

Domoic Acid & Harmful Algal Blooms Impacts on the Ecosystem

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West Coast Harmful Algal Bloom (Pseudo-nitzschia)

TUESDAY, JUNE 16, 2015
The Seattle Times
WINNER OF 10 PULITZER PRIZES
\$1.00

Toxic algae bloom might be largest ever

SHELLFISH HARVESTS SHUT DOWN
High temperatures suspected

By SANDI DOUGHTON
Seattle Times science reporter

Marine biotoxins
Marine biotoxins are produced by microscopic algae. Unlike the bacteria or viruses that can also contaminate shellfish, biotoxins are not destroyed by cooking or freezing. Also, harmful algal blooms usually don't color the water.

The three biotoxins of concern in Washington are:
• Paralytic shellfish poisoning.
Symptoms include

A team of federal biologists set out from Oregon Monday to survey what could be the largest toxic algae bloom ever recorded off the West Coast. The effects stretch from Central California to British Columbia, and possibly as far north as Alaska. Dangerous levels of the natural toxin domoic acid have shut down recreational and commercial shellfish harvests in Washington, Oregon and California this spring, including the lucrative Dungeness crab fishery off Washington's southern coast and the state's popular razor clam season.

At the same time, two other types of toxins rarely seen in combination are turning up in shellfish in Puget Sound and along the Washington coast, said Vera Trainer, manager of the Marine Microbes and Toxins Programs at the Northwest Fisheries Science Center in Seattle.

"The fact that we're seeing multiple

Closures of Puget Sound beaches frequently change. Check State Department of Health for latest conditions. doh.wa.gov

WASHINGTON

Closed for all recreational shellfish harvesting including clams, geoduck, scallops, mussels, oysters, snails and other invertebrates

OREGON

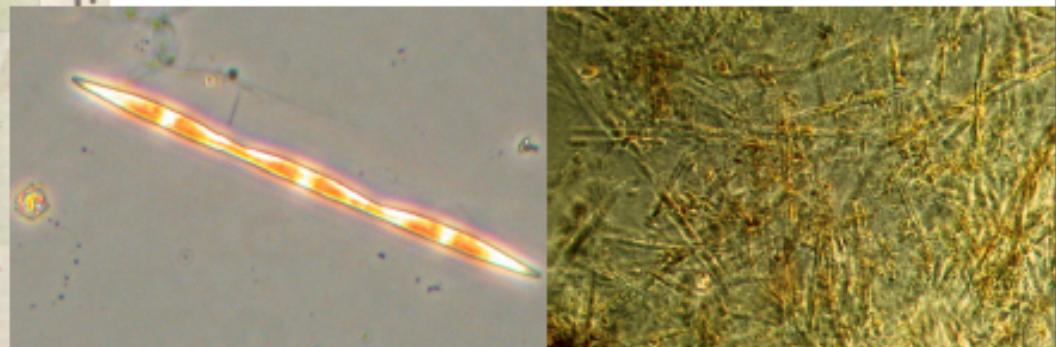
Closed beaches to recreational mussel harvesting every year in the spring and summer

CALIFORNIA

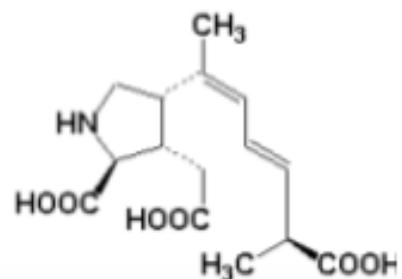
The California Department of Public Health is advising consumers to not eat recreationally harvested mussels, clams, anchovy, sardines, or the internal organs of crab from Monterey and Santa Cruz counties due to dangerous levels of domoic acid.



- Breadth – Channel Islands to Aleutian Islands
- Length – Longest lasting (mos)
- Levels – Highest toxin concentrations ever measured in anchovies
- “Super” *Pseudo-nitzschia* – large chains, chloroplasts bulging



Domoic acid



Clogged Bongo nets –
June 25, 2015 Sta. Barbara Channel

NY Times, November 2, 2015

[Science](#) 

