INTERNATIONAL PACIFIC HALIBUT COMMISSION

28 June 2025

IPHC CIRCULAR 2025-016

SUBJECT: FOR DECISION – FECUNDITY RESEARCH: Part II (2025 and 2026)

Dear Commissioners,

In accordance with the IPHC Rules of Procedure (2024), Rule 11 – Decision Making (paragraphs 4-10), I am seeking your approval of the Fecundity Research (Part II) planned to be undertaken in 2025 and 2026, as provided at **Appendix I**.

Intersessional decision required:

Please provide your decision on the below action no later than **8 July 2025**, in accordance with Rule 11.7 shown above.

I approve / I do not approve the following actions:

That the Commission:

1) **NOTE** that the Pilot Study (Part I: IPHC-2024-BN05) was successfully conducted in the fall of 2024 (FY2025) to assess the viability (sampling and fiscal) of the fecundity study in 2025 and 2026 (ref. Objective 1). The Pilot Study sampled female Pacific halibut at 50 stations (Table 1 of Appendix I) in Biological Region 2;
2) **ENDORSE** the implementation of Objectives 2 and 3 (Part II):

   Objective 2 will be conducted in the late summer/Fall of 2025 (FY2025). This study will sample female Pacific halibut at 50 stations in Biological Region 2 (IPHC Regulatory Area 2B);

   Objective 3 will be conducted in late summer/Fall of 2026 (FY2026). This study will investigate potential regional differences in fecundity by estimating fecundity in female Pacific halibut collected in different Biological Regions within the same year of collection.

Yours sincerely

David T. Wilson, Ph.D.
Executive Director, IPHC

Appendices:

Appendix I: Proposal on Fecundity Research: Part II

Appendix I
Proposal on Fecundity Research: Part II

PURPOSE

To provide the Commission with an update on progress made on Objective 1 of the Proposal on Fecundity Research (Part I) (IPHC-2024-BN05) and plans to complete Objectives 2 and 3 in 2025 and 2026, respectively (Part II).

***BOTTOM LINE UP FRONT (decision points)*:**

That the Commission:

1) **NOTE** that the Pilot Study (Part I: IPHC-2024-BN05) was successfully conducted in the fall of 2024 (FY2025) to assess the viability (sampling and fiscal) of the fecundity study in 2025 and 2026 (ref. Objective 1). The Pilot Study sampled female Pacific halibut at 50 stations (Table 1) in Biological Region 2.
2) **ENDORSE** the implementation of Objectives 2 and 3 (Part II):
   a) Objective 2 will be conducted in the late summer/Fall of 2025 (FY2025). This study will sample female Pacific halibut at 50 stations in Biological Region 2 (IPHC Regulatory Area 2B);
   b) Objective 3 will be conducted in late summer/Fall of 2026 (FY2026). This study will investigate potential regional differences in fecundity by estimating fecundity in female Pacific halibut collected in different Biological Regions within the same year of collection.

BACKGROUND

Recalling that following a Commission directive from the 2024 Work Meeting, the IPHC Secretariat provided 2024 Briefing Note 05 (IPHC-2024-BN05) describing a Proposal on Fecundity Research that included plans for the collection of fecundity samples from 2024 until 2026:

(**IPHC-2024-WM2024-R**: Actions arising Paper 3) ***NOTING*** *that maturity and fecundity research has been a high priority in the IPHC Five-Year Program of Integrated Research and Monitoring (5YPIRM), and that to date, focus has been on maturity sampling and analysis, the Commission* ***DIRECTED*** *the Secretariat to explore the fecundity research prioritized within the IPHC 5YPIRM, as follows:*

a) Provide a working paper by 30 September 2024 that would describe the goals, objectives, designs, costs, and revenue of such a project;

b) Incorporate plans for the collection of fecundity samples in Fall/Winter 2025;

c) *Consider a pilot project in winter of 2024*.

In this current ducument, the IPHC Secretariat describes the progress made on Objective 1 (Part I) (PILOT STUDY: IPHC-2024-BN05), and future plans for pursuing Objectives 2 and 3 (Part II).

