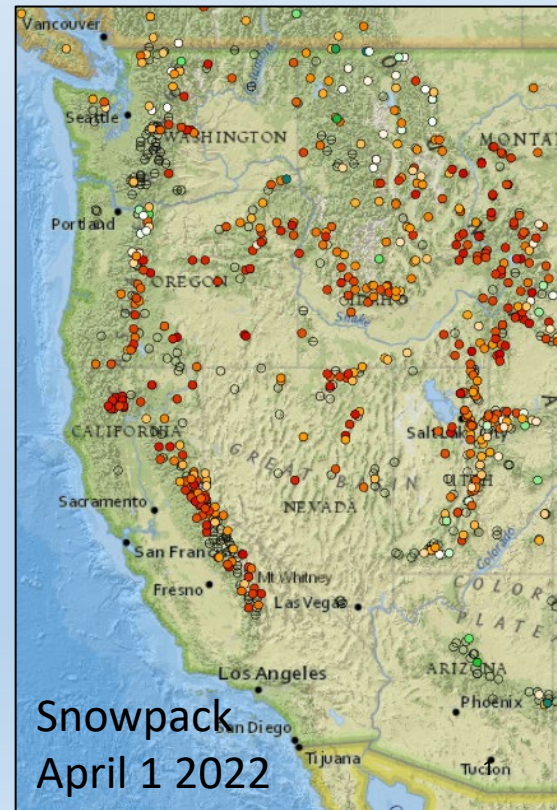
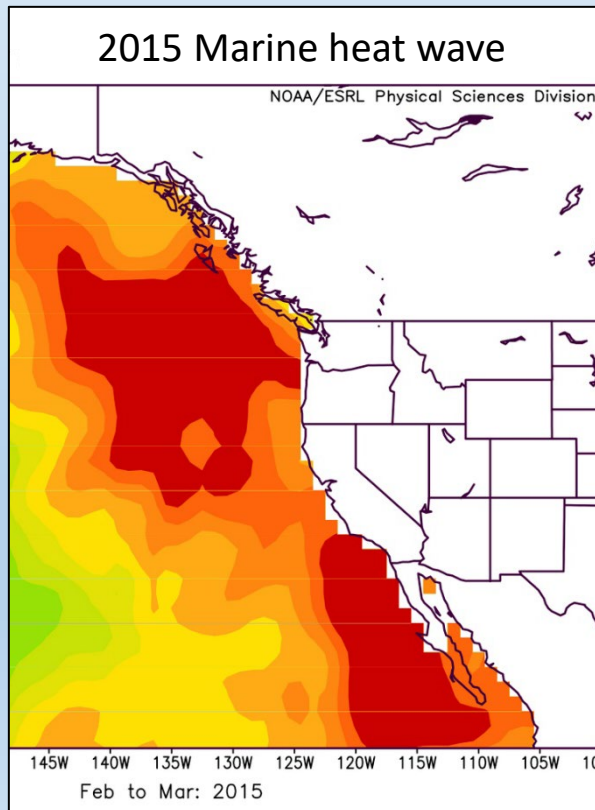


Climate change and salmon: why are fish responses variable?

Agenda Item D.1.b
Supplemental NMFS PPT 1
April 2022

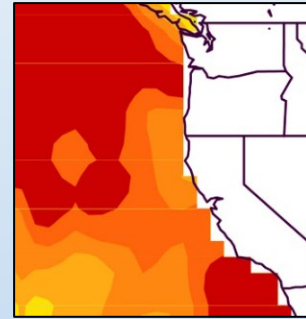
A review of recent Science Center research

Correigh Greene (NWFSC)
& Steve Lindley (SWFSC)

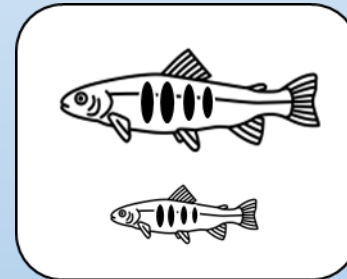


Climate change and salmon: why are fish responses variable?

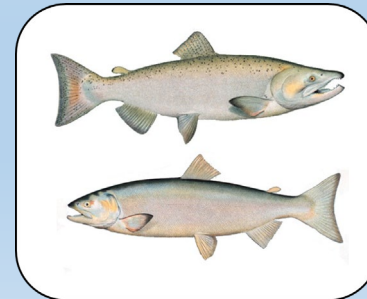
- Spatial & temporal variation
(where and when the fish are)



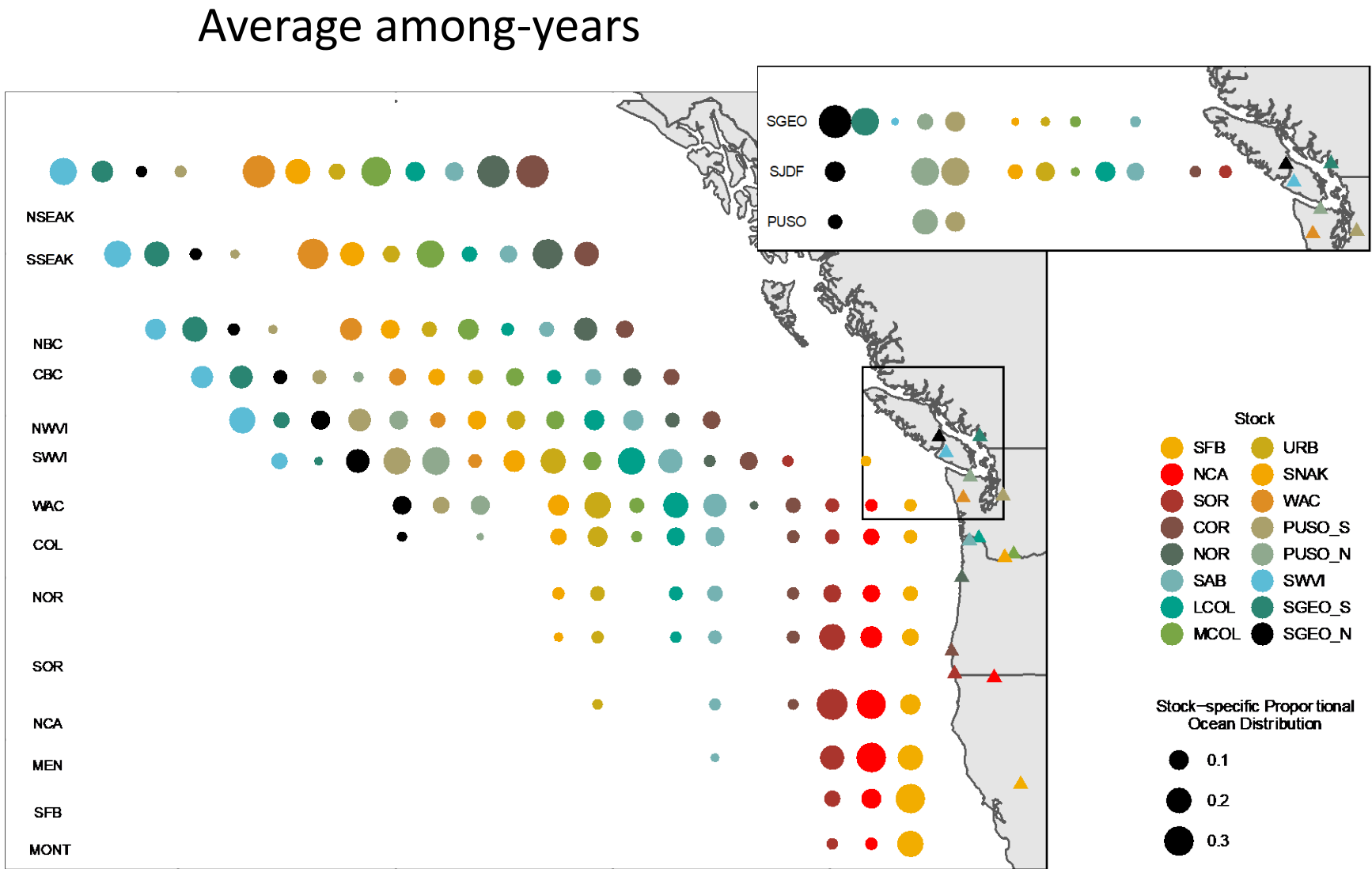
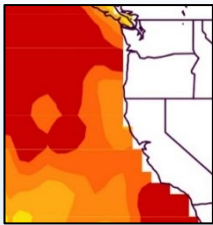
- Life history variation



