# West Coast HABs: Highlights of Monitoring and Modeling Technologies

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

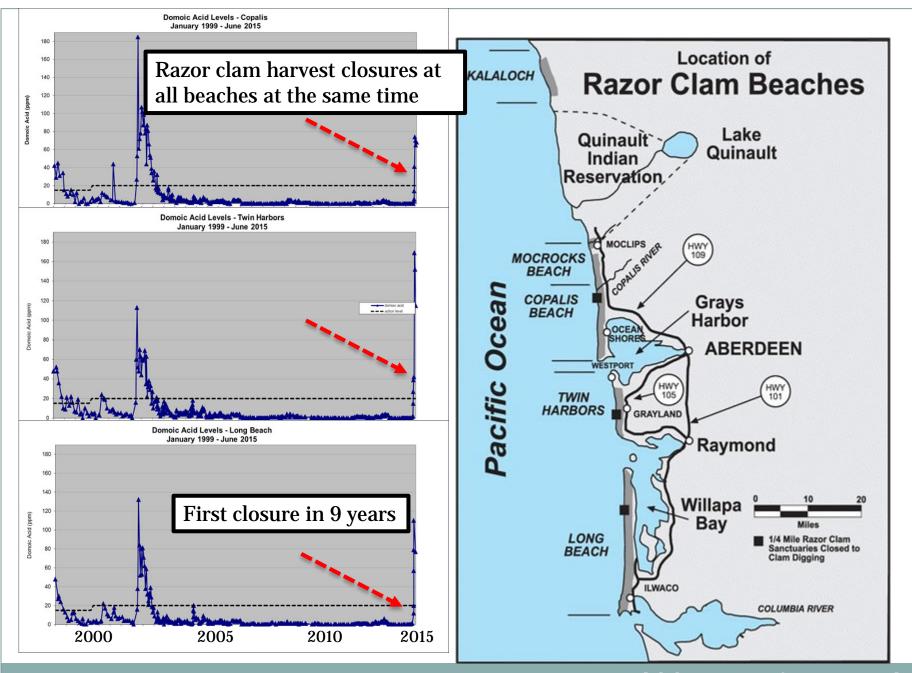
#### *Pseudo-nitzschia* and the Olympic Coast Health Shellfish Safety Information Richmond Langley View Options Start Over Surrey Legend Links Search/Help Canada Last Update: Thu, 29 Oct 2015 03:00:02 PDT Gulf of Alaska **Health Status Only** Whatcom Co Duncan All areas are closed for the recreational (sport) harvest of scallops due to biotoxins. **Public Shellfish Beaches** Okanogan Co Open Mount v Skagit Co. - Conditionally Open Victoria Closed (click beaches for species) Unclassified Marine Biotoxin Closure Zones sland Closed for all species including clams, geoduck, scallops, mussels, ovsters, snails and other Clallam Co Snohomish Co invertebrates (not crab or shrimp). Open for <u>Razor Clams</u>. Closed for all other species. Chelan Co Closed for <u>Butter Clams, Geoduck and Varnish Clams</u> Jefferson Co Closed for Butter and Varnish Clams only Seattle Douglas Co. Closed for Varnish Clams only 10. King Co 90 Closed for Butter and Geoduck Clams only Kent Mason Closed for Butter Clams only Closed for Geoducks only Grays Harbor Co Kittitas Co Olympi Closed for All Crab Species Pierce Co. Grant Co. K Closed for Other Species Combinations. Thurston Co Shellfish Harvest Area Classification Approved 12 Conditionally Approved akima Lewis Co Pacific Co Unclassified Yakima Co Closed Due to Pollution Benton Co Wahkiakum Co WDFW Seasons & Regulations Cowlitz Co Skamania Co Astoria Longview Last Update: Thu, 29 Oct 2015 03:00:02 PDT -123.1806. 49.1435

