



Report on current and future Biological and Ecosystem Science Research activities

> Agenda item: 9.1 IPHC-2023-IM099-14 (J. Planas)



# **Biological and Ecosystem Science Research**



Slide 2

### **5-Year PIRM and management implications**

#### 5-Year Program of Integrated Research and Monitoring

Primary search Areas	Main Objectives	Management implications
tion and on dynamics		
on		
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survival ent		
echnology		
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#### **Research activity prioritization**

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Research areas	Research activities	Research outcomes	Relevance for stock assessment	Relevance for MSE	Specific analysis input SA Rank		MSE Rank	Research priorization
	Population structure	Population structure in the Convention Area	Altered structure of future stock assessments		If 4B is found to be functionally isolated, a separate assessment may be constructed for that IPHC Regulatory Area	2. Biological input	t 1. Biological parameterization and validation of movement estimates and t recruitment distribution	2
Migration and population dynamics	Distribution	Assignment of individuals to source populations and assessment of distribution changes	Improve estimates of productivity	Improve parametization of the Operating Model	Will be used to define management targets for minimum spawning biomass by Biological Region	3. Biological input		2
	Larval and juvenile connectivity studies	Improved understanding of larval and juvenile distribution	Improve estimates of productivity		Will be used to generate potential recruitment covariates and to inform minimum spawning biomass targets by Biological Region	3. Biological input	<ol> <li>Biological parameterization and validation of movement estimates</li> </ol>	2
	Histological maturity assessment	Updated maturity schedule		Improve simulation of spawning biomass in the Operating Model	Will be included in the stock assessment, replacing the current schedule last updated in 2006		2. Biological parameterization and t validation of recruitment variability and distribution	1
	Examination of potential skip spawning	Incidence of skip spawning	Scale biomass and		Will be used to adjust the asymptote of the maturity schedule, if/when a time-series is available this will be used as a direct input to the stock assessment			1
Reproduction	Fecundity assessment	Fecundity-at-age and -size information	reference point estimates		Will be used to move from spawning biomass to egg-output as the metric of reproductive capability in the stock assessment and management reference points	1. Biological input		1
	Examination of accuracy of current field macroscopic maturity classification	Revised field maturity classification			Revised time-series of historical (and future) maturity for input to the stock assessment			1
		Identification and application of markers for growth pattern evaluation	Scale stock productivity and reference point estimates	Improve simulation of variability and allow for scenarios investigating climate change	May inform yield-per-recruit and other spatial evaluations of productivity that support mortality limit-setting		3. Biological parameterization and validation for growth projections	5
Growth	Evaluation of somatic growth variation as a driver for changes in size-at-age	Environmental influences on growth patterns			May provide covariates for projecting short-term size-at-age. May help to delineate between effects due to fishing and those due to environment, thereby informing appropriate management response			5
		Dietary influences on growth patterns and physiological condition			May provide covariates for projecting short-term size-at-age. May help to deleineate between effects due to fishing and those due to environment, thereby informing appropriate management response			5
	Discard mortality rate estimate: longline fishery	Experimentally-derived		Improve estimates of stock productivity	Will improve estimates of discard mortality, reducing potential bias in stock assessment results and management of mortality limits	– 1. Fishery yield	1. Fishery parameterization	4
Mortality and survival assessment	Discard mortality rate estimate: recreational fishery	DMR	Improve trends in unobserved mortality		Will improve estimates of discard mortality, reducing potential bias in stock assessment results and management of mortality limits			4
	Best handling and release practices	Guidelines for reducing discard mortality			May reduce discard mortality, thereby increasing available yield for directed fisheries	2. Fishery yield		4
Fishing technology	Whale depredation accounting and tools for avoidance	New tools for fishery avoidance/deterence; improved estimation of depredation mortality	Improve mortality accounting	Improve estimates of stock productivity	May reduce depredation mortality, thereby increasing available yield for directed fisheries. May also be included as another explicit source of mortality in the stock assessment and mortality limit setting process depending on the estimated magnitude	1. Assessment data collection and processing		3
	Bycatch reduction	Development of methods for reducing bycatch and better estimate mortality	Improve mortality accounting	Improve estimates of stock productivity	May reduce depredation mortality, thereby increasing available yield for directed fisheries. May also be included as another explicit source of mortality in the stock assessment and mortality limit setting process depending on the estimated magnitude	1. Assessment data collection and processing		3

