Model detection of a spatial break in the Gulf of Alaska Pacific cod stock

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Photo credit: Library of Congress

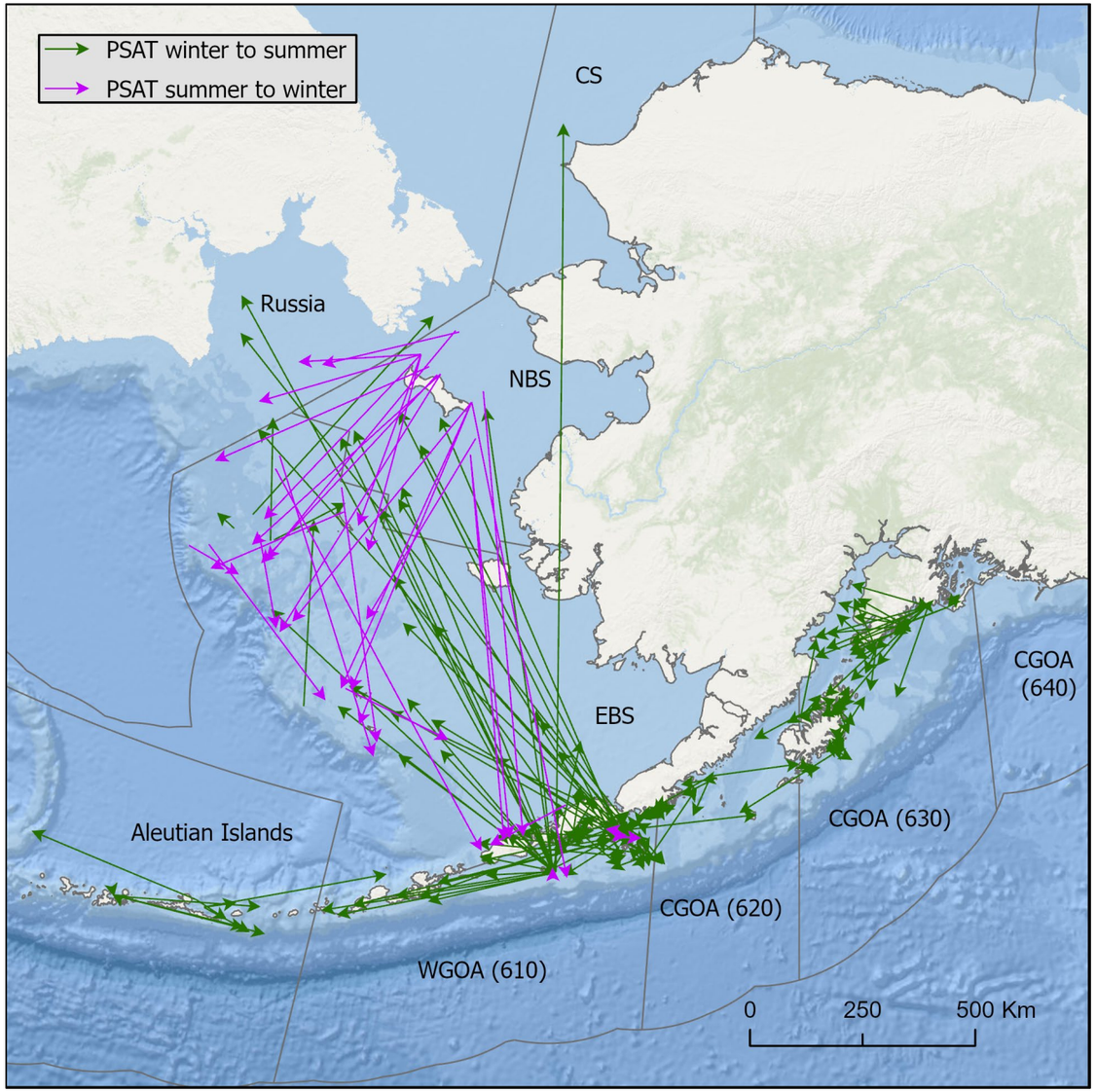
Population Spatial Structure

Can be defined by:

- Oceanography
- Demography
- Ecology
- Genetics
- Socio-economic factors

Pop-up Satellite tagging: seasonal connectivity

Susanne McDermott (NOAA AFSC), Charlotte Levy (Aleutians East Borough), Kimberly Rand (Atka Blue LLC),
Bianca Prohaska (NOAA AFSC), David Bryan (NOAA AFSC), Julie Nielsen (Kingfisher Marine Research LLC)



395 satellite tags deployed since 2019

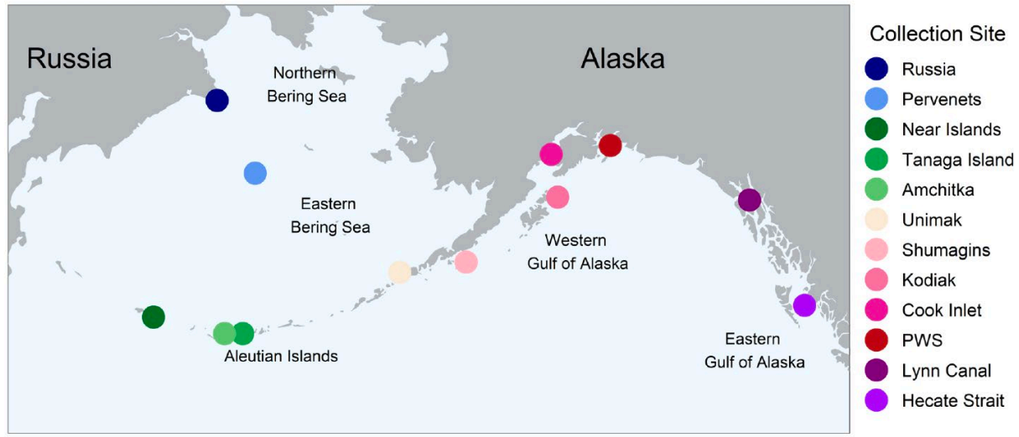
366 fishery-independent recovery locations:

Seasonal connectivity

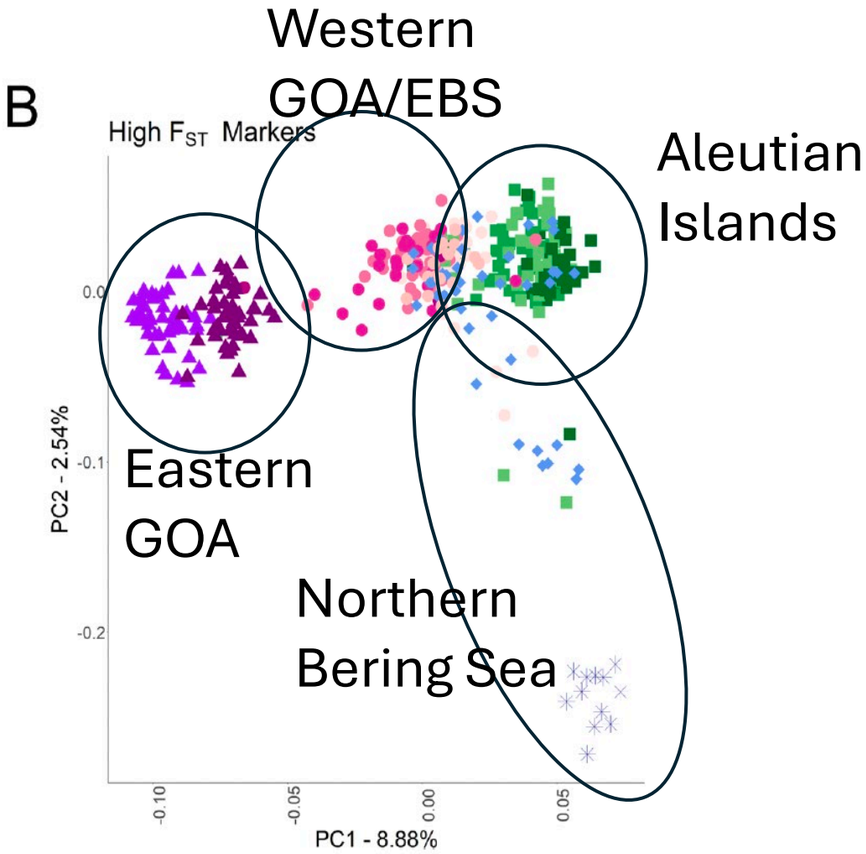
- Approximately 50% of fish tagged in western GOA in winter move to Bering Sea (or farther north) for summer foraging
- Little movement between western GOA and central GOA
- No eastward movement from Central Gulf area 630 observed so far
- Little movement between Aleutian Islands and western GOA or Bering Sea

Assignment tests cannot distinguish between fish from the western Gulf of Alaska (GOA) and the eastern Bering Sea.

