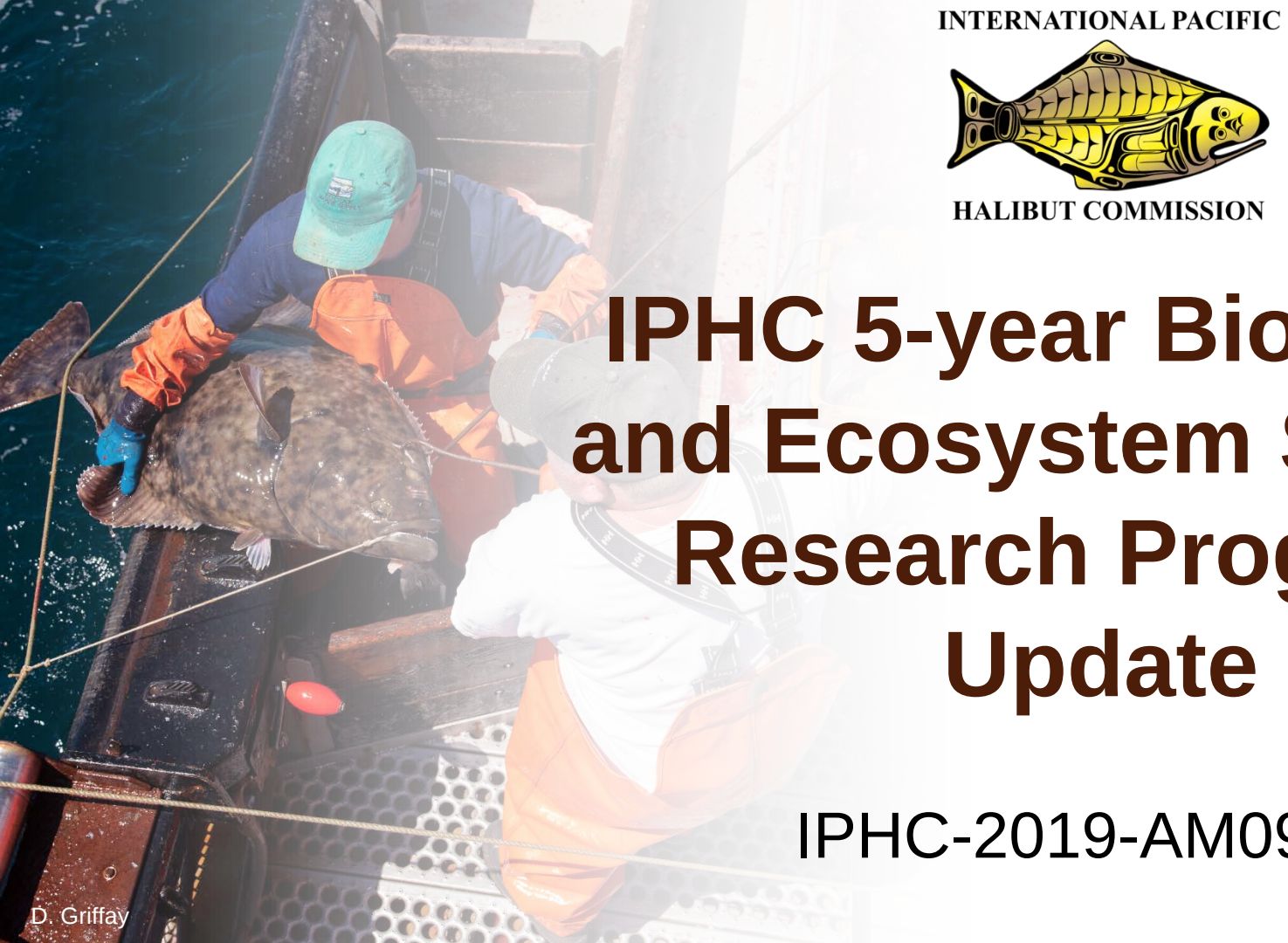


INTERNATIONAL PACIFIC HALIBUT COMMISSION

IPHC 5-year Biological and Ecosystem Science Research Program: Update

IPHC-2019-AM095-14

D. Griffay

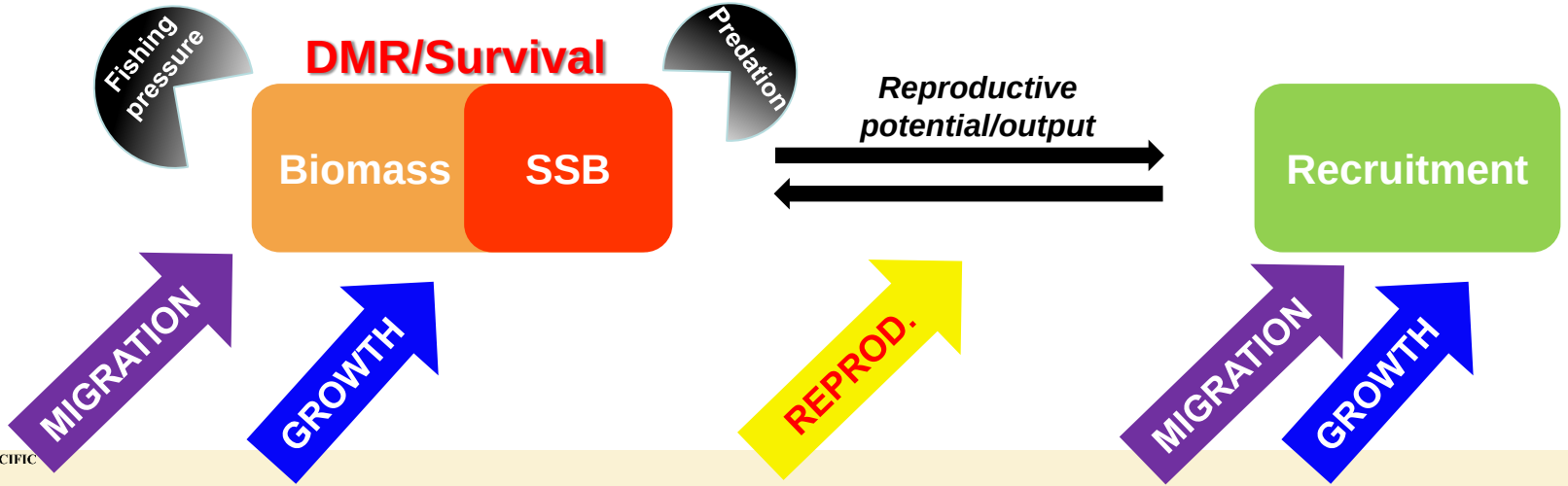
Outline

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

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



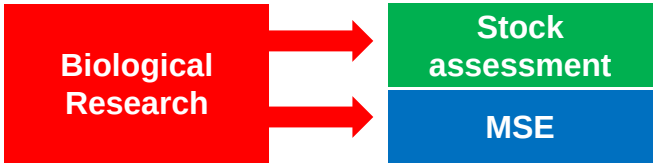
Five-year research plan and management implications

