D. Griffay

Overview of the IPHC 5-year Biological and Ecosystem Science Research Program

Josep V. Planas
Biological and Ecosystem Science Program Manager

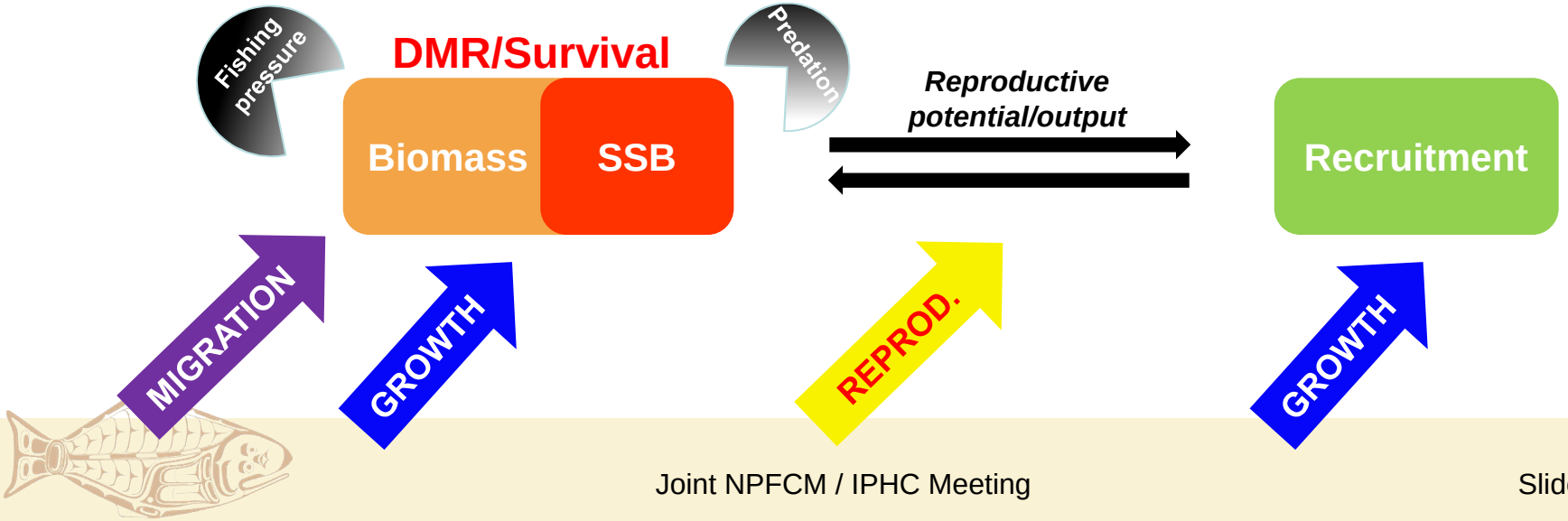
Joint NPFCM / IPHC Meeting

June 7, 2017

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**



Primary research activities at IPHC

1. **Reproduction**
   - SEX RATIO OF CATCH
   - IMPROVED MATURATION ESTIMATES OF SPAWNING BIOMASS
2. **Growth**
   - CHANGES IN SIZE AT AGE/BIOMASS
   - TOOLS TO ASSESS FISH CONDITION
3. **Migration**
   - LARVAL DISPERSAL
   - ADULT FEEDING AND REPRODUCTIVE MIGRATION
4. **DMRs and post-release survival assessment**
   - BYCATCH SURVIVAL ESTIMATES
5. **Genetics and genomics**
   - GENETIC STRUCTURE OF THE POPULATION
   - GENOMIC TOOLS (e.g. GENOME)

1. Reproduction

There are important knowledge gaps on the reproductive biology of the species

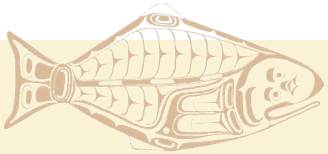
- **SEX RATIO OF CATCH**
- **IMPROVED MATURATION ESTIMATES OF SPAWNING BIOMASS**

What is needed?

