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

(Agenda Item 8.3)

Josep V. Planas
Biological and Ecosystem Science Branch Manager

IPHC Interim Meeting
28 – 29 November, 2017

INTERNATIONAL PACIFIC HALIBUT COMMISSION

L. Boitor

Outline of the presentation

- **Update on the research activities of the Biological and Ecosystem Science Branch**
- **Outcome of external funding applications**
- **Proposed research projects for 2018**

Paper IPHC-2017-IM093-11

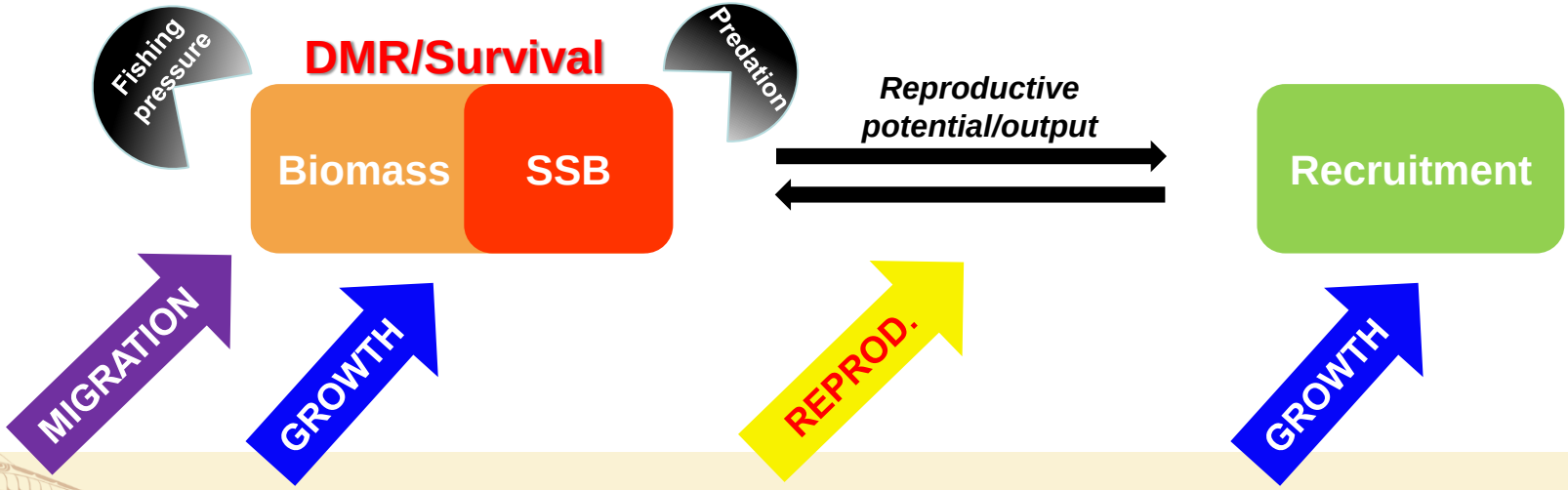
Outline of the presentation

- **Update on the research activities of the Biological and Ecosystem Science Branch**
- **Outcome of external funding applications**
- **Proposed research projects for 2018**

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 areas at IPHC

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

Update of research activities at IPHC

1. **Reproduction**
   - **SEX RATIO OF COMMERCIAL CATCH**
   - **IMPROVED MATURATION ESTIMATES OF SPAWNING BIOMASS**
2. Growth
3. DMRs and post-release survival assessment
4. Migration
5. Genetics and genomics

1. Reproduction

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

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

Projects:

1. ***Sex marking and identification of genetic sex (Projects 621.15 and 621.16)***
2. ***Full characterization of the annual reproductive cycle (Project 674.11)***
3. ***Identification of genetic reproductive markers***

Objectives:

- **Identification of genetic markers of sex and information on sex ratios.**
- **Knowledge on reproductive development, maturation, fecundity, 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.**

1. Reproduction

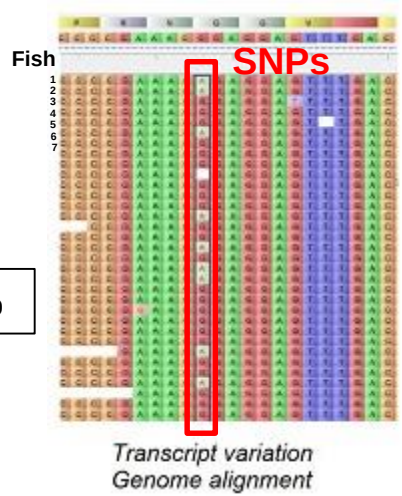
- ***Development of genetic markers for sex identification (Project 621.16)***

Objectives: To identify genetic markers for sex identification in the commercial catch

- **Restriction site-associated DNA sequencing (RADseq) approach**

  - **95 fish (55 female and 40 male) sequenced**
  - **40,308 loci identified**
  - **56 loci linked to sex (70 SNPs) based on FST values ≥ 0.4**
  - **Most females heterozygous and most males homozygous (ZW/ZZ)**
  - **3 loci found only in females (0 only in males)**
  - **TaqMan assays developed for 2 sex-linked loci: Hs10183, Hs23885**

Genetic assay accuracy (based on 199 morphologically sexed fish): 97.5%



Dr. Dan Drinan
Dr. Lorenz Hauser

Drinan, Loher and Hauser (2017) *J. Heredity*. In Press

1. Reproduction

- ***Sex marking at sea and validation of genetic sex (Project 621.15)***

Objectives: To establish a method for physically marking sex by the commercial fleet and validation of marking efficiency by genetic sex identification

Dorsal Cut (Female) Gill Plate Cut (Male)

- **2016 (Reg Area 2B; 10 R/V; 288 samples)**

79% marking accuracy (validated genetically)

- **2017 (Coastwide; 87 R/V; 929 samples)**

??% marking accuracy (validated genetically)

