INTERNATIONAL PACIFIC HALIBUT COMMISSION

IPHC–2026–RAB027–00
Last Update: 5 November 2026

27th Session of the IPHC Research Advisory Board (RAB027) – *Compendium of meeting documents*

17-18 November 2026, Seattle, WA, USA

Commissioners

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AGENDA FOR THE 27th SESSION OF THE IPHC RESEARCH ADVISORY BOARD (RAB027)

Date: 17-18 November 2026
Location: Seattle, Washington, USA
Venue: IPHC HQ office
Time: 17th: 09:00-16:00; 18th: 09:00-12:00
Chairperson: Dr David T. Wilson (Executive Director)
Vice-Chairperson: Dr Josep V. Planas (Biological & Ecosystem Sciences Branch Manager)

1. **OPENING OF THE SESSION** (Chairperson)
2. **ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION** (Chairperson)
3. **IPHC PROCESS** (Chairperson)
   - 3.1 Update on the actions arising from the 26th Session of the RAB (RAB026)
   - 3.2 Outcomes of the 102nd Session of the IPHC Annual Meeting (AM102)
4. **SEASON OVERVIEW – 2026: RAB MEMBERS**
5. **INTERNATIONAL PACIFIC HALIBUT COMMISSION INTEGRATED RESEARCH AND MONITORING PLAN**

   5.1 RESEARCH

   5.1.1 Biology and ecology

   - Description of IPHC Biological and Ecosystem Sciences Research (Core research streams)

   5.2 MONITORING

   5.2.1 Fishery-dependent data

   5.2.2 Fishery-independent data

   - 2026 FISS season: Design and implementation (K. Ualesi)
   - IPHC Fishery-Independent Setline Survey (FISS)
     - 2027-29 FISS design evaluation (R. Webster)
6. **GUIDANCE ON, AND DISCUSSION OF, OTHER POTENTIAL APPLIED RESEARCH PROJECTS** (Chairperson & Vice-Chairperson)
7. **OTHER BUSINESS**
8. **REVIEW OF THE DRAFT AND ADOPTION OF THE REPORT OF THE 27th SESSION OF THE IPHC RESEARCH ADVISORY BOARD (RAB027)** (Chairperson)

SCHEDULE FOR THE 27th SESSION OF THE IPHC RESEARCH ADVISORY BOARD (RAB027)

Tuesday, 17 November 2026		
Time	**Agenda item**	**Lead**
09:00-09:05	1. Opening of the Session	D. Wilson
09:05-09:15	2. Adoption of the agenda and arrangements for the Session	D. Wilson
09:15-09:30	3. IPHC Process	D. Wilson
09:30-10:30	4. Season overview: RAB members	RAB Members
10:30-10:45	Break	
10:45-10:55	5. International Pacific Halibut Commission Integrated Research and Monitoring Plan	D. Wilson
10:55-11:40	5.1 Research: Biology and Ecology - Description of IPHC Biological and Ecosystem Sciences Research (Core research streams)	J. Planas & Project leaders
11:40-12:30	5.2 Monitoring: 5.2.1 Fishery-dependent data 5.2.2 Fishery-independent data • 2026 FISS season: Design and implementation • IPHC Fishery-Independent Setline Survey (FISS) – 2027-29 FISS design evaluation	B. Hutniczak K. Ualesi R. Webster
12:30-13:30	Lunch	
13:30-16:00	6. Guidance on, and discussion of, other potential applied research projects	RAB Members
16:30-21:00	RAB Function/dinner	All
Wednesday, 18 November 2026		
Time	**Agenda item**	**Lead**
09:00-10:15	Guidance on, and discussion of, other potential applied research projects (cont.)	RAB Members
10:15-10:30	7. Other business	D. Wilson
10:30-10:45	Break	
10:45-12:00	8. Review of the draft and adoption of the report of the 27th Session of the IPHC Research Advisory Board (RAB027)	D. Wilson
12:00-13:00	Lunch and Departure	

LIST OF DOCUMENTS FOR THE 27th SESSION OF THE IPHC RESEARCH ADVISORY BOARD (RAB027)

LAST UPDATED: 5 NOVEMBER 2026

Document	Title	Availability
IPHC-2026-RAB027-01	Agenda & Schedule for the 27th Session of the IPHC Research Advisory Board (RAB027)	✓ 16 Dec 2025 ✓ 17 Oct 2026
IPHC-2026-RAB027-02	List of Documents for the 27th Session of the IPHC Research Advisory Board (RAB027)	✓ 16 Dec 2025 ✓ 23 Oct 2026 ✓ 5 Nov 2026
IPHC-2026-RAB027-03	Update on the actions arising from the 26th Session of the RAB (RAB026) (D. Wilson & J. Planas)	✓ 17 Oct 2026
IPHC-2026-RAB027-04	Outcomes of the 102nd Session of the IPHC Annual Meeting (AM102) (D. Wilson)	✓ 16 Oct 2026
IPHC-2026-RAB027-05	International Pacific Halibut Commission Integrated Research and Monitoring Plan (D. Wilson)	✓ 16 Oct 2026
IPHC-2026-RAB027-06	Report on current and future biological and ecosystem science research activities (J. Planas, C. Dykstra, A. Jasonowicz, C. Jones)	✓ 14 Oct 2026
IPHC-2026-RAB027-07 Rev_1	IPHC Fishery-independent setline survey (FISS) design and implementation in 2026 (K. Ualesi, T. Jack, K. Coll, C. Skalley)	✓ 16 Oct 2026 ✓ 5 Nov 2026
IPHC-2026-RAB027-08	2027-29 FISS designs (R. Webster, I. Stewart, K. Ualesi, & D. Wilson)	✓ 17 Oct 2026
Information papers		
IPHC-2026-RAB027-INF01	Preliminary assessment of sand flea prevalence in Pacific halibut commercial fisheries (B. Hutniczak)	✓ 23 Oct 2026

Update on actions arising from the 26th Session of the IPHC Research Advisory Board (RAB026)

PREPARED BY: IPHC SECRETARIAT (D. WILSON & J. PLANAS; 17 OCTOBER 2026)

PURPOSE

To provide the RAB with an opportunity to consider the progress made during the inter-sessional period, in relation to the recommendations and requests of the 26th Session of the IPHC Research Advisory Board (RAB026).

BACKGROUND

At the previous RAB meeting, a series of actions were agreed upon for implementation by the IPHC Secretariat. These action items and progress made on their implementation are 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 RAB, as well as including clear progress updates and document reference numbers.

RECOMMENDATIONS

That the RAB:

1) **NOTE** paper IPHC-2026-RAB027-03, that provided the RAB with an opportunity to consider the progress made during the inter-sessional period, in relation to the recommendations and requests of the 26th Session of the IPHC Research Advisory Board (RAB026).
2) **AGREE** to consider and revise as necessary the actions, and for these to be combined with any new actions arising from RAB027.

APPENDICES

Appendix A: Update on actions arising from the 26th IPHC Research Advisory Board (RAB027)

APPENDIX A

Update on actions arising from the 26th Session of the Research Advisory Board (RAB026)

Action No.	Description	Update
	RECOMMENDATIONS	
RAB026-Rec.01 (para. 18)	***Reproductive assessment of the female Pacific halibut population*** The RAB **RECOMMENDED** prioritising fecundity estimations to determine the relationship between Pacific halibut female weight and total egg production.	In Progress: Update: Special collection of fecundity samples has been completed, and a method for estimating fecundity in female Pacific halibut is being developed
RAB026-Rec.02 (para. 33)	***Guidance on, and discussion of, other potential applied research projects*** **NOTING** recent issues identified regarding the alleged illegal retention and landing of Pacific halibut by non-target sectors for processing into fishmeal (e.g. the Kodiak trawl fleet; https://www.northernjournal.com/alaska-troopers-seize-kodiak-trawl-groups-electronics-in-bycatch-probe/), the RAB **RECOMMENDED** that: a) the IPHC undertake an information gathering effort to document, explore via communications with enforcement entities engaged on the issue, so that the IPHC has a clear indication of what is being removed, and the likely impacts on the Pacific halibut resource. b) as an affected party, the RAB would like the IPHC to be kept in the loop of any penalties that may be applied, so that a portion be requested and used to subsidise the annual FISS. c) the gathered information should be summarised and provided as an information paper to the Annual Meeting and appropriate subsidiary bodies.	Completed Update: This issue was raised at the North Pacific Fisheries Management Council (NPFMC). On 5 June the Council passed a motion asking staff to prepare a regulatory amendment to clarify conflicting rules on disposing of prohibited species catch (PSC) that has already been landed. In addition, Jon Kurland, NOAA Alaska Region Administrator, sent a letter to the Council (13 March 2026) clarifying what is permissible under applicable regulations. A PSC disposition discussion paper, originally scheduled for October, has been postponed to the December 2026 Council meeting. Update on actions will

Action No.	Description	Update
		be provided in the Secretariat Report (IPHC-2027-AM103-04). Separately, the Council received an application for Exempted Fishing Permit (EFP) from Sea Share, Inc. & Glacier Fish Co. to trial donating Pacific halibut from a trawl catcher/processor.
RAB026-Rec.03 (para. 34)	**NOTING** the importance of accurate accounting for all sources of mortality from the Pacific halibut stock, and concerns about the accuracy of the estimates for the unguided recreational fisheries in Alaska and Canada, the RAB **RECOMMENDED** that the Secretariat first summarise the information received from Contracting Parties through the annual reporting process, and that the Commission request additional detail on the methods used to derive estimates of unguided removals, including the potential sources of bias and uncertainty in those estimates.	Completed Update: Details on the estimation methods are available annually in the Contracting Party National Reports. In particular, the issue that unguided harvest in Regulatory Area 2C was not accurately predicted was noted, at the Secretariat's request, in IPHC-2026-AM102-NR02-Rev_1.
REQUESTS		
RAB026-Req.01 (para. 28)	***Guidance on, and Discussion of, other Potential Applied Research Projects*** The RAB **REQUESTED** that the IPHC Secretariat continue investigations on Pacific halibut female maturity at age in different Biological Regions.	Completed & Ongoing Update: Continuing studies investigating temporal and spatial changes in histology-based maturity from 2022 to 2024, the IPHC Secretariat is conducting analyses of maturity at age from all four Biological Regions in 2025.

Action No.	Description	Update
RAB026-Req.02 (para. 29)	The RAB **REQUESTED** that the IPHC Secretariat set up efforts to increase documentation of sand flea occurrence during commercial fishing activities by encouraging fishing vessels to report such occurrences in logbooks, and to also relay this information to IPHC Fisheries Data Specialists (Field).	Completed & Ongoing Update: Data collection in commercial fishing sector commenced in 2026 as a trial. Update will be provided as IPHC-2026-RAB027-INF01.
RAB026-Req.03 (para. 30)	The RAB **REQUESTED** that the IPHC Secretariat collate and potentially analyse FISS data on sandflea prevalence.	Completed Update: See paper **IPHC-2026-RAB027-INF01**.
RAB026-Req.04 (para. 31)	The RAB **REQUESTED** that the IPHC Secretariat continue investigations on Pacific halibut juvenile stages, including the mapping of juvenile habitat throughout IPHC Convention Waters.	In Progress: Update: The IPHC Secretariat is continuing to analyze historical data on the presence and absence of juvenile Pacific halibut in shallow waters off Alaska
RAB026-Req.05 (para. 32)	The RAB **REQUESTED** that the IPHC Secretariat collect information on catch rates during openers of the Pacific halibut directed fishery in IPHC Regulatory Area 2A in relation to previous trawling activities in Pacific halibut fishing grounds.	Pending Update: yet to commence due to competing priorities.
RAB026-Req.06 (para. 35)	The RAB **REQUESTED** that the IPHC Secretariat continue to collaborate with industry on a range of research projects, noting the recent successful collaborations involving the catch-protection study. This could include facilitating the application and further innovation of catch protection devices by the commercial fishery.	Completed & Ongoing Update: This is an ongoing activity based on Commission priorities and funding, both internal and external.
RAB026-Req.07 (para. 36)	The RAB **REQUESTED** the consideration of an investigation of a floor coastwide mortality limit (e.g. a minimum Total Constant Exploitation Yield (TCEY)) be conducted as part of the MSE process to understand potential risks to the Pacific halibut stock and fisheries for this type of management procedure.	Pending Update: yet to commence due to competing priorities.

OUTCOMES OF THE 102ND SESSION OF THE IPHC ANNUAL MEETING (AM102)

PREPARED BY: IPHC SECRETARIAT (D. WILSON, 16 OCTOBER 2026)

PURPOSE

To provide the RAB with the outcomes of the 102nd Session of the IPHC Annual Meeting (AM102), relevant to the mandate of the RAB.

BACKGROUND

The agenda of the Commission's Annual Meeting (AM102) included several agenda items relevant to the RAB.

DISCUSSION

During the course of the 102nd Session of the IPHC Annual Meeting (AM102) the Commission made a number of specific recommendations and requests for action regarding the actions arising from the RAB026, and Fishery Regulations for 2026. Relevant sections from the report of the meeting are provided in Appendix A for the RAB's consideration.

RECOMMENDATION

That the RAB:

1) **NOTE** paper IPHC-2026-RAB027-04 which details the outcomes of the 102nd Session of the IPHC Annual Meeting (AM102), relevant to the mandate of the RAB.

APPENDICES

Appendix A: Excerpts from the 102nd Session of the IPHC Annual Meeting (AM102) Report (IPHC-2026-AM102-R).

APPENDIX A
Excerpts from the 102nd Session of the IPHC Annual Meeting (AM102) Report
(IPHC-2026-AM102-R)

RECOMMENDATIONS

Nil

REQUESTS

IPHC Fishery Regulations: Recreational (Sport) Fishing for Pacific Halibut - IPHC Regulatory Areas 2C, 3A, 3B, 4A, 4B, 4C, 4D, 4E (Sect. 28) – unguided sector bag limit

AM102–Req.01 (para. 93) The Commission **REQUESTED** that the Secretariat send a letter to the North Pacific Fishery Management Council transmitting copies of regulatory proposals C1 and C3 for the Council's awareness and consideration. The letter should inform the Council that the expansion of the unguided recreational harvest in Alaska prompted considerable feedback from IPHC stakeholders. In 2025 the final unguided harvest and removal estimate in Area 2C was 1.445 Mlb, compared to the preliminary removal estimate of 0.992 Mlb, and the increase is understood to be driven by growing harvest by anglers fishing from unguided rental boats. This poses both management and allocative concerns, particularly in light of the current low abundance of the halibut resource. Given the Council's important role in these matters, the Council may wish to consider measures to improve management and catch data collection for the unguided recreational sector of the Pacific halibut fishery.

OTHER

Report of the IPHC Research Advisory Board (RAB)

(para. 15) The Commission **NOTED** the RAB recommendation (RAB026-Rec.02 (para. 33a)), regarding "*alleged illegal retention and landing of Pacific halibut by non-target sectors for processing into fishmeal (e.g. the Kodiak trawl fleet)*" and that this refers to a recent Alaska Wildlife Troopers investigation involving vessels in the Trawl Electronic Monitoring (EM) program.

(para. 16) The Commission **NOTED** the indication from the USA, that pelagic pollock catcher vessels in the EM program (51 out of 52 vessels in the Gulf of Alaska), 100% of the catch is observed via EM and accounted for at the time of delivery, and the data for any caught Pacific halibut are accurately reported to the IPHC, and that there are no Pacific halibut accounting concerns. The RAB was advised of this during the RAB026 meeting; however, members requested that this recommendation be included in the meeting report.

IPHC FISHERY REGULATIONS 2026

IPHC Fishery Regulations: Mortality and Fishery Limits (Sect. 5)

(para. 81) The Commission **ADOPTED** fishery regulation proposal IPHC-2026-AM102-PropA1, that provided the mortality and fishery limits framework for population at the AM102 (Appendix VIII). *[Canada/USA: In favour=2; against=0; abstain=0; absent=1; USA: In favour=3; against=0; abstain=0; absent=0]*

(para. 82) The Commission **ADOPTED** the distributed mortality limits for each Contracting Party, by IPHC Regulatory Area (Table 5), and sector, as provided for in Appendix VIII. *[Canada/USA: In favour=2; against=0; abstain=0; absent=1; USA: In favour=3; against=0; abstain=0; absent=0]*

Table 5. Adopted TCEY mortality limits for 2026

Contracting Party IPHC Regulatory Area	Mortality limit (TCEY) (mlbs)	Mortality limit (TCEY) (metric tonnes)	% change from 2025
Canada Total: 2B	**5.06**	**2,295**	**-7.2%**
USA: 2A	1.65	748	0.0%
USA: 2C	5.22	2,368	0.0%
USA: 3A	9.08	4,119	0.0%
USA: 3B	2.86	1,297	0.0%
USA: 4A	1.34	608	0.0%
USA: 4B	1.04	472	0.0%
USA: 4CDE	3.08	1,397	0.0%
United States of America Total	**24.27**	**11,009**	**0.0%**
Total (IPHC Convention Area)	**29.33**	**13,304**	**-1.3%**

IPHC Fishery Regulations: Commercial Fishing Periods (Sect. 9)

(para. 87) The Commission **ADOPTED** fishery regulation proposal IPHC-2026-AM102-PropA2, that provided the framework for setting fishing periods for the commercial Pacific halibut fisheries. *[Canada/USA: In favour=2; against=0; abstain=0; absent=1; USA: In favour=3; against=0; abstain=0; absent=0]*

Commercial fishing periods

(para. 88) The Commission **ADOPTED** fishing periods for 2026 as provided below, thereby superseding the relevant portions of Section 9 of the IPHC Pacific halibut fishery regulations (Appendix IX) by specifying that commercial fishing for Pacific halibut in all IPHC Regulatory Areas may begin no earlier than 06:00 hrs local time on 26 March 2026 and must cease at 23:59 hrs local time on 7 December 2026. *[Canada/USA: In favour=2; against=0; abstain=0; absent=1; USA: In favour=3; against=0; abstain=0; absent=0]*

IPHC Fishery Regulations: Recreational (Sport) Fishing for Pacific Halibut – IPHC Regulatory Areas 2C, 3A, 3B, 4A, 4B, 4C, 4D, 4E (Sect. 28) (Charter Management Measures in IPHC Regulatory Areas 2C and 3A (USA))

(para. 89) The Commission **ADOPTED** fishery regulation proposal IPHC-2026-AM102-PropB1, that included charter management measures in IPHC Regulatory Areas 2C and 3A reflective of mortality limits adopted by the IPHC and resulting allocations under the North Pacific Fisheries Management Council's (NPFMC) Pacific halibut Catch Sharing Plan (Appendix X). *[Canada/USA: In favour=2; against=0; abstain=0; absent=1; USA: In favour=3; against=0; abstain=0; absent=0]*

IPHC Fishery Regulations: Recreational (Sport) Fishing for Pacific Halibut - IPHC Regulatory Area 2B (Sect. 28) - Daily bag limit in IPHC Regulatory Area 2B (Canada)

(para. 90) The Commission **ADOPTED** fishery regulation proposal IPHC-2026-AM102-PropB2, with an amendment to limit the application to one (1) year. PropB2 proposed a daily bag limit of up to three fish per day per person in the recreational fishery in IPHC Regulatory Area 2B beginning on or after 1 August of each year. This provision shall remain in effect through 2026, unless extended by a vote of the Commission (Appendix XI). *[Canada/USA: In favour=2; against=0; abstain=0; absent=1; USA: In favour=3; against=0; abstain=0; absent=0]*

IPHC Fishery Regulations: Recreational (Sport) Fishing for Pacific Halibut - IPHC Regulatory Area 2A – Season opening dates for recreational fishery subareas within IPHC Regulatory Area 2A (USA)

(para. 91) The Commission **ADOPTED** fishery regulation proposal IPHC-2026-AM102-PropB3, that proposed opening the 2026 Regulatory Area 2A recreational fishery in the Convention waters of the Washington Puget Sound and the U.S.A. Convention waters in the Strait of Juan de Fuca subarea and in the Convention Waters off the California subareas on 2 April and on 1 April (Appendix XII) *[Canada/USA: In favour=2; against=0; abstain=0; absent=1; USA: In favour=3; against=0; abstain=0; absent=0]*

IPHC Fishery Regulations: Commercial Fishing Periods (Sect. 9) – limited retention outside the commercial fishing period in IPHC Regulatory Area 2B (R. Hauknes)

(para. 94) The Commission **ADOPTED** fishery regulation proposal IPHC-2026-AM102-PropC2, with an amendment to limit the application to one (1) year. PropC2 proposed a three-year pilot program authorising limited retention of legal-sized Pacific halibut caught incidentally as bycatch outside the Pacific halibut commercial fishing period in year-round hook & line and trap groundfish fisheries in IPHC Regulatory Area 2B (Canada). As explicit regulatory language was not provided with the proposal, the Secretariat and Fisheries and Oceans Canada will convene in the coming days to develop specific regulatory language prior to the IPHC Fishery Regulations being finalized for implementation and enforcement. This measure will be applicable for a period of one (1) year, unless extended by a vote of the Commission. *[Canada/USA: In favour=2; against=0; abstain=0; absent=1; USA: In favour=3; against=0; abstain=0; absent=0]*

INTERNATIONAL PACIFIC HALIBUT COMMISSION INTEGRATED RESEARCH AND MONITORING PLAN

PREPARED BY: IPHC SECRETARIAT (D. WILSON; 16 OCTOBER 2026)

PURPOSE

To provide the RAB with the Integrated Research and Monitoring Plan, and iterative review and revision process moving forward.

BACKGROUND

Recalling that:

a) the IPHC Secretariat conducts activities to address key issues identified by the Commission, its subsidiary bodies, the broader stakeholder community, and the IPHC Secretariat;

b) the process of identifying, developing, and implementing the IPHC's science-based activities involves several steps that are circular and iterative in nature, but result in clear project activities and associated deliverables;

c) the process includes developing and proposing projects based on direct input from the Commission, the experience of the IPHC Secretariat given its broad understanding of the resource and its associated fisheries, and concurrent consideration by relevant IPHC subsidiary bodies, and where deemed necessary, including by the Commission, additional external peer review;

Also recalling that an overarching goal of the IPHC's Integrated Research and Monitoring Plans are to promote integration and synergies among the various research and monitoring activities of the IPHC Secretariat in order to improve knowledge of key inputs into the Pacific halibut stock assessment, and Management Strategy Evaluation (MSE) processes, thereby providing the best possible advice for management decision making processes.

The 1st iteration of the Plan was formally presented to the Commission at IM097 in November 2021 (IPHC-2021-IM097-12) for general awareness of the documents ongoing development. At the 98th Session of the IPHC Annual Meeting (AM098) in January 2022, the Commission requested a number of amendments which were subsequently incorporated.

In 2023 and 2024, the plan went through two cycles of review and improvement with the SRB, with amendments being suggested and incorporated accordingly.

The current plan, dated 17 March 2026, is provided at the following link for reference: https://www.iphc.int/uploads/2026/03/IPHC-2026-IRMP-17-March-2026-v1.pdf, and also at **Appendix A**.

DISCUSSION

The RAB should note that:

a) the intention is to ensure that the next plan is kept as a '*living plan*', and is reviewed and updated annually based on the resources available to undertake the work of the Commission (e.g. internal and external fiscal resources, collaborations, internal expertise);

b) the plan focuses on core responsibilities of the Commission; and any redirection provided by the Commission;

c) each year the RAB may choose to recommend modifications to the current Plan, and that any modifications subsequently adopted by the Commission, would be documented both in the Plan itself, and through reporting back to the RAB.

RECOMMENDATION

That the RAB:

1) **NOTE** paper IPHC-2026-RAB027-05 that provides the Integrated Research and Monitoring Plan, and iterative review and revision process moving forward.

APPENDICES

Appendix A: IPHC-2026-IRMP: IPHC Integrated Research and Monitoring Plan (17 March 2026)

APPENDIX A

INTERNATIONAL PACIFIC HALIBUT COMMISSION INTEGRATED RESEARCH AND MONITORING PLAN (IRMP)

INTERNATIONAL PACIFIC HALIBUT COMMISSION

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BIBLIOGRAPHIC ENTRY

IPHC 2026. International Pacific Halibut Commission Integrated Research and Monitoring Plan. Seattle, WA, U.S.A. *IPHC–2026-IRMP, 51 pp.*



INTERNATIONAL PACIFIC HALIBUT COMMISSION

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ACRONYMS

AI	Artificial Intelligence
AM	Annual Meeting
CB	Conference Board
DMR	Discard Mortality Rate
FAC	Finance and Administration Committee
FISS	Fishery-Independent Setline Survey
FSC	First Nations Food, Social, and Ceremonial [fishery]
IM	Interim Meeting
IPHC	International Pacific Halibut Commission
IRMP	Integrated Research and Monitoring Plan
MP	Management Procedure
MSAB	Management Strategy Advisory Board
MSE	Management Strategy Evaluation
OM	Operating Model
PAB	Processor Advisory Board
PDO	Pacific Decadal Oscillation
QAQC	Quality assurance/quality control
RAB	Research Advisory Board
SHARC	Subsistence Halibut Registration Certificates
SRB	Scientific Review Board
TCEY	Total Constant Exploitation Yield
U.S.A.	United States of America
WM	Work Meeting

DEFINITIONS

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

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EXECUTIVE SUMMARY

An **overarching goal** of this current IPHC Integrated Research and Monitoring Plan (IRMP) is to continue to integrate all research activities of the IPHC Secretariat in order to improve the Pacific halibut stock assessment and MSE process and thereby provide the best possible advice for management decision-making processes. In doing so, the Plan also responds to emerging challenges and opportunities, including those presented by advances in artificial intelligence (AI), to enhance analytical capacity, improve efficiency, and support innovation across scientific and operational domains. The intention is no longer to designate the Plan for a defined period, but rather, to annually review and update the Plan as needed, based on resources available to the IPHC, as well as new Commission directives.

Along with the implementation of the short- and medium-term activities contemplated in this IRMP and in pursuit of the overarching goal, the IPHC Secretariat will also aim to:

1) undertake cutting-edge research programs in fisheries research in support of fisheries management of Pacific halibut;
2) undertake groundbreaking methodological research;
3) undertake applied research;
4) establish new collaborative agreements and interactions with research agencies and academic institutions;
5) promote the international involvement of the IPHC by continued and new participation in international scientific organisations and by leading international science and research collaborations.
6) effectively communicate IPHC research outcomes; and
7) incorporate talented students and early researchers in research activities.

The IPHC Secretariat has five (5) enduring strategic goals in executing our mission, including our overarching goal and associated science and research objectives, as articulated in our Strategic Plan (IPHC Strategic Plan (2023-27)):

1) To operate in accordance with international best practice;
2) Be a world leader in scientific excellence and science-based decision making;
3) To foster collaboration (within Contracting Parties and internationally) to enhance our science, monitoring, and management advice;
4) Create a vibrant IPHC culture; and
5) Set the standard for fisheries commissions globally.

Although priorities and tasking will change over time in response to events and developments, the Strategic Plan provides a framework to standardise our approach when revising or setting new priorities and tasking. The Strategic goals as they apply to the science and research activities of the IPHC Secretariat, are operationalised through a multi-year tactical activity matrix at the organisational and management unit (Branch) level (Fig. 3). The tactical activity matrix is described and has been developed based on the core needs of the Commission, in developing and implementing robust, scientifically-based management decisions on an annual, and multi-year level. Relevant IPHC subsidiary bodies will be involved in project development and ongoing review.

The Secretariat's success in implementing the IRMP will be measured according to the following criteria relevant to the stock assessment, the MSE, and for all inputs to IPHC management:

1) Timeliness – was the research conducted, analysed, published, and provided to the Commission at the appropriate points to be included in annual management decisions?
2) Accessibility – was the research published and presented in such a way that it was available to other scientists, stakeholders, and decision-makers?
3) Relevance - was the information used to inform decisions made by the Commission?
4) Impact – did the research improve the perceived accuracy of or provide a better estimate of the uncertainty associated with information for use in management?
5) Reliability - has research resulted in more consistent information provided to the Commission for decision-making.

As with the previous two (2) plans, the IPHC Secretariat intends to maintain this IRMP document as a 'living plan', subject to annual reviews and updates as necessary. Revisions will reflect evolving priorities, resources available to undertake the work (e.g. internal and external fiscal resources, collaborations, internal expertise), and emerging opportunities. The IPHC Secretariat remains committed to transparency and to upholding the principles of open science in the development and implementation of this plan.

1. Introduction

The International Pacific Halibut Commission (IPHC) is a public international organisation so designated via Presidential Executive Order 11059 and established by a Convention between Canada and the United States of America. The IPHC Convention was signed on 2 March 1923, ratified on 21 July 1924, and came into effect on 21 October 1924 upon exchange. The Convention has been revised several times since, to extend the Commission's authority and meet new conditions in the fishery. The most recent change occurred in 1979 and involved an amendment to the 1953 Halibut Convention. The 1979 amendment, termed a "protocol", was precipitated in 1976 by Canada and the United States of America extending their jurisdiction over fisheries resources to 200 miles. The 1979 Protocol, along with the U.S. legislation that gave effect to the Protocol (Northern Pacific Halibut Act of 1982), has affected the way the fisheries are conducted and redefined the role of IPHC in the management of the fishery. Canada does not require specific enabling legislation to implement the protocol.

The basic texts of the Commission are available on the IPHC website: https://www.iphc.int/the-commission, and prescribe the mission of the organisation as:

*"..... **to develop the stocks of [Pacific] halibut in the Convention waters to those levels which will permit the optimum yield from the fishery and to maintain the stocks at those levels**. ....." IPHC Convention*, Article I, sub-article I, para. 2). The IPHC Convention Area is detailed in Fig. 1.

The IPHC Secretariat, formed in support of the Commission's activities, is based in Seattle, WA, U.S.A. As its shared vision, ***the IPHC Secretariat aims to deliver positive economic, environmental, and social outcomes for the Pacific halibut resource for Canada and the U.S.A. through the application of rigorous science, innovation, and the implementation of international best practice.***

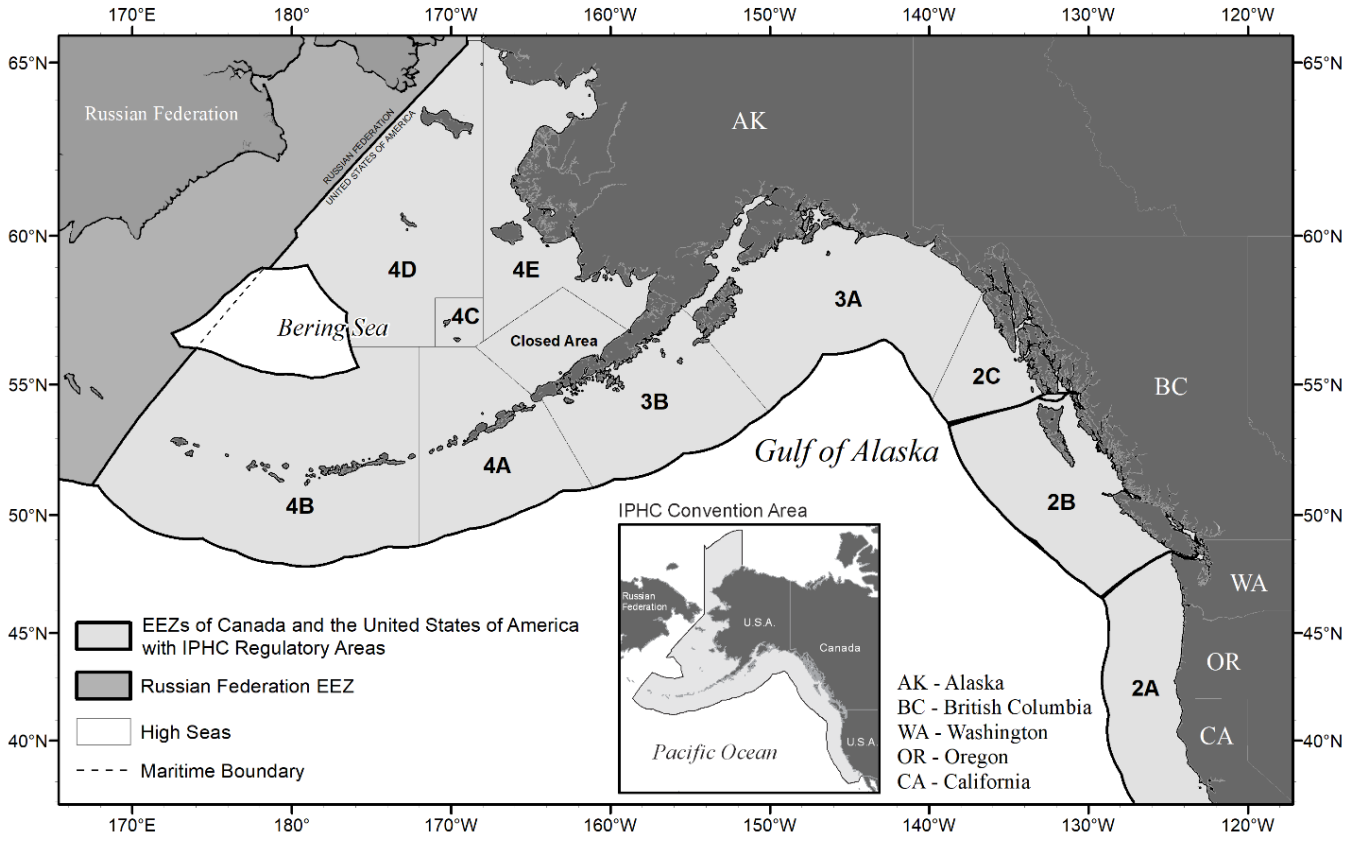

Figure 1. Map of the IPHC Convention Area (map insert) and IPHC Regulatory Areas.

2. Objectives

The IPHC has a long-standing history (since 1923) of collecting data, undertaking research, and stock assessment, devoted to describing and understanding the Pacific halibut (*Hippoglossus stenolepis*) stock and the fisheries that interact with it. Research at IPHC can be classified as "use-inspired basic research" (Stokes 1997) which combines knowledge building with the application of existing and emerging knowledge to provide for the management of Pacific halibut. The stock assessment, management strategy evaluation, management supporting information, and biology & ecology, all interact with each other as well as with fisheries monitoring activities in the IPHC program of integrated research and monitoring. Progress and knowledge building in one focal area influences and informs application in other core focal areas, also providing insight into future research priorities. The circular feedback loop is similar to the scientific method of observing a problem, creating a hypothesis, testing that hypothesis through research and analysis, drawing conclusions, and refining the hypothesis.

The IPHC Secretariat conducts activities to address key issues identified by the Commission, its subsidiary bodies, the broader stakeholder community, and of course, the IPHC Secretariat itself. The process of identifying, developing, and implementing our science-based activities involves several steps that are circular in nature, but result in clear research activities and associated deliverables. The process includes developing and proposing projects based on direct input from the Commission, the experience of the IPHC Secretariat given our broad understanding of the resource and its associated fisheries, and concurrent consideration by relevant IPHC subsidiary bodies, and where deemed necessary, additional external peer review.

Over the last ten (10) years, the research conducted by the IPHC Secretariat has been guided by two sequential detailed plans.

- 2017-2021: 5-Year Biological and Ecosystem Science Research Plan (IPHC–2019–BESRP-5YP).
- 2022-2026: 5-Year Program of Integrated Research and Monitoring (IPHC-2023-5YPIRM)

The aim of the first plan (2017-2021) was to increase our knowledge on the biology of Pacific halibut in order to improve the accuracy of the stock assessment and in the management strategy evaluation (MSE) process. The IPHC-2019-BESRP-5YP contemplated research activities in five focal areas, namely Migration and Distribution, Reproduction, Growth and Physiological Condition, Discard Mortality Rates and Survival, and Genetics and Genomics. Research activities were highly integrated with the needs of stock assessment and MSE by their careful alignment with biological uncertainties and parameters, and the resulting prioritisation (IPHC–2019–BESRP-5YP). The outcomes of the IPHC-2019-BESRP-5YP (summarised in Appendix I of IPHC-2023-5YPIRM) provided key inputs into stock assessment and the MSE process and, importantly, provided foundational information for subsequent plans. The first plan (2017-2021) developed into a second broader and more inclusive plan that encompassed all research and monitoring activities planned and conducted by the IPHC Secretariat as described in the 5-Year Program of Integrated Research and Monitoring (2022-2026) (IPHC-2023-5YPIRM).

