INTERNATIONAL PACIFIC HALIBUT COMMISSION

Report on current and future Biological and Ecosystem Science Research activities

Agenda item: 5.1.1

IPHC-2025-RAB026-06

(J. Planas, C. Dykstra, A. Jasonowicz, C. Jones)

Research updates for 2025

- **Migration and Population Dynamics**: Population Structure
- **Reproduction**: Revised maturity schedules and fecundity studies
- **Fishing Technology**: Reducing whale depredation by protecting longline catches

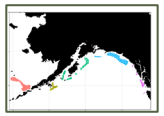
1. Migration and Population Dynamics

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*

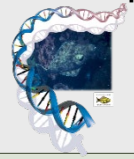
Juvenile connectivity

- 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

Relevance for stock assessment

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

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Improved estimates of productivity

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

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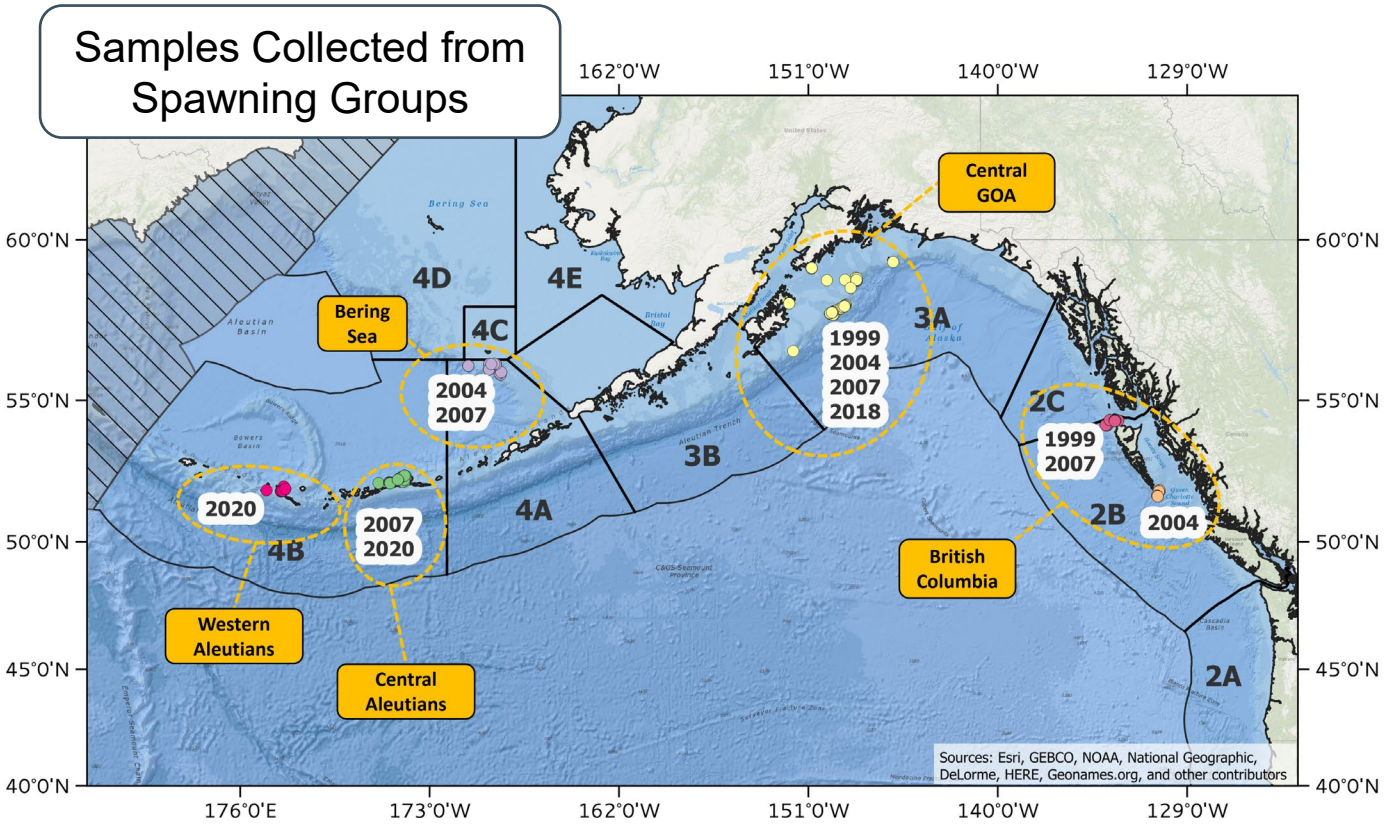
Potential revision of structure of future stock assessments

1. Migration and Population Dynamics

Population Genomics

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



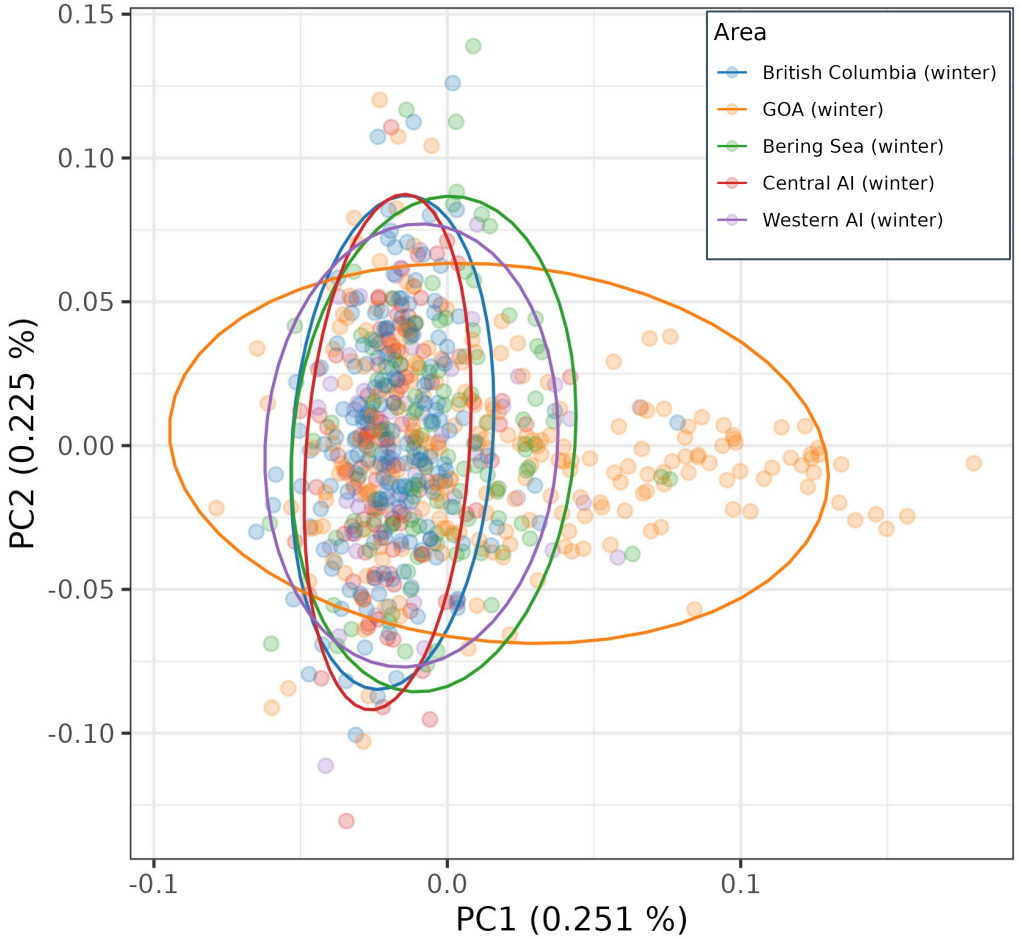
NPRB Project 2110 (2022-2024)

- Low-coverage whole-genome resequencing (lcWGR)
- Allows for screening genomic variation at very high resolution
- Conducted an additional sequencing run:
  - Added an additional 185 winter collected samples to 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)
  - *No discrete genetic groups detected*
- Ur… …ence of discrete groups

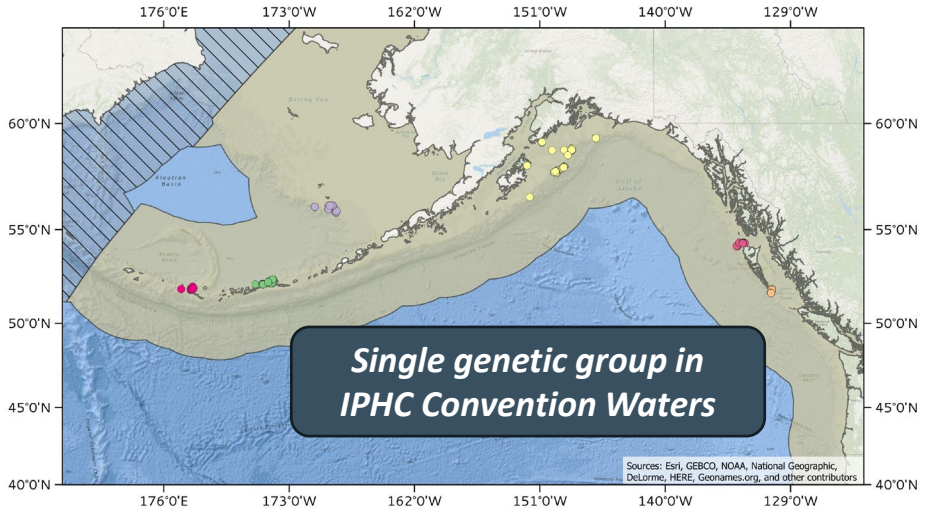
Assignment Testing

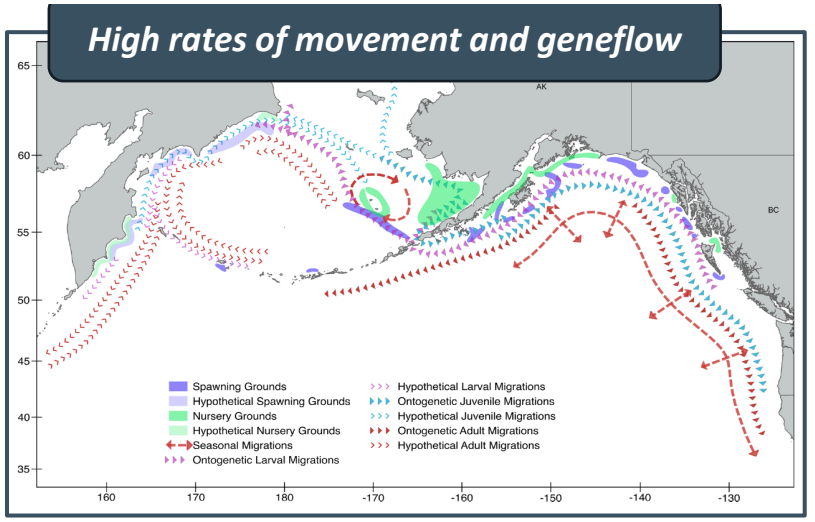
- C… …on th…
- A… …s-va…
  - *Very low (~35 %) assignment accuracy - can exceed 90% for Pacific salmon species*

