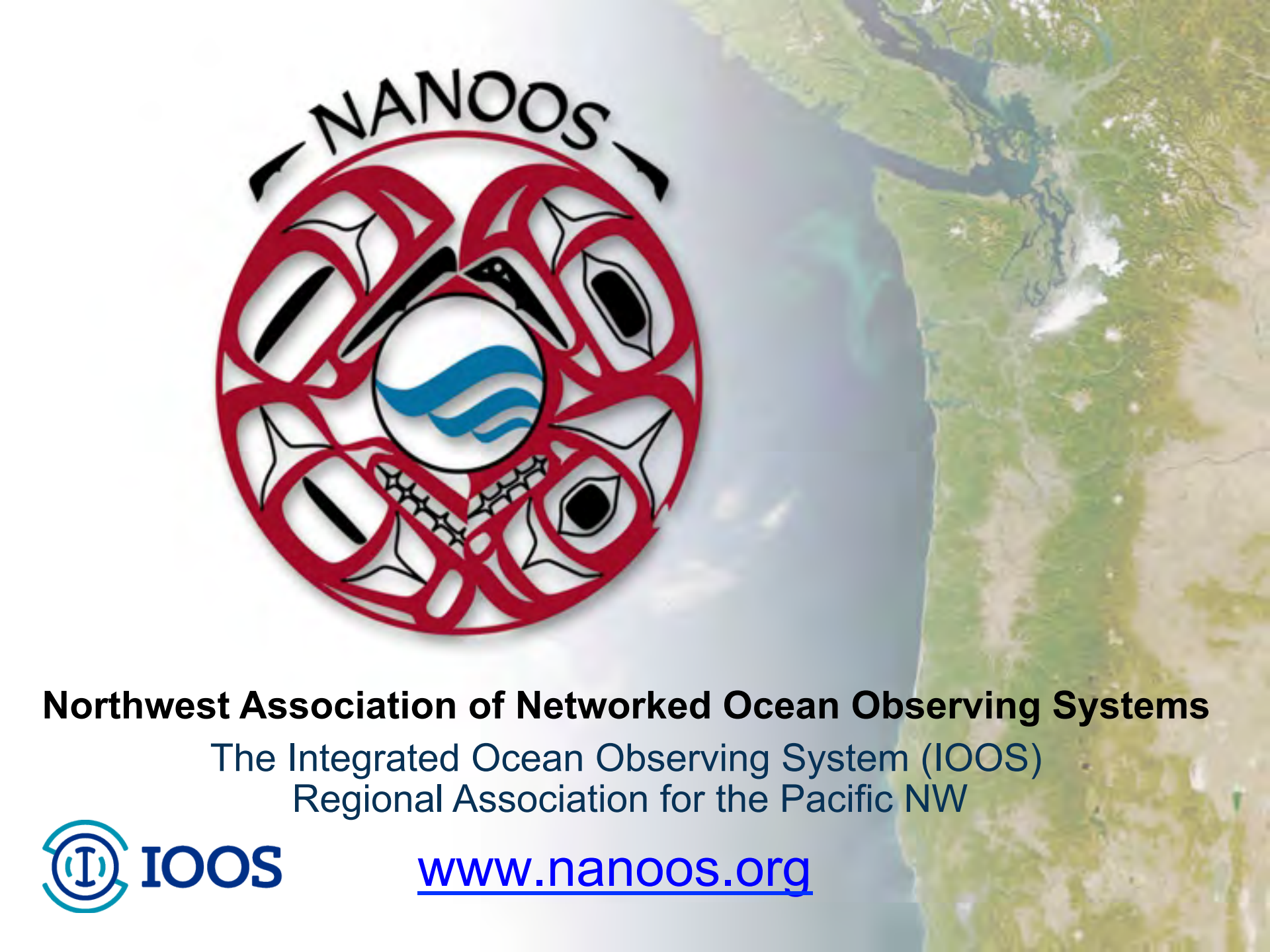


Northwest Association of Networked Ocean Observing Systems

The Integrated Ocean Observing System (IOOS)
Regional Association for the Pacific NW

IOOS

www.nanoos.org

U.S. Integrated Ocean Observing System (IOOS)

- ***IOOS Vision:***

A fully integrated ocean observing system to provide service to the Nation through:

- improved ecosystem and climate understanding;
- sustained living marine resources;
- improved public health and safety;
- reduced impacts of natural hazards and environmental changes; and
- enhanced support for marine commerce and transportation.

- ***IOOS Mission:***

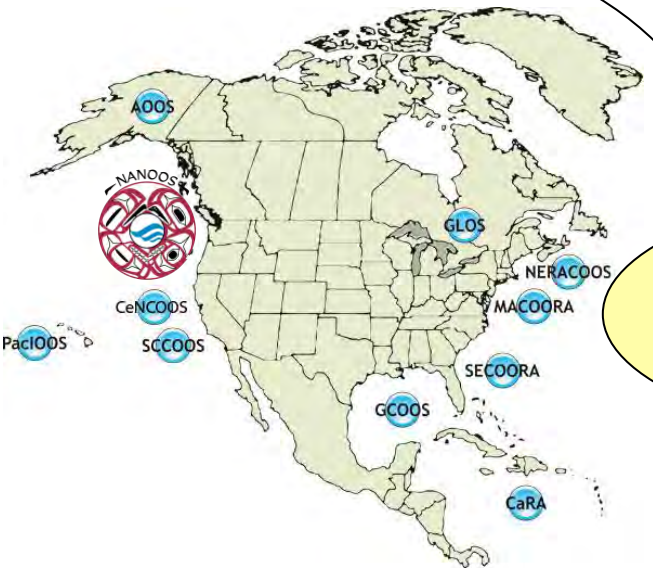
Lead the integration of ocean, coastal, and Great Lakes observing capabilities, in collaboration with Federal and non-Federal partners, to **maximize access to data** and **generation of information products**, ***inform decision making***, and ***promote economic, environmental, and social benefits to our Nation and the world***.

IOOS

IOOS
Integrated Ocean Observing System

CONSISTENT NATIONAL CAPABILITY

REGIONAL INFORMATION COORDINATION ENTITY
CERTIFIED
assure



Regional Associations

engage

Observations

Forecasts/Modeling

Data Management

User Products

Outreach

Leverage and Link

DIVERSE LOCAL STAKEHOLDERS

Started by defining the region, the users, their needs:

Coastal ocean:
Northern extent of California Current
Winds, topography, freshwater input, ENSO & other climate cycles

Major inland basins:
Puget Sound-Georgia Basin, Columbia River
Urban centers, nearshore development, climate variation

Coastal estuaries:
Willapa Bay, Grays Harbor, Yaquina Bay, Coos Bay, +20
Resource extraction, development, climate

Shorelines:
Rocky to sandy, dynamic: storms, erosion
Winds, development, climate

Major rivers:
Columbia River (~75% FW input to Pacific from US WC)
many rivers (e.g., Fraser, Skagit) via Strait Juan de Fuca
Dredging, water regulation, climate change

NANOOS Region User Groups:

Maritime: shipping, oil transport/spill remediation
Fisheries: salmon, shellfish, crab, groundfish, aquaculture
Environmental management: HABs, hypoxia
Shoreline: erosion, inundation
Hazards: Search and rescue, national security
Educators: formal, informal, research
Marine recreation: boating, surfing, diving

NANOOS Stakeholder Priorities

The NANOOS Governing Council selected five areas from results of numerous regional workshops as the highest regional priorities because "these issues represent those having the greatest impact on PNW citizenry and ecosystems and, we believe, are amenable to being substantively improved with the development of a PNW Regional Coastal Ocean Observing System:"

- **Maritime Operations**
- **Ecosystem Assessment**
- **Fisheries and Biodiversity**
- **Coastal Hazards**
- **Climate**

Effort:

- Observations
- Modeling/forecasts
- Data management and communication
- Tailored user-driven products
- Outreach, Engagement, Education

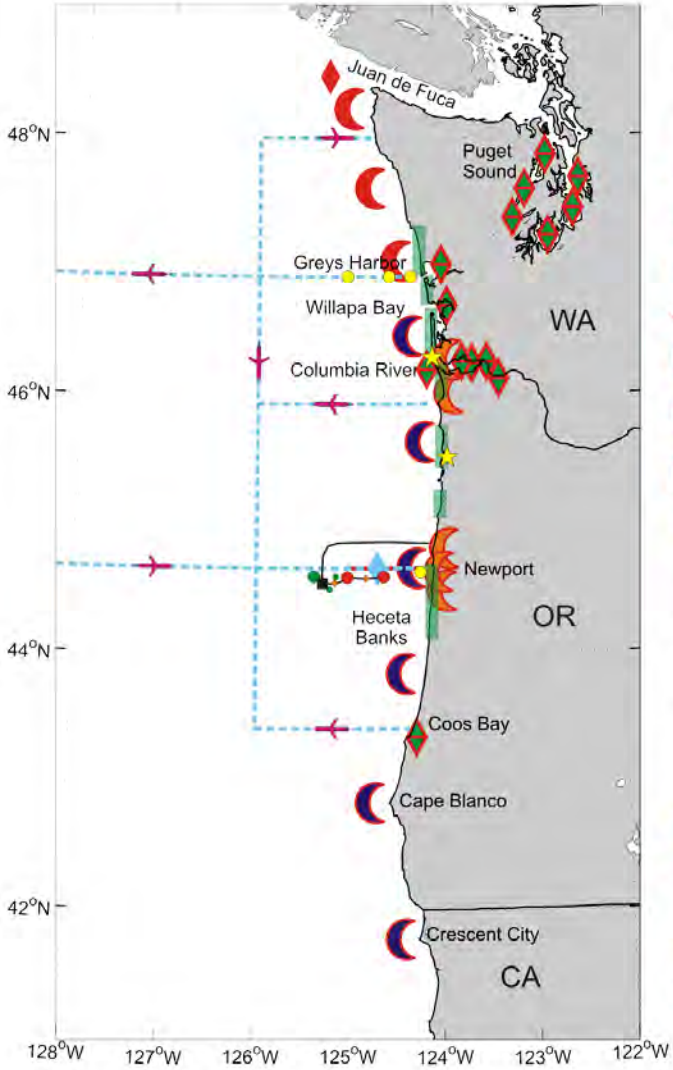
Strategy to develop a PNW Observing System

