Toward a Unified Understanding of Coastal Acidification Processes in Puget Sound

Cheryl Brown & Stephen Pacella (WED/ORD)

Rochelle Labiosa (Region 10)

The Seattle Times

Shellfish at risk: Puget Sound becoming acidified

The waters of Puget Sound and Hood Canal are becoming more acidified as a result of rising carbon dioxide from industries, power plants and vehicles. Scientists from the University of Washington and the National Oceanic and Atmospheric Administration warn that the shifting water chemistry could damage the region's shellfish industry.

The New York Times

Some See Clean Water Act Settlement Opening New Path to GHG Curbs

March 12, 2010

Los Angeles Times

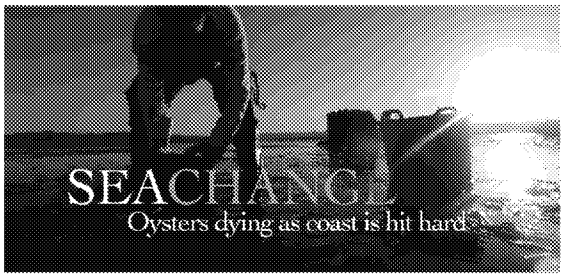
Oceans' rising acidity a threat to shellfish — and humans

By Kenneth R. Weiss, October 6 2012

The Seattle Times

Scientists have documented that sorting seas caused by CO_2 emissions are dissolving pteropods, a key routine food source. The research raises questions about what other sea life might be affected.

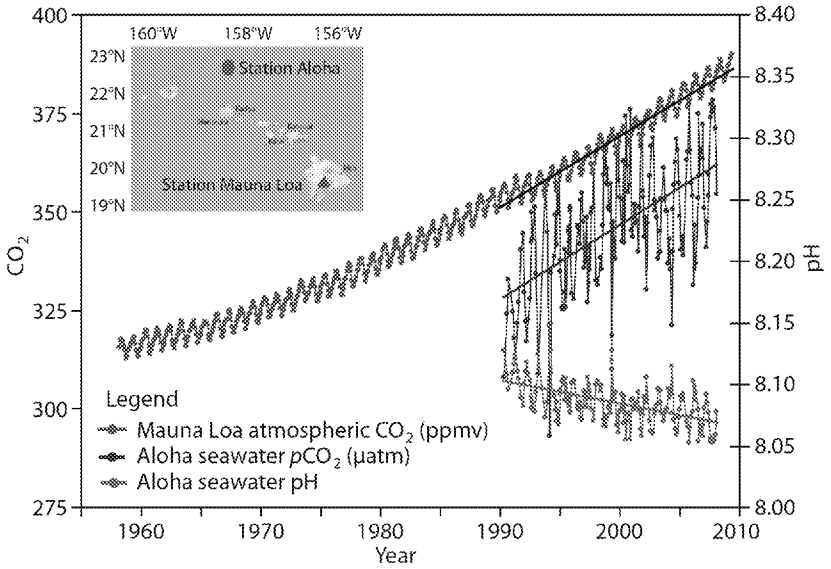
The Seattle Times



A Washington family opens a hatchery in Hawaii to escape lethal waters.

In January, we were happy to find out that our RARE proposal entitled "Toward a Unified Understanding of Coastal Acidification Processes in Puget Sound was funded" This is a one year study with Rochelle Labiosa at Region 10 is our technical contact.
So why are we doing this work?
Coastal acidification is emerging high priority issue in the region and has been the subject of recent litigation.
During the last 5 years, there has been a lot a press on the effects of ocean acidification in the coastal regions of Oregon and Washington.
The focus has been on acidification impacts on the shellfish industry and coastal foodwebs and this issue is resonating with the public.
Acidic conditions that were expected to occur until 2050 are regularly occurring along the west coast of the U.S, placing the west coast at the forefront of acidification research.

Ocean Acidification



Source: Doney et al. (2009)

So what is ocean acidification and why is it an issue?
As atmospheric carbon dioxide levels have increased, CO2 levels in seawater have risen, resulting in a decline of pH of about 0.02 units per decade in the open ocean.
Although this looks like a small change, pH is log base 10 scale so a change of one pH unit corresponds to a ten-fold change in hydrogen ion concentration .
This change in ocean chemistry reduces the availability of carbonate ions in seawater, which influences calcification of marine organisms with shells.

