

Bering Sea Chum Salmon Marine Distribution and Survival

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Cunningham Lab Background



- Lab Research focus: **Population** and **spatial** dynamics of salmon and groundfish
 - What drives variation in **survival** and **growth**?
 - Can we **predict** species' **distributions** in the marine environment using survey and fishery-dependent catch (or bycatch) observations?
 - What are effective harvest and bycatch mitigation **strategies**?
- Species distribution models used for both **retrospective** and **prospective** spatial prediction
 - Essential Fish Habitat (retrospective)
 - Improved understanding of spatial ecology
 - Spatial bycatch risk (prospective)
- Bayesian **lifecycle** models to estimate **relationships** between stage-specific survival and environmental and harvest processes



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NOAA/ADFG Surface Trawl Surveys



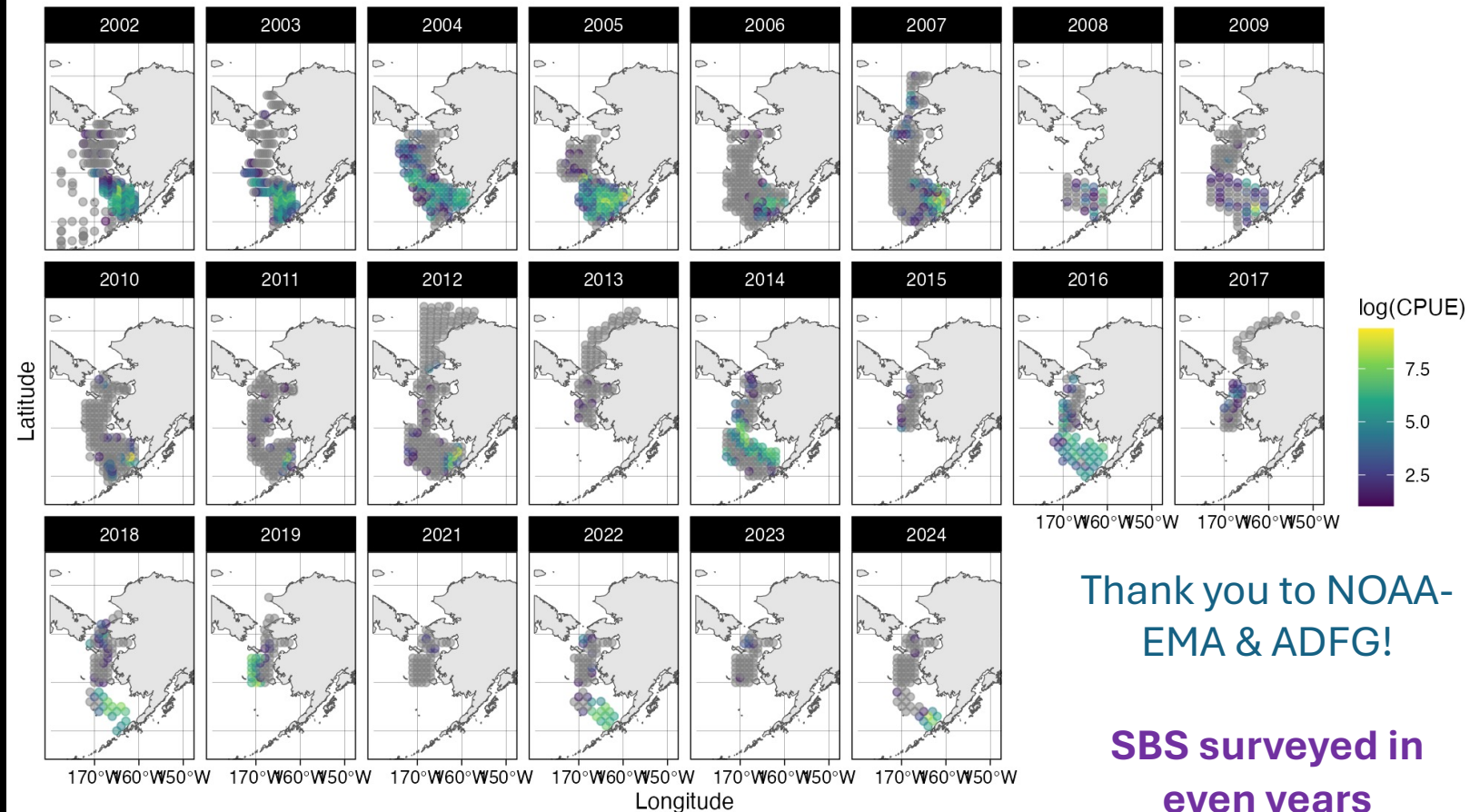
- Capture juvenile salmon
 - September-Oct. after outmigration from freshwater
- Index of juveniles surviving freshwater and early marine mortality

Northern Bering Sea Surface Trawl and Ecosystem Survey

F/V Northwest Explorer



Photo Credit: Jim Murphy (NOAA-AFSC)



Thank you to NOAA-
EMA & ADFG!

**SBS surveyed in
even years**

NOAA/ADFG Surface Trawl Surveys



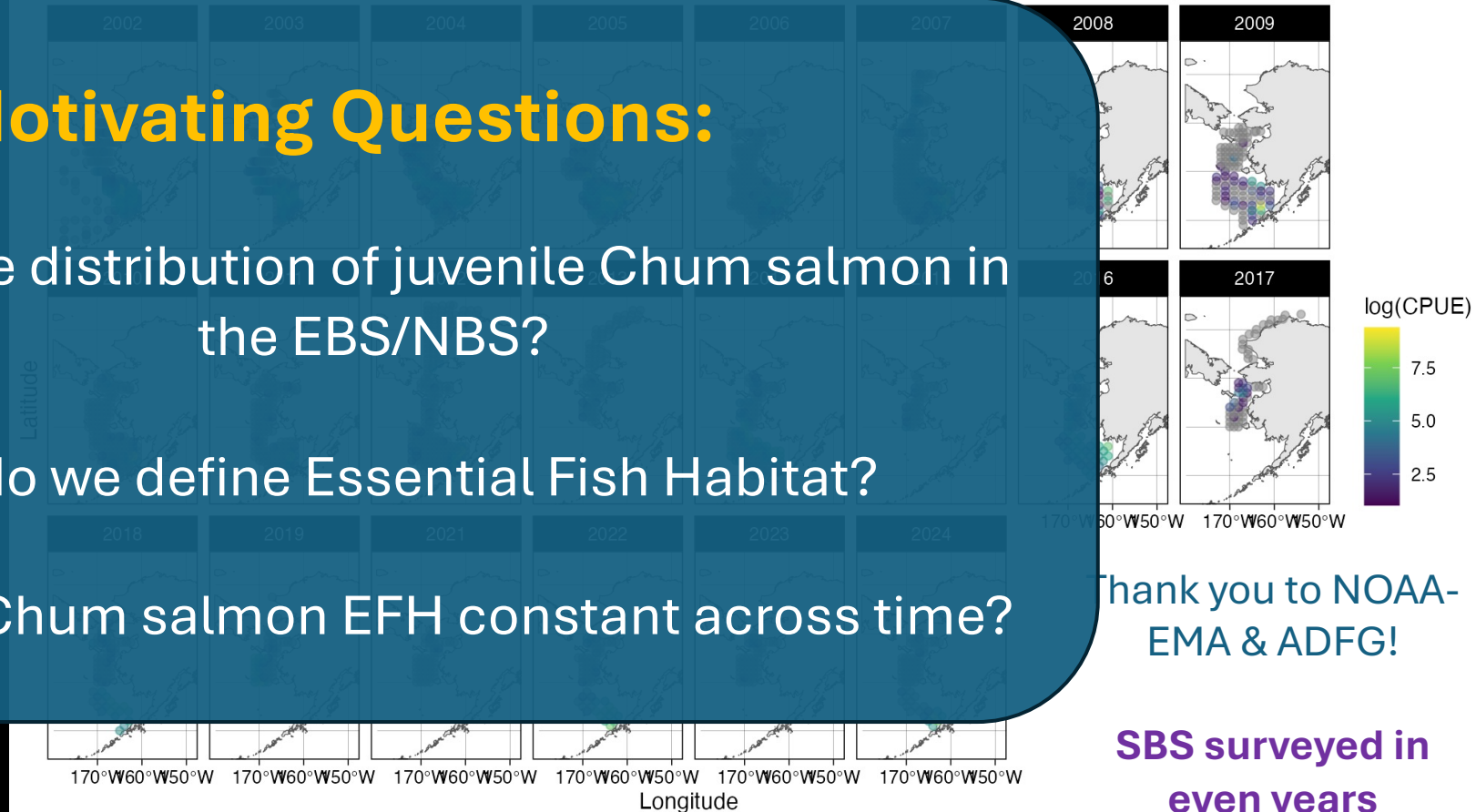
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Motivating Questions:

- 1) What is the distribution of juvenile Chum salmon in the EBS/NBS?
- 2) How do we define Essential Fish Habitat?
- 3) Is juvenile Chum salmon EFH constant across time?



