Using Vessel Monitoring Systems Data to Analyze the Spatial Distribution of the Pacific Salmon Ocean Troll Fishery on the West Coast of the U.S.

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Background

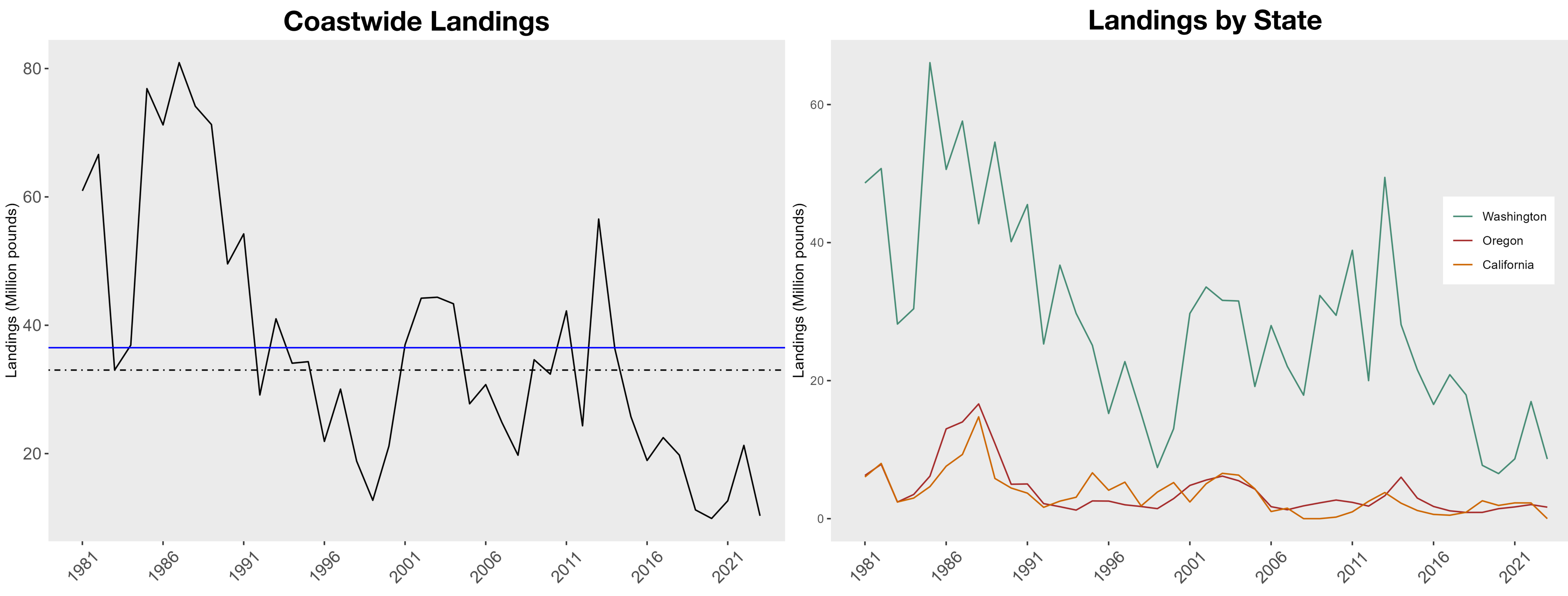

Figure 1: Coastwide and statewide historical salmon commercial fishery landed weight from 1981-2023 as computed using all salmon landings (from fish ticket data). The solid blue line is mean weight and the broken black line is median weight.

- This study uses data on the location of fishing vessels from 2007-2023 to develop models of spatial distribution and behavior of the Pacific Salmon Ocean Troll Fishery on the West Coast.
- This period is characterized by highly irregular oceanographic conditions, most notable of which was a severe marine heatwave (MHW) that persisted from 2013-2016.
- Previous studies have primarily investigated the biological impacts of this MHW[1], but, less is known about the economic and social consequences among port communities, where fishing plays a key role in the economy[2].
- The goal of this study is to describe how vessel monitoring system (VMS) data can be used with landings data (fish tickets) to produce high resolution data on the location of fishing activity on the West Coast, which can help us create metrics to analyze how fishing grounds have changed over time.