#### Top research priorities for stock assessment

SA Rank	Research outcomes	Relevance for stock assessment	Specific analysis input	Research Area	Research activities
1. Biological input	Updated maturity schedule		Will be included in the stock assessment, replacing the current schedule last updated in 2006		Histological maturity assessment
	Incidence of skip spawning	Scale biomass and reference point estimates	Will be used to adjust the asymptote of the maturity schedule, if/when a time-series is available this will be used as a direct input to the stock assessment		Examination of potential skip spawning
	Fecundity-at-age and -size information		Will be used to move from spawning biomass to egg-output as the metric of reproductive capability in the stock assessment and management reference points	Reproduction	Fecundity assessment
	Revised field maturity classification		Revised time-series of historical (and future) maturity for input to the stock assessment		Examination of accuracy of current field macroscopic maturity classification
2. Biological input	Stock structure of IPHC Regulatory Area 4B relative to the rest of the Convention Area	Altered structure of future stock assessments	If 4B is found to be functionally isolated, a separate assessment may be constructed for that IPHC Regulatory Area		Population structure
3. Biological input	Assignment of individuals to source populations and assessment of distribution changes	Improve estimates of	Will be used to define management targets for minimum spawning biomass by Biological Region	Migration and population dynamics	Distribution
	Improved understanding of larval and juvenile distribution	productivity	Will be used to generate potential recruitment covariates and to inform minimum spawning biomass targets by Biological Region		Larval and juvenile connectivity studies
1. Assessment data	Sex ratio-at-age	Scale biomass and	Annual sex-ratio at age for the commercial fishery fit by the stock assessment	Dennelisetise	Sex ratio of current commercial landings
processing	Historical sex ratio-at-age	fishing intensity	Annual sex-ratio at age for the commercial fishery fit by the stock assessment	Reproduction	Historical sex ratios based on archived otolith DNA analyses
2. Assessment data collection and processing	New tools for fishery avoidance/deterence; improved estimation of depredation mortality	Improve mortality accounting	May reduce depredation mortality, thereby increasing available yield for directed fisheries. May also be included as another explicit source of mortality in the stock assessment and mortality limit setting process depending on the estimated magnitude	Fishing technology	Whale depredation accounting and tools for avoidance
1. Fishery yield	Physiological and behavioral responses to fishing gear	Reduce incidental mortality	May increase yield available to directed fisheries	Fishing technology	Biological interactions with fishing gear
2. Fishery yield	Guidelines for reducing discard mortality	Improve estimates of unobserved mortality	May reduce discard mortality, thereby increasing available yield for directed fisheries	Mortality and survival assessment	Best handling practices: recreational fishery

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#### **Top research priorities for MSE**

MSE Rank	Research outcomes	Relevance for MSE	Research Area	Research activities	
1. Biological parameterization and	Improved understanding of larval and juvenile distribution	Improve parametization of the		Larval and juvenile connectivity studies	
validation of movement estimates	Stock structure of IPHC Regulatory Area 4B relative to the rest of the Convention Area	Operating Model	Migration and population	Population structure	
2. Biological parameterization and validation of recruitment variability and distribution	Assignment of individuals to source populations and assessment of distribution changes	Improve simulation of recruitment variability and parametization of recruitment distribution in the Operating Model	dynamics	Distribution	
	Establishment of temporal and spatial maturity and spawning patterns	Improve simulation of recruitment variability and parametization of recruitment distribution in the Operating Model		Recruitment strength and variability	
3. Biological parameterization and validation for growth projections	Identification and application of markers for growth pattern evaluation				
	Environmental influences on growth patterns	and allow for scenarios	Growth	Evaluation of somatic growth variation as a driver for changes in size-at-age	
	Dietary influences on growth patterns and physiological condition				
1. Fishery parameterization	Experimentally-derived DMRs	Improve estimates of stock productivity	Mortality and survival assessment	Discard mortality rate estimate: recreational fishery	



