A subtidal ocean acidification and hypoxia monitoring network for Oregon's marine reserve system

Intertidal ocean acidification monitoring in Oregon's marine reserves

Report to the Oregon Ocean Science Trust
April 2nd 2025
Francis Chan

Oregon State University

CIMERS
Cooperative Institute for Marine Ecosystem and Resources Studies

If our ocean changes, will we know?

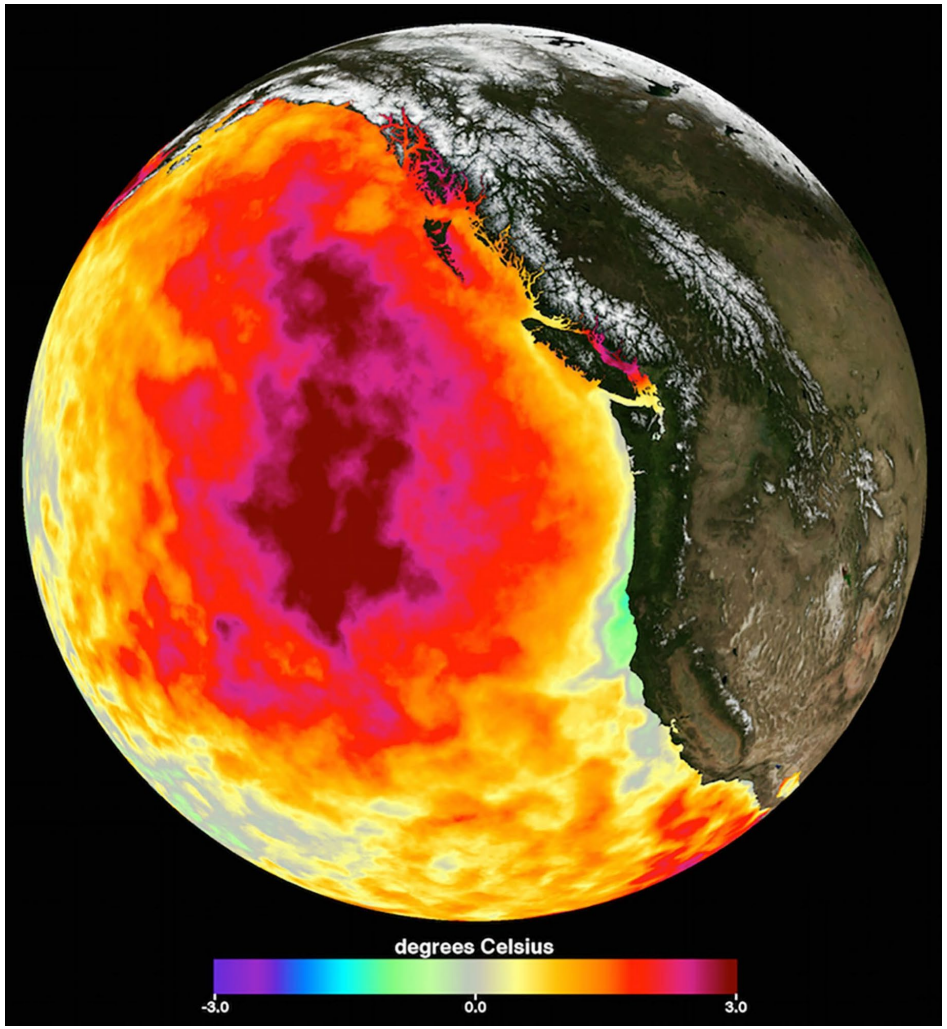
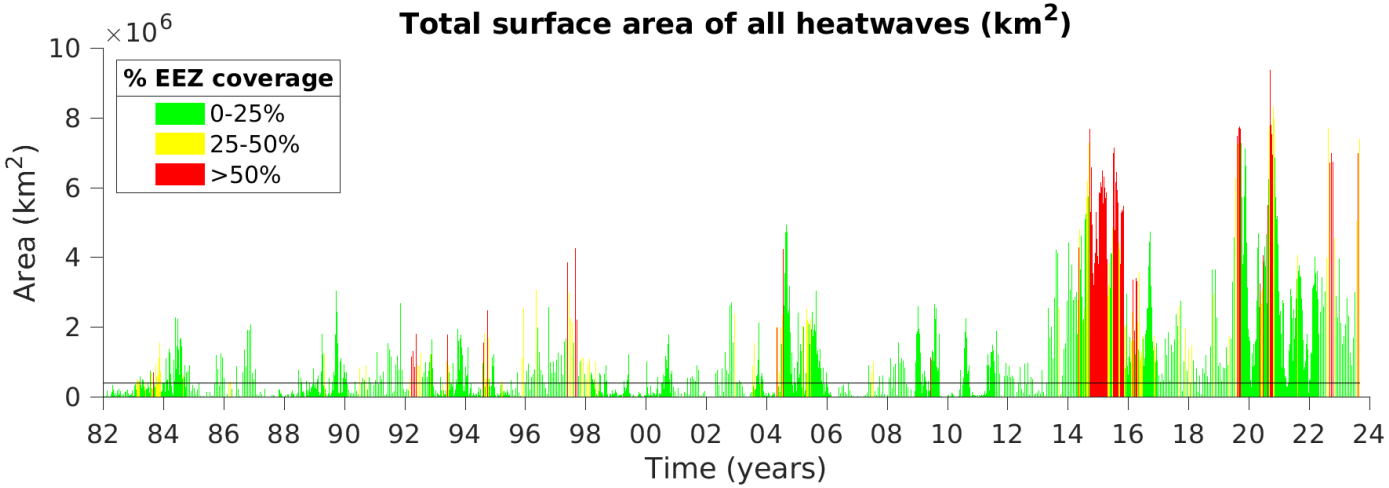
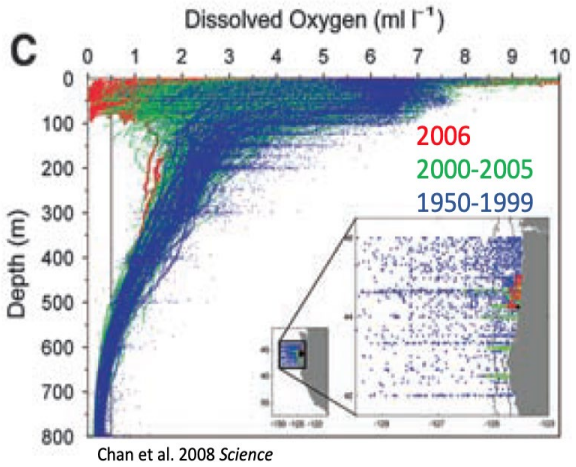


Image credit: NASA Physical Oceanography Distributed Active Archive Center

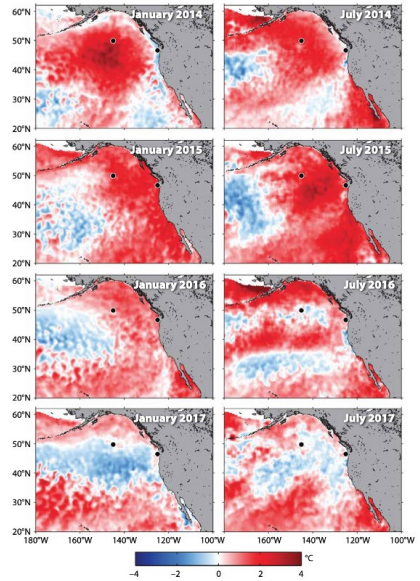


https://www.integratedecosystemassessment.noaa.gov/regions/california-current/california-current-marine-heatwave-tracker-blobtracker

but more than just temperature is changing…

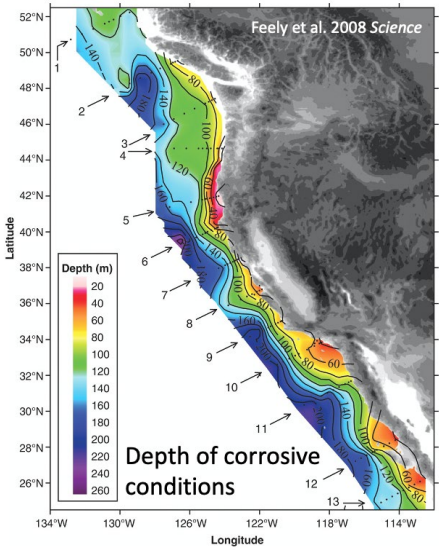


Hypoxia

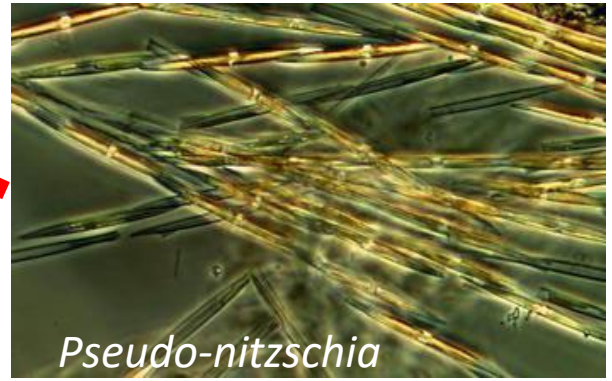


Barth et al. 2018

Marine Heatwaves



Ocean Acidification



Harmful Algal Blooms

A subtidal ocean acidification and hypoxia monitoring network for Oregon's marine reserve system

What were the major goals of the project?

- Sustain long-term observations of OAH exposure on Oregon's shelf that are crucial for detecting, tracking and understanding change.
- Develop a collaborative monitoring program with the fishing fleet as a means for sustaining cost-effective observations
- Broaden the knowledge base of traditional ocean uses

Intertidal ocean acidification monitoring in Oregon's marine reserves

What were the major goals of the project?

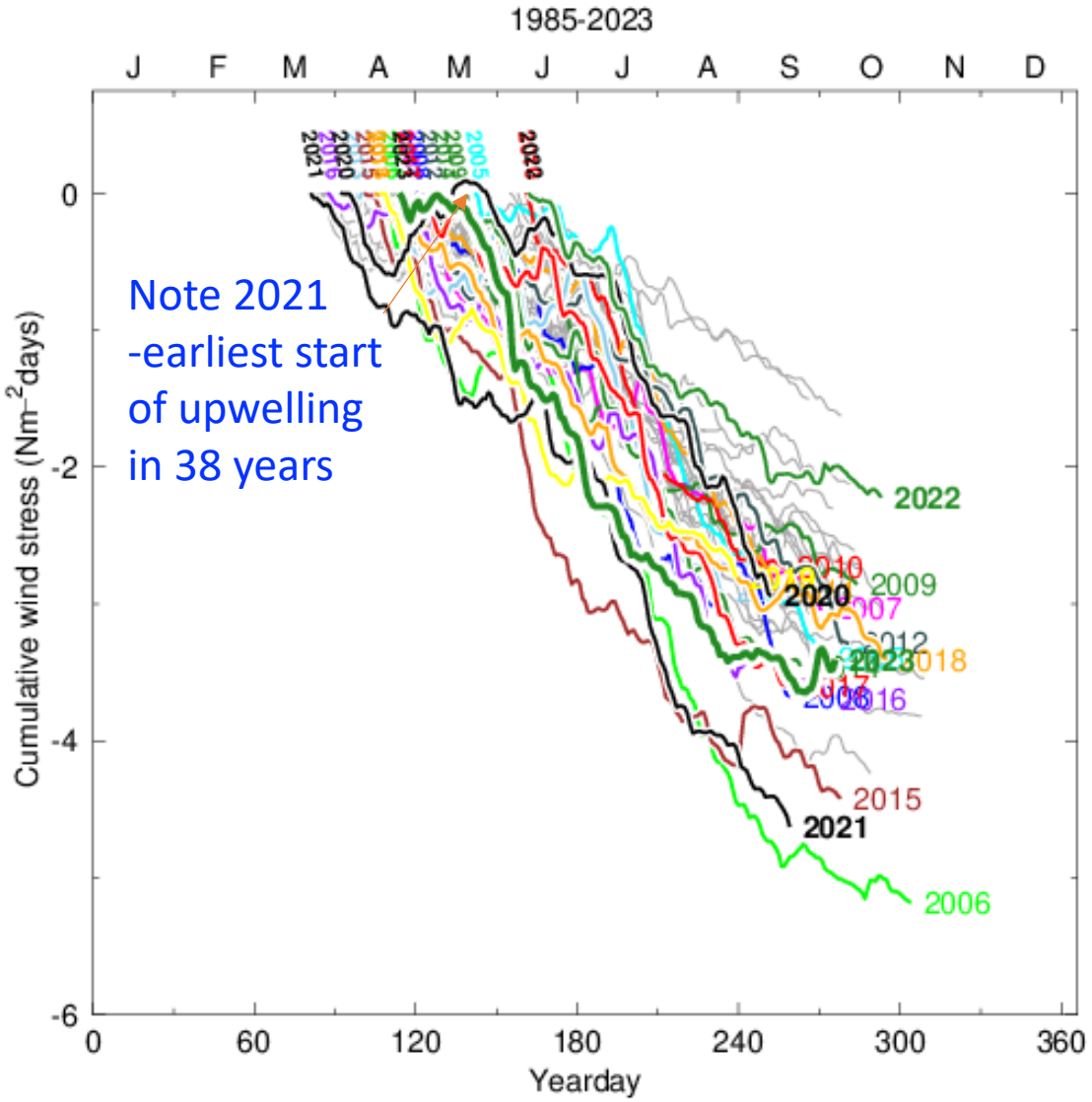
- Sustain crucial observations of OA exposure in Oregon's state waters through citizen science partnerships in marine reserves
- Broaden the knowledge base of traditional ocean uses
- Enhance the public's understanding of ocean legacy and ocean changes

My topline summary:

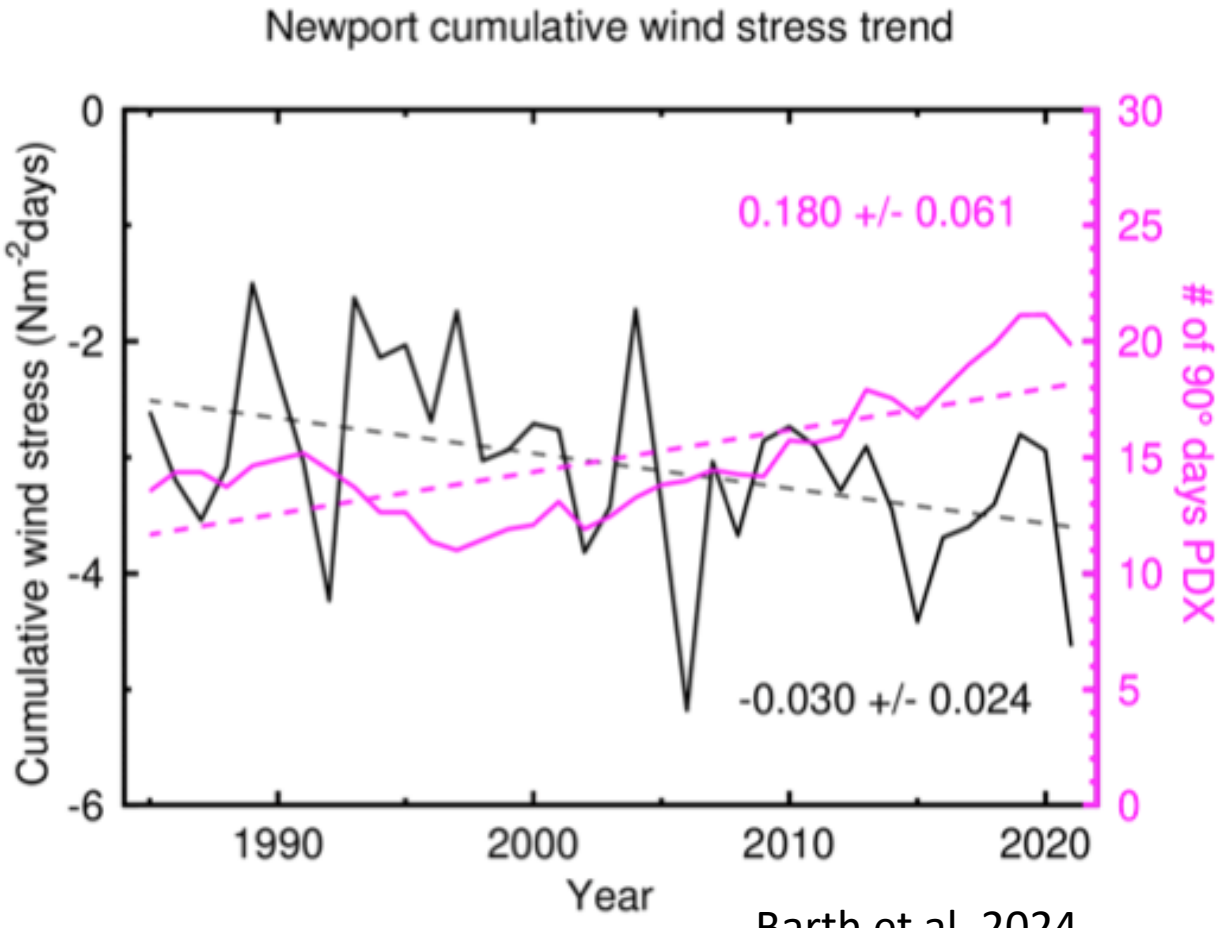
- It takes partnerships
- We have this in Oregon
- OOST has made this possible!




