

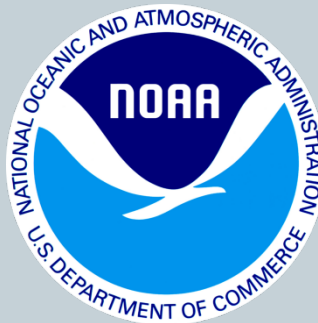
West Coast HABs: Highlights of Monitoring and Modeling Technologies

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SCIENCE CENTER

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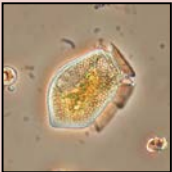




Overview

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- Pacific Northwest HAB species
- Update on the West Coast HAB event
- Advanced HAB Monitoring Platform
- Future plans for integrating Monitoring and Modeling approaches to improve HAB Forecasting

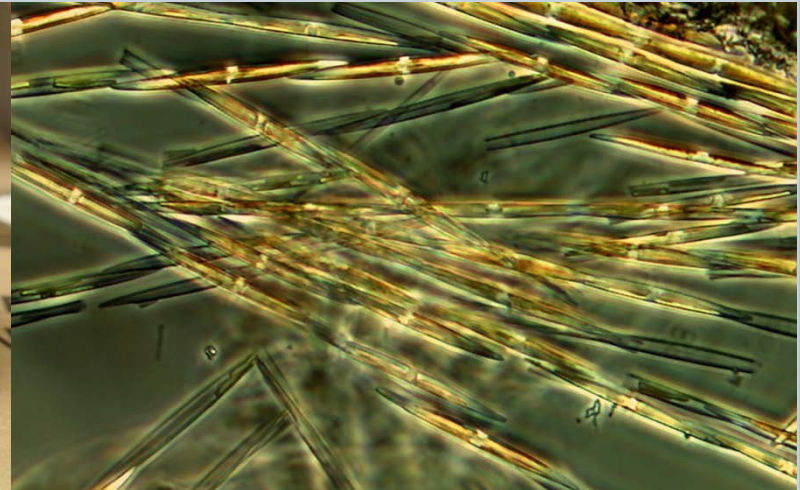
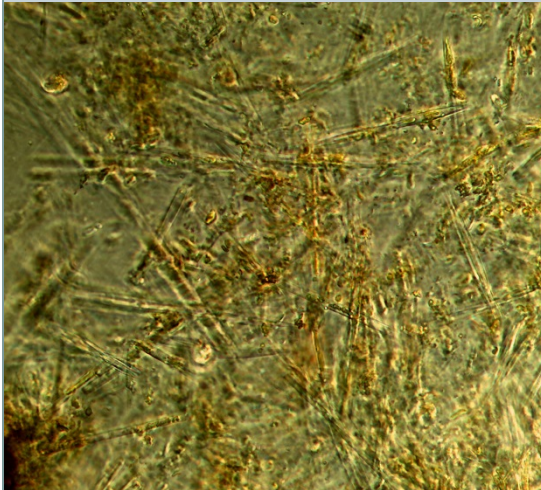
Pacific Northwest HABs

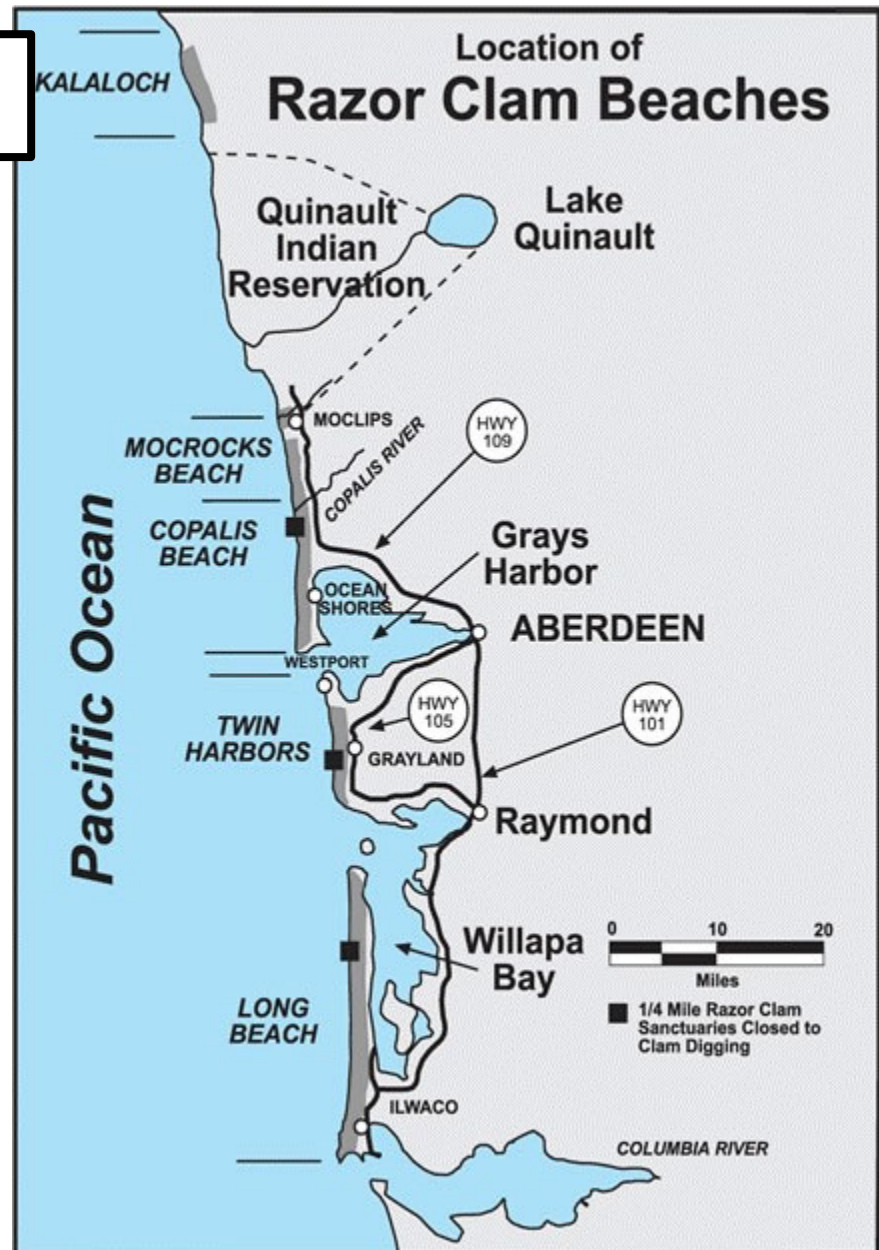
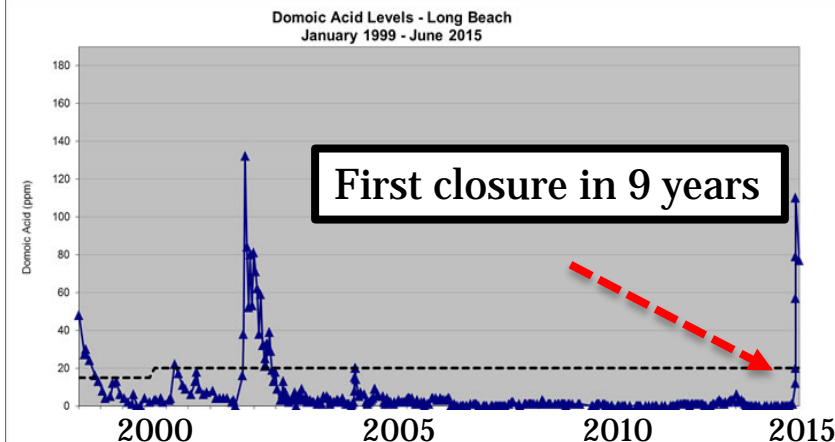
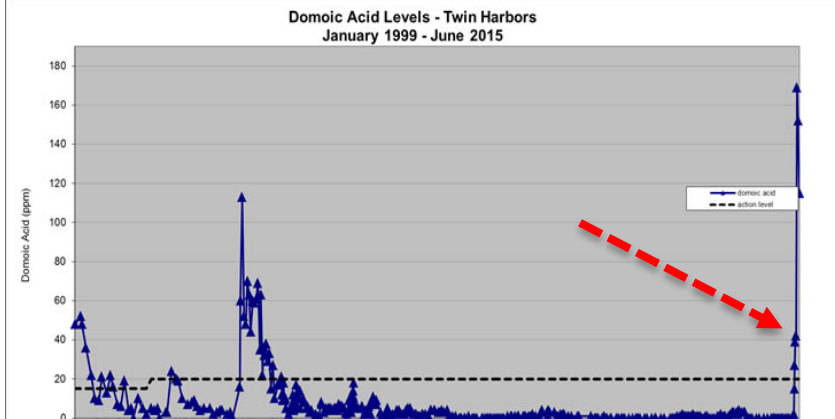
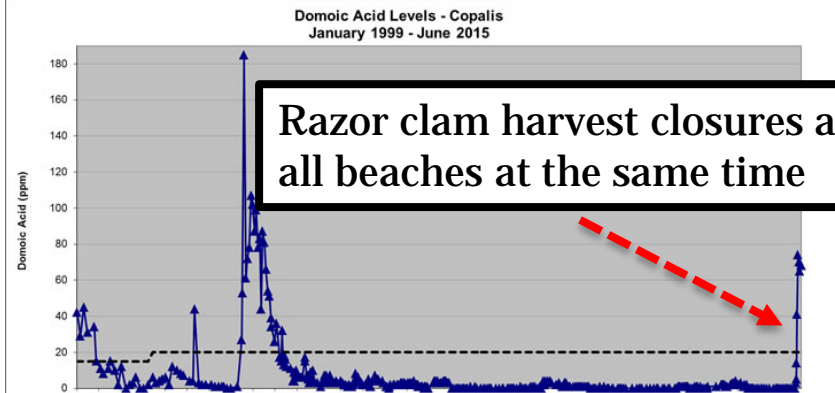
HAB species	Toxin	Illness	Symptoms
<i>Alexandrium</i> spp. 	Saxitoxin & derivatives	Paralytic Shellfish Poisoning (PSP)	Numbness & tingling of lips, mouth, face, neck; nausea & vomiting; muscle paralysis in chest & abdomen; possibly death
<i>Pseudo-nitzschia</i> spp. 	Domoic acid	Amnesic Shellfish Poisoning (ASP)	Nausea, vomiting & diarrhea; headache, dizziness & confusion; permanent short-term memory deficits; seizures, cardiac arrhythmias, & possibly death
<i>Dinophysis</i> spp. 	Okadaic acid & derivatives	Diarrhetic Shellfish Poisoning (DSP)	Nausea, vomiting, severe diarrhea & stomach cramps
<i>Heterosigma akashiwo</i> 	ROS + toxin?	—	

