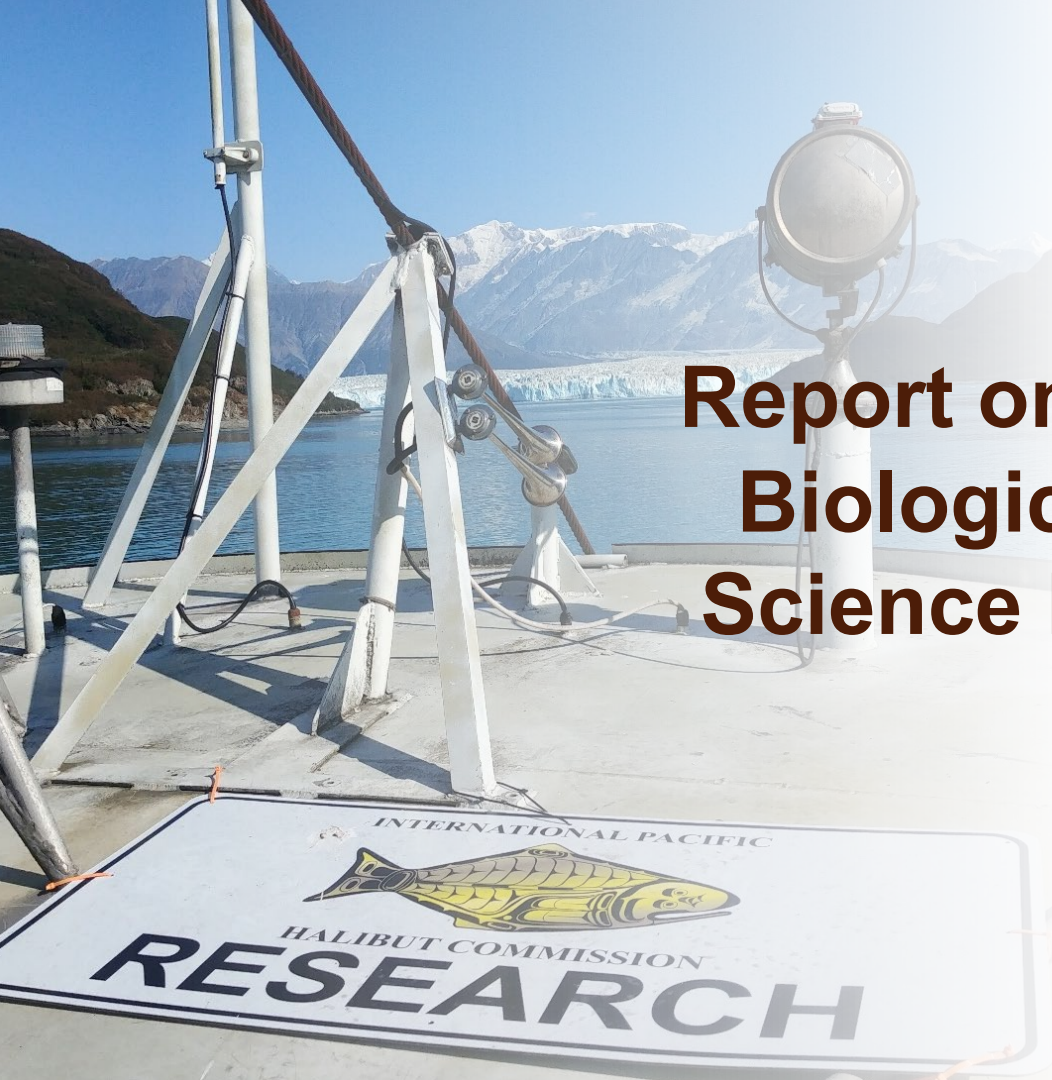
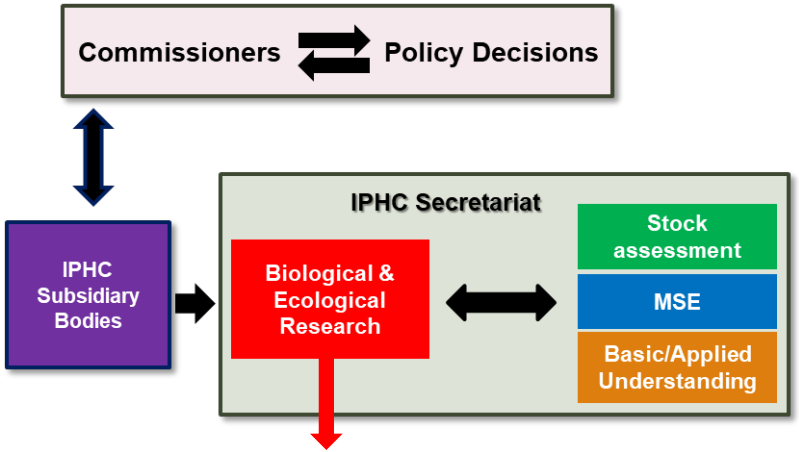