Sustaining observations has been vital

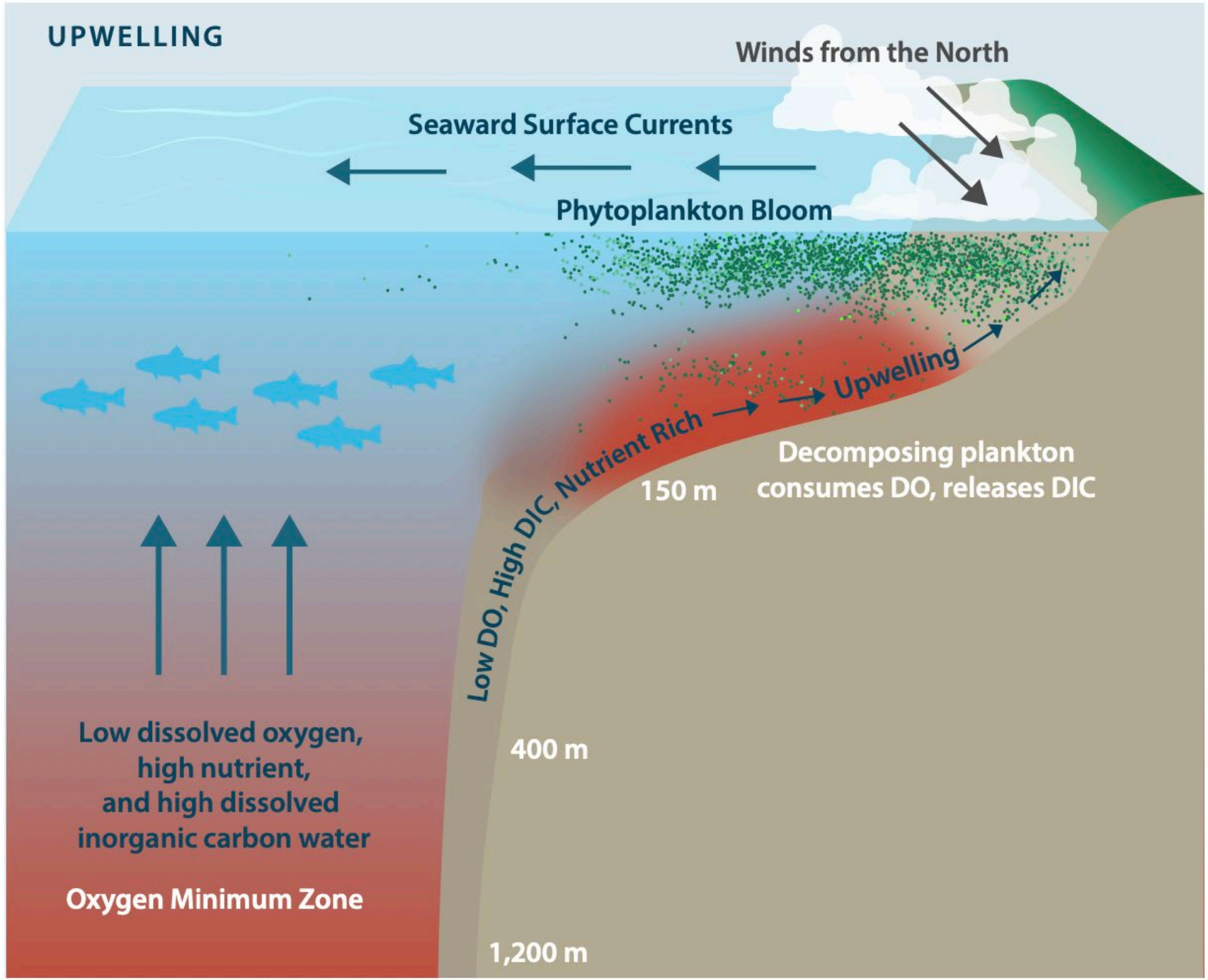


Against a backdrop of stronger upwelling…

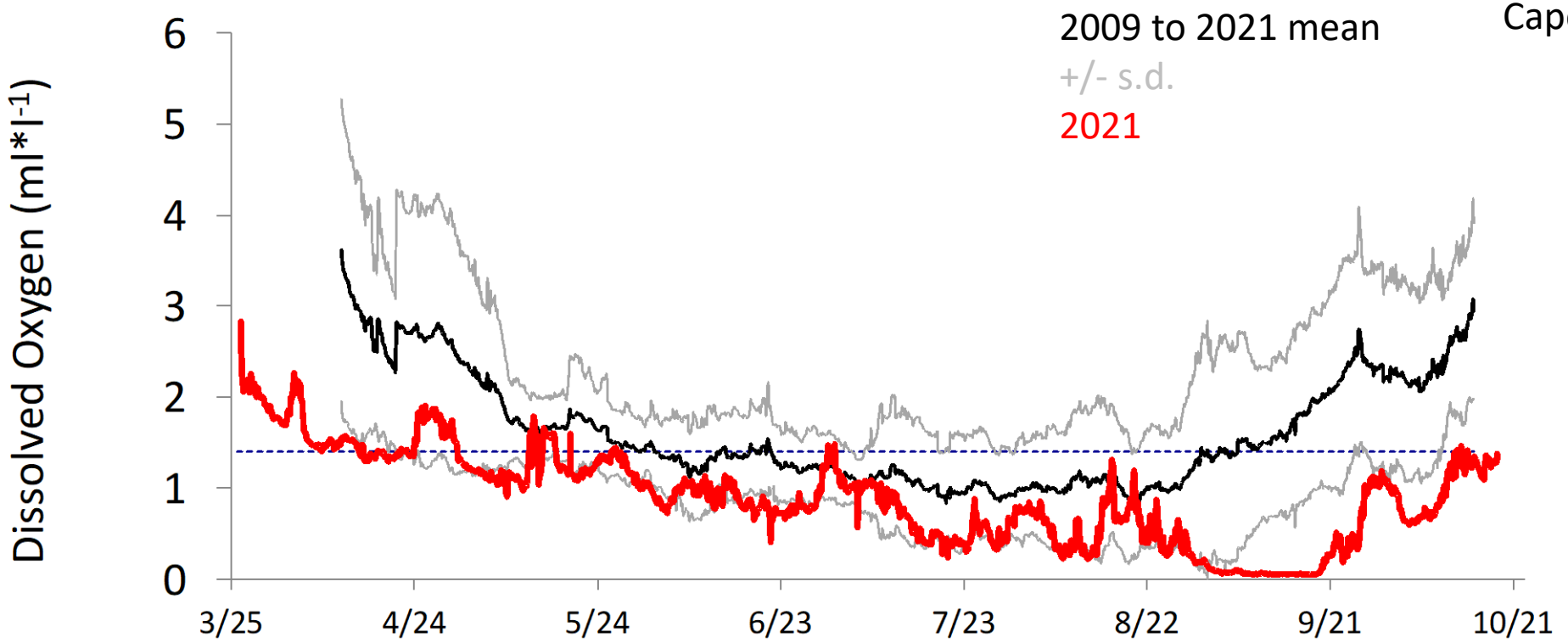


Barth et al. 2024

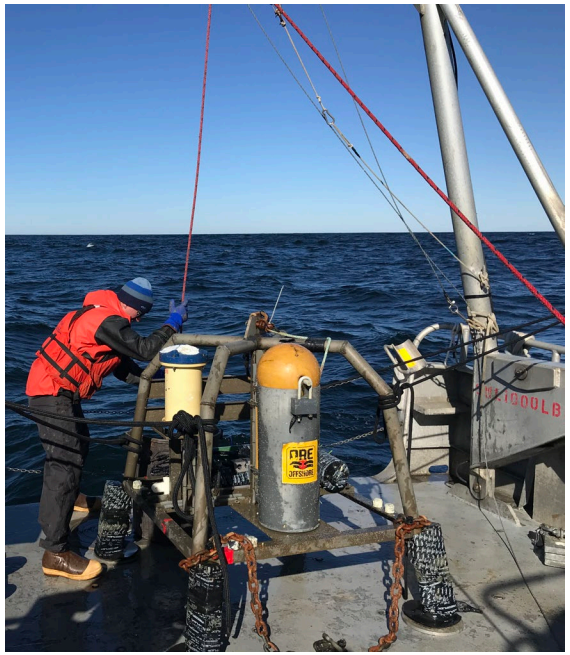
https://www.nanoos.org/products/cui_oregon/cui.php


UPWELLING
Winds from the North
Seaward Surface Currents
Phytoplankton Bloom
Upwelling
Low DO, High DIC, Nutrient Rich
150 m
Decomposing plankton
consumes DO, releases DIC
Low dissolved oxygen,
high nutrient,
and high dissolved
inorganic carbon water
Oxygen Minimum Zone
400 m
1,200 m

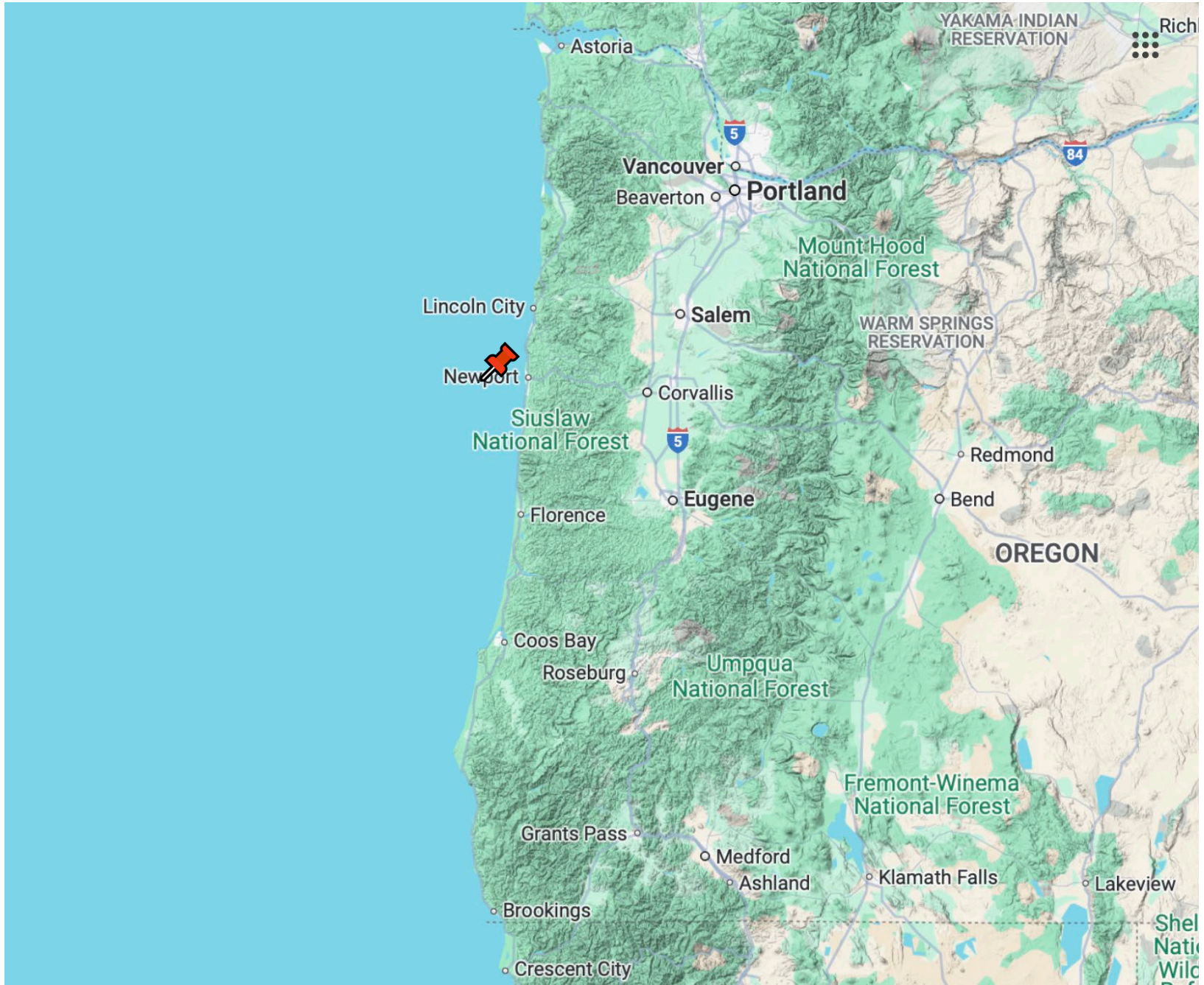
Sustained observations allowed us to detect and track the earliest onset of hypoxia on the Oregon shelf from our records…



Cape Perpetua Mid-Shelf Mooring



What was the geography of oxygen stress exposure?



