

# What is going on in the North Pacific?



Laurie Weitkamp  
NOAA Fisheries  
Northwest Fisheries Science Center  
Newport, Oregon

# Today's talk

## Physical environment drivers

1. El Niño/La Niña
2. Marine heat waves

## Biological response

3. Stoplight chart & Columbia salmon forecasts
4. Recent N Pacific salmon trends

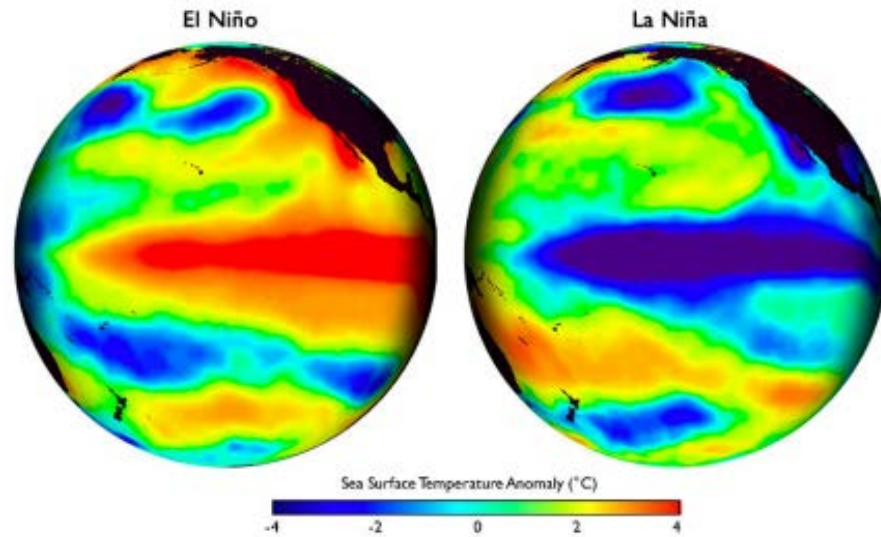
## Beyond the coastal realm

5. High seas research



# 1. El Niños/La Niñas

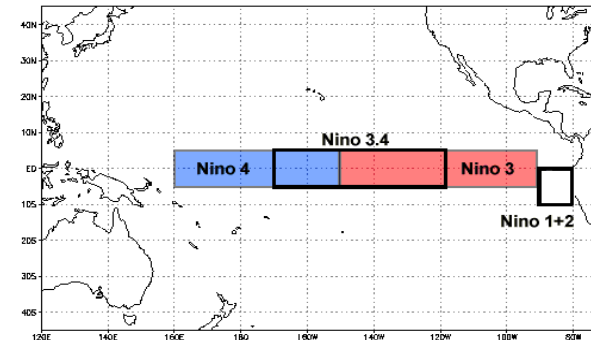
El Niños and La Niñas are tropical phenomena that impact global weather



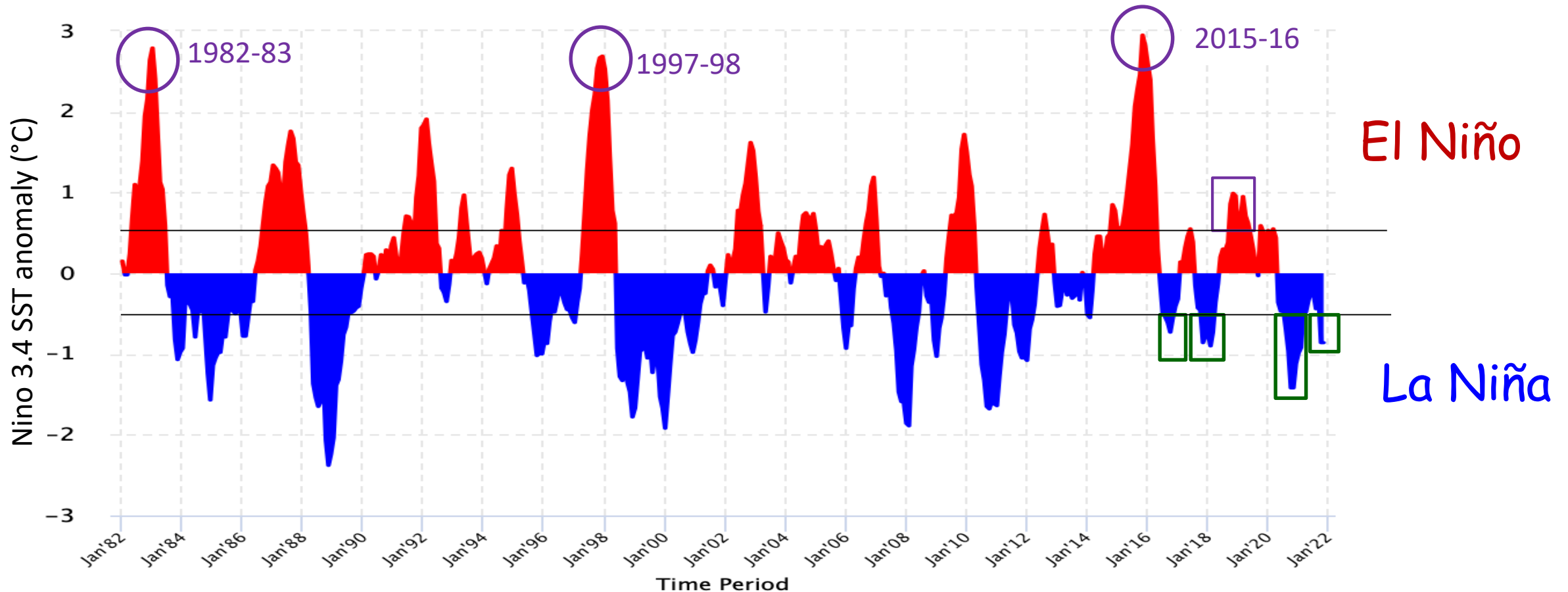
Measured as 5 consecutive 3-month SST anomalies in the Niño 3.4 area:

El Niños  $> +0.5^{\circ}\text{C}$

La Niñas  $< -0.5^{\circ}\text{C}$



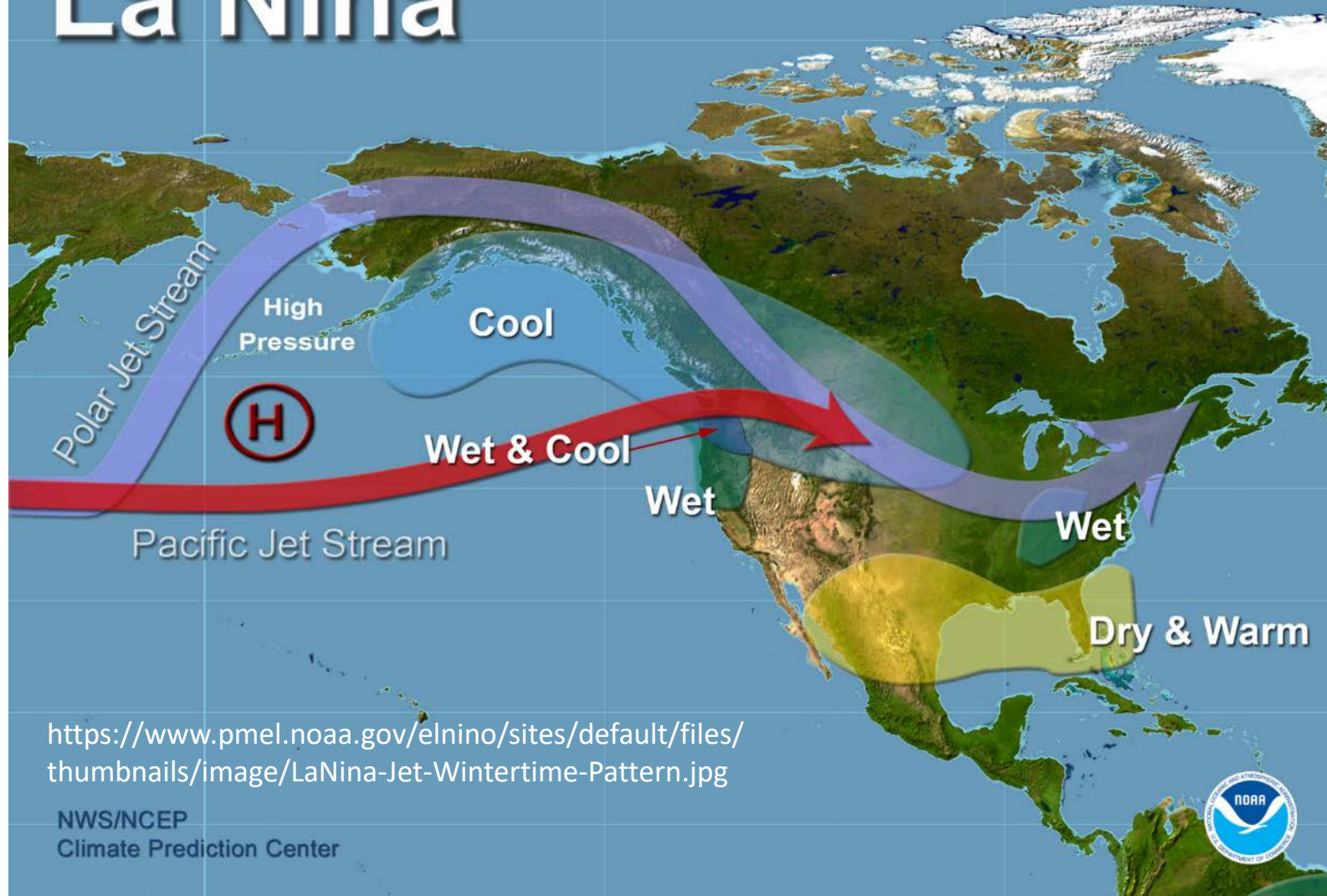
Since the extremely strong 2015/16 El Nino, there have been:  
2 La Niñas, 1 El Niño, and 2 more La Niñas  
(all weak except last year's moderate La Niña).





