INTERNATIONAL PACIFIC HALIBUT COMMISSION

Management Strategy Advisory Board (MSAB012) – A Collection of Published Meeting Documents

22 – 25 October 2018, Seattle, WA

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INTERNATIONAL PACIFIC HALIBUT COMMISSION

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DRAFT: AGENDA & SCHEDULE FOR THE 12th SESSION OF THE IPHC MANAGEMENT STRATEGY ADVISORY BOARD (MSAB012)

Date: 22-25 October 2018
Location: Seattle, Washington, U.S.A.
Venue: IPHC Training Room
Time: 22nd: 12:00-17:00; 23rd-25th: 09:00-17:00 daily
Co-Chairpersons: Mr. Adam Keizer (Canada) and Dr. Carey McGilliard (U.S.A.)

1. OPENING OF THE SESSION

2. ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION

3. IPHC PROCESS
- 3.1. MSAB Membership and Officers
- 3.2. Update on the actions arising from the 11th Session of the MSAB (MSAB011)
- 3.3. Review of the outcomes of the 13th Session of the Scientific Review Board (SRB013)

4. GOALS, OBJECTIVES, AND PERFORMANCE METRICS
- 4.1. A review of the coastwide goals and objectives of the IPHC MSE process
- 4.2. Performance metrics for evaluation

5. HARVEST STRATEGY POLICY, PART 1: SIMULATIONS TO EVALUATE FISHING INTENSITY
- 5.1. A description of the closed-loop simulation framework
- 5.2. A review of variability and scenarios
- 5.3. Closed-loop simulation results to investigate coastwide fishing intensity

6. HARVEST STRATEGY POLICY, PART 2: ADDRESSING STOCK AND TOTAL CONSTANT EXPLOITATION YIELD (TCEY) DISTRIBUTION
- 6.1. Discussion of distribution goals
- 6.2. Review the framework to investigate distributing the TCEY among IPHC Regulatory Areas and evaluate against objectives
- 6.3. Identify preliminary MPs related to distribution

7. MSAB PROGRAM OF WORK (2019-23)

8. OTHER BUSINESS
- 8.1. IPHC meetings calendar (2019-21)

9. REVIEW OF THE DRAFT AND ADOPTION OF THE REPORT OF THE 12th SESSION OF THE IPHC MANAGEMENT STRATEGY ADVISORY BOARD (MSAB012)

DRAFT: SCHEDULE FOR THE 12th SESSION OF THE IPHC MANAGEMENT STRATEGY ADVISORY BOARD (MSAB012)

Monday, 22 October 2018		
Time	**Agenda item**	**Lead**
12:00–12:30	Arrival: light lunch provided	
12:30–12:40	1. Opening of the Session	Co-Chairpersons
12:40–12:45	2. Adoption of the agenda and arrangements for the Session	Co-Chairpersons
12:45–12:55	3.1. MSAB Membership and Officers	D. Wilson
12:55–13:15	3.2. Update on the actions arising from the 11th Session of the MSAB (MSAB011)	A. Hicks
13:15–13:30	3.3. Review of the outcomes of the 13th Session of the Scientific Review Board (SRB013)	D. Wilson
13:30–15:30	4.1. A review of the coastwide goals and objectives of the IPHC MSE process	A. Hicks
15:30–15:45	Break	
15:45–16:30	4.2. Performance metrics for evaluation	A. Hicks
16:30–17:00	Unfinished business and review of the day	Co-Chairpersons
Tuesday, 23 October 2018		
09:00–09:15	Recap of previous day	Co-Chairpersons
09:15–10:30	5.1. A description of the closed-loop simulation framework	A. Hicks
10:30–10:45	Break	
10:45–12:30	5.2. A review of variability and scenarios	A. Hicks
12:30–13:30	Lunch	
13:30–15:30	5.3. Closed-loop simulation results to investigate coastwide fishing intensity	A. Hicks
15:30–15:45	Break	
15:45–16:30	6.1. Discussion of distribution goals	A. Hicks
16:30–17:00	Unfinished business and review of the day	Co-Chairpersons
Wednesday, 24 October 2018		
09:00–09:30	Recap from previous day	Co-Chairpersons
09:30–10:30	5.3. (Revisit) closed-loop simulation results to investigate coastwide fishing intensity (as necessary).	A. Hicks
10:30–10:45	Break	

10:45–12:30	6.2. Review the framework to investigate distributing the TCEY among IPHC Regulatory Areas and evaluate against objectives	A. Hicks
12:30–13:30	Lunch	
13:30-15:30	6.3. Identify preliminary MPs related to distribution	A. Hicks
15:30–15:45	Break	
15:45–16:00	Unfinished business and review of the day	Co-Chairpersons
16:00–17:00	Report drafting session	Steering Committee
Thursday, 25 October 2018		
09:00–10:30	Open session as needed	
10:30–10:45	Break	
10:45–11:00	7. MSAB Program of Work (2019-23)	Co-Chairpersons
11:00–11:15	8.1. IPHC meetings calendar (2019-21)	D. Wilson
11:15–12:30	IPHC Secretariat drafting Session	IPHC Secretariat
12:30–13:30	Lunch	
13:30–17:00	9. Review of the draft and adoption of the report of the 12th Session of the IPHC Management Strategy Advisory Board (MSAB012)	Co-Chairpersons & D. Wilson

DRAFT: LIST OF DOCUMENTS FOR THE 12th SESSION OF THE IPHC MANAGEMENT STRATEGY ADVISORY BOARD (MSAB012)

Last updated: 18 October 2018

Document	Title	Availability
IPHC-2018-MSAB012-01	Draft: Agenda & Schedule for the 12th Session of the IPHC Management Strategy Advisory Board (MSAB012)	✓ 23 July 2018 ✓ 21 September 2018
IPHC-2018-MSAB012-02	Draft: List of Documents for the 12th Session of the IPHC Management Strategy Advisory Board (MSAB012)	✓ 21 September 2018 ✓ 18 October 2018
IPHC-2018-MSAB012-03 Rev_1	MSAB Membership and Officers (IPHC Secretariat)	✓ 21 September 2018 ✓ 18 October 2018
IPHC-2018-MSAB012-04	Update on the actions arising from the 10th Session of the MSAB (MSAB011) (IPHC Secretariat)	✓ 21 September 2018
IPHC-2018-MSAB012-05	Outcomes of the 12th Session of the IPHC Scientific Review Board (SRB012) (IPHC Secretariat)	✓ 16 October 2018
IPHC-2018-MSAB012-06	Goals, Objectives, and Performance Metrics for the IPHC Management Strategy Evaluation (MSE) (A. Hicks)	✓ 21 September 2018
IPHC-2018-MSAB012-07 Rev_1	IPHC Management Strategy Evaluation to Investigate Fishing Intensity (A. Hicks & I. Stewart)	✓ 22 September 2018 ✓ 16 October 2018
IPHC-2018-MSAB012-08	Ideas on estimating stock distribution and distributing catch for Pacific halibut fisheries (A. Hicks & I. Stewart)	✓ 22 September 2018
IPHC-2018-MSAB012-09	IPHC Secretariat Program of Work for MSAB Related Activities 2019-23 (A. Hicks)	✓ 21 September 2018
Information papers		
Nil	Nil	Nil

MSAB MEMBERSHIP

PREPARED BY: IPHC SECRETARIAT (18 OCTOBER 2018)

PURPOSE

To provide the MSAB with the updated membership and list of officers.

BACKGROUND

Rule 4 of Appendix V [Management Strategy Advisory Board (MSAB) – Terms of Reference and Rules of Procedure] of the IPHC Rules of Procedure (2017), 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…*"

DISCUSSION

MSAB011, members considered the range of vacancies on the MSAB and agreed on a way forward:

IPHC-2018-MSAB011-R (Para. 9) "*The MSAB **AGREED** that an Expression of Interest (EOI) for the vacant MSAB member positions should be circulated by the IPHC Secretariat. At the close of a 30 day EOI period, the IPHC Secretariat shall provide the EOIs to the Commission, who will be asked to make an inter-sessional decision on MSAB membership. The MSAB would also be provided with the EOI's for information purposes.*"

On 15 May 2018, the IPHC Secretariat published an open call for expressions of interest (EOI) for MSAB membership via IPHC News Release 2018-012, closing on 15 June 2018.

The IPHC Secretariat communicated the EOIs received to the Commission for decision, via IPHC Circular 2018-011 on 19 June 2018.

The Commissioners appointed the following new members to the MSAB:

Mr Matt Damiano – 20 June 2018

Mr Joe Morelli – 29 August 2018

Since MSAB011, one (1) member of the MSAB resigned:

- Mr. Trent Hartill: USA government representative, ADFG.

The ADFG nominated Mr. James Hasbrouck as a replacement, effective 12 October 2018.

RECOMMENDATION/S

That the MSAB **NOTE** paper IPHC-2018-MSAB012-03 Rev_1 which details the MSAB membership as of 18 October 2018.

APPENDICES

Appendix A: MSAB Membership as of 18 October 2018

APPENDIX A
MANAGEMENT STRATEGY ADVISORY BOARD (MSAB) MEMBERSHIP
(*AS OF 18 OCTOBER 2018*)

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	Vacant	CDN Commercial			
4	Vacant	CDN Commercial			
5	Gabrys, Bruce		USA Commercial	9-May-17	8-May-21
6	Kauffman, Jeff		USA Commercial	9-May-17	8-May-19
7	Odegaard, Per		USA Commercial	9-May-17	8-May-21
8	Falvey, Dan		USA Commercial	9-May-17	8-May-21
First Nations/ Tribal fisheries (2-4)					
1	Lane, Jim	CDN First Nations		9-May-17	8-May-21
2	Vacant	CDN First Nations			
3	Mazzone, Scott		USA Treaty Tribes	9-May-17	8-May-19
4	Damiano, Matt		USA Treaty Tribes	20-Jun-18	19-Jun-22
Government Agencies (4-8)					
1	Keizer, Adam	DFO		9-May-17	08-May-19
2	Huang, Ann-Marie	CDN Science Advisor		10-May-18	09-May-22
3	Vacant	DFO			
4	Merrill, Glenn		NOAA-Fisheries	7-May-18	06-May-22
5	McGilliard, Carey		USA Science Advisor	9-May-17	08-May-21
6	Culver, Michele		PFMC	9-May-17	08-May-21
7	Cross, Craig		NPFMC	9-May-17	08-May-21
8	Hasbrouck, James		ADFG	12-Oct-18	11-Oct-18
Processors (2-4)					
1	Parker, Peggy	US/CDN Processing	US/CDN Processing	9-May-17	08-May-19
2	Mirau, Brad	CDN Processing		9-May-17	08-May-19
3	Morelli, Joseph		USA Processing	29-Aug-18	28-Aug-22
4	Vacant		CDN Processing		

Membership category	Member	Canada	U.S.A.	Current Term commence-ment	Current Term expiration
Recreational/ Sport fisheries (2-4)					
1	Paish, Martin	CDN Sport Fishing Advisory Board		9-May-17	08-May-21
2	Marking, Tom		USA Sportfishing (CA)	9-May-17	08-May-19
3	Vacant		USA sportfishing (AK)		
4	Vacant		Open		

Update on actions arising from the 11th Session of the IPHC Management Strategy Advisory Board (MSAB011)

PREPARED BY: IPHC SECRETARIAT (21 SEPTEMBER 2018)

PURPOSE

To provide the MSAB with an opportunity to consider the progress made during the inter-sessional period in relation to the recommendations and requests of the 11th Session of the IPHC Management Strategy Advisory Board (MSAB011).

BACKGROUND

At the 11th Session of the IPHC Management Strategy Advisory Board (MSAB011), participants agreed on a series of actions to be taken by the Commission, Subsidiary Bodies, and the IPHC Secretariat on a range of topics as detailed in Appendix A.

DISCUSSION

Noting that best practice governance requires the prompt delivery of core tasks assigned by the Commission, at each subsequent session of the Commission and its subsidiary bodies, attempts will be made to ensure that any recommendations and 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 (i.e., a specific Contracting Party, the IPHC Secretariat, a subsidiary body of the Commission, or the Commission itself);
3) a desired time frame for delivery of the action (i.e., by the next session of an subsidiary body, or other date).

This involves numbering and tracking all action items (see Appendix A) from the MSAB, as well as including clear progress updates and document reference numbers.

RECOMMENDATION/S

That the MSAB:

1) **NOTE** paper IPHC-2018-MSAB012-04, which provided the MSAB with an opportunity to consider the progress made during the inter-sessional period in relation to the recommendations and requests of the 11th Session of the IPHC Management Strategy Advisory Board (MSAB011).
2) **AGREE** to consider and revise as necessary, the actions arising from the MSAB011, and for these to be combined with any new actions arising from the MSAB012.

APPENDICES

Appendix A: Update on actions arising from the 11th Session of the IPHC Management Strategy Advisory Board (MSAB011)

APPENDIX A

Update on actions arising from the 11th Session of the IPHC Management Strategy Advisory Board (MSAB011)

Action No.	Description	Update
	RECOMMENDATIONS	
	NOTING that the core purpose of the MSAB011 is to review progress on the MSE Program of Work, and to provide guidance for the delivery of products to the MSAB012 in October 2018, the MSAB AGREED that formal recommendations to the Commission would not be developed at the present meeting, but rather, these would be developed at the MSAB012.	
	REQUESTS	
MSAB011–Req.01 (para. 18)	***A review of the goals and objectives of the IPHC MSE process*** The MSAB **REQUESTED** that the IPHC Secretariat standardize the terminology for types of objectives (e.g. general, higher level objectives vs. measurable objectives).	Completed: Standardization of terminology was implemented after discussion with the ad-hoc working group to refine goals and objectives.
MSAB011–Req.02 (para. 20)	The MSAB **REQUESTED** that the objectives as defined in Appendix Va, be refined by an Ad-Hoc Working Group (composition: Peggy Parker; Chris Sporer; Glenn Merrill; Dan Falvey; Michelle Culver). The Ad-Hoc Working Group shall provide refined objectives to the IPHC Secretariat for distribution to the MSAB for consideration by 15 June 2018. Comments from the MSAB members would then be provided to the IPHC Secretariat by 30 June 2018. Some points of interest include determining appropriate reference catch levels, considering the use of "economically sufficient," and retaining the concepts of a minimum catch, a reference catch, and stability in catch (which may be stated as a rate of change). A further consideration may be to identify an objective related to taking advantage of high yield opportunities. Another consideration may be to look at what minimum catch is necessary to maintain markets.	Completed: The ad-hoc Working Group met at the end of June and refined the goals and objectives after subsequent email exchanges. The timeline was delayed and the refined objectives are distributed to the MSAB members as part of document IPHC-2018-MSAB012-06 for discussion at MSAB012

MSAB011–Req.03 (para. 28)	The MSAB **REQUESTED** that the IPHC Secretariat continue to discuss the Biological Sustainability (conservation) objectives with the IPHCs Scientific Review Board (SRB), including the appropriate female spawning biomass limit and female spawning biomass threshold.	Completed: The SRB agreed with the current proposed biological objectives (paragraph 29 IPHC-2018-SRB012-R).
MSAB011–Req.04 (para. 33)	The MSAB **REQUESTED** that the objectives related to distributing the TCEY in Appendix Vb be the subject of further discussion by the Ad-Hoc Working Group (paragraph 20). The consideration of these objectives should be done after refinement of Scale objectives, as noted in paragraph 20. This task is to be completed no later than 1 September 2018, for consideration by the IPHC Secretariat and subsequent submission to the MSAB012 in accordance with the IPHC Rules of Procedure (2017).	Pending: The refinement of Scale objectives was delayed, thus delaying the consideration of distribution objectives. A discussion of distribution objectives will occur at MSAB012.
MSAB011–Req.05 (para. 37)	***Performance metrics for evaluation*** The MSAB **REQUESTED** that the IPHC Secretariat present the performance metrics determined from measurable objectives, as well as additional statistics listed in Appendix Va, at MSAB012.	Completed: the ad-hoc working group specified performance metrics and statistics of interest. These are presented in IPHC-2018-MSAB012-06.
MSAB011–Req.06 (para. 40)	***Short-term, mid-term, and long-term performance metrics*** The MSAB **REQUESTED** that the IPHC Secretariat determine methods to present qualitative results describing the transition from the short-term to the long-term for various performance metrics as a way to describe medium-term performance.	Pending: Methods to present medium-term results will be trialed at MSAB012.
MSAB011–Req.07 (para. 41)	The MSAB **REQUESTED** that the IPHC Secretariat present the methods for producing short-, medium- and long-term results to the SRB for their review and comment.	Pending: the SRB will further review these methods at SRB013 in Sept. 2018.
MSAB011–Req.08 (para. 45)	***A review of variability and scenarios*** The MSAB **REQUESTED** that the SRB clarify the meaning of paragraphs 24 and 28 in the SRB report, IPHC-2017-SRB011-R.	Completed: the SRB clarified these paragraphs in paragraph 28 of IPHC-2018-SRB012-R.

MSAB011–Req.09 (para. 48)	**NOTING** that domestic management measures for the recreational fisheries often include size limits that differ to various levels of catch limits, the MSAB **REQUESTED** the IPHC Secretariat to consider alternative methods to simulate bycatch mortality at various Pacific halibut abundances, as noted in IPHC-2017-MSAB010-R, paragraph 21.	Completed: Bycatch mortality is modelled as a function of abundance as explained in IPHC-2018-MSAB012-07.
MSAB011–Req.10 (para. 49)	The MSAB **REQUESTED** the IPHC Secretariat to consider alternative methods to simulate recreational mortality, and that the recreational mortality should continue to increase over the entire range of total mortality.	Completed: Recreational mortality continues to increase with increasing total mortality as explained in IPHC-2018-MSAB012-07.
MSAB011–Req.11 (para. 52)	***Management Procedures related to fishing intensity*** The MSAB **AGREED** that a performance metric related to "being on the ramp" of the HCR is not necessary and would be covered by catch variability performance metrics. However, the MSAB **REQUESTED** a statistic related to "being on the ramp" be reported.	Completed: This was captured by the ad-hoc Working Group and is explained in document IPHC-2018-MSAB012-06.
MSAB011–Req.12 (para. 54)	***Preliminary closed-loop simulations results to investigate SPR with estimation error*** The MSAB **AGREED** that estimation error should be simulated from a joint distribution representing error in the estimated Total Mortality and the estimated stock status, with autocorrelation. The MSAB **REQUESTED** that the SRB review these methods to incorporate estimate error.	Completed: The SRB reviewed this (paragraph 32 c,d,e of IPHC-2018-SRB012-R) and updates have been made, as described in IPHC-2018-MSAB012-07.

MSAB011–Req.13 (para. 60)	***Simulation design for evaluations at MSAB012 of the Scale component of the harvest strategy policy*** The MSAB **REQUESTED** that the simulations incorporate: a) SPR values from 30% to 56%, with higher resolution where change occurs in the performance metrics, and at values where IPHC feels the results are meeting the MSE objectives. b) fishery trigger values of 30% and 40%, and that 45% is also used if time allows. c) estimation error by jointly simulating the error in total mortality and stock status with coefficients of variation (CV) the same for each variable and equal to 0.15 with a correlation of 0.5. An CV of 0.0 (no estimation error) and 0.2 may be considered if time permits, and presented as a sensitivity as a minimum to understand the effects of the different levels of estimation error. d) autocorrelation at a level determined appropriate by the IPHC Secretariat and the SRB. e) a smoothing algorithm on the catch limit for a few simulations as an example to understand the effect on the performance metrics. The algorithm should be asymmetric (e.g. slow up/fast down) and reduce annual catch variability.	Pending: Results presented at MSAB012 will address as many of these requests as possible.

MSAB011–Req.14 (para. 61)	The MSAB **REQUESTED** that when reporting results: a) the long-term be represented by 100 simulated annual cycles from the Operating Model and performance metrics summarized over the 10 annual cycles. b) short- and medium-term performance metrics be presented for management procedures that meet long-term objectives. c) the short-term be represented by the assessment ensemble and performance metrics presented for the immediate three years. These performance metrics are not necessarily the same as for long-term metrics, and may be actual values (e.g. catch in 2019) instead of a summary over years. d) the medium-term be summarized qualitatively by describing the transition from the short-term to the medium-term using the closed-loop simulations. Sensitivities (e.g. holding weight-at-age at low levels or constant) can help to inform the medium-term transitions. e) phase-in procedures are considered when appropriate.	Pending: Results will be presented at MSAB012 based on this request and any further recommendations from SRB013.
MSAB011–Req.15 (para. 62)	The MSAB **REQUESTED** that IPHC Secretariat discuss the time-frames detailed in paragraph 61, with the SRB.	Pending: Outcomes of SRB013 related to this request will be presented at MSAB012.
MSAB011–Req.16 (para. 63)	The MSAB **REQUESTED** that the IPHC Secretariat consider the following improvements to the simulation framework: a) investigate improvements to simulating weight-at-age with input from the SRB. b) simulating bycatch be improved by linking it to abundance in some way. c) investigate methods to improve time-varying selectivity in the commercial fleet, possibly linking it to abundance.	Completed: It was determined that improvements to weight-at-age are not necessary at this time. The simulation of bycatch mortality has been improved and time-varying selectivity in the commercial fleet has been introduced (see IPHC-2018-MSAB012-07).

MSAB011–Req.17 (para. 64)	The MSAB **NOTED** that the Operating Model and how it is conditioned is adequate for the evaluation of the HCR, and **REQUESTED** that the IPHC Secretariat present these methods to the SRB.	Pending: The SRB has reviewed the conditioning of the OM and will make final recommendations at SRB013.
MSAB011–Req.18 (para. 65)	The MSAB **REQUESTED** the following sensitivities: a) Low and high states of weight-at-age. b) Low and high regimes determining mean recruitment. c) Implementation variability (variability associated with not exactly catching the quota or with departures during decision-making). d) Higher and lower levels of mean bycatch. e) Shift in bycatch selectivity to younger ages to address ongoing concerns on U26 mortality.	Pending: As many of these sensitivities as possible will be presented at MSAB012.
MSAB011–Req.19 (para. 72)	***Review framework to investigate distributing the TCEY among IPHC Regulatory Areas and evaluate against objectives*** The MSAB **REQUESTED** that the proposed TCEY distribution framework described in paragraphs 69, 70 and 71, be reviewed by the SRB in 2018.	Pending: The SRB will review this topic at SRB013 in Sept. 2018.
MSAB011–Req.20 (para. 76)	***Identify preliminary MPs related to distribution*** **NOTING** that these tools require further discussion, the MSAB **REQUESTED** that the IPHC Secretariat provide comments, and that further stakeholder feedback is elicited.	Ongoing: The tools mentioned here will be discussed at MSAB012 and subsequent MSAB meetings in 2019.

OUTCOMES OF THE 13TH SESSION OF THE IPHC SCIENTIFIC REVIEW BOARD (SRB013)

PREPARED BY: IPHC SECRETARIAT (16 OCTOBER 2018)

PURPOSE

To provide the MSAB with the outcomes of the 13th Session of the IPHC Scientific Review Board (SRB) relevant to the mandate of the MSAB.

BACKGROUND

The agenda of the 13th Session of the IPHC Scientific Review Board (SRB) included an agenda item dedicated to Management Strategy Evaluation (MSE).

DISCUSSION

During the course of the 13th Session of the IPHC Scientific Review Board (SRB013), a number of specific requests and recommendations regarding the IPHC MSE process where proposed by the SRB. Relevant sections from the report of the meeting are provided in Appendix A for the MSAB's consideration.

RECOMMENDATION

That the MSAB:

1) **NOTE** paper IPHC-2018-MSAB012-05 which details the outcomes of the 13th Session of the IPHC Scientific Review Board (SRB013) relevant to the mandate of the MSAB.

APPENDICES

Appendix A: Excerpt from the 13th Session of the IPHC Scientific Review Board (SRB013) Report (IPHC-2018-SRB013-R).

APPENDIX A
Excerpt from the 13th Session of the IPHC Scientific Review Board (SRB) Report (IPHC-2018-SRB013-R)

6. MANAGEMENT STRATEGY EVALUATION: UPDATE

22. The SRB **NOTED** paper IPHC-2018-SRB013-06 which provided an update on the progress of the IPHC Management Strategy Evaluation (MSE) process in 2018. The SRB appreciated the progress made by the IPHC Secretariat and MSAB in developing objectives and an initial operating model, and the suite of candidate management procedures that have been applied.

23. The SRB **NOTED** that all readers of this report need to understand that an MSE process is iterative and that the first iteration is still underway. Typically, the iterative process involves refining the operating model, defining robustness tests, developing management procedures, and exploring performance with stakeholders. This process is usually on a specified timeline. The SRB uses the word "preliminary" in subsequent paragraphs with this in mind.

24. The SRB **NOTED** the IPHC MSE program of work indicates that results on scale will be reported to the Commission at its 95th Annual Meeting (AM095) in January 2019 and results on distribution and scale will be reported to the Commission at its 97th Annual Meeting (AM097) in January 2021 (Fig. 1).

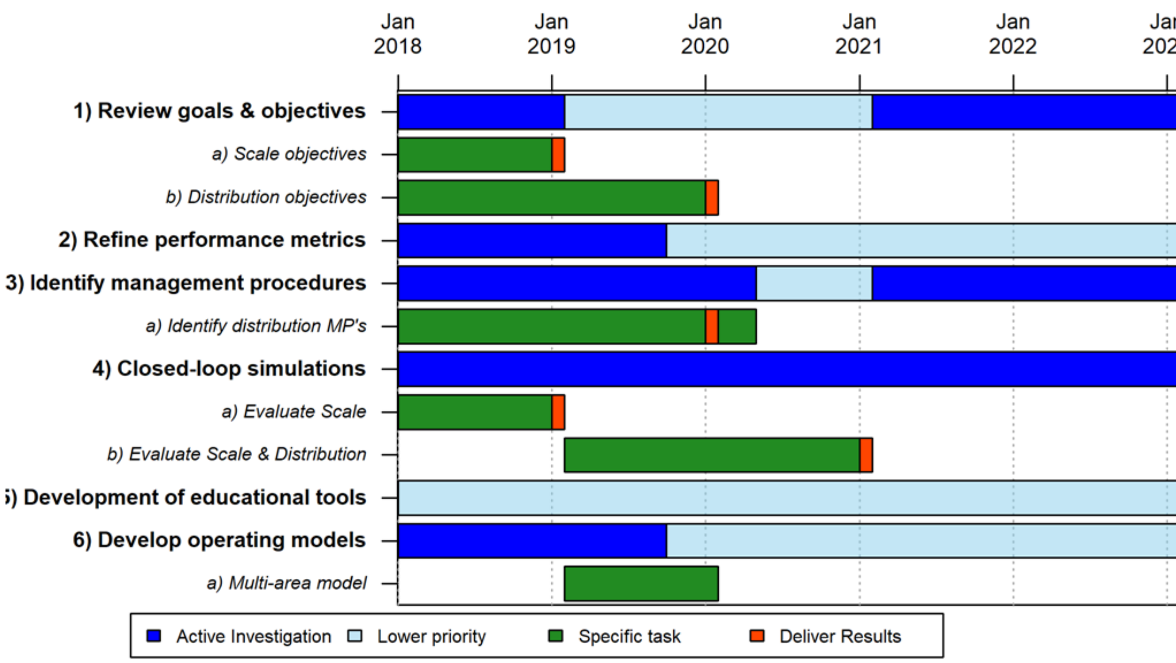


Fig. 1. Gantt chart for the IPHC MSE 5-year Program of Work. Tasks are listed as rows. Dark blue indicates when the major portion of the main tasks work will be done. Light blue indicates when preliminary or continuing work on the main tasks will be done. Dark green indicates when the work on specific sub-topics will be done. The orange colour shows when results will be presented at an Annual Meeting.

25. The SRB **NOTED** that the current IPHC MSE goals and objectives are useful to evaluate harvest strategies using the three primary performance metrics and additional statistics of interest. Further refinements to the fishery related objectives may be made at MSAB012, and reported to the SRB for review.

26. The SRB **REQUESTED** that the MSAB consider listing prioritized objectives used to guide the selection of a management procedure. These could include any combination of short, medium, and long-term objectives, provided Commission objectives be given highest priority. All performance

metrics in the MSE must be computed from the operating model. See paragraph 30 for further clarification.

6.1 Updates to MSE framework and closed-loop simulations

27. The SRB **AGREED** that the current conditioned operating model, described in paper IPHC-2018-SRB013-06, be used in a preliminary evaluation of harvest strategies and that this approach be used to present interim coast-wide management procedure performance to the upcoming MSAB012 meeting.

28. The SRB **AGREED** that the improvements and additions to the preliminary simulation framework, including updated allocation of the Total Mortality to bycatch and discard mortality, variable selectivity as a function of weight-at-age, can be used in the closed-loop simulations, including the current algorithm for simulating weight-at-age.

29. The SRB **REQUESTED** that in future iterations of the MSE, the IPHC Secretariat and MSAB consider:

   a) the use of estimation error in the proxy assessment method with coefficients of variation equal to 0.15, a correlation of 0.5, and autocorrelation equal to 0.2 represents one plausible scenario. A larger error and autocorrelation could be considered in robustness tests or as alternative scenarios;

   b) a management procedure include a constraint on the TMq change to be consistent with the maximum change that has happened historically;

   c) the current conditioned operating model be used to simulate a coast-wide survey index and that such data be used to consider an alternative survey-based management procedure (this may provide a more transparent TMq-setting algorithm than the current SPR based control-rule and help with MSAB deliberations).

6.2 MSE Simulation results

30. The SRB **RECOMMENDED** a clear separation between the current stock assessment process and MSE process, so that it is understood:

   a) these two processes, including statistics and performance metrics, are distinct and not comparable;

   b) the purpose of the current ensemble stock assessment approach is to develop a decision table to assist the Commission in setting an annual TCEY. This TCEY setting process lacks specificity and how decisions are made is unclear. Furthermore, repeated application of this process is difficult to evaluate relative to Commission objectives;

   c) the purpose of the MSE is to compare alternative management procedures against Commission objectives over a wide range of plausible uncertainties within the operating model and management procedures. Therefore, these procedures by definition must be specific and repeatable.

6.3 Distribution procedures

31. The SRB **REAFFIRMED** that 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. Better options may arise in the future should additional biological data become available.

32. The SRB **NOTED** the procedures and considerations for distributing the TCEY, which includes Regional Stock Distribution, Regional Allocation Adjustment, and a Regulatory Area Allocation.

33. The SRB **NOTED** a separation of scientific and management elements in procedures to distribute the TCEY.

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

PREPARED BY: IPHC SECRETARIAT (A. HICKS), 21 SEPTEMBER 2018

1 PURPOSE

To review the Management Strategy Advisory Board (MSAB) goals and objectives, including the objectives refined by the MSAB ad-hoc working group. Consider the directives from the Commission, including the consideration of additional objectives related to distributing the TCEY. Link goals and objectives with performance metrics, and define a set of performance metrics to use for evaluation.

1.1 INTRODUCTION

Defining goals and objectives is a necessary part of a management strategy evaluation (MSE) which should be revisited often to make sure that they are inclusive and relevant. The MSAB currently has four goals with multiple objectives for each. The four goals are

- biological sustainability,
- fishery sustainability, access, and stability,
- minimize discard mortality, and
- minimize bycatch and bycatch mortality

Performance metrics have also been developed from these objectives by defining a measurable outcome, a probability (i.e., level of risk), and time-frame over which it is desired to achieve that outcome.

In this document, we first present the MSAB ad-hoc working group (para 20, IPHC-2018-MSAB011-R) refined goals and objectives and provide reasoning behind the refinements. Performance metrics are linked to these objectives. We then present the distribution objectives proposed by the U.S. Commissioners at IM093 and the classification of each objective provided at MSAB011 for further discussion.

2 MSAB GOALS AND OBJECTIVES REFINED BY THE AD-HOC WORKING GROUP

The ad-hoc working group, consisting of Peggy Parker, Chris Sporer, Dan Falvey, and Michelle Culver from the MSAB (Glenn Merrill was not available), and Allan Hicks and Steve Keith from IPHC Secretariat met via webinar on June 26 to discuss and refine the MSAB goals and objectives. Subsequent email exchanges occurred before the publication of this document to make further refinements. The four goals were retained and the focus of the refinements was on identifying the main objectives and phrasing them in a useful manner. For each goal there are general objectives, which are broad and aspirational. Measurable objective(s) are related to these general objectives, and where possible a measurable outcome, time-frame, and tolerance are defined. A performance metric is then linked to each measurable objective. Some objectives are measurable, but a tolerance is not defined. These objectives are informational in that they are useful to consider, but are not a main factor when evaluating the management procedures. They can help to identify some of the properties of a management procedure and may be used to discriminate between a smaller set of management procedures.

2.1 BIOLOGICAL SUSTAINABILITY

A harvest policy should be internally consistent, meaning that the reference points defined should have mathematically defined relationships with each other. For example, if an objective was to fish at a level that resulted in Maximum Sustainable Yield (MSY), the harvest policy should define either a fishing mortality that would result in MSY, or an MSY that would determine a fishing mortality rate (F_{MSY}), because one leads to the other. Independently defining both of these reference points will likely result in inconsistencies and difficulty in meeting objectives. The harvest policies of many fisheries management agencies define a proxy target fishing mortality rate, a proxy biomass target, and a harvest control rule that reduces fishing intensity at low biomass levels (a biomass trigger). However, defining two of these quantities determines the third. For example, defining the proxy fishing mortality rate and a harvest control rule will determine the target biomass (the median biomass expected to be achieved).

A similar point can be made with respect to conservation objectives. A very important conservation objective for fisheries management is to avoid low stock sizes that may result in a lack of sustainability for the stock. Therefore, the main objective related to biological sustainability should be to avoid that minimum stock size with a high probability (many harvest policies use a biomass limit of 20% of B_0 and a probability of 90% to be above that biomass limit). A second conservation objective for a biomass threshold (an upper reference point) can be defined, but is not necessary because reporting the biomass target that would be achieved (along with fishery objectives related to stability and yield) would be sufficient to determine an appropriate harvest control rule while minimizing the risk of very low stock sizes. Defining a limit and a threshold to achieve will likely result in one being met before the other, thus making one moot. A single measurable conservation objective related to avoiding a biomass limit is all that needs to be defined as an objective.