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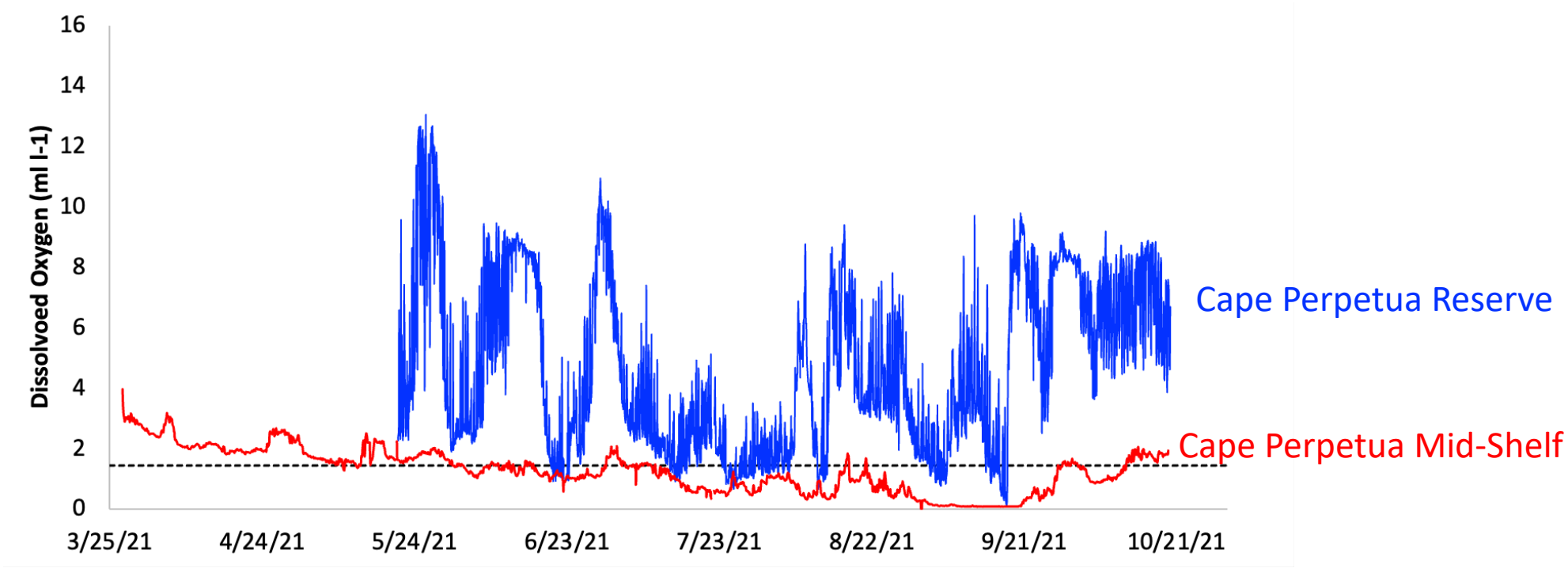

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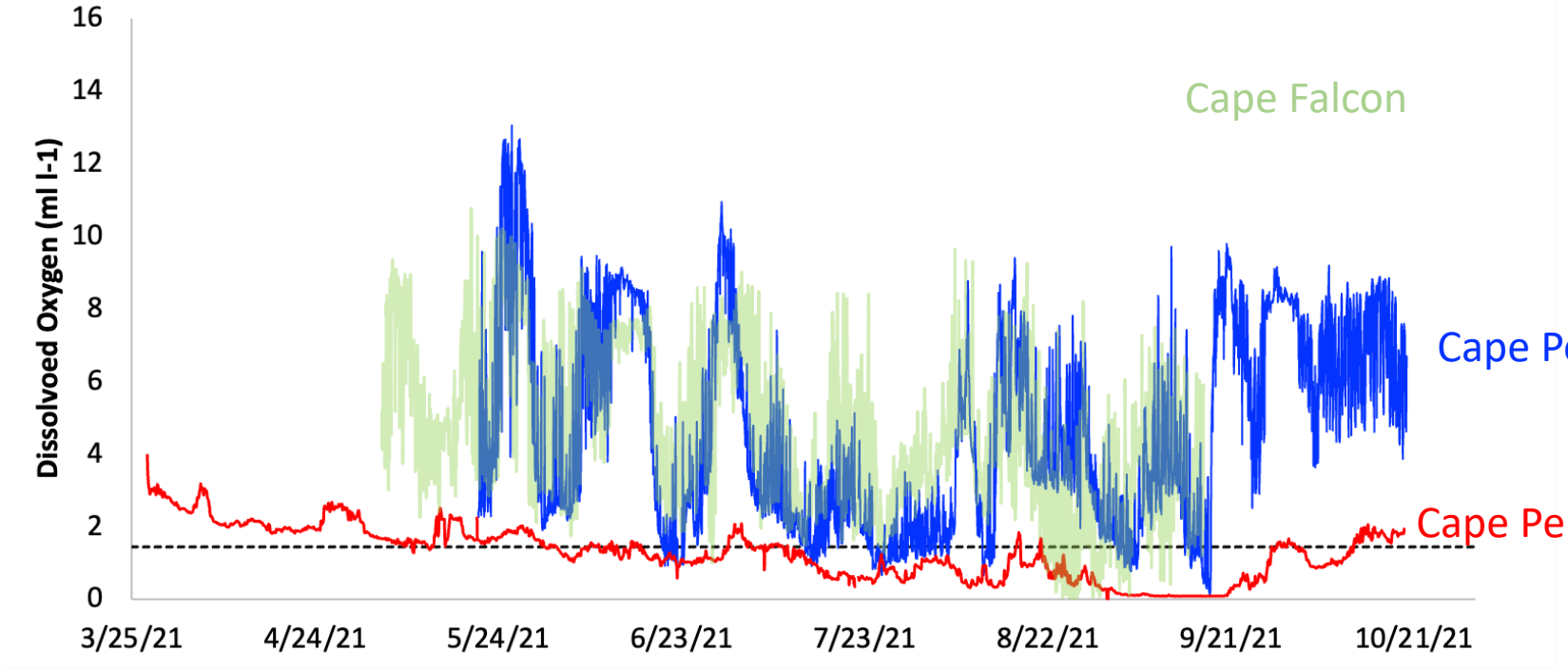

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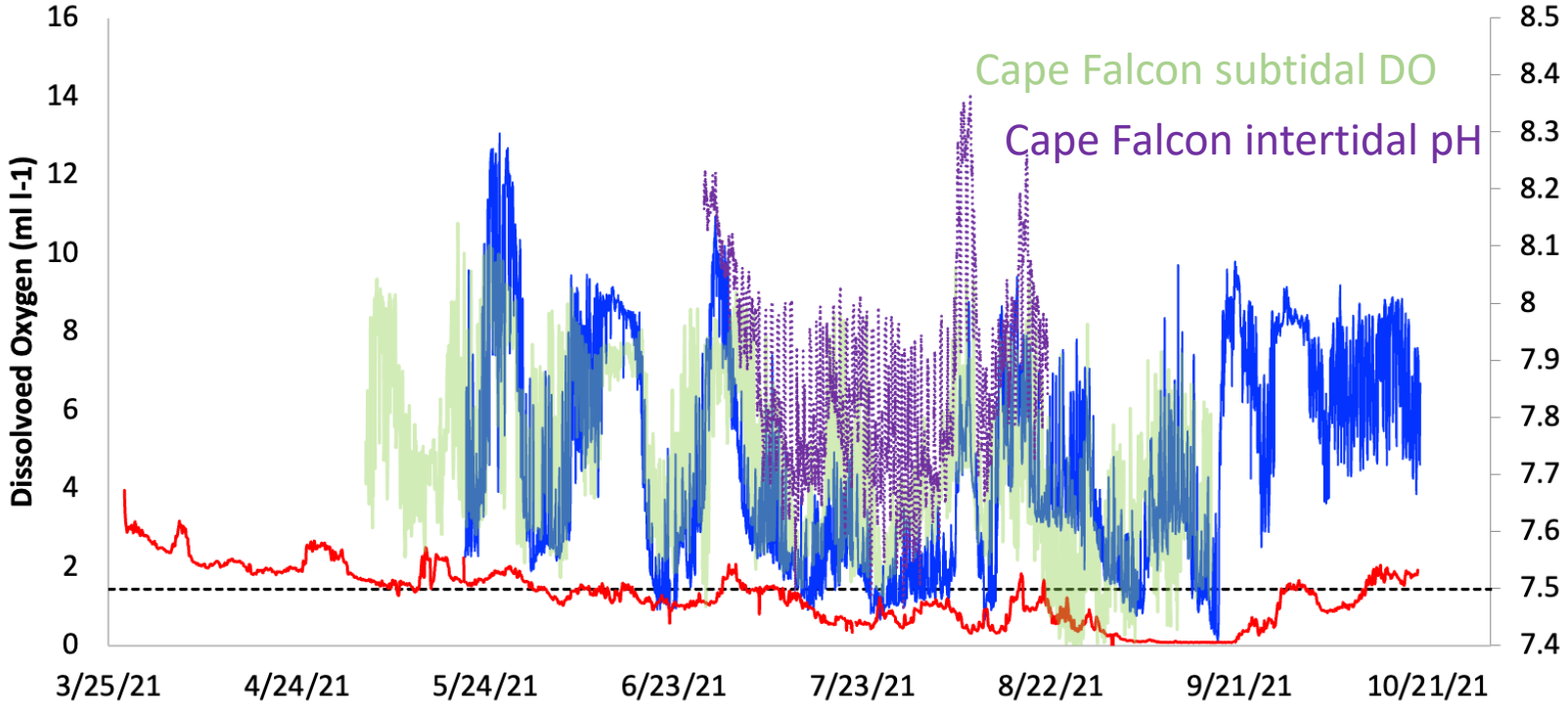

Cape Perpetua Reserve

Cape Perpetua Mid-Shelf

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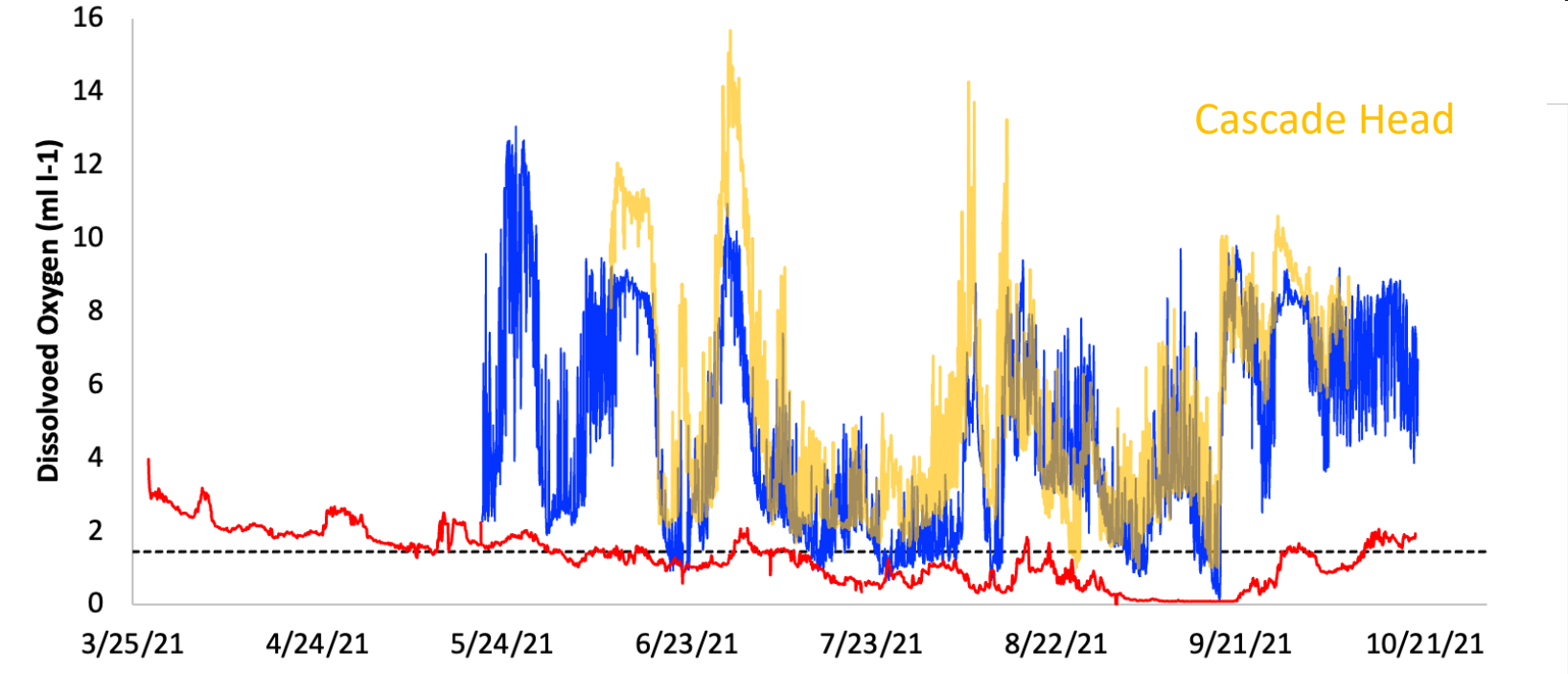

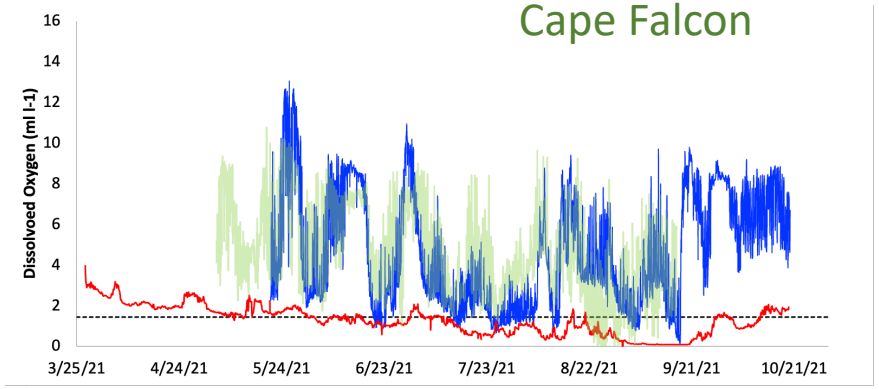

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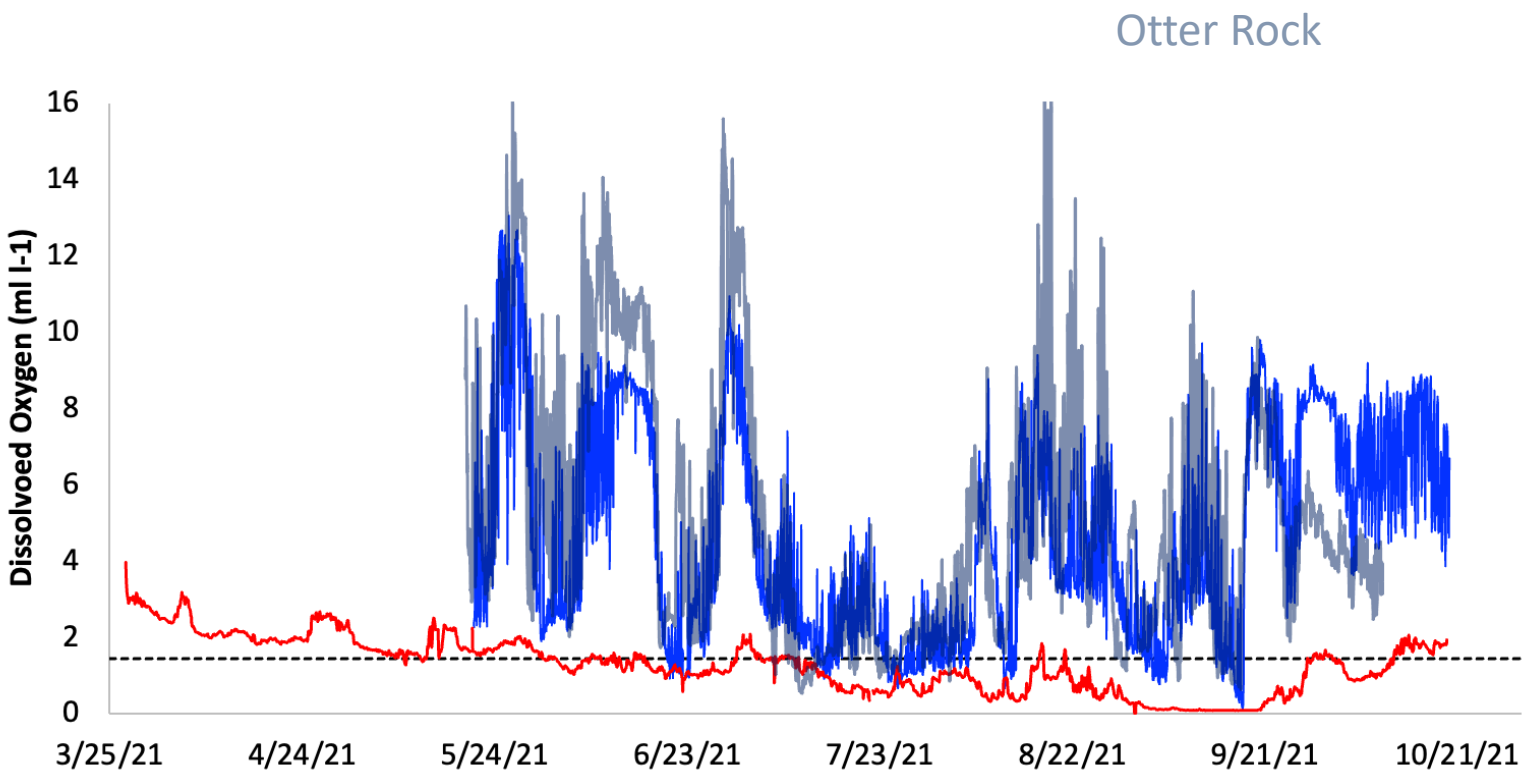