The 2nd Performance Review of the IPHC (IPHC-2019-PRIPHC02-R), carried out over the course of 2019, also provided a range of recommendations to the Commission on ways in which it could continue to improve on the quality of scientific advice being provided to the Commission. There were nine (9) specific recommendations relevant to the research and monitoring, as provided below. Of these, only recommendations 3 and 9 remain to be fully implemented and have been incorporated into this current IRMP:

Science: Status of living marine resources

PRIPHC02–Rec.03 (para. 44) The PRIPHC02 ***RECOMMENDED*** *that opportunities to engage with western Pacific halibut science and management agencies be sought, to strengthen science links and data exchange. Specifically, consider options to investigate pan-Pacific stock structure and migration of Pacific halibut.*

PRIPHC02–Rec.04 (para. 45) The PRIPHC02 ***RECOMMENDED*** *that:*

a) further efforts be made to lead and collaborate on research to assess the ecosystem impacts of Pacific halibut fisheries on incidentally caught species (retained and/or discarded);
b) where feasible, this research be incorporated within the IPHC's 5-Year Research Plan (https://www.iphc.int/uploads/pdf/besrp/2019/iphc-2019-besrp-5yp.pdf);
c) findings from the IPHC Secretariat research and that of the Contracting Parties be readily accessible via the IPHC website.

Science: Quality and provision of scientific advice

PRIPHC02–Rec.05 (para. 63) The PRIPHC02 ***RECOMMENDED*** *that simplified materials be developed for RAB and especially MSAB use, including training/induction materials.*

PRIPHC02–Rec.06 (para. 64) The PRIPHC02 ***RECOMMENDED*** *that consideration be given to amending the Rules of Procedure to include appropriate fixed terms of service to ensure SRB peer review remains independent and fresh; a fixed term of three years seems appropriate, with no more than one renewal.*

PRIPHC02–Rec.07 (para. 65) The PRIPHC02 ***RECOMMENDED*** *that the peer review process be strengthened through expanded subject specific independent reviews including data quality and standards, the FISS, MSE, and biological/ecological research; as well as conversion of "grey literature" to primary literature publications. The latter considered important to ongoing information outreach efforts given the cutting-edge nature of the Commission's scientific work.*

PRIPHC02–Rec.08 (para. 66) The PRIPHC02 ***RECOMMENDED*** *that the IPHC Secretariat develop options for simple graphical summaries (i.e. phase plot equivalents) of fishing intensity and spawning stock biomass for provision to the Commission.*

Conservation and Management: Data collection and sharing

PRIPHC02–Rec.09 (para. 73) The PRIPHC02 ***RECOMMENDED*** *that observer coverage be adjusted to be commensurate with the level of fishing intensity in each IPHC Regulatory Area.*

Conservation and Management: Consistency between scientific advice and fishery Regulations adopted

PRIPHC02–Rec.10 (para. 82) The PRIPHC02 ***RECOMMENDED*** *that the development of MSE to underpin multi-year (strategic) decision-making be continued, and as multi-year decision making is implemented, current Secretariat capacity usage for annual stock assessments should be refocused on research to investigate MSE operating model development (including consideration of biological and fishery uncertainties) for future MSE iterations and regularized multi-year stock assessments.*

PRIPHC02–Rec.11 (para. 83) The PRIPHC02 ***RECOMMENDED*** *that ongoing work on the MSE process be prioritised to ensure there is a management framework/procedure with minimal room for ambiguous interpretation, and robust pre-agreed mortality limit setting frameworks.*

The work outlined in this document builds on the previous Research and Monitoring Plans (IPHC–2019–BESRP-5YP; and IPHC-2023-5YPIRM), closing completed projects, extending efforts where needed, and adding new avenues in response to new information. Appendix I provides a detailed summary of the outcomes of the previous IPHC-2023-5YPIRM plan and the status of the work specifically undertaken. Key highlights relevant to the stock assessment and MSE include:

- Investigations on population genomics, including the delineation of a genetic baseline and genomic analyses of population structure (IPHC-2025-SRB026-06).
- Population-level sampling and analysis of maturity and fecundity leading to incorporation of an updated maturity ogive in the 2025 stock assessment and ongoing progress toward an updated fecundity relationship (IPHC-2025-SRB026-06).
- Investigations on methods for reducing whale depredation in the Pacific halibut commercial longline fishery (IPHC-2025-SRB026-06).

All previously described research areas continue to represent critical sources of information for the stock assessment and MSE and thus are closely linked to management performance. The previous 5-year plans were successful in either providing direct new information to the stock assessment or building the foundation for the collection/analysis of such information in this updated plan. As noted below, some new priorities have emerged, and others have evolved based on the work completed to date. The incorporation of research objectives in the current IRMP that address climate change as a factor influencing Pacific halibut biology and ecology as well as fishery performance and dynamics constitutes a timely and relevant contribution towards advancing IPHC-led research to the forefront of fisheries science.

An overarching goal of this current IPHC Integrated Research and Monitoring Plan (IRMP) is to continue to integrate all research activities of the IPHC Secretariat in order to improve the Pacific halibut stock assessment and MSE process and thereby provide the best possible advice for management decision-making processes. In doing so, the Plan also responds to emerging challenges and opportunities, including those presented by advances in artificial intelligence (AI), to enhance analytical capacity, improve efficiency, and support innovation across scientific and operational domains. The intention is no longer to designate the Plan for a defined period, but rather, to annually review and update the Plan as needed, based on resources available to the IPHC, as well as new Commission directives.

Along with the implementation of the short- and medium-term activities contemplated in this IRMP and in pursuit of the overarching goal, the IPHC Secretariat will also aim to:

1) undertake cutting-edge research programs in fisheries research in support of fisheries management of Pacific halibut;
2) undertake groundbreaking methodological research;
3) undertake applied research;
4) establish new collaborative agreements and interactions with research agencies and academic institutions;
5) promote the international involvement of the IPHC by continued and new participation in international scientific organisations and by leading international science and research collaborations;
6) effectively communicate IPHC research outcomes; and
7) incorporate talented students and early researchers in research activities.

The research and monitoring activities conducted by the IPHC Secretariat are organized into the following five (5) areas: stock assessment, MSE, biology and ecology, monitoring, and additional management support. The overall aim is to provide integrated research and monitoring where each area informs and benefits from the others (Fig. 2):

Research

1) **Stock assessment**: to improve the accuracy and reliability of the current stock assessment and the characterisation of uncertainty in the resultant stock management advice provided to the Commission;
2) **Management Strategy Evaluation (MSE)**: to develop an accurate, reliable, and informative MSE process to appropriately characterize uncertainty, investigate reasonable hypothetical scenarios, and provide for the robust evaluation of the consequences of alternative management options, known as harvest strategies, using defined conservation and fishery objectives;
3) **Biology and Ecology**: identify and assess critical knowledge gaps in the biology and ecology of Pacific halibut within its known range, including the influence of environmental conditions on population and fishery dynamics;

Monitoring

4) **Monitoring**: collect representative fishery dependent and fishery-independent data on the distribution, abundance, biology, and demographics of Pacific halibut through ongoing monitoring activities , and ensure these data are effectively managed, quality-controlled, and maintained in accessible data systems to support timely analysis;

Integrated management support

5) **Additional management-supporting inputs**: respond to Commission requests for additional information supporting management and policy development, including the provision of technical advice, synthesis of research results, and development of analytical tools to inform decision-making.

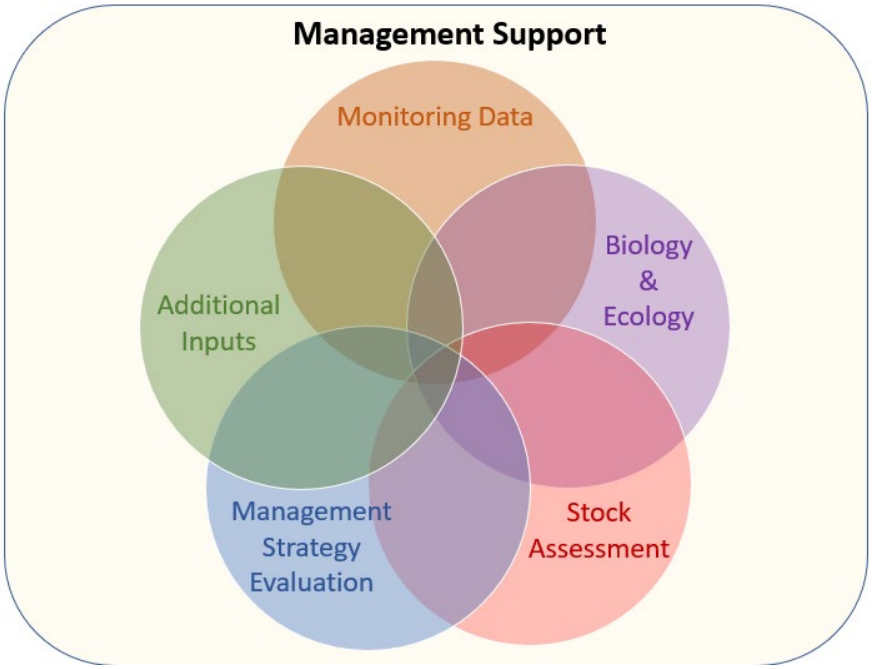

Figure 2. Core areas of the IPHC's Integrated Research and Monitoring Plan (IRMP) provide management support.

3. Strategy

The IPHC Secretariat has five (5) enduring strategic goals in executing our mission, including our overarching goal and associated science and research objectives, as articulated in our Strategic Plan (IPHC Strategic Plan (2023-27)): 1) to operate in accordance with international best practice; 2) be a world leader in scientific excellence and science-based decision making; 3) to foster collaboration (within Contracting Parties and internationally) to enhance our science, monitoring, and management advice; 4) create a vibrant IPHC culture; and 5) set the standard for fisheries commissions globally.

Although priorities and tasking will change over time in response to events and developments, the Strategic Plan provides a framework to standardise our approach when revising or setting new priorities and tasking. The Strategic goals as they apply to the science and research activities of the IPHC Secretariat, are operationalised through a multi-year tactical activity matrix at the organisational and management unit (Branch) level (Fig. 3). The tactical activity matrix is described in the sections below and has been developed based on the core needs of the Commission, in developing and implementing robust, scientifically-based management decisions on an annual, and multi-year level. Relevant IPHC subsidiary bodies will be involved in project development and ongoing review.

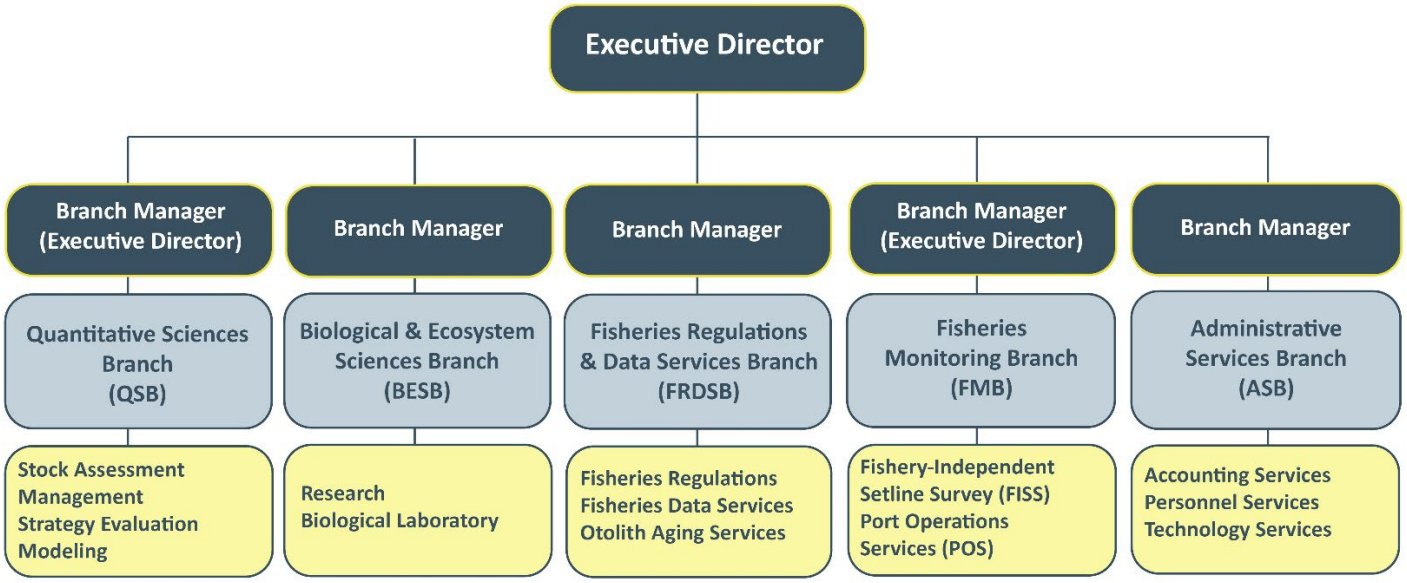

Figure 3. IPHC Secretariat organisation chart (2025).

4. Measures of Success

The Secretariat's success in implementing the IRMP will be measured according to the following criteria relevant to the stock assessment, the MSE, and for all inputs to IPHC management:

1) **Timeliness** – was the research conducted, analysed, published, and provided to the Commission at the appropriate points to be included in annual management decisions?
2) **Accessibility** – was the research published and presented in such a way that it was available to other scientists, stakeholders, and decision-makers?
3) **Relevance** - was the information used to inform decisions made by the Commission?
4) **Impact** – did the research improve the perceived accuracy of or provide a better estimate of the uncertainty associated with information for use in management?

5) **Reliability** - has research resulted in more consistent information provided to the Commission for decision-making.

4.1 Delivery of specified products and decision points

Each project line item will contain specific deliverables that constitute useful inputs into the understanding of the Pacific halibut stock and fisheries, the stock assessment, and the management strategy evaluation process, as well as support their implementation in the decision-making process at the level of the Commission.

In addition, decision points will be developed for each project to determine whether internally funded activities continue or stop. The goal will be to ensure that none of the projects contemplated within the IRMP are open-ended, and thus, are not continued indefinitely if the question is answered sufficiently to remove it from the high-priority list. For example, questions about stock structure could be continued, but they have been sufficiently addressed that the possibility of stock structure is no longer a high-priority risk.

Cost-benefit analysis: innovation and emerging scientific methods will undergo a cost-benefit analysis before implementation, where feasible.

4.2 Communication

The IPHC Secretariat will disseminate information about the activities contemplated in the IRMP and the resulting products to Contracting Parties, stakeholders, the scientific community, and the general public through a variety of channels:

1) IPHC website (www.iphc.int), including through the development of a Stock Status Dashboard;
2) Formal documentation provided for IPHC meetings (Interim and Annual Meetings, Subsidiary Body meetings, etc.);
3) Presentations at national and international scientific conferences;
4) Published reports and peer-reviewed publications (section 4.4);
5) Outreach events;
6) Posts on social media platforms;
7) Informal presentations and interactions with partners, stakeholders, and decision-makers at varied times and venues when needed;
8) Accessible and plain-language summaries of key findings, where appropriate, to facilitate broader stakeholder engagement and understanding.

4.3 External research funding

The Secretariat has set a funding goal of at least 20% of the funds for our research and monitoring activities, to be sourced from external funding bodies on an annual basis. Continuing the successful funding-recruitment strategy adopted during the previous plans (Appendix II), the Secretariat will target available external funding opportunities that are timely and that aim at addressing key research objectives that have important implications for stock assessment and the MSE process. The IPHC Secretariat has the necessary expertise to propose novel and important research questions to funding agencies and to recruit external collaborators from research agencies and universities as deemed necessary. The IPHC Secretariat will continue to capitalise on the strong analytical contributions of quantitative scientists to the development of biological research questions within the framework of research projects funded by external as well as internal funding sources. While the external funding environment has changed substantially in recent years, we will continue with this goal and adapt accordingly.

4.4 Peer-reviewed journal publication

Publication of research outcomes in peer-reviewed journals will be clearly documented and monitored as a primary measure of success. This may include single publications at the completion of a particular project, or a

series of publications throughout the project, as well as at its completion. Each sub-project shall be published in a timely manner and shall be submitted no later than 12 months after the end of the research. In the sections that follow, the expected publications from each research stream and cross-stream are defined.

5. Core focal areas – Background

The main activities of the IRMP involve 1) monitoring (fisheries-dependent and –independent data collection), 2) research (biological, ecological), and 3) modelling (FISS, stock assessment, and MSE), as outlined in the following sub-sections. These components are closely linked to one another, have goals that are integrated across the organisation, and all feed into management decision-making (Fig. 4). Additionally, management-supporting information constitutes a range of additional decision-making inputs within and beyond IPHC's current research and monitoring programs. The current program builds on the outcomes and experiences of the Commission arising from the implementation of the previous two (2) plans, and which are summarised in IPHC-2023-5YPIRM and Appendix I, respectively.

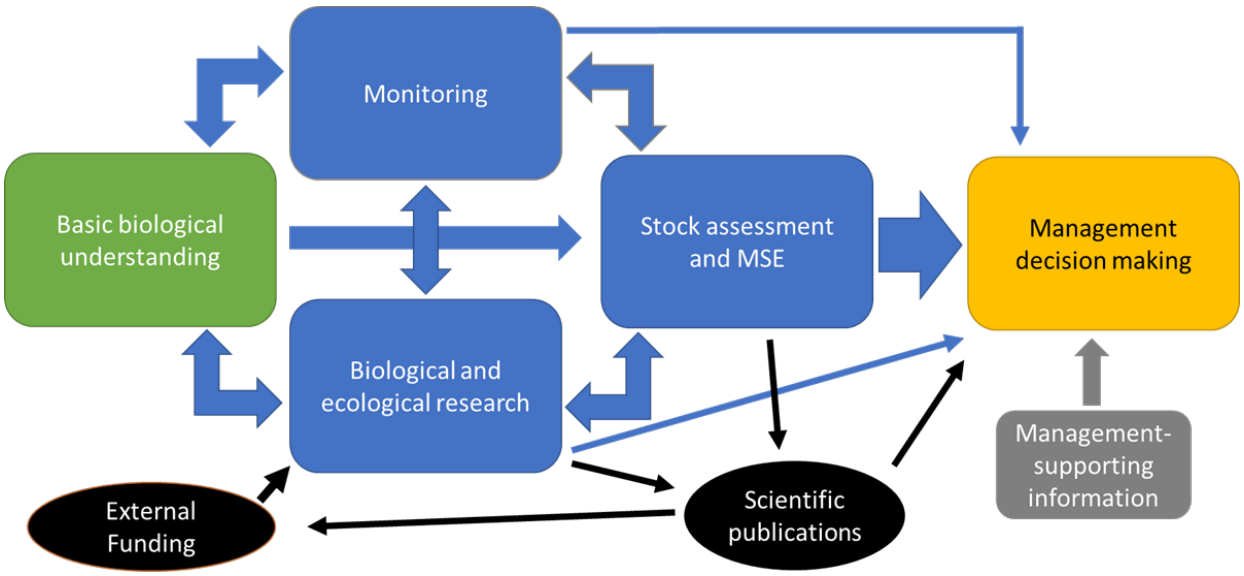

Figure 4. Flow of information from basic biological understanding of the Pacific halibut resource, through IPHC research components (monitoring, biological and ecological research, stock assessment, and MSE) to management decision-making. Management-supporting information (grey) constitutes a range of additional decision-making drivers within and beyond IPHC's current research and monitoring programs. Arrows indicate the strength (size of the arrow) and direction of information exchange. Also identified (in black) are the external links from funding and scientific publications, which supplement the IPHC's internal process.

5.1 Research

5.1.1 Stock Assessment

Focal Area Objective	To improve the accuracy and reliability of the current stock assessment and the characterisation of uncertainty in the resultant stock management advice provided to the Commission.
IPHC Website portal	https://www.iphc.int/management/science-and-research/stock-assessment

The IPHC conducts an annual stock assessment, using data from the fishery-independent setline survey (FISS), the commercial Pacific halibut and other directed and non-directed fisheries, as well as biological information

from its research program and programs from other fisheries agencies. The assessment includes the Pacific halibut resource in the IPHC Convention Area, covering the Exclusive Economic Zones of Canada and the United States of America. Data sources are updated each year to reflect the most recent scientific information available for use in management decision-making.

All recent stock assessments have relied on an ensemble of four population dynamics models to estimate the probability distributions describing the current stock size, trend, and demographics. The ensemble is designed to capture both uncertainty related to the data and stock dynamics (due to estimation) as well as uncertainty related to our understanding of the way in which the Pacific halibut stock functions and is best approximated by a statistical model (structural uncertainty).

Stock assessment results are used as inputs for harvest strategy calculations, including mortality projection tables for the upcoming year that reflect the IPHC's harvest strategy policy and other considerations, as well as the harvest decision table. The harvest decision table uses the probability distributions from short-term (three-year) assessment projections to evaluate the trade-offs between alternative levels of potential yield (catch) and the associated risks to the stock and fishery.

The stock assessment research priorities have been subdivided into three categories:

1) Assessment data collection and processing;
2) technical development;
3) biological understanding and fishery yield

It is important to note that ongoing monitoring, including the annual FISS and directed commercial landings sampling activities, is not considered research and is therefore not included in this research priority list despite the critical importance of these collections. These are described in the sections below.

5.1.2 Management Strategy Evaluation (MSE)

Focal Area Objective	To develop an accurate, reliable, and informative MSE process to appropriately characterise uncertainty, investigate reasonable hypothetical scenarios, and provide for the robust evaluation of the consequences of alternative management options, known as harvest strategies, using defined conservation and fishery objectives.
IPHC Website portal	https://www.iphc.int/management/science-and-research/management-strategy-evaluation

Management Strategy Evaluation (MSE) is a process to evaluate alternative management options, known as harvest strategies. MSE uses a simulation tool to determine how alternative harvest strategies perform given a set of pre-defined fishery and conservation objectives, taking into account the uncertainties in the system and how likely candidate harvest strategies are to achieve the chosen management objectives. An additional benefit of MSE is the potential to analyse scenarios that define a specific portion of the uncertainty or may be outside of the identified uncertainty to understand the management implications if the future did not follow past realizations.

The MSE uses an operating model that includes each part of the management cycle: the population and all fisheries, management decisions, the monitoring program, the estimation model, and potential ecosystem effects using a closed-loop simulation.

MSE is a simulation technique based on modelling the population and fisheries with closed-loop feedback from each part of the management cycle. An operating model (OM) represents aspects that are not controlled by management, such as fishery behavior, recruitment into the population, natural sources of mortality, and potential environmental and ecosystem effects. The management procedure (MP) represents the elements of the decision-

making process, including data collection, estimation models (e.g. stock assessment), and harvest rules such as fishing intensity. The MP also characterizes uncertainty in the decision-making process through sampling error, estimation error, and decision-making variability.

MSE reveals the trade-offs among a range of possible management decisions, given alternative harvest strategies, preferences, and attitudes to risk. The MSE was an essential part of the process of developing, evaluating, and adopting the IPHC Harvest Strategy Policy, and is now used to maintain and update that Harvest Strategy Policy.

The MSE process involves:

- Defining fishery and conservation objectives with the involvement of stakeholders and managers;
- Identifying harvest strategies (a.k.a. management procedures) to evaluate;
- Simulating a Pacific halibut population using those harvest strategies;
- Evaluating and presenting the results in a way that examines trade-offs between objectives;
- Applying a chosen harvest strategy for the management of Pacific halibut;
- Repeating this process in the future in case of changes in objectives, assumptions, or expectations.

There are many research priorities that would continue to improve the MSE framework and the presentation of future results to the Commission; they can be divided into five general categories:

1) **Objectives**: The goals and objectives that are used in the evaluation.
2) **Management Procedures (MPs)**: Specific, well-defined management procedures that can be coded in the MSE framework to produce simulated Total Constant Exploitation Yields (TCEY) for each IPHC Regulatory Area.
3) **Framework**: The specifications and computer code for the closed-loop simulations, including the operating model and how it interacts with the MP, specification of uncertainty, and the identification of scenarios.
4) **Evaluation**: The performance metrics and presentation of results. This includes how the performance metrics are evaluated (e.g. tables, figures, and rankings), presented to the Commission and its subsidiary bodies, and disseminated for outreach.
5) **Application**: Specifications of how an MP may be applied in practice and re-evaluated in the future, including responses to exceptional circumstances.

All these categories provide inputs and outputs of the MSE process, but the Framework category benefits most from the integration of biological and ecosystem research because the operating model, the simulation of the monitoring program, the estimation model, and potential ecosystem effects are determined from this knowledge. Outcomes of the MSE process inform the Commission on updates to the Harvest Strategy Policy.

5.1.3 Biology and Ecology

Focal Area Objective	To identify and assess critical knowledge gaps in the biology and ecology of Pacific halibut within its known range, including the influence of environmental conditions on population and fishery dynamics.
IPHC Website portal	https://www.iphc.int/research/biological-and-ecosystem-science-research/

Since its inception, the IPHC has had a long history of research activities devoted to describing and understanding the biology of and fisheries for the Pacific halibut. At present, the main objectives of the Biological and Ecosystem Science Research activities at the IPHC are to: 1) identify and assess critical knowledge gaps in the biology of the Pacific halibut; 2) understand the influence of environmental conditions in the biology of the Pacific halibut and its fisheries; and 3) apply the resulting knowledge to reduce uncertainty in the stock assessment and MSE.

The primary biological research activities at the IPHC follow Commission objectives, are selected for their important management implications, and are identified and described in this current IRMP. An overarching goal of the IRMP is to promote integration and synergies among the various research activities led by the IPHC to improve our knowledge of key biological inputs that feed into the stock assessment and MSE process. The goals of the main research activities of the IRMP are therefore aligned and integrated with the IPHC stock assessment and MSE processes.

The biological research activities contemplated in the IRMP and their specific aims are detailed in Section 6. Overall, the biological research activities at the IPHC aim to provide information on 1) factors that influence the biomass of the Pacific halibut population (e.g. distribution and movement of fish among IPHC Regulatory Areas, growth patterns and environmental influences on growth in larval, juvenile and adult fish, drivers of changes in size-at-age); 2) the spawning (female) population (e.g. reproductive maturity and fecundity, skipped spawning, reproductive migrations); and 3) resulting changes in population structure and dynamics. Furthermore, the research activities of IPHC also aim to develop and evaluate methods for estimating and reducing incidental mortality of Pacific halibut, to investigate modifications of fishing gear and/or methods to reduce whale depredation and bycatch of non-targeted species, and to investigate changes in the directed Pacific halibut fishery in response to environmental, biological, and technological drivers.

5.2 Monitoring

Focal Area Objective	To collect representative fishery-dependent and fishery-independent data on the distribution, abundance, biology, and demographics of Pacific halibut through ongoing monitoring activities. Monitoring also includes the management and stewardship of these data to ensure their quality, accessibility, and effective use in research and management.
IPHC Website portal	***Fishery-dependent data:*** • https://www.iphc.int/data/time-series-datasets/ • https://www.iphc.int/fisheries/commercial-fisheries/ • https://www.iphc.int/fisheries/recreational-fisheries/ • https://www.iphc.int/fisheries/subsistence-fisheries/ • https://www.iphc.int/fisheries/non-directed-commercial-discard-mortality-fisheries/ ***Fishery-independent data:*** • https://www.iphc.int/data/fishery-independent-setline-survey-fiss/

	• https://www.iphc.int/data/water-column-profiler-data/

5.2.1 Fishery-dependent data

The IPHC estimates the magnitude and demographics of all Pacific halibut removals within the IPHC Convention Area and uses this information in its annual stock assessment and other analyses. These data are collected and compiled by the IPHC Secretariat and include information provided by Federal and State agencies of each Contracting Party. Specific activities in this area are described below.

5.2.1.1 Directed commercial fisheries data

The IPHC Secretariat collects logbooks, otoliths, tissue samples, and associated sex-length-weight data from directed commercial landings coastwide (Fig. 5). For each IPHC Regulatory Area, a sampling rate is determined by port and calculated annually based on the current year's mortality limits and the estimated proportion of Pacific halibut weight landed and sampled in each port. This ensures that an adequate number of biological samples is collected by IPHC Regulatory Area.

Details on the data collected and sampling methods are provided in the annually updated *IPHC Directed Commercial Landings Sampling Manual* (e.g. for 2026: IPHC-2026-PSM01). Complementary to these efforts, the IPHC provides training to Tribal commercial fishery stakeholders in IPHC Regulatory Area 2A that supply additional data. In addition, the IPHC Secretariat summarises annually directed commercial fishery landings recorded by Federal and State agencies of each Contracting Party. Discard mortality for the directed commercial fishery is currently estimated using a combination of logbook, research survey, and observer data.

5.2.1.2 Recreational fisheries data

Recreational removals of Pacific halibut, including estimated recreational discard mortality, as well as demographic information (otoliths, sex-length-weight) where available, are provided by Federal and State agencies of each Contracting Party. These data are compiled annually for use in the stock assessment and other analyses.

5.2.1.3 Subsistence fisheries data

Subsistence fisheries refer to non-commercial, customary, and traditional use of Pacific halibut for direct personal, family, or community consumption, sharing as food, or customary trade. The primary subsistence fisheries include:

- the Treaty Indian Ceremonial and Subsistence fishery in IPHC Regulatory Area 2A off northwest Washington State (USA),
- the First Nations Food, Social, and Ceremonial (FSC) fishery in British Columbia (Canada), and
- the subsistence fishery in Alaska (USA), carried out by rural residents and federally recognised Native Tribes under the Subsistence Halibut Registration Certificate (SHARC) program.

Subsistence fishery removals of Pacific halibut, including estimated subsistence discard mortality, are provided by State and Federal agencies of each Contracting Party. These data are compiled annually for use in the stock assessment and other analyses.

5.2.1.4 Non-directed commercial discard mortality data

Non-directed commercial discard mortality estimates and associated demographic data (primarily length frequencies) by IPHC Regulatory Area and sector are provided by State and Federal agencies of each Contracting Party and compiled annually for use in the stock assessment and other analyses.

Non-directed commercial discard mortality of Pacific halibut is estimated because Pacific halibut are encountered in fisheries that do not permit their retention, and not all discarded Pacific halibut are assumed to die. In most fisheries, non-directed commercial discard mortality is estimated directly using data from observer programs operated by Contracting Party agencies. In cases where observer data are unavailable, estimates are based on non-IPHC research surveys or other sources.

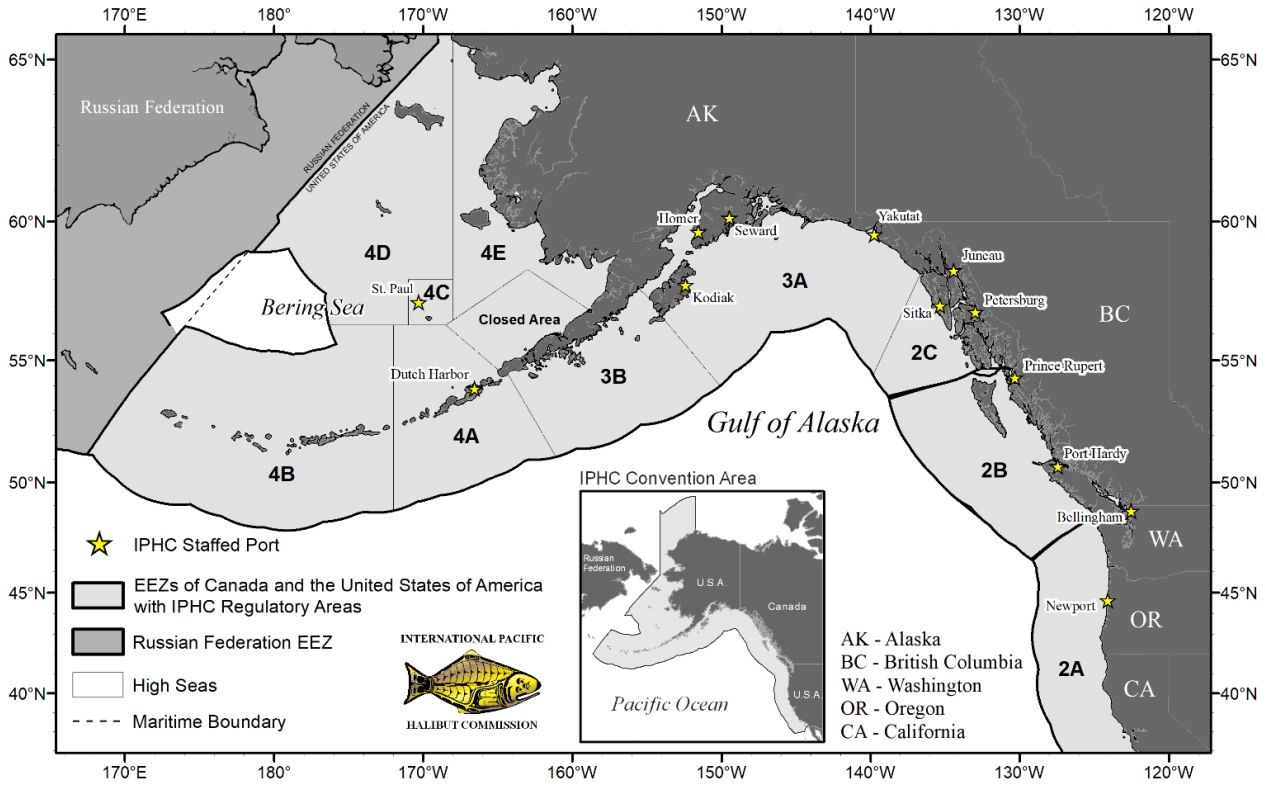

Figure 5. Ports where the IPHC has sampled directed commercial landings throughout the fishing period in recent years (note: ports sampled may change from year to year for operational reasons).

5.2.2 Fishery-independent data

Data collection and monitoring activities aimed at providing a standardised time-series of biological and ecological data that is independent of the fishing fleet.

5.2.2.1 Fishery-independent setline survey (FISS)

The IPHC Fishery-Independent Setline Survey (FISS) provides catch-rate information and biological data on Pacific halibut that are independent of the fisheries. These data, collected using standardised methods, bait, and gear, are used to estimate the primary index of population abundance used in the stock assessment. The FISS is restricted to the summer months but encompasses almost all known Pacific halibut habitat in Convention waters outside the Bering Sea, including the commercial fishing grounds in the Pacific halibut fishery. The standard FISS grid totals 1,890 stations from which a subset is sampled each year (Fig. 6).

Biological data collected on the FISS (e.g. the length, weight, age, and sex of Pacific halibut) are used to monitor changes in year-class strength, biomass, growth, and mortality. Tissue samples are collected from all Pacific halibut sampled by the FISS for use in genetic and other analyses. In addition, records of non-target species caught during FISS operations provide the basis for estimating bait competition and are used to index species abundance over time, making them valuable to the potential management and avoidance of non-target species. Environmental

data are also collected, including water column temperature, salinity, dissolved oxygen, pH, and chlorophyll concentration, to help identify the conditions in which the fish were caught, and these data can serve as covariates in space-time modeling used in the stock assessment. An example of the data collected and the methods used is provided in the annually updated FISS sampling manual (e.g. IPHC FISS Sampling Manual 2025: IPHC-2025-VSM01).

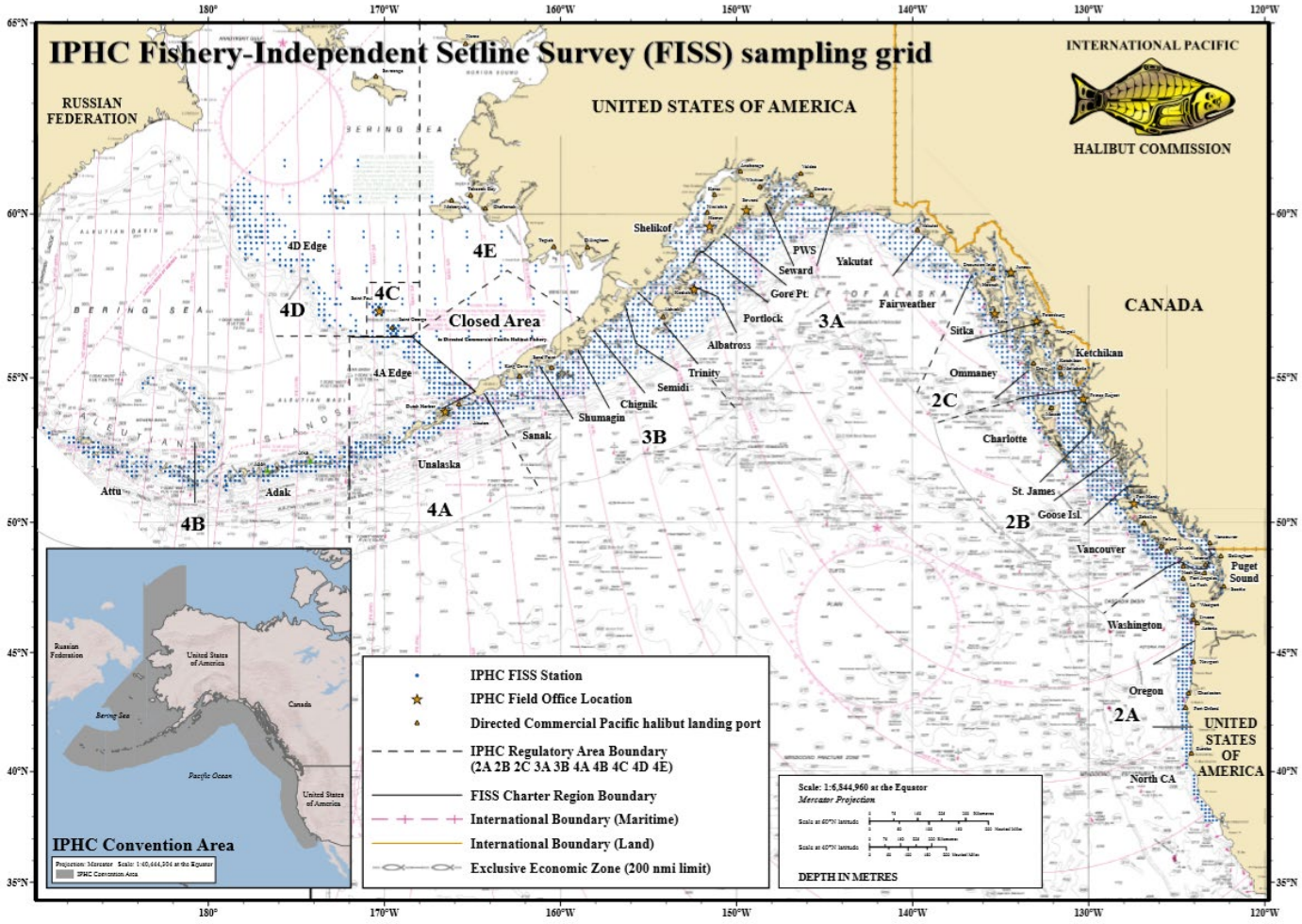

Figure 6. IPHC Fishery-Independent Setline Survey (FISS) with full sampling grid and charter regions.