INTRODUCTION

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 stock 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, as informed by recent sensitivity analyses (Stewart and Hicks, 2018). However, at present we have only historical time-aggregated estimates of maturity and fecundity schedules. Therefore, the current research priority under the 5YPIRM is to update estimates for each of these traits to reflect current environmental and biological conditions. After current 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.

The IPHC Secretariat is currently revising the historical estimates of maturity that have been used to date as inputs into the stock assessment through the use of recently developed histological maturity assessments (Fish et al., 2020; Fish et al., 2022) over different spatial (i.e. IPHC Biological Regions) and temporal (2022-2024) scales (IPHC-2024-WM2024-09). However, reproductive output as a function of body mass or age (i.e., fecundity) in female Pacific halibut has not been well characterized to date. A precise estimation of fecundity in female Pacific halibut is important because fecundity-at-size and fecundity-at-age could be used to replace spawning biomass with egg output as the metric for reproductive capability in stock assessment and management reference points.

Based on the results of a previous study conducted by the IPHC Secretariat (Fish et al., 2020), it is now known that female Pacific halibut have determinate fecundity. That is, the number of eggs that female Pacific halibut can produce during one reproductive cycle is fixed and, therefore, the number of eggs can be measured at any given time prior to the beginning of spawning. Given that Pacific halibut are winter spawners, with the peak of spawning observed during January and February (at least in the central Gulf of Alaska), it is reasonable to assume that fecundity can be successfully measured in Pacific halibut females from early Summer until late Fall. This is supported by our results on the progression of egg size within the ovary throughout the reproductive season (Fish et al., 2022), with larger eggs only present in the Fall.

OBJECTIVES

In view of the above considerations, the IPHC Secretariat has classified research activities directed towards providing accurate estimations of fecundity in female Pacific halibut as a priority within the 5YPIRM.

The main objectives of these proposed research activities are:

1) Develop and validate methodology to accurately estimate fecundity in female Pacific halibut.
2) Investigate potential temporal differences in fecundity by estimating fecundity in Pacific halibut collected in specific Biological Regions over a period of several years.
3) Investigate potential regional differences in fecundity by estimating fecundity in female Pacific halibut collected in different Biological Regions within the same year of collection.
4) Evaluate the costs of collecting biological samples and biological information required for fecundity estimations.
5) Generate revenue from fish sales to support these research activities as well others.

Part I:

Objective 1. PILOT STUDY (IPHC-2024-BN05) - Develop and validate methodology to accurately estimate fecundity in female Pacific halibut.

The first step in this research project was to develop and validate a method for accurately estimating fecundity in female Pacific halibut. The selected method to estimate fecundity in female Pacific halibut is the autodiametric method that has been developed for other teleost species (Thorsen and Kjesbu 2001;

Witthames et al., 2009). This method consists of establishing a relationship between the number of eggs per gram of ovary (i.e. egg density) and the mean egg diameter (i.e. size) for individual Pacific halibut females. Once this relationship is established over a wide range of egg diameters (see example in **Figure 1**), egg density in a particular ovarian sample can be calculated based on the measured mean egg diameter and extrapolated to the total number of eggs present in the entire ovary of a female (i.e. total fecundity) by multiplying by the weight of the ovary. This method has the advantage of being fast and accurate since the measurement of egg diameters in an ovarian sample can be automated through computer-assisted image analysis under a microscope. Therefore, once the egg density-mean egg diameter relationship (i.e. autodiametric curve) is established (see example in **Figure 1**), ovarian samples can be processed relatively rapidly for fecundity.

Based on the training that the IPHC Secretariat received on the autodiametric method from experts in the field (NOAA Fisheries, Northeast Fisheries Science Center, Woods Hole, MA) in May 2023, it was estimated that approximately 300 Pacific halibut females at different stages in ovarian development prior to spawning (e.g. from early vitellogenesis until after oocyte maturation) were needed to construct the autodiametric curve.

