Non-analogue ecosystem states in the Gulf of Alaska

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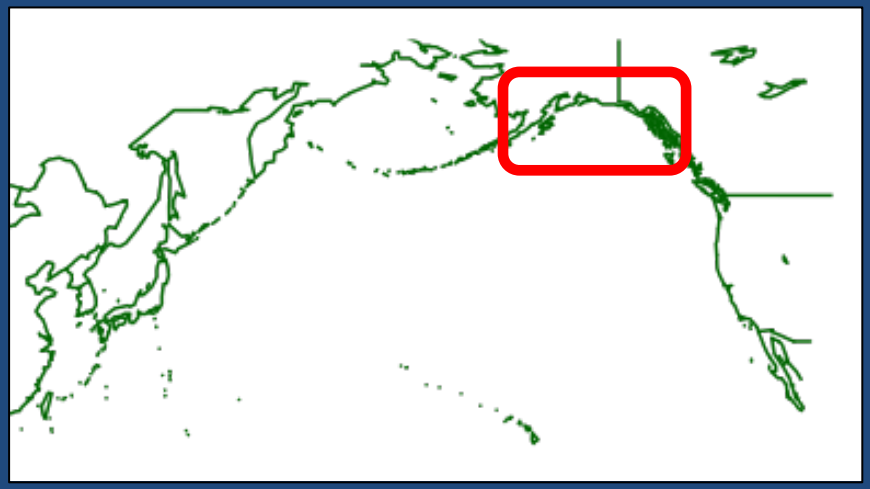
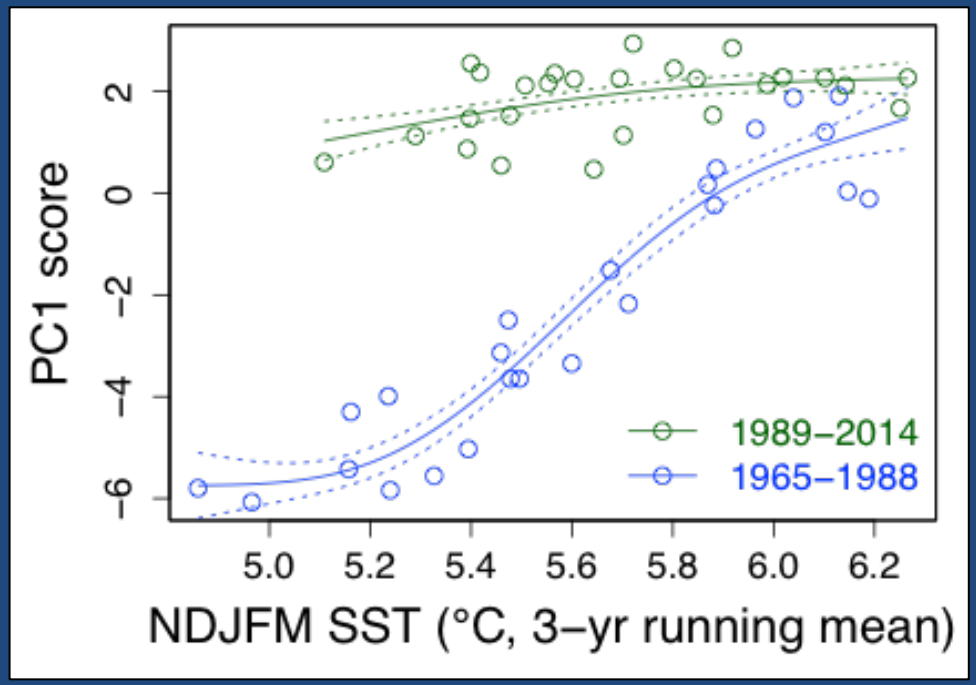
Gulf of Alaska: warm regime/cold regime biology

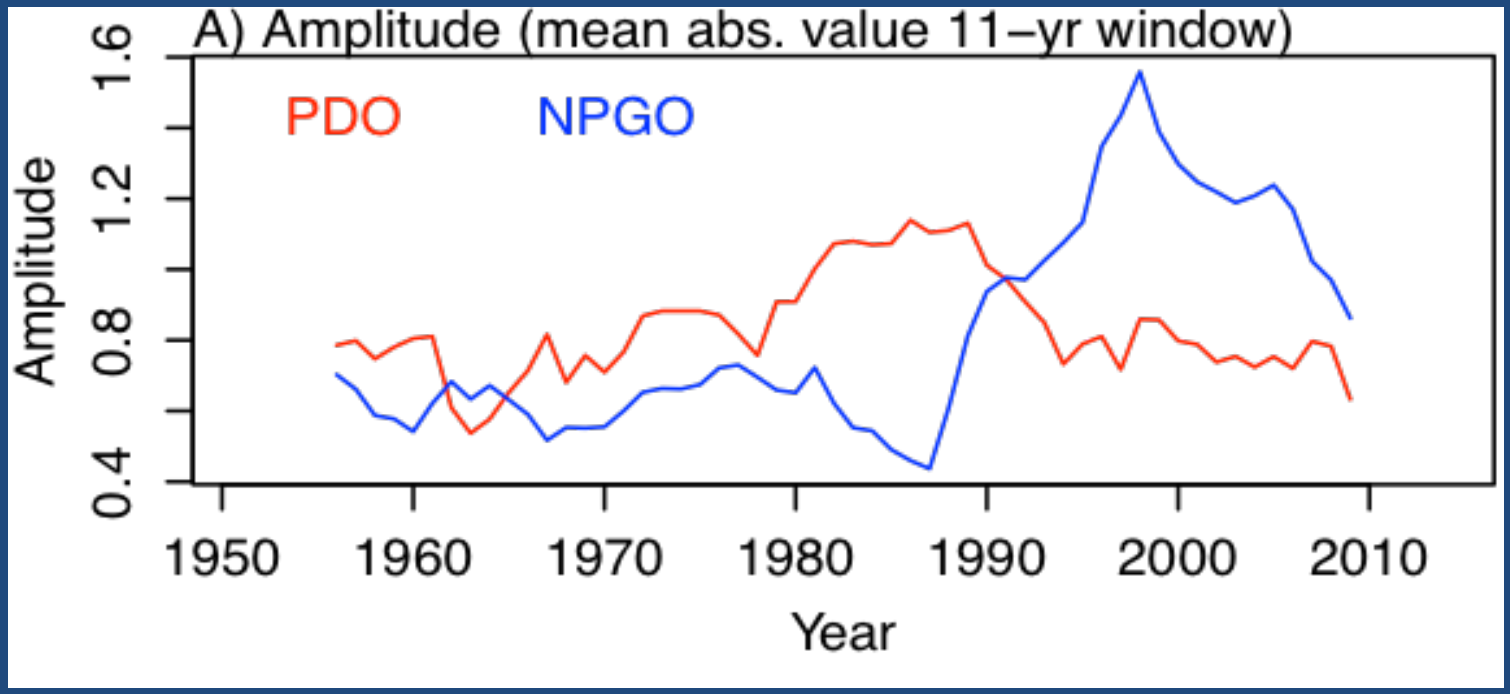


Gulf of Alaska: ~~warm regime/cold regime biology~~ *Two* temperature-biology relationships