# U.S. West Coast Pseudo-nitzschia bloom

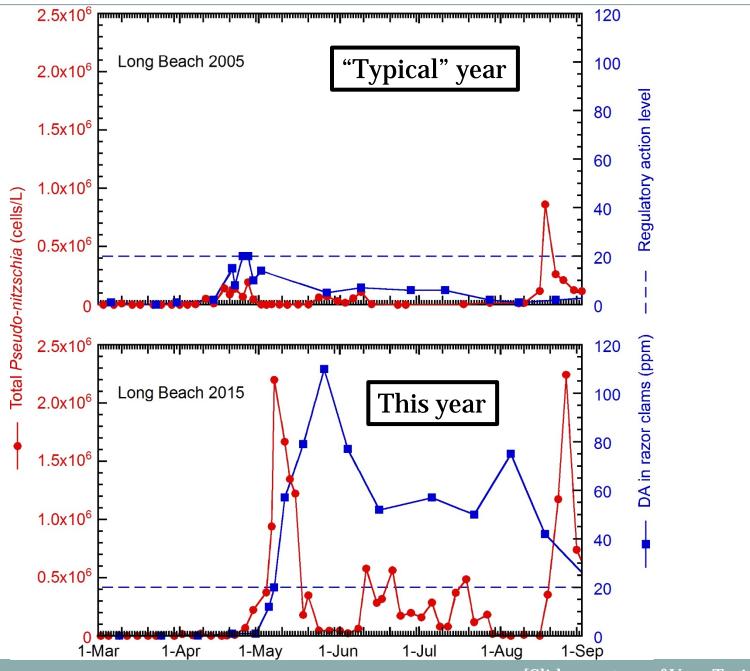
- Large geographical extent: Channel Islands to Aleutian Islands
- Long lasting (months)
- Highest toxin in anchovies ever measured
- "Super" *Pseudo-nitzschia* large chains, chloroplasts bulging



University Corporation for Atmospheric Research & NOAA's Northwest Fisheries Science Center [Slide courtesy of Vera Trainer]



[Slide courtesy of Vera Trainer]



<sup>[</sup>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





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

### **WARRN-West**

- 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 WARRN-West and Biomedical

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



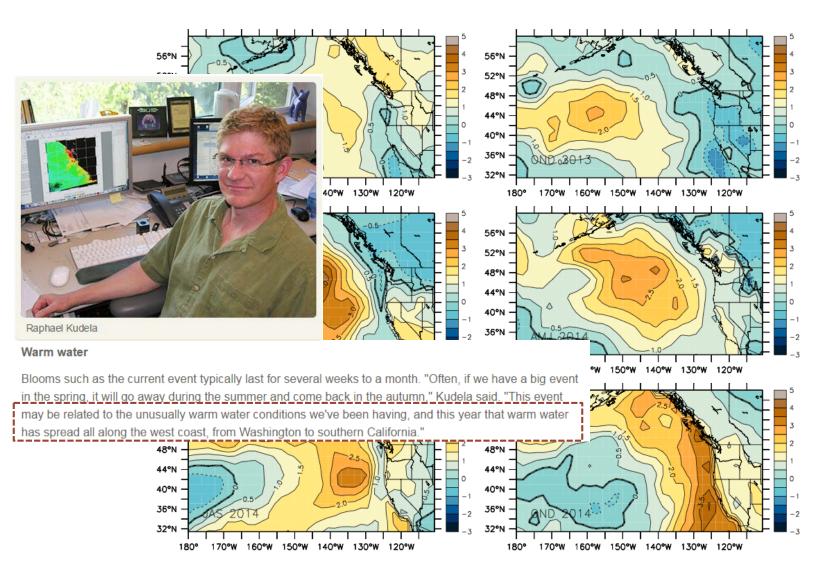


Diagnostics



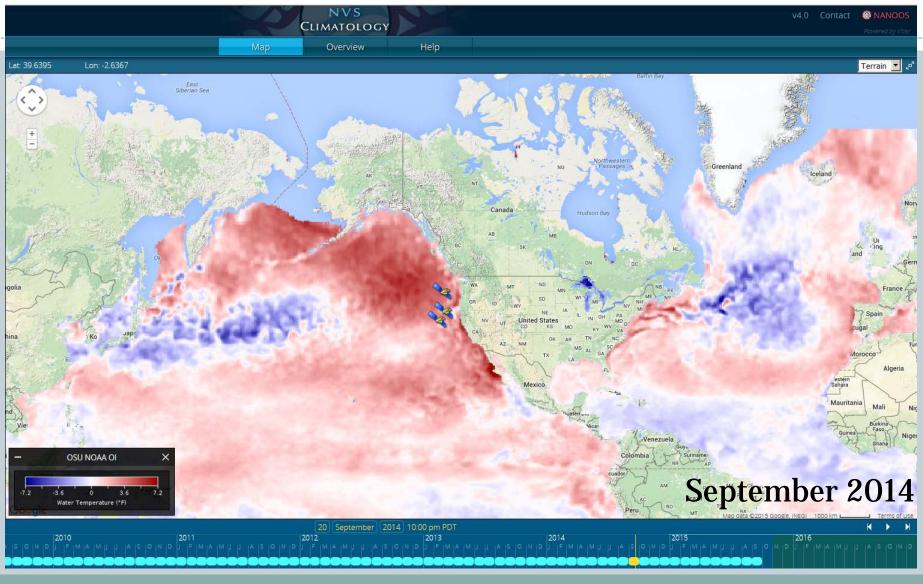
Kathi Lefebvre, Program Leader Anne Baxter, WARRN-West Manager

