Changing distribution of juvenile Pacific herring in an expanding population in the Strait of Georgia, British Columbia

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SPF Symposium

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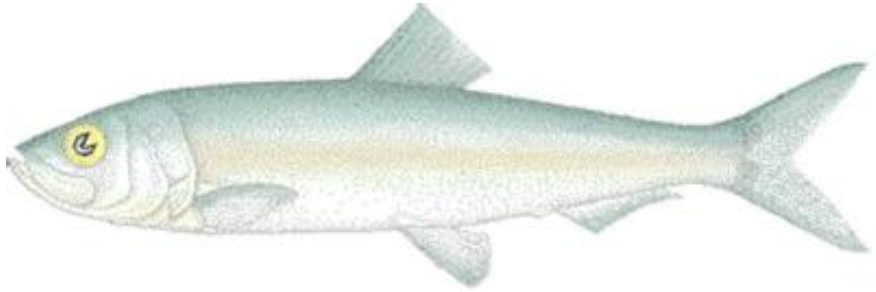
Strait of Georgia Herring Research (Jennifer Boldt & Jaclyn Cleary)

- **Current Objectives:**
  - **Spatial modeling of juvenile herring distribution in Strait of Georgia**
  - **Combine multiple surveys to determine habitat use and index of abundance for juvenile herring**
  - **Look at trends in spatial distribution over time**
  - **Compare to recruitment**

- **Others:**
  - ***Determine non-lethal assessment methods to estimate small pelagic fish biomass***
  - ***Examine seasonal use of nearshore habitat by small pelagic fishes***
    - ***Long-term acoustic moorings***
    - ***Stereo-optic species and size identification***
  - ***Surveys of juvenile herring and spawning herring***
  - ***Explore recruitment mechanisms***
  - ***Ecosystem effects and EAFM***
  - ***Stock assessment and management strategy evaluation***

