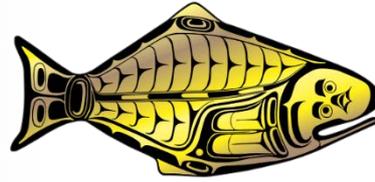


INTERNATIONAL PACIFIC



HALIBUT COMMISSION

# IPHC Biological and Ecosystem Science Research

2<sup>nd</sup> IPHC Performance Review

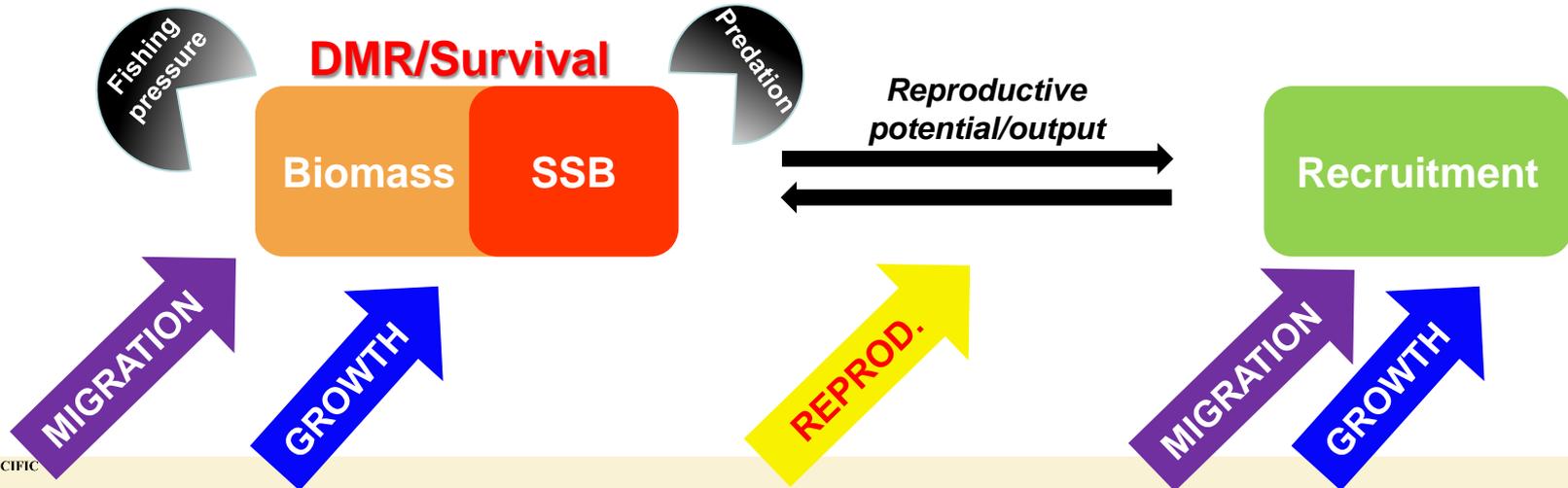
4-6 June, 2019

# Primary research activities at IPHC



## Primary objectives

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



# Five-year research plan and management implications

<i>Primary Research Areas</i>
<b>Migration and Distribution</b>
<b>Reproduction</b>
<b>Growth</b>
<b>Discard mortality</b>
<b>Genetics and genomics</b>

# Integration of biological research, stock assessment, and policy



# 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
<div style="border: 1px solid red; padding: 5px; display: inline-block;"> <b>Juvenile and adult distribution</b> </div>		<div style="border: 1px solid green; padding: 5px; display: inline-block; width: 40%;"> <b>Stock distribution</b>                      INPUT: Migration rates                 </div>	
<div style="border: 1px solid blue; padding: 5px; display: inline-block; width: 40%;"> <b>Operating Model</b>                      INPUT: Migration rates                 </div>		<div style="border: 1px solid black; padding: 5px; display: inline-block; width: 40%;"> <b>Policy Decisions</b> </div>	
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
Dispersal			Age
Genetics			Discards Discard

