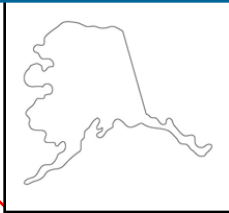


# Ten-year retrospective of the Northwest Association of Networked Ocean Observing Systems (NANOOS)

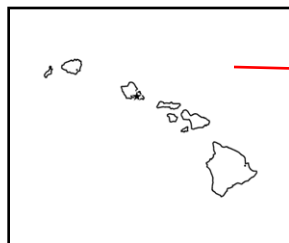
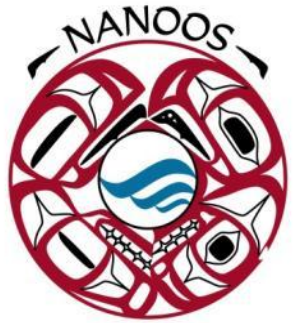
Jan A. Newton, Jack Barth,  
David L. Martin, Michael P.  
Kosro, Jonathan Allan, Emilio  
Mayorga and many NANOOS  
Colleagues

# The U.S. Integrated Ocean Observing System (IOOS®) consists of National and Regional Components

**AOOS**  
Alaska Ocean Observing System



**NERACOOS**  
Northeastern Regional Association of Coastal Ocean Observing Systems





# NANOOS

NORTHWEST ASSOCIATION OF NETWORKED OCEAN OBSERVING SYSTEMS



WASHINGTON - OREGON - NORTHERN CALIFORNIA

## Stakeholder Priorities

NANOOS selected five areas as the highest regional priorities:

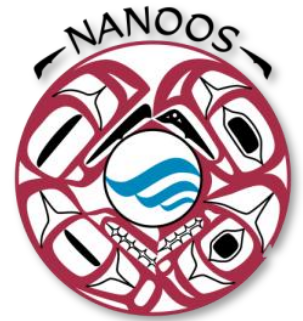
- Maritime Operations
- Ecosystem Impacts, including hypoxia and HABs
- Fisheries
- Mitigating Coastal Hazards
- Climate, including ocean acidification





# 10 years of NANOOS development

- Observing assets, *without this, we have no data*
- Members, stakeholders, PIs, users groups, *without this, we have no relevancy*
- Analysis, outreach & education, *without these, our products don't inform*
- Data/product dissemination, *without this, we don't connect anything we do to anyone who cares*



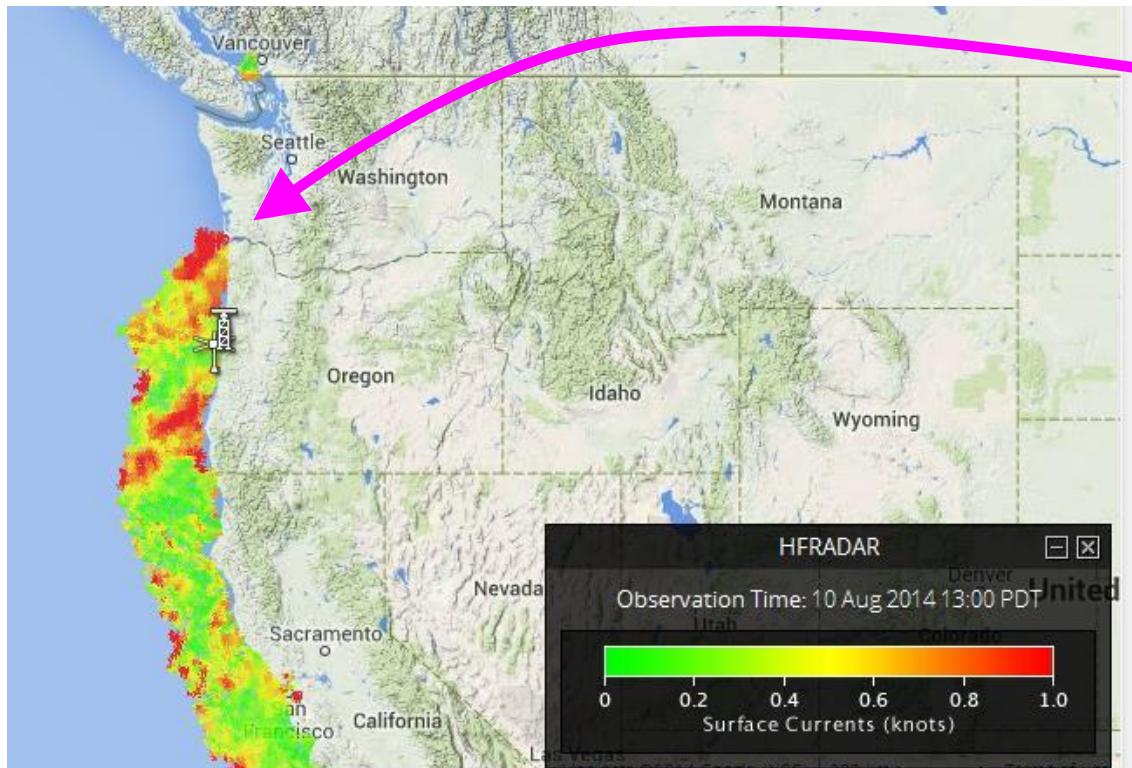
# 10 years of NANOOS development

- **Observing assets**, we have coastal ocean, shoreline, and inland (estuarine) focus
- **Members, stakeholders, PIs, users groups**, we have ~50 member organizations, ~12 PIs
- **Analysis, outreach & education**, we have models, data synthesis products, and information networks
- **Data/product dissemination**, we have the NANOOS visualization system, NVS

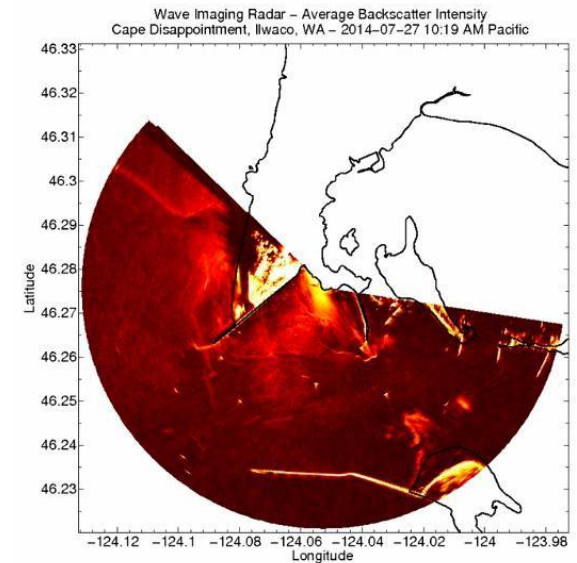
# NANOOS, the Pacific Northwest component of the U.S. IOOS<sup>®</sup>

## Surface current and wave mapping capability.

- maintain existing HF-radar
- continue investment in wave mapping at a critical port



## Wave radar at mouth of Columbia River

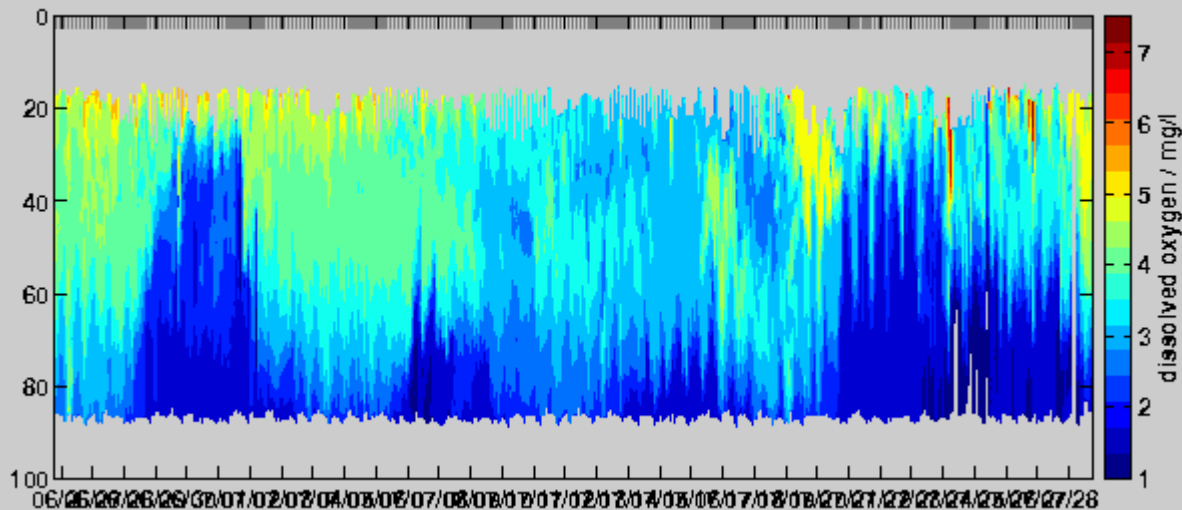
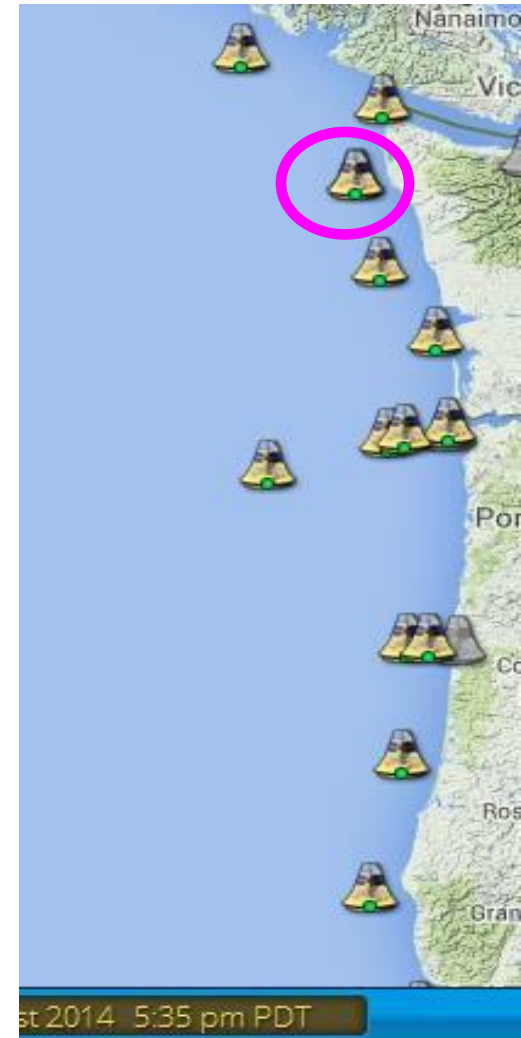
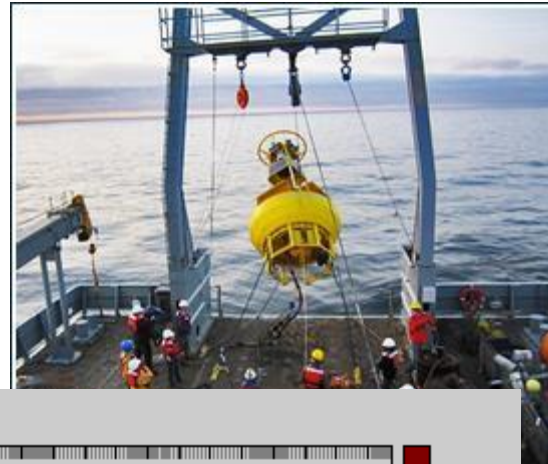


# NANOOS, the Pacific Northwest component of the U.S. IOOS<sup>®</sup>

Sustain existing buoys in the PNW coastal ocean, in coordination with national programs.