Photo Credit: Jim Murphy (NOAA-AFSC)



Thank you to NOAA-EMA & ADFG!

SBS surveyed in even years

Juvenile Chum Salmon in the EBS



Canadian Journal of
Fisheries and
Aquatic Sciences

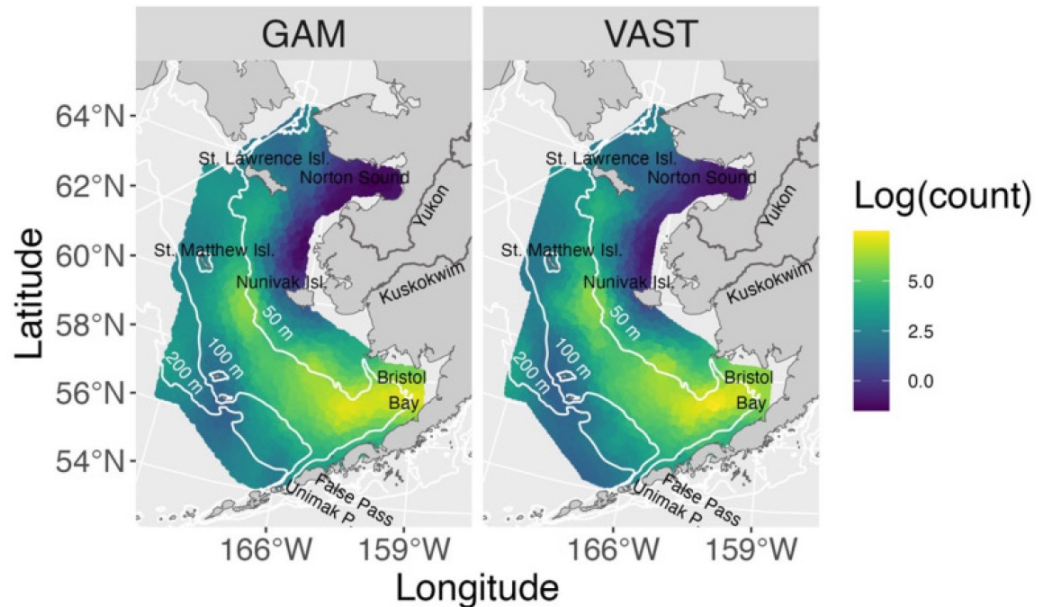
2025

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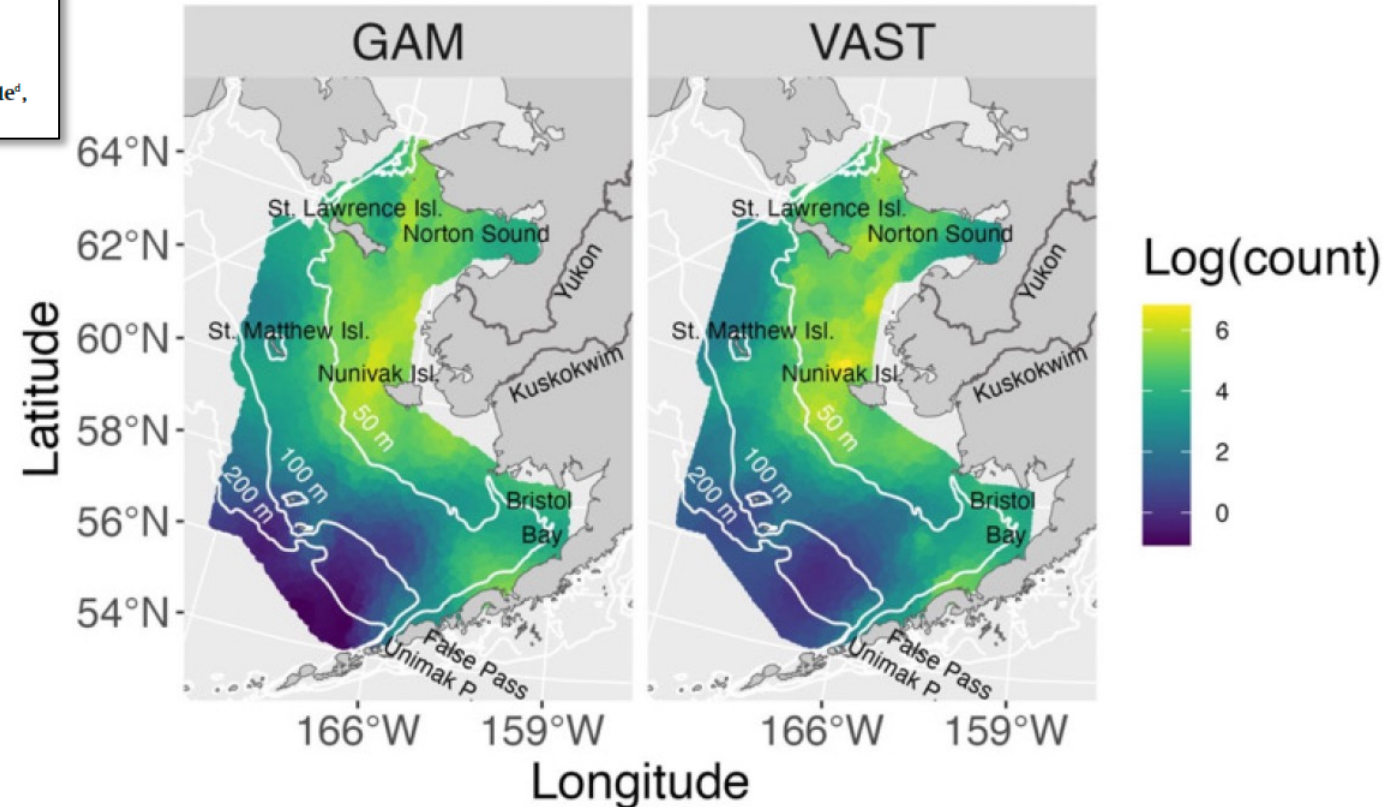
Species distribution models estimate time-varying juvenile salmon distributions in the north- and southeastern Bering Sea

Lilian K.G. Hart^{a,*}, Curry J. Cunningham^a, Ellen M. Yasumiishi^b, Franz J. Mueter^a, James T. Thorson^{a,c}, Jodi L. Pirtle^d, and J. Andrew Diamond^b

