation error.

There are three options for examining the effect of estimation error. The first is No Estimation Error, which is useful to understand the intrinsic qualities of a management procedure. The second is Simulated Estimation Error, which simulates the correlated uncertainty in relative spawning biomass and total mortality. This mimics the variability that may arise from a stock assessment, but not may not capture some of the nuances of the estimates from a stock assessment, such as bias and autocorrelation. The third is to run a stock assessment as part of the closed-loop simulation process (Simulated Stock Assessment). This can be time-consuming, especially with a complex ensemble assessment, thus simplifications are often made. Currently, a single simplified model from the Pacific halibut ensemble assessment is implemented in the MSE framework, and is useful for comparison to the simulated estimation error, but is not complete for decision-making purposes.

2.3 Runs and Scenarios

The primary closed-loop simulations consist of integrating the four OM models with equal weight by simulating an equal number of trajectories/projections from each model. Results from the full set of projections are used to calculate the performance metrics for measurable objectives and statistics of interest. Additional scenarios may be evaluated that include different types of implementation error or alternative scenarios of fishery selectivity (e.g. targeting or avoiding small Pacific halibut).

Scenarios that may be useful to examine include the following

- Targeting small Pacific halibut
- Avoiding small Pacific halibut
- Low or high weight-at-age
- Low or high recruitment regime

Specific management procedures being evaluated in 2022 are described in document IPHC-2022-MSAB07-09 along with preliminary results. Complete results will be presented at the 99th IPHC Annual Meeting. The MSE Explorer will be updated as results are obtained (Appendix A).

RECOMMENDATION/S

That the MSAB:

a) **NOTE** paper IPHC-2022-MSAB017-07 describing improvements to the closed-loop simulation framework, methods to include decision-making uncertainty, and possible scenarios to consider.

b) **RECOMMEND** additional improvements or additions to the MSE framework to be done in 2023.

c) **RECOMMEND** additional scenarios for consideration in the future.

REFERENCES

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Seitz, A. C., Farrugia, T. J., Norcross, B. L., Loher, T., & Nielsen, J. L. 2017. Basin-scale reproductive segregation of Pacific halibut (Hippoglossus stenolepis). Fisheries Management and Ecology, 24(4), 339–346.

Stewart, I., and A. Hicks. 2022. Assessment of the Pacific halibut (Hippoglossus stenolepis) stock at the end of 2021. IPHC-2022-SA-01. 16 December 2022. https://www.iphc.int/uploads/pdf/sa/2022/iphc-2022-sa-01.pdf

APPENDICES

Appendix A: Supplementary material

APPENDIX A
SUPPLEMENTARY MATERIAL

In addition to this document, an MSE technical document is available electronically. This is document IPHC-2022-MSE-01 and is available on the IPHC MSE page (https://www.iphc.int/management/science-and-research/management-strategy-evaluation). Additional updates will be made as time allows.

The MSE Explorer will also be updated as additional results.

(http://shiny.westus.cloudapp.azure.com/shiny/sample-apps/MSE-Explorer/).

Primary MSE goals, objectives, and performance metrics

PREPARED BY: IPHC SECRETARIAT (A. HICKS & I. STEWART; 16 SEPTEMBER 2022)

PURPOSE

To provide an overview of goals, scale and distribution objectives, and associated performance metrics to the Management Strategy Advisory Board (MSAB) for use in the MSE process.

1 INTRODUCTION

The Management Strategy Evaluation (MSE) at the International Pacific Halibut Commission (IPHC) has investigated elements of management strategies related to coastwide scale and distribution of the TCEY (Figure 1). Currently, the MSE is being used to investigate size limits and multi-year assessments. This document presents and describes the objectives that the MSAB and Commission have identified and may use to evaluate management procedures.

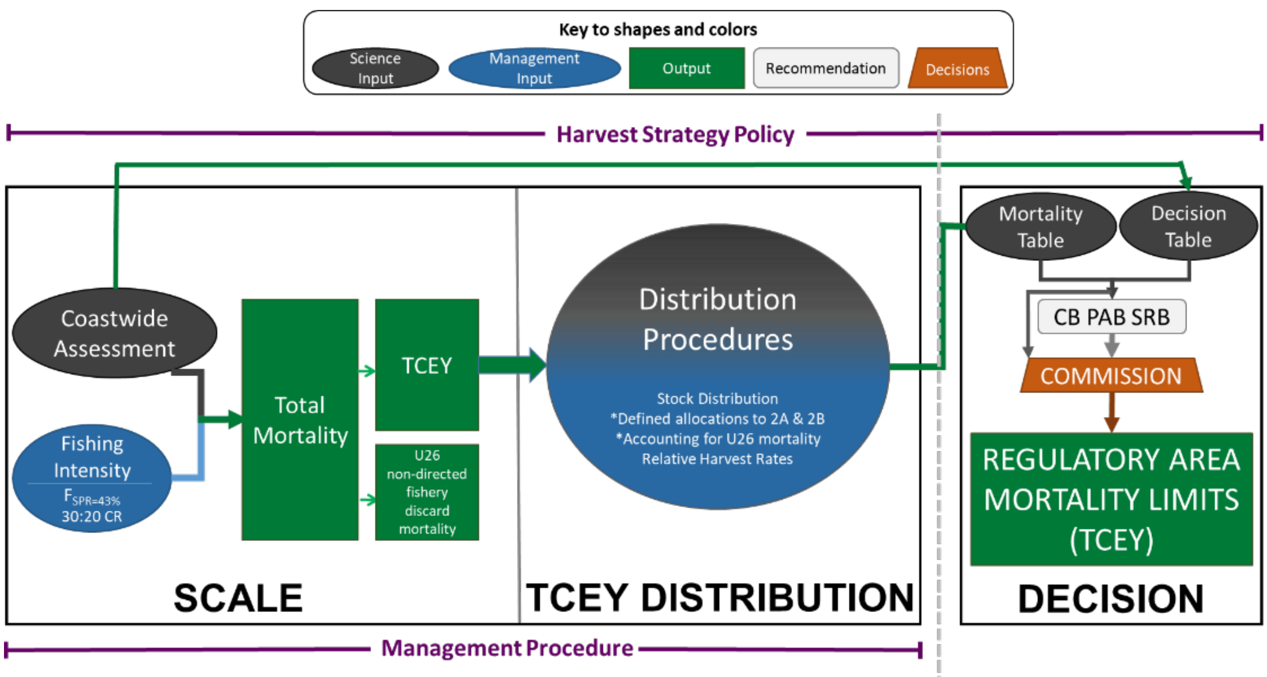

Figure 1. Illustration of the Commission interim IPHC harvest strategy policy (reflecting paragraph ID002 in IPHC-2020-CR-007) showing the coastwide scale and TCEY distribution components that comprise the management procedure. Items with an asterisk are interim agreements in place through 2022. The decision component is the Commission decision-making procedure, which considers inputs from many sources.

2 PRIMARY GOALS AND OBJECTIVES

The MSAB has previously defined four potential goals for evaluating management procedures, and the Commission has identified two of these as primary goals, each one with one or more objectives.

1. Biological Sustainability (also referred to as conservation goal)
   1.1. Keep biomass above a limit to avoid critical stock sizes
2. Optimise directed fishing opportunities (also referred to as fishery goal)
   2.1. Maintain spawning biomass around a level (i.e., a target biomass reference point) that optimises fishing activities
   2.2. Limit variability in mortality limits
   2.3. Provide directed fishing yield

Details of the primary goals and objectives defined by the Commission, along with performance metrics, are shown in Appendix I.

The two remaining goals, with undefined objectives are

3. Minimize discard mortality in directed fisheries
4. Minimize discards and discard mortality in non-directed fisheries (bycatch)

These goals related to discard mortality in directed fisheries and non-directed fisheries have not yet been specifically considered in the MSE but are identified by the MSAB as important to consider in the future.

