INTERNATIONAL PACIFIC HALIBUT COMMISSION

Report on current and future Biological and Ecosystem Science Research activities

Agenda item: 5.1.1

IPHC-2026-RAB027-06

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



Research updates for 2026

1. **Migration and Population Dynamics**: Development of an alternative genetic-based method for aging
2. **Reproduction**: Revised maturity schedules and fecundity studies
3. **Mortality and Survival Assessment:** Discard mortality rates in the recreational fishery
4. **Fishing Technology**: Reducing whale depredation by protecting longline catches

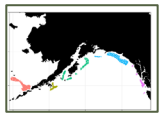
1. Migration and Population Dynamics

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*

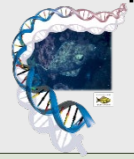
Juvenile connectivity

- NMFS trawl survey data
- Spatiotemporal model

→ Ontogenetic migration

Development and application of genomic approaches

Genome sequence



→ Population structure analyses

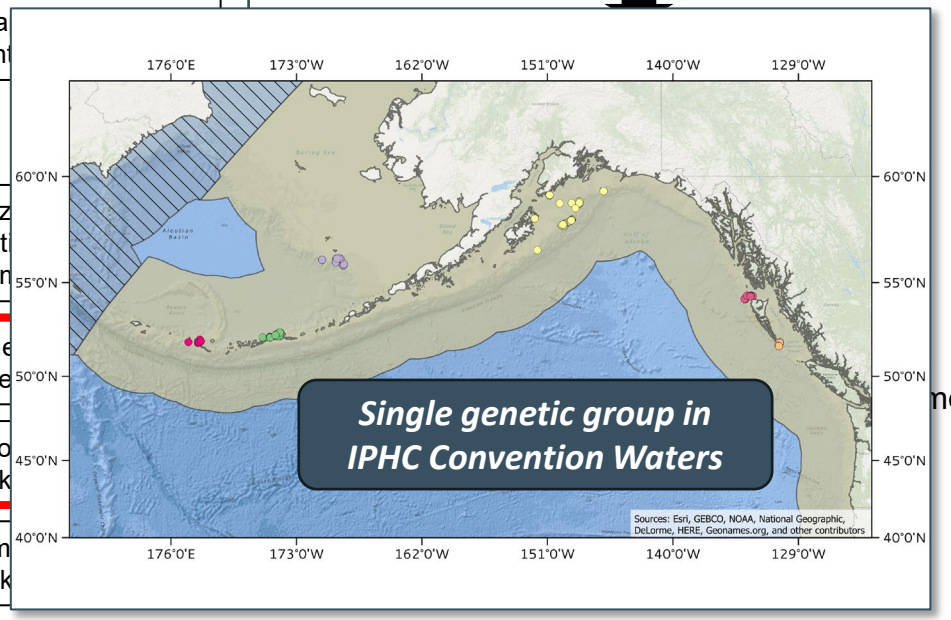
Jasonowicz et al. (2022) *Mol. Ecol. Res.* ***22****: 2685*

PIRM 2022-2026

- Climate effects on larval connectivity
- Connectivity with Western Pacific Ocean region
- Ma… settlement
- Characteriz… composit… settlen…
- Establishme… of gene…
- Delineatio… stock
- Stock com… stock
- Development of an epigenetic clock for aging Pacific halibut

Relevance for stock assessment

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



…ments

1. Migration and Population Dynamics

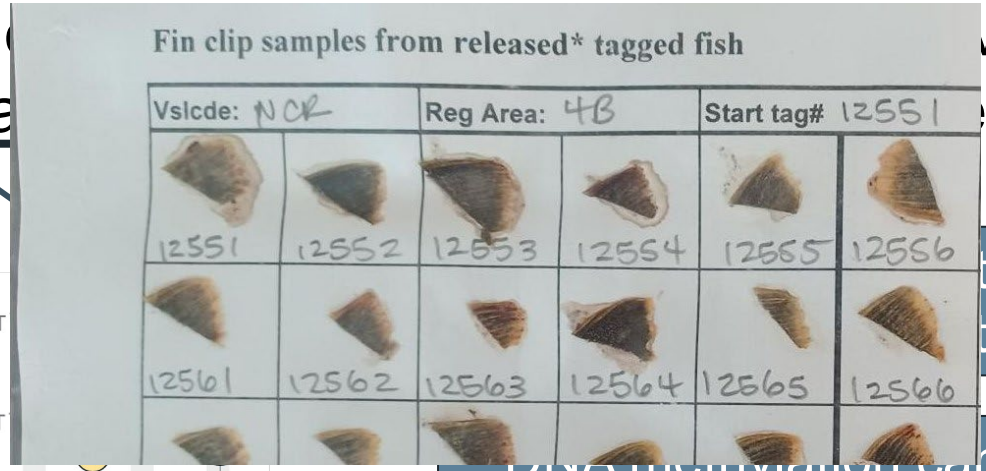
Development of an epigenetic clock for aging Pacific halibut

Sea Grant ALASKA
Project R/2024-05 (2025-2027)

What is an **epigenetic clock**?

- An alternative method of aging using genetics
- Use non-lethal samples: fin clips
- Is const ati vidual fish and the yla DNA = no sequen







terns
th age

DNA methylation can be quantified by sequencing

What is needed?: fin clips from well-aged Pacific halibut

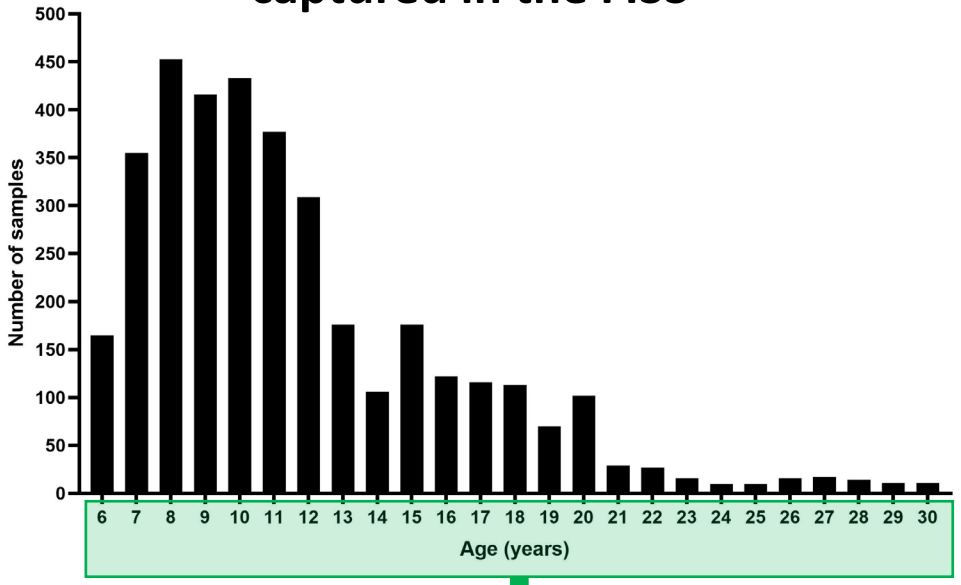


1. Migration and Population Dynamics

Development of an epigenetic clock for aging Pacific halibut

Sea Grant ALASKA
Project R/2024-05 (2025-2027)

Genetic samples: aged fin clips from fish captured in the FISS

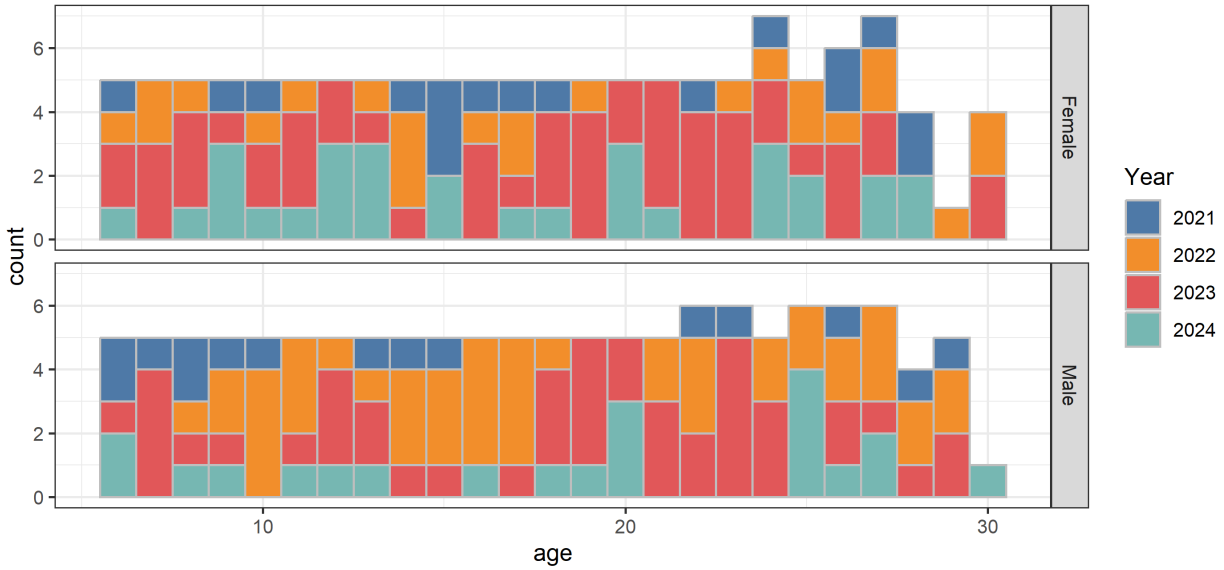


5♂ and 5♀/age from 6 to 30 years of age
N = 249 fish (fin clips)