1. Integrate what we have *(observing assets, people, technologies)*

   = federal, tribal, state, local, academic, NGO, and industry

2. Be strategic regarding what we need, based on priorities

PNW Ocean Observing Systems Design



NANOOS RCOOS Enhancement Conceptual Design

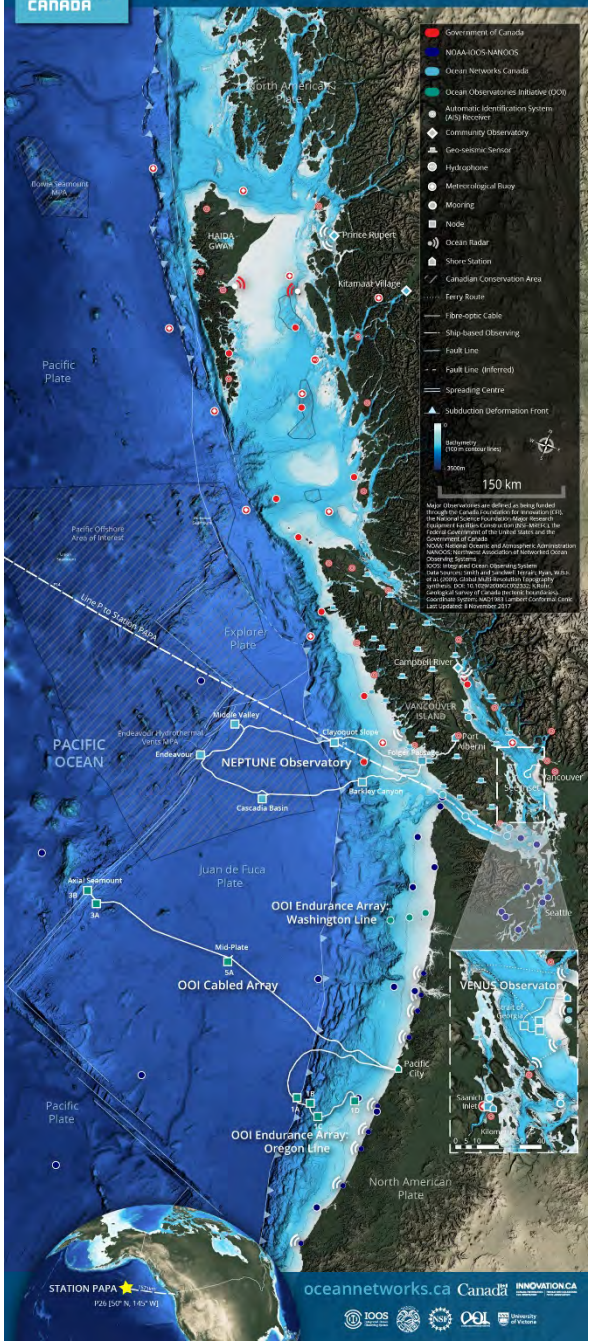
- Proposed new coastal buoy
- Existing coastal buoy to be sustained
- Existing estuarine buoys* to be sustained in partnership
- Existing glider track to be sustained
- Proposed new long-range HF site
- Existing long-range (180 km range) HF site to be sustained in partnership
- Existing standard-range (50 km range) HF site to be sustained in partnership
- Proposed new port wave radars
- Shoreline assessment to be sustained in partnership

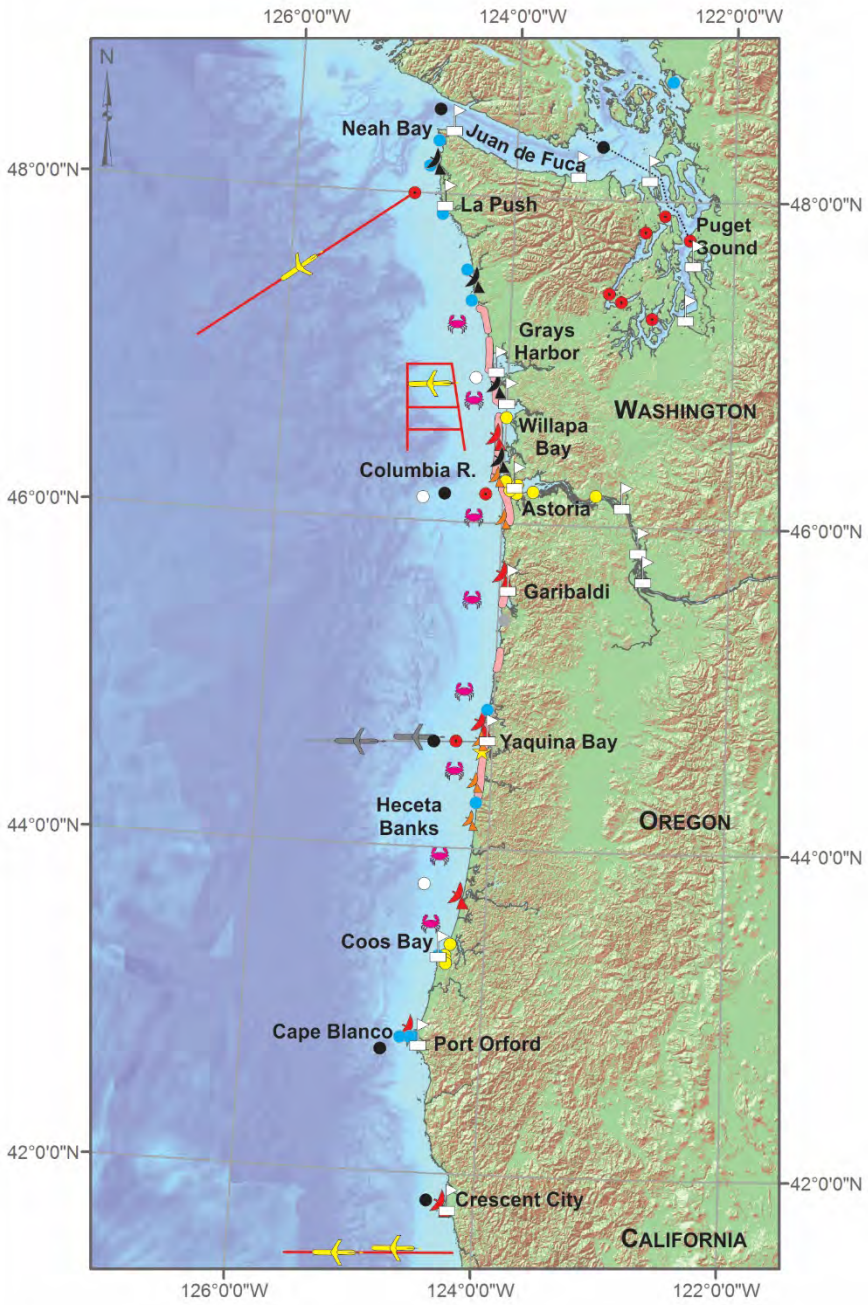
*estuarine buoys are more numerous than symbols

OOI Conceptual Design

- Coastal mooring
- Cabled mooring
- Deepwater column mooring
- High voltage primary node
- Medium voltage primary node
- RSN cable
- Glider track
- Glider

NORTHEAST PACIFIC MAJOR OBSERVING SYSTEMS





NANOOS RCOOS

Existing assets to be sustained in partnership:

- Existing ***coastal*** and ***estuarine*** buoys
- Existing fixed mooring ***estuarine*** buoys
- Existing glider tracks
- Existing long-range (180 km range) HF radar site
- Existing standard-range (50 km range) HF radar site
- Port X-band wave radar
- Beach and shoreline assessment. Includes multiple sites where nearshore bathymetry is being collected
- Puget Sound ferry box
- Existing glider tracks (OOI)

Federal assets:

- NDBC buoys
- CDIP buoys
- NOS Tide gauges

Proposed for new support to be sustained in partnership:

- Proposed long and short-range radar site
- Proposed support for estuarine and nearshore sites
- Crab pot moorings

NANOOS Objectives for FY2017

1) Maintain **NANOOS as the U.S. IOOS PNW Regional Associ**ation

2) Maintain **surface current and wave mappin**g capability.

3) Sustain **existing buoys and gliders in the PNW coastal ocean**, in coordination with national programs.

4) Maintain **observation capabilities in PNW estuaries**, in coordination with local and regional programs.

5) Maintain **core elements of beach and shoreline observing** programs.

6) Provide sustained support to a **community of complementary regional numerical models**.

7) Maintain NANOOS' Data Management and Communications (DMAC) system for **routine operational distribution of data and information**.

8) Continue to **deliver existing and, to the extent possible, create innovative and transformative user-defined products and services** for PNW stakeholders.

9) Sustain **NANOOS outreach, engagement, and education**.


NANOOS
Northwest Association of Networked Ocean Observing Systems
IOOS
Apps
Settings
Guide
NVS Data Explorer
Log In
More
NANOOS
Map
Asset List
Lat
Lon
Terrain Map
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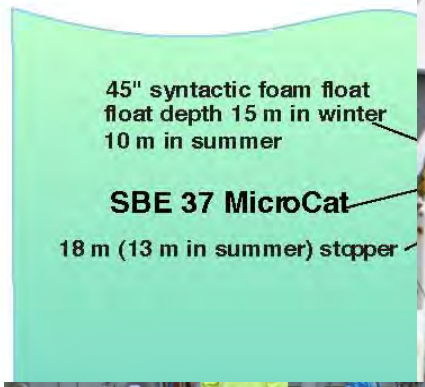
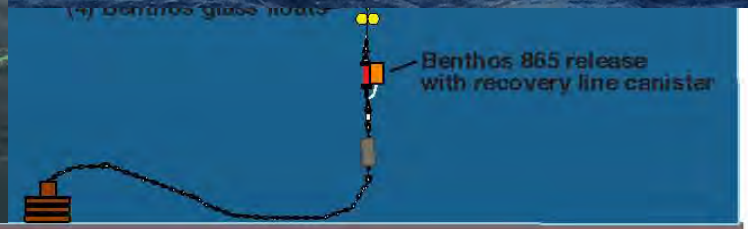
Flathead National Forest
Wenatchee National Forest
Spokane
WASHINGTON
Olympia
Yakima
Missoula
Nez Perce - Clearwater National Forests
Kennewick
Portland
Salem
Beaverhead-
Payette National Forest
Salmon - Challis National Forest
Sawtooth National Forest
Eugene
Bend
OREGON
Boise
Nampa
IDAHO
Twin Falls
Medford
Shasta-Trinity National Forest
Google
Map data ©2018 Google, INEGI
100 km
Terms of Use
7
May
2018
9:49 am PDT

"A multi-platform high-resolution coastal ocean observing sensor array for researching Washington coastal waters and ecosystem response to climate change."