A



B



Schaal, S.M., Larson, W., Vollenweider, J., Miller, K., Klenz, T., Maselko, J., Neff, D., Tobin, C., McDermott, S. and Spies, I., 2026. Genetic Data Reveal Nonlocal Juvenile Recruitment and Variable Seasonal Movement of a Highly Mobile Marine Fish Across Alaska. *Evolutionary Applications*, *19*(1), p.e70174.

Workflow for spatial models

2 seasons

- A: January - March
- B: April - December

Age range

- 2-8 years

3 gear types

- Longline
- Pot
- Bottom Trawl

3 size classes

- Sub-adult (31-50 cm)
- Adult (51-80 cm)
- Large Adult (81-135 cm)

Predict

- Construct a spatial prediction grid for each gear-season
- Target variable changes

Compute Derivatives

- Calculate slope across the grid
- Use finite-differences method (Kapur et al. 2020)

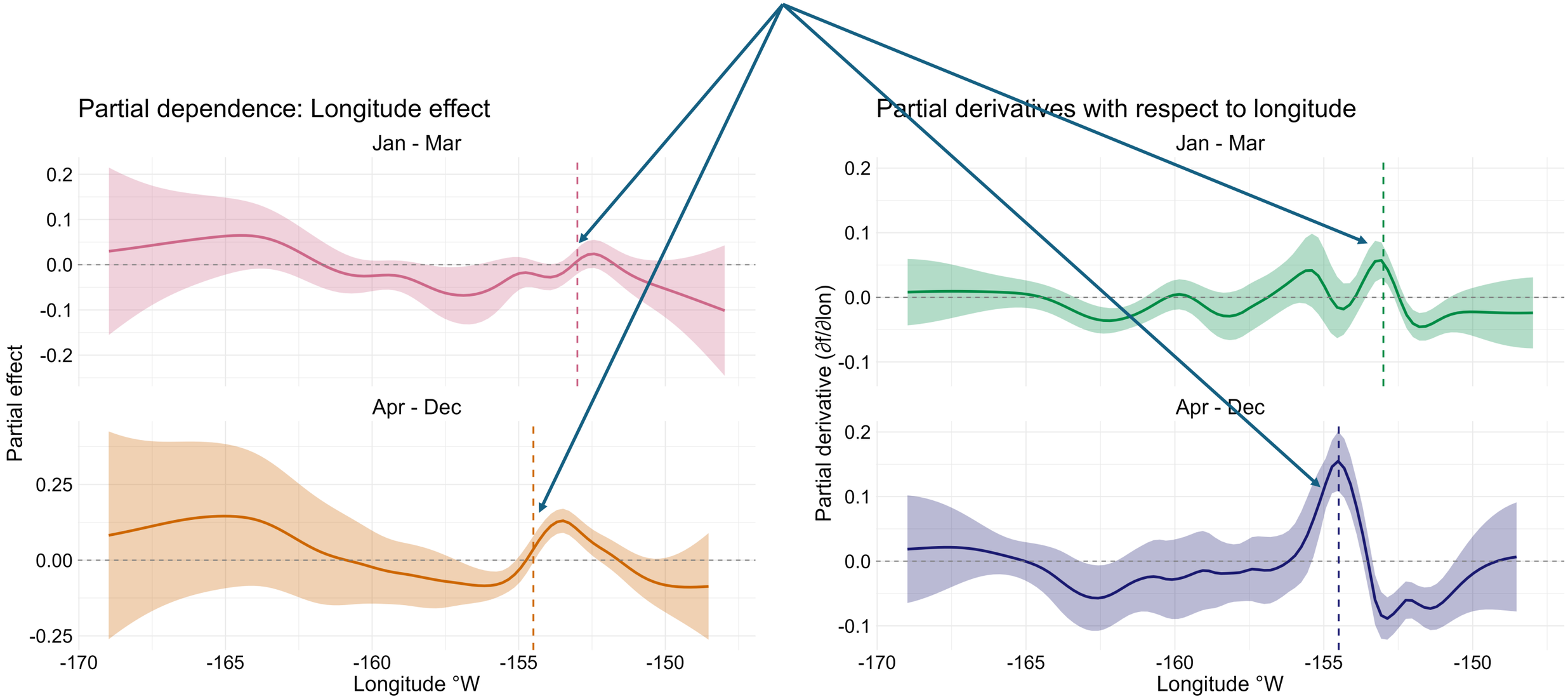
Error Calculation

- Compute the difference between prediction matrices
- Calculate standard error

Aggregate gear

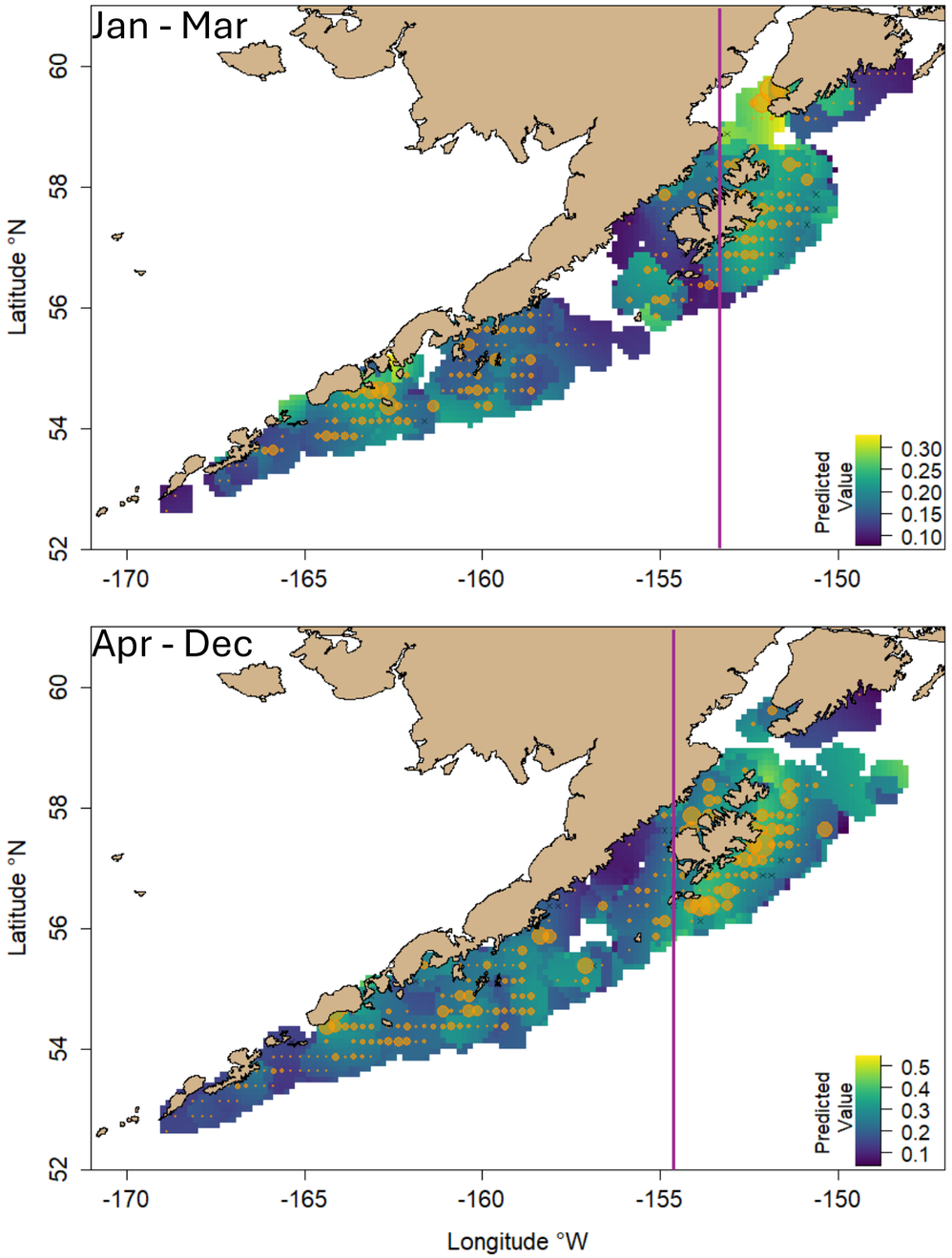
- Average the results by season
- Each size model results in a plot for each season