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**

Ages of FISS Samples Selected for Epigenetic Clock Development (2021-2024)

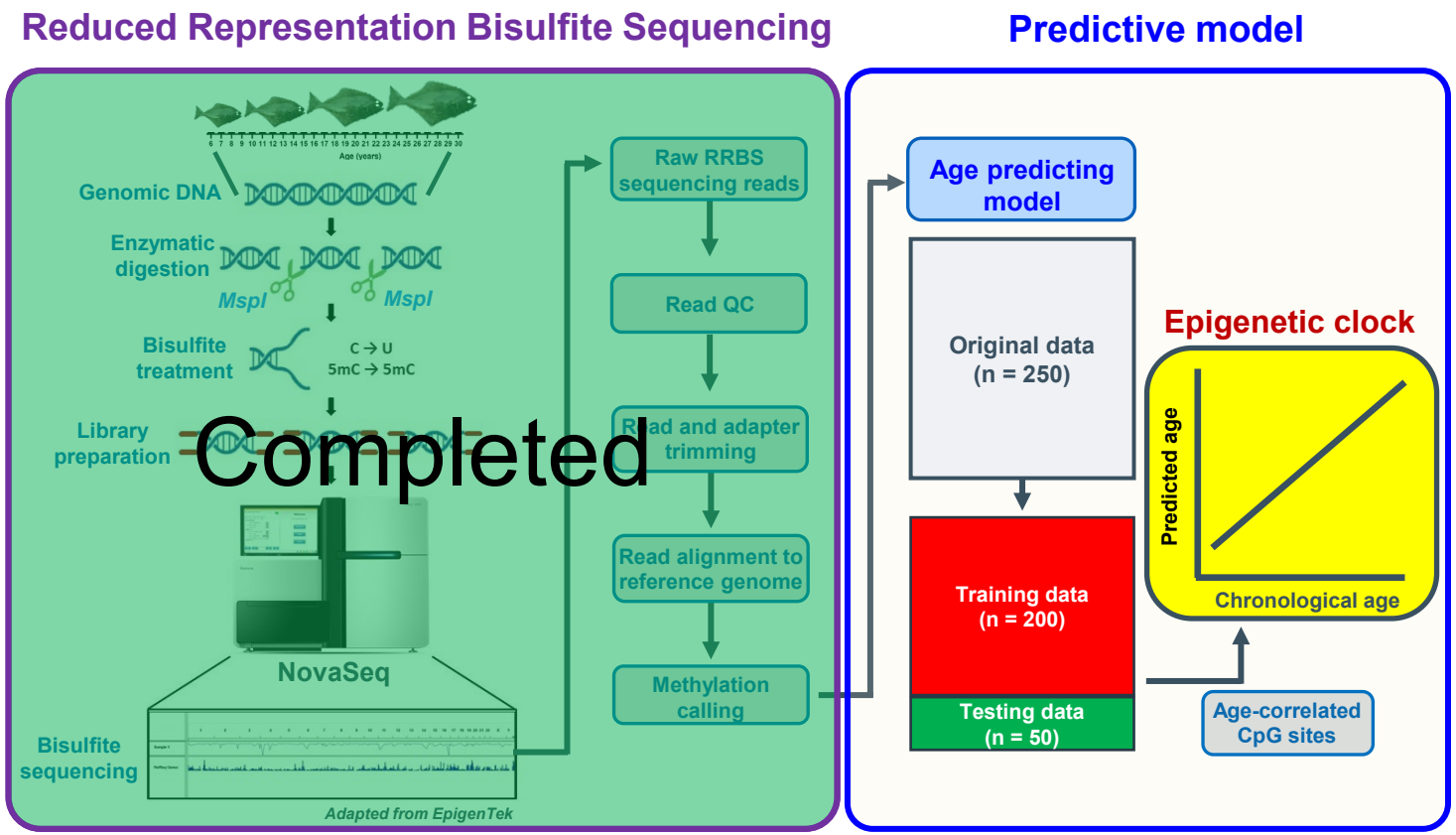


1. Migration and Population Dynamics

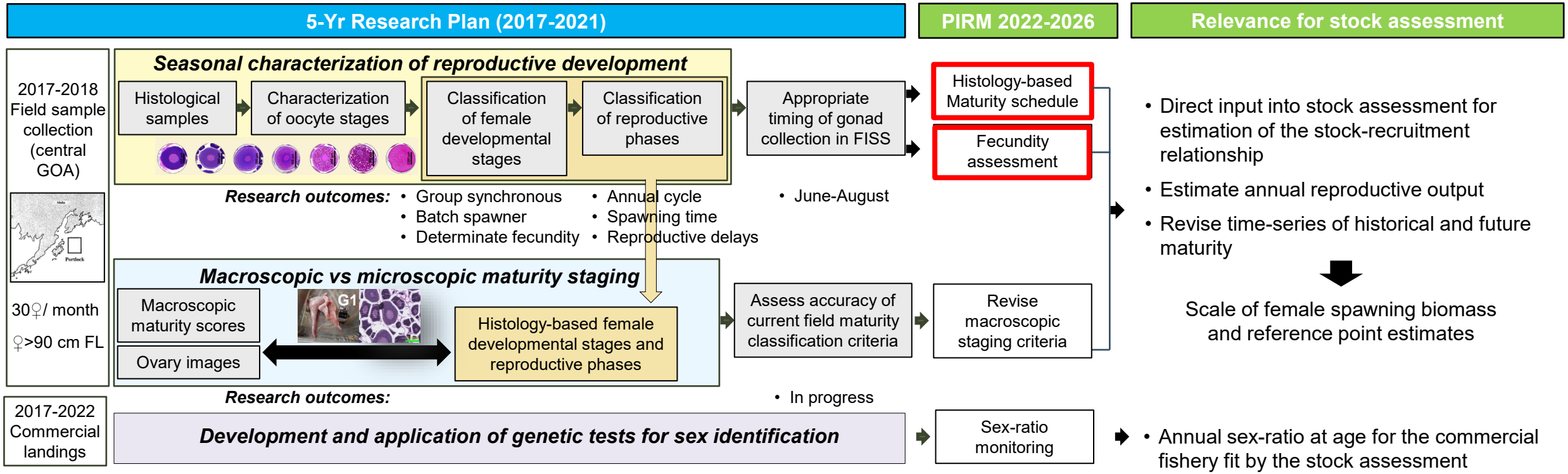
Development of an epigenetic clock for aging Pacific halibut

Sea Grant ALASKA
Project R/2024-05 (2025-2027)

Project workflow



2. Reproduction

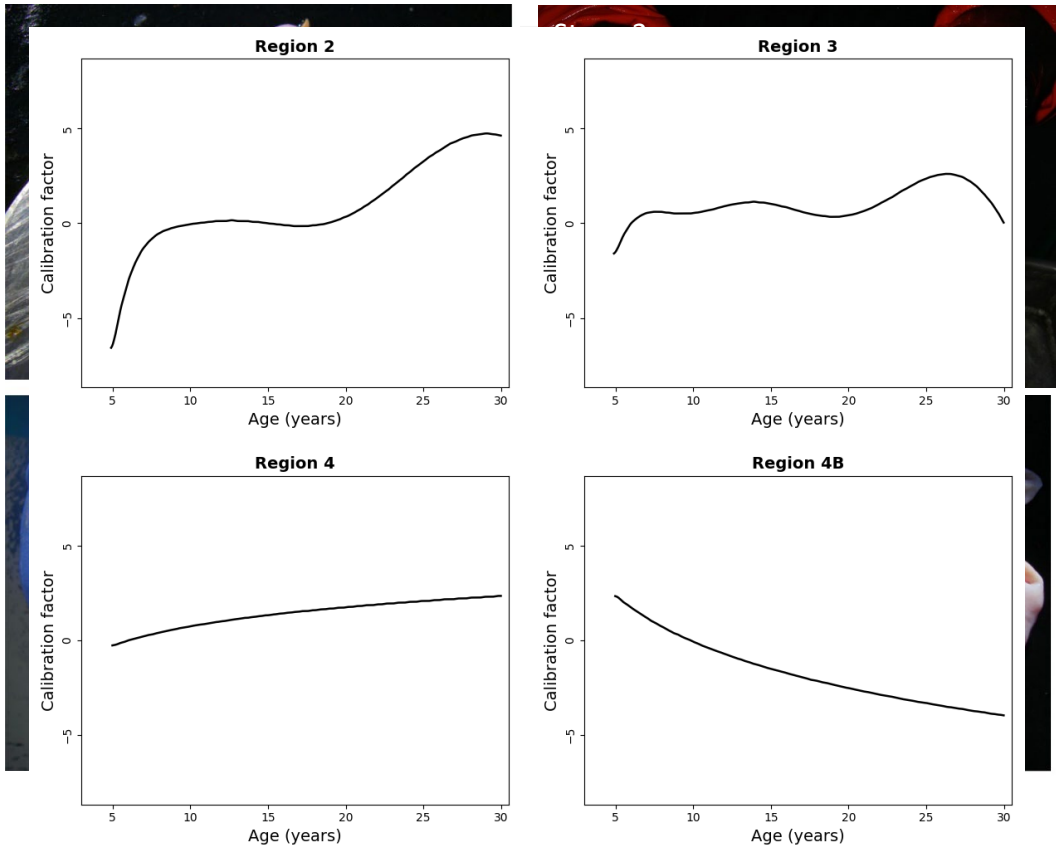


Publications: Fish et al. (2020) *J. Fish Biol.* ***97****: 1880–1885*
Fish et al. (2022) *Frontiers in Mar. Sci.* ***9****: 801759*
Simchick et al. (2024) *Gen. Comp. Endocrinol*. ***347****: 114425*