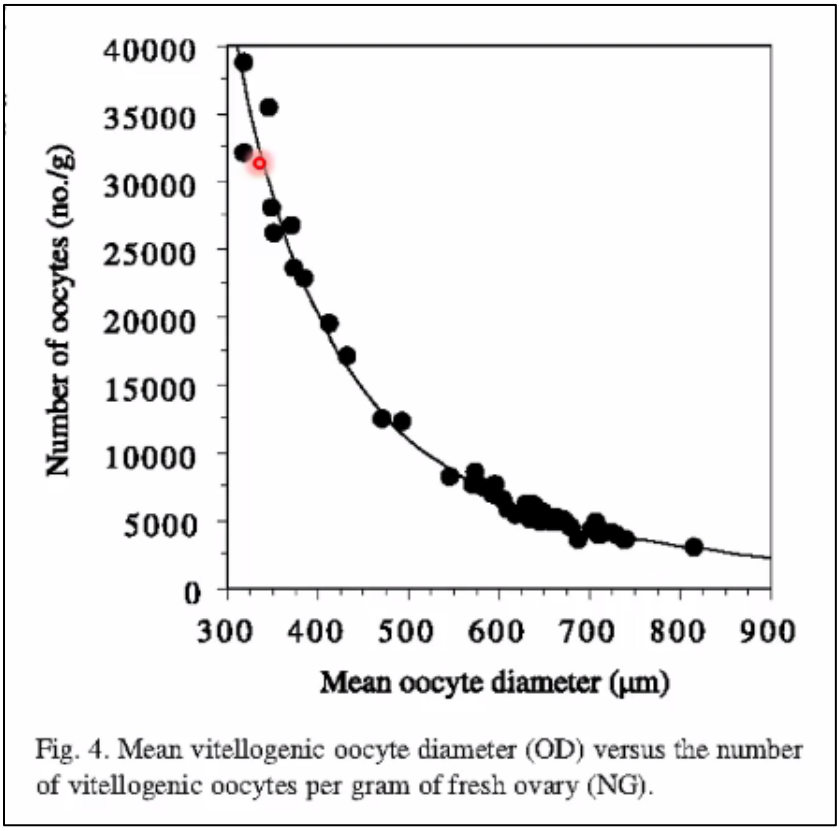

Figure 1. Example of an autodiametric curve: relationship between the number of oocytes (i.e. eggs) per gram of ovary and the mean oocyte diameter in Atlantic cod females. Taken from Thorsen and Kjesbu (2001).

Sampling methodology: From Pacific halibut females selected for sampling, dressed weight was measured with a large motion-compensated scale, ovarian weight was measured with a small motion-compensated scale, fork length was determined using a measuring cradle, macroscopic maturity stage was recorded, two samples of ovarian tissue were collected into pre-filled tubes with 10% buffered formalin for egg count and egg diameter measurements and histological maturity assessment, a fin clip was taken

from the pectoral or caudal fin and attached to chromatography paper for genetic studies, and the distal otolith was collected for age determination.

***Timeline*:** Fall of 2024 – Completed.

***Sampling location*:** Biological Region 2 (Charlotte charter region).

***Sampling collection timing*:** Sampling was conducted between early October and early November to ensure the pilot study was completed well before the beginning of preparation for spawning.

***Number of females targeted*:** 300 females with a fork length of 90 cm and above assuming a 100% sampling rate and 6 skates per station was set as the sampling goal. 50 stations were sampled to ensure sufficient samples would be taken. A stratified sampling strategy was devised and implemented to ensure proper representation of large mature females.

***Deliverables*:** Development of a reproducible and fast method to accurately estimate total fecundity in female Pacific halibut.

