

INTERNATIONAL PACIFIC



HALIBUT COMMISSION

IPHC 5-year Biological and Ecosystem Science research program: update

IPHC-2018-IM094-10

Outline



- **Five-year research program and management implications**
- **Progress on ongoing research projects**
- **Planned future research projects**
- **External research funding: awarded projects and grant applications**
- **New biological laboratory at IPHC**

Outline



INTERNATIONAL PACIFIC
HALIBUT COMMISSION



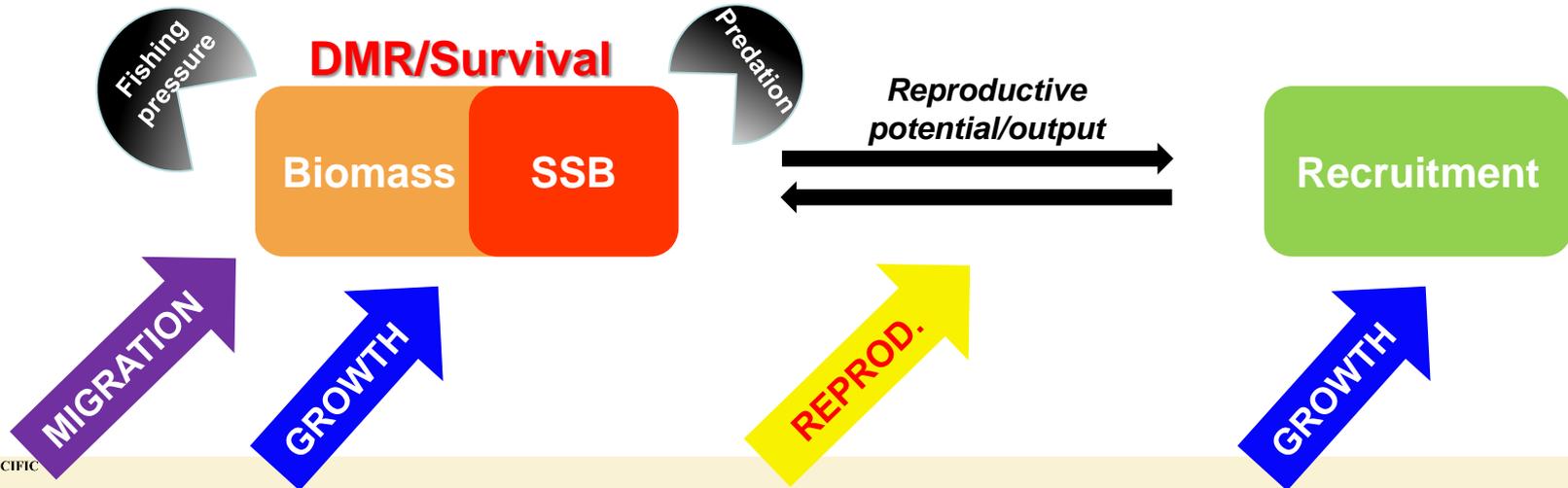
- **Five-year research plan and management implications**
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Primary research activities at IPHC



Primary objectives

- Identify and address *critical knowledge gaps* in the biology of the Pacific halibut
- Understand the influence of *environmental conditions* on halibut biology
- Apply resulting knowledge to reduce *uncertainty* in current stock assessment models



Five-year research plan and management implications



Primary research areas at the IPHC:

1. Migration

- LARVAL DISPERSAL
- ADULT FEEDING AND REPRODUCTIVE MIGRATION

2. Reproduction

- SEX RATIO OF COMMERCIAL CATCH
- IMPROVED MATURATION ESTIMATES OF SPAWNING BIOMASS

3. Growth

- CHANGES IN SIZE AT AGE/BIOMASS
- TOOLS TO ASSESS FISH CONDITION

4. DMRs and post-release survival assessment

- BYCATCH SURVIVAL ESTIMATES

5. Genetics and genomics

- GENETIC STRUCTURE OF THE POPULATION
- GENOMIC TOOLS (e.g. GENOME)

Integration of biological research, stock assessment and policy



Biological research

Research areas	Research outcomes
Migration	Larval distribution Juvenile and adult migratory behavior and distribution
Reproduction	Sex ratio Spawning output Age at maturity
Growth	Identification of growth patterns Environmental effects on growth Growth influence in size-at-age variation
Discard Survival	Bycatch survival estimates Discard mortality rate estimates
Genetics and Genomics	Genetic structure of the population Sequencing of the Pacific halibut genome

Stock assessment

Relevance for stock assessment
Geographical selectivity Stock distribution
Spawning biomass scale and trend Stock productivity Recruitment variability
Temporal and spatial variation in growth Yield calculations Effects of ecosystem conditions Effects of fishing
Scale and trend in mortality Scale and trend in productivity
Spatial dynamics Management units

Stock assessment MSE

Inputs to stock assessment and MSE development
Information for structural choices Recruitment indices Migration pathways and rates Timing of migration
Sex ratio Maturity schedule Fecundity
Predicted weight-at-age Mechanisms for changes in weight-at-age
Bycatch and discard mortality estimates Variability in bycatch and uncertainty in discard mortality estimates
Information for structural choices