Following a program of planned FISS expansions from 2014-19, a process of rationalisation of the annual FISS designs was undertaken. Currently, sampled stations are prioritised each year so that coastwide, Biological Region- and IPHC Regulatory Area-specific density indices will be estimated with high precision and low potential for bias. Based on funding and previous FISS results, potential FISS designs for the subsequent three years are evaluated. The resulting proposed designs and their evaluation are presented for review at the June Scientific Review Board (SRB) meetings and modified following SRB input and in-year FISS sampling results before presentation to the Commissioners at the Work Meeting and Interim Meeting. Annual biological sampling rates for each IPHC Regulatory Area are calculated based on the previous year's catch rates and an annual target of 2000 sampled fish (with 100 additional archive samples).

5.2.2.2 Fishery-independent Trawl Survey (FITS)

The IPHC relies on the NOAA Fisheries trawl surveys operating in the Bering Sea (Fig. 7), Aleutian Islands and Gulf of Alaska. The information collected from Pacific halibut caught on the Bering Sea trawl survey, together

with data from the IPHC Fishery-Independent Setline Survey (FISS) is used in estimating indices of abundance, while data from all three trawl surveys are used to monitor population demographics.

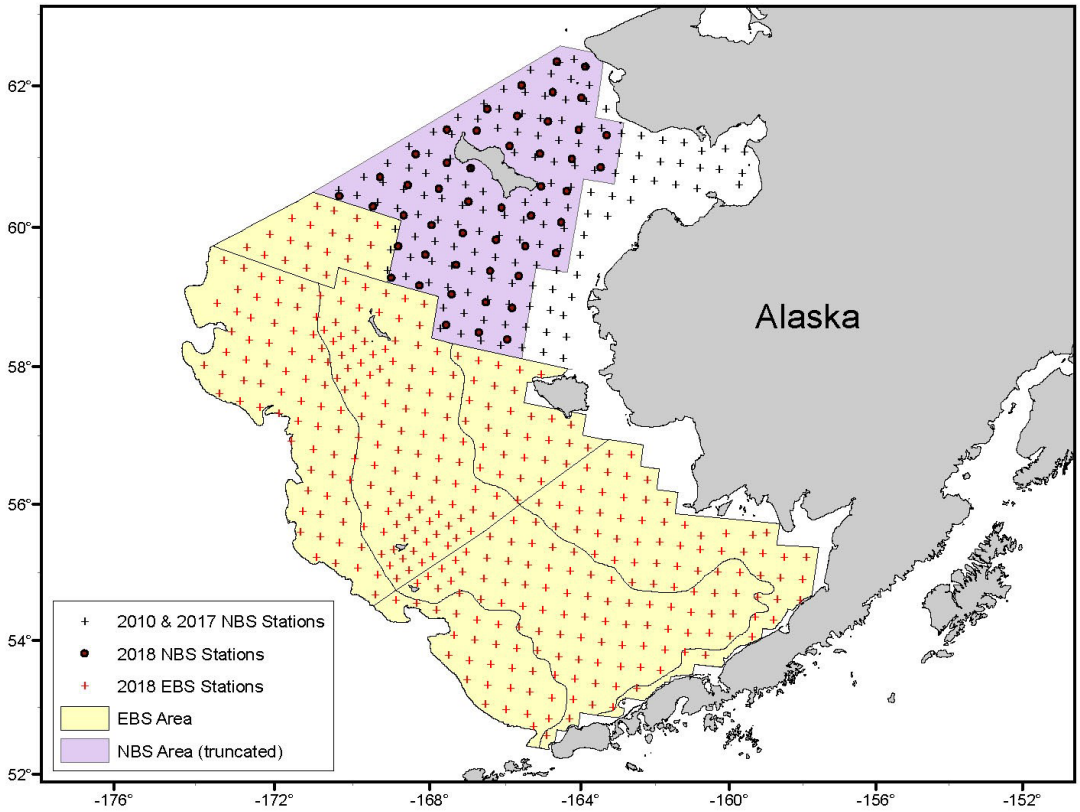

Figure 7. Representative sampling design for the NOAA Bering Sea bottom trawl survey. Black dots are stations sampled in the 2018 Northern Bering Sea trawl survey and black plus signs are stations sampled in prior Northern Bering Sea trawl surveys.

5.2.2.3 Norton Sound trawl survey

The Alaska Department of Fish and Game's annual Norton Sound trawl survey data are also used in the estimation of Pacific halibut indices of abundance in IPHC Regulatory Area 4CDE.

5.2.3 Age composition data (both fishery-dependent and fishery-independent)

Biological samples collected annually from commercial fisheries and FISS include otoliths, crystalline calcium carbonate structures found in the inner ear of fish whose growth patterns can be analysed to estimate the age of fish. Fish age is a key input to stock assessment models that inform management decisions related to fish exploitation and harvest strategies. Since its inception, the IPHC has aged over 1.5 million otoliths by trained readers under the stereoscopic microscope.

The IPHC Secretariat continues to age otoliths manually to provide the high-quality age estimates for the stock assessment. However, substantial progress has now been made toward an AI-assisted workflow. A deep-ensemble convolutional neural network (CNN) model has been developed and trained on otolith images. Through an iterative fine-tuning process, the model progressively improves predictive accuracy. The deep ensemble approach also provides uncertainty estimates, allowing low-confidence predictions to be flagged for expert review. This facilitates a mixed-method protocol where high-confidence estimates are fast-tracked while manual verification is retained for the remainder.

In addition to AI-based methods, the IPHC is exploring epigenetic ageing that may offer comparable precision to traditional human-read methods, potentially expanding the toolkit for robust and scalable age estimation in the future.

5.2.4 Data management and storage

Monitoring data collected through the IPHC's programs are subject to standardised data management procedures, including quality assurance and quality control, documentation, and secure storage. These procedures ensure that fishery-dependent and fishery-independent datasets are accurate, consistent, and traceable over time. Data are maintained in IPHC databases and are curated to support ongoing monitoring activities, stock assessment, and other scientific analyses.

Where appropriate, datasets and derived products are made available through IPHC data portals, reports, and other dissemination mechanisms. Effective data stewardship supports transparency, facilitates collaboration with Contracting Party domestic agencies and research partners, and ensures that monitoring data remain accessible and usable for scientific research and fisheries management decision-making.

5.3 Management-supporting information

To support science-based decision-making and advance the Commission's objective of developing the Pacific halibut stock to the level that permits the optimum yield from the fishery over time, the IPHC Secretariat undertakes a range of supplementary analyses that provide direct input into management procedures and policy evaluations. These efforts complement the stock assessment and biological data streams by addressing specific questions raised by the Commission, domestic agencies, and other stakeholders.

In recent years, the IPHC Secretariat has undertaken a project evaluating Pacific halibut multiregional economic impact, illustrating economic interdependencies between sectors and regions to bring a better understanding of the role and importance of the Pacific halibut resource to regional economies of Canada and the United States of America. Other work has focused on regulatory questions, such as evaluating size limits and associated tradeoffs between yield optimisation, reducing discards, and economic outcomes, as well as assessing the socioeconomic and logistical challenges of implementing year-round fishing.

The IPHC Secretariat remains well-positioned to respond to requests from the Commission or Contracting Parties for technical support on a broad range of management-relevant topics. These may include, among others, socioeconomic considerations, community development, political constraints, or logistical feasibility analyses to inform emerging policy needs. Such analyses are developed collaboratively, leverage a range of available data sources and partners, and can be tailored to specific regulatory or planning contexts.

6. Core focal areas – Planned and opportunistic activities

The IPHC Secretariat works with IPHC advisory bodies and the Commission to identify research priorities and refine hypotheses. This process occurs via an annual schedule of meetings, as shown in Fig. 8. The Management Strategy Advisory Board (MSAB) typically meets once a year. Recommendations related to the MSE and the Harvest Strategy Policy are then directed to the Commission. The SRB holds two meetings each year: one in June, where requests are typically directed to the IPHC Secretariat, and one in September, where recommendations are made to the Commission. The June SRB meeting has a focus on research; the September meeting represents a final check of science products to be presented to the Commission for use in management. The Research Advisory Board (RAB) meets in November to discuss ongoing research, provide guidance, and recommend new research projects. The Work Meeting (WM) is held in September to allow the IPHC Secretariat and the Commission to prepare for the Interim Meeting (IM) held in November and the Annual Meeting (AM) held in January. Outcomes from the AM include mortality limits (coastwide and by IPHC Regulatory Area),

directed fishery commercial fishing period dates, domestic regulations, and requests and recommendations for the IPHC Secretariat. In conjunction with the AM are meetings of the Finance and Administration Committee (FAC), the Conference Board (CB), and the Processor Advisory Board (PAB). The Commission may also hold Special Sessions (SS) throughout the year to take up and make decisions on specific topics.

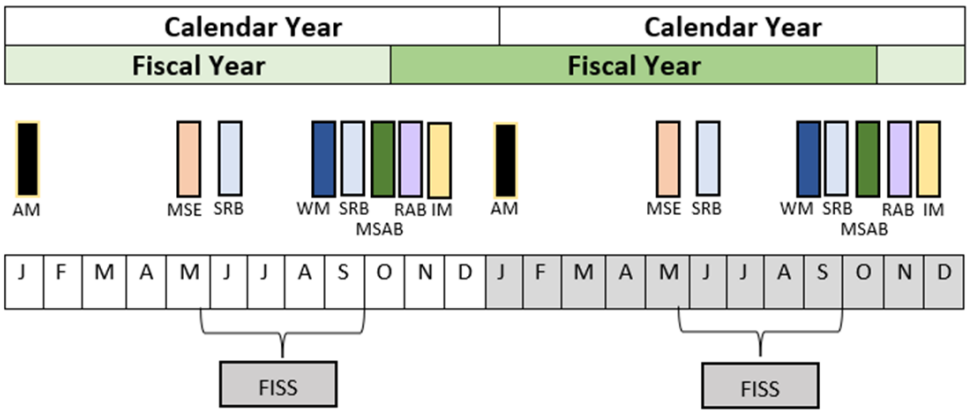

Figure 8. The typical IPHC annual meeting schedule with the calendar year and fiscal year shown. The meetings, shown in the middle row are: Annual Meeting where the Commission makes many final decisions for that year (AM), an MSE informational session (MSE), Scientific Review Board meetings (SRB), the Commission Work Meeting (WM), the Management Strategy Advisory Board meeting (MSAB), the Research Advisory Board Meeting (RAB), and the Interim Meeting (IM). The annual FISS schedule is also shown.

In addition to the annual meeting process at IPHC, individual core focal areas of research may identify and prioritise research for other core focal areas. For example, stock assessment research often identifies gaps in the knowledge of Pacific halibut biology and ecology, which then motivates priority research for the Biology and Ecology core area. Vice versa, basic biological and ecological research can identify concepts that could be better understood and result in improved implementation in any of the core areas. Furthermore, Management Strategy Evaluation can be used to identify priority research topics for any core areas by simulation testing hypotheses to identify research that may have the largest benefit to improving the management of Pacific halibut.

The top priorities of research for various categories in each of the core focal areas are provided below. The top priorities are a subset of the potential research topics in each core focal area. More exhaustive and up-to-date lists of research topics can be found in recent meeting documents related to each core focal area.

6.1 Research

6.1.1 Stock Assessment

Within the three assessment research categories, the following topics have been identified as top priorities in order to focus attention on their importance for the stock assessment and management of Pacific halibut. A brief narrative is provided here to highlight the specific use of products from these studies in the stock assessment. More extensive lists of research topics are produced every three years as part of each full stock assessment analysis.

6.1.1.1 Stock Assessment data collection and processing

6.1.1.1.1 Commercial fishery sex-ratio-at-age via genetics

Commercial fishery sex-ratio information has been found through sensitivity analyses to be closely correlated with the absolute scale of the population estimates in the stock assessment and has been identified as the greatest

source of uncertainty since 2013. With only a short time-series (2017-24) of commercial sex-ratio-at-age information available for the 2025 stock assessment, the annual genetic assay of fin clips sampled from the landings remains critically important. When the time series grows longer, it may be advantageous to determine the ideal frequency at which these assays need to be conducted. This assessment priority directly informs *6.1.3.2 Reproduction* as described below.

6.1.1.1.2 Whale depredation accounting and tools for avoidance

Whale depredation represents a source of unobserved and unaccounted-for mortality in the assessment and management of Pacific halibut. Stock assessment sensitivity analyses have shown that unobserved mortality can result in stock assessment bias and that trends in unobserved mortality may affect current status estimates. Reduction of depredation mortality through improved fishery avoidance and/or catch protection would be a preferable extension and/or solution to methods for estimation. As such, research to provide the fishery with tools to reduce depredation is considered a high priority. This assessment priority directly informs *6.1.3.4.2 Fishing Innovations* as described below.

6.1.1.2 Stock Assessment technical development

6.1.1.2.1 Maintaining coordination with the MSE

The stock assessment and MSE operating models have been developed in close coordination in order to identify plausible hypotheses regarding the processes governing Pacific halibut population dynamics. Important aspects of Pacific halibut dynamics include recruitment (possibly related to extrinsic environmental factors in addition to spawning biomass), size-at-age, movement/migration, and spatial patterns in fishery catchability and selectivity. Many approaches developed as part of the tactical stock assessment have been explored in the MSE operating model, and conversely, the MSE operating model has highlighted areas of data uncertainty or alternative hypotheses for exploration in the assessment (e.g. movement rates). Although these two modelling efforts target differing objectives (tactical vs. strategic), continued coordination is essential to ensure that the stock assessment and the MSE represent the Pacific halibut stock similarly and provide consistent and useful advice for tactical and strategic decision-making.

6.1.1.2.2 Estimation of natural mortality

The stock assessment has been shown to be extremely sensitive to the value of natural mortality. The current approach uses four separate models to estimate management quantities, with three of these models estimating natural mortality directly from the data and one using a fixed historical assumption. Further work to determine the conditions under which natural mortality is estimable in the fourth model and plausible ranges of values for this parameter could reduce perceived and actual uncertainty in the stock assessment and the management information arising from it. As time-series of critically informative data sources like the FISS and the sex-ratio of the commercial landings grow longer, it may be possible to better integrate this source of uncertainty into the stock assessment ensemble.

6.1.1.2.3 Development of state-space models

The IPHC has relied on statistical catch-at-age models for most of its stock assessment history (Stewart and Martell 2014). New programming environments (e.g., TMB; Kristensen et al. 2016) have led to an increased use of state-space models for stock assessment (e.g. SAM, WHAM; Nielsen and Berg 2014; Nielsen et al. 2021; Stock and Miller 2021). These models provide extremely efficient capabilities for modelling random effects and sparse matrices. As the Pacific halibut stock assessment models include time-varying processes (i.e. recruitment, selectivity, and catchability), it would be ideal to treat them as random effects, rather than using the penalised likelihood approach currently employed. Although few such applications include sex-specific dynamics that can

accommodate the necessary dimorphic growth capability to be applicable to Pacific halibut, development of a state-space model for Pacific halibut is prioritised in this research plan.

6.1.1.3 Stock Assessment biological inputs

6.1.1.3.1 Maturity, skip-spawning, and fecundity

Management of Pacific halibut is currently based on reference points that rely on relative female spawning biomass. Therefore, any changes to the understanding of reproductive output – either across age/size (maturity), over time (skip spawning), or as a function of body mass (fecundity) are crucially important. Each of these components directly affects the annual reproductive output estimated in the assessment. Ideally, the IPHC would have a program in place to monitor each of these three reproductive processes over time and use that information in the estimation of the stock-recruitment relationship and the annual reproductive output relative to reference points. This would reduce the potential for biased time-series estimates created by non-stationarity in these traits (illustrated via sensitivity analyses in several of the recent assessments). Building on the success of the previous research plan, we now have an updated maturity relationship included in the 2025 stock assessment. Moving forward, we will extend that research to include an updated fecundity relationship and an investigation of the potential for skip-spawning. After updated stock-wide estimates have been achieved, a program for extending this information to a time-series via transition from research to monitoring can be developed. This assessment priority directly informs *6.1.3.2 Reproduction* as described below.

6.1.1.3.2 Factors affecting size-at-age

Changes in size-at-age, along with recruitment, have been the largest contributors to the historical trends in biomass and fishery yield from the Pacific halibut stock. The relative role of potential factors underlying changes in size-at-age is not currently understood. Delineating between competition, density dependence, environmental effects, size-selective fishing, and other factors could allow improved prediction of size-at-age under future conditions and a better understanding of how management can adapt to changing trends.

6.1.2 Management Strategy Evaluation

MSE priorities have been subdivided into three categories: 1) biological parameterisation, 2) fishery parameterisation, and 3) technical development. Research provides specifications for the MSE simulations, such as inputs to the Operating Model (OM), but another important outcome of the research is to define the range of plausibility to include in the MSE simulations as a measure of uncertainty. The following topics have been identified as top priorities.

6.1.2.1 MSE biological and population parameterisation

6.1.2.1.1 Movement, distribution of life stages, and spatial spawning patterns

Research topics in this category will mainly inform parameterisation of movement in the OM but will also provide further understanding of Pacific halibut movement, connectivity, and temporal variability. This knowledge may also be used to refine specific MSE objectives. For example, further research into sub-population structure and connections between those sub-populations would provide an understanding of the importance of spatial heterogeneity in the Pacific halibut population. This includes the identification of important spawning locations, connections between spawning areas, spawning area contributions to juvenile distribution, temporal variability in spawning and recruitment, ontogenetic movement, and the importance of spawning locations to a sustainable population and efficient fisheries across the IPHC Convention Area. Larval and juvenile distribution is a main source of uncertainty in the OM and continued research in this area will improve the OM and provide justification

for parameterising temporal variability. Outcomes may also provide information on recruitment strength and the relationship with environmental factors. For example, recent work by Sadorus et al (2021) used biophysical and spatio-temporal models to examine connectivity across the Bering Sea and Gulf of Alaska. Furthermore, improved understanding of the distribution of adults resulting from ontogenetic movement will assist with conditioning the OM, verify patterns simulated from the OM, and provide information to develop reasonable sensitivity scenarios to test the robustness of MPs. Research under Section 6.1.3.1 will inform this MSE priority.

6.1.2.1.2 Understanding growth variation

Changes in the average weight-at-age of Pacific halibut is one of the major drivers of changes in biomass over time. The OM currently simulates temporal changes in weight-at-age via a random autocorrelated process which is unrelated to population size or environmental factors. Ongoing research in drivers related to growth in Pacific halibut will help to improve the simulation of weight-at-age. Research under Section 6.1.3.3 will inform this MSE priority.

6.1.2.1.3 Understanding the effects of productivity scenarios

Pacific halibut have experienced a wide range of productivity scenarios, mainly influenced by average recruitment and size-at-age. Understanding the consequences of productivity scenarios on management outcomes will help to understand past observed trends and current experiences, and to identify optimal harvest strategies for the future. Using the MSE to simulate scenarios assuming different productivity regimes can test alternative management procedures to identify a robust management procedure, or possibly differences between them given different productivity. The MSE scenarios would be informed by research described in Sections 6.1.3.1 and 6.1.3.3.

6.1.2.2 MSE fishery parameterisation

The definition of fisheries and their parameterisations in the MSE operating model involved consultation with Pacific halibut stakeholders, but some aspects of those parameterisations would benefit from targeted research. One specific example is knowledge of discarding and discard mortality rates in directed and non-directed fisheries. Discard mortality can be a significant source of fishing mortality in some IPHC Regulatory Areas, and appropriately modelling that mortality will provide a more robust evaluation of MPs. Research under Section 6.1.3.4 will inform this MSE priority.

6.1.2.3 MSE technical development

Technical improvements to the MSE framework will allow for rapid development of alternative operating models and efficient simulation of management strategies for future evaluation and support of the Harvest Strategy Policy. Coordination with the technical development of the stock assessment (Section 6.1.1.2.1) is necessary to ensure consistent assumptions and hypotheses for tactical (i.e. stock assessment) and strategic (i.e. MSE) models. Investigations done in the stock assessment will inform the MSE operating model, which will then inform management and stock assessment development through investigations using the closed-loop simulation framework. MSE development, simulations, and outcomes may also inform further development of the stock assessment. Conducting assessments at intervals longer than annually may allow for additional opportunity to coordinate between stock assessment and MSE.

6.1.2.3.1 Realistic simulations of estimation error

Closed loop simulation uses feedback from the management procedure to update the population in the projections. The management procedure consists of data collection, an estimation model, and harvest rules; currently IPHC uses an ensemble stock assessment, which is difficult to mimic as an estimation model. Future development of an efficient simulation process to mimic the stock assessment will more realistically represent the current

management process. This involves using multiple estimation models to represent the ensemble and appropriately adding data and updating those models in the simulated projections. Improvements to the current MSE framework include adding additional estimation models to better represent the ensemble stock assessment, ensuring that the simulated estimation model accurately represents the stock assessment now and in the future, and incorporate efficiencies to speed up the simulation process.

6.1.2.3.2 Incorporate additional sources of implementation uncertainty

Implementation uncertainty consists of three subcategories: 1) decision-making uncertainty, 2) realised uncertainty, and 3) perceived uncertainty. Decision-making uncertainty is the difference between mortality limits determined from the management procedure and those adopted by the Commission. This uncertainty is currently implemented in the MSE framework but improvements could be made. Realised uncertainty is the difference between the mortality limit set by the Commission and the actual mortality realised by the various fisheries. This type of uncertainty is currently partially implemented in the MSE framework. Finally, perceived uncertainty is the difference between the realised mortality and the estimated mortality limits from the various fisheries, which would be used in the estimation model. This third type of implementation uncertainty has not been implemented in the MSE framework and relies on improvements to the estimation model (Section 6.1.2.3.1). Improving the implementation of decision-making uncertainty is a priority for the MSE and will assist in understanding the performance of management procedures given the flexibility desired by the Commission.

6.1.2.4 Potential Future MSE projects

Management Strategy Evaluation is an iterative process where new management procedures may be evaluated, current management procedures may be re-evaluated under different assumptions, and the understanding of the population, environment, and fisheries may be updated with new information stemming from the stock assessment and biological/ecological research. The current research priorities focus on technical development, but various elements of Management Procedures will likely be of interest once technical improvements are made. The research being done now will inform the development of the MSE in the future to ensure a robust evaluation of any management procedure.

6.1.3 Biology and Ecology

Capitalising on the outcomes of the first 5-year plan (IPHC–2019–BESRP-5YP), the second 5-year plan (IPHC-2022-5YPIRM) developed five research areas to provide key inputs for stock assessment and the MSE process. In addition to linking genetics and genomics with migration and distribution studies in the area of Migration and Population Dynamics, a novel research area on Fishing Technology was incorporated in the IPHC-2023-5YPIRM. The outcomes of IPHC-2023-5YPIRM are provided in Appendix I, and the resulting peer-reviewed publications are provided in Appendix III. The present plan (IPHC-2026-5YPIRM) describes the continuation of these five research areas into the next phase of management-serving research goals, with Fishing Technology being incorporated into a new research area that includes Mortality Estimations and Fishery Practices and Behavior. A series of key objectives for each of the five research areas has been identified that integrate with specific needs for stock assessment and MSE processes and that are ranked according to their relevance (Appendix IV and Appendix V, respectively). To further describe the IPHC Secretariat's rationale for establishing research priorities, a ranked list of biological uncertainties and parameters for stock assessment and the MSE process, and their links to research activities and outcomes derived from the IRMP are also provided.

6.1.3.1 Migration and Population Dynamics

Studies aimed at improving current knowledge of Pacific halibut distribution and population dynamics throughout all life stages in order to achieve a complete understanding of stock structure and distribution across the entire range of Pacific halibut in the North Pacific Ocean and the biotic and abiotic factors that influence it through

multiple approaches. Specific objectives in this area include:

- Integrate analyses of Pacific halibut population dynamics, connectivity, and distribution changes by incorporating genomic approaches.
- Improve our understanding of the influences of oceanographic and environmental variation on connectivity, population structure, and adaptation at a genomic level using seascape genomics approaches.
- Improve our understanding of migration and basin-wide population structure between the Eastern and Western components of the Pacific halibut stock in the North Pacific Ocean.
- Improve our understanding of the contribution of known and putative (e.g. Washington coast) spawning areas to nursery/settlement areas in relation to year-class, recruit survival and strength, juvenile genetic diversity, and environmental conditions in the North Pacific Ocean.
- Improve our understanding of the relationship between the presence of juveniles in mapped nursery/settlement areas and adult distribution and abundance over temporal and spatial scales.
- Build upon the current conceptual model of Pacific halibut movement through a synthetic analysis of existing tagging data.
- Apply methods for individual identification based on computer-assisted tail image matching systems as an alternative for traditional mark and recapture tagging.

Horizon scan:

- Evaluate the potential use of environmental DNA (eDNA) for improving current understanding of Pacific halibut distribution and assist with mapping of juvenile habitat.
- Examine the feasibility of close-kin mark-recapture-based approaches to improve estimates of population size, migration rates among geographical regions, and demographic parameters (e.g. fecundity-at-age, natural mortality).

6.1.3.2 Reproduction

Studies aimed primarily at addressing several critical issues for stock assessment analysis based on estimates of female spawning biomass: 1) the sex ratio of the commercial catch; 2) revised maturity estimates, and 3) fecundity estimates. Specific objectives in this area include:

- Continued temporal and spatial analysis of female histology-based maturity-at-age estimates: identification of potential drivers (e.g. environmental, etc.) of temporal and spatial changes in maturity schedules.
- Develop and validate methods for fecundity estimations based on the auto-diametric method applied to other species.
- Provide estimates of fecundity-at-age and fecundity-at-size.
- Investigate the possible presence of skip spawning in Pacific halibut females.
- Improve accuracy in the current staging criteria of maturity status used in the field.
- Investigate possible environmental effects on the ontogenetic establishment of the phenotypic sex and their influence on sex ratios in the adult Pacific halibut population.
- Improve our understanding of the genetic basis of variation in age and/or size-at-maturity, fecundity, and spawning timing, by conducting genome-wide association studies.

- Characterise the temporal progression of reproductive development and gamete production throughout an entire annual reproductive cycle in male Pacific halibut.

6.1.3.3 Growth and size-at-age

Studies aimed at describing the role of factors responsible for the observed changes in size-at-age and at evaluating growth and physiological condition in Pacific halibut. Specific objectives in this area include:

- Investigate the effects of environmental and ecological conditions driving size-at-age and somatic growth in Pacific halibut.
- Investigate the influence of early growth (e.g. juveniles) in determining growth patterns during adulthood. Analysis of NMFS trawl data and investigation of potential early life regulatory mechanisms (e.g. epigenetic, etc.) that direct adult growth patterns.
- Investigate variation in somatic growth patterns in Pacific halibut as informed by physiological growth markers, physiological condition, energy content, and dietary influences.
- Evaluate the relationship between somatic growth, temperature, and trophic histories in Pacific halibut through the integrated use of physiological growth markers (e.g. gene expression, stable isotope profiles).
- Develop a non-invasive alternative method for aging Pacific halibut based on genetic analyses of DNA methylation patterns in tissues (fin clips). Development of an epigenetic clock and possible insights into the aging process/senescence in Pacific halibut.
- Improve our understanding of the genetic basis of variation in somatic growth and size-at-age by conducting genome-wide association studies.
- Explore emerging technological advances in genome sequencing that produce genomic and epigenetic data (e.g. PacBio, Oxford Nanopore) to assist in understanding the genetic and epigenetic basis of growth.
- Investigate the feasibility of otolith (or eye lens lamina) growth increment analyses for reconstructing individual growth histories in Pacific halibut.

Horizon scan:

- Investigate dietary composition in stomachs through metabarcoding (i.e. molecular identification of prey items in stomach contents).
- Investigate liver parasite loading and its effect on physiological conditions in Pacific halibut

6.1.3.4 Fishery dynamics and fishing technology

6.1.3.4.1. Mortality estimations. Studies aimed at developing and evaluating methods for estimating and reducing incidental mortality of Pacific halibut. Specific objectives in this area include:

- Incorporate experimentally-derived discard mortality rate data in the recreational fishery (based on research conducted under IPHC-2023-5YPIRM) into management.
- Review status of discard mortality rate (DMR) research conducted by the IPHC: synthesis paper of experimentally-derived DMR for Pacific halibut in different fisheries, with future research avenues and management recommendations.
- Investigate the application of electronic monitoring and AI-based analyses of discards for mortality estimations.

- Investigate new methods (e.g. AI-based) for improved estimation of depredation mortality from marine mammals.
- Support and collaborate in efforts to reduce Pacific halibut bycatch in other fisheries
- Investigate potential biological and ecological causes of mortality in Pacific halibut.

6.1.3.4.2. Fishing innovations. Studies investigating modifications of fishing gear/methods with the purpose of reducing depredation of Pacific halibut by toothed whales and reducing bycatch of non-targeted species. Specific objectives in this area include:

- Prepare a review paper summarising past and present directed (fixed) gear-related research by the IPHC.
- Investigate methods for whale avoidance and/or deterrence for the reduction of Pacific halibut depredation by whales (e.g. catch protection methods, pots).
- Investigate physiological and behavioral responses of Pacific halibut to fishing gear in order to increase the catch and reduce bycatch of non-targeted species: influence of lights on fishing gear, hook size, design or modification, pots, etc.

6.1.3.4.3. Fishery practices and behavior. Studies aimed at investigating changes in the directed Pacific halibut fishery in response to environmental, biological, and technological drivers. Specific objectives in this area include:

- Investigations into the interaction between climate change and fishing patterns
- Evaluations of the effects of sand fleas- and dogfish-prevalent areas on longline fisheries
- Tradeoffs of snap, fixed, and Autoline gear use on fishery efficiency.

6.2 Monitoring

The Commission's monitoring programs continue to include both direct data collection by the IPHC Secretariat and coordination with domestic agencies to generate comprehensive fishery-dependent and fishery-independent information on Pacific halibut stock and fishery trends. These critical sources include estimates of fishing mortality across all fisheries encountering Pacific halibut, biological sampling from these fisheries, as well as catch rates and biological sampling from longline and trawl surveys. Monitoring data will continue to underpin the stock assessment and MSE process, support numerous biological research studies, and inform the decision-making process (Fig. 4).

Over the coming years, monitoring activities will also focus on strengthening data management systems, improving data accessibility, and ensuring that monitoring programs remain aligned with emerging research priorities and management needs. Periodic reviews of monitoring programs and associated data systems will support the identification of gaps, the prioritization of improvements, and the integration of new technologies and analytical approaches.

6.2.1 Fishery-dependent data

The IPHC Secretariat will continue collecting fishery-dependent data from the directed commercial fishery, with a focus on maintaining adequate spatial and temporal coverage of catch, effort, and biological data. Coordination with Tribal, State and Federal agencies will continue to support the standardisation of data collection protocols, increase data collection capacity, improve reporting consistency, and help identify and fill data gaps that may impact stock assessment and management.

Collaborative work with commercial stakeholders will continue to advance the use of electronic logbooks, which were introduced in 2023, to enhance the accuracy, timeliness, and efficiency of data submission. Further development of digital quality assurance and quality control (QA/QC) systems will strengthen data integrity, ease operational demands, and increase the capacity of IPHC Secretariat for other advancements.

Future efforts will also include a comprehensive review and audit of existing monitoring databases and associated workflows. This work will aim to modernise data storage structures, improve interoperability among datasets, and implement new tools that reduce the potential for reporting errors while facilitating more efficient data access and analysis. These improvements will support more timely data availability for stock assessment, MSE analyses, and other research applications.

Annual reviews of sampling distribution across ports, data collection methods, sampling rates, and QA/QC procedures will continue, including in-season evaluations of port sampling coverage. These initiatives aim to ensure that data collection continues to support stock assessment, MSE, and management needs, while integrating relevant research findings into long-term monitoring strategies.

6.2.2 Fishery-independent setline survey (FISS)

An annual review process for the FISS station design has been developed (Fig. 9) and is expected to continue in the coming years. This process involves scientific review of proposed FISS designs by the Scientific Review Board and includes input from stakeholders prior to review and approval of designs by the Commissioners.

Sample rates for genetic monitoring will need to be determined for future sampling. Sampling rates of otoliths for aging, archive otoliths, and tagged fish will continue to be reviewed annually to ensure the data needs of the IPHC stock assessment and research program are met. Annual FISS sampler training and data QAQC (including at the point of data collection and during post-sampling review) will ensure high-quality data from the FISS program.

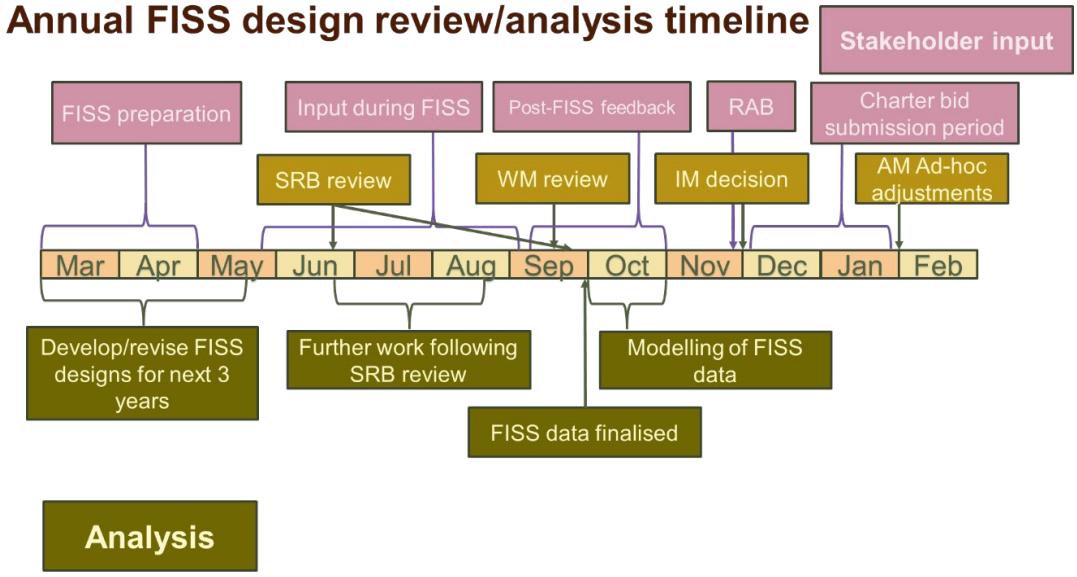

Figure 9. Timeline of annual FISS design review process.

6.2.2.1 Fishery-independent Trawl Survey (FITS)

The IPHC will continue to collaborate with NMFS on sampling procedures for Pacific halibut and on the placement of an IPHC sampler onboard a survey vessel for the collection of biological data.

6.2.3 Ageing methods (both fishery-dependent and fishery-independent)

6.2.3.1. Application of artificial intelligence (AI) for determining the age of fish from images of collected otoliths.

Progress in applying AI for determining the age of Pacific halibut from images of collected otoliths presents both opportunities and challenges, particularly in balancing gains in efficiency with the need to maintain data integrity and spatiotemporal consistency.

Future development will include the evaluation of candidate AI-based ageing methods that combine automated predictions with varying levels of manual verification. These approaches may differ in the proportion of AI-derived ages accepted without review or subjected to manual confirmation. A cost-benefit analysis will compare these candidate protocols with the current manual ageing process, considering labor requirements, processing time, operational costs, and implications for age composition estimates used in the stock assessment.

Before AI-derived ages can be incorporated into routine assessment inputs, additional methodological work will be required to develop imprecision matrices for candidate AI ageing approaches and compare them with existing break-and-bake and surface ageing matrices. These matrices will allow evaluation of the accuracy and precision of AI-based age estimates relative to traditional ageing methods and will support development of a testing framework for assessing their performance within the stock assessment model.