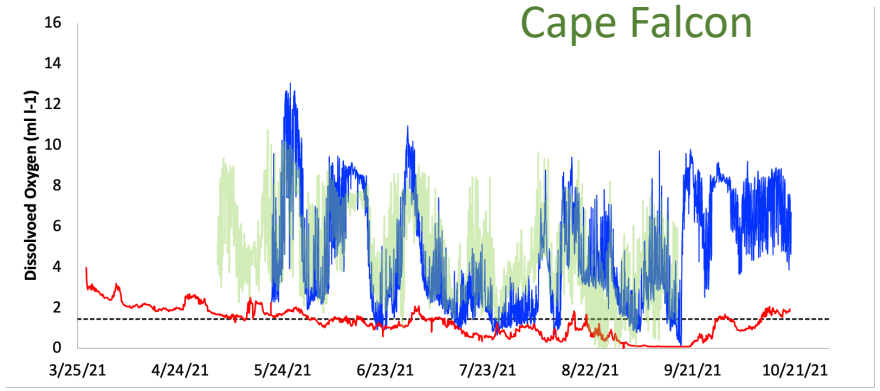

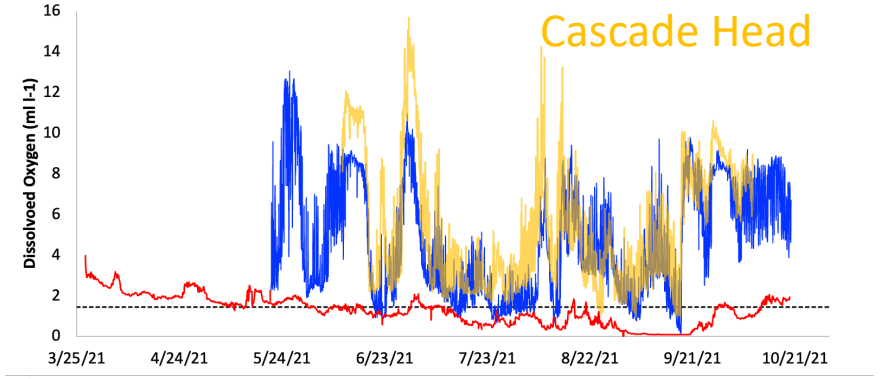

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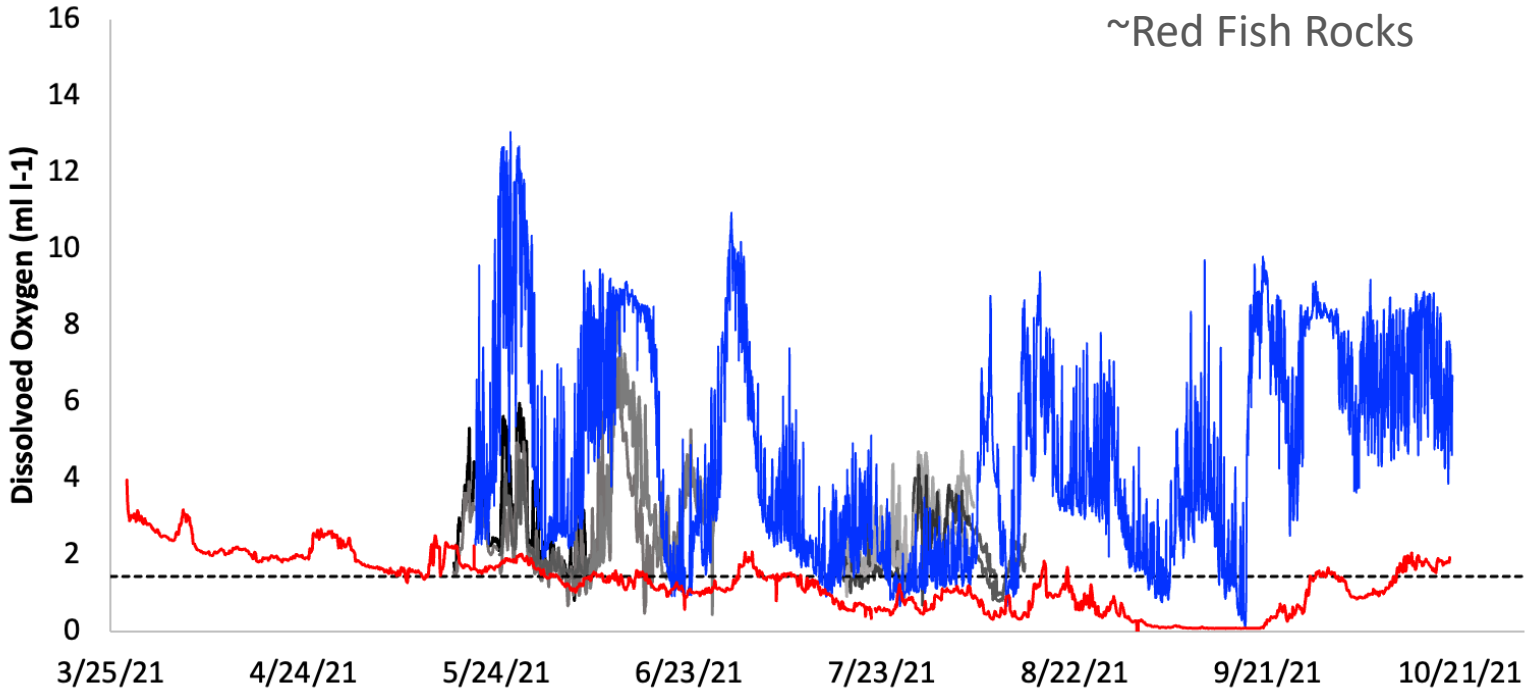
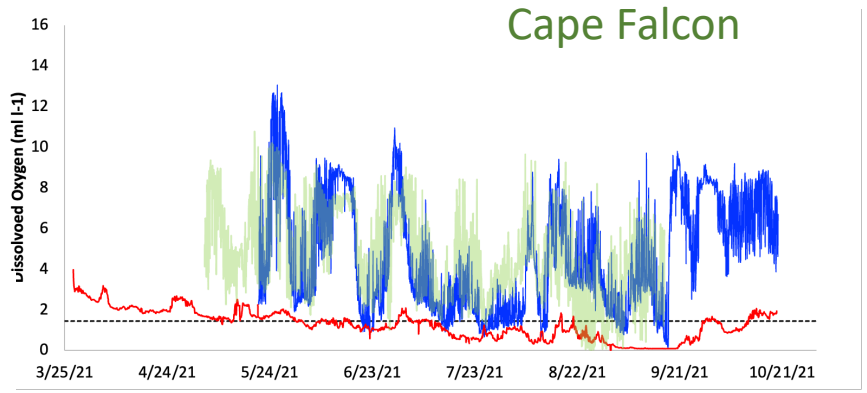
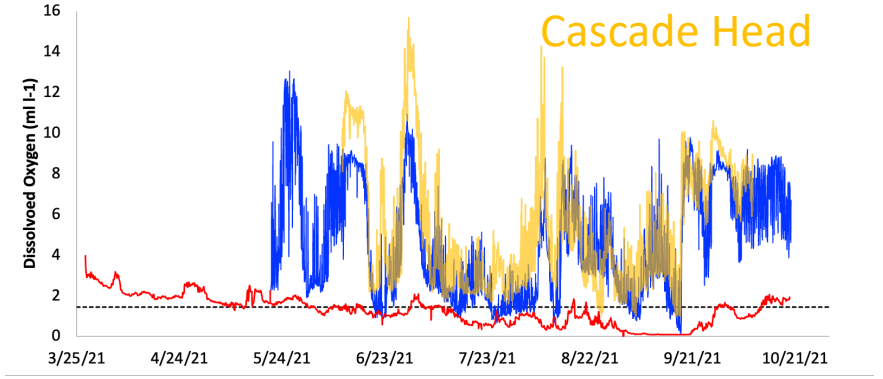
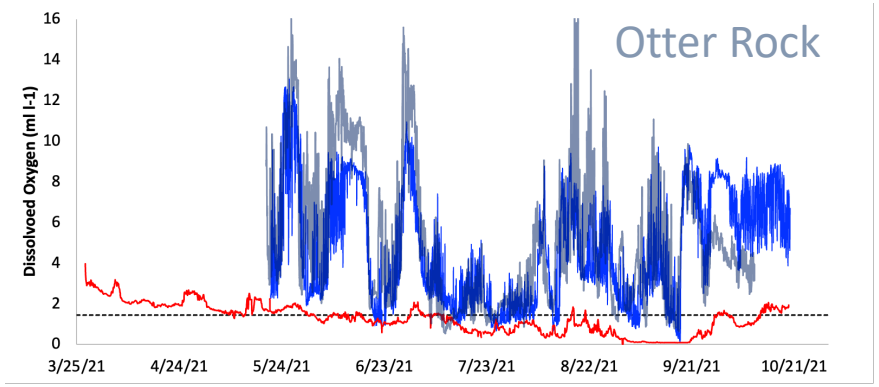
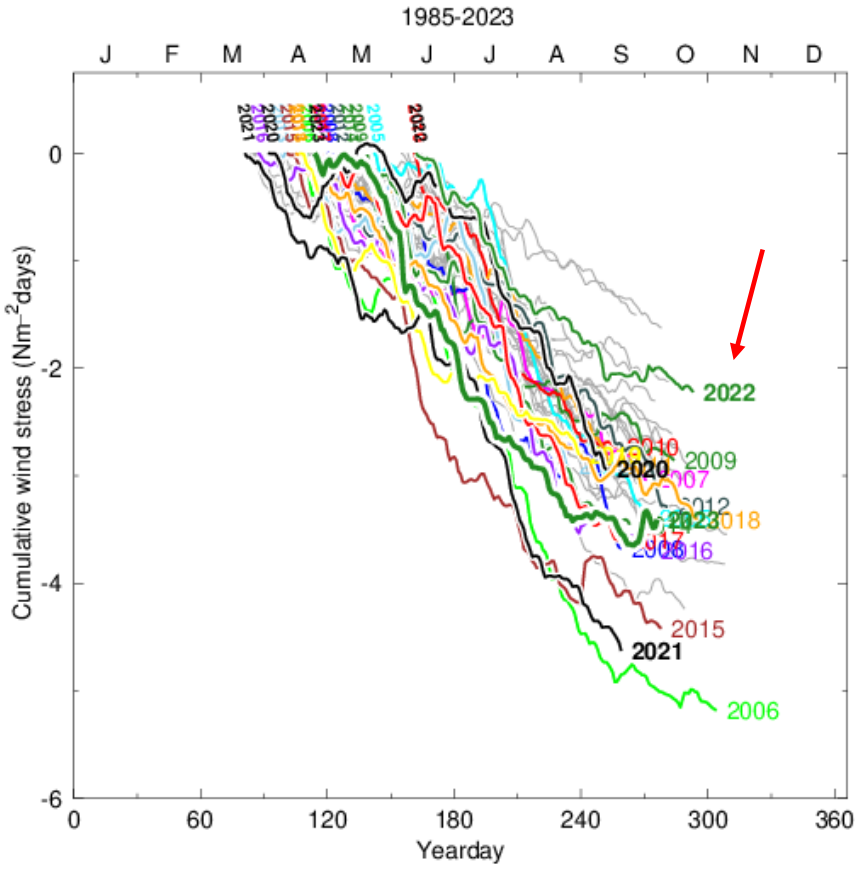








So we’re good with anoxia for a while then?



