Recent trends in salmon ocean ecology

Portland General Electric – 30th Annual Fisheries Workshop
July 18th, 2024

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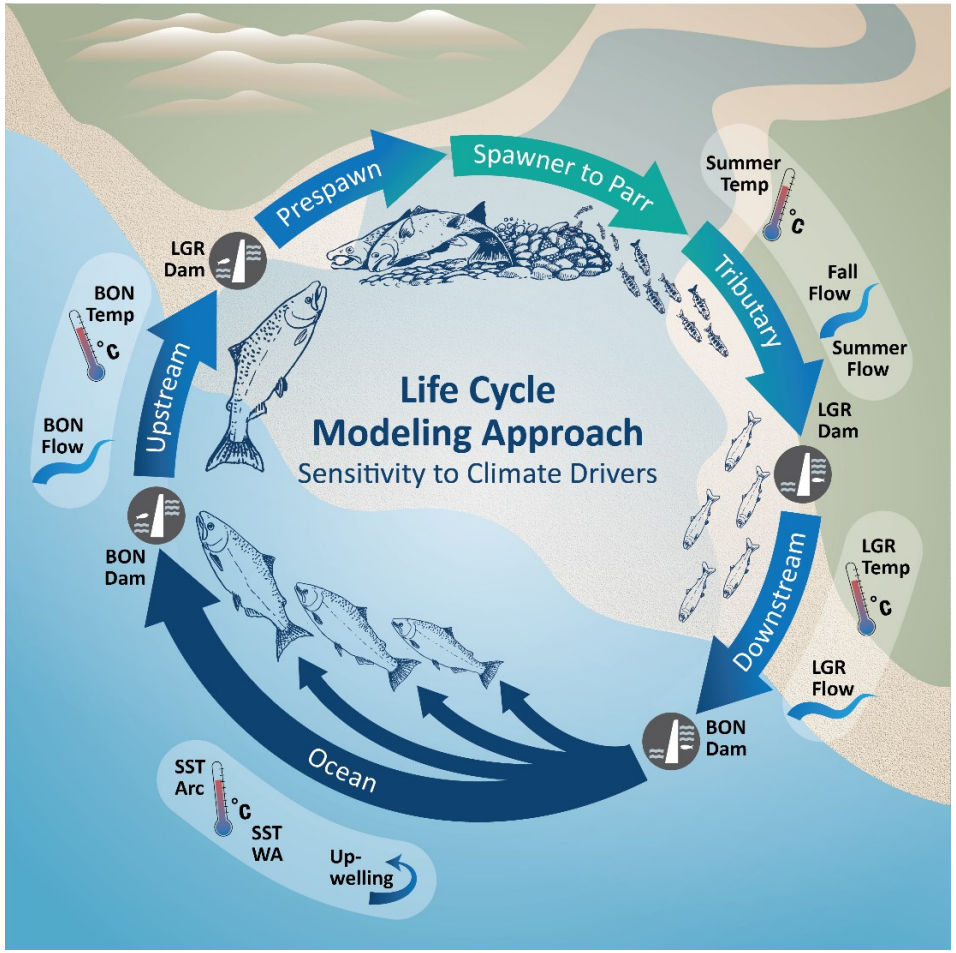
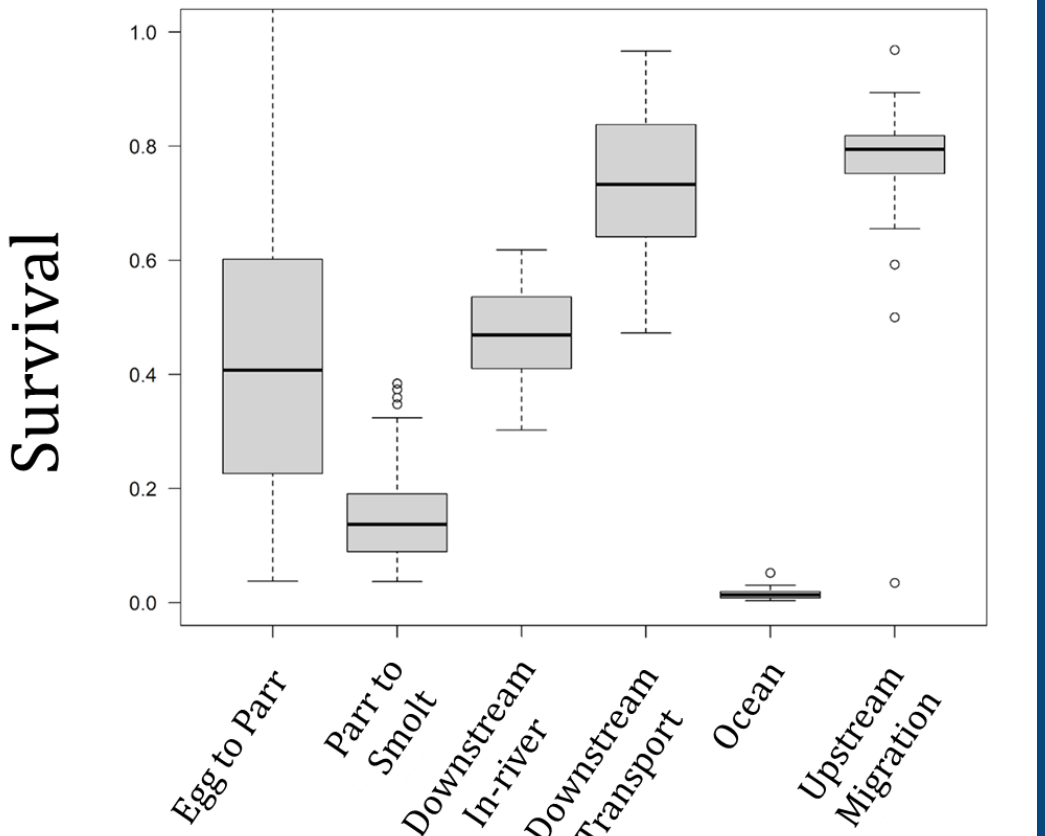
Also supported by:

Life Cycle Models, Survival, and the Ocean





Crozier et al. 2021. Communications Biology
https://doi.org/10.1038/s42003-021-01734-w

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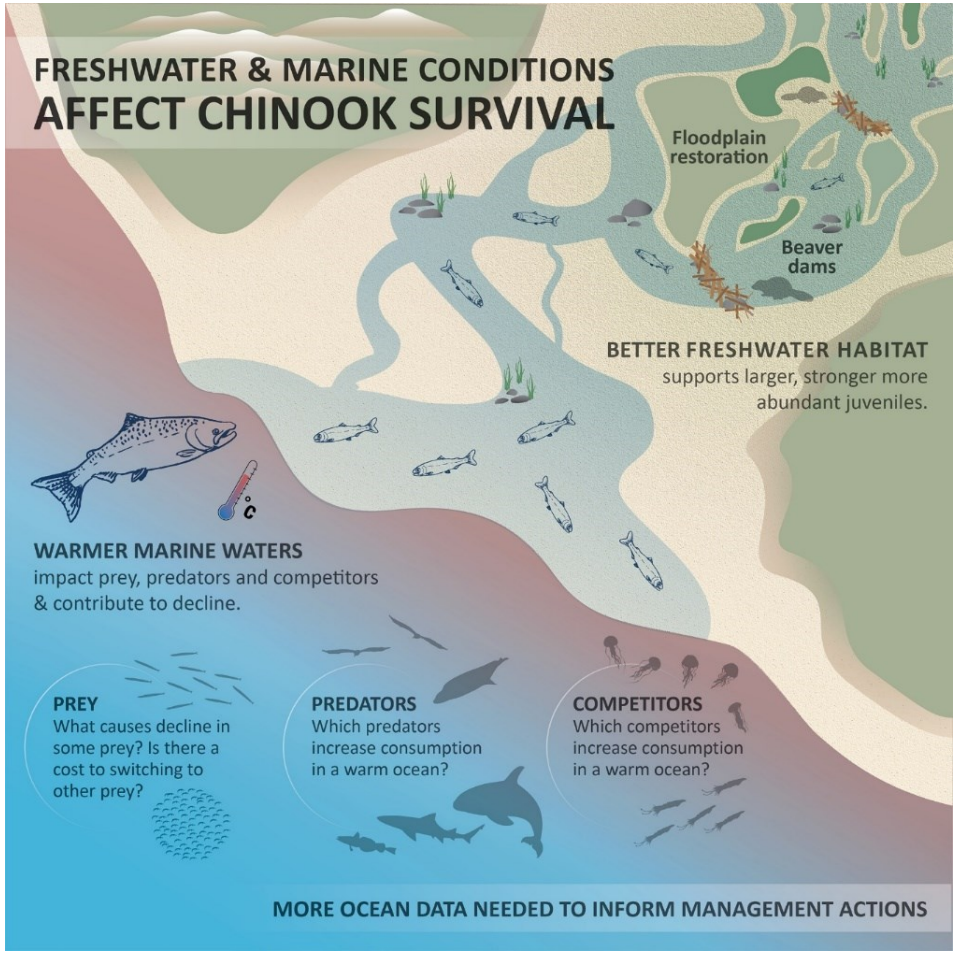
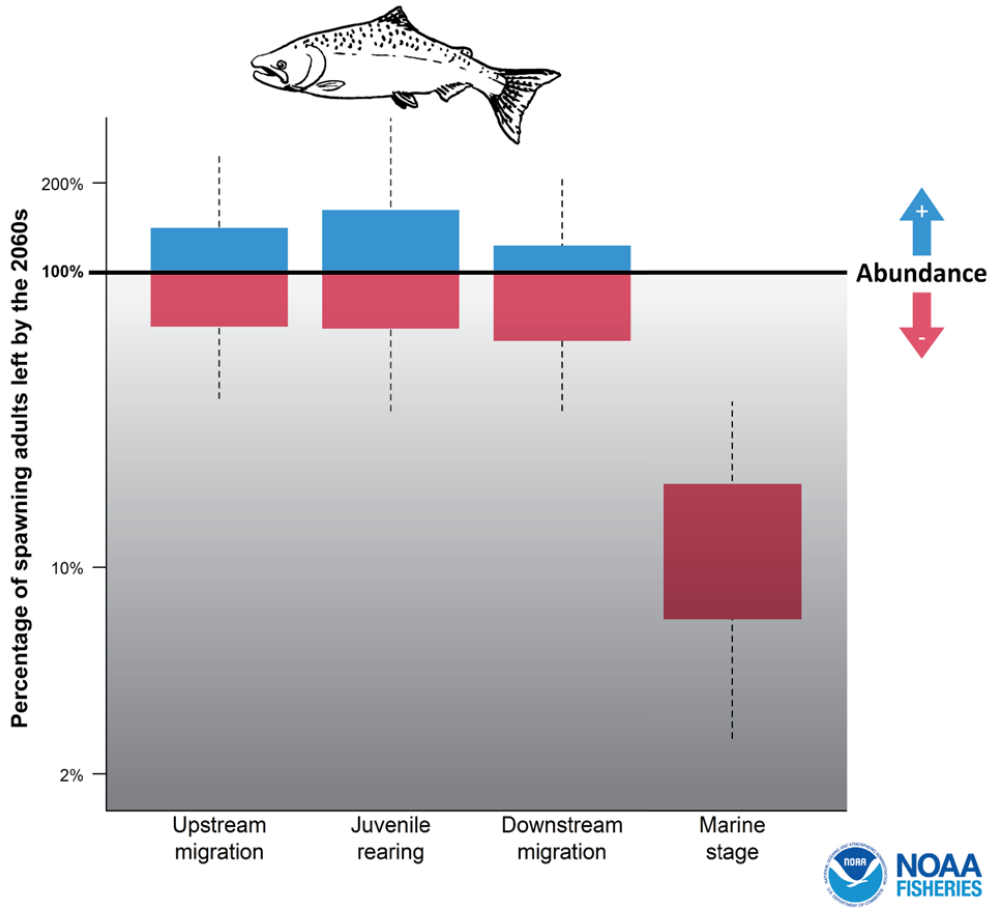
Climate Affects Habitats Differently





