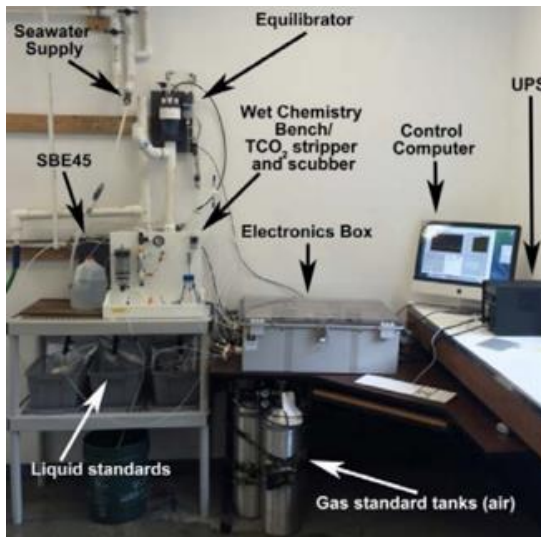


IOOS Support for US Shellfish

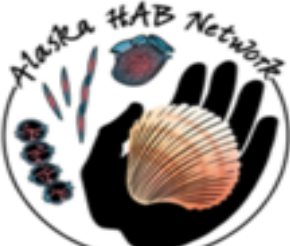


Molly McCammon
Alaska Ocean Observing System

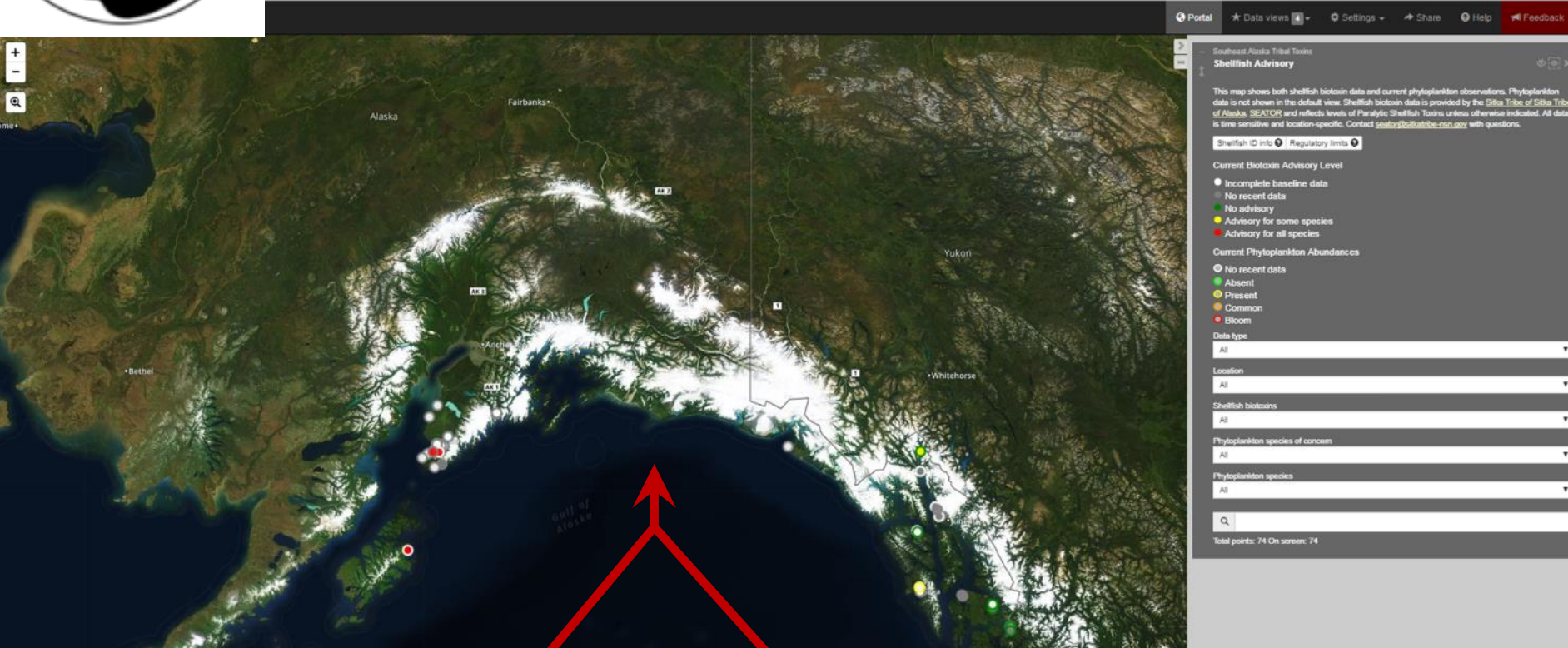


Oceanology International
October 23, 2018

- **Addressing Harmful Algal Blooms**
- **Siting Mariculture Farms**
- **Responding to Increasing Ocean Acidification**



Harmful Algal Bloom Network, Data Portal & Tools



Portal Data views Settings Share Help Feedback

Southeast Alaska Tribal Toxins
Shellfish Advisory

This map shows both shellfish biotoxin data and current phytoplankton observations. Phytoplankton data is not shown in the default view. Shellfish biotoxin data is provided by the Sitka Tribe of Alaska, SEATOR and reflects levels of Paralytic Shellfish Toxins unless otherwise indicated. All data is time sensitive and location-specific. Contact seator@sitkatribetoxins.gov with questions.

Shellfish info Regulatory limits

Current Biotoxin Advisory Level

- Incomplete baseline data
- No recent data
- No advisory
- Advisory for some species
- Advisory for all species

Current Phytoplankton Abundances

- No recent data
- Absent
- Present
- Common
- Bloom

Data type: All

Location: All

Shellfish biotoxins: All

Phytoplankton species of concern: All

Phytoplankton species: All

Total points: 74 On screen: 74

SEATOR
SITKA TRIBE OF ALASKA
SHELLFISH ADVISORIES

Home New! Basic Info STAERL Data Ocean Acidification Clean Water Links List

Shellfish Advisories

Welcome to the new SEATOR shellfish advisory page! This page is updated as soon as we have new shellfish information. Our advisories are based on shellfish and phytoplankton observations at each listed location. We follow the FDA regulatory levels of 80 µg toxin/100 g shellfish tissue for paralytic shellfish toxins and 30 µg/g for domoic acid. We do not recommend consuming shellfish with higher levels of toxins. **A few notes of caution when using this tool:** 1) This does not "warn" any of our monitored sites. Shellfish harvesting will always be at your own risk. 2) Data is site specific and time sensitive. Please pay attention to locations and the date of the last sample. 3) Some shellfish species will remain toxic long after an algal bloom is over! Know your shellfish species and pay attention to species-specific advisories. 4) Conditions may change rapidly, especially in the summer. Check frequently and contact us with questions at seator@sitkatribetoxins.gov.

For expanded information, click on the arrows to the left of each region. These advisories will soon be available in map form. Thank you for your patience as we update this site.

Advanced Search and Filtered Data Entry

ID	Program	Name	Use
88215	Shellfish	Shellfish	
88216	Shellfish	Shellfish	
88217	Shellfish	Shellfish	
88218	Shellfish	Shellfish	
88219	Shellfish	Shellfish	
88220	Shellfish	Shellfish	
88221	Shellfish	Shellfish	
88222	Shellfish	Shellfish	
88223	Shellfish	Shellfish	
88224	Shellfish	Shellfish	
88225	Shellfish	Shellfish	
88226	Shellfish	Shellfish	
88227	Shellfish	Shellfish	
88228	Shellfish	Shellfish	
88229	Shellfish	Shellfish	
88230	Shellfish	Shellfish	
88231	Shellfish	Shellfish	
88232	Shellfish	Shellfish	
88233	Shellfish	Shellfish	
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88241	Shellfish	Shellfish	
88242	Shellfish	Shellfish	
88243	Shellfish	Shellfish	
88244	Shellfish	Shellfish	
88245	Shellfish	Shellfish	
88246	Shellfish	Shellfish	
88247	Shellfish	Shellfish	
88248	Shellfish	Shellfish	
88249	Shellfish	Shellfish	
88250	Shellfish	Shellfish	

Map view showing sampling locations on a map of Alaska.

Data View of SEATOR Shellfish and HAB Data Developed by AOOS Data Team (Axiom Data Science)

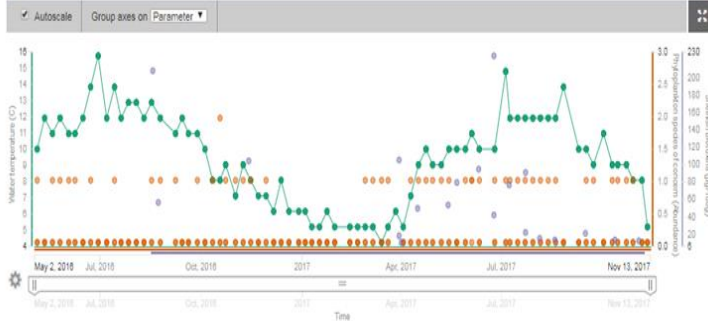
SEATOR Shellfish and HAB Data

Portal Data views Settings Share Help Feedback

★ Shellfish toxicity and abundance of harmful algae, Shoemaker Beach, Wrangell AK



Comparison chart



Water temperature (C)

Legend: Southeast Alaska Tribal Toxins: Shellfish Advisory, Wrangell: Shoemaker Beach

Phytoplankton species of concern (Abundance)

Legend: Southeast Alaska Tribal Toxins: Shellfish Advisory, Wrangell: Shoemaker Beach

