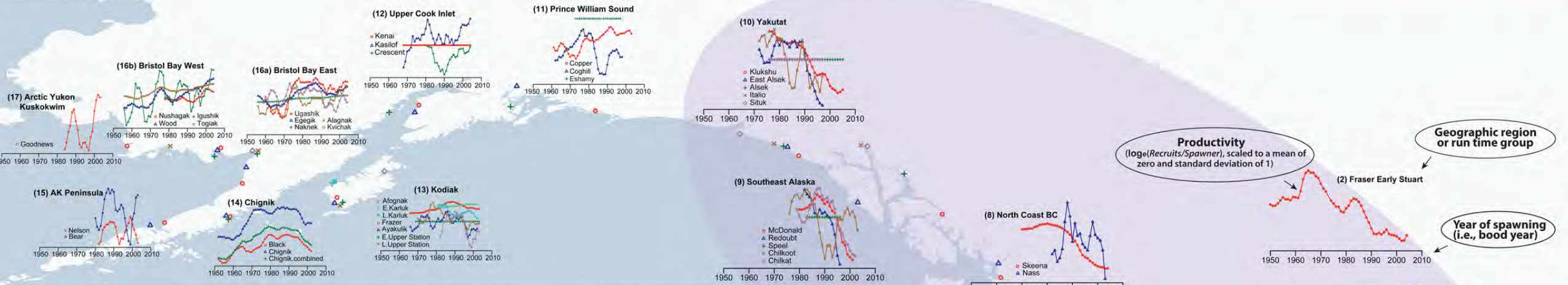


Implications for research from the widespread decrease in productivity of sockeye salmon populations in western North America

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Research objective

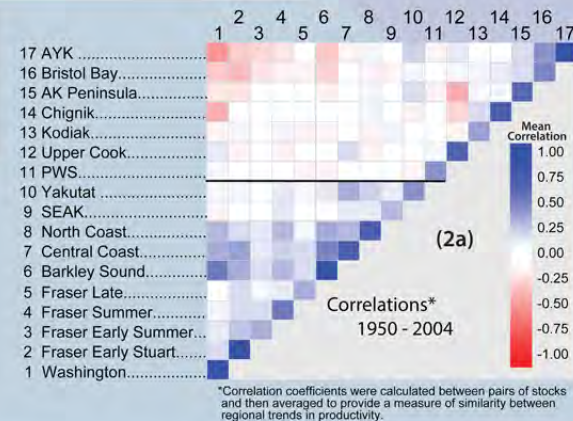
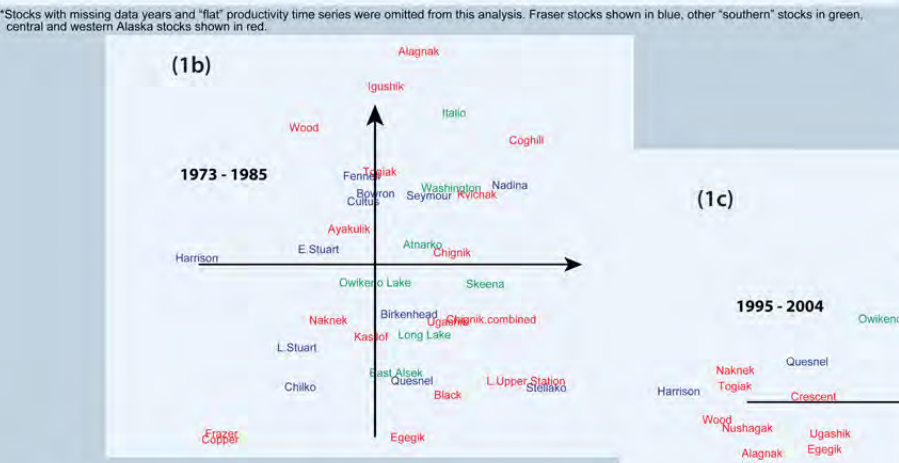
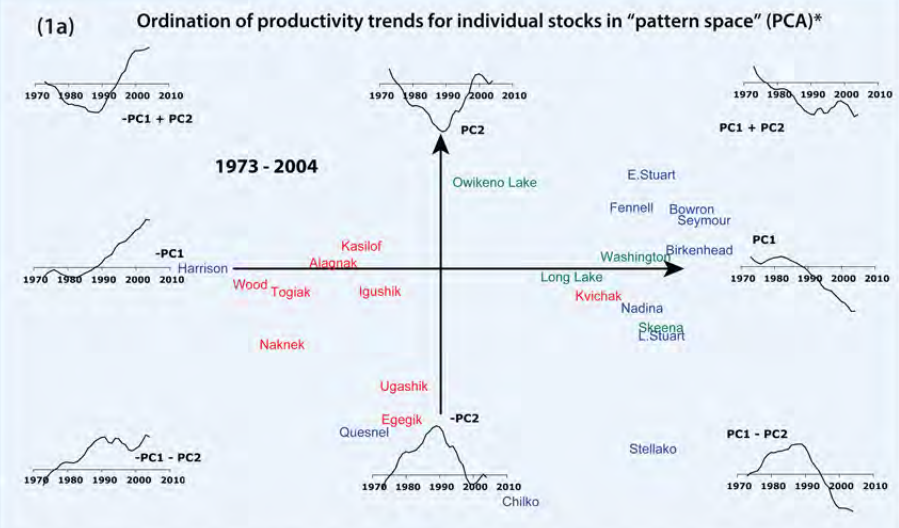
How unique are the decreases in productivity (adult recruits per spawner) observed in numerous sockeye salmon populations from the Fraser River, British Columbia, Canada? Do such time trends also show up in other sockeye populations in western North America? The spatial extent of such trends will help identify which mechanisms are the main causes of the declines:

- Small spatial extent implies local factors
- Large spatial extent implies large-scale factors

Methods

Data: Time series of number of adults returning per spawner for 64 wild sockeye populations

- Productivity estimated as the a parameter of the Ricker model (adult returns per spawner at low spawner abundance to account for density dependence)
- Changes in productivity through time reconstructed using a Kalman filter (to remove short-term variability and observation error)
- Compare trends in productivity.



Results

- (1) Decreasing sockeye productivity has occurred across a large region (purple ellipse), from Washington up through the Yakutat peninsula in Alaska, but not in central and western Alaska. Decreases occurred in 24 of the 37 sockeye stocks from the Yakutat peninsula southward, mostly starting in the late 1980s or early 1990s (as is evident for most of the time series in the purple ellipse, and also in PC1, the first component of the PCA, shown in Figure 1a).
 - Fraser River sockeye are thus not unique.
 - Decreases have been both widespread and substantial. For instance, the Early Stuart sockeye population of the Fraser River decreased by 85% (from 20 adult returns per spawner down to 3) from mid-1960s to mid-2000s.
- (2) "Southern" stocks (purple ellipse) show positively correlated time trends in productivity (Figure 2a below black horizontal line). These trends have recently become more "synchronized" (1995-2004), i.e., correlations among stocks are on average higher and more consistently positive, and the spatial extent of the positively correlated southern area appears to have spread further north over time (note the "spread" over time of the blue region of positive correlations in the correlation matrices in Figures 2b-d, and also note the clear separation between "southern" stocks and stocks from central and western Alaska that has emerged in the PCA after 1985 (Figures 1b-c).

Implications

- (1) Similar decreases occurred along west coast of North America.
 - Suggests that the main cause or causes are large-scale and shared.
- (2) Possible mechanisms:
 - Pathogens, predation, food
 - Climate-driven changes in these
- (3) Further research should focus on mechanisms that:
 - Operate at large, multi-regional spatial scales and/or
 - In marine areas where numerous correlated stocks overlap.
- (4) It is critical to maintain long-term datasets like these, and to collect data on survival rates through different life stages to further narrow down potential causal factors.

References

Peterman, R.M. and B. Dorner. 2012. A widespread decrease in productivity of sockeye salmon populations in western North America. *Can. J. Fish. Aquat. Sci.* 69: 1255-1260.

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