Juvenile sockeye salmon



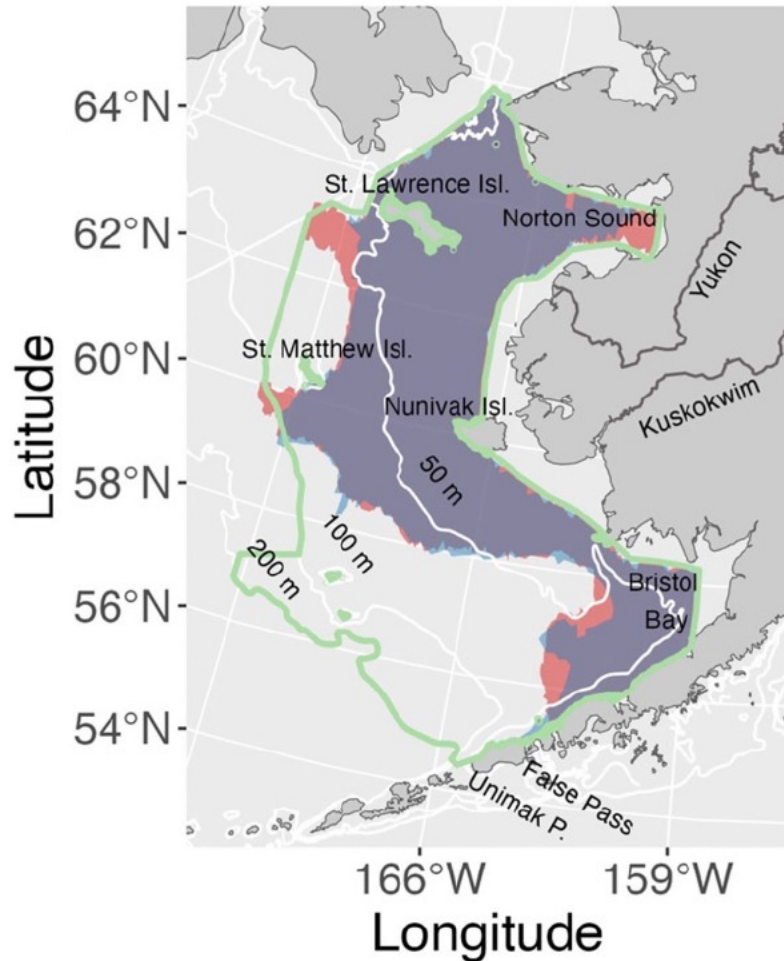
Juvenile chum salmon



Juvenile Chum Salmon in the EBS



Chum salmon

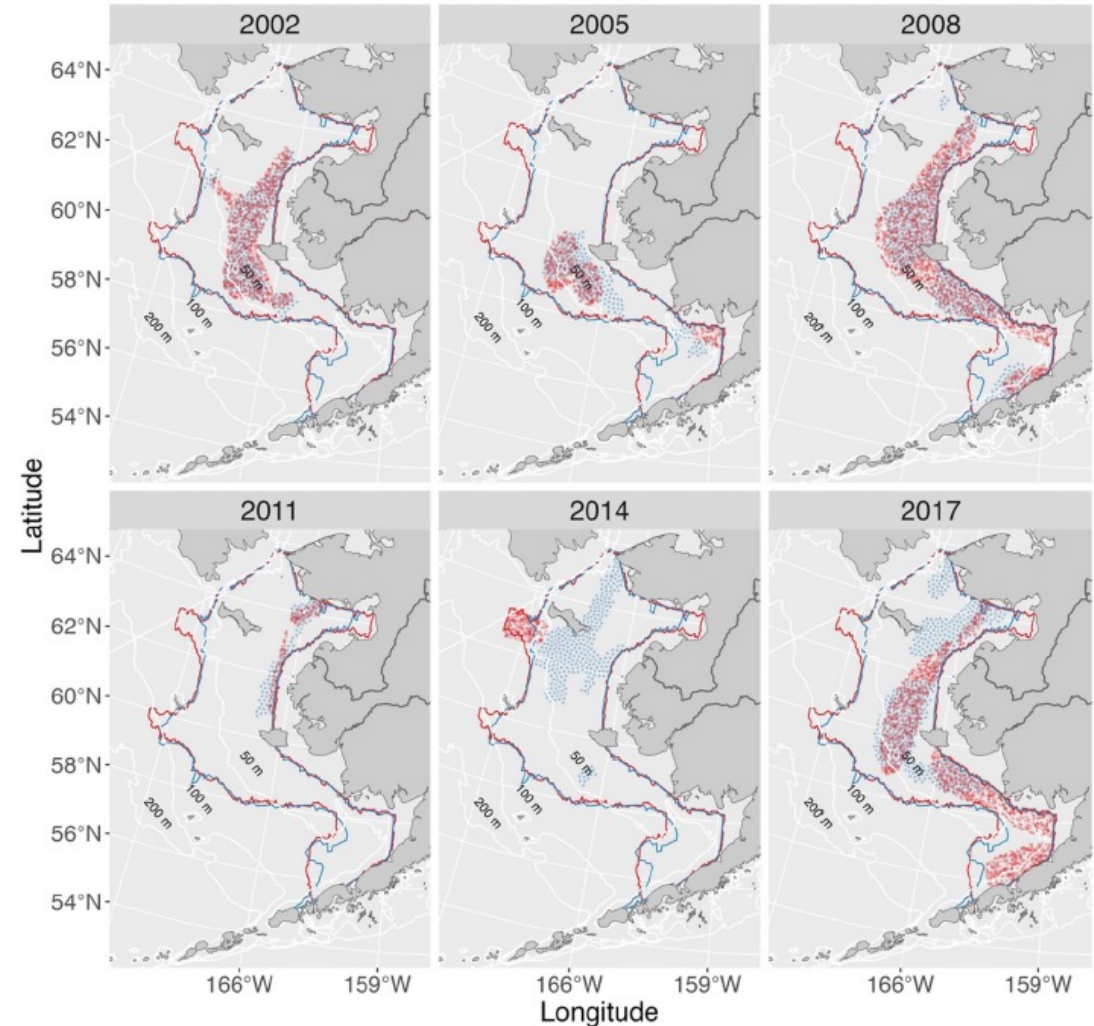


Chum EFH: Area representing top 95% of abundance

Predicted by **GAMs** or **VAST**

Core EFH (top 50% of abundance) across time

Chum salmon

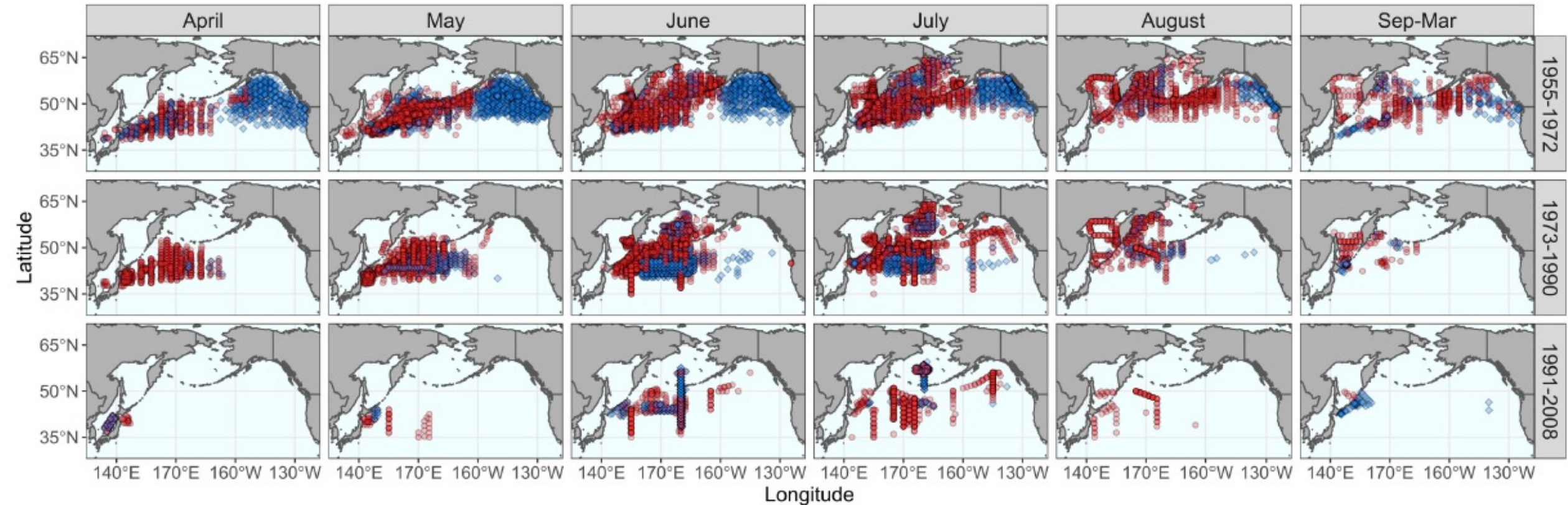


North Pacific Salmon Synthesis



- Objectives

- Compile historical high seas salmon survey data (US, Canada, Russia, Japan, Korea): 1950's - 2000's
- Describe the distribution of salmon relative abundance across the North Pacific
 - And temperature preferences, across spatially-unbalanced surveys and gear types

