



Global Ocean Acidification
Observing Network

The Global Ocean Acidification Observing Network

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MEOPAR OA Expert Forum, 17 February 2015
Victoria, British Columbia, Canada*



UK Ocean Acidification
Research Programme



Ocean Acidification
International
Coordination Centre
OA-ICC



What is GOA-ON?



The **Global Ocean Acidification Observing Network** (GOA-ON) is a **international partnership** to:

- 1. Document the status and progress of ocean acidification in open-ocean, coastal, estuarine, and coral reef environments,**
- 2. Understand the impacts of ocean acidification on diverse marine ecosystems and societies, and**
- 3. Support forecasts of ocean acidification conditions.**

www.goa-on.org

Why is a global approach needed ?



Processes are occurring at global scales; therefore we need to go beyond local measurements and **observe on global scales in order to understand OA and its drivers correctly.**

We need information and data products that can **inform policy and the public with respect to OA and implications** for the overall ecosystem health (status) of the planet.

We need sufficient data and understanding to **develop predictive skills and early warning systems.** This requires coverage at appropriate scales, nesting local observations within global context.

Designing GOA-ON



Two international workshops, with ~100 participants from ~30 countries, defined an approach to build a coordinated, integrated global observing network for ocean acidification:

- *Rationale*
- *Goals*
- *Design*
- *Suite of measurement parameters*
- *Data quality and data distribution strategies*
- *International program integration*

GOA-ON goals

- Three high level goals form the foundation for establishing an integrated global ocean acidification observing network.

GOA-ON will provide:

Goal 1 An understanding of global OA conditions

Identify spatial/temporal patterns and assess generality of response; document and assess variation to infer driving mechanisms; quantify rate of change

Goal 2 An understanding of ecosystem response to OA

Measure biological responses to physical/ chemical changes; quantify rate of change and identify areas of vulnerability

Goal 3 Data needed to optimize modeling for OA

Provide spatially and temporally-resolved chemical and biological data to be used in developing models for societally-relevant analyses and projections

GOA-ON defined two data quality objectives:

- **'Climate data'**: of sufficient and defined quality to assess long term trends with defined level of confidence
Detection of changes in OA state over multi-decadal timescales
- **'Weather data'**: of sufficient and defined quality to identify relative spatial patterns and short-term changes
Mechanistic interpretation of the ecosystem response to local, immediate OA dynamics

GOA-ON requirements:

Capacity for

- Physical infrastructure
- Operations and maintenance
- Data QA/QC
- Analytical and synthesis activities
- Intellectual infrastructure

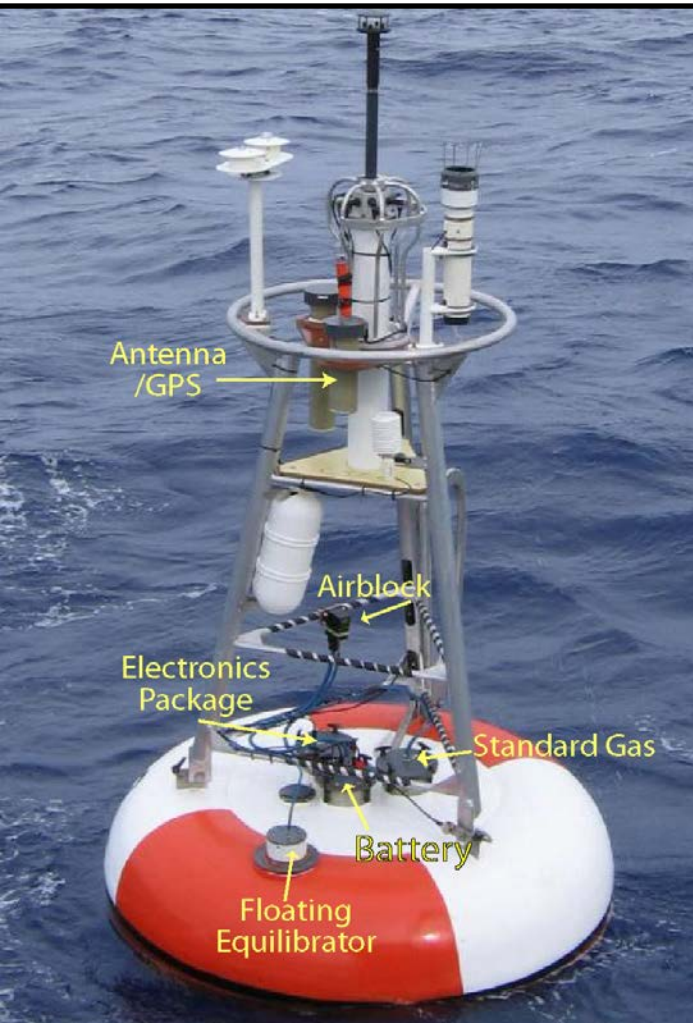
Observations across various ecosystems:

- Open ocean: polar, temperate, tropical
- Coasts and estuaries
- Coral reefs



Utilizing various platforms:

- Ship-based surveys & volunteer observing ships
- Moorings & piers
- Gliders & floats



100 m ↑ ↓ 2 m



GOA-ON has a nested system design

Coral reefs

Coasts & shelf seas

Open ocean

Goal 1 OA conditions	Goal 2 Ecosystem response	Goal 3 OA modeling
<u>Level 1</u>	<u>Level 1</u>	} Inputs to models
<u>Level 2</u>	<u>Level 2</u>	
<u>Level 3</u>	<u>Level 3</u>	