### Blame the "Blob"?

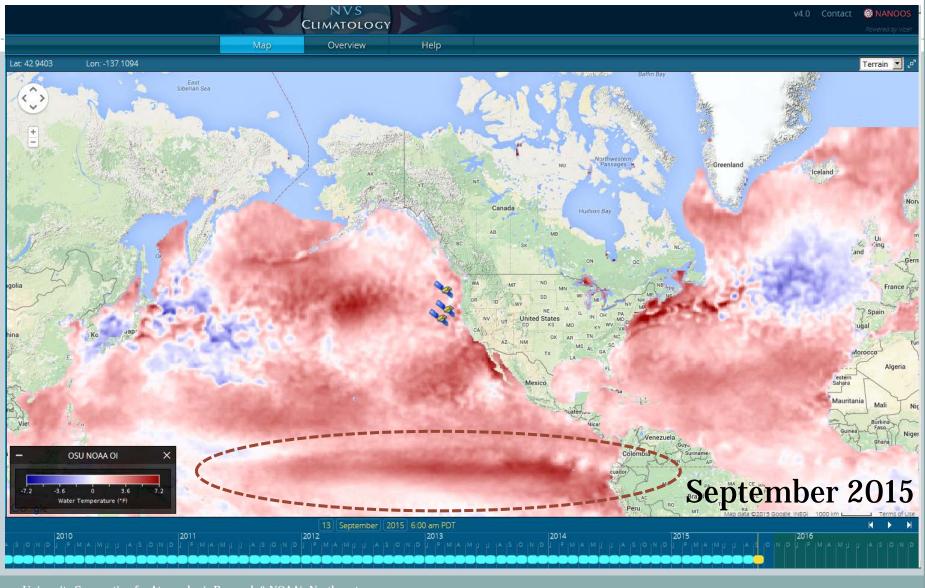


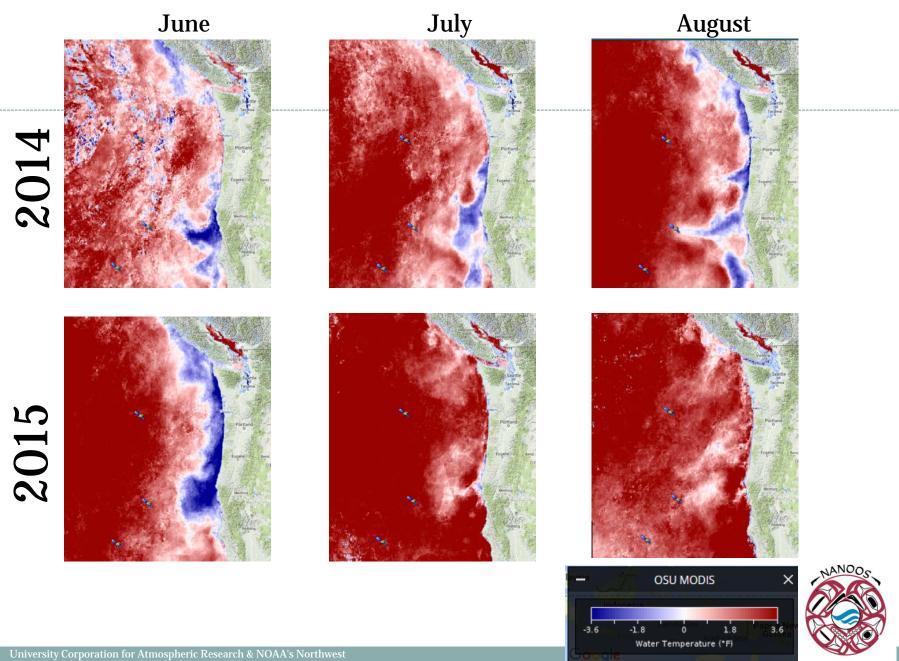
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# Return of the "Blob"?



# Return of the "Blob"?





## **ORHAB Partnership – Beach Monitoring**

### 1. Collect plankton



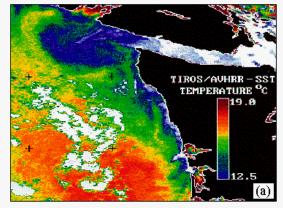
3. Test for toxin (sw & clams)