1. Migration and Population Dynamics

Conclusions

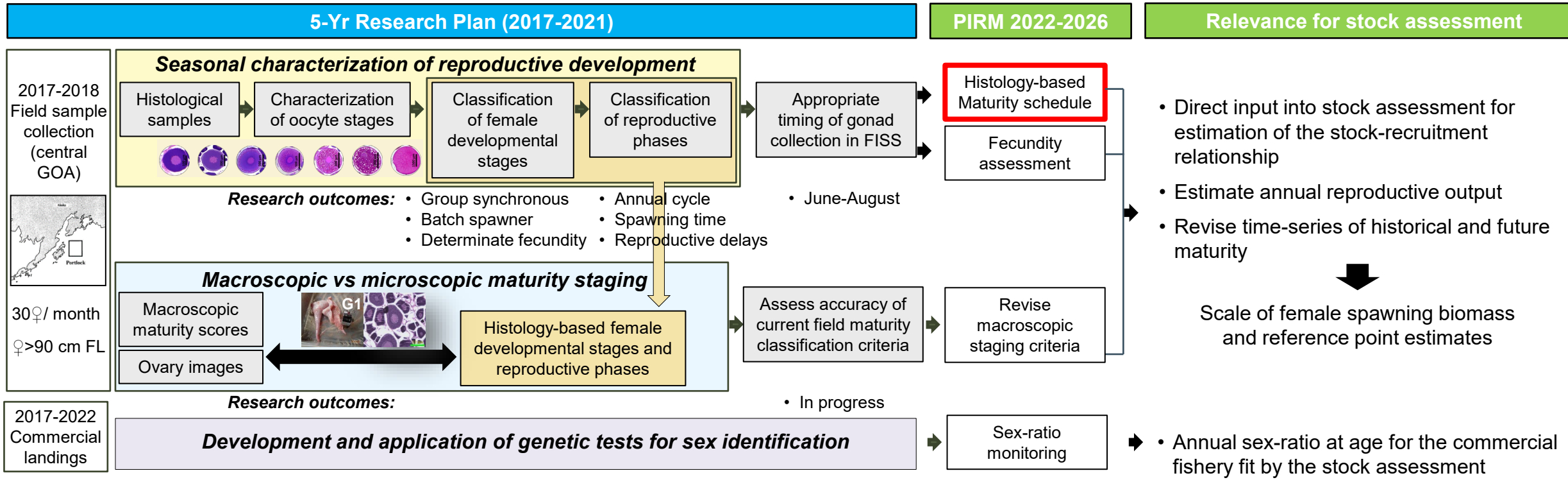
- We have improved the quality of our dataset by increasing and balancing sample sizes among the areas sampled.
- Even with a high-resolution genomic method we cannot identify discrete genetic groups among the population.
- There is a low probability of accurately assigning individuals back to the location 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.





Carpi, P., Loher, T., Sadorus, L.L., Forsberg, J.E., Webster, R.A., Planas, J. V., Jasonowicz, A., Stewart, I.J., and Hicks, A.C. 2021. Ontogenetic and spawning migration of Pacific halibut: a review. Rev. Fish Biol. Fish. **31**(4): 879–908.

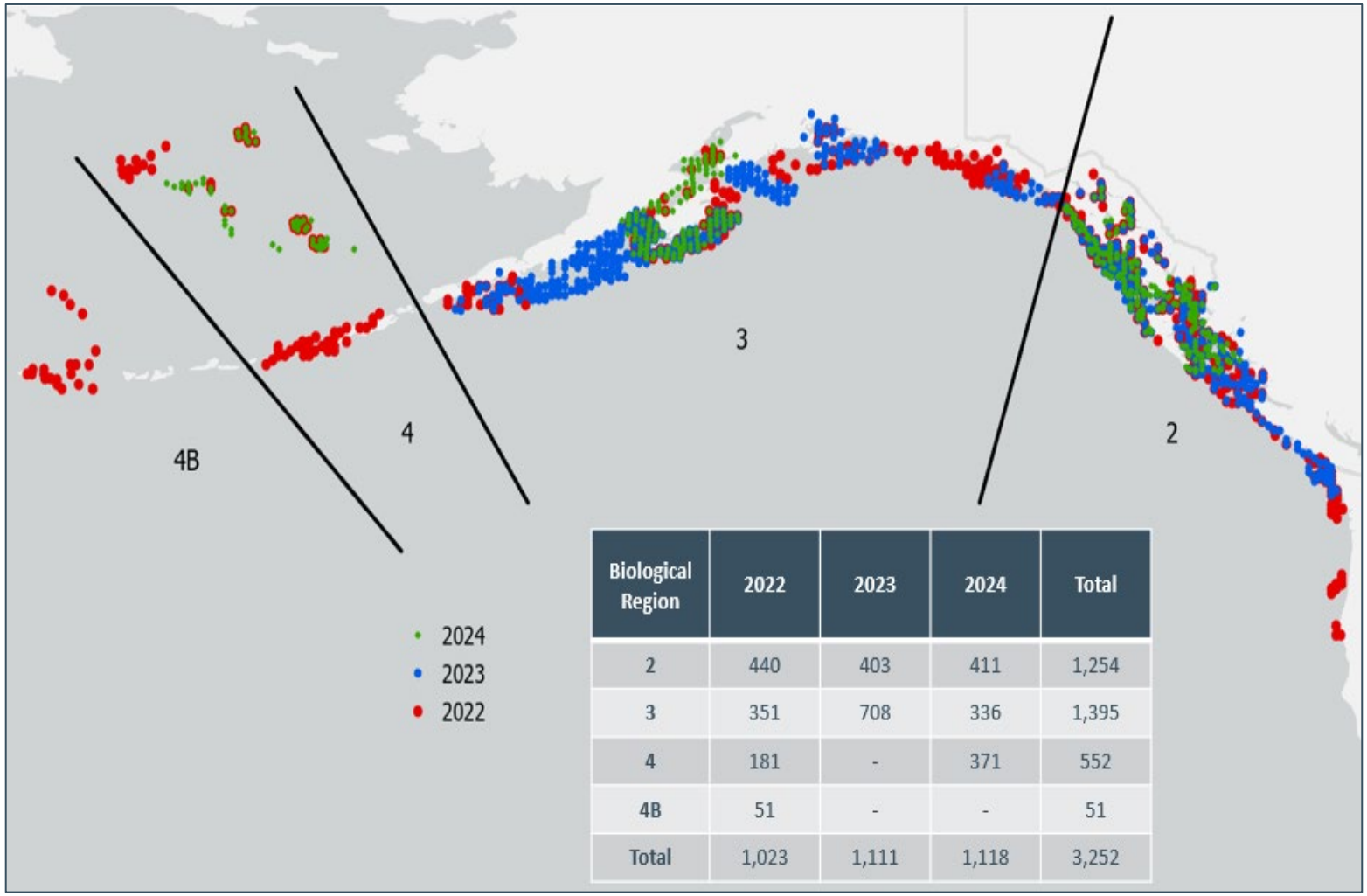
2. Reproduction



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

2022-2024 FISS
Collection for Histological
Assessment

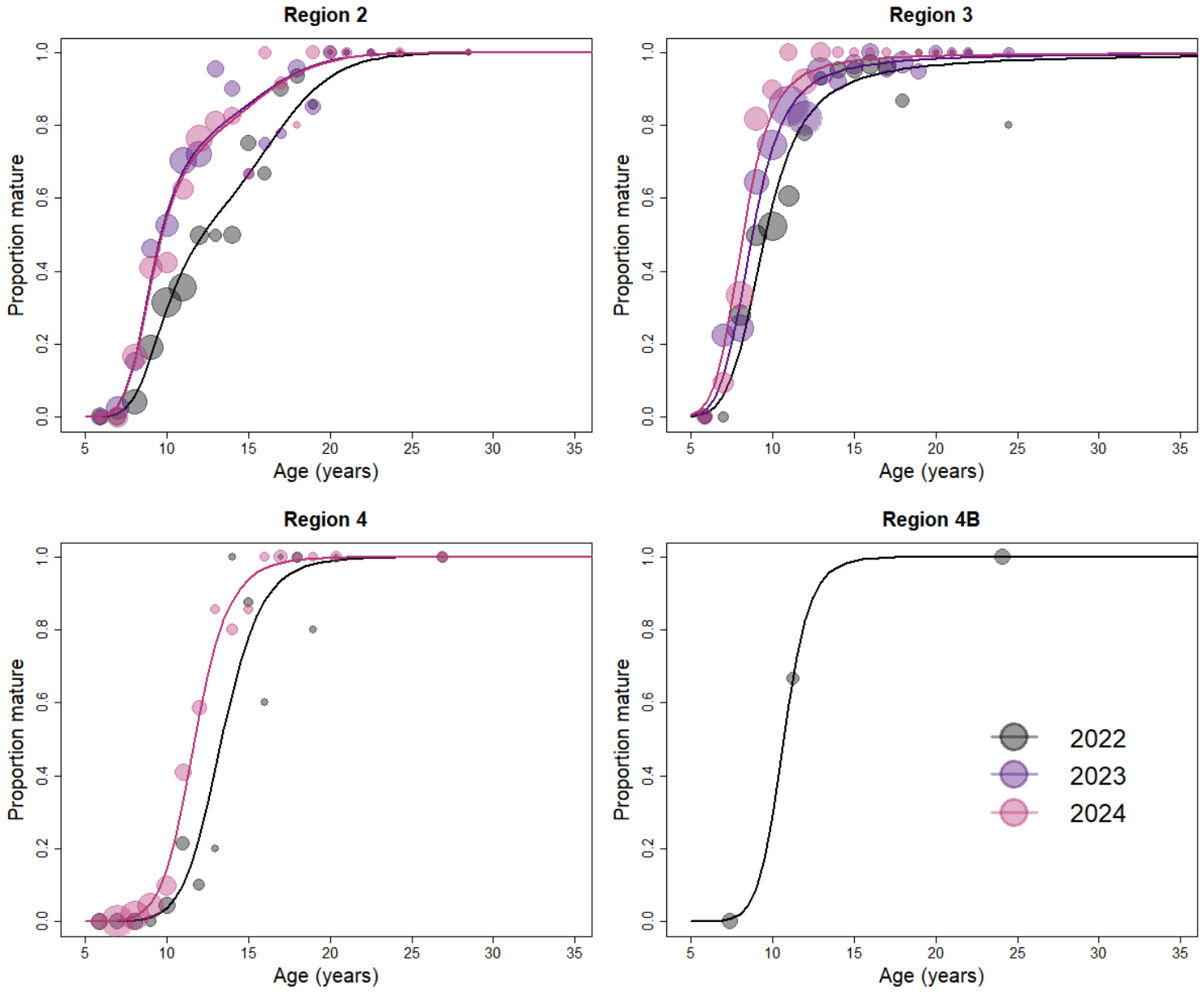


Biological Region	2022	2023	2024	Total
2	440	403	411	1,254
3	351	708	336	1,395
4	181	-	371	552
4B	51	-	-	51
Total	1,023	1,111	1,118	3,252