GOA-ON has a nested system design

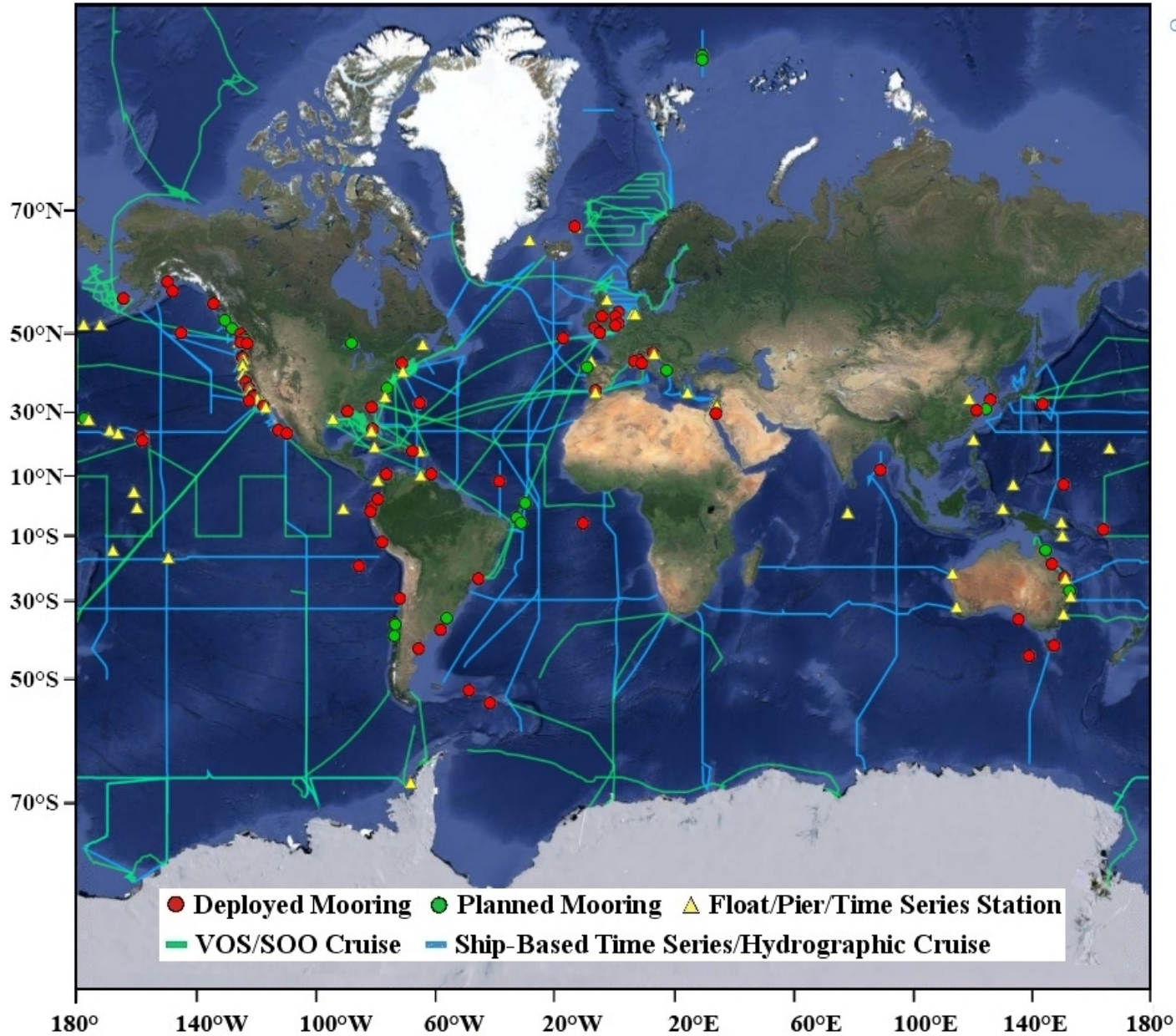
Coral reefs

Coasts & shelf seas

Open ocean

Goal 1 OA conditions	Goal 2 Ecosystem response	Goal 3 OA modeling
<p><u>L1:</u> carbonate-system constraint, T, S, O, fluorescence, irradiance</p> <p><u>L2:</u> nutrients, bio-optics, transport, meteorology, trace metals...</p> <p><u>L3:</u> capability-specific</p>	<p><u>L1:</u> biomass of functional groups (phytoplankton, zooplankton & microbes)</p> <p><u>L2:</u> species; processes incl. growth, grazing & respiration</p> <p><u>L3:</u> capability-specific</p>	<p>Inputs to models</p>