We first present the MSAB-defined coastwide objectives and performance metrics linked to those objectives. We then present objectives for IPHC Regulatory Areas and Biological Regions that have been defined by the MSAB. This is followed by a discussion of potential additional objectives.

2.1 Coastwide objectives

Primary general objectives were identified by the MSAB and the Commission for evaluating MSE results related to coastwide fishing intensity as presented at AM095. At that time, the biological sustainability objective (maintain the biomass above a limit) was prioritized to be met before evaluating the fishery stability objective (limit variability in mortality limits), which must be met before evaluating the fishery yield objective (maximize the TCEY). Performance metrics were developed from these objectives by defining a measurable outcome, a tolerance (i.e., level of risk), and a timeframe over which it is desired to achieve that outcome. Many more objectives and performance metrics were identified (IPHC-2019-MSAB013-07 Appendix I) which were used to further evaluate the MSE results. Objectives that did not have a measurable outcome, tolerance, and/or timeframe defined were labeled as “statistics of interest.”

Subsequent to the presentation of coastwide objectives and MSE results at the 95th Annual Meeting (AM095), the following paragraphs from the Report of the 95th Annual Meeting (IPHC-2019-AM095-R) have guided further refinement of coastwide objectives.

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

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

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

The development of a spawning biomass target (i.e. a biomass level with a 50% probability of being above or below) was discussed extensively at MSAB013. Noting that the current IPHC harvest strategy policy (https://iphc.int/the-commission/harvest-strategy-policy) suggests using a proxy for Maximum Economic Yield (MEY), which is related to Maximum Sustainable Yield (MSY), much of the discussion focused around these quantities and what appropriate proxies may be.

The need to maximise economic benefit rather than maximising only yield has been widely recognized. However, the estimation of MEY and related quantities (SB_{MEY} and F_{MEY}) for specific fisheries remains challenging and requires a deep understanding of the economic variables relevant to the fishery. In the absence of this information and of a bio-economic model of the fishery, a proxy for MEY may be obtained from MSY. For example, the Australian government's harvest strategy policy uses the relationship: $SB_{MEY} = 1.2 \times SB_{MSY}$ (Rayns, 2007), and Pascoe *et al*. (2014) suggested that $SB_{MEY} = 1.45 \times SB_{MSY}$ may be appropriate for data-poor single-species fisheries.

Four dynamic equilibrium reference points were estimated for the Pacific halibut stock: 1) unfished equilibrium dynamic spawning biomass (SB_0), 2) MSY, 3) B_{MSY} as a percentage of SB_0 (RSB_{MSY}), and 4) the equilibrium fishing intensity to achieve MSY using spawning potential ratio (SPR_{MSY}), using three different methods (IPHC-2019-SRB015-11 Rev_1). Document IPHC-2019-SRB015-11 Rev_1 describes the methods and results from this analysis, and estimates the dynamic equilibrium RSB_{MSY} for Pacific halibut to likely be in the range of 20% to 30% and SPR_{MSY} to likely be between 30% and 35%. A reasonable RSB_{MSY} proxy, including a precautionary allowance for unexplored sources of uncertainty, would be 30%, and would put a proxy for SB_{MEY} between 36% and 44% given the recommendations of Rayns (2007) and Pascoe et al. (2014).

The objective of maintaining the spawning biomass around a target or above a level that optimises fishing activities can be viewed as a fishery objective (e.g. optimise yield) as well as a biological sustainability objective (e.g., maintain a sustainable biomass). However, sustainability of the Pacific halibut stock would be satisfied by meeting the objective of avoiding low stock sizes that may result in an impairment to recruitment. Therefore, the primary biological sustainability objective should be to avoid a minimum stock size threshold (i.e. B_{Lim}) with a high probability. Defining a fishery objective related to MSY or MEY, along with other fishery objectives, would be prioritized after meeting this single conservation objective.

Fishery objectives related to stability are included in the coastwide objectives (Appendix I). An *ad hoc* working group that met in July 2019 discussed the coastwide objective to limit annual changes in the TCEY, which is measured by the average annual variability (AAV), which is an average taken over a ten-year period. Using this performance metric means that when meeting the objective (a defined threshold) some of the individual annual changes in the TCEY might exceed the defined threshold. In addition, stakeholders may be interested in the actual annual changes from year to year and to limit them to a threshold that is never exceeded in a ten-year period or allow it to be exceeded in a small number of years. A statistic called Annual Change (AC) was defined to represent actual annual change in the TCEY and has been used as a primary stability objective in addition to AAV to provide an alternative view of stability.

2.2 Area-specific objectives

2.2.1 Biological sustainability

In paragraph 31 of IPHC-2018-SRB012-R, "the SRB AGREED that the defined Bioregions (i.e. 2,3,4, and 4b described in paper IPHC-2018-SRB012-08) are presently the best option for implementing a precautionary approach given uncertainty about spatial population structure and dynamics of Pacific halibut." Therefore, primary objectives related to conserving spatial population structure have been included under the Biological Sustainability goal (Appendix I).

Conserving spatial population structure may imply several meanings, such as maintaining the current biomass distribution across regions, maintaining the proportion of spawning biomass in each Biological Region within a specified range, or maintaining a minimum spawning biomass or proportion of spawning biomass in each Biological Region. The *ad hoc* working group proposed objectives to maintain a defined minimum proportion of spawning biomass in each Biological Region (Figure 2), which complement the coastwide biological sustainability objective of maintaining the coastwide spawning biomass above a limit. These minimum proportions were determined from recent observations, but not be reflective of long-term potential shifts in distribution. Therefore, they may be updated in the future.

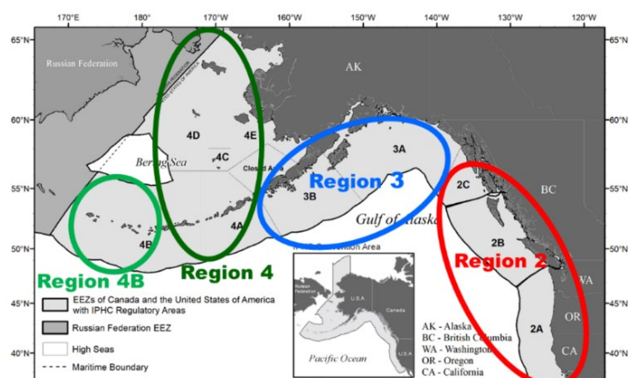

Figure 2. IPHC Regulatory Areas, Biological Regions, and the Pacific halibut geographical range within the territorial waters of Canada and the United States of America.

2.2.2 Optimise Directed Fishing Opportunities

Three primary general objectives are currently defined for this goal: 1) maintain the spawning biomass around a level that optimises fishing activities, 2) limit variability in mortality limits, and 3) provide directed fishing yield. Under each general objective, there are coastwide TCEY measurable objectives. While Biological Regions are the spatial scale for the biological sustainability goal, fishery objectives are related to IPHC Regulatory Areas because quotas are defined within these areas and are therefore of interest to a quota holder. A finer spatial scale than IPHC Regulatory Areas may be important to individual fishers and may be considered in future evaluations.

2.2.2.1 Maintain the spawning biomass around a level that optimises fishing activities

The objective to maintain the spawning biomass around a level that optimises fishing activities does not have corresponding objectives for IPHC Regulatory Areas. Defining a level of biomass that optimises fishing activity in an area of the coastwide population may be difficult without consideration of fishing activities in other areas. Therefore, only a coastwide objective has been defined.

2.2.2.2 Limit variability in mortality limits

The same objectives are defined for IPHC Regulatory Areas as for the coastwide objective to limit annual changes in the TCEY. This objective would capture the objective for stability in a stakeholder's area of interest as well as recognize that there is uncertainty in the distribution procedure that will likely add to variability in IPHC Regulatory Area mortality limits. The *ad hoc* working group from 2019 discussed the potential for redundancy when having the same objectives at a coastwide and IPHC regulatory area scale and it was noted that, even though this could be the case, the two will address two different issues: the coastwide objective will address the annual variability as a result of the population variability and assessment error, while at the regulatory area level the objective will address the uncertainty in the distribution procedure. For this reason, both have been carried forward. All objectives for variability are measured via statistics of interest and are directly evaluated rather than determining if they meet a defined tolerance.