Testing within the stock assessment will likely involve split-sample or hybrid approaches in which AI-derived ages are incorporated alongside manually aged samples. Alternative scenarios may evaluate different proportions of AI-derived ages and different durations of AI-based ageing within the time series. This approach will help determine how varying levels of AI integration influence estimated year-class strength, population trends, and management quantities used to inform mortality limit decisions.

Further research will also evaluate the spatial and temporal generalization of AI models, particularly when predictions are applied to regions or years that are underrepresented in the training dataset. Additional improvements may be achieved through the incorporation of relevant covariates, such as fish sex, location, or date collected, to improve model performance and reduce prediction uncertainty. Maintaining a subset of manually aged otoliths will remain important during this transition period to support model validation, maintain training datasets, and ensure continuity with the historical age series.

Through continued development, testing, and review in collaboration with the Scientific Review Board, AI-assisted ageing methods may provide a scalable and efficient complement to traditional ageing protocols while maintaining the reliability of age data used in Pacific halibut stock assessment and management.

6.2.3.2. Application of an epigenetic clock for aging Pacific halibut using fin clips.

Epigenetic aging is a genetic method for aging that is based on the fact that methylation patterns on genomic DNA change predictably with age. Therefore, age-associated DNA methylation patterns can be modelled to generate molecular (i.e., epigenetic) age predictors capable of estimating chronological age with high accuracy. These are referred to as “epigenetic clocks” and can be developed from DNA isolated from any tissue, including non-lethal biological samples, such as a fin clip.

The objective of this project is to develop an epigenetic clock for Pacific halibut using fin clips from Pacific halibut of known ages. The specific objectives are (1) to identify DNA methylation signals in Pacific halibut fin tissue, (2) to develop an age prediction model based on age-associated DNA methylation patterns, and (3) to develop a targeted assay with selected age-associated epigenetic markers for cost-effective, high-throughput age estimations in Pacific halibut. Once this objective is met, this IRMP will be updated to describe how this ageing method would be investigated for potential inclusion into the stock assessment, similar to that described for AI ageing above.

6.3 Management-supporting information

6.3.1 Potential of integrating human dynamics into management decision-making

Effective Pacific halibut management requires understanding not only biological stock dynamics, but also the human dimensions that shape fishery outcomes (Lane and Stephenson 1995). As new technologies such as AI, digital logbooks, and real-time monitoring evolve, so too does the potential to integrate human behavior, economic dependencies, and community-level impacts into the management framework.

Recent socioeconomic analyses conducted by the IPHC highlight disparities in how different regions and user groups benefit from Pacific halibut fisheries, and how external forces such as shifting markets and climate change can amplify these differences (Cheung and Frölicher 2020). Recognising these factors can improve both the fairness and resilience of fishery policies.

Looking ahead, the IPHC Secretariat aims to be prepared to integrate human dynamics, such as fleet behavior, market access, or social vulnerability, into stock assessment and MSE, where such complementary analyses may add value to the decision-making process (Lynch et al. 2018). This may include linking fishery performance metrics to socioeconomic indicators or exploring how alternative management scenarios affect community and fisher behavior. These efforts will ensure that science-based advice not only supports biological sustainability but is also responsive to the evolving realities of people and communities who depend on the resource.

7. Amendment

As with the previous two (2) plans, the IPHC Secretariat intends to maintain this IRMP document as a '*living plan'*, subject to annual reviews and updates as necessary. Revisions will reflect evolving priorities, resources available to undertake the work (e.g. internal and external fiscal resources, collaborations, internal expertise), and emerging opportunities. The IPHC Secretariat remains committed to transparency and to upholding the principles of open science in the development and implementation of this plan.

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APPENDICES

Appendix I: Outcomes of IPHC-2023-5YPIRM

Appendix II: External funding received by the IPHC

Appendix III: Publications arising

Appendix IV: List of ranked research priorities for stock assessment

Appendix V: List of ranked research priorities for management strategy evaluation

APPENDIX I
OUTCOMES OF THE IPHC-2023-5YPIRM

1. Biology and Ecology

A. Outcomes by Research Area:

1. Migration and Population Dynamics

1.1. Development and application of genomic approaches. Planned research outcomes: generation of genomic resources for Pacific halibut that will support genomic research.

Main results:

- Sequencing of the Pacific halibut genome.
- Generation of a high-quality chromosome-level genome assembly for Pacific halibut and full characterisation of the genome
- Complete sequencing and annotation of the Pacific halibut genome into a publicly available online resource
- Identification of the sex determining region of the Pacific halibut genome in Chromosome 9.
- Successful mapping of single nucleotide polymorphisms used for genetic sexing into the sex determining region of the Pacific halibut genome.
- Generation of tissue-specific transcriptomes and combined transcriptome for Pacific halibut. Identification of tissue-specific transcriptomic characteristics.

1.2. Population genomic studies. Planned research outcomes: delineation of population structure within Convention Waters.

Main results:

- Application of low-coverage whole-genome resequencing to screen genomic variation at very high resolution.
- Development of a bioinformatic platform to process and analyse high-throughput whole genome sequencing data.
- Establishment of a baseline of genetic diversity by whole genome resequencing of genetic samples from spawning individuals collected from the main five spawning areas within Convention Waters.
- Lack of evidence for population structure, as evidenced by the inability of high-resolution genomics techniques to identify discrete genetic groups.
- Low ability to assign individuals back to the location in which they were sampled.
- Lack of population structure supports the modeling of the Pacific halibut stock as a single coastwide stock

1.3. Environmental influences on Pacific halibut distribution. Planned research outcomes: relationship between Pacific halibut distribution and environmental variables.

Main results:

- Establishment of baseline environmental data for Pacific halibut habitat for older juvenile and adult individuals in different Biological Regions.
- Application of environmental profiler data in spatio-temporal modeling.
- Identification of changes in Pacific halibut density and distribution of Pacific halibut in Biological Region 2 associated with low near-bottom dissolved oxygen levels. These hypoxic events are the result of seasonal upwelling.

Publications:

Jasonowicz, A.J., Simeon, A., Zahm, M., Cabau, C., Klopp, C., Roques, C., Iampietro, C., Lluch, J., Donnadieu, C., Parrinello, H., Drinan, D. P., Hauser, L., Guiguen, Y., Planas, J.V. Generation of a chromosome-level genome assembly for Pacific halibut (*Hippoglossus stenolepis*) and characterization of its sex-determining genomic region. *Molecular Ecology Resources.* 2022. 22: 2685–2700. https://doi.org/10.1111/1755-0998.13641.

Jasonowicz, A.J., Simchick, C., Planas, J. V. Tissue-specific and reference transcriptomes for Pacific halibut (*Hippoglossus stenolepis*). 2025. In Preparation.

Jasonowicz, A.J., Simchick, C., Dawson, L., Spies, I., Larson, W., Planas, J.V. Genomic support for a single stock of Pacific halibut (*Hippoglossus stenolepis*) in the Northeastern Pacific Ocean. 2025. In Preparation.

Planas, J.V., Rooper, C.N., Kruse, G.H. Integrating biological research, fisheries science and management of Pacific halibut (Hippoglossus stenolepis) across the North Pacific Ocean. *Fisheries Research*. 2023. 259: 106559. https://doi.org/10.1016/j.fishres.2022.106559.

Sadorus, L.L., Webster, R.A. and Sullivan, M.E. Environmental conditions on the Pacific halibut (Hippoglossus stenolepis) fishing grounds obtained from a decade of coastwide oceanographic monitoring, and the potential application of these data in stock analyses. *Marine and Freshwater Research*. 2024. 75: MF23175. https://doi.org/10.1071/MF23175.

Integration with Stock Assessment and MSE: The relevance of research outcomes from activities in this research area for stock assessment is in evaluating the biological support for modeling the Pacific halibut stock as a coastwide stock and in the improvement of estimates of productivity. Research outcomes will be used to generate potential recruitment covariates and to inform minimum spawning biomass targets by Biological Region and represent one of the top three biological inputs into stock assessment. Additionally, current assumptions of stock structure used in the current stock assessment will be tested by these research activities. The relevance of these research outcomes for MSE is in the improvement of the parametrisation of the Operating Model and represent the top ranked biological input into the MSE.

2. Reproduction

2.1 Sex ratio of commercial landings. Planned monitoring outcomes: sex ratio information.

Main results:

- Sex ratio information for the 2017-2024 commercial landings.

2.2 Histological maturity assessment. Planned research outcomes: updated maturity schedule.

Main results:

- Application of histological ovarian development classification criteria to revise female maturity and establishment of criteria to identify immature versus mature females.
- Successful staging of ovarian samples collected in the FISS from 2022 to 2024.
- Testing of various types of models (i.e. generalised linear models (GLMs) and generalised additive models (GAMs)) to fit maturity data.
- Application of best-fit GAM models to estimate maturity ogives by Biological Region and year.
- Generation of a coastwide maturity ogive using weighed Biological Region ogives for the period 2022-2024.
- Development of a calibration factor between histology- and field (visual)-based maturity estimates.
- Integrate the calibration factor to revise FISS historical maturity data with which to investigate decadal changes in female maturity.
- Description of endocrine parameters that are associated with female developmental stages and identification of potential physiological markers for maturity.
- Collection of samples in the summers of 2023-2025 and fall of 2024 for the development of the fecundity estimation method and for generating the first estimates of fecundity.

Publications:

Fish, T., Wolf, N., Harris, B.P., Planas, J.V. A comprehensive description of oocyte developmental stages in Pacific halibut, *Hippoglossus stenolepis*. *Journal of Fish Biology.* 2020. 97: 1880-1885. doi: 10.1111/jfb.14551.

Fish, T., Wolf, N., Smeltz, T. S., Harris, B. P., and Planas, J. V. Reproductive Biology of Female Pacific Halibut (*Hippoglossus stenolepis*) in the Gulf of Alaska. *Frontiers in Marine Science.* 2022. 9:801759. doi: 10.3389/fmars.2022.801759.

Simchick, C., Simeon, A., Bolstad, K., Planas, J.V. Endocrine patterns associated with ovarian development in female Pacific halibut (*Hippoglossus stenolepis*). *General and Comparative Endocrinology*. 2024. 347: 114425. https://doi.org/10.1016/j.ygcen.2023.114425

Integration with Stock Assessment and MSE: Research activities in this Research Area aim at providing information on key biological processes related to reproduction in Pacific halibut (maturity and fecundity) and to provide sex ratio information of Pacific halibut commercial landings. The relevance of research outcomes from these activities for stock assessment is in the scaling of Pacific halibut biomass and in the estimation of reference points and fishing intensity. These research outputs will result in a revision of current maturity schedules and will be included as inputs into the stock assessment and represent the most important biological inputs for stock assessment. The relevance of these research outcomes for MSE is in the improvement of the simulation of spawning biomass in the Operating Model.

3. Growth

3.1 Identification of physiological growth markers and their application for growth pattern evaluation. Planned research outcomes: informative physiological growth markers to monitor somatic growth variation in Pacific halibut.

Main results:

- Transcriptomic profiling by RNA sequencing of white skeletal muscle from juvenile Pacific halibut subjected to temperature-induced growth manipulations.
- Identification of a set of genes that change their expression levels in response to growth suppression and to growth stimulation: growth marker identification.
- Proteomic profiling by LC-MS/MS of white skeletal muscle from juvenile Pacific halibut subjected to temperature-induced growth manipulations.
- Identification of a set of proteins that change their abundance in response to growth suppression and to growth stimulation: growth marker identification.
- Application of putative growth marker genes in the characterisation of somatic growth variation in Pacific halibut juveniles collected in the Eastern Bering Sea by the NMFS Trawl Survey.
- Transcriptomic profiling by RNA sequencing of white skeletal muscle from juvenile Pacific halibut subjected to density- and stress-induced growth manipulations under experimental conditions.

Publications:

Planas, J.V., Jasonowicz, A.J., Simeon, A., Simchick, C., Timmins-Schiffman, E., Nunn, B.L., Kroska, A.C., Wolf, N., and Hurst, T.P. Molecular mechanisms underlying thermally induced growth plasticity in juvenile Pacific halibut. *Journal of Experimental Biology*. 2025. 228 (19): jeb251013. https://doi.org/10.1242/jeb.251013.

Integration with Stock Assessment and MSE: Research activities conducted in this Research Area aim at providing information on somatic growth processes driving size-at-age in Pacific halibut. The relevance of research outcomes from these activities for stock assessment resides, first, in their ability to inform yield-per-recruit and other spatial evaluations for productivity that support mortality limit-setting, and second, in that they may provide covariates for projecting short-term size-at-age and may help delineate between fishery and environmental effects, thereby informing appropriate management responses. The relevance of these research outcomes for MSE is in the improvement of the simulation of variability and to allow for scenarios investigating climate change.

4. Mortality and Survival Assessment

4.1 Discard mortality rate estimation in the longline Pacific halibut fishery. Planned research outcomes: full characterisation of discarded Pacific halibut in the longline fishery.

Main results:

- Hook release methods strongly influence the viability category assigned to discarded Pacific halibut in the longline fishery, with careful shaking and gangion cutting resulting in >75% of fish being assigned to the excellent viability category.
- The use of the hook stripper results in >85% of the fish being classified in the moderate and poor viability categories, and sustained injuries of medium and high severity particularly among

smaller fish. These results support minimising the use of hook strippers in non-directed fisheries to optimise survival of discarded Pacific halibut.

- High lactate plasma levels and low hematocrit were characteristic of fish assigned to the dead viability category, and were attributed to sand flee intrusion.
- Reducing the use of hook strippers and limiting soak times in areas of known sand flea activity are likely to improve viability outcomes of Pacific halibut released from commercial longline gear.

Publications:

Dykstra, C., Wolf, N., Harris, B.P., Stewart, I.J., Hicks, A., Restrepo. F., Planas, J.V. Relating capture and physiological conditions to viability and survival of Pacific halibut discarded from commercial longline gear. *Ocean & Coastal Management*. 2024. 249: 107018. https://doi.org/10.1016/j.ocecoaman.2024.107018.

4.2 Discard mortality rate estimation in the guided recreational Pacific halibut fishery. Planned research outcomes: experimentally-derived discard mortality rate, full characterisation of discarded Pacific halibut and assessment of best handling practices.

Main results:

- The mortality rate estimated from Pacific halibut captured and released in excellent viability category is 1.35%.
- The size of circle hooks (12/0 and 16/0) does not affect the size of the catch nor the types of injuries incurred by captured fish, with torn cheek being the predominant injury for both hook sizes.
- The levels of stress indicators in the blood (glucose and lactated, and cortisol to a lesser extent) increase with fight time.
- Our results on the low level of mortality associated with the release of Pacific halibut in excellent viability category is consistent with current discard mortality estimates.

Publications:

Dykstra, C.L., Wolf, N., Harris, B.D., Stewart, I.J., Hicks, A., Planas, J.V. Discard mortality rates of recreationally caught Pacific halibut (*Hippoglossus stenolepis*). 2026. In Preparation for submission to *Fisheries Management and Ecology*.

Integration with Stock Assessment and MSE: The relevance of research outcomes from these activities for stock assessment resides in their ability to accurately capture trends in unobserved mortality in order to improve estimates of stock productivity and represent the most important inputs in fishery yield for stock assessment. The relevance of these research outcomes for MSE is in fishery parametrisation

5. Fishing Technology

5.1 Investigations on new methods for whale avoidance and/or deterrence for the reduction of Pacific halibut depredation by whales (e.g. catch protection methods). Planned research outcomes: information on feasibility, and performance of catch protection devices.

Main results:

- A virtual International Workshop (link) was organised in 2022 on protecting fishery catches from whale depredation with industry (affected fishers, gear manufacturers), gear researchers and scientists to identify methods to protect fishery catches from depredation.
- Development of two catch protection designs stemming from the outcomes of the International Workshop into functional prototypes.
- Successful initial testing of two selected catch protection devices (underwater shuttle and branch gear with sliding shroud system) in the field.
- As a catch protection device, the shuttle is a safe and effective gear type that entrained comparable quantities, sizes and types of fish as control (i.e. longline) gear.
- Additional testing in the presence of whales was conducted in May of 2025.

5.2 Investigate physiological and behavioral responses of Pacific halibut to fishing gear in order to reduce bycatch. Planned research outcomes: effective ways to reduce Pacific halibut bycatch and bycatch of non-targeted species.

Main results:

- Hook size did not significantly affect the catch efficiency of Pacific halibut or yelloweye rockfish.
- Circle hooks with a 45° appendage angle caught fewer yelloweye rockfish than hooks without an appendage, irrespective of hook size, and did not affect the catch efficiency of Pacific halibut.
- Hook appendages could have potential use in reducing catch rates on yelloweye rockfish in Pacific halibut longline fisheries.

Publications:

Lomeli, M.J.M., Wakefield, W.W., Abele, M., Dykstra, C.L., Herrmann, B., Stewart, I.J., and G.C. Christie. Testing of hook sizes and appendages to reduce yelloweye rockfish bycatch in a Pacific halibut longline fishery. *Ocean & Coastal Management*. 2023. 241: 106664. https://doi:10.1016/j.ocecoaman.2023.106664.

Heppell, D.S., Lomeli, M.J.M., Wakefield W.W., Herrmann, B., Dykstra, C.L., and Stewart, I.J. Hook modification to reduce rockfish and Pacific spiny dogfish bycatch in the U.S. West Coast Pacific halibut longline fishery. *Reviews in Fish Biology and Fisheries*. 2026. 36: 38. https://doi.org/10.1007/s11160-026-10042-7.

Integration with Stock Assessment and MSE: The relevance of research outcomes from these activities for stock assessment resides in the improvement of mortality accounting through a reduction of depredation mortality, thereby increasing the available yield for directed fisheries. Depredation mortality can also be included as another explicit source of mortality in the stock assessment and mortality limit setting process, depending on the estimated magnitude.

APPENDIX II
EXTERNAL FUNDING RECEIVED BY THE IPHC

Project #	Grant agency	Project name	PI	Partners	IPHC Budget ($US)	Management implications	Grant period
1	**Saltonstall-Kennedy NOAA**	Improving discard mortality rate estimates in the Pacific halibut by integrating handling practices, physiological condition and post-release survival (NOAA Award No. NA17NMF4270240)	IPHC	Alaska Pacific University	$286,121	Bycatch estimates	September 2017 – August 2020
2	**North Pacific Research Board**	Somatic growth processes in the Pacific halibut (*Hippoglossus stenolepis*) and their response to temperature, density and stress manipulation effects (NPRB Award No. 1704)	IPHC	AFSC-NOAA-Newport, OR	$131,891	Changes in biomass/size-at-age	September 2017 – February 2020
3	**Bycatch Reduction Engineering Program - NOAA**	Adapting Towed Array Hydrophones to Support Information Sharing Networks to Reduce Interactions Between Sperm Whales and Longline Gear in Alaska	Alaska Longline Fishing Association	IPHC, University of Alaska Southeast, AFSC-NOAA	-	Whale Depredation	September 2018 – August 2019
4	**Bycatch Reduction Engineering Program - NOAA**	Use of LEDs to reduce Pacific halibut catches before trawl entrainment	Pacific States Marine Fisheries Commission	IPHC, NMFS	-	Bycatch reduction	September 2018 – August 2019
5	**National Fish & Wildlife Foundation**	Improving the characterisation of discard mortality of Pacific halibut in the recreational fisheries (NFWF Award No. 61484)	IPHC	Alaska Pacific University, U of A Fairbanks, charter industry	$98,902	Bycatch estimates	April 2019 – November 2021
6	**North Pacific Research Board**	Pacific halibut discard mortality rates (NPRB Award No. 2009)	IPHC	Alaska Pacific University,	$210,502	Bycatch estimates	January 2021 –March 2022
7	**Bycatch Reduction Engineering Program - NOAA**	Gear-based approaches to catch protection as a means for minimising whale depredation in longline fisheries (NA21NMF4720534)	IPHC	Deep Sea Fishermen's Union, Alaska Fisheries Science Center-NOAA, industry representatives	$99,700	Mortality estimations due to whale depredation	November 2021 – October 2022
8	**North Pacific Research Board**	Pacific halibut population genomics (NPRB Award No. 2110)	IPHC	Alaska Fisheries Science Center-NOAA	$193,685	Stock structure	December 2021- January 2024

9	**Bycatch Reduction Engineering Program - NOAA**	Full scale testing of devices to minimize whale depredation in longline fisheries (NA23NMF4720414)	IPHC	NOAA Fisheries -Alaska Fisheries Science Center (Seattle)	$199,870	Mortality estimations due to whale depredation	November 2023 – April 2026
10	**Alaska Sea Grant**	Development of a non-lethal genetic-based method for aging Pacific halibut (R/2024-05)	IPHC, Alaska Pacific Univ. (APU)	Alaska Fisheries Science Center-NOAA (Juneau)	$60,374	Stock structure	January 2025-December 2026
				Total awarded ($)	**$1,281,045**		

APPENDIX III
PUBLICATIONS ARISING

2020:

Fish, T., Wolf, N., Harris, B.P., Planas, J.V. A comprehensive description of oocyte developmental stages in Pacific halibut, *Hippoglossus stenolepis*. *Journal of Fish Biology*. 2020. 97: 1880-1885. https://doi: 10.1111/jfb.14551.

Stewart, I.J., Hicks, A.C., and Carpi, P. 2021. Fully subscribed: Evaluating yield trade-offs among fishery sectors utilizing the Pacific halibut resource. Fisheries Research **234**. doi:10.1016/j.fishres.2020.105800.

Webster, R.A., Soderlund, E., Dykstra, C.L., and Stewart, I.J. 2020. Monitoring change in a dynamic environment: spatio-temporal modelling of calibrated data from different types of fisheries surveys of Pacific halibut. Canadian Journal of Fisheries and Aquatic Sciences **77**: 1421–1432.

Forrest, R.E., Stewart, I.J., Monnahan, C.C., Bannar-Martin, K.H., and Lacko, L.C. 2020. Evidence for rapid avoidance of rockfish habitat under reduced quota and comprehensive at-sea monitoring in the British Columbia Pacific halibut fishery. Canadian Journal of Fisheries and Aquatic Sciences **77**: 1409–1420.

2021:

Carpi, P., Loher, T., Sadorus, L., Forsberg, J., Webster, R., Planas, J.V., Jasonowicz, A., Stewart, I. J., Hicks, A. C. Ontogenetic and spawning migration of Pacific halibut: a review. *Rev Fish Biol Fisheries*. 2021. https://doi.org/10.1007/s11160-021-09672-w.

Kroska, A.C., Wolf, N., Planas, J.V., Baker, M.R., Smeltz, T.S., Harris, B.P. Controlled experiments to explore the use of a multi-tissue approach to characterizing stress in wild-caught Pacific halibut (*Hippoglossus stenolepis*). *Conservation Physiology* 2021. 9(1):coab001. https://doi:10.1093/conphys/coab001.

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Lomeli, M.J.M., Wakefield, W.W., Herrmann, B., Dykstra, C.L., Simeon, A., Rudy, D.M., Planas, J.V. Use of Artificial Illumination to Reduce Pacific Halibut Bycatch in a U.S. West Coast Groundfish Bottom Trawl. *Fisheries Research*. 2021. 233: 105737. doi: 10.1016/j.fishres.2020.105737.

Sadorus, L., Goldstein, E., Webster, R., Stockhausen, W., Planas, J.V., Duffy-Anderson, J. Multiple life-stage connectivity of Pacific halibut (*Hippoglossus stenolepis*) across the Bering Sea and Gulf of Alaska. *Fisheries Oceanography*. 2021. 30:174-193. doi: https://doi.org/10.1111/fog.12512.

Stewart, I.J., Scordino, J.J., Petersen, J.R., Wise, A.W., Svec, C.I., Buttram, R.H., Monette, J.L., Gonzales, M.R., Svec, R., Scordino, J., Butterfield, K., Parker, W., and Buzzell, L.A. 2021. Out with the new and in with the old: reviving a traditional Makah halibut hook for modern fisheries management challenges. Fisheries **46**(7): 313–320. doi:10.1002/fsh.10603.

2022:

Fish, T., Wolf, N., Smeltz, T. S., Harris, B. P., and Planas, J. V. Reproductive Biology of Female Pacific Halibut (*Hippoglossus stenolepis*) in the Gulf of Alaska. *Frontiers in Marine Science* 2022. 9:801759. doi: 10.3389/fmars.2022.801759.

Jasonowicz, A.C., Simeon, A., Zahm, M., Cabau, C., Klopp, C., Roques, C., Iampietro, C., Lluch, J., Donnadieu, C., Parrinello, H., Drinan, D.P., Hauser, L., Guiguen, Y., Planas, J.V. Generation of a chromosome-level genome assembly for Pacific halibut (*Hippoglossus stenolepis*) and characterization of its sex-determining genomic region. *Molecular Ecology Resources.* 2022. 22: 2685–2700. doi: https://doi.org/10.1111/1755-0998.13641.

Loher, T., McCarthy, O., Sadorus, L.L., Erikson, L.M., Simeon, A., Drinan, D.P., Hauser, L., Planas, J.V., and Stewart, I.J. 2022. A Test of Deriving Sex-Composition Data for the Directed Pacific Halibut Fishery via At-Sea Marking. Marine and Coastal Fisheries **14**(4). doi:10.1002/mcf2.10218.

Loher, T., Dykstra, C.L., Hicks, A., Stewart, I.J., Wolf, N., Harris, B.P., Planas, J.V. Estimation of post release longline mortality in Pacific halibut using acceleration-logging tags. *North American Journal of Fisheries Management*. 2022. 42: 37-49. DOI: http://dx.doi.org/10.1002/nafm.10711.

2023:

Lomeli, M.J.M., Wakefield, W.W., Abele, M., Dykstra, C.L., Herrmann, B., Stewart, I.J., and G.C. Christie. Testing of hook sizes and appendages to reduce yelloweye rockfish bycatch in a Pacific halibut longline fishery. *Ocean & Coastal Management* .2023. 241: 106664. https://doi:10.1016/j.ocecoaman.2023.106664.

Planas, J.V., Rooper, C.N., Kruse, G.H. Integrating biological research, fisheries science and management of Pacific halibut (Hippoglossus stenolepis) across the North Pacific Ocean. *Fisheries Research*. 2023. 259: 106559. https://doi.org/10.1016/j.fishres.2022.106559.

2024:

Dykstra, C., Wolf, N., Harris, B.P., Stewart, I.J., Hicks, A., Restrepo. F., Planas, J.V. Relating capture and physiological conditions to viability and survival of Pacific halibut discarded from commercial longline gear. *Ocean & Coastal Management*. 2024. 249: 107018. https://doi.org/10.1016/j.ocecoaman.2024.107018.

Hutniczak, B., Wilson, D.T., Stewart, I.J., and Hicks, A.C. 2024. A hundred years of Pacific halibut management in the context of global events and trends in fisheries management. Frontiers in Marine Science **11**. doi:10.3389/fmars.2024.1424002.

Sadorus, L.L., Webster, R.A. and Sullivan, M.E. Environmental conditions on the Pacific halibut (Hippoglossus stenolepis) fishing grounds obtained from a decade of coastwide oceanographic monitoring, and the potential application of these data in stock analyses. *Marine and Freshwater Research*. 2024. 75: MF23175. https://doi.org/10.1071/MF23175

Simchick, C., Simeon, A., Bolstad, K., Planas, J.V. Endocrine patterns associated with ovarian development in female Pacific halibut (*Hippoglossus stenolepis*). *General and Comparative Endocrinology*. 2024. 347: 114425. https://doi.org/10.1016/j.ygcen.2023.114425

2025:

Adams, G.D., Holsman, K., Rovellini, A., Stewart, I.J., Privitera-Johnson, K., Wassermann, S.N., and Punt, A.E. 2025. Implications of predator–prey dynamics for single species management. Canadian Journal of Fisheries and Aquatic Sciences 82: 1–19. doi:10.1139/cjfas-2024-0225.

Planas JV, Jasonowicz AJ, Simeon A, Simchick C, Timmins-Schiffman E, Nunn BL, Kroska AC, Wolf N, Hurst TP. Molecular mechanisms underlying thermally induced growth plasticity in juvenile Pacific halibut. Journal of Experimental Biology. 2025. 228 (19): jeb-251013. https://doi.org/10.1242/jeb.251013

Ritchie, BA, Smeltz, TS, Stewart, IJ, Harris, BP, and N. Wolf. 2025. Exploring Spatial and Temporal Patterns in the Size-At-Age of Pacific Halibut in the Gulf of Alaska. Fisheries Management and Ecology. doi:10.1111/fme.12814.

Stewart, I.J., and Monnahan, C.C. 2025. Diagnosing common sources of lack of fit to composition data in fisheries stock assessment models using One-Step-Ahead (OSA) residuals. Canadian Journal of Fisheries and Aquatic Sciences. http://dx.doi.org/10.1139/cjfas-2025-0158.

2026*:*

Heppell, D.S., Lomeli, M.J.M., Wakefield, W.W., Herrmann, B., Dykstra, C.L., and Stewart, I.J. 2026. Hook modification to reduce rockfish and Pacific spiny dogfish bycatch in the U.S. West Coast Pacific halibut longline fishery. Reviews in Fish Biology and Fisheries **36**(1). doi:10.1007/s11160-026-10042-7.

Submitted peer-reviewed journal papers – In review

Larson, S., Lowry, D., Andrews, K., Dykstra, C.L., Juanes, F., Timmer, B., and May, S. Molecular relatedness-based analyses reveal breeding site philopatry in female bluntnose sixgill sharks (*Hexanchus griseus*). Frontiers of Marine Science.

McGilliard, C.R., Ianelli, J., Cunningham, C., Hicks, A., Hanselman, D., Stram, D., Henry, A. Evaluating Bering Sea Pacific halibut bycatch management options using closed-loop simulations in a dynamic, multi-agency setting. Canadian Journal of Fisheries and Aquatic Sciences.

APPENDIX IV
LIST OF RANKED RESEARCH PRIORITIES FOR STOCK ASSESSMENT

Research priorities for the Pacific halibut stock assessment are delineated into three broad categories: improvements in basic biological understanding (including fishery dynamics), investigation of existing data series and collection of new information, and technical development of models and modelling approaches. The highest priority items in each of these categories are highlighted in the 5YPIRM and are expected to be the primary focus of ongoing efforts. However, it is helpful to maintain a longer list of items to inform future prioritization, to create a record of data and research needs, and to foster opportunistic and/or collaborative work on these topics when possible.

Biological understanding and fishery yield:

- *Highest priority*: Updating the fecundity-weight relationship and the presence and/or rate of skip spawning.
- *Highest priority*: The relative role of potential factors underlying changes in size-at-age is not currently understood. Delineating between competition, density dependence, environmental effects, size-selective fishing and other factors could allow improved prediction of size-at-age under future conditions.
- Movement rates among Biological Regions at the adult, juvenile and larval stages remain uncertain and likely variable over time. Long-term research to inform these rates could lead to a spatially explicit stock assessment model for future inclusion into the ensemble.
- Improved understanding of recruitment processes and larval dynamics could lead to covariates explaining more or the residual variability about the stock-recruit relationship than is currently accounted for via the binary indicator used for the Pacific Decadal Oscillation.

Potential projects relating to existing and new data sources that could benefit the Pacific halibut stock assessment:

- *Highest priority*: Continued collection of sex-ratio from the commercial landings will provide valuable information for determining relative selectivity of males and females, and therefore the scale of the estimated spawning biomass, and the level of fishing intensity as measured by SPR.
- *Highest priority*: Evaluation of the magnitude of marine mammal depredation and tools to reduce it.
- A space-time model could be used to calculate weighted FISS and/or commercial fishery age-composition data. This might alleviate some of the lack of fit to existing data sets that is occurring not because of model misspecification but because of incomplete spatial coverage in the annual FISS sampling which is accounted for in the generation of the index, but not in the standardization of the composition information.
- The work of Monnahan and Stewart (2015) modelling commercial fishery catch rates could be used to provide a standardized fishery index for the recent time-series that would be analogous to the space-time model used for the FISS.
- There is a vast quantity of archived historical data that is currently inaccessible until organized, electronically entered, and formatted into the IPHC's database with appropriate meta-data. Information

on historical fishery landings, effort, and age samples would provide a much clearer (and more reproducible) perception of the historical period.

- Additional efforts could be made to reconstruct estimates of subsistence harvest prior to 1991.
- Discard mortality estimates for the IPHC Regulatory Area 2B recreational fishery are currently unavailable, but there is an estimation system in place. Further work to develop these estimates would be preferable to the use of proxy rates from IPHC Regulatory Area 2C.
- NMFS observer data from the directed Pacific halibut fleet in Alaska could be evaluated for use in updating discard mortality rates and the age-distributions for discard mortality. This may be more feasible if observer coverage is increased and if smaller vessels (< 40 feet LOA, 12.2 m) are observed in the future. Post-stratification and investigation of observed vs. unobserved fishing behavior may be required.
- Historical bycatch length frequencies and mortality estimates should be reanalyzed accounting for sampling rates in target fisheries and evaluating data quality over the historical period.
- There are currently no comprehensive variance estimates for the sources of mortality used in the assessment models. In some cases, variance due to sampling and perhaps even non-sampling sources could be quantified and used as inputs to the models via scaling parameters or even alternative models in the ensemble.

Technical explorations and improvements that could benefit the stock assessment models and ensemble framework:

- *Highest priority*: Maintaining consistency and coordination between MSE, and stock assessment data, modelling and methodology.
- *Highest priority*: Exploration of state-space models for Pacific halibut allowing for direct estimation of the variance in time-varying processes.
- *Highest priority*: Continued exploration into the estimation of *M* in the short coastwide model.
- Continued refinement of the ensemble of models used in the stock assessment. This may include investigation of alternative approaches to modelling selectivity that would reduce relative down-weighting of certain data sources (see section above), evaluation of additional axis of uncertainty (e.g., steepness, as explored above), or others.
- Exploration of methods for better including uncertainty in directed and non-directed discard mortalities in the assessment (now evaluated only via alternative mortality projection tables or model sensitivity tests) in order to better include these sources uncertainty in the decision table. These could include explicit discard/retention relationships, including uncertainty in discard mortality rates, and allow for some uncertainty directly in the magnitude of mortality for these sources.
- Bayesian methods for fully integrating parameter uncertainty may provide improved uncertainty estimates within the models contributing to the assessment, and a more natural approach for combining the individual models in the ensemble (see section above).

- Alternative model structures, including a growth-explicit statistical catch-at-age approach and a spatially explicit approach may provide avenues for future exploration. Efforts to develop these approaches thus far have been challenging due to the technical complexity and data requirements of both. Previous reviews have indicated that such efforts may be more tractable in the context of operating models for the MSE, where conditioning to historical data may be much more easily achieved than fully fitting an assessment model to all data sources for use in tactical management decision making.

Summary table of top ranked biological research priorities for stock assessment (SA)

SA Rank	Research outcomes	Relevance for SA	Specific analysis input	Research Area	Research activities
1. Biological input	Fecundity-at-age and -size information	Scale biomass and reference point estimates	Will be used to move from spawning biomass to egg-output as the metric of reproductive capability in the stock assessment and management reference points	Reproduction	Fecundity assessment
	Incidence of skip spawning		Will be used to adjust the asymptote of the maturity schedule, if/when a time-series is available this will be used as a direct input to the stock assessment		Examination of potential skip spawning
	Revised temporal and spatial maturity schedules		Will be used to revise the maturity schedule used in stock assessment		Continued temporal and spatial analysis of female histology-based maturity-at-age estimates
	Revised field maturity classification		Revised time-series of historical (and future) maturity for input to the stock assessment		Examination of accuracy of current field macroscopic maturity classification
2. Biological input	Understanding the role of factors driving size-at-age	Improve estimates of biomass and fishery yield	Will be used to identify contributors to historical trends in biomass and fishery yield	Growth and size-at-age	Studies on growth and size-at-age
1. Assessment data collection and processing	Sex ratio-at-age	Scale biomass and fishing intensity	Annual sex-ratio at age for the commercial fishery fit by the stock assessment	Reproduction	Sex ratio of current commercial landings
	Historical sex ratio-at-age		Annual sex-ratio at age for the commercial fishery fit by the stock assessment		Historical sex ratios based on archived otolith DNA analyses
2. Assessment data collection and processing	New tools for fishery avoidance and/or reduction of depredation	Improve mortality accounting	May reduce depredation mortality, thereby increasing available yield for directed fisheries. May also be included as another explicit source of mortality in the stock assessment and mortality limit setting process depending on the estimated magnitude	Fishing innovations	Whale depredation accounting and tools for avoidance

APPENDIX V
LIST OF RANKED RESEARCH PRIORITIES FOR MANAGEMENT STRATEGY EVALUATION

Summary table of top ranked biological research priorities for management strategy evaluation (MSE)

MSE Rank	Research outcomes	Relevance for MSE	Research Area	Research activities
1. Biological parameterization: Movement and distribution of life stages	Improved understanding of larval and juvenile distribution	Improve parametization of the Operating Model and provide justification for parametising temporal variability. Assist with conditioning the OM, very patterns simulated from the OM, and provide information to develop reasonable sensitivity scenarios to test the robustness of MPs	Migration and population dynamics	Larval and juvenile connectivity studies
	Ontogenetic movement and resulting adult distribution			Population structure and dynamics
	Genomic analysis of population size and connectivity			Genomic and Close-Kin Mark-Recapture studies (Horizon Scan)
2. Biological parameterization: spatial spawning patterns and connectivity between spawning populations	Information on spatial heterogeneity in the Pacific halibut population	Information on spatial heterogeneity can be incorporated directly into the OM, and/or into an objective to maintain spatial heterogeneity.		Population structure and dynamics
	Information on temporal and spatial maturity and spawning patterns	Improve simulation of recruitment variability and parametization of recruitment distribution in the Operating Model	Reproduction	Temporal and spatial analyses of maturity and spawning activity
3. Biological parameterization of growth variation	Environmental and ecological influences on growth patterns	Improve simulation of variability in weight-at-age and allow for scenarios investigating influence of population size or environmental factors	Growth and size-at-age	Evaluation of somatic growth variation as a driver for changes in size-at-age

Report on Current and Future Biological and Ecosystem Science Research Activities

PREPARED BY: IPHC SECRETARIAT (J. PLANAS, C. DYKSTRA, A. JASONOWICZ, C. JONES, 14 OCTOBER 2026)

PURPOSE

To provide the Research Advisory Board (RAB) with a description of the biological and ecosystem science research projects conducted and planned by the IPHC Secretariat and contemplated within the Five-year Program of Integrated Research and Monitoring (2022-2026).