2. Reproduction

Histology-based ogives by biological region and year

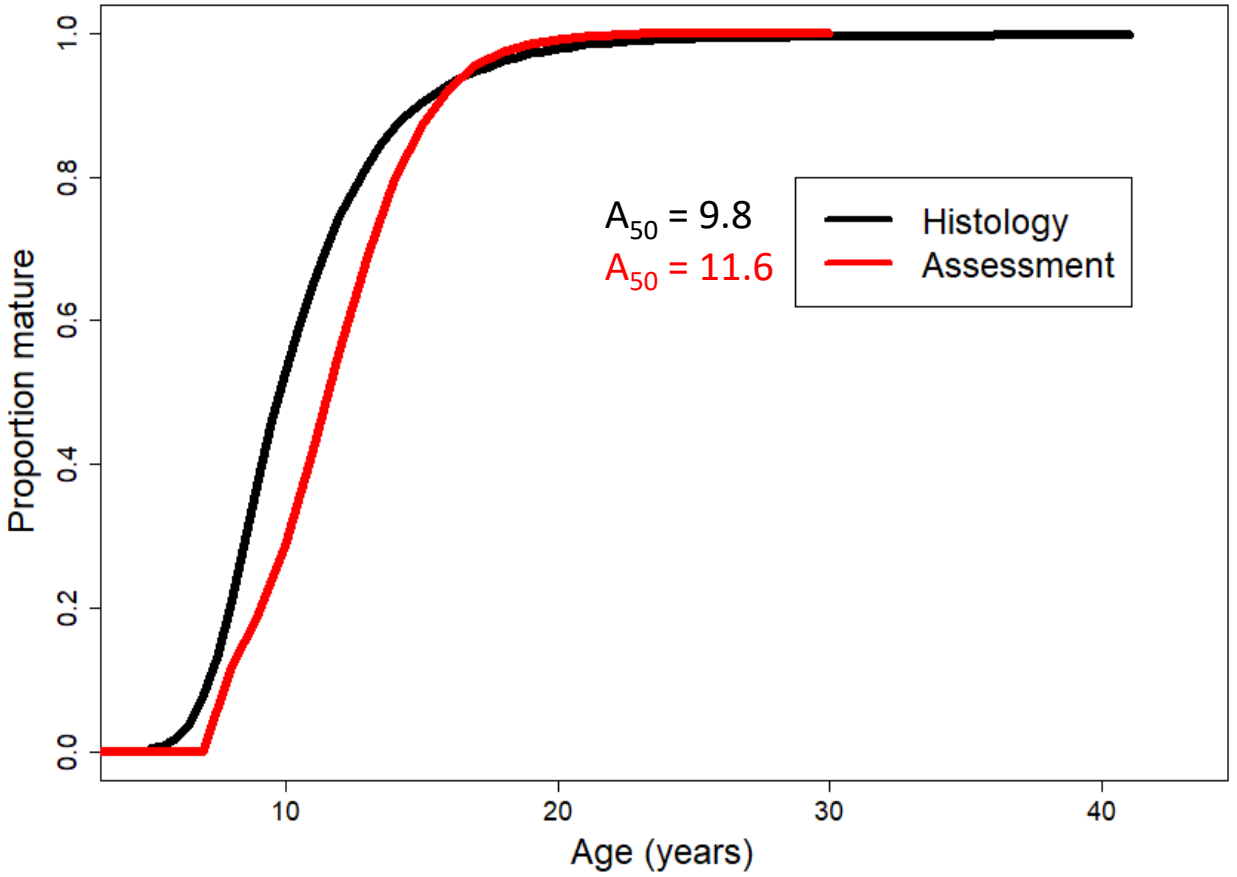
- Spatial and temporal differences from 2022-2024
- A shift to left in regional curves, indicating earlier maturation



2. Reproduction

Histology-based coastwide ogive

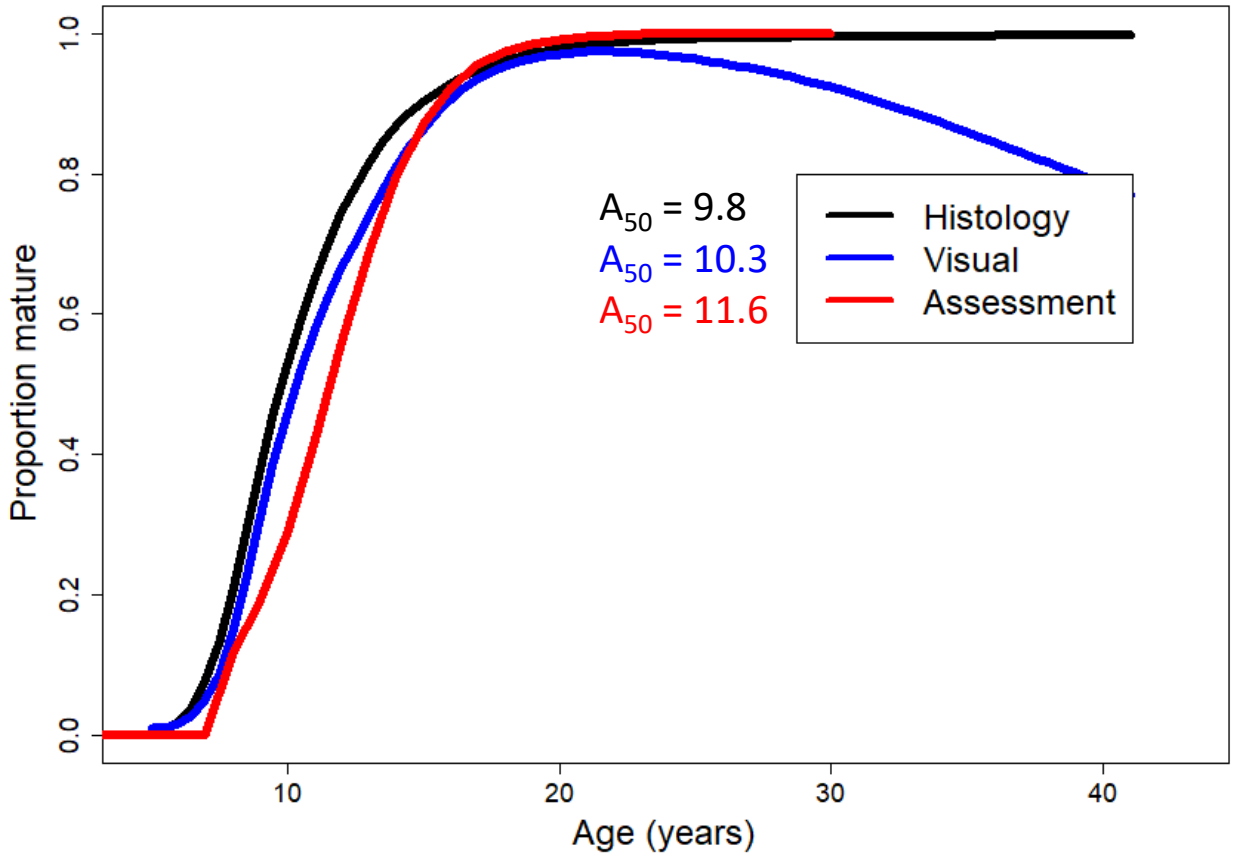
- GAM s(log(Age) * Region)
- Coastwide ogive calculated from weighted regional ogives using average FISS space-time model abundance estimates from 2022-2024
- Coastwide ogive falls between Biological Regions 2 and 3