Primary Research Areas	*Main Objectives*	*Management implications*
Migration	Improve understanding of migration throughout all life stages (larval, juvenile, adult feeding and reproductive migrations)	Stock distribution, regional management
Reproduction	Information on sex ratios of commercial landings and improved maturity estimates	Female stock spawning biomass
Growth	Improve understanding of factors responsible for changes in size-at-age and development of tools for monitoring growth and physiological condition	Biomass estimates
DMRs and discard survival	Improve estimates of DMRs in the directed longline and guided recreational fisheries	Discard mortality estimates
Genetics and genomics	Improve understanding of the genetic structure of the population and create genomic tools (genome)	Stock distribution, local adaptation

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
Growth	Identification of growth patterns Environmental effects on growth Growth influence in size-at-age variation	Temporal and spatial variation in growth Yield calculations Effects of ecosystem conditions Effects of fishing	Predicted weight-at-age Mechanisms for changes in weight-at-age
Discard Survival	Bycatch survival estimates Discard mortality rate estimates	Scale and trend in mortality Scale and trend in productivity	Bycatch and discard mortality estimates Variability in bycatch and uncertainty in discard mortality estimates
Genetics and Genomics	Genetic structure of the population Sequencing of the Pacific halibut genome	Spatial dynamics Management units	Information for structural choices

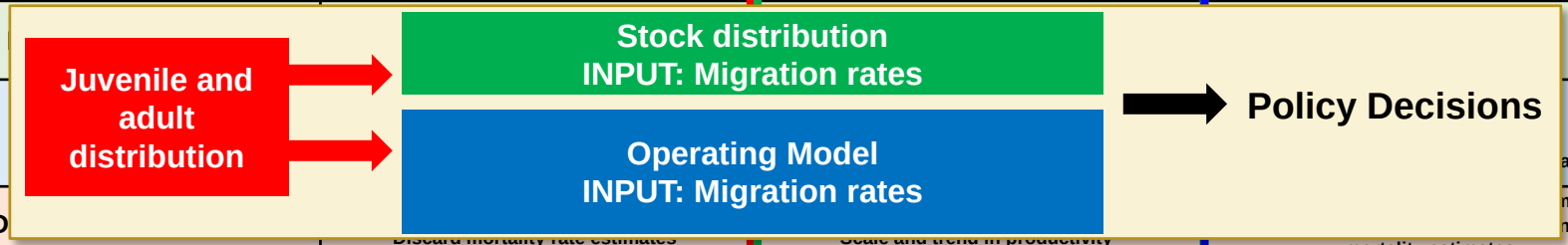
Integration of biological research, stock assessment, and policy



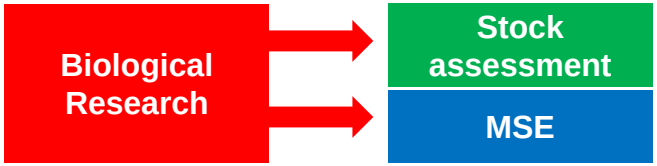
Policy Decisions

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**
Genetics and Genomics	**Genetic structure of the population** **Sequencing of the Pacific halibut genome**	**Spatial dynamics** **Management units**	**Information for structural choices**



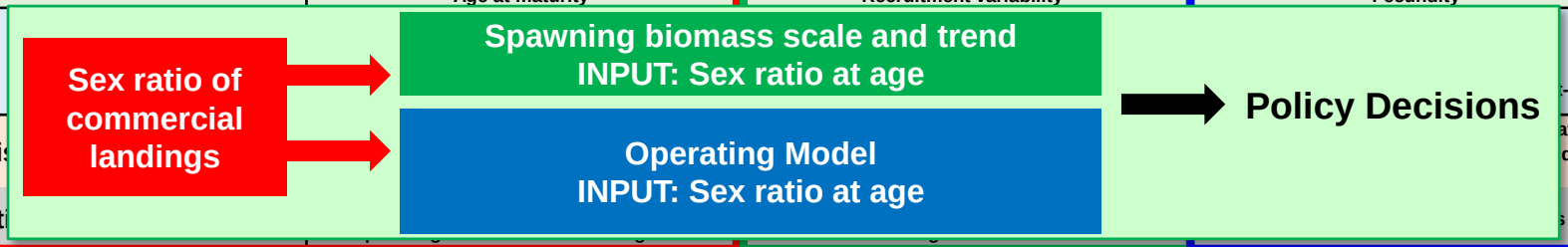
Integration of biological research, stock assessment, and policy