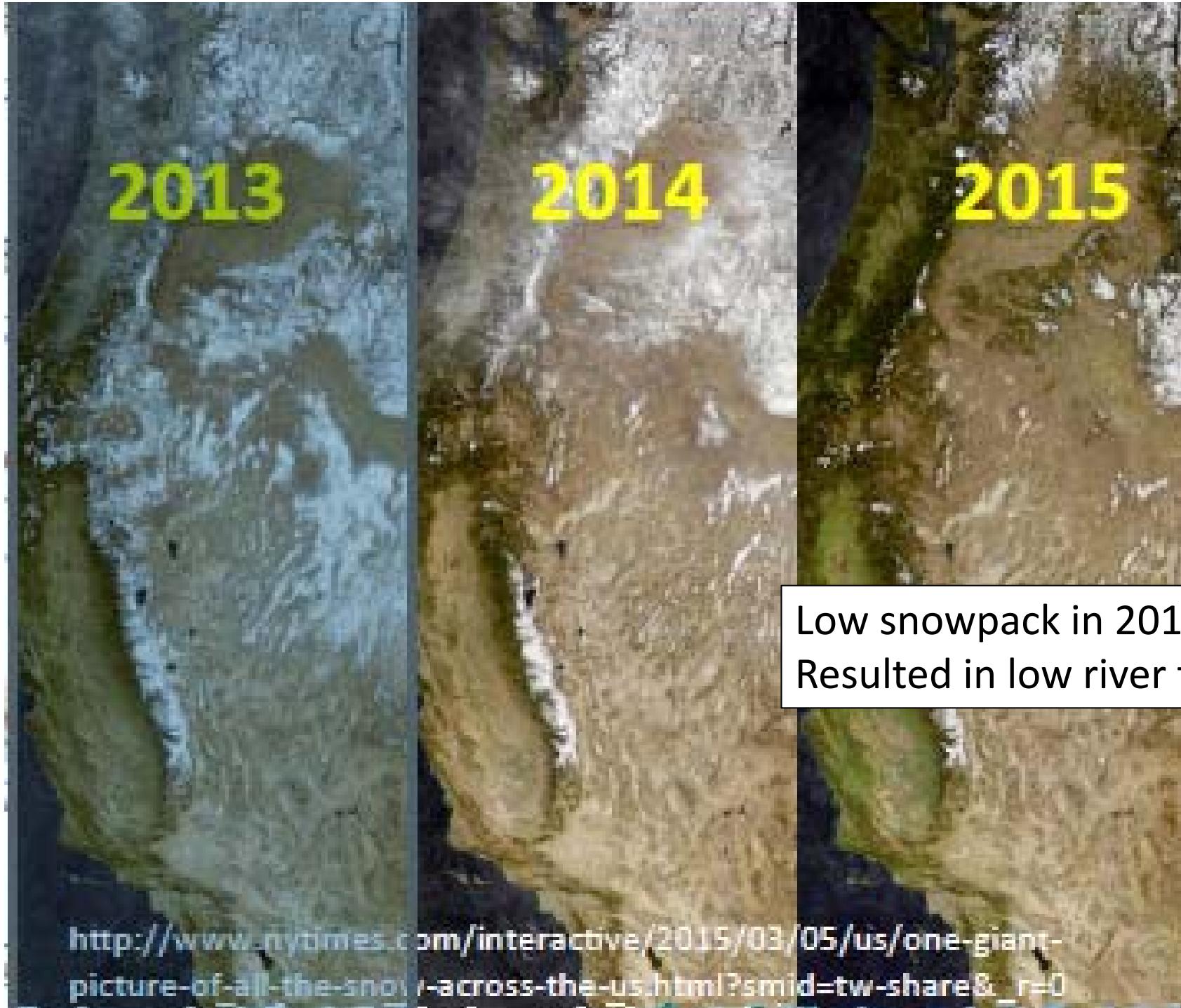
The Pacific Ocean Becomes a Cauldron

By [JOHN SCHWARTZ](#) NOV. 2, 2015 

Photo 

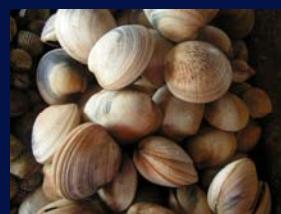
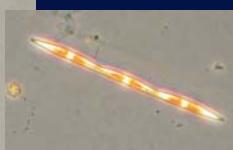


Bleached coral in American Samoa earlier this year. Credit: XL Catlin Seaview Survey 



Toxic Vectoring Through the Marine Food Chain

HABs may or may not be visible as “colored” seawater



Toxin producer



Filter feeder/plankton eater



Predator



illness
or death?

Bioaccumulation

Biggest-ever toxic algal bloom hits West Coast, shutting down shellfish industries



NOAA research vessel, Bell M. Shimada (NOAA)

QUESTIONS, ANSWERS ABOUT TOXIC WEST COAST CRABS



An imported Dungeness crab sits on ice for sale at Fisherman's Wharf Thursday, Nov. 5, 2015, in San Francisco. (AP Photo/Eric Risberg)

California's commercial Dungeness crab season postponed indefinitely over toxin risk



Kory Cropper, left, loads crab traps into the Amber Lynn before the start of the dungeness crab season in Bodega Bay on Wednesday, November 13, 2013. (Conner Jay/The Press Democrat)



**Closure of the majority of the
2015 commercial razor clam
season resulted in a \$300 K loss
to a small community of
commercial harvesters. Oregon
reports a similar loss.**



Amnesic Shellfish poisoning (ASP) in seabirds, mammals

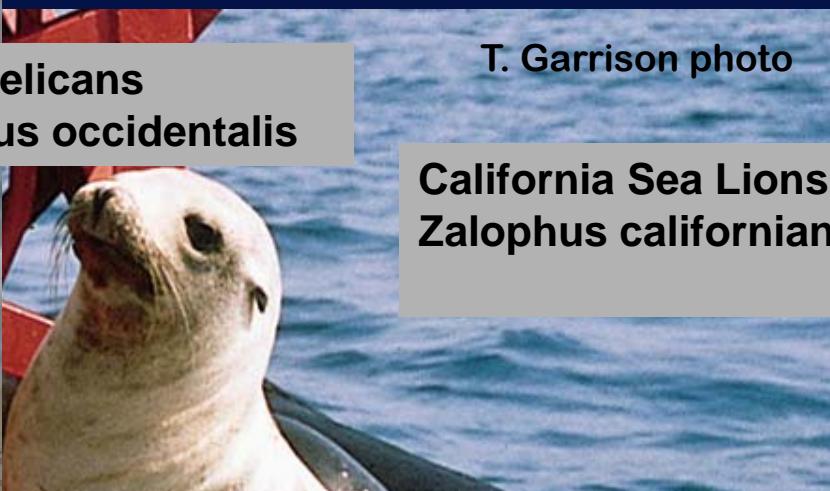
Photo by Tom Grey

Brown pelicans
Pelecanus occidentalis



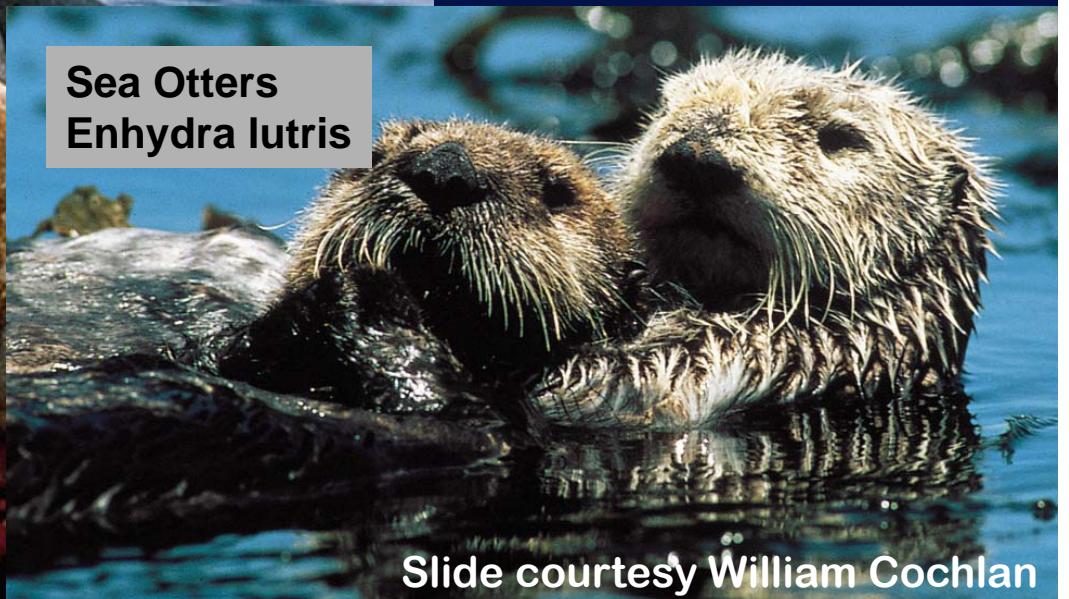
T. Garrison photo

California Sea Lions
Zalophus californianus



Brandt's cormorants
Phalacrocorax penicillatus

Sea Otters
Enhydra lutris



**Vectors = shellfish,
sardine, anchovy**

Slide courtesy William Cochlan

Impacts of largest West Coast HAB



Closure of razor clam fishery
~\$23 million lost in lost spending



Seizing sea lion (first ever observed on WA coast)
Many sea lion, seal mortalities in Monterey Bay

Tuesday, November 3, 2015

San Francisco Chronicle

SPCHRONICLE.COM | Tuesday, November 3, 2015 | PRINTED ON RECYCLED PAPER | \$1.00

Toxic bloom puts start of crab season in doubt

Danielle Mitchell and Andrew Cresalia prepare traps at Pier 45 for the start of the commercial crab season.

