

"A widespread decrease in productivity of sockeye salmon on the west coast of North America"

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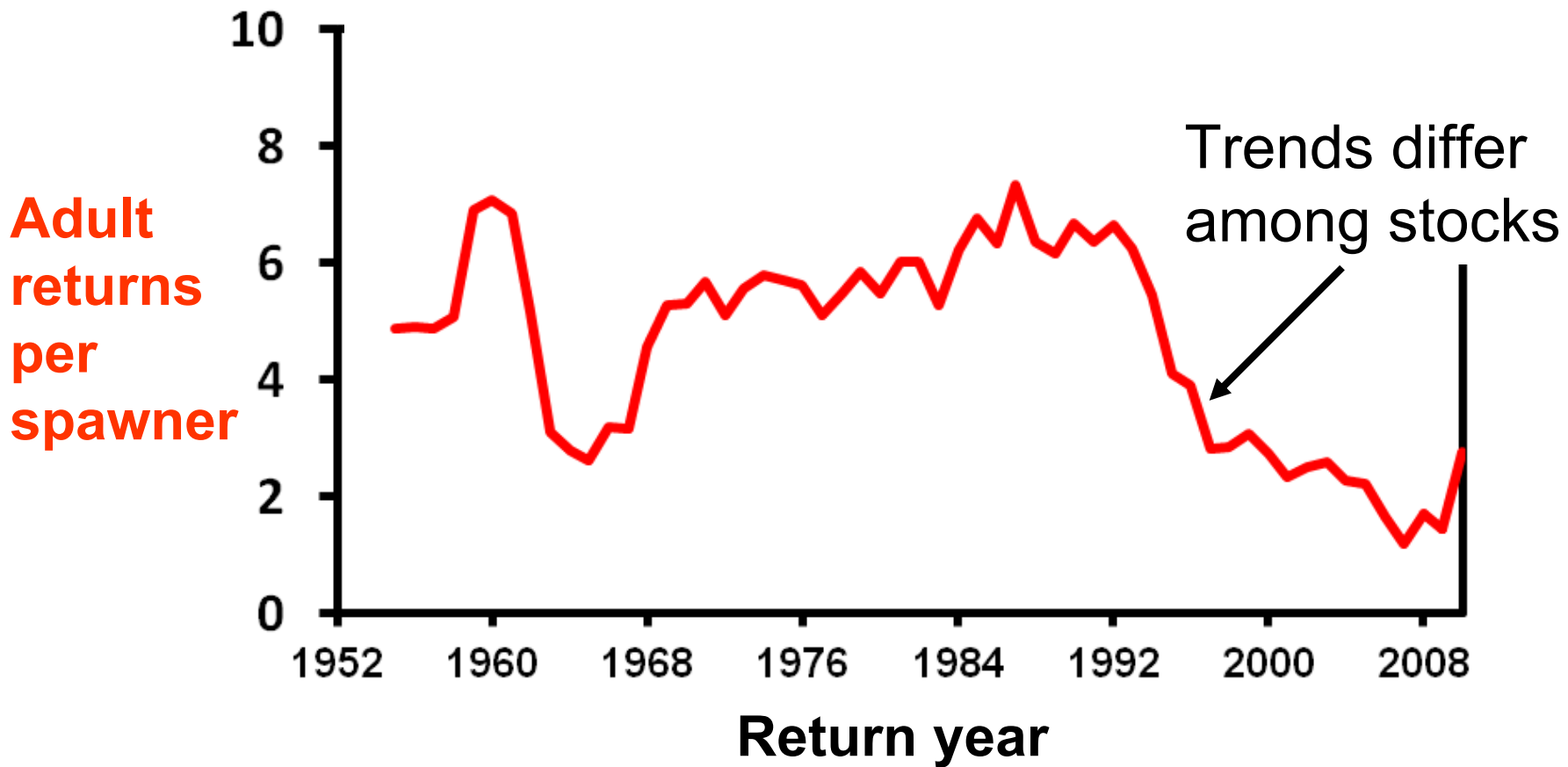
Background