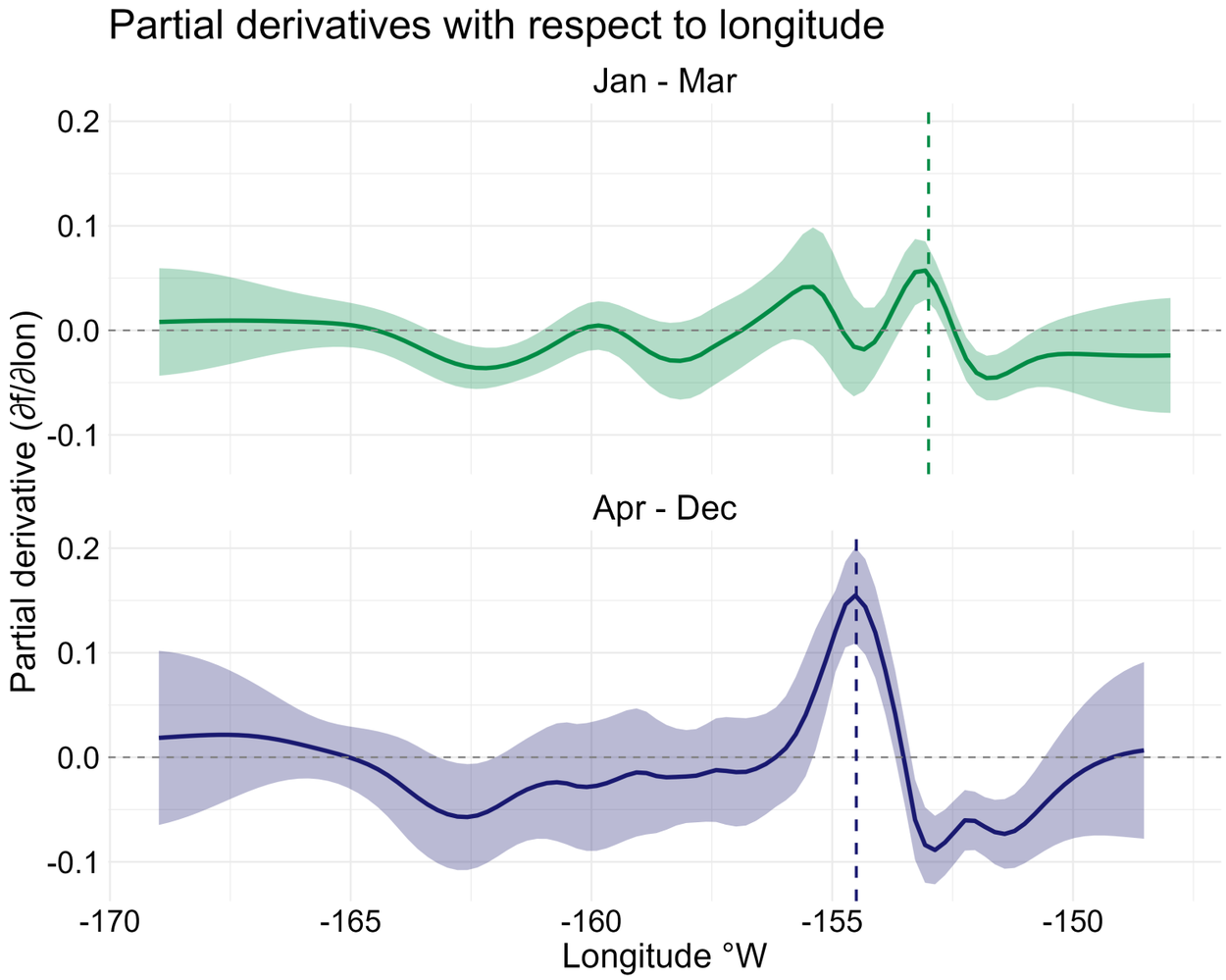
Breakpoints defined as the greatest interior local extrema



Small Sizes (31-50 cm)