- **Knowledge on reproductive development, maturation, fecundity, sex determination mechanisms (sex identification), environmental and hormonal control of reproduction.**
- **Scientific-based criteria to identify reproductive status and potential.**
- **Updated estimates of age and size at maturation.**
- **Information on skipped spawning.**

New proposed studies:

- ***Full characterization of the annual reproductive cycle***
- ***Identification of sex determination mechanism(s) and influencing factors***

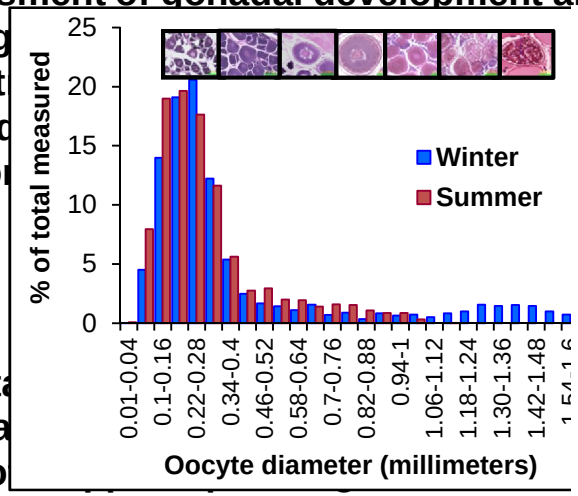


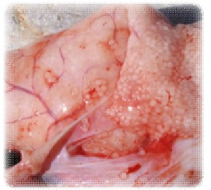
1. Reproduction

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

  Objective: Understand temporal changes in reproductive development throughout an entire annual reproductive cycle in male and female Pacific halibut

  - **Histological assessment of gonadal development and maturation.**
  - **Endocrine profiling**
  - **Gene expression (t**
  - **Gonadosomatic ind**
  - **Ultrasound monitor**





Deliverables:

- **Accurate st**
- **Updated ma**
- **Estimates o**
- **Comprehensive reproductive monitoring of the adult population in order to improve our estimate of actual spawning biomass**

1. Reproduction

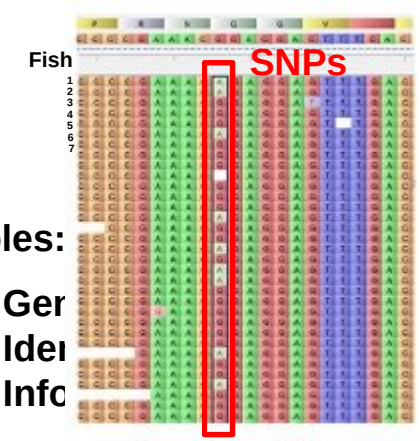
- ***Identification of sex by genetic means and of sex determination mechanisms***

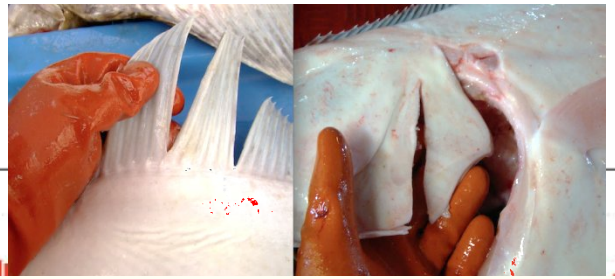
  Objectives: To identify genetic markers for sex identification in commercial catch and to understand how sex is established in Pacific halibut

  - **Identification of genetic sex markers: Validation of the coast-wide sex-marking project**

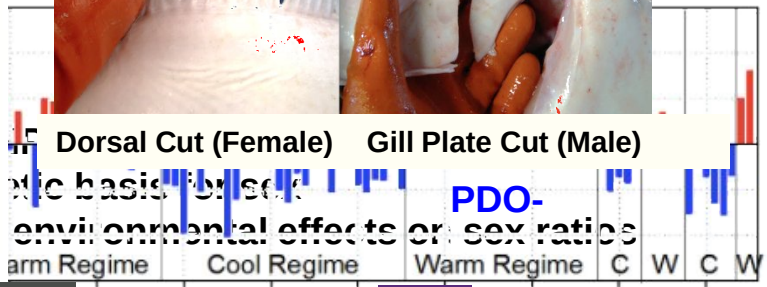
Deliverables:

- **Ger**
- **Ide**
- **Info**





Dorsal Cut (Female) **Gill Plate Cut (Male)**



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Dr. Yann Guiguen

Dr. Lorenz Hauser

2. Growth

Little is known regarding what factors influence growth in this species

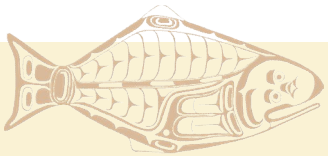
- **CHANGES IN SIZE AT AGE/BIOMASS**
- **TOOLS TO ASSESS FISH CONDITION**

What is needed?