2. Reproduction

Revised maturity estimates

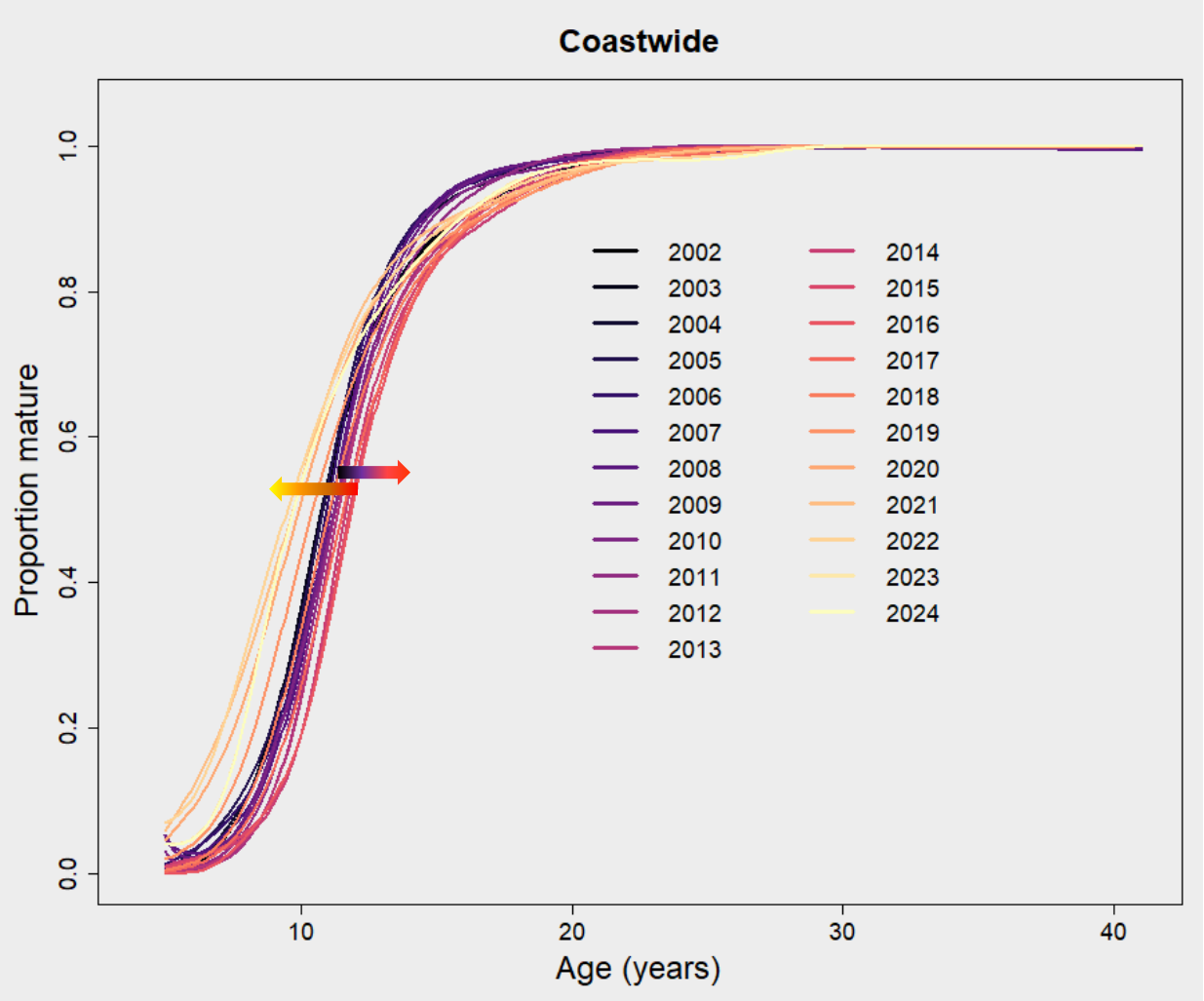
- 2022-2024 histology and visual assessments both estimate a shift to the left from previous estimates
- Calibration between the two methods was established to revise historical coastwide visual maturity estimates



2. Reproduction

Calibrated coastwide maturity ogives from 2002 to 2024

- Time-series starts at 2002 due to change in aging methods
- Temporal shifts in maturity estimates are apparent



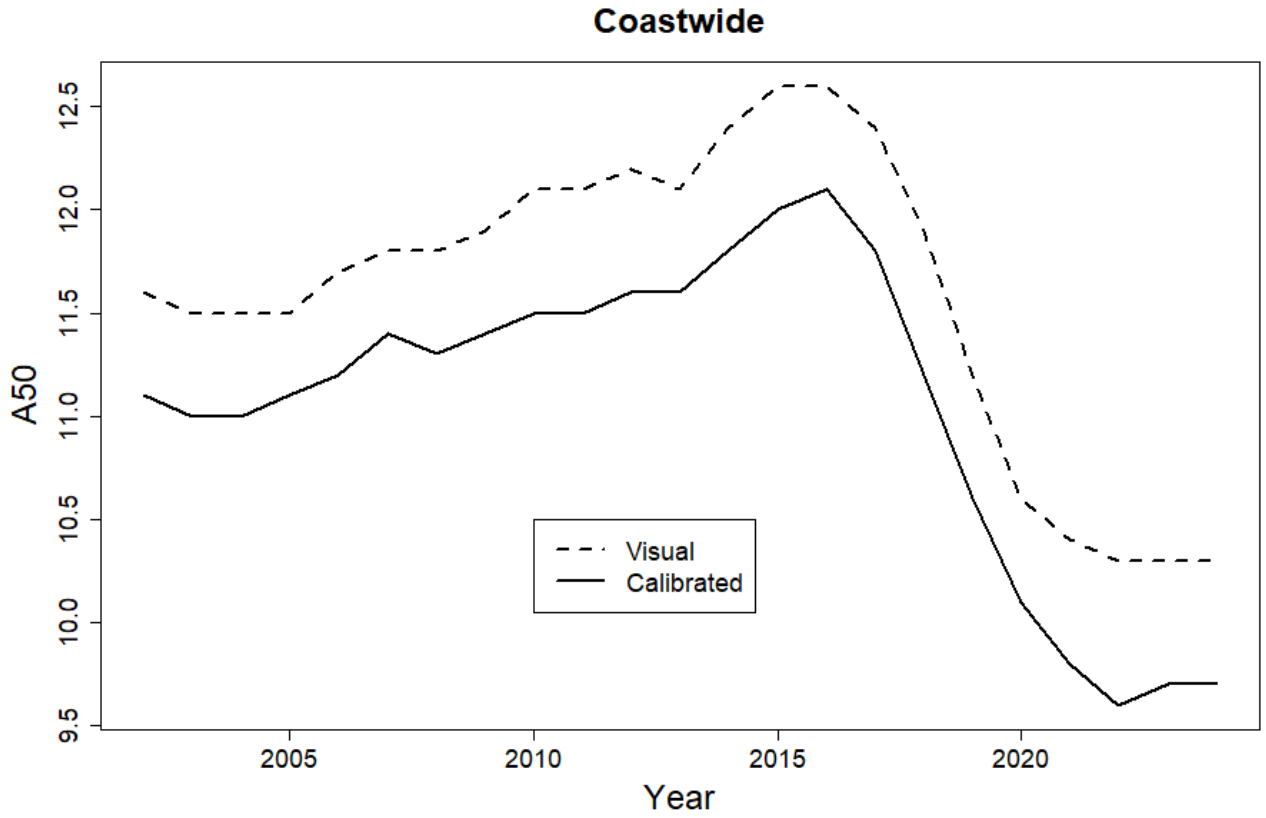
2. Reproduction

Calibrated coastwide maturity ogives from 2002 to 2024

- 2002 - 2024
  - Raw visual data (dotted line)
  - Calibrated visual data using histology (solid line)