Policy Decisions

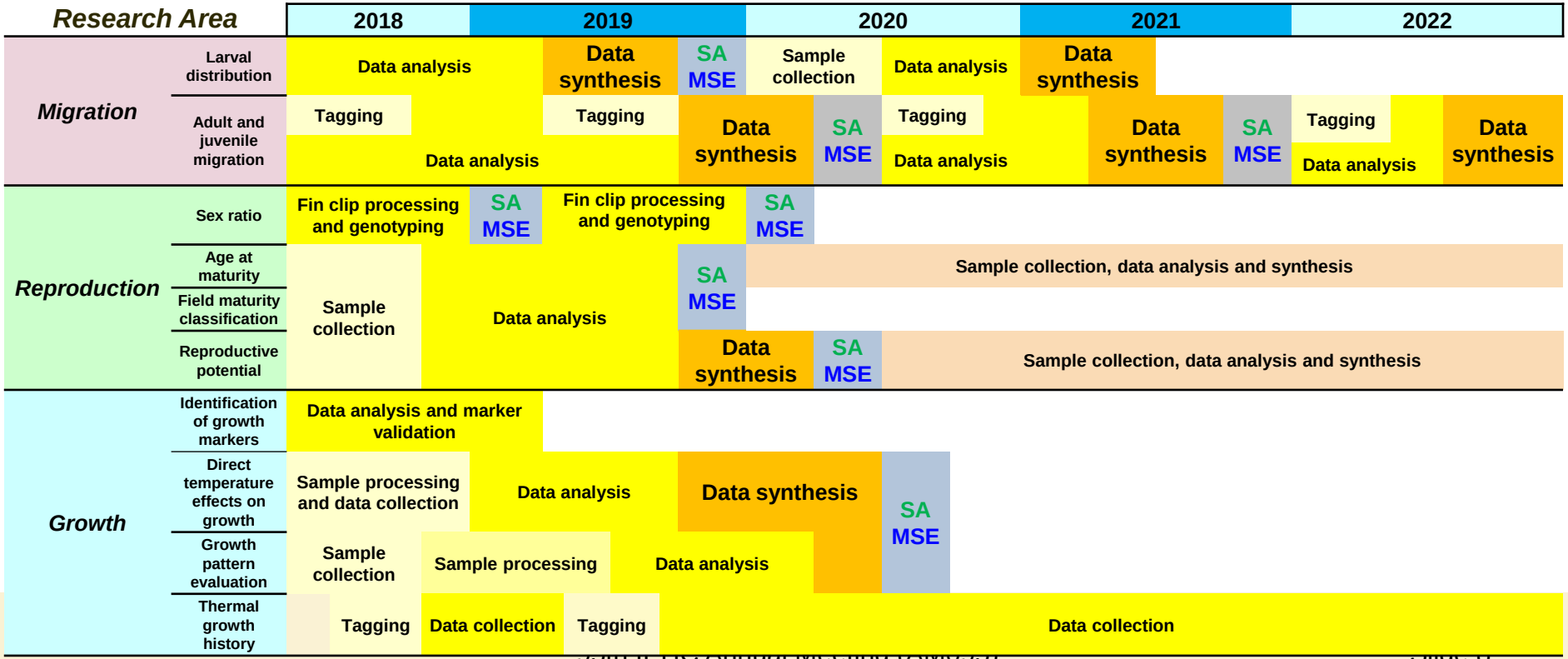
Biological research | **Stock assessment** | **Stock assessment** **MSE**

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**
Dis			**discard**
Genet			



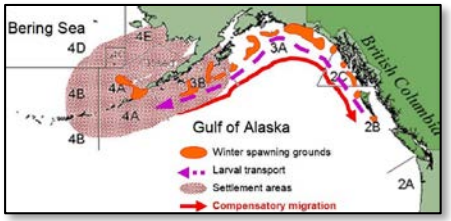
Policy Decisions

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



Outline

- Five-year research plan and management implications
- **Progress on ongoing research projects**



1. Migration

Projects:

1. Larval distribution and connectivity

2. U32 migration

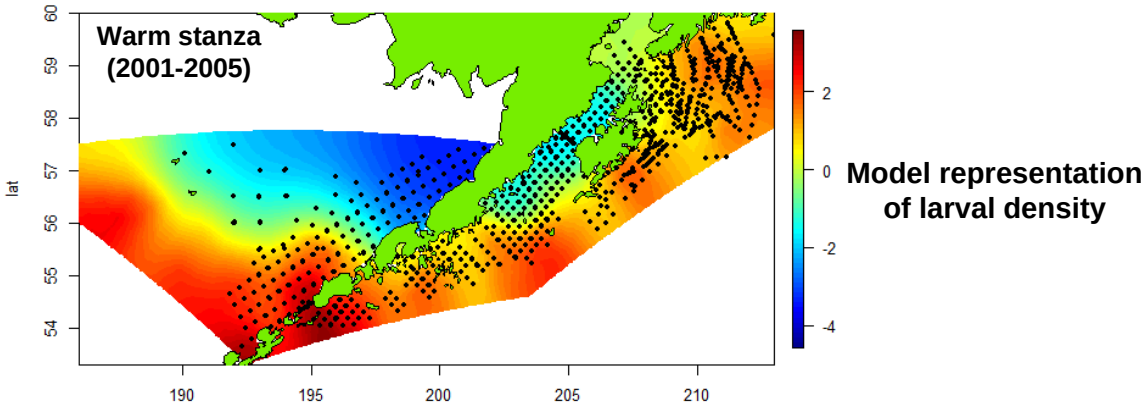
3. Seasonal and reproductive migrations: archival tagging

4. Tail pattern recognition

Migration

1. Larval distribution and connectivity

- **Contribution of spawning grounds to settlement grounds**
- **Connectivity of ocean basins**
- **Environmental effects on larval distribution**
- **Collaboration with NOAA/EcoFOCI**
- **First phase scheduled for completion in 2019**