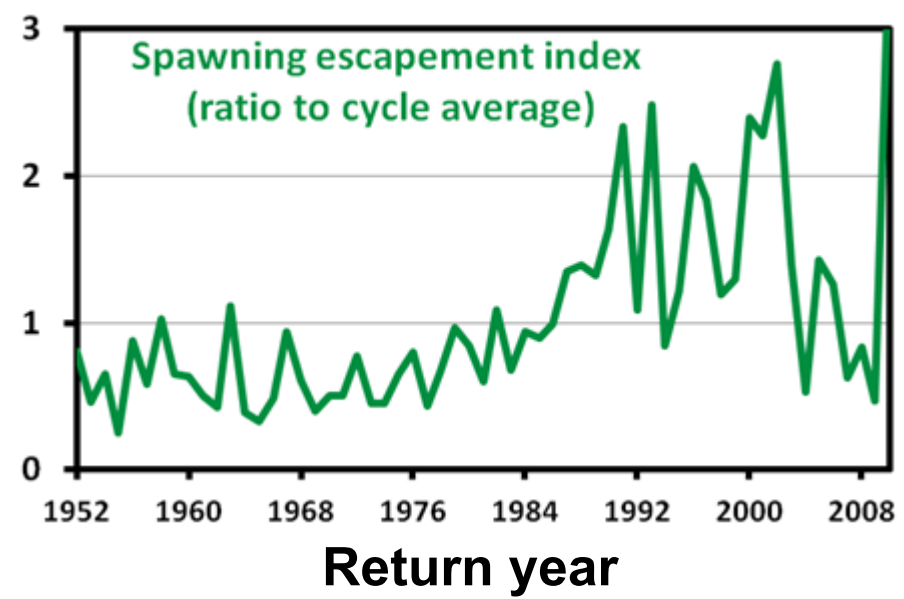
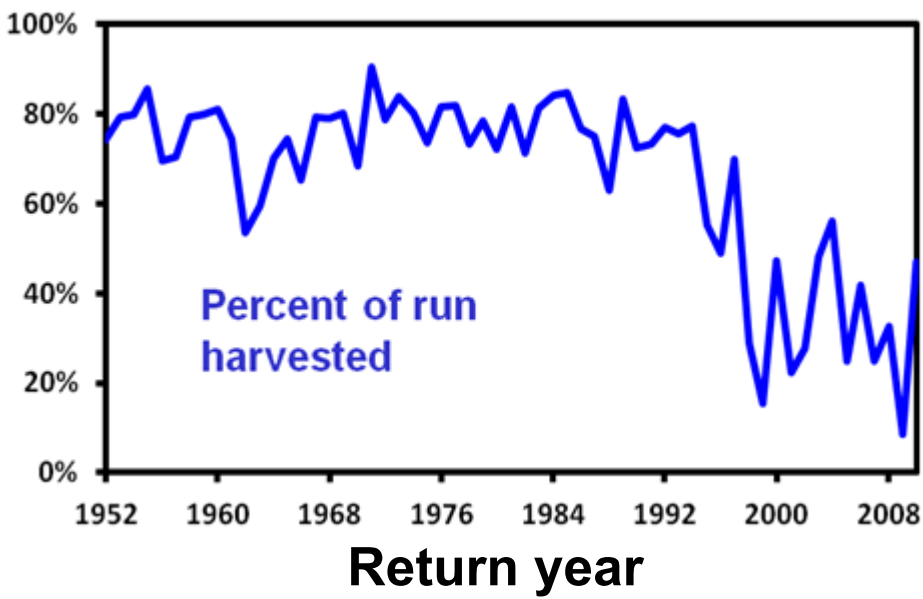
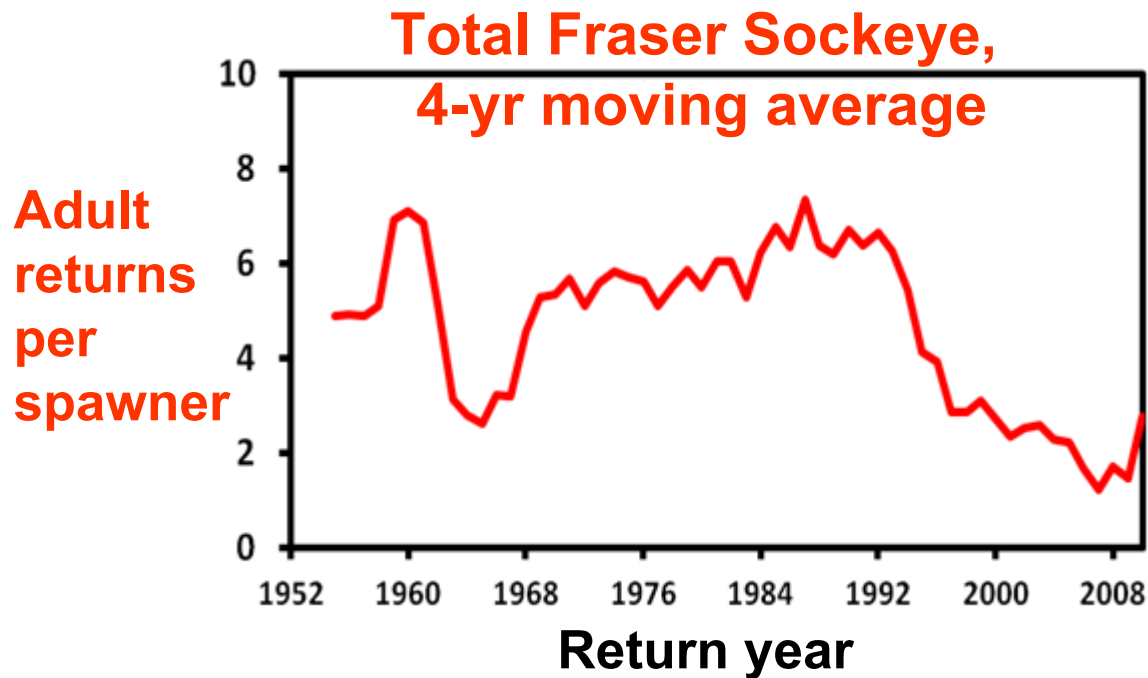
Fraser River sockeye salmon

- 2009 returns: lowest since 1947
- Since early 1990s, have had decreases in
 - Abundance (adult returns)
 - Productivity (adult returns **per spawner**)



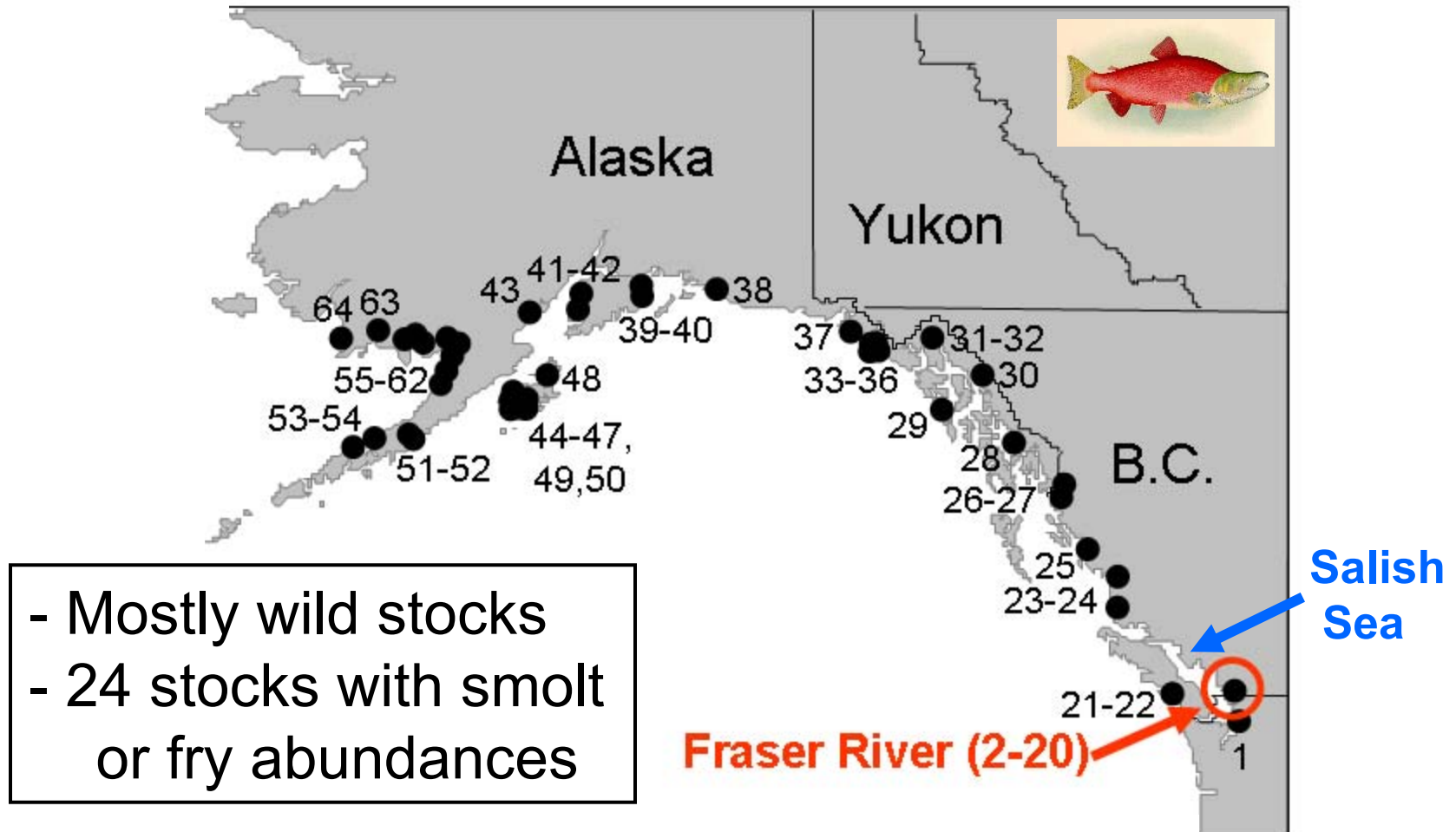
Total Fraser Sockeye, 4-yr moving average