- Two temporal shifts
  - 2002 - 2016
  - 2017 - 2022

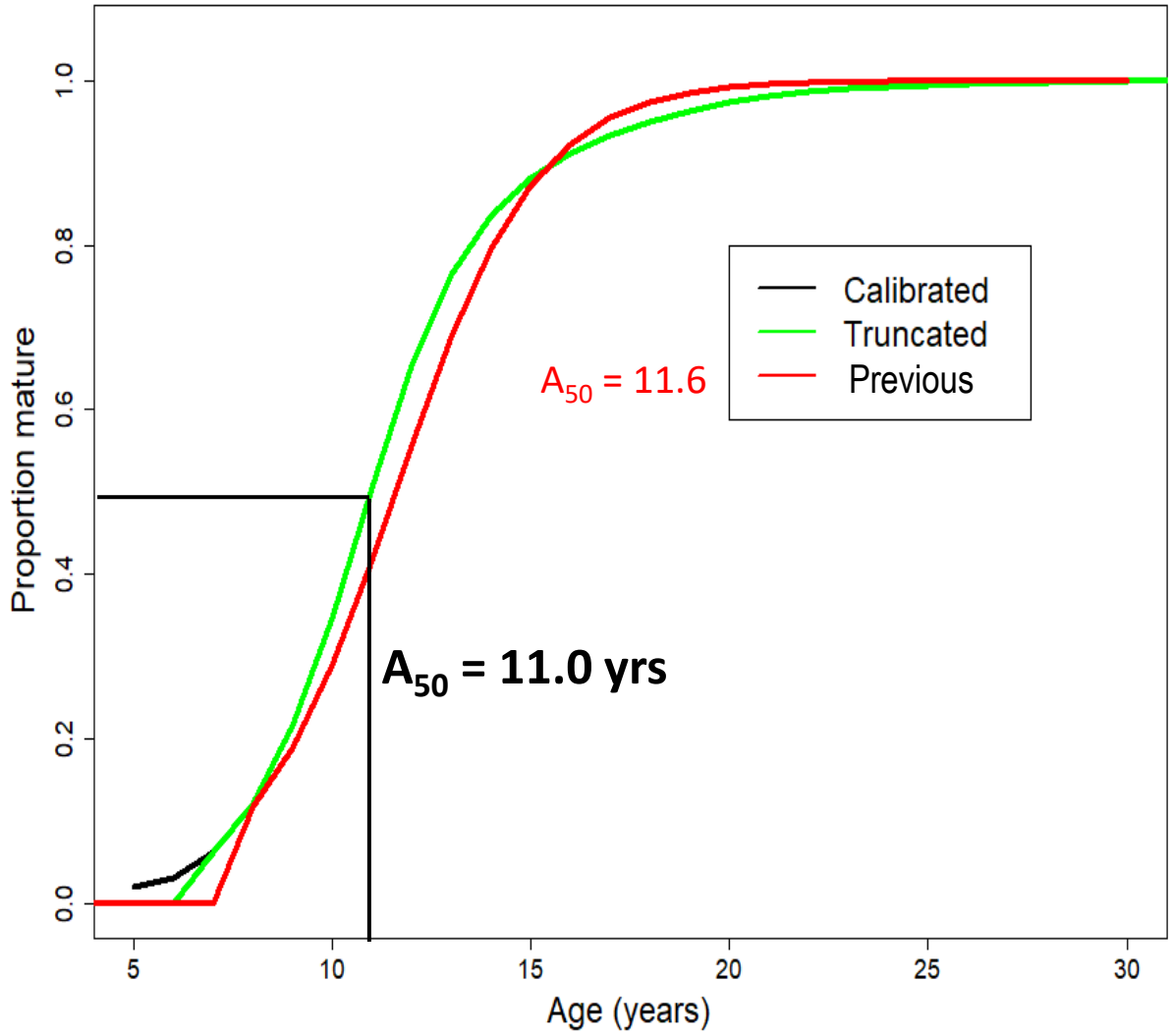
- Biological and environmental variables being examined as potential drivers



2. Reproduction

New coastwide maturity ogive

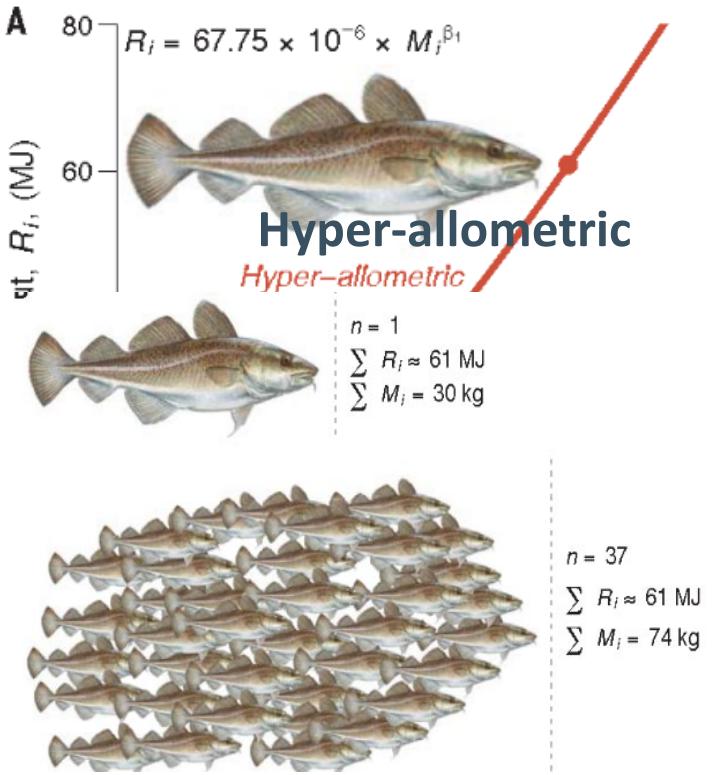
- Generated using average calibrated coastwide ogives from 2002-2024
- Maturity estimates are shifted slightly to the left of **previous** assessment ogive (A_{50} = 0.6 yrs lower)
- Truncated to zero < Age 7
- **New coastwide maturity ogive used in the 2025 stock assessment**



2. Reproduction

Fecundity estimates

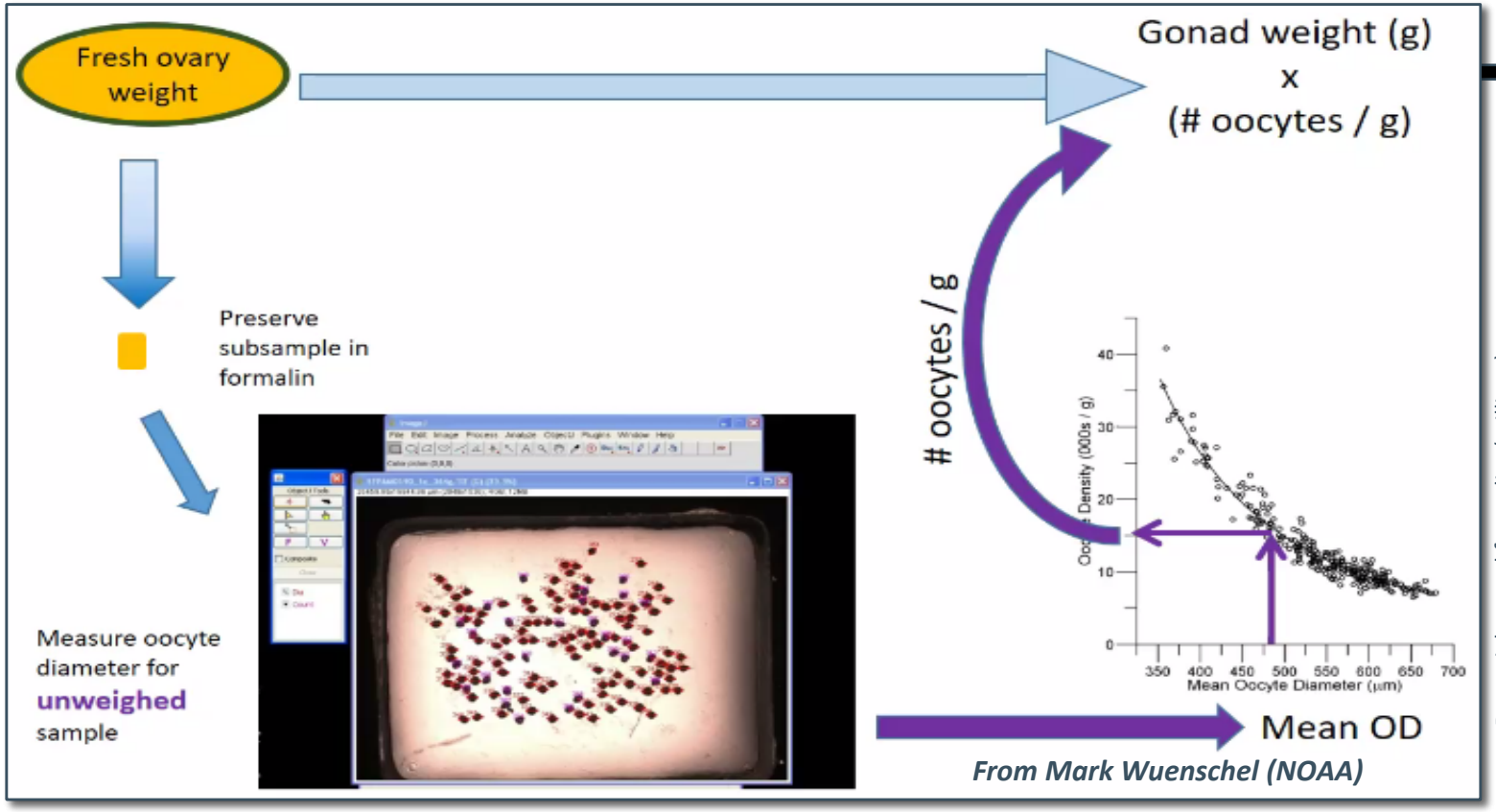
- Fecundity - # of eggs an individual female produces per spawning event or season
- Why important? – true measure of reproductive potential
- Is female Pacific halibut fecundity proportional to body weight?
  - Isometric vs hyper-allometric