INTERNATIONAL PACIFIC HALIBUT COMMISSION

Report on Current and Future Biological and Ecosystem Science Research Activities

Agenda Item 6.1
IPHC-2022-IM098-12
(J. Planas)

Biological and Ecosystem Sciences



Main research areas (BESRP 2017-2021)

- Migration and distribution
- Reproduction
- Growth
- Discard mortality
- Genetics and genomics

Main research areas (PIRM 2022-2026)

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

5Y-PIRM and management implications

5-Year Five-Year Program of Integrated Research and Monitoring

Primary Research Areas	*Main Objectives*	*Management implications*
Migration and Population Dynamics		
Reproduction		
Growth		
Mortality and Survival Assessment		
Fishing Technology		

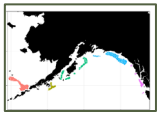
1. Migration and Population Dynamics

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*

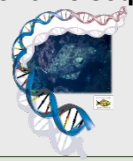
Juvenile connectivity

- 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*

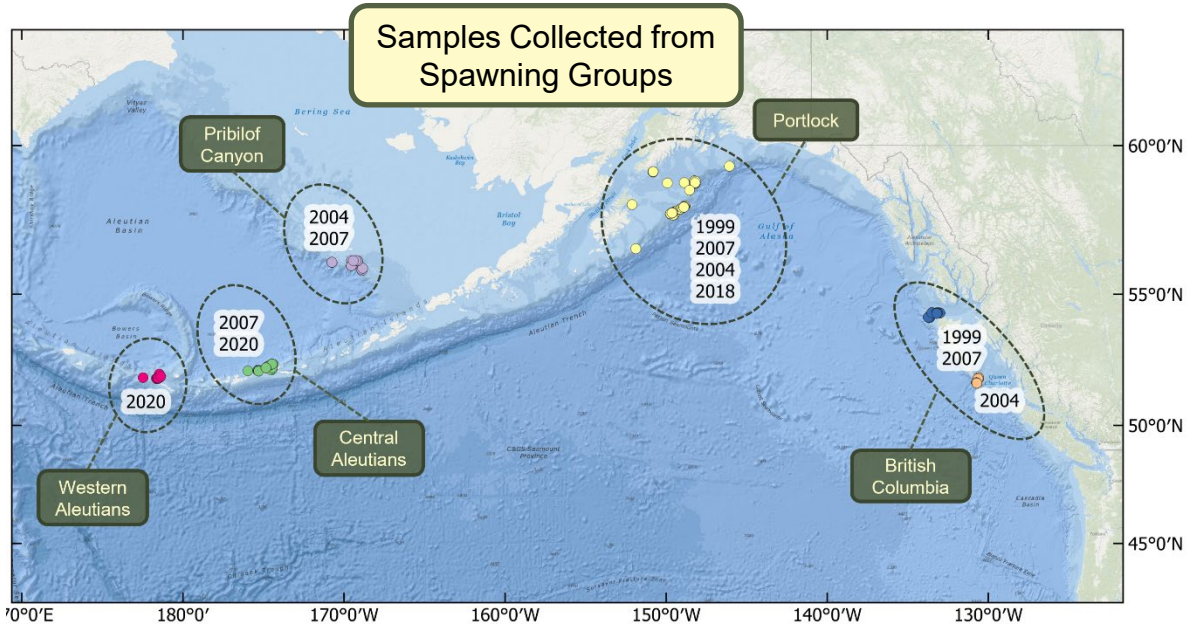
PIRM 2022-2026

- Climate effects on larval connectivity
- Connectivity with Russian waters
- 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