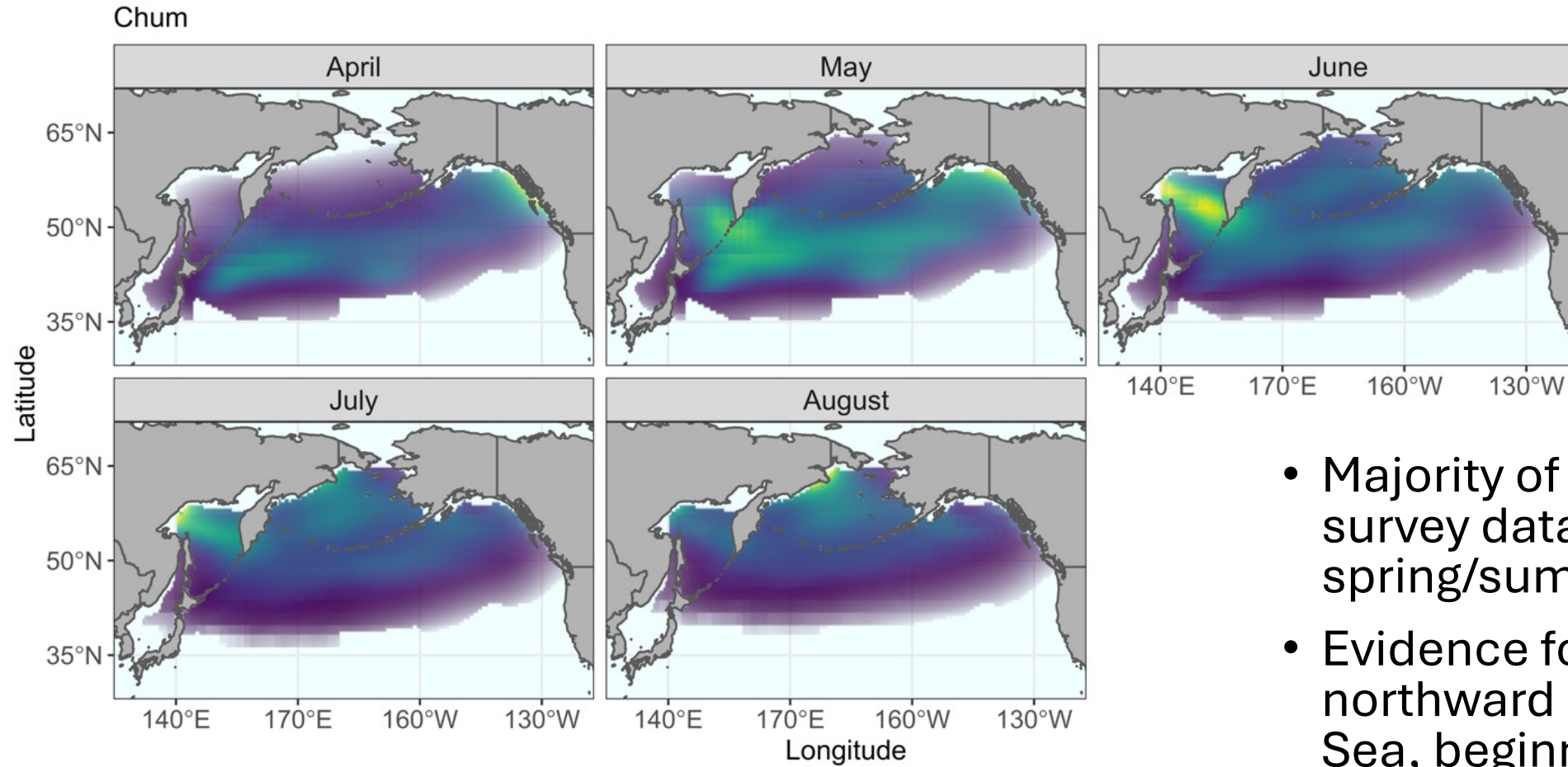


Data from the NPAFC/INPFC

Gear ● Gillnet ◆ Longline

Collaborator: Skip McKinnell (DFO Can Ret.)

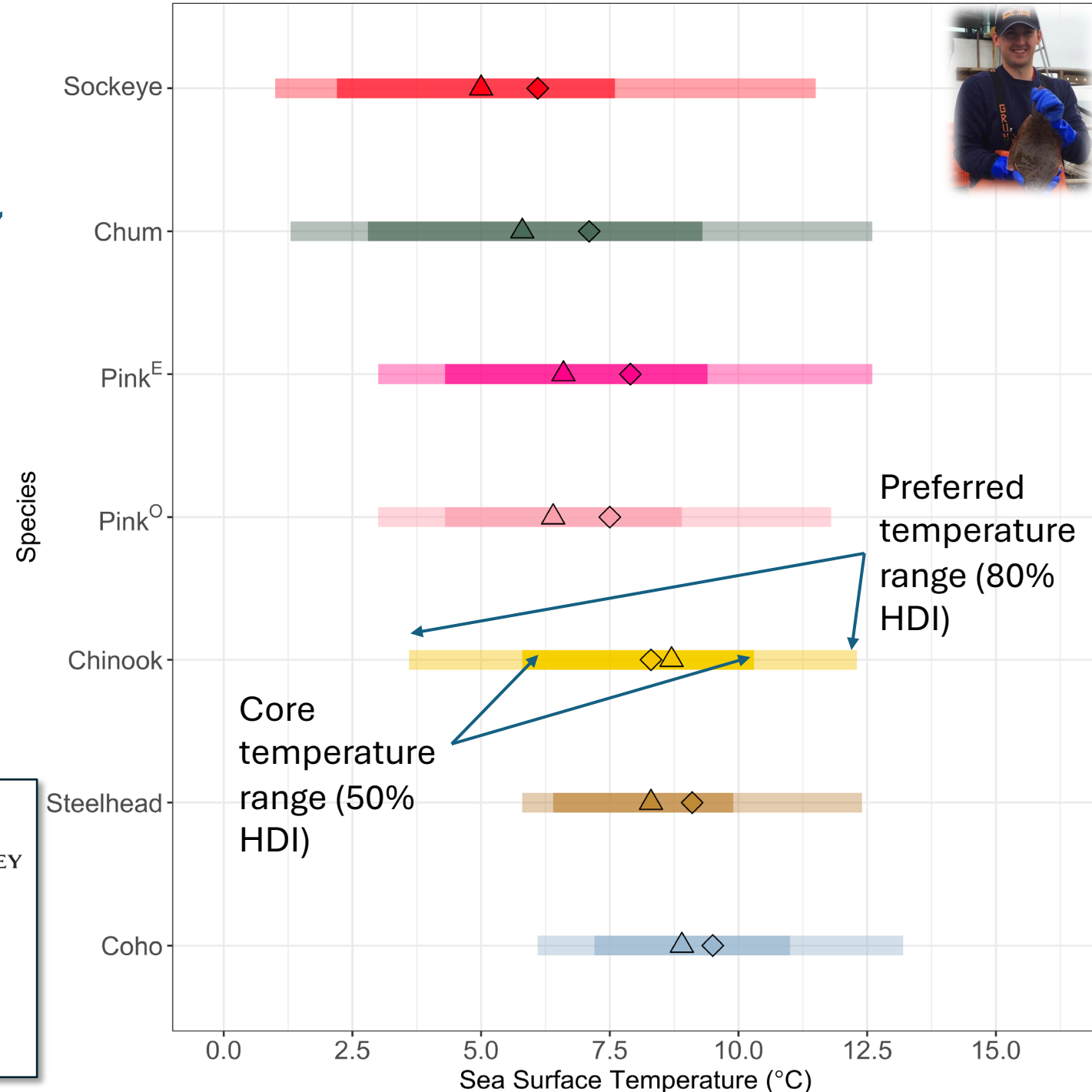
North Pacific Salmon Distribution: Chum



- Majority of high seas survey data from spring/summer
- Evidence for general northward shift into Bering Sea, beginning in June

How *different* are the thermal preferences of Pacific salmon in the ocean'

- Similar upper limits on preferred temperature range: ~12.5 deg C
- Variation in lower range
 - Most cold tolerant: Sockeye & Chum
 - Least cold tolerant: Coho & Steelhead



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ORIGINAL ARTICLE

FISH and FISHERIES WILEY

Opening the black box: New insights into the role of temperature in the marine distributions of Pacific salmon

Joseph A. Langan^{1,2} | Curry J. Cunningham¹ | Jordan T. Watson³ | Skip McKinnell⁴

