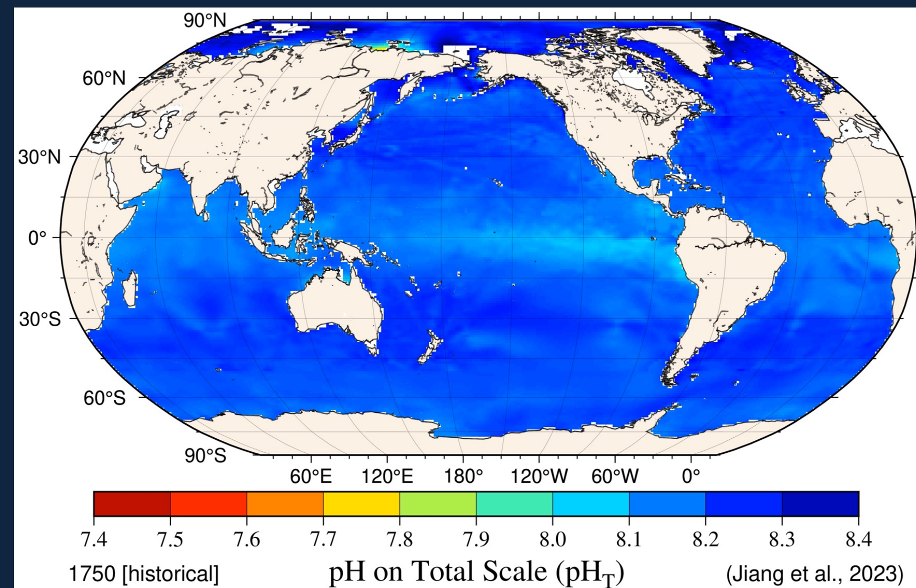
Ocean Acidification Monitoring in the California Current Ecosystem



After Jiang et al 2023

Dr. Richard A. Feely
Senior Scientist
Pacific Marine Environmental Laboratory/NOAA

NOAA Science Advisory Board Meeting
SCCWRP Headquarters, Costa Mesa, California
July 26, 2023

http://www.oceanacidification.noaa.gov/

The Ocean Acidification Challenge

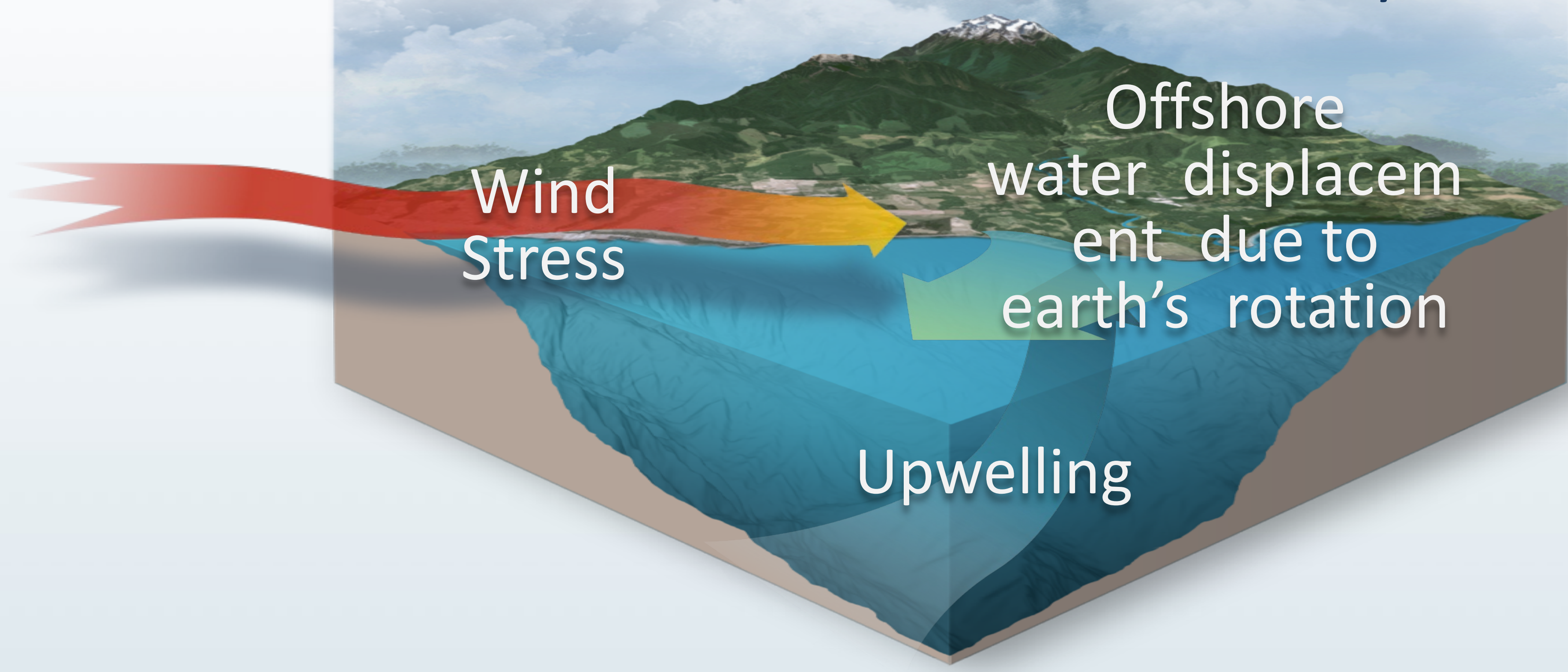
GOA-ON
Global Ocean Acidification Observing Network