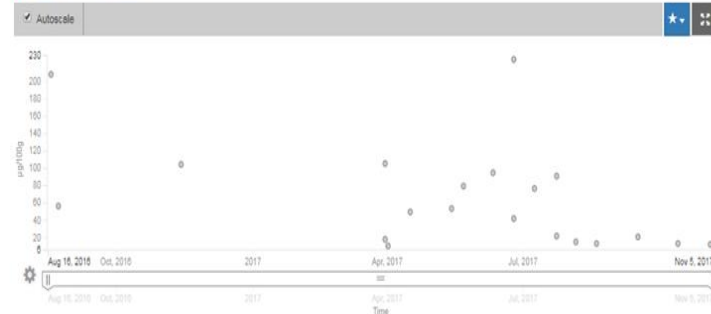
Shellfish biotoxins (µg/100g)

Legend: Southeast Alaska Tribal Toxins: Shellfish Advisory, Wrangell: Shoemaker Beach

Saved charts

Shellfish biotoxins

Southeast Alaska Tribal Toxins: Shellfish Advisory
Wrangell: Shoemaker Beach

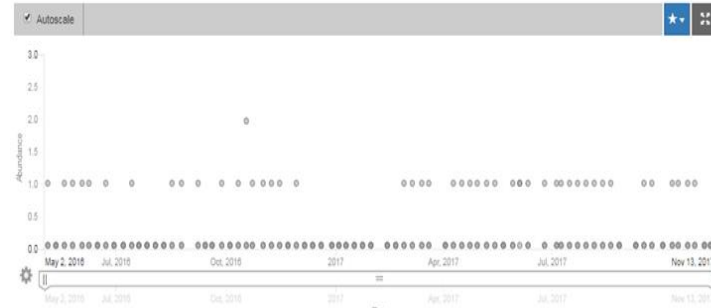


Shellfish species (All)

Download Detail

Phytoplankton species of concern

Southeast Alaska Tribal Toxins: Shellfish Advisory
Wrangell: Shoemaker Beach



Toxic phytoplankton species (All)

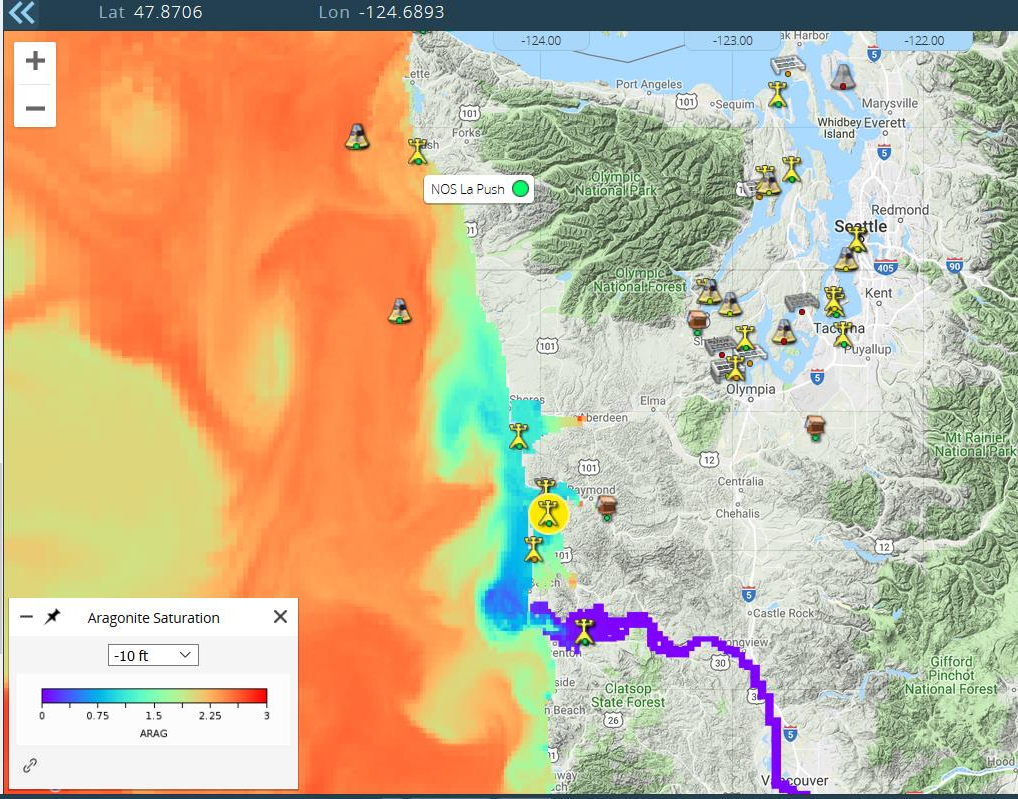
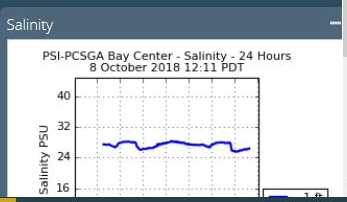
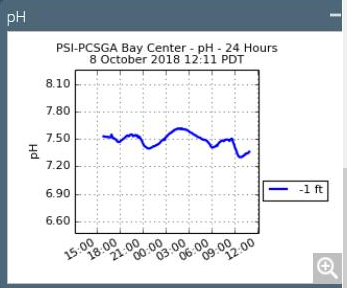
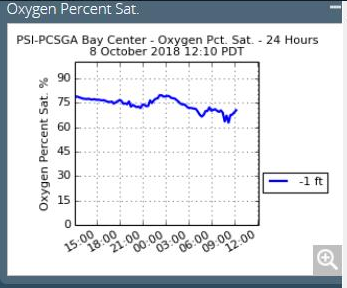
Download Detail

Water temperature

Southeast Alaska Tribal Toxins: Shellfish Advisory
Wrangell: Shoemaker Beach

Lat 47.8706 Lon -124.6893

- Layers
- Platforms
- Plots
- Legend



PCSGA - Bay Center Port mooring, Willapa Bay

Observations Forecasts Comparator Details History Credits

Data Updated: 8 Oct 2018 9:58 PDT Provider: PSI

HYDROGRAPHIC

Alkalinity (total) (-1 ft)	1,936 $\mu\text{mol/kg}$
CO2 Water (-1 ft)	1,171 μatm
TCO2 (-1 ft)	1,925 $\mu\text{mol/kg}$
Omega Arag. Sat. (-1 ft)	0.7
Oxygen Conc. (-1 ft)	7.2 mg/L
Oxygen Pct. Sat. (-1 ft)	70 %
pH (-1 ft)	7.3
Salinity (-1 ft)	25.9 PSU
Water Temperature (-1 ft)	57.7 °F

Link



REALTIME HABs

Real-time Information About Harmful Algal Blooms

Home

ESP Now

ESP Then

About

Media

People

Partners

Disclaimer

Contact

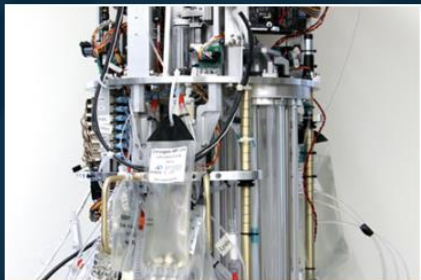


Real-Time HABs provides timely information on harmful algae in the Pacific Northwest. Measurements are made remotely and autonomously by an underwater robot, the ESP, and are available in near-real time in the *ESP Now* section. The ESP detects certain phytoplankton species that are known to be harmful at times, as well as the toxin that they produce. Toxic phytoplankton blooms can contaminate seafood and harm marine wildlife. These events are called "harmful algal blooms" or HABs. By detecting both the potentially harmful phytoplankton species as well as the toxin they produce, the ESP gives us early warning of these events.



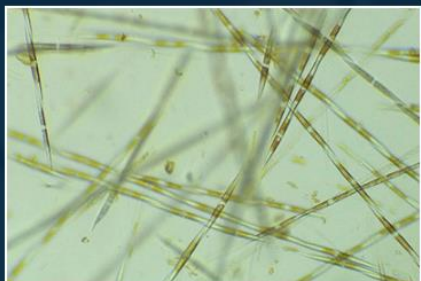
ESP Data and Information

The most recent data and information coming from the ESP mooring.



A new tool is on the lookout for harmful algal blooms and their toxins off the coast of La Push, Washington. The Environmental Sample Processor (ESP) will monitor specific algal species and domoic acid, a toxin the algae produce.