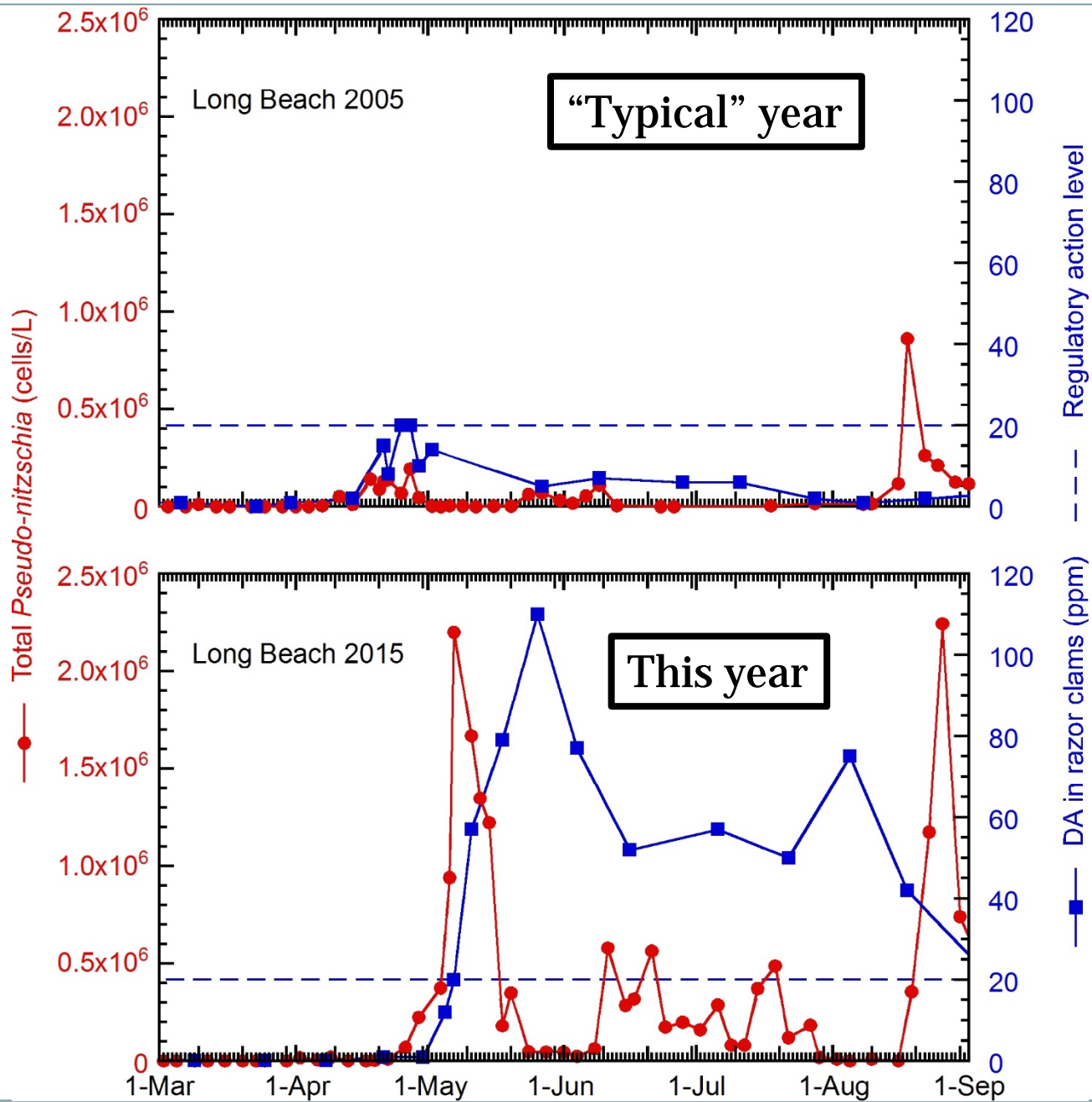
U.S. West Coast *Pseudo-nitzschia* bloom

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- Large geographical extent: Channel Islands to Aleutian Islands
- Long lasting (months)
- Highest toxin in anchovies ever measured
- “Super” *Pseudo-nitzschia* – large chains, chloroplasts bulging







[Slide courtesy of Vera Trainer]

Impacts of largest West Coast HAB



Closure of razor clam fishery
~\$7 million lost in WA State alone



Seizuring sea lion first ever observed on
WA coast; Many sea lion, seal mortalities
in Monterey Bay



Anchovy and sardine fisheries health
advisory in CA due to high toxins

Dungeness Crabbers Hit Hard By Algae Bloom On Washington Coast

By ASHLEY AHEARN • 18 HOURS AGO

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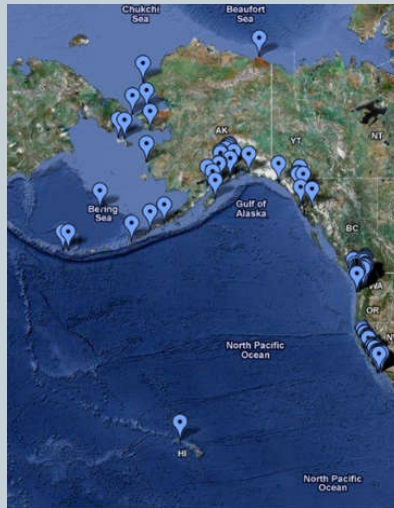
Dungeness crab fisheries closed in
multiple states; WA crab fishery valued
at \$84 million

WARRN-West

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- Wildlife Algal-toxin Research and Response Network for the U.S. West Coast (WARRN-West)
- Domoic acid detected in marine wildlife from Northern Alaska to Southern California in summer of 2015

Sampling covers the entire U.S. West Coast, with over 3,000 samples analyzed for DA and PSP to date

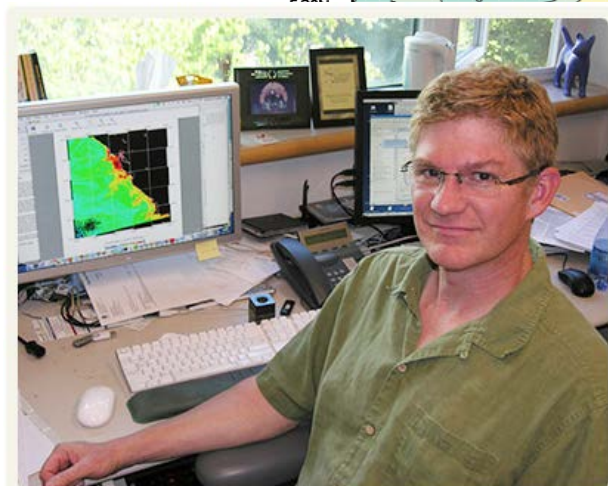


WARRN-West and Biomedical Diagnostics



Kathi Lefebvre, Program Leader
Anne Baxter, WARRN-West Manager

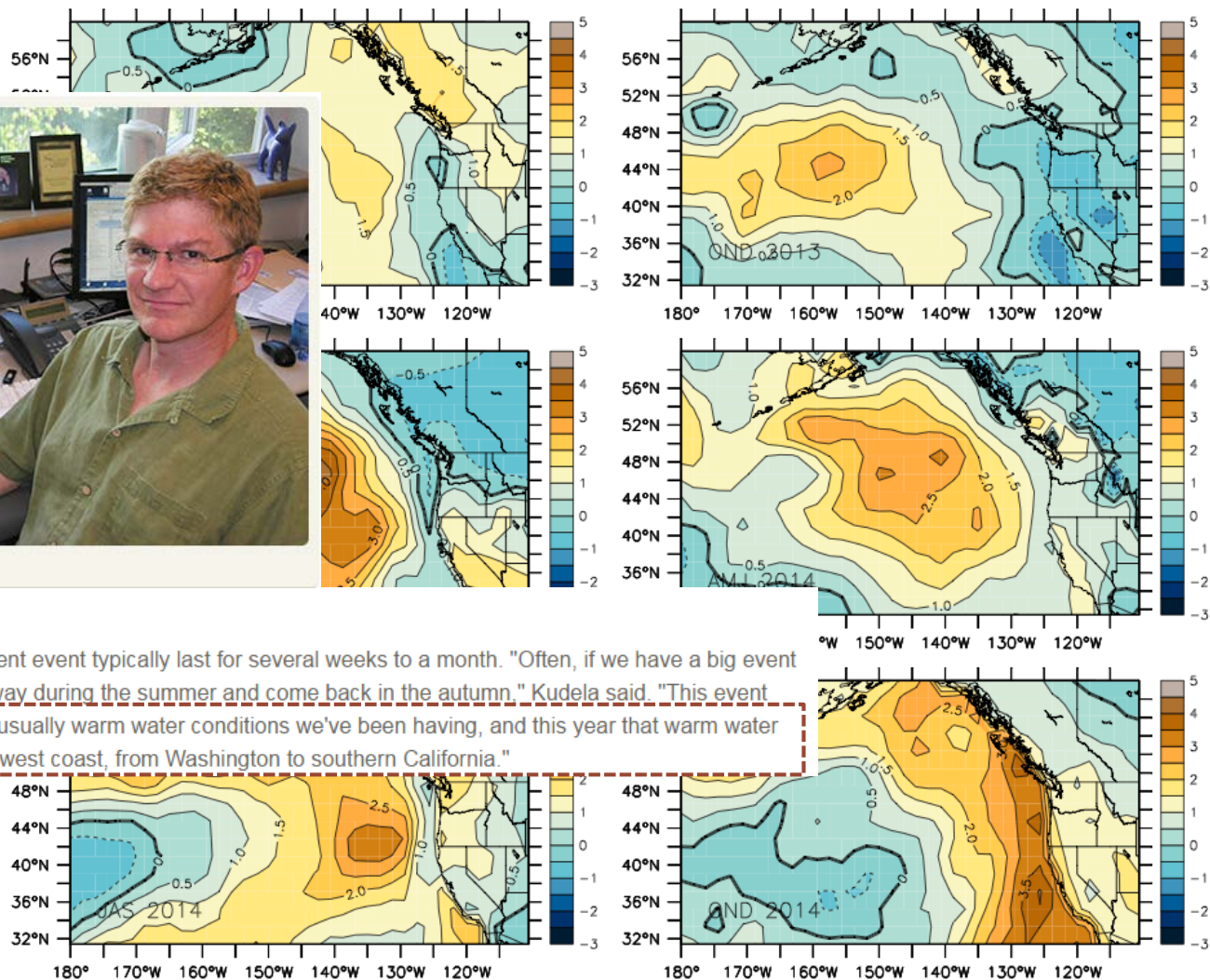
Blame the “Blob”?