- **Knowledge on growth patterns and environmental influences.**
- **Improved understanding in the possible role of growth alterations in the observed decrease in size at age.**

New proposed studies:

- ***Extensive catalogue of physiological markers to monitor growth***
- ***Evaluation of growth patterns and effects of environmental influences***



2. Growth: proposed studies

- ***Catalogue of mo***

Objective: Identify **th studies.**

- **Identification of g**
- **Develop molecula** **ant tissues.**

Annotation	Gene symbol	Length (nt)	Identity (%)	Function
Androgen receptor	*ar*	4426	81.48	Protein synthesis
Calcium/calmodulin-dependent protein kinase II alpha	*camk2a*	2342	87.27	Force transmission
Creatine kinase, muscle a	*ckma*	2256	89.76	Energy metabolism
Carnitine palmitoyltransferase 1B	*cpt1b*	762	81.87	Lipid metabolism
Dystrophin	*dmd*	1282	85.23	Force transmission
Eukaryotic translation initiation factor 4eb	*eif4eb*	1168	85.19	Protein synthesis
F-box protein 32	*fbxo32*	695	86.25	Protein atrophy
Glycogen synthase 1	*gys1*	3023	89.47	Energy metabolism
Histone deacetylase 1	*hdac1*	2490	96.35	Muscle repressor
Insulin-like growth factor 2 receptor	*igf2r*	511	70.51	Growth regulator
Insulin-like growth factor binding protein 5b	*igfbp5*	1372	81.5	Growth regulator
Lipoprotein lipase	*lpl*	1789	60.48	Lipid metabolism
Myocyte enhancer factor 2cb	*mef2cb*	594	79.8	Muscle growth
Myostatin b	*mstnb*	789	95.71	Growth regulator
Mechanistic target of rapamycin	*mtor*	1153	97.92	Protein synthesis
Myogenic factor 6	*myf6*	819	87.19	Muscle growth
Myosin, heavy polypeptide 1.3, skeletal muscle	*myh1.3*	246	86.42	Muscle growth
Myoblast determination protein 1 homolog	*myod*	2467	72.67	Muscle development
Myozenin 1a	*myoz1a*	799	74.6	Force transmission
Nuclear factor of activated T-cells, cytoplasmic 3	*nfatc3*	1587	62.96	Muscle activity
Paired box 3a	*pax3a*	269	75	Muscle development
Paired box 7b	*pax7b*	297	85.71	Muscle development
Peroxisome proliferator-activated receptor gamma, coactivator 1 alpha	*ppargc1a*	519	88.7	Energy metabolism
Protein phosphatase 3, catalytic subunit, alpha isozyme	*ppp3ca*	3407	83.69	Muscle activity
Protein kinase, AMP-activated, alpha 1 catalytic subunit	*prkaa1*	1925	70.96	Energy metabolism
Phosphorylase, glycogen, muscle	*pygma*	5514	90.91	Energy metabolism
Serum response factor	*srf*	4393	63.81	Muscle development
Transforming growth factor, beta 1a	*tgfb1a*	561	77.04	Growth regulator
Tripartite motif containing 63b	*trim63b*	2117	81.16	Protein atrophy

Growth regulation
Energy metabolism
Muscle activity/ function

Deliverables:

- **Establishment of a growth-related gene sequence dataset**
- **Molecular assays to monitor growth patterns based on growth-markers**

2. Growth

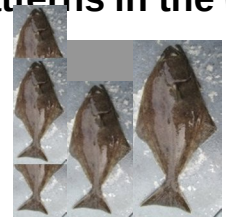
- ***Evaluation of growth patterns and effects of environmental influences***

  Objective: Identify molecular, biochemical and isotopic profiles characteristic of specific growth patterns and evaluate potential effects of environmental influences.