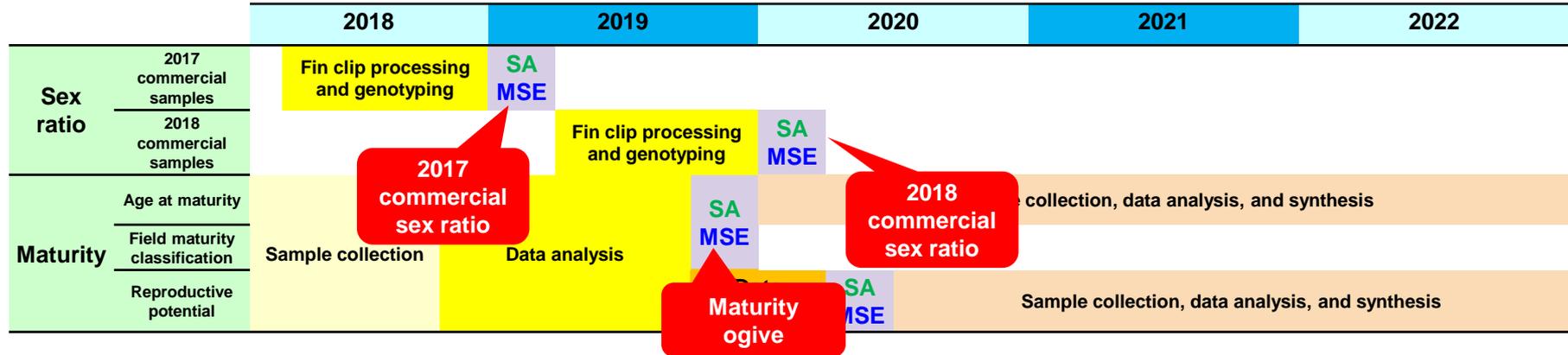
  

Sex ratio of commercial landings	Spawning biomass scale and trend INPUT: Sex ratio at age	Policy Decisions
	Operating Model INPUT: Sex ratio at age	

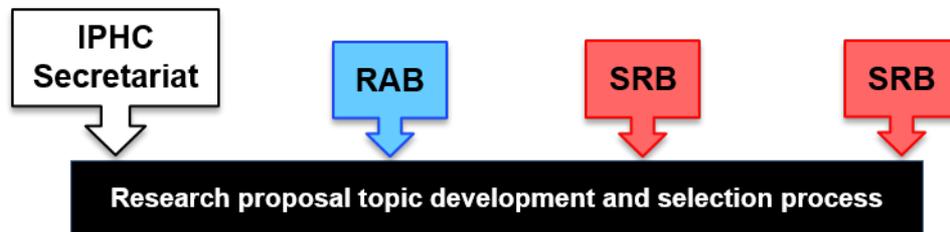
# Integration of biological research, stock assessment, and policy: timelines

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

# Reproduction: timeline and integration with stock assessment, and MSE



# Scientific advice inputs into IPHC's research development and selection process



# Current IPHC biological research projects

## 1. Migration and distribution

### Projects:

- 1. Larval and early juvenile dispersal*
- 2. Late juvenile migration*
- 3. Tail pattern recognition*



2. Reproduction

3. Growth

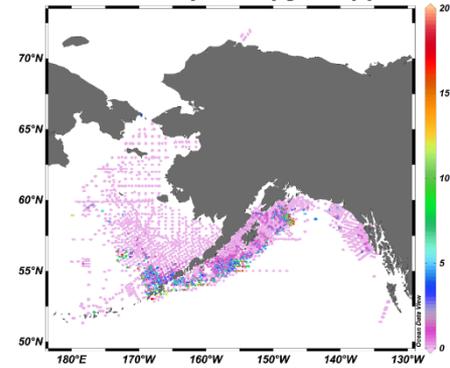
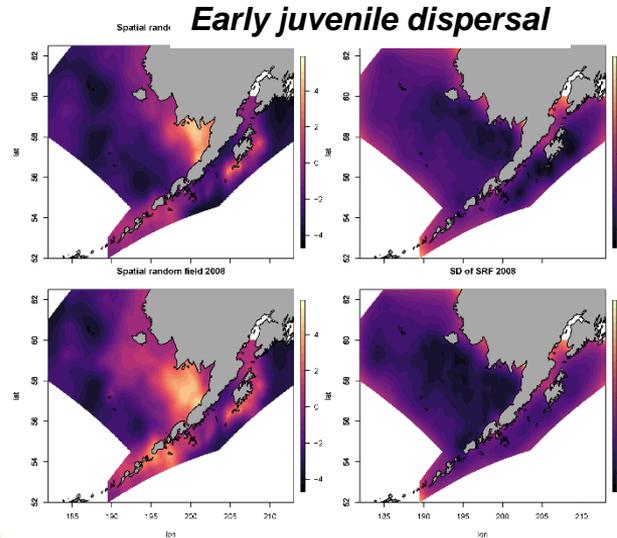
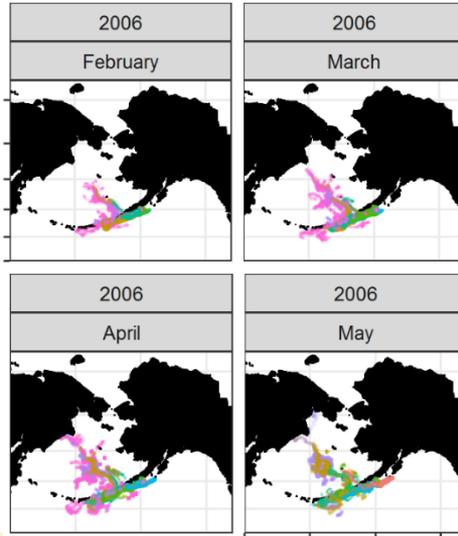
4. Discard Mortality