Data

- Port level in Washington, Oregon, and California
- 2007-2023
- VMS Data
  - Vessel ID, location and time
  - One observation (poll)/ hour
- Fish Ticket (FT) Data
  - Vessel ID
  - Landings date
  - Landings revenue
- Observation are non-random
  - VMS trips are a subset of all salmon fishing trips
- Locations for each trip include both transiting and fishing activity
  - Spatial statistics incorporate all points associated with a trip

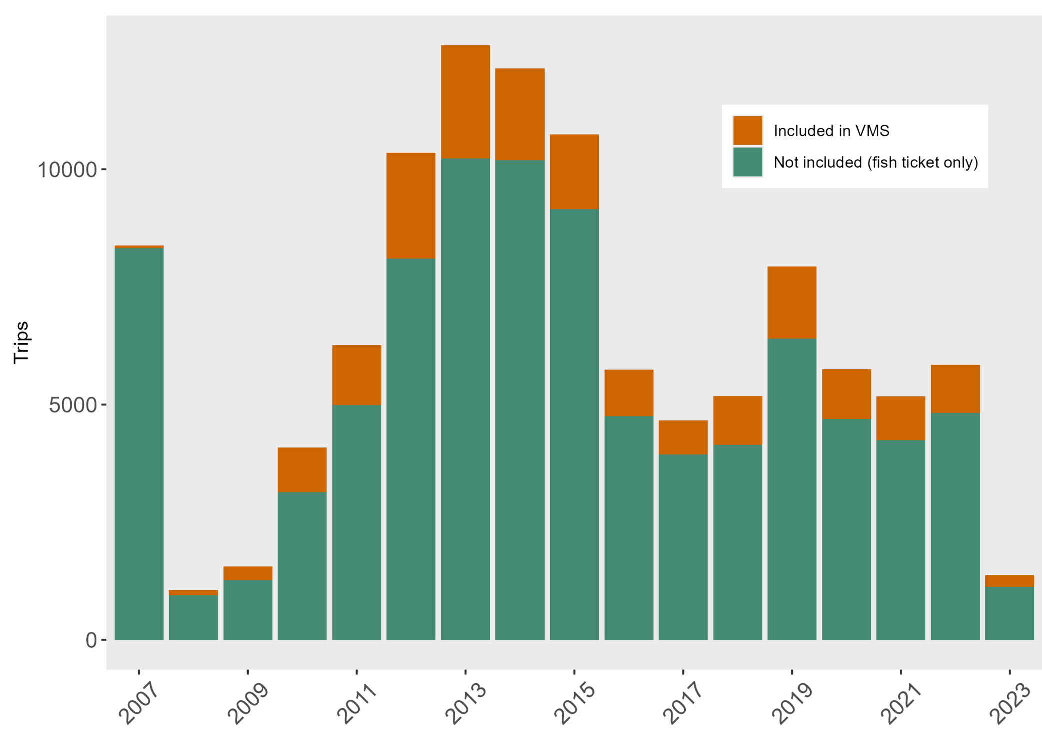

Figure 2: Number of salmon trips in the dataset constructed from VMS data compared to the number of trips in the fish ticket data.