  - **Evaluation of different growth patterns in the *wild*.**

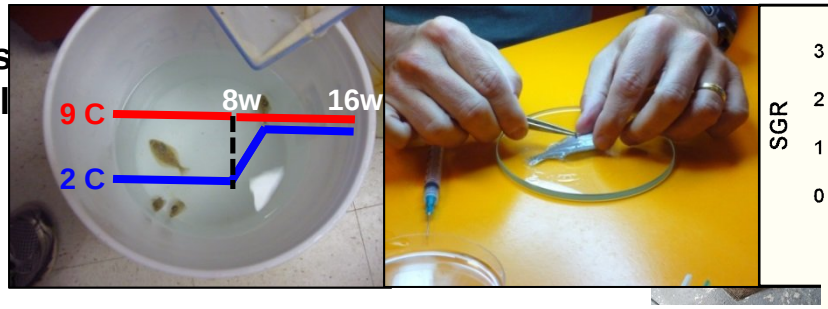
    In BS NMFS trawl survey in 2016:
    - **- 75 fish <40 cm length**
    - **- 75 fish 40-60 cm length**
    - **- 75 fish 60-80 cm length**

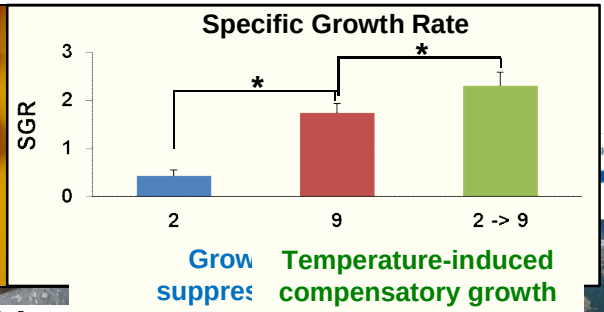
    Continued in 2017



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

  - **Establis**
    molecul





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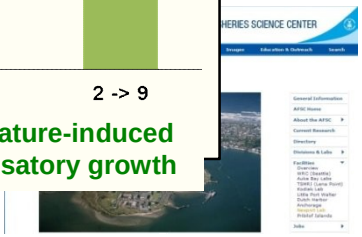
suppres

Temperature-induced compensatory growth

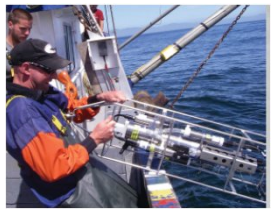


  - **Isotopic tissue turnover to trace dietary and/or habitat shifts**

    ^{13}C, ^{15}N

2. Growth

- **Investigate the effects of environmental factors on growth performance.**
  - ***Effects of temperature, salinity, dissolved oxygen and water pH on growth.***