BACKGROUND

The main objectives of the Biological and Ecosystem Science Research at the IPHC are to:

1) identify and assess critical knowledge gaps in the biology of the Pacific halibut (*Hippoglossus stenolepis*);
2) understand the influence of environmental conditions; and
3) apply the resulting knowledge to reduce uncertainty in current stock assessment models.

The primary biological research activities at IPHC that follow Commission objectives are identified and described in the IPHC Five-Year Program of Integrated Research and Monitoring (2022-2026). These activities are summarized in five broad research areas designed to provide inputs into stock assessment and the management strategy evaluation processes (Appendix I), as follows:

1) Migration and Population Dynamics. Studies are aimed at improving current knowledge of Pacific halibut migration and population dynamics throughout all life stages in order to achieve a complete understanding of stock structure and distribution across the entire distribution range of Pacific halibut in the North Pacific Ocean and the biotic and abiotic factors that influence it.
2) Reproduction. Studies are aimed at providing information on the sex ratio of the commercial catch and to improve current estimates of maturity.
3) Growth. Studies are aimed at describing the role of factors responsible for the observed changes in size-at-age and at evaluating growth and physiological condition in Pacific halibut.
4) Mortality and Survival Assessment. Studies are aimed at providing updated estimates of discard mortality rates in the guided recreational fisheries and at evaluating methods for reducing mortality of Pacific halibut.
5) Fishing Technology. Studies are aimed at developing methods that involve modifications of fishing gear with the purpose of reducing Pacific halibut mortality due to depredation and bycatch.

DISCUSSION ON CURRENT RESEARCH ACTIVITIES

1. Migration and Population Dynamics.

The IPHC Secretariat is currently conducting studies on Pacific halibut juvenile habitat and movement through conventional wire tagging, as well as studies that incorporate genomics approaches to produce useful information on population structure and distribution and connectivity of Pacific halibut. The relevance of research outcomes from these activities for stock assessment (SA) resides (1) in the introduction of possible changes in the structure of future stock assessments, as separate assessments may be constructed if functionally isolated components of the population are found (e.g. IPHC Regulatory Area 4B), and (2) in the improvement of productivity estimates, as this information may be used to define management targets for minimum spawning biomass by Biological Region. These research outcomes provide the second and third top ranked biological inputs into SA (Appendix II). Furthermore, the relevance of these research outcomes for the management and strategy evaluation process is in biological parametization and validation of movement estimates, on one hand, and of recruitment distribution, on the other hand (Appendix III).

1.1. Genetic-based method for estimating age of Pacific halibut. The primary objective of this project (funded by Alaska Sea Grant; Appendix IV) is to develop an alternative genetic method for aging Pacific halibut using fin tissue, a sample that can be easily collected from either live or dead individuals. This method is based on the identification of DNA methylation patterns (i.e. chemical modifications in DNA that do not involve changes in DNA sequence) in fin tissue that are associated with age through the development of an age estimation model (i.e., an epigenetic clock) for Pacific halibut.

To develop an epigenetic clock for Pacific halibut, we selected genetic samples (fin clips) from 249 fish collected in the FISS from 2021 to 2024 throughout IPHC Convention Waters (Figure 1) including most of IPHC's Regulatory Areas (Table 1). These genetic samples correspond to fish with known ages (read twice by the break and bake aging method) between 6 to 30 years of age and include 6-10 individual samples (aiming at equal number of males and females) per year of age (Figure 1).

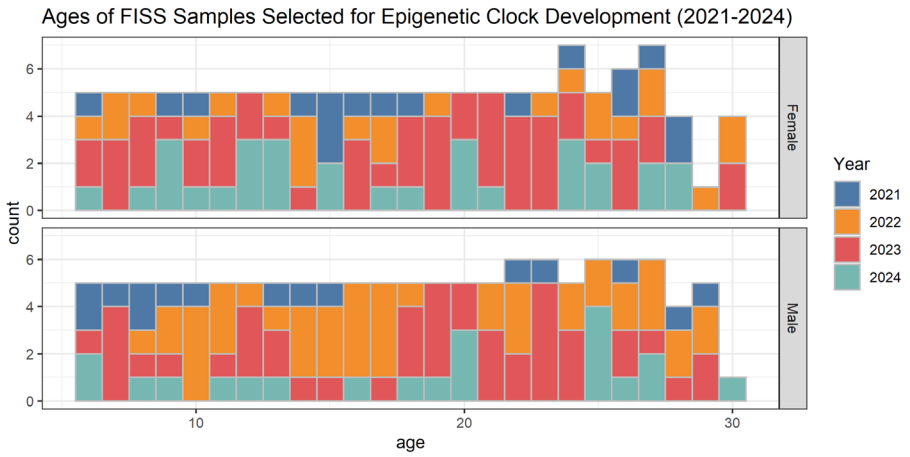

Figure 1. Histograms showing the number of female (top) and male (bottom) genetic samples by age year that are available for the development of the Pacific halibut epigenetic clock.

Year	2A	2B	2C	3A	3B	4A	4B	4D	Total
2021	1	12	12	3	0	3	1	0	32
2022	2	22	17	20	2	2	3	1	69
2023	16	32	25	14	10	0	0	0	97
2024	0	15	26	7	1	0	0	2	51
Total	**19**	**81**	**80**	**44**	**13**	**5**	**4**	**3**	**249**

Table 1. Number of genetic samples available by year and IPHC Regulatory Area.

To date, all 249 genetic samples have been processed for DNA extraction and sequenced to identify methylated sites in the genome and quantify the percentage of methylation at each site. Current efforts are devoted to analyze the methylation data from all individuals using a bioinformatic pipeline developed specifically for this project. Once finalized, we will characterize the relationship between otolith-derived age and percent methylation across age-correlated genomic sites using established models.

2. Reproduction.

Research activities in this Research Area aim at providing information on key biological processes related to reproduction in Pacific halibut (maturity and fecundity) and to provide sex ratio information of Pacific halibut commercial landings. The relevance of research outcomes from these activities for stock assessment (SA) is in the scaling of Pacific halibut biomass and in the estimation of reference points and fishing intensity. These research outputs will result in a revision of current maturity schedules and will be included as inputs into the SA (Appendix II) as they represent the most important biological inputs for SA. The relevance of these research outcomes for the management and strategy evaluation process is in the improvement of the simulation of spawning biomass in the Operating Model (Appendix III).

Recent sensitivity analyses have shown the importance of changes in spawning output due to changes in maturity schedules and/or skip spawning and fecundity for SA (Stewart and Hicks, 2018). Information on these key reproductive parameters provides direct input to SA. For example, information on fecundity-at-age and -size could be used to replace spawning biomass with egg output as the metric of reproductive capability in the SA and management reference points. This information highlights the need for a better understanding of factors influencing reproductive biology and success of Pacific halibut. To fill existing knowledge gaps related to the reproductive biology of female Pacific halibut, research efforts are devoted to characterizing female reproduction in this species. Specific objectives of current studies include: 1) update of maturity schedules based on histology- and calibrated visual data; and 2) fecundity estimations using the auto-diametric method.

2.1. Update of maturity schedules based on histology and calibrated visual data. The IPHC Secretariat provided an update on spatial and temporal patterns in maturity ogives by Biological Region from 2022 to 2024, and a revised coastwide maturity ogive using histological based data in IPHC-2025-RAB026-06. At present, the IPHC Secretariat has submitted a manuscript for publication in a peer-reviewed journal describing the

temporal and spatial changes in histology-derived maturity ogives and ovarian developmental stages. Furthermore, the IPHC Secretariat developed a calibration between histological and visual maturity ogives from the 2022-2024 data and produced calibrated maturity ogives based on FISS visual maturity data from 2002-2024. During this 23-year period, we observed significant shifts in the age at 50% (A_{50}) maturity (Figure 2). These results evidence two temporal shifts, one characterized by a gradual increase in the A_{50} (i.e. females maturing at a later age) from 2004 to 2016, and a second one characterized by a sharp decrease in A_{50} from 2017 to 2022 (i.e. females rapidly maturing at an earlier age). Studies are planned to identify possible drivers of these temporal shifts in maturity-at-age in female Pacific halibut.

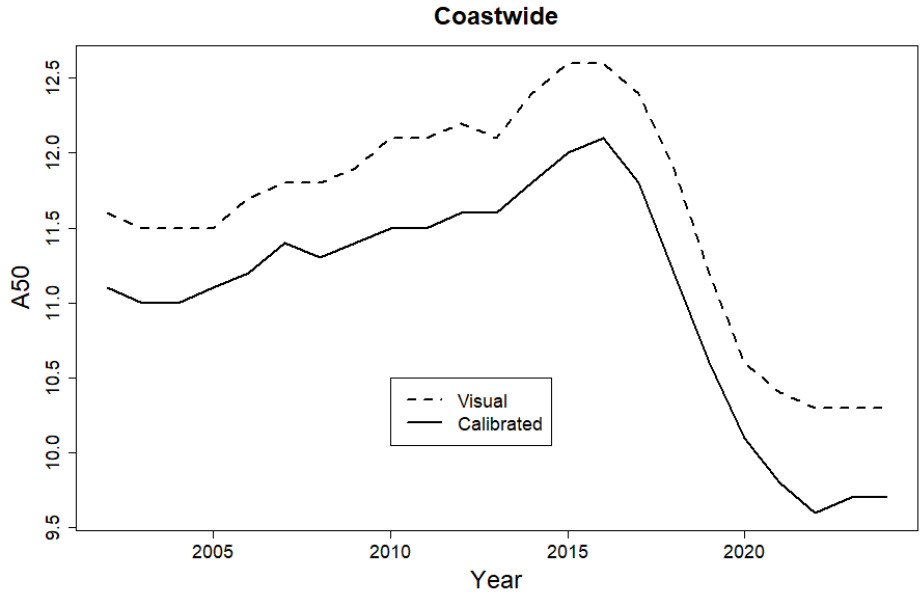

Figure 2. Coastwide A_{50} calculated from visual and calibrated maturity ogives from 2002 to 2024.

The IPHC Secretariat continued collecting ovarian samples for maturity in the 2025 and 2026 FISS seasons. In 2025, FISS sampling resulted in the successful collection of 1,276 ovarian samples from all four Biological Regions: 275 samples in Biological Region 2, 380 samples in Biological Region 3, 355 samples in Biological Region 4, and 266 samples in Biological Region 4B. In 2026, we collected 1,183 ovarian samples from Biological Regions 2, 3 and 4: 277 samples in Biological Region 2, 479 samples in Biological Region 3, and 427 samples in Biological Region 4. Unfortunately, no samples were collected in Biological Region 4B in 2026 due to the lack of FISS vessel bids. These samples will allow us to further investigate both spatial and temporal differences in histological-based female Pacific halibut maturity.

2.2. Fecundity estimations. The IPHC Secretariat has initiated studies that are aimed at improving our understanding of Pacific halibut fecundity. These studies will allow us to estimate fecundity-at-size and -age and could be used to replace spawning biomass with egg output as the metric for reproductive capability in SA and management

reference points. Fecundity determinations will be conducted using the auto-diametric method (Thorsen and Kjesbu, 2001; Witthames et al., 2009) and IPHC Secretariat staff received training on this method by experts in the field (NOAA Fisheries, Northeast Fisheries Science Center, Wood Hole, MA) in May 2023. Ovarian samples for the development and application of the auto-diametric method to estimate fecundity in female Pacific halibut have been collected during the FISS in 2023, 2024 and 2025, as well as two special collections in IPHC Regulatory Area 2B in 2024 and 2025 (Figure 3). In 2023, sampling was conducted only in Biological Region 3, with a total of 452 fecundity samples collected. In 2024, sampling was conducted in Biological Regions 2 and 4, with 149 and 359 fecundity samples collected, respectively. In the Fall (Oct/Nov) of 2024, 271 additional fecundity samples targeting large females (85-200+ cm in fork length) were collected in Biological Region 2. This sampling was conducted to collect later developing females to help build the auto-diametric curve for fecundity estimations. In 2025, in addition to 878 samples collected in all four Biological Regions in the FISS, 242 fecundity samples were collected in Biological Region 2 in a special project targeting large females during the late summer months. This comprehensive collection of ovarian samples will be used initially for the development of the auto-diametric method, followed by actual fecundity estimations by age and by size (length and weight).

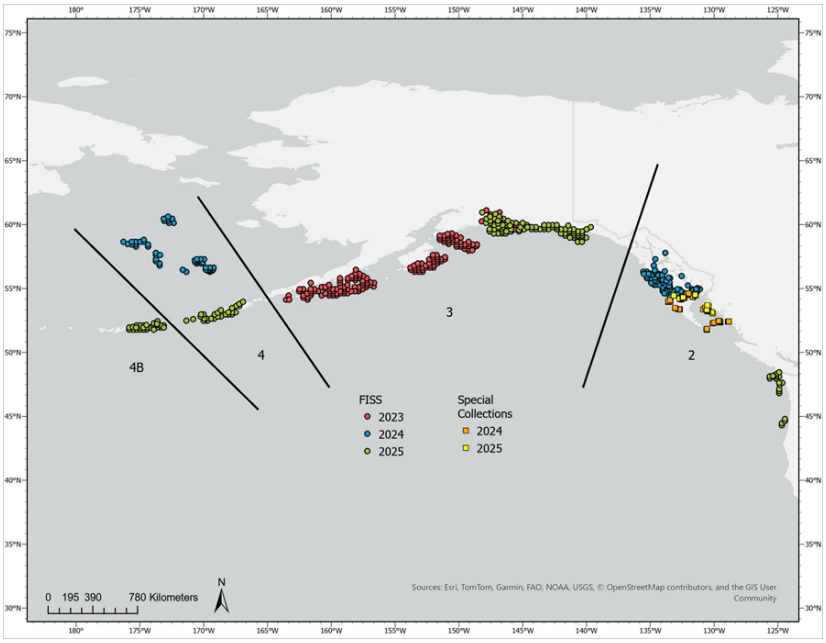

Figure 3. Coastwide map of 2023, 2024 and 2025 samples for fecundity collected in FISS (circle colors), and 2024 and 2025 special collection fecundity samples in IPHC Regulatory Area 2B (square colors).

From 2023-2025, a total of 1,154 ovarian samples from mature females (i.e. G2 field classification) were collected for fecundity estimations. When examining the age and weight distribution of mature females collected for fecundity sampling (Figures 4-5), the distribution of fish appeared to be skewed to the right for both parameters, but more pronounced for weight (Figure 5). For the mature female samples collected from 2023-2025, the total range of ages was from 6 to 38 years old, and the total range of weights was from 2 to 92 kg. The largest proportion of sampled fish was from 11 to 13 years old, and from 3 to 9 kg in weight.

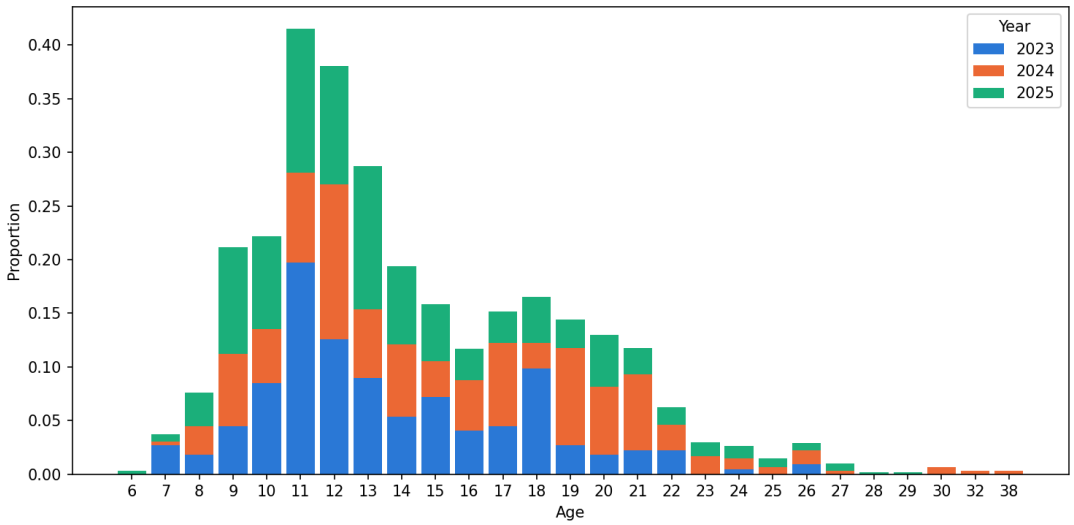

Figure 4. Stacked bar chart showing proportions of age (years) of mature (G2) female Pacific halibut collected for fecundity estimation in 2023, 2024, and 2025.

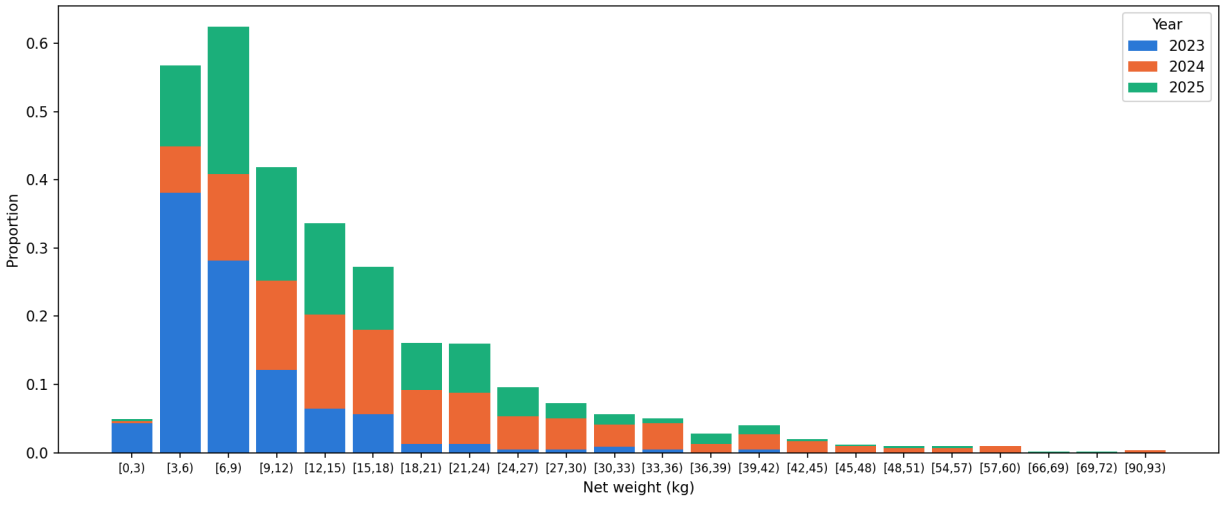

Figure 5. Stacked bar chart showing proportions of net weight (kg) of mature (G2) female Pacific halibut collected for fecundity estimation in 2023, 2024, and 2025.

To examine potential indicators of increased reproductive output of female Pacific halibut, IPHC Secretariat calculated gonadosomatic index (GSI) values for all fecundity samples that have been histologically staged. This includes all FISS samples in 2023 and 2024, as well as the special collection samples in Regulatory Area 2B in 2024 and 2025. GSI was calculated as $GSI = \frac{G}{W} x\ 100$. Where *G* = total gonad weight (kg), and *W* = dressed weight (kg). We compared GSI to age (Figure 6) and weight (Figure 7) across four different female ovarian developmental stages (Vtg1, Vtg2, Vtg3, and GVM).

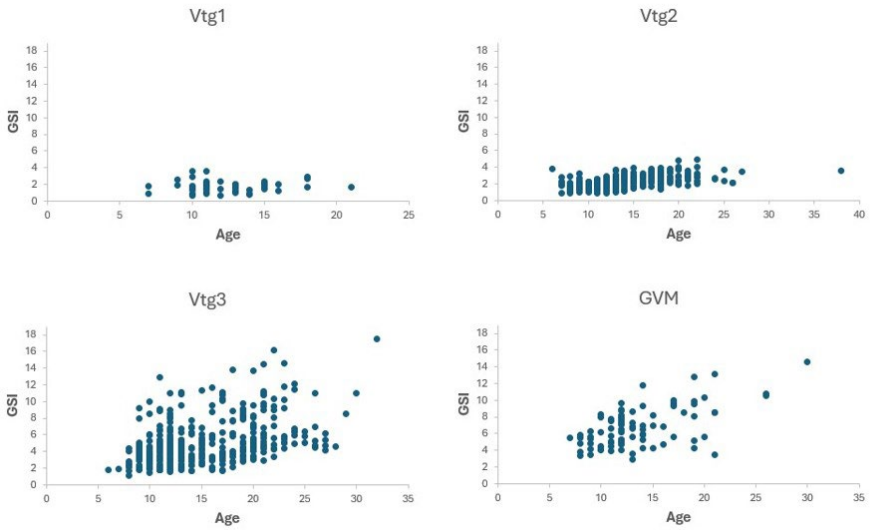

Figure 6. Gonadosomatic index (GSI) of female Pacific halibut according to age and female developmental stage (from less advanced to more advanced in maturity: Vitellogenic 1, Vtg1; Vitellogenic 2, Vtg2; Vitellogenic 3, Vtg3; Germinal Vesicle Migration, GVM).

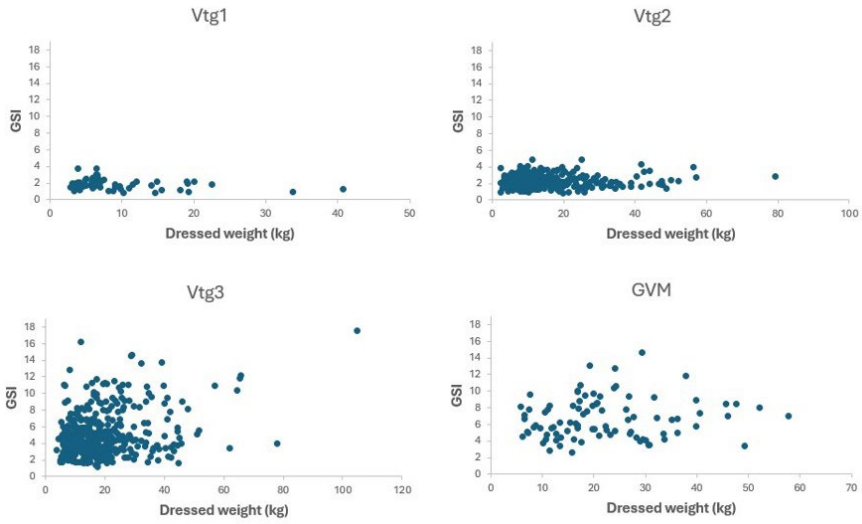

Figure 7. Gonadosomatic index (GSI) of female Pacific halibut according to weight and female developmental stage (please see legend to Figure 6 for abbreviations).

Our preliminary results show no increase in GSI with age for earlier developing females (e.g. Vtg1 and Vtg2), and a slight trend towards an increase in GSI with older females as they progress to the more advanced Vtg3 and GVM stages. When comparing GSI to weight, there is no indication of increasing gonad size with overall body weight, with higher variability in later stage developing females (Vtg3 and GVM). These preliminary results suggest that egg output might follow an isometric relationship with weight, which is the current assumption in the Pacific halibut SA.

In 2026, the IPHC Secretariat continued to collect ovarian samples during the FISS for fecundity estimation. Specifically, whole ovary weights and samples were collected from G2 (i.e. mature) females in Biological Region 2 (Sitka charter region), Biological Region 3 (Fairweather, Gore Pt., and Chignik charter regions), and Biological Region 4 (Unalaska charter region): 5, 29 and 38 samples collected, respectively. The IPHC Secretariat also collected fecundity samples from mid-September to October of 2026 (outside of FISS) during a special project in Biological Region 2 (Ommaney charter region) and Biological Region 3 (Gore Pt. charter region). In each Biological Region, 200 samples of G2 (i.e. mature) females greater than 90 cm in fork length were collected. These samples will allow the IPHC Secretariat to spatially compare fecundity estimations among multiple Biological Regions, as previous special project collections (2024 and 2025) were conducted in Biological Region 2.

3. Mortality and Survival Assessment.

Information on all Pacific halibut removals is integrated by the IPHC Secretariat, providing annual estimates of total mortality from all sources for its stock assessment (SA). Bycatch and wastage of Pacific halibut, as defined by the incidental catch of fish in non-target fisheries and by the mortality that occurs in the directed fishery (i.e. fish discarded for sublegal size or for regulatory reasons), respectively, represent important sources of mortality that can result in significant reductions in exploitable yield in the directed fishery. Given that the incidental mortality from the commercial Pacific halibut fisheries and bycatch fisheries is included as part of the total removals that are accounted for in the SA, changes in the estimates of incidental mortality will influence the output of the SA and, consequently, the catch levels of the directed fishery. Research activities conducted in this Research Area aim at providing information on discard mortality rates and producing guidelines for reducing discard mortality in Pacific halibut in the longline and recreational fisheries. The relevance of research outcomes from these activities for SA resides in their ability to improve trends in unobserved mortality in order to improve estimates of stock productivity and represent the most important inputs in fishery yield for SA (Appendix II). The relevance of these research outcomes for the management and strategy evaluation process is in fishery parametization (Appendix III).

3.1. Discard mortality rates of Pacific halibut in the charter recreational fishery. The Pacific halibut recreational fishery (combined guided and unguided) is an important contributor (20%) to the total fishery-induced mortality, with 2,581 metric tons (5.7 million pounds) of removals in 2025. Under current regulations, the number of fish captured, handled and discarded by the Pacific halibut recreational fisheries is significant. Capture-related events impose stress and injury to the fish and, consequently, decrease the survival of

discarded fish. In contrast to the trawl and longline Pacific halibut fisheries, discard mortality rates (DMRs) have not been determined experimentally in the recreational fisheries and in Alaska and Canada are currently based on DMR information generated from commercial gear using circle hooks combined with rates derived for other sport fisheries for non-circle hooks, and coarsely applied to recreational hook type and creel census data (Meyer 2007). This project aims at better understanding the role of fishing practices and capture conditions on injury profile, physiological stress levels and survival in the Pacific halibut recreational fisheries in order to estimate DMRs. Recent reductions in Pacific halibut catch limits place added importance for improved DMR estimates applied to the recreational fishery.

The IPHC conducted field studies informed by common gear and handling practices as determined by a survey of charter owners and operators. The guided recreational vessel F/V High Roller (operated by Alaska Premier Charters) was chartered by the IPHC from 21-27 May 2021 in IPHC Regulatory Area 2C (out of Sitka, AK). The research charter in IPHC Regulatory Area 3A (out of Seward, AK) was conducted on the fishing vessel Gray Light (operated by Graylight Fisheries) from 11-16 June 2021. The fishing vessels were required to fish 6 rods at a time, three (3) rigged with 12/0 circle hooks and three (3) rigged with 16/0 circle hooks to establish a comparison of the two most common gear types used in the Pacific halibut recreational fishery.

In IPHC Regulatory Area 2C, we captured, sampled, wire tagged and released 243 Pacific halibut that were on average 80.1 ± 19.0 cm in fork length (range from 52 to 149 cm) and 7.4 ± 7.5 Kg in weight (range from 1.5 to 49.75 Kg). In IPHC Regulatory Area 3A (Seward, AK), we captured, sampled, tagged (80 sPAT, 38 wire), and released 118 Pacific halibut that were on average 72.5 ± 14.1 cm in fork length (range from 42 to 110 cm) and 5.0 ± 3.3 Kg in weight (range from 0.55 to 17 Kg). Therefore, a total of 361 Pacific halibut were captured, sampled, and released in the two research charters conducted.

Fish size distributions were nearly identical between the two IPHC Regulatory Areas. Larger hooks (16/0) caught significantly larger fish compared to the smaller hook (12/0) for fish caught out of Seward, but no difference in fish sizes by hook size was seen in fish landed out of Sitka. The majority (97%) of Pacific halibut captured were classified in the Excellent viability category. Fish of Moderate or Poor viability were only caught on the smaller 12/0 hooks.

To date, of the 281 fish that were tagged with opercular wire tags (243 fish in IPHC Regulatory Area 2C and 38 in IPHC Regulatory Area 3A) 41 wire tags (39 from IPHC Regulatory Area 2C and 2 from IPHC Regulatory Area 3A), 78 sPATs transmitted data, and two sPAT tethers (of successfully reported tags) have been recovered. Of the 76 fish with functional sPAT tags, one stopped moving for 12 hours prior to detachment (8.3 days), whereas all others were active until tag detachment. Kaplan-Meier survival analysis generated a mortality rate estimate of 1.35% (95% CI 0.00-3.95%) for Pacific halibut released in excellent condition. Final DMR estimates incorporate estimates of mortality for all viabilities (excellent, moderate, and poor) as well as ratios of hook types

used in the fishery historically. Table 2 shows how the current study of survival under recreational conditions translates to overall estimates, and how it compares to DMR estimates currently used in management.

IPHC Regulatory Area	2C	2C	3A	3A
Sector	Charter/Guided	Private/Non-guided	Charter/Guided	Private/Non-guided
Original calculated DMR	5.10%	5.60%	3.90%	4.50%
Calculated DMR - this study (95% CI)	4.41% (3.42-6.31%)	4.98% (4.09-6.68%)	3.04% (1.81-5.41%)	3.72% (2.62-5.86%)
DMR currently applied for management	6.00%	7.00%	5.00%	6.00%

Table 2. Discard mortality rates (DMR) by IPHC Regulatory Area and recreational sector in Alaska. Original calculated rates (Meyer 2007) and the rates applied by current management are contrasted to the results generated by this study.

The Alaska Department of Fish and Game (ADFG) applies slightly higher discard mortality rates than those calculated to accommodate variation from year to year in the numbers of fish released, undocumented variation in hook use (circle vs non circle) from year to year, and probable increases in mortality due to the cumulative effects of multiple recaptures. The IPHC secretariat applies discard mortality rates calculated for IPHC Regulatory Area 2C to data provided by the Department of Fisheries and Oceans Canada for discard estimates in IPHC Regulatory Area 2B.

4. Fishing Technology.

The IPHC Secretariat has determined that research to provide the Pacific halibut fishery with tools to reduce whale depredation is considered a high priority. This research is now contemplated as one of the research areas of high priority within the 5-year Program of Integrated Research and Monitoring (2022-2026) (Appendix I).

Removal of captured fish from fishing gear (known as depredation) is a growing problem among many hook-and-line fisheries worldwide. In the north Pacific Ocean, both Killer (*Orcinus orca*) and Sperm (*Physeter macrocephalus*) whales are involved in depredation behavior in Pacific halibut, sablefish (*Anoplopoma fimbria*), and Greenland turbot (*Reinhardtius hippoglossoides*) longline fisheries. In 2011 and 2012, fisheries observers estimated that 21.4% of sablefish sets, 9.9% of Greenland turbot sets, and 6.9% of Pacific halibut sets were affected by whale depredation in the Bering Sea (Peterson et al. 2014). Reductions in catch per unit effort (CPUE) when whales were present ranged across geographic regions from 55%-69% for sablefish, 54%-67% for Greenland turbot, and 15-57% for Pacific halibut (Peterson et al. 2014). These impacts also incur significant time, fuel, and personnel costs to fishing operations. From a fisheries management perspective, depredation creates an additional and highly uncertain source of mortality, loss of data (e.g. compromised survey activity), and reduces fishery efficiency. Stock assessments of both Pacific halibut and sablefish have adjusted their analysis of fishery-independent data to account for the effects of whale depredation on catch rates. In the sablefish assessment, fishery limits are also adjusted downward to reflect expected depredation during the commercial fishery. In recent years, whale depredation has been limiting fishers' ability to harvest their Greenland turbot allocations, and they have been well below (35-78% in the last 5 years) the total allowable catch for that fishery. Meanwhile, potential risks to the whales

include physical injury due to being near vessels and gear, disruption of social structure and developing an artificial reliance on food items that can be affected by fishery dynamics.

Terminal gear modification and catch protection have been identified as an avenue with the highest likelihood of 'breaking the reward cycle' in depredation behaviors. Particularly for Pacific halibut and Greenland turbot, two species whose catches are prohibited and closely regulated, respectively, in trawl fisheries and that are difficult to capture efficiently in pots, novel approaches to protection of longline catch are necessary.

This project focused on investigating strategies aimed at protecting longline-caught fish, through low cost, easy to adopt gear modifications that securely retain catch, while breaking the 'reward cycle' in depredation. This project, that received funding from the Bycatch Reduction Engineering Program (BREP)-NOAA, was structured in two parts. First, in early 2022 we conducted a virtual International Workshop (link) on protecting fishery catches from whale depredation with industry (affected fishers, gear manufacturers), gear researchers and scientists to identify methods to protect fishery catches from depredation. The second part of the project involved developing the top catch protection design outcomes of the Workshop into functional prototypes and conducting field testing in longline sea trials. The two selected catch protection devices were: 1) an underwater shuttle (Figure 8A) and 2) a branch gear with a sliding shroud system (not shown). Results from field testing conducted in May 2023 indicated that the shuttle was a safe and effective gear type which entrained comparable quantities, sizes, and types of fish as the control gear, whereas the sliding shroud and branch gear had substantial logistical issues that would need to be addressed before scaling up to a fishery level.

Based on the success of the first two components of this work, the IPHC secured additional funding from BREP-NOAA to expand testing of the shuttle concept in the presence of depredating Orcas in Alaskan waters (Appendix IV). This work focused on further refinement and performance characterization of the shuttle device in the presence of toothed whales in IPHC Regulatory Area 4A. Field operations occurred from 21-28 May 2025 aboard the F/V Oracle (Figure 8). Eighteen sets were successfully completed, generating 15 sets of shuttle and control catch comparison data along with close to 80 hours of underwater footage combined (control, shuttle exterior, shuttle interior). Depredating orcas were present at 6 of the paired sets.

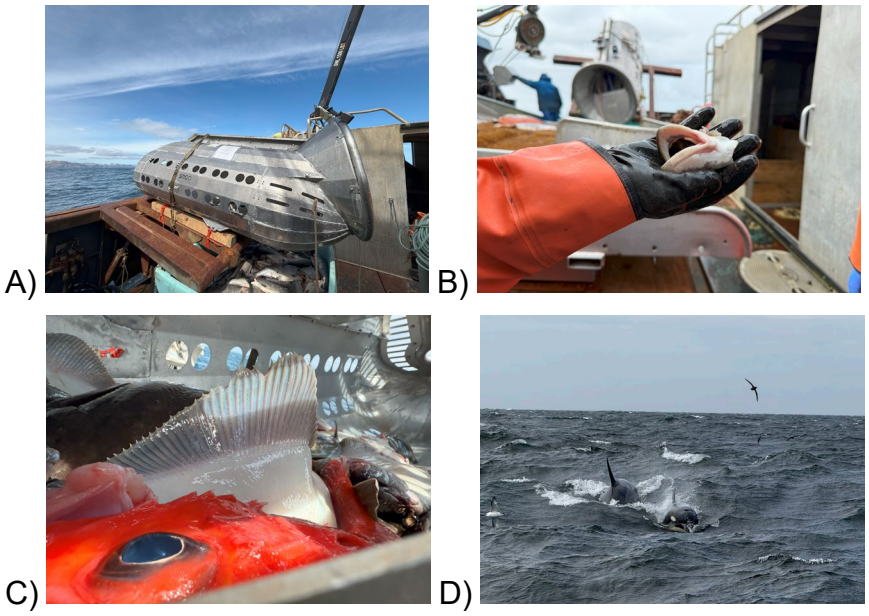

Figure 8. A) Shuttle device in transport. B) Typical evidence (lips only) of depredation. C) Catch entrained within the shuttle. D). Killer whales rapidly approaching the hauling site.