Typical Wintertime Pattern

# La Niña



[https://www.pmel.noaa.gov/el\\_nino/sites/default/files/thumbnails/image/LaNina-Jet-Wintertime-Pattern.jpg](https://www.pmel.noaa.gov/el_nino/sites/default/files/thumbnails/image/LaNina-Jet-Wintertime-Pattern.jpg)

NWS/NCEP  
Climate Prediction Center



# ENSO Summary

11 April 2022

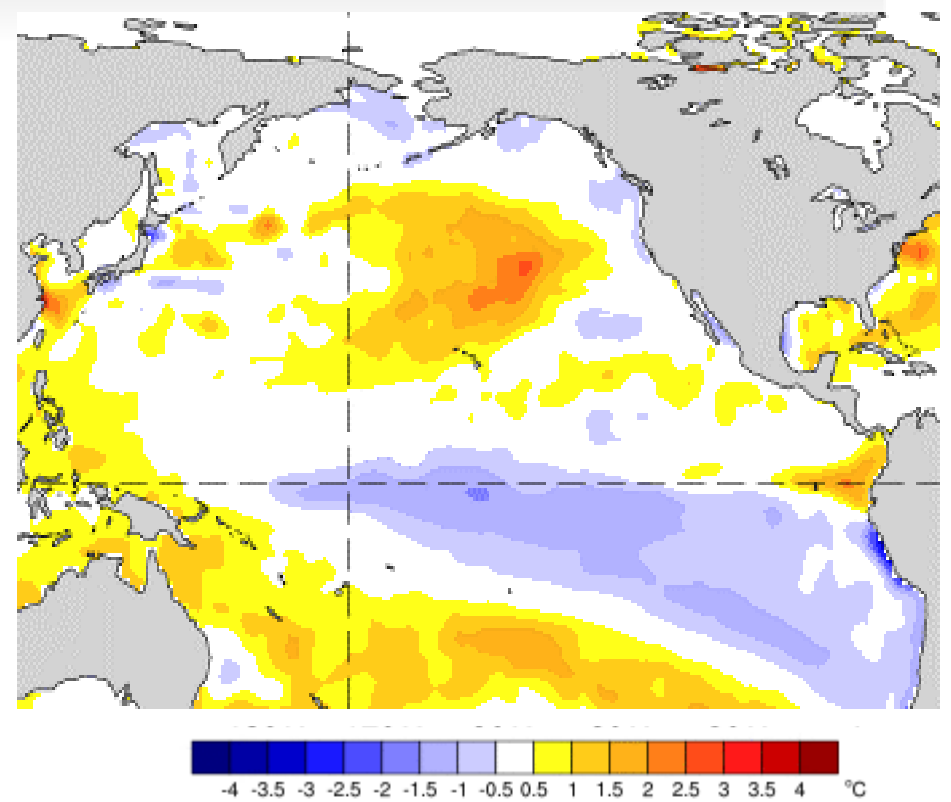
ENSO Alert System Status: La Niña Advisory

La Niña is present.

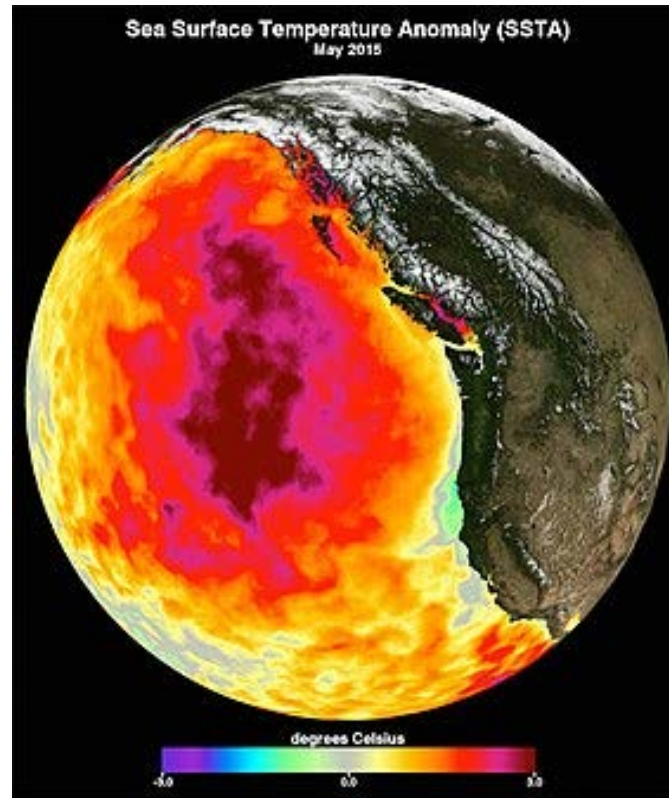
La Niña is favored to continue into the Northern Hemisphere summer (53% chance during June-August 2022), with a 40-50% chance of La Niña or ENSO-neutral thereafter.\*

<https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/enso.shtml>

Monthly SST anomaly, Mar 13-Apr 9, 2022

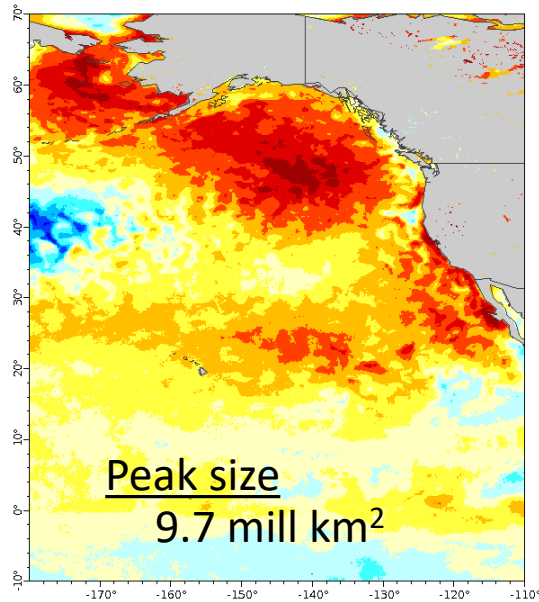


## 2. Marine heat waves

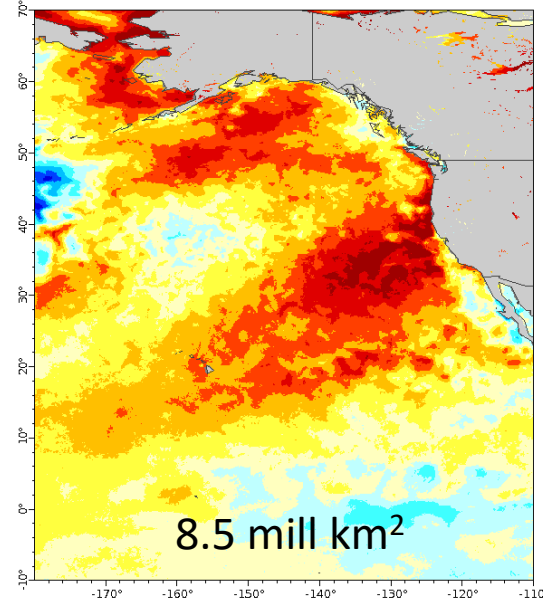


# Recent NE Pacific marine heat waves (Sea surface temperature [SST] anomalies) in September

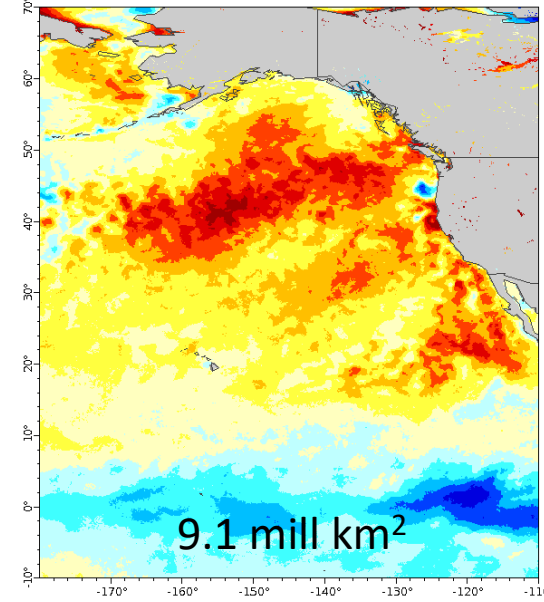
2014-16 "The blob"



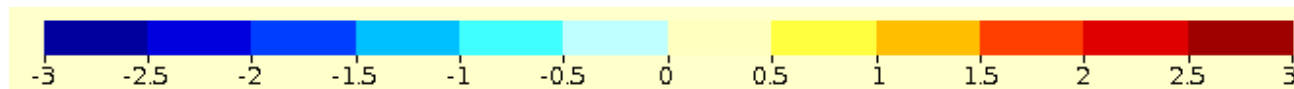
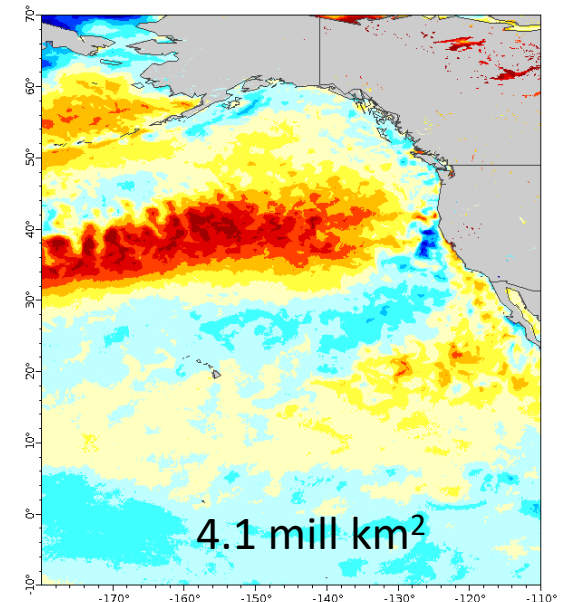
2019



2020



2021



<https://www.integratedecosystemassessment.noaa.gov/regions/california-current/cc-projects-blobtracker>  
<https://coastwatch.pfeg.noaa.gov/erddap/index.html>



# Recent NE Pacific marine heat waves

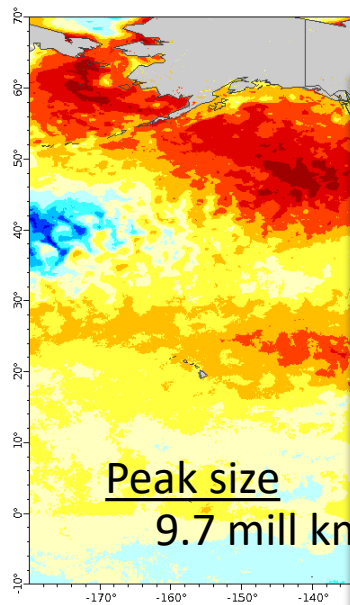
(Sea surface temperature [SST] anomalies) in September

2014-16 "The blob"

2019

2020

2021

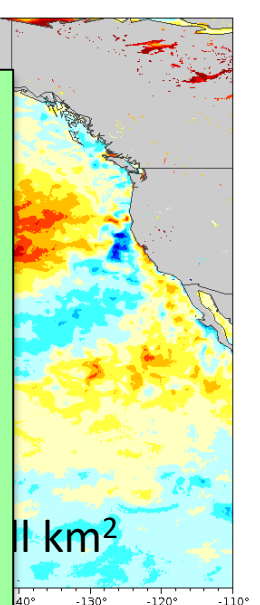


Huge biological impacts to marine ecosystems at all trophic levels, including:

- harmful algal blooms
- extreme bird and whale mortality events
- species ranges extensions
- explosions of unusual species (e.g., pyrosomes)