Research objective

How widespread has **decreasing productivity** been among 64 west-coast sockeye populations?



- Mostly wild stocks
- 24 stocks with smolt or fry abundances

Methods

Measures of productivity

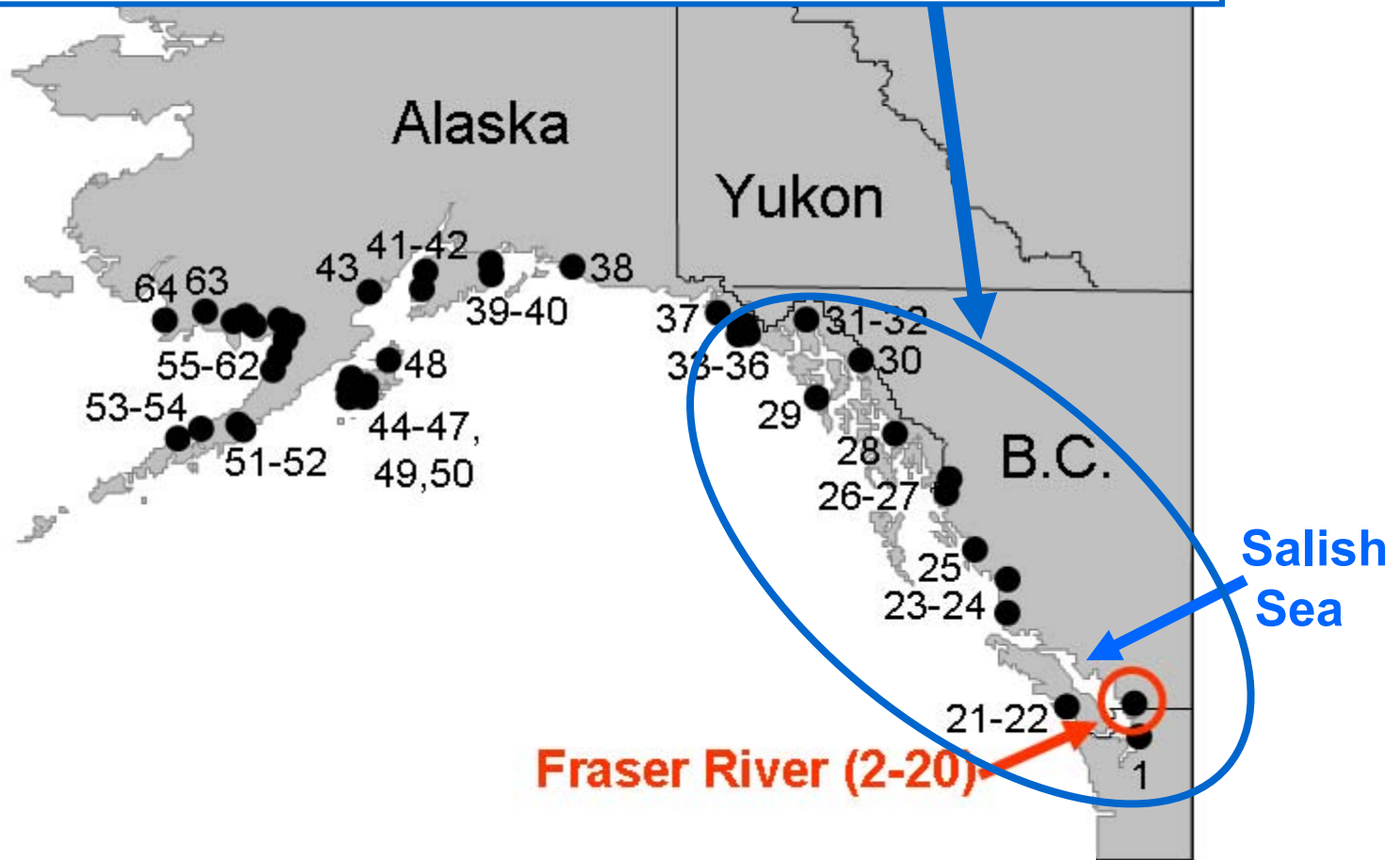
1. Annual adult returns per spawner
2. "Kalman filter" smoothed values of #1 that account for:
 - Density-dependent effects of spawner abundance
 - Measurement error
 - Reduces "noise"