Integration of biological research, stock assessment and policy



Biological research

Stock assessment

Stock assessment MSE

Research areas	Research outcomes	Relevance for stock assessment	Inputs to stock assessment and MSE development
Migration	Larval distribution	Geographical selectivity	Information for structural choices Recruitment indices Migration pathways and rates Timing of migration
	Juvenile and adult migratory behavior and distribution	Stock distribution	
<div style="display: flex; align-items: center;"> <div style="border: 2px solid red; padding: 5px; margin-right: 10px;"> Juvenile and adult distribution </div> <div style="display: flex; flex-direction: column; gap: 10px;"> <div style="border: 2px solid green; padding: 5px; background-color: #e0ffe0;"> Stock distribution INPUT: Migration rates </div> <div style="border: 2px solid blue; padding: 5px; background-color: #e0e0ff;"> Operating Model INPUT: Migration rates </div> </div> <div style="margin-left: 20px;"> </div> </div>		Policy Decisions	
Genetics and Genomics	Genetic structure of the population Sequencing of the Pacific halibut genome	Spatial dynamics Management units	mortality estimates Information for structural choices

Integration of biological research, stock assessment and policy



Biological research

Stock assessment

Stock assessment MSE

Research areas	Research outcomes	Relevance for stock assessment	Inputs to stock assessment and MSE development
Migration	Larval distribution Juvenile and adult migratory behavior and distribution	Geographical selectivity Stock distribution	Information for structural choices Recruitment indices Migration pathways and rates Timing of migration
Reproduction	Sex ratio Spawning output Age at maturity	Spawning biomass scale and trend Stock productivity Recruitment variability	Sex ratio Maturity schedule Fecundity
Sex ratio of commercial landings	Spawning biomass scale and trend INPUT: Sex ratio at age	Operating Model INPUT: Sex ratio at age	Policy Decisions

Integration of biological research, stock assessment and policy: timelines

<i>Research Area</i>		2018	2019	2020	2021	2022
<i>Migration</i>	Larval distribution	Data analysis	Data synthesis	SA MSE Sample collection	Data analysis	Data synthesis
	Adult and juvenile migration	Tagging	Tagging	Data synthesis	SA MSE Tagging	Data synthesis
		Data analysis			Data analysis	

Outline



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Progress on ongoing research projects



1. Migration

- LARVAL DISPERSAL
- ADULT FEEDING AND REPRODUCTIVE MIGRATION

2. Reproduction

Projects:

3. Growth

1. *Pacific halibut larval distribution and connectivity*

2. *Reproductive and seasonal migrations*

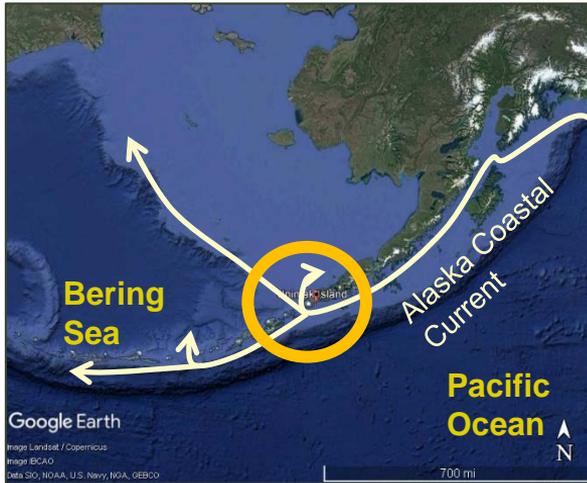
4. DMRs and post-release survival assessment

5. Genetics and genomics

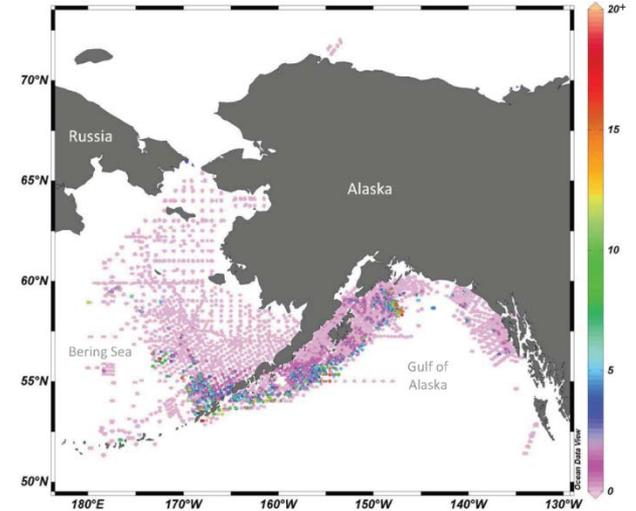
Migration

- **Larval distribution and connectivity**

Objective: Understand the mechanisms and magnitude of larval connectivity between the Gulf of Alaska and the Bering Sea.



Finding environmental and biological predictors for larval abundance and recruitment