2. Reproduction

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

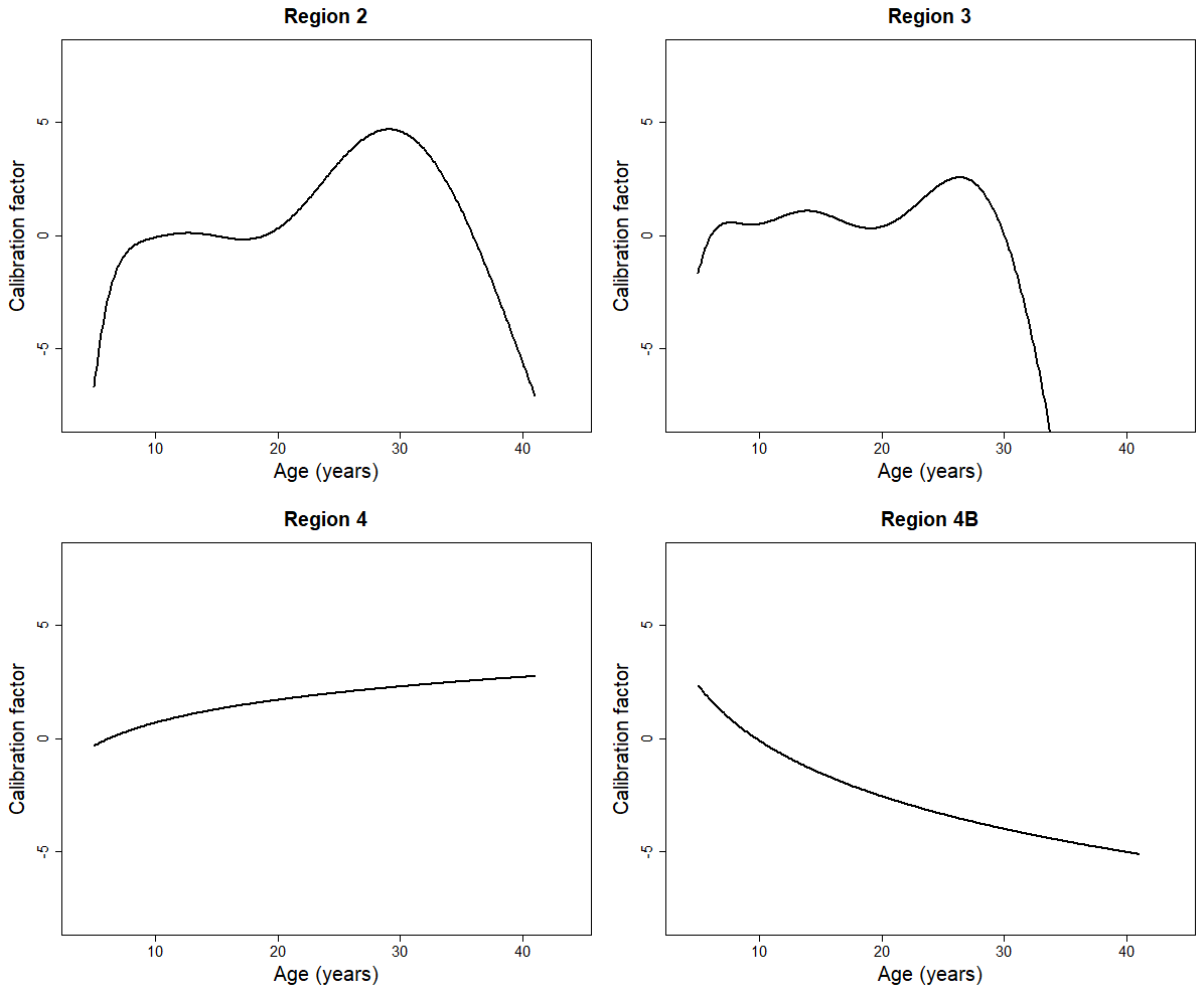
- GAM s(log(Age) * Region)
- Coastwide ogive calculated from weighted regional ogives using average FISS space-time model abundance estimates from 2022-2024



2. Reproduction

Histology-visual ogive calibration

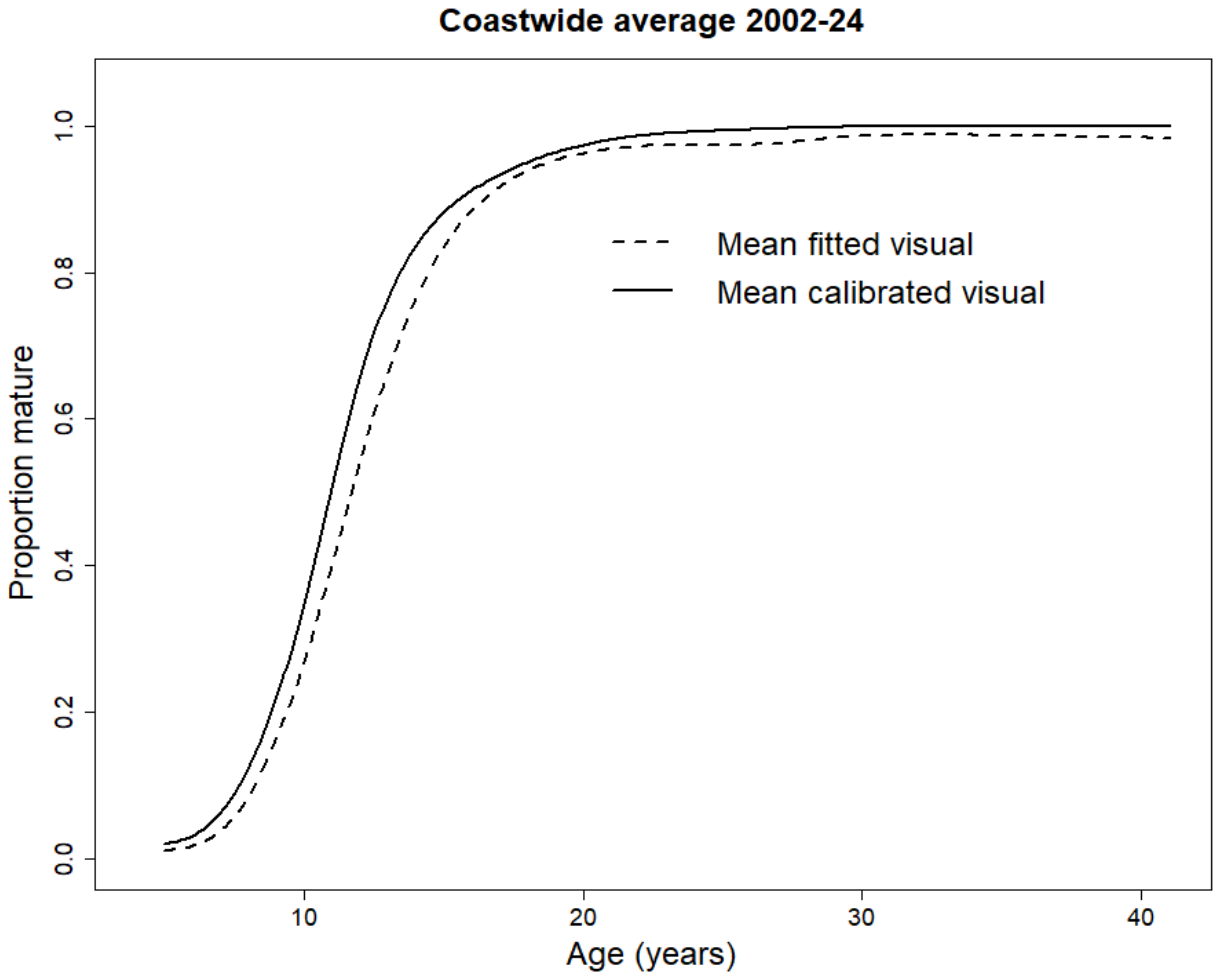
- Calibration between visual and histology estimates from 2022-2024
- The calibration factor at age, $\delta(a)$, is estimated as the difference between the histological and visual model estimates of maturity at age a on the logit scale.
- Estimated for each Biological Region
- Positive = shifted up for a given age
  Negative = shifted down



2. Reproduction

Calibrated historical visual-based coastwide ogive (2002-2024)

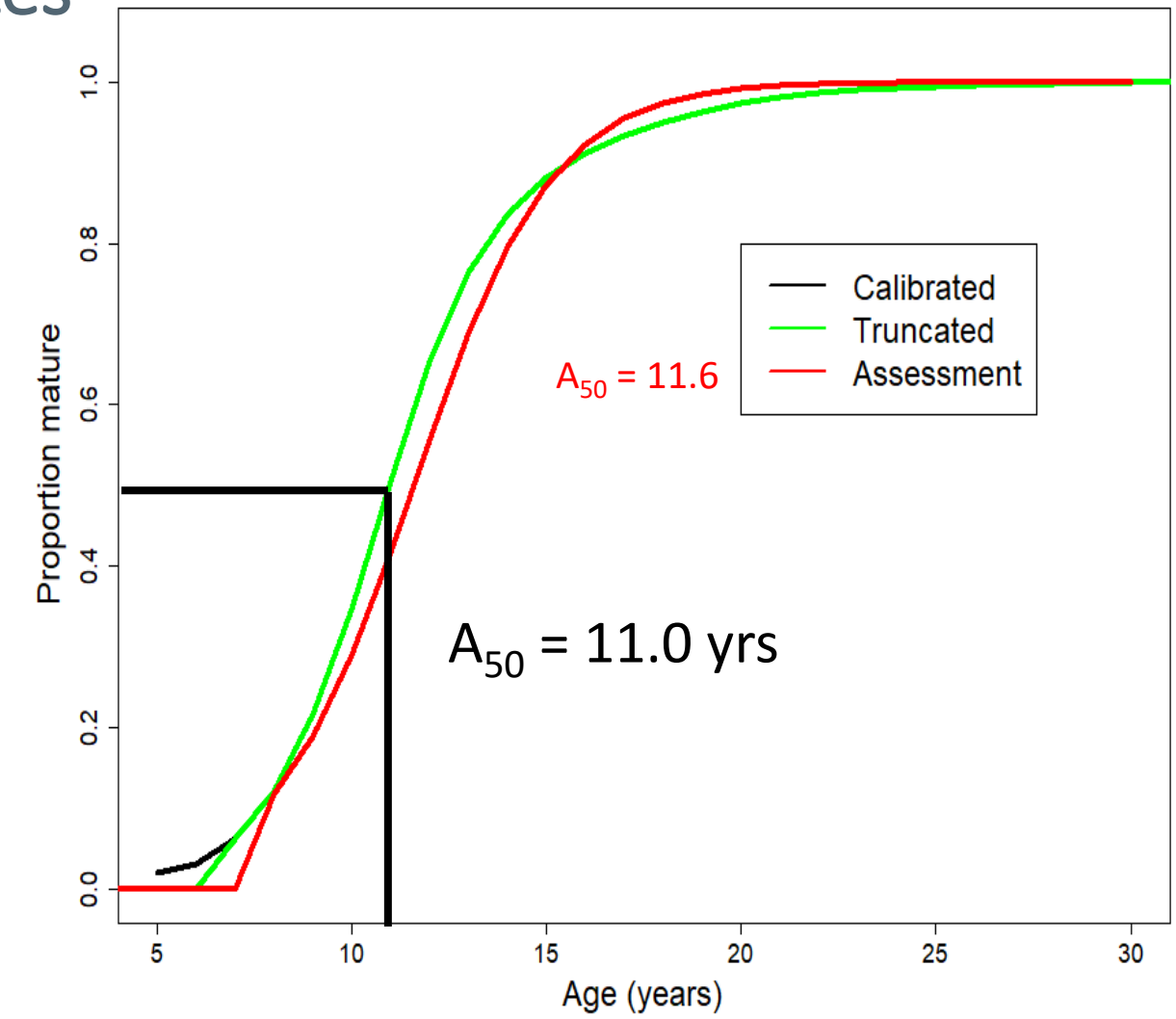
- Coastwide fitted visual maturity ogives by year estimated using three-year rolling data windows
- Applied calibration factor to obtain coastwide calibrated visual ogives
- Averaged across all three-year rolling data windows to obtain final coastwide calibrated visual maturity ogive (i.e. 2003-2005, 2004-2006, etc.)