Barneche et al, Science 360, 642-645 (2018)

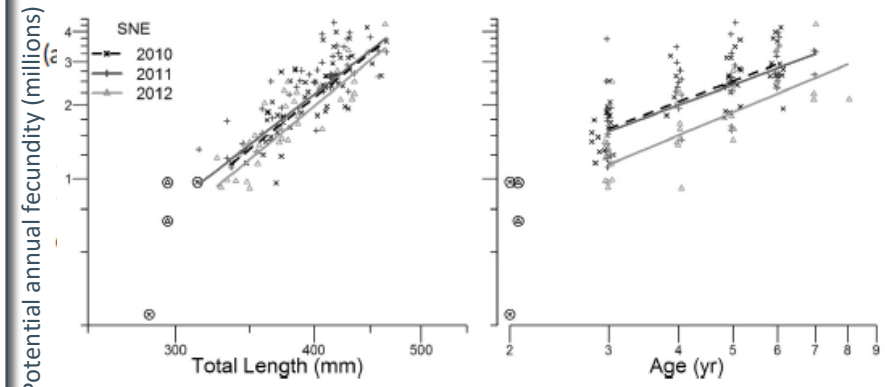
2. Reproduction

Auto-diametric fecundity estimation method



Fecundity (Total # oocytes)





McElroy et al. 2015

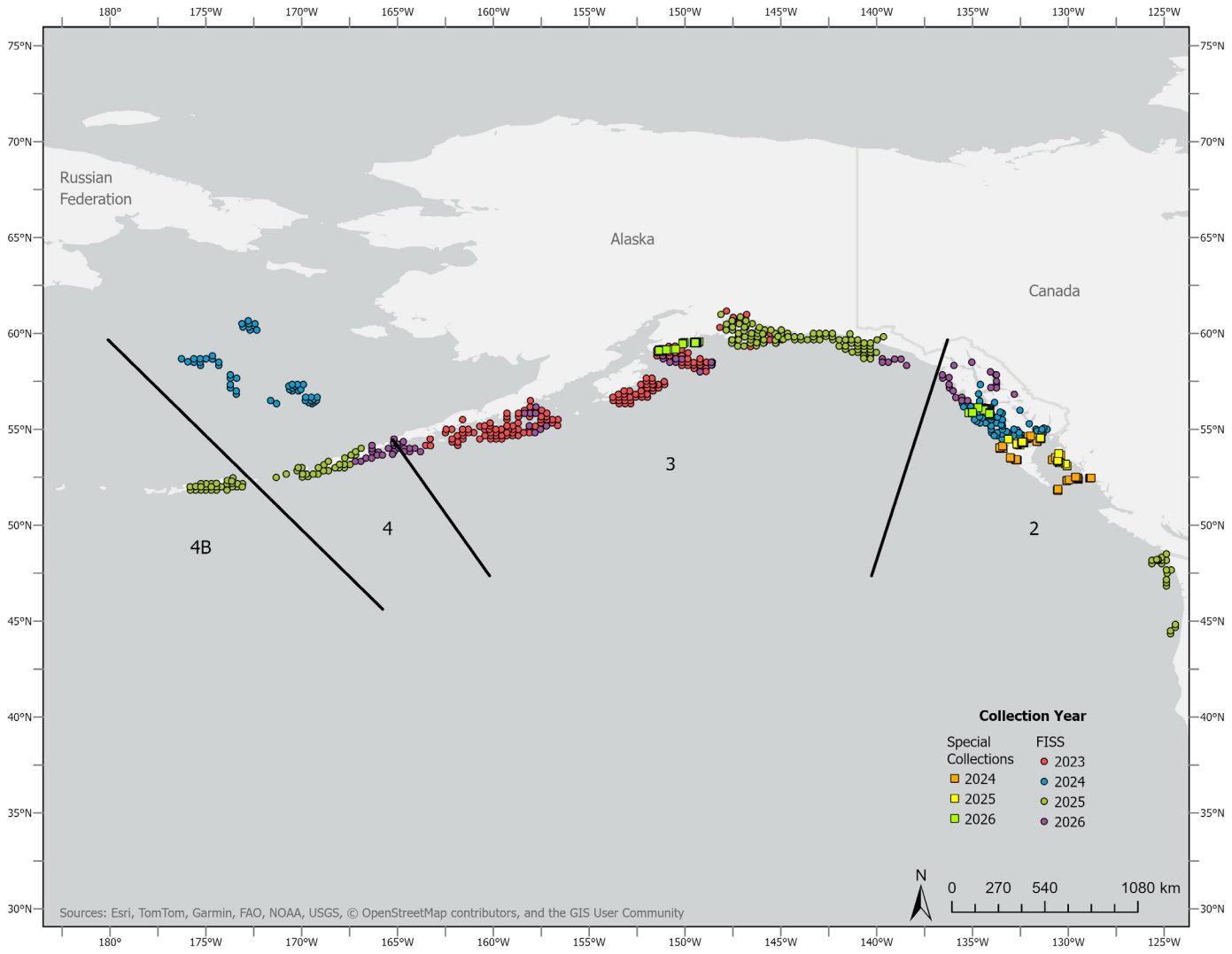
2. Reproduction

Fecundity method development and fecundity estimations – Sample collection

- FISS
  - 2023: Region 3
  - 2024: Regions 2 and 4
  - 2025: All Regions
  - 2026: Regions 2, 3 and 4

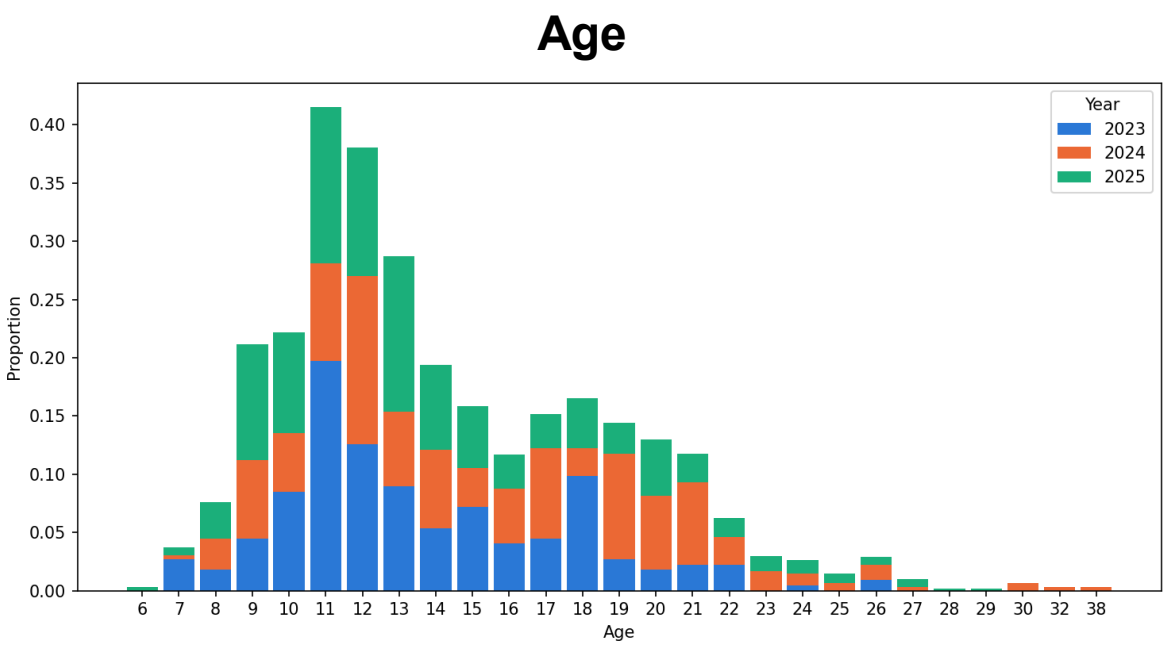
- Special Collections
  - 2024 and 2025: Region 2
  - 2026: Regions 2 and 3