- Each year the global oceans absorb about 27% of anthropogenic CO_2 emissions.
- CO_2 changes in the upper ocean interact with other stressors (higher temperatures, lower oxygen, harmful algal blooms, etc) to exacerbate biological impacts

This requires a sustained observing network of physical, chemical and biological measurements at a range of spatial and temporal scales!

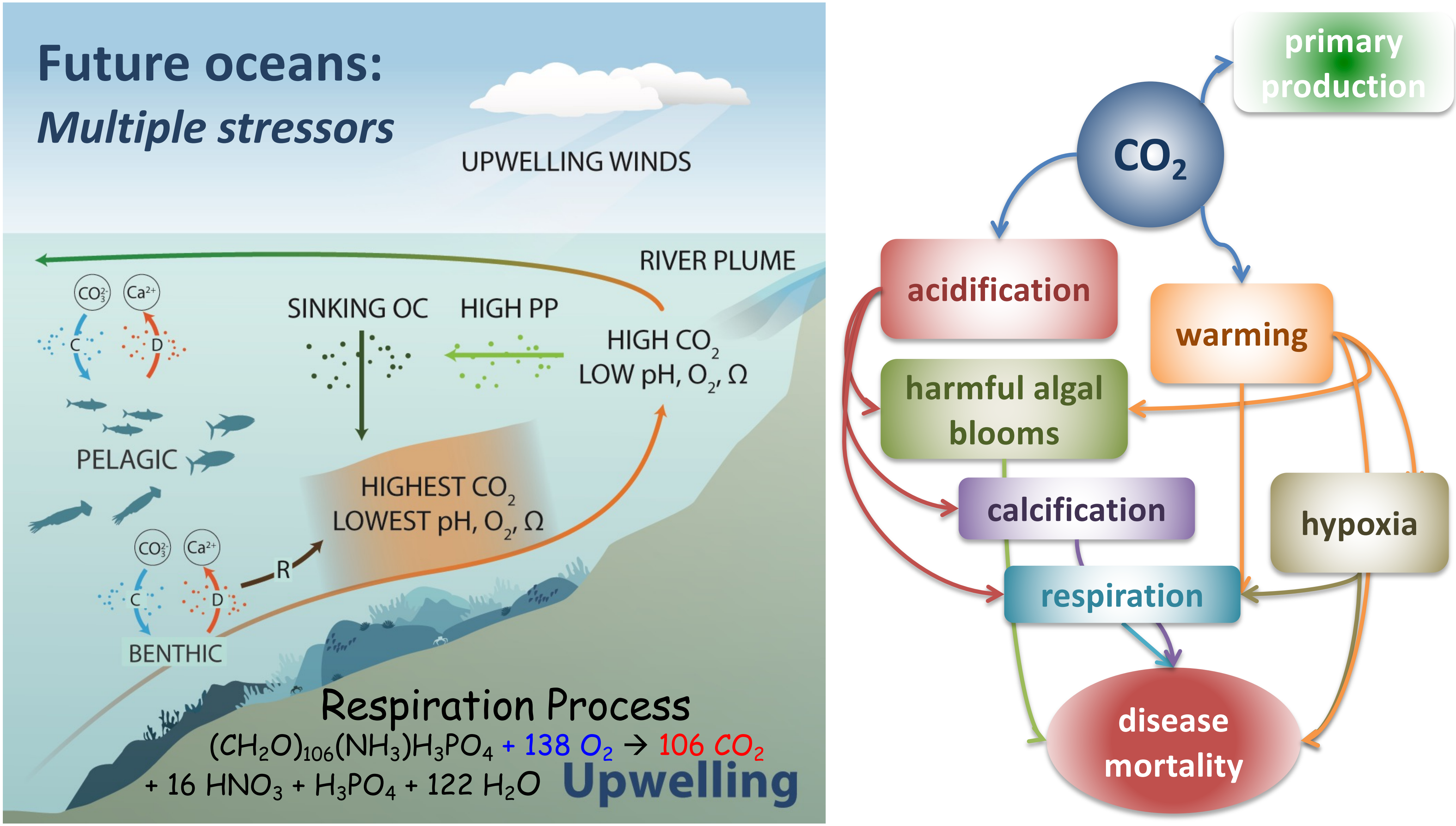
www.goa-on.org

Natural processes that could accelerate ocean acidification in the California Current Ecosystem