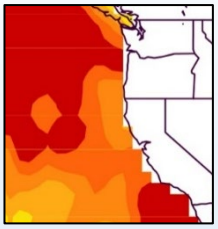
- Species differences



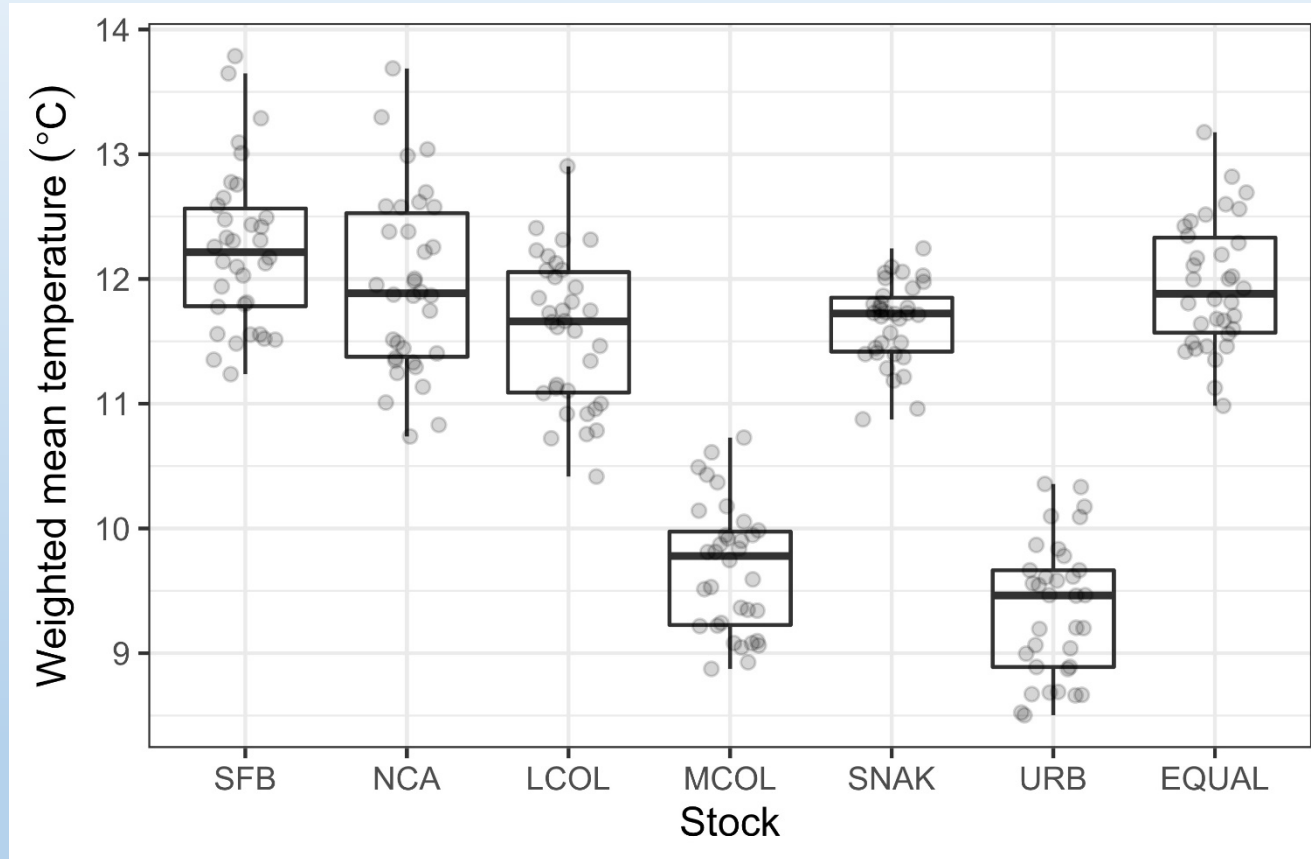
Climate-related distribution shifts in Fall Chinook salmon



Chinook stocks vary markedly in their associations with temperature

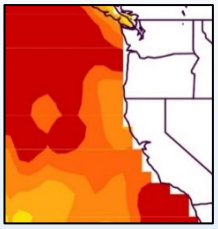


- No simple thermal niche for the entire species
- Using a single thermal niche will provide incorrect projections for future distribution