Describing Chum Salmon Distribution by Genetic Reporting Group

Data: Prohibited Species Catch from Pollock Mothership and Catcher-processors

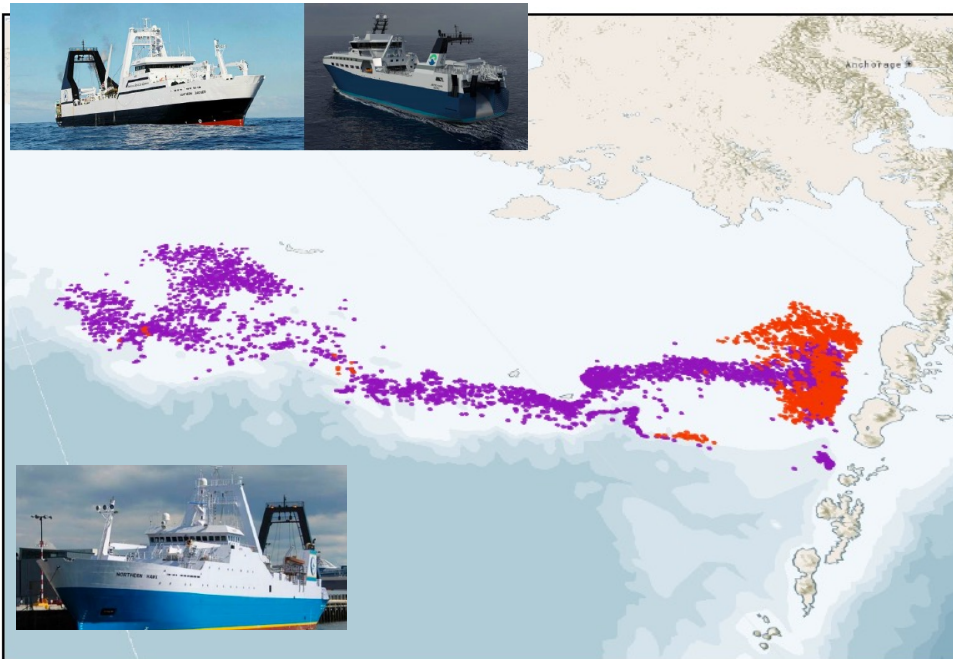
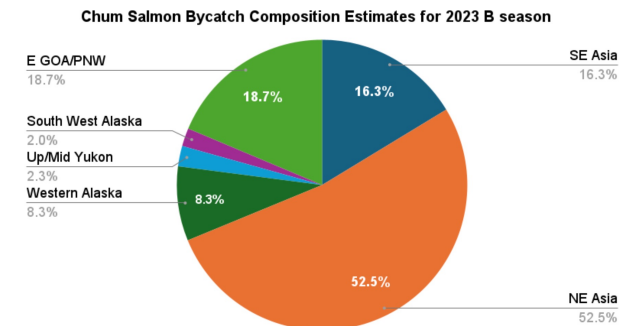


Figure 8. Pollock CP trawl locations between September 1st and February 28th for the years 2008-2010 (blue), 2022-2023 (orange).

Figure source:

AFA Catcher Processor Sector Chinook and Chum Salmon Bycatch
Incentive Plan and Agreement – Annual Report 2022

Genetic Stock Composition Estimates from NOAA-ABL Genetics Lab:
Stratified in space and time

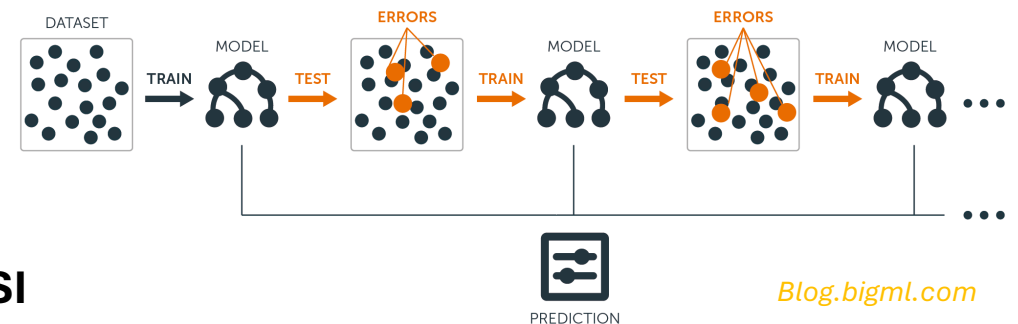


Barry et al. (2023)

$P(\text{stock}_i)$

$\ln(\text{CPUE}_i + 1)$

Boosted Regression Trees:
Predict bycatch rate based on climate, environmental and space-time predictors



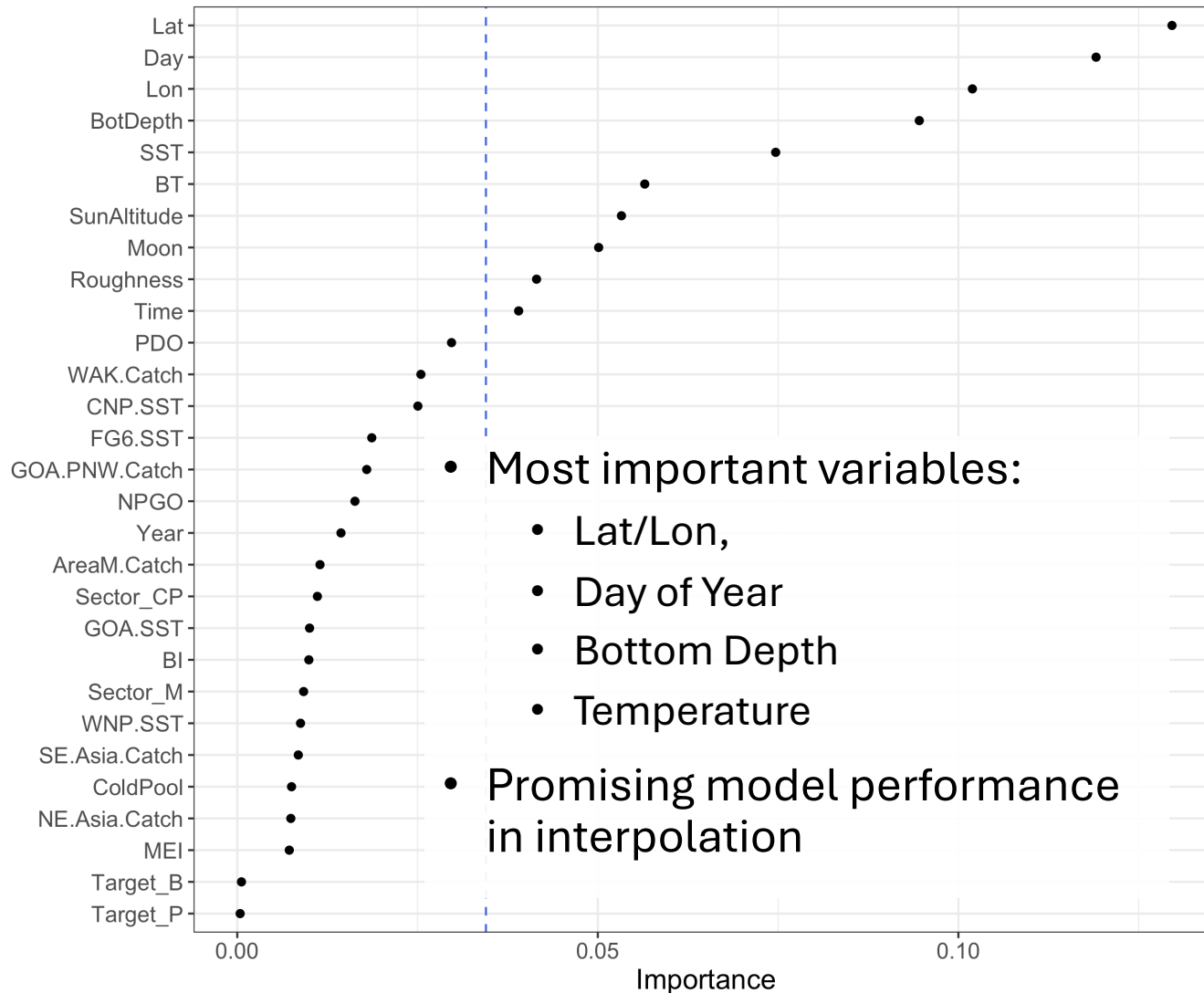
Funding: AYK-SSI

[Blog.bigml.com](https://blog.bigml.com)