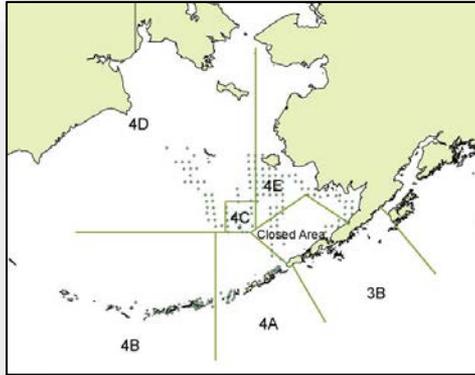


Pacific halibut larval catch during NOAA ichthyoplankton surveys 1972-2015

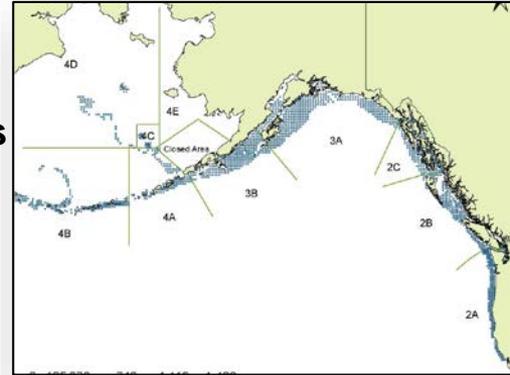
Migration

- **Wire tagging of U32 Pacific halibut: 2018 efforts**

**NMFS Trawl
Survey**
916 tags
(BS 768 tags)
(AI 148 tags)



**IPHC
FISS**
1,747 tags

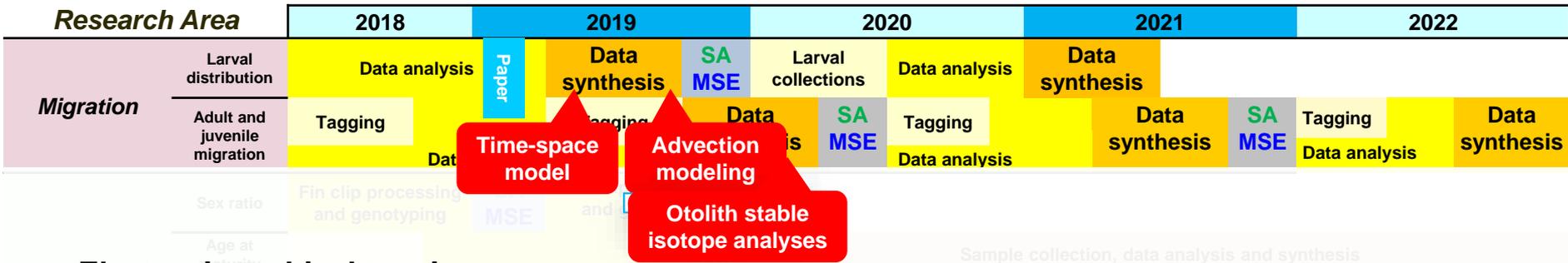


- **Electronic archival tagging**



- 255 internal tags released coastwide that record temperature, depth and light
- Reward offered
- 13 PAT tags released in 4B

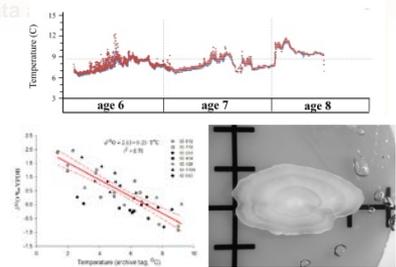
Migration: timeline and integration with stock assessment and MSE



- Electronic archival tagging:

Temperatures recorded by the tags will be correlated with oxygen isotope ratios in otolith growth annuli

- Allowing otoliths to be used as recorders of **thermal growth history**
- Growth reconstructions can provide inputs into bioenergetic models and estimates of regional and temporal **stock productivity**



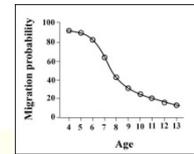
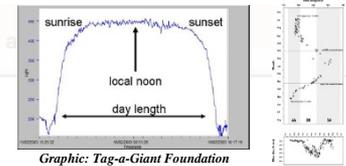
Migration: timeline and integration with stock assessment and MSE

Research Area		2018	2019	2020	2021	2022
Migration	Larval distribution	Data analysis	Paper	Data synthesis	SA MSE	Larval collections
	Adult and juvenile migration	Tagging	Tagging	Data synthesis	SA MSE	Tagging
		Data analysis		Data analysis	Data synthesis	SA MSE
			Data analysis	Tagging	Data analysis	Tagging
				Data analysis	Data synthesis	Data analysis
						Data synthesis

Light-based geopositioning

Light data will be converted into daily longitude estimates

- Allowing for **age- and sex-specific movement** patterns to be resolved
- Generating dispersal functions (kernels) for use in **spatially-explicit modeling** (assessment, metapopulation) that incorporates migration



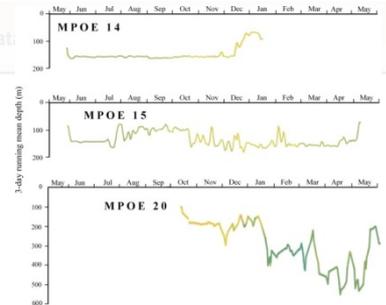
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	Adult and juvenile migration	Tagging Data analysis	Tagging	Data synthesis SA MSE	Tagging Data analysis Data synthesis	SA MSE Tagging Data analysis Data synthesis

Seasonal depth analysis

Depth data will be examined for seasonal patterns, in particular onshore-offshore movements and spawning rises

- Allowing for **behavioral maturation** to be identified (i.e. age of entry into the spawning population)
- Refining definitions of **effective spawning biomass** relative to total mature biomass



Progress on ongoing research projects



1. Migration

2. Reproduction

- SEX RATIO OF COMMERCIAL LANDINGS
- IMPROVED MATURATION ESTIMATES OF SPAWNING BIOMASS

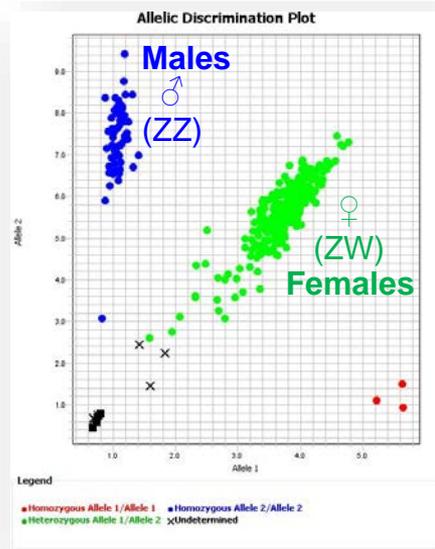
Projects:

1. *Genetic identification of sex in the commercial landings*
2. *Full characterization of the annual reproductive cycle*

Reproduction

- **Genetic identification of sex in the commercial landings**

Objective: To provide sex data from the commercial landings for stock assessment



- Current efforts: Fin clips from entire set of aged 2017 landed commercial samples (12,000): **sex ratios**



2019 FULL STOCK ASSESSMENT

Reproduction

- **Full characterization of the annual reproductive cycle**

Objective: Revise maturity estimates for male and female Pacific halibut

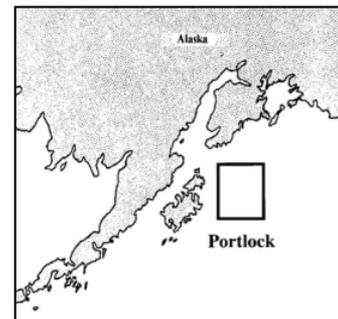
Annual reproductive cycle



- Histological assessment of gonadal development
- Gonadosomatic index
- Reproductive hormones in the blood
- Activation of the endocrine reproductive axis (pituitary and gonads)
- Energy levels (fat content/hepatosomatic index)
- Revised scoring criteria of maturity stages by macroscopic observations in the field

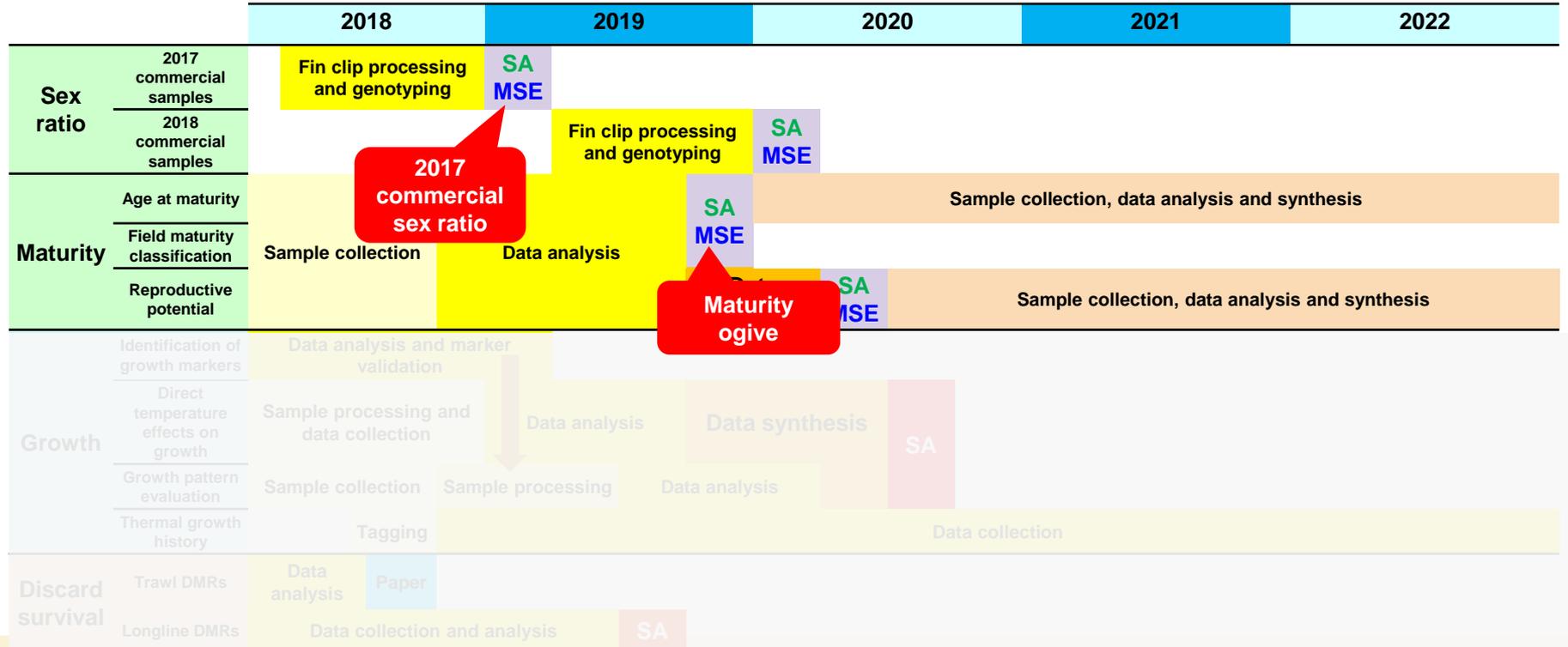
Deliverables:

- Accurate staging of reproductive status
- Updated maturity-at-age estimates
- Estimates of skipped-spawning



Sept Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug
2017 2018
30 ♀ / 30 ♂