## Cha'ba Mooring

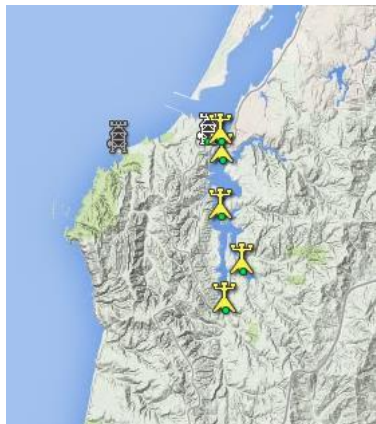
*Cha'ba has physics, oxygen, pCO<sub>2</sub>, pH, chlorophyll*



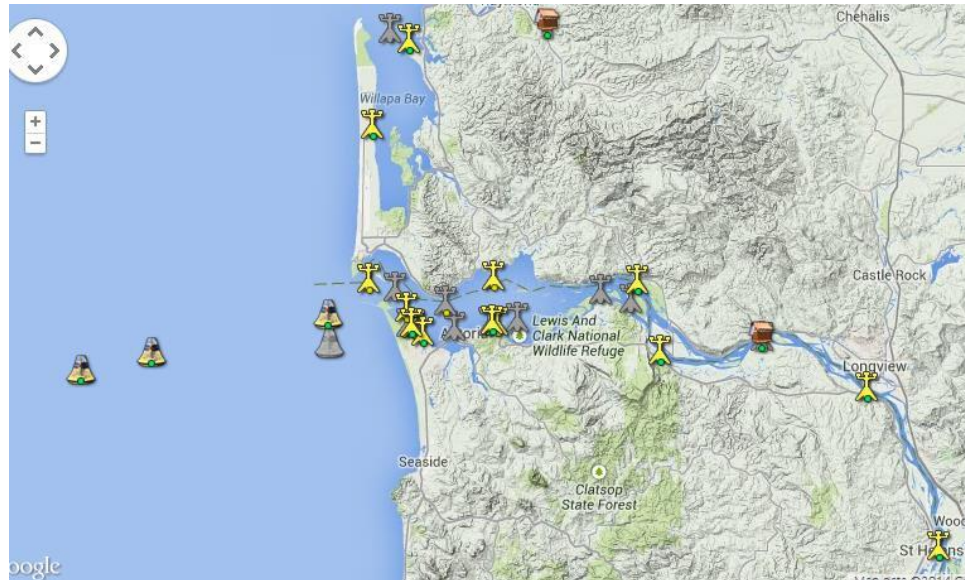
# NANOOS, the Pacific Northwest component of the U.S. IOOS®

Maintain observation capabilities in PNW estuaries, in coordination with local and regional programs

Coos Bay,  
Oregon



Columbia River  
(Astoria--Portland)



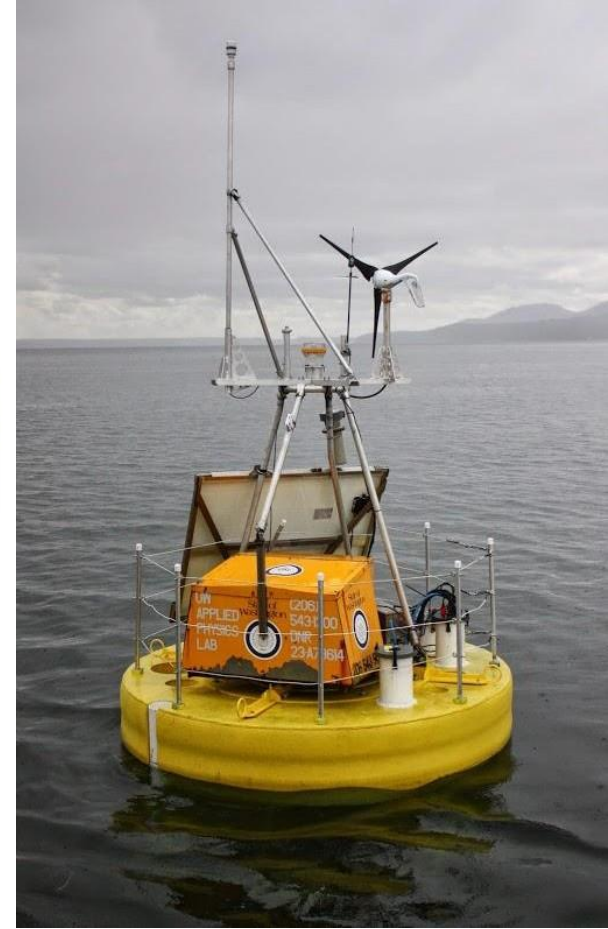
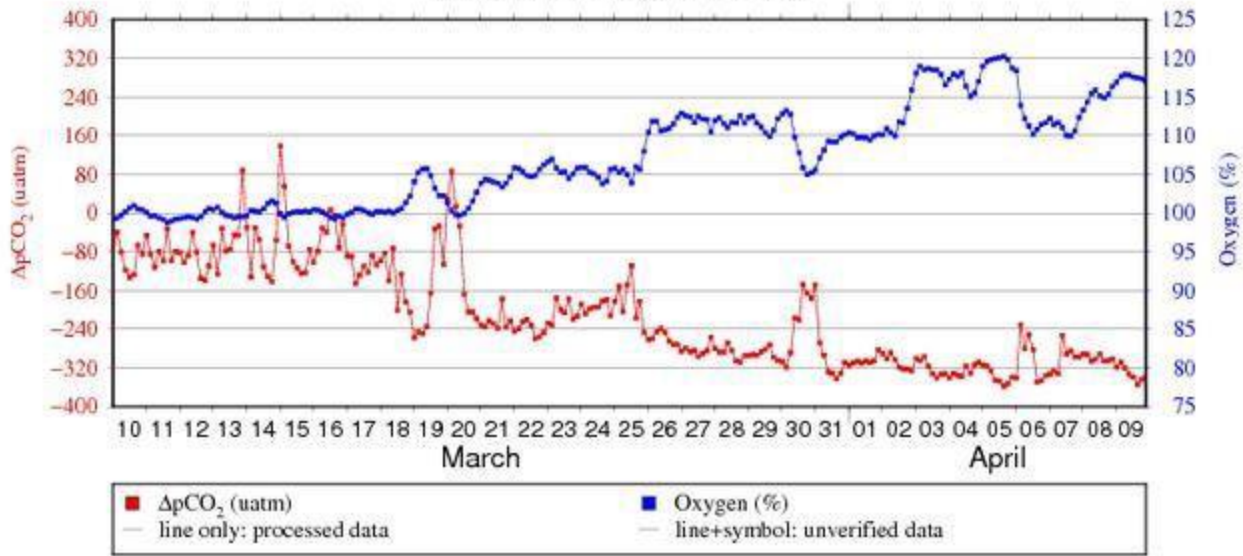
Puget Sound  
(Seattle)





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]