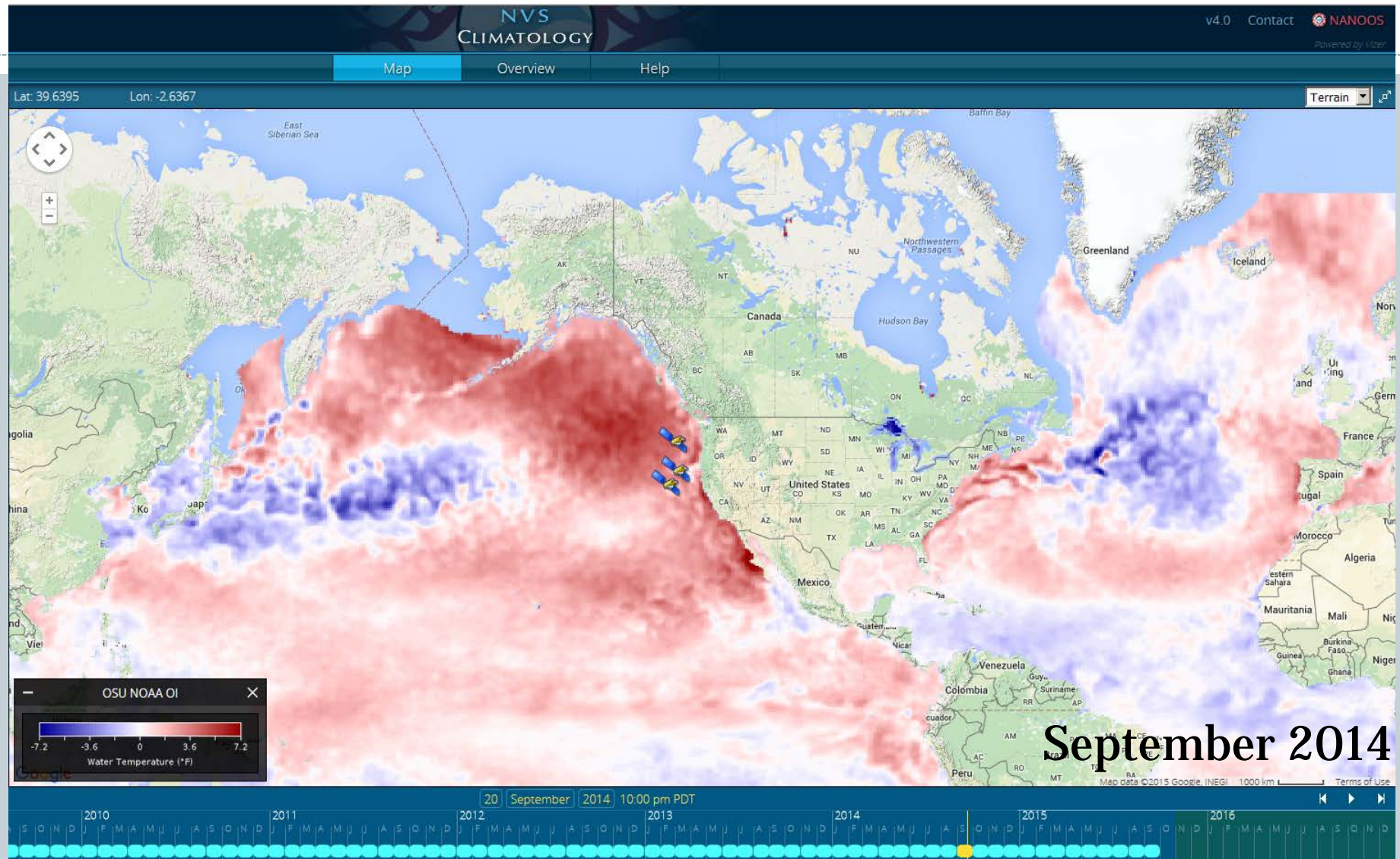
Raphael Kudela

Warm water

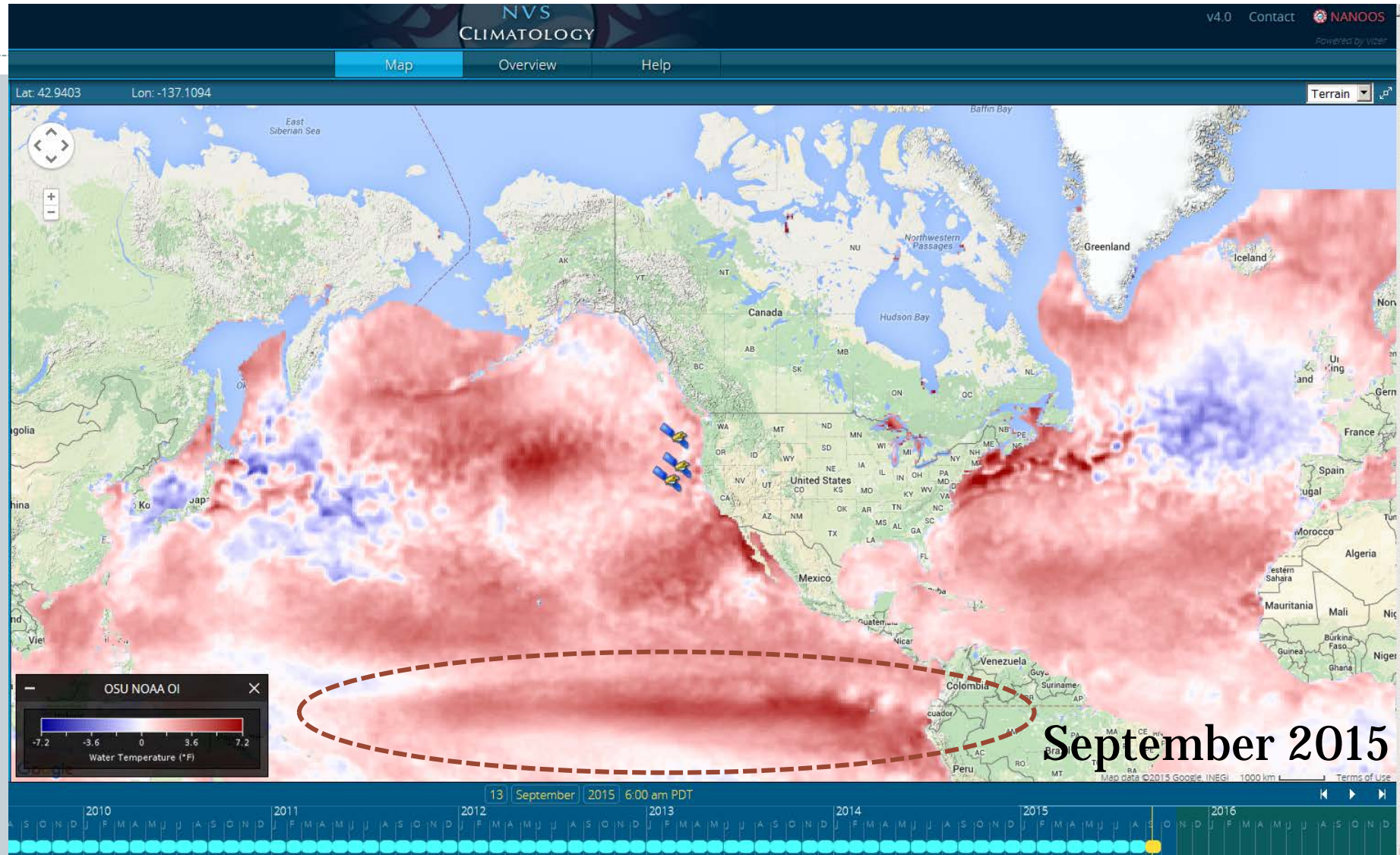
Blooms such as the current event typically last for several weeks to a month. "Often, if we have a big event in the spring, it will go away during the summer and come back in the autumn," Kudela said. "This event may be related to the unusually warm water conditions we've been having, and this year that warm water has spread all along the west coast, from Washington to southern California."



Return of the “Blob”?

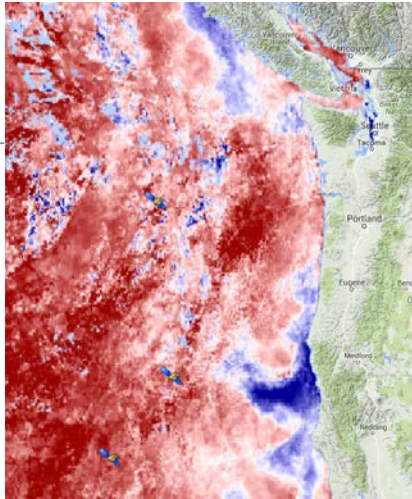


Return of the “Blob”?

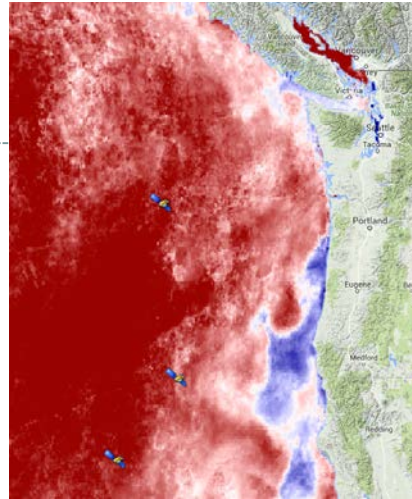


2014

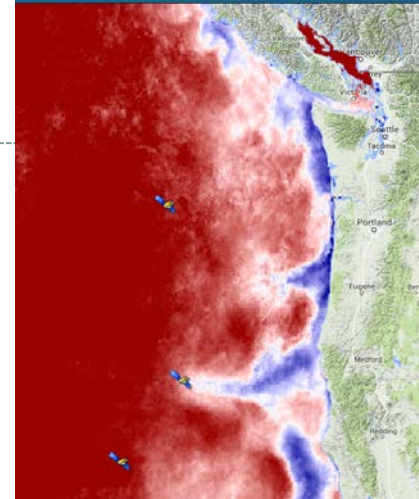
June



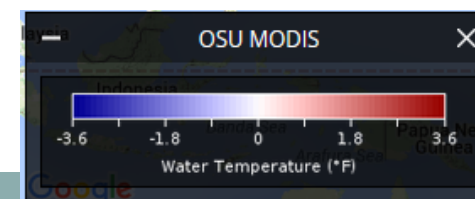
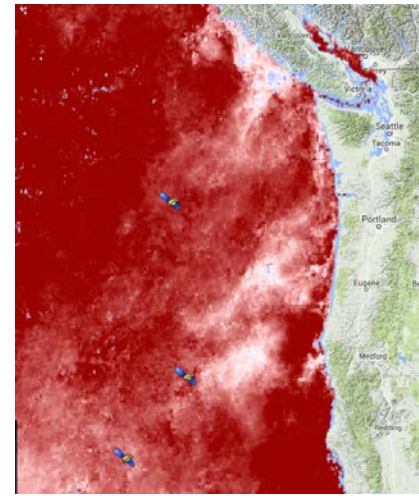
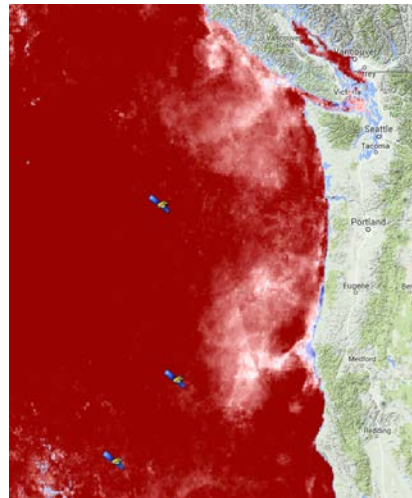
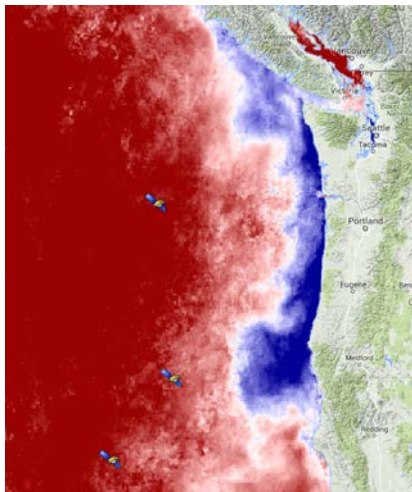
July