  - ***Identify the optimal environmental conditions for growth.***

- **Understand the basis of sexual dimorphic growth in the Pacific halibut.**

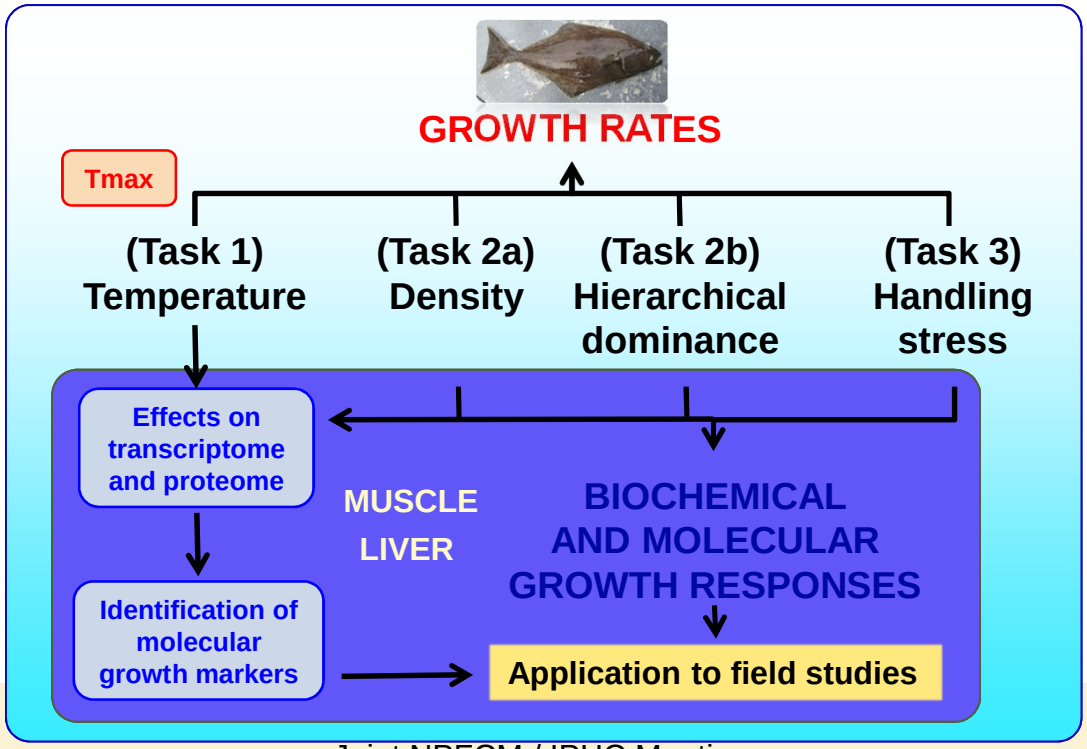
Male  **Female** 

Deliverables:

- **Identification and validation of growth markers for field studies**
- **Characterization of molecular and biochemical growth signatures**
- **Environmental effects on somatic growth**
- **Improved biological inputs on biomass estimates**

2. Growth

- **NPRB Funding (2017-2019): "*Somatic growth processes in the Pacific halibut (Hippoglossus stenolepis) and their response to temperature, density and stress manipulation effects*". IPHC (coordinator) / AFSC – Newport, OR**



Dr. Thomas Hurst

3. Migration

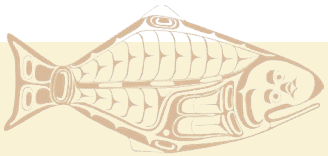
- **LARVAL DISPERSAL**
- **ADULT FEEDING AND REPRODUCTIVE MIGRATION**

What is needed?

- **Improve our understanding on larval, juvenile and reproductive migration.**
- **Incorporate additional sources of biological information on migration studies.**

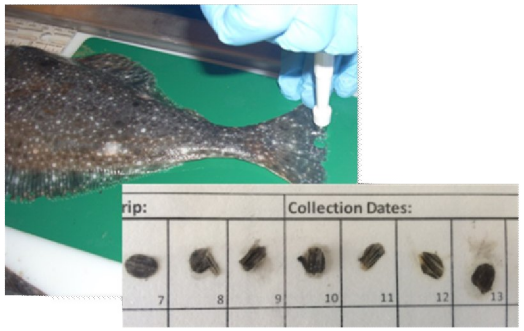
Projects:

- ***Juvenile and adult feeding migrations***
- ***Reproductive and annual migrations of adult fish***
- ***Larval migration and connectivity***



3. Migration

- ***Juvenile and adult migration studies***
  - **- Juvenile wire tagging:** • **NMFS trawl tagging project**
  - **- Adult wire tagging:** • **IPHC survey tagging project**
    - **2016 pilot study in area 4D (U32)**
    - **2017 coast-wide study (U32)**



Fin clips are collected: Genetic analyses of tagged fish to shed light on migration patterns and geographic origin.

- Tail pattern recognition

- **PAT tagging Bower's Ridge (4B)**

- ***Reproductive and annual migration***

Deliverables:

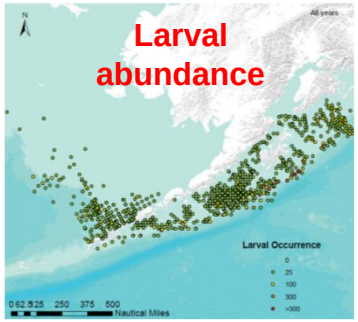
- **Improved knowledge on juvenile, adult and reproductive migrations and identification of spawning areas**

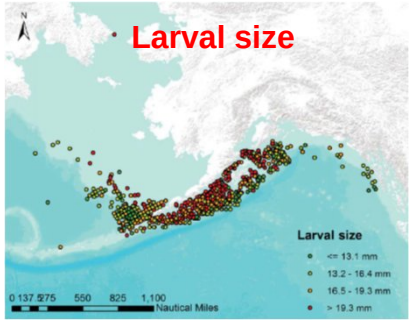
3. Migration

- ***Larval migration and connectivity***

Objective: Understand the mechanisms of larval connectivity between GOA and BS.