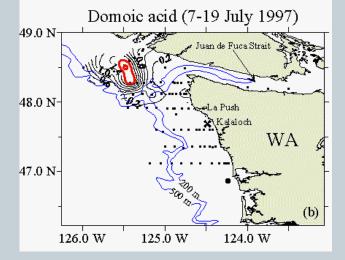


### 4. Test clams at WDOH

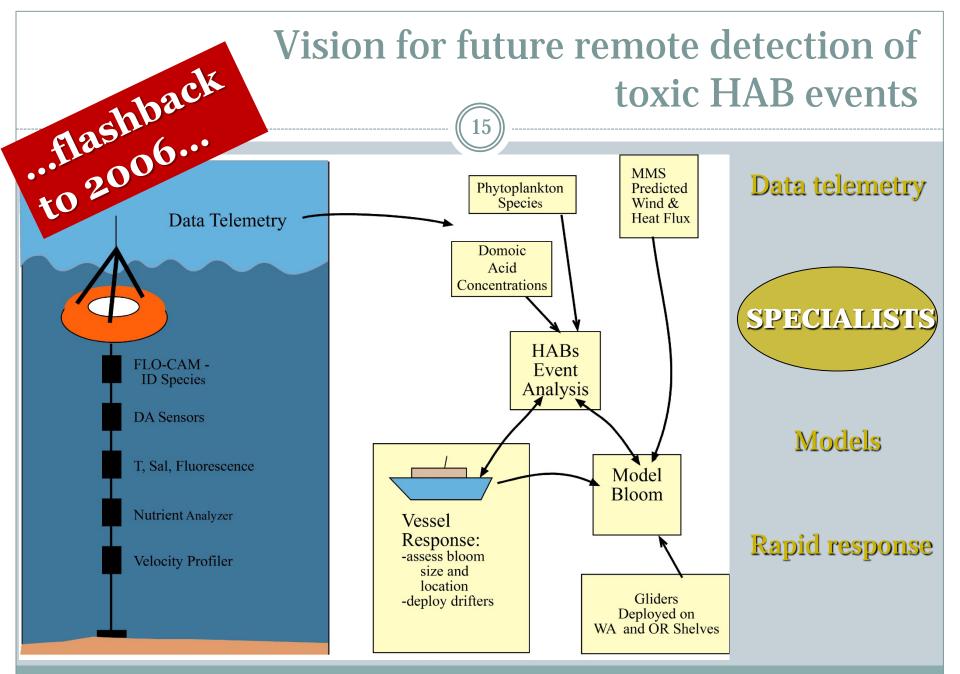


#### AVHRR (18 July 1997)





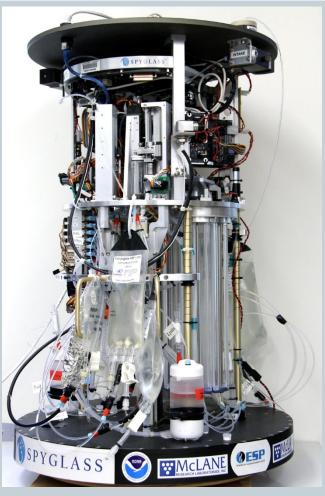
#### [Slide courtesy of Vera Trainer]



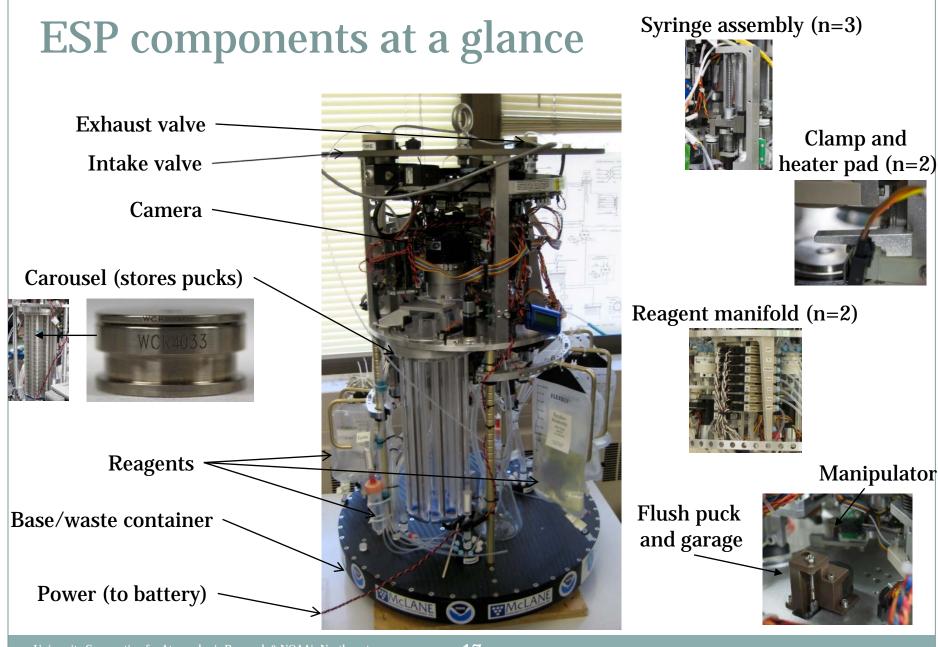
University Corporation for Atmospheric Research & NOAA's Northwest Fisheries Science Center [Slide courtesy of B. Hickey & V. Trainer]