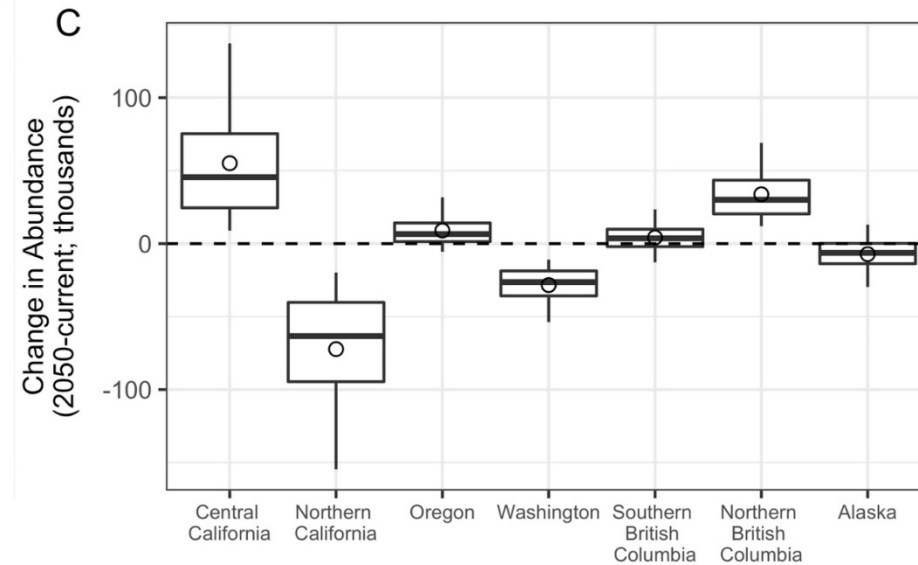
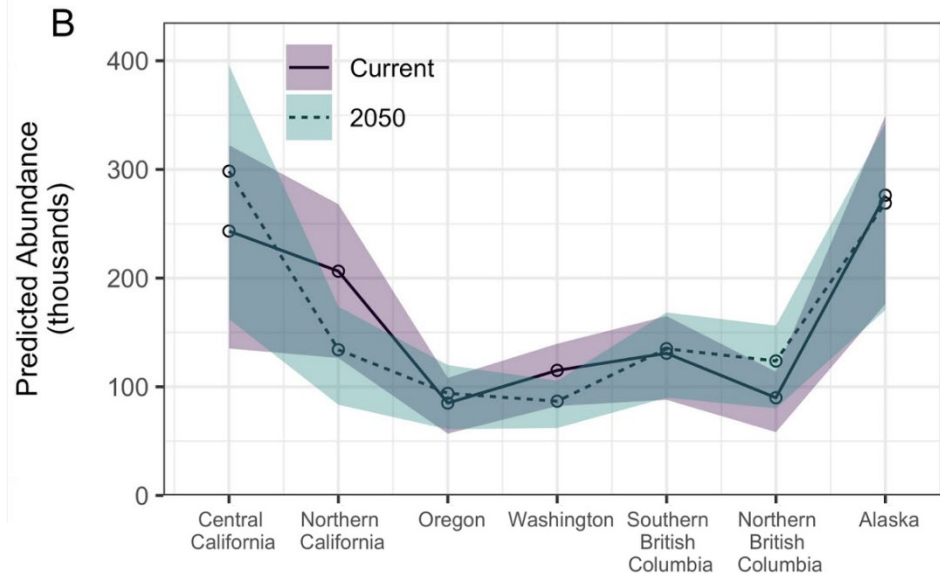


Shelton et al. 2021. Fish and Fisheries

Projections of temperature changes on spatial distributions of different populations



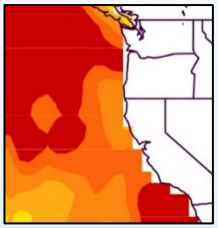
Simulate focal populations based on observed abundances (post-1990)



- Changes in some areas are 20-40%
- Changes are due entirely to distributional shifts, not productivity shifts.

Shelton et al. 2021. Fish and Fisheries

Temperature impacts on survival of juvenile salmon in the Sacramento River



Received: 1 December 2020 | Revised: 7 June 2021 | Accepted: 10 June 2021

DOI: 10.1002/ece3.7840

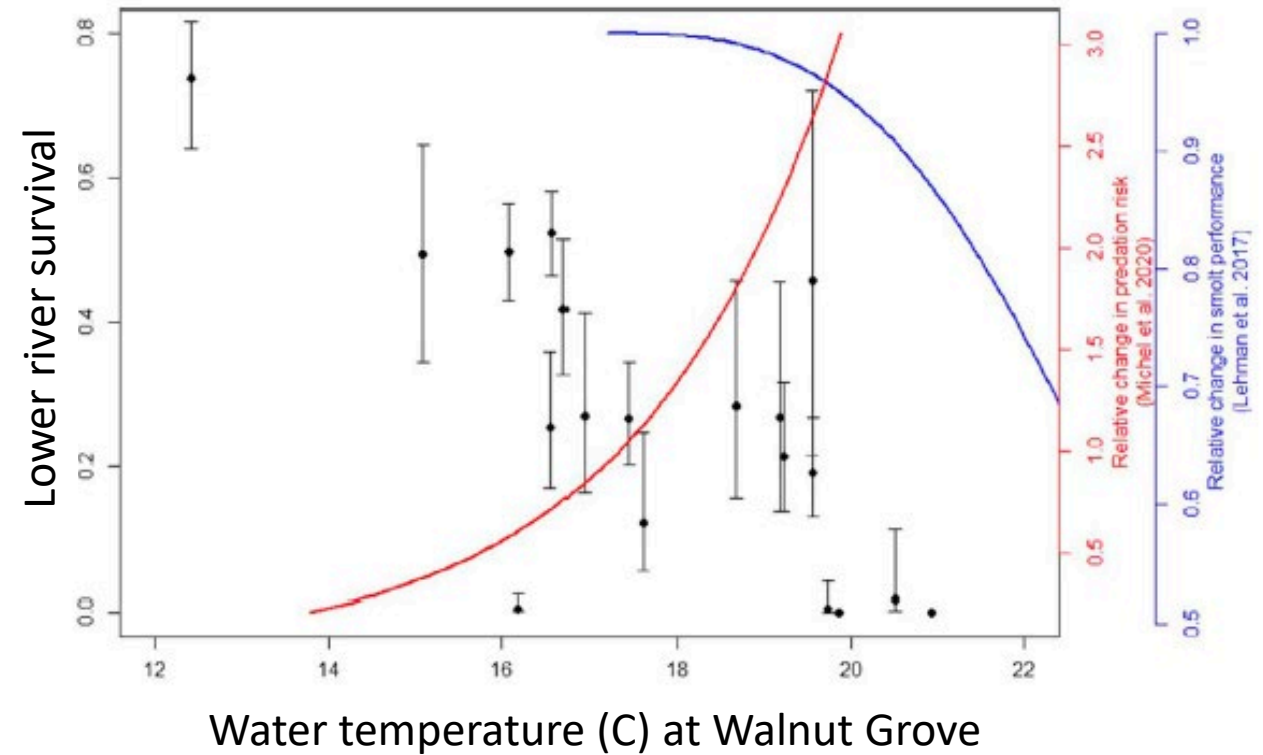
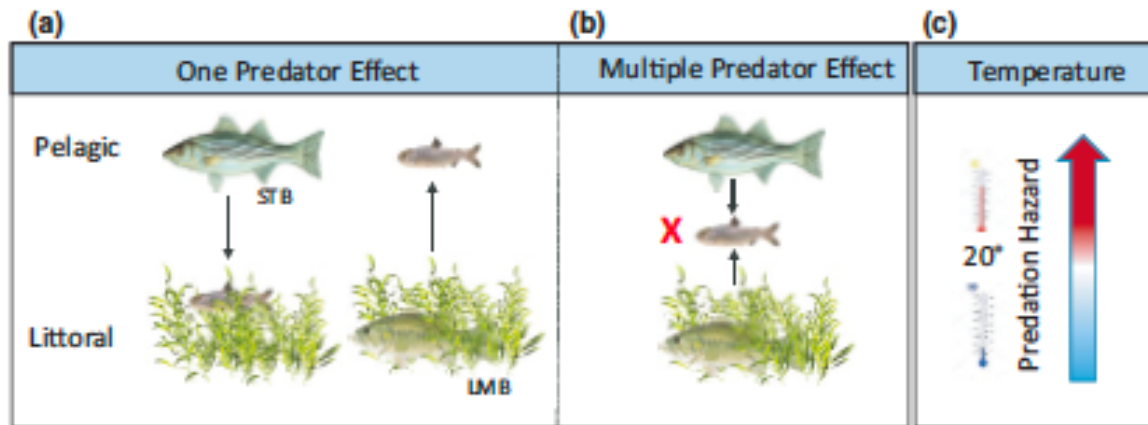
ORIGINAL RESEARCH