Funded by Murdock Charitable Trust & UW now sustained as part of NANOOS





NANOOS: UW-NOAA OAP

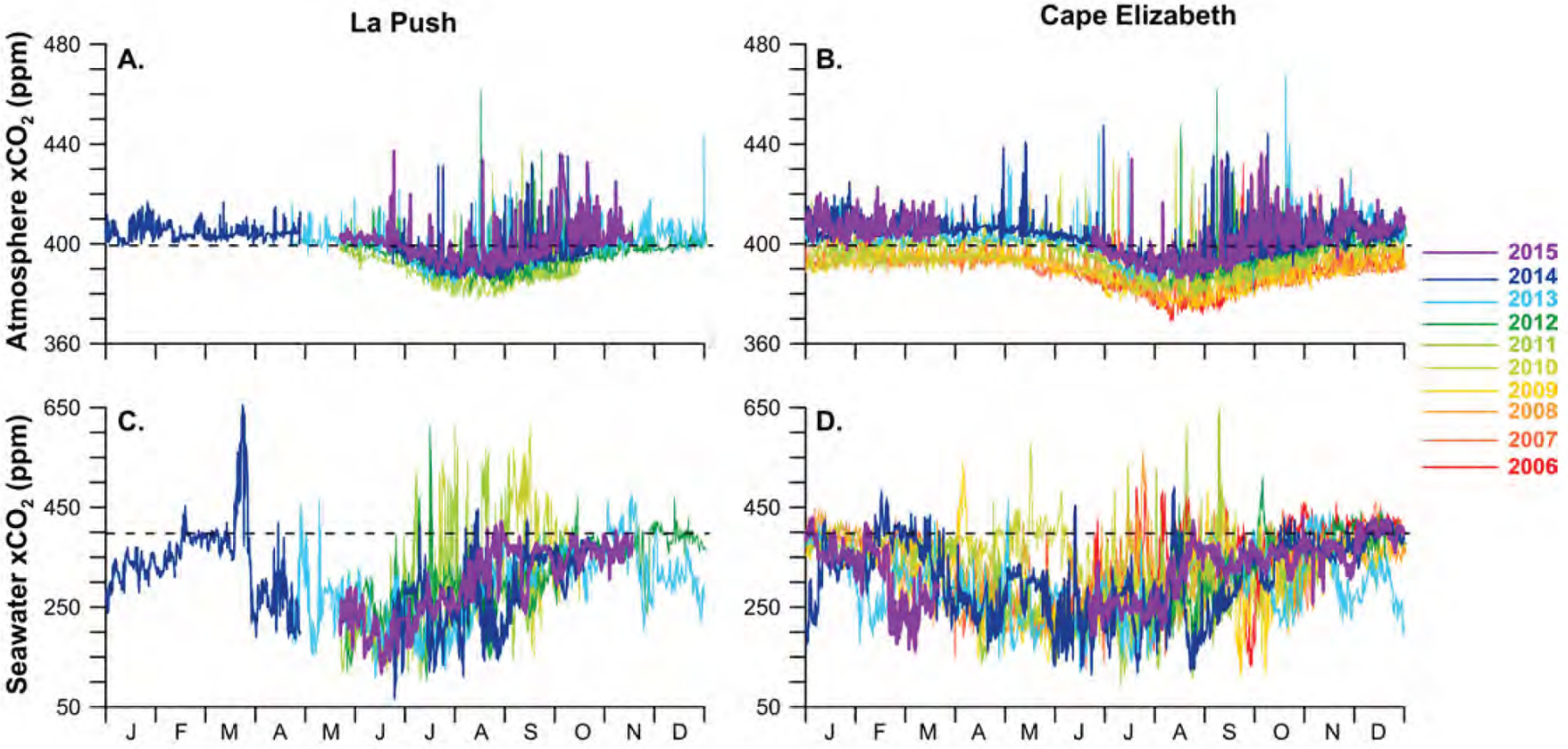
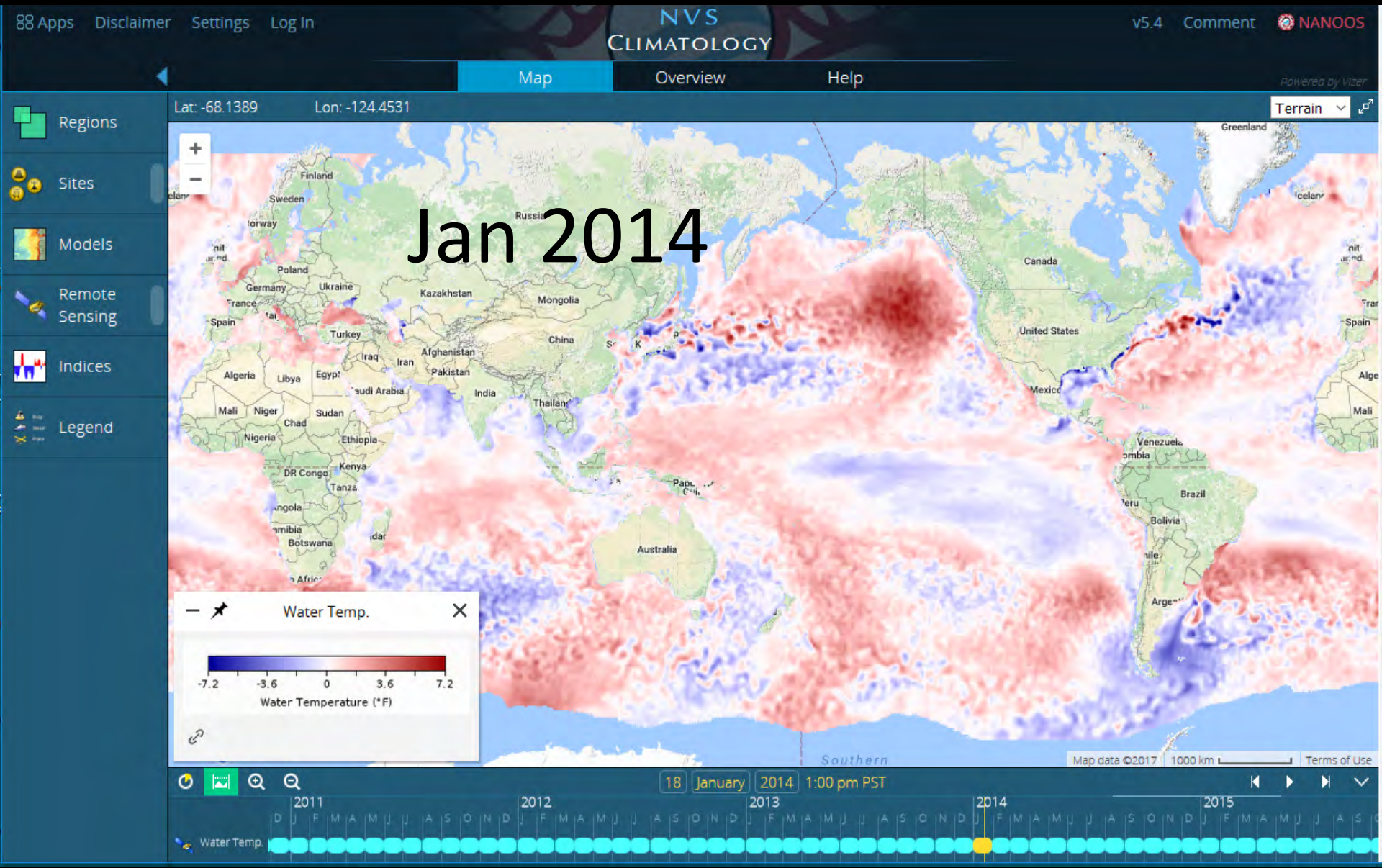


Figure 9. The mole fraction of carbon dioxide (xCO_2) in air at 1.5 m above seawater and in surface seawater at 0.5 m depth on the surface Chá Bă mooring off La Push, WA, and on the NDBC mooring 46041 off Cape Elizabeth, WA. Globally averaged marine surface air 2015 annual mean xCO_2 value of 399 ppm is indicated with a dashed line in each panel. Typical uncertainty associated with quality-controlled measurements from these systems is < 2 ppm for the range 100–600 ppm.

Simone Alin, 2016


Apps
Disclaimer
Settings
Log In
NVS
CLIMATOLOGY
v5.4
Comment
NANOOS
Map
Overview
Help
Powered by Vizer
Regions
Sites
Models
Remote Sensing
Indices
Legend
Lat: -68.1389
Lon: -124.4531
Terrain
Jan 2014
Water Temp.
-7.2
-3.6
0
3.6
7.2
Water Temperature (°F)
Map data ©2017
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2014
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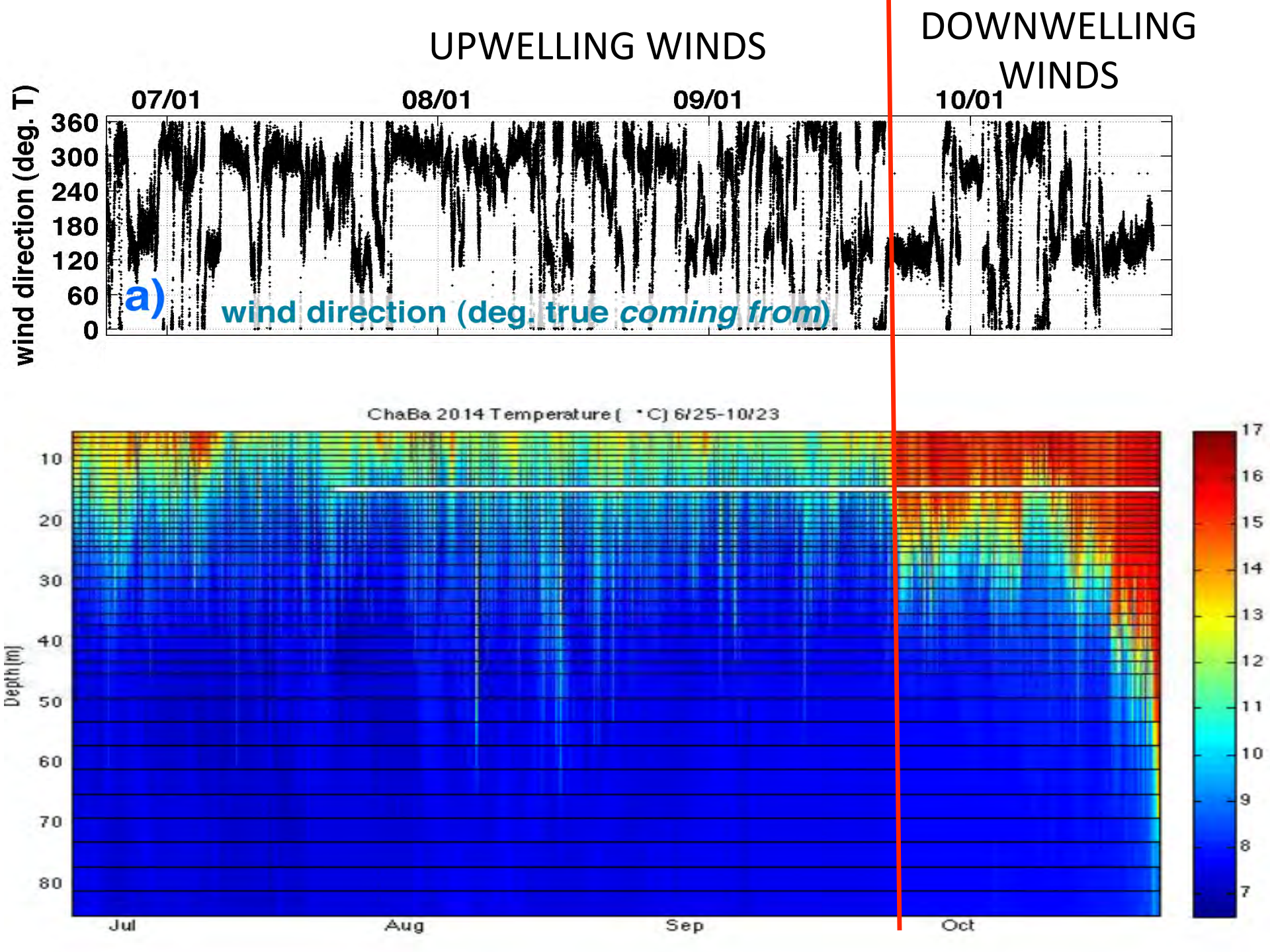
2011
2012
2013
2014
2015
Water Temp.