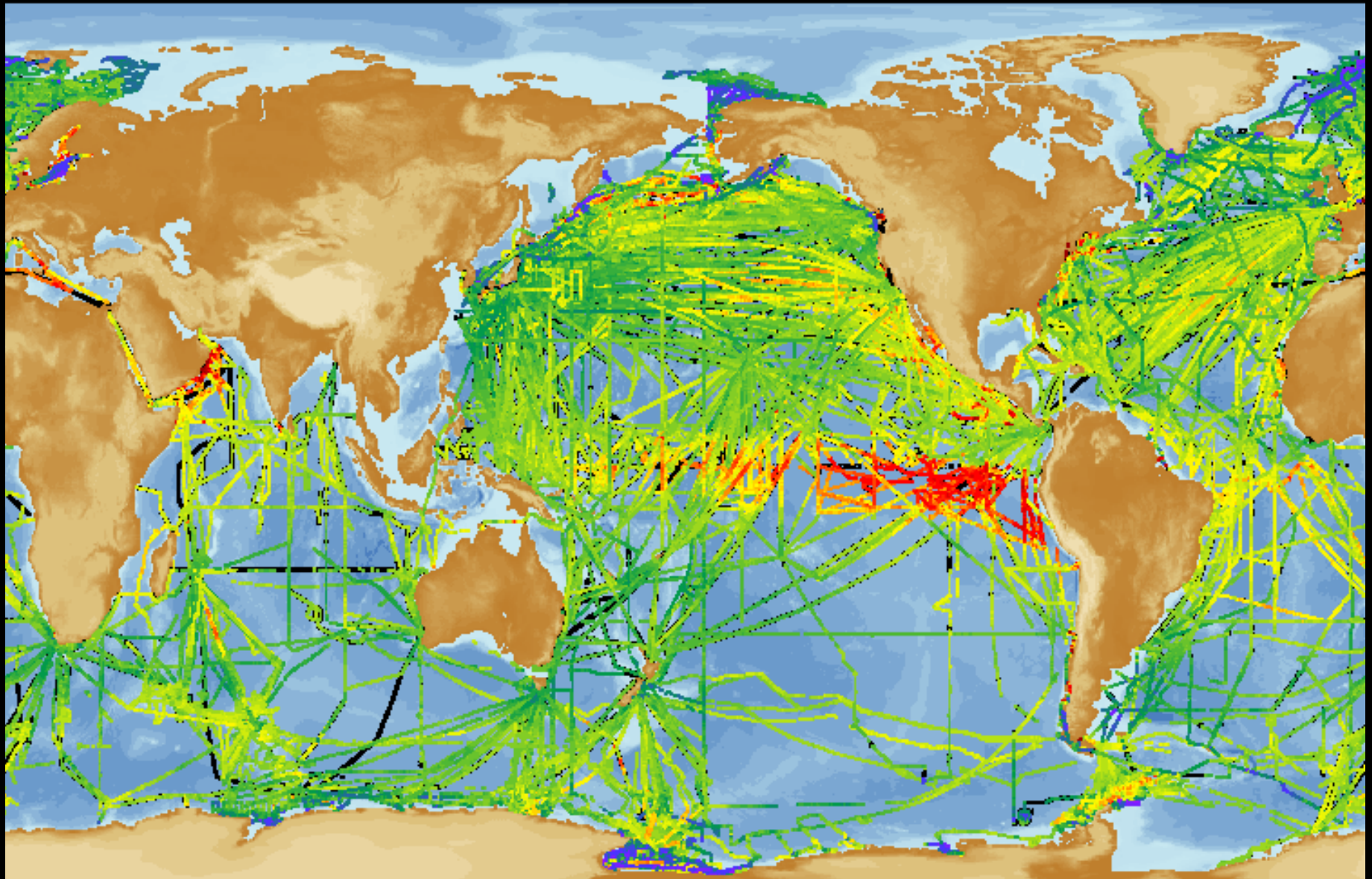
GOA-ON observing assets:



Outcomes from GOA-ON:

Globally distributed, high quality data, near-real-time data, and data synthesis products that:

- Facilitate research (new knowledge) on OA
- Communicate status of OA and biological response
- Enable forecasting/prediction of OA conditions



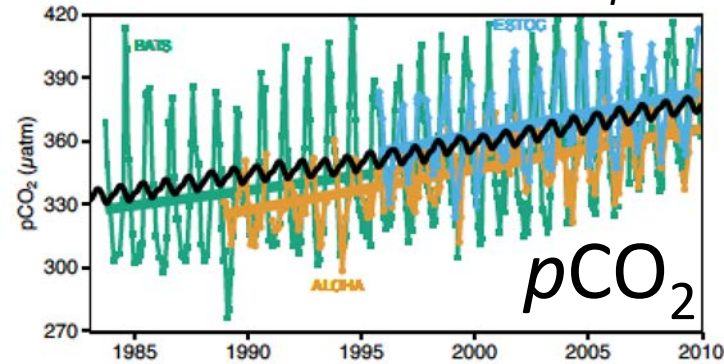
Surface Ocean CO₂ Atlas; www.socat.info

End-uses of GOA-ON information:

- **International policy** including carbon emission policies
- **Food security and livelihoods**
 - **Fisheries**
 - **Shellfish aquaculture**
 - **Coral reefs**
- **Shore protection, tsunami protection** from coral reefs
- **Cultural identity**
- **Tourism**