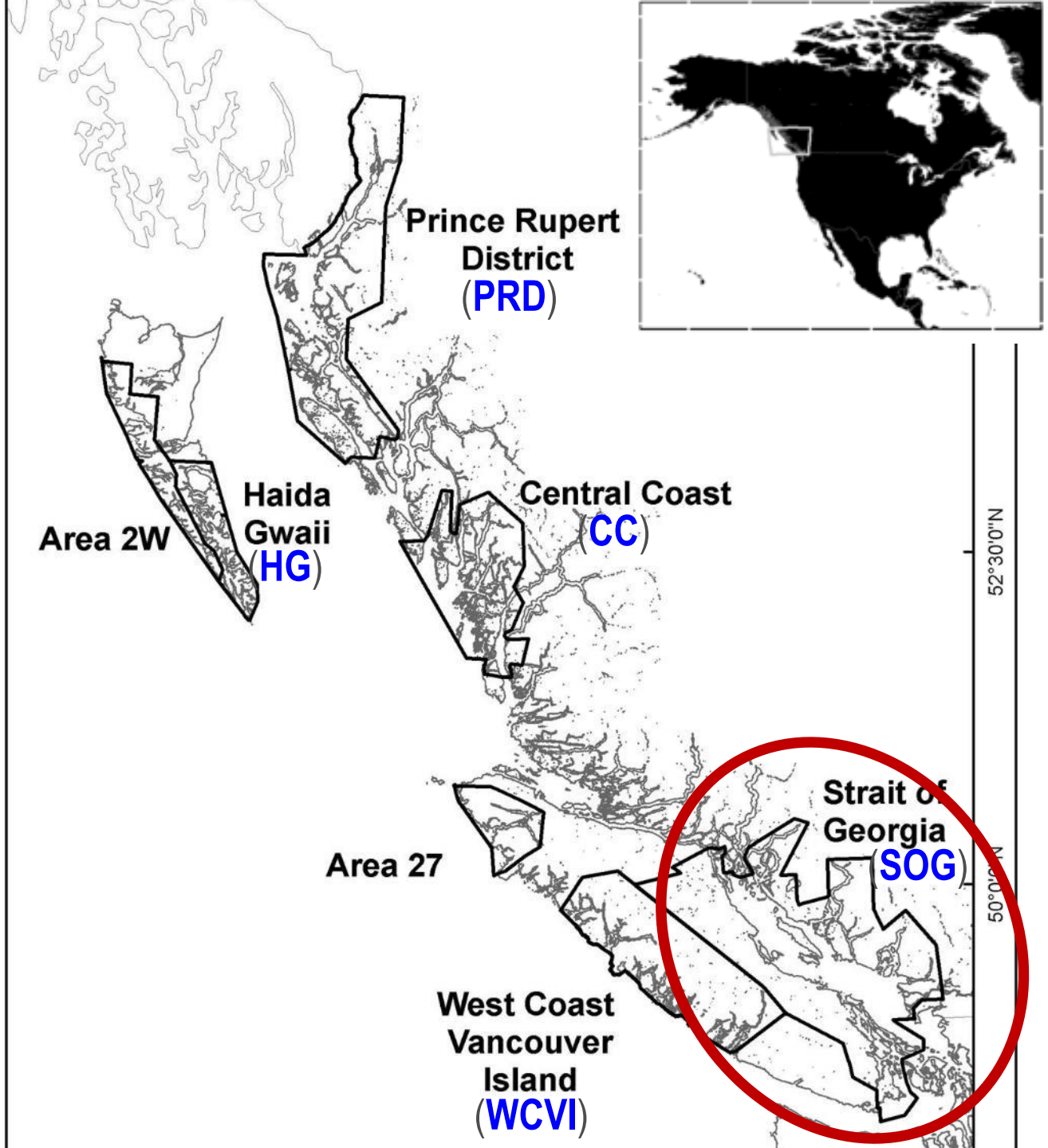
British Columbia Pacific Herring

5 major & 2 minor stocks

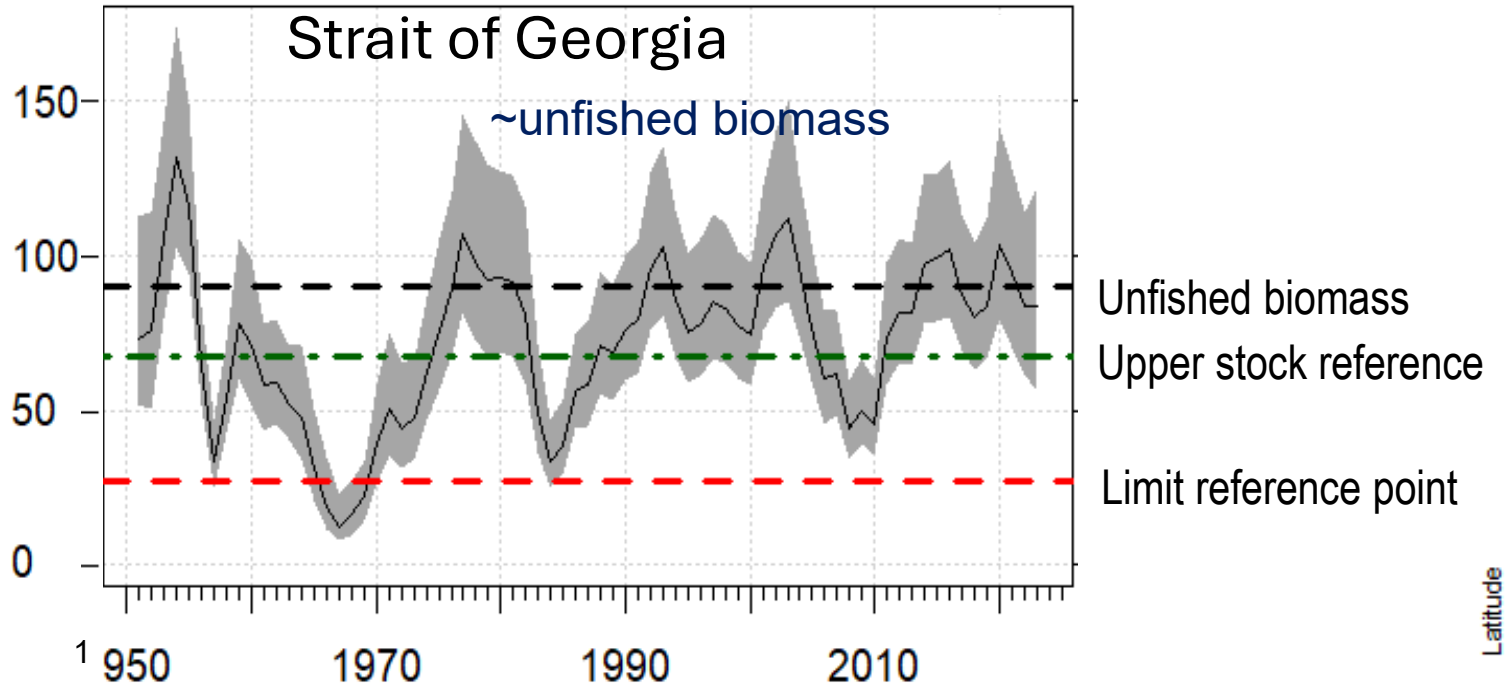


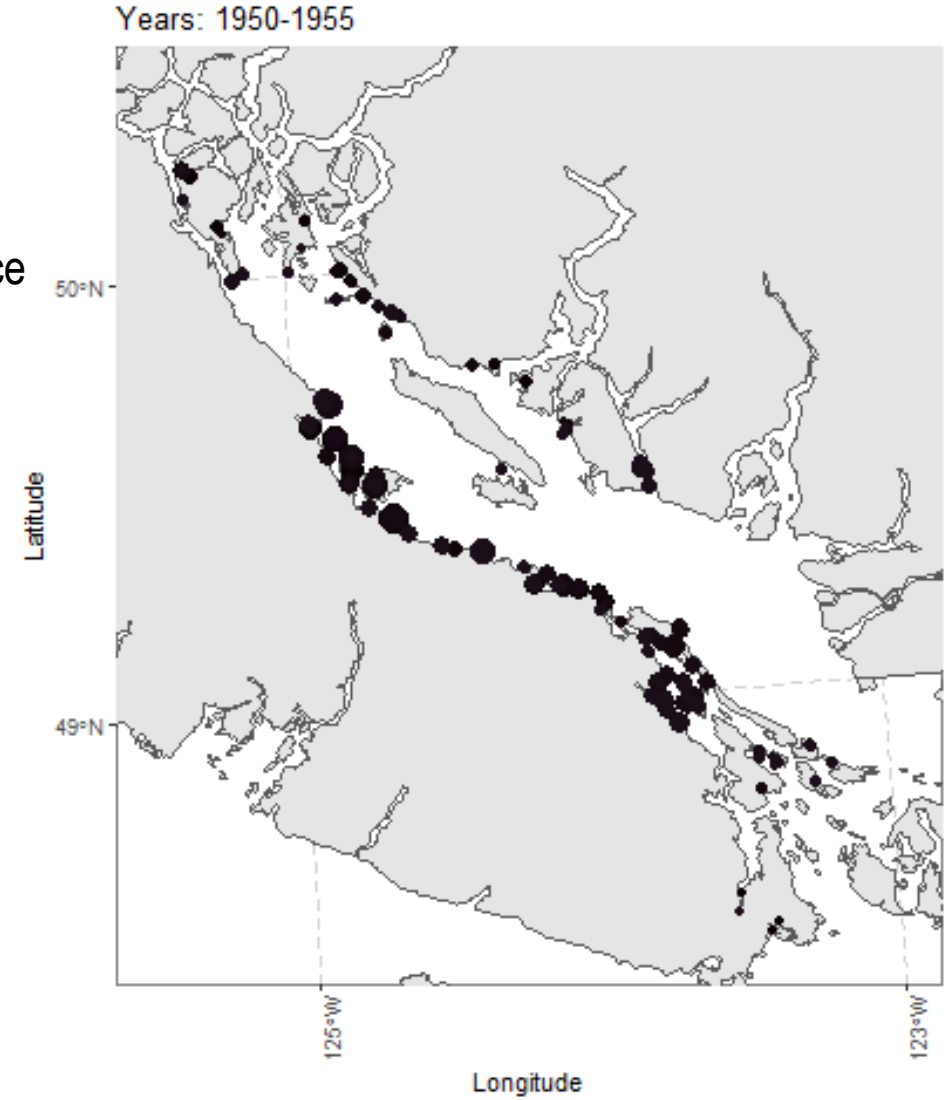
- Ecologically important species (salmon, hake, groundfish, mammals)
- Culturally and nutritionally important to coastal First Nations
- SoG currently has a commercial fishery
- Major population centers = lots of attention

DFO 2010



Pacific Herring spawning biomass, 1951 to 2025 (DFO 2026)



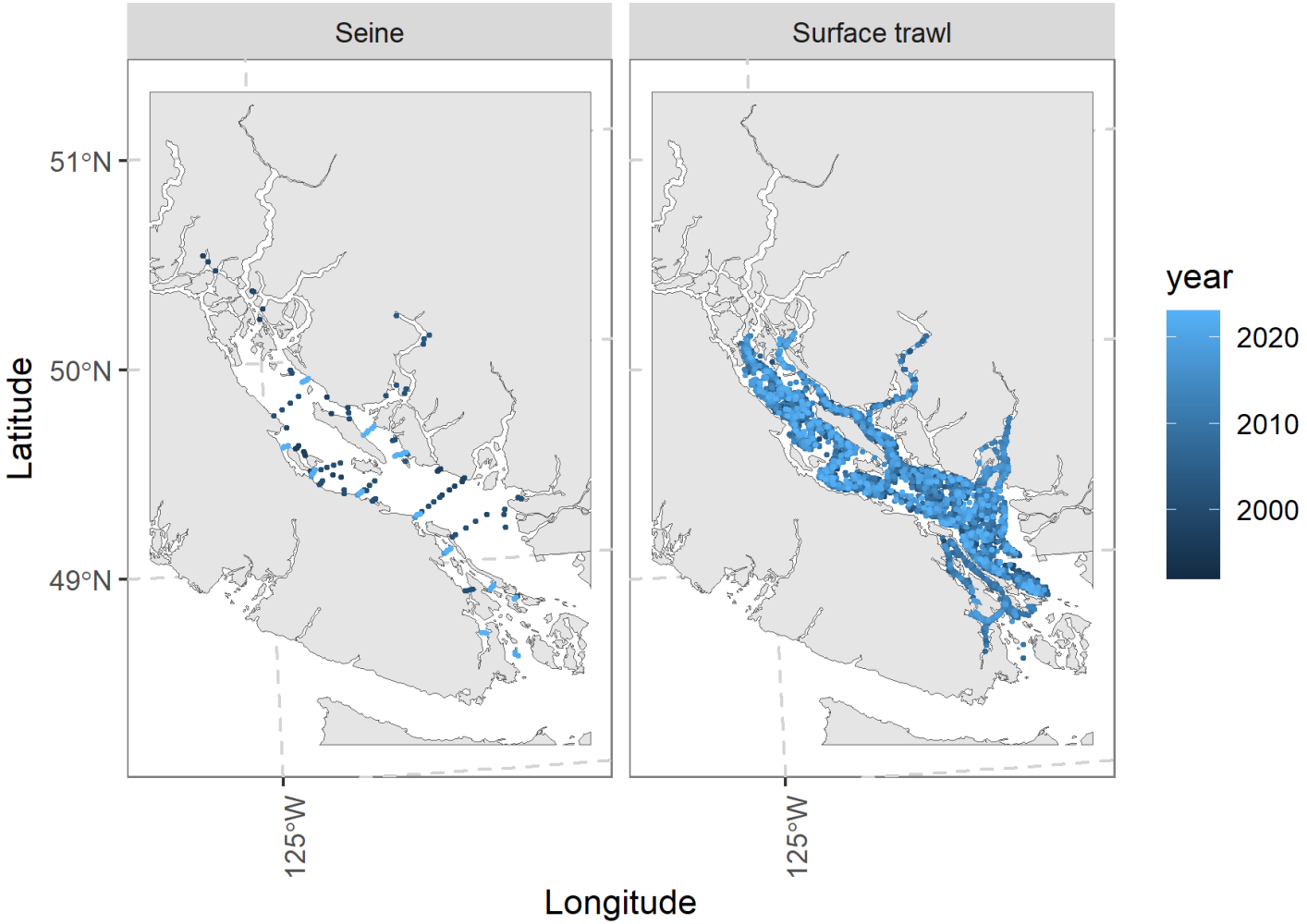


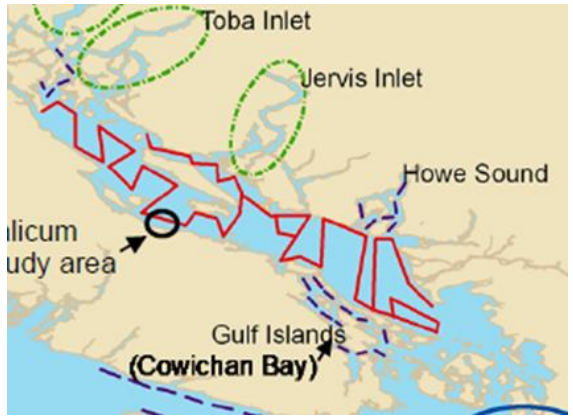
Strait of Georgia Age-0 Herring

Surveys:

Seine (1992-2023, June & September)

Mid-water Trawl (1993-2023, June & September)



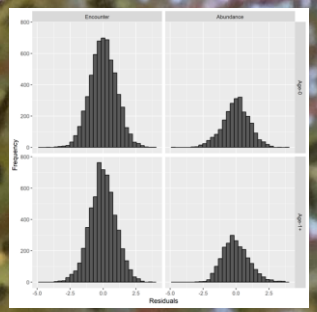


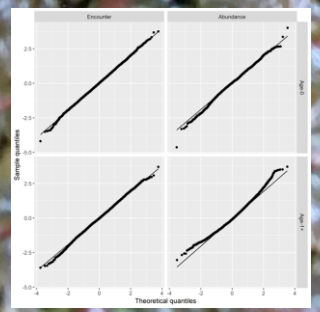
Herring distribution modeling

Data
- SoG juvenile Herring survey (1992-2023)
- SoG juvenile Salmon survey (2000-2023)

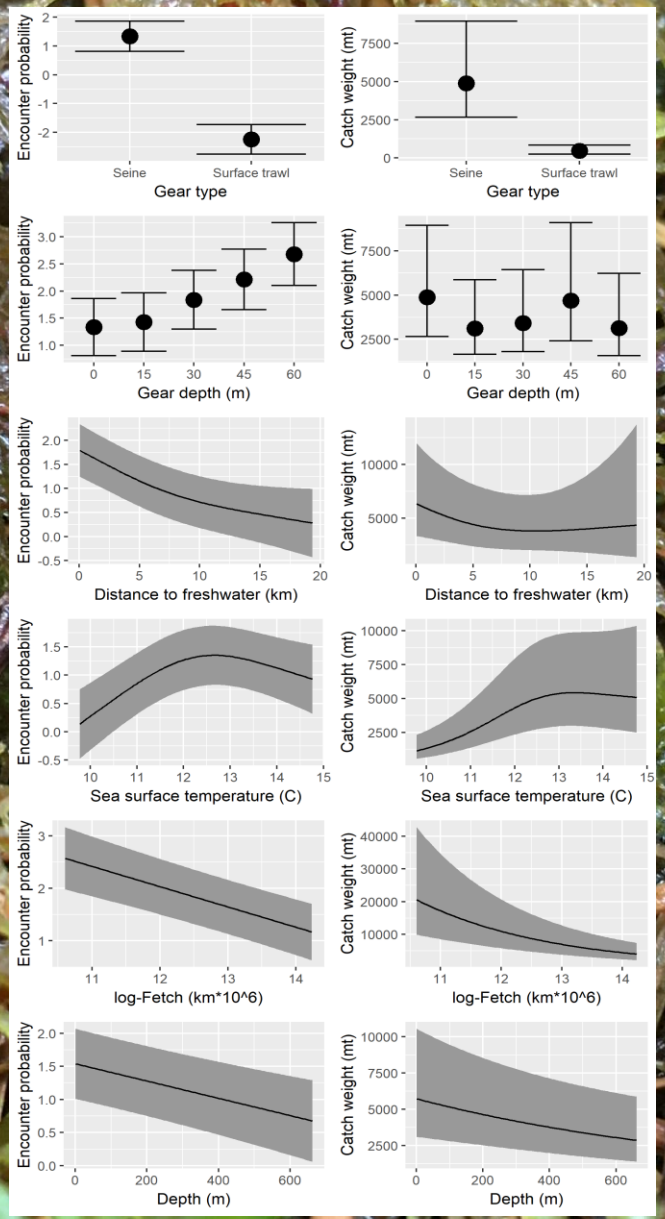
Model – Spatial temporal
- sdmTMB
- Delta-log normal (logit & log links)
- Gaussian random fields

Covariates
- Gear depth
- Gear type
- Year
- Depth
- Exposure index (fetch)
- *SST & salinity (NEMO & ROMS)*