By ASHLEY AHEARN • 18 HOURS AGO

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A photograph showing two individuals, Danielle Mitchell and Andrew Cresalia, working on a wooden pier. They are surrounded by large metal crab traps stacked vertically. One person is standing and reaching for something, while the other is crouching nearby. The background shows a body of water under a clear sky.

Dungeness Crabbers Hit Hard By Algae Bloom On Washington Coast



Dungeness crab fisheries closed in multiple states.
West coast crab fishery valued at \$180 million

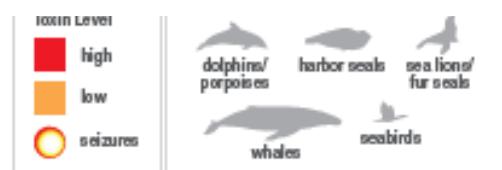


Anchovy and sardine fisheries health advisory in California due to high toxins

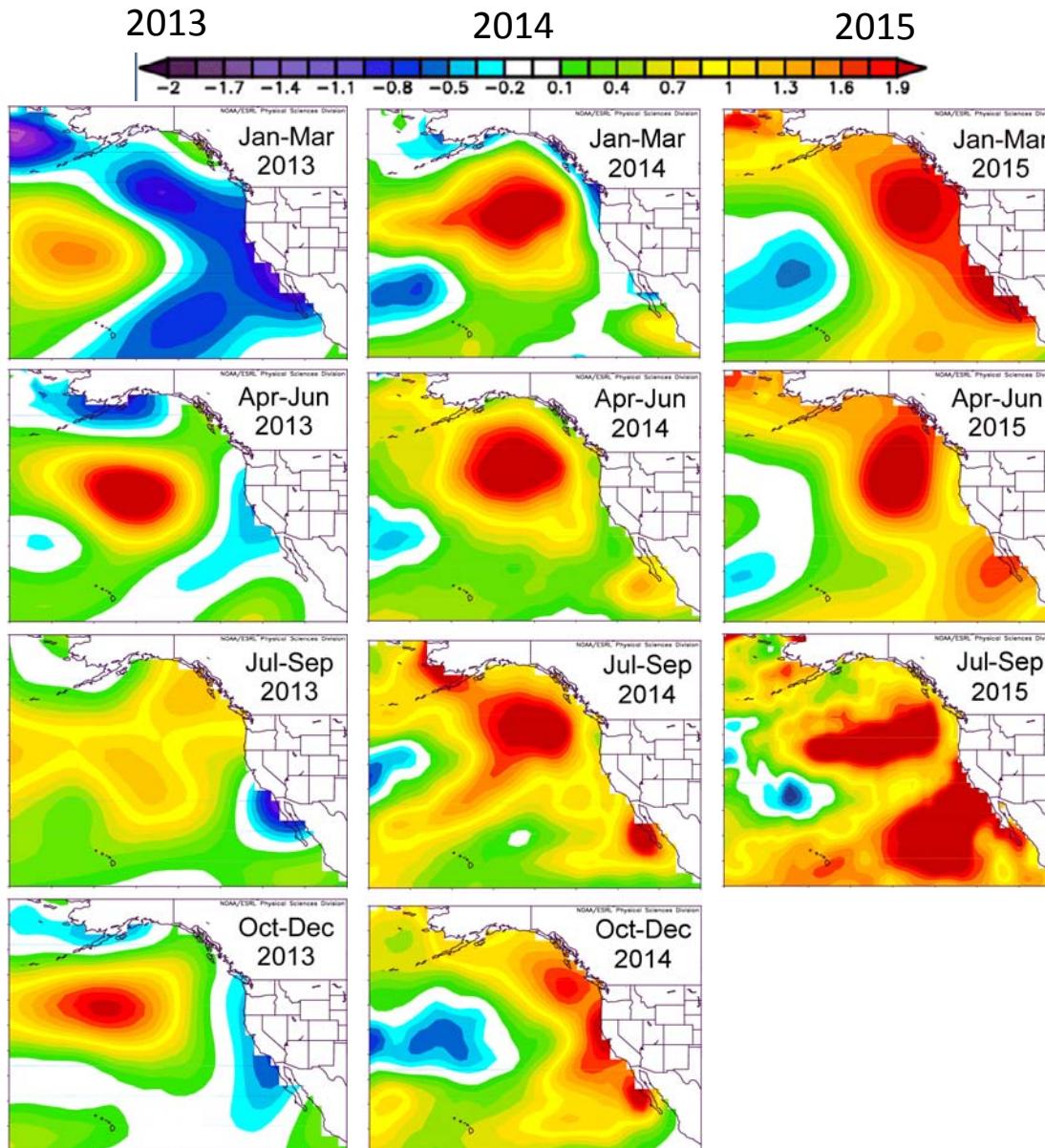
Domoic acid detected in marine wildlife from the Pacific Northwest to Southern California during a record-setting bloom of toxic algae in the North Pacific in the summer of 2015



