INTERNATIONAL PACIFIC HALIBUT COMMISSION

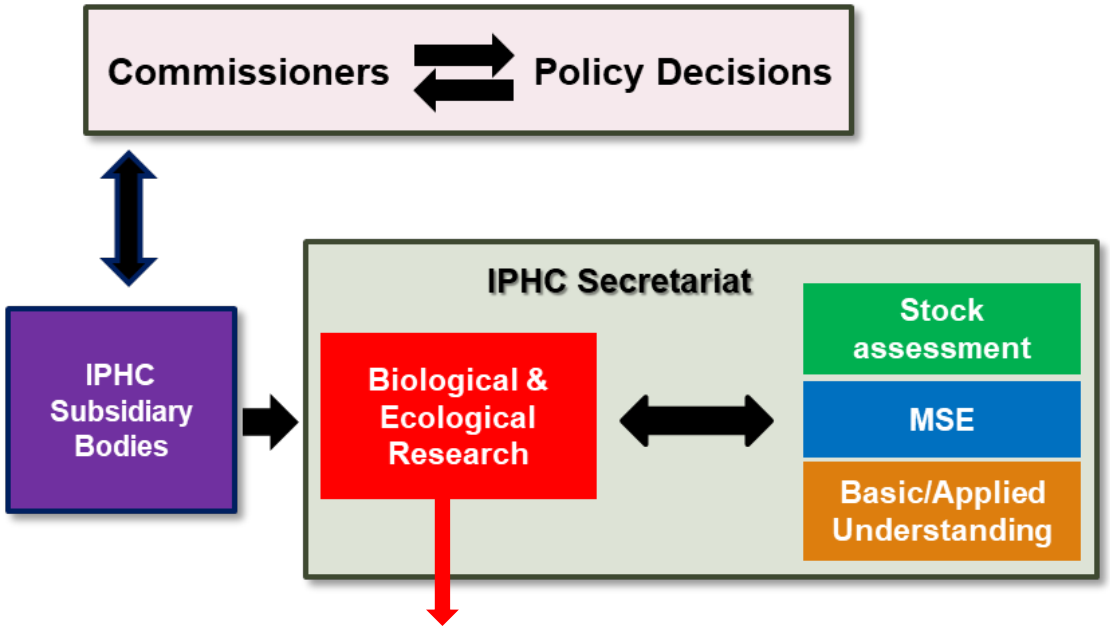
Report on current and future Biological and Ecosystem Science Research activities

Agenda item: 9.1

IPHC-2026-AM102-14

(J. Planas)

Biological and Ecosystem Science Research



5 Yr –Program of Integrated Research and Monitoring (2022-2026)

Research Areas:

- Migration and Population Dynamics
- Reproduction
- Growth
- Mortality and Survival Assessment
- Fishing Technology

Inputs for stock assessment

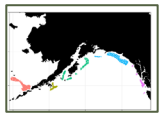
1. Migration and Population Dynamics

5-Yr Research Plan (2017-2021)

Multiple life-stage connectivity

Bering Sea

Gulf of Alaska



Genetic samples of spawning aggregations

Larval connectivity

- Larval catch and effort data
- Individual-based biophysical model
- Hydrographic ROMS model

→ Larval dispersal pathways → Inter-basin and intra-basin larval connectivity

Sadorus et al. (2021) *Fish. Oceanog.* ***30****: 174*

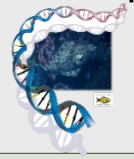
Juvenile connectivity

- NMFS trawl survey data
- Spatiotemporal model

→ Ontogenetic migration

Development and application of genomic approaches

Genome sequence



→ Population structure analyses

Jasonowicz et al. (2022) *Mol. Ecol. Res.* ***22****: 2685*

PIRM 2022-2026

- Climate effects on larval connectivity
- Connectivity with Western Pacific Ocean region
- Mapping of settlement/nursery areas
- Characterization of genetic composition/mixture of settlement areas
- Establishment of a baseline of genetic diversity
- Delineation of fine-scale stock structure
- Stock composition: mixed stock analyses
- Development of an epigenetic clock for aging

Relevance for stock assessment

- Generate potential recruitment covariates
- Define management targets for minimum spawning biomass by Biological Region

→ Improved estimates of productivity

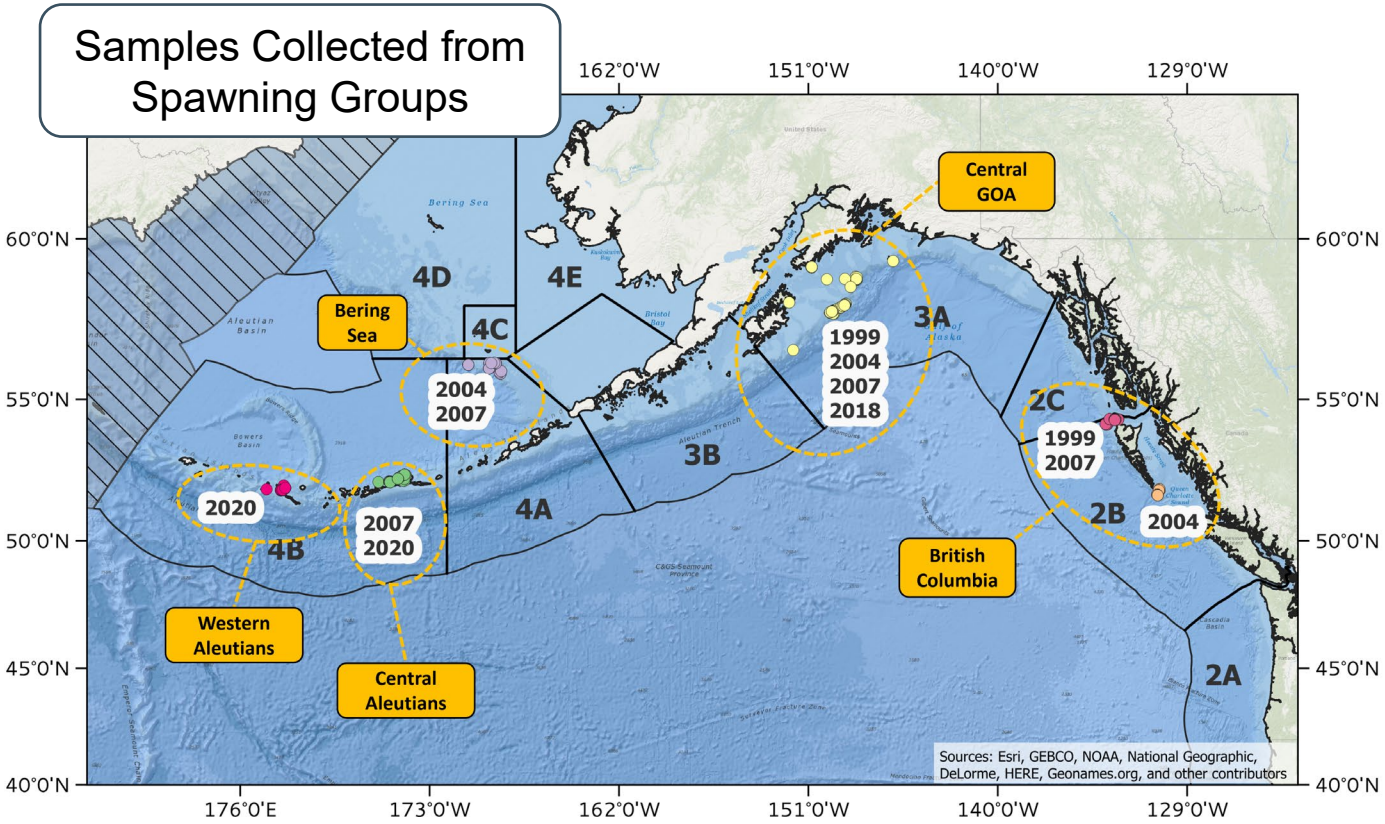
- Determine the need for separate assessments for certain components of the stock