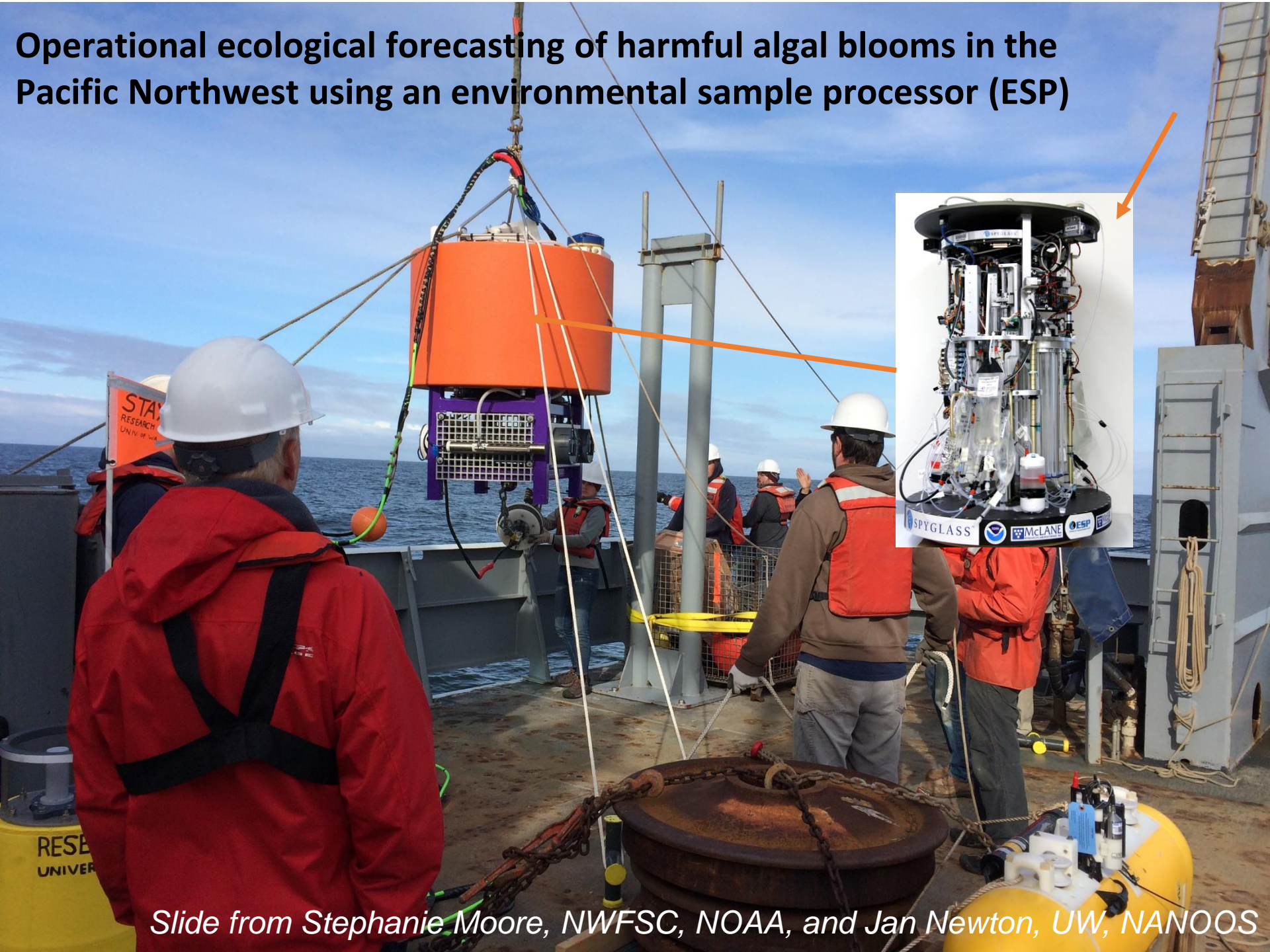
[Learn more about the ESP](#)



"Harmful Algal Blooms" (HABs) can cause serious health and economic problems including injuries to marine mammals, human illness or even death and economic losses related to fishery failures and lost tourism revenue.

[What are HABs?](#)

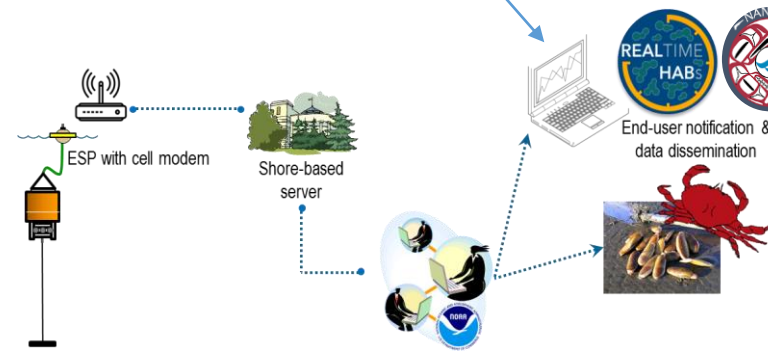
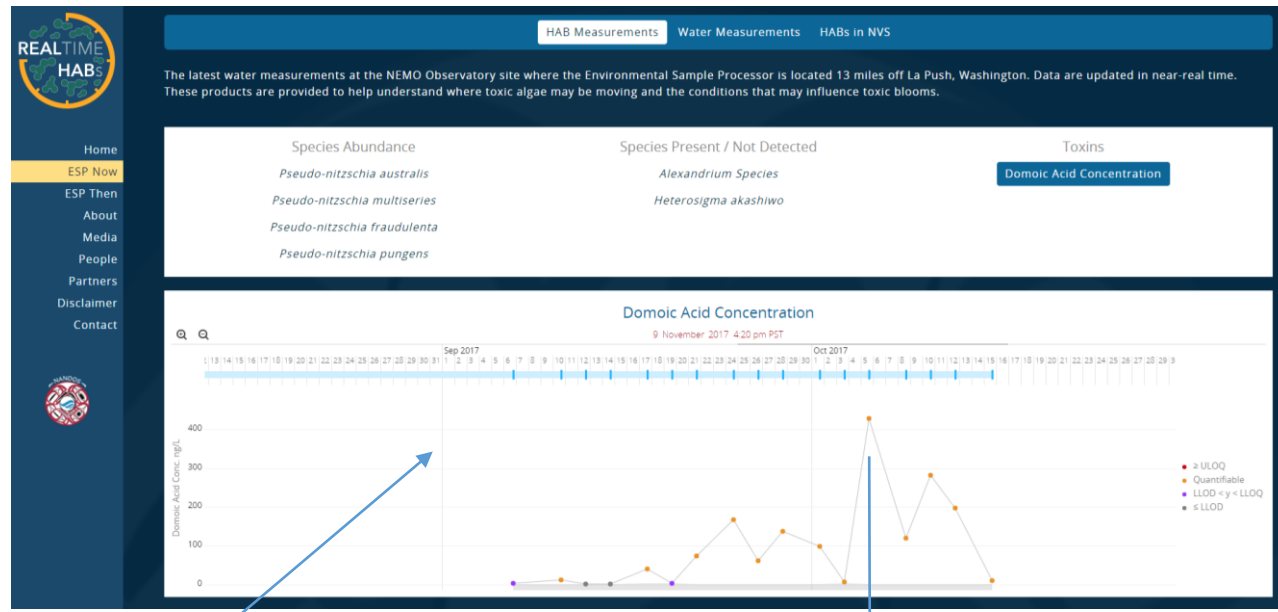
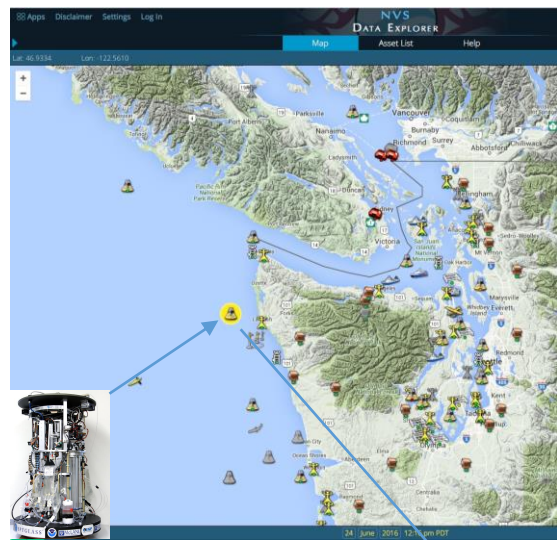
Operational ecological forecasting of harmful algal blooms in the Pacific Northwest using an environmental sample processor (ESP)



Slide from Stephanie Moore, NWFSC, NOAA, and Jan Newton, UW, NANOOS

Can we protect against HABs?

The ESP detects *Pseudo-nitzschia* cells, other HAB species, and cell toxicity, and relays the data to the NANOOS app that managers can access in near-real time.



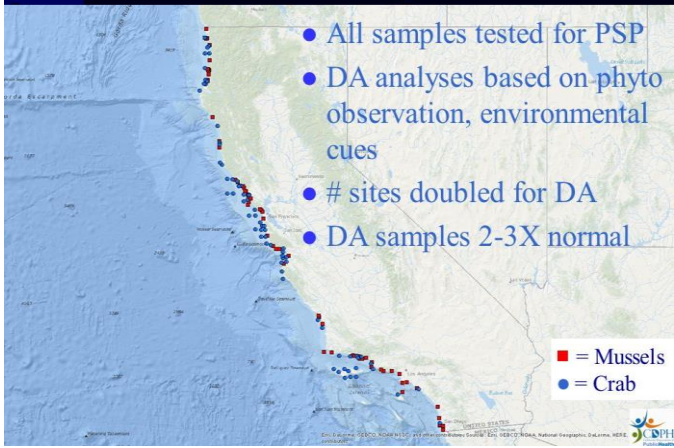
Spike in domoic acid detected eve of razor clam opening weekend

**triggered analysis of additional razor clam samples that were determined to be safe*



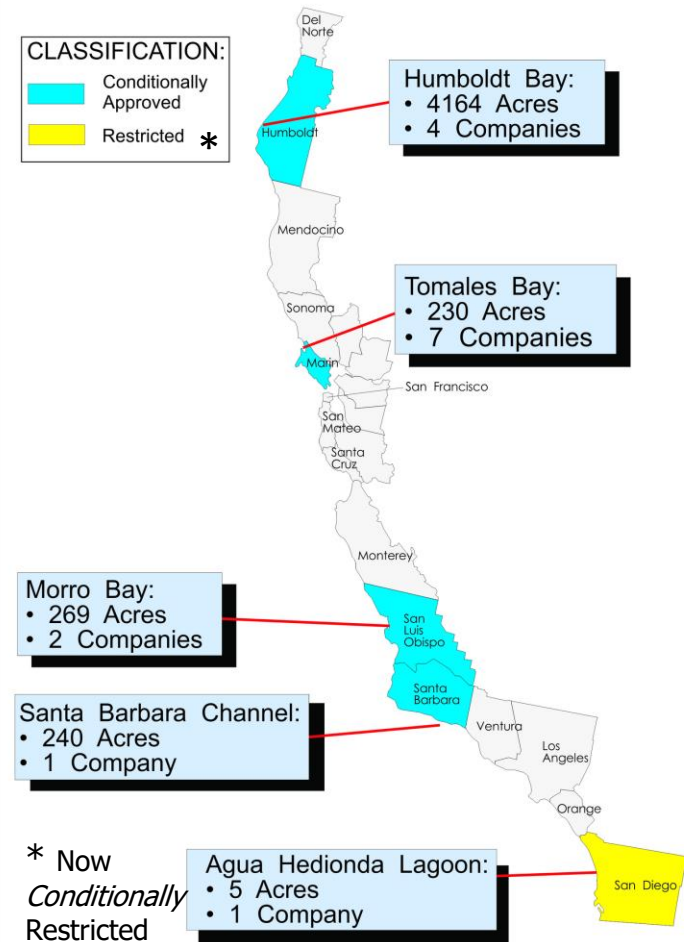
What does the domoic acid problem mean for shellfish consumption?