PCA on 17 biology time series:
salmon, crustaceans, herring, groundfish



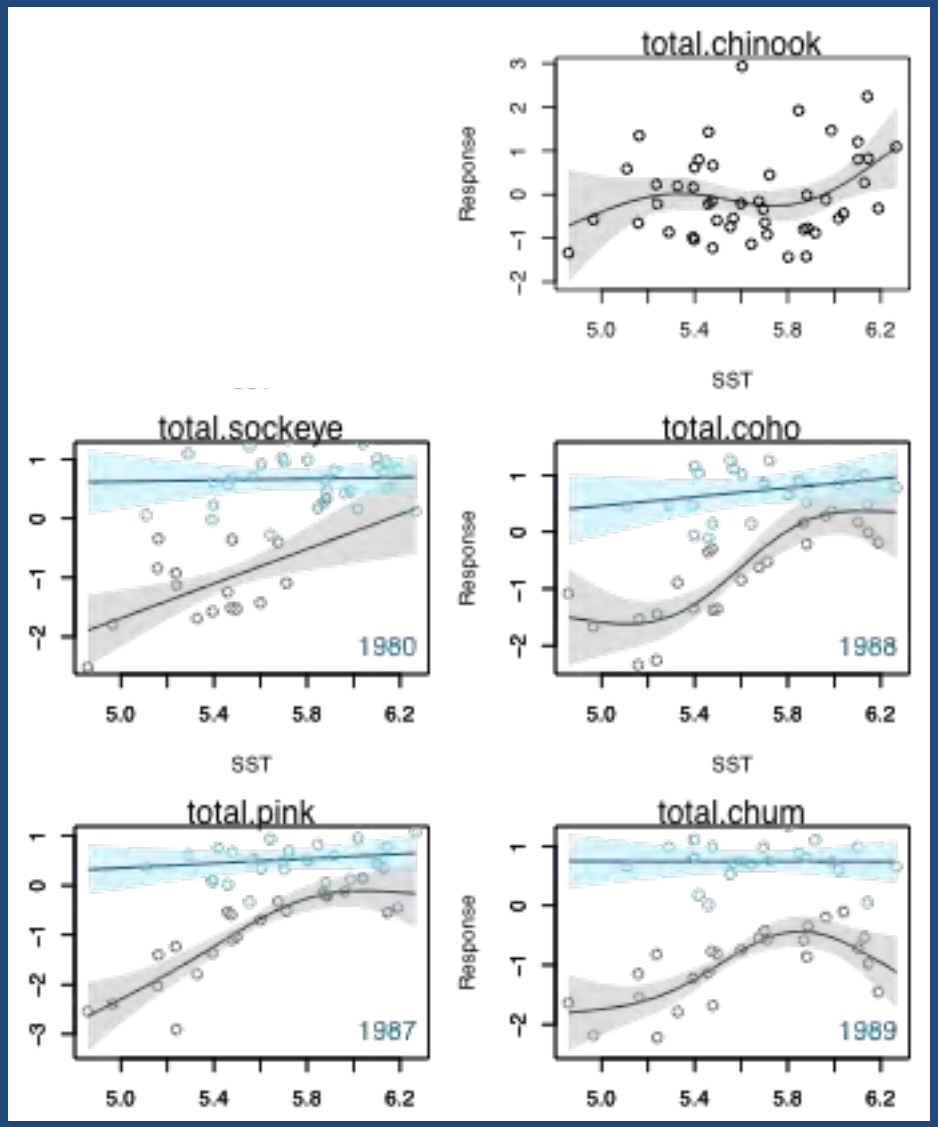
Changing temperature-biology relationships coincide with change in basin-scale climate



Working hypothesis

Changing relationships between SST and other climate parameters

Gulf of Alaska salmon catch: Two temperature-catch relationships – why?



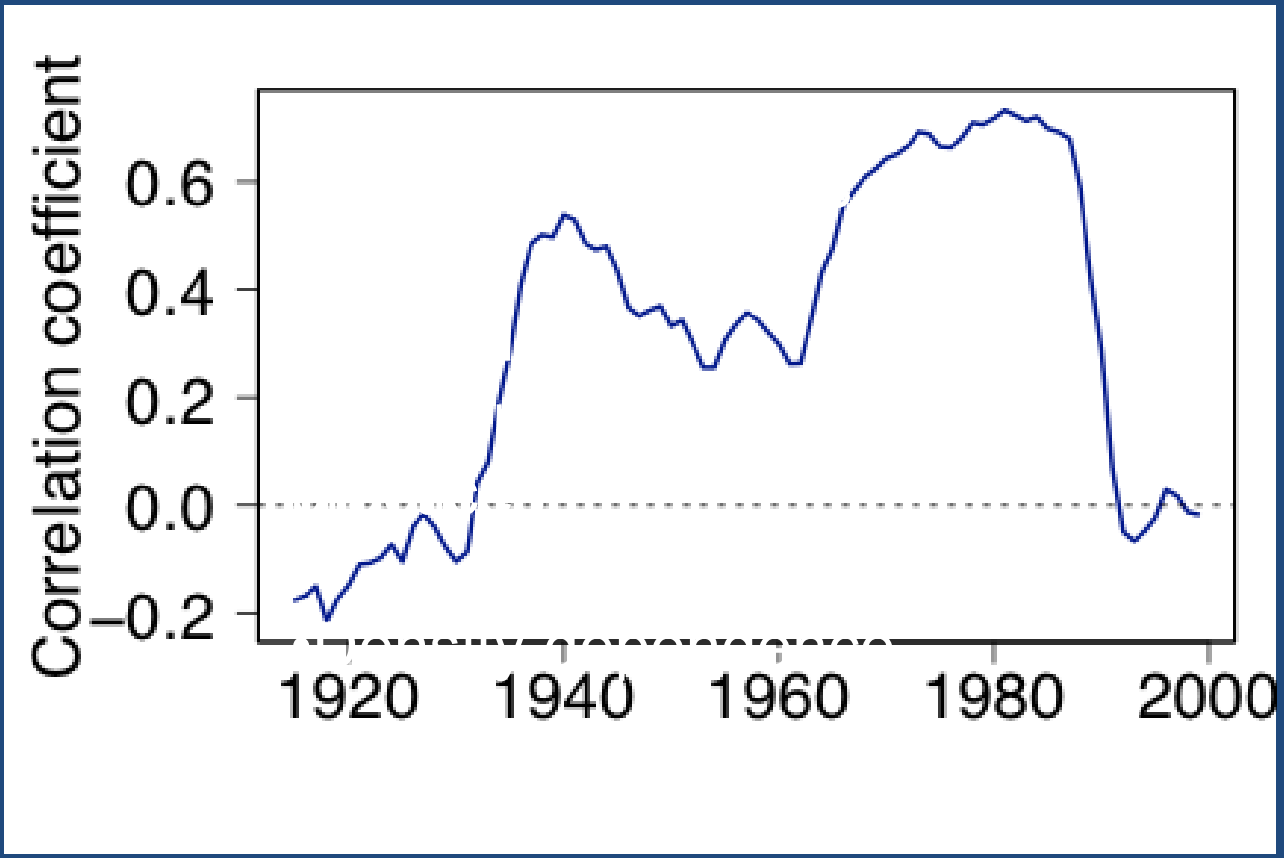
Catch anomaly

Winter SST(°C)