Results: Fishing was conducted on a chartered fishing vessel in the Fall of 2024 in the Charlotte charter region (Biological Region 2). After a total of three trips, 271 females were captured and sampled for fecundity. Captured females ranged in fork length from 82 to 204 cm (**Figure 2**). The collection of large females was successful in expanding the number of females above 100 cm in fork length for which fecundity samples are available. These samples, together with those collected in the 2023 and 2024 FISS, represent a valuable collection of fecundity samples from a wide range of female sizes with which to develop the autodiametric method for fecundity estimation. The development and validation of the autodiametric method (Part II) is proposed to occur late Summer/early Fall of 2025.

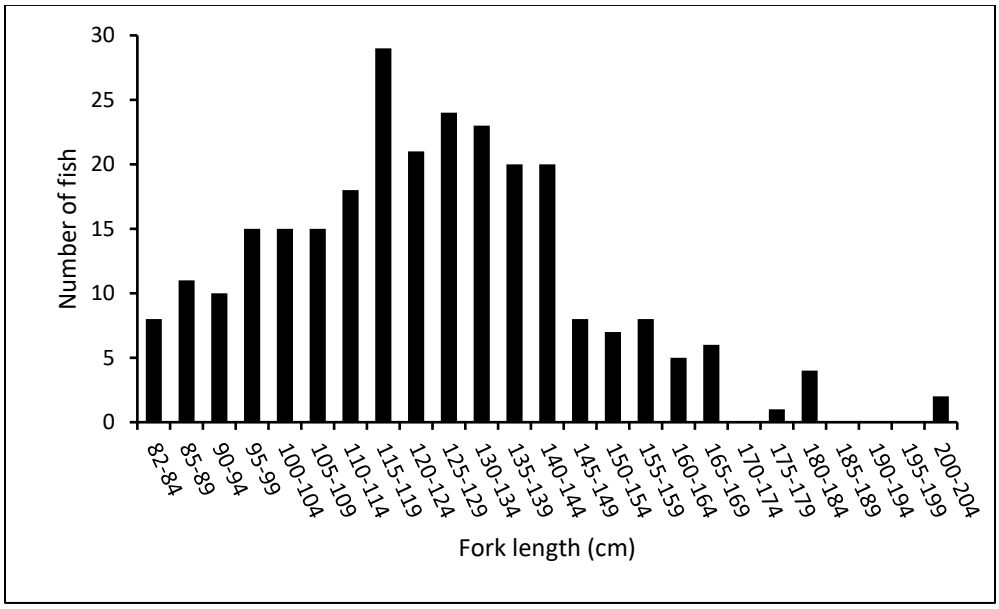

Figure 2. Distribution of Pacific halibut females by fork length (cm) collected in the Fall of 2024.

Part 2:

Objective 2. Investigate potential temporal differences in fecundity by estimating fecundity in Pacific halibut collected in specific Biological Regions over a period of several years.

With the use of the autodiametric method for estimating fecundity in female Pacific halibut developed for Objective 1, potential temporal differences in fecundity will be investigated by estimating fecundity in

Pacific halibut females collected in the late Summer/Fall of 2025 and again in the late Summer/Fall of 2026 in Biological Region 2. By incorporating age, weight and length information, fecundity-at-age, fecundity-at-weight, and fecundity-at-length will be estimated and compared among years 2024 (Objective 1; completed), 2025 (Objective 2) and 2026 (Objective 2) for Biological Region 2.

Sampling methodology: From Pacific halibut females selected for sampling, dressed weight will be measured with a large motion-compensated scale, ovarian weight will be measured with a small motion-compensated scale, fork length will be determined using a measuring cradle, macroscopic maturity stage will be recorded, two samples of ovarian tissue will be collected into pre-filled tubes with 10% buffered formalin for egg count and egg diameter measurements and histological maturity assessment, a fin clip will be taken from the pectoral or caudal fin and attached to chromatography paper for genetic studies, and the distal otolith will be collected for age determination.

Timeline**:** Late summer/Fall of 2025 and 2026

Sampling location**:** Biological Region 2 (Charlotte charter region).

Sampling collection timing**:** Sampling will take place well before the beginning of preparation for spawning.