→ Potential revision of structure of future stock assessments

1. Migration and Population Dynamics

Population Genomics

Objective: Resolve the genetic structure of the Pacific halibut stock in IPHC Convention Waters



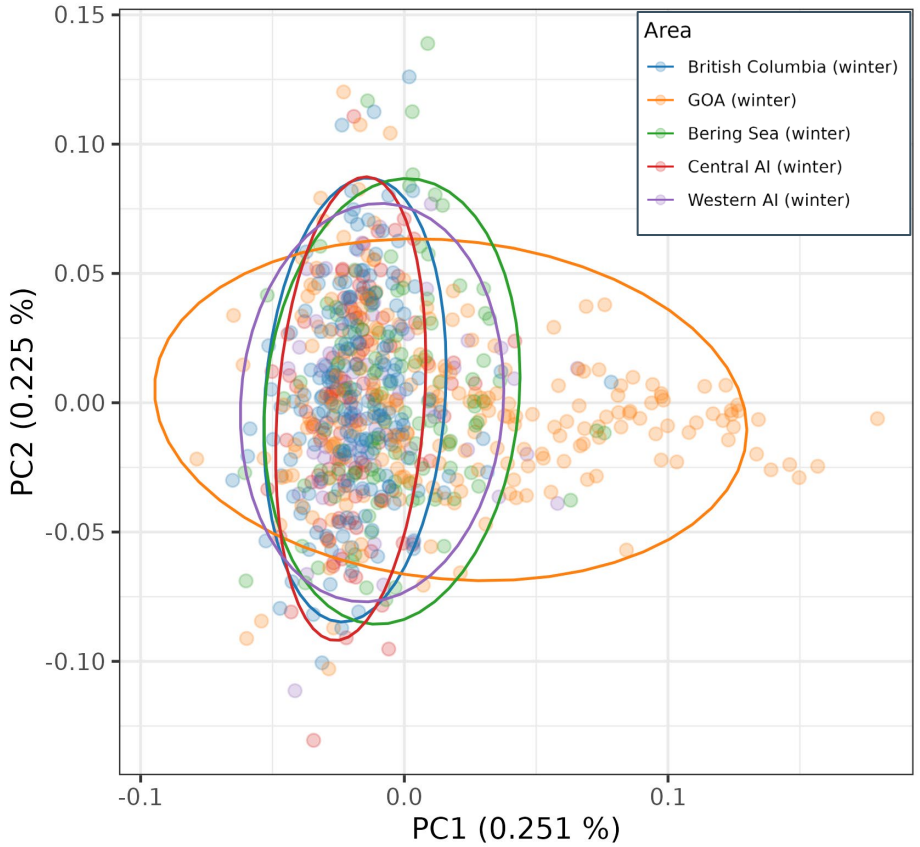
NPRB Project 2110 (2022-2024)

- Low-coverage whole-genome resequencing (lcWGR)
- Allows for screening genomic variation at very high resolution
- Added 185 winter- collected samples to the dataset

- **731 individuals (~60/collection)**
- **4 sequencing runs - Illumina NovaSeq**
- **~ 3.7 million autosomal SNPs (minor allele frequency ≥ 0.05)**

1. Migration and Population Dynamics

Population Structure



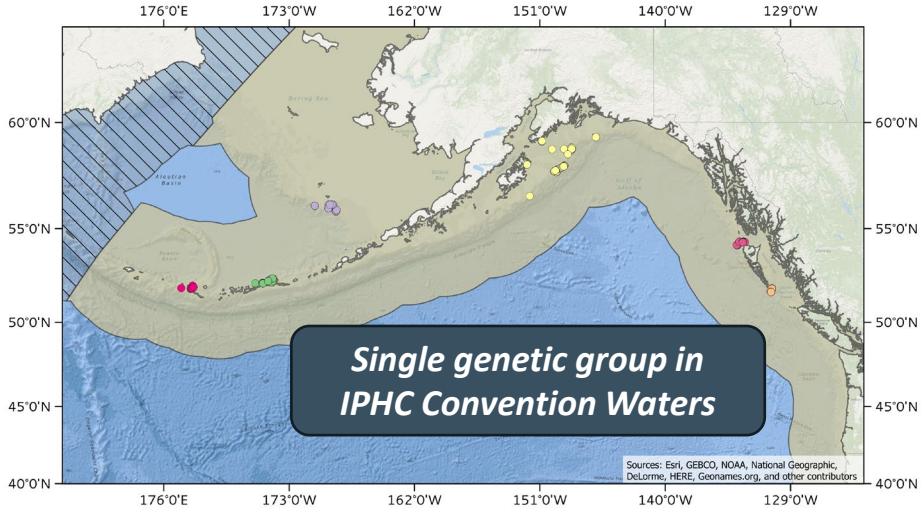
- Principal components analysis (PCA)
- Ur ence of discrete groups