For simplicity and the reasons noted above, the ad-hoc working group has suggested moving to a single conservation objective related to avoiding a biomass limit (MSAB could add other conservation objectives in the future if needed or as we move to the spatial scale). The conservation/biological sustainability objective to avoid low stock sizes, as defined by the MSAB, is to maintain a minimum female spawning stock biomass above a biomass limit reference point (SB_{Lim}=20% spawning biomass) at least 90% of the time. The management procedure is a harvest control rule defined by a fishing mortality related to SPR (F_{SPR}), an upper control point (i.e., fishery trigger), and a lower control point (i.e., fishery limit). The biomass limit reference point is also serving as the lower control point of the harvest control rule, although they can be defined independently.

This leaves the F_{SPR} and the trigger as elements of the management procedure to be investigated. The MSAB is now investigating these two elements of the harvest control rule to determine how they may meet the objectives defined by the MSAB and Commissioners.[1] As noted in the report of the May 2018 MSAB meeting (IPHC-2018-MSAB011-R) SPR values to be evaluated range from 30% to 56% (with higher resolution at values where change occurs in the performance metrics), and the control points to be evaluated are 30%:20% of spawning biomass, 40%:20% of spawning biomass, and if time permits 45%:20% of spawning biomass.

Additional objectives can be defined for informational purposes that may have a secondary influence on the evaluation of management procedures. These are called “Statistics of Interest” here and can be objectives such as the reporting an absolute measure of spawning biomass or even reporting probability of being below a spawning biomass other than 20% of unfished equilibrium spawning biomass (the biomass limit defined in the objective). In this case, the informational probability of being below a specified biomass would not have a tolerance associated with it, but would be informative nonetheless. Additionally, reporting the median biomass that would be achieved with the management procedure is useful to understand how close to the limit the biomass is likely to be.

The objectives and performance metrics refined by the ad-hoc working group are shown in Table 1. Note that there is only one objective related to the coastwide biomass, which the SRB felt was reasonable (paragraph 29 of IPHC-2018-SRB012-R). Additional conservation objectives could be defined to meet region-specific objectives.

[1] The upper control point is sometimes referred to as a trigger value or trigger, as they “trigger” a management response if they are breached (e.g., the fishing intensity begins to be reduced under the harvest control rule).

2.1.1 A note on biocomplexity

Paragraph 30 of IPHC-2018-SRB012-R stated that "[t]he SRB … recognized that biocomplexity is not an appropriate concept because it is poorly defined and not understood for Pacific halibut, especially over large spatial scales. Further, the terms "preserve" and "preservation" should be "conserve" and "conservation" as most fisheries management is about conservation." However, 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, objectives should be defined that relate to conserving some level of spatial population structure, and these can be included under the Biological Sustainability goal. Given the uncertainty about spatial population structure and dynamics of Pacific halibut, these objectives may be more difficult to define. The ad-hoc working group did not address spatial biomass objectives.

2.2 OPTIMIZE DIRECTED FISHING OPPORTUNITIES

The goal previously called "fishery sustainability, access, and stability" was refined to be "optimize directed fishing opportunities" to better reflect the desires of the directed fishery. It is felt that the goal is to optimize fishery yield with respect to stability and sustainability, and optimizing the fishing opportunities ensures access.

Two general objectives fall under this goal: 1) Limit catch variability (Table 2) and 2) maximize directed fishery yield (Table 3). They are listed in this order because the stability objectives directly relate to the ramp in the harvest control rule, and it is not meant to prioritize stability objectives over yield objectives (although that could be done if desired), but is a natural progression to evaluating the objectives. For example, a final step may be to maximize the yield subject to meeting conservation and stability objectives. Or, the trade-offs between stability and yield could be examined and these two fishery objectives be evaluated simultaneously. However, with only one conservation objective, it seems natural to prioritize that one such that fishery objectives are not evaluated unless that conservation objective is met.

Under each general objective, there are coastwide TCEY measurable objectives and IPHC Regulatory Area measurable objectives. The IPHC Regulatory Area measurable objectives are placeholders for now to be discussed in more detail at future MSAB meetings. For the coastwide evaluations of fishing intensity, there is one objective related to catch variability that is not a statistic of interest: the average annual variability (AAV) is no more than 15%. For the general objective of maximizing the directed fishery yield, there is also one measurable objective that is not a statistic of interest: maintain the TCEY above a minimum level. Other statistics of interest provide insight into the behavior of various management procedures.

The ad-hoc working did not discuss the goals related to discard mortality and bycatch mortality, but the objectives related to those (if defined) are shown in Table 4 and Table 5.

Table 1. Objectives and performance metrics for the Biological Sustainability goal.

GENERAL OBJECTIVE	MEASURABLE OBJECTIVE	MEASURABLE OUTCOME	TIME-FRAME	TOLERANCE	PERFORMANCE METRIC
1.1. KEEP BIOMASS ABOVE A LIMIT TO AVOID CRITICAL STOCK SIZES Biomass Limit	Maintain a minimum female spawning stock biomass above a biomass limit reference point at least 90% of the time	SB < Spawning Biomass Limit (SB_{Lim}) SB_{Lim}=20% spawning biomass	Long-term	0.10	$P(SB < SB_{Lim})$
REPORT A METRIC THAT IS BASED ON NUMBERS OF PACIFIC HALIBUT	*An absolute measure*	*Number of mature female halibut*	*Long-term*	*STATISTIC OF INTEREST*	*Median Number of Mature Females*
REPORT A METRIC INDICATING THE SPAWNING BIOMASS EXPECTED TO BE ABOVE 50% OF THE TIME (I.E., AN IMPLIED TARGET)	*An absolute measure*	*Spawning Biomass*	*Long-term*	*STATISTIC OF INTEREST*	*Median* $\overline{SB}$

SB = dynamic relative (unfished equilibrium) spawning biomass, also noted as dRSB.
Short-term: immediate future 3 years (metrics reported for each year)
Long-term: time period needed to represent equilibrium conditions, i.e., 100+ time-steps (metrics reported for the last 10 time-steps of the long term time period)
P( ): Probability (times out of 100) that the event occurs
Statistic of Interest: A metric that will be reported, but is not to be evaluated as meeting a specific criteria.

Table 2. Objectives and performance metrics related to stability in quotas.

GENERAL OBJECTIVE	MEASURABLE OBJECTIVE	MEASURABLE OUTCOME	TIME-FRAME	TOLERANCE	PERFORMANCE METRIC
2.1. LIMIT CATCH VARIABILITY	Limit annual changes in the coastwide TCEY	Average Annual Variability (*AAV*) > 15%	Long-term	0.25	$P(AAV > 15\%)$
		AAV	*Long-term*	*STATISTIC OF INTEREST*	*AAV and variability*
		Change in TCEY > 15% in any year	*Short-term*	*STATISTIC OF INTEREST*	$\frac{TCEY_{i+1} - TCEY_i}{TCEY_i}$
	Limit annual changes in the TCEY for each Regulatory Area	Average Annual Variability by Regulatory Area (AAV_A) > 15%	Long-term	0.25	$P(AAV > 15\%)$
		AAV_A	*Long-term*	*STATISTIC OF INTEREST*	*AAV and variability*
		Change in TCEY by Regulatory Area > 15% in any year	*Short-term*	*STATISTIC OF INTEREST*	$\frac{TCEY_{i+1} - TCEY_i}{TCEY_i}$
	Gain insight into the additional variability in the TCEY when on the ramp	*AAV while on the ramp*	*Long-term*	*STATISTIC OF INTEREST*	*AAV given estimated SB <* SB_{Trig}
		Percent of time "on the ramp" (estimated stock status is below the fishery trigger; SB_{trig}*)* SB_{Trig} *to be evaluated (e.g., 30% or 40%)*	*Long-term*	*STATISTIC OF INTEREST*	$P(\widehat{SB} < SB_{Trig})$

Average Annual Variability (AAV): The average percentage change in TCEY from year to year. Note, that the TCEY may change by a higher percentage or a lower percentage, but would be this value on average.

Fishery trigger (SB_{Trig}): The value that triggers a reduction in fishing intensity when the stock is estimated to be below this spawning biomass

"On the ramp": The state of reduced fishing intensity because the biomass is estimated to be below the fishery trigger. The "ramp" refers to the reduction of fishing intensity in the harvest control rule.

Statistic of Interest: A metric that will be reported, but is not to be evaluated as meeting a specific criteria.

TCEY: For the coastwide operating model this is the sum of commercial landings, commercial discard mortality, recreational mortality, and subsistence mortality.

Table 3. Objectives and performance metrics related to directed fishery yield.

GENERAL OBJECTIVE	MEASURABLE OBJECTIVE	MEASURABLE OUTCOME	TIME-FRAME	TOLERANCE	PERFORMANCE METRIC
2.2. MAXIMIZE DIRECTED FISHING YIELD	*Maximize average TCEY coastwide*	*Median coastwide TCEY*	*Long-term* *Short-term*	*STATISTIC OF INTEREST*	$Median\ \overline{TCEY}$
	Maintain TCEY above a minimum level coastwide	Coastwide TCEY < $TCEY_{min}$	Long-term Short-term	?? ??	$P(TCEY < TCEY_{min})$
	Maximize high yield (TCEY) opportunities coastwide	*Coastwide TCEY > 46 Mlbs (70% of 1993-2012 average)*	*Long-term* *Short-term*	*STATISTIC OF INTEREST*	$P(TCEY < 46\ Mlbs)$
	Present the range of coastwide TCEY that would be expected	*Range of coastwide TCEY*	*Long-term* *Short-term*	*STATISTIC OF INTEREST*	*5^{th} and 75^{th} percentiles of TCEY*
	Maximize average TCEY by Regulatory Area	*Median coastwide TCEY*	*Long-term* *Short-term*	*STATISTIC OF INTEREST*	$Median\ \overline{TCEY}$
	Maintain TCEY above a minimum level by Regulatory Area	$TCEY_A < TCEY_{A,min}$	Long-term Short-term	?? ??	$P(TCEY < TCEY_{min})$
	Maximize high yield (TCEY) opportunities by Regulatory Area	*$TCEY_A$ > 46 Mlbs (70% of 1993-2012 average)*	*Long-term* *Short-term*	*STATISTIC OF INTEREST*	$P(TCEY < 46\ Mlbs)$
	Present the range of TCEY by Regulatory Area that would be expected	*Range of TCEY by Regulatory Area*	*Long-term* *Short-term*	*STATISTIC OF INTEREST*	*5^{th} and 75^{th} percentiles of TCEY*

Table 4. Objectives and performance metrics related to discard mortality (note that the ad-hoc working group did not discuss these).

GENERAL OBJECTIVE	MEASURABLE OBJECTIVE	MEASURABLE OUTCOME	TIME-FRAME	TOLERANCE	PERFORMANCE METRICS
3.1. HARVEST EFFICIENCY	Discard mortality is a small percentage of the longline fishery annual catch limit	>10% of annual catch limit	Long-term Short-term	0.25	$P(DM > 10\%FCEY)$
ABSOLUTE MEASURE	*Absolute*	*Discard Mortality (DM)*	*Long-term* *Short-term*	***NA***	*Median* $\overline{DM}$

Table 5. Objectives and performance metrics related to bycatch mortality (note that the ad-hoc working group did not discuss these).

GENERAL OBJECTIVE	MEASURABLE OBJECTIVE	MEASURABLE OUTCOME	TIME-FRAME	TOLERANCE	PERFORMANCE METRICS

3 COMMISSION REVIEW OF GOALS AND OBJECTIVES

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

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

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

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

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

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

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

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

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

AM094-R, para 37. The Commission **REQUESTED** that the objectives related to distributing the TCEY, as detailed in Circular IPHC-2017-CR022, be presented at MSAB11 for further stakeholder feedback.

The guidance from Commissioners had one request: that the objectives outlined in IPHC-2017-CR022 be presented at MSAB11 for discussion (IPHC-2018-AM094-R, para 37). These are the objectives related to distribution that were proposed by U.S. Commissioners at IM093, and are shown in Table 6. This table also shows response of the MSAB at MSAB011 to each objective. The MSAB felt that two of the objectives are already covered in the current objectives, one should be dropped because it is not pertinent to the current MSE work, and more discussion is needed for the others.

The Commission also had one recommendation: to endorse the current MSAB goals and objectives and to continue to refine them as necessary. An important piece of the guidance was to evaluate the objectives in a hierarchical manner with conservation as the first priority. This could mean that specified conservation objectives must be met for a management procedure to be considered any further. Or, it may mean that conservation objectives are given a higher weighting when evaluating the management procedures. With one objective under the biological sustainability goal, it is natural to not consider management procedures that do not meet that conservation goal.

Table 6. Pacific halibut TCEY distribution goals and objectives presented by U.S.A. Commissioners at IM093. Table reproduced from IPHC-2017-IM093-R. The column labeled MSAB011 shows the response of the MSAB at MSAB011 to each objective.

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

4 RECOMMENDATION/S

That the MSAB:

1) **NOTE** paper IPHC-2018-MSAB012-06 which provides a review of the goals and objectives previously defined by the MSAB and refined by the MSAB ad-hoc working group, associated performance metrics, and outcomes of AM094 as they relate to objectives.
2) **CONSIDER** the refined MSAB goals, measurable objectives and associated performance metrics, and the prioritizing of conservation objectives.
3) **CONSIDER** the statistics of interest to supplement the evaluation of management procedures.
4) **CONSIDER** the objectives identified by the US Commissioners at IM093 for distributing the TCEY.
5) **RECOMMEND** goals and objectives for evaluation of the Scale component of the harvest strategy policy.
6) **RECOMMEND** a practical set of performance metrics, including statistic of interest, to report for the evaluation of future simulations.
7) **SUGGEST** methods (e.g. tables and figures) to report the performance metrics listed here for the evaluation of future results from the simulations.

5 Additional Documentation / References

IPHC. 2017. Management Strategy Evaluation Goals and Objectives. 18 December 2017. IPHC Circular 2017-022. https://iphc.int/library/documents/circulars/management-strategy-evaluationmse-goals-and-objectives 2pp

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

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

IPHC. 2018. Report of the 11th Session of the IPHC Management Strategy Advisory Board (MSAB011). Seattle, Washington, United States of America, 7-10 May 2018. IPHC-2018-MSAB011-R. https://iphc.int/uploads/pdf/msab/msab11/iphc-2018-msab011-r.pdf 29 pp.

IPHC. 2018. Report of the 12th Session of the IPHC Scientific Review Board (SRB012). Seattle, Washington, United States of America, 19-21 June 2018. IPHC-2018-SRB012-R. https://iphc.int/uploads/pdf/srb/srb012/iphc-2018-srb012-r.pdf 17 pp.

IPHC Management Strategy Evaluation to Investigate Fishing Intensity

PREPARED BY: IPHC SECRETARIAT (A. HICKS & I. STEWART; 22 SEPT, 16 OCT 2018)

1 PURPOSE

To provide an update on the progress of the IPHC Management Strategy Evaluation process to investigate fishing intensity, and to present results of the closed-loop simulations (as of 16 October 2018).

NOTE: In this latest revision, Appendix A has been added to provide updated results on some long-term performance metrics for some runs requested at MSAB011 (IPHC-2018-MSAB011-R). Some short-term performance metrics area also reported for those same runs, following direction received from the Commission on 4 October 2018, as follows

*The Commission **RECOMMENDED** that the MSAB:*

- *While it is recognized that the MSAB has spent considerable time and effort in developing objectives for evaluating management procedures, for the purpose of expediting a recommendation on the level of the coast-wide fishing intensity, and noting SRB11–Rec.02 to develop an objectives hierarchy, the MSAB is requested to evaluate management procedure performance against objectives that prioritize long-term conservation over short-/medium-term (e.g., 3-8 years) catch performance. Where helpful in accelerating progress on scale, the MSAB is requested to constrain objectives to (1) maintain biomass above a limit to avoid critical stock sizes, (2) maintain a minimum average catch, and (3) limit catch variability.*

2 INTRODUCTION

At the 2017 Annual Meeting (AM093) Commissioners supported a revised harvest policy that separates the scale and distribution of fishing mortality (Figure 1). Furthermore, the Commission identified an interim "hand-rail" or reference for harvest advice based on a status-quo SPR, which uses the average estimated coastwide SPR for the years 2014–16 from the 2016 stock assessment, resulting in an SPR of 46%. The justification for using an average SPR from recent years is that this corresponds to fishing intensities that have resulted in a stable or slightly increasing stock, indicating that, in the short-term, this may provide an appropriate fishing intensity that will result in a stable or increasing female spawning biomass.

The 2017 stock assessment updated the population estimates and determined that the SPR resulting from actual total mortality from all sources in 2017 was 40%, instead of the 45% adopted by Commissioners at AM093. This was an example of estimation error and something that is inherent in the process due to uncertainty in the data. The SPR of 40% was well within the confidence bounds for SPR reported in the 2017 stock assessment (30-59%) and was most likely less than the adopted SPR because of the updated estimation of recent below average recruitment. The estimation may easily go either way (above or below the adopted value).

This document (IPHC-2018-SRB013-07 focuses on the coastwide simulations and includes the following topics:

1. changes to the simulation framework, and
2. preliminary closed-loop simulation results for the evaluation of the harvest control rule. This includes values of SPR and the fishery trigger in the control rule. Final results will be provided before and at MSAB012.

Appropriate background or reference to documents is provided, when needed. Useful documents to reference are IPHC-2018-MSAB012-06 for a description of objectives, and IPHC-2018-MSAB011-08 for a description of the simulation framework. The MSAB011 report (IPHC-2018-MSAB011-R) provides a summary of the outcomes of that meeting. Additionally, documents IPHC-2018-SRB012-08 and IPHC-2018-SRB012-R provide background to SRB discussions in June 2018.

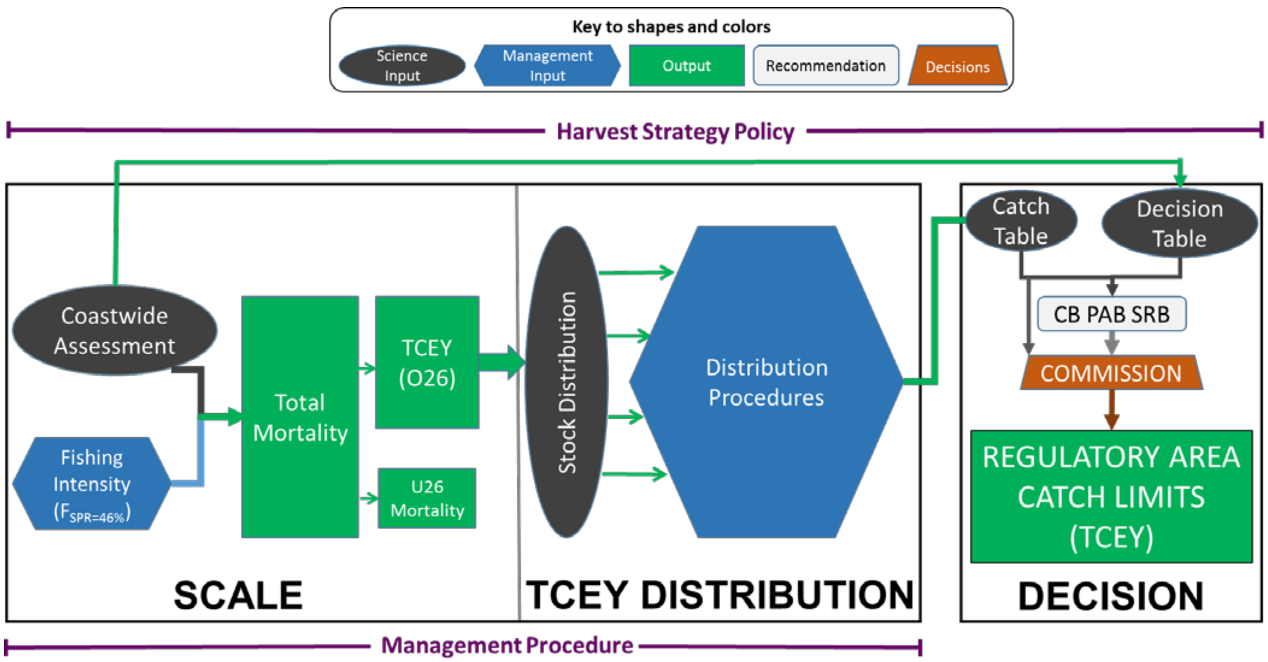


Fig. 1. A pictorial description of the interim IPHC harvest strategy policy showing the separation of scale and distribution of fishing mortality. The "decision step" is when policy and decision making (not a procedure) influences the final mortality limits.

3 Closed-Loop Simulation Framework

The framework of the closed-loop simulations is a map to how the simulations will be performed (Figure 2). There are four main modules to the framework:

1. The **Operating Model (OM)** is a representation of the population and the fishery. It produces the numbers-at-age, accounting for mortality and any other important processes. It also incorporates uncertainty in the processes and may be composed of multiple models to account for structural uncertainty.

2. **Management Procedure**

   a. **Monitoring (data generation)** is the code that simulates the data from the operating model that is used by the estimation model. It can introduce variability, bias, and any other properties that are desired.

b. The **Estimation Model (EM)** is analogous to the stock assessment and simulates estimation error in the process. Using the data generated, it produces an annual estimate of stock size and status and provides the advice for setting the catch levels for the next time step. However, simplifications may be necessary to keep simulation times within a reasonable time.

c. **Harvest Rule** is the application of the estimation model output along with the scale and distribution management procedures (Figure 1) to produce the catch limit for that year.

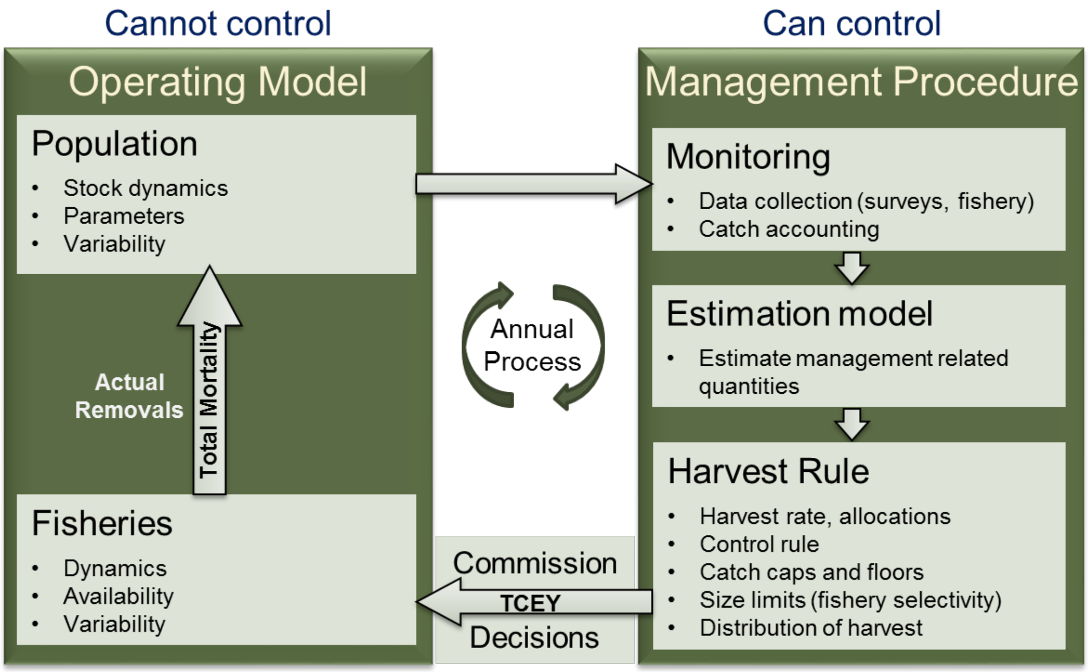


Fig. 2. Diagram of the relationship between the four modules in the framework. The simulations run each module on an annual time-step, producing output that is used in the next time-step. See text for a description of operating model, monitoring, estimation model, and harvest rule.

3.1 Operating Model

For the simulations to investigate a coastwide fishing intensity, the stock synthesis (Methot and Wetzel 2013) assessment software was used as an operating model. This platform is currently used for the stock assessment, and the operating model was comprised of the two coastwide assessment models (short and long time-series) currently used in the ensemble. For future MSE evaluations (in particular, investigating the Distribution component of the harvest policy) a more complex operating model will be developed that can provide outputs by defined areas or regions and can account for migration between these areas. This model has been referred to as a multi-area model.

The current stock assessment ensemble, composed of four different assessment models, includes a cross between coastwide or fleets-as-areas structuring of the data, and the length of the time series. Using an areas-as-fleets model would require generating data and distributing catch to four areas of the coast, which would involve many assumptions. In addition, without a multi-area model, there would not be feedback from migration and productivity of harvesting in different areas. Therefore, only the two coastwide models were used, but with additional variability. These models are structured to use five general sources of removals (these are aggregated for modelling purposes and do not necessarily correspond to specific fisheries or sectors): the directed commercial halibut fishery (including research landings), commercial discard mortality (previously known as wastage), bycatch (from non-halibut-target fisheries), recreational, and subsistence. The TCEY was distributed to each source in an ad hoc manner using current available information (see below).

3.1.1 Conditioning the Operating Model

The operating model (OM) should be a reasonable depiction of reality with an appropriate level of uncertainty, which is accomplished through a process called conditioning. The operating model (OM) consists of two Stock Synthesis, or SS (Methot and Wetzel 2013), models parameterized similarly to the short and long coastwide assessment models for Pacific halibut (Stewart 2015 appendix of RARA). Each SS model is conditioned by fitting to the same data used in the 2017 stock assessment (Stewart & Hicks 2018, documents 08-10). In order to evaluate and choose management procedures that are robust to uncertainty in the population, many assumptions in the assessment model were freed up to characterize a wider range of possibilities in the future. Table 1 shows the parameters that were different from the assessment models. Estimating natural mortality in both models and estimating steepness were the only processes changed from the assessment model when conditioning.

Table 1. Parameter estimation in the assessment and operating model.

Parameter	Assessment	OM
Natural Mortality (*M*)	Some estimated	All estimated without priors
Recruitment (lognormal devs)	Variability fixed at 0.6 (long) 0.9 (short)	Same as assessment
Steepness (*h*)	Fixed at 0.75	Estimated variability based on long model centered around 0.75 for both.

3.1.1.1 Characterizing Variability in Stock and Fishery Dynamics

Variability was characterized by the estimated variance-covariance matrix estimated automatically by inverting the Hessian within ADMB (http://www.admb-project.org/), which is the optimization software that SS uses. This provides the uncertainty for each estimated parameter, and its correlation with other parameters, given the data and assumptions. Using this variance-covariance matrix, sets of parameters were randomly generated from a truncated multivariate normal distribution. The truncation of parameter bounds was determined from the bounds entered in the SS model files. Some bounds (e.g. dev parameters) were infinite.

An alternative approach for characterizing variability is to design a grid over which different parameter values and assumptions are used. For example, different values of steepness could be chosen and simulations use those fixed values of steepness. Then, the simulations are combined across grid points. We are using the Hessian approach to integrate over a range of parameter values and account for correlation between parameters.

To ensure that parametrically sampling from using a multivariate normal distribution and the inverted Hessian produced similar results as the assessment SS models (the current best information for the historical trajectory), 1000 samples of the parameters estimated in the assessment models were generated from a multivariate normal distribution. Estimated recruitment deviations were bias-corrected by their corresponding estimated variances before sampling from the multivariate normal distribution. The mean spawning biomass trajectory and 95%

confidence interval around that trajectory were compared to the assessment results and the long coastwide model showed an increased density of low spawning biomass compared to the assessment model (Figure 3). Trajectories with a maximum F greater than 0.4 were not within the 95% confidence interval determined from the inverted Hessian in assessment model, thus the sampling from the multivariate normal was limited to trajectories that had a maximum fishing mortality rate less than 0.4.

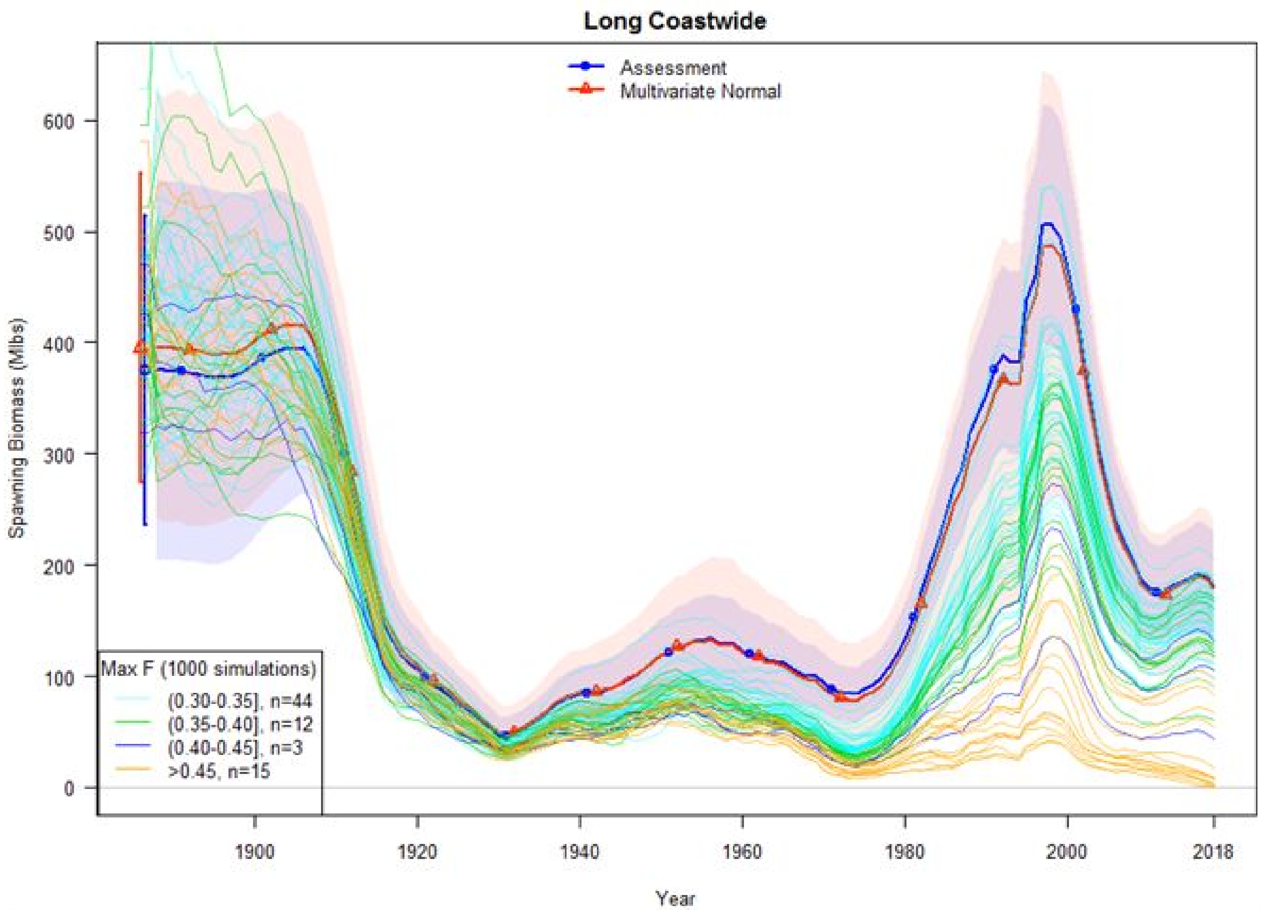


Fig. 3. Mean spawning biomass trajectories from the long coastwide assessment model with 95% confidence range (blue) and the mean and 95% confidence range of 1000 samples from a multivariate normal using the parameter estimates and inverted Hessian from the long coastwide assessment model (red). Individual trajectories from specific samples that produced large maximum F values are also plotted with the number of trajectories for various ranges of F listed in the legend.

Implementing a maximum F of 0.4 when sampling from the multivariate normal distribution (only the long coastwide was limited as short coastwide showed fishing mortality rates lower than 0.2), the assessment was mimicked reasonably well by the sampled trajectories for the long and short coastwide models (Figure 4).

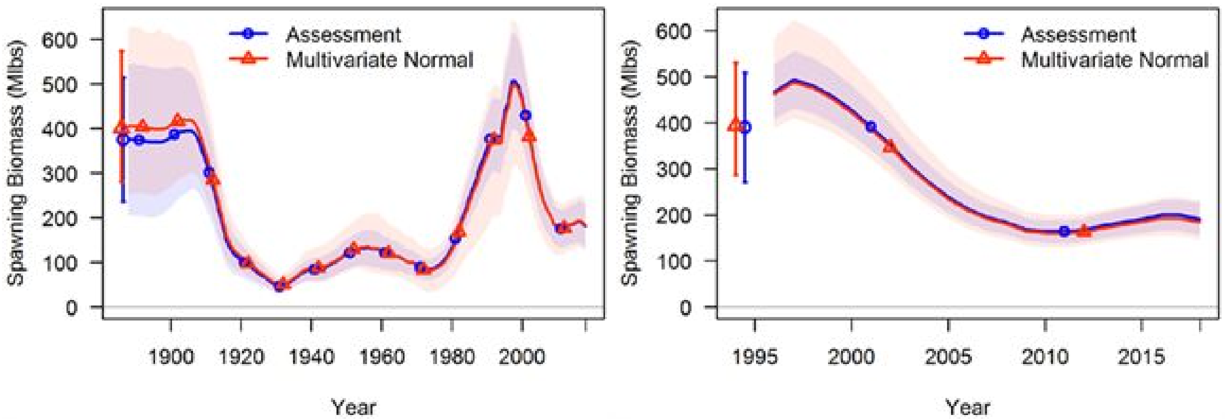


Fig. 4. Median spawning biomass trajectories from the long coastwide (left) and short coastwide (right) assessment models with a 95% confidence range (blue) and the median and 95% confidence range of 1000 samples from a multivariate normal using the parameter estimates and inverted Hessian from each assessment model (red).