August



2015



ORHAB Partnership – Beach Monitoring

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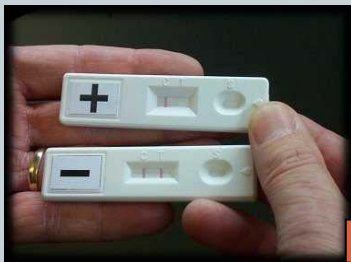
1. Collect plankton



2. Look for Pn



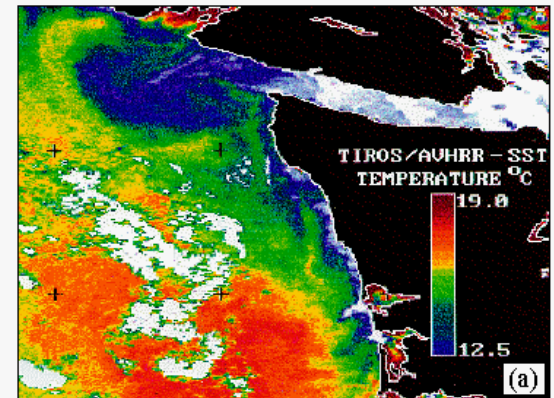
3. Test for toxin (sw & clams)



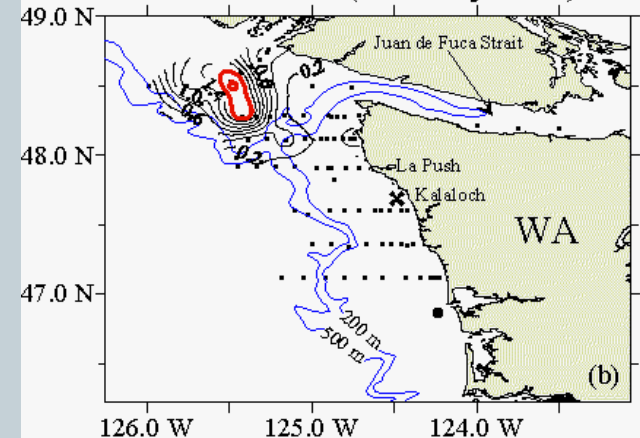
4. Test clams at WDOH



AVHRR (18 July 1997)



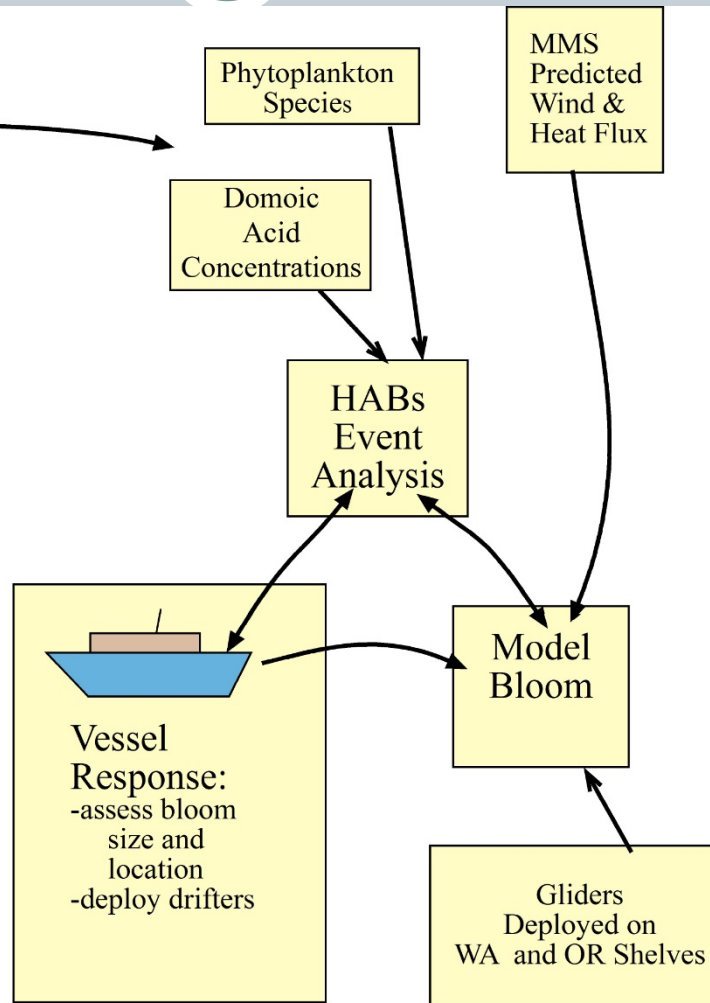
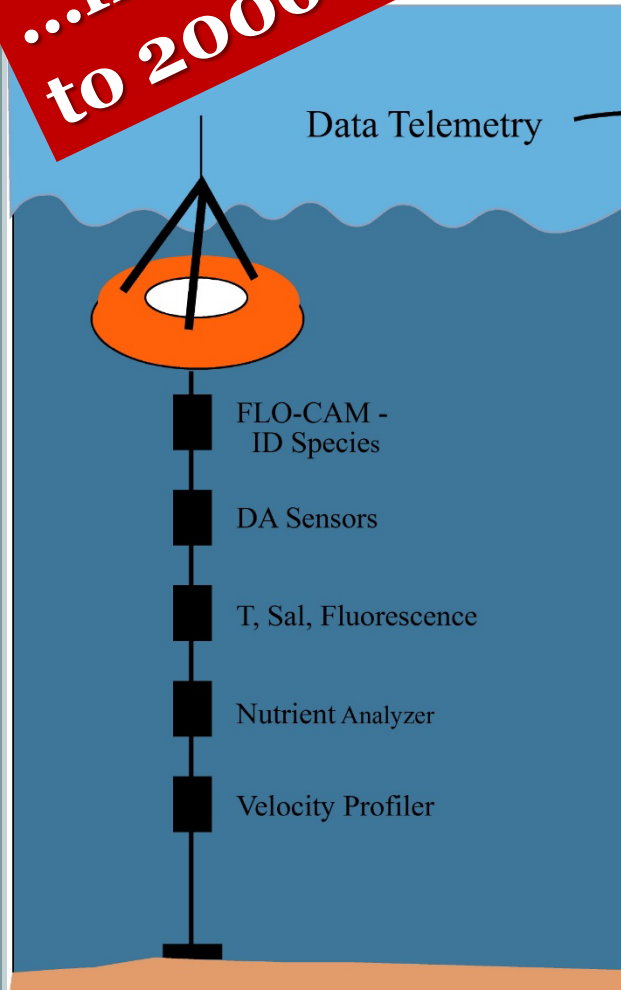
Domoic acid (7-19 July 1997)



Vision for future remote detection of toxic HAB events

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...flashback
to 2006...



Data telemetry

SPECIALISTS

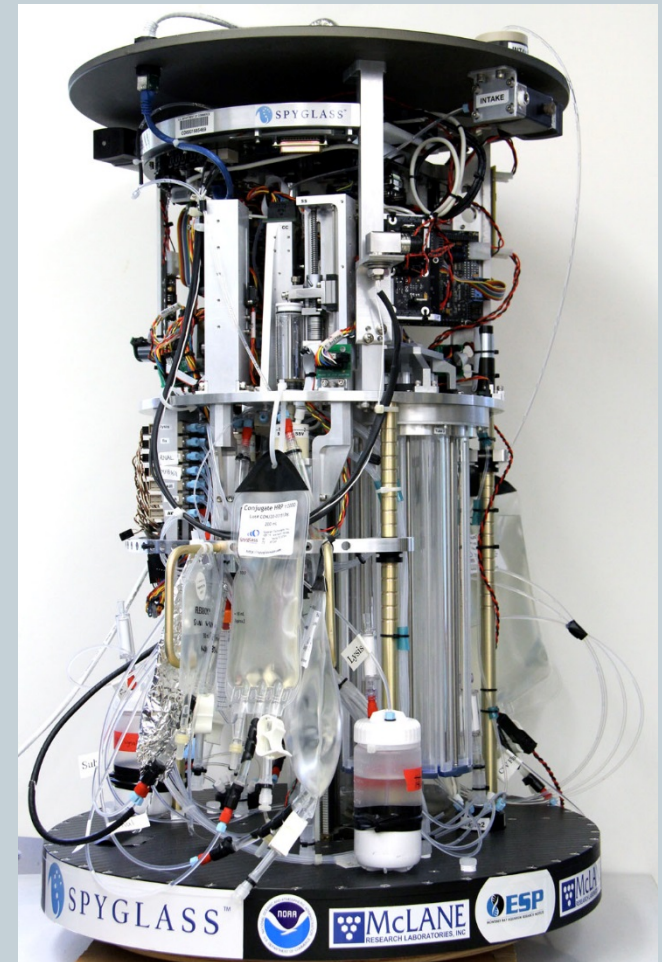
Models

Rapid response

Environmental Sample Processor (ESP)

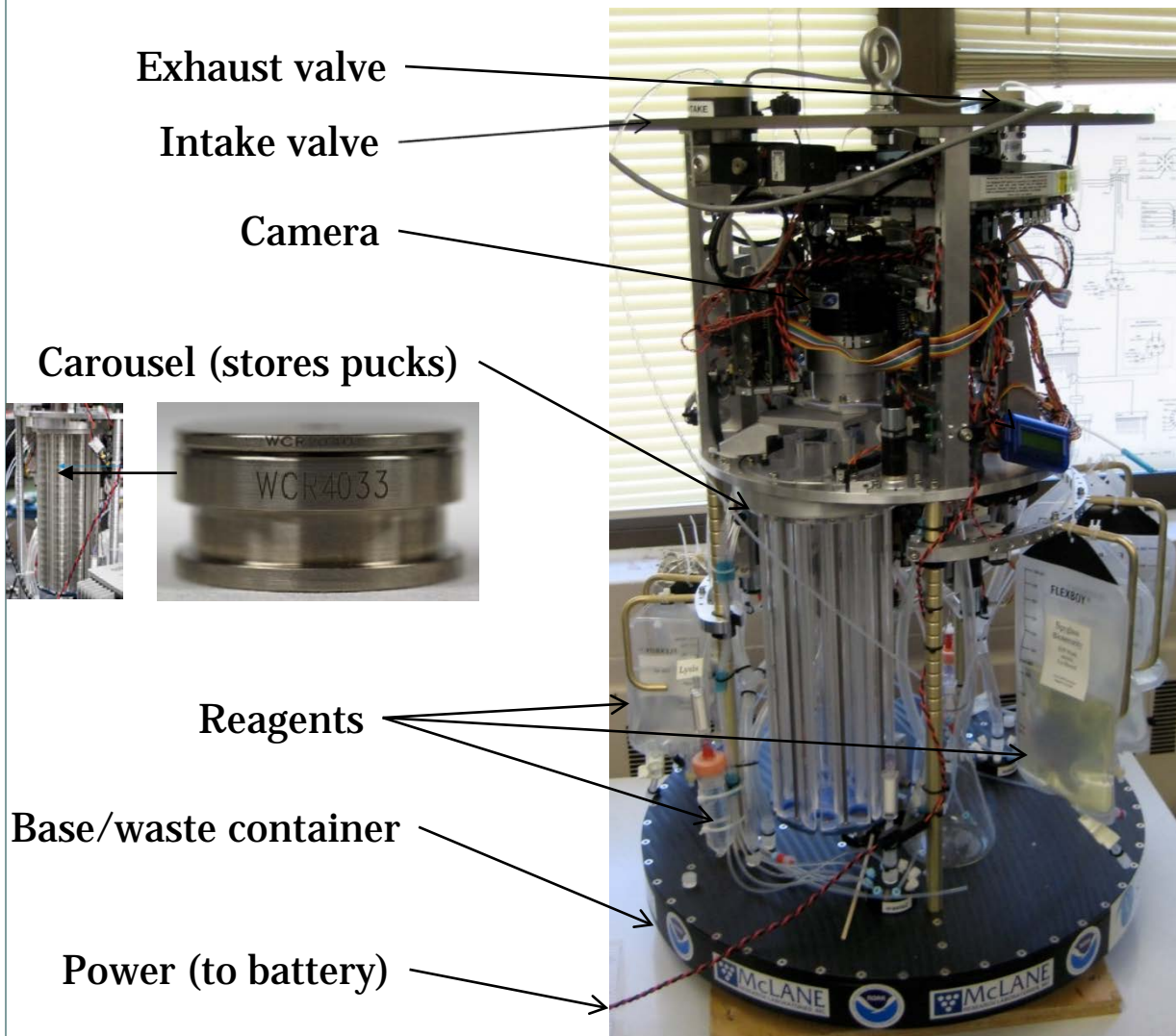
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- Advanced, automated, quantitative, in situ, biological sensing system
- Near real-time data delivery
- Extended, high frequency, and responsive surveys
- Early warning of HABs and their toxins