- ~65 sea lions strand in a typical year
- In 2015, 229 sea lions stranded



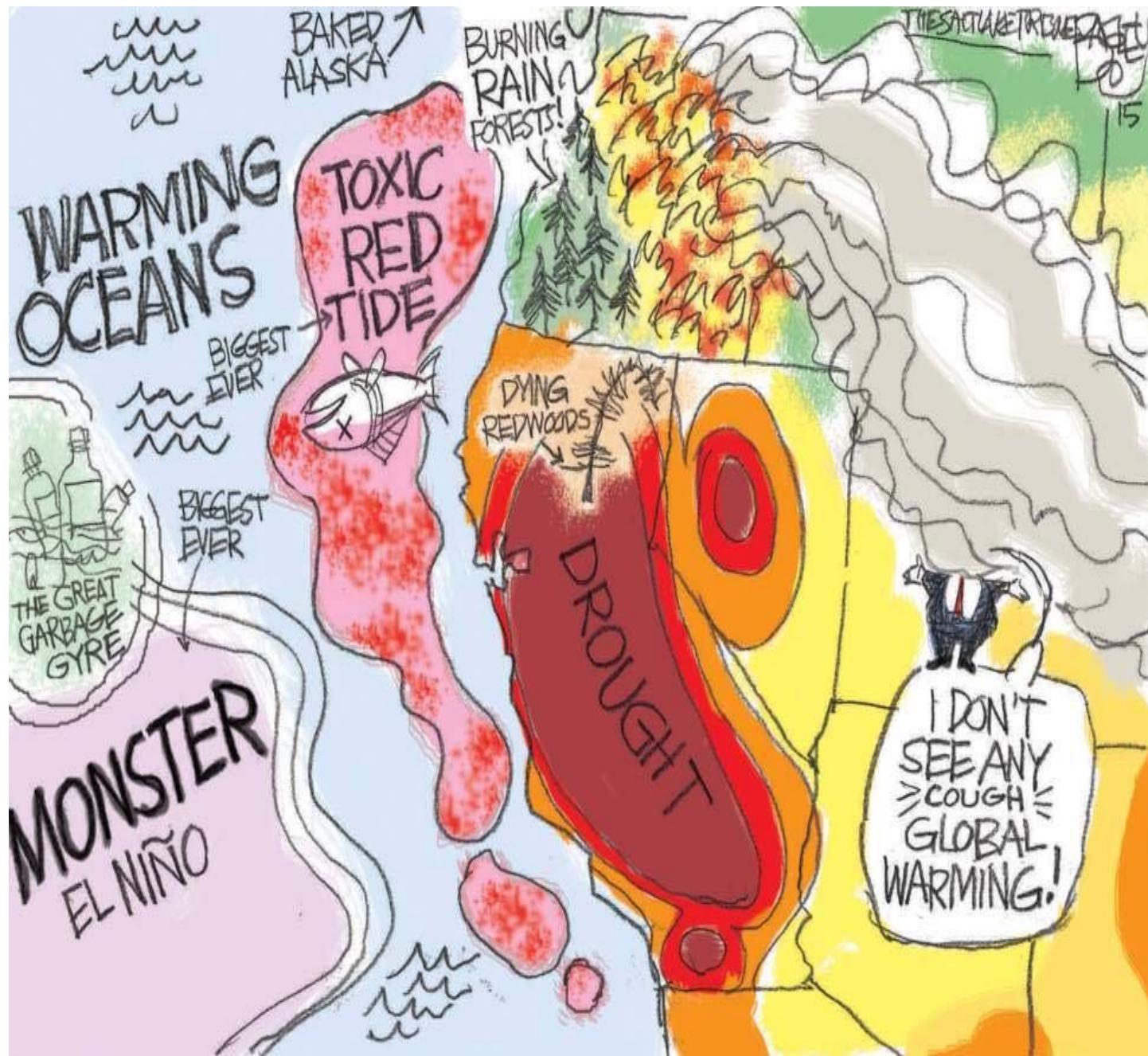
Seasonal temperature anomalies in the Northeast Pacific with respect to 1981-2010 averages

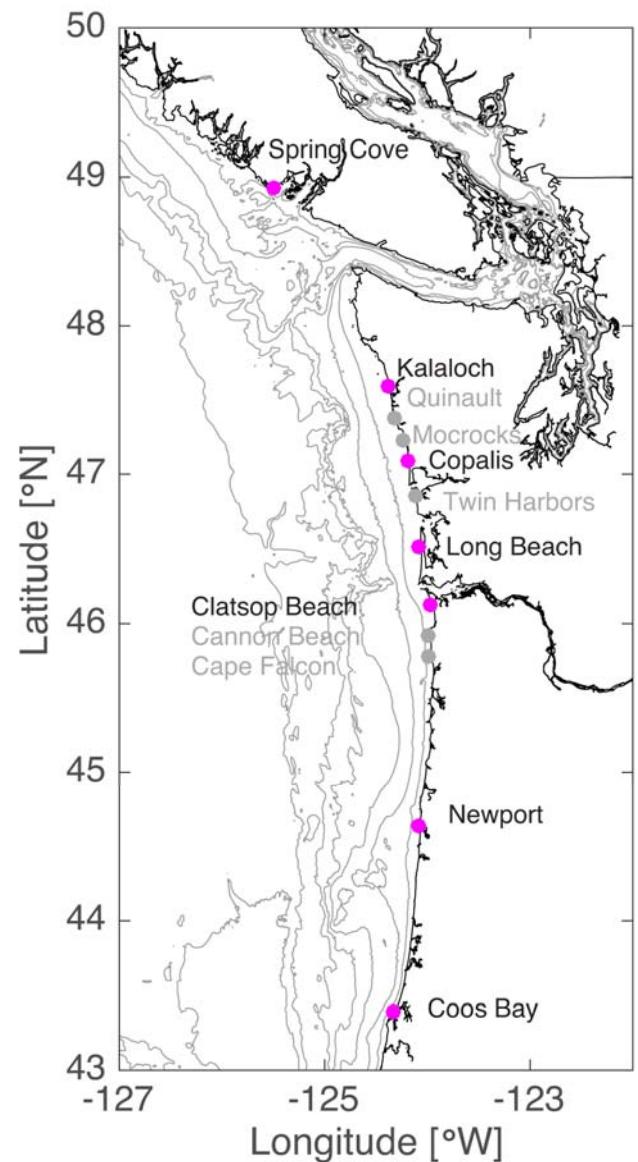
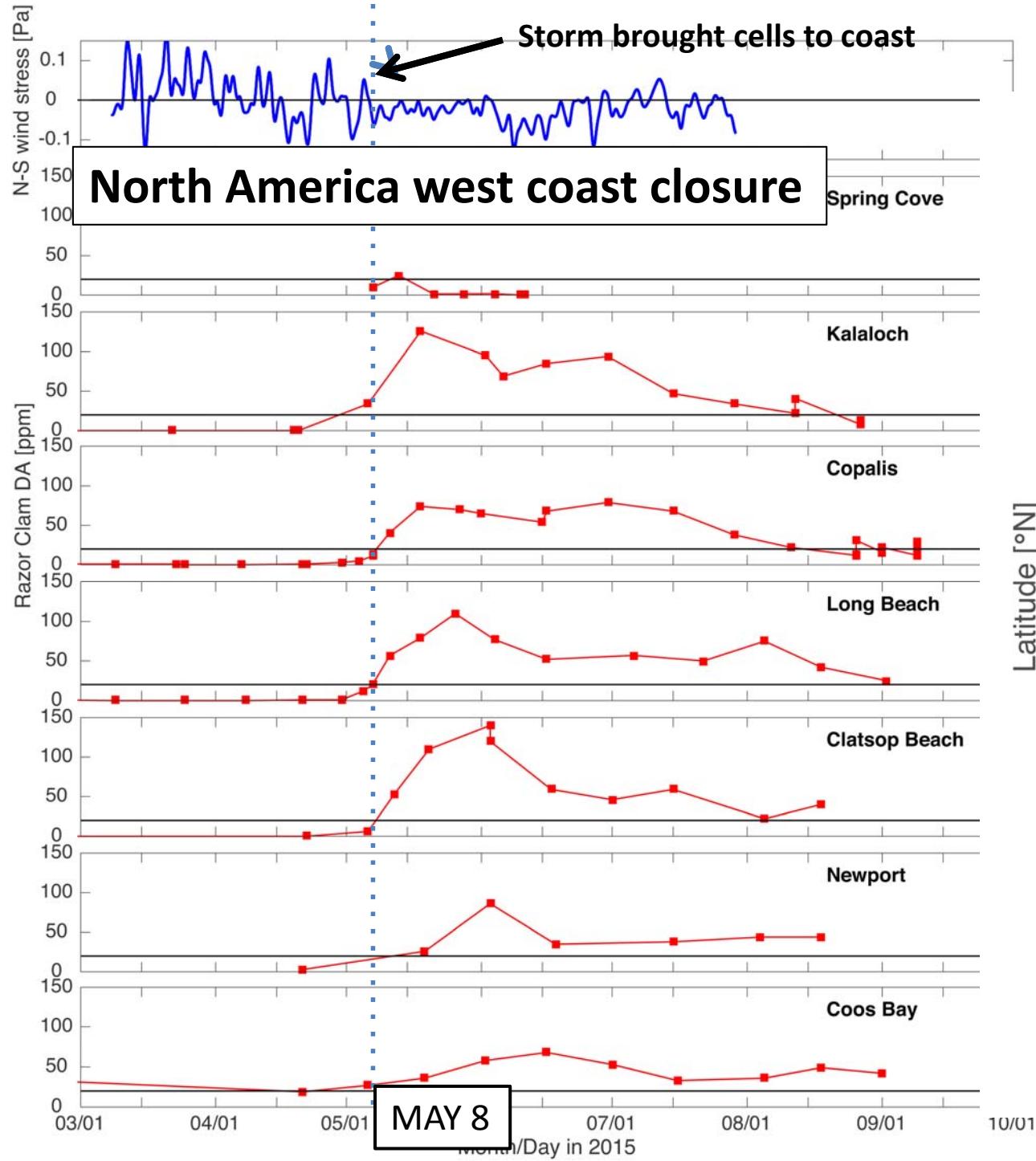