2017

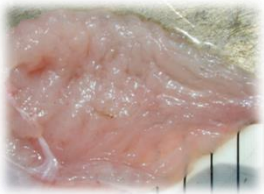
Reg Area	Sampled trips	Number of fish
2A	36	70
2B	5	84
2C	16	116
3A	10	113
3B	9	292
4A	2	77
4B	2	95
4C	4	86
4D	1	19
TOTAL	84	929

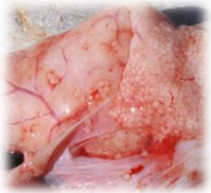
- **71 US vessels**
- **16 BC vessels**
- **Wide participation WA Tribes**

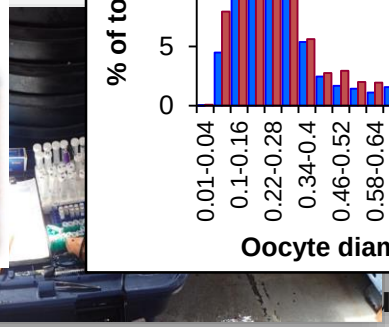
1. Reproduction

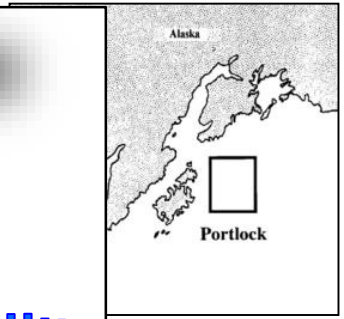
- ***Full characterization of the annual reproductive cycle (Project 674.11)***

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









c Jan Feb Mar Apr May Jun Jul Aug

2018

September 2017: 27 ♀ / 30 ♂

October 2017: 30 ♀ / 30 ♂

November 2017: 30 ♀ / 30 ♂

- **Comprehensive re… …lt population in order to improve our estimate of actual spawning biomass**

1. Reproduction

- ***Identification of genetic reproductive markers by RNA sequencing***

Ovarian genes

Sample transcript ID	Length (nt)	Database	Database ID	Identity (%)	Gene_symbol	Annotation	Function
TRINITY_DN13531_c0_g1_i1	3754	Danio rerio	ENSDARP00000004431	89,31	acvr1ba	activin A receptor, type IBa	Oogenesis
TRINITY_DN31883_c0_g1_i1	585	Danio rerio	ENSDARP00000121689	74,74	adamts2	ADAM metallopeptidase with thrombospondin type 1 motif, 2	Ovulation
TRINITY_DN14738_c0_g1_i1	3062	Danio rerio	ENSDARP00000088795	82,07	ar	androgen receptor	Hormone signaling
TRINITY_DN18096_c0_g1_i1	1654	Danio rerio	ENSDARP00000076033	76,81	aqp10b	aquaporin 10b	Oocyte hydration
TRINITY_DN18849_c1_g1_i1	1680	Danio rerio	ENSDARP00000112455	94,97	bmp1a	bone morphogenetic protein 1a	Oogenesis
TRINITY_DN16877_c1_g1_i1	976	Danio rerio	ENSDARP00000111604	70,78	cyp19a1a	cytochrome P450, family 19, subfamily A, polypeptide 1a	Aromatase (estrogen production)
TRINITY_DN16252_c0_g1_i1	2580	Danio rerio	ENSDARP00000124026	76,09	ddx4	DEAD (Asp-Glu-Ala-Asp) box polypeptide 4	Oogonia marker
TRINITY_DN23892_c0_g1_i1	232	Danio rerio	ENSDARP00000073932	71,62	EGFR	epidermal growth factor receptor	Maturational signaling
TRINITY_DN4356_c0_g1_i1	209	Uniprot	Q4JK73	66,67	HSD17B11	Estradiol 17-beta-dehydrogenase 11	Steroidogenesis
TRINITY_DN21356_c3_g1_i2	4620	Uniprot	Q9W6M2	80,88	esr2	Estrogen receptor beta	Hormone signaling
TRINITY_DN6202_c1_g1_i1	287	Danio rerio	ENSDARP00000096529	79,79	fshr	follicle stimulating hormone receptor	Hormone signaling
TRINITY_DN9106_c0_g1_i1	2006	Danio rerio	ENSDARP00000061827	80,39	foxl2	forkhead box L2	Female sex differentiation
TRINITY_DN21868_c0_g1_i1	306	Danio rerio	ENSDARP00000055566	70,83	gnrhr4	gonadotropin releasing hormone receptor 4	Hormone signaling
TRINITY_DN16738_c0_g1_i1	1391	Danio rerio	ENSDARP00000059752	71,32	inhbb	inhibin, beta B	Oogenesis
TRINITY_DN21305_c0_g1_i1	1466	Uniprot	Q90674	62,65	LHCGR	Lutropin-choriogonadotropic hormone receptor	Hormone signaling
TRINITY_DN12886_c1_g1_i1	771	Danio rerio	ENSDARP00000109370	82,1	pgr	progesterone receptor	Maturational signal
TRINITY_DN15432_c0_g1_i1	2592	Danio rerio	ENSDARP00000003684	80,26	ptgs2b	prostaglandin-endoperoxide synthase 2b	Prostaglandin synthesis
TRINITY_DN14537_c0_g1_i1	3164	Danio rerio	ENSDARP00000006091	77,49	mmp2	matrix metallopeptidase 2	Ovulation
TRINITY_DN24972_c0_g1_i1	292	Uniprot	P41245	76,92	Mmp9	Matrix metalloproteinase-9	Ovulation