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Outline

- Who we are and what we do
- Where do salmon go in the ocean?
- Ocean Indicators and Non-stationarity
- Carryover effects

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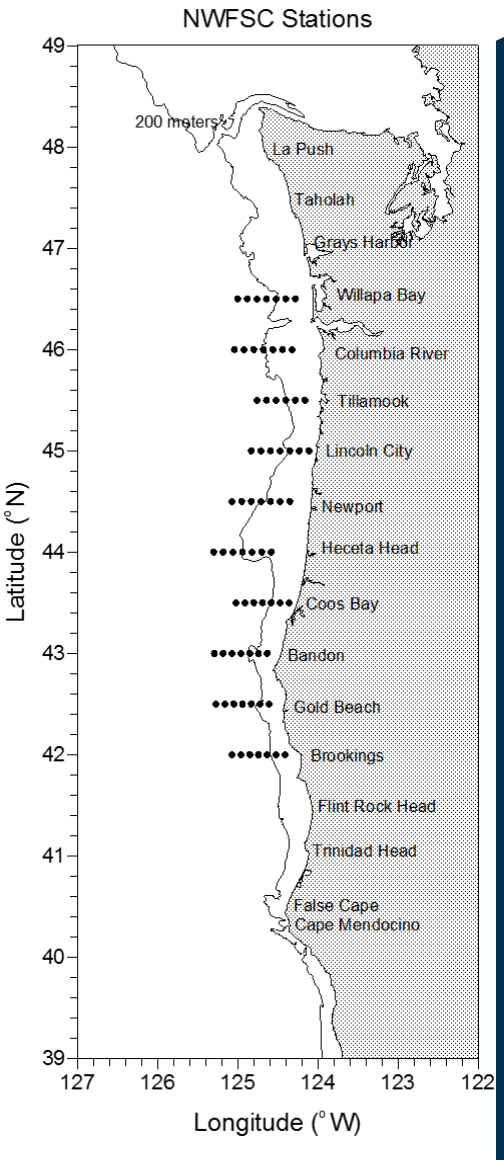
Newport Hydrographic Line and Northern California Current Survey



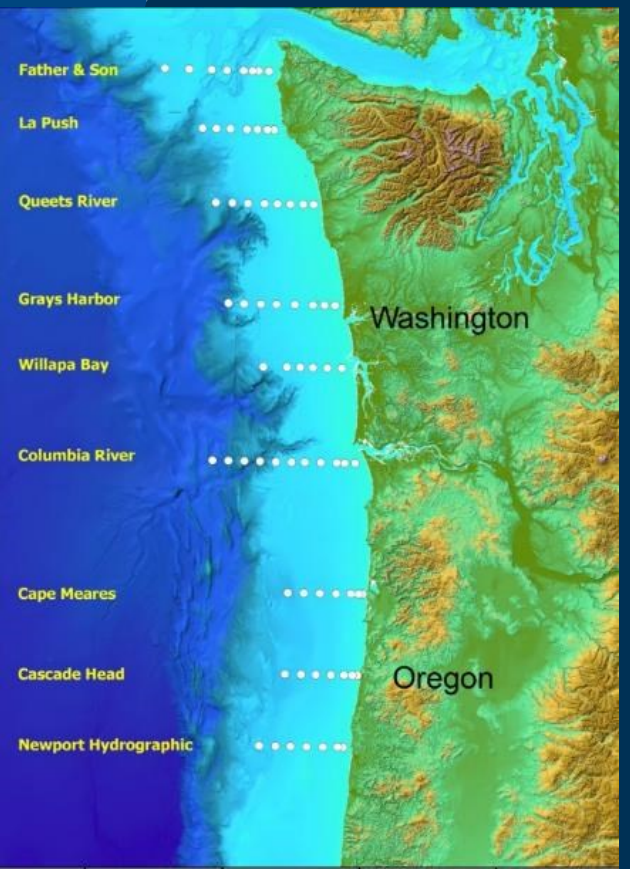
Newport Line: Sampled biweekly for 27 years

Pre-recruit: May-June (2011, 2013-2019)

NCC Survey: Seasonal (2-4 times per year)

Juvenile Salmon and Ocean Ecosystem Survey (JSOES)

- May (2006 – 2012, 2015 - present)
- June (1998 – present)
- September (1998 – 2012)



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First summer in the ocean: 3 general patterns for Columbia River salmon

Pattern 1: Rapid north-wards movement on shelf to Gulf of Alaska

- Spring Chinook, chum, sockeye, some coho

Pattern 2: Remain in local waters

- Fall Chinook, some coho

Pattern 3: Move rapidly offshore

- Steelhead

Plots by Laurie Weitkamp, NOAA Fisheries

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Adults returning to the Columbia: 3 general migration patterns

Pattern 1: Southwards movement along shelf

Which: Fall Chinook, Chum (?), sockeye (?)

Pattern 2: Northwards along California & Oregon Coasts

Which: Coho

Pattern 3: Move rapidly onshore (or unknown)

Which: Steelhead, Spring Chinook

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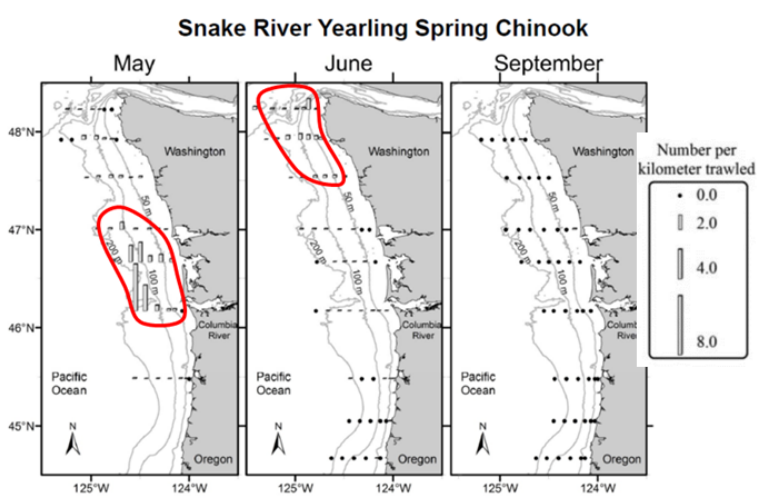
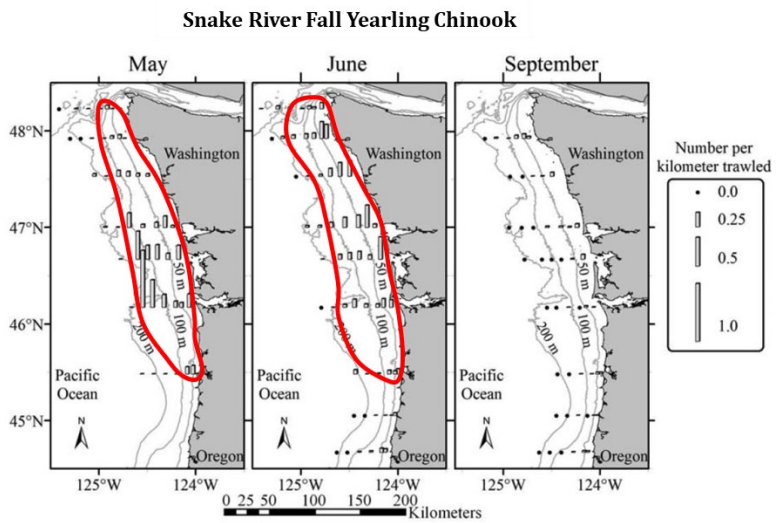
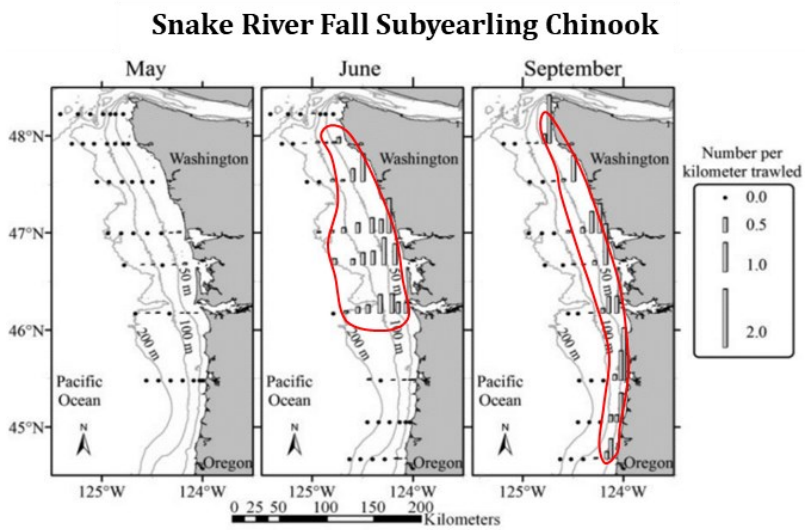
Spatial distribution is stock-specific

Snake River Chinook Salmon







Teel, et al. 2015. Marine and Coastal Fisheries 7:274-300.

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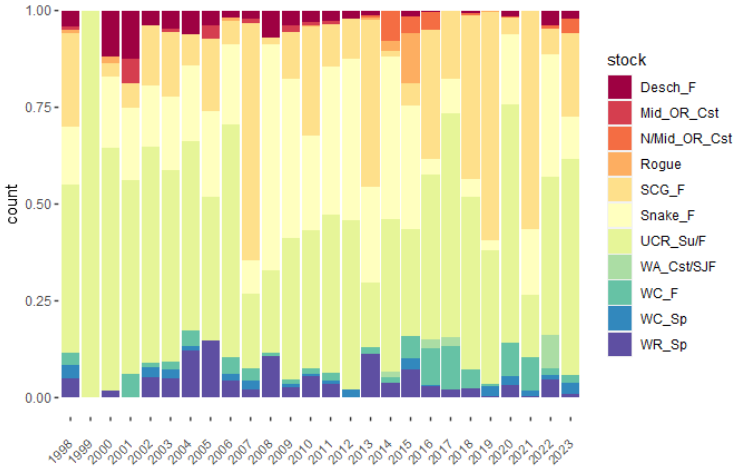
Deschutes River Chinook

