Salmon in the Ocean:

We'll take the good with the bad

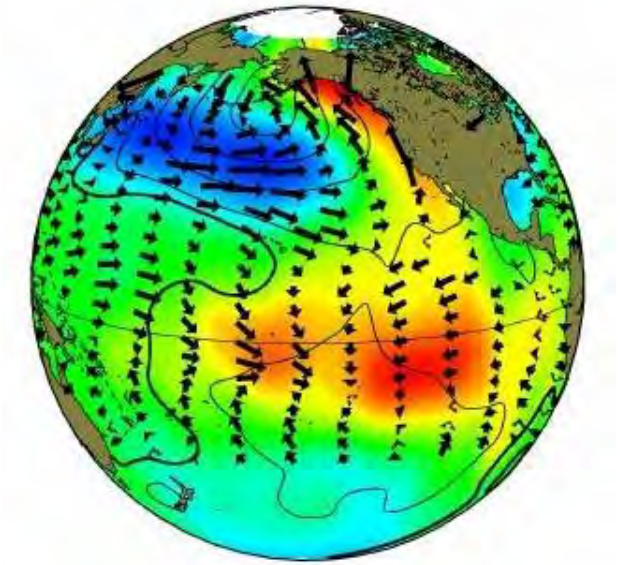
Northwest Power and Conservation Council Meeting
March 10th, 2021

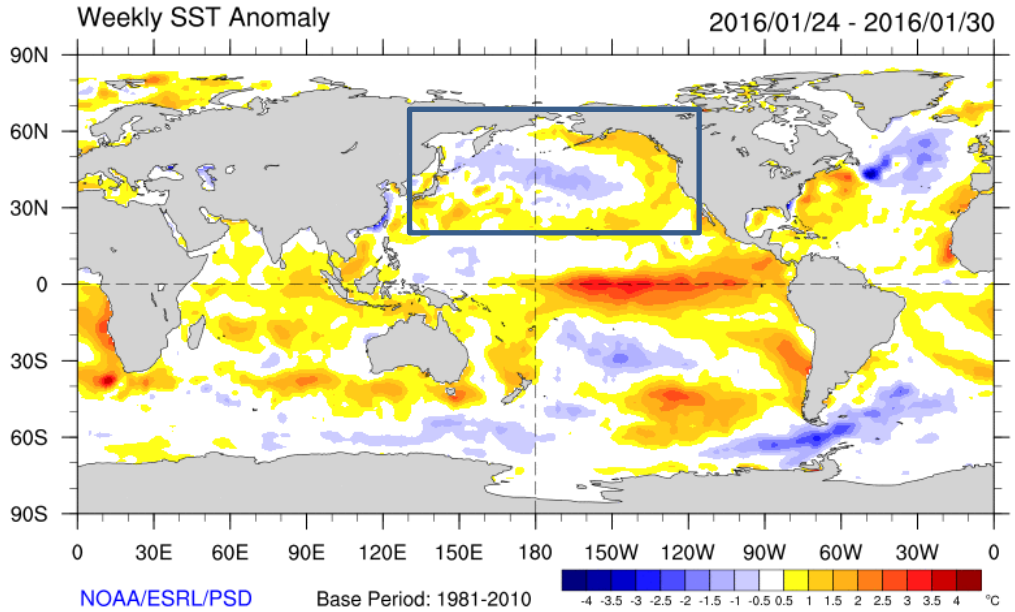
Presenter: Brian Burke
NOAA Fisheries, NWFSC

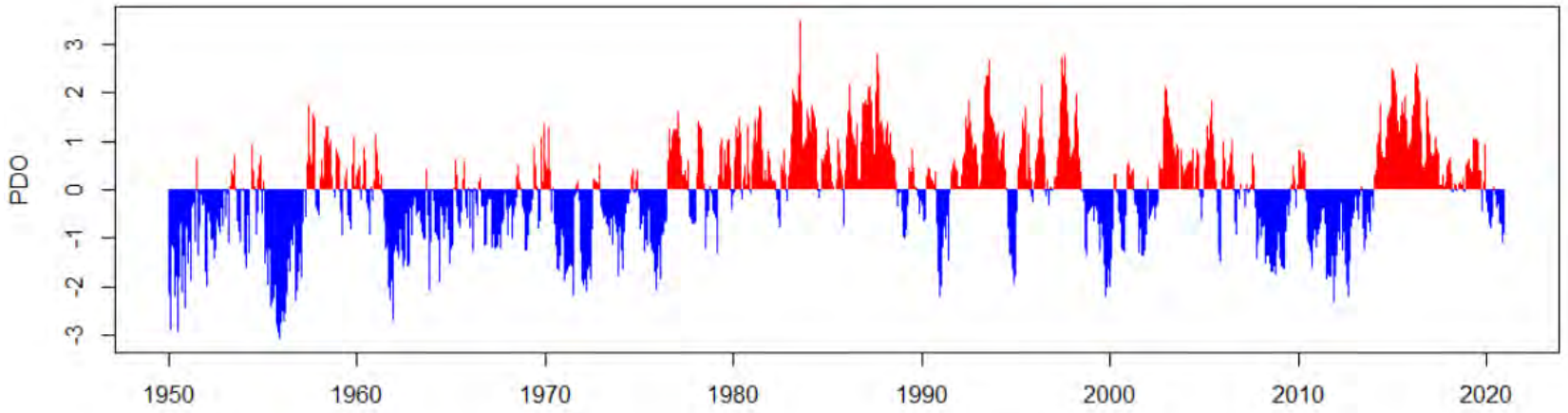
Supported by:

1. Ocean Conditions
2. Monitoring and Research
3. Modeling Efforts

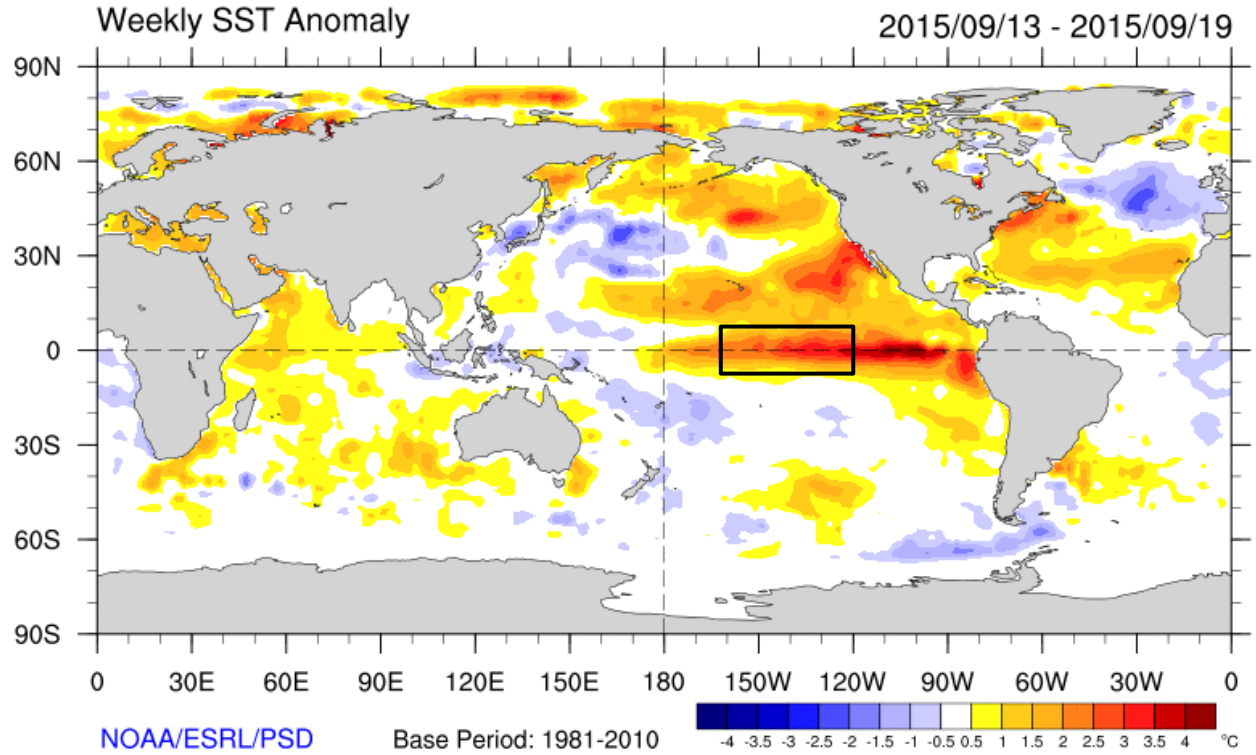
Pacific Decadal Oscillation (PDO)

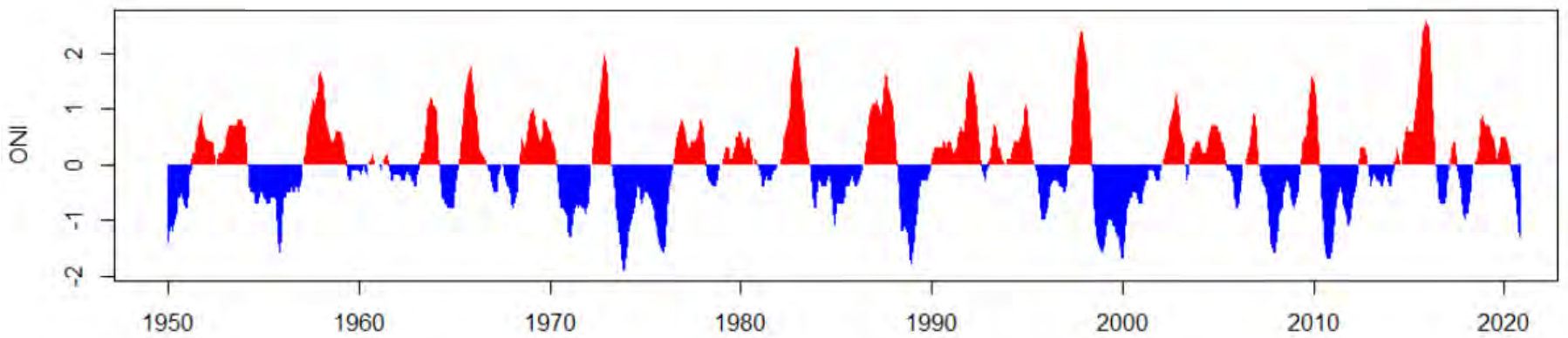




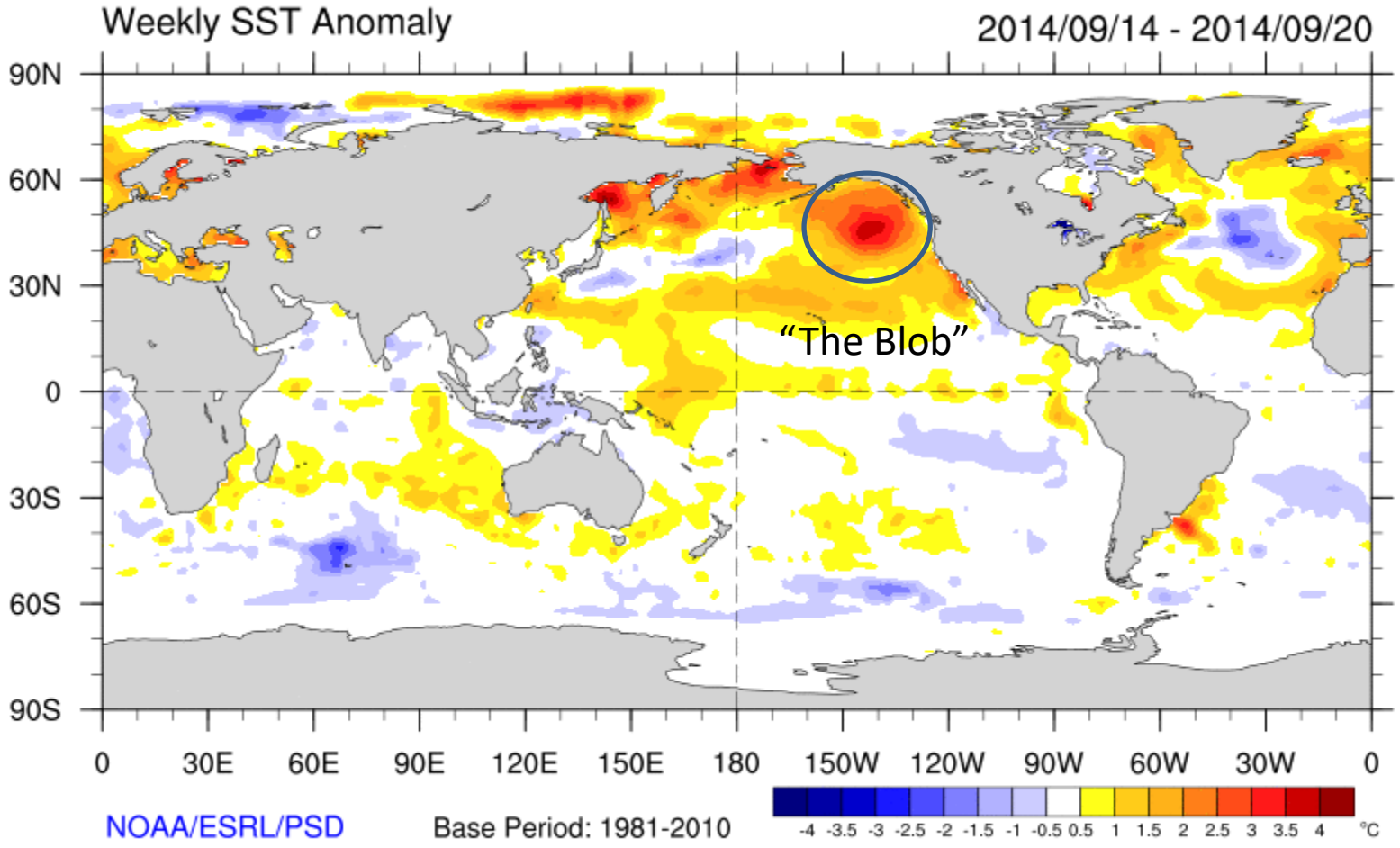


El Niño


Weekly SST Anomaly
2015/09/13 - 2015/09/19
90N
60N
30N
0
30S
60S
90S
0
30E
60E
90E
120E
150E
180
150W
120W
90W
60W
30W
0
NOAA/ESRL/PSD
Base Period: 1981-2010
-4 -3.5 -3 -2.5 -2 -1.5 -1 -0.5 0.5 1 1.5 2 2.5 3 3.5 4
°C