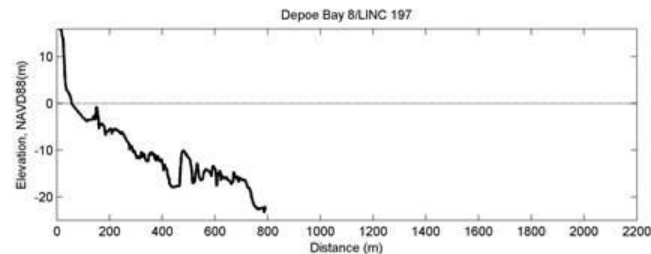
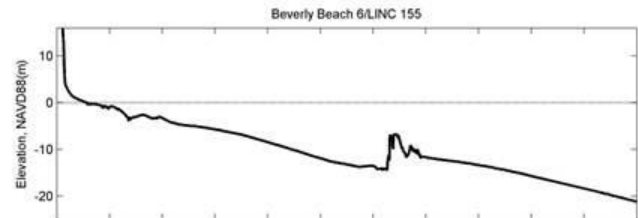
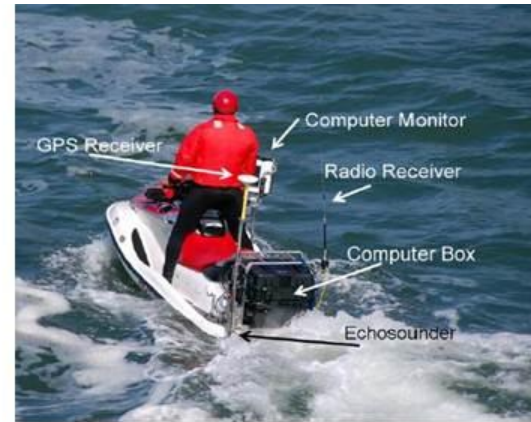
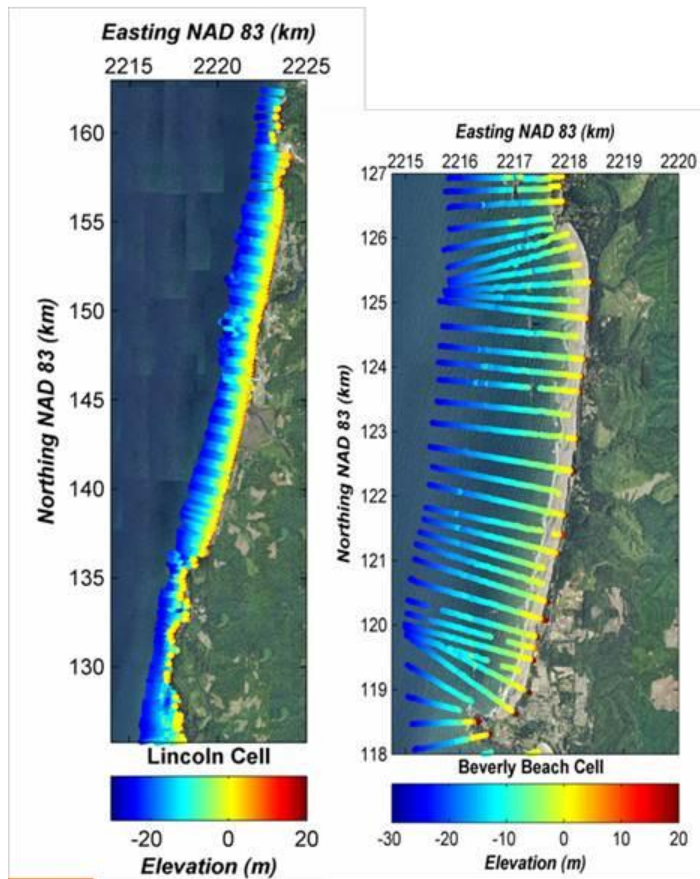


***Hello Spring Bloom !!***

# Sustaining NANOOS, the Pacific Northwest component of the U.S. IOOS<sup>®</sup>

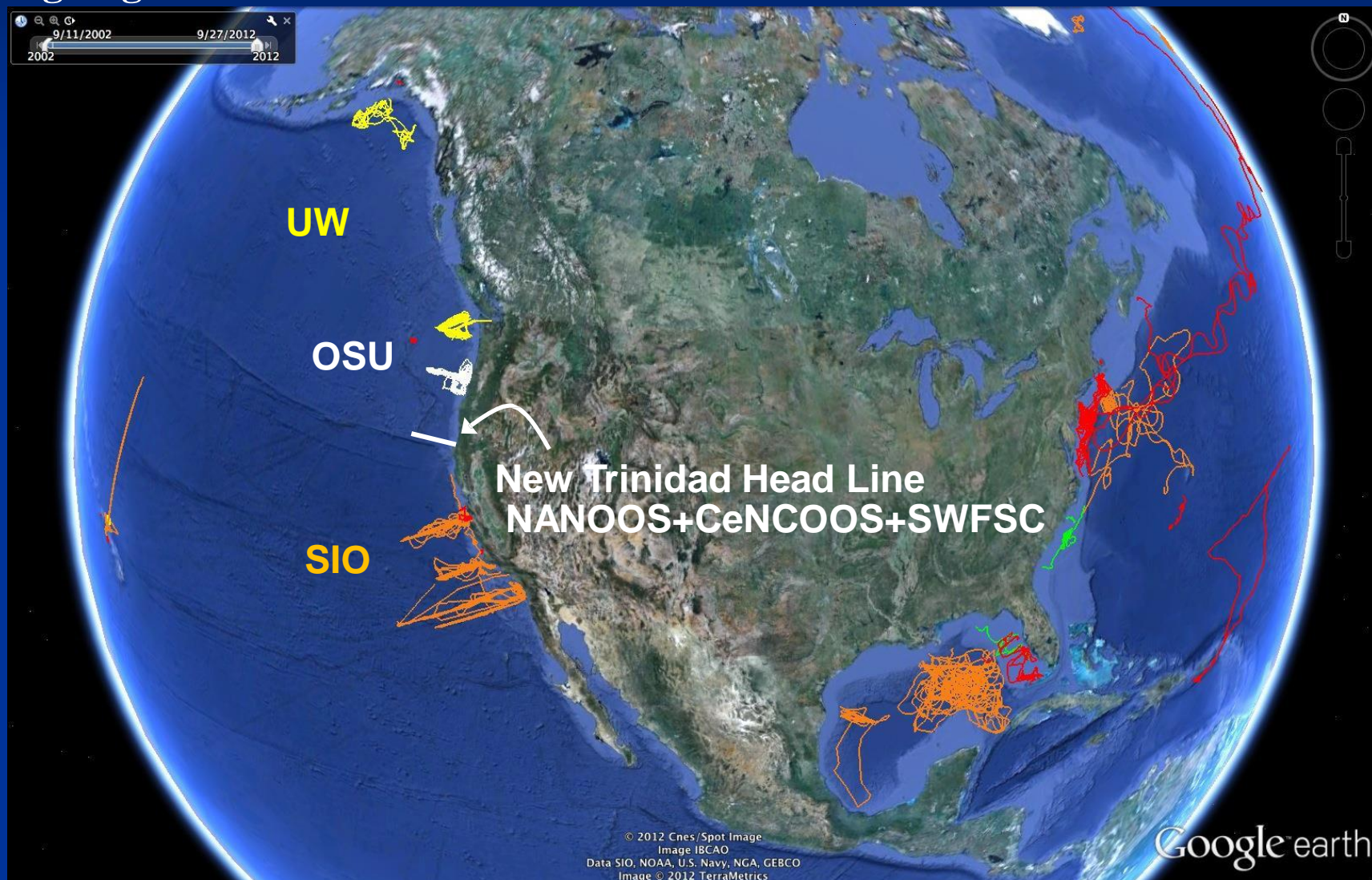
Maintain core elements of beach and shoreline observing

## Bathy Monitoring Stations



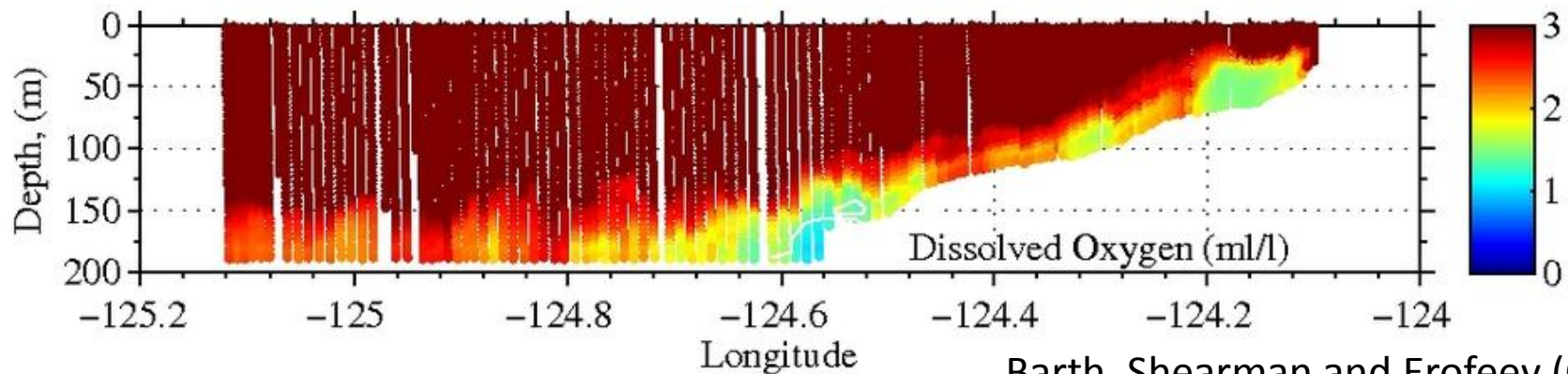
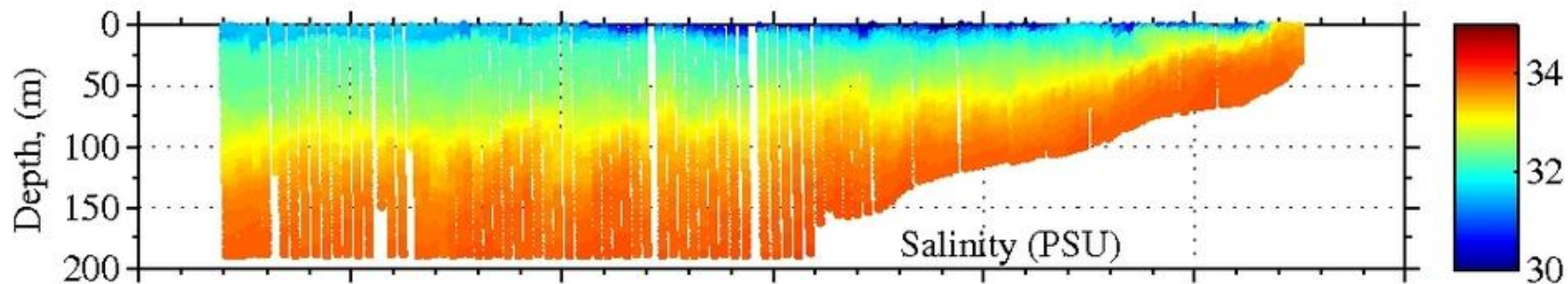
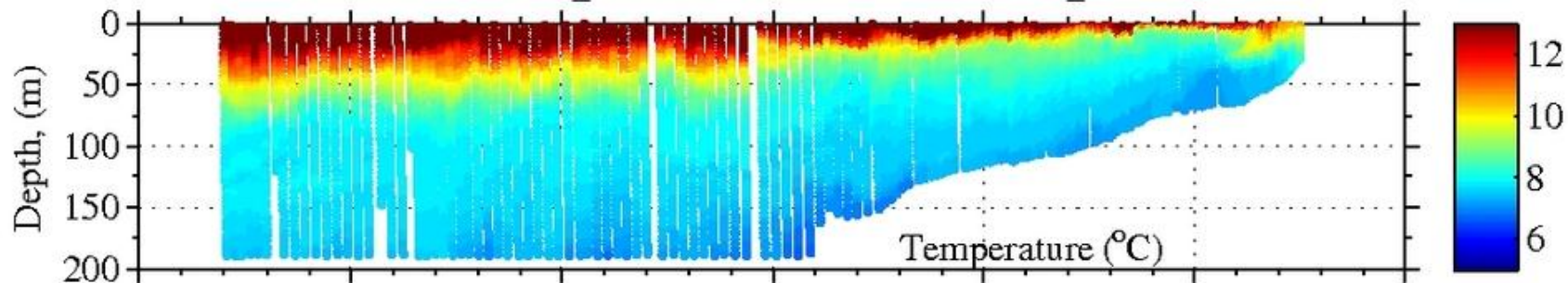
# U.S National glider activities

all lines are combinations of NOAA IOOS and other funding; not all are ongoing!



