Agenda Item H.1.a
Supplemental CCIEA Team Presentation 1
March 2023

2022-23 California Current Ecosystem Status Report

NOAA California Current IEA Team

Presented to PFMC Advisory Bodies
March 4, 2023

Acknowledgments

2022-2023 CALIFORNIA CURRENT ECOSYSTEM STATUS REPORT

A report of the NOAA California Current Integrated Ecosystem Assessment Team (CCIEA) to the Pacific Fishery Management Council, March 7, 2023

Edited by: Chris Harvey, Andy Leising, Nick Tolimieri, and Greg Williams
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Special thanks to Dr. Toby Garfield, SWFSC

Summary

Key takeaways from 2022:

Basin-scale climate patterns started out encouragingly for the California Current

Partly offset later in the year by local dynamics and a major marine heatwave

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Mixed Ecological Signals

Base of food web and forage productive in central and south, mixed in the north

Mixed signals for Chinook salmon returns in different regions

Good production of predators in central and south

A strong new year class of sablefish?

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Unfavorable conditions and risk factors

Major marine heatwave, with coastal influence

Dry spring in 2022 contributed to ongoing drought

Uptick in HABs in late 2022 in the north

Fishing portfolios continued to be less diversified

Potential constraints of offshore wind energy on fishing & surveys are coming into focus

Mixed Ecological Signals

Base of food web and forage productive in central and south, mixed in the north

Mixed signals for Chinook salmon returns in different regions

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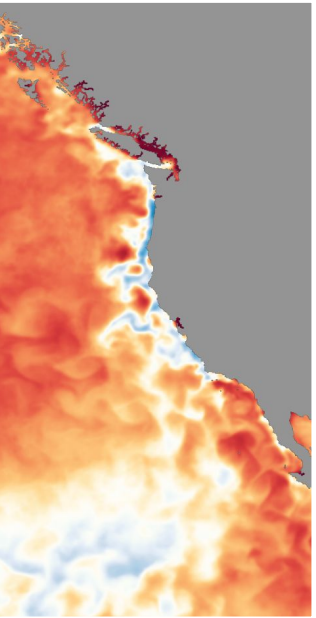
A strong new year class of sablefish?

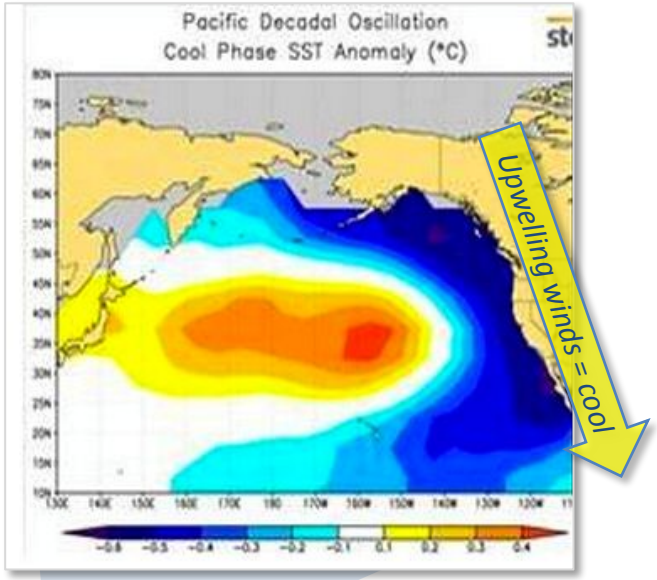


Month-by-month
“year in review”

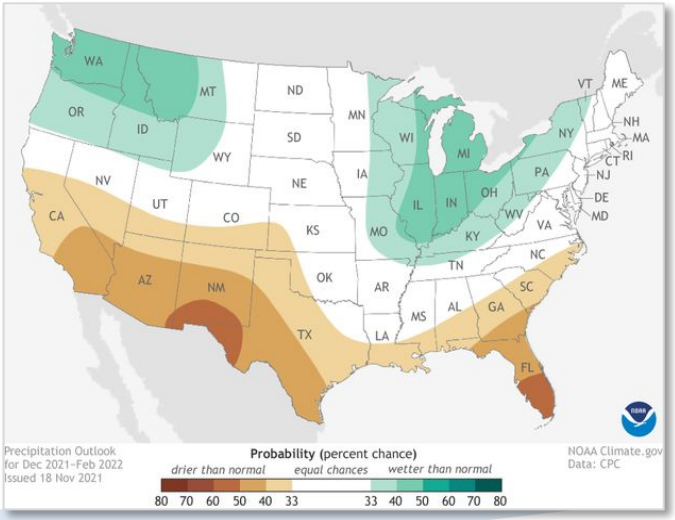
January 2022: Encouraging physics in the North Pacific

Negative PDO + La Niña

Usually means conditions will be GOOD!

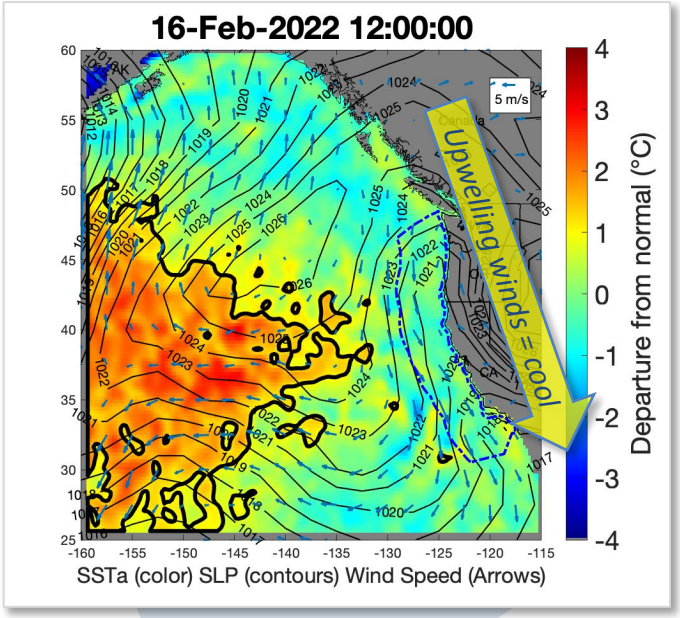


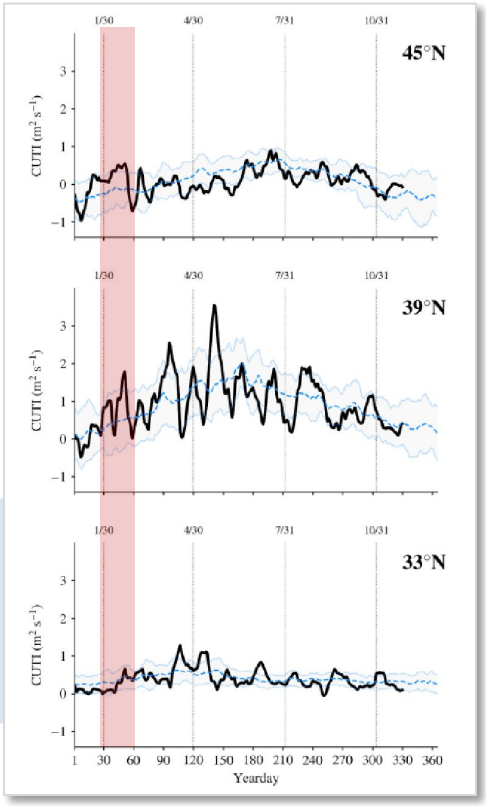
High Winter Precipitation in NW, Dry in the SW



Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

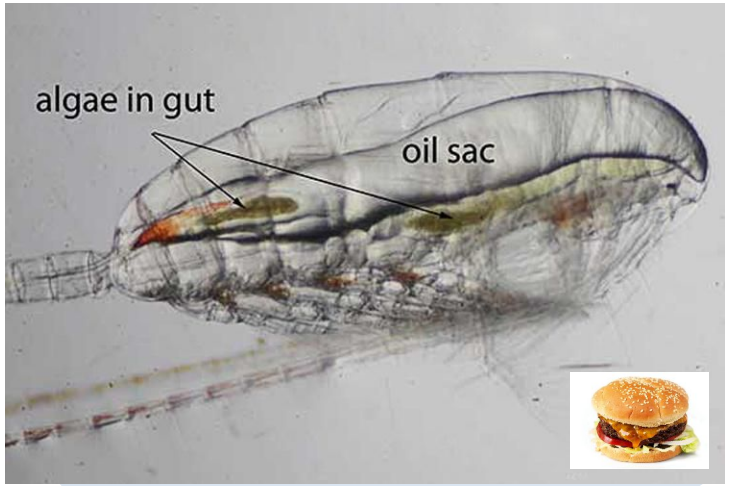
February 2022: Heatwave appears offshore, upwelling surges inshore



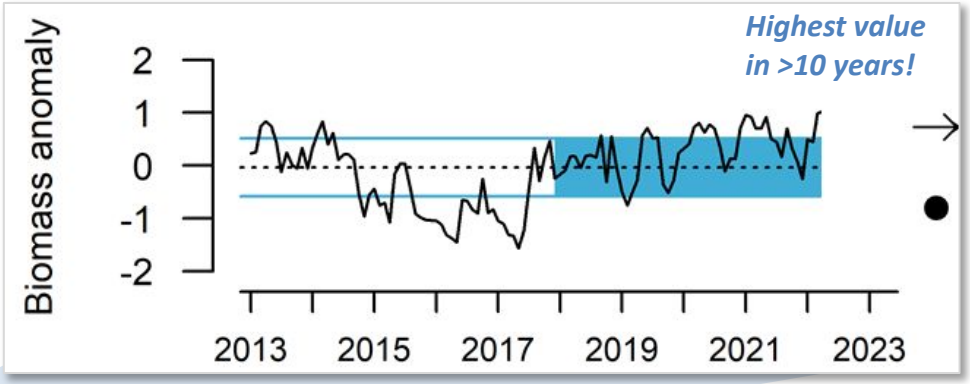


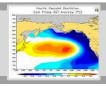
Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec

March 2022: good numbers of fatty copepods off Oregon!



Northern Copepod Biomass Anomaly, 44.6 °N

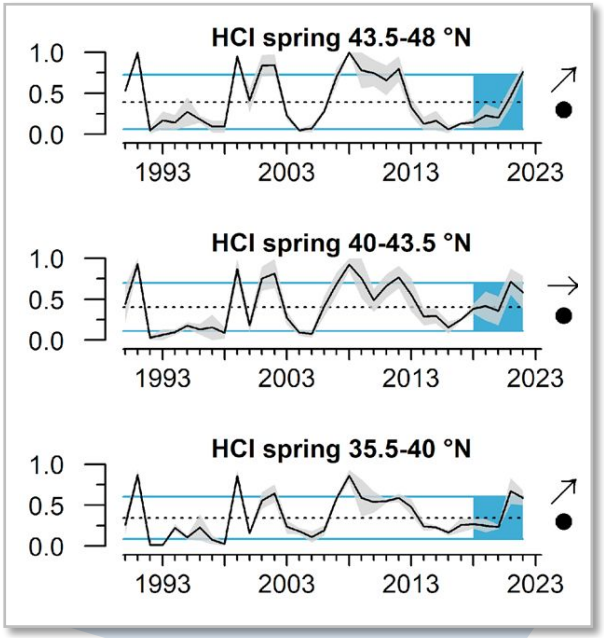




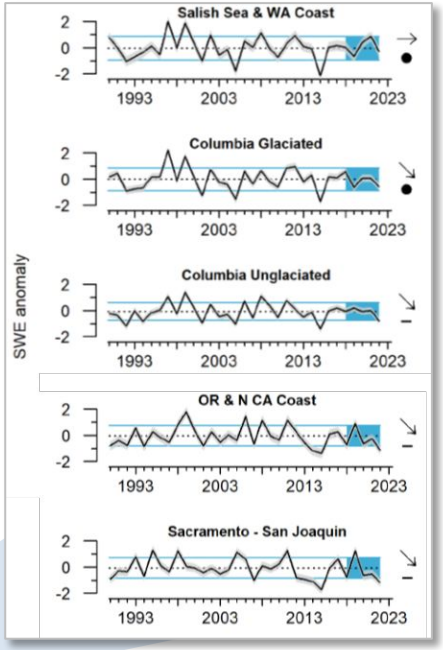

Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec

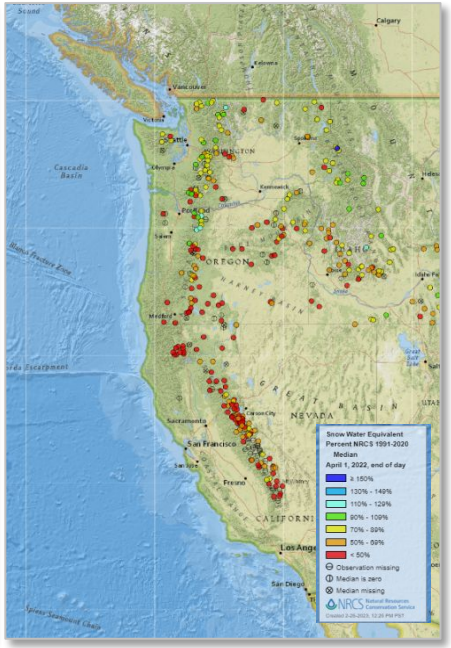
April 2022: Cool coastal waters, but concerning signs on land

Lots of **cool** coastal habitat available



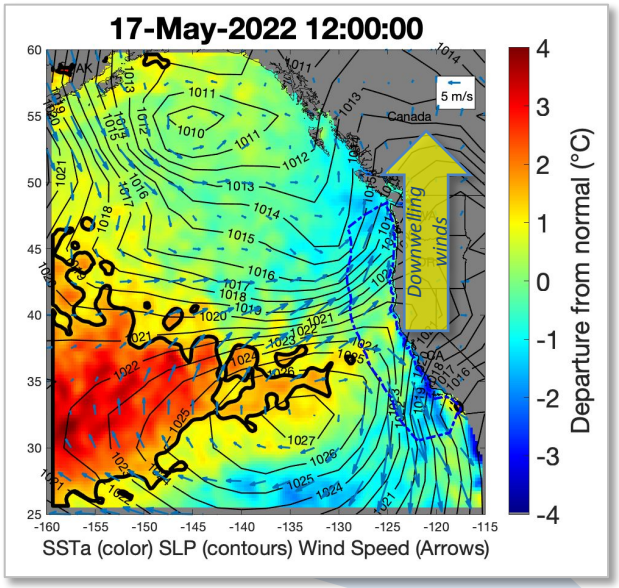
Generally **poor** regional snowpack on April 1, 2022

