

Science Update

MRAC 28 April 2014

Terrie Klinger

Jan Newton

Washington Ocean Acidification Center

Washington Ocean Acidification Center
T. Klinger and J. Newton

Funded Research Projects
Modeling
Monitoring
Biological Experimentation

Collaborations w/ Shellfish Industry

Two new post-doctoral research projects

PACE Program



University Corporation
for Atmospheric Research
Visiting Scientist Program



Andrea Fassbender

Research Objectives:

- Analyze pH and other carbon data from NOAA/PMEL moorings
- Establish natural variability in pH, CO₂, and associated variables
- Address EPA water quality standards

Research Partners:

- NOAA/PMEL (S. Alin, A. Sutton)
- WA Dept of Ecology (C. Krembs)
- WOAC (J. Newton, T. Klinger)

Anticipated Outputs:

- Improved protocols from collection of pH and carbon system variables
- Improved understanding of natural range of variation in pH
- Improved understanding of association between pH and water quality in WA
- Progress on redefining EPA standards for pH

Post-doctoral
SCIENCE-POLICY SPECIALIST

The Science-Policy Specialist will help connect the WOAC with entities and agencies in Washington to maximize the utility of research products to decision makers and to the public

Research Objectives:

- Build relationships with decision-makers and assess information needs with respect to ocean acidification science
- Communicate emerging science to decision-makers effectively and efficiently
- Engage with local entities on issues of ocean acidification

Anticipated Outputs and Outcomes:

- Improved understanding and uptake of decision-relevant science
- Improved models of communication and engagement
- Enhanced capacity for WOAC

Washington State is a leader



UW TODAY

Ocean acidification center another example of state leading the nation

Washington's governor and state legislators in the last session created a hub at the University of Washington to coordinate research and monitoring of ocean acidification and its effects on local sea life such as oysters, clams and fish.

[Read more »](#)

Barbara Kinney

But WA is not alone

- WA is joined by the nation's lead federal agency on ocean acidification, NOAA, that will contribute to our Center's efforts.
- WA is engaging with EPA through the Center's participation on the West Coast Panel on Ocean Acidification and Hypoxia and locally.
- WA is benefiting from NOAA investments through OAP and US IOOS (regionally as NANOOS) that enhance the Center's abilities.



'Like putting headlights on a car'

Pacific oysters gain from IOOS® data

About six years ago, production at some Pacific Northwest oyster hatcheries began declining at an alarming rate, posing severe economic impact and challenging a way of life held by shellfish growers for more than 130 years.

By 2008, the oyster harvest at Whiskey Creek, a major Oregon supplier to the majority of West Coast oyster farmers, plummeted 80 percent. At about the same time, corrosive, acidified seawater was hitting the shores of the Pacific.

Something had to be done. Oyster production accounts for more than \$84 million of the West Coast shellfish industry, which supports more than 3,000 jobs.

"When you see oyster shells dissolving in water, there's a compelling need to know why," says Bill Dewey of Taylor Shellfish Farms in Washington state.

Thanks to a \$500,000 federal investment in monitoring coastal seawater strengthened by data and observational information from the U.S. **Integrated Ocean Observing System (IOOS®)** and the **NOAA Ocean Acidification Program**, oyster hatcheries on the verge of collapse just a few years ago are again major contributors to the \$111 million West Coast shellfish industry.

IOOS is a NOAA-led interagency and regional effort aimed at "knowing" — that



IOOS partners in the Northwest Association of Networked Ocean Observing Systems (NANOOS) deployed this buoy in 2010 as part of a three-piece observing array to assess issues in the Northwest, including **ocean acidification**, **hypoxia and harmful algal blooms**, and **climate change**. The coastal buoy will aid computer models that predict ocean and atmospheric conditions. Known as "Chá bã," the buoy is named for the Native American word (pronounced "chay buh") for "whale tail."

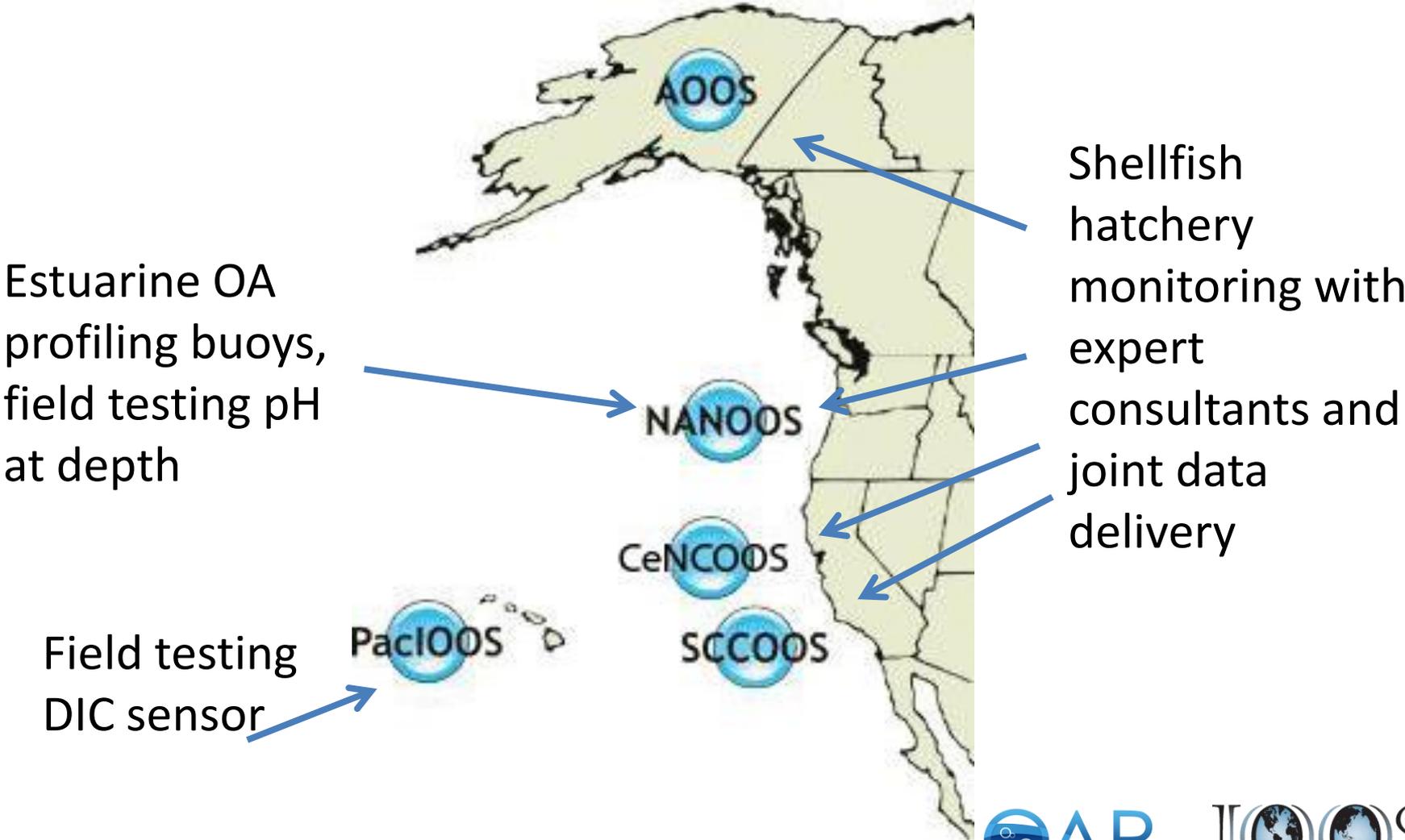
(Photo courtesy of Dr. John Payne, Pacific Ocean Shelf