Model representation of larval density

Migration

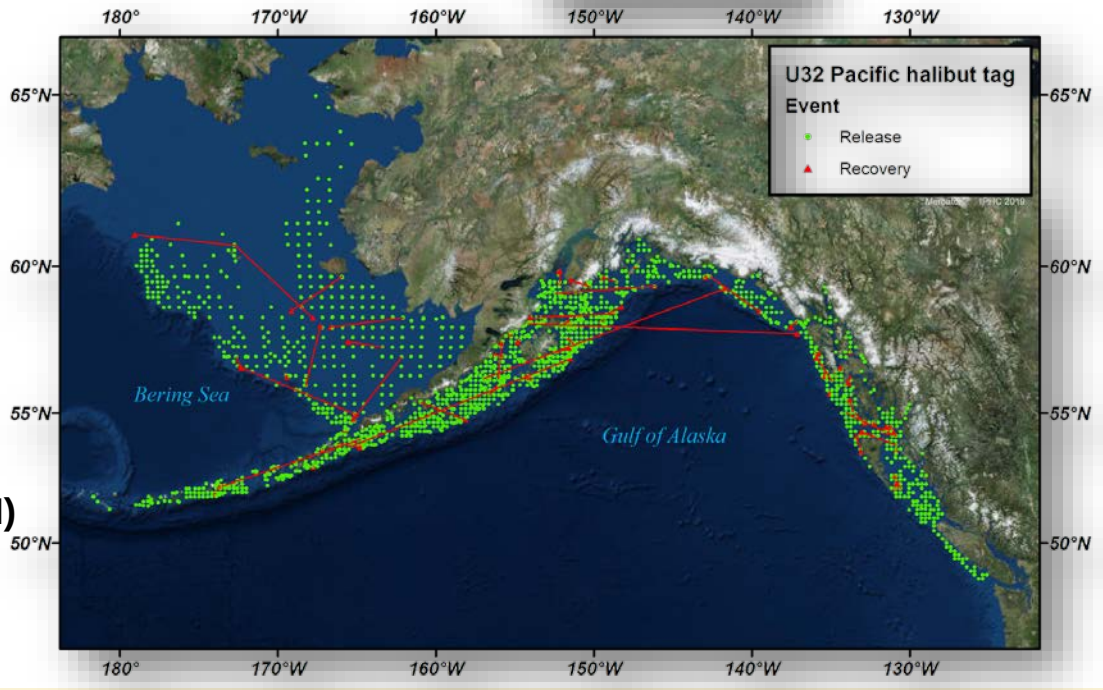
2. U32 migration: wire tagging efforts

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)**



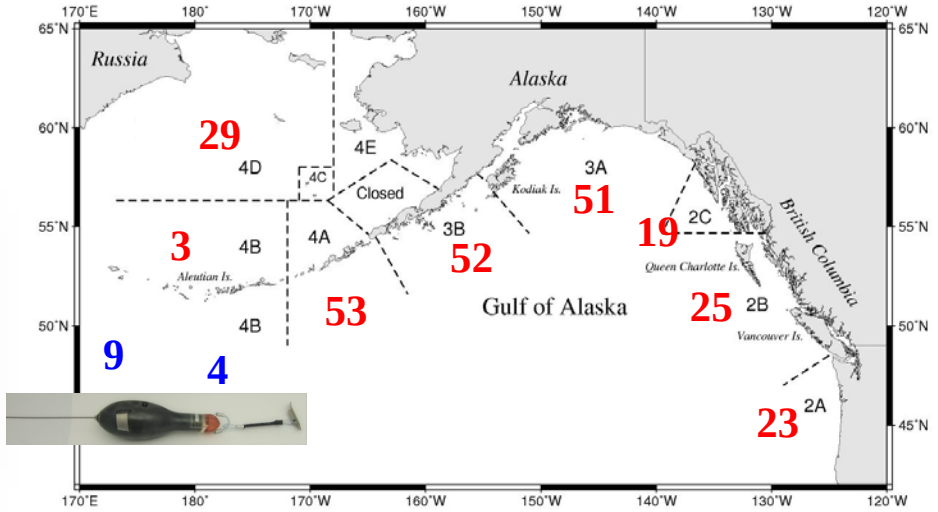
Migration

3. *Electronic archival tagging*

Image: Lotek Wireless

Photo: Craig Rose

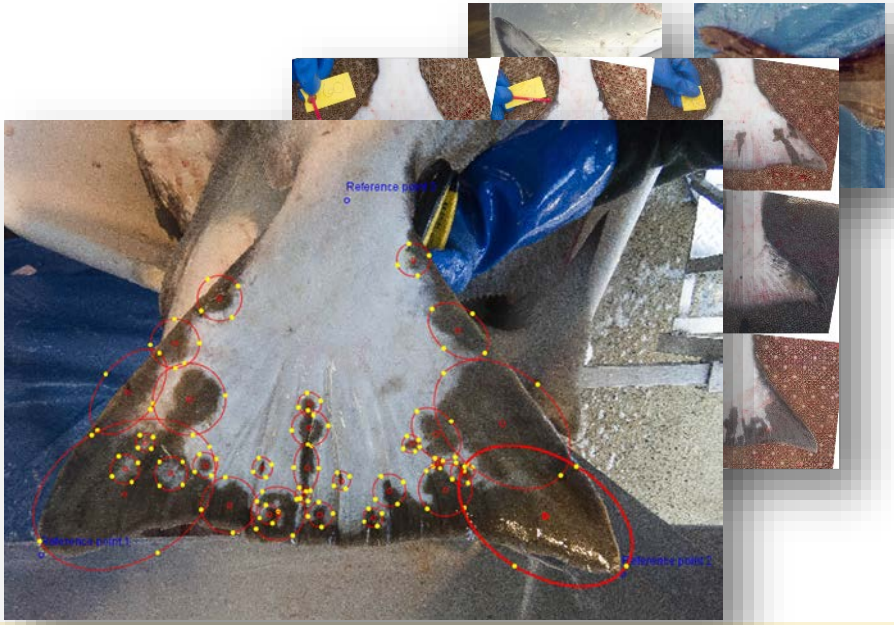
- **255 external dart-and-tether tags released coastwide, that record temperature, depth, and light**
- **13 PAT tags released in 4B**
- **Rewards offered for tag and otolith recovery**