The NWFSC's ESPfriday

ESP components at a glance



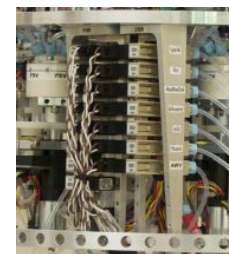
Syringe assembly (n=3)



Clamp and heater pad (n=2)

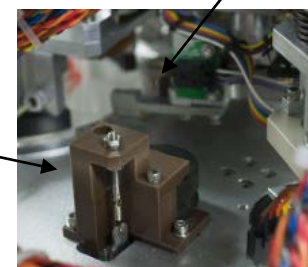


Reagent manifold (n=2)

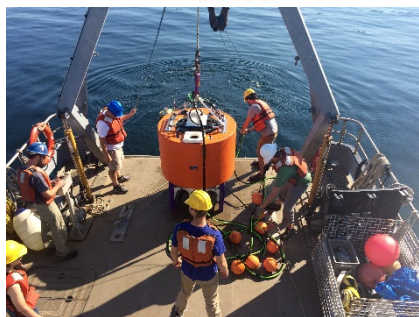


Manipulator

Flush puck and garage



Moored ESP (~20 m)



ESP deployment options

Deep ESP



Drifting ESP



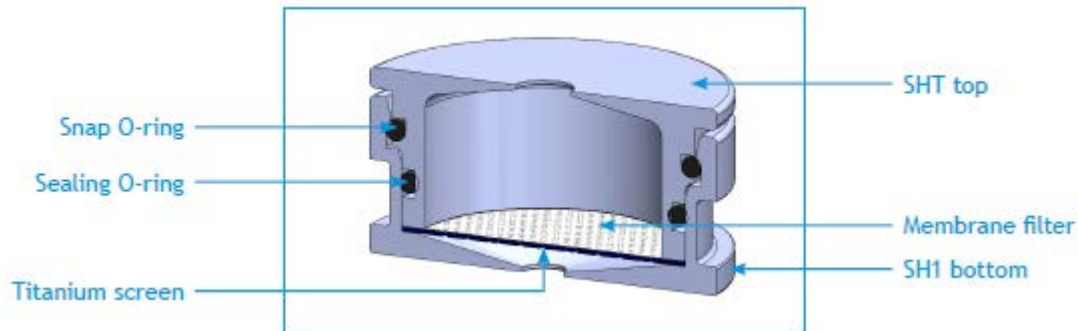
Dockside ESP



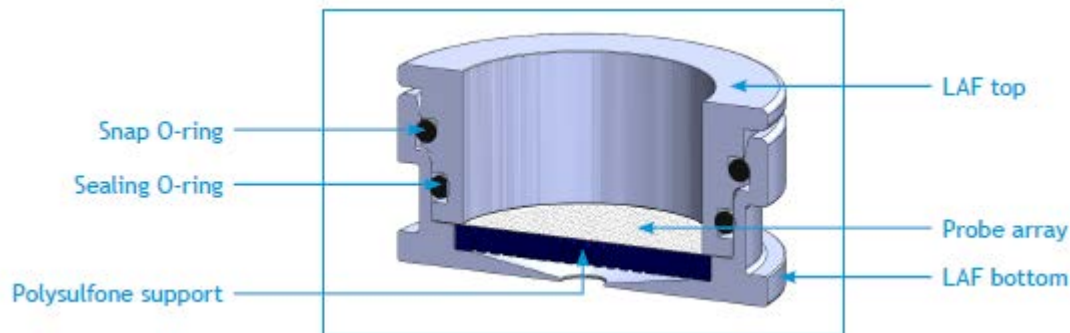
ESP currency = “Pucks”

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Sample puck



Array puck



Camera

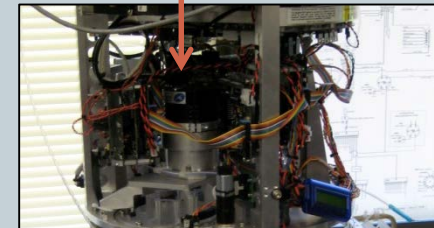
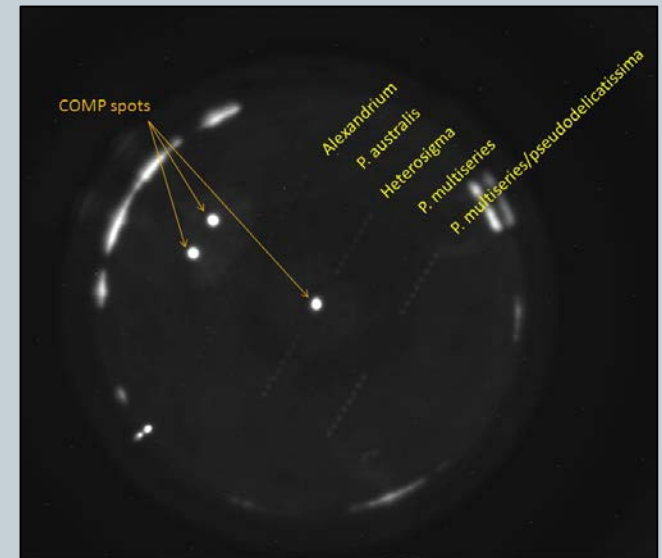


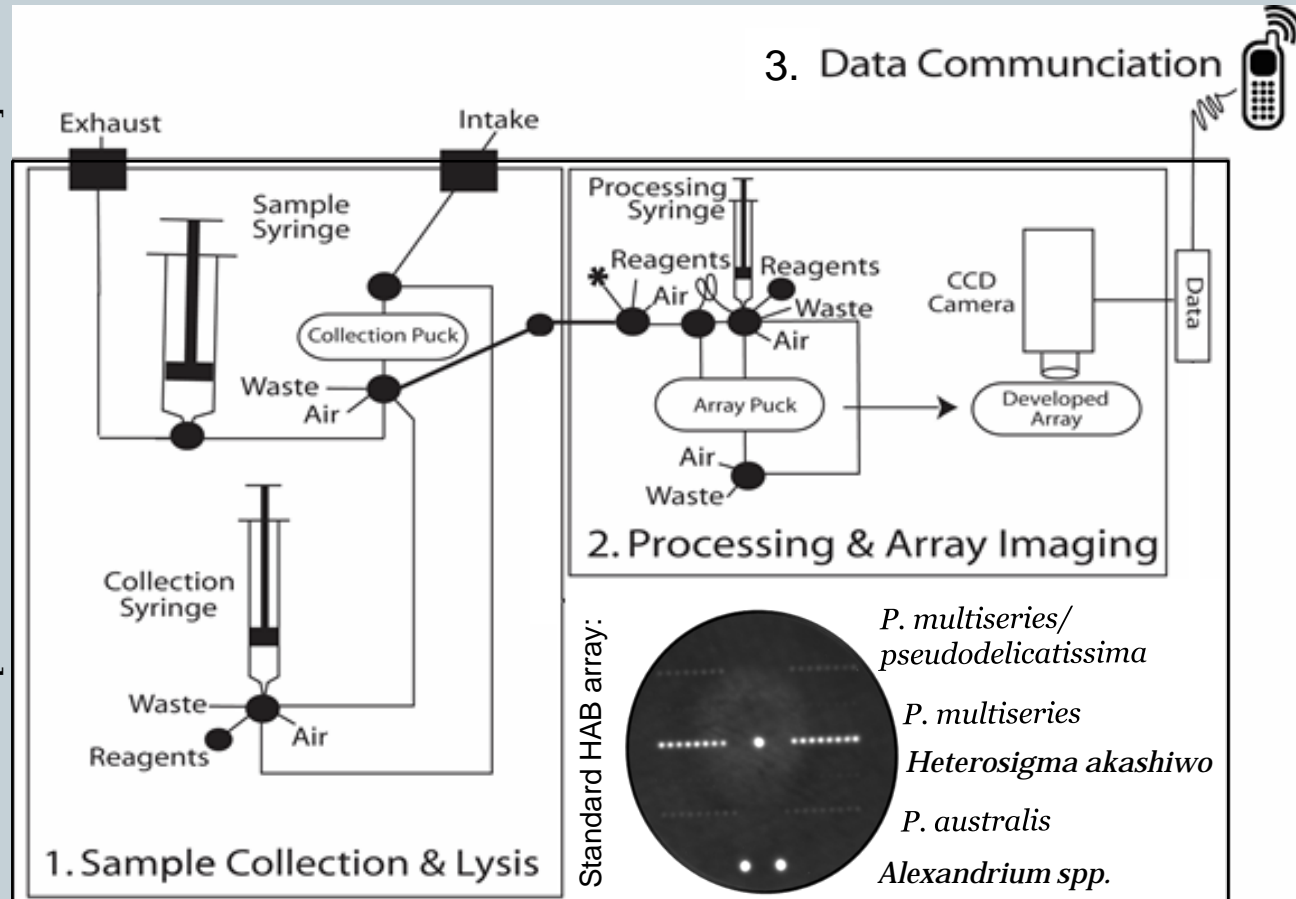
Image of HAB array June 6, 2012



How does the ESP work?