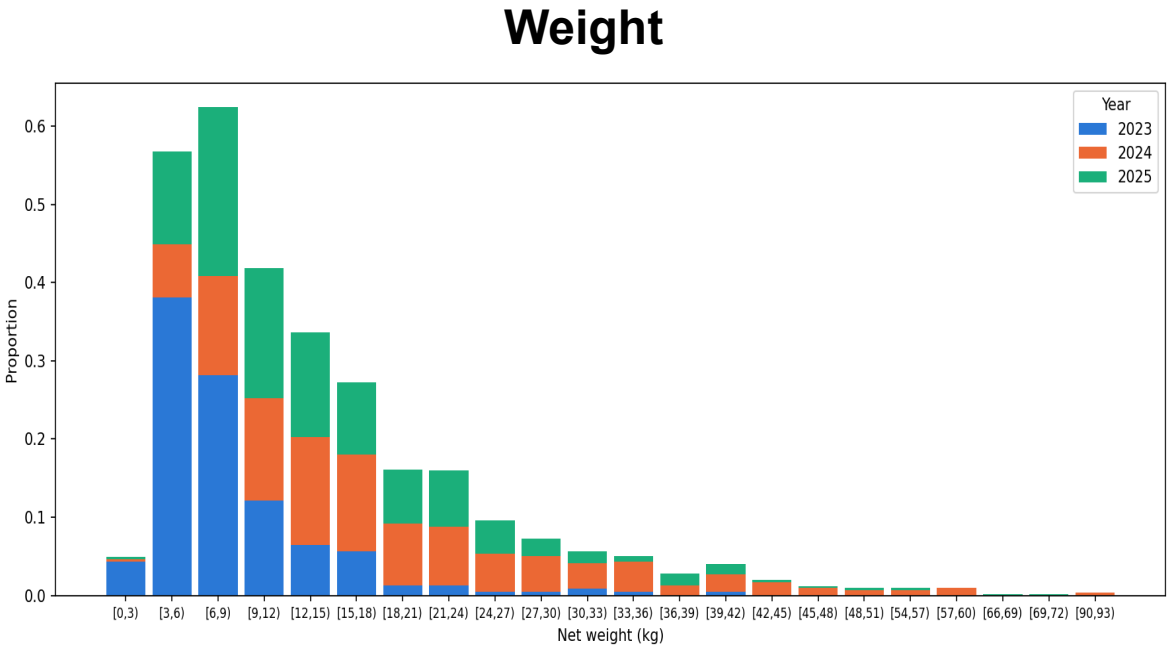
2023-2026: 1,645 G2 samples collected



2. Reproduction

Fecundity estimation – Age and weight distribution of mature samples



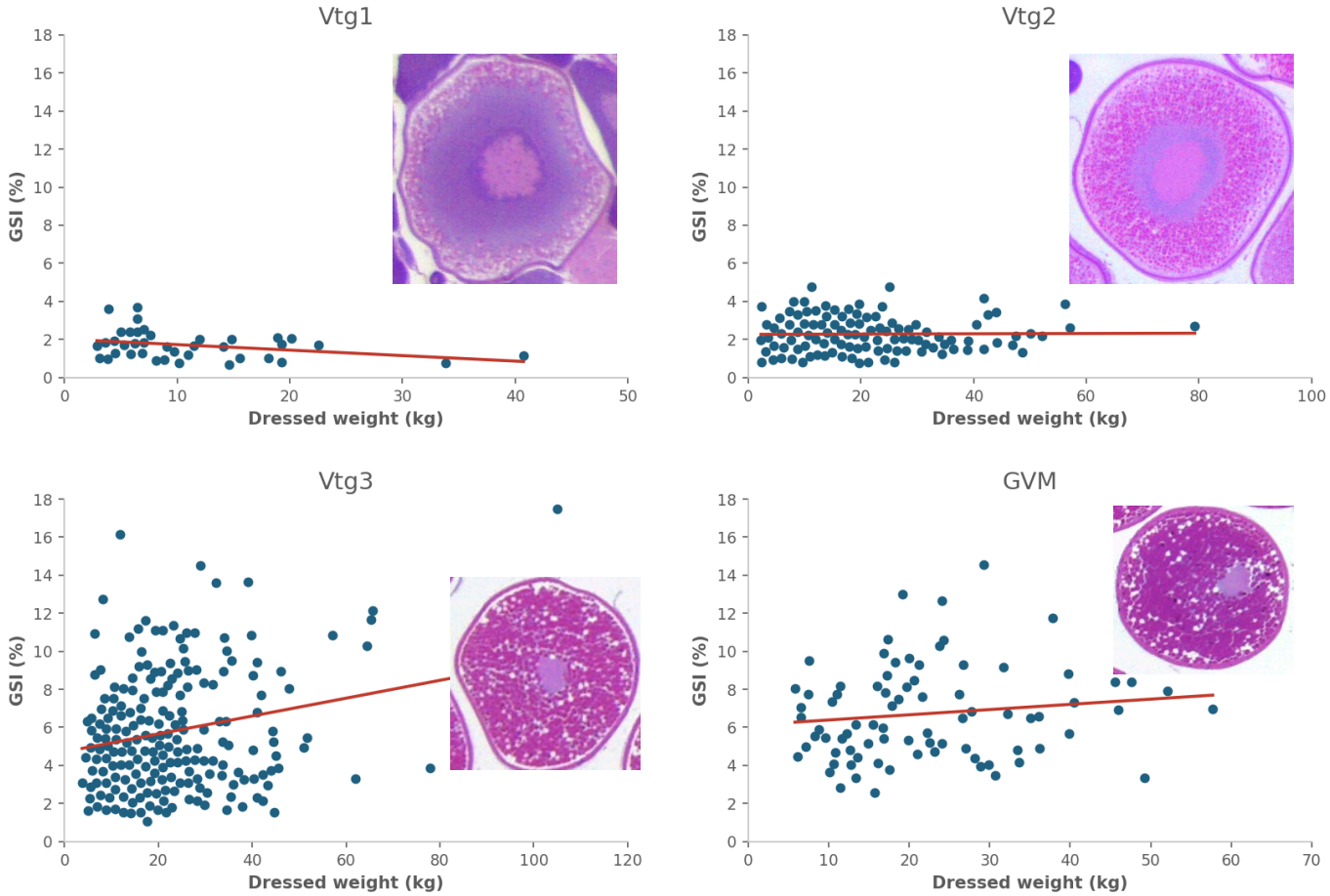


2. Reproduction

Fecundity estimation – GSI vs Weight

- Gonadosomatic index (GSI)
  - ratio of gonad weight to total body weight
  - used as a proxy for reproductive output

- No indication of allometric relationship with weight



2. Reproduction

Conclusions

- Calibrated coastwide maturity ogives (2002-2024):
  - Increase in A_{50} from 2002-2016
  - Sharp decline in A_{50} from 2017-2022
  - Potential drivers of temporal changes are currently being examined
- Fecundity:
  - We collected the type of ovarian samples (range in oocyte development) required for the development of the auto-diametric method
  - Once method is developed, this will be applied to ask the question: Is female Pacific halibut fecundity proportionally (isometric) or disproportionally (hyper-allometric) related to body weight?
  - GSI vs Weight shows no indication of hyper-allometric relationship

3. Mortality and Survival Assessment

5-Yr Research Plan (2017-2021) | **PIRM 2022-2026** | **Relevance for stock assessment**

Fall 2017 field experiment (GOA)



Discard mortality rate estimation: longline fishery

Capture and handling conditions
- Careful shake
- Gangion cut
- Hook strip

→ Injury and viability assessment
→ Physiological condition assessment
→ Analysis of capture-related variables
→ Survival assessment by tagging

Research outcomes:
- Injury and viability profiles of hook release methods
- Physiological profile of fish under different capture and handling conditions
- Longline DMR

→ Best handling practices in longline fishery

Summer 2021 field experiments (Sitka, AK Seward, AK)

Discard mortality rate estimation: charter recreational fishery

Capture and handling conditions
- 12/0 and 16/0 hooks

→ Injury, viability and physiological assessment
→ Survival assessment by tagging
→ Analysis of capture-related variables

Research outcomes:
- Recreational DMR

→ Best handling practices in recreational fishery

- Improved estimates of discard mortality
- Reduce potential bias in stock assessment results and management of mortality limits

↓

Reduce unobserved mortality and its effect on stock assessment

External funding: Saltonstall-Kennedy NOAA (2017-2020); NFWF (2019-2021); NPRB#2009 (2021-2022)

Publications:
Kroska et al. (2021) *Conservation Physiology* ***9****: coab001*
Loher et al. (2022) *North American Journal of Fisheries Management* ***42****: 37-49*
Dykstra et al. (2024) *Ocean & Coastal Management*. ***249****: 107018*.
} **Longline fishery**

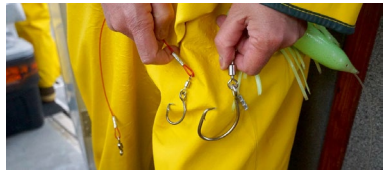
Dykstra et al. In Preparation } **Charter recreational fishery**