Shellfish Monitoring Sites: 2015



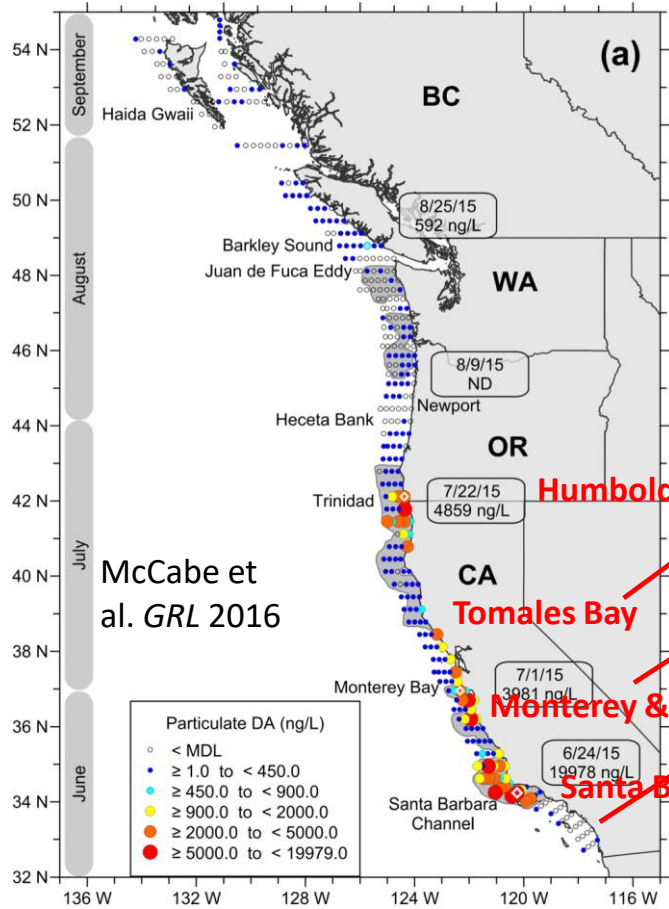
- CA Department of Public Health monitors for DA if the diatom is present at high abundance in the water
- Recreational harvests regulated via fixed quarantine periods

California Commercial Shellfish Growing Areas

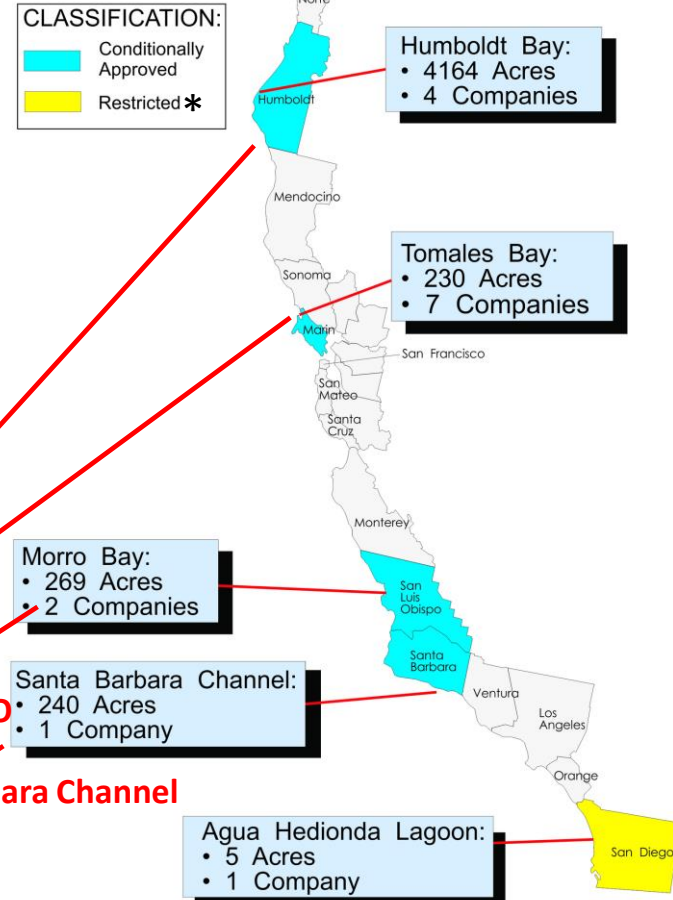


Map: CDPH

HAB Hotspots Align with Shellfish Growing



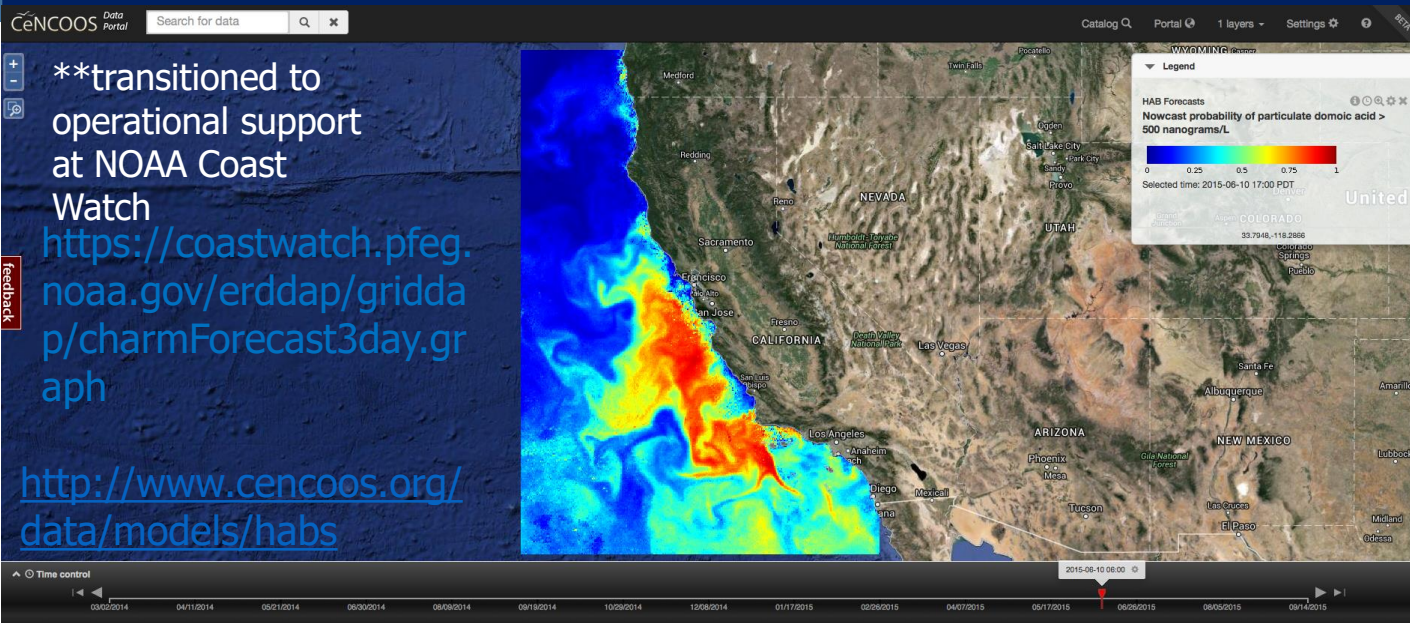
California Commercial Shellfish Growing Areas



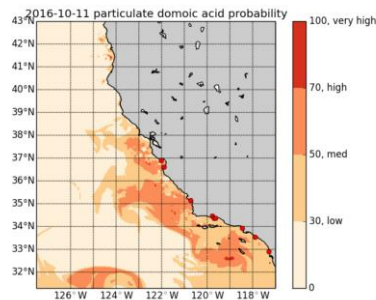
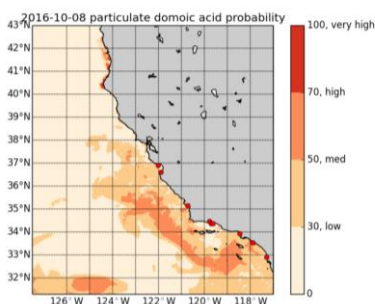
Map: CDPH

California Harmful Algae Mapping (C-HARM) System

Anderson et al., *Harmful Algae* (2009), *GRL* (2011), *Harmful Algae* (2016)



SCCOOS-NCCOS-
 West Coast CoastWatch
 Collaboration to create
 C-HARM Bulletin
 distributed to a listserv
 & on SCCOOS website



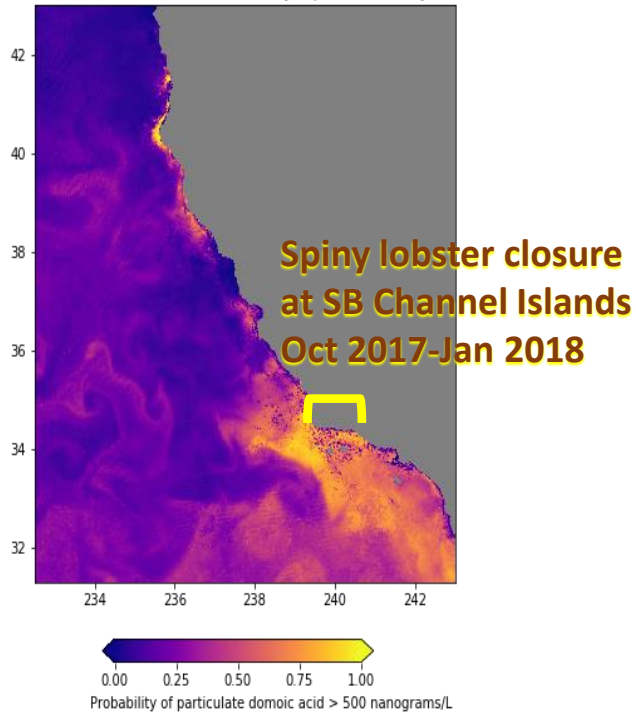
Stakeholder
 engagement is
 done via web
 surveys and
 continual
 outreach to super
 end-users



What does C-HARM tell us about crab (benthic) toxicity?