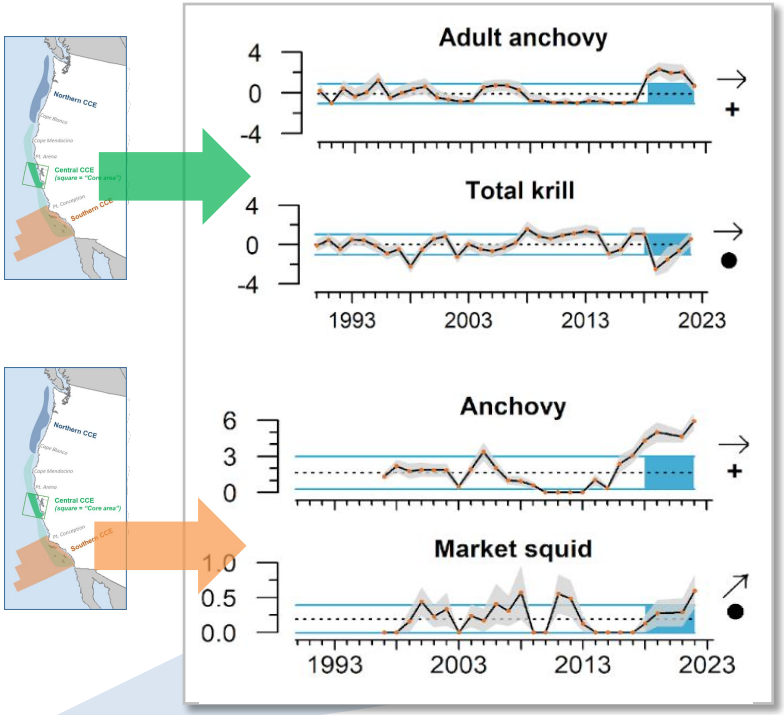




May 2022: Changing physics, and first look at forage

Anomalous Low Pressure Cell: heatwave moves towards coast, upwelling is disrupted

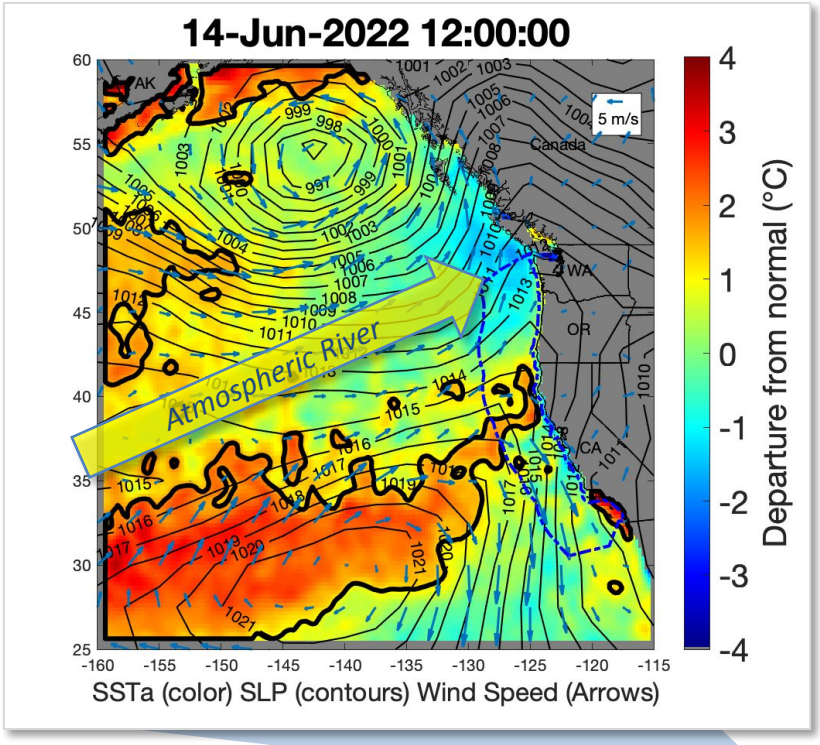




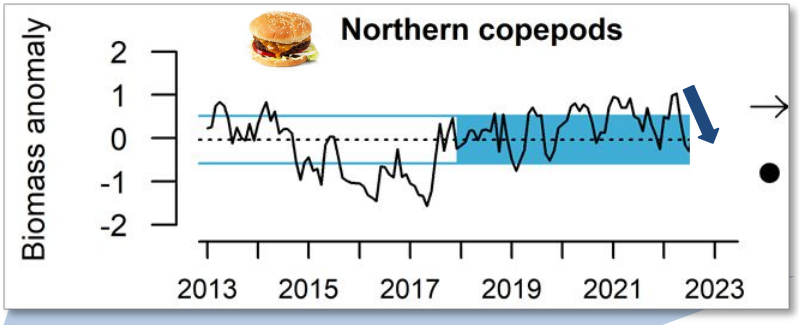
Adult anchovy and krill catches good in the Central CCE

Anchovy and squid larvae very abundant in the South

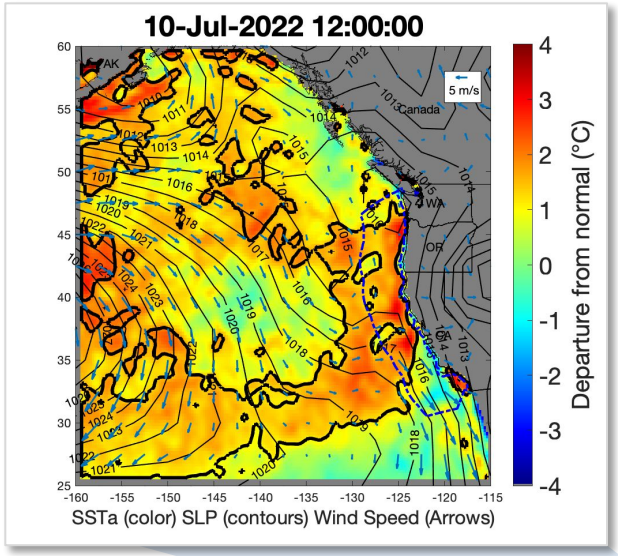
June 2022: Storm brings first Atmospheric River and Disruption

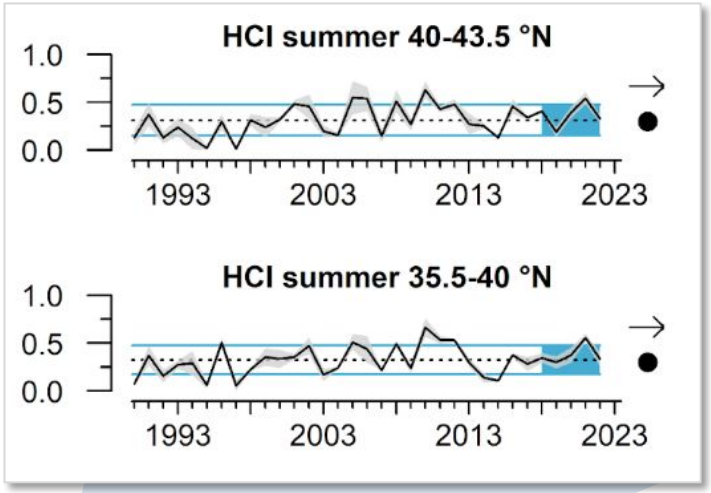


Tasty copepods have declined, much earlier than normal, but are still at ***average*** levels

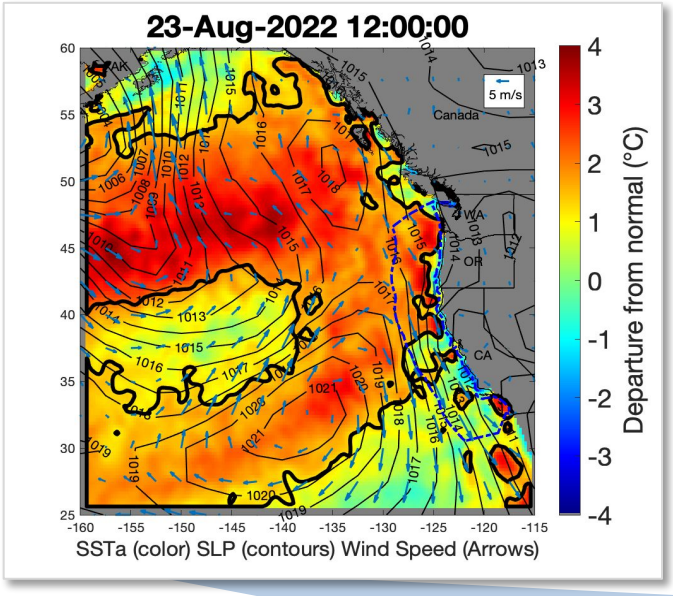


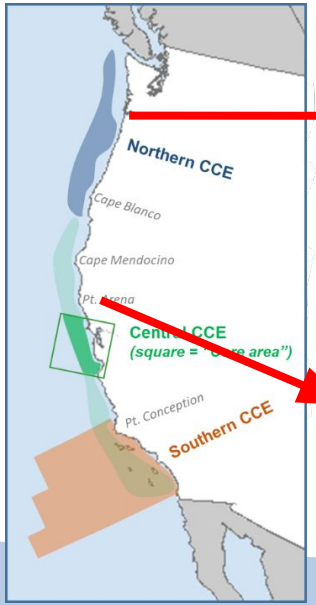
July 2022: Heatwave intrusion compresses Habitat





August 2022: Heatwave in full swing, Ecosystem feeling the effects

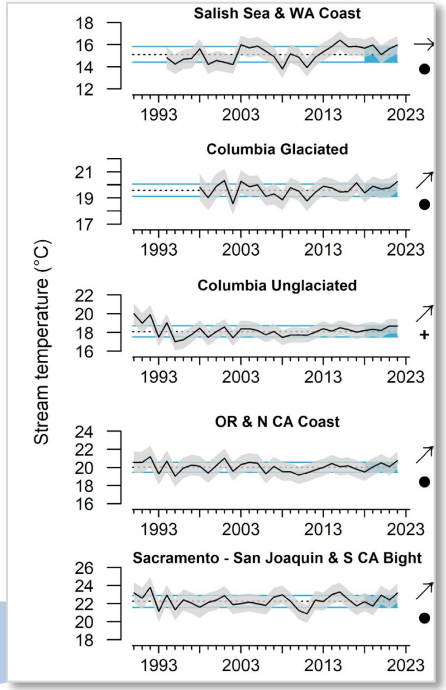


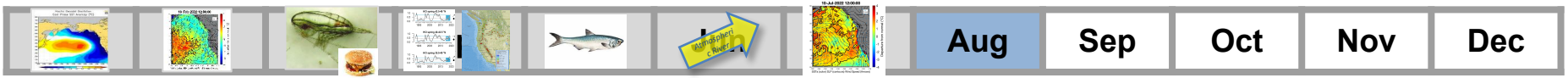


FAT copepod numbers continue to decrease

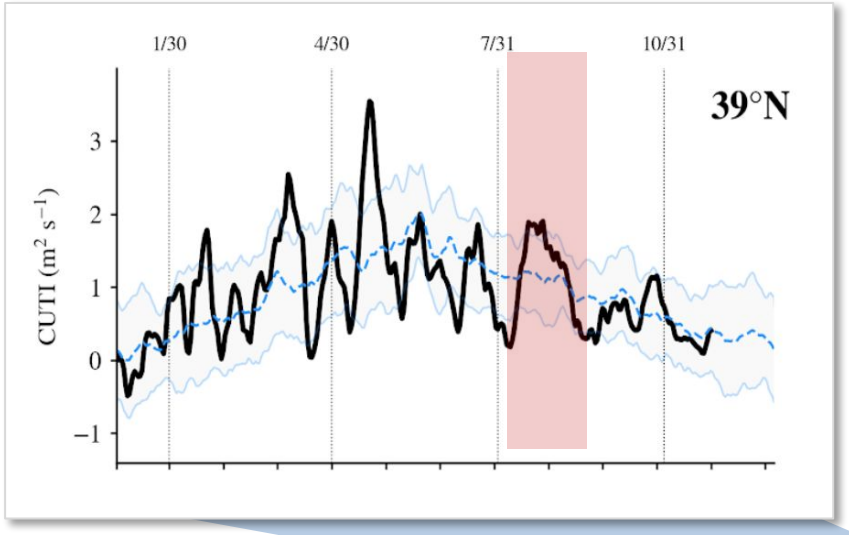
Krill in Central, Smaller than expected due to high temps

Warm Stream Temps



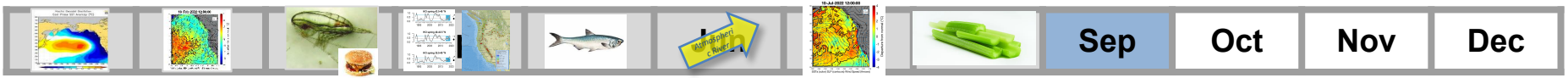


September 2022: Late season upwelling presages DA closures

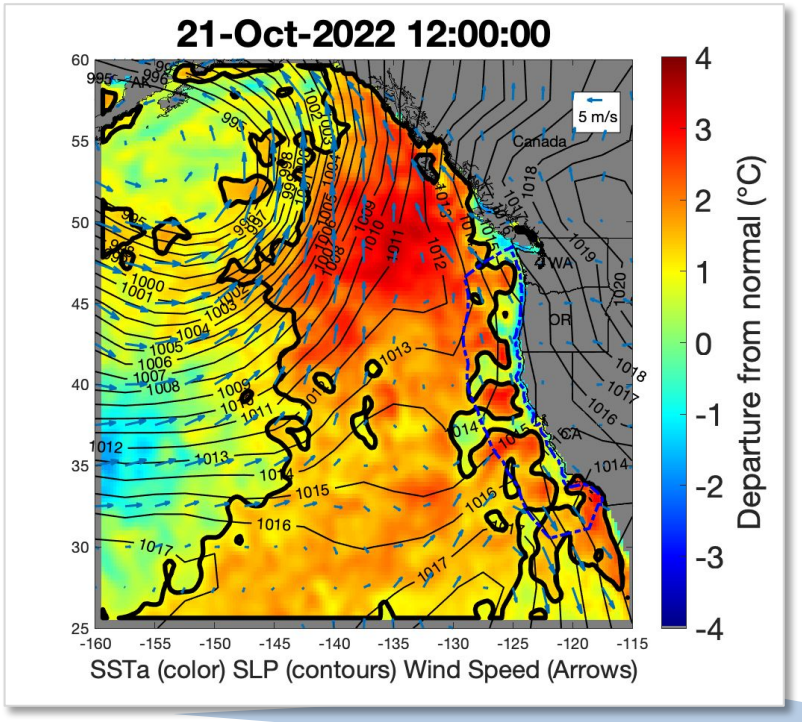


Razor clams closed on Quinault beaches, early Sept., opening of Mocrocks and Point Grenville cancelled in Mid Sept., northern Oregon (OR/WA border to Cascade Head) was closed on September 23, and the rest of the Oregon coast (Cascade Head to the OR/CA border) was closed on September 30

***Highest known recorded animal DA ~ 507,608 ng/g in feces of California Sea Lion CIMWI-SB-22-124-CU-001 from Channel Islands Marine Wildlife Institute (CIMWI), also large numbers of strandings**

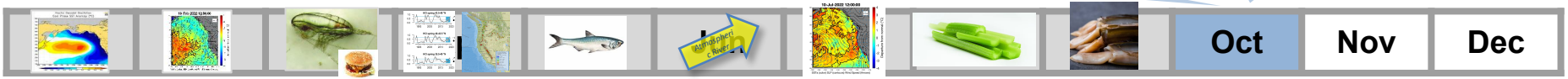


October 2022: More heatwave, more closures…

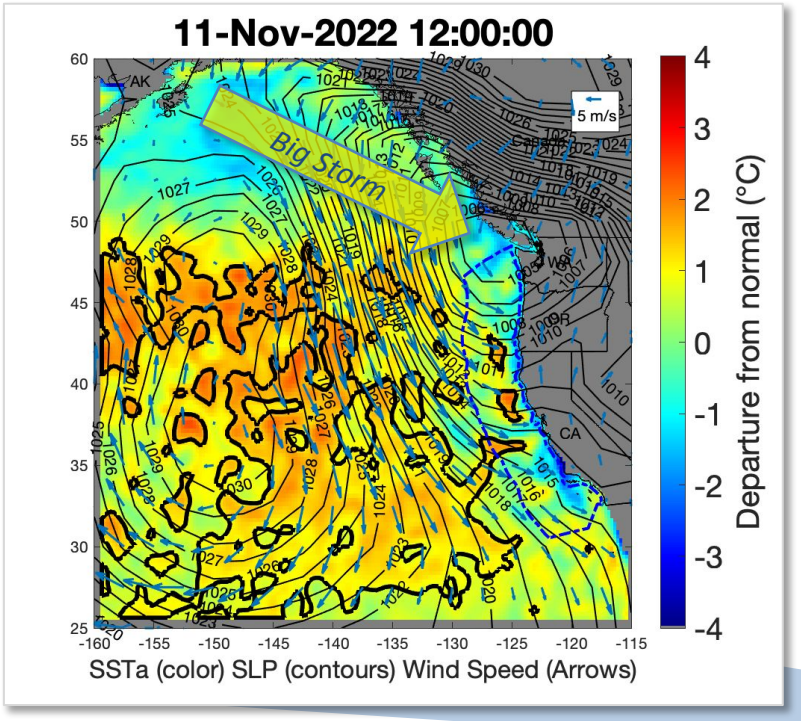


October 14, mussels exceeded the regulatory threshold, resulting in a closure from Yachats River to the OR/CA border.