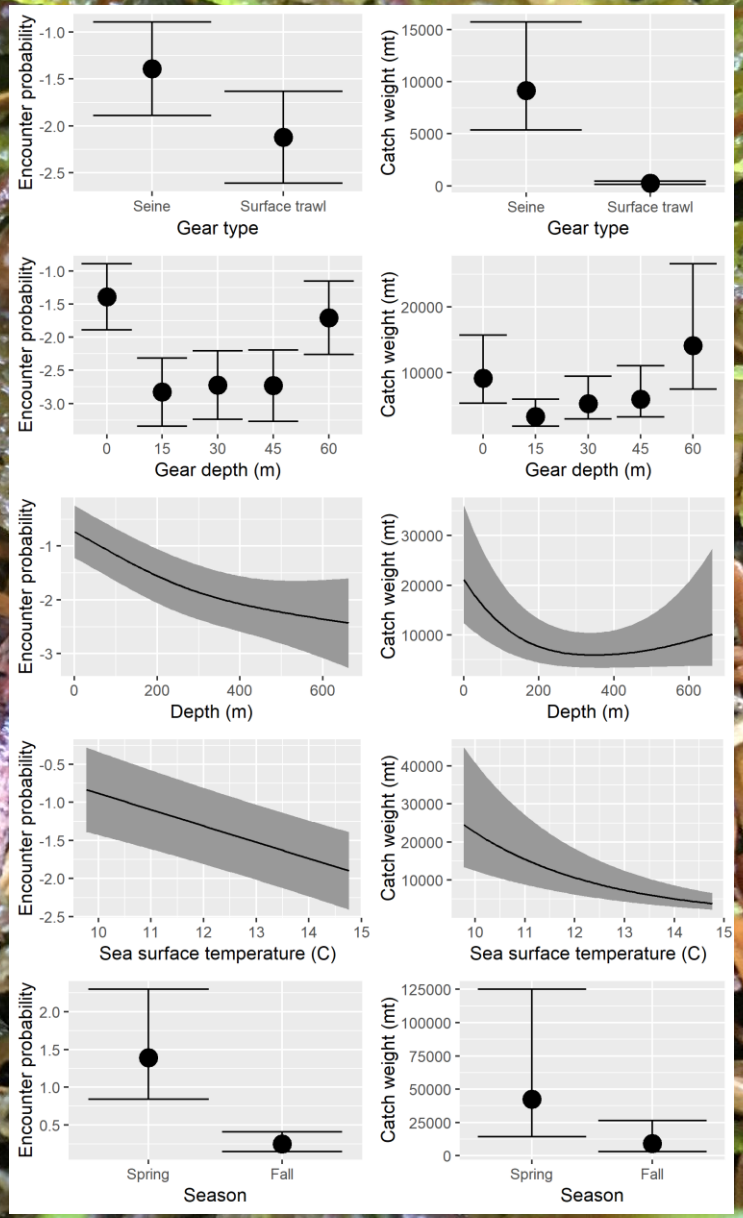




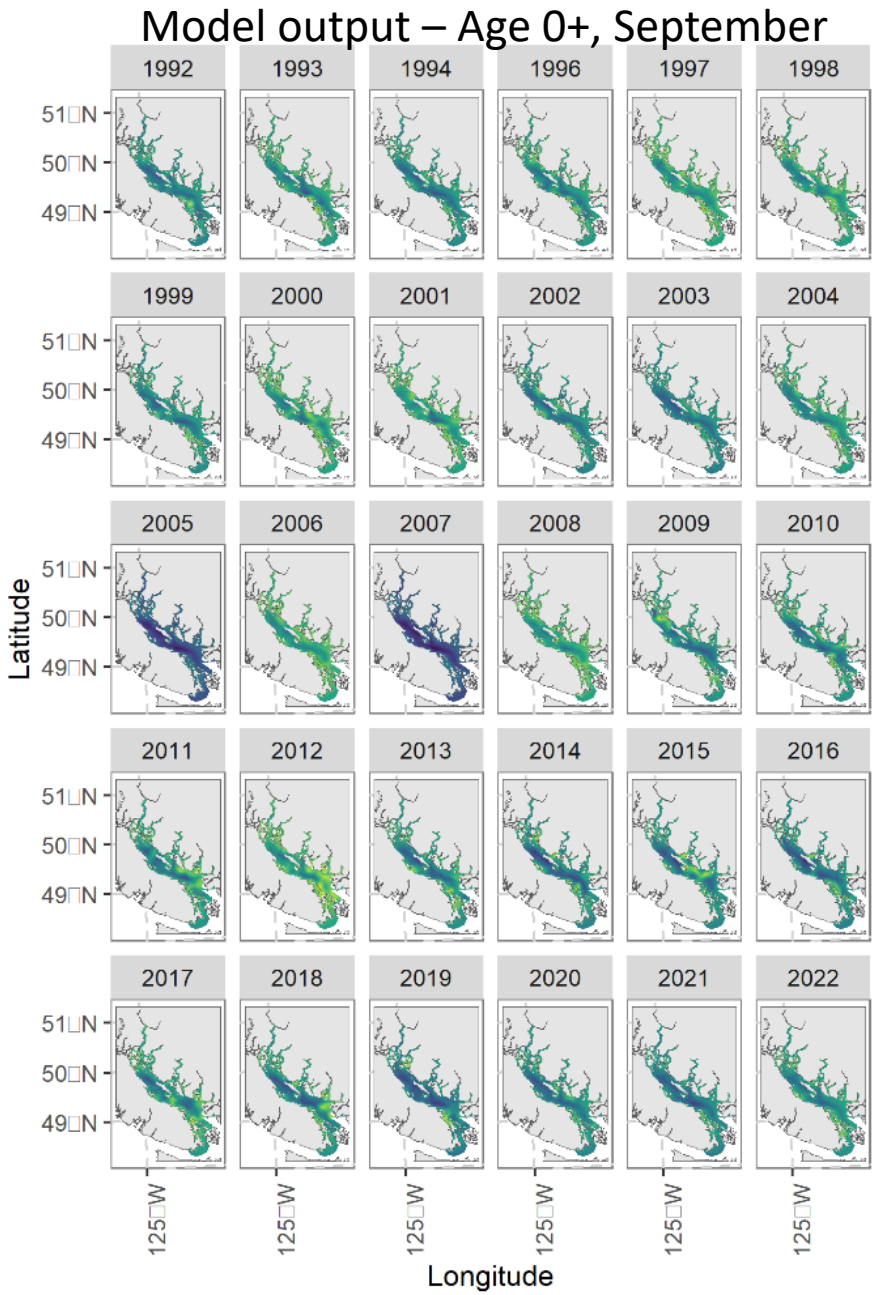
Response curves – Age 0

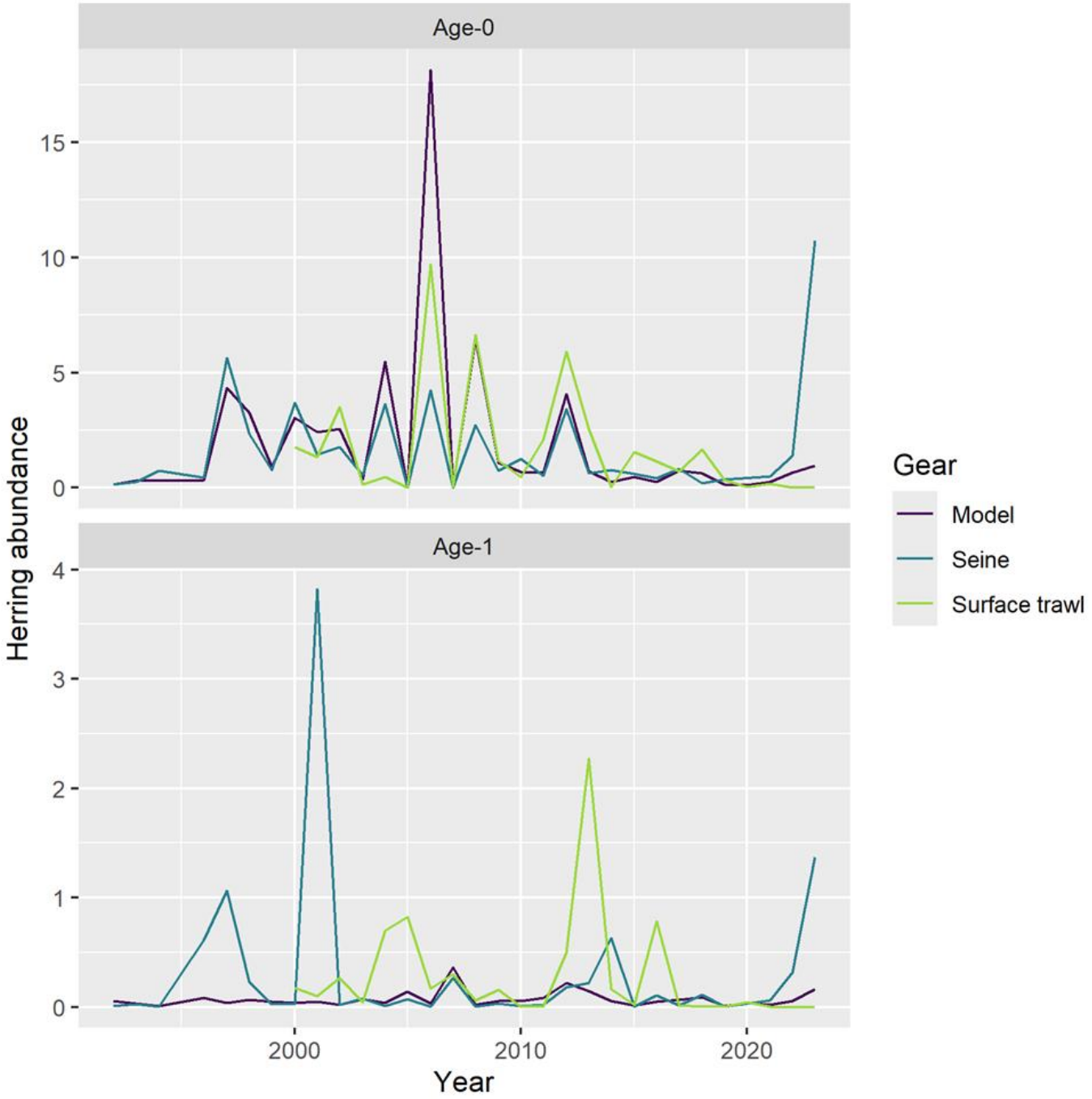


Response curves – Age 1

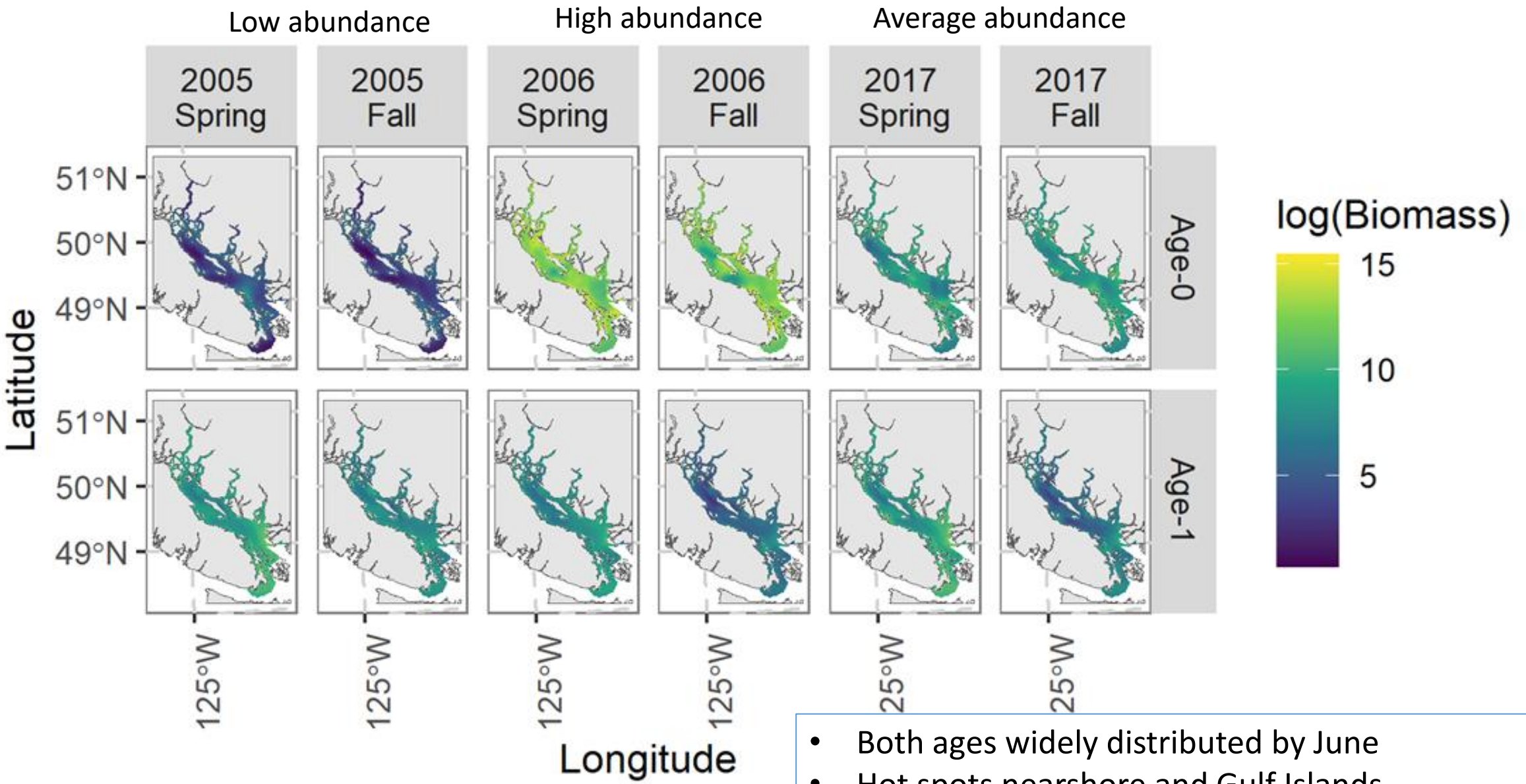


Model results