ONI
2
1
0
-1
-2
1950
1960
1970
1980
1990
2000
2010
2020

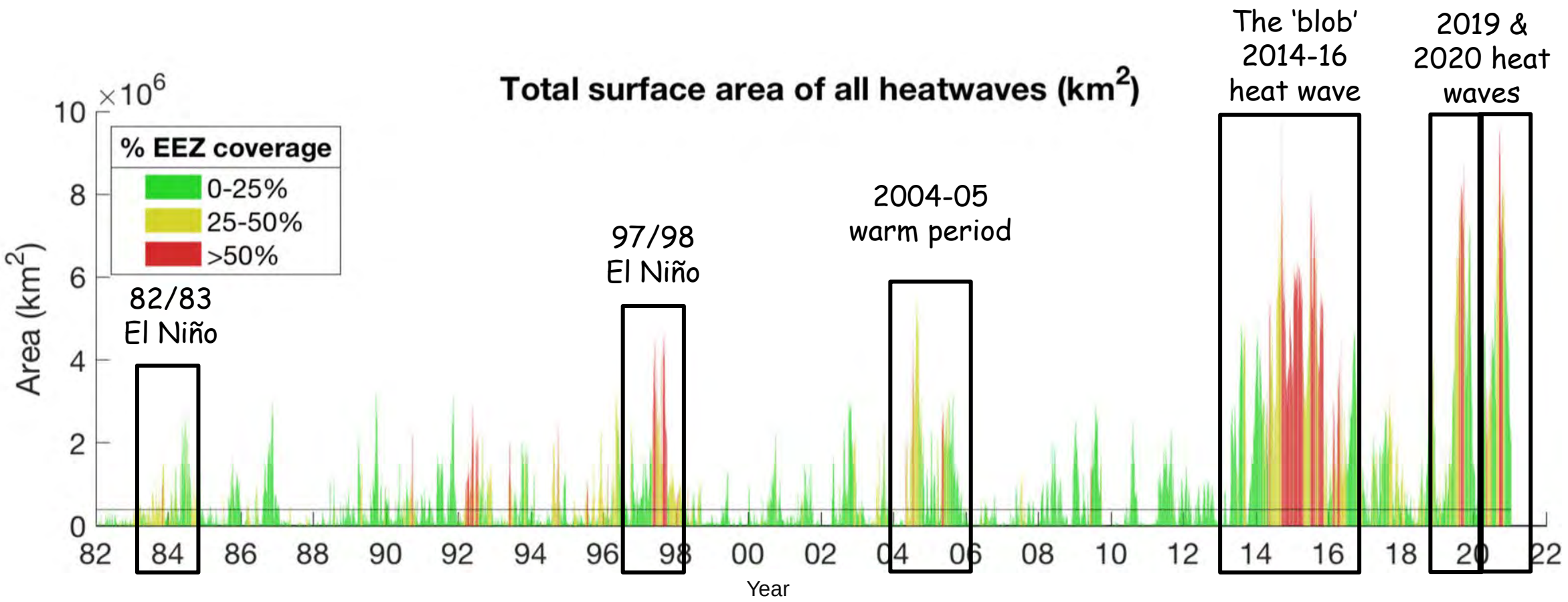
Marine Heat Wave



* High pressure reduces winter storms, resulting in less mixing with deep, cold water

https://psl.noaa.gov/map/clim/sst.shtml

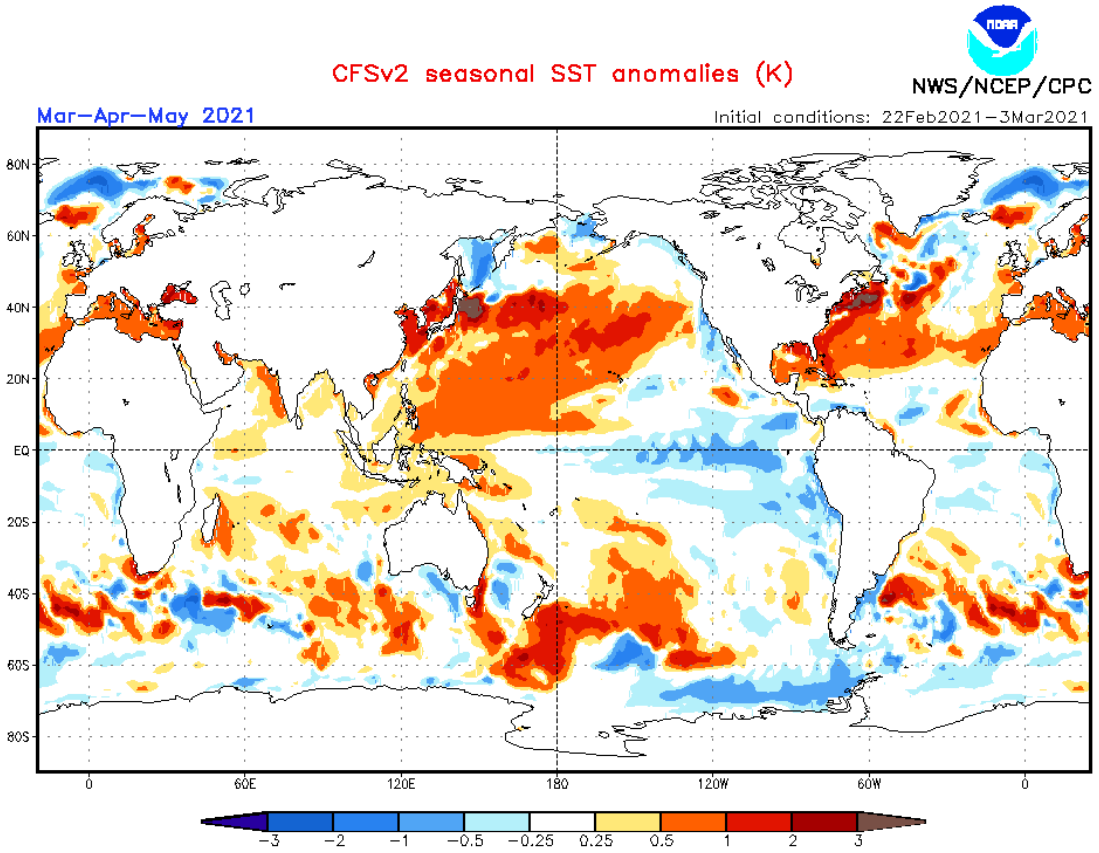
NE Pacific marine heatwaves are increasing



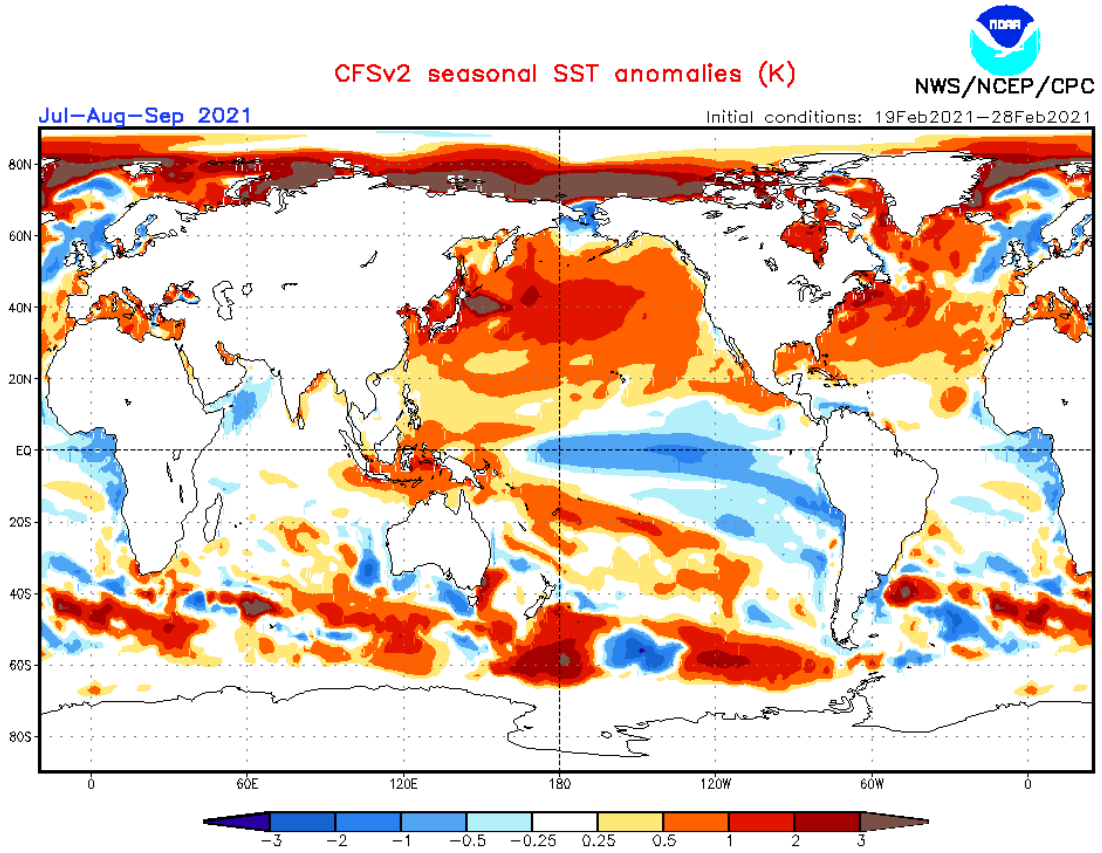
2020-21 California Current Ecosystem Status Report
NOAA California Current IEA Team