- **Collect data from the NMFS icthyoplankton survey and map larval distribution over time and space.**
- **Collect larval samples from the survey to conduct genetic analyses.**





Collaboration with Janet Duffy-Anderson, Esther Goldstein, William Stockhausen (NOAA-AFSC-Seattle)

Deliverables:

- **Improved knowledge on larval distribution, migration and genetic structure within the population**

4. DMRs and survival assessment

Little is known regarding the factors that influence bycatch survival

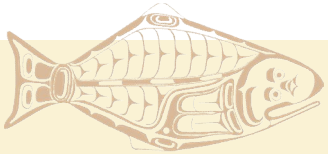
- **BYCATCH SURVIVAL ESTIMATES**

What is needed?

- **To introduce quantitative measurable factors that are linked to fish handling practices and to fish physiological condition and ultimately to survival in order to improve current DMR estimations**

Projects:

- ***Evaluation of the effects of fish handling practices on injury levels and the physiological condition of captured Pacific halibut***
- ***Investigate the relationship between physiological condition post-capture and survival as assessed by the use of accelerometer tags.***
- **FUTURE*: Improving estimates of survival of fish caught in the trawl fishery***



4. DMRs and survival assessment

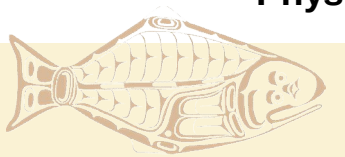
- ***Evaluation of the effects of fish handling practices on injury levels and the physiological condition of captured Pacific halibut***

Objective: Understand relationship between handling practices and physiological condition of captured Pacific halibut in the longline fishery

- **Assess injuries associated with release techniques (gangion cut, careful shake, hook straigthening).**
- **Determine the physiological condition of all captured fish with associated injury levels after different deck exposure times: condition factor index (Kn), energy (fat) levels, morphometric analyses.**
- **Measure the levels of stress and physiological disturbance indicators in the blood of all captured fish (cortisol, lactate, glucose, potassium, hematocrit).**

Deliverables:

- **Injury profile for different release techniques in the longline fishery**
- **Physiological assessment of fish handling practices: fish condition index post-capture**



4. DMRs and survival assessment

- ***Investigate the relationship between physiological condition post-capture and survival as assessed by tagging.***

Objective: Measure post-release survival in Pacific halibut and relate it to physiological condition and capture-related events

- **Tag fish that have been exposed to different handling practices in the longline fishery with accelerometer tags in addition to conventional tags (wire).**
- **Assess survival of fish according to size and physiological conditon.**

Deliverables:

- **Information on post-release survival in relation to handling practices and physiological condition.**
- **Information on post-release survival in relation to size.**
- **Estimating DMRs by EM.**

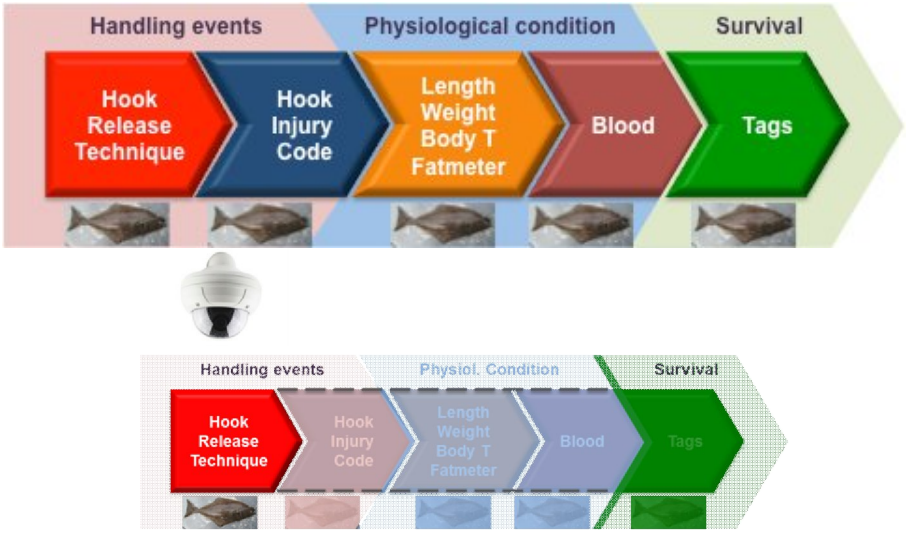
3. DMRs and survival assessment

NOAA FISHERIES
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

- **Saltonstall – Kennedy Program Funding (2017-2019): "*Improving discard mortality rate estimates in the Pacific halibut by integrating handling practices, physiological condition and post-release survival*". IPHC (coordinator) / APU – Anchorage, AK**