# June 17-20, 2014

line: NH\_201406171719-201406201652\_bob





# NANOOS data dissemination

*Needs to:*

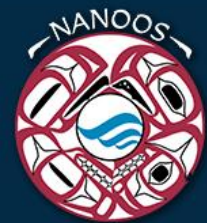
- Deliver diverse data streams
- Deliver products that user groups want
- Deliver in near real-time as well as reference
- ...
- But not overwhelm users !

**→ NANOOS Visualization System (NVS)**



# NANOOS

NORTHWEST ASSOCIATION OF NETWORKED OCEAN OBSERVING SYSTEMS



## NANOOS

Welcome to NANOOS, the Pacific Northwest regional ocean observing system of IOOS (Integrated Ocean Observing System). NANOOS is creating customized information and tools with these areas of emphasis:

Maritime Operations

Ecosystem Assessment

Fisheries & Biodiversity

Coastal Hazards

Climate

Home

About NANOOS

Join NANOOS

Contact Us

Disclaimer

Site Map

NVS

Products

Mobile Apps

Education

Resources

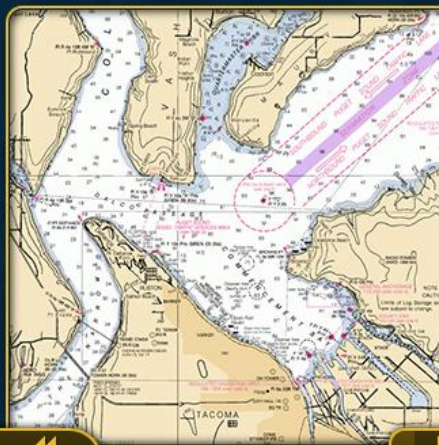
Log In

New Account



### Data Exploration

NVS (NANOOS Visualization System) is a web app that provides easy access to observations, forecasts, data, and visualizations.



### Nautical Charts are available on NVS Web Apps

Nautical charts are available on both the NVS Maritime Operations and NVS Tuna Fishers Apps. To view NOAA Navigational Charts, select "Charts" from the left hand menu and charts will display on the map. Within the Charts Panel, users can select "Seamless Nautical Charts" to be able to pan and zoom within the entire map view.

[Visit the NVS Maritime Operations App](#)

[Visit the NVS Tuna Fishers App](#)



Finding a Story in Data Educator Workshop August 15-16, 2014

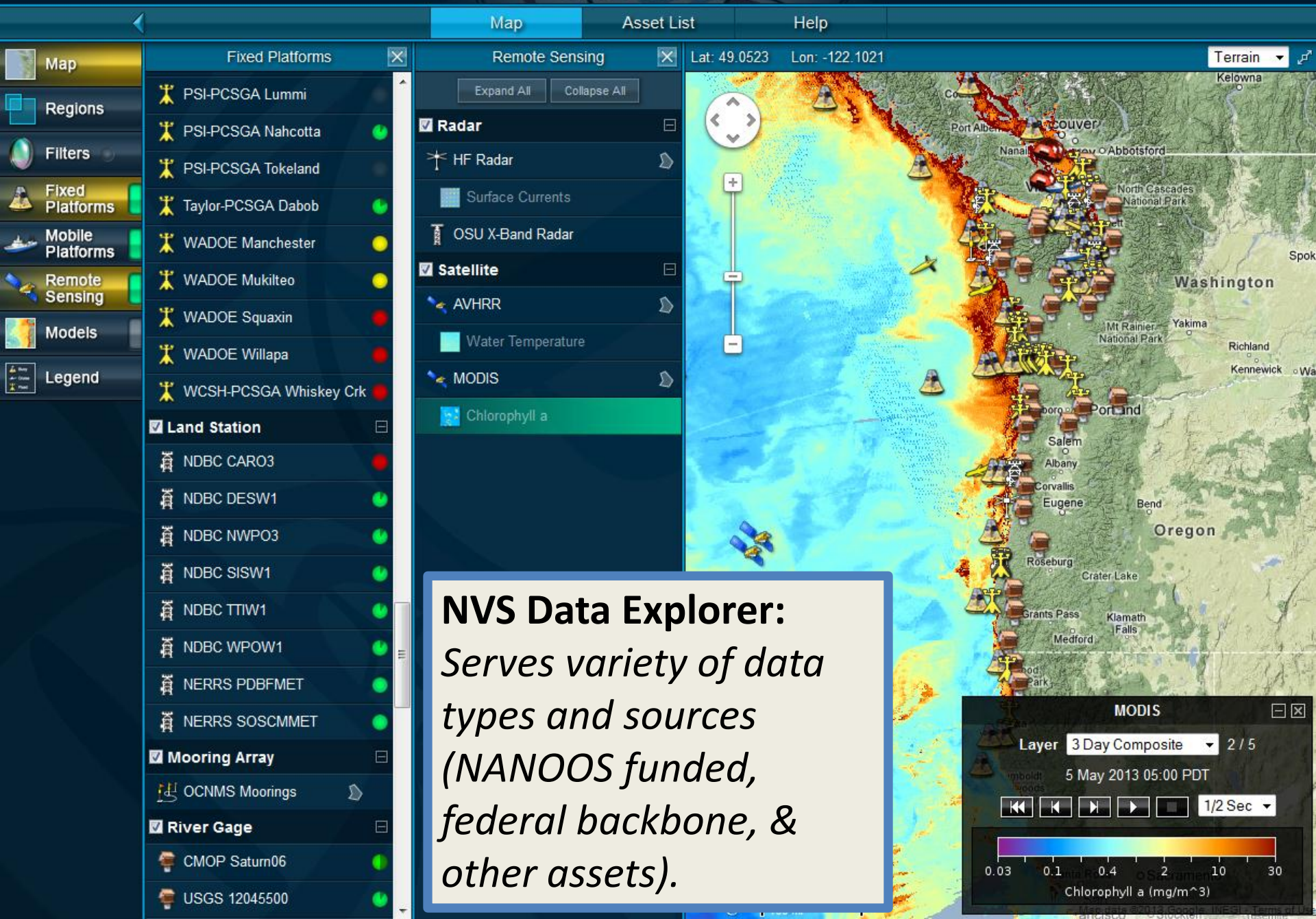


New NVS Boaters App



Ocean Acidification Webinar Series



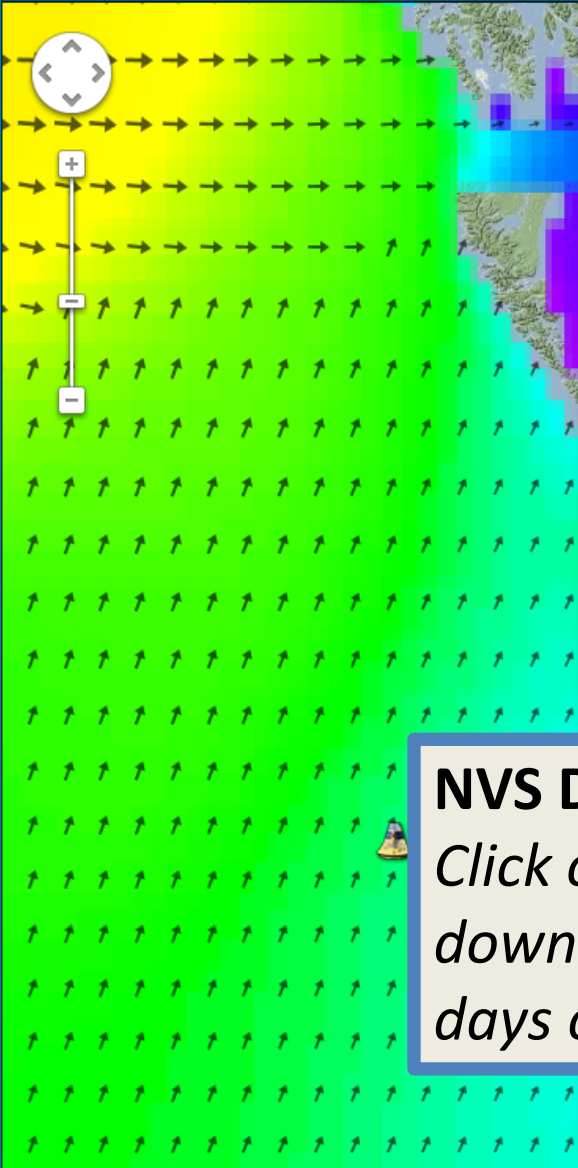


**NVS Data Explorer:**  
*Serves variety of data types and sources (NANOOS funded, federal backbone, & other assets).*

- Map
- Regions
- Filters
- Fixed Platforms
- Mobile Platforms
- Remote Sensing
- Models
- Legend

Lat: 52.3622 Lon: -131.3525

Terrain



### NH-10 Buoy, Newport

Observations Forecasts Comparator Details History

Provider: OSU

Data Updated: 20 May 2013 10:00 PDT

OSU NH-10 - Water Temp. - 30 Days  
20 May 2013 10:38 PDT

24 Hours 7 Days 30 Days 60 Days

Download icon

Air Temp. (2.1m):	10.5 °C
Baro. Pressure (2.1m):	1023.9 mbar
Oxygen Conc. (-70m):	1.6 mL/L
Pressure (-70m):	67.7 dbar
Salinity	
-1.7m:	32.2 PSU
-30m:	33.1 PSU
-70m:	33.9 PSU
Solar Rad. (2.1m): 633.1 W/m <sup>2</sup>	
Water Temp.	
-1.7m:	12.3 °C
-30m:	7.6 °C
-70m:	7.3 °C
Wind Direction (2.7m):	2.7 deg (from)
Wind Speed (2.7m):	5.8 m/s