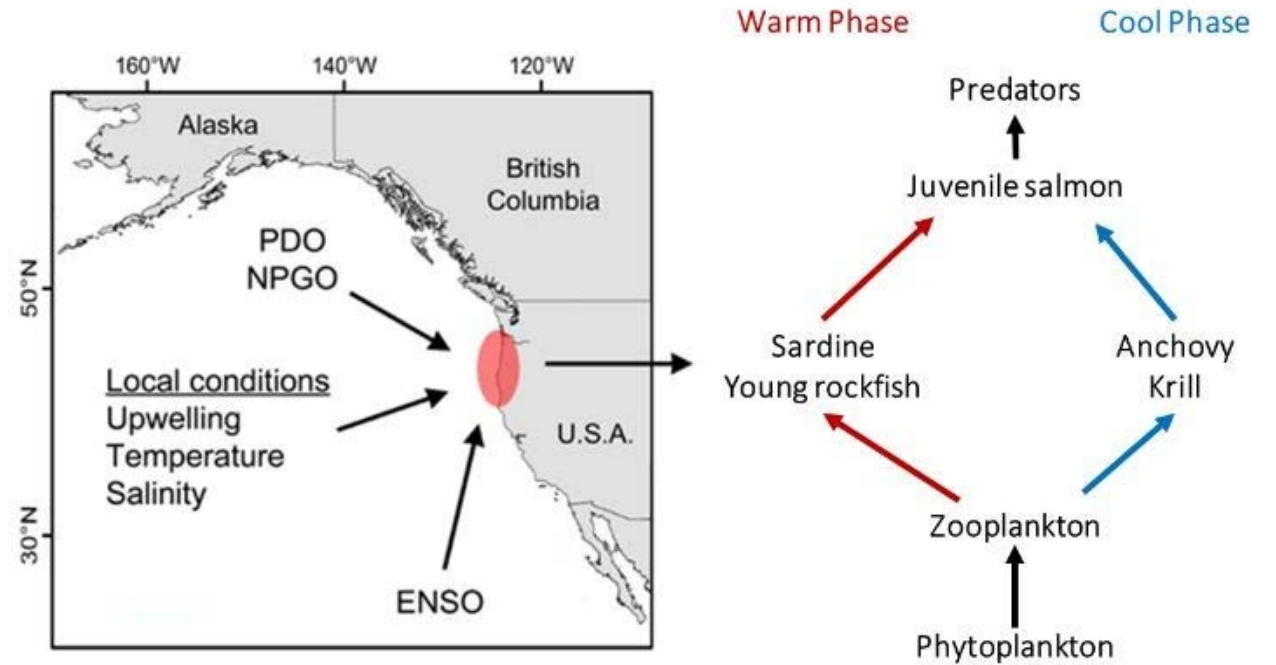
<https://www>

<https://coastwatch.preg.noaa.gov/erddap/index.html>



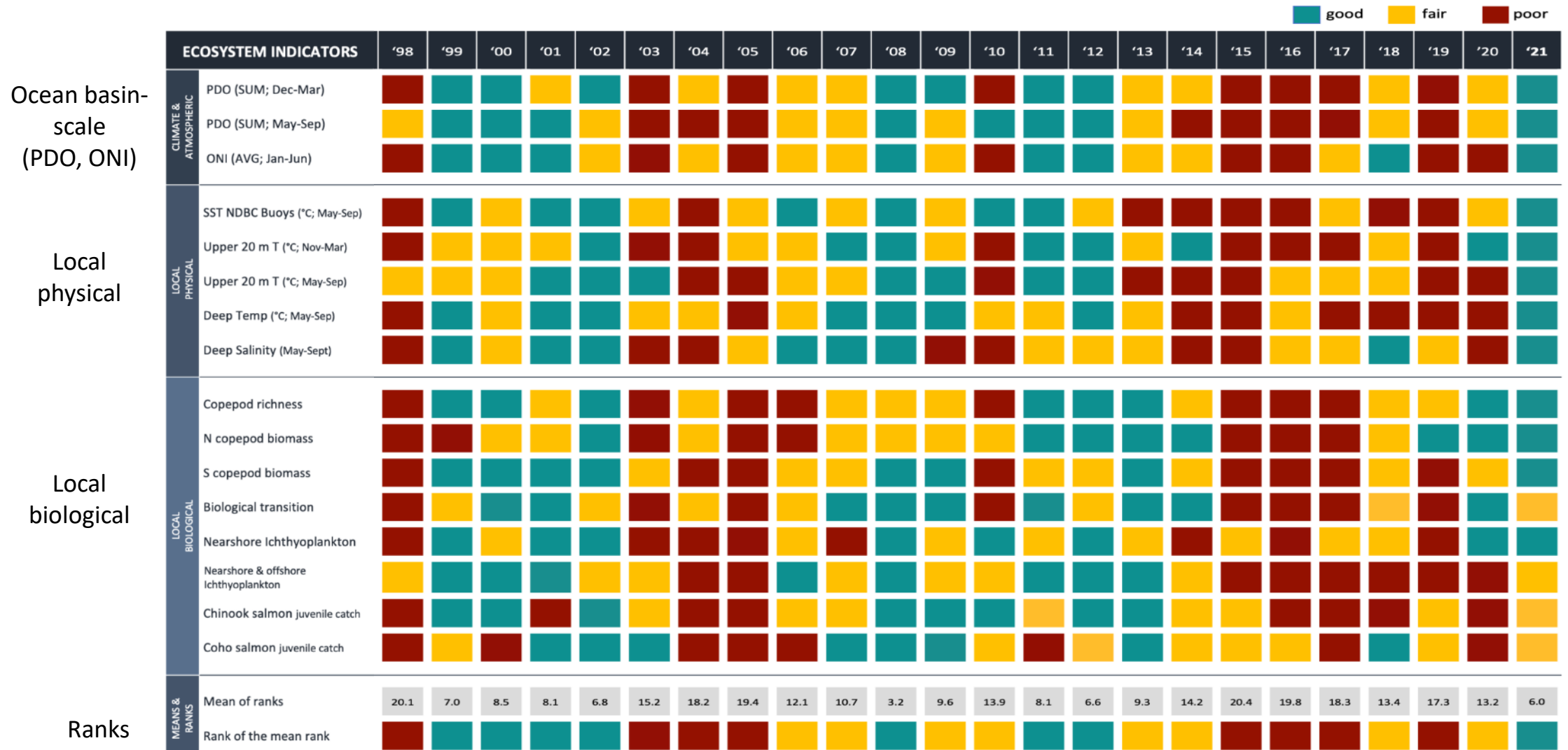
acker

### 3. NW/FSC's stoplight chart



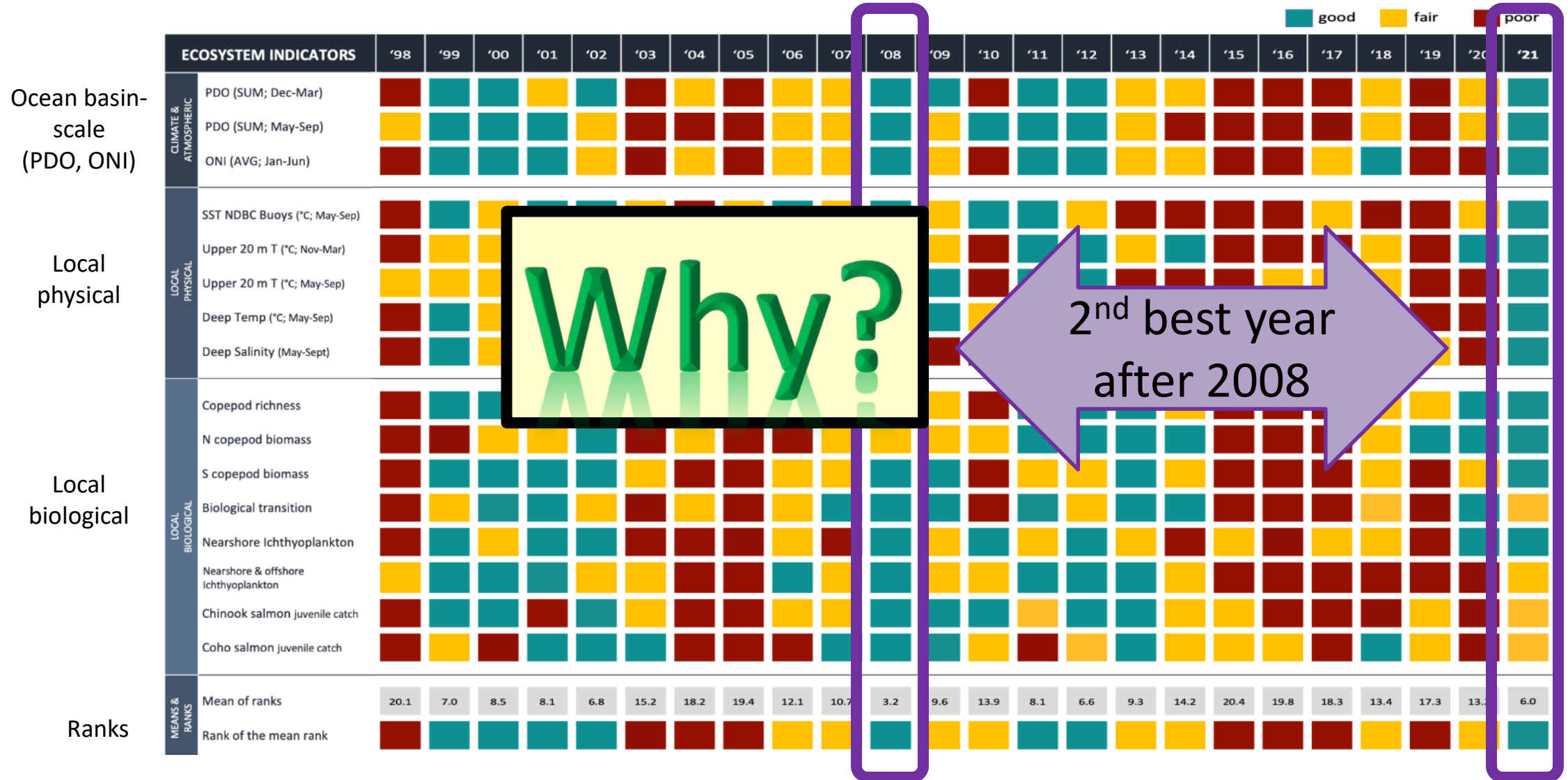
<https://www.fisheries.noaa.gov/west-coast/science-data/ocean-ecosystem-indicators-pacific-salmon-marine-survival-northern>