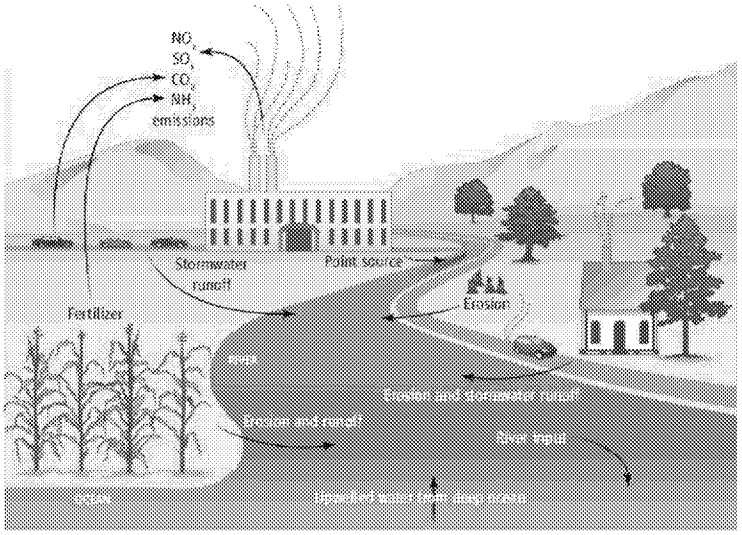
POLICYFORUM

OCEANS

Mitigating Local Causes of Ocean Acidification with Existing Laws

Even as global and national efforts struggle to mitigate CO_2 emissions, local and state governments have policy tools to address "hot spots" of ocean acidification.

R. P. Kelly,[1*†] M. M. Foley,[1*] W. S. Fisher,[2] R. A. Feely,[3] B. S. Halpern,[4] G. G. Waldbusser,[5] M. R. Caldwell[1]



Contributors to ocean acidification. In addition to global atmospheric CO_2, this figure depicts the major local (within 100 km) sources contributing to coastal ocean acidification.

"Local & state governments have both the authority and motive to address many stressors that drive or exacerbate acidification conditions"

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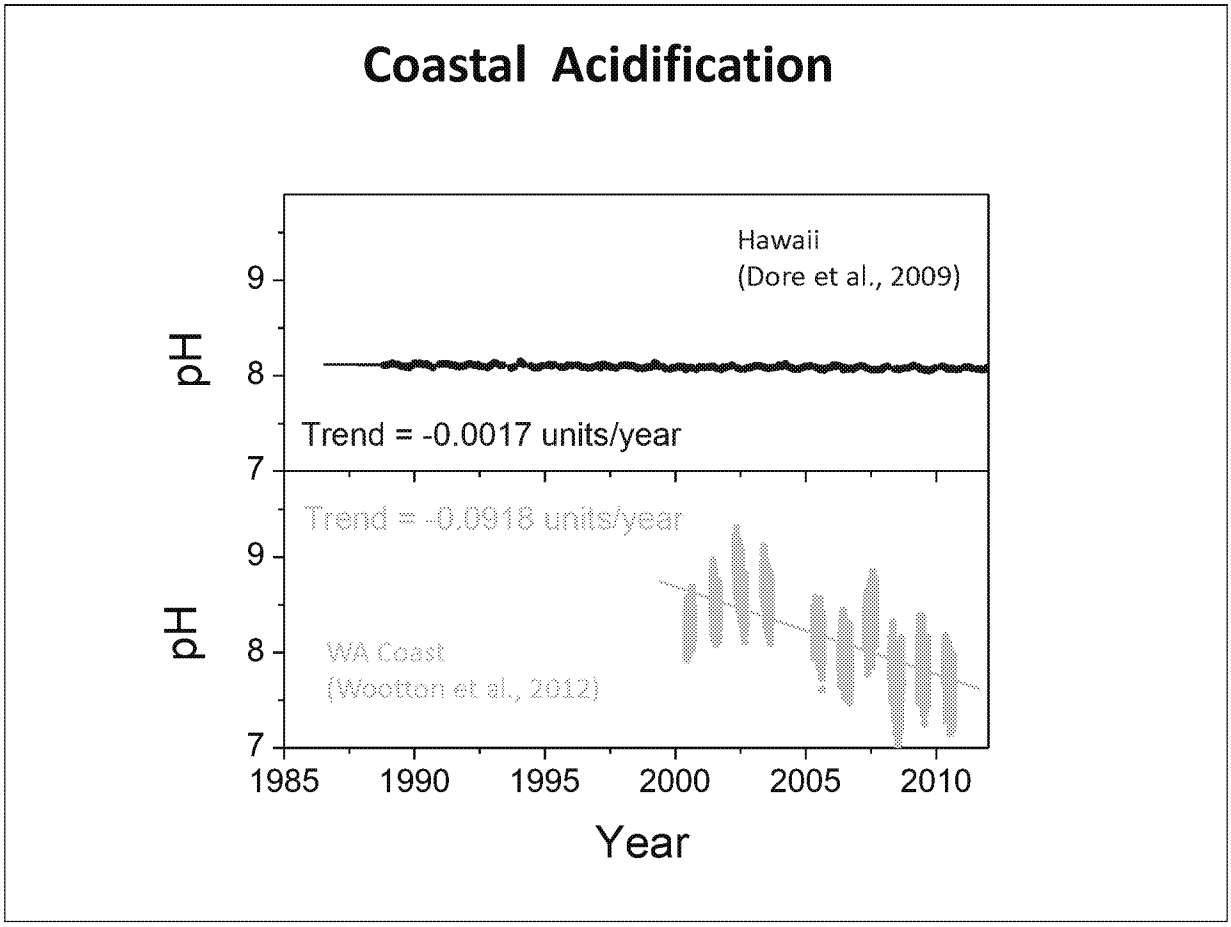
Clean Water Act