#### Key research outputs informing management



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# **1. Migration and Population Dynamics**



- Substrate information: usSeabed database.
- B.C. substrate layer 100-m resolution – provided by Dr. Dana Haggarty (DFO).
- Next step: bathymetry layer.





# **1. Migration and Population Dynamics**





Low-coverage whole-genome resequencing (IcWGR): allows for screening genomic variation at very high resolution

#### **Objectives**

- 570 individuals
- 3 sequencing runs Illumina NovaSeq S4
- Mean coverage 3.5x
- 10,230,908 autosomal SNPs
- 4,725,899 (minor allele frequency ≥ 0.05)



# 2. Reproduction



Publications: Fish et al. (2020) <u>Journal of Fish Biology</u> **97**: 1880–1885 Fish et al. (2022) <u>Frontiers in Marine Science</u> **9**: 801759

- Generate estimates of fecundity at age
   and at size
- Monitor maturity schedules in Biological Regions 2 and 3

Age (yr)



# 3. Growth

5-Yr Research Plan (2017-2021)

(2022-2026)



Research outcomes: • Effects of temperature on growth rates

• Temperature-specific molecular responses

External collaborators: Behavioral Ecology Program at AFSC-NOAA (Newport, OR), Alaska Pacific University, UW External funding: NPRB Grant#1704 (Sept. 2017-Feb. 2020) Publications: Planas et al. (in preparation)



#### 4. Mortality and Survival Assessment



External funding: Saltonstall-Kennedy NOAA (2017-2020); NFWF (2019-2021); NPRB#2009 (2021-2022) Publications: Kroska et al. (2021) Conservation Physiology 9: coab001 Loher et al. (2022) North American Journal of Fisheries Management 42: 37-49

Dykstra et al. (2023) Submitted.





## 4. Mortality and Survival Assessment



Min. DMR: 1.35% (Excellent viability)



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# 5. Fishing technology



External funding: Bycatch Reduction Engineering Program NOAA NA21NMF4720534 (2021-2023), NA23NMF4720414 (2023-2025) Publications: Lomeli et al. (2021) *Fisheries Research* **233**: 105737 Lomeli et al. (2023) *Ocean & Coastal Management* 2**41**: 106664



## Summary of awarded research grants in 2023

Project #	Grant agency	Project name	PI	Partners	IPHC Budget (\$US)	Management implications	Grant period
1	Bycatch Reduction Engineering Program-NOAA	Gear-based approaches to catch protection as a means for minimizing whale depredation in longline fisheries (NOAA Award Number NA21NMF4720534)	IPHC	Deep Sea Fishermen's Union, Alaska Fisheries Science Center-NOAA, industry representatives	\$99,700	Mortality estimations due to whale depredation	November 2021 – October 2023
2	North Pacific Research Board	Pacific halibut population genomics (NPRB Award No. 2110)	IPHC	Alaska Fisheries Science Center-NOAA	\$193,685	Stock structure	February 2022 – January 2024
3	Bycatch Reduction Engineering Program-NOAA	Full scale testing of devices to minimize whale depredation in longline fisheries (NOAA Award Number NA23NMF4720414)	IPHC	Alaska Fisheries Science Center-NOAA	\$199,870	Mortality estimations due to whale depredation	November 2023 – April 2025
Total awarded							