Link

**NVS Data Explorer:**  
*Click on icon to see and download data up to 60 days old.*

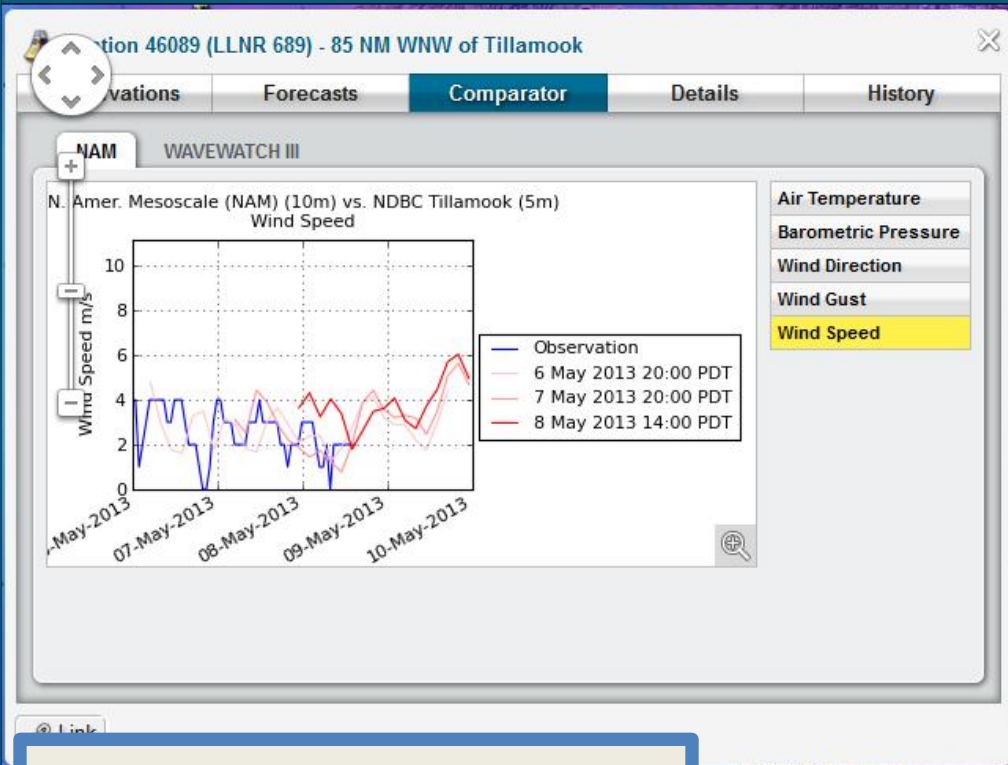


- Map
- Regions
- Filters
- Fixed Platforms
- Mobile Platforms
- Remote Sensing
- Models
- Legend

- Fixed Platforms
- NDBC Oregon
  - NDBC Port Orford
  - NDBC St. Georges
  - NDBC Stonewall Bank
  - NDBC Tillamook
  - NDBC Washington
  - ORCA Hansville
  - ORCA Hoodspout
  - ORCA Twanoh
  - ORCA Dabob Bay
  - OSU NH-10
  - Ocean Station Papa
  - Fixed Shore Platform
  - CMOP Am169
  - CMOP Cbnc3
  - CMOP Coaof
  - CMOP Dsdma
  - CMOP Grays
  - CMOP Hmndb
  - CMOP Jetta
  - CMOP Sandi
  - CMOP Saturn01
  - CMOP Saturn03

Lat: 45.9664 Lon: -128.6829

Terrain



**NVS Data Explorer:**  
*Compares real-time data with model prediction output.*

NAM

Model Run: 7 May 2013 23:00 PDT

Forecast Time 7 May 2013 23:00 PDT 1 / 29

1/2 Sec

5.0 10.0 15.0

Wind Speed (m/s)

0 5 10 15 20 25

Wind Speed (m/s)

Google 100 km 50 mi

Map

Data

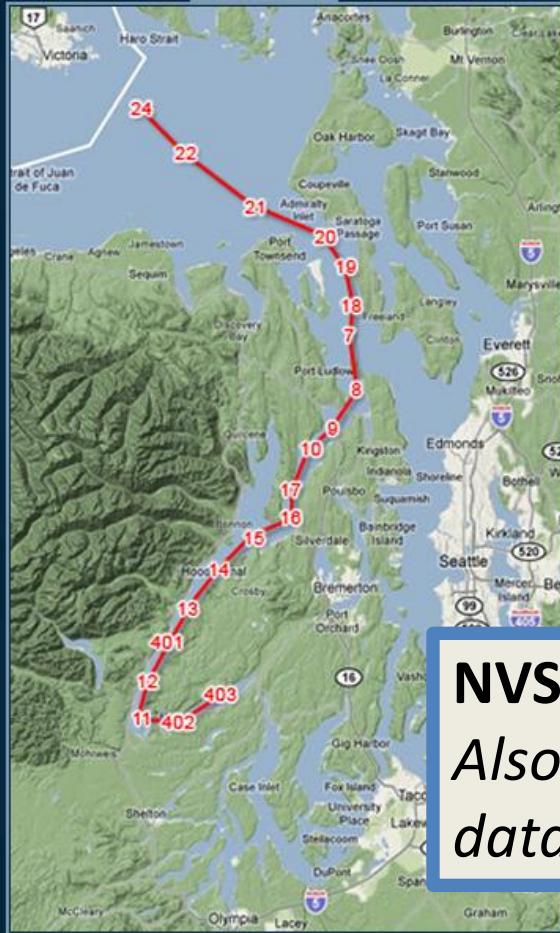
Plots

Matrix

Help

### Basin Cross Sections

Main Basin Hood Canal Whidbey Island



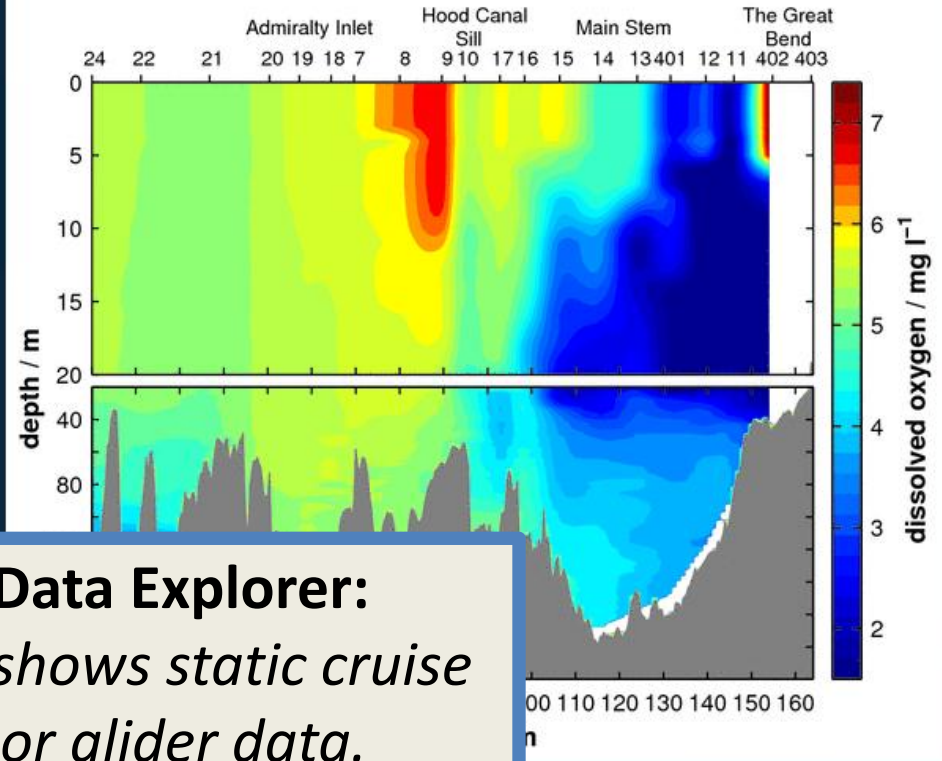
### Cruises

2011 October

### Variables

Oxygen Concentration - Uncalibrated

### PRISM Cruise 12-Oct-2011



**NVS Data Explorer:**  
*Also shows static cruise data or glider data.*

(All NANOOS assets and data streams)



Data Explorer



Tsunami Evacuation Zones



Boaters



Tuna Fishers



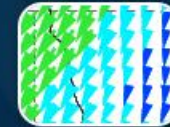
Shellfish Growers



Beach and Shoreline Changes



Maritime Operations



High Frequency Radar



Cruises



Gliders



Help



NVS for specific user groups with targeted subsets of the data

ADDITIONS & UPDATES

[View Last 3 Months](#)



**APL-UW NPB-1**

Meteorological sensors were redeployed on Oct 1, and are now available on NVS.

Updated on 3 Oct 2014



**CMOP Saturn02**

Summer-deployment buoy has been recovered, and returned as only a seasonal aid to navigation (no monitoring sensors) during winter. Next sensor deployment will be in late April or May 2015.

Updated on 30 Sep 2014



**CMOP Saturn08**

New monitoring LOBO buoy now on NVS. First deployed Sept 2013.