Dr. Brad Harris
Dr. Nathan Wolf

ALASKA PACIFIC UNIVERSITY



3. DMRs and survival assessment

- ***Improving estimates of survival of Pacific halibut in the trawl fishery***

Objective: Assess the conditi  **discarded Pacific halibut in the non-directed trawl fishery an** **nates of discard mortality rates**

- **Continue and capitalize c** **.g. Amendment 80 fleet) to plan collaborative research on**
- **Apply methods to assess** **captured halibut.**
- **Determine survival rates of discarded halibut after tagging.**
- **Relate physiological condition with survival rates of discarded halibut**

Deliverables:

- **Improved knowledge of survival of discarded halibut and, consequently, improved estimates of discard mortality rates in the trawl fishery.**

5. Genetics and genomics

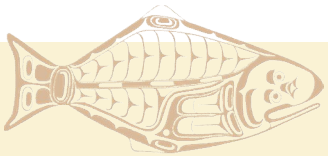
- **GENETIC STRUCTURE OF THE POPULATION**
- **GENOMIC TOOLS (e.g. GENOME)**

What is needed?

- **Improved knowledge on the genetic composition of the population**
- **Establish genomic resources for the species**
- **Genome-wide association studies to evaluate genetic effects of fishery-dependent and fishery-independent influences on growth, reproduction, nutrition, etc.**

New proposed studies:

- ***Population genetic studies***
- ***Sequencing of the Pacific halibut genome***

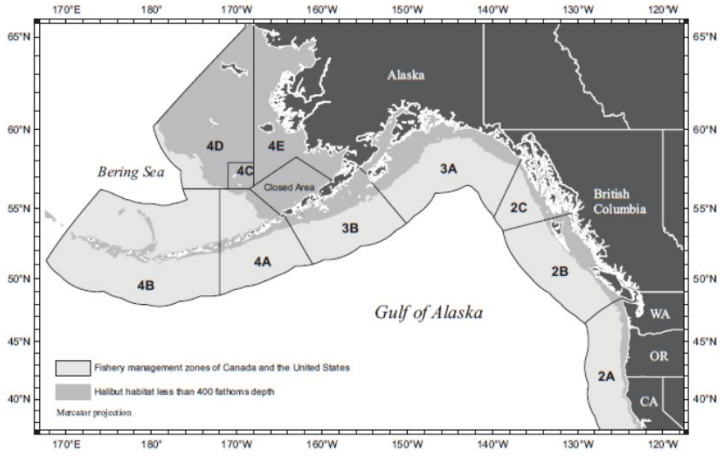


5. Genetics and genomics

- ***Population genetic studies***

Objective: Genetic characterization of Pacific halibut throughout its distribution range

- **Characterization of population structure by RAD sequencing and SNP analysis.**
- **Identification of possible genetic signatures of geographical origin**