5. Genetics and genomics

# Migration and Distribution

## 1. Larval and early juvenile dispersal

- Contribution of spawning grounds to settlement grounds
- Connectivity of ocean basins
- Environmental effects on larval distribution
- Collaboration with NOAA/EcoFOCI
- Dispersal of young fish post-settlement



# Migration and Distribution

## 2. Late juvenile dispersal: wire tagging of U32 fish

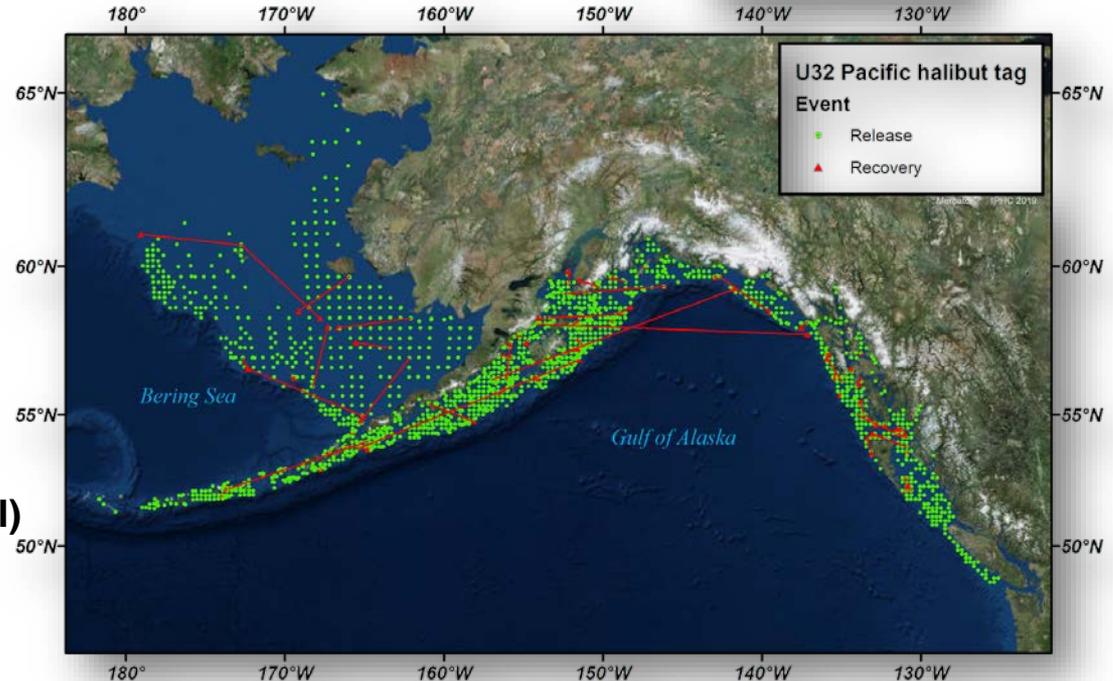


### Since 2015:

- **8,600** U32 fish wire tagged in FISS and NMFS Trawl Survey
- **74** recoveries

### In 2018:

- FISS (1,747 tags)
- NMFS (916 tags; BS/AI)