2.2.2.3 Provide directed fishing yield

Three different types of objectives related to fishery yield in an IPHC Regulatory Area were defined.

1. An optimal yield/mortality level. This identifies an optimal TCEY, for example, that is desired within an IPHC Regulatory Area.
2. A minimum yield/mortality level. This identifies what is needed for economic viability or for directed fisheries to occur. This requires stakeholders in an area to only consider what is desired within that area.
3. A proportional share of the coastwide yield/mortality. This is a percentage of the coastwide mortality limit and would provide for sharing among areas even in times of low abundance and may maintain a sense of equity among areas. This requires within- and among-area considerations.

Given these three types of objectives, one coastwide and four IPHC Regulatory Area measurable objectives were defined (Appendix I). These objectives do not have a specific measurable outcome or tolerance, thus are statistics of interest. Performance metrics for are reported for each and evaluated directly.

3 Possible additional goals and objectives

Objectives in addition to the primary objectives described above may be useful when evaluating management procedures. In some cases, performance metrics are defined that are specifically associated with an objective. There are many examples in the MSE Explorer.

3.1 Goals and objectives related to discards and discard mortality

The evaluation of management procedures utilising different size limits may benefit from using objectives related to discard mortality in the directed fisheries. The MSAB has considered discard mortality objectives in the past (Table 1). It would be simple to report performance metrics related to discard mortality, but specifics of an objective should be selected by the MSAB and Commission (e.g. the 10% threshold in Table 1).

Table 1. Objectives related to discard mortality in directed fisheries as defined by the MSAB at MSAB011. See IPHC-2018-MSAB011-07.

General Objective	Measurable Objective	Measurable Outcome	Time-frame	Tolerance	Performance Metric
Minimise discard mortality in the longline fishery	Minimize directed fishery discard mortality	Median coastwide DM_d	Short-term		$Median\ \overline{DM_d}$
	Maintain the directed-fishery discard mortality at less than 10% of the annual mortality limit	DM_d<10% of the TCEY	Short-term		$P(DM_d < 0.1 \times TCEY)$

RECOMMENDATION/S

That the MSAB:

a) **NOTE** paper IPHC-2022-MSAB017-08 which includes descriptions of coastwide and area-specific objectives for use in the MSE.

b) **RECOMMEND** additional objectives, statistics of interest, and performance metrics to report.

REFERENCES

Pascoe S, Thebaud O, & Vieira S. 2014. Estimating proxy economic target reference points in data-poor single-species fisheries. M*arine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science*, 6(1), 247–259. https://doi.org/10.1080/19425120.2014.966215

Rayns, N. 2007. The Australian government's harvest strategy policy. *ICES Journal of Marine Science*, 64, 596–598.

APPENDICES

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

Appendix B: Supplementary material

APPENDIX A
PRIMARY OBJECTIVES DEFINED BY THE COMMISSION FOR THE MSE

Table I.1. 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.

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 a female spawning stock biomass above a biomass limit reference point at least 95% of the time	*SB* < Spawning Biomass Limit (SB_{Lim}) SB_{Lim}=20% unfished spawning biomass	Long-term	0.05	$P(SB < SB_{Lim})$
	Maintain a defined minimum proportion of female spawning biomass in each Biological Region	$p_{SB,2} > 5\%$ $p_{SB,3} > 33\%$ $p_{SB,2} > 10\%$ $p_{SB,2} > 2\%$	Long-term	0.05	$P\left(p_{SB,R} < p_{SB,R,min}\right)$
2.1 MAINTAIN SPAWNING BIOMASS AROUND A LEVEL THAT OPTIMIZES FISHING ACTIVITIES	Maintain the coastwide female spawning biomass above a biomass target reference point at least 50% of the time	*SB*<Spawning Biomass Target (SB_{Targ}) SB_{Targ}=$SB_{36\%}$ unfished spawning biomass	Long-term	0.50	$P\left(SB < SB_{Targ}\right)$
2.2. 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
2.3. 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)*

APPENDIX B
SUPPLEMENTARY MATERIAL

In addition to this document, an MSE technical document is available electronically. This is document IPHC-2022-MSE-01 and is available on the IPHC MSE page (https://www.iphc.int/management/science-and-research/management-strategy-evaluation).

The MSE Explorer will also be updated with additional results.

(http://shiny.westus.cloudapp.azure.com/shiny/sample-apps/MSE-Explorer/).

IPHC Secretariat MSE Program of Work (2022–2023) and an update on progress

PREPARED BY: IPHC SECRETARIAT (A. HICKS & I. STEWART; 16 SEPTEMBER 2022)

PURPOSE

To provide the Management Strategy Advisory Board (MSAB) with results for the Management Strategy Evaluation (MSE) simulations of size limit and multi-year stock assessment management procedures (MPs).

1 INTRODUCTION

The current interim management procedure at the International Pacific Halibut Commission (IPHC) is shown in Figure 1.

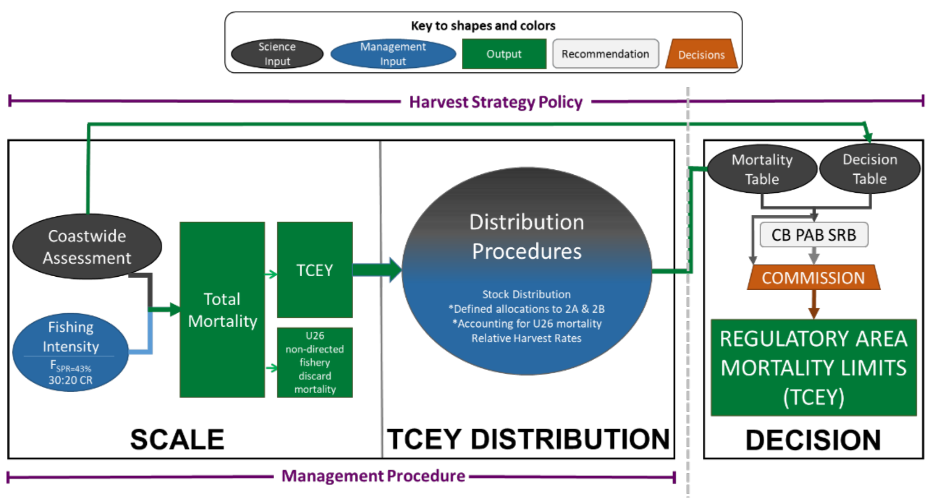

Figure 1. Illustration of the Commission interim IPHC harvest strategy policy (reflecting paragraph ID002 in IPHC-2020-CR-007) showing the coastwide scale and TCEY distribution components that comprise the management procedure. Items with an asterisk are interim agreements in place through 2022. The decision component is the Commission decision-making procedure, which considers inputs from many sources.

The Management Strategy Evaluation (MSE) at the IPHC completed an evaluation in 2021 of management procedures relative to the coastwide scale and distribution of the Total Constant Exploitation Yield (TCEY) to IPHC Regulatory Areas for the Pacific halibut fishery using a recently developed closed-loop simulation framework. Descriptions of those MPs evaluated, and simulation results are presented in Hicks et al. (2021). Additional tasks were identified at the 11th Special Session of the IPHC (IPHC-2021-SS011-R) to supplement and extend this analysis for future evaluation (Table 1). Document IPHC-2021-MSE-02 contains details of the current MSE Program of Work.

Table 1. Tasks recommended by the Commission at SS011 (IPHC-2021-SS011-R para 7) for inclusion in the IPHC Secretariat MSE Program of Work for 2021–2023.