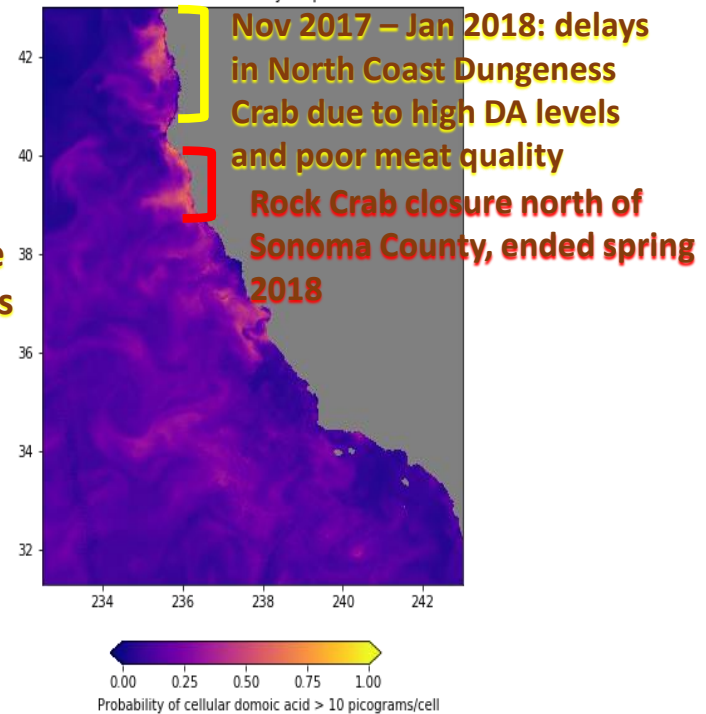
Mean Particulate Domoic Acid Risk April-July 2017

Mean Particulate Domoic Acid Probability: Apr-01-2017 to Jul-01-2017

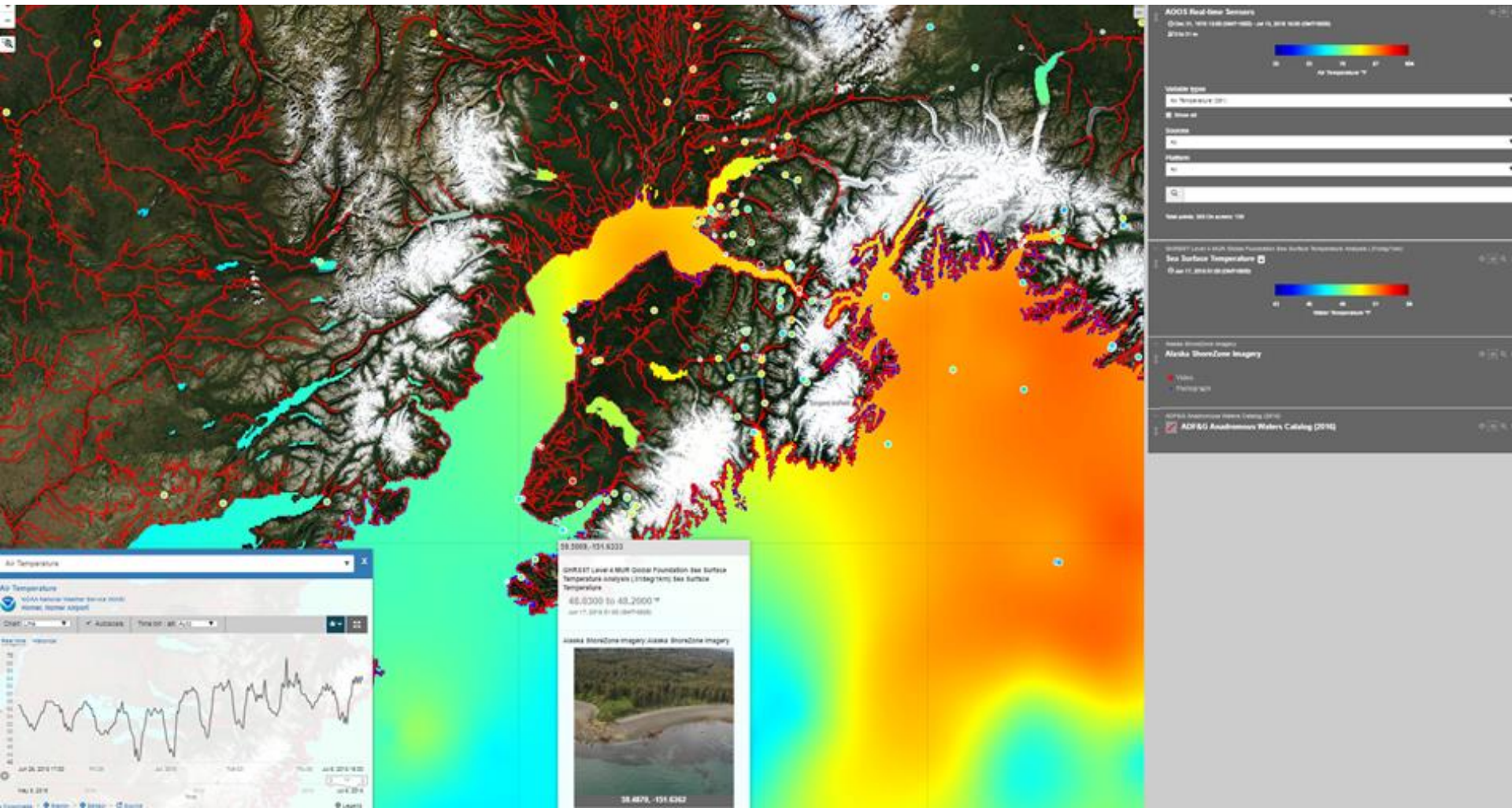


Mean Cellular Domoic Acid Risk Sep-Oct 2017

Mean Cellular Domoic Acid Probability: Sep-01-2017 to Oct-31-2017



Alaska Mariculture Map: prototype



AHAB helps with potential siting



Alaska Ocean Acidification Network



Alaska Ocean
Acidification Network

About the Network About OA Monitoring Biological Impacts Data Resources & Links Find an Expert



Alaska Ocean Acidification Network



Starting in October, Alaska ferry will measure ocean acidification along 1,000 miles of coastline

Ketchikan's KRBD radio shares the story of a project 3 years in the making.

1 2 3 4 5 6 7 8 9 10

[Alaska Ocean Acidification Network News Features archive](#)

Scientist Interview

Allison Bidlack is the director of the Alaska Coastal Rainforest Center at the University of Alaska Southeast in Juneau. Through her focus on temperate rainforests and carbon cycle dynamics, she has been one of the leading proponents behind using the Alaska State Ferry system to collect OA data.



How did you get into the field of ocean acidification, and what drew you to this type of work?

I actually kind of stumbled into it in the course of my current job. My background is in

News feed

- September 26, 2017 [Alaska writer Nancy Lord publishes new novel on ocean acidification](#)
- September 14, 2017 [Southeast residents learn about OA at Petersburg festival](#)
- September 1, 2017 [R/V Healy now collecting data in the Arctic](#)

Video



Watch the trailer for Nancy Lord's recent book "pH: A Novel"

Upcoming events

- Oct 3: First sailing of the state ferry M/V Columbia equipped with OA sensor package (Zx/wk between Bellingham, WA to Skagway, AK)
- Oct 4: OA talk at UAA Campus Bookstore (Anchorage)
- Nov 2-3: Subsistence Advisory Council (Juneau) – OA presentation

- Engage with communities to expand understanding
- Identify information needs and monitoring priorities
- Share best practices
- Promote data sharing

<http://www.aos.org/alaska-ocean-acidification-network/>

***Progress on measuring ocean
acidification variables
with data delivery
to support shellfish aquaculture***

Jan Newton

University of Washington & NANOOS

Wiley Evans

Hakai Institute

Burke Hales, OSU; Jim Beck, Sunburst Sensors;

Simone Alin, NOAA; Tessa Hill, UC Davis; Todd Martz, SIO;

Emilio Mayorga, UW & NANOOS;

Molly McCammon, AOOS; Henry Ruhl, CeNCOOS; Clarissa Anderson, SCCOOS;

Margaret Barrette, Pacific Coast Shellfish Growers Association;

Carl Gouldman, U.S. IOOS; Libby Jewett, NOAA OAP



Measuring OA variables:



'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.