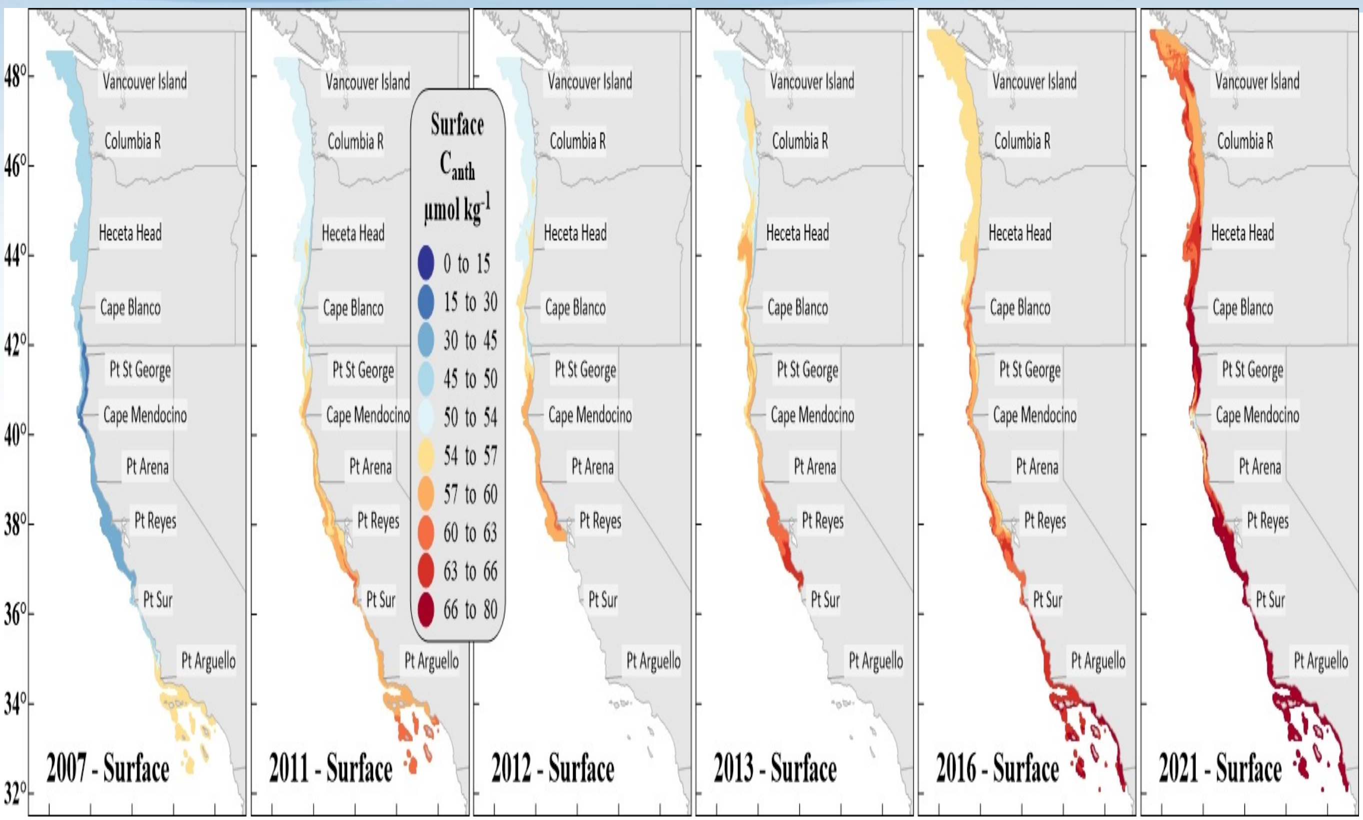
brings high CO_2, low pH, low Ω, low O_2 water to surface