A rapid and unexpected warming of the surface waters in the Gulf of Alaska was observed in the fall of 2013 that persisted into 2015.

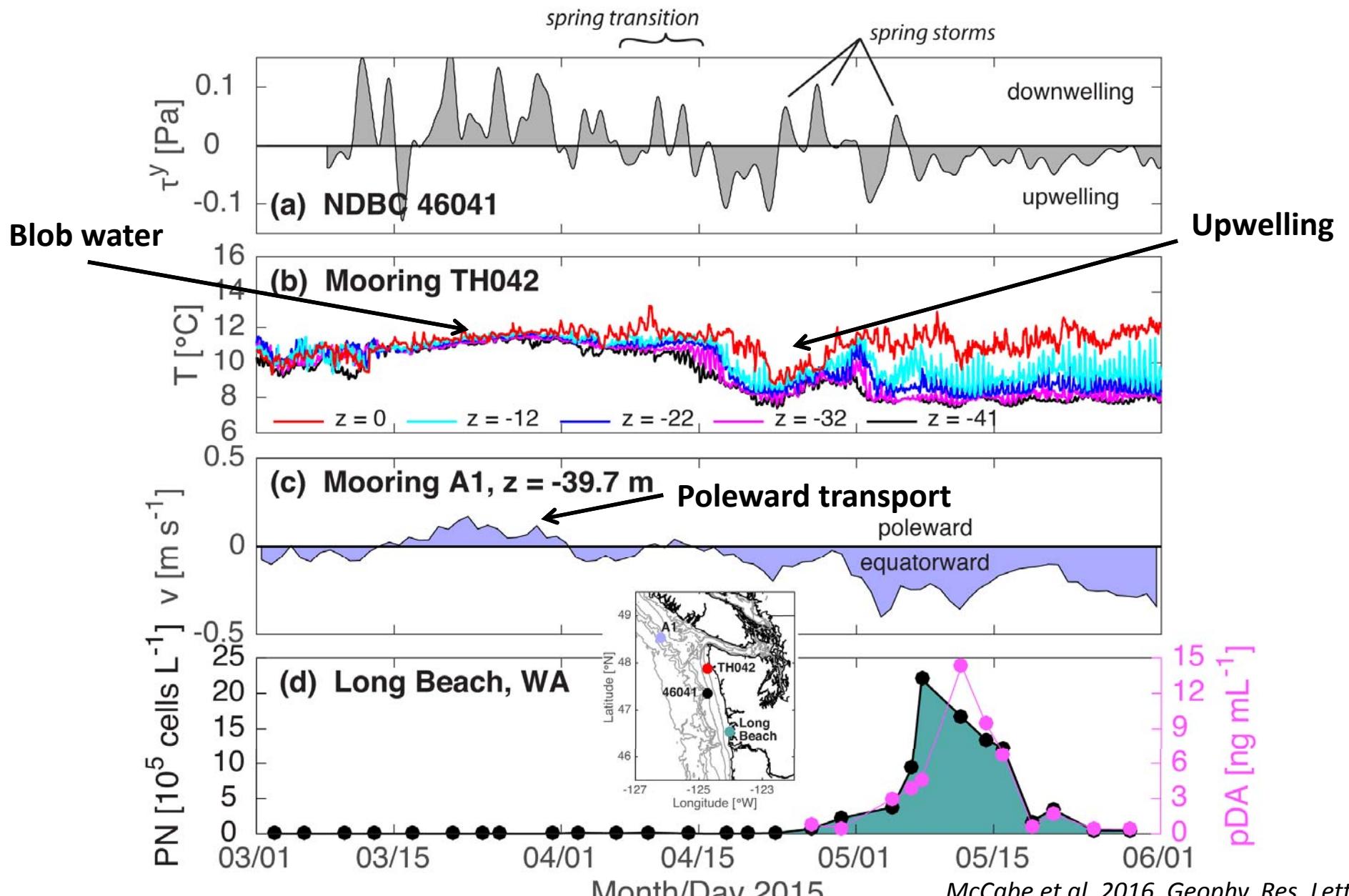
This feature, labelled the "warm blob", reached $\sim 4^{\circ}\text{C}$ above normal.