UPWELLING WINDS
DOWNWELLING WINDS
07/01
08/01
09/01
10/01
wind direction (deg. T)
360
300
240
180
120
60
0
a)
wind direction (deg. true coming from)
ChaBa 2014 Temperature (°C) 6/25-10/23
Depth (m)
10
20
30
40
50
60
70
80
Jul
Aug
Sep
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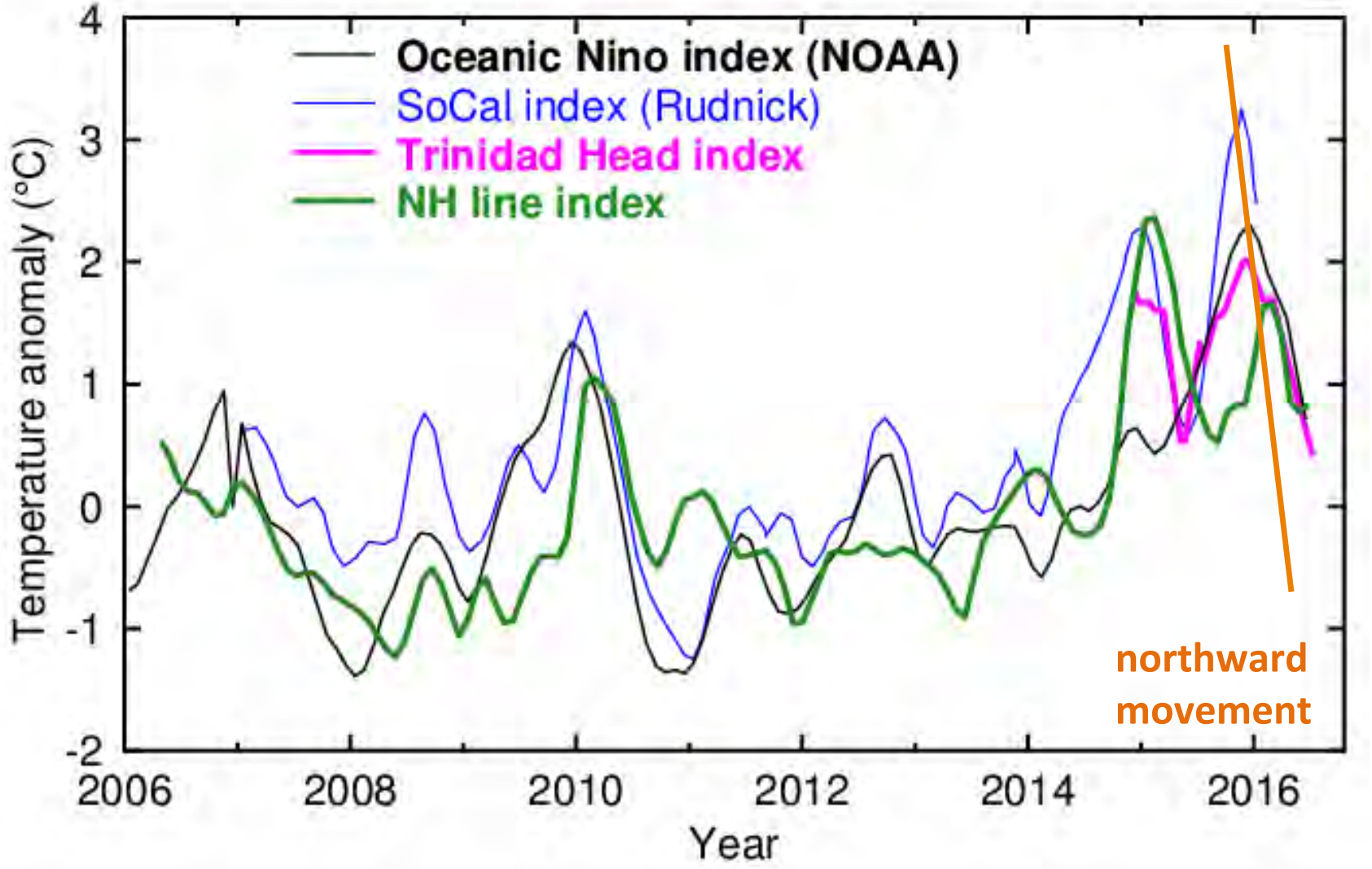
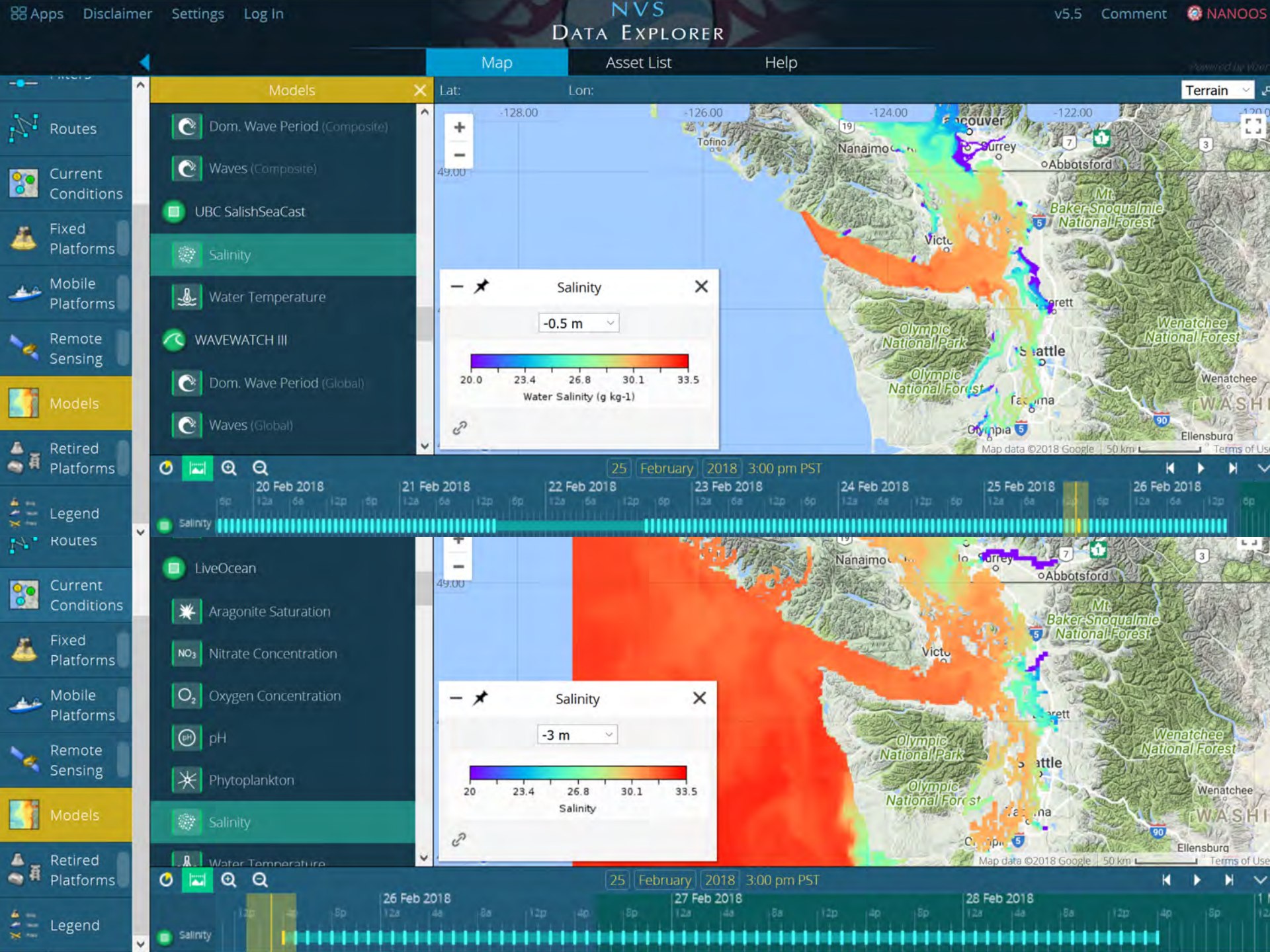
17
16
15
14
13
12
11
10
9
8
7

50-m temperature anomaly averaged within 200 km of the coast (ala Rudnick)



Barth, Shearman, Erofeev, Pierce, Bjorkstedt


Apps
Disclaimer
Settings
Log In
NVS
DATA EXPLORER
v5.5
Comment
NANOOS
Map
Asset List
Help
Routes
Current Conditions
Fixed Platforms
Mobile Platforms
Remote Sensing
Models
Retired Platforms
Legend
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Waves (Composite)
UBC SalishSeaCast
Salinity
Water Temperature
WAVEWATCH III
Dom. Wave Period (Global)
Waves (Global)
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Lon:
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-128.00
-126.00
-124.00
-122.00
49.00
Tofino
Nanaimo
Surrey
Abbotsford
Mt. Baker-Snoqualmie National Forest
Olympic National Park
Olympic National Forest
Wenatchee National Forest
Wenatchee
Ellensburg
Olympia
Salinity
-0.5 m
20.0
23.4
26.8
30.1
33.5
Water Salinity (g kg-1)
Map data ©2018 Google
50 km
Terms of Use
25 February 2018 3:00 pm PST
20 Feb 2018
21 Feb 2018
22 Feb 2018
23 Feb 2018
24 Feb 2018
25 Feb 2018
26 Feb 2018
Salinity
LiveOcean
Aragonite Saturation
Nitrate Concentration
Oxygen Concentration
pH
Phytoplankton
Salinity
Water Temperature
-3 m
20
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30.1
33.5
Salinity
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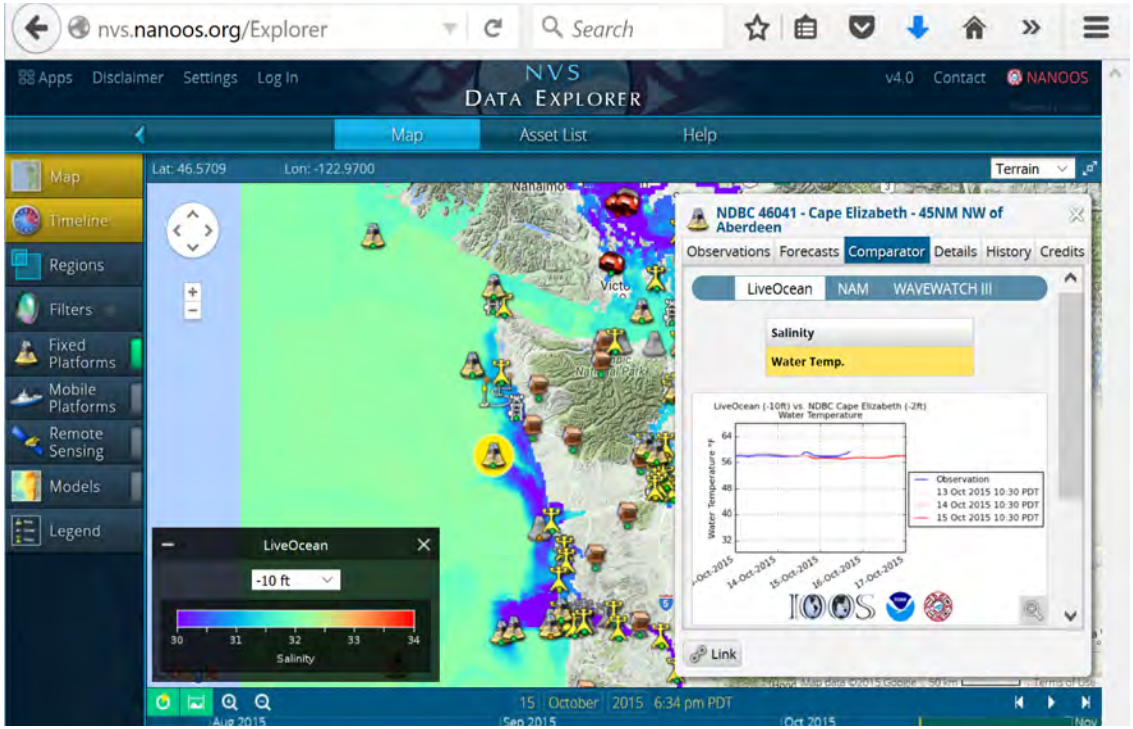
28 Feb 2018
Salinity
Legend