Analyses

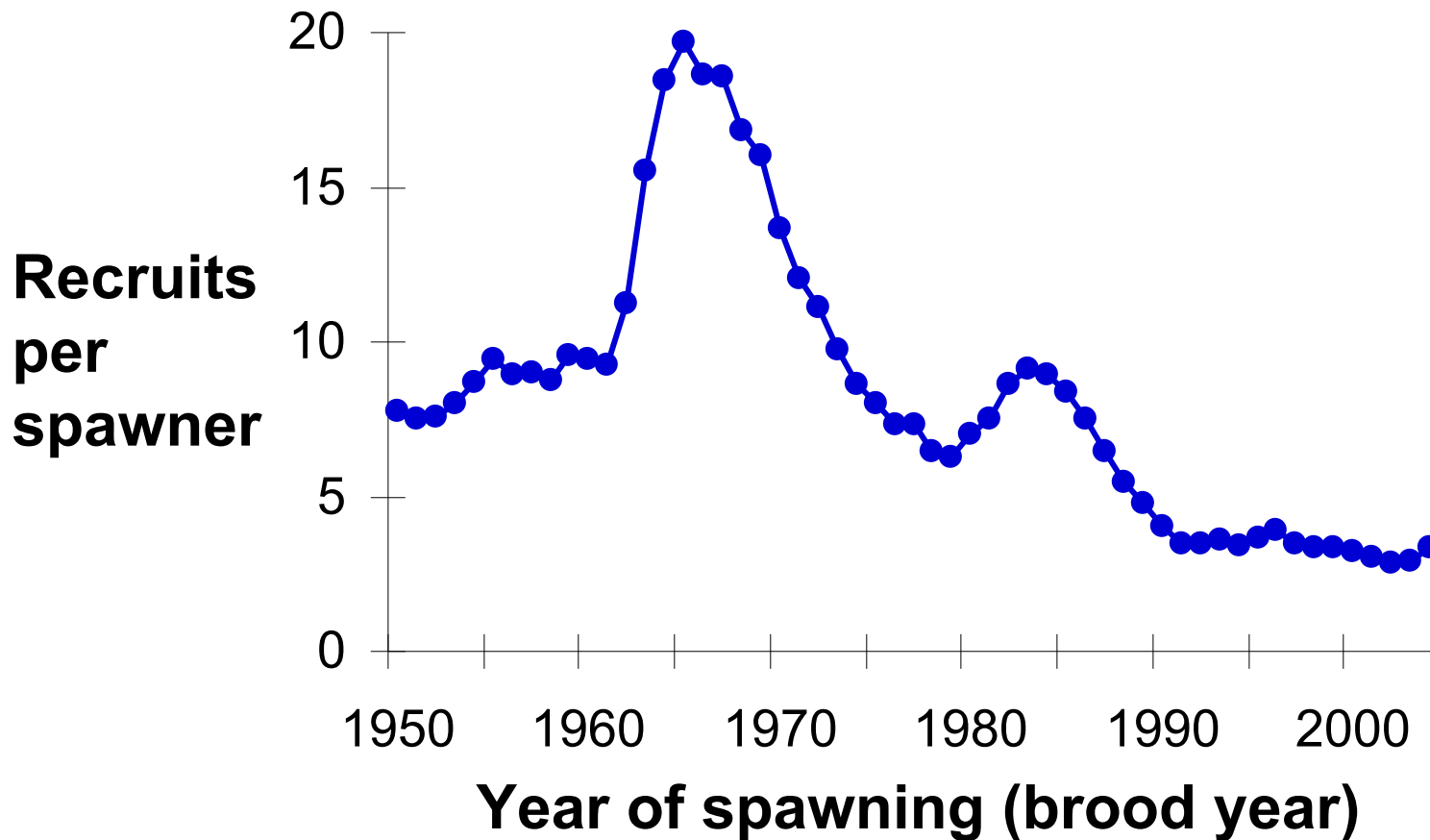
- Model comparisons based on AIC_c (Larkin vs. Ricker)
- Cross-correlations
- Principal components analysis
- Clustering

Results

- Widespread decreases in productivity, especially since 1990s
- **Not unique to Fraser River**



Fraser River (Early Stuart) Sockeye

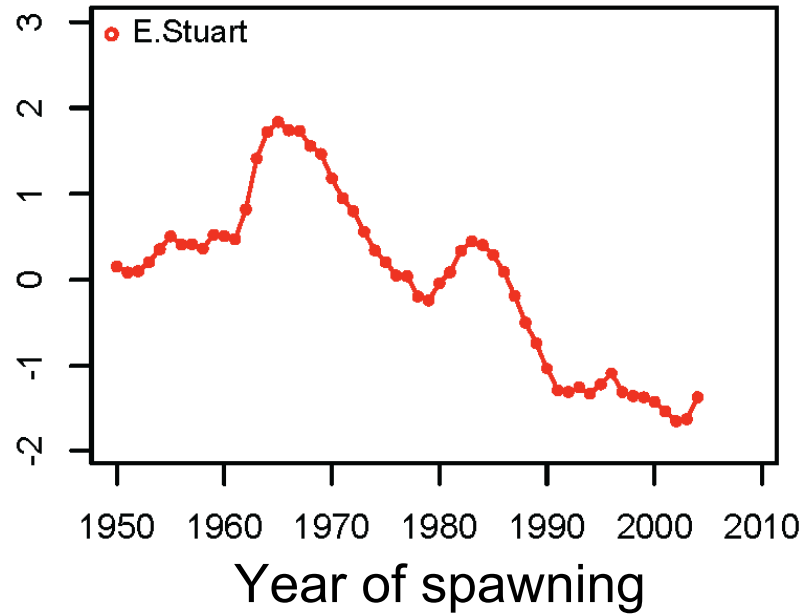


Then we standardized time series for comparisons across stocks (mean = 0, SD = 1)