Migration

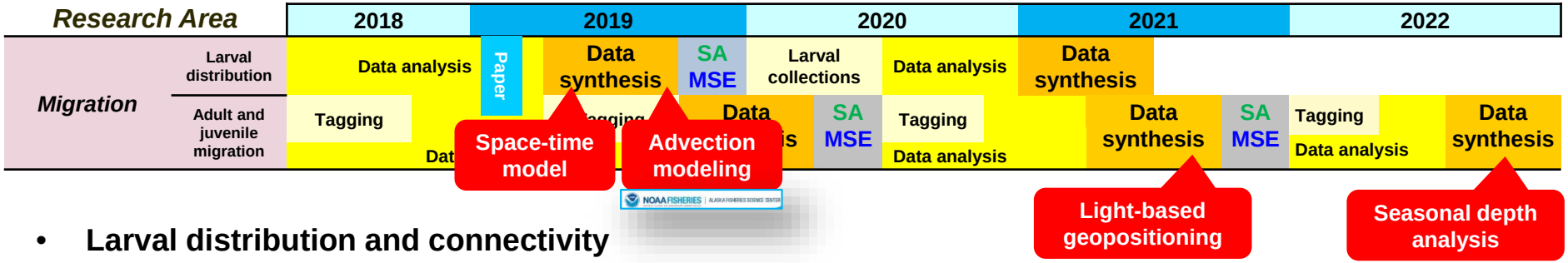
4. *Tail pattern recognition*

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**

Migration: timeline and integration with stock assessment, and MSE



- Larval distribution and connectivity
- Electronic archival tagging:
  - Analyze age- and sex-specific movement patterns
  - Generate "dispersal kernels" for use in spatially-explicit models (*assessment, metapopulation*) that incorporate migration
  - Analyze onshore-offshore and spawning movements to refine definitions of effective spawning biomass

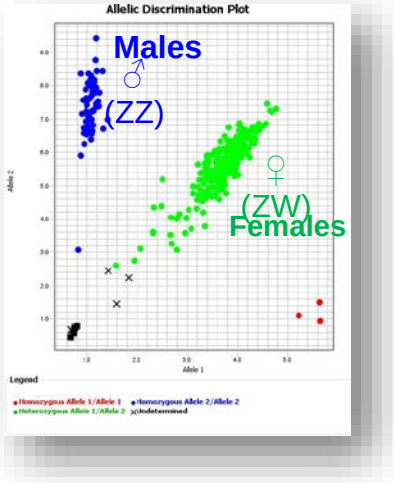
Progress on ongoing research projects

2. Reproduction

Projects:

1. Genetic identification of sex in the commercial landings

2. Full characterization of the annual reproductive cycle



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

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

2019 FULL STOCK ASSESSMENT

Reproduction

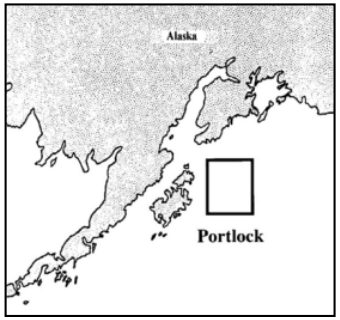
2. Full characterization of the annual reproductive cycle

Objective: Revise maturity estimates for male and female Pacific halibut

Annual reproductive cycle

Gonadal growth	Maturation	Spawning

- 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



Sept Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug

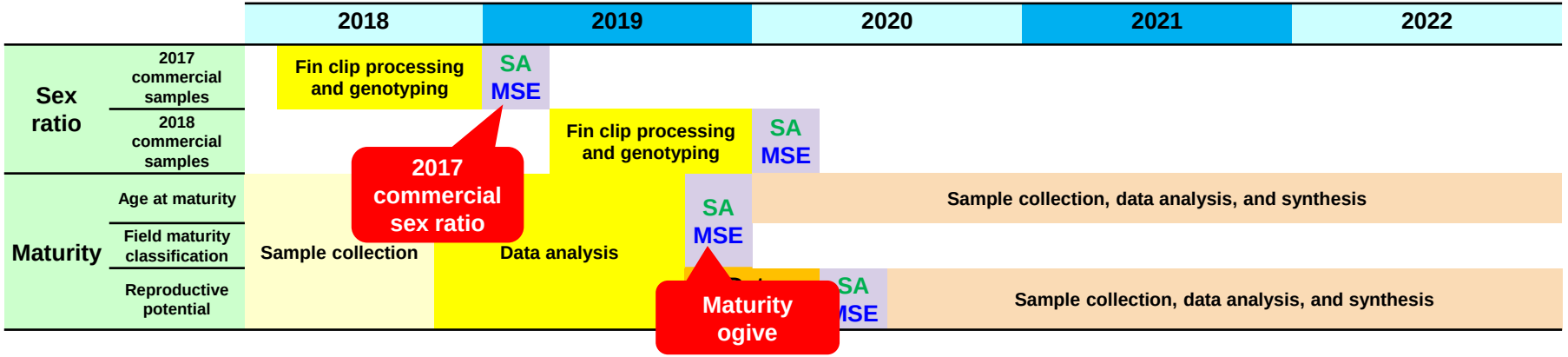
2017 2018

30♀ / 30 ♂

Deliverables:

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

Reproduction: timeline and integration with stock assessment, and MSE

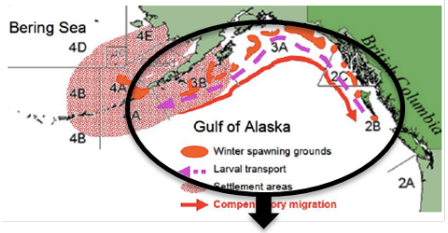


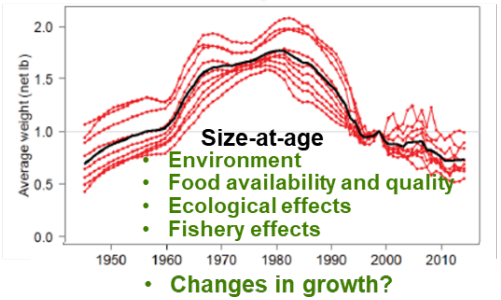
Progress on ongoing research projects

3. Growth

Projects:

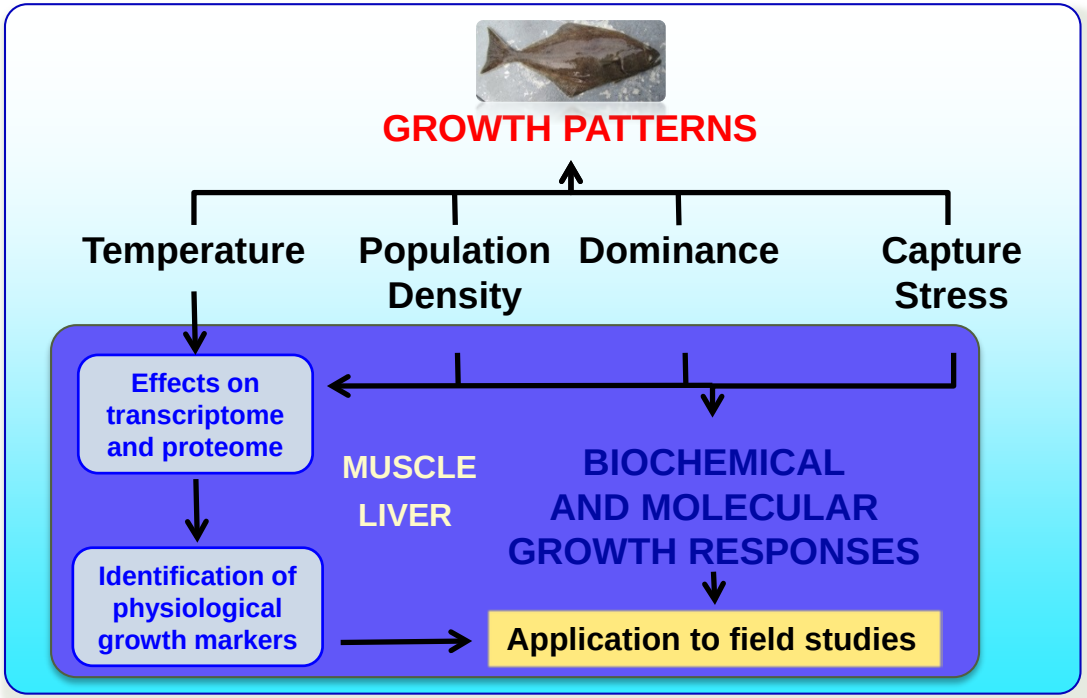
1. ***Identification and validation of physiological markers for growth***
2. ***Evaluation of growth patterns in the Pacific halibut population and possible effects of environmental variability***





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

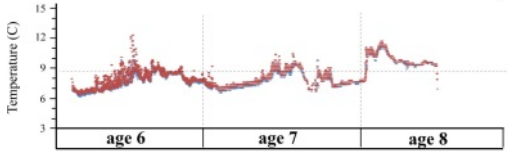
60-80 cm FL

Characterization of physiological growth markers in muscle samples from age-matched individuals

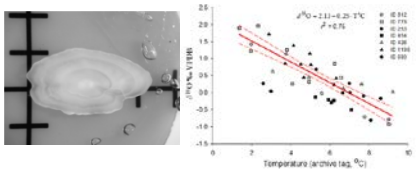
- Effects of environmental variability: influence of thermal history on growth patterns

- **U32 tagged fish with archival tags that record temperature**
- **Relate temperature history to otolith chemistry (O_2 isotopes); and then to growth**

Tag

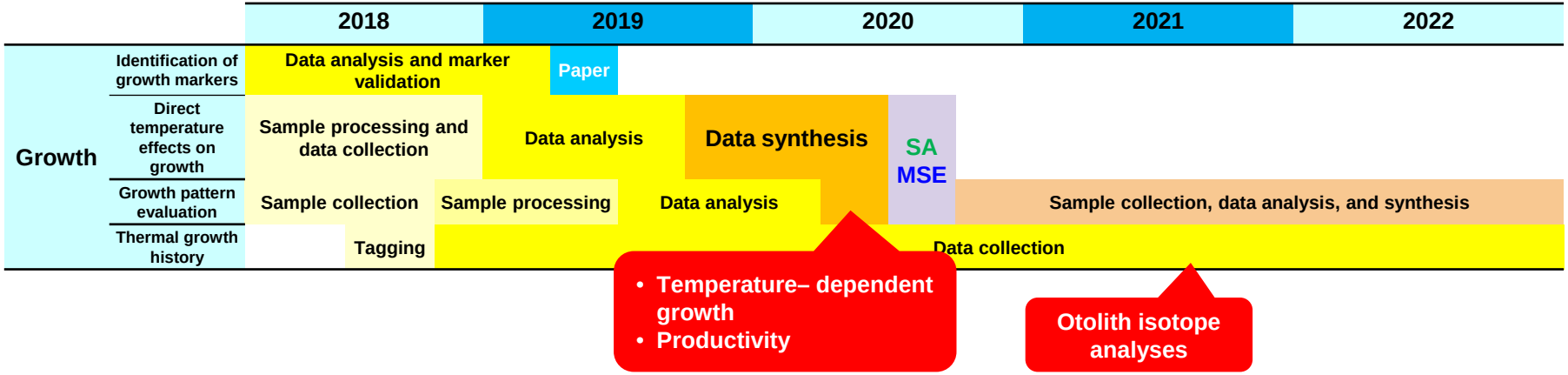


Temperature time-series



Otolith as temperature-recorder

Growth: timeline and integration with stock assessment, and MSE



Progress on ongoing research projects

4. DMRs and post-release survival assessment in Pacific halibut

Projects:

1. Improve DMR estimations in the directed longline fishery

NOAA FISHERIES **Saltonstall – Kennedy Grant NA17NMF4270240** ALASKA PACIFIC UNIVERSITY

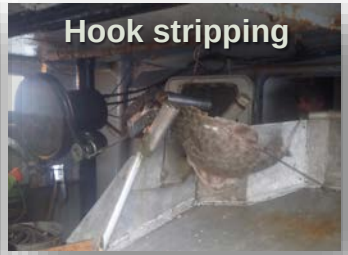
2. Estimate DMRs in the guided recreational fishery

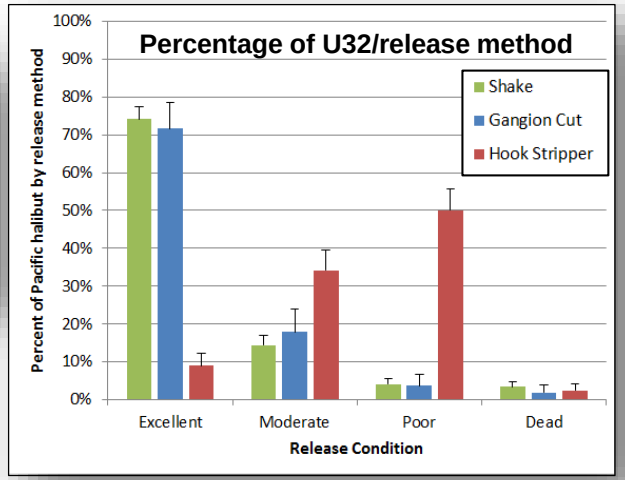
NFWF **National Fish and Wildlife Foundation** UAF UNIVERSITY OF ALASKA FAIRBANKS ALASKA PACIFIC UNIVERSITY ACA Alaska Charter Association