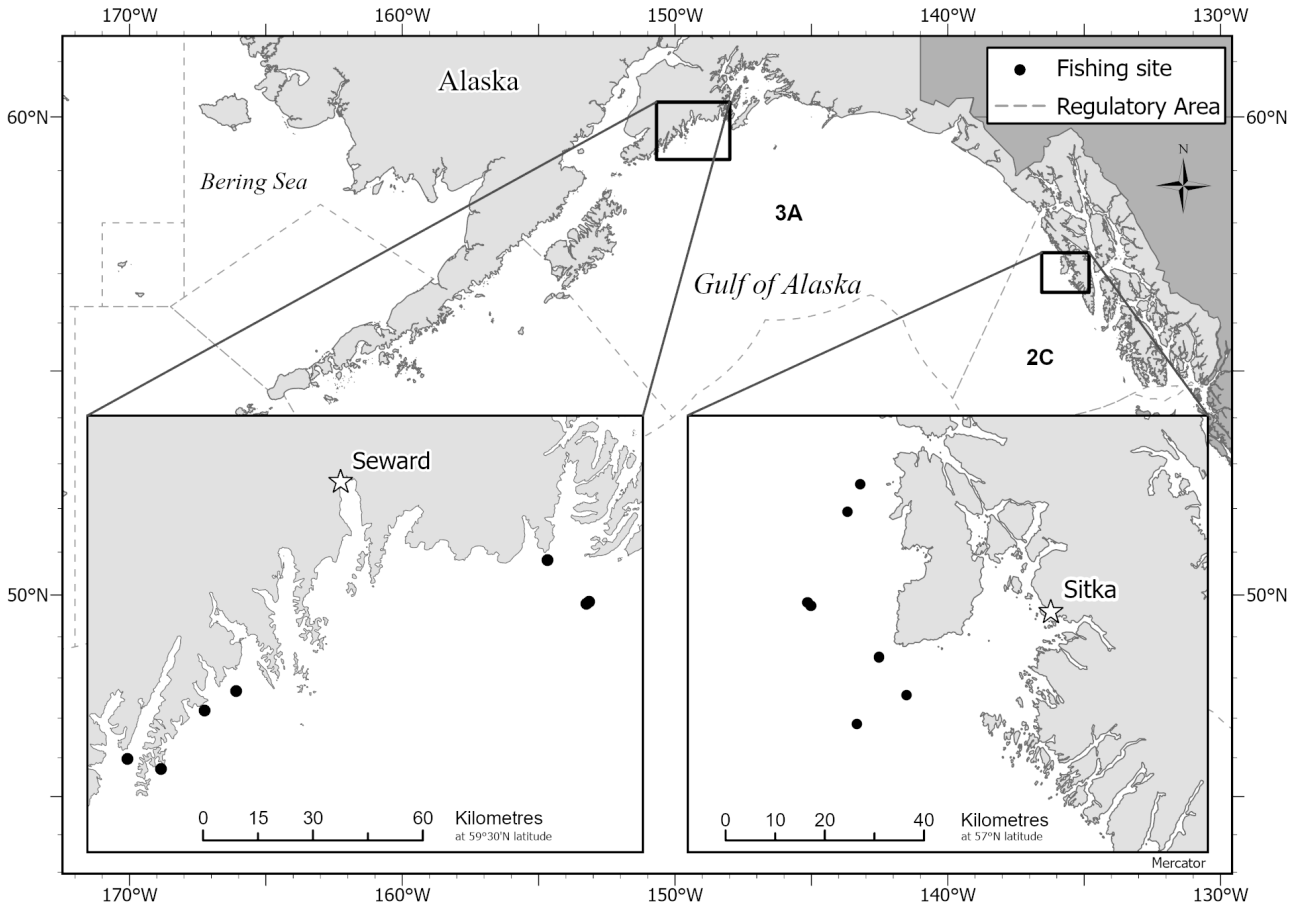
3. Mortality and Survival Assessment

Establishing evidence-based discard mortality rates in the recreational fishery



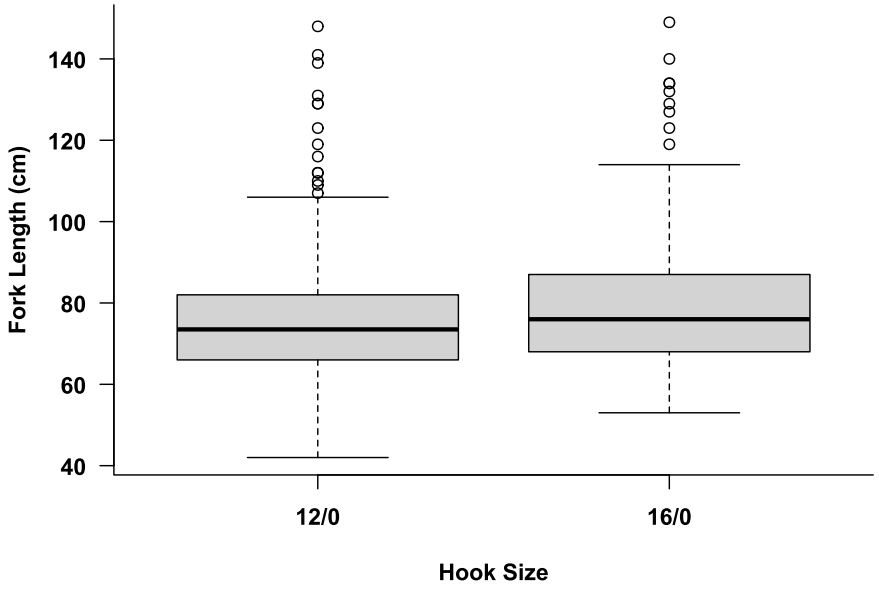


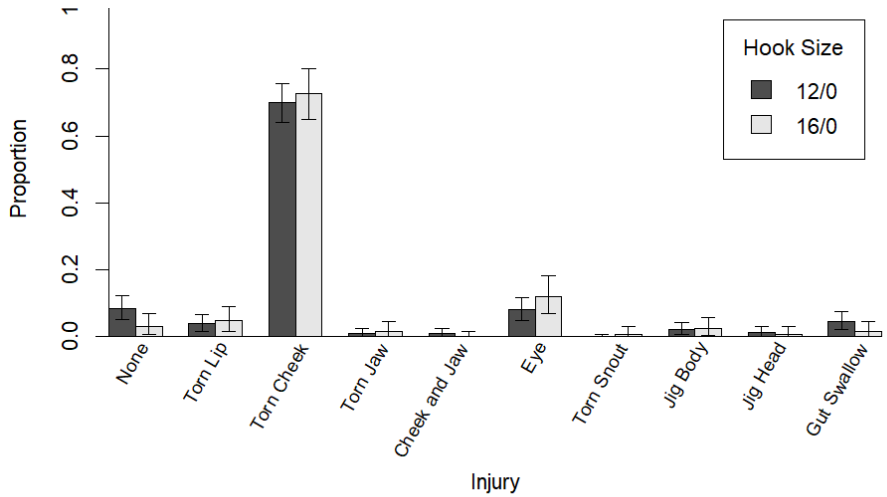




3. Mortality and Survival Assessment

- 16/0 hooks caught larger Pacific halibut (length and weight)
- 12/0 hooks were the only size that reduced viability (largely due to hook swallowing)
- Longer fight times resulted in stress, but not predictive of fish survival.
- Lower stress than commercially caught fish
- Capture depth, temperature exposures not predictive of fish survival

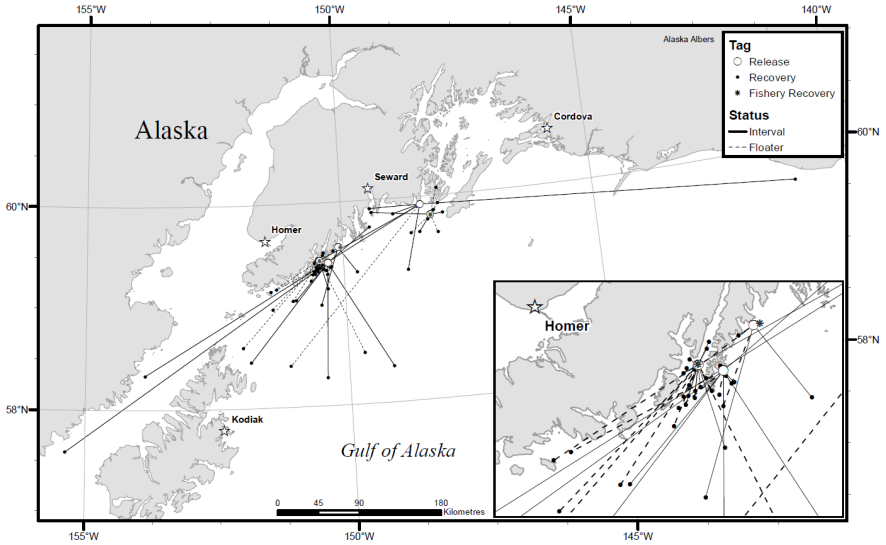




3. Mortality and Survival Assessment

Survival Estimation with sPAT tags (Excellent viability, n = 76)





Status	Sex	Count	Distance Traveled			Days at Liberty		
			Average	Min	Max	Average	Min	Max
Premature Release	F	18	39.35	0.1	227.77	46.06	8.25	69.08
Premature Release	M	12	26.3	0.21	74.51	36.23	3.58	76.83
Full Duration	F	21	66.6	0.45	415.6	96	96	96
Full Duration	M	25	21.4	0.51	139	96	96	96

Mortality rate of 1.35% (95% CI: 0.00-3.95%) for fish of Excellent viability.

3. Mortality and Survival Assessment

- Management-applied DMRs are based on a calculated value (commercial and other marine recreational species DMRs, data on hook types) and assumptions on release viability.
  - ➢ Updated DMR estimates are lower than the calculated DMR.
  - ➢ Management agencies will need to decide how to integrate new data with management-ready DMRs.

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%

Conclusions

- Larger hooks catch larger fish.
- Small hooks cause more gut swallowing leading to poorer survival outcomes.
- Lower stress responses observed over short duration capture events.
- High rates of survival when fish are handled and released properly.
- New calculation resulted in a ~11-22% reduction in calculated DMR estimates (~30-40% compared to management-applied DMRs).