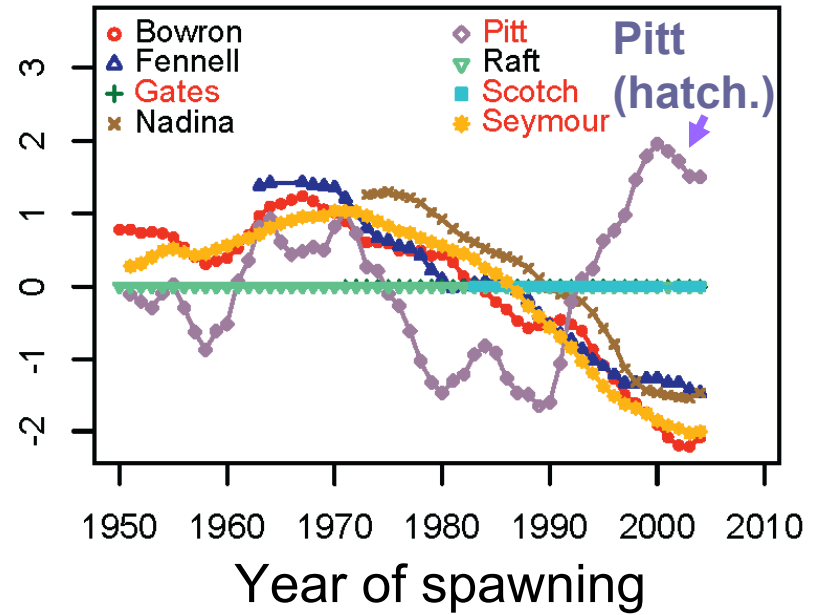
Standardized productivity

(Kalman filter a_t scaled in SDUs, best model)

Fraser Early Stuart



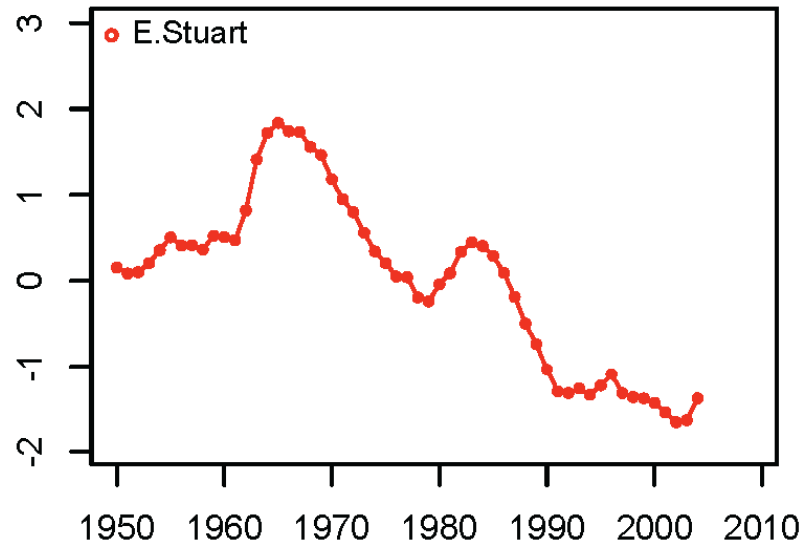
Fraser Early Summer



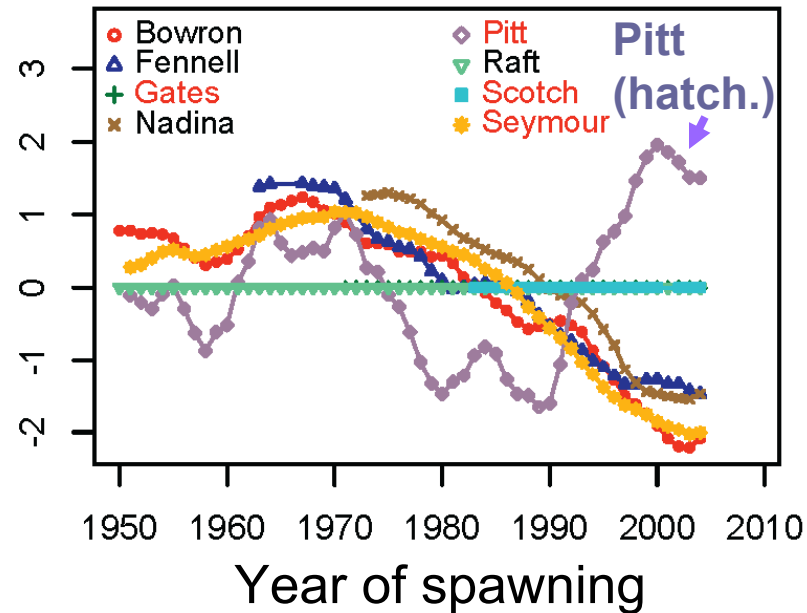
Standardized productivity

(Kalman filter a_t scaled in SDUs, best model)