Along the continental shelf, cooler than normal waters persisted in early 2014 but by autumn the warm blob moved eastward, bringing extreme warm anomalies to the coast.



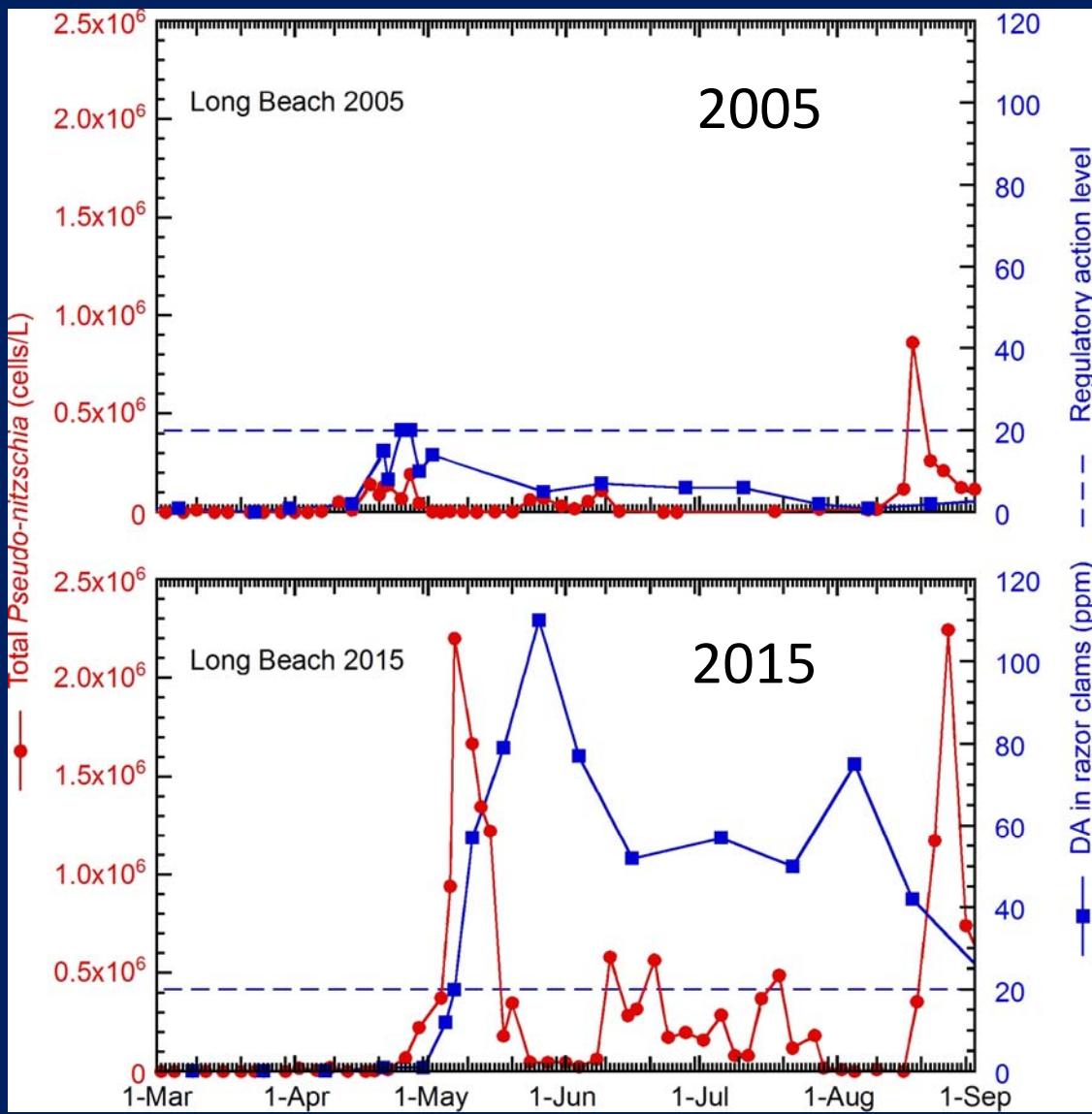


Cells brought to coast by storm, nutrients from upwelling fueled the BLOOM