2. Reproduction

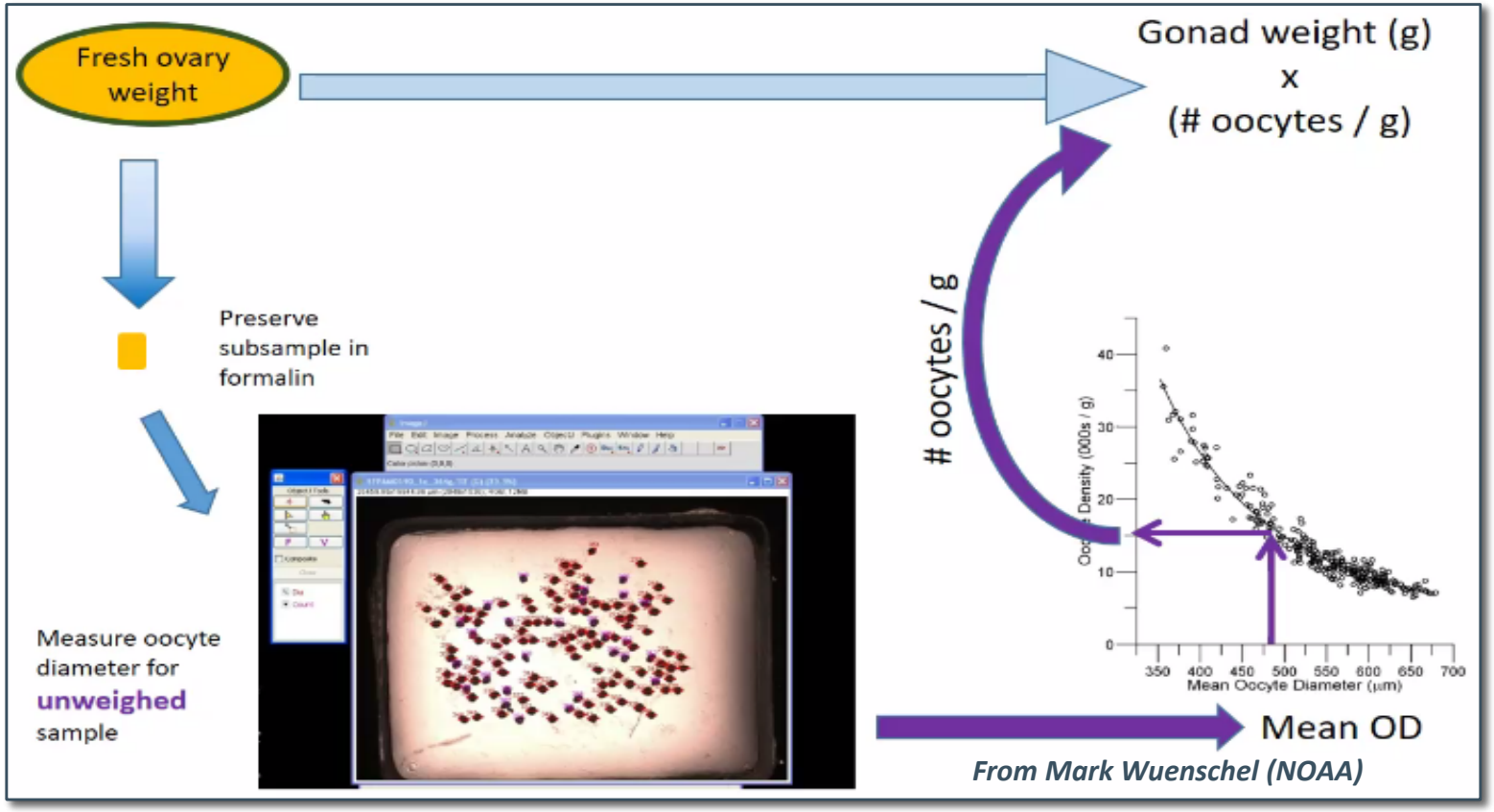
Visual (macroscopic)-based estimates

- Comparison of new coastwide calibrated visual ogive (2002-2024) vs. current assessment ogive (2002-2003)
- Visual maturity estimates from the average 2002-2024 calibrated coastwide ogive are slightly to the left of current assessment ogive
- Truncated to zero < Age 7

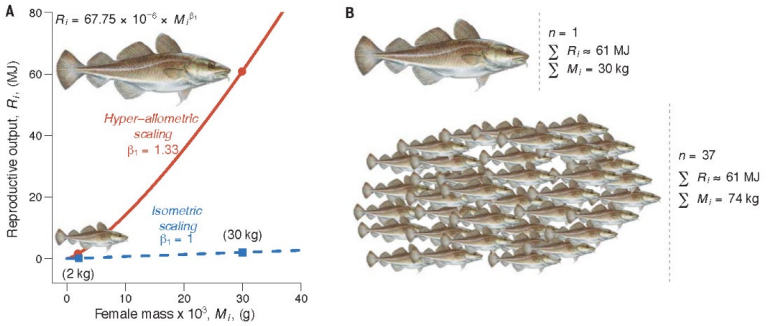


2. Reproduction

Auto-diametric fecundity estimation



Fecundity
(Total # oocytes)



Barneche et al. 2018

Is female Pacific halibut fecundity proportional to body weight?

2. Reproduction

Auto-diametric fecundity estimation

Year	Region	Platform	# of Samples (mature)
2023	3	FISS	297
2024	2	FISS	90
2024	4	FISS	76
2025	All	FISS	???
2024	2	Fall	273
2025	2	Summer	254

- New stereo microscope purchased

- Sample processing to begin Fall 2025 / Winter 2026

2. Reproduction

Conclusions

- Histology-based maturity estimates:
  - Region 3 continues to show higher proportion of mature females at younger ages
  - Regional and coastwide ogives have shifted to the left from 2022-2024

- Visual-based maturity estimates:
  - Maturity estimates have shifted back and forth from 2002-2024 (not consistent)
  - Calibrated coastwide ogive has shifted slightly to left of current assessment ogive

- Fecundity (next step in reproductive journey):
  - Samples collected in 2023, 2024 and 2025
  - Question: Is female Pacific halibut fecundity proportional to body weight?

3. Fishing technology

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

Relevance for stock assessment

Summer 2023 pilot test

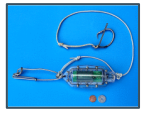
Investigate new methods for whale avoidance/deterrence to reduce whale depredation in the longline fishery

International Workshop on Protecting Fishery Catches from Whale Depredation → Catch protection device selection and production:
- Shuttle
- Slinky pot-Shroud

→ Pilot testing → Catch protection device refinement and improvement → Field testing in presence of whales:
- Killer whales (orcas)
- Sperm whales

Research outcomes:
- New tools for fishery avoidance and/or deterrence
- Improved estimation of depredation mortality

Collaboration with PSMFC



Investigate behavioral and physiological responses to fishing gear to reduce bycatch

Use of artificial illumination to reduce bycatch → Method refinement and improvement

Circle hook modifications to reduce rockfish bycatch → Method refinement and improvement

Research outcomes:
- New methods for reducing bycatch
- Improved estimation of bycatch mortality

- Increasing available yield for directed fishery.
- Reduce potential bias and uncertainty in the stock assessment.

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Improve mortality accounting

External funding: Bycatch Reduction Engineering Program NOAA NA21NMF4720534 (2021-2023), NA23NMF4720414 (2023-2025)

Publications: Lomeli et al. (2021) *Fisheries Research* ***233****: 105737*

Lomeli et al. (2023) *Ocean & Coastal Management* ***241****: 106664*

3. Fishing technology

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Bycatch Reduction Engineering Program
(BREP) NA23NMF4720414

Reducing whale depredation by protecting longline catches

Second phase: Testing shuttle in the presence of depredators

- Objective: Further refine and characterize performance of the shuttle device in the presence of toothed whales in IPHC Regulatory Area 4A.
- Field study took place from 21-28 May 2025 from Dutch Harbor, AK on the F/V Oracle.
- 18 sets: 15 sets with shuttle and control catch paired comparisons (6 sets in the presence of orcas).
- Collected ~ 80 hours of underwater footage (~ 70 hr reviewed to date: 10/15 paired sets).