Promoting
Economic Vitality

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



NOAA technology investments



IOOS data investments

OA data accessible via regional portals AND discoverable nationally via IOOS

NANOOS VISUALIZATION SYST

Map List Help

PCSGA - Taylor Shellfish Hatchery intakes, Dabob Bay

Observations Details History Credits

Provider: TaylorShellfish Data Updated: 11 Jul 2013 3:26 PDT

Taylor-PCSGA Dabob - pH - 7 Days
12 July 2013 17:31 PDT

8.40
7.80
7.20
6.60
6.00
5.40

06-Jul-2013 07-Jul-2013 08-Jul-2013 09-Jul-2013 10-Jul-2013 11-Jul-2013 12-Jul-2013

4.5m
30.5m
30.8m

24 Hours 7 Days 30 Days 60 Days

Oxygen Conc.

4.5m:	7.2 mg/L
30.5m:	3.5 mg/L
30.8m:	4.2 mg/L

Oxygen Pct. Sat.

4.5m:	93.7 %
30.5m:	37.8 %

pH

4.5m:	8.1
30.5m:	7.5
30.8m:	7.4

Salinity

4.5m:	25.6 PSU
30.5m:	29.9 PSU

Water Temp.

4.5m:	21.2 °C
30.5m:	10.7 °C

Link

NVS • Send Us Your Comments About NVS • Version History • NANOOS

IOOS INTEGRATED OCEAN OBSERVING SYSTEM

Home IOOS In Action About Data Observing Systems Modeling

This map shows locations of in-situ platforms, as well as numerical models and satellite gridded data collected from data servers maintained by the regional associations and select federal partners.

There are currently 2497 observation platforms and 39 bounding boxes surrounding various gridded data fields.

[Register Your Data Service](#)
[Bookmark this view \(right click this link.\)](#)
[View Data Publisher Summary](#)

Map Satellite

Click to filter map

NANOOS NANOOS Sensor Observation Service (SOS)
Platform: TAF Dabobbay (47.8199, -122.8215) [DescribeSensor](#)

[FAIRL](#)
Start: 2013-03-10 10:30:00 End: now
Data Provider: TaylorShellfish
Last obs time: 2013-05-09 14:44

WaterTemperature: 15.94 at 2013-05-09 14:44
Salinity: 26.25 PSU at 2013-05-09 14:44
DissolvedOxygen: 6.60 mg/L at 2013-05-09 14:44

North Pacific Ocean Gulf of California Mexico Guatemala Nicaragua Venezuela Guyana North Atlantic Ocean

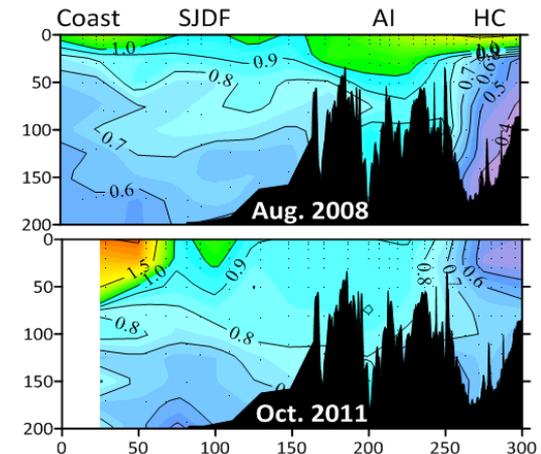
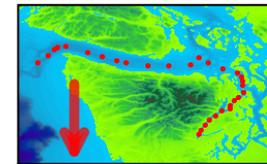
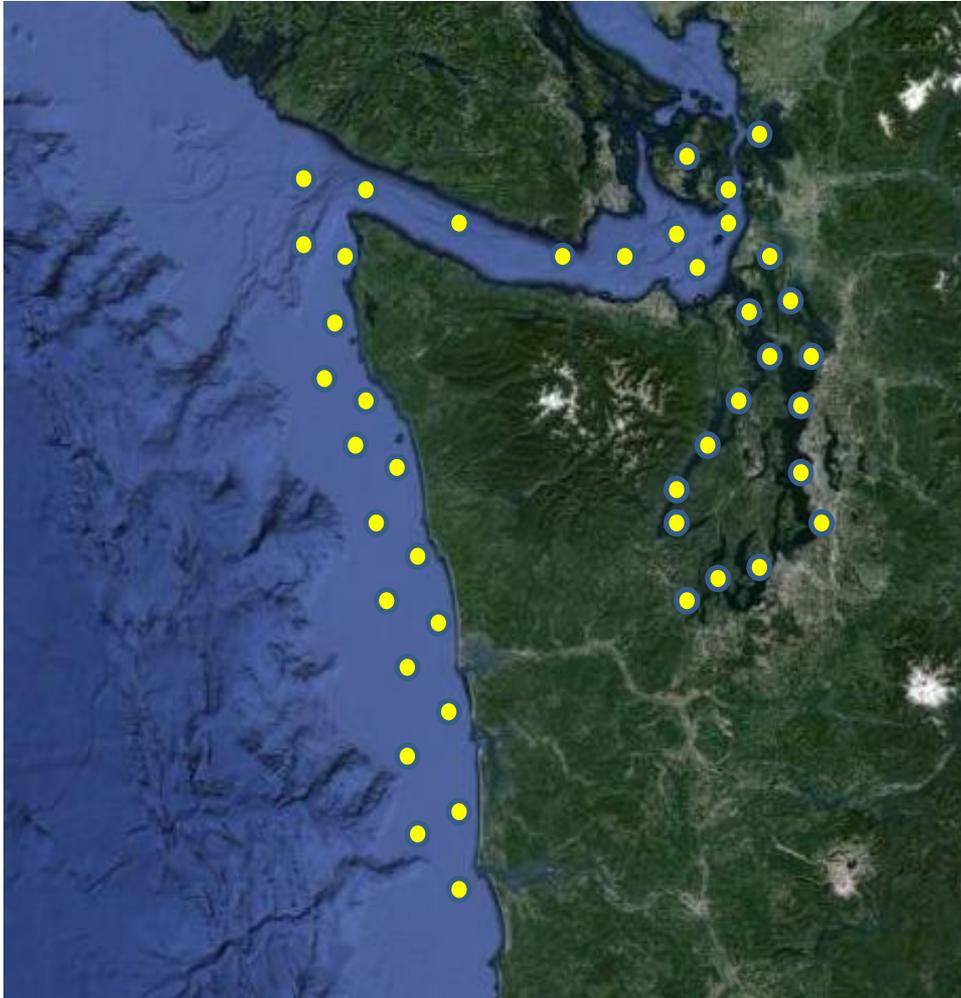
1000 km 500 mi