Methods

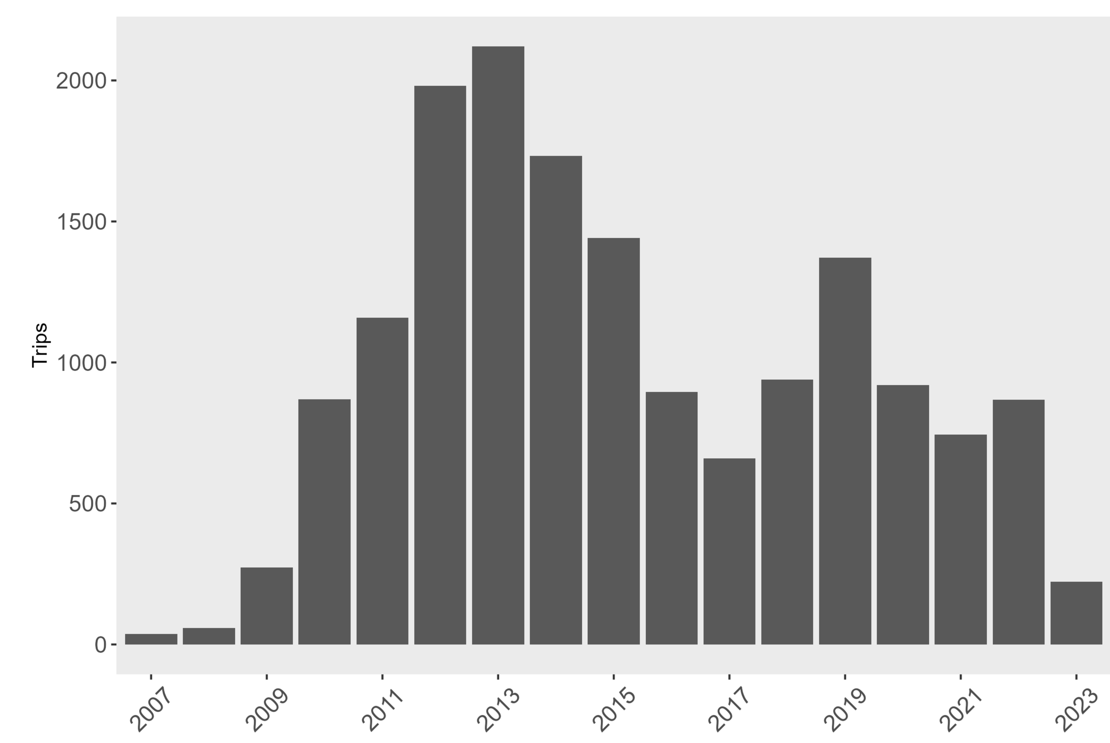

Figure 3: Number of salmon trips per year identified in the VMS data.

1. Matched VMS polls with FT data according to vessel identity and time.
2. Expanded landings date for each FT back seven days to create a trip window.
3. Joined datasets and analyzed trip characteristics and fleet-level spatial distribution of fishing effort over time.
4. Used the minimum convex polygon estimator[3] commonly used in animal movement ecology to define a "home range" (the area most commonly utilized by an individual) at the fleet and individual level.

Results

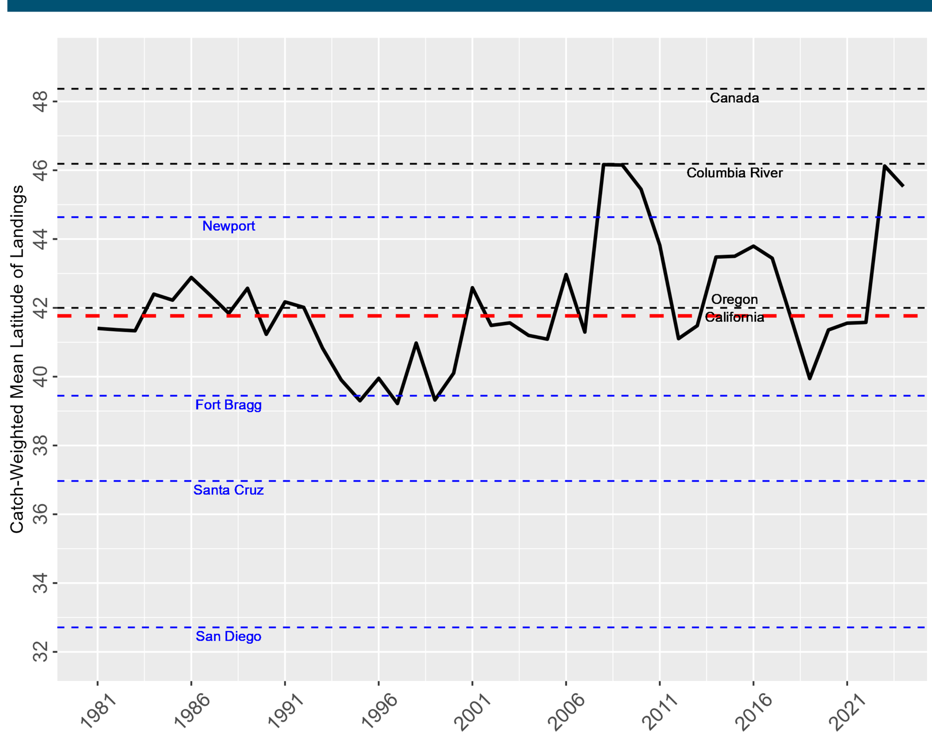

Figure 4: Catch-weighted mean latitude of fishing trips.