- Historical context
- Alternate hypotheses
- Working hypothesis

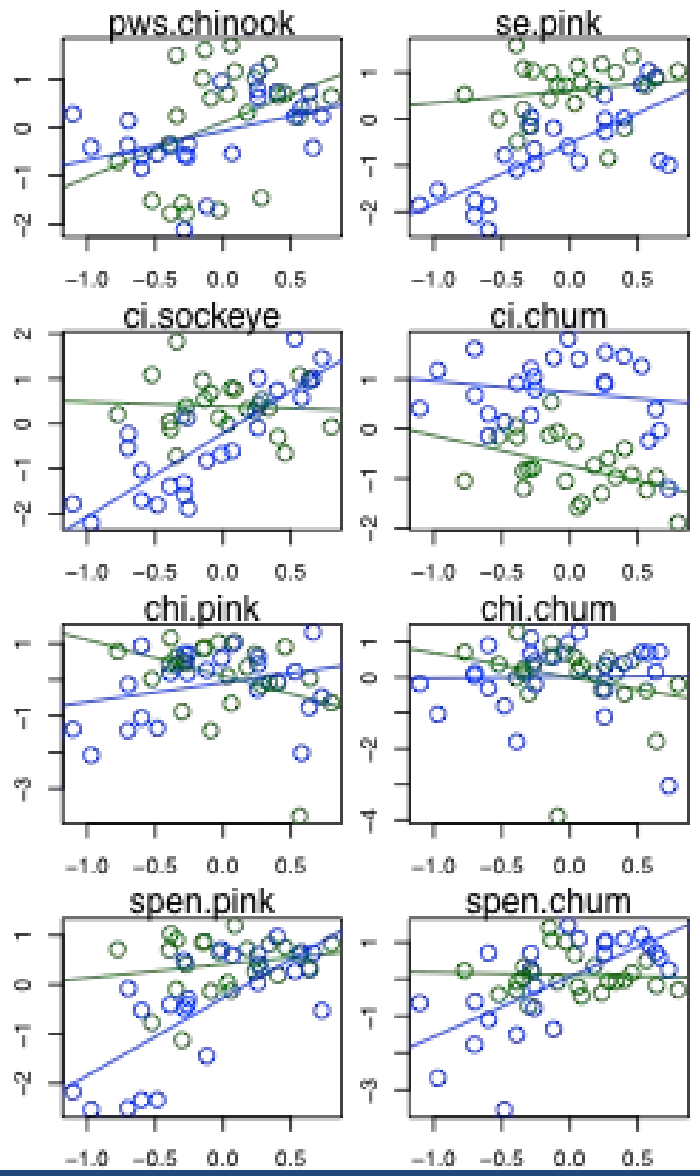
Correlation between winter SST and detrended Alaska sockeye salmon catch

31-year windows centered on 1915-1999



Catch-SST relationship for *wild* fisheries

Catch anomaly



— 1965-1988 *sensitive* to SST

— 1989-2012 *not sensitive* to SST

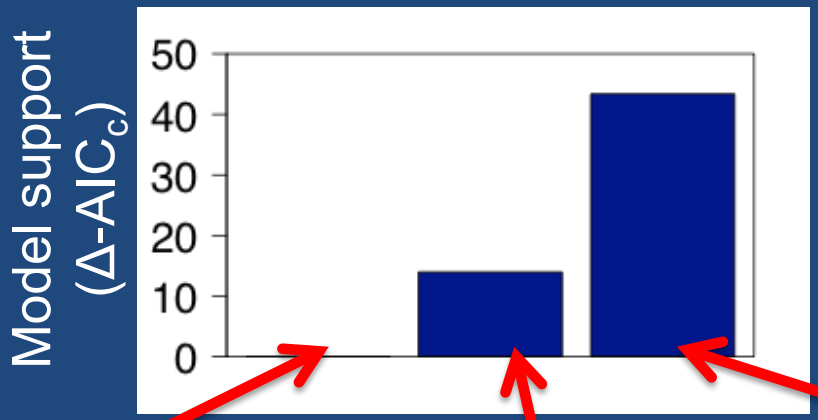
p(sst × era) < 0.0001

Winter SST (3-yr running mean)

Wild-run pink salmon runs

Mixed-effects spawner-recruit (Ricker) model

Survival (recruits per spawner) explained by:



Density dependence + SST*time
p(sst*time) = 0.0004

Density dependence*time + SST

Density dependence + SST

Current hypotheses for temperature-survival relationships in GOA salmon:

SST-survival relationships reflect correlation between SST and other important climate parameters