Estimating parameters that were fixed in the assessment may produce stock dynamics that are not consistent with the assessment. To condition the OM to match the assessment, but introduce additional variability, the following steps were performed.

1. Allow for the estimation of the additional parameters in the assessment models. For the long coastwide model, steepness was estimated without a prior. For the short coastwide model, female M was estimated without a prior (and the upper bounds on female and male M's were increased to 0.45) and steepness was estimated with a prior created from the results of the long coastwide model and assuming a normal distribution. A prior on steepness was used to keep steepness within a reasonable range and force the estimated standard deviation for the short coastwide OM to be similar to the standard deviation in the long coastwide OM (i.e., both operating models are sampling from the same steepness distribution). Without a prior, the estimated variability in steepness resulted in a nearly uniform distribution between 0.2 and 1.0. The prior is centered around 0.75 with a standard deviation of 0.084 (2.5th and 97.5th percentiles equal to 0.59 and 0.91, respectively). See Figure 5 and the following steps.
2. Use the estimated covariance from the models with the extra parameters estimated (full model), the variances from the assessment model, and the variance of the additional estimated parameters from the full model to build a covariance matrix. Use the point estimates from the assessment model with that covariance matrix to sample from a multivariate normal distribution. This keeps the full model's predictions near the assessment model, but introduces extra variability accounting for correlation between estimated parameters.
3. Run the SS model using the sampled parameters, but without estimation to predict the historical population dynamics.
4. Eliminate the simulation if the maximum exploitation rate is greater than 0.4 in any year, or if the spawning biomass drops below 100 pounds in any year.
5. Repeat 2 through 4 as many times as necessary to create 1000 simulated trajectories.

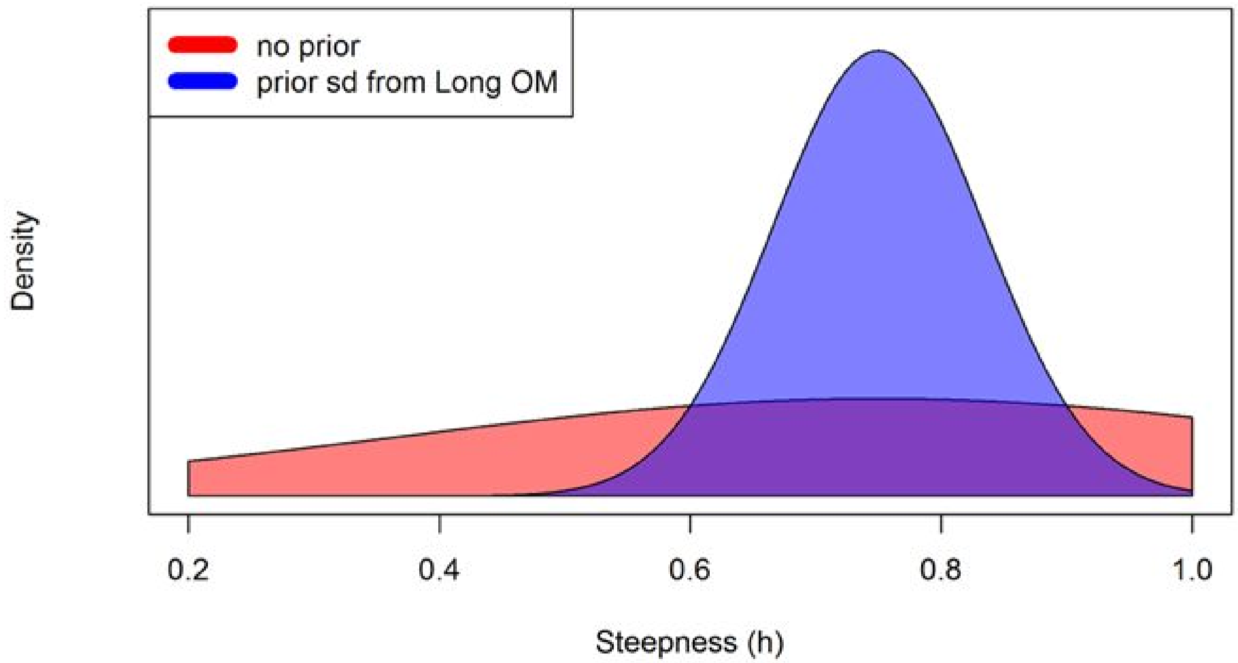


Fig. 5. Steepness Normal distributions centered around 0.75 using the standard deviations estimated without a prior in the short coastwide model (red) and with a prior determined from the long coastwide operating model (blue).

3.1.1.2 Long coastwide operating model

Steepness was the only additional parameter in the long coastwide operating model, compared to the assessment, that had variability. Steepness was centered on 0.75, as in the assessment, even though the estimated value of steepness was 0.9463, but the estimated variance (standard deviation = 0.08376) and covariances were used. The normal distribution of steepness, from which values were sampled, can be seen as the blue curve in Figure 5, and the estimated value (0.9463) is the 88th percentile in this distribution.

The parameters, including steepness centered around 0.75, were sampled from a multivariate normal distribution to create 1000 parameter vectors, each used to create a population trajectory. Trajectories that showed a maximum exploitation rate greater than 0.4 at any point in the time series were eliminated and parameters were re-sampled until 1000 acceptable parameter vectors were found. In total, 399 parameter draws were eliminated in the process. The final 1000 trajectories of historical spawning biomass from the operating model are compared to the assessment in Figure 6.

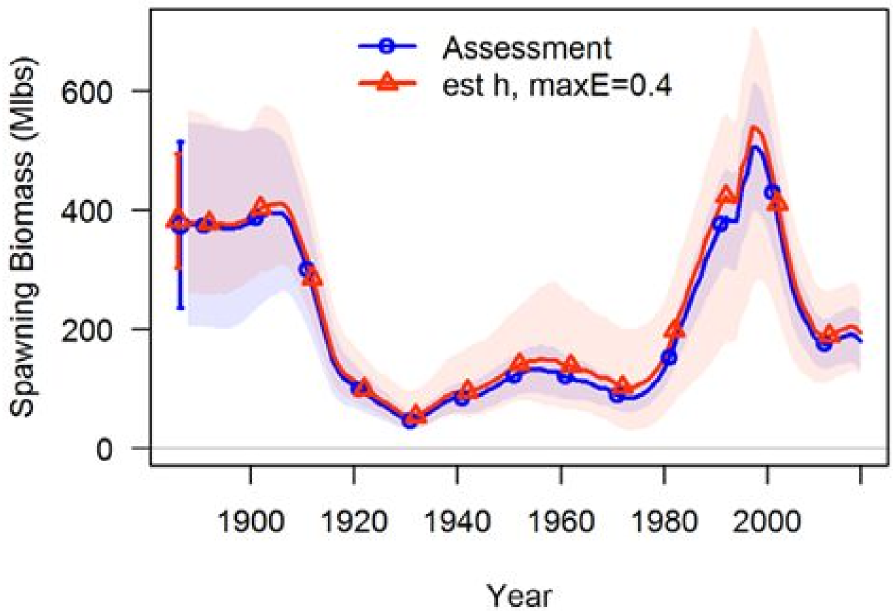


Fig. 6. Predicted median biomass trajectories with 95% confidence intervals for the long coastwide assessment model (blue) and the long coastwide operating model (red).

The median spawning biomass in the operating model is slightly greater than the assessment model. This is an effect of using a parametric bootstrap and adding the variability on steepness, even though the distribution of steepness was centered on the assessment value of 0.75. There are a number of reasons that the median of the operating model is slightly greater than the assessment model.

1. The distribution of spawning biomass from the operating model is broader and not necessarily symmetric, whereas the assessment model uses a point estimate (maximum likelihood) and an assumption that the variability in spawning biomass is characterized by a normal distribution.
2. The threshold maximum exploitation rate of 0.4 eliminates some low trajectories.
3. The covariances in the variance-covariance matrix used to characterize the normal distribution are from the full model (with steepness estimated) and are different than the covariances estimated in the assessment model. The variances of the parameters estimated in the assessment model are from the assessment model in the variance-covariance matrix used for sampling. Even setting the variance and covariances of the steepness parameter to zero in the variance-covariance matrix for sampling resulted in a median spawning biomass trajectory slightly above the assessment for most of the time-series, although it was similar to the assessment in recent years.

The 2018 point-estimate of spawning biomass from the assessment is the 36th percentile of the distribution of 2018 spawning biomass in the operating model (see Figure 7).

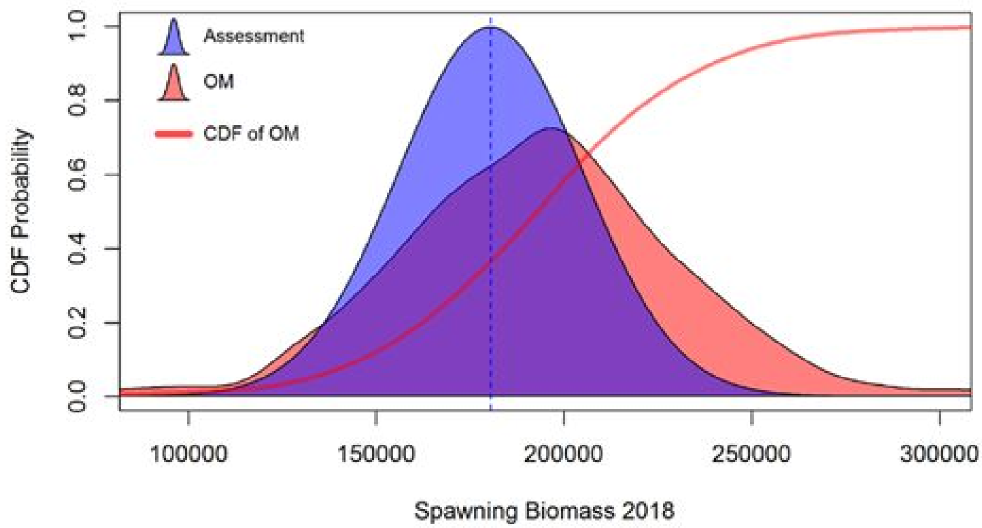


Fig. 7. Predicted distributions of 2018 spawning biomass for the long coastwide assessment model (blue) and the long coastwide operating model (OM, red). The cumulative distribution function (CDF) of the OM distribution and the median of the assessment 2018 spawning biomass (dashed blue line) are also shown.

3.1.1.3 Short coastwide operating model

Steepness and female natural mortality were the additional parameters in the full short coastwide model, compared to the assessment, that had variability. Steepness was centered on 0.75, as in the assessment. A prior was put on the steepness parameter (normal with a mean of 0.75 and a standard deviation of 0.08376, from the long coastwide model estimate of steepness), as discussed above, to make it have a similar distribution as the long coastwide model (see Figure 5). Female natural mortality was estimated without a prior, but the upper bound was extended to 0.45 because the estimate was 0.35. The upper bound on male natural mortality was also extended to 0.45 and its estimate was 0.26.

The estimated variances and covariances of steepness and female natural mortality were used, along with estimated variances and covariances from the assessment model for other parameters, to characterize the variance-covariance matrix used in the multivariate normal distribution from which parameters were sampled. The estimated standard deviations for steepness and female natural mortality were 0.08399 and 0.00864, respectively. The means for the multivariate normal distribution were the estimated or fixed values from the assessment (i.e., h = 0.75 and female M = 0.15).

The parameters, including steepness, were sampled from a multivariate normal distribution to create 1000 parameter vectors, each used to create a population trajectory. Trajectories that showed a maximum exploitation rate greater than 0.4 at any point in the time series were eliminated until 1000 parameter vectors were obtained. In total, 68 parameter draws were eliminated. The final 1000 trajectories of historical spawning biomass from the operating model are compared to the assessment in Figure 8.

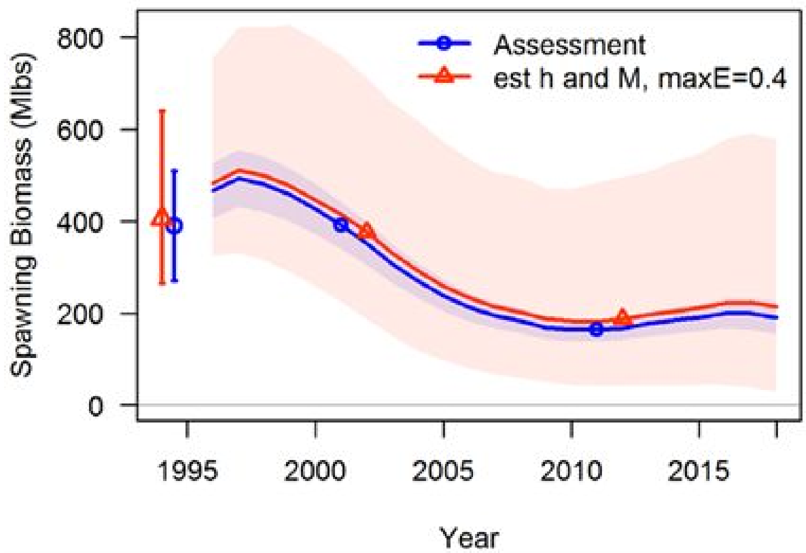


Fig. 8. Predicted median biomass trajectories with 95% confidence intervals for the short coastwide assessment model (blue) and the short coastwide operating model (red).

The median spawning biomass in the operating model is slightly greater than the assessment model. This is an effect of using a parametric bootstrap and adding the variability on steepness and female natural mortality, even though the distributions of these parameters were centered on the assessment values. This occurs for a number of reasons, as outlined above when discussing the long coastwide model.

The 2018 point estimate of spawning biomass from the assessment is the 44th percentile of the distribution of 2018 spawning biomass in the operating model (see Figure 9).

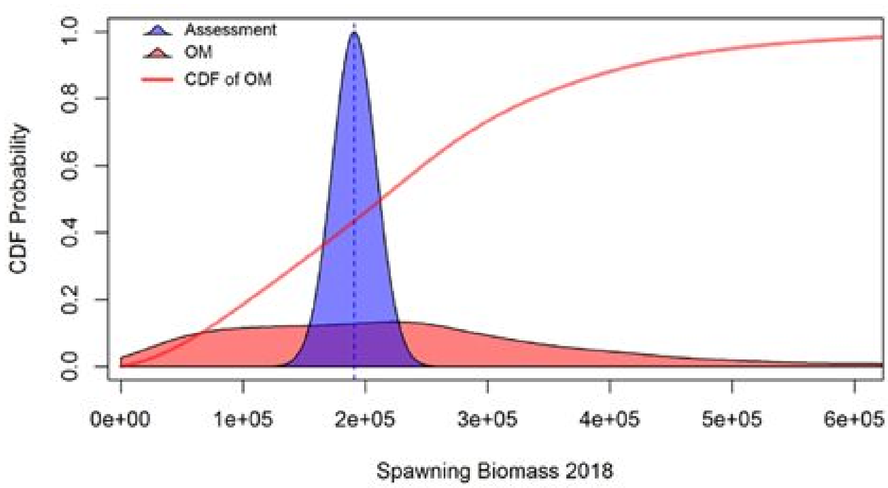


Fig. 9. Predicted distributions of 2018 spawning biomass for the short coastwide assessment (blue) and the short coastwide operating model (OM, red). The cumulative distribution function (CDF) of the OM distribution and the median of the assessment 2018 spawning biomass are also shown.

3.1.1.4 Summary of conditioned operating models

Overall, the individual operating models mimic the assessment well, but with additional uncertainty. The presence of a slightly higher median spawning biomass in the individual operating models is not a concern because the MSE is focused on ranking procedures and is not meant to predict the exact quantities. The most important aspect is to characterize variability and the dynamics of the stock. The variability in the short coastwide model is much greater than in the long coastwide model, and is a large contributor to the overall variability, in recent years, of the operating model consisting of the combination of the two individual models (Figure 10). When comparing the combined operating model to the ensemble assessment, the median spawning biomass trajectories are similar, but the variability in the operating model is much greater than the ensemble assessment (Figure 10).

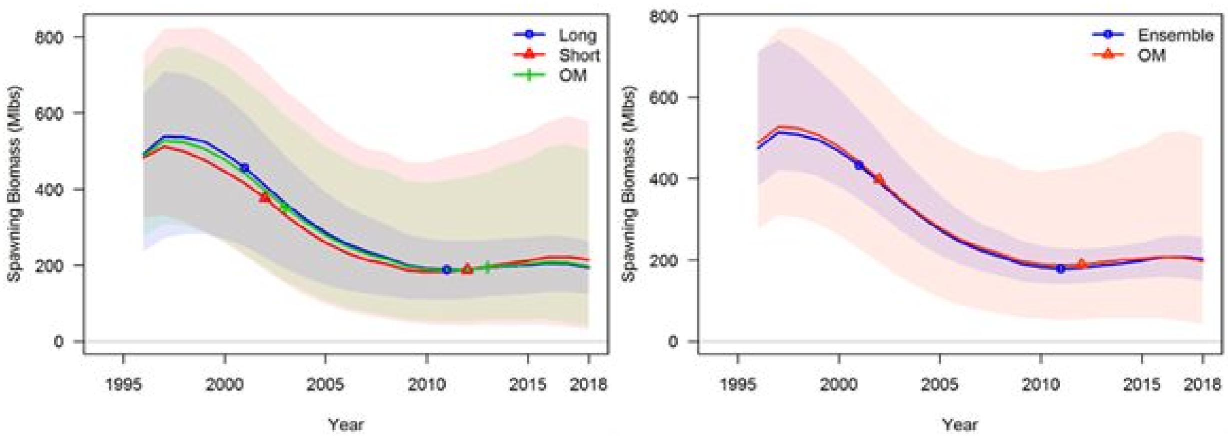
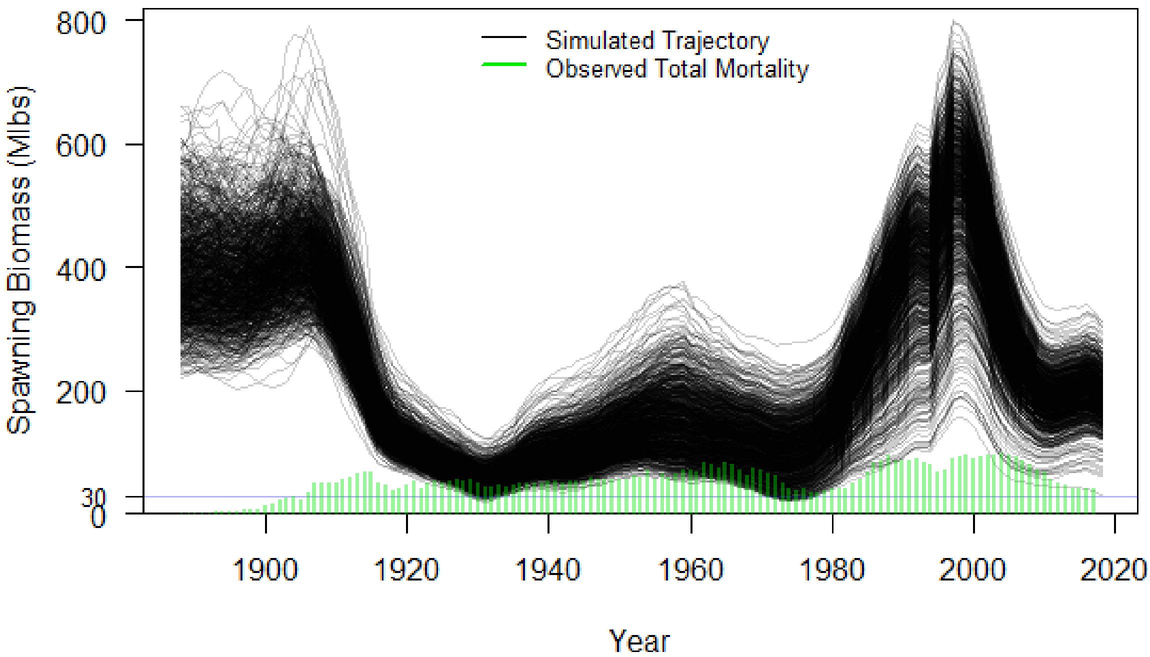


Fig. 10. The conditioned operating model (red) compared to the stock assessment ensemble (blue) with 95% confidence intervals on each.

The historical simulated trajectories were examined for evidence of “quasi-extinction”, which can be defined as a trajectory that reaches a value low enough that it would unlikely recover (in reality). That low value is not defined, so we compared simulated trajectories of spawning biomass to observed total mortality from all fisheries (Figure 11). The spawning biomass was generally low from around 1920 to 1980, and again in recent years. Especially low spawning biomass occurred near 1930 and 1975, and in recent years in the short coastwide model. The observed total mortality from fishing overlaps the lower trajectories around these low points, even with a maximum exploitation rate of 0.4. This can occur because the fishing mortality is partially composed of immature, young fish. Overall, some spawning biomass trajectories are surprisingly low, but it does not appear that quasi-extinction is apparent.



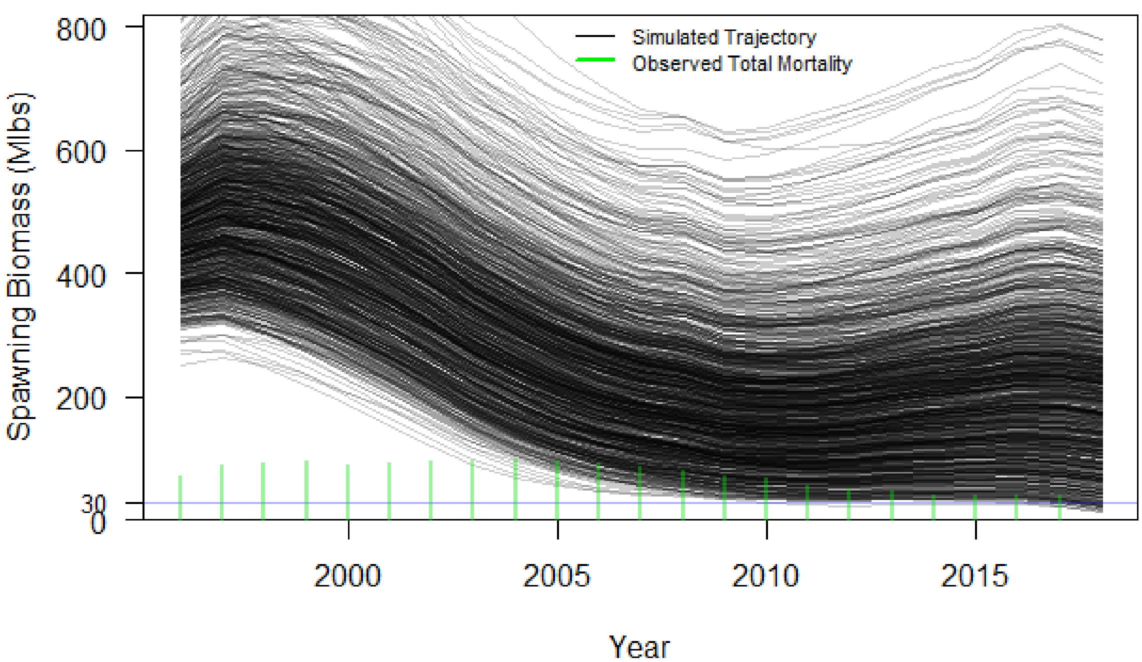


Fig. 11. Historical simulated trajectories of spawning biomass (M lbs) from the long coastwide operating model (top) and the short coastwide operating model (bottom). Observed total mortality (M lbs) from all fisheries is shown by the green histogram bars. A horizontal line at 30 million pounds is drawn for reference.

3.1.2 Simulating Forward with the Operating Model

The short and long coastwide models make up the operating model and incorporate variability associated with estimated parameters describing stock and fishery dynamics. Variability from other sources (e.g., weight-at-age, recruitment regimes, and allocation to fishery sectors) was introduced when projecting into the future. Descriptions of these procedures are provided in IPHC-2017-MSAB010-09 Rev1, and updates to the procedures are described here. An overview of major sources of variability are shown in Table 2.

Table 2. Processes and associated variability in the operating model (OM). TM refers to total mortality.

Process	Uncertainty
Natural Mortality (M)	Estimate appropriate uncertainty when conditioning OM
Recruitment	Random, lognormal deviations
Size-at-age	Annual and cohort deviations in size-at-age with bounds
Steepness	Estimate appropriate uncertainty when conditioning OM
Regime Shifts	Autocorrelated indicator based on properties of the PDO for regime shift
TM to sectors	See section on allocating TM to sectors
Proportion of TCEY	Sector specific. Sum of mortality across sectors may not equal coastwide TM

3.1.2.1 Allocating the Total Mortality to Fishery Sectors

There are five fishing sectors in simulations, as is defined in the coastwide assessment models. These are a commercial fishery, a discard mortality from the commercial fishery, a recreational fishery, bycatch mortality, and a subsistence fishery. The changes to the methods used to allocate total mortality to these five sectors are described below.

Bycatch Mortality

Bycatch mortality across all IPHC Regulatory Areas (Figure 12) has been declining since a peak in 1992 of 20 million pounds (~9,000 t). In 2017, bycatch mortality was estimated to be 6.0 million pounds (~2,700 t), which is due to industry measures to reduce bycatch as well as reductions in the Pacific halibut stock.

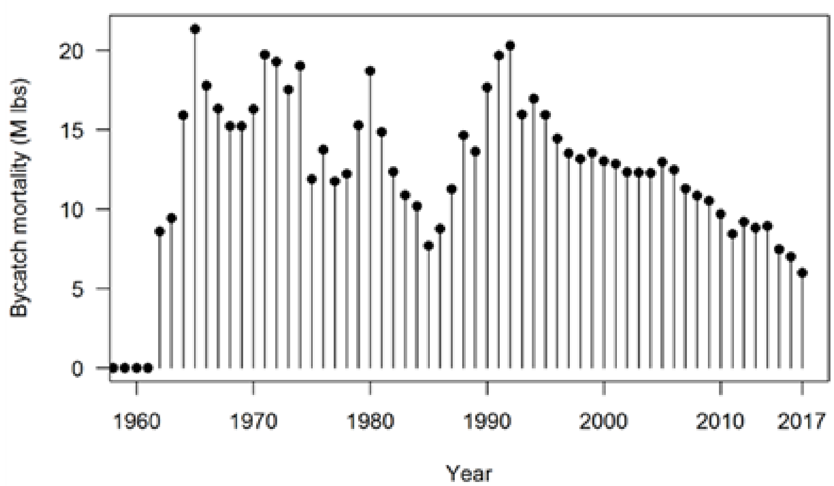


Fig. 12. Observed bycatch mortality.

A look at the historical relationship between bycatch mortality and total biomass was done to predict how bycatch may change with changes in Pacific halibut biomass. Before 1997 bycatch increased greatly with little change to total biomass (Figure 13) and after 2014 the bycatch dropped substantially with little change in total biomass (likely due to the industry specified protocols to reduce bycatch, such as deck sorting in the Amendment 80 trawl fleet). Therefore, using bycatch mortality from 1997 to 2014 and estimating the relationship with total biomass, the predicted slope of the line is 0.004. This is interpreted as each pound increase in total biomass results in a 0.4% increase in bycatch mortality. However, in the past three years, the bycatch mortality has declined from approximately 9 million pounds (4,000 t) to 6 million pounds (2,700 t) with little change in total biomass, thus the prediction line should reflect the efforts to reduce bycatch mortality, and the intercept was shifted to match the 2017 observations of bycatch mortality and total biomass (Figure 13). The predicted total biomass in 2017 was 848 million pounds (385 thousand t) which shifts the line downward by 3.4 million pounds to current bycatch levels but retains the relationship (change in bycatch) with total biomass.

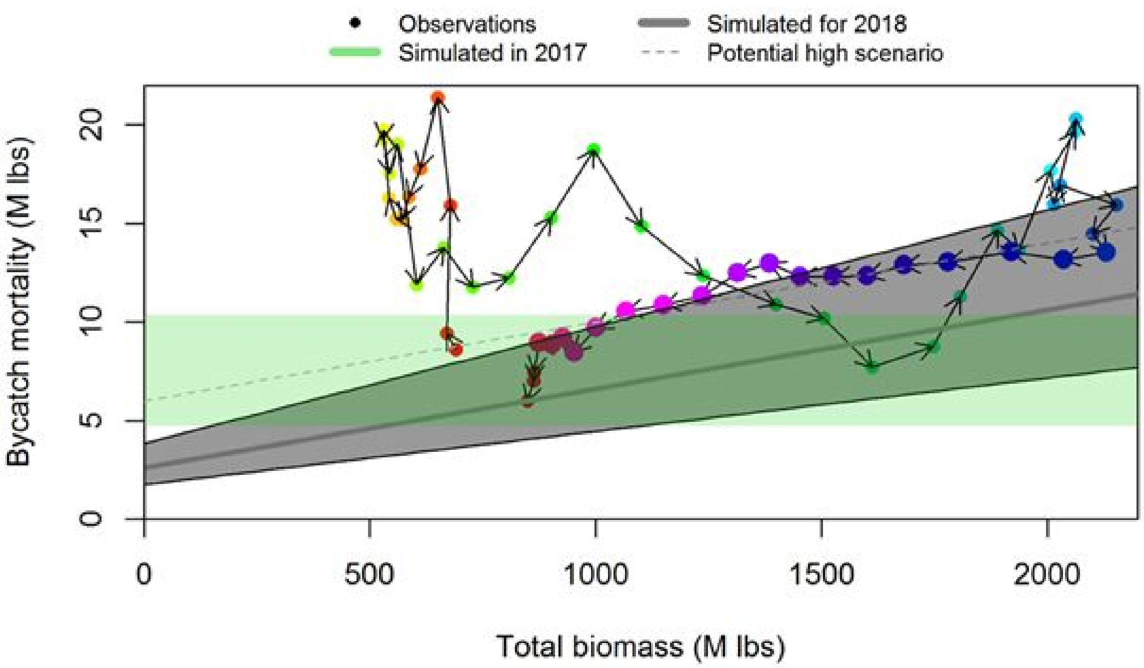


Fig. 13. Bycatch mortality (colored dots) plotted against estimated total biomass from the 2017 stock assessment. Arrows and colors show the sequence of time. The years 1997 to 2014 are shown by larger dots. The light green area shows the range of bycatch that was simulated from a lognormal distribution for 2017 MSE results, and did not change with total biomass. The grey areas shows the updated lognormal distribution for simulated bycatch that is a function of total biomass. The dashed line shows the mean of a potential high scenario for simulating bycatch.

A potential high bycatch scenario would be to use the original intercept of 6, which creates a line passing through the 1997-2014 observations (Figure 2, dashed line).

The previous CV on bycatch was 0.2 with a constant mean bycatch regardless of total biomass. This CV was kept to maintain the unpredictability of bycatch in the future.

Recreational mortality

A recommendation from MSAB012 was to modify the recreational allocation so that it kept increasing as the biomass (or TCEY) increased (REF to paragraph). Therefore, recreational mortality was investigated, and a constant proportion of the total mortality was used for allocation. To determine the proportion, the last five years (2013-2017) were used to determine the mean proportion, which was 0.18. The error on the proportion was set to capture the range of proportions observed over the past five years, resulting in a CV of 0.01. Figure 14 shows the recreational mortality and the proportion of recreational mortality plotted against the total mortality, as well as the simulated mean and range.

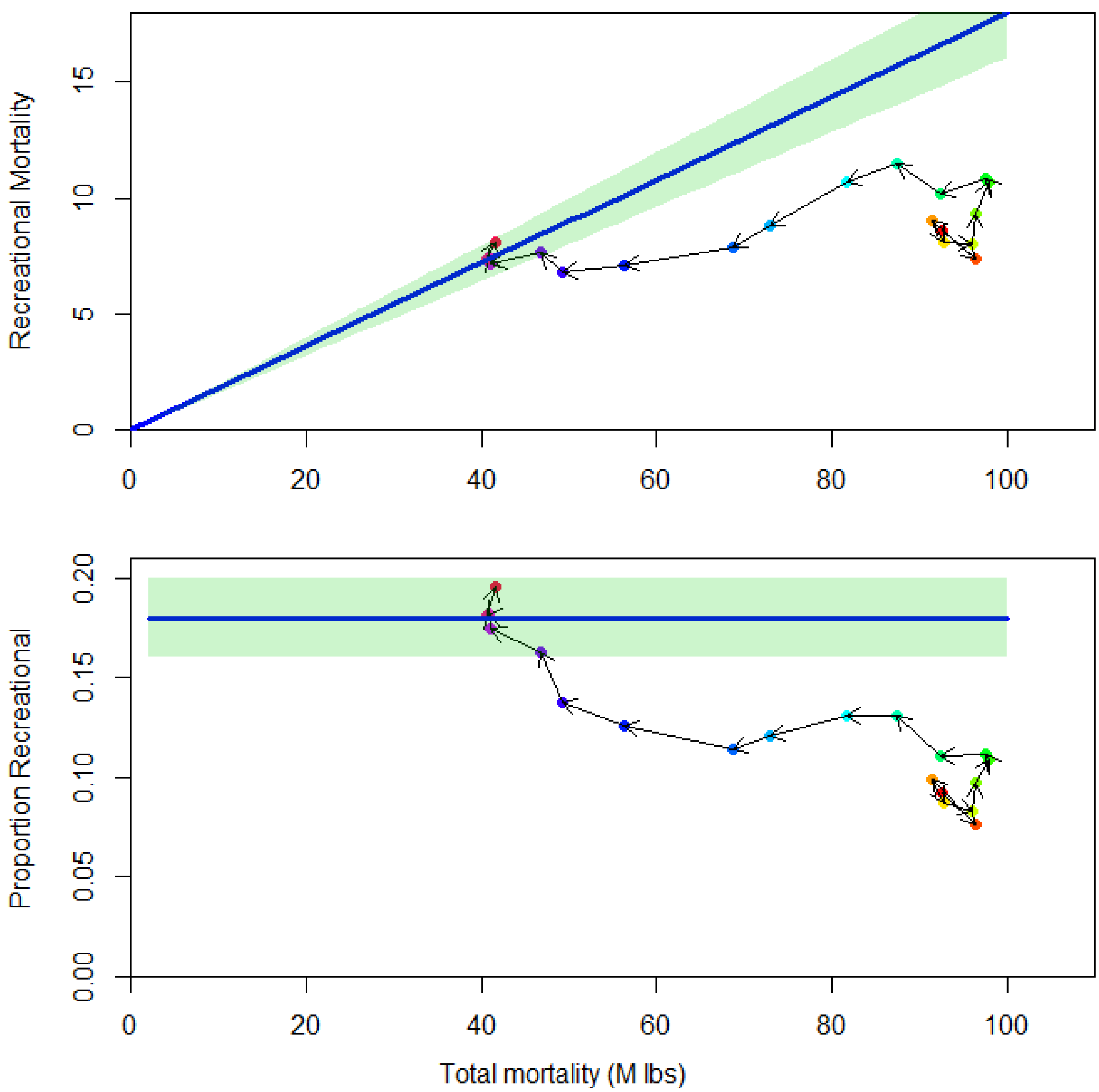


Fig. 14.: Recreational mortality (top) and the proportion of recreational mortality (bottom) plotted against the total mortality, as well as the simulated mean (blue line) and range (green area). Arrows show the sequence of time.