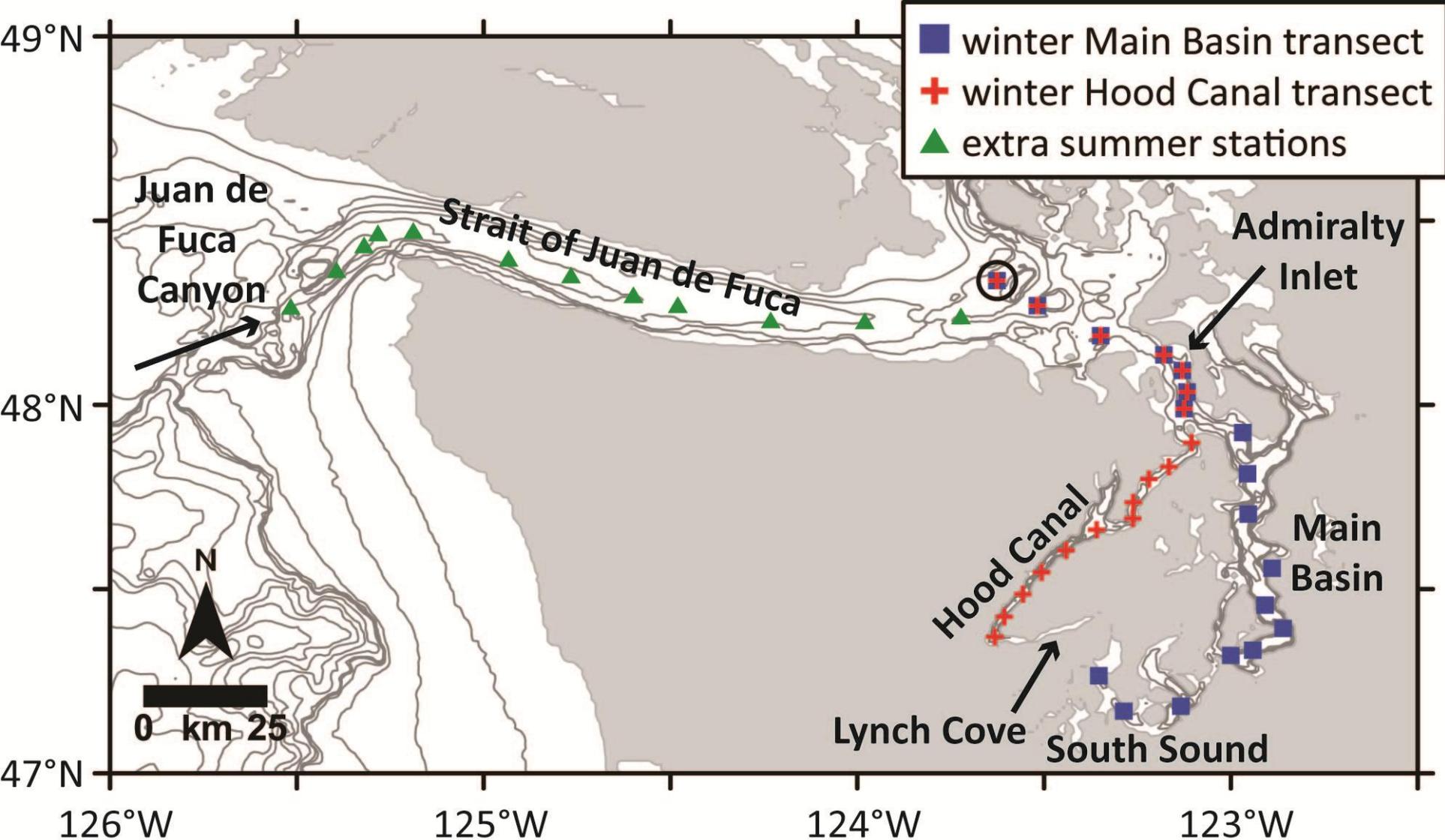
Map data ©2013 Google, INEGI, MapLink - Terms of Use

NOAA & WA OA Center shared shiptime investment

NOAA PMEL & UW-NANOOS

- Past shared cruises yielded important insights to condition
- Currently engaging in joint cruise planning, inclusive of other science partners

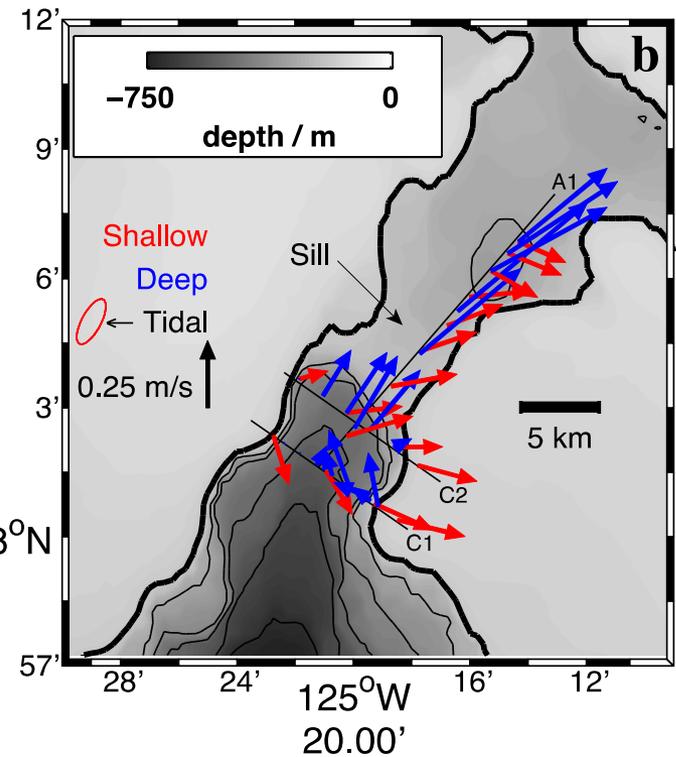
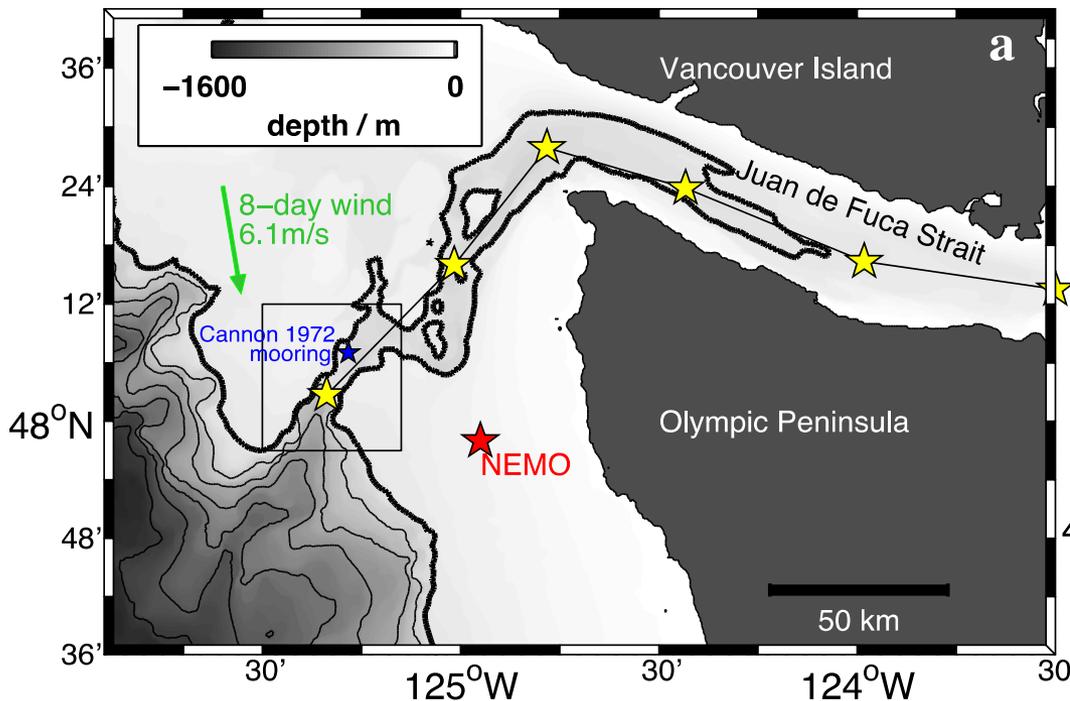