1. Migration and Population Dynamics

Population Genomics

Objective: to resolve the genetic structure of the Pacific halibut stock in Convention Waters



NPRB Project 2110

- **L**ow-**c**overage **w**hole-**g**enome **r**esequencing (lcWGR)
- Interrogate genomic variation at very high resolution

Pacific Halibut Genome

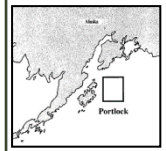
- Version 2 – March 2022
- Identify potential local and/or environmental adaptations.
- Provide genetic basis for life-history traits (e.g. growth, maturity, migratory behavior, etc.).
- Establish genetic baseline

2. Reproduction

5-Yr Research Plan (2017-2021)

PIRM 2022-2026

2017-2018 Field sample collection (central GOA)



30♀/ month

♀>90 cm FL

2017-2021 Commercial landings

Seasonal characterization of reproductive development

Histological samples → Characterization of oocyte stages → Classification of female developmental stages → Classification of reproductive phases

Appropriate timing of gonad collection in FISS

Histology-Based Maturity schedule **2022**

Fecundity assessment **2023**

Research outcomes:

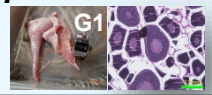
- Group synchronous
- Batch spawner
- Determinate fecundity
- Annual cycle
- Spawning time
- Reproductive delays

- June-August

Macroscopic vs microscopic maturity staging

Macroscopic maturity scores

Ovary images



Histology-based female developmental stages and reproductive phases

Assess accuracy of current field maturity classification criteria → Revise macroscopic staging criteria

Research outcomes:

- In progress

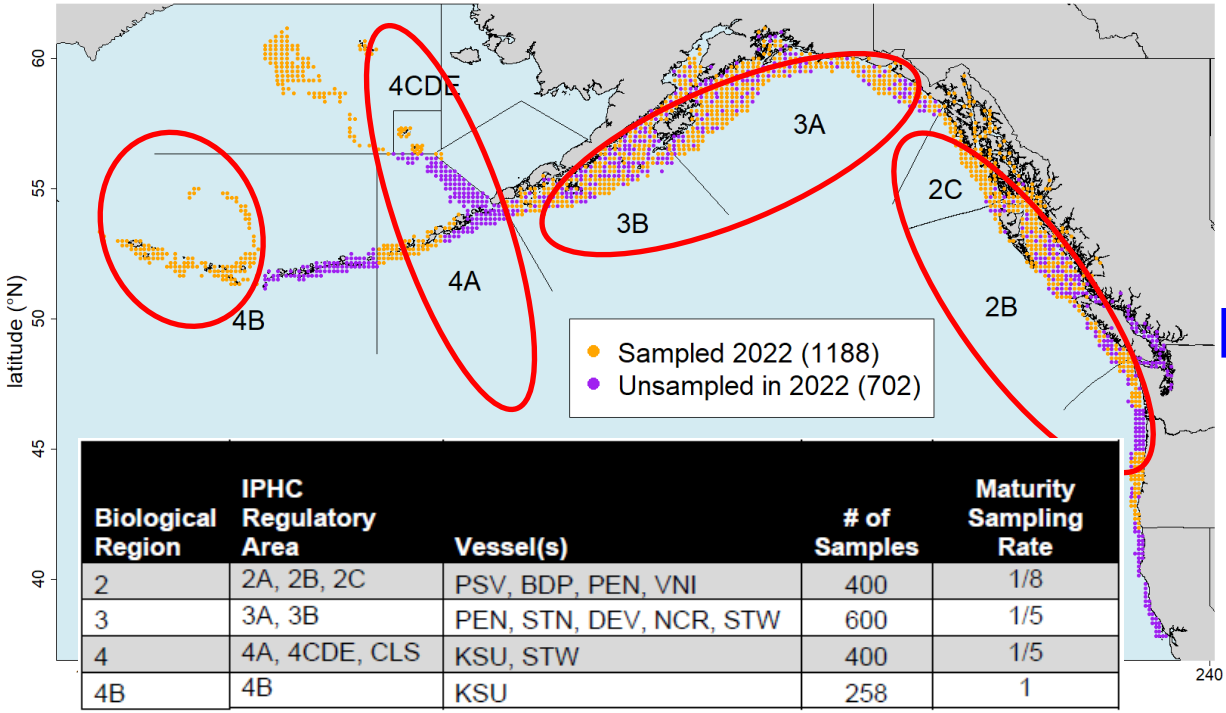
Development and application of genetic tests for sex identification