Testicular genes

Sample transcript ID	Length (nt)	Database	Database ID	Identity (%)	Gene_symbol	Annotation	Function
TRINITY_DN28811_c1_g1_i2	2574	Danio rerio	ENSDARP00000088795.3	71,15	ar	androgen receptor	Spermatogenesis
TRINITY_DN37544_c0_g1_i1	248	Uniprot	sp|C6KI89|CTSG2_MOUSE	68,75	Catsperg2	Cation channel sperm-associated protein subunit gamma 2	Sperm activation
TRINITY_DN32484_c1_g1_i1	1411	Danio rerio	ENSDARP00000123870.1	78,57	ddx4	DEAD (Asp-Glu-Ala-Asp) box polypeptide 4	PGC marker
TRINITY_DN34322_c0_g1_i1	2573	Uniprot	sp|Q801F8|DMRT1_ORYLA	65,77	dmrt1	Doublesex- and mab-3-related transcription factor 1	Male sex differentiation factor
TRINITY_DN23128_c0_g1_i1	2126	Danio rerio	ENSDARP00000136983.1	89,68	fsta	follistatin a	Hormone
TRINITY_DN46346_c0_g1_i1	624	Danio rerio	ENSDARP00000130239.1	80,56	INHBB	inhibin beta B	Hormone receptor
TRINITY_DN49968_c0_g1_i1	310	Danio rerio	ENSDARP00000131027.1	79,61	gnrhr1	gonadotropin releasing hormone receptor 1	Hormone receptor
TRINITY_DN15829_c0_g2_i1	2899	Danio rerio	ENSDARP00000089386.3	82,09	nanos3	nanos homolog 3	Spermatogonial marker
TRINITY_DN32323_c1_g1_i1	2763	Danio rerio	ENSDARP00000109370.2	83,42	pgr	progesterone receptor	Hormone receptor
TRINITY_DN6999_c1_g1_i1	345	Danio rerio	ENSDARP00000104772.2	74,56	ptgs1	prostaglandin-endoperoxide synthase 1	Prostaglandin production
TRINITY_DN20678_c0_g1_i1	234	Danio rerio	ENSDARP00000136548.1	97,83	RSBN1	round spermatid basic protein 1	Spermatid marker
TRINITY_DN33366_c1_g1_i5	3258	Danio rerio	ENSDARP00000104616.2	89,27	strbp	spermatid perinuclear RNA binding protein	Spermatid marker
TRINITY_DN34579_c8_g1_i1	635	Danio rerio	ENSDARP00000106978.2	92,67	sox9a	SRY (sex determining region Y)-box 9a	Male sex differentiation factor
TRINITY_DN6843_c0_g1_i1	235	Danio rerio	ENSDARP00000023907.6	79,49	star	steroidogenic acute regulatory protein	Testicular steroidogenesis

Halibut gonadal transcriptome dataset

Primary research areas at IPHC

1. Reproduction
2. **Growth**
   - **CHANGES IN SIZE AT AGE/BIOMASS**
   - **TOOLS TO ASSESS FISH CONDITION**
3. DMRs and post-release survival assessment
4. Migration
5. Genetics and genomics

2. Growth

Little is known regarding what factors influence growth in this species

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

Projects:

1. ***Identification and validation of physiological markers for growth (Project 673.14)***
2. ***Evaluation of growth patterns and effects of environmental influences (NPRB 1704)***

Objectives:

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

2. Growth

1. Mass identificati ***4)***

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	[illegible]	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*	[illegible]	89.47	Energy metabolism
Histone deacetylase 1	*hdac1*	2490	96.15	Muscle repressor
Insulin-like growth factor 2 receptor	*igf2r*	511	70.52	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*	[illegible]	79.8	Muscle growth
Myostatin b	*mstnb*	[illegible]	95.74	Growth regulator
Mechanistic target of rapamycin	*mtor*	1153	97.92	Protein synthesis
Myogenic factor 6	*myf6*	819	[illegible].19	Muscle growth
Myosin, heavy polypeptide 1.3, skeletal muscle	*myh1.3*	246	86.42	Muscle growth
Myoblast determination protein 1 homolog	*myod*	2497	72.67	Muscle development
Myozenin 1a	*myoz1a*	[illegible]	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

2. 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.

- **Establishment of different growth trajectories in juvenile fish in captivity to identify molecular and biochemical signatures of growth patterns.**
  - ***Manipulating growth rates (ration, density, thermal- or fasting-induced compensation, etc.):***

Low rate *Normal rate* *High rate*

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

Samples collected in NMFS trawl survey
In 2016 and 2017 from 3 size categories:
- <40 cm length
- 40-60 cm length
- 60-80 cm length

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

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

^{13}C, ^{15}N

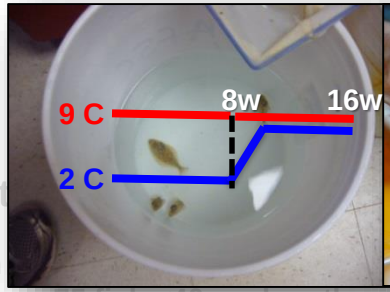
ALASKA PACIFIC UNIVERSITY

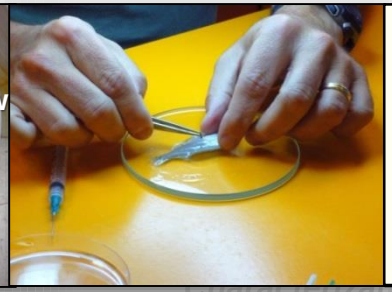
2. Growth

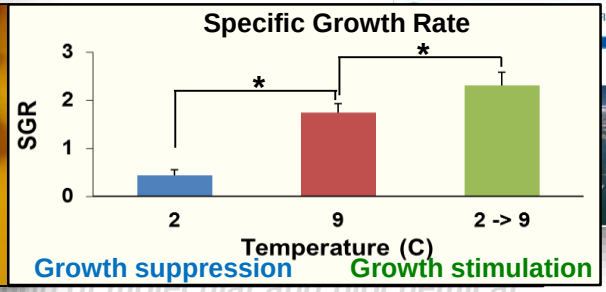
- ***Evaluation of growth patterns and effects of environmental influences***

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

  - **Establishment of different growth trajectories in juvenile fish in captivity to identify molecular and biochemical signatures of growth patterns.**







  - Evaluat

In
- - 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

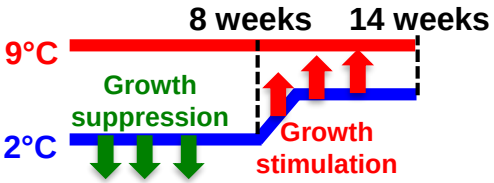
  - Isotopic tissue turnover to trace dietary and/or habitat shifts