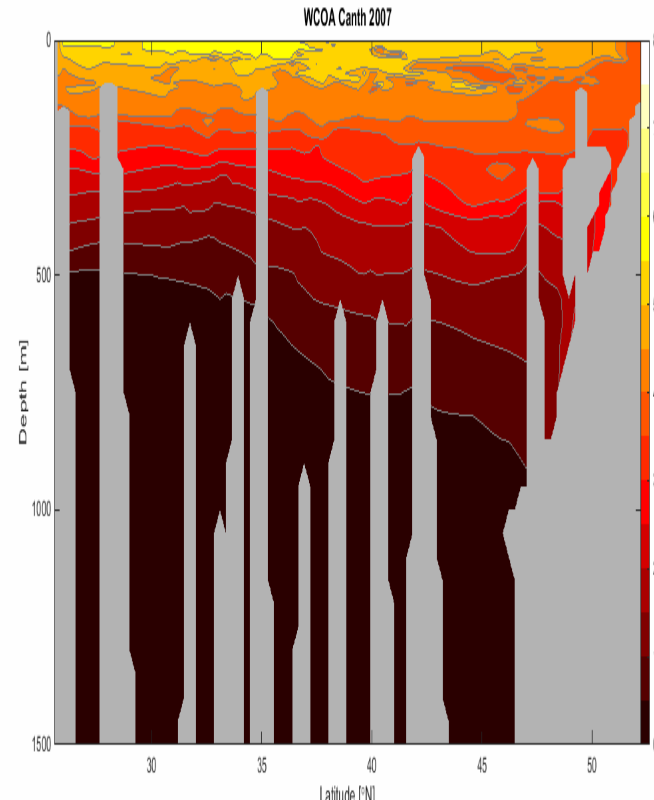
Coastal Upwelling


Future oceans:
Multiple stressors
UPWELLING WINDS
RIVER PLUME
SINKING OC
HIGH PP
HIGH CO2
LOW pH, O2, Ω
CO3 2-
Ca2+
C
D
PELAGIC
HIGHEST CO2
LOWEST pH, O2, Ω
R
BENTHIC
Respiration Process
(CH2O)106(NH3)H3PO4 + 138 O2 → 106 CO2
+ 16 HNO3 + H3PO4 + 122 H2O
Upwelling
primary production
CO2
acidification
warming
harmful algal blooms
calcification
hypoxia
respiration
disease mortality

Regional Patterns

Anthropogenic CO_2 (μmol/kg)





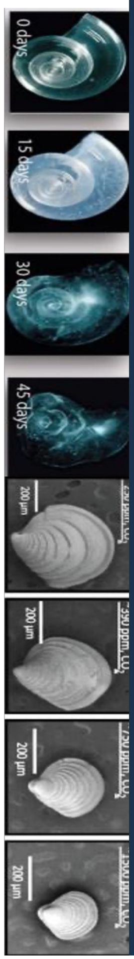
Anthropogenic CO_2 estimated using the eMLR approach of Carter et al 2019

Species Response to Ocean Acidification

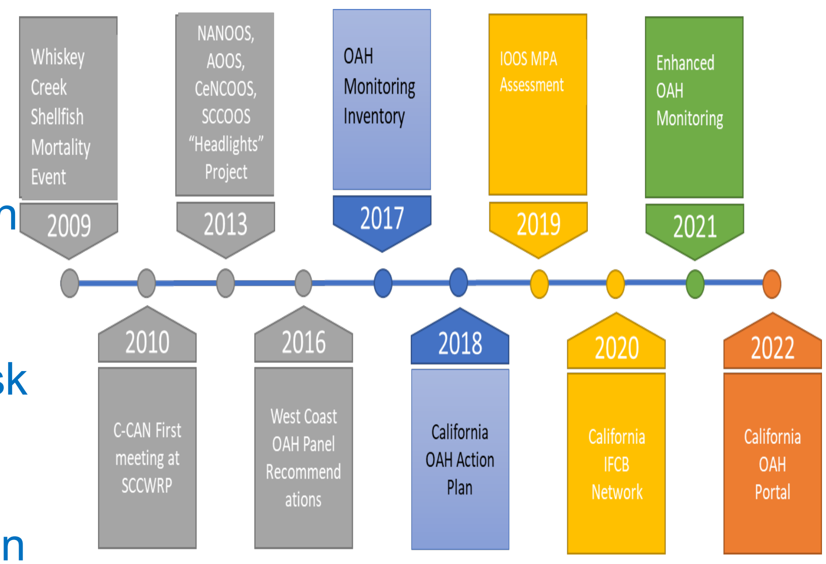
↑ ↓ =
ONGOING ?

Science Priority Setting

- NOAA Contributes to the State Needs at Several Levels



- 2012 Washington State Blue Ribbon Panel on Ocean Acidification
- 2013 Washington State Marine Resources Advisory Council formed
- 2016 and 2018 West Coast Ocean Acidification and Hypoxia Science Panel and California Action Plan
- 2017 Addendum to Washington State BRP Report
- 2019 Oregon Ocean Acidification and Hypoxia Action Plan
- 2020 California Ocean Acidification and Hypoxia Task Force
- California Current Acidification Network (emphasis on communications/documentation/training/outreach)