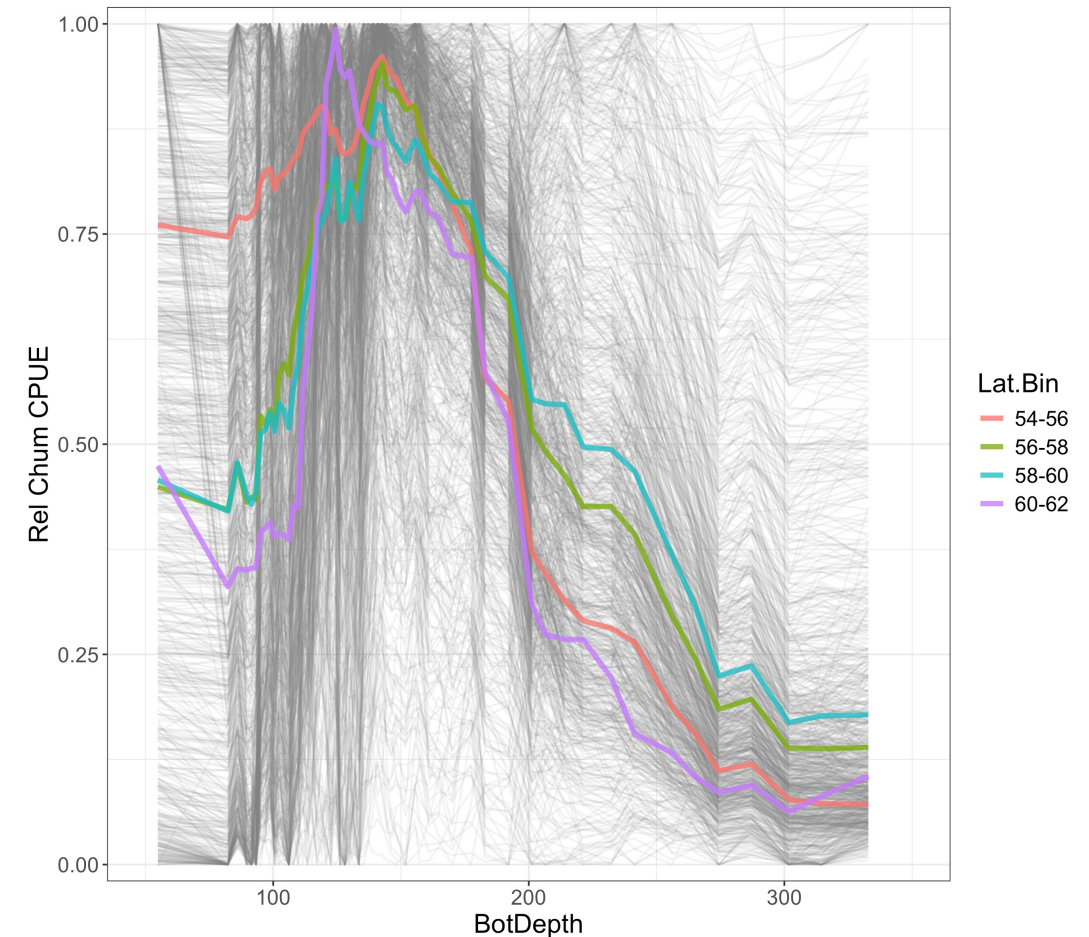
Preliminary Results: Covariates



Preliminary Results

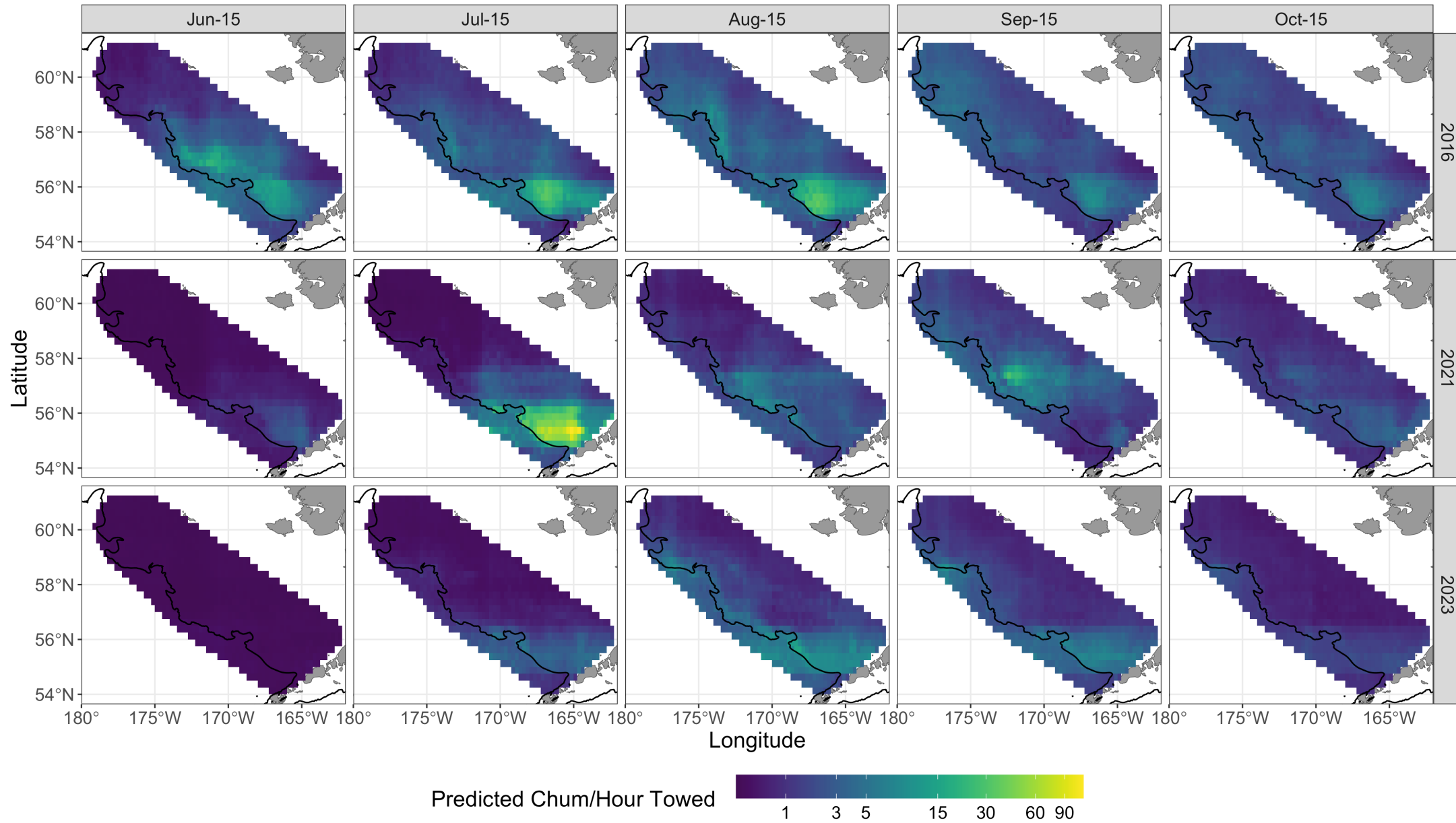


Bottom Depth Partial Effect





Preliminary Results



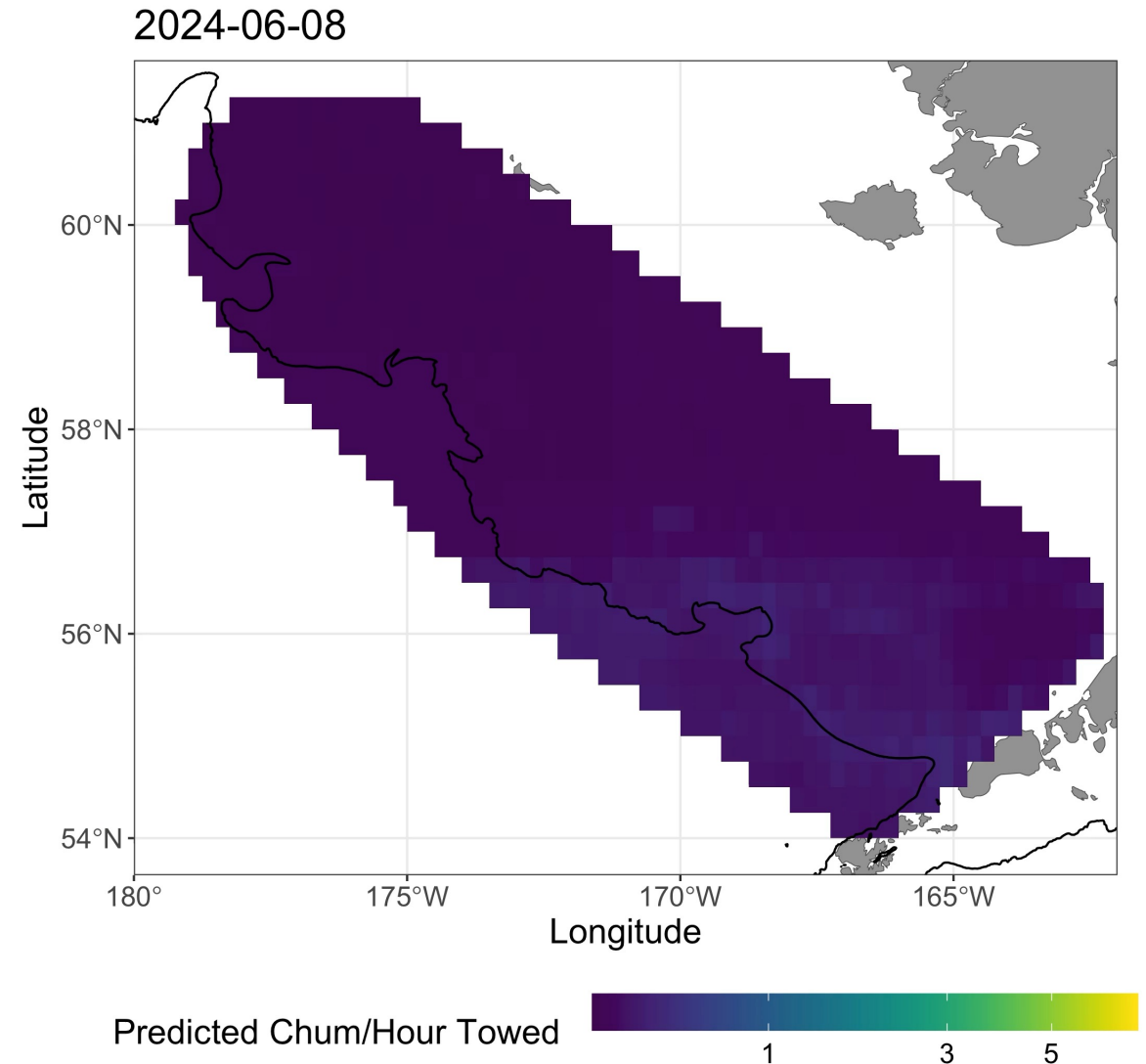


Preliminary Results



Distributional Patterns

- High (relative) abundance near Alaska Peninsula early in the Pollock B Season (summer)
- Chum spread NW up the continental shelf as the season progresses
- Largely follow the shelf break