No discrete genetic groups detected

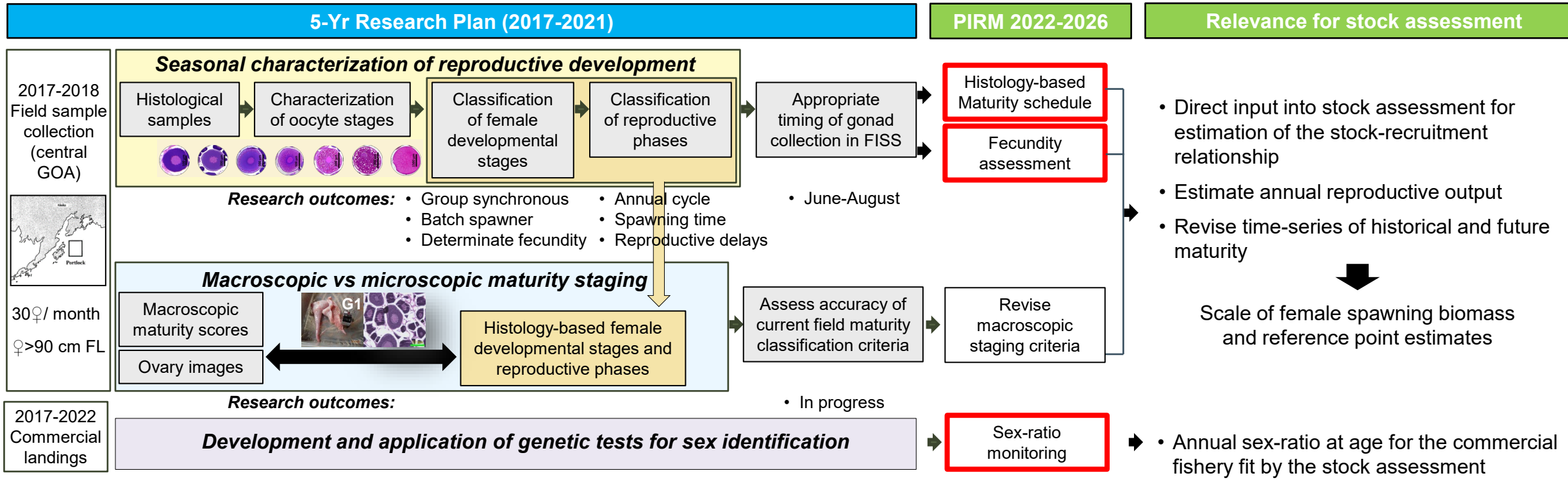
1. Migration and Population Dynamics

Conclusions

- We have improved the quality of our dataset by increasing and balancing sample sizes among the geographic areas studied
- Even with a high-resolution genomic method we cannot identify discrete genetic groups among the population
- There is a low probability of accurately assigning individuals back to the location in which they were sampled
- These results support the concept of a single genetic group in IPHC Convention Waters and are consistent with current IPHC assessment practices: modeled as a single coastwide stock



2. Reproduction

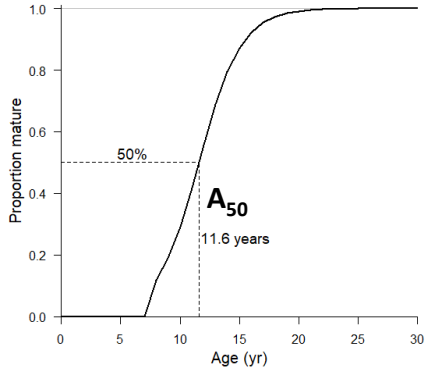


Publications: Fish et al. (2020) *J. Fish Biol.* ***97****: 1880–1885*
Fish et al. (2022) *Frontiers in Mar. Sci.* ***9****: 801759*
Simchick et al. (2024) *Gen. Comp. Endocrinol*. ***347****: 114425*

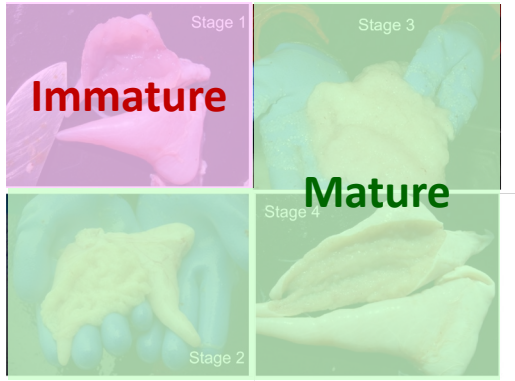
2. Reproduction

Revision of female maturity schedules

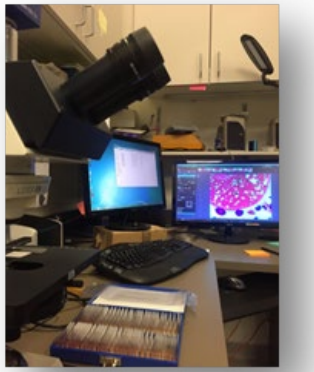
- **Previously used female maturity schedule (ogive) in stock assessment**



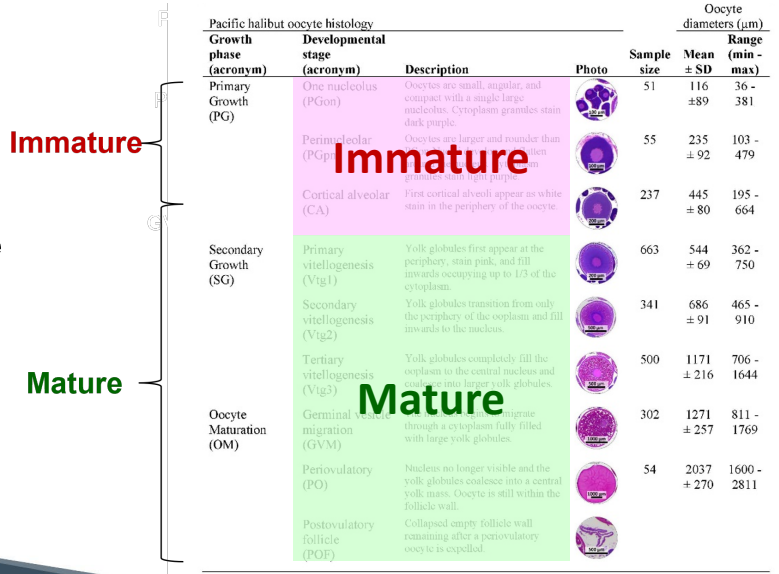
- 2002-2003
- IPHC Reg. Areas 2B and 3A
- Based on **visual** classification of female maturity in the field (FISS)



- **An accurate, histologically-based female maturity classification method has been developed**



Female oocyte stages



Maturity progession

Vtg1 (Vitellogenic 1)
↓
Vtg2
↓
Vtg3
↓
Mature
(Germinal vesicle migration)
↓
PO (Periovulatory)
↓
PS (Post-spawning)