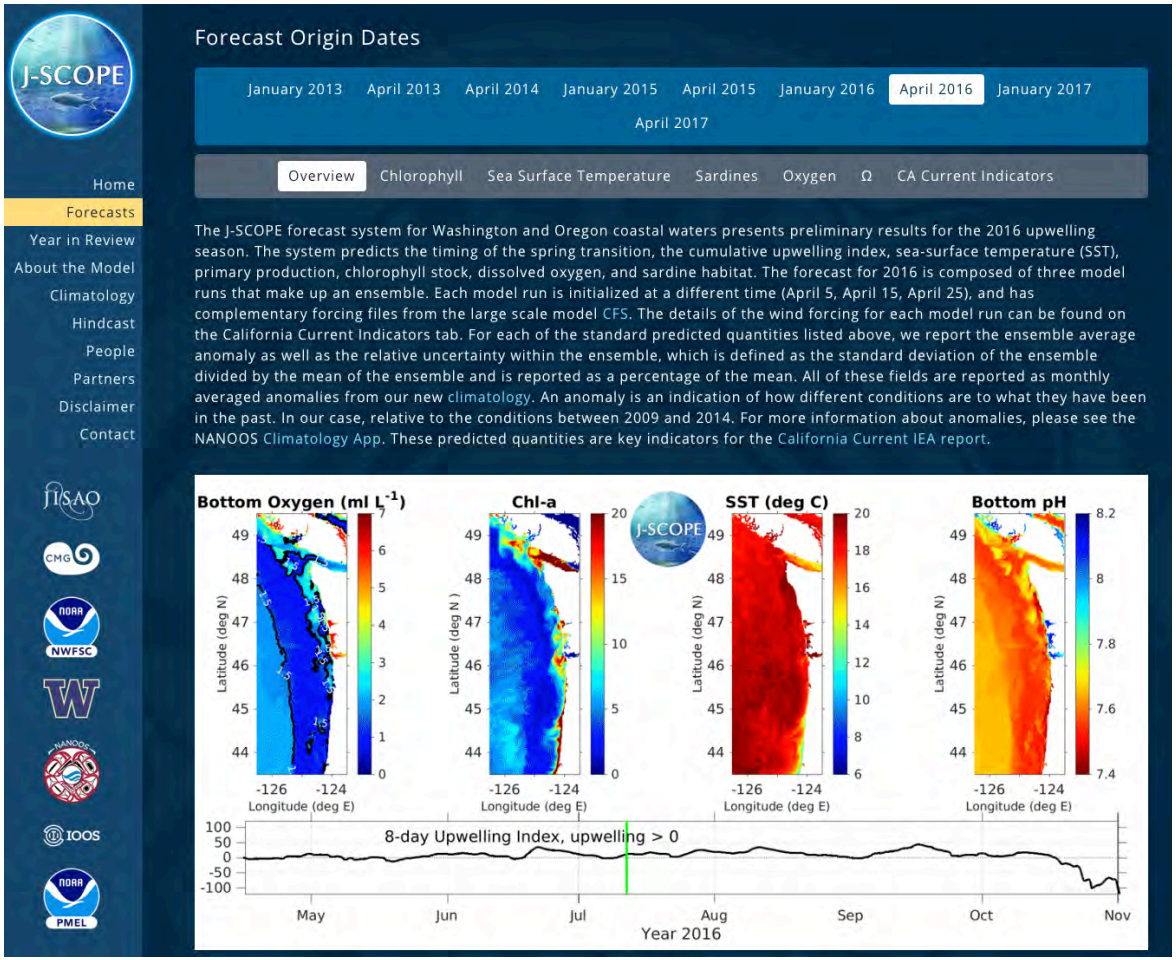
Three-day forecasts to inform shellfish industry and management



- The ocean acidification community is developing tools to inform managers, industry, policymakers, and the public.
- The LiveOcean "event-scale" model forecasts ocean conditions including temperature, salinity, and chemistry a few days ahead of time (*map colors show modeled surface temperature*). → PI: Parker MacCready, UW
- NANOOS allows stakeholders (e.g., shellfish growers) to compare current (measured) and forecasted temperature, salinity, and biogeochemistry (oxygen, nitrate, *p*H, Ω_{arag}).

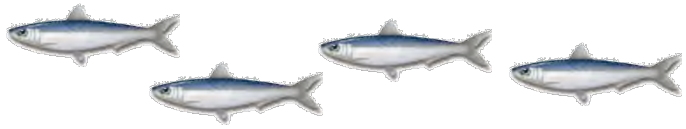
http://nvs.nanoos.org/ShellfishGrowers

Seasonal forecasts to inform shellfish industry and management



- J-SCOPE seasonal forecast model predicts ocean temperature, salinity, and chemistry six to nine months in advance.
- We are working with tribal and state fishery managers to develop tools relevant to specific fisheries, such as forecasting "optimal windows" for oyster recruitment in Willapa Bay and tools to understand OA impacts on Dungeness crab at various life stages.

→ PI: Samantha Siedlecki, UConn



http://www.nanoos.org/products/j-scope/home.php

IOOS | Integrated Ocean Observing System

Sign up for our Newsletter

NANOOS

Welcome to NANOOS, the Northwest Association of Networked Ocean Observing Systems. NANOOS is part of IOOS and provides information and products related to weather and ocean data.

Home
About

NANOOS Visualization System
NVS provides easy access to observations, forecasts, data, and visualizations.
Demo

NVS for specific user groups with targeted subsets of the data

Apps | Disclaimer | Settings | Log In

NVS

Contact

(All NANOOS assets and data streams)