Reproduction: timeline and integration with stock assessment and MSE



Progress on ongoing research projects



1. Migration

2. Reproduction

3. Growth

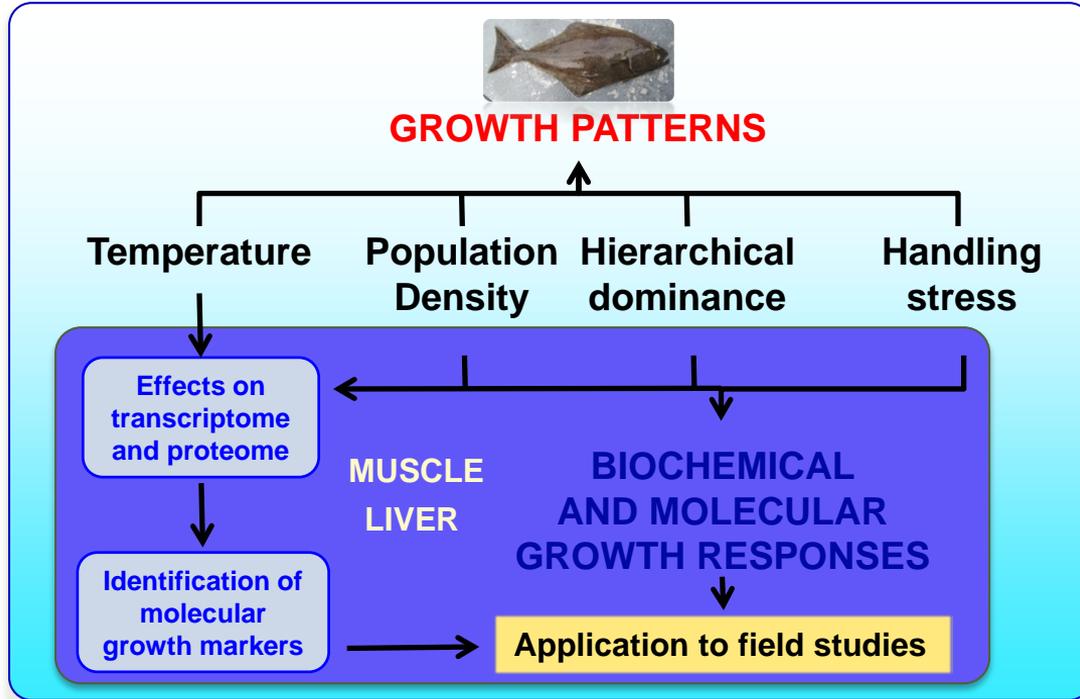
- CHANGES IN SIZE AT AGE/BIOMASS
- TOOLS TO ASSESS FISH CONDITION

Projects:

- 1. Identification and validation of physiological markers for growth*
- 2. Evaluation of growth patterns in the Pacific halibut population and possible effects of environmental variability*

Growth

- Identification and validation of physiological markers for growth



IPHC / AFSC-NOAA
(Newport, OR)

Dr. Josep Planas (PI)



Dr. Thomas Hurst




NPRB Grant 1704
(2017-2019)

Growth

Molecular growth markers



Application to field studies

- Evaluation of growth patterns in the Pacific halibut population

Age-matched skeletal muscle samples collected in the NMFS trawl survey (2016 – 2018) from 3 size categories:

<40 cm FL



40-60 cm FL



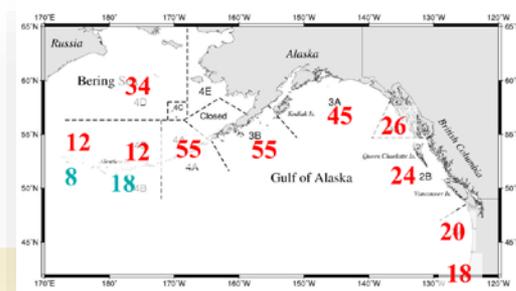
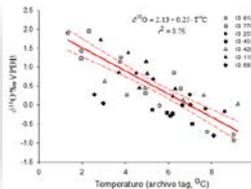
60-80 cm FL



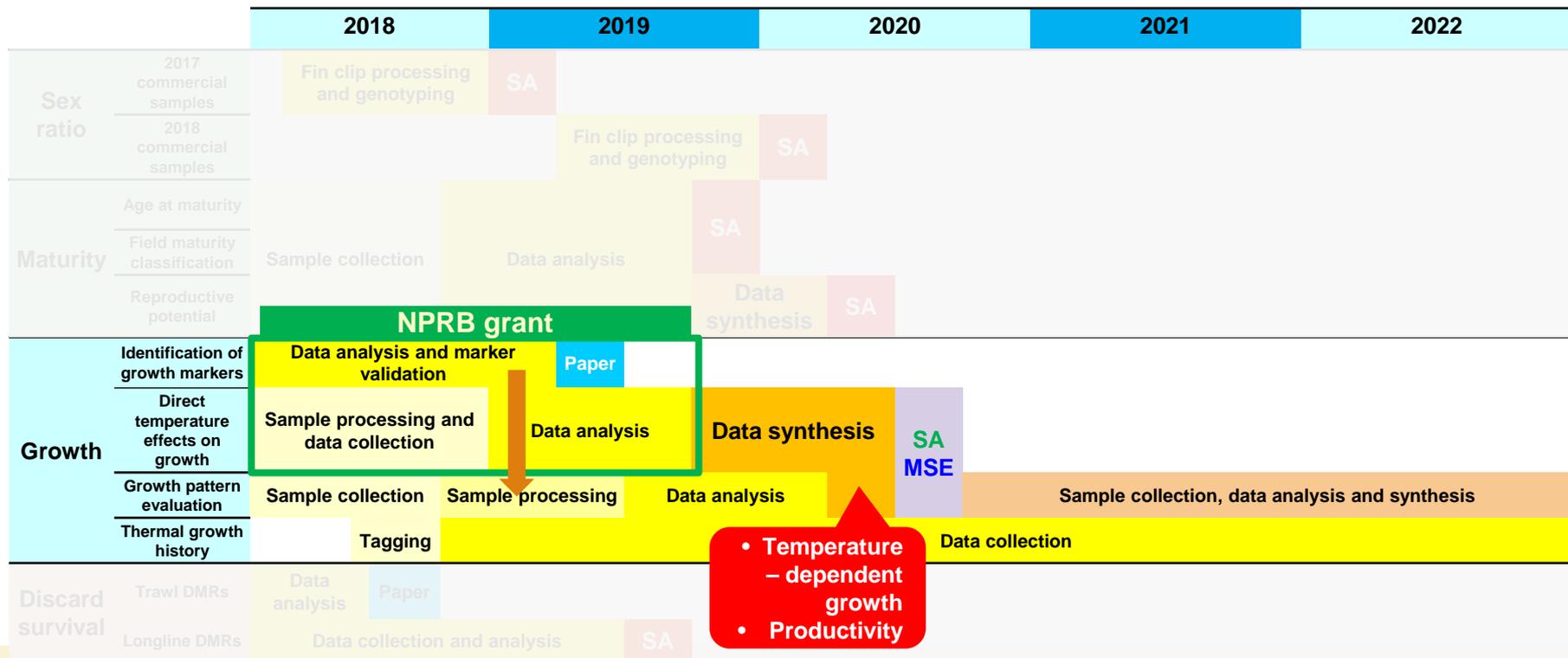
Characterization of molecular and biochemical growth markers in muscle samples from age-matched individuals