ID	Category	Task	Deliverable
F.1	Framework	Develop migration scenarios	Develop OMs with alternative migration scenarios
F.2	Framework	Implementation variability	Incorporate additional sources of implementation variability in the framework
F.3	Framework	Develop more realistic simulations of estimation error	Improve the estimation model to more adequately mimic the ensemble stock assessment
F.5	Framework	Develop alternative OMs	Code alternative OMs in addition to the one already under evaluation.
M.1	MPs	Size limits	Identification, evaluation of size limits
M.3	MPs	Multi-year assessments	Evaluation of multi-year assessments
E.3	Evaluation	Presentation of results	Develop methods and outputs that are useful for presenting outcomes to stakeholders and Commissioners

This document provides simulation results for size limits and multi-year stock assessment elements of the IPHC harvest strategy policy. These results are compared and contrasted across assumptions of estimation error and decision-making variability.

2 MANAGEMENT PROCEDURES

Two categories of MPs were prioritised in the MSE Program of Work for 2021–2023. One was the investigation of size limits (M.1) and the other was to investigate multi-year stock assessments (i.e. not conducting the stock assessment annually; M.3). Due to improvements in the MSE framework and changes in the OM, select MP elements investigated previously, such as SPR, may need to be re-evaluated.

2.1 Size limits

Since 1973, IPHC has restricted the directed commercial fishery for Pacific halibut with a 32 inch (81.3 cm) minimum size limit, although other forms of size limits have been in place since 1940 (Myhre 1973). Many investigations of size limits have been completed since then including IPHC (1960), Clark & Parma (1995), Parma (1999), Valero & Hare (2012), Martell et al. (2015a), Martell et al. (2015b), Stewart & Hicks (2018), and Stewart et al (2021). Most of these analyses have focused on short-term effects or effects on reference points. The novelty of this analysis using the MSE framework was to examine long-term effects of different size limits in relation to defined conservation and fishery objectives. Additionally, long-term changes to the stock and fishery distribution as well as changes in productivity were examined.

The Commission requested that three size limits be investigated: 32 inches, 26 inches, and no size limit.

> **IPHC-2022-AM098-R, para. 61**: *The Commission RECALLED SS011-Rec.01 and REQUESTED that the current size limit (32 inches), a 26 inch size limit, and no size limit be investigated. to understand the long-term effects of a change in the size limit.*

It is uncertain how selectivity of the directed commercial fisheries may change with the implementation of a different size limit than the current 32 inches. Fisheries may choose to target smaller fish to increase efficiency, they may maintain current practices, or they may target larger fish if that provides improved economic gains. Some sensitivities to changes in selectivity (e.g. alternative scenarios) may be investigated.

An important concept to bring into the evaluation of size limits is market considerations. Stewart et al. (2021) used the ratio between the U32 price and O32 price for Pacific halibut to determine what ratio is necessary for the fishery to break even economically. It is unknown what prices will be for U32 Pacific halibut if a size limit was removed, but the FISS has recently begun selling U32 fish, which may be an indicator for future market conditions of small fish. Regardless, a performance metric related to economics will be important to consider in this evaluation.

2.2 Multi-year assessments

Management procedures with multi-year assessments incorporate a process where the stock assessment occurs at intervals longer than annually. The mortality limits in a year with the stock assessment can be determined as in previously defined MPs, but in years without a stock assessment, the mortality limits would need an alternative approach. This may be as simple as maintaining the same mortality limits for each IPHC Regulatory Area in years with no stock assessment, or as complicated as invoking an alternative MP that does not require a stock assessment (such as an empirical-based MP relying only on data/observations).

The Commission requested that the Secretariat investigate biennial assessments and potentially longer intervals as time allows.

> **IPHC-2022-AM098-R, para 64**: *The Commission REQUESTED that multi-year management procedures include the following concepts:*
>
> *a) The stock assessment occurs biennially (and possibly triennial if time in 2022 allows) and no changes would occur to the FISS (i.e. remains annual);*
>
> *b) The TCEY within IPHC Regulatory Areas for non-assessment years:*
>
> *i. remains the same as defined in the previous assessment year, or*
>
> *ii. changes within IPHC Regulatory Areas using simple empirical rules, to be developed by the IPHC Secretariat, that incorporate FISS data.*

There are many different empirical rules that could be applied to determine the TCEY in non-assessment years. We identified three empirical rules for determining IPHC Regulatory Area specific TCEYs in non-assessment years, which either use no observations or FISS observations .

a. The same TCEY from the previous year for each IPHC Regulatory Area.

b. Updating the coastwide TCEY proportionally to the change in the coastwide FISS O32 WPUE and updating the distribution of the TCEY using FISS results and the applied distribution procedure.

c. Maintaining the same coastwide TCEY as the previous year but updating the distribution of the TCEY using FISS results and the applied distribution procedure.

Empirical rule (a) does not update the TCEY in Regulatory Areas, which may deviate from distributions agreements related to a percentage of the coastwide TCEY, if present, due to changes in the distribution of biomass. Empirical rules (b) and (c) both adjust the distribution of the coastwide TCEY and would maintain any agreements related to distribution.

The coastwide TCEY set in the assessment year also can be calculated using different methods. The coastwide TCEY may simply be determined from the one-year projection of the stock assessment without any consideration of the projections beyond one year. This is the method assumed in the above empirical rules. An alternative method would be to take an average of the coastwide TCEYs, given a defined fishing intensity, projected for all years before the next assessment. This would account for potential changes in the population and may maintain the stock closer to target biomass levels and the fishing intensity closer to reference SPR levels. Alternative methods of averaging projected TCEYs were not considered.

Alternative approaches that would not require the current stock assessment for setting mortality limits in any year would be to use a simpler estimation model that is tuned to achieve the performance desired (i.e. meet primary objectives) or to adopt an empirical-based MP as the method for setting annual mortality limits. The stock assessment would be used at a defined interval to verify that management is effective, determine status of the stock, and to potentially tune the MSE OM and existing MP (Cox and Kronlund 2008). This concept was a request of the SRB

> **IPHC-2022-SRB020-R, para 20** The SRB REQUESTED that the MSE not attempt to implement a Stock Synthesis estimation procedure as part of the management procedure and, instead, to integrate a simpler assessment modelling approach into the management procedure via tuning

The Commission has realized that there are benefits to multi-year assessments, including stability and transparency in mortality limits for multiple rather than single years, additional time during the Interim/Annual meeting process to focus on topics other than setting mortality limits, time for development/improvement of the stock assessment, and the potential for increased collaborative research across branches within the IPHC Secretariat. However, there may be some costs associated with multi-year assessments. For example, performance in meeting conservation and fishery objectives may be reduced depending on the interval for multi-year assessments and the specifics of the selected management procedure.

The Commission has asked the SRB to assist the Secretariat in identifying potential costs and benefits of not conducting an annual stock assessment.

> **IPHC-2022-AM098-R, para 63:** *The Commission REQUESTED that the IPHC Secretariat work with the SRB and others as necessary to identify potential costs and benefits of not conducting an annual stock assessment. This will include a prioritized list of work items that could be accomplished in its place.*

The SRB provided some insight at SRB020 and the Secretariat will continue to work with the SRB in identifying costs and benefits.

> **IPHC-2022-SRB020-R, para 27**. *The SRB NOTED that assessment research activities (e.g. paras. 23-26) are examples of work that could be done more extensively in non-assessment years within a multi-year assessment schedule. Other work could include investigating optimal sub-sampling designs for ages, sex-ratio, annual assessment methods to use within the MPs, and well as any of the several topics listed under Stock Assessment Research. The quantifiable costs of multi-year assessments could be estimated within the MSE, for example, of potentially lower average yield for longer assessment cycles to achieve the same levels of risk associated with annual assessments.*

It may be premature to begin identifying detailed costs and benefits of multi-year assessments until an evaluation has been done to determine whether multi-year assessments may meet the Commission objectives already defined. An evaluation of multi-year assessments using Commission conservation and fishery objectives will be presented at the 99th IPHC Annual Meeting, after which a discussion of detailed costs and benefits would be informative.