Added on 29 Sep 2014



**CMOP Saturn09**

New Buoy... (text partially cut off)

Added on 29 Sep 2014





# NVS for Tsunami Evacuation Zones

# Oregon Tsunami Clearinghouse

[Home](#) | [Coastal Residents](#) | [Visitors](#) | [Boaters](#) | [Kids & Teachers](#) | [Community Planners](#) | [Scientists](#)

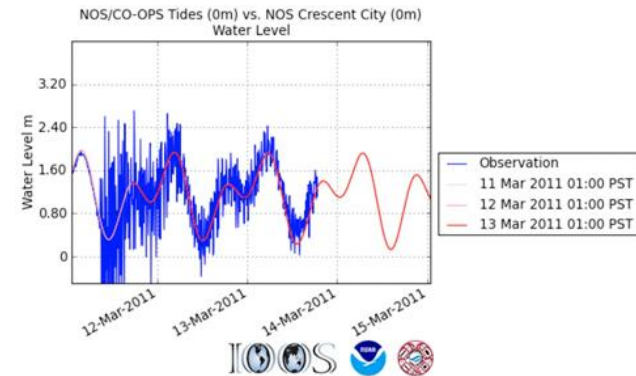
[Frontpage](#) [Evacuation Zone Map Viewer](#) [Evacuation Brochures](#) [Regulatory Maps](#) [Resource Library](#)

*Is your family prepared for disaster?*



*“This is a great tool for education and preparedness.”*

*“I never book hotels in the orange or yellow zones.”*



## [Tsunami Evacuation Zone Map Viewer](#)

Search by address or coastal area.  
[web map](#) | [iPhone app](#) | [Android app](#)



## PACIFIC NORTHWEST TSUNAMI EVACUATION ZONES

- Map
- Map Layers
- Regions
- Places
- Markers
- Info
- Legend

Places ✕ Lat: 51.1104 Lon: -131.8799 Terrain

Enter Address Click on Map

2nd Street, Cannon Beach, Oregor

Get Location

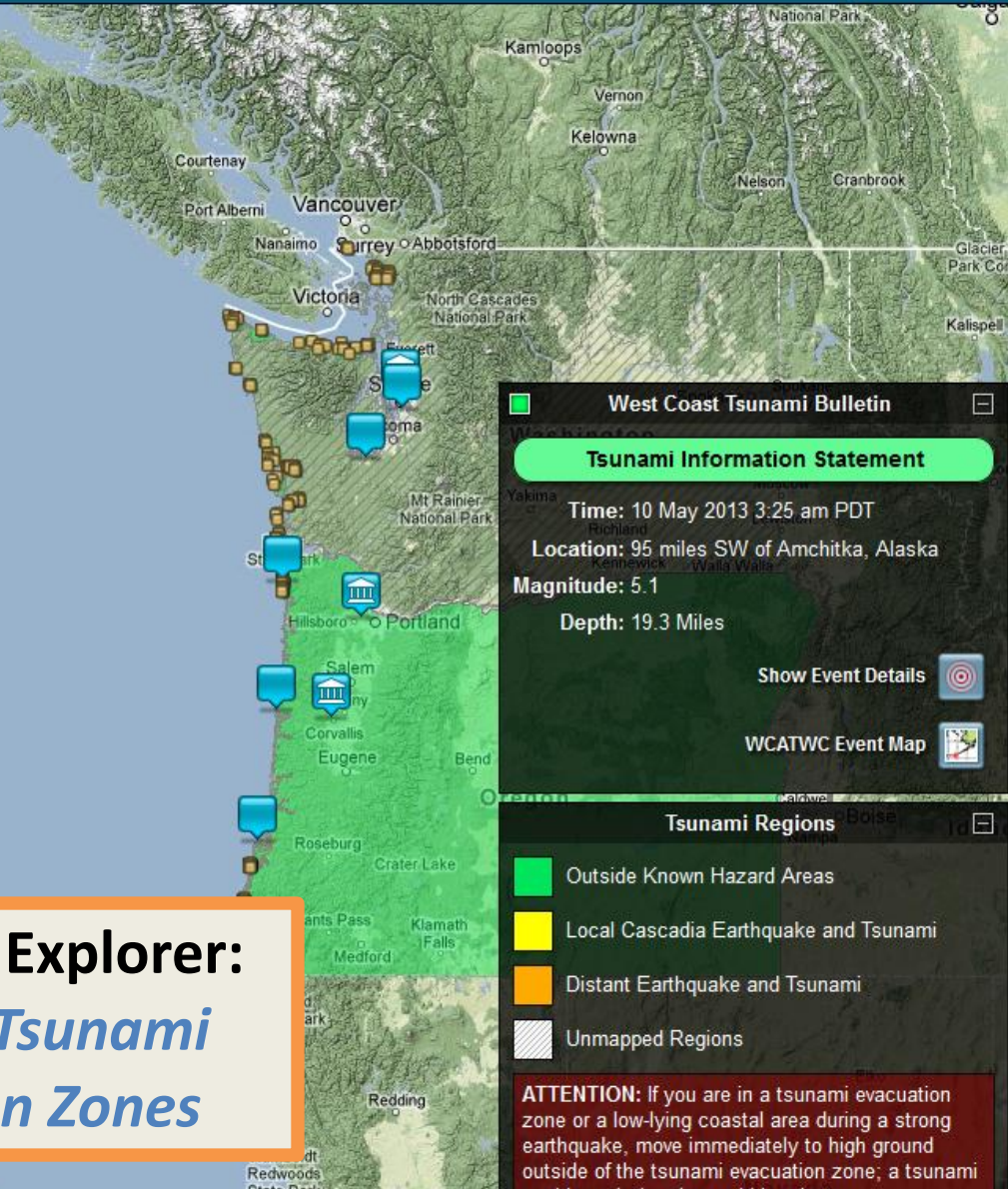
Your Places ☐

Edit Places Off

Place 1 📍

Common ☐

- APL-UW 📍
- Boeing 📍
- CMOP 📍
- DOGAMI 📍
- ODSL-SSNERR 📍
- OSU 📍
- WA-Ecology 📍



**West Coast Tsunami Bulletin**

**Tsunami Information Statement**

Time: 10 May 2013 3:25 am PDT

Location: 95 miles SW of Amchitka, Alaska

Magnitude: 5.1

Depth: 19.3 Miles

Show Event Details 🎯

WCATWC Event Map 🗺️

**Tsunami Regions**

- Outside Known Hazard Areas
- Local Cascadia Earthquake and Tsunami
- Distant Earthquake and Tsunami
- Unmapped Regions

**ATTENTION:** If you are in a tsunami evacuation zone or a low-lying coastal area during a strong earthquake, move immediately to high ground outside of the tsunami evacuation zone; a tsunami could reach the shore within minutes.

**NVS Data Explorer:**  
*For PNW Tsunami Evacuation Zones*

# PACIFIC NORTHWEST TSUNAMI EVACUATION ZONES

Map Brochures Warnings Planning Help

- Map
- Map Layers
- Regions
- Places
- Markers
- Info
- Legend

Markers

- Show All Hide All
- Airport 3
  - Assembly Area 114
  - Beach Access 34
  - Bridge 20
  - City Hall 6
  - Fire Department 45
  - Hospital 15
  - Law Enforcement 20
  - Lighthouse 1
  - School 8
  - School/Assembly Area 2
  - Tsunami Warning Siren 17

Lat: 45.8994 Lon: -123.9539

Hybrid



**Place 2**

Type: Generic

Address: 2nd Street, Cannon Beach, OR 97110, USA

Latitude: 45.8983 Longitude: -123.9599

**Tsunami Zone Information**

**Distant Earthquake and Tsunami Region**  
If a distant tsunami occurs, make your way to higher ground.

Edit

**Bridge: Bridge (101 over Ecola Creek)**

**DANGER**  
Earthquakes can damage or destroy bridges. When evacuating, avoid bridges if possible.

**Helps public identify routes, safe zones, and helps coastal managers visualize situation**

West Coast Tsunami Bulletin

Tsunami Regions



# NVS for Maritime Operations





*“The maritime community needs real time data and accurate forecasts of waves, wind, tides and currents.”*

– Capt. Dan Jordan, Columbia River bar pilot

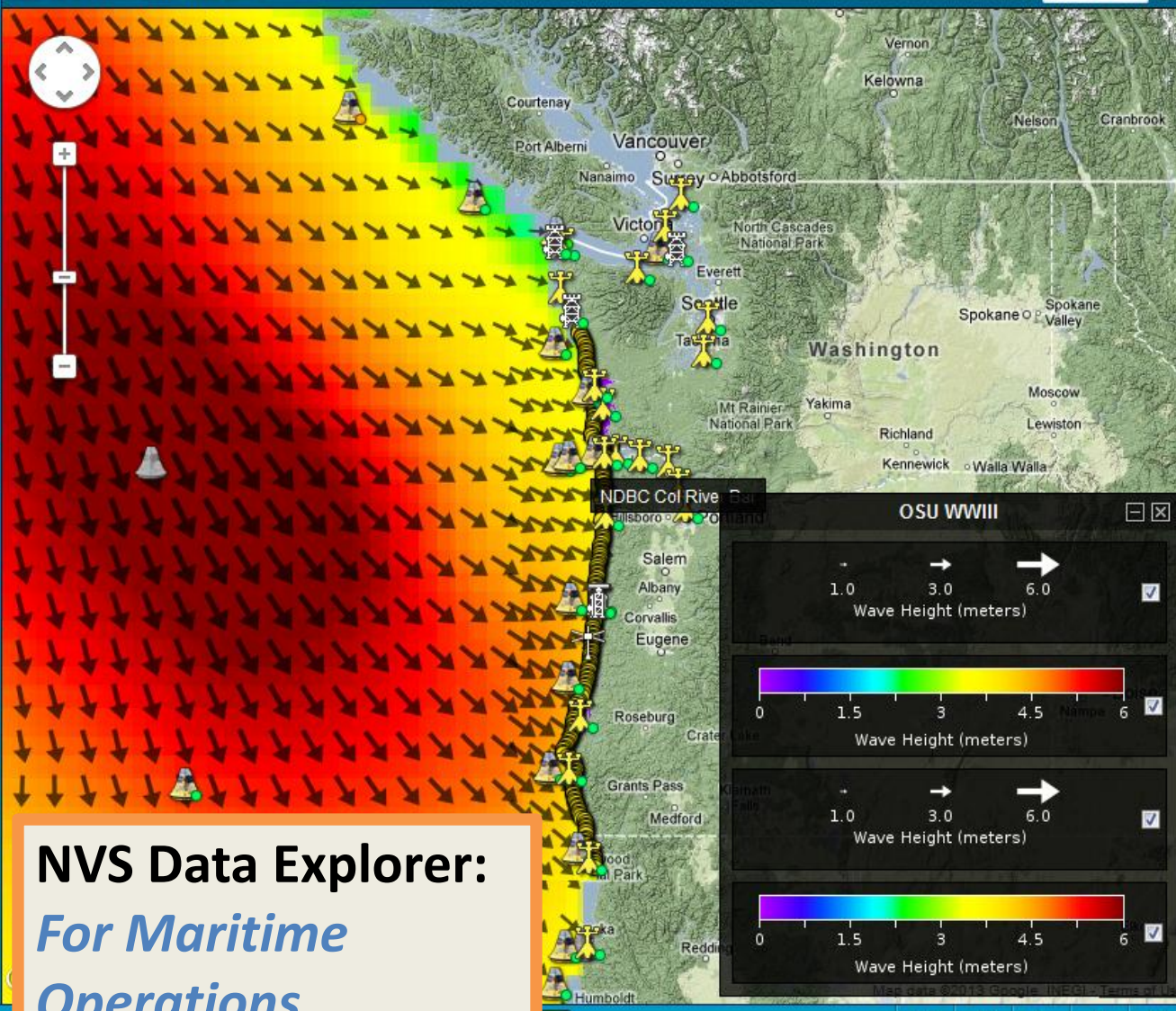
- Map
- Timeline
- Charts
- Map Layers
- Regions
- Fixed Platforms
- Remote Sensing
- Models
- Nodes
- Legend