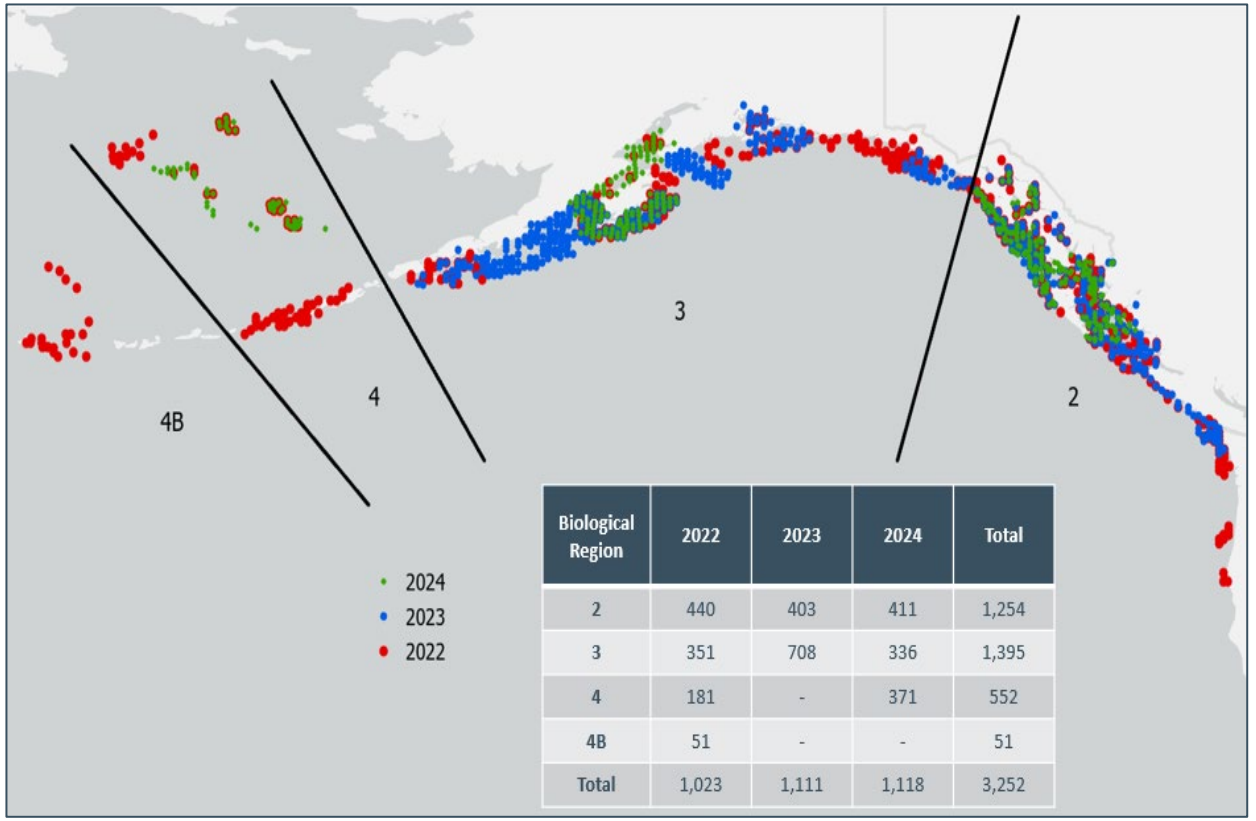
Fish et al. (2020) *J Fish Biol.* **97**:1880-1885
Fish et al. (2022) Front Mar Sci 9:801759

2. Reproduction

Revision of female maturity schedules

- **Primary objective**: Use histological (microscopic) criteria to classify female maturity and revise maturity schedules using this accurate method

2022-2024 FISS
Sample Collections for
Histological Assessment



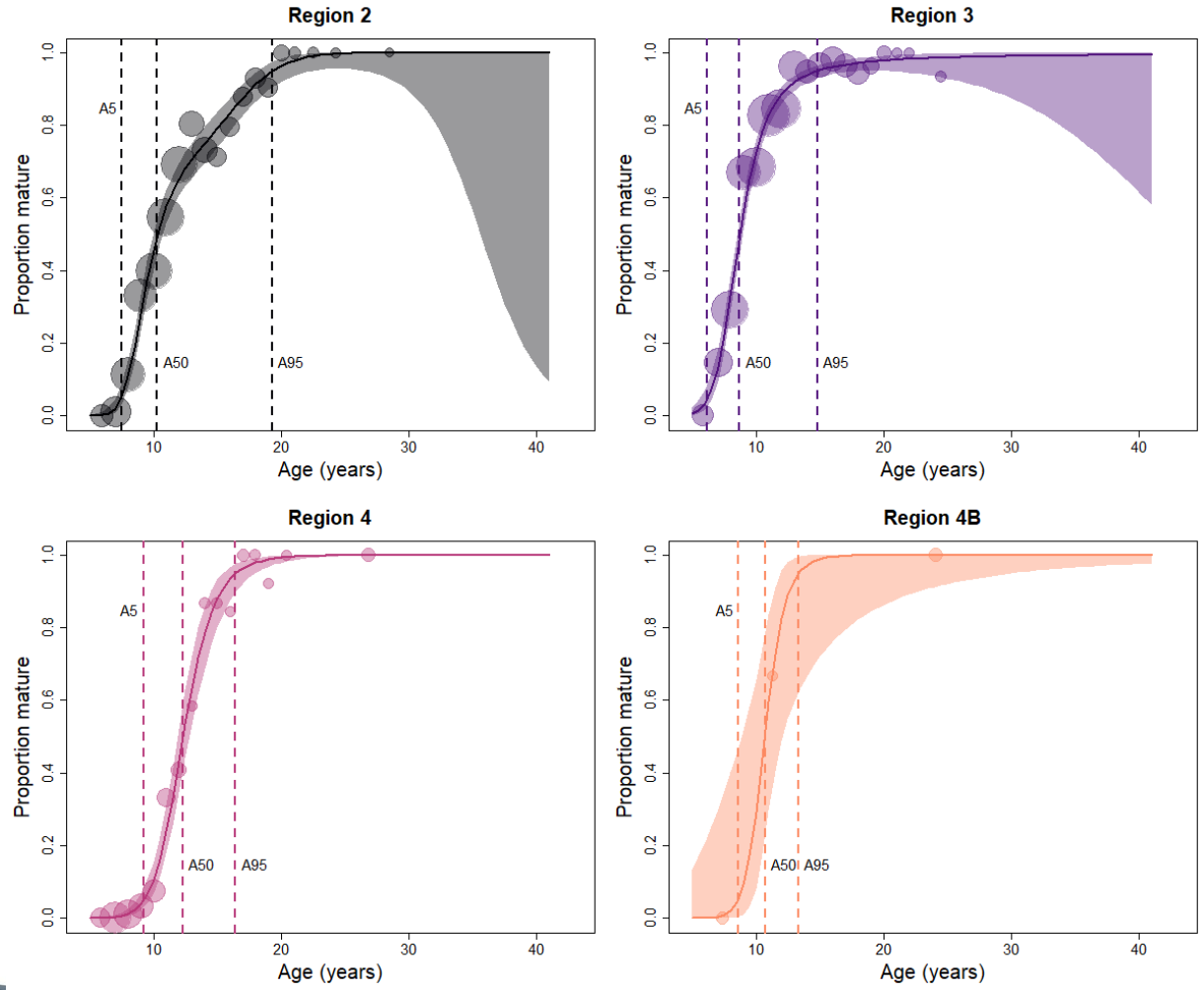
Biological Region	2022	2023	2024	Total
2	440	403	411	1,254
3	351	708	336	1,395
4	181	-	371	552
4B	51	-	-	51
Total	1,023	1,111	1,118	3,252