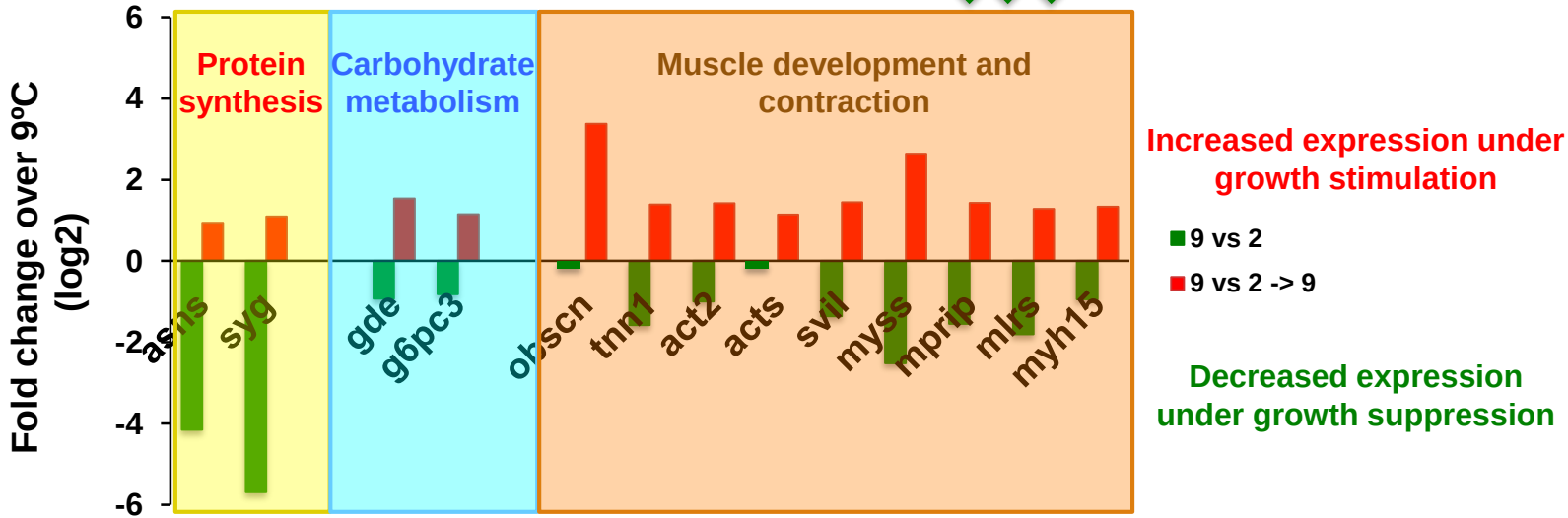
^{13}C, ^{15}N

2. Growth

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

Identification of genes that respond to temperature-induced growth alterations





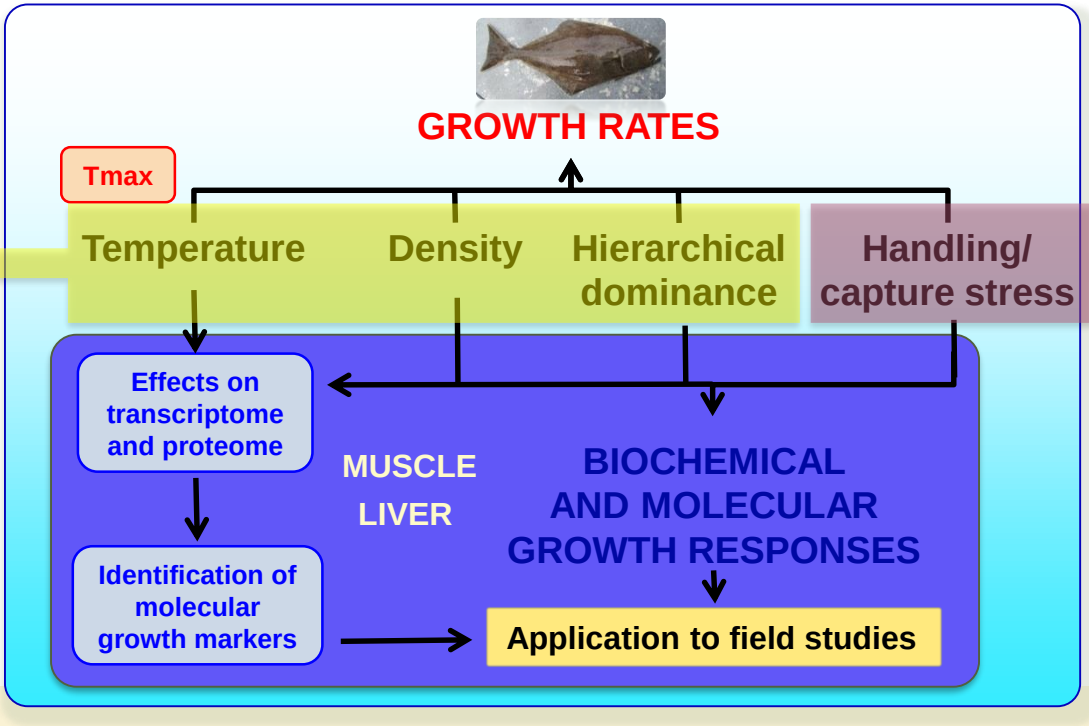
Potential molecular markers for temperature-regulated growth

2. Growth

- **NPRB Grant 1704 (2017-2019)**: "***Somatic growth processes in the Pacific halibut (Hippoglossus stenolepis) and their response to temperature, density and stress manipulation effects***". **IPHC / AFSC – Newport, OR**

Dr. Josep Planas (PI)

Dr. Thomas Hurst



Environmental / ecological conditions (i.e. nursery areas)

Discard survival / fitness

2. Growth

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

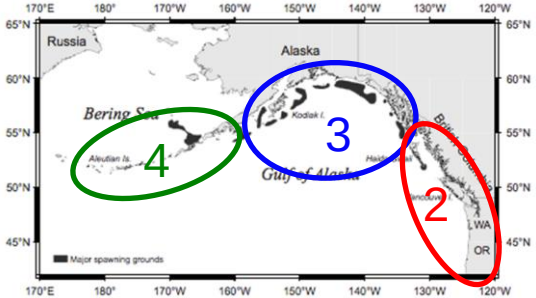
  Objective: Identify molecular, biochemical and isotopic profiles characteristic of specific growth patterns and evaluate potential effects of environmental influences.