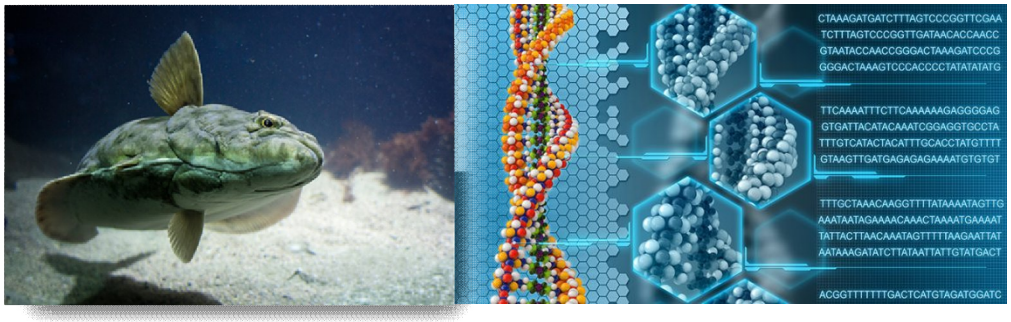


Dr. Lorenz Hauser

5. Genetics and genomics

- ***Pacific halibut genome***

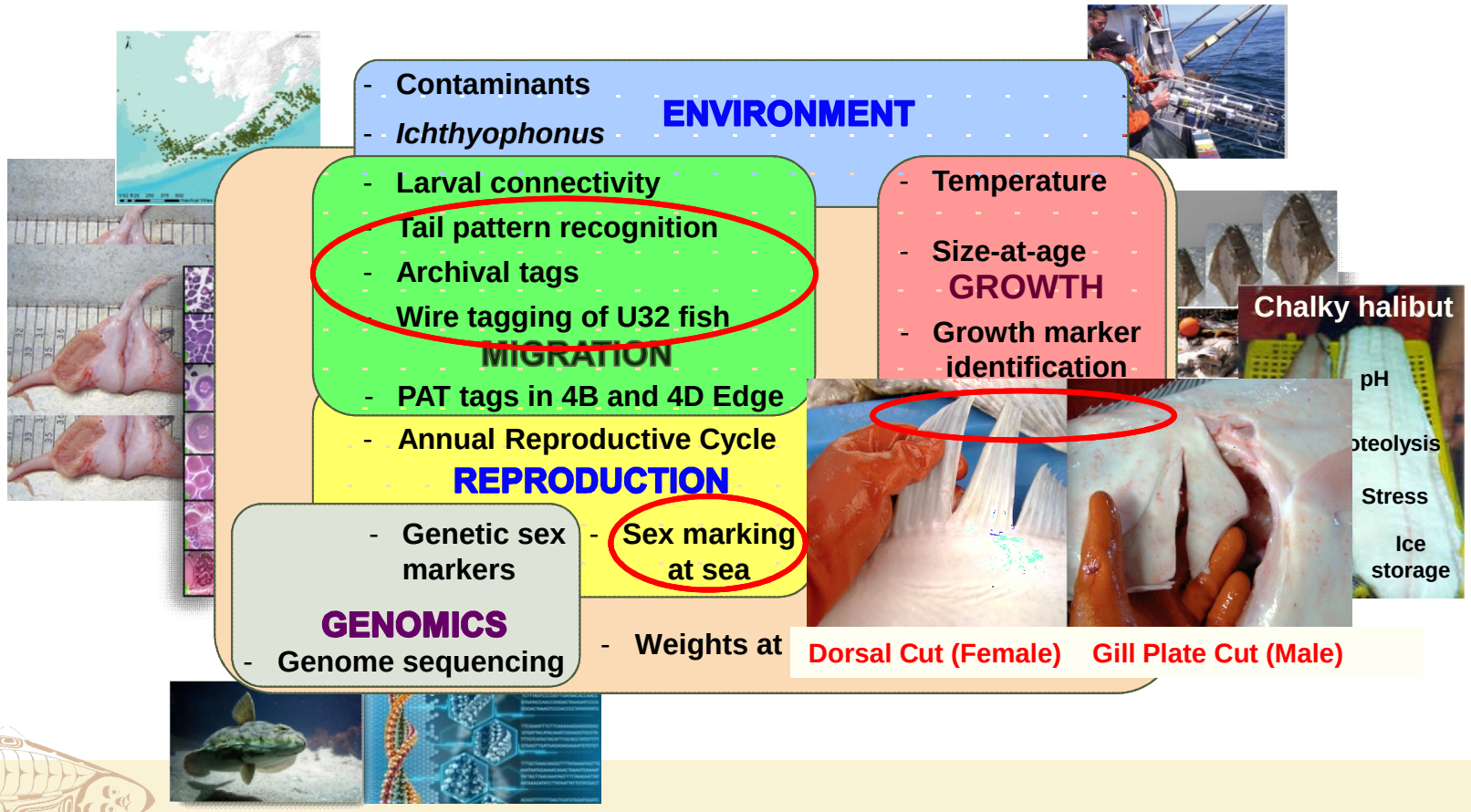
  Objective: Obtain a first draft sequence of the Pacific halibut genome



  - **Provide genomic resolution to genetic markers (SNPs or transcripts).**
  - **Identify genomic regions and genes responsible for temporal and spatial adaptive characteristics.**
  - **Genome-wide association studies to try to understand the genetic basis of growth, reproductive performance, migratory behavior and performance, etc.**
  - **Link genotype and phenotype.**

INRA 70 Years SCIENCE & IMPACT **Dr. Yann Guiguen** **Dr. Lorenz Hauser**

Research projects for 2017



Temporal chart of activities

	2016	2017	2018	2019	2020	2021
Reproduction		Annual reproductive cycle				
			Sex determination mechanisms			
	Sex identification