# **Environmental Sample Processor (ESP)**

- 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



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# **ESP deployment options**

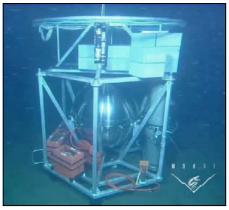


**Moored ESP** 

© MBARI



### Deep ESP



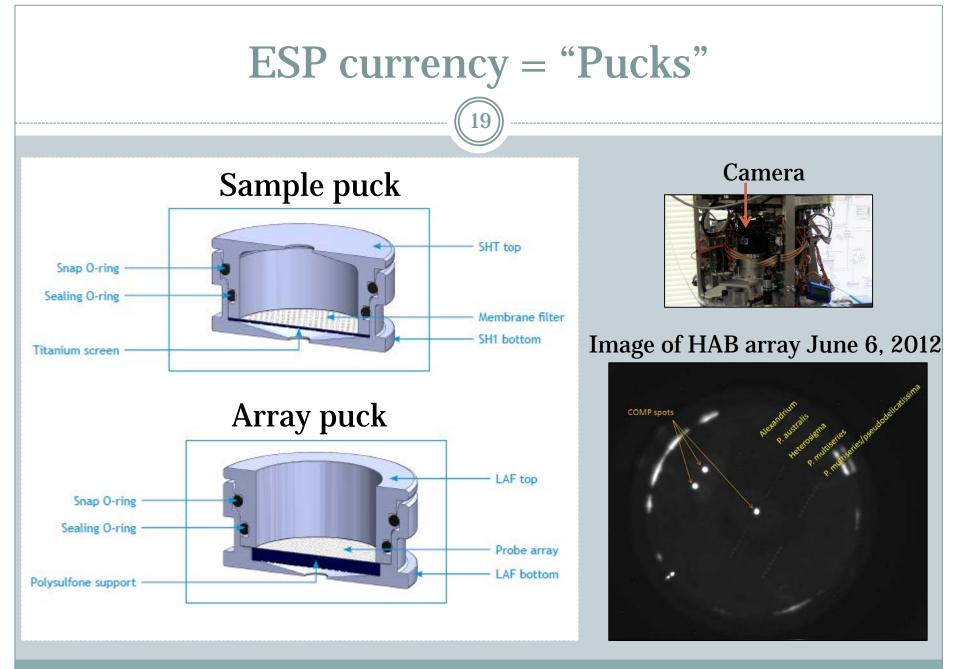
### **Drifting ESP**



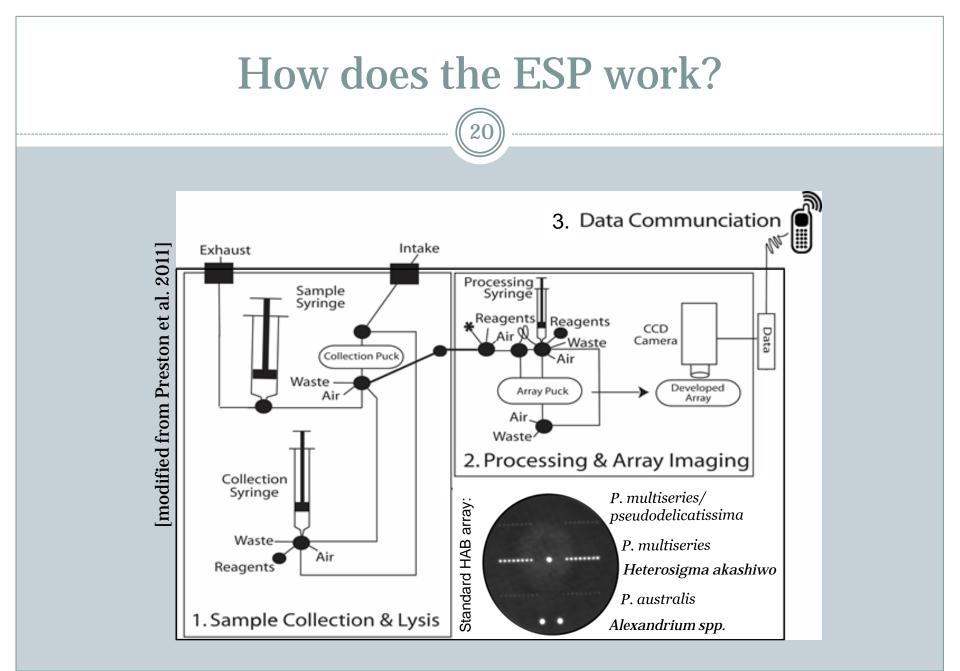
### **Dockside ESP**



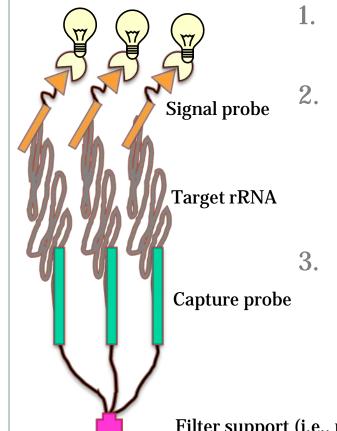
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[Figure credit: Spyglass Biosecurity]



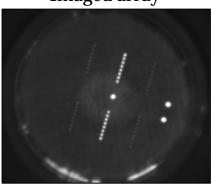
### Molecular analysis = Sandwich Hybridization Assay **DNA probe arrays detect ribosomal RNA of target sequences**



- Capture probe part of the 1. printed DNA probe array