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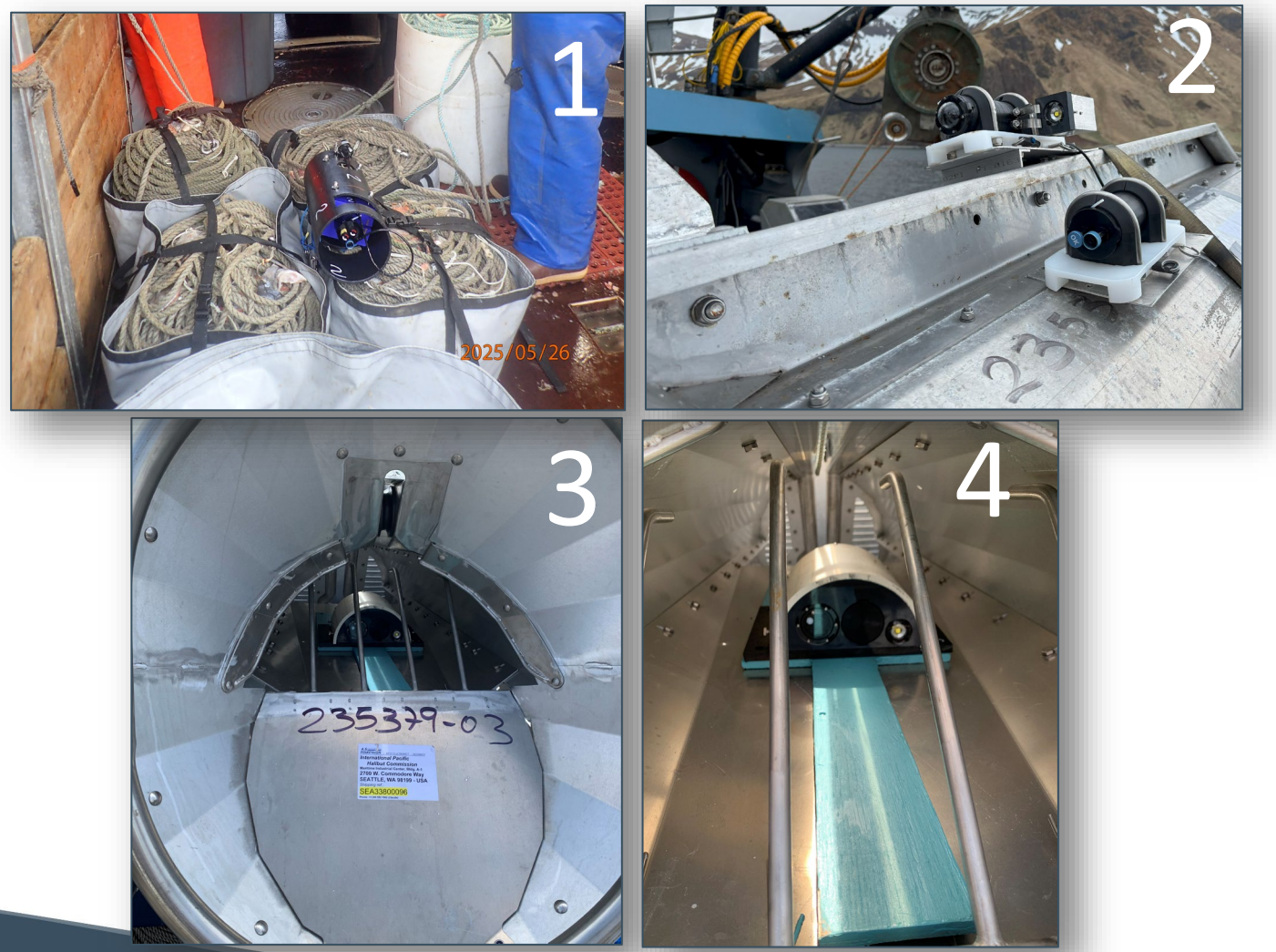
Reducing whale depredation by protecting longline catches

Four Camera Systems

1. Long Line Cam (Control)
2. Shuttle External Cam
3. Shuttle Internal Forward Facing (towards entrance)
4. Rear Facing (towards keyhole)



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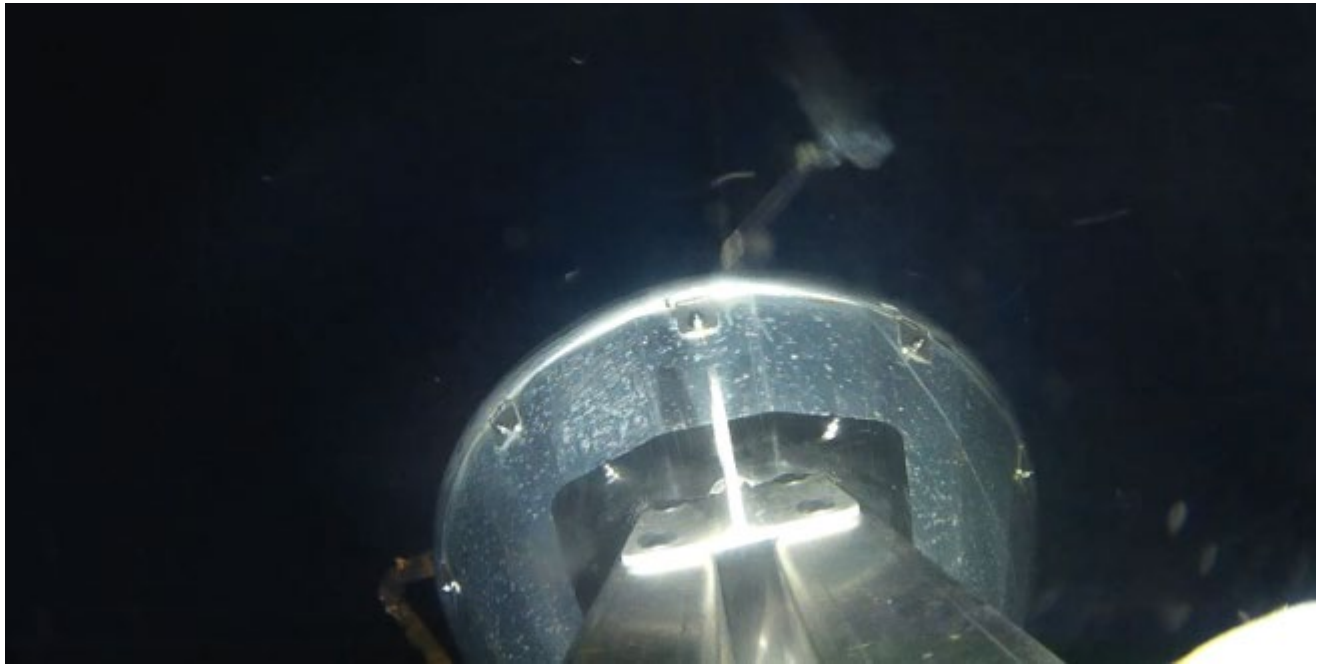
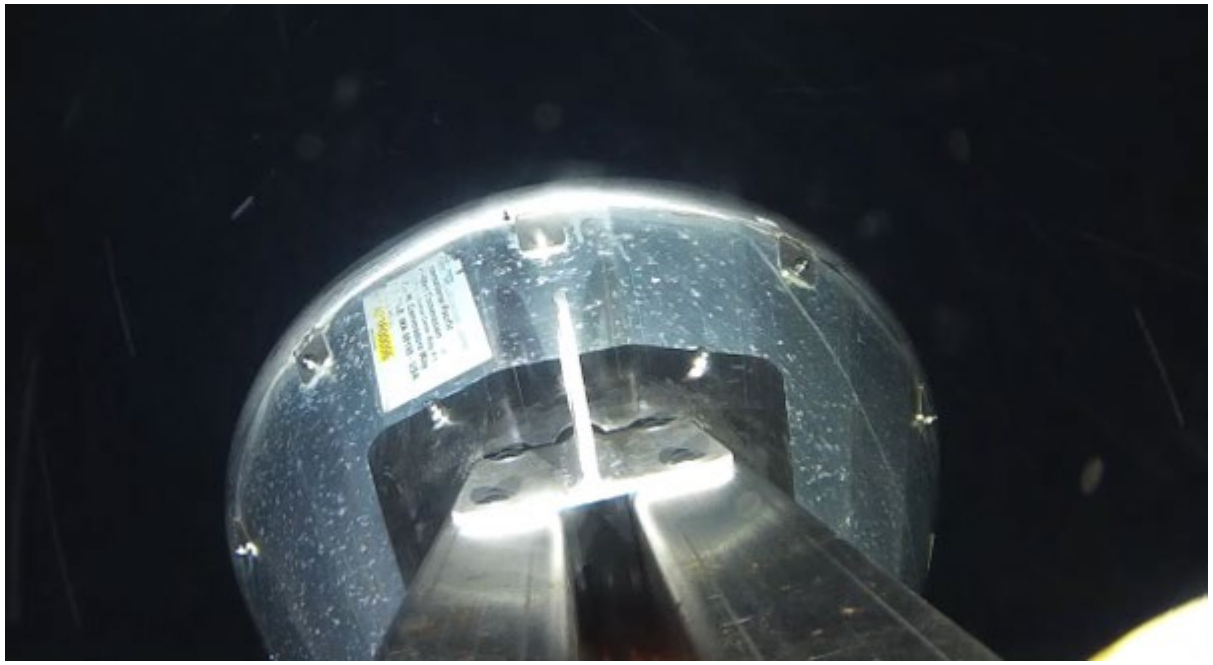
Reducing whale depredation by protecting longline catches