We are expecting another Marine Heat Wave this year

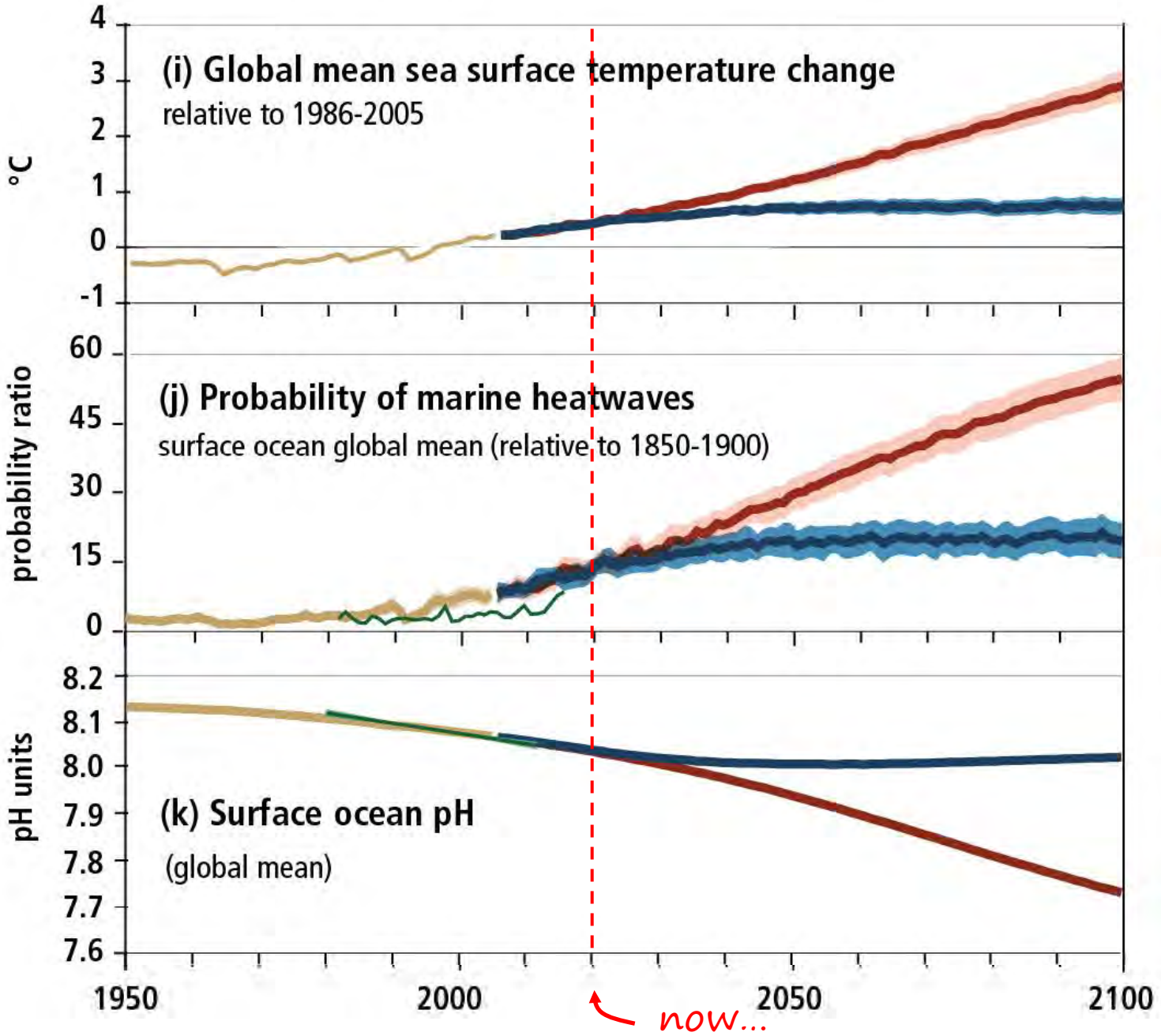
Spring 2021



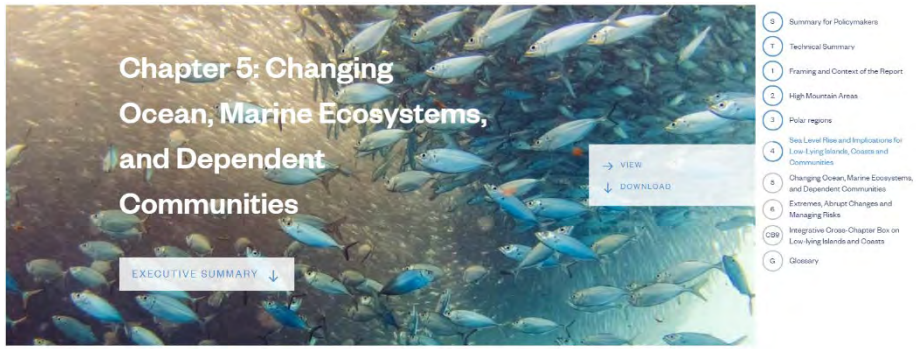
Summer 2021



https://www.cpc.ncep.noaa.gov/products/CFSv2/CFSv2seasonal.shtml



Observed
Modelled historical
projected RCP8.5
projected RCP2.6

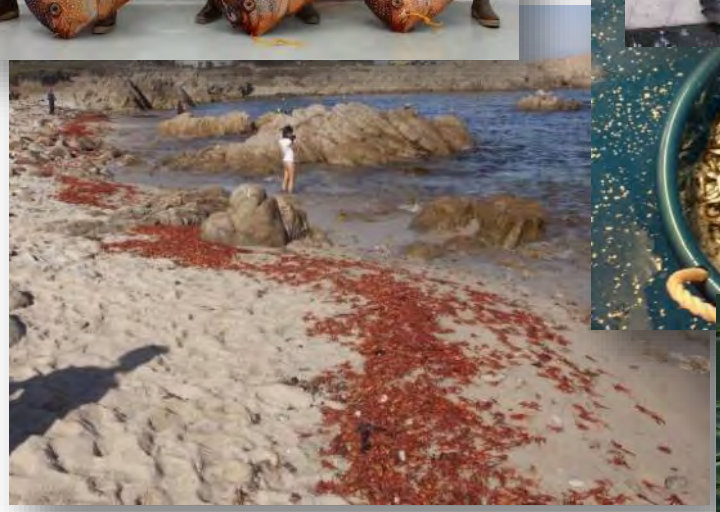


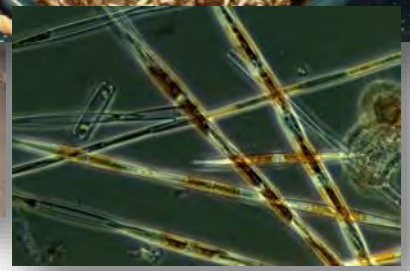
IPCC 2019. The Ocean and Cryosphere in a Changing Climate, Fig SPM.1

Biological Responses

Range Expansions, Lack of Food, Disease

Domoic acid closes crab and clam fisheries, AK-CA



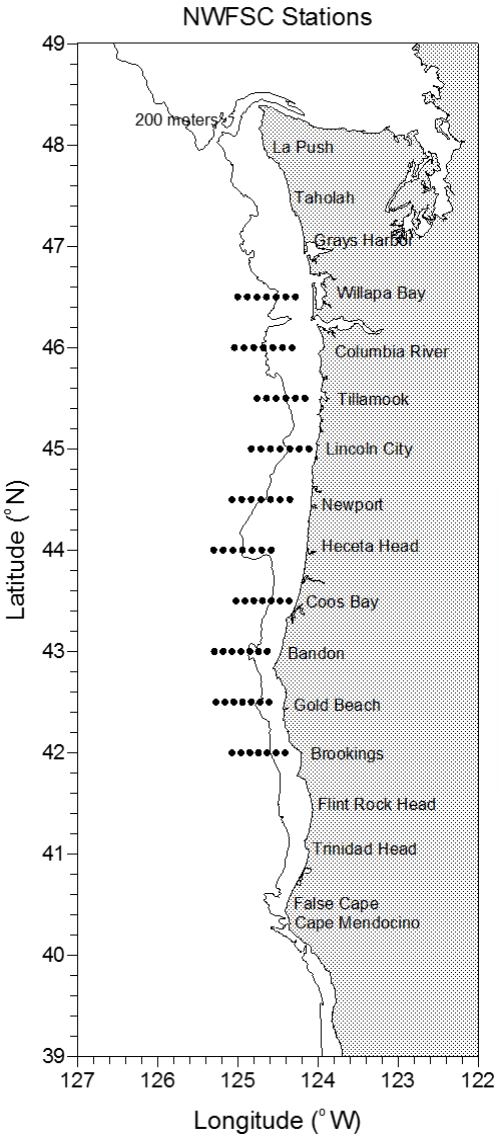


1. Ocean Conditions

2. Monitoring and Research

3. Modeling Efforts

1. Newport Hydrographic Line and Northern California Current Survey



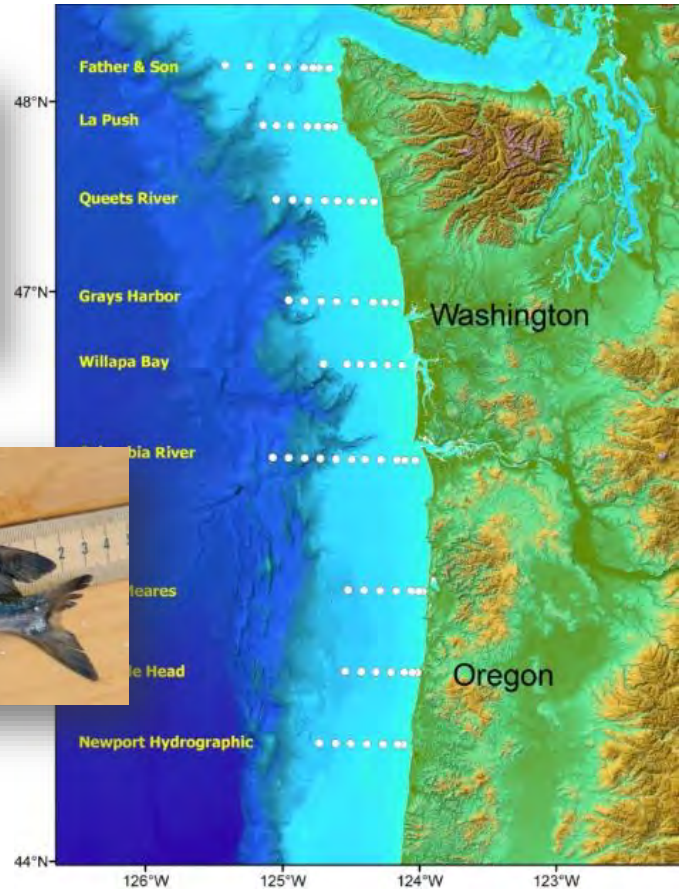
NH Line: Sampled biweekly for 25 years (1996 – present); CTD, nutrients, chl-*a*, phytoplankton and HABs, zooplankton, ichthyoplankton

Pre-recruit: May-June (2011, 2013-2019); night trawls at 30 m depth, plankton, CTD, acoustic, seabird and mammal surveys

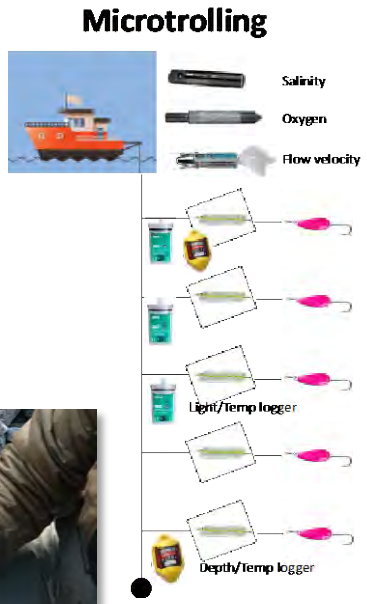
NCC Survey: Seasonal (2-4 times per year); plankton, CTD, acoustic, seabird and mammal surveys

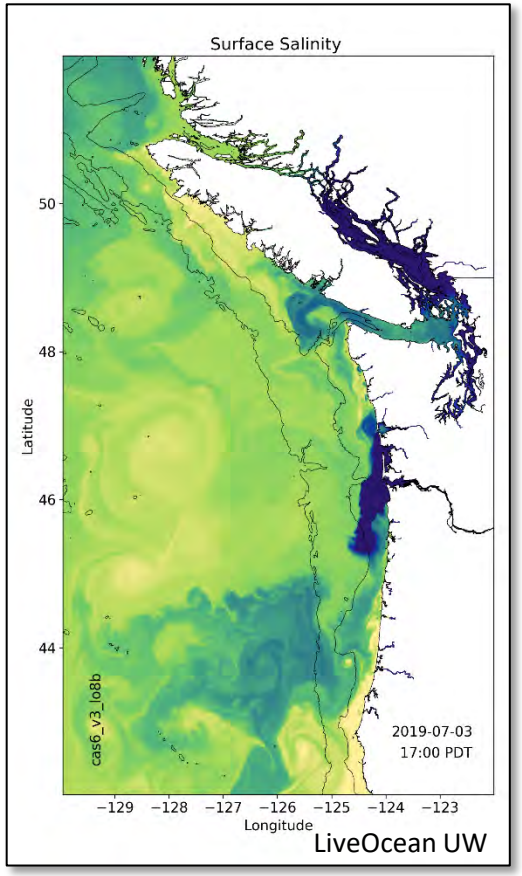
2. Juvenile Salmon and Ocean Ecosystem Survey (JSOES)

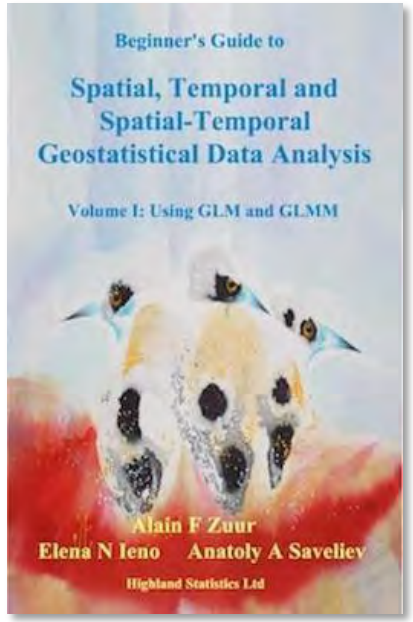
- May (2006 – 2012, 2015 - present)
- June (1998 – present)
- September (1998 – 2012, 2015)