Data Explorer

Tsunami Evacuation Zones

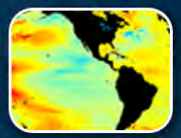
Boaters

Tuna Fishers

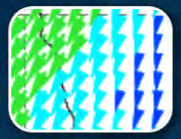
Shellfish Growers

Beach and Shoreline Changes

Maritime Operations



Climatology



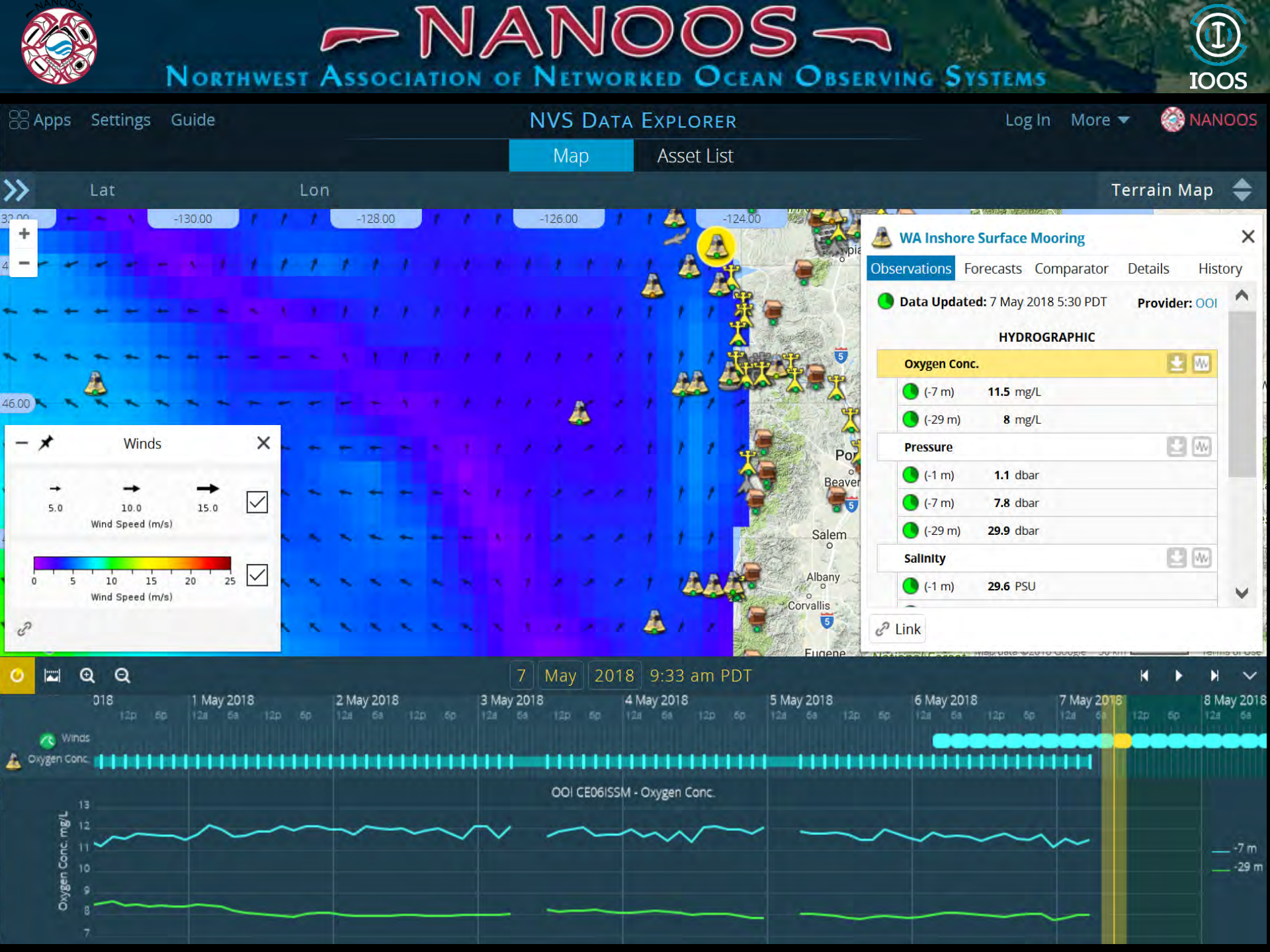
High Frequency Radar

Cruises

Gliders

Help

IOOS


NANOOS
Northwest Association of Networked Ocean Observing Systems
IOOS
Apps
Settings
Guide
NVS Data Explorer
Log In
More
NANOOS
Map
Asset List
Lat
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25
Wind Speed (m/s)
WA Inshore Surface Mooring
Observations
Forecasts
Comparator
Details
History
Data Updated: 7 May 2018 5:30 PDT
Provider: OOI
HYDROGRAPHIC
Oxygen Conc.
(-7 m) 11.5 mg/L
(-29 m) 8 mg/L
Pressure
(-1 m) 1.1 dbar
(-7 m) 7.8 dbar
(-29 m) 29.9 dbar
Salinity
(-1 m) 29.6 PSU
Link
Beaver
Salem
Albany
Corvallis
Eugene
7 May 2018 9:33 am PDT
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4 May 2018
5 May 2018
6 May 2018
7 May 2018
8 May 2018
Winds
Oxygen Conc.
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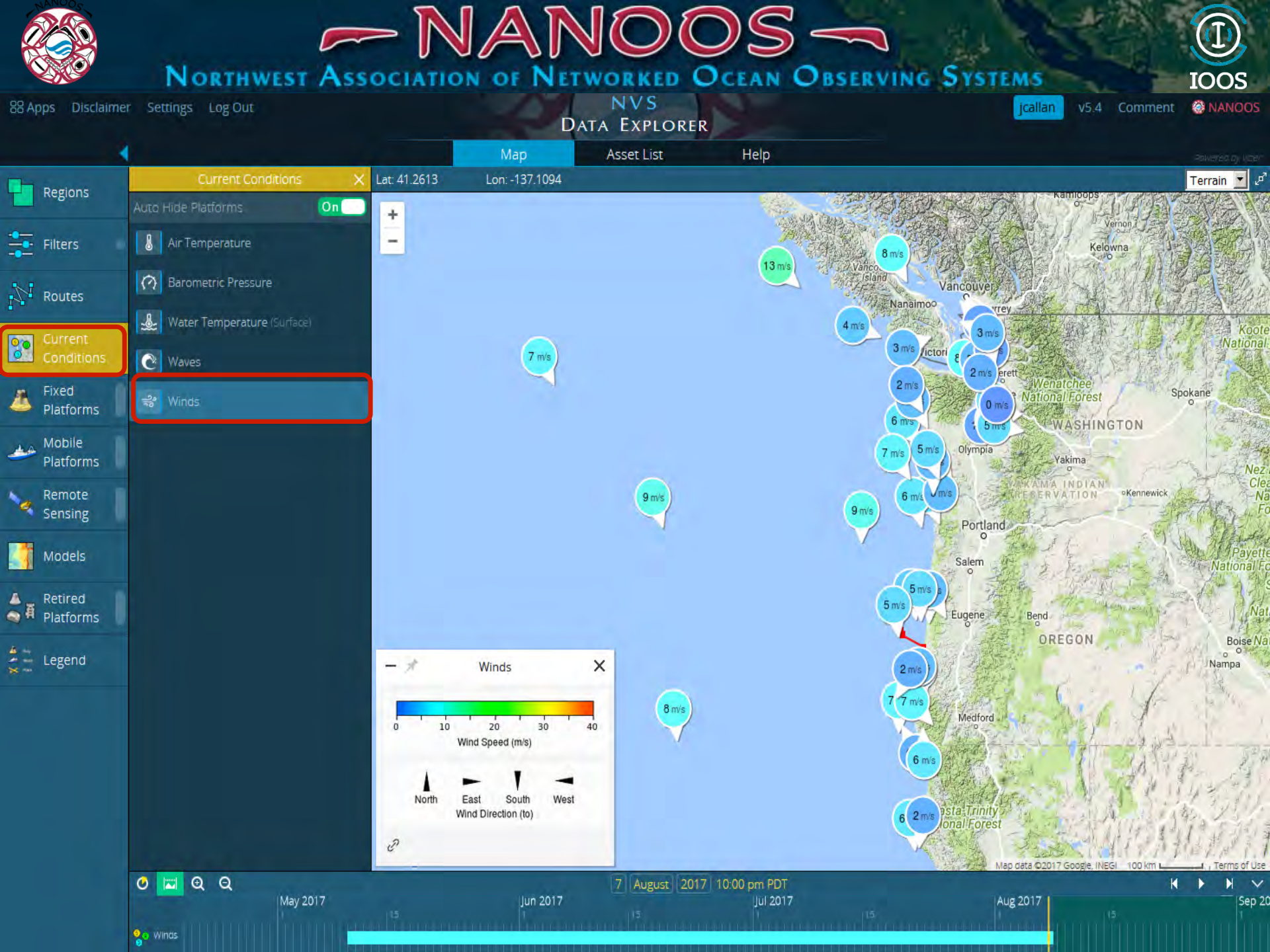
Oxygen Conc. mg/L
-7 m
-29 m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IOOS
Apps
Disclaimer
Settings
Log Out
NVS
Data Explorer
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Comment
NANOOS
Map
Asset List
Help
Regions
Filters
Routes
Current Conditions
Fixed Platforms
Mobile Platforms
Remote Sensing
Models
Retired Platforms
Legend
Current Conditions
Auto Hide Platforms
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Barometric Pressure
Water Temperature (Surface)
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Terrain
Winds
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30
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Wind Speed (m/s)
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West
Wind Direction (to)
Vancouver
Victoria
Nanaimo
Kelowna
Vernon
Kamloops
Spokane
Wenatchee National Forest
WASHINGTON
Olympia
Yakima
Kennewick
Portland
Salem
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Bend
OREGON
Medford
Boise
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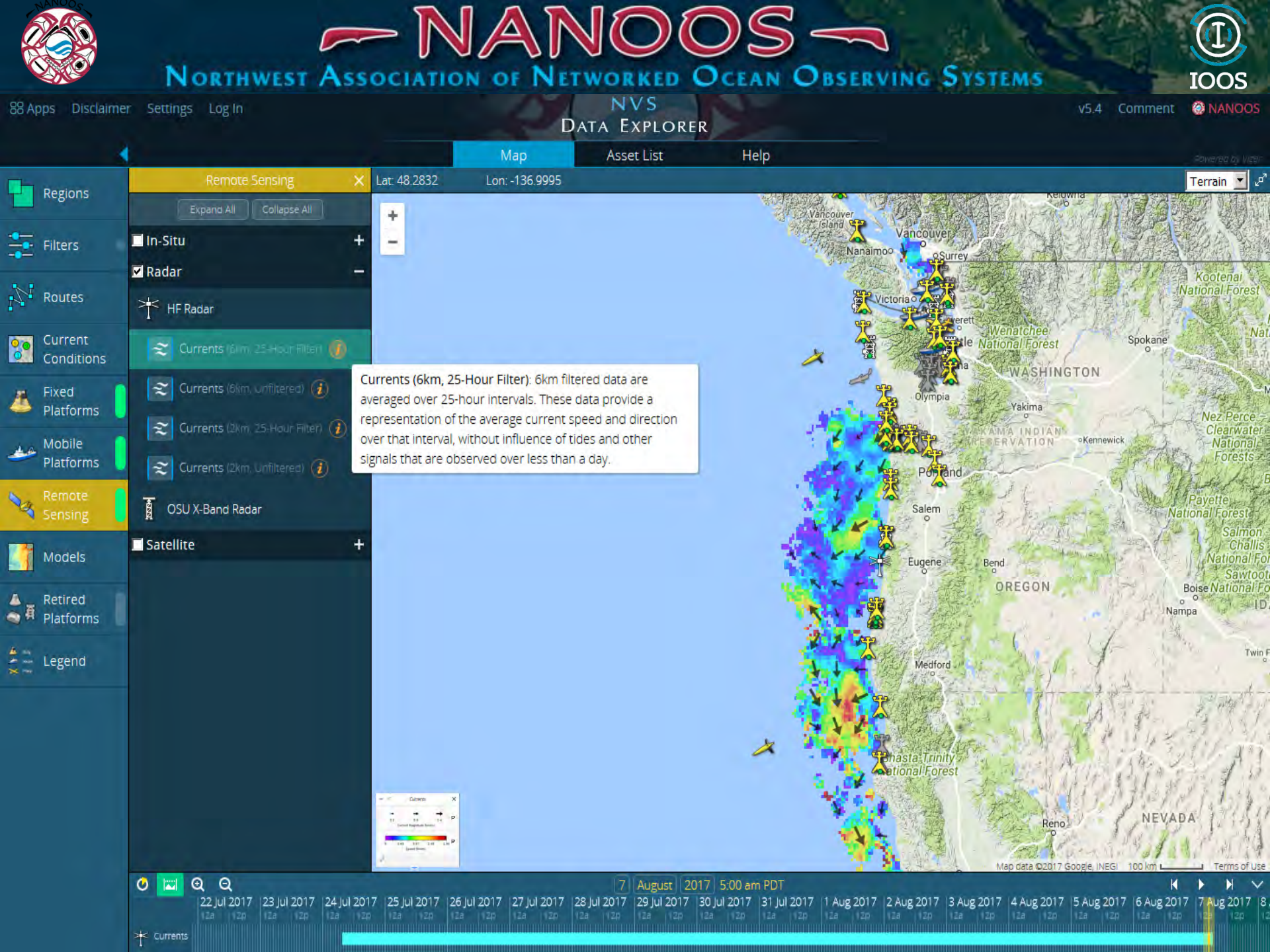
May 2017
Jun 2017
Jul 2017
Aug 2017
Winds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Northwest Association of Networked Ocean Observing Systems
IOOS
Apps
Disclaimer
Settings
Log In
NVS
Data Explorer
v5.4
Comment
NANOOS
Map
Asset List
Help
Regions
Filters
Routes
Current Conditions
Fixed Platforms
Mobile Platforms
Remote Sensing
Models
Retired Platforms
Legend
Remote Sensing
Expand All
Collapse All
In-Situ
Radar
HF Radar
Currents (6km, 25-Hour Filter)
Currents (6km, Unfiltered)
Currents (2km, 25-Hour Filter)
Currents (2km, Unfiltered)
OSU X-Band Radar
Satellite
Currents (6km, 25-Hour Filter): 6km filtered data are averaged over 25-hour intervals. These data provide a representation of the average current speed and direction over that interval, without influence of tides and other signals that are observed over less than a day.
Lat: 48.2832
Lon: -136.9995
Terrain
Vancouver Island
Vancouver
Nanaimo
Surrey
Victoria
Wenatchee National Forest
Spokane
WASHINGTON
Olympia
Yakima
Kennewick
Portland
Salem
Eugene
Bend
OREGON
Medford
Nampa
Reno
NEVADA
Kootenai National Forest
Nez Perce Clearwater National Forests
Payette National Forest
Boise National Forest
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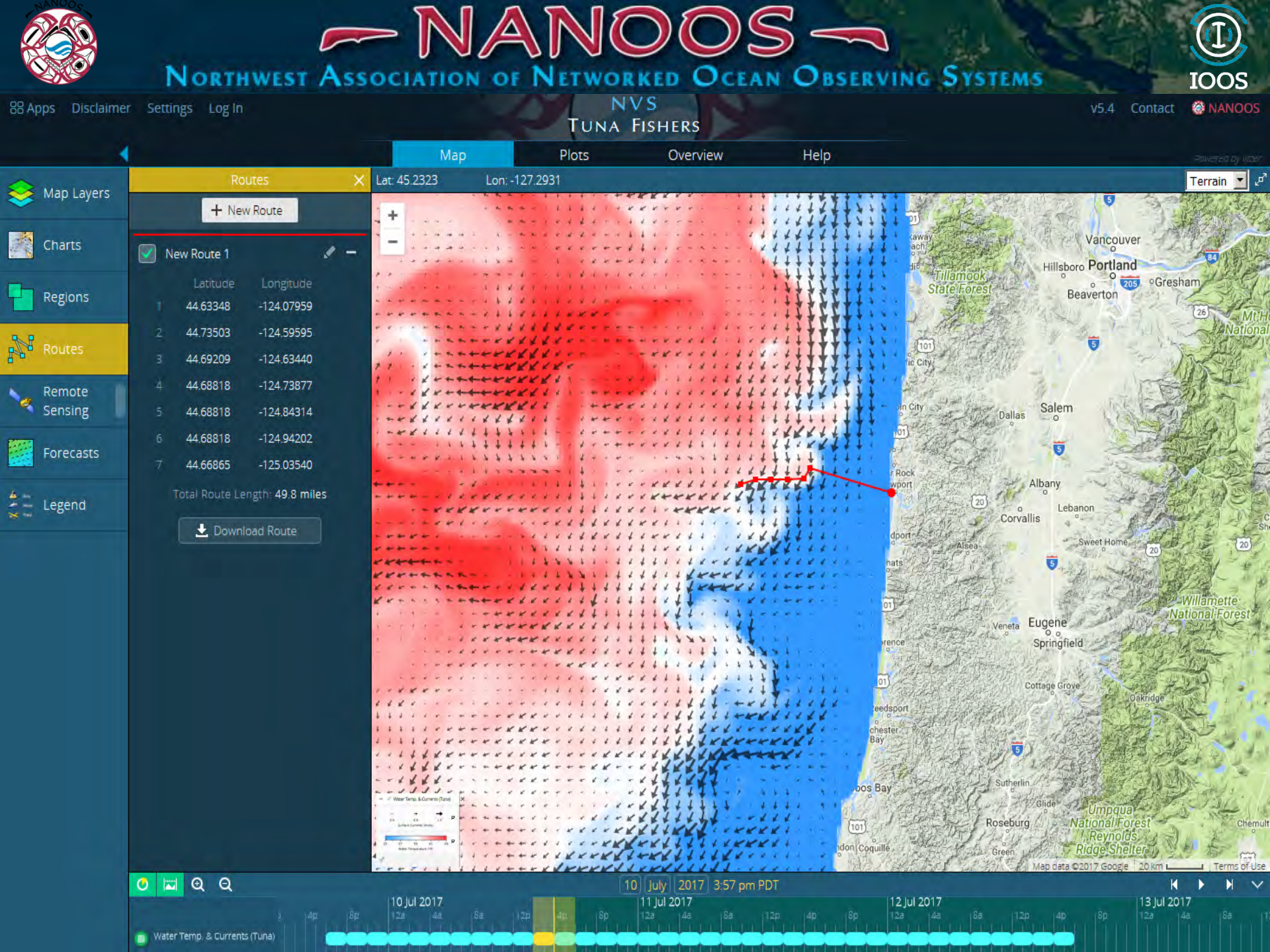
7 Aug 2017
Currents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Northwest Association of Networked Ocean Observing Systems
IOOS
Apps
Disclaimer
Settings
Log In
NVS
Tuna Fishers
v5.4
Contact
NANOOS
Map
Plots
Overview
Help
Map Layers
Charts
Regions
Routes
Remote Sensing
Forecasts
Legend
Routes
+ New Route
New Route 1
Latitude
Longitude
1 44.63348 -124.07959
2 44.73503 -124.59595
3 44.69209 -124.63440
4 44.68818 -124.73877
5 44.68818 -124.84314
6 44.68818 -124.94202
7 44.66865 -125.03540
Total Route Length: 49.8 miles
Download Route
Lat: 45.2323
Lon: -127.2931
Terrain
Vancouver
Hillsboro
Portland
Gresham
Beaverton
Tillamook State Forest
Salem
Dallas
Albany
Corvallis
Lebanon
Sweet Home
Willamette National Forest
Eugene
Springfield
Veneta
Cottage Grove
Oakridge
Roseburg
Umpqua National Forest
Reynolds Ridge Shelter
Sutherlin
Glide
Coquille
Green
Chemult
Map data ©2017 Google
20 km
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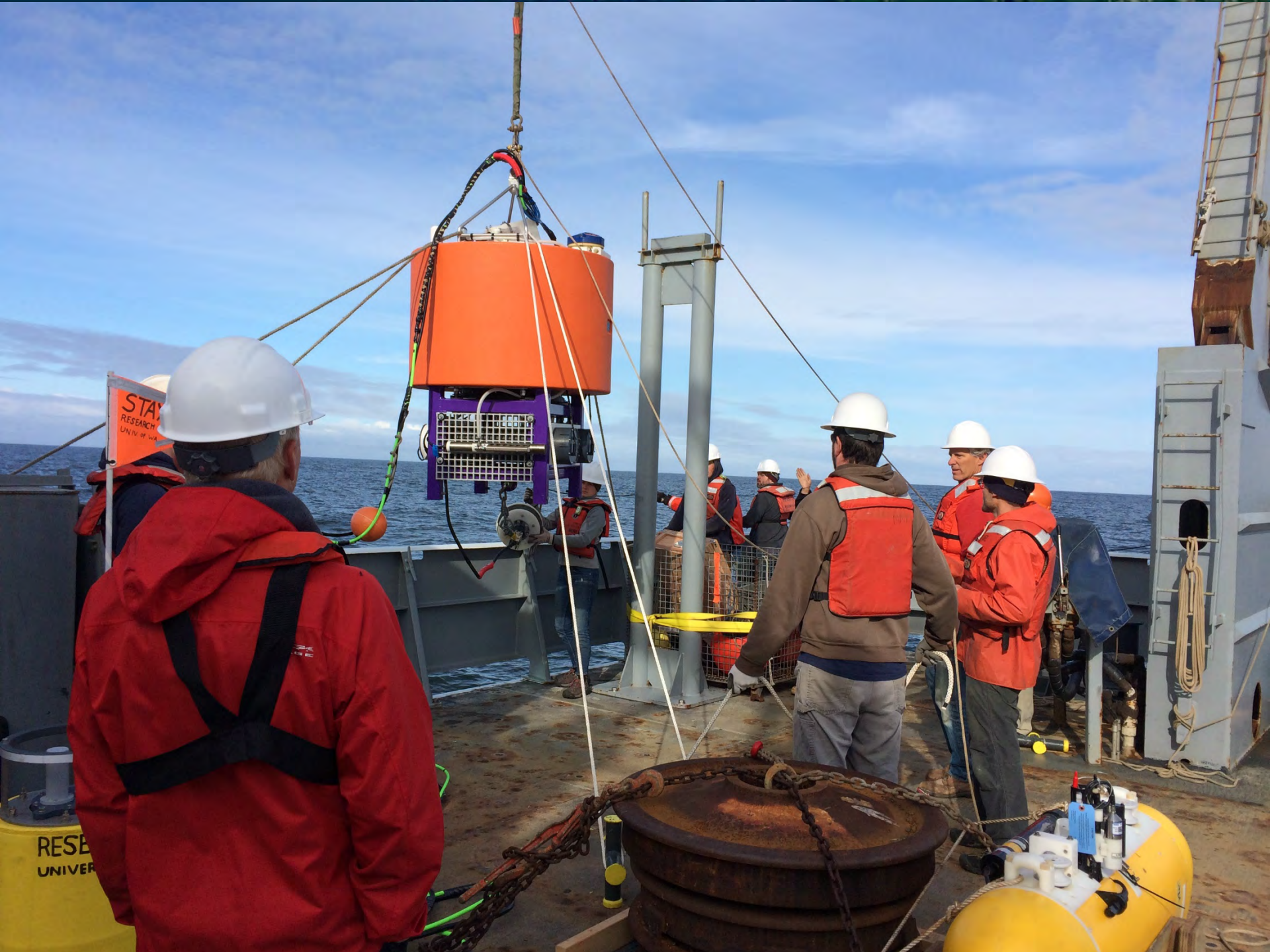
10 July 2017 3:57 pm PDT
10 Jul 2017
11 Jul 2017
12 Jul 2017
13 Jul 2017
Water Temp. & Currents (Tuna)