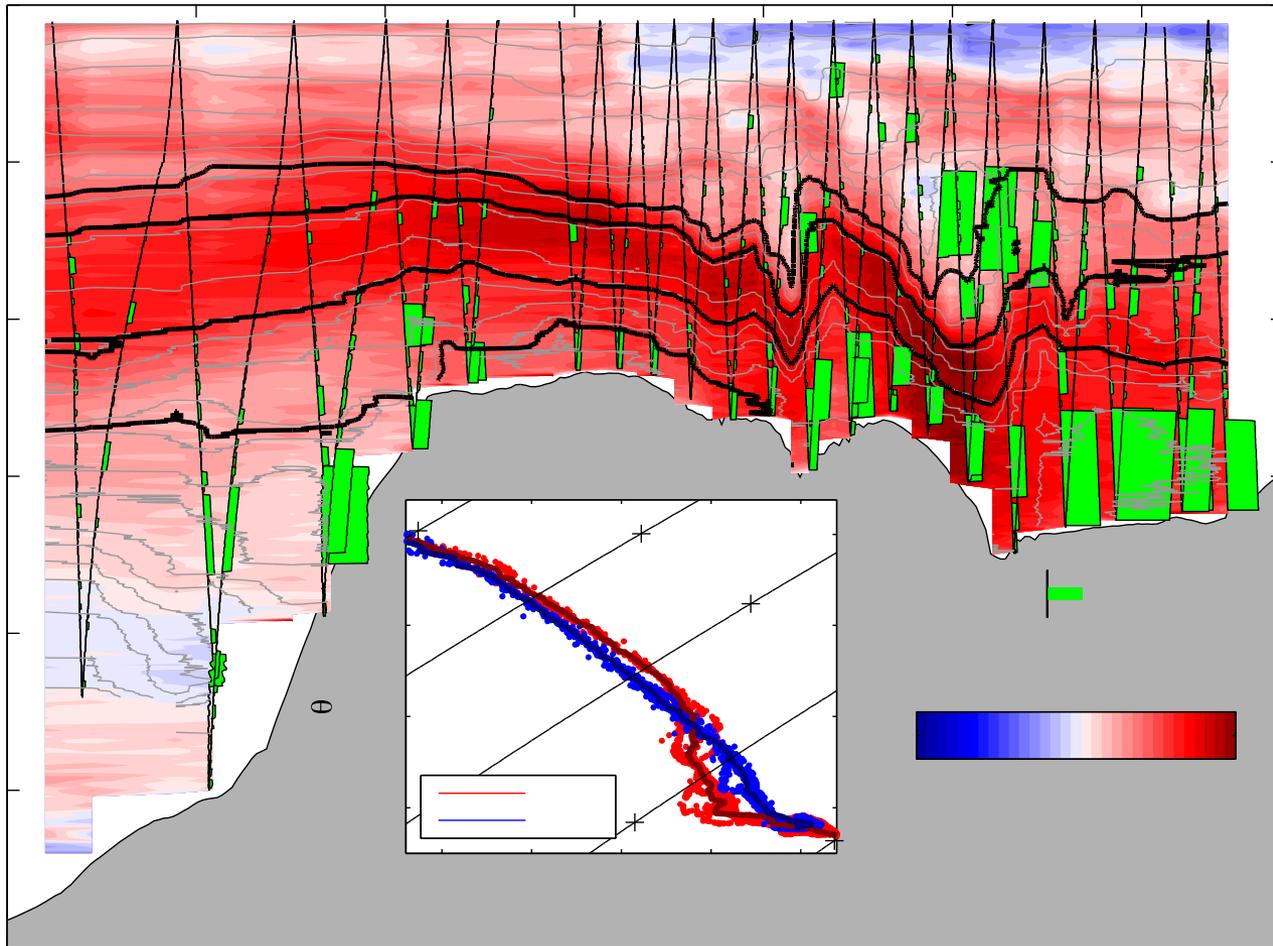
- Five cruises from Hood Canal into the Strait of Juan de Fuca or to the coast – snapshots from 2008-2011.
- Need more continuous time series.