2. Reproduction

Histology-based ogives by biological region: 2022-2024 combined

N = 3,252 females

Generalized Additive Model:
s(log(Age) * Region)

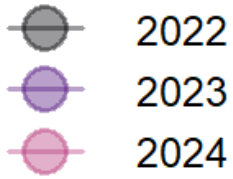


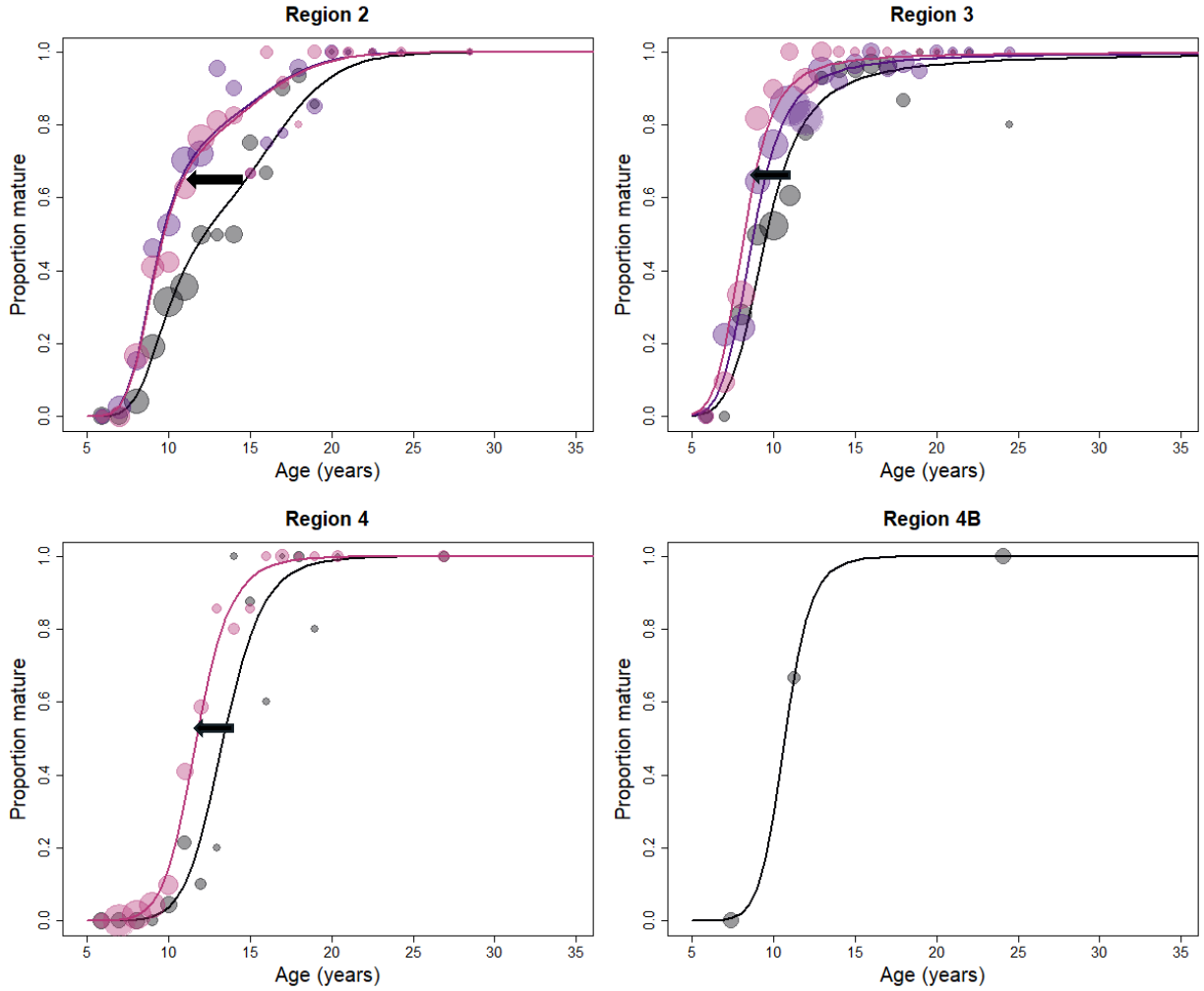
Age at maturity:

- BR2 > BR3
- Females are maturing at a younger age in BR3

2. Reproduction

Histology-based ogives by biological region and year: 2022-2024





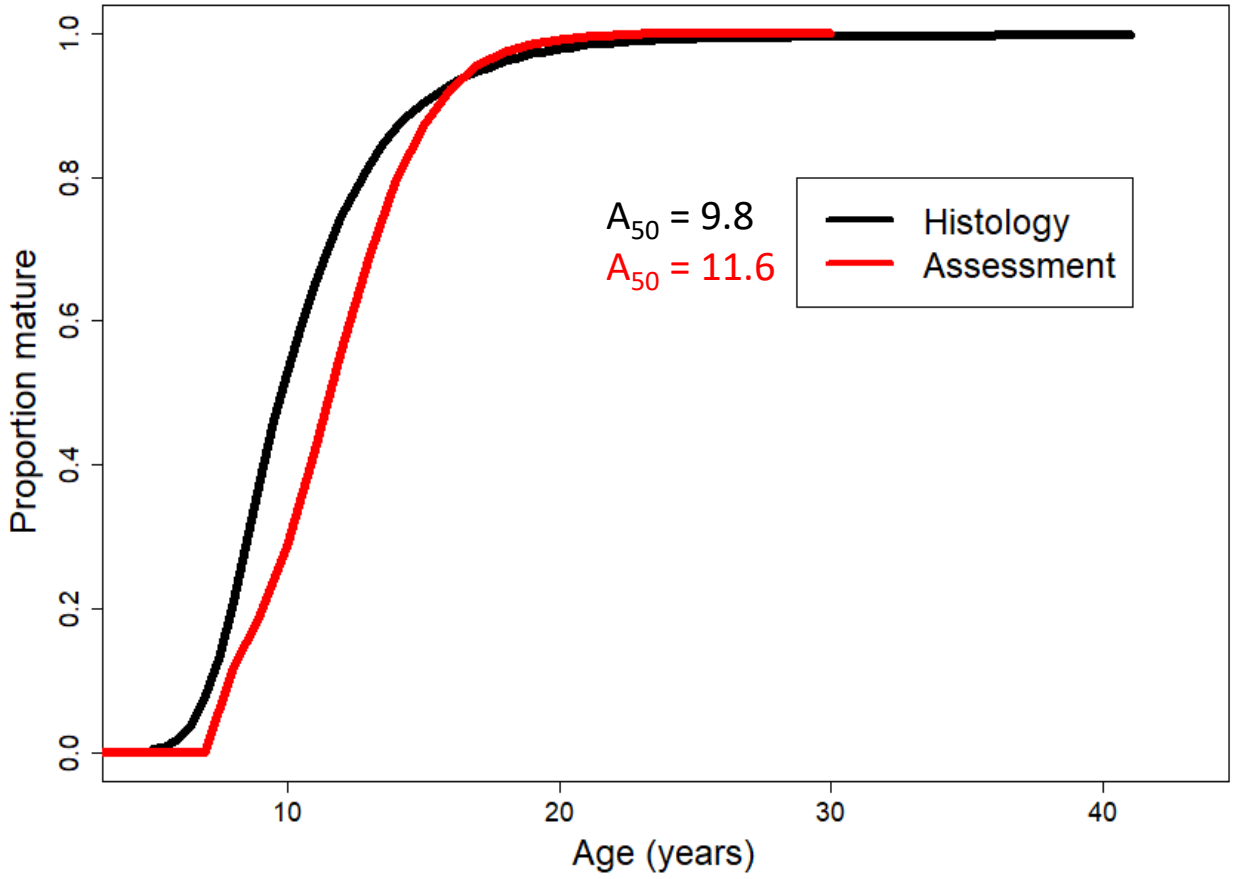
Age at maturity:

- 2022 > 2023 > 2024
- Females appear to be progressively maturing at a younger age in various BRs

2. Reproduction

Histology-based coastwide maturity ogive: 2022-2024 combined

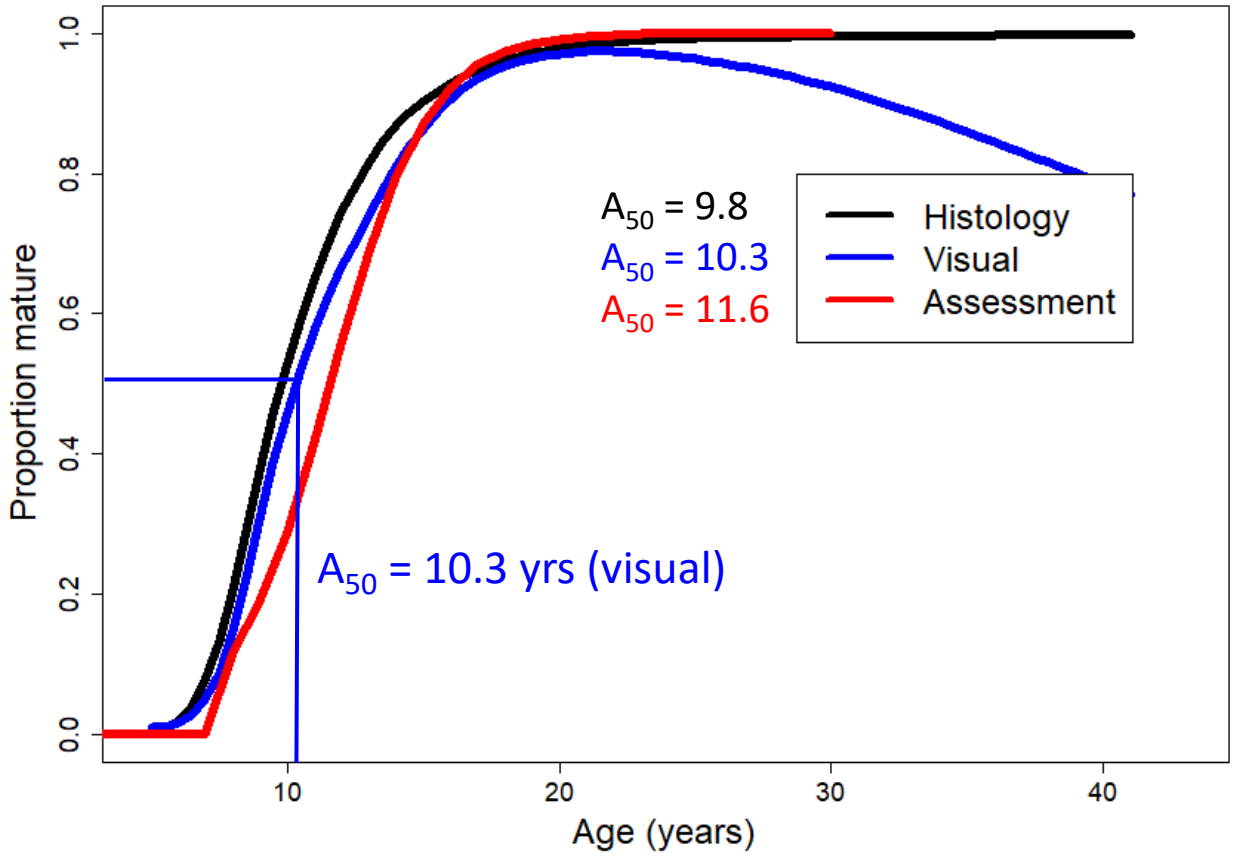
- GAM s(log(Age) * Region)
- Coastwide maturity ogive calculated from weighted regional ogives using average FISS space-time model abundance estimates from 2022-2024
- New maturity ogive shows earlier age at maturity than previously used estimates