The resulting average allocations are shown in Figure 15.

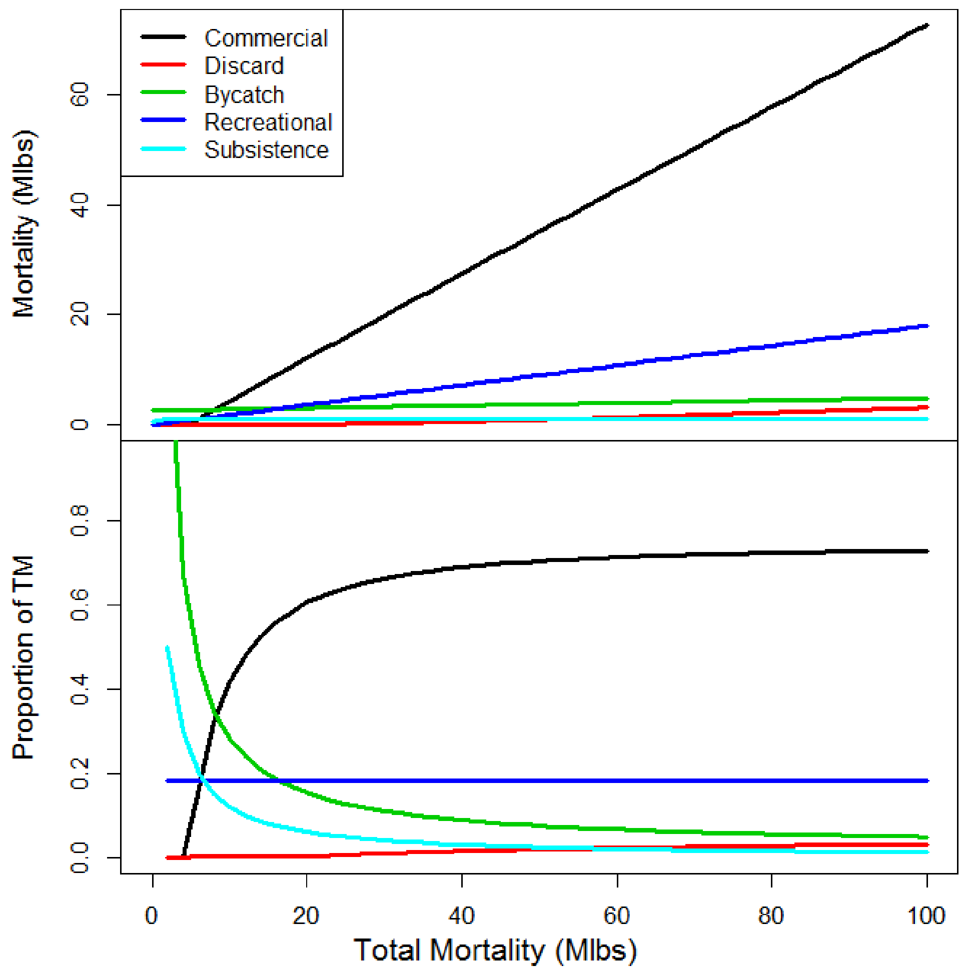


Fig. 15. Average allocations in terms of mortality (top) and proportion (bottom) for the five fishing sectors. Bycatch allocation is a function of total biomass, and it was assumed that total mortality is 17.5% of total biomass (based on estimates from 1998–2017).

3.1.2.2 Variability in Commercial Selectivity

Selectivity-at-age for the commercial sector is modeled in the long and coastwide models with a double-normal formulation. However, the descending width parameters are fixed such that the function in monotonic and asymptotes at one (i.e., full selectivity at older ages), and only two parameters are estimated: the ascending width (controlling how steep the ogive is) and the peak parameter (controlling where the ogive reaches a value of one. These two parameters are time-varying and result in year-specific selectivity ogives. Annual deviates are estimated and the changes in the parameters are a random walk from the previous year.

$$\mathrm{param}_{\{y\}} = \mathrm{param}_{\{y-1\}} + \mathrm{dev}_{\mathrm{y}}$$

The estimated selectivity ogives for the commercial sector from the long coastwide model are shown in Figure 16.

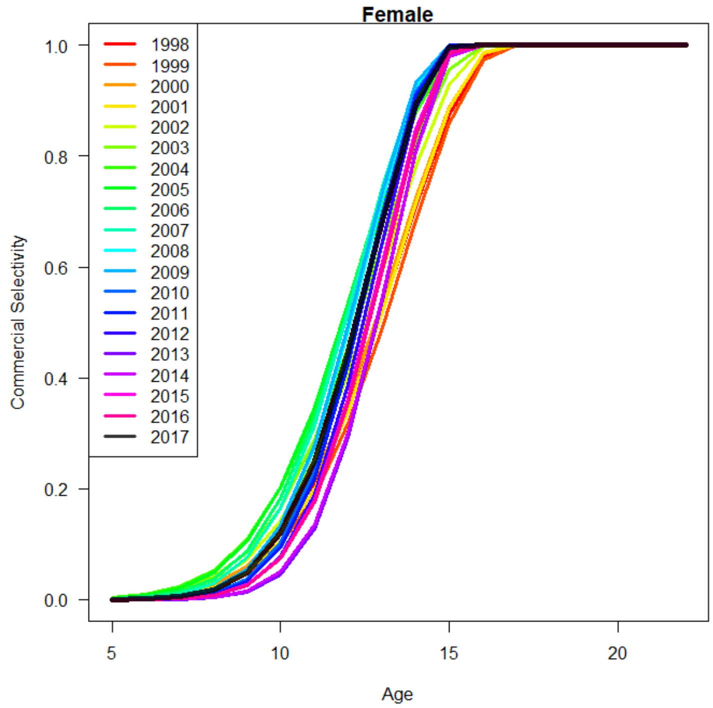


Fig. 16. Estimated commercial selectivity from the long coastwide model for the years 1998-2017.

Changes in selectivity may be related to changes in weight-at-age because weight-at-age is a proxy for changes in size. Given that the selectivity parameters are a random walk from the previous year's adjusted parameter, simply modeling the deviates as a function of weight-at-age is not clear, but modeling the adjusted parameter estimates as a function of weight-at-age is reasonable. There are likely many other factors affecting selectivity, such as economic conditions, bycatch, and other fisheries, thus only recent observations of weight-at-age and estimates of parameters were used. The current design of the survey began in 1998, which gives twenty years of observations with a large amount of data collected coastwide to inform the weight-at-age. Figure 17 shows that the selectivity parameters and weight at age 9 are correlated to some degree.

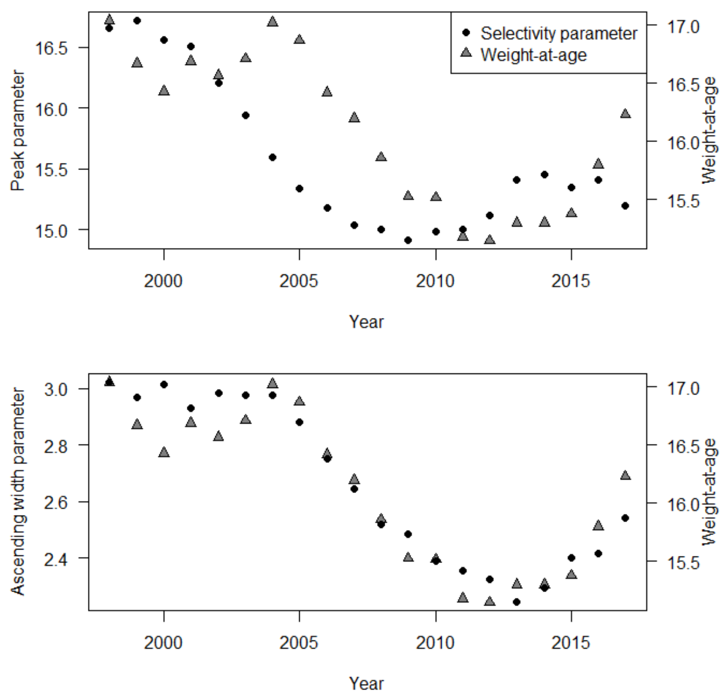


Fig. 17. Estimates of the peak (top plot) and ascending width (bottom plot) parameters for the years 1998-2017 (circles). Also shown are the observations of weight at age 9 (triangles) for those same years.

The estimates of the peak and ascending width parameters are highly correlated (Pearson correlation coefficient = 0.75) and show a positive relationship with weight at age 9 (Figure 18). When fish are growing to a larger size, the peak is shifted to the right and the ascending width is larger, resulting in an ogive that is less steep and the increasing portion is spread out more ages. It may seem counter intuitive that the peak is shifted to the right (older ages) when the fish are growing faster (i.e., they should be selected at an earlier age if the process is truly size-based). However, the ascending width parameter is increasing, and we believe it does that to select more of the fish that are not fully selected (Figure 16, ages 8-12, green lines). Then, because of inflexibility in the two-parameter approach, the peak parameter is shifted to older ages to accommodate the informative data that occurs at the younger ages.

Therefore, it appears that the ascending width parameter is driven by weight at age 9, and the peak parameter is related to the ascending width parameter estimate. The linear regression line for the relationship between the ascending width parameters and weight at age 9 had a R^2 value of 0.9 and showed a positive slope (Figure 18). The relationship of the peak parameter to the ascending width parameter seems to be two phases: a small peak parameter with small variability when the ascending width parameter is small, and a higher peak parameter with a larger variability when ascending width parameter is large. This was simulated with two states of the peak parameter, with a linear connection between ascending width values of 2.7 and 2.9 (Figure 18). The relationship was captured when relating the peak parameter to weight at age 9, even though weight at age 9 was not used directly to predict it. The correlation between the peak and ascending width parameters was 0.88, without extra variability.

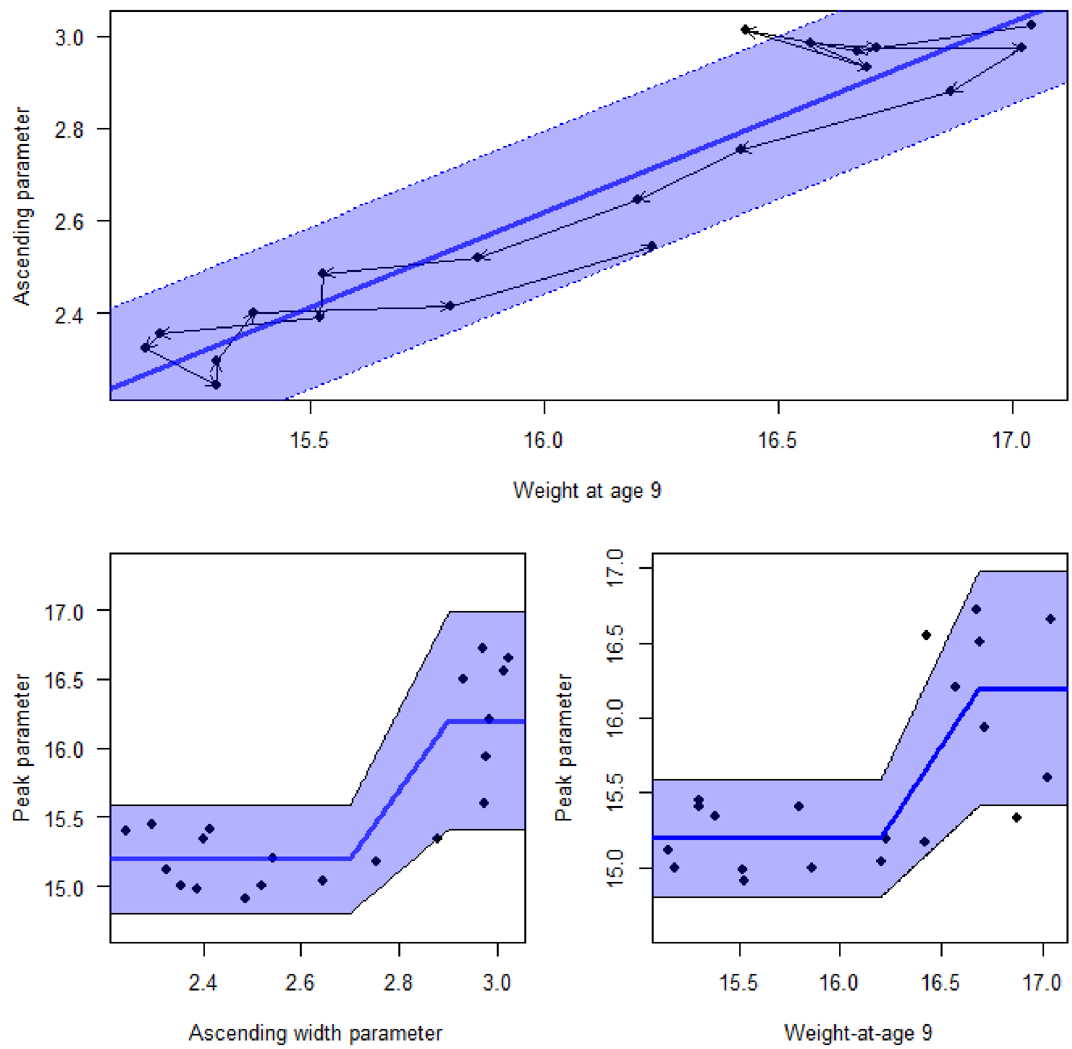


Fig. 18. Estimates of the ascending width parameters for the years 1998-2017 plotted against weight at age 9 (top). The blue line is the fitted regression line. The bottom row shows the peak parameter plotted against the ascending width parameter and against the weight at age 9. The blue shaded area is the 95% interval for the simulated values.

With the short model, weight at age 9 had a high correlation with the ascending width parameter (R^2=0.60. Figure 19). The peak parameter had very little variation (ranged between 15.57 and 15.78), thus was considered to not be time-varying. The male asymptote was time-varying in the short coastwide model, but there was not clear relationship with any weight-at-age. Figure 20 shows the relationship with weight at age 9 and seems well correlated in early part of the time series, but varies just as much with little change the weight at age in more recent years. Therefore, the male asymptote is simulated as a random walk.

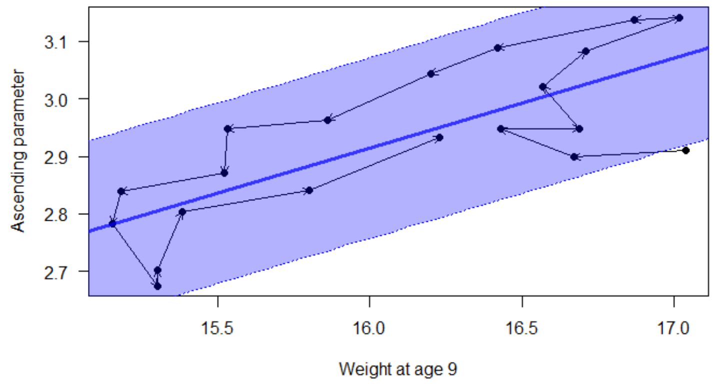


Fig. 19. Estimates of the ascending width parameter of the female selectivity ogive in the short coastwide model for the years 1998-2017 plotted against weight at age 9. The blue line is the fitted regression line.

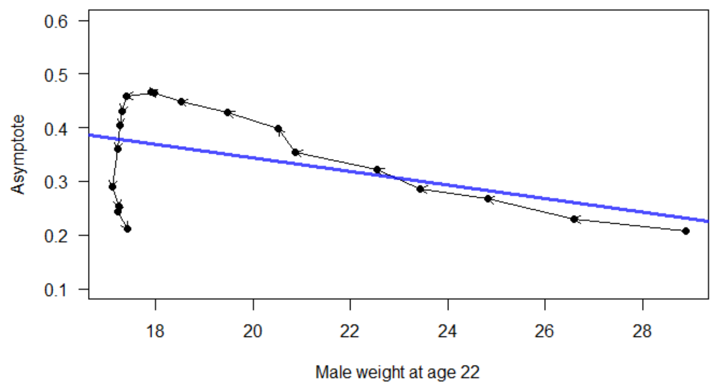


Fig. 20. Estimates of the asymptote of the male selectivity ogive for the years 1998-2016 plotted against weight at age 22. The blue line is the fitted regression line.

An example of simulated selectivity at age 10 and age 15 is shown in Figure 21. The parameters were bounded so that they did not traverse to values outside of the estimates for the last two decades. Overall, the selectivity shows a randomness that is linked to weight-at-age but not completely driven by weight-at-age. This is likely due to the spatial availability of specific year-classes as the distribution of landings has changed over time (Stewart and Martell 2014).

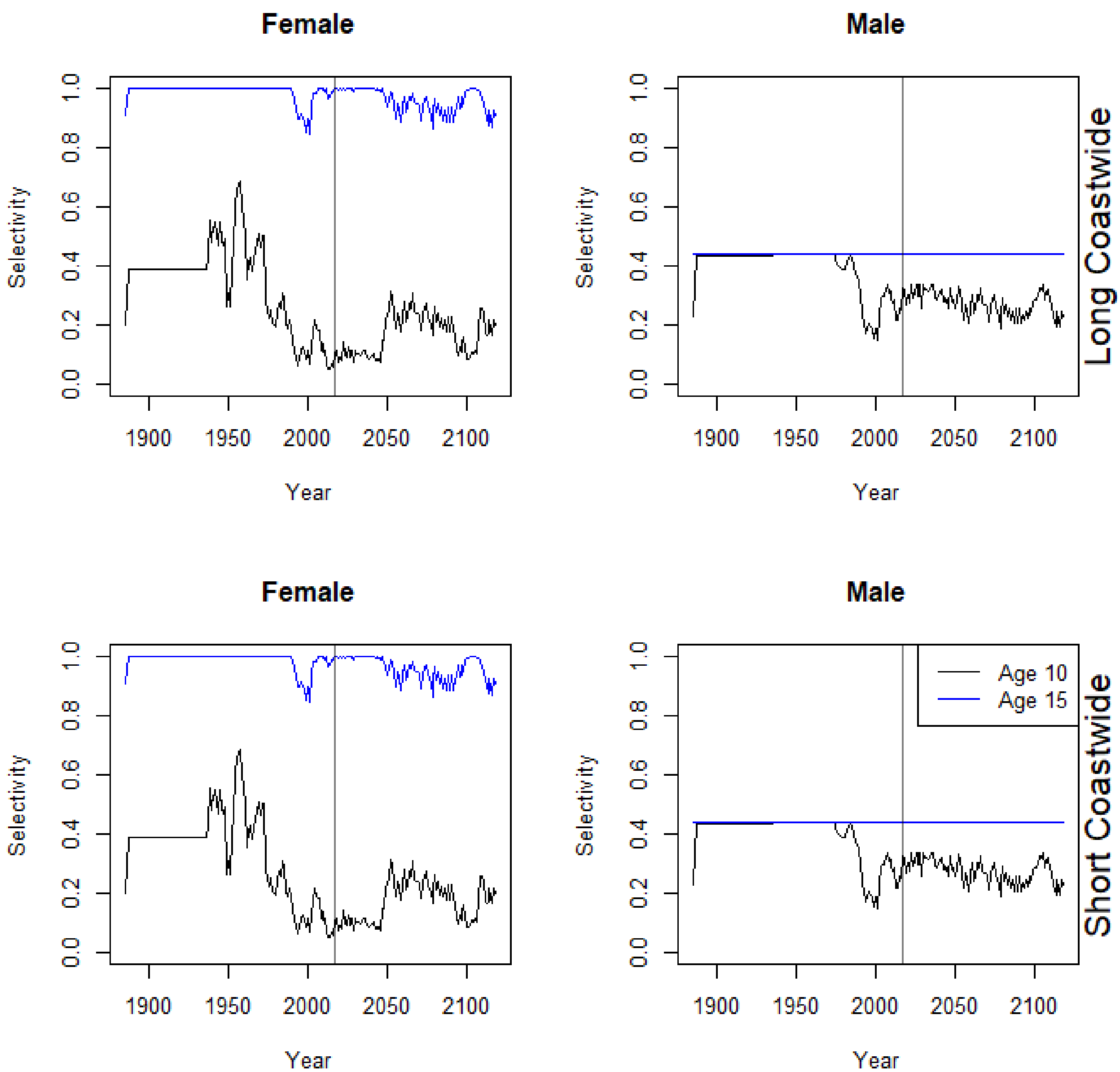


Fig. 21. Example of simulated commercial selectivity at age 10 and age 15 for the long coastwide model (top) and the short coastwide model (bottom). The vertical grey line is at the year 2018.

3.2 Management Procedure

The elements of the management procedure are described in reverse order because it is easier to understand the decisions made for modelling them since they are dependent on each other. Therefore, the harvest rule is presented first, followed by the estimation model, and finishing with monitoring.

3.2.1 Harvest Rule

The generalized management procedure to evaluate is shown in Figure 1, but the focus will be on the Scale portion to produce results for the MSAB to evaluate before AM095 in 2019. Specifically, the portion of the management procedure being evaluated is a harvest control rule (Figure 22) that is responsive to stock status and consists of a procedural SPR determining fishing intensity, a fishery trigger based on stock status that determines when the fishing intensity begins to be linearly reduced (note that this may differ from the biological threshold), and a fishery limit that determines when there is theoretically no fishing intensity (this may differ from the biological limit). For these simulations, the two coastwide models were used, thus mortality only needed to be distributed to the five coastwide sources of mortality (directed commercial, discard mortality, bycatch mortality, recreational, and subsistence).

Simulations have been used in the past to evaluate a range of SPR values from 25% to 60% and trigger values of 30% and 40% (IPHC-2017-MSAB10-09 Rev 1). Those simulations provided insight into how those different levels of SPR would meet the objectives defined by the MSAB, but few values of SPR below 40% were tested. Future simulations will use a finer resolution of SPR values ranging from 30% to 56% and fishery trigger points of 30% and 40% (with the addition of 45% if time allows).

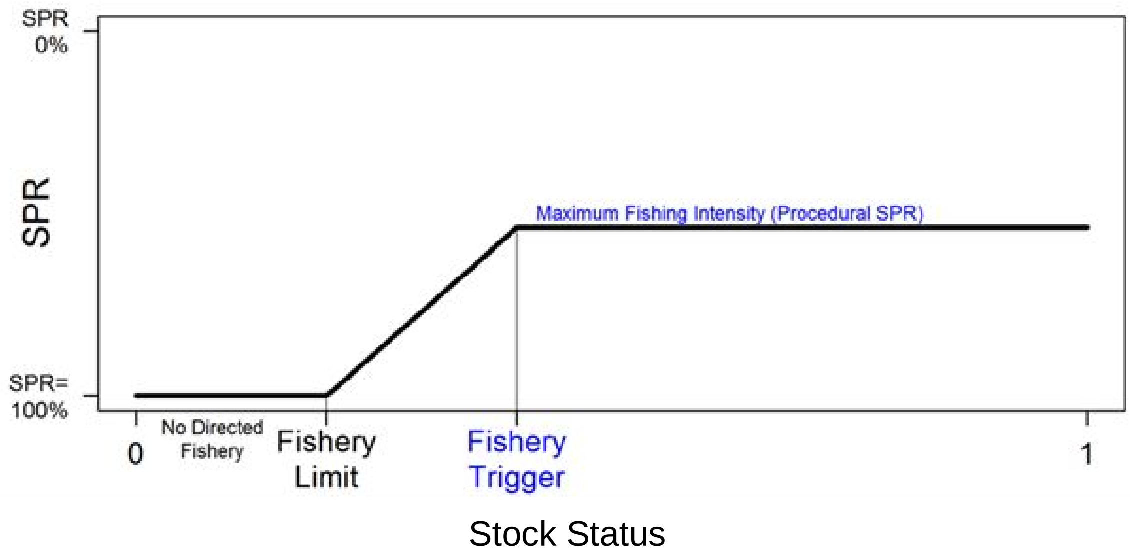


Fig. 22: A harvest control rule responsive to stock status that is based on Spawning Potential Ratio (SPR) to determine fishing intensity, a fishery trigger level of stock status that determines when the fishing intensity begins to be linearly reduced, and a fishery limit based on stock status that determines when there is theoretically no fishing intensity (SPR=100%). In reality, it is likely that only the directed fishery would cease. The Procedural SPR and the Fishery Trigger (in blue) are the two values to be evaluated.

3.2.2 Estimation Model

Two options to simulate an estimation model will be used: the No Estimation Model (previously called Perfect Information) option, as was used in past simulations, and the Simulate Error option. The No Estimation Model method assumes that the population values needed to apply the management procedure are exactly known (e.g. spawning biomass). This option is useful as a reference to better understand the performance with and without uncertainty in an estimation model. Due to time constraints, the only other option to be considered for simulations in 2018 is the Simulate Error option, which will be suitable to understand the effects of estimation error. This method is described below.

The harvest control rule contains two components that have estimation error. The first component is the estimated total mortality determined from the specified SPR. The second component is the estimated stock status that is used to reduce the fishing intensity when stock status is low (fishery trigger and fishery limit). These components are dependent on the estimated biomass, but it is more straightforward and computationally efficient to introduce error into these two components, rather than introducing error on the estimated biomass and then determining the resulting estimates of total mortality and stock status.

The 2017 stock assessment (Hicks & Stewart 2018) was used to determine a reasonable amount of variability in these two components and the correlation between them (see Section 4.2 of IPHC-2018-SRB012-08).

Autocorrelation is implemented by independently applying it to the deviation of the estimated stock status and the estimated total mortality. The correlated variability in these two quantities is applied and then the autocorrelation occurs independently using equation 1.

$$\left(\hat{X}_t - X_t\right) = \rho\left(\hat{X}_{t-1} - X_{t-1}\right) + \sqrt{1-\rho^2}\varepsilon_X \quad (1)$$

Where $\left(\hat{X}_{t-1} - X_{t-1}\right)$ is the deviation for the quantity of interest (TM or stock status) in time step *t*, ρ is the autocorrelation parameter, and ε_X is a randomly generated deviation from a multivariate normal distribution for TM and stock status (as described above).

Overall, there are many assumptions in this incorporation of estimation error, but we are only trying to determine a reasonable amount of error for the simulations. Coefficients of variation on stock status and total mortality were fixed at 15% with a correlation of 0.5. Autocorrelation was fixed at 0.2. Other levels of error will likely be simulated to determine how sensitive the results are to the assumed estimation error.

3.2.3 Monitoring (Data Generation)

The simplified incorporation of estimation error will be used due to time constraints; thus no data are required to be generated. However, if a stock assessment were simulated, there would be many sources of data to generate.

3.3 SUMMARY OF THE FRAMEWORK

A summary of the major specifications for each component is provided below, with the components listed in a specific order where the next component is dependent on the decisions for the previous components.

1) Operating Model
    a) Stock synthesis, based on coastwide assessment models (short and long models).
    b) Five fleets, as in the assessment models (commercial, discards, bycatch, sport, personal use).
    c) Fishing mortality assigned to sectors based on historical information (with variability).
    d) Uncertainty incorporated through parameter uncertainty, model uncertainty, a simulated variability in future weight-at-age and recruitment.
2) Management Procedure
    a) Estimation Models

i) Perfect Information (as a reference if we knew population values exactly when applying the harvest rule).

ii) Simulate error in total mortality (cv=0.15) and spawning biomass (cv=0.15), with autocorrelation (0.2), from the simulated time-series to mimic an unbiased stock assessment.

b) Data Generation

i) Not needed at this time.

c) Harvest Rule

i) Coastwide fishing intensity (F_{SPR}) using a procedural SPR (to be evaluated).

ii) A fishing trigger to reduce the fishing intensity (increase SPR) when stock status is below a specified level (to be evaluated).

iii) A fishing limit to cease directed fishing when the stock status is less than a specified value (20%).

4 PERFORMANCE METRICS

Defining goals and objectives is a necessary part of a management strategy evaluation (MSE) which should be revisited often to make sure that they are inclusive and relevant. The MSAB is currently refining goal and objectives (see IPHC-2018-MSAB012-06), which are translated into performance metrics. Many performance metrics have been developed by defining a measurable outcome, a probability (i.e. level of risk), and time-frame over which it is desired to achieve that outcome. Management procedures can then be evaluated by determining which ones meet various objectives (via the performance metrics). Some performance metrics have been defined by the MSAB that are called statistics of interest, and even though they are associated with various objectives, they are secondary to the evaluation of the management procedure. Some of the primary performance metrics and statistics of interest being reported are described in Table 3.

5 SIMULATION RESULTS

Using the simulation framework described above and in previous documents, test cases were first investigated to better understand the dynamics of the simulations. The simulations were done with no directed fishing, but with bycatch and subsistence fishing (approximately ranging from 4.5 million pounds to 12 million pounds), to investigate the nature of the projections and the presence, if any, of quasi-extinction. Additionally, projections with constant levels of weight-at-age and recruitment (low/high combinations) were done.

Figure 23 shows forward simulation results for the no directed fishing case with simulated variability in weight-at-age and simulated recruitment regimes. Only one-hundred trajectories were simulated, but it is clear that the entire range of variability is not captured until at least after 60 years. As also shown in the conditioning results, the short coastwide model had a wider range of variability. No simulated trajectory for the long coastwide model produced a spawning biomass less than 30 million pounds, and the minimum spawning biomass from all long coastwide model trajectories was near 60 million pounds, which occurred at time step 2. The short coastwide model produced four (out of 100) trajectories that had a spawning biomass less than 30 million pounds. Of these four, three of them started at a spawning biomass less than 30 million pounds, and all three recovered to levels above that. One trajectory started above 30 million pounds, but eventually crashed to zero.

Table 3. Performance metrics and statistic of interest for the long-term to evaluate the management procedures. Primary metrics are the main performance metrics for the evaluation and the statistics of interest are intended to supplement and inform that evaluation.

Primary Metrics	
Performance metric	**Description**
P(SB > SB_{Lim})	Times out of 100 that the stock biomass (status) is above the limit. The limit is defined as 20% of the biomass if no fishing had occurred.
P(AAV > 15%)	Times out of 100 that the average annual variability (AAV) is greater than 15%. AAV can be thought of as the average change in the Total Mortality quota (TMq) from year to year.
P(TM < TM_{min})	Times out of 100 that the Total Mortality quota (TMq) would be set below a minimum value. The minimum TMq has not been determined, and is currently an *ad hoc* value of 34 Mlbs, which is the minimum Total Mortality observed (TM) since 1906.
Secondary Metrics	
Statistic of interest	**Description**
Median SB	The median biomass expected in the long-term
Median # females	The median number of females expected in the long term.
AAV	The Average Annual Variability, which can be thought of as the average change in the TM from year to year.
P(↓TM > 15%)	Times out of 100 that the TMq decreases by more than 15% compared to the previous year.
AAV|SB<SB_{Trig}	The average annual variability when the stock status is below the fishery trigger (often referred to as ‘on the ramp’).
$P\left(\widehat{SB} < SB_{Trig}\right)$	Times out of 100 that the estimated spawning biomass (status) is less than the fishery trigger, thus invoking ‘the ramp’ and reducing fishing intensity.
Median TMq	Median coastwide TMq. The TMq is greater than this value in half of the simulations.
P(TMq < 54)	Times out of 100 that the TMq is less than 54 Mlbs, which is 70% of the average TM from 1993 to 2012.
5^{th} & 75^{th} TMq	The 5^{th} and 75^{th} percentiles of the Total Mortality quota from the simulations. This means that 5 out of 100 are less than or equal the 5^{th} percentile and 25 out of 100 are greater than or equal to the 75^{th} percentile.

Specific states of weight-at-age and recruitment regimes were simulated to investigate how these factors, and the combination of them, affect the simulated population trajectories. Low and high recruitment regimes were simulated by fixing the regime in the model at its low or high value since it is modeled as discrete low or high. Changes in weight-at-age are continuous, thus specific states had to be determined. Low, medium, and high states are determined by calculating the 15^{th}, 50^{th}, and 85^{th} percentiles of the historical weight-at-age (1935-2017) for each age, running a loess smoother through the specific quantile-at-ages, and then making sure it increases monotonically over age by predicting weight (from the loess model) for any ages that had a weight less than the weight at a younger age (Figure 24).

Using the low and high states of weight-at-age, crossed with the low and high recruitment regimes, and keeping them static for the entire simulation allowed for the investigation of these different factors as well as testing to make sure that they produced reasonable results. Figure 23 shows the simulated trajectories using the long coastwide model and the short coastwide model for the four different combinations. The long coastwide model was most influenced by weight-at-age, and each combination produced a well-defined band of trajectories. The short coastwide model showed more influence from recruitment with the high weight low recruitment scenario showing similar trajectories as the low weight high recruitment scenario. Some trajectories in the low weight low recruitment scenario showed quasi-extinction. In both models, the high recruitment regime resulted in more variability.