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

Samples collected in NMFS trawl survey In 2016 and 2017 from 3 size categories:
- **<40 cm length**
- **40-60 cm length**
- **60-80 cm length**

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

- **Phase 2: Regional monitorization of growth patterns**



2. Growth

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

Relate to catch efforts in FISS in time and space model

- Identify the optimal environmental conditions for growth.

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**

Primary research areas at IPHC

1. Reproduction
2. Growth
3. **DMRs and post-release survival assessment**
4. Migration
5. Genetics and genomics

- **BYCATCH SURVIVAL ESTIMATES**

3. DMRs and survival assessment

Little is known regarding the factors that influence bycatch survival

- **BYCATCH SURVIVAL ESTIMATES**

Project components:

1. ***Evaluate the effects of fish handling practices on injury levels and the physiological condition of captured Pacific halibut (Project 672.13, S-K Grant)***
2. ***Investigate the relationship between physiological condition post-capture and survival as assessed by the use of accelerometer tags (S-K Grant)***
3. ***Explore the applicability of electronic monitoring in DMR estimations (S-K Grant)***

Objectives:

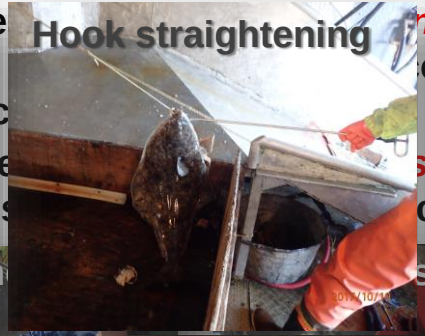
- **To introduce quantitative measurable factors that are linked to fish handling practices and to fish physiological condition and ultimately to survival in order to improve current DMR estimations**

3. DMRs and survival assessment

- ***Evaluate 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 straightening, hook stripping).



Deliverables

- Injury
- Physio

ost-capture

3. DMRs and survival assessment

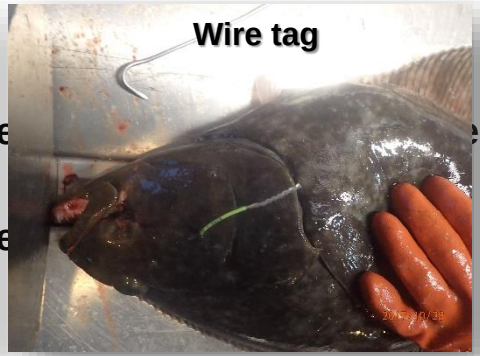
- ***Investigate the relationship between physiological condition post-capture and survival as assessed by tagging***

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 condition.**

Deliverab

- **Info** **re** **es and phys**
- **Info** **re**



3. DMRs and survival assessment

- ***Explore the applicability of electronic monitoring in DMR estimations***

Objective: Test the ability of electronic monitoring to capture fish handling events and fish condition and relate it to survival

- **Deploy electronic monitoring (EM) system on a longline vessel.**
- **Video record fish handling events during capture.**
- **Determine injury profile by release method.**

Delive

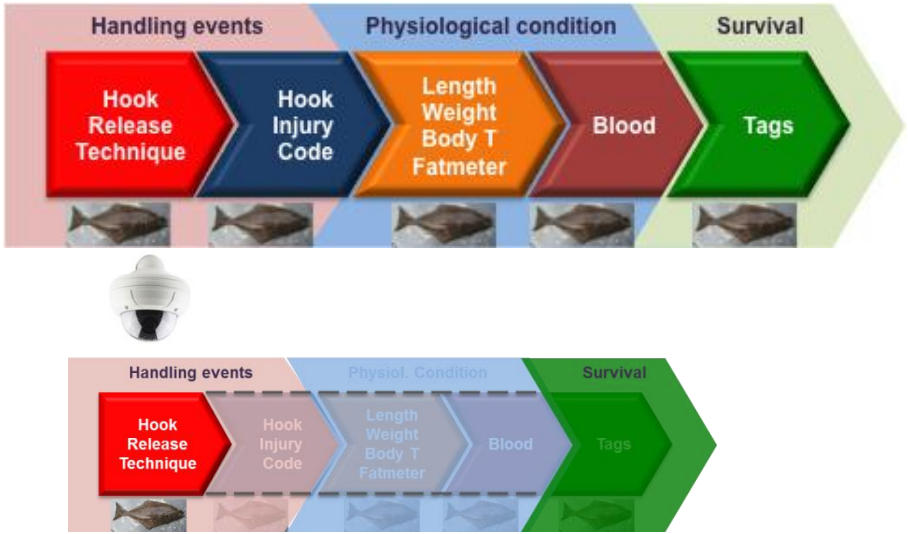
- **E h and associated injury levels and projected survival.**

3. DMRs and survival assessment

- **Saltonstall – Kennedy Grant NA17NMF4270240 (2017-2019): "*Improving discard mortality rate estimates in the Pacific halibut by integrating handling practices, physiological condition and post-release survival*". IPHC / APU – Anchorage, AK**

Dr. Josep Planas (PI)
Claude Dykstra
Dr. Tim Loher
Dr. Ian Stewart
Dr. Allan Hicks

November 2017
- 2 6-day trips (GOA, F/V Kema Sue)
- 38 sets (8 standard skates/set)
- 3 randomized treatments/skate
- 1,048 fish sampled and wire tagged
- 79 fish tagged with accelerometer tags (mini satellite tags; 96 days recording)
- EM on each haul



Dr. Brad Harris
Dr. Nathan Wolf

Primary research areas at IPHC

1. Reproduction
2. Growth
3. DMRs and post-release survival assessment
4. **Migration**
   - **ADULT FEEDING AND REPRODUCTIVE MIGRATION**
   - **LARVAL DISPERSAL**
5. Genetics and genomics

