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Report on current and future Biological and Ecosystem Science Research activities

Agenda item: 4.1.3 IPHC-2024-SRB025-08 (J. Planas, C. Dykstra, A. Jasonowicz, C. Jones)







#### **Population Genomics**

#### Objective: Resolve the genetic structure of the Pacific halibut stock in IPHC Convention Waters





#### NPRB Project 2110 (2022-2024)

- Low-coverage whole-genome resequencing (IcWGR)
- Allows for screening genomic variation at very high resolution
- 570 individuals (~ 50/collection)
- 3 sequencing runs Illumina NovaSeq S4
- Mean coverage 3.5x
- 10,371,343 autosomal SNPs
- 4,793,014 SNPs(minor allele frequency  $\geq$  0.05)
- Discrete genetic groups not detected



The SRB NOTED the Secretariat's studies of Pacific halibut stock structure based on genomics are nearing completion and suggest very limited genetic differentiation among individuals across the northeast Pacific and RECOMMENDED that:
a) the Secretariat test for stock structure using only male Pacific halibut;
b) the Secretariat prepare a manuscript for submission to a peer-reviewed scientific journal;
c) subject to the results from recommendation a (above), revise the 5-Year Program of Integrated Research and Monitoring to deprioritize stock structure studies as well as consideration of separate assessments of different stock components.

- Conducted PCA and k-means clustering separately for each sex (males n=289, females n=281)
- The same procedure was used for the entire dataset
  - Estimate covariance matrix from genotype likelihoods (*PCAngsd*)
    - − Minor allele frequency  $\ge 0.05$
  - Eigendecomposition (R)
  - K-means clustering (R) tested K=1-20



#### Population structure: *sex–specific PCAs*





#### Conclusions

- We failed to detect discrete groups when each sex was analyzed individually (similar to previous results).
  - Considerable degree of geneflow among areas.





Publications: Fish et al. (2020) *J. Fish Biol.* **97**: 1880–1885 Fish et al. (2022) *Frontiers in Mar. Sci.* **9**: 801759 Simchick et al. (2024) *Gen. Comp. Endocrinol.* **347**: 114425

Reduce uncertainty in stock size and fishing intensity



2022/2023 FISS Collection for Histological Assessment



• 2023

• 2022

	Biological Region	2022	2023	Total	
	2	440	403	843	
	3	351	708	1,059	
	4	181	-	181	
	4B	51	-	51	
	Total	1023	1,111	2,134	



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2022 GLM log(age)\*Region

- AIC = 874.1
- log() transform improves fit





2022 GAM s(log(age) by Region)

- AIC = 869.4
- k = 14

EDF
 Region 2 = 1.03
 Region 3 = 5.01
 Region 4 = 1.58
 Region 4B = 1.1







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2023 GLM log(age)\*Region

- AIC = 935.1
- Similar model trends to 2022





2023 GAM s(log(age) by Region)

- AIC = 913.9
- k = 14

EDF Region 2 = 2.74 Region 3 = 2.48





#### Maturity Model Comparisons with Year

GLM or GAM Model #		Model	AIC	
GLM	GLM 1 log(Age) * Region		1858.7	
GLM	GLM2log(Age) * Region + Year		1811.7	
GLM	GLM 3 log(Age) * Region + log(Age) * Year		1812	
GLM	4	log(Age) * Region + Year * Region	1807	
GLM	GLM 5 log(Age) * Region + log(Age) * Year + Year * Reg		1808.2	
GLM	6	log(Age) * Region * Year	1809.2	
GAM	1	s(log(Age) * Region)	1832.4	
GAM	2	s(log(Age) * Region) + s(log(Age) * Year)	1778.9	
GAM	3	s(log(Age) * Region) + Year * Region	1778.9	



GLM log(Age) \* Region + Year \* Region

- AIC = 1807
- Estimating higher proportion mature at younger and older ages





GAM s(log(Age) \* Region) + Year \* Region

- AIC = 1778.9
- Extra year of data smoothed out model in Region 3
- EDF
   Region 2 = 3.4
   Region 3 = 2.82





#### Coastwide Ogive using GAM

- 2022/2023 data pooled by region
- Coastwide ogive calculated from weighted regional ogives using FISS space-time model abundance estimates
- Coastwide ogive falls between Biological Regions 2 and 3





#### Coastwide Ogive Comparison

- GAM vs GLM vs Assessment
- GAM better represents maturity at younger ages and lower proportion mature for older individuals





#### 2024 FISS Sample Collection



•	2023	3

• 2022

Biological Region	2022	2023	2024	lotal
2	440	403	411	1,254
3	351	708	336	1,395
4	181	-	371	552
4B	51	-	-	51
Total	1,023	1,111	1,118	3,252



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#### Conclusions

- General modeling approach
  - GAM is the best fit model
- Coastwide ogive
  - Using pooled data from 2022/2023
  - Observed reduction in A50 from 2022 to 2023
- 2024 samples sent for histological processing
  - Use in 2025 full stock assessment



#### 3. Mortality and Survival Assessment



External funding: Saltonstall-Kennedy NOAA (2017-2020); NFWF (2019-2021); NPRB#2009 (2021-2022)

Publications: Kroska et al. (2021) <u>Conservation Physiology</u> 9: coab001

Loher et al. (2022) <u>North American Journal of Fisheries Management</u> **42**: 37-49 Dykstra et al. (2024) Ocean & Coastal Management. **249**: 107018.



#### 3. Mortality and Survival Assessment

Characterization of discards: stress indicators in the blood



#### 3. Mortality and Survival Assessment

Characterization of discards: size and condition by viability





# 4. 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







#### **Reducing whale depredation by protecting longline catches**

#### Next phase: Testing shuttle in the presence of depredators

Secured funding from NOAA BREP 2023 NA23NMF4720414

- Permit and vessel selection permitting:
  - 10 days of fishing in presence of Orcas / Sperm whales.
  - Further refinements (attachment protocols, gangion/hook strength).
  - Catch rate comparisons with and without shuttle device.
  - Catch composition details (size ranges, species, catch volume).
- Actively seeking vessels interested / available for the project in spring/summer of 2025.



### Summary of awarded research grants to IPHC

Project #	Grant agency	Project name	Pl	Partners	IPHC Budget (\$US)	Management implications	Grant period
1	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 2026
2	Alaska Sea Grant	Development of a non-lethal genetic- based method for aging Pacific halibut (R/2024-05)	IPHC, Alaska Pacific U. (APU)	Alaska Fisheries Science Center-NOAA (Juneau)	\$60,374	Stock structure	January 2025- December 2026
				Total awarded (\$)	\$260,244		



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