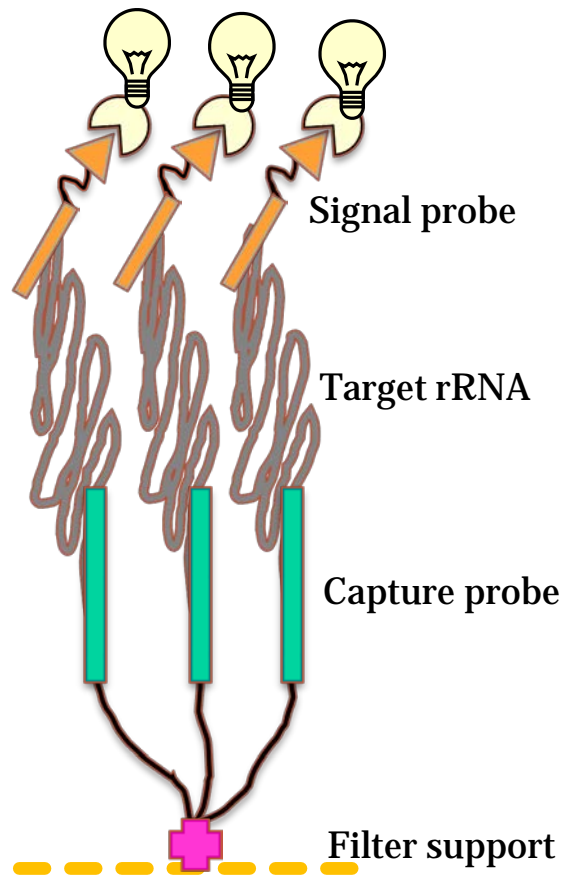
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[modified from Preston et al. 2011]



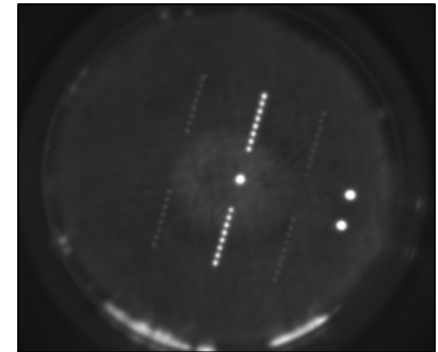
Molecular analysis = Sandwich Hybridization Assay

DNA probe arrays detect ribosomal RNA of target sequences

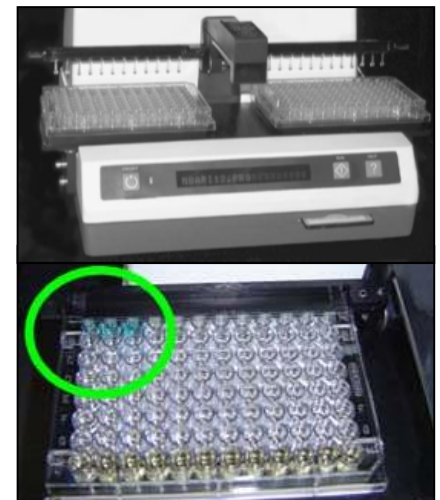


1. Capture probe part of the printed DNA probe array
2. ESP collects sample, creates nucleic acid extract, target rRNA sticks to capture probe, rest of extract washed away
3. Signal probe attaches to different part of rRNA – completing the “sandwich”

Imaged array



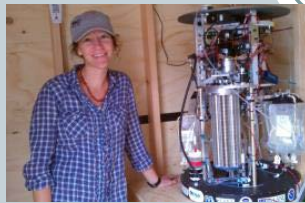
Verification by matching 96-well plate



[Slide modified from MBARI; Scholin et al. 1996, 1999; Goffredi et al. 2005]

ESP research at NOAA's NWFSC

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- First ever deployment of an ESP in PNW
- Shore-based



- Archive deployment and technology transfer to NOAA FTEs
- Shore-based
- IOOS OTT award!!

2011

- Took delivery of ESPfriday [NOAA OHHI]

2012

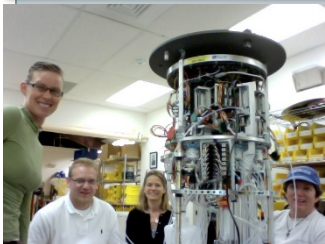
- Coordinated deployment of 4 ESPs [NOAA Office of Aquaculture]
- Expanded detection capability
- Shore-based with near-real time data dissemination

2013

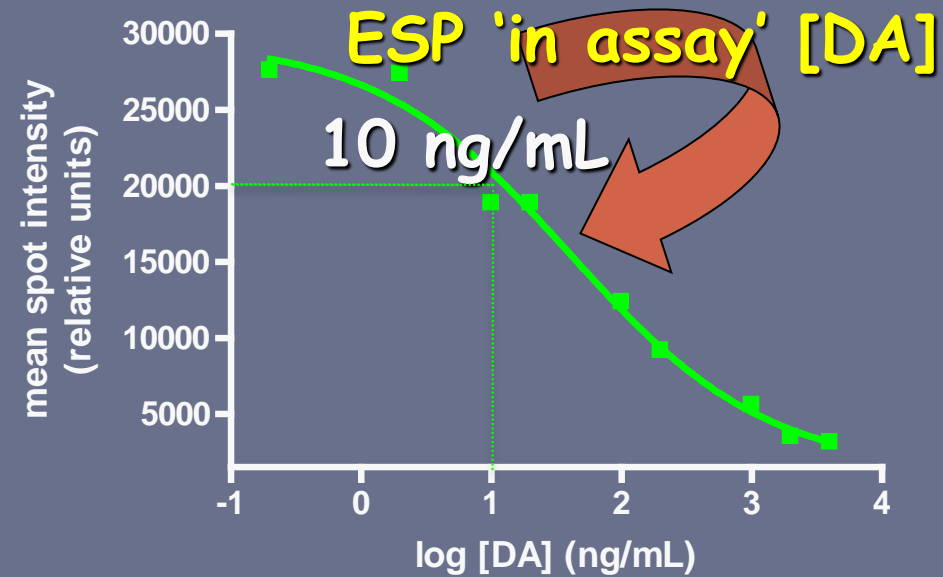
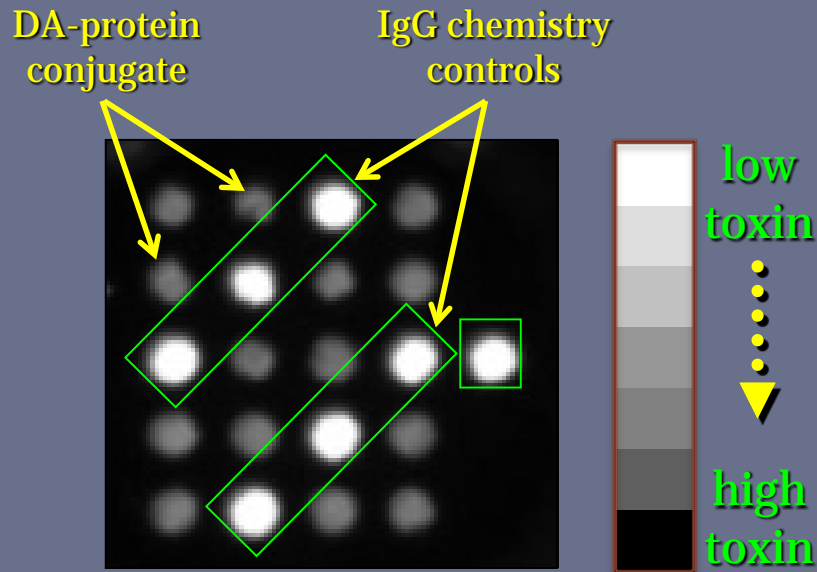
2014

2015

- Underwater deployment on a new mooring design
- Expanded detection capability (**domoic acid**)
- Trial sophisticated pipeline for data handling and display

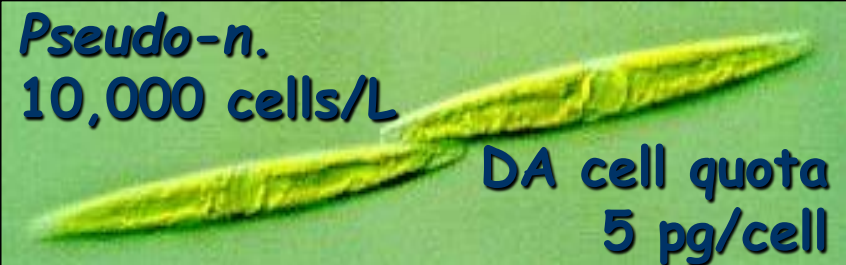


DA cELISA: detection of domoic acid on ESP



DA extracted in 2.5 mL;
ESP filtered 0.5 L SW;

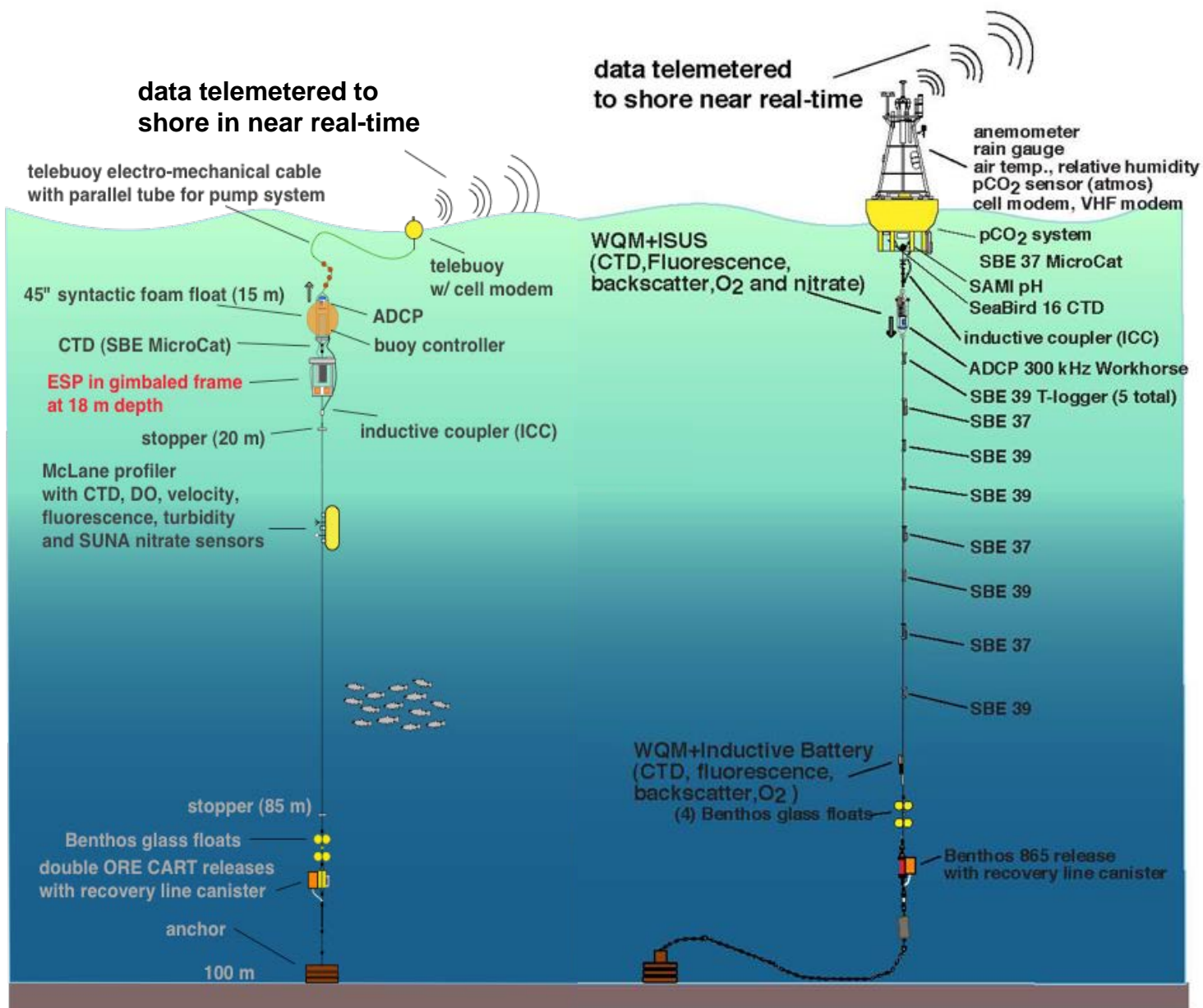
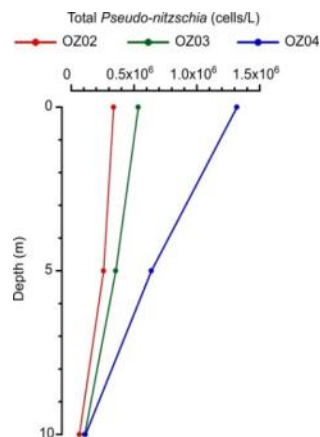
In-water [DA] = 50 ng/L