27 MAY 2011 VOL 332 SCIENCE www.sciencemag.org

Although increasing anthropogenic atmospheric CO2 inputs drive acidification at global scales, coastal and estuarine waters are also acidified by more local processes such as atmospheric emissions, point source inputs, non-point runoff as well as upwelling of deep water. These local factors can exacerbate the acidification. Although ocean acidification is a global problem, it is has been proposed that local and state governments have the authority to address many of the stressors that exacerbate acidification conditions through the clean water act.



This shows open ocean pH times series from Hawaii, showing the trend of about 0.02 pH units per decade.
The lower panel shows recent trend observed in the WA coastal region, near Tatoosh Island.
You can see that our coastal region is experiencing a much larger decline pH.
This is particularly evident if you plot the two times series at the same scale.
This Tatoosh Island dataset was actually the subject of recent litigation.
I provided technical support to Region 10 in trying to tease out the factors that are causing this observed rapid decline in pH.

Litigation Relevant to Coastal Acidification

May 2009: Center for Biological Diversity (CBD) sued EPA for failure to list WA coastal waters as impaired due to ocean acidification.
March 2010: Lawsuit settled.

Nov 2010: EPA acknowledged the seriousness of aquatic life impacts associated with OA.
2013-ongoing: EPA HQ convened a technical workgroup.

Oct 2013: CBD filed second lawsuit challenging EPA's approval of OR and WA 2010 303(d) lists.
Feb 2015: Judge upheld EPA's decision to not list as impaired due to OA.

States Petitioned to list coastal waters as impaired due to OA

2007: Alaska, California, Hawaii, Oregon, Washington
New York, New Jersey, Florida, Maine, Delaware
2009: Massachusetts, New Hampshire
2010: Texas
2011: Connecticut, Georgia, Rhode Island
2013: Oregon & Washington

2009: marine pH water quality standard (6. 5 to 8.5 for marine aquatic life, but not varying more than 0.2 units outside of the normally occurring range)
2013: Oregon's ocean waters do not attain water quality standards, including narrative criteria, biological criteria, dissolved gas standards, and antidegradation requirements. Accordingly, the State of Oregon was required to list each segment of Oregon's coastal waters, and in particular Netarts Bay, as threatened or impaired for failing to achieve one or more of Oregon's water quality standards

Research Goals

1. Characterize the variability of carbonate chemistry and oxygen dynamics experienced by a shellfish bed under oceanic and riverine influences.

2. Quantify the relative contributions of natural and anthropogenic nitrogen sources.

3. Quantify potential departures in magnitude, frequency, and duration of carbonate chemistry variability from natural conditions due to respiration driven by anthropogenic nutrients.