Source: IPCC Report



**OA is
a global condition
with
local effects**



OA is a global condition with local effects



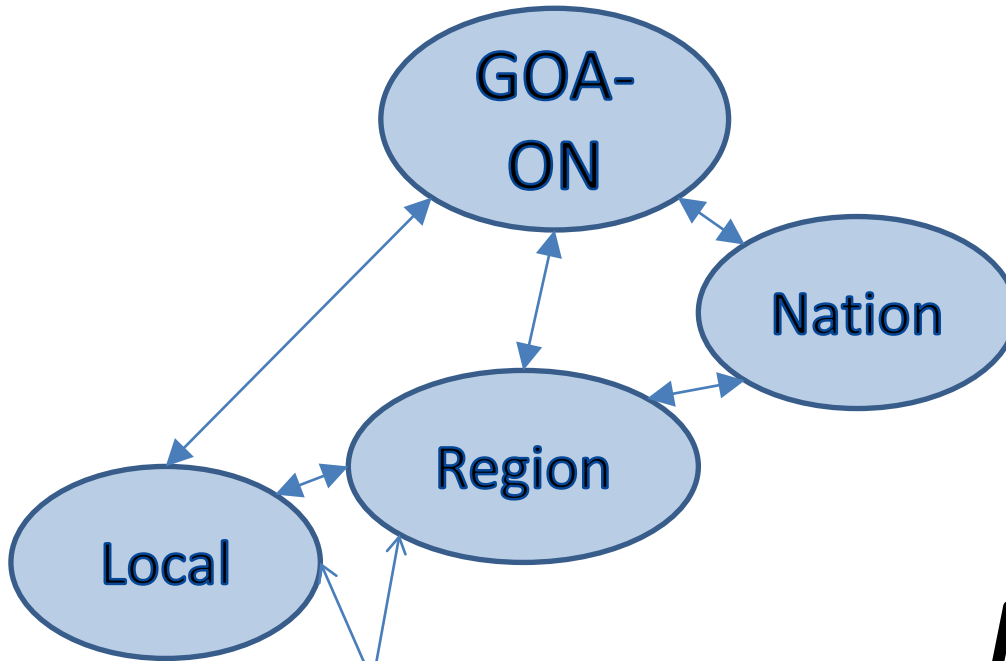


OA is

a global condition with local effects

- We need local through global scale observations **in order to get either correct**
- This issue **demands our coordination**, networked skill, and open analysis

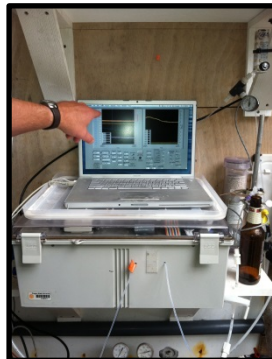
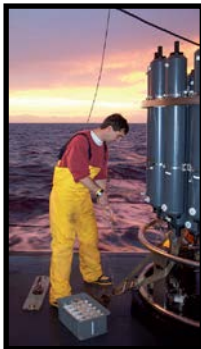
Integration of local through global



Weekly Trends

Partnerships:

Governments
Academia
Industry
NGOs
etc.




2012 Washington State Blue Ribbon Panel

NOAA OAR Special Report

*Washington Shellfish Initiative
Blue Ribbon Panel on Ocean Acidification*

Scientific Summary of Ocean Acidification in Washington State Marine Waters




Pac

*Ocean
Editors*

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Meg Chadsey Washington Sea Grant


Advance Copy – November 2012

Washington State Blue Ribbon Panel on Ocean Acidification



Ocean Acidification: From Knowledge to Action

Washington State's Strategic Response



November 2012

Washington waters are particularly vulnerable to ocean acidification

Ocean acidification is appearing in Washington decades *sooner* than anticipated.

...regional factors can exacerbate acidification caused by global CO₂ emissions:

Coastal upwelling of CO₂-rich waters

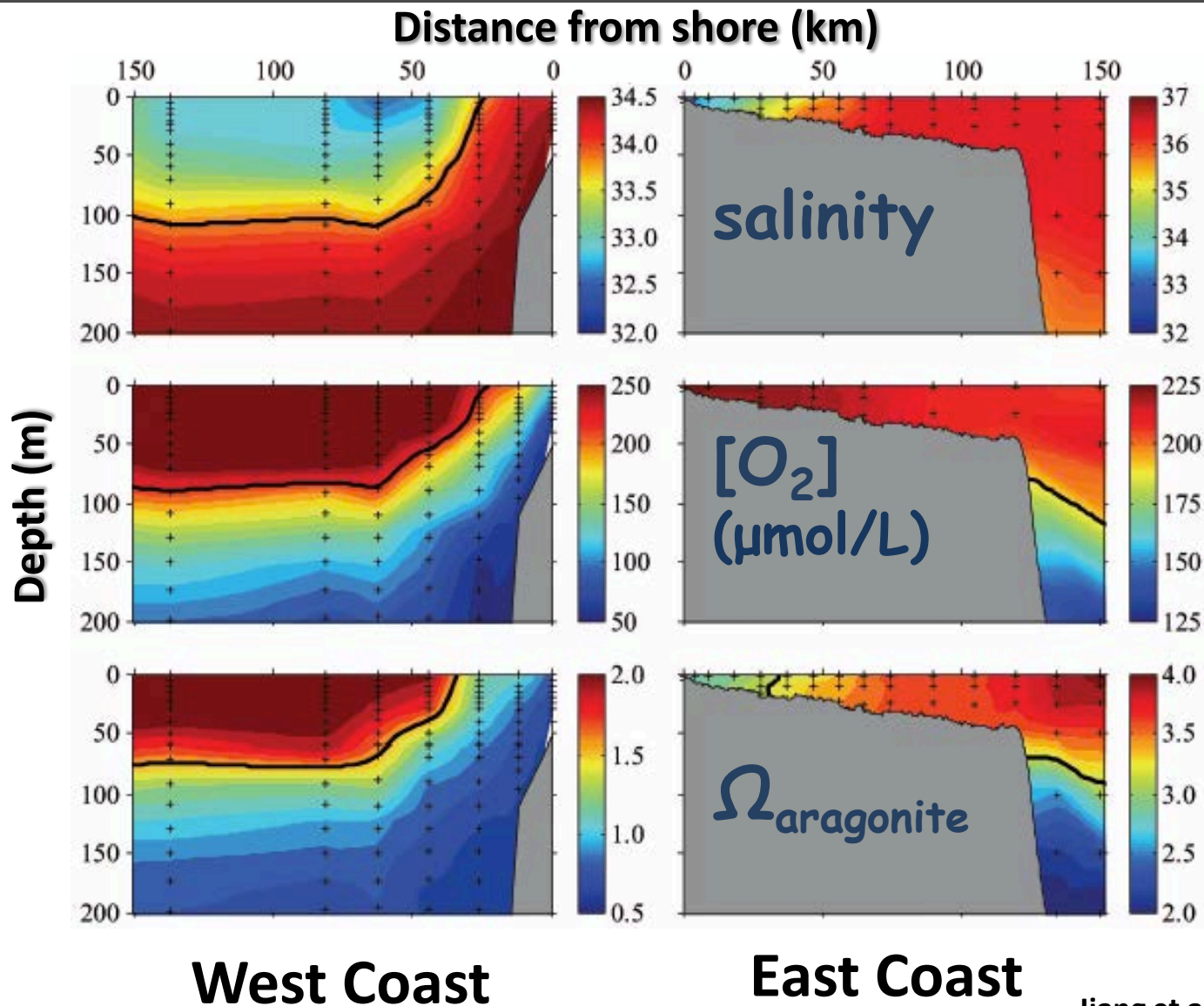
Runoff of nutrients and organic carbon from land-based activities