3. SOBaD Advanced Technologies and Emerging Tools

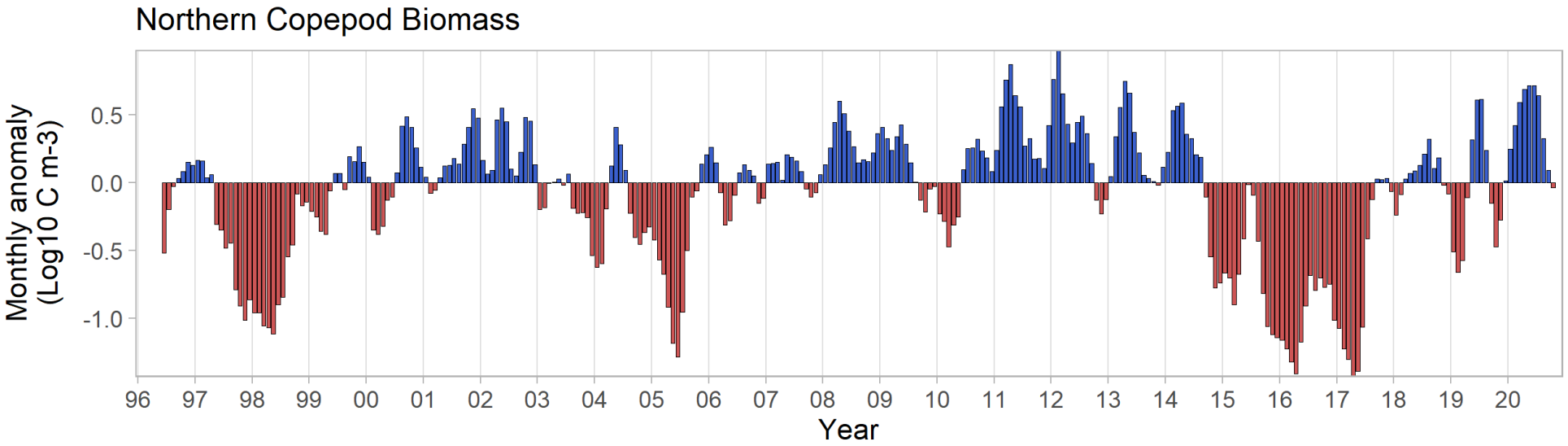


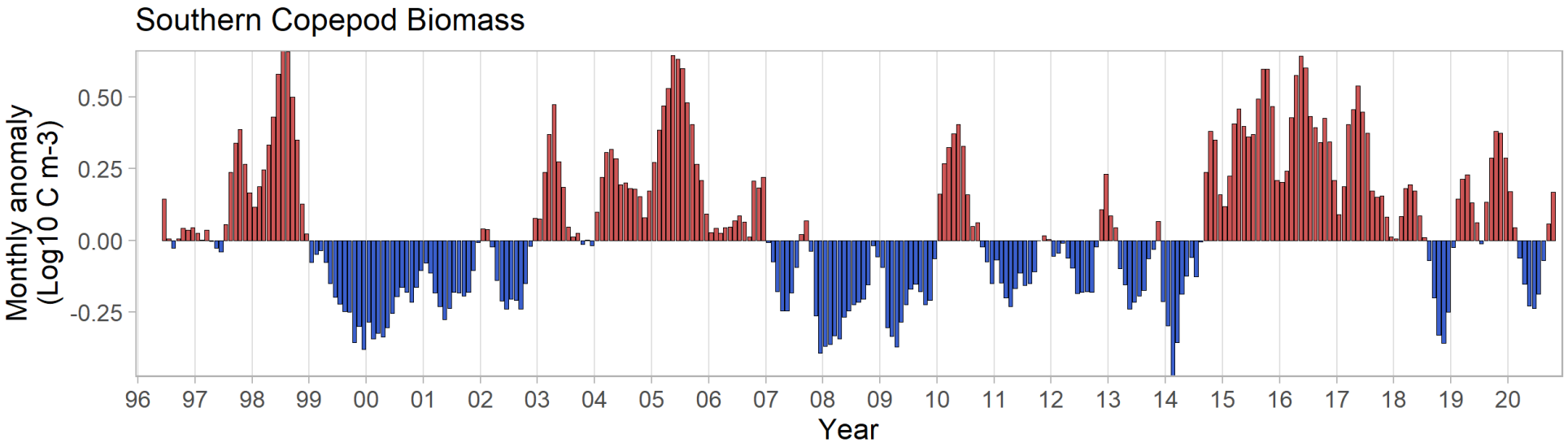




Some results...

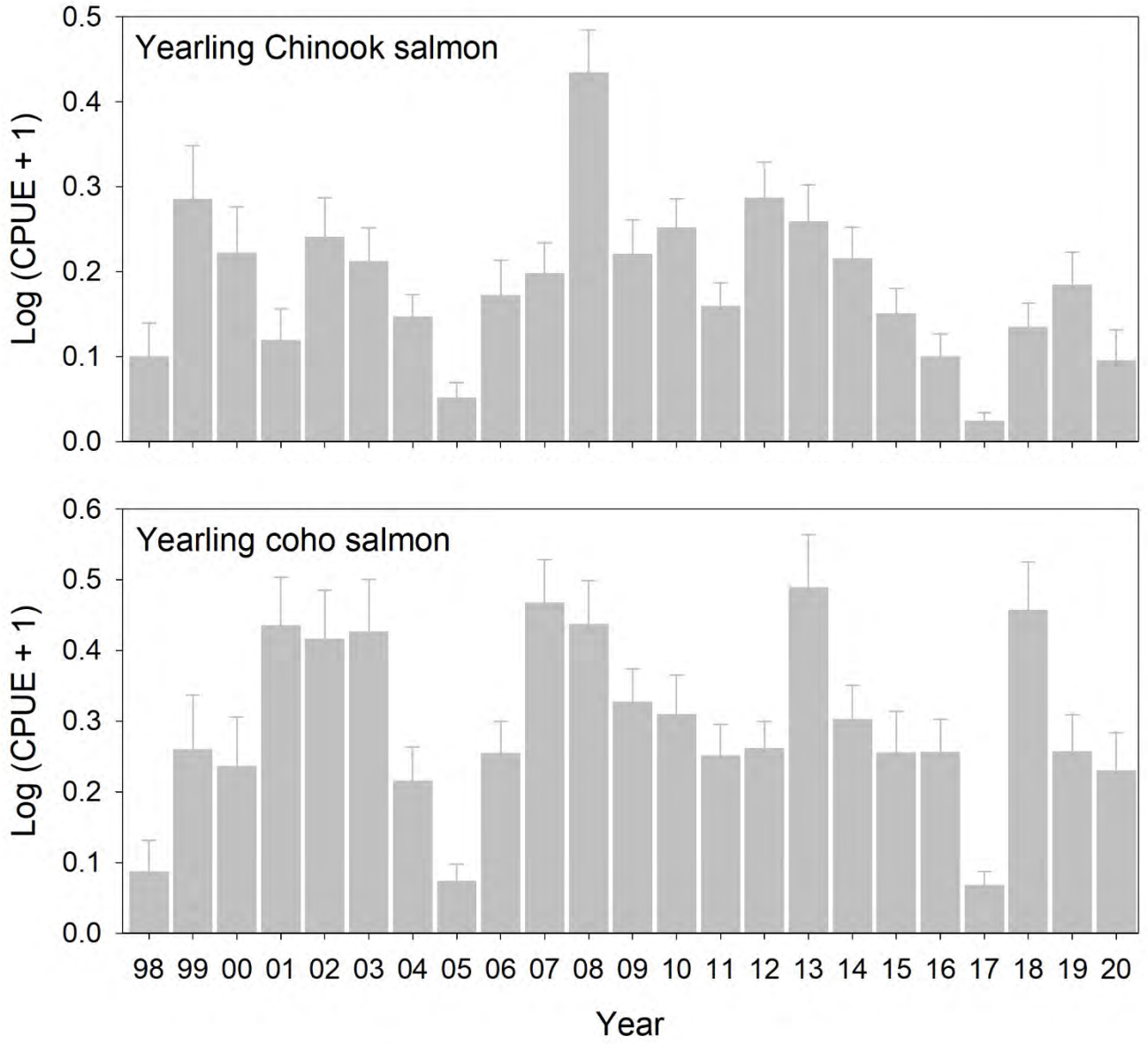
Copepod Biomass was high this summer





Catch per Unit Effort (CPUE)

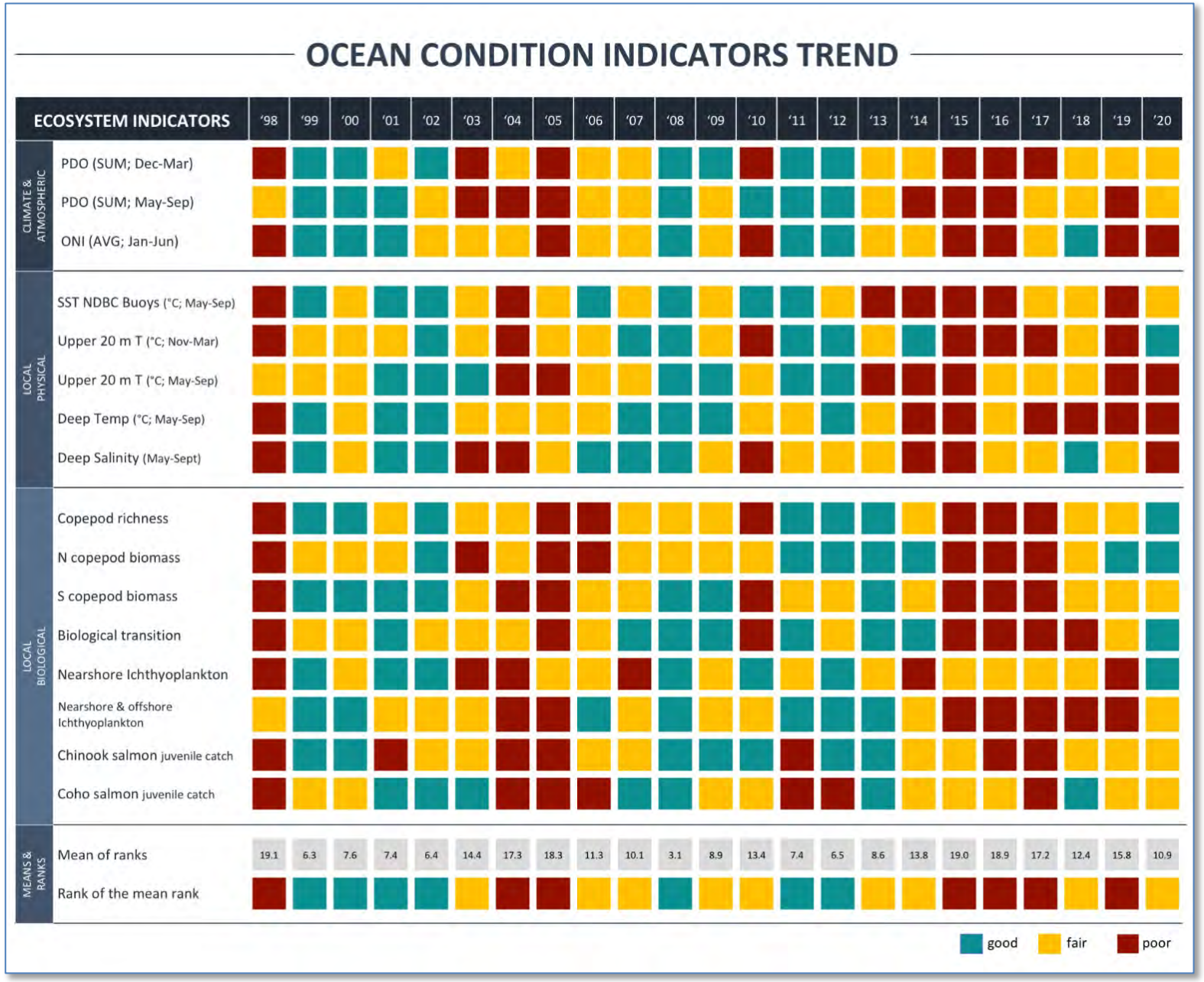
Chinook below average and Coho about average in 2020



Juvenile Salmon and Ocean Ecosystem Survey

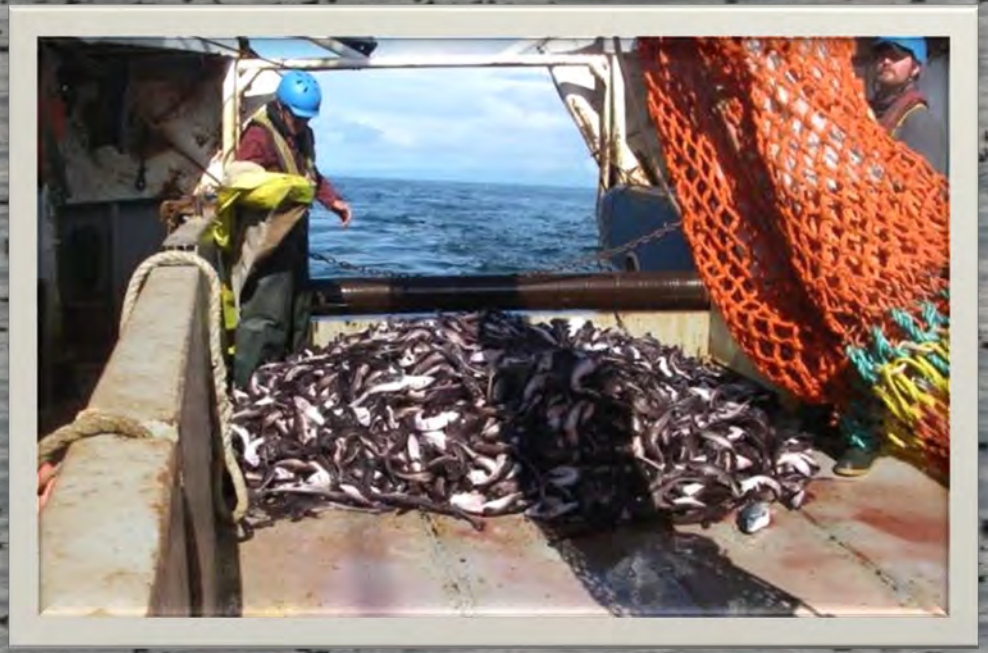
Results from June surveys 1998-2020

New ‘Stoplight’ Website
(still in development)