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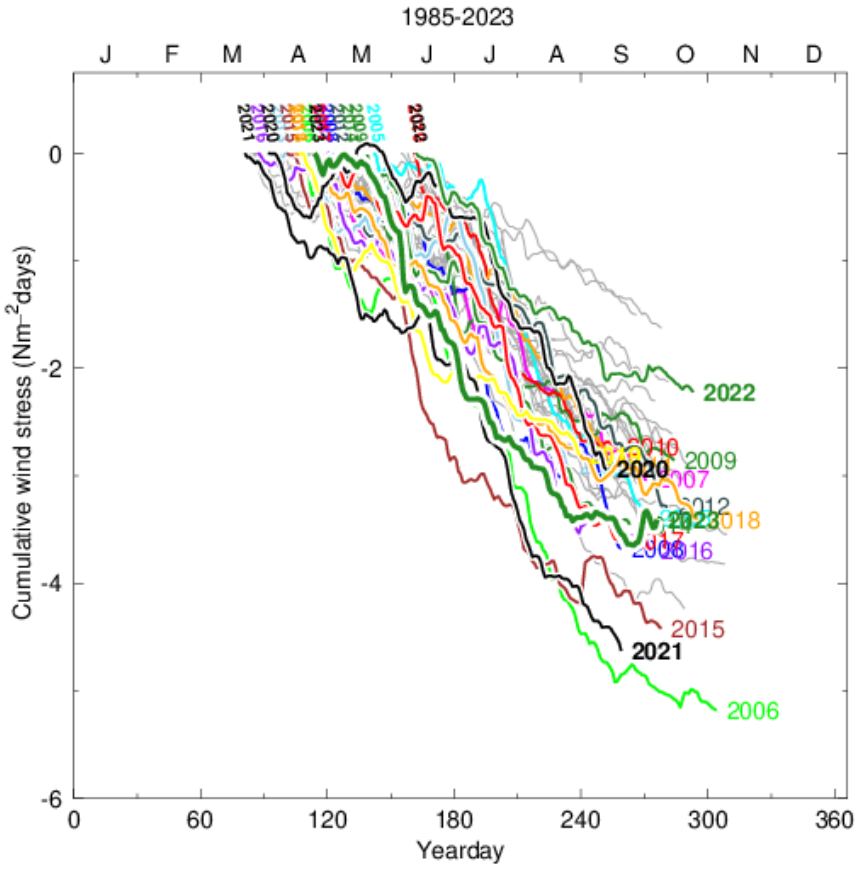
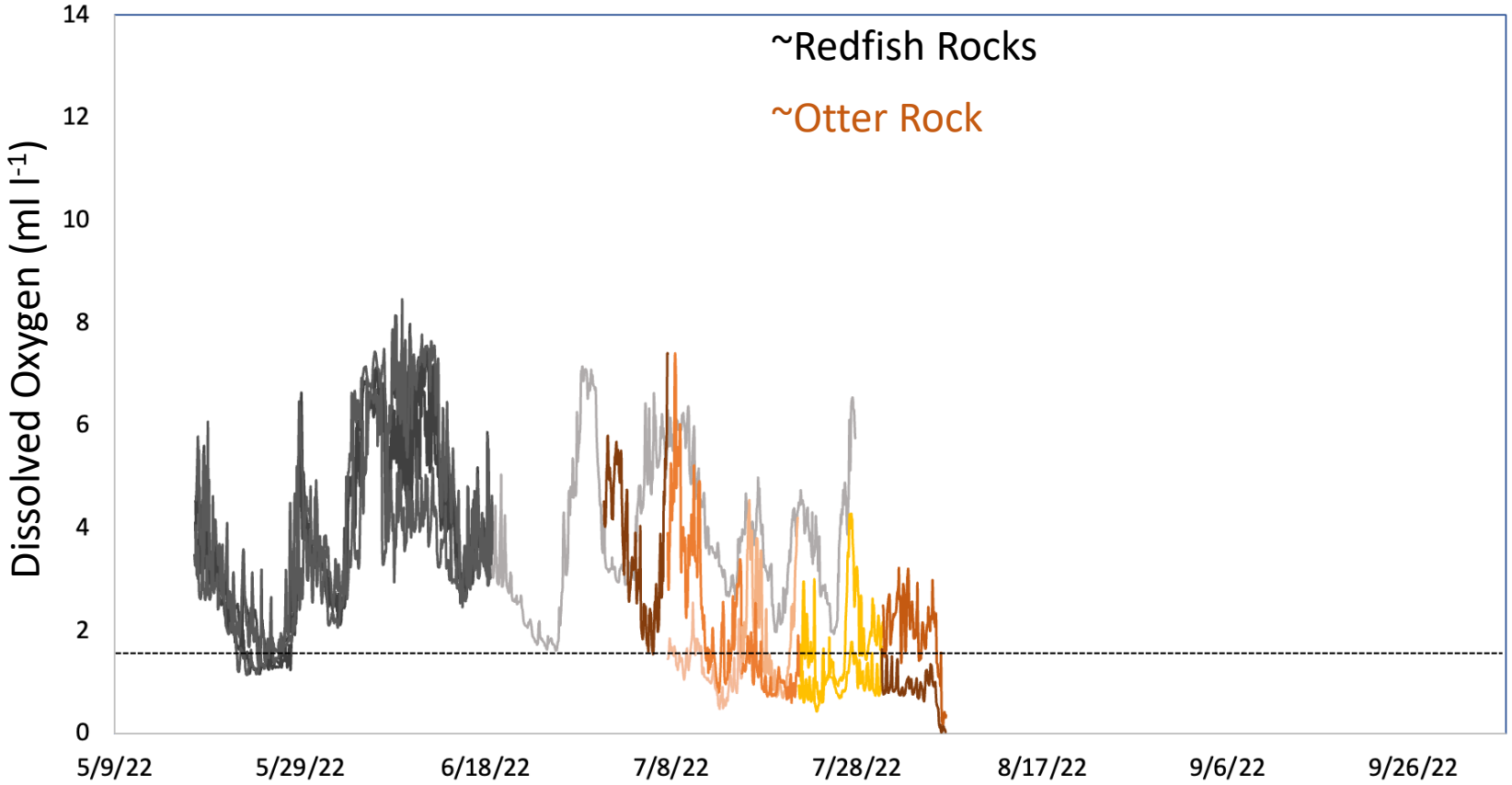
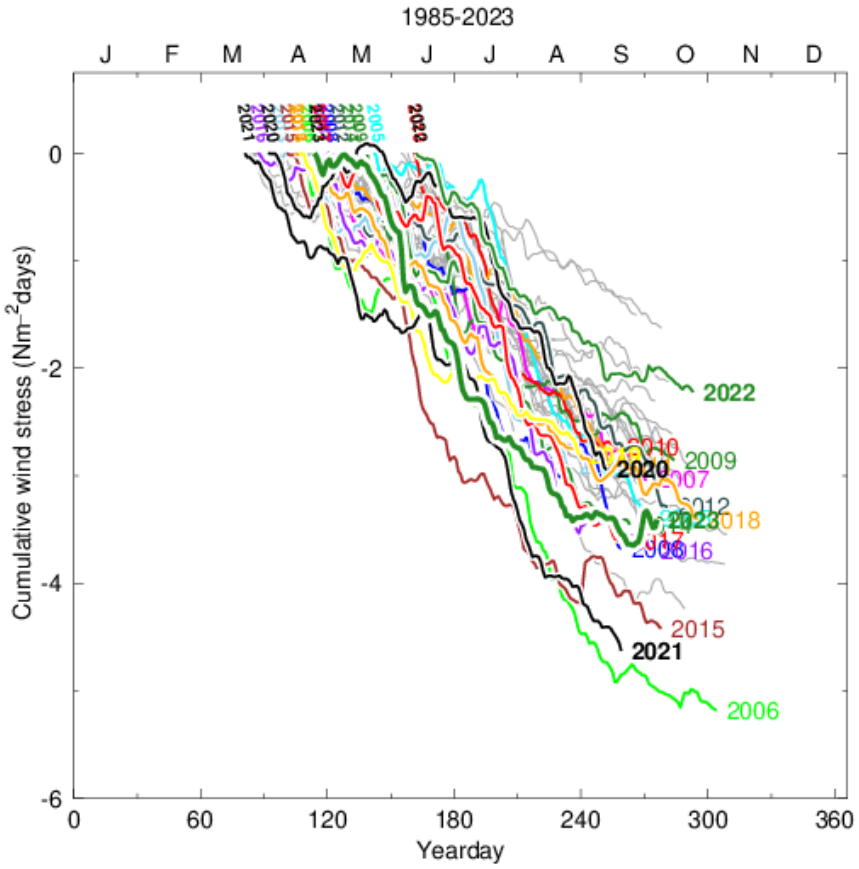
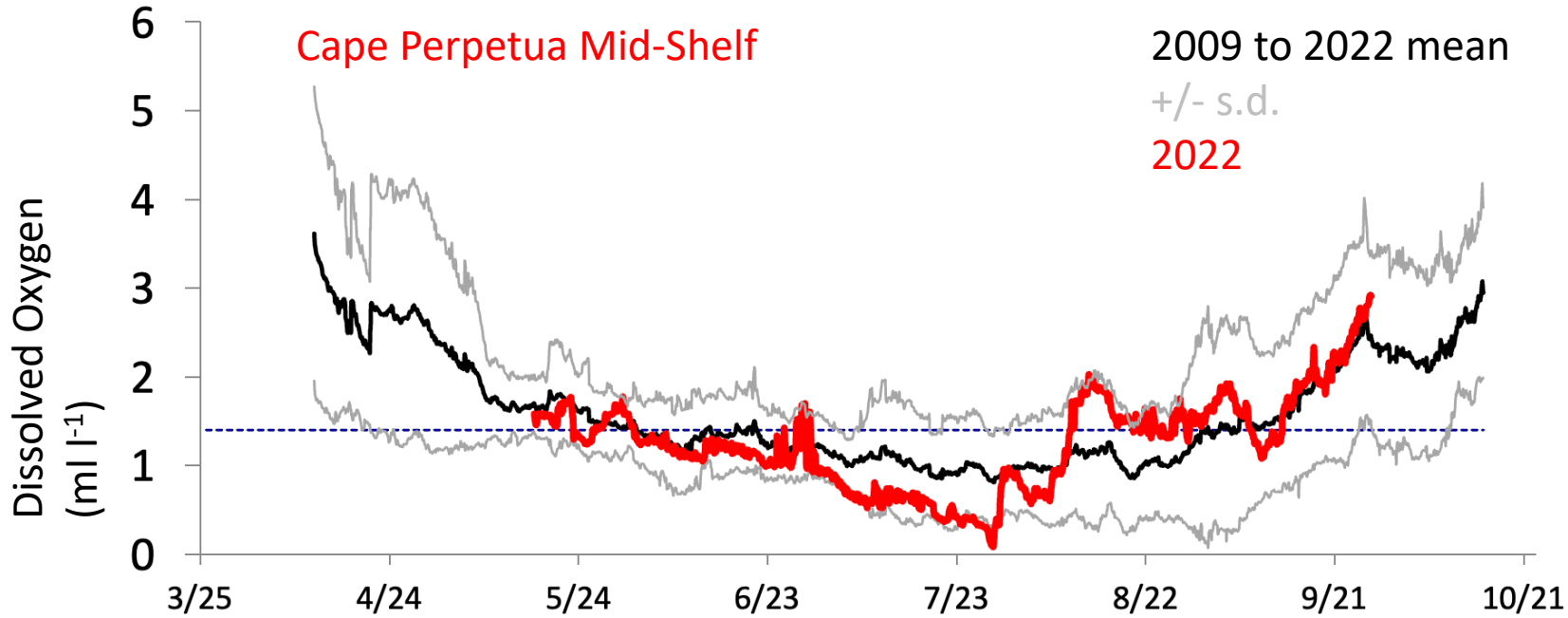




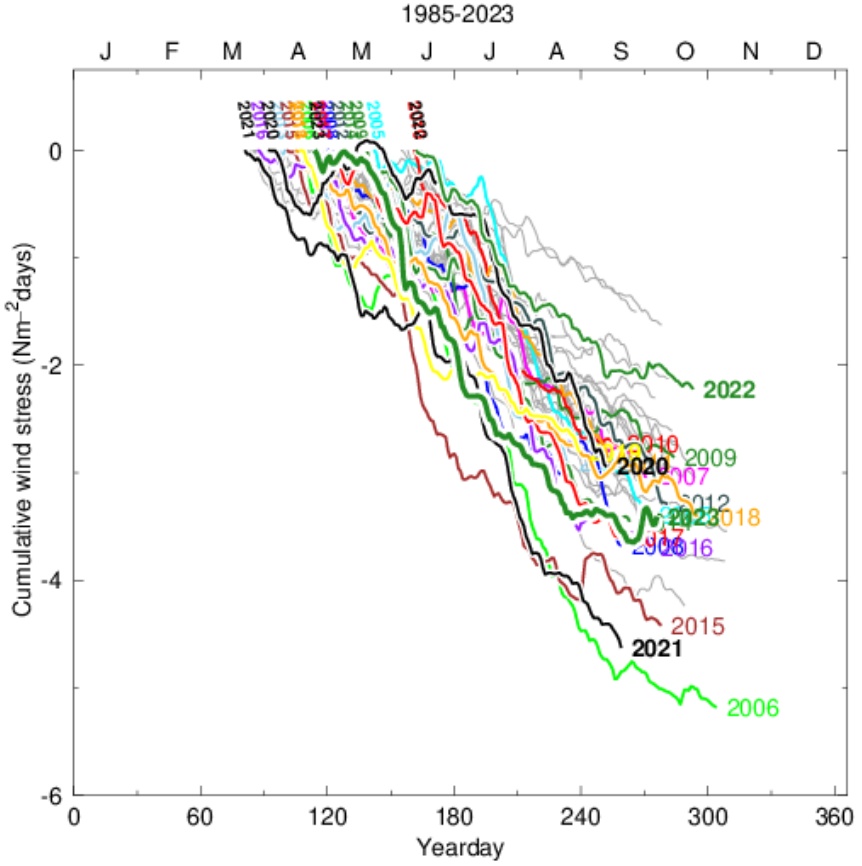
**only near real time bottom hourly DO observations then available*

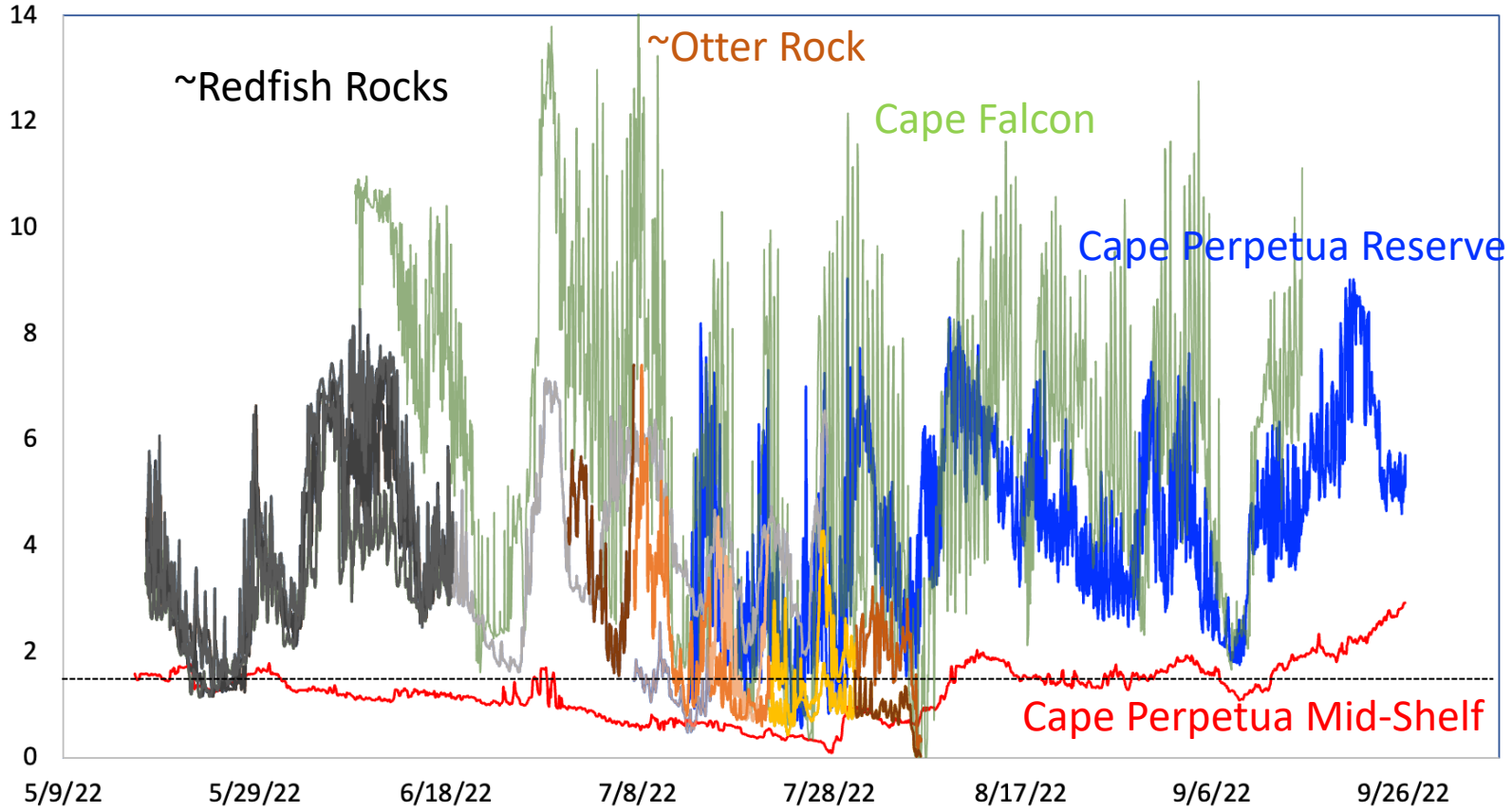
And then 2 months later when we recovered our research mooring we saw this…





We are actually vulnerable to acute low oxygen events (anoxia) that affect half our coast in state waters!