Models × Lat: 48.9946 Lon: -130.6714 Terrain

Expand All Collapse All

Forecast

- N. Amer. Mesoscale (NAM)
- Air Temperature
- Barometric Pressure
- Relative Humidity
- Wind Speed
- OSU Wave Forecasts
- Dom. Wave Period (Composite)
- Waves (Composite)

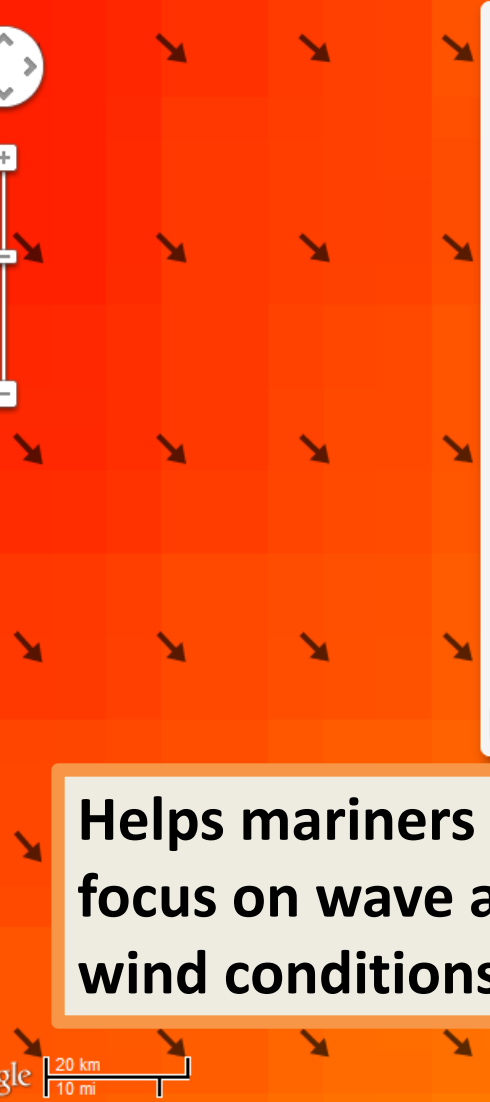


**NVS Data Explorer:**  
*For Maritime Operations*

- Map
- Timeline
- Charts
- Map Layers
- Regions
- Fixed Platforms
- Remote Sensing
- Models
- Nodes
- Legend

Lat: 43.8107 Lon: -125.6067

Terrain



**Station 46015 (LLNR 590) - Port Orford**

Observations Forecasts **Comparator** Details History

NAM OSU WWIII

OSU Wave Forecasts (0m) vs. NDBC Port Orford (0m)  
Wave Height

Legend:  
 - Observation (blue line)  
 - 19 May 2013 07:00 PDT (red line)  
 - 20 May 2013 07:00 PDT (red line)  
 - 21 May 2013 07:00 PDT (red line)

Dominant Wave Period  
 Wave Height  
 Wave Mean Direction

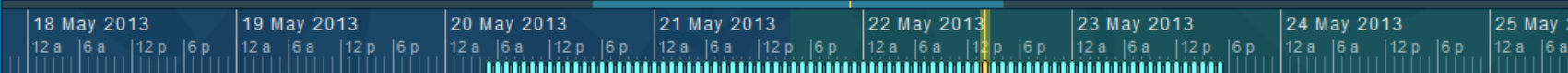
Link

**Helps mariners focus on wave and wind conditions**



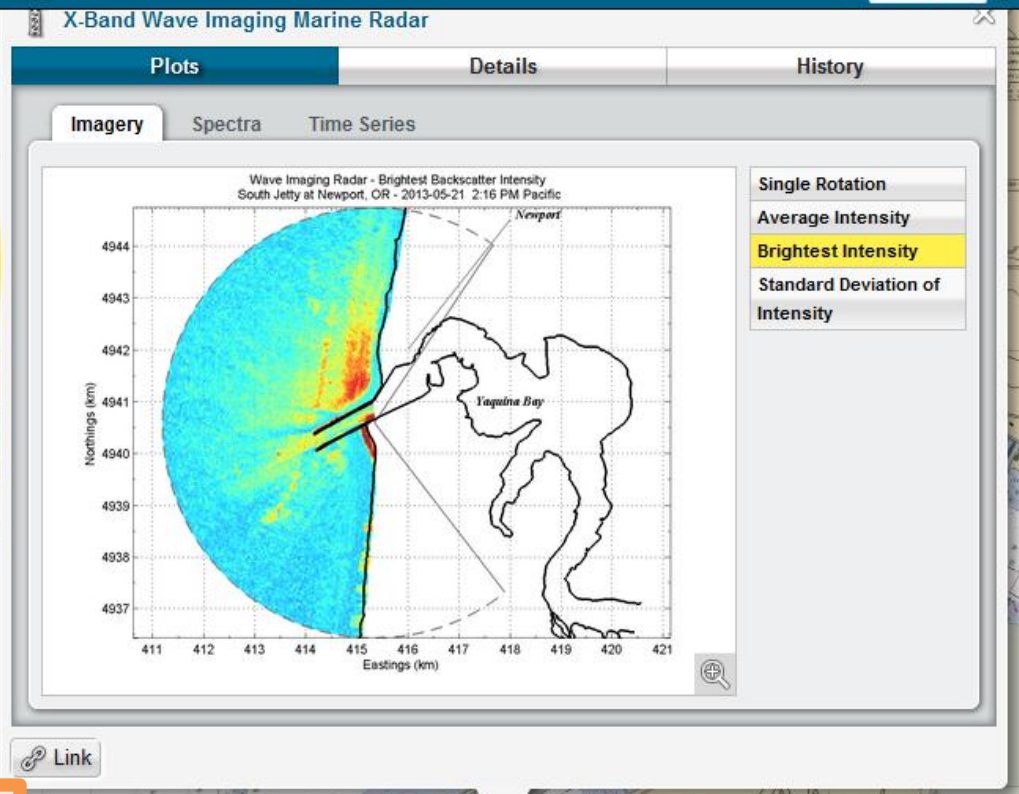
22 May 2013 2:00 pm PDT

OSU WWIII



- Map
- Timeline
- Charts
- Map Layers
- Regions
- Fixed Platforms
- Remote Sensing
- Models
- Nodes
- Legend

- Charts
- Seamless Nautical Charts
    - NOAA Nautical Charts
  - Washington Nautical Charts
  - Oregon Nautical Charts
    - Cape Blanco - Yaquina Bay
    - Cape Sebastian - Humbug Mt.
    - Coquille River (Entrance)
    - Coos Bay
    - Depoe Bay - Alsea Bay
    - Nehalem River
    - Port Orford - Cape Blanco
    - Pyramid Point - Cape Sebastian
    - Siuslaw River
    - Trinidad Head - Cape Blanco
    - Tillamook Bay
    - Umqua River - Entrance

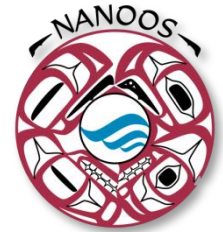


**Helps operators know conditions at dangerous bars**





# NVS for Shellfish Growers



## '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.*

- Map
- Timeline
- Regions
- Fixed Platforms
- Remote Sensing
- Forecasts
- Plots
- Legend

Plots

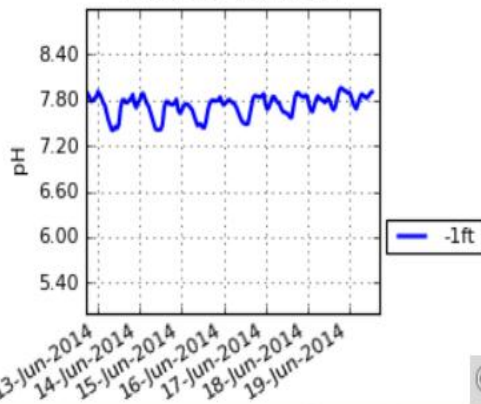
Lat: 50.4631

Lon: -119.7949

Oxygen Percent Sat.