Ecology and Evolution
WILEY

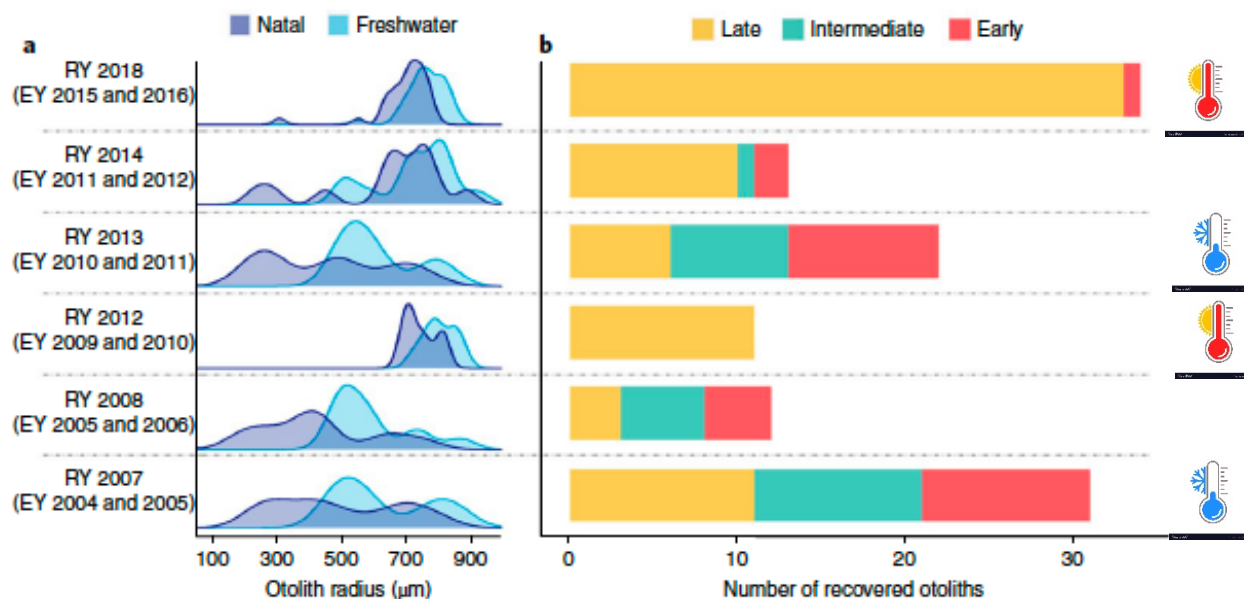
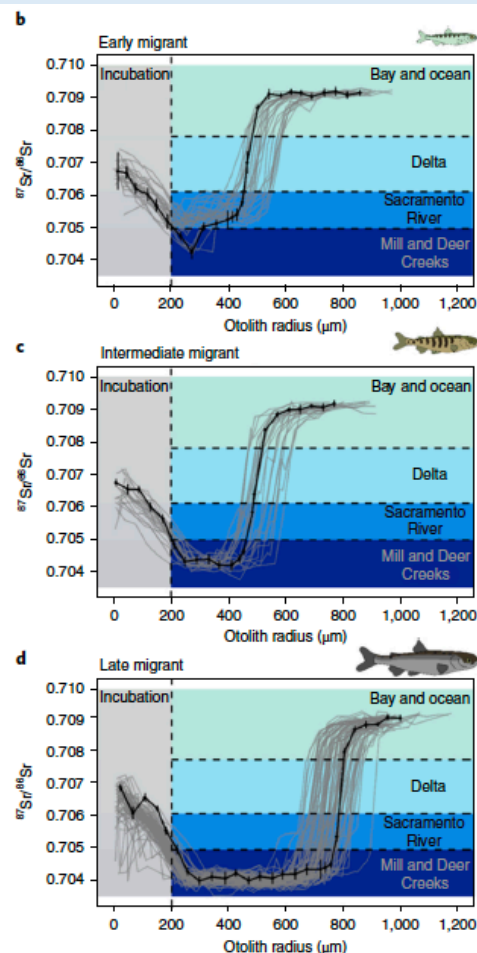
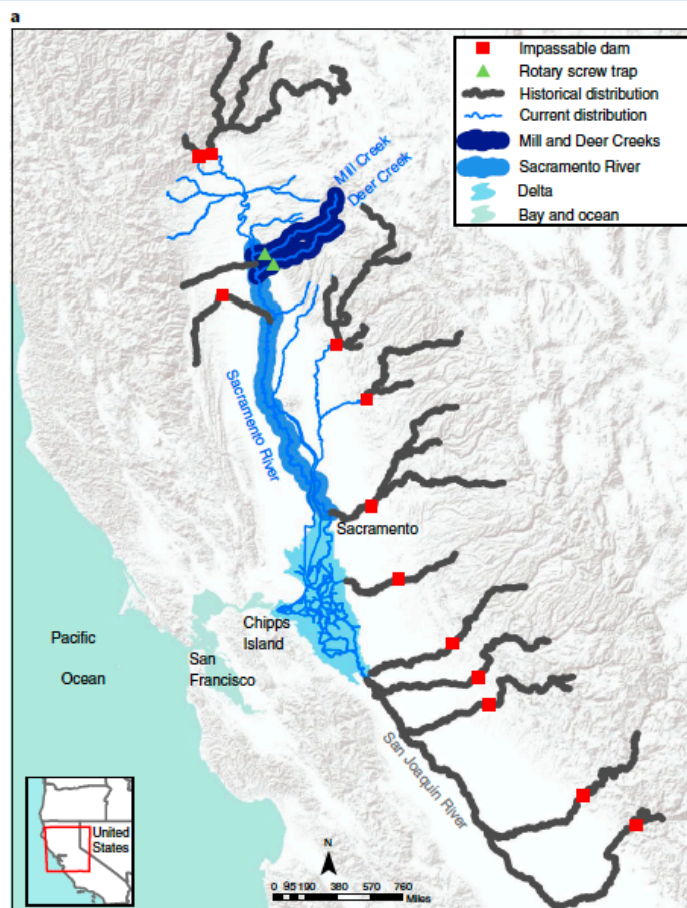
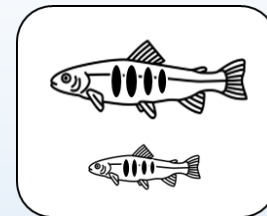
Coldwater fish in a warm water world: Implications for predation of salmon smolts during estuary transit