Project timeline:

- ☑ QAPP approved
- ☑ IAG with USGS – Menlo Park
- ☐ July Field Work
- ☐ November Field Work

Collaborators:

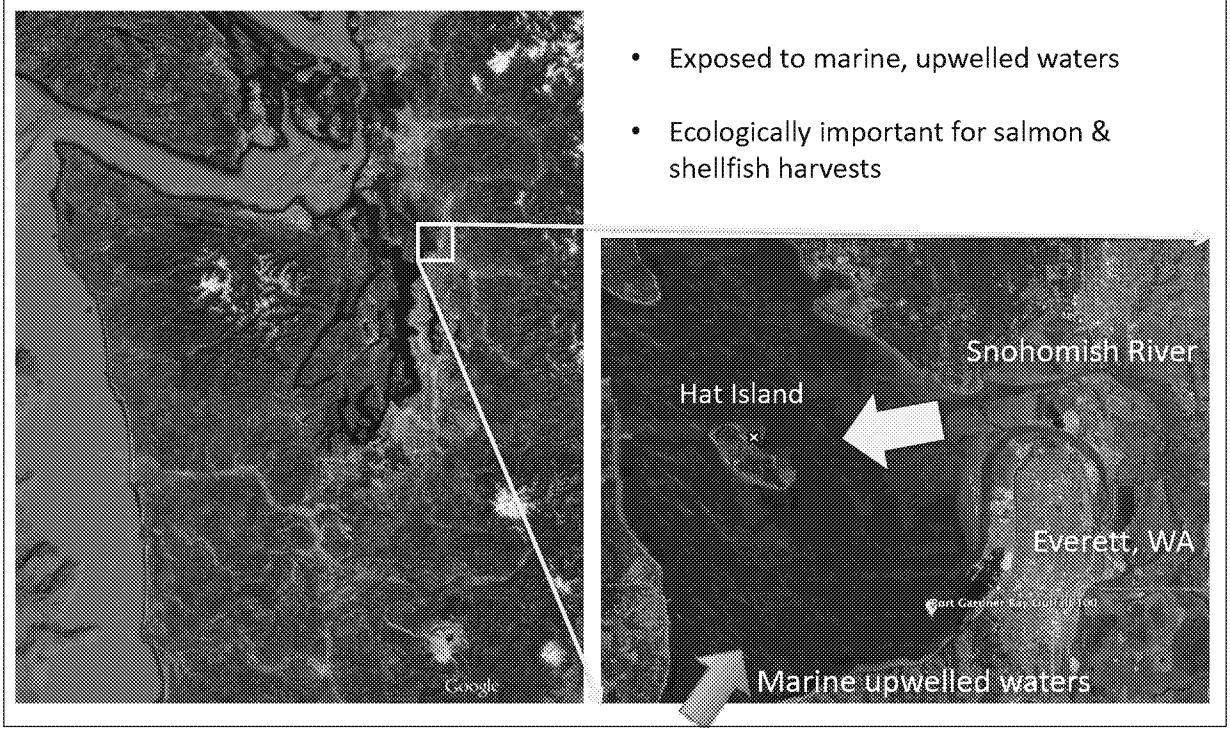
USGS – Menlo Park
Oregon State University
Tulalip Tribes
Washington Department of Ecology
Pacific Northwest National Laboratory

USGS science for a changing world

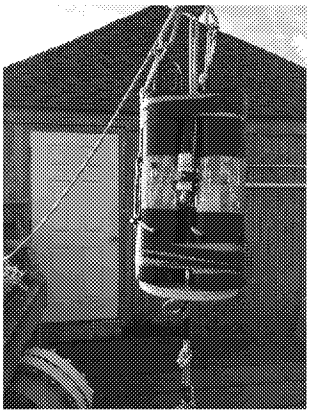
Oregon State University OSU

Study Site

- Large land-based nutrient inputs (river, agricultural and wastewater)
- Exposed to marine, upwelled waters
- Ecologically important for salmon & shellfish harvests



Methods



State-of-the Art Instrumentation:

- CO_2 and pH
- Nutrients
- Oxygen

Water quality cruises

End member sampling

Stable Isotopes

- Dissolved inorganic nutrients
- Dissolved inorganic carbon
- Dissolved organic matter
- Primary producers
- Shellfish

The link between nutrient delivery and carbonate chemistry variability will be made by tracing nutrients from distinct natural and anthropogenic end-members to the nearshore water column, and subsequent assimilation by nearshore primary producers, through isotopic analyses.

Products

- Techniques to separate relative contributions of land based and marine sources.
- Quantification of carbonate chemistry in shallow nearshore habitats.

Questions?
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