External Shuttle Camera

Exclusions



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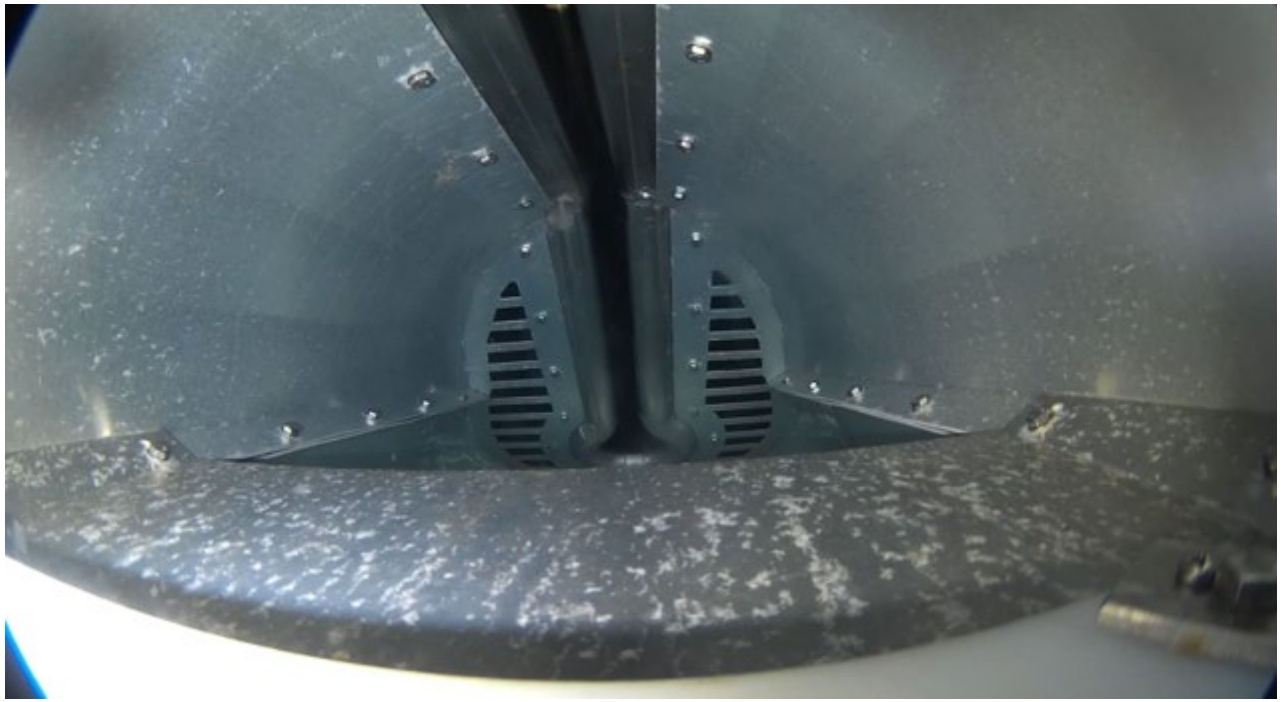
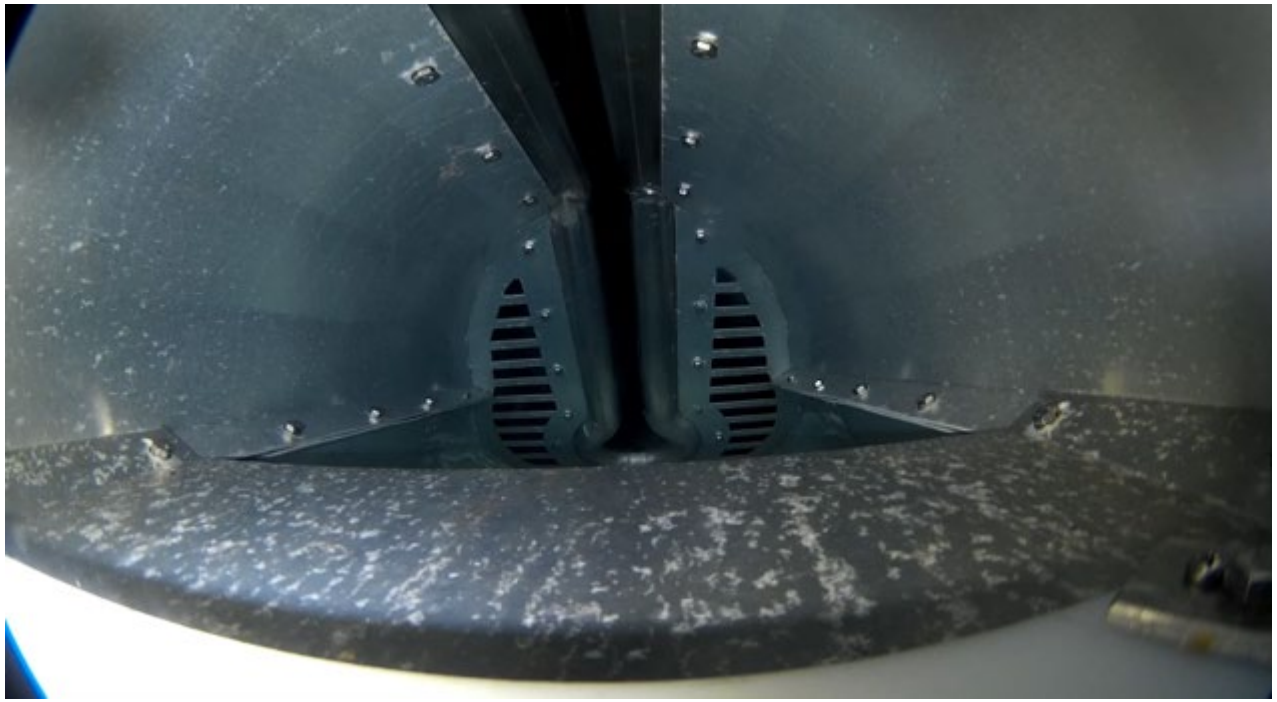
Reducing whale depredation by protecting longline catches

Pass Throughs





Internal Rear Facing Camera

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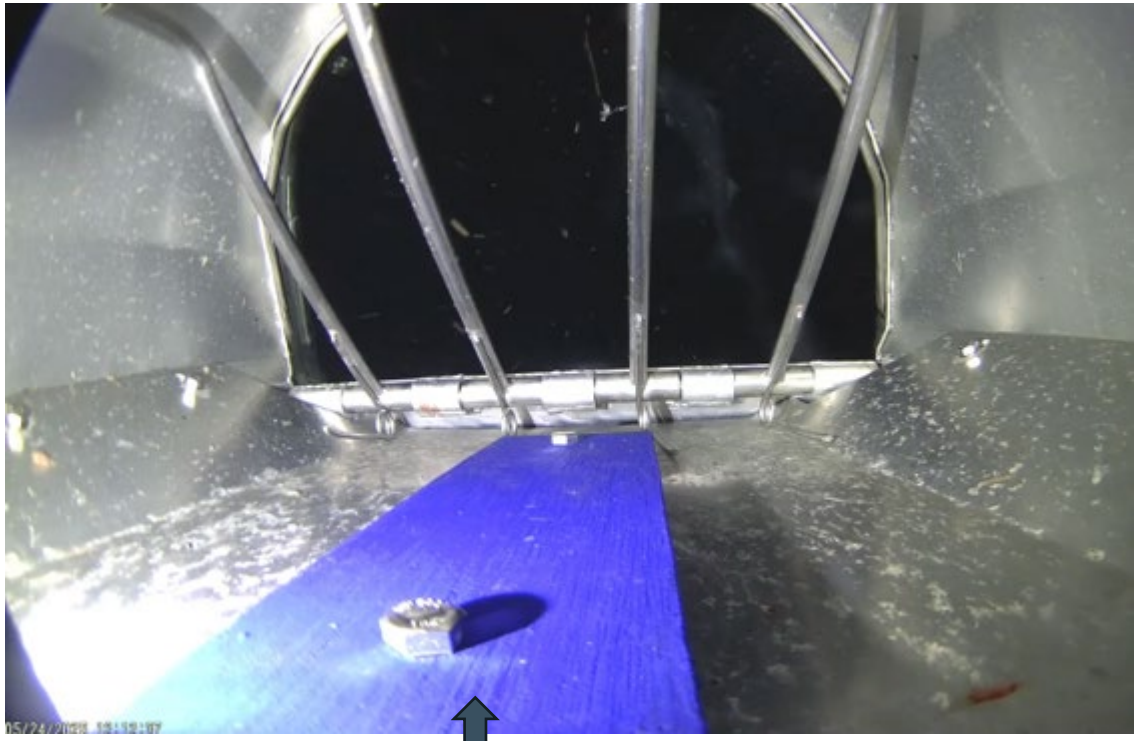
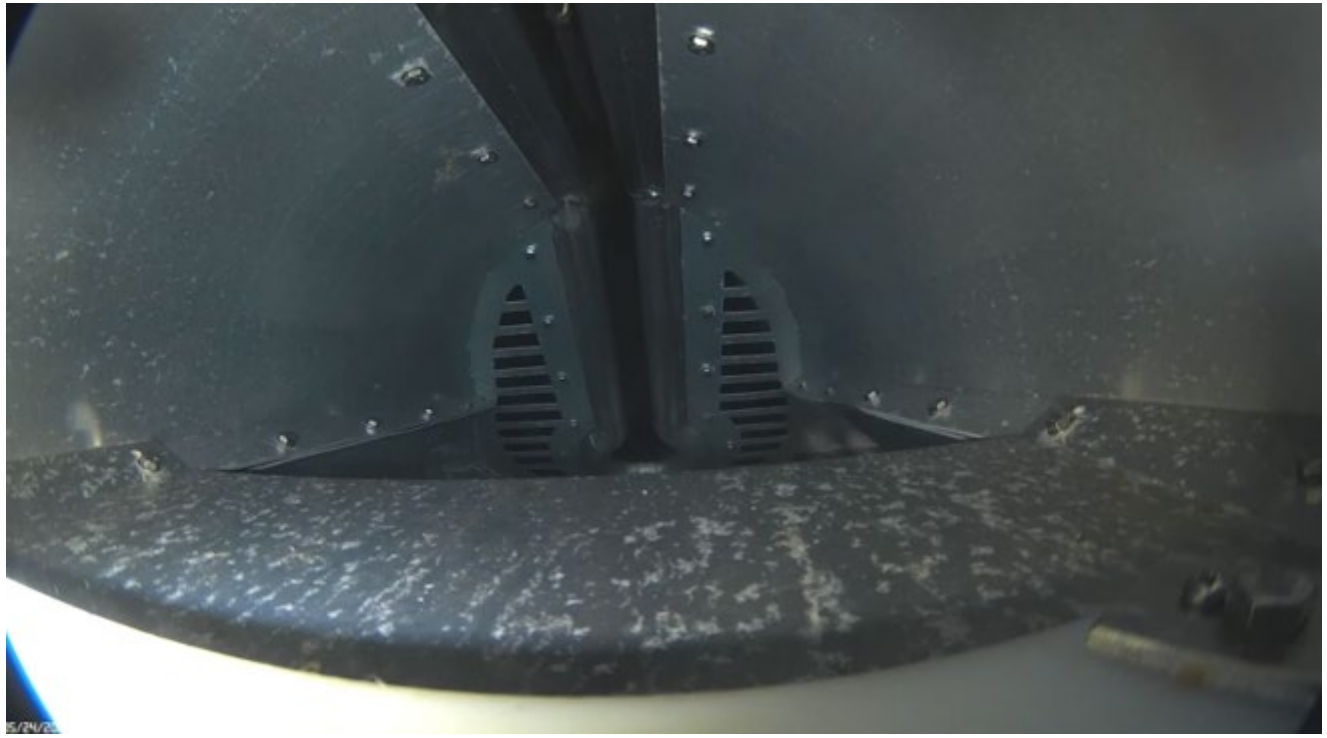
Reducing whale depredation by protecting longline catches