Number of females targeted**:** 300 females per year in Biological Region 2 with a fork length of 90 cm and above, assuming a 100% sampling rate and 6 skates per station. The minimum number of stations fished to achieve the sampling targets is 50 stations in the Charlotte charter region per year. Total: 600 females. A stratified sampling strategy will be devised to ensure proper representation of large, mature females.

Deliverables**:** Comparison of fecundity-at-age, fecundity-at-weight, and fecundity-at-length estimates across years (2024-2026) in Biological Region 2.

Objective 3. Investigate potential regional differences in fecundity by estimating fecundity in female Pacific halibut collected in different Biological Regions within the same year of collection.

With the use of the autodiametric method for estimating total fecundity in female Pacific halibut developed for Objective 1, potential differences in fecundity across various geographic areas will be investigated by estimating fecundity in Pacific halibut females collected in the late Summer/Fall of 2026 in Biological Regions 2 (Objective 2), 3 and 4, provided net revenue in each of the Biological Regions is positive. By incorporating age, weight, and length information, fecundity-at-age, fecundity-at-weight, and fecundity-at-length will be estimated and compared among the three Biological Regions sampled.

Sampling methodology: From Pacific halibut females selected for sampling, dressed weight will be measured with a large motion-compensated scale, ovarian weight will be measured with a small motion-compensated scale, fork length will be determined using a measuring cradle, macroscopic maturity stage will be recorded, two samples of ovarian tissue will be collected into pre-filled tubes with 10% buffered formalin for egg count and egg diameter measurements and histological maturity assessment, a fin clip will be taken from the pectoral or caudal fin and attached to chromatography paper for genetic studies, and the distal otolith will be collected for age determination.

Timeline**:** Late Summer/Fall of 2026

Sampling location**:** Biological Regions 2 (Charlotte charter region; sampling contemplated in Objective 2), 3 (charter region TBD), and 4 (charter region TBD), provided the research is self-funding.

***Sampling collection timing*:** Sampling will take place well before the beginning of preparation for spawning.

***Number of females targeted*:** 150 females in each Biological Region (sampling in Biological Region 2 contemplated in Objective 2) with a fork length of 90 cm and above, assuming a 100% sampling rate and 6 skates per station. The minimum number of stations fished to achieve the sampling targets is 50 stations in Biological Region 2 (contemplated in Objective 2), 50 stations in Biological Region 3, and 50 stations in Biological Region 4. Total: 450 females. A stratified sampling strategy will be devised to ensure proper representation of large mature females.

***Deliverables*:** Comparison of fecundity-at-age, fecundity-at-weight, and fecundity-at-length estimates across Biological Regions.

Summary: ***Evaluation of the costs of collecting biological samples and biological information required for fecundity estimations and the revenue generated to support these research activities as well others.***

Part I:

1. **Pilot study 2024 (Objective 1).**

   The IPHC Secretariat has completed the sample collection required for this objective successfully.

Part II:

2. **Investigate potential temporal differences in fecundity by estimating fecundity in Pacific halibut collected in specific Biological Regions over a period of several years (Objective 2).**

   The IPHC Secretariat has produced cost and revenue estimates for Biological Region 2 in 2025 based on fishing 50 stations at 6 skates each, and this information is provided in **Table 1**. Estimated costs and revenues incurred from fishing the same number of stations in 2026 will be derived in late 2025 using an adjustment based on the 2026 FISS projections (TBD).

   Table 1. Cost and revenue estimate for sample collection efforts in 2025 in Biological Region 2.

Biological Region	Number of stations	Cost	Revenue	Net
2	50	$178,000	$255,000	$77,000

   Detailed costs and revenue estimates for Biological Region 2 in 2025 are shown in Attachment I.

3. **Part II: Investigate potential regional differences in fecundity by estimating fecundity in female Pacific halibut collected in different Biological Regions within the same year of collection (Objective 3).**

   The IPHC Secretariat will develop an estimate of costs and revenues incurred from fishing different numbers of stations in different Biological Regions in 2026 once the 2026 FISS projections are available. Only financially viable options will be contemplated.

