INTERNATIONAL PACIFIC HALIBUT COMMISSION

Report on current and future biological and ecosystem science research activities

Agenda Item 8

IPHC-2022-SRB021-09

(J. Planas)

Outline

Progress and future activities in key research areas:

1. **Migration and Distribution**
2. **Reproduction**
3. **Mortality and Survival Assessment**
4. **Population genomics**

1. Migration and Distribution

5-Yr Research Plan (2017-2021)

Multiple life-stage connectivity

Bering Sea

Gulf of Alaska

Larval connectivity

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

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

Research outcomes:

- AI constrain connectivity between GOA and BS
- Island passes as pathways between GOA and BS
- Connectivity influenced by spawning location

Juvenile connectivity

- NMFS trawl survey data
- Spatiotemporal model

→ Ontogenetic migration

Research outcomes:

- Post-settlement migration from BS to GOA

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

GT-seq panel

External collaborators: EcoFOCI Program at AFSC-NOAA (Seattle, WA).

Publications: Sadorus et al. (2021) *Fisheries Oceanography*. ***30***: *174-193*

2. Reproduction

5-Yr Research Plan (2017-2021)

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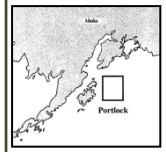
2017-2018 Field sample collection (central GOA)



30♀/ month

♀>90 cm FL

Seasonal characterization of reproductive development

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

Research outcomes:

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

Appropriate timing of gonad collection in FISS

- July/August

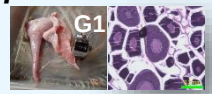
Histology-Based Maturity schedule **2022-2023**

Fecundity assessment **2023-2024**

Macroscopic vs microscopic maturity staging

Macroscopic maturity scores

Ovary images



Histology-based female developmental stages and reproductive phases

Research outcomes:

Assess accuracy of current field maturity classification criteria

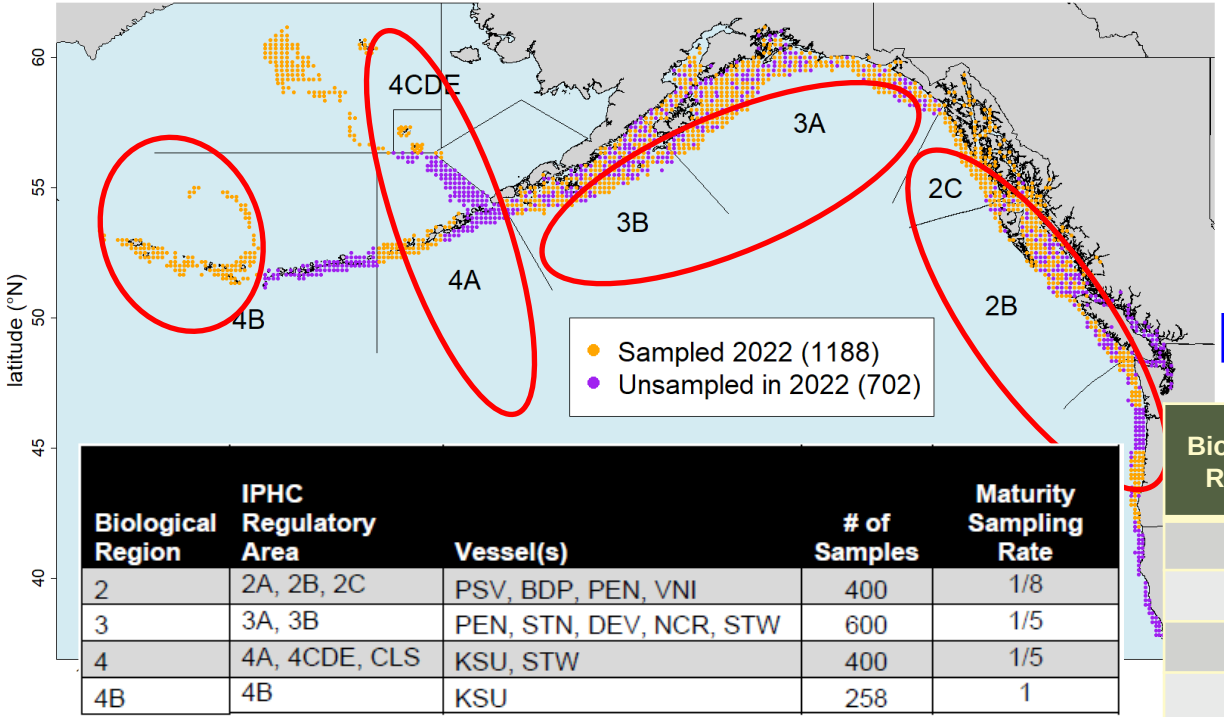
- In progress

Revise macroscopic staging criteria **2023-2024**

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

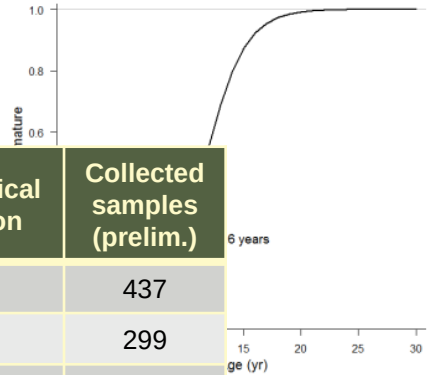
2. Reproduction

FISS 2022: ovarian sample collection for histology-based maturity



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

- **Revise maturity estimates per biological region by histological staging**



Biological Region	Collected samples (prelim.)
2	437
3	299
4	178
4B	51

3. 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

Whale depredation-related mortality

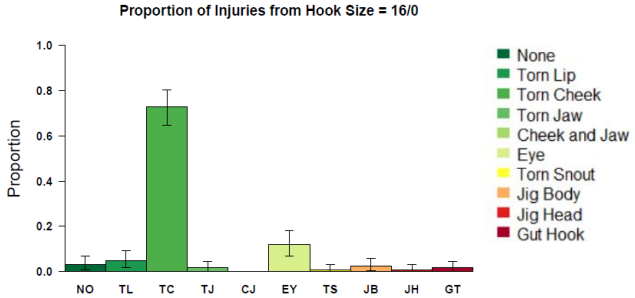
External funding: Saltonstall-Kennedy NOAA (2017-2020); NFWF (2019-2021); NPRB#2009 (2021-2022)

Publications: Kroska et al. (2021) *Conservation Physiology* **9**: coab001
Loher et al. (2022) *North American Journal of Fisheries Management* ***42****: 37-49*

3. Mortality and Survival Assessment

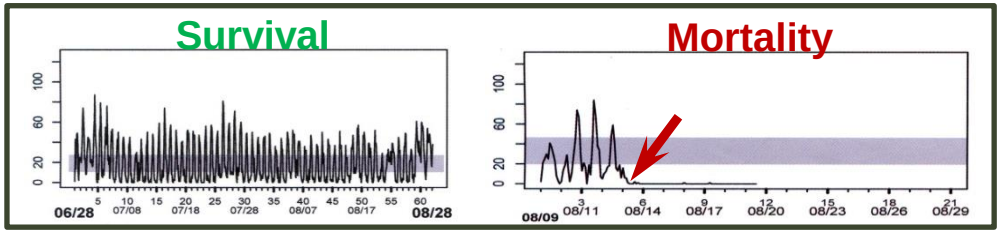
Direct discard mortality rate estimation in the guided recreational fishery by tagging

- Wire = 281 (243 in Sitka, 38 in Seward) – 28 recovered to date
- sPAT = 80 (Seward) – 76 provided functional data
  - 48 full duration (96 days)
  - 7 fishery recoveries
  - 21 premature release,
  - **Mortality rate estimate: 2.04% (0.00-5.92 CI)**



A) Wire Tag

B) sPAT Tag



C) Typical acceleration patterns for fish that survive and fish that die

3. Mortality and Survival Assessment

Reducing mortality from whale depredation by protecting longline catches

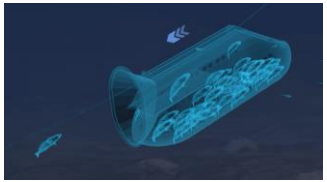
1. International Workshop on Protecting Fishery Catches from Whale Depredation:

- 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 – Fish Tech Inc. (US)

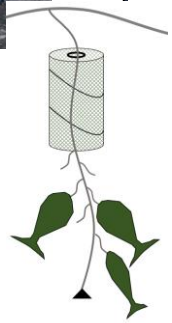
NOAA FISHERIES
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Bycatch Reduction Engineering Program (BREP) NA21NMF4720534