Entrainments



Internal Forward-Facing Camera



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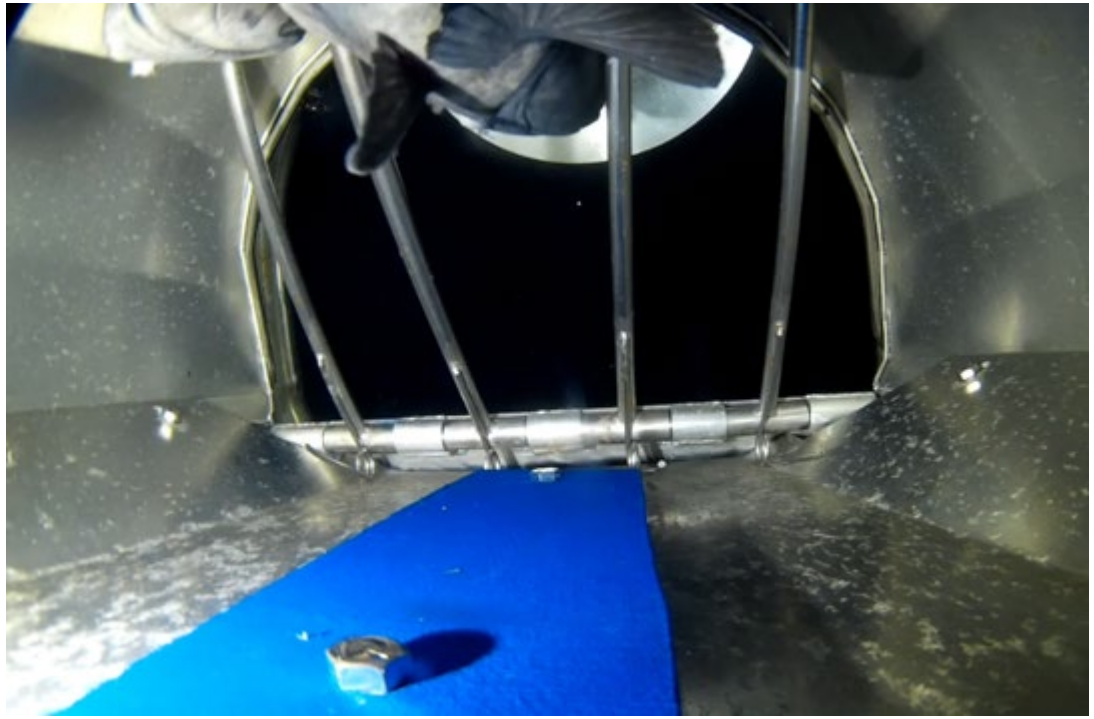
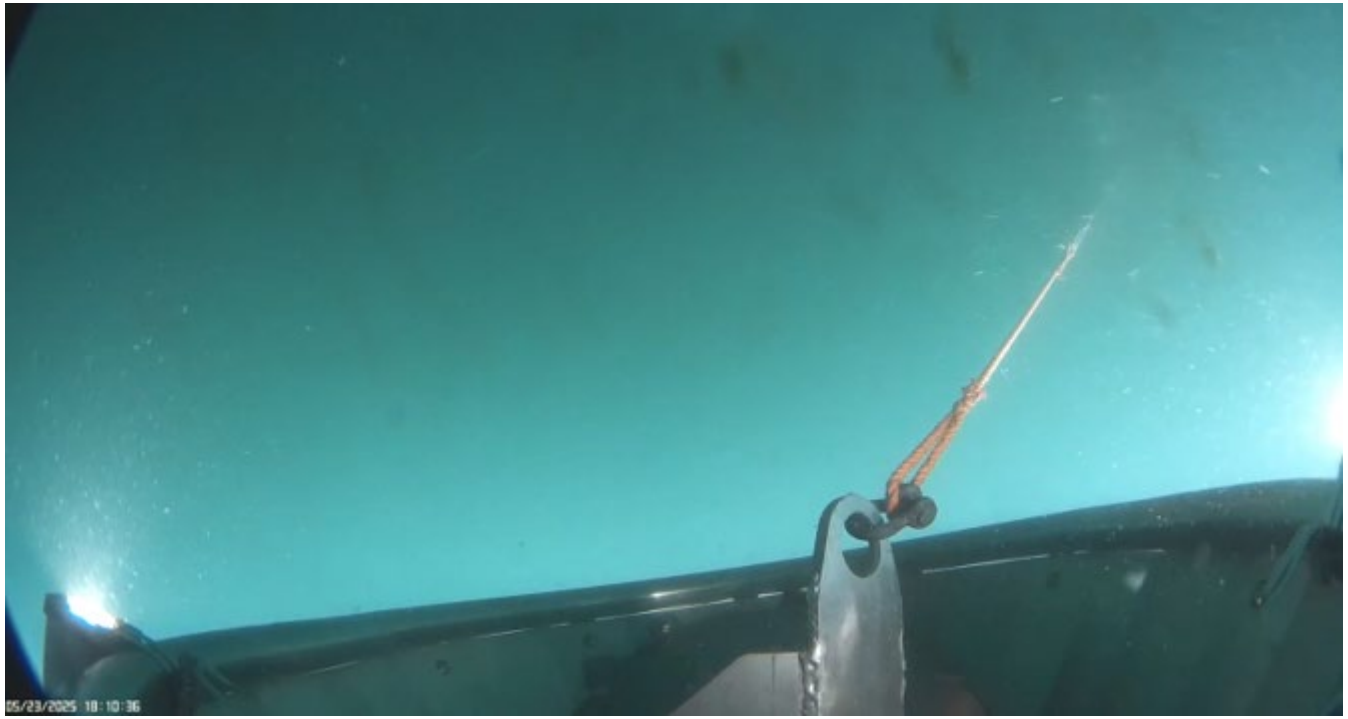
Reducing whale depredation by protecting longline catches

Escapes





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Reducing whale depredation by protecting longline catches

- Preliminary Results: Retention Trends from Camera

Common Name	Encountered	Excluded	Entered	Escaped	Passed Through	Entrained
Pacific halibut	89	1 (1.1%)	88	0	8 (9.1%)	80 (90.9%)
Sablefish	160	2 (1.3%)	158	45 (28.5%)	30 (19.0%)	83 (52.5%)
Pacific cod	124	3 (2.4%)	121	13 (10.7%)	6 (5.0%)	102 (84.3%)
Rockfish	16	7 (43.8%)	9	2 (22.2%)	1 (11.1%)	6 (66.7%)
Skate	18	3 (16.7%)	15	0	2 (13.3%)	13 (86.7%)

- 4,863 hook status observations recorded across all four cameras.
- Species morphology is primarily responsible for retention outcomes when encountering the shuttle.
- Retention rates can be improved with simple modifications.
- Captured rare footage of killer whales swimming around the groundline.

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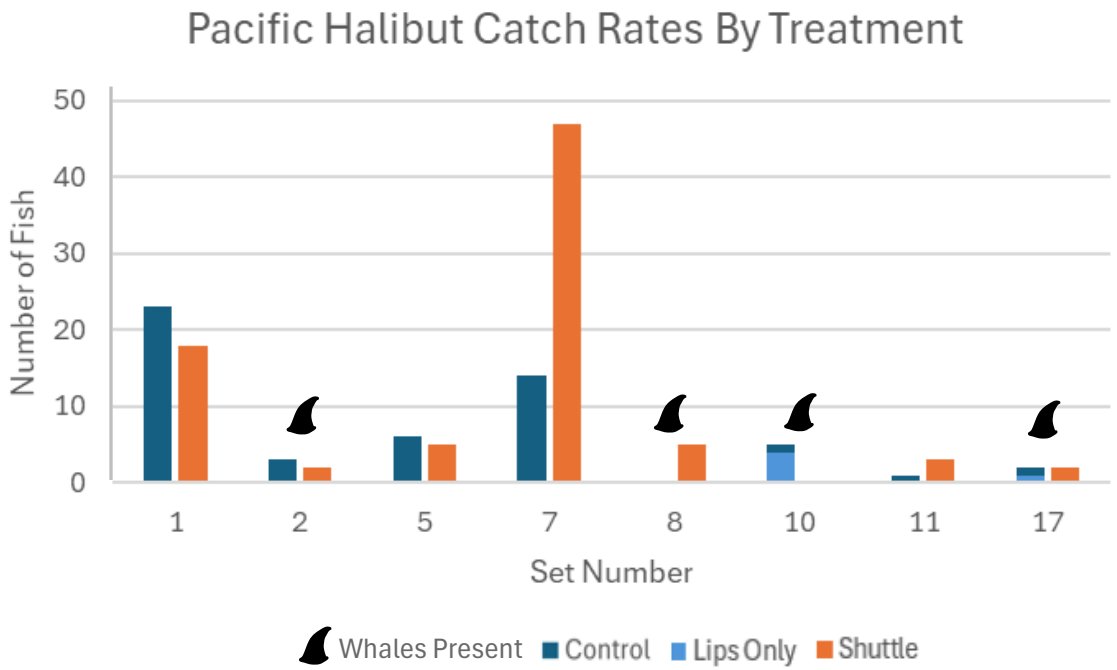
Reducing whale depredation by protecting longline catches

- Preliminary Results: Treatment Catch Rates (Surface)



- Shuttle is capable of good retention.
  - Results variable between control and shuttle
- Uncontrollable factors confound results (crab pot snarls, species composition).

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Reducing whale depredation by protecting longline catches

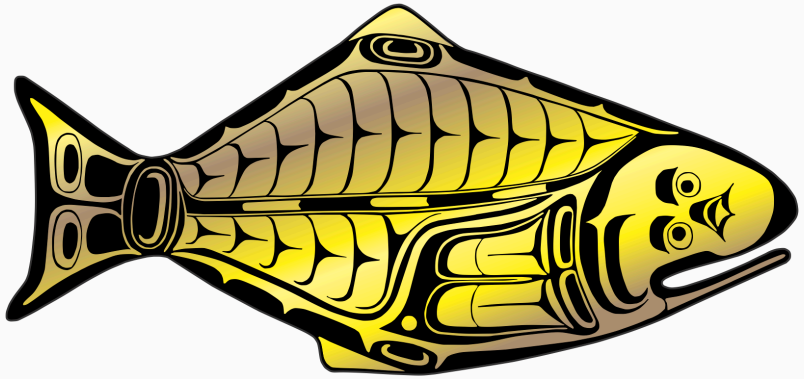
Killer whales captured swimming around the groundline

3. Fishing technology

Conclusions

- Shuttle device can be safely deployed and retrieved by vessels with a picking boom.
- Shuttle device has good retention of Pacific halibut.
- Simple modifications will increase retention of smaller species (i.e. Pacific cod and Sablefish).
- Next steps to help foster this new device to reduce impacts of whale depredation should be investigated and may include:
  - Weaker gangions, softer hooks, or modified hooks considered to reduce hook removal damage.
  - Consider a collapsible design for safer stowage and transport.
  - Possible regulatory changes allowing use of the shuttle device.

INTERNATIONAL PACIFIC



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https://www.iphc.int/