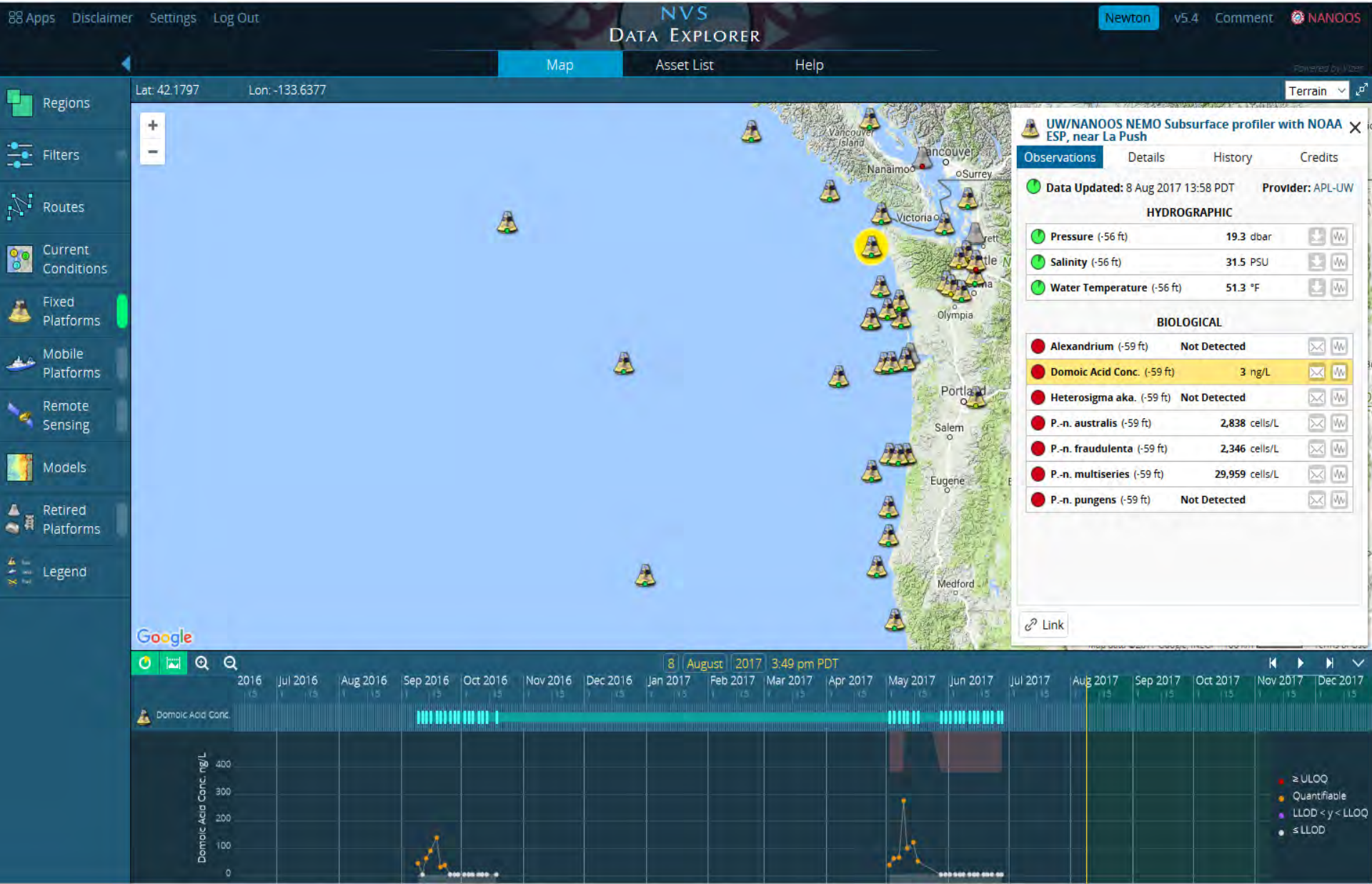
Ocean Tech Transfer: HABs

"Operational ecological forecasting of harmful algal blooms in the Pacific Northwest using an environmental sample processor"