- DA measured using competitive ELISA (cELISA)
- Chemiluminescent signal imaged with ESP camera
- Data transmitted to shore
- assay ~1 hr



Pump surface water to the ESP at depth



Puget Sound trial underwater ESP deployment

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- New mooring design
- New pump system
- Dual HAB species and toxin detection
- August 6-19, 2015

Preparing ESPfriday

NWIC intern Jessica Williams with
NWFSC Nick Adams



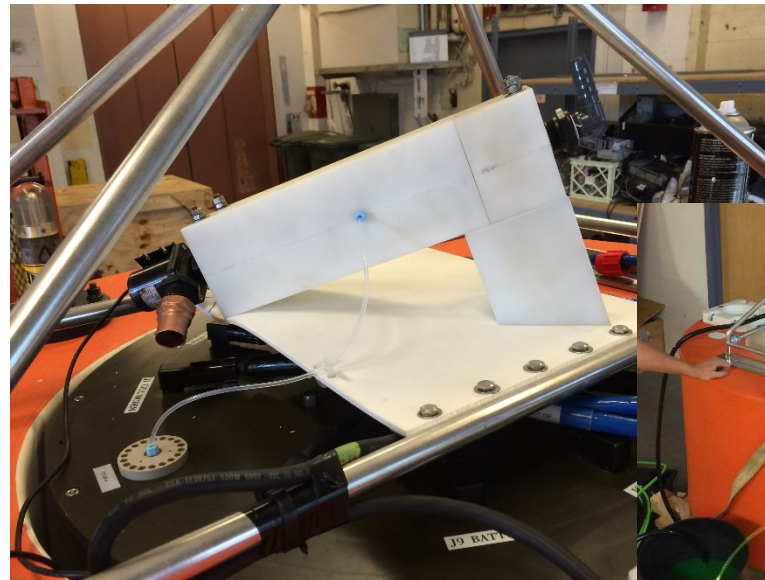
Building the mooring

NWIC intern Jessica Williams with
UW/APL Nick Michele-Hart



Fabrication of the underwater housing

UW/APL John Mickett with IOOS
Director Zdenka Willis



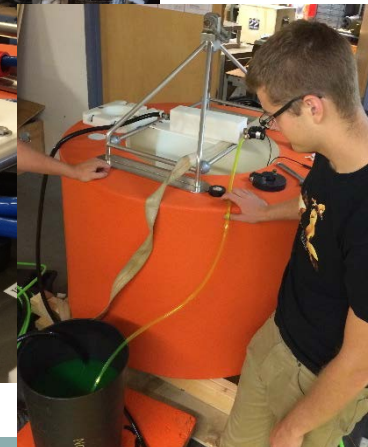
Canning ESPfriday

UW/APL Keith Magness and John Mickett
assist NWFSC Linda Rhodes to “can”
ESPfriday

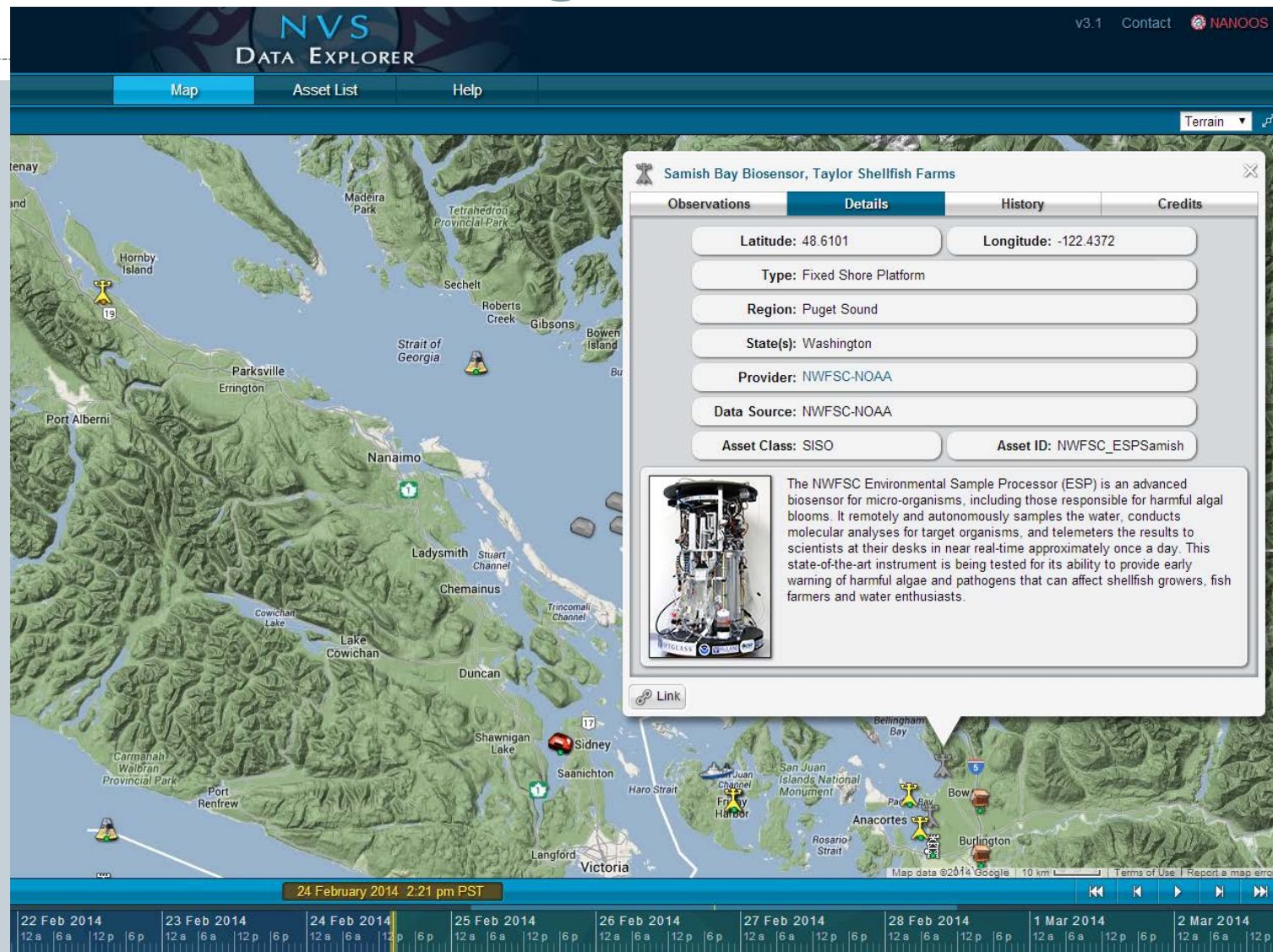


Testing the pump

UW/APL Derek Martin tests the “transit
time” of the pump system using
fluorescein dye



Data handling and visualization



Operational ESP deployment site

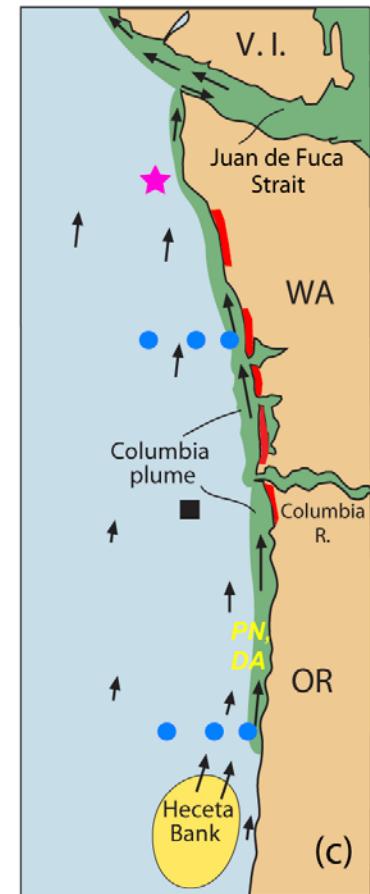
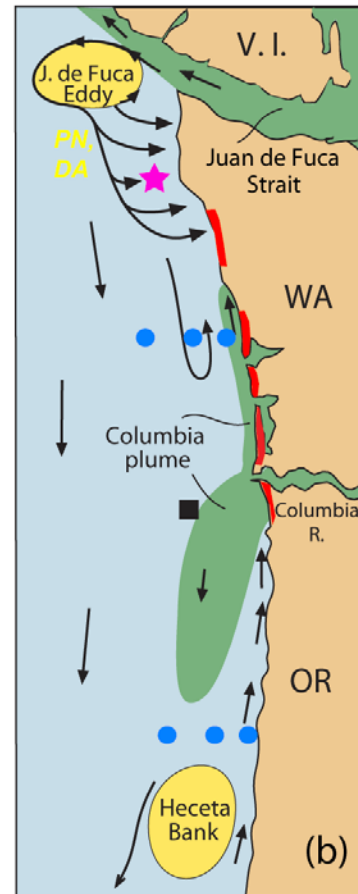
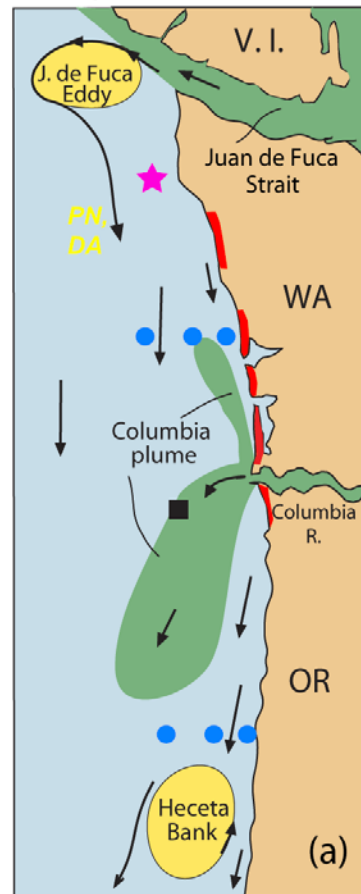
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Summer/fall good weather