Decay of organic matter in subsurface waters

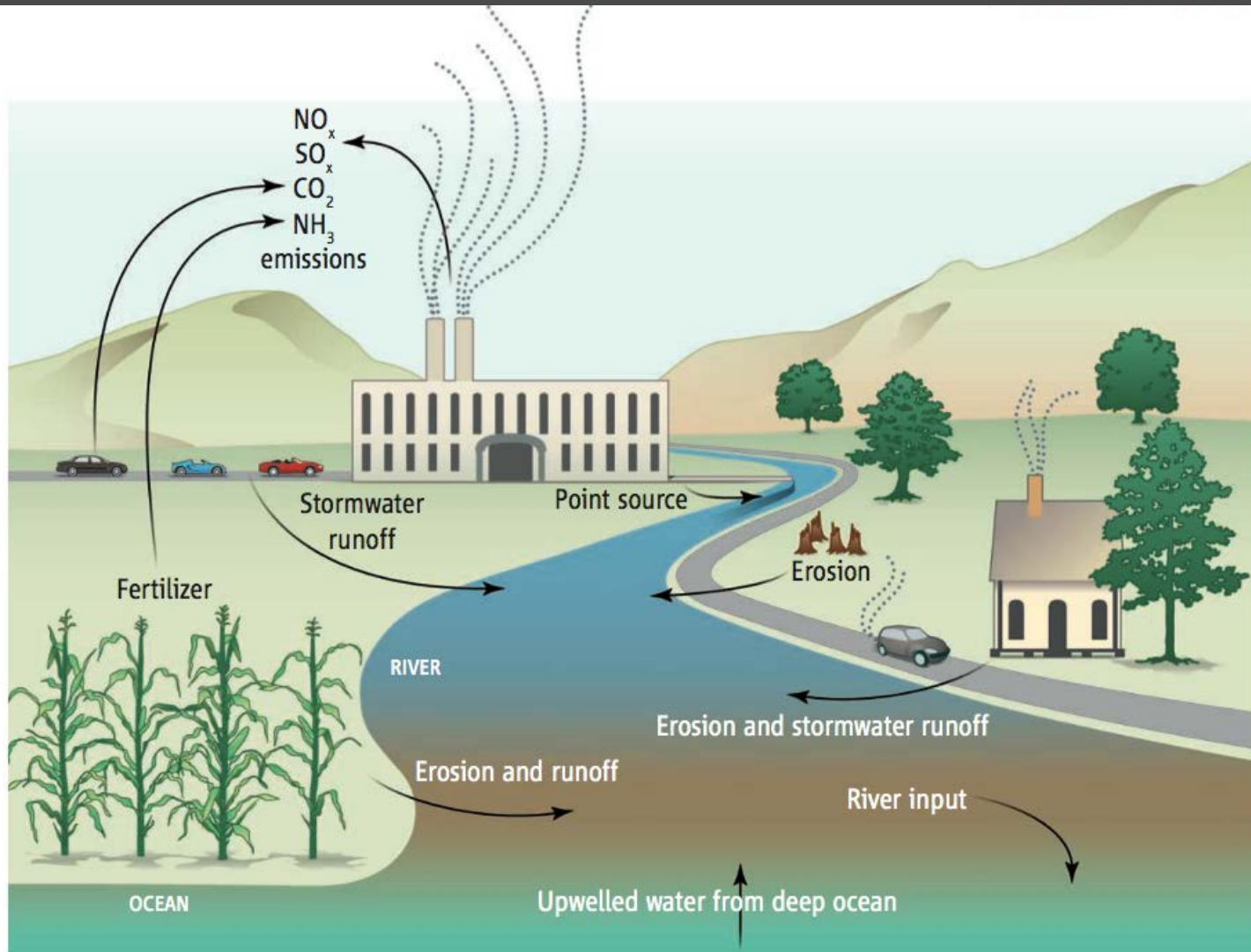


Photo: Russ McMillan

Ocean Acidification: Upwelling



Are local stressors contributing too?