2.3 Modelling distribution

The fisheries in the OM are specified by IPHC Regulatory Area because many of the Commission objectives used to evaluate MPs are specific to IPHC Regulatory Areas and the OM is spatially structured by Biological Region. This makes it necessary to distribute the TCEY across the fisheries to appropriately remove biomass from each Biological Region and allow for the calculation of necessary performance metrics. Distribution procedures have been evaluated (Hicks et al. 2021), but a specific MP has not been implemented. Even though distribution procedures are not currently being evaluated and there is no specific agreement on a single distribution procedure, they are part of the MP and need to be included in the simulations. Therefore, the Commission has recommended five different distribution procedures representing a practicable range to provide a robust analysis of size limits and multi-year assessments.

> **IPHC-2022-SS012-R, para 11**: *The Commission RECOMMENDED the following five distribution procedures to be used in the management strategy evaluation of size limits and multi-year assessments, noting that these distribution procedures are for analytical purposes only and are not endorsed by both parties, thus would be reviewed in the future if the Commission wishes to evaluate them for implementation.*
>
> > *a) Baseline based on recent year O32 FISS results, relative harvest rates of 1.0 for IPHC Regulatory Areas 2-3A, relative harvest rates of 0.75 for IPHC Regulatory Areas 3B-4, and no application of the current interim agreements for 2A and 2B;*

b) Baseline based on recent year O32 FISS results, relative harvest rates of 1.0 for IPHC Regulatory Areas 2-3A, relative harvest rates of 0.75 for IPHC Regulatory Areas 3B-4, and current interim agreements for 2A and 2B;

c) Baseline based on recent year O32 FISS results with 1.65 Mlbs to 2A and 20% of the coastwide TCEY to 2B;

d) Baseline based on recent year O32 FISS results, relative harvest rates of 1.0 for IPHC Regulatory Areas 2-3, 4A, and 4CDE, a relative harvest rate of 0.75 for IPHC Regulatory Area 4B, and no agreements for 2A and 2B;

e) Baseline based on recent year O32 FISS results, relative harvest rates of 1.0 for IPHC Regulatory Areas 2-3, 4A, and 4CDE, a relative harvest rate of 0.75 for IPHC Regulatory Area 4B, and current interim agreements for IPHC Regulatory Areas 2A and 2B

Three of the five distribution procedures contain agreements for IPHC Regulatory Areas 2A and 2B (b, c, and e). Decision-making variability for these two areas is set to zero when agreements are in place.

2.4 MP combinations

The simulation time for a single MP may be days, therefore it is useful to identify a minimal set of runs that will provide insight into the performance of each element of the MP of interest. There are six main elements of MPs to evaluate which include the three size limits and three empirical rules for biennial assessments, as presented above, and are combined as shown in Table 2. For each MP, an SPR of 43% was used, with some specific combinations using SPR values of 40% and 46% to further investigate the effects of fishing intensity.

Table 2. Primary MPs to be evaluated. The multi-year assessment specifies the frequency of the stock assessment and the procedure for years without a stock assessment (see Section 2.2).

MP ID	Multi-year assessment	Size Limit (inches)
MP-A32	Annual	32
MP-A26	Annual	26
MP-A0	Annual	0
MP-Ba32	Biennial, constant TCEY	32
MP-Bb32	Biennial, empirical rule	32
MP-Bc32	Biennial, update distribution	32

Additional factors are often useful to investigate to understand how sources of variability affect the outcomes. We examine estimation error (with or without) and decision-making variability (none and two options) to further examine the specific effects of these sources of variability. Evaluation of the main elements of the MPs under consideration (i.e. size limits and multi-year assessments, Table 2) should be done with estimation error and an appropriate specification of decision-making variability. However, an appropriate specification of decision-making variability is difficult to know. Therefore, we will compare results using the two decision-making variability options presented in IPHC-2022-MSAB017-07 with each other as well as with no decision-making variability. Results only for no decision-making variability and option 1 (distribution only) were available to report in this document, but results for option 2 will be available at MSAB017.

A secondary set of MPs may be developed based on the performance of the primary set. This may include crossing size limits with biennial assessments, tuning SPR values to best meet objectives, examining different levels of estimation error, and incorporating various forms of implementation variability. This secondary set will not be a full factorial, but instead a specific investigation of relevant factors, and to refine the best performing MPs relative to stock and fishery objectives.

Furthermore, a set of sensitivities will be done using alternative scenarios (see Section 2.3 in IPHC-2022-MSAB017-07). These will be performed on a small set of the best performing MPs.

3 RESULTS AND EVALUATION

The MPs were integrated across the distribution procedures, resulting in the six MPs in Table 2 as distribution is considered an uncertainty in this evaluation. However, any interesting differences between distribution procedures may be reported.

Improvement of the methods to evaluate simulation results and present those for decision-making are ongoing. Current tasks specifically include updates to the MSE Explorer tool, improving the ranking procedure to identify best performing management procedures, determining new methods to identify best performing management procedures, and providing new types of plots and tables that effectively communicate the results. This task will benefit from interactions with stakeholders and management agencies, including MSAB017.

3.1 Projections

The improvements to the MSE framework, including the updated OM, resulted in some different outcomes compared to the previous OM. However, general conclusions were consistent with previous analyses. The additional years at the end of the historical time-series in the OM resulted in immediate optimistic trends in the spawning biomass (Figure 2) due to a possibly large 2012 year class, a positive PDO regime, and increasing trends in weight-at-age. Therefore, short-term results from this analysis are likely more optimistic than previous analyses.

3.2 Size limits

Applying the three size limits resulted in little change to the biological sustainability performance metrics, but short-term fishery sustainability performance metrics showed some improvements when lowering the size limit (Table 3). The TCEY, on average, was 2.8% higher with a 26-inch size limit and 3.3% higher with no size limit. Annual variability in the TCEY was slightly reduced with lower size limits but above 15%.

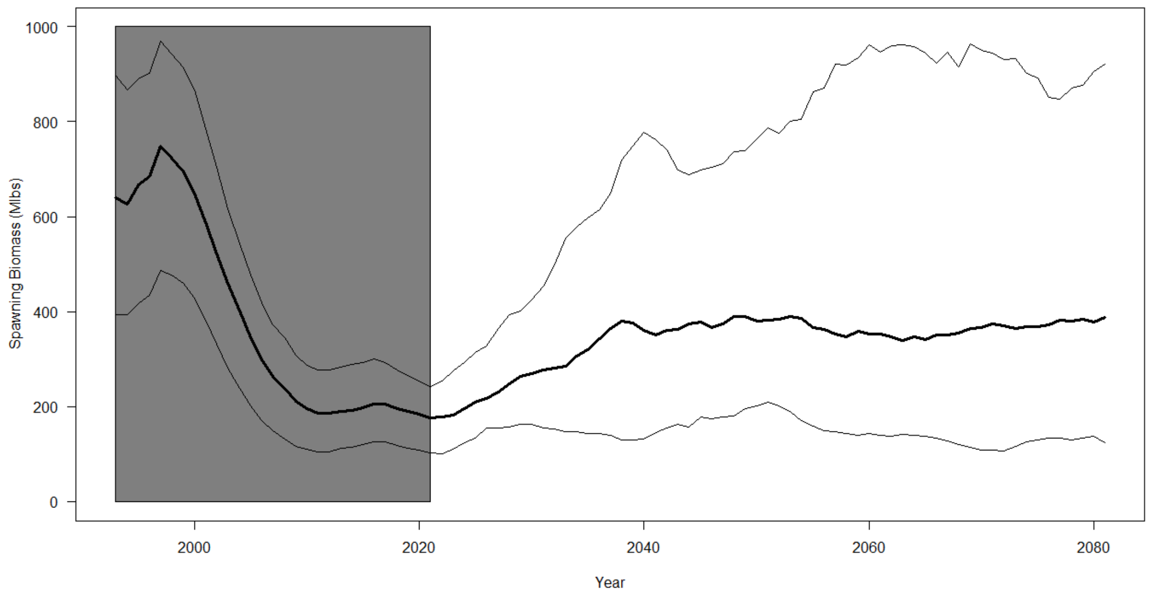

Figure 2. Projected spawning biomass with MP-A32, an SPR of 43%, and no estimation error. The shaded area is the historical region with fixed data and fishing mortality. The thick line is the median and the thin lines are the 5th and 95th percentiles.