Matthew L. Nobriga¹ | Cyril J. Michel² | Rachel C. Johnson³ | John D. Wikert⁴

Salmon outmigration predation hazard



Temperature-dependent migration strategies



ARTICLES

<https://doi.org/10.1038/s41558-021-01186-4>

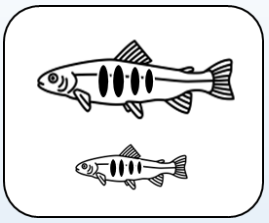
nature
climate change

Check for updates

Threatened salmon rely on a rare life history strategy in a warming landscape

F. Cordoleani^{1,2}, C. C. Phillis³, A. M. Sturrock⁴, A. M. FitzGerald^{1,2}, A. Malkasian⁵, G. E. Whitman⁶, P. K. Weber^{1,7} and R. C. Johnson^{1,2,6}

170 years of stressors erode salmon fishery climate resilience in CA's warming landscape

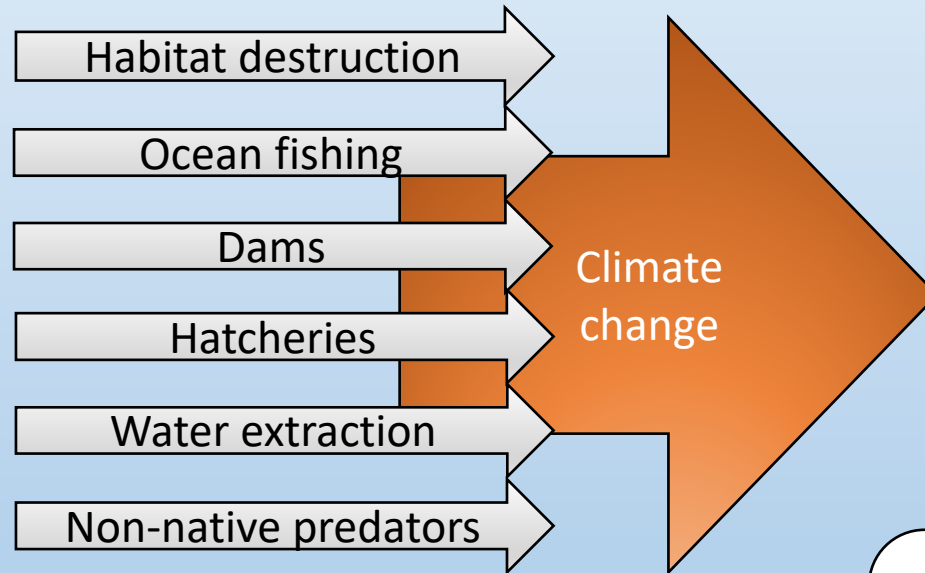


SH Munsch, CM Greene, NJ Mantua, WH Satterthwaite

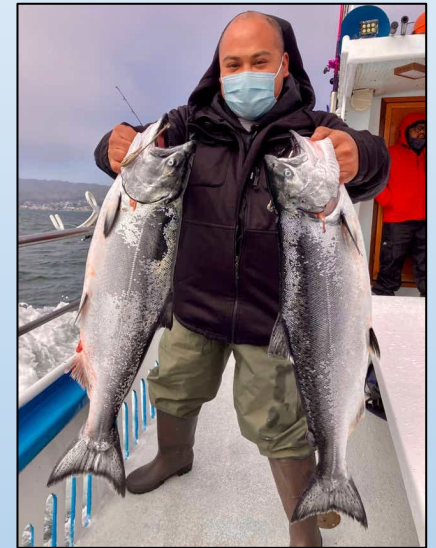
Global Change Biology DOI: 10.1111/gcb.16029



Historical: diverse salmon age structure **smoothed impacts of drought across multiple years**, promoting steady landings.

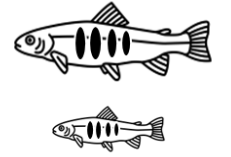


- Made temp effects worse
- Concentrated risk via lost habitat & life history diversity