May

June

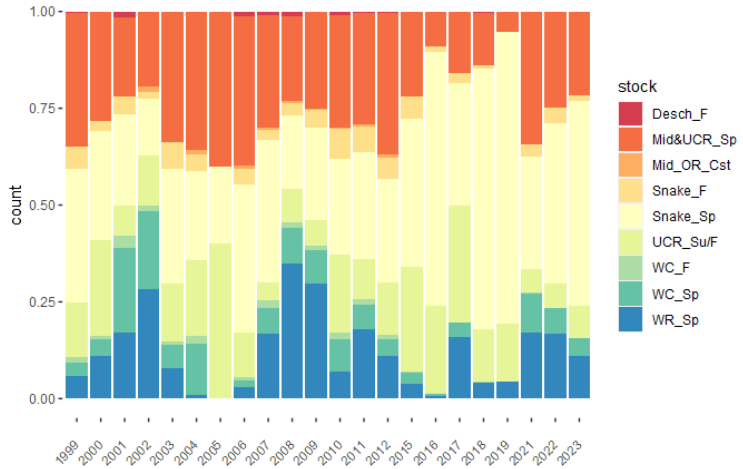
Subyearling Chinook

We catch very few subyearling Chinook in May

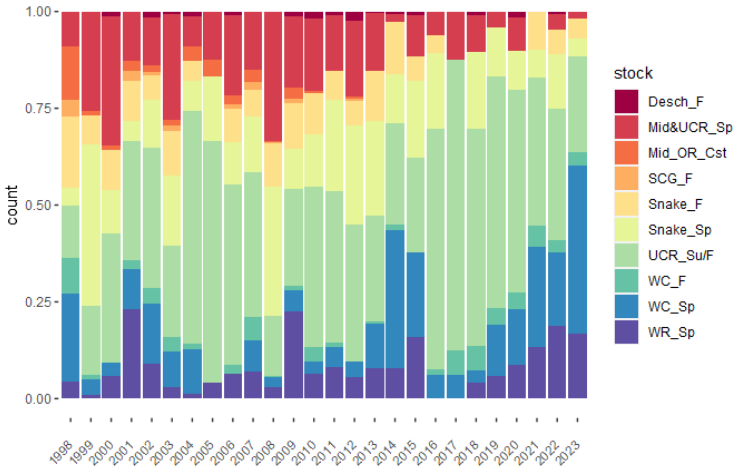


N = 87 out of 3,599

Yearling Chinook



N = 18 out of 5,933



N = 23 out of 3,124

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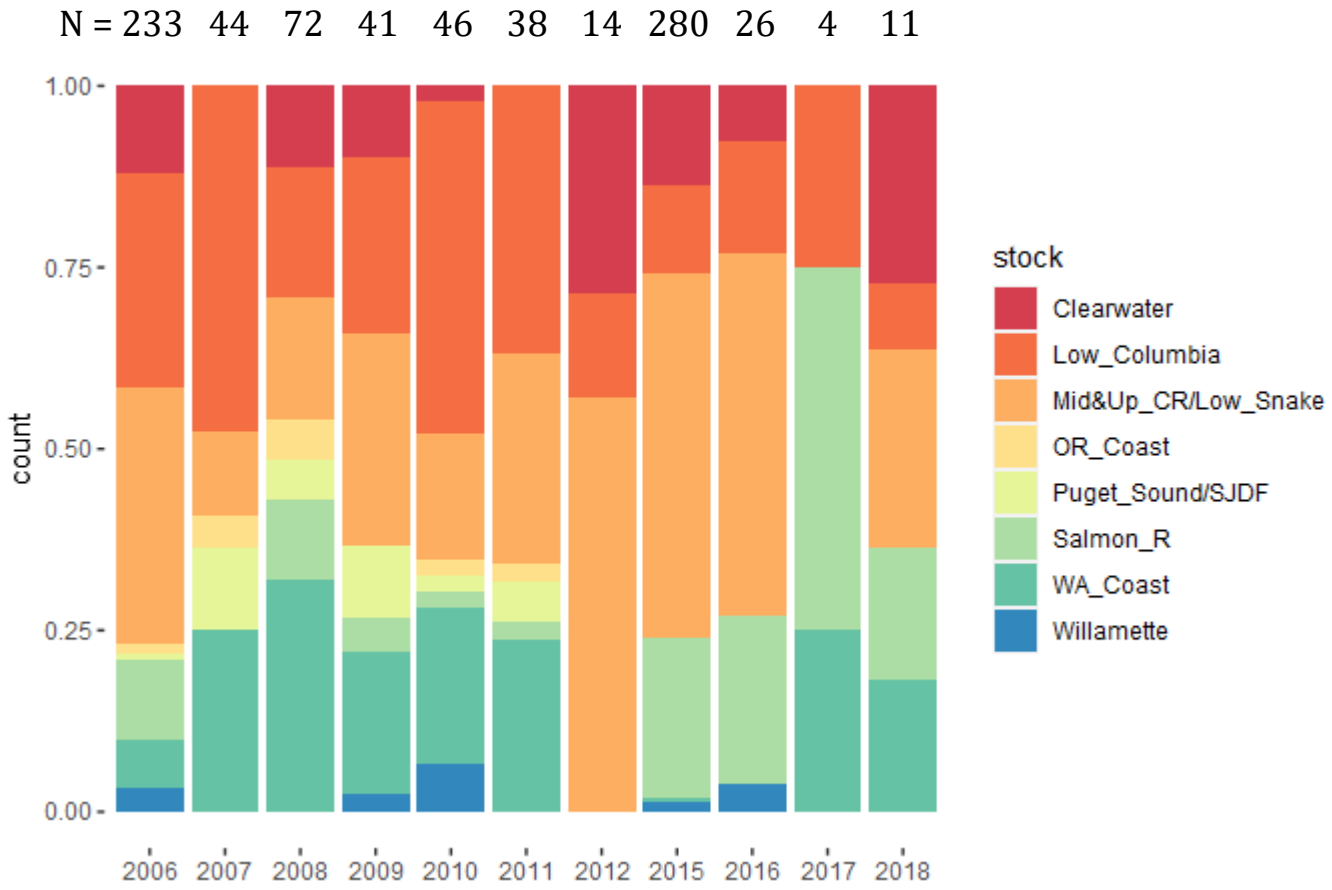
Columbia River Steelhead

All from May
N = 811



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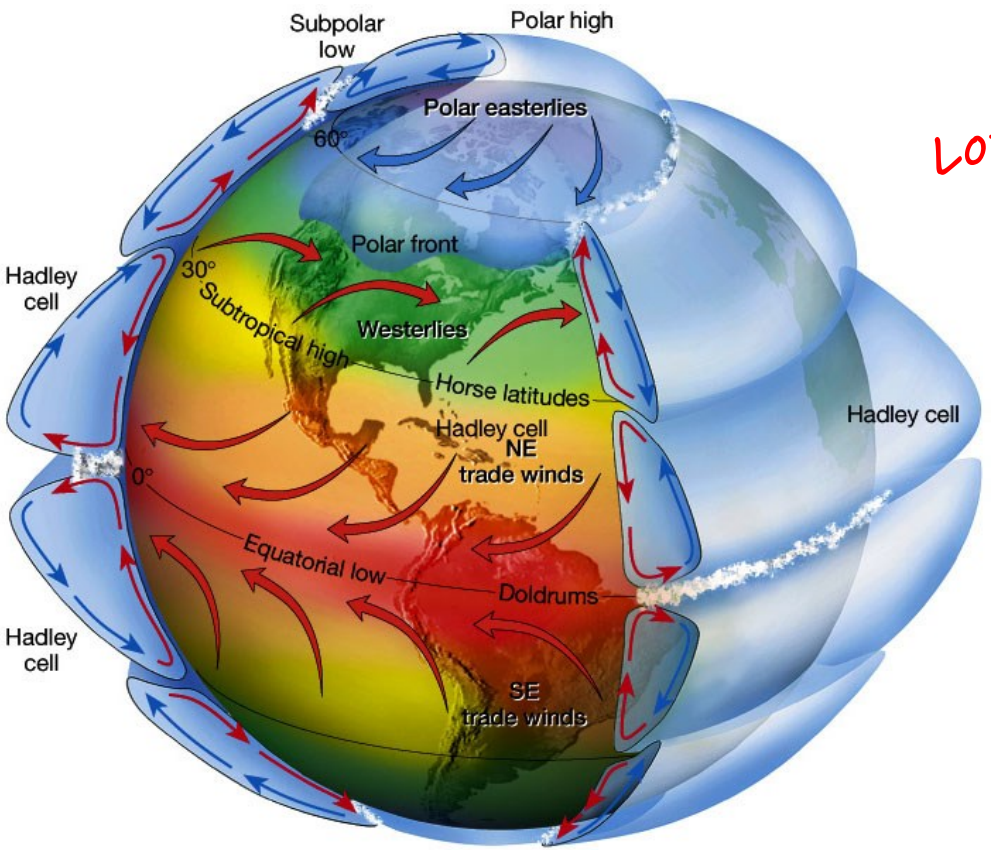
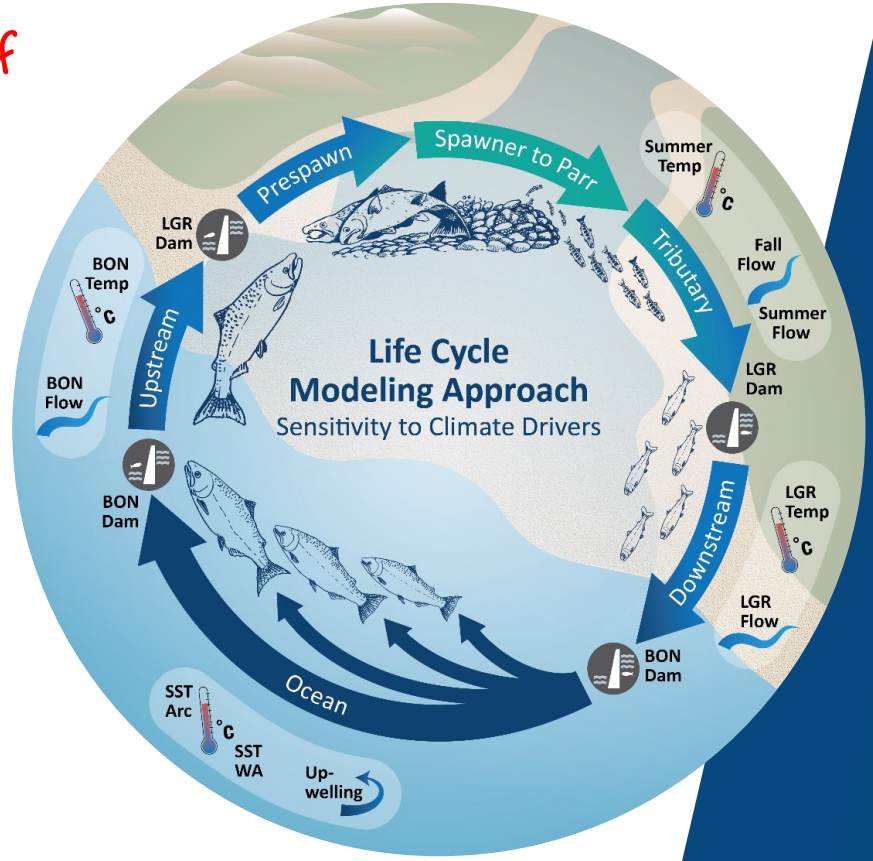
Global Dynamics Shape Local Conditions



Lots of stuff



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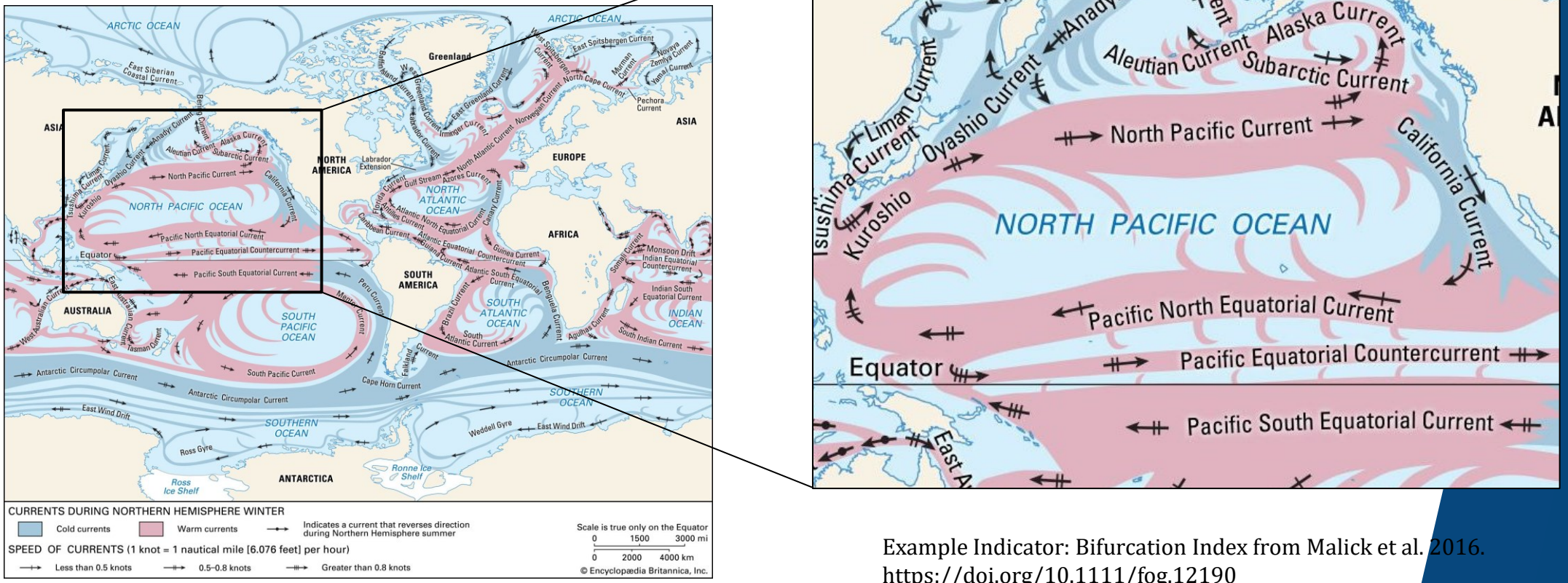
Local Conditions depend on ocean currents