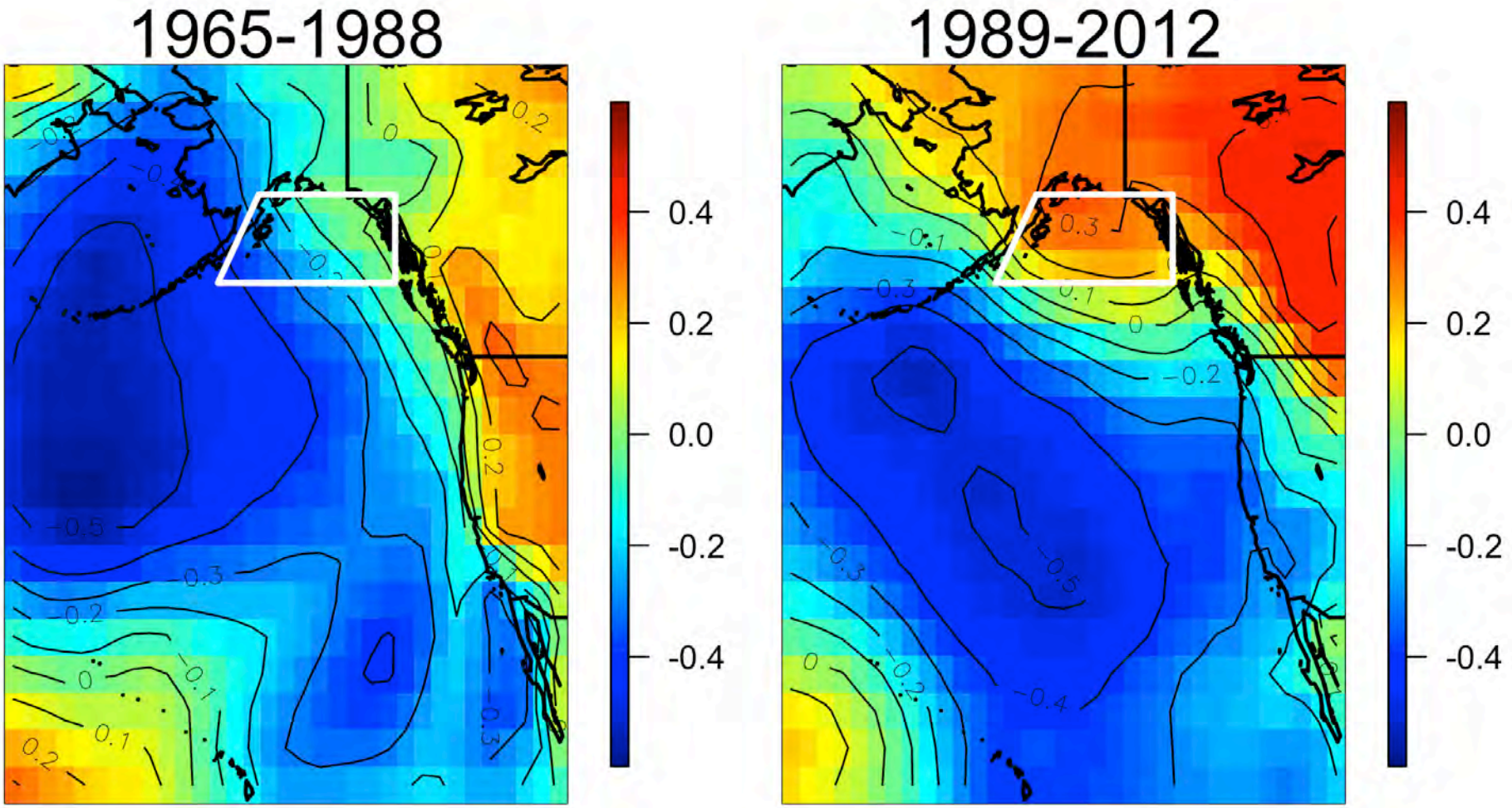
- Water column stability (Gargett 1997)

2002)

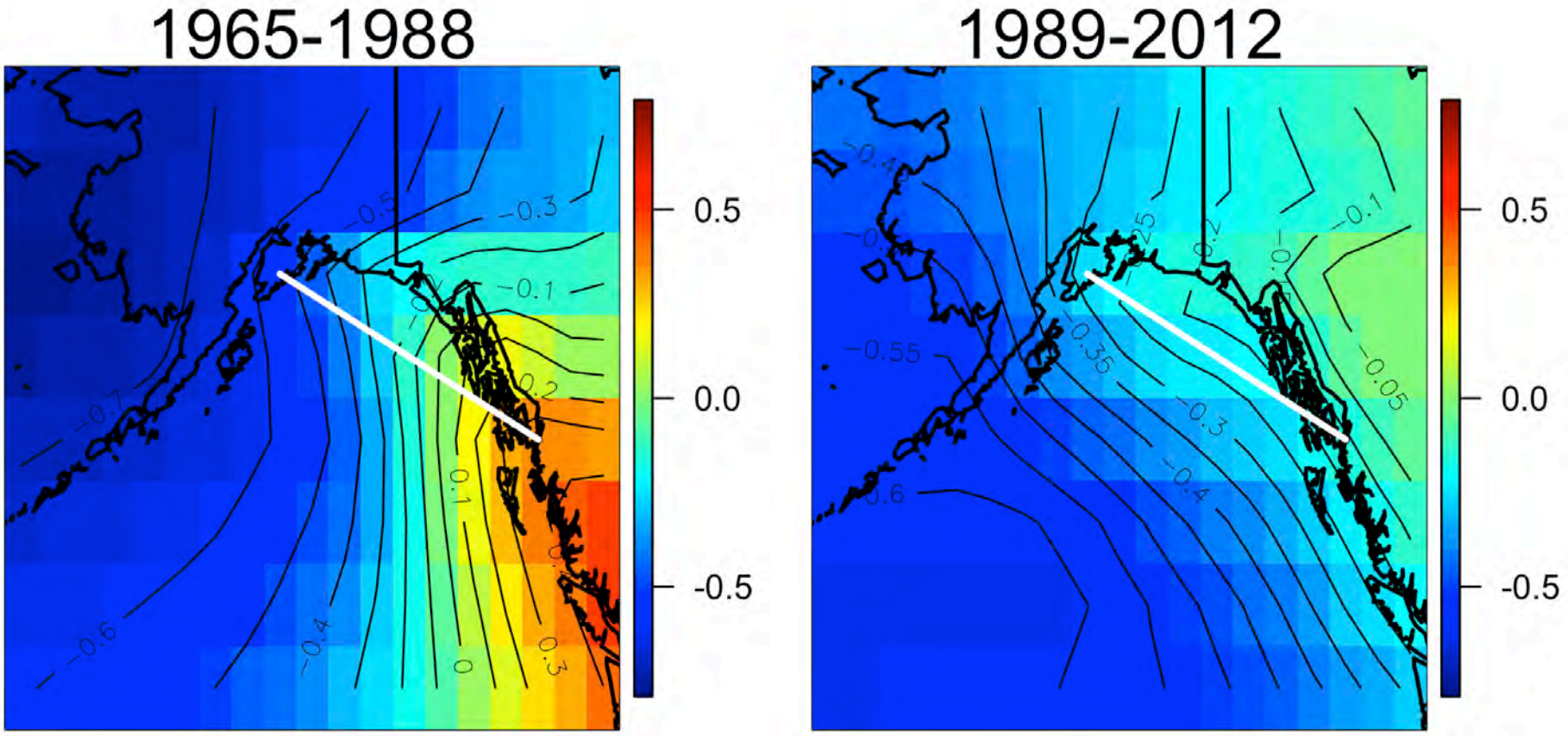
How might changing SST-SLP relationships affect GOA oceanography?