Washington Marine Waters

Puget Sound & Strait

Outer Pacific coast

Shallow estuaries

Columbia River

Astoria

Distinctive Influencing Factors

Outer Coast

- Upwelling
- Columbia R plume effect

Puget Sound/Strait

- Oceanic input
- Nutrient addition effect
- Local atmospheric effect

Columbia R/shallow estuaries

- Terrestrial input
- Freshwater influence

Diversity of factors and degree of human influence

Biology exists within these environments and thus face different pressures

2012-2013 Legislative Actions

Established the **Marine Resource Advisory Council**

Established the **Washington Ocean Acidification Center** at the University of Washington

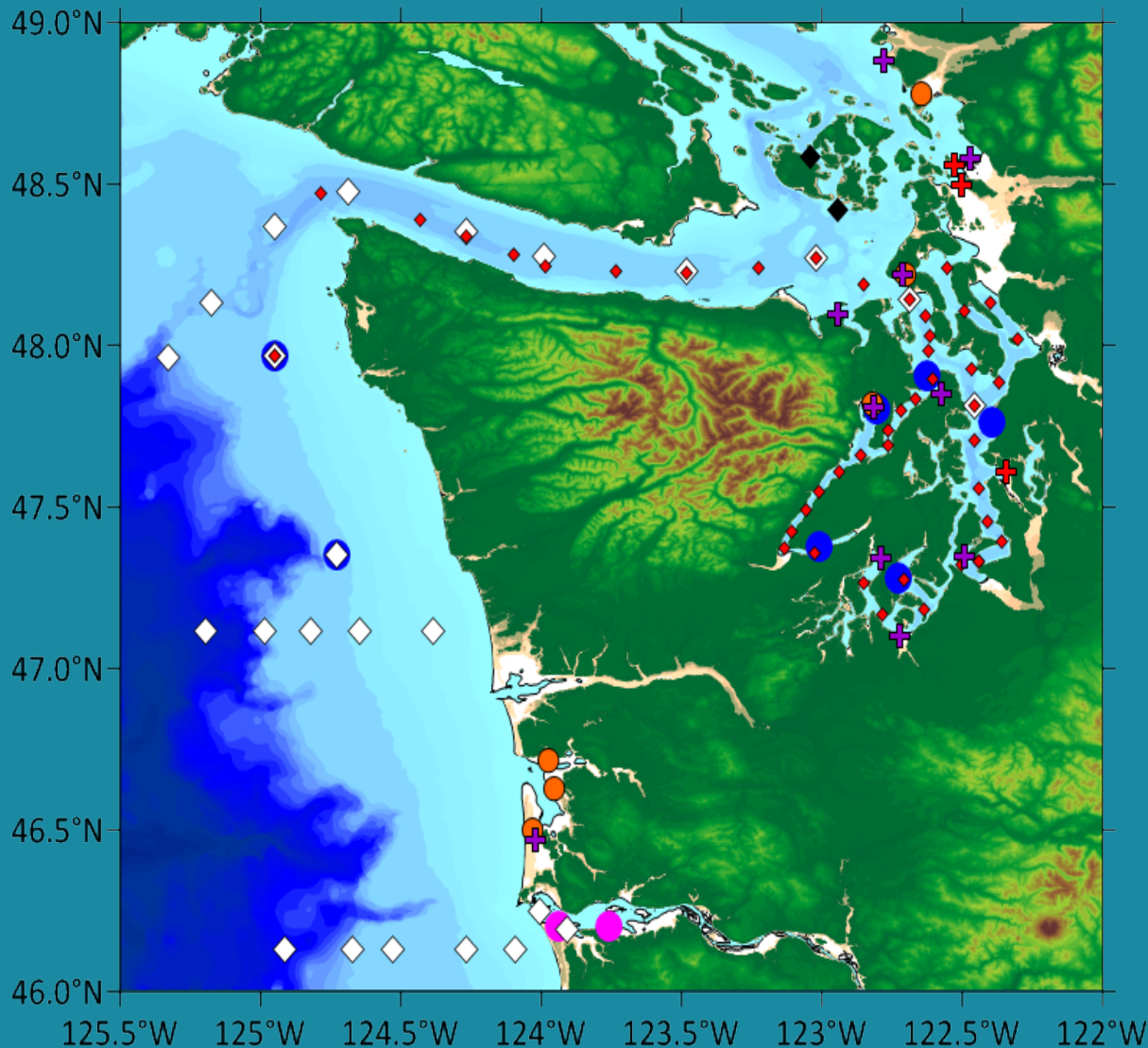
Directed Center to implement five actions from **Blue Ribbon Panel recommendations**



State-federal collaboration

- **NOAA**, the US's lead federal agency on ocean acidification, collaborates with the Center in all five actions.
- **EPA** is engaging with the Center through participation on the “West Coast Ocean Acidification and Hypoxia Panel” and locally.
- **US IOOS** investments , regionally as **NANOOS**, substantially enhance the Center's abilities.

Action: Sustain Integrated Monitoring



- Integrates water and biological measurements
- Mix of moorings and cruises
- Mix of environments
- Leverages existing networks
- Numerous and diverse partners

Action: Sustain Integrated Monitoring

- Phytoplankton, micro and macro zooplankton
- Pteropods show significant dissolution