Observations of the “Headwaters of the Salish Sea” : Juan de Fuca Canyon

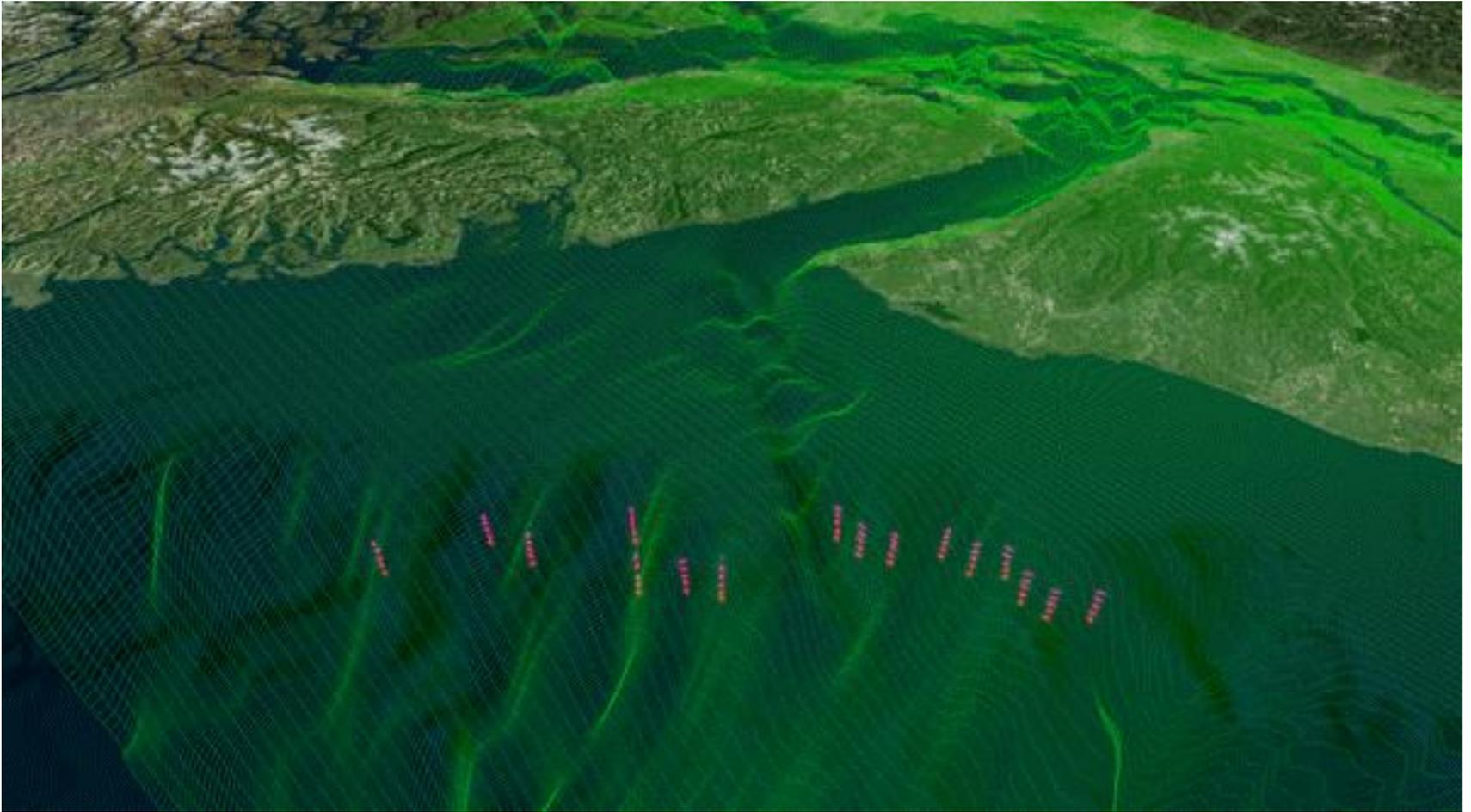
Matthew Alford and Parker MacCready, UW



Along-Canyon Section



Simulated Water Parcel Tracks

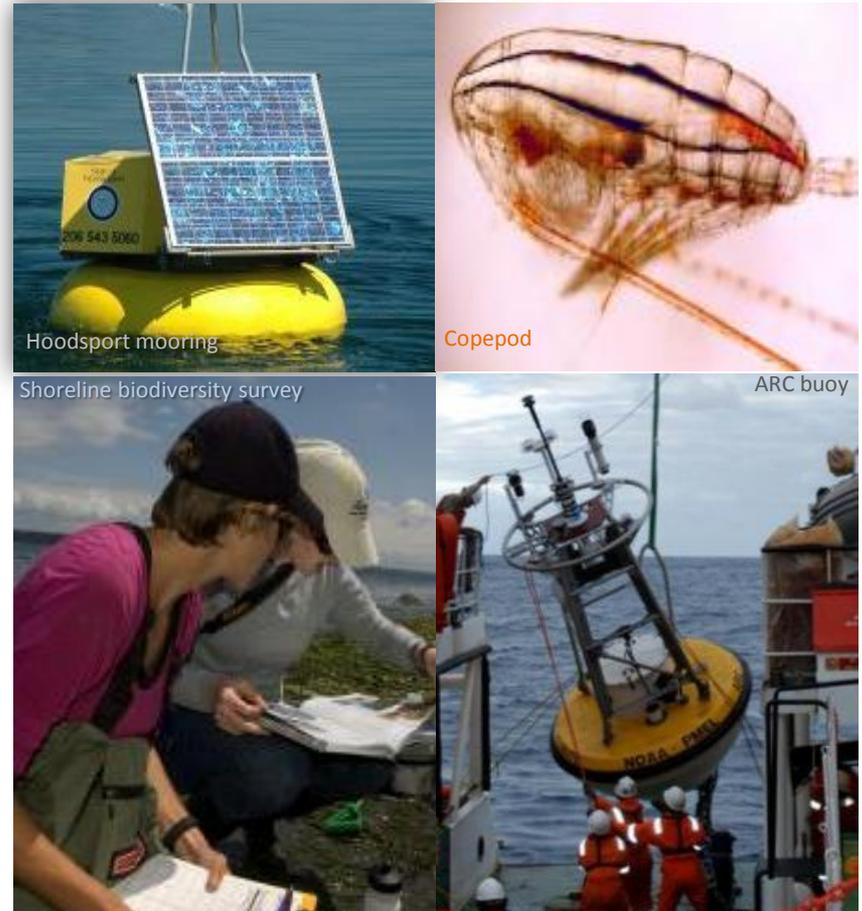


Focus on Research and Monitoring

Panel

Recommendation:

Increase research and monitoring of acidification in state waters



Washington Ocean Acidification Center

The Center is charged by the legislature to execute five priority actions from the Blue Ribbon Panel:

- continue water quality monitoring at the six existing shellfish hatcheries
- develop commercial-scale water treatment methods or hatchery designs
- conduct laboratory studies on Washington's species and ecosystems
- make short-term forecasts of corrosive conditions
- expand and sustain ocean acidification monitoring network

WOAC Progress on Implementation:

Monitoring Network

5. Establish an expanded and sustained ocean acidification monitoring network to measure trends in local ocean acidification conditions and related biological responses

Focused on water properties, OA chemistry, and plankton Partnership effort along WA coast, Puget Sound, Northern Straits, and Columbia River to include:

- Ship/boat cruises

- High temporal resolution buoy/mooring observations

- Targeted time series and sensor upgrades

Integrated with shellfish monitoring sites

Data via existing NANOOS portal

OA Monitoring Network: elements

1. High resolution OA moorings
2. Cruises for OA and plankton timeseries
3. Nearshore OA and biology timeseries
4. Integration with Washington Department of Natural Resources OA/Seagrass project
5. Integration with Washington Department of Ecology NEP monitoring
6. Sensor technology comparisons
7. QA/QC

OA Monitoring Network: scope & variables

1. High resolution OA moorings: PS and coast
 - T, S, O, pCO₂, pH, chlorophyll, plus nutrients
2. Cruises for OA and plankton timeseries: six areas
 - Plus phytoplankton, micro/meso zooplankton
3. Nearshore OA and biology timeseries
 - Olympic coast intertidal & Padilla Bay seagrass beds
4. Integration with Washington Department of Natural Resources OA/Seagrass project
 - Puget Sound and Willapa Bay
5. Integration with Washington Department of Ecology NEP monitoring
 - Analyze 1 & 2 with NEP data for proxies, etc.