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

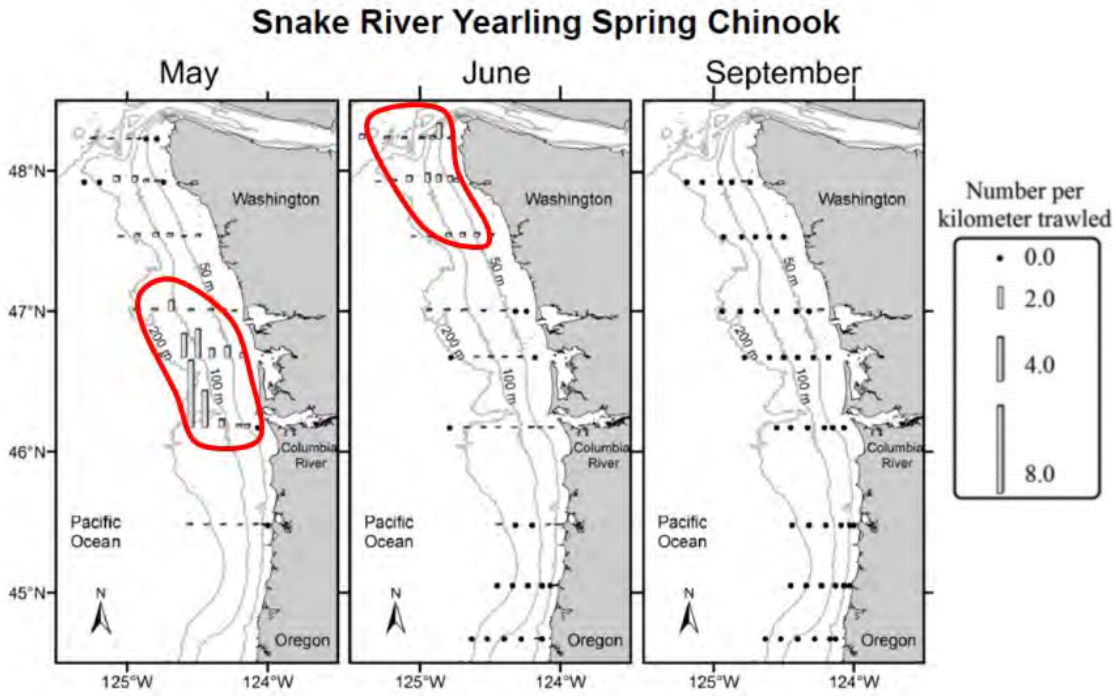
Predation remains a large data gap

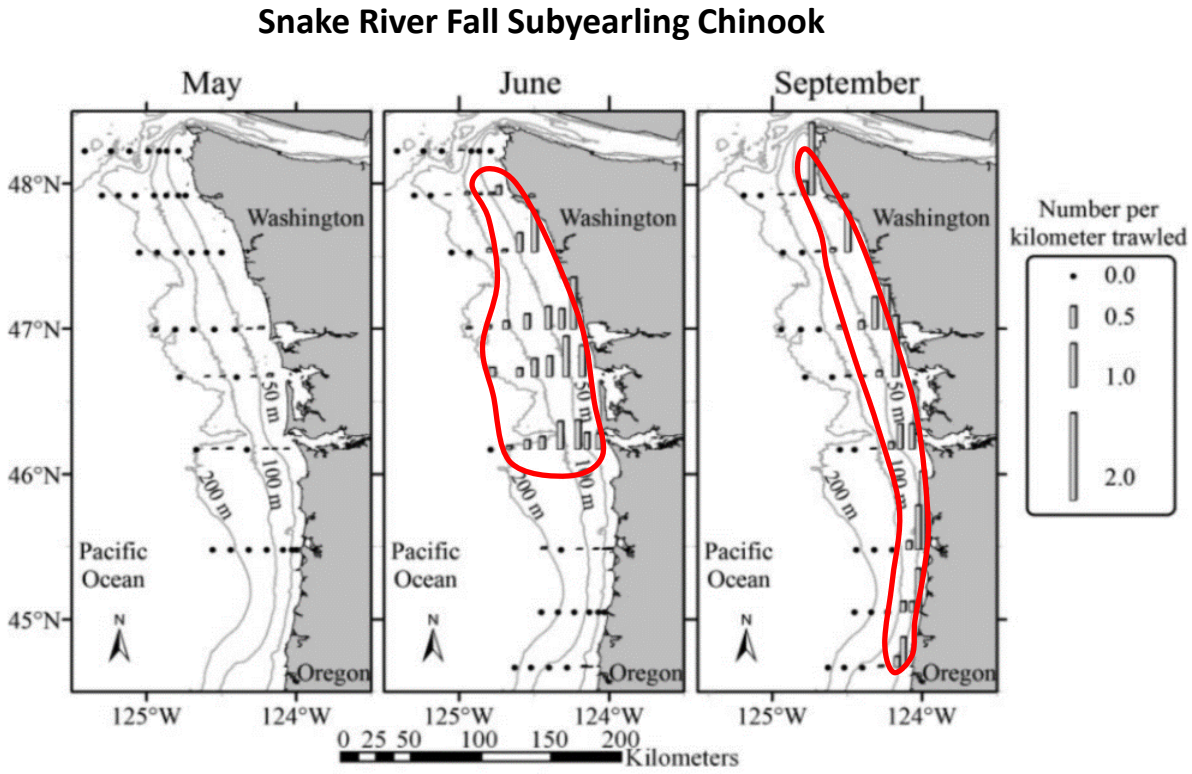


1. Ocean Conditions
2. Monitoring and Research
3. **Modeling Efforts**

Salmon forecasting...

Spatial distribution is stock-specific
(models should be too)



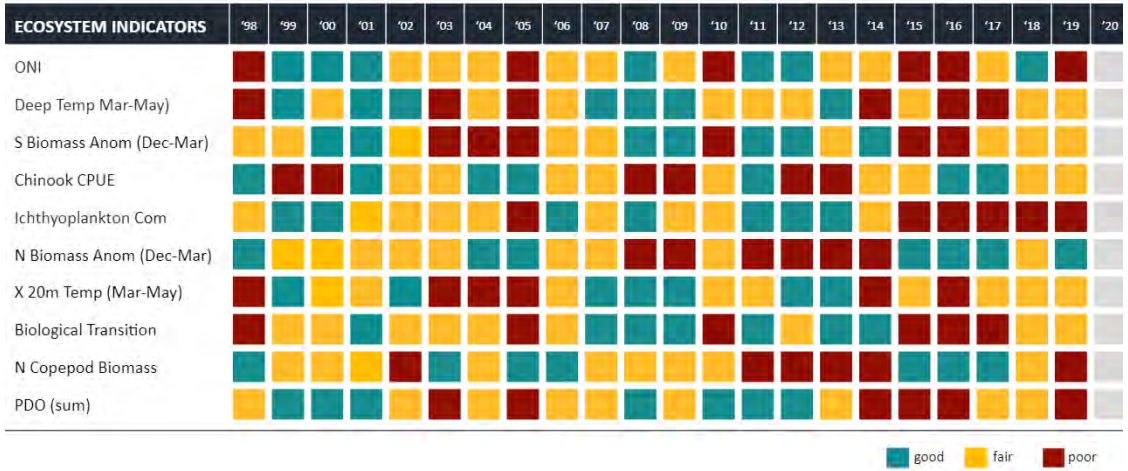


Teel, et al. 2015. Marine and Coastal Fisheries 7:274-300.