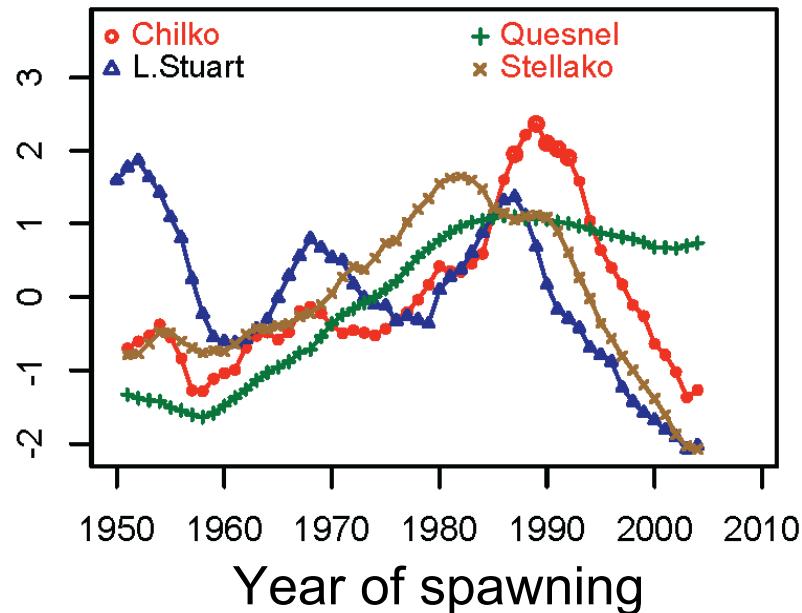
Fraser Early Stuart



Fraser Early Summer



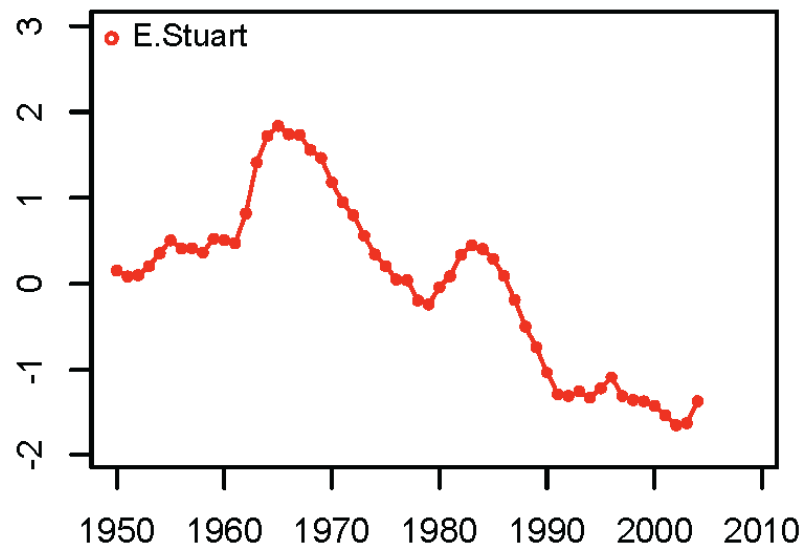
Fraser Summer



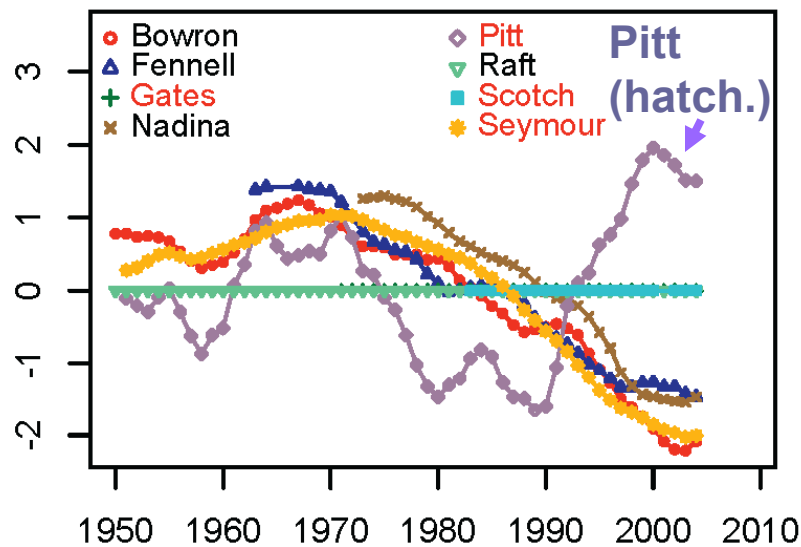
Standardized productivity

(Kalman filter a_t scaled in SDUs, best model)