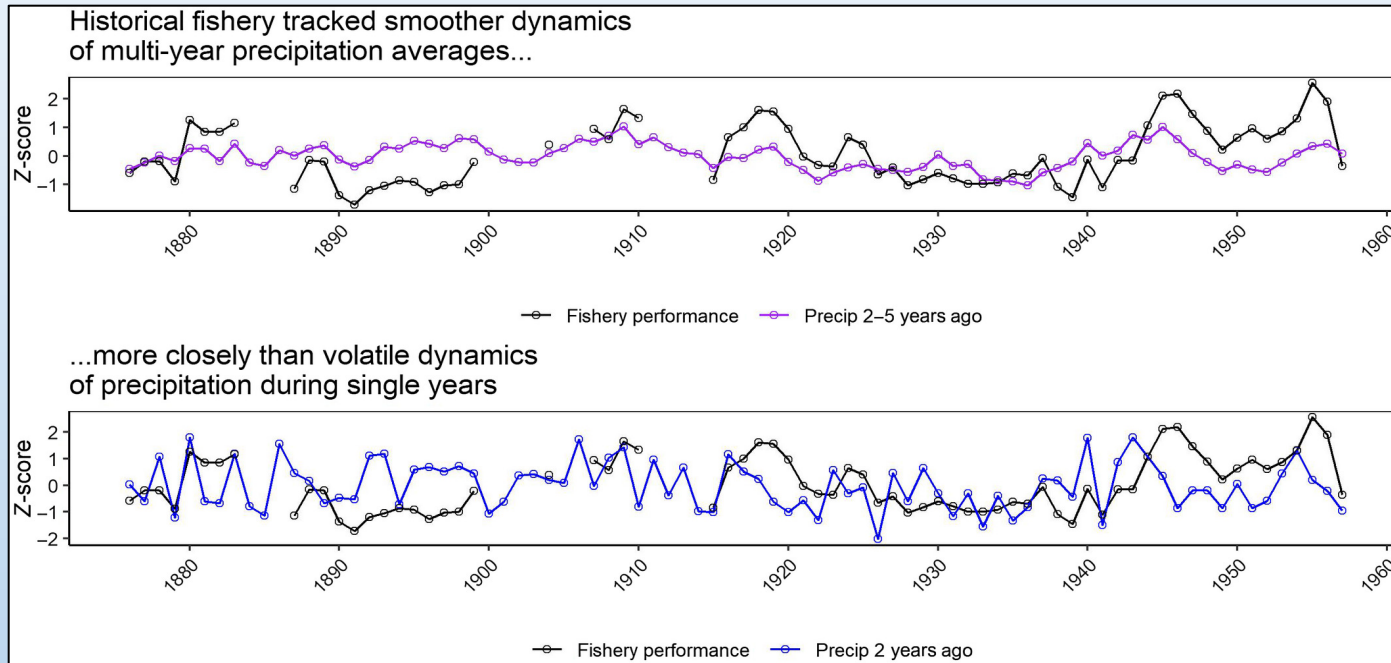


Today: simplified system relies on **precipitation and cold temperatures from singular years**. Now, adult returns tightly track CA's drought-prone, often-hot, & warming climate.

Shifting climate drivers & rising variation in salmon returns

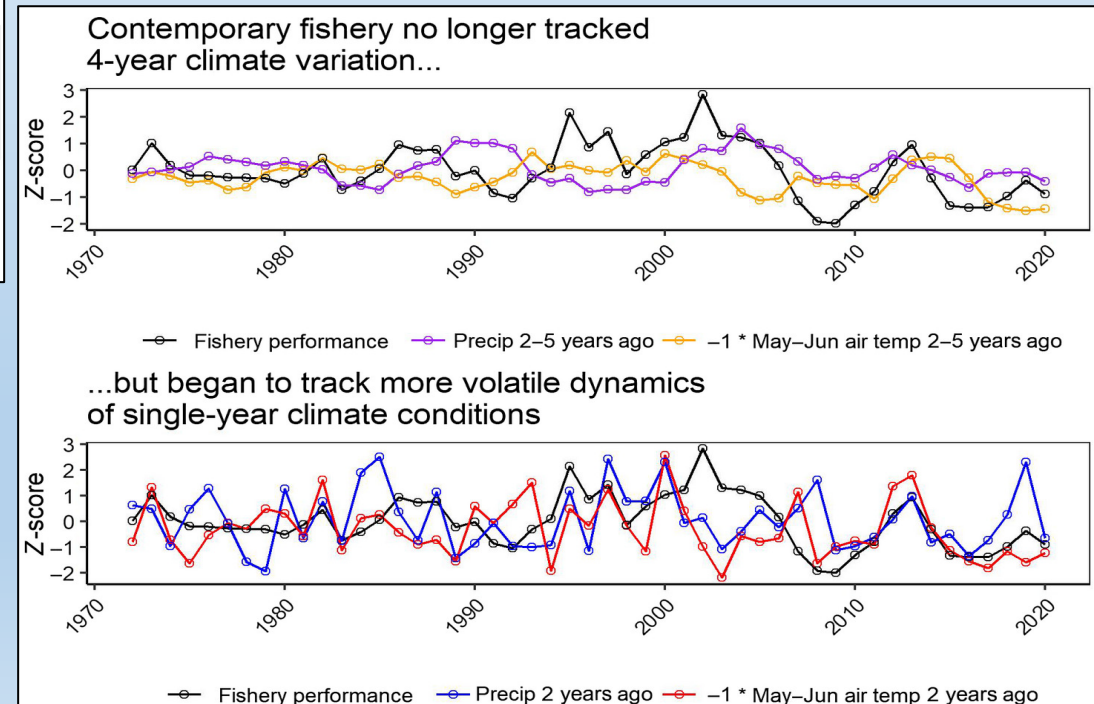


Historical



- Precipitation always important
- Rising importance of May-Jun air temp
- Rising importance of shorter climate windows
- Year-to-year variation in returns rising

Contemporary



Using life cycle models to examine combined effects of climate change and restoration