n = 5,142

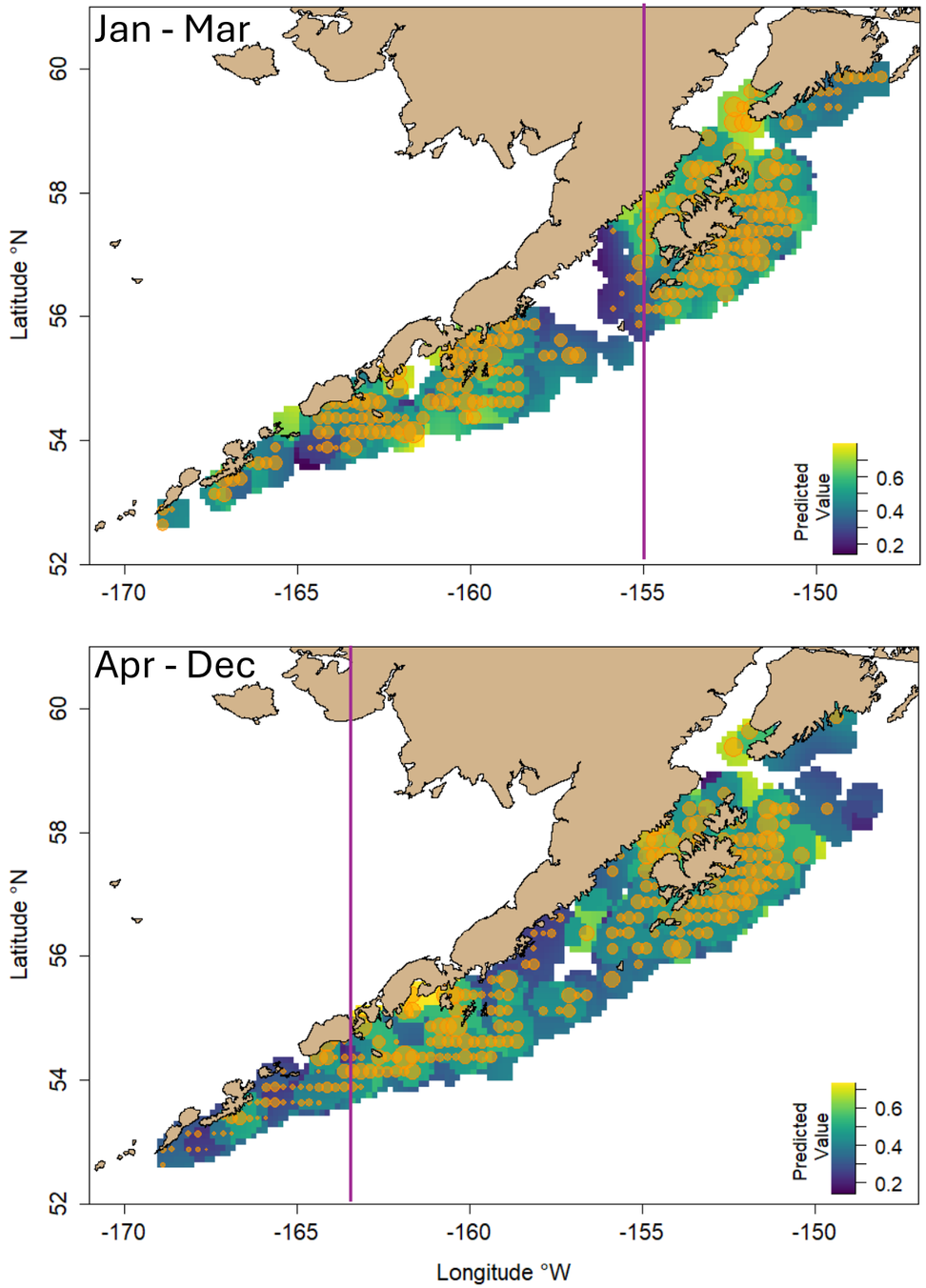


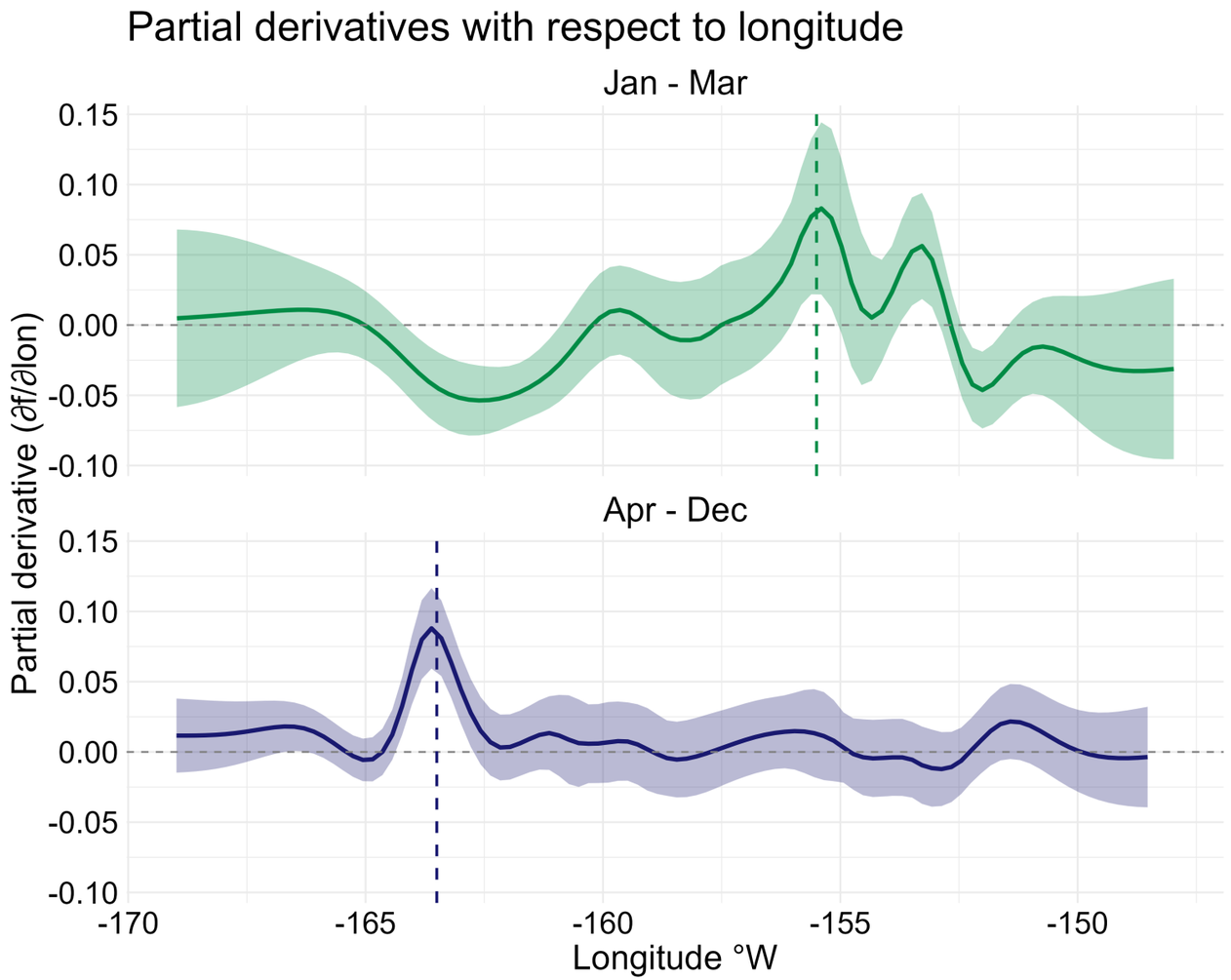


log(CPUE + 1) ~ gear:season + s(year, by = gear:season) + s(lon, lat, by = gear:season) + s(depth, by = gear:season)

Medium Sizes (51-80 cm)