- ESP on Cha'ba at La Push
- UW, NOAA NWFSC, MBARI, NOAA CCEHBR, NWIC, Spyglass, WHOI
- Detects *Pseudo-nitzschia* cells, species, toxicity
- Strong support from coastal tribes, WA managers
- Tested in PS 2015; NANOOS served data: "Real-Time HABs"
- Deployed off coast May-July'16, Sep-Oct '16, May-July '17, and Sep '17



HABs on NVS


Apps
Disclaimer
Settings
Log Out
NVS
Data Explorer
Newton
v5.4
Comment
NANOOS
Map
Asset List
Help
Regions
Filters
Routes
Current Conditions
Fixed Platforms
Mobile Platforms
Remote Sensing
Models
Retired Platforms
Legend
Lat: 42.1797
Lon: -133.6377
Terrain
Vancouver Island
Nanaimo
Surrey
Victoria
Olympia
Portland
Salem
Eugene
Medford
Google
UW/NANOOS NEMO Subsurface profiler with NOAA ESP, near La Push
Observations
Details
History
Credits
Data Updated: 8 Aug 2017 13:58 PDT
Provider: APL-UW
HYDROGRAPHIC
Pressure (-56 ft) 19.3 dbar
Salinity (-56 ft) 31.5 PSU
Water Temperature (-56 ft) 51.3 °F
BIOLOGICAL
Alexandrium (-59 ft) Not Detected
Domoic Acid Conc. (-59 ft) 3 ng/L
Heterosigma aka. (-59 ft) Not Detected
P.-n. australis (-59 ft) 2,838 cells/L
P.-n. fraudulenta (-59 ft) 2,346 cells/L
P.-n. multiseries (-59 ft) 29,959 cells/L
P.-n. pungens (-59 ft) Not Detected
Link
8 August 2017 3:49 pm PDT
2016
Jul 2016
Aug 2016
Sep 2016
Oct 2016
Nov 2016
Dec 2016
Jan 2017
Feb 2017
Mar 2017
Apr 2017
May 2017
Jun 2017
Jul 2017
Aug 2017
Sep 2017
Oct 2017
Nov 2017
Dec 2017
Domoic Acid Conc.
Domoic Acid Conc. ng/L
400
300
200
100
0
≥ ULOQ
Quantifiable
LLOD < y < LLOQ
≤ LLOD

Constraining our understanding

Climate & ocean driven variation

- Climate change
- ENSO
- MHW
- Hypoxia
- OA
- HABs
- Food web & biodiversity
- Fluxes

Sustained observing needs

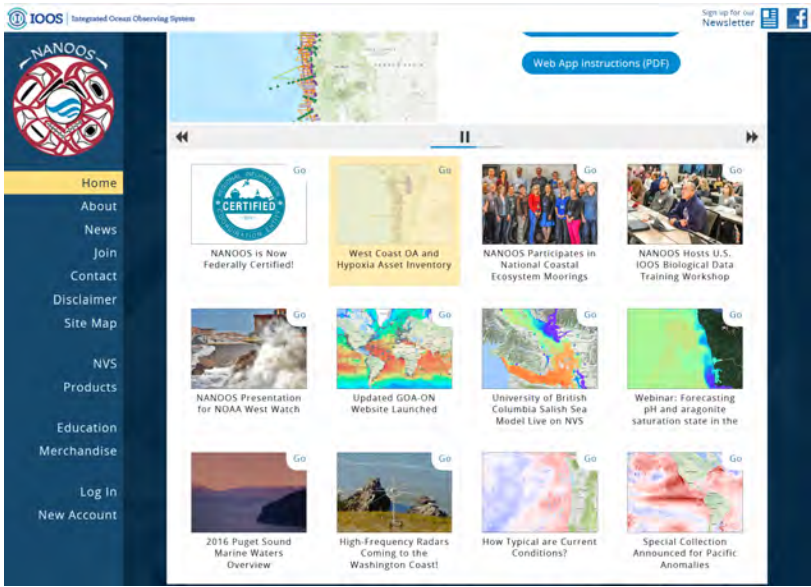
- Mooring time-series (temporal)
- Glider lines (spatial)
- Physical variables, surface currents/circulation
- Ecosystem variables
- Biogeochemical variables

NANOOS commitments

- Mooring time-series (temporal)
  - **La Push, Saturn 02, NH-10, CB-06**
- Glider lines (spatial)
  - La Push, Columbia, NH-10, **Trinidad**
- Surface currents
  - **HFR in WA x 3, HFR in OR x 8**
- Ecosystem variables
  - **Chl, ESP for HABs,** plankton
- Biogeochemical variables
  - **pH/pCO_2, oxygen, nitrate**

Increasing collaborations

- Data products
- Lessons learned
- Observing assets: gliders
- Data processing/validation
- Community engagement



Pacific Coast

Ed Dever OSU
Chris Harvey NOAA
John Mickett, UW
Todd Mudge, U Alaska Fairbanks
Amanda Netburn, NOAA
Jan Newton, UW
Uwe Send, SIO
Ian Walsh, Sea-Bird

Societal needs & stakeholders:

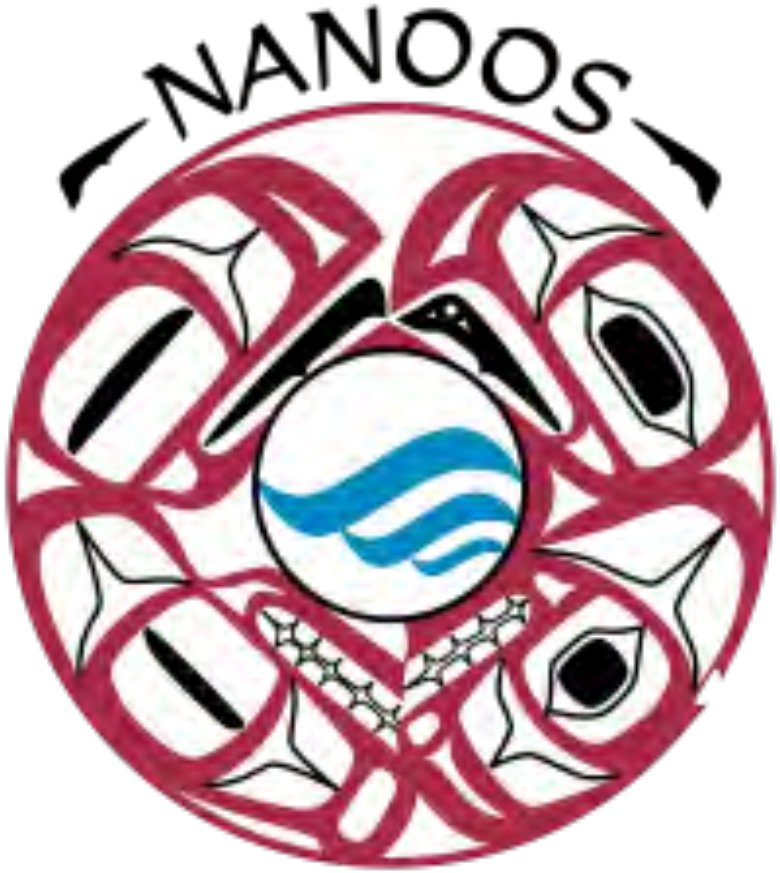
- Hypoxia impacts on sustaining fishing, tribes, and local economies
- HAB impacts on fishing, tribes, human health, and local economies
- OA impacts on aquaculture, tribal sustenance, and local economies
- Temperature variation as relates to fishing and ecosystems
- Currents to understand crab pot recoveries
- Interactions between protected species and fisheries and how these are impacted by ocean events (MHW, ENSO, etc.), climate change, etc. (e.g., whale migration shifts into crab pots and entanglements occur)
- Noise pollution and how this affects species distribution and migrations
- Understanding ecosystem shifts and how these affect economies, tribes, etc.
- Availability of forage species is a huge gap and affects higher trophic levels linked to economies, etc.
- Carbon cycle research and sequestration
- Understanding how to achieve energy needs/export without disrupting ecosystem
- Forecasting/nowcast model support: how to optimize in order to provide societally useful information
- Invasive species: e.g., eDNA, flow cytobot, etc.

Improvements needed:

- Enhance existing moorings:
  - more sustained O&M needed to avoid time gaps
  - explore enhancing non-ecosystem moorings with existing ecosystem sensors
- Spatial coverage needs attention:
  - North-South gradient: Nothing between Coos Bay, OR, and Bodega, CA
  - Cross-shelf gradient: Nothing cross-shelf off N Washington; off So California; cross shelf gradients are very important to understanding processes driving ecosystem dynamics.
- Sensors do not exist for many items needed (e.g., biodiversity), or are too expensive (e.g., ESP)
- Calibration: not sufficient - none of current approaches is satisfactory or feasible for all operators (cals either are time consuming or do not hold; or take too long….6 months!); must be in context of QC mechanisms.
- Biofouling


complex area…

www.nanoos.org



- Very briefly show us what observations NANOOS makes and who uses them. I would spend no more than 1/3 of your time on this.
- You might emphasize what measurements NANOOS is committed to making for many years or 'forever' to detect climate scale changes.
- What are your thoughts on how NANOOS, and IOOS in general (you are in a way speaking for all of IOOS), can collaborate with the other organizations committed to long-term measurements in the NE Pacific.
- OOIFB will want to give NSF guidance on the OOI activities in the NE Pacific so your thoughts and recommendations can help.
- Finally, you might tell us anything that has been bugging you about OOI and what solutions you might suggest. This is a chance to air any issues.
- A brief description of the synergies between OOI and NANOOS would be good information for the Early Career Workshops and if you have any thoughts on important gaps, that would be good to identify for future planning.