Publications: Fish et al. (2020) *Journal of Fish Biology* **97**: 1880–1885
Fish et al. (2022) *Frontiers in Marine Science* **9**:801759

2. Reproduction

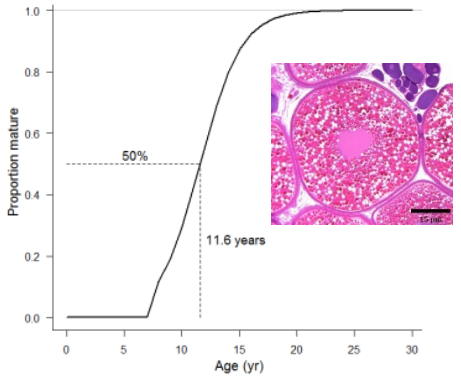
Update of maturity schedules

Objective: Generate accurate histology-based maturity schedules



Biological Region	IPHC Regulatory Area	Vessel(s)	# of Samples	Maturity Sampling Rate
2	2A, 2B, 2C	PSV, BDP, PEN, VNI	400	1/8
3	3A, 3B	PEN, STN, DEV, NCR, STW	600	1/5
4	4A, 4CDE, CLS	KSU, STW	400	1/5
4B	4B	KSU	258	1

- **Maturity estimates per biological region by histological staging**



3. Growth

5-Yr Research Plan (2017-2021)

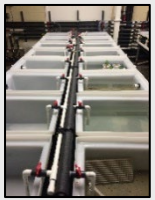
PIRM 2022-2026

2016-2018 Age-0 summer collections (Kodiak)

Fish rearing at Hatfield Marine Science Center (Newport)

Identification and validation of physiological growth markers

Growth laboratory experiments



Temperature manipulations

Density manipulations

Handling manipulations

Transcriptomic and proteomic profiling

Temperature-responsive growth markers

Density-responsive growth markers

Handling-responsive growth markers

Validation studies

Research outcomes:
- Differentially-expressed genes
- Differentially-expressed proteins
- Validated growth markers

Environmental influences on growth patterns

Research outcomes:
- Effects of temperature on growth rates
- Temperature-specific molecular responses

Environmental influences on growth patterns

Dietary influences on growth patterns and physiological condition

4. Mortality and Survival Assessment

5-Yr Research Plan (2017-2021) | **PIRM 2022-2026**

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 → Survival assessment by tagging

→ Physiological condition assessment → Analysis of capture-related variables

→ Best handling practices in longline fishery

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

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

→ Best handling practices in recreational fishery

Research outcomes: • In progress

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*

4. Mortality and Survival Assessment

Discard mortality rates in the Pacific halibut charter fishery

Objectives:

- Conduct experimental fishing in which Pacific halibut are subjected to typical recreational gear and handling practices, to:
    - Investigate relationships between hook size and catch size
    - Develop injury and physiological stress profiles
    - Quantify and characterize survival by tagging

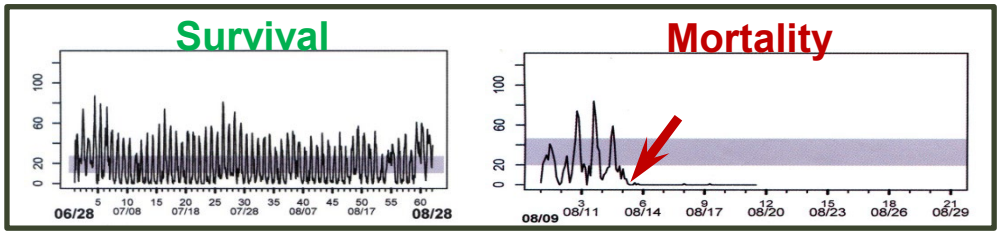





4. Mortality and Survival Assessment

Direct discard mortality rate estimation by tagging

- Tag types
  - Wire = 281 (all viabilities) – 28 recovered to date
  - sPAT = 80 (**only** on Excellent viability) – 76 provided functional data
    - ➢ 48 full duration (96 days)
    - ➢ 7 fishery recoveries
    - ➢ 21 premature release,
    - ➢ *Mortality rate estimate*: 1.35% (95% CI of 0.00-3.95% for Excellent viability fish)