Summer/fall weak storms

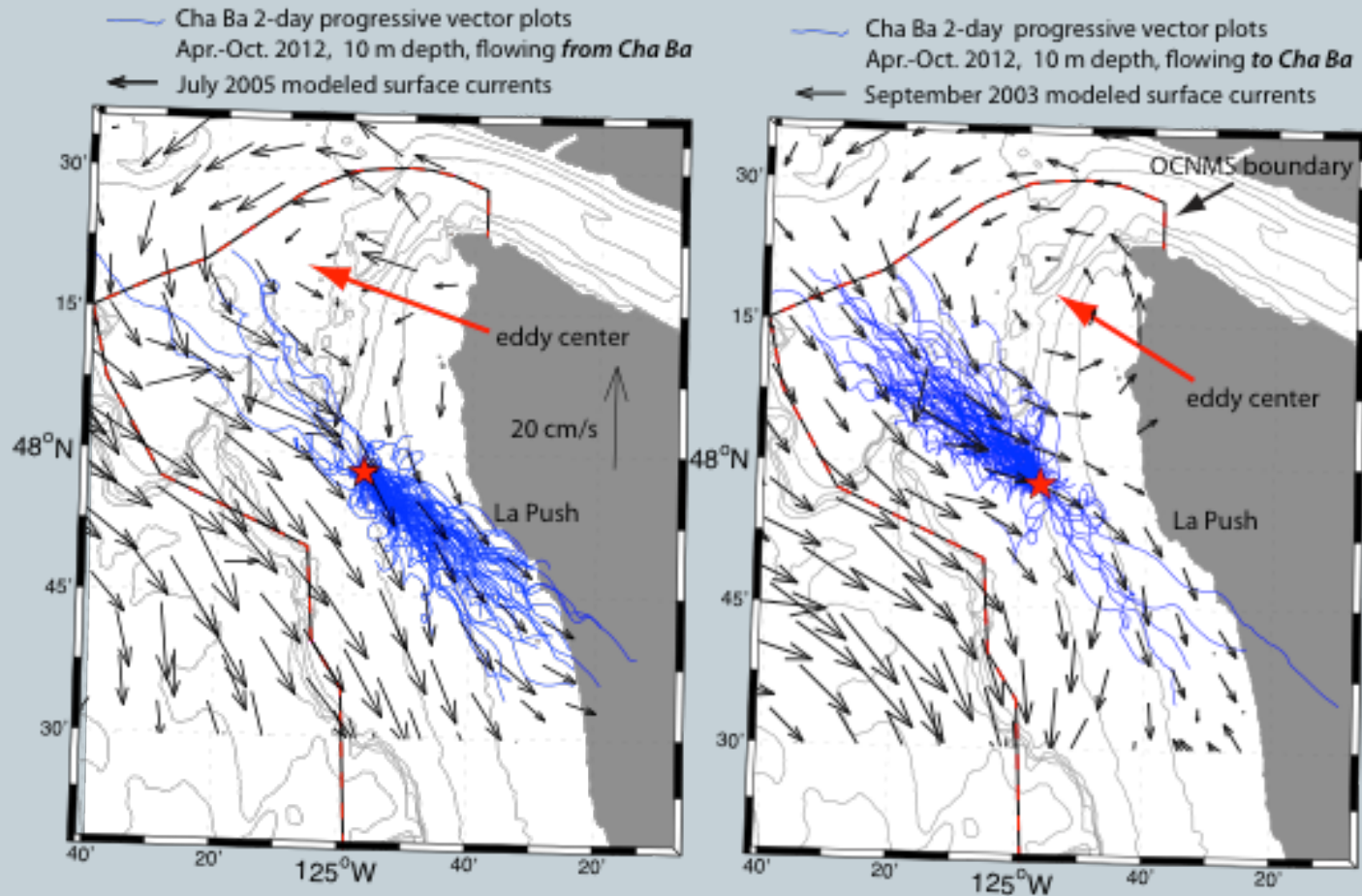
Winter/early spring strong storms

- ★ NEMO with ESP
- OOI Endurance Array moorings
- NDBC wind buoy
- ▬ Razor clam beaches
- Fresher plume water
- Semi-retentive areas



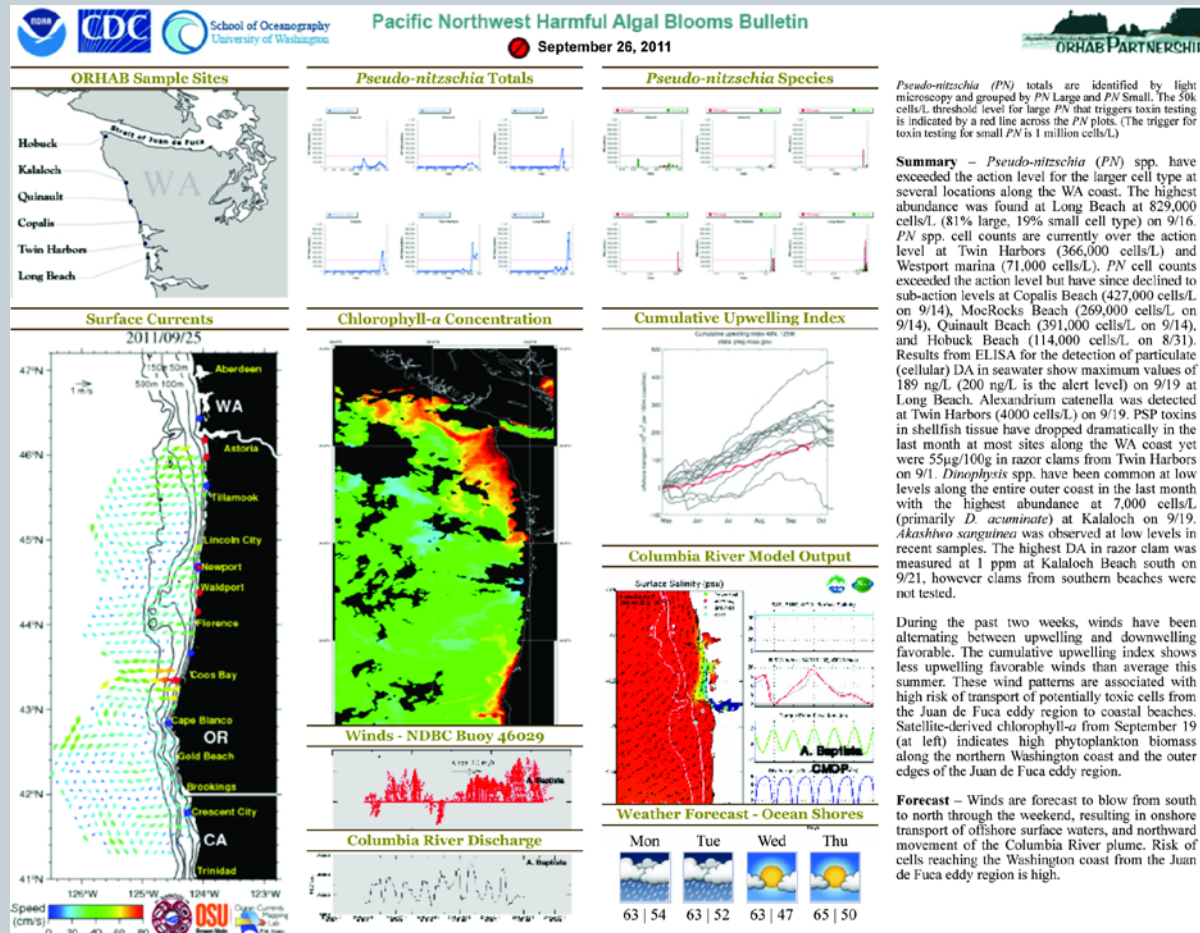
NEMO ideally located to detect toxic *Pseudo-nitzschia* escaping from eddy

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ESP and Beach Monitoring inform Modeling and HAB Forecasts

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2014-2016 IOOS OTT Project (PI: John Mickett, Applied Physics Lab)

**...vision
from 2006**

Data Telemetry

FLO-CAM -
ID Species

DA Sensors

T, Sal, Fluorescence

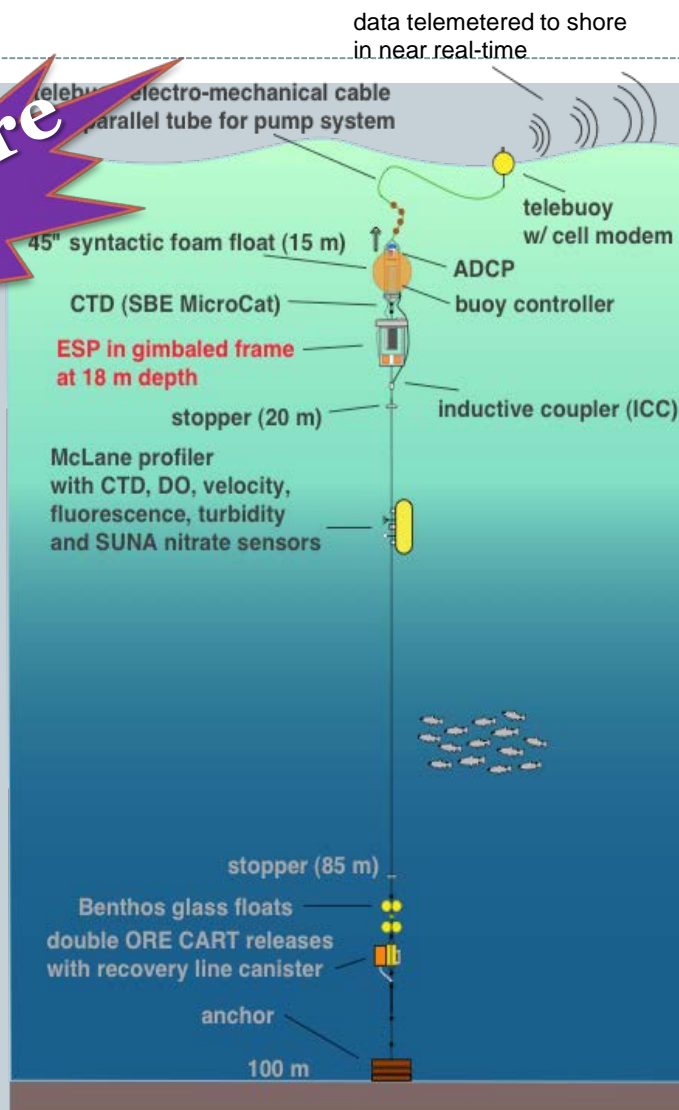
Nutrient Analyzer

Velocity Profiler

**...the future
is here!!**



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Acknowledgments

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- **UW APL**
 - John Mickett + team
 - Jan Newton
- **UW Oceanography**
 - Ryan McCabe
 - Barbara Hickey
- **NOAA CCEHBR**
 - Greg Doucette
 - Tina Mikulski
- **NOAA NWFSC**
 - Nick Adams
 - Linda Rhodes
 - Vera Trainer
 - Kathi Lefebvre
- **MBARI**
 - Jim Birch
 - Roman Marin III
 - Brent Roman
 - Chris Scholin
- **WHOI**
 - Don Anderson
 - Bruce Keafer
- **NWIC**
 - Marco Hatch
- **ORHAB**
- **Quinault Indian Nation**
- **Quileute Nation**
- **OCNMS**
- **WDOH**
- **WDFW**
- **U.S. IOOS**
- **NOAA OHHI**
- **NOAA Office of Aquaculture**
- **NANOOS**
- **Spyglass Technologies**