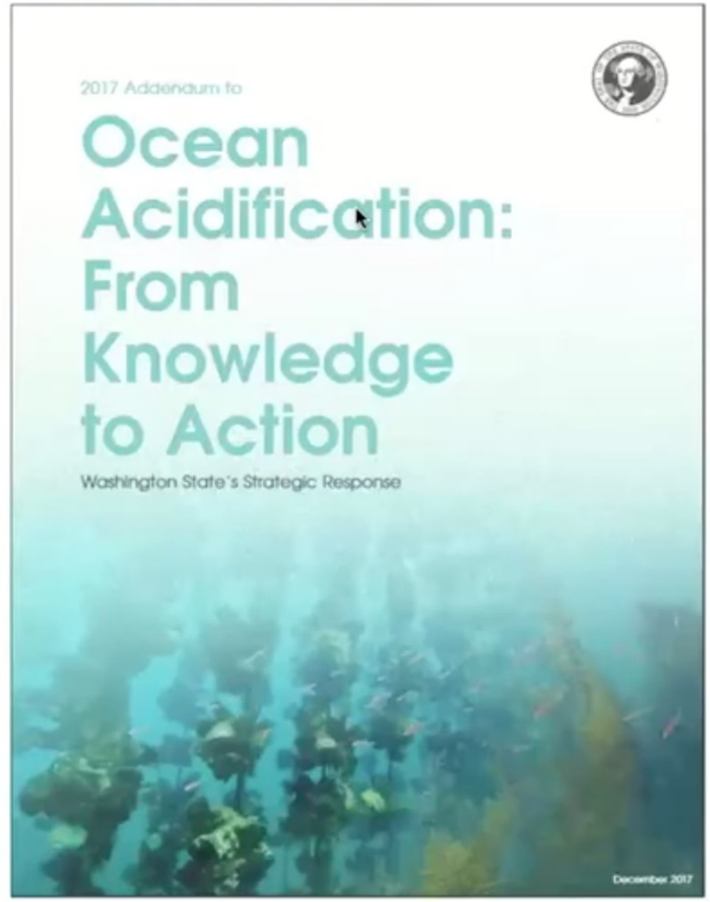


Knowledge Generation

2017 Addendum

Since 2012 we have:

- Gained a better understanding of the status and trends of ocean acidification through a distributed monitoring network with co-located chemistry and biology.
- Ocean acidification in Washington's waters **varies greatly depending on depth, season, and location,** shown by NOAA and WOAC cruises.
- Direct, high-resolution observations of seawater pCO_2 and pH reveal that **marine life is currently exposed** to surface ocean pH and aragonite saturation values **outside the envelope of preindustrial variability** that they have evolved under, as measured at the La Push buoy, operated by UW, NOAA, and NANOOS.
- Scientists have found that **upwelled water now is more corrosive to calcifying organisms than it was in the past**, with 30-50% of the enriched CO_2 concentration in surface waters attributable to human activities.
- **Corrosive waters have been observed very close to the surface** in many locations off the coast, and some organisms have already been impacted by acidified waters.



CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

West Coast OAH Inventory and data gaps

What we heard.

How we responded.

Data quality, accessibility, and integration issues

- Further implement QARTOD via the Cal OOS Portal
- OAH Portal: Establish nearshore data quality working group

Subsurface and offshore obs lacking

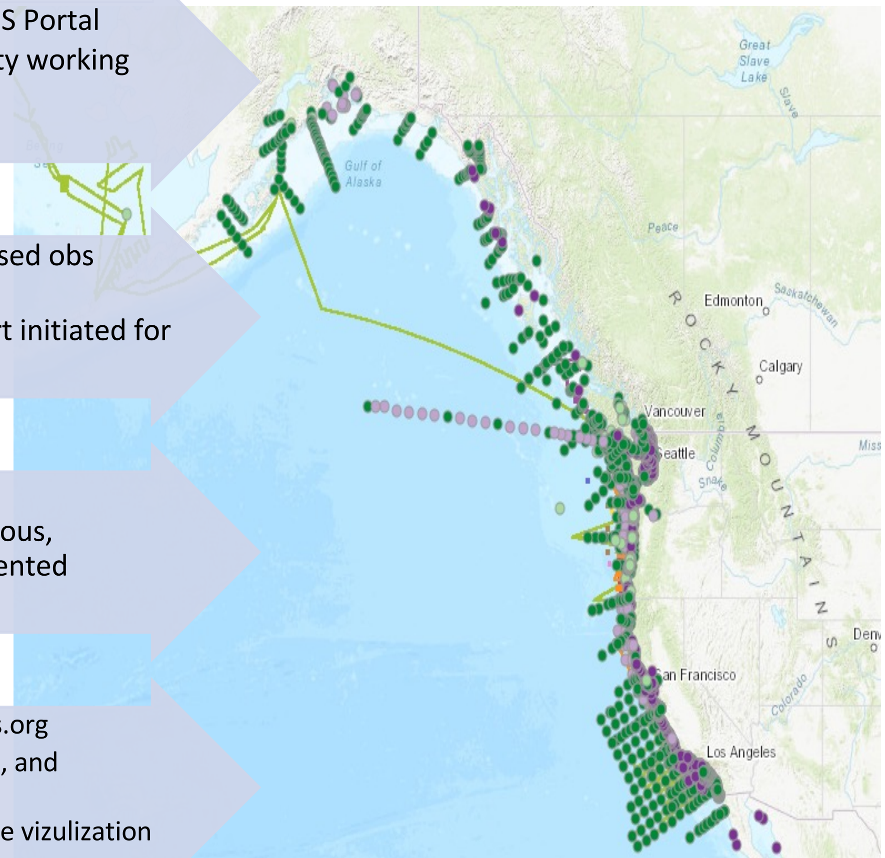
- Targeted investments in moorings, ship-based obs (ACCESS, CalCOFI)
- Data handling, processing, and access effort initiated for existing moorings