- Freshwater input affects alongshore transport, stratification, nutrient input (Royer et al. 2001, 2006)
- Freshwater input is greater when Ketchikan SLP > Seward SLP (Weingartner et al. 2005)

Correlation coefficients: Gulf of Alaska SST vs. NE Pacific SLP



Correlation coefficients: Gulf of Alaska NDJFM SST vs. NDJFM SLP



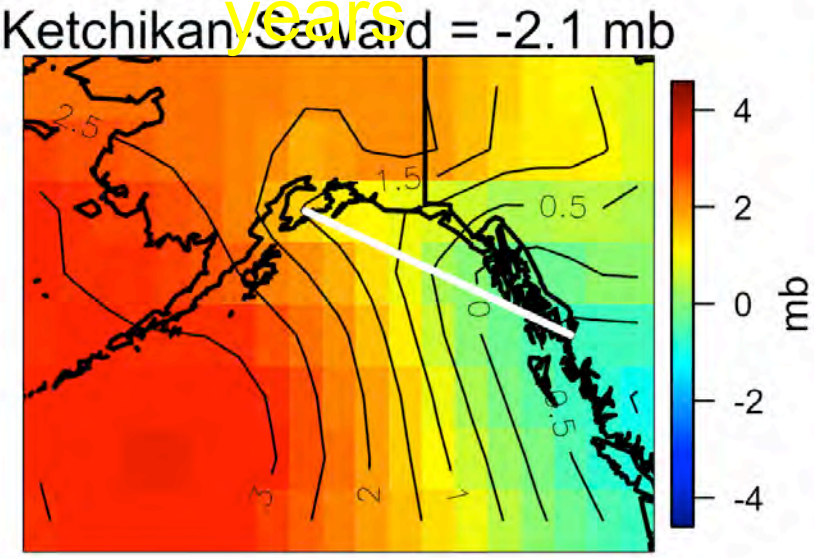
SLP anomalies: cold vs. warm years, 1965-1988 vs. 1989-2012