- Effects of environmental variability: influence of thermal history on growth patterns

- Tagged U32 fish with archival tags that record temperature and depth
- Relate temperature history to size-at-age and to otolith O_2 stable isotope ratios



Growth: timeline and integration with stock assessment and MSE



Progress on ongoing research projects



1. Migration
2. Reproduction
3. Growth
4. DMRs and post-release survival assessment

Projects:

1. *Improve DMR estimation in the directed longline Pacific halibut fishery*



NOAA FISHERIES
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

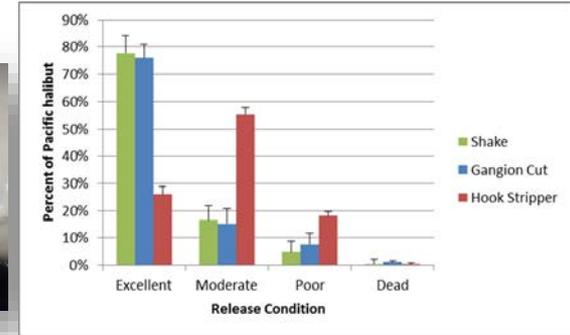
Saltonstall – Kennedy Grant NA17NMF4270240



DMRs and survival assessment

- **Relationship between handling practices and injury levels and physiological condition of released Pacific halibut**

- Assessed **injuries** associated with release techniques (careful shake, gangion cut, hook stripping).



- **Physiological condition** of released fish

- **Capture conditions**



- **Condition factor indices**
- **Blood stress parameters**
- **Fat content determinations**



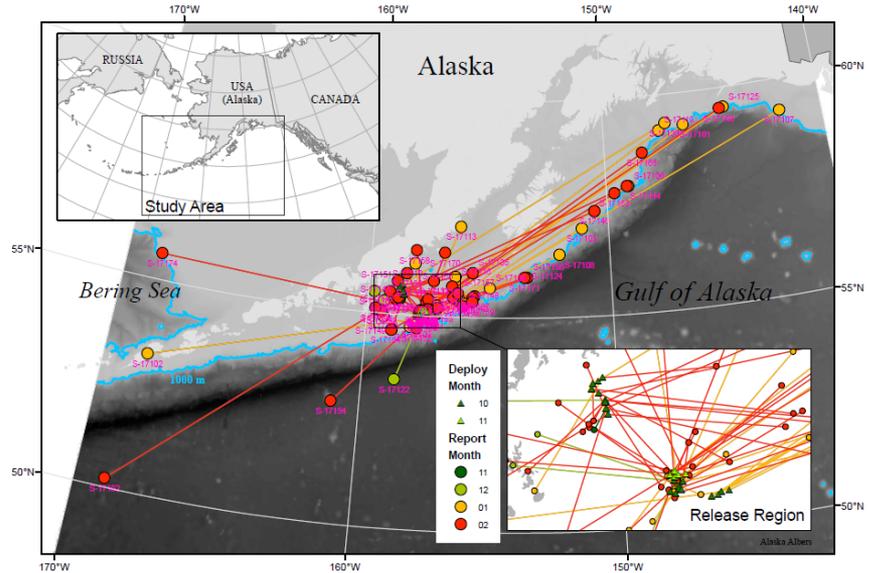
DMRs and survival assessment

- **Relationship between physiological condition post-capture and survival post-release as assessed by tagging**
 - Tagged fish exposed to different handling practices and of varied conditions with conventional tags (wire); and fish in Excellent Condition with accelerometers.