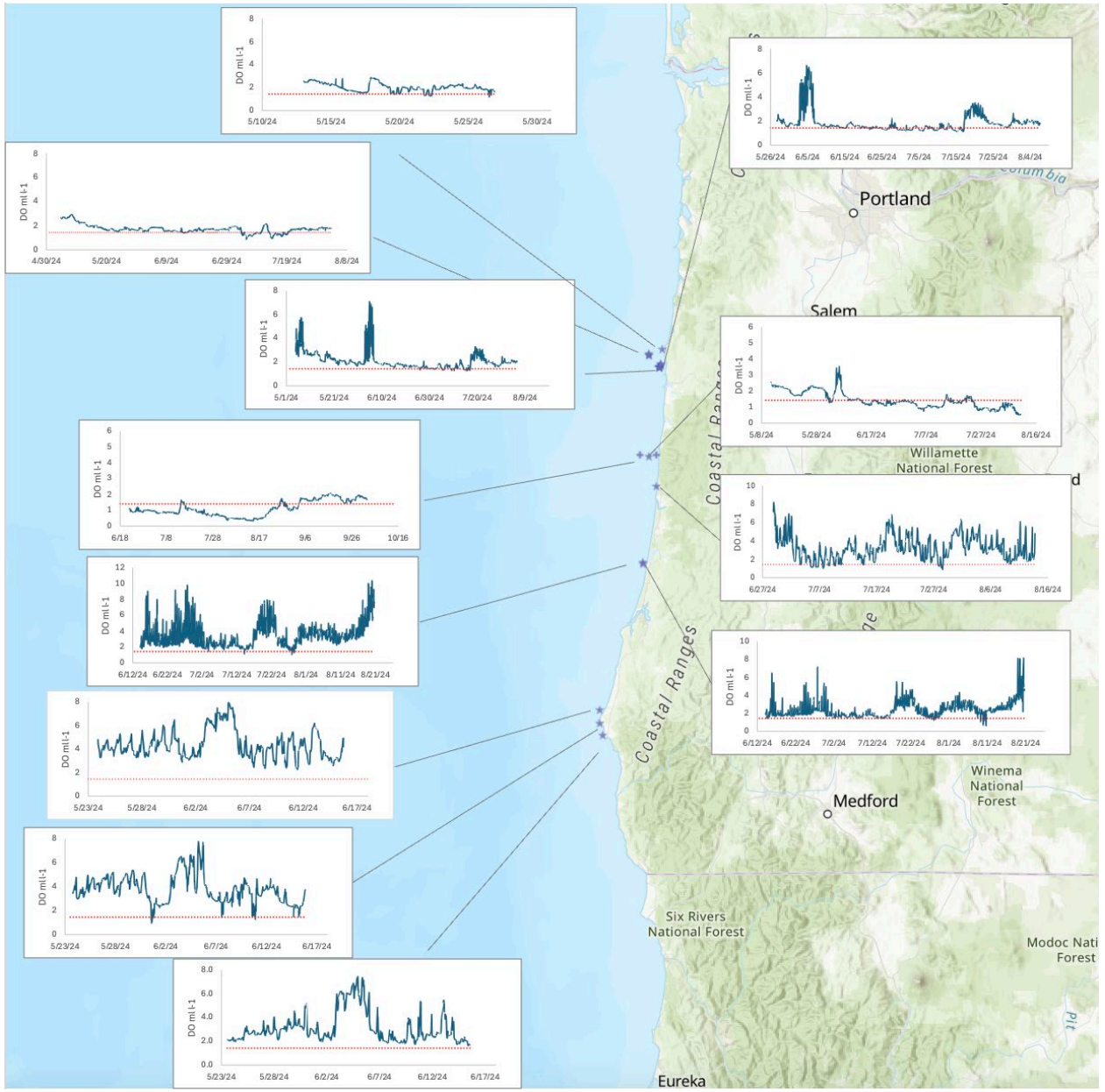




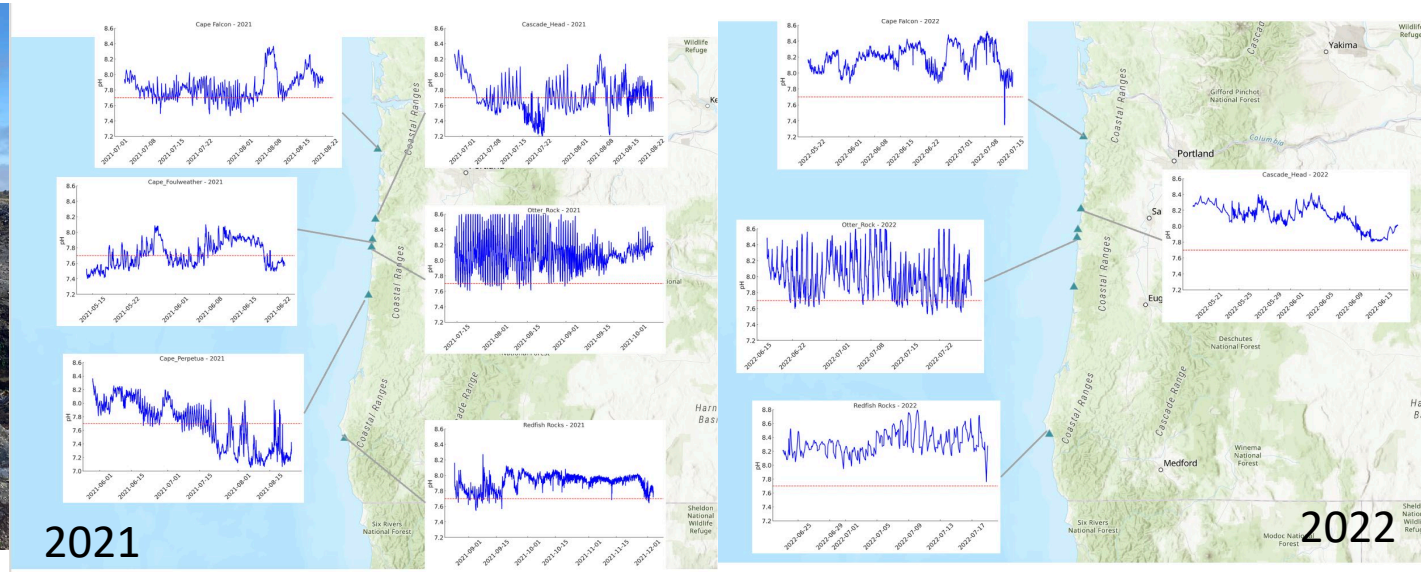
Back to geography….

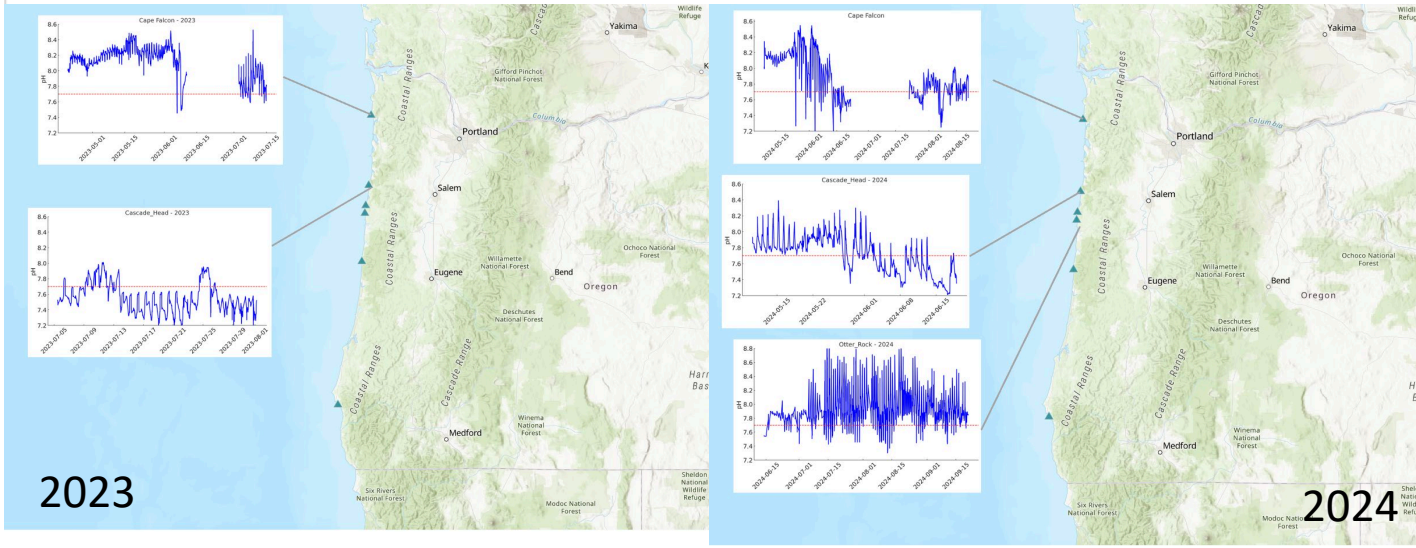
We have a north (worst) to south (better) gradient in hypoxia risk and stress that repeats through time

2024 Oregon hypoxia state waters observing network

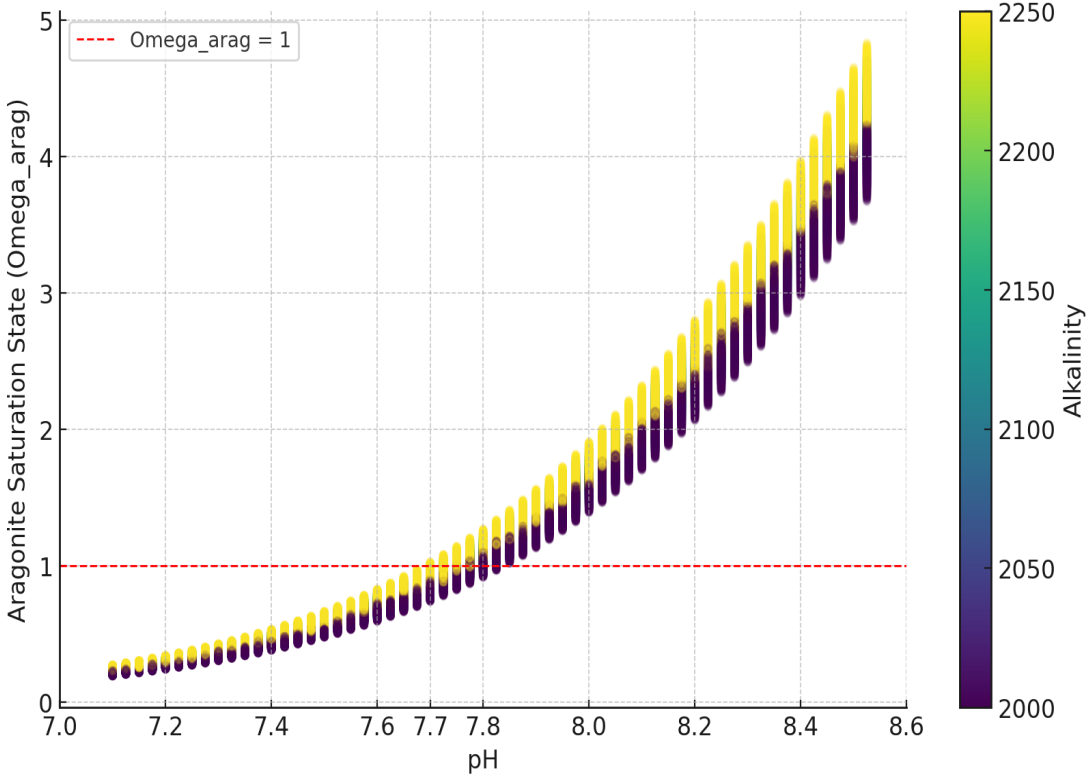


Are we tracking OA?





So what's a bad pH value?



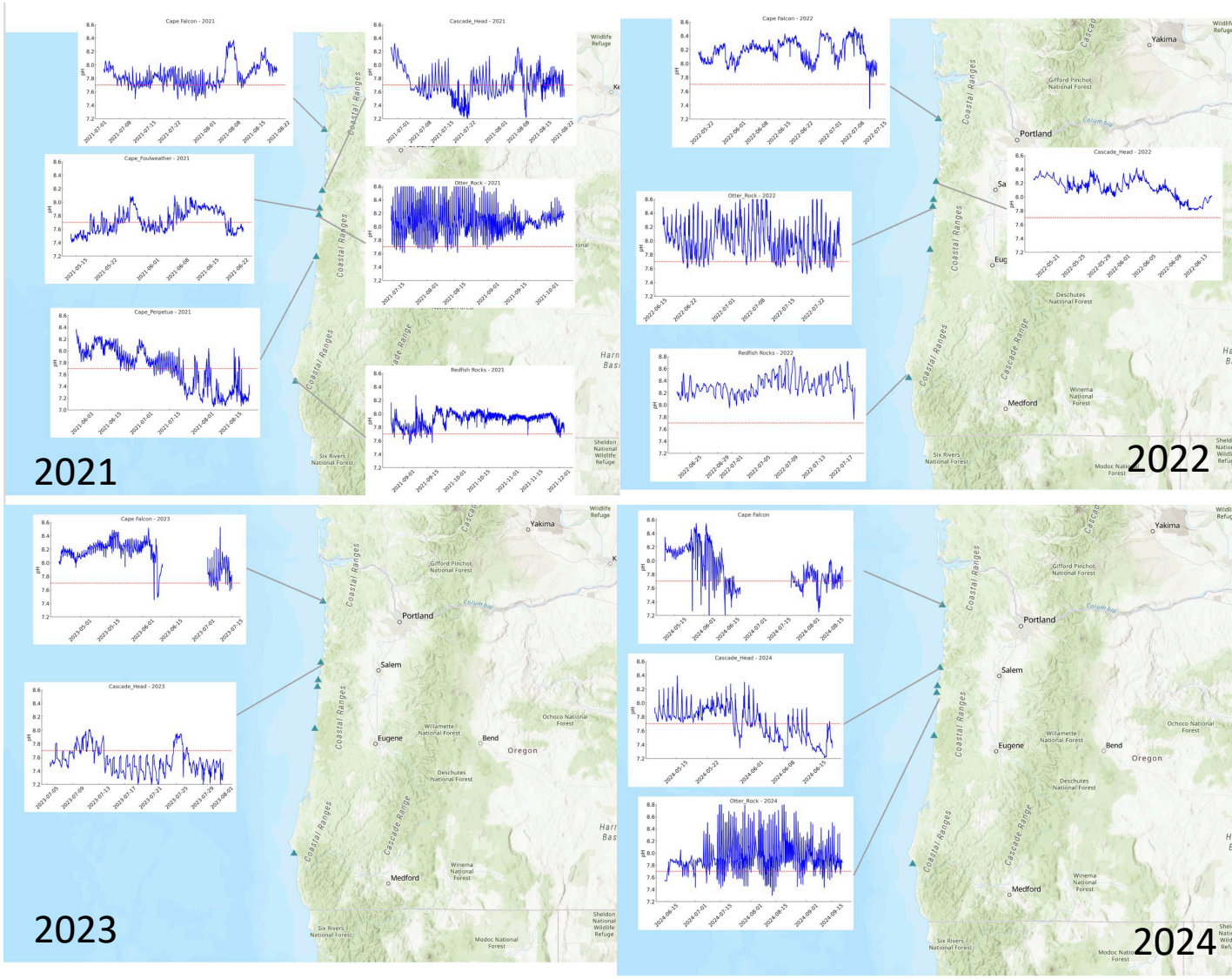
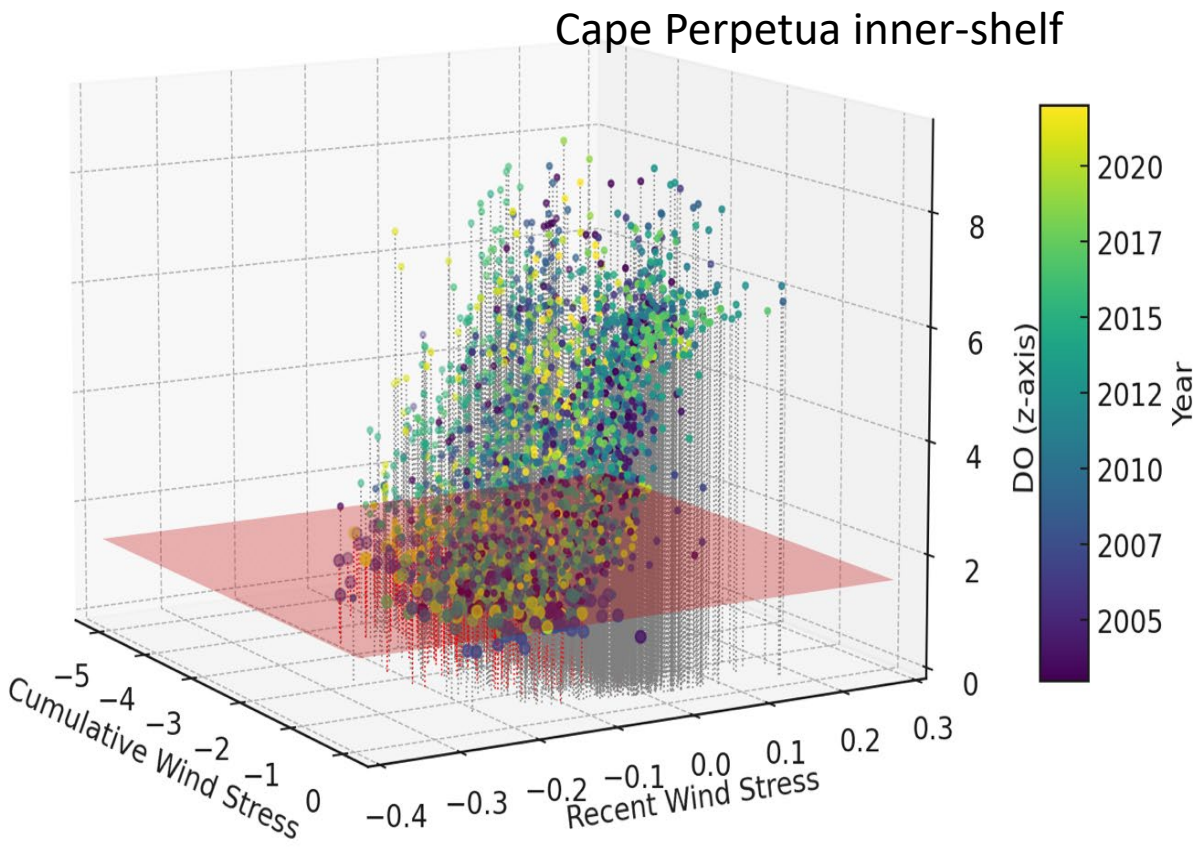