n = 9,861

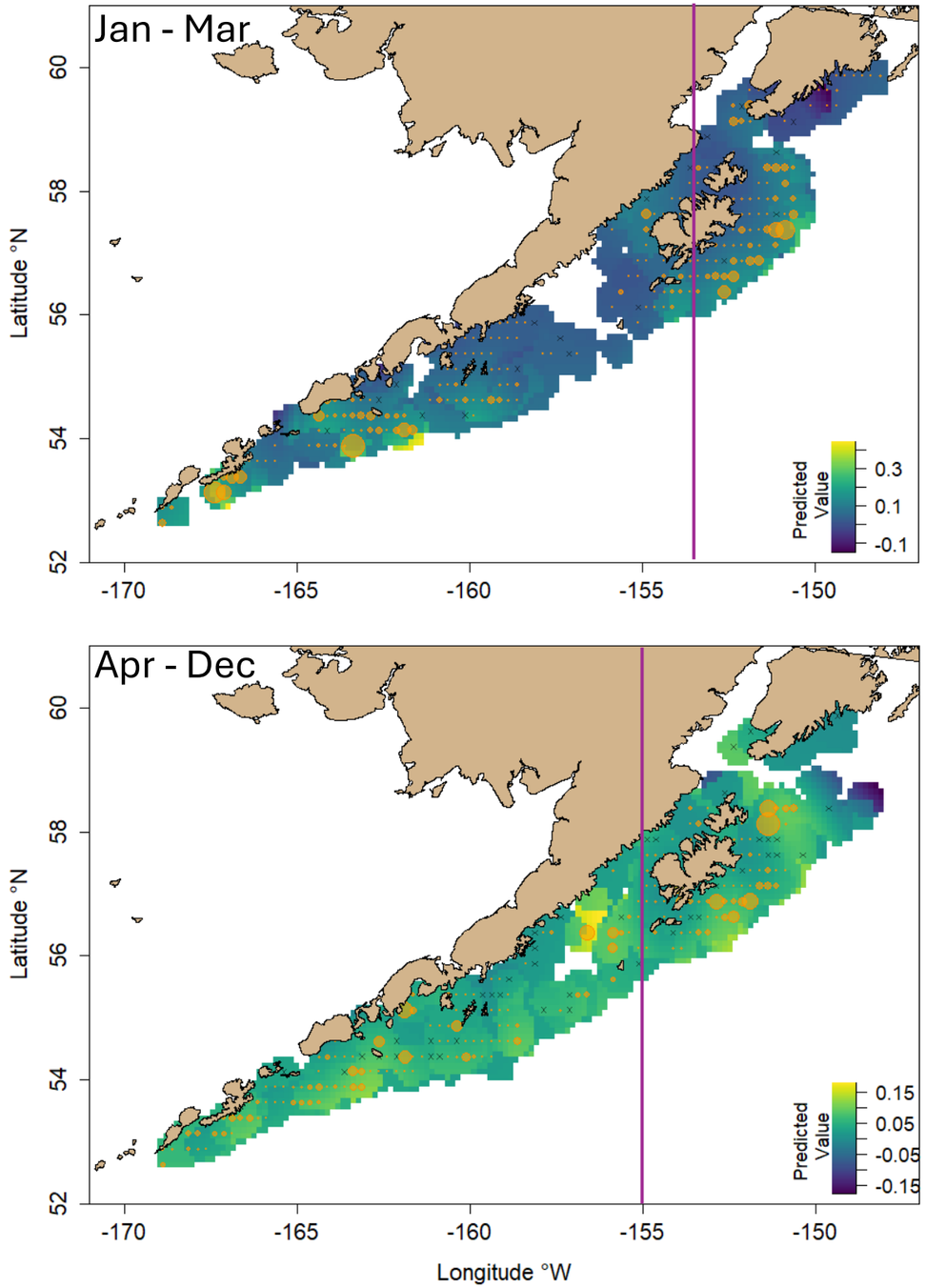


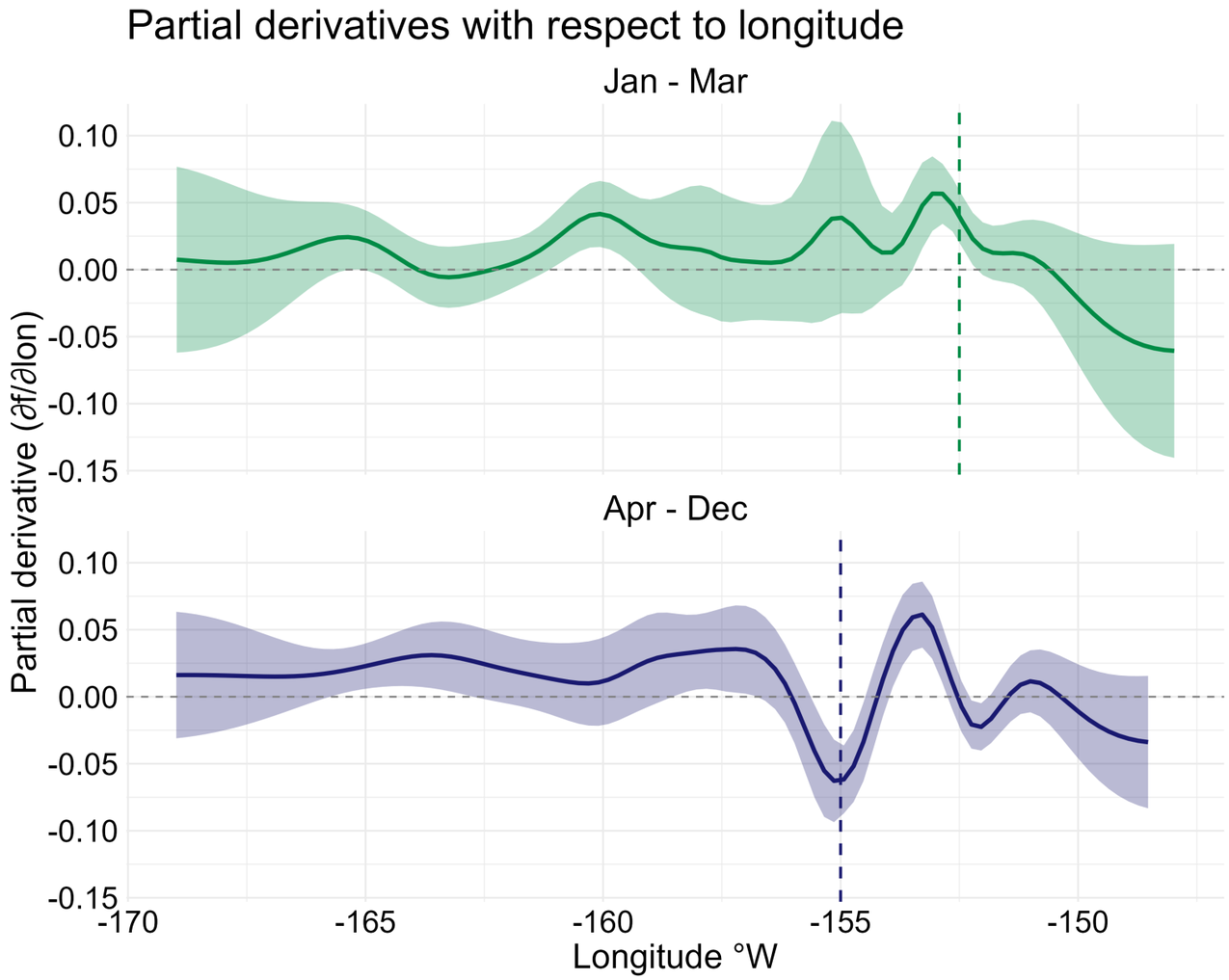


log(CPUE + 1) ~ gear:season + s(year, by = gear:season) + s(lon, lat, by = gear:season)
+ s(depth, by = gear:season)

Large Sizes (81-135 cm)