RECOMMENDATION/S

That the Commission:

3) **NOTE** that the Pilot Study (Part I: IPHC-2024-BN05) was successfully conducted in the fall of 2024 (FY2025) to assess the viability (sampling and fiscal) of the fecundity study in 2025 and 2026 (ref. Objective 1). The Pilot Study sampled female Pacific halibut at 50 stations (Table 1) in Biological Region 2.

4) **ENDORSE** the implementation of Objectives 2 and 3 (Part II):

   a) Objective 2 will be conducted in the late summer/Fall of 2025 (FY2025). This study will sample female Pacific halibut at 50 stations in Biological Region 2 (IPHC Regulatory Area 2B);

   b) Objective 3 will be conducted in late summer/Fall of 2026 (FY2026). This study will investigate potential regional differences in fecundity by estimating fecundity in female Pacific halibut collected in different Biological Regions within the same year of collection.

REFERENCES

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

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Thorsen, A., and Kjesbu, O.S. 2001. A rapid method for estimation of oocyte size and potential fecundity in Atlantic cod using a computer-aided particle analysis system. J. Sea Res. 46: 295-308.

Witthames, P.R., Greenwood, L.N., Thorsen, A., Dominguez, R., Murua,H., Korta,M., Saborido-Rey, F., Kjesbu, O.S., 2009. Advances in methods for determining fecundity: application of the new methods to some marine fishes. Fishery Bulletin 107, 148–164.

ATTACHMENT

Attachment I: Detailed cost and revenue information of sampling 50 stations in Biological Region 2 in 2025.

Attachment I
Detailed cost and revenue information of sampling 50 stations in Biological Region 2 in 2025.

Design parameters	Projected
Charter regions sampled	1
Sampled stations	50
Average skates fished	6.0
ercent of 1890 station full design	3%
Projected performance	
Fish landings (pounds)	28,000
Fish landings (tons)	13
Average price per lb (USD)	$ 9.00
Total fish sales (USD)	$ 248,000
IPHC fish sales (USD)	$ 223,000
Total byproduct sales (USD)	$ 7,000
IPHC byproduct sales (USD)	$ 7,000
Bait used (pounds)	11,000
Costs (USD)	
Total bids (leases and contracts)	$ (90,000)
53100.05 - Bait	$ (20,000)
50000.01 - Salary - Staff (HQ)	$ –
50000.02 - Salary - Staff (Field)	$ (18,000)
50000.12 - Payroll Tax expense (HQ)	$ –
50000.12 - Payroll Tax expense (Field)	$ (2,000)
50100.01 - Benefits (HQ)	$ –
50100.02 - Benefits (Field staff)	$ (3,000)
50200 - Training and education	$ –
50300 - Personnel related expenses	$ –
51000 - Publications	$ –
51100 - Mailing and shipping	$ (10,000)
51200 - Travel	$ (5,000)
51400 - Technology	$ –
52000 - Professional fees	$ –
52100 - Vessel revenue share	$ (25,000)
52100.06 - Gear replacement	$ (6,000)
52200 - Other Fees and Charges	$ –
53000 - Equipment Expense	$ –
53100 - Supplies Expense	$ –
53200 - Maintenance & Utilities	$ –
53300 - Facility rentals	$ –
54000 - Communications	$ –
FISS cost-recovery (10% overhead)	$ –
Total cost	$ (178,000)
Net Revenue (USD)	77,000

Design map:

Map not available for manual designs

Projection sensitivity:

Price change: \ Landings change:	20%	15%	10%	5%	0%
35%	$ 117,000	$ 106,000	$ 95,000	$ 84,000	$ 73,000
30%	$ 107,000	$ 97,000	$ 86,000	$ 75,000	$ 65,000
25%	$ 97,000	$ 87,000	$ 77,000	$ 67,000	$ 57,000
15%	$ 78,000	$ 68,000	$ 59,000	$ 50,000	$ 40,000
10%	$ 68,000	$ 59,000	$ 50,000	$ 41,000	$ 32,000