- 2. ESP collects sample, creates nucleic acid extract, target rRNA sticks to capture probe, rest of extract washed away

Signal probe attaches to different part of rRNA completing the "sandwich"

**Imaged array** 



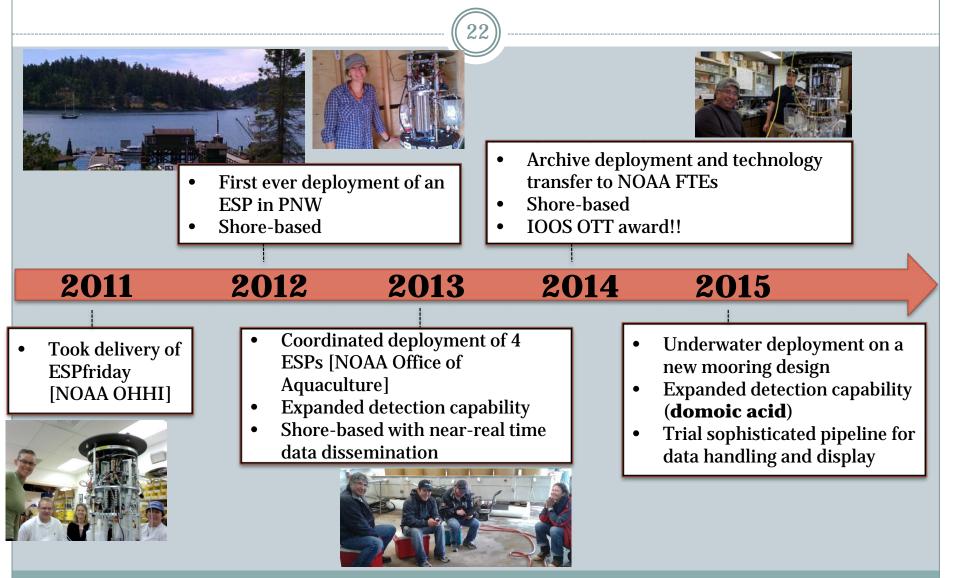
Verification by matching 96-well plate



**Filter support (i.e., printed probe array)** 

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

# ESP research at NOAA's NWFSC



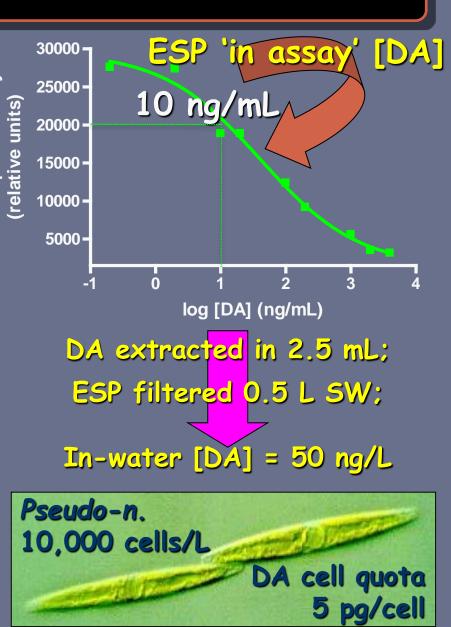
### DA cELISA: detection of domoic acid on ESP

intensi

mean spot

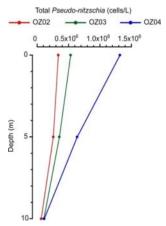
DA-protein IgG chemistry conjugate controls