Fig 14. Modeled responses of aragonite saturation state to variations in pH where another carbon system variable is not available. Across ranges of T 8 to 10°C, Salinity of 31 to 34, and total alkalinity of 2000 to 2250 umol kg^{-1}, aragonite saturation is calculated for a given pH value. The exercise illustrates that likelihood that pH 7.7 (total scale) encountered in Oregon's open coast will exhibit aragonite saturation state value of 1 or less, denoting a transition to corrosive state. Note also that biological impairment of calcification is reached at aragonite saturation state values above 1, with impacts on oyster larvae evident ~1.7 (Barton et al. 2012).

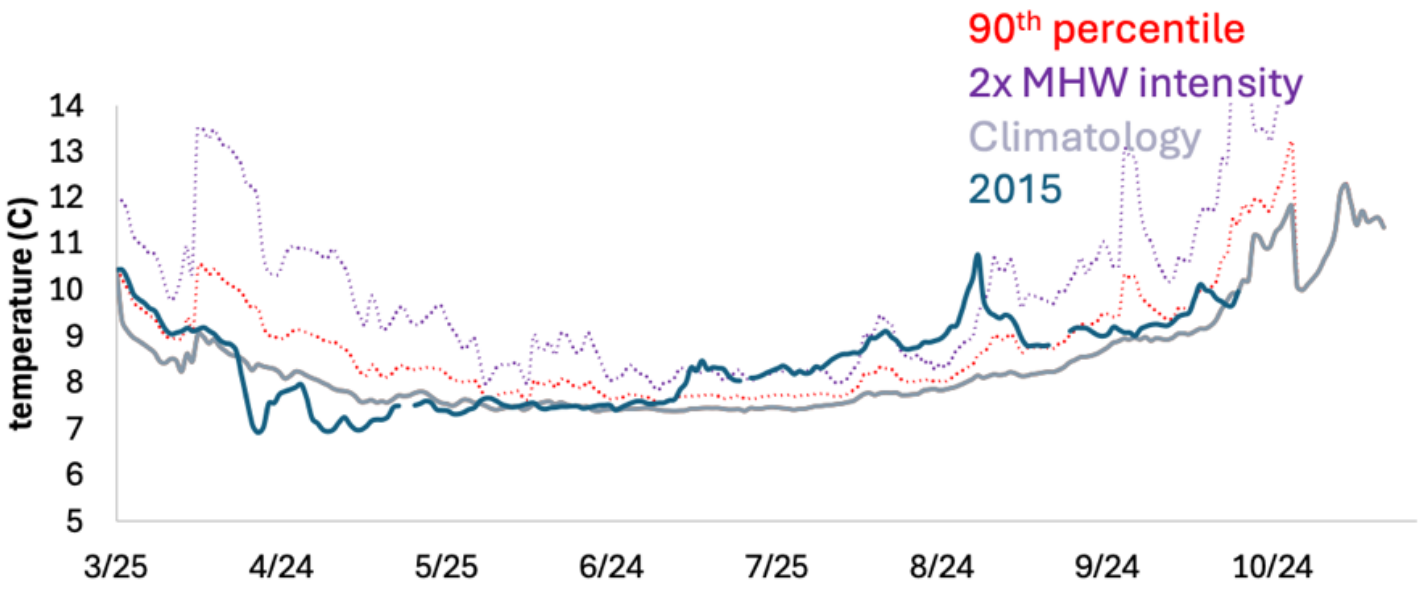
Isn’t sustained observations just code for keep giving science money?



Are there predictable patterns?

Is system baseline changing?

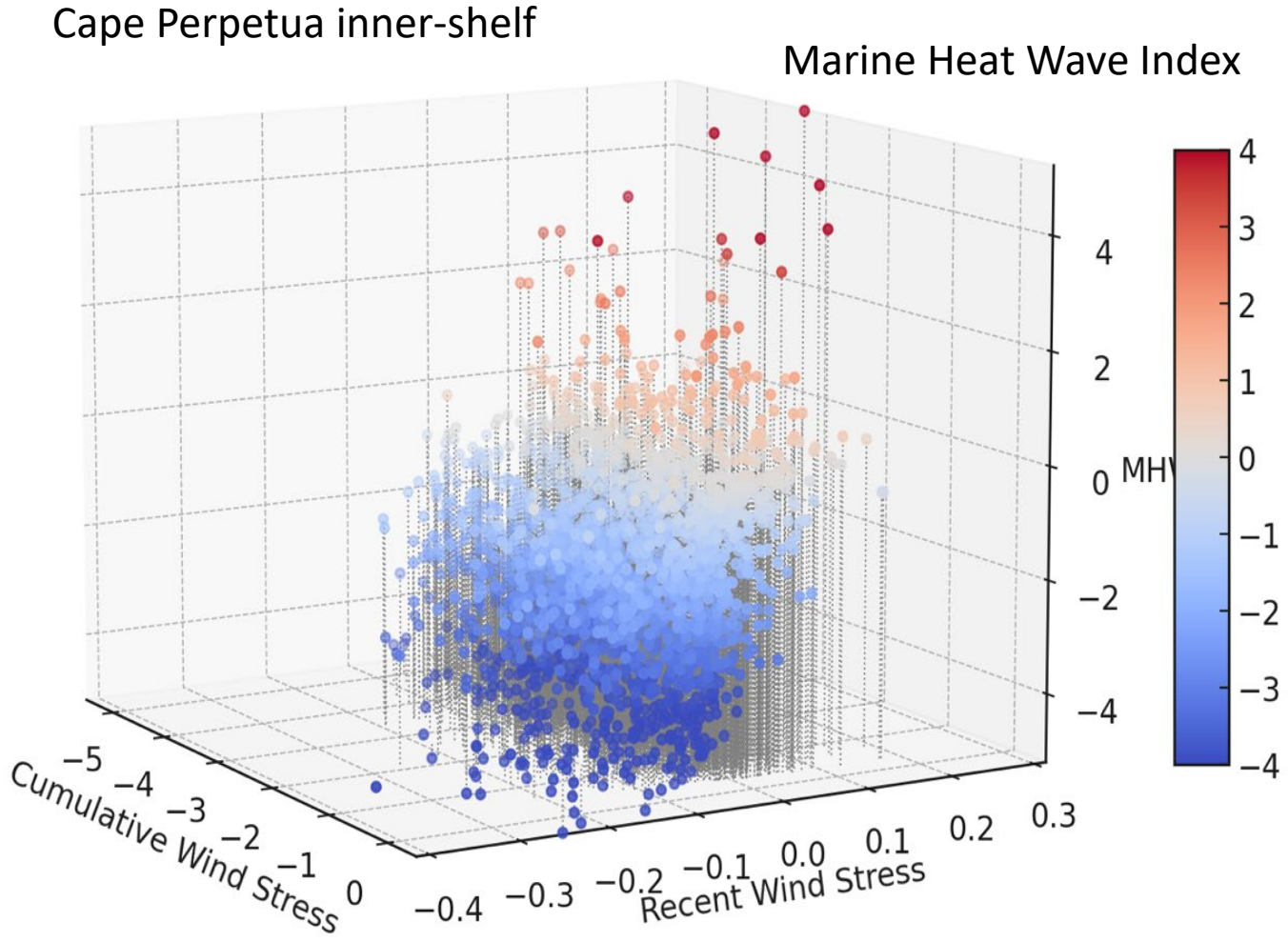
Isn’t sustained observations just code for keep giving science money?



Heatwave? Seems pretty cold to me… How do we know what’s not normal?

Are we just collecting more and more year-to-year noise?

Isn’t sustained observations just code for keep giving science money?



Now we know the relationship between upwelling winds on the risk and severity of marine heat wave events nearshore

Isn’t sustained observations just code for keep giving science money?

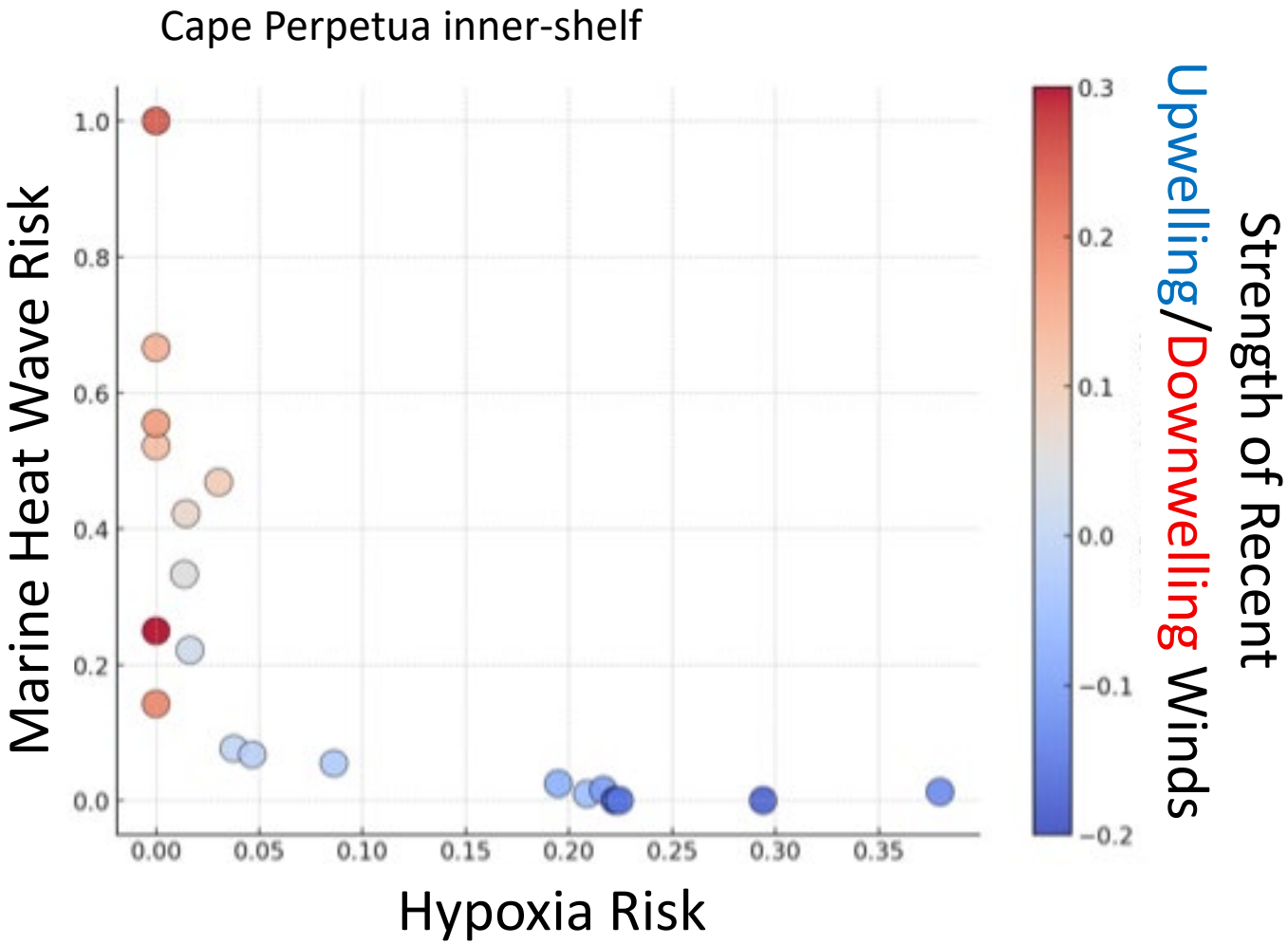
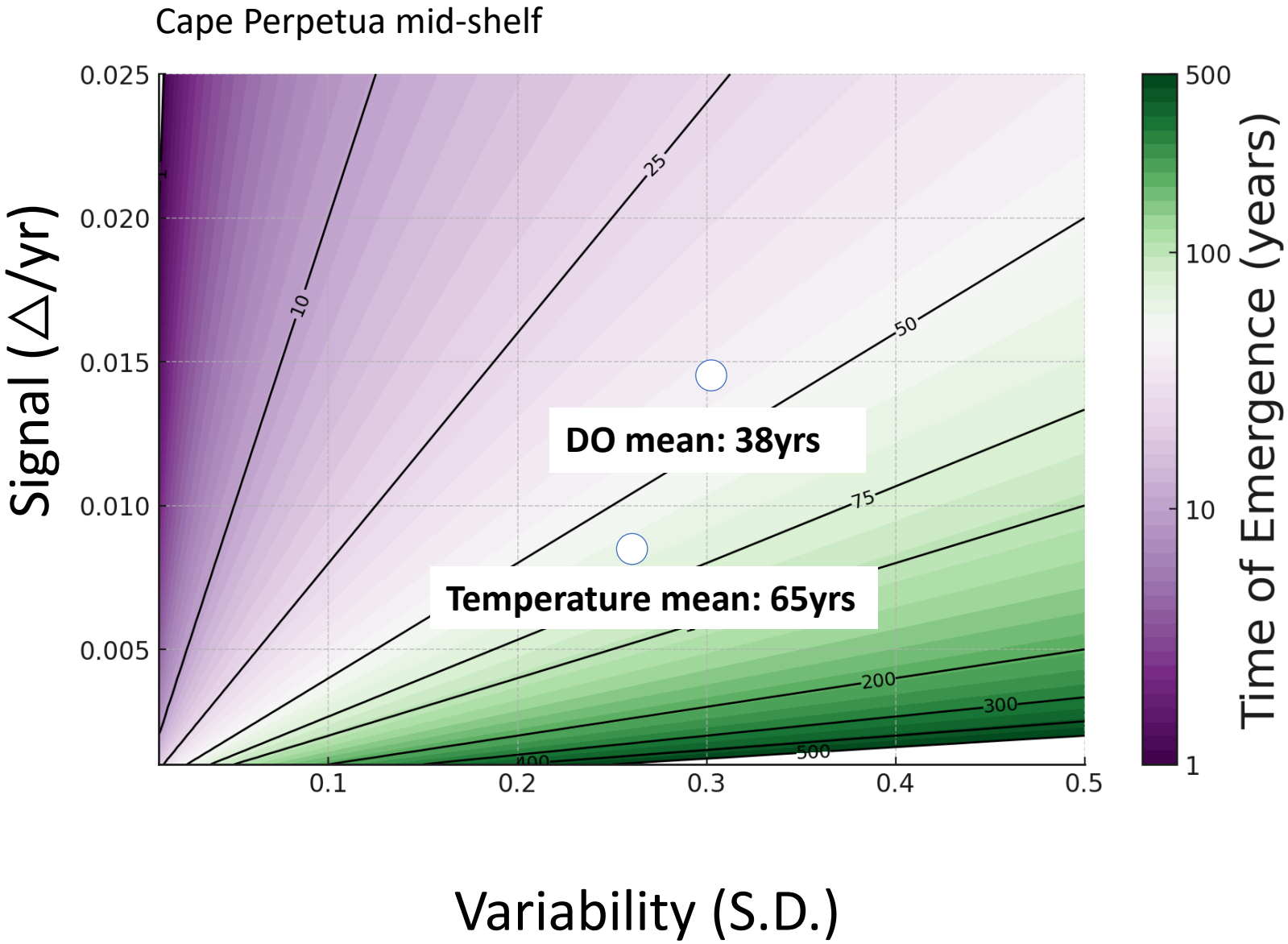


