Stock-specific, temperature-dependent shifts in ocean distributions of Chinook salmon

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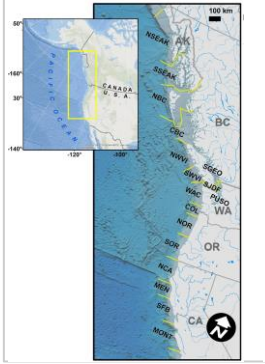
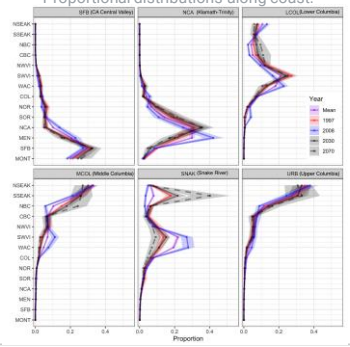
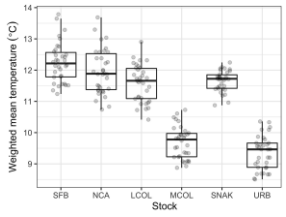
Introduction & Methods

- Chinook salmon stocks from different rivers partially overlap in the ocean, where they experience mixed-stock fisheries. Distributions and how they change are incompletely understood, but are key to successful fisheries management.
- We developed a Bayesian state-space model of local abundance for each stock, accounting for initial cohort size, natural mortality, harvest, and distribution as a function of SST.
- Fit retrospectively to 40 years of fishery-dependent collection of tagged Chinook salmon.
- Predicted how each stock would redistribute under SST predictions for 2030-2090 from Max Planck Institute Earth System Model RCP45 scenario.
- Looked at ocean area-specific abundances summed across stocks to explore shifts in aggregate salmon abundance.

Stock-Specific Responses

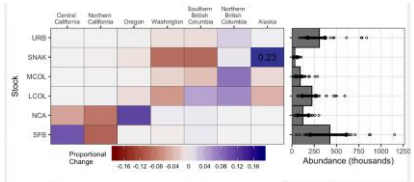


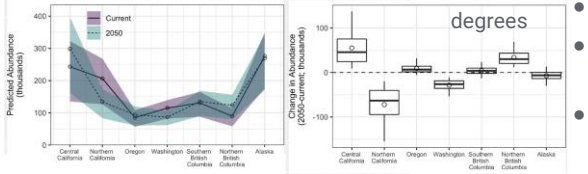




Mean summertime SST experienced by individual fish of each stock during the model calibration period.

Aggregate Response (2050 prediction)





- California stocks shift away from northern CA, but one goes north while one goes south (upwelling retention refuge?) as ocean warms
- Other stocks largely shift north to varying degrees
  - Net loss in northern CA, WA
  - Net gain in central CA, northern BC
  - Little net change other regions (if production constant)

Conclusions and Implications

- A warmer ocean shifts salmon distributions, but it is not a simple poleward displacement.
- This can create winners and losers in both future fishing opportunity and ecosystem services provided by a shifting prey base.
- Stocks vary in their relationships with temperature, and this leads to divergent distributional responses to a warming climate.
- Species-level models of ocean distributions and drivers that ignore among stock variation will lead to errant predictions.
- Weak stock constraints on mixed-stock fisheries may limit ability to take full advantage of movement into areas.
- Changes in productivity of individual stocks (not modeled) will also affect area-specific total abundance and may exacerbate or counteract distributional shifts.

Shelton, A. O., G. H. Sullaway, E. J. Ward, K. A. Somers, V. J. Tuttle, J. T. Watson, and W. H. Satterthwaite. Redistribution of salmon populations in the Northeast Pacific Ocean in response to climate. In press at Fish and Fisheries.