The percentage gain in the TCEY is variable across years and is higher in the short-term given starting conditions of the projections (Figure 3) There is a very small probability that the TCEY is less without a size limit. The high percent gain in recent projected years is due to starting conditions, which declines as recruitment, weight-at-age, and environmental regimes become more integrated across the range of possible values. Therefore, the gains in yield due to lowering the size limit are likely dependent on the current size-at-age and incoming recruitment.

The patterns were similar for performance metrics calculated for each IPHC Regulatory Area (Table 4). The median average TCEY in the IPHC Regulatory Areas increased between 4.3% and 5.8% except for IPHC Regulatory Area 2A (no change since three of the five distribution procedures had a fixed 1.65 Mlbs) and IPHC Regulatory Area 2B (3.5%). Even though the TCEY in IPHC Regulatory Area 3A showed a modest percent increase without a size limit (4.3%), the absolute increase in the TCEY was over 1 million pounds. Annual variability in the TCEY for each IPHC Regulatory Area decreased when removing the size limit, but remained above 15.7% for all areas except 2A.

The majority of the gain in median average TCEY and the reduction in annual variability of the TCEY was achieved when lowering the size limit from 32 inches to 26 inches. This is because the directed commercial gear has a low selectivity for Pacific halibut less than 26 inches.

Table 3. Performance metrics related to primary objectives for size limit MPs with estimation error and decision-making variability option 1. Biological sustainability metrics are long-term and fishery sustainability are short-term (4–13 years).

MP name	**MP-A0**	**MP-A26**	**MP-A32**
Decision-making variability	**Option1**	**Option1**	**Option1**
Estimation Error	**Sim**	**Sim**	**Sim**
Assessment Frequency	**Annual**	**Annual**	**Annual**
Size Limit	**0**	**26**	**32**
SPR	**0.43**	**0.43**	**0.43**
Median average SPR	43.9%	44.0%	44.0%
Biological Sustainability			
Median average RSB	38.9%	38.9%	38.9%
P(any RSB_y<20%)	0	0	0
P(all RSB<36%)	0.14	0.14	0.15
Fishery Sustainability			
Median average TCEY	60.08	59.80	58.16
P(any3 change TCEY > 15%)	0.932	0.942	0.958
Median AAV TCEY	18.0%	18.2%	18.5%

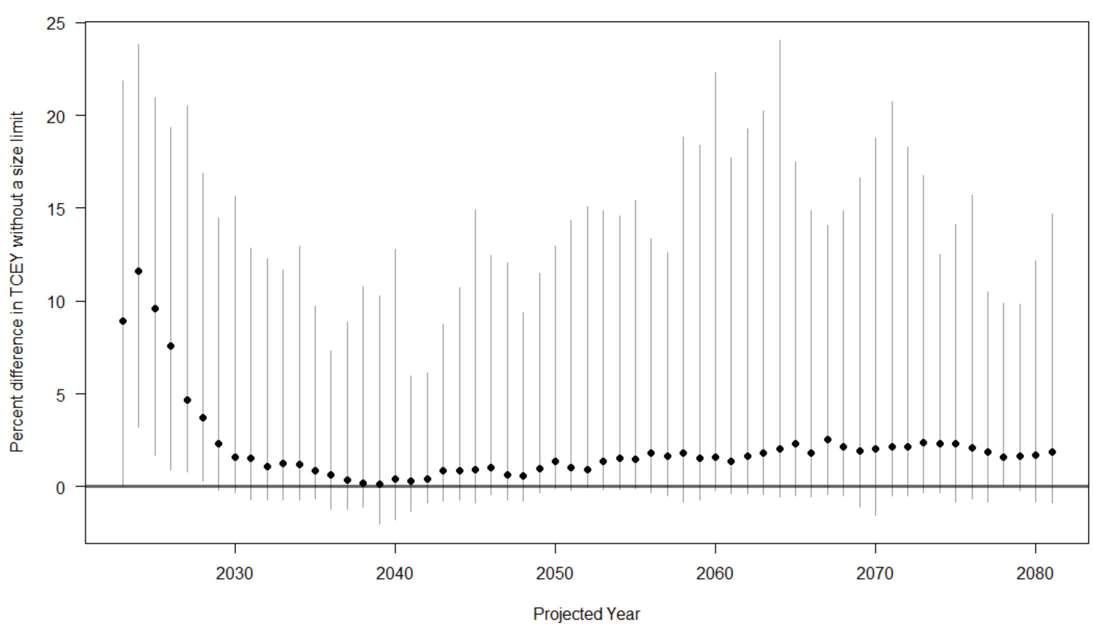

Figure 3. Percent difference in the TCEY without a size limit compared to a 32-inch size limit for each projected year when simulating estimation error and using an input SPR equal to 43%. The points are the median and the vertical lines connect the 5th and 95th percentiles.

Table 4. Performance metrics related to area-specific primary objectives for size limit MPs with no decision-making variability. Fishery sustainability metrics are short-term (4–13 years).

MP name	**MP-A0**	**MP-A26**	**MP-A32**
Decision-making variability	**Option1**	**Option1**	**Option1**
Estimation Error	**Sim**	**Sim**	**Sim**
Assessment Frequency	**Annual**	**Annual**	**Annual**
Size Limit	**0**	**26**	**32**
SPR	**0.43**	**0.43**	**0.43**
Median average TCEY-2A	1.63	1.63	1.63
Median average TCEY-2B	9.09	9.03	8.78
Median average TCEY-2C	6.79	6.77	6.47
Median average TCEY-3A	24.41	24.14	23.32
Median average TCEY-3B	7.48	7.45	7.17
Median average TCEY-4A	3.63	3.6	3.43
Median average TCEY-4CDE	4.25	4.22	4.04
Median average TCEY-4B	2.95	2.89	2.79
P(any3 change TCEY 2A > 15%)	0.262	0.266	0.294
P(any3 change TCEY 2B > 15%)	0.690	0.674	0.734
P(any3 change TCEY 2C > 15%)	0.748	0.768	0.786
P(any3 change TCEY 3A > 15%)	0.758	0.780	0.790
P(any3 change TCEY 3B > 15%)	0.758	0.778	0.788
P(any3 change TCEY 4A > 15%)	0.854	0.834	0.870
P(any3 change TCEY 4CDE > 15%)	0.612	0.624	0.610
P(any3 change TCEY 4B > 15%)	0.834	0.826	0.856
Median AAV TCEY 2A	2.30%	2.30%	2.50%
Median AAV TCEY 2B	16.80%	17.50%	18.00%
Median AAV TCEY 2C	18.40%	18.70%	19.20%
Median AAV TCEY 3A	19.90%	20.10%	20.40%
Median AAV TCEY 3B	20.80%	21.50%	21.50%
Median AAV TCEY 4A	21.50%	21.60%	22.30%
Median AAV TCEY 4CDE	15.70%	16.00%	15.80%
Median AAV TCEY 4B	21.90%	21.80%	22.50%

3.2.1 Effects of estimation error and decision-making variability

Simulated estimation error resulted in a lower average fishing intensity (i.e. higher SPR) but a slightly lower average relative spawning biomass when using an input SPR equal to 43%. The lower portion of the distribution of average relative spawning biomass was more compact than without estimation error as shown by the lower probability of being less than 36%. The upper portion of the distribution of average RSB was wider with estimation error (Figure 4).