- Catch-weighted mean latitude is a rough indicator of the spatial distribution of fisheries landings, which have gradually shifted North over time (Fig. 4).

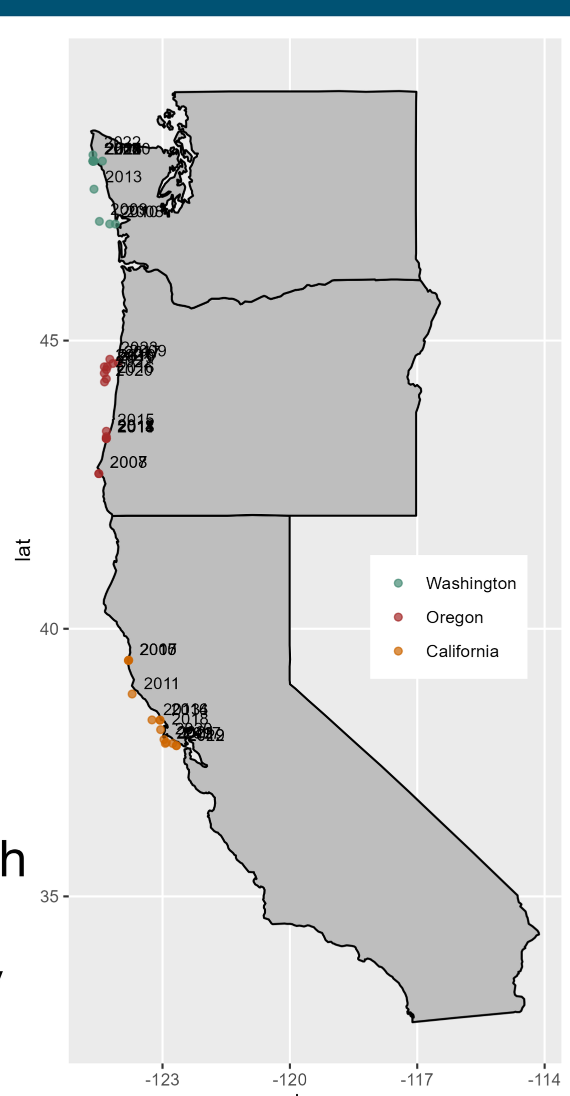

Figure 5: Median latitude and longitude of fishing trips by year from 2007-2023.

- The "center" of fishing grounds vary across years with an overall shift northward in Washington and Oregon and Southward in California, possibly as a result of the MHW (Fig. 5).