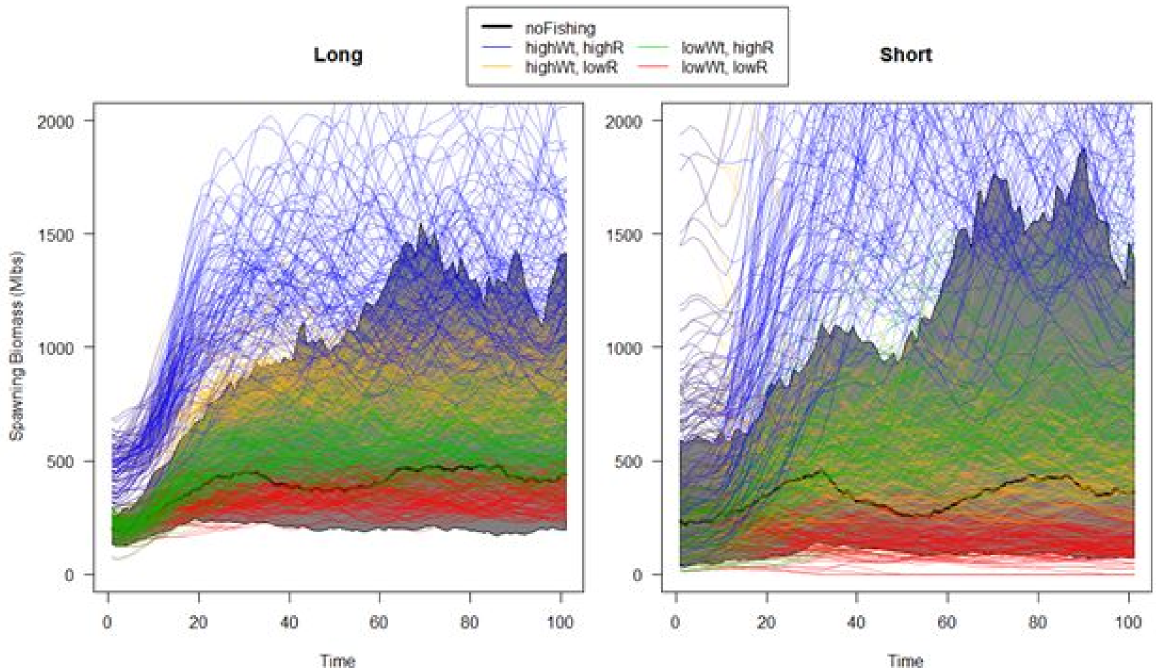


Fig. 23. One-hundred forward simulated trajectories of spawning biomass without directed fishing. Bycatch mortality and subsistence mortality occurred (note, bycatch is simulated as a constant level with error for these trajectories). The gray area shows the range of simulations between the 2.5th and 97.5th percentiles with no fishing, but with simulated weight-at-age and simulated recruitment regimes. The individual lines of different colors show individual simulated trajectories with specific constant levels of weight-at-age and recruitment.

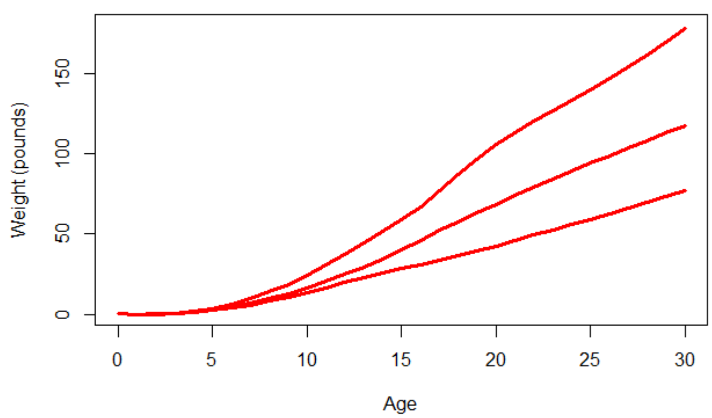


Fig. 24. Plot of the low, medium, and high states of weight-at-age for testing.

Table 4. Performance metrics for four different management procedures. The additional two columns of performance metrics show the effect when estimation error and autocorrelation are introduced. (*Note the results in this table are superseded by the results presented in Appendix A*).

Control Rule	**30:20**	**30:20**		**40:20**	**40:20**		**30:20**	**30:20**
SPR	**0.40**	**0.46**		**0.40**	**0.46**		**0.46**	**0.46**
Est Error	**None**	**None**		**None**	**None**		**0.1**	**0.1**
Autocorrelation	**NA**	**NA**		**NA**	**NA**		**0.0**	**0.2**
Metric								
P(SB < 20%)								
P(AAV > 15%)								
P(TM < 34)								
Median SB								
Median # females								
P(SB < 30%)								
AAV								
P(↓TM > 15%)								
Median TMq								
5^{th} & 75^{th} TMq								

Table 4 presents a small sample of results that will be shown at MSAB012. Additional results and alternative ways to view those results will be discussed at the meeting.

6 RECOMMENDATIONS

That the MSAB:

1) **NOTE** paper IPHC-2018-MSAB012-07 which provides the MSAB with an update on the MSE framework and presents a small subset of results.
2) **NOTE** the simulation framework and improvements to the simulation framework
3) **NOTE** the results of simulating forward in time with no fishing and the influence of weight-at-age and recruitment regimes.
4) **NOTE** the performance metrics reported for various management procedures.
5) **RECOMMEND** additional ways to present the results and examine trade-offs between objectives.
6) **RECOMMEND** a management procedure that meets the goals and objectives defined by the MSAB.

7 APPENDICES

Appendix A: Updated results – Long- and short-term performance metrics

Appendix A: Updated results

Tables A1 and A2 show some long-term performance metrics for some runs requested at MSAB011 (IPHC-2018-MSAB011-R). Tables A3 and A4 show some short-term performance metrics for those same runs. For long-term results with a control rule (Figure A1), the probability that the stock is below 20% of the dynamic unfished equilibrium biomass is less than 1% for all cases. This is a result of the control rule limiting the fishing intensity as the stock approaches this threshold, even with estimation error present. It is rare that the estimation persists such that fishing intensity remains high and the stock falls below the 20% threshold. The outcome of this can be seen in the average annual variability (AAV), which is a measure of the change in the quota from year to year. At fishing intensities greater than that associated with an SPR 0f 40% (i.e., SPR values less than 40%) the probability that the AAV is greater than 15% is more than 0.90. This probability declines to 0.61 at an SPR of 56%. The median AAV's range from 16% to 42% when using a 30:20 control rule (Table A1) and from 21% to 46% when using a 40:20 control rule (Table A2). The 40:20 showed higher variability in the quota. The absolute value of the Total Mortality quota ranged from 34% to 42% and was highly variable for a given SPR (Figure A1). In summary, long-term performance metrics showed little risk of falling below the 20% threshold, high variability in catches that increased with higher fishing intensities (i.e., lower SPR), and median Total Mortality quotas that increased slightly with greater fishing intensity.

Many more results and sensitivities will be shown at MSAB012.

Table A1. Long-term performance metrics for an estimation error CV of 0.15, autocorrelation of 0.4, a 30:20 control rule, and a range of input SPRs.

Input Est Error	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**
Input Autocorrelation	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**
Input Control Rule	**30:20**	**30:20**	**30:20**	**30:20**	**30:20**	**30:20**	**30:20**	**30:20**	**30:20**	**30:20**	**30:20**
Input SPR	**30%**	**32%**	**34%**	**36%**	**38%**	**40%**	**42%**	**44%**	**46%**	**48%**	**56%**
Median SPR	42.6%	42.4%	42.4%	42.5%	42.7%	43.5%	44.5%	45.9%	47.4%	49.0%	56.3%
Biological Sustainability											
Median average dRSB	30.4%	31.0%	31.7%	32.9%	33.9%	35.0%	36.5%	37.9%	39.7%	41.6%	50.2%
P(all dRSB<20%)	0.004	0.004	0.006	0.005	0.002	0.002	0.003	0.004	0.003	0.002	0.002
P(any dRSB_y<20%)	0.011	0.008	0.009	0.006	0.002	0.002	0.004	0.005	0.004	0.003	0.002
P(all dRSB<30%)	0.470	0.405	0.338	0.253	0.191	0.142	0.094	0.065	0.031	0.023	0.002
P(any dRSB_y<30%)	0.867	0.789	0.676	0.545	0.402	0.307	0.202	0.149	0.07	0.044	0.003
Fishery Sustainability											
P(all AAV > 15%)	0.993	0.988	0.958	0.927	0.905	0.847	0.813	0.771	0.722	0.689	0.606
P(all TM < 34 Mlbs)	0.465	0.458	0.457	0.439	0.425	0.432	0.426	0.436	0.448	0.455	0.507
P(any TM < 34 Mlbs)	0.891	0.862	0.81	0.758	0.718	0.681	0.661	0.641	0.633	0.627	0.662
Median average TM	42.06	41.84	39.64	40.6	41.12	39.57	39.82	38.48	37.97	37.39	33.95
P(all decrease TM > 15%)	0.365	0.352	0.336	0.319	0.302	0.285	0.273	0.261	0.244	0.236	0.221
P(any decrease TM > 15%)	0.997	0.992	0.992	0.982	0.974	0.967	0.958	0.946	0.94	0.932	0.921
median AAV TM	41.8%	37.3%	33.1%	30.2%	26.8%	23.9%	21.1%	19.4%	18.4%	17.5%	16.3%
Rankings (lower is better)											
P(<20%)[1]	11	10	9	8	7	6	5	4	3	2	1
P(AAV > 15%)[2]	11	10	9	8	7	6	5	4	3	2	1
Maximum catch (TM)[3]	1	2	3	4	5	6	7	8	9	10	11

[1] This ranking is determined using P(any dRSB < 20%) and the objective to maintain RSB above 20% at least 90% of the time. Note that all procedures meet this objective.

[2] This ranking is determined using P(aall AAV >15%) and the objective to maintain AAV below 15%.at least 75% of the time. Note that no procedures meet this objective.

[3] This ranking is determined using a smoothed relationship for Median average TM to account for variability in the simulations. Note that the highest fishing intensity meets this objective.

Table A2. Long-term performance metrics for an estimation error CV of 0.15, autocorrelation of 0.4, a 40:20 control rule, and a range of input SPRs.

Input Est Error	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**
Input Autocorrelation	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**
Input Control Rule	**40:20**	**40:20**	**40:20**	**40:20**	**40:20**	**40:20**	**40:20**	**40:20**	**40:20**	**40:20**	**40:20**
Input SPR	**30%**	**32%**	**34%**	**36%**	**38%**	**40%**	**42%**	**44%**	**46%**	**48%**	**56%**
Median SPR	47.7%	47.9%	47.9%	48.1%	48.3%	48.6%	49.1%	49.6%	50.4%	51.3%	55.4%
Biological Sustainability											
Median average dRSB	35.8%	36.4%	37.1%	37.8%	38.6%	39.5%	40.4%	41.5%	42.6%	43.9%	47.2%
P(all dRSB<20%)	0.002	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001
P(any dRSB_y<20%)	0.003	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001
P(all dRSB<30%)	0.083	0.059	0.044	0.028	0.018	0.014	0.007	0.007	0.008	0.006	0.008
P(any dRSB_y<30%)	0.309	0.214	0.16	0.102	0.052	0.036	0.022	0.015	0.011	0.007	0.011
Fishery Sustainability											
P(all AAV > 15%)	0.998	0.996	0.994	0.994	0.986	0.985	0.974	0.948	0.921	0.88	0.788
P(all TM < 34 Mlbs)	0.495	0.488	0.479	0.476	0.470	0.468	0.465	0.463	0.460	0.459	0.483
P(any TM < 34 Mlbs)	0.889	0.869	0.856	0.836	0.819	0.801	0.778	0.756	0.735	0.711	0.693
Median average TM	39.71	39.6	39.97	39.59	39.19	38.79	38	37.73	37.6	37.27	35.56
P(all decrease TM > 15%)	0.390	0.386	0.381	0.372	0.362	0.349	0.337	0.326	0.310	0.289	0.275
P(any decrease TM > 15%)	0.999	0.998	0.998	0.998	0.998	0.997	0.996	0.994	0.981	0.973	0.953
median AAV TM	46.2%	43.6%	41.9%	39.3%	36.0%	33.5%	30.9%	28.2%	25.9%	23.2%	21.1%
Rankings (lower is better)											
P(<20%)[1]	11	10	9	8	7	6	5	4	3	2	1
P(AAV > 15%)[2]	11	10	9	8	7	6	5	4	3	2	1
Maximum catch (TM)[3]	1	2	3	4	5	6	7	8	9	10	11

[1] This ranking is determined using P(any dRSB < 20%) and the objective to maintain RSB above 20% at least 90% of the time. Note that all procedures meet this objective.

[2] This ranking is determined using P(aall AAV >15%) and the objective to maintain AAV below 15%.at least 75% of the time. Note that no procedures meet this objective.

[3] This ranking is determined using a smoothed relationship for Median average TM to account for variability in the simulations. Note that the highest fishing intensity meets this objective, although the yield curve appears flat at those low SPR values.

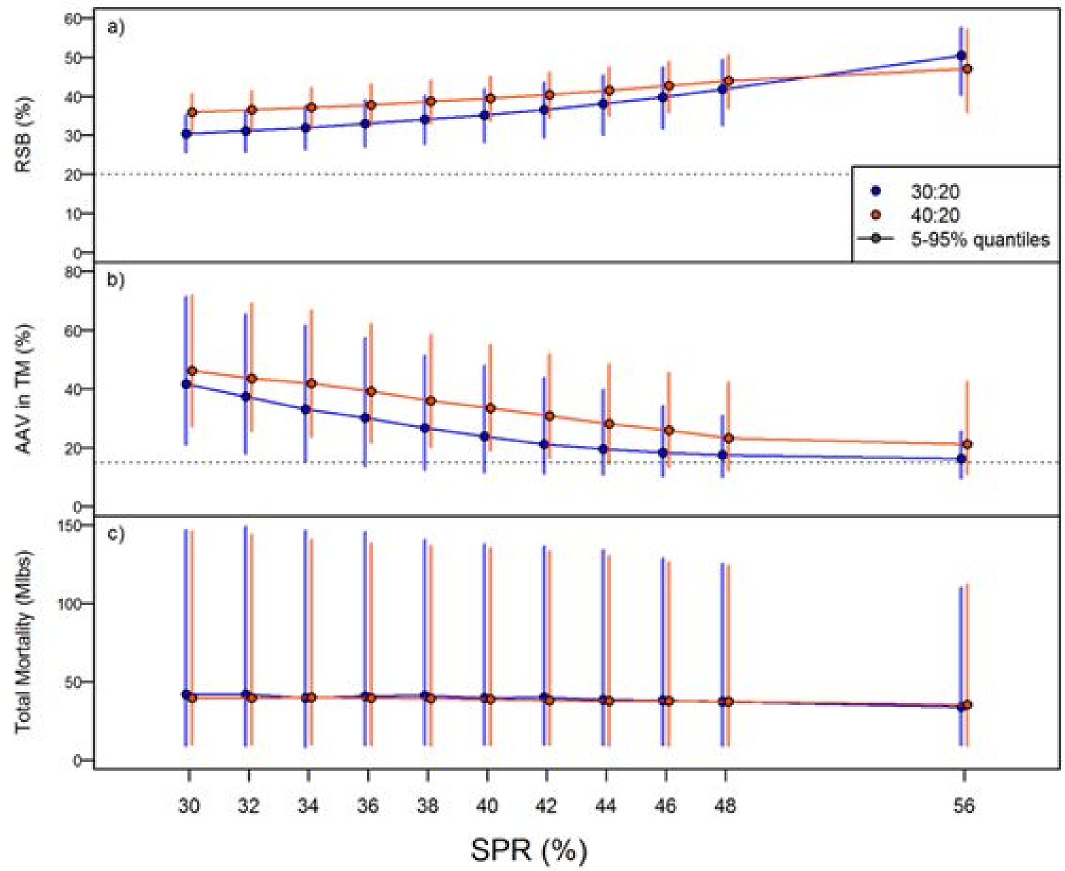


Figure A1. Long-term mdedian relative spawning biomass (a), median AAV for Total Mortality (b), and median Total Mortality (Mlbs, c) shown as points, with 90% confidence intervals shown as vertical lines for various SPRs and two control rules (30:20 and 40:20). The estimation error CV is 0.15 and autocorrelation is 0.4.

Table A3. Short-term (3-8 annual time-steps) performance metrics for an estimation error CV of 0.15, autocorrelation of 0.4, a 30:20 control rule, and a range of input SPRs.

Input Est Error	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**
Input Autocorrelation	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**
Input Control Rule	**30:20**	**30:20**	**30:20**	**30:20**	**30:20**	**30:20**	**30:20**	**30:20**	**30:20**	**30:20**	**30:20**
Input SPR	**30%**	**32%**	**34%**	**36%**	**38%**	**40%**	**42%**	**44%**	**46%**	**48%**	**56%**
Median SPR	39.8%	39.6%	39.9%	40.6%	41.7%	43.2%	44.6%	46.4%	48.1%	49.9%	57.2%
Biological Sustainability											
Median average dRSB	31.1%	32.1%	33.0%	33.8%	34.6%	35.4%	36.2%	37.0%	37.8%	38.6%	41.4%
P(all dRSB<20%)	0.074	0.074	0.074	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073
P(any dRSB_y<20%)	0.11	0.108	0.108	0.107	0.106	0.107	0.107	0.107	0.107	0.106	0.106
P(all dRSB<30%)	0.459	0.395	0.347	0.316	0.287	0.265	0.248	0.232	0.221	0.213	0.183
P(any dRSB_y<30%)	0.688	0.568	0.485	0.428	0.377	0.342	0.309	0.286	0.273	0.263	0.234
Fishery Sustainability											
P(all AAV > 15%)	0.893	0.866	0.832	0.81	0.796	0.78	0.751	0.734	0.722	0.713	0.677
P(all TM < 34 Mlbs)	0.377	0.356	0.353	0.354	0.360	0.378	0.399	0.426	0.460	0.494	0.683
P(any TM < 34 Mlbs)	0.732	0.664	0.629	0.594	0.594	0.59	0.608	0.637	0.67	0.708	0.902
Median average TM	46.81	46.4	45.62	44.26	42.89	41.53	40.02	38.61	37.25	35.61	29.41
P(all decrease TM > 15%)	0.398	0.382	0.359	0.341	0.324	0.312	0.300	0.291	0.284	0.273	0.249
P(any decrease TM > 15%)	0.943	0.937	0.919	0.91	0.893	0.885	0.876	0.867	0.856	0.842	0.811
median AAV TM	35.9%	32.1%	27.6%	25.6%	23.4%	22.6%	21.6%	20.9%	20.3%	20.0%	18.7%
Rankings (lower is better)											
P(<20%)[1]	11	9.5	9.5	6	2	6	6	6	6	2	2
P(AAV > 15%)[2]	11	10	9	8	7	6	5	4	3	2	1
Maximum catch (TM)[3]	1	2	3	4	5	6	7	8	9	10	11

[1] This ranking is determined using P(any dRSB < 20%) and the objective to maintain RSB above 20% at least 90% of the time. Note that no procedure meets this objective.

[2] This ranking is determined using P(aall AAV >15%) and the objective to maintain AAV below 15%.at least 75% of the time. Note that no procedures meet this objective.

[3] This ranking is determined using a smoothed relationship for Median average TM to account for variability in the simulations. Note that the highest fishing intensity meets this objective.

Table A4. Short-term (3-8 annual time-steps) performance metrics for an estimation error CV of 0.15, autocorrelation of 0.4, a 40:20 control rule, and a range of input SPRs.

Input Est Error	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**
Input Autocorrelation	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**
Input Control Rule	**40:20**	**40:20**	**40:20**	**40:20**	**40:20**	**40:20**	**40:20**	**40:20**	**40:20**	**40:20**	**40:20**
Input SPR	**30%**	**32%**	**34%**	**36%**	**38%**	**40%**	**42%**	**44%**	**46%**	**48%**	**56%**
Median SPR	50.0%	49.7%	49.9%	50.3%	50.8%	51.5%	52.2%	53.1%	54.1%	55.3%	58.9%
Biological Sustainability											
Median average dRSB	34.5%	35.2%	35.8%	36.5%	37.1%	37.7%	38.2%	38.9%	39.5%	40.1%	41.5%
P(all dRSB<20%)	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073
P(any dRSB_y<20%)	0.105	0.105	0.104	0.105	0.106	0.105	0.105	0.105	0.105	0.105	0.105
P(all dRSB<30%)	0.238	0.218	0.204	0.195	0.186	0.179	0.177	0.172	0.170	0.168	0.169
P(any dRSB_y<30%)	0.392	0.334	0.301	0.281	0.261	0.246	0.242	0.235	0.229	0.227	0.228
Fishery Sustainability											
P(all AAV > 15%)	0.963	0.956	0.957	0.945	0.94	0.923	0.904	0.89	0.872	0.859	0.819
P(all TM < 34 Mlbs)	0.550	0.539	0.530	0.523	0.518	0.517	0.523	0.532	0.544	0.560	0.646
P(any TM < 34 Mlbs)	0.941	0.93	0.905	0.885	0.868	0.852	0.846	0.845	0.848	0.848	0.912
Median average TM	38.16	37.42	37.13	37.03	36.3	35.39	34.54	33.66	32.77	31.82	28.86
P(all decrease TM > 15%)	0.413	0.404	0.393	0.382	0.367	0.356	0.343	0.328	0.316	0.309	0.282
P(any decrease TM > 15%)	0.94	0.941	0.936	0.932	0.926	0.922	0.92	0.912	0.904	0.89	0.857
median AAV TM	47.1%	43.9%	40.9%	38.9%	36.3%	34.2%	31.7%	29.9%	28.3%	27.1%	24.6%
Rankings (lower is better)											
P(<20%)[1]	6	6	1	6	11	6	6	6	6	6	6
P(AAV > 15%)[2]	11	9	10	8	7	6	5	4	3	2	1
Maximum catch (TM)[3]	1	2	3	4	5	6	7	8	9	10	11

[1] This ranking is determined using P(any dRSB < 20%) and the objective to maintain RSB above 20% at least 90% of the time. Note that no procedure meets this objective.

[2] This ranking is determined using P(aall AAV >15%) and the objective to maintain AAV below 15%.at least 75% of the time. Note that no procedures meet this objective.

[3] This ranking is determined using a smoothed relationship for Median average TM to account for variability in the simulations. Note that the highest fishing intensity meets this objective.

Ideas on estimating stock distribution and distributing catch for Pacific halibut fisheries

PREPARED BY: IPHC SECRETARIAT (A. HICKS AND I. STEWART; 22 SEPTEMBER 2018)

1 PURPOSE

To update the Management Strategy Advisory Board (MSAB) on discussions and ideas related to science inputs and management procedures for distributing the Total Constant Exploitation Yield (TCEY) across the IPHC Convention Area (as of 22 September 2018).

2 INTRODUCTION

The report from the 94th Session of the IPHC Annual Meeting (AM094) included the following text related to distributing TCEY among the Regulatory Areas (IPHC-2018-AM094-R):

*37. The Commission **REQUESTED** that the objectives related to distributing the TCEY, as detailed in Circular IPHC-2017-CR022, be presented at MSAB11 for further stakeholder feedback.*

*38. The Commission **REQUESTED** that the proposed TCEY distribution methodology of the Harvest Strategy Policy reflect an understanding of both stock distribution and fishery management distribution procedures.*

*39. The Commission **RECOMMENDED** that the IPHC Secretariat consider the survey WPUE grid across the fishery as well as other biological factors (e.g. habitat configuration, size distribution in the region etc.) and provide alternatives to the current management areas (e.g. biological regions), and that the MSAB consider additional ways to incorporate biological information into TCEY distribution procedures.*

*40. The Commission **NOTED** that the current procedure to distribute the TCEY could be replaced by an interim procedure to be developed in the near term while the MSAB completes their Program of Work to deliver guidance in 2021 on scale and TCEY distribution.*

*41, The Commission **AGREED** to meet via an inter-sessional electronic meeting (soon after the AM094), along with the IPHC Secretariat, to discuss TCEY distribution procedures to use in the interim while long-term distribution procedures are being developed by the MSAB. MSAB representatives and the IPHC Secretariat will inform the Commission of what guidance the MSAB may be able to provide to help develop an interim distribution strategy, and how the development of an interim harvest procedure may affect the MSAB's current Program of Work.*

*42. The Commission **AGREED** that distributing the TCEY to regions does not necessarily need to be the first step of the TCEY distribution procedure, and other biological factors, such as habitat and size distribution, be considered.*

*43. The Commission **NOTED** that the work the MSAB has already completed on distribution procedures may help to inform the development of an interim distribution strategy. MSAB representatives and the IPHC Secretariat will advise the Commission of how this may affect their current Program of Work, and what guidance they may be able to provide to help develop an interim distribution strategy.*

The report from the 10th meeting of the Management Strategy Advisory Board (MSAB) in October 2017 included the following related to distributing the TCEY:

37. ***NOTING*** *the order of operations in the proposed TCEY distribution procedure, the MSAB AGREED that the order of stock distribution and TCEY distribution procedures is a management choice that could be evaluated.*

38. *The MSAB* ***NOTED*** *that the order of operations in the proposed TCEY distribution procedure will be subject to review at future MSAB meetings and that the specific components require further definition.*

The report from the 11th meeting of the Management Strategy Advisory Board (MSAB) in May 2018 included the following related to distributing the TCEY:

The MSAB ***NOTED*** *that the proposed TCEY distribution procedure contains four main components, each of which may contain multiple elements. These four components are listed below and have a computational outcome:*

a) ***Coastwide Target Fishing Intensity****: this defines the TCEY to be distributed.*

b) ***Regional Stock Distribution****: this distributes the TCEY to biological Regions to satisfy the Biological Sustainability objective of preserving biocomplexity.*

c) ***Regional Allocation Adjustment (optional)****: this adjusts the distribution of the TCEY among Regions to account for additional Biological Sustainability objectives and fishery objectives.*

d) ***Regulatory Area Allocation****: this distributes the TCEY from Regions to Regulatory Areas to satisfy fishery objectives.*

71. *The MSAB* ***NOTED*** *that the output of the TCEY distribution procedure will be a catch table describing proposed mortality (allocation) in each IPHC Regulatory Area (Appendix VI).*

72. *The MSAB* ***REQUESTED*** *that the proposed TCEY distribution framework described in paragraphs 69, 70 and 71, be reviewed by the SRB in 2018.*

73. *The MSAB* ***NOTED*** *the intent expressed by the Commission that the output from the management procedure (proposed mortality – allocation – by IPHC Regulatory Area) would then be subject to an annual Regulatory Area adjustment by the Commission, which may deviate from the harvest strategy by changing the distribution and the SPR.*

74. *The MSAB* ***NOTED*** *that the SPR is maintained after distributing the catch. A deviation from the SPR determined in the Harvest Control Rule due to distribution procedures may be useful to investigate, but there must be a minimum SPR which is not exceeded. This ensures that a maximum fishing intensity is not exceeded.*

75. *The MSAB* ***NOTED*** *some potential tools for use as distribution procedures when distributing the TCEY:*

    a) *Relative harvest rates.*
    b) *O32:O26 ratios.*
    c) *trends in survey WPUE by IPHC Regulatory Area.*
    d) *Trends in modelled survey WPUE by biological region.*
    e) *trends in fishery CPUE.*
    f) *Smoothing algorithms on area-specific catch limits.*
    g) *Percentage allocation with a floor (i.e. minimums of 1.5 Mlbs in 2A and 1.7 Mlbs in 4CDE).*
    h) *A maximum SPR with catch distribution by IPHC Regulatory Area determined from the modelled survey WPUE.*
    i) *Coastwide TCEY target and maximum calculated; distribution by target, but with ability to adjust TCEY up to the maximum.*

76. ***NOTING*** *that these tools require further discussion, the MSAB* ***REQUESTED*** *that the IPHC Secretariat provide comments, and that further stakeholder feedback is elicited.*
77. *The MSAB* ***NOTED*** *that observations of stock and catch distribution during various reference periods should be considered when defining objectives for evaluation.*

This document advances IPHC-2018-MSAB011-09 (and repeats important material) and reports progress on the topic of distributing the TCEY.

3 Distributing the TCEY

A considerable amount of discussion related to a description of the harvest strategy policy occurred at previous MSAB meetings. Figure 1 shows an updated depiction of the harvest strategy policy with terms describing the various components. These terms are defined in the IPHC glossary[1], but of note for this paper are TCEY distribution, stock distribution, and distribution procedures. The management procedure is the sequence of elements including the assessment, fishing intensity, stock distribution, and distribution procedures. The goal of the MSAB is to define a management procedure that will be used to output O26 mortality limits (TCEY) for each Regulatory Area that meet the long-term objectives of managers and stakeholders. The "decision" step on the right of Figure 1 is where a deviation from the management procedure may occur due to input from other sources and decisions of the Commissioners that may reflect current biological, environmental, social, and economic conditions.

In 2017, the Commission agreed to move to an SPR-based management procedure to account for the mortality of all sizes and from all fisheries. The procedure uses a coastwide fishing intensity based on spawning potential ratio (SPR), which defines the "scale" of the coastwide catch. This eliminates the use of EBio and area-specific absolute harvest rates. Therefore, there are currently two inputs to the current management procedure for distributing the TCEY among IPHC Regulatory Areas: 1) the current estimated stock distribution and 2) relative target harvest rates.

[1] https://iphc.int/the-commission/glossary-of-terms-and-abbreviations

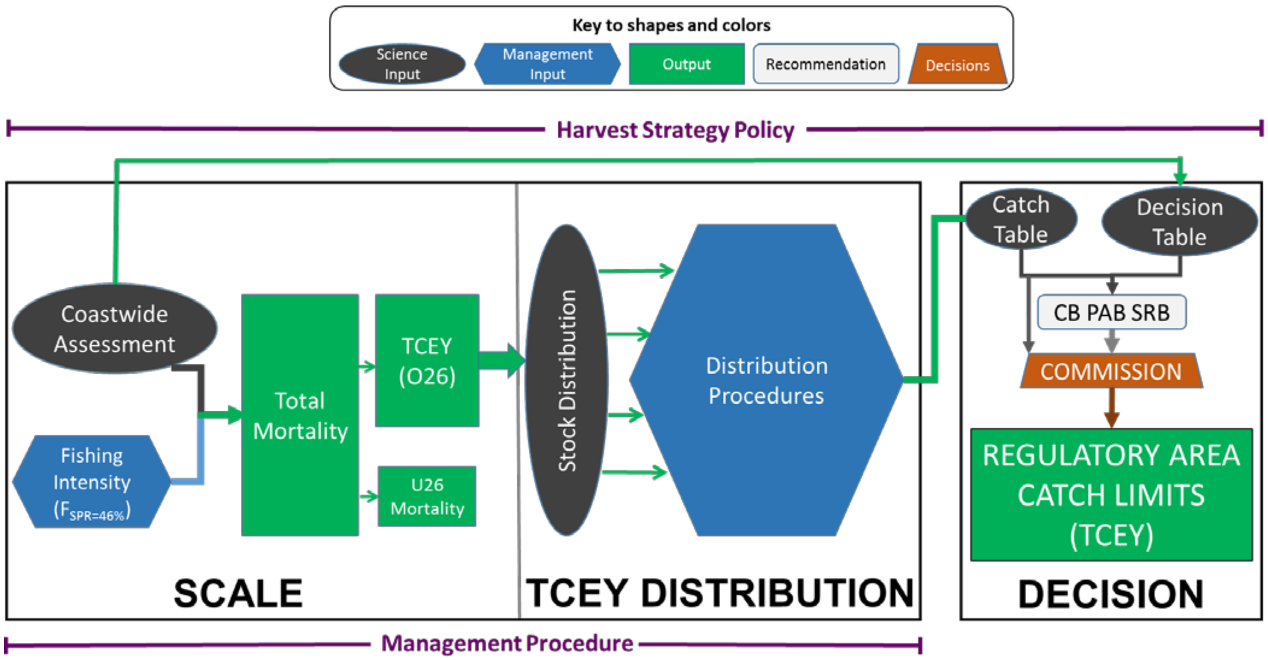


Fig. 1. A pictorial description of the interim IPHC harvest strategy policy showing the separation of scale and distribution of fishing mortality. The "decision step" is when policy and decision making (not a procedure) influences the final mortality limits.

3.1 STOCK DISTRIBUTION

The IPHC uses a space-time model to estimate annual Weight-Per-Unit-Effort (WPUE) for use in estimating the annual stock distribution of Pacific halibut (Webster 2018). Briefly, observed WPUE is fitted with a model that accounts for correlation between setline survey stations over time (years) and space (within Regulatory Areas). Competition for hooks by Pacific halibut and other species, the timing of the setline survey relative to annual fishery mortality, and observations from other fishery-independent surveys are also accounted for in the approach. This fitted model is then used to predict WPUE (relative density) of Pacific halibut for every setline survey station in the design (including all setline survey expansion stations), regardless of whether it was fished in a particular year. These predictions are then averaged within each IPHC Regulatory Area, and combined among IPHC Regulatory Areas, weighting by the "geographic extent" (calculated area within the survey design depth range) of each IPHC Regulatory Area. It is important to note that this produces relative indices of abundance and biomass, but does not produce an absolute measure of abundance or biomass because it is weight-per-unit-effort scaled by the geographic extent of each IPHC Regulatory Area. These indices are useful for determining trends in stock numbers and biomass, and are also useful to estimate the geographic distribution of the stock.

3.2 USING RELATIVE HARVEST RATES

The distribution of the TCEY for 2018 was shifted from the estimated stock distribution to account for additional factors related to productivity and paucity of data in each IPHC Regulatory Area. Previously, this was accomplished by applying different harvest rates in western areas (16.125% in IPHC Regulatory Areas 3B, 4A, 4B, and 4CDE)) and eastern areas (21.5% in IPHC Regulatory Areas 2A, 2B, 2C, and 3A). However, with the elimination of EBio and the use of SPR-based fishing intensity to determine the coastwide scale, the TCEY, rather than the esoteric concept of exploitable biomass, was distributed. Therefore, an absolute measure of harvest rate is not necessary, but it may still be desired to shift the distribution of the TCEY away from the estimated stock distribution to account for other factors. Consistent with the previous approach, relative harvest rates were used with a ratio of 1.00:0.75, being equal to the ratio between 21.5% and 16.125%. This application shifted the target TCEY distribution away from the stock distribution by moving TCEY into IPHC Regulatory Areas 2A, 2B, 2C, and 3A and removing TCEY from IPHC Regulatory Areas 3B, 4A, 4B, and 4CDE (Table 1), thus harvesting at a higher rate in eastern IPHC Regulatory Areas.