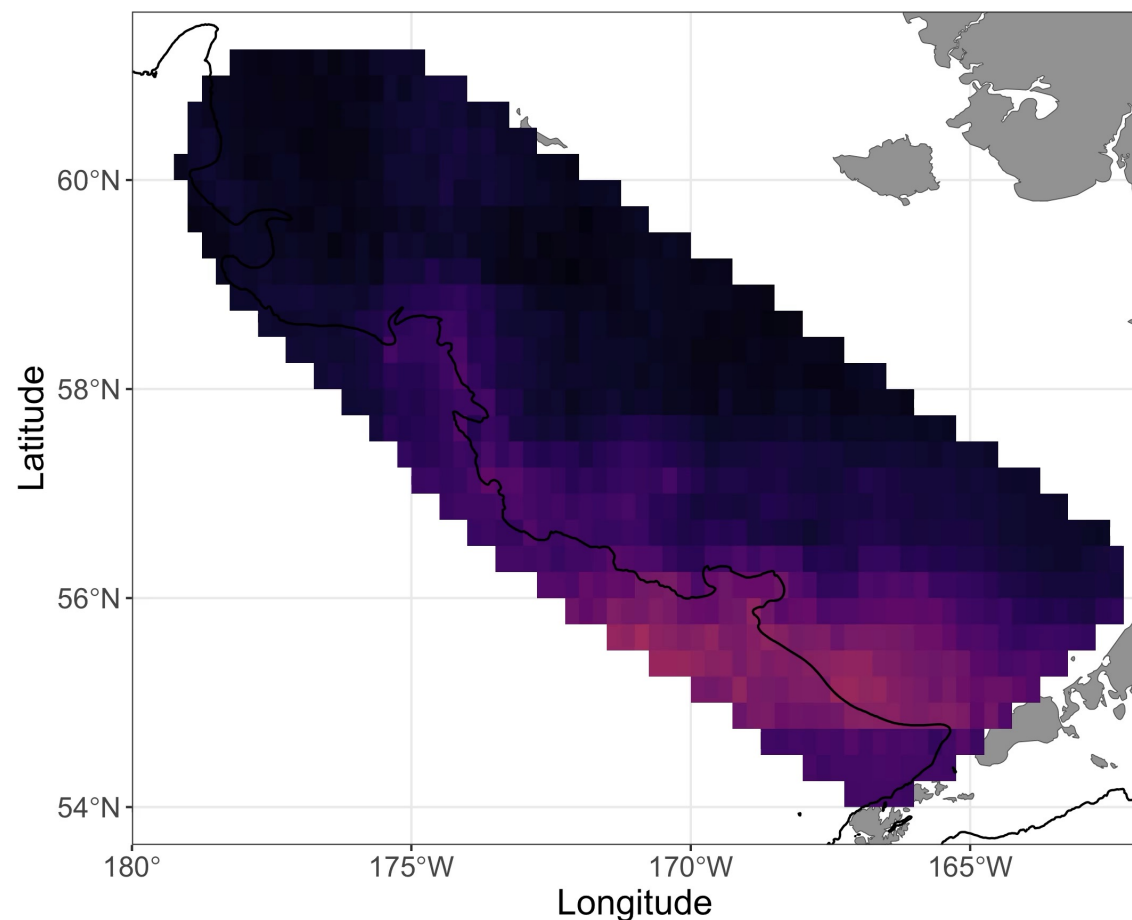


Preliminary Results



Distributional Patterns

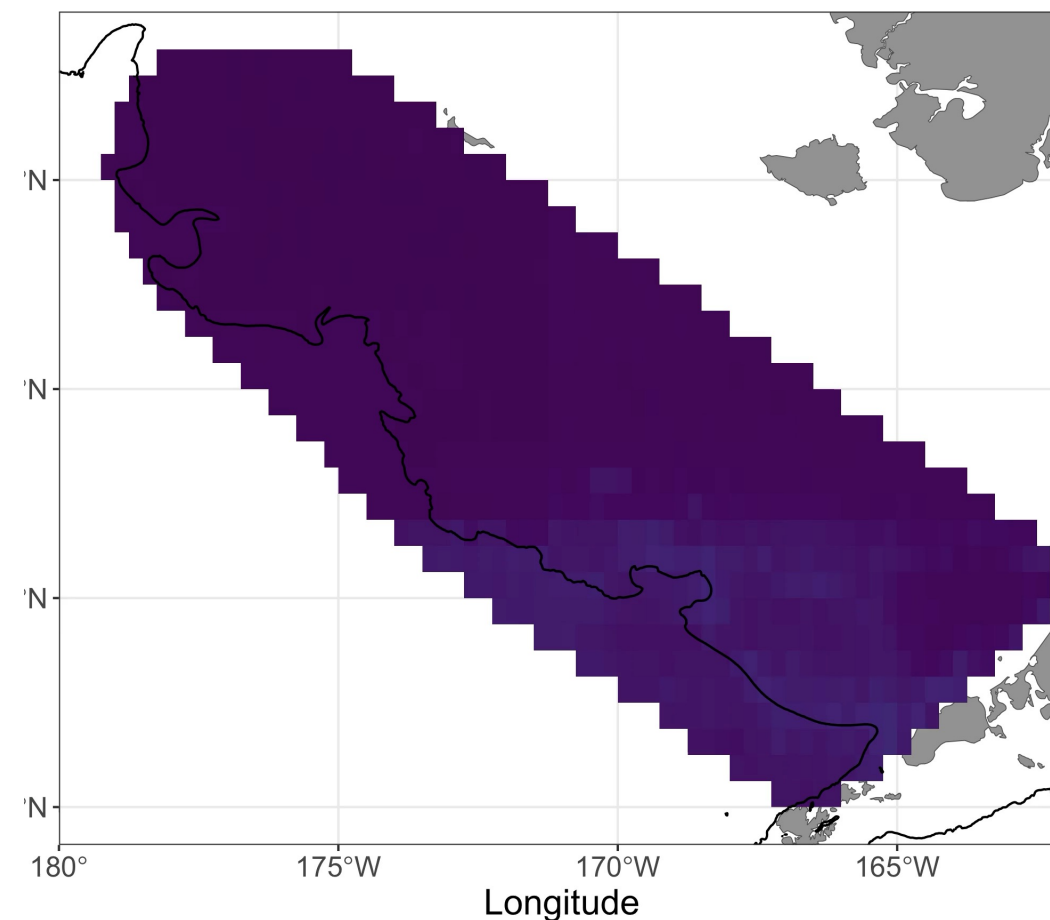
2017-06-09



Predicted Chum/Hour Towed



2024-06-08

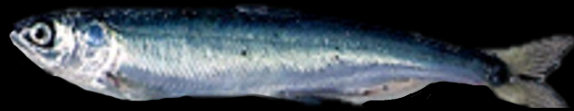


Predicted Chum/Hour Towed





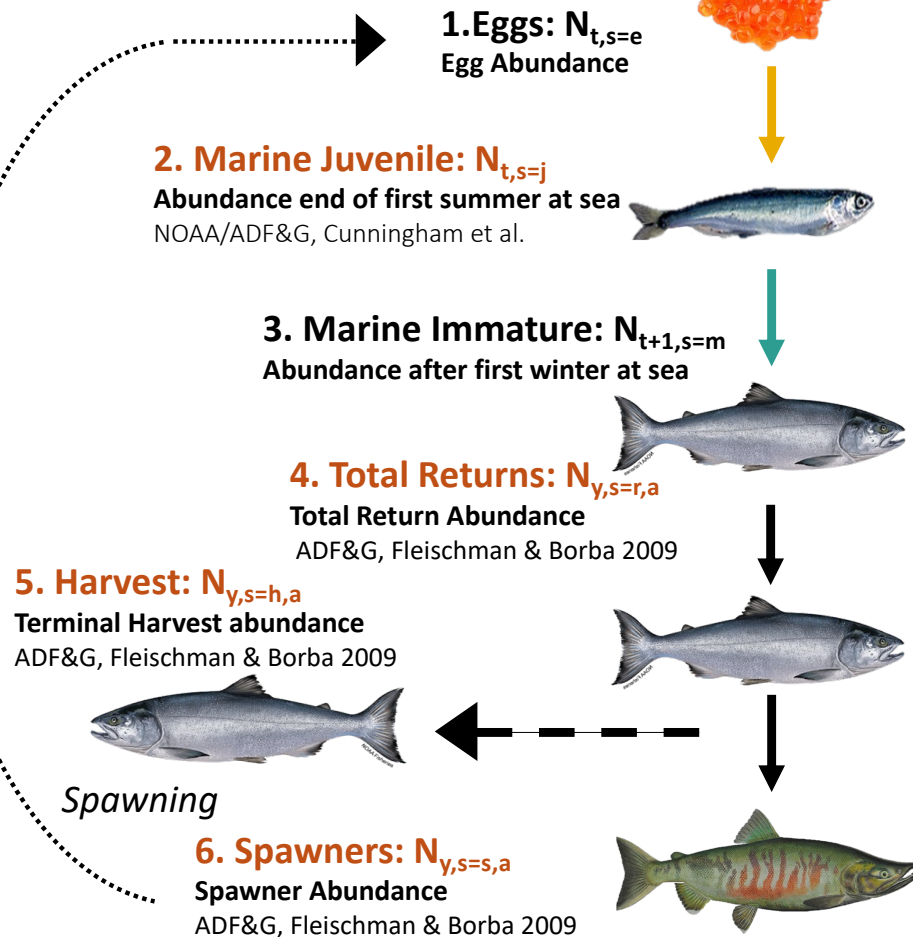
What is the relative influence of environmental processes and competition on Yukon River Fall Chum salmon survival?



Estimation Model Structure



Fall Chum Integrated Population Model Structure



Juvenile Survival Covariates (Stage 1→2)

1. Mean Spawner Size
ADF&G Age Sex Length Database
2. Winter Snowpack
Alaska Climate Research Center,