# Migration and Distribution

## 3. Tail pattern recognition

**Objective:** Use natural markings to identify individuals over time and inform on movement patterns and growth



- Blind side of tail is preferable for imaging
- Spots and patterns appear to be unique
- Markings could be used to identify individuals with image recognition software
- Future could integrate into vessel/shoreside electronic monitoring (EM) or recreational fisher applications
- In 2018, **827** U32 Pacific halibut photographed and wire tagged as part of this project

# Reproduction



## Projects:

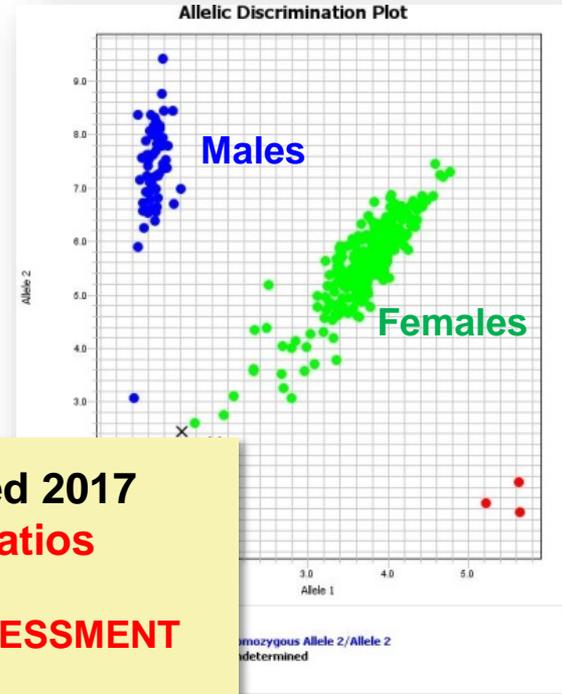
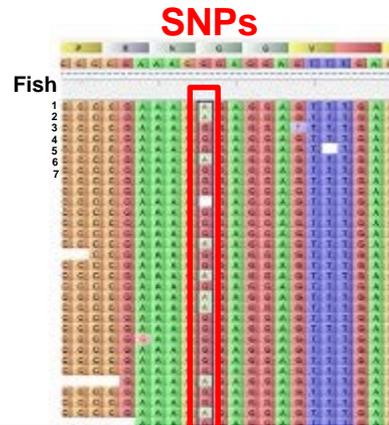
- 1. Identification of sex in the commercial landings*
- 2. Full characterization of the annual reproductive cycle*

# Reproduction

## 1. Identification of sex in the commercial landings

To generate sex-ratio data for use in assessment and policy analysis

Application of genetic techniques (SNPs)



- **Completed:** Fin clips from entire set of aged 2017 commercial samples (>10,000 fish) : **sex ratios**

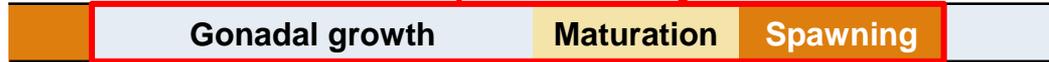
↓  
**2019 FULL STOCK ASSESSMENT**

# Reproduction

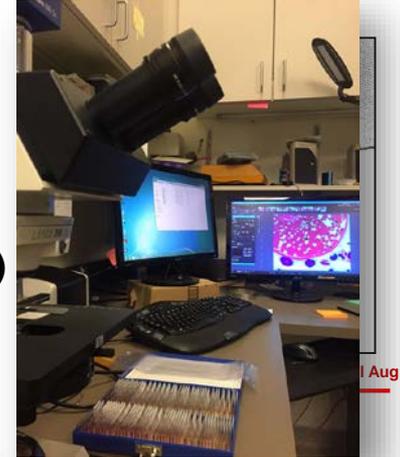
## 2. Full characterization of the annual reproductive cycle

**Objective:** Revise maturity estimates for male and female Pacific halibut

### Annual reproductive cycle



- Histological assessment of gonadal development
- 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:

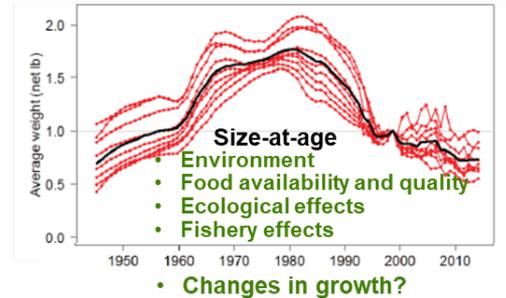
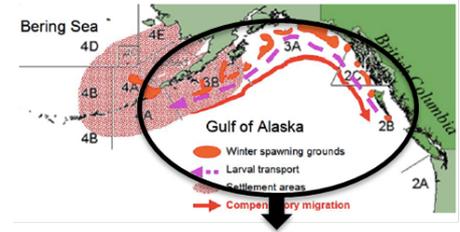
- Accurate staging of reproductive status
- Updated maturity-at-age estimates
- Estimates of skipped-spawning



# Growth

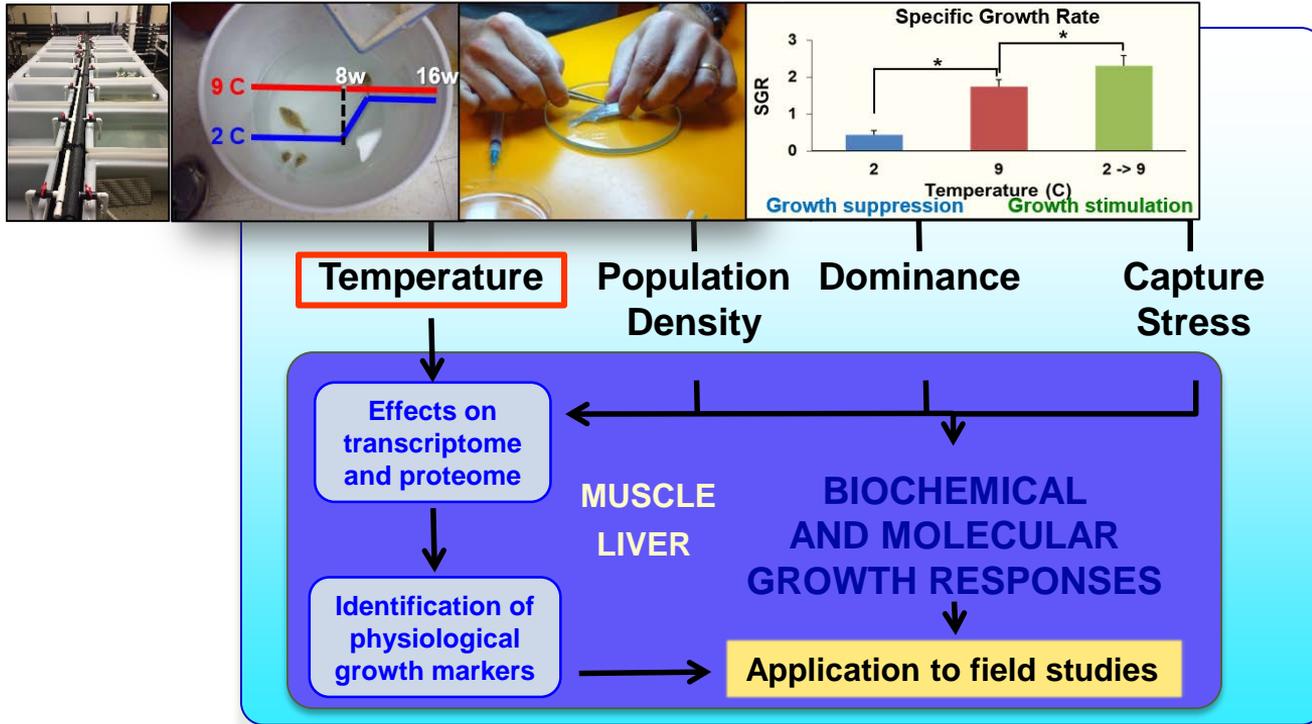
## Projects:

- 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

## 1. 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

Physiological  
growth markers



Application to field studies

## 2. 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



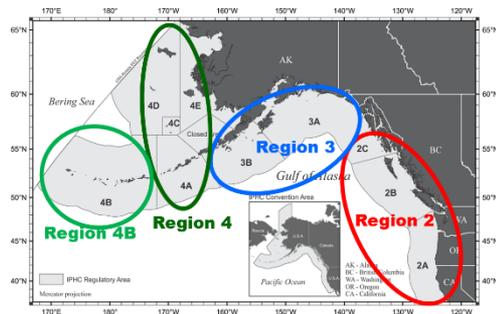
60-80 cm FL



*Slow growth rate?*

*Fast growth rate?*

### – Regional monitoring of growth patterns



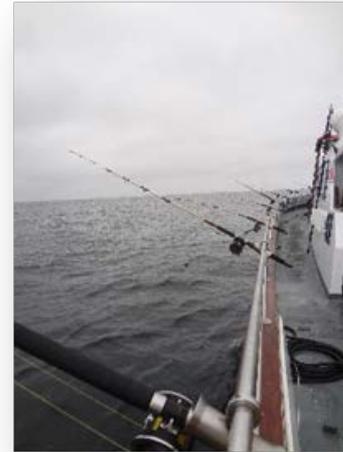
# Discard Mortality Assessment

## Projects:

1. ***Discard mortality rate estimation in the directed longline Pacific halibut fishery***



2. ***Discard mortality rate estimation for Pacific Halibut in the charter recreational fishery***



# Discard Mortality Assessment

## 1. Directed longline fishery: NOAA FISHERIES Saltonstall – Kennedy Grant NA17NMF4270240



### A. Establish a relationship between **handling practices** and **injury levels** and **physiological condition** of released Pacific halibut

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



- **Physiological condition** of released fish

- Condition factor indices
- Fat content
- Blood stress



- **Capture conditions**

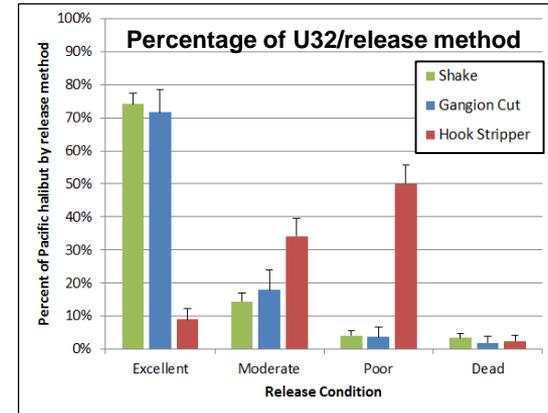
- Time



- Water temperature loggers



- Fish temperature



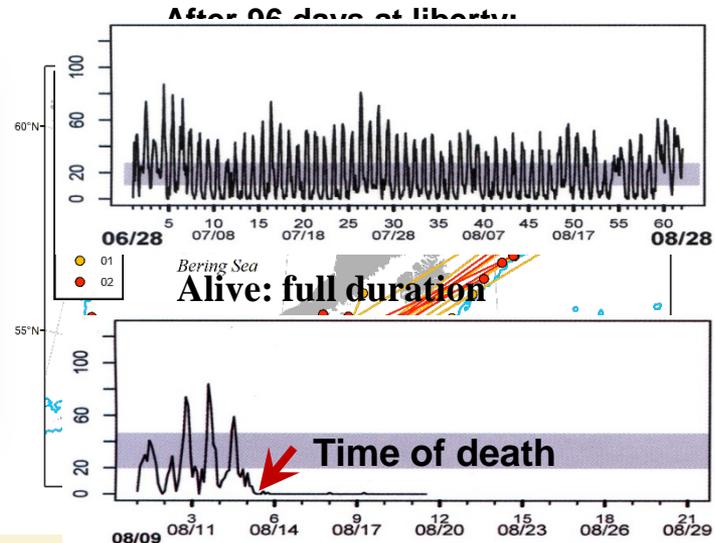
# Discard Mortality Assessment

## B. Relationship between *physiological condition* post-capture and *survival* post-release as assessed by tagging

- Accelerometer tags (n=79): only fish in excellent condition
- Wire tags (n=1,048): including all handling practices and release conditions