Geographic gaps & Vulnerabilities

- California's North Coast / Southern Oregon
- Communication issue – messaging, Indigenous, traditionally underserved and underrepresented communities

"One-stop shop" for data access, forecasts

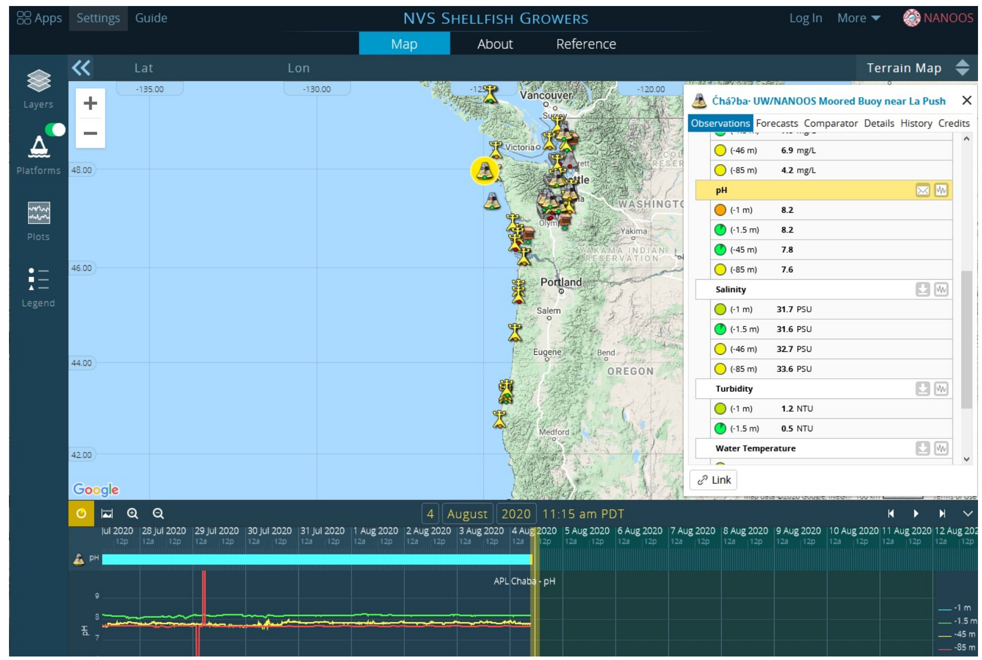
- Developed statewide information center caloos.org
- Further unified delivery with SCCOOS, NANOOS, and monitoring partners
- Enhanced portal capabilities for model / satellite vizulization



When NOAA and academic scientists constructed coastal moorings for assessing OA status and variation at the coast (more dynamic and extreme than open ocean), the utility of these data as sentinels of changing OA conditions for nearshore shellfish growers was also realized.

*"Putting an IOOS buoy in the water **is like putting headlights on a car**. It lets us see changing water conditions in real time."*
-- Mark Wiegardt, co-owner of Whiskey Creek Shellfish Hatchery


The NOAA research ship Ronald H. Brown taking calibration samples at the NANOOS Cha'ba monitoring mooring. Photo credit: R. Feely, Pacific Marine Environmental Laboratory/NOAA.



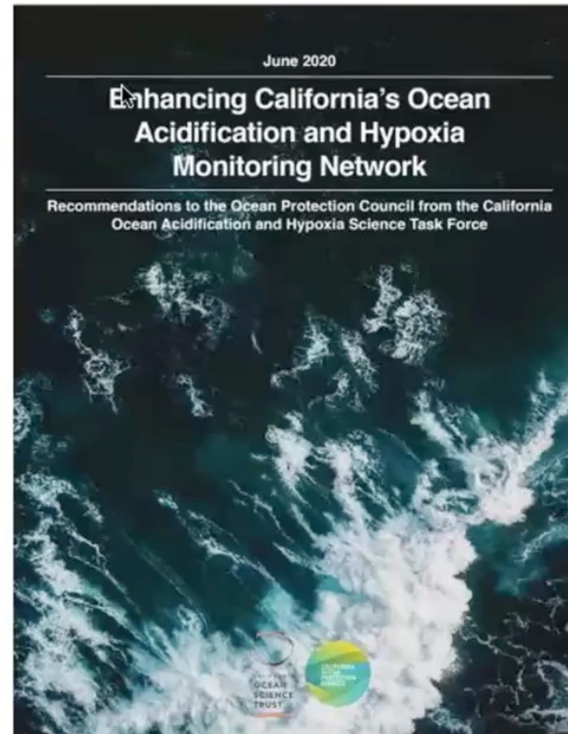
Example is NANOOS, UW, and NOAA PMEL collaboration; similar ones supported nation-wide via IOOS and NOAA OAP