NSF-Funded Research Cruise from San Francisco, CA to Seattle, WA

May 13 – June 6, 2014

Collaborative Research to determine the relationship between iron availability and ocean acidification, and their resultant effects on the nutritional quality of phytoplankton

- Manipulation (pH and Fe) experiments using deck-board continuous and batch culturing systems
- Coastal survey at high and low pH regions to evaluate the resultant effects on phytoplankton species composition, physiology, toxicity, and the lipid/fatty acid concentration and composition

William Cochlan – Romberg Tiburon Ctr., San Francisco State University

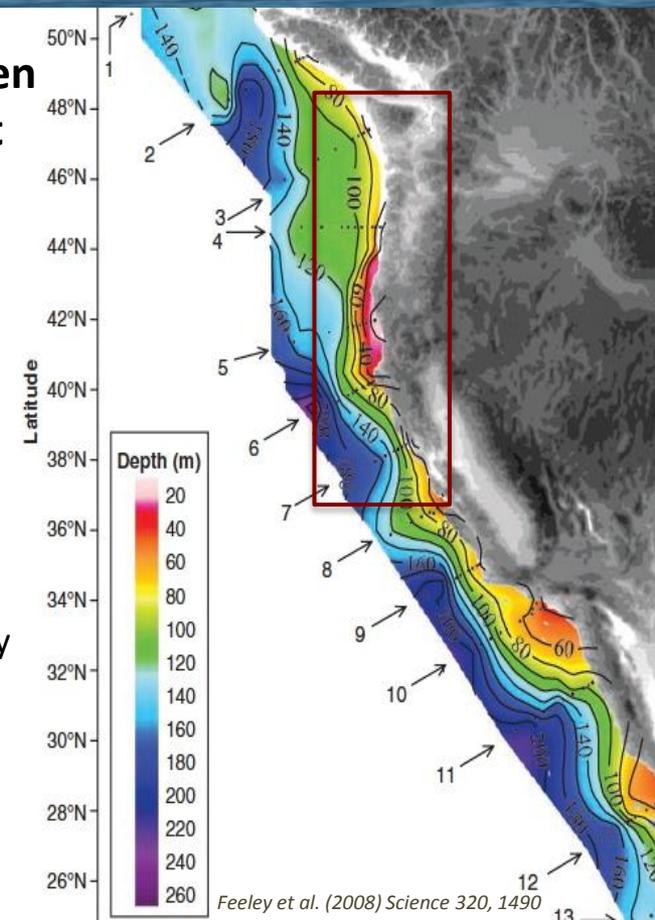
Bob Bidigare – University of Hawaii

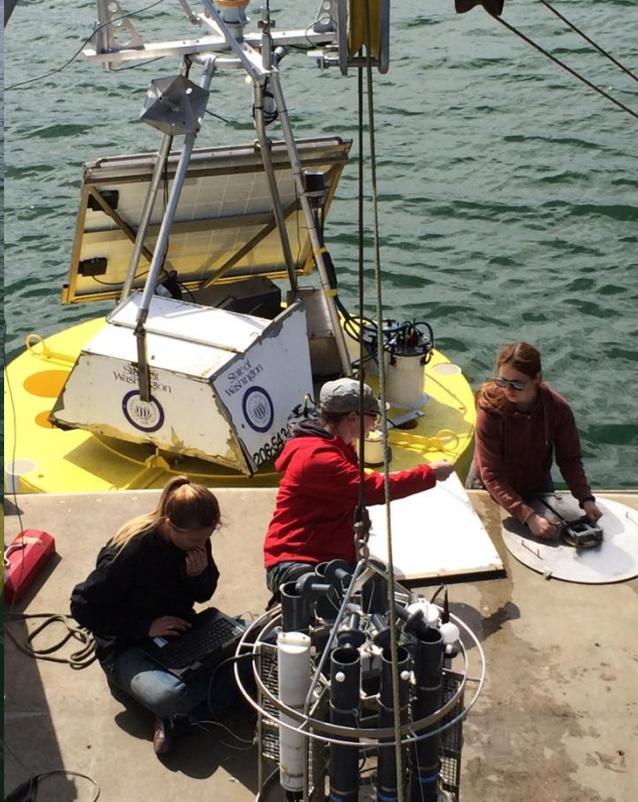
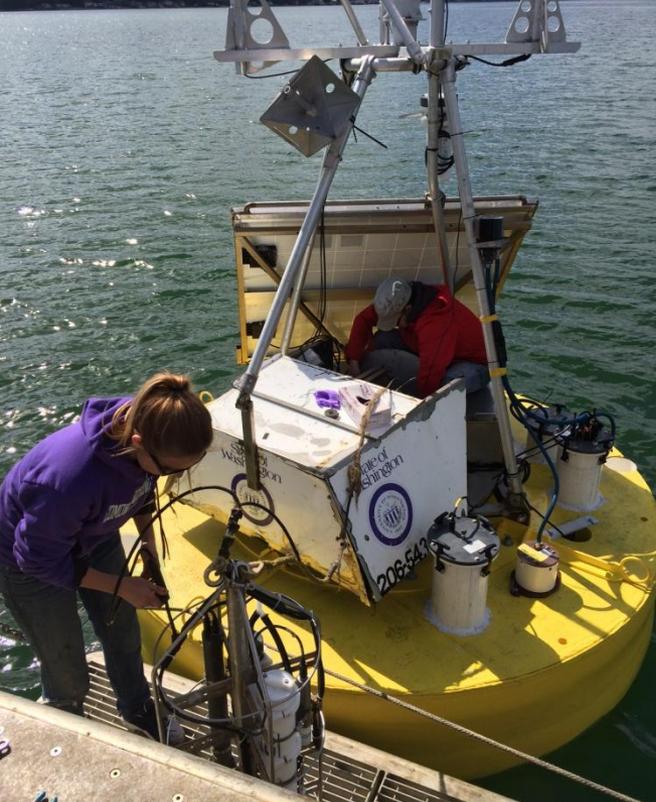
Vera Trainer – NOAA Northwestern Fisheries Science Ctr.

Charles Trick – Western University, London Ontario

Mark Wells – University of Maine

Jan Newton & Simone Alin – NOAA PMEL and Univ. Washington

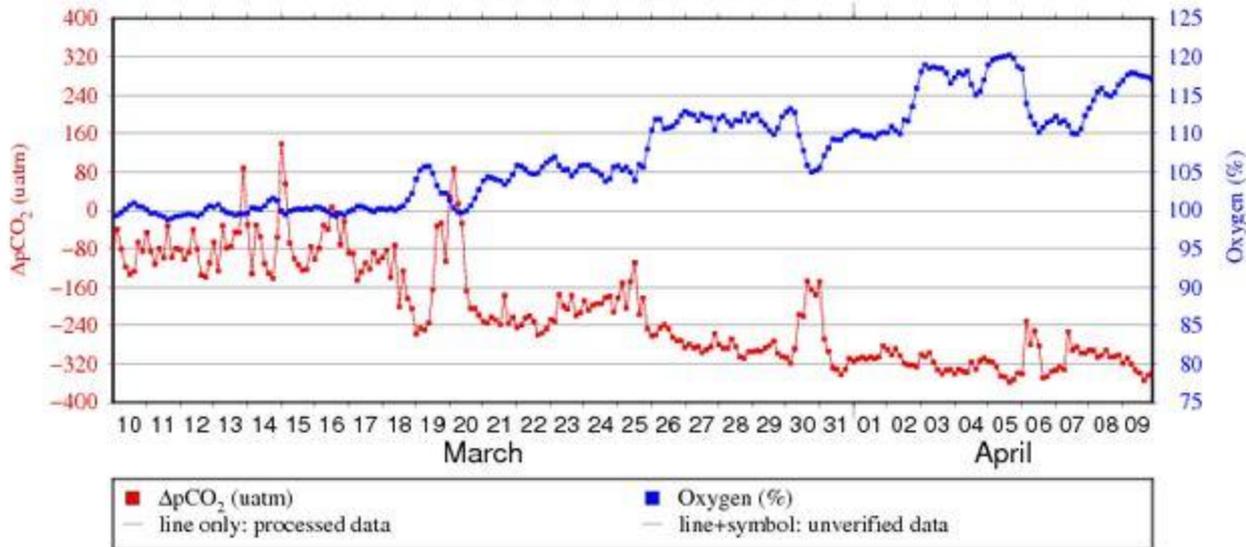




Southern Hood Canal at Twanoh

Location: Twanoh (123W,47.37N) (Last 30 days)