Off coast



In Puget Sound

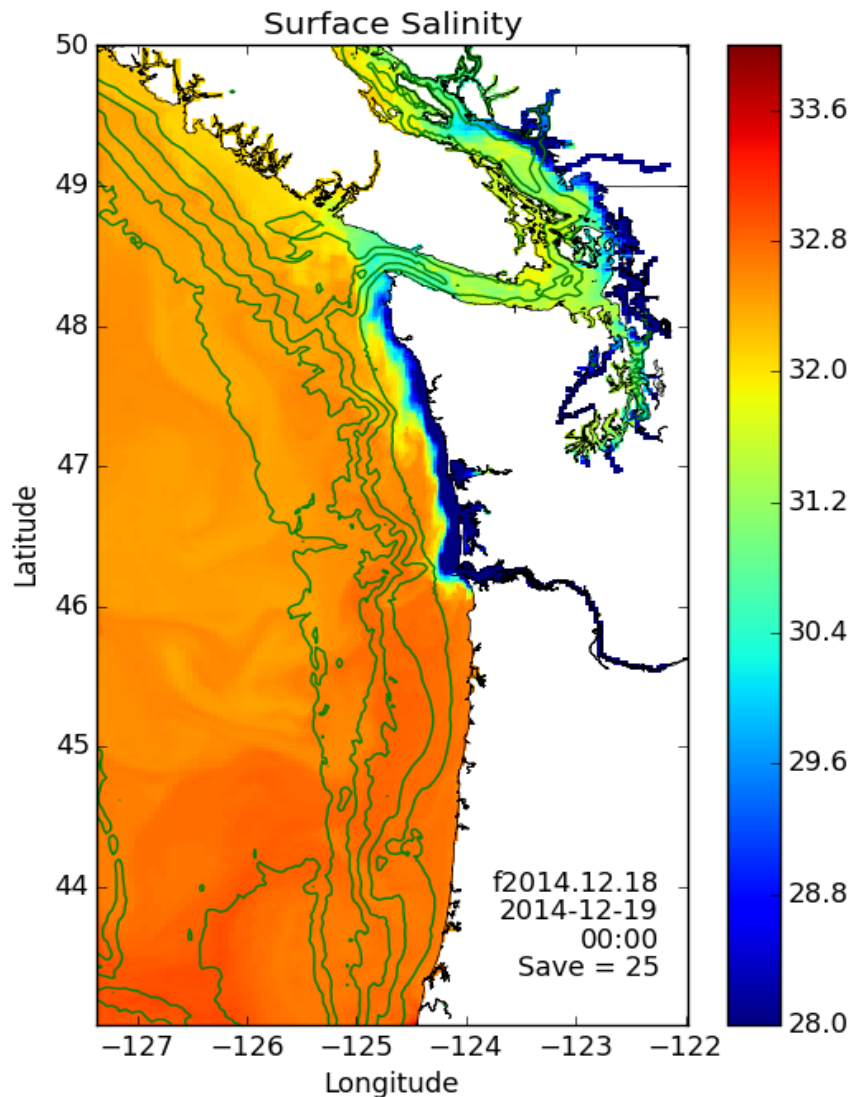


Action: Conduct biological experiments

- Important WA species
 - Copepods, krill, Olympia oysters, Dungeness crab
- Multi institution team
- Exposure to higher levels of CO₂ resulted in:
 - Reduced survival in krill
 - Delayed development in crab



Action: Develop forecast model



- ROMS based:
 - Physics, chemistry, plankton
 - First off coast, then in Salish Sea, hopefully then sub-estuaries

Actions: Support shellfish cultivation

- Via monitoring for corrosive water conditions
 - Data integrated with OA monitoring network
- Via hatchery adaptation research





'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.



New IOOS data portal

Settings

IOOS PACIFIC REGION OCEAN ACIDIFICATION



Data Explorer

Click for access to ocean acidification data and visuals for the Northeast Pacific Ocean

Welcome to the IOOS Pacific Region Ocean Acidification Data Portal



Ocean acidification refers to the change in the chemistry of seawater caused primarily by the ocean's absorption of carbon dioxide from the atmosphere.

From our data explorer, you can find data relevant to ocean acidification from partners in the Pacific region. This portal was funded by U.S. IOOS, with data streams contributed by regional IOOS observing systems in Alaska (AOOS), Washington and Oregon (NANOOS), Central and Northern California (CeNCOOS), Southern California (SCCOOS), and the Pacific Islands (PacIOOS) as well as through NOAA's Ocean Acidification Program (OAP) and Pacific Marine Environmental Laboratory (PMEL). Data presented here were funded through NOAA OAP, U.S. IOOS, or regional observing system collaborators. For further information about ocean acidification, follow these national and regional links, which include FAQs and videos on the basic understanding of and consequences from ocean acidification, as well as links to information on sensors (Alliance for Coastal Technologies, ACT) and practices (California Current Acidification Network, C-CAN) used to monitor ocean acidification status.

The seawater chemistry changes from ocean acidification affect the ecology and economy of marine communities, and this is projected to grow with time. We can better prepare for potential impacts to marine communities, fisheries, and livelihoods by learning more about how the ocean absorbs carbon dioxide. IOOS is committed to working with a diversity of partners to provide data about ocean acidification conditions.

For ocean acidification relevant information from the organizations below, click on the icons.