Activity Area Relevance

Scientific Priority Setting

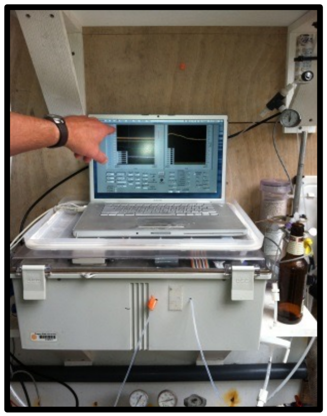
- NOAA Contributes to State Level Needs at Several Levels:
  - OA Task Force for OA Gap Analysis

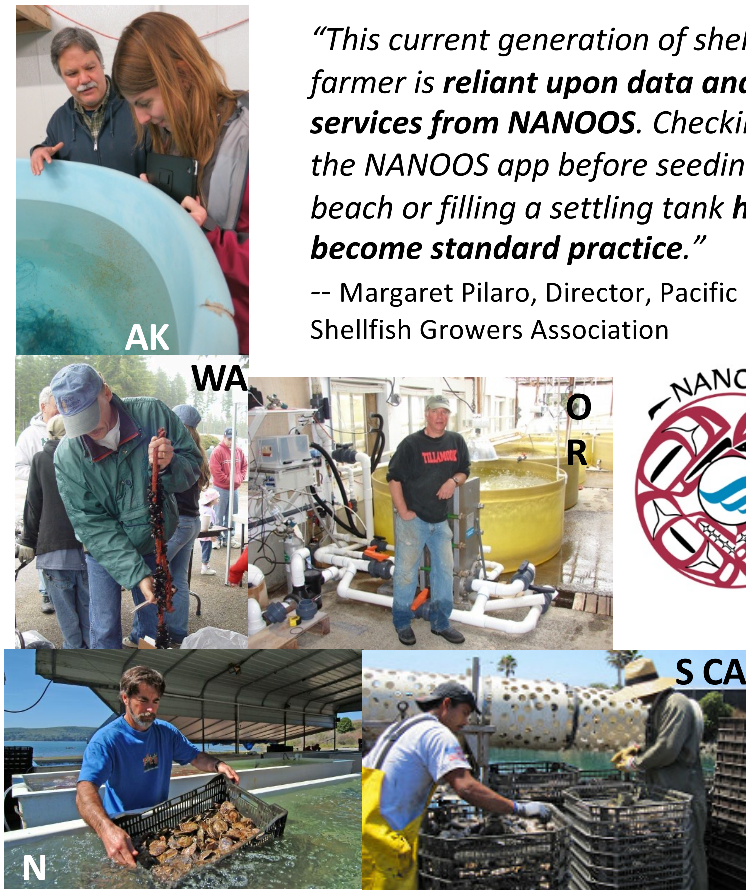
June 2020



➢ Recommendation 1: Better Connect Chemical and Biological Monitoring
➢ Recommendation 2: Continuously Improve Your OAH Models
➢ Recommendation 3: Strengthen Continuity of Long-term Chemistry Programs

When shellfish growers needed access to real-time data at their hatchery intakes for production decisions, a network of sensors constructed along the coast filled that need but also revealed broad spatial patterns in conditions and driving factors.