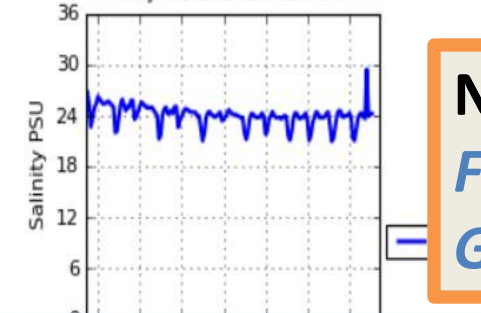
pH

PSI-PCSGA Bay Center - pH - 7 Days  
19 June 2014 17:13 PDT



Salinity

PSI-PCSGA Bay Center - Salinity - 7 Days  
19 June 2014 17:13 PDT



## PCSGA - Bay Center Port mooring, Willapa Bay

Observations

Details

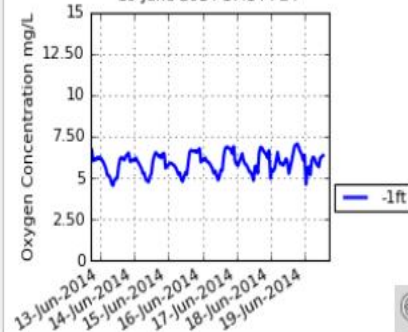
History

Credits

Provider: PSI

Data Updated: 19 Jun 2014 13:01 PDT

PSI-PCSGA Bay Center - Oxygen Conc. - 7 Days  
19 June 2014 17:14 PDT



Oxygen Conc. (-1ft):	6.3 mg/L
Oxygen Pct. Sat. (-1ft):	77.8 %
pH (-1ft):	7.9
Salinity (-1ft):	24.2 PSU
Water Temp. (-1ft):	64.8 °F

24 Hours 7 Days 30 Days 60 Days



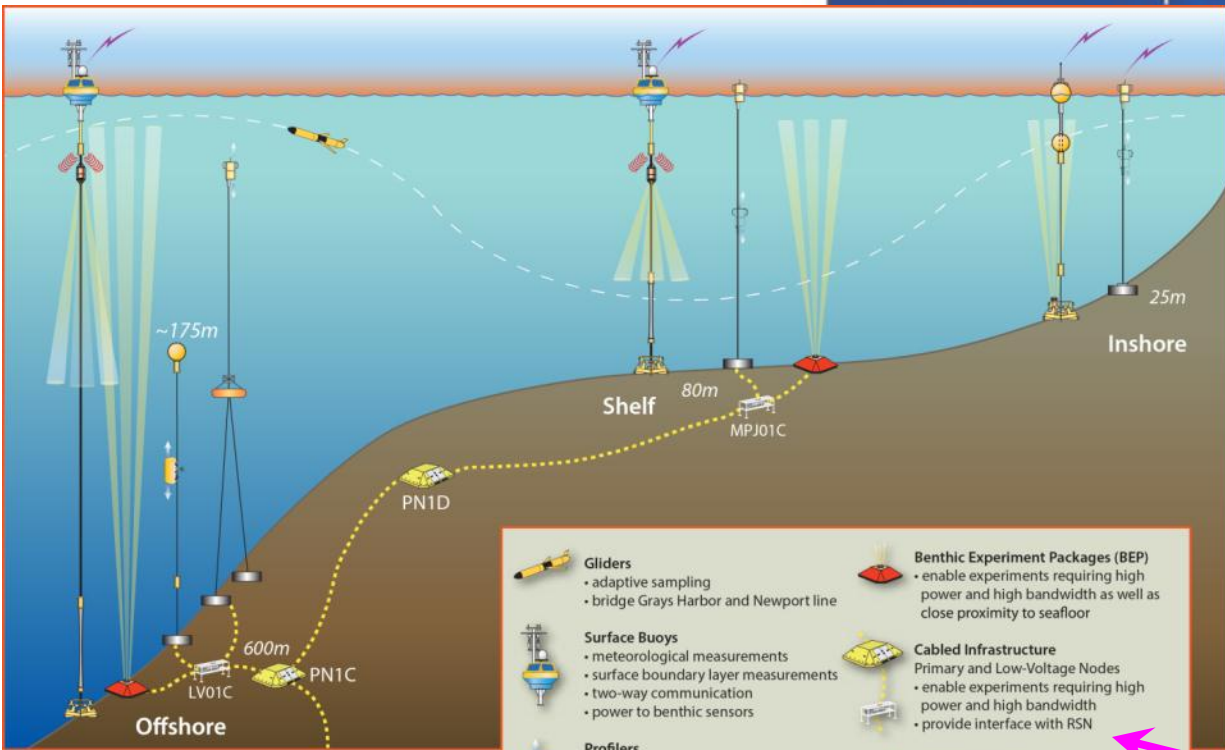
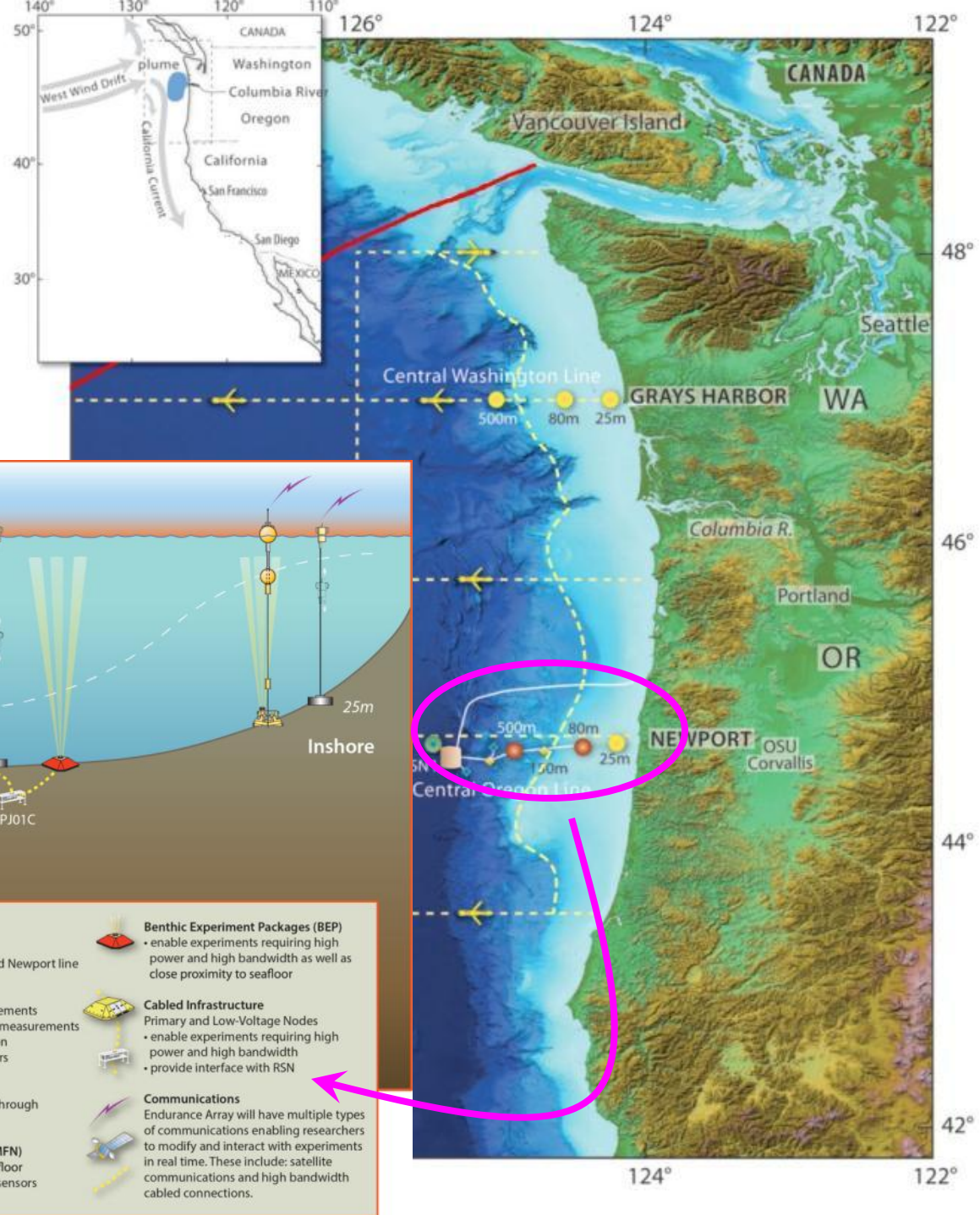
**NVS Data Explorer:**  
*For PNW Shellfish Growers*

# Ocean Observatories Initiative (OOI)

Installing observing arrays off the Pacific Northwest 2010-2015



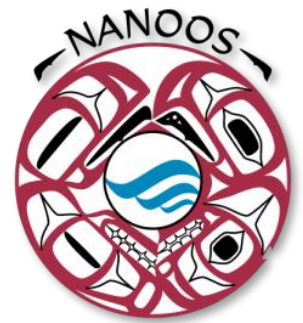
(operate for 25-30 years)



To PN1B of the RSN cable

<p><b>Glanders</b></p> <ul style="list-style-type: none"> <li>• adaptive sampling</li> <li>• bridge Grays Harbor and Newport line</li> </ul>	<p><b>Benthic Experiment Packages (BEP)</b></p> <ul style="list-style-type: none"> <li>• enable experiments requiring high power and high bandwidth as well as close proximity to seafloor</li> </ul>
<p><b>Surface Buoys</b></p> <ul style="list-style-type: none"> <li>• meteorological measurements</li> <li>• surface boundary layer measurements</li> <li>• two-way communication</li> <li>• power to benthic sensors</li> </ul>	<p><b>Cabled Infrastructure</b></p> <ul style="list-style-type: none"> <li>Primary and Low-Voltage Nodes</li> <li>• enable experiments requiring high power and high bandwidth</li> <li>• provide interface with RSN</li> </ul>
<p><b>Profilers</b></p> <ul style="list-style-type: none"> <li>• move sensors vertically through the water column</li> </ul>	<p><b>Communications</b></p> <ul style="list-style-type: none"> <li>Endurance Array will have multiple types of communications enabling researchers to modify and interact with experiments in real time. These include: satellite communications and high bandwidth cabled connections.</li> </ul>
<p><b>Multi-function Nodes (MFN)</b></p> <ul style="list-style-type: none"> <li>• anchor mooring to sea floor</li> <li>• platform for mounting sensors</li> </ul>	





# 10-year NANOOS Retrospective

- Takes energy, perseverance and dedication (and \$\$) to sustain observations
- Need to be aware of and work with users to tailor both observation/modeling system and data/product delivery
- Work on different ways to deliver data, analyses and products (science-friendly web page is likely not enough)
- Challenges
  - not much flexibility to do new things (e.g., biological variables, start new time series, etc.)
  - easy to overwhelm users
  - need to establish metrics to evaluate observational system