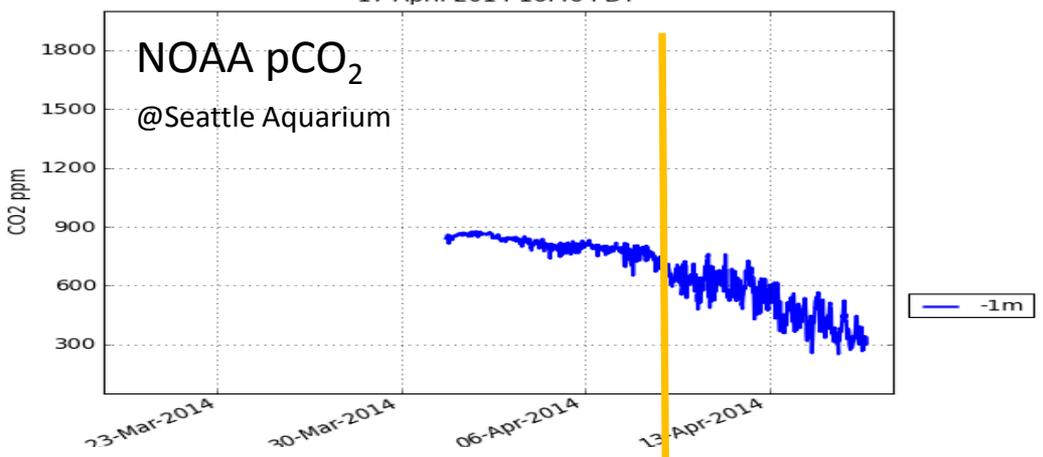
$\Delta p\text{CO}_2$ & Oxygen @ Twanoh (123W,47.37N)
[Date: 2014-03-10 to 2014-04-09]



Hello Spring Bloom !!

UW – NOAA PMEL – NOAA
OAP – NANOOS/IOOS –
WOAC collaboration

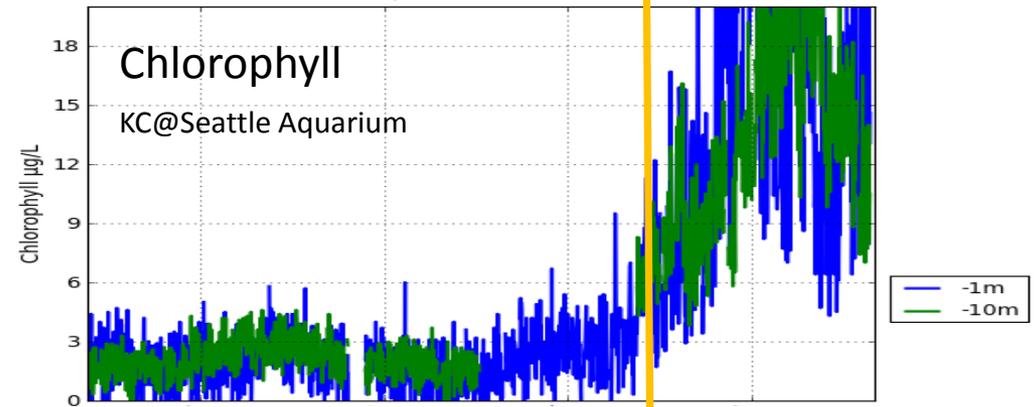
KC SEAQYSI - CO2 - 30 Days
17 April 2014 16:46 PDT



Puget Sound Main Basin at Seattle

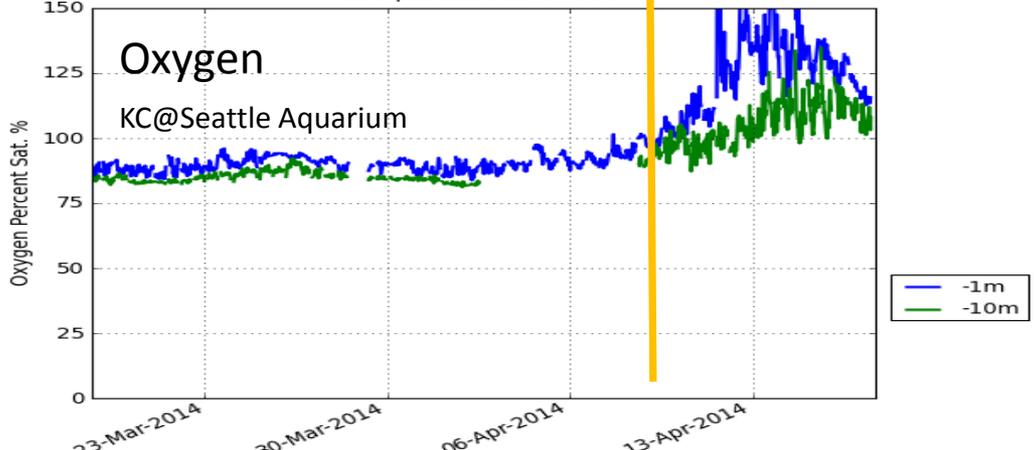
Seattle Aquarium – King County – NOAA PMEL – NANOOS collaboration