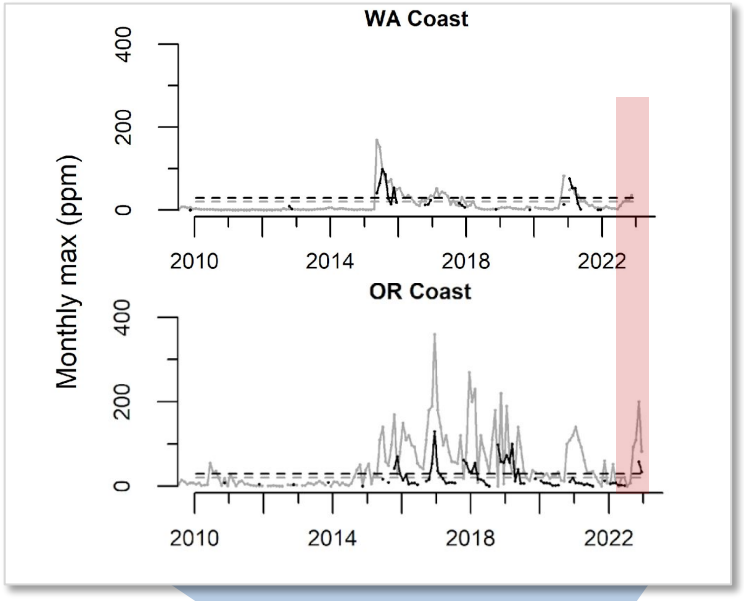
Domoic acid exceedances in mussels in Humboldt County, October

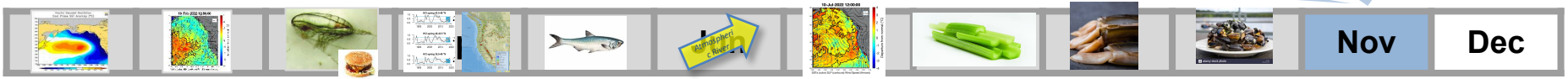


November 2022: Relief from the heat, at the price of more storms



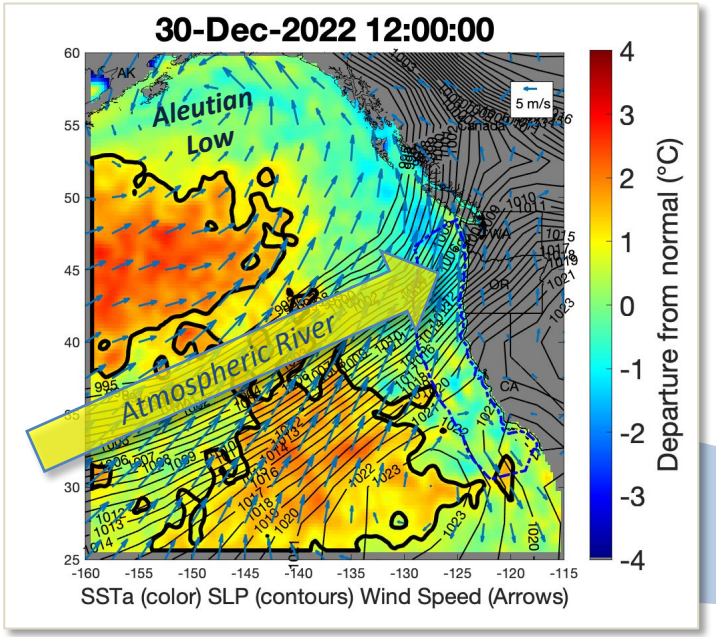
WA and OR:
ALL RAZOR CLAMS CLOSED





December 2022: Downwelling and atmospheric rivers

Aleutian Low dominates; full transition to downwelling; heatwave persists but far offshore



The Washington Post
Democracy Dies in Darkness

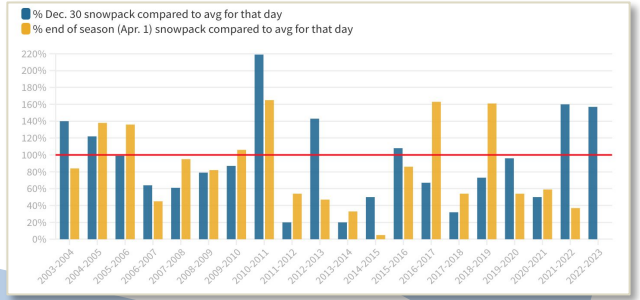
A truly 'brutal system': Atmospheric river to slam California

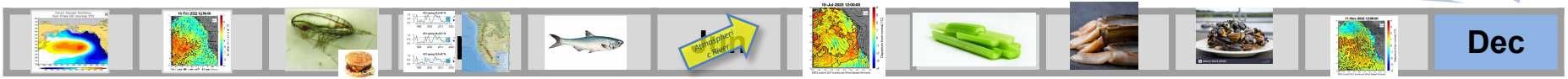
Western US battles rain and flooding as 'atmospheric river' storm hits

The Guardian

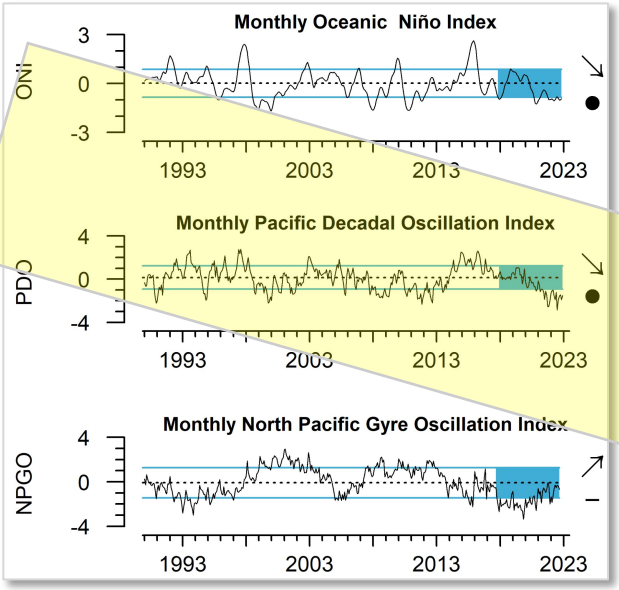
Portions of northern California, Oregon and Washington could see an inch of rain an hour, spurring mudslides and debris flows

High snowpack already by end of December



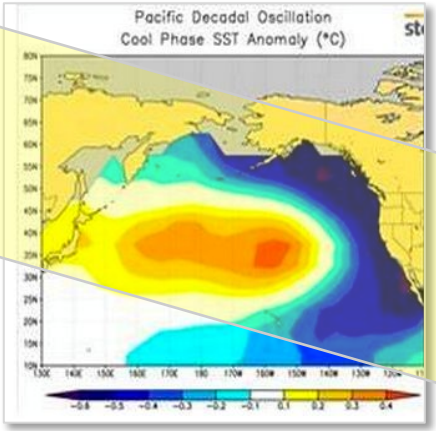


2022, Physical Summary: what we expected…

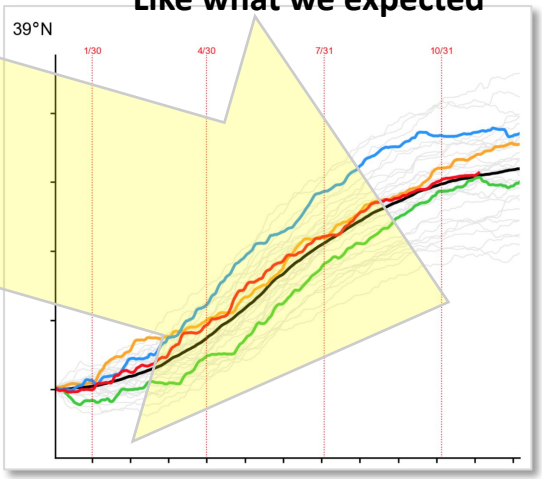


Broad-scale indices were encouraging

Generally Favorable Cool Coastal Conditions



Cumulative Upwelling Like what we expected

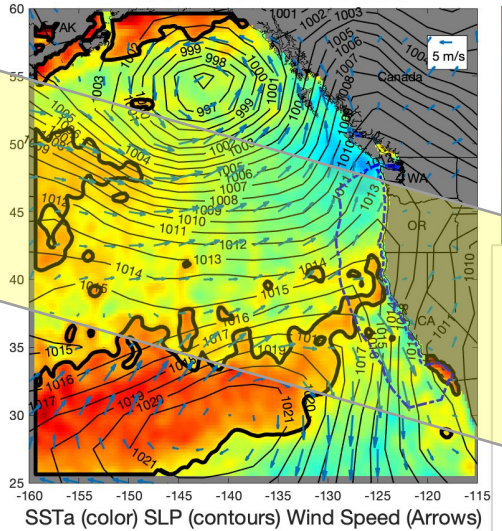


Total looks "average" for 2022

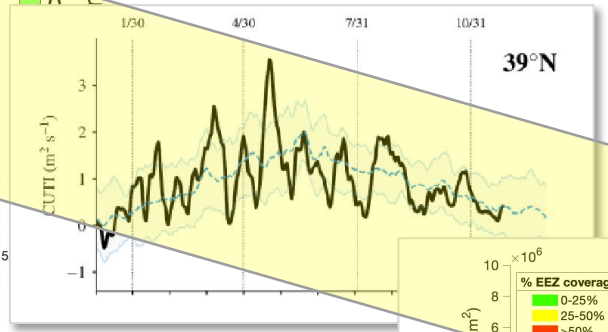
2019 2020 2021 2022

2022, Physical Summary: What we got…

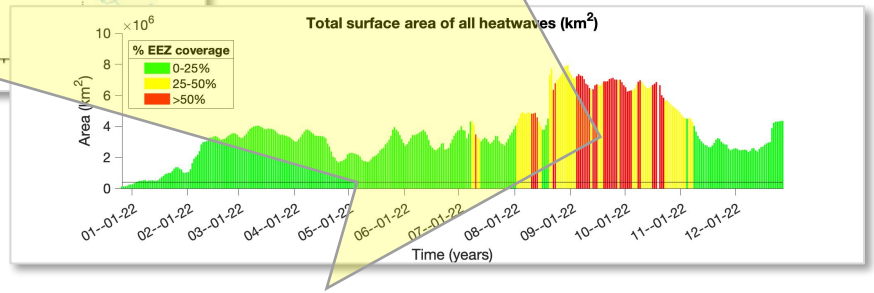
Atmospheric Anomalies
(Strong summer Aleutian Low)
14-Jun-2022 12:00:00



Extremely Variable
upwelling/downwelling



Disruptions to system (heatwaves, etc.),
mostly to the North

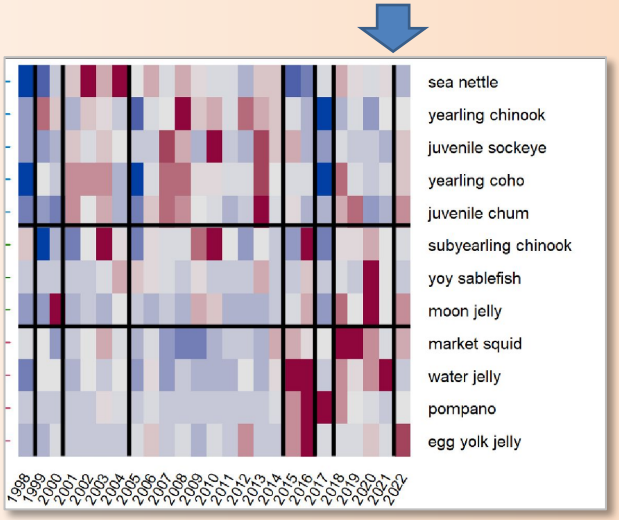


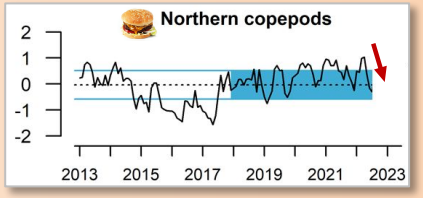
Connecting some dots in the food web

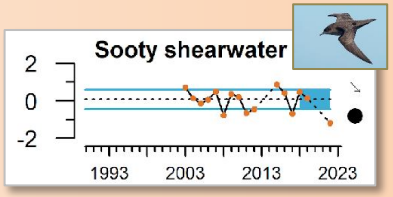
Indicators of May/June feeding conditions varied from North to South

North

- Shift in pelagic community composition, including some warm/offshore species
- Springtime drop in fat-rich copepods; average krill indices
- "Bird desert" offshore in spring