n = 3,286



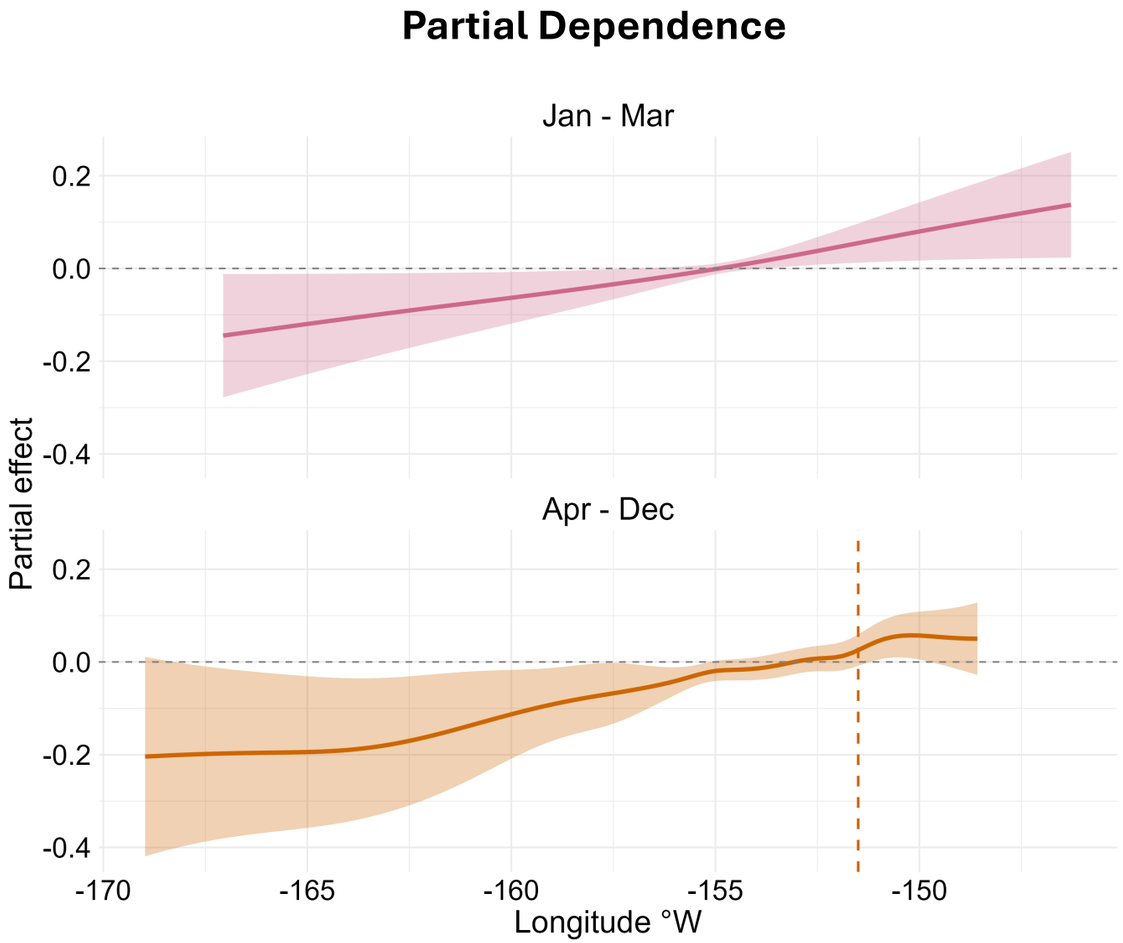


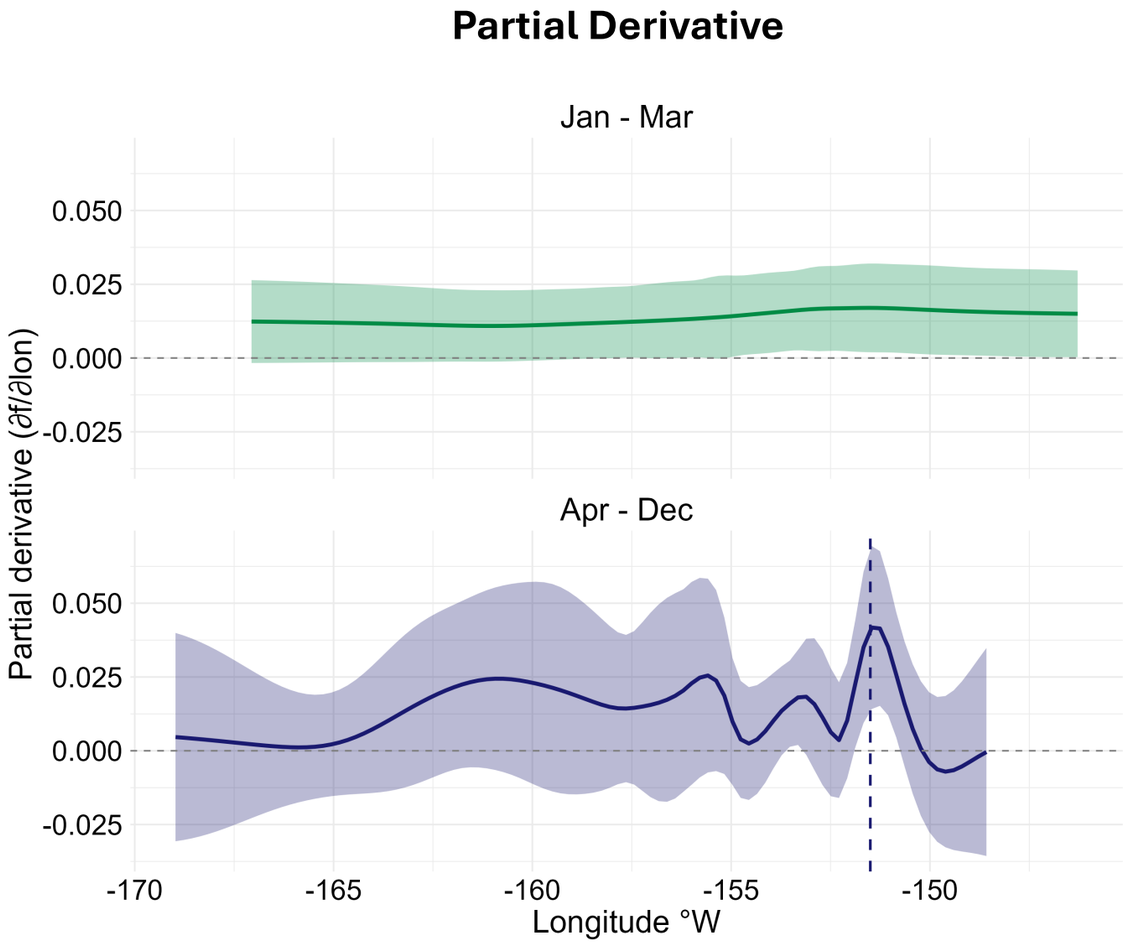
log(CPUE + 1) ~ gear:season + s(year, by = gear:season) + s(lon, lat, by = gear:season)
+ s(depth, by = gear:season)

Age Models Identify Similar Breakpoints

Age 3

n = 1058



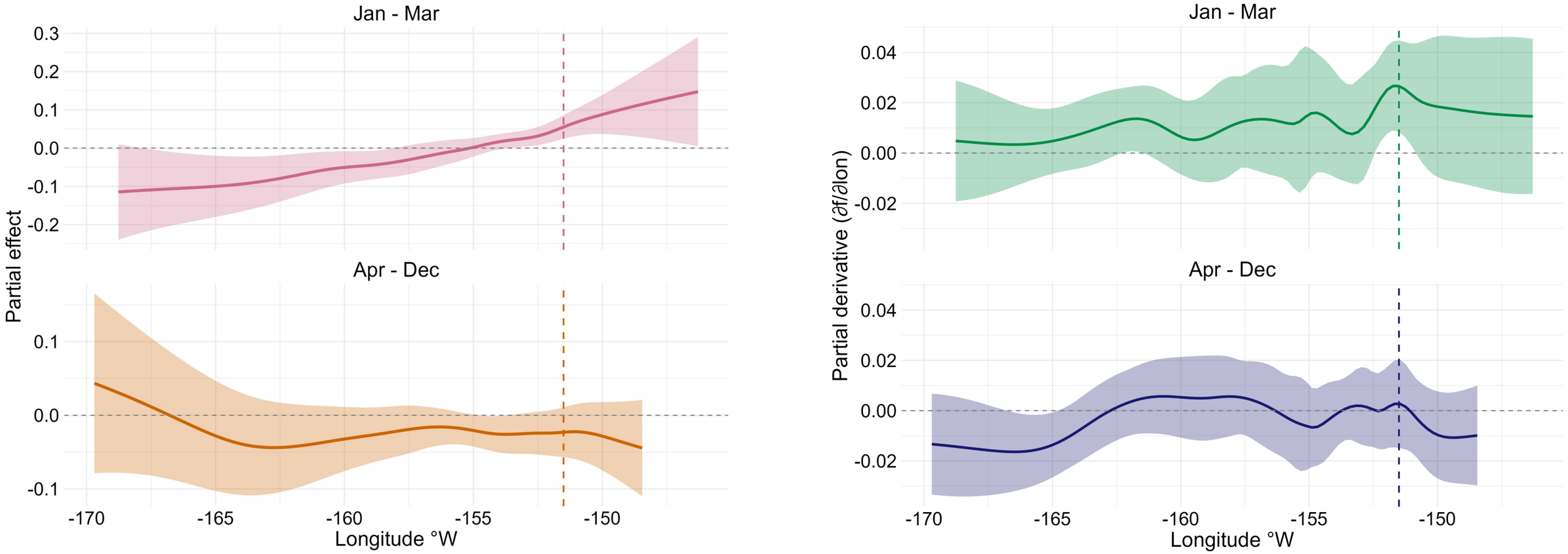


length ~ gear:season + s(year, by = gear:season) + s(lon, lat, by = gear:season)

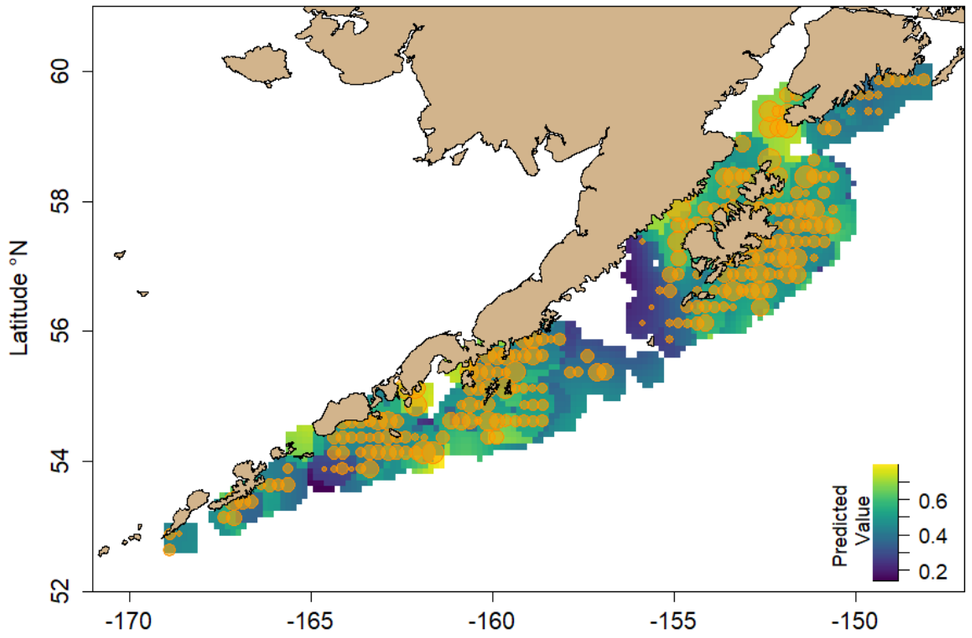
Age Models Identify Similar Breakpoints

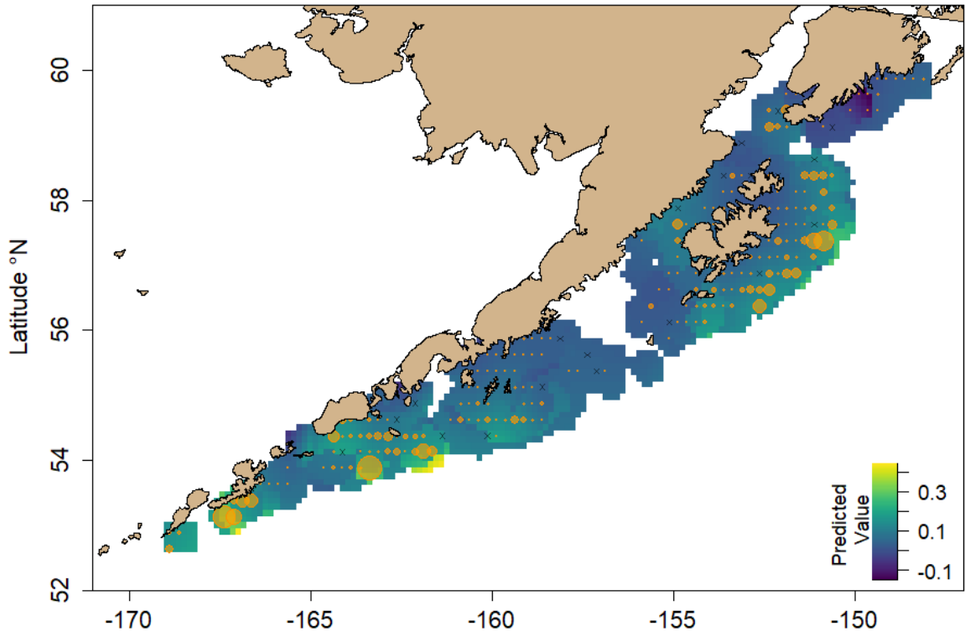
Age 4

n = 1540



length ~ gear:season + s(year, by = gear:season) + s(lon, lat, by = gear:season)