Table 1. IPHC Regulatory Area stock distribution estimated from the 2017 space-time model O32 WPUE, IPHC Regulatory Area-specific relative target harvest rates, and resulting 2018 target TCEY distribution based on the IPHC's 2018 interim management procedure (reproduced from Table 1 in IPHC-2018-AM094-11 Rev_1).

	2A	2B	2C	3A	3B	4A	4B	4CDE	Total
O32 stock distribution	1.7%	11.3%	16.6%	35.6%	10.0%	6.6%	4.8%	13.3%	100.0%
Relative harvest rates	1.00	1.00	1.00	1.00	0.75	0.75	0.75	0.75	--
Target TCEY Distribution	1.9%	12.4%	18.2%	38.9%	8.2%	5.4%	3.9%	10.9%	100.0%

3.3 REDEFINING THE DISTRIBUTION OF THE TCEY

TCEY distribution is the part of the management procedure for distributing the TCEY among Regulatory Areas and is composed of a purely scientific component to distribute the TCEY in proportion to its estimated biomass in each area (stock distribution) and steps to further modify the distribution of the TCEY based on additional considerations (distribution procedures). Those two components are described below.

3.3.1 Stock Distribution

Emerging understanding of Pacific halibut diversity across the geographic range of the Pacific halibut stock indicates that IPHC Regulatory Areas should only be considered as management units and do not represent relevant sub-populations (Seitz et al. 2017). Balancing the removals against the current stock distribution is likely to protect against localized depletion of spatial and demographic components of the stock that may produce differential recruitment success under changing environmental and ecological conditions. Biological Regions, defined earlier and shown in Figure 2, are considered by the IPHC Secretariat, and supported by the SRB (paragraph 31 IPHC-2018-SRB012-R), to be the best current option for biologically-based areas to meet management needs.

The overarching conservation goal for Pacific halibut is to maintain a healthy coastwide stock, which implies an objective to retain viable spawning activity in all pertinent portions of the stock. One method for addressing this objective, without knowing what pertinent portions of the stock are, is to distribute the fishing mortality relative to the distribution of observed stock biomass. This requires defining appropriate areas for which the distribution is to be conserved. Splitting the coast into many small areas for conservation objectives can result in complications including being cumbersome to determine if conservation objectives are met, being difficult to accurately determine the proportion of the stock in that area, being subject to inter-annual variability in estimates of the proportion, forcing arbitrary delineation among areas with evidence of strong stock mixing, and not being representative of biological importance. Therefore, Biological Regions represent the most logical scale over which to consider conservation objectives related to distribution of the fishing mortality.

In addition to using Biological Regions for stock distribution, the "all sizes" WPUE from the space-time model (Figure 3), which is largely composed of O26 Pacific halibut (due to selectivity of the setline gear), is more congruent with the TCEY (O26 catch levels) than O32 WPUE. Therefore, when distributing the TCEY to Biological Regions, the estimated proportion of "all sizes" WPUE from the space-time model should be used for consistency.

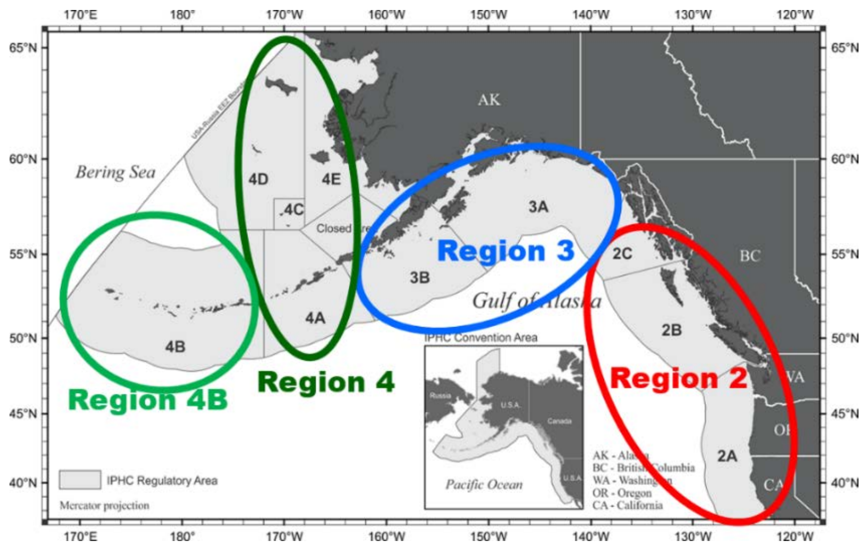


Fig. 2. Biological Regions overlaid on IPHC Regulatory Areas with Region 2 comprised of 2A, 2B, and 2C, Region 3 comprised of 3A and 3B, Region 4 comprised of 4A and 4CDE, and Region 4B comprised solely of 4B.

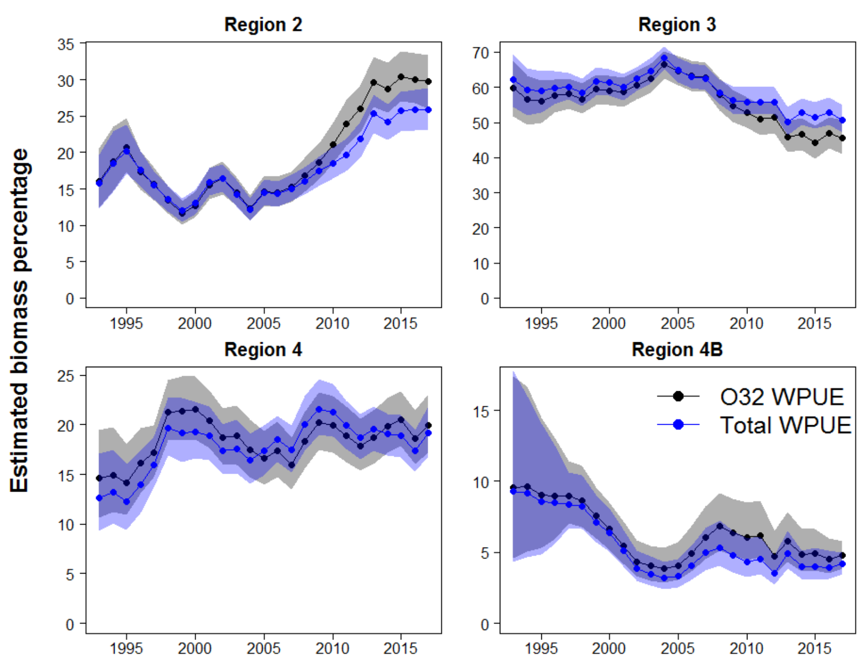


Fig. 3. Estimated stock distribution (1993-2017) based on estimate WPUE from the space-time model of O32 (black series) and all sizes (blue series) of Pacific halibut. Shaded zones indicate 95% credible intervals.

3.3.2 Distribution Procedures

Distribution Procedures contains additional steps of further modifying the distribution of the TCEY among Biological Regions and then distributing the TCEY among IPHC Regulatory Areas within Biological Regions (Figure 4). Modifications at the Biological Region or IPHC Regulatory Area level may be based on differences in production between areas, observations in each area relative to other areas (e.g. WPUE), uncertainty of data or mortality in each area, defined allocations, or national shares. Data may be used as indicators of stock trends in each Region or IPHC Regulatory Area and are included in the Distribution Procedures component because they may be subject to certain biases and include factors that may be unrelated to biomass in that Biological Region or IPHC Regulatory Area. For example, commercial WPUE is a popular source of data used to indicate trends in a population, but may not always be proportional to biomass. Types of data that could be used may include but is not limited to

- fishery WPUE,
- survey observations (not necessarily the IPHC fishery-independent setline survey),
- age-compositions,
- size-at-age, and
- environmental observations.

The steps in the Distribution Procedures may consider conservation objectives, but they will mainly be developed with respect to fishery objectives. Yield and stability in catch levels are two important fishery objectives that often contradict each other (i.e. higher yield often results in less stability). Additionally, area-specific fishery objectives may be in conflict across IPHC Regulatory Areas. Pacific halibut catch levels are defined for each IPHC Regulatory Area and quota is accounted for by those Regulatory Areas. Therefore, IPHC Regulatory Areas are the appropriate scale to consider fishery objectives.

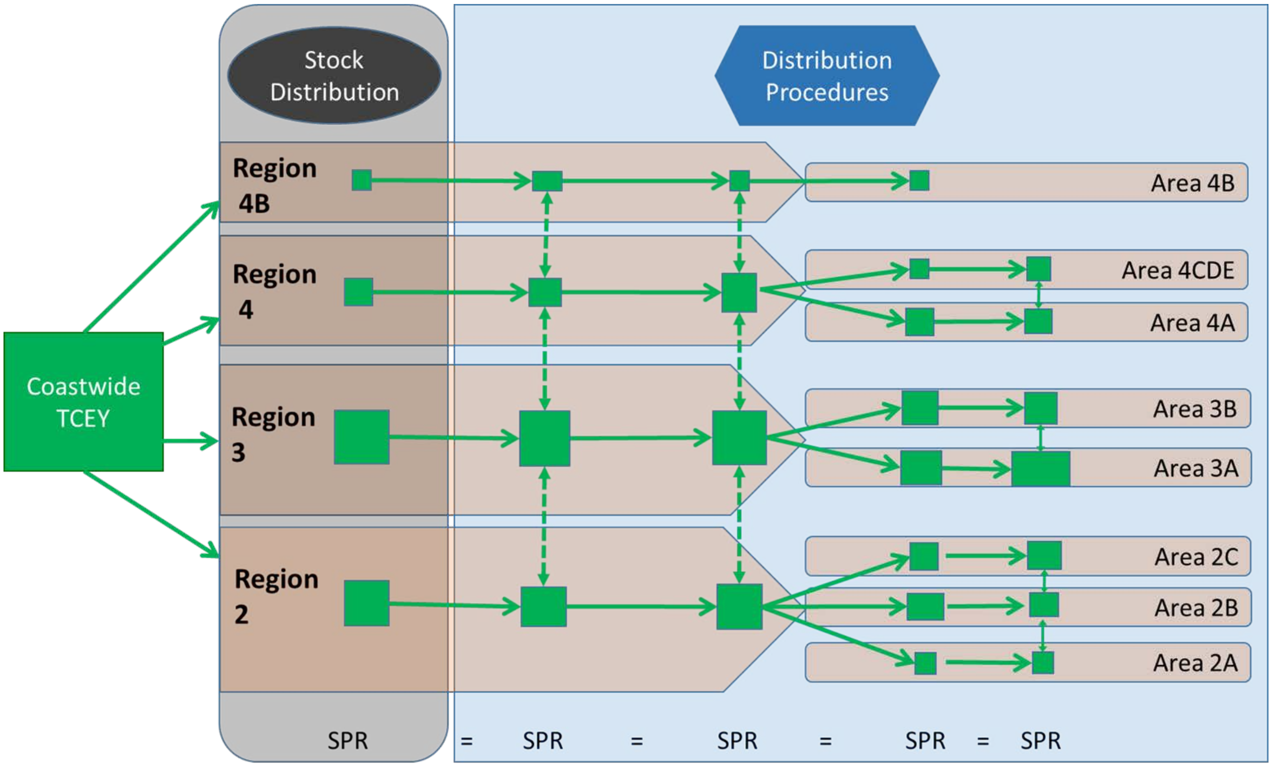


Fig. 4. The process of distributing the TCEY to Regulatory Areas from the coastwide TCEY. The first step is to distribute the TCEY to Biological Regions based on the estimate of stock distribution. Following this, a series of adjustments may be made based on observations or social, economic, and other considerations. Finally, the adjusted regional TCEY's are allocated to IPHC Regulatory Areas. The allocation to IPHC Regulatory Areas may occur at any point after regional stock distribution. The dashed arrows represent balancing that is required to maintain a constant coastwide SPR.

3.4 A Summary of the Management Procedure for Distributing TCEY Across the Coast

The harvest strategy policy begins with the coastwide TCEY determined from the stock assessment and fishing intensity determined from a target SPR (Figure 1). When distributing the TCEY among regions, stock distribution occurs first to distribute the harvest in proportion to biomass and satisfy conservation objectives, and then is followed by adjustments across Regions and Regulatory Area based on distribution procedures to further encompass conservation objectives and consider fishery objectives. The key to these adjustments is that they are relative adjustments such that the overall fishing intensity (target SPR) is maintained (i.e. a zero sum game relative to fishing intensity). Otherwise, the procedure is broken, and it is uncertain if the defined objectives will be met.

A framework for a management procedure that ends with the TCEY distributed among IPHC Regulatory Areas and would encompass conservation and fishery objectives is described below.

1. **Coastwide Target Fishing Intensity:** Determine the coastwide total mortality using a target SPR that is most consistent with IPHC objectives defined by the Commission. Separate the total mortality in ≥26 inches (O26) and under 26 inches (U26) components. The O26 component is the coastwide TCEY.
   1.1. Target SPR is scheduled for evaluation at the 2019 Annual Meeting. The current interim target SPR is 46%.
2. **Regional Stock Distribution:** Distribute the coastwide TCEY to four (4) biologically-based Regions using the proportion of the stock estimated in each Biological Region for all sizes of Pacific halibut using information from the IPHC setline survey and the IPHC space-time model.
   2.1. Four Regions (2, 3, 4, and 4B) are defined above (**Figure 2**).
3. **Regional Allocation Adjustment:** Adjust the distribution of the TCEY among Biological Regions to account for other factors.
   3.1. For example, relative target harvest rates are part of a management/policy decision that may be informed by data and observations. This may include evaluation of recent trends in estimated quantities (such as fishery-independent WPUE), inspection of historical trends in fishing intensity, recent or historical fishery performance, and biological characteristics of the Pacific halibut observed in each Biological Region. The IPHC Secretariat may be able to provide Yield-Per-Recruit (YPR) and/or surplus production calculations as further supplementary information for this discussion. The regional relative harvest rates may also be determined through negotiation, which is simply an allocation agreement for further Regional adjustment of the TCEY.
4. **Regulatory Area Allocation:** Apply IPHC Regulatory Area allocation percentages within each Biological Region to distribute the Region-specific TCEY's to Regulatory Areas.
   4.1. This part represents a management/policy decision, and may be informed by data, based on past or current observations, or defined by an allocation agreement. For example, recent trends in estimated all sizes WPUE from the setline survey or fishery, age composition, or size composition may be used to distribute the TCEY to IPHC Regulatory Areas. Inspection of historical trends in fishing intensity or catches by IPHC Regulatory Area may also be used. Finally, agreed upon percentages are also an option. This allocation to IPHC Regulatory Areas may be a procedure with multiple adjustments using different data, observations, or agreements

The four steps described above would be contained within the IPHC Harvest Strategy Policy as part of the Management Procedure and are pre-determined steps that have a predictable outcome. The decision-making process would then occur (Figure 1).

5. **Seasonal Regulatory Area Adjustment**: Adjust individual Regulatory Area TCEY limits to account for other factors as needed. This is the policy part of the harvest strategy policy and occurs as a final step where other objectives are considered (e.g. economic, social, etc.).
   5.1. Departing from the target SPR may be a desired outcome for a particular year (short-term, tactical decision making based on current trends estimated in the stock assessment) but would deviate from the management procedure and the long-term management objectives. Departures from the management procedure may result in unpredictable outcomes but could also take advantage of current situations.

4 MANAGEMENT PROCEDURES RELATED TO DISTRIBUTION

The MSAB011 report (IPHC-2018-MSAB012-R) listed nine potential tools for use in developing distribution procedures (paragraph 75, noted above in Section 2). Each of these potential tools is discussed below.

Relative harvest rates. This was discussed above in the context of Regional Allocation Adjustment and Regulatory Area Allocation. The relative harvest rates may be justified by productivity differences, for example, or they may simply be allocation agreements between areas.

O32:O26 ratios. We interpret this tool as an indicator of the proportion of the TCEY that is under the size limit, and note that O32:U32 would likely produce a similar ratio and could be more easily understood. This ratio would give insight into the encounter rate with undersized Pacific halibut, and there may be objectives defined that are related to minimizing encounters with these undersized fish. Using this ratio to adjust allocation percentages could change the mortality on undersized Pacific halibut. This could occur in the Regional Allocation Adjustment or Regulatory Area Allocation steps.

Trends in setline survey WPUE by IPHC Regulatory Area. This tool applies to the Regulatory Area Allocation step and may be a useful method to inform the distribution to Regulatory Area. However, the Biological Regions are areas where it is likely that within-year movement may occur, and minimal movement occurs between Regions within a year. For this reason, trends from the survey within a Regulatory Area may be inconsistent with the location of Pacific halibut when the fisheries occur. In other words, Pacific halibut may occur anywhere in the Biological Region within a year, but are unlikely to move out of that Region in that year, thus the timing of the survey and the fishery are important to consider.

Trends in modelled survey WPUE by biological region. Using trends from the survey index that is already used to distribute TCEY to Biological Regions (Regional Stock Distribution) may result in some contradictions. The information from the survey is already being used. The potential benefit may be that the trend is indicative of what may occur in the future and potentially be a closer representation of stock distribution in the year when the fishery would occur.

Trends in fishery CPUE. Using trends in fishery CPUE to satisfy fishery objectives may be useful in that it is a more direct representation of what the fishery observes. However, fishery CPUE is subject to uncertainty and possibly bias which makes it inappropriate for biological objectives. Therefore, it is not useful for regional stock distribution, but is useful for Regulatory Area Allocation.

Smoothing algorithms on area-specific catch limits. A smoothing algorithm could reduce large swings in area-specific catch limits that may be a result of various uncertainties in the estimation and distribution processes. However, smoothing algorithms can slow down a sometimes-necessary response when a trend is occurring. For example, if the stock is trending downwards it may be necessary to reduce catch levels, or if the stock is increasing quickly, it may be reasonable to increase catch levels. Smoothing algorithms can be beneficial if the correct level of smoothing is used.

Percentage allocation with a floor (i.e. minimums of 1.5 Mlbs in 2A and 1.7 Mlbs in 4CDE). A simple method is to agree on pre-determined allocation percentages. However, there are often minimum amounts that a sector needs to be profitable. Defining percentage allocations can be very useful when agreed upon, and minimum amounts may also be useful. But, when the total catch to be allocated is small, there may not be enough to satisfy the minimum amounts. Therefore, agreements must be in place on where catch may be taken (i.e., the percentage allocation declines) when minimum levels are enacted.

A maximum SPR with catch distribution by IPHC Regulatory Area determined from the modelled survey WPUE. This is interpreted to be a tool similar to status quo where a SPR determines the TCEY and is distributed directly to Regulatory Areas based on survey WPUE. However, status quo also adjusts that distribution with relative harvest rates shifting TCEY to Eastern areas.

Coastwide TCEY target and maximum calculated; distribution by target, but with ability to adjust TCEY up to the maximum. This tool is interpreted to consist of a default SPR which would determine a coastwide TCEY, but also contain a higher fishing intensity (smaller SPR) that would determine a maximum TCEY. This could be viewed similar to the U.S. OFL and ABC concept, where an overfishing limit (OFL) is calculated and an ABC (allowable biological catch) is determined that is less than the OFL. However, it also differs in that the total allowable catch (TAC) is less than or equal to the ABC. This tool suggests that the TCEY could exceed the target when necessary, but not exceed the maximum. The danger of this is that it does not guarantee that the TCEY would not be set at the maximum every year, thus making this tool moot. Some clear guidelines would have to included regarding under what circumstances the default could be exceeded.

There are many other tools that could be used, some of which are mentioned in Section 3.3.2.

5 RECOMMENDATION

That the MSAB:

1) **NOTE** paper IPHC-2018-MSAB012-08 which provides the MSAB with discussions related to distributing the TCEY.
2) **NOTE** the distribution frame-work and the separation of scientific and management elements of distribution procedures.
3) **RECOMMEND** elements of management procedures for the distribution of the TCEY.

6 APPENDICES

NIL

IPHC Secretariat Program of Work for MSAB Related Activities 2019-23

PREPARED BY: IPHC SECRETARIAT (A. HICKS); 21 SEPTEMBER 2018

PURPOSE

To update the IPHC Program of Work for MSAB related activities for the period 2019-23.

INTRODUCTION

This Program of Work is a description of activities related to the Management Strategy Advisory Board (MSAB) that IPHC Secretariat staff will engage in for the next five years. It describes each of the priority tasks, lists some of the resources needed for each task, and provides a timeline for each task. However, this work plan is flexible and may be changed throughout this period with the guidance of the MSAB, Science Review Board (SRB) members, and Commission. The order of the tasks in this work plan represents the sequential development of each task, and many subsequent tasks are dependent on the previous tasks.

It is important to have a set of working definitions, and this is especially true to the Management Strategy Evaluation (MSE) process since it involves many technical terms that may be interpreted or used differently by different people. A set of working definitions are provided in the IPHC Glossary of Terms and abbreviations: https://iphc.int/the-commission/glossary-of-terms-and-abbreviations

MANAGEMENT STRATEGY EVALUATION (MSE)

Management Strategy Evaluation (MSE) is a process to evaluate alternative management strategies. This process involves the following:

1. defining fishery goals and objectives with the involvement of stakeholders and managers,
2. identifying management procedures to evaluate,
3. simulating a halibut population with those management procedures,
4. evaluating and presenting the results in a way that examines trade-offs,
5. applying a chosen management procedure, and
6. repeating this process in the future in case of changes in objectives, assumptions, or expectations.

Figure 1 shows these different components and that the process is not necessarily a sequential process, but there may be movement back and forth between components as learning progresses. The involvement of stakeholders and managers in every component of the process is extremely important to guide the MSE and evaluate the outcomes.

BACKGROUND

Many important tasks have been completed or started and much of the work proposed will use past accomplishments to further the Management Strategy Evaluation (MSE) process. The past accomplishments include:

1. Familiarization with the MSE process.
2. Defining goals for the halibut fishery and management.
3. Developing objectives and performance metrics from those goals.
4. Development of an interactive tool (the Shiny application).

5. Discussions about coast-wide (single-area) and spatial (multiple-area) models.
6. Presentation of preliminary results investigating fishing intensity.
7. Discussions of ideas for distributing the TCEY to Regulatory Areas.

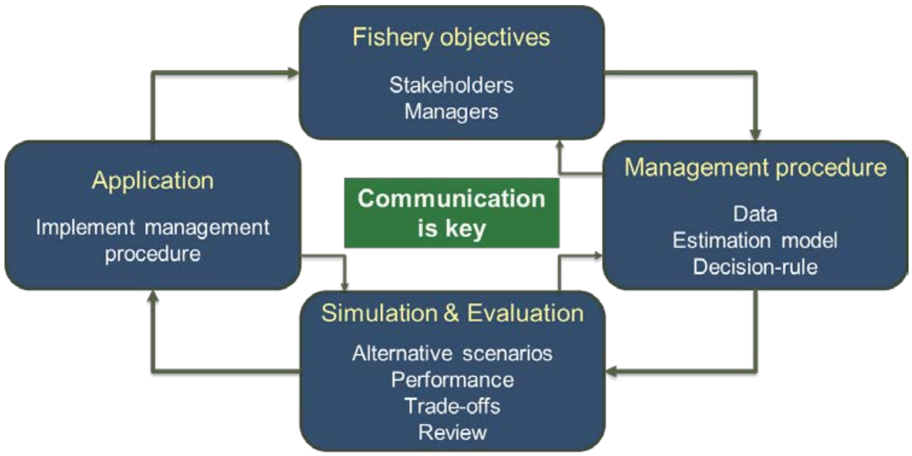


Fig. 1. A depiction of the Management Strategy Evaluation (MSE) process showing the iterative nature of the process with the possibility of moving either direction between most components.

Management Strategy Evaluation is a process that can develop over many years with many iterations. It is also a process that needs monitoring and adjustments to make sure that management procedures are performing adequately. Therefore, the MSE work for Pacific halibut fisheries will be ongoing as new objectives are addressed, more complex models are built, and results are updated. This time will include continued consultation with stakeholders and managers via the MSAB meetings, defining and refining goals and objectives, developing and coding models, running simulations, reporting results, and making decisions. Along the way, there will be useful outcomes that may be used to improve existing management and will influence recommendations for future work.

Overall, the plan is to use what has already been learned to continue making progress on the investigation of management strategies.

MAIN TASKS FOR THE NEXT 1-2 YEARS (WITH PAGE NUMBER OF DESCRIPTION)

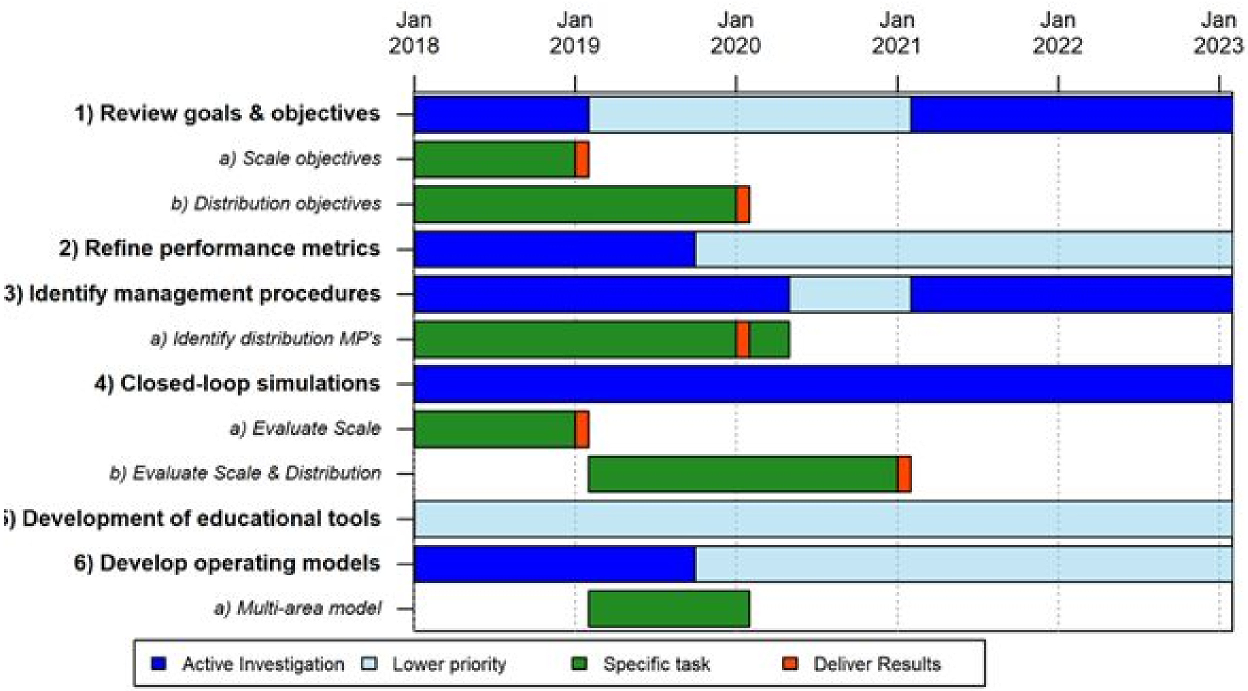


Fig. 2. Gantt chart for the five-year work plan. Tasks are listed as rows. Dark blue indicates when the major portion of the main tasks work will be done. Light blue indicates when preliminary or continuing work on the main tasks will be done. Dark green indicates when the work on specific sub-topics will be done. Red areas show when results will be presented.

Task 1. REVIEW, UPDATE, AND FURTHER DEFINE GOALS AND OBJECTIVES

Timeline: Ongoing

Deliverables: A list of goals important to the management of the halibut fishery, and a set of measureable objectives associated with those goals.

Relevance: Relevant goals and measureable objectives are essential to the MSE process. They are necessary to determine what types of models are needed and how to evaluate the management strategies.

Resources: Time to review past meetings, MSAB members to confirm and verify intent of existing goals and objectives, MSAB members to assist in the development of additional goals and objectives, MSAB members to assist with the development of measureable objectives and performance metrics.

Relation to other tasks: Defining goals and objectives is critical to developing useful performance metrics (Task 2), determining applicable management procedures (Task 3), and identifying the complexity needed in the operating model (Task 6).

Description: A very important part of the MSE process is to define goals (aspirational and realistic) and turn those into measureable objectives. The first step is to define a set of goals that are important to stakeholders and managers, which has been done at past MSAB meetings. It is important to verify that these aspirations are still of interest to all MSAB members, and to determine if additional goals should be added to the list. Currently, there are four overarching goals.

1. Biological sustainability
2. Fishery (all directed fisheries) sustainability, stability, and access
3. Minimize discard mortality
4. Minimize bycatch mortality

Measurable objectives can then be defined from these goals. Measurable objectives are objectives that have

1. an *outcome* (a specific and measurable description of what is desired),
2. a *time frame* (over what period of time is this outcome desired, which can be how far in the future and/or over a period of years), and
3. a *tolerance* (the tolerance for failure expressed as a probability).

An example of defining a measureable objective may be to take an objective such as “avoid stock sizes from which the stock may not recover” and define the measureable objective as the predicted spawning biomass from the assessment is less than 20% of unfished equilibrium spawning biomass (*outcome*) over a ten-year period far in the future (*time frame* incorporating both components) no more than 5% of the time (*tolerance*).

These measurable objectives are then used to define a performance metric that is used to evaluate alternative management strategies. Measureable objectives can also be used to develop the specifics of a MSE simulation framework. For example, what spatial resolution is needed to evaluate the objectives (e.g., coast-wide single area vs. spatial operating model). The development of measureable objectives may be iterative, in that they may be revised as the MSE evolves and more is understood about the relative performance of various management procedures.

Task 2. Develop performance metrics to evaluate objectives

Timeline: October 2018 and ongoing

Deliverables: A list of performance metrics that would be informative to stakeholders, managers, and scientists to effectively evaluate the performance of different management strategies and the trade-offs between them.

Relevance: The performance metrics are the key to evaluating management strategies and communicating outcomes to stakeholders. Determining important metrics and finding ways to present them effectively will help with the interpretation of the MSE results.

Resources: Time to review past meetings, MSAB members to confirm and verify current metrics, MSAB members to assist with the development of various performance metrics.

Relation to other tasks: Performance metrics are the key to presenting results from the management strategy evaluations and will be used in the outcomes from Task 4 (Closed-loop simulation programming).

Description: Measurable objectives guide the development of the simulation framework for an MSE, and performance metrics are needed to gauge the performance of a management strategy relative to those objectives. For example, a measurable objective may be to keep the average catch above a specific amount (the *outcome*), in the long-term over a 10-year period (the *time frame*), at least 95% of the time (the *probability*). The performance metric, framed as a risk, could then be the probability that the average catch was less than that level in this time period (average here refers to the average over the 10-year period and the probability accounts for the many replicated simulations). Another example is that a potential aspirational goal would be to have stability in yield, which could be translated to a measurable objective as keeping the annual change in catch to less than 10% (*outcome*) over a 10-year period (*time frame*) at least 90% of the time (*probability*). The performance metric may then be, again framed as a risk, the average number of years that the absolute change in catch exceeded 10% over that 10-year period (the average number of years refers to average over simulations and is used because many replicate simulations would be done).

Other performance metrics may not be directly associated with measureable objectives, but related to aspirational goals. These could be the average catch and the average annual variability in catch, and they do not have a probability associated with them. They do, however, provide a comparison between management procedures, but can be more ambiguous in interpretation (e.g., compare an average catch of 101 tons to 100 tons, as opposed to a defined probability threshold for achieving a particular catch). If the goal is to maximize average catch or minimize average annual variability, then these performance statistics could be used to measure achievement of those goals (or to examine the trade-offs between them), but it is more difficult to gauge the performance of a metric like average catch in light of uncertainty. An important component of performance metrics is the *distribution of outcomes* under different scenarios; some scenarios may confer much greater sensitivity of results than others and the understanding of this sensitivity is critical to the evaluation of the management procedures that are tested. This is also a key element in understanding the uncertainty associated with results.

Determining important and useful metrics, as well as how to present them, is key to communicating outcomes, interpreting MSE results, evaluating trade-offs, and making decisions on management procedures. Many performance metrics have already been defined, and this task will refine those, identify new metrics, and develop ways to present them. For example, Table 1 and Figure 3 show preliminary results from the IPHC MSE for Pacific halibut that were presented in IPHC document IPHC-2018-AM094-12. The probabilities and other details are apparent in Table 1, while the trade-offs are more easily seen in Figure 3. Additionally, performance metrics can be related to past performance, such as the observed average catch over the last 2 decades, and advice will be solicited to determine if there is a historical period for comparison.