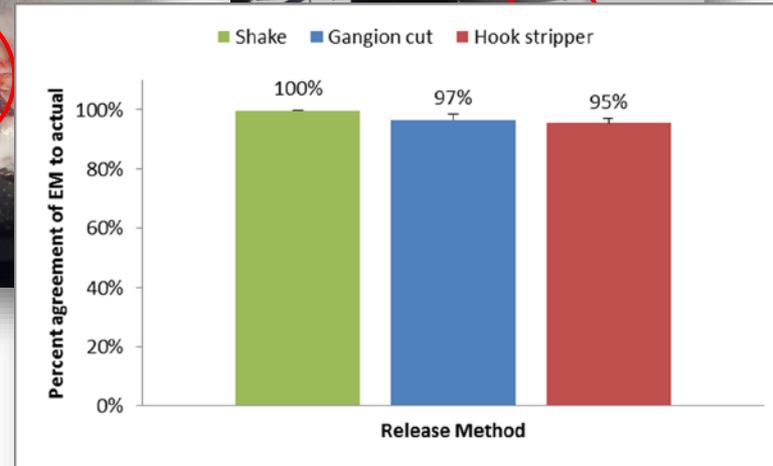
Results: 4% mortality



# Discard Mortality Assessment

## C. Applicability of *electronic monitoring (EM)* in DMR estimations

- Deployed EM system on a longline vessel
- Video recorded fish handling events during capture
- This will allow us to determine injury profile by release method



# Discard Mortality Assessment

## 2. Guided recreational fishery: First estimation of discard mortality rate

### Objectives:

1. Collect information on hook types and sizes and handling practices
2. Investigate the relationship between gear types and capture conditions and size composition of captured fish
3. Injury profiles and physiological stress levels of captured fish
4. Assessment of mortality of discarded fish



Recreational charter



Captured Pacific halibut



Hook injury assessment



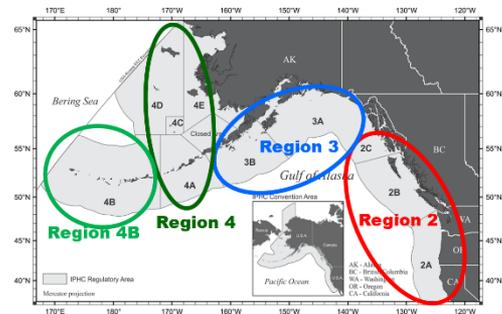
Tagging with sPATs



# Genetics and Genomics

## Projects:

1. Genetic structure of the Pacific halibut population
2. Genome sequencing



- Genomic DNA sequenced from one Pacific halibut female (WZ).
- Conducted first genome assembly:
  - Full genome sequenced. Genome size: 700 Mb
  - Non-continuous genome sequence.
- Additional sequencing is being conducted to complete assembly.



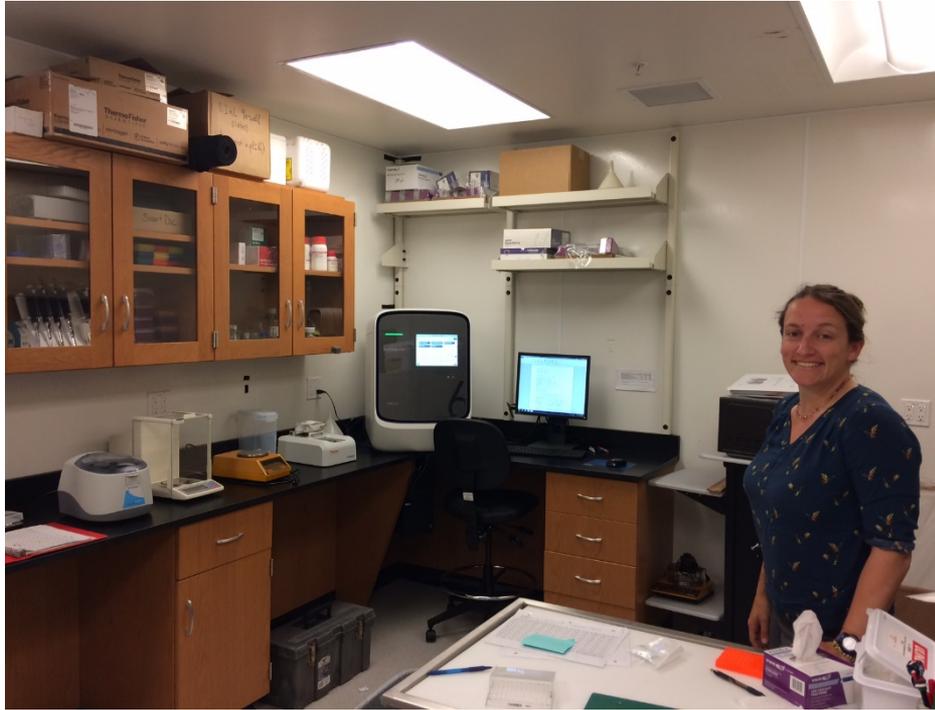
# Externally-funded collaborative research