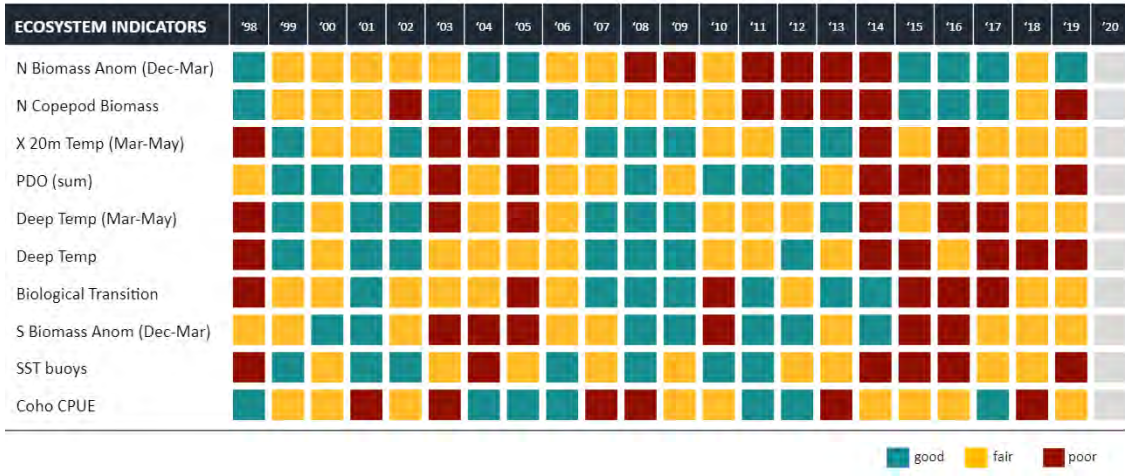
Stock-Specific Stoplight Charts

Optimized for Predictive Ability

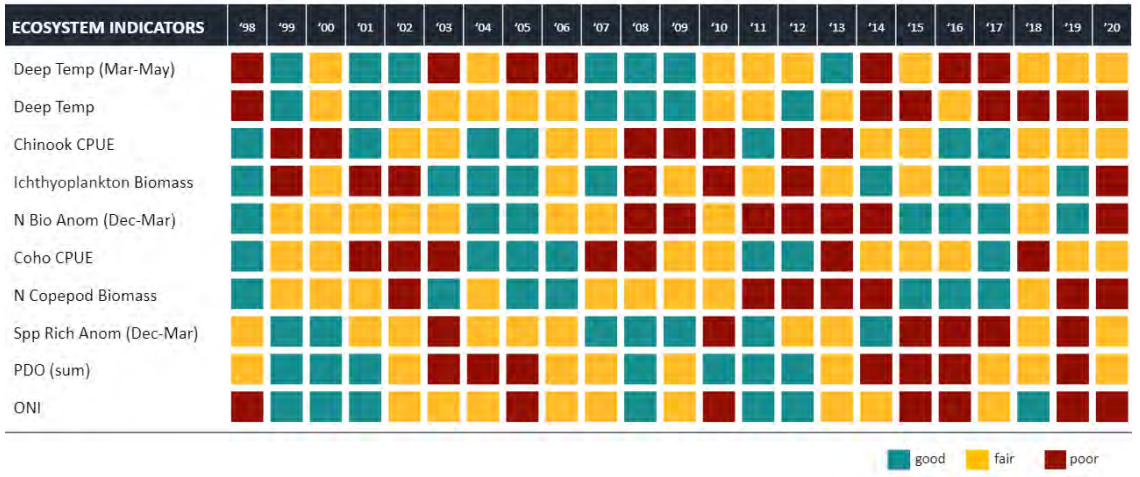
Spring Chinook



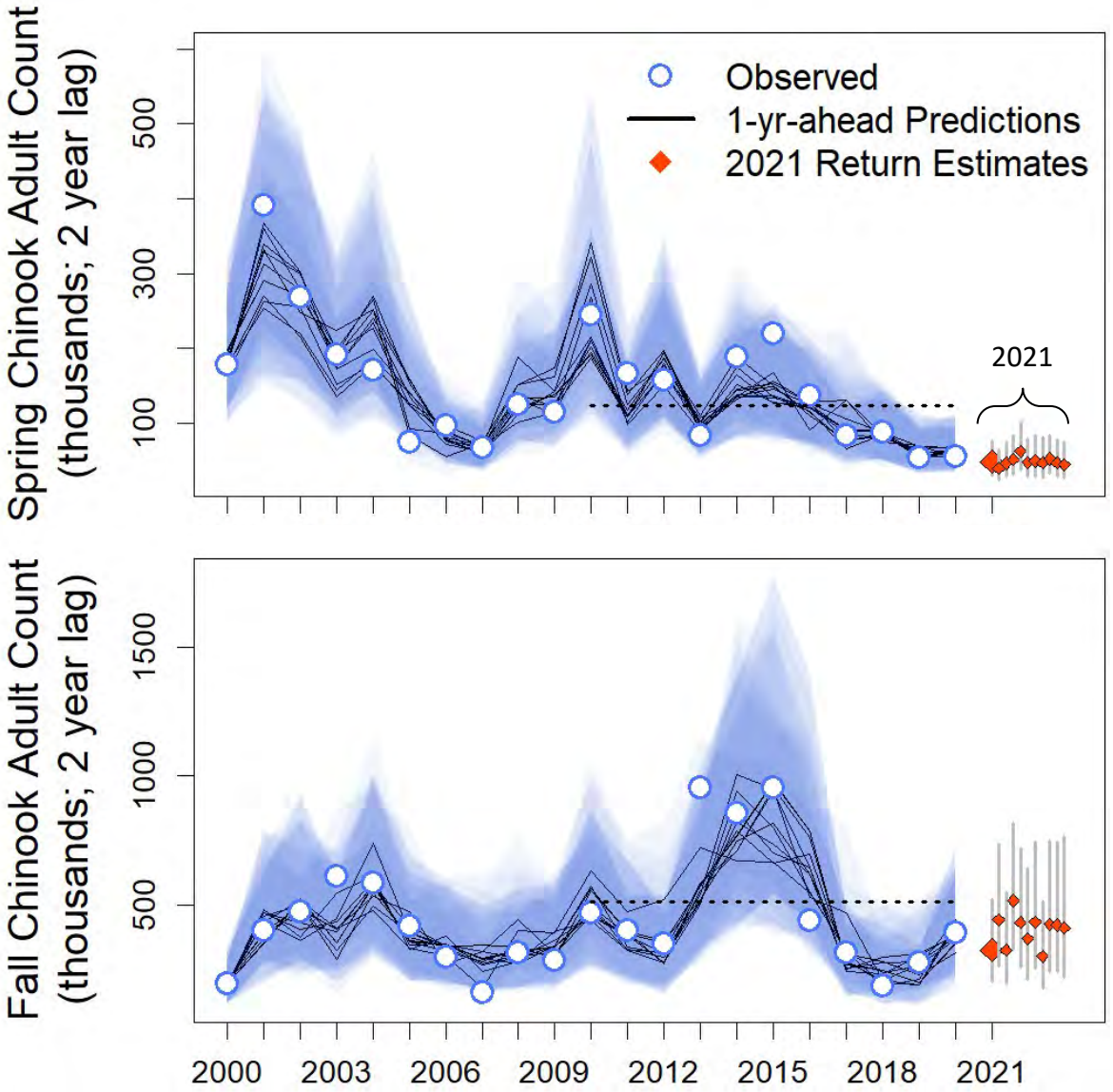
Fall Chinook



Coho



One-Step Ahead Predictions and 2021 Estimates

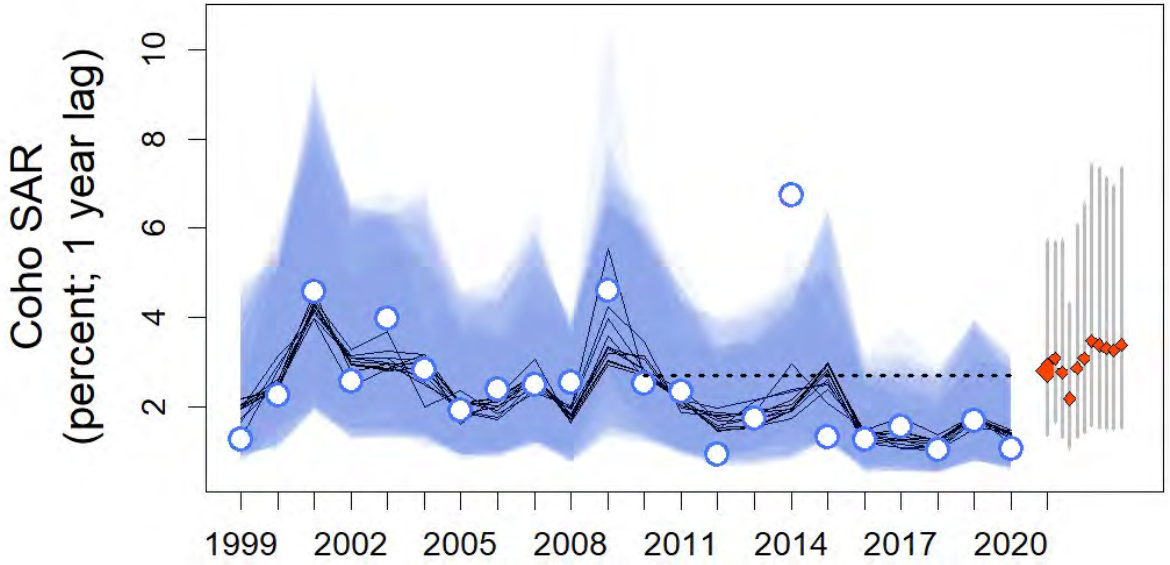


Estimates for 2021 returns

Spring Chinook: 48K Adults (30K - 76K)

Fall Chinook: 325K Adults (203K – 520)

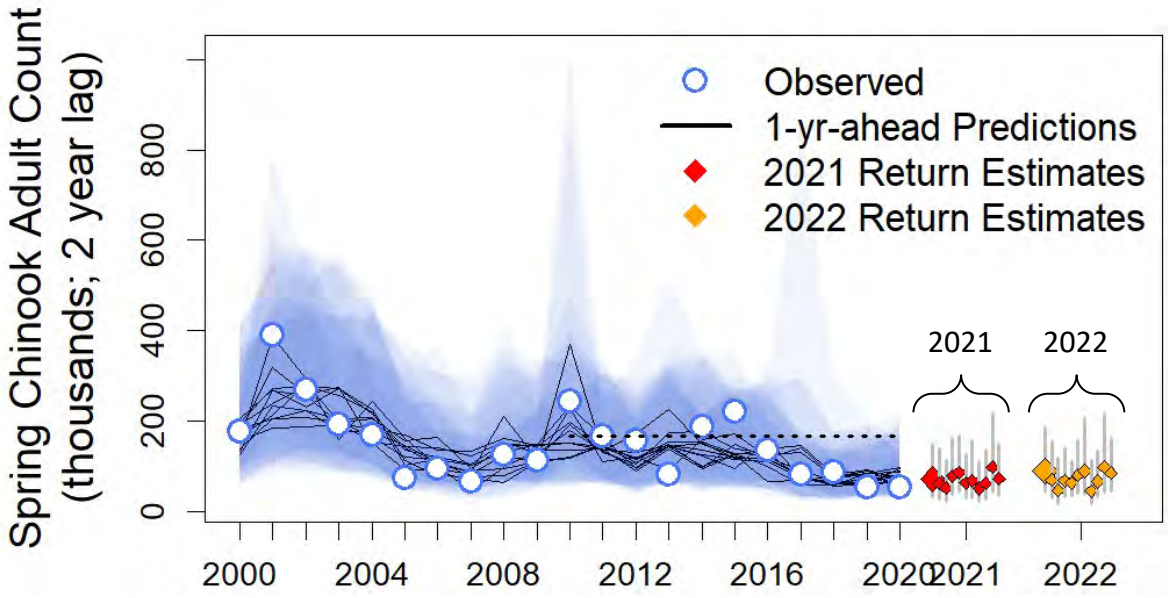
OPIH coho SAR: 2.6% Survival (1.3 - 5.4)



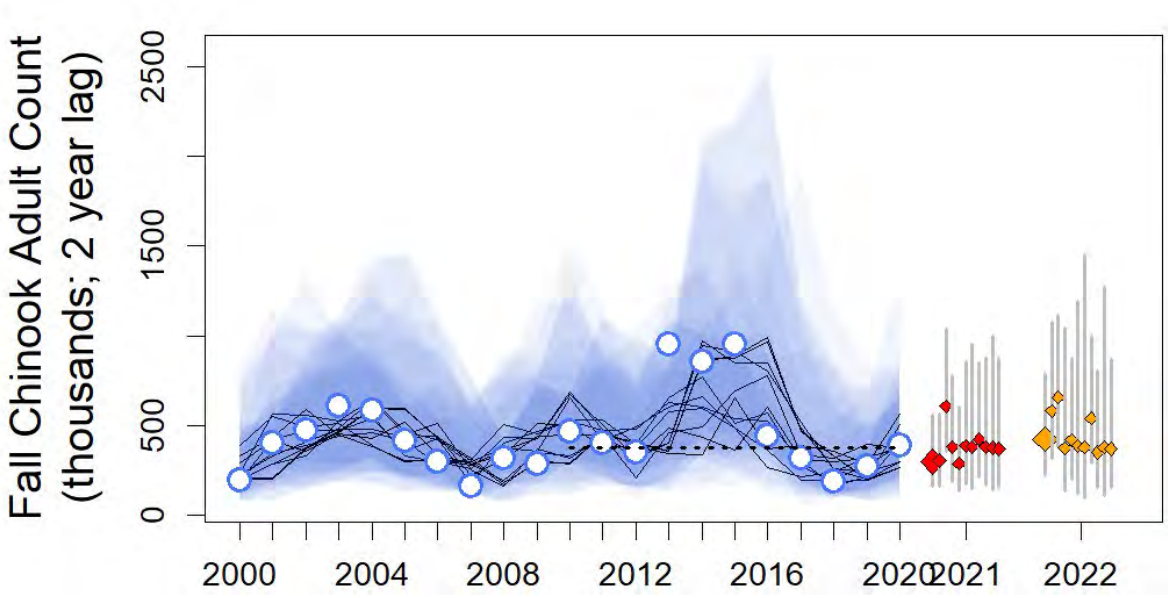
One-Step Ahead Predictions and 2021, 2022 Estimates

(no jacks included)

Spring Chinook

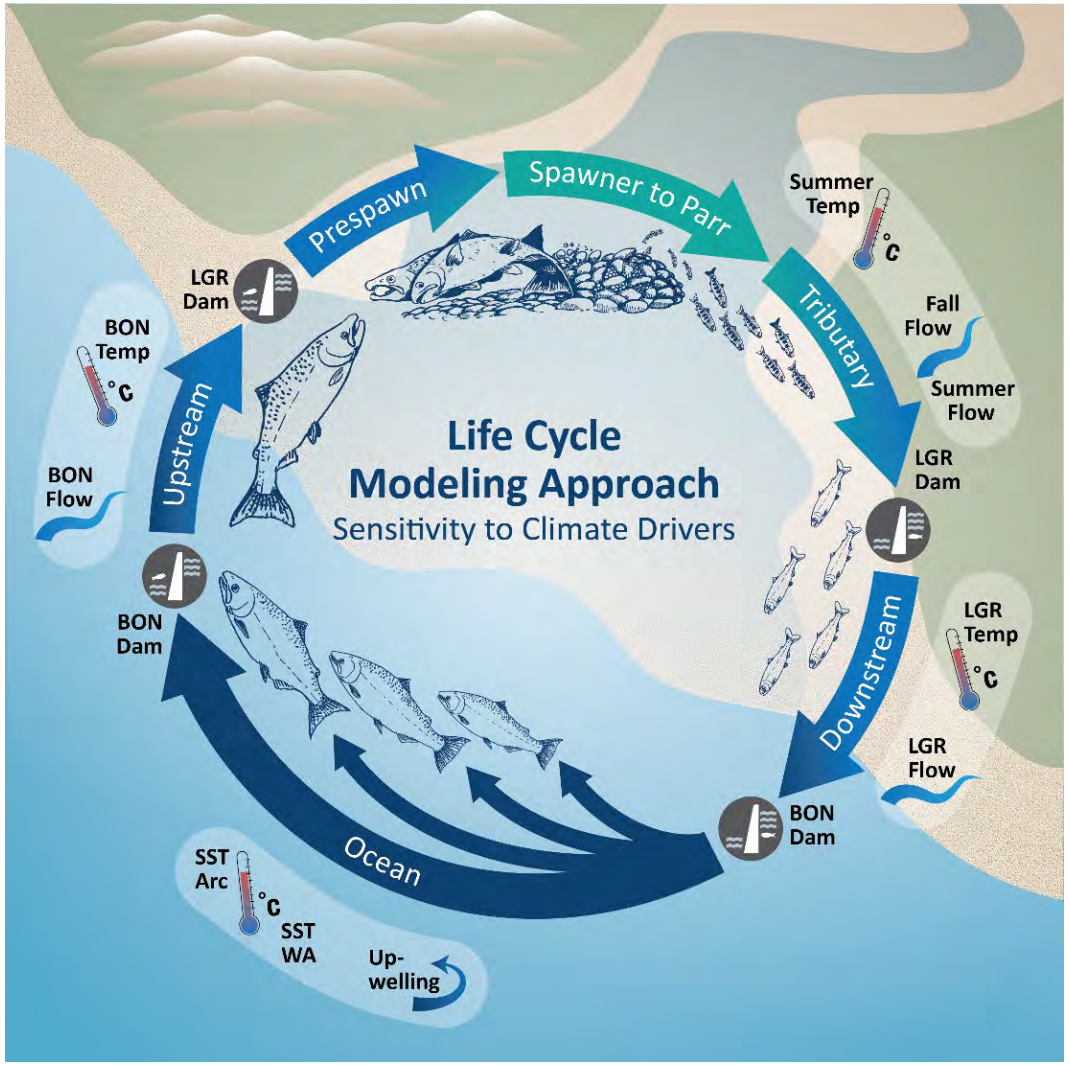


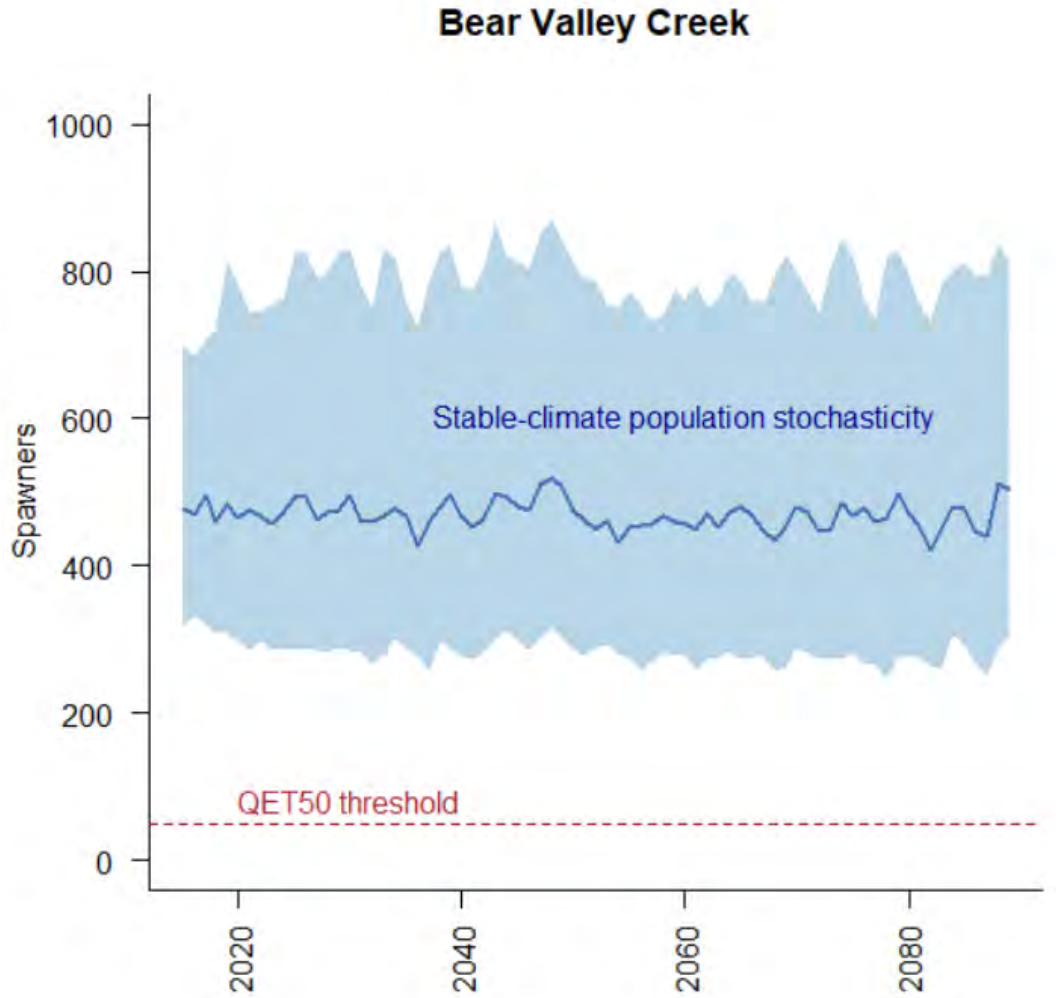
Fall Chinook



Life Cycle Models...