## OCEAN CONDITION INDICATORS TREND



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

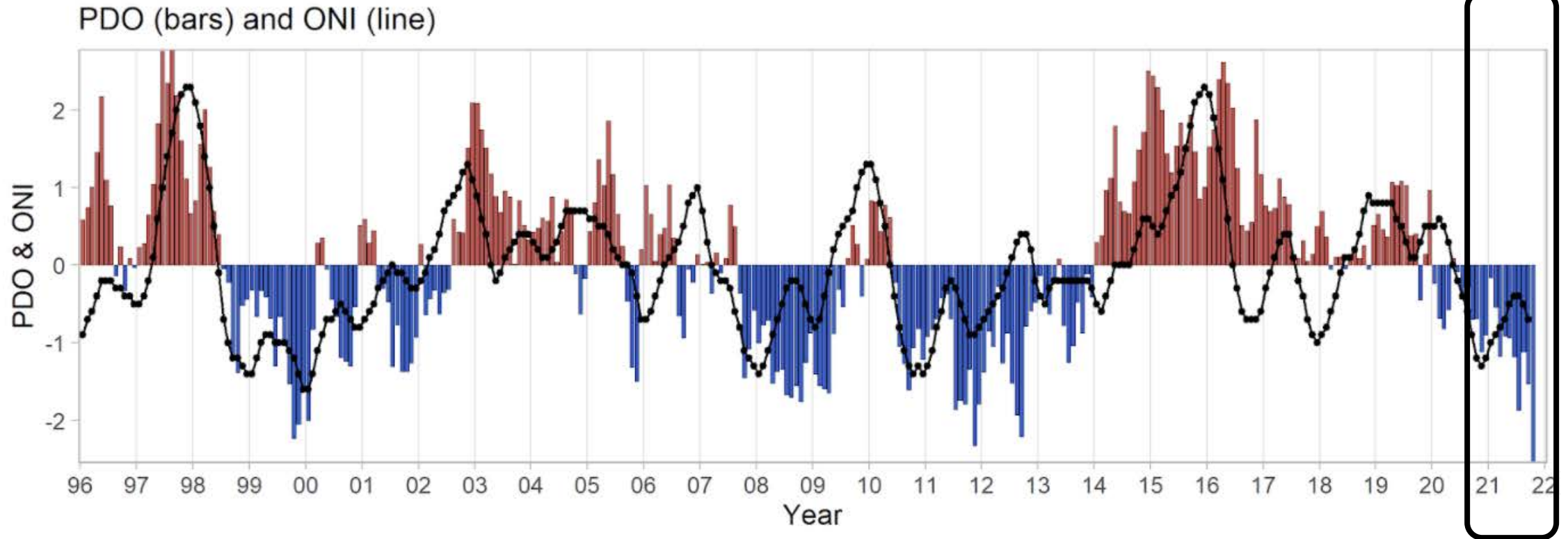
## OCEAN CONDITION INDICATORS TREND



# Why was 2021 so good?

Good **ocean-basin** conditions

Negative PDO  
and back-to-  
back La Niñas





## Sea surface temperature anomalies, 2020 vs 2021

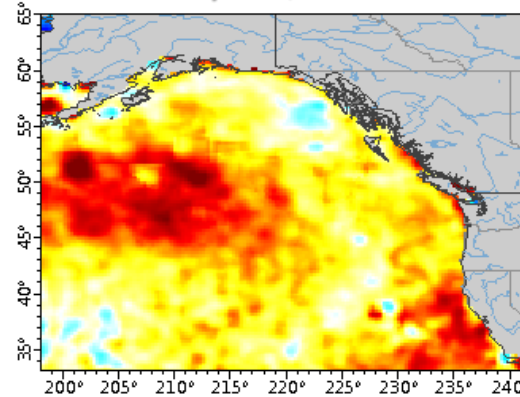
### Why was 2021 so good?

Good **ocean-basin** conditions

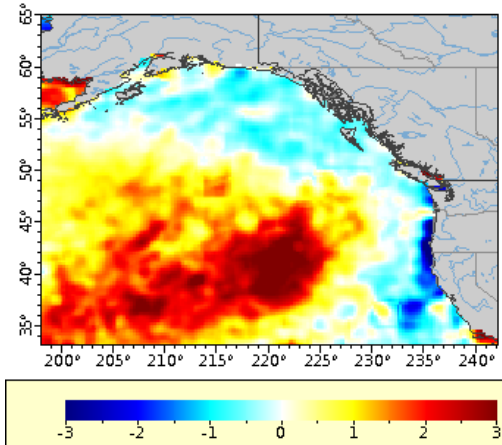
Good **physical** conditions

- Early spring transition
- Strong upwelling
- Cold salty water

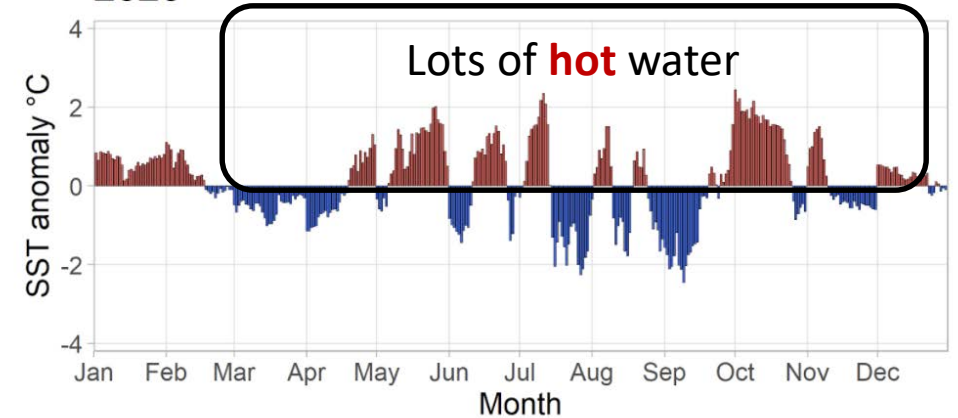
May 15, 2020



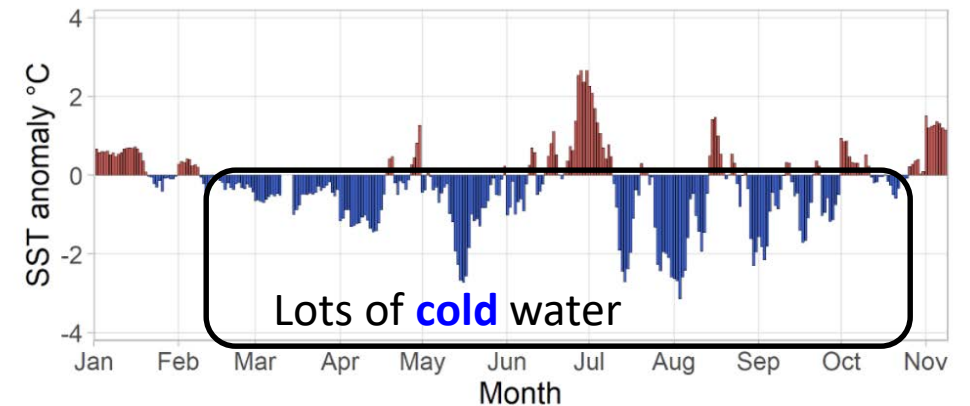
May 15, 2021



2020



2021



# Why was 2021 so good?

Good **ocean-basin** conditions

Good **physical** conditions

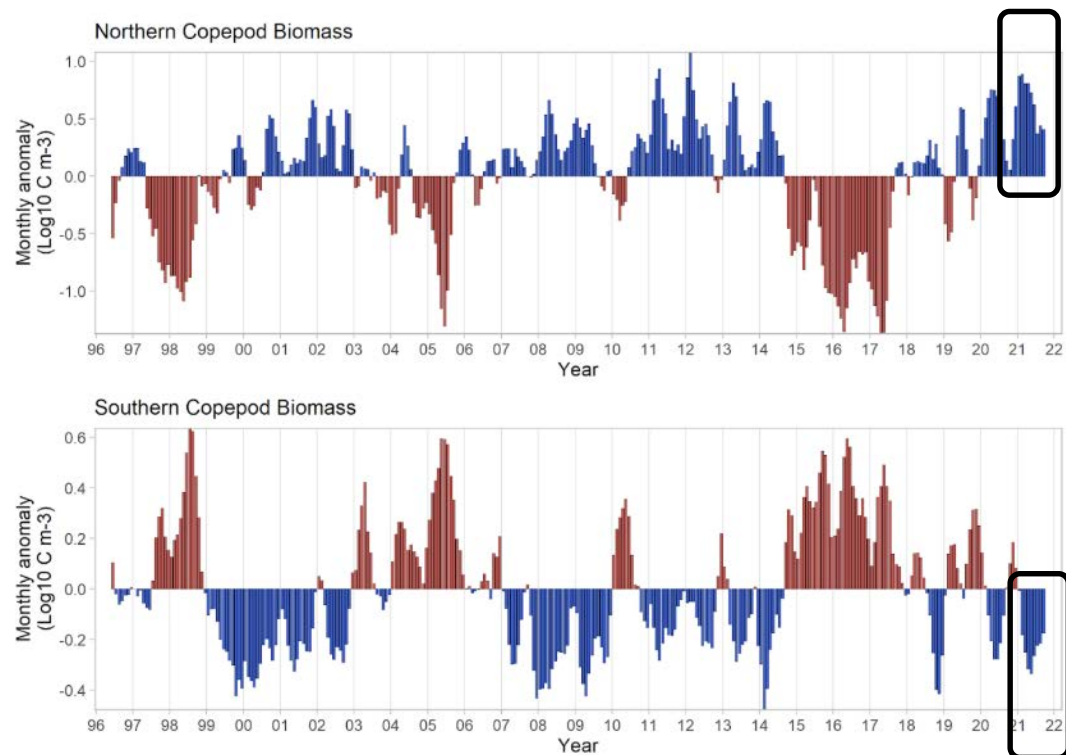
- Early spring transition
- Strong upwelling
- Cold salty water



Good **biological** conditions

- High chlorophyll
- High biomass N copepods
- Low biomass S copepods

2021 saw the highest N copepod biomass ever  
and below average S copepods!