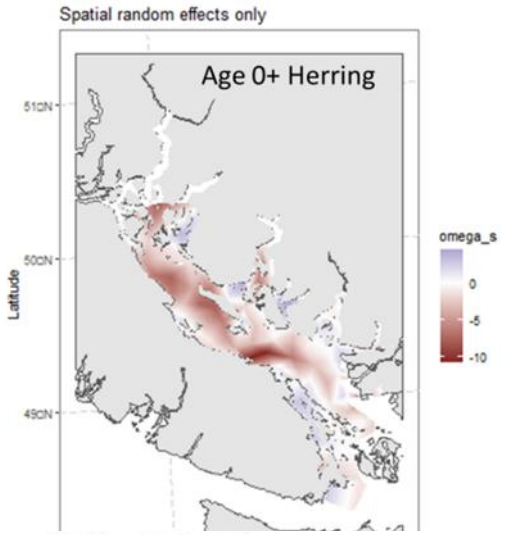


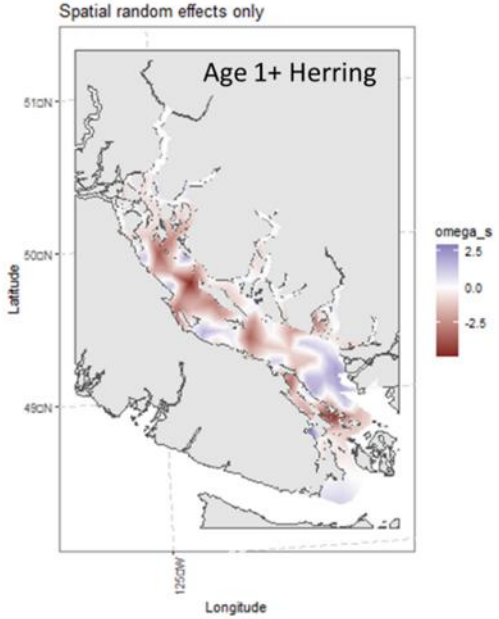


Distribution

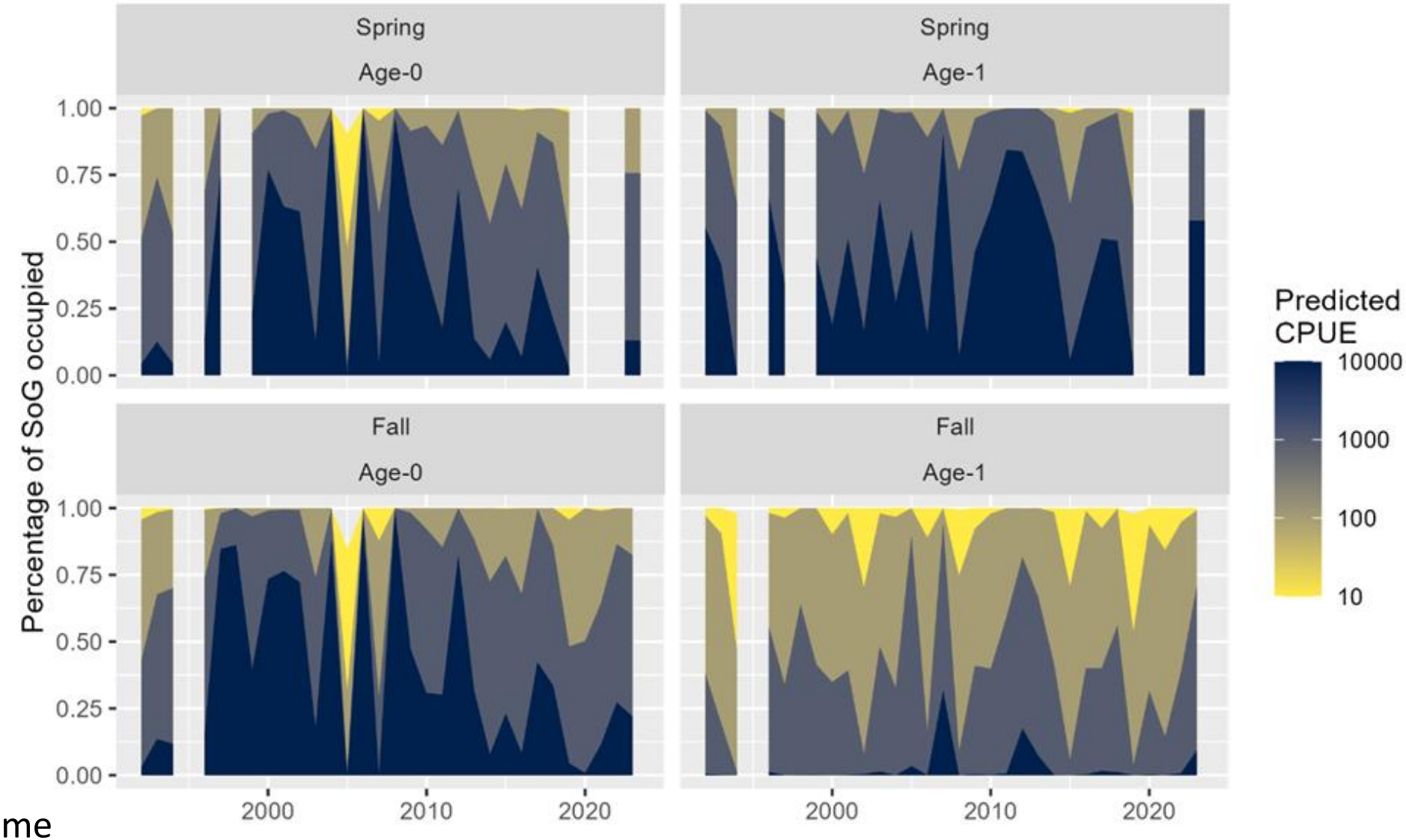


- Both ages widely distributed by June
- Hot spots nearshore and Gulf Islands
- Expansion in years of high abundance to offshore