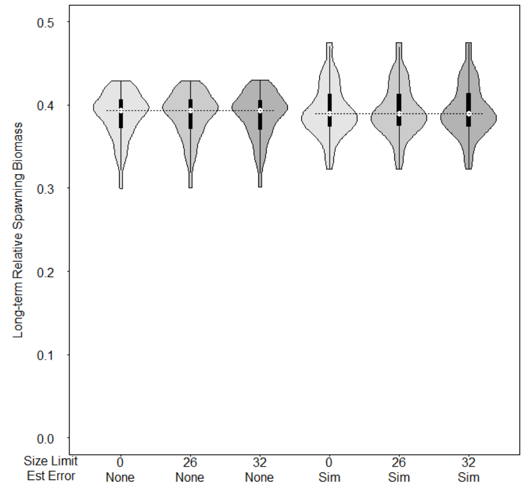

Figure 4. Violin plots of long-term relative spawning biomass for the three size limits (different shades of grey) and no estimation error (left) or simulated estimation error (right) and an input SPR equal to 43%. A dashed line is drawn at the median for the 32 inch size limit of each estimation error type.

Estimation error had a minor effect on the short-term TCEY but had a greater effect on the range of TCEY in the long-term (Figure 5). There was a clear lower bound on the TCEY, which was slightly lower in the long-term and with estimation error. The gain in TCEY when removing the size limit was reduced when simulating estimation error.

The biggest difference between no estimation error and simulated estimation error was seen in the variability metrics for the TCEY. The short-term coastwide AAV was greater than 18% (Table 3) and the short-term coastwide AAV was near 5% without estimation error. The probability of the change in TCEY for any 3 years out of 10 being greater than 15% was above 0.90 without estimation error (Table 3) and below 0.10 without estimation error. With or without estimation error, the removal of the size limit resulted in a very slight decrease in variability metrics.

Decision-making variability (option1) showed very little difference when compared to results not simulating decision-making variability. Results using option 2 for decision-making variability (departures from the coastwide TCEY) were not available for this document, but may show more of a difference.

3.2.2 Effects of fishing intensity (SPR)

Increasing fishing intensity resulted in higher average TCEY and higher variability in the TCEY (Table 5). Short-term median average TCEYs without a size limit and an input SPR of 40% increased by 4.6% compared to the short-term median average TCEY with a size limit of 32 inches and an input SPR of 40%. The short-term increase in yield was 2.4% without a size limit and an input SPR of 46%. Long-term yields showed a similar pattern with less increase (Table 6). Long-term probabilities of relative spawning biomass being less than 36% were around 42% with an input SPR of 40%.

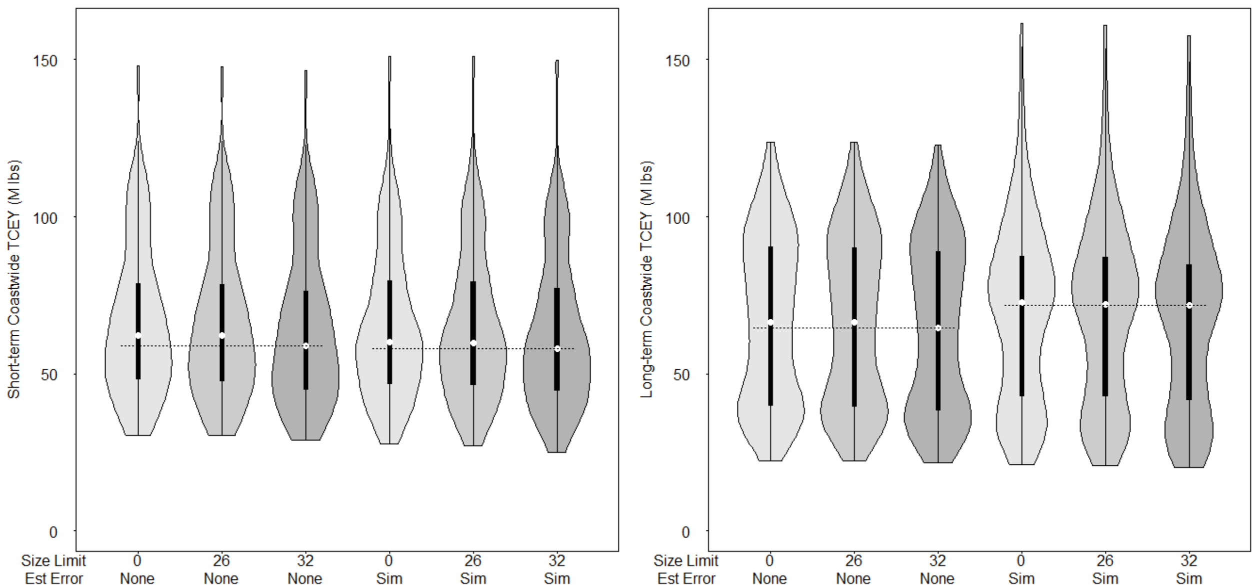

Figure 5. Short-term coastwide TCEY (left) and long-term coastwide TCEY (right) for the three size limits with (Sim) and without (None) simulated estimation error and an input SPR equal to 43%.

Table 5. Performance metrics related to primary objectives for no size limit and 32 inch size limit MPs with estimation error and decision-making variability option 1. Three different input SPR values (40%, 43%, and 46%) are used.

MP name	**MP-A0**	**MP-A0**	**MP-A0**	**MP-A32**	**MP-A32**	**MP-A32**
Decision-making variability			**Option1**			
Estimation Error			**Sim**			
Assessment Frequency			**Annual**			
Size Limit	**0**	**0**	**0**	**32**	**32**	**32**
SPR	**0.40**	**0.43**	**0.46**	**0.40**	**0.43**	**0.46**
Median average SPR	41.50%	43.70%	46.10%	41.60%	43.70%	46.30%
Biological Sustainability						
Median average RSB	36.50%	38.90%	41.70%	36.60%	38.90%	41.70%
P(any RSB_y<20%)	0	0	0	0	0	0
P(all RSB<36%)	0.43	0.14	0.05	0.42	0.15	0.06
Fishery Sustainability						
Median average TCEY	63.85	60.08	56.16	61.04	58.16	54.85
P(any3 change TCEY > 15%)	0.952	0.932	0.928	0.982	0.958	0.956
Median AAV TCEY	22.30%	18.00%	16.80%	22.40%	18.50%	17.20%

Table 6. Percent change in short-term and long-term yield of MPs with no size limit compared to MPs with a 32 inch size limit using three levels of input SPR**.**

SPR	**0.40**	**0.43**	**0.46**
Short-term	4.6%	3.3%	2.4%
Long-term	2.8%	1.9%	0.7%

3.3 Multi-year assessments

Simulations of an MP with a biennial assessment frequency were done using three options for non-assessment years: option a) used the same TCEY in each IPHC Regulatory from the previous assessment year, option b) updated the coastwide TCEY proportional to the change in the coastwide FISS index and updated distribution using FISS results, and option c) used a constant coastwide TCEY in non-assessment years but updated distribution using FISS observations. Long-term biological sustainability metrics were very similar across the four MPs of an annual assessment and three options for a biennial ssessment (Table 7). The long-term probability that the relative spawning biomass would be less than 36% differed slightly between MPs, with the biennial assessment frequency having a slightly higher probability. Differences in short-term median average TCEY were almost negligible, although the biennial MPs that did not update the coastwide TCEY in non-assessment years were slightly smaller and the biennial MP that used the FISS observations to update the coastwide TCEY was slightly larger. The annual variability of the TCEY was less for the biennial assessments that did not update the coastwide TCEY in non-assessment years, which is likely due to the fact that 5 of the 10 years had zero change. It is not known how much change occurred every other year when the TCEY was able to change, and there are no current objectives that would indicate whether a stable 2-year period with a larger biennial change is preferable to possibly smaller annual changes in the TCEY. The patterns in TCEY across MPs were similar for each IPHC Regulatory both in the short-term (Table 7) and the long-term (not shown).