2. Reproduction

Visual (macroscopic)-based coastwide ogive: 2022-2024 combined

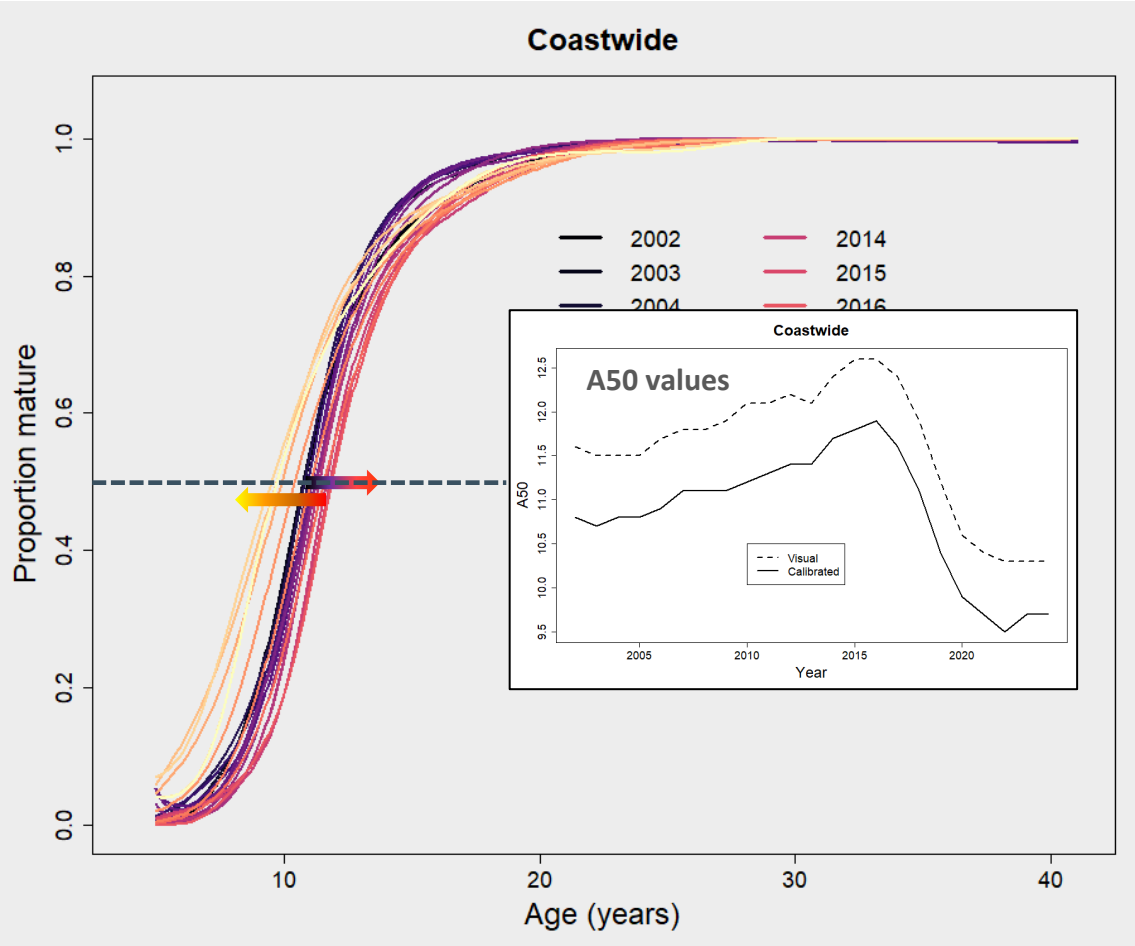
- GAM s(log(Age) * Region)
- Coastwide maturity ogive calculated from weighted regional ogives using average FISS space-time model abundance estimates from 2022-2024
- A calibration was developed between **histological** and **visual** maturity curves to estimate temporal patterns of age at maturity using the 2002-2024 FISS time series of visual maturity data



2. Reproduction

Calibrated coastwide maturity ogives from 2002 to 2024

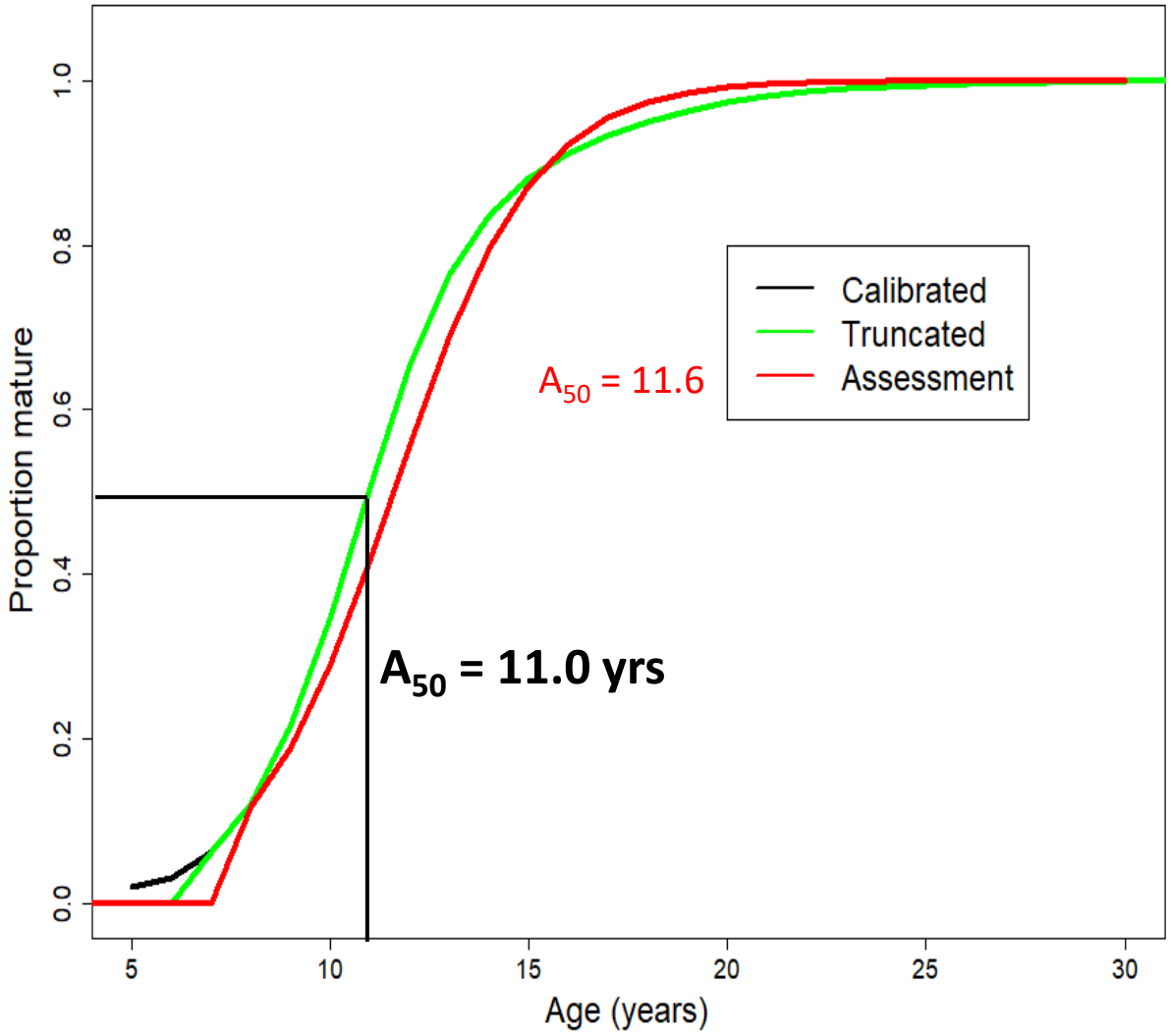
- GAM s(log(Age) * Region)
- Coastwide maturity ogive calculated from weighted regional ogives using average FISS space-time model abundance estimates from 2022-2024
- A calibration was developed between histological and visual maturity curves to estimate temporal patterns of age at maturity using the 2002-2024 time series of visual maturity data
- Temporal shifts in maturity schedules are apparent