Preliminary results from video footage indicated that the shuttle device had high retention rates of Pacific halibut when compared to other frequently encountered species (Table 3). In addition, preliminary results did not show clear differences on catch rates between protected and unprotected skates, likely due to high variability among catch rates within treatments. Overall, the shuttle device demonstrated good retention capacity (up to 835 kg/1,800 lb) in the trials, with capacity for higher weight retention. Incidentally, rare footage of Orcas around the groundline at depth was also captured.

Common Name	Encountered	Excluded	Entered and Escaped	Entered and Passed Through	Retained
Pacific halibut	**121**	**1 (0.8%)**	**0**	**9 (7.5%)**	**112 (93.3%)**
Sablefish	186	2 (1.1%)	54 (29.4%)	34 (18.5%)	96 (52.2%)
Pacific cod	124	3 (2.4%)	13 (10.7%)	6 (5.0%)	102 (84.3%)
Rockfish	19	7 (43.8%)	2 (16.7%)	1 (8.3%)	9 (75.0%)
Skate	18	3 (16.7%)	0	2 (13.3%)	13 (86.7%)

Table 3. Numbers of fish encountered by the shuttle device that were either excluded, entered and escaped, passed through still on the hook, and/or finally entrained in 11 of 15 sets with video footage analyzed to date.

Further testing of the shuttle device was conducted under typical commercial fishing conditions in the Bering Sea in October 2025 on the same fishing vessel with an IPHC field specialist aboard to assist with data collection. No cameras were used during this phase. The shuttle was only deployed for a total of 4 sets over this effort due to weather challenges and lack of whales present on many fishing days.

RECOMMENDATION/S

1) That the RAB **NOTE** IPHC-2026-RAB027-06, that provides a report on current and planned biological and ecosystem science and research activities contemplated in the IPHC's Five-Year Program of Integrated Research and Monitoring (2022-2026).

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APPENDICES

Appendix I: Biological research areas in the 5-Year Program of Integrated Research and Monitoring (2022-2026) and ranked relevance for stock assessment and management strategy evaluation (MSE).

Appendix II: List of ranked research priorities for stock assessment

Appendix III: List of ranked research priorities for management strategy evaluation (MSE)

Appendix IV: Summary of current competitive research grants awarded to IPHC

APPENDIX I

Biological research areas in the 5-Year Program of Integrated Research and Monitoring (2022-2026) and ranked relevance for stock assessment and management strategy evaluation (MSE)

Research areas	Research activities	Research outcomes	Relevance for stock assessment	Relevance for MSE	Specific analysis input	SA Rank	MSE Rank	Research priorization
Migration and population dynamics	Population structure	Population structure in the Convention Area	Altered structure of future stock assessments	Improve parametization of the Operating Model	If 4B is found to be functionally isolated, a separate assessment may be constructed for that IPHC Regulatory Area	2. Biological input	1. Biological parameterization and validation of movement estimates and recruitment distribution	2
	Distribution	Assignment of individuals to source populations and assessment of distribution changes	Improve estimates of productivity		Will be used to define management targets for minimum spawning biomass by Biological Region	3. Biological input		2
	Larval and juvenile connectivity studies	Improved understanding of larval and juvenile distribution	Improve estimates of productivity		Will be used to generate potential recruitment covariates and to inform minimum spawning biomass targets by Biological Region	3. Biological input	1. Biological parameterization and validation of movement estimates	2
Reproduction	Histological maturity assessment	Updated maturity schedule	Scale biomass and reference point estimates	Improve simulation of spawning biomass in the Operating Model	Will be included in the stock assessment, replacing the current schedule last updated in 2006	1. Biological input		1
	Examination of potential skip spawning	Incidence of skip spawning			Will be used to adjust the asymptote of the maturity schedule, if/when a time-series is available this will be used as a direct input to the stock assessment			1
	Fecundity assessment	Fecundity-at-age and -size information			Will be used to move from spawning biomass to egg-output as the metric of reproductive capability in the stock assessment and management reference points			1
	Examination of accuracy of current field macroscopic maturity classification	Revised field maturity classification			Revised time-series of historical (and future) maturity for input to the stock assessment			1
Growth	Evaluation of somatic growth variation as a driver for changes in size-at-age	Identification and application of markers for growth pattern evaluation	Scale stock productivity and reference point estimates	Improve simulation of variability and allow for scenarios investigating climate change	May inform yield-per-recruit and other spatial evaluations of productivity that support mortality limit-setting		3. Biological parameterization and validation for growth projections	5
		Environmental influences on growth patterns			May provide covariates for projecting short-term size-at-age. May help to delineate between effects due to fishing and those due to environment, thereby informing appropriate management response			5
		Dietary influences on growth patterns and physiological condition			May provide covariates for projecting short-term size-at-age. May help to deleineate between effects due to fishing and those due to environment, thereby informing appropriate management response			5
Mortality and survival assessment	Discard mortality rate estimate: longline fishery	Experimentally-derived DMR	Improve trends in unobserved mortality	Improve estimates of stock productivity	Will improve estimates of discard mortality, reducing potential bias in stock assessment results and management of mortality limits	1. Fishery yield	1. Fishery parameterization	4
	Discard mortality rate estimate: recreational fishery				Will improve estimates of discard mortality, reducing potential bias in stock assessment results and management of mortality limits			4
	Best handling and release practices	Guidelines for reducing discard mortality			May reduce discard mortality, thereby increasing available yield for directed fisheries	2. Fishery yield		4
Fishing technology	Whale depredation accounting and tools for avoidance	New tools for fishery avoidance/deterence; improved estimation of depredation mortality	Improve mortality accounting	Improve estimates of stock productivity	May reduce depredation mortality, thereby increasing available yield for directed fisheries. May also be included as another explicit source of mortality in the stock assessment and mortality limit setting process depending on the estimated magnitude	1. Assessment data collection and processing		3

APPENDIX II

List of ranked research priorities for stock assessment

SA Rank	Research outcomes	Relevance for stock assessment	Specific analysis input	Research Area	Research activities
1. Biological input	Updated maturity schedule	Scale biomass and reference point estimates	Will be included in the stock assessment, replacing the current schedule last updated in 2006	Reproduction	Histological maturity assessment
	Incidence of skip spawning		Will be used to adjust the asymptote of the maturity schedule, if/when a time-series is available this will be used as a direct input to the stock assessment		Examination of potential skip spawning
	Fecundity-at-age and -size information		Will be used to move from spawning biomass to egg-output as the metric of reproductive capability in the stock assessment and management reference points		Fecundity assessment
	Revised field maturity classification		Revised time-series of historical (and future) maturity for input to the stock assessment		Examination of accuracy of current field macroscopic maturity classification
2. Biological input	Stock structure of IPHC Regulatory Area 4B relative to the rest of the Convention Area	Altered structure of future stock assessments	If 4B is found to be functionally isolated, a separate assessment may be constructed for that IPHC Regulatory Area	Migration and population dynamics	Population structure
3. Biological input	Assignment of individuals to source populations and assessment of distribution changes	Improve estimates of productivity	Will be used to define management targets for minimum spawning biomass by Biological Region		Distribution
	Improved understanding of larval and juvenile distribution		Will be used to generate potential recruitment covariates and to inform minimum spawning biomass targets by Biological Region		Larval and juvenile connectivity studies
1. Assessment data collection and processing	Sex ratio-at-age	Scale biomass and fishing intensity	Annual sex-ratio at age for the commercial fishery fit by the stock assessment	Reproduction	Sex ratio of current commercial landings
	Historical sex ratio-at-age		Annual sex-ratio at age for the commercial fishery fit by the stock assessment		Historical sex ratios based on archived otolith DNA analyses
2. Assessment data collection and processing	New tools for fishery avoidance/deterence; improved estimation of depredation mortality	Improve mortality accounting	May reduce depredation mortality, thereby increasing available yield for directed fisheries. May also be included as another explicit source of mortality in the stock assessment and mortality limit setting process depending on the estimated magnitude	Fishing technology	Whale depredation accounting and tools for avoidance
1. Fishery yield	Physiological and behavioral responses to fishing gear	Reduce incidental mortality	May increase yield available to directed fisheries	Fishing technology	Biological interactions with fishing gear
2. Fishery yield	Guidelines for reducing discard mortality	Improve estimates of unobserved mortality	May reduce discard mortality, thereby increasing available yield for directed fisheries	Mortality and survival assessment	Best handling practices: recreational fishery

APPENDIX III

List of ranked research priorities for management strategy evaluation (MSE)

MSE Rank	Research outcomes	Relevance for MSE	Research Area	Research activities
1. Biological parameterization and validation of movement estimates	Improved understanding of larval and juvenile distribution	Improve parametization of the Operating Model	Migration and population dynamics	Larval and juvenile connectivity studies
	Stock structure of IPHC Regulatory Area 4B relative to the rest of the Convention Area			Population structure
2. Biological parameterization and validation of recruitment variability and distribution	Assignment of individuals to source populations and assessment of distribution changes	Improve simulation of recruitment variability and parametization of recruitment distribution in the Operating Model		Distribution
	Establishment of temporal and spatial maturity and spawning patterns	Improve simulation of recruitment variability and parametization of recruitment distribution in the Operating Model	Reproduction	Recruitment strength and variability
3. Biological parameterization and validation for growth projections	Identification and application of markers for growth pattern evaluation	Improve simulation of variability and allow for scenarios investigating climate change	Growth	Evaluation of somatic growth variation as a driver for changes in size-at-age
	Environmental influences on growth patterns			
	Dietary influences on growth patterns and physiological condition			
1. Fishery parameterization	Experimentally-derived DMRs	Improve estimates of stock productivity	Mortality and survival assessment	Discard mortality rate estimate: recreational fishery

APPENDIX IV

Summary of current competitive research grants awarded to IPHC

Project #	Grant agency	Project name	PI	Partners	IPHC Budget ($US)	Grant period	Research area	Management implications	Research prioritization
1	**Alaska Sea Grant**	Development of a non-lethal genetic-based method for aging Pacific halibut (R/2024-05)	IPHC APU	Alaska Fisheries Science Center-NOAA (Juneau)	$60,374	January 2025-February 2027	Population dynamics	Stock structure	2
Total awarded ($)					**$60,374**				

IPHC Fishery-Independent Setline Survey (FISS) design and implementation in 2026

PREPARED BY: IPHC SECRETARIAT (K. UALESI , T. JACK, K. COLL, C. SKALLEY; 16 OCTOBER, & 05 NOVEMBER 2026)

PURPOSE

To provide a summary of the IPHC Fishery-Independent Setline Survey (FISS) design and implementation in 2026.

BACKGROUND

The annual IPHC Fishery-Independent Setline Survey (FISS) of the Pacific halibut stock was augmented from 2014-2019 with expansion stations that filled in gaps in coverage in the annual FISS. Prior to 2020, the standard grid of stations comprised 1,200 stations. Following the completion in 2019, expansion stations were added to the standard grid in all IPHC Regulatory Areas, now totaling 1,890 stations for the full FISS design (Figure 1), within the prescribed depth range of 18 to 732 metres (10 to 400 fathoms).

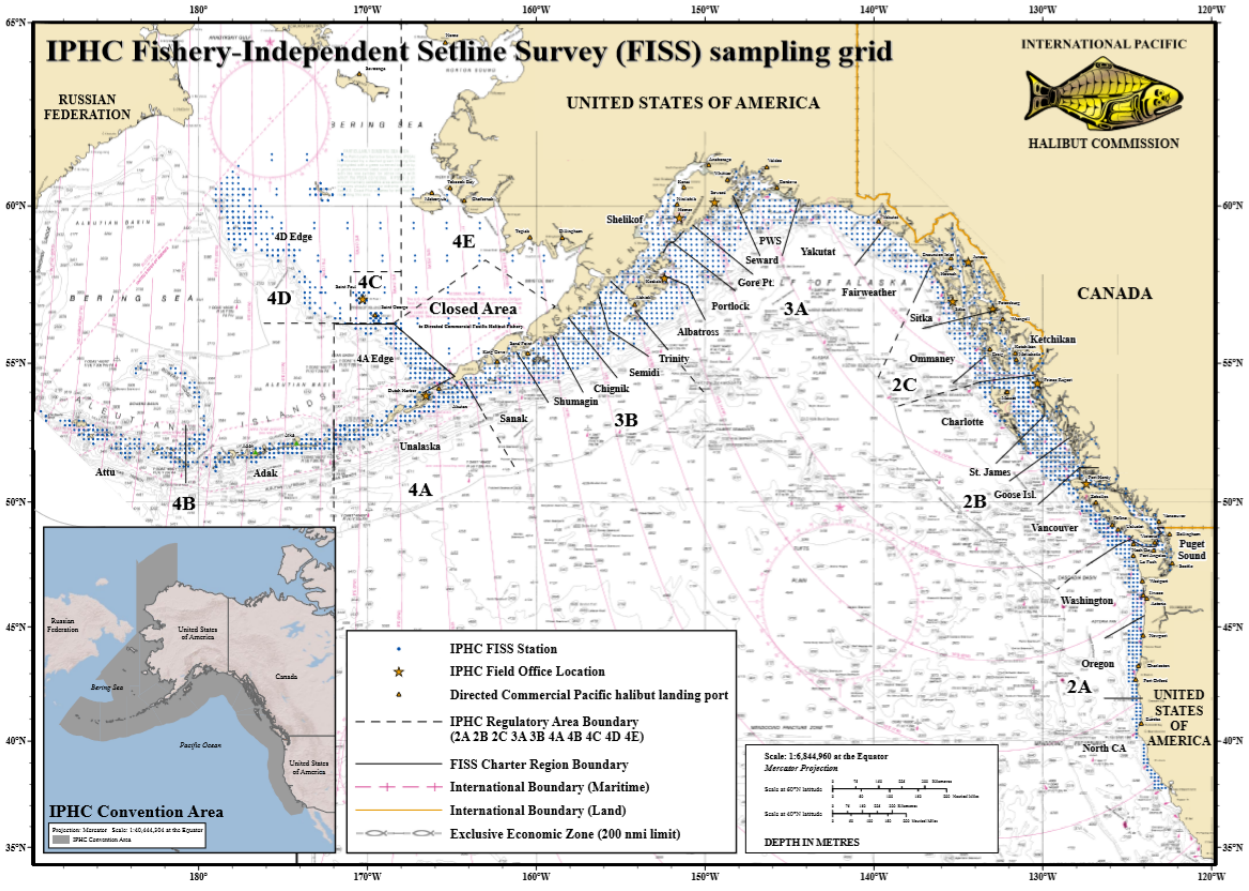

Figure 1. IPHC Fishery-Independent Setline Survey (FISS) with full sampling grid shown.

Prior to 2019, only fixed gear was used to fish FISS sets. With increasing use of snap gear in the commercial fishery, this restriction has limited the number of vessels available for the FISS. Further, any differences between snap and fixed gears (including catch rate differences and differences in fishing locations) may affect our understanding of trends in commercial fishery indices. This has motivated the need for a study comparing the two gear types with this work being done in 2019, 2020, and again in 2021. No further comparison was undertaken in 2022;

recognizing the increased use of snap gear, the IPHC Secretariat opened all bids for 2023 to both fixed gear and snap gear vessels and has continued this practice through 2026.

Beginning in 2019, individual weight data were collected coastwide from Pacific halibut caught on the FISS to eliminate questions that have arisen regarding the accuracy of estimates that depend on these weights, including weight per unit effort (WPUE) indices of density. Data from IPHC collections from commercial landings and other sources had provided evidence that the current standard length-net weight curve used for estimating Pacific halibut weights on the FISS may have been over-estimating weights on average in most IPHC Regulatory Areas, and that the relationship between weight and length may vary spatially.

2026 FISS design

On 19 December 2025 (IPHC-2025-MR-019), the 2026 FISS Tender Specifications were published to the IPHC website, with a deadline of 1 February 2026 for tenders (subsequently extended to 8 February 2026).

At the 101st Session of the IPHC Interim Meeting (IM101, 2 December 2025), the Commission adopted the Supplemented Reduced Loss design (Option 2; 692 stations) for the 2026 FISS (IPHC-2025-IM101-R). At its 102nd Session of the IPHC Annual Meeting (AM102, 19–22 January 2026), the Commission subsequently adopted a revised 2026 FISS design, substituting the Gore Point and Fairweather charter regions for Prince William Sound and Yakutat respectively and adding the Goose Island charter region, bringing the total to 717 stations coastwide, an increase of 25 stations on the design adopted at IM101 (IPHC-2026-AM102-R).

The design (Figure 2) comprised sampling subareas within IPHC Regulatory Areas 2B, 2C, 3A, 3B, 4A and 4B, intended to balance the Commission's primary and secondary objectives for the FISS, on the understanding that vessel availability, bids received, additional bait needs, and field staff recruitment may affect operational feasibility. **MATERIALS AND METHODS**

The IPHC's FISS design encompasses nearshore and offshore waters of the IPHC Convention Area (Fig. 1). The IPHC Regulatory Areas are divided into 29 charter regions, each requiring between 10 and 46 charter days to complete. FISS stations are located at the intersections of a 10 nmi by 10 nmi square grid within the depth range occupied by Pacific halibut during summer months (18 – 732 m [10 – 400 fm]). Figure 2 depicts the 2026 FISS station positions adopted at AM102, together with the IPHC Regulatory Areas, for a coastwide total of 717 stations.

Fishing vessels are chosen through a competitive bid process where up to four (4) charter regions per vessel may be awarded and typically 8-15 vessels are chosen. In 2026, the process was clearly documented on the IPHC website for accountability and transparency purposes: Vessel Recruiting - IPHC.

In 2026, six (6) vessels were chartered to complete the FISS, reflecting the reduced scale of the design adopted at AM102 (717 stations, against 1,890 stations under the full FISS design), as detailed in IPHC-2026-MR-004 Notification of IPHC Fishery-Independent Setline Survey (FISS) 2026 Contract Awards - IPHC.

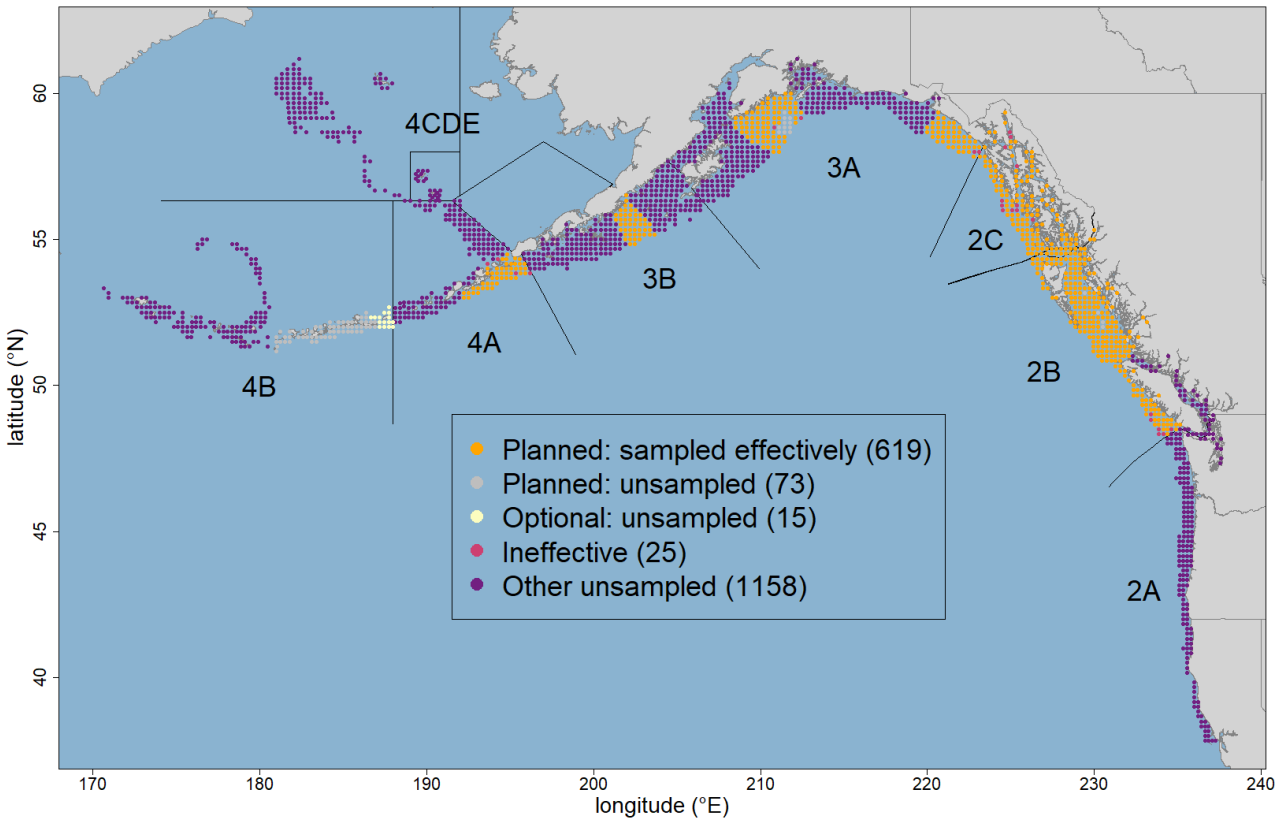

Figure 2. Map of the 2026 FISS design (717 stations, plus 15 optional stations in IPHC regulatory area 4B), approved by the Commission at AM102 on 22 January 2026. This map shows the 619 stations sampled effectively (in orange, the 73 unsampled stations (in grey), the 15 optional stations in IPHC regulatory area 4B (in yellow) and the 25 ineffective stations (in red).

Sampling protocols

IPHC Setline Survey Specialists (Field) collected data according to protocols established in the 2026 FISS Sampling Manual (IPHC-2026-VSM01).

Sampling challenges - 2026

Of the 717 FISS stations planned for the 2026 FISS season, 619 (86%) were effectively sampled.

Not sampled: A total of 73 stations initially planned for sampling in 2026 were not completed. In the Adak charter region, 58 stations were not sampled due to lack of vessel availability. In the Charlotte charter region, one (1) station was excluded because it was located within the Hecate Marine Protected Area. Additionally, three (3) stations in the St James charter region were not completed because they were in the Hecate Marine Protected Area. In the Seward charter region, 11 stations were not completed because the vessel contracted for this region encountered a significant mechanical issue that required substantial repairs.

Ineffective stations: Coastwide, twenty-five (25) stations were deemed ineffective due to orca depredation (n=5), sperm whale depredation (n=14), sand fleas (n=4), soak time (n=1), and setting and gear issues (n=1).

Bait (Chum salmon)

The minimum quality requirement for FISS bait is No. 2 semi-bright (Alaska Seafood Marketing Institute grades A through E), headed and gutted, and individually quick-frozen chum salmon. Bait usage is based on 0.17 kilograms (0.37 pounds) per hook resulting in approximately 136

kilograms (300 pounds) per eight skate station. Bait quality was monitored and documented throughout the season and found to meet the standard as described above.

Pre-season: In August 2025 (IPHC-2025-MR-011), the Secretariat solicited pre-season bait purchases of up to approximately 72.4 tonnes (159,600 lbs) of chum salmon (28.3 t in Canada; 44.1 t in the United States) to ensure a smooth start to the 2026 FISS.

RESULTS

Interactive views of the FISS results are provided via the IPHC website here:

https://www.iphc.int/data/setline-survey-catch-per-unit-effort

As in previous years, legal-sized (O32) Pacific halibut caught on the FISS were sacrificed in order to obtain biological data and were retained for sale. In addition, beginning in 2020, sub-legal (U32) Pacific halibut randomly selected for otolith sampling were also retained and sold. This helped to offset costs of the FISS. FISS vessels also retained for sale incidentally captured rockfish (*Sebastes spp*.) and Pacific cod (*Gadus macrocephalus*) as these species rarely survive the barotrauma resulting from capture. Most vessel contracts provided the vessel a lump sum payment, along with a 10% share of the Pacific halibut proceeds and a 50% share of the incidental catch proceeds.

The 2026 FISS chartered six (6) commercial longline vessels (three Canadian and three USA), during a combined 37 trips and 364 charter days (Tables 1). Otoliths were removed from 9,791 fish coastwide. Approximately 160 tonnes (353,451 pounds) of Pacific halibut, 14.72 tonnes (32,458 pounds) of Pacific cod, and 38.44 tonnes (84,737 pounds) of rockfish were landed from the FISS stations.

Table 1a. Effort and landing summary by FISS charter region and vessel for all 2026 stations and all Pacific halibut (sampled U32 and all O32).

IPHC Regulatory Area	Charter Region	Vessel	Vessel Number[1]	Charter Days[2]	Planned Stations	Effective Stations[3]	Pacific halibut Sold (t)[4]	Pacific halibut Sold (lb)[4]	Average Price USD/kg[5]	Average Price USD/lb[5]
2B	Vancouver Outside	*Vanisle*	21912	32	56	50	8	18,424	$22.04	$10.00
2B	Goose Is.	*Star Wars II*	99997	32	57	57	9	20,382	$24.19	$10.97
2B	St. James	*Vanisle*	21912	28	60	57	17	36,705	$24.64	$11.17
2B	Charlotte	*Vanisle*	21912	54	89	88	24	52,489	$23.85	$10.82
2C	Ketchikan	*Pender Isle*	27282	23	43	43	20	43,466	$23.82	$10.80
2C	Ommaney	*Pender Isle*	27282	28	52	45	31	67,483	$22.84	$10.36
2C	Sitka	*Predator*	33133	31	52	48	17	38,300	$21.52	$9.76
3A	Fairweather	*Predator*	33133	24	51	49	4	8,329	$19.95	$9.05
3A	Seward	*J-Bae*	56103	34	52	39	8	16,547	$21.18	$9.61
3A	Gore Pt.	*Kema Sue*	41033	28	48	48	8	17,127	$21.24	$9.64
3B	Chignik	*Kema Sue*	41033	25	48	48	5	11,466	$16.17	$7.34
4A	Unalaska	*Kema Sue*	41033	25	51	47	10	22,733	$16.76	$7.60
Total		**6 Vessels**		**364**	**659**	**619**	**160**	**353,451**	**$22.36**	**$10.14**

[1] Canada: Vessel Registration Number and USA: ADF&G vessel number.

[2] Days are estimated - some vessels fished two charter regions in one day.

[3] Stations that did not meet setting parameters or deemed ineffective are excluded.

[4] Net weight (head-off, dressed, washed). May not sum to correct total due to rounding.

[5] Ex-vessel price.

Table 1b. Effort and landing summary by FISS charter region and vessel for all 2026 stations and O32 Pacific halibut.

IPHC Regulatory Area	Charter Region	Vessel	Vessel Number[1]	Charter Days[2]	Planned Stations	Effective Stations[3]	Pacific halibut Sold (t)[4]	Pacific halibut Sold (lb)[4]	Average Price USD/kg[5]	Average Price USD/lb[5]
2B	Vancouver Outside	*Vanisle*	21912	32	56	50	8	17,745	$22.14	$10.04
2B	Goose Is.	*Star Wars II*	99997	32	57	57	9	18,924	$24.32	$11.03
2B	St. James	*Vanisle*	21912	28	60	57	16	35,975	$24.67	$11.19
2B	Charlotte	*Vanisle*	21912	54	89	88	23	49,634	$23.99	$10.88
2C	Ketchikan	*Pender Isle*	27282	23	43	43	19	41,975	$23.91	$10.84
2C	Ommaney	*Pender Isle*	27282	28	52	45	29	64,722	$23.06	$10.46
2C	Sitka	*Predator*	33133	31	52	48	17	36,820	$21.52	$9.76
3A	Fairweather	*Predator*	33133	24	51	49	3	7,705	$20.04	$9.09
3A	Seward	*J-Bae*	56103	34	52	39	7	15,115	$21.33	$9.68
3A	Gore Pt.	*Kema Sue*	41033	28	48	48	7	15,135	$21.43	$9.72
3B	Chignik	*Kema Sue*	41033	25	48	48	4	9,247	$17.51	$7.94
4A	Unalaska	*Kema Sue*	41033	25	51	47	5	10,253	$18.10	$8.21
Total		**6 Vessels**		**364**	**659**	**619**	**147**	**323,249**	**$22.79**	**$10.34**

[1] Canada: Vessel Registration Number and USA: ADF&G vessel number.
[2] Days are estimated - some vessels fished two charter regions in one day.
[3] Stations that did not meet setting parameters or deemed ineffective are excluded.
[4] Net weight (head-off, dressed, washed). May not sum to correct total due to rounding.
[5] Ex-vessel price.

Table 1c. Effort and landing summary by FISS charter region and vessel for all 2026 stations and sampled U32 Pacific halibut.

IPHC Regulatory Area	Charter Region	Vessel	Vessel Number1	Charter Days2	Planned Stations	Effective Stations[3]	Pacific halibut Sold (t)[4]	Pacific halibut Sold (lb)[4]	Average Price USD/kg[5]	Average Price USD/lb[5]
2B	Vancouver Outside	*Vanisle*	21912	32	56	50	0	679	$19.57	$8.88
2B	Goose Is.	*Star Wars II*	99997	32	57	57	1	1,458	$22.56	$10.23
2B	St. James	*Vanisle*	21912	28	60	57	0	730	$22.74	$10.31
2B	Charlotte	*Vanisle*	21912	54	89	88	1	2,855	$21.45	$9.73
2C	Ketchikan	*Pender Isle*	27282	23	43	43	1	1,491	$21.28	$9.65
2C	Ommaney	*Pender Isle*	27282	28	52	45	1	2,761	$17.75	$8.05
2C	Sitka	*Predator*	33133	31	52	48	1	1,479	$21.61	$9.80
3A	Fairweather	*Predator*	33133	24	51	49	0	625	$18.84	$8.54
3A	Seward	*J-Bae*	56103	34	52	39	1	1,432	$19.58	$8.88
3A	Gore Pt.	*Kema Sue*	41033	28	48	48	1	1,992	$19.84	$9.00
3B	Chignik	*Kema Sue*	41033	25	48	48	1	2,219	$10.58	$4.80
4A	Unalaska	*Kema Sue*	41033	25	51	47	6	12,480	$15.66	$7.10
Total		**6 Vessels**		**364**	**659**	**619**	**14**	**30,202**	**$17.71**	**$8.04**

[1] Canada: Vessel Registration Number and USA: ADF&G vessel number.
[2] Days are estimated - some vessels fished two charter regions in one day.
[3] Stations that did not meet setting parameters or deemed ineffective are excluded.
[4] Net weight (head-off, dressed, washed). May not sum to correct total due to rounding.

[5] Ex-vessel price.

Vessels chartered by the IPHC delivered fish to 12 different ports (Tables 2). Fish sales were awarded based on obtaining a fair market price. When awarding sales, the Commission considered the price offered, the number of years that a buyer had been buying and marketing Pacific halibut, how fish were graded at the dock (including the determination of No. 2 and chalky Pacific halibut), and the promptness of settlements following deliveries. In the case of multi-port bidding, vessel transit logistics and operational requirements were also considered. Individual sales were evaluated after each event to ensure that the buyer was meeting IPHC standards. Average prices increased from $18.04/kg in 2025 to $22.36/kg in 2026 (Tables 3). This represents a 24% increase in price.

Table 2a. FISS Pacific halibut landings by port for all Pacific halibut (sampled U32 and all O32), 2026[1,2].

Offload Port	Trips	Tonnes	Pounds	Total USD	Average Price (USD/kg)	Average Price (USD/lb)
Dutch Harbor	2	10	22,733	$172,840.89	$16.76	$7.60
Homer	3	8	17,127	$165,024.60	$21.24	$9.64
Juneau	1	2	4,223	$38,881.75	$20.30	$9.21
Petersburg	2	8	17,357	$168,028.00	$21.34	$9.68
Port Hardy	5	25	54,197	$599,413.71	$24.38	$11.06
Prince Rupert	12	77	169,400	$1,804,771.28	$23.49	$10.65
Sand Point	2	5	11,466	$84,115.20	$16.17	$7.34
Seward	5	8	18,476	$177,771.00	$21.21	$9.62
Sitka	2	10	22,167	$215,097.00	$21.39	$9.70
Tofino/Ucluelet	1	4	9,905	$91,767.60	$20.43	$9.26
Vancouver	1	2	5,447	$58,622.53	$23.73	$10.76
Yakutat	1	0	953	$8,455.68	$19.56	$8.87
Grand Total	**37**	**160**	**353,451**	**$3,584,789.24**	**$22.36**	**$10.14**

[1] Net weight (head-off, dressed, washed).
[2] Prices based on net weight.

Table 2b. FISS Pacific halibut landings by port for O32 Pacific halibut, 2026[1,2].

Offload Port	Trips	Tonnes	Pounds	Total USD	Average Price (USD/kg)	Average Price (USD/lb)
Dutch Harbor	2	5	10,253	$84,179.80	$18.10	$8.21
Homer	3	7	15,135	$147,096.60	$21.43	$9.72
Juneau	1	2	4,168	$38,386.75	$20.30	$9.21
Petersburg	2	8	17,062	$165,293.00	$21.36	$9.69
Port Hardy	5	24	52,329	$580,563.46	$24.46	$11.09
Prince Rupert	12	73	161,703	$1,733,843.68	$23.64	$10.72
Sand Point	2	4	9,247	$73,464.00	$17.51	$7.94
Seward	5	8	17,024	$164,884.00	$21.35	$9.69
Sitka	2	9	20,525	$199,466.00	$21.42	$9.72
Tofino/Ucluelet	1	4	9,541	$89,150.19	$20.60	$9.34
Vancouver	1	2	5,401	$58,132.86	$23.73	$10.76
Yakutat	1	0	861	$7,646.08	$19.58	$8.88
Grand Total	**37**	**147**	**323,249**	**$3,342,106.42**	**$22.79**	**$10.34**

[1] Net weight (head-off, dressed, washed).
[2] Prices based on net weight.

Table 2c. FISS Pacific halibut landings by port for sampled U32 Pacific halibut, 2026[1,2].

Offload Port	Trips	Tonnes	Pounds	Total USD	Average Price (USD/kg)	Average Price (USD/lb)
Dutch Harbor	2	6	12,480	$88,661.10	$15.66	$7.10
Homer	3	1	1,992	$17,928.00	$19.84	$9.00
Juneau	1	0	55	$495.00	$19.84	$9.00
Petersburg	2	0	295	$2,735.00	$20.44	$9.27
Port Hardy	5	1	1,868	$18,850.25	$22.25	$10.09
Prince Rupert	12	3	7,697	$70,927.57	$20.32	$9.21
Sand Point	2	1	2,219	$10,651.20	$10.58	$4.80
Seward	5	1	1,452	$12,887.00	$19.57	$8.88
Sitka	2	1	1,642	$15,631.00	$20.99	$9.52
Tofino/Ucluelet	1	0	364	$2,617.41	$15.85	$7.19
Vancouver	1	0	46	$489.67	$23.47	$10.65
Yakutat	1	0	92	$809.60	$19.40	$8.80
Grand Total	**37**	**14**	**30,202**	**$242,682.80**	**$17.71**	**$8.04**

[1] Net weight (head-off, dressed, washed).
[2] Prices based on net weight.

Table 3a. FISS landings (total pounds and price) of all Pacific halibut (sampled U32 and all O32) by IPHC Regulatory Area in 2026[1].

IPHC Regulatory Area	2B	2C	3A	3B	4A	Total Weight and Average Price
Tonnes	58	68	19	5	10	160
Pounds	128,000	149,249	42,003	11,466	22,733	353,451
Price USD/kg	$23.87	$22.79	$20.96	$16.17	$16.76	$22.36
Price USD/lb	$10.83	$10.34	$9.51	$7.34	$7.60	$10.14

[1] Net weight (head-off, dressed, washed)

Table 3b. FISS landings (total pounds and price) of O32 Pacific halibut by IPHC Regulatory Area in 2026[1].

IPHC Regulatory Area	2B	2C	3A	3B	4A	Total Weight and Average Price
Tonnes	55	65	17	4	5	147
Pounds	122,277	143,517	37,955	9,247	10,253	323,249
Price USD/kg	$23.97	$22.91	$21.11	$17.51	$18.10	$22.79
Price USD/lb	$10.87	$10.39	$9.57	$7.94	$8.21	$10.34

[1] Net weight (head-off, dressed, washed)

Table 3c. FISS landings (total pounds and price) of sampled U32 Pacific halibut by IPHC Regulatory Area in 2026[1].

IPHC Regulatory Area	2B	2C	3A	3B	4A	Total Weight and Average Price
Tonnes	3	3	2	1	6	14
Pounds	5,723	5,731	4,049	2,219	12,480	30,202
Price USD/kg	$21.67	$19.67	$19.59	$10.58	$15.66	$17.71
Price USD/lb	$9.83	$8.92	$8.89	$4.80	$7.10	$8.04

[1] Net weight (head-off, dressed, washed)

FISS timing

The months of June, July, and August are targeted for FISS fishing every year. In 2026, this activity took place from 22 May through 15 September. On a coastwide basis, FISS vessel activity was highest in intensity at the beginning of the FISS season (Figure 3). All FISS activity was completed by the middle of September.