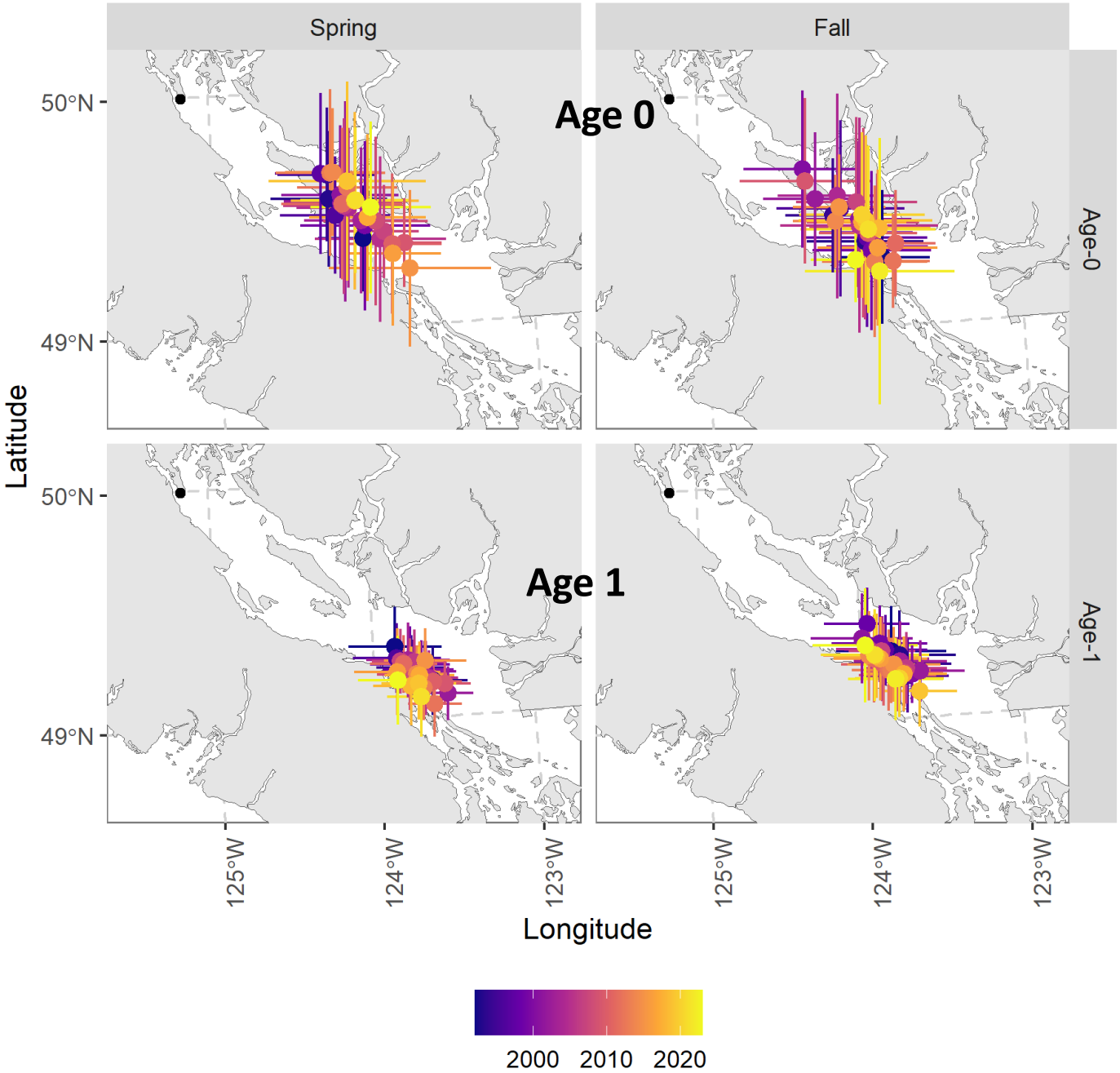




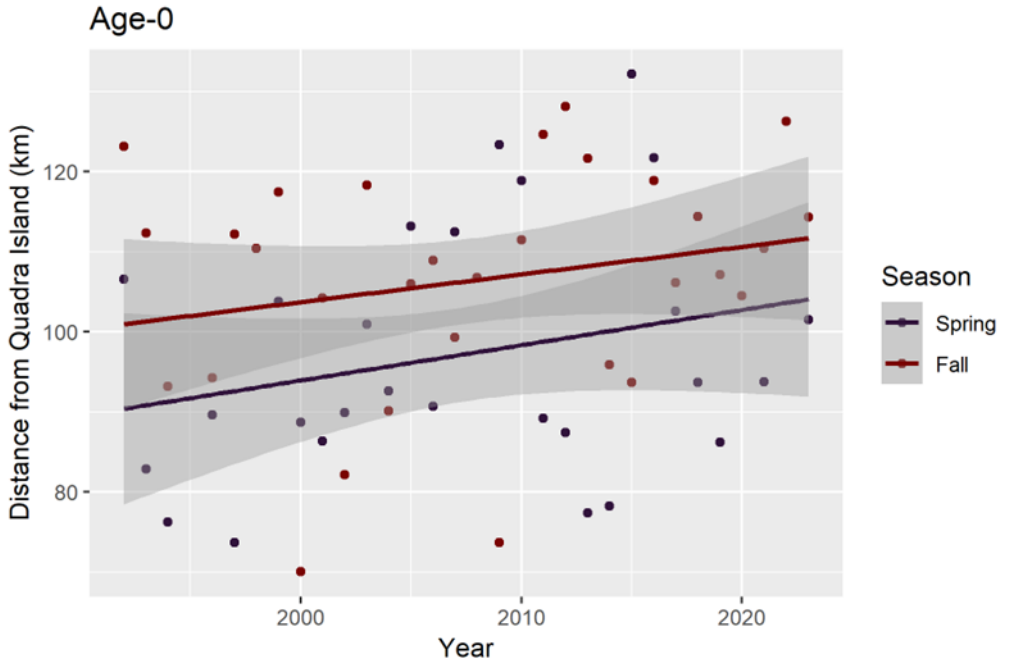
Area Occupied at Threshold CPUE

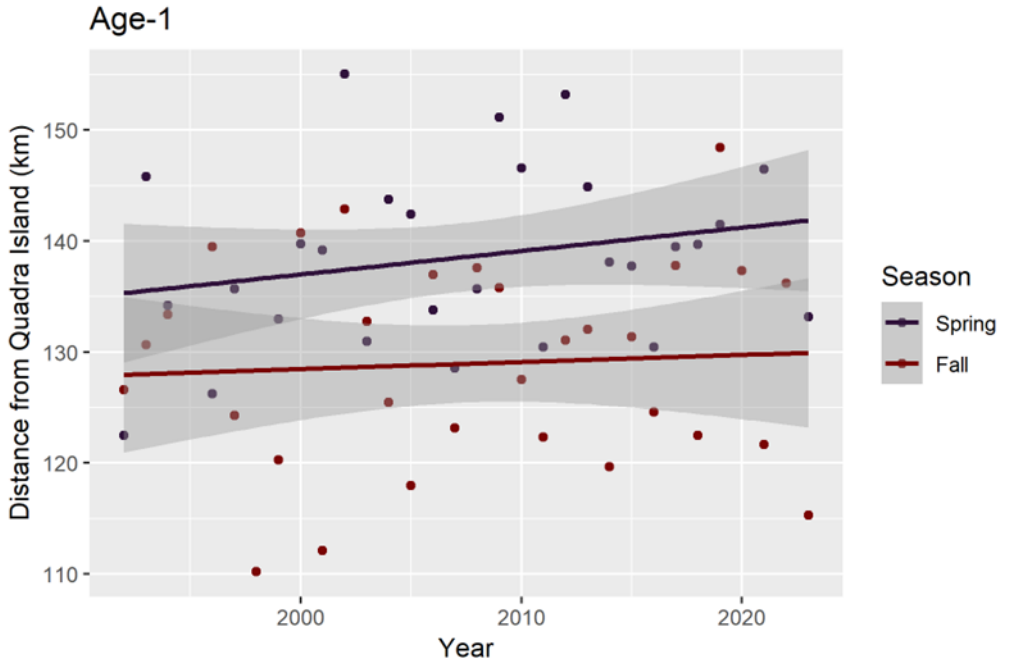


- In most years at least some occupancy predicted everywhere
- Basin effect?