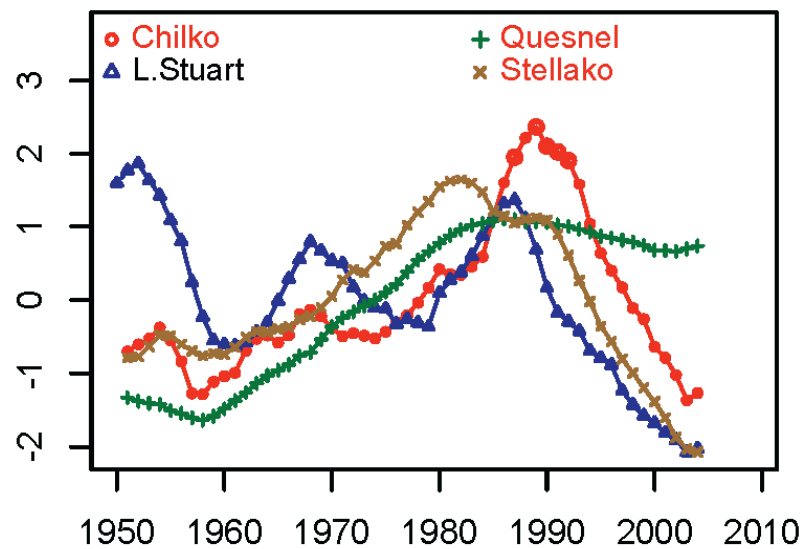
Fraser Early Stuart



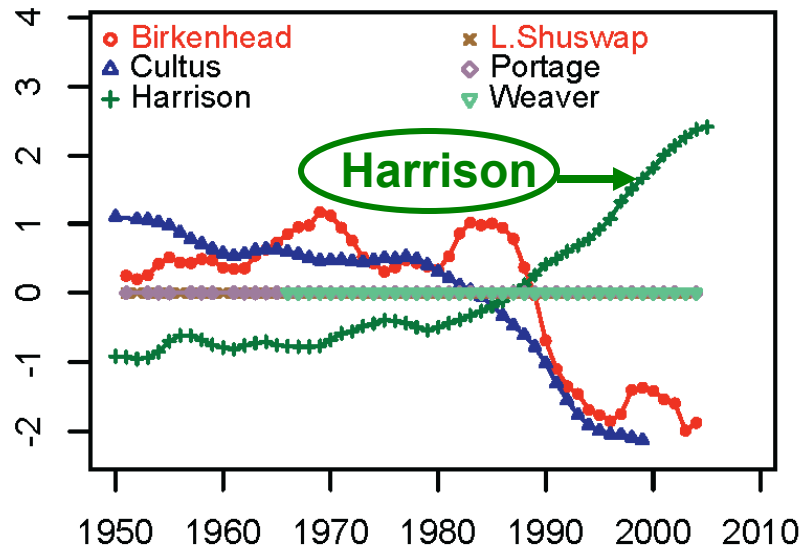
Fraser Early Summer



Fraser Summer



Fraser Late



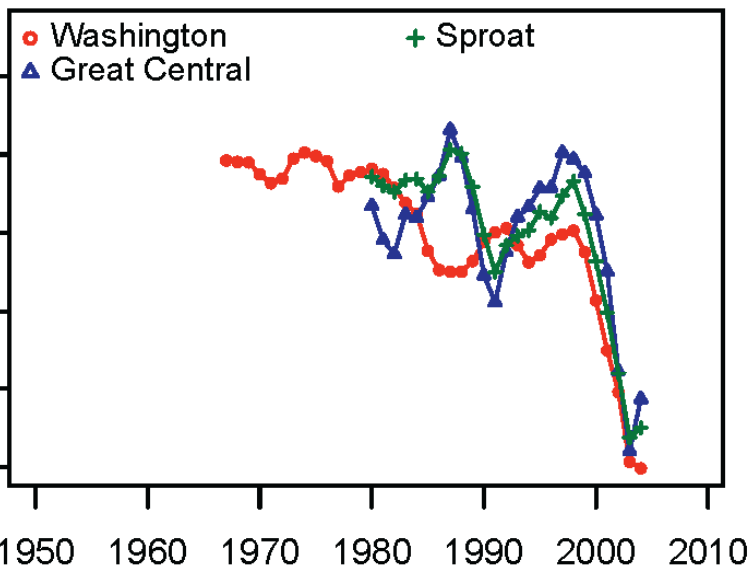
Year of spawning

Peterman and Dorner 2011

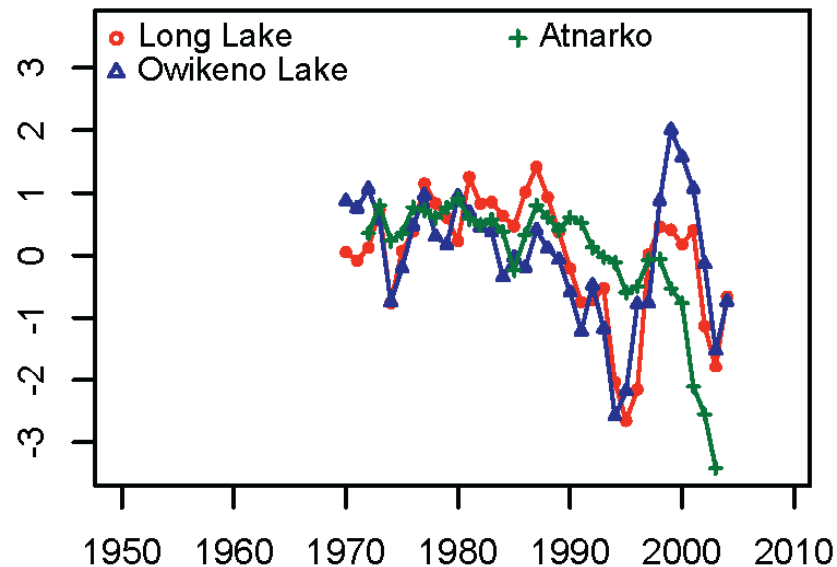
Standardized productivity

(Kalman filter a_t scaled in SDUs, best model)

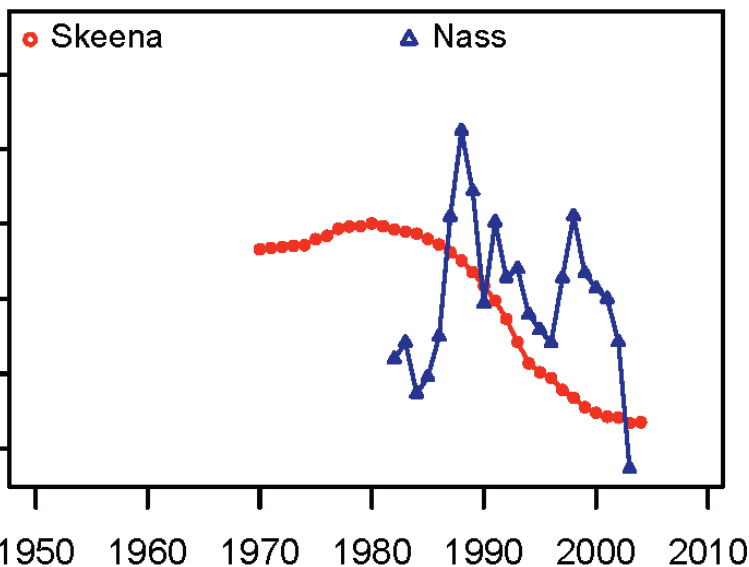
Wash. & Barkley Sd., B.C.



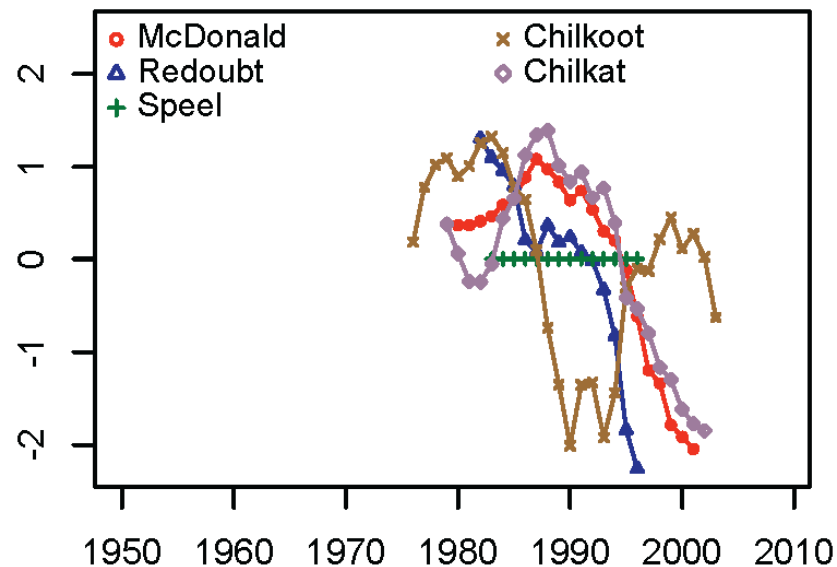
Central Coast B.C.



North Coast B.C.