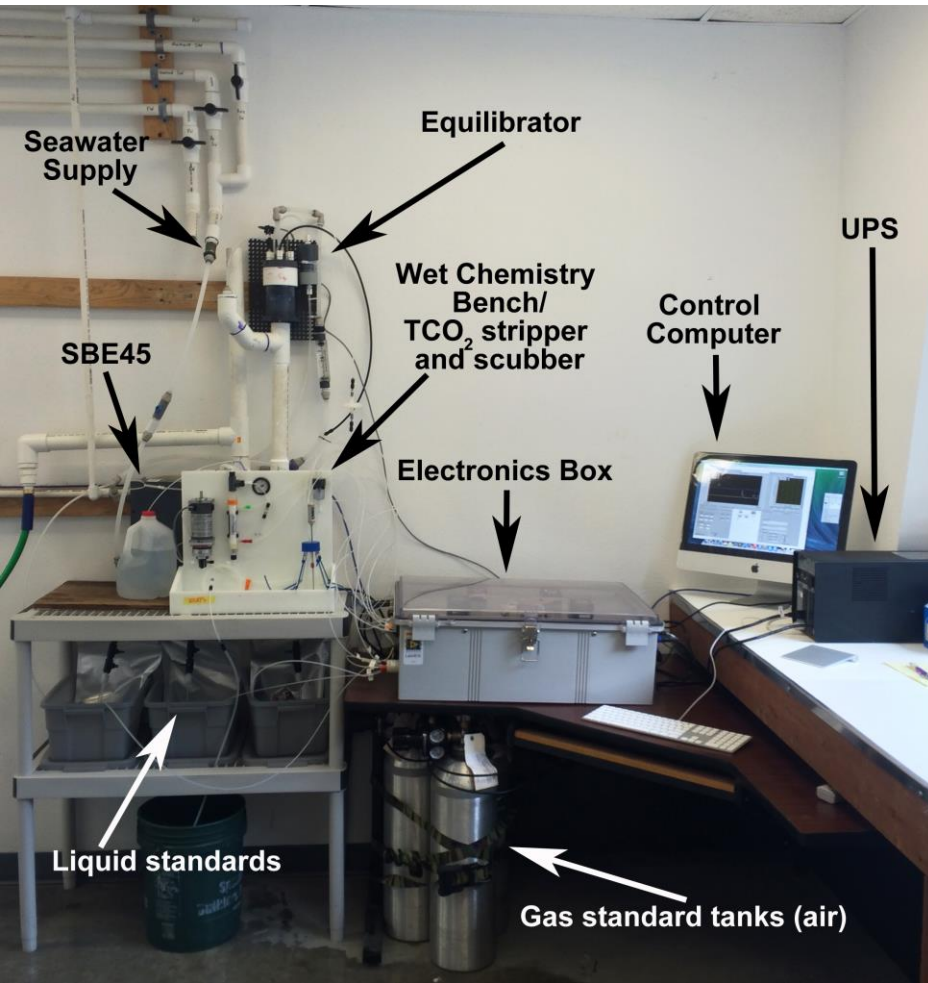
Thanks to a \$500,000 federal investment in monitoring coastal seawater strengthened by data and observational information from the U.S. **Integrated Ocean Observing System (IOOS®)** and the **NOAA Ocean Acidification Program**, oyster hatcheries on the verge of collapse just a few years ago are again major contributors to the \$111 million West Coast shellfish industry.



IOOS 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 "Châ bã," the buoy is

"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.

Measuring OA variables: “Burke-O-Lator”



A bi-modal system that reports Ω_{arag} in real-time

Measurement accuracies:

Temperature (SBE45) = 0.002° C

Salinity (SBE45) = 0.0005

pCO₂ (NDIR, SW and atm) = ~1% based on comparison w/ reference gases

TCO₂ (NDIR) = < 1-2 % based on comparison w/ certified reference materials

TA(S) = ~ 2% based on RMSE

= uncertainty in Ω_{arag} w/ pCO₂-TCO₂ or pCO₂-TA(s) of ~4% (<0.2% for pH_T)

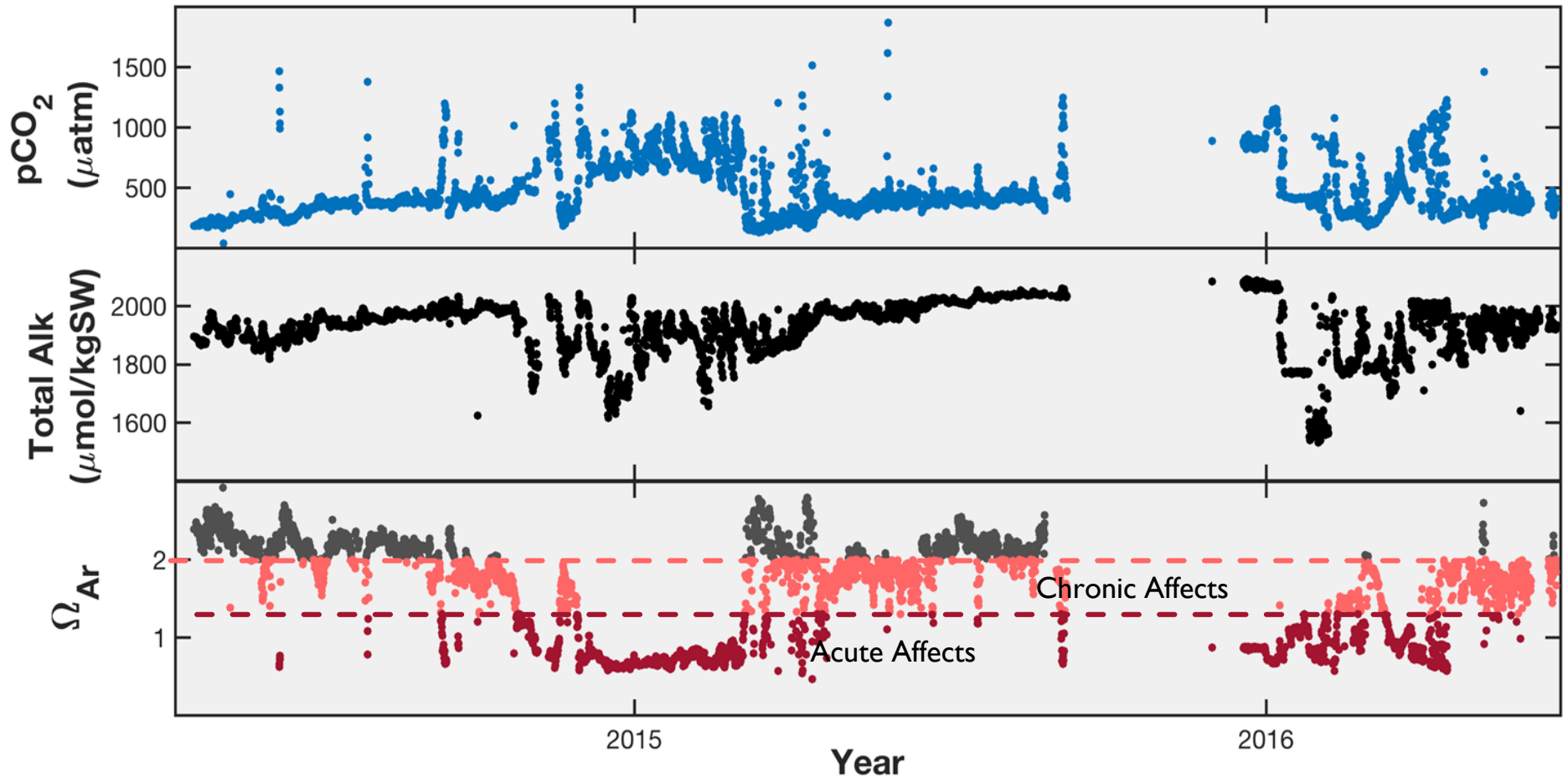
Operationally use pCO₂-TA(s) in continuous

“High degree of technical oversight required”

Quote and slide by Wiley Evans, Hakai

Measuring OA variables: “Burke-O-Lator” data now guide shellfish hatchery operations

Taylor Shellfish Hatchery data, WA



Measuring OA variables: need for improvement

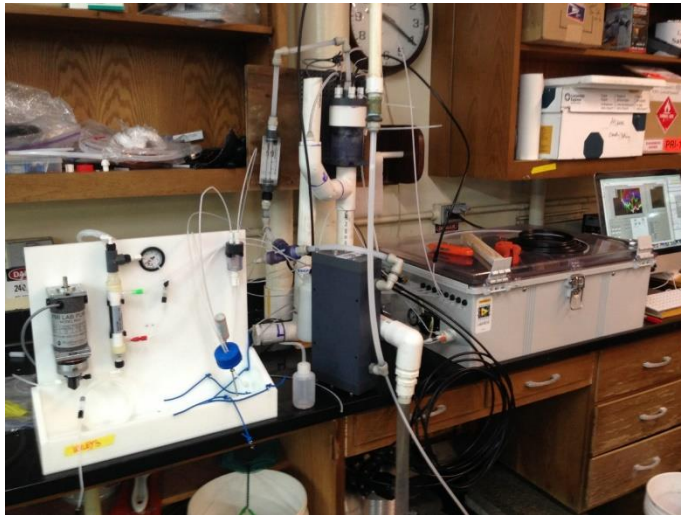
We learned from growers that their **ideal monitoring technology** is:

“a bullet proof sensor that delivers pH, aragonite saturation, T, and S.

Similar to the system we have in place now **but lighter and not so crashy”**

Alan Barton, Pacific Coast Shellfish Growers Association monitoring lead

Burke-o-Lator



ACDC



We needed a new system, new technology to complement the buoys, the Buke-o-Lators for more versatile, widespread measuring of pCO₂ and pH.

IOOS Ocean Technology Transfer

“Turning the headlights on 'high': Improving an ocean acidification observation system in support of Pacific coast shellfish growers.”