4. Migration

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

Projects:

1. ***Juvenile and adult feeding migrations (Project 670.11)***
2. ***Tail pattern recognition (Project 675.11)***
3. ***Adult dispersal on Bowers Ridge (Reg. Area 4B) (Project 650.21)***
4. ***Larval migration and connectivity***

Objectives:

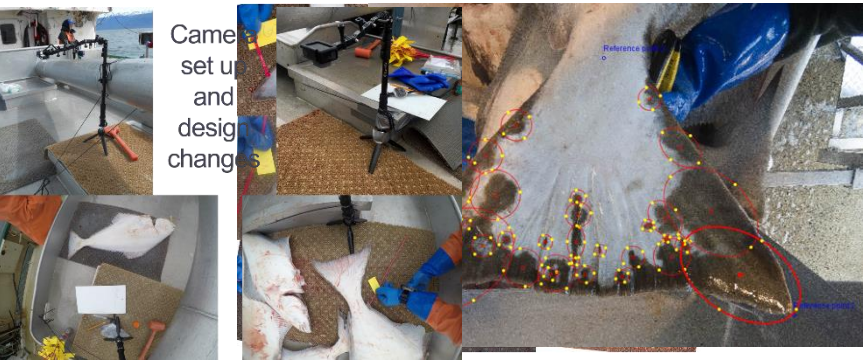
- **To improve our understanding on larval, juvenile and reproductive migration.**

4. Migration

- ***Juvenile and adult migration studies (Project 670.11)***
  - **Juvenile wire tagging:**
    - **NMFS trawl tagging project: 1469 fish**
      - **713 fish in GOA and 756 fish in BS**
  - **Adult wire tagging:**
    - **IPHC survey tagging project**
      - **2016 pilot study in area 4D (U32)**
      - **2017 coast-wide study (U32): 1927 fish**

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

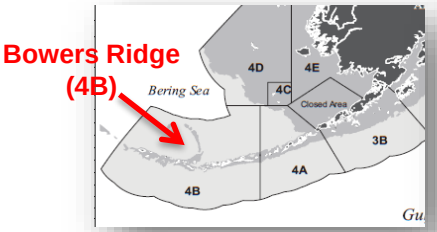
- ***Tail pattern recognition (Project 675.11)*** **2017 Intern Project**



- **Blind side of tail is preferable for imaging.**
- **Spots and patterns appear to be unique.**
- **Tail markings can be used to identify individuals with image recognition software.**
- **Promising for implementation in FISS.**

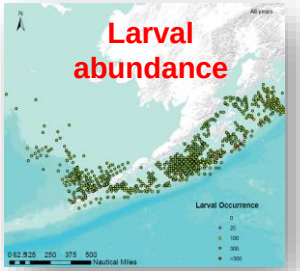
4. Migration

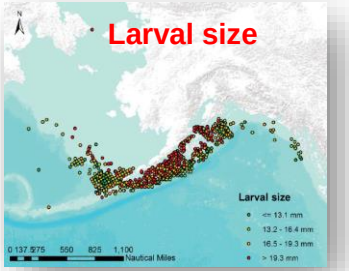
- ***Reproductive and annual migration (Project 650.21)***
  - **In 2017: 22 adult fish tagged with miniPAT tags**
    No satellite data received yet (expected in January and July 2018).



- ***Larval migration and connectivity***

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





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

Primary research areas at IPHC

1. Reproduction
2. Growth
3. DMRs and post-release survival assessment
4. Migration
5. **Genetics and genomics**

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

5. Genetics and genomics

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

Projects:

1. Sequencing of the Pacific halibut genome (Project 673.13)

2. Population genetic studies (PLANNED)

Objectives:

- **Improve knowledge on the genetic composition of the population**
- **Establish genomic resources for the species**
- **Evaluate effects of fishery-dependent and fishery-independent influences on growth, reproduction, nutrition, etc.**

5. Genetics and genomics

- ***Pacific halibut genome sequencing (Project 673.13)***

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

- **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 required to complete assembly.**

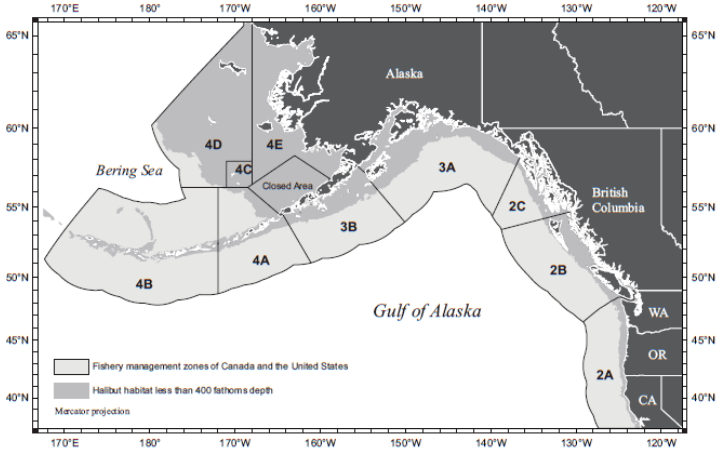
Dr. Yann Guiguen **Dr. Lorenz Hauser**

5. Genetics and genomics

- ***Population genetic studies (PLANNED)***

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

Outline of the presentation

- Update on the research activities of the Biological and Ecosystem Science Branch
- **Outcome of external funding applications**
- Proposed research projects for 2018