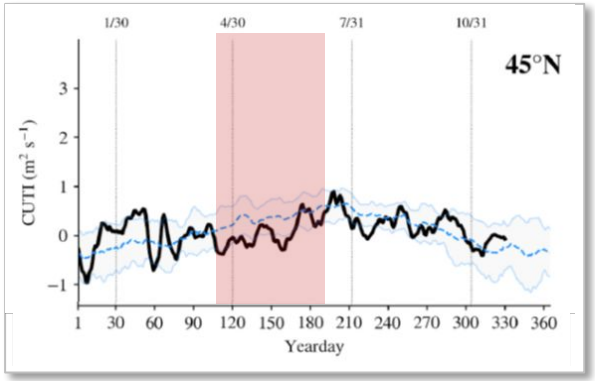






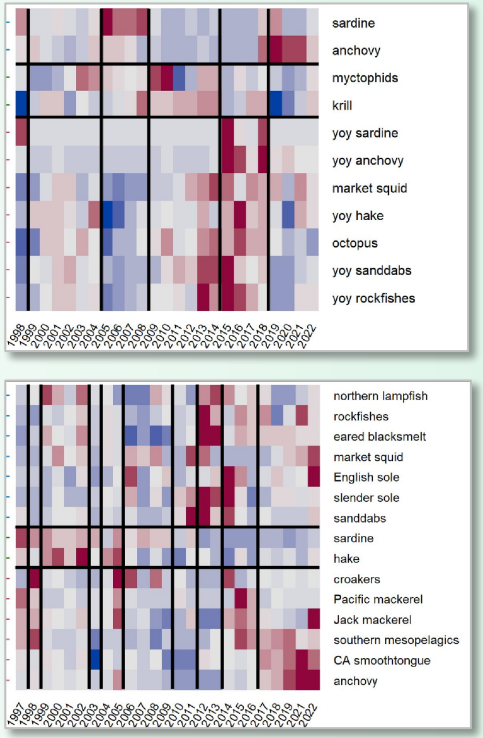
Sustained weak upwelling and even downwelling occurred off Newport in spring

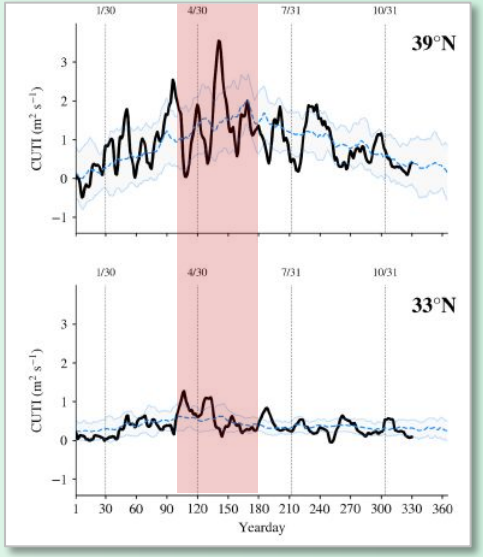
*(**surprising** for La Niña and PDO-)*



Indicators of May/June feeding conditions varied from North to South

- No significant pelagic community shifts in either region
- Anchovy remain very abundant; average to good catches of many other groups
- ***Better upwelling conditions***





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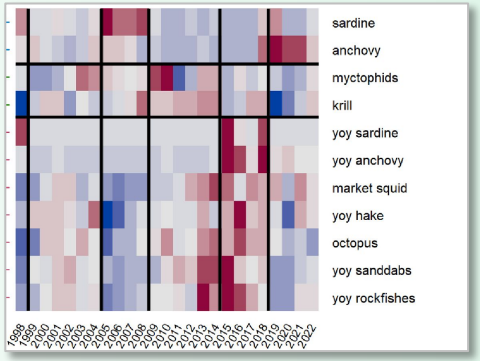
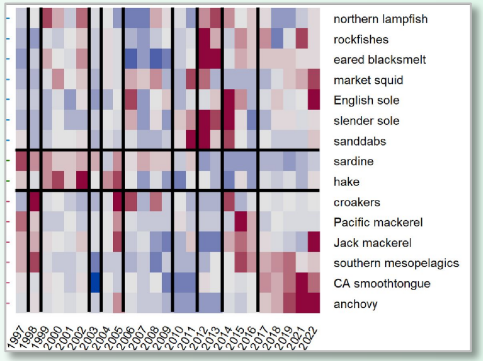
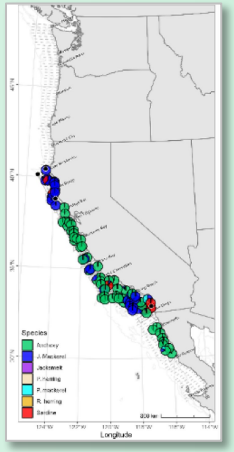
Central

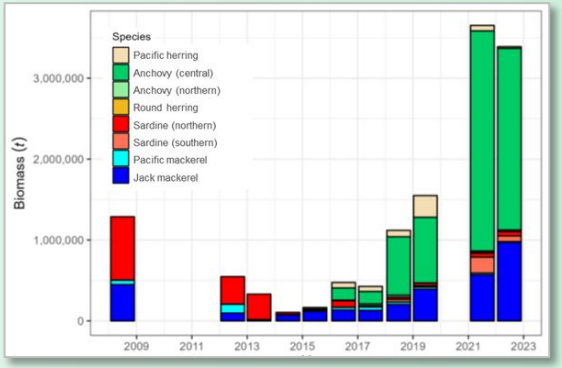
South





Anchovy observations consistent with results from June CPS survey:





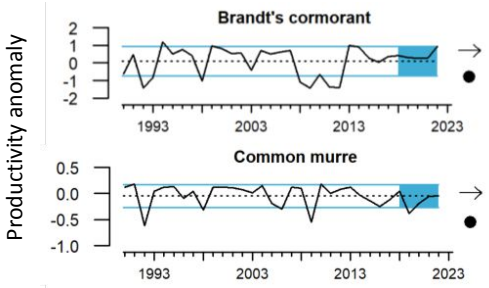
Anchovy production continues, and is supporting a lot of predators

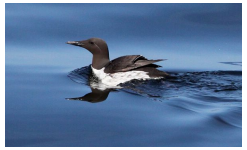
Central CA seabirds

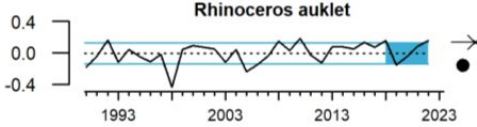
California sea lions

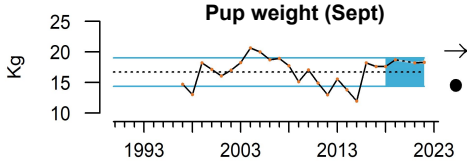
HMS

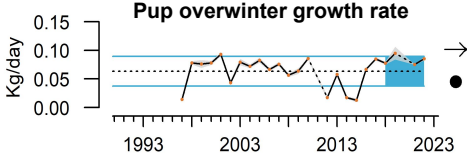
Central Valley fall Chinook salmon?

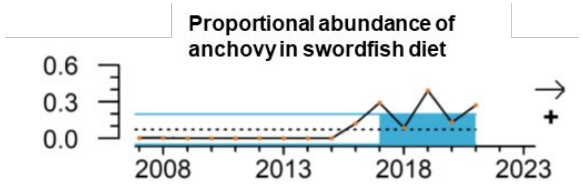










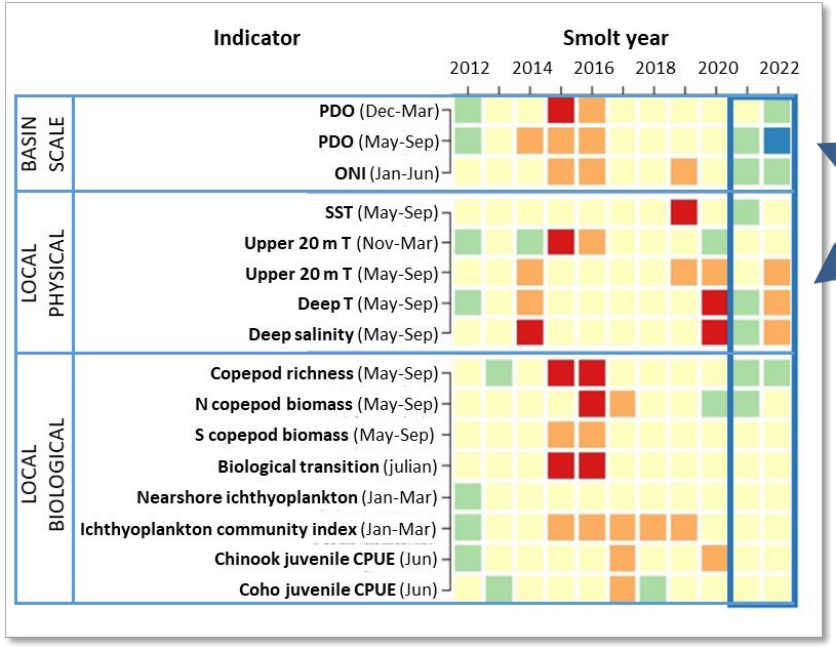


Several hundred anchovy from a single bluefin tuna stomach

Salmon signals are mixed by life history, region and life stage

Northern California Current stoplight table

(Columbia Basin Chinook, Oregon coho)



Mismatch between basin-scale and local physics in spring and summer 2022

Those conditions will influence coho returns in 2023

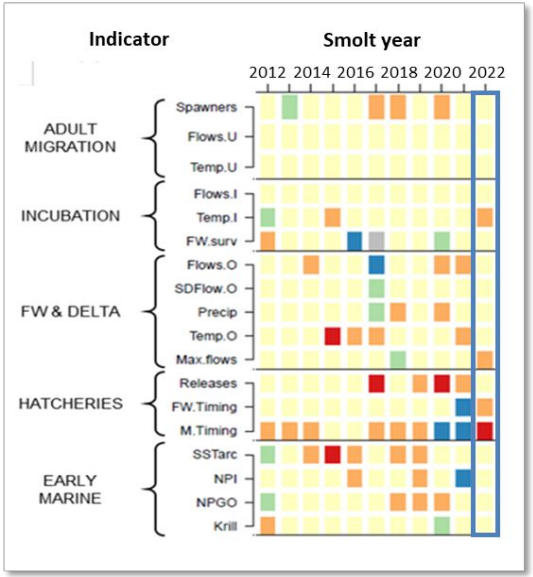
Signals from smolt year 2021 were more positive, which is encouraging for Chinook returns to the Columbia Basin in 2023 (see Appendix J.2)

Salmon signals are mixed by life history, region and life stage

Klamath River Fall Chinook

Smolt year 2022:

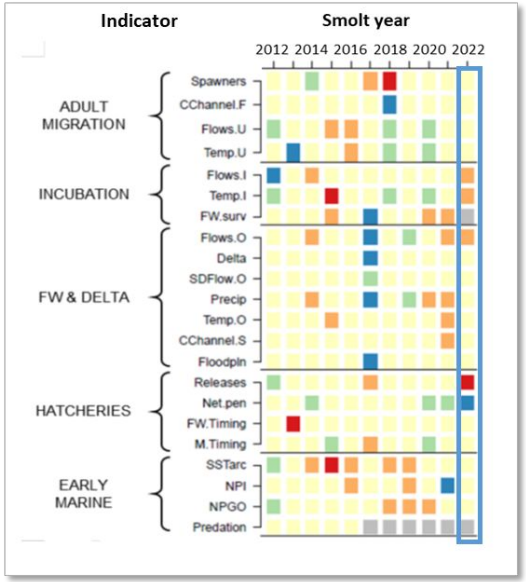
- ***worst*** conditions of the time series
- below-average freshwater conditions
- below-average marine conditions



Sacramento River Fall Chinook

Smolt year 2022:

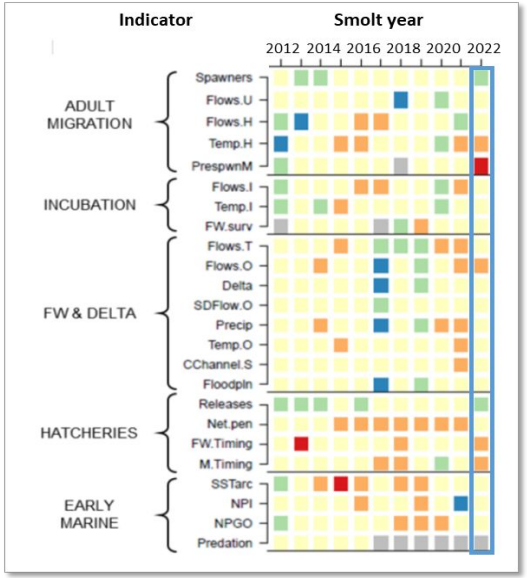
- mixed overall conditions
- below-average freshwater conditions
- average marine conditions



Central Valley Spring Chinook

Smolt year 2022:

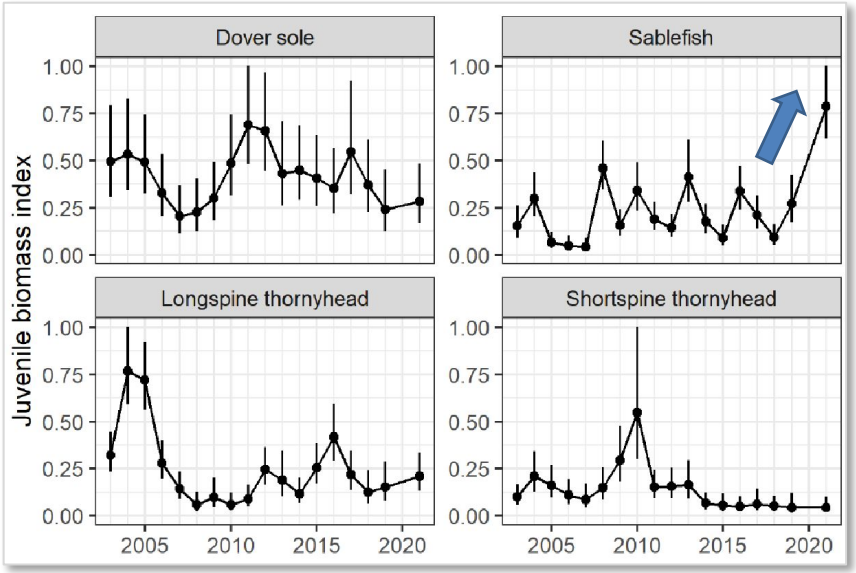
- ***3rd worst*** conditions of the time series
- below-average freshwater conditions
- below-average marine conditions



Other notable ecological information

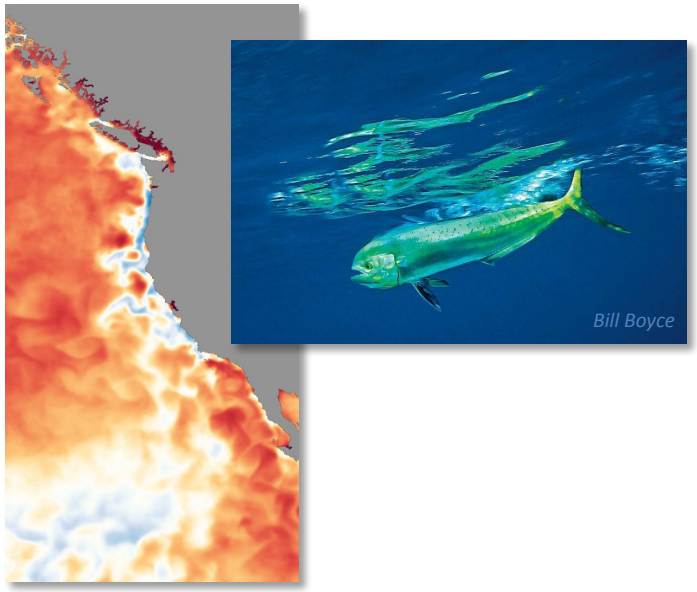
Groundfish:

- Trawl survey data and modeling analysis point to potential **big year class of sablefish from 2021**
- *Consistent w/ expectations from 2021 sea level indicator!*



Highly migratory species:

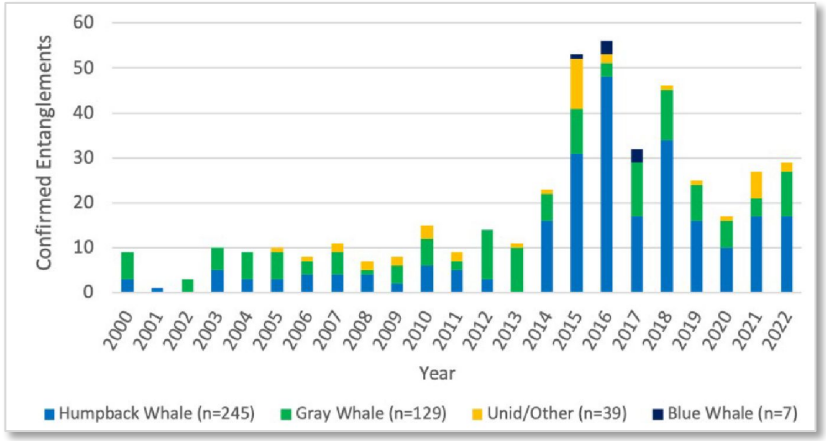
- Close proximity of warm water to productive upwelling cells may have boosted HMS catches
- *Habitat compression*



Other notable ecological information

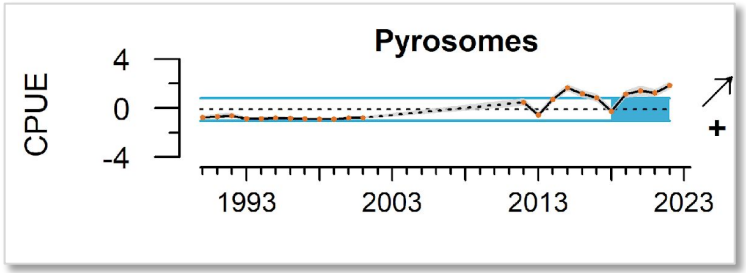
Confirmed whale entanglement reports:

- Remained above pre-2014 levels, but off from the peaks
- *No confirmed reports in 2022 attributed to sablefish fixed gear or large-mesh drift gillnet gear*
- *Data still preliminary*



Pyrosomes:

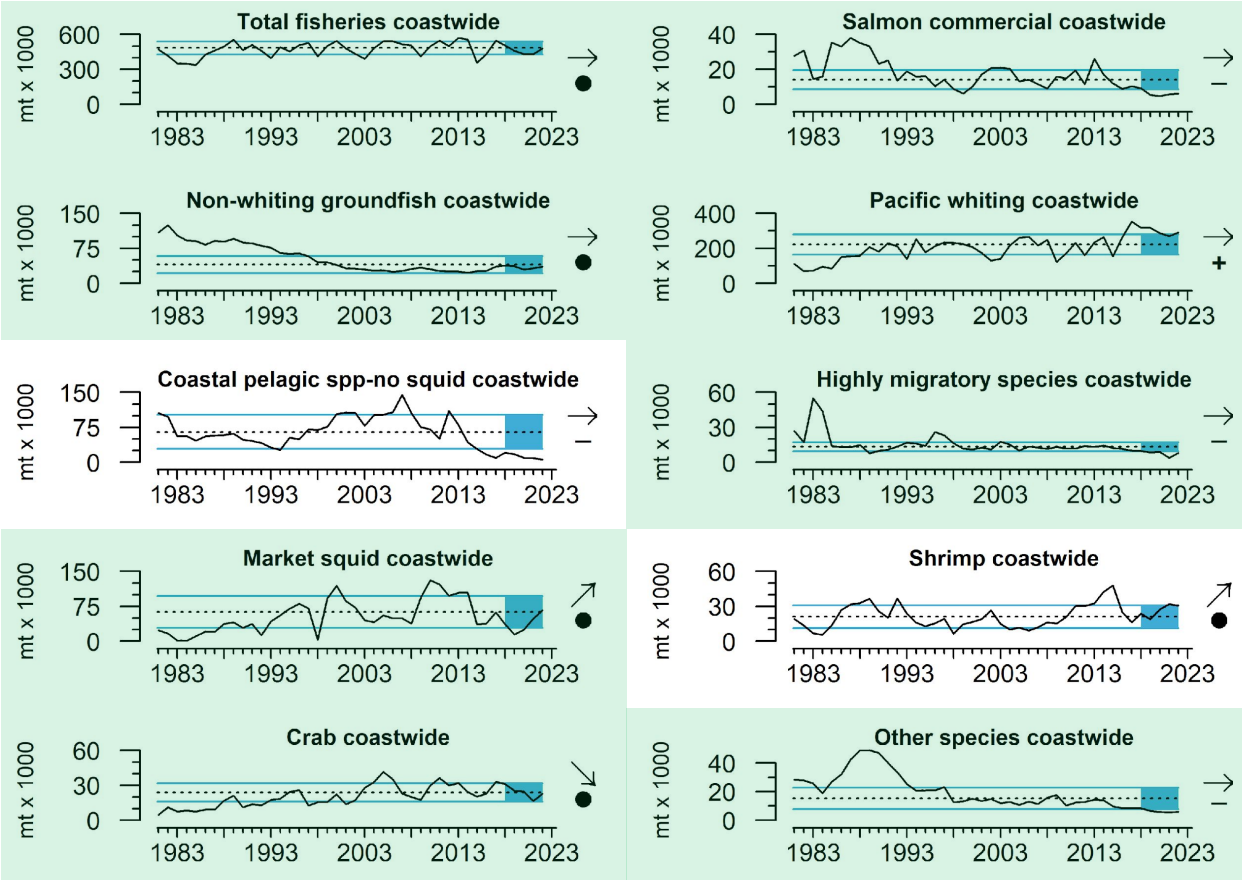
- *Warm water pelagic tunicates*
- **Highest catches off Monterey Bay since sampling began in 1983** (even greater than during "Blob")



Human activities and wellbeing

John Pohl, NOAA

Fishery landings increased in 2022, in total and in most harvest groups

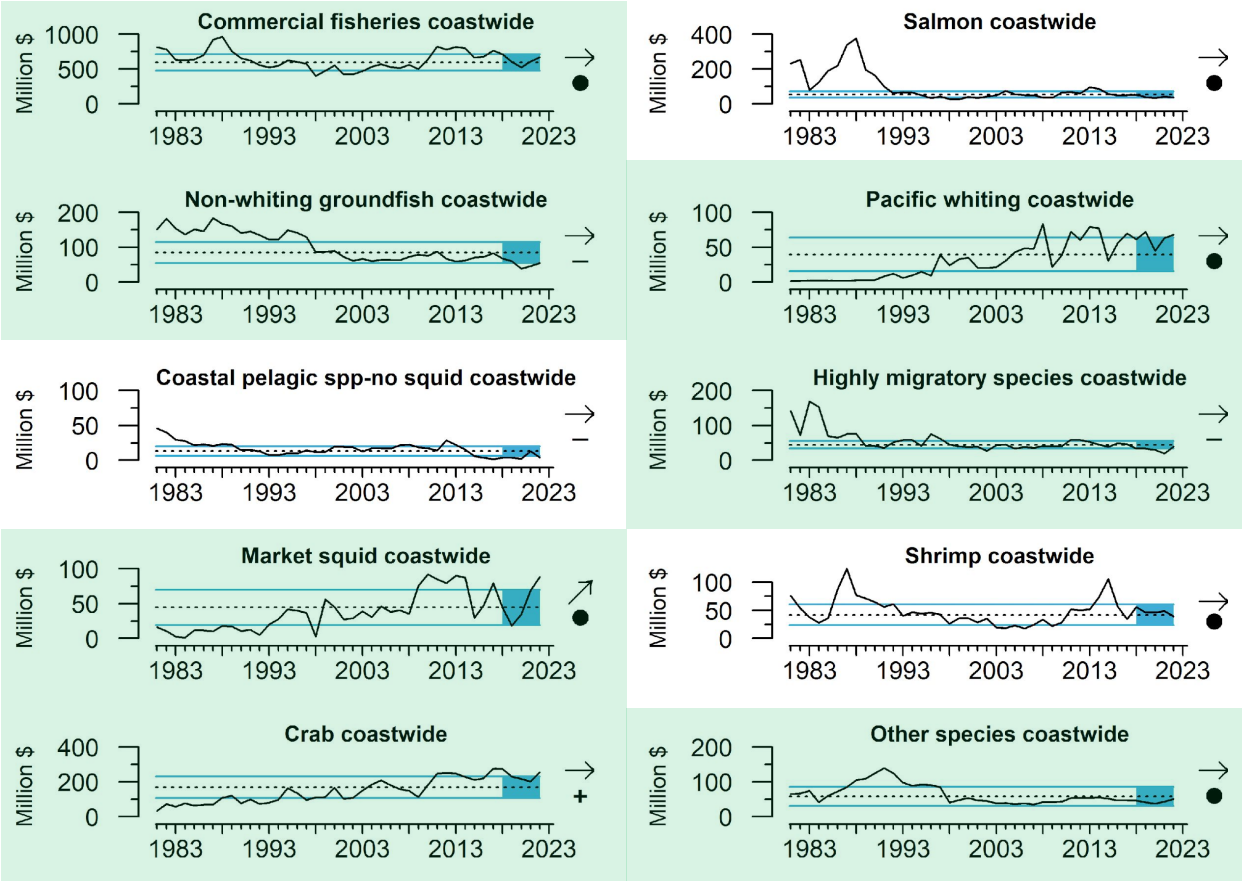


Commercial landings increased ~11% in 2022 relative to lower levels in 2020, 2021

- Fisheries that increased in 2022 shaded green
- Increases mostly observed in Oregon and California

- Recreational data not yet complete, but late-arriving data now suggest 2022 was at least similar to 2021
  - *Salmon and CA HMS still being finalized*

Fishery revenue also increased in 2022 for most harvest groups



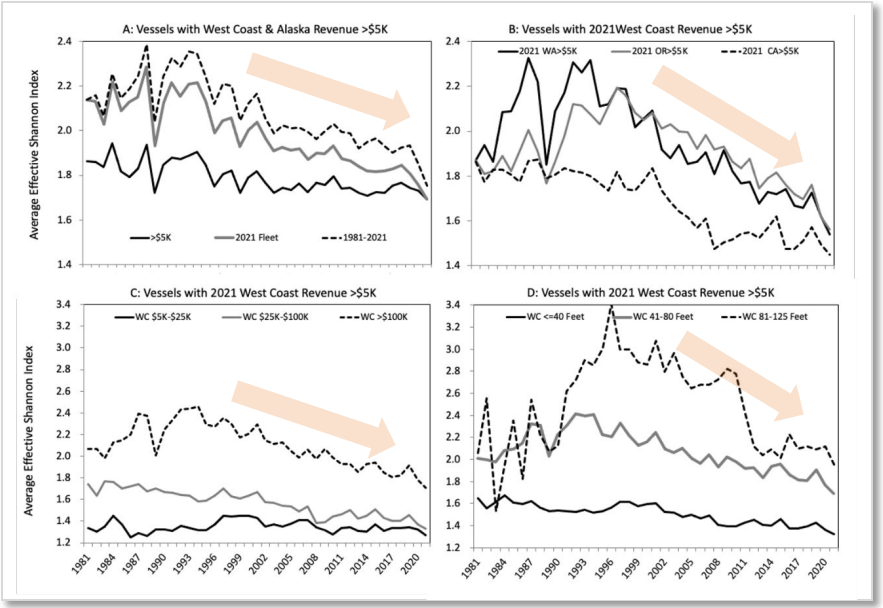
Commercial revenue increased ~10% in 2022 relative to 2021

- Based on available data
- Fisheries that increased in 2022 shaded green
- Increases mostly observed in Oregon and California
- Consecutive years of ≥10% revenue increases

Fisheries constraint? Diversification is declining, in more ways than one

Concept: greater diversification of fishing portfolio may increase average revenue and reduce yearly revenue variability; possibly greater resilience to shocks

Diversification of number of species groups harvested has declined steadily for decades on West Coast:



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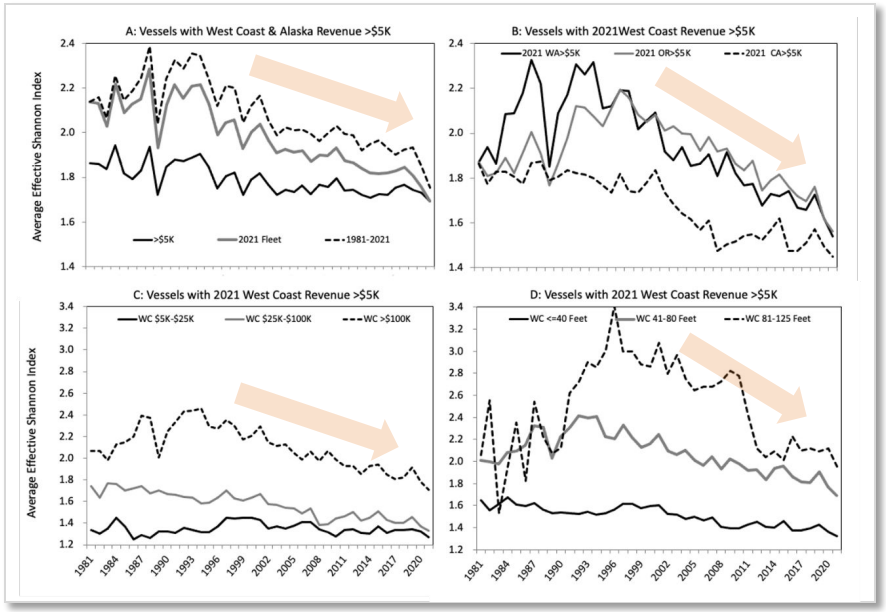
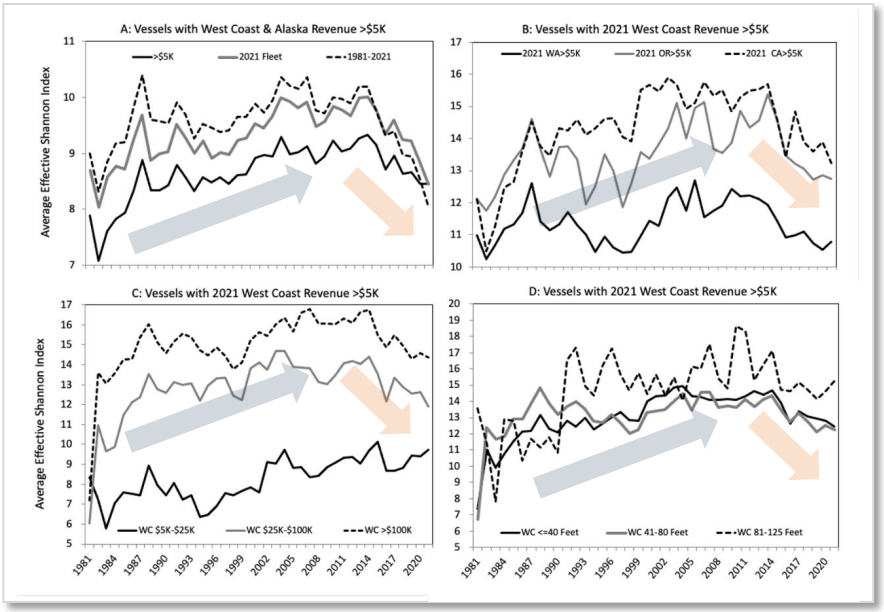
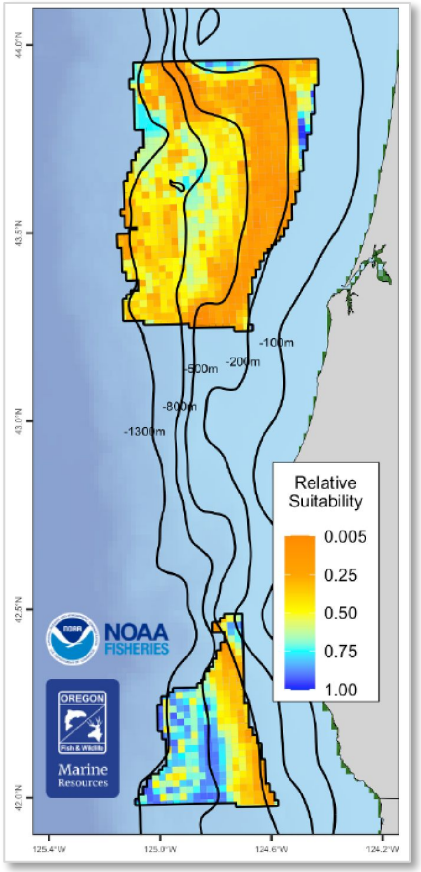


"Temporal diversification"—spreading effort and revenue throughout the year—had been increasing, but has generally decreased since the mid 2010s:



Fisheries constraint? Potential spatial overlap with Offshore Wind Energy

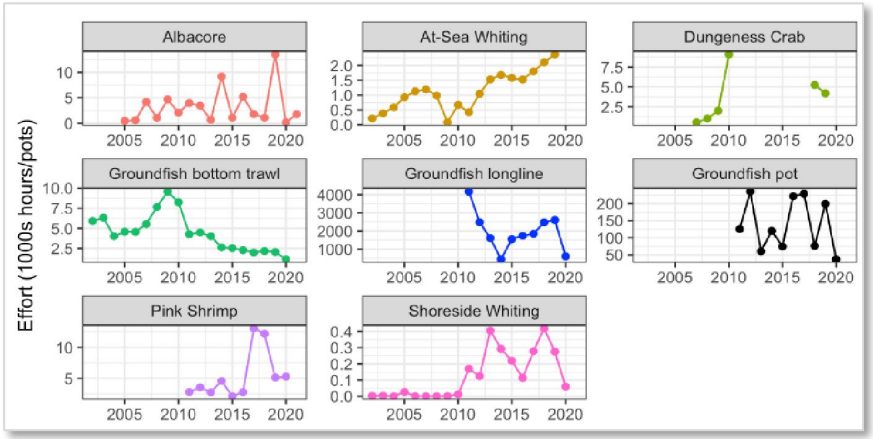


NMFS/CCIEA and ODFW researchers have collaborated to develop OWE "suitability scores" for 2x2 km pixels in the Call Areas off southern Oregon

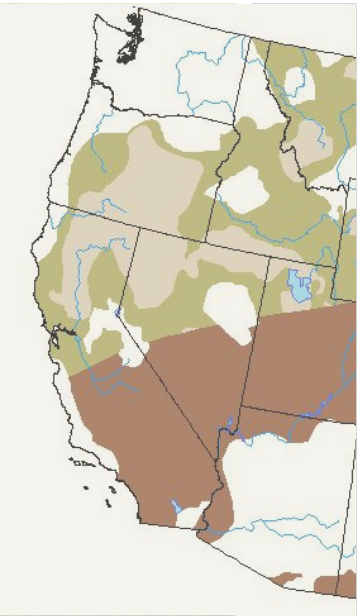
- Scores consolidate revenue and effort information from 9 fisheries, 2011-2020
- High score (blue) □ more "suitable" for OWE development

High levels of fishing activity (= low OWE suitability) in both Call Areas, particularly between depths of 200 m to 500 m

Temporal variability in overlap is likely, for multiple fisheries

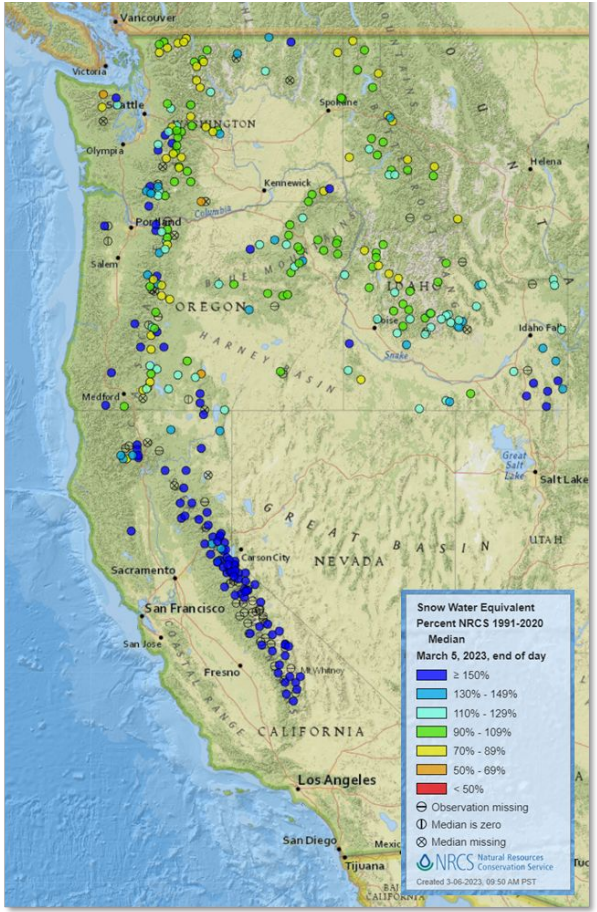


Analyses of impacts on NMFS surveys are underway



What can we expect in 2023?

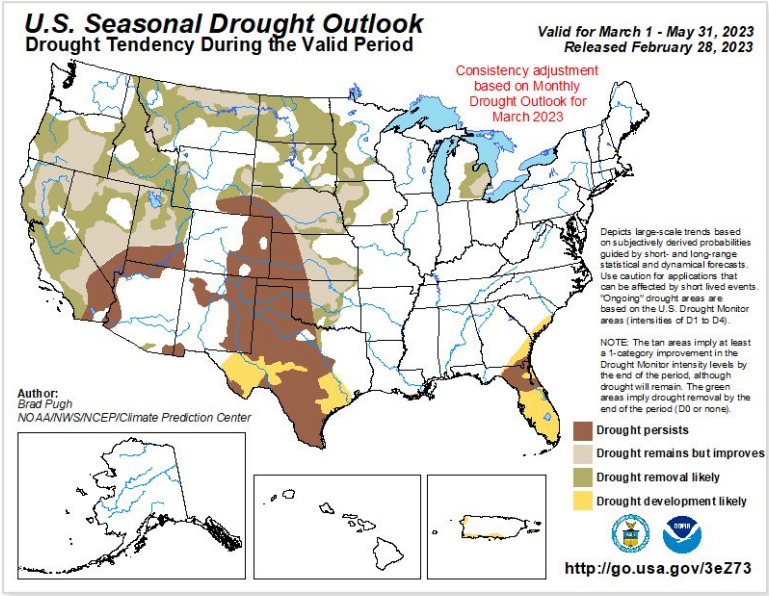
2023 Physical forecasts:



Fantastic, if not record-breaking snowpack and SWE in some areas…

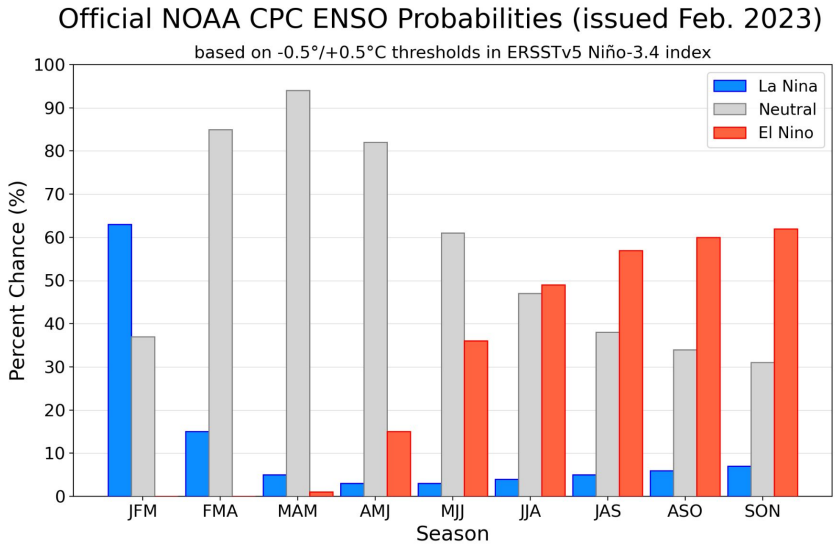
***although 2022, we also saw a lot of early snowpack but followed by drought…**

Snow water equivalents as of March 5, 2023



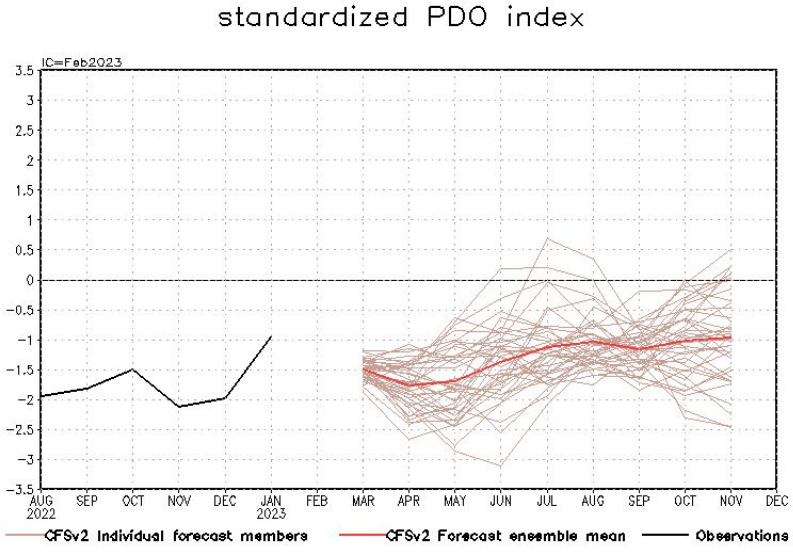
Drought outlook as of February 28, 2023

2023 Physical forecasts:



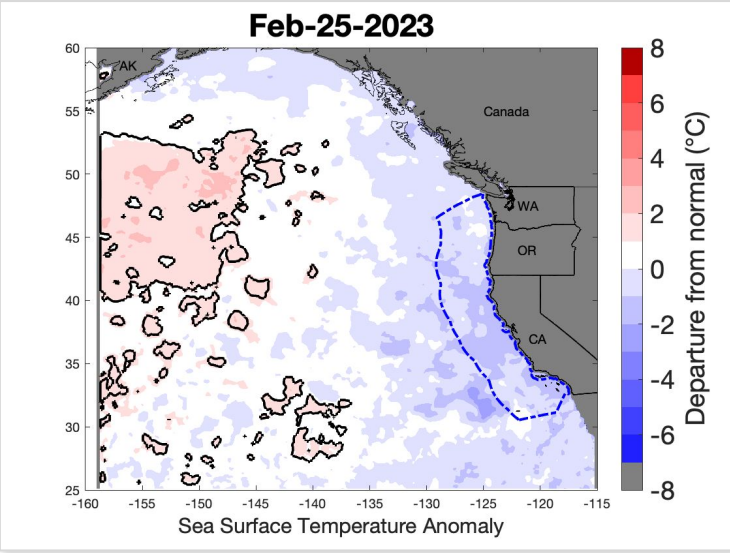
Headed toward ENSO neutral or El Niño (highly likely one of the two, but low confidence as to which one), two additional Models, however, do predict higher likelihood of El Niño (UK met and German Institute Climate Research)

Less "negative" PDO, but PDO will likely follow ENSO signal (2-4 month lag)

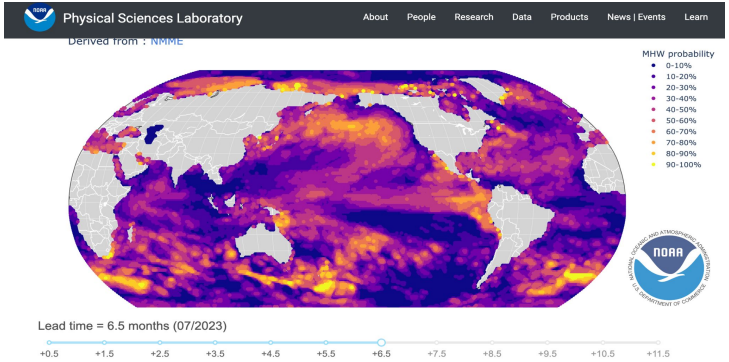


2023 Physical forecasts:

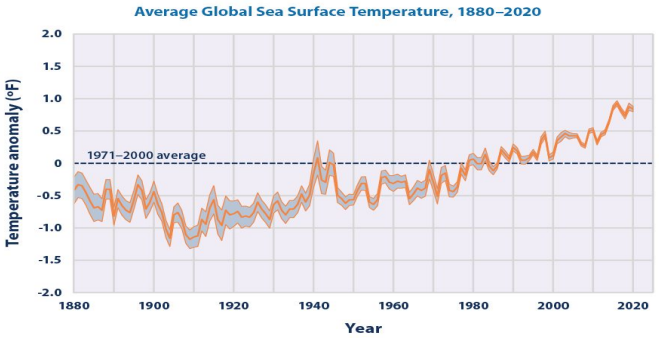
Heatwave still there, but diminished and far offshore