- New, lower cost “ACDC” pCO₂ sensor
- Strong support from shellfish industry
- Partnerships: NANOOS, UW, OSU, Sunburst, AOOS, CeNCOOS, SCCOOS, NOAA, PCSGA
- Builds on existing Burke-o-lators in hatcheries and a Pacific-wide IOOS data portal

Science-Shellfish Grower Partnerships

Wiley Evans,
Hakai Institute



Alutiiq Pride Shellfish Hatchery
Seward, AK



Simone Alin,
NOAA PMEL

QA

Tessa Hill,
UC Davis



Taylor Shellfish Hatchery
Quilcene, WA

Whiskey Creek Shellfish Hatchery
Tillamook, OR



Hog Island Oyster Company
Tomales Bay, CA



Burke Hales,
OSU

Todd Martz,
SIO



Carlsbad Aquafarm
Carlsbad, CA



Science-Grower Partnerships

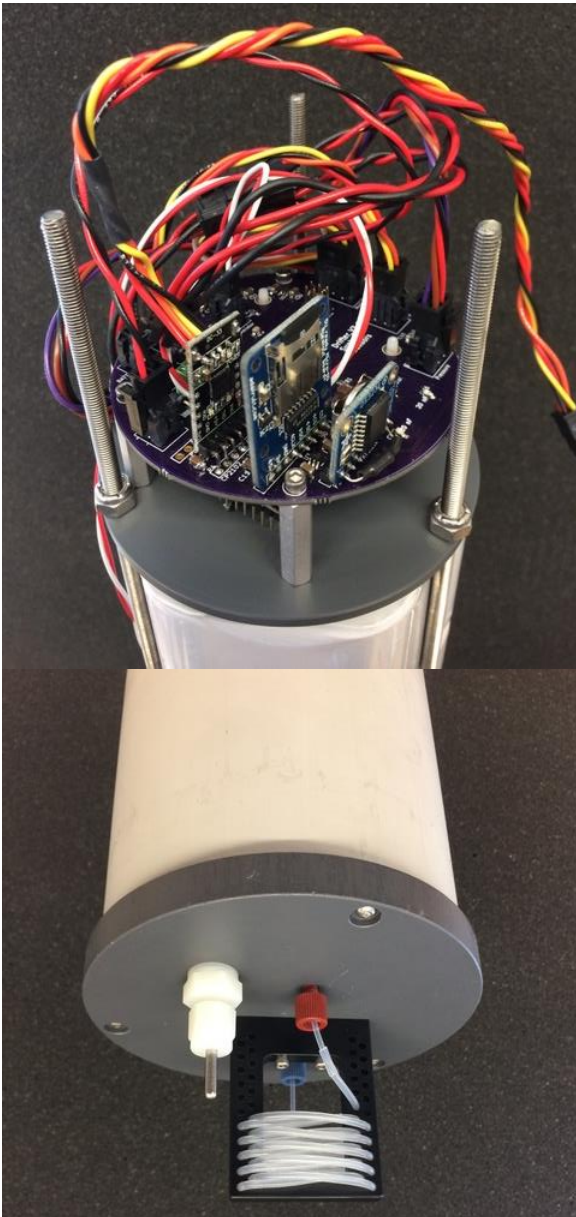
Site	On-site	Regional support	Regional Expert
Alutiiq Pride Shellfish, Seward, AK	J. <u>Hetrick*</u> (APSH)	J. Ramsay (UAF/APSH)	W. Evans (<u>Hakai Institute</u>)
Taylor Shellfish, <u>Quilcene, WA</u>	B. <u>Eudeline*</u> (Taylor)	G. <u>LeBon</u> (NOAA/PMEL)	S. <u>Alin</u> (NOAA/PMEL)
Whiskey Creek Shellfish, <u>Netarts, OR</u>	A. Barton* (WCSH)	S. Smith/D. Hubbard (OSU)	B. Hales (OSU)
Hog Island Oyster Co., Marshall, CA	T. Sawyer* (HIOC)	G. <u>Susner</u> (UCD-Bodega)	T. Hill (UCD-Bodega)
Carlsbad <u>AguaFarm</u> , Carlsbad, CA	T. Grimm* (CAF)	K. Shipley (UCSD-SIO)	T. Martz (UCSD – SIO)

*Hatchery manager responsible for designating routine maintenance responsibilities to hatchery personnel.

The technical experts alone make a difference This partnership is expanding to other West Coast growers; it already has within British Columbia, Canada, thanks to Wiley Evans at the Hakai Institute.

From Ron Zebel: *“At the OceansAlaska hatchery, **we learned more about our water quality in 7 hours of Burke-O-Lator data than we did in 7 years of monitoring with off the shelf instrumentation.** We have adjusted our soda ash injections upward and are going forward with expanded kelp bioconditioning.”*

ACDC: 'Autonomous Coastal Drifter' CO₂ system

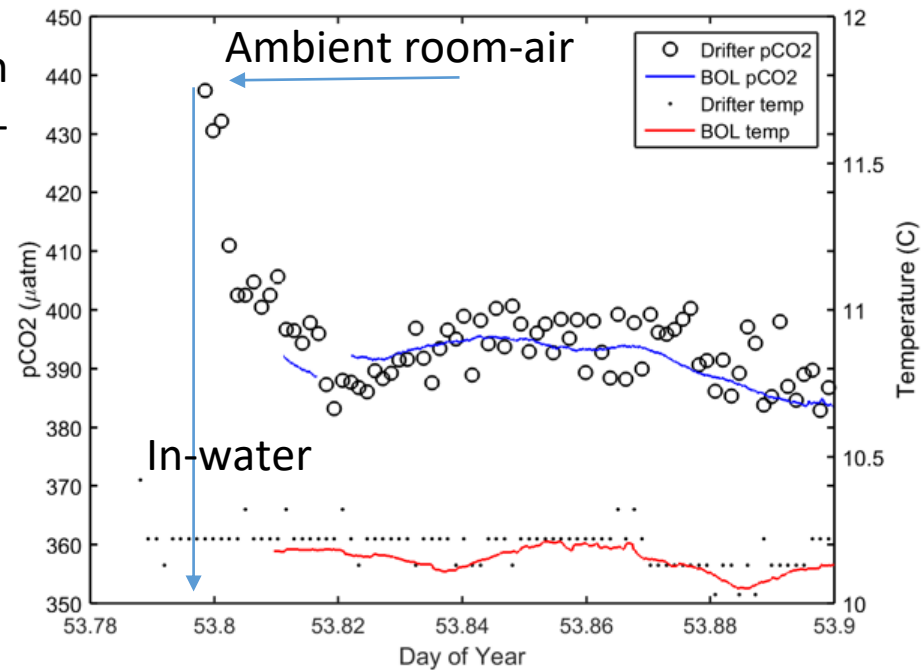


Raspberry PI-driven system with K30 IR-based detector

Battery-powered, telemetry/GPS capable

Gaseous headspace, pumped through equilibrator-detector loop.

Sample mode as frequent as every 2 minutes.



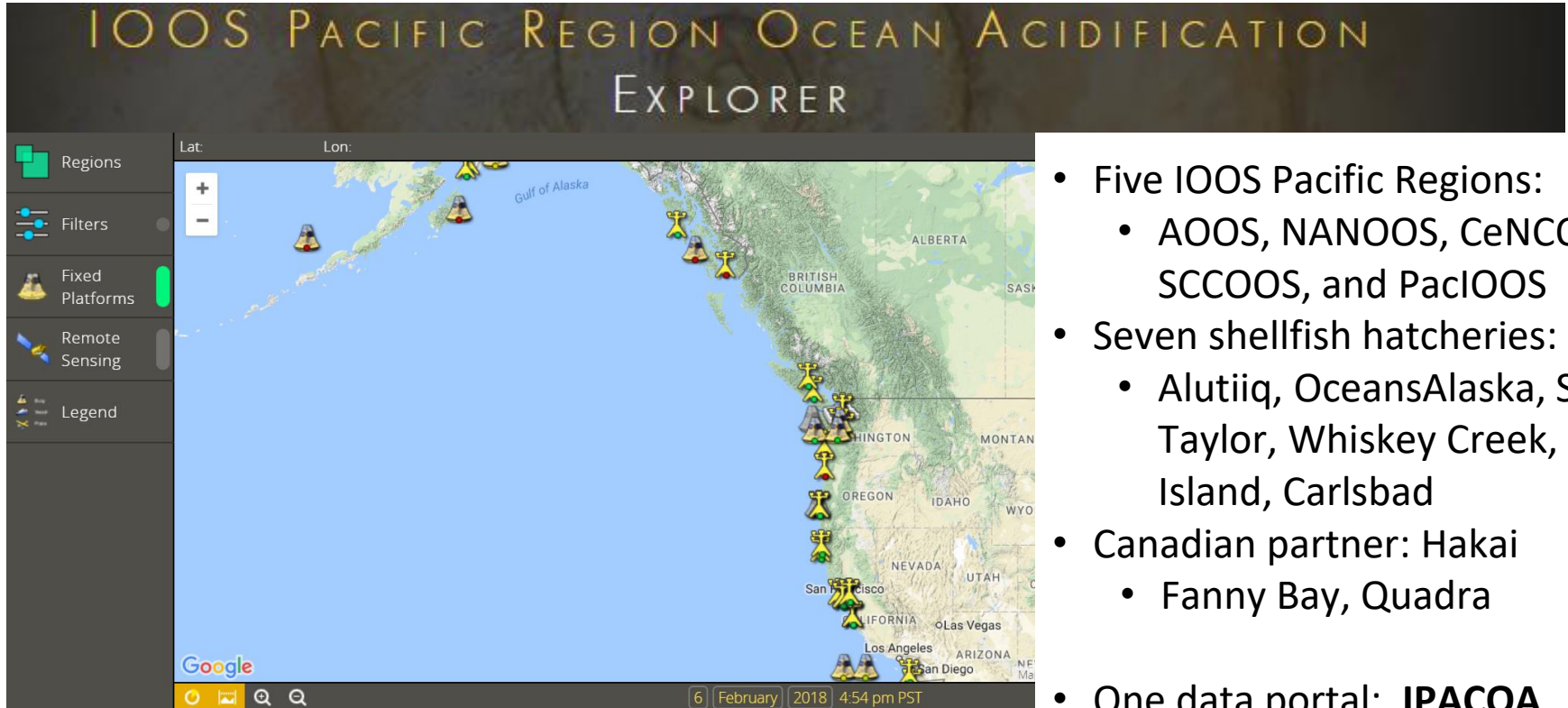
3 hours of ACDC + continuous BoL data from WCSH, Netarts Bay, OR.