S.E. Alaska

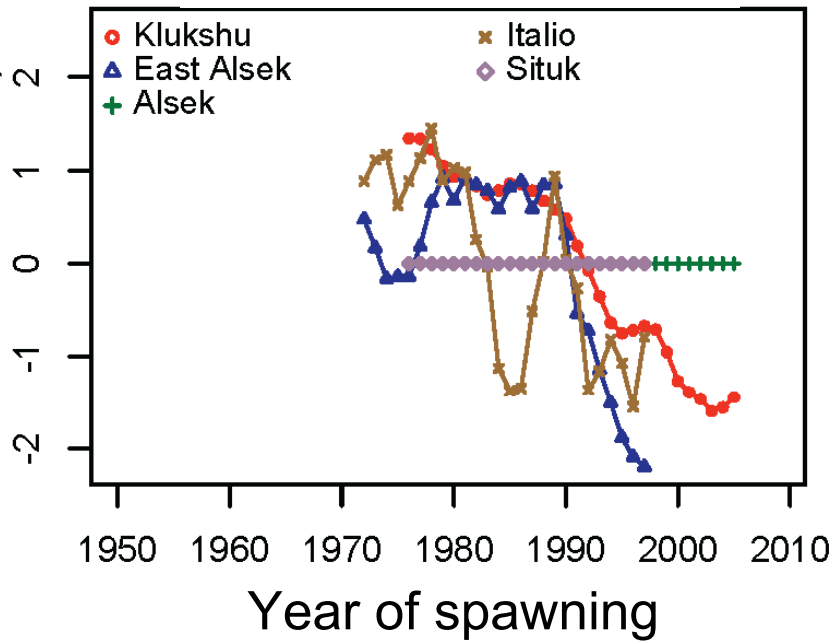


Year of spawning

Yakutat Pen., Alaska

Standardized productivity

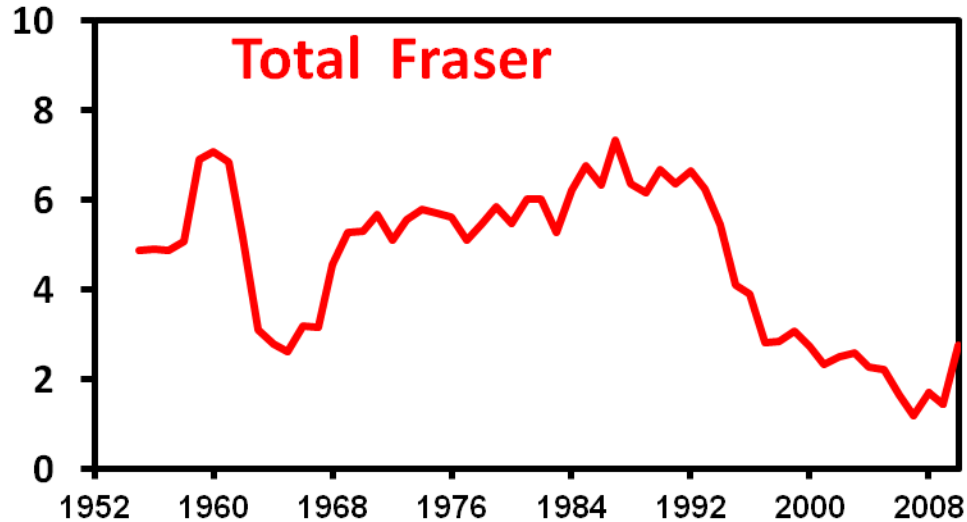
(Kalman filter a_t scaled in SDUs, best model)



Harrison Sockeye Productivity

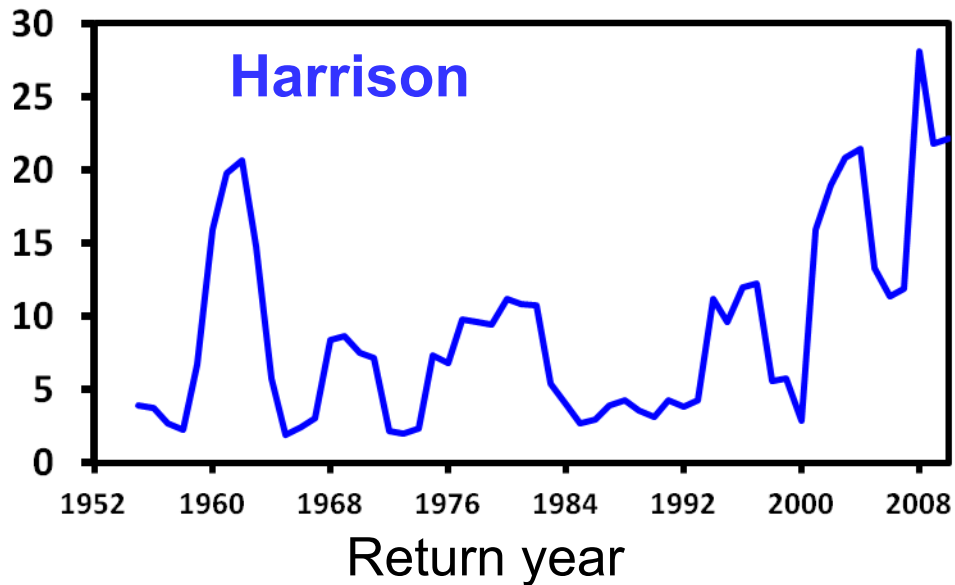


Productivity
(adult returns
per spawner)



- Enter Salish Sea as smolts
- Use Johnstone Strait

Productivity
(adult returns
per spawner)



- Enter Salish Sea as fry
- Later migrants
- Use Juan de Fuca Strait?

Conclusions

1. Similar decreases in productivity along west coast suggest that main causes are most likely shared and are outside of Salish Sea.
2. From juvenile data:
 - Most of mortality that caused decreases ***occurred in*** post-juvenile stage (still possibly freshwater ***origin***)
3. Possible mechanisms
 - Predation
 - Food
 - Pathogens
 - Climate-driven changes in these (reflected by SST)
 - ...?

Recommendations

1. Place research priority on large-scale processes
2. Create Canada-U.S. sockeye working group
 - Multi-disciplinary research program
 - Life history of juveniles (Harrison vs. others)
 - Oceanography
 - Food, predators, pathogens, harmful algae, ...
 - Shared data base for entire west coast
3. Estimate juvenile abundance on more stocks

Reference

Peterman, R.M. and B. Dorner. 2011. Fraser River sockeye production dynamics. Cohen Commission Technical Report 10: 133 pp., see www.cohencommission.ca