High probability of heatwave persisting in offshore region



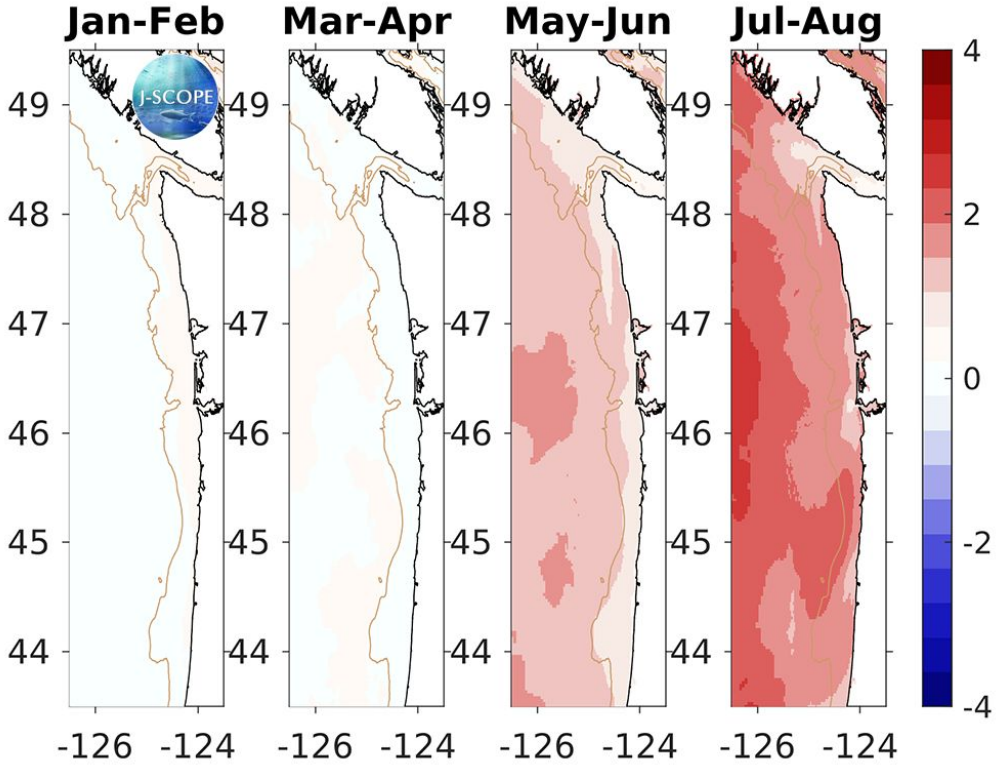
Reminder, this is all happening on top of the long term trend



Data source: NOAA (National Oceanic and Atmospheric Administration). 2021. Extended reconstructed sea surface temperature (ERSST.v5). Accessed February 2021.
www.ncdc.noaa.gov/data-access/marineocean-data/extended-reconstructed-sea-surface-temperature-ersst.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.

J-SCOPE model forecasts warmer than normal temperatures



Warmer than normal in the late spring and summer

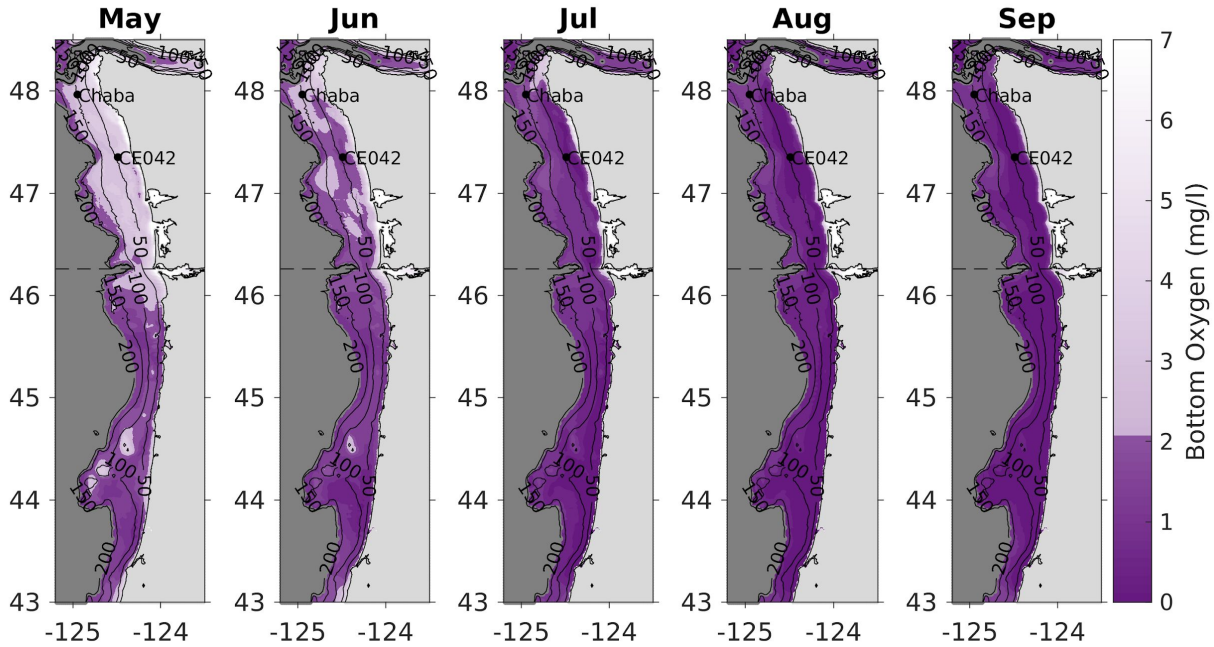
Relatively low uncertainty, summer is known to be biased towards too warm, however.

Upwelling (not shown) is expected to be slightly lower than the climatological average

Courtesy of Dr. Samantha Siedlecki, University of Connecticut; http://www.nanoos.org/products/j-scope/forecasts.php

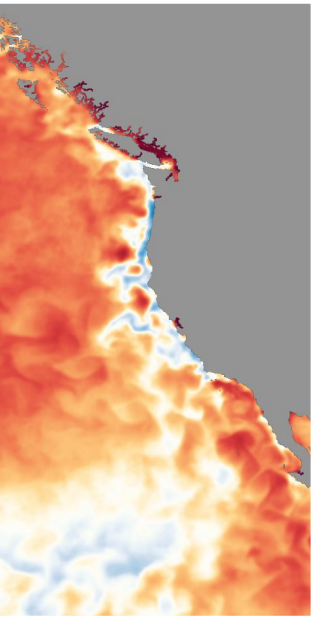
J-SCOPE model forecasts early, strong hypoxia on northern shelf

J-SCOPE ensemble forecast of benthic DO, from model runs conducted in January:



- Dissolved oxygen in 2023 is forecast to be **lower than average** in bottom waters off of Oregon and Washington
- Widespread hypoxia (<2 mg/L) is forecast to occur **earlier than average,** relative to recent years
  - *May in Oregon*
  - *July in Washington*
- High uncertainty due to disagreement in model ensemble members

Courtesy of Dr. Samantha Siedlecki, University of Connecticut; http://www.nanoos.org/products/j-scope/forecasts.php

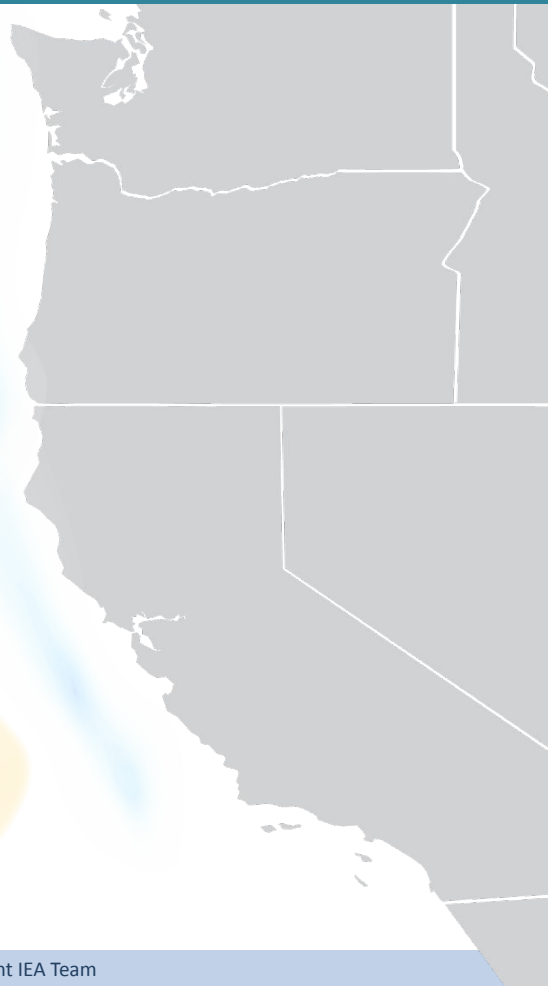


Conclusions

Summary and synthesis

Ecologically, 2022 was a mix of met and unmet expectations

- Basin-scale drivers foretold good ecosystem productivity
- That played out more in the Central and South than the North
- Local upwelling / downwelling and a major marine heatwave played big roles
- Inertia in the food web from lag effects and surprising or resilient species



Summary and synthesis

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- Basin-scale drivers foretold good ecosystem productivity
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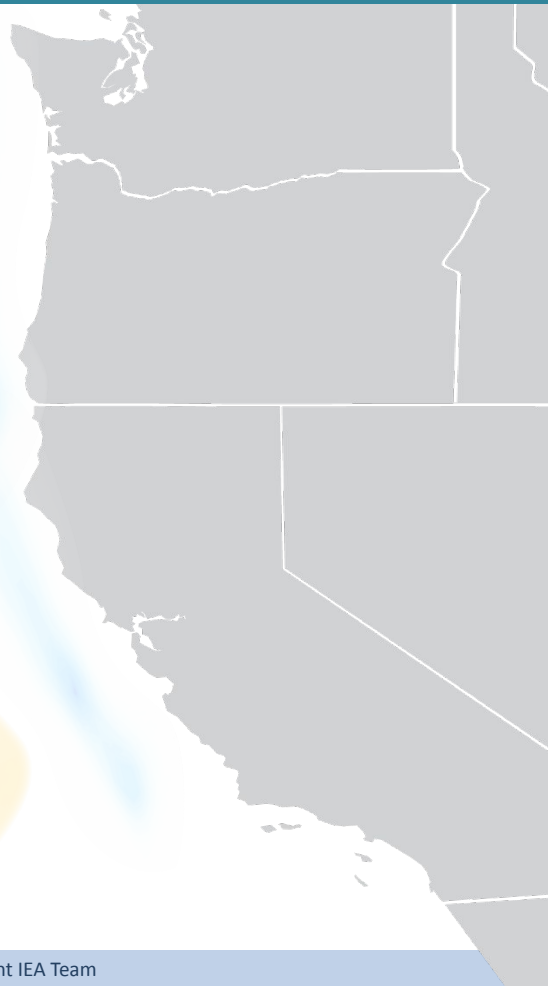
- Local upwelling / downwelling and a major marine heatwave played big roles
- Inertia in the food web from lag effects and surprising or resilient species

Fishery landings and revenue improved overall in 2022

- Across several species groups, particularly in Oregon and California
- Better understanding of potential overlap with offshore wind energy off Oregon
- Fishery diversification has declined for both species caught and weeks on the water

2023: ENSO neutral and continued warm water?



Summary and synthesis

Climate change is leading to more mismatches between expectations and observations

Appendix E (the "Climate Change Appendix") conversation continued…

GOAL: use indices to provide forecasts of various ecosystem properties

Reduce the issue of mismatches through mechanism

- What indices do we have that could be used towards this goal?
- How might we "operationalize" such indices?
- What are our paths forward with the ESR?

Summary and synthesis

We are enthusiastic about FEP Initiative 4, as a clear parallel to the ESR

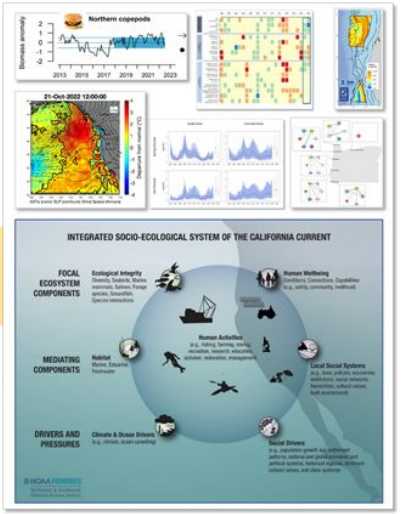
- *Ideas and expertise around indicator screening, stoplights, advanced data analyses*
- *Tools and concepts outlined in the Climate Change Appendix*
- *Ensuring complementarity and manageable workloads for analysts*
- *Reciprocal ideas for how to align and improve future ESRs*

"Risk Table" derived from Dorn and Zador (2020)

Information sources

Concern Level

	Assessment-related	Population dynamics	Ecosystem	Fishery Performance
Level 1: Normal	Typical to moderately increased uncertainty/minor unresolved issues in assessment	Stock trends are typical for the stock; recer recruitment is within normal range.	No apparent environmental and/or ecosystem concerns relevant to the stock	lo apparent fishery/resource-use erformance and/or behavior oncerns
Level 2: Substantially increased concerns	Substantially increased assessment uncertainty/ unresolved issues.	Stock trends are unusual; abundance increasing or decreasing faster than has been seen recently, or recruitment pattern is atypical.	Some indicators showing adverse signals for the stock, but the pattern is not consistent across all indicators.	ome indicators showing adverse ignals but the pattern is not onsistent across all indicators.
Level 3: Major Concern	Major problems with the stock assessment, very poor fits to data, high level of uncertainty, strong retrospective bias.	Stock trends are highly unusual; very rapid changes in stock abundance, or highly atypical recruitment patterns.	Multiple indicators showing consistent adverse signals a) across the same trophic level as the stock, and/or b) up or down trophic levels from the stock	Multiple indicators showing onsistent adverse signals a) across ifferent sectors, and/or b) different ear types
Level 4: Extreme concern	Severe problems with the stock assessment, severe retrospective bias. Assessment considered unreliable.	Stock trends are unprecedented. More rapi changes in stock abundance than ever seer previously, or very long stretch of poor recruitment compared to previous patterns	Extreme anomalies in multiple ecosystem indicators that are highly likely to impact the stock. Potential for cascading effects on other ecosystem components	xtreme anomalies in multiple erformance indicators that are ighly likely to impact the stock.