Fig 22. Integrated evaluation of the relationship between risks of MHW and hypoxia in nearshore waters. From 2 decades of observations at SH15 at Cape Pepetua, a sharp trade-off in risks is evident. K8 in the color scale refers to recent windstress as described for Fig 16.The pattern shows that MHW and hypoxia stressors do not co-occur, although the system is poised to be face one set of stressors or the other.

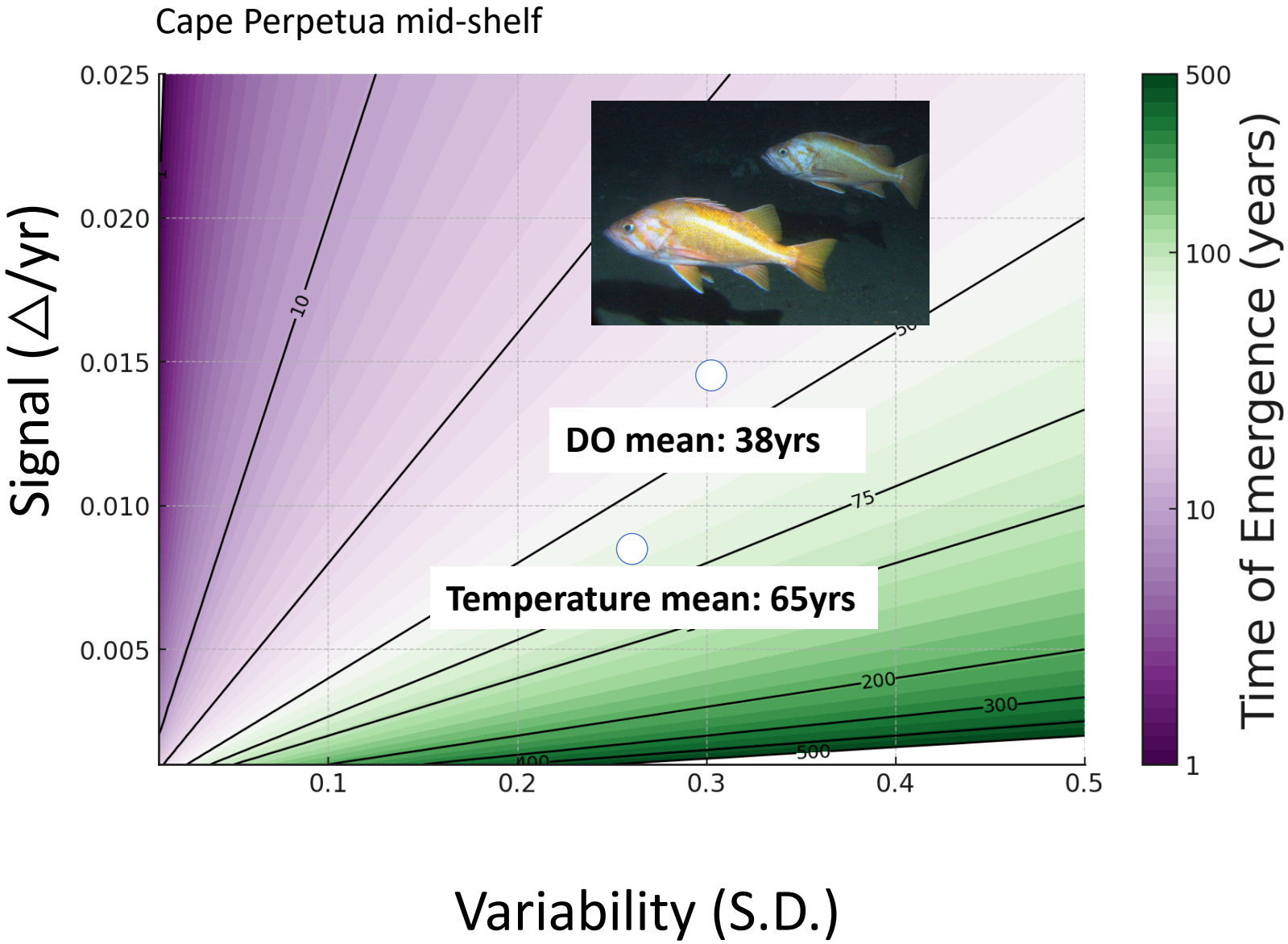
We also see the sharp trade-off between hypoxia and marine heatwave risks

Isn’t sustained observations just code for keep giving science money?



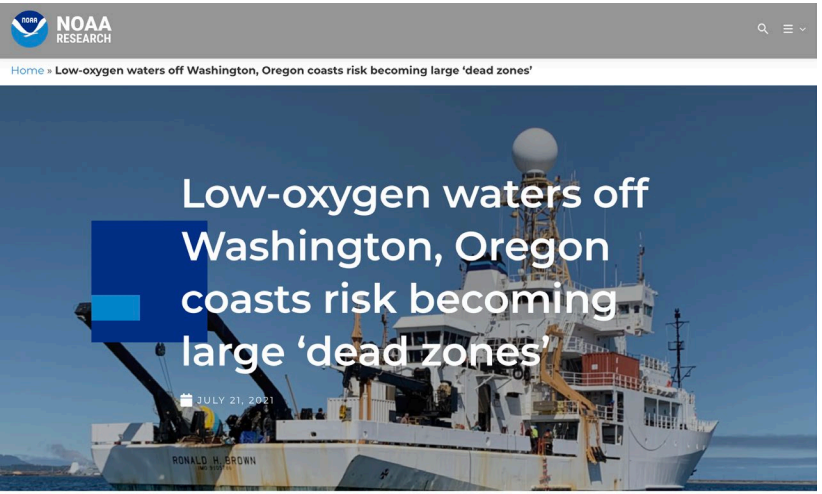
How long before our ocean looks different than the past? (i.e. time of emergence of natural variability)

Isn’t sustained observations just code for keep giving science money?

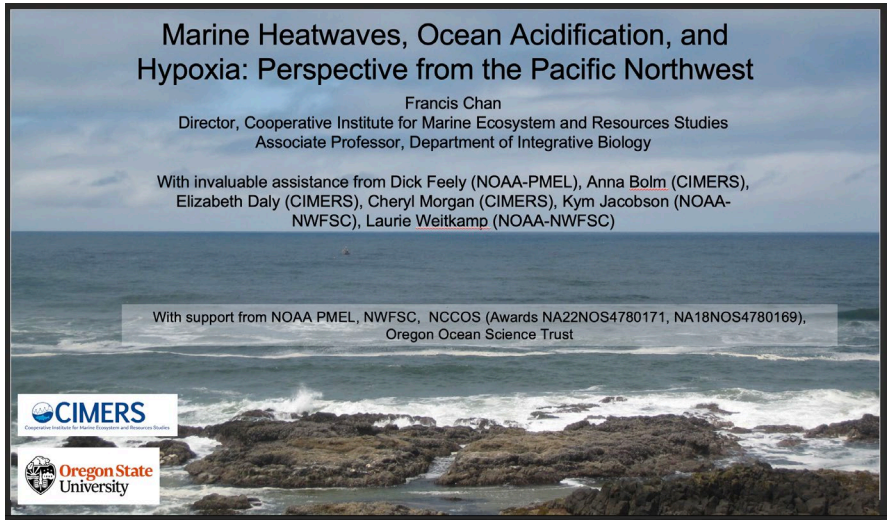


How long before our ocean looks different than the past? (i.e. time of emergence of natural variability)

Are we reaching people with our science?



C-CAN (California Current Acidification Network)
Nov 2022



US Ocean Studies Board
Oct 2023

Are we reaching people with our science?

Environment | Local News | Northwest | Science | Weather

Low oxygen levels along Pacific Northwest coast a 'silent' climate change crisis

Sep. 28, 2021 at 6:00 am

By Michala Garrison

Seattle Times staff reporter

Dead zones, a 'horseman' of climate change, could suffocate crabs in the West, scientists say

By María Luisa Paúl

July 30, 2021 at 12:10 a.m. EDT

The Washington Post

Democracy Dies in Darkness

Oregon State University scientists and students conduct research to track hypoxia in the Pacific Ocean off the Oregon coast. (Francis Chan/Oregon State University)

Hakai magazine — Coastal science and societies

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To better understand how hypoxia—dangerously low oxygen levels—affects crabs, researchers and fishers are working together to find a way to adjust to changing conditions in the northeast Pacific Ocean. Photo by Robin Loznak/ZUMA Wire/Alamy Live News

Catching Crabs in a Suffocating Sea

by Julia Rosen

March 1, 2022 | 3,300 words, about 16 minutes

Are we reaching people with our science?

HOUSE SELECT COMMITTEE ON THE CLIMATE CRISIS

OUR WORK ABOUT NEWS COMMITTEE ACTIVITY CONTACT

Building Climate-Resilient Coastal Communities: Perspectives from Oregon's State, Local, and Tribal Partners

Wed, 08/03/2022 - 10:00am

Patriot Hall, Clatsop Community College. 1650 Lexington AvenueAstoria, OR 97103

This hearing will examine challenges facing Oregon's coastal communities and ecosystems due to the climate crisis and opportunities for the federal government to help state, local, and Tribal partners build resilient, climate-ready coasts.

COMMITTEE ACTIVITY

All Activity

Hearings

Are we leveraging the investments?

NCCOS | NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

ABOUT US FACILITIES FUNDING RESEARCH & TOOLS NEWS

NOAA Awards $4.2 Million for Multi-Stressor Research on Northern California Current Ecosystem

Published on: 11/02/2022

Research Area(s): Marine Spatial Ecology / Ecological and Biogeographic Assessments, Regional Ecosystem Science; Coastal Change / Climate Impacts on Ecosystems, Ocean Acidification; Stressor Impacts and Mitigation / Biological Effects of Contaminants and Nutrients, Harmful Algal Bloom Detection and Forecasting, Hypoxia; Other Topics / Sponsored Research

Region(s) of Study: Waterbodies / Pacific Ocean; U.S. States and Territories / California, Oregon, Washington

Primary Contact(s): kimberly.puglise@noaa.gov

NOAA has awarded $967,505 of an anticipated four-year, $4.2 million project to support research on multi-stressor impacts on marine ecosystems under climate change. The newly funded project, led by Oregon State University and NOAA's Pacific Marine Environmental Laboratory, will occur off the coasts of northern California, Oregon, and Washington, including NOAA's Olympic Coast National Marine Sanctuary, and will focus on climate impacts to Dungeness crab, an iconic and valuable fishery resource that is culturally and economically important to the region's coastal communities.

IOOS ABOUT COMMUNICATIONS DATA IOOS IN ACTION REGIONS COMMUNITY

Ocean Technology Transition

Home / IOOS in Action / Ocean Technology Transition

About | Project Information | Documents

IOOS advances technology through the transition of ocean, coastal, and marine sensors and platforms to operations.

"Fishing for Hypoxia" $1.2 million, Sept 2023 to Aug 2026

Jessica Garwood, OSU (lead PI)
Jack Barth, OSU
Francis Chan, OSU
Jeremy Childress, The Sexton Corporation
Jan Newton, UW
R. Kipp Shearman, OSU

Thank you!

- The Oregon Legislature, particularly past and present members of the Coastal Caucus
- Oregon Ocean Science Trust
- NOAA NCCOS

Dick Vander Schaaf
Charlie Plybon
Kerry Holman
Taylor Brooks
Tom Calvanese
Chrissy Smith
The ODFW Marine Reserve Team!
Many others!

Jack Barth
Samantha Chisholm Hatfield
Linus Stoltz
Ben Frieberg
Brandon Russell
Kipp Shearman
Jessica Garwood
Jeremy Childress

Dave Bailey
Aaron Ashdown
Pat Kemmish
John Terebesi
Jake Fletcher
Greg Niles

OREGON STATE UNIVERSITY PRESENTS

CONVERSATIONS IN SCIENCE

Impacts of NOAA and CIMERS Science on Coastal Fisheries and Businesses.

CIMERS

Oregon State University

Fishermen, seafood businesses, and coastal communities depend on access to science. Sound science ensures safety at sea for fishermen, supports productive fisheries that provide consumers with high quality and safe domestic seafoods, and enables buildable and insurable businesses and communities in the face of flooding and tsunami risks. The positive impacts of NOAA and CIMERS science run deep in Oregon. Hear about these benefits from coastal residents who depend on access to sound science in their jobs and businesses.

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