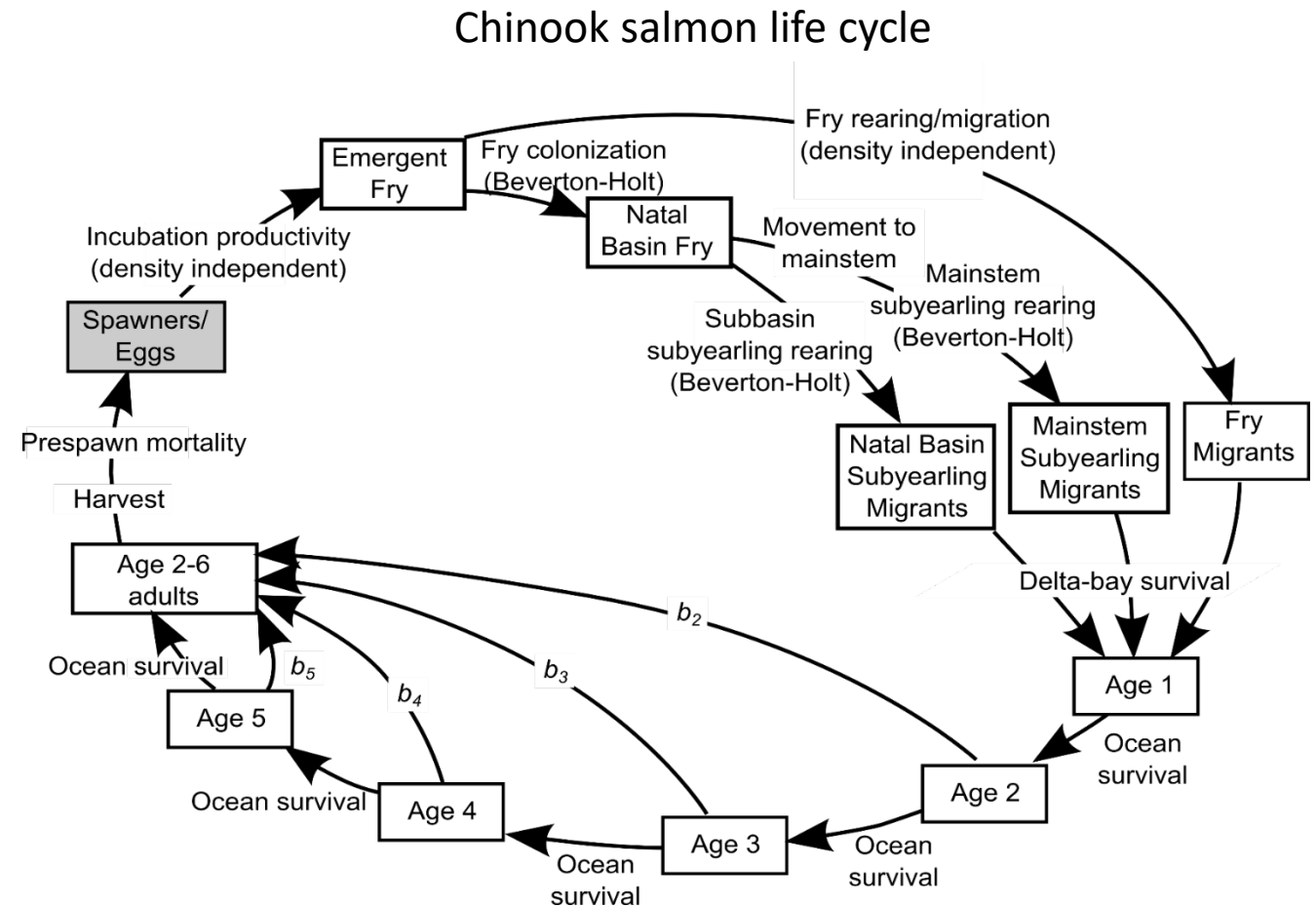


Climate impacts

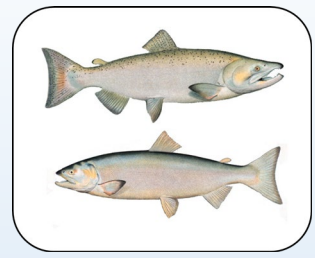
- Increasing summer temperature
- Declining summer flows
- Increasing peak flows

Types of restoration

- Remove barriers
- Add Large woody debris
- Increase riparian shade
- Improve channel length
- Improve bank condition
- Increase beaver ponds
- Broaden floodplains

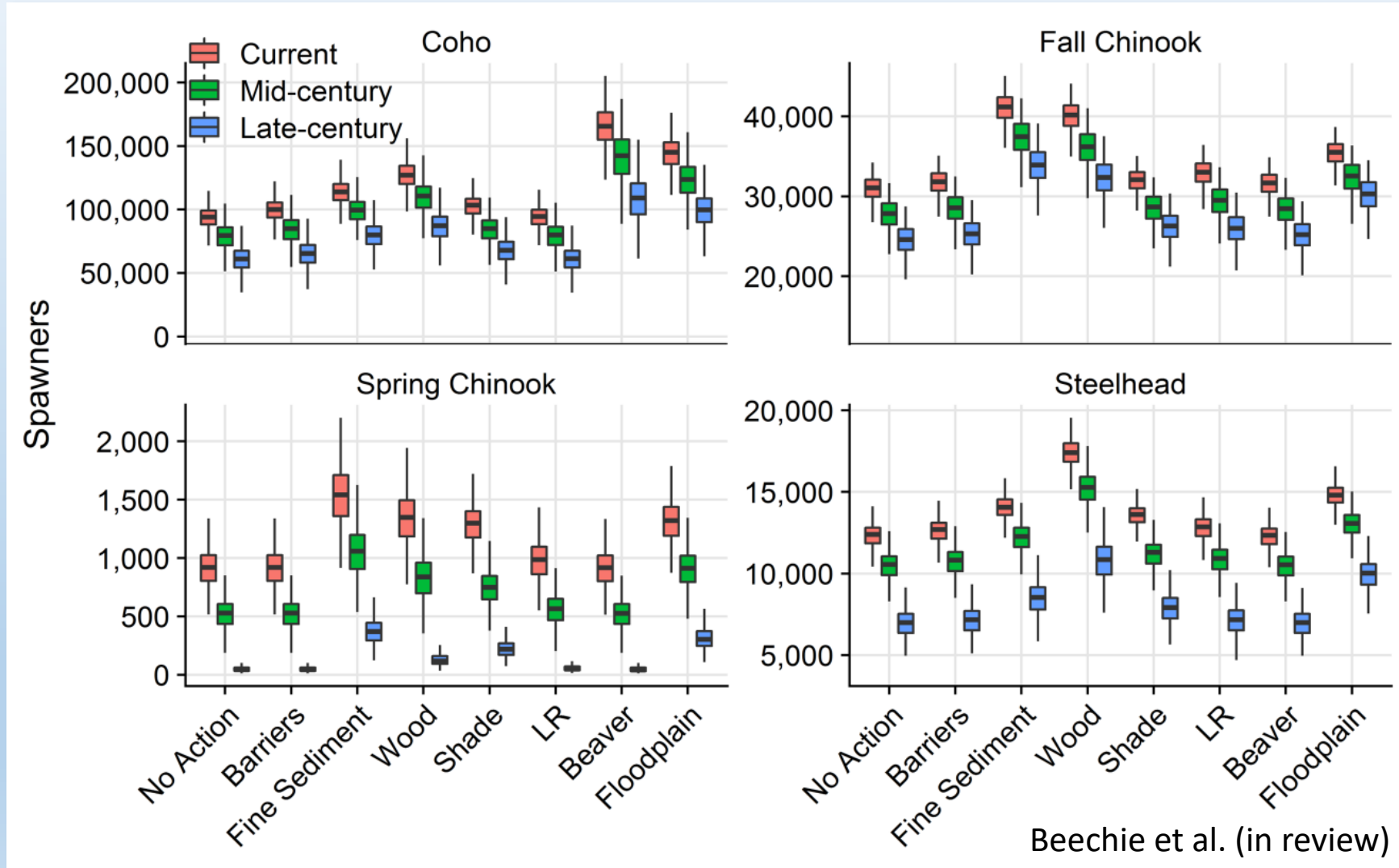
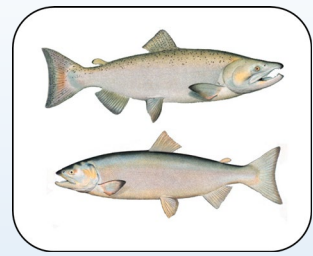