Example Indicator: Bifurcation Index from Malick et al. 2016. https://doi.org/10.1111/fog.12190

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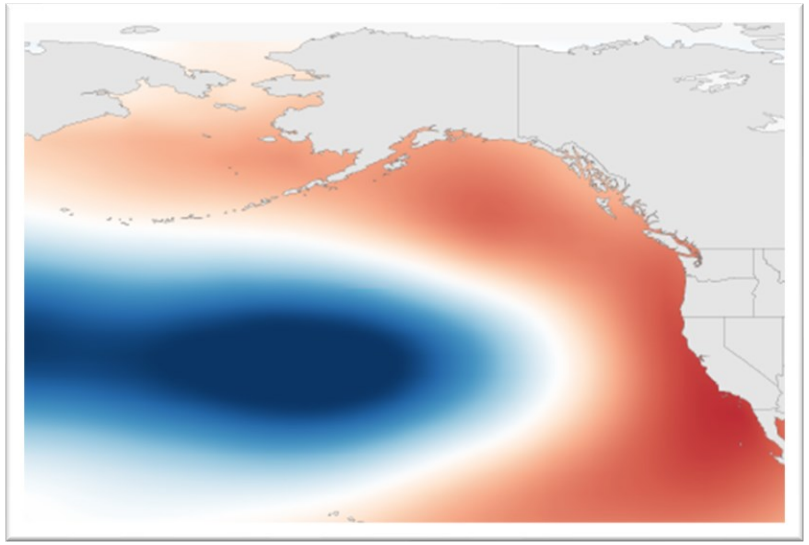
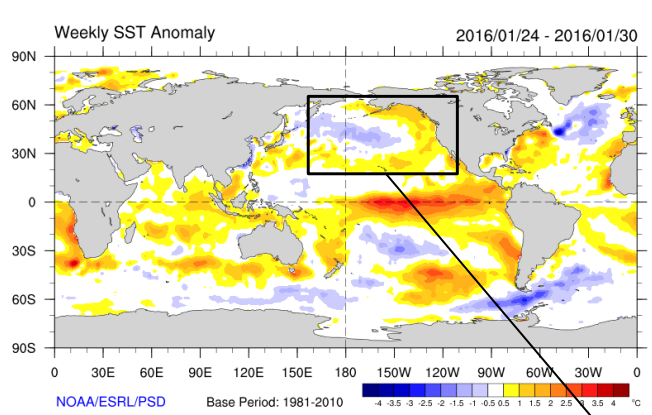
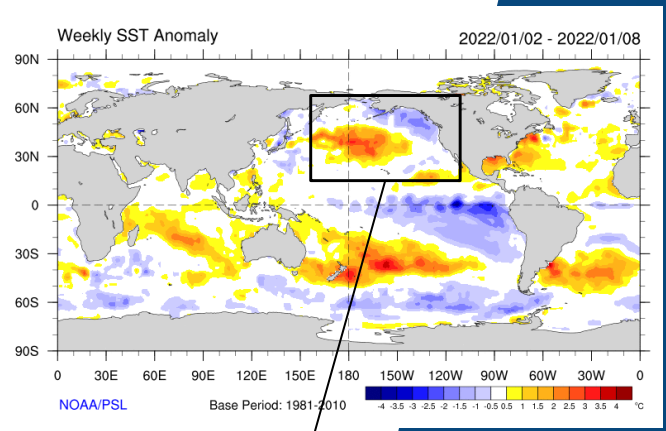
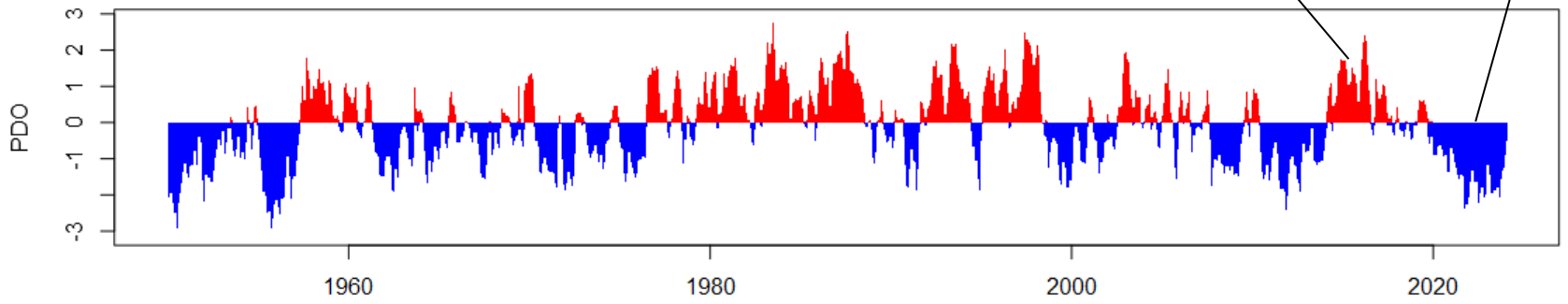
Pacific Decadal Oscillation (PDO)



https://www.fisheries.noaa.gov/insight/ocean-atmosphere-climate-indices







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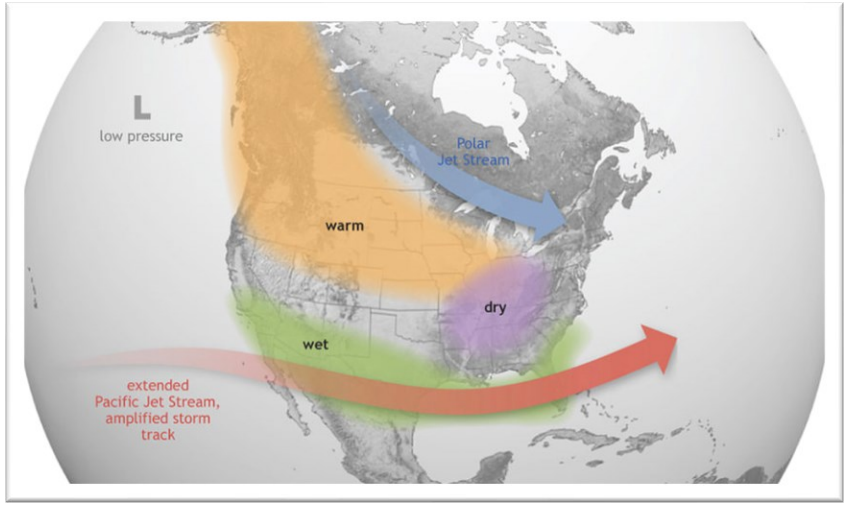
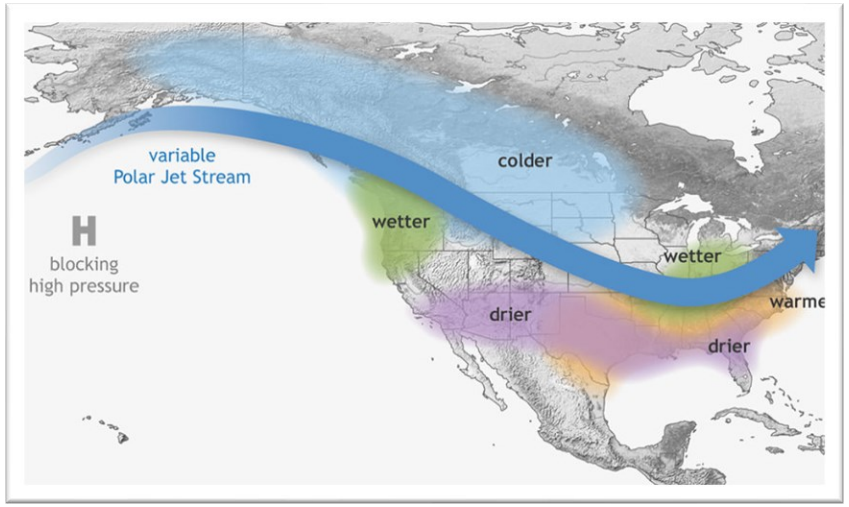
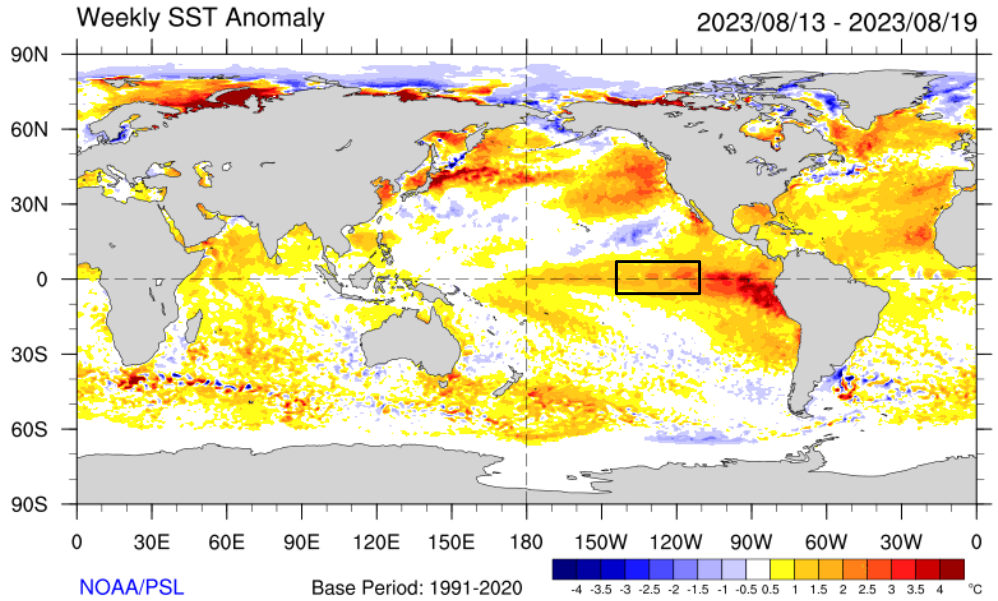
El Niño