Figure 3. Percent of the total FISS stations completed by IPHC Regulatory Area during each week of the year (2020-2026). Week 21 begins in late May or early June, depending on the year.

RECOMMENDATION/S

That the RAB:

1) **NOTE** paper IPHC-2026-RAB027-07 Rev_1 that provides a summary of the IPHC Fishery-Independent Setline Survey (FISS) design and implementation in 2026.

APPENDICES

Nil.

2027-29 FISS designs

PREPARED BY: IPHC SECRETARIAT (R. WEBSTER, I. STEWART, K. UALESI & D. WILSON; 17 OCTOBER 2026)

PURPOSE

To present the Research Advisory Board with potential FISS designs for 2027-29, including a preliminary cost projection for the 2027 Base Block design, along with potential modular add-ons for 2027.

BACKGROUND

The IPHC's Fishery-Independent Setline Survey (FISS) provides data used to compute indices of Pacific halibut density for use in monitoring stock trends, estimating stock distribution, and as an important input in the stock assessment. Stock distribution estimates are based on the annual mean weight per unit effort (WPUE) for each IPHC Regulatory Area, computed as the average of WPUE of all Pacific halibut and for O32 (greater than or equal to 32" or 81.3cm in length) Pacific halibut estimated at each station in an area. Mean numbers per unit effort (NPUE) is used to index the trend in Pacific halibut density for use in the stock assessment models. Annual FISS designs are developed by selecting a subset of stations for sampling from the full 1890-station FISS footprint (Figure 1).

In recent years, financial constraints due to reduced catch rates and the combined impact of factors affecting revenue and costs (FISS accounting changes, Pacific halibut sales prices, charter vessel and bait costs) have resulted in the implementation of FISS designs with reduced spatial footprints. Effort has been concentrated in IPHC Regulatory Areas 2B, 2C, 3A and 3B (the core of the stock), with limited sampling in other areas in most years (Figures 2 and 3).

At the Commission Work Meeting (September 2026), Commissioners were presented with:

- The Base Block design for 2027-31, a design based on rotating blocks of stations that provides full coverage of core IPHC Regulatory Areas (2B, 2C, 3A and 3B) over a two to three-year period, and prioritizes sampling elsewhere based on maintaining precise estimates with low bias
- A series of optional modular add-ons to the 2027 Base Block design that can be added depending on Commission priorities

Prior to the 2026 Work Meeting, it was confirmed that The Commission has secured a voluntary contribution of US$749,000 from the United States government to fund several of the modular add-ons to the FISS:

- $19,000 to fund one additional charter region in IPHC Regulatory Area 3A
- $186,000 to fund sampling in eastern IPHC Regulatory Area 4B
- $268,000 to fund sampling in western IPHC Regulatory Area 4A

- $276,000 to complete sampling on the Bering Sea Shelf Edge in IPHC Regulatory Area 4CDE

These additions to the Base Block design for 2027 will allow the FISS to sample regions in IPHC Regulatory Areas 3A and 4B that were part of the 2026 Base Block design but were not sampled this year and bring forward some revenue-negative regions to reduce projected costs in 2028 and subsequent years. The resulting design will be presented to the Commission for review at the upcoming Interim Meeting (IM102, 1 December 2026).

FISS DESIGN OBJECTIVES (Table 1)

Primary objective: *To sample Pacific halibut for stock assessment and stock distribution estimation.*

The primary purpose of the annual FISS is to sample Pacific halibut to provide data for the stock assessment (abundance indices, biological data) and estimates of stock distribution for use in management. The priority of the current rationalized FISS is therefore to maintain or enhance data quality (precision and bias) by establishing baseline sampling requirements in terms of station count, station distribution and skates per station.

Secondary objective: *Cost effectiveness.*

The FISS is intended to be cost-effective without compromising the scientific integrity of the design. Any implemented design must consider logistics and cost together with scientific integrity.

Tertiary objective: *Minimise removals and assist others where feasible on a cost-recovery basis.*

Consideration is also given to the total expected FISS removals (impact on the stock), data collection assistance for other agencies, and emerging IPHC informational needs.

Table 1. Prioritized FISS objectives and corresponding design layers.

Priority	Objective	Design Layer
Primary	Sample Pacific halibut for stock assessment and stock distribution estimation	Minimum sampling requirements in terms of: • Station distribution • Station count • Skates per station
Secondary	Cost effectiveness without compromising the scientific integrity of the FISS design.	Balance operational feasibility/logistics, cost/revenue, and scientific needs. Includes an aspirational target reserve of US$4,000,000
Tertiary	Minimise removals, assist others where feasible on a cost-recovery basis, address specific Commission informational needs.	Removals: minimise impact on the stock while meeting primary priority Assist: assist others to collect data on a cost-recovery basis IPHC policies: ad-hoc decisions of the Commission regarding the FISS design

POTENTIAL DESIGNS FOR 2027-29

BASE BLOCK DESIGN

At AM102, Secretariat staff presented the Base Block design for 2026 and subsequent years based a rotational block design (IPHC-2025-AM102-13). This design implements sampling of complete FISS charter regions (subsets of stations generally sampled by a single vessel via multiple trips) in each area rather than randomly selected stations as was previously done in the core of the stock. Sampled charter regions are rotated over two or three years depending on area. Block designs are potentially more efficient from an operational perspective than a randomized design as they involve less running time between stations, leading to cost reductions on a per station basis. The proposed Base Block designs for 2027-29 are shown in Figures 4 to 6.

PRELIMINARY COST PROJECTION FOR 2027

The proposed 2027 **Base Block design** is projected to result in an operating loss of approximately **US$131,000**. Preliminary cost and revenue projections for the Base Block design are based on the following assumptions:

1. Designs are optimised for numbers of skates, with sets of 4, 6 or 8 100-hook skates used, depending on projected catch rates and bait costs.
2. Projected Pacific halibut average sales price for 2027 in each charter region is unchanged from our current best estimate of 2026 FISS values (based on both 2025 data and 2026 data received to date)
3. Projected Pacific halibut average landings per station remain unchanged in each charter region from 2026 FISS values (based on both 2025 data and 2026 data received to date).

4. The price of chum salmon bait remains at the average 2026 price of US$2.40/lb.

Cost estimates are preliminary and do not fully account for 2026 realized costs as the FISS is in progress at the time of writing. Thus, there is considerable uncertainty in the catch and cost projections for 2027. Projected income and expenses for the 2027 design will be updated once FY2026 has been reconciled (expected late-October 2026).

MODULAR ADD-ONS

Ten potential modular add-ons to the proposed 2027 Base Block design are described below, with the following aims:

1) Reduce the projected net loss of the FISS in 2027;
2) 'Catch up' on FISS regions that were part of the 2026 **Base Block design** but were not fished;
3) Reduce the heterogeneity in net revenue among future years by sampling in 2027 some of the more costly regions planned in future years;
4) Set the FISS station charter rate at a higher value to increase the chance of receiving bids for challenging charter regions (i.e. Adak in IPHC Regulatory Area 4B);
5) Fully clear the 'backlog' of uncertainty created by the reduced designs implemented in 2023-2026 to provide the most informative data in 2027 for the stock assessment and management decisions.

With the 2027 **Base Block design** as Option 1, Options 2 to 11 are as follows:

- **Options 2 and 3** add revenue-positive charter regions in IPHC Regulatory Areas 2C and 3A, respectively, to the design to further reduce the projected net loss.
- **Options 4, 5 and 6** would add charter regions from IPHC Regulatory Areas 3A and 4B that were included in the approved 2026 Base Block design but were not fished in 2026 for reasons of cost (3A) or a lack of charter bids (4B). In the case of IPHC Regulatory Area 4B, the region is split into two (2) components (west and east, 29 stations each) to allow more flexibility for those considering submitting a bid for 2027 FISS work.
- **Option 7** brings sampling in IPHC Regulatory Area 4A forward from 2028 to reduce costs in that year, which is otherwise projected to have a large net loss.
- **Options 8 and 9** bring sampling of the northern and central Bering Sea shelf edge (IPHC Regulatory Area 4CDE) forward from 2028 and 2029, respectively, potentially reducing net losses in those years. If adopted, these options would result in complete sampling of standard FISS stations in IPHC Regulatory Area 4CDE in 2027.
- **Option 10** brings forward sampling of stations in IPHC Regulatory Area 2A from 2028, reducing costs in that year, along with stations in deep and shallow waters and the Salish Sea that have not been sampled since 2018 but were not planned until after 2031.
- **Option 11** fixes the charter rate at $5,500 per station in the Adak region of IPHC Regulatory Area 4B, which would be a 28% increase over the previous highest accepted bid. It expands sampling over Options 5 and 6 (58 stations combined) to include all 118 stations in the Adak charter region.

Figure 7 presents a map of stations included in Options 2 to 11.

The United States of America has agreed to voluntarily provide US$749,000 in supplementary funding for the 2027 FISS in order to fund modular Options 4 to 9 of Figure 7 as additions to the 2027 Base Block design (Figure 3).

DISCUSSION

The **Base Block design** has a preliminary projected net loss of US$131,000 for 2027 and therefore can be implemented using FISS reserves without the need for supplementary funding. With supplementary funding, the design is able to add charter regions in IPHC Regulatory Areas 3A and 4B that were part of the approved 2026 Base Block design but were not fished this year and bring forward other revenue-negative regions to reduce projected costs in 2028 and subsequent years.

RECOMMENDATION

That the RAB **NOTE** paper IPHC-2026-RAB027-08, which presents potential Base Block designs for 2027-29, including a preliminary cost projection for the 2027 design and potential modular add-ons to this design.

References

IPHC (2026). Report of the 102nd Session of the IPHC Annual Meeting (AM102) IPHC-2026-AM102-R. 54 p.

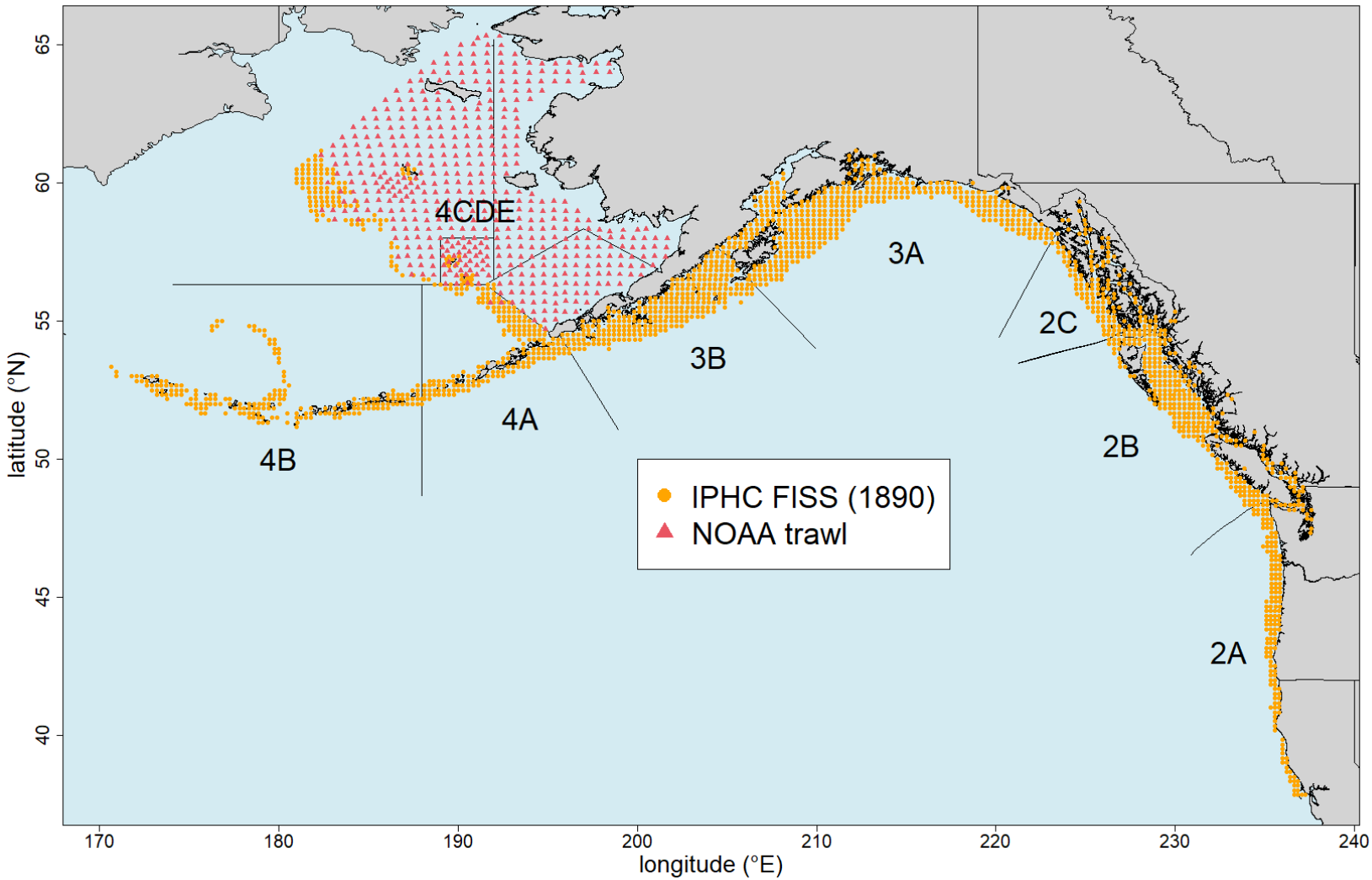

Figure 1. Map of the full 1890 station FISS design, with orange circles representing stations available for inclusion in annual sampling designs. Red triangles represent standard locations of NOAA trawl stations used to provide complementary data for Bering Sea modelling (actual NOAA trawl design can vary year-to-year).

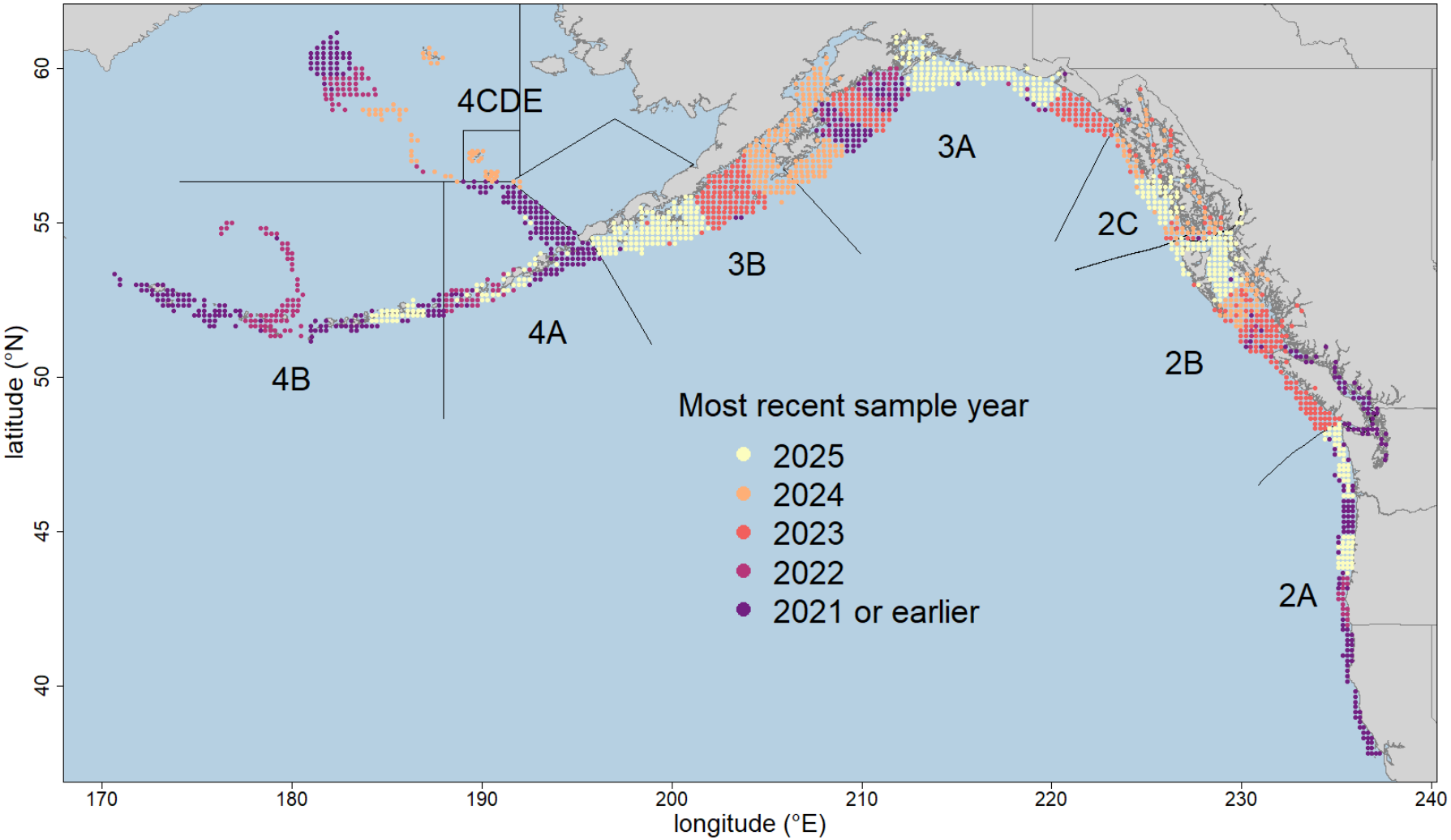

Figure 2. Map showing the most year that each station on the full FISS grid was successfully sampled.

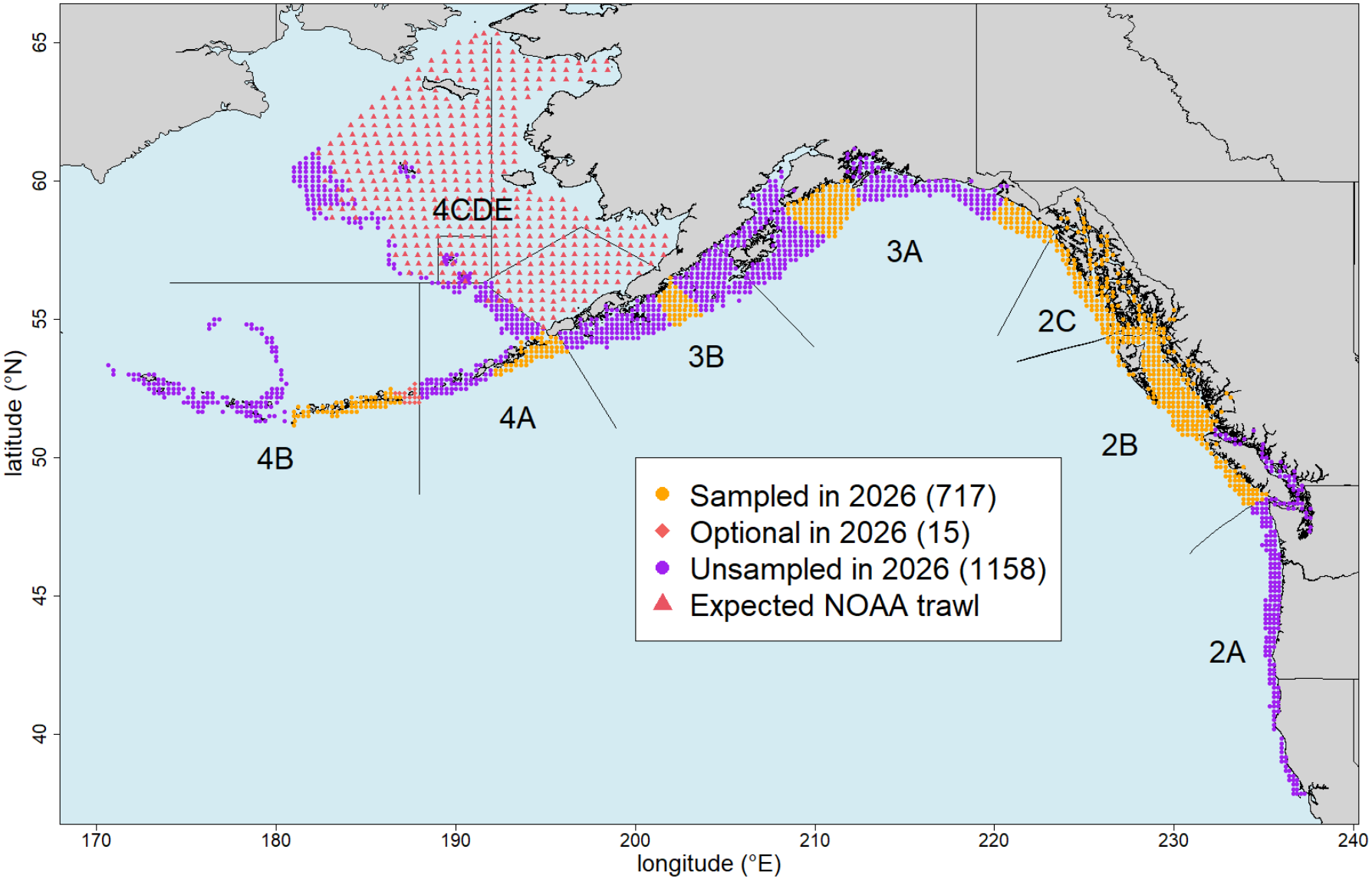

Figure 3. Adopted 2026 FISS design, with planned FISS stations shown as orange circles.

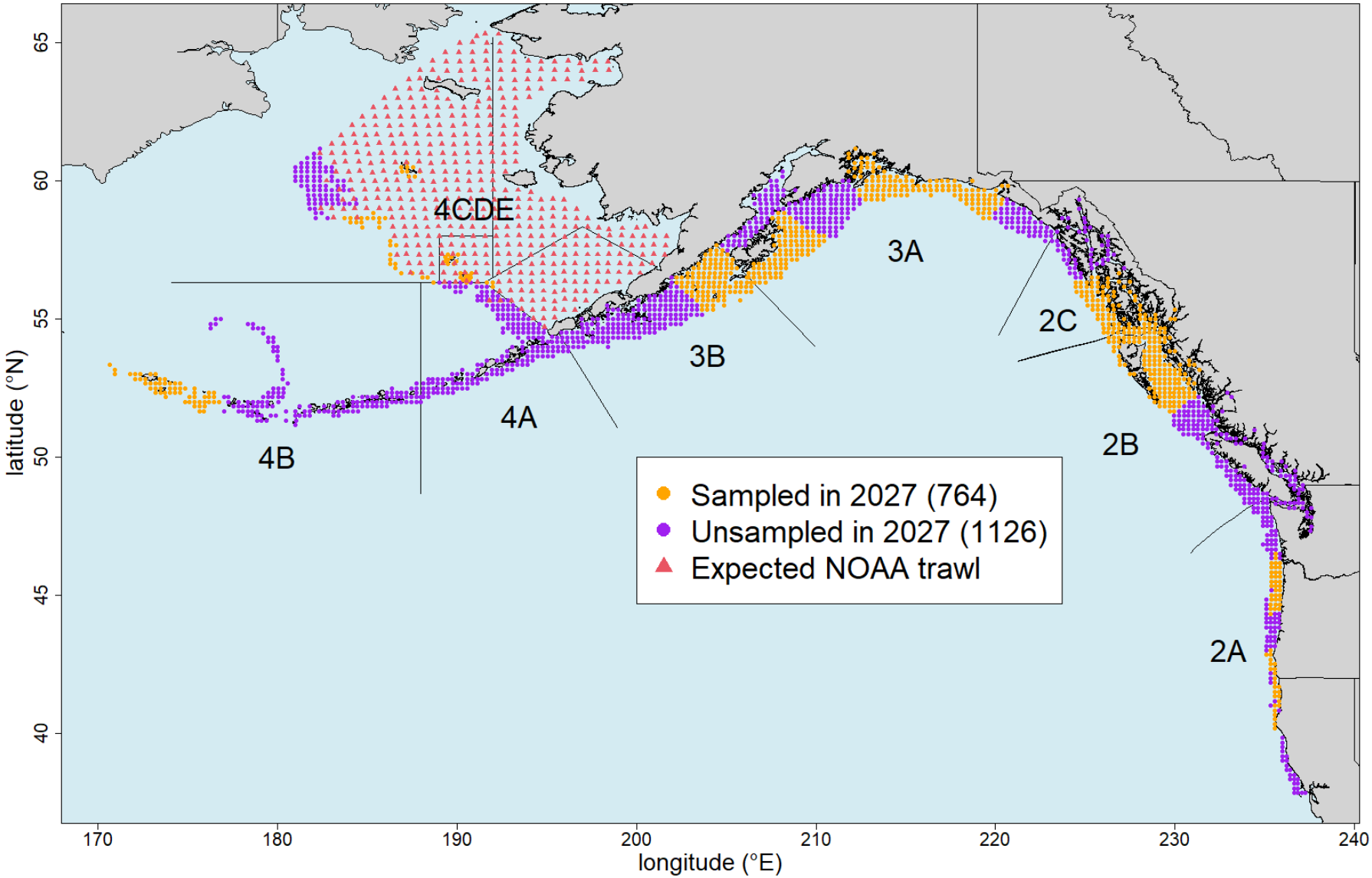

Figure 4. Base Block design for 2027 (orange circles). Design is based on fishing 2-4 complete blocks of stations (charter regions) in the core areas (2B, 2C, 3A and 3B) and previously implemented subareas elsewhere.

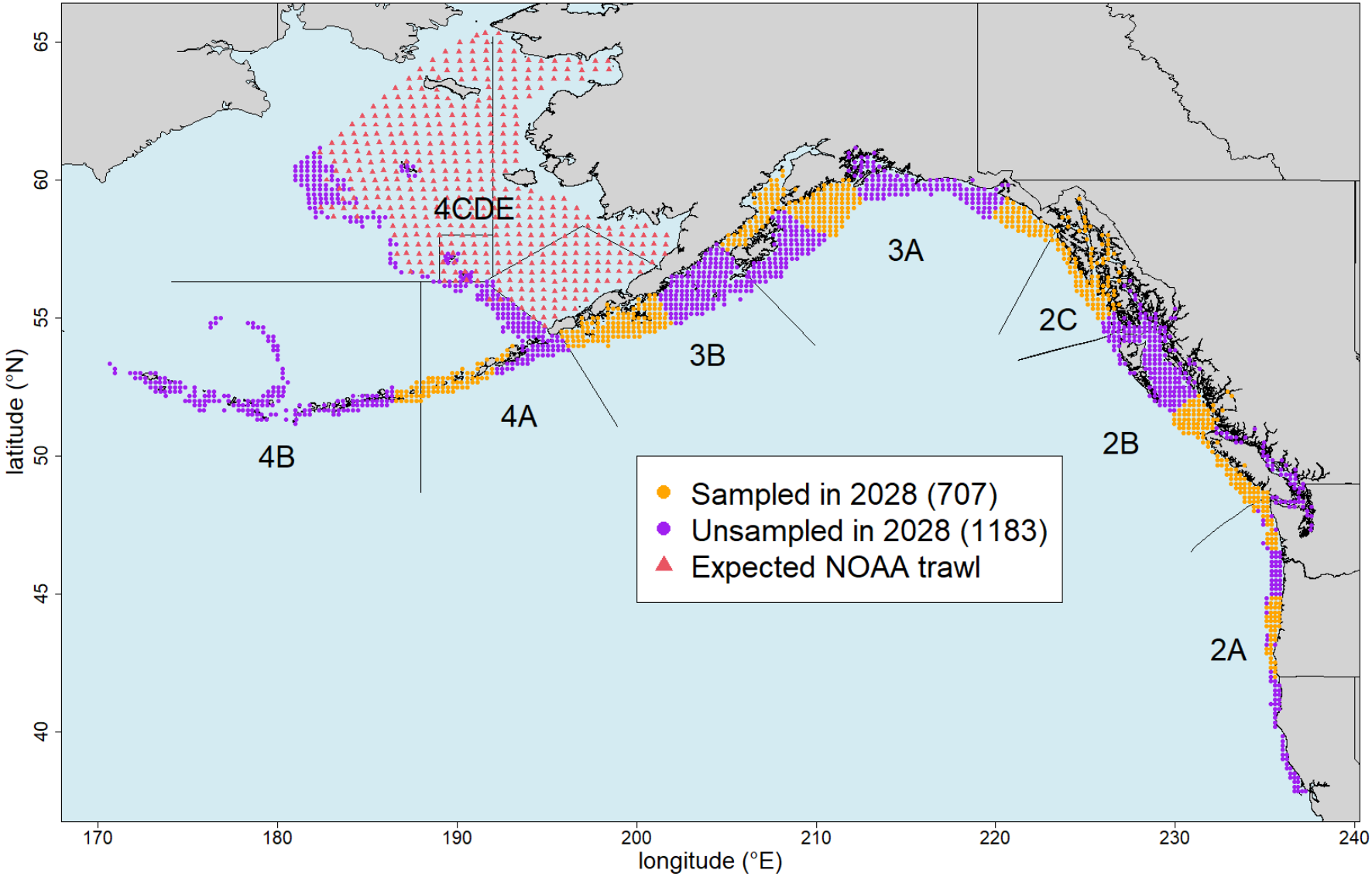

Figure 5. Base Block design for 2028 (orange circles). Design is based on fishing 2-4 complete blocks of stations (charter regions) in the core areas (2B, 2C, 3A and 3B) and previously implemented subareas elsewhere.

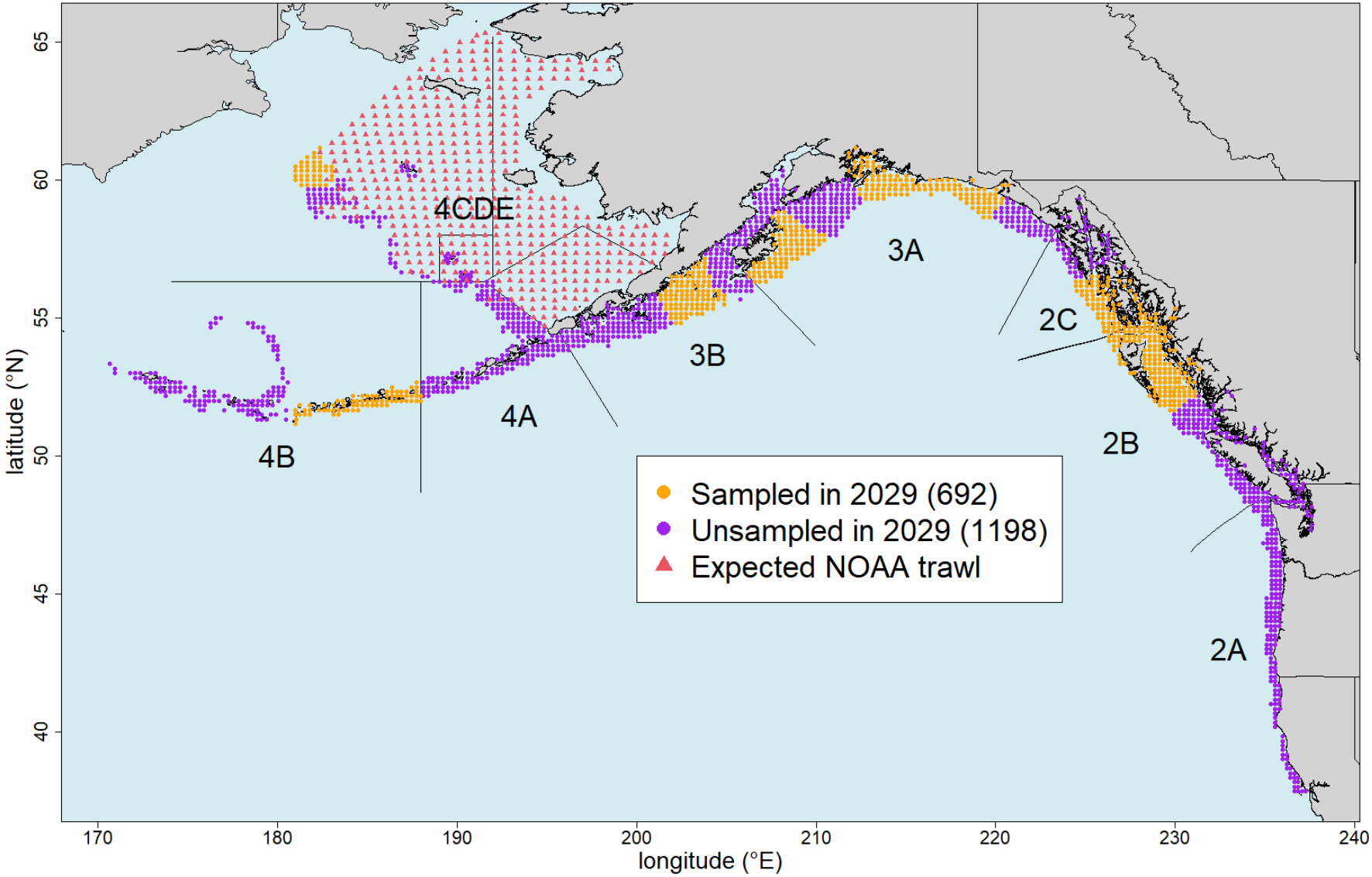

Figure 6. Base Block design for 2029 (orange circles). Design is based on fishing 2-4 complete blocks of stations (charter regions) in the core areas (2B, 2C, 3A and 3B) and previously implemented subareas elsewhere.

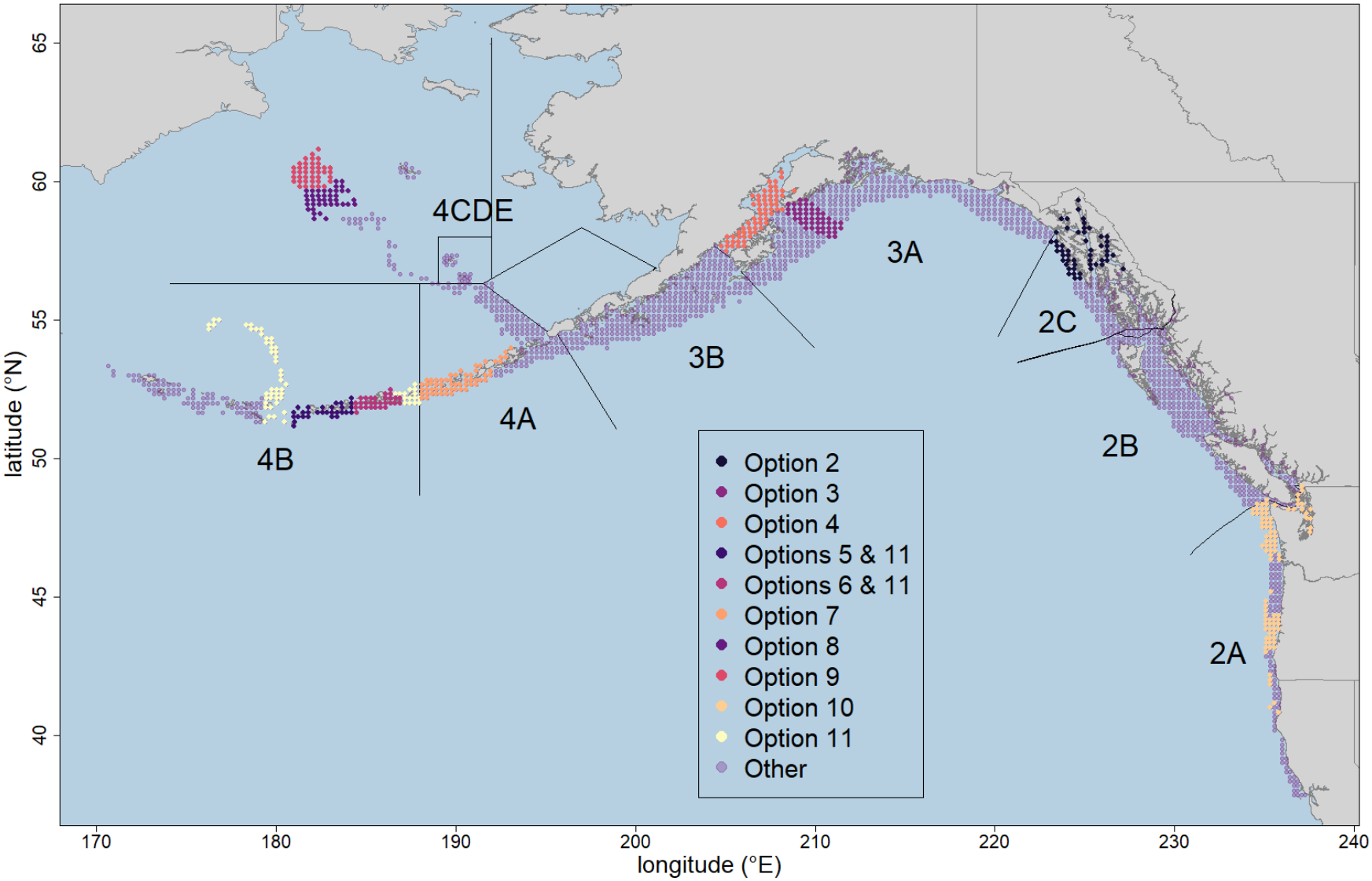

Figure 7. IPHC FISS modular Options 2 to 11 for 2027.