## Why was 2021 so good?

Good **ocean-basin** conditions

Good **physical** conditions

- Early spring transition
- Strong upwelling
- Cold salty water



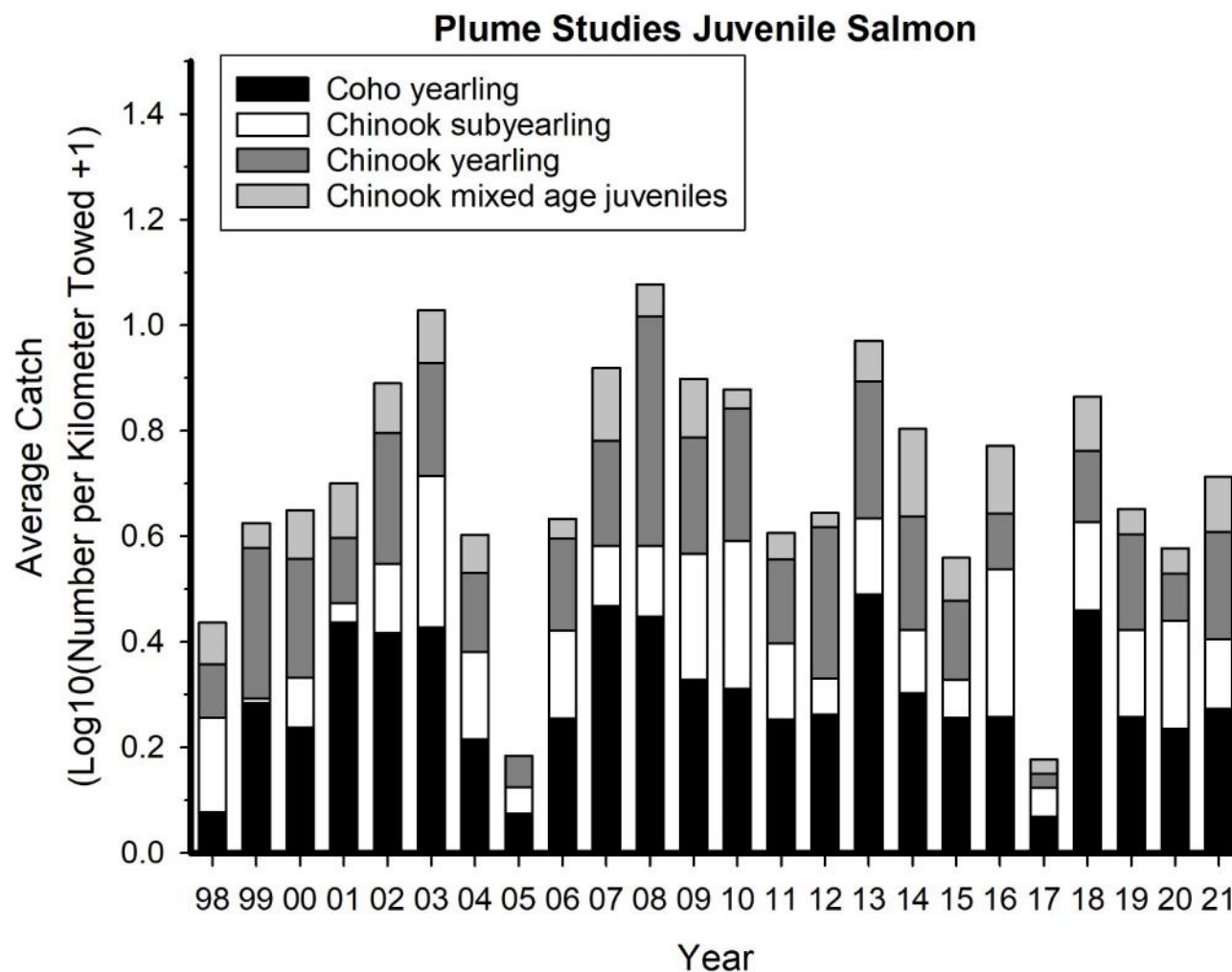
Good **biological** conditions

- High chlorophyll
- High biomass N copepods
- Low biomass S copepods

+ respectable numbers of juvenile salmon  
(=good predictor of Columbia returns)

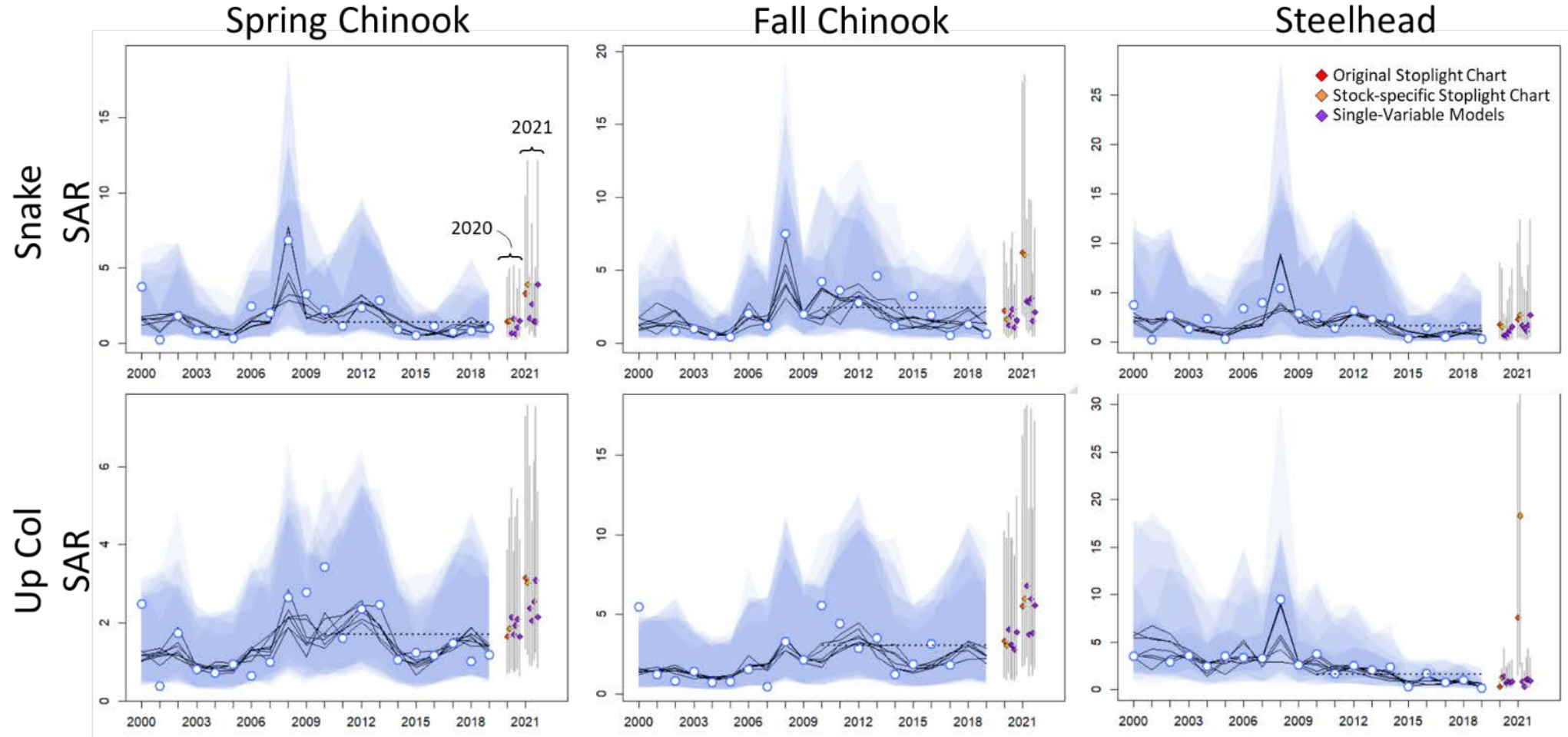


Expect **above average survival**  
for young salmon that entered  
the ocean in 2021

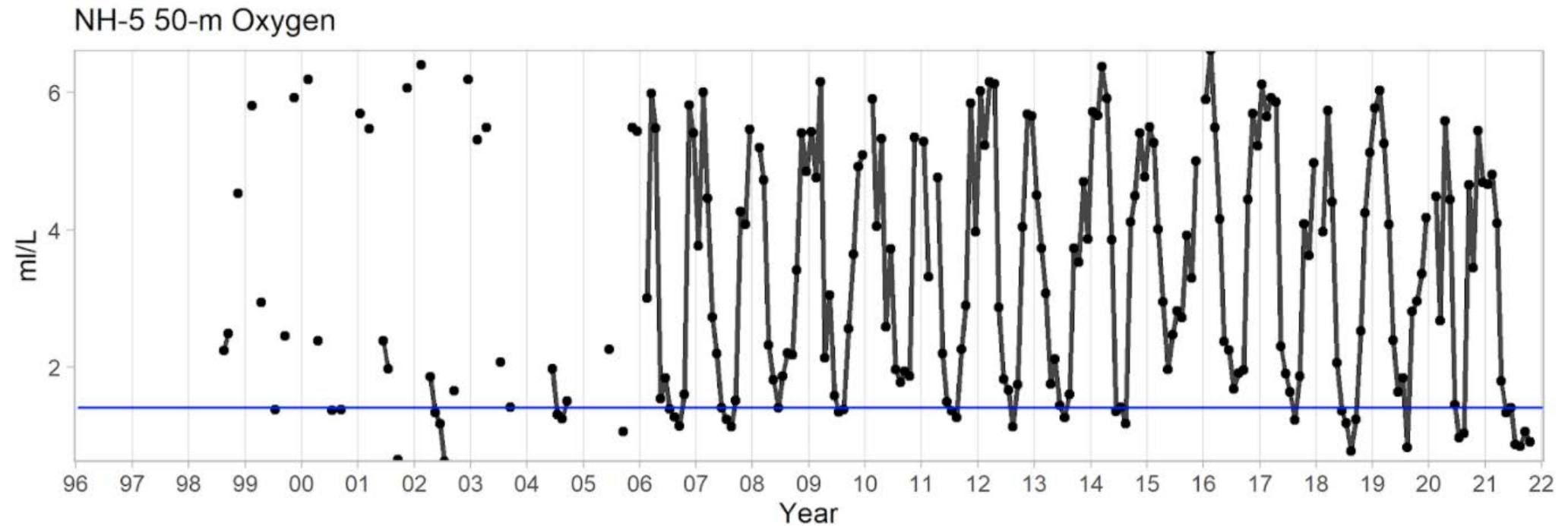


# Smolt to adult forecasts for 2020 & 2021 out migrants

(From Brian Burke, NWFSC)



But... hypoxia (low oxygen) was strong in bottom waters





## 4. Recent Pacific salmon trends

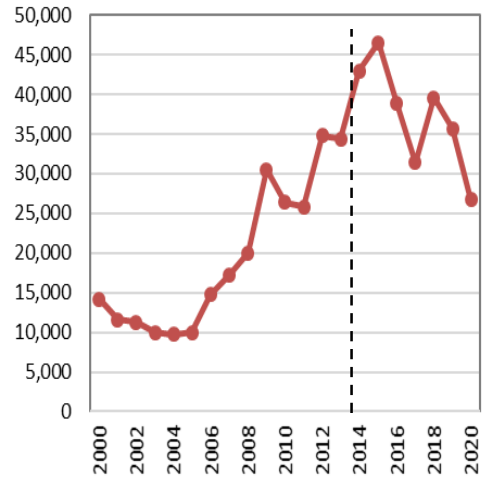
seeing impacts of marine heat waves around the Pacific Rim (high & low)



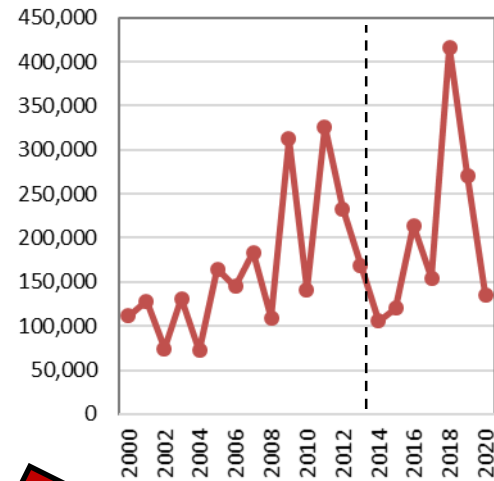
# Catch by country/state shows diverse trends

(numbers of fish in 1,000s)