DMRs and survival assessment

1. *Directed longline fishery*: A. 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**

- **Condition factor indices**

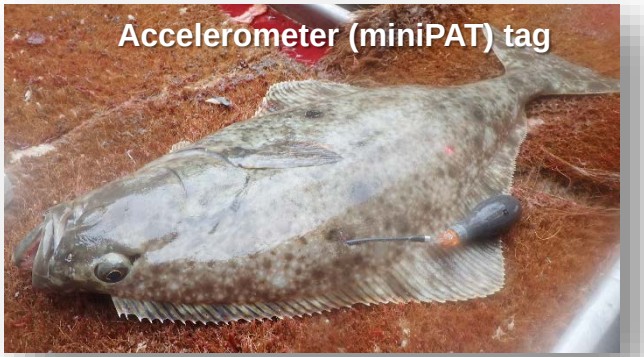
– ***Capture conditions***

•Time

DMRs and survival assessment

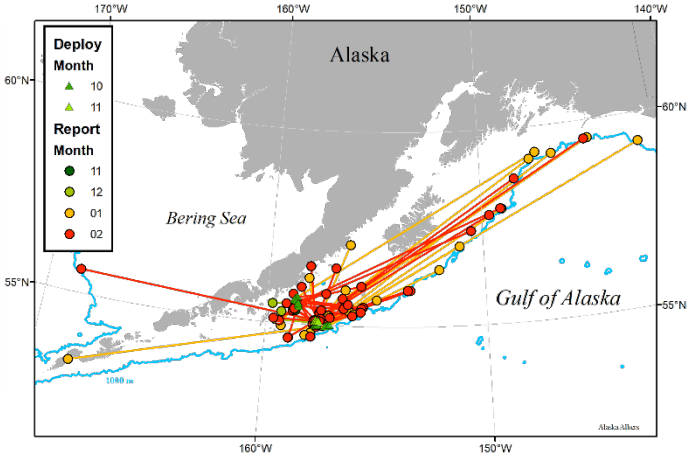
B. Relationship between physiological condition post-capture and survival post-release as assessed by tagging

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



Results: 4% mortality

After 96 days at liberty:



DMRs and survival assessment

C. Applicability of electronic monitoring (EM) in DMR estimation

- **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**

DMRs and survival assessment

C. Applicability of EM in DMR estimation

– **Results: Comparison of EM-determined release method to the actual**

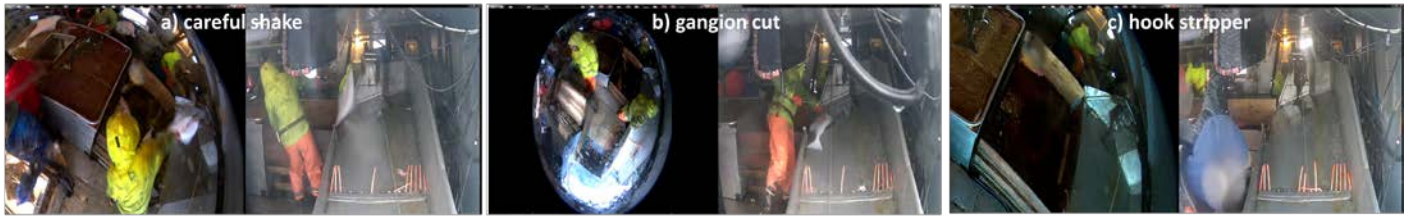
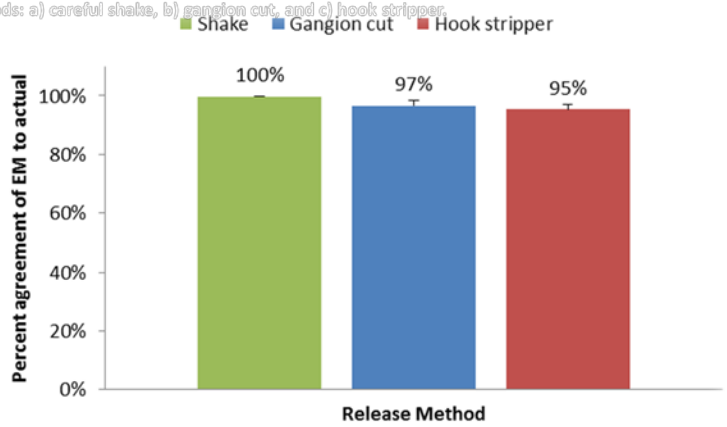


Figure 4. EM capture of hook release methods: a) careful shake, b) gangion cut, and c) hook stripper.



DMRs and survival assessment

2. *Guided recreational fishery: Estimation of DMRs*

– **To be initiated in 2019**

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**

Sport charter

Captured Pacific halibut

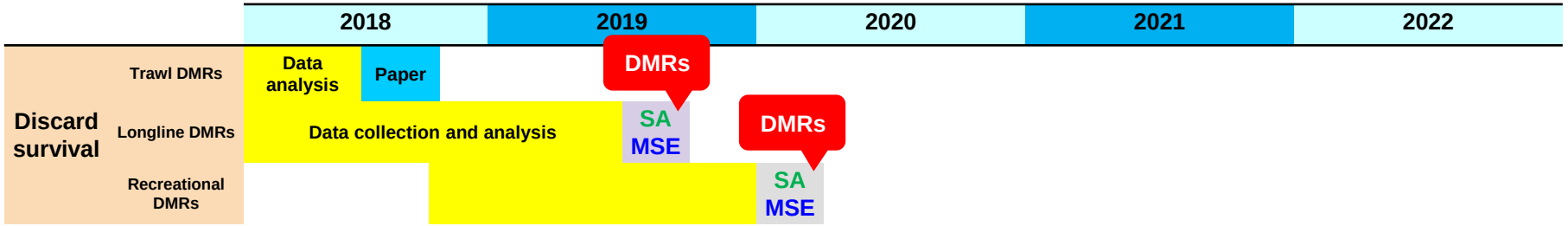
Hook injury assessment

Tagging with sPATs

NFWF National Fish and Wildlife Foundation

UAF University of Alaska Fairbanks | Alaska Pacific University | ACA Alaska Charter Association