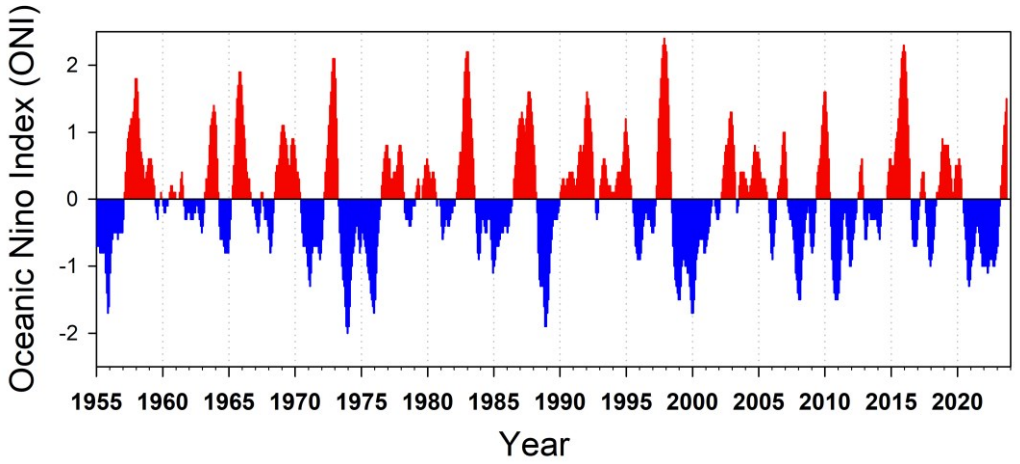
El Niño



La Niña







https://oceanservice.noaa.gov/facts/ninonina.html

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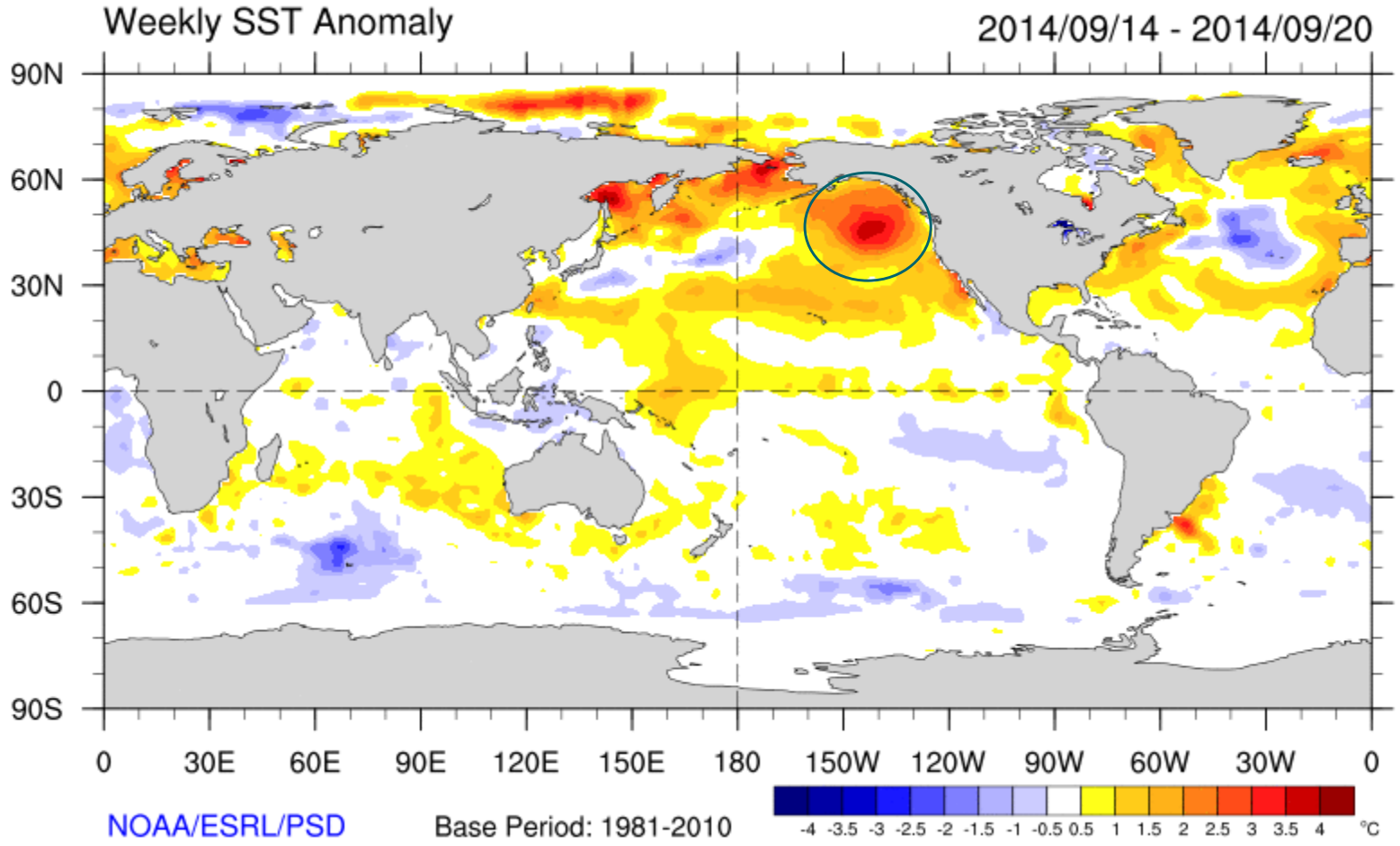
What is a Marine Heat Wave?



* High pressure reduces winter storms, resulting in less mixing with deep, cold water
https://psl.noaa.gov/map/clim/sst.shtml

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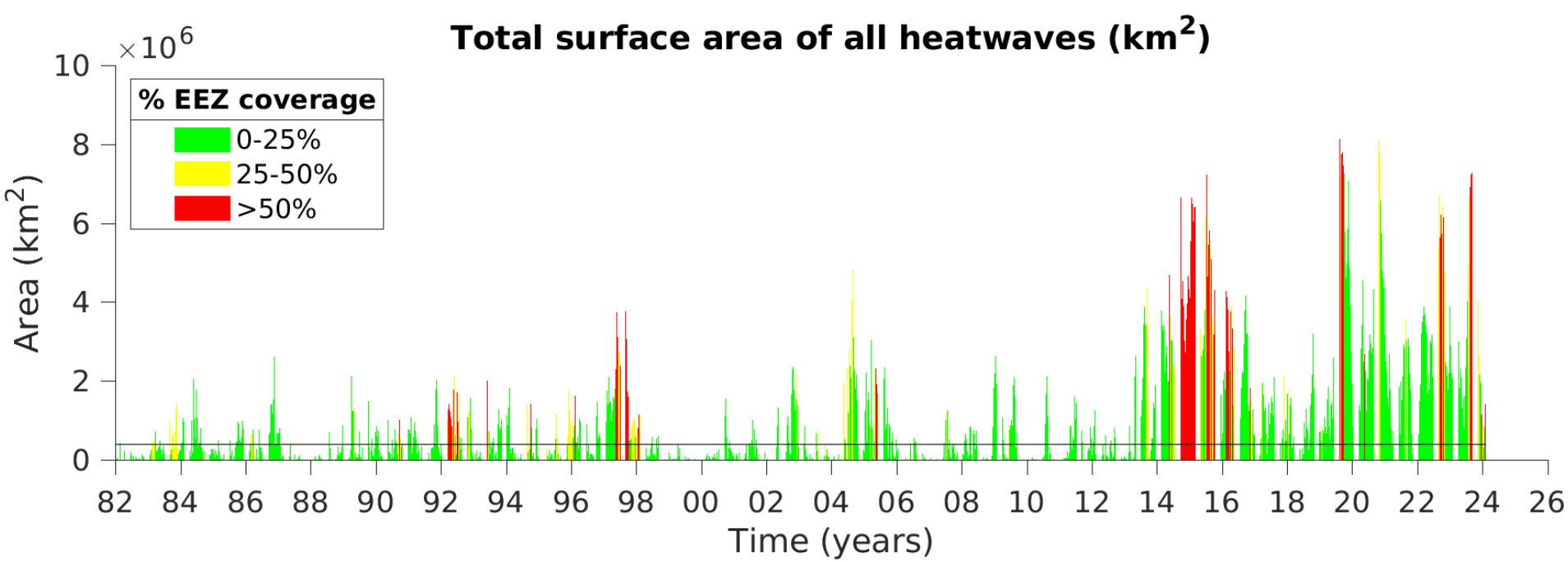
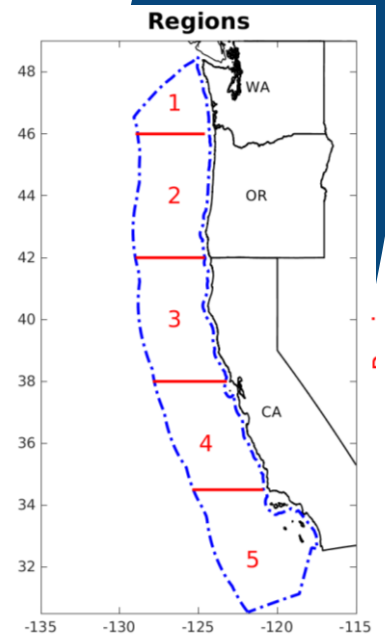
NE Pacific marine heatwaves are increasing





California Current Ecosystem Status Report NOAA
https://www.integratedecosystemassessment.noaa.gov/regions/california-current/california-current-marine-heatwave-tracker-blobtracker

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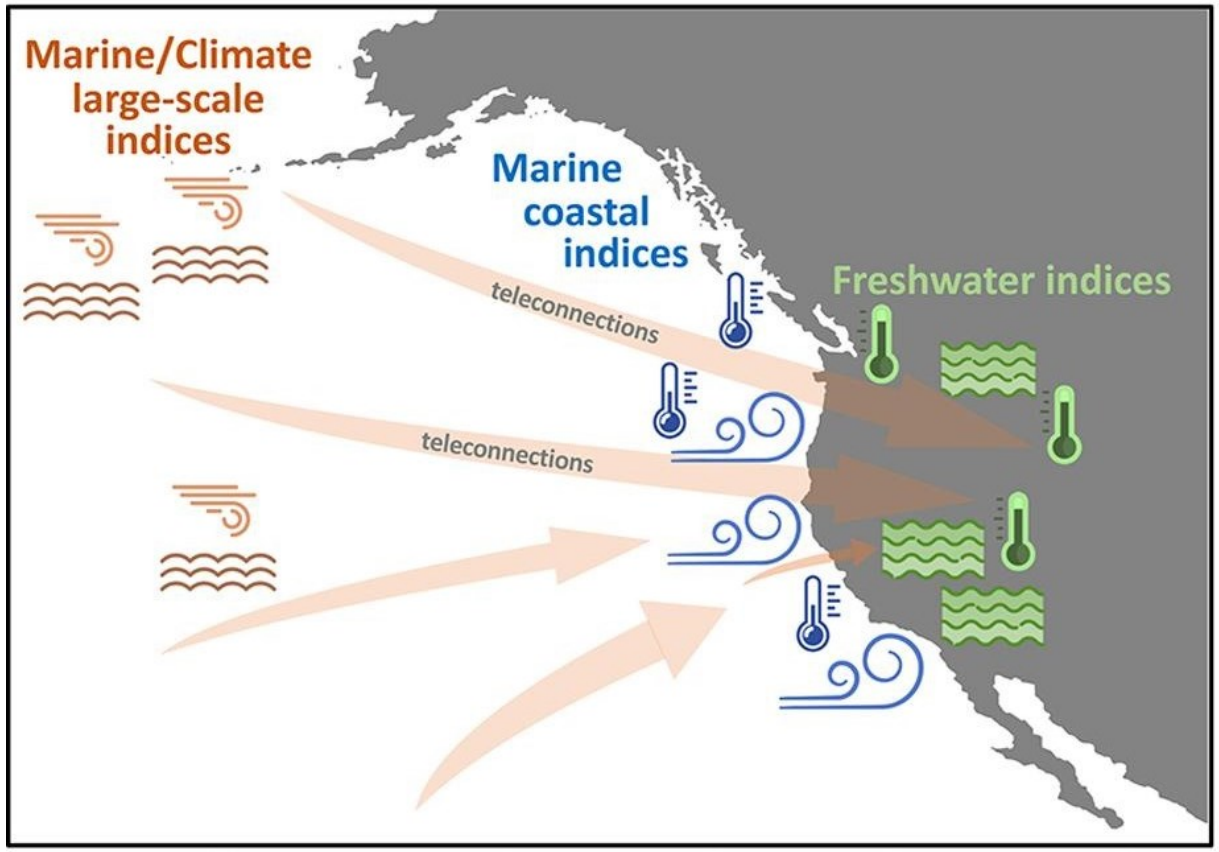
Spatial ‘teleconnections’ are broader than just marine conditions

Types of indices where migratory salmon occur:



Legend:

Climate indices

Sea surface temperature

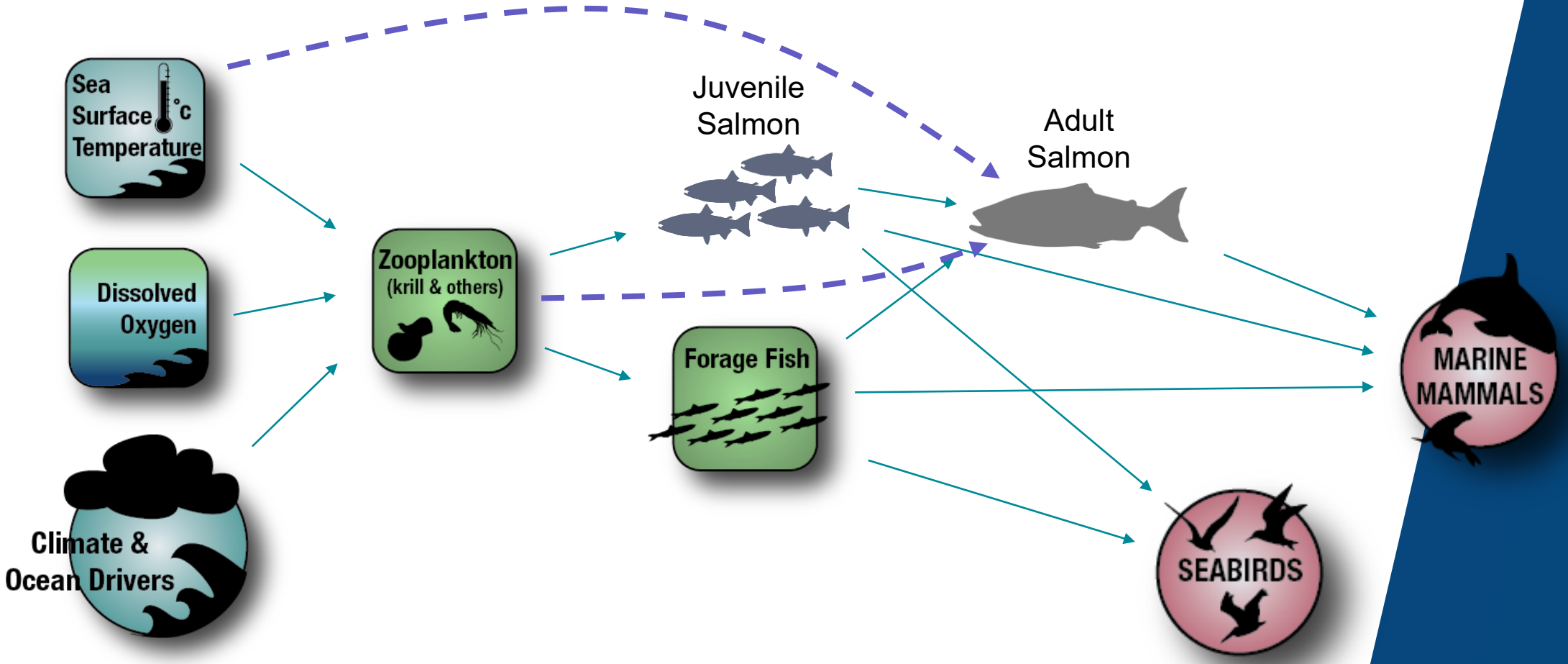
Upwelling indices

Air temperature

River flow indices

Gosselin et al. 2021. https://doi.org/10.1016/j.ecolind.2020.107167

Oversimplified Ocean Dynamics



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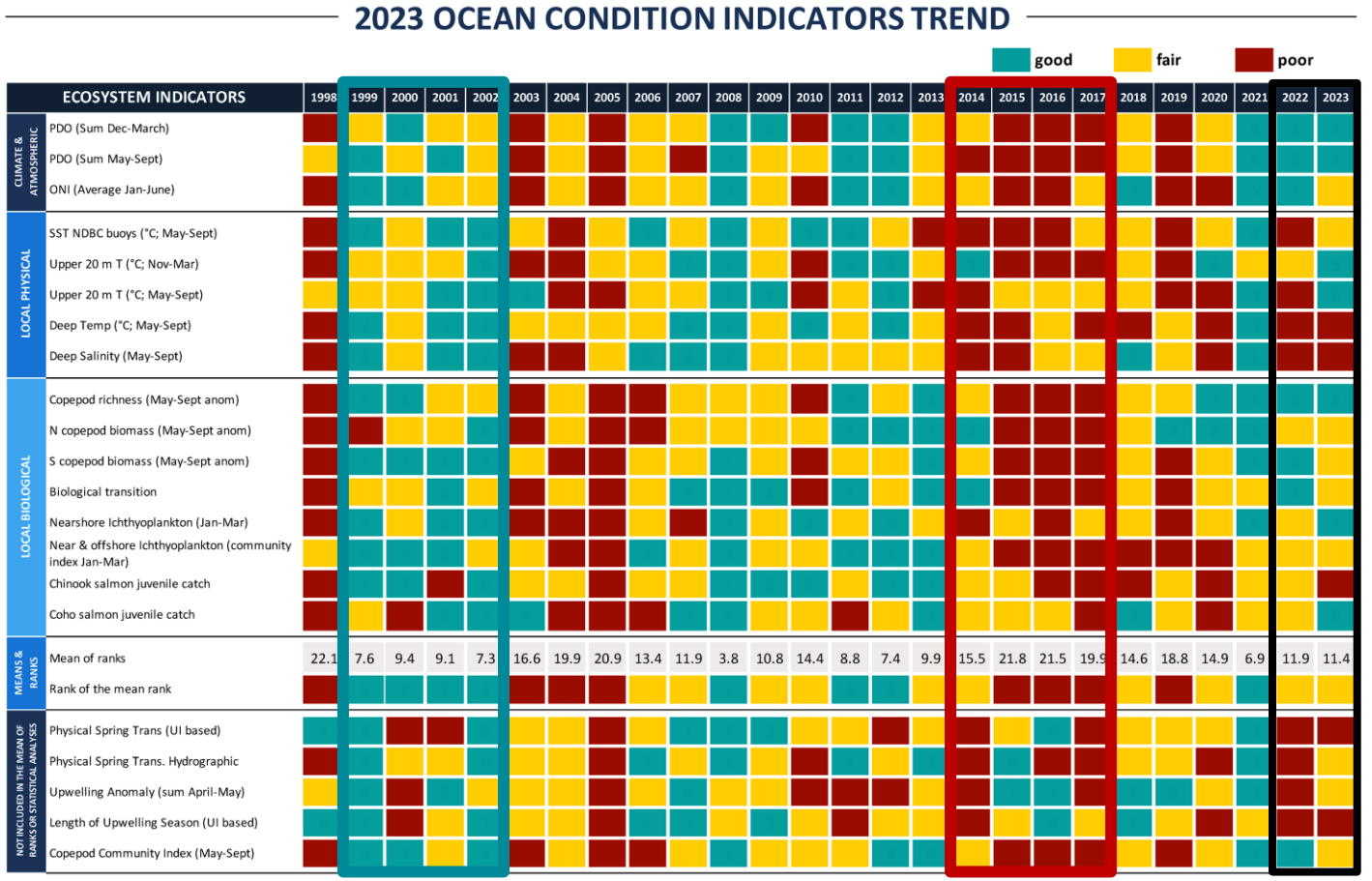
NOAA's 'Stoplight Chart'

https://www.fisheries.noaa.gov/west-coast/science-data/ocean-ecosystem-indicators-pacific-salmon-marine-survival-northern

Basin Scale

Local Physical Conditions

Local Biological Conditions



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Non-stationarity

(you know, cause it wasn't complicated enough already)

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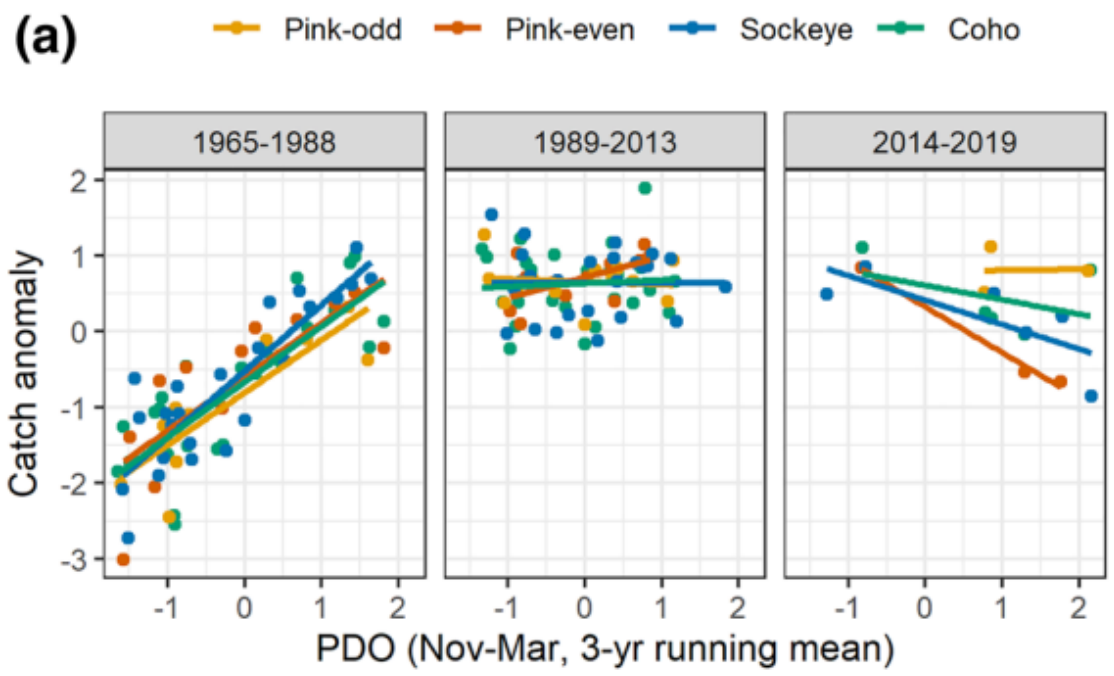
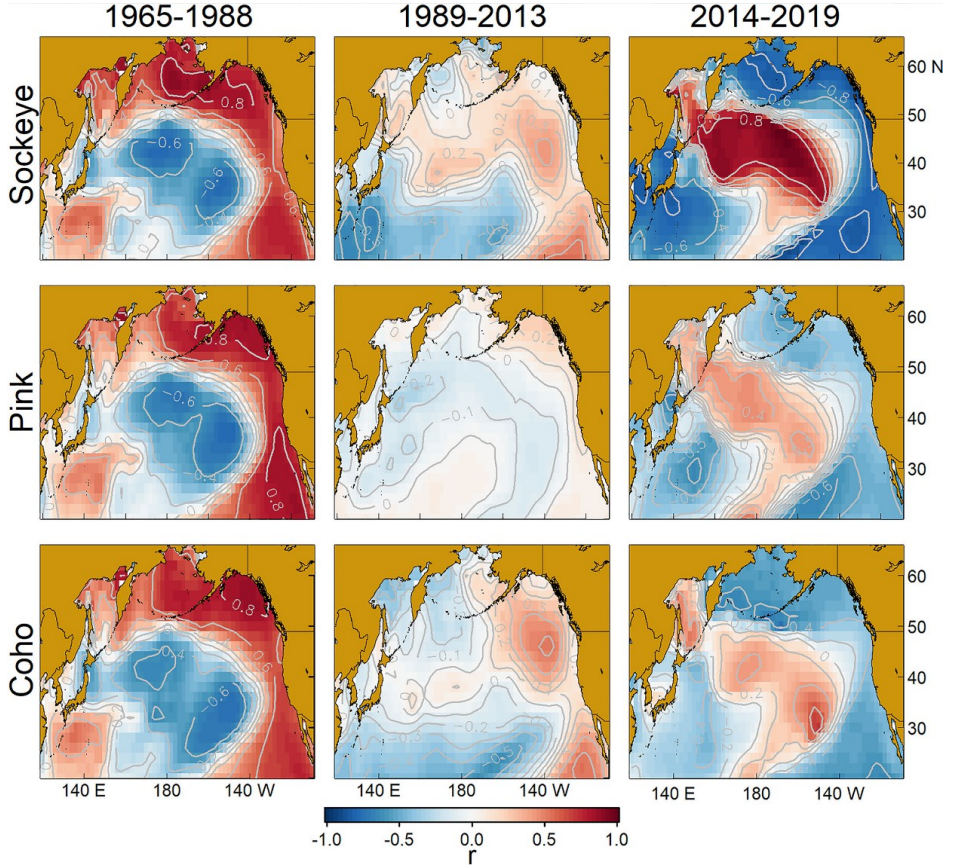
Changing PDO-Salmon Relationships