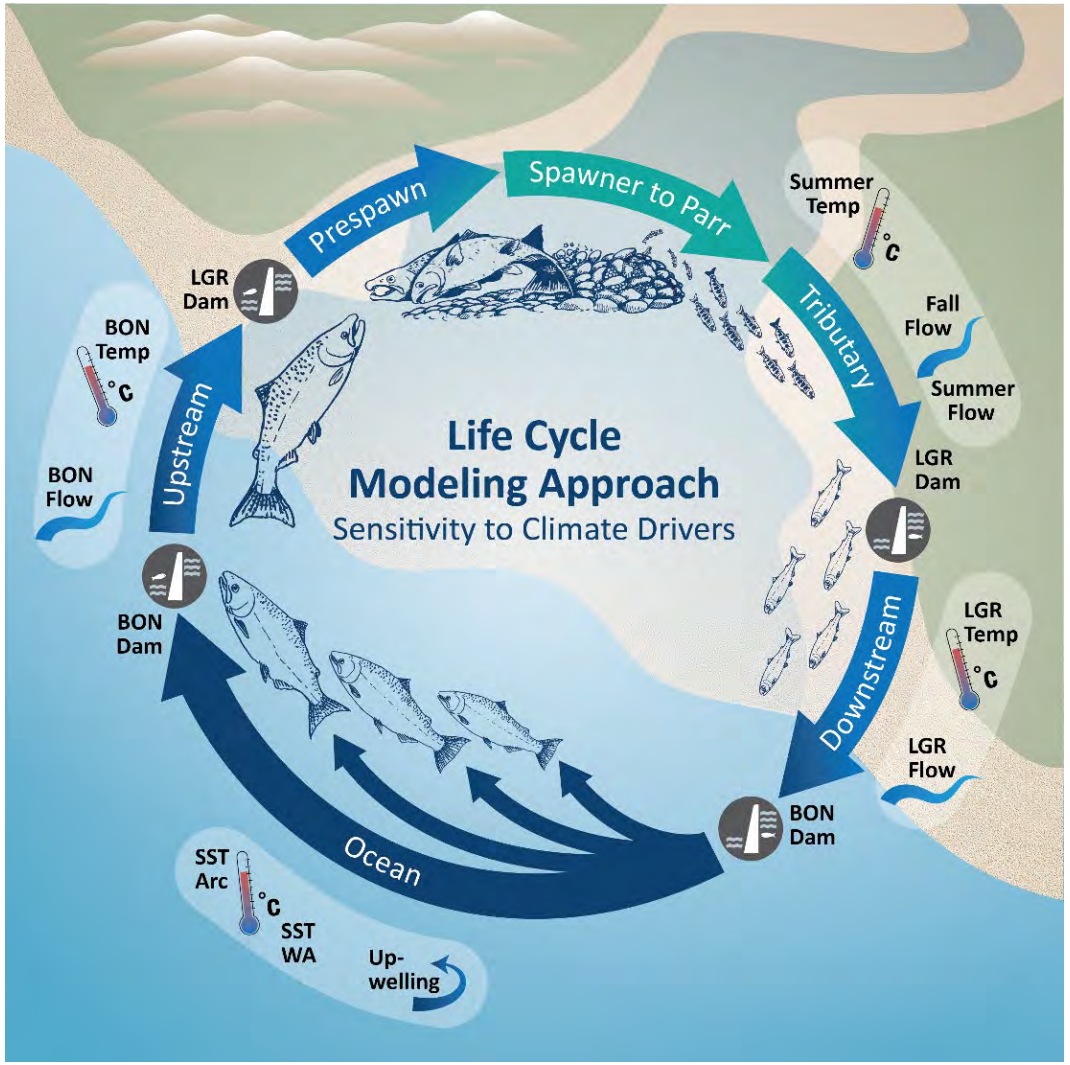
Life Cycle Models and Climate Effects



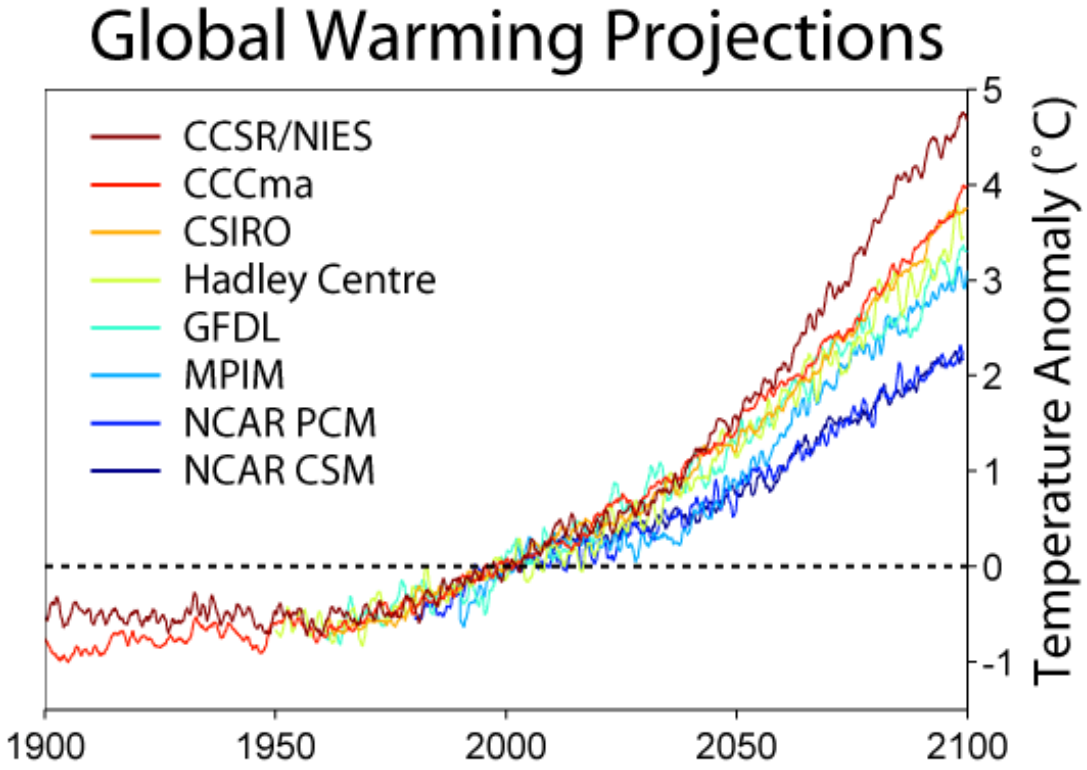


Crozier et al. 2021. Communications Biology
https://doi.org/10.1038/s42003-021-01734-w

Life Cycle Models and Climate Effects

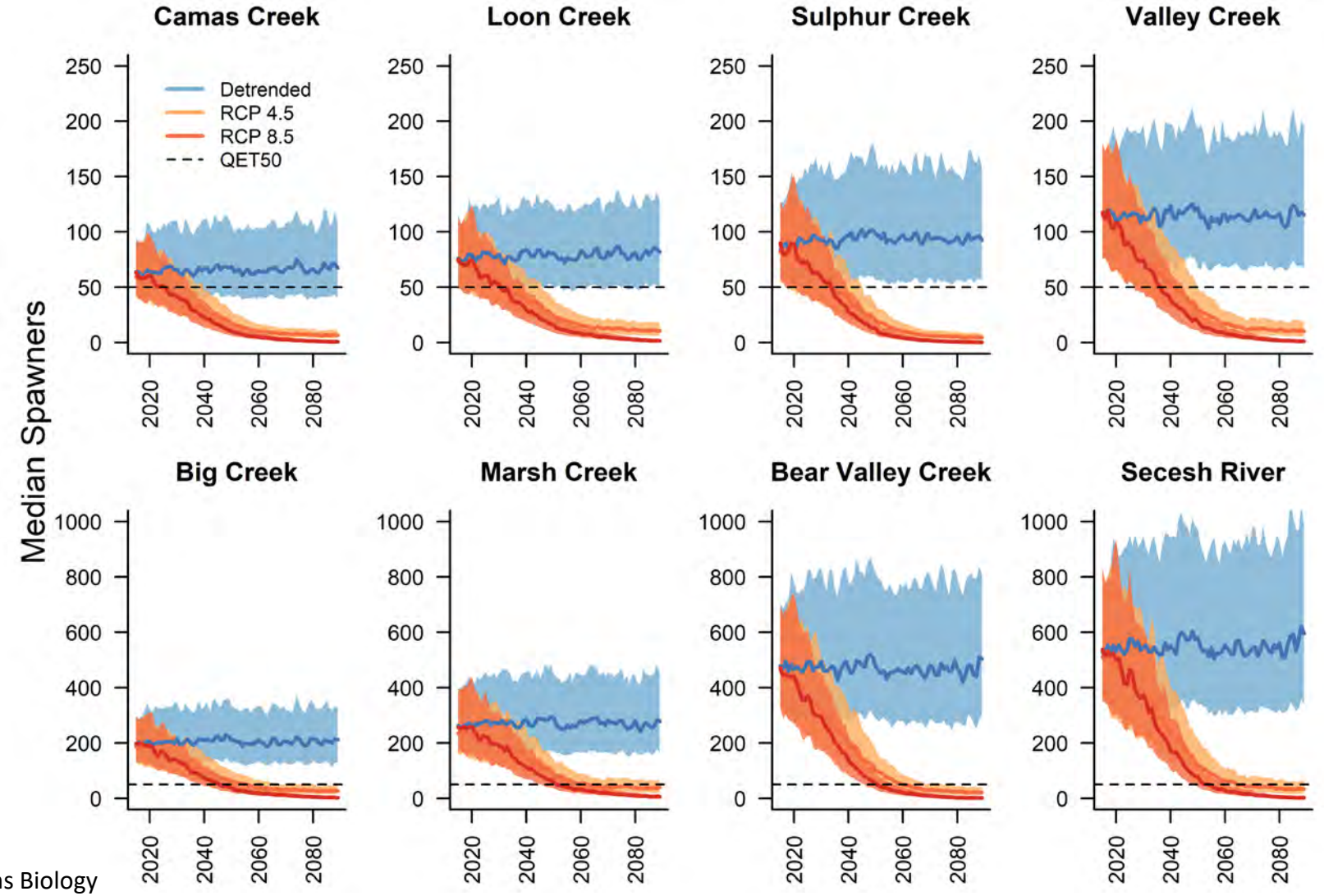


Crozier et al. 2021. Communications Biology
https://doi.org/10.1038/s42003-021-01734-w



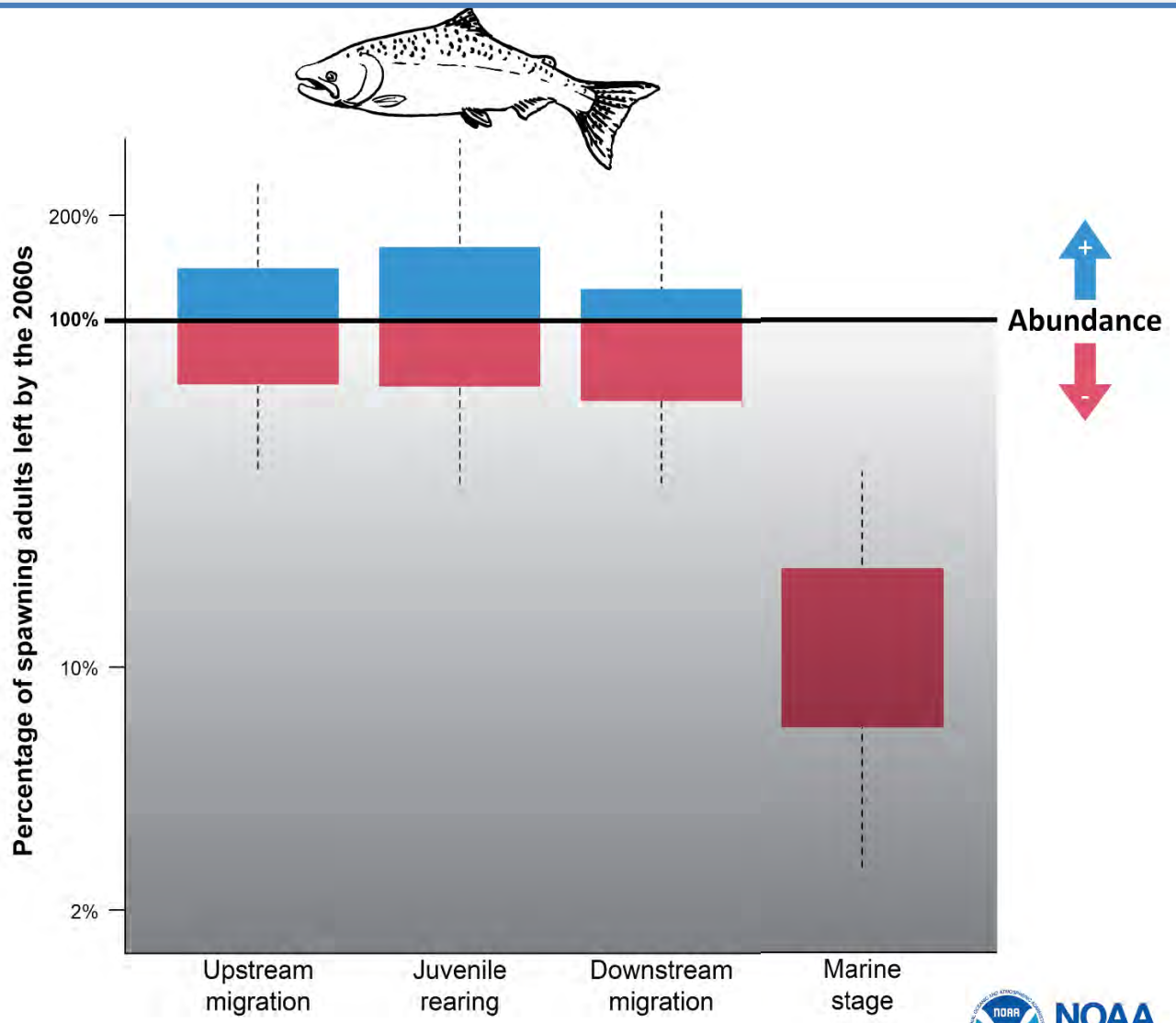
Climate Change and Global Warming
Ashwini S. Jajda, P. V. Khandve, Mangesh L. Gulhane