Center of gravity moving southward over time





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Small pelagic fish vulnerability to climate change – growth rate potential of age-0 Pacific herring in the Strait of Georgia, British Columbia

Jennifer L. Boldt[1], Christopher N. Rooper[1], Hilari Dennis-Bohm[1], Angelica Peña[2], Matthew Thompson[1], Matthew Grinnel[1], and Jaclyn Cleary[1]

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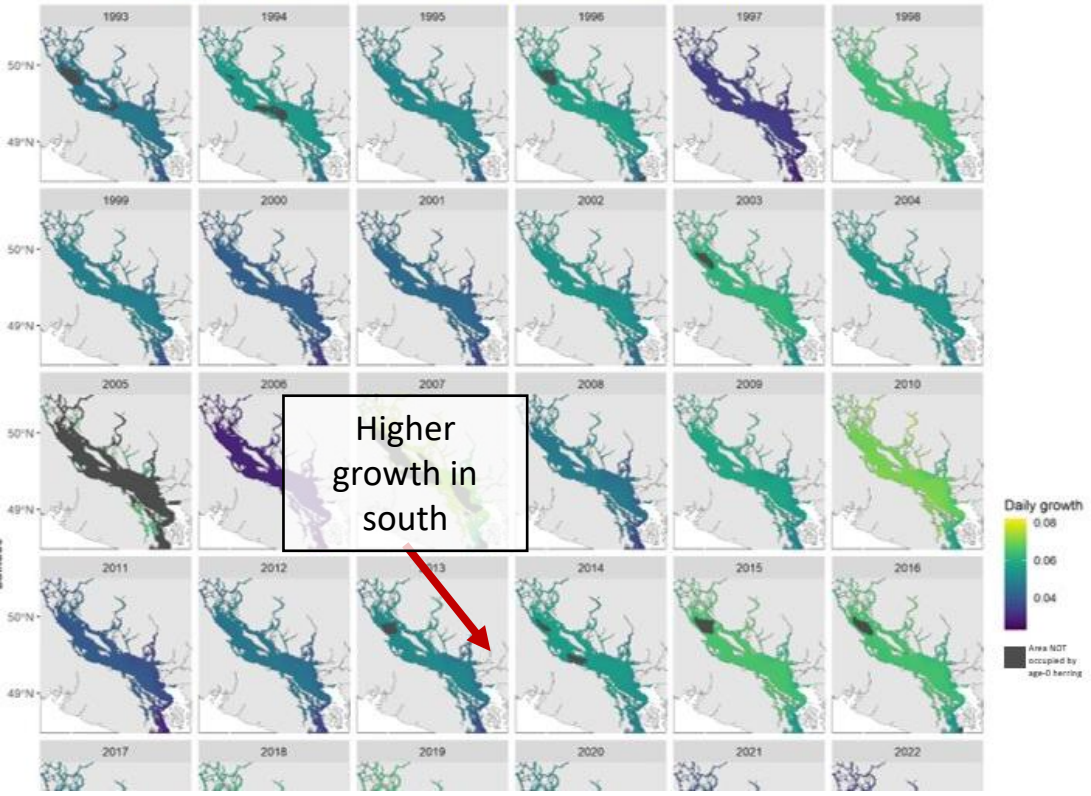
Average daily growth rates (g/day) of herring during their first 6 months



Age-2 recruits vs age-0 growth:

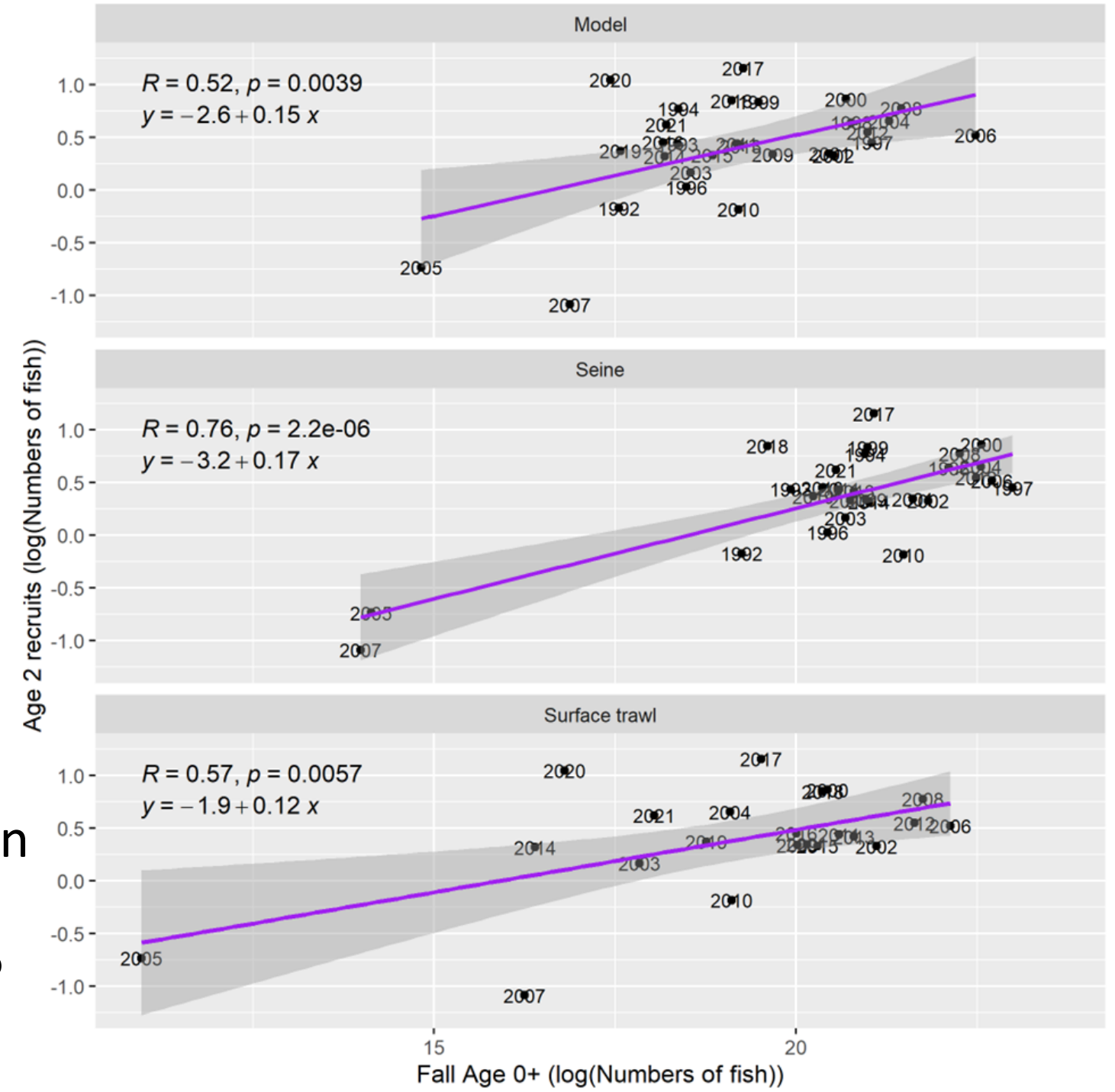
See the poster!

How does this compare to recruitment 2 years later?

- Seine ~ 58% of variance
- Trawl survey ~ 32% of variance
- Model ~ 27% of variance

Why?