KC SEAQYSI - Chlorophyll - 30 Days
17 April 2014 16:46 PDT



Spring Bloom here too, but later

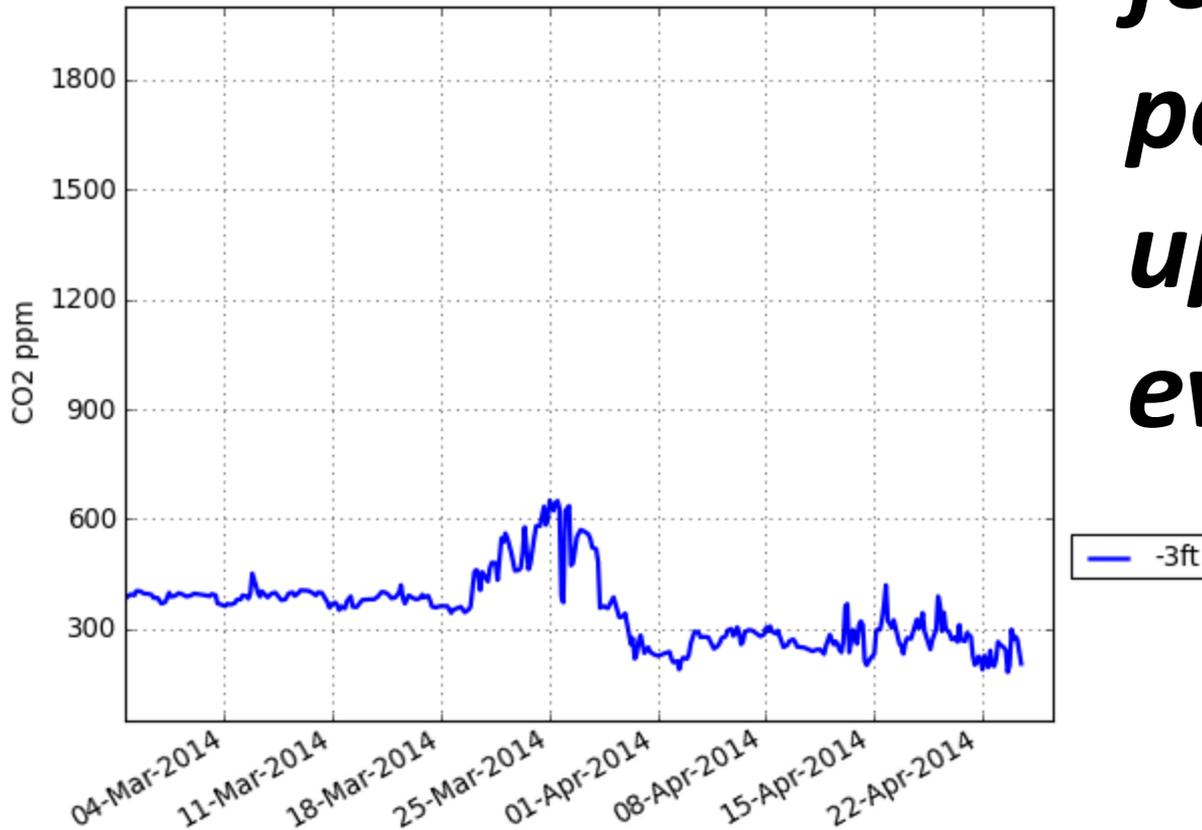
KC SEAQYSI - Oxygen Percent Sat. - 30 Days
17 April 2014 16:47 PDT



Outer WA Coast at La Push

UW – NOAA PMEL – NOAA
OAP – NANOOS/IOOS –
collaboration

APL-UW Chá?ba - CO2 - 60 Days
26 April 2014 14:23 PDT



***Spring Bloom
evident
following
possible
upwelling
event***



Washington Ocean Acidification Center

The Center will:

- **Coordinate scientific efforts** to promote scientific collaboration and leverage resources.
- **Bring a regional focus** to research and serve as a hub for OA science.
- **Connect decision-relevant** OA science with managers and policy-makers.
- **Promote outreach and education.**
- **Engage broadly with others.**

OA Monitoring Network partners *to date*

- King County Dept. Natural Resources
- National Estuarine Research Reserve Padilla Bay
- NOAA PMEL and OAP
- NANOOS - IOOS
- Olympic Coast National Marine Sanctuary
- Olympic National Park
- Oregon Health and Sciences University (and CMOP)
- Pacific Coast Shellfish Growers Assn, including PSI, Taylor, etc.
- PSEMP
- Seattle Aquarium
- Stilliguamish Tribe
- Suquamish Tribe
- University of Washington (and Friday Harbor Laboratories)
- Washington Dept. of Ecology
- Washington Dept. of Natural Resources
- Western Washington University (and Shannon Point Marine Center)

OA Monitoring Network

1. High resolution OA moorings:

Measure pCO₂ and pH on buoys in Puget Sound and off the coast

- Puget Sound: Carr Inlet, Dabob Bay, and Twanoh (UW, NOAA PMEL NOAA OAP and US IOOS – NANOOS)
- Coast: La Push (NANOOS & NOAA OAP-PMEL), Cape Elizabeth (NOAA OAP-PMEL), Newport OR (NANOOS & NOAA OAP-PMEL), plus new NSF buoys off Grays Harbor
- Columbia River (OHSU-CMOP & NANOOS)

WOAC will also purchase new SeaFET pH sensors to expand OA monitoring capability to three other Puget Sound buoys:

- near Admiralty Inlet, at Pt Wells, and at Hoodspport
- In future years, a priority is to expand to Whidbey basin and Bellingham Bay

OA Monitoring Network

2. Cruise OA and plankton timeseries:

Establish, with partners, routine cruises using consistent measurements of: carbon variables, phytoplankton and microzooplankton, and mesozooplankton

- a. Sound to Ocean: NANOOS buoy – student cruises and NOAA OAP cruises. Partners: UW, PMEL, students. Variables: CTD, oxygen, nutrients, OA chemistry, plankton
- b. Sound-wide: New cruises to all Puget Sound basins; subset of former PRISM stations. Partners: UW, PMEL, students. Variables: CTD, oxygen, nutrients, OA chemistry, plankton.
- c. San Juan Channel and Strait of Juan de Fuca: Continue timeseries at two stations in San Juan Channel and Strait of Juan de Fuca. Partners: WWU, UW. Variables: CTD, oxygen, nutrients, OA chemistry, plankton, and respiration rates.
- d. Outer coast: NOAA OAP and NANOOS buoy maintenance cruises. along the WA coast. Partners: NOAA PMEL, UW. Variables: CTD, oxygen, nutrients, OA chemistry, plankton.
- e. Columbia River: Monitoring by the Oregon Health and Sciences University National Science Foundation's Center for Coastal Margin Observations and Prediction (CMOP). Partners: OHSU, NANOOS. Variables: CTD, oxygen, nutrients, OA chemistry, plankton.
- f. Willapa Bay and Puget Sound seagrass beds: WA DNR project comparing OA and water quality in and out side of seagrass beds. Partners: DNR.

OA Monitoring Network

3. Nearshore OA and biology timeseries:

WOAC will invest in purchasing 2 SeaFETs for use at two nearshore timeseries:

- At Olympic National Park, this timeseries has pH measurements off the outer coast with contemporaneous intertidal invertebrate monitoring of calcareous species (e.g., barnacles, limpets, etc.). At this site the SeaFET will be compared to the YSI used for this timeseries. Partner: ONP
- The Padilla Bay NERRS supports pH measurements in the nearshore. New measurements of eelgrass and water chemistry will be conducted by WWU. Partners: NERRS and Love WWU. At this site, two lab-built mimics of the SeaFET design will be built and compared to the SeaFET.

4. Integration with Washington Department of Ecology NEP monitoring:

WOAC, NOAA, and Ecology partner with a NOAA PACE post doc

- The cruise and mooring data from Puget Sound will allow baseline understanding of spatial and seasonal differences in this system. We will work with Ecology and NOAA PMEL to analyze the existing data to devise water quality standards, interpreting cruise and mooring data. This project will utilize a NOAA PACE post-doc partially supported by WOAC. With this work and the initial data from WA waters, we will begin to assess an optimal monitoring program for OA wrt water quality.