- 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



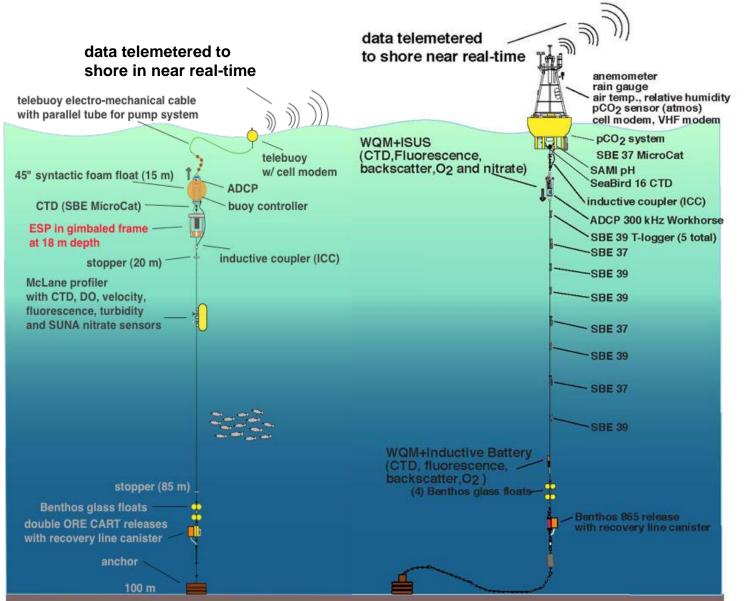


Figure credits: J. Mickett and N. Adams

### 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

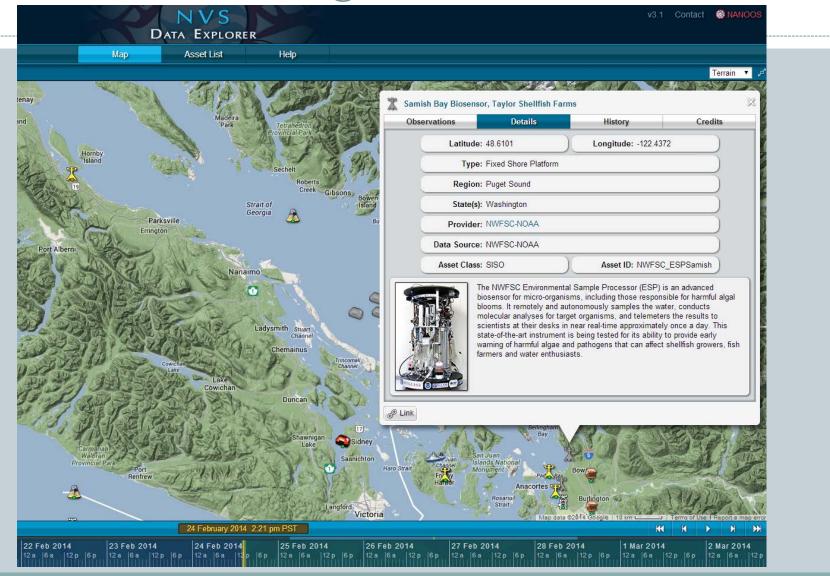
**Canning ESPfriday** UW/APL Keith Magness and John Mickett assist NWFSC Linda Rhodes to "can"

ESPfriday



Testing the pump UW/APL Derek Martin tests the "transit time" of the pump system using fluorescein dye

### Data handling and visualization





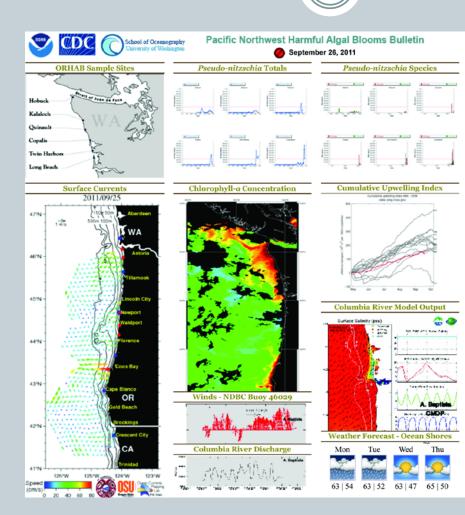
University Corporation for Atmospheric Research & NOAA's Northwest Fisheries Science Center

#### Modified from Hickey et al. 2013

#### NEMO ideally located to detect toxic *Pseudo*nitzschia escaping from eddy 29 Cha Ba 2-day progressive vector plots Cha Ba 2-day progressive vector plots Apr.-Oct. 2012, 10 m depth, flowing from Cha Ba Apr.-Oct. 2012, 10 m depth, flowing to Cha Ba July 2005 modeled surface currents September 2003 modeled surface currents OCNMS boundary 30 eddy center eddy center 20 cm/s $48^{\circ}$ 48°1 a Push La Push 30 30 20 125°W 40' 20 125°W 40 20