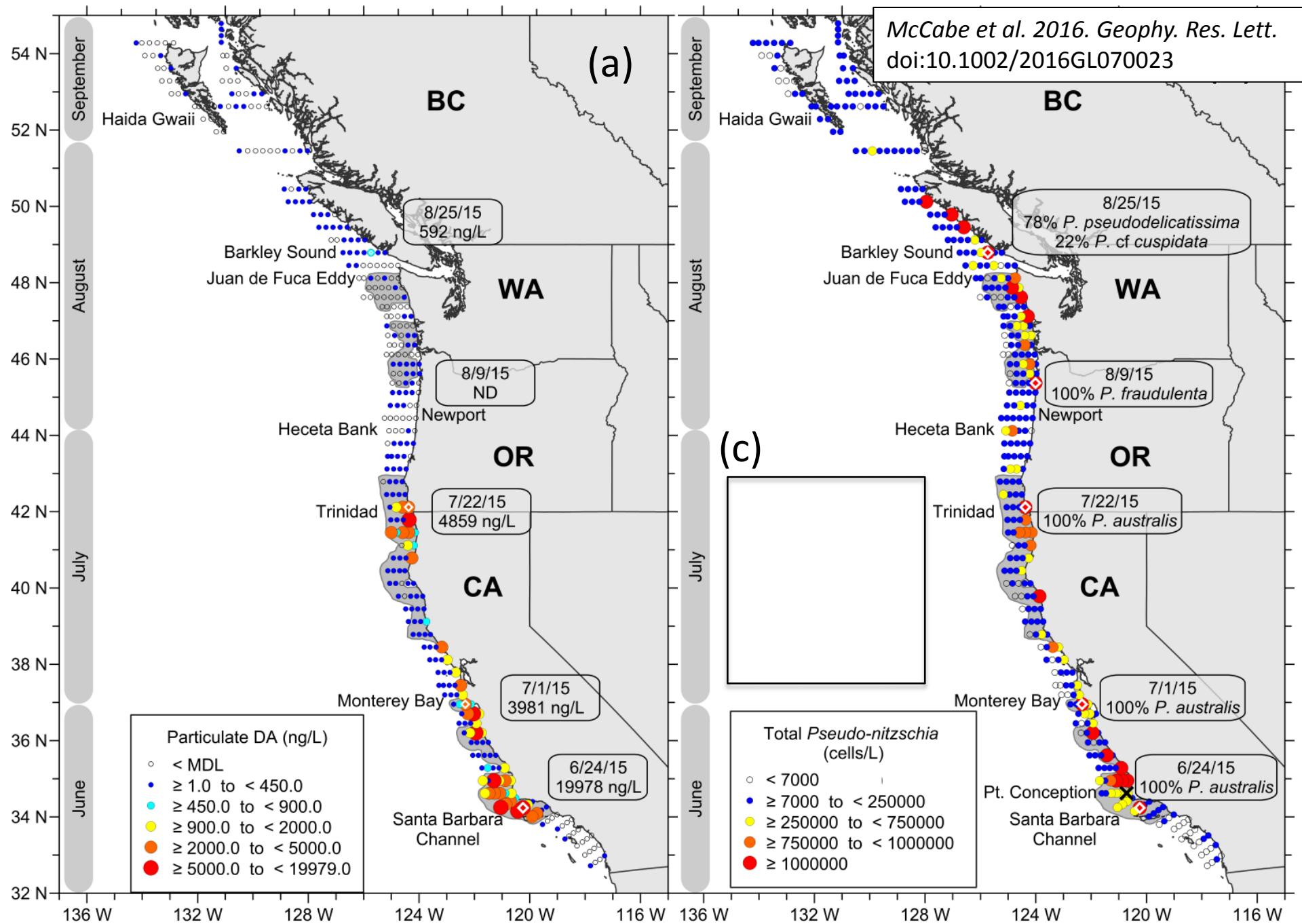


“The new normal”

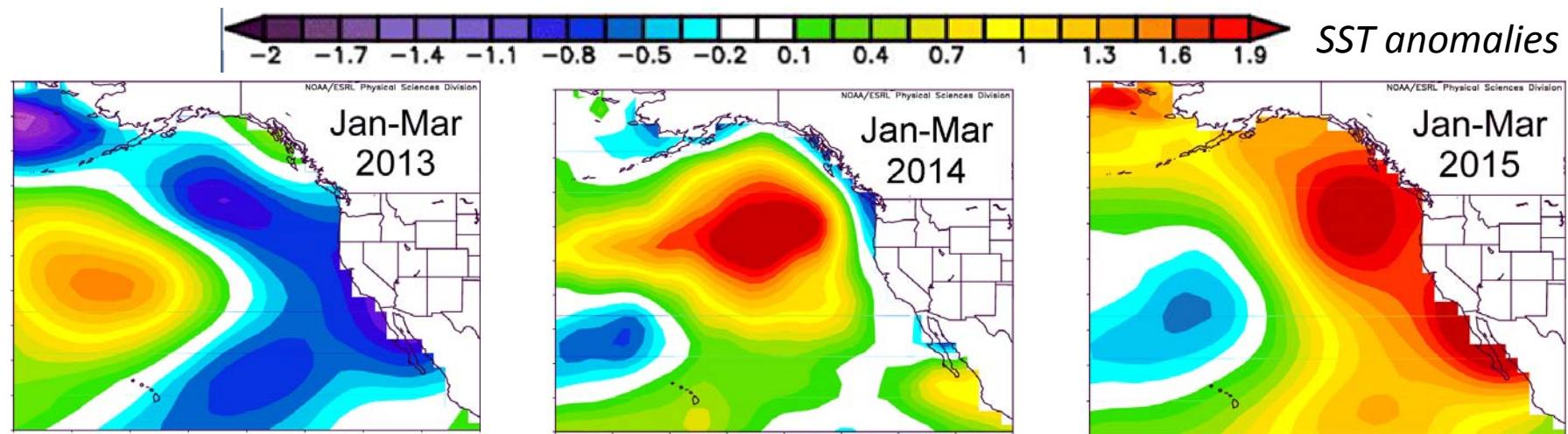
Highly toxic, widespread blooms in spring?



R/V Shimada cruise: June – Sept 2015



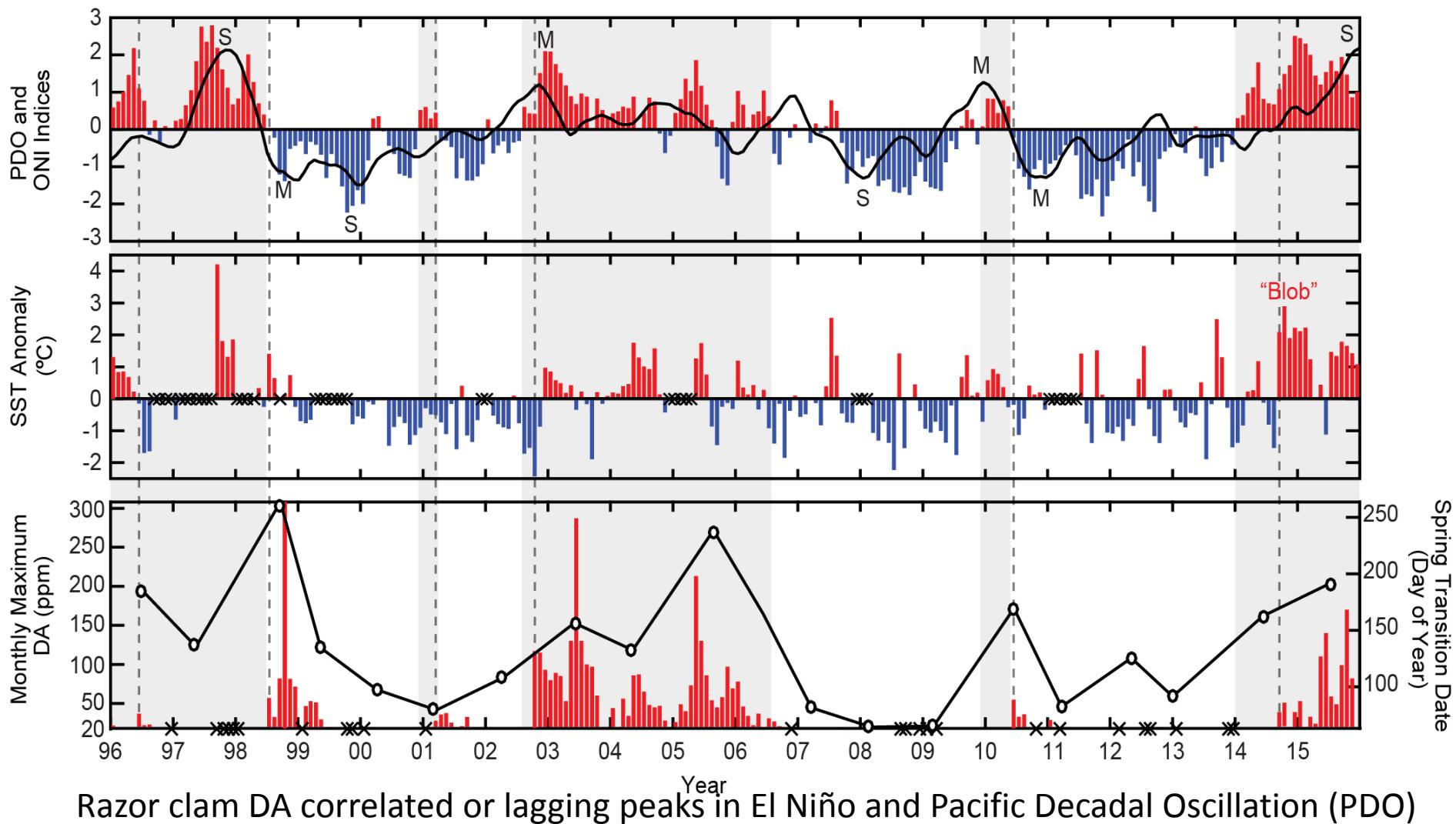
Preceding the Bloom was the "Blob"