2. Field testing of catch protection devices

- Production of prototypes of two different devices:
  - Reduced size Sago Extreme shuttles (2) with modified entry (A)
  - Open end slinky pots over easy slip snap gear on branchlines (B)
- Field testing (**Spring 2023** in Gulf of Alaska):
  - Deployment / Retrieval logistics
  - Optimal configurations (weighting, attachments)
  - Basic performance (species/sizes)



A) Sago shuttle



B) Slinky shroud

4. Population genomics

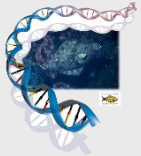
5-Yr Research Plan (2017-2021)

Collection of genetic samples of spawning aggregations spanning the Gulf of Alaska, Bering Sea and Aleutian Islands

(1999-2020)

Development and application of genomic approaches

Chromosome-level genome assembly



Development of methods based on low-coverage whole genome resequencing

Establishment of a bioinformatic pipeline in the cloud (Microsoft Azure)

Population structure analyses

Research outcomes:

- Sequenced genome (size=602 Mbp)
- Full annotation (NCBI) (27,944 genes)
- 24 chromosome-length scaffolds
- SNP detection and genotyping

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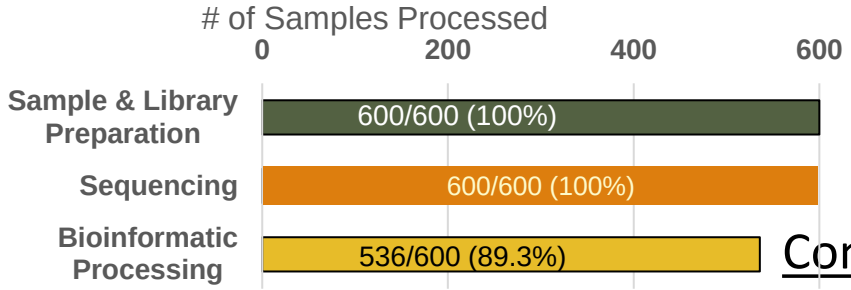
Establishment of a baseline of genetic diversity

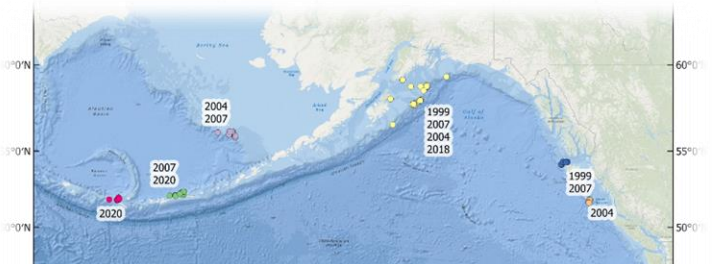
Delineation of fine-scale stock structure

External Funding: NPRB#2110 (2021-2024)

Publications: Jasonowicz et al. (2022) *Molecular Ecology Resources* 22, 1– 16.