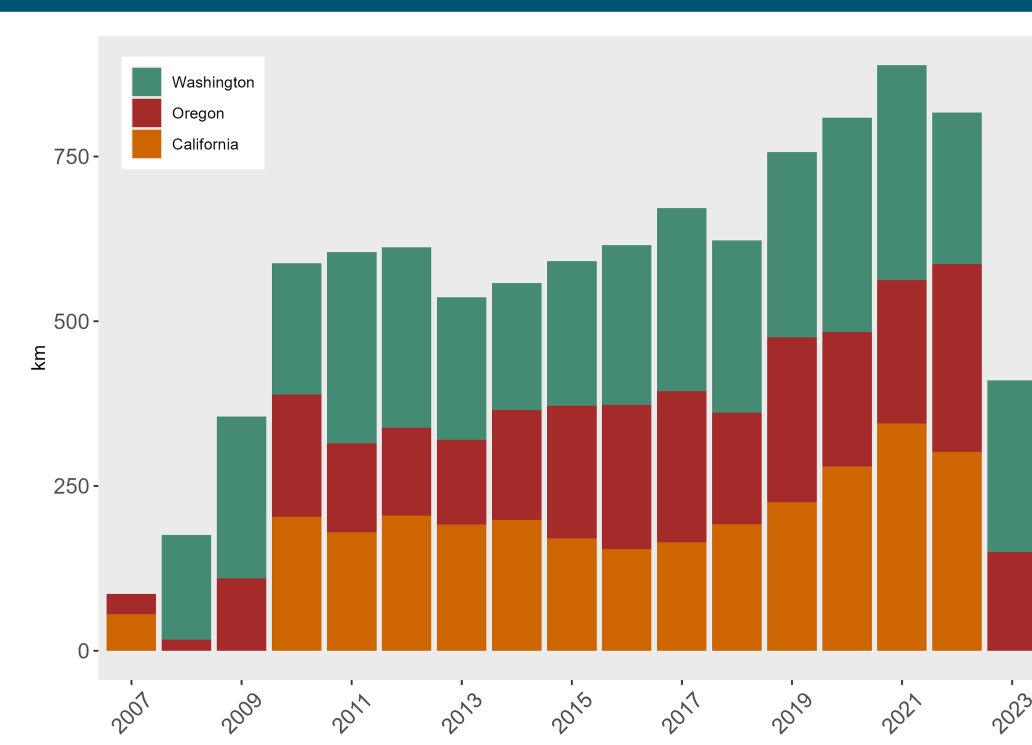

Figure 6: Trip length (in km) by year.

- Longer distance traveled per trip could indicate some combination of longer search time for fish, fish aggregations moving further offshore, or fishing grounds moving further from high-activity ports due to changes in fish distribution or fishery closure (Fig. 6).

- Constructed home ranges for the commercial salmon fishery by state and year are the minimum convex polygons that surround the location representing fishing trips for each year (Fig. 7). By comparing the shape and extent of the polygons across years, we can visualize how the spatial distribution of fishing effort may vary across time.

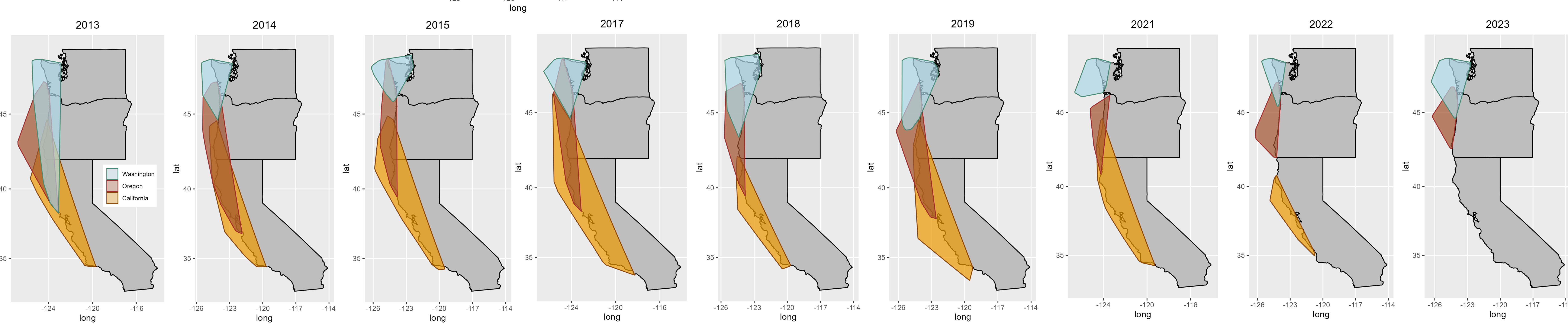

Figure 7: Estimated home range of the Salmon fleet by state for selected years of 2013-2015, 2017-2019, and 2021-2023.

Discussion

- This study shows how VMS data can be used with fisheries landings data to analyze spatially and temporally dynamic issues in the West Coast commercial salmon fishery and lays the groundwork for future analysis of the effects of climate and ecosystem change on the spatial distribution of fishing effort.
- Next steps include: 1) Estimating home ranges using more sophisticated estimators (e.g., kernel estimation); 2) forecasting the future spatial distribution of the Pacific Salmon ocean troll fishery; and 3) comparing predicted fishery distribution with Pacific Salmon species distribution models.

References

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2. Watson, B., Reimer, M. N., Guettabi, M., & Haynie, A. 2021. Commercial fisheries & local economies. Journal of Environmental Economics and Management, 106, 102419.
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