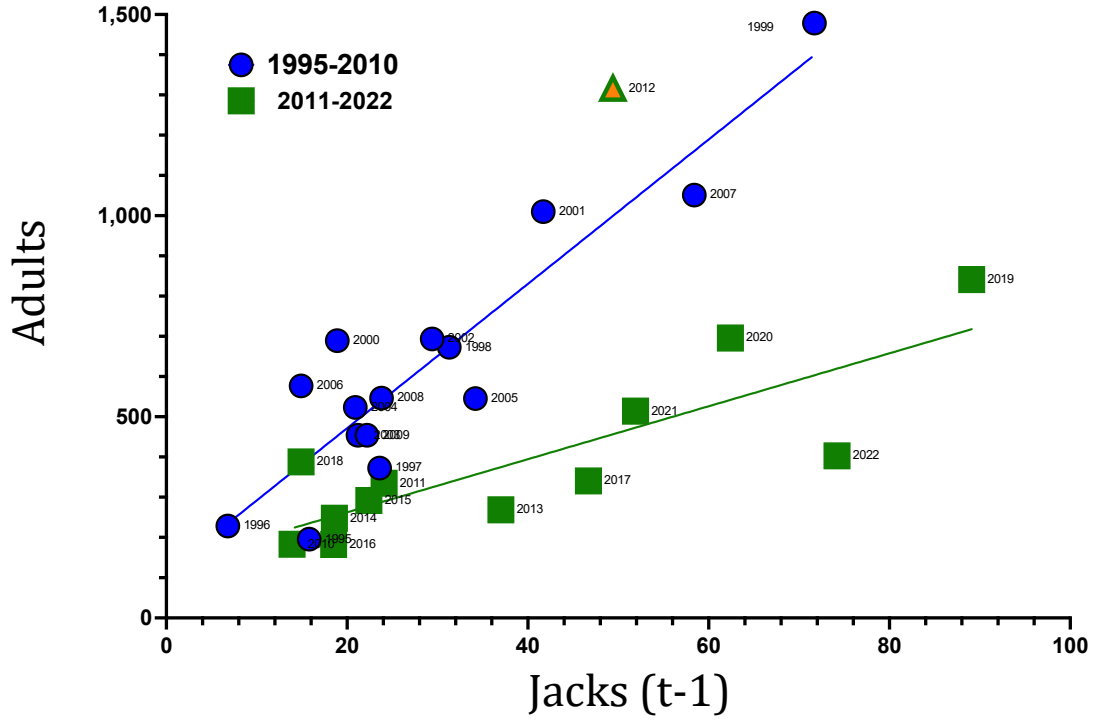




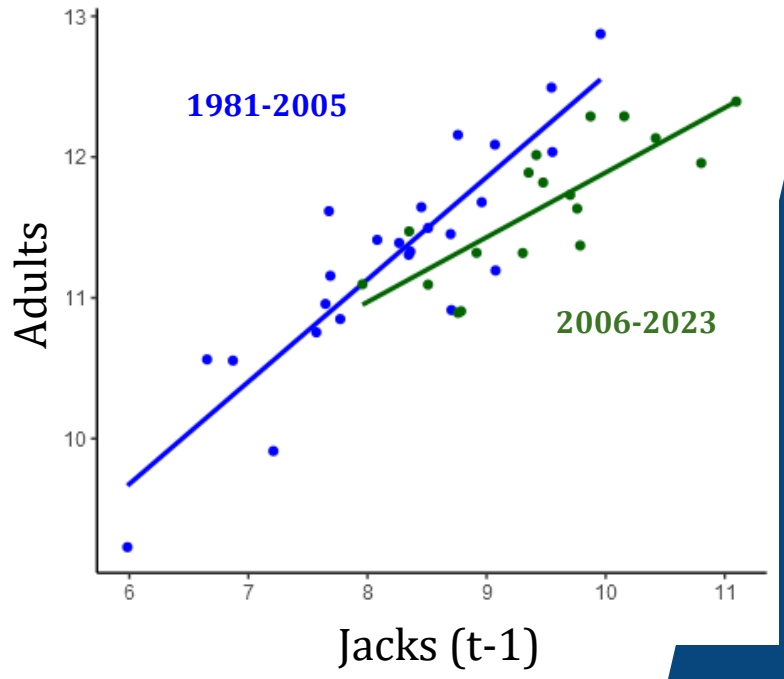
Litzow, M. A., et al. (2020). Quantifying a novel climate through changes in PDO-climate and PDO-salmon relationships. Geophysical Research Letters, 47, e2020GL087972. https://doi. org/10.1029/2020GL087972

Sibling Regressions are not immune

Coho Oregon Production Index - Hatchery



Counts of spring Chinook at Bonneville Dam (in log space)



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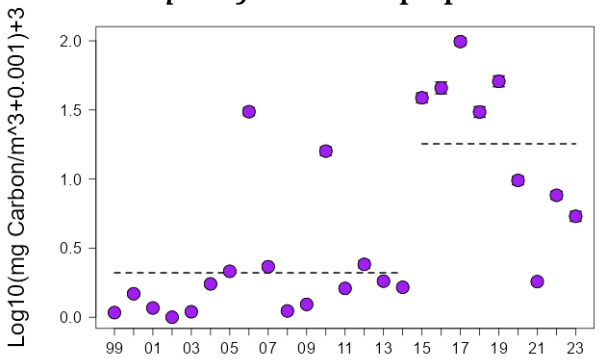
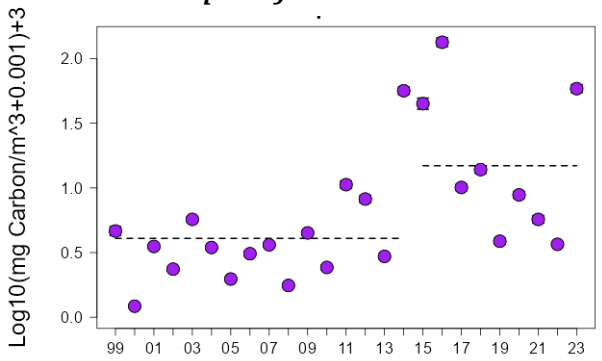
Multiple Plankton Species Increased Since 2014 (from copepods to larval fish)