Table 1. Performance metrics determined from outputs of the closed-loop simulations for various fishing intensities indicated by a procedural Spawning Potential Ratio (SPR) and a 30:20 threshold:limit in the harvest control rule. Table reproduced from IPHC document IPHC-2017-AM094-12

	30:20 Threshold:Limit										
	High Fishing Intensity										**Low Fishing Intensity**
Procedural SPR	**25%**	**30%**	**40%**	**42%**	**44%**	**46%**	**48%**	**50%**	**55%**	**60%**	**100%**
Median average realized SPR	39%	39%	42%	44%	46%	47%	49%	51%	56%	61%	93%
Biological Sustainability											
Median average dRSB	29%	29%	34%	36%	38%	41%	43%	45%	50%	56%	92%
Median Average # of Mature Females (million)	5.87	5.97	6.73	6.98	7.19	7.59	7.91	8.03	9.01	9.75	13.63
P(dRSB<20%)	3%	3%	3%	2%	2%	2%	2%	2%	1%	1%	0%
P(dRSB<30%)	78%	64%	19%	13%	10%	7%	6%	5%	3%	2%	0%
Fishery Sustainability											
Median average Total Mortality (Mlbs)	40.09	39.56	39.91	37.62	35.27	36.37	34.71	35.50	33.48	32.72	7.63
10th & 90th percentiles TM (Mlbs)	13 113	13 126	13 109	13 101	14 98	13 99	13 90	13 91	13 82	12 75	7 8
Median average FCEY (Mlbs)	32.86	32.69	32.72	30.76	28.31	29.23	27.57	28.14	26.33	25.38	0.50
P(No Commercial)	11%	9%	8%	8%	7%	8%	8%	8%	8%	10%	100%
P(FCEY < 50.6 Mlbs)	69%	66%	69%	69%	72%	73%	74%	74%	77%	80%	100%
P(decrease TM > 15%)	24%	17%	6%	5%	5%	5%	5%	4%	4%	3%	27%
Median catch variability (AAV of TM)	19%	13%	7%	7%	6%	6%	6%	6%	6%	6%	20%
Median catch variability (AAV of FCEY)	25%	17%	10%	10%	10%	10%	10%	10%	10%	10%	17%
Median catch variability (AAV of Commercial)	34%	23%	13%	13%	14%	13%	14%	14%	14%	14%	0%

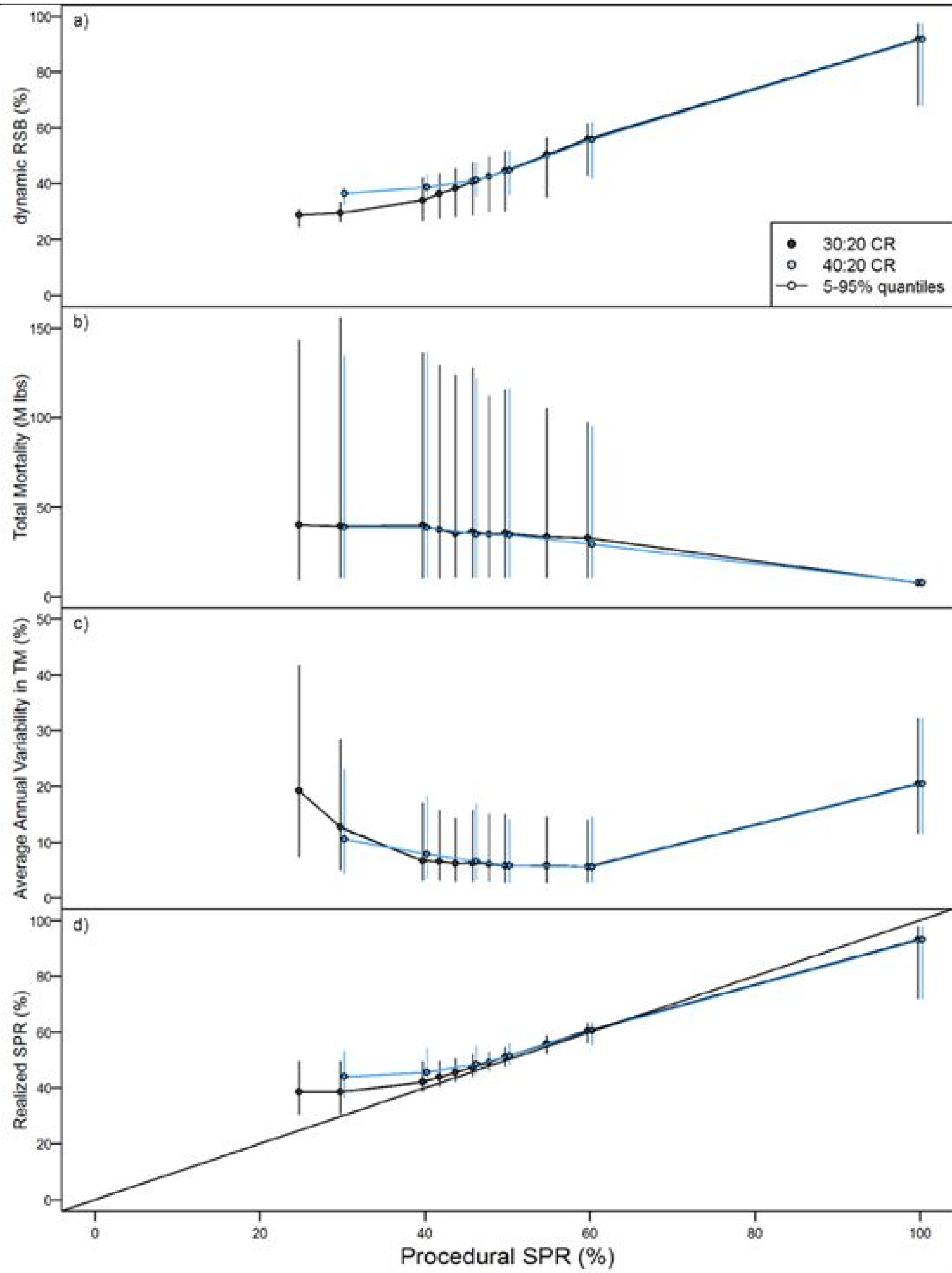


Fig. 3: Performance metrics plotted against the procedural SPR (horizontal axis) for different threshold:limit combinations (30:20 in black and 40:20 in blue). Panel a) shows the dynamic relative spawning biomass (biological sustainability goal), panel b) shows the total mortality (fishery sustainability goal), and panel c) shows the average annual variability for total mortality (fishery stability goal). Panel d) shows the realized SPR.

Task 3. IDENTIFY REALISTIC MANAGEMENT PROCEDURES OF INTEREST TO EVALUATE WITH A CLOSED-LOOP SIMULATION FRAMEWORK

Timeline: 2018-19, and then ongoing.

Deliverables: Various management procedures related to scale and TCEY distribution to be tested using closed-loop simulations.

Relevance: Identifying realistic management procedures that are of interest to stakeholders, managers, and scientists will ensure that the results of the MSE are pertinent and useful to managing the Pacific halibut stock.

Resources: Discussions between IPHC staff and MSAB members.

Relation to other tasks: This task will rely on defined goals and objectives (Task 1) and will feed into the closed-loop simulation programming (Task 4).

Description: The purpose of MSE is to evaluate management procedures by examining and comparing the performance and trade-offs of each. A small enough set needs to be determined so that the simulations can be completed in a reasonable amount of time and be easily compared and contrasted. Management procedures can be identified by modifying the current one, consulting with stakeholders, or examining other fisheries. Initially, many may be identified, and then reduced to a manageable size, which can occur through further consultation and investigation with simpler models such as the equilibrium model.

A management procedure contains elements related to data collection, assessment, and harvest rules. Combined with objectives, this makes a management strategy. Some elements of management procedures that have been proposed by the MSAB are:

- **Total mortality**: Direct accounting by area for all sources of mortality in that area, including sub-legals and bycatch mortality.
- **Fishing Intensity**: SPR-based (spawning potential ratio).
- **Harvest rules**: 30:20 and 40:20 coast-wide control rules, reference harvest rate 21.5%/16.125% by IPHC Regulatory Area.

The management procedure that would be evaluated as part of the MSE process would contain all of the necessary elements to set catch levels for the stock. An example management procedure may be:

- Coast-wide F_{SPR} with a 30:20 control rule to determine coast-wide total removals
- Coast-wide directed fishery catch levels apportioned to regulatory areas based on proportion of survey biomass
- Status quo recreational, subsistence, and bycatch allocation
- Annual survey to inform the stock assessment
- Status quo fishery data collected
- Annual assessment to determine total catch

The Commission at its 2017 Annual Meeting (AM093) recommended investigating a management approach based-on Spawning Potential Ratio (SPR) to account for all mortality. Spawning Potential Ratio is the long-term equilibrium spawning biomass per recruit with fishing divided by the long-term equilibrium spawning biomass per recruit without fishing. An SPR-based approach is defining a fishing level that results in a specific SPR (reduction in spawning potential) and noted as $F_{SPR=XX\%}$, where XX% is the SPR. This $F_{SPR=XX\%}$ will be treated as an element of a management procedure and evaluated with closed-loop simulation to find a level that best satisfies the defined objectives.

Management procedures related to distribution of the TCEY will be evaluated in the future. In the meantime, discussions of potential management procedures are ongoing and will need to be finalized by May 2020 to ensure enough time to perform the closed-loop simulations.

Task 4. DESIGN A CLOSED-LOOP SIMULATION FRAMEWORK AND CODE A COMPUTER PROGRAM TO EXTEND THE CURRENT SIMULATION FRAMEWORK

Timeline: 2018, and ongoing improvement after that

Deliverables: A design for a computer program that can perform closed-loop simulations for various operating models and management procedures. Once the design and framework are determined, the computer program will be written and tested. Updates will then occur as needed.

Relevance: A computer program to perform closed-loop simulations is the engine for the MSE. It will perform the simulations and create the output needed to calculate performance metrics. A good design will ensure that the code is useful to address current questions and flexible to accommodate future questions.

Resources: IPHC staff, computer programmer, MSE researcher, computing time

Relation to other tasks: This task will incorporate performance metrics (Task 2), management procedures (Task 3), and spatial model complexity and operating models (Task 6).

Description: Prior to 2017, the MSAB used an equilibrium model to introduce the concepts of a MSE. This model was used in a web-based application (the Shiny tool) because it produced results quickly and allowed MSAB members to change a few management options and see equilibrium outcomes related to biomass and yield. Those equilibrium outcomes are long-term averages of quantities that have natural variation (e.g., catches) if the fishery took place for an infinite amount of time.

Understanding the variability of the outcomes, such as yield and spawning biomass, is an important aspect of a MSE, but cannot be assessed with an equilibrium model. The equilibrium model is very useful because it produces results quickly and can be used to see the general patterns of various management strategies. However, this equilibrium model does not include the variability around the long-term equilibrium values, and does not incorporate a closed-loop simulation framework.

A closed-loop evaluation is the process of simulating the population dynamics with an operating model, as well as the feedback from the management strategy and decision-making process (Figure 4). The operating model consists of concepts that we cannot, or choose not to, control. The management procedure is what we can and choose to control. For example, the operating model will contain the population dynamics and some of the fishery dynamics that are not a part of the management process. The management procedure consists of data gathering, estimation models, and harvest rules, as well as anything else that informs the decisions affecting the fishery and fish population. Figure 4 attempts to show the annual process of a closed-loop simulation.

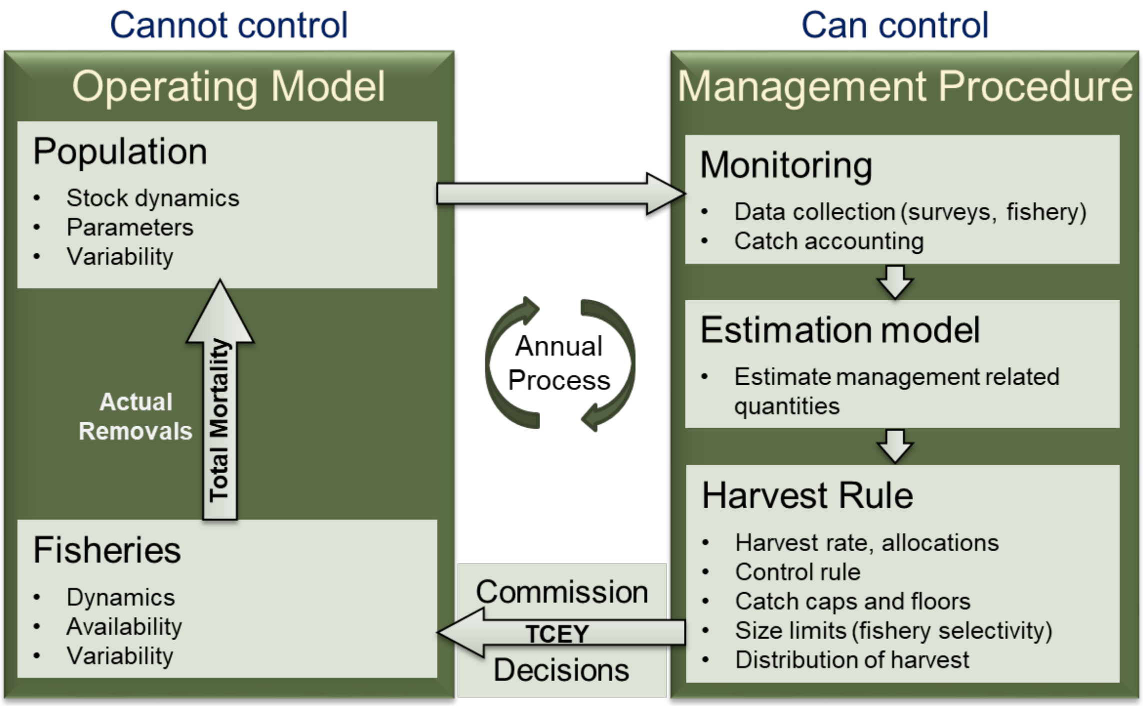


Fig. 4. A flow chart of how the annual process is simulated in a closed-loop simulation.

The operating model incorporates variability in the system and additional variability can be added to various parts of the management procedure (e.g., sampling error, assessment uncertainty, and implementation error). This variability is characterized by replicate simulations, resulting in a distribution of outcomes, which can be described with summary statistics (such as the mean) or by probabilities (such as the proportion of time the catch was below a certain level). It is important to note that closed-loop simulations are different than assessment projections because they incorporate hypotheses about the system that may be beyond what is useful for tactical decision making.

The management procedure must be able to be coded in a computer program, although implementation error can be introduced to mimic a real process more closely (e.g., not consistently following the management procedure). The average of a long-term closed-loop simulation with a consistent management procedure should be very similar to the results of an equilibrium model. However, the closed-loop simulation will also provide an insight into the variability of the process.

The development of a closed-loop simulation framework (see IPHC-2017-MSAB10-09 for more details) has involved coding a program that will incorporate the following:

1. Operating model (OM). The OM is meant to represent reality, including the uncertainty about it. Multiple models making up the OM will allow for structural uncertainty and alternative hypotheses of reality. They will have to be selected, coded, and conditioned. Conditioning an operating model is to tune it such that it is the best representation of reality possible (as indicated by fits to data). Currently, the two coastwide assessment models (short and long) are used as an operating model. In the future, the fleets-as-areas models may be incorporated as well as other individual models yet to be developed.
2. Management Procedure
    a. Data monitoring. This represents the types of data that are collected (e.g., fishery age compositions, survey index), how and how often they are collected, and the processes that generate them.
    b. Estimation model. The method to assess the population can range from simple (e.g., an average of recent survey observations) to complex (e.g., an ensemble of age-structure stock assessment models using multiple sources of data), but its main purpose is to use the simulated data to provide an input for the harvest rule. The current assessment approach (ensemble modelling) is likely too time-consuming for a simulation framework, so simplifications will need to be made. The simplest approach to mimic the assessment process is to add bias and variability to the outcomes of the operating model.
    c. Harvest rule. This is a common focus of a MSE and is the set of procedures that defines how the total removals are determined. Currently, an SPR of 46% defines the fishing intensity which may be modified by a 30:20 control rule. This is not always exactly followed, so introducing implementation error will more closely mimic the current paradigm.

The framework will have to be flexible and compartmentalized to allow changes to be made for each component.

An equilibrium model still has a role in MSE and can be used, as it has been already, to quickly narrow the choices of prospective management procedures. Once the candidate management procedures are narrowed to a plausible number for simulation testing, the closed-loop simulations can be used to further investigate them and characterize the distribution of results.

The closed-loop simulation framework will first be used to evaluate management procedures related to coastwide fishing intensity to be presented at the 95th Annual Meeting in 2019. After the development of multi-area models to include in an operating model, the updated framework will be used to evaluate distribution management procedures for presentation at the 97th Annual Meeting in 2021. See Appendix A for a more specific timeline.

Task 5. DEVELOP EDUCATIONAL TOOLS THAT WILL ENGAGE STAKEHOLDERS AND FACILITATE COMMUNICATION

Timeline: 2018 and ongoing

Deliverables: Materials, programs (web-based or installed), examples, etc. that will allow users to understand the MSE process through reading or interaction.

Relevance: For a stakeholder driven process to be effective, an understanding of the process and how to interpret results is necessary. These educational tools will facilitate communication and allow users to understand trade-offs between performance metrics given alternative management procedures.

Resources: IPHC staff, MSE researcher, computer programmer

Relation to other tasks: Effective understanding and communication is key to interpreting results and fostering communication between science, stakeholders, and management. Therefore, educational tools will be useful for all tasks.

Description: An interactive tool has been developed using the equilibrium model (called the Shiny tool) and has been useful for education and the investigation of some management procedures. The development of a similar tool that incorporates closed-loop simulation results, including variability, will be developed. Incorporating closed-loop simulations and introducing variability will necessitate the output to be changed to reflect the uncertainty in the results by reporting performance metrics, and results will be shown using various graphics and tables.

In addition, the development of materials that are useful to MSAB members and their constituents to assist with understanding the MSE process and facilitate communication will be done with the guidance of MSAB members.

Task 6. FURTHER THE DEVELOPMENT OF OPERATING MODELS

Timeline: October 2019 and ongoing

Deliverables: Individual models to make up various operating models (a collection of models depicting uncertainty) that will satisfy the objectives defined by MSAB members will be supplied.

Relevance: Operating models are necessary to examine structural uncertainty and to answer specific management questions.

Resources: IPHC staff, MSE researcher, computer programmer, computing time

Relation to other tasks: The further development of operating models will be guided by the tasks necessary to complete (Appendix A). In particular, expanding the spatial complexity will be necessary to appropriately evaluate management procedures (Task 3) related to TCEY distribution against goals and objectives (Task 1). These operating models will be used within the closed-loop simulation framework (Task 4).

Description: Management advice for Pacific halibut is currently developed using an ensemble of four different models to account for structural uncertainty. This same concept extends to MSE, and using various operating models with different assumptions can help to properly characterize the overall uncertainty in the management of a fish stock.

Currently, the operating model consists of coastwide models and cannot be used to evaluate area-specific objectives, which can only be answered with a multi-area model. For example, investigating the yield in each IPHC Regulatory Area would require simulating the biomass and fishery in each Area. The spatial complexity of the model depends on the questions being asked, thus before developing an operating model it is useful to determine the extent of the objectives. This will determine the structure of the operating model; for example, whether it needs to be flexible to incorporate different area specifications, or if it can have a fixed set of areas with simple movement between them. Once the level of complexity is decided, the next step is to determine how to best model space, movement, and time. After the design of the model is complete, programming can begin. Finally, the model will need to be conditioned to halibut data before being used in an MSE to ensure that it is a reasonable depiction of reality (or at least what we understand of it), and that we have enough data and knowledge to actually define the complexity of the operating model.

Taking the time to develop the specifications of an operating model is very important. The development of a multi-area model was part of the annual assessment process, and a multi-area model developed in Stock Synthesis as part of that process may be useful to begin to investigate various hypotheses related to movement between broad areas. That progress will provide some of the framework for future operating model development. Given the complexity of this task, a fully developed multi-area model is not likely to be completed before 2020.

There are many questions that can be answered with a single-area model before transitioning to a multi-area model and using a single-area model to answer those questions will be much more efficient. Therefore, evaluations of coastwide fishing intensity using coastwide operating models will occur in the meantime.

RECOMMENDATION/S

That the MSAB:

1) **NOTE** paper IPHC-2018-MSAB012-09 which updates the IPHC Program of Work for MSAB related activities for the period 2019-23.
2) **NOTE** the delivery dates January 2019 for coastwide results and January 2021 for the first complete MSE results including Scale and Distribution components of the management procedure for potential adoption by the Commission and subsequent implementation.
3) **CONSIDER** the six tasks, descriptions, and timeline.
4) **SUGGEST** additions or deletions to this Program of Work, or changes to the timeline, priorities, and deliverables.

ADDITIONAL DOCUMENTATION / REFERENCES

IPHC. 2017. Report of the 93rd Session of the IPHC Annual Meeting (AM093). Victoria, British Columbia, Canada, 23-27 January 2017. IPHC-2017-AM093-R, 61 pp. https://iphc.int/venues/details/94th-session-of-the-iphc-annual-meeting-am094

IPHC. 2018. IPHC Management Strategy Evaluation (MSE): update. IPHC-2018-AM094-12. 33 pp https://iphc.int/venues/details/94th-session-of-the-iphc-annual-meeting-am094

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

MSAB 2017. Report of the 10th Session of the IPHC Management Strategy Advisory Board (MSAB10). IPHC-2017-MSAB10-R. https://iphc.int/venues/details/10th-session-of-the-iphc-management-strategy-advisory-board-msab10

APPENDIX A: MSE PROGRAM OF WORK (2018-22): TIMELINE (FROM IPHC-2017-MSAB10-R)

May 2018 Meeting
Review Goals
Look at results of SPR
Review Performance Metrics
Identify Scale MP's
Review Framework
Identify Preliminary Distribution MP's
October 2018 Meeting
Review Goals
Complete results of SPR
Review Performance Metrics
Identify Scale MP'S
Verify Framework
Identify Distribution MP's
Annual Meeting 2019
Recommendation on Scale Present possible distribution MP’s
May 2019 Meeting
Review Goals
Spatial Model Complexity
Identify MP's (Distn Scale)
Review Framework
October 2019 Meeting
Review Goals
Spatial Model Complexity
Identify MP's (Distn Scale)
Review Framework
Review multi-area model development
Annual Meeting 2020
Update on progress
May 2020 Meeting
Review Goals
Review multi-area model
Review preliminary results
October 2020 Meeting
Review Goals
Review preliminary results
Annual Meeting 2021
Recommendations on Scale and Distribution

Report of the 12th Session of the IPHC Management Strategy Advisory Board (MSAB012)

Seattle, Washington, U.S.A., 22-25 October 2018

DISTRIBUTION:
Participants in the Session
Members of the Commission
IPHC Secretariat

BIBLIOGRAPHIC ENTRY
IPHC 2018. Report of the 12th Session of the IPHC Management Strategy Advisory Board (MSAB012). Seattle, Washington, U.S.A., 22-25 October 2018.
IPHC–2018–MSAB012–R, 28 pp.

INTERNATIONAL PACIFIC HALIBUT COMMISSION

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ACRONYMS

AAV	Average Annual Variability
CPUE	Catch-per-unit-effort
CV	Coefficient of Variation
dRSB	dynamic Relative Spawning Biomass
FCEY	Fishery Constant Exploitation Yield
FISS	Fishery-independent setline survey
F_{SPR}	The Fishing Intensity that results in an equilibrium Spawning Potential Ratio
HCR	Harvest Control Rule
IPHC	International Pacific Halibut Commission
MP	Management Procedure
MSAB	Management Strategy Advisory Board
MSE	Management Strategy Evaluation
RSB	Relative Spawning Biomass
SB	Spawning Biomass
SRB	Scientific Review Board
SPR	Spawning Potential Ratio
TCEY	Total Constant Exploitation Yield
TM	Total Mortality
U.S.A.	United States of America
WPUE	Weight-per-unit-effort

DEFINITIONS

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

HOW TO INTERPRET TERMINOLOGY CONTAINED IN THIS REPORT

This Report has been written using the following terms and associated definitions so as to remove ambiguity surrounding how particular paragraphs should be interpreted.

Level 1: **RECOMMENDED**; **RECOMMENDATION** (formal); **REQUESTED** (informal): A conclusion for an action to be undertaken, by the Commission, a Contracting Party, a subsidiary (advisory) body of the Commission and/or the IPHC Secretariat. *Note*: Subsidiary (advisory) bodies of the Commission must have their Recommendations and Requests formally provided to the next level in the structure of the Commission for its consideration/endorsement (e.g. from a subsidiary body to the Commission). The intention is that the higher body will consider the action for endorsement under its own mandate, if the subsidiary body does not already have the required mandate. Ideally, this should be task-specific and contain a timeframe for completion.

Level 2: **AGREED**: Any point of discussion from a meeting, which the IPHC body considers to be an agreed course of action covered by its mandate, which has not already been dealt with under Level 1 above; a general point of agreement among delegations/participants of a meeting which does not need to be elevated in the Commission's reporting structure.

Level 3: **NOTED/NOTING**; **CONSIDERED**; **URGED**; **ACKNOWLEDGED**: General terms to be used for consistency. Any point of discussion from a meeting, which the IPHC body considers to be important enough to record in a meeting report for future reference. Any other term may be used to highlight to the reader of an IPHC report, the importance of the relevant paragraph. Other terms may be used but will be considered for explanatory/informational purposes only and shall have no higher rating within the reporting terminology hierarchy than Level 3.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The 12th Session of the International Pacific Halibut Commission (IPHC) Management Strategy Advisory Board (MSAB012) was held in Seattle, Washington, U.S.A. from 22 to 25 October 2018. The MSAB consists of 21 board members, 18 of which attended the Session from the two (2) Contracting Parties. A total of four (4) individuals attended the Session as Observers. In addition, three (3) IPHC Commissioner's were in attendance, Mr Paul Ryall (Canada), Mr Bob Alverson (USA) and Mr Richard Yamada (USA).

The following are a subset of the complete recommendations/requests for action from the MSAB012, which are provided in full at Appendix VII.

RECOMMENDATIONS

A review of the goals and objectives of the IPHC MSE process

MSAB012–Rec.01 (para. 20) The MSAB **NOTED** the refined objectives provided by the ad-hoc working group (contained in paper IPHC-2018-MSAB012-06), and **RECOMMENDED** prioritizing a single conservation objective over fishery measurable objectives (Table 1).

Table 1. Priority objectives phrased as measurable outcomes used to evaluate MSE results. The first objective is prioritized over the others.

MEASURABLE OUTCOME	TIME-FRAME	TOLERANCE
SB < Spawning Biomass Limit (SB_{Lim}) SB_{Lim}=20% spawning biomass	Long-term	0.10
Relative AAV	Short-term	
Average Annual Variability (AAV) > 15%	Short-term	0.25
Maximize average TCEY coastwide	Short-term	

Performance metrics for evaluation

MSAB012–Rec.02 (para. 24) The MSAB **RECOMMENDED** that performance-metrics for the short-term span 4-13 years, medium-term span 14-23 years, and the long-term span 91-100 years, be reported to understand how the management procedures may rank differently in the different periods of the forward simulations.

Closed-loop simulation results to investigate coastwide fishing intensity

MSAB012–Rec.03 (para. 37) The MSAB **RECOMMENDED** that a coastwide fishing intensity SPR should not be lower than 40% nor higher than 46%, with a target SPR of 42%-43% with a 30:20 HCR. Rationale for this recommendation is provided in paragraph 38.

REQUESTS

Closed-loop simulation results to investigate coastwide fishing intensity

MSAB012–Req.03 (para. 40) The MSAB **REQUESTED** that additional MPs components be considered to meet the objective of catch stability. The IPHC Secretariat may consider the following MPs, but is **ENCOURAGED** to explore other options to report at MSAB013.

a) 25:10 control rule, and other control rules, as possible, potentially including 30:10 and 30:15 and 30:20;

b) Multi-year quotas, defined as setting the TCEY in one year and sticking with the same TCEY in one or more following years, noting that AAV may not be an appropriate metric to measure variability;

c) Limiting change in catch limits from the previous year to +/-15% per year, in addition to other relevant percentages, with the goal of finding MPs that meet the main objectives;

d) Limiting change in catch limits from the previous year to a maximum increase of 15% per year with no limit on decreasing the catch limit;

e) Slow up (33% of the change in TCEY), fast down (-50% of the change in TCEY).

Identify preliminary MPs related to distribution

MSAB012–Req.05 (para. 54) The MSAB **REQUESTED** that an additional management procedure be considered to define allocations and a catch limit floor that reduces catch limits in a stair-step manner during times of large abundance changes.

1. OPENING OF THE SESSION

1. The 12th Session of the International Pacific Halibut Commission (IPHC) Management Strategy Advisory Board (MSAB012) was held in Seattle, Washington, U.S.A. from 22 to 25 October 2018. The MSAB consists of 21 board members, 18 of which attended the Session from the two (2) Contracting Parties. A total of four (4) individuals attended the Session as Observers. In addition, three (3) IPHC Commissioner's were in attendance, Mr Paul Ryall (Canada), Mr Bob Alverson (USA), and Mr Richard Yamada (USA). The list of participants is provided at Appendix I.

2. The MSAB **NOTED** apologies received from the following board members: Mr Robert Hauknes (Canadian Commercial harvester representative), Mr Tom Marking (USA sport fishing representative and Martin Paish (Canadian sport fishing representative).

3. The MSAB **RECALLED** that the primary objectives of MSAB, as described in Appendix V, para. 2 of the IPHC Rules of Procedure (2017) are as follows:

    a) *define clear measurable objectives and performance measures for the fishery;*

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

    c) *advise IPHC staff about plausible 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).*

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

    e) *encourage and allow members to test tentative ideas and exploratory suggestions without prejudice to future discussions;*

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

    g) *encourage the understanding and support of their constituencies for the MSAB process and for consensus positions developed by MSAB.*

4. **NOTING** paragraph 3, the MSAB **RECALLED** that the Management Strategy Evaluation process is a stakeholder informed, scientifically driven process.

2. ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION

5. The MSAB **ADOPTED** the Agenda as provided at Appendix II. The documents provided to the MSAB012 are listed at Appendix III.

3. IPHC PROCESS

3.1 MSAB Membership

6. The MSAB **NOTED** paper IPHC-2018-MSAB012-03 Rev_1 which provided the current membership list and term expirations for the MSAB. The full membership list is provided at Appendix IV:

7. The MSAB **WELCOMED** the following new MSAB members appointed by the Commission:

    a) Mr Matt Damiano: USA Treaty tribes representative

    b) Mr Joseph Morelli: USA Processor representative

8. The MSAB **WELCOMED** the following government members appointed by ADFG:

    a) James Hasbrouck: USA government representative, ADFG.

3.2 Update on the actions arising from the 11th Session of the MSAB (MSAB011)

9. The MSAB **NOTED** paper IPHC-2018-MSAB012-04 which provided an opportunity to consider the progress made during the inter-sessional period in relation to the recommendations and requests of the 11th Session of the IPHC Management Strategy Advisory Board (MSAB011).

10. The MSAB **AGREED** to consider and revise as necessary, the actions arising from the MSAB011, and for these to be combined with any new actions arising from the MSAB012.

3.2.1 *Additional Commission directives*

11. The MSAB **NOTED** that the Commission met for its annual Work Meeting (WM2018) in September 2018. At that meeting, the Commission developed several additional directives for the MSAB012 as follows:

    "*The Commission **RECOMMENDED** that the MSAB:*

    a) focus its efforts on providing a recommendation on the level of the coast-wide fishing intensity for IM094 in November 2018. This work on the scale portion of the harvest strategy policy should be prioritized over work on distribution.

    b) While it is recognized that the MSAB has spent considerable time and effort in developing objectives for evaluating management procedures, for the purpose of expediting a recommendation on the level of the coast-wide fishing intensity, and noting SRB11–Rec.02 to develop an objectives hierarchy, the MSAB is requested to evaluate management procedure performance against objectives that prioritize long-term conservation over short-/medium-term (e.g. 3-8 years) catch performance. Where helpful in accelerating progress on scale, the MSAB is requested to constrain objectives to (1) maintain biomass above a limit to avoid critical stock sizes, (2) maintain a minimum average catch, and (3) limit catch variability."

3.3 Review of the outcomes of the 13th Session of the IPHC Scientific Review Board (SRB013)

12. The MSAB **NOTED** paper IPHC-2018-MSAB012-05, which provided the outcomes of the 13th Session of the IPHC Scientific Review Board (SRB013) relevant to the mandate of the MSAB, which were provided for reference.

13. The MSAB **AGREED** with the SRB that objectives should be hierarchal, include a combination of long-term and short-term timeframes, and be computed from the MSE simulation framework, noting that the goal of the MSE process is to rank the relative performance of management procedures.

14. The MSAB **AGREED** with the SRB that the current stock assessment process is distinct from the MSE process.

15. The MSAB **NOTED** that a phase-in of procedures to transition from the status quo to a recommended management procedure may be useful.

16. The MSAB **NOTED** that the stock assessment decision table may also be useful in understanding the 1-3 year consequences of a management procedure, given it is used for decision-making.

17. The MSAB **AGREED** with the SRB that this is an iterative process, but **NOTED** that the results presented at MSAB012 provide insight into management procedures that are likely to meet the conservation and fishery objectives related to coastwide scale.

4. GOALS, OBJECTIVES, AND PERFORMANCE METRICS

4.1 A review of the goals and objectives of the IPHC MSE process

18. The MSAB **NOTED** paper IPHC-2018-MSAB012-06 which provided a review of the goals and objectives of the IPHC MSE process, and to consider the directives from the Commission, including the consideration of additional objectives related to distributing the TCEY.

19. The MSAB **NOTED** that the additional directives regrading objectives that arose from the 2018 IPHC Work Meeting (WM2018; see para. 11) align with the refined objectives provided by the ad-hoc working group.

20. The MSAB **NOTED** the refined objectives provided by the ad-hoc working group (contained in paper IPHC-2018-MSAB012-06), and **RECOMMENDED** prioritizing a single conservation objective over fishery measurable objectives (Table 1).

Table 1. Priority objectives phrased as measurable outcomes used to evaluate MSE results. The first objective is prioritized over the others.

MEASURABLE OUTCOME	TIME-FRAME	TOLERANCE
SB < Spawning Biomass Limit (SB_{Lim}) SB_{Lim}=20% spawning biomass	Long-term	0.10
Relative AAV	Short-term	
Average Annual Variability (AAV) > 15%	Short-term	0.25
Maximize average TCEY coastwide	Short-term	

21. The MSAB **AGREED** that statistics of interest are useful when evaluating management procedures and **REQUESTED** that they continue to be reported.

4.2 Performance metrics for evaluation

22. The MSAB **NOTED** the performance metrics, including statistics of interest, reported in IPHC-2018-MSAB012-07 Rev_1.
23. The MSAB **REQUESTED** that the same metrics are calculated for the recreational sector as are calculated for the commercial sector and be reported for subsequent evaluations.
24. The MSAB **RECOMMENDED** that performance-metrics for the short-term span 4-13 years, medium-term span 14-23 years, and the long-term span 91-100 years, be reported to understand how the management procedures may rank differently in the different periods of the forward simulations.