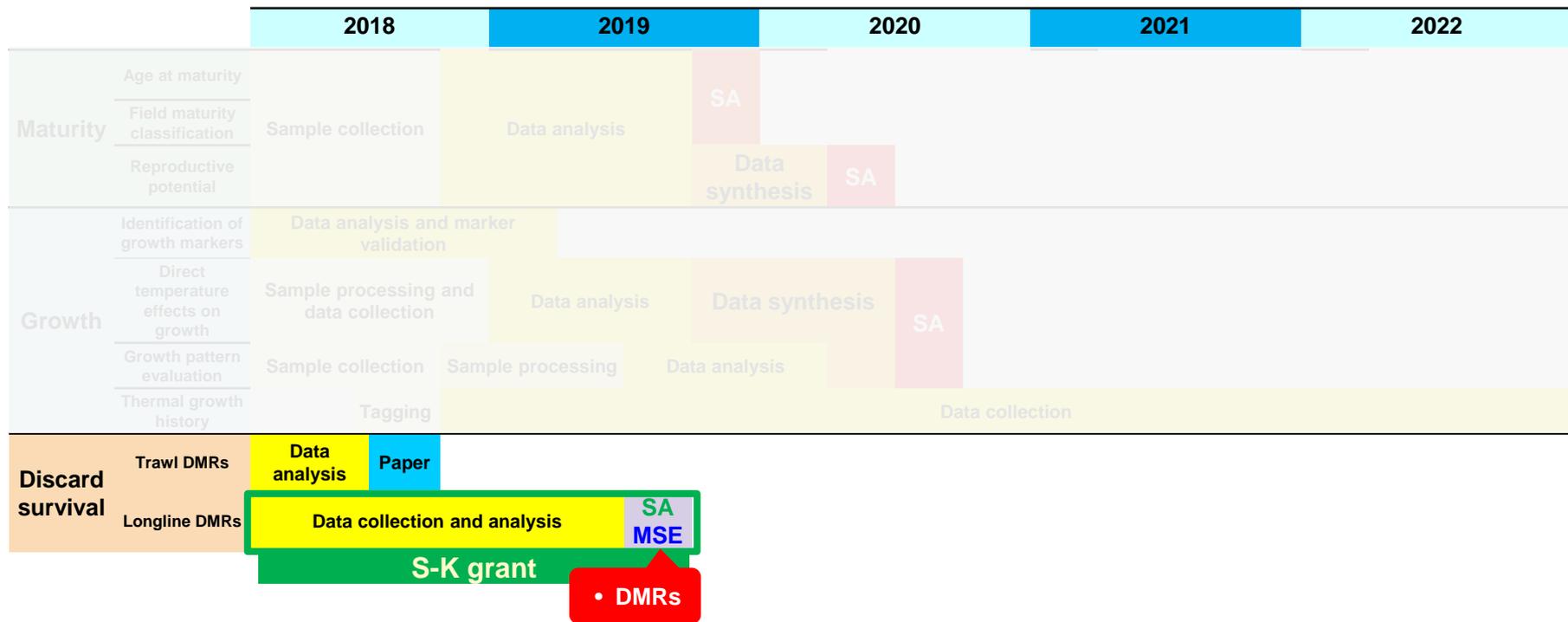


Accelerometer (miniPAT) tag

4% mortality



DMR: timeline and integration with stock assessment and MSE

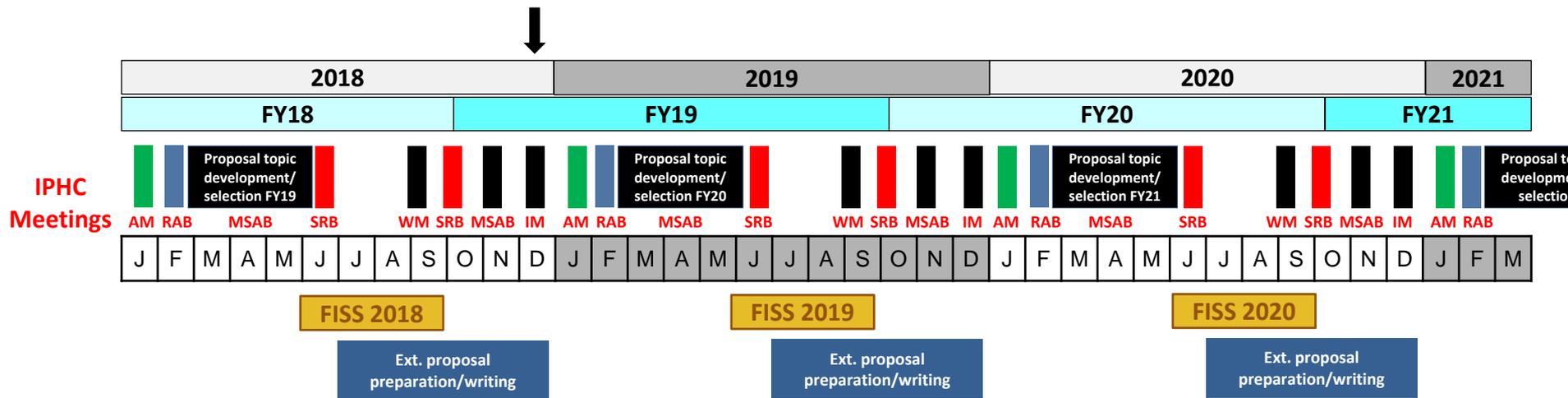


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Revised research topic development and selection process



Planned future research projects

	Project name	Project description	Management implications
1	Up-to-date genetic analysis of population structure	Collection of genetic samples from spawning fish in Reg. Area 4B and revisit genetic analyses	Adult distribution, regional management
2	Investigations on chalky Pacific halibut	Collection of information from stakeholders on the incidence of chalky Pacific halibut and understanding possible causes leading to chalkiness	Product quality
3	Dispersal and recruitment success of juvenile Pacific halibut	Application of genetics and otolith chemical analyses to understand juvenile distribution and recruitment success	Juvenile distribution and recruitment