IOOS PACIFIC REGION OCEAN ACIDIFICATION EXPLORER

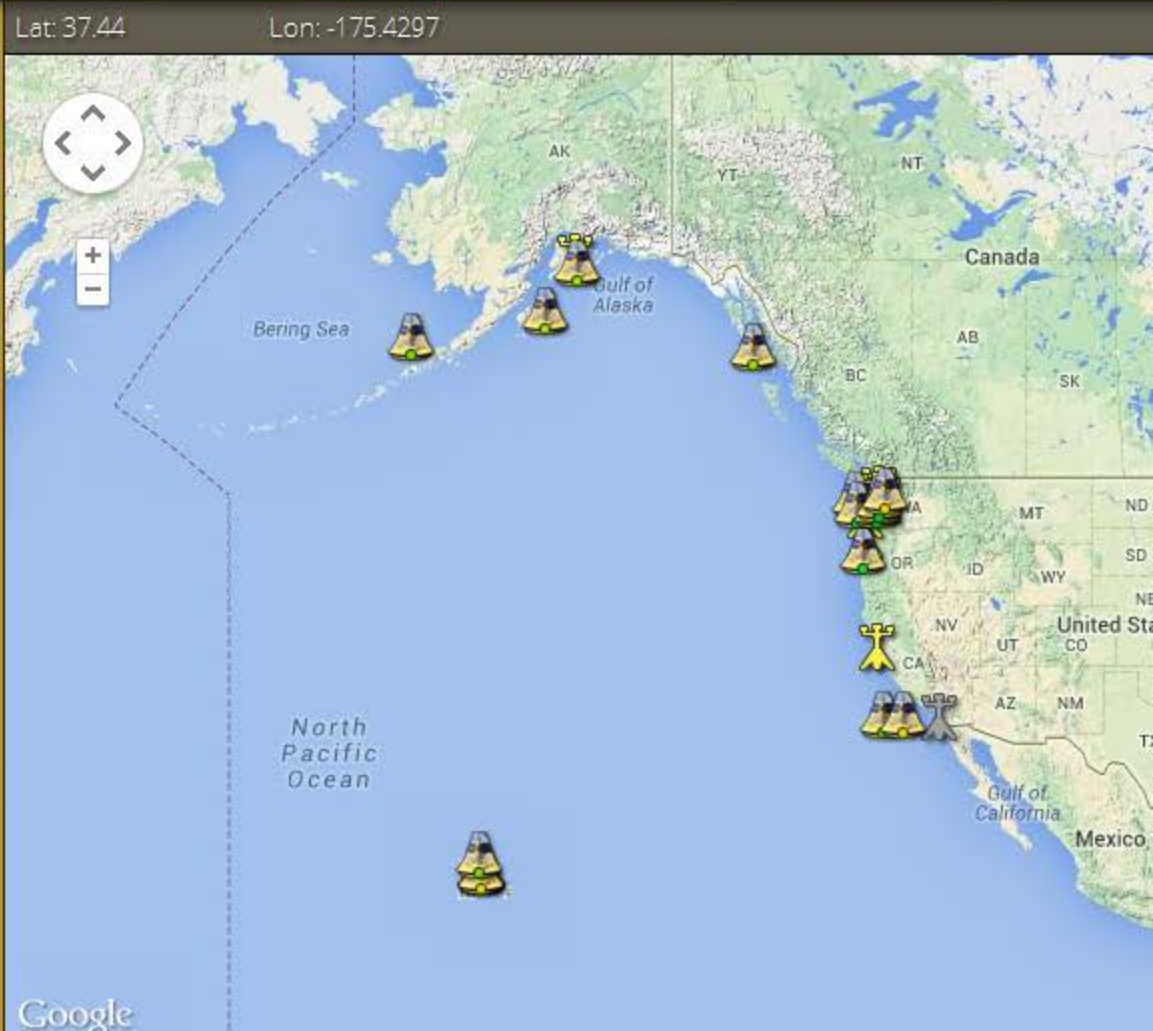
Map

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 - PMELCO2 kodiak
 - PMELCO2 m2
 - PMELCO2 seek
 - PMELCO2 whots
 - STTI Port Susan
 - Fixed Shore Platform
 - AOOS Alutiiq Burkolator
 - SCCOOS Carlsbad Burkolator (Au
 - HIOC CO2
 - Seattle Aquarium
 - Penn Cove Shellfish
 - PSI-PCSGA Bay Center
 - Taylor-PCSGA Dabob
 - WCSH-PCSGA Whiskey Crk



IOOS PACIFIC REGION OCEAN ACIDIFICATION EXPLORER

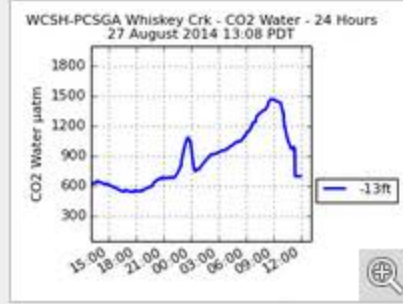
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- Regions
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- Fixed Platforms
- Legend

Lat: 54.8513 Lon: -134.9121



PCSGA - Whiskey Creek Shellfish Hatchery, Netarts Bay

Provider: WhiskeyCrShel Data Updated: 27 Aug 2014 11:59 PDT



24 Hours 7 Days 30 Days 60 Days



Alk_T (-13ft):	2224.4 µeq
CO2 Water (-13ft):	697.1 µatm
TCO2 (-13ft):	2121.7 µm
Omega_ArgSat (-13ft):	1.4
Oxygen Conc. (-13ft):	...
Oxygen Pct. Sat. (-13ft):	97.4 %
pH (-13ft):	9.1
Salinity (-13ft):	32.5 PSU
Water Temp. (-13ft):	60.5 °F

IOOS PACIFIC REGION OCEAN ACIDIFICATION EXPLORER

- Map
- Regions
- Filters
- Fixed Platforms
- Legend

Lat: 52.9089 Lon: -100.6787



PCSGA - Whiskey Creek Shellfish Hatchery, Netarts Bay

Provider: WhiskeyCrShel Data Updated: 27 Aug 2014 11:59 PDT



24 Hours 7 Days 30 Days 60 Days



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Oxygen Pct. Sat. (-13ft):	97.4 %
pH (-13ft):	9.1
Salinity (-13ft):	32.5 PSU
Water Temp. (-13ft):	60.5 $^{\circ}\text{F}$

Thank you

GOA-ON: www.goa-on.org

US IOOS: ioos.noaa.gov/

IPACOA: www.ipacoa.org

NANOOS: www.nanoos.org

WA OA Center: (just search)

<http://coenv.washington.edu/research/major-initiatives/ocean-acidification/>