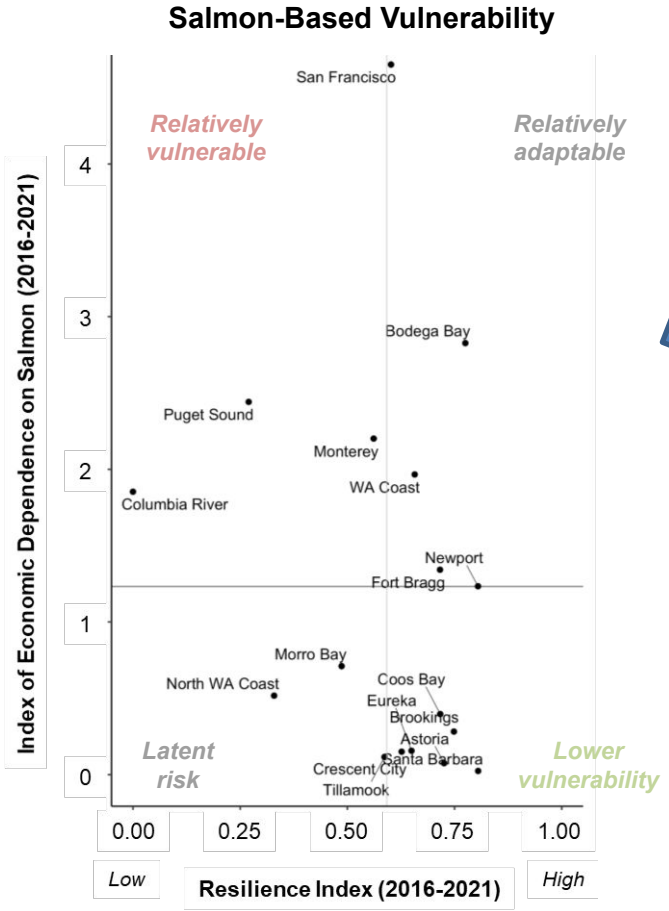
Thank you

Andrew.Leising@noaa.gov
Chris.Harvey@noaa.gov

John Pohl, NOAA

Extra slides

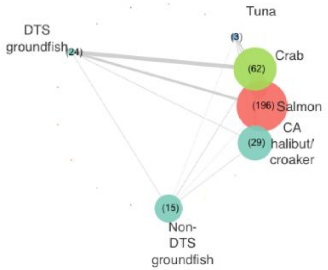
Fisheries resilience? Connectivity between fisheries



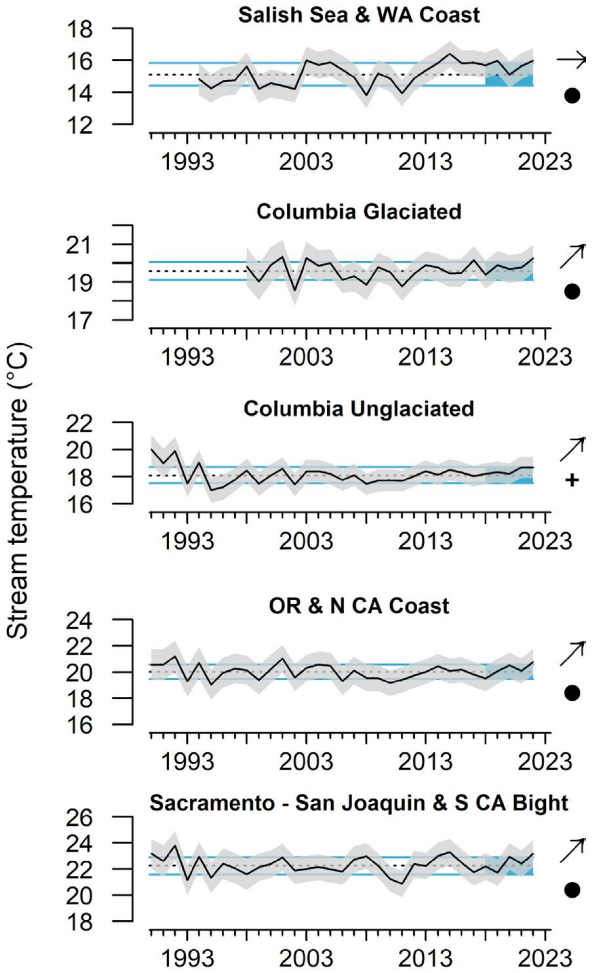
Within port groups, greater levels of participation in multiple fisheries may build resilience against revenue drops in one fishery

- Horizontal axis: recent (2016-2021) vs. historic (2004-2021) resilience
- Vertical axis: recent vs. historic index of dependence on salmon revenue

- ***Quadrants reflect the relative vulnerability or adaptive potential of a port group to a shock in salmon fishing***

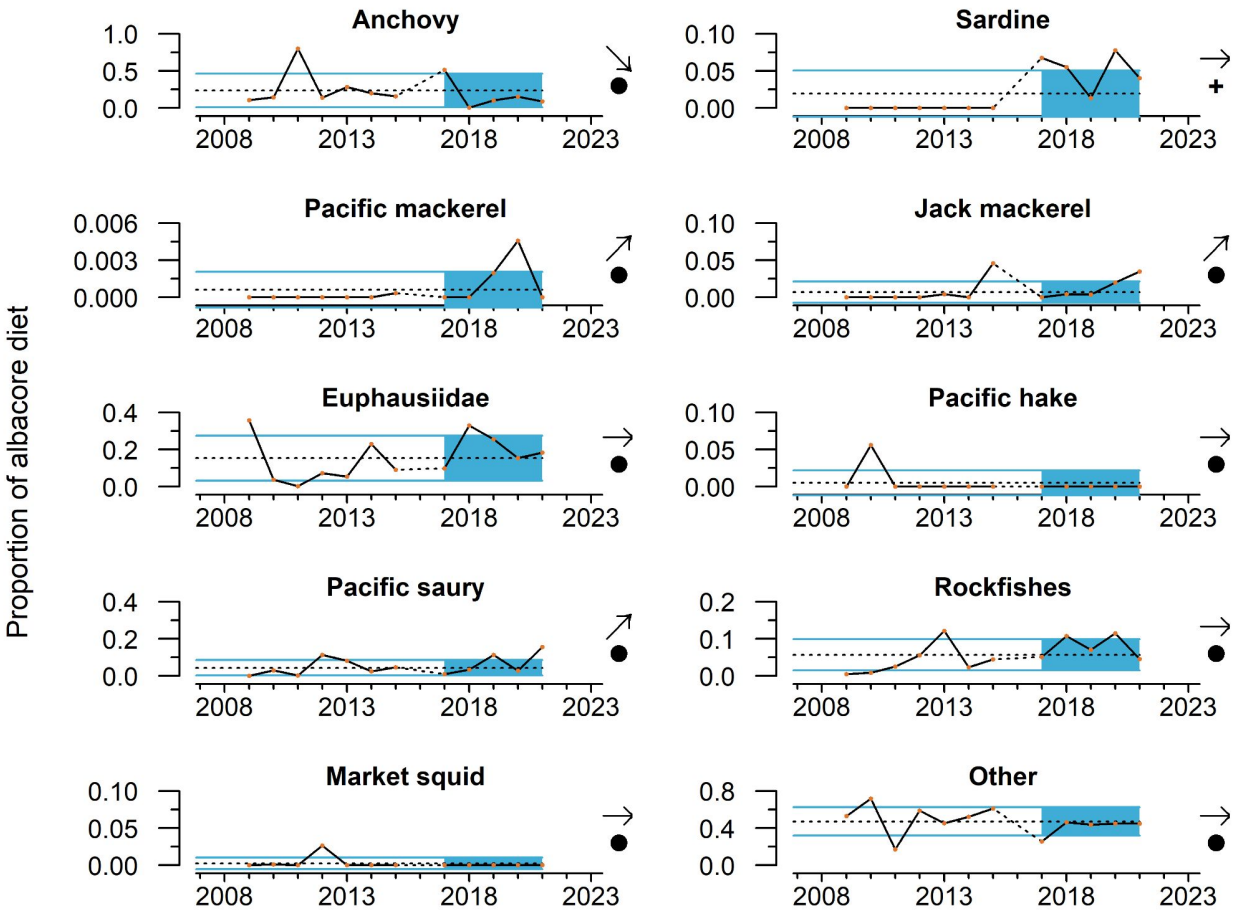


Example fishery participation network:
***Bodega Bay,** based on 2020/21 revenues*



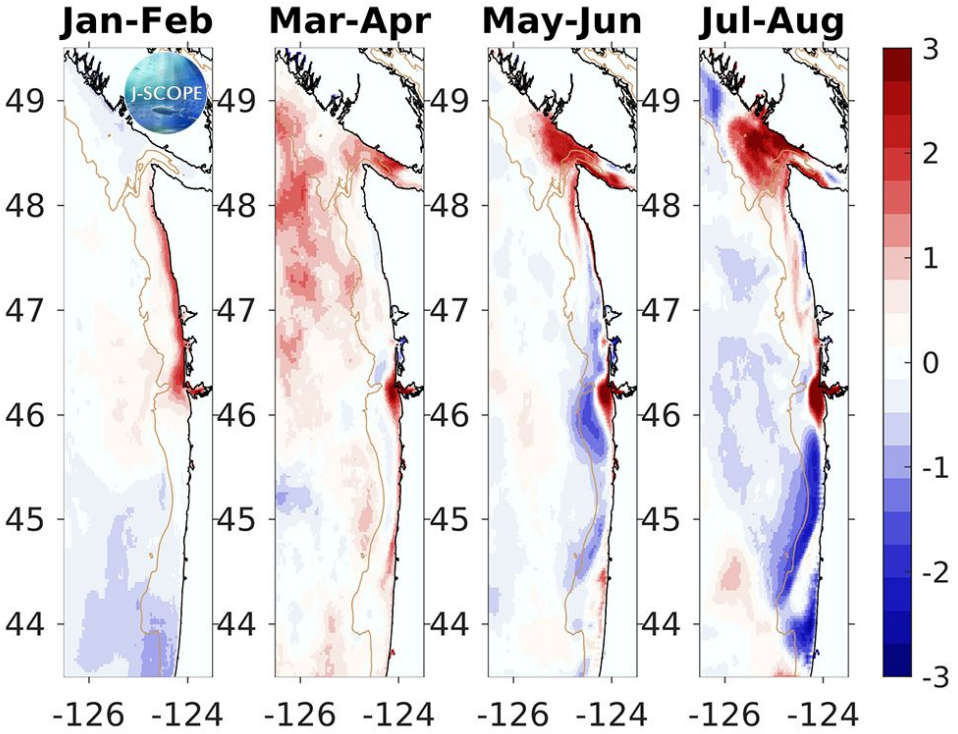
Mean maximum August stream temperatures increasing in nearly every freshwater ecoregion over last five years

2022 generally warmer than previous 2-3 years


Proportion of albacore diet
Anchovy
1.0
0.5
0.0
Sardine
0.10
0.05
0.00
Pacific mackerel
0.006
0.003
0.000
Jack mackerel
0.10
0.05
0.00
Euphausiidae
0.4
0.2
0.0
Pacific hake
0.10
0.05
0.00
Pacific saury
0.4
0.2
0.0
Rockfishes
0.2
0.1
0.0
Market squid
0.10
0.05
0.00
Other
0.8
0.4
0.0
2008
2013
2018
2023

J-SCOPE model forecasts slightly higher primary production

10m integrated Chlorophyll-a



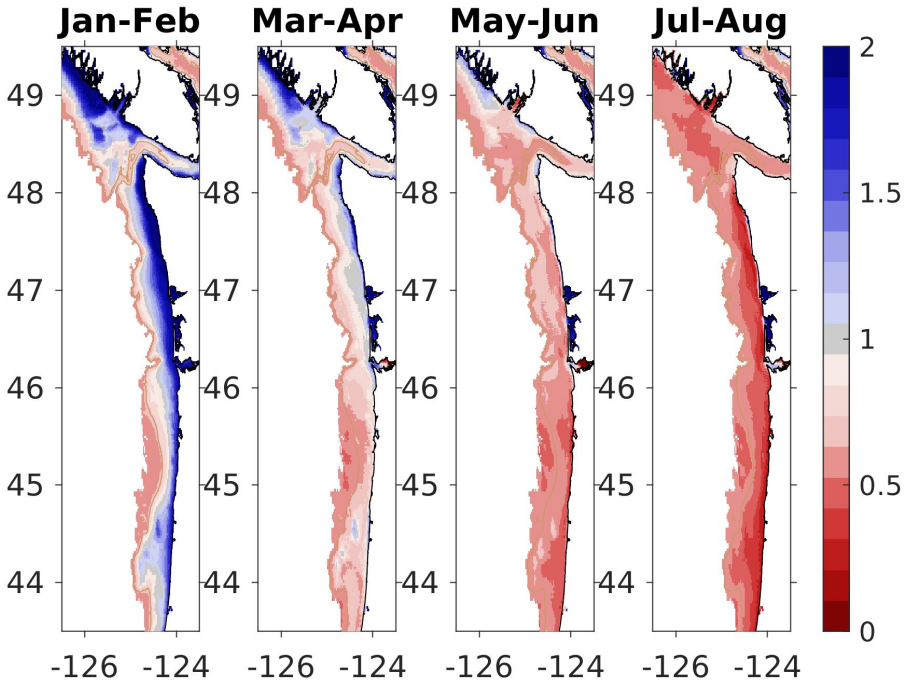
Generally **higher than average** primary productivity

High uncertainty in early months/ low chl-a levels

Higher certainty later in season, during higher chl-a levels

Courtesy of Dr. Samantha Siedlecki, University of Connecticut; http://www.nanoos.org/products/j-scope/forecasts.php

J-SCOPE model forecasts more corrosive waters on the bottom



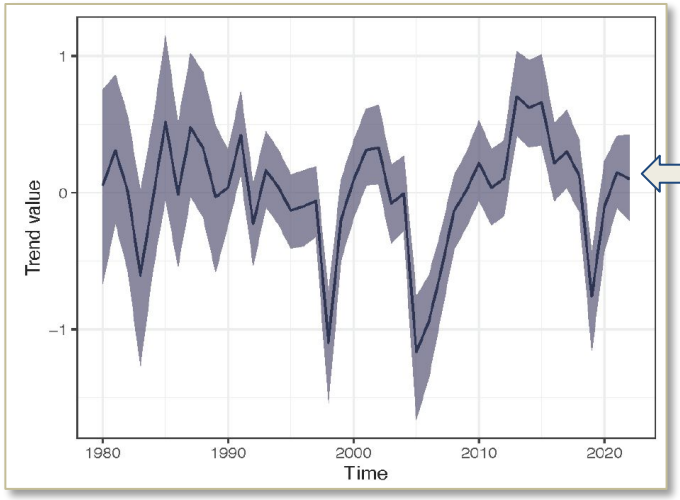
- Aragonite on the bottom is expected to be undersaturated (i.e., **more corrosive**) throughout the upwelling season for most of the bottom waters in the region
- surface waters are expected to be **supersaturated** throughout the season

Courtesy of Dr. Samantha Siedlecki, University of Connecticut; http://www.nanoos.org/products/j-scope/forecasts.php

Summary and synthesis

Ecologically, 2022 was a mix of met and unmet expectations

- Basin-scale drivers foretold good ecosystem productivity
- That played out more in the Central and South than the North
- Local upwelling / downwelling and a major marine heatwave played big roles
- Inertia in the food web from lag effects and surprising or resilient species



Stability in "Ecosystem State Index" from 2020-2022