- Unusually warm SST resulted in drought, low snowpack
- Ocean temperatures $\sim 3^{\circ}\text{C}$ above normal.
- The blob was 1000 miles long and 300 ft deep
- Nutrients (N) became depleted within the blob
- An “incubator” for toxic algae

What does the future hold?

Toxic *Pseudo-nitzschia* & climate



McKibben et al. 2017 (Proc. Natl. Acad. Sci. doi:10.1073/pnas.1606798114) &
McCabe et al. 2016 (Geophys. Res. Lett. 43 doi:10.1002/2016GL070023)

New statewide advisory for razor clam consumption



Contents lists available at ScienceDirect

Harmful Algae

journal homepage: www.elsevier.com/locate/hal



The association between razor clam consumption and memory in the CoASTAL cohort



Lynn M. Grattan ^{a,*}, Carol Boushey ^b, Kate Tracy ^c, Vera L. Trainer ^d, Sparkle M. Roberts ^a, Nicolas Schluterman ^c, J. Glenn Morris Jr. ^e

FOR “SUPER CONSUMERS” - “There is a possible association between long-term, low level exposure to domoic acid through razor clam consumption and memory functioning”

News Release

For immediate release: October 7, 2016

(16-116)

Contact: [Dave Johnson](#), Strategic Communications Office

360-545-2944

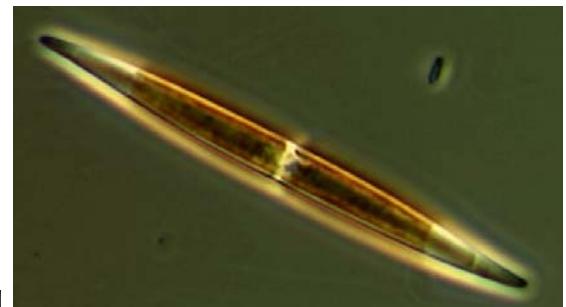
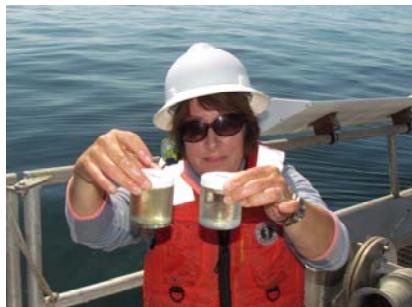
Health Department Issues Razor Clam Advisory Over Health Concerns

OLYMPIA -- Washington State Department of Health (DOH) issued an interim advisory today due to potential health risks associated with eating large quantities of razor clams harvested from the Washington coast.

DOH recommends that people eat no more than 15 razor clams per month during a one-year period.

This interim advisory applies to everyone, especially women who are pregnant or might become pregnant, nursing mothers, children, the elderly, and people with compromised renal function.

What made 2015 unusual?



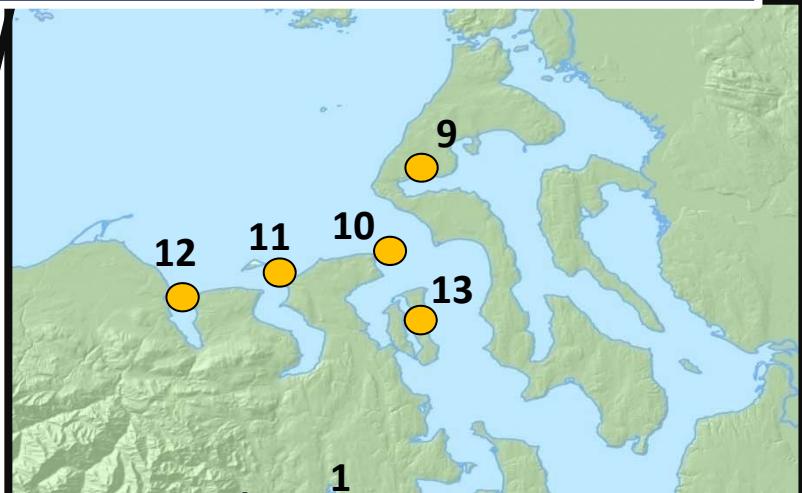
- Spring timing of large-scale toxic *Pseudo-nitzschia* bloom
- Simultaneous coastwide closures of shellfish harvest
- Unusual delivery of *P. australis* due more northward transport
- The Blob as an offshore incubator for toxic cells
- NO_3^- concentrations decreased in Blob water
- Surge uptake of upwelled nutrients by *P. australis* after they were delivered to the coast by storms
- Blob provided a natural experiment to simulate global warming

Phytoplankton monitoring: SoundToxins and ORHAB

- Weekly phytoplankton monitoring (24 sites)
- Shellfish and water collection during blooms.

Olympic Region HAB (ORHAB) Partnership

Partners include WDFW, WDOH, UW, Tribes



SoundToxins Partnership

Partners include NOAA, WA SeaGrant (co-leads), Taylor, Coast, Penn Cove & Seattle Shellfish, Tribes, UW, WSU, Evergreen College, volunteers

Collaborators



Olympic Region Harmful Algal Blooms
ORHAB PARTNERSHIP

SOUND
TOXINS



Acknowledgments

- NOAA CSCOR Event Response Funding, ECOHAB, MERHAB
- NOAA's Northwest Fisheries Science Center
- WDFW, WDOH, Tribal co-managers
- Cruise volunteers



Phytoplankton monitoring team, ORHAB