DMR: timeline and integration with stock assessment, and MSE



Outline

- Five-year research plan and management implications
- Progress on ongoing research projects
- **Planned future research projects**

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	**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
3	**Investigations on chalky Pacific halibut**	Collection of information from stakeholders on the incidence of chalky flesh and understanding possible causes leading to its development	Landed value
4	**Whale detection techniques**	Use of acoustic towed array hydrophones for whale detection. Participation in project led by ALFA and funded by BREP-NOAA	Whale depredation
5	**Bycatch reduction techniques**	Use of LEDs in trawl gear to facilitate escape responses of Pacific halibut. Participation in project led by PSMFC and funded by BREP-NOAA	Bycatch reduction

Outline

- Five-year research plan and management implications
- Progress on ongoing research projects
- Planned future research projects
- **External research funding**

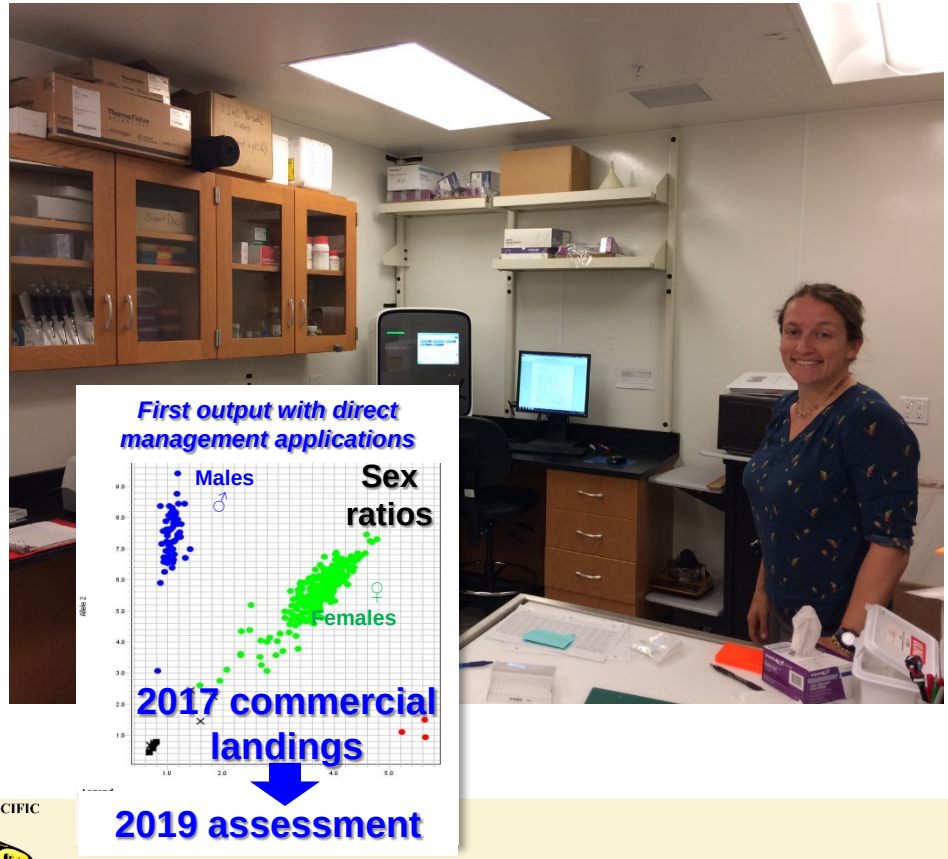
External funding: research grants

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	Discard estimates	September 2017 – August 2019
2	North Pacific Research Board	**Somatic growth processes in the Pacific halibut (*Hippoglossus stenolepis*) 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	-	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	$1,750	Bycatch reduction	September 2018 – August 2019
5	National Fish and Wildlife Foundation	**Discard mortality rate characterization in the Pacific halibut recreational fishery (*NFWF Award No. 61484)***	IPHC	UA Fairbanks, APU, Grey Light Fisheries, Alaska Charter Association	$98,901	Discard estimates	2019
				Total awarded ($)	**$518,663**		

Outline

- Five-year research plan 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**

New biological laboratory at IPHC

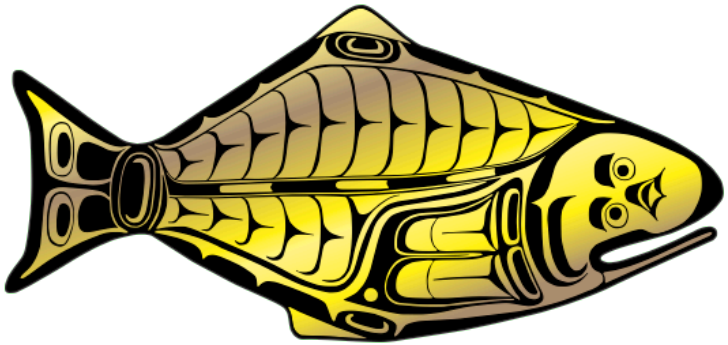


- **Lab technician: Anna Simeon (full time; 2 yr appointment; salary co-financed by NPRB grant)**
- **Lab equipment:**
  - **PCR machine**
  - **Spectrophotometer**
  - **Microplate reader**
- **Current lab capabilities:**
  - **Nucleic acid extraction and quantification**
  - **Genotyping**
  - **Gene expression** → **Growth/reproduction**
  - **Blood metabolite and hormone determinations**
  - **Staff and student training**

Sex ratios/ genetics/ migration

Discard survival/ reproduction

INTERNATIONAL PACIFIC



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