~12 min response time.

Near-perfect accuracy

~±5 µatm imprecision

Delivering the OA Data:



- Five IOOS Pacific Regions:
 - AOOS, NANOOS, CeNCOOS, SCCOOS, and PacIOOS
- Seven shellfish hatcheries:
 - Alutiiq, OceansAlaska, Sitka, Taylor, Whiskey Creek, Hog Island, Carlsbad
- Canadian partner: Hakai
 - Fanny Bay, Quadra
- One data portal: **IPACOA**
- Funded jointly by U.S. IOOS and NOAA OAP to enhance OA monitoring in shellfish hatcheries

Allows access to real-time data and information links; eventually links to manuals, FAQ, etc. in order to facilitate a 'community of practice'.

IPACOA Data Portal

EXPLORER

Map Asset List Asset History Help

Map Regions Filters Fixed Platforms Legend

Lat: 58.1243 Lon: -90.8789 Terrain

Chukchi Sea Nome Bering Sea

PCSGA - Whiskey Creek Shellfish Hatchery, Netarts Bay

Provider: WhiskeyCrShelfish

Observations Details History Credits

ICSHA-PCSGA Whiskey Crk - Omega Arag. Sat. - 24 Hours
1 June 2015 18:29 PDT

Omega - Aragonite Saturation

Parameter (-13ft)	Value
Alkalinity (-13ft)	2146.7 $\mu\text{mol/kg}$
CO2 Water (-13ft)	627 μatm
TCO2 (-13ft)	26.7 $\mu\text{mol/kg}$
Omega Arag. Sat. (-13ft)	1.4
pH (-13ft)	9.1
Salinity (-13ft)	32.2 PSU
Water Temp. (-13ft)	55.9 $^{\circ}\text{F}$

24 Hours 7 Days 30 Days 60 Days

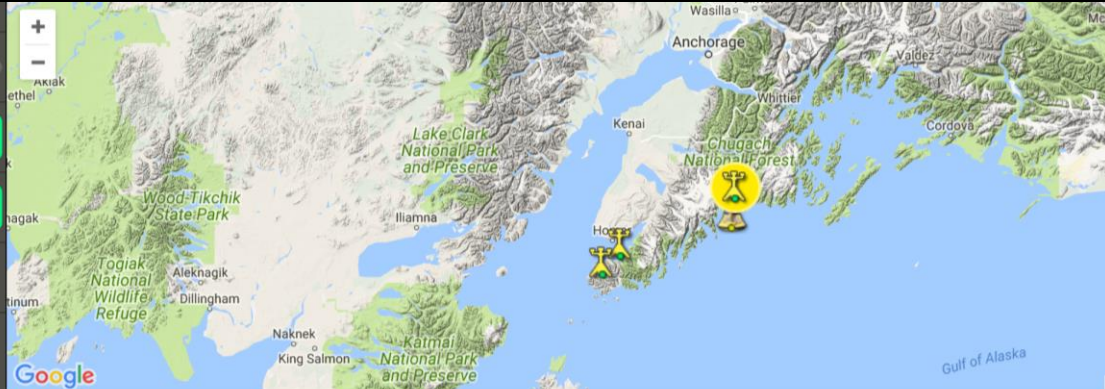
Link

Real-time aragonite saturation state data from shellfish hatcheries!!!
...as well as coastal buoys and moorings.

United States

Map data ©2015 Google, INEGI, Inav/Geosistemas SRL, SK planet, ZENRIN

- Filters
- Fixed Platforms
- Remote Sensing
- Legend



AOS Burkolator at Alutiiq Pride Shellfish Hatchery

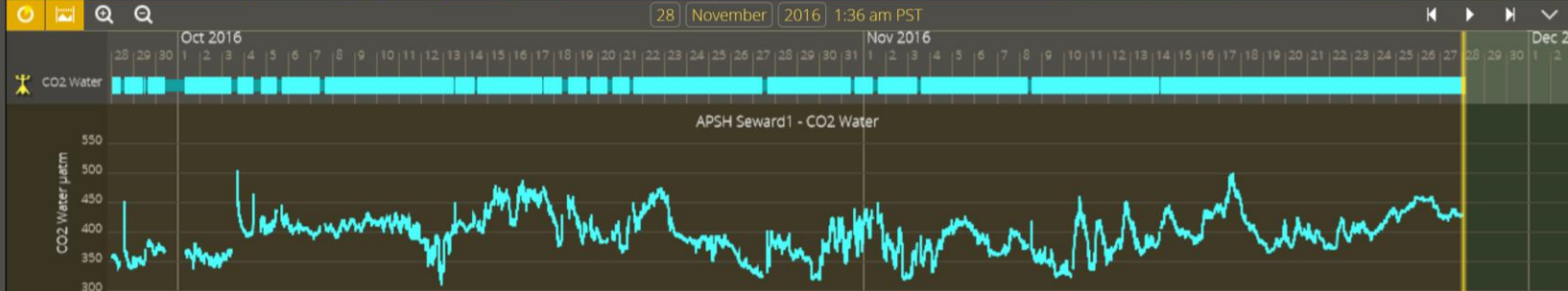
Observations | Details | Credits

Data Updated: 28 Nov 2016 1:14 PST Provider: Alutiiq Pric

HYDROGRAPHIC

Alkalinity (total) (-30.5 m)	2073.3 $\mu\text{mol/kg}$	↓ W
CO2 Water (-30.5 m)	425.5 μatm	↓ W
Dissolved Inorg. Carbon (-30.5 m)	$\mu\text{mol/kg}$	↓ W
Omega - Aragonite Sat. (-30.5 m)	1.6	↓ W
pH (-30.5 m)	8	↓ W

[Link](#)



- regions
- Filters
- Fixed Platforms
- Remote Sensing
- Legend



SCCOOS Burkolator at Carlsbad Aquafarm

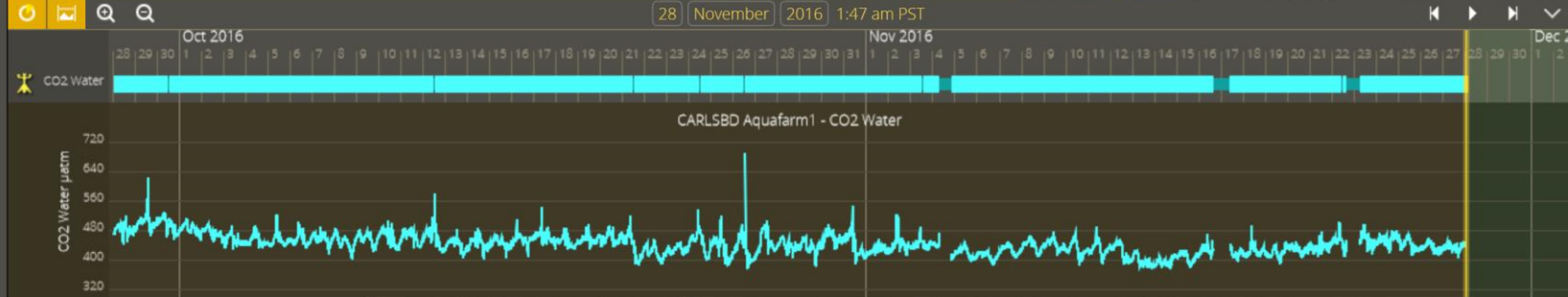
Observations | Details | History | Credits

Data Updated: 28 Nov 2016 0:40 PST Provider: Carlsbad A

HYDROGRAPHIC

Alkalinity (total) (-1 m)	2209.2 $\mu\text{mol/kg}$	↓ W
CO2 Water (-1 m)	438.9 μatm	↓ W
Dissolved Inorg. Carbon (-1 m)	$\mu\text{mol/kg}$	↓ W
Omega - Aragonite Sat. (-1 m)	2	↓ W
Salinity (-1 m)	32.7 PSU	↓ W

[Link](#)



IPACOA expanded nationwide and renamed: IOOS Partners Across Coasts Ocean Acidification data portal

Home Explorer Settings IPACOA EXPLORER IOOS

Map Asset List

Lat 65.0091 Lon -45.1348 Terrain Map

Layers Platforms Filters Regions Legend

www.ipacoa.org

Map data ©2018 Google, INEGI 1000 km Terms of Use

17 September 2018

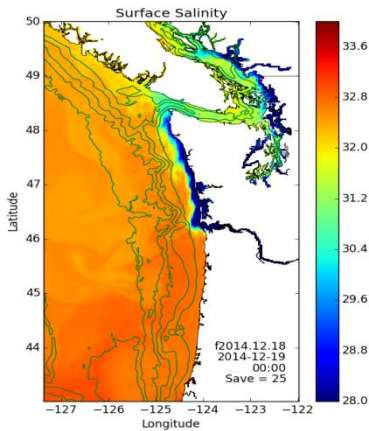
Lines of defense for adaptation



Real-time observations at the hatchery or growing sites

Real-time observations at the adjacent estuary, sea, or ocean

Communicated !!



Regional forecasts on days to weeks scale (weather)

Forecasts at months to years scale (seasonal to interannual)

Conclusions

- Access to real-time data aids shellfish growers, and the provision of nearshore data aids scientific understanding of both ocean acidification and harmful algal blooms.
- This collaboration between growers, scientists, and the sensor industry serves to advance knowledge to each one of these sectors.