Populations quickly declined in climate change scenarios



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

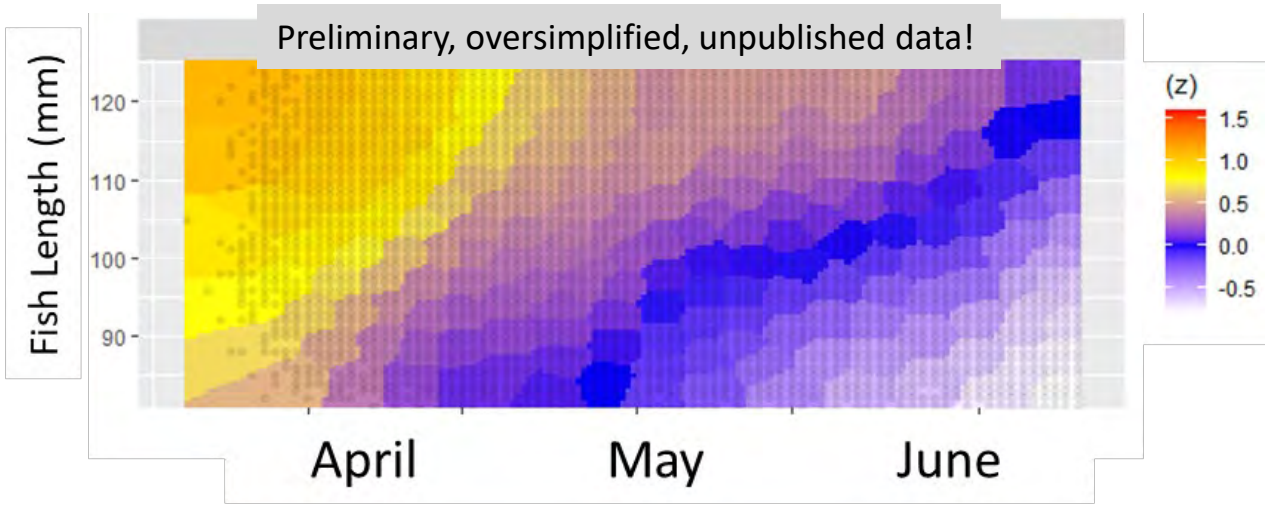
Sensitivity in different life stages



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

Carryover Effects…

Carryover Effects of *Migration Timing, Size, and Growth*

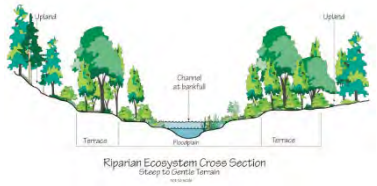


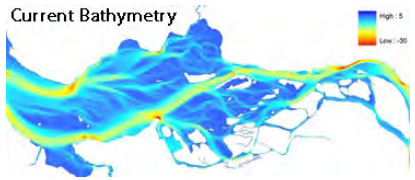
impact survival out here…

Experiences here…

Management Authorities

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

Anticipated Responses

Smolt body size and timing

Carryover effects

Zooplankton, invertebrates, fish larvae

Prey

Anchovy

Competitors
Prey

Hake

Predators
Competitors

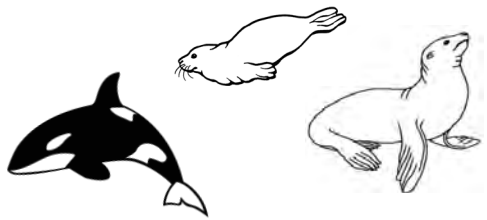
Other Fisheries

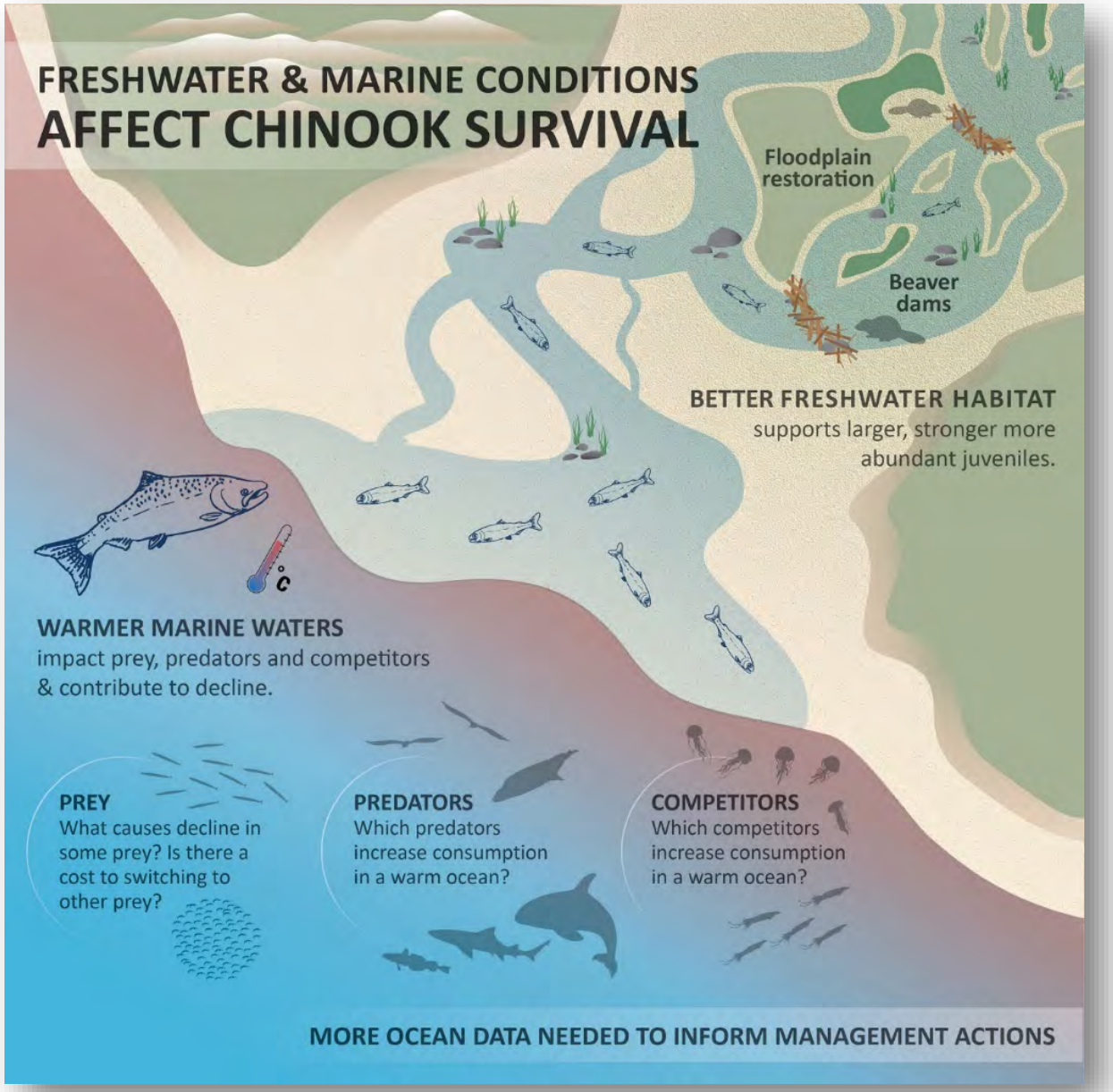
Indirect effects

Seabirds

Predators

Marine mammals





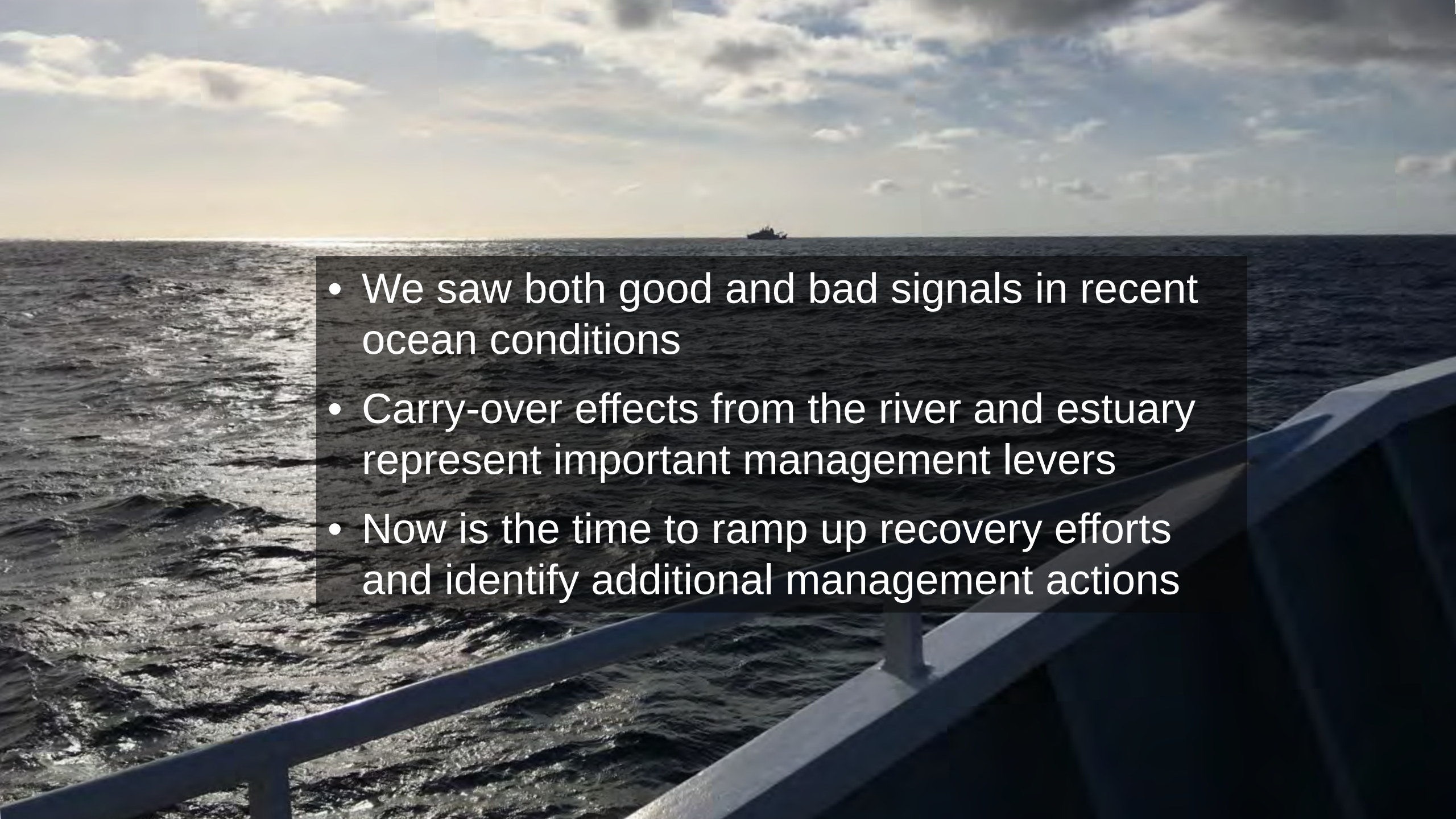
Action Items

1. **Monitoring and Modeling of marine stage**
   - ❑ Fill critical ocean ecology data gaps on predators, competitors and prey
   - ❑ Test hypothesized trophic interactions through modeling

2. **Experimental Studies**
   - ❑ Acoustic tag study to estimate spatio-temporal predation and unaccounted-for mortality
   - ❑ Test effectiveness of freshwater actions

3. **Estuary habitat improvements**
   - ❑ Replace losses to diet from terrestrial sources
   - ❑ Restore nursery habitat for prey species
   - ❑ Plan for sea level rise, storm surge, extreme events, and human population growth

4. **Actively manage other marine species**
   - ❑ Prey (forage fish, squid, rockfish)
   - ❑ Predators (marine mammals, birds)
   - ❑ Plan for increase in warm-water species



- We saw both good and bad signals in recent ocean conditions
- Carry-over effects from the river and estuary represent important management levers
- Now is the time to ramp up recovery efforts and identify additional management actions