Research proposals submitted for external funding in 2017

Project #	Grant agency	Project name	Partners	IPHC Budget (US$)	PI	Management implications	Submission status
1	**Saltonstall-Kennedy NOAA**	Improving discard mortality rate estimates in the Pacific halibut by integrating handling practices, physiological condition and post-release survival	Alaska Pacific University	223,220	Planas (lead PI) Dykstra Loher Stewart Hicks	Bycatch estimates	Awarded
2	**NPRB**	Somatic growth processes in the Pacific halibut (Hippoglossus stenolepis) and their response to temperature, density and stress manipulation effects	AFSC-NOAA-Newport	122,264	Planas (lead PI)	Changes in biomass/size-at-age	Awarded
3	**NPRB**	Larval transport, supply, and connectivity of Pacific halibut between the Gulf of Alaska and the Bering Sea	AFSC-NOAA-Seattle UAF	8,000	Sadorus Planas Stewart	Biomass distribution	Rejected
4	**Essential Fish Habitat NOAA**	Validating biochemical markers of growth for habitat assessment in flatfishes	AFSC-NOAA-Newport	35,000	Hurst (lead PI) Planas	Changes in biomass/ recruitment	Rejected
5	**NFWF**	Evaluating virtual vitality assessments of discarded Pacific halibut	AFSC-NOAA, APU, NFR	-	Harris (APU), Dykstra	Bycatch estimates	Rejected

Outcome of external funding applications

Project #	Grant agency	Project name	Partners	IPHC Budget ($US)	PI/IPHC Staff	Management implications	Submission status
1	**Saltonstall -Kennedy NOAA**	**Improving discard mortality rate estimates in the Pacific halibut by integrating handling practices, physiological condition and post-release survival**	Alaska Pacific University	$223,220	Planas (lead PI) Dykstra Loher Stewart Hicks	Discard mortality estimates	**Awarded** Started in September 2017
2	**NPRB**	**Somatic growth processes in the Pacific halibut (*Hippoglossus stenolepis*) and their response to temperature, density and stress manipulation effects**	AFSC-NOAA-Newport	$131,891	Planas (lead PI) Rudy	Changes in biomass/size-at-age	**Awarded** Started in September 2017
			Total awarded ($US)	**$355,111**			

Temporal chart of activities

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

NPRB

Saltonstall-Kennedy

Outline of the presentation

- Update on the research activities of the Biological and Ecosystem Science Branch
- Outcome of external funding applications
- **Proposed research projects for 2018**

Research projects proposed for 2018

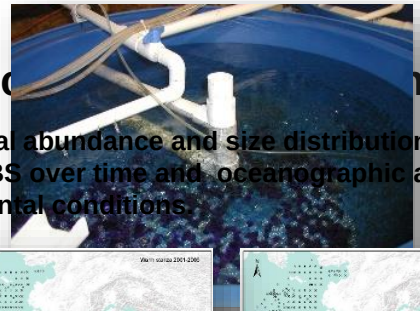
Project #	Project Name	Priority	Budget ($US)	External funding for FY2018 ($US)	Management implications
New Projects					
2018-01	Influence of thermal history on growth	High	$136,004	-	Changes in biomass / size-at-age
2018-02	Adult captive holding studies	High	$53,395	-	Changes in biomass / size-at-age / larval distribution
2018-03	Whale detection methods	High	$37,511	-	Mortality estimation
2018-04	Larval connectivity modeling	High	$20,000	-	Larval distribution
Continuing Projects					
621.16	Development of genetic sexing techniques	High	$33,928	-	Sex composition of the catch
642.00	Assessment of Mercury and other contaminants	Medium	$8,400	-	Environmental effects
650.18	Archival tags: tag attachment protocols	High	$800	-	Adult distribution
650.21	Investigation of Pacific halibut dispersal in Regulatory Area 4B	High	$6,800	-	Spawning areas
661.11	Ichthyophonus Incidence Monitoring	Medium	$8,755	-	Environmental effects
669.11	At-sea Collection of Pacific Halibut Weight to Reevaluate Conversion Factors	High	$7,645	-	Length-weight relationship
670.11	Wire tagging of Pacific halibut on NMFS trawl and setline surveys	High	$12,840	-	Juvenile and adult distribution
672.12	Condition factors for tagged U32 Fish	High	$9,116	-	DMR estimates
672.13	Discard mortality rates and injury classification profile by release method	High	$1,037	$255,402	DMR estimates
673.13	Sequencing the Pacific halibut genome	High	$32,500	-	Environmental/Fishery effects
673.14	Identification and validation of markers for growth	High	$25,681	$57,773	Changes in biomass / size-at-age
674.11	Full characterization of the annual reproductive cycle	High	$121,488	-	Maturity assessment
675.11	Tail pattern recognition	High	$3,900	-	Juvenile and adult distribution
	Total - New Projects		**$251,910**		
	Total - Continuing Projects		**$273,090**		
	Overall Total (all projects for FY2018)		**$525,000**		
	External Funding (for FY2018) ($US)			**$313,175**	

New research projects proposed for 2018

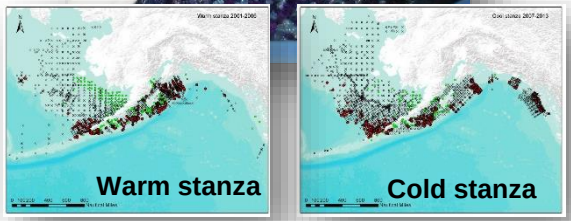
- **Influence of thermal history on growth**
  - Relate temperature history to individual growth as assessed by archival tagging
  - Tag U32 fish with electronic archival tags recording temperature and depth.
  - Quantify growth patterns in captured fish and relate them to their thermal history.
  - Compare archival data analyses with otolith microchemistry (O^{18}).

- **Whale**
  - Test ac… …nologies for whale d…
  - Relate v… …acific halibut capture…

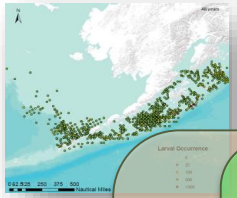
- **Adult captive holding studies**
  - Test permanence of individual tail markings (Tail Pattern Recognition)
  - Conduct diet manipulation experiments: fat meter validation, stable isotope studies on growth (N^{15}/C^{13})
  - Conduct temperature manipulation experiments for growth and O^{18} calibration studies
  - Perform larval swimming performance tests
  - Test transgenerational marking approaches through broodstock labeling



- **Larval …ng**
  - Model larval abundance and size distribution in the GOA and BS over time and oceanographic and environmental conditions.