3.3.1 Effects of estimation error and decision-making variability

Simulations with estimation error showed a lower probability of the relative spawning biomass being less than 36%, slightly lower short-term median average TCEY, and much higher short-term variability in the TCEY. Option 1 decision-making variability had little effect on the results for biennial assessment MPs. Results using option 2 for decision-making variability (departures from the coastwide TCEY) were not available for this document but may show more of a difference.

Table 7. Performance metrics related to primary objectives for annual and biennial MPs with a size limit of 32 inches simulated with estimation error and option 1 decision-making variability. Biological sustainability metrics are long-term and fishery sustainability are short-term (4–13 years). Long-term fishery sustainability metrics (not shown here) suggested a slightly larger median average TCEY in the biennial assessment MPs and slightly lower variability in the TCEY for biennial assessment MPs.

MP name	**MP-A32**	**MP-Ba32**	**MP-Bb32**	**MP-Bc32**
Decision-making variability	**Option1**	**Option1**	**Option1**	**Option1**
Estimation Error	**Sim**	**Sim**	**Sim**	**Sim**
Assessment Frequency	**Annual**	**Biennial**	**Biennial**	**Biennial**
Size Limit	**32**	**32**	**32**	**32**
SPR	**0.43**	**0.43**	**0.43**	**0.43**
Median average SPR	44.0%	43.3%	43.7%	43.3%
Biological Sustainability				
Median average RSB	38.9%	38.9%	38.8%	38.9%
P(any RSB_y<20%)	0.00	0.00	0.00	0.00
Fishery Sustainability				
P(all RSB<36%)	0.15	0.18	0.16	0.18
Median average TCEY	58.16	57.93	58.32	57.94
P(any3 change TCEY > 15%)	0.958	0.768	0.900	0.770
Median AAV TCEY	18.5%	14.6%	18.9%	14.6%

3.3.2 Effects of fishing intensity (SPR)

A higher fishing intensity (SPR=40%) showed higher long-term probabilities of the relative spawning biomass being below 36%, which were highest in the biennial assessment MPs (Table 9). Surprisingly, though, the long-term median average SPR for the biennial assessment MPs were higher, indicating a lower fishing intensity. It is uncertain why this occurs. The TCEY is similar across MPs and although the variability of the TCEY is higher due to higher fishing intensity, the pattern is the same as with SPR=43%.

Table 8. Short-term fishery-sustainability performance metrics for each IPHC Regulatory Area related to primary objectives for annual and biennial MPs with a size limit of 32 inches simulated with estimation error and option 1 decision-making variability.

MP name	MP-A32	MP-Ba32	MP-Bb32	MP-Bc32
Decision-making variability	**Option1**	**Option1**	**Option1**	**Option1**
Estimation Error	**Sim**	**Sim**	**Sim**	**Sim**
Assessment Frequency	**Annual**	**Biennial**	**Biennial**	**Biennial**
Size Limit	**32**	**32**	**32**	**32**
SPR	**0.43**	**0.43**	**0.43**	**0.43**
Median average TCEY-2A	1.63	1.63	1.63	1.63
Median average TCEY-2B	8.78	8.67	8.7	8.69
Median average TCEY-2C	6.47	6.31	6.42	6.39
Median average TCEY-3A	23.32	22.89	23.27	22.82
Median average TCEY-3B	7.17	7.05	7.16	7.06
Median average TCEY-4A	3.43	3.44	3.47	3.40
Median average TCEY-4CDE	4.04	4.03	4.04	4.02
Median average TCEY-4B	2.79	2.75	2.76	2.71
P(any3 change TCEY 2A > 15%)	0.958	0.768	0.900	0.770
P(any3 change TCEY 2B > 15%)	0.294	0.128	0.244	0.184
P(any3 change TCEY 2C > 15%)	0.734	0.454	0.624	0.492
P(any3 change TCEY 3A > 15%)	0.786	0.492	0.698	0.512
P(any3 change TCEY 3B > 15%)	0.790	0.532	0.778	0.560
P(any3 change TCEY 4A > 15%)	0.788	0.518	0.772	0.594
P(any3 change TCEY 4CDE > 15%)	0.870	0.516	0.754	0.580
P(any3 change TCEY 4B > 15%)	0.610	0.298	0.556	0.396
Median AAV TCEY 2A	2.5%	1.9%	2.3%	2.0%
Median AAV TCEY 2B	18.0%	13.8%	17.8%	15.0%
Median AAV TCEY 2C	19.2%	15.2%	19.4%	16.7%
Median AAV TCEY 3A	20.4%	15.5%	21.0%	16.6%
Median AAV TCEY 3B	21.5%	16.7%	21.9%	18.1%
Median AAV TCEY 4A	22.3%	17.0%	22.0%	19.6%
Median AAV TCEY 4CDE	15.8%	11.9%	16.0%	14.0%
Median AAV TCEY 4B	22.5%	16.3%	21.4%	19.7%

3.4 Additional results anticipated for the 99th IPHC Annual Meeting

Additional results and comparisons will be provided at the 99th IPHC Annual Meeting. Option 2 for decision-making variability with estimation error will be simulated and contrasted to runs without this source of variability. Additional performance metrics will also be examined, including the age/size composition of landings, the amount of fish discarded and discard mortality in the directed commercial fisheries, and other sector-specific metrics.

Table 9. Performance metrics related to primary objectives for annual and biennial MPs with a size limit of 32 inches and SPR equal to 40%, simulated with estimation error and option 1 decision-making variability. Biological sustainability metrics are long-term and fishery sustainability are short-term (4–13 years).

MP name	**MP-A32**	**MP-Ba32**	**MP-Bb32**	**MP-Bc32**
Decision-making variability	**Option1**	**Option1**	**Option1**	**Option1**
Estimation Error	**Sim**	**Sim**	**Sim**	**Sim**
Assessment Frequency	**Annual**	**Biennial**	**Biennial**	**Biennial**
Size Limit	**32**	**32**	**32**	**32**
SPR	**0.40**	**0.40**	**0.40**	**0.40**
Median average SPR	41.7%	42.5%	42.3%	42.4%
Biological Sustainability				
Median average RSB	36.6%	36.4%	36.3%	36.4%
P(any RSB_y<20%)	0.00	0.00	0.00	0.00
Fishery Sustainability				
P(all RSB<36%)	41.8%	45.1%	44.3%	45.1%
Median average TCEY	61.04	61.03	61.74	60.97
P(any3 change TCEY > 15%)	0.982	0.824	0.934	0.822
Median AAV TCEY	22.4%	17.8%	22.9%	17.7%

RECOMMENDATION/S

That the MSAB:

a) **NOTE** paper IPHC-2022-MSAB017-09 describing size limits and biennial assessment management procedures with simulation results to evaluate.

b) **RECOMMEND** additional scenarios or additional MPs to be presented at IM098 and AM099.

c) **RECOMMEND** additional performance metrics that may be useful for evaluation of size limit and biennial assessment MPs.

d) **RECOMMEND** MPs to evaluate beyond 2023.

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APPENDICES

Appendix A: Supplementary material

APPENDIX A
SUPPLEMENTARY MATERIAL

In addition to this document, an MSE technical document is available electronically. This is document IPHC-2022-MSE-01 and is available on the IPHC MSE page (https://www.iphc.int/management/science-and-research/management-strategy-evaluation). Additional updates will be made as time allows.

The MSE Explorer will also be updated as additional results.

(http://shiny.westus.cloudapp.azure.com/shiny/sample-apps/MSE-Explorer/).