5. Fishing technology

NOAA FISHERIES
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Bycatch Reduction Engineering Program
(BREP) NA21NMF4720534

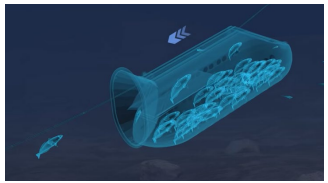
Reducing whale depredation by protecting longline catches

1. International Workshop on Protecting Fishery Catches from Whale Depredation (9 Feb. 2022):

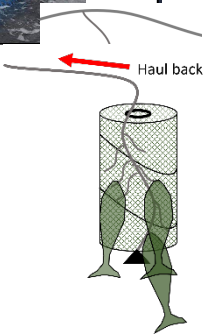
- Virtual workshop - 74 participants from 6 countries
- 3 presentations on different strategies for protecting the catch from longlines:
  - Shuttles – Sago Solutions (Norway),
  - Shrouds – INFREMER, IRD, MARBEC, (France)
  - Slinky Pots – Cod Coil (US)

2. Field testing of catch protection devices

- Production of prototypes of two different devices:
  - Reduced size Sago Extreme shuttle with modified entry
  - Open end slinky pots over easy slip snap gear on branchlines
- Field testing (Spring 2023 in Gulf of Alaska):
  - Deployment / Retrieval logistics
  - Optimal configurations (weighting, attachments)
  - Basic performance (species/sizes)



Shuttle



Shroud

Externally-funded collaborative research

Project #	Grant agency	Project name	PI	Partners	IPHC Budget ($US)	Management implications	Grant period	
1	National Fish & Wildlife Foundation	Improving the characterization of discard mortality of Pacific halibut in the recreational fisheries (NFWF Award No. 61484)	IPHC	Alaska Pacific University, University of Alaska Fairbanks, charter industry	$98,902	Bycatch estimates	1 April 2019 – 1 November 2021	
2	North Pacific Research Board	Pacific halibut discard mortality rates (NPRB Award No. 2009)	IPHC	Alaska Pacific University	$210,502	Bycatch estimates	1 January 2021 – 31 March 2022	
3	Bycatch Reduction Engineering Program-NOAA	Gear-based approaches to catch protection as a means for minimizing whale depredation in longline fisheries (NOAA Award Number NA21NMF4720534)	IPHC	Deep Sea Fishermen's Union, Alaska Fisheries Science Center-NOAA, industry representatives	$99,700	Whale depredation	1 November 2021 – 31 October 2023	Current
4	North Pacific Research Board	Pacific halibut population genomics (NPRB Award No. 2110)	IPHC	Alaska Fisheries Science Center-NOAA	$193,685	Stock structure	1 December 2021 – 31 January 2024	Current
Total awarded ($)					**$602,789**			

Recommendations

That the Commission:

a) **NOTE** paper IPHC-2022-IM098-12 that provided 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).

b) **PROVIDE** any redirection or suggestions on the various research streams covered by the IPHC mandate.

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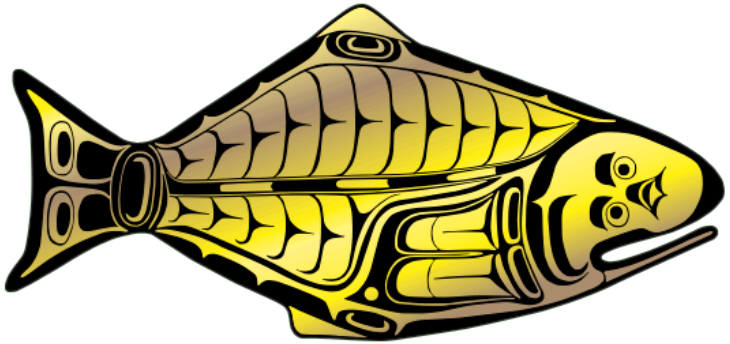

HALIBUT COMMISSION