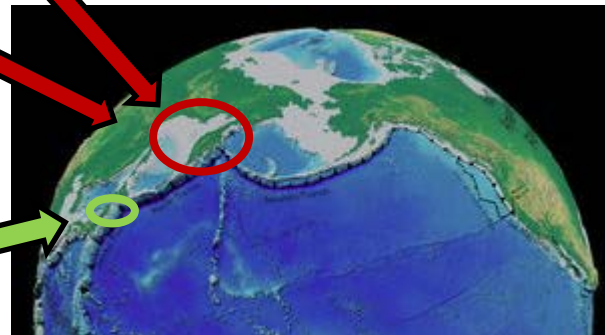
Russia chum



Russia pink



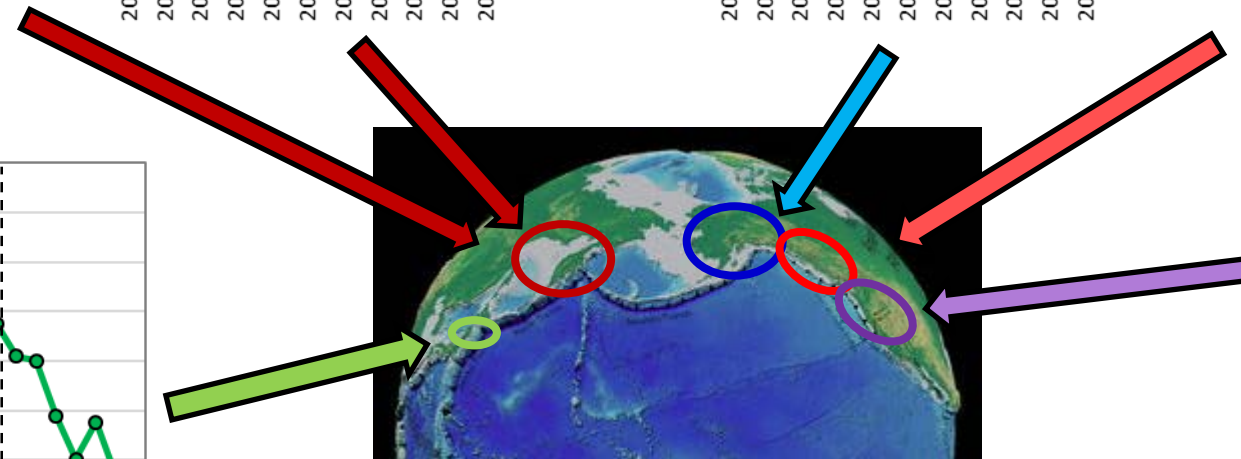
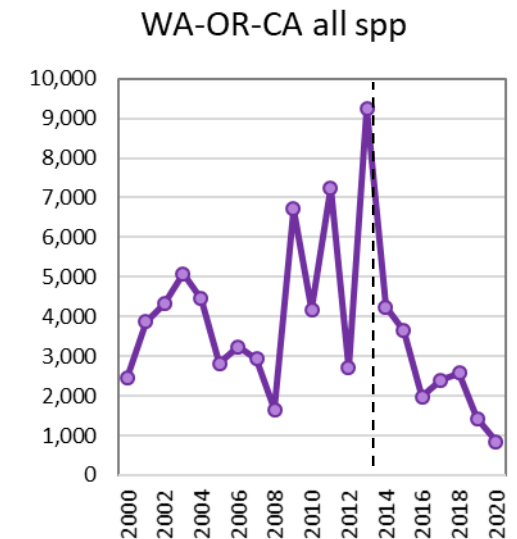
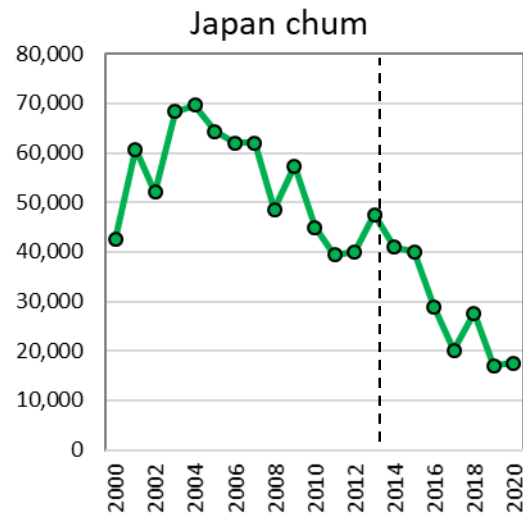
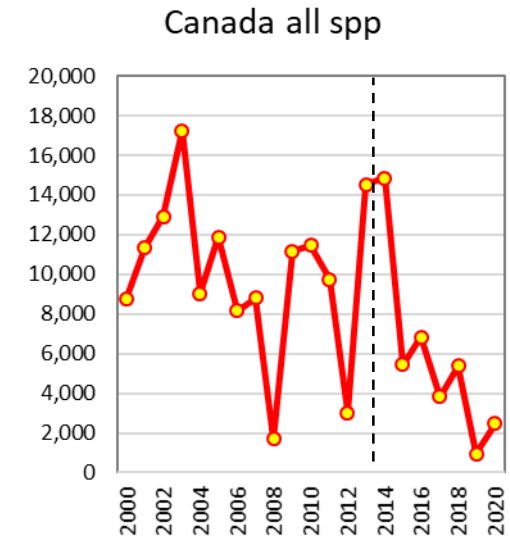
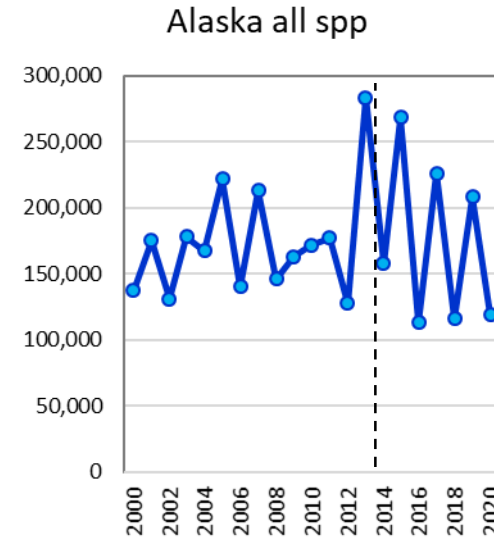
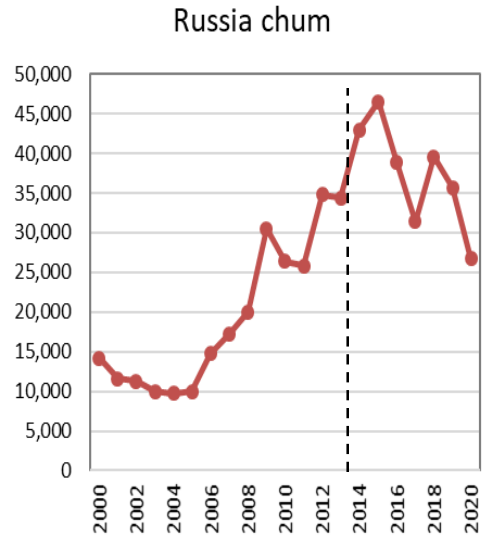
Japan chum



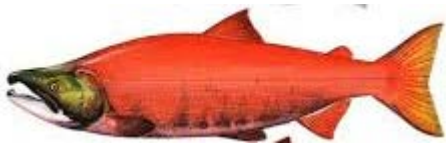
Data from NPAFC.org

# Catch by country/state shows diverse trends

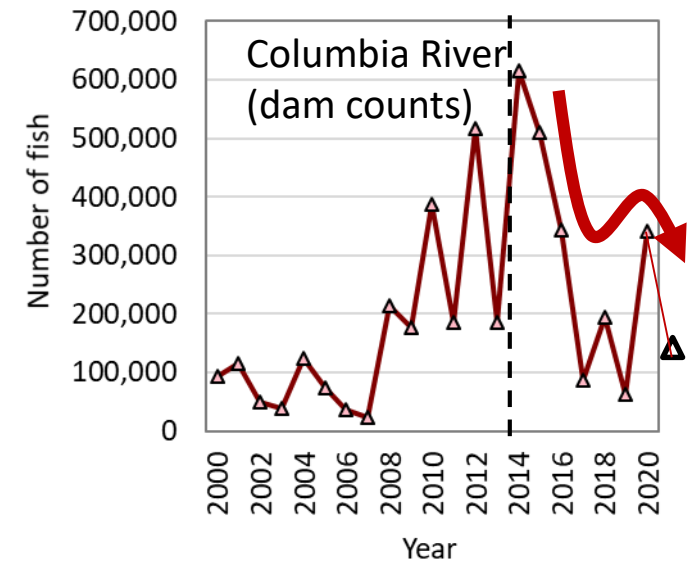
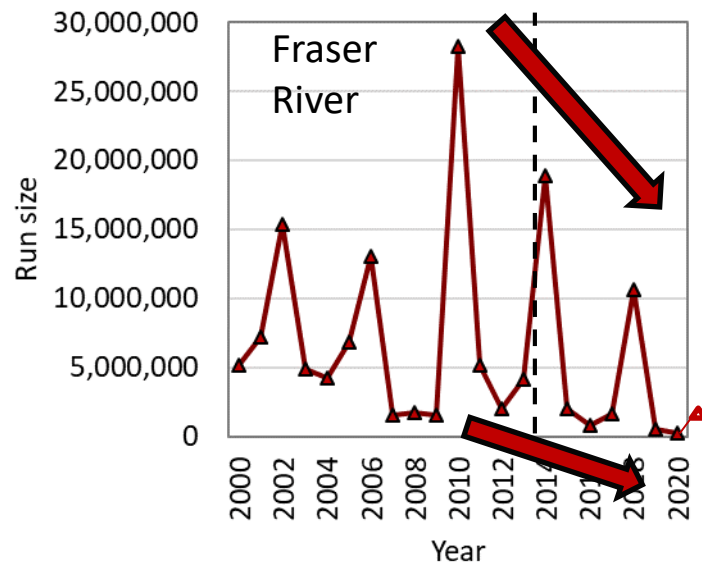
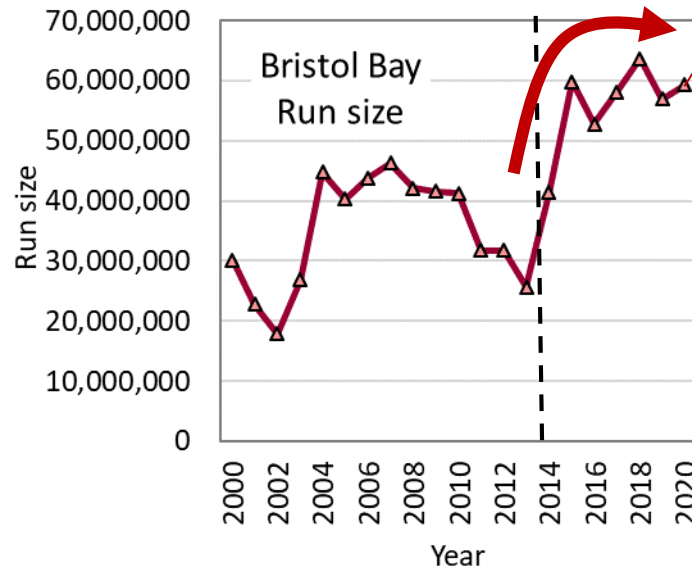
(numbers of fish in 1,000s)