Research projects for 2018



- Contaminants
- *Ichthyophonus*

ENVIRONMENT

- Larval connectivity
- Tail pattern recognition
- Archival tags
- Wire tagging of U32 fish

MIGRATION

- PAT tags in 4B
- Annual Reproductive Cycle

REPRODUCTION

- Genetic sex identification

GENOMICS

- Genome sequencing

- Weights at sea
- Whale detection

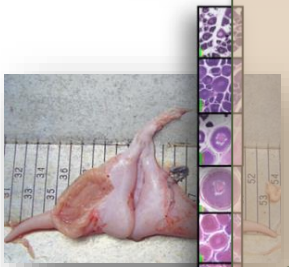
- Temperature
- Size-at-age

GROWTH

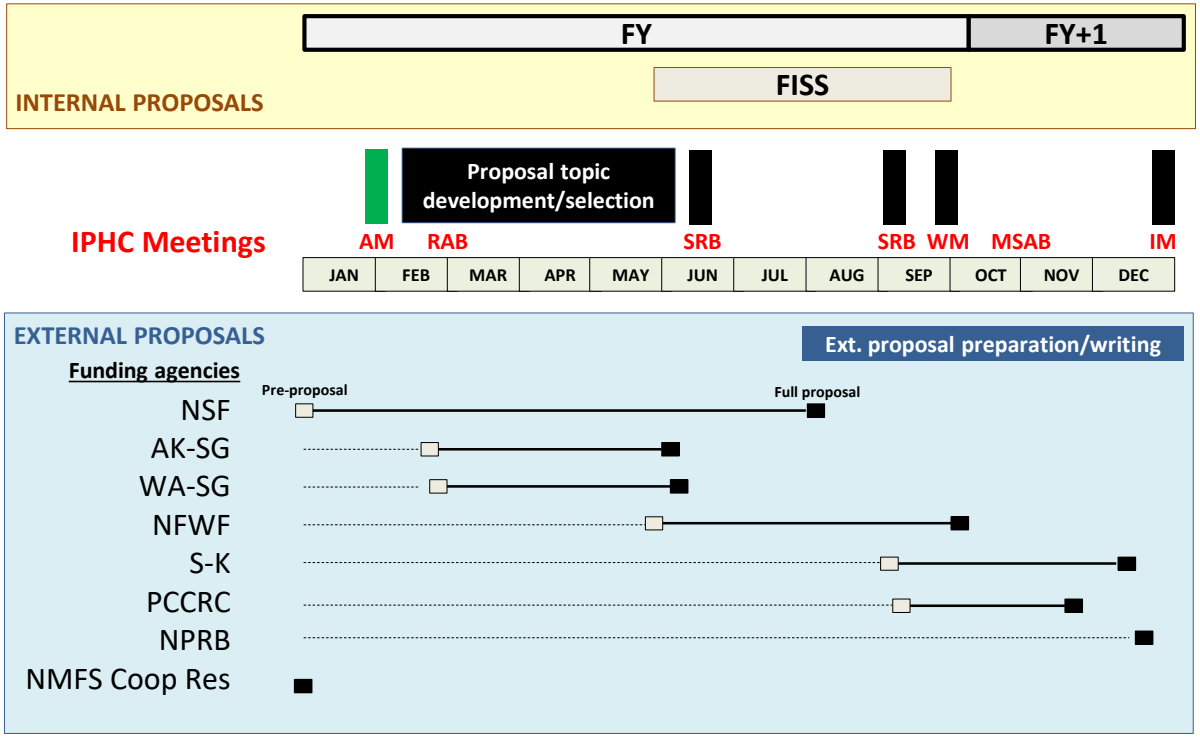
- Growth marker validation
- Condition factor
- Injury profiles
- Discard survival
- EM

DMR

MANAGEMENT



New Research Project Selection Process

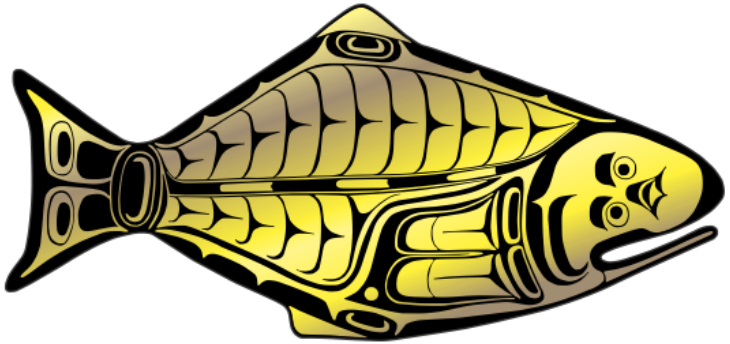


Special research projects with outside agencies conducted in 2017

Project #	Outside agency	Project name	Regulatory area	Status	Management implications
1	**NOAA**	Testing the efficacy of stereoscopic electronic monitoring for species identification, enumeration and length measurement	2B, 2C, 3A, 3B	New	Integrating EM into observer program
2	**PBS-DFO**	Opportunistic shark sampling	2B	New	Understanding shark biology and distribution
3	**WDWF**	Yelloweye rockfish tagging on rockfish index stations	2A	New	Distribution
4	**NOAA**	Longnose skate age and maturity	2A, 2B, 2C, 3A, 3B, 4A	New	Age, growth and maturity
5	**PBS-DFO**	Rockfish sampling in area 2B	2B	Continuing	Age, size and maturity
6	**WDFW**	Rockfish sampling in area 2A	2A	Continuing	Species composition, relative abundance
7	**ADFG**	Yelloweye rockfish enumeration in Alaska	2C, 3A	Continuing	Distribution and assessment
8	**ADEC**	Environmental contaminant sampling	2C, 3A, 3B	Continuing	Environmental monitoring
9	**NOAA**	Pacific cod length frequency sampling	4A, 4B and 4D	Continuing	Stock assessment
10	**NMFS-Auke Bay**	Spiny dogfish sampling	2, 3 and 4	Continuing	Length, sex and distribution
11	**Seattle Aquarium**	Sixgill shark genetics	All areas	Continuing	Population genetics and distribution

Please stand by as we bring up the next presentation

INTERNATIONAL PACIFIC



HALIBUT COMMISSION