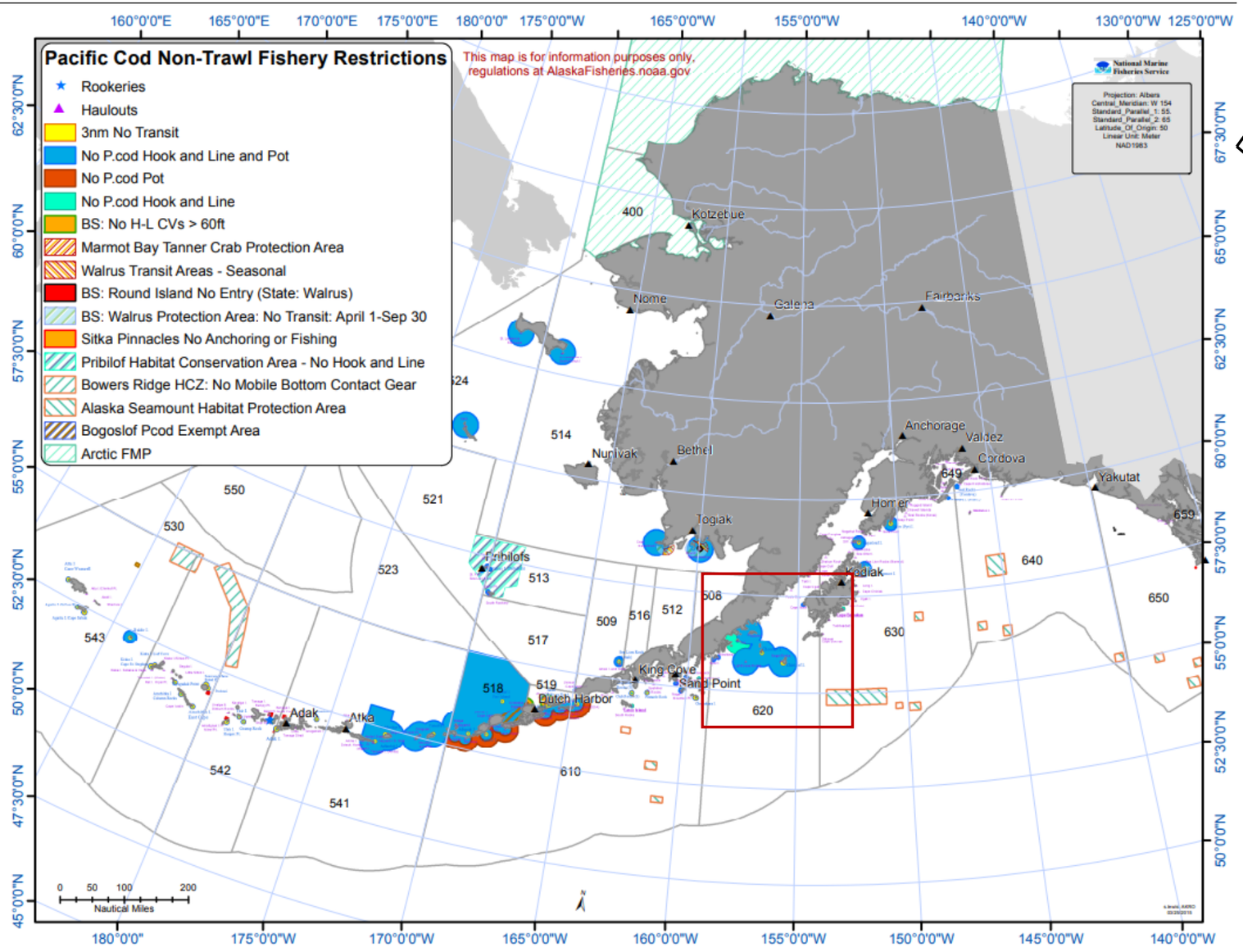


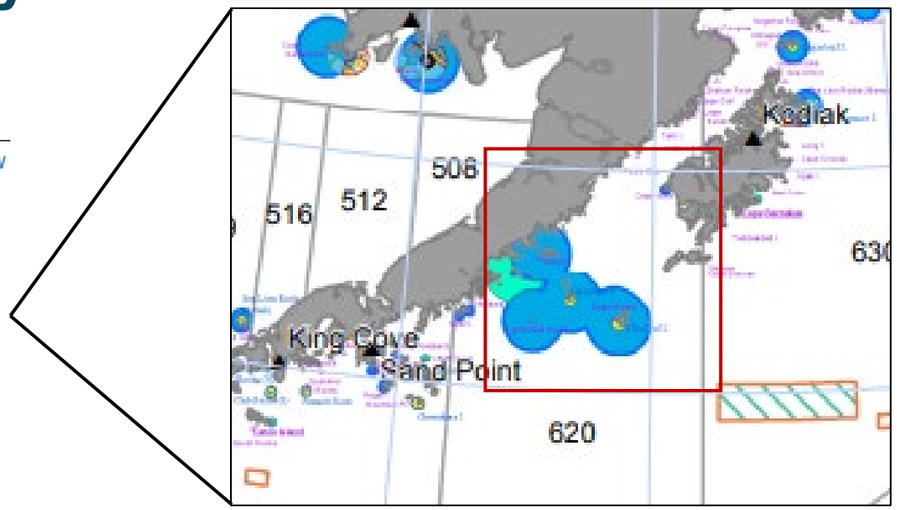


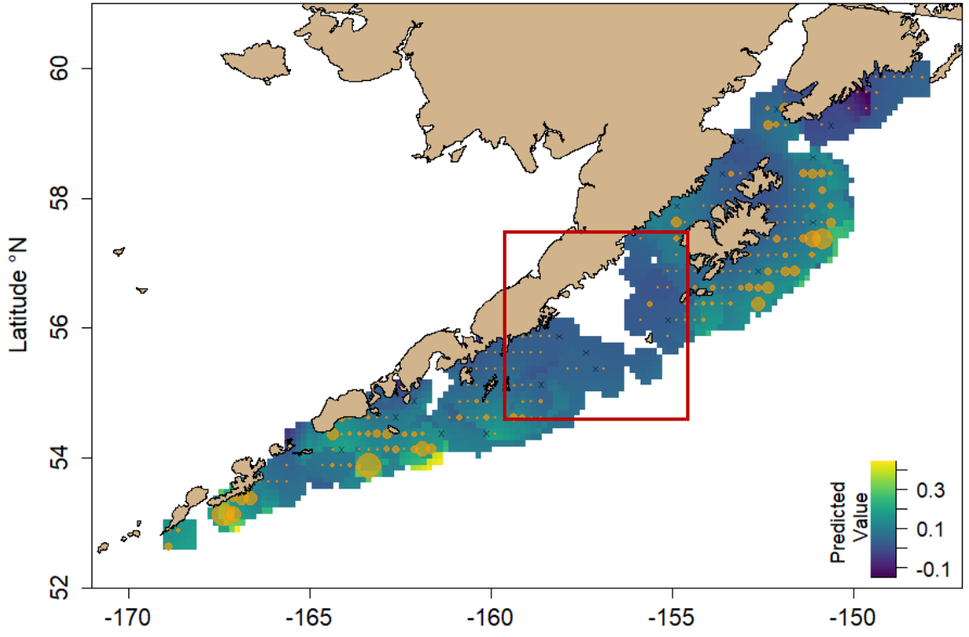
Possible explanations for gap at ~156 W

- Stellar sea lion fishery closures
- Bathymetry – depth
- Strong current
- Fishery avoidance
  - Sleeper shark prevalence
  - Dangerous ocean conditions
  - Proximity to market