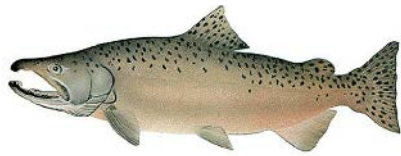


Data from NPAFC.org

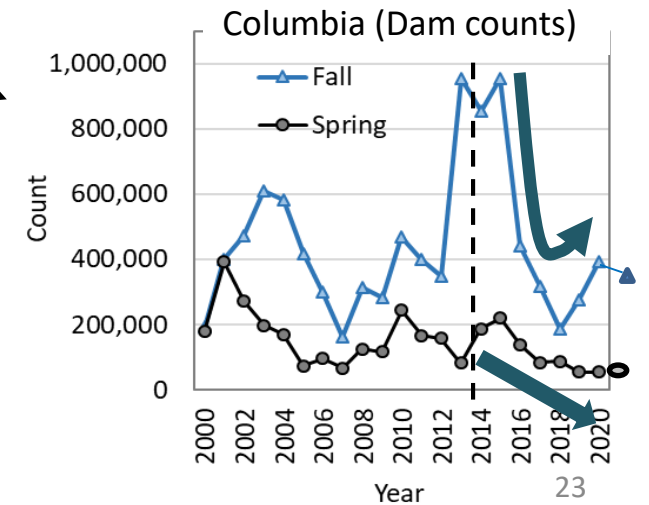
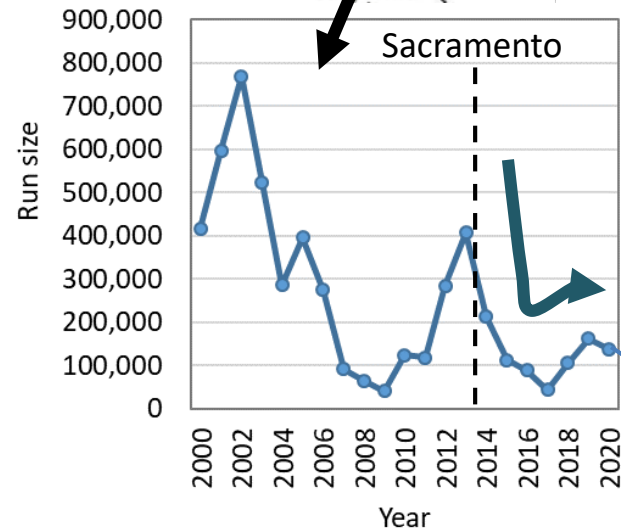
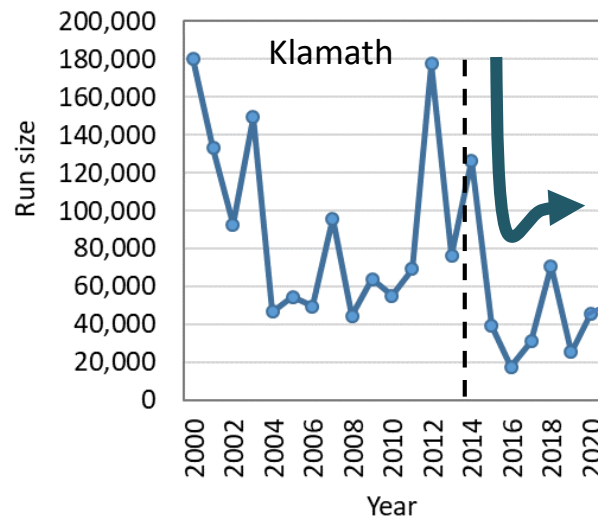
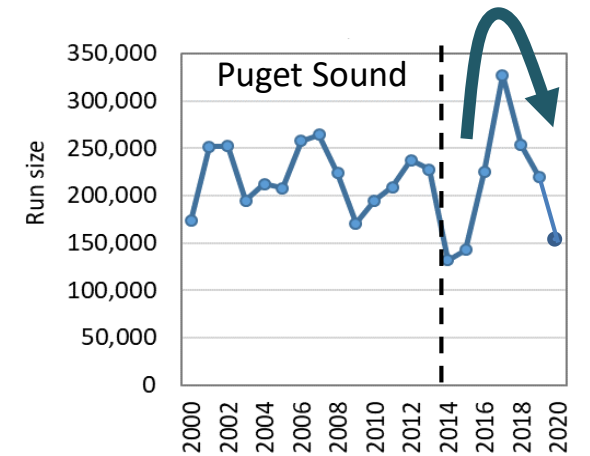
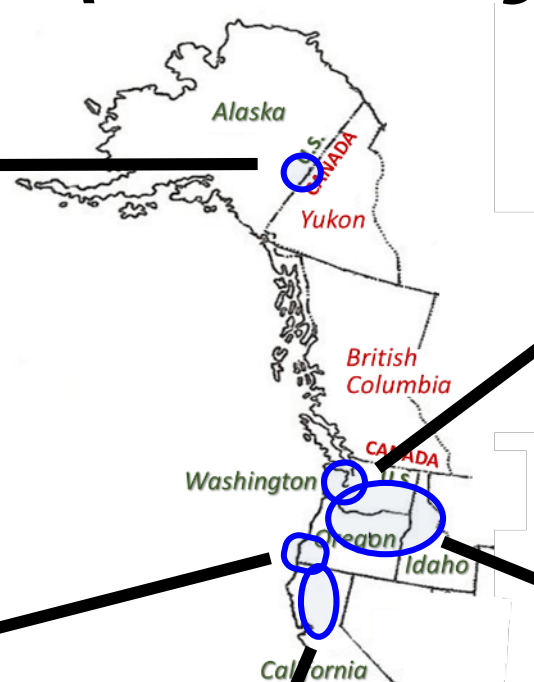
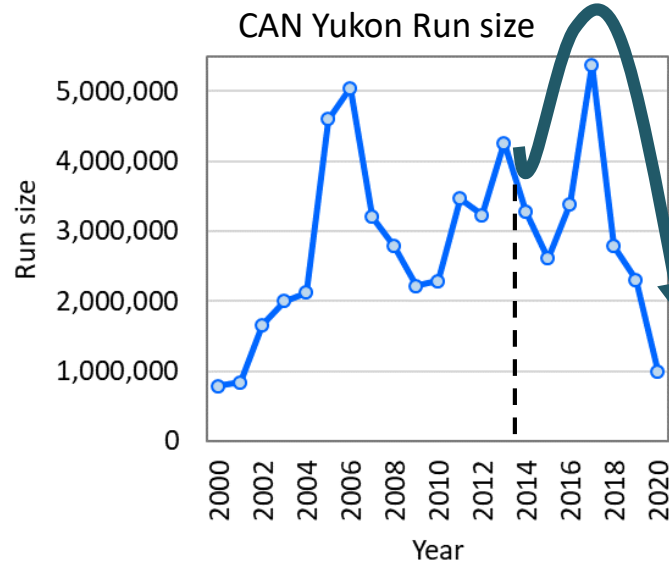


# Sockeye (*O. nerka*)





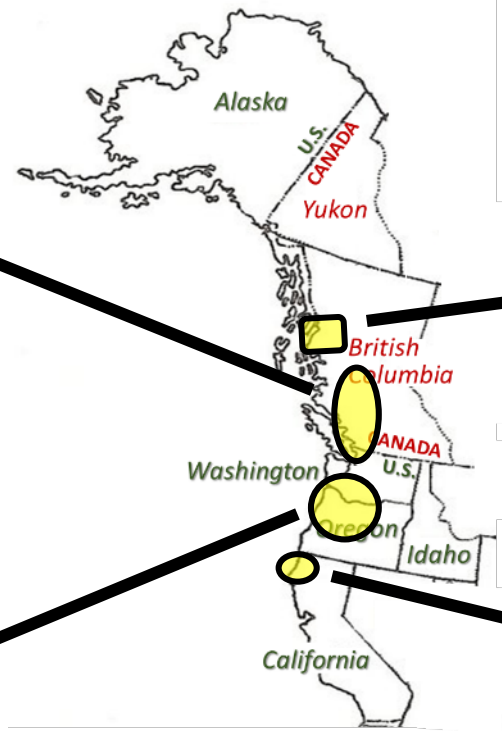
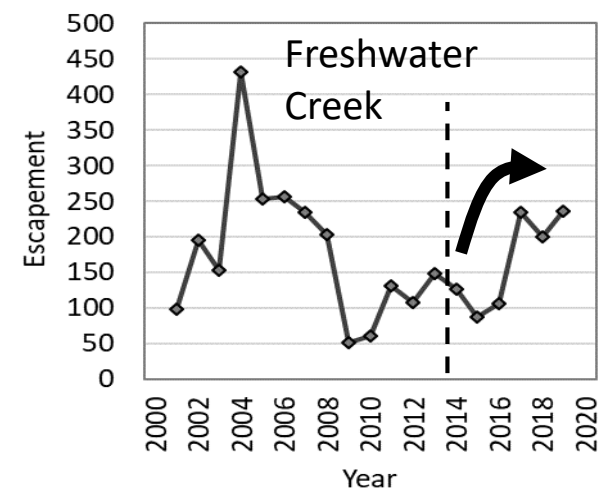
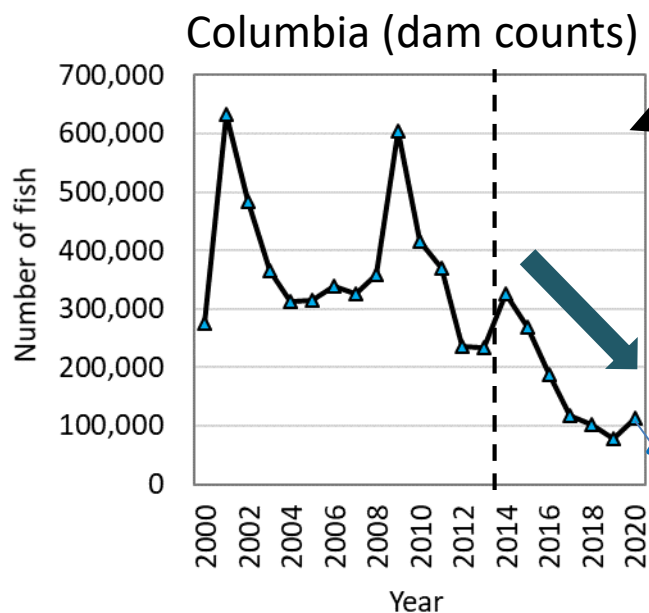
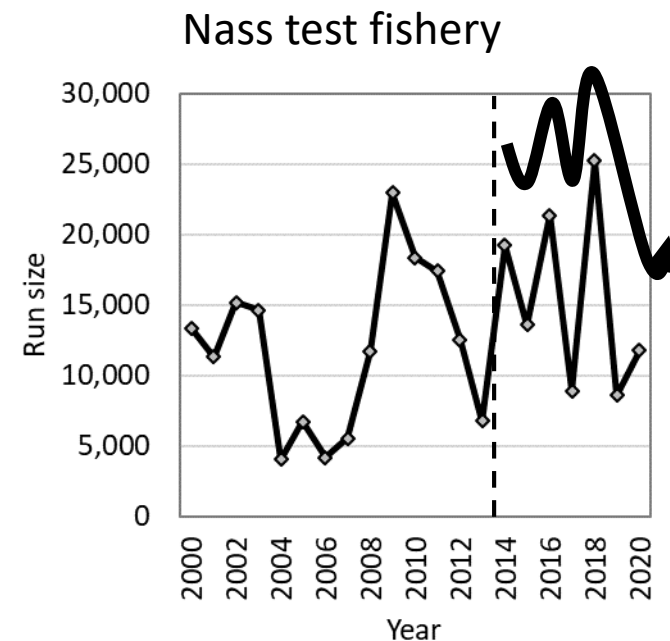
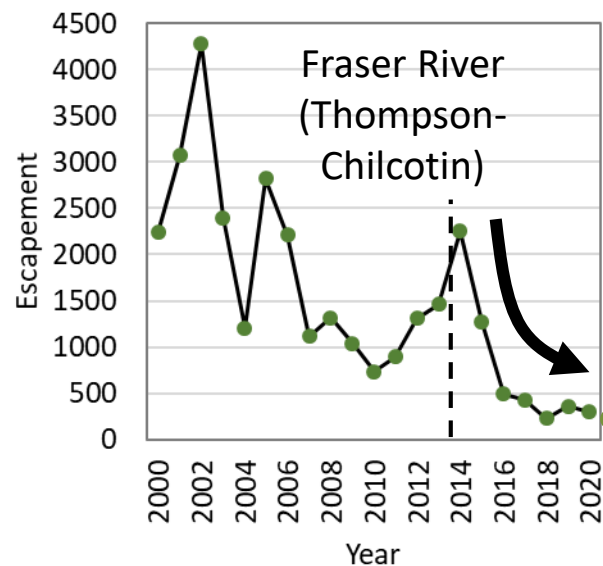
# Chinook (*O. tshawytscha*)