4. Population genomics





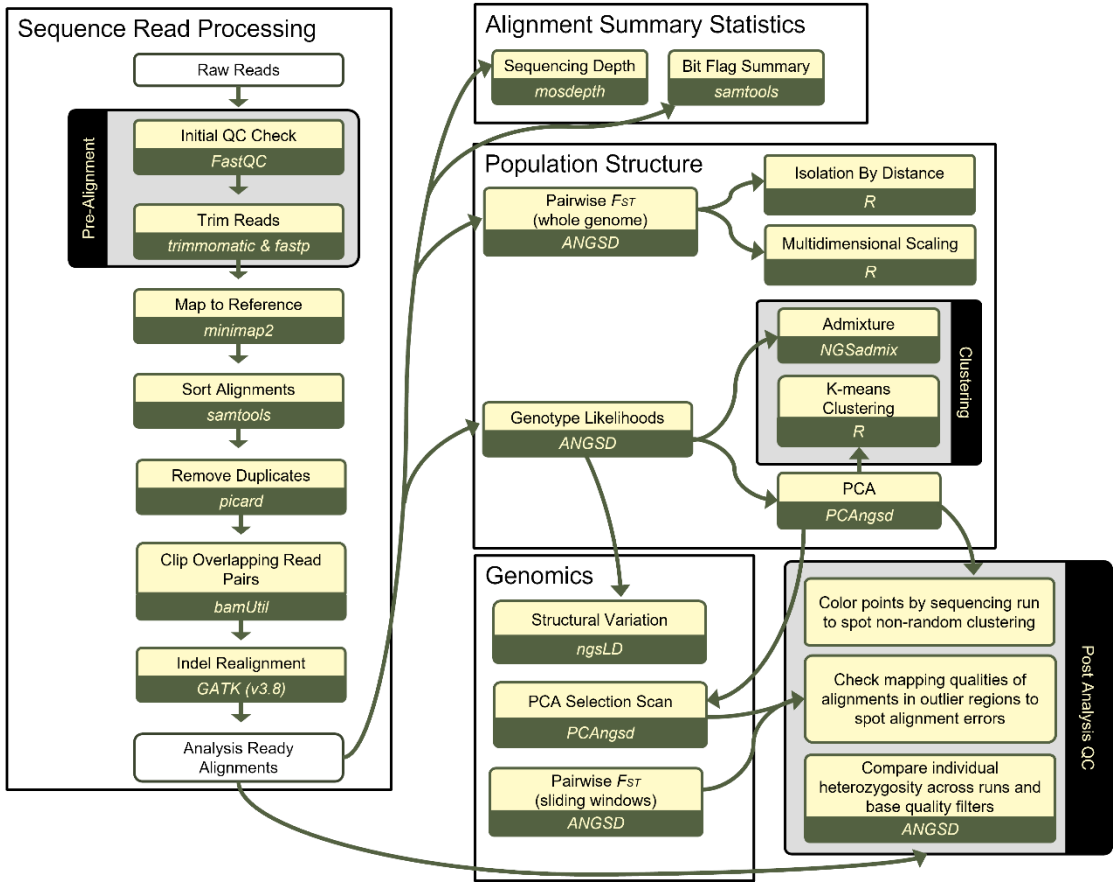
Completed sequencing runs to date:

Library	IPHC_001	IPHC_002	IPHC_003
Number of samples*	249	249	102
Sequencing Platform	Illumina NovaSeq S4	Illumina NovaSeq S4	Illumina NovaSeq S4
Raw Reads Per Sample (Millions)**	24.7 (10.7-47.2)	24.9 (13.0-51.6)	25.8 (10.9-85.8)
Reads Retained (%)**	62 (22-69)	61 (46-70)	In Progress
Coverage Per Sample (x)**	3.0 (0.9-5.0)	3.0 (1.3-5.9)	In Progress

*numbers in parenthesis indicate number of samples with > 1,000,000 raw sequence reads.

4. Population genomics

Bioinformatic Workflow



Current externally-funded collaborative research

Project #	Grant agency	Project name	PI	Partners	IPHC Budget ($US)	Management implications	Grant period
1	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
2	North Pacific Research Board	Pacific halibut population genomics (NPRB Award No. 2110)	IPHC	Alaska Fisheries Science Center-NOAA	$193,685	Stock structure	1 December 2021 – 31 January 2024
Total awarded ($)					**$293,385**		

Recommendation

That the SRB:

- **NOTE** paper IPHC-2022-SRB021-09 which outlines progress on the on biological and ecosystem science research activities, contained within the IPHC's 5-year Program of Integrated Research and Monitoring (2022-26).

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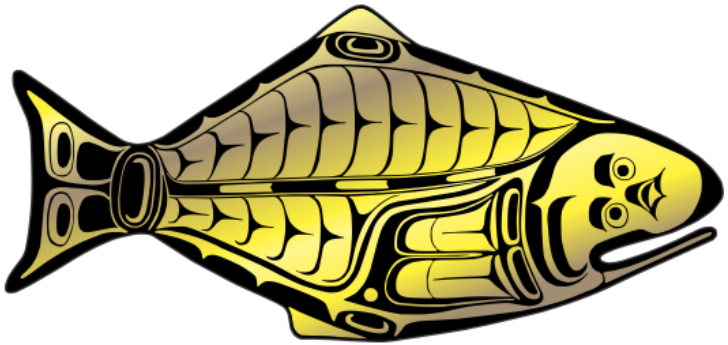

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