Stellar Sea Lion Fishery Closures & Port Proximity







Currents and Water Depth

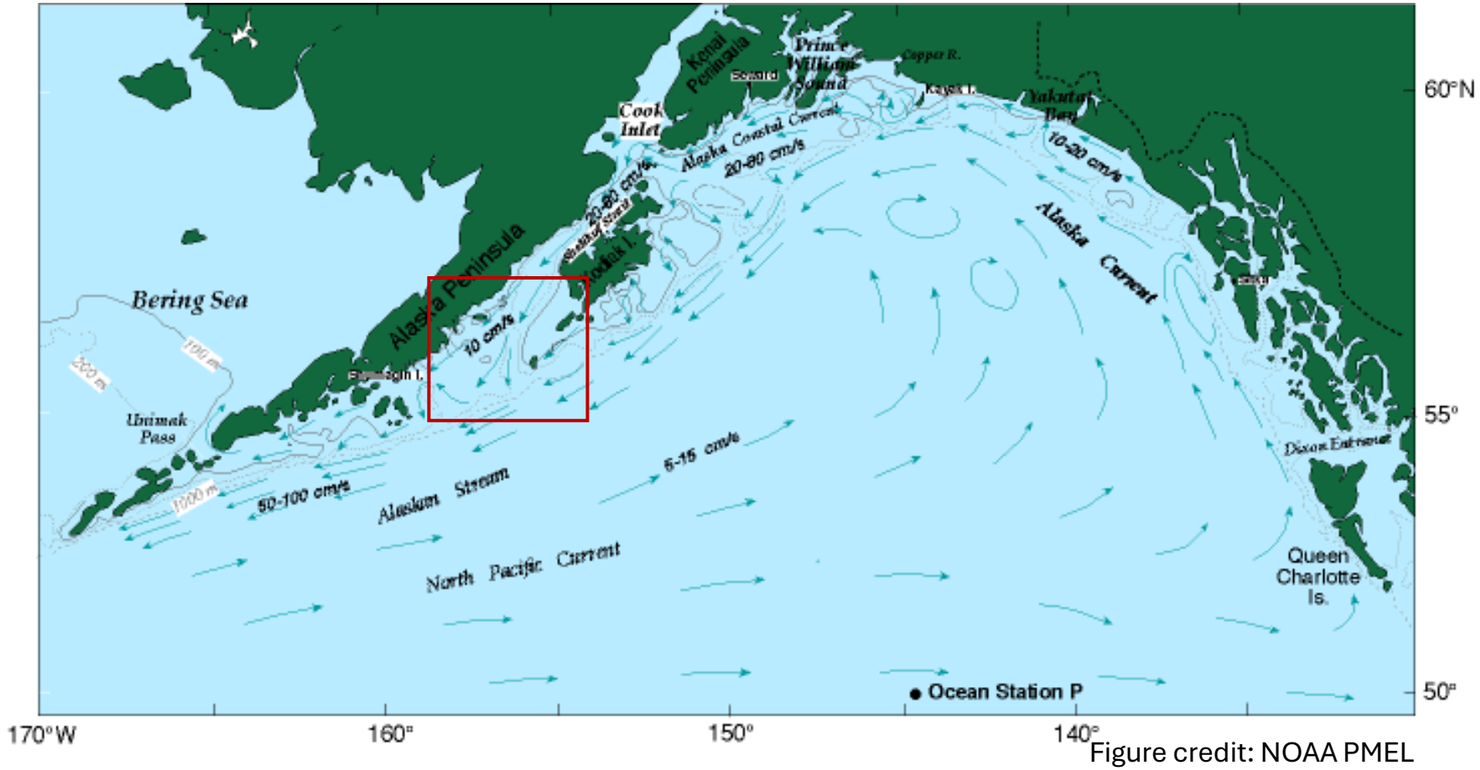
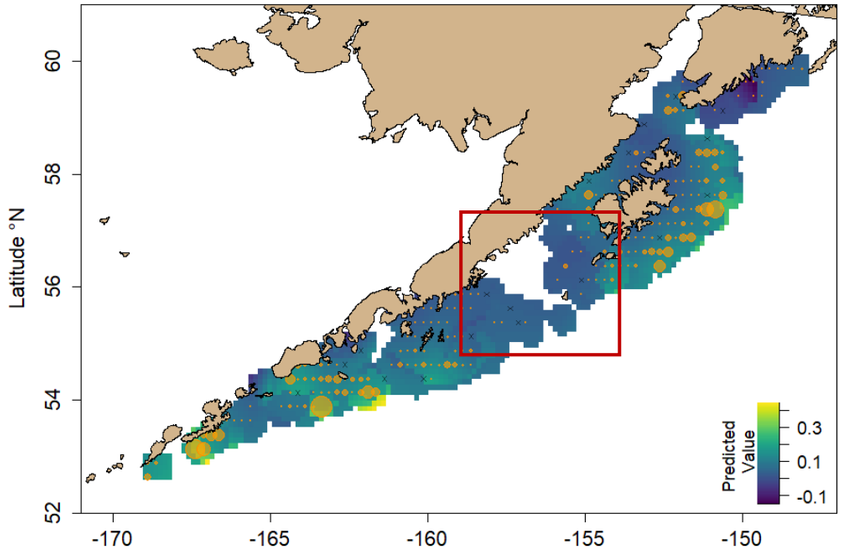


Figure credit: NOAA PMEL



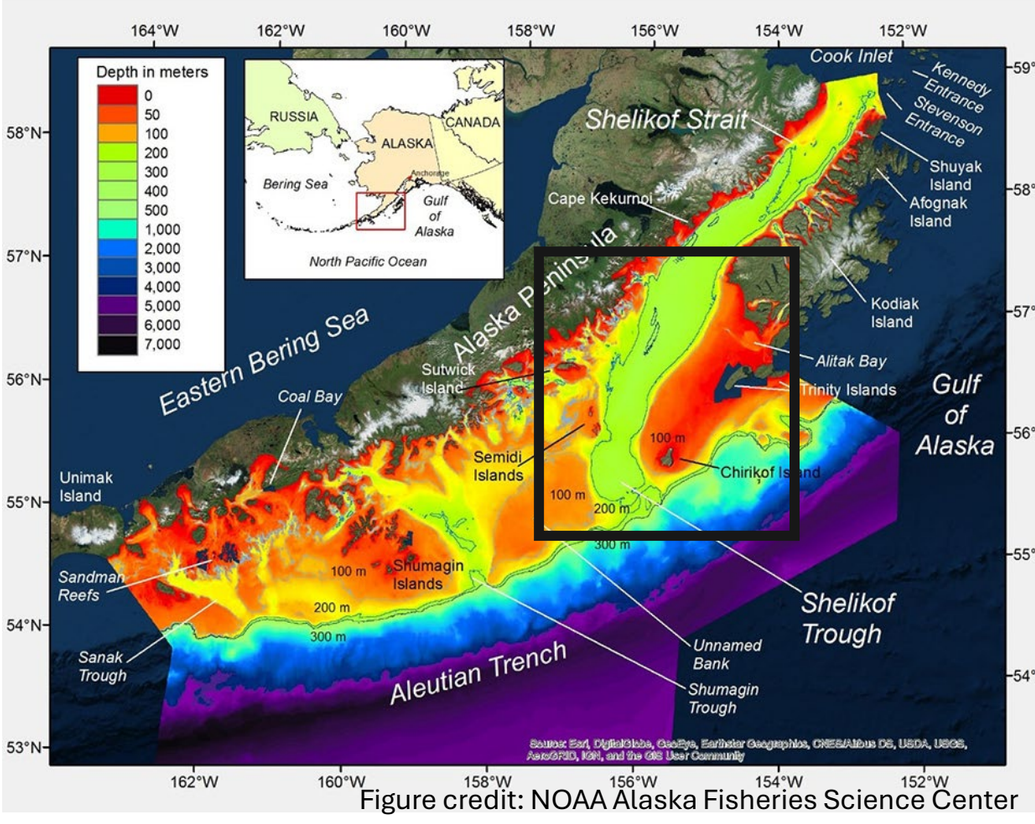


Figure credit: NOAA Alaska Fisheries Science Center

Summary and conclusions

- Abundance and size at age models spatial break at 152-155W
- Spatial gap in catch at 156W driven by multiple processes
- Western GOA P cod is demographycally and genetically connected to EBS
- Central GOA is not connected to EBS
- More work in testing model against gap in data and size thresholds
- Implications for stock structure and assessment