5. HARVEST STRATEGY POLICY, PART 1: SIMULATIONS TO EVALUATE FISHING INTENSITY

25. The MSAB **NOTED** paper IPHC-2018-MSAB011-07 Rev_1 which provided an update on the progress of the IPHC Management Strategy Evaluation process to investigate fishing intensity, and to present results of the closed-loop simulations.

5.1 A description of the closed-loop simulation framework

26. **NOTING** the current simulation framework for the MSE, the MSAB **AGREED** that the changes made (bycatch mortality, recreational mortality, and time-varying commercial selectivity) improve the simulation framework.
27. The MSAB **NOTED** the importance of periodic check-ins to update the simulation framework with current knowledge as part of the iterative MSE process.

5.2 A review of variability and scenarios

28. The MSAB **NOTED** that the results presented at MSAB012 included four levels of estimation error (none, 0.10, 0.15, and 0.20) and four levels of autocorrelation (0.0, 0.2, 0.4, and 0.6). An estimation error of 0.15 and an autocorrelation was considered the default based on investigations of the current stock assessment models.

5.3 Closed-loop simulation results to investigate coastwide fishing intensity

29. The MSAB **NOTED** that the Management Procedures (MPs) requested by the MSAB at MSAB011 consisted of SPR values from 0.3 to 0.56 and control rules of 30:20 and 40:20.
30. The MSAB **NOTED** that additional MPs were presented for evaluation that consisted of SPR values and a control rule of 25:10. An additional MP with no control rule was presented.
31. The MSAB **NOTED** that additional MPs incorporating a constant catch with 30:20 or 40:20 control rules were presented.

32. The MSAB **NOTED** that sensitivities with different levels of estimation error, autocorrelation, fixed weight-at-age, fixed recruitment regime (high or low), low and high bycatch, and bycatch selectivity shifted to younger fish were presented to determine the robustness of the management procedures.

33. The MSAB **NOTED** the results of two MPs that limit the change of TM: (1) an MP that limits the maximum change in TM in either direction to 15%, and (2) an MP that limits the maximum increase in the TM to 15%, with no limit on the maximum decrease.

34. The MSAB **REVIEWED** the performance metrics related to the objectives in Appendix V, for MPs with SPR ranging from 0.3 to 0.56 in combination with 40:20, 30:20, 25:10 HCRs, and without an HCR, and **NOTED** the following:

    a) All of these MPs meet the primary long-term conservation objective of maintaining the spawning biomass above a biomass limit of 20 percent at least 90 percent of the time, except for the MPs without an HCR and for the highest fishing intensity investigated (F_{SPR} = 0.30);

    b) While some of the MPs result in lower average annual variability (AAV), none of them achieves the specific AAV measurable outcome of more than 15 percent less than 25% of the time; however, MPs with a control rule of 25:10 produce the lowest AAV values in the short, medium, and long-term timeframes;

    c) the performance of MPs across different SPR values is relative to the corresponding harvest control rule (HCR) and that there are trade-offs associated with various HCRs and SPR values, particularly with regard to AAV and coastwide TM.

35. The MSAB **NOTED** that an HCRs is a useful way to help meet the conservation objective (SB > 0.2) is met at all fishing intensities investigated.

36. **NOTING** that a 40:20 HCR results in a lower yield and higher AAV when compared to other HCRs, the MSAB **AGREED** MPs for current consideration be limited to 30:20 and 25:10 HCRs.

37. The MSAB **RECOMMENDED** that a coastwide fishing intensity SPR should not be lower than 40% nor higher than 46%, with a target SPR of 42%-43% with a 30:20 HCR. Rationale for this recommendation is provided in paragraph 38.

38. The MSAB **AGREED** on the rationale for paragraph 37 as follows:

    a) that at fishing intensities greater than SPR 40%, AAV appears to increase at a faster rate, with little gain in yield; and

    b) at fishing intensities greater than SPR 40%, Pr(SB<SB30) and Pr(SB<20) increased; and

    c) fishing intensities lower than SPR 46% yield appears to decrease at a faster rate, with little gain to conservation and stability objectives; and

    d) that conservation risk is lower under the 30:20 HCR than for a 25:10 HCR, although the probability of a directed fishery closure is greater than under the 25:10 HCR; and

    e) that median total mortality is lower, and median AAV is higher under a 30:20 HCR across all SPRs considered compared to the 25:10 HCRs.

39. **NOTING** paragraph 34(b), the MSAB ranked the MPs relative to one another in terms of median AAV in TM. To meet the AAV objective, additional MPs to limit the percent change TM limit from the previous year were also discussed.

40. The MSAB **REQUESTED** that additional MPs components be considered to meet the objective of catch stability. The IPHC Secretariat may consider the following MPs, but is **ENCOURAGED** to explore other options to report at MSAB013.

    a) 25:10 control rule, and other control rules, as possible, potentially including 30:10 and 30:15 and 30:20;

    b) Multi-year quotas, defined as setting the TCEY in one year and sticking with the same TCEY in one or more following years, noting that AAV may not be an appropriate metric to measure variability;

c) Limiting change in catch limits from the previous year to +/-15% per year, in addition to other relevant percentages, with the goal of finding MPs that meet the main objectives;

d) Limiting change in catch limits from the previous year to a maximum increase of 15% per year with no limit on decreasing the catch limit;

e) Slow up (33% of the change in TCEY), fast down (-50% of the change in TCEY).

41. The MSAB **CONSIDERED** the objectives described in Table 2 in making its recommendation in Paragraph 37.

Table 2. Priority objectives phrased as measurable outcomes used to evaluate MSE results and results for SPR values from 46% to 40% using a 30:20 control rule for each objective. Pass/Fail or change in the metric are reported to reflect the ranking of management procedures.

MEASURABLE OUTCOME	TIME-FRAME	TOLERANCE	SPR 46%	SPR 44%	SPR 42%	SPR 40%
SB < Spawning Biomass Limit (SB_{Lim}) SB_{Lim}=20% spawning biomass	Long-term	0.10	Pass	Pass	Pass	Pass
Median AAV	Short-term		Min	+0.9%	+1.8%	+3.2%
Average Annual Variability (AAV) > 15%	Short-term	0.25	Fail	Fail	Fail	Fail
Maximize average TCEY coastwide (Median TM)	Short-term		-9.9% diff	-6.3% diff	-3.4% diff	Max

42. The MSAB **NOTED** additional statistics of interest over the long-term in making its recommendation in Paragraph 37, described in Table 3.

Table 3. Statistics of interest used for the evaluation of MSE with results for SPR values from 46% to 40% using a control rule of 30:20.

STATISTIC OF INTEREST	TIME-FRAME	SPR 46%	SPR 44%	SPR 42%	SPR 40%
Median realized SPR	Long-term	47.4%	45.9%	44.5%	43.5%
SB < Spawning Biomass Limit (SB_{Lim}) SB_{Lim}=20% spawning biomass	Long-term	<0.01	<0.01	<0.01	<0.01
Median AAV	Long-term	18.4%	19.4%	21.1%	23.9%
Probability Average Annual Variability (AAV) > 15%	Long-term	0.722	0.771	0.813	0.847
Maximize average TCEY coastwide (Median TM, Mlbs)	Long-term	38.0	38.5	39.0	39.6
Median relative spawning biomass	Long-term	39.7%	37.9%	36.5%	35.0%
Probability SB<30% in a year	Long-term	0.031	0.065	0.094	0.142
Probability SB<30% in at least 1 of 10 years	Long-term	0.070	0.149	0.202	0.307
Probability commercial allocation = 0 in a year	Long-term	0.034	0.046	0.051	0.063
Probability commercial allocation = 0 in at least 1 of 10 years	Long-term	0.147	0.192	0.233	0.283

75th percentile of TM	Long-term	63.5	65.3	65.9	68.4
Probability TM<34 Mlbs in a year	Long-term	0.448	0.435	0.426	0.432
Probability TM<34 Mlbs in at least 1 of 10 years	Long-term	0.633	0.641	0.661	0.681
Probability Directed < 50.6 Mlbs* in a year	Long-term	0.7212	0.7078	0.6958	0.6819
Probability Directed < 50.6 Mlbs* in at least 1 of 10 years	Long-term	0.8550	0.8470	0.8500	0.8530

*70% of average TM from 1993-2012

43. The MSAB **REQUESTED** that the IPHC Secretariat provide a report at MSAB013 of IPHC research and other relevant research (to the extent possible) activities related to relationships between population dynamics and environmental conditions, noting that the IPHC 5-year research plan is available on the IPHC website, to aid in the discussion of hypotheses that are plausible to include in the MSE process.

44. The MSAB **NOTED** that the MSE framework is an appropriate way to explore how management procedures perform under potential future environmental conditions given plausible hypotheses about such relationships.

45. The MSAB **NOTED** paragraph 39 of the SRB013 report which states:

> *"The SRB NOTED that the biological research activities being undertaken by the IPHC Secretariat should help to define hypotheses associated with processes that affect plausible states of nature for the assessment and MSE process (e.g. climate effects on growth and recruitment)." (IPHC-2018-SRB013-R, para. 39)."*

6. Harvest strategy policy, Part 2: Addressing stock and total constant exploitation yield (TCEY) distribution

46. The MSAB **NOTED** paper IPHC-2018-MSAB012-08 which provided an update on discussions and ideas related to science inputs and management procedures for distributing the Total Constant Exploitation Yield (TCEY) across the IPHC Convention Area.

6.1 Discussion of distribution goals

47. The MSAB **NOTED** that the ad-hoc working group did not refine objectives related to distribution of TCEY, but differentiated between current objectives related to scale and distribution.

48. The MSAB **ACKNOWLEDGED** the importance and continued support among members for the following principle: conserving spatial population structure by applying a precautionary approach and using bioregions. This would be maintained as a general objective in Appendix V.

6.2 Review the framework to investigate distributing the TCEY among IPHC Regulatory Areas and evaluate against objectives

49. The MSAB **NOTED** the distribution framework and the separation of scientific and management elements of distribution procedures.

50. The MSAB **NOTED** that catch limit decisions are based on TCEY (O26), therefore using "all-sizes" WPUE from the FISS space-time model is more congruent with regional stock distribution.

6.3 Identify preliminary MPs related to distribution

51. The MSAB **NOTED** the MPs that are currently listed for consideration, as follows:

    a) Relative harvest rates.

    b) O32:O26 ratios.

    c) Trends in setline survey WPUE by IPHC Regulatory Area.

d) Trends in modelled setline survey WPUE by biological region.

e) Trends in fishery CPUE.

f) Smoothing algorithms on area-specific catch limits.

g) Percentage allocation with a floor (i.e. minimums of 1.5 Mlbs in 2A and 1.7 Mlbs in 4CDE).

h) A maximum SPR with catch distribution by IPHC Regulatory Area determined from the modelled setline survey WPUE.

i) Coastwide TCEY target and maximum calculated; distribution by target, but with ability to adjust TCEY up to the maximum.

52. The MSAB **AGREED** that an ad-hoc working group would be formed to recommend elements of management procedures for the distribution of TCEY. The working group will organize the management procedures listed in paper IPHC-2018-MSAB012-08 with respect to the framework of five steps for distributing TCEY to bioregions and regulatory areas listed in Section 3.4 of paper IPHC-2018-MSAB012-08. The members of the ad-hoc working group will be: Bruce Gabrys, Peggy Parker, Dan Falvey, Chris Sporer, Glenn Merrill, Scott Mazzone, Jim Lane, Adam Keizer, and Carey McGilliard. The working group will meet electronically between the AM095 and MSAB013 and the meeting will be facilitated by the IPHC Secretariat.

53. The MSAB **URGED** members to document candidate management procedures and share any such MPs with the ad-hoc working group prior to MSAB013, via the IPHC Secretariat. The 95th Session of the IPHC Annual Meeting (AM095) will be a key engagement point for this task.

54. The MSAB **REQUESTED** that an additional management procedure be considered to define allocations and a catch limit floor that reduces catch limits in a stair-step manner during times of large abundance changes.

55. The MSAB **REQUESTED** that the IPHC Secretariat and the MSAB continue to develop the concept of a 'fishery footprint', as previously considered in IPHC-2015-MSAB006-R, in part to consider how it may be incorporated into a MP.

7. MSAB PROGRAM OF WORK 2019-23

56. The MSAB **NOTED** paper IPHC-2018-MSAB012-09 which provided an update on the 5-year MSE Program of Work (2019-23), given current Commission directives.

57. The MSAB **NOTED** the delivery dates of January 2019 for coastwide results and January 2021 for the MSE results, including Scale and Distribution components of the management procedure for potential adoption by the Commission and subsequent implementation.

58. The MSAB **ENDORSED** the Program of Work provided at Appendix VI.

8. OTHER BUSINESS

8.1 IPHC meetings calendar (2019-21)

59. The MSAB **NOTED** the annual IPHC meetings calendar (2019-21) adopted by the Commission at its 94th Session in 2018, as published on the IPHC website.

60. The MSAB **NOTED** the indication from the IPHC Secretariat that the MSAB may not need the four (4) days currently scheduled for MSAB013 (6-9 May 2019).

8.2 IPHC Rules of Procedure (2017)

61. **NOTING** the proposed revisions to the IPHC Rules of Procedure presented by the IPHC Secretariat, the MSAB **AGREED** to the following:

a) ***Intersessional process and ad-hoc working groups: Steering Committee*** (Section V, para. 10): given the changes to the MSAB in recent years, there is no longer a need for a Steering Committee and this section should be removed;

b) ***Reports and Records*** (Section VI, para. 12): currently, the drafting of the MSAB report is the responsibility of the Co-Chairpersons, with the Steering Committee being delegated some of that responsibility. With the changes agreed to above, and the need for standardisation among all of the Commission's subsidiary bodies, para. 12 of the Rules of Procedure (2017) should be standardised to those of the other subsidiary bodies of the Commission.

62. The MSAB **AGREED** that support for rapporteuring will be determined tentatively during each MSAB meeting for the next MSAB meeting, and confirmed at the commencement of each meeting.

9. REVIEW OF THE DRAFT AND ADOPTION OF THE REPORT OF THE 12TH SESSION OF THE IPHC MANAGEMENT STRATEGY ADVISORY BOARD (MSAB012)

63. The report of the 12th Session of the IPHC Management Strategy Advisory Board (IPHC-2018-MSAB012–R) was **ADOPTED** on 25 October 2018, including the consolidated set of recommendations and/or requests arising from MSAB012, provided at Appendix VII.

APPENDIX I
LIST OF PARTICIPANTS FOR THE 12TH SESSION OF THE IPHC MANAGEMENT STRATEGY ADVISORY BOARD (MSAB012)

Officers

Co-Chairperson (Canada)	**Co-Chairperson (United States of America)**
Mr Adam **Keizer**: adam.keizer@dfo-mpo.gc.ca	Dr Carey **McGilliard**: Carey.McGilliard@noaa.gov

MSAB Members

Canada	**United States of America**
Ms Ann-Marie **Huang:** Ann-Marie.Huang@dfo-mpo.gc.ca	Mr Craig **Cross**: craigc@starboats.com
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Mr Brad **Mirau**: brad@aerotrading.ca	Mr Dan **Falvey**: myriadfisheries@gmail.com
Mr Chris **Sporer**: chris.sporer@phma.ca	Mr Bruce **Gabrys**: gabryscpa@mtaonline.net
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	Ms Peggy **Parker**: peggyparker616@gmail.com
Absentees	**Absentees**
Mr Robert **Hauknes**: robert_hauknes@hotmail.com	Mr Tom **Marking**: tmmarking@gmail.com
Mr Martin **Paish**: martinpaish1@gmail.com	

Commissioners

Canada	**United States of America**
Mr Paul **Ryall**: Paul.Ryall@dfo-mpo.gc.ca	Mr Robert (Bob) **Alverson**: RobertA@fvoa.org
	Mr Richard **Yamada**: richard@alaskareel.com

Observers

Canada	**United States of America**
	Ms Ruth **Christiansen**, United Catcher Boats: ruth.christiansen78@gmail.com
	Ms Keeley **Kent** – NOAA-Fisheries: keeley.kent@noaa.gov
	Mr Frank **Lockhart**, NOAA-Fisheries: frank.lockhart@noaa.gov
	Ms Sarah **Webster**, Alaska Department of Fish and Game: sarah.webster@alaska.gov

IPHC Secretariat

Name	**Position and email**
Dr David **Wilson**	Executive Director, david@iphc.int
Mr Stephen **Keith**	Assistant Director, steve@iphc.int

Dr Allan **Hicks**	Quantitative Scientist, allan@iphc.int
Dr Ian **Stewart**	Quantitative Scientist, ian@iphc.int

APPENDIX II
AGENDA FOR THE 12TH SESSION OF THE IPHC MANAGEMENT STRATEGY ADVISORY BOARD (MSAB012)

Date: 22-25 October 2018
Location: Seattle, Washington, U.S.A.
Venue: IPHC Training Room
Time: 22nd: 12:00-17:00; 23rd-25th: 09:00-17:00 daily
Co-Chairpersons: Mr. Adam Keizer (Canada) and Dr. Carey McGilliard (U.S.A.)

1. **OPENING OF THE SESSION**

2. **ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION**

3. **IPHC PROCESS**
   3.1. MSAB Membership
   3.2. Update on the actions arising from the 11th Session of the MSAB (MSAB011)
   3.3. Review of the outcomes of the 13th Session of the Scientific Review Board (SRB013)

4. **GOALS, OBJECTIVES, AND PERFORMANCE METRICS**
   4.1. A review of the coastwide goals and objectives of the IPHC MSE process
   4.2. Performance metrics for evaluation

5. **HARVEST STRATEGY POLICY, PART 1: SIMULATIONS TO EVALUATE FISHING INTENSITY**
   5.1. A description of the closed-loop simulation framework
   5.2. A review of variability and scenarios
   5.3. Closed-loop simulation results to investigate coastwide fishing intensity

6. **HARVEST STRATEGY POLICY, PART 2: ADDRESSING STOCK AND TOTAL CONSTANT EXPLOITATION YIELD (TCEY) DISTRIBUTION**
   6.1. Discussion of distribution goals
   6.2. Review the framework to investigate distributing the TCEY among IPHC Regulatory Areas and evaluate against objectives
   6.3. Identify preliminary MPs related to distribution

7. **MSAB PROGRAM OF WORK (2019-23)**

8. **OTHER BUSINESS**
   8.1. IPHC meetings calendar (2019-21)
   8.2. IPHC Rules of Procedure (2017)

9. **REVIEW OF THE DRAFT AND ADOPTION OF THE REPORT OF THE 12th SESSION OF THE IPHC MANAGEMENT STRATEGY ADVISORY BOARD (MSAB012)**

APPENDIX III
LIST OF DOCUMENTS FOR THE 12TH SESSION OF THE MANAGEMENT STRATEGY ADVISORY BOARD (MSAB012)

Document	Title	Availability
IPHC-2018-MSAB012-01	Draft: Agenda & Schedule for the 12th Session of the IPHC Management Strategy Advisory Board (MSAB012)	✓ 23 July 2018 ✓ 21 September 2018
IPHC-2018-MSAB012-02	Draft: List of Documents for the 12th Session of the IPHC Management Strategy Advisory Board (MSAB012)	✓ 21 September 2018 ✓ 18 October 2018
IPHC-2018-MSAB012-03 Rev_1	MSAB Membership and Officers (IPHC Secretariat)	✓ 21 September 2018 ✓ 18 October 2018
IPHC-2018-MSAB012-04	Update on the actions arising from the 10th Session of the MSAB (MSAB011) (IPHC Secretariat)	✓ 21 September 2018
IPHC-2018-MSAB012-05	Outcomes of the 12th Session of the IPHC Scientific Review Board (SRB012) (IPHC Secretariat)	✓ 16 October 2018
IPHC-2018-MSAB012-06	Goals, Objectives, and Performance Metrics for the IPHC Management Strategy Evaluation (MSE) (A. Hicks)	✓ 21 September 2018
IPHC-2018-MSAB012-07 Rev_1	IPHC Management Strategy Evaluation to Investigate Fishing Intensity (A. Hicks & I. Stewart)	✓ 22 September 2018 ✓ 16 October 2018
IPHC-2018-MSAB012-08	Ideas on estimating stock distribution and distributing catch for Pacific halibut fisheries (A. Hicks & I. Stewart)	✓ 22 September 2018
IPHC-2018-MSAB012-09	IPHC Secretariat Program of Work for MSAB Related Activities 2019-23 (A. Hicks)	✓ 21 September 2018
Information papers		
Nil	Nil	Nil

APPENDIX IV
MSAB MEMBERSHIP

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	Vacant	CDN Commercial			
4	Vacant	CDN Commercial			
5	Gabrys, Bruce		USA Commercial	9-May-17	8-May-21
6	Kauffman, Jeff		USA Commercial	9-May-17	8-May-19
7	Odegaard, Per		USA Commercial	9-May-17	8-May-21
8	Falvey, Dan		USA Commercial	9-May-17	8-May-21
First Nations/ Tribal fisheries (2-4)					
1	Lane, Jim	CDN First Nations		9-May-17	8-May-21
2	Vacant	CDN First Nations			
3	Mazzone, Scott		USA Treaty Tribes	9-May-17	8-May-19
4	Damiano, Matt		USA Treaty Tribes	20-Jun-18	19-Jun-22
Government Agencies (4-8)					
1	Keizer, Adam	DFO		9-May-17	08-May-19
2	Huang, Ann-Marie	CDN Science Advisor		10-May-18	09-May-22
3	Vacant	DFO			
4	Merrill, Glenn		NOAA-Fisheries	7-May-18	06-May-22
5	McGilliard, Carey		USA Science Advisor	9-May-17	08-May-21
6	Culver, Michele		PFMC	9-May-17	08-May-21
7	Cross, Craig		NPFMC	9-May-17	08-May-21
8	Hasbrouck, James		ADFG	12-Oct-18	11-Oct-22
Processors (2-4)					
1	Parker, Peggy	US/CDN Processing	US/CDN Processing	9-May-17	08-May-19
2	Mirau, Brad	CDN Processing		9-May-17	08-May-19
3	Morelli, Joseph		USA Processing	29-Aug-18	28-Aug-22
4	Vacant		CDN Processing		
Recreational/ Sport fisheries (2-4)					
1	Paish, Martin	CDN Sport Fishing Advisory Board		9-May-17	08-May-21
2	Marking, Tom		USA Sport fishing (CA)	9-May-17	08-May-19

Membership category	Member	Canada	U.S.A.	Current Term commence-ment	Current Term expiration
3	Vacant		USA sportfishing (AK)		
4	Vacant		Open		

APPENDIX VA
PRIMARY OBJECTIVES AND ASSOCIATED PERFORMANCE METRICS

Primary objectives for the evaluation of Management Procedures (MPs) on coastwide scale

GENERAL OBJECTIVE	MEASURABLE OBJECTIVE	MEASURABLE OUTCOME	TIME-FRAME	TOLERANCE	PERFORMANCE METRIC
1.1. KEEP BIOMASS ABOVE A LIMIT TO AVOID CRITICAL STOCK SIZES Biomass Limit	Maintain a minimum female spawning stock biomass above a biomass limit reference point at least 90% of the time	*SB* < Spawning Biomass Limit (SB_{Lim}) SB_{Lim}=20% spawning biomass	*Long-term*	0.10	$P(SB < SB_{Lim})$
2.1. LIMIT CATCH VARIABILITY	Limit annual changes in the coastwide TCEY	Average Annual Variability (*AAV*) > 15%	Short-term	0.25	$P(AAV > 15\%)$
2.2. MAXIMIZE DIRECTED FISHING YIELD	*Maximize average TCEY coastwide*	*Median coastwide TCEY*	*Short-term*	*STATISTIC OF INTEREST*	$Median\ \overline{TCEY}$

APPENDIX VB
ADDITONAL OBJECTIVES AND ASSOCIATED PERFORMANCE METRICS

GOAL: Biological Sustainability

GENERAL OBJECTIVE	MEASURABLE OBJECTIVE	MEASURABLE OUTCOME	TIME-FRAME	TOLERANCE	PERFORMANCE METRIC
REPORT A METRIC THAT IS BASED ON NUMBERS OF PACIFIC HALIBUT	*An absolute measure*	*Number of mature female halibut*	*Long-term*	*STATISTIC OF INTEREST*	*Median Number of Mature Females*
REPORT A METRIC INDICATING THE SPAWNING BIOMASS EXPECTED TO BE ABOVE 50% OF THE TIME (I.E., AN IMPLIED TARGET)	*An absolute measure*	*Spawning Biomass*	*Long-term*	*STATISTIC OF INTEREST*	*Median* $\overline{SB}$
REPORT A METRIC THAT GIVES AN INDICATION HOW OFTEN THE BIOMASS IS BELOW THE FISHERY TRIGGER	*Maintain a biomass that is above the biomass limit and not on the ramp a high percentage of the time*	*B* < Spawning Biomass Limit (Fishery Trigger) Fishery Trigger=30% spawning biomass	*Long-term*	*STATISTIC OF INTEREST*	$P(SB < Fish_{Trig})$
CONSERVE SPATIAL POPULATION STRUCTURE					

GOAL: Optimize directed fishing opportunities.

General Objective	Measurable Objective	Measurable Outcome	Time-frame	Tolerance	Performance Metric
2.1. Limit Catch Variability	Limit annual changes in the coastwide TCEY	*AAV*	*Long-term*	*STATISTIC OF INTEREST*	*AAV and variability*
		Change in TCEY > 15% in any year	*Short-term*	*STATISTIC OF INTEREST*	$\frac{TCEY_{i+1} - TCEY_i}{TCEY_i}$
	Limit annual changes in the TCEY for each Regulatory Area	Average Annual Variability by Regulatory Area (AAV_A) > 15%	Long-term	0.25	$P(AAV > 15\%)$
		AAV_A	*Long-term*	*STATISTIC OF INTEREST*	*AAV and variability*
		Change in TCEY by Regulatory Area > 15% in any year	*Short-term*	*STATISTIC OF INTEREST*	$\frac{TCEY_{i+1} - TCEY_i}{TCEY_i}$
	Gain insight into the additional variability in the TCEY when on the ramp	*AAV while on the ramp*	*Long-term*	*STATISTIC OF INTEREST*	*AAV given estimated SB <* SB_{Trig}
		Percent of time "on the ramp" (estimated stock status is below the fishery trigger; SB_{trig}*)* SB_{Trig} *to be evaluated (e.g., 30% or 40%)*	*Long-term*	*STATISTIC OF INTEREST*	$P(\widehat{SB} < SB_{Trig})$

General Objective	Measurable Objective	Measurable Outcome	Time-frame	Tolerance	Performance Metric
2.2. Maximize Directed Fishing Yield	Maintain TCEY above a minimum level coastwide	Coastwide TCEY < $TCEY_{min}$	Long-term Short-term	?? ??	$P(TCEY < TCEY_{min})$
	Maximize high yield (TCEY) opportunities coastwide	*Coastwide TCEY > 50.6 Mlbs (70% of 1993-2012 average)*	*Long-term* *Short-term*	*STATISTIC OF INTEREST*	$P(TCEY < 50.6\ Mlbs)$
	Present the range of coastwide TCEY that would be expected	*Range of coastwide TCEY*	*Long-term* *Short-term*	*STATISTIC OF INTEREST*	*5th and 75th percentiles of TCEY*
	Maximize average TCEY by Regulatory Area	*Median coastwide TCEY*	*Long-term* *Short-term*	*STATISTIC OF INTEREST*	*Median* $\overline{TCEY}$
	Maintain TCEY above a minimum level by Regulatory Area	$TCEY_A < TCEY_{A,min}$	Long-term Short-term	?? ??	$P(TCEY < TCEY_{min})$
	Maximize high yield (TCEY) opportunities by Regulatory Area	*$TCEY_A$ > 50.6 Mlbs (70% of 1993-2012 average)*	*Long-term* *Short-term*	*STATISTIC OF INTEREST*	$P(TCEY < 50.6\ Mlbs)$
	Present the range of TCEY by Regulatory Area that would be expected	*Range of TCEY by Regulatory Area*	*Long-term* *Short-term*	*STATISTIC OF INTEREST*	*5th and 75th percentiles of TCEY*
Minimize potential for no catch limit for the directed commercial fishery	*Minimize fishery closures*	*Directed commercial allocation = 0*	*Long-term* *Short-term*	*STATISTIC OF INTEREST*	*P(Directed Mort = 0)*

GOAL: Minimize Discard Mortality

GENERAL OBJECTIVE	MEASURABLE OBJECTIVE	MEASURABLE OUTCOME	TIME-FRAME	TOLERANCE	PERFORMANCE METRICS
3.1. HARVEST EFFICIENCY	Discard mortality is a small percentage of the longline fishery annual catch limit	>10% of annual catch limit	Long-term Short-term	0.25	$P(DM > 10\% FCEY)$
ABSOLUTE MEASURE	*Absolute*	*Discard Mortality (DM)*	*Long-term* *Short-term*	***NA***	*Median* $\overline{DM}$

GOAL: Minimize Bycatch Mortality

GENERAL OBJECTIVE	MEASURABLE OBJECTIVE	MEASURABLE OUTCOME	TIME-FRAME	TOLERANCE	PERFORMANCE METRICS

APPENDIX VI
MSE PROGRAM OF WORK (2019-23)

May 2018 MSAB Meeting
Review Goals
Look at results of SPR
Review Performance Metrics
Identify Scale MP's
Review Framework
Identify Preliminary Distribution MP's
October 2018 MSAB Meeting
Review Goals
Complete results of SPR
Review Performance Metrics
Identify Scale MP's
Verify Framework
Identify Distribution MP's
Annual Meeting 2019
Recommendation on Scale Present possible distribution MP's
May 2019 MSAB Meeting
Evaluate additional Scale MP's
Review Goals
Spatial Model Complexity
Identify MP's (Distn Scale)
Review Framework
October 2019 MSAB Meeting
Review Goals
Spatial Model Complexity
Identify MP's (Distn Scale)
Review Framework
Review multi-area model development
Annual Meeting 2020
Update on progress
May 2020 MSAB Meeting
Review Goals
Review multi-area model
Review preliminary results
October 2020 MSAB Meeting
Review Goals
Review preliminary results
Annual Meeting 2021
Presentation of first complete MSE product to the Commission Recommendations on Scale and Distribution MP

APPENDIX VII
CONSOLIDATED SET OF RECOMMENDATIONS AND REQUESTS OF THE 12TH SESSION OF THE IPHC MANAGEMENT STRATEGY ADVISORY BOARD (MSAB012)

RECOMMENDATIONS

A review of the goals and objectives of the IPHC MSE process

MSAB012–Rec.01 (para. 20) The MSAB **NOTED** the refined objectives provided by the ad-hoc working group (contained in paper IPHC-2018-MSAB012-06), and **RECOMMENDED** prioritizing a single conservation objective over fishery measurable objectives (Table 1).

Table 1. Priority objectives phrased as measurable outcomes used to evaluate MSE results. The first objective is prioritized over the others.

MEASURABLE OUTCOME	TIME-FRAME	TOLERANCE
SB < Spawning Biomass Limit (SB_{Lim}) SB_{Lim}=20% spawning biomass	Long-term	0.10
Relative AAV	Short-term	
Average Annual Variability (AAV) > 15%	Short-term	0.25
Maximize average TCEY coastwide	Short-term	

Performance metrics for evaluation

MSAB012–Rec.02 (para. 24) The MSAB **RECOMMENDED** that performance-metrics for the short-term span 4-13 years, medium-term span 14-23 years, and the long-term span 91-100 years, be reported to understand how the management procedures may rank differently in the different periods of the forward simulations.

Closed-loop simulation results to investigate coastwide fishing intensity

MSAB012–Rec.03 (para. 37) The MSAB **RECOMMENDED** that a coastwide fishing intensity SPR should not be lower than 40% nor higher than 46%, with a target SPR of 42%-43% with a 30:20 HCR. Rationale for this recommendation is provided in paragraph 38.

REQUESTS

A review of the goals and objectives of the IPHC MSE process

MSAB012–Req.01 (para. 21) The MSAB **AGREED** that statistics of interest are useful when evaluating management procedures and **REQUESTED** that they continue to be reported.

Performance metrics for evaluation

MSAB012–Req.02 (para. 23) The MSAB **REQUESTED** that the same metrics are calculated for the recreational sector as are calculated for the commercial sector and be reported for subsequent evaluations.

Closed-loop simulation results to investigate coastwide fishing intensity

MSAB012–Req.03 (para. 40) The MSAB **REQUESTED** that additional MPs components be considered to meet the objective of catch stability. The IPHC Secretariat may consider the following MPs, but is **ENCOURAGED** to explore other options to report at MSAB013.

a) 25:10 control rule, and other control rules, as possible, potentially including 30:10 and 30:15 and 30:20;

b) Multi-year quotas, defined as setting the TCEY in one year and sticking with the same TCEY in one or more following years, noting that AAV may not be an appropriate metric to measure variability;

c) Limiting change in catch limits from the previous year to +/-15% per year, in addition to other relevant percentages, with the goal of finding MPs that meet the main objectives;

d) Limiting change in catch limits from the previous year to a maximum increase of 15% per year with no limit on decreasing the catch limit;

e) Slow up (33% of the change in TCEY), fast down (-50% of the change in TCEY).

MSAB012–Req.04 (para. 43) The MSAB **REQUESTED** that the IPHC Secretariat provide a report at MSAB013 of IPHC research and other relevant research (to the extent possible) activities related to relationships between population dynamics and environmental conditions, noting that the IPHC 5-year research plan is available on the IPHC website, to aid in the discussion of hypotheses that are plausible to include in the MSE process.

Identify preliminary MPs related to distribution

MSAB012–Req.05 (para. 54) The MSAB **REQUESTED** that an additional management procedure be considered to define allocations and a catch limit floor that reduces catch limits in a stair-step manner during times of large abundance changes.

MSAB012–Req.06 (para. 55) The MSAB **REQUESTED** that the IPHC Secretariat and the MSAB continue to develop the concept of a 'fishery footprint', as previously considered in the 2015 IPHC Report of Assessment and Research Activities, page 238, in part to consider how it may be incorporated into a MP.