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Awarded research projects

Project #	Grant agency	Project name	PI	Partners	IPHC Budget (\$US)	Management implications	Grant period
1	Saltonstall-Kennedy NOAA	Improving discard mortality rate estimates in the Pacific halibut by integrating handling practices, physiological condition and post-release survival (Award No. NA17NMF4270240)	IPHC	Alaska Pacific University	\$286,121	Bycatch estimates	September 2017 – August 2019
2	North Pacific Research Board	Somatic growth processes in the Pacific halibut (<i>Hippoglossus stenolepis</i>) and their response to temperature, density and stress manipulation effects (NPRB Award No. 1704)	IPHC	AFSC-NOAA-Newport, OR	\$131,891	Changes in biomass/size-at-age	September 2017 – August 2019
3	Bycatch Reduction Engineering Program - NOAA	Adapting Towed Array Hydrophones to Support Information Sharing Networks to Reduce Interactions Between Sperm Whales and Longline Gear in Alaska	ALFA	IPHC, University of Alaska Southeast, AFSC-NOAA	TBD	Whale Depredation	September 2018 – August 2019
4	Bycatch Reduction Engineering Program - NOAA	Use of LEDs to reduce Pacific halibut catches before trawl entrainment	PSMFC	IPHC, NMFS	TBD	Bycatch reduction	September 2018 – August 2019
Total awarded (\$)					\$418,012		

Grant applications for external funding

Project #	Grant agency	Project name	PI	Partners	Management implications	Status
1	National Fish and Wildlife Foundation	Discard mortality rate characterization in the Pacific halibut recreational fishery	IPHC	University Alaska Fairbanks, Alaska Pacific University, Gray Light Fisheries, Alaska Charter Association	Mortality estimations	Full proposal submitted in July 2018 (expected outcome in November 2018)
2	Saltonstall-Kennedy NOAA	Biological characterization of critical early life history events of the Pacific halibut in relation to short- and long-term environmental variability	IPHC	University of Washington, Northwest Fisheries Science Center-NMFS	Larval distribution, sex ratios	Full proposal submitted in November 2018 (expected outcome in Spring 2019)

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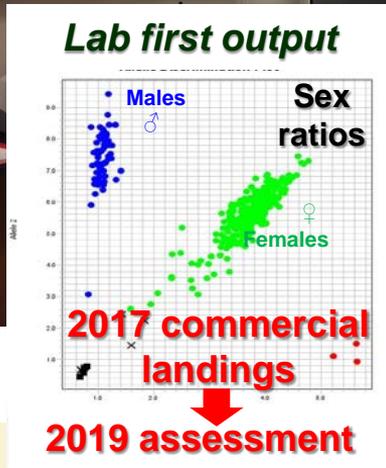
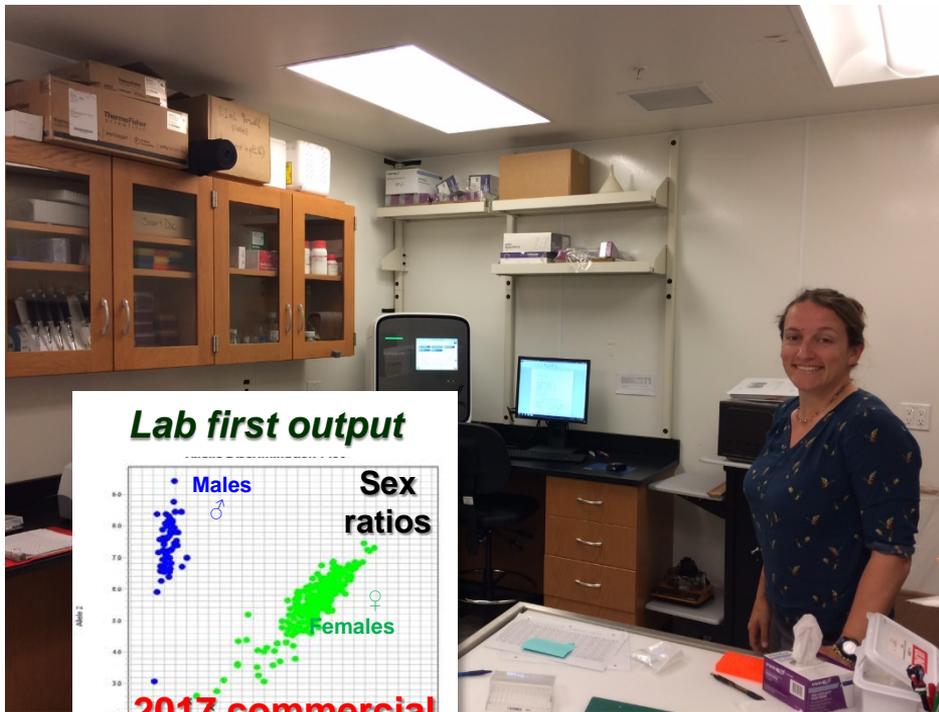


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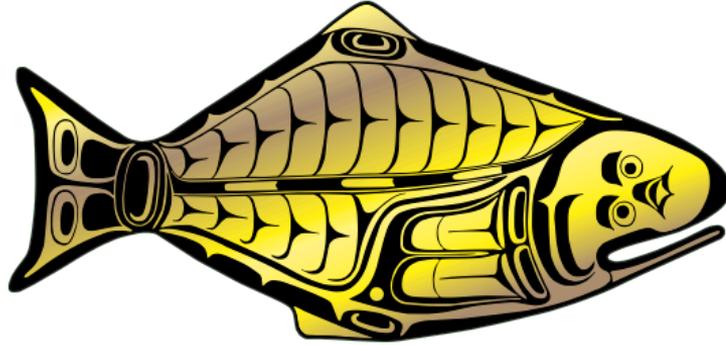
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New biological laboratory at IPHC



- Lab technician: Anna Simeon (full time; 2 yr appointment; salary co-funded by NPRB grant)
- Lab equipment:
 - PCR machine (QuantStudio 6)
 - Spectrophotometer (Nanodrop 8000)
 - Microplate reader (AccuSkan FC)
- Current lab capabilities:
 - Genotyping (TaqMan)
 - Gene expression (qPCR)
 - Nucleic acid extraction and quantification
 - Blood metabolite and hormone determinations
 - Staff and student training

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