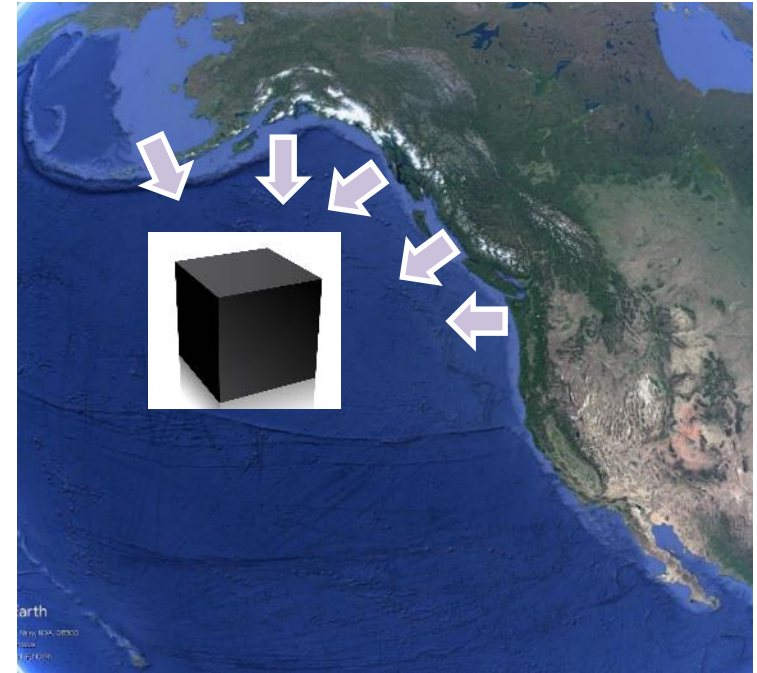
# Steelhead (*O. mykiss*)



# 5. IYS High seas salmon survey

## Why the survey?

- We know very little about salmon once they leave coastal areas for high seas (=black box)
- Low prey availability in winter may create survival bottleneck
- Recent unexpected salmon returns (both high and low) suggest changes in mortality schedules
  - high seas to blame?
- Builds on Gulf of Alaska expeditions in 2019 and 2020.



<https://yearofthesalmon.org/high-seas-expeditions/>

# Using 5 ships concurrently with identical methodologies



Canada: Franklin



US: Shimada



Russia: TINRO



Canada: Raw Spirit



US: NW Explorer

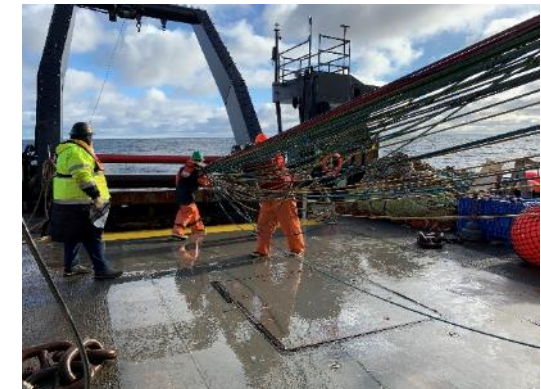
Physical  
oceanography



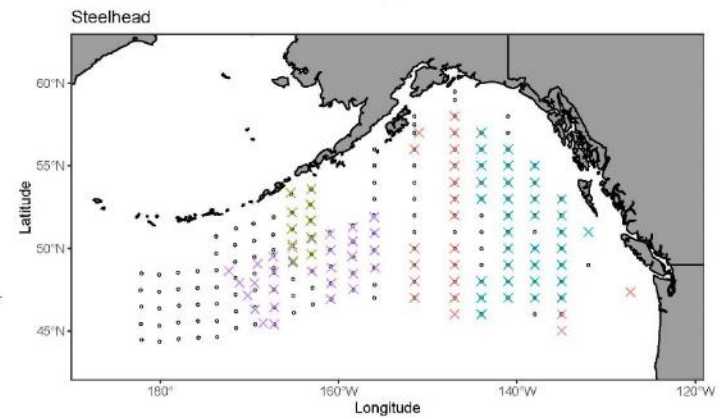
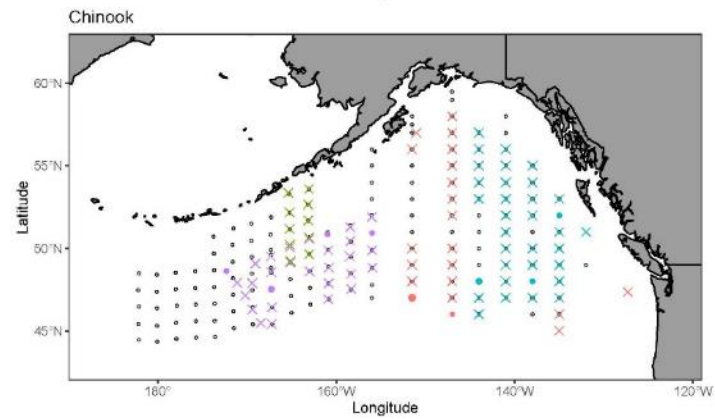
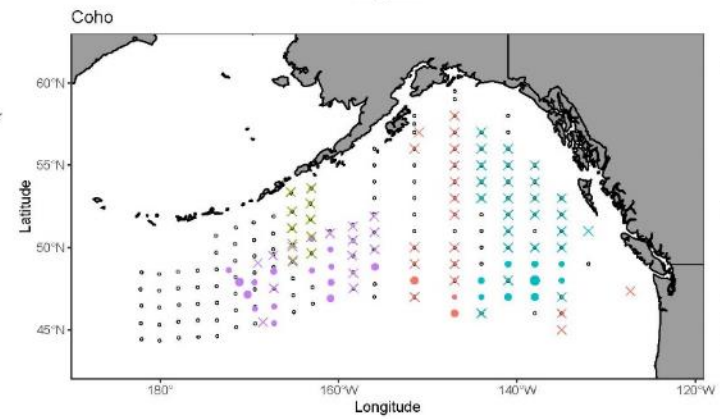
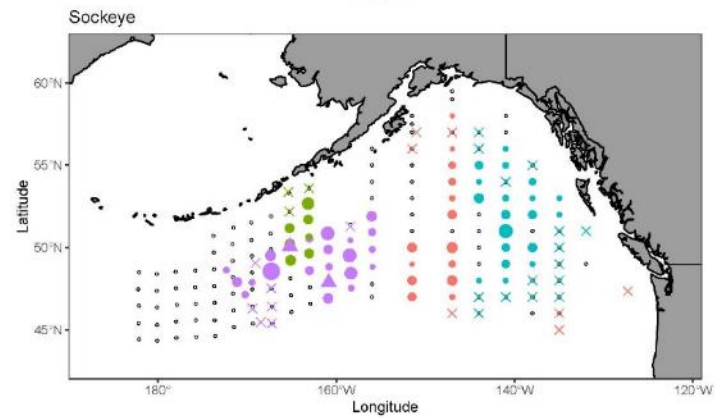
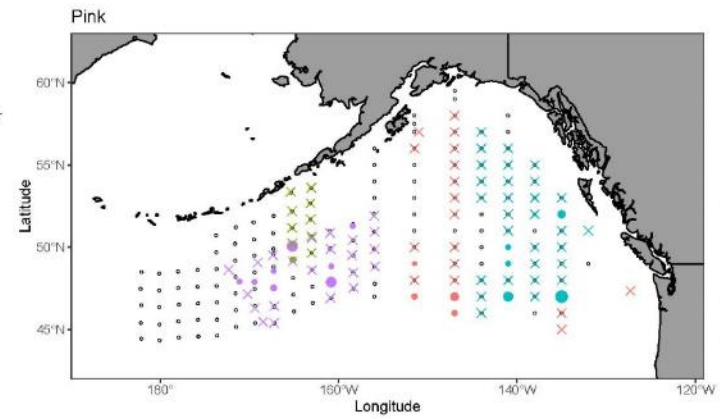
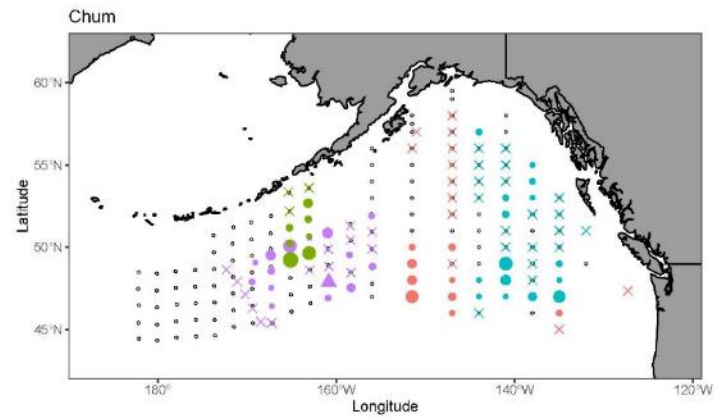
Biological  
oceanography



Fishing  
(surface trawl  
or gillnet)







Questions?