## ESP and Beach Monitoring inform Modeling and HAB Forecasts

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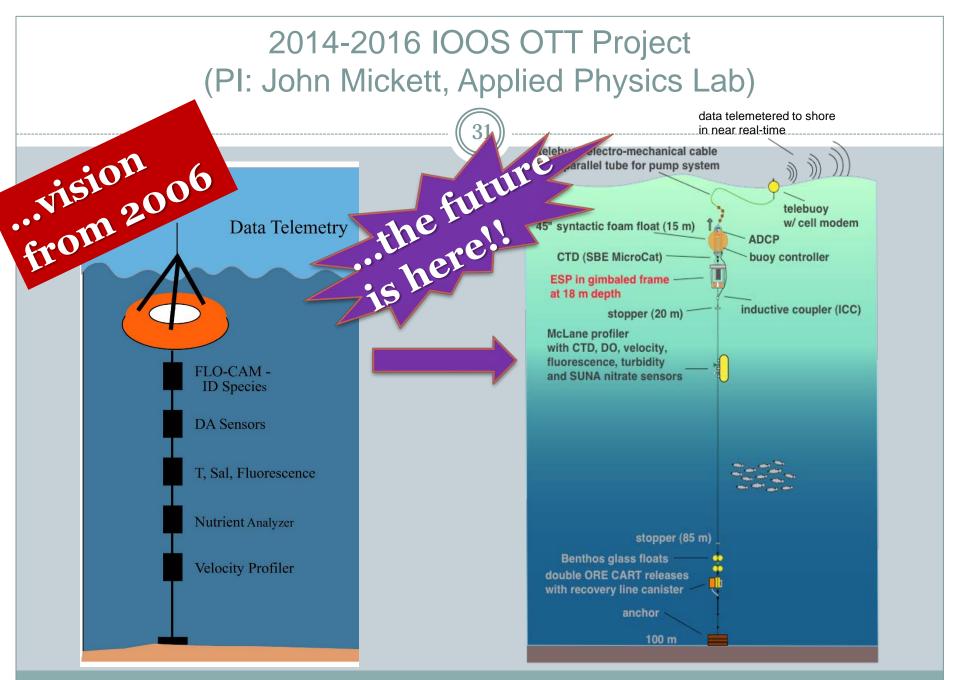


Pseudo-nitzschia (PN) totals are identified by light microscopy and grouped by PN Large and PN Small. The 50k cells/L threshold level for large PN that triggers toxin testing is indicated by a red line across the PN plots. (The trigger for toxin testing for small PN is 1 million cells/L).

Summary - Pseudo-nitzschia (PN) spp. have exceeded the action level for the larger cell type at several locations along the WA coast. The highest abundance was found at Long Beach at 829,000 cells/L (81% large, 19% small cell type) on 9/16. PN spp. cell counts are currently over the action level at Twin Harbors (366,000 cells/L) and Westport marina (71,000 cells/L). PN cell counts exceeded the action level but have since declined to sub-action levels at Copalis Beach (427,000 cells/L on 9/14), MocRocks Beach (269,000 cells/L on 9/14), Quinault Beach (391,000 cells/L on 9/14), and Hobuck Beach (114,000 cells/L on 8/31). Results from ELISA for the detection of particulate (cellular) DA in seawater show maximum values of 189 ng/L (200 ng/L is the alert level) on 9/19 at Long Beach. Alexandrium catenella was detected at Twin Harbors (4000 cells/L) on 9/19. PSP toxins in shellfish tissue have dropped dramatically in the last month at most sites along the WA coast yet were 55µg/100g in razor clams from Twin Harbors on 9/1. Dinophysis spp. have been common at low levels along the entire outer coast in the last month with the highest abundance at 7,000 cells/L (primarily D. acuminate) at Kalaloch on 9/19. Akashiwo sanguinea was observed at low levels in recent samples. The highest DA in razor clam was measured at 1 ppm at Kalaloch Beach south on 9/21, however clams from southern beaches were not tested.

During the past two weeks, winds have been alternating between upwelling and downwelling favorable. The cumulative upwelling index shows less upwelling favorable winds than average this summer. These wind patterns are associated with high risk of transport of potentially toxic cells from the Juan de Fuca eddy region to coastal beaches. Satellite-drived chlorophyll-*a* from September 19 (at left) indicates high phytoplankton biomass along the northern Washington coast and the outer edges of the Juan de Fuca eddy region.

Forecast – Winds are forecast to blow from south to north through the weekend, resulting in onshore transport of offshore surface waters, and northward movement of the Columbia River plume. Risk of cells reaching the Washington coast from the Juan de Fuca eddy region is high.



# Acknowledgments

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