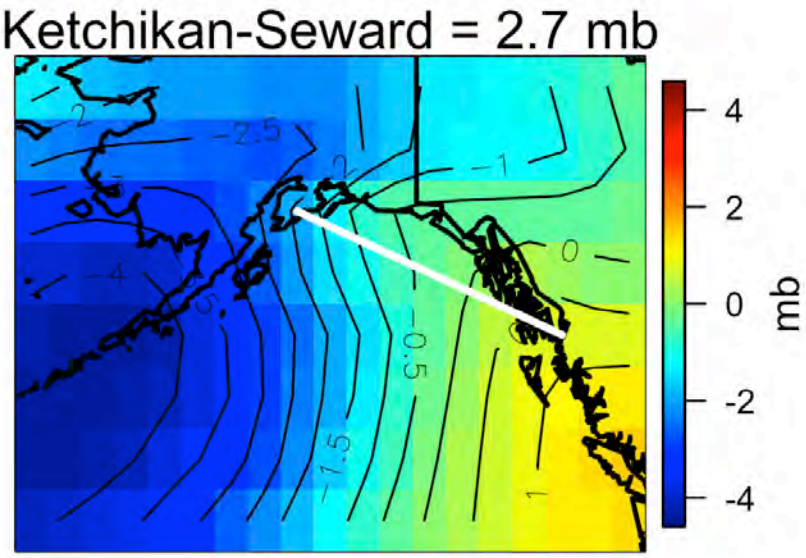
5 coldest years

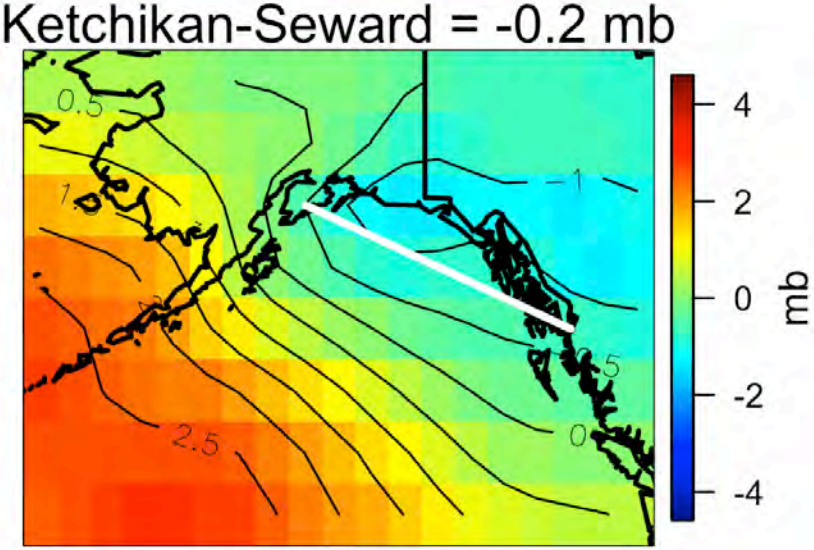
5 warmest years

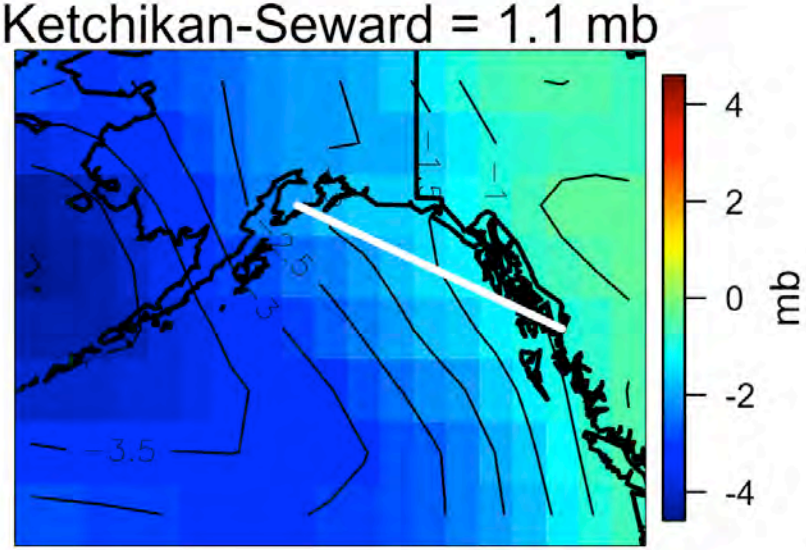
1965-1988

1989-2012







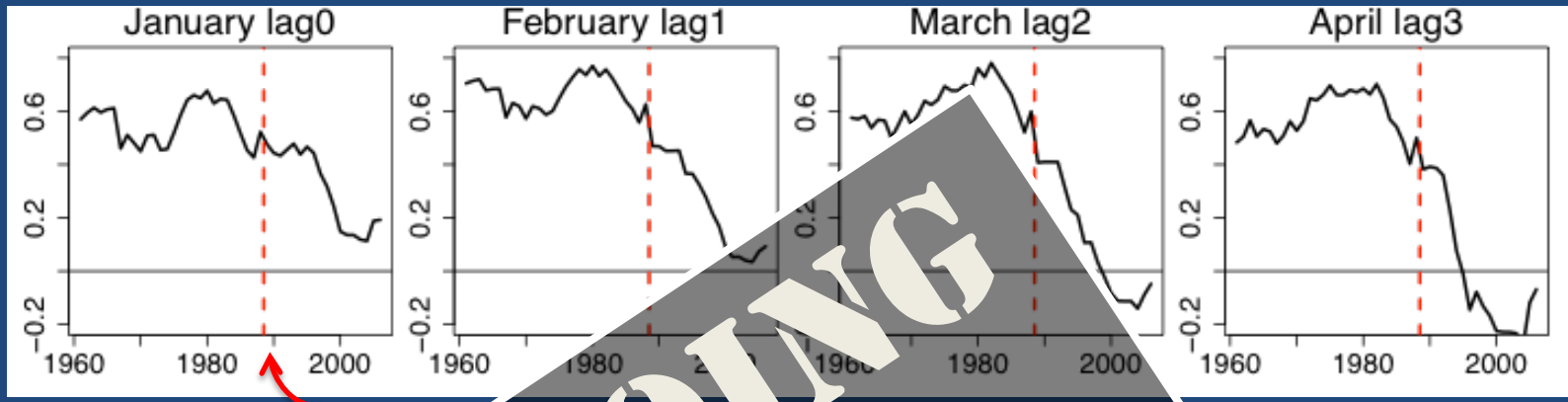


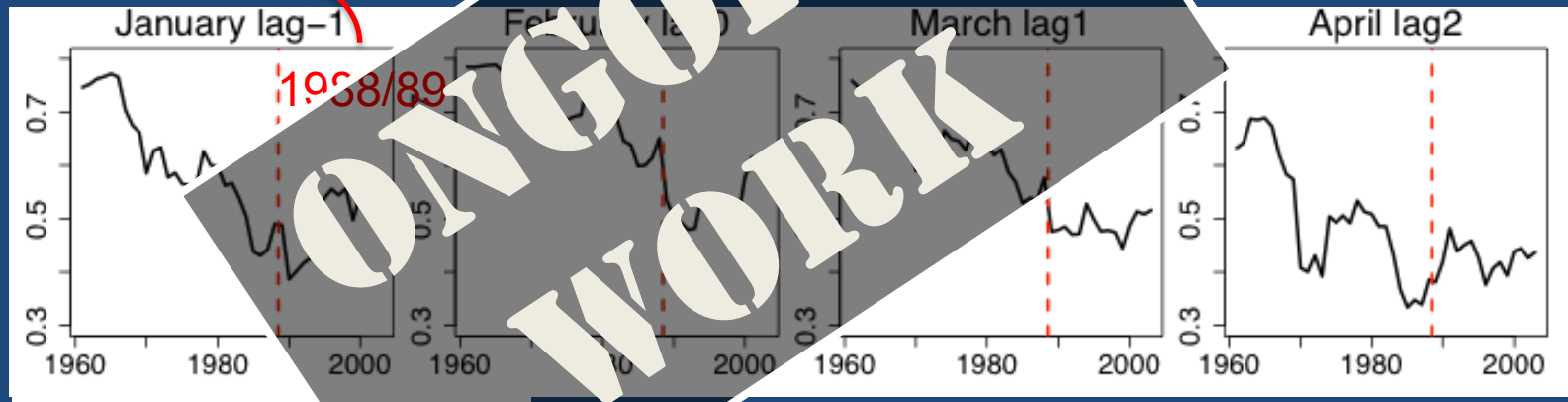
Time-evolving correlations: SST vs SLP➔Freshwater➔Salinity?

SST vs SLP (Ketchikan-Seward diff.)

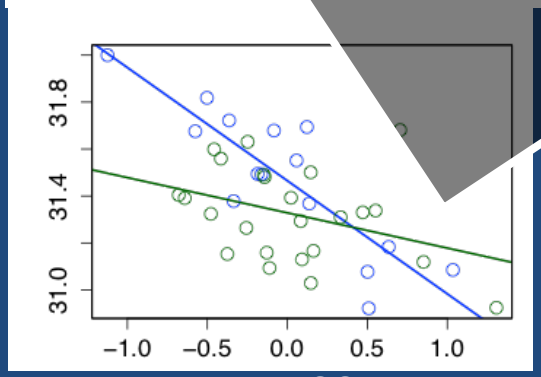
SST vs Freshwater Discharge

SST vs Salinity (GAK1 30m)