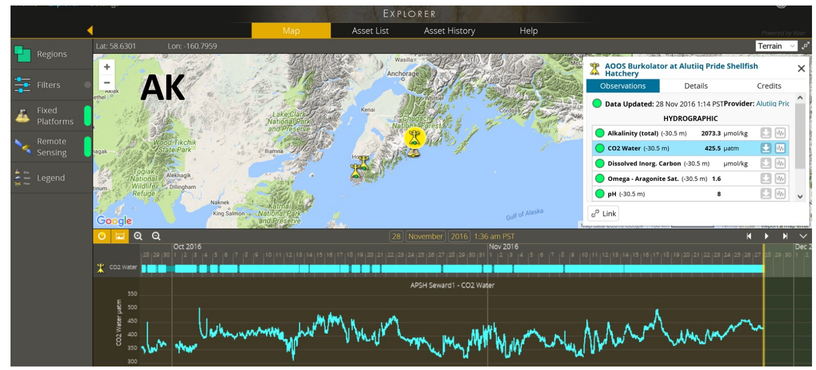


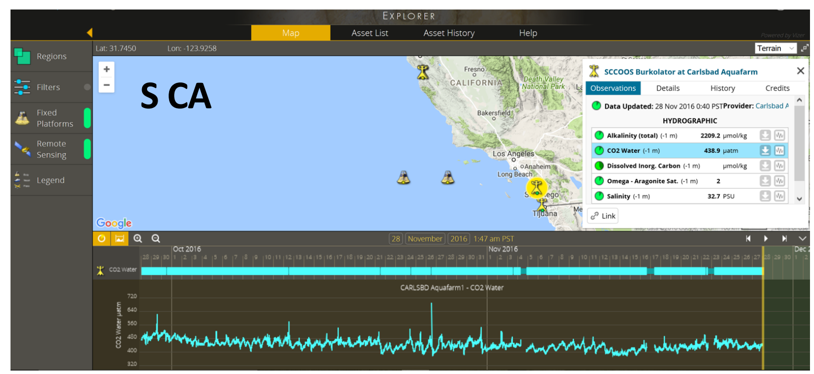


*"This current generation of shellfish farmer is **reliant upon data and services from NANOOS**. Checking the NANOOS app before seeding a beach or filling a settling tank **has become standard practice**."*

-- Margaret Pilaro, Director, Pacific Shellfish Growers Association

NANOOS





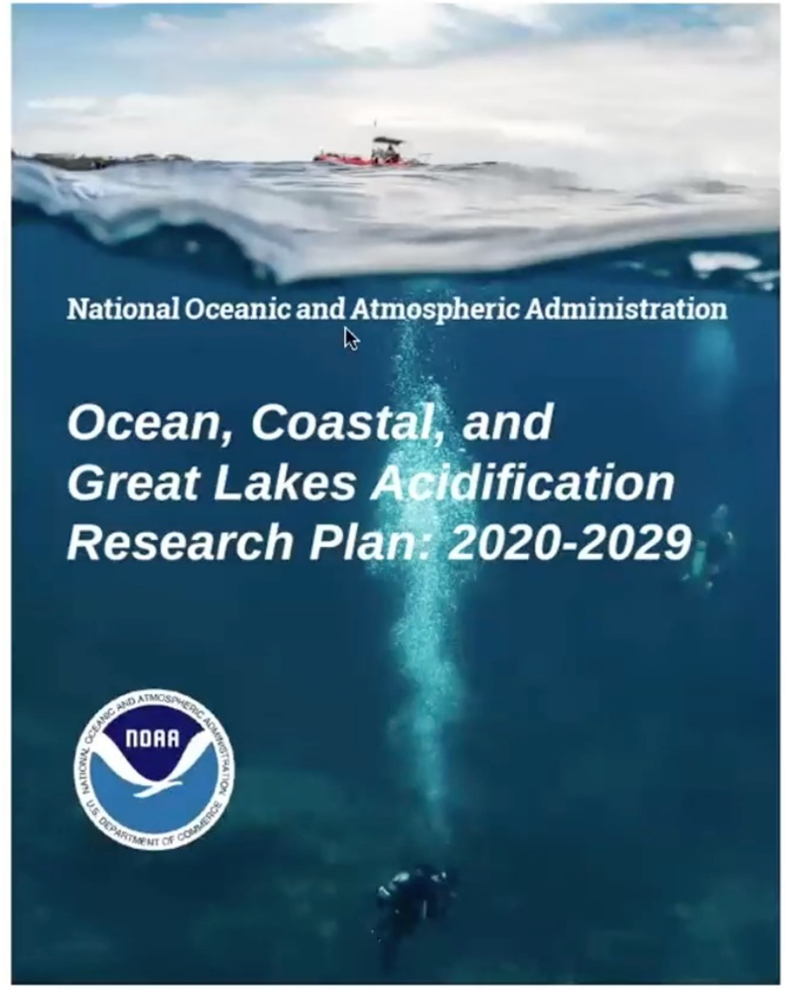
Grower-scientist partnerships funded by Pacific states and nationally by IOOS and NOAA OAP

NOAA's Research Plan Goals

1. Expand and advance observing systems and technologies to improve the understanding and predictive capability of acidification trends and processes;

2. Understand and predict ecosystem responses and adaptive capacity of ecologically and economically important species to acidification and co-stressors; and

3. Identify and engage stakeholders and partners, assess needs, and generate products and tools that support management, adaptation, and resilience to acidification.



Jewett et al., 2020

Key Takeaways

- Federal participation in research and planning is necessary to coordinate between regions, states and tribal nations.
- Ocean Acidification impacts are a clear and present danger for marine ecosystems in US Coastal waters and continued Federal/State coordination on maintaining the observing system is an imperative.
- The California Current Ecosystem is particularly susceptible to OA and future projections indicate increasing vulnerability.
- Chemical and biological studies need to be incorporated into forecasts and model projections.

Looking Forward

- Maintain and improve support of our integrated observing networks and data dissemination.
- Provide for integration of chemical/biological studies into models in order to increase our predictive skill for biogeochemical processes.
- Develop better understanding of multiple stressors impacts on marine ecosystems.
- Find a home for operational forecasts of ocean acidification and muti-stressor impacts.