Testing resilience strategies



- Single actions
 - Does ameliorating a climate change effect lessen population decline?
- Combinations of actions
 - Top 4 actions at +25%, +50% and +75% intensity (shade, floodplain, beaver ponds, wood)
 - Top 5 actions at +25%, +50% and +75% intensity (shade, floodplain, beaver ponds, wood, fine sediment)

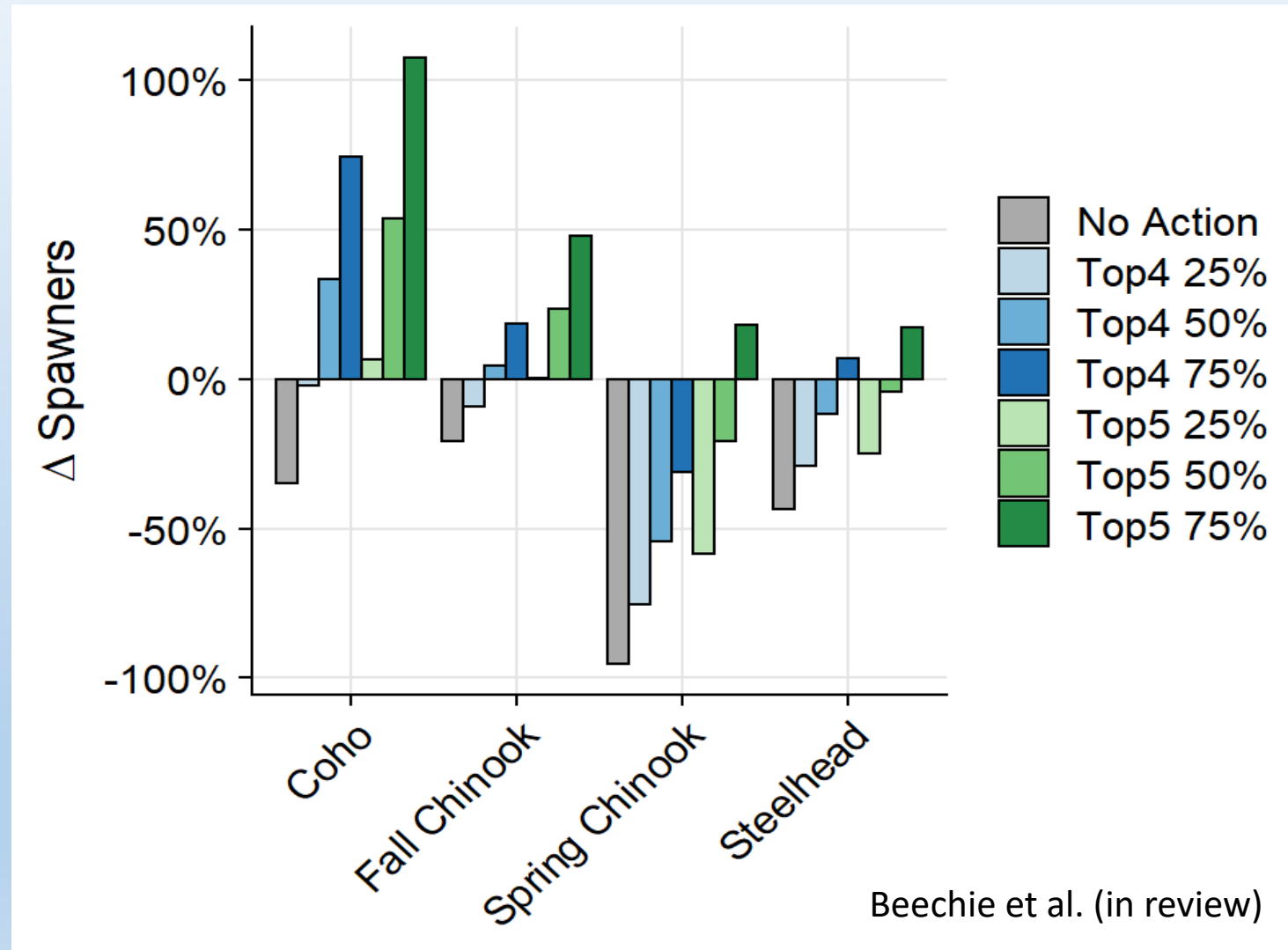
What are the likely effects of climate change?



Climate vulnerability varies by species

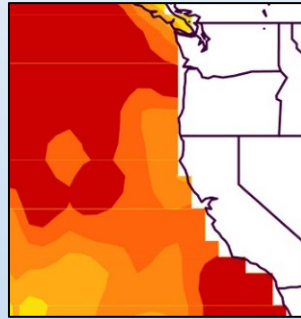


- Less vulnerable species respond more to restoration
- Very vulnerable species require a lot more restoration effort

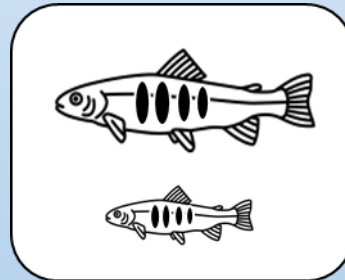


Climate change and salmon: why are fish responses variable?

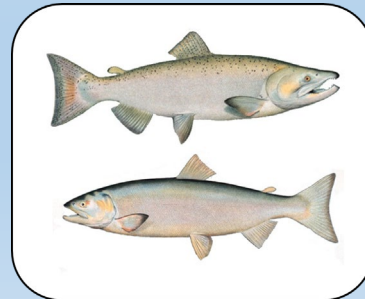
- Spatial & temporal variation
(where and when the fish are)



- Life history variation



- Species differences



Fisheries management implications

- **Forecasting:** better understanding of various scales of climate impacts
- **Recovery actions:** Importance of improving habitat conditions
- **Recovery actions:** measures besides abundance and productivity metrics are important for resilient fisheries
- **Forecasting:** ecosystem indicators should be placed in context of species and population life histories
- **Recovery actions:** Value of prioritizing actions for vulnerable stocks/species