3. N Bering Sea Summer Temperature (Cumulative Degree Days)
AKFIN, NOAA
4. EBS Pollock Recruitment Index
Iannelli et al. 2024

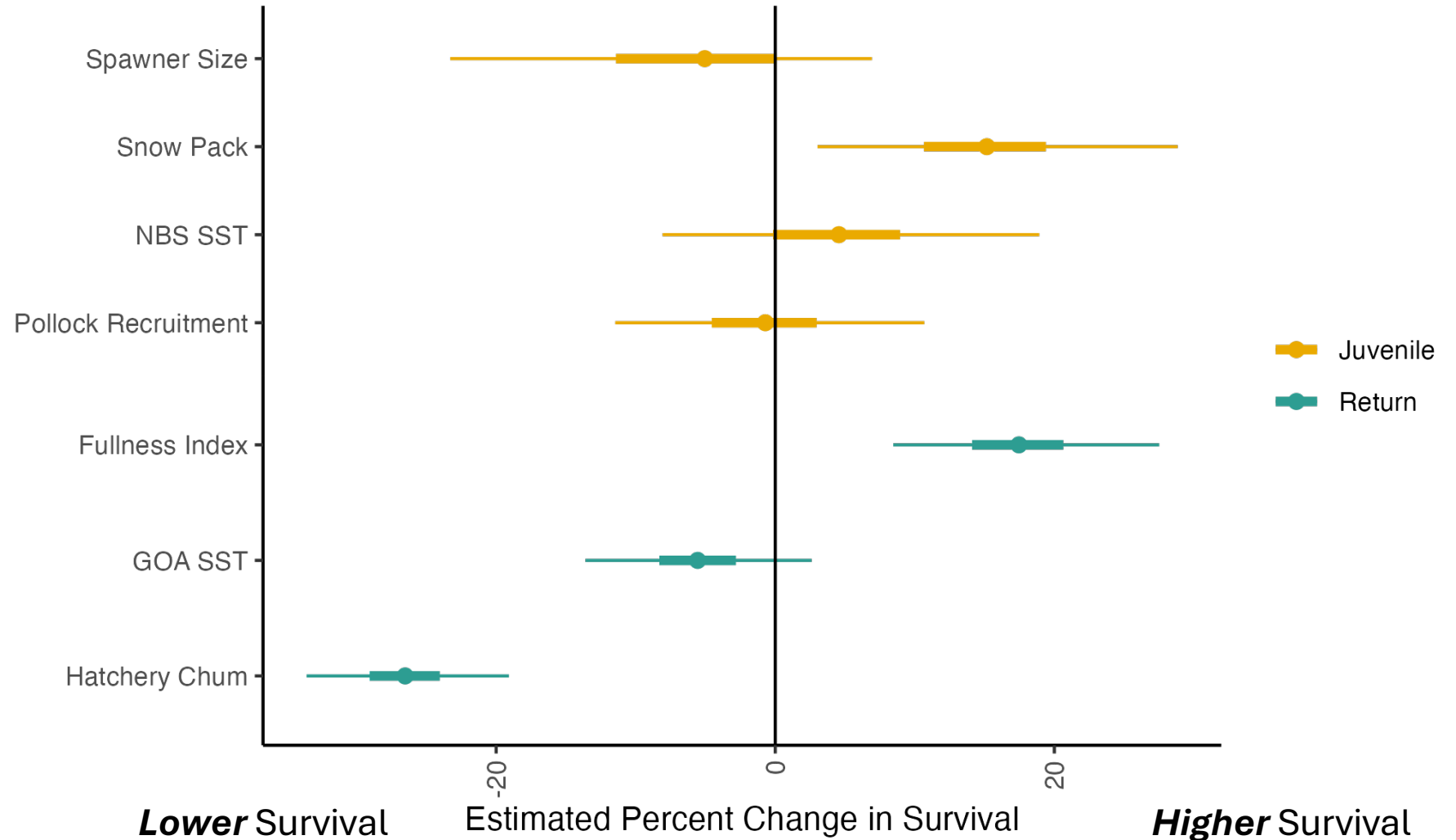
Marine Survival Covariates (Stage 2→4)

5. Stomach Fullness Index
NOAA, ADF&G, NBS Surveys
6. GOA Temperature (Cumulative Degree Days) during 1st winter
AKFIN, NOAA
7. Chum hatchery salmon release numbers
North Pacific Anadromous Fish Commission

Estimated Effects



**Estimated
effect of each
covariate
represented as
the expected
percent change
in survival**





Thanks for your interest!



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