Project #	Grant agency	Project name	PI	Partners	IPHC Budget (\$US)	Management implications	Grant period
1	Saltonstall-Kennedy NOAA	<b>Improving discard mortality rate estimates in the Pacific halibut by integrating handling practices, physiological condition and post-release survival</b> (Award No. NA17NMF4270240)	IPHC	Alaska Pacific University	\$286,121	Discard estimates	September 2017 – August 2019
2	North Pacific Research Board	<b>Somatic growth processes in the Pacific halibut (<i>Hippoglossus stenolepis</i>) and their response to temperature, density and stress manipulation effects</b> (NPRB Award No. 1704)	IPHC	AFSC-NOAA-Newport, OR	\$131,891	Changes in biomass/size-at-age	September 2017 – February 2020
3	Bycatch Reduction Engineering Program - NOAA	<b>Adapting towed array hydrophones to support information sharing networks to reduce interactions between sperm whales and longline gear in Alaska</b>	ALFA	IPHC, University of Alaska Southeast, AFSC-NOAA	-	Whale Depredation	September 2018 – August 2019
4	Bycatch Reduction Engineering Program - NOAA	<b>Use of LEDs to reduce Pacific halibut catches before trawl entrapment</b>	PSMFC	IPHC, NMFS	\$1,750	Bycatch reduction	September 2018 – August 2019
5	National Fish and Wildlife Foundation	<b>Discard mortality rate characterization in the Pacific halibut recreational fishery</b> (NFWF Award No. 61484)	IPHC	UA Fairbanks, APU, Grey Light Fisheries, Alaska Charter Association	\$98,901	Discard estimates	2019-2020
<b>Total awarded (\$)</b>					<b>\$518,663</b>		

# Other collaborative research

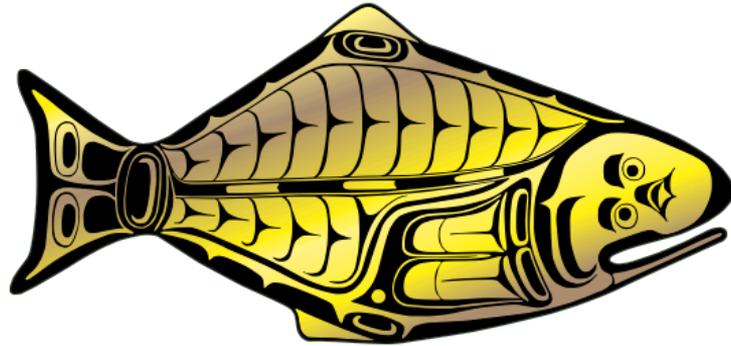
Project #	Partners	Topic of collaboration
1	<b>Agencies from contracting parties</b> (NOAA-Fisheries, DFO, PHMA, PSMFC, ADEC)	<b>Collaborative research and data collection in IPHC FISS</b>
2	<b>Industry</b>	<ul style="list-style-type: none"> <li>• Collaborative research with trawl fishery and with Pacific halibut directed (longline) and recreational fisheries on discard mortality rate.</li> <li>• Collaborative research with Pacific halibut directed fishery on (1) sex marking at sea and (2) incidence of chalky halibut.</li> </ul>
3	<b>North Pacific Fisheries Management Council</b>	<b>Joint research priority list NPFMC-IPHC (last updated in 2018)</b>
4	<p><b>Scientific partners</b></p> <ol style="list-style-type: none"> <li>1. <b>Contracting parties: US</b> (AFSC-NOAA Fisheries, NWFSC-NOAA Fisheries, University of Washington, University of Alaska Fairbanks, Alaska Pacific University)</li> <li>2. <b>Contracting parties: Canada</b> (Simon Fraser University, Dalhousie University)</li> <li>3. <b>International: France</b> (INRA)</li> </ol>	<b>Scientific collaborative research on various topics (genomics, genetics, migration, ecosystem studies, etc)</b>

# New IPHC's biological laboratory



- Lab technician: Anna Simeon
  - Current lab capabilities:
    - Nucleic acid extraction and quantification
    - Genotyping
    - Gene expression
    - Blood metabolite and hormone determinations
    - Staff and student training
- Sex ratios/  
genetics/  
migration
- Growth/reproduction
- Discard  
survival/  
reproduction

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