ONGOING WORK

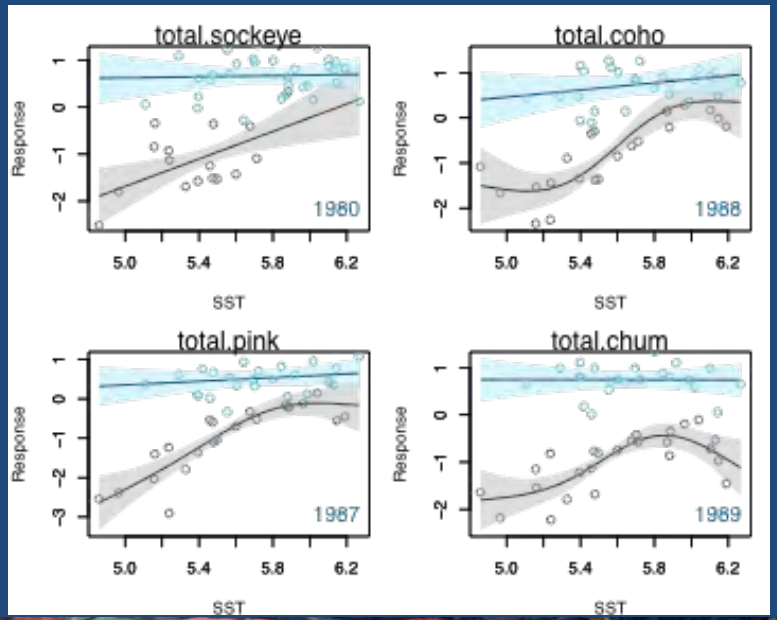


p(sst × era) = 0.03

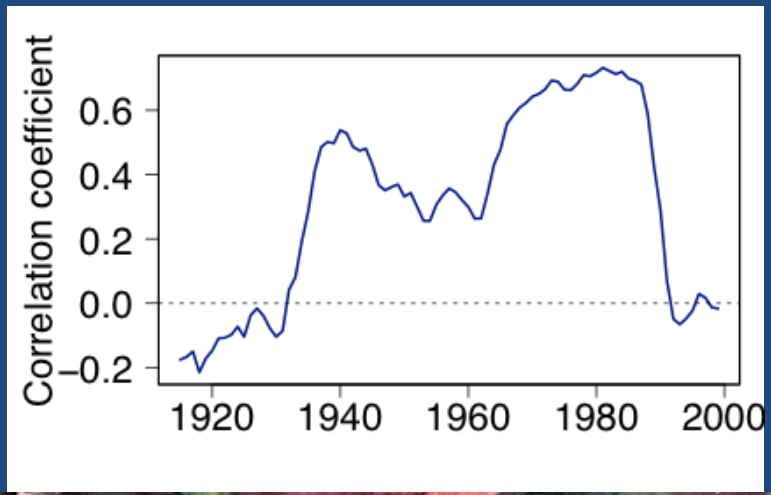
Summary

-SST effects on biology are nonlinear and state-dependent

survival = { f1(temperature) *before* 1988/89
f2(temperature) *after* 1988/89



Correlation: SST and sockeye salmon catch



Summary

-SST effects on biology are nonlinear and state-dependent

survival = { f1(temperature) *before* 1988/89
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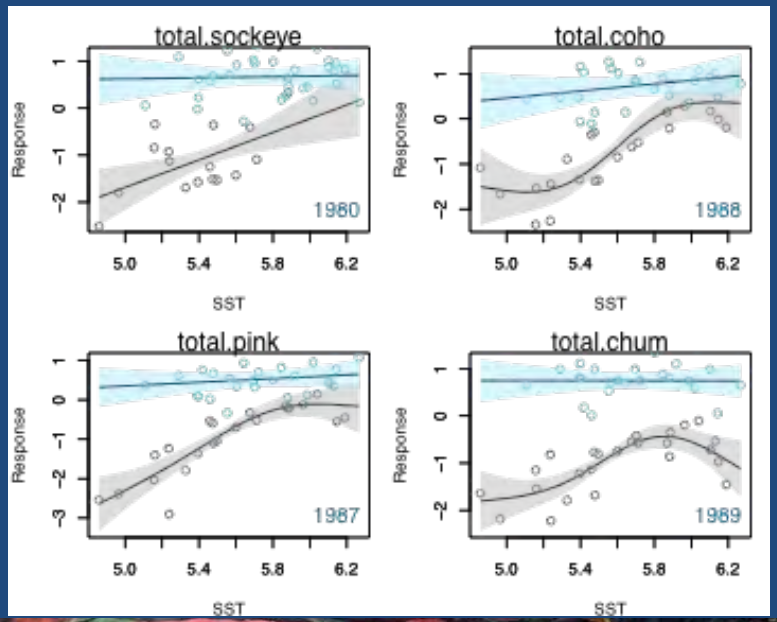
Implications

-Observations from one state are not useful for predictions to another state



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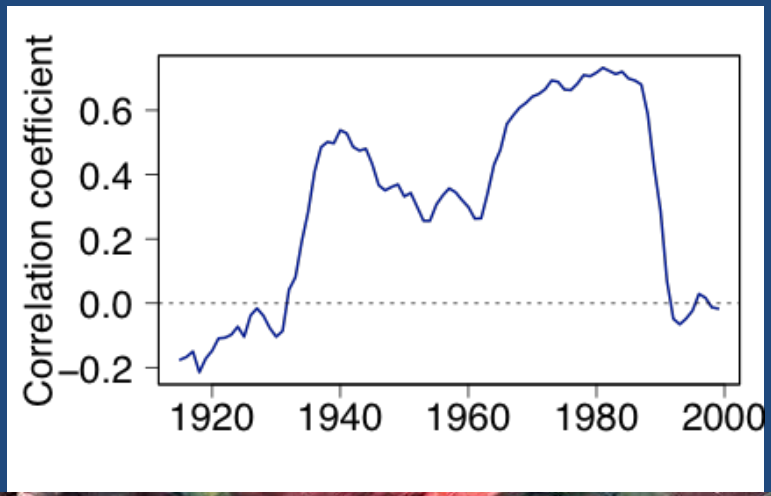


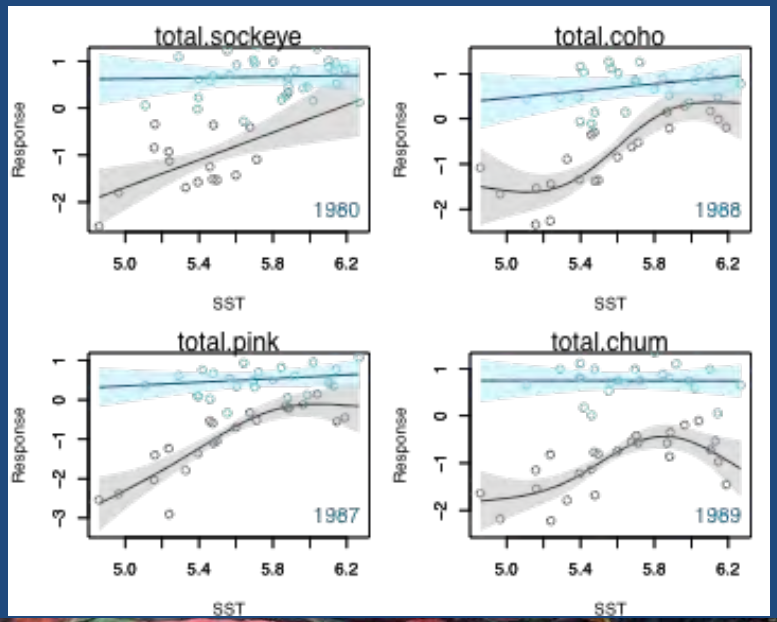
Summary

-SST effects on biology are nonlinear and state-dependent

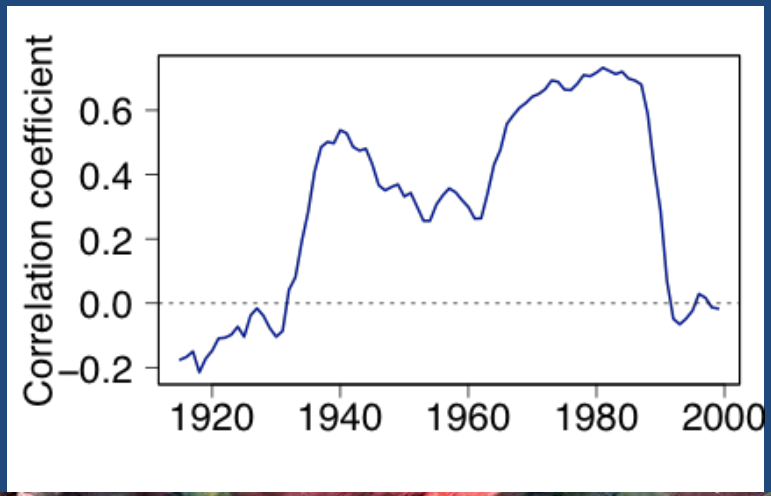
survival = { f1(temperature) *before* 1988/89
f2(temperature) *after* 1988/89