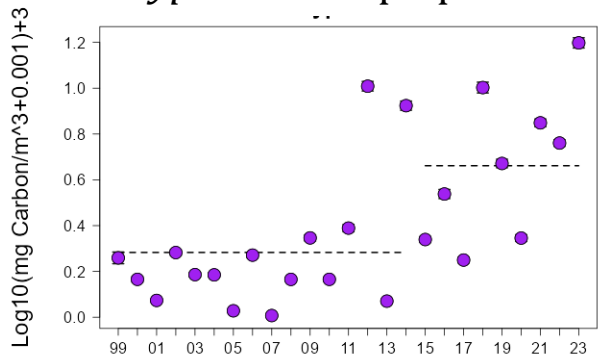
C. pacificus - copepod



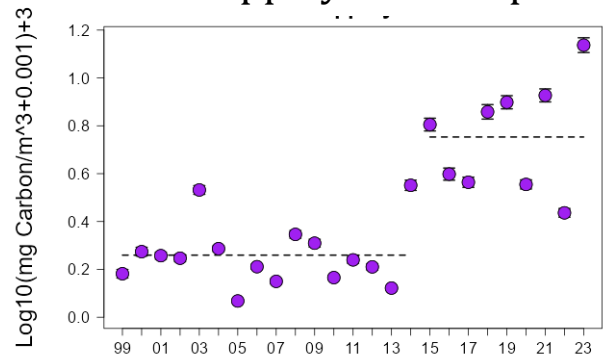
E. pacifica - krill



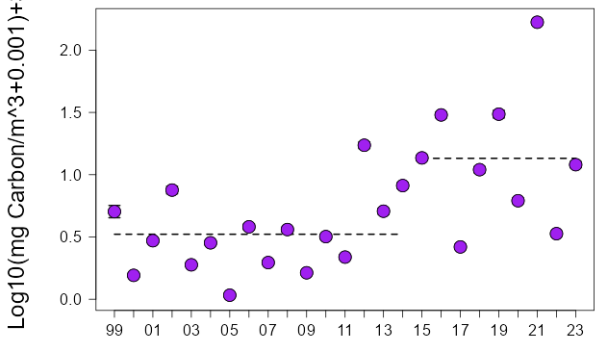
Hyperoche amphipod



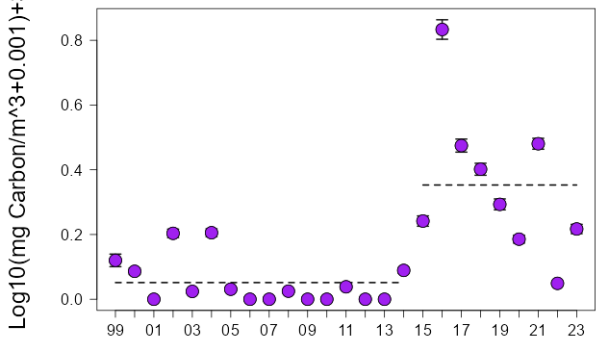
Hippolytid shrimp



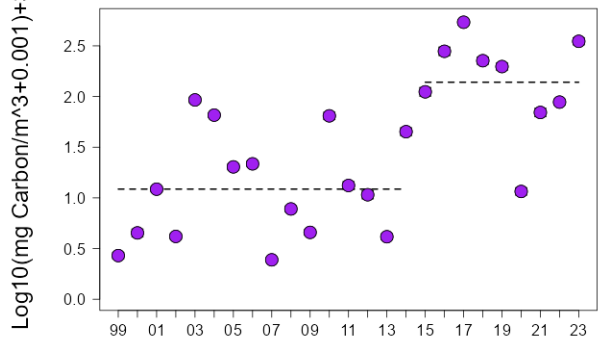
Pygmy/Red rock crab



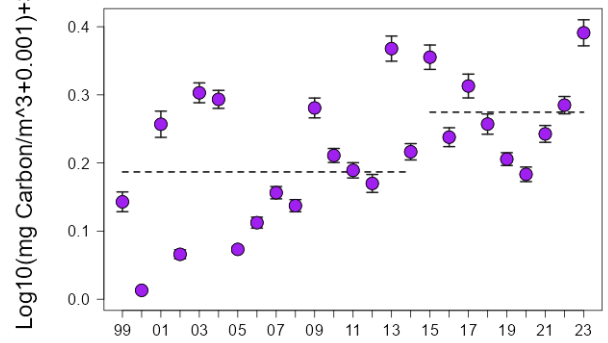
Pacific/Graceful rock crab



Chaetognath



Sebastes spp. – rockfish



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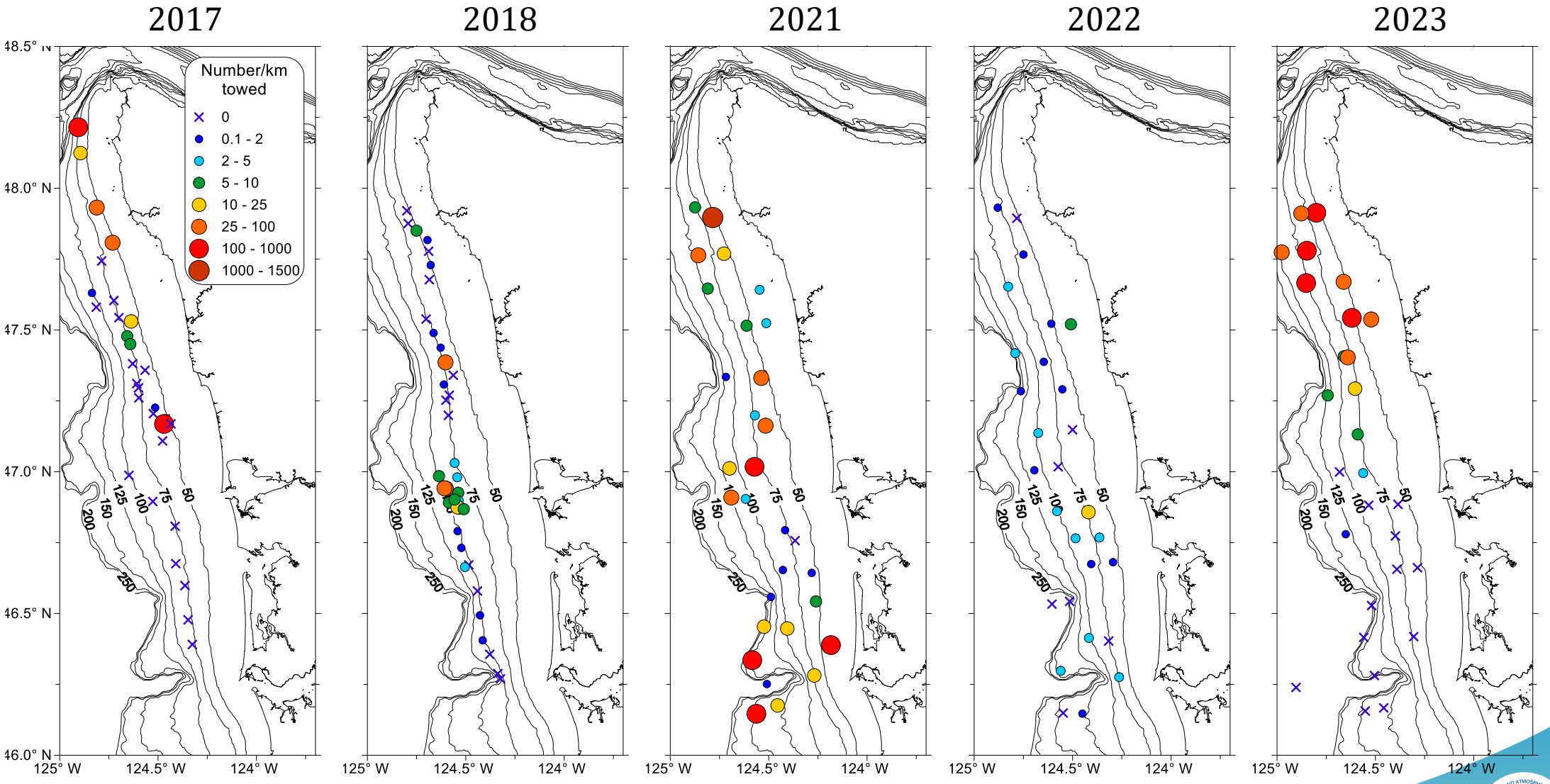
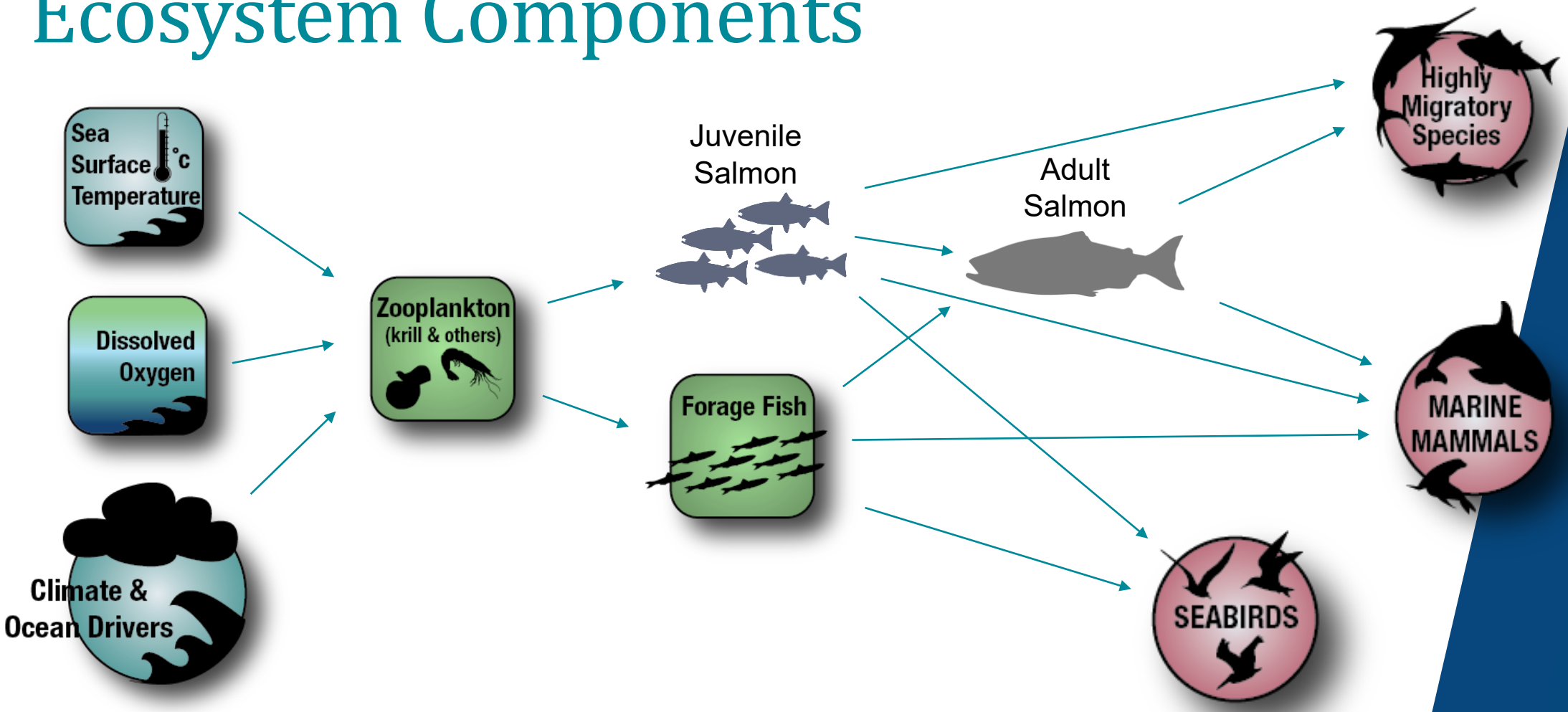
May Prey – Juvenile Pacific sardine



Solution to Complex Dynamics is to Sample All Ecosystem Components



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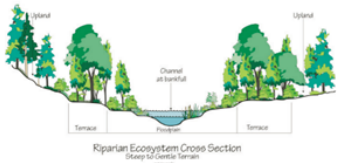
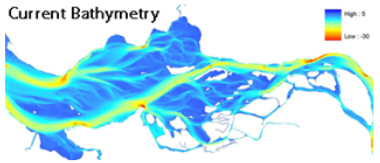
We Have Management Options for Ocean Survival

Riparian and floodplain restoration





Estuary Restoration Act

Fishery Management Plans:
- Coastal Pelagic Species
- Hake
- Salmon

Colony management

Marine Mammal Protection Act
Pinniped Removal Program

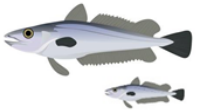
https://www.fisheries.noaa.gov/west-coast/marine-mammal-protection/marine-mammal-protection-act-section-120-pinniped-removal

Smolt body size and timing — Carryover effects

Zooplankton, invertebrates, fish larvae — Prey

Anchovy — Competitors, Prey

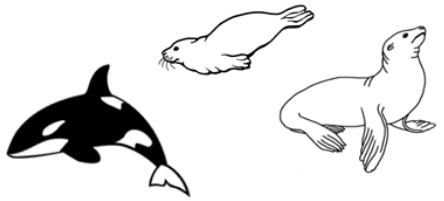
Hake — Predators, Competitors



Other Fisheries — Indirect effects

Seabirds — Predators

Marine mammals



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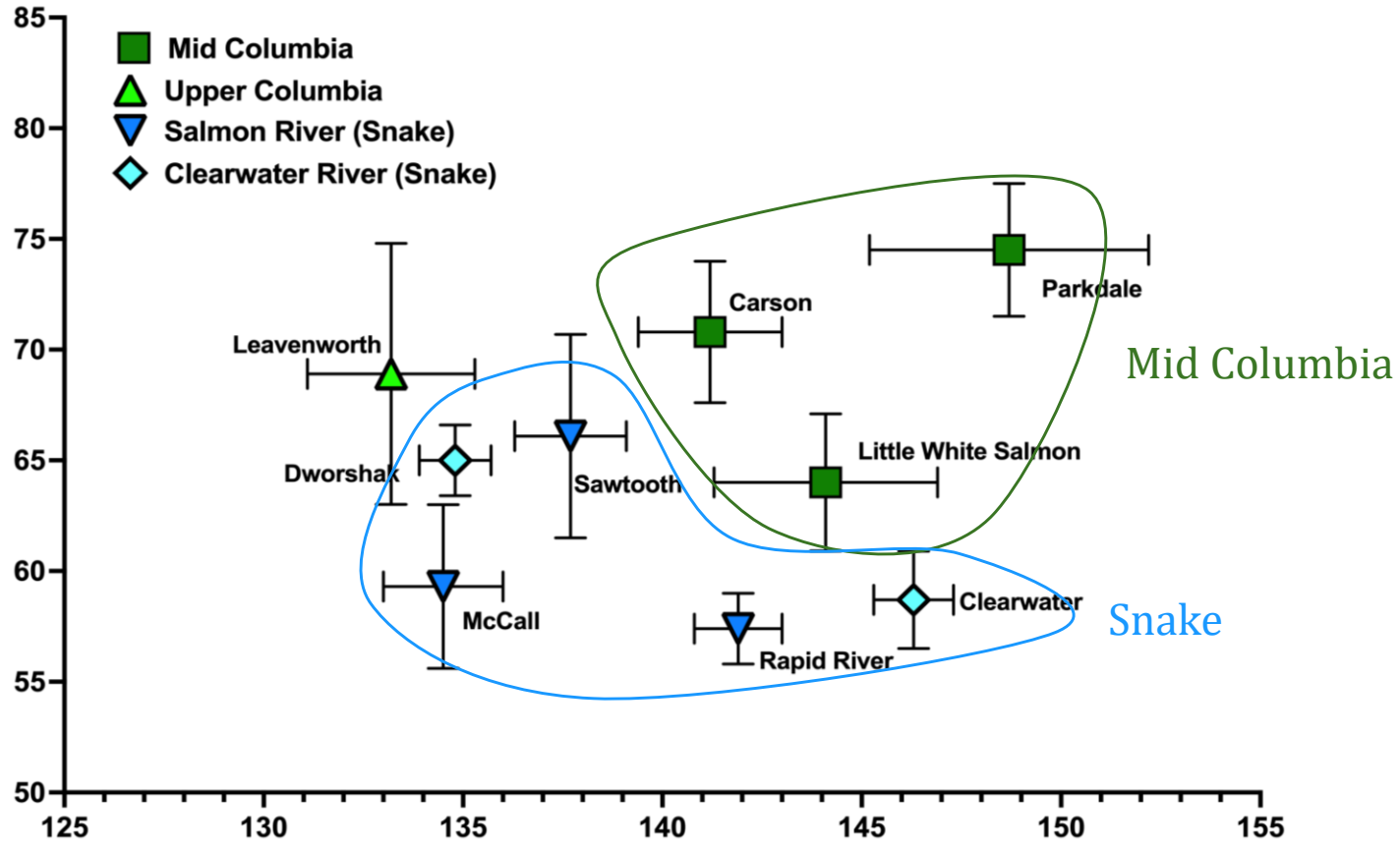
Carryover Effects:

Size and Growth are artifacts from freshwater experiences



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Take Home Messages

1. The Ocean is not homogenous – where and when salmon migrate will determine their ocean experience, growth, and survival
2. The last few years were about average – adult returns this year and next year should be too (generally speaking)
3. We *can* influence marine survival; even freshwater management can affect marine survival

Questions?

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