Preliminary assessment of sand flea prevalence in Pacific halibut commercial fisheries

PREPARED BY: IPHC SECRETARIAT (B. HUTNICZAK; 23 OCTOBER 2026)

PURPOSE

To address the request IPHC-2025-RAB026-Req.02 (para. 29):

> *"The RAB **REQUESTED** that the IPHC Secretariat set up efforts to increase documentation of sand flea occurrence during commercial fishing activities by encouraging fishing vessels to report such occurrences in logbooks, and to also relay this information to IPHC Fisheries Data Specialists (Field)."*

BACKGROUND

Nil.

DISCUSSION

Provided at **Appendix A** is the first spatial and risk factor analysis of sand flea infestation prevalence in Pacific halibut in the IPHC Convention Area, providing a basis for the reporting efforts requested by the RAB. It is adapted from a report prepared during the summer of 2026 by an IPHC Intern (W. Mixon). The work was supervised by B. Hutniczak, A. Hicks, and I. Stewart, and also benefited from discussions with IPHC field staff, guidance from the FISS HQ team in working with the FISS dataset, and information about sand fleas and the accompanying video provided by C. Dykstra. The original work has been revised and expanded here, but the analysis, maps, and findings build directly on the interns work.

RECOMMENDATIONS

That the RAB **NOTE** paper IPHC-2026-RAB027-INF01, that provided the RAB with an update on Secretariat efforts regarding IPHC-2025-RAB026-Req.02 (para. 29):

> *"The RAB **REQUESTED** that the IPHC Secretariat set up efforts to increase documentation of sand flea occurrence during commercial fishing activities by encouraging fishing vessels to report such occurrences in logbooks, and to also relay this information to IPHC Fisheries Data Specialists (Field)."*

APPENDICES

Appendix A: Risk Factor and Geospatial Analysis of Sand Flea Infestation Prevalence

APPENDIX A
RISK FACTOR AND GEOSPATIAL ANALYSIS OF SAND FLEA INFESTATION PREVALENCE

(W. MIXON, B. HUTNICZAK, A. HICKS, I. STEWART)

ABSTRACT

Sand flea infestation has long been observed in the Pacific halibut (*Hippoglossus stenolepis*) fishery but has yet to be formally documented. This study aimed to produce the first spatial and risk factor analysis for sand flea damage in the IPHC Convention Area. Data from the fishery independent setline survey (FISS) and 2026 fisherman-initiated data collection trial (commercial) were used to model the effect of environmental variables and gear use on the probability and severity of sand flea infestation. Using generalized additive models, factors such as set depth, soak duration, and bottom temperature were shown to have a relationship with infestation probability but showed no clear relationship with infestation severity. Maps produced from the FISS dataset showed that broad trends of distribution are sustained over decades, with particularly high activity around Kodiak Island, in the central Aleutians, and in southeast Alaska. The commercial logbook dataset confirmed that sand flea infestations are being reported across several Regulatory Areas, but in its first year remained too limited to support detailed analysis. The FISS and commercial logbook datasets are both valuable resources for documenting sand flea prevalence and should be the subject of continued investment by the fishery.

INTRODUCTION

Modern commercial fisheries are regularly subject to human-wildlife conflicts as evolving exploitation practices lead to opportunistic behaviors of marine wildlife. Among these fisheries, longliners are particularly vulnerable to marine predators and scavengers (Tixier et al., 2021) as prolonged exposure while on the hook makes captured fish easy targets. These removals incur economic loss and drive down catch rates (Peterson et al., 2014), interfering with population assessments and lowering the profitability of the fishery. In order to understand the evolving landscape of wildlife conflict and reciprocal changes in fleet behavior, managers must have an adaptive strategy which can minimize instances of conflict and account for its occurrence. Therefore, documenting the activity of these wildlife opportunists and building models to predict conflict are key to the productivity of a fishery.

The directed commercial Pacific halibut (*Hippoglossus stenolepis*) fishery operates nearly exclusively using longline gear and must contend with a variety of marine wildlife conflicts. Among these are sand fleas – members of the amphipod family *Talitridae* whose activity can render catches completely unmarketable (Figure 1). These arthropods are known to infest hooked Pacific halibut by intruding through the eyes, mouth, and anus, which either kills the Pacific halibut on the line or seriously reduces its chances of surviving discard (Dykstra et al., 2024). Despite damage, any captured Pacific halibut considered unfit for human consumption must be counted as part of quota (except in IPHC Regulatory Area 2B), which directly reduces the economic potential of an individual's quota ownership. Sand flea infestations can have an additive effect with other forms of wildlife conflict as well. When vessels are fishing in an area with extreme sand flea infestation they may choose to haul in their gear even while depredating marine mammals are present, giving them an opportunity to eat fish off the line. This decision to "fish through the whales" can exacerbate losses and risk damage to the gear (Peterson et al., 2014) by exposing catch to other forms of depredation.



Figure 1: Examples of sand flea infestation on Pacific halibut.

While they are well-known pests that already influence fleet behavior, little verified information exists about sand flea distribution, behavior, and their overall effect on the Pacific halibut fishery. There are many examples of anecdotal sand flea experience among fishermen which determine how they set their gear. Captains avoid setting lines at night when amphipod activity is assumed to be highest and have noted that infestations are more prevalent in some areas than others. A common tactic for fishermen when operating in areas of suspected sand flea activity is to reduce soak times and set at shallower depths. Outside the Pacific halibut fishery, scavenging amphipods are known to arrive at fish carcasses within 90 minutes of discard (Bozzano & Sardà, 2002), which puts the probable onset of sand flea attacks well within the typical soak time of a Pacific halibut longline set (Keith et al., 2014). The attacking behavior of sand fleas in the Pacific halibut fishery is not fully understood and may not be directly comparable to discards, but this suggests that soak duration is likely only partially responsible for infestation outcomes. Evidence gathered by previous studies has shown that dead Pacific halibut brought on board – the majority of which were infested by sand fleas - are correlated to lower bottom depth and colder bottom temperatures (Dykstra et al., 2024) which may also be contributing factors to infestation probability.

Although anecdotal and research knowledge suggest that factors such as depth, temperature, soak duration, and time of day may correlate with infestation, no direct analysis has yet been conducted. It is the purpose of this report to assemble the first verified dataset of sand flea infestations and lay the groundwork for future investigations. This dataset will be used to document where infestations are most prevalent within the IPHC Convention Area and assess infestation risk based on environmental factors and gear use.

This report utilized two sources of data collected in the Pacific halibut fishery: the fishery-independent setline survey (FISS) and the fisherman-initiated data collection trial (commercial). The data collection trial began during the 2026 season in response to requests by the Research Advisory Board (RAB) to document sand flea infestations. Under the trial, captains may voluntarily record in their logbooks how many Pacific halibut on each set were observed to have been damaged by sand fleas. The FISS is conducted annually by the IPHC at predetermined stations and uses standardized sets to estimate Pacific halibut abundance and collect biological information for each captured Pacific halibut (Figure 2). This includes evidence of sand flea damage. Both data sources were evaluated for how they may contribute to future sand flea prevalence studies.

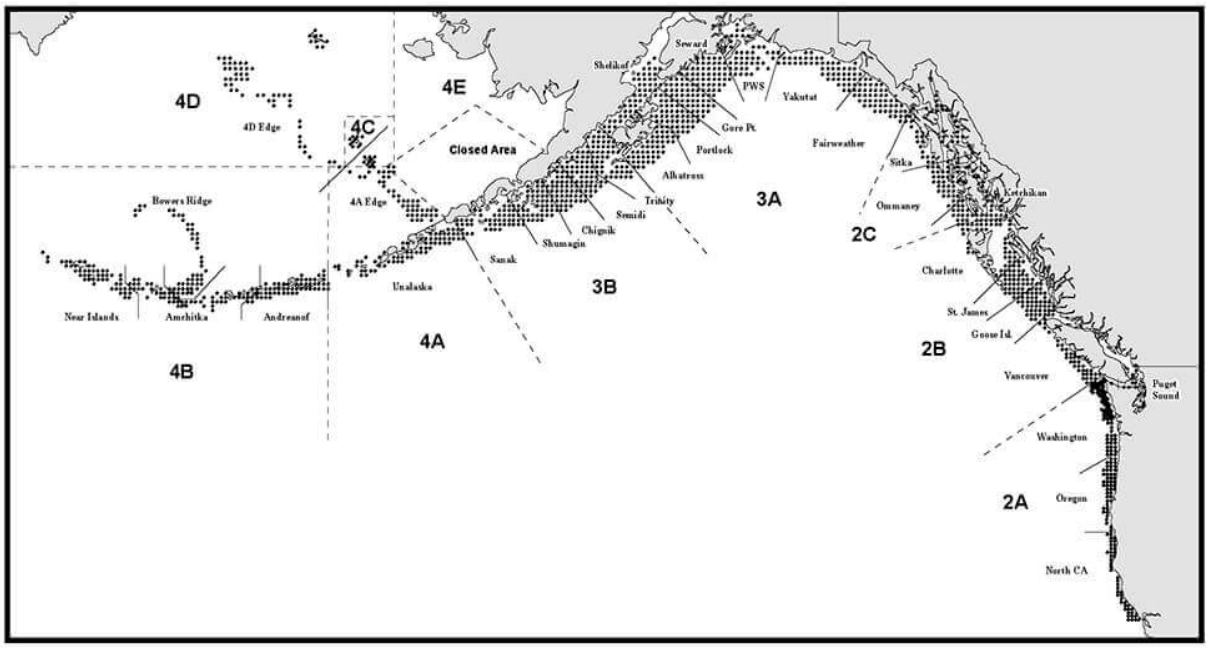

Figure 2: The fishery-independent setline survey operates annually and returns to geographically selected stations. Since 2020, only a subset of stations have been covered by the survey each year.

METHODS

Observations from the 2026 IPHC fisherman-initiated data collection trial and from the FISS were retrieved via SQL Management Studio 22 from the IPHC database. The trial data were voluntarily collected and reported by vessels participating in the 2026 directed Pacific halibut fishery and marked with the damage code '2001' to indicate that sand fleas had intruded into the body of the fish. These data included the number of legal Pacific halibut damaged, location, set and catch information. The FISS data encompassed environmental measurements taken at each station, the biological properties of each Pacific halibut captured (including damage), location, and set information. 77,912 individual Pacific halibut observations from the 2019 FISS were used to construct a single-year snapshot of sand flea distribution across the IPHC Convention Area. This was expanded to 384,386 observations between 2019 and 2025 for semi-parametric modeling. 3,674 aggregated sites were collected from the setline surveys between 2000 and 2024 and used for spatial and temporal analysis. 2025 was excluded from the spatial analysis only for the purpose of creating even 5-year periods.

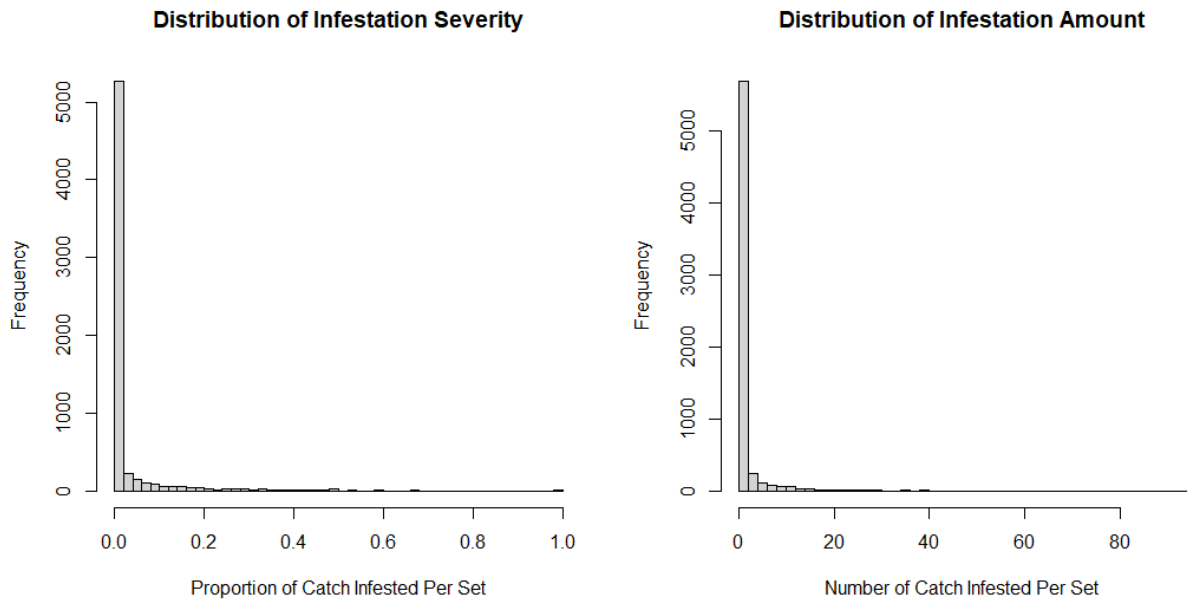

Figure 3: Both infestation amount and severity data from the FISS were extremely right skewed, with most sets reporting no Pacific halibut with signs of sand flea damage. The 95th percentile of each was seven or more infested Pacific halibut and 19% or more of the set being infested.

For the purpose of this report, a quantitative metric was developed for determining a 'problematic site' in the FISS – a station which exhibits high sand flea activity and could pose a risk to fishing productivity. Problematic sites were defined using the 95th percentile of two distributions across all sets: the proportion of the catch damaged by sand fleas and the number of fish damaged. The 95th percentile marks the value exceeded by only the top 5% of sets, so these thresholds single out the most heavily infested sites. As shown in Figure 3, a set had to have at least seven damaged fish and have those account for 19% or more of the total catch to be classified as problematic. However, this metric is not intended to predict what a captain considers to be too high of sand flea activity to continue fishing. Remarks from IPHC port staff suggested that a true metric for fleet behavior would be complex and potentially beyond the scope of this study, as the decision to haul gear in and set at another location is highly dependent on context beyond sand flea activity. Therefore, the determination of a problematic site only serves as a method of comparison within this report and should not be considered a predictor of fleet behavior.

The 'sp' and 'tmaps' packages in R were used to construct a spatial analysis of infestation prevalence in both datasets. For the FISS, the proportion of catch damaged by sand fleas was determined by dividing the number of Pacific halibut with remark code 'S' by the total number of Pacific halibut caught. Latitude and longitude were then rounded to the nearest tenth of a degree and all stations within were averaged by catch size and proportion infested. Points with higher proportions of infestation were layered above overlapping points for visual clarity. Sites which had been deemed ineffective by the FISS team due to sand fleas were noted. A single map was produced for the 2019 FISS, as it was the most recent survey to encompass all IPHC Regulatory Areas. For the comparison over time, five 5-year periods were selected between 2000 and 2024. The point size was determined by the number of times that each site was visited within that period, and color was graded based on the percentage of those years that the site was labeled as problematic. To reduce overlap and improve readability latitude and longitude were again rounded a tenth of a degree and point attributes were averaged. The commercial data were reviewed only in general terms to describe the broad distribution of reported infestations; the

limited number of first-year observations and data confidentiality requirements prevented detailed maps from being presented.

The commercial data were not selected for modeling as a lack of consistent absence data prevented strong relationships from being determined. Instead, risk factor analysis was conducted exclusively using the FISS data. Set depth, soak time, and bottom temperature were explored as variables influencing the probability and severity of sand flea infestation. Generalized additive models were used to model each covariate separately, in pairs, and in a combined model. Model selection using Akaike's Information Criteria (Akaike, 1998) indicated that the combined model had the best fit and that soak time should be modeled without a smooth term. For infestation severity, sets with no sand fleas were trimmed from the data set and a transformation was applied to fit the data onto a range between zero and one (Smithson & Verkuilen, 2006) . GAMs were built using the beta family and model selection yielded the same results.

RESULTS

The single year spatial distribution of sand fleas in 2019 (Figure 4) shows infestation across all IPHC Regulatory Areas, however greater severity of infestation was observed in the inland channels of IPHC Regulatory Area 2C, as well as in the Shelikof Strait between Regulatory Areas 3A and 3B. A similar pattern was observed among sites deemed ineffective by the FISS due to extreme rates of sand flea infestation. Five-year comparisons showed a distribution of problematic sites in southeast Alaska, around Kodiak Island, along the Alaska Peninsula, and in the Aleutian Islands (Figure 5). The most consistent problematic sites between 2000 and 2024 could be found in the Icy Strait and off the coast of Kodiak Island.

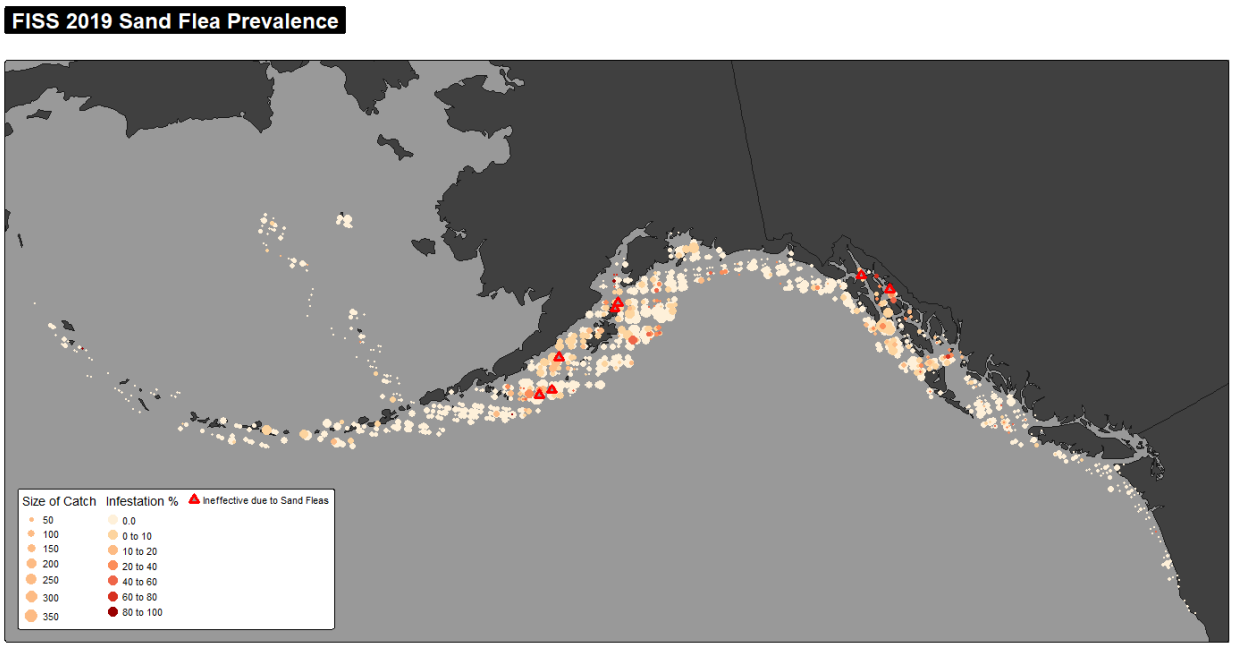

Figure 4: The 2019 FISS sand flea prevalence map. Stations have been binned together into longitude/latitude groups to the nearest tenth of a degree. Larger point size indicates a higher average catch in that group and darker shading indicates higher average infestation percentage. Higher infestations are layered closer to the top when points overlap. Stations deemed ineffective by the survey are indicated by red triangles.

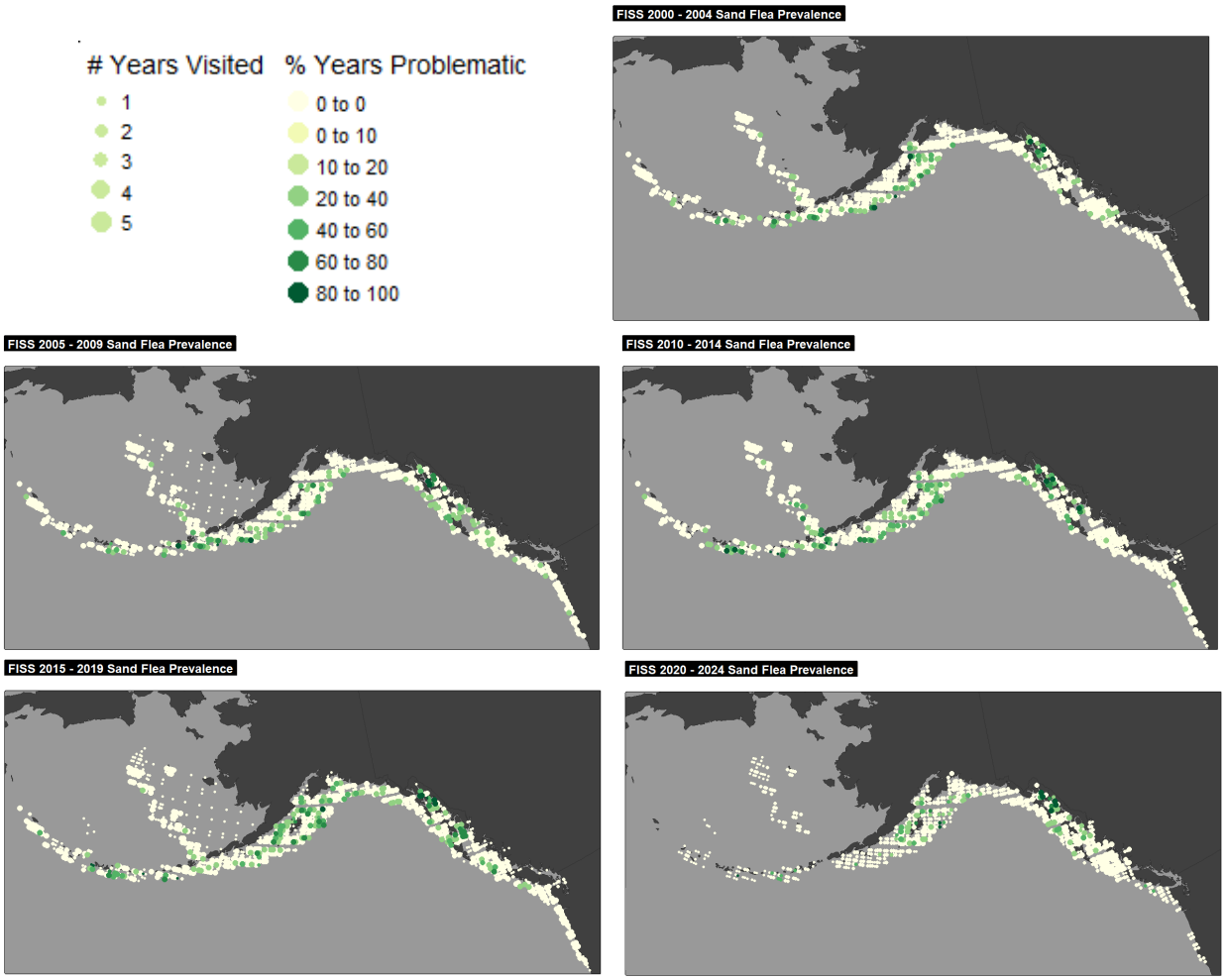

Figure 5: 5-year prevalence maps between 2000 and 2024. Stations have been binned together into longitude/latitude groups to the nearest tenth of a degree. Larger point size indicates a higher average number of survey visits during the 5-year period and darker shading indicates higher average percentage of times that a site was considered problematic.

The 2026 fisherman-initiated data collection trial provided only a limited number of observations in its first year. Because of this small sample size, the need to meet data confidentiality requirements, and uncertainty about whether the absence of sand fleas is being reported consistently, a detailed analysis of the commercial data could not be presented at this time. In general, the trial confirmed that captains reported sand flea infestations across several IPHC Regulatory Areas. Severity observations were too few to support meaningful interpretation. The challenges of the commercial dataset and options for strengthening future data collection are addressed in the Discussion.

For both infestation probability and infestation severity on FISS, the full model with all three covariates was found to have the best fit (Figure 6). The infestation probability GAM explained 11% of the deviance and showed positive trends in both set depth and soak time. Non-linear relationships were estimated for set depth and bottom temperature where an asymptote was reached at high values. All three covariates had much wider confidence intervals at larger values due to fewer data, and the prediction for high bottom temperature was highly uncertain but may decrease from a peak near six degrees Celsius. While the infestation severity model was able to explain slightly more deviance (13%), none of the covariates had a clear relationship with infestation severity. Confidence intervals on set depth and soak duration were wide enough to

encompass both increasing and decreasing relationships at higher values. Additionally, the temperature component of the model appeared to be heavily influenced by outlier points.

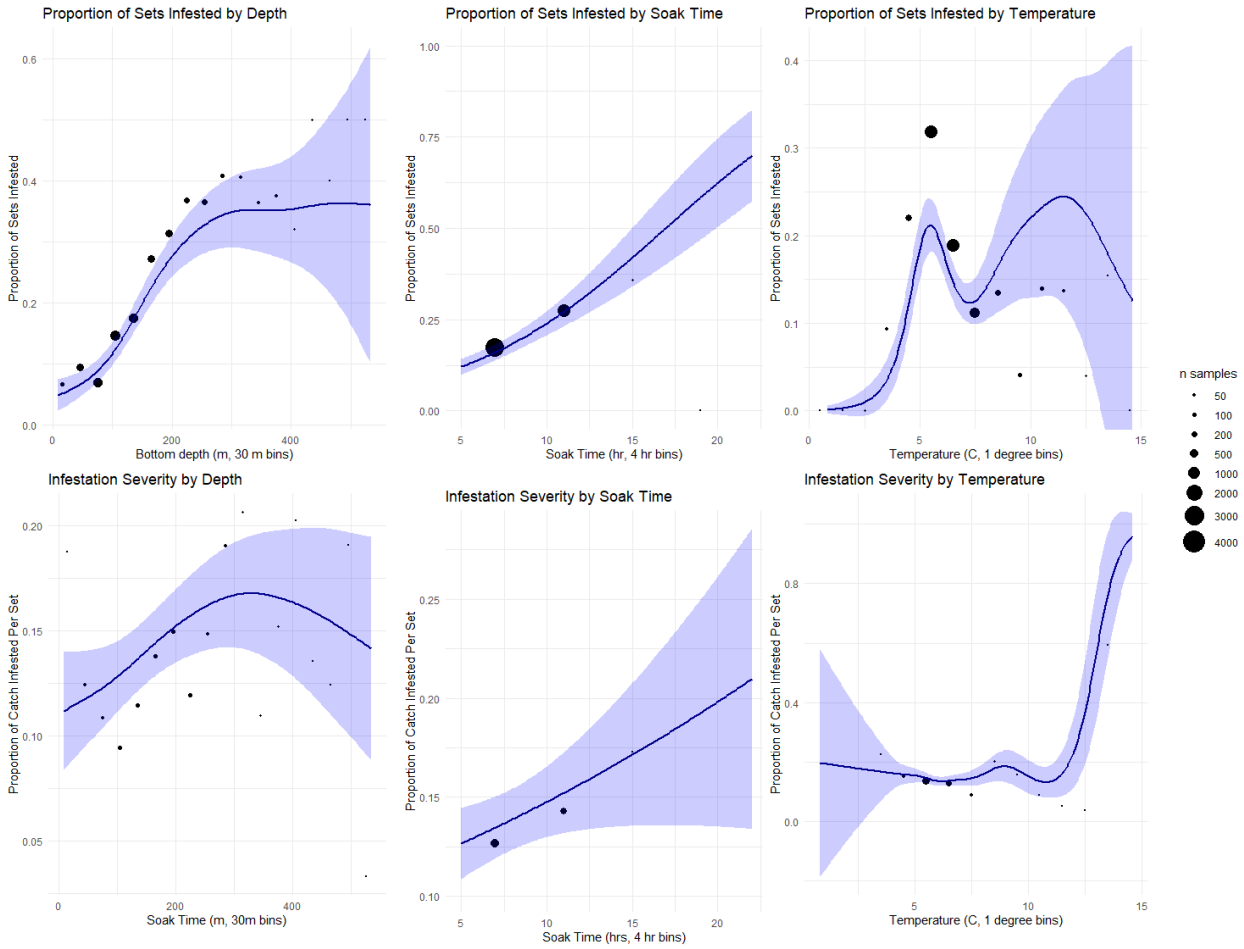

Figure 6: Two generalized additive models were produced, each with all predictor variables and one response variable: infestation probability and infestation severity. For visual clarity, raw data were binned together and the average value of each bin was calculated. The size of the point indicates the number of data points in each bin. In each figure, when another predictor variable is being manipulated, depth is held at 128 meters, soak duration at 7 hours, and bottom temperature at 6.3°C.

DISCUSSION

This report demonstrated that the distribution of sand fleas is not geographically even and may be influenced by environmental factors and local abundance. The FISS dataset revealed broad patterns in sand flea distribution which carried over several decades. Across the entire IPHC Convention Area, the greatest concentrations of problematic sites occurred in the channels of southeast Alaska, near Kodiak Island, and in the central Aleutians. These areas of high activity appear to have persisted for decades while other areas experience a more random rise and fall in activity. The wide and even placement of the FISS stations, however, means that although there is broad geographic range, patterns can only be observed with a very coarse resolution. By contrast, the commercial data suggest that areas identified by the FISS as having a sand flea presence may still show considerable variation in infestation severity when fished, although these early observations remain preliminary.

Generalized additive modeling demonstrated that the likelihood of encountering sand fleas is influenced by factors such as depth, temperature, and soak duration. Although the statistical

power of the binary model is relatively low, the relatively narrow confidence intervals over the observed range and clear trends indicate that set depth and soak duration may have a relationship with infestation probability. This relationship is not strong enough to be used as a predictor but could be used to support fleet behaviors like moving to shallower depths and reducing soak time to avoid infestation. Bottom temperature showed that the probability of sand flea infestation may peak near six degrees Celsius, which could indicate an optimal temperature range for sand fleas. However, it is important to note that observations of infestation may not exactly align with true sand flea distribution across geography and environmental conditions. The remaining deviation is explained by yet unknown or unmeasured variables, likely including sediment type and location, and timing. Infestation severity did not show a clear relationship with any of the covariates despite explaining a similar level of deviance. Severity may be a much more complex response variable than probability which will require an experimental study to better understand.

The breadth of the FISS dataset across the IPHC Regulatory Areas and through time made it an ideal starting point for an investigation into sand flea prevalence. Biological information being recorded for each Pacific halibut that was captured on the set made observations more comparable, as sand flea infestations could be standardized by total catch. However, the design of the FISS created limitations. Soak durations are standardized to be between 5 and 24 hours and only set during daylight hours. These parameters are meant to avoid sand flea infestation and may not accurately reflect commercial fleet behavior. Additionally, the FISS dataset is constrained to FISS stations, which aids in year-to-year comparison but locks the observations to a very coarse resolution. This is exacerbated in coastal regions like the channels of southeast Alaska, where landmasses interrupt the evenly spaced station grid, and by the recently reduced survey footprint.

The commercial logbook dataset is a growing resource with the potential to reveal further patterns in sand flea activity; however, its early state limits the contribution it could make to the analysis of this study. Remarks from port sampler interviews indicate that sand flea damage recordings are highly variable from captain to captain – some collected detailed observations while others only provided an estimate. Many more recordings did not state the number of Pacific halibut damaged by sand fleas on a set, but only that damage was observed. Recordings of sand flea damage may have also been partially dependent on other forms of damage. The nature of the logbook questionnaire has led to concerns that damage recordings are heavily associated with marine mammal interactions or that recording damage due to sand fleas is only prompted by recording other damage types.

Most importantly, it is often unclear whether a record of “no damage” reflects a deliberate determination that sand fleas were absent. A reasonable number of sets do report no damage, but these records typically indicate the absence of any damage rather than the absence of sand fleas specifically. Because the logbook questionnaire emphasizes other sources of damage, it is uncertain whether sand fleas were actively considered when no damage was recorded. This ambiguity in the absence data limits the potential to model relationships between sand flea damage and the environment.

The data collection trial represents a strong first effort, and participation is expected to grow as it continues to be distributed and adopted by the fishery. Building on this foundation, refining the reporting protocol — particularly how the absence of sand fleas is recorded — would substantially improve the reliability and analytical value of the dataset in future years. The RAB, which originally requested this data collection, could be a valuable resource in developing and

refining that protocol. Reporting initial findings from this study may also help promote continued participation in commercial data collection.

Despite its inherent challenges, the fisherman-initiated data collection trial has the potential to explore sand flea activity in ways that are unavailable to the FISS. Commercial logs offer a much wider range of potential data as they can be collected throughout the Pacific halibut commercial fishing period and are not constrained by the standardization of the FISS. Longer soak times, overnight sets, observations from outside the summer survey season, and densely located observations are all possible data points that can be recorded in the commercial logs. The number of sand flea damaged Pacific halibut per set is still an uncertain value that should be interpreted with caution, but presence and absence data alone is still a very valuable asset. Heat maps of sand flea activity may be produced which accurately depict where infestations occur and, assuming that infestations are reported at a consistent rate, would inherently reflect fishing effort.

To improve commercial data collection, this report demonstrates a need for clearer information on where sand fleas are absent and for greater standardization in how observations are reported. As discussed above, records of “no damage” are difficult to interpret, because it is unclear whether sand fleas were specifically considered or whether the entry reflects the absence of other damage types. One way to address this would be to include a separate question in the logbook dedicated specifically to sand fleas, rather than treating sand flea damage as an optional note tied to other forms of damage. A dedicated question would prompt captains to consider sand fleas on every set, making a record of absence as informative as a record of infestation. This is reinforced by the wording of the current trial flyer, which states, “When you are already reporting damaged Pacific halibut in your log, you may optionally note how many of those fish were damaged by sand fleas.” Because sand flea infestations are common and often occur without other accompanying damage, this phrasing may introduce bias by implying that another damage type must be present before sand fleas are reported.

The way sand flea observations are recorded could also be reconsidered. Rather than a single count of damaged fish, infestation could be collected as a categorical variable — for example, distinguishing the absence of sand fleas, their presence without damage, and damage severe enough to reduce marketable value. A categorical approach may be easier for captains to report consistently while still capturing meaningful variation in infestation impact. If counts are retained, it should also be specified whether they include sublegal Pacific halibut, which would be useful for estimating coast-wide mortality due to sand fleas. For future communications with the fishery, it is important to establish clearly what sand flea observations should describe and how they should be reported.

Future investigations into sand flea prevalence would be aided by conducting a regional study and investigating additional covariates. Coastwide-level analysis like that of this study increases variability within the dataset which may mask relationships between variables. By reducing the area of study to a smaller region, researchers can intentionally choose an area with known sand flea activity using the findings of the FISS and test how infestation varies with gear use in that area. Reduction in scope could also open the way to introducing difficult-to-measure covariates such as sediment type and total fishing effort. Sediment type may determine what stretches of seafloor are habitable to sand fleas and fishing effort across all bottom longline fisheries could indicate where sand fleas have abundant food resources. Captured fish and discard mortality create scavenging opportunity, so it is reasonable to hypothesize that sand flea populations may increase in areas with high fishing effort. Future studies could also examine the economic impact of sand flea damage, a key piece of which would be damage severity. Some sand flea damaged

Pacific halibut may still be sold as ‘Number 2’ fish to buyers at a lower price, while others are completely unmarketable. Documenting the value lost due to sand flea infestation would be another key piece of information for characterizing the prevalence of sand fleas.

As a separate effort, in 2026 the IPHC also introduced a Fisher Sentiment Survey to assess fishers’ perceptions and attitudes regarding their fishing experience in a given year. Among its questions is one on the challenges faced during the season, which includes “poor quality fish (e.g., small, infested)” as a response option. While less specific than logbook records, this survey could serve as a broad pulse of the fishery’s main concerns over time and help track whether sand fleas remain a prominent issue for the fleet. The IPHC encourages commercial fishermen to participate in both data collection efforts.

Continued investment in sand flea data collection and analysis would hold deep benefits for the Pacific halibut fishery. Knowledge of sand flea infestations is widespread across vessel captains, but each holds a small piece of the broader picture. Sharing that knowledge about where infestations occur would be mutually beneficial to all who participate in the fishery. Data can empower fishermen to avoid conflict with sand fleas and allow the IPHC to improve coastwide mortality estimates. As individuals, quota owners would be able to make more efficient use of their resources; as a fishery, better understanding of the Pacific halibut stock will help sustain it in perpetuity. Therefore, sharing personal understandings of sand flea distributions and accurately reporting data should be common practice in the Pacific halibut fishery.

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