Implications

-Ephemeral climate-biology relationships are coherent across the community



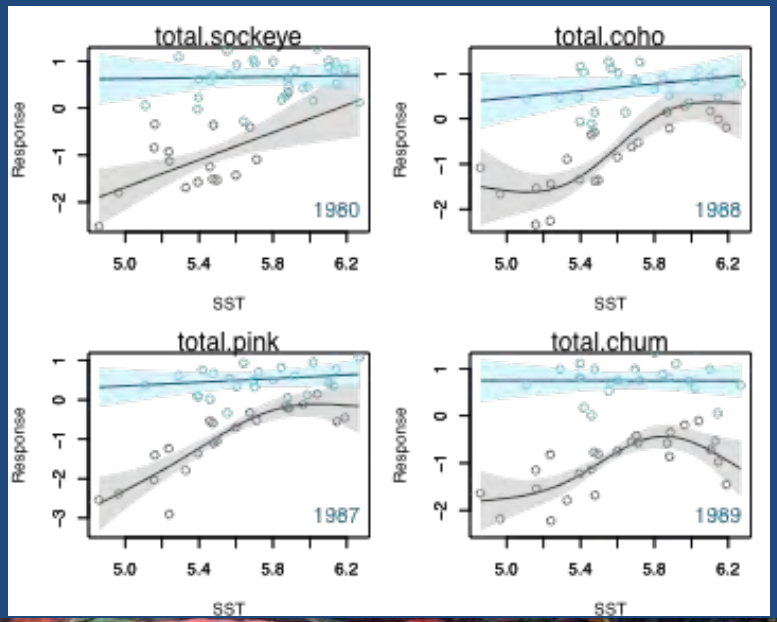
Correlation: SST and sockeye salmon catch



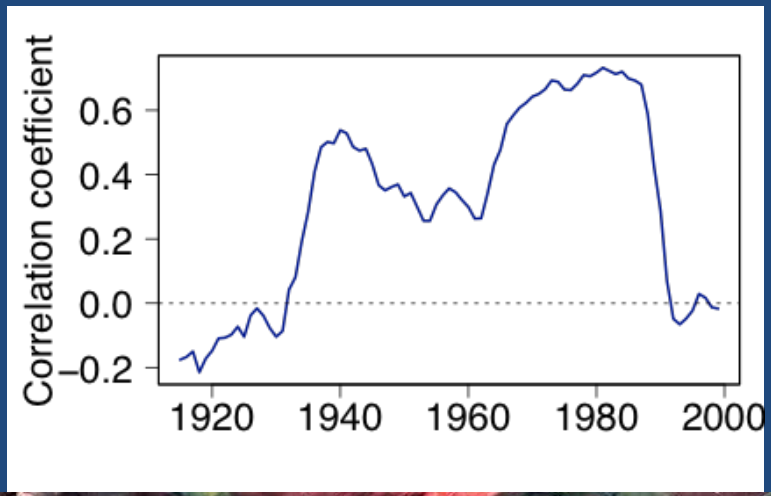
New hypothesis

survival = temperature + strength of SST-SLP association

necessary, but not sufficient

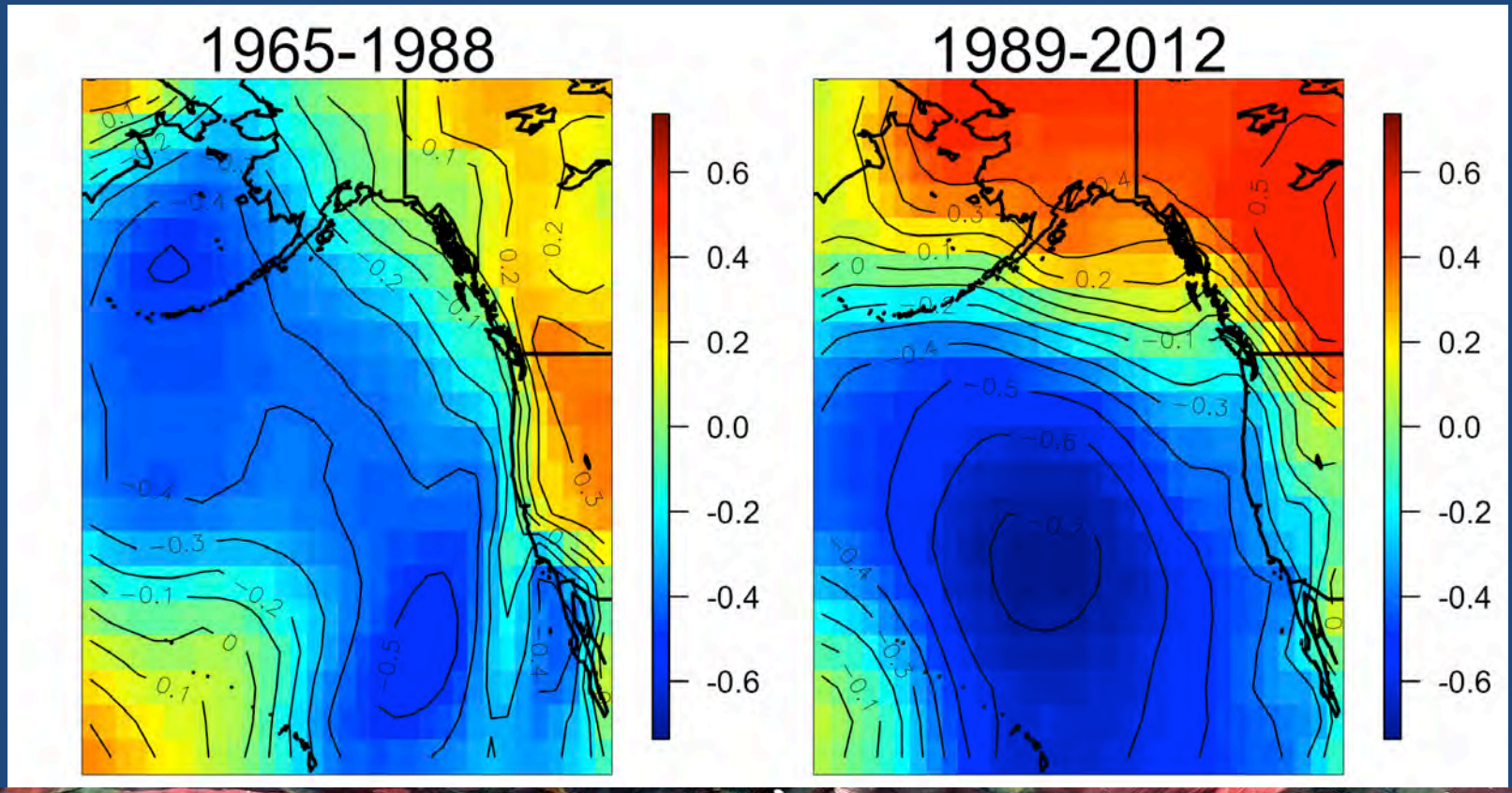


Correlation: SST and sockeye salmon catch



Implications

Correlation coefficients: PDO vs. NE Pacific SLP



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