- Dampening effect of trawl survey (more zeros & more data)
- Non-linear relationship between the two gears not captured?
- Daytime v. nighttime sampling?



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Analytical Framework for Evaluating Physical, Biological, Fishery-related Drivers of Population Dynamics: An Application to Pacific Herring

Caihong Fu[1], Jennifer L. Boldt[1], Christopher N. Rooper[1], Jaclyn S. Cleary[1], Thomas Doniol-Valcroze[1], Roy A. S. Hourston[2], Christie J. McMillan[1], Akash R. Sastri[2], Strahan Tucker[1]

[1] Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, BC; [2] Fisheries and Oceans Canada, Institute of Ocean Sciences, Sidney, BC

INTRODUCTION

- Small pelagic fish populations undergo significant fluctuations in abundance
- Implementing an ecosystem-

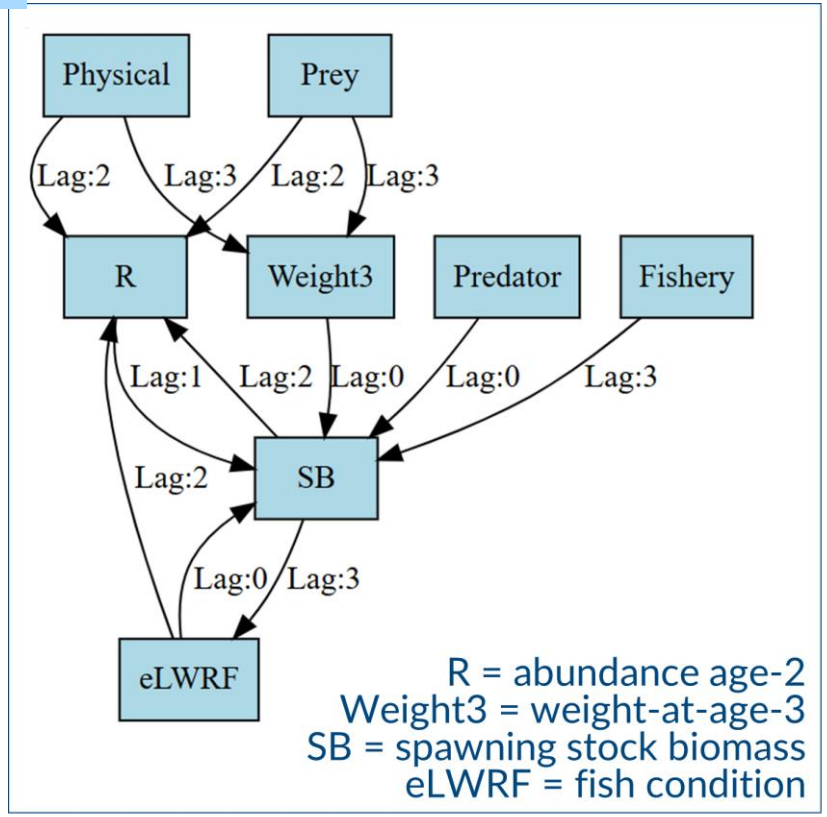
Novel, randomized Dynamic Structural Equation Modeling (DSEM) framework highlights important drivers:

Best-performing model, WCVI herring example

Seven drivers emerged as most influential across full set scenarios

Spawning Biomass as

See the poster!

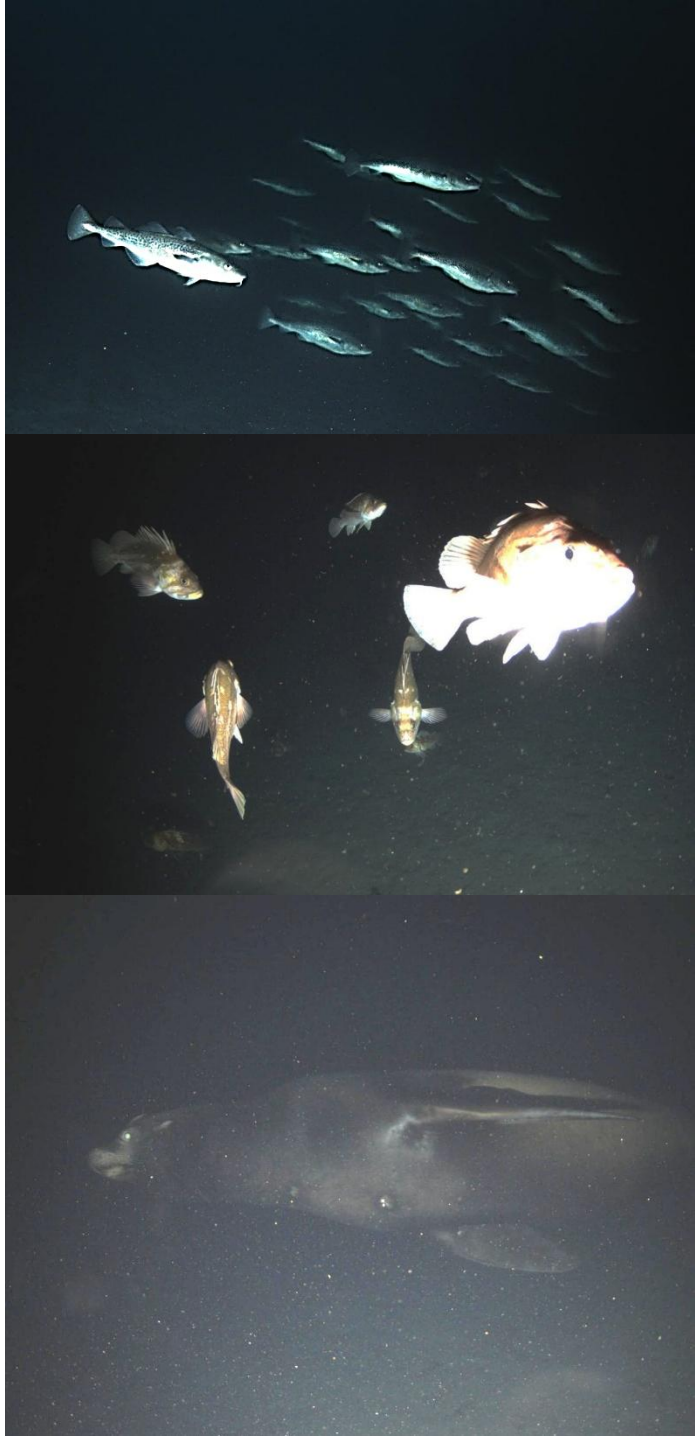


Findings & next steps

<u>Herring distributed throughout the Strait of Georgia</u>

- Persistent areas of high and low density
- Age 0+ spread throughout the nearshore (at least by June)
- Important environmental variables (depth, exposure, perhaps SST and salinity) linked to distribution
- Evidence of recent southward shift for Age 0
- Trends correlated with recruitment 2 years later

- Link to bioenergetics (Boldt et al. poster)
- Continuing monitoring work to identify years of low recruitment & track southern distribution shift
- Explore potential ways to incorporate basin effect?

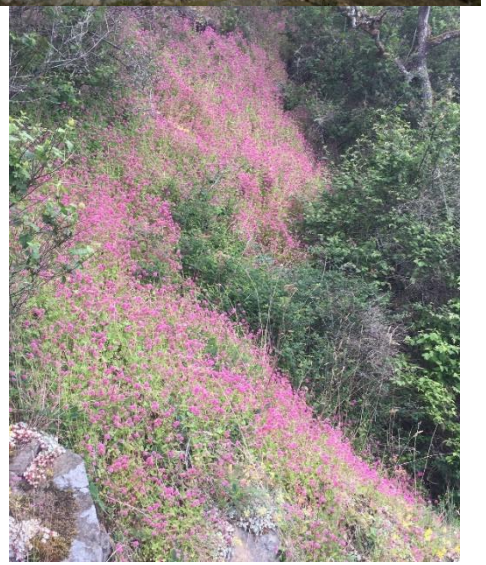


Acknowledgements









- Jaclyn Cleary
- Patrick Thompson
- Sean Anderson
- Jim Thorson
- Capt. & crew and many scientists who collect survey data

This research was completed on the traditional and unceded territory of the Coast Salish Peoples, mostly on the traditional territory of the Snuneymuxw First Nation.