4. Fishing technology

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

Relevance for stock assessment

Summer 2023 pilot test



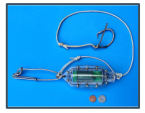
Investigate new methods for whale avoidance/deterrence to reduce whale depredation in the longline fishery

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

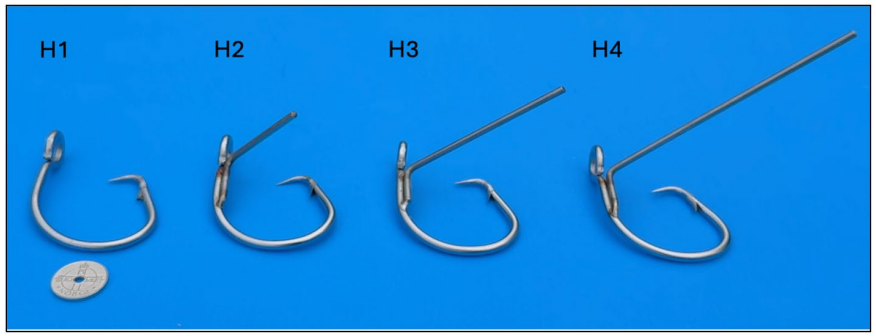
- Increasing available yield for directed fishery.
- Reduce potential bias and uncertainty in the stock assessment.

⬇

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*
Lomeli et al. (2026) *Aquaculture and Fisheries* *In press, published online*



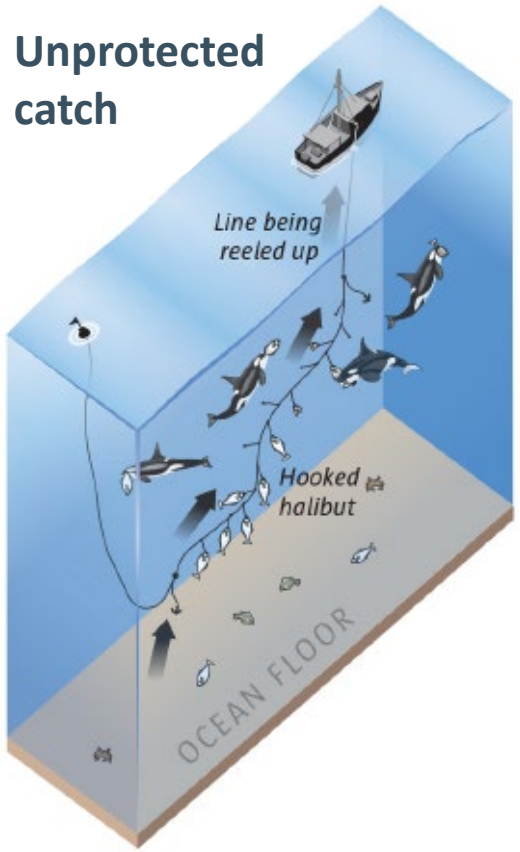
4. Fishing technology

NOAA FISHERIES
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Bycatch Reduction Engineering Program
(BREP) NA23NMF4720414

Reducing whale depredation by protecting longline catches

- Underwater Shuttle: Encapsulate fish at depth – protect enroute to the surface

Unprotected catch



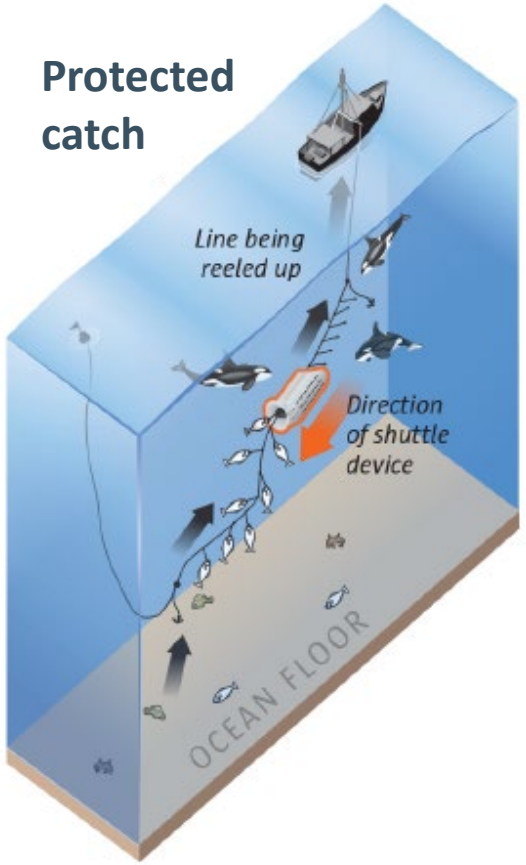
Underwater Shuttle





2.6 m x 0.8 m
100 kg empty

Protected catch



Emptying shuttle





Graphics by Mark Nowlin / The Seattle Times. Source materials: Alaska Sealife Center in Seward, NOAA, North Pacific Longline Association, Alaska Department of Fish and Game, Sago Solutions AS. Photos IPHC.

4. Fishing technology

NOAA FISHERIES
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Bycatch Reduction Engineering Program
(BREP) NA23NMF4720414

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 (reviewed to date: 11/15 paired sets).







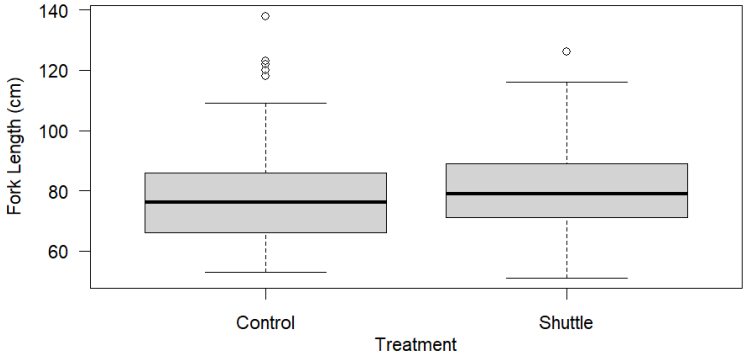
4. Fishing technology

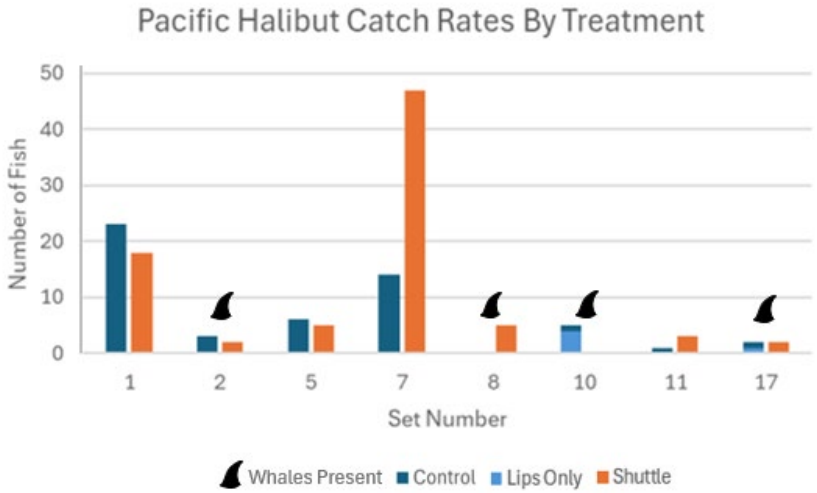
Reducing whale depredation by protecting longline catches: preliminary results

- Retention trends in shuttle from analyzed video footage (11/15 sets)

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%)

- Size of retained Pacific halibut





- Shuttle is capable of good retention.
- Catch rates are variable between control and shuttle
- Uncontrollable factors confounded catch and retention results (crab pot snarls, species composition).

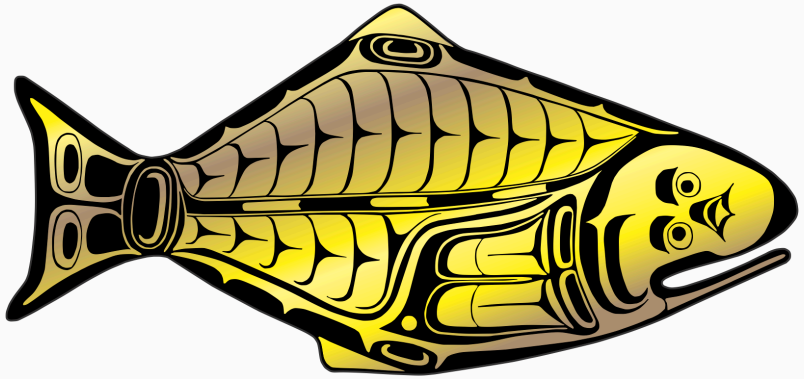
4. Fishing technology

Reducing whale depredation by protecting longline catches

Conclusions

- Shuttle can be safely deployed and retrieved by vessels with a picking boom.
- Shuttle has comparable retention in terms of numbers and size of Pacific halibut.
- Simple modifications will increase retention of smaller species (i.e. Pacific cod and sablefish).
- Continued interest from the fleet in this approach.
- 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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