2. Reproduction

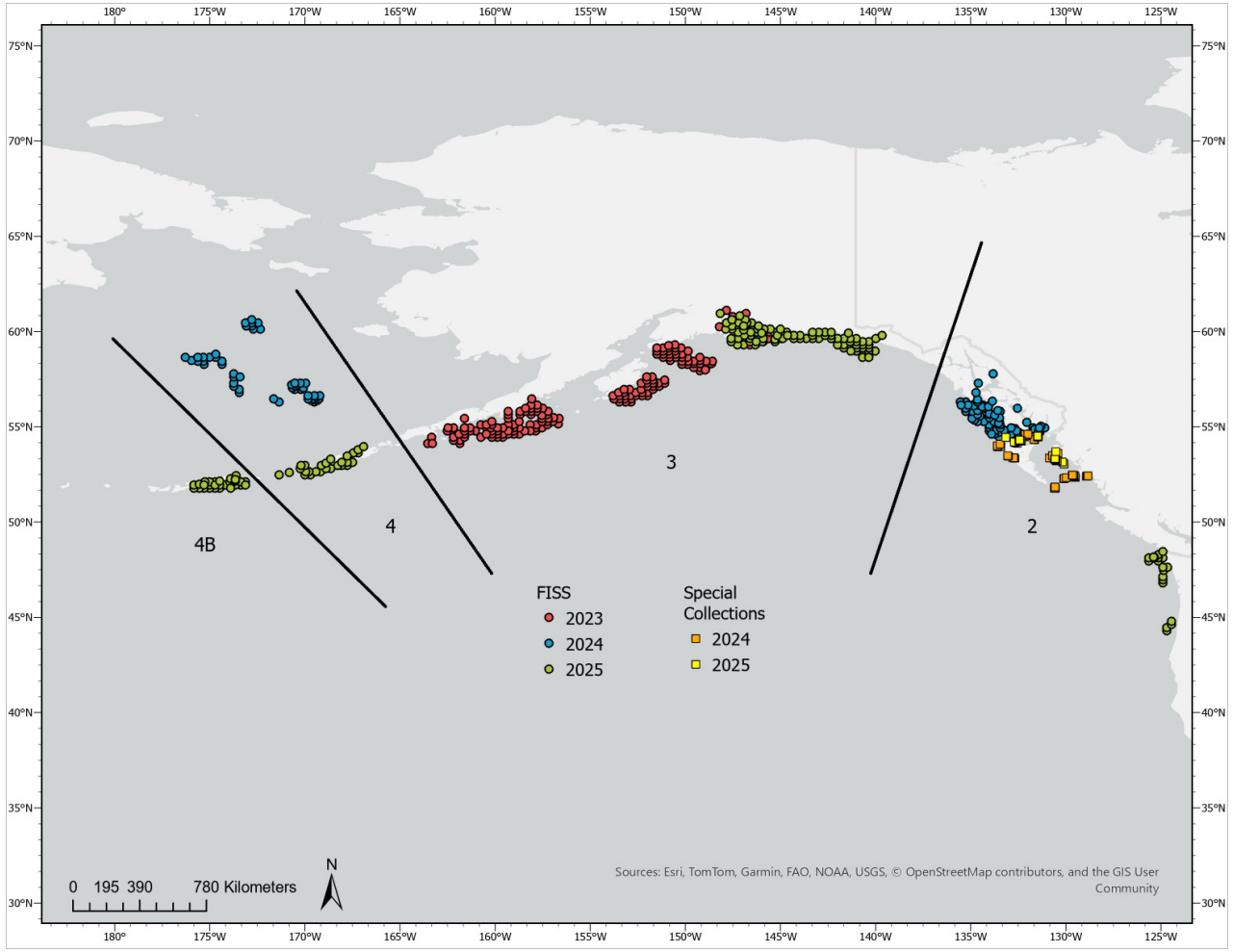
New coastwide maturity ogive

- Comparison of new **calibrated** coastwide visual ogive (2002-2024) vs. **previous** ogive (2002-2003)
- Maturity estimates from the average 2002-2024 calibrated coastwide ogive are slightly to the left of previous assessment ogive: A_{50} is **0.6 yrs** lower
- Truncated to zero < Age 7
- **New coastwide maturity ogive used in the 2025 stock assessment**



2. Reproduction

Fecundity assessment: sample collection efforts



Year	Biological Region	Platform	Samples
2023	3	FISS	452
2024	2	FISS	149
2024	4	FISS	359
2025	All	FISS	878
2024	2	Special collection	271
2025	2	Special collection	242
		Total	**2,351**

- Special collection of fecundity samples from large females (> 90 cm)
- Sample processing to begin Winter 2026

2. Reproduction

Conclusions

- Histology-based maturity estimates:
  - Region 3 shows higher proportion of mature females at younger ages than other regions
  - Regional maturity ogives have shifted to the left from 2022-2024
  - Continued coastwide monitoring in 2025 and planned for 2026
  - A new coastwide maturity ogive using calibrated visual maturity estimates from the 2002 to 2024 FISS has been incorporated into the 2025 stock assessment

- Fecundity estimates:
  - Samples collected in 2023, 2024 and 2025
  - Question: Is female Pacific halibut fecundity proportional to body weight?

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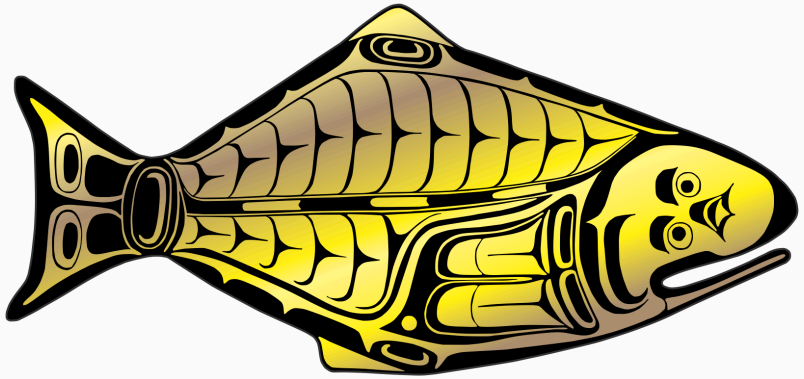

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https://www.iphc.int/